

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Test methods for electrical materials, printed boards and other interconnection structures and assemblies –  
Part 3-913: Test method for thermal conductivity of printed circuit boards for high-brightness LEDs**

**Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles –  
Partie 3-913: Méthodes d'essai pour la conductivité thermique des circuits imprimés pour les LED à forte luminosité**



## 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 Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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](http://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](http://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](http://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](http://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](http://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](mailto: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](http://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](http://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](http://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](http://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](http://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](http://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](mailto:csc@iec.ch).

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Test methods for electrical materials, printed boards and other interconnection structures and assemblies –  
Part 3-913: Test method for thermal conductivity of printed circuit boards for high-brightness LEDs**

**Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles –  
Partie 3-913: Méthodes d'essai pour la conductivité thermique des circuits imprimés pour les LED à forte luminosité**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 31.180

ISBN 978-2-8322-3104-3

**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.**

## CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references .....	6
3 Terms and definitions .....	6
4 Pre-conditioning.....	6
5 Test methods.....	6
5.1 General.....	6
5.2 Thermal conductivity.....	6
5.2.1 Measurement of thermal resistance on the plane .....	6
5.2.2 Measurement of thermal resistance across the thickness.....	8
Annex A (normative) Boards and panels .....	13
A.1 Panel and board sizes .....	13
A.1.1 Board size .....	13
A.1.2 Allowance of dimensions .....	13
A.1.3 Perforation and slit .....	14
A.1.4 V-cut.....	14
A.2 Total board thickness.....	15
A.3 Holes .....	16
A.3.1 Insertion holes and vias.....	16
A.3.2 Datum hole.....	19
A.3.3 Assembly hole (through-hole without wall plating).....	19
A.4 Conductor .....	19
A.4.1 Width of conductor pattern and its allowance .....	19
A.4.2 Distance between conductors and its allowance .....	20
A.4.3 Thickness of the insulating layer.....	21
A.5 Printed contact.....	21
A.5.1 Allowance of the distance between the centers of two adjacent printed contacts.....	21
A.5.2 Allowance of the terminal width of printed contacts.....	22
A.5.3 Shift of the center of printed contacts on the front and back sides of a board.....	22
A.6 Land pattern .....	23
A.6.1 Allowance of the distance between the centers of two lands .....	23
A.6.2 Allowance of a land width .....	23
A.6.3 Land diameter and its allowance for BGA/CSP .....	24
A.7 Fiducial mark and mark for component positioning.....	25
A.7.1 Typical form and size of the fiducial mark .....	25
A.7.2 Dimensional allowance of fiducial mark and component positioning mark .....	26
A.7.3 Position allowance of the component positioning mark.....	26
A.8 Interlayer connection – Copper plating.....	26
Annex B (normative) Equilibrium test .....	27
Bibliography.....	28
Figure 1 – Illustration of an apparatus for the thermal conductivity test .....	10
Figure 2 – Surface layer specimen pattern for thermal conductivity test .....	11
Figure 3 – Test equipment for thermal resistance to the thickness direction .....	12

