IEC 60747-5-6

Edition 1.0 2016-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices –
Part 5-6: Optoelectronic devices – Light emitting diodes

Dispositifs à semiconducteurs –
Partie 5-6: Dispositifs optoélectroniques – Diodes électroluminescentes

IEC 60747-5-6:2016-02(en-fr)

This document is a preview generated by EVS

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2016 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 Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
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 also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
65 000 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.

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: csc@iec.ch.

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.

Catalogue IEC - webstore.iec.ch/catalogue
Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

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 aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
65 000 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.

Service Clients - webstore.iec.ch/csc

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

This document is a preview generated by EVS

IEC 60747-5-6

Edition 1.0 2016-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

This document is a preview generated by EVS

Semiconductor devices –
Part 5-6: Optoelectronic devices – Light emitting diodes

Dispositifs à semiconducteurs –
Partie 5-6: Dispositifs optoélectroniques – Diodes électroluminescentes

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.080.99

ISBN 978-2-8322-3209-5

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.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FOREWORD 7
1 Scope 9
2 Normative references 9
3 Terms and definitions 10
  3.1 General terms and definitions 10
  3.2 Terms and definitions relating to the measurement of the quantity of radiation 12
  3.3 Terms and definitions relating to the measurement of the photometric quantity 14
4 Absolute maximum ratings 17
5 Electrical and optical characteristics 18
6 Measuring method 19
  6.1 Basic requirements 19
    6.1.1 Measuring conditions 19
    6.1.2 Measuring instruments and equipment 20
    6.1.3 Essential requirements 21
    6.1.4 General precautions 21
  6.2 Forward voltage (V_F) measurement 22
    6.2.1 Purpose 22
    6.2.2 Circuit diagram 22
    6.2.3 Requirements 22
    6.2.4 Measurement procedure 23
    6.2.5 Precautions to be observed 24
    6.2.6 Specified conditions 24
  6.3 Reverse voltage (V_R) measurement 24
    6.3.1 Purpose 24
    6.3.2 Circuit diagram 24
    6.3.3 Measurement procedure 24
    6.3.4 Precautions to be observed 24
    6.3.5 Specified conditions 25
  6.4 Differential resistance (r_f) measurement 25
    6.4.1 Purpose 25
    6.4.2 Circuit diagram 25
    6.4.3 Requirements 25
    6.4.4 Measurement procedure 25
    6.4.5 Precautions to be observed 26
    6.4.6 Specified conditions 26
  6.5 Reverse current (I_R) measurement 26
    6.5.1 Purpose 26
    6.5.2 Circuit diagram 26
    6.5.3 Provisions 27
    6.5.4 Measurement procedure 27
    6.5.5 Precautions to be observed 27
    6.5.6 Specified conditions 27
  6.6 Measurement of capacitance between terminals (C_t) 27
    6.6.1 General 27

This document is a preview generated by EVS

6.6.2 Measurement using LCR meter 27
6.6.3 Measurement using AC bridge 28
6.7 Measurement of junction temperature and thermal resistance ($R_{\mathrm{th(j\text{-}X)}}$) 29
6.7.1 Purpose 29
6.7.2 Measurement principle 29
6.7.3 Measurement procedure 30
6.7.4 Precautions to be observed 33
6.8 Response time measurement 34
6.8.1 Purpose 34
6.8.2 Circuit diagram 34
6.8.3 Provisions 34
6.8.4 Measurement procedure 34
6.8.5 Precautions to be observed 35
6.8.6 Specified conditions 35
6.9 Frequency response and cut-off frequency (f_{c}) measurement 36
6.9.1 Purpose 36
6.9.2 Circuit diagram 36
6.9.3 Provisions 37
6.9.4 Measurement procedure 37
6.9.5 Precautions to be observed 38
6.9.6 Specified conditions 38
6.10 Luminous flux (Φ_{V}) measurement 38
6.10.1 Purpose 38
6.10.2 Measurement principle 38
6.10.3 Measuring circuit 38
6.10.4 Measurement procedure 39
6.10.5 Precautions to be observed 39
6.10.6 Measurement conditions to be defined 40
6.11 Radiant power (Φ_{e}) measurement 40
6.11.1 Purpose 40
6.11.2 Measurement principle 40
6.11.3 Measuring circuit 40
6.11.4 Measurement procedure 41
6.11.5 Precautions to be observed 41
6.11.6 Measurement conditions to be defined 42
6.12 Luminous intensity (I_{V}) measurement 42
6.12.1 Purpose 42
6.12.2 Measurement principle 42
6.12.3 Measuring circuit 43
6.12.4 Measurement procedure 44
6.12.5 Precautions to be observed 44
6.12.6 Measurement conditions to be defined 44
6.13 Radiant intensity (I_{e}) measurement 44
6.13.1 Purpose 44
6.13.2 Measurement principle 44
6.13.3 Measuring circuit 45
6.13.4 Measurement procedure 45
6.13.5 Measurement conditions to be defined 45
6.14 Luminance (L_{V}) measurement 45

