INTERNATIONAL STANDARD

ISO 516

Third edition
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Photography — Camera shutters — Timing

Photographie — Obturateurs d'appareils photographique — Durée d'exposition

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Contents

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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.

International Standard ISO 516 was prepared by Technical Committee ISO/TC 42, *Photography.*

This third edition cancels and replaces the second edition (ISO 516:1986), of which it constitutes a technical revision.

Annex A forms a normative part of this International Standard.

Introduction

This International Standard is intended to provide a uniform basis for determining the timing and marking of exposure times of all types of shutters used in still cameras, and to give suitable definitions of the terms used.

Photography — Camera shutters — Timing

1 Scope

This International Standard defines the characteristics of all types of shutters which are mounted in still cameras and affect the control of exposure, motion-stopping ability and synchronization with a photoflash light source.

It also specifies the exposure-time markings for the shutters and their tolerances.

The tolerances specified are the target values for the shutter performance that can be expected to give good results. They are not intended for application as a general inspection standard in controlling the performance of shutters, since tolerances may vary with the feature and price class of camera tested.

Test methods are described for routine manufacturing testing and quality control.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, such publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document 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 10330:1992, *Photography — Synchronizers, ignition circuits and connectors for cameras and photoflash units — Electrical characteristics and test methods*.

3 Terms and definitions

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

NOTE The meanings of symbols used in this clause are given in clause 4.

3.1
front shutter
any shutter in the vicinity of the lens

NOTE 1 The front shutter may be in front of, behind or between the lens elements and may consist of rotating discs, rotating slats, sliding blades, oscillating blades, etc. Programmed shutters are also included.

NOTE 2 The common characteristic for the front shutter is that the entire picture area is exposed almost simultaneously.

NOTE 3 When the shutter and diaphragm are located too far apart, both exposure and shutter speed may vary at different points in the picture area.

3.2
focal-plane shutter
any shutter in the vicinity of the focal plane

NOTE 1 The focal-plane shutter may consist of fixed or variable slit curtains, rotating discs, sliding blades, etc.

NOTE 2 The essential feature of the focal-plane shutter is that the picture area is exposed incrementally, in such a way that the time required to expose the entire picture area is greater than the exposure time of any one point.

3.3
effective time
t_e
the best measure of the amount of light falling on the picture area as defined by the following equation

$$t_e = \frac{H}{E_o} \quad (1)$$

NOTE At any point on the picture area, t_e is generally the same for the entire picture area for front shutters when vignetting is not severe. For focal-plane shutters, t_e will vary with w and V_c. Equation (1) may be approximated with the equation (2) for convenience in measurement:

$$t_e = \frac{w}{V_c} \text{ (focal-plane shutter)} \quad (2)$$

Equation (2) may only be applied under the condition of $w \geqslant d_s/A$.

3.4
exposure time
t_{eo}
effective time measured at the centre of the picture area

3.5
total time
t_o
the time for which any given point in the picture area is exposed to light

See Figure 1.

NOTE 1 At any point on the picture area, t_o is generally the same, or almost, on the entire picture area for front shutters.

NOTE 2 For a focal-plane shutter, however, t_o is dependent on w, A, d_s and V_c. The curtain displacement to completely expose one point becomes $w + d_s/A$, which can be converted to t_o, if the velocity is known, using the following equation:

$$t_o = \frac{w + \frac{d_s}{A}}{V_c} \quad (3)$$

NOTE 3 This equation may be inexact in the presence of vignetting.

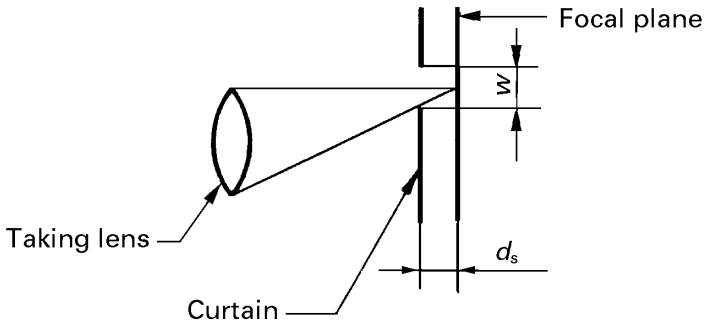

Figure 1 — Total time for a focal-plane shutter

3.6
shutter efficiency
η
ratio of effective time to total time

$$\eta = \frac{t_e}{t_o} \tag{4}$$

3.7
fluctuation of exposure time
p
the value of p is determined by the following equation

$$2^p = \frac{\bar{x} + \sigma}{\bar{x} - \sigma} \tag{5}$$

Where $\bar{x}$ and σ are the mean and standard deviation of the values of five successive measurements.

