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Photography — Digital cameras — Image flare measurement

National foreword

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Foreword

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

Introduction

When images are produced by a digital camera, the camera captures not only the light from the scene but also stray, unwanted light (flare) that can reduce contrast in the image. Generally, the processing applied to the image will compensate for normal amounts of flare light, resulting in improved image quality. However, flare light can be quite variable, and image processing algorithms are not always successful at removing it. Poor or excessive flare removal processing can reduce the quality of the final image. For example, subtraction of the average flare across the image could result in over-subtraction of the flare in dark areas, resulting in loss of shadow detail. In evaluating digital cameras, it is therefore useful to measure the signal from the flare light remaining in processed images. This remaining flare signal is called "image flare."

Image flare in digital cameras is caused not only by lenses but also by camera bodies and image sensors, and is affected by image processing. Measurements of image flare include all contributing factors: the optical system, camera body, image sensor, and image processing. ISO 9358 specifies methods of measuring "veiling glare," the flare from lens systems, but it is not intended to be applied for the measurement of image flare. This document specifies a method to measure image flare using the image data output by digital cameras.

A standard method is needed in part because of the nature of image flare. It can vary both locally and from image to image depending on all the factors mentioned above. While it is possible to measure image flare at different positions in different images, the variability of image flare makes it difficult to compare such measurements out of context. This document provides a standard method for measuring image flare which can be useful for cross comparison.

INTERNATIONAL STANDARD ISO 18844:2017(E)

Photography — Digital cameras — Image flare measurement

1 Scope

This document specifies the definition of image flare for digital cameras, test patterns, measurement conditions, and methods, so as to enable the comparison of the results of measurement.

The methods of measurement are designed to enable the assessment of the performance of digital cameras by using image data output by the digital cameras.

This document does not specify the aim values or the allowable range of value for the image flare.

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.

IEC 61966-2-1, *Multimedia systems and equipment —Colour measurement and management — Part 2-1: Default RGB colour space — sRGB*

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:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
image flare
unwanted increase in signal in a processed image output by a digital camera resulting from light detected by an image sensor that does not emanate from a corresponding subject point

Note 1 to entry: Image flare is measured for a camera system. The camera system includes lenses, camera body, image sensor, and image processing used for the measurement. The following four are common with regard to light detection: i) internal multiple reflections, scattering or diffraction of optics (including lens surfaces, filter surfaces, or sensors), ii) light diffusion at lens barrel, body, or edge of lens, iii) leaking of light, and iv) the optical system as measured by point spread function including spherical and chromatic aberrations. Differentiation between these four might be difficult once an image is captured, but it is more appropriate to isolate the last one with regard to the system resolution. Thus, care should be taken to minimize point spread function contribution in the measurement of image flare. Image flare also includes the effects of image processing. Even if the same camera is used to capture RAW image data, different image flare values might be measured if different image processing algorithms are applied. This is an intended result because the measurement of image flare includes all contributing factors of lenses, camera body, image sensor, and image processing.

Note 2 to entry: “Image flare” was defined in ISO 3664:2000 in another context, but it was deleted in ISO 3664:2009.

Note 3 to entry: “Image flare” is defined in ISO 12231:2012 but without any source standards. The definition is the same statement as in ISO 3664:2000. ISO 3664:2000 was replaced by ISO 3664:2009 and this does not include the definition of “image flare.”

4 Measurement chart and method

4.1 Conditions of shooting

Each test chart shall be specified together with the lighting conditions such as illuminance, luminance, and colour temperature of illumination.

4.1.1 Arrangement of measuring equipment

4.1.1.1 Reflection-type test chart

The arrangement of the measuring equipment for a reflection-type test chart shall be set up as shown in Figure 1. The light source(s) should be positioned to provide uniform illumination and produce no glare or specular reflections from the target.