This document is a preview generated by EVS

6.14.1 Purpose 45
6.14.2 Measuring circuit 46
6.14.3 Measurement procedure 46
6.14.4 Measurement conditions to be defined 46
6.15 Emission spectrum distribution, peak emission wavelength (λ_p), and spectral half bandwidth ($\Delta\lambda$) measurement 47
6.15.1 Purpose 47
6.15.2 Measuring circuit 47
6.15.3 Measurement procedure 48
6.15.4 Measurement conditions to be defined 48
6.16 Chromaticity measurement 49
6.16.1 Purpose 49
6.16.2 Measurement principle 49
6.16.3 Measuring circuit 51
6.16.4 Measurement procedure 51
6.16.5 Measuring conditions to be defined 51
6.17 Directional characteristics measurement 51
6.17.1 Purpose 51
6.17.2 Measuring circuit 51
6.17.3 Measurement procedure 52
6.17.4 Measuring conditions to be defined 53
6.18 Illuminance (E_V) measurement 54
6.18.1 Purpose 54
6.18.2 Measuring circuit 54
6.18.3 Measurement procedure 54
6.18.4 Measuring conditions to be defined 54
7 Items to be indicated on the package 54
8 Quality evaluation 55
8.1 Classification of quality evaluations 55
8.1.1 General 55
8.1.2 Classification I 55
8.1.3 Classification II 55
8.1.4 Classification III 55
8.1.5 Precautions to be observed 55
8.2 Quality evaluation test 60
8.2.1 General 60
8.2.2 Specimens 60
8.3 Lot quality inspection 60
8.3.1 General 60
8.3.2 Specimens 60
8.4 Periodical quality inspection 60
8.4.1 General 60
8.4.2 Specimens 60
8.4.3 Inspection period 60
8.5 Easing of the lot quality inspection standards 61
8.6 Periodical evaluation maintenance tests 61
8.6.1 Test items and specimens 61
8.6.2 Test period 61
8.7 Long-term storage products 61

This document is a preview generated by EVS

8.8 Continuous current test 61
8.8.1 General 61
8.8.2 Initial measurement....61
8.8.3 Test circuits 61
8.8.4 Test conditions 62
8.8.5 Post-treatment 62
8.8.6 Final measurement 62
Annex A (normative) Standard luminous efficiency 63
Annex B (normative) How to obtain the self-absorption correction factor 66
B.1 Purpose 66
B.2 LED light sources for self-absorption measurement....66
B.3 Method 66
Annex C (normative) How to obtain the colour correction factor 68
C.1 Purpose 68
C.2 Method 68
C.2.1 Luminous flux and luminous intensity measurement 68
C.2.2 Radiant power and radiant intensity measurement 69
Annex D (normative) Calibration of the luminance meter 70
D.1 Purpose 70
D.2 How to perform the calibration 70
Annex E (normative) Colour-matching function of the XYZ colour system 72
Annex F (normative) Spectral chromaticity coordinates 77
Annex G (normative) Illuminometer calibration....82
G.1 Purpose 82
G.2 How to perform the calibration 82
Bibliography 83

Figure 1 – Radiant intensity 12
Figure 2 – Radiance....13
Figure 3 – Radiant exitance 14
Figure 4 – Irradiance....14
Figure 5 – Spectral luminous efficiency 15
Figure 6 – Circuit diagram for V_F measurement 22
Figure 7 – Circuit diagram for V_F measurement with a constant voltage source and a current-limiting resistor 23
Figure 8 – Circuit diagram for V_F measurement using an SMU 23
Figure 9 – Circuit diagram for V_R measurement....24
Figure 10 – circuit diagram for r_f mesurement 25
Figure 11 – Circuit diagram for I_R measurement....26
Figure 12 – Circuit diagram for C_t measurement 27
Figure 13 – Circuit diagram for C_t measurement 28
Figure 14 – Circuit diagram for measurement of change in V_F....30
Figure 15 – Waveform of change in V_F 32
Figure 16 – Transient change in thermal resistance (double-logarithmic plots) 33
Figure 17 – Circuit diagram for response time measurement....34
Figure 18 – Waveform of response time measurement....36

This document is a preview generated by EVS

Figure 19 – Circuit diagram for f_c measurement 37
Figure 20 – Circuit diagram for Φ_V measurement 39
Figure 21 – circuit diagram for Φ_e measurement 41
Figure 22 – Schematic diagram for I_V measurement 43
Figure 23 – Circuit diagram for I_V measurement 43
Figure 24 – circuit diagram for I_e measurement 45
Figure 25 – Circuit diagram for L_v measurement 46
Figure 26 – Circuit diagram for λ_p measurement 47
Figure 27 – Circuit diagram for λ_p measurement 48
Figure 28 – Schematic diagram of $\Delta\lambda$ measurement 48
Figure 29 – Chromaticity 50
Figure 30 – Circuit diagram for chromaticity measurement 52
Figure 31 – Directional characteristics (example 1) 53
Figure 32 – Directional characteristics (example 2) 53
Figure 33 – Circuit diagram for E_V measurement 54
Figure 34 – Circuit diagram for continuous current test 62
Figure B.1 – Schematic diagram for self-absorption measurement 66
Figure D.1 – Schematic diagrams for calibration 71
Figure G.1 – Schematic diagram for calibration 82

