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Optics and optical instruments — Test methods for telescopic systems —

Part 8: Test methods for night-vision devices

Optique et instruments d'optique — Méthodes d'essai pour systèmes téléscopiques —

Partie 8: Méthodes d'essai pour dispositifs de vision de nuit

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14490-8 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 4, *Telescopic systems*.

ISO 14490 consists of the following parts, under the general title *Optics and optical instruments — Test methods for telescopic systems*:

— *Part 1: Test methods for basic characteristics*

— *Part 2: Test methods for binocular systems*

— *Part 3: Test methods for telescopic sights*

— *Part 4: Test methods for astronomical telescopes*

— *Part 5: Test methods for transmittance*

— *Part 6: Test methods for veiling glare index*

— *Part 7: Test methods for limit of resolution*

— *Part 8: Test methods for night-vision devices*

Optics and optical instruments — Test methods for telescopic systems —

Part 8:
Test methods for night-vision devices

1 Scope

This International Standard describes the test methods for determining the performance of night-vision devices as specified in ISO 21094.

2 Normative references

The following referenced documents are indispensable for the application 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 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

ISO 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

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

ISO 14490-7, *Optics and optical instruments — Test methods for telescopic systems — Part 7: Test methods for limit of resolution*

ISO 21094, *Optics and photonics — Telescopic systems — Specifications for night vision devices*

3 General requirements for the test conditions and preparation of tests

Measurements shall be carried out under the normal conditions of the work area, namely:

— air temperature: (20,0 ± 5,0) °C;

— relative humidity of the air: 40 % to 60 %.

During measurements, the temperature shall not vary by more than ± 2 °C and the relative humidity shall not vary by more than 4 %.

The measurements should be carried out in conditions in which the test specimen is protected from stray light and electrical and strong magnetic fields.

The recommended illuminance in the test room is 0,01 lx to 0,04 lx.

Measurements of the basic characteristics of night-vision devices shall be carried out with the aid of a dedicated power supply.

The use of an external power supply is acceptable subject to its voltage not departing from the nominal voltage of the dedicated power supply by more than ± 0,1 V.

The testing of instruments equipped with a source of radiation shall be carried out while the source is switched off.

The source of radiation used in collimators and other instruments for measuring the characteristics of production prototypes of night-vision devices shall be incandescent lamps which have a filament colour temperature, T_c, of (2 856 ± 50) K, unless otherwise stated. The instability of the voltage on incandescent lamps, at the time of measurement, shall not exceed 0,3 %.

It is important that the spectral characteristics of the source of radiation cover the full range of spectral sensitivity of the image intensifier. The transmission spectrum of filters placed in collimators or in front of a night-vision device shall correspond to the sensitivity spectral region of the test specimen.

When measuring the characteristics of production samples, the use of incandescent lamps, where the filament colour temperature, T_c, is different from the one specified above, is acceptable.

The objectives of collimators used in test arrangements may be lens, mirror or catadioptric systems.

Integrating spheres may be used for uniform illumination of scales and reticles in collimators.

During all measurements of the characteristics of night-vision devices, the luminance of the image intensifier screen shall be the optimum for the observer.

In the assessment of results (see 4.4, 5.4, 6.4, 7.4, 8.4, 9.4, 10.4, 11.4, 13.4 and 14.4), repeatability shall be stated in accordance with ISO 5725-1. The assessment of the correctness of the average value obtained, i.e. the assessment of the systematic error, shall be carried out either analytically or by comparison of the measurement results obtained in different test laboratories.

4 Test method for measuring magnification and difference in magnification

4.1 General

The measurement of magnification is based on the measurement of the image size of an object within the field of view of the night-vision device.

The magnification, Γ, is calculated in accordance with the following equation:

$$\Gamma = \frac{\tan w'}{\tan w} \tag{1}$$

where w and w' are the angles between the conjugate rays and the optical axis in object space and in image space respectively.

For night-vision devices with variable magnification, Γ shall be measured for the maximum and minimum magnifications.

