BS ISO 9345-2:2014

BSI Standards Publication

Microscopes — Imaging distances related to mechanical reference planes

Part 2: Infinity-corrected optical systems

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National foreword

This British Standard is the UK implementation of ISO 9345-2:2014. It supersedes BS ISO 9345-2:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/172, Optics and Photonics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Second edition
2014-09-15

Microscopes — Imaging distances related to mechanical reference planes —

Part 2: Infinity-corrected optical systems

Microscopes — Tirages mécaniques en fonction des plans mécaniques de référence —

Partie 2: Systèmes d'optique corrigés à l'infini

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 5, *Microscopes and endoscopes*.

This second edition cancels and replaces the first edition (ISO 9345-2:2003), which has been technically revised.

ISO 9345 consists of the following parts, under the general title *Microscopes — Imaging distances related to mechanical reference planes*:

— *Part 1: Tube length 160 mm*

— *Part 2 Infinity-corrected optical systems*

INTERNATIONAL STANDARD ISO 9345-2:2014(E)

Microscopes — Imaging distances related to mechanical reference planes —

Part 2: Infinity-corrected optical systems

1 Scope

This part of ISO 9345 specifies the imaging distances of objectives, eyepieces and the focal length of "normal" tube lenses of microscopes with infinity-corrected optical systems.

NOTE A specific combination of eyepiece, objective, and tube lens is frequently used to correct aberrations. Therefore the combination of an objective from one manufacturer and the tube lens or eyepiece from another manufacturer, although conforming to this part of ISO 9345, can cause errors in magnification and/or in optical performance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9345-1, *Microscopes — Imaging distances related to mechanical reference planes — Part 1: Tube length 160 mm*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
parfocalizing distance of the objective
l_1
distance in air between the object plane (i.e. the uncovered surface of the object) and the locating flange of the objective, when the microscope is in its working position

Note 1 to entry: The parfocalizing distance of the objective is one of the optical interfacing dimensions.

[SOURCE: ISO 10934-1:2002, 2.80.2.4]

Note 2 to entry: See Figure 1, Figure 2 and footnote b in Table 1.

3.2
image distance of the objective
l_2
distance in air between the objective locating surface and the primary image plane

Note 1 to entry: An infinity-corrected objective alone produces a primary image at infinity. In combination with an infinity-corrected tube lens, the primary image is produced in the back focal plane of this tube lens (see Figure 1).

3.3
parfocalizing distance of the eyepiece
l_3
distance between the locating flange of the eyepiece and the plane upon which the eyepiece is focused

Note 1 to entry: The plane upon which the eyepiece is focused is coincident with the plane of the final real image of the microscope when the eyepiece is mounted in the viewing tube. The parfocalizing distance of the eyepiece is one of the optical interfacing dimensions, and is commonly 10 mm.

[SOURCE: ISO 10934-1:2002, 2.80.2.3]

Note 2 to entry: This plane is coincident with the primary image plane of the microscope when the eyepiece is mounted in the viewing tube (see Figure 1).

3.4
focal length of the "normal" tube lens
f_{NTL}
focal length related to the magnification and the focal length of the objectives which are designed to operate with this tube lens

4 Requirements

4.1 Nominal dimensions and tolerances

The nominal dimensions shall be as given in Table 1 and as illustrated in Figure 1.

Table 1 — Nominal dimensions and tolerances

Feature	Symbol	Nominal values/range mm	Numerical aperture	Tolerance mm
Parfocalizing distance of objective[a,b]	l_1	45 + 15 k (k = −1, 0, 1, 2, 3, 4)	≤ 0,1	± 0,2[c]
			> 0,1 to ≤ 0,25	± 0,06
			> 0,25 to ≤ 0,45	± 0,03
			> 0,45	± 0,01
Image distance of objective[d]	l_2	∞		
Parfocalizing distance of eyepiece	l_3	10		± 0,2
Focal length of "normal" tube lens[e]	f_{NTL}	150 ≤ f_{NTL} ≤ 250		

[a] The choice of a parfocalizing distance for an objective depends on the design concept of the microscope as a whole. The parfocalizing distance, l_1 = 45 mm of objectives, has become the standard value for microscopes with tube length 160 mm (see ISO 9345-1) and has been adopted for various existing infinity-corrected microscope systems. Examples of common values in use are given in Annex A.

[b] The parfocalizing distance, l_1, shown in Figure 1 and Table 1, is intended to apply to objectives when used with uncovered objects (specimens). Objectives for use with objects covered by a cover glass shall have the following parfocalizing distance, to allow for the virtual displacement of the object by the cover glass (see also Figure 2):

$$l_1 + t\,\frac{n-1}{n}\ \text{mm}$$

where:

