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Optics and optical instruments — Test methods for telescopic systems —

Part 1: Test methods for basic characteristics

Optique et instruments d'optique — Méthodes d'essai pour systèmes télescopiques —

Partie 1: Méthodes d'essai des caractéristiques fondamentales

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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.

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 14490-1 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 4, *Telescopic systems*.

ISO 14490 consists of the following parts, under the general title *Optics and optical instruments — Test methods for telescopic systems*:

— *Part 1: Test methods for basic characteristics*

— *Part 2: Test methods for binocular systems*

— *Part 3: Test methods for telescopic sights*

— *Part 4: Test methods for astronomical telescopes*

— *Part 5: Test methods for transmittance*

— *Part 6: Test methods for veiling glare index*

— *Part 7: Test methods for limit of resolution*

The following part is under preparation:

— *Part 8: Test methods for night-vision devices*

Optics and optical instruments — Test methods for telescopic systems —

Part 1:
Test methods for basic characteristics

1 Scope

This part of ISO 14490 specifies the test methods for the determination of the following basic characteristics of telescopic systems and observational telescopic instruments:

— angular magnification (see Clause 4);

— entrance pupil diameter (see Clause 5);

— exit pupil diameter and eye relief (see Clause 6);

— angular field of view in the object space (see Clause 7);

— angular field of view in the image space (see Clause 8);

— angular field of view in the object space for spectacle wearers (see Clause 9);

— collimation of the bundle of rays emergent from the eyepiece (see Clause 10);

— image rotation (see Clause 11);

— closest distance of observation (see Clause 12).

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 14132-1:2002, *Optics and optical instruments — Vocabulary for telescopic systems — Part 1: General terms and alphabetical indexes of terms in ISO 14132*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14132-1 apply.

4 Method of measurement of the angular magnification

4.1 General

In accordance with ISO 14132-1, the angular magnification Γ of a telescopic system is defined by the following equation:

$$\Gamma = \frac{\tan w'}{\tan w} \approx \frac{w'}{w} \tag{1}$$

where w and w' are angles that the axes of conjugate beams make with the optical axis in the object space and image space, respectively.

The method of measurement of the angular magnification is based on the measurement of the angular size of an object placed in the field of view of a test specimen and that of its image.

4.2 Test arrangement

Measurement of the magnification shall be carried out with the angular test arrangement shown in Figure 1.

For systems for which the magnification is to be measured under a focus setting other than infinity, the collimator scale shall be adjusted in order to form the image of the scale at the specified distance from the test specimen.

The test arrangement shall be provided with a green optical filter to avoid any chromatism of the image. The maximum transmittance of the filter shall be at a wavelength of about 0,55 µm.

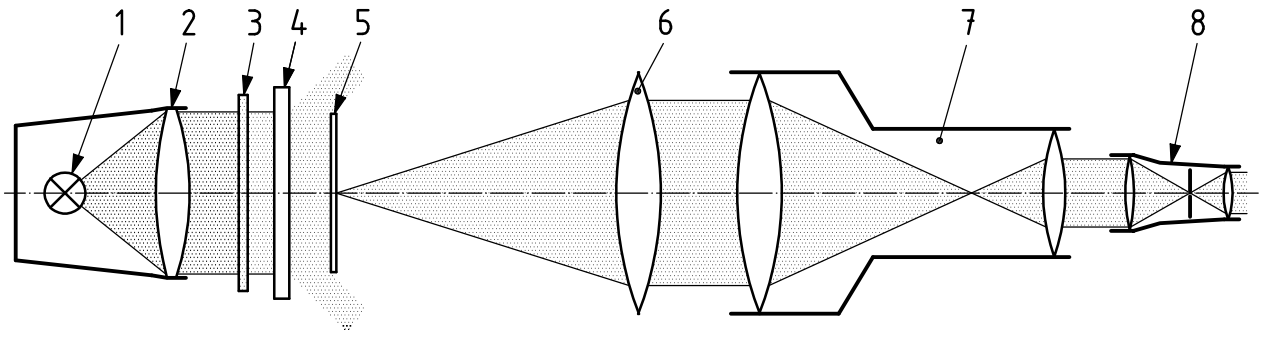
As an optical angular measuring device, one of the following shall be used:

— a telescope with a scale having divisions of known angular size;

— a telescope with a micrometer eyepiece;

— any other angle-measuring device which assures the required measurement precision.

