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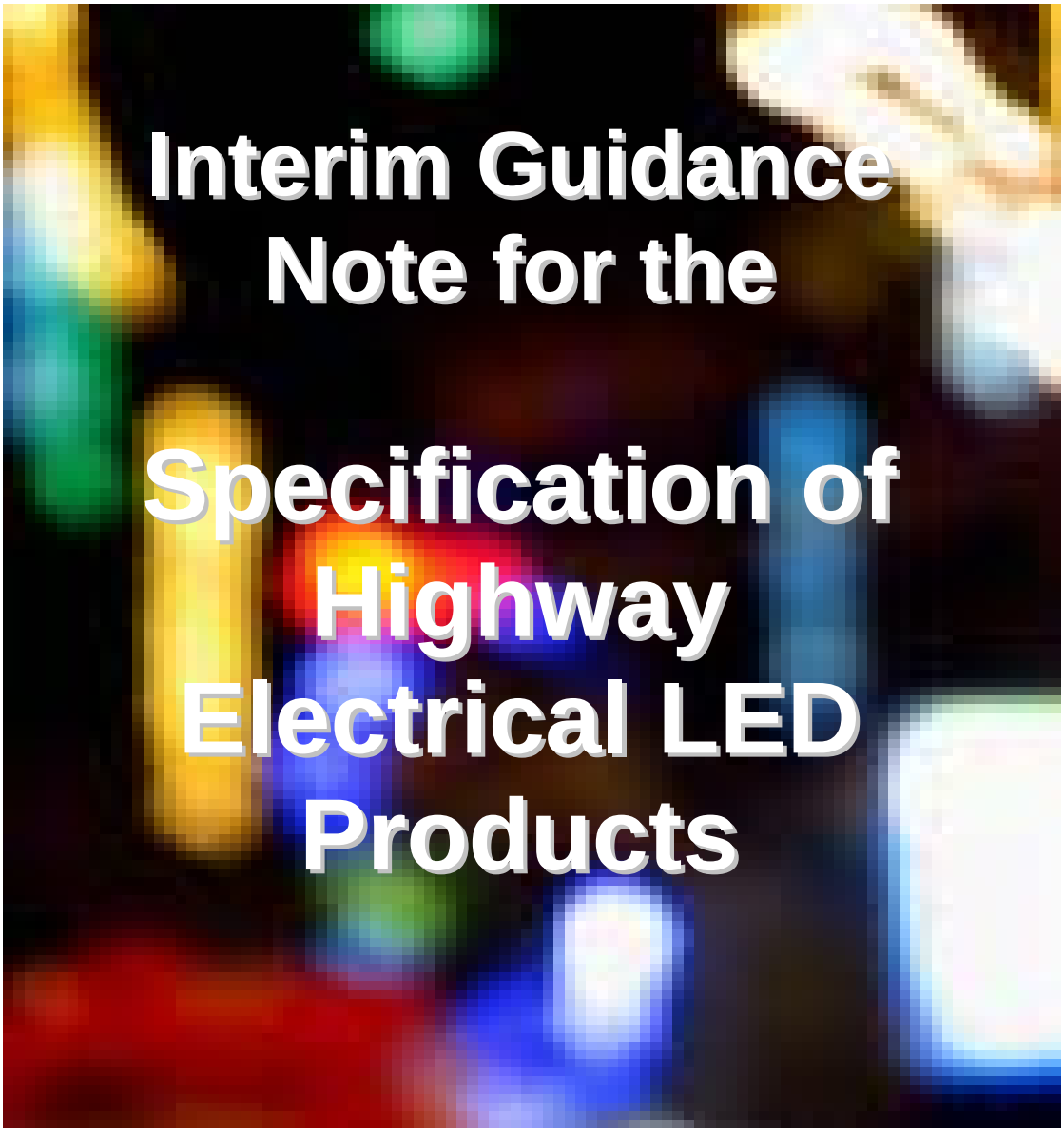
The Highway Electrical Manufacturers and Suppliers Association



A Guide to the Specification of LED Products

Introduction

With the continuing development of LED's as a new light source there is a need to ensure performance claims are made in a consistent way. Although standards are developing, there is concern that the speed of innovation is moving ahead of standardisation. As a result a number of organisations have produced a template as the basis for the specification of LED luminaires performance criteria.

