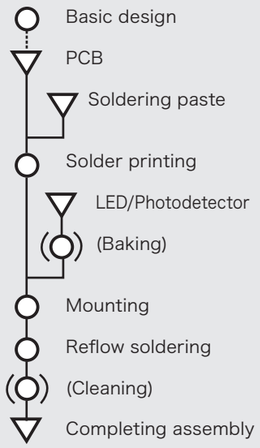
HANDLING PRECAUTIONS: FROM DESIGN TO ASSEMBLY

Stanley Electric's devices are designed to take advantage of the characteristics of optical semiconductors and ensure high reliability. However, device performance may vary depending on the usage conditions. Below, a description is provided regarding the precautions and points that should be taken into consideration while using our products.
Please contact our sales representatives regarding any questions you may have, or any conditions that are not noted below.
The flow-chart diagram shown below illustrates the basic manufacturing process from design to assembly.

Surface mount LEDs
standard mounting flow
(Reflow soldering)



❶ Basic design

1-1. Safety design

Our devices are designed to operate in a failure-free manner under the recommended usage conditions. However, optical semiconductors are generally prone to unexpected malfunctions and failures. Please take care to give consideration to safety design points, such as fail-safe design, to avoid fire, injury and other forms of social harm in case any malfunction or failure should occur.

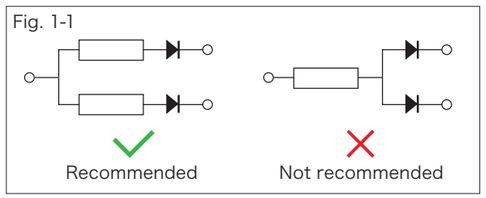
1-2. Absolute maximum ratings

Absolute maximum ratings are set as limiting values to prevent our devices from failing due to excess stresses (i.e., via temperature, current, voltage, etc.). Usage conditions should not exceed the listed ratings even momentarily, and should not be exceeded for even one item among the ratings.

1-3. Design for actual usage

1) In order to ensure higher reliability, it is necessary to derate forward current or power consumption according to the actual temperature, or allow a sufficient margin by considering characteristic fluctuations.
2) Please insert straight protective resistors into the circuit in order to stabilize LED operations and also to avoid burnouts due to excess current. Please contact us in advance if you plan to use our LED devices in a matrix circuit.
3) We recommend that our LED devices be used with standard current (specific current), and at 2 mA or above when used with a low current. Since V_F varies widely in the low current range, LED device brightness also varies widely when a current of 2 mA or less is used.
4) Our visible LED devices are specifically designed to be used for visible lighting applications. We do not recommend that they be employed for other applications, for which they may be unsuitable in some cases. Please consult with us in advance if you are planning to employ our visible LEDs for uses such as sensors or optical communications devices.
5) We recommend that you place a series resistance in each line in order to reduce brightness variations when using a parallel circuit for two or more LED devices (Note: brightness may still vary, primarily due to the resistor tolerance or difference in LED V_F values.) (Fig. 1-1)
6) When using two or more of the same LEDs mounted on one PCB simultaneously, it is recommended that you adjust the luminous intensity and color tone bins. Products classified into bins are packed according to the same bin in each packing unit (reel, etc.).

Fig. 1-1



1-4. Chemical safety

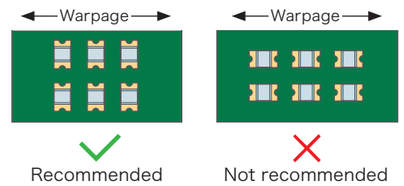
The main chemicals included in Stanley's devices are as follows:
[Main components] InGaN, AlGaInP, GaAlAs, etc. (LED dies)
Si (phototransistor dies)
Cu (leads, wiring and electrodes)
Fe (leads)
Ag (plating material on leads, conductive adhesives)
Ni (plating material on leads, base plating)
Epoxy resin, silicone resin (encapsulant, PCB)
Phosphor
Au (connecting wires, plating on wires and electrodes)
Glass (reinforcement material)

Some products may contain arsenic compounds such as GaAlAs in the die; however, it has been confirmed that such products are designed to prevent any leakage of these materials under normal conditions, even if they are released into the environment. Nevertheless, when disposing of these products, please request the assistance of a specialist holding a license of industrial-waste disposal business in accordance with Article 14, Paragraph 1 of the Japanese Waste Management and Public Cleaning Law. The disposal must be compliant with each country's law.

❷ PCB

2-1. PCB for surface mount LEDs

1) The recommended pads are described for each specification. When designing the circuit board, please take the utmost care to ensure ease of mounting, reliable bonding, and prevention of bridges or the tombstone (Manhattan) effect by the solder.
2) When mounting a surface mount type on a PCB, please make sure that the LED electrodes are aligned perpendicular to the PCB surface. In addition, please take into full consideration the mounting positions of the components from the board edges, hole pitches of perforations for cutting, depth of v-cutting etc. when mounting these products onto multiple PCBs.



2-2. PCB for LED numeric displays

1) The recommended PCB pitch hole diameter is as shown in the chart on the right. (Fig. 2-2)
2) The PCB mounting hole spacing (pitch) must match the lead pitch.
3) It is recommended that a space of 2 mm or greater should be made between the lead base and soldering point, and that patterning should not be made on the surface of the PCB and the hole area (the same structure as that of a single-sided PCB) when a product is directly placed onto the PCB.

