Precautions on Mounting

Package mounting methods can be broadly classified into two methods. One is the flow solder mounting method, and the other is the reflow solder mounting method. In this section, the reflow soldering mounting method for mounting surface mount type packages will be explained.

1 Selection of mounting materials

1.1 Printed wiring board design

1) Desirable conditions for printed wiring boards

Since surface mounting is high density and the semiconductor device bodies as well as the printed wiring board will be directly subjected to high stress during the processes, printed wiring boards which will minimize the load transferred from the printed wiring board to the semiconductor device bodies as much as possible should be selected.

Printed wiring boards with higher performance than in the past for characteristics such as heat resistance, moisture resistance, dimensional change ratio, warpage, dimensional accuracy, etc. are desired.

2) Warpage and heat for surface mounting

Among the various conditions mentioned in the previous paragraph, let's consider the problems of warpage and heat. In conventional mounting, the heat of soldering is blocked by the printed wiring board, so that the semiconductor device body on the opposite side is not greatly affected. But in surface mounting, the semiconductor device body is subjected to high temperatures, and directly receives heat stress. In addition, since the semiconductor device body is adhered directly to the printed wiring board, warpage or shrinkage due to the soldering becomes stress applied directly to the semiconductor device body or poles (See Figure 6.6).

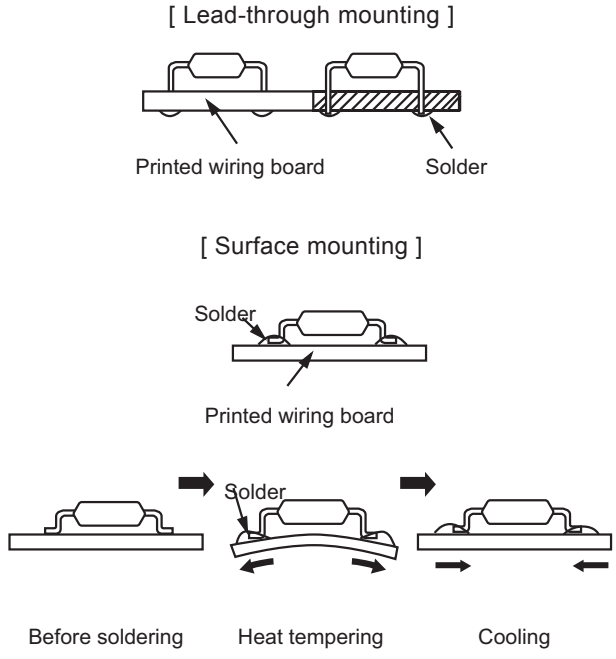


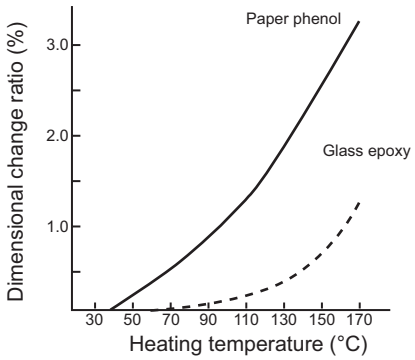
Figure 6.6 Warpage and Heat During Surface Mounting

3) Printed wiring board selection

The important point for surface mounting is to greatly minimize the stress due to this heat and warpage. In order to do so, printed wiring board material which has the minimum possible dimension change ratio or warpage due to external stress is desirable. Figure 6.7 shows comparison data for glass epoxy material and paper phenol material commonly used in consumer products.

Although it would be ideal to use 1.6 mm-thick glass epoxy material, its high cost cannot be avoided, and actually paper phenol material is widely used. In this case, consideration must be given to greatly minimizing the heat stress and reducing printed wiring board warpage during the mounting processes.

Relationship between heating temperature and dimensional change



Relationship between external stress and warpage

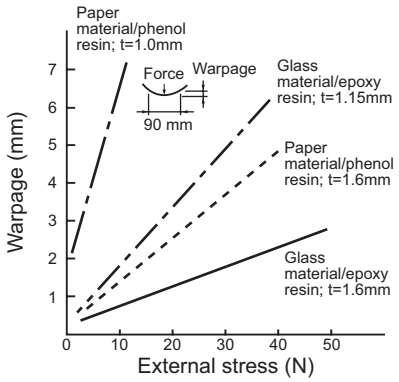
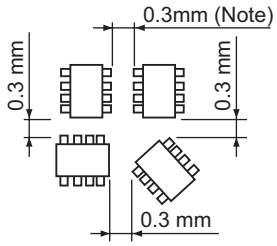


Figure 6.7 Dimensional Change Ratio and Warpage for Printed Wiring Board Materials

4) Mounting density and package spacing

Since the main purpose for surface mounting is to achieve high-density mounting, fine patterns are also desired in designing the printed wiring board. However, if the package spacing is too tight, incidences of solder bridging will of course increase. Considering the three factors of the positioning accuracy of the mounting equipment, dimensional variations in the printed wiring boards, and the external dimensions of the packages, using a minimum spacing dimension of at least 0.3 mm is safer (See Figure 6.8).



Note: Land dimension spacing is greater than 0.3 mm

Figure 6.8 Minimum Spacing Dimensions between Packages

5) Solder resist region

One point in soldering semiconductor devices is that the amount of solder on both sides be uniform. If there is excessive solder on one side, there will be differences in the hardening time, resulting in stress toward the side with more solder. It is necessary to use solder resist to separate the solder and keep the solder amounts on uniform when attaching semiconductor devices or when semiconductor devices and lead-equipped components use the same land.

6) Layout of semiconductor devices

Faults may occur due to how the semiconductor devices are laid out. In SOP type flow soldering, in order to avoid insufficient solder wetting, it is better to arrange the leads so that they are parallel to the solder flow (See Figure 6.9). When laying out semiconductor devices near easily bent sections of the printed wiring boards or separation grooves, the devices should be laid out so that the received stress is uniform for both poles; in other words, the effects of stress are reduced when the component poles are arranged perpendicular to the separation grooves or bending line.

