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Optics and optical instruments — Microscopes — Testing of stereomicroscopes

Optique et instruments d'optique — Microscopes — Essai des stéréomicroscopes

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15227 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 5, *Microscopes and endoscopes*.

Optics and optical instruments — Microscopes — Testing of stereomicroscopes

1　Scope

This International Standard specifies test conditions and recommended test methods to ensure the minimum requirements for stereomicroscopes. These minimum requirements are given in ISO 10936-1, ISO 11884-1 and ISO 11884-2.

The test methods specified in this International Standard are recommended, but use of other test methods is permitted if the same results are obtained.

2　Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 10934-1, *Optics and optical instruments — Vocabulary for microscopy — Part 1: Light microscopy.*

ISO/CIE 10526, *CIE standard illuminants for colorimetry.*

3　Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 10934-1 apply.

4　Accuracy of testing

Testing shall be performed with an accuracy better than 10 % of the value to be determined. Measurements shall be carried out according to general rules of statistical evaluation.

NOTE　　The accuracy of measurement methods and results based on statistical evaluation is described in the ISO 5725 series.

5　Test conditions

5.1　Total visual magnification ($M_{\text{TOT VIS}}$)

The total visual magnification shall be measured at the highest magnification (M_{max}) and the lowest magnification (M_{min}) on a vertical centreline.

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5.2 Difference in total visual magnification between left and right optical systems

The difference shall be measured at magnifications M_{max} and M_{min} on a vertical centreline.

5.3 Difference in axes between left and right optical systems

The maximum difference shall be measured at magnifications M_{max} and M_{min}, each at an interpupillary distance (IPD) of 65 mm.

5.4 Difference in the centres of the image fields between left and right optical systems

The difference shall be measured at magnifications M_{max} and M_{min} each at an IPD of 65 mm.

5.5 Difference in imaging rotations between right and left images

The difference shall be measured at IPDs of 55 mm and 75 mm.

5.6 Axial shift of object plane by magnification change

The maximum shift shall be measured during the magnification change of the stereomicroscope between M_{max} and M_{min}.

5.7 Lateral shift of image plane by magnification change

The maximum shift shall be measured during the magnification change of the stereomicroscope between M_{max} and M_{min}.

5.8 Focus difference between left and right optical systems

The difference shall be measured at magnifications M_{max} and M_{min} at 0 D on the dioptre scale.

5.9 Resolution for the highest magnification at the centre of the field

Check the resolution chart under illumination with the standard illuminant type A according to ISO/CIE 10526 having a numerical aperture larger than that of the objective of the stereomicroscope.

5.10 Difference in exit pupil heights between left and right optical systems

The distance shall be measured at 0 D on the dioptre scale and an IPD of 65 mm.

5.11 Minimum range for interpupillary distance

The range shall be measured at the exit pupils of the eyepieces set at 0 D on the dioptre scale.

5.12 Calibration error if a dioptre scale is used

The error shall be measured at an IPD of 65 mm.

5.13 Minimum eyepiece dioptre adjustment range

The range shall be measured at an IPD of 65 mm.

6   Test methods

6.1   Apparatus

6.1.1   Double telescope (see Figure 1).

Two telescopes are mechanically combined with the distance and convergent angle between them either adjustable or fixed to the value specified by the manufacturer, while both optical axes remain on the plane. Graticules with cross-lines, micrometer scales and goniometer scales are fitted in the intermediate planes of the telescopes.