The same method should be used for Galilean telescopes.



Key

1 light source
2 condenser
3 filter
4 diffusing plate
5 scale
6 collimator lens
7 test specimen
8 optical angle measuring telescope

Figure 1 — Test arrangement for measurement of the angular magnification

4.3 Procedure

Before starting the measurements, adjust the eyepiece of the test specimen to 0 m^{-1} and focus the test specimen onto an infinitely remote object.

Determine the number of telescope (8 in Figure 1) scale divisions covered by an integral number of collimator scale (5 in Figure 1) image divisions produced by the test specimen.

If a telescope with a micrometer eyepiece is used, measure the angular size of the image of a part of the collimator scale (5 in Figure 1) produced by the test specimen.

4.4 Determination of results

The magnification Γ that is to be found is defined as the ratio of the size of the image of the collimator scale (5 in Figure 1) produced by the telescope to the size of the corresponding part of the collimator scale.

For the case in which a telescope with a micrometer eyepiece is used

$$\Gamma = \frac{n \cdot a_1}{m \cdot a_2} \tag{2}$$

where

n is the number of divisions of the telescope (8 in Figure 1) scale that corresponds to the number of divisions m of the collimator scale (5 in Figure 1) image;

a_1 is the scale division value of the measuring telescope scale;

a_2 is the scale division value of the collimator scale.

The uncertainty of magnification shall be less than one third of the maximum deviation from the nominal value specified in the relevant specification standard. For calculation of the magnification difference between the telescopes of a binocular having a magnification of 6× or more, this tolerance shall be reduced by half.

4.5 Test report

A test report shall be presented and shall include the general information specified in Clause 13 and the result of the test as specified in 4.4.

5 Method of measurement of the entrance pupil diameter

5.1 General

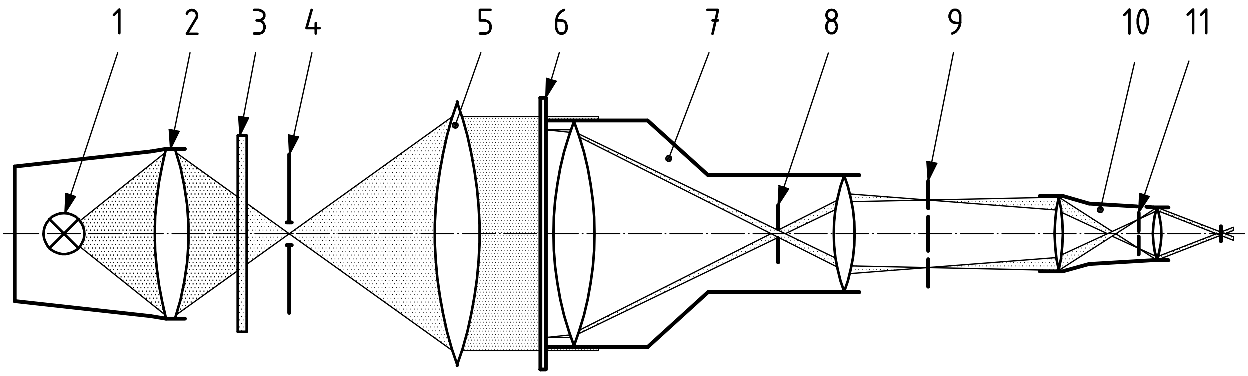
The method of measurement of the entrance pupil diameter D is based on viewing a reticle which is placed near the entrance pupil through the test specimen and reading off the linear size of the entrance pupil diameter.

5.2 Test arrangement

For a schematic representation of the test arrangement see Figure 2.

The test arrangement shall be provided with a green optical filter to avoid any chromatism of the image. The maximum transmittance of the filter should be at a wavelength of about 0,55 µm.

The same method shall be used for Galilean telescopes.



Key

1 light source
2 condenser
3 filter
4 pinhole
5 collimator lens
6 reticle
7 test specimen
8 intermediate image
9 exit pupil; reticle optional
10 magnifier or microscope
11 scale

Figure 2 — Test arrangement for the measurement of the entrance pupil diameter

5.3 Procedure

To measure the entrance pupil diameter, set a reticle with a fixed scale (or two adjustable knife edges) immediately in front of the test specimen's objective lens.

