

Safety Aspects of a Miniature Handheld Laser Projector

The laser industry is fifty years old and yet remains dynamic with the continued introduction of applications in an increasing number of fields.

Lasers have become an integral part of familiar devices used daily such as; bar-code scanners, office/home scanners and printers, compact disk players, gaming consoles, laser pointers, mice and more.

A LASER (Light Amplification by Stimulated Emission of Radiation) diode is a device that generates and amplifies a beam of coherent and monochromatic light. This is in contrast to other light sources which emit a wide wavelength spectrum of light.



Everyday Laser Products

Laser's
applications
propagation

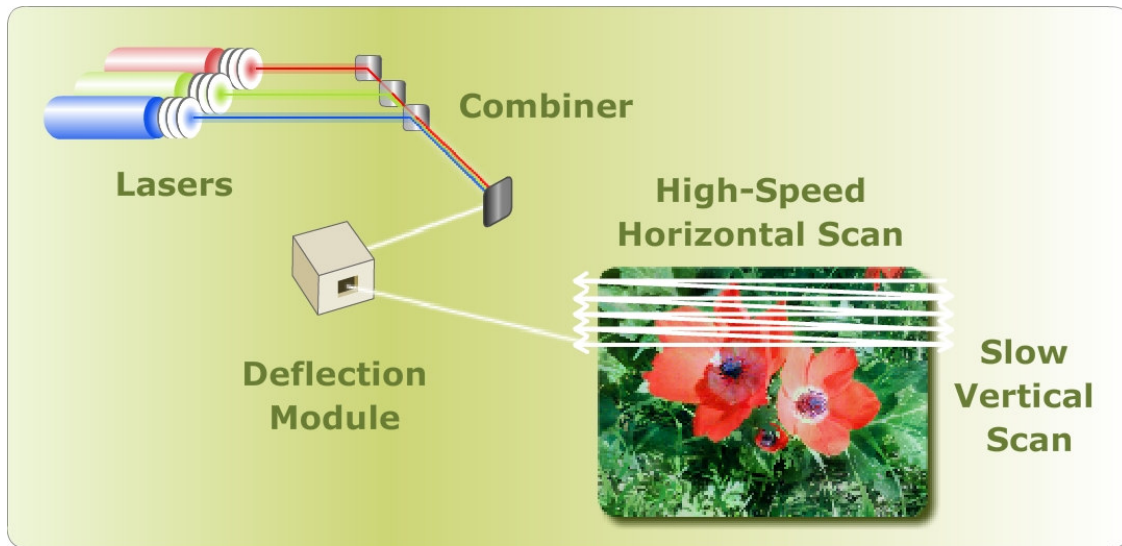
Most people associate the laser with a red beam; however laser technology is known to enable a superior full color gamut. Selecting lasers of the saturated RGB (Red, Green and Blue) primary colors enables excellent coverage of the human eye's viewable color spectrum.

With the increased availability, reduced cost and increase in customer expectation for true colors, it is not surprising that laser technology has just started its march into the display space.

Recently, the miniaturization of display projection technologies into personal handheld devices has also brought the laser technology into this application space, introducing the laser scanning projector.

Laser based
scanning
projector

A laser based scanning projector 'builds up' the projected image using very fast sequential projection – a 'flying spot' of single pixels. This occurs at a frequency that is unnoticed by the eye, which perceives a complete image or video. This represents a very similar approach to the way conventional (CRTs) TVs images were built.



Laser Scanning Projector

The laser beam guidance is achieved by a steering mechanism which is based on sophisticated deflection of the beam both in horizontal and vertical dimensions. The color information is generated by synchronous modulation of the laser primary RGB color sources.

Safety Class

Any product which contains a laser or any other intense illumination source needs to be assigned a safety class.

The specific need for safety classes in the case of lasers arises from the fact that laser beams can carry high energy in a very narrow beam cross section, which might therefore fully enter the eye through the pupil.

