
**Ophthalmic instruments — Refractor
heads**

Instruments ophtalmiques — Têtes de réfracteurs

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Foreword

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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 10341 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 7, *Ophthalmic optics and instruments*.

This second edition cancels and replaces the first edition (ISO 10341:1997), which has undergone minor revision in order to update normative references.

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Ophthalmic instruments — Refractor heads

1 Scope

This International Standard specifies requirements and test methods for refractor heads used for the determination of refractive errors and binocular functions of the human eye.

This International Standard takes priority over ISO 15004-1, if differences exist.

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 7944, *Optics and optical instruments — Reference wavelengths*

ISO 8429, *Optics and optical instruments — Ophthalmology — Graduated dial scale*

ISO 13666, *Ophthalmic optics — Spectacle lenses — Vocabulary*

ISO 15004-1:2006, *Ophthalmic instruments — Fundamental requirements and test methods — Part 1: General requirements applicable to all ophthalmic instruments*

IEC 60601-1, *Medical electrical equipment — Part 1: General requirements for basic safety and essential performance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13666 and the following apply.

3.1

refractor head

instrument providing a means of positioning spherical and cylindrical lenses, prisms and other optical devices in front of a subject's eyes for the purpose of determining refractive error and binocular functions

3.2

reference plane

plane at which the readings and the power tolerances of the refractor head apply

3.3

reference distance

distance between the reference plane of the refractor head and the corneal vertex

4 Requirements

4.1 General

The refractor head shall conform to the requirements specified in ISO 15004-1.

4.2 Measuring ranges

The requirements specified in Table 1 for refractor heads shall apply.

Table 1 — Measuring ranges for refractor heads

Criterion	Minimum measuring ranges for each side
Spherical power	0 D to +15 D in steps of 0,25 D 0 D to –15 D in steps of 0,25 D
Astigmatic power	0 D to 5 D in steps of 0,25 D in plus or minus cylinder form
Cylinder axis ^a	0° to 180° indicated in 5° steps; in addition, readings or estimates to 1° shall be possible
Prismatic power ^b	0 Δ to 10 Δ in steps of 1 Δ, or continuously
Prism base ^a	0° to 360° indicated in 5° steps; in addition, readings or estimates to 1° shall be possible. Indication of the prism base by horizontal and vertical components is allowed as an alternative
^a Cylinder axis and prism base settings shall be indicated according to ISO 8429.	
^b The combined prismatic powers of both sides shall be at least 30 Δ.	

4.3 Optical requirements

The requirements specified in Tables 2 to 7 shall apply. Powers shall be measured in the reference plane. Conformance shall be verified as described in 5.2.

The dioptric powers indicated in Tables 2, 3 and 5 shall be referenced to the wavelength $\lambda = 546,07$ nm or alternatively $\lambda = 587,56$ nm in accordance with ISO 7944.

If the requirements are not met for both wavelengths, the reference wavelength used shall be indicated.

The requirements for spherical power are given in Table 2.

Table 2 — Tolerances on spherical power

Indicated spherical power (absolute)	Tolerance on	
	mean power	residual astigmatism
	$\frac{S_1 + S_2}{2}$ D	$ S_1 - S_2 $ D
0,00 to 3,00	$\pm 0,06$	0,03
> 3,00 to 6,00	$\pm 0,09$	
> 6,00 to 9,00	$\pm 0,12$	
> 9,00 to 12,00	$\pm 0,15$	
> 12,00 to 15,00	$\pm 0,18$	
> 15,00	$\pm 0,25$	
NOTE	S_1 and S_2 refer to the vertex powers in the principal meridians.	

The requirements for cylindrical power are given in Table 3.

Table 3 — Tolerances on cylindrical power

Meridian of highest absolute power (nominal value) D	Indicated cylindrical power D				
	$\leq 0,50$	$> 0,50$ to 1,00	$> 1,00$ to 3,00	$> 3,00$ to 6,00	$> 6,00$
	Tolerance D				
0,00 to 5,00	0,06	0,06	0,06	0,09	0,12
$> 5,00$ to 10,00			0,09	0,12	0,18
$> 10,00$ to 15,00		0,09	0,12	0,18	0,25
$> 15,00$			0,12	0,18	0,25

NOTE The tolerance for the meridian with the higher absolute power, given in Table 2, is valid for both meridians in addition to the cylinder tolerances of this table.

