How to Improve Laser Diode Lifetime

Advice and Precautions on Mounting

Overview:

Laser diodes have increased in output power and the increased power means added waste heat to contend with. The mounting or heatsinking of the laser package is of tremendous importance because operating temperature has a strong influence on laser lifetime and performance. Achieving correct mounting or heatsinking of the laser package effectively is not as simple as many would assume. This article will discuss the various package types and the best practices for ensuring the laser diode is mounted correctly. Making sure the laser diode is mounted correctly will ensure the best performance and longest lifetimes.

Laser Diodes (Semiconductor Lasers):

Laser diode is a generic term that includes several different semiconductor lasers and many additional types of housings or packages for these semiconductor lasers. The more common types of semiconductor lasers include:

1. **Fabry-Perot Laser Diodes** – This is the simplest form of laser diode, typically called edge emitters. These lasers can be single mode or multimode or used as an array of emitters (bar) to achieve much higher powers. Available in the UV, visible, and infrared wavelengths.

2. **Stabilized Laser Diodes** – This family of laser diodes utilizes an optical element to introduce feedback into the laser cavity. This feedback mechanism can be internal or external to the actual laser cavity. Some examples include; Distributed Bragg Reflector (DBR) lasers, Distributed feedback (DFB) lasers, and external-cavity (EC) lasers. Available primarily in the visible and infrared wavelengths.

3. **Vertical-Cavity Surface Emitting Lasers (VCSEL)** – VCSELs have the optical cavity perpendicular to the mounting surface. VCSELs have advantages such as circular beam profile and reduced speckle. Available in the visible and infrared wavelengths.

4. **Quantum Cascade and Interband Cascade Lasers** – Available in the mid-infrared wavelengths.

These semiconductor lasers are called laser diodes and most, if not all, of the advice and mounting procedures discussed below, are applicable for all laser diodes.

Laser Diode Housings and Packages:

Most of the laser diode types discussed above are available in many different housings or package types, depending on the output power of the laser and the options needed. We will group these packages types into the following groups: Open Packages, Sealed Packages, and Fiber Coupled Packages. Each of these groups has some specific requirements and concerns to achieve the best performance. Before we get to the specifics for each package group, here are some general advice and precautions that should be taken for all laser diodes.

General Advice and Precautions for all laser diodes:

1. **Laser Classification** – You should know the classification of your laser and take the necessary precautions to avoid direct or indirect laser light. Moderate and high-power lasers are potentially hazardous because they can burn the retina of the eye or even the skin. To control the risk of injury, various specifications, for example, 21 Code of Federal Regulations (CFR) Part 1040 in the US and IEC 60825 internationally, define "classes" of laser depending on their power and wavelength.

2. **Eye Safety** – Working with lasers can be dangerous, especially to the naked eye. Laser goggles, protective enclosures, etc. should be used in addition to safety equipment such as “laser active” signs, door interlocks, and switches. Ideally, diode lasers should be operated in a light-tight box, the door of which should be equipped with a switch, that shuts down the diode laser when the door is opened.
3. **Electrostatic Discharge (ESD)** – Most all laser diodes are very sensitive to damage by electrostatic discharge (ESD), or other voltage transients. ESD procedures are required when handling laser diodes. During shipment, the laser diode will be in a conductive plastic bag, and when possible, the anode and cathode electrical contacts shorted together to prevent ESD damage. When the laser is not connected to a power supply, the user should also short the anode and cathode electrical contacts. All persons and tools that may contact the laser must be continuously grounded.

