International Standard

ISO 20793

Photography — Lenticular print for changing images — Measurements of image quality

Photographie — Impression lenticulaire pour images changeantes — Mesurages de la qualité des images

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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 document 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).

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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 first edition of ISO 20793 cancels and replaces the first edition of ISO/TS 20793:2019, which has been technically revised.

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

Lenticular printing is a technology wherein lenticular lenses are used to produce printed images with an illusion of depth, i.e. three-dimensional (3D) effect, or the ability to change or move as the image is viewed from different angles. Lenticular prints for displaying changing images are built up with a lenticular lens sheet and a printed sheet that contains at least two images, interleaved with the same spatial frequency as the lenticular lens sheet.

In this context, lenticular lenses generally take the form of arrays of cylindrical lenses, each acting as a magnifying lens. Widespread applications of lenticular printing are signage, display posters, business cards, multilingual message boards, packages with changing images or 3D effects, and secure documents.

It has been reported that the market size of lenticular prints is over 100 million m^2 and that the market is growing. Furthermore, the potential image qualities of lenticular printing have dramatically improved, and further improvements are expected in the future. While production of lenticular sheets with a lens frequency of 100 lpi (lines per inch) is routine, products with a 200 lpi frequency are also currently available.

Although the potential image quality of lenticular prints is high as described above, the quality of images is not always good in the market due to various causes, e.g., due to the misalignment of the lenticular lens and lenticular printed images. This is a critical problem for lenticular printing.

To improve the image quality of lenticular prints, image quality measurements are essential. This document provides standard measurement methods and the specifications for the image quality of lenticular prints.

Photography — Lenticular print for changing images — Measurements of image quality

1 Scope

This document specifies the measurement methods and specification of image quality of lenticular prints that are used for changing images. This document does not cover lenticular prints that are used for 3D images.

NOTE Lenticular prints for 3D images can be measured with the same types of procedures. However, it needs more information, such as the dependence of the measurement distance, to evaluate the 3D performance.

This document specifically describes measurement methods for crosstalk, viewing angle range, angular misalignment from the designed viewing angle and the uniformity of the image within the printing area of the lenticular print images. These are critical for the image quality of lenticular prints for changing images.

This document is applicable to lenticular prints produced by printing technologies that include impact and non-impact printing. Examples of the former are off-set, gravure and flexography, while the examples of the latter are silver halide, inkjet, dye diffusion thermal transfer and electrophotography. The multiple laser images (MLI) and changeable laser images (CLI) process of using a laser to write through a lenticular screen at different angles to create two monochrome images is also used.

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 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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

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

3.1 Terms

3.1.1
lenticular lens
array of magnifying semi-cylindrical lenses, designed to produce a desired perception, such as 3D, motion or morphing, to the underlying interlaced image

EXAMPLE This technique is widely used in lenticular printing, wherein the lenticular lens is used to provide an illusion of depth, change or motion to an underlying interlaced image when viewed from different angles.

[SOURCE: ISO/TS 20328:2016, 3.1, modified — Note 1 to entry has been removed.]

3.1.2
lenticular print
print combined with lenticular lenses which produces printed images with an illusion of depth, i.e. three-dimensional (3D) effect, or the ability to change or move as the image is viewed from different angles

Note 1 to entry: The detailed explanation of lenticular print is provided in Annex A.

Note 2 to entry: Lenticular prints to display changing images are built up with a lenticular lens sheet and a printed sheet that contains at least two images, interleaved with the same spatial frequency as the lenticular lens sheet.

3.2 Abbreviations

CIE commission internationale de l'éclairage (International Commission on Illumination)

CLI changeable laser image

CTP computer to plate

LMD light measuring device

MLI multiple laser image

RGB red, green, blue

4 Standard environmental conditions

4.1 Temperature and humidity

The standard environmental conditions shall be applied for the measurements of lenticular prints. The standard environmental conditions shall be a temperature of 23 °C ± 3 °C and a humidity of 50 % RH ± 15 % RH.

4.2 Ambient illumination conditions

For standard dark room conditions, the ambient illuminance at any position on the lenticular print is below 0,3 lx in all directions or the illuminance shall at least be less than a level that does not influence the measurement results.

When directional illumination is used, standard dark room conditions shall be applied unless the instrumentation used is effective in suppressing background illumination.

When the sample is set in an integrated sphere, a dark room may not be required.

5 Measurement conditions

5.1 General

For the measurements, the lenticular print samples shall be illuminated with hemispherical diffuse lighting. Directional illumination can also be used when it is appropriate for simulating the use application.

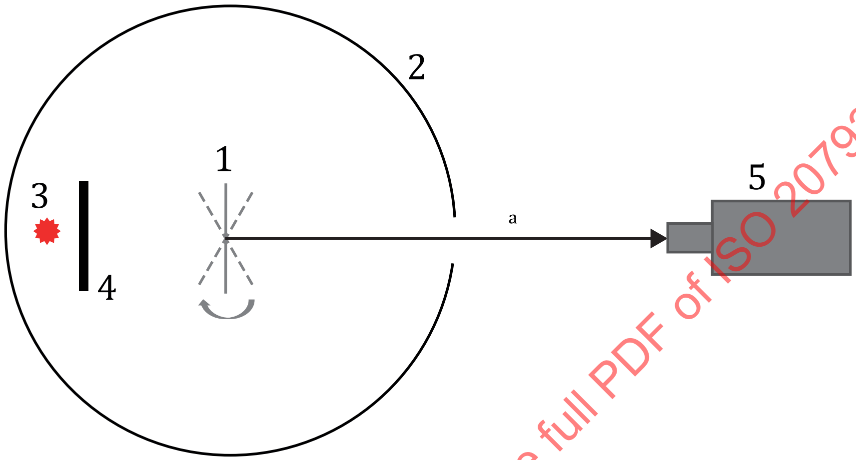
The reflected light from the print sample shall be measured using a spectroradiometer or a radiometer with photopic response (V_{λ} - filter).

5.2 Geometry of measurements

5.2.1 Standard conditions with hemispherical illumination

Uniform hemispherical diffuse illumination is generally realized by using an integrating sphere. The lenticular print sample shall be placed in the centre of an integrating sphere as shown in Figure 1. For the calibration, the reflection standard, i.e. a standard white board, shall be placed at the same position of the lenticular print sample. Best practices for integral sphere design and measurements are described in References [2] and [3].

When the viewing direction dependence is measured, the print sample shall be rotated around the axis parallel to the direction of the array of lenticular lens.



