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Microscopes — Interfacing dimensions for imaging components

Microscopes — Dimensions d'interfaçage pour composants d'imagerie

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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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This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 5, *Microscopes and endoscopes*.

This first edition of ISO 9345 cancels and replaces ISO 8038:2013, ISO 9345-1:2012, ISO 9345-2:2014, and ISO 10937:2000.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Microscopes — Interfacing dimensions for imaging components

1 Scope

This document specifies optically and mechanically related dimensions for imaging components of a microscope such as

a) the dimensions related to objective, eyepiece and tube lens,

b) the dimensions of screw thread types for connecting a microscope objective to the nosepiece, and

c) the diameters of interchangeable eyepieces and corresponding viewing tubes of microscopes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 10934-1, *Optics and optical instruments — Vocabulary for microscopy — Part 1: Light microscopy*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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: See Figure 1, Figure 2 and Footnote b in Table 1.

[SOURCE: ISO 10934-1:2002, 2.80.2.4; modified — the symbol l_1 added in the definition; Note from ISO 10934-1:2002 omitted, and Note 1 to entry added.]

3.2
objective to primary image distance
l_2
distance in air between the objective locating surface (of the nosepiece) and the primary image plane

Note 1 to entry: It commonly has a value either 150 mm or infinity. It is a hypothetical value applied to microscopes designed for infinity-corrected objectives.

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

[SOURCE: ISO 10934-1:2002, 2.80.2.1, modified — the symbol l_2 added, Note 1 to entry modified, and Note 2 to entry added.]

3.3
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

Note 1 to entry: See Figure 2.

3.4
mechanical tube length
l_4
distance in air between the objective-locating surface of the nosepiece and the eyepiece-locating surface of the viewing tube

Note 1 to entry: It is the length of the tube in its simplest form without any intermediate lenses for objectives corrected for a finite primary image distance.

Note 2 to entry: It commonly has a value of 160 mm. See Figure 1.

Note 3 to entry: For infinity-corrected objectives, the mechanical tube length is hypothetically considered to be infinite.

3.5
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.

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 and Figure 2.

[SOURCE: ISO 10934-1:2002, 2.80.2.3, modified — the symbol l_3 added, and Note 2 to entry added.]

3.6
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.

3.7
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.

4 Requirements

4.1 Nominal dimensions and tolerances of main imaging components

The nominal dimensions and tolerances of imaging components shall be as given in Table 1 and as illustrated in Figure 1 and Figure 2.

A specific combination of eyepiece, objective, and tube lens is frequently used to correct aberrations. Therefore, there is a possibility that the combination of an objective from one manufacturer and the

tube lens or eyepiece from another manufacturer, although conforming to this document, causes errors in magnification and/or in optical performance.

Table 1 — Nominal dimensions and tolerances of imaging components

Feature	Used for imaging system	Symbol	Nominal value/ range mm	Numerical aperture	Tolerance mm
parfocalizing distance of the objective[a] [b]	both with 160 mm mechanical tube length and infinity-corrected	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
objective to primary image distance	with 160 mm mechanical tube length	l_2	150		±0,5
	with infinity-corrected optical systems (in combination with a tube lens to produce an image)[d]	l_2	∞		
focal length of the normal tube lens[e]	with infinity-corrected	f_{NTL}	150 ≤ f_{NTL} ≤ 250		
parfocalizing distance of the eyepiece	both with 160 mm mechanical tube length and infinity-corrected	l_3	10		±0,2
mechanical tube length	with 160 mm mechanical tube length	l_4	160		±0,5

NOTE 1 Examples of values with infinity-corrected imaging components in use by the several microscope manufacturers are given in the informative Annex A.

NOTE 2 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, which are described in the informative Annex C.

[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 and has been adopted for various existing infinity-corrected microscope systems.