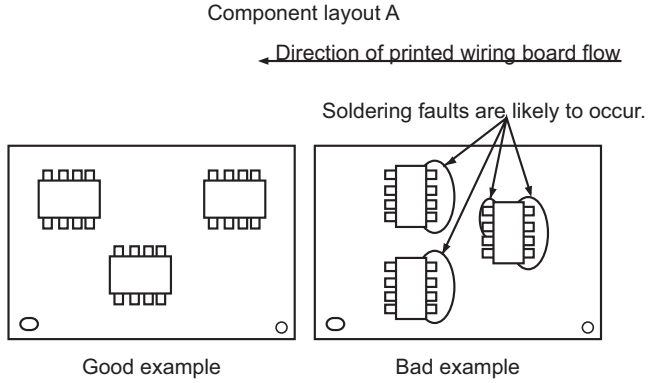


Figure 6.9 Semiconductor Device Layout

1.2 Selection of solder material

During selection, the following points should be considered.

1) Desired performance before reflow

(a) Has suitable viscosity for application

(b) Maintains the applied shape

(c) Good adhesive power to semiconductor devices or their leads

(d) Minimal change in adhesive characteristics over time

2) Desired performance during/after reflow

(a) Good soldering characteristics

(b) Low incidence of solder balls

(c) Composition which inhibits increases in temperature

3) Cleaning characteristics

The flux in the solder should be a non-halogen flux which will enable cleaning of remaining flux without leaving remnants and which will also not adversely affect reliability if some remnants do remain.

4) Environmental factors

Previously, virtually all solder was Sn-Pb solder, but since Pb is a hazardous hazardous substance, its use is restricted. (2006, RoHS restrictions)

For lead-free solder (solder which contains no Pb), currently the following compositions are used.

Examples of lead-free solder:

Reflow system: Sn-Ag-Cu type, Sn-Ag-Bi-In type, Sn-Zn type, etc.

Flow system: Sn-Cu type, Sn-Ag-Cu type, etc.

(For reference) Semiconductor terminals: Pd plating, Sn-Bi plating, Sn-Ag-Bi dipping, etc.

When selecting lead-free solder, care should be taken to prevent the peak reflow temperature from becoming high. Care must be taken since the ratio of crack occurrence in the semiconductor device packages will increase if the peak temperature increases.

1.3 Selection of adhesive

Adhesives can be broadly classified as UV-hardening acryl polyester materials and heat-hardening epoxy materials, and there are various combined UV-/heat-hardening types. It is necessary to select the adhesive according to production performance, such as the application method, viscosity, hardening temperature/time, pot life, etc., but generally, the following points should be considered:

1) Quick hardening at as low a temperature as possible
2) No adverse effects on electronic components already mounted on the reverse side
3) High viscosity with superior heat resistance after hardening for the soldering process
4) Long pot life and easily stored
5) No stringiness during printing and little sagging after printing
6) Since some will remain even after soldering, no corrosiveness

1.4 Selection of cleaning agents

After soldering, washing off of flux is recommended. If flux remains, halogen ions in the flux may cause corrosion of metal.

Due to environmental problems such as global warming due to the destruction of the ozone layer, the use of flon 113, 1-1-1 trichloroethane, etc. is restricted, and there are shifts to the following cleaning agents:

1) Alcohol-based cleaning agents

Ethanol, methanol, isopropyl alcohol (IPA), high-grade alcohol-based cleaning agents

2) HCFC substitute flon-based agents

AK-225AES (Asahi Glass) etc. Since the use of HCFC substitutes will become prohibited in the future, sufficient consideration must be given.

3) No cleaning through the use of non-halogen flux

When using no-wash flux, since it contains virtually no halogens which may cause corrosion, there is virtually no risk of residue causing fatal flaws in devices. However, residue may cause leakage between pins, resulting in device operation malfunction or damage.

In addition, since there are also products which contain much non-ionic halogenated materials, caution is necessary. Be sure to perform evaluation of the reliability characteristics of each mounting method, and verify whether or not washing can be performed.

2 Processes prior to mounting

2.1 Lead shaping/cutting process

Before mounting semiconductor devices on the printed wiring board, the external leads must be bent, shaped, and/or cut. During this process, if stress is applied to the device body, damage such as leads breaking off or disconnection of internal wiring may occur, which reduces reliability. In particular, there may be large effects on the seal characteristics of the border between the external leads and the package for hermetically sealed types or on the moisture resistance for plastic sealed types. Although no problems may occur at that point, the service life may be reduced. Therefore, care should be given to the following points during lead processing:

1) When bending external leads, fix the base of the lead in place before bending the lead so that no stress is applied to the device body (See Figure 6.10).
2) Bend the leads at a distance of at least 2.5 mm from the base of the lead. Also, keep the bend angle to within 90 degree and make the bend radius at least 0.75 mm. In addition, do not bend the leads toward their thicker side (See Figure 6.11).
3) The pulling stress along the axis of the lead wires and the bending strength are specified according to the lead diameter or cross-sectional area. Do not apply loads which exceed these specified values.
4) Depending on the shape of the forming jig, the jig may cause damage to the plating surface on lead wires, reducing reliability. Be careful when using such jigs.