Fig. 2-2

Lead diameter	Hole diameter of PCB	Land diameter
0.25×0.5mm	ϕ0.8±0.1mm	ϕ1.5mm

❸ Soldering paste (surface mount LEDs)

Please select an appropriate soldering paste in accordance with the suitable heating method, considering its coating reliability in order to prevent sagging and corrosion.
1) Normal viscosity: 200–400 Pa·s (20–40×10⁴cP)
2) Standard sodium content: 0.2 wt % or less
3) Flux: Stanley Electric recommends the use of the rosin type.

④ Solder printing (surface mount LEDs)

Please use an appropriate amount of solder on the soldering pad to prevent displacement of parts after they have been mounted. Stanley Electric recommends the use of the screen printing method, which is suitable for high-precision mounting and is widely used for fine patterns. The thickness of a stencil mask is fixed at 100 μm – 200 μm (1113F type: 120 μm – 150 μm, 1105P type: 50 μm), and the use of a urethane rubber printing squeegee (hardness-90) with a nose angle of 90° is recommended. Please adjust the speed so that the solder paste turns at a slow, constant pace at the tip of the squeegee when printing, and perform all operations in a temperature and humidity-controlled environment to avoid variation in mounting.

Maintain a sharp tip at all times

⑤ Mounting

5-1. Suction nozzle

All surface mount type devices and photodetectors can be automatically mounted using a mounter with standard suction nozzles. When using round suction nozzles, please use small nozzles with an inner diameter that does not exceed the size of the absorption face of the component. Due to the possibility of mounting displacement when using a rotary head-type mounter, please take care to verify proper function in advance.

5-2. Position of suction

The nozzles should be adjusted so that they pick up the device at its center, in order to balance the mounting position.

5-3. Transport

Vibration that occurs during the mounting process may reduce the accuracy of device positioning prior to soldering, and may adversely affect solderability. Accordingly, please optimize the mounting speed, including tape transport speed and tension.

5-4. Static electricity

Although anti-static measures have been taken for both our products and their packaging, a dry working environment may generate some static electricity, and the resulting static charge buildup may lead to the adherence of a product to the taping material, resulting in poor mounting. Please take the following points into account.

1) Handling environment: an ESD protected area (an area in which static discharge or risks of damages are within the tolerance range allowing ESDS devices to be handled).
2) Taping peeling rate: 10 mm/s recommended.
3) Other prevention measures: use static eliminators, such as an ionizer.

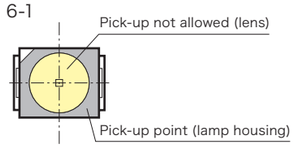
⑥ Handling and mounting for 11□1CS, 1154RS, 11□2GS, 11□4LS, 1158LS, 1313HS, 1314AS, 1149JT, 115CAT, 11□AJT, 125DJT, 110□MS types

<Recommended conditions>

1) Nozzle suctioning position: Lamp housing area of the product (area) (Fig. 6-1) Suctioning with the nozzle should only be applied at the lamp housing area, as the product uses a low hardness silicone resin for the lens.
2) Regarding 11□1CS and 1313HS, please adjust the load to 10 N or less, and suction the lens area.
3) Regarding 115CAT, please adjust the load to 3 N or less, and suction the lens area.
4) Regarding 1154RS (reverse mount type), please adjust the load to 5 N or less, and suction the back surface of the package.

* Since the lamp housing may be broken by the load of the mounter nozzles during mounting, please adjust the load, the nozzle suction position and the nozzle diameter, etc. prior to use.

Fig. 6-1



Recommended nozzle diameters for the mounter

Units: mm

Product type	Inner diameter	Outer diameter
11□1CS	Φ0.6	-
11□2GS	Φ1.1	Φ2.2
11□4LS	Φ2.5	Φ3.5
1158LS	Φ1.0	Φ2.0
1149JT, 11□AJT, 125DJT	Φ1.7	Φ3.5
115CAT	Φ0.6	Φ1.0
110□MS	Φ3.3	Φ3.7

* Please request the respective specifications for packages other than those above.

⑦ Handling for 1105P types

Since all parts of this product have become thinner to achieve a thin LED, this type is more sensitive to externally applied forces than other types. Stanley Electric recommends that you pay attention to the following precautions before using this type of LED.

1) Loads on the board during the mounting process should be restricted to 2 N or less.
2) Since the terminal area of the product is small, avoid using an excessive amount of soldering paste. (Stencil mask thickness for the 1105P type: 50 μm)
3) After mounting on the board, any shock to or collision with the mounting board of LEDs should be avoided.
4) When using a product that may induce substantial warpage of the circuit board after mounting FPCs, etc., please verify in advance that such usage will cause no problems.
5) When using multiple PCBs, please verify in advance that there will be no problem with the mounting position from the edge of the board when LEDs are mounted.

8 Soldering

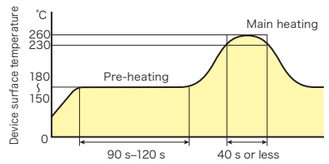
1) Thermal stress from soldering may influence LED reliability; however, the stress level will vary depending on the heating method. When components in different forms are soldered together, we recommend that the characteristics of the component that is most sensitive to thermal stress (e.g. a surface mount LED) should be used as the basis for soldering. (Recommended condition: soldering pad temperature > package temperature)
2) Since the parts of an LED, including the resin, are not stable immediately after soldering (i.e., before cooling to room temperature), any mechanically applied force is likely to damage the product. Please avoid stacking the boards after soldering, and the storage of boards in a manner that may cause them to warp, etc. In addition, please avoid friction due to contact with hard materials.
3) During the soldering process with a soldering iron, please take care to confirm that the iron has reached its preset temperature before initiating soldering, as its temperature is temporarily lowered just after cleaning. Please also avoid applying any force that could displace the components just after soldering until the soldering paste has cooled and hardened, as such displacement may degrade the performance and quality of the soldering.

