INTERNATIONAL STANDARD

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Optics and optical instruments — Optical transfer function — Application —

Part 2:
Lenses for office copiers

Optique et instruments d'optique — Fonction de transfert optique — Application —

Partie 2: Objectifs pour photocopieurs de bureau

Reference number
ISO 9336-2:1994(E)

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 9336-2 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 1, *Fundamental standards*.

ISO 9336 consists of the following parts, under the general title *Optics and optical instruments — Optical transfer function — Application*:

— *Part 1: Interchangeable lenses for 35 mm still cameras*

— *Part 2: Lenses for office copiers*

— *Part 3: Telescopes*

Annex A of this part of ISO 9336 is for information only.

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Optics and optical instruments — Optical transfer function — Application —

Part 2:
Lenses for office copiers

1 Scope

This part of ISO 9336 specifies a method of testing lenses for office copiers in terms of imaging states aimed at making valid optical transfer function measurements.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9336. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9336 are encouraged to investigate the possibility of applying the most recent editions of the standards 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.*

ISO 9335:—[1], *Optics and optical instruments — Optical transfer function — Principles and procedures of measurement.*

3 Definitions

For the purposes of this part of ISO 9336, the definitions given in ISO 9334 apply.

4 General description of the lenses to be tested

Office copier lenses are a subclass of printer lenses designed to produce a legible image of an object when viewed with an unaided eye.

The image can be produced on film, paper or other material. Compared to the size of the object being copied, the image can be the same size, larger or smaller. The lenses are dedicated to the copier in which they are installed and are not user-interchangeable. The following does not apply to lens arrays. Two general types of copiers are covered. The first type has parallel image and object slits which are stationary with respect to the lens. The full object and image surfaces are scanned by relative motion between those surfaces and the lens/slit assembly. The lens is oriented so that its reference angle of best performance coincides with the slit openings. At any given time, the object format is not the entire object to be copied but rather is the object slit. The second type keeps the object and image surfaces effectively stationary with respect to the lens, and uses all reference angles of the lens to form the object, by using either a scanning or a pulsing illumination system. In both types, the lens assembly may be constructed of refractive surfaces only, or of a combination of refractive and reflective surfaces (e.g. mirror half lens, see figure 1). Also, in any type, the light path may be folded by means of plano mirrors. See figure 2.

1) To be published.