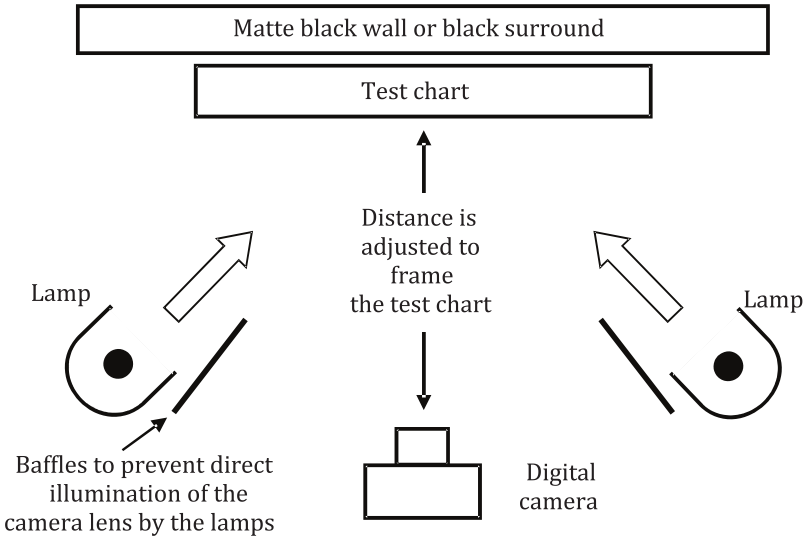


Figure 1 — Arrangement of measuring equipment for reflection-type test chart

4.1.1.2 Transparent-type test chart

The arrangement of the measuring equipment for a transparent-type test chart shall be set up as shown in Figure 2.

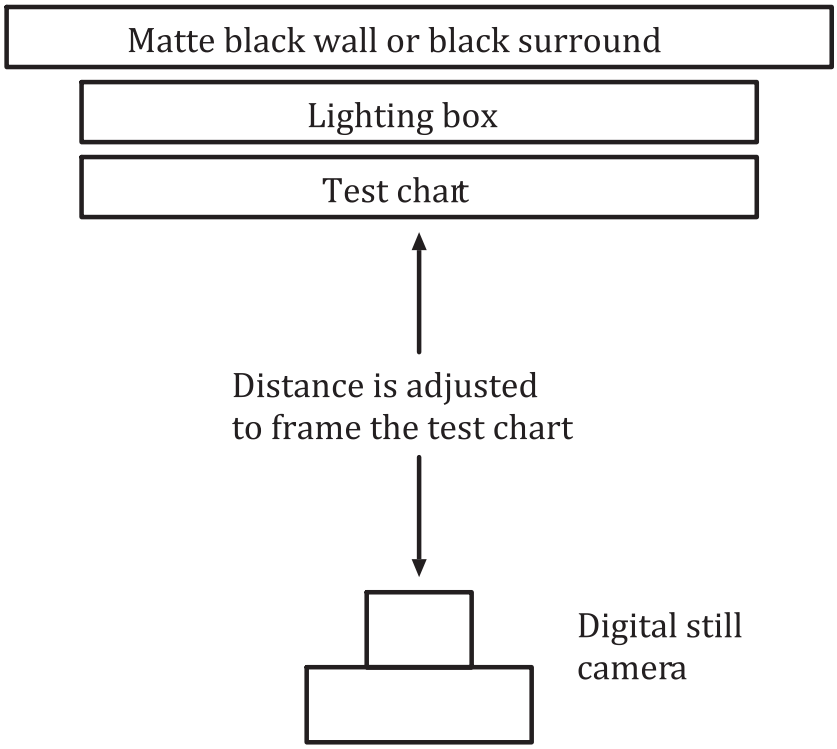


Figure 2 — Arrangement of measuring equipment for transparent-type test chart

4.1.2 Conditions of shooting

Unless otherwise stated, the conditions of shooting are as follows.

a) Illuminance of illumination of a reflection-type test chart should be 1 000 lx to 2 000 lx.

b) Luminance of transparent-type lighting box should be 318 cd/m^2 to 637 cd/m^2.

c) Total non-uniformity of lighting and test chart shall be <5 %; (|Max-Ave|/Ave <0,05 and |Min-Ave|/Ave <0,05).

d) Average outdoor daylight illuminant shall be used. The CCT (correlated colour temperature) of the illuminant shall be 5 700 K ± 1 000 K.

The illuminance should be measured using an illuminance meter (without cosine correction) positioned at the centre of the test chart, pointing the receptor in the direction of the digital camera to be measured.