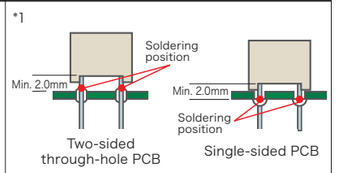
8-1. Soldering surface mount LEDs

1) The temperature of the resin surface is adopted for the recommended temperature profile for the reflow soldering. This is due to the fact that temperature distribution varies depending on the heating method, PCB materials, other types of mounted components, and their mounting density. Generally, when one device is mounted on an FR-4 PCB, and heated with a far Infrared heater or heated air, the temperature difference between the PCB and the resin of the device will be around 5°C to 10°C. Please do not repeat the reflow heating process three times or more.
2) Regarding photodetectors, there is a possibility of an increase in dark current during reflow soldering after moisture absorption by the product. Accordingly, please store and use these products under the specified moisture absorption conditions.
   Please refer to “MOISTURE-PROOF PACKAGING” for more details.
3) If soldering manually, Stanley Electric recommends using a soldering iron with a temperature adjustment function. Please make sure that the soldering iron never touches the products directly (in particular, the resin part), and avoid allowing the heated electrode temperature of device products to exceed above the heating temperature of the soldering pad on the board during the actual soldering process. Repairs must be performed only once per location, and please avoid reusing detached products.

8-2. Soldering requirements

The chart below represents the maximum ratings for typical lead-free solder. However, lowering the heating temperature and using a shorter heating time, relative to the conditions shown below are very effective methods of ensuring higher reliability.

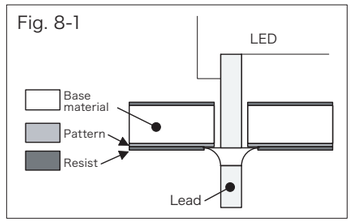
Type	Soldering	Dip soldering	Reflow furnace
Surface mount LEDs 	Iron tip temperature: 350°C or less Soldering duration: 3 s or less Number of times: Once *The peak temperature varies according to the size of the land and the shape of the soldering iron tip. Please confirm there is no problem prior to use. We recommend lowering the peak temperature and using a soldering iron with a temperature adjustment function.	Not recommended	Pre-heating: 150°C–180°C/90 s–120 s or less Main heating: 230°C or above, 40 s or less Peak temperature: 260°C or less (Profile: temperature history of the device resin surface) 

Type	Soldering	Dip soldering	Reflow furnace	Soldering position
LED numeric displays 	Iron tip temperature: 400°C or less Soldering duration: 3 s or less Position: At least 2.0 mm from the base of the lead.	Pre-heating : 100°C or less (resin surface temperature) 60 s or less Soldering basin temperature: 265°C or less Dipping time: 5 s or less Position: At least 2.0 mm from the base of the lead.	Incompatible	*1 

* The above table shows typical numeric values. As actual values will vary depending on the product, please contact us for specifications to check on the guaranteed values for each product.

*1 Regarding the use of two-sided through-hole PCBs, if PCBs are designed to avoid drawing the pattern inside the holes, two-sided through-hole PCBs can be mounted using the same soldering positions used for single-sided PCBs. (Fig. 8-1)

Fig. 8-1



9 Cleaning

1) Some chemicals, including alternative chlorofluorocarbon cleaning agents, may corrode, oxidize, cloud or crack the surfaces of the lens or cases. Please carefully review the reference chart below before selecting a cleaning method. If water is used for cleaning (including use during the final cleaning process), please use only purified water (i.e., not tap water), and artificially dry the components after use.

Alternative chlorofluorocarbon cleaning agents	Surface mount LEDs	LED numeric displays
Clean through 750H	✓ Recommended	✗ Not recommended
Pine alpha ST-100SX	✓ Recommended	✗ Not recommended

Cleaning agents	Recommended / Not recommended
Pure water	✓ Recommended
Ethyl alcohol	✓ Recommended
Isopropyl alcohol	✓ Recommended
Trichloroethylene	✗ Not recommended
Chloroethene	✗ Not recommended
Acetone	✗ Not recommended
Thinner	✗ Not recommended

2) Please limit each cleaning process to three minutes and to temperatures suitable for the detergent used (generally ranging from 30°C to 50°C). When simultaneously using ultrasonic waves, the bonding wire in the package may cause resonance and influence product reliability. Accordingly, please confirm in advance that the LED device does not touch the vibration source directly, and also confirm that there will be no problems under mass production conditions. There have been reports that resonance points generally exist in the tens of kHz range. As the positions of these resonance points vary depending on the wash basin shapes and device positions, Stanley Electric recommends that you take these issues into full account before cleaning the device.
   <Reference> Test conditions for the EIAJ standard
   1) Ultrasonic wave frequency: 25 kHz ± 4 kHz or 40 kHz (+ 8 kHz/-4 kHz)
   2) Output: 10 W/liter–30 W/liter
   3) Duration: 60 s ± 5 s; Temperature: 40°C
3) The cases and seals used for LED numeric displays may be damaged by alcohols. Therefore, when cleaning, please take care to clean the lead portion only, and not the entire display. Since alcohols may spatter during cleaning, please also be careful to avoid inadvertent splashing onto the cases. In addition, please do not clean the cases by wiping them with alcohols.

