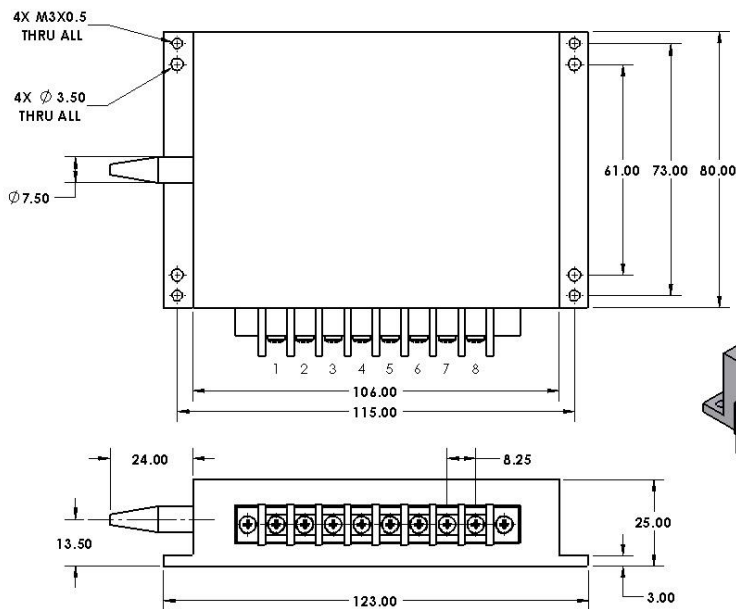




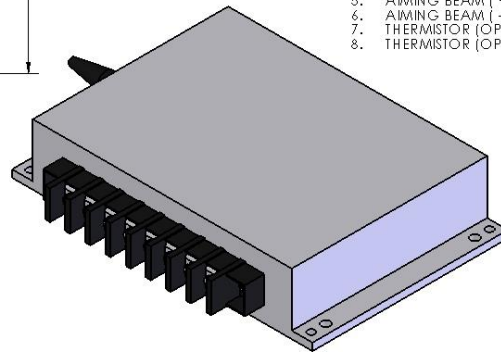
Application note for Multi-chip module

The multi-chip module (MCM) is comprised of SemiNex 4-pin fiber coupled devices (3 to 7 lasers) bundled together with an optional red aiming beam. The output power available is 10W to 20 watts terminated with an SMA-905 connector. This application note is intended to help assist in determining different methods of driving and thermally cooling the module.



PIN OUT: (FOR REFERENCE ONLY, REFER TO DOCUMENTATION SUBMITTED WITH PRODUCT FOR ACTUAL PIN OUT)

1. LD ANODE (+)
2. LD CATHODE (-)
3. PD (-)
4. PD (+)
5. AIMING BEAM (+5V) (OPTIONAL)
6. AIMING BEAM (-) (OPTIONAL)
7. THERMISTOR (OPTIONAL)
8. THERMISTOR (OPTIONAL)



Methods of Thermal Compensation

SemiNex Corporation recommends two methods to thermally compensate MCM modules. The first is an integrated cooling system (ICS) manufactured by SemiNex and the second is via thermoelectric coolers.

The integrated cooling system (ICS) is designed to dissipate up to 140W of heat while maintaining an average base temperature of 5°C above ambient. The ICS uses a convective cooling fan to dissipate heat generated by the attached device. Higher wattages of heat can be dissipated with an increase in average base temperature. A data sheet and application note is available from your SemiNex representative or by visiting www.seminex.com.

Large capacity thermoelectric coolers (TECs) are also used to control the multi-chip module temperature for high power operation. Proper operational procedures for the TEC are critical for reliable performance of the module during its lifetime. TECs are typically operated with closed-loop temperature controllers/power supply circuits. Closed-loop circuits allow maintaining internal temperatures of the laser module at the target temperature 25°C (nominally). The TEC can be switched from a cooling mode to a heating mode by reversing the direction of current flow.