HEMSA has taken this template and added to it - as an Interim Guidance Note; Interim, because as technologies develop and standards change, the guidance will need to be revised accordingly. In particular, the **Executive Summary** is intended to outline the key criteria that specifiers, manufacturers and suppliers should be aware of, and use. The Executive Summary should not be relied on exclusively, as important information is contained in the rest of this Guidance Note.

Executive Summary

When specifying or supplying LED luminaires, specifiers, manufacturers and suppliers should ensure that the following critical areas are covered:

4.1 Luminaire Lumen Output – any figure quoted should be substantiated by reference to this document, and quote the ambient temperature, T_{board} temperature and Driver current. The effect of the temperatures and driver current on the individual LED performance and output should also be shown (in general, as the LED temperature increases, the light output falls).

4.2 Luminaire Life – Using the definition of life within this document as lumen depreciation / maintenance at L80 and failures over life at F10, this should be clearly set out for the intended ambient and T_{board} temperatures and the Driver current (Life in hours should always quote the L and F assumptions – recommended as L80, F10 in this Guidance Note). Luminaire life should be split into Life – Measured and Life – Calculated / Extrapolated.

4.3 Luminaire Lumen Depreciation – curves should be provided showing the lumen depreciation over the measured and calculated life of the luminaire and its LEDs as defined in this document and at the temperatures and driver current encountered / used in the luminaire

4.4 Luminaire Colour Characteristics – the various colour characteristics and colour rendering characteristics should be clearly set out at the intended temperatures and driver current and should show the effect of any colour shift over both the measured and calculated / extrapolated life.

4.5 Luminaire Electrical Characteristics – total power consumed and measured power factor should be shown. Whilst the product standards may not cover power factor for lower wattage luminaires, nevertheless this is an important consideration for users in order to comply with their DNO connection and supply agreements

Criteria

These criteria are designed to ensure that performance claims can be matched against traceable data. They are also designed to ensure that the performance data relates to the luminaire during operation and not just to the performance of the LED. This is because:

1. **Thermal Losses**: The temperature of the p-n junction of the raw LED (die) (T_j) is measured at a temperature in the vicinity of the LED of 25°C whereas in a luminaire it will be operating at a higher temperature. All performance parameters are variable with Junction Temperature (T_j).
2. **Optical Losses**: In addition the luminaire often includes "secondary" optics to suit the particular application needs of such luminaire, but leading to additional performance losses as well.
3. **Driver Electronic Losses**: In most cases an "LED-driver" is included in the luminaire which will introduce additional losses compared with the initial LED performance.

Data

Data is split into two parts:

1. Luminaire manufacturers design data, available for traceability
2. Luminaire manufacturers declared performance data

Measurement

Five CIE technical committees are currently working on measurement methods for the measurement of LED performance:

- **TC2-46** CIE/ISO standards on LED intensity measurements
- **TC2-50** Measurement of the optical properties of LED clusters and arrays
- **TC2-58** Measurement of LED radiance and luminance
- **TC2-63** Optical measurement of High-Power LEDs
- **TC2-64** High speed testing methods for LEDs

(See also Appendix B)

For luminaire designers the LEDs are normally supplied as a package comprising of the silicon wafer integrated into a package ready for placing onto a circuit board or within a luminaire. There is an advised operating temperature, to achieve their design performance, on the outer surface of the package or LED module T_{board} (see Fig 1). This may be achieved under normal operating conditions and also at the rated voltage/current/power when appropriate measures to remove heat from the device have been adopted. The junction temperature can be calculated from the thermal resistance/W data available from the LED supplier.

