

# **WL-CSP**

# **Package Mount Manual**

This manual describes notes on using Epson WL-CSP products. It is the responsibility of the customer to optimize the process to obtain the desired results.

## NOTICE

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# Table of Contents

<b>1. Outline .....</b>	<b>5</b>
<b>1.1 WL-CSP Structure .....</b>	<b>5</b>
<b>1.2 WL-CSP Photo .....</b>	<b>5</b>
<b>1.3 WL-CSP Dimensions .....</b>	<b>6</b>
<b>1.4 Precautions for WL-CSP Handling .....</b>	<b>7</b>
<b>2. Soldering .....</b>	<b>8</b>
<b>2.1 Soldering for WL-CSP Package .....</b>	<b>8</b>
2.1.1 Reflow Soldering .....	8
2.1.2 Hot air soldering .....	9
2.1.3 Flip Chip Soldering .....	9
<b>2.2 Reflow Soldering Process flow .....</b>	<b>9</b>
<b>3. PCB Design Guide .....</b>	<b>10</b>
<b>3.1 Precautions for PCB Design.....</b>	<b>10</b>
<b>3.2 Land Pattern and Solder Resist Design, NSMD and SMD.....</b>	<b>10</b>
<b>3.3 PCB Land Size for WL-CSP .....</b>	<b>11</b>
<b>3.4 PCB Land Surface Treatment.....</b>	<b>12</b>
<b>3.5 PCB Warp.....</b>	<b>12</b>
<b>4. Solder Printing .....</b>	<b>13</b>
<b>4.1 Solder Paste .....</b>	<b>13</b>
<b>4.2 Stencil Design .....</b>	<b>14</b>
<b>4.3 Solder paste supply.....</b>	<b>15</b>
<b>4.4 Squeegee.....</b>	<b>15</b>
4.4.1 Polyurethane Rubber Squeegee.....	15
4.4.2 Metal Squeegee .....	15
4.4.3 Plastic Squeegee .....	15
<b>4.5 Solder Printing .....</b>	<b>16</b>
<b>5. Mounting.....</b>	<b>17</b>
<b>5.1 Precautions for Mounting WL-CSP.....</b>	<b>17</b>
5.1.1 Taking out from Carrier Tape or Tray .....	17
5.1.2 Mounting on PCB .....	17
<b>6. Reflow Soldering.....</b>	<b>18</b>
<b>6.1 Reflow Soldering Oven .....</b>	<b>18</b>
6.1.1 Preheating Zone.....	18
6.1.2 Reflow Zone .....	18
6.1.3 Cooling Zone .....	18
<b>6.2 Reflow Profile .....</b>	<b>19</b>
<b>6.3 Recommended reflow soldering conditions .....</b>	<b>20</b>
<b>7. Cleaning.....</b>	<b>21</b>
<b>7.1 Cleaning after WL-CSP Soldering.....</b>	<b>21</b>

<b>7.2</b>	<b>General PCB Cleaning .....</b>	<b>21</b>
7.2.1	PCB Cleaning .....	21
7.2.2	Cleaning Method .....	21
7.2.3	Water Cleaning .....	21
7.2.4	No Cleaning .....	21
<b>7.3</b>	<b>Others .....</b>	<b>21</b>
<b>8.</b>	<b>Rework .....</b>	<b>22</b>
<b>9.</b>	<b>General Precautions for Use of Semiconductor Devices .....</b>	<b>23</b>
9.1	Introduction .....	23
9.2	Storage .....	23
9.3	Design and Handling .....	23
	<b>Revision History .....</b>	<b>25</b>

## 1. Outline

WL-CSP \*1) (Wafer Level Chip Size Package) is a small, lightweight and dimension close to actual chip size package. WL-CSP is manufactured in wafer form, WL-CSP is then completed with just dicing saw. Although the production process of WL-CSP is simple, WL-CSP reliability is comparable to its equivalent conventional plastic package.\*2)

\*1) Epson naming convention for package name is "WCSP", but in this manual, "WL-CSP" is used according to the JEITA.

\*2) Because of the structure of WL-CSP, the load and impact resistance of WL-CSP are inferior to those of plastic packages, so please handle with care.

### 1.1 WL-CSP Structure

WL-CSP has a "stress relieving dielectric layer" (polyimide) on the IC chip's surface and follows by a copper "redistribution layer" (RDL). The purpose of this stress relieving dielectric layer is to relieve the stress to RDL from IC chip. One end of this RDL is connected to the electrode pad of the IC chip, and the other end is connected to the solder ball pad. Also, solder balls are mounted on the solder ball pads to form the external electrode terminals.

Since WL-CSP uses copper wiring in RDL, the impedance can be kept lower than the aluminum wiring in IC chip. In addition, there is some flexibility for the connections between the electrode pads of the IC chip and the solder ball pads. Therefore it is possible to customize the placement of the external electrode terminals.

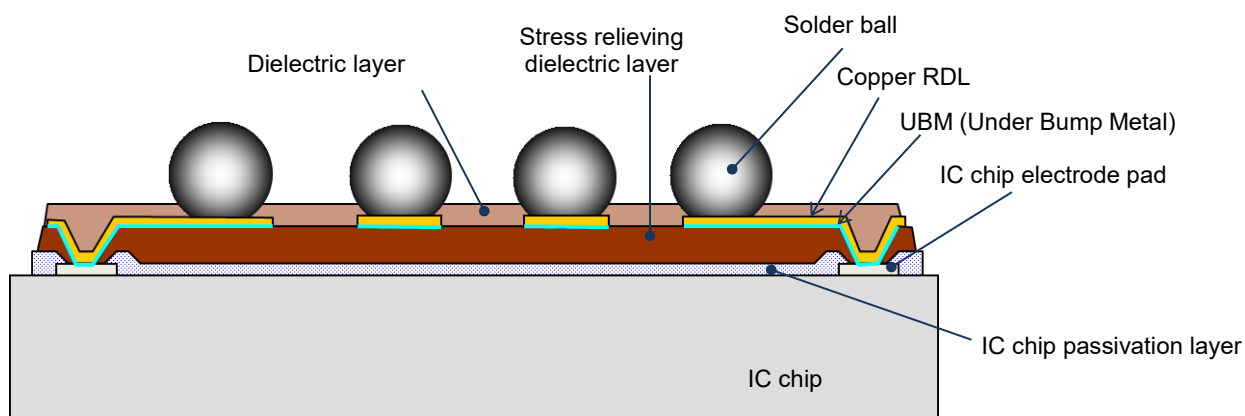


Fig 1.1 WL-CSP Structure

### 1.2 WL-CSP Photo



Fig 1.2 Package Top Surface

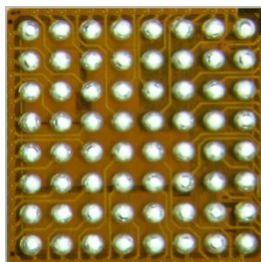


Fig 1.3 Package Bottom Surface (Solder Ball Side)