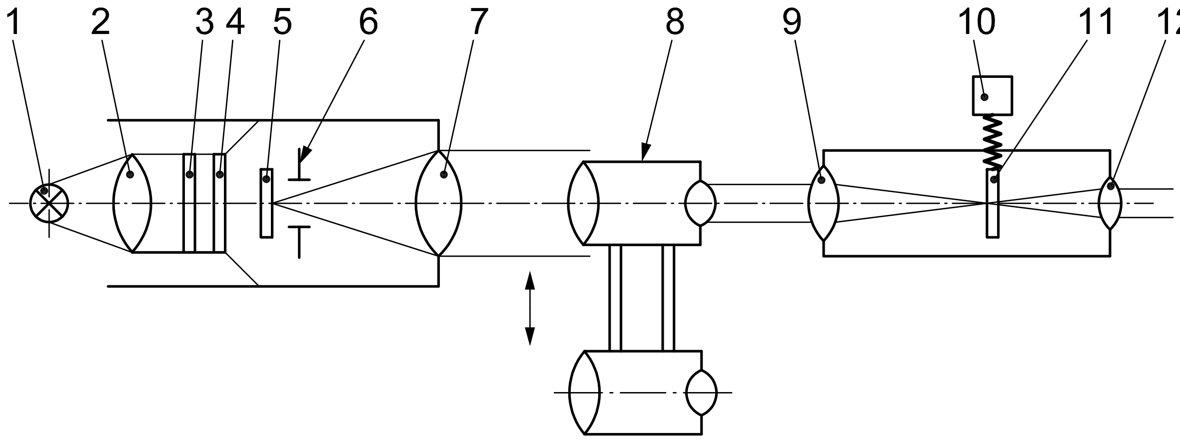
Depending on the value of magnification and the size of the field of view of the night-vision device, the measurements of Γ shall be carried out in accordance with the arrangements shown in Figure 1 or Figure 2.

The diameter of the collimator lens used in these arrangements shall exceed by 15 % to 20 % the lens diameter of the test specimen.

The diameter of the telescope objective lens used shall exceed by 15 % to 20 % the diameter of the pencil of light that emerges from the test specimen.

4.2 Requirements for the test arrangements and their principal parts

4.2.1 Requirements for the test arrangement shown in Figure 1



Key

1 source of radiation
2 condenser
3 filter
4 diffusing plate
5 collimator scale with cross-lines [a]
6 opaque diaphragm with aperture
7 collimator lens
8 test specimen
9 telescope objective lens
10 telescope read-out device
11 reticle
12 telescope eyepiece

[a] For this method, a scale without cross-lines may be used. When testing as specified in other test methods, the use of a cross-line can be indispensable. For the sake of unification, it is recommended that a scale with cross-lines be used in all test arrangements.

Figure 1 — Arrangement for measurement of the magnification and difference in magnification of night-vision devices with fields of view up to 12° and magnifications up to 1,5×

The linear size of the collimator scale shall be such that the size of the image of the scale at the image intensifier screen of the night-vision device would cover 1/5 to 2/5 of the diameter of image intensifier screen.

For the scale (5), the line widths and the spaces between them shall have dimensions that are at least 2½ times greater than the limit of resolution of the test specimen, so that they can be clearly resolved.

The marginal part of the scale (5) shall be opaque; this is achieved by means of a diaphragm (6).

The range of the scale of the telescope read-out device (10) (see Figure 1) shall be at least 25 mm with a read-out error of no more than 0,05 mm.

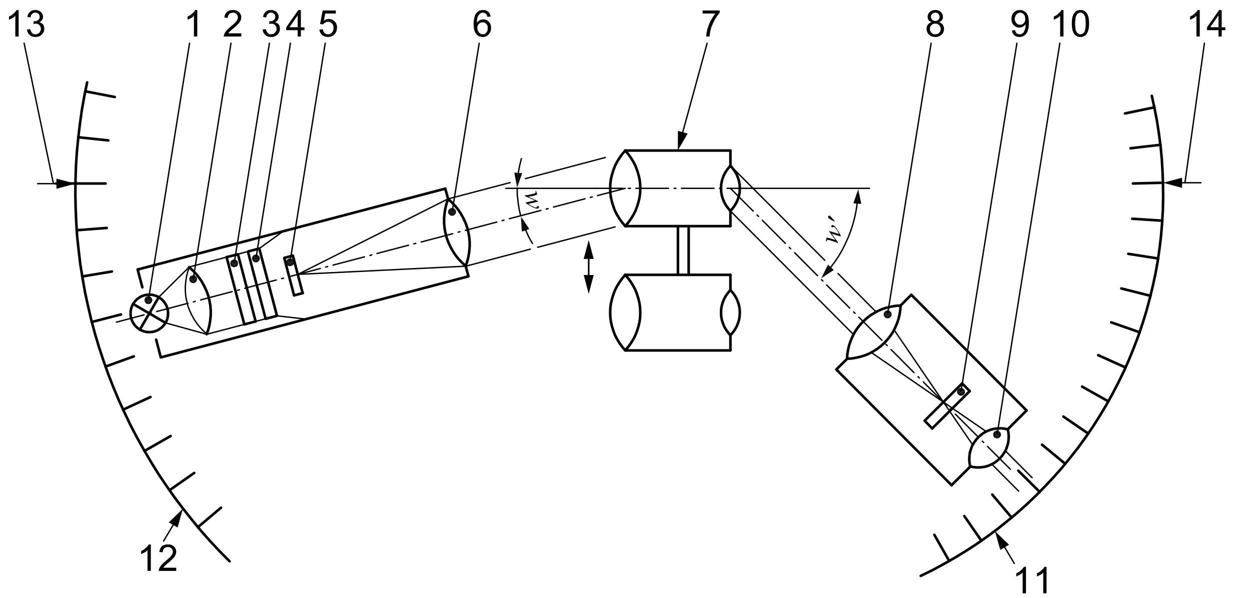
Aberrations of the optical systems of the collimator and telescope shall be within the limits that allow for the specified precision of measurements.

