

CONSOLIDATED VERSION

VERSION CONSOLIDÉE



LED modules for general lighting – Performance requirements

Modules de LED pour éclairage général – Exigences de performance



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

CONSOLIDATED VERSION

VERSION CONSOLIDÉE



LED modules for general lighting – Performance requirements

Modules de LED pour éclairage général – Exigences de performance

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.140.99

ISBN 978-2-8322-6485-0

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

REDLINE VERSION

VERSION REDLINE



LED modules for general lighting – Performance requirements

Modules de LED pour éclairage général – Exigences de performance

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	8
1 Scope.....	9
1.2 General.....	9
1.3 Statement	10
2 Normative references	10
3 Terms and definitions	11
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 a family.....	18
6.2.3 Compliance testing of family members.....	19
7 Electrical LED module input.....	20
7.1 LED module power.....	20
7.2 Displacement factor (u.c.)	20
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.....	21
8.2.4 Peak intensity value.....	21
8.2.5 Beam angle value	21
8.3 Luminous efficacy	21
9 Chromaticity coordinates, correlated colour temperature (CCT) and colour rendering.....	21
9.1 Chromaticity coordinates.....	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	24
10.3.1 General	24
10.3.2 Temperature cycling test	25
10.3.3 Supply switching test	26
10.3.4 Accelerated operation life test	26
11 Verification	27
12 Information for luminaire design.....	27
Annex A (normative) Method of measuring LED module characteristics	28

A.1	General.....	28
A.2	Electrical characteristics	30
A.2.1	Test voltage, current or power	30
A.2.2	Ageing	30
A.3	Photometric characteristics	30
A.3.1	General	30
A.3.12	Test voltage, current or power	30
A.3.23	Luminous flux	30
A.3.34	Luminous intensity distribution	30
A.3.5	Colour characteristics	31
A.3.4	Peak intensity	30
A.3.5	Beam angle	30
A.3.6	Colour rendering	30
A.3.7	Chromaticity coordinate values	30
Annex B (informative)	Information for luminaire design	32
B.1	Temperature stability	32
B.2	Binning procedure of white colour LEDs	32
B.3	Ingress protection	32
Annex C (informative)	Explanation of recommended LED product lifetime metrics	33
C.1	General.....	33
C.2	Life time specification for gradual light output degradation	34
C.3	Lifetime specification for abrupt light output degradation	35
C.4	Combined gradual and abrupt light output degradation	36
C.5	Overview of LED lifetime metrics and related lighting product groups.....	37
C.6	Example of lifetime metric values	38
Annex D (normative)	Explanation of the photometric code	40
Annex E (normative)	Measurement of displacement factor	41
E.1	General.....	41
E.2	Phase shift angle definition	41
E.3	Measurements requirements	42
E.3.1	Measurement circuit and supply source	42
E.3.2	Requirements for measurement equipment.....	42
E.3.3	Test conditions	42
Annex F (informative)	Explanation of displacement factor	43
F.1	General.....	43
F.2	Recommended values for displacement factor	44
Annex G (informative)	Examples of LED dies and LED packages.....	45
G.1	LED die.....	45
G.2	LED package	46
Annex H (informative)	Test equipment for temperature measurement	47
H.1	General.....	47
H.2	Set-up and procedure	47
Annex I (informative)	Use of ANSI/IES LM-80-15 for luminous flux maintenance and maintained chromaticity coordinates data	48
I.1	General.....	48
I.2	Criteria for the use of ANSI/IES LM-80-15.....	48
I.2.1	LED package data used for LED modules	48
I.2.2	LED module with ANSI/IES LM-80-15 data	48

