

General Precautions:

1. Special wavelength diodes and especially diodes in the red are much, much more susceptible to damage than standard infrared diodes.
2. Think about how you are employing the diodes to make sure you are doing everything possible to get a long lifetime. We want you to have a success using these products.
3. Keep the diodes *clean*. They should not be operated in an environment where dust particles in the air can reach the active region (output facet) of the diode.
4. Keep the output facet (which emits light) *dry*. If you store the unit in a high humidity, the optical coatings can be damaged and render the diode useless.
5. Operating the laser diode at a *temperature lower* than recommended will usually slightly increase the output power (higher efficiency) and improve lifetime.
6. Operating the laser diode at a *temperature higher* than recommended will increase the threshold current and decrease the slope efficiency.
7. Laser diodes need to be operated with an *approved power supply/driver* or they may be damaged and/or destroyed quickly. Off-the-shelf drivers can deliver a high spike of current at turn-on, and they can deliver a very short duration reverse biasing when the unit is turned off. Either of these will damage and/or destroy the diode laser.
8. The power supply/driver should be current-regulated and specifically designed for laser diodes. The power supply should create no surges or spikes, no reverse voltages and should not have any ringing. Many poorly designed power supplies have voltage transients during turn-on, turn-off, or in the case of power failure.
9. Never make the connection to the laser diode with the power supply voltage on. Most laser diode power supplies have provision to disable the supply and short the output to allow for connection of the diode.
10. Laser diodes are very sensitive to damage by electrostatic discharge (ESD), or other voltage transients. The laser should be handled using static-safe procedures when it is taken out of its static-protective shipping container. When the laser is not connected to a power supply, the user should short the anode and cathode together to prevent static damage.
11. Some laser diodes are susceptible to damage from *back reflections* into the device. This is more the case with lower wavelength material than with higher wavelengths. Thus, if attempting to collimate the output, care must be taken to avoid back reflections.
12. The emission wavelength changes with temperature: the wavelength changes about +1 nm for every 6° C increase in temperature. This value varies by wavelength.

Thermal Management Precautions:

1. *Heat*: This is the biggest cause of field failures.
2. Some laser diodes are more sensitive than others to the operating temperature. Red laser diodes tend to be more temperature sensitive than the infrared laser diodes.
3. Many customers do not appreciate the importance and/or the complexity of removing waste heat.
4. Because operating temperature has a strong influence on laser lifetime, the heatsinking of the laser package is of tremendous importance and doing it well is not as simple as many assume it is.
5. Waste heat must be removed efficiently and instantaneously, or the laser will heat up and burn out, or, as a minimum, experience an abbreviated lifetime.
6. The laser can be operated at higher temperatures than recommended, but the lifetime of the laser is reduced exponentially as the operating temperature is increased.
7. The diode package should be attached to a heatsink plate at least several millimeters thick.
8. The heatsink must be capable of dissipating the waste heat generated by the laser diode. High power laser diodes are typically 10 – 50% efficient at converting electricity into light. The remainder of the electrical input power is dissipated as heat. Therefore, there may be several watts of waste heat generated by the laser. Because so much heat is generated within the small area, it is critical that the laser is securely connected to an adequate heatsink
9. The best heatsink material is copper, but aluminum is also a fair heat conductor. If aluminum is used, the surface should not be anodized in the region where the laser package makes contact with the heatsink. The aluminum oxide anodized coating makes an effective thermal insulator.
10. The surface of the heatsink should be machined flat and smooth where it will contact the back of the laser package to allow for efficient heat transfer.
11. Thermal compound, or an indium foil washer can be used to reduce the thermal impedance of this interface. Our experience is that indium foil offers negligible improvement over a good copper-to-copper interface. In permanent installations, some improvement of the heatsinking can be achieved using a silver-filled epoxy at this interface. If silver-filled epoxy is used, it should be a “space qualified” low outgassing. To avoid contamination of the laser facets (Epoxy Technology H21D, for example)
12. The heatsink may be cooled by air, water, or thermoelectric coolers. Depending on the type of laser, an air-cooled heatsink may provide sufficient cooling, as long as the application does not require stability of the laser wavelength and output power. Most often, active cooling of the heatsink must be used. Active cooling usually is either water-cooling, or thermoelectric coolers (TEC’s).
13. Finally, when testing out a heatsink configuration, it is wise to test the temperature drop between the laser package and the heatsink using a very small thermocouple touched against the base of the package. The temperature drop during laser operation should be only 1-2 ° C.