Illumination from the outside of the chart can increase the measured image flare value, and should therefore be avoided for this measurement.

When shooting, lower camera sensitivity setting should be used in order to avoid the effect of noise.

4.2 Charts

4.2.1 General

The size of the charts shall exceed the field of view of the camera lens by (41 ± 2) %, in both the vertical and horizontal directions.

Chart 1 has a white surface, and the field of view shall be specified by a black rectangle whose thickness is one five-hundredth of the vertical length (shorter side) of the rectangle. The measurement areas shall be specified by black areas drawn in the rectangle. Several black areas may be arranged diagonally, but

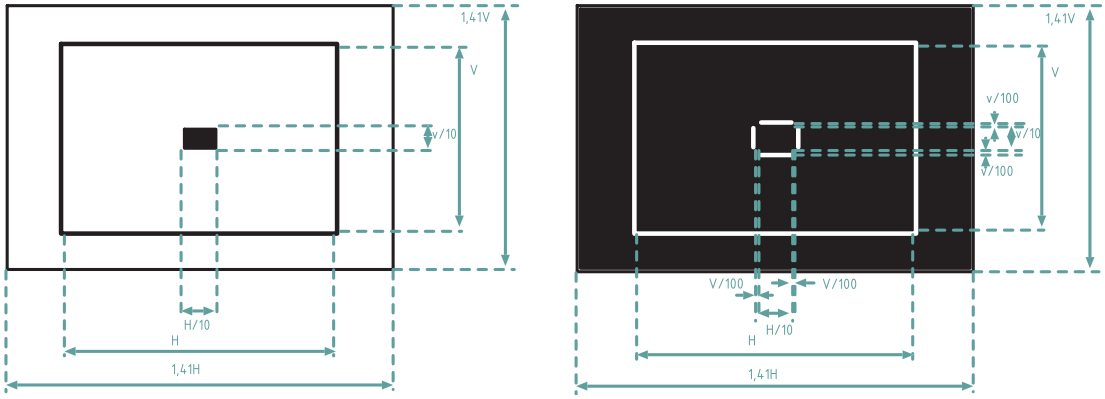
the total of the black areas shall be no larger than 5 % of the inner area of the rectangle. The total of the black areas does not include the black rectangle itself. At least one measurement area at the centre of the rectangle shall be used.

Chart 2 has a black surface, and the field of view shall be specified by a white rectangle whose thickness is one five hundredth of the vertical length of the rectangle. White lines whose thicknesses are one hundredth of the vertical length of the rectangle shall be drawn around the corresponding part of the centre black area of the chart 1 with one hundredth of the vertical length from it. The total length of the white lines shall be the same as the total of side lengths of the centre black area of chart 1.

The white part shall have 80 % or more reflectance ratio or 80 % or more transmittance ratio. The contrast ratio of charts is defined in 4.3.4. The white parts of the reflectance-type charts should have reflectance characteristics close to that of a Lambertian surface. The reflectance or transmittance of the black parts of test chart 1 and 2 shall be equal. Specular reflections from the black part of chart 1 and the corresponding region in chart 2, which will be used to calculate Y_{B2}, Y_{B3}, should be avoided. Thus, when reflection-type charts are used, it is recommended to place light traps in those regions.

4.2.2 Charts for single spot measurement

When measuring image flare only at the centre part, window pattern charts specified in Figure 3 should be used.