⑩ Other

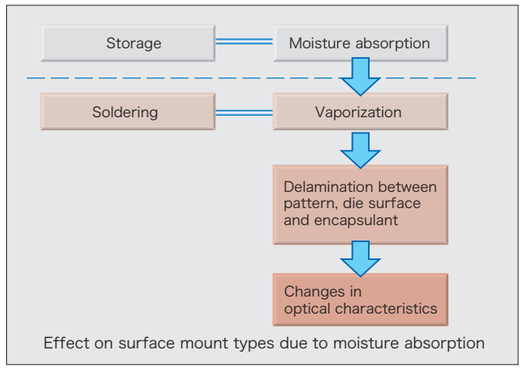
1) After mounting on the PCB, any shock to or collision with the mounting board of LEDs should be avoided. Mechanical strength is not guaranteed.
2) Products warranty period for the unopened packaging bag of surface mount LEDs: six months or less (temperature: +5°C-30°C; humidity: 70% or less).
3) After opening the moisture-proof package, please use the device as soon as possible, as package opening followed by long-term storage could result in oxidation of the leads or soldering terminals. For storage, please avoid humid conditions, and also avoid the potential for moisture condensation due to rapid temperature changes.
4) The terminals of LED products may be silver-plated. There have been many reports of cases in which corrugated cardboards, rubber products, etc. have generated the outgasses containing elements that can corrode the silver plating on the lead frame of the product (mainly reducing sulfur gas-based components: H_2S, S_8, CH_3SH, etc.)
   Since outgassing may reduce the solderability, please take particular care to isolate products from the corrugated cardboards and rubber products, etc. for storage. As these products in an opened moisture-proof package are subject to a greater influence by the environment, they should be stored appropriately to avoid the effects of both moisture and such gasses.
5) Please make a note of the lot number listed on the product's package label. This number will be helpful in speeding our response and actions in cases involving product failure.
6) Please refrain from looking directly at the light source of high output LEDs, as this may cause eye damage. With regard to the output light safety of infrared LEDs in particular, based on the values prescribed by "IEC62471" standard, our infrared LEDs are considered as belonging to the "Exempt" class in the general usage assumed at this stage. However, IEC62471 standard specifications are evaluated in the final product (product set), taking into consideration the conditions of the optical system, the driving circuit, etc. and the overcurrent operations under failure state; therefore, please make sure to check for any issues relating to the products. Please consult us for additional data should further examinations be needed.
7) If ultrasonic welding (or other similar process) is needed after mounting the product, it may affect the reliability of the junction part in the device package (junction parts of the die bonding and wire bonding). Please make sure in advance that such processes will cause no problem.
8) The light attenuation ratio varies for each LED device, depending on the specific luminescent color. The color of an LED device consisting of multiple LED dies of different colors may change over time from that at the initial stage, even though each color source experiences the same accumulated usage time.
9) The following factors should be considered during visible light LEDs design. Please request all of the necessary specifications and technical data from Stanley Electric for verification.
   - Variation factors: luminous intensity, luminous flux, chromaticity, color tone, forward voltage, directivity, mounting accuracy, surrounding reflected materials, etc.
   - Fluctuating factors: temperature characteristics of luminous intensity, luminous flux, chromaticity, color tone and forward voltage, fluctuations in luminous intensity, luminous flux, chromaticity and color tone due to prolonged use, fluctuations in power and voltage, etc.

   The following factors should be considered during infrared LEDs and photodetectors design. Please request all of the necessary specifications and technical data from Stanley Electric for verification.
   - Variation factors: radiant intensity, total luminous flux, forward voltage, photocurrent, directivity, mounting accuracy, transmittance and reflectance of detected materials, background, etc.
   - Fluctuating factors: temperature characteristics of radiant intensity, total luminous flux, photocurrent, forward voltage, dark current, fluctuations in radiant intensity, total luminous flux, photocurrent and dark current due to prolonged use, ambient light, fluctuations in detected materials, power and voltage, etc.
10) Please contact us for details regarding usage, taping of products, packaging, etc. that are not listed in this catalog.
11) This catalog contains information regarding the main items from the product specification sheets. Please request the latest specifications and confirm the details prior to use.
12) Please contact our sales representatives regarding any other questions.

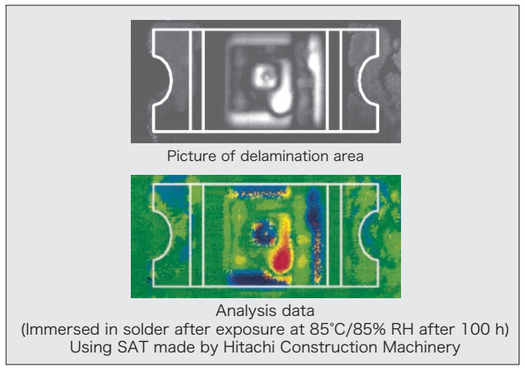
MOISTURE-PROOF PACKAGING OF SURFACE MOUNT LEDs

Since surface mount type devices are composed mainly of plastic resin, they tend to absorb moisture in the air by diffusion and capillarity while in the natural environment. Accordingly, rapid heating of such devices that have absorbed moisture during the soldering process may cause interfacial delamination due to moisture vaporization and expansion, resulting in degradation of optical characteristics or the occurrence of external/internal cracks. Disconnection of bonding wire and misalignment of LED dies, accompanied by such interface delamination, may also occur and cause lighting failures. All surface mount type devices are packed in moisture-proof packages as shown below to minimize moisture absorption during transportation and storage. Nevertheless, Stanley Electric recommends the use of a dry box or the following conditions for product storage.

