

Using OSRAM OS Visible InGaN Laser Diodes

Application Note

Introduction

OSRAM Opto Semiconductors offers visible laser diodes based on InGaN that are well suited for following application:

- Projection
 - Pico projection
 - Business & Cinema Projection
- Industry
 - Stage Lighting
 - Metrology
 - Medical
 - Spectroscopy
- Automotive
 - Headlamp
 - Head-Up Display

This application note provides a guideline for proper use of Osram Opto Semiconductors visible InGaN laser diodes.

For more detailed information and the latest product update please visit www.osram-os.com or contact your local sales office to get technical assistance during design-in phase.

Safety Instructions

Depending on the mode of operation, these laser diodes emit highly concentrated visible light which can be hazardous to the human eye. Products which incorporate these devices have to follow the safety precautions found in IEC 60825-1 "Safety of laser products".

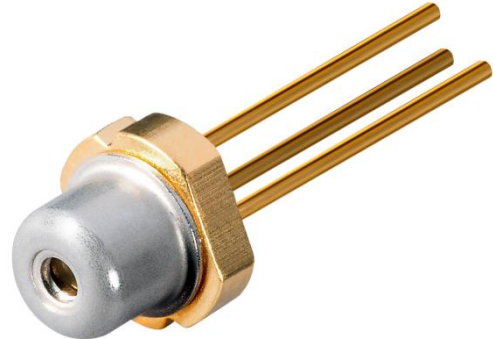


Figure 1: Product picture of a green single mode laser, PL 520, in a TO38ic package

Testing and maintenance of these products shall be performed only by personnel trained in laser safety. For details please refer to relevant local safety regulations and to the manufacturer's requirements according to IEC 60825-1.

The laser class is determined by the driving conditions and optical design, such as focusing lenses and needs to be determined by the manufacturer of the final product.

Storage and Shipping

Storage and shipping of diode lasers should be done in a clean and dry atmosphere in a temperature range of 0°C up to 60°C

Unpacking and Handling

The visible InGaN diode lasers are shipped in a conductive plastic shipping container that is packed in a sealed conductive plastic bag.

Before opening the plastic bag, diode lasers should be kept at least 4 hours in the room where the bag will be opened to achieve

thermal equilibrium. The protective bag may be opened only in a clean environment and non-humid atmosphere.

Solvents, non-conductive plastics and glues are not allowed near the diode lasers as solvents could emerge and deposit on the window. Especially, the blue multi mode power laser light can bake the contamination on the window, reducing the transparency of window.

Dust on the window can be removed by clean oil-free compressed air. Mechanical stress to the window should be avoided to prevent the breaking of the hermetic seal.

Please also avoid scratches at the bottom surface of TO package. They can increase the thermal resistance of the mounted device to the heat sink, which might result in a reduced efficiency and thermal overload of the diode laser.

Label Information

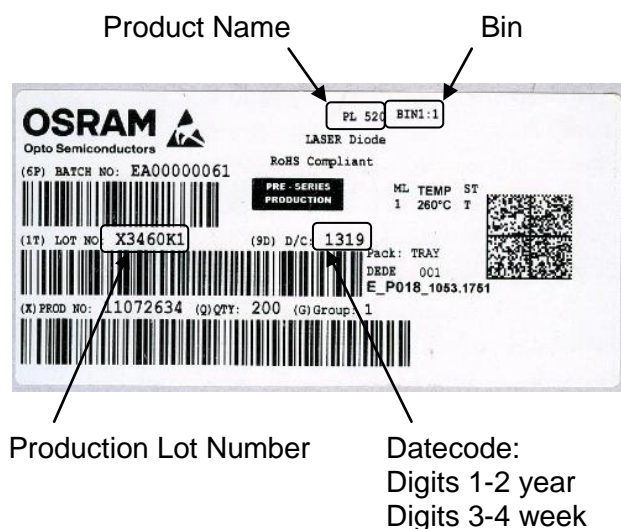


Figure 2: Standard label for visible laser diodes

In graph 2 the label for visible laser diodes, is shown which is placed on the sealed conductive plastic bag. Besides of the product name, binning information and production lot number, the date code which

reflects the Backend production date is printed on the label.

