

JIS

JAPANESE INDUSTRIAL STANDARD

**Biological microscope objectives
and eyepieces — Methods of
measurement of performance**

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鋼板の寸法と公差

Steel plates - Dimensions and tolerances

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Biological microscope objectives and eyepieces – B 7152-1991
Methods of measurement of performance1. Scope

This Japanese Industrial Standard specifies the measuring methods of the magnification, numerical aperture, decentering, working distance and range of clear view of the biological microscope objectives specified in JIS B 7147, hereinafter referred to as the "objectives", and of the magnification, difference of magnification, field number, difference of field number, decentering of field stop, difference of object position and decentering of optical axis of the biological microscope oculars specified in JIS B 7148, hereinafter referred to as the "oculars".

Remarks: The applicable standards to this Standard are as given in the following:

- JIS B 7132-Biological microscopes for immersion-objectives
- JIS B 7137-Stage micrometer for biological microscope
- JIS B 7138-Net stage micrometer for biological microscope
- JIS B 7140-Microscope test specimens
- JIS B 7142-Screwed parts of microscope objectives and nosepieces
- JIS B 7147-Biological microscope objectives
- JIS B 7148-Biological microscope eyepieces
- JIS B 7149-1/10 mm eyepiece micrometers for microscopes
- JIS B 7503-Dial gauges reading in 0.01 mm
- JIS B 7538-Autocollimators
- JIS R 3702-Cover glass for microscope
- JIS Z 8120-Glossary of optical terms

2. Definitions

For the purposes of this Standard, the following definitions apply, and others are in accordance with JIS Z 8120.

- (1) difference of object-point position of ocular The difference of the distance from the mounting reference plane to a front side object-point of each ocular.
- (2) auxiliary lens for exit-pupil observation In measuring the numerical aperture of an objective, a lens which enlarges an index image and decreases parallax for enabling an accurate measurement, being attached to the screw thread of the lower part of the scale tube and by focussing to an aperturemeter index assembled with the ocular. This is annexed to the aperturemeter.

- (3) reference scale plate The scale plate being attached to the ocular integrated performance tester, having the reference scales for measuring the magnification, field number and decentrating of optical axis of the ocular (See Attached Figs. 1a and b).
- (4) ground glass projection screen That screen being mounted on the ocular integrated performance tester, having transparent portions for decentering measurement at the scale for magnification measurement and the centre part (See Attached Fig. 2).
- (5) scale plate of magnifying lens The focal mirror of the magnifying lens of the ocular integrated performance tester, having the cross-hair lines with scale for decentering measurement (See Attached Fig. 3).

3. Measuring instruments

3.1 Measuring instruments for objectives The measuring instruments for objectives shall be in accordance with the following:

- (1) Biological microscope That microscope which complies with JIS B 7132, having a scale tube (that is provided with an objective lens screw thread.) capable of adjusting to the designated mechanical barrel length, and providing no reflection mirror, prism, compensating lens, etc. between the objective lens and the ocular (See Attached Fig. 4).
- (2) Stage micrometer That is specified in JIS B 7137.
- (3) Ocular for measuring objective magnification The positive ocular which is capable of adjusting, diopter of grade 1 and magnification 10 specified in JIS B 7148, having the class 1 ocular micrometer specified in JIS B 7149 at the position of front side object point.
- (4) Apertometer That is for biological microscope objective which is capable of reading numerical aperture directly from 0 to 1.5 in measuring range.
- (5) Decentering, tester of objective That having the threaded part specified in JIS B 7142 and is capable of being rotated around the centre line of the threaded part as a centre.

Furthermore, the decentering at the position 36 mm apart from the attaching surface of the objective shall be 0.01 mm or under.

- (6) Sectionalized stage micrometer That is specified in JIS B 7138.
- (7) Biological microscope test specimens The biological microscope test specimens of class 0, class 1 and class 2 specified in JIS B 7140.
- (8) Working distance test specimen That having the cover glass of 0.5 ± 0.01 mm in thickness, and the bottom surface of which the cover glass is coated with an opaque thin film, and of which film surface shall have transparent index and the like facilitating visibility, when inspecting by the combination of the objective of nominal magnification 40 and the ocular of nominal magnification 10.

Furthermore, the refractive index (n_d) and Abbe number (ν_d) of the cover glass shall be in accordance with JIS R 3702.

(9) Test ocular The test ocular shall be in accordance with the following.

- (a) It shall be the ocular of class 1, magnification 10 and field number 15 or over specified in JIS B 7148, and of which decentering of optical axis shall be 8 min or under and of which decentering of field stop shall be 1 % or under.
- (b) That having field number scales in crosswise direction at the specified object point position, and the scale spacing shall be 1 in field number.
- (c) That having cross lines at the centre of the field number scale, and its point of intersection, when the ocular has been rotated, shall be 0.05 mm or under in amount of transfer.
- (d) That is used in combination with the objective, and of which aberration has been corrected.

3.2 Measuring instruments for oculars The measuring instrument for oculars shall be in accordance with the following:

- (1) Integrated performance tester for oculars That is composed of a light source, condenser lens, reference scale plate, 1 magnification image forming lens, ocular supporting stand, projecting lens and ground-glass projection screen or transparent screen, and it has a construction provided with a scaled magnifying lens with scale for carrying out measurements on details by magnifying the images on the screen (see Attached Fig. 5), and it shall be in accordance with the following:
 - (a) That forms image of 1 magnification of the scale of the reference scale plate which has been illuminated by the light source on the front-side focussing point of ocular, through the image forming lens, and this image is formed on the projection screen through the ocular and the projecting lens, and that which is capable of reading this reference scale plate scale by the projection screen scale.
 - (b) The reference scale plate has cross wires for decentering measurement at centre, having the scale for field number measurement in longitudinal direction, except centre part, and the scale for magnification measurement in lateral direction.
 - (c) The ground glass projection screen shall be that having the central transparent part for measuring difference of object point position and the scale for measuring magnification.
 - (d) The transparent screen is without scale and is used for field number measurement.
 - (e) The magnifying lens shall be that having the angle scale for measuring decentering at centre part.

