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Photography — Digital still cameras — Determination of exposure index, ISO speed ratings, standard output sensitivity, and recommended exposure index

Photographie — Appareils de prises de vue numériques — Détermination de l'indice d'exposition, des régimes de vitesse ISO, de la sensibilité normale de sortie et de l'indice d'exposition recommandé

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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, 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.

This document was prepared by Technical Committee ISO/TC 42, *Photography*.

This third edition cancels and replaces the second edition (ISO 12232:2006), which has been technically revised.

The main changes compared to the previous edition are as follows:

— definitions of photographic sensitivity and sensitivity setting were added;

— Clause 4 was simplified and clarified;

— it has been defined how to determine the exposure saturation level in 6.2;

— the applicability of SOS values for scene-dependent rendering and raw files was clarified;

— original Table 1 was expanded to include higher values, and separated the SOS and REI columns into a new Table 2, which includes alternate values for some of the rows;

— Annex B was updated to clarify the mathematical basis of Formula (2);

— Annex E was cancelled.

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Introduction

The exposure index (EI), ISO speed ratings, standard output sensitivity (SOS) and recommended exposure index (REI) are useful metrics related to the capture of digital images. Standardization assists users and manufacturers in determining the capabilities of Digital Still Cameras (DSCs), in setting DSCs appropriately for the capture conditions, in obtaining well-exposed images, and in communicating exposures and the related DSC characteristics in image files.

The exposures produced by a DSC are determined by the exposure time, the lens aperture, the lens transmittance, the lens illumination falloff, the flare light present at the sensor, and the level and spectral distribution of the scene radiances incident on the camera lens. However, it is not typical for users to deal with this degree of complexity when determining and specifying image exposures. To provide a means for simply communicating exposure information, this document specifies an exposure index (EI) that corresponds to the focal plane exposure of a typical mid-tone. It is intended to be used for setting the camera exposure and as a record of the camera exposure in image files.

When an image from a DSC is obtained using an insufficient exposure, proper tone reproduction can generally be maintained by increasing the electronic or digital gain, but the image will contain an unacceptable amount of noise. As the exposure is increased, the gain can be decreased, and, therefore, the image noise can normally be reduced to an acceptable level. If the exposure is increased excessively, the resulting signal in bright areas of the image may exceed the maximum signal level capacity of the image sensor or camera signal processing. This can cause the image highlights to be clipped to form a uniformly bright area, or to bloom into surrounding areas of the image. Therefore, it is important to know the EI that will on-average produce the best image quality for specific DSC settings, and the range of EIs over which the DSC can be expected to produce acceptable image quality. The ISO speed and speed latitude ratings are intended to provide such information.

This document was designed to harmonize with earlier standards developed for film-based photography. For example, the equations were chosen so that using a particular EI on a DSC should result in approximately the same camera exposure settings, and resulting focal plane exposures, as would be obtained using the same EI on a photographic film camera. For example, the value of 10 as the constant in Formula (1) of this document is consistent with ISO 2721, so as to harmonize with this earlier ISO standard for photographic film cameras. ISO 2721 uses the term nominal exposure and assumes that the nominal exposure is an arithmetic mean exposure value, which usually corresponds to the mid-tone in photographs of average scenes.

However, there are differences between electronic and film-based imaging systems that preclude exact equivalency. DSCs can include variable gain and can provide digital processing after the image data has been captured, enabling desired tone reproduction to be achieved over a range of camera exposures. It is therefore possible for DSCs to have a range of ISO speed ratings. This range is defined as the ISO speed latitude. To prevent confusion, a single value is designated as the ISO speed, with the ISO speed latitude upper and lower limits indicating the speed range.

It can also be useful to compare or record the sensitivity of a DSC, for cases where the DSC has a fixed sensitivity. The standard output sensitivity (SOS) is designed to meet this need. Likewise, it can be useful to know the EI recommended by the DSC manufacturer for a specific condition. This information is provided by the recommended exposure index (REI).

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Photography — Digital still cameras — Determination of exposure index, ISO speed ratings, standard output sensitivity, and recommended exposure index

1 Scope

This document specifies the method for assigning and reporting ISO speed ratings, ISO speed latitude ratings, standard output sensitivity values, and recommended exposure index values, for digital still cameras. It is applicable to both monochrome and colour digital still cameras.