ESD Handling

InGaN diode lasers are electrostatic sensitive devices. Thus, their handling requires strict precautions against electrostatic charges. Every person and each tool that might get into contact with the diode laser must be continuously ESD protected. Therefore, the devices should only be handled in ESD protected areas (EN 100 015 former CECC 000 15).

InGaN laser diodes without an ESD protection diode have an ESD class 0 according to the Human Body Model. Especially ESD pulses in reverse voltage can cause damage to the laser diodes. Operating the laser afterwards may result in a strong reduction of output power.

The blue multi mode laser PL TB450B has an ESD protection diode inside the package and is protected to voltages of up to 2 kV (HBM model). For polarity please refer to the datasheet.

Recommendations for ESD control

To enhance the protection grade in the laser module we recommend implementing an ESD protection diode (e.g. Zener Diode) in the circuit design. For the protection diode following points should be considered

- Break down voltage: The break down voltage of the ESD protection diode has to be higher than the total forward voltage of the laser diode to ensure functionality of the circuitry under normal circumstances.
- Response time: The response time of the ESD protection diode has to be faster than the one of the laser diode. Thus the protection mechanism can work effectively before a pulse might cause any damage to the laser diodes. Due to fast switching time of laser diodes, the response time of the

protection diode is supposed to be in the range of 1 ns or less.

Basics for protection against statics

Grounding

Grounding systems shall be used to ensure that devices, personnel and any other conductors are at the same electrical potential.

Protection

To avoid exposure to static charges, keep components and modules separated during storage and transit. By protecting against exposure to statically charged objects, and electric fields, potential damage to laser components is minimized. As statically charged insulators cannot be discharged by grounding. It is advisable to eliminate non-conductive plastic material and other type of insulator from the working place, transit and storage areas.

Neutralization

Neutralization is the process to discharge insulators. This happens naturally through the process of ionization. Ions are charged particles that are always present in the atmosphere in form of atoms, molecules or groups of molecules like water drops. The use of an ionizer generates billions of ions into the air and enables the static charge on insulator to leak away.

Prevention

Prevention can be the largest personal contribution to eliminate damage caused by ESD. Please find below a set of guidelines :

Always keep work areas clean and tidy. Remove unwanted objects, especially those made of non-conductive plastic materials.

When transferring components from one person to another, both should be grounded or at the same voltage potential.

Avoid that the laser components or modules come into contact with any insulating material.

Never enter a static-proof work area without taking the appropriate precautions.

Always be aware of these rules when working with devices that can be damaged by electrostatic discharges.

For further information on ESD handling we refer to the application note „ESD Protection while Handling LEDs“, which is also valid for InGaN laser diodes <http://catalog.osram-os.com/catalogue/catalogue.do;jsessionid=4E1480F2ABAF39F230EF1A39DD7FA210?act=downloadFile&favOid=0200000000023697000200b6>

Mounting

Mounting of a laser diode should be done only at the base plate of the TO package. The cap should not be exposed to mechanical stress.

Reference surface for positioning the laser diode is the front side and the circumference of the baseplate

Reference surfaces

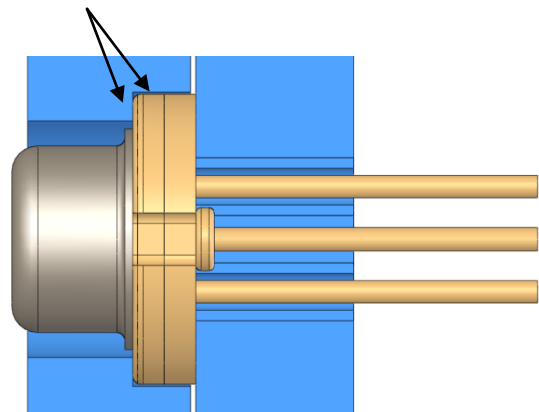


Figure 3 shows the reference surfaces of a TO56 package

To prevent breakage of the hermetic seal of the pins, the laser diode's pins and base plate must not be stressed too much during mounting. Deformation of the base plate has to be prevented.

Thermal Management

To obtain the specified output power and a long lifetime of the laser diode an appropriate cooling is required. The maximum rating for the junction temperature T_{junction} for GaN lasers is 150°C. Operation at this value will reduce the life time of the diode. For long term operation the junction temperature should not exceed 100° C.

