4 Precautions and Usage Considerations Specific to Each Product Group

This section describes matters specific to each product group that need to be taken into consideration when using devices. If the same item is described in Sections 3 and 4, the description in Section 4 takes precedence.

4.1 Optical Semiconductor Devices

Handling precautions common to all optical semiconductor devices are described in Section 4.1.1. Handling precautions for devices classified by product group are described in Sections 4.4.2 to 4.4.6. When using this brochure, please be sure to read the precautions common to all devices in Section 4.1.1 and those specific to the types of device used in your design.

4.1.1 Precautions Common to All Optical Semiconductor Devices
4.1.2 Visible LEDs (LED lamps, LED displays, LED matrix modules)
4.1.3 Photosensors (infrared LEDs, photodetectors, photointerrupters, photoreflective Sensors)
4.1.4 Photocouplers
4.1.5 Fiber-Optic Devices (TOSLINK®)
4.1.6 Visible Semiconductor Lasers

4.1.1 Precautions Common to All Optical Semiconductor Devices

4.1.1.1 Moisture-Proof Packing

(1) Once unpacked, keep devices in storage at a temperature of between 5°C and 30°C, and at 60% humidity or less. Mount the devices on the circuit board within 48 hours of unpacking.

(2) If 48 hours has elapsed after unpacking or the period of effectiveness for the moisture-proofing has expired, bake the devices before use under the conditions described below:

Recommended baking conditions: 50°C for 48 hours or more. Do not bake devices at temperatures above 50°C as taping packages may be adversely affected.

4.1.1.2 Design

(1) Derating
The life characteristics of optical semiconductor devices are closely associated with the operating temperature, case temperature and operating humidity environment. This requires that in addition to ordinary derating, the relationship between the fluctuation and degradation rates for each of the device's primary characteristics (e.g. luminous intensity, radiant power and current conversion efficiency) and the operating and environment conditions be fully taken into consideration at the design stage.

(2) Fail-safe implementation
If there is a possibility that failure in optical semiconductor devices, degradation of characteristics (e.g. luminous intensity, radiant power, current conversion efficiency or laser light output power) or functional abnormality will impair the safe operation of the system, design a fail-safe measure in accordance with the system's intended use.

4.1.1.3 Inspection, Testing and Evaluation

(1) When inspecting devices, be sure to observe the specifications laid down in the individual datasheets and databooks for the devices used. In particular, the reverse voltage/reverse current characteristics differ between different types of light-emitting material, so if current is forced to flow in the reverse polarity, the rate of failure in device characteristics may be high.

4.1.1.4 Safety Standards

The resin used in packages where light transmissivity is an important characteristic does not meet the combustion resistance requirements set forth in safety standards. Because resin is not self-extinguishing, it not only generates poisonous gases, but will also causes secondary ignition if it burns. The possibility of risk to devices and their packaging material must be taken into account when specifying the ambient environment in which mounting will be performed.

4.1.1.5 Disposal Precautions

For details of the precautions which must be taken when disposing of a particular device, refer to the relevant databook for the device concerned.

4.1.2 Visible LEDs

4.1.2.1 Impact and Vibration

(1) Matrix modules
If an excessive impact is applied to the packing, the relative positions of the display and the drive substrates may shift. In such cases it will not be possible to mount the device on the board at the designated pitch.

4.1.2.2 Design

(1) Uses
LED lamps are designed for display purposes. Using an LED lamp as a light source for a photosensor is prohibited. If a light source for a photosensor is required, choose a device designed specifically for that purpose.

(2) Heat radiation
For display systems configured with an array of multiple visible LED devices, ensure that sufficient heat radiation measures are incorporated. Partial unbalanced heat generation must be taken into consideration, as this may reduce the luminous intensity of LED devices due to their temperature dependency. A reduction in luminous intensity will impair the device's display quality. Moreover, it may give rise to differences in the luminous intensity degradation characteristics between devices.

4.1.3 Photosensors

4.1.3.1 Design

(1) Uses
Using a visible LED lamp as a light source for a photosensor is prohibited. If a light source for a photosensor is required, choose a device designed specifically for that purpose.

(2) Reliability design
The degradation of radiant power in LED devices is closely associated with the device's operating conditions, its package temperature and the level of humidity of the environment in which it is operated. If the degradation of radiant power could seriously degrade system safety, design a safety measure, such as a closed loop control for the radiant intensity using a monitor, or some other similar fail-safe measure.