1.2.3	Boundary conditions	48
1.3	Compliance criteria	49
1.3.1	Chromaticity coordinates	49
1.3.2	Luminous flux maintenance factor.....	49
	Bibliography.....	50
	Figure 1 – Types of LED modules	9
	Figure 2 – Luminous flux depreciation over test time.....	24
	Figure C.1 – Lumen Light output over life of a LED-based luminaire comprised of a single LED module.....	33
	Figure C.2 – Life time specification for gradual light output degradation.....	34
	Figure C.3 – Reliability curve R_{abrupt} for abrupt light output degradation	36
	Figure C.4 – Reliability curve R_{gradual} for gradual light output degradation	37
	Figure C.5 – Combined R_{gradual} and R_{abrupt} degradation	37
	Figure C.6 – Overview of LED lifetime metrics	38
	Figure E.1 – Definition of the fundamental current phase shift angle ϕ_1 (I_1 leads U_{mains} , $\phi_1 > 0$)	41
	Figure E.2 – Definition of the fundamental current phase shift angle ϕ_1 (I_1 lags U_{mains} , $\phi_1 < 0$)	42
	Figure G.1 – Schematic drawings of LED dies	45
	Figure G.2 – Schematic drawings of LED packages	46
	Table 1 – Mandatory marking and location of marking ¹	16
	Table 2 – LED module life-time median useful life information.....	17
	Table 3 – Optional marking and location of marking.....	17
	Table 4 – Allowed variations within a family	19
	Table 5 – Tolerance (categories) on rated chromaticity coordinate 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 – Examples of lifetime metric values for lumen luminous flux maintenance factor ratings.....	39
	Table C.2 – Examples of lifetime metric values for abrupt failure	39
	Table C.3 – Examples of lifetime metric values of x for median LED lamp life (combined failures)	39
	Table C.4 – Examples of lifetime metric values	39
	Table C.5 – Examples of metric values for LED module useful life $L_x B_y$	39
	Table F.1 – Recommended values for displacement factor.....	44

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.

DISCLAIMER

This Consolidated version is not an official IEC Standard and has been prepared for user convenience. Only the current versions of the standard and its amendment(s) are to be considered the official documents.

This Consolidated version of IEC 62717 bears the edition number 1.2. It consists of the first edition (2014-12) [documents 34A/1796/FDIS and 34A/1817/RVD], its amendment 1 (2015-09) [documents 34A/1853/FDIS and 34A/1870/RVD] and its amendment 2 (2019-01) [documents 34A/2121/FDIS and 34A/2127/RVD]. The technical content is identical to the base edition and its amendment.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

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

This edition includes the following significant technical changes with respect to IEC PAS 62717.

- all terms and definitions are aligned with IEC 62504 and relevant documents of CIE. For example, general terms like “rated value” are shifted to IEC 62504.
- a statement on the applicability on a population is included.
- the normative references are completed and cleaned from standards that are not in use.
- with regard to EMC, references to harmonic currents are given.
- the change, which has an effect on most parts of the standard, is the split of failure mechanisms into abrupt failures and luminous flux depreciation. Consequently, new terms and definitions, new requirements for lumen maintenance and a complete new structure and contents of Annex C are introduced.
- transition from t_{pmax} to t_{prated} is made, with the background that there is not one t_{pmax} , but a choice of $t_p(rated)$ values, in combination with lifetime.
- places where to mark (product, packaging, data sheets) are changed, and as a consequence of the split of failure mechanisms, new parameters are listed. Further, changes in the endurance test (ramping speed of temperature) are reflected in marking.
- the concept of displacement factor instead of power factor is introduced. This led to new definitions, requirements and Annexes E and F.
- the requirements on luminous efficacy are changed.
- the requirements, associated with the family concept are reviewed.
- statistics, based on confidence intervals are removed. This concerns requirements and limits for LED module power and luminous flux and deletion of Annex E.
- new requirements for lumen maintenance are introduced.
- as part of the endurance test, the maximum light decrease after accelerated operation life test is now fixed.
- with regard to the discussion on type test and sample size, the number of pieces in a test sample is drastically reduced, see Table 7.
- Annex A on measuring methods is completely restructured and reviewed, for example for ambient temperature and for shortening of stabilisation time when conducting subsequent light output measurements.
- for electrical characteristics, the ageing time may be chosen as 500 h.
- for photometric data file formats, reference is given to IEC 62722-1.
- mistakes in the photometric code (Annex D) are corrected.
- Annex G on optimised test duration is removed; instead, an INF sheet shall be published.
- from the luminaire standard, a new Annex H on “Test equipment for temperature measurement” is taken over.
- finally, the Bibliography is updated.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

In this standard, the following print types are used:

- requirements: roman type.
- *test specifications: italic type.*
- notes: smaller roman type.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

The first edition of a performance standard (precursor: IEC PAS 62717) 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 performance standard publication (which also started with a Publicly Available Specification) for luminaires in general (IEC 62722-1) and for LED-luminaires (IEC 62722-2-1). Changes in the LED module standard will have an impact on the luminaire standards and vice versa, due to the behaviour of LED. Therefore, in the development of the present standard, a close collaboration between experts of both products has taken place.

The provisions in the standard 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 separate controlgear.