The junction temperature can be calculated with the following equation

$$T_{\text{junct}} = (U \cdot I - P_{\text{opt}}) \cdot R_{\text{th}} + T_{\text{case}}$$

,where P_{opt} is the optical output power, U the operating voltage, I the operating current, T_{case} the temperature of the package and R_{th} the thermal resistance (junction to case).

Insufficient cooling can also result in a decrease of the output power, especially at high power levels or temperatures. In Figure 4 the influence of cooling for the output power vs. current is shown for a blue multi mode laser. In the worst case the output power can even drop to zero at currents above 1A and within the specified operation range.

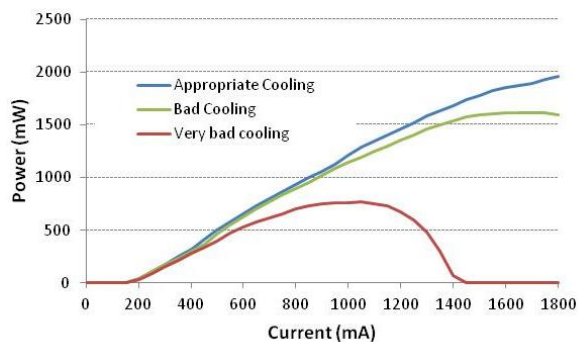


Figure 4 shows the dependence of the output power of a blue multi mode laser (PL TB450) on the cooling

If a laser diode does not reach the specified optical output power at the specified maximum operating current please review your cooling system.

Influence of the mounting on thermal resistance (junction to case) R_{th}

Figure 5 shows different thermal connection configurations of a TO56 package to a highly thermally conductive heat sink, like copper. The thermally connected surfaces are indicated as blue area. Using just a low conductive heat sink material, like a PCB board, will increase the thermal resistance.

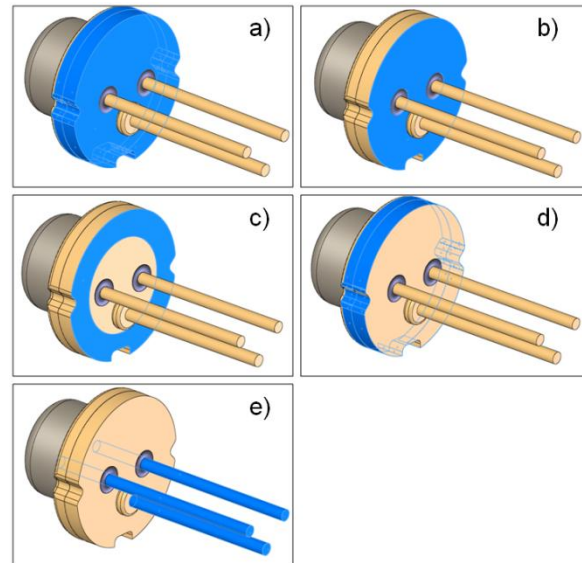


Figure 5: Different thermal connections of a laser diode package to a high thermally conductive heat sink

Figure 6 shows the corresponding simulation results performed with the software COMSOL for the blue multi mode laser PL TB450B in a TO56 improved package. Here, dark bluish colors indicate low temperatures, whereas light to red colours increased, high temperatures.

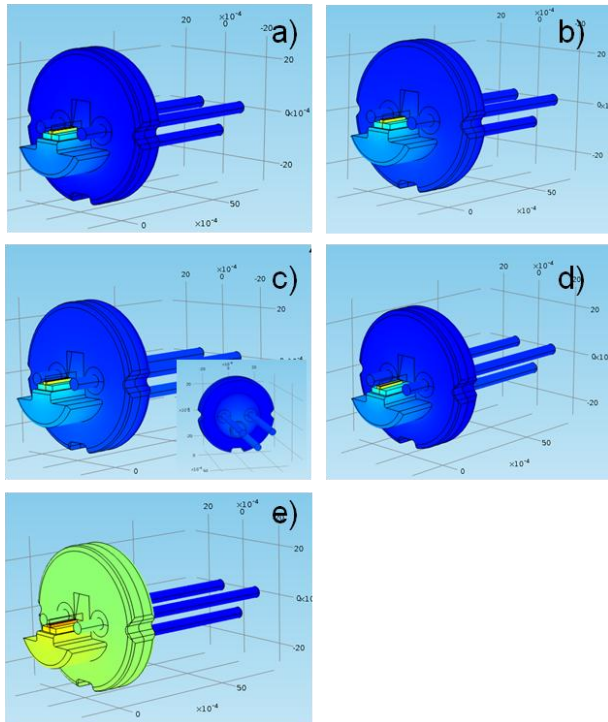


Figure 6: Simulation results for the cooling configurations shown in fig. 5 performed with the software COMSOL. The thermal resistances for the blue multi mode laser PL TB450B were the following: a) 15 K/W, b) 15.8 K/W, c) 16.3 K/W, d) 15.5 K/W and e) 31.3 K/W