Key

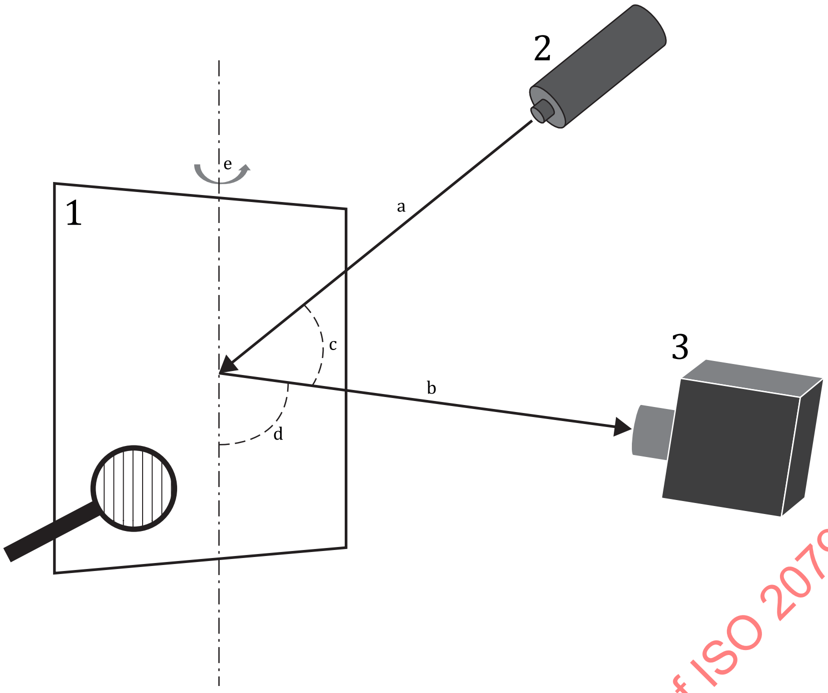
1 lenticular print
2 integration sphere
3 light source
4 baffle
5 light measurement device
a Reflected light from sample.

Figure 1 — Geometry of measurement with hemispherical illumination

NOTE A colorimetric conoscopic measurement device with diffuse illumination through the optical system gives similar information but not equivalent results.

5.2.2 Standard conditions with directional illumination

For samples that are not laser engraved, the directional light shall be illuminated at an angle of 45° from the normal, and the reflected light shall be detected from the direction normal to the print as shown in Figure 2. The light source and the detector shall be placed in the same plane. The lenticular print shall first be set normal to the detector, and it shall be rotated from the normal direction in order to measure the viewing angle dependence.



Key

1 lenticular print

2 light source — directional

3 detector

a Incident light.

b Reflected light.

c Angle of the incident light = 45°.

d Angle of the detection = 90°.

e Angle of rotation of the print.

Figure 2 — Geometry of measurement with directional illumination

NOTE A colorimetric conoscopic measurement device with directed illumination through the optical system gives similar information but not equivalent results.

Laser-engraved, lenticular prints with small sample sizes, such as those used in security printing are illuminated most effectively with 0°/45° directional illumination, with the illumination perpendicular to the lenticular screen.

5.3 Light source

For the standard conditions, hemispherical illumination shall be applied. The illumination spectra shall be a stable and spectrally continuous broadband visible light source, for example, an incandescent lamp defined as CIE Standard Illuminant A.

5.4 Light measuring device (LMD)

The light reflected from the lenticular print shall be measured. Illuminant D50 shall be applied. The following requirements are given for measurement instrument:

a) The spectroradiometer shall be capable of measuring spectral radiance over at least the 380 nm to 780 nm wavelength range, with a maximum bandwidth of 10 nm for smooth broadband spectra.

Care shall be taken to ensure that the LMD has enough sensitivity and dynamic range to perform the required task. The measured LMD signal shall be at least ten times greater than the dark level (noise floor) of the LMD, and no greater than 85 % of the saturation level.

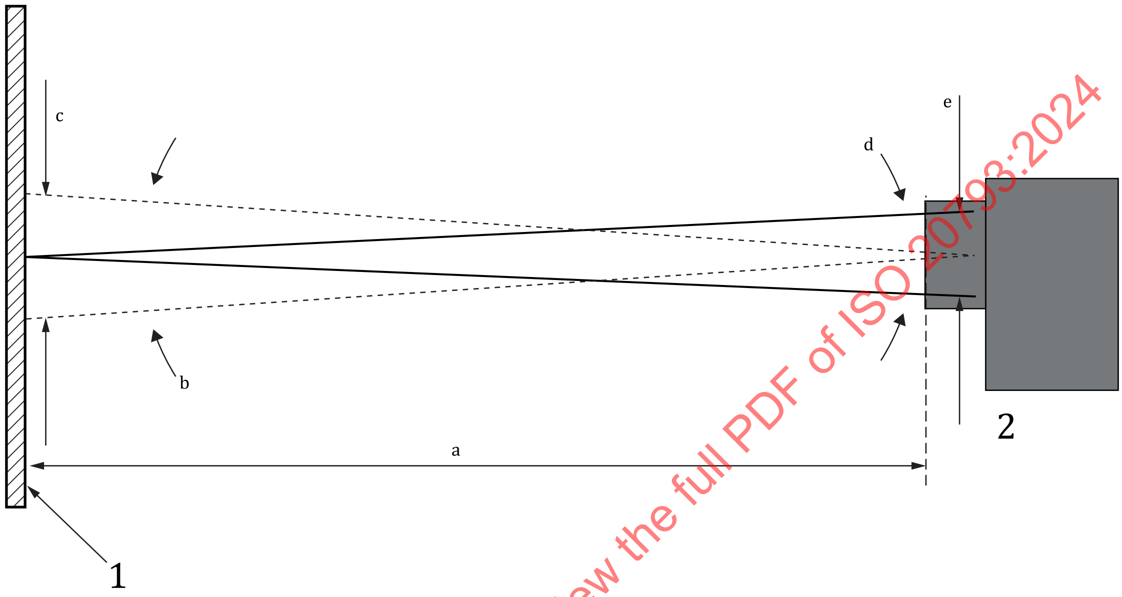
b) The LMD shall be focused on the image plane of the print and aligned perpendicular to its surface, unless stated otherwise.

c) The relative uncertainty and repeatability of all the measuring devices shall be maintained by following the instrument supplier's recommended calibration schedule.

d) The recommended measuring distance is between 30 cm to 60 cm. The measuring distance shall be noted in the report.

e) The angular aperture shall be less than or equal to 5°, and the measurement field angle shall be less than or equal to 2° (see Figure 3).

f) The measurement field of the LMD shall be centred and enclosed within the illuminated measuring spot on the print.



