A CASE STUDY FOR CLASSIFICATION OF LASER PRODUCT
BY IEC 60825-1

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Abstract- The aim of this study is to suggest a guide line for classification of Laser product base on IEC 60825-1. The guide line is published with main parameter to classify a class of Laser product with 1, 1C, 1M, 2, 2M 3R, 3B, and 4 according to the international laser safety standard IEC 60825-1. In this paper, one prototype Laser product has been used to classify a laser class by using a guide line.

Keywords- Laser safety, IEC 60601-1 3rd, Laser Classification, Output Power, Beam Diameter, Beam Divergence

I. INTRODUCTION

The IEC (International Electrotechnical Commission) has recently published Edition 3.0 to the IEC 60825-1 safety of laser products – Part 1: Equipment classification and requirements on May 2014. This paper briefly describes to classify a laser product with main parameter on the basis of IEC 60825-1 safety of laser products – Part 1: Equipment classification and requirements. In this paper, we summarized the process on protocols section and implement a process on case section.

II. PROTOCOLS

The 60825-1 standard has simple examples to classify the laser products which is already known the information (output power, beam diameter, beam divergence, wave length of laser radiation) as follows;

“Classify a CW carbon dioxide laser (λ = 10.6nm) use for

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In the 60825-1 standard, they also have shown a detail solution and final class as follows. “Therefore, as this exceeds the total laser output power this laser is classified as Class 3B.” In this paper, we described the method how to measure a key information (output power, beam diameter, beam divergence, wave length of laser radiation) to classify the laser product. Some key words were defined according to the 60825-1 standard.

The beam diameter is defined as “diameter of the smallest circle which contains ≥6% of the total laser power or (energy)” as Fig. 1. The beam divergence is defined as “far field plane angle of the cone defined by the beam diameter” as Fig. 2.

The process has constructed to measure the main parameters as follows:
- Measurement of output power
- The output power of laser product is measured with laser power and energy meter.
  - Unit: SI unit (nW, mW, W, etc)
- Measurement of beam diameter
  - The beam diameter of laser product is measured with laser CCD beam profiler system.
  - Unit: SI unit (radian)
- Measurement of beam divergence
  - The beam divergence of laser product is measured with laser CCD beam profiler system.
  - Unit: SI unit (radian)
- Setup and procedure [2]

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A schematic of the setup for divergence measurement is shown below in Fig 3. The procedure for measuring the divergence is as follows:

1. Set up the laser (or fiber), a lens of focal length F, and the CCD camera as shown in Fig 3.
2. Make sure the lens is oriented correctly (front-to-back) to minimize aberrations. The steepest curvature should face away from the CCD camera.
3. Place the CCD camera so that the pickup is exactly $F_b$ millimeters from the center of the last surface of the imaging lens.
4. With the beam profiler, measure the beam diameter at this point in both the horizontal and vertical directions. Denote them as $D_x$ and $D_y$. For these measurements use the diameters inside which 86.5% of the total power falls.
5. The divergences in the horizontal ($x$) and vertical ($y$) directions can be calculated using the formula (1):

$$\theta_{x,y} = \frac{D_{x,y}}{F}$$  

(1)

where $D_{x,y}$ is either $D_x$ or $D_y$, depending on which axis is being measured, and $F$ is the effective focal length of the lens at the laser wavelength.

6. For elliptical beams, the average divergence (average of $x$ and $y$) can be calculated using the formula (2):

$$\theta_{ave} = \frac{D_x+D_y}{2}$$  

(2)

III. CASE

A. Laser product

A laser product, which is prototype version, was used to verify a suggesting protocol. The two parameters of laser products are noticed an 825 nm, and 50 mW for wavelength, and output power, respectively on products data sheet.

B. Experiments

The Vega (OPHIR, USA) was used to measure an output power as Fig 4. The output power, and wavelength was 48 mW (Maximum), and 823 nm, respectively. The Gevicam (OPHIR, USA) was used to measure a beam diameter, and divergence. The laser beam diameter, and divergence was 4 mm, and 1mrad, respectively.

C. Classification

The main parameter (48 mW for output power, 823 nm for wavelength, 4 mm for beam diameter, and 1mrad for beam divergence) of laser product was measured by optical devices. The classification process is refer to flowchart guide for the classification of 60825-1 standard.

First, this laser product is CW (continued wave). Second, the time base is 100s and the class is assumed by Class 3B. The aperture may be 7mm because of the beam diameter and beam divergence angle. The AEL (Accessible emission limits) is chosen by 0.5W. The chosen AEL is higher than measured AEL. Third, we need check the lower class condition (3R). The time of Class 3R is 0.25s (C6=1) in this laser product, then the AEL is calculated as (3).
\[ AEL = 5 \times 10^{-3}C_0 W \] 

Therefore, the AEL is 5\( \mu \)W which is lower than laser product (output power: 48\( \mu \)W). The laser product in this paper would be classified as Class 3B.

**CONCLUSION**

The aim of this paper is introduce the protocol of classification method of laser product base on IEC 60825-1 standard. We used a laser product on prototype version and to measure the main parameter (output power, wave length, beam diameter, and beam divergence). To classify a laser product, we refer to flowchart guide for the classification of laser products. Further, we will publish a simple guide line book which will be included various pictures (e.g. Laser products setting, scene of experiment, and result data,) and tables from IEC 60825-1 standard.

**REFERENCES**