A complete thermal base plate contact of the package results in the lowest thermal resistance of 15 K/W (figure 6a)). Decreasing the connected area at the bottom of the baseplate will increase the thermal resistance. E.g. figure 6d), where only the lateral surface is thermally connected, the R_{th} increases slightly to 15.5 K/W. Without a suitable fixture the thermal connection is reduced to the pins and therefore, the thermal resistance will dramatically increase by roughly a factor of 2 figure 6 e).

Wavelength shift versus temperature and current

The shift of the emission wavelength with temperature for GaN laser diodes is in the range of 0.04 to 0.06 nm/K. In figure 7 the

wavelength shift at different temperatures and currents is shown for the blue multi mode laser PL TB450B (a) and the green single mode laser PL520 (b), respectively.

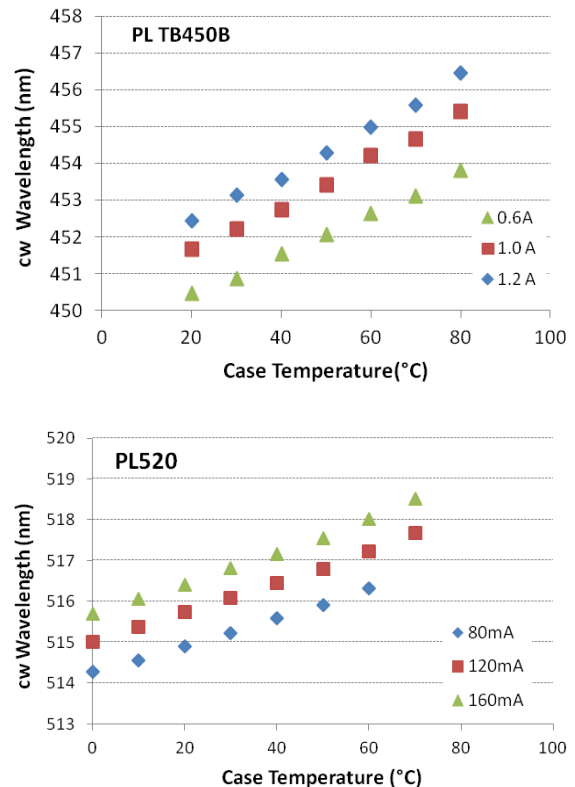


Figure 7 shows the wavelength shift for different temperatures and currents for the blue multi mode laser PL TB450B (a) and the green single mode laser PL520 (b)

Thermal rollover

A so called thermal rollover in cw-operation is observed mainly for the visible multi mode lasers which have the highest thermal load at the operating point (figure 8). This effect is caused by a self-heating of the laser diodes. The rollover starts at lower currents with increasing temperature due to lower efficiencies at higher temperature.

If a laser diode is operated in overstress, which means at too high power levels or temperatures and therefore, driven nearby or at this thermal rollover the lifetime of the laser diode will be reduced.

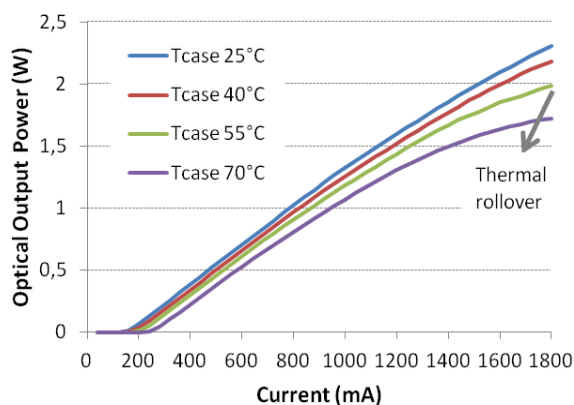


Figure 8: Temperature dependence of the thermal rollover for a blue multi mode laser PL TB450B

Therefore, we recommend to operate the blue multi mode laser PL TB450B at the below shown maximum and typical operating currents (figure 9).