Key

1 lenticular print

2 LMD

a Measuring distance.

b Measurement area angle (measurement field angle).

c Measurement area (measurement field).

d Angular aperture.

e Aperture area.

Figure 3 — Layout diagram of measurement setup

5.5 Working standards and references

The LMD shall be calibrated with a diffuse white reflectance standard sample with a diffuse reflectance of 98 % or more. The reflectance shall be calculated based on the reflectance of the perfect white panel and the black panel.

Diffuse white reflectance standard samples can be obtained with a diffuse reflectance of 98 % or more. They are also available in different shades of grey. A luminance L_{std} measurement from such reflectance standards can be used to determine the illuminance E on the standard for a defined detection geometry and illumination spectra and configuration, as given by Formula (1):

$$E = \frac{\pi L_{std}}{R_{std}} \tag{1}$$

where R_{std} is the calibrated luminous reflectance factor for that measurement configuration. When the illumination configuration is a uniform hemispherical illumination, then R_{std} is equivalent to luminous reflectance ρ_{std}. The luminous reflectance value associated with the standard is only valid for the hemispherical illumination in which it was calibrated. If it is used with a directed source at any angle, there is no reason to expect that the luminous reflectance value will be the correct luminous reflectance factor value for that illumination configuration or spectra.

The terms luminous reflectance and luminous reflectance factor shall be abbreviated to reflectance and reflectance factor, respectively.

Black glass (e.g. BG-1 000), or a very high neutral density absorption filter (density of 4 or larger), can be used to determine the luminance of a source, L_s, from the measured luminance, L_{std}, of the virtual source image as reflected by the black glass, and the luminous specular reflectance, ζ_{std}, of the black glass for the measurement configuration used, as given by Formula (2):

$$L_s = \frac{L_{std}}{\zeta_{std}} \tag{2}$$

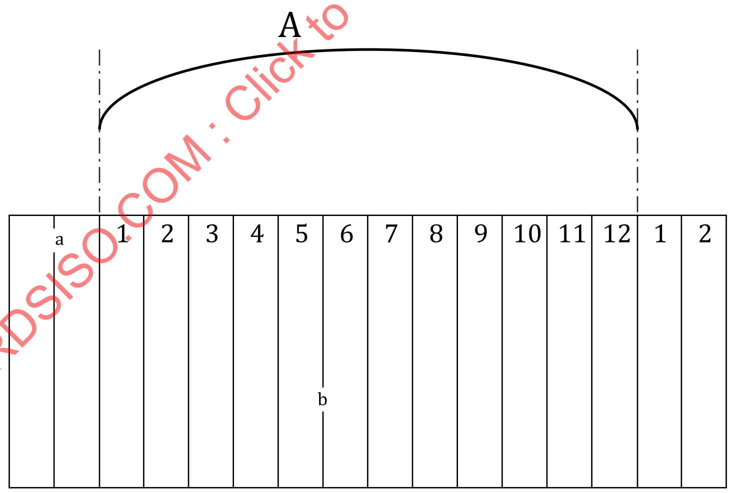
When making specular measurements, the detector is focused on the virtual image of the source. Black glass can be considered as a front surface mirror that has a low specular reflectance of between 4 % and 5 %. A black glass standard can be helpful when the measurement geometry does not allow measuring the source luminance directly, but only by using a mirror. The low specular reflectance of black glass allows measuring the source luminance at about the same order of magnitude as the reflection measurement.

The specular reflectance of black glass is affected by the specular angle, the illumination spectrum, and the cleanliness of its surface. The calibration shall be repeated when the measurement geometry is changed.

6 Preparation of lenticular print samples

6.1 Test pattern

The lenticular images are divided by several picture elements for one lenticular lens width, as shown in Figure 4. For the measurements of this document, striped test patterns shall be used, where each strip element shall be white or black, or other primary colours.



Key

A lenticular lens

[a] Number of picture element.

[b] Picture elements of lenticular print.

Figure 4 — Schematic illustration of the picture elements of a lenticular print

The test pattern shown in Table 1 shall be applied for the measurement. Table 1 is for 12 picture elements in one lenticular lens width. For other cases, an analogous test pattern shall be applied. Table 1 is illustrated with black and white. For the evaluation of colour images, black shall be replaced with a primary colour of yellow, magenta, or cyan, or a secondary colour of red, green, or blue.

Table 1 — Example of test patterns for 12 views

Picture element		1	2	3	4	5	6	7	8	9	10	11	12
All white													
All black		■	■	■	■	■	■	■	■	■	■	■	■
2-way split	1/2	■	■	■	■	■	■						
	2/2							■	■	■	■	■	■
3-way split	1/3	■	■	■	■								
	2/3					■	■	■	■				
	3/3									■	■	■	■
4-way split	1/4	■	■	■									
	2/4				■	■	■						
	3/4							■	■	■			
	4/4										■	■	■
NOTE The black box indicates a black strip and the white box indicates a white strip.													

NOTE The image quality is improved with modification of the printing patterns. For example, the patterns shown in Table 2 are used to improve cross talk. The image quality with these patterns are also used when those technique are used in the printing process.

Table 2 — Additional example of test patterns for 12 views

Picture element		1	2	3	4	5	6	7	8	9	10	11	12
All white													
All black		■	■	■	■	■	■	■	■	■	■	■	■
2-way split	1/2	■	■	■	■	■							
	2/2							■	■	■	■	■	
3-way split	1/3	■	■	■									
	2/3					■	■	■					
	3/3									■	■	■	
4-way split	1/4	■	■										
	2/4				■	■							
	3/4							■	■				
	4/4										■	■	
NOTE The black box indicates a black strip and the white box indicates a white strip.													

6.2 Printing

The test pattern shall be printed using the printing system under evaluation.

The test patterns should be printed at the position 1 to 9 shown in Figure 8. However, the test patterns can be printed in the opening space between the printing contents or in the external side of the printing contents.

6.3 Test images for lenticular prints produced by imaging directly through the lenticular screen

Create three cards using the same settings that will be used for the final laser engraving. Use RGB = 128,128,128 to emulate a photograph or other bitmap image. Use a black box from a suitable font such as Arial Black with RGB = 0,0,0 to emulate text. Use a blank card to adjust for angle dependence of reflectivity of the lenticular screen.