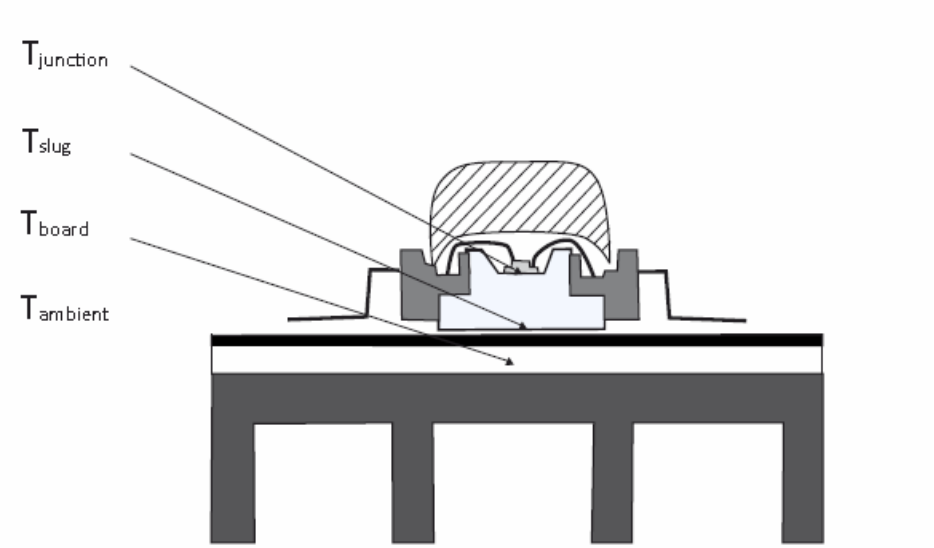


Fig 1 - Critical temperature points in a High Power LED

1.0 Luminaire manufacturers design data, available for traceability

1.1 Manufacturer of the LED package and part number or other device identifier

1.2 Drive current/voltage/power

1.3 Lumen depreciation curves, electrical life, CCT, x & y and CRI for the LED package outside the luminaire at an ambient temperature of 25°C

1.4 The board temperature T_{board} ** of the LED package installed in the luminaire, when the luminaire is operating at an ambient temperature of 25°C. (15°C for Exterior luminaires)

1.5 Lumen depreciation curves, electrical life, CCT, x & y and CRI for the LED package at the operating T_{board} **

1.6 The colour bin, CCT, x & y values and MacAdam ellipse category (e.g. Cat 1-4) of the LED package at the operating T_{board}**

1.7 Ra8 Colour Rendering Index at the operating T_{board} **
1.8 Ra14 Colour Rendering Index at the operating T_{board} **

** These may be calculated from the LED manufacturers data of performance vs. junction temperature, taking account of the thermal resistance between the junction and the board, assuming accurate correction curves exist.

2.0 Luminaire manufacturer's performance measurements

2.1 Luminaire lumen output

2.2 Luminaire power

2.3 Luminaire efficacy

2.4 Correlated Colour Temperature, CCT (+ shift over life)

2.5 Colour coordinates, x & y (+shift over time)

2.6 Colour rendering index, CRI, Ra8 (+ shift over life)

2.7 Luminaire Life which should always be qualified by:
Lumen depreciation / maintenance at L80
Failures over life at F10

2.8 Luminous Intensity Distribution

Luminaire manufacturers' performance claims are measured in accordance with the requirements of IEC/PAS 62612: Edition 1:2009-06: Clauses 4,6,7,8,9,10 and 11. (The testing quantity for LED Package lamps is given as minimum 20 and a value for modules and luminaires will need to be checked).

The drive current and bin reference for the LED used for luminaire performance data should be stated.

Supporting information on the performance claims is given in Appendix A.