<<Storage conditions>> Temperature: +5°C – +30°C; Humidity: 70% or less. Avoid areas with corrosive gases or dust.



Effect on surface mount types due to moisture absorption


Picture of delamination area

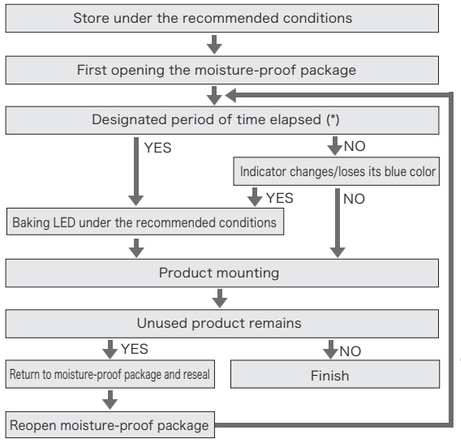
Analysis data
(Immersed in solder after exposure at 85°C/85% RH after 100 h)
Using SAT made by Hitachi Construction Machinery

The moisture-proof package should be opened only immediately before use, and the time frame between package opening and soldering should be as short as possible. Please solder within the "elapsed time since first opening the package" described in the chart below. If the device needs to be soldered 2 times, cumulative operation time of both the first and second soldering is shown. (For details, please consult the note (*) of "Workflow outline" shown below.)
After the package has been opened, we recommend that you return unused products to the moisture-proof package, reseal with a fastener and store under the same conditions as described in the "Product storage conditions" above.
In addition, baking (moisture removal) should be performed if a designated time has passed since the package has been opened. A silica gel desiccant contained in the package has a blue indicator that shows the moisture level. If the indicator changes or loses its blue color or if the designated period of time for each product has elapsed, please perform baking (moisture removal) just before use, as stated in the chart below. Baking may be performed in the taped form after removing from the package; however, please note that if this process is performed on products that are stacked, or if force is applied, this may cause deformation of the reels and taping materials, which will later impede mounting. After baking, please use the products after they have cooled to room temperature.

Elapsed time since first opening the package (under recommended storage conditions)	Recommended baking temperature	Maximum number of baking repeats	Applied devices
Elapsed time: 8,760 hours (equivalent to MSL 2)	+60°C ± 5°C	2 times	1108GS / 115CAT
Elapsed time: 672 hours (equivalent to MSL 2a)			11□1CS / 1154RS / 11□2GS / 11□4LS / 1149JT / 11□AJT / 125DJT / 1105MS / 1106MS / 1107MS / 1108MS
Elapsed time: 168 hours (equivalent to MSL 3)			1104P / 1116P / V series 1111C / V series 1112H / VFJ□1105W / VCDG1113F / 1158LS / VTPS11□2H
Elapsed time: 72 hours (equivalent to MSL 4)			All devices not listed above

* The above table shows the typical numeric values. As some conditions (baking time, etc.) will vary depending on the specific product used, please contact us for specifications.

Workflow outline: package opening to mounting



* The designated period of time refers to the maximum allowable time before using the product after opening the moisture-proof package. Please determine the actual designated period of time by subtracting the time required for completion of the soldering process. If you use a reopened moisture-proof package, please check the elapsed time since first opening the package, or since baking has finished. A similar workflow will apply to storage in a desiccator.

HANDLING OF InGaN PRODUCTS / GaN BASED PRODUCTS (ESD SENSITIVE LEDs)

An LED device with an InGaN or GaN based die is highly sensitive to surge voltage generated by on/off power source switching and discharges of static electricity, which may cause severe damage to the die or undermine its reliability. Damaged products may experience conditions such as an extremely high reverse current (leak current), or a decrease in the forward voltage rise in the low current range, causing a deterioration of its light-emitting characteristics.
Some of our InGaN products and GaN based products are not designed to withstand 1,000 V or more under the EIAJ ED-4701/300 test procedure #304 (HBM (human body model): C=100 pF, R2=1.5 kΩ); accordingly, anti-static materials are used for its packaging. The following precautions and measures are necessary to ensure product quality at the time of product shipment.
(*1,000V is the typical numeric value. Since values vary depending on the specific product used, please contact us for specifications.)

❶ Design precautions

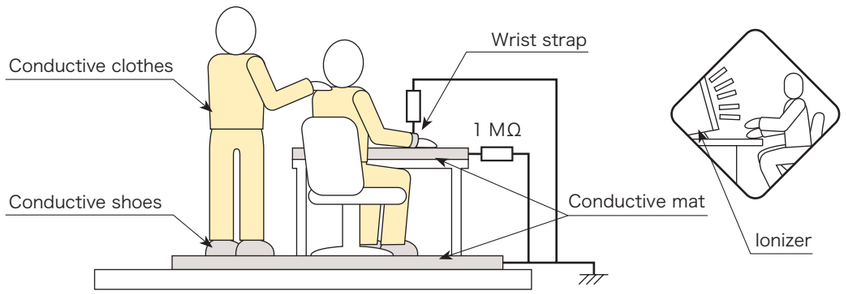
If InGaN products or GaN based products are incorporated into the circuit design, please consider installing a protective circuit that prevents the surge voltage generated by on/off power source switching from directly impacting the product.