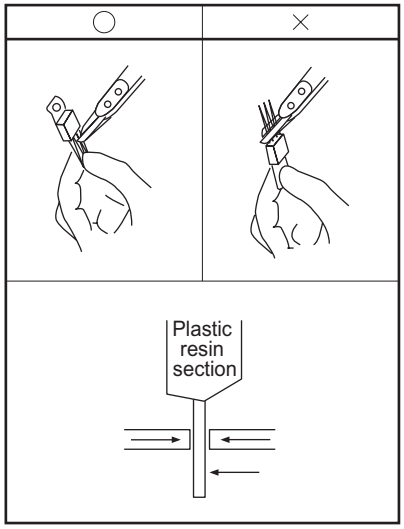


Figure 6.10 Bending External Leads

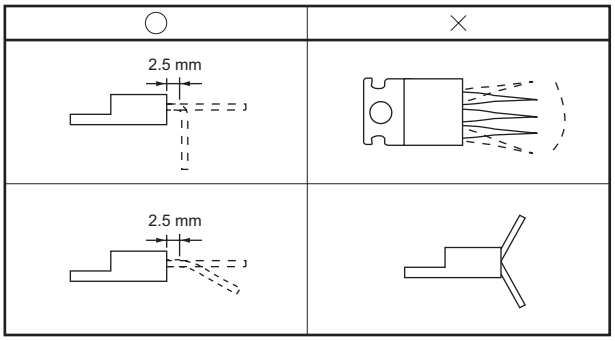


Figure 6.11 External Lead Bending Positions

2.2 Precautions with moistureproof packaged products

1) Do not open moistureproof packages until just before mounting. After opening, use the enclosed products as soon as possible.
2) Keep the temperature and humidity of the storage location before the package is opened to within the range of T_a = 5°C to 30°C and 30%RH to 70%RH (For image sensors, T_a = 0°C to 30°C.) The storage period in the moistureproof package is 1 year from the date of shipment from our company.
3) After opening the moistureproof package, in order to prevent condensation, moisture absorption by package, and oxidation of leads, store the products at T_a = 5°C to 30°C and 30%RH to 70%RH. (For image sensors, T_a = 0°C to 30°C. For Hologram Units, T_a = 5°C to 35°C and 45%RH to 75%RH.)
4) Some packages have a limited storage period after opening the moistureproof package. For information on the storage period, refer to the product specifications.
5) After opening the moistureproof package, if the specified storage has been exceeded or if the indicator of the dehumidifying agent at the time of opening the package has changed to pink, perform baking before mounting. Baking conditions depend on the type of package and the packaging form.
   The packaging material of taped products, however, is not heat resistant. For this reason, taped products should not be subject to high-temperature baking without peeling off the tape. For details, refer to Sec. "6.3.2 Precautions on storage", or consult our company's sales division.
6) Taping materials and stick materials are not heat-resistant. Therefore, perform mounting within the specified time, or, if it is forecast in advance that the specified time will be exceeded, store the products in a dry box or in a packaging environment equivalent to the moistureproof package (Temperature: Room temperature; Relative humidity: 30% or less.) or lower.
7) To prevent oxidation of the leads, perform baking only once.

2.3 Precautions when using semiconductor products

Please avoid impacts such as drops to the floor when the product is handled.

The radical material might crack and be lacked.

Further, be careful that strong mechanical stress is not applied to the package. For thin packages, since the mold is thin, if strong stress is applied the package or elements may be damaged.

In addition, since electrostatic discharge damage, deterioration of solderability, corrosion between electrode wiring, etc. may occur if products are touched with bare hands, be sure to be sufficiently careful when handling products.

Read the following items and handle the products with caution.

- ◆ Static electricity may cause incidence of break down, dysfunction, or malfunction to the product.
- ◆ Rough handling such as scratching, cracking, or breaking the product may lead to dysfunction and malfunction.
- ◆ Handling the product with your bare hands or saliva or perspiration from human body may result malfunction of the outer electrodes and wires.
- ◆ Environments containing high humidity, dust, or harmful gases (hydrogen chloride, sulfurous acid gas, or hydrogen sulfide) may cause deterioration of the soldering characteristics of the external electrodes.

3 Mounting process

3.1 Mount

Since the thickness of surface mount packages is thin and they are very susceptible to force from above or below, do not press against them excessively with the suction nozzle (chuck). If the lower dead point for the suction nozzle is set incorrectly, it may result in problems such as deformation of the leads or cracking of the chip. Even for packages of similar thickness and height, they may be slightly different depending on the semiconductor manufacturer, etc. Perform settings while checking the product specifications.

3.2 Applying solder to printed wiring board (for reflow soldering)

1) Cream solder and application method

Methods for applying cream solder include screen printing, using dispensers, or using a metal mask. However, along with the increasing complexity of solder application, the use of a metal mask has become more and more common. Also, when selecting cream solder, select the appropriate one according to the application method and circuit wiring density.

2) Precautions with using cream solder

(a) Perform suitable preheating depending on the substrate size, flux type, etc.

(b) Manage the land dimensions and solder resist printing accuracy. (To prevent defects, such as deviation from the right position, check whether solder is uniformly applied to the electrode, etc.)

(c) Maintain the proper printing thickness for any lead pitch, lead width, pattern, etc. For details, refer to Sec. “6.5.4.2 Precautions with LGA (C-CSP/L-CSP) and BGA packages”.

(d) Do not apply vibrations to the printed wiring board after mounting the semiconductor devices.

(e) Complete the reflow process within 5 to 7 hours (to prevent deterioration of the cream solder.) after applying solder

3.3 Soldering

1) Soldering method

Soldering of semiconductor devices can be broadly classified as flow soldering and reflow soldering. In addition, reflow soldering can be further classified into full-body heating or partial heating.

- ◆ Flow soldering solders together with lead-equipped components in a single process, and is suitable for mass production.
- ◆ Reflow soldering enables high-accuracy soldering through the use of cream solder, but care must be taken with the infrared radiation system for temperature control. In addition, to overcome the faults of the infrared radiation system, recently the system combining the infrared radiation system and hot air flow and the hot air flow system only have been mainstream. We recommend these systems.
- ◆ Using a laser beam or light beam causes little thermal stress and enables precise soldering, making it suitable for multi-pin LSI mounting (See Table 6.6).

Table 6.6 Soldering Methods for Semiconductor Devices

Method	Heat source	Features	Evaluation			
			Productivity	Soldering accuracy	Temperature accuracy	Thermal stress
Flow	Wave solder	Enables soldering with lead-equipped components in a single process	○	×	○	×
Full-body heating reflow	Infrared radiation	Heating of entire body with beam radiation	○	○	×	△
	Infrared radiation and hot air flow	Temperature control is relatively easier.	○	○	○	△
	VPS	Uniform steam heating to 215°C	○	○	○	○
	Hotplate	Heat conductance reduces stress.	△	○	△	○
Partial heating reflow	Laser/ light beam	High-accuracy spot heating	×	○	○	○

2) Soldering temperature profile

Since surface mounting applies drastic temperature variations directly to the bodies of semiconductor devices, sufficient care must be taken with temperature control, especially for solder.

In flow soldering, a maximum temperature of 260°C for 3 to 5 seconds is common. The soldering time for the doublewave method is the sum of the two waves.

In reflow soldering, the optimum temperature should be set considering the mounting condition. If there are large and small components are mixed, the mounting temperature should be set particularly carefully. For example, considering a lead pin with a large heat capacity, the optimum temperature should be set for each component so that all the components can be soldered properly. While checking whether there is an SMD with a small heat capacity on the same board, carefully set the temperature so that the package surface temperature cannot exceed the recommended range. Note that even if the temperature of the solder joint area rises to the soldering possible point, the temperature of a large package main body may still be low because of its large heat capacity.

Examples of soldering temperature profiles are shown in Figure 6.12. Also, please check with the sales division of our company as to whether or not the semiconductor device you are investigating is compatible with Pb-free solder.