Figure A.1 – Board arrangement in a panel.....	13
Figure A.2 – Distances from the datum point to perforation and slit.....	14
Figure A.3 – Distance from the datum point to the V-cut .....	15
Figure A.4 – Allowance of position off-set of V-cuts on front and back surfaces .....	15
Figure A.5 – PWB board with symbol mark, solder resist, copper foil and plating .....	16
Figure A.6 – Positions of component insertion holes .....	17
Figure A.7 – Distance between the wall of a hole and the board edge.....	18
Figure A.8 – Wall of a hole and the minimum designed spacing to the inner conductor .....	19
Figure A.9 – Width of finished conductor.....	20
Figure A.10 – Distance between conductor and board edge.....	21
Figure A.11 – Thickness of the insulating layer .....	21
Figure A.12 – Distance between centers of terminals of printed contacts .....	22
Figure A.13 – Terminal width of a printed contact .....	22
Figure A.14 – Shift of the center of printed contacts on front and back sides of a board.....	23
Figure A.15 – Land pattern .....	23
Figure A.16 – Land width of a land pattern.....	24
Figure A.17 – Land diameter of BGA/CSP formed of a conductor only .....	24
Figure A.18 – Land diameter ( $d$ ) of BGA/CSP formed at the opening of solder resist.....	25
Figure A.19 – Examples of fiducial mark and component positioning mark.....	26
Table 1 – Applied power ( $P$ ) that corresponds to a range of thermal resistance on the plane.....	8
Table 2 – Applied power ( $P$ ) that corresponds to a range of thermal resistance across the thickness ( $K/W$ ) .....	9
Table A.1 – Panel dimensions.....	13
Table A.2 – Allowance of dimensions .....	14
Table A.3 – Allowance of the distances from the datum point to perforation and slit.....	14
Table A.4 – Allowance of the distance from the datum point to the center of the V-cut.....	15
Table A.5 – Total thickness and its allowance .....	16
Table A.6 – Allowance of holes for component insertion.....	16
Table A.7 – Position allowance of component insertion holes.....	17
Table A.8 – Distance between the wall of a hole and board edge.....	18
Table A.9 – Minimum clearance between the wall of a hole and the inner layer conductor.....	18
Table A.10 – Allowance of conductor width .....	20
Table A.11 – Allowance of the distance between conductors.....	20
Table A.12 – Allowance of terminal width of a printed contact .....	22
Table A.13 – Allowance of terminal width of a printed contact .....	23
Table A.14 – Allowance of the width of a land of a land pattern.....	24
Table A.15 – Land diameter and its allowance for BGA/CSP .....	25
Table A.16 – Allowance of the land diameter ( $d$ ) of BGA/CSP formed at the opening of solder resist.....	25
Table A.17 – Shapes and sizes of typical fiducial marks and component positioning marks .....	26
Table A.18 – Minimum thickness of copper plating.....	26

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARDS AND  
OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –****Part 3-913: Test method for thermal conductivity of printed  
circuit boards for high-brightness LEDs**

## 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, accept 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 61189-3-913 has been prepared by IEC technical committee 91: Electronics assembly technology.

This first edition cancels and replaces the first edition of IEC PAS 61189-3-913 published in 2011. This edition constitutes a technical revision. This edition focused only on the test methods for thermal conductivity specific to printed circuit boards for high-brightness LEDs.

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

FDIS	Report on voting
91/1304A/FDIS	91/1328/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.

A list of all parts in the IEC 61189, published under the general title *Test methods for electrical materials, printed boards and other interconnection structures and assemblies*, can be found on the IEC website.

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

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.

**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.**

# TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARDS AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

## Part 3-913: Test method for thermal conductivity of printed circuit boards for high-brightness LEDs

### 1 Scope

This part of IEC 61189 specifies the test methods for thermal conductivity specific to printed circuit boards for high-brightness LEDs. The test applies to printed circuit boards for high-brightness LEDs with surface mounted LEDs or with device embedded LEDs in electronic control devices (ECDs).

### 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 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 62326-20, *Printed boards – Part 20: Printed circuit boards for high-brightness LEDs*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194 apply, unless otherwise specified.

### 4 Pre-conditioning

Pre-conditioning described in a) or b) below shall be carried out in accordance with the specific standard.

- a) Leave a specimen for 24 h in the standard condition.
- b) Leave a specimen for 60 min in a thermostat chamber at 85 °C and then leave the specimen for  $24 \pm 4$  h in the standard atmospheric condition.

### 5 Test methods

#### 5.1 General

In this standard, the following test methods are specified in order to classing the printed circuit board in accordance with Table 1 in IEC 62326-20.

#### 5.2 Thermal conductivity

##### 5.2.1 Measurement of thermal resistance on the plane

In this subclause, the measurement of thermal resistance on the plane (horizontal direction of the specimen) is addressed as follows.