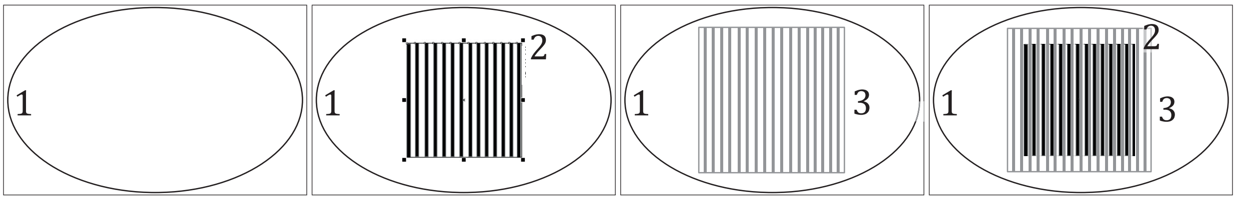
a) One sample with no image.

b) One card with the "left" or “front” image.

c) One card with the "right" or “back” image.

d) One card with both images.

The test print shall consist of two images singly and in combination produced via laser engraving at two distinct angles, as shown in Figure (5).



Key

1 CLI feature

2 6 mm text box 22 point arial black

3 8 mm photo box RGB = (128, 128, 128)

Figure 5 — Representative diagram of a typical 14 mm × 10 mm CLI feature showing an unimaged oval, two single laser images, and one dual laser image

6.4 Construction of a lenticular print

The lenticular print can be produced

a) by printing directly on the back face of a lenticular lens sheet,

b) by bonding the printed sheet to the lenticular lens sheet, or

c) by direct imaging of the lenticular sheet using a laser engraver at two distinct angles.

The precise alignment of the lenticular lens and the printed lenticular image is essential in methods a) and b). When using method c), the lenticular screen and the lenticular image are automatically aligned. For method c), CLI lenticular screens are oriented parallel to the short edge of the card, while MLI lenticular screens are oriented parallel to the long edge of the card. The procedures for the printing of high-quality lenticular images are described in Annex B, Annex C, and Annex D.

7 Measurements and calculations

7.1 General

This document specifically describes the measurement methods of the density and the evaluation methods for the following critical attributes of lenticular prints for changing images:

a) crosstalk of lenticular images;

b) viewing direction angle range of a lenticular image;

c) divergence from the designed viewing direction angle of the main lenticular image;

d) uniformity of the image within the printing area.

These attributes are critical for high quality lenticular prints for changing images.

These items are measured by changing the angle of the print to the plane of the light measurement device (LMD).

7.2 Measurements of angular dependence

The measurements of the viewing direction dependence of density shall be done using the measurement system described in Clause 5.

For black and white images, all white patches, all black patches, and patches with a micro-striped pattern that are illustrated in Figure 4 and Tables 1 or 2 shall be measured. For colour images, the black striped pattern shall be replaced with a primary colour, i.e. yellow, magenta, or cyan, or with a secondary colour, i.e. red, green, or blue.

The reflected light from the lenticular print shall be measured from the normal direction of the print. Then, the print shall be rotated as shown in Figure 1 or Figure 2. The reflected light shall be measured in intervals of 2° from −45° to +45°.

The visual density shall be calculated with Formula (3), in accordance with ISO 5-3 and ISO 5-4.

$$D_{v,\theta} = -\log\left(I_{s,\theta} / I_{w,\theta}\right) \quad (3)$$

$I_{w,\theta}$ is the intensity of the reflected light at an angle θ from the standard white board calibrated as described in 5.5, and $I_{s,\theta}$ is the intensity of the reflected light at an angle θ from the sample.

$I_{s,\theta}$ and $I_{w,\theta}$ are calculated from spectrum data with Formula (4) and Formula (5), respectively

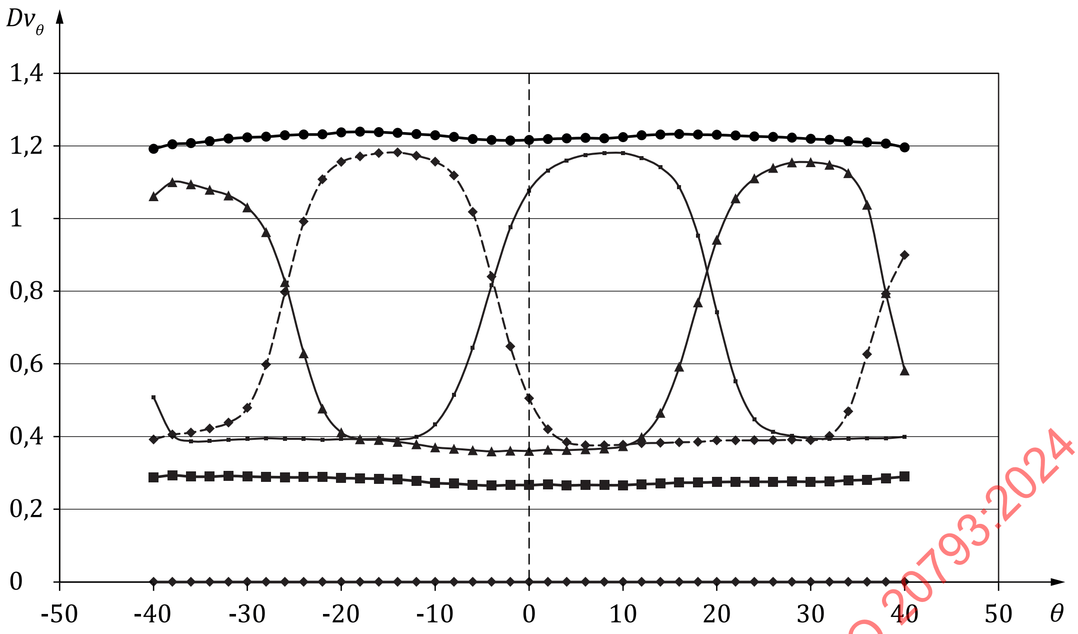
$$I_{s,\theta} = \sum_{\lambda=380}^{720} R_{s,\theta}(\lambda) \times \Pi\, v(\lambda) \quad (4)$$

$$I_{w,\theta} = \sum_{\lambda=380}^{720} R_{w,\theta}(\lambda) \times \Pi\, v(\lambda) \quad (5)$$

where $R_{s,\theta}(\lambda)$ is the reflection intensity at wavelength λ at an angle θ from the sample, $R_{w,\theta}(\lambda)$ is the reflection intensity at wavelength, λ, at an angle θ from the standard white board, and Πv is the spectral products defined in ISO 5-3.