4. **Unpacking** – Before opening the conductive plastic bag, diode lasers should be kept for at least 4 hours in the room where the bag will be opened to achieve thermal equilibrium. The protective bag should only be opened in a clean environment. The handling personnel and the tools used for handling must be grounded for ESD-protection purposes. During handling the personnel should wear clean gloves and use plastic tweezers to avoid contaminating the facets of the laser. Some lasers may be secured to a transport plate by fixing screws. Understand which screws are fixing screws and which screws are part of the assembly. Do not loosen the assembly screws which keep the diode laser together. The fixing screws may also be the short-circuit between the anode and cathode electrical contacts to prevent ESD damage. The laser diodes must be kept in a clean and dry atmosphere with a temperature range of 0°C to 60°C once removed from the shipping containers.
5. **Cleaning** – Solvents, plastics, glues and heat conductive paste are not allowed near the laser diodes. These substances can outgas and deposit on optical surfaces including the laser diode facets. The laser diode front facet is extremely sensitive and must be kept free of dust, water, and any other kind of contamination. Any contact to the laser front facet will lead to irreversible damage and failure of the laser diode, even if there is no sudden failure. There is no way to clean the front facets by neither solvents nor by mechanical tools. The semiconductor crystal and its coatings are very sensitive to any kind of solvents and liquids. Do not touch the laser front facet with any object!
6. **Laser Diode Driver** – Laser diodes need to be operated with an approved laser diode driver that is current regulated and specifically designed for laser diodes. Off-the-shelf power supplies can deliver a high spike of current at turn-on, and/or deliver a very short duration reverse biasing when the unit is turned off. Either of these will damage or destroy the diode laser. Laser diodes are very sensitive to current and voltage spikes. Under all circumstances, spiking must be ruled out both for switching on and off and during the operation of the diode laser. The residual ripple

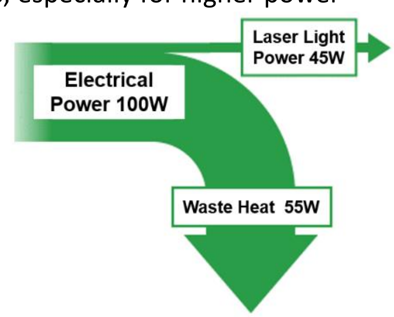
of the current must not exceed a value of ± 10 %. The diode driver should also include a safety circuit that, in the case of faults, allows the system to be switched off within approx. 100 ms. Faults are all conditions which put the safety of persons or the device at risk.

7. **Electrical Connections** – Most laser diode drivers have provision to disable the supply and short the output to allow for connection of the diode. Never make the connection to the laser diode with the power supply voltage on.
8. **Thermally-conductive Compounds** – Pastes are typically not recommended for lasers. The liquids contained in these pastes liberate gas over time and can deposit on optical surfaces. Also, over time the initially homogeneous distribution of the paste can change to a mixture of conductive and non-conductive areas. This will impair the heat transfer from the laser.
9. **Back Reflections** – Some laser diodes are susceptible to damage from back reflections into the device. This is more common with lower wavelength material than with higher wavelengths. Thus, if attempting to collimate the output, or if there are optical components in the optical path, care must be taken to avoid back reflections. This can be more of an issue with fiber coupled or FAC lensed lasers because the optics help focus the back-reflected light into the laser.
10. **Flammability** – All objects exposed to laser radiation are subject to heating by the absorption of radiation power. Preclude exposure of flammable and/or combustible material to the radiation.

11. **Noxious Substances** – By the interaction of laser radiation with exposed materials, substances may be generated in the form of aerosols, gases and/or dust, which are injurious to health. Therefore, an appropriate exhaust device should be installed, and care needs to be taken to adequately clean the exhaust air for the specific application.
12. **Laser Lifetime -** By general, the end of life of a high-power diode laser is reached at the point in time at which the output power at constant current shows a reduction of 20%. To counter the effect of power loss, the operation current can be increased by up to 20% to maintain the nominal optical output power. This laser diode lifetime rule is defined differently on some types of laser diodes.

General Thermal Management Advice and Precautions:

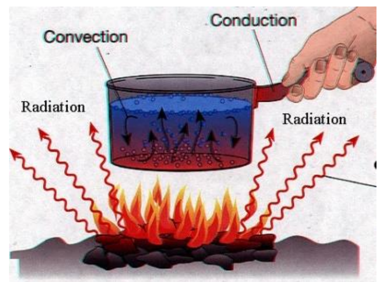
1. **Waste Heat -** Many customers do not appreciate the importance and/or the complexity of removing waste heat. Heat is the biggest cause of field failures, especially for higher power laser diodes. Waste heat must be removed efficiently and instantaneously, or the laser will be catastrophically damaged or, as a minimum, experience a shortened lifetime. You must ensure the laser diode has an adequate heatsink for the waste heat produced. A simple method for determining the amount of waste heat is to take the total input power (Amps*Voltage=Input Power Watts) minus the optical output power (Watts). The balance is the watts of max waste heat. Depending on the semiconductor laser type and wavelength, laser diodes are typically 10 – 60% efficient at converting electricity into light. This heat is generated within a small area, it is critical that the laser is securely connected to an adequate heatsink.