NOTE The requirements for the aberrations of the optical systems might be less severe if corrections for the real angular sizes of the scale divisions and of the telescope scale movement read-out mechanism are applied to the measurement results.

It is important that the spectral characteristics of the source of radiation cover the long-wavelength cut-off of the image intensifier.

It is recommended that the support beneath the test specimen allows for its movement normal to the collimator axis, in order to enable successive measurements to be made of the magnification in each channel of the night-vision device.

4.2.2 Requirements for the test arrangement shown in Figure 2



Key

1 source of radiation
2 condenser
3 filter
4 diffusing plate
5 scale with cross-lines
6 collimator lens
7 test specimen
8 telescope objective lens
9 reticle with cross-line
10 telescope eyepiece
11 angle-measuring device
12 angle-measuring device
13 fixed indexes
14 fixed indexes

Figure 2 — Arrangement for measurement of the magnification and difference in magnification of night-vision devices with any field of view and any magnification

The focal plane of the collimator lens shall bear a scale with cross-lines, where the line width shall exceed the limit of resolution of the night-vision device under test at least by 2½ times.

The field of view of the collimator and that of the telescope may not exceed 1°.

The focal plane of the telescope lens shall have a reticle with cross-lines or a straight line.

The use of a telescope in accordance with the arrangement shown in Figure 1 is acceptable, provided the telescope read-out device and the reticle remain stationary.

The axes of rotation of the angle-measuring devices shall be situated as close as possible to the objective and eyepiece of the night-vision device under test.

In addition to the test arrangement shown in Figure 2, two other versions of this test arrangement are acceptable:

a) the test specimen is mounted on the angle-measuring device while the other angle-measuring device bears the collimator (Figure 2, key items 1 to 6) or the telescope (Figure 2, key items 8 to 10);

b) two independent angle-measuring devices use a common axis of rotation, which shall be situated approximately in the middle of the test specimen.

In any version, the vignetting of bundles of rays that enter or emerge from the night-vision device under test shall be reduced to the minimum.

The angle measurement error of the angle-measuring devices (Figure 2, key items 11 and 12) shall not exceed 6 minutes of arc.

4.3 Sequence of measurements

4.3.1 Sequence of measurements in arrangement of Figure 1

— Adjust the eyepiece of the test specimen to 0 D (0 m^{-1}).

— Mount the test specimen, or one of its channels, so as to obtain an image of the central point of the scale in the centre of the image intensifier screen.

— By adjustment of the objective (provided that the objective of the night-vision device is focusable) and of the eyepiece, obtain a sharp image of the scale.

— Determine the number, n_1, of divisions of the telescope read-out mechanism that conforms to as large a number as possible of collimator scale divisions.

— Remove the test specimen from the support and determine the number, n_2, of divisions of the telescope read-out mechanism that corresponds to the previously selected number of collimator scale divisions.

4.3.2 Sequence of measurements in arrangement of Figure 2

— Mount the test specimen, or one of its channels, in the test position in such a manner that the image of the collimator cross-line would be found in the centre of the image intensifier screen and the collimator scale would be observed sharply through the eyepiece of the telescope.

— Rotate the angle-measuring device and collimator by the angle, w, and take a reading of the angle.

— Rotate the angle-measuring device and telescope by the angle, w', until the previously selected line of the telescope scale coincides with the image of the selected line of the collimator scale, and take a reading of this angle.

4.4 Assessment of results

The angular magnification measured in the test arrangement shown in Figure 1 shall be calculated in accordance with the following equation:

$$\Gamma = \frac{n_1}{n_2} \tag{2}$$

where

n_1 is the number of divisions of the telescope read-out mechanism;

n_2 is the number of the collimator scale divisions.

