AN-19 LASER DIODES IN THE COS PACKAGE

The COS (Chip On Submount) package laser uses a simple open heatsink, with 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 dust accumulation. When the laser is operating, dust particles tend to be attracted to the laser facet. As dust particles enter the intense optical field at the laser facet, they burn, leaving residues that accumulate on the facet. Unless the laser is operated in a true “class 100” clean room environment, dust accumulation will occur, even in a seemingly clean “lab” environment. This kind of contamination does not occur 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 COS laser is to be operated outside a clean room for more than short periods, it should be packaged in a sealed container to prevent 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, COS 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 with a high-quality constant-current driver designed for 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 COS must be attached 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 only 10-50% efficient at converting electrical energy into light. The remaining 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 COS package, it is critical that the laser is securely connected to an adequate heatsink.

The COS consists of a layer of thermally-conductive ceramic (BeO or AlN), with a thick layer of Copper on the top and bottom surfaces. The laser chip is soldered to the COS with either AuSn solder or with Indium solder. Most COS devices use AuSn solder, but certain stress-sensitive chips must use Indium solder chip attachment. Devices soldered with AuSn can tolerate short-term temperature excursions up to 270 °C. Devices soldered with Indium can only tolerate short-term excursions to 150 °C.

Some laser diodes are more sensitive to operating temperature than others. 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 heatsink cooling must be used. Active cooling is usually either water cooling or thermoelectric coolers (TECs).

If the laser is operated below room temperature, moisture can condense onto the bare laser, causing problems. Condensed moisture on the laser facets can lead to permanent damage. If the COS must be operated at temperatures below its environment's dew point, it should be housed in a protective enclosure purged with dry gas (air or nitrogen) or in a sealed enclosure filled with dry gas. Solid desiccant materials can be used to dry the air in a sealed enclosure.

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

Proper attachment of the COS to a heatsink can be tricky. Mechanical clamping can be used to press the mount against the heatsink. This is sometimes adequate, but only for lower power devices with power dissipation less than a couple of watts. Excessive mechanical clamping force can crack the ceramic of the COS and damage the device. Attachment to a heatsink can also be achieved using a good thermally-conductive, Silver-filled epoxy between the COS 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). Soldering of the COS to a heatsink is an option only for devices soldered with AuSn. Fluxless SnAg soldering would typically be used. Given the temperature restrictions imposed by Indium solder chip attachment, solder options are limited and would typically require flux. Flux residues would contaminate the laser facets.

Our experience is that a COS attachment with solder offers little thermal advantage over Silver-filled epoxy. In most cases, solder attachment is not worth the extra difficulty.

The COS has both the laser anode and cathode on the top surface. Both the anode and cathode are electrically isolated from the bottom surface of the COS. We recommend against soldering directly to the COS. Electrical connections to the COS are most commonly made using wire bonding to a nearby standoff or trace. Spring-loaded pogo pins can also be used to make electrical connections.