# 1. Outline

## 1.3 WL-CSP Dimensions

Table 1.1 (Reference) Standard Design Rule for External Terminals (WL-CSP)

\*1) Unit: mm

WL-CSP ball pitch *2)	Solder ball diameter before solder ball attach	WL-CSP land opening diameter (Cu2)	WL-CSP solder ball height *3)	WL-CSP solder ball diameter *4)
0.40	Nom. 0.22	Nom. 0.20	0.20±0.03	0.23±0.03
	Nom. 0.25	Nom. 0.20	0.23±0.03	0.26±0.03
0.50	Nom. 0.30	Nom. 0.25	0.27±0.03	0.31±0.03
0.65	Nom. 0.40	Nom. 0.40	0.32±0.03	0.44±0.03

\*1) It is customizable depending on the RDL layout and so on.

\*2) The repeated pitch of external electrode solder balls.

\*3) Measured from the surface of IC scribe line to the solder ball tips.

\*4) Solder ball diameter may differ depending on the thickness of the dielectric layer and the opening diameter of the WL-CSP's land.

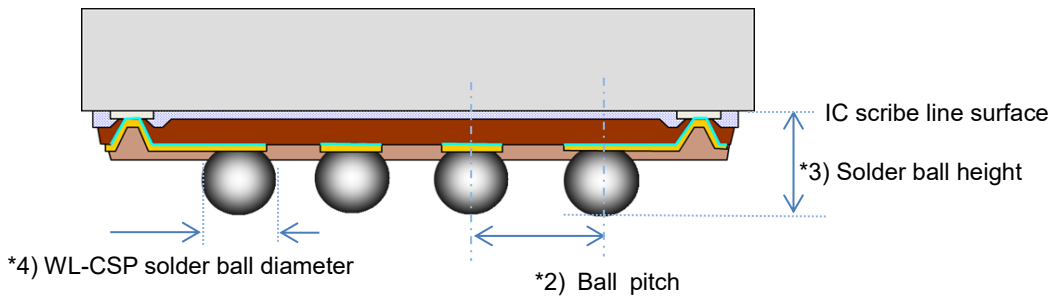


Fig. 1.1 WL-CSP Sectional View

Table 1.2 (Reference) Design Rule for WL-CSP Solder Ball Land \*1)

Unit:

mm

Dimension	Symbol	0.4mm pitch	0.5mm pitch	0.65mm pitch
Copper land diameter	Cu1	Nom. 0.22	Nom. 0.27	Nom. 0.42
Land opening diameter	Cu2	Nom. 0.20	Nom. 0.25	Nom. 0.40

\*1) Cu1 and Cu2 are for information only, they may be changed according to customer's PCB design.

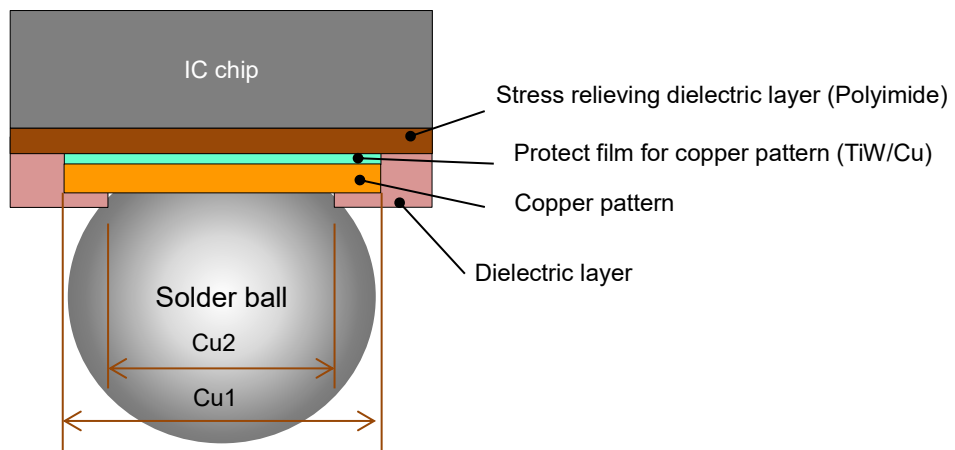


Fig. 1.5 WL-CSP External Terminal Sectional View

## 1.4 Precautions for WL-CSP Handling

The exposed IC chip (brittle material: Silicon) structure is to minimize the mounting footprint and height. WL-CSP is fragile compared to conventional plastic package with impact load applied. Therefore, please pay sufficient attention to the following items for WL-CSP handling.

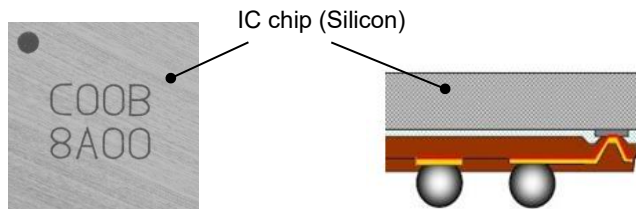


Fig 1.6 WL-CSP Top Surface

Fig 1.7 WL-CSP Sectional View

- (1) In pick and place process, please choose the suction nozzle to avoid contact to package edge.
- (2) In case of handling WL-CSP with tweezers, please avoid using metal tweezers. Please use vacuum or resin tweezers instead.
- (3) Due to strong mechanical vibrations, shocks and continuous stress during component pick and place, IC chip damage such as chipping, chip crack and so on, may occur. Therefore, please set the appropriate parameter on component mounter.
- (4) Light irradiation may change the IC's characteristics. To prevent IC from malfunction, consider following items for WL-CSP mounted PCB and product with WL-CSP.
  - > In product design and assembly, please include a shield to prevent light irradiation to WL-CSP.
  - > For testing, please use light-shielded environment.
  - > For effective light shielding for WL-CSP, please shield its surface, back, and side of the WL-CSP.