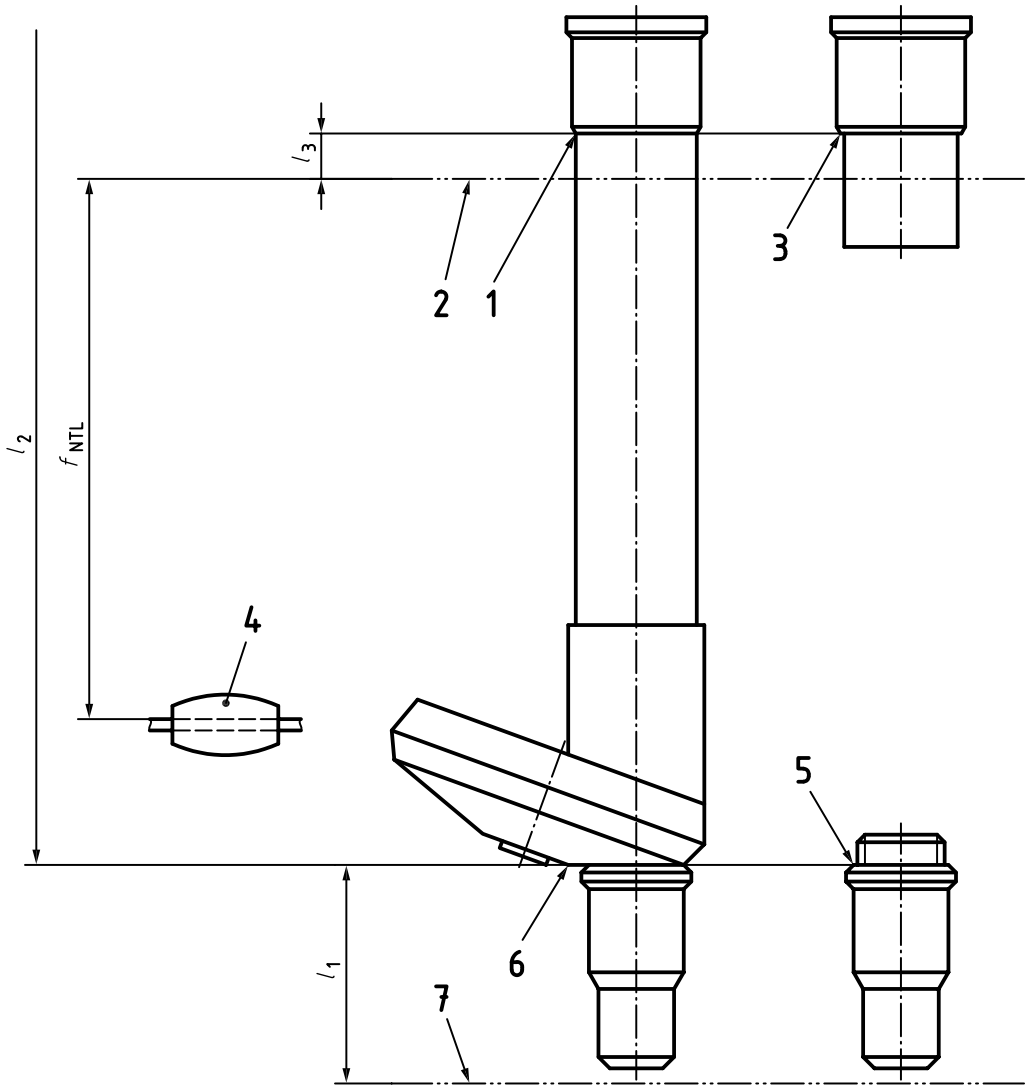
t is the thickness of cover glass;

n is the refractive index of the cover glass.

[c] The tolerance ± 0,2 mm for the parfocalizing distance of objectives with numerical aperture ≤ 0,1 does not necessarily apply to objectives with magnifications lower than 4 ×.

[d] In infinity-corrected optical systems, the primary image is always produced by the objective in combination with a tube lens. The distance between the locating flange of the objective and the tube lens depends on the design of the microscope. The microscope shall have such a design that, in combination with objectives and tube lenses in accordance with this part of ISO 9345, the primary image is produced 10 mm below the eyepiece-locating surface of the viewing tube.

[e] The choice of focal length for a "normal" tube lens depends on the design concept of the microscope system. Its value shall be in the range of 150 mm ≤ f_{NTL} ≤ 250 mm. Examples of common values in use are given in Annex A.



Key

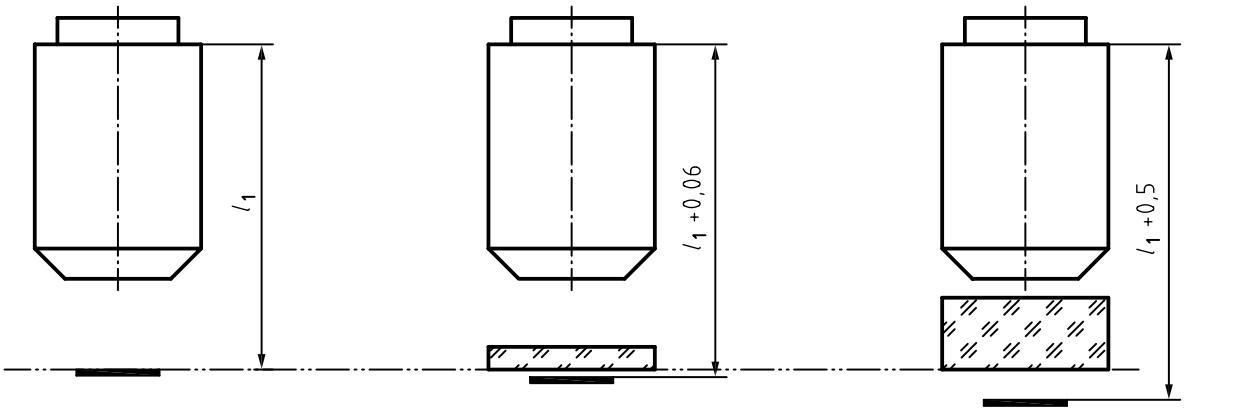
1 eyepiece-locating surface of the viewing tube
2 primary image plane
3 locating flange of the eyepiece
4 tube lens
5 locating flange of the objective
6 objective-locating surface (of the nosepiece)
7 object plane