- (2) Measuring instrument of integrated magnification That measuring instrument which measures the magnification integrated by an objective and an ocular (integrated magnification). It shall be that on which focal position of the objective of approximately 50 mm in focal length the micrometer of 0.1 mm in scale spacing and 5 mm or over in total length has been placed exactly, and the ocular shall be capable of adjusting diopter with respect to the micrometer and the value of constant K shall have been stated clearly.

$$K = \frac{2\,500}{f}$$

where, f : focal length of objective (mm)

Furthermore, the accuracy of the micrometer scale shall be class 2 specified in JIS B 7149 (See Attached Fig. 6).

- (3) Telescope for measuring positional difference of object point The telescope which is used in the case where the positional difference of object point of an ocular viewing at a limited position is to be measured, and it shall be that a focal mirror has been located at the prescribed design image position of the ocular to be measured. It is capable of forming a microscopic image at the design image position of ocular, coinciding with the diopter with the focal mirror by the diopter adjustment of the ocular to form a microscopic image on the focal mirror.
- (4) Objective The objective shall be that of which magnification has been measured by the objectives of magnifications 10 and 40 of grade 1 specified in JIS B 7147.
- (5) Dial gauge That dial gauge specified in JIS B 7503.
- (6) Autocollimator The autocollimator shall be that specified in JIS B 7538, having an angle scale and 500 mm or over in focal length.
- (7) Biological microscope The biological microscope shall be in accordance with 3.1 (1).
- (8) Stage micrometer The stage micrometer shall be that specified in JIS B 7137.
- (9) Sectionalized stage micrometer The sectionalized stage micrometer specified in JIS B 7138.

4. Measuring methods for performances of objective

Table 1. Measuring methods for performances of objective

No.	Measuring item	Measuring method
1	Magnification	(1) Attach an objective to a biological microscope, adjust the scale tube so that it coincides with the specified mechanical barrel length of the objective, and attach an ocular for magnification measurement to the ocular sleeve and a stage micrometer onto the stage respectively. (2) Carry out inspection by illuminating by white light source, obtain the positions where the image of the stage micrometer scale coincide with the scale of the ocular micrometer at two places, within a range where these can be seen clearly at the same time with the visual field centre, and take readings of both scales. (3) Obtain the magnification of the objective from the following formula: $m_0' = \frac{l_e}{l_0}$ where, m_0' : magnification of objective l_e : length between the scales where the ocular micrometer coincides (= length of image) l_0 : length between the scales where the stage micrometer coincides (= length of object) (4) From the following formula, obtain the error with respect to the nominal magnification. $\Delta m_0 = \frac{m_0' - m_0}{m_0} \times 100 (\%)$ where, Δm_0 : error with respect to nominal magnification m_0' : magnification of objective m_0 : nominal magnification of objective (See Attached Fig. 7)
2	Numerical aperture	(1) Attach an objective to a biological microscope, adjust the scale tube so that it coincides with the specified mechanical barrel length of the objective, and attach a test ocular to the ocular sleeve and an apertmeter onto the stage respectively. (2) After focal point has been coincided with the slit of upper surface of the apertmeter, coincide the focal point with the indexes of the apertmeter, coincide the focal point with the indexes of the apertmeter, attaching an auxiliary lens for exit pupil observation to the lower part of the scale tube. (3) Travel the index of the apertometer in the left and right, and read out scale at the position where the rim of the exit pupil of the objective has coincided with the index.

Table 1. (Continued)

No.	Measuring item	Measuring method
2	Numerical aperture	(4) Consider the value of arithmetic mean of numerals which have read out at the left and right to be the numerical aperture. (5) Obtain the error with respect to nominal numerical aperture, from the following formula: $\frac{NA' - NA}{NA} \times 100 (\%)$ where, NA': numerical aperture NA: nominal numerical aperture [See (a) and (b) of Attached Fig. 8]
3	Decentering	(1) Attach an objective decentering inspecting instrument to the biological microscope, an objective to the objective decentering inspecting instrument, a sectionalized stage micrometer onto the stage and a test ocular to the ocular sleeve. (2) Carry out inspection illuminating by white light source, carry out diopter adjustment of the test ocular and cross-wires focussing, next, focus the sectionalized stage micrometer, and adjust so that the image of the objective section micrometer and the cross-hair lines of the test ocular can be seen clearly at the same time. (3) Rotate the objective decentering inspecting instrument, read out the maximum width of travelling range of the image of the sectionalized stage micrometer and consider its 1/2 value to be the decentering of the objective at the object surface. Obtain the mean value, measuring several times. (See Attached Fig. 9)
4	Working distance	(1) Attach an objective to a biological microscope, adjust the scale tube so that it coincides with the specified mechanical barrel length of the objective, attach a test ocular to the ocular sleeve, and attach the test specimen or working distance test specimen specified in JIS B 7140 onto the stage. (2) Illuminate by white light source, and allow the numerical aperture of the substage condenser to coincide with the numerical aperture of the objective to inspect. (3) When focussing has been made using the test specimen specified in JIS B 7140 or revolver has been rotated as it stands, examine whether any clearance exists between the front head of the objective and the upper surface of the cover glass. (4) For the achromat objective of nominal magnification 35 to 45, when focussing has been made using the working distance test specimen or revolver has been rotated as it stands, examine whether any clearance exists between the front end of the objective and the upper surface of the cover glass.