A SAFEhouse Guide to LED Lighting

LED lighting introduction

With the rapid change from traditional lamp types to more efficient LED (light emitting diode) lighting and the large variety of lighting products available, the selection of suitable LED light sources (lamps) and LED luminaires (light fittings) for lighting interior and exterior areas, offers the consumer many choices.

Product branding, where importers have the ability to mark products with the brand names of their choice, complicates the issue as it is difficult to evaluate such brands based on past experience with products from the same manufacturer. Although products from leading lighting companies are readily available and are supported by extensive research and product development programmes, the market offers a multitude of LED product brands. The suppliers of many of these products make optimistic claims of light output and product life expectancy.

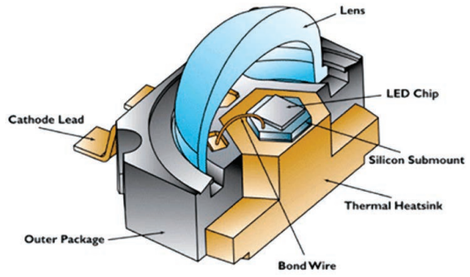
While product safety is very important, the reliable performance of the LED light source and luminaire are essential for a good lighting installation; one that will allow occupants to move around safely and perform tasks efficiently. The safety requirements for LED lamps and luminaires are fairly clearly defined in standards and specifications and can be determined through suitable testing and inspection. The luminaire and light source performance and lifetime reliability are more difficult to determine and require extensive and costly testing.

Product design basics

Owing to the high energy efficiency, extended life expectancy, and colour variation available in LED light sources, designs of all shapes and sizes with standard lamp-cap configurations have become available to replace existing 'traditional' lamps. In South Africa, this changeover has gained impetus due to the energy crisis.

LED modules are extensively used in the manufacture of luminaires and are available in various configurations. The design of the luminaires should be such that temperature limitations, as specified by the LED module manufacturer, are maintained and insulation between the primary mains voltage circuit and the low voltage circuits are ensured, to prevent accessible luminaire parts from becoming live.

Because of the construction of LEDs, the LED chip emits directional light in a fairly narrow beam, whereas light from most traditional sources is omni-directional (emitting light in all directions in space) and most luminaires are designed for these light sources.



The replacement of other lamps with LED lamps in existing luminaires therefore requires omni-directional LEDs, which are readily available with most of the standard lamp-cap configurations. This has been achieved by mounting the LED chips in the required directions and, in some instances, by covering the entire lamp with diffusers or lenses to disperse the light.

It is therefore possible to retain a luminaire's photometric distribution characteristics and light output, through the careful selection of LED lamps with omni-directional light distribution and equivalent light output (lumen), provided the LED lamp has a similar shape and similar dimensions as the original lamp for which the luminaire was designed.

Basic lighting concepts

To make the correct choice, it is essential that some basic concepts of lamps and lighting are understood. Specifically in the case of LED lamps, aspects such as light output, colour and colour rendering, lamp efficacy and life expectancy should be considered to justify the higher expense of LED lighting when compared with traditional lamps.

- **Light output, lumen:** the total amount of light emitted from a light source or luminaire, (lm).
- **Lumen maintenance, %:** the rate of deterioration of light output of a lamp over time.
- **Lamp efficacy, lumen/Watt:** The amount of light emitted from a bare lamp (lm) divided by the input electrical power (W).
- **Lamp life, hours:** The rated lamp life of lamps is generally based on the average life of a sample of lamps burning under controlled conditions. It gives the number of burning hours at which the sample of lamps maintains its claimed light output.

Life expectancy

LEDs emit visible light when electricity is passed through a semiconductor. In this process, heat is generated that needs to be dissipated effectively to prevent overheating of the LED, which could result in reduced light output and lamp life.

Some manufacturers make optimistic claims about their LED lamps' life expectancy (25 000 to 50 000 hours are common claims). Because actual life testing is extremely costly and impractical, these claims are projections based on the life of the LED chip, when operating under temperature conditions as specified by the LED chip manufacturer. The design of the LED lamps or LED luminaires should therefore ensure that these conditions are not exceeded. Users should also understand that their operating environment may affect the life expectancy of the product.

EMI (electromagnetic interference)

LED lamps emit electromagnetic energy and there are very clear local and international specifications as to the maximum levels of these conducted and radiated emissions. Exposure to high frequency electromagnetic fields, even as low as 100 kHz, may have health consequences. High EMI can also interfere with electronic devices such as audio visual equipment, communication systems and pacemakers, amongst others. For these reasons, all lighting-related products must comply with international compulsory standards – part of the European EMC directive – or the South African SANS 215 standard of which ICASA is the regulatory authority.