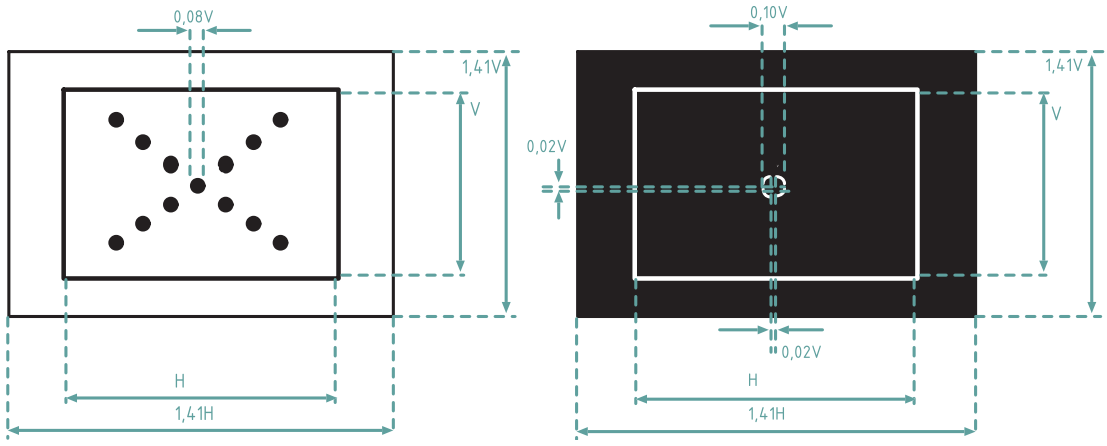


a) Chart 1 **b) Chart 2**

Figure 3 — Window pattern charts

4.2.3 Charts for multiple spot measurement

Examples of charts that conform to this document and that can be used for measuring image flare at multiple spots are shown in Figure 4.



a) Chart 1 **b) Chart 2**

Figure 4 — Dot pattern charts

4.3 Measurement procedure

4.3.1 General

Each test chart shall be positioned so that the full horizontal and vertical extents (H and V) fill the field of view of the digital camera. The aspect ratio of the image shall be equal to H:V.

The measurement shall be carried out using the digital signals of the images output from the measured digital camera with which the test chart is shot.

White balance should be adjusted to render the centre part of the image as neutral as possible, using manual or auto-white balance.

The focusing shall be in the manual or auto-focusing mode under the in-focus condition at the centre of the image.

For a camera with a user selectable compression ratio (e.g. different JPEG compression ratios), the compression ratio should be set to the minimum ratio (largest file size) to minimize compression artifacts. Alternatively, RAW format image data processed using RAW converter software may be used with the RAW converter output format using minimal or no compression.

If the lens was delivered with a bundled hood from a manufacturer, the bundled hood shall be used. Optional measurements without the hood may be performed.

NOTE 1 Lens hoods and filters on the lens will affect the measurement.

NOTE 2 When measuring image flare, dust and dirt on the lens can greatly increase the measured value.

4.3.2 Calculation of luma and luminance

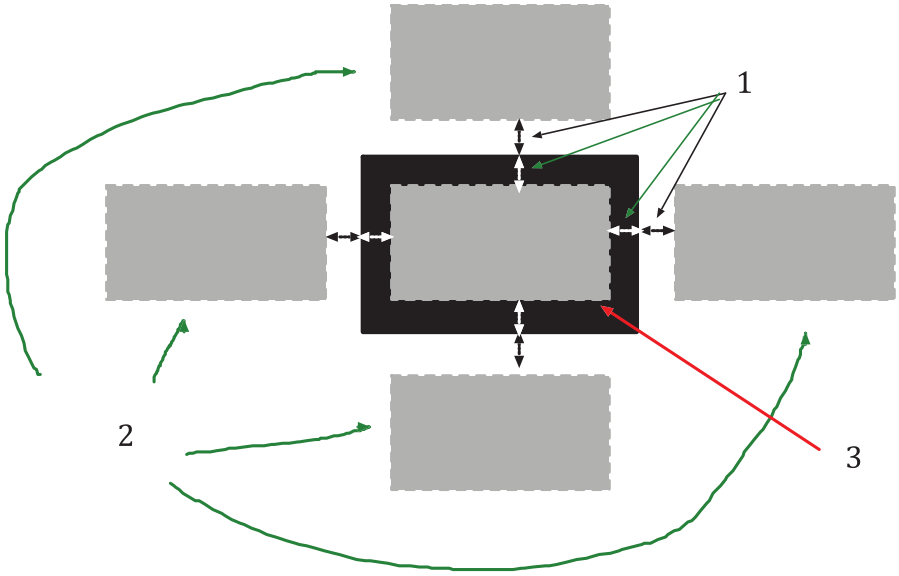
The output luma value (Y'_{luma}) shall be obtained from the camera eight-bit-per-channel RGB output signals (R', G', and B'), by using Formula (1).

$$Y'_{\text{luma}} = 0{,}299\,0 \cdot R' + 0{,}587\,0 \cdot G' + 0{,}114\,0 \cdot B' \tag{1}$$

The calculation from the camera output signals (R', G', and B') to a luminance signal (Y) is provided in colour encoding specification. In the case of sRGB output images, the conversion specified in IEC 61966-2-1 shall be used.

