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LEDs in General Lighting

Optical Radiation Safety

in Connection with Luminaires

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Topic: Optical Radiation Safety in Connection with Luminaires

Introduction

To promote the free movement of goods within the European Community (EC) and at the same time to enable the authorities to determine quickly whether the legal requirements with regard to safety have been met, as of 1 January 1997 the symbol referred to as the CE marking became mandatory also for electrical equipment, e.g. luminaires. The "CE" marking, long in use for example with toys, stands for "Communauté Européenne" (European Community) and is sometimes also called the "EC conformity marking".

Affixing of the CE marking is the responsibility of the manufacturer. However, before affixing this marking to a product the manufacturer must make sure that the requirements in all of the European directives relevant for that product have been met, i.e. each of these requirements is to be checked and the fact that it has been met is to be documented.

European directives must be incorporated into national law within a specified period of time, i.e. a violation such as placing a product on the market that does not meet the requirements is subject to legal prosecution. The requirements in the directives are limited to essential requirements so as not to hinder technical development. The requirements are made more specific in technical product standards, which preferably are based on international agreements. This too shows the aim of all these efforts, i.e. to promote the free movement of goods and to pull down barriers to trade.

Prior to the adoption of a given standard a questionnaire procedure is carried out to determine whether the content of the standard is acceptable. If the standard is accepted, in some cases with common modifications, the standard is then ratified. This means that within a specified period of time and without any technical or editorial changes it must be made part of the national standards and published as a European Standard (EN). Furthermore, any conflicting standards must be withdrawn within a specified period of time. Ratified standards are listed in the "Official Journal of the European Communities", with reference being made to the relevant directive.

For luminaires, the following directives are relevant:

a) Electromagnetic compatibility
b) "Low Voltage Directive" (safety requirements for electrical equipment)[1]

The following comments focus on the directive listed under b).

For the "usual" luminaires the relevant standard is EN 60598 "Luminaires" (German standard: VDE 0711), with Part 1 containing general requirements and several Parts 2, each of which details requirements for a particular type of luminaire.

For luminaires with LED modules, EN 60825-1 "Safety of laser products-Part 1: Equipment classification, requirements and user's guide" (German standard: VDE 0837, Part 1) is to be followed additionally.

What do LEDs have to do with lasers?

The possibility of damage to the eyes by laser beams is generally known. For many people, however, it is surprising that light emitting diodes are also thought to pose a potential hazard for the eye. The LEDs used in huge quantity for displays and indicators are in fact "harmless" in this regard.

[1] In Germany the "Erste Verordnung zum Gerätesicherheitsgesetz".

The generic term “LED”, however, is now used collectively for a wide spectrum of optoelectronic components ranging from “lamp-like” LEDs at one extreme to more “laser-like” superluminescence diodes at the other. LEDs used for displays or indicators and for lighting are thus only a subgroup.

Because some types of LEDs are used for the same purposes as laser diodes (e.g. in optical fibre systems), these components in general were added already in 1993 to the scope of IEC 60825-1 dealing with the safety of laser products. This standard requires that a safety classification must be made.

In 1997 this standard, with identical content, became European Standard EN 60825-1. This turned out to be a hindrance to the use of LEDs in general lighting.

The reasons are as follows:

> The classification requirement of the laser standard was developed for sources of optical radiation, for which a possible safety hazard can not be assessed individually and into which one really does not look directly. Therefore it is based on a number of assumptions about worst-case scenarios that are not appropriate for pure light sources.
>
> As for viewing other (artificial or natural) bright sources, a degree of protection is afforded by natural aversion responses like the blink reflex and pupil contraction.

Attempts to adapt the laser safety standard so that it would be more appropriate for use with LEDs led to some major revisions (the most recent being ”Amendment 2” in January 2001). In this way the situation for LEDs was improved mainly via a revised safety philosophy[2] (with consequences for all lasers).

But in the meantime LEDs were also expressly (and again without any differentiation) included in the international and national regulations governing the optical radiation safety of incoherent optical sources of radiation. This is in line with a relevant ICNIRP[3] statement that for “surface-emitting LEDs”[4] even says in general that they are absolutely harmless. But in the light of the rapid progress in semiconductor technology (doubling of light output every two years) a certain degree of caution is certainly appropriate.