[b] The parfocalizing distance, l_1, shown in Figure 1, Figure 2 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 informative Annex B and Figure B.1):

$$l_1 + t(n - 1)/n \text{ mm}$$

where

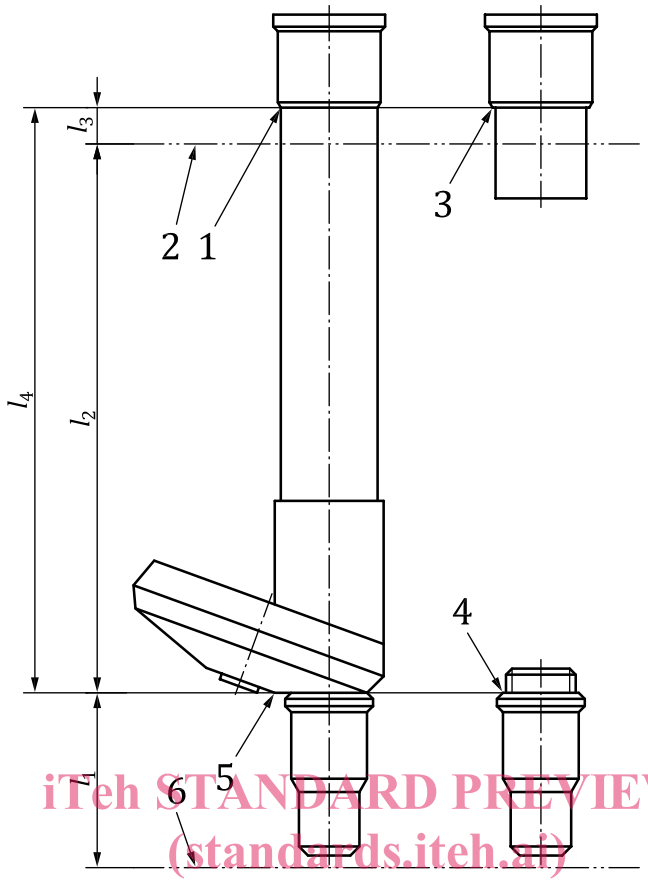
t is the thickness of cover glass;

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 document, the primary image is produced 10 mm below the eyepiece-locating surface of the viewing tube.

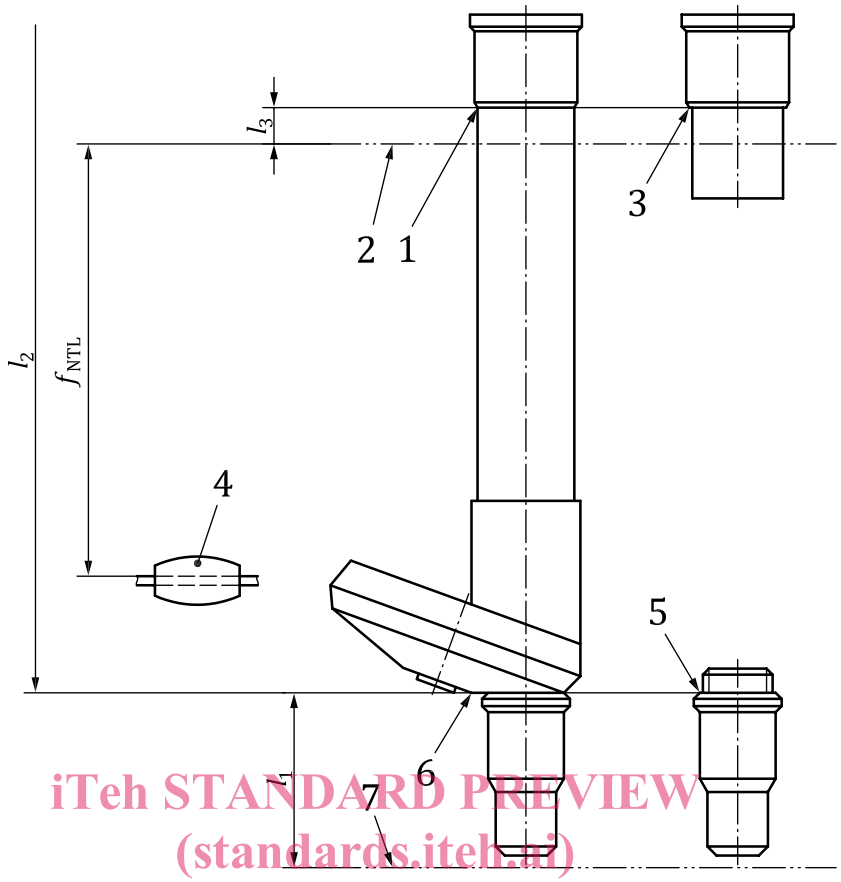
[e] The choice of focal length for a "normal" tube lens depends on the design concept of the microscope system. Its value shall be in the range of 150 mm ≤ f_{NTL} ≤ 250 mm.



