

TECHNICAL REFERENCE

# **LED modules for general lighting – Performance requirements**

Confirmed 2014



**TR 27 : 2011 (2014)**  
(ICS 29.140.99)

---

TECHNICAL REFERENCE

**LED modules for general lighting – Performance  
Requirements**

---

All rights reserved. Unless otherwise specified, no part of this Singapore Standard may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilming, without permission in writing from SPRING Singapore at the address below:

Standards  
SPRING Singapore  
1 Fusionopolis Walk,  
#01-02 South Tower, Solaris  
Singapore 138628  
Email : [standards@spring.gov.sg](mailto:standards@spring.gov.sg)

ISBN 978-981-4353-05-02

First published, 2011

**NOTE**

1. *Users of this Technical Reference should refer to the relevant professional or experts for any technical advice on the subject matter. SPRING Singapore shall not be liable for any damages whether directly or indirectly suffered by anyone as a result of reliance on this Technical Reference.*
2. *Compliance with this Technical Reference does not exempt users from legal obligations.*

**Contents**

	<b>Page</b>
NATIONAL FOREWORD .....	5
FOREWORD .....	7
INTRODUCTION.....	9
1 Scope .....	10
2 Normative references.....	11
3 Terms and definitions.....	12
4 Marking .....	15
4.1 Mandatory marking .....	15
4.2 Additional marking .....	16
5 Dimensions .....	17
6 Test conditions .....	17
6.1 General test conditions.....	17
6.2 Creation of module families to reduce test effort.....	18
6.2.1 General.....	18
6.2.2 Variations within family.....	18
6.2.3 Compliance testing of family members .....	19
7 Module power .....	19
8 Light output .....	20
8.1 Luminous flux.....	20
8.2 Luminous intensity distribution, peak intensity and beam angle .....	20
8.2.1 General.....	20
8.2.2 Measurement .....	20
8.2.3 Luminous intensity distribution .....	20
8.2.4 Peak intensity value* .....	21
8.2.5 Beam angle value* .....	21
8.3 Efficacy .....	21
9 Chromaticity co-ordinates, correlated colour temperature (CCT) and colour rendering .....	21
9.1 Chromaticity co-ordinates.....	21
9.2 Correlated colour temperature (CCT).....	22
9.3 Colour rendering index (CRI).....	22
10 LED module life.....	23
10.1 General .....	23
10.2 Lumen maintenance .....	23
10.3 Endurance tests.....	25
10.3.1 General.....	25
10.3.2 Temperature cycling test.....	25
10.3.3 Supply switching test.....	26
10.3.4 Accelerated operation life test.....	26
11 Verification .....	26
12 Information for luminaire design .....	27

Annex A (normative) Method of measuring LED module characteristics .....	28
Annex B (informative) Information for luminaire design.....	31
Annex C (informative) Explanation of recommended life time metrics .....	32
Annex D (normative) Explanation of the photometric code .....	37
Annex E (informative) Meaning of confidence intervals .....	38
Annex F (informative) Examples of LED dies and LED packages .....	41
Annex G (informative) Optimised test duration for future consideration.....	43
Bibliography .....	45
Figure 1 – Types of LED modules .....	10
Figure 2 – Luminous flux depreciation over test time .....	25
Figure C.1 – Life time specification for gradual light output degradation .....	33
Figure C.2 – Life time specification for abrupt light output degradation .....	34
Figure C.3 – Reliability curve $R_{\text{gradual}}$ for gradual light output degradation.....	35
Figure C.4 – Reliability curve $R_{\text{abrupt}}$ for abrupt light output degradation.....	35
Figure C.5 – Combined $R_{\text{gradual}}$ and $R_{\text{abrupt}}$ degradation .....	36
Figure E.1 – t-distribution with right sided confidence interval $(1-\alpha)$ .....	39
Figure F.1 – Schematic drawings of LED dies.....	41
Figure F.2 – Schematic drawings of LED packages.....	42
Table 1 – Mandatory marking and location of marking .....	16
Table 2 – LED module life time information.....	16
Table 3 – Optional marking and location of marking .....	17
Table 4 – Allowed variations within family .....	18
Table 5 – Tolerance (categories) on rated chromaticity co-ordinate values.....	22
Table 6 – Lumen maintenance code at an operational time as stated in 6.1 .....	23
Table 7 – Sample sizes.....	27
Table C.1 – Recommended x and y values for life time metrics to be used in life time specification .....	36
Table E.1 – Values of the t-distribution.....	40

## National Foreword

This Technical Reference (TR) was prepared by the Technical Committee on Lamps and Related Equipment under the direction of the Electrical and Electronic Standards Committee (EESC). It was endorsed by EESC on 28 July 2011.

This TR is a modified adoption of IEC PAS 62717 published in 2011. PAS (Publicly Available Specification) is a pre-standard published by the International Electrotechnical Commission.