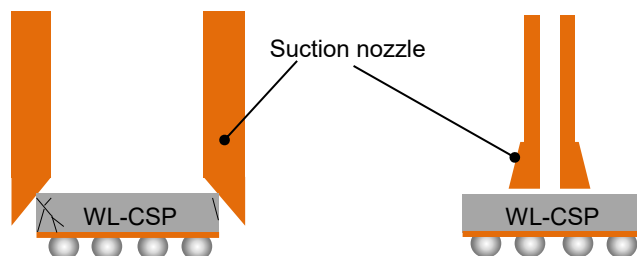


Fig 1.8 NG: End Face Suction

Fig 1.9 OK: Flat Surface Suction

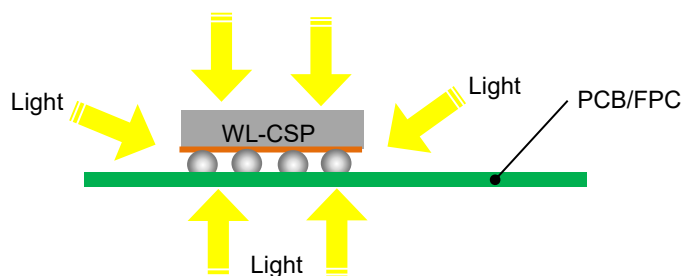


Fig 1.10 Light Irradiation to IC

## 2. Soldering

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## 2. Soldering

### 2.1 Soldering for WL-CSP Package

There are three soldering methods for surface mount device (SMD) such as WL-CSP, reflow, hot air, and flip chip method. Among those, a reflow soldering method is the most popular. Please refer to Section 2.2 for reflow method's detail.

To select the optimum soldering method, please take into consideration of customer's product, its purpose, mounted parts, mounting equipment, and so on.

Table 2.1 (Reference) Comparison of Soldering Methods

Method	Heating method	Soldering	Position accuracy after soldering
Reflow	Entire	All together	Medium
Hot air	Partial	One by one	High
Flip chip	Partial	One by one	High

#### 2.1.1 Reflow Soldering

The reflow process is as follows. Firstly solder paste is printed on PCB, then surface mount devices are mounted on the PCB, and then the PCB with SMD is soldered by the heat of a reflow oven. This technology is called "Surface mount technology" (SMT), and SMT is popular for SMD. Reflow heating methods include infrared (IR) method, hot air method (convection method), infrared (IR) hot air combined method, hot plate method and so on.

In the reflow soldering process, SMD soldering accuracy does not depend on SMD mounting accuracy. Soldering accuracy depends on solder self-alignment by the solder surface tension. \*1) Therefore, in PCB designing, it is necessary to design the land and PCB considering the characteristics of this self-alignment function.

For WL-CSP package soldering, the recommended method is hot air method or IR hot air combined method same as other area array packages. By only IR, solder balls on the bottom surface of the WL-CSP are hard to obtain enough heat for soldering, because IR might be blocked by silicon package body, especially for large size WL-CSP packages.

\*1) Solder self-alignment: Solder surface tension force during reflow soldering corrects a certain level of SMD mounting shift. Solder self-alignment depends on the solder surface tension force and package weight, so it works effectively to the light packages. However, solder self-alignment effect might not occur, when there is a huge offset between PCB land and WL-CSP solder ball.



### 2.1.2 Hot air soldering

Hot air method is a convection soldering method. Heat generated from a ceramic heater and so on is transmitted through the air to perform soldering. Heat propagation path is as follows: heater → hot air → component's surface → solder joint.

In the hot air method, it is possible to perform relatively uniform heating with nozzles close to the mounting board.

The heating time with hot air is about one second, and productivity is high for single component soldering. However, it is necessary to consider the interaction between the mounting component and the surrounding components, the influence on peripheral components and so on.

### 2.1.3 Flip Chip Soldering

This is another soldering method to mount a bare chip, including WL-CSP, on the PCB.

In the flip chip method, the bare chip is flipped and mounted directly to the electrode land on the PCB. It is possible to connect with high precision fine pitch alignment and no thermal stress for peripheral components. On the other hand, the cycle time from solder heating to cooling is long, so productivity is low for mounting multiple bare chips at the same time.

## 2.2 Reflow Soldering Process flow

The table below shows the typical and most regularly used reflow soldering process flow for WL-CSP package soldering.

Table 2.2 Reflow Soldering Process Flow

	Process	Material	Machine, Jig, etc.
1	<b>Printing</b> [Chapter 4]	PCB [Chapter 3] Solder paste [Section 4.1, 4.3]	Printing machine Stencil [Section 4.2] Squeegee [Section 4.4]
(2)	(Printing inspection)	-----	Inspection unit SPI
3	<b>Mounting</b> [Chapter 5]	SMD WL-CSP, Chip components, Connector, etc.	SMD mounter
4	<b>Reflow soldering</b> [Chapter 6] Preheating [Section 6.1.1] Reflow [Section 6.1.2] Cooling [Section 6.1.3]	PCB after SMD mounted.	Reflow oven Reflow profile [Section 6.2] N2 gas
5	<b>Cleaning</b> [Chapter 7]	PCB after soldering.	Cleaning machine Cleaner
(6)	(Function test)	-----	In-circuit tester
(7)	(Visual inspection)	-----	Inspection unit AVI

\* For details of each process, please refer to the explanation page.

(2), (6) and (7) are the inspection process, so the explanation is omitted.

### 3. PCB Design Guide

## 3. PCB Design Guide

### 3.1 Precautions for PCB Design

There are two types of PCB mounting pad, Non-Solder Mask Defined (NSMD) and Solder Mask Defined (SMD).

In general, it is said that the solder joint strength of NSMD is higher than that of SMD, because solder joint exists not only land pattern surface but also land pattern side wall in NSMD. But sometimes solder printability for SMD is better than that for NSMD because of printing parameter and/or stencil design. So please select NSMD or SMD according to the application.

Also, in order to obtain stronger WL-CSP solder joint strength, customers can reinforce the solder joint between WL-CSP and PCB by using epoxy type underfill after soldering.

### 3.2 Land Pattern and Solder Resist Design, NSMD and SMD

In NSMD, land size is defined by the land pattern size. In SMD, land size is defined by the solder resist opening size.

