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Optics and photonics — Test methods for telescopic systems —

Part 7: Test methods for limit of resolution

Optique et photonique — Méthodes d'essai pour systèmes télescopiques —
Partie 7: Méthodes d'essai pour limite de résolution

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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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 4, *Telescopic systems.*

This second edition cancels and replaces the first edition (ISO 14490-7:2005), which has been technically revised with the following changes:

— addition of a new sentence in A.4 “Alternatively, a test pattern down to $2^{-1/3} = 0{,}79$ is acceptable.”;

— corrected Table A.2, last row: 302 replaced by 320.

A list of parts in the ISO 14490 series can be found on the ISO website.

Introduction

There are various characteristics which are relevant for overall image quality of telescopic systems and observational telescopic instruments. Two important characteristics are the limit of resolution and the optical transfer function.

This document specifies the test method for the determination of the limit of resolution of telescopic systems and observational telescopic instruments. Optical transfer function measurement as applied to telescopic systems is specified in ISO 9336-3.

Besides the limit of resolution and the optical transfer function, further characteristics are relevant for an assessment of the image quality; the most important of them are the following:

— secondary spectrum (dispersive aberrations);

— distortion;

— vignetting;

— colour matching.

The secondary spectrum of the test specimen can produce colour fringes surrounding observed objects (especially at high contrast edges) which can look like coloured neon tube light.

The perceived image might have barrel or pincushion distortion. Pincushion distortion is considered to give a more natural impression of the observed object when swivelling the test specimen.

Vignetting can lead to a perceivable intensity degradation from the centre to the edge of the field of view.

Colour matching is the accuracy of the colour rendition of an object observed with the test specimen. Any colour deviation might be due to the lens material or to coatings.

Optics and photonics — Test methods for telescopic systems —

Part 7: Test methods for limit of resolution

1 Scope

This document specifies the test methods for the determination of the limit of resolution of telescopic systems and observational telescopic instruments.

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 14490-1:2005, *Optics and optical instruments — Test methods for telescopic systems — Part 1: Test methods for basic characteristics*

3 Terms and definitions

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

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

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

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

4 Method of determination of the limit of resolution

4.1 General

The limit of resolution of a telescopic system is the minimum angular distance between centrelines of two adjacent bright (or dark) bars of the bar-type resolution test target whose direction can be detected when viewing through the test specimen.

4.2 Test equipment

The limit of resolution of telescopic systems shall be determined with the test arrangement shown in Figure 1.

The bar-type resolution test target has contrast, as given by Formula (1):

$$K = \frac{\tau_{tr} - \tau_{op}}{\tau_{tr} + \tau_{op}} \geq 0,9 \quad (1)$$

where

τ_{tr} is the transmittance of a translucent part of the resolution test target;

τ_{op} is the transmittance of an opaque part of the resolution test target.

The resolution test target shall be placed at the focal plane of the collimator lens.

For systems that require the limit of resolution to be measured with a focus setting other than infinity, the position of the resolution test target with respect to the collimator lens shall be adjusted in order to obtain its image at the specified distance from the test specimen.

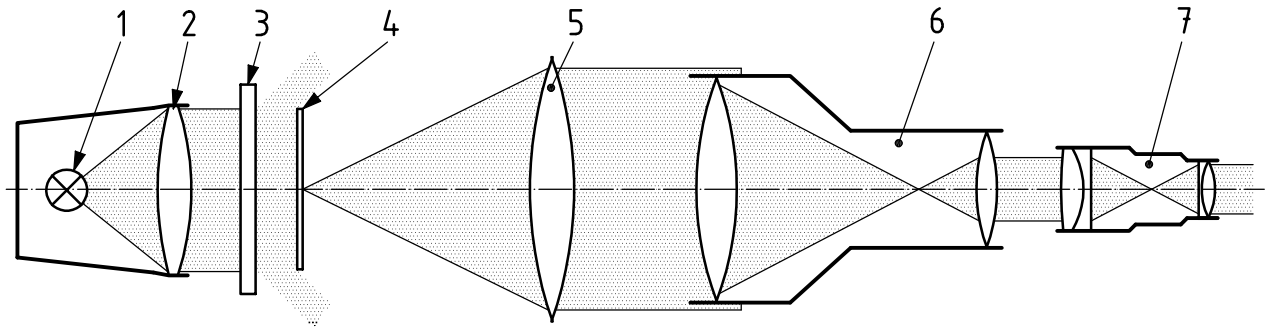
The bar-type resolution test target is a glass plate bearing a picture that consists of bright bars having different widths on a dark background, the directions of which are vertical, horizontal and diagonal in ± 45 angular degrees.