(3) Dust and oil
If dust accumulates on, or oil sticks to the lens surfaces of a device, the device's optical characteristics will be affected, making it impossible to obtain the designed radiant power or photodetection sensitivity. Also, this dust or oil may generate an adverse chemical reaction with the device, in a similar manner to corrosive gas.

4.1.3.2 Mounting

(1) Cleaning accumulated dust from lens surfaces and checking for level shift
To prevent system malfunction due to the degradation of characteristics caused by accumulated dust on the lens surfaces of light-emitting and photodetecting parts, Toshiba recommends that dust be periodically cleaned off. After cleaning, check to see that the photosensor operates normally, and that no misalignment, such as a level shift, has occurred.

4.1.4 Photocouplers

4.1.4.1 Design

(1) Dust and oil
Dust accumulating on, or oil sticking to devices causes a reduction in the device's dielectric strength between the input and the output. Also, this dust or oil may generate an adverse chemical reaction with the device, in a similar manner to corrosive gas. If a reduction in the input-to-output dielectric strength of a device or an increase in the leakage current through its package could seriously degrade the system's functionality, countermeasures such as resin impregnation must be considered at the design stage.

(2) Observing the guaranteed operation range
The life characteristics of a light-emitting device are closely associated with the device's operating current and package temperature. This requires that in addition to ordinary derating, the relationship between the fluctuation rate of the device's coupling characteristics (e.g. current conversion efficiency and trigger LED current) and the operating current and operating temperature be fully taken into consideration at the design stage.

(3) Combustibility of package resin
The resin used in packages is V0 grade under UL-94 standards. Since this resin is not incombustible, it may emit smoke or ignite if it is scorched or burned. Therefore, do not use devices packaged in this material near articles that may burn, generate heat or catch fire.

4.1.4.2 Inspection, Testing and Evaluation

⚠WARNING When testing the dielectric strength of a photocoupler, use testing equipment which can shut off the supply voltage to the photocoupler. If you detect a leakage current of more than 100 µA, use the testing equipment to shut off the photocoupler's supply voltage; otherwise a large short-circuit current will flow continuously, and the device may break down or burst into flames, resulting in fire or injury.

(1) Dielectric strength of a device between input and output

- (a) Control standards and application limits
  A device's input-to-output insulation performance is stipulated and tested in conformity with the criteria laid down in the American UL and German VDE component standards. The stipulated insulation performance for devices states that the performance retention time is 1 minute. Therefore, use of these devices in applications designed to provide continuous high-voltage insulation for a long time is not recommended.

4.1.4.3 Mounting

(1) Resin impregnation

- (a) Before applying resin impregnation, check that it will not affect the device.
- (b) Before applying resin inpregnation clean off dirt and impurities and dehumidify the device adequately. To ascertain the correct treatment method for resin impregnation, consult the resin manufacturer, informing them of the voltages which are applied between the device's input and output.

4.1.4.4 Usage Environment

(1) Light disruption (e.g. sunlight or strobe flash)
Strong light (e.g. sunlight, a strobe flash or a search light) impinging upon a photocoupler-based system may cause it to operate erratically. Therefore, shield the device from light in a suitable manner, according to the system's intended use.

4.1.5 Fiber-Optic Devices (TOSLINK®)

4.1.5.1 Design

(1) External noise
To improve the noise resistance of an optical receive module (simplex type) or optical transmit/receive module (duplex type) when mounting it on a circuit board, connect the module's package fixing reinforcing pins to SIGNAL-GND. At the same time make sure that the module's package will not touch the power supply lines or any other circuits.

(2) When using an optical transmit or receive module or an optical transmit/receive module in a location that is prone to noise, test the device's noise resistance under actual operating conditions in advance and take the following corrective measures as necessary:

- (a) If power supply ripples are large, increase the performance capability of the noise filter connected to the power supply line.
- (b) Protect the optical transmit or receive module or optical transmit/receive module and the power supply filter with covers to enhance the shielding capability. At the same time make sure that the module's case will not touch the metal cover.

(3) Dust and oil
Devices are not dust-proof. When using a device in a location that is prone to dust or in a location where oil may be splashed, incorporate some kind of dust-proofing cover into the design which will protect everything: the optical transmit/receive module, the connected optical fibers and all fiber-optic connectors.

(4) Vibration
When mounting optical modules in equipment which will be subject to vibration, resonance or mechanical shock, incorporate a structural measure into the design to alleviate the effects of these external phenomena. In particular, if a system incorporating optical fibers (and fiber-optic connectors) is subjected to vibration or mechanical shock, the optical module's package fixing reinforcing pins may be sheared by inertial stress. Extreme care must be taken in this kind of situation.
Optical modules in ceramic packages are hollow and therefore require even more protection from vibration, resonance and mechanical shock than resin molded devices.