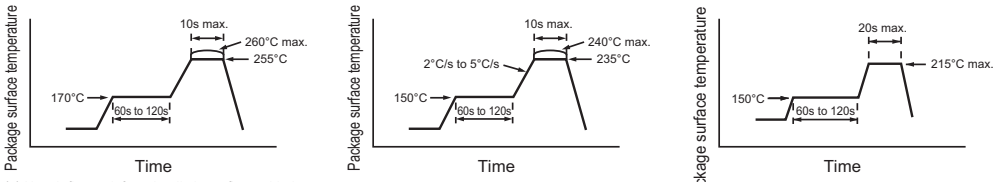


Figure 6.12 Examples of Soldering Conditions

3) Common recommended conditions for soldering

Recommended conditions for soldering semiconductor devices vary according to each semiconductor device.

In our company, we carry out soldering heat resistance tests in accordance with the JEITA standard so that we can ensure the soldering heat resistance of semiconductor devices. Regarding the large packages with a large heat capacity, JEITA specifies the soldering temperature for each package volume and thickness. This is because as a package is enlarged, the package has a larger heat capacity and the package main body cannot be easily heated.

For details of the test method, refer to Table 2.8 shown in Sec. "2.2.3 Reliability test method".

The heat resistance of devices depends on the product. For details, refer to the delivery specifications. Table 6.7, however, shows the recommended soldering conditions for mounting standard devices. Note that Table 6.7 does not show the solderability guarantee temperatures, but only shows the heat resistant temperatures of devices.

Table 6.7 Standard Recommended Soldering Conditions for Mounting

Soldering method		Reflow soldering (for Pb-free compatible products)	Flow soldering	Soldering iron
Recommended soldering conditions	Temperature	260°C max.	260°C max.	350°C max.
	Time	255°C or more, within 10 sec	Single: Within 5 sec Double: Within 10 sec	Within 3 sec
Preheating before soldering	Temperature	150°C to 180°C	—	—
	Time	60s to 120s	—	—

3.4 Multiple cycle reflow

There are some products for which multiple cycle reflow cannot be recommended. Since it is different for each product, when using the product, check the receiving specifications or consult our company's sales division.

3.5 Cleaning

1) Since flux remaining on printed wiring boards on which semiconductor devices have been installed is not desirable in terms of moisture resistance and corrosion resistance, it is recommended that cleaning be performed.
2) When performing cleaning using ultrasound, if the output is set too high, the strength of external electrodes may be reduced or problems due to resonance may occur. Be careful so that these do not occur (See Table 6.8).
3) Worrying about cleaning is not necessary for rosin flux in which the amount of chlorine is low.
4) Flon-based agents or chlorine-based agents cannot be recommended from an environmental aspect.

Table 6.8 Example of Ultrasound Cleaning Conditions

Frequency: 28 kHz to 29 kHz (no resonance with devices)
Ultrasound output: 15 W/ℓ
Vibration source shall not directly touch the devices or the printed wiring board.
Time: 30s or less

5) The petroleum solvent may cause degradation of adhesive between hologram lens and package. Therefore, the use of these solvents should be avoided.

In addition, ultrasonic cleaning should be avoided because this hologram is a hollow device, and also please pay attention to brushing the surface of hologram lens not to damage the surface.

4 Precautions with special packages

4.1 Precautions with power device packages

Power loss at the connections during operation of the device is always accompanied by an increase in temperature. Since it is necessary that the connection temperature be below the rated maximum temperature during use, how much of a margin to provide for use is an important point in designing system reliability.

Particularly for power devices, since the cases in which they are used at temperatures close to the rated temperatures due to large power losses, suitable heat sink designs are important. In order to reduce the increase in heat, heat sinks are attached. At this time, since the dimensional accuracy of the attached parts and the attachment method have a great influence on thermal characteristics and mechanical stress, which can cause malfunctions or reduced service life, sufficient care must be taken regarding the following points:

1) Thermal grease

Since the use of thermal greases when attaching the heat sink to the power transistor can reduce the contact thermal resistance to the levels of $R_{th\,(j\text{-}c)}$ shown in Table 6.9, it is often used. For metal-sealed devices, this was not a problem but for plastic-sealed power transistors, it is necessary to use care when selecting the thermal grease to use.

Table 6.9 Examples of Contact Thermal Resistance and Insulation Plate Thermal Resistance

Shape	Presence/absence of insulation plate	$R_{th(c\text{-}f)}$ (°C/W)			
		Grease applied		Grease not applied	
TO-126	No insulation plate	0.5	—	1.0	—
	Mica (100 µm)	—	3.0	—	6.0
TO-220 (SC-46)	No insulation plate	0.4	—	1.7	—
	Mica (100 µm)	—	2.3	—	5.0
TO-220 Full pack	No insulation plate	—	2.3	—	4.5
TOP-3 Full pack	No insulation plate	—	0.6	—	1.5

If a highly oil-separated grease is used, the stress of the power cycle, etc. may result in faults such as partially disconnected wires after a relatively short time. The reason for this is that the silicon oil which forms the base oil of thermal grease separates out and penetrates into the inside of the transistor through gaps between the plastic resin and the fins or lead frame, and swells the junction coating resin (JCR), increasing the stress on the connection base of the Al or Au electrode lead wires and causing them to be disconnected.

Because of this, it is necessary to select a thermal grease which has low oil separation and which is based on silicon oil which does not swell JCR easily. For example, G-746 (Shin-Etsu Chemical Co., Ltd.) and YG-6260 (Toshiba Silicone Co., Ltd.) are recommended.

2) Mounting heat sink of package

When attaching the heat sink of power packages to the chassis, etc., attention should be paid to the tightening torque of the attaching bolts and to the flatness of the attachment surface.

Do not bend, cut deform, or bend the mounting pins of the heat sink. Also, avoid applying solder directly to the heat sink.

When attaching the heat sink, since if the mounting brackets or positioning tabs (projections) are in contact with the plastic areas of the product, cracks may occur and mechanical stress may be applied internally, resulting in element breakage or disconnection faults, care must be taken with the attachment methods.

Regarding the hole diameter of the attachment surface, it should be determined taking into consideration the screw head diameter and the overlapping of insulation tubes, insulation plates, etc.

[Tightening torque]

If the tightening torque is too low, the heat resistance will be high, and the heat emission effectiveness will be poor. On the other hand, if the torque is too high, it may cause warpage of elements or apply stress to the semiconductor chips inside the package, causing element breakage or disconnection.

Since the recommended tightening torque, mounting hardware etc. are different for each package, refer to the product specifications or contact our company's sales division.