Key

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

Figure 1 — Locating surfaces, reference planes and imaging distances with 160 mm mechanical tube length



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 2 — Locating surfaces, reference planes, and imaging distances with infinity-corrected imaging components

Many microscopes have built-in prisms and lenses to change the position and/or the magnification of the image. In this case, the microscope shall have a construction such that, in combination with objectives conforming to this document, the primary image is produced 10 mm below the eyepiece-locating surface of the viewing tube.

4.2 Nominal dimensions and tolerances of connecting screw threads of objective and nosepiece

Recommended nominal dimensions and tolerances of connecting screw threads of objective and nosepiece are given in Table 2 to Table 7 and illustrated in Figure 3 and Figure 4.

Table 2 — Basic dimensions of the screw thread

Dimensions	Symbol	Value				
		Whitworth screw		Metric screw		
		RMS[a]	W26	M25	M27	M32
angle of thread	α	55°	55°	60°	60°	60°
pitch	*P*	0,706 mm	0,706 mm	0,75 mm	0,75 mm	0,75 mm
height of fundamental triangle	*H*	0,678 mm	0,678 mm	0,65 mm	0,65 mm	0,65 mm
nominal diameter	*D*	20,320 mm	26 mm	25 mm	27 mm	32 mm

[a] With the exception of the length of the thread lug (see Figure 3), the values of the RMS thread conform to the internationally used screw thread defined by Reference [2].

Table 3 — Limit of size and tolerances of RMS

Dimensions in millimetres

Dimensions for		Major diameter		Pitch diameter		Minor diameter		Calculated play between internal and external threads		Allowances	Tolerance	Thread lug
internal thread	max.	*D*	20,396	D_2	19,944	D_1	19,492	minimum play	maximum play	+0,076	0,076	—
	min.		20,320		19,868		19,416			0,000		—
external thread	max.	*d*	20,274	d_2	19,822	d_1	19,370	0,046	0,198	−0,046	0,076	5,000
	min.		20,198		19,746		19,294			−0,122		—

Table 4 — Limit of size and tolerances of W26

Dimensions in millimeters

Dimensions for		Major diameter		Pitch diameter		Minor diameter		Calculated play between internal and external threads		Allowances	Tolerance	Thread lug
internal thread	max.	*D*	—	D_2	25,660	D_1	25,300	minimum play	maximum play	+0,204	0,100	—
	min.		26,000		25,580		25,200			+0,104		—
external thread	max.	*d*	25,930	d_2	25,520	d_1	25,070	0,060	0,220	−0,070	0,100	5,000
	min.		25,830		25,440		24,940			−0,170		—

Table 5 — Limit of size and tolerances of M25

Dimensions in millimeters

Dimensions for		Major diameter		Pitch diameter		Minor diameter		Calculated play between internal and external threads		Allowances	Tolerance	Thread lug
internal thread	max.	*D*	—	D_2	24,659	D_1	24,378	minimum play	maximum play	+0,190	0,190	—
	min.		—		24,513		24,188			0,000		—
external thread	max.	*d*	24,978	d_2	24,491	d_1	—	0,022	0,279	−0,022	0,140	5,000
	min.		24,838		24,380		—			−0,162		—

Table 6 — Limit of size and tolerances of M27

Dimensions in millimeters

Dimensions for		Major diameter		Pitch diameter		Minor diameter		Calculated play between internal and external threads		Allowances	Tolerance	Thread lug
internal thread	max.	D	—	D_2	26,660	D_1	26,378	minimum play	maximum play	+0,190	0,190	—
	min.		—		26,513		26,188			0,000		—
external thread	max.	d	26,978	d_2	26,491	d_1	—	0,022	0,281	−0,022	0,140	4,500
	min.		26,838		26,379		—			−0,162		—

Table 7 — Limit of size and tolerances of M32

Dimensions in millimeters

Dimensions for		Major diameter		Pitch diameter		Minor diameter		Calculated play between internal and external threads		Allowances	Tolerance	Thread lug
internal thread	max.	D	—	D_2	31,663	D_1	31,378	minimum play	maximum play	+0,190	0,190	—
	min.		—		31,513		31,188			0,000		—
external thread	max.	d	31,978	d_2	31,491	d_1	—	0,022	0,286	−0,022	0,140	5,000
	min.		31,838		31,377		—			−0,162		—