(5) Laying optical fiber cables
When laying optical fiber cables, bend them at 6 to 10 times the stipulated minimum bending radius.

4.1.5.2 Inspection, Testing and Evaluation

(1) Optical receive module output pins
Do not connect the output pins directly to the power supply or GND. Otherwise a large current may flow into the device's internal chip, causing it to break down.
If the output pins need to be pulled up or down, connect a resistor between the pin and the power supply or ground. For an explanation of how to choose the resistance value, refer to the relevant individual datasheets and databooks for the devices concerned.

4.1.5.3 Mounting

(1) Soldering
Since optical transmit/receive modules are optical components, do not use a soldering method affected by a flux to mount them on the board. Cleaning of these devices is not recommended either. For this reason, when optical transmit/receive modules are to be mounted along with other circuit components on a printed circuit board, solder on the other components, clean the board and then solder the optical transmit/receive modules using a soldering iron.

4.1.5.4 Maintenance

(1) Protective caps
When an optical module is not in use, attach a protective cap to the socket of each optical connector. Light (including external light) impinging on an optical module which is not in use (in particular an optical receive module) may adversely affect other circuits.

(2) Toshiba recommends that you stipulate in your system maintenance documentation that the system's combined fiber-optical output power be periodically checked.

4.1.6 Visible Semiconductor Lasers

4.1.6.1 Design

⚠WARNING When incorporating a visible semiconductor laser into a design, use the device's internal photodetector or a separate photodetector to stabilize the laser's radiant power so as to ensure that laser beams exceeding the laser's rated radiant power cannot be emitted.

If this stabilizing mechanism does not work and the rated radiant power is exceeded, the device may break down or the excessively powerful laser beams may cause injury.

(1) Heat radiation
Large amounts of heat emanate from the PN junctions of semiconductor lasers, necessitating a certain level of heat radiation. Normally semiconductor lasers are constructed in such a way that the heat generated is efficiently conducted to the flange section of the package. Therefore, the requisite external heat sink in your design must be in full contact with the flange section.

(2) Power supplies and external noise
Before a device is operated, check that the device's maximum ratings are not exceeded due to spike currents generated when the power is turned on or off. If chattering or overshoot is observed, incorporate a filter (e.g. an RC circuit) or a soft start circuit into your design to eliminate this type of noise.
Moreover, if the input/output signal lines of the radiant power control component are long, the radiant power ratings may be exceeded due to induced noise or surges from external sources, causing the device to break down. For this reason, Toshiba recommends carrying out noise simulation and implementing appropriate protective measures based on the results.

(3) Laser beams
The laser beams emitted from a device are extremely dangerous if they impinge directly upon human eyes. This is highly likely to impair vision, and in the worst case, may cause blindness. Therefore, when designing equipment that incorporates laser devices, include proper handling and safety precautions according to IEC standards IEC60825-1 in the user's manuals and in the instructions for workers who will be involved in inspection, testing and adjustment of the equipment.

4.1.6.2 Inspection, Testing and Evaluation

⚠CAUTION When a visible semiconductor laser is operating, do not look directly into the laser beam or look through the optical system.

This is highly likely to impair vision, and in the worst case, may cause blindness. If it is necessary to examine the laser apparatus, for example, to inspect its optical characteristics, always wear the appropriate type of laser protective glasses according to IEC standard IEC60825-1.

4.1.6.3 Mounting

(1) When fitting a device to a heat sink, secure it by its flange. Do not fit a device in such a way that the device's cap will be nipped by the heat sink, as this will cause the window glass to break. When fixing a device's flange to the heat sink with screws, use a fastening torque of approximately 0.8 N·m and evenly tighten all the screws in stages (i.e. do not fully tighten one screw while the rest are still only loosely tightened).

(2) Device packages are hermetically sealed. Applying excessive stress to the lead-to-case junctions and glass surfaces will cause the hermetic seal to degrade.

(3) Be careful not to scratch or stain the window glass. The device's radiant power may decrease or the farfield pattern may become deformed. Avoid wiping the glass surface with cotton swabs etc. to remove accumulated dirt as this could cause damage to the glass.

(4) Avoid cleaning devices. Not only does cleaning reduce the adhesive strength of the window glass, but it also causes the device's radiant power to decrease or the farfield pattern to become deformed due to impurities adhering to the window glass.

