INTERNATIONAL STANDARD

**ISO 6328**

Second edition
2000-05-01

Corrected and reprinted
2000-09-01

# Photography — Photographic materials — Determination of ISO resolving power

*Photographie — Surfaces sensibles — Détermination du pouvoir résolvant ISO*



Reference number
ISO 6328:2000(E)

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6328 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 6328:1982), which has been technically revised.



In this revision, the description of the process of evaluating images has been expanded. The specifications of the resolving power camera's objectives have been altered slightly, and the illustration of a resolving-power camera has been moved to informative annex A. The text describing qualification of the camera has been expanded to include the target.



This second edition also contains many other changes, most of which were made for the sake of clarity of understanding. Among these changes is a clarification of part of the scope. The definitions have also been expanded; some terms have been substituted for others in order for their usage to be more consistent and their meaning to be clearer. The term “element” has been introduced in place of “test pattern” and “tribar resolving-power target” replaces “test chart”. Other terms introduced or clearly defined include “target polarity”, “limiting element” and “ISO resolving power”.

Annex A of this International Standard is for information only.

## Introduction

The resolving power of a photographic material is used to estimate the smallest detail that may be visually observable when recorded on the material. It combines the effects of modulation transfer function, graininess and contrast, all of which contribute to overall image quality, and human observers, each of whom may differ in their assessment of quality. The method is particularly useful for appraising materials that will be viewed at high magnification such as microfilm, 8 mm and 16 mm motion picture film, etc. However, resolving power should not be expected to predict overall image quality in every situation, because image quality is too complex to be described by a single factor. This is particularly the case for low-contrast continuous-tone products.

Resolving power as measured by photographing suitable tribar resolving-power targets is very dependent on conditions of measurement, and the structure of the target element. It depends markedly on the photographic conditions employed and on the presence of background glare from the illuminated target. It is affected by such factors as the spectral content of the light used, the exposure level, the focus, processing procedures, the lens aperture at which the test is made, the contrast of the target and the magnification of the camera lens and the microscope through which the images are observed, etc.

The judgment exercised by the human observer in determining resolving power can be a source of significant experimental error. The criterion of resolution given in this International Standard was selected because it appeared to admit less latitude in interpretation than others. The description of the process of evaluating images has been expanded in this revision.

# Photography — Photographic materials — Determination of ISO resolving power

## 1 Scope

This International Standard specifies a method for determining the resolving power of photographic films, plates and papers, including black-and-white films, black-and-white printing papers, colour-reversal films, colour-negative films, and colour-printing papers.

Materials designed for X-ray and other high-energy radiation are excluded, as are photographic materials used in medical radiography where the exposure source is an intensifying screen in contact with the film (sensitized on one or two sides). Also excluded are materials having photo-polymer, diazo, etc. light-sensitive layers.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.



ISO 497:1973, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*.

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*.

## 3 Terms and definitions

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

**3.1**
**element**
three parallel bars and two spaces of equal width and separation

**3.2**
**group number**
number of square dots preceding the array of elements which is used to locate a position on the tribar resolving-power target

**3.3**
**tribar resolving-power target**
array of identical elements that decrease in size (geometrically), and typically spirals towards the centre of the target format

**3.4**
**spatial period**
within an element of a tribar target, the distance between the leading edges of two consecutive bars

NOTE The spatial period is usually expressed in millimetres (mm).

**3.5**
**spatial frequency**
reciprocal of the spatial period denoting the number of identical bar and space pairs that can be contained within an overall width of 1 mm

NOTE The spatial frequency is expressed as reciprocal millimetres (cycles per millimetre).

**3.6**
**contrast ratio**
ratio of the luminances of the bars of the element to the luminance of the surround or the antilog of the density difference between the bar and its surround

**3.7**
**target polarity**
transmission relationship of the parallel bars and their surround

**3.7.1**
**negative polarity**
light bars against a dark surround

**3.7.2**
**positive polarity**
dark bars against a light surround

**3.8**
**camera**
optical system by which the tribar resolving-power target is imaged and recorded, with suitable reduction in size, on the photographic material being tested



**3.9**
**reference surface**
flat surface against which the emulsion side of the photographic material is pressed during exposure

**3.10**
**qualification**
⟨camera⟩
attainment of the necessary high optical performance of a camera, essential for its use in determining resolving power

**3.11**
**replicate set**
series of images of the tribar resolving-power target made at the same focus and exposure settings

**3.12**
**exposure series**
series of images made at different exposure settings

**3.13**
**focus series**
series of images made at different focus settings

**3.14**
**resolving power**
ability of a photographic material to maintain, in the developed image, the separate identity of parallel bars when their separation is small

NOTE The resolving power is numerically equal to the spatial frequency of the smallest element that can be resolved.