❷ Preventive measures against electrification/electrical discharge during work time

Stanley Electric recommends the following measures to avoid product (die) damage from static electricity generated by the human body during contact with a device, and from discharge during contact with metals after a product has been charged by friction or inductive charging that transfers energy from surrounding charged materials.
1) Do not place insulators near the LED device.
2) Avoid allowing the LED devices to carelessly come into contact with metallic materials (such a charge product may make electric current flow rapidly and become damaged).
3) Avoid implementing any working process that may cause the LED devices to rub against other materials.
4) Any manufacturing equipment or measuring instruments should be grounded if possible, and measures should be taken to avoid electrical surges.
5) Prepare an ESD protective area by installing antistatic devices such as conductive mats (10^8-10^9Ω, in general) and ionizers.
6) Operators' bodies should be grounded by wearing a wrist-strap. (In general, such wrist-straps are equipped with 1 MΩ resistors placed in a series connection.)
7) Operators should wear conductive work-clothes and shoes, and work on a conductive floor.
8) When directly handling the products, use ceramic, not metallic tweezers. In addition, if a soldering iron is used, it should be properly grounded. Do not use any insulator such as bakelite for manufacturing jigs.

❸ Operating environment

1) A dry environment is more likely to cause static electricity. Although a dry environment is required for the storage of LED products, Stanley Electric recommends the use of an environment with a humidity of around 50% during the working process following soldering.
2) Recommended static electricity level in the working environment is 150 V or less, which is the same numeric value as for integrated circuits, which are also sensitive to static electricity.
(150 V is a typical numeric value. Since values vary depending on the specific product used, please contact us for specifications.)
3) A container made of a conductive material is recommended for product storage.



Handling for UV LEDs

- UV LEDs emit high intensity UV (ultraviolet) light.
- Do not look directly into the UV light source; this can be harmful to your eyes and skin.
- Wear protective eyewear to avoid exposure to UV light, as well as protective masks and gloves, etc. in order not to expose your skin to the light.
- Attach warning labels to your products which contain UV LEDs.
- Keep out of reach of children.

DESCRIPTION OF TERMINOLOGY

LED	Device that emits spontaneous emitted light using a forward current flowing through a semiconductor PN junction or similarly structured junction.
Visible LED	LED emitting light with a wavelength in the 380 nm–780 nm range, which is visible to the human eye as light.
IR (infrared) LED	LED emitting light with a wavelength exceeding 780 nm.
UV (ultraviolet) LED	LED emitting light with a wavelength of 400 nm or less.
Photodetector	Device that converts received light photons into electric current.
Surface mount LED	Device consisting of an LED die encased in resin on a lead frame, a board, etc. for surface mounting.
LED numeric display	LED display unit used primarily to display numbers, configured by arranging a set of linearly-shaped display units in an array to form numbers via combination of lighting.

LIGHT-EMITTING DIODES

Items		Symbol	Definition	Unit
Absolute maximum ratings	Forward current	I_F	Maximum current that can flow continuously from anode to cathode.	mA or A
	Forward current reduction rate	ΔI_F	Reduction in permissible forward current when ambient temperature exceeds a specified point.	mA/˚C
	Pulse forward current	I_{FRM}	Maximum forward current that flows during repetitive pulsed operation, specified by pulse width and duty ratio.	mA or A
	Junction temperature	T_j	Maximum junction temperature of a device's die.	˚C
Thermal characteristics	Thermal resistance	$Rth_{(j-s)}$	Difference in junction temperature and solder terminal temperature when 1-watt power is applied.	˚C/W
Electro-optical characteristics	Forward voltage	V_F	Yield value of voltage drop from anode to cathode when current flows in the forward direction.	V
	Sorting current	–	Current value serving as reference when checking characteristics.	mA
	Half-intensity angle	$2\theta ½$	The angle at which 50% of the peak intensity is reached on either side of the origin of the spatial distribution graph.	deg.
	Spatial distribution	–	Directional pattern of an LED's radiant power distribution, with the central axis of the LED taken as the origin.	–

VISIBLE LEDs, LED NUMERIC DISPLAYS

Items		Symbol	Definition	Unit
Electro-optical characteristics	Chromaticity coordinates	x,y	Tristimulus values of an LED's emitted color, expressed in a two-dimensional, orthogonal color coordinates system; an XY coordinate system is used, in general.	–
	Dominant wavelength	λd	The light color emitted by an LED as perceived by the human eye, expressed in numbers.	nm
	Luminous intensity	Iv	The amount of light power emitted per steradian within a solid angle, when an LED is modeled as a point light source.	mcd or cd
	Luminous flux	ϕv	Total amount of light emitted in all directions, when an LED is modeled as a point light source.	lm

IR LEDs

Items		Symbol	Definition	Unit
Electro-optical characteristics	Peak wavelength	λp	Wavelength that corresponds to the maximum value of the light output.	nm
	Radiant intensity	I_E	Radiant energy emitted per steradian on the optical axis, when an LED is modeled as a point light source.	mW/sr
	Light output	ϕe	Total radiant energy emitted in all directions, when an LED is modeled as a point light source.	mW
	Cut-off frequency	fc	Frequency at which the amplitude of sinusoidal output obtained by performing intensity modulation via a sinusoidal wave decreases to 50% of its reference (low frequency) amplitude.	MHz
	Response speed	tr・tf	Time frame during which the radiant intensity exhibits a rise from 10% to 90% or a fall from 90% to 10%, relative to the maximum value, in response to a light pulse input.	ns or μs

