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Optics and optical instruments — Quality evaluation of optical systems — Determination of distortion

*Optique et instruments d'optique — Évaluation de la qualité des systèmes
optiques — Détermination de la distorsion*



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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.

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.

International Standard ISO 9039 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 1, *Fundamental standards*.

Annexes A and B of this International Standard are for information only.

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Introduction

Generally, the function of rotationally symmetric optical systems is to form an image that is geometrically similar to the object, except some particular systems such as fish-eye lenses and eyepieces, where this condition is deliberately not maintained. This function is accomplished ideally according to the geometry of perspective projection. Departures from the ideal image geometry are called distortion. The distortion is a position-dependent quantity which generally has a vectorial character. In a given image plane (which may also lie at infinity), this vector, representing the difference between theoretical and real image position, has a radial and a tangential component. In optical systems, the tangential component is basically conditioned by imperfect rotational symmetry. The systems manufactured in accordance with the present state of the art have a negligible tangential distortion. A tangential component of the distortion appears, however, as primary aberration in the case of electromagnetically focused electrooptical systems. This International Standard deals only with the radial distortion. For special systems, e.g. certain electrooptical systems, an expansion may become necessary to include vectorial representation.

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Optics and optical instruments — Quality evaluation of optical systems — Determination of distortion

1 Scope

This International Standard specifies methods of determining distortion in optical systems for the purposes of quality evaluation.

It applies to optical imaging systems in the optical spectral range from 100 nm to 15 000 nm which, by their design, aim at a rotationally symmetric image geometry. It is applicable to electrooptical imaging systems provided that adequate rotational symmetry of the image is guaranteed. It does not apply, therefore, to anamorphic and fibre optic systems.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9334:—¹⁾, *Optics and optical instruments — Optical transfer function — Definitions and mathematical relationships*.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 distortion: Measure of the deviation of the extra-axial image points from the ideal image points

in a given plane lying parallel to the reference plane of the system. If the image plane is at infinity, the image positions are given in terms of tangents of field angles.

3.2 reference plane: Plane corresponding to a physical feature of the device under test which is used for alignment e.g. a mounting flange or a fixture specially mounted for that purpose.

3.3 absolute distortion, V_a : Distance in the radial direction between the observed image point and the ideal image point, expressed in millimetres or micrometres.

3.4 relative distortion, V_r : Distance in the radial direction between the observed image point and the ideal image point, expressed as a percentage of the ideal image height h'_0 . With the image at infinity, relative distortion is the difference between the tangents of the observed field angle and the ideal field angle, expressed as a percentage of the tangent of the ideal field angle ω'_0 .

3.5 object height, h : Distance between an object point and the axis of rotational symmetry of the test specimen, expressed in millimetres.

3.6 image height, h' : Distance between an image point and the axis of rotational symmetry of the test specimen, expressed in millimetres.

3.7 object pupil field angle, ω_o : Absolute value of the angle, expressed in radians or degrees, between the axis of rotational symmetry and the direction of travel of radiation from the object to the entrance pupil of the test specimen.

1) To be published.