The requirements on centration of lens combinations are given in Table 4.

Table 4 — Tolerances of prismatic effect of spherical and cylindrical lenses relative to the centre point of the aperture in the combined optical mechanical system (not including crossed cylinders)

Indicated power (absolute) D	Tolerance Δ
0,00	0,12
$> 0,00$ to 6,00	0,25
$> 6,00$ to 12,00	0,37
$> 12,00$	0,50

The requirements for rotary and fixed prisms are given in Table 5.

Table 5 — Tolerances on prismatic power

Indicated power Δ	Tolerance
$\leq 5,00$	$\pm 0,25 \Delta$
$> 5,00$	$\pm 5 \%$

NOTE The indicated prismatic power refers to an incident ray parallel to the axis of the optical system.

The requirements for axis and base direction are given in Table 6.

Table 6 — Tolerances on cylinder axis and prism base setting

Criterion	Indicated power (absolute)	Tolerance
Cylinder axis ^a (excluding crossed cylinders)	> 0 D to 0,25 D	± 5°
	> 0,25 D to 1 D	± 3°
	> 1 D	± 2°
Prism base setting ^a	≤ 1 Δ	± 5°
	> 1 Δ to 10 Δ	± 3°
	> 10 Δ	± 2°
NOTE Zero direction for cylinder axis and prism base is defined as the line connecting the aperture centres when the instrument is adjusted for zero height difference between both sides.		
^a Cylinder axis and prism base settings shall be indicated according to ISO 8429.		

The requirements for calibration accuracy are given in Table 7.

Table 7 — Tolerances on reference and pupillary distance values

Criterion	Tolerance mm
Scale for reference distance	± 0,5
Scale for pupillary distance	± 0,5

4.4 Construction and function

These requirements shall be verified as described in 5.3.

- Minimum free aperture for all lenses within the refractor head shall be 16 mm; however, for prisms with a power of 6 Δ and more, the aperture may be reduced to a minimum of 11 mm.
- The manufacturer shall indicate the reference plane for the instrument and shall make provision for the measurement of the reference distance of each side.
- There shall be at least a device provided to allow for occlusion and dissociation. A Jackson crossed cylinder shall be installed on each side.
- The interpupillary distance shall be continuously adjustable in a minimum range from 50 mm to 75 mm.
- The adjustable range of the forehead rest shall be at least 10 mm.
- The instrument shall be designed and constructed to eliminate all detrimental internally reflected or stray light.
- The structures of the lens chamber shall not interfere with the visual function of the patient when viewing the target.
- The instrument shall be designed and constructed so that when the lenses and accessories are positioned in front of the viewing aperture, they shall be positively aligned and centred.

5 Test methods

5.1 General

All tests specified in this International Standard are type tests.

5.2 Checking optical requirements

Conformance to the requirements specified in 4.3 shall be tested by using a device that does not exceed a measuring error of 0,01 D or 20 % of the given tolerance for vertex power, whichever is greater, and of 0,5° for cylinder axis direction and prism base setting. Measurement shall be made at the aperture centre, and referred to the reference plane.

NOTE An example is given in Annex A.

Test results shall be evaluated according to the general rules of statistics.

5.3 Checking construction and function

Conformance to the requirements specified in 4.4 shall be checked by observation.

6 Information supplied by the manufacturer

6.1 Accompanying documents

The refractor head shall be accompanied by documents containing instructions for use and any necessary precautions. In particular, this information shall contain:

- a) name and address of the manufacturer;
- b) instructions for effective disinfection of the refractor head with particular reference to instruments returned to the manufacturer for repair and maintenance;
- c) if appropriate, a statement that the refractor head in its original packaging conforms to the transport conditions as specified in 5.3 of ISO 15004-1:2006;
- d) any additional documents as specified in IEC 60601-1.