LED MODULES FOR GENERAL LIGHTING – PERFORMANCE REQUIREMENTS

1 Scope

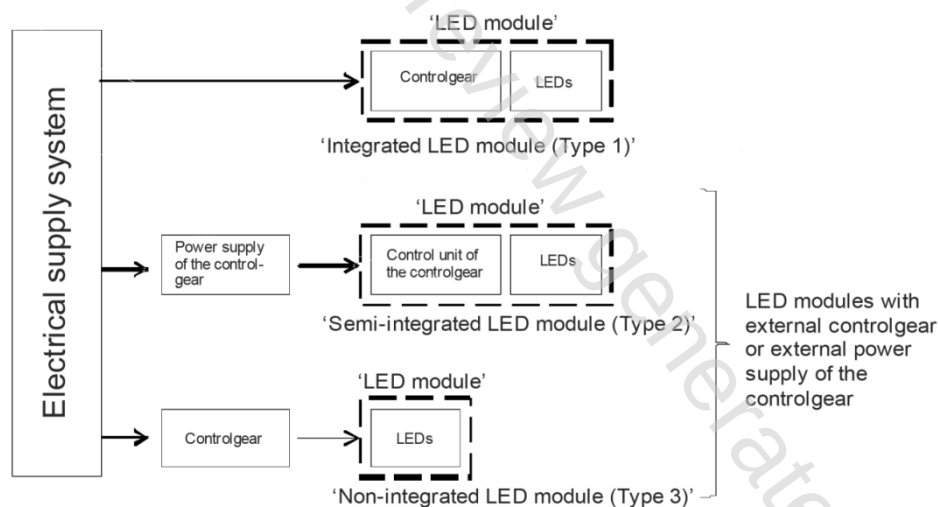
1.2 General

This International Standard specifies the performance requirements for LED modules, together with the test methods and conditions, required to show compliance with this standard. The following types of LED modules are distinguished and schematically shown in Figure 1:

Type 1: integrated 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 part of separate controlgear connected to the mains voltage, and having further control means inside (“semi-integrated”) for operation under constant voltage, constant current or constant power.

Type 3: LED modules where the complete controlgear is separate from the module (non-integrated) for operation under constant voltage, constant current or constant power.



IEC

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 LEDs.

A LED module with separate 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 standard relate only to type testing.

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

This standard covers LED modules, based on inorganic LED technology that produces white light.

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 an operational time as stated in 6.1, is out of the scope of this standard.

Instead of life time validation this standard 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, represented by the code, are lumen-depreciation character categories showing behaviour in agreement with manufacturer's information which is 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 standard is different from the life time metrics claimed by manufacturers. For explanation of recommended life time metrics, see Annex C.

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

The separate electronic controlgear for LED modules as mentioned in Type 2 and Type 3 is not part of the testing against the requirements of this standard.

Protection for water and dust ingress, see B.3.

1.3 Statement

It may be expected that integrated LED modules which comply with this standard will start and operate satisfactorily at voltages between 92 % and 106 % of rated supply voltage. LED modules with separate 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 LED module manufacturer and in a luminaire complying with IEC 60598-1.

The requirements for individuals apply for 95 % of the population.

2 Normative references

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

IEC 60050-845:1987, *International Electrotechnical Vocabulary – Chapter 845: Lighting*

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

IEC 60068-3-5:2001, *Environmental testing – Part 3-5: Supporting documentation and guidance – Confirmation of the performance of temperature chambers*

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

IEC 61000-3-2:2005¹, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-2:2005/AMD 1:2008

IEC 61000-3-2:2005/AMD 2:2009

IEC 61000-4-7, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

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

IEC 61347-2-13, *Lamp controlgear – Part 2-13: Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules*

IEC 62031:2008, *LED modules for general lighting – Safety specifications*

IEC 62504, *General lighting – Light emitting diode (LED) products and related equipment – Terms and definitions*

CIE 13.3:1995, *Method of measuring and specifying colour rendering properties of light sources*

~~CIE 121:1996, *The photometry and goniophotometry of luminaires*~~

CIE 177:2007, *Colour rendering of white LED light sources*

CIE S 025/E:2015, *Test Method for LED Lamps, LED Luminaires and LED Modules*

ANSI/IES LM-80-15, *Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62504 and IEC 60050-845, as well as the following apply.

3.1

test voltage, current or power

input voltage, current or power at which tests are carried out

Note 1 to entry: Specification of test voltage, current or power is given in A.2.

3.2

luminous flux maintenance factor

lumen maintenance factor

Unit: %

ratio, expressed as a percentage x , of the luminous flux emitted by the light source at a given time in its life to its initial luminous flux emitted

Note 1 to entry: The lumen maintenance factor of a LED light source includes optical parts degradation, the effect of decrease of the luminous flux output of the LED package and failure(s) of individual LED packages if the LED light source contains more than one LED package.

¹ Third edition. This edition has been replaced in 2014 by IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*.