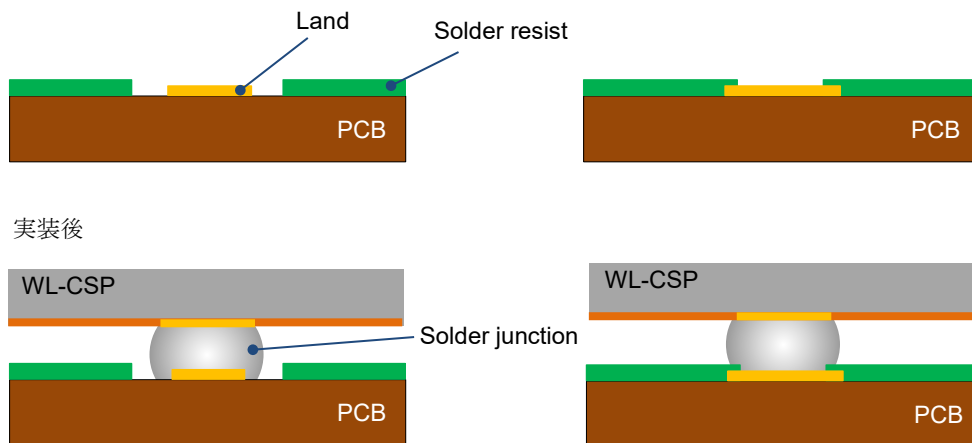


Fig. 3.1 NSMD Sectional View

Fig. 3.2 SMD Sectional View

Table 3.1 (Reference) Joint Strength Comparison of NSMD and SMD

Joint strength between land and PCB *1)	NSMD $\leq$ SMD
Joint strength between land and solder *2)	NSMD $\geq$ SMD

\*1) As the land pattern is covered by solder resist, joint strength between land and PCB of SMD is higher than that of NSMD.

\*2) As solder covers not only land pattern top surface but also land pattern side wall, joint strength between land and solder of NSMD is higher than that of SMD.

### 3.3 PCB Land Size for WL-CSP

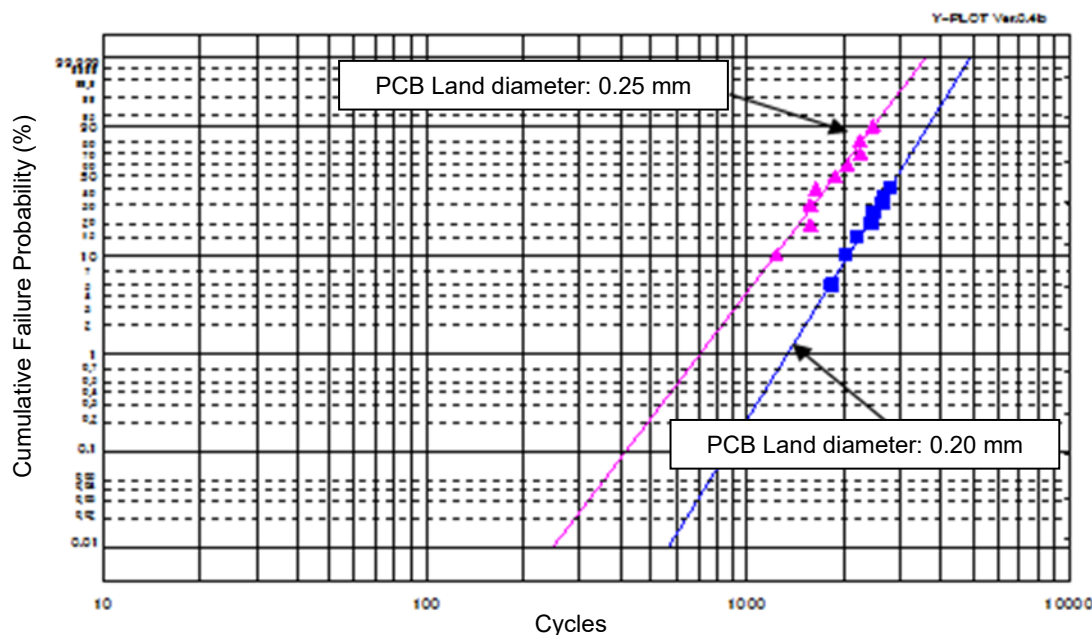
Typically, it is better to design the land diameter of PCB equal to that of the WL-CSP for better stress relaxation. However, in the evaluation for NSMD land in Epson, better board level reliability result was obtained, when the ratio of the land diameter of PCB to the land diameter of WL-CSP was 1:0.8.

The optimum land diameter may depend on the customer's mounting conditions and PCB. PCB land diameter within the range of 0.8 to 1.0 of the land diameter of the WL-CSP is recommended.

Please decide the PCB land structure and the PCB land dimension based on the evaluation results of joint strength, reliability, mounting property, solder paste printability and so on.

Table 3.2 (Reference) PCB Land Diameter Unit : mm

Ball pitch	WL-CSP	PCB	
	Land diameter	NSMD Land diameter	SMD Land diameter
0.40	0.20	0.16 - 0.20	0.20
0.50	0.25	0.20 - 0.25	0.25
0.65	0.40	0.32 - 0.40	0.40



Temperature cycle test: -40°C ↔ +125°C  
 WL-CSP: 2.5mm<sup>2</sup>, 16pin, Pitch 0.5mm

Ratio of land diameter 1:0.8“■”; WL-CSP land diameter 0.25mm vs 0.20mm PCB land diameter (NSMD)  
 Ratio of land diameter 1:1.0“▲”; WL-CSP land diameter 0.25mm vs 0.25mm PCB land diameter (NSMD)

Fig 3.3 (Reference) Reliability Test Result:  
 Ratio of Land Diameter: WL-CSP land Diameter vs PCB Land Diameter  
 (The Weibull plot based on Epson evaluation)

### 3. PCB Design Guide

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#### 3.4 PCB Land Surface Treatment

Leaving PCB in the atmosphere might oxidize the land surface of PCB, and this oxidation may affect the solder wettability during soldering. It is better to use protective film coating or plating to prevent this oxidation. In general, Organic Solderability Preservatives (OSP) and Ni/Au plating are used for PCB land surface oxidation prevention treatment. Therefore, the adoption of these treatments is strongly recommended.

#### 3.5 PCB Warp

Solder connection between the component and the PCB may not be obtained, or the solder joint reliability may be adversely affected, if the warp of the PCB is large during reflow and after reflow. In the PCB designing, please select the material with high warpage resistance, and equalize the ratio occupied by the conductor on each layer of the PCB.

Additionally, in PCB components layout design, please do not place SMD including WL-CSP near the place with stress concentration during soldering and actual use. Stress concentration places are, for example, in the vicinity of switches and connectors, on the backside of switches and connectors, and the movable part such as the hinge.

## 4. Solder Printing

### 4.1 Solder Paste

Solder paste consists of solder particles, flux, surfactant, thixotropic agent and so on. Since there are many kinds of solder paste, for each solder paste it is necessary to determine the reflow temperature profile individually.

The composition and size of the solder particles in the solder paste are determined depending on the application, mount land pitch and so on. Solder paste with narrow particle distribution has better soldering stability.

Full attention is required for selecting the particle size of solder paste. Smaller solder particle tends to have surface more oxidation during storage, printing, and reflow. This may lead to “head-in-pillow” failure and worsen the solder wettability.