Figure 1 — Locating surfaces, reference planes, and imaging distances

4.2 Examples

Figure 2 illustrates the influence of different cover glass thicknesses on the parfocalizing distance.

Dimensions in millimetres



Uncovered object t = 0 mm	Object with cover glass t = 0,17 mm thickness n = 1,5	Object with culture chamber t = 1,5 mm bottom thickness n = 1,5
$l_{CG} = l_1$[a]	$l_{CG} = l_1 + 0{,}06$ mm[a]	$l_{CG} = l_1 + 0{,}5$ mm[a]
[a] l_{CG} is the resulting parfocalizing distance due to different cover glass thickness.		

Figure 2 — Examples of parfocalizing distances as function of cover glass thickness

5 Marking

If the magnification of the primary image is changed by built-in optical systems, the tube factor shall be marked on the magnification changing component (stand, tube, etc.); e.g. 1,25 ×.

Annex A
(informative)

Examples of dimensions in use

Table A.1 shows the nominal values l_1, l_2, l_3, and f_{NTL} used by the main microscope manufacturers (in alphabetical order) at the time of publication of this part of ISO 9345.

Table A.1 — Examples of dimensions l_1, l_2, l_3 and f_{NTL} in use

Dimensions in millimetres

Feature	Leica	Nikon	Olympus	Zeiss
Parfocalizing distance of objective, l_1	45	45/60	45	45
Image distance of objective, l_2	∞	∞	∞	∞
Parfocalizing distance of eyepiece, l_3	10	10	10	10
Focal length of "normal" tube lens, f_{NTL}	200	200	180	160

Annex B
(informative)

Requirements and recommendations for OEM-use of objectives and tube lenses

B.1 General

In case of adaptation of infinity-corrected objectives and tube lenses to instruments and equipment other than the microscopes of the manufacturer, the user of these components needs additional dimensional information from the manufacturer for proper assembly.

This annex contains recommendations for the minimum information that should be transferred to the OEM.

NOTE A specific combination of eyepiece, objective, and tube lens is frequently used to correct aberrations. Therefore, the combination of an objective from one manufacturer and the tube lens or eyepiece from another manufacturer, although conforming to this part of ISO 9345, can cause errors in magnification and/or in optical performance.

B.2 Terms and definitions

B.2.1
image distance of the tube lens
l_{NTL}

distance between the primary image plane and the locating flange of the tube lens

Note 1 to entry: It depends on the optical and mechanical design concept and is an important dimension for OEM use.

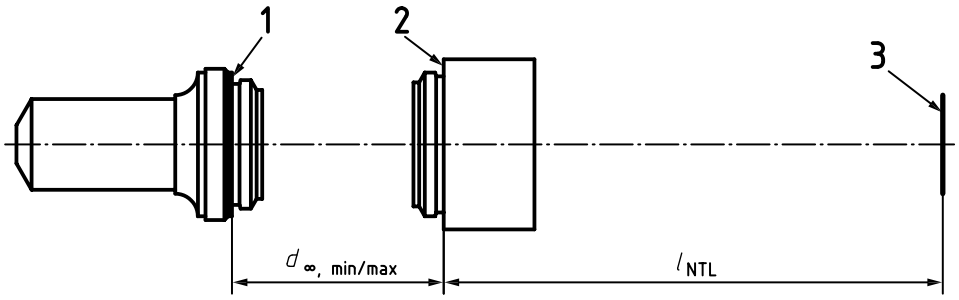
B.2.2
distance between objective and tube lens
d_{∞}

distance between the locating flange of the objective and the locating flange of the tube lens

Note 1 to entry: It depends on the optical and mechanical design concept. To ensure correct optical performance for OEM the indication of the minimum and maximum value is recommended.

B.3 Recommended information for the user

See Figure B.1.



Key

1 locating flange of the objective

2 locating flange of the tube lens

3 primary image

NOTE The external dimensions of the tube lens mount, the method of fixing (screw thread etc.) and the screw thread of the objectives (see ISO 8038) for which it is designed and the position of the locating flange should be indicated by the manufacturer.

Figure B.1 — Assembling dimensions for objectives and tube lenses

Bibliography

[1] ISO 8038, *Microscopes — Screw threads for objectives and related nosepieces*

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

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