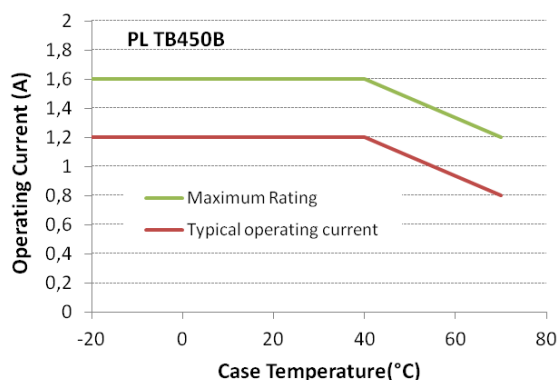


Figure 9: Maximum and typical operating current for the blue multi mode laser PL TB450B vs. case temperature

Operation conditions

OSRAM OS visible InGaN laser diodes are developed for cw operation. To obtain the full lifetime it is strongly recommended not to exceed the nominal output power and the nominal operation conditions (operating current, case temperature) for a longer period of time. Operation above nominal operation conditions may reduce the lifetime of the laser diode and operation above the

maximum ratings specified in the data sheet even for a short time may irreversible damage the device.

OSRAM OS visible InGaN laser diodes may also be operated in pulsed mode at any pulse widths between a few ns and dc and at any duty cycle. However, the maximum ratings specified for cw operation apply to the pulsed operation as well.

Electrical Driving

A laser diode is a current-driven device which should not be driven by a voltage source. Otherwise electrical overstress may occur to the laser diodes as the operation voltage varies from device to device and additionally depends on the case temperature.

Special care has to be taken, when switching the electrical power on and off, as transient currents beyond the maximum ratings can occur damaging the laser diode.

To operate laser diodes correctly, a proper electrical driving mechanism has to be employed. A reliable laser diode driver must act as an accurate constant current source with good transient protection and very low noise.

Furthermore, please note that at different temperatures the output power of the laser diode will change. Thus, for applications that require a constant output power over a broad range of temperatures an automated power control (APC) is necessary. A photodiode (PD) is usually adopted to optically monitor the output power of laser diode. OSRAM Opto Semiconductors provides a series of photo detectors with compact size and high sensitivity which are suitable for APC. (Refer to Appendix Table 1)

Electrical driver for battery-powered applications

The operating voltage of visible InGaN laser diodes can reach up to 8 V, which is higher

than the standard battery voltage of 3 V or 6 V. Therefore, a step-up DC-DC converter is usually required for battery-powered applications. Additionally, as already mentioned, special care for transient suppression has to be taken to prevent the laser diodes from any electrical overstress.

Optical

In case of optic design or simulation needs, ray files of laser diodes for various software versions (e.g. Lighttools, Zemax, ASAP, Tracepro, Speos) can be downloaded from OS website (Application Support): www.osram-os.com

Off-the-shelf aspherical collimating lens designed for Osram green laser diodes are available from e.g. LightPath Technology. For latest lens update, please contact the local OS sales office.

Appendix

Selected available photo detectors for APC (www.osram-os.com)




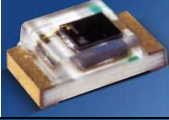

Part Number	Photograph	Spectrum Range	Package Size (mm)
SFH2701		400~1050nm	1.5*3.2*1.
SFH2430		400~900nm	4.4*3.85*1.15
SFH3010		420~1100nm	1.7*0.8*0.65
SFH3711		440~690nm	2*1.28*0.8
SFH3204		420~1100nm	1.1*3.0*1.2

Table 1: Series of OSRAM Opto Semiconductors photo detectors with compact size and high sensitivity which are suitable for APC feature

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About Osram Opto Semiconductors

Osram Opto Semiconductors GmbH, Regensburg, is a wholly owned subsidiary of Osram GmbH, one of the world's three largest lamp manufacturers, and offers its customers a range of solutions based on semiconductor technology for lighting, sensor and visualisation applications. The company operates facilities in Regensburg (Germany), Sunnyvale (USA) and Penang (Malaysia). Further information is available at www.osram-os.com.

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