Light Emitting Diode (LED) modules are widely used as components in luminaires and lighting systems. LED lighting has environmental benefits (due to absence of mercury and other hazardous substances), good light efficacy and long life span minimising maintenance and replacements. So the use of LED is increasing in many lighting applications.

This document specifies the performance requirements for LED modules for general lighting applications, together with the test methods and conditions required to show compliance. It is expected to be referenced in procurement by building owners, specifiers, developers and suppliers.

Strikethrough in the text indicates the IEC PAS text being deleted or replaced by a new text highlighted in grey. A left vertical bar indicates that there is a deviation from that particular clause. The following deviations apply:

Clauses	Deviations
6.2.2	3 <sup>rd</sup> paragraph, <i>delete</i> '(see Note 3)' and 'NOTE 3'.
9.1	3 <sup>rd</sup> sentence, <i>replace</i> '4' by '3'. Table 5, <i>delete</i> the last row.
10.2	NOTE 5, <i>delete</i> the last sentence.
Annex D	<i>Replace</i> 'CRI = 87 – ≥90 → code "9" ' by 'CRI ≥ 87 → code "9" '.

### Explanation

The changes and differences made were to take into consideration local requirements and to align with industry practices.

Editorial amendments are as follows:

Where "PAS" appears, it should be interpreted as "Technical Reference".

The comma has been used throughout as a decimal marker whereas in Singapore Standards, it is a practice to use a full point on the baseline as the decimal marker.

IEC Foreword	Boxed text at the end of the Foreword – This TR does not contain a 'colour inside' logo on the cover page of the publication.
6.2.1	1 <sup>st</sup> line, after 'towards', <i>delete</i> 'to' Last line, after 'complying', <i>insert</i> 'to'.
6.2.2	3 <sup>rd</sup> paragraph, 1 <sup>st</sup> line, after 'family' <i>replace</i> 'for' by 'to'.
8.2.2	NOTE, before 'account', to insert 'into'.
A.1	4 <sup>th</sup> line, after 'established' to delete 'at'
B.4	NOTE, before 'specified' <i>insert</i> 'be'.

- Annex G                      Throughout the annex, *replace* 'principle' by 'principal'.  
G.2 Clause title, *replace* 'owned to optimise' by 'due to optimizing '  
6.1 General test conditions, 1<sup>st</sup> paragraph, 1<sup>st</sup> sentence, *amend* 'data of are available' to 'data is available', and 4<sup>th</sup> paragraph, after 6000 h, *replace* 'of' by 'for'.

This TR is not to be regarded as Singapore Standard. This TR is made available for provisional application for a period of two years and it does not have the status of a Singapore Standard. The Technical Committee aims to use the experience and feedback gained in the ensuing period to improve the TR so that it can be later developed as a Singapore Standard. Users of the TR are invited to comment on its content, ease of use and areas for improvement. Comments can be submitted using the feedback form provided at the end of this TR and will be taken into account in the review later. At the end of proposed two years, the TR will be reviewed by the Technical Committee to discuss the comments received and to determine its suitability as a Singapore Standard. Submission for approval by the Standards Council as a Singapore Standard will be carried out only upon agreement after review.

Attention is drawn to the possibility that some of the elements of this Technical Reference may be the subject of patent rights. SPRING Singapore shall not be held responsible for identifying or acknowledging any or all of such patent rights.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LED MODULES FOR GENERAL LIGHTING –  
PERFORMANCE REQUIREMENTS

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC/PAS 62717 has been prepared by subcommittee 34A: Lamps, of IEC technical committee 34: Lamps and related equipment.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
34A/1444/PAS	34A/1462/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.



This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

**IMPORTANT** – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

## **INTRODUCTION**

This first edition of a performance PAS for LED modules for general lighting applications acknowledges the need for relevant tests for this new source of electrical light, sometimes called “solid state lighting”. The publication is closely related to simultaneously developed and edited performance standards publications (or PAS) for luminaires in general and for LED-luminaires. Changes in the LED module PAS will have an impact on the luminaire standards and vice versa, due to the behaviour of LEDs. Therefore, in the development of the present PAS, a close collaboration of experts on both products has taken place.

The provisions in the PAS represent the technical knowledge of experts from the fields of the semiconductor (LED chip) industry and of those of the traditional electrical light sources.

Three types of LED-modules are covered: with integral controlgear, with means of control on board, but with separate controlgear (“semi-ballasted”), and with complete external controlgear.