When R, G, B densities are required, Π_R, Π_G or Π_B shall be used respectively. $\Pi v(\lambda)$.

Examples of the density measurement results of 3-way lenticular prints are shown in Figure 6.



Key

θ	angle
$D_{v,\theta}$	visual density
—◆—	NCS
—■—	base
--◆--	1/3 (*W*)
—·—	2/3 (*W*)
—▲—	3/3 (*W*)
—●—	black

Figure 6 — Examples of density measurement results — 3-way lenticular image — Viewing angle dependence

7.3 Calculation of crosstalk, viewing angle range and angular misalignment

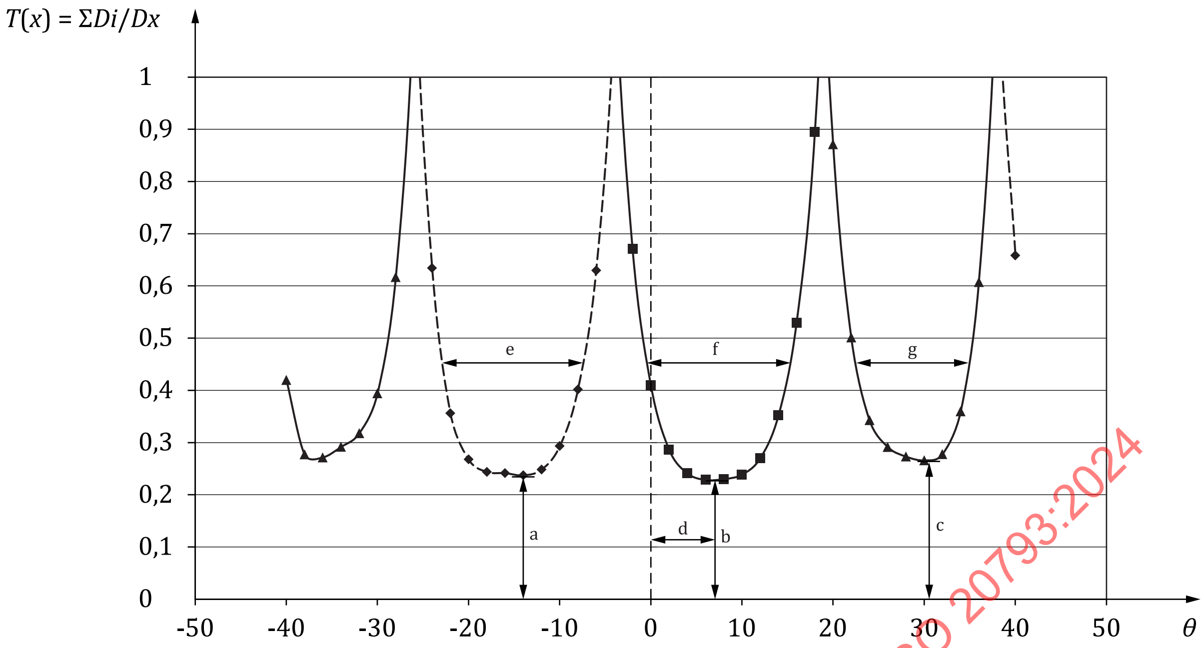
The crosstalk, *T*, is reduction of image contrast and is defined as the ratio of the unwanted image to the wanted image at the optimum viewing angle for the wanted image. The crosstalk is defined by Formula (6):

$$T(x)=\left(\sum_{1}^{n} D_{\mathrm{i}} / D_{\mathrm{w}}\right) \tag{6}$$

where $T(x)$ is the crosstalk at the angle that is the optimum viewing angle for the wanted image x, n is the number of picture elements, D_{i} is the density of the unwanted images, and D_{w} is the density of the wanted images at the optimum viewing angle for the wanted image x.

Examples of the measurement results of $T(x)$ are shown in Figure 7.

The crosstalk of each image shall be evaluated from the minimum value of $T(x)$ of each image, defined as $T(x)$ as shown in Figure 7.



Key

θ	angle	[b]	Crosstalk for image 2/3.
$T(x)$	crosstalk at the angle that is the optimum viewing angle for the wanted image x	[c]	Crosstalk for image 3/3.
--◆--	1/3 (W)	[d]	Angular misalignment.
—■—	2/3 (W)	[e]	Viewing angle range for image 1/3.
—▲—	3/3 (W)	[f]	Viewing angle range for image 2/3.
[a]	Crosstalk for image 1/3.	[g]	Viewing angle range for image 3/3.

Figure 7 — Examples of measurement result of $T(x)$ — 3-way lenticular image — Viewing angle dependence

The misalignment angle is the divergence of the angle at the minimum point of the crosstalk to the designed viewing angle of the main lenticular image. If the designed viewing angle of the main lenticular image is normal, i.e. $\theta = 0$, then the misalignment angle of the main image (image 2/3) is '*d*' in Figure 7.

The viewing angle range is the angle range where the crosstalk is equal to or less than 0,45, as shown in Figure 7.

7.4 Crosstalk for laser-engraved, lenticular samples

Density is calculated from luminance of the image, L_i, corrected for the angular dependence of the unimaged lenticular screen reflection, L_s, using the following Formula (7):

$$D = -\log 10\left(\frac{L_i}{L_s}\right) \quad (7)$$

Crosstalk, T, is calculated by comparing the density of the desired feature when printed without the second feature, D_F, to the combined density when both features are present, D_C. In Formula (8) and Formula (9), the undesired density, D_U, represents the density attributable to the undesired feature when both features are present:

$$D_U = D_C - D_F \quad (8)$$

$$T = 100 \cdot D_U / D_F \quad (9)$$

Misalignment is not possible with directly imaged laser-engraved samples. As with samples produced using other processes, the viewing angle range for laser-engraved, lenticular samples is the angle range where the crosstalk is equal to or less than 0,45.

7.5 Uniformity in the printing area

Uniformity in the printing area shall be measured at the nine points shown in Figure 8, using the same measurement procedures described in 7.2 and 7.3.