There are currently a large number of LED products on the South African market that do not comply with this standard and that, when installed, become a distributed source of high emissions.

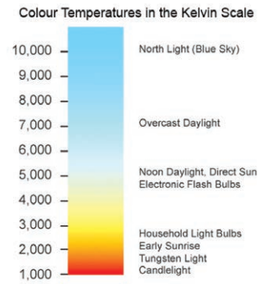
LED lamp dimming

Incompatibility between dimmers and LED lamps is often experienced by users. Where the marking (left) is displayed on LED lamp packaging, the dimming of such lamps is not allowed. Suppliers should be approached for technical advice on dimming.

Colour characteristics

The colour characteristics of light emitted from light sources are described in various ways.

- **Correlated Colour Temperature (CCT)** is a measure of the emitted light's colour. This classification is commonly seen on LED lamp packaging and gives the user a choice of some lamp colours to suit different applications.



- Colour Rendering Index (CRI) is a rating R_a that is given to a light source and which represents the degree of colour shift that would be obtained when each of eight specified colour samples are illuminated by the light source and compared with the colour obtained with a reference light source.

A value of R_a= 100 means perfect colour rendition.

For indoor lighting, the value of R_a should not be less than 75. Where the recognition of colour is important the LED lamps with the highest R_a value should be selected.

SAFE™ HOUSE

The South African SAFEhouse Association is an independent, registered, non-profit organisation established by the electrical industry and committed to communicating with customers.
SAFEhouse has been established to combat the proliferation of dangerous products and services by making the market aware of the risks in using such products and services, exposing sub-standard products and services, and persuading specifiers, suppliers and distribution channels not to recommend or to offer such products and services for sale.
SAFEhouse members have signed a code of conduct that commits them to dealing only in safe electrical products and to responsible behaviour.
If you have doubts about a particular product or service, contact SAFEhouse for guidance.

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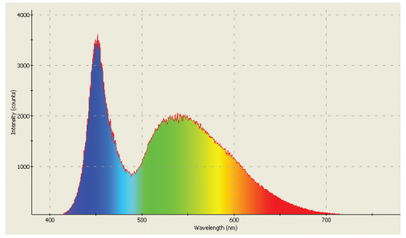
Colour characteristics continued ...

The colour rendering index depends on the spectral emission of light from the source over the visible range. A typical spectral emission curve for a white LED is given below. From the curve it is clear that the blue component is dominant and that there is lower emission in the green/yellow/red areas. This would lead to lower colour rendering of these colours.



While there are many LEDs with different emission curves available, LEDs with good colour rendering index values should be selected where colour matching is important.

Luminaire and lamp suppliers/manufacturers should be contacted for technical advice.

LEDs can fail due to overheating if they are made from poor quality materials and if the heat from the LEDs is not dissipated efficiently. LED lamps with a greater light output are particularly prone to this problem.

Compulsory standards/specifications for LED luminaires

VC8055: Electrical and Electronic apparatus is the applicable compulsory specification for luminaires.

VC9012: Electrical luminaires will shortly be implemented to separate luminaires, including those for LED lamps, from the present version of VC8055.

The following safety standards are compulsory by reference in VC8055 and VC9012 to the following safety standards:

SANS 60598-1: Luminaires Part 1: General requirements and tests.

SANS 60598-2-1: Fixed general purpose luminaires.

SANS 60598-2-2: Recessed luminaires.

SANS 60598-2-4: Portable general purpose luminaires.

SANS 60598-2-5: Floodlights.

SANS 60598-2-7: Portable luminaires for garden use.

SANS 60598-2-8: Hand lamps.

SANS 60598-2-9: Photo and film luminaires (non-professional).

SANS 60598-2-10: Portable luminaires for children.

SANS 60598-2-11: Aquarium luminaires.

SANS 60598-2-12: Mains socket-outlet mounted nightlights.

SANS 60598-2-13: Ground recessed luminaires.

SANS 60598-2-18: Luminaires for swimming pools and similar applications.

SANS 60598-2-19: Air-handling luminaires.

SANS 60598-2-20: Lighting chains.

SANS 60598-2-23: Extra low voltage lighting systems for filament lamps.

SANS 60598-2-24: Luminaires with limited surface temperatures.

SANS 60598-2-25: Luminaires for use in clinical areas of hospitals and health care buildings.

SANS 1464: Luminaires for emergency lighting.

SANS 60570: Electrical supply track systems for luminaires.

Various other standards for luminaires, lamps and lighting components are available. Information can be obtained from suppliers, the NRCS or the SABS.

Standards for LED lamps and control gear

The standards for LED lamps are voluntary as they **are not regulated** by the National Regulator for Compulsory Specifications in terms of compulsory specifications. Further information can be obtained from the SABS.