Further, when tightening at two or more points, be careful to tighten all points equally so that no warpage is applied to the elements.

[Flatness]

The purpose of attaching power transistors to the chassis, etc. is to enable the efficient transfer of the heat generated by the elements to the heat sink. In order to achieve this, the attachment surface of the transistor must be sufficiently smooth. If the surface roughness is high, or if there are burrs or metal chips, dirt, or other foreign materials stuck to the surface, not only will the heat sink be damaged, but the elements may also be damaged. Therefore, be sure to keep the surface flatness to 0.05 mm or less and the surface twist to 20 μm or less.

When the mounting plate such as a chassis is a pressed plate, be sure that there is no press burrs or bending, and be sure to smooth the surface of the screw holes. In addition, since if gaps occur between the product and the attachment surface, heat emission efficiency may be poor, when attaching the heat sink, be sure to check that the mounting plate or the product are not deformed.

3) Attaching to the printed wiring board

Do not attach heat sinks to the elements after soldering lead wires to the printed wiring board. Attaching heat sinks to the elements after soldering the leads to the printed wiring board will cause excessive stress due to variations in the lead wire length, heat sink, printed wiring board, etc. to be concentrated in the lead wires, causing damage to the lead wires such as pulling them out, disconnecting them, etc.

Processes should be carried out in the following order:

Attachment of heat sink to power transistor → Attachment of heat sink to printed wiring board → Soldering of power transistor to printed wiring board

4.2 Precautions with LGA (C-CSP/L-CSP) and BGA packages

1) Rules for printed wiring board design

Recommended rules for printed wiring board design applicable to LGA (Land Grid Array) (C-CSP: Ceramic Chip Size Package; L-CSP: Leadframe CSP) and BGA (Ball Grid Array) are shown in Figure 6.13.

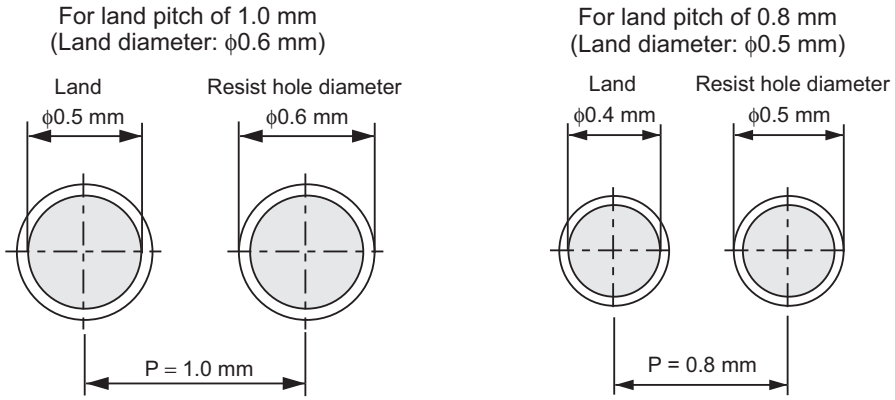


Figure 6.13 Printed Wiring Board Design Rules

2) Metal masks

The following specifications are recommended for metal masks (See Figure 6.14)

(a) Manufacturing method: Full additive

(b) Metal thickness A: 0.12 mm to 0.15 mm

(c) Opening diameter B: ϕ0.6 mm to 1.0 mm pitch (CSP land diameter: ϕ0.6 mm)
ϕ0.5 mm to 0.8 mm pitch (CSP land diameter: ϕ0.5 mm)

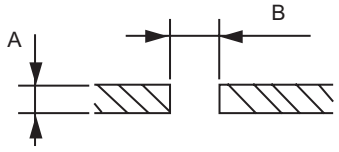


Figure 6.14 Metal Mask Specifications

3) Cream solder

The following points should be considered when selecting the solder paste:

(a) Composition

Select a lead-free solder.

(b) Grain size

Printing characteristics are good for grain sizes of 20 μm to 50 μm

(c) Viscosity

There are no particular specifications, but focus should be placed on characteristics such as sagging after printing, the capability to print repeatedly, etc.

(d) Other

Be careful of the creation of solder balls after reflow.

4) Reflow

For reflow soldering, it is necessary to set the individual optimum temperature conditions according to the mounting conditions. At our company, we recommend mounting by hot air flow reflow, but infrared radiation systems can also be used without problems.

However, as described before, if there are large and small components that should be mounted on the same board, the temperature should be set particularly carefully. For example, considering an SMD with a small heat capacity, carefully set the temperature so that the package surface temperature cannot exceed the recommended conditions. For details, refer to Sec. "6.5.3.3 Soldering". The recommended temperature profile is shown in Figure 6.15. For details, refer to the product specifications.

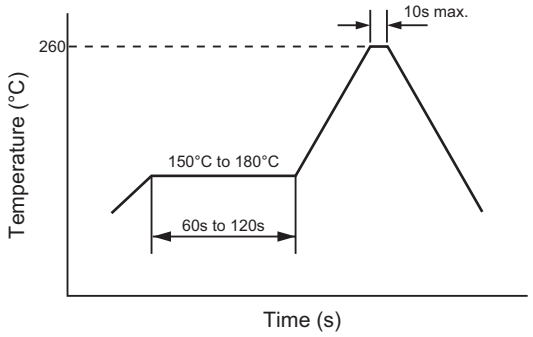


Figure 6.15 Reflow Temperature Profile

5) Storage

Environments containing high humidity, dust, or harmful gases (hydrochlorides, sulfuric acid gases, hydrosulfides) may cause deterioration of the soldering characteristics of the external electrodes. Avoid storage in areas subject to high temperatures and humidity.

6) Repairs

After mounting, if repairs are necessary, remove the package using hot air, etc. and mount the replacement device. However, if it is necessary to analyze the removed device, be careful not to heat the device extremely. This is because it is difficult to analyze the device if it is extremely heated. It is recommended that the device should be locally heated after baking. Please consult our company's sales division regarding repair methods (See Figure 6.16).