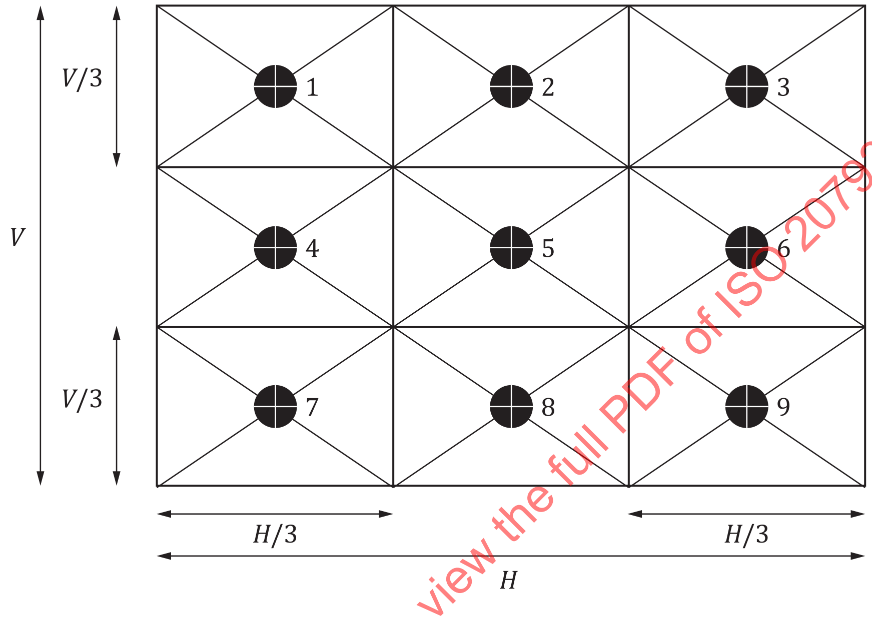


Figure 8 — Standard measurement positions with nine measurement positions equally spaced in the printing image area

8 Classifications

8.1 General

Crosstalk, viewing direction angle range, angular misalignment, and uniformity in printing area shall be reported. The importance of each item depends on the use application. For example, for a business card, which shows different images and text, cross talk may be bothering but the viewing angle range may not be critical because it is viewed by properly adjusting the angle. For a poster, both crosstalk and the viewing angle range may be critical. The guidelines of the classification are described in this clause.

8.2 Crosstalk

Crosstalk value, $T(x)$, shall be reported as described in 7.3 and 7.4. The level of the crosstalk shall be classified as shown in Table 3.

Table 3 — Classification of the level of crosstalk

Class	Classification	Crosstalk *T*(*x*)
Aa	Very high differentiation	<0,30
A	High differentiation	0,30 to 0,45
B	Low differentiation	0,45 to 0,60
C	Very low differentiation	>0,60

8.3 Viewing angle range

The viewing angle range shall be reported in degrees (°) as described in 7.3 and 7.4. The level of the viewing angle range shall be classified as shown in Table 4.

Table 4 — Classification of the level of the viewing angle range

Class	Classification	Viewing angle range
Aa	Very wide	>20°
A	Wide	10° to 20°
B	Narrow	5° to 10°
C	Very narrow	<5°

8.4 Angular misalignment

Angular misalignment shall be reported in degrees (°) as described in 7.3. The level of angular misalignment shall be classified as shown in Table 5.

Table 5 — Classification of the level of angular misalignment

Class	Classification	Angular misalignment
Aa	Very accurate	<5°
A	Accurate	5° to 10°
B	Fair	10° to 20°
C	Not accurate	>20°

NOTE Continuous binning can be used when it is required.

8.5 Uniformity in the printing area

For uniformity in the printing area, the cross talk $T(x)$ of position 1 to 9 shown in Figure 8 shall be reported.

Annex A
(informative)

Explanation of a lenticular lens print

A.1 General

A lenticular lens comprises an array of magnifying lenses which are designed so that when the underlying interlaced images are viewed from slightly different angles, different images are magnified. When used in lenticular printing, this technology provides an illusion of depth, morph, or motion as the underlying composite image is viewed from different angles.

A.2 Structure of a lenticular lens print

A photograph of a typical lenticular lens sheet is shown in Figure A.1.

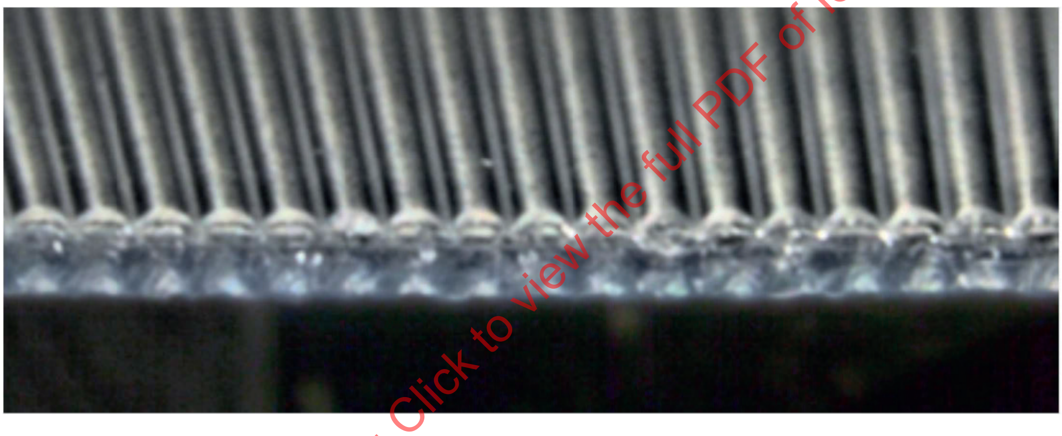
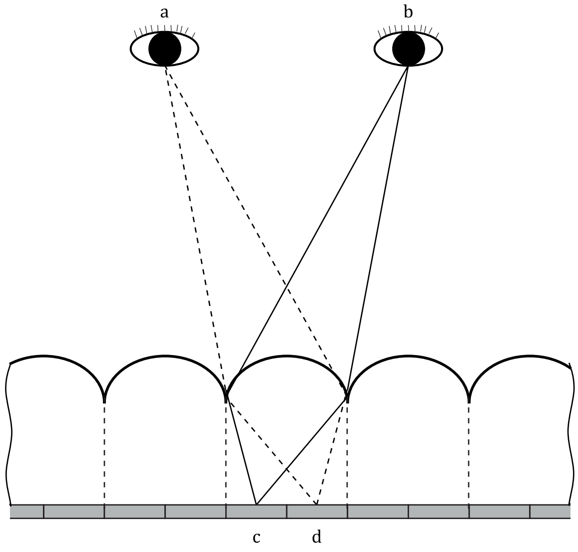


Figure A.1 — Image of a lenticular lens sheet

A.3 Mechanism for changing images

The mechanism for changing images is illustrated in Figure A.2.



a Viewing position a).
b Viewing position b).
c Image element for position a).
d Image element for position b).

