

TECHNICAL REPORT



Safety of laser products – Part 13: Measurements for classification of laser products



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 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 la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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.

- Catalogue of IEC publications: www.iec.ch/searchpub

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00



IEC/TR 60825-13

Edition 2.0 2011-10

TECHNICAL REPORT



**Safety of laser products –
Part 13: Measurements for classification of laser products**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XB**

ICS 31.260

ISBN 978-2-88912-741-2

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references.....	6
3 Terms and definitions.....	6
4 Applicability.....	8
4.1 General.....	8
4.2 Initial considerations.....	8
5 Instrumentation requirements.....	9
6 Classification flow.....	10
7 Parameters for calculation of accessible emission limits.....	12
7.1 Wavelength (λ).....	12
7.1.1 Wavelength determination.....	12
7.1.2 Ocular hazard regions.....	14
7.2 Multiple wavelength sources.....	14
7.2.1 General.....	14
7.2.2 Single hazard region.....	15
7.2.3 Two or more hazard regions.....	15
7.3 Spectrally broad sources.....	15
7.3.1 General.....	15
7.3.2 Spectral regions with small variation of the AEL with wavelength.....	15
7.3.3 Spectral regions with large variation of the AEL with wavelength (302,5 nm - 315 nm, 450 nm – 600 nm and 1 150 nm – 1 200 nm).....	16
7.3.4 Spectral regions containing hazard-type boundaries (near 400 nm and 1 400 nm).....	16
7.3.5 Very broad sources.....	16
7.4 Source temporal characteristics.....	17
7.4.1 General.....	17
7.4.2 Sources with limited “ON” time.....	17
7.4.3 Periodic or constant duty factor sources.....	17
7.4.4 Sources with amplitude variation.....	19
7.4.5 Sources with varying pulse durations or irregular pulses.....	20
7.5 Angular subtense (α).....	20
7.5.1 General.....	20
7.5.2 Location of the reference point.....	22
7.5.3 Methods for determining angular subtense (α).....	23
7.5.4 Multiple sources and simple non-circular beams.....	26
7.6 Emission duration.....	31
7.6.1 General.....	31
7.6.2 Pulse duration.....	31
7.6.3 Pulse repetition frequency.....	31
7.7 Measurement conditions.....	31
7.7.1 General.....	31
7.7.2 Measurement conditions for classification.....	31
7.7.3 Measurement conditions for hazard evaluation.....	33
7.8 Scanning beams.....	36
7.8.1 General.....	36

7.8.2	Stationary angular subtense (α_s)	36
7.8.3	Scanned pulse duration (T_p)	37
7.8.4	Scanning angular subtense (α_{scan})	38
7.8.5	Bi-directional scanning	39
7.8.6	Number of scan lines in aperture (n)	39
7.8.7	Maximum hazard location	40
7.8.8	Gaussian beam coupling parameter (η)	41
7.8.9	Scan angle multiplication factor	41
Annex A (informative)	Examples	43
Annex B (informative)	Useful conversions	64
Bibliography	65
Figure 1	– Continuous wave laser classification flow	11
Figure 2	– Pulsed laser classification flow	12
Figure 3	– Important wavelengths and wavelength ranges	13
Figure 4	– Pulse duration definition	18
Figure 5	– Flat-topped and irregular pulses	20
Figure 6	– Angular subtense	21
Figure 7	– Location of beam waist for a Gaussian beam	23
Figure 8a	– Measurement set-up with source imaging	24
Figure 8b	– Measurement set-up for accessible source	26
Figure 8	– Apparent source measurement set-ups	26
Figure 9	– Linear array apparent source size	27
Figure 10	– Measurement geometries	29
Figure 11	– Effective angular subtense of a simple non-circular source	30
Figure 12	– Imaging a stationary apparent source located beyond the scanning beam vertex	37
Figure 13	– Imaging a scanning apparent source located beyond the scanning beam vertex	37
Figure 14	– Scanning mirror with an arbitrary scan angle multiplication factor	42
Figure A.1	– Multiple raster lines crossing the measurement aperture at distance from scanning vertex where $C_6 = 1$	49
Table 1	– Reference points	22
Table 2	– Four source array	28
Table A.1	– Number of source cases	62
Table A.2	– Number of source cases	63

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF LASER PRODUCTS –

Part 13: Measurements for classification of laser products

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.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 60825-13, which is a technical report, has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

This second edition cancels and replaces the first edition of IEC 60825-13, published in 2006. It constitutes a technical revision.

The main changes with respect to the previous edition are as follows:

Minor changes and additions have been made in the definitions, classification flow has been updated, apparent source sections have been clarified, scanning has been updated, and more examples and useful conversions have been added to the annexes.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
76/424/DTR	76/447/RVC

Full information on the voting for the approval of this technical report 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.

This technical report is to be used in conjunction with IEC 60825-1:2007.

A list of all parts of the IEC 60825 series, published under the general title *Safety of laser products*, 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 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.

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.

SAFETY OF LASER PRODUCTS –

Part 13: Measurements for classification of laser products

1 Scope

This part of IEC 60825 provides manufacturers, test houses, safety personnel, and others with practical guidance on methods to perform radiometric measurements or analyses to establish the emission level of laser energy in accordance with IEC 60825-1:2007 (herein referred to as “the standard”). The measurement procedures described in this technical report are intended as guidance for classification of laser products in accordance with that standard. Other procedures are acceptable if they are better or more appropriate.

Information is provided for calculating accessible emission limits (AELs) and maximum permissible exposures (MPEs), since some parameters used in calculating the limits are dependent upon other measured quantities.

This document is intended to apply to lasers, including extended sources and laser arrays. Users of this document should be aware that the procedures described herein for extended source viewing conditions may yield more conservative results than when using more rigorous methods.

NOTE Work continues on more complex source evaluations and will be provided as international agreement on the methods is reached.

2 Normative references

The following referenced document is 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 60825-1:2007, *Safety of laser products – Part 1: Equipment classification and requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60825-1:2007 as well as the following terms and definitions apply.

3.1

angular velocity

speed of a scanning beam in radians per second

3.2

beam profile

irradiance distribution of a beam cross-section

3.3

beam waist

minimum diameter of an axis-symmetric beam

Note 1 to entry: For non-symmetric beams, there may be a beam waist along each major axis, each located at a different distance from the source.