UV LEDs

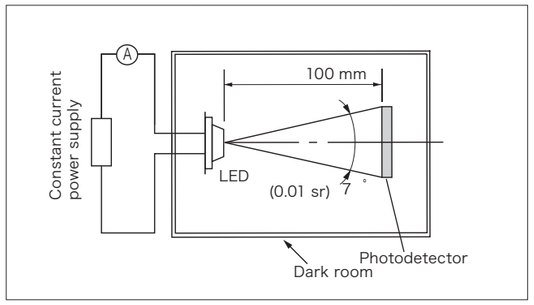
Items		Symbol	Definition	Unit
Electro-optical characteristics	Peak wavelength	λp	Wavelength that corresponds to the maximum value of the light output.	nm
	Light output	Po	Total radiant energy emitted in all directions, when an LED is modeled as a point light source.	mW

PHOTODETECTORS

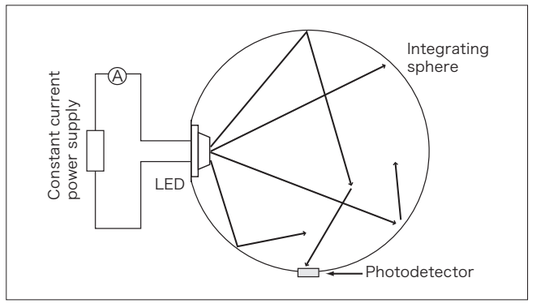
Items		Symbol	Definition	Unit
Absolute maximum ratings	Collector-emitter voltage	V_{CEO}	Maximum value of the voltage applied from the collector to the emitter of a phototransistor.	V
	Collector current	I_C	Maximum value of the current that flows from the collector to the emitter of a phototransistor.	mA
Electro-optical characteristics	Peak sensitivity wavelength	λp	Wavelength that maximizes photosensitivity.	nm
	Photocurrent	I_C	Collector current of a phototransistor that flows due to an input of light under specified conditions.	mA
	Dark current	I_{CEO}	Collector current that flows to a phototransistor when forward voltage is applied to the transistor in the dark.	μA
	Response speed	tr・tf	Time frame during which the photocurrent exhibits a rise from 10% to 90% and a fall from 90% to 10%, relative to the maximum value, in response to a light pulse input.	ns or μs
	Half-intensity angle	$2\theta ½$	The angle at which 50% of the peak photosensitivity is reached on either side of the origin of the spatial distribution graph.	deg.
	Spatial distribution	–	Directional pattern of a device's photosensitivity distribution, with the central axis of the device taken as the origin.	–

MEASUREMENT METHODS

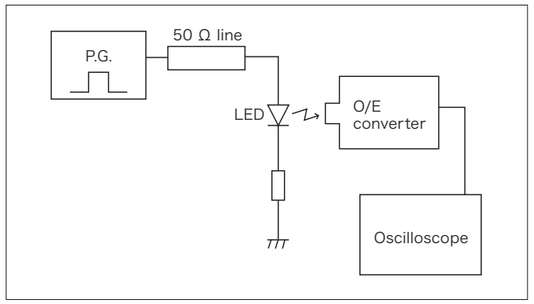
Luminous intensity / Radiant intensity (LEDs)



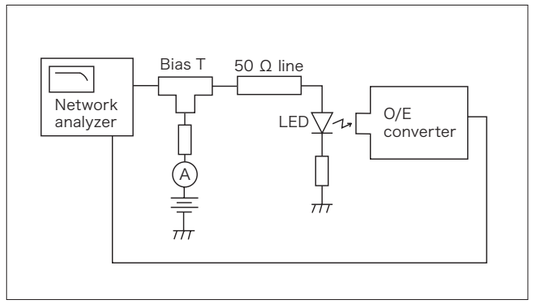
Luminous flux / Total luminous flux (LEDs)



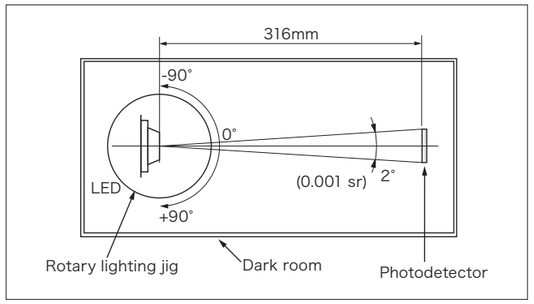
Response speed (IR LEDs)



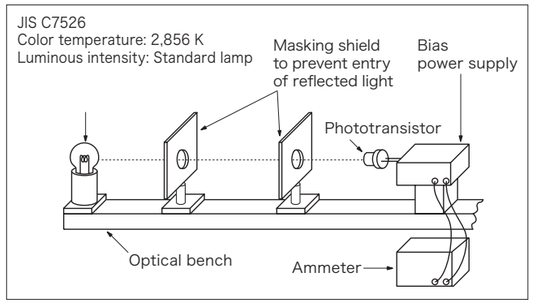
Cut-off frequency (IR LEDs)