3.8
ratio of two adjacent exposure times
q
ratio of the mean values of two adjacent shutter speed settings obtained from values of five successive measurements, expressed by the following equation:

$$2^q = \frac{t_{eo}\,(n)}{t_{eo}\,(n+1)} \tag{6}$$

NOTE $t_{eo}\,(n)$ and $t_{eo}\,(n+1)$ are the exposure times of two adjacent shutter speed settings represented by (n) and (n + 1).

3.9
non-uniformity of exposure
r
characteristic which may be found during any single exposure due to lack of coincidence with the principal plane (front shutter) or to variations in curtain velocity or slit width (focal-plane shutters)

NOTE Such non-uniformity is expressed as the ratio of the maximum and minimum effective time found by exploring the picture area, and is derived from the following equation:

$$2^r = \frac{t_e\ \max}{t_e\ \min} \tag{7}$$

3.10
overall time
T
elapsed time for exposure of all points in the entire picture area

NOTE For front shutters, $T = t_o$.

3.11
photoflash synchronization delay time
t_d
time interval from the initial closing of the shutter synchronization contacts to the moment at which the shutter element moves to the specified position (see 5.2)

NOTE For details of ignition circuits of synchronizers, refer to ISO 10330.

3.12
X contact
synchronization contact for an electronic flash unit

NOTE The contact closes while the shutter is fully opened to enable reception of the reflected light from the object through the aperture of the lens or for total illumination of the camera aperture. The X contact may sometimes be used for the M or MF class of photoflash lamp at the slower shutter speeds.

3.13
M contact
synchronization contact for M class of photoflash lamp

3.14
FP contact
synchronization contact for FP class of photoflash lamp

NOTE This contact is provided only in the focal plane shutter and may be used for M or MF class of photoflash lamp at the slower shutter speeds.

4 Symbols

A = f-number of the lens

b = exposure time error

c = tolerance for exposure time

d = tolerance for stop

d_s = distance between focal plane and curtain

E_o = maximum illuminance (full open shutter)

E_v = exposure value in units

e = tolerance for exposure meter

f = tolerance for film sensitivity

H = exposure (time-integral of illuminance)

L = film latitude

m = magnification factor

n = a positive or negative integer or zero

p = fluctuation of exposure time, expressed in E_v

q = ratio of two adjacent exposure times, expressed in E_v

r = non-uniformity of exposure, expressed in E_v

s = width of the mask slit in drum tester

T = overall time in seconds (see Figure 3)

t_c = minimum contact duration in seconds

t_d = delay time in seconds (see Figures 2 and 3)

t_E = theoretical exposure time In seconds [see equation(8)]

t_e = effective time in seconds (see Figure A.2)

t_{eo} = exposure time in seconds (effective time measured at the centre of the picture area)

t_o = total time In seconds (see Figure A.2)

v_C = average linear velocity of curtain

v_d = linear velocity of rotating drum periphery

w = width of the focal-plane curtain slit

η = shutter efficiency

5 Required characteristics and their tolerances

5.1 Exposure time

Theoretical exposure times that form a series are given, in seconds, by the following equation:

$$t_E = \frac{1}{2^n} \quad (8)$$

Shutters shall be designed to provide exposure times selected from the series below, subject to the tolerances specified in 5.1.2.

....8,4,2,1,1/2,1/4,1/8,1/16,1/32, 1/64,1/128,1/256, 1/512, 1/1024,1/2048...

NOTE 1 Timing of the shutters should be measured at the appropriate aperture of the lens used (see Figures 4 and 5). In the case of cameras that have interchangeable lenses, the standard lens should be used for exposure-time measuring.

NOTE 2 In evaluating shutters without lenses, exposure times should be measured under the conditions fixed so as to be equivalent to the requirements of this International Standard.

NOTE 3 A change in n by one unit requires a change in time by a factor of 2. This unit is called E_V or a step.

5.1.1 Exposure time marking

The exposure-time marking shall be marked as the following rounded-off values of reciprocal numbers of the series specified in 5.1. Exposure times longer than 1 s shall not, however, be marked as reciprocal numbers, but should be made evident by color or some other means of identification.

...8,4,2, 1,2,4,8, 15,30, 60, 125, 250, 500,1 000, 2 000...

The highest marking, however, need not necessarily be selected from this series, but the series beginning with the next lower number should be selected from this series, whenever practicable, and progressing as far as is required in the particular application.

5.1.2 Tolerances

The tolerances of exposure time error, fluctuation of exposure times, ratio of two adjacent exposure times and non-uniformity of exposure should be as shown in Table 1 (see also 7.1). The following equation, in seconds, is applicable to the tolerance of the exposure time:

$$t_{eo} = \frac{1}{2^{(n+b)}} \quad (9)$$