**3.15**
**limiting element**
that element in the image of the tribar resolving-power target selected by the observer, with reasonable confidence, to be at the threshold of no longer being able to distinguish three bars and two spaces, even if the number were not known to be three

**3.16**
**resolving power of a replicate set**
median of the resolving powers of the test material in images of the replicate set

**3.17**
**maximum resolving power**
resolving power of the test material under conditions of optimum focus and exposure and the test conditions defined in this International Standard

**3.18**
**ISO resolving power**
averaged maximum resolving power, rounded according to Table 5 and ISO 497

NOTE There is an ISO high-contrast and an ISO low-contrast resolving power.

## 4 Sampling and storage

In determining the resolving power of a product, it is important that the samples evaluated yield the average results obtained by users. This will require evaluating several different batches periodically under the conditions specified in this International Standard.



Prior to evaluation, the samples shall be stored according to the manufacturer's recommendations for a length of time that simulates the average age at which the product is normally used. When no specific recommendation is made, storage shall comply with the specifications of ISO 554, 23 °C ± 2 °C and a relative humidity of (50 ± 5) %. Several independent evaluations shall be made to ensure the proper calibration of equipment and processes. The basic objective in selecting and storing samples as described above is to ensure that the material characteristics are representative of those obtained by a consumer at the time of use.

## 5 Test method

### 5.1 Principle

The resolving power of a material is determined by visual inspection of the image of the tribar resolving-power target recorded on the test material by means of a suitable camera system. It depends on the contrast ratio, polarity and exposure. The resolving power passes through a maximum as the exposure is changed from a value at the toe of the characteristic curve to a value toward the shoulder. Furthermore, the resolving power passes through a maximum as the focus setting is given successive values that vary from one side of the correct focus to the other.

In brief, the procedure is to first determine the exposure that gives the best-resolved image of the tribar resolving-power target, using the focus setting determined during the camera qualification test. A through focus series is then run at this exposure level to optimize focus. The maximum resolving power obtained from this series is used to determine the ISO resolving power of a sample using the scale defined in Table 5.

Because of the granular structure of the image when viewed under magnification, a replicate set often yields a range of resolving power values. To mitigate the effect of this variable, ISO resolving power is defined below in terms of the median value of a set of not less than nine replicate images made at the same focus and exposure setting.

Microscopic examination and readout of the tribar target's image is required to determine resolving power. Since the technique involves observer judgment in determining the finest element resolved, experience has shown that, without application of the procedures of this International Standard, observers may differ by more than a factor of two in the resolving power value they assign to the same image.

NOTE No known set of calibrated images exists for training and definition purposes.

Accordingly, this International Standard provides a set of guidelines that, when applied, has been shown to produce consistent results within and between observers. With training and use of these guidelines, experienced observers should agree to within ± 1 element or about ± 12 % (in terms of cycles per millimetre) for single-point estimates, and ± 6 % for mean estimates with a standard deviation of ± 6 %.

## 5.2 Apparatus

### 5.2.1 Element

The element shall be three parallel bars and two spaces of equal width and separation, inscribed in a square as shown in Figure 1. For a negative-polarity target, the shaded part of Figure 1 represents the darker portion, and the unshaded part the lighter portion, of the field of view. The bar length to width aspect ratio shall be 5:1. In terms of displacement $L$ (period distance in millimetres) of the bars and interspaces, the dimensions of the square are 2,5 $L$ x 2,5 $L$. The shaded part of Figure 1 is termed the "surround".

The width of the bars and the width of the interspaces shown in Figure 1 shall be within ± 2,5 % of the aim value. The overall width and length of the element (2,5 $L$) shall also be within ± 2,5 % of the aim value.