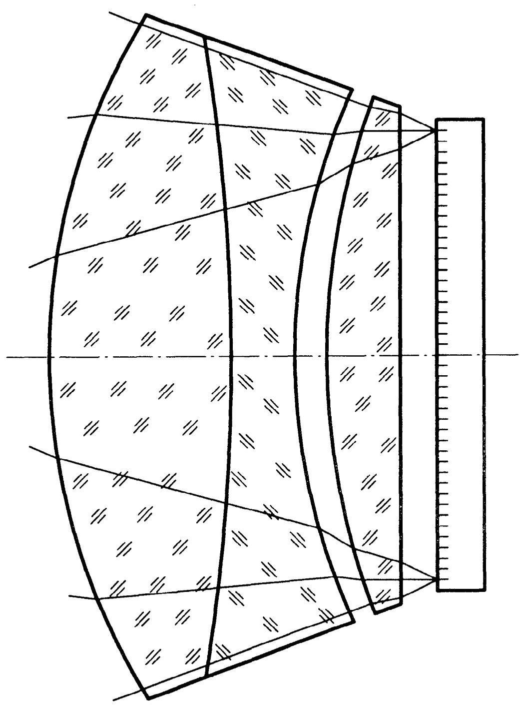

Figure 1 — Mirror half lens

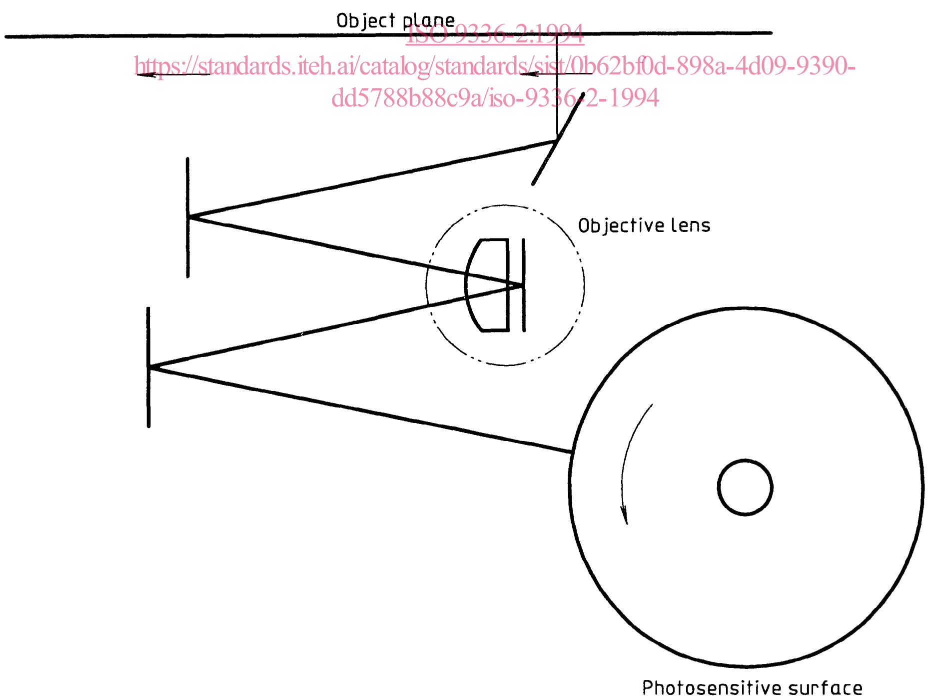

Figure 2 — Folded path system

5 Limitations, precautions and special features

Measurements shall be made with finite image and object conjugates and in accordance with the general principles and procedures given in ISO 9335.

The spectral response of the measuring system shall closely match that of the copier for which the lens was designed, since there is no standardization of copier spectral response from manufacturer to manufacturer and also because both black-and-white and colour copiers are available. Focusing and the setting of image scale shall be carried out using the method used in the copier. For lenses used with slits, the selection of test azimuth is critical. The maximum object size which is reproducible can vary with image scale. For lens assemblies with one or more reflective surfaces, the centre of the object (full field or slit) and image will probably not be on-axis, but at a nominal angle off-axis, w_{ctr}, corresponding to a nominal object height of h_{min}. However, for lenses with only refractive surfaces, the object and image centres are normally on-axis of the lens, such that $h_{min} = 0$ and $w_{ctr} = 0$.

6 Specification of the imaging state

6.1 Test specimen

Table 1 specifies an imaging state for the test specimen.

6.2 Mesuring equipment

Table 2 specifies an imaging state for the measuring equipment.

6.3 Measurement

Table 3 specifies an imaging state for the measurement.

7 Presentation

Table 4 specifies an imaging state for the presentation.

Table 1

Parameter	Value/Setting	Notes
Aperture (*f*-number)	Maximum (full) for the image scale tested	For any given image scale, the aperture may be selected on the basis of receiver sensitivity rather than depth-of-field considerations.
Reference mark	A mounting characteristic should be selected	Many copier lenses lack aperture or distance scales or other fiducials.

Table 2

Parameter	Value/Setting	Notes
Bench configuration	Both object and image conjugates[1)] to be finite (up to 1.1). Field coverage to h_{max} or w_{max}	
Spacial frequency range	Up to 8 mm^{-1}	
Spectral characteristics	Must match those of the copier in which the lens will be used	Testing with several different spectral distribution can be required.

1) A glass plate, duplicating the platen in the copier, shall be included in object space, parallel to the object plane. The material and thickness of the glass plate shall be same as those of the platen. The platen's surface quality shall be good enough not to affect image quality. Furthermore, the surface figure and homogeneity of the glass plate shall be of increasingly better quality as the distance between the plate and the object plane increases.

Table 3

Parameter	Value/Setting	Notes
MTF/PTF	MTF PTF if possible	
Image height	h_{min} $0,5h$ $0,7h$ h_{max}	See annex A.
Image scale	1:1, plus the extremes of magnification or reduction	
Reference angle	Slit systems: Angle of best performance 90°, from angle of worst performance Other systems: 0°, 90°, 180°, 270°	
Spectral characteristics	As specified	Lenses designed to produce colour images should be tested for several basic colours.
Azimuth	Radial and tangential	
Reference plane	Midway between two planes where MTF has fallen by 5 % from the maximum value at selected spatial frequency, for h_{ctr}	

Table 4

Parameter	Value/Setting	Notes
Selected spatial frequencies	$4\ mm^{-1}$ $6\ mm^{-1}$ $8\ mm^{-1}$	To be used when the OTF is given as a fonction of image height.
Frequencies for numerical presentations	Three equidistant frequencies within the range $4\ mm^{-1}$ to $8\ mm^{-1}$	

Annex A
(informative)

Calculation of field height

The general expression for field height, for a system with axial rotational symmetry of response (see figure A.1), is defined as:

$$a \cdot h = a(h_{max} - h_{min}) + h_{min} \quad \text{... (A.1)}$$

When expressed in field components, the vector equation is as follows:

$$\boldsymbol{a \cdot h} = h_{min} + 2\boldsymbol{a \cdot h_z} + \boldsymbol{a \cdot h_y} \quad \text{... (A.2)}$$

For $\boldsymbol{h_z}$ perpendicular to $\boldsymbol{h_y}$ and $\boldsymbol{h_{ctr}}$ parallel to $\boldsymbol{h_z}$ and h_{min} (which is normally true), this becomes

$$a \cdot h = [(h_{min} + 2a \cdot h_z)^2 + (a \cdot h_y)^2]^{1/2} \quad \text{... (A.3)}$$

where

a is the decimal fraction of the relative image or object height ($0 < a < 1$);

h is the maximum distance of a point in the format or slit from the optical axis;

h_{ctr} is the distance of the centre of the format or the slit from the optical axis in the unfolded optical path. For a lens with only refractive surfaces, the centre will normally be on-axis; then, $h_{ctr} = 0$.