SANS 62560: Self-ballasted LED lamps for general lighting services by voltage >50 V – safety specifications (IEC 62560).

SANS 62031: LED modules for general lighting – safety specification (IEC 62031).

SANS 61347-2-13: Lamp control gear. Particular requirements for dc and ac supplied electronic control gear for LED modules (IEC 613437-2-13).

VC 9087: Compulsory specification for lamp control gear. (This specification refers to SANS 61347-1.)

SANS 1662: Self-ballasted LED tubular lamps for general lighting services for voltage >50 V – safety specification.

Luminaire safety

Luminaire safety requirements are set to prevent harm to persons or damage to property mainly through fire, electric shock or burning. Users should be aware of important safety aspects in selecting luminaires, some of which are listed below:

Marking: Luminaires shall be marked with at least the following:

- Manufacturer's name, mark of origin.
- Lamp type and max W.
- Rated supply voltage.
- Any precautions for installation and maintenance.

Luminaire construction: Specific aspects are:

- Protection against electric shock – luminaires shall be of one of the following classes:
  - Class I – Protection relies on basic insulation only and must be provided with a protective earth conductor (live, neutral and earth).
  - Class II – Protection relies on basic insulation with additional double insulation or reinforced insulation. No provision for protective earthing (live and neutral).
    Luminaires shall be clearly marked with the symbol:

  - Class III – Luminaires in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV (<50V) are not generated. Such luminaires shall be clearly marked with the symbol:

  - Class 0 – Luminaires in which protection against electric shock relies upon basic insulation only, are not permitted in South Africa.

Provision for earthing: Class I luminaires shall be provided with an earth terminal to which all accessible metal parts, which may become live in the event of an insulation failure, are permanently and reliably electrically connected. The earth connection shall be locked against accidental loosening.

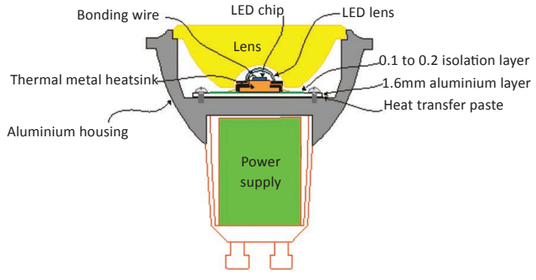
Protection against electric shock: Luminaires shall be so constructed that their live parts are not accessible when the luminaire has been installed and wired as in normal use, and when it is opened as necessary for replacing lamps.

LED lamp safety

For LED lamps with externally accessible metal parts, these parts must be effectively insulated with reinforced or double insulation to ensure protection against accidental contact with live parts.

(SANS 62560: Some LED lamps have been found not to comply with this requirement, resulting in a safety risk.)

Compliance with this requirement can only be determined through testing.



The basic requirement is that no single failure can result in dangerous voltage becoming exposed so that it might cause an electric shock and that this is achieved without relying on an earthed metal casing. This is usually achieved at least in part by having two layers of insulating material surrounding live parts or by using reinforced insulation such as insulating sleeves, grommets and bushings.

Who polices the lighting industry in South Africa?

- The Illumination Engineering Society of South Africa (IESSA) represents the interests of the South African lighting industry.
- The South African Bureau of Standards (SABS) sets the national standards.
- The National Regulator for Compulsory Specifications (NRCS) is mandated to set compulsory specifications and carry out surveillance and compliance monitoring against these specifications.

What to look out for when buying LED products

- Visible workmanship is usually an indication of product quality and reliability.
- For lamps with accessible metal parts, such as cooling fins and heat sinks, establish whether the product complies with the relevant safety standard.
- If a product is materially cheaper than other, similar products on offer, be wary.
- Be suspicious of excessive life expectancy claims compared with products from reputable brands.
- Consult a qualified, registered electrician or electrical engineer for extensive installations, especially renovations and retro-fits.
- Do not buy products with poor earthing of accessible metal parts or inadequate protection of wiring of double insulated luminaires.
- Third party product certification, such as an SABS mark, provides some comfort in the event of premature product failure ('CE' marking is not a third party certification).
- Choose products from reputable, established suppliers and look for brand names from known manufacturers who have proven design and manufacturing capabilities.
- If in doubt, contact the SAFEhouse Association for assistance.

Beware of deliberate or negligent misinformation

The non-compliant LED luminaire's driver (above) is marked with the double insulated marking, but the supply leads only have basic insulation and are not marked.

For more information on safety aspects see the SAFEhouse Guide to Luminaires.

For a list of reputable local suppliers or for more information on these products, please contact:

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