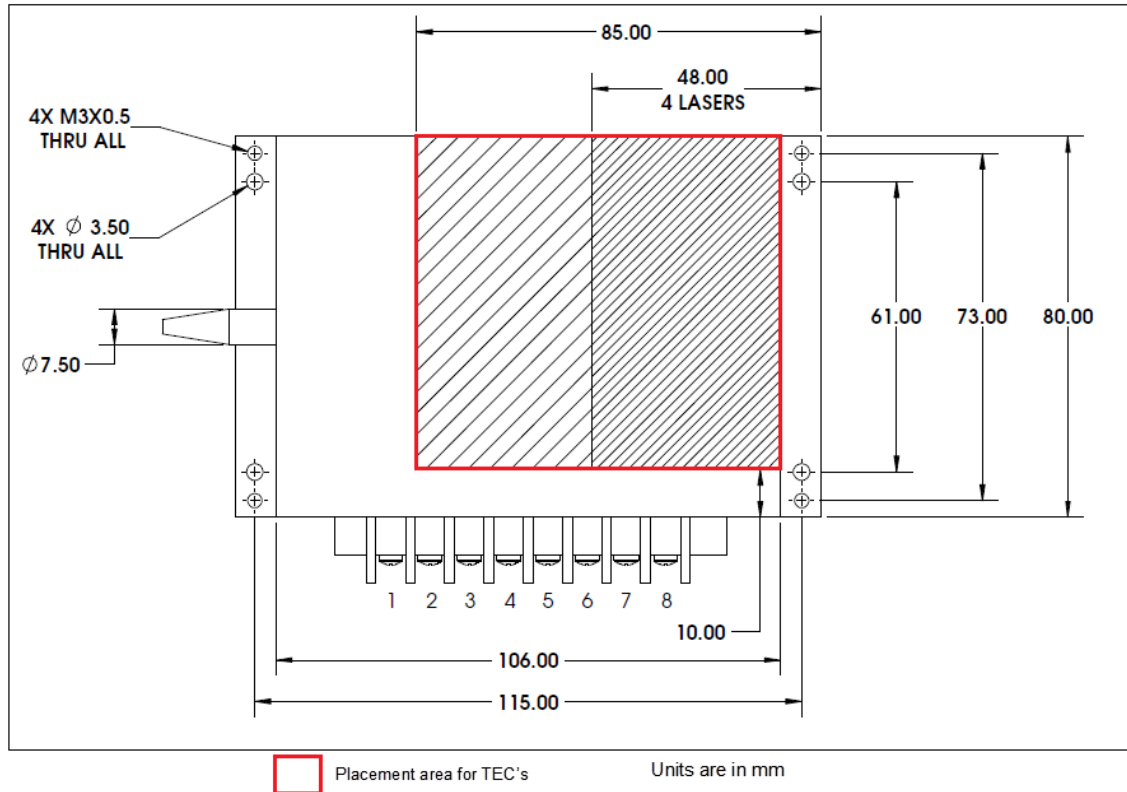
The laser module TEC operates from a DC power source. An important criterion for reliable high power operation is to use a filtered DC current. DC ripple affects the TEC performance and, as a result, subsequent pump module performance during its lifetime.

When the laser module is first turned on, there will be a transient current supplied to the TEC as it stabilizes via the feedback circuit. It is also important to note the absolute operating current is the current at which a TEC can operate for an unlimited time throughout the lifetime of the module.

To summarize:

- Limit TEC power supply ripple factor to less than 10 percent.
- Limit the TEC controller power supply to the absolute maximum TEC current rating.
- Do not operate the TEC at its rated maximum current except as transient applied current during module start up.
- Limit the TEC operating current to 70 percent of the specified TEC maximum current.
- Operate the TEC in constant temperature mode rather than in constant current mode, using temperature feedback from the module thermistor.

The following diagram illustrates the appropriate placement of the thermoelectric coolers for proper cooling of the laser module.



Heat sinks for high power module mounting

The design of the receiving heat sink, intended to dissipate the heat pumped by the TEC is crucial to the overall multi-chip module performance and reliability. All laser modules with a TEC to control diode laser temperature require heat sinks and will fail catastrophically if operated without one. The goal of the heat sink design is to dissipate the heat from the package base with minimized thermal resistance.

Heat sink performance is usually specified in terms of thermal resistance (Θ_S):

$$\Theta_S = (T_S - T_a)/Q$$

Θ_S = thermal resistance in $^{\circ}\text{C}/\text{watt}$

T_S = heat sink temperature in $^{\circ}\text{C}$.