Figure A.2 — Illustration displaying the mechanism for changing images

Annex B
(informative)

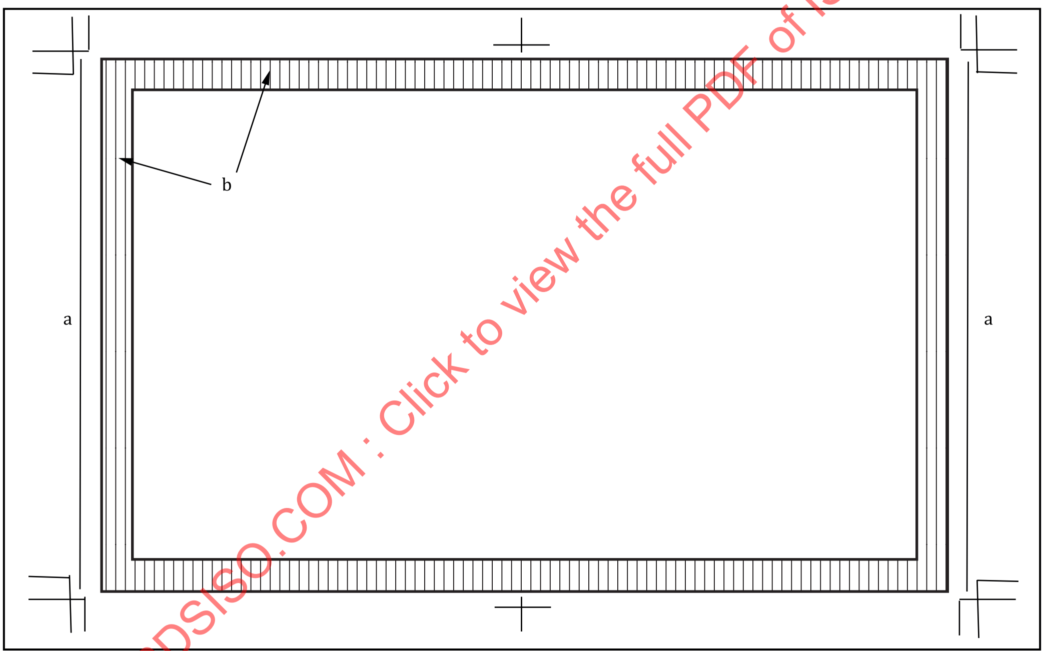
Procedures of lenticular printing

B.1 Marker

It is critical to print accurately and precisely by aligning the lenticular images relative to lenticular lenses. Markers are used for aligning the position. An example of the markers is shown in Figure B.1.

The striped lines are used to make adjustments in the inclination of the lenses. The striped lines are also used to check the pitch or the width of the lenticular lens.

The reference line is used to make precise adjustments of the inclination and the position of the printing position relative to the lenticular lens. The reference line is also used to adjust the colour register. In the latter case, a broken line is used to easily see the colour.



a Reference line.

b Striped line.

Figure B.1 — An example of markers

B.2 Printing procedures

B.2.1 Outline

The outline for printing is as follows;

a) print on waste paper (lens sheet) for colour and density adjustments;

b) print on a lens sheet or actual printing stock:

   1) adjustment of the inclination;

   2) adjustment of the colour register;

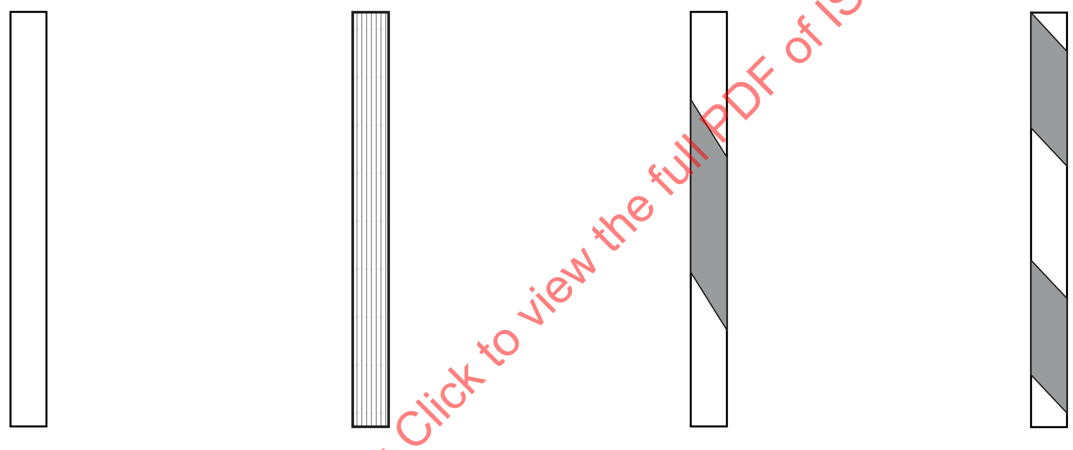
   3) checking the pitch;

   4) proofing;

   5) production printing.

B.2.2 Adjustment of the inclination of the lens sheet

First, the striped lines of both the right and left sides are used to adjust the inclination of the lens sheet. The front guide at the feeder of the printer is adjusted so that each striped line of both the right and left sides is seen as a straight white line or a straight black line, as shown in Figure B.2 a) and b). If a skew gradation of black and white is seen as shown in Figure B.2 c) and d), the lens is inclined. If the pattern shown in Figure B.2 c) is observed, the printing is slanted to the extent equivalent to one lens pitch, and if the pattern shown in d) is observed, the printing is slanted to the extent equivalent to two lens pitches. The inclination should be adjusted for printing.

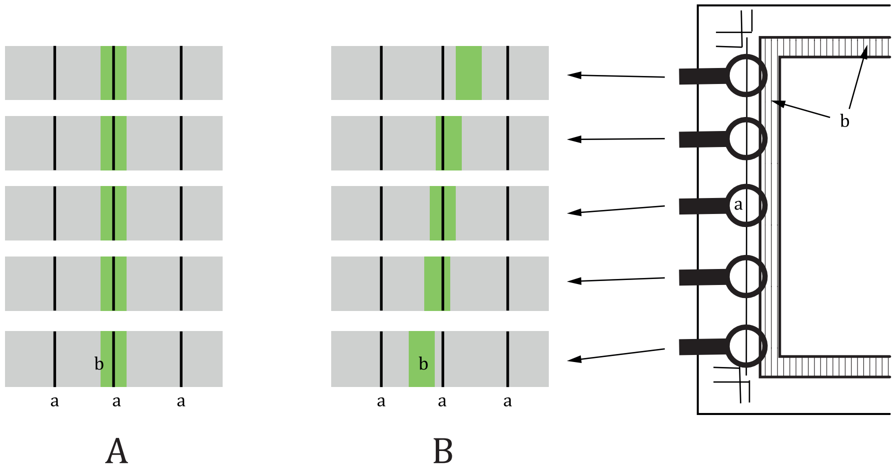


a) Good b) Good c) No good d) No good

Figure B.2 — Assessment of the inclination of lenses

For precise observation, the print should be rotated 90°, and the striped lines should be viewed horizontally.