6.1.2   Dioptric tester, placed on the top surface of the eyepiece.

6.1.3   Centring telescope, placed in place of the eyepiece of the telescope, for centring the exit pupil of the stereomicroscope.
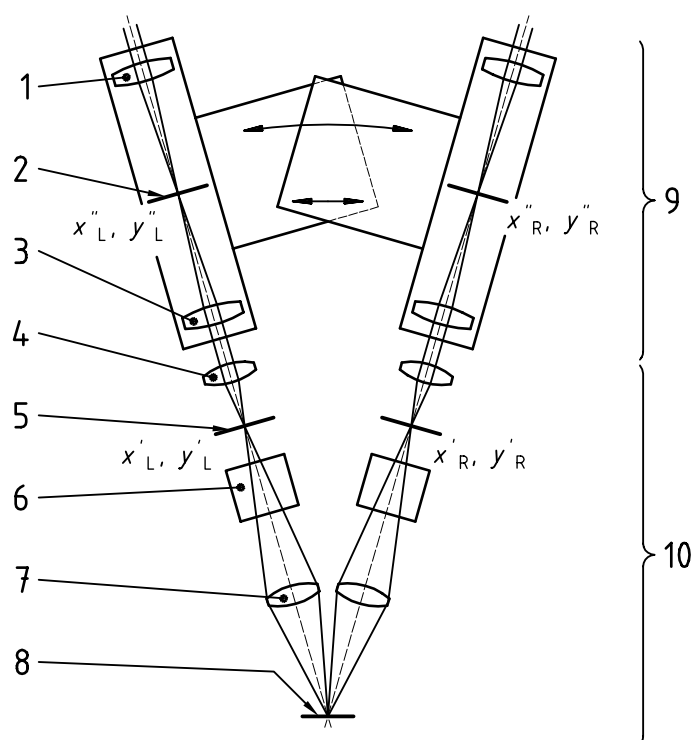
Key

1   Eyepieces
2   Intermediate image planes
3   Objectives (f_{OT})
4   Eyepieces (f_{OC})
5   Primary image planes
6   Erecting prisms
7   Objectives
8   Object plane
9   Double telescope with magnification between $2\times$ and $4\times$
10   Stereomicroscope to be tested

Figure 1 — Apparatus configuration with a double telescope

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6.1.4   Test object, placed in the object plane of the stereomicroscope to be tested and used in a separate or combined form of the following test objects:

a)   cross-lines;

b)   circular line;

c)   goniometer scale;

d)   resolution chart.

6.1.5   Graticules, placed either on the primary image planes of the stereomicroscope or on the image planes of the double telescope (6.1.1) and used in a separate or combined form of the following graticules:

a)   cross-lines;

b)   circular line;

c)   micrometer scale;

d)   goniometer scale.

6.2   Apparatus configuration

For the cases where the double telescope (see 6.1.1 and Figure 1) is used (6.3.1 through 6.3.3, and 6.3.5), that is fixed to the stereomicroscope to conform to the specifications of the stereomicroscope, and 10× eyepieces are focused at the 0 D position. For the other cases (6.3.4, and 6.3.6 through 6.3.13), the dioptre adjustment is made according to the instructions in the user manual.

6.3   Test procedures

6.3.1   Total visual magnification ($M_{\text{TOT VIS}}$)

a)   Place a micrometer scale as the test object at the centre of the object plane.

b)   Read the image size y'' of a distance y in the object plane with the micrometer scale placed in the intermediate plane of each telescope.

c)   Calculate the total visual magnification using the following equation:

$$M_{\text{TOT VIS}} = \frac{250 \cdot y''}{f_{\text{OT}} \cdot y} \tag{1}$$

where f_{OT} is the focal length, expressed in millimetres, of the objective of the telescope.

6.3.2   Difference in total visual magnification between left and right optical systems

a)   Place a micrometer scale as the test object at the centre of the object plane.

b)   Read the size y''_{R} and y''_{L} of a distance y in the object plane with the micrometer scale placed in the intermediate plane of the right and left telescopes respectively.

c) Calculate the difference, expressed as a percentage, between right and left total visual magnifications $M_{\text{TOT VIS R}}$ and $M_{\text{TOT VIS L}}$ using the following equation:

$$\Delta M_{\text{TOT VIS}} = 200 \cdot \left| \frac{y''_{\text{R}} - y''_{\text{L}}}{y''_{\text{R}} + y''_{\text{L}}} \right| \% \tag{2}$$

where $\Delta M_{\text{TOT VIS}}$ is the difference between $M_{\text{TOT VIS R}}$ and $M_{\text{TOT VIS L}}$.