As Epson standard, Sn-3.0Ag-0.5Cu solder ball is used for external terminals of WL-CSP. However, sometimes other composition solder ball is used depending on the customer’s requirement, so please check each product specification and confirm the solder paste compatibility.

Additionally, please refer to the above and select a suitable solder paste based on the result from sufficient evaluation of solder wettability, the state of generation of intermetallic compounds and so on.

Table 4.1 (Reference) Solder Paste Structure

Component	Function
Solder particle	As the solder particles melt and the solder wetting progresses, the solder particles in solder paste and the solder balls of WL-CSP melt together uniformly. As a result, electrical connection and mechanical joint strength are obtained after cooling.
Flux	Flux reduces the oxide film on each terminal surface, and prevents re-oxidation of the solder surface during reflow heating, and accelerates molten solder fluidity.
Surfactant	The surfactant is added in a small amount to mix the flux, solder, and other components uniformly.
Thixotropic agent	Thixotropic agent is added to the solder paste to keep the shape of the solder paste after printing and to hold the mounted components.

Table 4.2 (Reference) Solder Melting Point

Solder paste composition	Melting temperature (°C)		
	Solidus	Peak temperature *1)	Liquidus-line
Sn - 3.0Ag - 0.5Cu	217	219	220
Sn - 1.0Ag - 0.5Cu	217	219	227
Sn - 3.5Ag - 0.75Cu	218	219	219

\*1) Peak temperature: Temperature at the maximum heat absorption point of DSC curve.

## 4. Solder Printing

### 4.2 Stencil Design

Since the design of the stencil greatly affects the SMT process quality (solderability, standoff, solder bridge and so on), proper stencil design is necessary. The volume and stability of solder paste to be transferred to PCB is determined by the design of stencil specifications, such as stencil thickness, opening size for solder filling, planar shape, and cross-sectional shape.

In typical solder printing process, to obtain the stable solder paste transfer volume, stencil property such as small physical variation material and excellence stencil releasing after solder printing should be selected. Also, when mounting multiple SMDs, special attention is required on designing for printing stencil due to optimum solder paste volume and thickness that might be different in each component.

Excessive or insufficient, and unstable of solder paste might occur, if the selection of stencil property and design are incorrect. This causes defective solder joint. Stencil selection and design based on the sufficient evaluation of mounting and soldering are necessary.

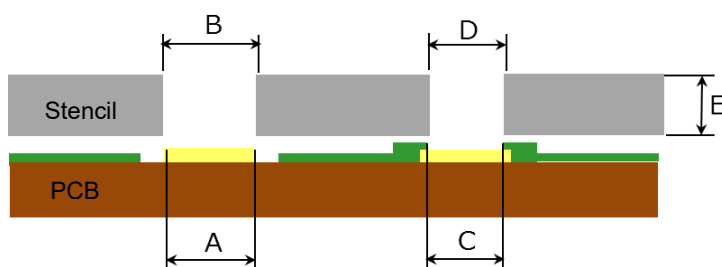


Fig. 4.1 Sectional View of Stencil and PCB

Table 4.3 (Reference) Stencil Design

Unit : mm

Ball pitch	PCB land diameter A (NSMD) , C (SMD)	Stencil opening diameter B , D	Stencil thickness E
0.40	0.16 - 0.20	0.16 - 0.24	0.10 (Reference)
0.50	0.20 - 0.25	0.20 - 0.30	0.10 (Reference)
0.65	0.32 - 0.40	0.32 - 0.48	0.10 (Reference)

\*) The ratio of stencil opening diameter for the PCB land diameter is 1:1 to 1:1.2.

Table 4.4 (Reference) Failure Mode Caused by Solder Paste Printing

Solder paste printing condition	Main failure mode
Excessive solder paste	<ul style="list-style-type: none"> <li>&gt; Solder bridge</li> <li>&gt; Solder ball scattering</li> <li>&gt; Component tilt/lifting</li> </ul>
Insufficient solder paste	<ul style="list-style-type: none"> <li>&gt; Solder no joint</li> <li>&gt; Solder bad wetting</li> <li>&gt; Head-in-pillow</li> </ul>

### 4.3 Solder paste supply

Solder paste should be stored under supplier's recommended conditions and use solder paste within supplier's guaranteed life time. Once the container is opened and the solder paste is exposed to the environment, please use solder paste under supplier's warranty conditions and recommended conditions.

Please refer to general precautions for using the solder paste below.

- > Please open the solder paste container after the temperature of solder paste reaches to near room temperature.
- > Please stir solder paste 10 to 20 times by spatula, or please print a trial printing several times after supplying adequate solder paste on the stencil.
- > Please don't return solder paste once used for printing to the original container. Please discard it.

### 4.4 Squeegee

As there are various types of the squeegee, please select the optimum according to the PCB, solder paste and printing machine.

Table 4.5 (Reference) Squeegee Material Comparison

Squeegee material	Use for uneven surface	Amount of printed solder	Stencil life	Squeegee life
Polyurethane rubber	◎	△	◎	△
Metal	△	◎	△	◎
Plastic	△	◎	○	○

\*) Above is the relative comparison in general. (◎: Excellent, ○: Good, △: Acceptable)

#### 4.4.1 Polyurethane Rubber Squeegee

By using polyurethane rubber as the squeegee material, it is possible to extend the lifetime of the stencil, but there is a tendency that the volume of printed solder paste becomes lesser than expected.

By using this type squeegee on the uneven PCB, it is possible to obtain good solder printing.

#### 4.4.2 Metal Squeegee

By using metal material as the squeegee material, it is good for printed solder paste volume, but it tends to shorten the lifetime of the stencil.

By using this type squeegee on even PCB, it is possible to obtain good solder printing.

#### 4.4.3 Plastic Squeegee

By using plastic material as the squeegee material, it is possible to keep the amount of printed solder equivalent to that of the metal squeegee and to extend the lifetime of the stencil, but the lifetime of the squeegee itself is inferior to the metal squeegee.

## 4. Solder Printing

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### 4.5 Solder Printing

Solder paste is printed on the PCB solder connection land designated for mounted components including WL-CSP. In general, solder paste is filled in the stencil hole with a squeegee, and transferred to the required position, with the required thickness through a stencil separation process.

In order to achieve good quality of solder paste printing, solder paste handling, printing machine maintenance and setting, such as stencil clearance, printing pressure, and squeegee speed are important. Particularly, solder paste property varies depending on the environment such as temperature, humidity, atmospheric convection and so on, it is necessary to pay attention to those environmental factors.

After solder printing, please complete the solder reflow process as soon as possible by following solder paste supplier recommendation.



## **5. Mounting**

WL-CSP is to be mounted on the land where the solder paste is printed. For WL-CSP mounting, please use general component mounting equipment, SMD mounter.

