TECHNICAL SPECIFICATION

ISO/TS 19264-1

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Photography — Archiving systems — Image quality analysis —

Part 1: Reflective originals

Photographie — Systèmes d'archivage — Analyse de la qualité d'image —

Partie 1: Documents réfléchissants

Reference number
ISO/TS 19264-1:2017(E)

3.41
resolution
theoretical resolution
limiting resolution
measure of the ability of a camera system, or a component of a camera system, to depict picture detail

Note 1 to entry: Resolution measurement metrics include resolving power, limiting resolution, special frequency response (SFR), MTF and OTF.

[SOURCE: ISO 12233:2017, 3.22, modified — Two new terms and a Note 1 to entry have been added.]

3.42
RGB
additive process colour model where the channels are called Red, Green and Blue

[SOURCE: ISO 15930-7:2010, 3.25]

3.43
sampling efficiency
ratio of the measured limiting resolution and the Nyquist frequency

Note 1 to entry: Both values need to have the same unit.

[SOURCE: ISO 19262:2015, 3.220]

3.44
sampling rate
number of samples per unit of time, angle, revolutions or other mechanical, independent variable for uniformly sampled data

[SOURCE: ISO 18431-1:2005, 3.13]

3.45
scanner
electronic device that converts a fixed image, such as a film or film transparency, into an electronic signal

[SOURCE: ISO 21550:2004, 3.19]

3.46
scene referred image state
image state image state associated with image data that represents estimates of the colour-space coordinates of the elements of a scene

Note 1 to entry: When the phrase "scene-referred" is used as a qualifier to an object, it implies that the object is in a scene referred image state. For example, scene-referred image data are image data in a scene-referred image state.

Note 2 to entry: Scene-referred image data can be determined from raw DSC image data before colour-rendering is performed. Generally, DSCs do not write scene-referred image data in image files, but some do so in a special mode intended for this purpose. Typically, DSCs write standard output-referred image data where colour-rendering has already been performed.

Note 3 to entry: Scene-referred image data typically represents relative scene colourimetry estimates. Absolute scene colourimetry estimates can be calculated using a scaling factor. The scaling factor can be derived from additional information such as the image OECF, F-number or ApertureValue, and ExposureTime or ShutterSpeedValue tags.

Note 4 to entry: Scene-referred image data can contain inaccuracies due to the dynamic range limitations of the capture device, noise from various sources, quantization, optical blurring and flare that are not corrected for, and colour analysis errors due to capture device metamerism. In some cases, these sources of inaccuracy can be significant.

6.4 Details

Characteristic	**Sampling rate (obtained)**
Description	Sampling rate in pixels per unit of space determined from imaging a test chart with known geometric structures.
Related standards	
Measurement	Determine the number of pixels for a block with a given geometric size in the image of a test chart and convert to number of pixels per inch.
Reference target	Checkerboard structure on Target defined in Annex A.
Aim	The obtained sampling rate should be as close as possible to the claimed sampling rate provided in the metadata of the image file.
Notes	Also known as sampling frequency. Sampling rate should not be confused with limiting resolution. The sampling rate of a digital reproduction can be used to calculate the size of the physical record if stored in an uncompressed format. The sampling rate limits the maximum possible resolution of an imaging system. According to the Nyquist theorem, it is necessary to have at least two detecting points (pixels) on a cycle of a harmonic signal to be able to reproduce the signal. In other words, to scan a black-and-white test structure, you should have at least one pixel for the white part and one pixel for the black part to be able to reproduce the structure.

Characteristic	**Resolution (limiting resolution)**
Description	Measure of the ability of a camera system, or a component of a camera system, to depict picture detail (see ISO 12233).
Related standards	ISO 12233, ISO 16067-1
Measurement	Analysis of the edge spread function in a slanted edge target. Use the sampling frequency at 10 % modulation threshold for limiting resolution.
Reference target	The slanted edge structures in the target defined in Annex A are designed for SFR (spatial frequency response) measurements.
Aim	Reaching a frequency as high as possible but not higher than Nyquist (to avoid aliasing) for the 10 % modulation threshold (limiting resolution). Depending on the sampling rate the max. resolution that can be reached varies. The resolution should be constant over the field of imaging and the difference in different directions (horizontal and vertical respectively slow scan and fast scan direction) should be as small as possible.
Notes	Also known as true optical resolution. Note that resolution measurements based on slanted edge analysis requires uncompressed and unsharpened data. The ratio between the limiting resolution and the theoretical Nyquist limit is based on the obtained sampling rate.