4.3.3 Areas used for calculation of luma and luminance

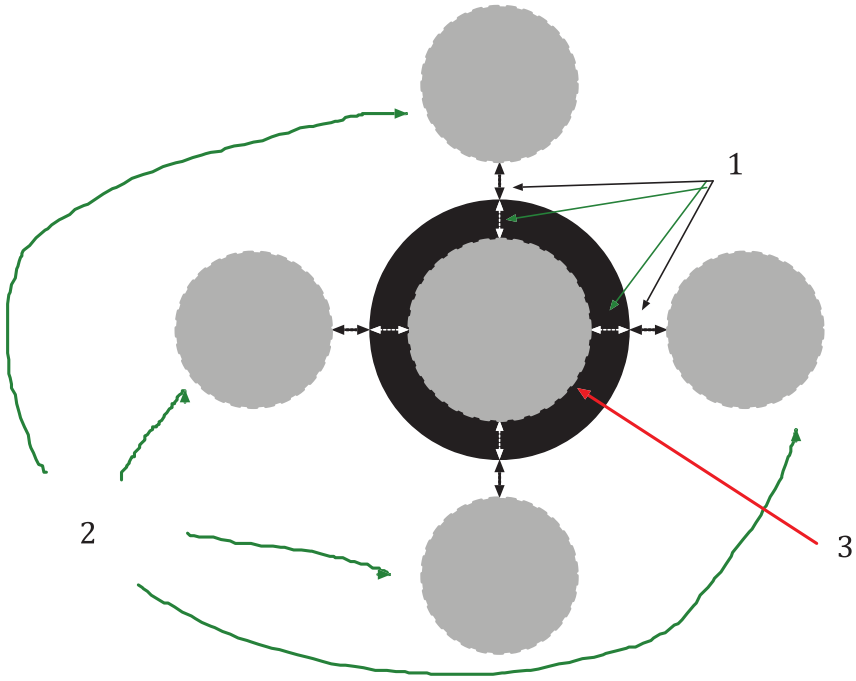
When the luminance value of black part is calculated, pixels of the black part whose distances from the edges are equal to or larger than $D/70$ shall be used. Where D is the diagonal distance across the rectangular H-V frame $[D=\sqrt{\left(H^2+V^2\right)}]$. When the luminance value of the white part is calculated, pixels that lie in the areas located above, below, to the left and to the right of the centre black area are used. The shape and dimensions of the areas used for the white measurement are equivalent to the shape and dimensions of the area used for the black measurement. The distances of the white measurement areas from the edges of the centre black part are equal to $D/70$. When multiple black areas are arranged, each black area shall be arranged so that its distance from the white calculation areas is equal to or larger than D/70. Illustrations of these areas are shown in Figures 5 and 6.



Key

1 D/70
2 white calculated area
3 black calculated area

Figure 5



Key

1 D/70
2 white calculated area
3 black calculated area

Figure 6

4.3.4 Measurement types

In this document, three measurement types A, B, and C are defined. These types are defined considering camera functions and chart characteristics. In the following measurement types, A, B and C, the values for R'_{W1}, G'_{W1}, B'_{W1} and R'_{Bx}, G'_{Bx}, B'_{Bx}, where x = 1,2,3, are obtained from the white and black areas respectively described in 4.3.3.

When the contrast ratio of the charts is greater than or equal to 40:1 but less than 3 000:1, measurement type A or B shall be used. If a camera has manual exposure function, measurement type A should be used. If a camera does not have manual exposure function, measurement type B should be used.

When the contrast ratio of the charts is greater than or equal to 3 000:1, all the measurement types A, B, or C may be used. It is also advised that measurement type A or C should be used for a camera that has manual exposure function and measurement type B or C should be used for a camera that does not have manual exposure function.

When using type A or B, tone reproduction characteristics are required to be the same when shooting chart 1 and 2.

The recommended measurement types are listed in Table 1.

