

INTRODUCTION

About laser

- LASER is an acronym from “Light Amplification by Stimulated Emission of Radiation”. It is a device which radiates coherent light by excitation of molecules in a gas, or electrons in a solid, to a high energy stage and their release of this energy in the form of light after amplification by to and fro oscillations.

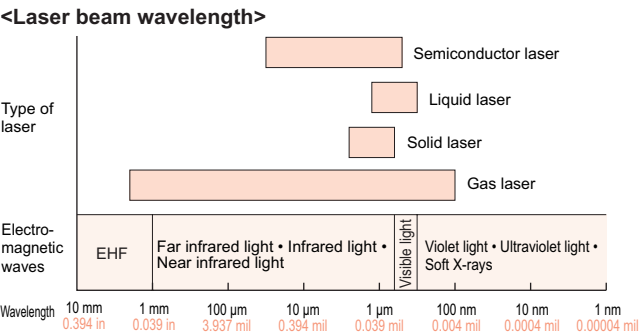
A laser beam has the following features:

- ① Monochromatic
- ② Low divergence
- ③ High energy density
- ④ Coherent in phase

Types of lasers

- Examples of materials which are used to emit laser beam are as follows:

LiquidPigment
GasHe-Ne, Ar and CO₂
SolidYAG, Ruby and Glass
SemiconductorGaAs



SAFE USE OF LASERS

Safety standards for laser

- Even a thin laser beam has such a high energy density that it may be harmful to the human skin or eyes. For the purpose of preventing users from suffering injuries by laser products, IEC 60825-1 (Safety of laser products). IEC 60825-1 provides a classification system for laser products according to their degree of hazard, and safety requirements to be executed for each class of laser products. (The FDA regulations also have a similar classification.)

Classification by IEC 60825-1

Classification	Description
Class 1	Lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.
Class 1M	Lasers emitting in the wavelength range from 302.5 nm to 4,000 nm which are safe under reasonably foreseeable conditions of operation, but may be hazardous if the user employs optics within the beam.
Class 2	Lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm where eye protection is normally afforded by aversion responses, including the blink reflex. This reaction may be expected to provide adequate protection under reasonably foreseeable conditions of operation including the use of optical instruments for intrabeam viewing.
Class 2M	Lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm where eye protection is normally afforded by aversion responses, including the blink reflex. However, viewing of the output may be more hazardous if the user employs optics within the beam.
Class 3R	Lasers that emit in the wavelength range from 302.5 nm to 10 ⁶ nm where direct intrabeam viewing is potentially hazardous but the risk is lower than for Class 3B lasers, and fewer manufacturing requirements and control measures for the user apply than for Class 3B lasers.
Class 3B	Lasers that are normally hazardous when direct intrabeam exposure occurs (i.e. within the NOHD). Viewing diffuse reflections is normally safe.
Class 4	Lasers that are also capable of producing hazardous diffuse reflections. They may cause skin injuries and could also constitute a fire hazard.

SAFE USE OF LASERS

Summary of user precautions

- The IEC 60825-1 stipulates safeguards that users must perform according to the class of laser product.

Summary of user precautions (IEC 60825-1)

* Quoted from safety of laser products, Annex Table D.3

Requirements subclause	Classification						
	Class 1	Class 1M	Class 2	Class 2M	Class 3R	Class 3B	Class 4
Laser safty officer	Not required but recommended for applications that involve direct viewing of the laser beam				Not required for visible emission Required for non-visible emission	Required	
Remote interlock	Not required					Connect to room or door circuits	
Key control	Not required					Remove key when not in use	
Beam attenuator	Not required					When in use prevents inadvertent exposure	
Emission indicator device	Not required				Indicates laser is energized for non-visible wavelengths	Indicates laser is energized	
Warning signs	Not required					Follow precautions on warning signs	
Beam path	Not required	Class 1M (Note 1) as for Class 3B	Not required	Class 2M (Note 2) as for Class 3B	Terminate beam at end of useful length		
Specular reflection	No requirements	Class 1M (Note 1) as for Class 3B	No requirements	Class 2M (Note 2) as for Class 3B	Prevent unintentional reflections		
Eye protection	No requirements					Required if engineering and administrative proceudres not practicable and MPE exceeded	
Protective clothing	No requirements					Sometimes required	Specific requirements
Training	No requirements	Class 1M (Note 1) as for Class 3R	No requirements	Class 2M (Note 2) as for Class 3R	Required for all operator and maintenance personnel		

Notes: 1) Class 1M lasers products that failed condition 1 of table 10. Not required for Class 1M laser products that failed condition 2 of table 10.

2) Class 2M lasers products that failed condition 1 of table 10. Not required for Class 2M laser products that failed condition 2 of table 10.

Remarks: This table is intended to provide a convenient summary of precautions. See text of this standard for complete precautions.

FDA (Food and Drug Administration)

- The U.S. imposes regulations on the manufactures of laser products sold in the U.S. and obliges compliance with set standards through the Radiation Control for Health and Safety Act of 1968.
The FDA has set regulations such as implementation standards related to laser products based on the law.
The standards indicate a classification for the laser according to the degrees of risk of laser radiation and also engineering request items according to the class of laser. Laser products must be compliant with these regulations.

Performance standards for light-emitting products (Quoted from FDA part 1040)

Classification	Description
Class I	Not considered to be hazardous.
Class IIa	Not considered to be hazardous if viewed for any period of time less than or equal to 1×10^3 seconds but are considered to be a chronic viewing hazard for any period of time greater than 1×10^3 seconds.
Class II	Considered to be a chronic viewing hazard.
Class IIIa	Considered to be, depending upon the irradiance, either an acute intrabeam viewing hazard or chronic viewing hazard, and an acute viewing hazard if viewed directly with optical instruments.
Class IIIb	Considered to be an acute hazard to the skin and eyes from direct radiation.
Class IV	Considered to be an acute hazard to the skin and eyes from direct and scattered radiation.