INTERNATIONAL **ISO**

Fourth edition
2023-04

Photography — Electronic still-picture imaging — Noise measurements

Photographie — Imagerie des prises de vue électroniques — Mesurages du bruit

Reference number
ISO 15739:2023(E)

Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 Test conditions **3**
4.1 General 3
4.2 Illumination 4
4.2.1 Characteristics 4
4.2.2 Daylight illumination 4
4.2.3 Tungsten illumination 4
4.2.4 Uniformity of illumination and reflection test chart illumination geometry 4
4.2.5 Light source amplitude variations 4
4.3 Temperature and relative humidity 4
4.4 White balance 5
4.5 Infrared (IR) blocking filter 5
4.6 Photosite integration time 5
4.7 Compression 5

5 Noise measurement procedures **5**
5.1 General 5
5.2 Measurement of a DSC using a test chart 5
5.2.1 General 5
5.2.2 OECF measurement 5
5.2.3 Adjustment of illumination 6
5.2.4 Test chart 6
5.2.5 Non-uniformity and image structure spatial components 6
5.2.6 Camera lens focus 6
5.3 Measurement of a DSC having manual exposure control 7
5.3.1 General 7
5.3.2 OECF measurement 7
5.3.3 Adjustment of illumination 8
5.3.4 Test densities 8
5.3.5 Diffuser setting 8
5.3.6 Camera lens focus 8
5.4 Measurement of a DSC having a removable lens 9
5.4.1 General 9
5.4.2 OECF measurement 9
5.4.3 Adjustment of illumination 9
5.4.4 Test densities 9

6 Calculation of metrics **10**
6.1 General 10
6.2 Noise 10
6.2.1 General 10
6.2.2 Determining the noise for luminance measurements 11
6.2.3 Determining the noise for exposure measurements 12
6.3 Signal-to-noise ratios — large area 12
6.3.1 General 12
6.3.2 Determining the reference luminance and luminance value for calculating signal-to-noise ratio 12
6.3.3 Determining the signal-to-total noise ratio 13
6.3.4 Determining the temporal signal-to-noise ratio 14
6.3.5 Determining the fixed pattern signal-to-noise ratio 14

6.3.6 Determining the exposure values and the signal-to-noise ratios for exposure measurements ... 15
6.4 DSC dynamic range ... 15
6.4.1 General ... 15
6.4.2 Determining the DSC dynamic range for luminance measurements ... 15
6.4.3 Determining the DSC dynamic range for exposure measurements ... 17

7 Presentation of results ... 17
7.1 General ... 17
7.2 Signal-to-noise ratios ... 17
7.3 DSC dynamic range ... 17

Annex A (normative) **Noise component analysis ... 18**

Annex B (normative) **Visual noise measurements ... 24**

Annex C (normative) **Removing low frequency variations from the image signals ... 34**

Annex D (informative) **Procedure for determining signal-to-noise ratio ... 35**

Annex E (informative) **Practical viewing conditions for various output media ... 37**

Annex F (informative) **Introduction of perceptually uniform mapping of visual noise to noisiness JND ... 38**

Bibliography ... 41

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 of 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 www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 15739:2017), which has been technically revised.

The main changes are as follows:

— several terms and definitions have been modified, added, and deleted (see Clause 3);

— calculation procedures of camera noise, signal-to-noise ratios, and DSC dynamic range have been revised for measurement accuracy (see Clause 6);

— presentation of results has been specified expressly (see Clause 7);

— description of noise component analysis has been revised to be more detailed (see Annex A);

— measurement method of visual noise has been revised to model the human visual system more closely (see Annex B);

— method for removing low frequency variations from the image signals has been revised and changed from informative to normative processing (see Annex C);

— description of procedure for determining signal-to-noise ratio has been revised (see Annex D);

— introduction of perceptually uniform mapping of visual noise to noisiness JND has been added (see Annex F).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Noise is an important attribute of electronic still-picture imaging. If noticeable levels of noise exist in the images captured by a camera, then detail textures of objects are lost in reproduction and the visibility of the images is degraded. Therefore, measurement methods for noise are very important and are needed to provide important information relevant to evaluating image fidelity and the visibility of noise in captured images. Measurement methods are also important for assessing camera performance relative to these image quality factors.

The primary sources of noise in captured images are photon shot noise, dark current shot noise, analogue processing readout noise of image sensors, and quantization noise of A/D converters. This type of noise source adds spatially random noise to captured still images, whose spatial pattern differs from frame to frame. The other type of noise source includes dark current pattern noise, row/column pattern noise, and photo response non-uniformity of image sensors. This type of noise source also introduces spatially random noise in captured images; however, its spatial pattern does not change under the same shooting conditions.

The noise level introduced by these sources in output images is highly dependent on shooting conditions, such as the camera exposure time, aperture value, and ISO sensitivity. Camera operating temperature is also an influential factor. Some camera processing, such as contrast amplification and noise reduction, heavily influence the noise spectrum, in addition to the noise level itself.

The image quality metrics described in this document are determined from the measurement of spatially distributed noise in the output still image that is viewed by an observer. The metrics include the effect of the internal camera processing on the spectrum and level of the noise.

When observers view output images, several factors affect how they perceive noise in images, in addition to the noise level itself. Observers view noise differently depending on the apparent tone of the area being viewed, the luminance and colour channels where noise exists, the noise spectrum, and the viewing conditions.

This document specifies methods for measuring noise and related metrics of digital still cameras accounting for these influential factors. Measurement conditions are specified to minimize the influence of disturbance factors, to ensure that temporal and spatial statistical property changes are negligible, and to provide a good estimate of the noise level.

The main body of this document specifies methods for measuring input-referred noise, signal-to-noise ratios, and DSC dynamic range. Noise is determined as an estimate of the perceived noise computed using root mean square values measured in image signals linearized from the camera output signals. The two types of spatially random noise, temporal and fixed pattern, are determined using a noise component analysis applied to multiple captured images, the details of which are provided in Annex A.

Annex B describes a procedure for measuring the visual noise (an output-referred noise metric) using a human visual model that aims to predict the perceived quality of the image. The model weights spectral components of the noise and takes into account the noise spectrum, viewing conditions, and the perceived difference between luminance and colour channels. The metric has been shown to provide a high level of correlation with human perception of noise in images.

Low frequency variations may be introduced in the captured image due to lens shading and non-uniform test chart illumination. Since these variations can influence the noise measurement a method for removing low frequency variations from the image is provided in Annex C.

Annex D provides a recommended step-by-step procedure for determining the signal-to-noise ratio.

Annex E describes recommendations for practical viewing conditions for various output media.

Annex F introduces perceptually uniform mapping of visual noise to noisiness JND.