Table 1 – Absolute maximum ratings 18
Table 2 – Electrical and optical characteristics 19
Table 3 – CIE averaged LED intensity measurements 43
Table 4 – Items for the screening test and their conditions(reference) 55
Table 5 – Quality evaluation tests *(1 of 2)* 56
Table 6 – Lot quality inspection 58
Table 7 – Periodical quality inspection 59
Table A.1 – Definitive values of the spectral luminous efficiency function for photopic vision $V(\lambda)$ *(1 of 3)* 63
Table E.1 – Colour-matching function of the XYZ colour system *(1 of 5)* 72
Table F.1 – Spectral chromaticity coordinates *(1 of 5)* 77

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –

Part 5-6: Optoelectronic devices – Light emitting diodes

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.

International Standard IEC 60747-5-6 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This first edition of IEC 60747-5-6, together with IEC 60747-5-4, IEC 60747-5-5 and IEC 60747-5-7, cancels and replaces IEC 60747-5-1, IEC 60747-5-2 and IEC 60747-5-3, published in 1997, and their amendments. This edition constitutes a technical revision.

This edition includes significant technical changes to the clauses for light emitting diodes in IEC 60747-5-1:1997, IEC 60747-5-2:1997 and IEC 60747-5-3:1997, including their amendments.

This document is a preview generated by EVS

The text of this standard is based on the following documents:

FDIS	Rapport de vote
47E/529/FDIS	47E/535/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 60747 series, published under the general title *Semiconductor devices*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

This document is a preview generated by EVS

SEMICONDUCTOR DEVICES –

Part 5-6: Optoelectronic devices – Light emitting diodes

1 Scope

This part of IEC 60747 specifies the terminology, the essential ratings and characteristics, the measuring methods and the quality evaluations of light emitting diodes (LEDs) for general industrial applications such as signals, controllers, sensors, etc. LEDs for lighting applications are out of the scope of this part of IEC 60747.

The types of LED are divided into the following five classes:

a) LED package;
b) LED flat illuminator;
c) LED numeric display and alpha-numeric display;
d) LED dot-matrix display;
e) I LED (infrared-emitting diode).

LEDs with a heat spreader or having a terminal geometry that performs the function of a heat spreader are within the scope of this part of IEC 60747.

An integration of LEDs and controlgears, integrated LED modules, semi-integrated LED modules, integrated LED lamps or semi-integrated LED lamps, are out of the scope of this part of IEC 60747.

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 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60749-6, *Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature*

IEC 60749-10, *Semiconductor devices – Mechanical and climatic test methods – Part 10: Mechanical shock*

IEC 60749-12, *Semiconductor devices – Mechanical and climatic test methods – Part 12: Vibration, variable frequency*

IEC 60749-14, *Semiconductor devices – Mechanical and climatic test methods – Part 14: Robustness of terminations (lead integrity)*

This document is a preview generated by EVS

IEC 60749-15 *Semiconductor devices – Mechanical and climatic test methods – Part 15: Resistance to soldering temperature for through-hole mounted devices*

IEC 60749-20 *Semiconductor devices – Mechanical and climatic test methods – Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat*

IEC 60749-21 *Semiconductor devices – Mechanical and climatic test methods – Part 21: Solderability*

IEC 60749-24 *Semiconductor devices – Mechanical and climatic test methods – Part 24: Accelerated moisture resistance – Unbiased HAST*

IEC 60749-25 *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

IEC 60749-36 *Semiconductor devices – Mechanical and climatic test methods – Part 36: Acceleration, steady state*

ISO 2859, *Sampling procedures for inspection by attributes*

This document is a preview generated by EVS

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General terms and definitions

3.1.1
integrating sphere
hollow sphere whose internal surface is a diffuse reflector, as non-selective as possible

[SOURCE: IEC 60050-845:1987, 845-05-24, modified – The term "Ulbricht sphere" and the note have been removed.]

3.1.2
diffuse reflector
reflector composed of a surface with diffuse reflection

3.1.3
diffuse reflection
diffusion by reflection in which, on the macroscopic scale, there is no regular reflection

[SOURCE: IEC 60050-845:1987, 845-04-47]

3.1.4
diffuse transmission
diffusion by transmission in which, on the macroscopic scale, there is no regular transmission

[SOURCE: IEC 60050-845:1987, 845-04-48]

3.1.5
diffuse reflectance
R_d
ratio of the diffusely reflected part of the (whole) reflected flux, to the incident flux

Note 1 to entry: $R = R_\mathrm{r} + R_\mathrm{d}$