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 7589:2002, *Photography — Illuminants for sensitometry — Specifications for daylight, incandescent tungsten and printer*

ISO 14524, *Photography — Electronic still-picture cameras — Methods for measuring opto-electronic conversion functions (OECFs)*

ITU-R BT.709, *Parameter values for the HDTV standards for production and international programme exchange*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
digital still camera
DSC
device which incorporates an image sensor and which produces digital image data representing a still picture

Note 1 to entry: A digital still camera is typically a portable, hand-held device. The device can provide additional functions, for example video image capture or wireless telephony. The digital image data is usually recorded on a removable memory, such as a solid-state memory card or using internal memory.

3.2
DSC image signal
image data stored or output by a digital still camera

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3.3
exposure index
EI
numerical value that is inversely proportional to the exposure provided to an image sensor to obtain an image

Note 1 to entry: Images obtained from a DSC using a range of exposure index values will normally provide a range of image quality levels.

3.4
exposure saturation
minimum focal plane exposure that produces the maximum valid (not clipped or bloomed) DSC image signal

Note 1 to entry: The exposure saturation is expressed in lux-seconds (lx·s).

3.5
exposure series
series of images of the same subject taken using different exposure index values

3.6
image sensor
electronic device that converts incident electromagnetic radiation into an electronic signal

EXAMPLE A charge coupled device (CCD) array or a CMOS image array.

3.7
ISO speed
numerical value calculated from the exposure provided at the focal plane of a DSC to produce specified DSC image signal characteristics

Note 1 to entry: The ISO speed is usually the highest exposure index value that still provides peak image quality for normal scenes. However, a DSC does not necessarily use the ISO speed value as the exposure index value when capturing images.

3.8
ISO speed latitude
set of two numerical values calculated from the exposure provided at the focal plane of a DSC to produce specified DSC image signal characteristics

Note 1 to entry: The ISO speed latitude is expected to correlate with the range of exposure index values that provide acceptable image quality for normal scenes.

3.9
photographic sensitivity
general term used for numerical values calculated based on the exposure at the focal plane of a DSC which produces a specified DSC image signal level, such as the standard output sensitivity or recommended exposure index

Note 1 to entry: In practise, the photographic sensitivity is often called the "sensitivity" or the "camera sensitivity". It is sometimes called the “ISO sensitivity”, for historical reasons that date from ISO standards for photographic film cameras.

3.10
photosite integration time
total time period during which the photosites of an image sensor are able to integrate the light from the scene to form an image

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3.11
recommended exposure index
REI
specific exposure index value recommended by a DSC provider as a reference for adjusting photographic accessories

Note 1 to entry: REI provides a practical exposure index value for setting the reference exposure index of light meters, studio lighting, etc., but images taken using this exposure index value do not necessarily provide the best image quality.

3.12
signal processing
operations performed by electronic circuits or algorithms that convert or modify the output of an image sensor

3.13
sensitivity setting
numerical value of the photographic sensitivity used by a DSC when capturing images

Note 1 to entry: In some cases the sensitivity setting is set by the user. In other cases it is set automatically by the DSC.

Note 2 to entry: In DSCs employing an automatic exposure control system, the difference between the EI value used to capture an image and the sensitivity setting is called the “exposure bias”. The value of the exposure bias is typically indicated using EV (exposure value) units.

Note 3 to entry: For historical reasons, the sensitivity setting of a DSC is often labelled the "ISO".

3.14
standard output sensitivity
SOS
specific exposure index value for a DSC that provides a still image with a specified DSC image signal value under specified test conditions

Note 1 to entry: SOS provides a practical exposure index value based on the signal level of images captured with a DSC, but images taken using this exposure index value do not necessarily provide the best image quality.

4 Exposure index

4.1 General

An exposure index (EI) is a numerical value that is inversely proportional to the exposure provided to an image sensor to obtain an image. Images obtained from a DSC using a range of EI values will normally provide a range of image quality levels. The photographic sensitivity of a DSC is a particular EI value calculated from the exposure provided at the focal plane of the DSC that produces a specified camera image signal level.

The EI value I_{EI} for a specific image captured by a DSC shall be equal to the EI reference exposure of 10 lx·s divided by the focal plane exposure used to capture the image, as specified in Formula (1):

$$I_{EI} = K/H_m \tag{1}$$

where

K is a constant equal to 10 lx·s and

H_m is the average focal plane exposure, expressed in lx·s.

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