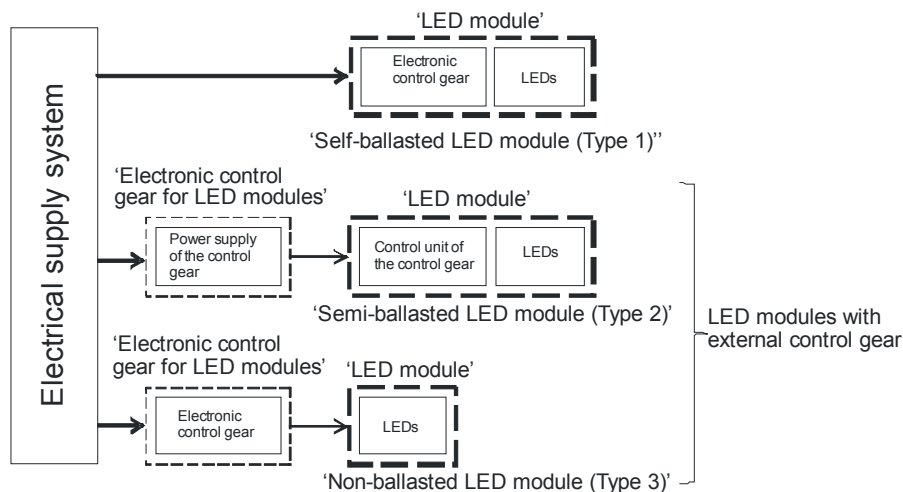
## LED MODULES FOR GENERAL LIGHTING – PERFORMANCE REQUIREMENTS

### 1 Scope

This PAS specifies the performance requirements for LED modules, together with the test methods and conditions, required to show compliance with this PAS.

The following types of LED modules are distinguished (see Figure 1):

- Type 1: Self-ballasted LED modules for use on d.c. supplies up to 250 V or on a.c. supplies up to 1 000 V at 50 Hz or 60 Hz;
- Type 2: LED modules operating with external controlgear connected to the mains voltage, and having further control means inside (“semi-ballasted”) for operation under constant voltage, constant, current or constant power;
- Type 3: LED modules where the complete controlgear is separate from the module for operation under constant voltage, constant current or constant power.



The power supply of the controlgear for semi-ballasted LED modules (Type 2) is an electronic device capable of controlling currents, voltage or power within design limits.

The control unit of the controlgear for semi-ballasted LED modules (Type 2) is an electronic device to control the electrical energy to the LED's.

A LED module with external controlgear can be either a non-ballasted LED module or a semi-ballasted LED module.

**Figure 1 – Types of LED modules**

The requirements of this PAS relate only to type testing.

Recommendations for whole product testing or batch testing are under consideration.

This PAS covers LED modules that intentionally produce white light, based on inorganic LEDs.

These performance requirements are additional to the requirements in IEC 62031 safety standard for LED modules.

Life time of LED modules is in most cases much longer than the practical test times. Consequently, verification of manufacturer's life time claims cannot be made in a sufficiently confident way, because projecting test data further in time is not standardised. For that reason, the acceptance or rejection of a manufacturer's life time claim, past 25 % of rated life (with a maximum of 6 000 h), is out of the scope of this PAS.

Instead of life time validation, this PAS has opted for lumen maintenance codes at a defined finite test time. Therefore, the code number does not imply a prediction of achievable life time. The categories are lumen-depreciation character categories showing behaviour in agreement with manufacturer's information which are provided before the test is started.

In order to validate a life time claim, an extrapolation of test data is needed. A general method of projecting measurement data beyond limited test time is under consideration.

The pass/fail criterion of the life time test as defined in this PAS is different from the life time metrics claimed by manufacturers. For explanation of recommended life time metrics, see Annex C.

NOTE 1 – When modules are operated in a luminaire, the claimed performance data can deviate from the values established via this PAS due to e.g. luminaire components that impact the performance of the module.

NOTE 2 – The external electronic controlgears for LED modules as mentioned in Type 2 and Type 3 are not part of the testing against the requirements of this PAS.

NOTE 3 – For protection for water and dust ingress, see Clause B.4.

It may be expected that self-ballasted LED modules which comply with this PAS will start and operate satisfactorily at voltages between 92 % and 106 % of rated supply voltage. LED modules with external controlgear are expected to start and operate satisfactorily in combination with the specified controlgear complying with IEC 61347-2-13 and IEC 62384. All LED modules are expected to start and operate satisfactorily when operated under the conditions specified by the module manufacturer and in a luminaire complying with IEC 60598-1.

For compliance with EMC requirements, reference is made to regional requirements. For relevant standards, see Bibliography.

NOTE – It should be regarded that only those types of LED modules are subject to EMC requirements which

- in case of harmonic current are directly connected to the mains and have active elements on board;
- in case of radiated or conducted disturbances are directly connected to the mains (Type 1) or to a battery;
- in case of immunity are directly connected to the mains (Type 1) or to a battery.

## **2 Normative references**

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-845, *International Electrotechnical Vocabulary – Part 845: Lighting*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60081:1997, *Double-capped fluorescent lamps – Performance specifications*

IEC 60598-1, *Luminaires – Part 1: General requirements and tests*

IEC/TR 61341, *Method of measurement of centre beam intensity and beam angle(s) of reflector lamps*