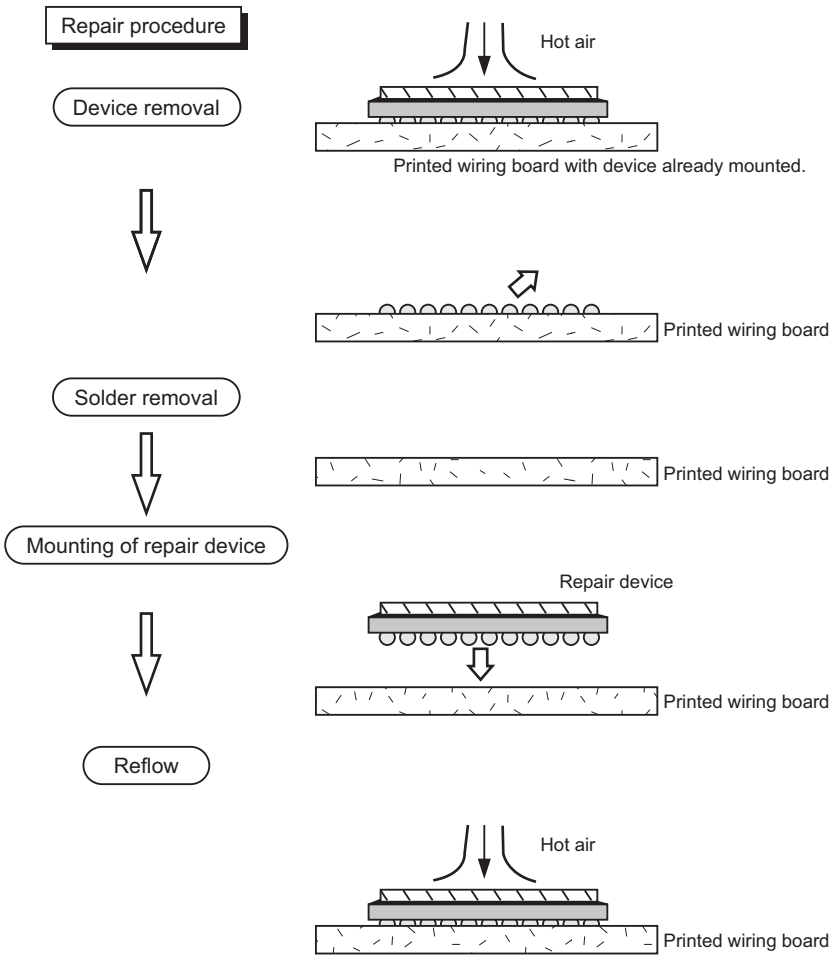


Figure 6.16 Repair Method

4.3 Precautions with TCP (Tape Carrier Packages)

1) TCP storage

The following storage specifications are recommended for TCPs. However, they may vary somewhat according to the product. For details, refer to the receiving specifications for each product (See Table 6.10).

Table 6.10 TCP Storage Specifications

Packing condition	Storage environment	Storage period
Before opening seal	Avoid high temperatures and high humidity. Store in a cool, dark place.	6 months
After opening seal	Avoid high temperatures and high humidity. Store in a cool, dark place. Store in a nitrous environment.	1 month

4.4 Precautions with image sensors packages

1) Precautions with soldering

- ◆ Unlike general SMD-type semiconductors, reflow mounting of image sensors cannot be guaranteed.
- ◆ Do not dip solder or reflow solder.
- ◆ Solder devices with a solder iron.

Table 6.11 Recommended Conditions for Manual Soldering

1/6 package	350°C, 2 sec.
Other packages	370°C, 2 sec.

- ◆ The temperature applied to the seal between the cover glass and package should be kept to 80°C or lower. In addition, be sure that the tip of the soldering iron does not touch the package. To reduce the temperature of the glass seal area, please solder the GND terminal first. Thereafter, as long as the glass seal area does not exceed 80°C, soldering can be performed in any order.
- ◆ Limit temperatures for each image sensors section

  The limit temperatures for each section are as follows from reference to the physical limitations of the composite materials.

Table 6.12 Limit Temperatures for Each Image Sensors Section

	Limit temperature	Damage when limit temperature is exceeded
Image sensors element area	≦ 170°C	Deterioration of on-chip filter/lens material
Glass seal area	≦ 80°C	Deterioration of glass seal material

2) Precautions with resoldering

- When resoldering a image sensor which has been removed once, there is a risk of package breakage, so extra care should be used.
- When manually fixing the image sensor mounting area or removing the image sensor, be sure to leave sufficient cooling time when performing work to keep each section below the temperatures listed in Table 6.12.

  When using automatic soldering equipment, be sure to use temperature control and electrostatic discharge countermeasures. In addition, to prevent surges from the vacuum pump motor, etc., be sure to connect the equipment to ground.

3) Precautions with package breakage

In order to avoid package breakage, be careful of the following:

- Since the image sensor package has a hollow construction and plastic and ceramic materials are used, be sure not to drop it or subject it to impact.

  In particular, when the outer leads are fixed in place in a socket or on a wiring board, even smaller shocks than for the package alone may cause breakage.
- When mounting, be sure not to apply stress to the roots of the image sensor outer lead areas. If stress is applied to the outer lead areas, cracks may occur in the connected root of the leads.
- When attaching the image sensor to a wiring board, use a mounting method which avoids warping the package. If the package is slightly warped and is sandwiched between hard wiring boards, etc., the package may be broken.

4) Precautions with attaching position control plates to the bottom surface of the package

- Mold-release agents, organic solvents, etc. may be adhered to the bottom surface of the package. When gluing the position control plate to the bottom surface of the package, the adhesion strength may be reduced, depending on the components and hardening conditions of the adhesive used. The adhesive strength should be evaluated as part of your purchasing investigations.
- If the materials used in the adhesive, position control plate, etc. are changed, the adhesive strength should be evaluated. Please carry out careful investigations when selecting adhesives, etc.

4.5 Precautions with QFN packages

- When forming the pattern on the package mounting area of the printed wiring board, since the lead frame which is electrically connected to the chip GND is exposed at the package corner, be very careful of leak shorts with the wiring pattern.
- Since structurally the soldering connection area of QFN packages on the terminal side is small and the flat section of the bottom surface of the solder terminal becomes the main connection point, be careful of scratches or dirt on the terminals.

4.6 Precautions with hologram unit packages

1) Heat sink design of LDHU

The higher temperature rises, the shorter the life of semiconductor laser becomes, therefore, proper heat sink designing is necessary. It is recommended to use thermal interface sheet or Si rubber as a heat sink material if there is the heat sink part on the back of LDHU/LDU package.