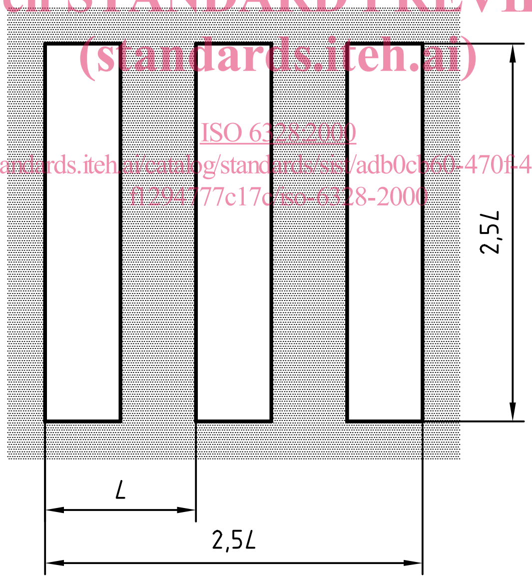



**Figure 1 — Element test pattern**

The spatial frequency, expressed as reciprocal millimetres, of the element may be calculated by one of the methods described in a) or b) below. Selection is based upon the measurement instrumentation that provides the highest dimensional accuracy within the distances being measured.

a) By measuring the bar interspace distance, or period $L$, in millimetres, and applying the formula:

$$\text{Spatial frequency} = \frac{1}{L}$$

b) By measuring the overall element width (2,5 $L$), in millimetres, and applying the formula:

$$\text{Spatial frequency} = \frac{2{,}5}{\text{Overall element width}}$$

### 5.2.2 Tribar resolving-power target

The tribar resolving-power target shall be an array of elements as illustrated in Figure 2.

The spatial frequencies of the elements in the array shall be as shown in Table 1. The change in spatial frequency between successive elements shall be equal to $10^{0,05}$. This corresponds to increments of about 12 %.

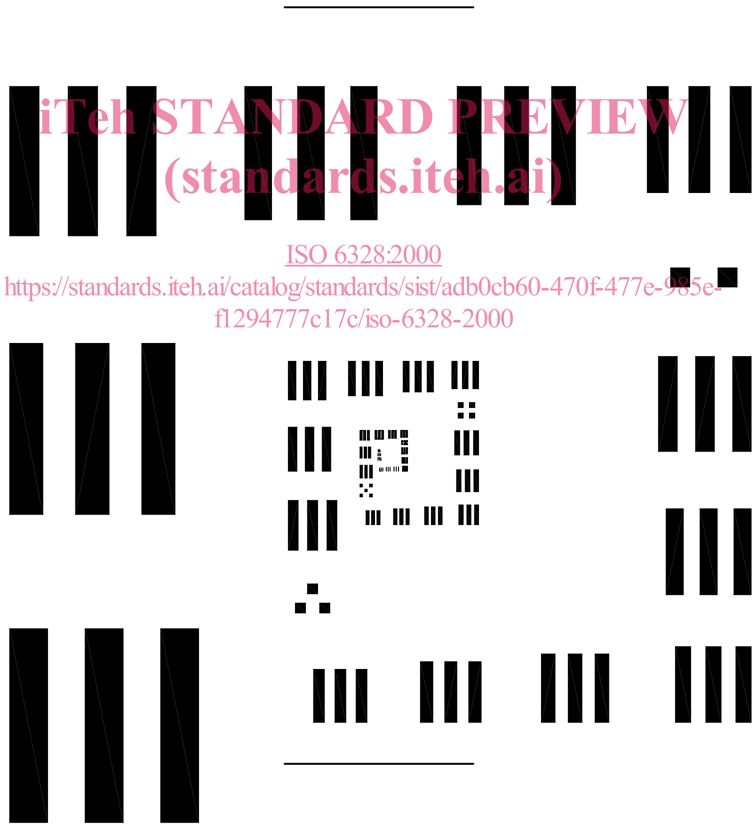
The tribar resolving-power target shall be a spectrally non-selective neutral transparency.

The array of elements in Figure 2 is approximately 100 mm square and is centred in a surround that is about 125 mm square. The two horizontal lines are 100 mm ± 0,5 mm apart and are used to determine the magnification.

The luminance of the three bars of each element and the luminance of the surround shall be measured at the position of the eyepiece which serves as the imaging lens.

NOTE A spot photometer may be used to measure the luminance of the surround and that of the largest bars to verify the contrast ratio of the tribar resolving-power target in the resolving-power camera. Since it will not be feasible to measure the luminance of the smaller bars with the spot photometer, a micro-densitometer may be used to verify the contrast uniformity of the target from the largest to the smallest elements.

This International Standard specifies tribar resolving-power targets of two different contrast ratios and polarities.




Although a negative-polarity tribar resolving-power target has light bars on a darker background, for the sake of clarity of reproduction, this figure shows the bars black against a white background.

**Figure 2 — Tribar resolving-power target**