The dimensions of one acceptable design of bar-type resolution test target are given in Annex A.

The resolution test target shall be illuminated uniformly (mean illuminance ±5 % Peak to Valley) by means of a light source with a correlated colour temperature of 5 000 K to 6 000 K, condenser and diffuser for non-dazzling observation conditions. The luminance of the resolution test target shall be optimum for observation of its image.

The diameter of the collimator lens shall at least exceed 1,2 times the diameter of the entrance pupil of the test specimen. The focal length of the collimator lens shall be at least five times that of the objective of the test specimen.

The magnification of the auxiliary telescope shall not reduce the diameter of the exit pupil of the whole system below 0,8 mm.



Key

1 light source
2 condenser
3 diffuser
4 bar-type resolution test target
5 collimator lens
6 test specimen
7 auxiliary telescope

The auxiliary telescope should not be used if the angular limit of resolution behind the eyepiece of the test specimen is worse than 2' to 3' and the diameter of the exit pupil is below 1 mm.

Figure 1 — Test arrangement for measurement of the limit of resolution (schematic)

4.3 Preparation and carrying out of measurements

Stray light and vibration shall be minimized (and if possible eliminated) from the test set up.

Check the cleanliness of the optical surfaces of the lenses of the test specimen, the collimator lens, the condenser, and the auxiliary telescope. No traces of lubricants, fingerprints, moisture, or dust are allowed.

Select the size number of the resolution test target according to the focal length of the collimator lens and the limit of resolution of the test specimen (for instance, see Table A.2 or use the formula given for the angular resolution defined in ISO 14132).

If an auxiliary telescope is used, adjust its eyepiece according to the observer's eye to allow sharp viewing of the telescope reticle. The auxiliary telescope and the eye of the observer shall not limit the assessment of the resolution. After that, focus the auxiliary telescope on the image of the resolution test target which is located in the focal plane of the collimator lens.

Focus the test specimen on the image of the resolution test target; then position the test specimen and the auxiliary telescope coaxially with the collimator lens.

Set the eyepiece of the test specimen in a position which enables sharp viewing of the reticle of the test specimen through the auxiliary telescope. If no reticle is provided, adjust the eyepiece to zero dioptres.

Determine the limit of resolution of the test specimen in the centre of the field of view.

During observation through the eyepiece of the auxiliary telescope, the maximum sharpness of bars of a pattern at lowest sharpness in one group of the resolution test target shall be obtained by means of refocusing the test specimen. If no focusing is available in the test specimen, the maximum sharpness of bars of a pattern at lowest sharpness in one group of the resolution test target shall be obtained by refocusing the auxiliary telescope.

During successive viewing of images of certain groups of the resolution test target having different spatial frequencies, a group of the resolution test target shall be found which enables easy detection of all four bar directions. This shall be achieved without refocusing for the different bar directions. This group shall be located in the centre of the field of view of the test specimen.

4.4 Determination of results

From the size number of the resolution test target group that enables the detection of all four pattern directions, determine the bar width, *b*.

Calculate the angular distance, φ, in seconds of angle, between the centrelines of adjacent bright (or dark) bars of each resolution test target group according to Formula (2):

$$\varphi = \frac{2b}{f_k'} \times 206\,265 \qquad (2)$$

where

b	is the bar width, in mm;
f_k'	is the focal length of the collimator lens, in mm;
206 265	is the number of arc seconds/radian.