Characteristic	**Sharpening**
Description	Amplification of the spatial frequency response by means of image processing to achieve sharper appearing images. Also, a class of image processing operations that enhances the contrast of selective spatial frequencies, usually visually important ones.
Related standards	ISO 12233, ISO 16067-1
Measurement	Analysis of the edge spread function in a slanted edge target. For an image without sharpening the SFR should at no frequency significantly exceed the value of 1.

Reference target	The slanted edge structures in the Target defined in section 6 are designed for SFR (spatial frequency response) measurements.
Aim	The SFR should not significantly exceed the value of 1.
Notes	

Characteristic	**MTF 50 (limiting resolution)**
Description	Measure of frequency based on the SFR measurement where a 50 % contrast level is reached (see ISO 12233). This is an indicator for the sharpness of an image.
Related standards	ISO 12233, ISO 16067-1
Measurement	Analysis of the edge spread function in a slanted edge target. Use the sampling frequency at 50 % modulation threshold as a sharpness indicator.
Reference target	The slanted edge structures in the target defined in Annex A are designed for SFR (spatial frequency response) measurements.
Aim	Reaching a frequency as high as possible but not higher than Nyquist (to avoid aliasing) for the 50 % modulation threshold.
Notes	

Annex A
(normative)

Test chart requirements

The test chart shall be designed to evaluate the imaging systems quality of scanners and other digital input devices used to create digital images of documents, photos and other reflective media. Individual measurements and regular checks of the target ensure that the results obtained from the measurements are reliable.

For flatbed or reprographic scanners it should be mounted on a solid backing material like aluminium or other suitable material.

The standard chart defined in this document is designed for a maximum sampling rate of 600 dots per inch (dpi). In case a manufacturer creates a chart with a resolution higher than 600 dpi, it should be indicated on the chart.

Problems with the illumination systems of test devices shall be avoided by using a material that consists of a non structured surface. For the target in combination with the production process a max density at a minimum of 2,3. Therefore the target will usually be produced on glossy material. The material shall have a white substrate with a L^* value of 94 ± 2, an a^* value between −1,0 and 1,0, and a b^* value between $-4{,}0 < b^* < 0$.

Each feature of the test target can have one or multiple functions.

The target shall be suited for visual and automatic evaluation that covers all the basic aspects of imaging systems quality and at the same time is scalable. Depending on the field of view of the system or the size of the originals that are intended to be scanned respectively, the target needs to be varied in size.

All structures designed to be neutral grey at different brightness levels should have a spectral reflectance as uniform as possible over the visual spectrum. The patches shall appear uniform under typical halogen, tungsten, and fluorescent lighting. The measured a^* and b^* values for all neutral patches (D50, 2° observer) shall not exceed the ±4 range.

The chart shall consist of the following structures:

— The size shall be that of the largest original that is intended to be scanned with the system.

— It shall contain at least one gray scale in horizontal and one in vertical position. The L^* values should be between 5 and 95 and shall be between 10 and 90. A minimum of 15 steps is required and they should be equally spaced over the L^* value range.

— At least 9 slanted edges fulfilling the requirement of the ISO 16067-1 resolution standard in combination with structures for visual resolution analysis. One edge positioned in or close to the centre and the other edges spread as a regular grid over the imaging field with the farthest distance from the centre being at least 65 % of the imaging field (diagonal).

— All edges shall be on the same target to ensure the same focus position for all evaluations.

— A regular grid (crosses, checkerboard etc.) shall surround all other structures to enable distortion and Illumination measurement.

— A black white and grey line shall cover the width and length of the entire chart to enable banding and defect pixel analysis for scanners.

— Colour reproduction is determined on a colour checker SG which does not fit on the chart in addition to the other structures. But the chart may contain colours (e.g. a subset of the Colour Checker SG) that can be used for monitoring the colour reproduction.

Annex B
(normative)

Guidelines for imaging performance aims and tolerances

Depending on the application each quality aspect may be of different importance, e.g. if a book is scanned to apply an OCR to it and make it inducible and searchable the colour accuracy is of minor importance and a high tolerance can be accepted. Therefore this document creates three quality levels for each of the characteristics. Users may combine the different quality levels they require for each characteristic to a full set of specifications.

For a manufacturer to advertise a level A compliant device according to this document the device shall be within all aim and tolerances stated for level A devices.