Our verification of sealing performance is that there is no penetrating by red-ink check in 10 minutes, but the heat sink part of LDHU/LDU is not completely sealed. When Si grease is used as a heat sink material, there is the possibility of the characteristic degradation by penetrating of Si grease from heat sink part, because heat isolates oil component of Si grease, and which can make Si grease penetrate the inside of package. When Si grease adheres to hologram lens part, which may also cause solvent cracks.

Please consult our company's sales division as to the evaluation method for heat sink effect (heat resistance) etc..

2) Precautions with soldering

Since a particular plastic is used for package and hologram lens of LDHU/LDU, please give attention to rising temperature by heating in soldering. Adhesive temperature should be less than the recommended mounting temperature profile specified in the product specifications, because when the temperature becomes higher, the joint strength between hologram lens/glass and package weakens rapidly.

It is recommended to solder only one side of lead part (terminal) at short times (after heating one side with solder iron or laser beam etc. and cooling down, please heat another side). Heating the both sides of lead part at once or full heating method like re-flow should be avoided. In addition, it is recommended to radiate heat by putting heat sink on the package, because the package temperature becomes higher due to heat conduction and heat radiation, even when the lead part is heated.

Please note that when LDHU/LDU is exposed to mechanical stress like vibration etc. at high temperature in or just after soldering, the stress can affect hologram lens/glass, and LDHU/LDU characteristic may change. Figure 6.17 shows the mounting temperature profile. Figure 6.18 shows an adhesive temperature measurement points.

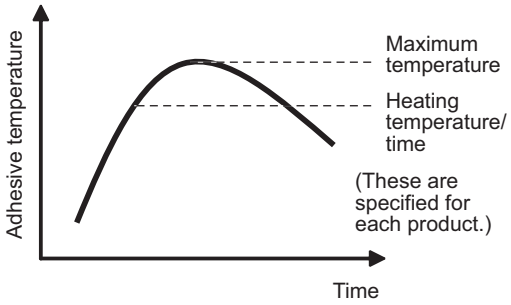


Figure 6.17 Mounting Temperature Profile

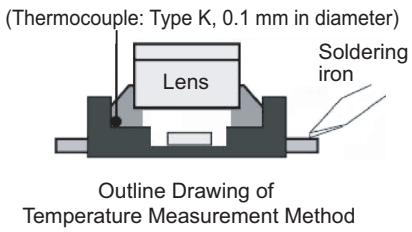


Figure 6.18 Adhesive Temperature Measurement Points

3) Mechanical stress

Panasonic LDHU/LDU is designed thinner and smaller, therefore, the characteristic may be degraded by the mechanical stress in mounting. Please pressurize on a lead part, but on the back of a package in soldering (at high temperature).

When it is imperative to pressurize on the back of a package in soldering, point pressurizing should be avoided. Please pressurize on a wider plane than a package and solder with a condition, less than 2.9N (300gf).

For pressurizing on the back of a package at normal temperature, it is also required to pressurize on a wider plane than a package instead of point pressurizing and less than 4.9N (500gf).

4.7 Precautions with built-in heat radiation board LQFP packages

(Package Code: LQFP256-P-2828, LQFP216-P-2424, LQFP208-P-2828)

1) Influence of mounting board warpage behavior when reflowing

Mounting board might warp widely because mounting board become low-profile and high density and reflow temperature become high with the introduction of lead-free policy.

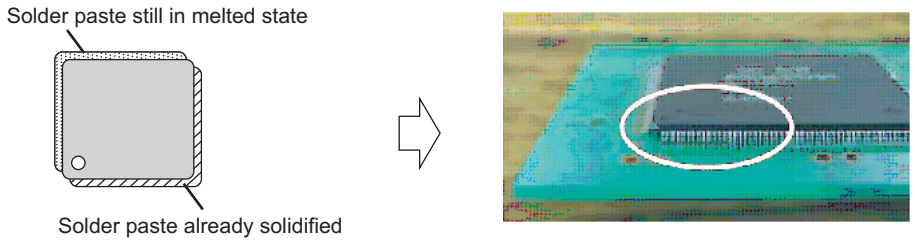
Warpage behavior of board when reflowing will be influenced by material and thickness of board and wiring pattern. And this will lead not only simple warpage at whole board but also local warpage and swell at parts mounting area.

Therefore, please examine the warpage evaluation of mounting board (especially at LQFP mounting area) at high temperature atmosphere and its countermeasures for warpage when you use this product.

For the above-described packages, a heat radiation board is incorporated in the package structure so that the thermal characteristic can be improved. So, the package flatness and the stand-off value may fluctuate depending on the reflow mounting temperature profile, heat capacity of the component to be mounted, board type, etc.

When you determine the mounting conditions, carefully check the temperature profile (mounting condition of your company) obtained by the initial mounting evaluation and the package connection condition (wettability of solder).

After reflow mounting, if there is great difference in the solder paste solidifying speed (if the solder paste is already solidified enough in one area, but is still melted in another area), the leads of the non-solidified area (still-melted area) may be lifted as shown in Figure 6.19. To prevent such a problem, reduce the solder cooling speed (slowly cool the solder). Before starting mounting, carefully adjust the mounting conditions.



(a) Solder paste status during cooling (solidification)　　(b) Result of experiment that simulated status (a)

Figure 6.19　Lifted leads due to great difference in solder paste solidifying speed (solder paste already solidified in one area but still melted in another area)

4.8　Handling precautions

a) Precautions for LGA (C-CSP/L-CSP) and BGA (P-BGA)

1) Precautions regarding use conditions

◆Influence of light

The CSP type is highly affected by light because this semiconductor chip is an exposed type (front surface, rear surface, side surface).

If a chip receives light from the outside, the chip may generate electromotive force due to the photoelectric effect, and this may cause abnormal operation. When designing, be sure to check that external light cannot reach any chips. At the inspection process and in practical use, also check that chips can be kept away from light.

◆ Influence of temperature and humidity

There are some devices whose electrode terminal is exposed to the outside. If such a type of device is stored in extremely humid air or extremely dry air, or if such a type of device is stored for a long time, the electrode surface may be oxidized, and the solderability may be deteriorated. Handle this type of device carefully.

