SLOVENSKI STANDARD
SIST ISO 14524:2011
01-julij-2011

Fotografija - Digitalne kamere za mirujoče slike - Metode za merjenje optoelektronske prehodne funkcije (OECFs)

Photography - Electronic still-picture cameras - Methods for measuring opto-electronic conversion functions (OECFs)

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Photographie - Appareils de prises de vue électroniques - Méthodes de mesure des fonctions de conversion opto-électroniques

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Ta slovenski standard je istoveten z: ISO 14524:2009

ICS:

37.040.10	Fotografska oprema. Projektorji	Photographic equipment. Projectors

SIST ISO 14524:2011 en

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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INTERNATIONAL STANDARD

ISO 14524

Second edition
2009-02-15

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

Photographie — Appareils de prises de vue électroniques — Méthodes de mesure des fonctions de conversion opto-électroniques

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Reference number
ISO 14524:2009(E)

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Case postale 56 • CH-1211 Geneva 20
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Published in Switzerland

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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 14524 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 14524:1999), which has been technically revised.

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Introduction

This International Standard establishes standard methods for measuring the functional relationship between the focal plane log exposures or scene luminances, and the digital output levels of a digital camera. This information is required for the development and testing of digital cameras, is used in other electronic still-picture camera measurement standards and may be helpful in the processing of digital image data.

An opto-electronic conversion function (OECF) measurement standard is required for several reasons, as outlined below.

a) Well-established measurement methods have been used to determine the characteristic curves for television cameras, where the characteristic curve is known as the “gamma correction” curve, and for silver halide photography, where the characteristic curve is known as the “H&D” or “DlogH” curve. However, these methods cannot be easily or unambiguously applied to the characterization of electronic still-picture cameras.

b) The sampling and quantization processes found in digital systems present fundamental issues that need to be addressed in a standardized manner.

c) The flexibility of digital systems complicates the determination and presentation of the functional relationship between the camera's optical input and digital output levels. This International Standard attempts to account for all the variables and ensure that results are presented in a consistent fashion.

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The OECF of a digital camera might appear to be the analogue of the characteristic curve used in photography and television, but this observation is only partly true. Characteristic curves show the relationship between a physical input, such as log exposure or reflectance, and a physical output, such as density or volts. The OECF, on the other hand, shows the relation between a similar physical input and a digital code value assigned to the physical response produced by that input. Since this assignation can be arbitrary, digital values themselves do not have physical meaning or units. For example, a change of a factor of two in digital values could correspond to a doubling of the physical response to the input, to an order of magnitude change, or to something else, depending on how the code values are assigned.

In digital photography applications, it is generally not necessary to know the physical response produced in a digital camera. It is sufficient to know what digital values will be produced by a variety of inputs. Consequently, this International Standard does not specify how to measure the true characteristic curve of a digital camera. Rather, it specifies how to measure the relationship between the input to a digital camera and the digital code values produced. These values are only absolutely meaningful in that they represent information. The graphical reporting formats specified in this International Standard support this viewpoint by allowing OECFs to be reported with either digital code values or bits on the vertical axis. This is the convention in information theory. Users of this International Standard are advised that the actual physical response of a digital camera, or of a complete digital photography system, can be linear, logarithmic, or something else, regardless of the form of the OECF plot and whether digital code values or bits are reported on the vertical axis.

NOTE In accordance with the rules given in the ISO/IEC Directives, Part 2, commas are used rather than full-stops as the decimal radix in this International Standard.

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

1 Scope

This International Standard specifies methods for the measurement of opto-electronic conversion functions (OECFs) of electronic still-picture cameras whose output is encoded as a digital image file. The OECF is defined as the relationship between the focal plane log exposures or scene log luminances, and the digital output levels of an opto-electronic digital image capture system.

This International Standard applies to both monochrome and colour electronic still-picture cameras.

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.

