

Laser sensors Safety Standards and Safety Classifications

Abstract:

The primary concern in laser sensor safety is the possibility of eye injury. A secondary one is damage to the skin. Biological effects of laser light may depend on a number of factors including the wavelength of the light, its power, whether it possesses a continuous wave nature or is pulsed, or whether it is the result of a direct exposure of laser light rather than a diffuse reflection.

Lasers are to be treated with great respect and caution.

Keywords: Safety Standars, Laser Sensor, Laser Diodes, Safety Classifications.

Detailed explanation:

The classifications categorize lasers according to their ability to produce damage in exposed people. There are two classification systems, the "old system" used before 2002, and the "revised system". The latter reflects the greater knowledge of lasers that has been accumulated since the original classification system was devised. From 2007, the revised system is also incorporated into ANSI Z136.1. The old and revised systems can be distinguished by the 1M, 2M and 3R classes used only in the revised system and the IIIA and IIIB classes used only in the old system. The classification of a laser is based on the concept of accessible emission limits (AEL) that are defined for each laser class. This is usually a maximum power (in W) or energy (in J) that can be emitted in a specified wavelength range and exposure time. For infrared wavelengths above 4 μm , it is specified as a maximum power density (in W/m^2). It is the responsibility of the manufacturer to provide the correct classification of a laser, and to equip the laser with appropriate warning labels and safety measures as prescribed by the regulations.

The revised classification system Class

Class 1

Laser is safe under all conditions of normal use. This means the maximum permissible exposure (MPE) cannot be exceeded. This class includes high-power lasers within an enclosure that prevents exposure to the radiation and that cannot be opened without shutting down the laser. For example, a continuous laser at 600 nm can emit up to 0.39 mW, but for shorter wavelengths, the maximum emission is lower because of the potential of those wavelengths to generate photochemical damage. The maximum emission is also related to the pulse duration in the case of pulsed lasers and the degree of spatial coherence.

Class 1M

A Class 1M laser is safe for all conditions of use except when passed through magnifying optics such as microscopes and telescopes. Class 1M lasers produce large-diameter beams, or beams that are divergent. The MPE for a Class 1M laser cannot normally be exceeded unless focusing or imaging optics are used to narrow the beam. If the beam is refocused, the hazard of Class 1M lasers may be increased and the product class may be changed. A laser can be classified as Class 1M if the total output power is below class 3B but the power that can pass through the pupil of the eye is within Class 1.

Class 2

A Class 2 laser is safe because the blink reflex will limit the exposure to no more than 0.25 seconds. It only applies to visible-light lasers (400–700 nm). Class-2 lasers are limited to 1 mW continuous wave, or more if the emission time is less than 0.25 seconds or if the light is not spatially coherent. Intentional suppression of the blink reflex could lead to eye injury. Many laser pointers are class 2.

Class 2M

A Class 2M laser is safe because of the blink reflex if not viewed through optical instruments. As with class 1M, this applies to laser beams with a large diameter or large divergence, for which the amount of light passing through the pupil cannot exceed the limits for class 2.

Class 3R

A Class 3R laser is considered safe if handled carefully, with restricted beam viewing. With a class 3R laser, the MPE can be exceeded, but with a low risk of injury. Visible continuous lasers in Class 3R are limited to 5 mW. For other wavelengths and for pulsed lasers, other limits apply.

Class 3B

A Class 3B laser is hazardous if the eye is exposed directly, but diffuse reflections such as from paper or other matte surfaces are not harmful. Continuous lasers in the wavelength range from 315 nm to far infrared are limited to 0.5 W. For pulsed lasers between 400 and 700 nm, the limit is 30 mJ. Other limits apply to other wavelengths and to ultrashort pulsed lasers. Protective eyewear is typically required where direct viewing of a class 3B laser beam may occur. Class-3B lasers must be equipped with a key switch and a safety interlock.

Class 4

Class 4 lasers include all lasers with beam power greater than class 3B. By definition, a class 4 laser can burn the skin, in addition to potentially devastating and permanent eye damage as a result of direct or diffuse beam viewing. These lasers may ignite combustible materials, and thus may represent a fire risk. Class 4 lasers must be equipped with a key switch and a safety interlock. Many industrial, scientific, and medical lasers are in this category.

User Safety precautions:

Safety precautions required for users of laser products in each laser product class are stated in JIS C 6802 and IEC 60825-1. The following table is only a summary for the sake of convenience. Refer to the original standard for complete requirements.

Requirement/Item	Class 1	Class 1M	Class 2	Class 2M	Class 3R	Class 3B	Class 4
Laser safety supervisor	Basically not required, but recommended if direct observation of laser beam is required.				Required if beam is invisible	Required	
Remote interlock connector	Not required				Connected to room or door circuit.		
Control by means of a key	Not required				Key is removed when laser is not in use.		
Beam attenuator	Not required				Prevents accidental exposure during use.		
Laser emission indicator	Not required				ON during emission of invisible laser beam	ON during laser emission	
Warning sign	Not required				Gives warning instructions.		
Beam path	Not required	Some Class 1M: same as Class 3B* ¹	Not required	Some Class 2M: same as Class 3B* ²	Stops the beam at the end of the range.		
Specular reflection	No need	Some Class 1M: same as Class 3B* ¹	No need	Some Class 2M: same as Class 3B* ²	Accidental reflection is avoided.		
Eye protection	No need				Required where technical or administrative measures cannot be taken, and where MPE (maximum permissible exposure) would be exceeded.		
Protective clothing	No need				Required depending on the conditions.		Specific instructions are required.
Training	No need	Some Class 1M: same as Class 3B* ¹	No need	Some Class 2M: same as Class 3B* ²	Required for all operators and maintenance personnel.		

Laser safety eyewear is required for Class 3b and Class 4 lasers and laser systems. Eyewear should be comfortable and in good condition, not scratched or discolored. Some filters may be clear and others tinted, depending on the laser wavelength.

References & Academic research:

[1] Handbook of modern sensor J. Fraden Springer 4ième ed 2010.

[2] 2004 High Frequency Electronics (Basic Operation of Optical Detectors)

[3] Light Sources and Laser Safety Fred Seeber Camden County College Blackwood, New Jersey-2015.

[4] Bart Elias; Wessels, G (2005). "Lasers Aimed at Aircraft Cockpits: Background and Possible Options to Address the Threat to Aviation Safety and Security".