T_a = ambient or coolant temperature in $^{\circ}\text{C}$

Q = heat input to heat sink in watts

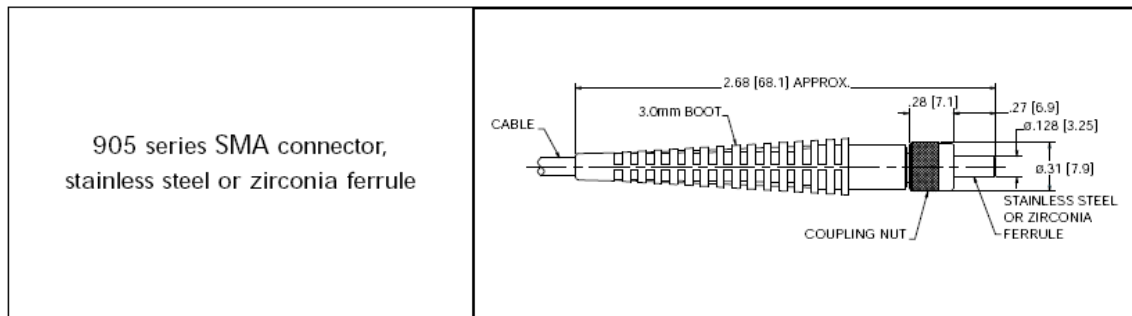
Each thermoelectric cooling application will have a unique heat sink requirement, and frequently there will be various mechanical constraints that may complicate the overall design. Because each case is different, there is no single heat sink configuration suitable for all situations.

A well-designed heat sink, in combination with a high-performance thermal interface material and package mounting technique, should guarantee that the laser module case temperature does not exceed the maximum temperature specified for each module. The following general heat sink guidelines are recommended:

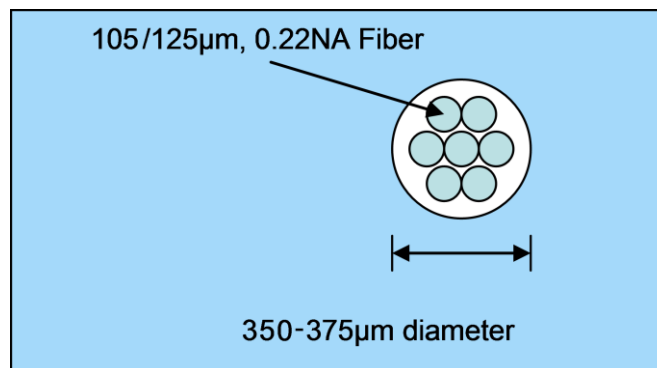
- Mount the module on a heat sink with flatness of 50 microns or less over the entire mating surface to the module.
- Mount the module on a heat sink with a surface finish of 0.8 micron or less.
- The heat sink should be designed to handle at least the maximum module heat dissipation throughout the life of the product. Maximum module heat dissipation is approximately equal to total module power consumption (diode laser and TEC) minus the ex-fiber optical power.

Fiber and connector information

The Multi-chip module is comprised of our fiber-coupled, single emitter devices (4PN-1XXX-6-96) devices. There can be anywhere from 3 to 7 devices inside the module package. The 4 pin devices use a 105um/125um 0.22NA fiber. The fiber from each of these devices is bundled together and terminated with a SMA-905 connector. The effective core diameter of the fiber bundle is 375µm regardless if there is 3 or 7 fibers. The diagram below shows the end of the connector and how the fibers are situated in the connector along with a drawing of the SMA-905 connector. The typical fiber length is 3 meters.



SMA-905 connector drawing (courtesy of Amphenol fiber optic products)



Fiber bundle illustration

Photodiode (PD)

Monitor Photodiode: A photodiode is used to measure the light out of the laser by monitoring scattered light inside the package. This can be used in a power feedback loop for CW devices and a range zero pulse for pulsed devices. Since the signal level is dependent on scattered light, the value of the responsivity in any given package can vary widely. The use of a monitor photodiode should be verified in each new application.

Thermistor (optional)

SemiNex uses an NTC type Thermistor with a constant of 3477 and a resistance of 10,000 Ohms.

Aiming Beam (optional)

In order to determine whether the light emitted from the bundle is hitting the appropriate target, a red aiming beam is available and can be enabled by applying 5 volts (DC) to the appropriate terminals on the terminal strip.

Multi-chip module power supply (laser driver)

When designing or using a diode laser power supply, designers should refer to the specified absolute maximum ratings, specified for the particular module. Electrical overstress (EOS) damage occurs when a module is subjected to voltage or current levels beyond its' surge-absorbing capacity. The location and degree of damage depends on the magnitude and duration of the voltage, current, total energy, polarity, and waveform of the electrical overstress.

Power supplies and test equipment can induce EOS. Some recommended guidelines for preventing EOS of multi-chip modules are:

- Transient electrical stress to the module should be avoided or minimized through operation life. The maximum specified transient current time for a module should never be exceeded while operating a laser diode.
- Use transient suppression for power supplies.
- Use over-voltage protection for power supplies and fuses at critical locations.
- Confirm modules are mounted with the correct electrical pin configuration as specified.
- Ensure that all operation and assembly equipment is properly grounded with no loose connections (which can lead to intermittent connections).
- Always ensure the TEC controller is enabled and the module is being actively cooled prior to turning on the laser diode controller. Allow the internal temperature of the module to stabilize at the target operating temperature of 25°C.