4.2 Power Devices

4.2.1 Vibration and Impact

Use caution when handling devices and packing. Dropping devices or packing, or subjecting them to impact, may cause devices to break down. Be especially careful not to subject devices and packing to mechanical vibration or shock.
Some modules contain direct bond copper (DBC) ceramic boards. In addition, some high-power device packages are made of ceramics. High-power devices are heavy; if they are dropped, the ceramic may be damaged (i.e. it may crack).

4.2.2 Design

⚠WARNING

① Do not use devices under conditions in which their absolute maximum ratings (e.g. current, voltage or safe operating area) will be exceeded.
If used under these conditions, a device may break down, causing a large short-circuit current to flow, which may in turn cause it to catch fire or explode, resulting in fire or injury.

② Use a unit which can detect short-circuit currents and which will shut off the power supply if a short-circuit occurs. If the power supply is not shut off, a large short-circuit current will flow continuously, which may in turn cause the device to catch fire or explode, resulting in fire or injury.

③ When designing a case for enclosing your system, consider how best to prevent the user from shrapnel in the event of the device catching fire or exploding. Flying shrapnel can cause injury.

④ Make sure that all metal casings in your design are grounded to earth.
Even in modules where a device's electrodes and metal casing are insulated, capacitance in the module may cause the electrostatic potential in the casing to rise. Dielectric breakdown may cause a high voltage to be applied to the casing, causing electric shock and injury to anyone touching it.

⑤ When designing the heat radiation and safety features of a system incorporating high-speed rectifiers, remember to take the device's forward and reverse losses into account.
The leakage current in these devices is greater than that in ordinary rectifiers; as a result, if a high-speed rectifier is used in an extreme environment (e.g. at high temperature or high voltage), its reverse loss may increase, causing thermal runaway to occur. This may in turn cause the device to explode and scatter shrapnel, resulting in injury to the user.

4.2.2.1 Unused Pins

If a device is used with its unused pins left open, device operation may become unstable or the device may operate erratically. Connect unused signal pins to the power supply voltages used for signals. Apply a negative gate voltage of 10 V or more to the gate terminals of IGBTs, to make them resistant to breakdown voltages and voltage fluctuations.

4.2.2.2 Latch-up

Some types of IGBT do not have sufficient tolerance against load shorting or overcurrent, resulting in a fault condition called "latch-up". When choosing an IGBT, check its intended use.

4.2.3 Inspection, Testing and Evaluation

⚠ DANGER

① Never touch a power device while it is powered on. Also, after turning off a power device, do not touch it until it has thoroughly discharged all remaining electrical charge.
Touching a power device while it is powered on or still charged could cause a severe electric shock, resulting in death or serious injury.

② When conducting any kind of evaluation, inspection or testing, be sure to connect the testing equipment's electrodes or probes to the device under test before powering it on. When you have finished, discharge any electrical charge remaining in the device.
Connecting the electrodes or probes of testing equipment to a device while it is powered on may result in electric shock, causing injury.

⚠WARNING

① When conducting any kind of evaluation, inspection or testing, always use protective safety tools such as a cover for the device.
A device may explode, catch fire or generate sparking between an electrode and ground, resulting in injury to the user.

② Make sure that all metal casings in your design are grounded to earth.
Even in modules where a device's electrodes and metal casing are insulated, capacitance in the module may cause the electrostatic potential in the casing to rise. Dielectric breakdown may cause a high voltage to be applied to the casing, causing electric shock and injury to anyone touching it.

⚠CAUTION

When conducting any kind of evaluation, inspection or testing, either wear protective gloves or wait until the device has cooled properly before handling it.
Devices become hot when they are operated. Even after the power has been turned off, the device will retain residual heat which may cause a burn to anyone touching it.

4.2.3.1 Inspection

For protection against static charges, the gate and emitter terminals of IGBT modules are protected with conductive copper tape. Do not use them as shorted gate and emitter terminals for test purposes.

4.2.4 Mounting

Power devices are housed in various types of package, such as modules, lead insertion packages, surface-mount packages and flat-type packages. The signal pins and the method of attaching the package to a heat sink (e.g. screwing, soldering or direct bond) are different for each type of package. For the screwing and direct bond heat sink attachment methods, there is a recommended tightening torque; in these cases all the screws must be tightened evenly (i.e. one screw should not be fully tightened while the rest are still only loosely tightened). Similarly, soldering should be performed with caution so that no thermal stress is applied to the device. To ensure that device reliability will not be impaired, devices must be fitted so that they remain within stipulated torque and stress limits. For details of these limits, refer to the relevant individual datasheets and databooks for the devices used.