Precautions for Free Space Packages:

1. Free space packages can be either a simple open heatsink or a sealed TO can type package. With open heatsinks there is no protection for the delicate laser chip. The laser chip is very fragile and must be protected from any mechanical contact. The exposed laser facets (mirror coatings) must not be contaminated with any foreign material. Facet contamination can cause immediate and permanent damage to the laser. You should not blow on the laser, or expose the laser to smoke, dust, oils, or adhesive fumes.
2. The laser facets are sensitive to accumulation of dust. When the laser is operating, dust particles tend to be attracted to the laser facet. As the dust particles enter the intense optical field at the laser facet, they burn, and the residues accumulate in the laser facet. Unless the laser is operated in a true “class 100” clean-room environment, this dust accumulation will occur, even in a seemingly clean “lab environment. This kind of contamination does not occur very rapidly, but over several hundred hours of operation in a normal room environment, an open heatsink laser will show tiny “specks” on the lasers facet under microscopic examination. These will gradually degrade the laser prematurely. If an open heatsink laser is to be operated outside of a clean-room for more than short periods, it should be packaged within a sealed container to prevent this dust accumulation. This does not require a true hermetic sealing of the laser. An epoxy seal or o-ring seal around the laser assembly is perfectly sufficient.

C-Mount Package:

1. To operate, the C-mount must be screwed down securely to a heatsink using a #2-56 (English) or M-2 (metric) screw. The C-mount has a swallow counterbore around the mounting hole, for applications which require close mounting of a component in front of the laser. A shallow binding head screw, or a button head cap screw can be used in this situation.
2. Thermal grease should not be used with a C-mount. Most thermal greases tend to “creep” and the material will eventually contaminate the diode facets.
3. The copper C-mount is the laser diode anode (+) terminal, so the power supply anode connection is best made to the heatsink. Do not attempt to solder directly to the copper C-mount. The laser diode cathode (-) terminal is the wire lead attached to the C-mount. Connection to this lead can be made either by soldering, or by using a small, high quality, spring contact socket. The best sockets of this type have four contact fingers, and the fingers are gold-plated (see for example parts made by Mill-Max).
4. Great care must be used if soldering to the cathode wire lead. The soldering is best done with the C-mount already attached to the heatsink. This will prevent the body of the laser from heating up excessively. The cathode lead itself can withstand high temperature, but the main part of the laser

Precautions for Free Space Packages:

C-Mount Package: (cont)

block must remain $<120^{\circ}\text{C}$. During soldering, the laser can also be damaged by contamination of the laser facets with solder flux fumes. Typical rosin-core electronics solder generated a cloud of smoke when it is melted. This smoke will coat the laser facets, and if the laser is then operated, permanent facet damage can occur. If it is necessary to solder near the laser diode, the diode should be covered to prevent this contamination. One method is to use a piece of aluminum foil to loosely cover or block-off the area around the laser chip. The chip and the wire bonds are very fragile, so the foil must be applied carefully, without actually contacting the laser chip.