In the reflow soldering method, the final components accuracy after reflow soldering does not reflect the components mounting accuracy. The shift of alignment in components mounting process, to some extent, is corrected by the self-alignment during reflow soldering process. Therefore, please mount the components within the range where the position can be corrected by self-alignment.

Firstly small chip components such as ceramic chip capacitor and so on should be mounted. Then the large components such as QFP and so on should be mounted last. Please decide the mounting order in consideration of the size of the mounting components and WL-CSP.

### **5.1 Precautions for Mounting WL-CSP**

Please follow the items in section "1.4 Precautions for WL-CSP Handling", and also take note of the items below.

#### **5.1.1 Taking out from Carrier Tape or Tray**

Please be careful not to apply excessive load or impact during component pickup. Also, please do not press the WL-CSP strongly with parts suction nozzle and so on. WL-CSP package chipping and/or cracking may occur.

#### **5.1.2 Mounting on PCB**

When mounting WL-CSP on the PCB, it is necessary to push the WL-CSP into the printed solder paste on the PCB land appropriately. However, excessive loading and/or pressing may cause the solder bridge failure between WL-CSP solder balls and the solder ball scattering failure, due to the solder paste collapse.

Impact and pressing beyond the limit may result in the breakage of WL-CSP package and deformation of solder balls. Therefore, please decide the mounting parameters after sufficient evaluation.

## 6. Reflow Soldering

## 6. Reflow Soldering

### 6.1 Reflow Soldering Oven

The outline of the reflow soldering oven that is generally used for SMD soldering is as follows. The reflow oven has the following temperature zone arrangement, and it is necessary to set optimum temperature profile and circumstances for each zone.

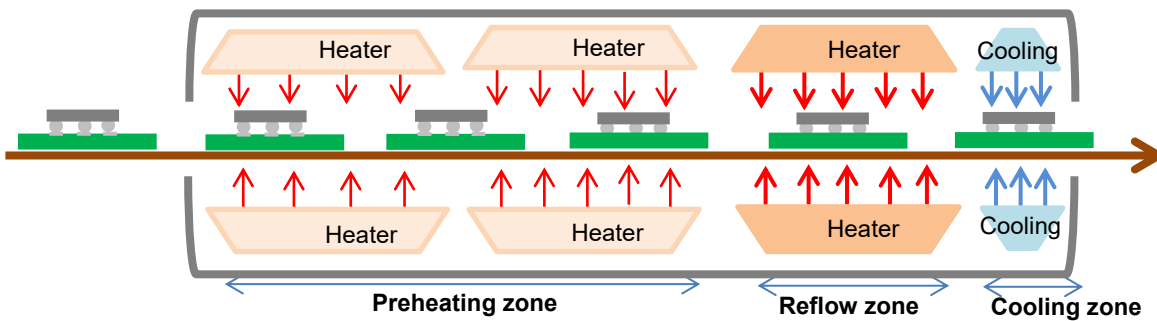


Fig. 6.1 Sketch of Reflow Soldering Oven

#### 6.1.1 Preheating Zone

PCB and mounted components are preheated in the preheating zone. Temperature is from about 140 degrees to about 200 degrees in general.

The purpose of preheating is to equalize the temperature of components with various heat capacity mounted on the PCB, to relieve the sudden thermal shock stress to the components, to activate the flux, and to vaporize the organic solvent, in order to obtain stable solder joints.

#### 6.1.2 Reflow Zone

Temperature is then raised to the solder melting point, in general from 220 degrees to 260 degrees, for a short duration.

As the solder melting point depends on the solder composition, the reflow temperature for lead-free solder must be higher than that for conventional lead solder. However, when the reflow heating temperature becomes higher, oxidation will be accelerated, and the wettability tends to become worse. For stable soldering, in order to prevent accelerated oxidation at high temperature, it is necessary to keep the oxygen concentration low.

Also, lead-free reflow profile may not be suitable for some components mounted at the same time. Heatproof guarantee temperature of some components may bring down lead-free reflow profile temperature. Therefore, it is necessary to confirm the heatproof temperature of each component beforehand.

#### 6.1.3 Cooling Zone

Although natural cooling is common, it is recommended to cool down rapidly in order to release the mounted components from the thermal stress quickly and to obtain a thin and uniform intermetallic compound at the solder joint.

## 6.2 Reflow Profile

The figure below shows the reflow temperature profile for typical lead-free solder, Sn-Ag-Cu alloy solder. The temperature of the soldering position of the mounted components during reflow soldering is affected by the following. The structure of mounted components (for example, area array package or peripheral package), surrounding components layout, components position in the PCB, mounted components density and its heat capacity will affect the temperature. Therefore please verify the temperature profile at multiple solder joint positions on the PCB.

When setting reflow profile by the customer, please refer to the recommended reflow profile from solder paste supplier, check the temperature profile by using actual reflow soldering oven and actual PCB, and set the optimum temperature parameter.

In general, reflow heating under nitrogen environment is highly recommended because this gives a better result of soldering stability and wettability.

For Epson WL-CSP, please refer to “6.3 Recommended Reflow Soldering Conditions”.