6.3.3 Difference in axes between left and right optical systems

6.3.3.1 Vertical and horizontal differences in axes between left and right optical systems

This test should be applied only if the mechanical axes of the eyepieces are parallel to each other due to design.

a) Set the optical axes of the double telescope parallel to each other.

b) Place the cross-lines as the test object and focus them, using the focusing drive of the stereomicroscope.

c) Centre the cross-lines of the test plate to the cross-lines in the primary image plane.

d) Centre the left [right] telescope to the exit pupil of the left [right] beam path of the stereomicroscope using the centring telescope (6.1.3).

e) Adjust the horizontal (x -) and vertical (y -) directions of the double telescopes until the cross-lines in the left [right] telescope are centred on the image of the test plate.

f) Centre the right [left] telescope to the exit pupil of the right [left] beam path of the stereomicroscope using the centring telescope.

g) Adjust the direction of the right [left] telescope until the x -line of the cross-lines in the telescope goes through the centre of the image of the test object.

h) Read the horizontal difference $\Delta x''$ between the y -line of the telescope graticule and the centre of the image of the test plate with the micrometer scale in the right [left] telescope.

i) Calculate the horizontal difference in axes δ_x between the left and right optical systems using the following equation.

$$\delta_x = \arctan \frac{\Delta x''}{f_{\text{OT}}} \tag{3}$$

where $\Delta x''$ is the horizontal difference measured in divergent directions with the telescope graticule (6.1.5).

j) Adjust the direction of the right [left] telescope until the y -line of the cross-lines in the telescope goes through the centre of the image of the test object.

k) Read the vertical difference $\Delta y''$ between the x -line of the telescope graticule and the centre of the image of the test object with the micrometer scale in the right [left] telescope.

l) Calculate the vertical difference in axes δ_y between the left and right optical systems using the following equation.

$$\delta_y = \arctan \left| \frac{\Delta y''}{f_{\text{OT}}} \right| \tag{4}$$

where $\Delta y''$ is the vertical difference measured with the telescope graticule.

6.3.3.2 Vertical difference of the primary images between right and left optical systems

This test should be applied only if the mechanical axes of the eyepieces are not parallel to each other due to the design.

a) Place the cross-lines as the test object and focus them by the use of the focusing drive of the stereomicroscope.

b) Centre the cross-lines of the test plate to the cross-lines in the primary image plane.

c) Centre the left [right] telescope to the exit pupil of the left [right] beam path of the stereomicroscope by using centring telescope.

d) Adjust the horizontal (x -) and vertical (y -) directions of the double telescopes until the cross-lines in the left [right] telescope are centred to the image of the test plate.

e) Centre the right [left] telescope to the exit pupil of the right [left] beam path of the stereomicroscope by using centring telescope.

f) Adjust the direction of the right [left] telescope until the y -line of the cross-lines in the telescope goes through the centre of the image of the test object, by varying the convergent angle of the double telescope.

g) Read the vertical difference $\Delta y''$ between the x -line of the telescope graticule and the centre of the image of the test object with micrometer scale in the right [left] telescope.

h) Calculate the vertical difference in axes δ_y between the left and right optical systems using the following equation.

$$\delta_y = \arctan\left|\frac{\Delta y''}{f_{OT}}\right| \qquad (5)$$

where $\Delta y''$ is the vertical difference measured with the telescope graticule.

6.3.4 Difference in the centres of the image field between left and right optical systems

a) Place the cross-lines with micrometer scales as a test object.

b) Centre the cross-lines to the centre of the field diaphragm of the eyepiece in the left [right] beam path of the stereomicroscope.

c) Read the difference in the centres of the image field as the horizontal and vertical deviations $\Delta x'$ and $\Delta y'$ of the centre of the cross-lines from the centre of the field diaphragm of the eyepiece in the right [left] beam path of the stereomicroscope.

