Lasers and laser-related equipment - Test methods for determination of the shape of a laser beam wavefront - Part 1: Terminology and fundamental aspects

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EESTI STANDARDI EESSÕNA **NATIONAL FOREWORD**

Käesolev Eesti standard EVS-EN ISO 15367-1:2004 sisaldab Euroopa standardi EN ISO 15367-1:2003 ingliskeelset teksti. Käesolev dokument on jõustatud 23.11.2004 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN ISO 15367-1:2004 consists of the English text of the European standard EN ISO 15367-1:2003. This document is endorsed on 23.11.2004 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

Käsitlusala: This part of ISO 15367 specifies methods for the measurement of the topography of the wavefront of a laser beam by measurement and interpretation of the spatial distribution of the phase of that wavefront across a plane approximately perpendicular to its direction of propagation. Requirements are given for the measurement and analysis of phase distribution data to provide quantitative wavefront parameters and their uncertainty in a test report.	**Scope:** This part of ISO 15367 specifies methods for the measurement of the topography of the wavefront of a laser beam by measurement and interpretation of the spatial distribution of the phase of that wavefront across a plane approximately perpendicular to its direction of propagation. Requirements are given for the measurement and analysis of phase distribution data to provide quantitative wavefront parameters and their uncertainty in a test report.

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English version

Lasers and laser-related equipment

Test methods for determination of the shape of a laser beam wavefront

Part 1: Terminology and fundamental aspects
(ISO 15367-1 : 2003)

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
(ISO 15367-1 : 2003)

Laser und Laseranlagen – Prüfverfahren für die Bestimmung der Wellenfrontform von Laserstrahlen – Teil 1: Begriffe und grundlegende Aspekte
(ISO 15367-1 : 2003)

This European Standard was approved by CEN on 2003-09-01.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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Management Centre: rue de Stassart 36, B-1050 Brussels

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Foreword

International Standard

ISO 15367-1 : 2003 Lasers and laser-related equipment – Test methods for determination of the shape of a laser beam wavefront – Part 1: Terminology and fundamental aspects,

which was prepared by ISO/TC 172 'Optics and optical instruments' of the International Organization for Standardization, has been adopted by Technical Committee CEN/TC 123 'Lasers and laser-related equipment', the Secretariat of which is held by DIN, as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by March 2004 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 15367-1 : 2003 was approved by CEN as a European Standard without any modification.

NOTE: Normative references to international publications are listed in Annex ZA (normative).

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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.

1 Scope

This part of ISO 15367 specifies methods for the measurement of the topography of the wavefront of a laser beam by measurement and interpretation of the spatial distribution of the phase of that wavefront across a plane approximately perpendicular to its direction of propagation. Requirements are given for the measurement and analysis of phase distribution data to provide quantitative wavefront parameters and their uncertainty in a test report.

The methods described in this part of ISO 15367 are applicable to the testing and characterization of a wide range of beam types from both continuous wave and pulsed lasers. Definitions of parameters describing wavefront deformations are given together with methods for the determination of those parameters from phase distribution measurements.

2 Normative references

The following referenced documents are 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.

ISO 9334, *Optics and optical instruments — Optical transfer function — Definitions and mathematical relationships*

ISO 10110-5, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 5: Surface form tolerances*

ISO 11145, *Optics and optical instruments — Laser and laser-related equipment — Vocabulary and symbols*

ISO 11146, *Lasers and laser-related equipment — Test methods for laser beam parameters — Beam widths, divergence angle and beam propagation factor*

ISO 13694, *Optics and optical instruments — Lasers and laser-related equipment — Test methods for laser beam power (energy) density distribution*

ISO 15367-2, *Lasers and laser related equipment — Test methods for determination of the shape of a laser beam wavefront — Part 2: Hartmann-Shack sensors*

IEC 60825, (All parts), *Safety of Laser Products*

IEC 61040, *Power and energy measuring detectors, instruments and equipment for laser radiation*