This is especially important with non-visible 'IR laser' applications, where people might not even be aware that they are exposed until dangerous non-reversible photo-chemical effects occur in the eyes.

It is important to note that other optical instruments (e.g. projectors using high intensity mercury or halogen lamps) present an equal level of hazard to a human eye when observed directly, certainly from a short range.

The safety class is indicated in addition to the common manufacturer safety instructions or warning labels regarding appropriate use.

The warning "not to stare at the projector light source/output lens while it is turned 'On' " is common on most tabletop projectors – although obvious as the warning "*do not look directly at the sun....*"

Laser safety class is defined by the European standard IEC 60825-1 which indicates, in broad terms, the harm to the eyes or skin that could result from exposure to the emitted light. (In the USA, the similar CFR title 21 Part 1040.10 is applicable).

The classification was founded back in the early 70's and originally had four primary classes ranging from 1 to 4, based on wavelength and power. An international experts committee reviews the standard annually.

The following table provides a simplified description of the current international laser safety classes.

Safety Class	Simplified Description
1	Safe under reasonably foreseeable conditions
1M	As for # 1 except may be hazardous if user employs optical instrumentation
2	Low power; eye protection normally afforded by aversion responses (including blink response)
2M	As for # 2 except may be hazardous if user employs optical instrumentation
3R	Direct intrabeam viewing may be hazardous
3B	Direct intrabeam viewing normally hazardous

For further details the reader is invited to consult the applicable laser safety standard documents: Information source: IEC 60825-1 annex D (informative).

Power Vs
Potential Risk

As the class guidelines have developed, additional sub-classes have been defined. One of the recent revisions recognizes that laser power and its potential hazards do not necessarily match.

Limitation of
warning labels

The meanings of the various laser safety classes and their limitations can be quite confusing, which inevitably means that they might be misunderstood.

Such misunderstandings might arise since worst-case assumptions are used as the basis of the classification procedure. In other words, warning labels are still mostly related to the radiation source itself and might sometimes indicate a level of hazard that does not apply to the system overall safety level.

This means that the actual class of the light source component is not necessarily represented in the actual device output. This is because the observed light level depends on many additional attributes such as:

- Reception phase (pulse, continuous)
- Frequency
- Inclination by a scanning pattern
- Diffraction through the mediation medium
- Other optical qualities and elements

As implied by the class structure, it is acceptable to take people's natural instincts and reactions into account when calculating the device safety level. These might include eye aversion and blinking due to intensified light.

In a scanning projector, the beam can't be focused on a single point and consequently its energy is being spread, delivering a lower energy level on the projected spot area. Even at the worst case of penetration into the eye, the energy is still distributed over the whole retina (over 150 million cells...) and not focused on a single point.

System overall design

A device rating takes into account the system's overall design, as well as its built-in safety features, such as embedded proactive safety and control circuitry which is also referred as the 'Fail Safe' mechanisms.

'Fail Safe' module

In a scanning projector, the embedded 'Fail Safe' mechanism monitors the operation of the deflection mechanism and the laser power output, thereby ensuring, for example, that there are no conditions under which the system can beam light if the deflection mechanism is not operating properly or erroneously deliver more laser power than specified.

bTendo's Safety Class

Base on the described before, bTendo's products were found to be of low power and with eye protection which is afforded by normal aversion responses of the eye, thus it is classified as Class 2M.

It's the overall system safety that counts

Miniature handheld laser projectors hold the promise of numerous professional and entertainment applications and as with many advanced systems in our daily lives, it is the overall system safety that counts, rather than the worst case safety ratings of a single component.

Appropriate safety mechanisms designed into the product, and in accordance to the laser source parameters, ensures a device that is totally safe to own and use.

Such design is common practice in today's laser technology environment, as implemented in laser printers and scanners, multimedia laser shows, and even supermarket bar-code scanners. Laser safety design has matured to the point where high power laser beams are commonly (and safely) used for numerous medical procedures, even within the human eye!