In fact, the rules for incoherent sources of radiation would be more appropriate for assessing the safety of LEDs in general lighting than the laser safety criteria. Their use would also ensure a way of judgement similar to that for the conventional lamps used in such applications up to now.

Whether it is appropriate or not, the manufacturers of LED products in and for Europe currently have no choice. EN 60825 –1 is listed under the Low Voltage Directive and hence for reasons of equipment safety must be taken into account.

This brings us to the topic of

Classification in accordance with EN 60825-1

For LED applications in general lighting, the only classes of possible relevance of those available are the following two:

- Class 1: Laser and LED equipment that is safe under reasonably foreseeable conditions of operation

- Class 1M: Laser and LED equipment that is safe under reasonably foreseeable conditions of operation for use with the naked eye. Looking directly into the source of radiation by employing optics within the beam such as a magnifying glass, telescope or microscope can be potentially hazardous.

[2] See also DIN EN 60825-1 of November 2001.
[3] ICNIRP: International Non-Ionizing Radiation Committee.
[4] Surface-emitting LEDs are conventional LEDs without gain where the emission is orthogonal to the chip surface, and the chip surface can be viewed directly. It may have a built-in lens or reflector.

Generally, these laser safety classes are separated by Accessible Emission Limits (AEL) which have to be measured also under different conditions and they are connected with specific safety requirements, e.g. labeling with warning signs.

As a general rule, classification must include consideration of any reasonably foreseeable fault condition. A recent expressly-stated exception is “surface-emitting LEDs” – such as are currently used for lighting purposes and as indicators. These components are capable of exceeding the AELs only very briefly at most, for example during failure of the electrical control equipment.

There is no provision in the standard for classifying individual components (e.g. individual LED modules) because the optical radiation safety depends on the concrete conditions of use and operation in the final product. The final product manufacturer therefore has the ultimate responsibility for the proper classification of the "laser (or LED) product". In the case of general lighting, however, these are mostly small to medium enterprises that are not usually in a position to make such assessments. Those manufacturers of LEDs aware of this situation will therefore make an effort to supply basic information about the relevant properties of their components.

This “manufacturer’s declaration” can then serve as part of the “Technical File” that is a prerequisite for the EC Declaration of Conformity.

If the values of the emission are kept below the AELs (including the assessment conditions) of Class 1 or the new Class 1M there are no problems–either the LED equipment is outside the scope of the safety standard (in the case of Class 1) or a warning notice is given (in the case of Class 1M). A statement included in the information for the user would be sufficient for this purpose.

An evaluation, classification and certification of LEDs in accordance with EN 60825-1 based on measurements is currently possible only to a certain degree or not at all (due to a lack of mandatory advice). The standard, however, allows the use of equivalent tests or procedures, with calculations usually being the alternative. These show that the standard LEDs currently available have values below the Class 1 upper limits of the standard mentioned above under conditions that can reasonably be anticipated, including the fault situation.[5]

Hence they are outside the scope of the safety standard.

Under real conditions of use there is absolutely no risk since the laser safety standard applies worst case viewing conditions.

Even if the radiation output continues to increase, the upper limits of Class 1M (safe for the “naked” eye) will not soon be reached. The equipment is then within the scope of the safety standard, but even under these conditions the only thing required is a warning notice in the instruction manual.

Outlook

LED modules for general lighting are on their way to becoming a “normal” light source like those already existing, i.e. lamps of all types.

The evaluation of LED modules regarding optical radiation safety, referred to as classification, is currently being looked at with this in mind, and in the future will become more and more like that for existing light sources. The most recent changes in EN 60825-1 are steps in this direction.

Close cooperation between manufacturers of LED modules and manufacturers of luminaires is the right approach in regard to this new light source to speed up the technical progress in the field of general lighting.

[5] This statement was made at the ZVEI conference “LEDs in der Allgemeinbeleuchtung“ (LEDs in General Lighting) held on 28 November 2001.