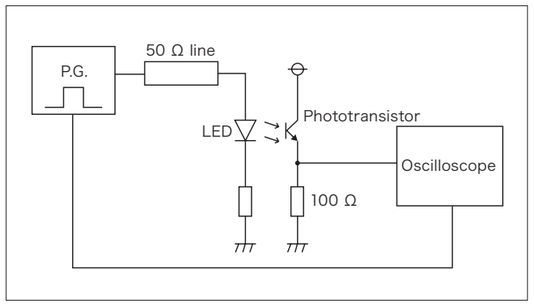
Directivity (LEDs)



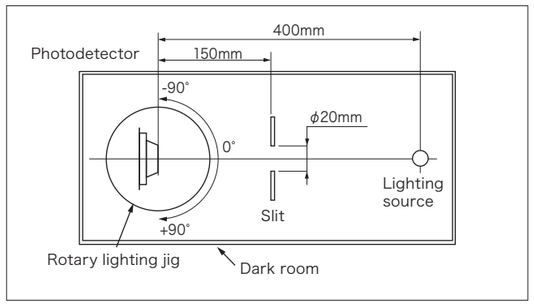
Photocurrent (Photodetectors)



Response speed (Photodetectors)



Directivity (Photodetectors)



RELIABILITY TEST
SURFACE MOUNT LEDs

RELIABILITY TEST ITEMS

Test item	Standards	Definition
Endurance operational test	EIAJ ED-4701/100 Test procedure 101	Ta=25°C I_F=maximum rated current t=1,000 h
Solder heat resistance test	EIAJ ED-4701/300 Test procedure 301	Pre-heating: 150°C–180°C/120 s or less Main heating: 230°C/40 s or less Peak temperature: 260°C, 2 times
Temperature cycling test	EIAJ ED-4701/100 Test procedure 105	Minimum rated storage temperature (30 min)–normal temperature (15 min) –maximum rated storage temperature (30 min)–normal temperature (15 min), 5 cycles
Moisture resistance storage test	EIAJ ED-4701/100 Test procedure 103	Ta=60°C±2°C RH=90%±5% t=1,000 h
High temperature storage test	EIAJ ED-4701/200 Test procedure 201	Ta=maximum rated storage temperature t=1,000 h
Low temperature storage test	EIAJ ED-4701/200 Test procedure 202	Ta=minimum rated storage temperature t=1,000 h
Vibration test	EIAJ ED-4701/400 Test procedure 403	98.1 m/s² (10 G) 100 Hz–2,000 Hz 20 min sweep; t=2 h for each direction X, Y, Z

* The above chart represents a typical example. Please refer to individual specifications for details.

FAILURE CRITERIA

Item	Measurement conditions	End of service life		Units
		Maximum	Minimum	
Luminous intensity I_V	I_F value of luminous Intensity of each product	–	L×0.5	mcd
Forward voltage V_F	I_F value of forward voltage of each product	U×1.2	–	V
Reverse current I_R	V_R value of reverse current of each product	U×2.5	–	μA

U: Standard maximum value
L: Standard minimum value

RELIABILITY TEST
LED NUMERIC DISPLAYS

RELIABILITY TEST ITEMS

Test item	Standards	Definition
Endurance operational test	EIAJ ED-4701/100 Test procedure 101	Ta=25˚C I_F=maximum rated current t=1,000 h
Solder heat resistance test	EIAJ ED-4701/300 Test procedure 302	260˚C±5˚C, 10 s
Temperature cycling test	EIAJ ED-4701/100 Test procedure 105	Minimum rated storage temperature (30 min)–normal temperature (15 min) –maximum rated storage temperature (30 min)–normal temperature (15 min), 5 cycles
Moisture resistance storage test	EIAJ ED-4701/100 Test procedure 103	Ta=60˚C±2˚C RH=90%±5% t=1,000 h
High temperature storage test	EIAJ ED-4701/200 Test procedure 201	Ta=maximum rated storage temperature t=1,000 h
Low temperature storage test	EIAJ ED-4701/200 Test procedure 202	Ta=minimum rated storage temperature t=1,000 h
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Luminous intensity I_V	I_F value of luminous Intensity of each product	–	L×0.5	mcd
Forward voltage V_F	I_F value of forward voltage of each product	U×1.2	–	V
Reverse current I_R	V_R value of reverse current of each product	U×2.5	–	μA

U: Standard maximum value
L: Standard minimum value

RELIABILITY TEST
PHOTODETECTORS

RELIABILITY TEST ITEMS

Test item	Standards	Definition
Endurance operational test	EIAJ ED-4701/100 Test procedure 101	Ta=25˚C Pc=maximum collector dissipation t=1,000 h
Solder heat resistance test	EIAJ ED-4701/300 Test procedure 301	Pre-heating: 150˚C–180˚C/120 s or less Main heating: 230˚C/40 s or less Peak temperature: 260˚C
Temperature cycling test	EIAJ ED-4701/100 Test procedure 105	Minimum rated storage temperature (30 min)-normal temperature (15 min) –maximum rated storage temperature (30 min)-normal temperature (15 min), 5 cycles
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* The above chart represents a typical example. Please refer to individual specifications for details.

FAILURE CRITERIA

Item	Measurement conditions	End of service life		Units
		Maximum	Minimum	
Photocurrent I_P	E_e=5.0 mW/cm^2 V_R=5 V	U×1.3	L×0.7	mA
Dark current I_D	V_R=10 V	U×2.5	–	μA

U: Standard maximum value
L: Standard minimum value