Illuminate the reticle marks (or knife edges) with a collimator. Position a field stop, whose apparent size may not exceed three arc minutes, in the focal plane of the collimator.

Use a microscope or a magnifier behind the eyepiece of the test specimen. Determine which two reticle marks are coincident with the edges of the entrance pupil (or adjust the knife edges to be coincident with the edges of the entrance pupil).

The distance between the reticle marks (or knife edges) coincident with the edges of the entrance pupil is equal to the entrance pupil diameter.

5.4 Determination of results

The result is determined by reading off the distance (in mm) between the reticle marks (or knife edges).

The distance between the reticle marks (or knife edges) in front of the lens can easily be determined with a precision of 0,1 mm. In order to make sure the uncertainty is less than 1 %, a microscope or magnifier of sufficient magnification shall be chosen appropriately for the specimen being tested.

5.5 Test report

A test report shall be presented and shall include the general information specified in Clause 13 and the result of the test as specified in 5.4.

6 Method of measurement of the exit pupil diameter and eye relief

6.1 General

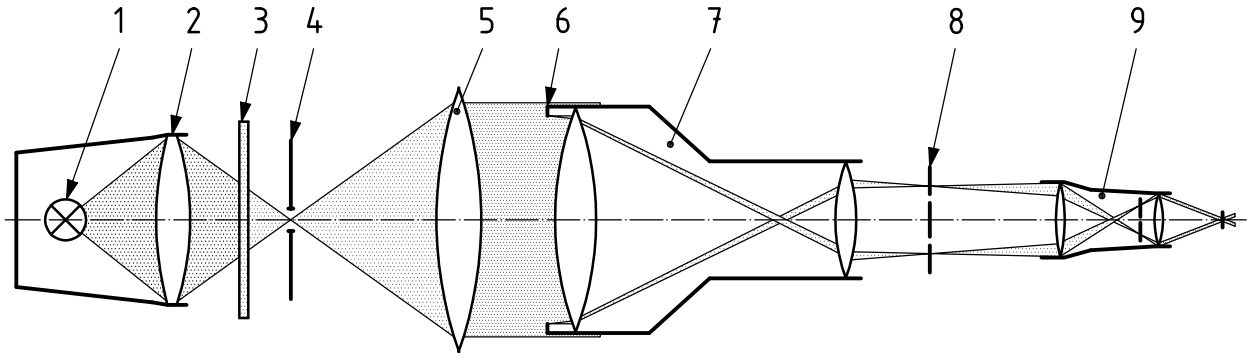
The exit pupil diameter D' is defined to be the size of the image of the entrance pupil produced by the test specimen.

The eye relief l' is defined as the distance of the exit pupil from the vertex of the last optical surface of the eyepiece.

6.2 Test arrangement

The exit pupil diameter of the test specimen and the eye relief shall be measured with the test arrangement shown in Figure 3.

The test arrangement shall be provided with a green optical filter to avoid any chromatism of the image. The maximum transmittance of the filter shall be at a wavelength of about 0,55 µm.



Key

1	light source	4	pinhole	7	test specimen
2	condenser	5	collimator lens	8	exit pupil; reticle optional
3	filter	6	entrance pupil	9	measuring microscope

Figure 3 — Test arrangement for the measurement of the exit pupil diameter and eye relief

6.3 Procedure

Before starting the measurements, adjust the eyepiece of the test specimen to 0 m^{-1} and focus the test specimen onto an infinitely remote object.

To measure the diameter of the exit pupil, focus the measuring microscope onto the exit pupil. Bring the image of the pupil into coincidence with the microscope reticle scale and count the number of scale divisions covering the diameter of the exit pupil image.

To measure the eye relief, focus the measuring microscope first onto the exit pupil, then onto the vertex of the last refracting surface of the test specimen.

6.4 Determination of results

Calculate the exit pupil diameter D' (in mm) in accordance with the equation

$$D' = n \cdot K \tag{3}$$

where

n is the number of scale divisions covering the exit pupil diameter of the test specimen;

K is the linear scale division value, in millimetres, of the measuring microscope.