2. **Operating Temperature –** Most lasers have a recommended operating temperature and a location where this temperature is measured. If the laser is operated at a temperature higher than recommended, the lifetime of the laser is reduced exponentially as the operating

temperature is increased above the recommended temperature. Diode laser degradation accelerates with increased temperature.
For many laser diodes, operating at a temperature lower than recommended can slightly increase the output power (higher efficiency) and/or improve lifetime. Therefore, the operating temperature should be minimized when possible, but lowering the diode laser temperature below 15 °C is only suitable in a hermetically sealed housing with dry inert atmosphere (e.g. Nitrogen). Condensation will irreversibly damage laser diodes.

3. **Heatsinks -** Most all laser diode packages will need some sort of heatsinking. The heatsink must be capable of dissipating the waste heat generated by the laser. Lower power devices may only need to be mounted to a baseplate, higher power devices will need a more substantial heatsink or a forced air finned heatsink, and laser diodes arrays (bars) may need active cooling to handle the waste heat. The best heatsink material is copper, but aluminum is also a suitable heat conductor. If aluminum is used, the surface should not be anodized in the region where the laser package contacts the heatsink. The aluminum oxide anodized coating makes an effective thermal insulator. The surface of the heatsink should be machined flat and smooth where it will contact the mounting surface of the laser package to allow for efficient heat transfer. The heatsink surface should be finely milled or lapped (flatness: 0.5 µm, roughness: 0.5 µm), clean and free of scratches to guarantee good thermal contact.



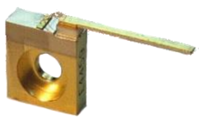
The heatsink may be cooled by air, water, or thermoelectric coolers. Depending on the type of laser, an air-cooled heatsink may provide sufficient cooling. If sized correctly, an air-cooled heatsink can maintain an operating temperature a few degrees above your ambient temperature. If the ambient temperature changes, so do the heatsink temperature. This temperature change will not provide stability of the laser wavelength and output power. Most often, active cooling of the heatsink must be used. Actively cooled heatsinks offer much better heatsinking performance and introduce temperature control into the system. Active cooling usually is either water-cooling or thermoelectric coolers (TEC's). The simplest design of an actively cooled heatsink is a metal plate with a cooling hole which allows coolant to flow thru the heatsink. Usually, water is used as a coolant, for ecological reasons and because of its high heat capacity.
4. **Thermal spacer -** An indium foil spacer can be used to reduce the thermal impedance of the laser package to heatsink interface. Our experience is that indium foil offers a 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).
5. **Temperature Drop Check-** 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 to the base of the laser package. The temperature drop during laser operation should be only 1-2° C.
6. **Wavelength Check –** Another test for the heatsink configuration is to check the laser emission wavelength at the specified current and operating temperature. A much longer wavelength than specified on the data supplied with the laser indicates bad thermal contact and thermal overload of the diode laser. The thermal contact must be improved before continuing laser operation. The laser emission wavelength will change with operating temperature: the wavelength increases approximately 1nm for every 4° C temperature increase (~0.25nm/K). This value varies by wavelength.

Advice and Precautions for Open Packages:

Open heatsinks provide no or minimal protection for the delicate laser chip. The laser chip is very fragile and must be protected from any mechanical contact or contamination. For long lifetimes, the exposed laser facets (mirror coatings) must not be contaminated with any foreign material.

Here are some examples of open packages:

C-mount

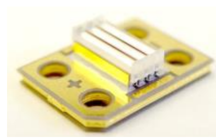


B Mount

Q Mount

Chip on Submount

CS Package

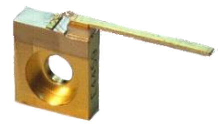


General Precautions for Open Packages:

1. **Heatsink –** All laser diodes in an open package must be attached to a heatsink prior to operation.
2. **Keep the laser diodes clean -** Open Packages should not be operated in an environment where dust particles in the air can reach the active region (output facet) of the diode. The laser facets are sensitive to accumulation of dust. High electrical fields near the active region attract dust particles, that cause irreversible damage of the facets during operation. 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. For open packages, cleanroom class 10,000 for handling, and cleanroom class 100 for operation is highly recommended. If an open heatsink laser is 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 sufficient.
3. **Facet contamination** - Contamination of the laser facets can cause immediate and permanent damage to the laser. You should not blow on the laser, or expose the laser to smoke, dust, oils, and adhesive fumes. Avoid touching optically active surfaces of the laser, such as the laser chip, microlenses, optical elements and beam-exit windows. Contamination of the optical surfaces will lead to the destruction of the laser. There is no way to clean the front facet of the diode laser! During handling all personnel should wear clean gloves and use plastic tweezers to avoid contamination the facets of the laser.
4. **Thermally-conductive Compounds -** Thermal grease should never be used with open heatsinks. Most thermal greases tend to “creep” and the material will eventually contaminate the diode facets.