3.0 Photometry

Photometric data is available in two formats. Absolute Photometry does not require the use of a separate lumen output for the light source. Relative Photometry requires the LED package flux to be quoted. Both methods produce the same result. The manufacturer should state the format in which the photometric data is supplied.

Absolute photometry of LED luminaires should be conducted according to *IES LM-79-08 Photometric Measurements of Solid-State Lighting Products*. Relative photometry should be conducted according to *EN13032-1 (2004) Light and lighting - Measurement and presentation of photometric data of lamps and luminaires - Part 1: Measurement and file format*

These standards contains advice on measurement uncertainty. Luminaire performance data to be quoted at operating temperature $T_{board.}$

Photometric results that are calculated by deviation from the tested sample by the use, for example of higher or lower drive currents or dies from bins other than the bin used for the tested device are to be clearly identified as such. Correction factors used are to be provided with the results.

Appendix A

A1. Efficacy

Luminaire efficacy should be calculated from the initial lumen output of the luminaire that has reached thermal stability operating in an ambient temperature of 25°C and based on the total power of the LED's and driver circuit.

A2. Colour Point (see Clause 7 IEC/PAS 62612)

The colour point (x & y) of the luminaire and the colour temperature derived from it shall be one of the listed preferred values

Tolerance (categories) on nominal x & y values
All measured x & y colour coordinates:

3-step ellipses	Cat 1
5-step ellipses	Cat 2
7-step ellipses	Cat 3

A3. Life (see Clause 10 IEC/PAS 62612)

Life is calculated based on two factors, lumen depreciation and failure. Life testing also consists of an endurance test. It should be made clear what part of the life and lumen depreciation has been measured and what has been derived from extrapolation or calculation.

A4.Lumen Depreciation

The length of time during which a complete LED-luminaire provides more than a percentage of the rated luminous flux, under standard test conditions. A customer must be assured that the declared life is the design life. It should be made clear what figures have been measured and what have been derived from extrapolation or calculation.

For illuminating luminaires the percentage should be >80%, indicated as L80
For direct view luminaires the percentage should be >50%, indicated as L50

A5 Failure

The percentage of a number of tested LED's of the same type, that have reached the end of their individual lives and have no visible light output.

For luminaires the percentage should be <10%, indicated as F10

A6 Endurance test

This consists of the following:

- Temperature cycle shock test
- Voltage switching test
- Ambient temperature test at 45°C

It should be made clear what figures have been measured and what have been derived from extrapolation or calculation

A7 Temperature cycle shock test

Luminaire to be operated at full power (at elevated ambient temperature, in excess of 45°C) until T_{board} = LED manufacturers maximum operating limit for 1 hour then luminaire to be rapidly cooled to 0°C by placing in a temperature controlled container set to 0°C until T_{board} = 0°C

A8 Voltage switching test

Luminaire to be subjected to a switching cycle of 5 seconds on 5 seconds off for 2 minutes

A9 Ambient temperature test at 45°C

Luminaire to be operated in a temperature controlled container set to 45° C. T_{board} to be monitored until steady state reached. If T_{board} exceeds LED manufacturer's value for claimed life and output of fitting then test is failed.

Appendix B

Product type	Safety Standard	Performance Standard
LED lamps	IEC 62560 Edition 1 Publication expected 2010	IEC 62612/PAS Publicly Available Specification
LED Drivers	IEC 61347-2-13 Published 2006	IEC 62384 Published 2006
LED Modules	IEC 62031 Edition 1 Publication 2008	Draft under preparation
LED Luminaires	IEC 60598-1	No standard
LED products	IEC TS 62504 Terms and Definitions for LED's and LED modules in general lighting	

The Criteria, Data and Measurement sections, and Parts 1-3 and Annex A of this document are approved for use by the following:

HEMSA
Highway Electrical Manufacturers & Suppliers Association

Institution of Lighting Engineers

PLDA
Professional Lighting Designers Association

Lighting Industry Federation

Society of Light and Lighting

IALD
International Association of Lighting Designers

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