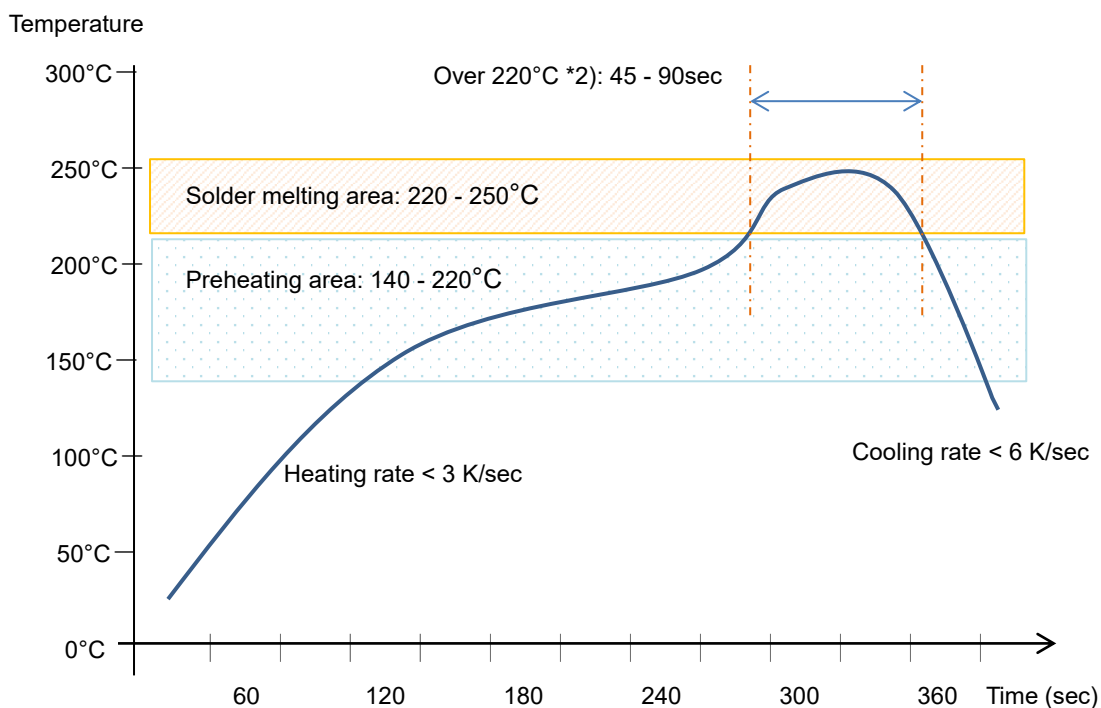


Fig. 6.2 (Reference) Typical Reflow Temperature Profile \*1)

\*1) Reprint from “JEITA ET-7407B Fig. 3 Sn-3.0AG-0.5Cu”. About detail, please refer to JEITA standard.

\*2) Allowable soldering temperature and soldering time depends on the components and the packages.  
Please check the specification of components and packages.

## 6. Reflow Soldering

### 6.3 Recommended Reflow Soldering Conditions

This package is the surface mount device (SMD).

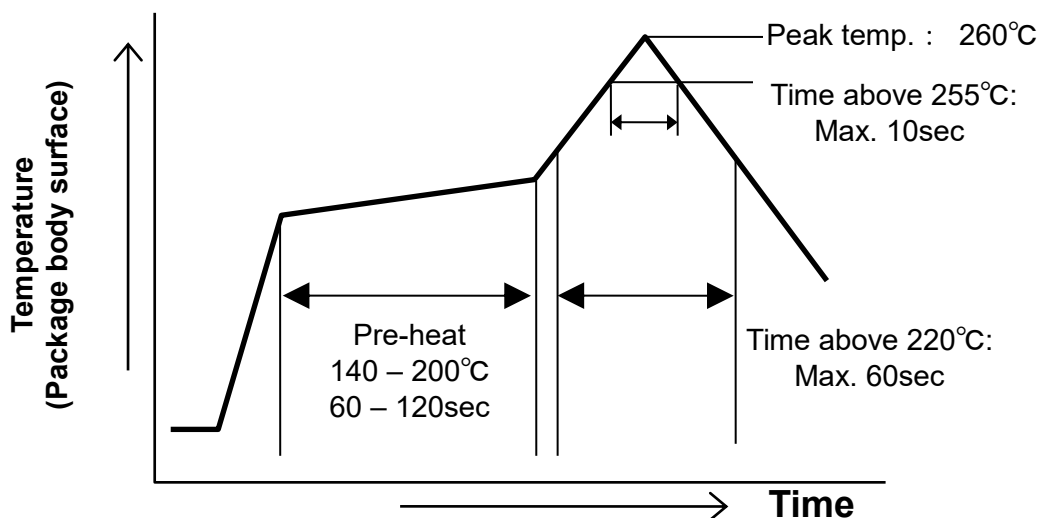
The resistance to soldering heat of SMD depends on storage conditions, soldering methods, and soldering conditions.

Please solder packages according to the following conditions.

#### Recommended storage conditions

	Conditions	Time
Before opening dry pack:	$\leq 30^{\circ}\text{C} 85\% \text{RH}$	1 year
After opening dry pack:	$\leq 30^{\circ}\text{C} 70\% \text{RH}$	1 year

#### Recommended reflow profile



This package should be soldered with IR reflow, full convection, or IR/convection.

The allowable number of time with the reflow is max 2 times. This must be done in the above-mentioned condition (after opening dry pack).

Nitrogen reflow is recommended to inhibit the effects of oxidation and improve wettability.

\* Hand soldering using a soldering iron should be performed under the following conditions:

<Temperature: less than 350 °C, Time: less than 5 sec, Times: twice or less>

Pay sufficient attention not to let a soldering iron contact any parts other than leads.

(Storage rank: MSL2)

Fig 6.3 Recommended Reflow Soldering Conditions

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## 7. Cleaning

### 7.1 Cleaning after WL-CSP Soldering

Since WL-CSP standoff \*1) is very narrow after soldering, it is very difficult to remove the solder paste flux residue between the WL-CSP and the PCB. Solder paste that does not require cleaning after soldering is recommended.

Also, when selecting the solder paste that requires cleaning, cleaning condition need to be decided after detail discussion with solder paste supplier.

\*1) Standoff: The distance between WL-CSP mounted PCB surface and WL-CSP package bottom surface.

### 7.2 General PCB Cleaning

#### 7.2.1 PCB Cleaning

The flux residue after PCB production process may cause the leakage or migration between terminals. These may affect the reliability. Cleaning is effective in removing flux sticking on the components and connection terminals that require flux cleaning. Also, cleaning is effective in removing scattered solder balls that occurred during reflow soldering. If “no-clean solder” is not used, it is still recommended to perform flux cleaning after reflow soldering.

#### 7.2.2 Cleaning Method

Standard cleaning methods for PCB include immersion cleaning, ultrasonic cleaning, spray cleaning, vapor cleaning and so on. Hot water immersion ultrasonic cleaning is widely used. Regarding detail cleaning method, please follow the recommendation from solder paste supplier and cleaning fluid supplier.

#### 7.2.3 Water Cleaning

In case of using water-soluble solder paste, in order to prevent moisture absorption, it is necessary to control the staging time between solder paste printing and components mounting and reflow soldering. Regarding operation time management, please follow the recommendation from solder paste supplier.

#### 7.2.4 No Cleaning

For eliminating “Cleaning process” after reflow soldering, it is necessary to check the effect of halogen content, especially chlorine content, in flux and to use solder paste with less flux residue. Before “no cleaning” is implemented, please check that the solder is “no-clean solder” type and perform mounting evaluation and reliability test by using actual PCB.

### 7.3 Others

- (1) Cleaning time should be short, and the cleaning temperature should be as low as possible.
- (2) Please be sure to check the quality (effect on the terminal) after cleaning.
- (3) If water adheres and remains on the WL-CSP terminal after cleaning, there is a risk of causing troubles, so please perform drying treatment thoroughly.
- (4) Please evaluate the influence by cleaning agent, diluent, water and pure water on the PCB and mounted components thoroughly. Influence by acid, alkali, organic solvent and water should be considered as well.