5. **Keep the laser diodes dry -** Keep the laser diode facets dry. If open packages are stored or operated in a high humidity environment, the optical coatings can be damaged, and the lasers will not work. The laser should never be operated below the dew point. The dew point is the temperature, starting from which a condensation of the humidity in the air at the diode laser begins. The relative humidity must not exceed 85% (no condensation). Because of possible fluctuations, we recommend aiming at a mean relative humidity of maximally 60 %.

Precautions for Specific Open Packages:



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. 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 parts made by Mill-Max for example).
3. Great care must be used if soldering to the cathode wire lead. 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 block must remain <120°C.
4. 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:

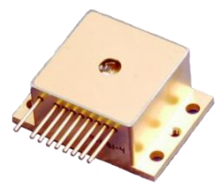


1. To operate, these open heatsinks must be securely attached to a heatsink.
2. Attaching these open packages to a heatsink is critical. This can be accomplished by either using a low-temperature solder or a silver-filled epoxy at this interface. If silver-filled epoxy is used, it should be a “space 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°C to prevent the laser from reflowing and/or damaging the laser.

3. 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.
4. The base material on these package types varies. Copper, CuW (Copper Tungsten) and ceramics like BEO and AlN are often used. Depending on the base material, the laser may or may not be isolated from the heatsink. If an electrically conductive material is used, the base is the laser diode anode (+) terminal, so the power supply anode connection is best made to the heatsink. If an electrically isolated material is used, the anode connection is typically a pad on the surface the laser chip is mounted. The laser diode chip should be covered to prevent contamination when soldering to this pad.

Sealed packages:






Sealed Packages or windowed packages are hermetically sealed at the factory prior to shipment. Sealed packages offer lower risk due to the laser diode chip or laser diode bar is protected from dust, mechanical damage, humidity, out-gassing, etc.…

Smaller sealed packages are typically conductive cooled, but larger and/or higher power packages can be actively cooled with either an internal TEC or water cooled.

9mm Package, 5.6mm Package, 3.8mm Package, TO type packages.

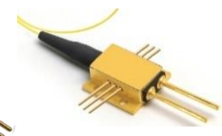
1. It is important that the Copper portion of the base be in good contact with the heatsink to achieve optimal heat extraction from the laser package.
2. Not all parts of the TO type packages are made of Copper. The window cap and the portion of the base to which it is attached are made of Steel, which is a poor thermal conductor.
3. The preferred method for mounting these packages is by clamping the package to the heatsink. The clamp should have a hole for the cap and the clamping force should be applied to the header flange.

TO-3 Package, HHL Package, and other sealed packages



1. The package must be screwed down securely to the heatsink using the proper screw size and recommended torque.

2. The laser package should be cooled well enough that the temperature rises 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. The heatsink must be able to dissipate the heat generated by the laser and the TE cooler if installed.



Fiber-Coupled Packages:

1. The package must be screwed down securely to the heatsink using the proper screw size and recommended torque.
2. The laser package should be cooled well enough that the temperature rises 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. The heatsink must be able to dissipate the heat generated by the laser and the TE cooler if installed
5. Special care needs to be taken with fiber pigtailed laser diodes. The fiber should not 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 an 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. Ensure there are no particles on the end of the fiber. All particles on the end of the fiber will become a damage spot once the laser is turned on.
7. Higher power fiber coupled packages may be equipped with a water-cooled base plate, a water-cooled special heat exchanger (DCB) /PAT_DCB/ and/or thermoelectric coolers (TEC).

8. For the connection of water-cooled modules, suitable hoses must be used. We recommend tube material by SMC (www.smc.com), type TRBU.
9. The quality of the cooling water to be used with water-cooled plates must correspond to normal industrial quality tap water.
10. A coarse filter must be included in the water-supply system only if a particle size of < 500 µm cannot be ensured. When using DCBs, a particle size of < 100 µm must be ensured.
11. Absolute cleanliness of the end faces of the fiber is crucial for the perfect operation of the diode laser. Before starting the installation, check the end faces of the fiber for contamination or mechanical damage using a microscope at a magnification of at least 20x. Contamination on the

end faces will at least cause a loss in power or heating up of the fiber. In the worst case, the fiber can burn off thereby also contaminate the output window of the diode laser.