Calculations in accordance with Equation (2) shall be carried out for each channel of the night-vision device.

The difference in magnification, $\Delta\Gamma$, expressed as a percentage (%), shall be calculated in accordance with Equation (3):

$$\Delta\Gamma = \frac{\Gamma_{\text{max}} - \Gamma_{\text{min}}}{\Gamma_{\text{min}}} \times 100\ \% \tag{3}$$

where

Γ_{max} is the maximum angular magnification;

Γ_{min} is the minimum angular magnification.

The angular magnification measured in the test arrangement shown in Figure 2, shall be calculated in accordance with the Equation (1).

The repeatability of the measured value of angular magnification of the night-vision device shall not exceed 1 % of the average value. The repeatability of the measured value of the difference in channel magnification shall not exceed 2 %.

5 Test method for measuring night-vision device gain

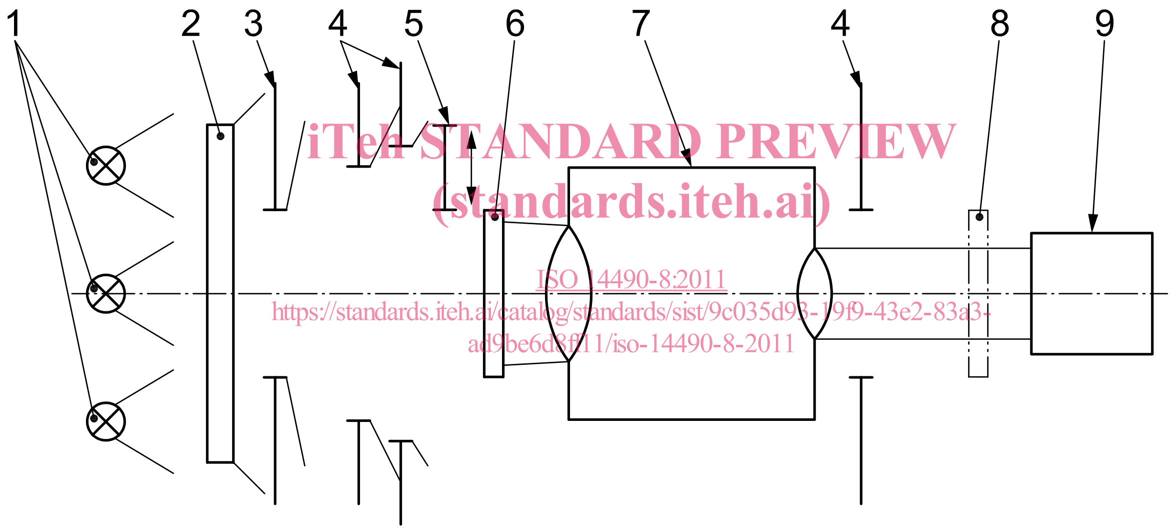
5.1 General

The test method for measuring night-vision device gain consists of measuring the ratio of the luminance of the output screen, measured in the plane of the exit pupil, to the luminance of the object of observation. This test method is based on the assumption that both the radiation from the diffuse translucent screen (Figure 3, key item 2) and that emerging from the eyepiece of the test specimen obey the Lambert law within ±20° from the screen normal and from the optical axis of the eyepiece, accordingly.

NOTE See 7.1 for an explanation of the concept of exit pupil as applied to night vision devices.

5.2 Requirements for the test arrangement and principal parts

Measurement of night-vision device gain shall be carried out using the test arrangement shown in Figure 3.



Key

1 incandescent lamps
2 diffuse translucent screen
3 field diaphragm
4 glare baffles
5 shutter
6 filter
7 test specimen
8 neutral filter
9 luminance meter

Figure 3 — Arrangement for measuring night-vision device gain

The colour temperature of lamp filaments shall comply with CIE standard illuminant A, in accordance with ISO 11664-2.

The luminance of the diffuse translucent screen shall be within the limits of $1 \cdot 10^{-3}$ to $3 \cdot 10^{-3}$ cd/m^2 across the area limited by the opening in the diaphragm. The size of this opening shall allow for the illumination of an area of 1/5 to 2/5 of the diameter of the image intensifier screen but it shall not be less than 7 mm. The number and position of incandescent lamps shall be such as to ensure that these requirements are met.

The spectral transmittance of the filter is to be specified by the manufacturer and shall comply with the radiation spectrum of the image intensifier screen.