6.2 Marking of the auxiliary wheel

The following letters or symbols shall be used, as appropriate:

MR	Maddox rods
SS or	Stenopaic slit
PH or 	Pinhole
BL or 	Occluder
FL	Frosted lens
CL or 	Cross line
RF	Red filter
GF	Green filter
PF	Polarization filter
OA	Open aperture
RL	Retinoscopic lens

6.3 Identification of the refractor head

The refractor head shall be permanently marked with at least the following information:

- a) name and address of manufacturer or supplier;
- b) name, model and serial number of instrument;
- c) if appropriate, reference wavelength used;
- d) additional markings as required by IEC 60601-1;
- e) a reference to this International Standard, i.e. ISO 10341:2009, if the manufacturer or supplier claims compliance with it.

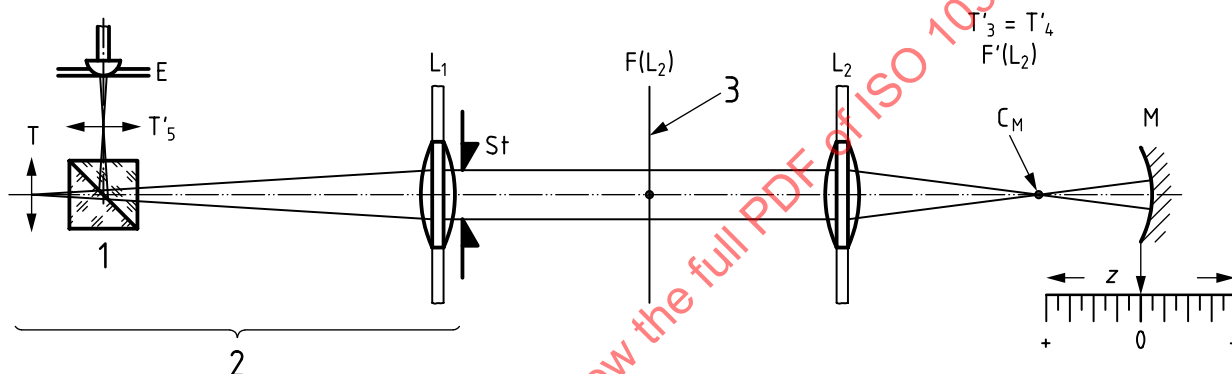
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Annex A (informative)

Example of test device for checking accuracy of refractor head elements

A.1 Determination of spherical and cylindrical power

For testing and determining the tolerances of spherical and cylindrical elements of the refractor head, 5.2 states that the uncertainty of the testing device is not to exceed 20 % of the given tolerance of the optical elements. A simplified design of a device for testing these elements is shown in Figure A.1. Commercial lensmeters or focimeters conforming to ISO 8598:1996 do not comply with this requirement.



Key

1	beam splitter	E	eyepiece
2	autocollimating telescope	L ₁ , L ₂	objective lenses
3	reference plane for refractor head	St	stop
F	focal point	T	target
M	mirror	T'	target image
C _M	centre of curvature of the mirror M	z	movement of the mirror

Figure A.1 — Set up for a refractor head test device

The example in Figure A.1 shows the ray tracing when the refractor head power is zero. The lenses L₁ and L₂ are high quality compound objectives. L₁ and eyepiece E form an autocollimating telescope with a minimum magnification of $\times 15$. The stop St reduces the diameter of the measuring bundle to 7 mm. Lens L₁ of this collimating telescope forms an image T'₁ of target T at infinity. The refractor head is adjusted to the measuring device so that its reference plane matches the front focal point F(L₂) of the lens L₂ and both optical axes coincide. The front surface of refractor head is facing the autocollimating telescope.

As in this example the refractor head has zero power, it forms image T'₂ = T'₁ at infinity. Lens L₂ forms another image T'₃ at its back focal point F'(L₂). This real image also forms another real image T'₄ coincidentally produced by concave mirror M which is movable along the axis of the test equipment, and whose position is indicated by the precision scale. The coincident images are produced at the centre of curvature C_M of mirror M and coincidence is achieved by movement z of the mirror. The rays are then reflected back along their original paths, thereby forming image T'₅ on a graticule viewed through eyepiece E. The vertex power S of the combined optical elements of the refractor head is calculated by

$$S = z \left(\frac{1}{f} \right)^2$$