Table 1 — Recommended measurement types

	The contrast ratio of chart is greater than or equal to 40:1 but less than 3 000:1.	The contrast ratio of chart is greater than or equal to 3 000:1
For a camera that has manual exposure function	Type A	Type A, C
For a camera that does not have manual exposure function	Type B	Type B, C

a) Measurement type A (when this method is applied, the contrast ratio of the test chart shall be greater than or equal to 40:1).

Step 1: An image of chart 1 shall be captured with exposure H_1 (luminance L_1 or illumination E_1, f/number A_1, exposure time T_1, and ISO sensitivity S_1) so as to make output luma level (Y'_{luma}) of the white part to be 225 ± 5 (8-bit output). R'_{W1}, G'_{W1}, and B'_{W1} values shall be obtained from the image.

Step 2: An image of chart 2 shall be captured with exposure H_2 (luminance L_2 or illumination E_2, f/number A_1, exposure time T_2, and ISO sensitivity S_1) that is 8 times ± 10 % of the exposure in step 1. R'_{B2}, G'_{B2}, and B'_{B2} values shall be obtained from the image.

Step 3: An image of chart 1 shall be captured with exposure H_2 (luminance L_2 or illumination E_2, f/number A_1, exposure time T_2, and ISO sensitivity S_1). R'_{B3}, G'_{B3}, and B'_{B3} values shall be obtained from the image.

Step 4: Luminance signal Y_{B2} shall be calculated from the R'_{B2}, G'_{B2}, and B'_{B2} values, luminance signal Y_{B3} shall be calculated from the R'_{B3}, G'_{B3}, and B'_{B3} values, and luminance signal Y_{W1} shall be calculated from the R'_{W1}, G'_{W1}, and B'_{W1} values.

Step 5: The percentage of image flare shall be calculated using Formula (2):

$$F = \frac{Y_{B3} / H_2 - Y_{B2} / H_2}{Y_{W1} / H_1} \times 100 \tag{2}$$

When multiple-spot measurement is conducted, Y_{B3} and Y_{B2} at the corresponding position shall be used.

NOTE In measurement type A, the exposure level is increased to 8 times at step 2 and 3. This makes measurable image flare value less than type B and C. For example, when Y'_{W1} = 225 and Y'_{B3} = 1, calculated image flare is about 0,005 %. This value is small, but, when capturing very high dynamic scenes, it is useful to have this level of precision.

b) Measurement type B (when this method is applied, the contrast ratio of the test chart shall be greater than or equal to 40:1).

Step 1: An image of chart 1 shall be captured with exposure H_1 (luminance L_1 or illumination E_1, f/number A_1, exposure time T_1, and ISO sensitivity S_1) so as to make output luma level (Y'_{luma}) of the white part to be 225 ± 25 (8-bit output) if the camera has control of exposure. R'_{W1}, G'_{W1}, and B'_{W1} values and R'_{B1}, G'_{B1}, and B'_{B1} values shall be obtained from the image.

Step 2: An image of chart 2 shall be captured with exposure H_2 ((luminance L_1 or illumination E_1, f/number A_2, exposure time T_2, and ISO sensitivity S_2) under the same conditions as in step 1. If the camera can fix the exposure level according to the chart 1, the exposure should be set as the same as when capturing chart 1. If the camera can fix the f/number, the f/number shall be set to A_1. R'_{B2}, G'_{B2}, and B'_{B2} values shall be obtained from the image.

Step 3: Luminance signal Y_{B1} shall be calculated from the R'_{B1}, G'_{B1}, and B'_{B1} values, luminance signal Y_{B2} shall be calculated from the R'_{B2}, G'_{B2}, and B'_{B2} values, and luminance signal Y_{W1} shall be calculated from the R'_{W1}, G'_{W1}, and B'_{W1} values.

Step 4: The percentage of image flare shall be calculated using Formula (3):

$$F = \frac{Y_{B1} / H_1 - Y_{B2} / H_2}{Y_{W1} / H_1} \times 100 \quad (3)$$

When multiple-spot measurement is conducted, Y_{B1} and Y_{B2} at the corresponding positions shall be used.