	Level A	**Level B**	**Level C**
Tone reproduction (of gray scale next to image centre)	$\Delta L^* \leq \pm 2$	$\Delta L^* \leq \pm 3$	$\Delta L^* \leq \pm 4$
Gain Modulation highlights Patches (L^*between 95 and 85*) (of gray scale next to image centre)	Gain between 0,8 and 1,1	Gain between 0,7 and 1,2	Gain between 0,6 and 1,3
Gain Modulation all other Patches (of gray scale next to image centre)	Gain between 0,7 and 1,3	Gain between 0,6 and 1,4	Gain between 0,3 and 1,6
Noise (visual noise)	<5	<6	<7
Dynamic range (of gray scale next to image centre)	≥2,3	≥2,1	≥1,9
Banding	Based on visual inspection, no banding	Based on visual inspection, no banding	Based on visual inspection, slight banding
Defect pixels (flat field illumination required)	No defects measureable	Less than 0,1 per million	Less than 1 per million
White balance (over field)	$\Delta C^* \leq \pm 2$	$\Delta C^* \leq \pm 3$	$\Delta C^* \leq \pm 5$
Colour reproduction	Max ΔE^* is recommended to be ≤ ± 10 Mean $\Delta E^* \leq \pm 4$	Max ΔE^* is recommended to be ≤ ± 15 Mean $\Delta E^* \leq \pm 5$	Max ΔE^* is recommended to be ≤ ± 15 Mean $\Delta E^* \leq \pm 5$
Sampling rate (Difference between claimed and obtained)	≤2 %	≤3 %	≤4 %
Resolution measured as frequency where 10 % Modulation is reached (MTF10) according to ISO 16067-1 at each location in the image and in both directions horizontal / vertical	≥85 % of claimed Sampling rate	≥80 % of claimed Sampling rate	≥70 % of claimed Sampling rate
Sharpening	Max SFR contrast value ≤1,05	Max SFR contrast value ≤1,1	Max SFR contrast value ≤1,2
MTF 50	≥0,5 × the minimum frequency required for MTF10	≥0,45 × the minimum frequency required for MTF10	≥0,45 × the minimum frequency required for MTF10

	Level A	Level B	Level C
Illumination non-uniformity for A3 and smaller	$\Delta L^* \leq 3$	$\Delta L^* \leq 3$	$\Delta L^* \leq 3$
Illumination non-uniformity for > A3 and ≤ A2	$\Delta L^* \leq 4$	$\Delta L^* \leq 5$	$\Delta L^* \leq 5$
Illumination non-uniformity for > A2 and ≤ A0	$\Delta L^* \leq 5$	$\Delta L^* \leq 6$	$\Delta L^* \leq 6$
Colour mis-registration	≤0,4 pixel	≤0,7 pixel	≤1 pixel
Distortion	≤1,5 %	≤2 %	≤5 %

Table C.2 *(continued)*

Colour patches	L^*	a^*	b^*
C5	47	−5	−25
C6	69	−35	−1
C7	86	−19	−1
C8	87	10	18
C9	85	−14	−9

The numbers shall be printed as shown on the bottom and the inside of the scale in 8 pt Verdana and orange colour.

C.11 Slanted edges

The slanted edge structures are designed for SFR (spatial frequency response) measurements used to determine sharpness and resolution of the imaging system. They shall be combined with the visual resolution ones into a box of 50 mm × 25 mm. The box located on the imagined centred horizontal line shall be rotated by 90° clockwise. Each slanted edge structure is arranged on an imagined 140 mm grid from the target centre. The slanted edge is located on the left side of the box with a rectangle of 25 mm × 25 mm and a grey level of L^* 63. Centred within that box is another box of 15 cm × 15 cm and a grey level of L^* 34 that is rotated by 5°. On the right side of the outer box there shall be another substrate white box of 25 mm × 25 mm that contains the visual structures described in 4.8. In the corners and the upper and lower centre of the 50 mm × 25 mm box there shall be crosses needed for the automatic detection. These crosses consist of 3 mm black lines with 0,38 mm thickness.

Figure C.10 — Example of slanted edges

The exact dimensions and locations can be found in the Excel spec sheet.

The manufacturer shall be responsible for the sharpness of the slanted edge. The edge shall be sufficient (and not be the bottle neck) to measure scanner resolutions of up to 600 pixels/in (~ 12 LP/mm) according to ISO 16067.

C.12 Visual resolution structures

The visual resolution structures shall be the ones specified in DIN 19051-2 target starting at 2,8 LP/mm up to 18 LP/mm. They shall be centred in the white box and rotated 45° clockwise (see image under 4.7).

The manufacturer shall be responsible for an appropriate resolution up to 18 LP/mm.

C.13 Additional chart border

Those who want to perform an additional more detailed colour check can mount an IT8 target inside of the additional chart border in centre of the ISO 19264 TEST CHART. By doing that the centre SFR structure, the colour patches of the ISO 19264 TEST CHART, and the background checkerboard will be covered and cannot be used.