SLOVENSKI STANDARD
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Laserji in laserska oprema - Preskusne metode za parametre laserskega žarka - Polarizacija (ISO/DIS 12005:2021)

Lasers and laser-related equipment - Test methods for laser beam parameters - Polarization (ISO/DIS 12005:2021)

Laser und Laseranlagen - Prüfverfahren für Laserstrahlparameter - Polarisation (ISO/DIS 12005:2021)

Lasers et équipements associés aux lasers - Méthodes d'essai des paramètres du faisceau laser - Polarisation (ISO/DIS 12005:2021)

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Lasers and laser-related equipment — Test methods for laser beam parameters — Polarization

Lasers et équipements associés aux lasers — Méthodes d'essai des paramètres du faisceau laser — Polarisation

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 172, *Optics and Photonics*, Subcommittee SC 9, *Laser and electro-optical systems*.

This third edition cancels and replaces the second edition (ISO 12005:2003), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Description errors in subclause 4.5 (Analysis of the results) were corrected.

— Definitions of the “degree of polarization” and the “degree of linear polarization” were made clear.

— Definition of extinction ratio was changed.

— Previous subclause 3.3 (direction of polarization) and subclause 3.4 (plane of polarization) were deleted, because these terms are confusing due to the different definitions, and they are not necessarily required for this document.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document specifies a relatively quick and simple method, requiring minimum equipment, for determining the state of polarization of a laser beam.

This method is for well-polarized laser beams, including those emitted by lasers with a high divergence angle. However, if more completeness in the determination of the polarization status is required, the use of a more sophisticated analysing device is necessary. Although not within the scope of this document, the principle of operation of such devices is given in Annex A, together with a description of the Stokes parameters which are needed in that case.

Lasers and laser-related equipment — Test methods for laser beam parameters — Polarization

1 Scope

This document specifies a method for determining the polarization status and, whenever possible, the degree of polarization of the beam from a continuous wave (cw) laser. It can also be applied to repetitively pulsed lasers, if their electric field vector orientation does not change from pulse to pulse.

This document also specifies the method for determining the direction of the electric-field vector oscillation in the case of linearly polarized (completely or partially) laser beams. It is assumed that the laser radiation is quasimonochromatic and sufficiently stable for the purpose of the measurement. This document is applicable to radiation that has uniform polarization over its cross-sectional area.

The knowledge of the polarization status can be very important for some applications of lasers with a high divergence angle, for instance when the beam of such a laser shall be coupled with polarization dependent devices (e.g. polarization maintaining fibres). This document also specifies a method for the determination of the state of polarization of highly divergent laser beams, as well as for the measurement of beams with large apertures.

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.

ISO 11145, *Optics and photonics — Lasers and laser-related equipment — Vocabulary and symbols*

ISO 11554, *Optics and photonics — Lasers and laser-related equipment — Test methods for laser beam power, energy and temporal characteristics*

IEC 61315, *Calibration of fibre-optic power meters*

CIE 059-1984, *Definitions and Nomenclature, Instrument Polarization*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11145, ISO 11554, IEC 61315, CIE 059-1984 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
polarization
restriction of oscillations of the electric field vector to certain directions

Note 1 to entry: This is a fundamental phenomenon which can be explained by the concept that electromagnetic radiation is a transverse wave motion, i.e. the oscillations are at right angles to the direction of propagation. It is customary to consider these oscillations as being those of the electric field vector.

3.2
state of polarization
classification of polarization as linear, random, circular, elliptical or unpolarized

3.3
ellipticity
b/a
<elliptically polarized radiation> ratio of the minor semiaxis *b* to the major semiaxis *a* of the ellipse

Note 1 to entry: The ellipse is described by the motion of the terminal point of the electric field vector in a transverse plane to the direction of radiation propagation (see Annex A).

3.4
ellipticity angle
ε
angle whose tangent is the ellipticity; i.e. $\tan\varepsilon = b/a$

Note 1 to entry: The ellipticity angle is constrained to $-45° \le \varepsilon \le +45°$. When $\varepsilon = \pm 45°$ the polarization is circular and when $\varepsilon = 0°$ the polarization is linear (see Annex A).

3.5
azimuth
Φ
angle between the major axis of the instantaneous ellipse and a reference axis perpendicular to the direction of propagation

Note 1 to entry: See Annex A.

3.6
linear polarizer
optical device whose output is linearly polarized, without regard to the status and degree of polarization of the incident radiation

3.7
extinction ratio
r_e
<linear polarizer> measure of the quality of the linear polarizer

Note 1 to entry: If perfectly linearly polarized radiation is incident on a polarizer, then the extinction ratio of the polarizer is given by

$$r_e = \frac{\tau_{max}}{\tau_{min}} \text{ or } \frac{\rho_{max}}{\rho_{min}}$$

where

τ_{max} (ρ_{max}) is the maximum transmittance (reflectance)

τ_{min} (ρ_{min}) is the minimum transmittance (reflectance)

of power (energy) through (from) the linear polarizer.

Note 2 to entry: The extinction ratio is often described in the following form:

$$r_e = \frac{\tau_{max}}{\tau_{min}}:1 \text{ or } \frac{\rho_{max}}{\rho_{min}}:1$$

3.8
polarization ratio
< laser beam > measure of the linear polarization for completely or partially polarized laser beams

Note 1 to entry: See 4.4.2.

3.9
quarter-wave plate
optical device which resolves a completely polarized incident beam of radiation into two orthogonally polarized components and introduces a 90° phase shift between them

3.10
Stokes parameters
set of four real quantities, which completely describe the polarization state of monochromatic or quasimonochromatic radiation

Note 1 to entry: The parameters are, collectively, known as the Stokes vector, a 4 × 1 vector (see Annex A for a complete description and formulae for Stokes parameters).

3.11
degree of polarization
p
ratio of the beam power (or energy) of the completely polarized component to the total beam power (or energy)

3.12
degree of linear polarization
p_L
ratio of the difference to the sum of beam powers P (energies Q) in the direction x of maximum transmission and the direction y of minimum transmission through the linear polarizer

$$p_L = \frac{P_x - P_y}{P_x + P_y} \text{ or } \frac{Q_x - Q_y}{Q_x + Q_y}$$

Note 1 to entry: The measured beam powers P_x and P_y and measured beam energies Q_x and Q_y are defined in 4.4.2.

4 Test method for state of polarization

4.1 Principle of measurement

The first test for laser beam polarization determines whether the beam is linearly polarized. This involves recording the maximum and minimum levels of the transmitted radiation while the angular orientation of the linear polarizer is varied, as shown in Figure 1.

If the beam is not linearly polarized (according to the criteria given in 4.5), it is tested for elliptical or circular polarization. For this test the beam is measured after transmission by both a quarter-wave plate and a linear polarizer, as shown in Figure 2.

If not in either of these states, it is only partially polarized or unpolarized.