6.3.5 Difference in imaging rotations between right and left images

a) Align the goniometer scales placed at the intermediate planes of the telescopes in the horizontal direction.

b) Place the cross-lines as the test object.

c) Align the cross-lines to the goniometer scale of the telescope in the left [right] beam path of the stereomicroscope.

d) Read the angle of the image of the cross-lines with the goniometer scale of the telescope in the right [left] beam path of the stereomicroscope.

6.3.6 Axial shift of object plane by magnification change

a) Place the cross-lines as the test object and focus it at M_{max} using the focusing drive of the stereomicroscope.

b) Change the magnification and find the position of the focusing drive where the maximum defocus is observed.

c) Read the shift of the stereomicroscope when it is refocused.

6.3.7 Lateral shift of imaging plane by magnification change

a) Place the cross-lines as the test object in the object plane. Use the eyepieces, each of which is provided with a circle 0,4 mm in diameter as the graticule, in the primary image plane of the stereomicroscope.

b) Set the magnification of the stereomicroscope at M_{max}.

c) Align the centre of the image of the cross-lines with the centre of the circle.

d) Check whether the centre of the cross-lines remains within the circle or not during the change of magnification to M_{min} with the left and right optical systems.

6.3.8 Focus difference between left and right optical systems

a) Place the cross-lines as the test object and focus it on the left [right] image plane using the focusing drive of the stereomicroscope at each magnification.

b) Read the shift of the stereomicroscope when the test object is focused with the right [left] optical system.

6.3.9 Resolution for the highest magnification at the centre of the field

a) Place the resolution chart in the centre of the object plane of the stereomicroscope.

b) Determine the resolution through each of the eyepieces of the stereomicroscope.

6.3.10 Difference in exit pupil heights between left and right optical systems

a) Set the dioptre scale at 0 D.

b) Measure the distance between a reference surface of the left eyepiece and its exit pupil.

c) Measure the distance between the corresponding reference surface of the right eyepiece and its exit pupil.

d) Calculate the difference between the two measurements.

6.3.11 Minimum range for interpupillary distance

a) Measure the distance between the centre of the left exit pupil and that of the right exit pupil when the left and right eyepieces are separated by the minimum distance.

b) Measure the distance between the centre of the left exit pupil and that of the right exit pupil when the left and right eyepieces are separated by the maximum distance.

6.3.12 Calibration error if a dioptre scale is used

a) Focus the test object through a dioptric tester adjusted to 0 D and placed at a specified position against the eyepiece without dioptre adjustment device, using the focusing drive of the stereomicroscope.

b) Place the tester at a specified position against the eyepiece with the dioptre adjustment device and set the dioptre scale of the eyepiece of the stereomicroscope at 0 D. Then read the dioptre scale of the tester when it is focused on the test object, using its dioptre adjustment device.

6.3.13 Minimum eyepiece dioptre adjustment range

a) Focus the test object through a dioptric tester adjusted to 0 D and placed at a specified position against the eyepiece without dioptre adjustment device, using the focusing drive of the stereomicroscope.

b) Place the tester at a specified position against the eyepiece with the dioptre adjustment device and set the dioptre scale of the eyepiece of the stereomicroscope at the maximum position in the positive dioptre region. Then read the dioptre scale of the tester when it is focused on the test object, using its dioptre adjustment device.

c) Place the tester at a specified position against the eyepiece with the dioptre adjustment device and set the dioptre scale of the eyepiece of the stereomicroscope at the maximum position in the negative dioptre region. Then read the dioptre scale of the tester when it is focused on the test object, using its dioptre adjustment device.

Bibliography

[1]   ISO 11884-1, *Optics and optical instruments — Minimum requirements for stereomicroscopes — Part 1: Stereomicroscopes for general use.*

[2]   ISO 11884-2, *Optics and optical instruments — Minimum requirements for stereomicroscopes — Part 2: High performance microscopes.*

[3]   ISO 10936-1, *Optics and optical instruments — Operation microscopes — Part 1: Requirements and test methods.*

[4]   ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results.*

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