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ISO 5-1, *Photography — Density measurements — Part 1: Terms, symbols, and notations*

ISO 5-2, *Photography — Density measurements — Part 2: Geometric conditions for transmission density*

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ISO 5-3, *Photography — Density measurements — Part 3: Spectral conditions*

ISO 5-4, *Photography — Density measurements — Part 4: Geometric conditions for reflection density*

ISO 516, *Photography — Camera shutters — Timing*

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply[1)].

3.1
camera opto-electronic conversion function
camera OECF
relationship between the input scene log luminances and the digital output levels for an opto-electronic digital image capture system

NOTE The units of measurement for this function are $\log_{10}$ candelas per square metre.

1) Additional definitions of interest can be found in ISO 12232.

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3.2
digital output level
digital code value
numerical value assigned to a particular output level

3.3
electromechanical shutter
mechanical shutter which is electronically controlled

3.4
electronic still-picture camera
camera incorporating an image sensor that outputs an analogue or digital signal representing a still picture and/or records an analogue or digital signal representing a still picture on a removable medium, such as a memory card or magnetic disc

3.5
focal plane opto-electronic conversion function
focal plane OECF
relationship between the input focal plane log exposures and the digital output levels for an opto-electronic digital image capture system

NOTE The units of measurement for this function are $\log_{10}$ lux seconds.

3.6
illuminance scale exposure series
series of exposures produced using a constant exposure time and a varying focal plane illuminance

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3.7
incremental gain function
change in the output level (digital code value) divided by the change in the input level (luminance or exposure) as a function of input level

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NOTE 1 For the determination of incremental gain values, log input values are not used.

NOTE 2 If the input exposure points are very finely spaced and the output noise is small compared to the quantization interval, the incremental gain function can have a jagged shape. Such behaviour is an artefact of the quantization process and it is advisable to remove this by using an appropriate smoothing algorithm or by fitting a smooth curve to the data. In some cases, it might be desirable to fit a curve to the input-output data and then determine the incremental gain function by taking the first derivative of the function used for the curve fit.

3.8
incremental output signal
input level (luminance or exposure; not logged) multiplied by system incremental gain at that level

3.9
maximum exposure limit
smallest exposure which produces the digital output level corresponding to the maximum detectable exposure

NOTE The maximum detectable exposure is also known as the saturation or quantization ceiling.

3.10
minimum exposure limit
largest exposure below saturation which produces an incremental output signal equal in magnitude to the output noise

3.11
opto-electronic conversion function
OECF
relationship between the log of the input levels and the corresponding digital output levels for an opto-electronic digital image capture system

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NOTE If the input log exposure points are very finely spaced and the output noise is small compared to the quantization interval, the OECF can have a step-like character. Such behaviour is an artefact of the quantization process and it is advisable to remove this by using an appropriate smoothing algorithm or by fitting a smooth curve to the data.

3.12
opto-electronic digital image capture system
system which converts either a light exposure at the focal plane, or a spatial arrangement of luminances (a scene) to digital information

3.13
output noise
root-mean-square fluctuation about the mean in the digital output level for a constant input level

3.14
scene luminance ratio
ratio of the highest (highlight) luminance value to the lowest (shadow) luminance value in a scene

3.15
time scale exposure series
series of exposures produced using a constant focal plane illuminance and a varying exposure time

3.16
white balance
adjustment of electronic still-picture colour channel gains or image processing so that radiation with relative spectral power distribution equal to that of the scene illumination source is rendered as a visual neutral

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4 Test methods

4.1 General

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This International Standard describes test methods for measuring both camera OECFs and focal plane OECFs. Camera OECFs include the effects of the camera lens and associated flare, while focal plane OECFs do not. These image-formation effects vary with the overall scene luminance ratio, the amounts of each of the different luminances present in the scene and the spatial arrangement of these luminances. This variability can be quite large and, consequently, it is possible to determine a repeatable camera OECF only for a specific scene, such as a test chart. The camera OECF measurement method described in this International Standard allows for the determination of different camera OECFs based on test charts with different luminance ratios, but does not allow for the effects of different amounts or spatial arrangements of scene luminances. The camera OECF test charts are designed to simulate the image formation effects produced by a scene with a specific luminance ratio and average distribution of luminances; however many scenes are significantly different from average. When determining camera OECFs, it is important to keep in mind that the OECF characteristics measured may be quite different from those exhibited by the camera in capturing specific scenes. The reasons for inclusion of a camera OECF measurement method are as follows:

a) the mandatory automatic exposure control found in some cameras precludes the determination of focal plane OECFs;

b) the camera OECF measurement method allows for one-step determination of the camera system characteristics for the scene simulated by the test chart used;

c) focal plane OECF values can be estimated from camera OECF values for the midtone and highlight regions of most images, provided the range of interest is covered by the test chart used.

The focal plane OECF is a characteristic of the camera only and is not dependent on the scene.

NOTE Some cameras and/or supporting software can contain scene-dependent rendering algorithms. These algorithms are generally bypassed when performing focal plane OECF measurements because of the approximately uniform illumination incident on the focal plane. In situations where it is impossible or undesirable to bypass the rendering algorithms, it is more appropriate to perform camera OECF measurements.

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Two methods are described for focal plane OECF measurement, although both methods should give the same result. The preferred method (method A) allows for a higher degree of accuracy than the alternative method (method B). Method B should be used only with cameras that have fixed lenses. The advantages of focal plane OECFs are as described below.

— Separation of the optical image formation stage from the focal plane image to output stage allows each stage of the image capture to be dealt with independently. These two stages behave quite differently. The image formation stage is strongly scene dependent, while the focal plane image to output stage depends only on the sensor and camera electronics' characteristics. On the other hand, the response of pictorial cameras tends to be highly non-linear, complicating the subsequent analysis of optical image formation effects if the focal plane OECF is not known. The analysis of camera systems is much easier if the two stages are dealt with independently.

— Traditionally, only the density versus log exposure relation, or characteristic curve, is measured for film. This curve is analogous to the focal plane OECF.

— The predominant factor affecting camera OECF values in the darker areas of a scene is the camera flare. These values are, therefore, primarily scene dependent and do not provide much information about the general camera characteristics.

— Focal plane OECFs cover the entire usable range of the camera and are not limited by the test chart luminance ratio.

The methods for measurement of the OECFs described above are given in 4.2 to 4.4.

4.2 Camera OECF measurement

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The OECF may be determined for the entire camera opto-electronic digital image capture system using a camera OECF test chart as defined in this International Standard. This determination is accomplished by using the camera system to capture an image of the chart under controlled conditions. It should be noted that the independent variable for the camera OECF is scene log luminance, not focal plane log exposure as with the focal plane (method A) and alternative focal plane (method B) measurement methods.

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4.3 Focal plane OECF measurement (method A)

This method involves the exposure of the electronic still-picture camera sensor directly to specific quantities of uniform illumination with the camera lens removed. The illumination shall have the spectral characteristics specified in 5.1 and shall be produced by a small source at a distance, such that the largest dimensions of the source and the sensor are no greater than 1/20 the distance from the source to the sensor. In addition, reflective surfaces shall not be placed where they could cause additional illumination to be incident on the sensor.

4.4 Alternative focal plane OECF measurement (method B)

If a particular electronic still-picture camera does not allow the lens to be removed, method B may be employed. This method involves the use of a uniformly emissive, approximately Lambertian target (reflective surface or illuminator), which is then imaged by the camera lens on the sensor. If method B is used, the illuminance falling on the sensor, E_s, expressed in lux, shall be assumed to be as calculated from Equation (1) (see Reference [9]):

$$E_\mathrm{s} = \frac{0{,}65\, L_\mathrm{t}}{{f_\mathrm{e}}^2} \qquad (1)$$

where

L_t is the arithmetic mean luminance of the target in candela per square metre;

f_e is the effective f-number of the lens.

If method B is used, the target shall be measured to verify that it is approximately Lambertian and uniform in luminance. Luminance readings of the target shall be within 2 % of the arithmetic mean value for readings

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