

# INTERNATIONAL STANDARD



---

**Semiconductor devices –  
Part 5-9: Optoelectronic devices – Light emitting diodes – Test method of the  
internal quantum efficiency based on the temperature-dependent  
electroluminescence**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 31.080.99

ISBN 978-2-8322-7656-3

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Normative references .....	5
3 Terms, definitions and abbreviated terms .....	5
3.1 Terms and definitions.....	5
3.2 Abbreviated terms.....	7
4 Measuring methods .....	7
4.1 Basic requirements .....	7
4.1.1 Measuring conditions.....	7
4.1.2 Measuring instruments and equipment.....	7
4.2 Purpose .....	7
4.3 Measurement.....	8
4.3.1 Measurement setup .....	8
4.3.2 Measurement principle.....	8
4.3.3 Measurement sequence.....	11
5 Test report.....	12
Annex A (informative) Test examples.....	13
A.1 Test example (category 1) .....	13
A.2 Test example (category 2) .....	16
Bibliography.....	19
Figure 1 – Example of the measurement setup with the TDEL.....	8
Figure 2 – Schematic diagram of radiant power as a function of forward current at various temperatures .....	9
Figure 3 – Examples of relative EQEs showing whether the IQE is measurable or not .....	10
Figure 4 – IQE measurement with TDEL .....	10
Figure 5 – Sequence of IQE determination with TDEL.....	12
Figure A.1 – Radiant power as a function of forward current at various temperatures (category 1) .....	13
Figure A.2 – Relative EQE as a function of forward current at various temperatures (category 1) .....	14
Figure A.3 – Check $T_C$ in relative EQE curves (category 1) .....	14
Figure A.4 – Evaluation of the relative EQE (category 1).....	15
Figure A.5 – IQE as a function of forward current at various temperatures including an operating temperature (category 1).....	15
Figure A.6 – Radiant power as a function of forward current at various temperatures (category 2) .....	16
Figure A.7 – Relative EQE as a function of forward current at various temperatures (category 2) .....	17
Figure A.8 – Check $T_C$ in relative EQE curves (category 2) .....	17
Table A.1 – Summary of test report.....	18

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## SEMICONDUCTOR DEVICES –

**Part 5-9: Optoelectronic devices – Light emitting diodes –  
Test method of the internal quantum efficiency based  
on the temperature-dependent electroluminescence**

## 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 60747-5-9 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

The text of this International Standard is based on the following documents:

CDV	Report on voting
47E/651/CDV	47E/676/RVC

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

This document 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.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

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

A bilingual version of this publication may be issued at a later date.

**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.**

## SEMICONDUCTOR DEVICES –

### **Part 5-9: Optoelectronic devices – Light emitting diodes – Test method of the internal quantum efficiency based on the temperature-dependent electroluminescence**

#### **1 Scope**

This part of IEC 60747 specifies the measuring method of the internal quantum efficiency (IQE) of single light emitting diode (LED) chips or packages without phosphor. White LEDs for lighting applications are out of the scope of this document. This document utilizes the relative external quantum efficiencies (EQEs) measured at cryogenic temperatures and at an operating temperature, which is called temperature-dependent electroluminescence (TDEL). In order to identify the reference IQE of 100 %, the maximum values of the peak EQE are found by varying the environmental temperature and current.

#### **2 Normative references**

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60747-5-6:2016, *Semiconductor devices – Part 5-6: Optoelectronic devices – Light emitting diodes*