AN-01 LASER DIODES IN THE C-MOUNT PACKAGE

The C-mount package laser is a simple open heatsink, and there is no protection for the delicate laser chip. The semiconductor crystal and the wire bonds are very fragile, and the chip 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.

The laser facets are sensitive to accumulation of dust. When the laser is operating, dust particles tend to be attracted the laser facet. As the dust particles enter the intense optical field at the laser facet, they burn, and the residues accumulate on 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 laser facet under microscopic examination. These will gradually degrade the laser prematurely. If the C-mount 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 true hermetic sealing of the laser. An epoxy seal or O-ring seal around the laser assembly is perfectly sufficient. The laser could also be operated inside a chamber purged with a low flow of clean dry air.

As with all laser diodes, C-mount lasers are very sensitive to damage from static electric charges. Laser diodes should always be handled using standard static-avoidance practices. When possible, the laser diode anode and cathode leads can be shorted together for protection when the laser is not connected to a driver. The laser should be operated from a high-quality constant-current driver which is designed for use with laser diodes. Such drivers include protection circuitry to prevent damaging spikes, turn-on and turn-off transients, over-limit currents, reverse biases, etc.

To operate properly, the C-mount must be screwed down securely to a heatsink. The heatsink must be capable of dissipating the waste heat generated by the laser diode. High power laser diodes are typically 10 to 50% efficient at converting electricity into light. The remainder of the electrical input power is dissipated as heat. Thus, there may be several watts of waste heat generated by the laser. Because so much heat is generated within the small space of the C-mount package, it is critical that the laser is securely connected to an adequate heatsink.

Some laser diodes are more sensitive than others to operating temperature. Red laser diodes tend to be more temperature sensitive than infrared laser diodes. 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, the stability of the laser wavelength and output power are important, and active cooling of the heatsink must be used. Active cooling usually is either water-cooling, or thermoelectric coolers (TEC's).

If the laser will be operated below room temperature, condensation of moisture on to the bare laser can be a problem. Condensed moisture on the laser facets can lead to permanent damage. If the C-mount must be operated at temperatures below the dew-point of its environment, it should be housed in a protective enclosure that is purged with dry gas (air or nitrogen), or in a sealed enclosure that is filled with dry gas. Solid desiccant materials can be used to dry the air in a sealed enclosure.

For most efficient heat transfer, the heatsink should be made from Copper or Aluminum. The Aluminum should not anodized in the mounting area (an anodized layer is a good thermal insulator). The surface of the heatsink should be machined flat and smooth where it will contact the laser package to allow for efficient heat transfer**. Thermal grease should not be used with a C-mount laser**. Most thermal greases tend to "creep" and the material will eventually contaminate the laser facets.

The C-mount should be attached to the heatsink using a small screw with a #2–56 (english) or M2 (metric) thread. The C-mount has a shallow 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.

Some people advocate using a piece of thin (.001") Indium foil between the laser and the heatsink, but it is our experience that this offers negligible improvement over a good Copper-to-metal interface. The use of Indium foil can lead to distortion of the soft Copper C-mount. In permanent installations, some improvement of heatsinking can be achieved using a thermally-conductive, Silver-filled epoxy between the C-mount and the heatsink. If Silver-filled epoxy is used, it should be a "space-qualified" low-outgassing epoxy, to avoid contamination of the laser facets (Epoxy Technology H20E, for example).

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 fly-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). **Great care must be used if soldering to the cathode wire lead**. The soldering is best done with the C-mount already attached to its heatsink. This will prevent the body of the laser from heating up excessively. The laser chip is attached to the heatsink with Indium solder, which melts at 157 °C. The cathode fly-lead can withstand high temperatures, but the Copper body of the C-mount should remain below ~120 °C.

During soldering, the laser can also be damaged by contamination of the laser facets with solder flux, or flux fumes. Typical rosin-core electronic solder generates 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.