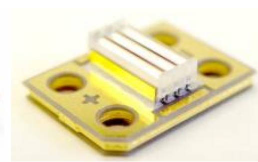
12. Many of the fiber coupled packages include a short-circuiting bridge during shipment for ESD. It is not designed for conducting a high current. If a current of more than 5 A should flow through the short-circuiting bridge for longer than 3 seconds, the insulation of the internally laid cables heats up. Remove the ESD shorting prior to operation of the laser.

Laser Diode Bars:

Laser diode chips consisting of a single emitter as shown in the packages above are limited in their output power by the amount of power from the emitter. For much higher output powers, several or many emitters can be united in a single chip. These chips with multiple emitters are called laser diode bars. Theoretically, it would also be possible to mount several single emitter chips onto one heatsink each and to integrate them onto a single common mechanical base. But laser diode bars are used due to the simplified handling and the higher precision of the spatial arrangement of the individual emitters obtainable with bars.

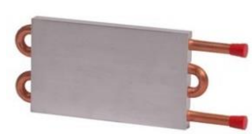
A high-power laser diode bar package is a sensitive electronic component. To ensure long lifetimes and trouble-free operation of the high-power diode laser, you must have a thorough understanding of the package design, the operating principle, and the properties of the diode laser. This understanding is also required for an adequate heatsink design and diode driver selection.

Open Bar Packages:



Passive (Conductive) Cooled Packages:

1. To operate, the bar package must be screwed down securely to a lapped heatsink using the proper screw size and recommended torque.
2. The heatsink must be able to handle the waste from the laser diode bar package. A water-cooled cold plate is often used for bar packages. The quality of the cooling water to be used with water-cooled plates must correspond to normal industrial quality tap water.



3. For some of these bar packages, typically single bar packages, the copper base is the laser diode anode (+) terminal. For other packages, typically stacks of bars, the laser diode bars are electrically isolated. Consult the drawing to determine if the laser diode bar(s) are electrically isolated. If not electrically isolated, all laser diode bars are soldered with the p-contact to the heatsink. Thus, the heat sink is always the p-contact!
4. If the laser diode bar is not electrically isolated from the base and the mounting plate does not need to be potential-free, the diode laser can be mounted onto the mounting plate directly or by means of a soft, metal contact film. Suitable film materials include, for instance, InSn of a thickness of 25 µm or In film having a thickness of 50 µm. Take care to ensure that the film is attached to the complete mounting surface of the bar package.
5. If the diode laser must be electrically insulated from the mounting surface, insulation may be achieved by a thin flat ceramic plate of high thermal conductivity. Plastic insulation foil (e.g. Kapton) will affect laser lifetime because of an increased thermal resistance and possible solvent emerging that might damage the semiconductor crystal. Even highly thermally conductive

ceramic plates have a higher thermal resistance than, for instance, indium films, an additional temperature difference between the heatsink temperature and the cooling-plate temperature will appear. The temperature of the heat sink must not be increased beyond the permissible value, as this would involve a higher degradation rate. If necessary, the optical output power should be limited, or the cooling-plate temperature lowered. For more information on suitable films, contact RPMC.

6. The electrical connections of some laser diode packages are to be connected to the diode laser by means of cable lugs, ring tongue terminals, at the laser mounting screws. Pay special attention to the correct polarity!

Actively Cooled Packages:

High power laser diode bar stacks require a very efficient actively cooled package due to a large amount of waste heat in a small area. Microchannel heatsinks (MCHS) are based on the principle of convective heat transfer, the heat is transferred from the bar to a thin, mostly metal substrate, and then to a liquid coolant flowing through it. The MCHS is a stack of several layers which define the route of the cooling medium in an optimized path directly under the mounting surface of the diode laser bar. The cooling capacity of the heatsink determines the power level the laser diode bar can be operated. The better the cooling, the higher the output power and lifetime from the bar. If the laser diode bar operated at a higher operating temperature, the lifetime will be impacted.