NOTE 1 For a camera that does not have manual exposure function, the exposure H_1 and H_2 are controlled by the camera. If the value of A_2 is not the same as A_1, this can introduce an error in Y_{B2}, relative to the condition when A_1 is equal to A_2. This will decrease measurement precision.

NOTE 2 When measuring image flare, Y'_{W1} affects the lowest measurable image flare values. If Y_{W1} becomes smaller the quantization error becomes bigger. For example, when Y'_{W1} = 225 and Y'_{B1} = 1, calculated image flare is 0,040 % (it is assumed Y_{B2} is zero for simplicity). But when Y'_{W1} = 118 and Y'_{B1} = 1, calculated image flare is 0,168 %. Smaller image flare than these values will not be measured and it is advised to avoid too small Y'_{W1}.

c) Measurement type C (When this method is applied, the contrast ratio of the test chart shall be greater than or equal to 3000:1. Preferably the contrast ratio of the test chart should be greater than or equal to 10000:1.)

Step 1: An image of chart 1 shall be captured with exposure H_1 (luminance L_1 or illumination E_1, f/number A_1, exposure time T_1, and ISO sensitivity S_1) so as to make output luma level (Y'_{luma}) of the white part to be 225 ± 25 (8-bit output) if the camera have control of exposure. R'_{W1}, G'_{W1}, and B'_{W1} values and R'_{B1}, G'_{B1}, and B'_{B1} values shall be obtained from the image.

Step 2: Luminance signal Y_{B1} shall be calculated from the R'_{B1}, G'_{B1}, and B'_{B1} values, and luminance signal Y_{W1} shall be calculated from the R'_{W1}, G'_{W1}, and B'_{W1} values.

Step 3: The percentage of image flare shall be calculated using Formula (4):

$$F = \frac{Y_{B1}}{Y_{W1}} \times 100 \quad (4)$$

NOTE 1 The measurement value obtained by measurement type C will suffer reflection at the black areas of the chart 1. The contrast ratio 3 000:1 will result in an increase of 0,033 % of image flare value measured by measurement type C. For the cameras whose image processing changes with their captured subject, the compensation for reflection in the black parts of charts 1 and 2 is not effective.

NOTE 2 When measuring image flare, Y'_{W1} affects the lowest measurable image flare values. If Y_{W1} becomes smaller the quantization error becomes bigger. For example, when Y'_{W1} = 225 and Y'_{B1} = 1, calculated image flare is 0,040 %. But when Y'_{W1} = 118 and Y'_{B1} = 1, calculated image flare is 0,168 %. Smaller image flare than these values will not be measured and smaller Y'_{W1} will worsen the precision of the measured value. It is advised to avoid too small Y'_{W1}.

5 Presentation of results

The following measurement conditions shall be reported. If a condition is unknown, write “unknown.”

If optional measurement without a bundled hood was performed, “without a bundled lens hood” shall be reported.

— Manufacturer(s) (camera and lens, if different).

— Model(s) (camera and lens).

— f/number (in case of measurement type B and if f/numbers are different at step 1 and 2, report both of them).

— Focal length.

— Focus distance.

— Camera ISO Exposure Index setting (±EV setting shall also be reported if not set to 0).

— Measurement type (A, B, or C).

— Output luma level (Y'_{luma}).

— Model name/number of the lens hood (if a lens hood was used).

— Model name/number of the lens filter (if a lens filter was used).

— Name, version number and settings of the RAW converter (if RAW format image data was used).

The following measurement conditions should be reported:

— reflection or transmission charts;

— illuminance or luminance used in the measurement.

Annex A
(informative)

Examples of reporting

Table A.1 — Examples of reporting

Manufacturer	[Manufacturer name to be substituted]
Model	[Model name of camera and lens to be substituted]
f/number	5,6
Focal length	50 mm
Focus distance	1,2 m
Camera ISO setting	200
Measurement type	A
Output luma level	223,9
Model name/number of the lens hood	[Model name/number of the lens hood to be substituted]
Model name/number of the lens filter	-
Chart type	Reflection
Luminance	2 000 lx
Image flare	0,6 %

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[5] CIE S017/E:2011 ILV: International Lighting Vocabulary

[6] Recommendation ITU-R BT.601, *Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios*

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