

First edition  
2003-09-15

---

---

# **Lasers and laser-related equipment — Test methods for determination of the shape of a laser beam wavefront —**

## **Part 1: Terminology and fundamental aspects**

*Lasers et équipements associés aux lasers — Méthodes d'essai pour la  
détermination de la forme du front d'onde du faisceau laser —*

*Partie 1: Terminologie et aspects fondamentaux*



Reference number  
ISO 15367-1:2003(E)

© ISO 2003

This is a preview of "ISO 15367-1:2003". [Click here to purchase the full version from the ANSI store.](#)

**PDF disclaimer**

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

© ISO 2003

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 ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland

This is a preview of "ISO 15367-1:2003". Click here to purchase the full version from the ANSI store.

## Contents

Page

Foreword.....	iv
Introduction .....	v
1 Scope.....	1
2 Normative references .....	1
3 Terms and definitions.....	2
3.1 General definitions.....	2
3.2 Definitions associated with power (energy) density distribution .....	4
3.3 Definitions associated with astigmatism.....	4
3.4 Definitions related to the characteristics and topography of the wavefront. ....	5
3.5 Definitions related to wavefront gradient measurements .....	7
4 Test methods.....	8
4.1 Laser types .....	8
4.2 Safety.....	8
4.3 Test environment .....	8
4.4 Beam modification .....	9
4.5 Detector system .....	10
4.6 Wavefront measuring instruments.....	10
5 Test and measurement procedures .....	11
5.1 Alignment.....	11
5.2 Calibration.....	11
5.3 Visual inspection of automated data analysis .....	11
5.4 Measurement procedures .....	12
6 Analysis of wavefront quality .....	12
6.1 Polynomial representation of wavefronts .....	12
6.2 Computation of wavefront quality.....	12
7 Uncertainty.....	13
7.1 Requirements for uncertainty estimation .....	13
7.2 Sources of uncertainty .....	14
8 Test report.....	14
Annex A (informative) Astigmatism and laser beams .....	15
Bibliography .....	20

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15367-1 was prepared by Technical Committee ISO/TC 172, Optics and optical instruments, Subcommittee SC 9, Electro-optical systems.

ISO 15367 consists of the following parts, under the general title *Lasers and laser-related equipment — Test methods for determination of the shape of a laser beam wavefront*:

- *Part 1: Terminology and fundamental aspects*
- *Part 2: Hartmann-Shack sensors*

This is a preview of "ISO 15367-1:2003". [Click here to purchase the full version from the ANSI store.](#)

## Introduction

It is important, when designing, operating or maintaining a laser system, to be able to ensure repeatability, predict the propagation behaviour of the laser beam and to assess the safety hazards. There are four sets of parameters that could be measured for the characterization of a laser beam:

- power (energy) density distribution (ISO 13694);
- beam width, divergence angle and beam propagation factor (ISO 11146);
- phase distribution (ISO 15367);
- spatial beam coherence.

This part of ISO 15367 defines the terminology and symbols to be used when making reference to or measuring the phase distribution in a transverse plane of a laser beam. It specifies the procedures required for the measurement of

- the azimuth of the principal planes of the phase distribution;
- the magnitude of astigmatic aberrations;
- evaluation of the wavefront aberration function and the RMS wavefront deformation.

A useful technique for qualitative assessment of a beam is visual inspection of the fringe pattern in interferograms or an isometric view of a wavefront surface. However, more quantitative methods are needed for quality assurance and transfer of process technology. The measurement techniques indicated in this part of ISO 15367 allow numerical analysis of the phase distribution in a propagating beam and can provide recordable quantitative results.

While it is quite possible to ascribe other conventional aberrations (e.g. coma or spherical aberration) as well as astigmatism to a laser beam, these are not commonly used. Departure of the wavefront of a beam from some ideal surface is a more common indication of quality. On the other hand, rotational asymmetry has a much wider range of effects in a laser beam than is usually associated with astigmatism imposed on a beam of optical radiation by conventional optical systems. For this reason, various forms and characteristics of astigmatism in beams are now defined in detail.

The provisions of this part of ISO 15367 allow a test report to be commissioned with measurements or analysis of a selection of beam characteristics. Measurements of astigmatism are important to system designers who wish to specify optical elements for the correction of astigmatic beams. The measurement techniques defined in this part of ISO 15367 can also be used to assess any residual astigmatism after the addition of corrective elements and to aid with alignment.

A major application of phase distribution measurements comes with the possibility of combining those measurements with a simultaneous measurement of the power (energy) density distribution (ISO 13694) at the same location in the path of a beam. Digital processing of the data can reveal much more detailed characteristics of the propagating beam than can measurements of the power (energy) envelope resulting from calculation of the beam propagation ratio (ISO 11146). The more detailed information can be important to assessors of laser damage and safety hazards as well as process development engineers when it is necessary to know the power (energy) density distribution at the process interaction point.