## 8. Rework

### 8. Rework

Reuse of the WL-CSP that is removed from the PCB after reflow soldering will void the warranty. Please do not reuse the removed WL-CSP.

Also, in case of re-mounting new WL-CSP on the PCB from which the old WL-CSP is removed, please perform soldering of new WL-CSP after cleaning the PCB surface and reapplying new solder paste.

The method of removing mounted WL-CSP is as follows. Use a dedicated jig for removing the components, and remove the WL-CSP by melting solder connection while locally heating by high-temperature air. Before heating the WL-CSP, preheat the WL-CSP area and its surrounding. Preheating reduces the high-temperature heating time required for removal and minimizes the distortion and the deformation of the PCB.

Additionally in case of PCB rework and reuse, please check the influence of damage, deformation, reliability and so on of the PCB thoroughly by the customer.

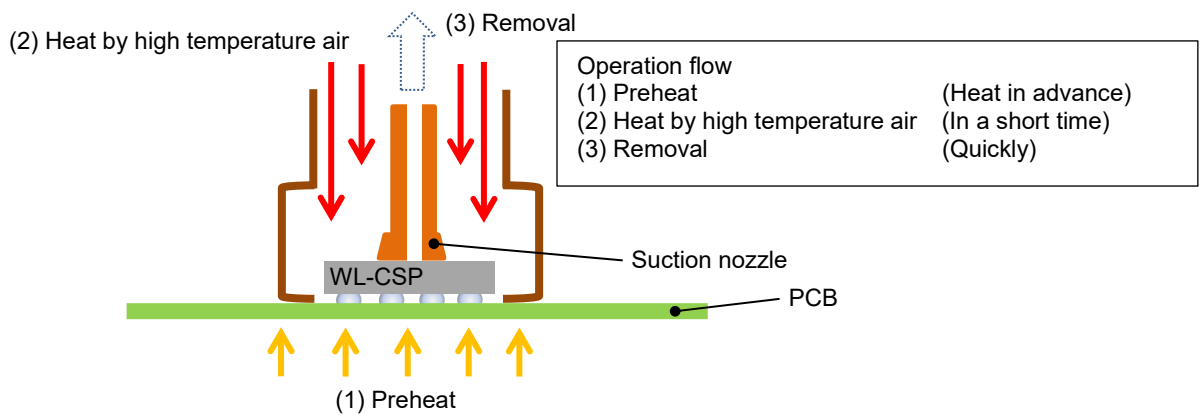


Fig 8.1 (Reference) Sketch of BGA Rework

### 9. General Precautions for Use of Semiconductor Devices

Please follow the precautions of our semiconductor products mentioned below. For details on WL-CSP, please also check the notes mentioned in each chapter in this document.

#### 9.1 Introduction

Epson's semiconductor devices are designed and manufactured to assure trouble-free operation when used under normal operating conditions. Also, all products are subjected to stringent electrical and mechanical testing to ensure reliability. However users are strongly recommended to observe the following precautions when designing systems, handling or storing devices to minimize the chance of failure.

#### 9.2 Storage

- (1) Take care so that packages are not subjected to impact, vibration or water leakage.
- (2) Do not store and use the product under the environment in which moisture condensation may be formed due to rapid changes in temperature. Also, please do not apply the load to the products during storage.
- (3) When storing, avoid dusty locations and corrosive gases.
- (4) Before opening the moisture-proof bag, please make sure that the moisture-proof bag is not broken or scratched. Also, check the silica gel in the bag has not absorbed moisture, after the bag is opened.
- (5) When using after a long term of storage, use after confirming that terminal discoloration, solderability deterioration and so on, does not occur.

#### 9.3 Design and Handling

- (1) Use ICs within the rated ranges of operating voltage, temperature, input/output voltage and current. Devices may sometimes work properly for a short period of time even when used outside of rated ranges, but their failure ratio may increase. Even within the rated conditions, failure ratio will change depending on the operating temperature and voltage of embedded systems. This must be fully considered when designing systems.
- (2) When the noise such as spark and electrostatic is given from the input terminals, IC may malfunction. Pay sufficient attention in product designing. Electromagnetic can cause ICs to operate erratically. Shield all interference sources in equipment that uses ICs.
- (3) Excessive electrical noise occurred to the power, input or output pin can cause ICs to Latch-Up, resulting in device malfunction or damage. If this occurs, turn off the power, solve the problem, then supply power again.
- (4) Although all pins are equipped with an anti-electro static circuit, electro static beyond the capacity may lead to breakage. Take appropriate countermeasures for ESD when handling ICs.
- (5) Avoid using packing and transporting containers made of plastic, use electrically conductive containers. Also, special care must be taken when handling ICs, by wearing an antistatic wrist strap or taking other possible measures.
- (6) Use a soldering iron and test circuits without high voltage leakage and use them with grounding.
- (7) Storage conditions after opening a moisture-proof bag, soldering method and soldering temperature must meet the requirements specified by Epson for respective products.
- (8) Minimize mechanical stress to a printed circuit board during or after soldering.
- (9) As for a surface mount device, the land of a PCB and the lead of a package will be soldered with those both surfaces in contact. Although Epson ships the products securing sufficient lead flatness for soldering, when handling, take care not to apply the force which leads to deformation of the lead.

## 9. General Precautions for Use of Semiconductor Devices

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- (10) Use the IC under the proper temperature and humidity. The humidity must not be more than 85% with no dew condensation. In the environment where the IC is directly exposed to acid gas such as SO<sub>2</sub>, or exposed to dust or salt, it may cause electrical leakage between leads or corrosion. In order to prevent such problems, in the above environment, apply corrosion-proof coatings to PCB and ICs.
- (11) Avoid the following as much as possible, since mechanical vibration, shock, continuous stress, sudden temperature change and so on, may cause package cracks and/or wire breakage.
- (12) In some packages, a part of the signal line is exposed on the surface of the package. Pay attention to contamination of the package when using these products. Also avoid handling products with bare hands.
- (13) Light irradiation to ICs may cause the characteristics change of IC. To prevent IC from malfunction, consider following points for IC mounted PCB and IC used products.
  - > In product design and assembly, consider the product structure so that IC (especially IC chip) is shielded from light in actual use.
  - > In the testing process, provide the light-shielded environment for the semiconductor device under test.
  - > Regarding the light shielding of IC, consider the light shielding for the surface, back, and side of IC chip.



## Revision History

Attachment-1

<b>Rev. No.</b>	<b>Date</b>	<b>Page</b>	<b>Category</b>	<b>Contents</b>
Rev 1.0	2018/09/26	All	New	New release.



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