However, for a mirror half lens the centre of the format or slit will normally be off-axis; then, h_{ctr} is not zero;

h_{min} is the distance from the optical axis to the nearest point of the format or slit;

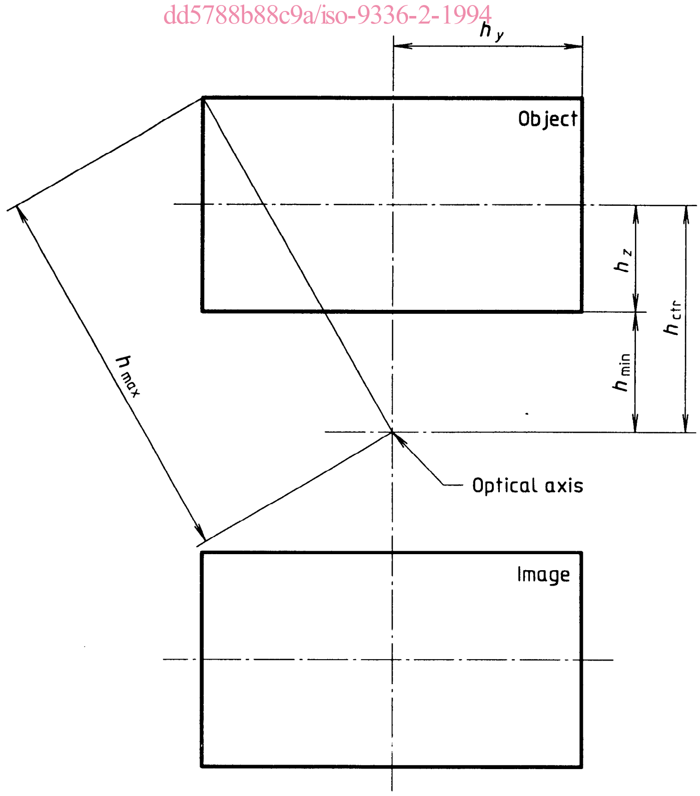

Figure A.1

h_{max} is the distance from the optical axis to the farthest point of the format or slit;

h_y is half the format height or half the slit length;

h_z is half the format width or half the slit width. In many cases the slit width will be negligibly small.

EXAMPLE

For a half field ($a = 0,5$) of a mirror half lens having an extended format of 215,9 mm × 279,4 mm (8,5 in × 11 in), with the object and image touching on the long side of the format and assuming an unfolded light path at 1:1 magnification (see figure A.2), the parameters are as follows:

$$h_{ctr} = h_z = 215,9/2$$

$$= 108,0 \text{ mm}$$

and

$$h_y = 279,4/2$$

$$= 139,7 \text{ mm}$$

If $a = 0$, then

$$h = h_{min} + [(0 \times 2 \times 108,0)^2 + (0 \times 139,7)^2]^{1/2}$$

$$= h_{min}$$

but h_{min} is also zero, since the optical axis touches the edge of the format.

Thus,

$$h = h_{min} = 0$$

If $a = 1,0$, then

$$h_{max} = h_{min} + [(1 \times 2 \times 108,0)^2 + (1 \times 139,7)^2]^{1/2}$$

$$= 257,2 \text{ mm}$$

If $a = 0,5$, then

$$0,5h = 0 + [(0,5 \times 2 \times 108,0) + (0,5 \times 139,7)^2]^{1/2}$$

$$= 128,6 \text{ mm}$$

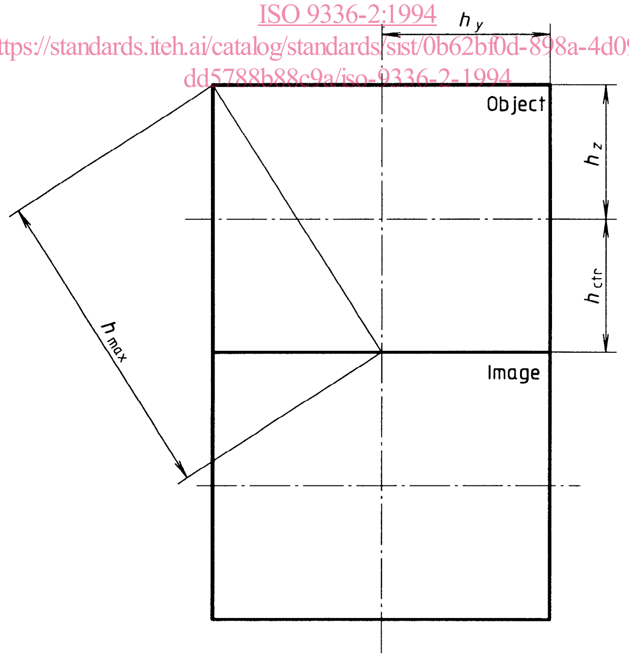

Figure A.2

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