1. For the best cooling, the microchannels in the MCHS are small, ~40 - 400 µm by typically 300 µm high.
2. High flow rates of the liquid coolant provide ideal conditions for the convective heat transfer from copper to the coolant. Flow rates too high will increase the mechanical abrasion in the cooling channels; flow rates too low will result in a diminished cooling and higher operating temperature.
3. The cooling system requirements for MCHS are very specific and critical for good lifetimes. The general requirements are:
   a) Deionized water
   b) Filters to maintain particle size: < 15 µm
   c) An ion exchanger cartridge to keep the conductivity at 2..10 µS/cm.
   d) Do not use any material that in combination with copper would form galvanic elements (e.g. aluminum, zinc, brass).
   e) Plastics must be free of chlorine and additives especially plasticizers (softeners) that can be washed out (suitable for deionized water, recommended: food grade).
   f) When using high-grade steel, we recommend the use of the alloys X5CrNi 1810 or X6CrNiMoTi 17122. Basically, you should use sulfur-free V4A alloys.
   g) The flow rate should be 300 ml/min ± 10 % (corresponding to 18 l/h ± 10 %). For stacks, this flow rate has to be multiplied by the number of submounts used on the stack. Example: On a stack with six submounts, for instance, the prescribed flow rate is approx. 1.8 l/min ± 10 % (corresponding to 108 l/h ± 10 %).
   h) Avoid bubble generation and superficial oxygen intake
4. Prior to every turn-on and before connecting to the laser diode package, the cooling system must be operated for at least 20 min in coolant-side short-circuit mode until the specified

conductivity is reached. This also guarantees no particles get into the microchannels of the laser diode package and cause irreversible damage due to reduced cooling. After the operation of the cooling system in short-circuit mode, the coolant hoses are to be connected to the actively cooled stack.

5. Typically, different size hoses are used for the plug connections. Hoses with the correct outer diameter must be used. We recommend hoses by SMC (www.smc.com), type TRBU, to be used because they are flexible and simultaneously vapor-tight.
6. Actively cooled packages will require O-rings. The O-rings must be resistant to deionized water and reach a compression of 20 - 30 % of their normal thickness.
7. The storage temperature for MCHSs is limited to the freezing temperature of the liquid coolant. At low temperatures, residual moisture in the microchannels may freeze and mechanically destroy the microchannels. Even after removal of the coolant and purging of the cooling channels with nitrogen or clean oil-free air, residual moisture may remain inside.
8. When a stack is shipped, it is electrically shorted to a metal base plate which for security against electrostatic discharge (ESD) and sealed into a conductive plastic bag. Once removed from the bag and these screws are removed, the stack is no longer protected from ESD damage.
9. The electric cables are to be connected to the diode laser by means of cable lugs, ring tongue terminals, at the specified locations with the screws supplied. Pay special attention to the correct polarity! Keep the electrical cables as short as possible. Electrical cables should be arranged in a low-inductance constellation to avoid any tendency towards current oscillations.
10. The case and the base plate of the MCHS assembly are potential-free (Electrically Isolated).
11. To operate, turn on the cooling system and check the coolant connectors that are closest to the diode laser for leaks, if you find any leaks, instantly turn the cooler off. If the coolant connectors that are closest to the diode laser are leakproof, check the other connectors and joints.
12. Let the system run for approximately 20 minutes to detect any residual leaks. During this period, check the flow rate and the conductivity of the coolant. The latter can be checked with a commercially available conductivity meter. As a rule, the reservoir of the chiller is the best place accessible for this measurement. Compare this measurement to the possibly existing remote measurement by your software.
13. Normally, coolant residues on the optical surface of the diode laser cannot be perfectly cleaned nor can the cleaning result be sufficiently checked!
14. Make sure the nominal current of the diode driver has been set to 0 amps. Turn on the diode driver. Most diode drivers provide an additional switch for enabling the current to flow. If your driver contains such a switch, actuate it now. Increase the current to approx. 1 - 1.5 A. The correlating voltage should now amount to about 1.6 - 2 V per bar. Then, increase the current slowly until the output power is to the desired value. Never exceed the rated output power specified in the product datasheet.

There are many different laser diode packages. We tried to supply enough general advice and precautions that regardless of the laser diode package you have, you will have a basic understanding of the requirements needed to properly mount the laser for optimum lifetimes and performance.

If you have any questions about the mounting of your laser or the operation of your laser, please contact us immediately. We are happy to help. We want you to be successful.