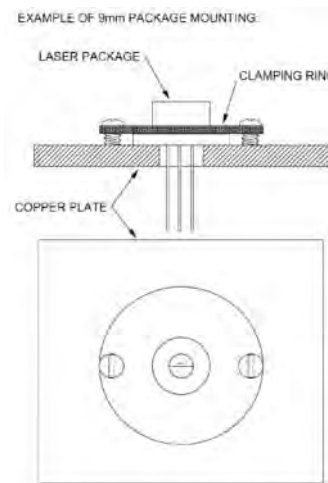
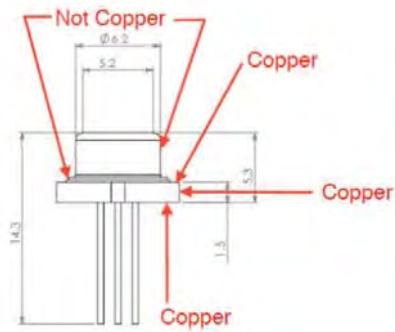
Q-mount, B-mount, Chip on Submount (COS) and other open heatsinks:

1. To operate, these open heatsinks must be securely attached to a heatsink.
2. Thermal grease should not be used with open heatsinks. Most thermal greases tend to “creep” and the material will eventually contaminate the diode facets.
3. Attaching these open packages to a heatsink is critical. This can be accomplished by either using a low temperature solder or a silver-filled epoxy at this interface. If silver-filled epoxy is used, it should be a “space qualified” low outgassing. To avoid contamination of the laser facets (Epoxy Technology H21D, for example). Great care must be used if soldering the package to the heatsink. The laser must remain $<120^{\circ}\text{C}$ to prevent the laser from reflowing and/or damaging the laser. During soldering, the laser can also be damaged by contamination of the laser facets with solder flux fumes. Typical rosin-core electronics solder generated a cloud of smoke when it is melted. This smoke will coat the laser facets, and if the laser is then operated, permanent facet damage can occur. The laser diode should be covered to prevent this contamination. One method is to use a piece of aluminum foil to loosely cover or block-off the area around the laser chip. The chip and the wire bonds are very fragile, so the foil must be applied carefully, without actually contacting the laser chip.

Precautions for Free Space Packages:

9mm Package

1. It is important for good heat extraction from the 9mm laser package that the Copper portion of the base must be in good contact with the heatsink.
2. Not all parts of the 9mm package are made of Copper. See below drawing 1, which indicate the Copper portion of the base. The window cap, and the portion of the base to which it is attached, are made of Steel, which is a poor thermal conductor.



TO-3 Package, HHL Package and other sealed packages

1. The package must be screwed down to a heatsink that can dissipate the heat generated by the laser and the TE cooler, if installed.
2. The heatsink should be cooled well enough that the temperature rises to no more than 40-45°C during operation.
3. The surface of the heatsink should be machined flat and smooth so that the base of the package is not bent when the screws are tightened. Screwing the package to a heatsink that is not flat could potentially fracture the TE cooler inside of the package.
4. A layer of thermal grease between the package and the heatsink is suggested to improve the heat dissipation. When using thermal grease, tighten the mounting screws gently at first to allow excess grease to squeeze out the edges.
5. The laser chip is oriented so that the wide dimension (i.e. 150um) is along the x direction, The narrow dimension (I.e. 1um) is along the Y directions

Precautions for Fiber Coupled Packages:

Fiber Coupled Packages:

1. The package must be screwed down to a heatsink that can dissipate the heat generated by the laser and the TE cooler, if installed.
2. The heatsink should be cooled well enough that the temperature rises to no more than 40-45°C during operation.
3. The surface of the heatsink should be machined flat and smooth so that the base of the package is not bent when the screws are tightened. Screwing the package to a heatsink that is not flat could potentially fracture the TE cooler inside of the package.
4. A layer of thermal grease between the package and the heatsink is suggested to improve the heat dissipation. When using thermal grease, tighten the mounting screws gently at first to allow excess grease to squeeze out the edges.
5. Special care needs to be taken with fiber pigtailed laser diodes. The fiber should be exceed the minimum bend radius of the fiber. The minimum bend radius is defined by the fiber type and core diameter.
6. Typically the fiber is terminated with a SMA connector. The cap should be replaced if the laser is not in use. The end of the fiber is very susceptible to damage if it is not handled correctly. The fiber end should be inspected prior to starting the laser. Insure there is not particles on the end of the fiber. All particles on the end of the fiber will become damage spot once the laser is turned on.