◆Influence of vibration and other mechanical stresses

- The CSP type semiconductor chip is an exposed type (front surface, rear surface, side surface). So, if metallic tweezers are used carelessly, or if a chip falls to the floor or a shock is applied to a chip, the chip may be chipped or broken.
- There are some devices whose electrode terminal is exposed to the outside. If you directly touch such a type of device with your bare hand, electrostatic damage may occur, solderability may be deteriorated, or corrosion may occur between the electrode and the wire. In addition, if contaminant is transferred from a contaminated jig or tool to a device, or if saliva or sweat of a human being touches a device, the external electrode or the external wiring may be damaged.
- The BGA type semiconductor device has solder balls on the rear terminal. If this type of device is handled carelessly, balls may be removed, ball surfaces may be flawed or distorted, or the base material may be broken or chipped. Even if devices are in a magazine or a tray, carefully handle the devices so that devices cannot fall to the floor, and shocks or vibration cannot be applied to the devices.

2) Precautions regarding mounting

◆Influence of vibration and other mechanical stresses

- After mounting BGA or CSP on a board, carefully handle the board. For example, during the in-circuit test, be careful not to apply a shock to the board. The board may warp greatly, and the product or the soldered area may be broken.
- The CSP type semiconductor chip is an exposed type (front surface, rear surface, side surface). If the under-fill is used after mounting this type of chip, a stress may be generated due to difference in the shapes or the wire expansion factors between the under-fill and the fillet. This stress may delaminate the semiconductor chip from the re-wired layer, or break the semiconductor chip.

◆ Influence of temperature and humidity

- If heat stress is applied such as when removing products for repairs, etc., be careful not to overheat the product. Do not reuse our product if it is once removed. We cannot guarantee the quality of such a product.
- After mounting BGA or CSP, if you carry out double-surface mounting using the flow soldering method, carefully check the temperature of the flow solder in the soldering bath. If the flow temperature is too high, the printed wiring board may warp due to the heat applied from one side of the board, and the ball electrodes of the mounted device may be delaminated from the warped board. In addition, if the balls are melted again by the heat, more ball electrodes may be delaminated from the board. Figure 6.20 shows the mechanism of delamination. Figure 6.21 shows an example (analysis photo of cross section) of delamination caused by re-melting.

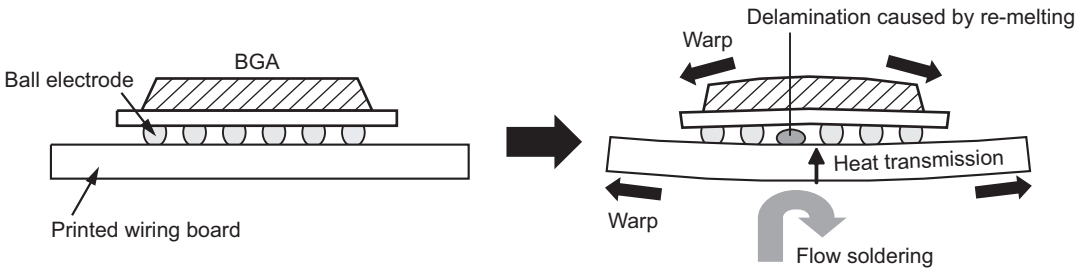


Figure 6.20 Mechanism of Delamination

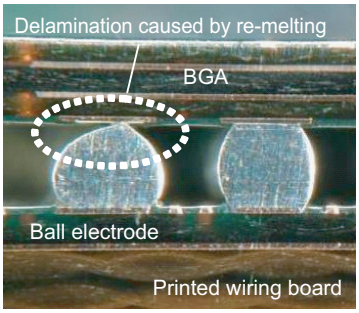


Figure 6.21 Example of Delamination Caused By Re-melting (Cross Section Analysis Photo)

◆ Inspection method after mounting

After mounting BGA or CSP, you cannot visually check a soldering error. It is, therefore, recommended that the X-ray examination should be performed to check soldering errors.

While observing the above precautions, carefully handle our products.

For detailed precautions of product handling, refer to Sec. "6.2.2 Precautions on use environment" and Sec. "6.5.2.3 Precautions when using semiconductor products".

b) Precautions for TCP

◆ Since the substrates of TCP use polyimide film, this structure easily generates static electricity. When handling products, be careful to use an ion blower and attach an earth strap so that charge does not build up in the film.

c) Precautions for CCD image sensors

1) Cautions regarding the cover glass surface

Since the glass surface is cleaned thoroughly at the time of shipment of the image sensors, be extremely careful of the following points so that the glass surface does not become scratched or dirty:

◆ Perform work in a clean environment such as a clean booth (Clean class: Around 1000).

◆ Be careful not to touch the product directly, since touching the glass surface with your hands may cause dirt, etc. to adhere. If dirt or stains are on the glass surface, use an air blower in a charge-free environment to blow off the dirt or stains. For dirt adhering to the product due to static electricity, use of an ionized air blower is recommended. However, when using an air blower on the image sensors, be sure to connect all terminals to ground as a countermeasure against static electricity.

◆ For stains such as oily dirt, etc. which still cannot be removed, use a cleaning swab or lens-cleaning paper soaked with isopropyl alcohol to wipe off the stain gently, being careful not to scratch the glass surface. Further, even when using a soft cloth or swab, if the cloth or swab is dry, the cloth or swab itself may generate dust, and that dust may scratch the glass.

◆ Do not subject the glass surface to strong impact or strong scratching. Doing so may cause impact gouges, cracks, etc., and such damage or scratching may result in inferior characteristics.

◆ As a countermeasure against dirt or stains, it is necessary to store the products in the packing case.

◆ To prevent condensation, when transferring products between rooms with a drastic temperature change, be careful in eliminating the temperature differences.

2) Cautions regarding storage environment

◆ Do not store products in areas where they will be subject to strong light or infrared radiation, such as in direct sunlight. If strong light is incident on the image sensor for a long time, the transparency of the filter or lens material will be reduced.

3) Cautions regarding image sensors as optical elements

◆ Microlenses to focus the light on the photodiodes and color filters to discriminate color information are integrated on-chip in the photoelectric converter section of the image sensor. Since the integrated on-chip structure is formed of plastic, the transparency of the filter or lens material will decrease depending on the intensity and wavelength of the light incident on the image sensor and the amount of time the light is incident.

Because of this, be careful not to expose the image sensor to infrared radiation or sunlight even when it is not being used (during storage, transportation, and manufacturing).

◆ When the same pattern is imaged for a long time, depending on the intensity of the incident light and the exposed time, abnormalities such as burning in of the pattern on the image sensor pixels or harshness may occur, regardless of whether or not power is being supplied to the image sensor.

When not using the image sensor, be sure to shade it from light and switch off the power.

◆ For image sensors, as time passes white marks may appear due to cosmic radiation. Please use white-mark compensation circuits to compensate for these white marks.