Next, the reference lines for both the right and left sides are used to adjust the inclination of the lens sheet more precisely. The positions of the lens channel and the reference line are checked for at least five points on the reference line. Fine adjustment is done so that the reference line is parallel to the lens channel, as shown in Figure B.3.



Key

A good

B no good

a Lens channel.

b Reference line.

Figure B.3 — Assessment of the inclination of lenses

B.2.3 Adjustment of colour register

The colour register is checked for yellow, magenta and cyan using the reference line. The lines of yellow, magenta and cyan should be precisely overlapped.

B.2.4 Adjustment of the pitch

B.2.4.1 Outline

The printing images interlace according to the pitch value of the lenticular lenses. The adjustment of the pitch is essential to ensure an optimal viewing experience.

The mechanical pitch of the lenticular lens is measured precisely before printing. The pitch of the lens can vary from lot to lot of the production run of a lenticular lens sheet. Furthermore, a lenticular lens sheet expands or contracts with humidity and/or temperature swings. Therefore, it is preferable to place the lenticular lens sheet for a couple of days in the atmosphere of the printing environment; also, it is desirable to measure the pitch just before printing.

NOTE Measurements and classifications of the dimensions of a lenticular lens sheet are stipulated in ISO/TS 20328[1].

A test chart for the pitch measurements is printed on a plate which is dimensionally stable. The test chart includes a sequence of patterns which have slightly incremental pitches around the nominal pitch. Then, the lenticular lens sheet is superimposed on the printed test chart. The test chart is visually inspected through the lens sheet, and the pattern with the best image quality is selected. The pitch value of the lenticular lens is the pitch of the pattern.

When the nominal pitch of the lenticular lens sheet is not indicated and unknown, the approximate pitch is estimated beforehand. For that purpose, a coarse test chart with the wider range of the pitch values is used.

B.2.4.2 Creation of a test chart for pitch measurements

A test chart for the pitch measurement includes patterns which have slightly incremental pitches around the nominal pitch value of the lenticular lens. For example, if the nominal pitch value is 75 lpi, patterns of ..., 74,085 lpi, 74,090 lpi, 74,095 lpi, 75,000 lpi, 75,005 lpi, 75,010 lpi, 75,015 lpi, ... are included in the test chart. An example of a test chart is illustrated in Figure B.4.

Figure B.4 — An example of a test chart for the measurement of the lens pitch

NOTE These types of test charts are easily created with commercially available software.

The test chart shown in Figure B.4 is LentiDotManager® provided by RittaiGiken Inc. Other examples of software are shown below:

— RittaiGiken, Inc., Easy Lenti Studio (https://www.rittaigiken.co.jp/en/software/els.html)

— Imagiam High Image Techs SL, Lenticular Suite (https://www.imagiam.com/)

— Triaxes, 3D Master Kit (https://triaxes.com/3dmasterkit/)

B.2.4.3 Printing of the test chart for pitch measurements

The test chart described in B.2.4.2 is printed on a CTP plate with laser beam.

B.2.4.4 Estimation of the pitch of a lenticular lens

The lenticular lens sheet is placed over the printed test chart. The inclination of the lens sheet and printed images is adjusted as described in B.2.2.

The lens sheet is adjusted horizontally in such a way that the pattern of the left column is clearly observed, as shown in Figure B.5.

Then, the line for which the patterns are clearly observed from the left (column 1) to right (column 8) is searched for, as shown in Figure B.6. The number indicated in the line is the pitch of the lens sheet.

Figure B.5 — Example of horizontal adjustment of a lenticular lens sheet and the print

Figure B.6 — Representation of the search for the line where the pattern is clearly observed from the left column to the right column to estimate the pitch of the lenticular lens

B.3 Quality inspection

The quality of the print is inspected in the following points:

— for changing images:

  — crosstalk;

  — false colour or fringe during the change;

— moire (interference between lens and lenticular images);

— dot, screen pattern, graininess, or mottle;

— reproduction of fine lines;

— colour reproduction;

— transparency to the backside;

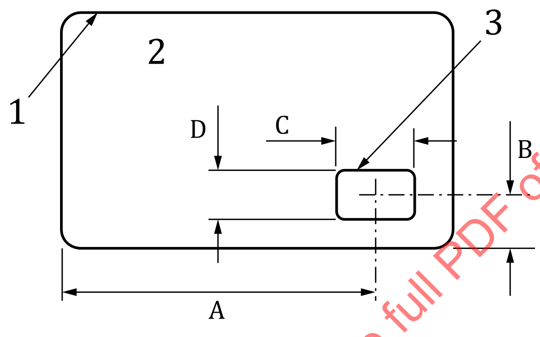
— fringe caused due to CTP.

Annex C
(informative)

Evaluation of lenticular material quality prior to laser imaging

C.1 Lenticular card product construction example

Card product dimensions for identity card and driving licenses are generally chosen for conformity to ISO/IEC 7810 for the ID-1 card size of 85,60 mm width x 53,98 mm height x 0,76 mm thickness. Lenticular areas for laser imaging cover only a small area of the card. An example lens area and location are shown in Figure C.1



Key

1 top reference edge of card

2 front of card

3 lens area

Figure C.1 — Location and dimensions of lenticular lens area on card

As noted in ISO/IEC 7501-1, passport data pages can also contain lenticular areas to record a variable laser image. These data pages conform to the ID-3 width and height specifications as specified in ISO/IEC 7501-1 and ISO/IEC 7810.

For applications that require the formation of high-quality laser marked images it is often desirable to use an Nd:YAG (neodymium-doped yttrium aluminium garnet) fibre laser with output at 1 064 nm. At those wavelengths, polycarbonate absorbs some of the laser energy and blackens via carbonization reactions.

Multilayer laser-imageable cards are constructed by laminating clear laser-reactive (LR) layers around an opaque central core layer. In the construction illustrated below in Figures C.2 and C.3, the LR layers comprise a polycarbonate resin. Lenses are formed during the elevated temperatures and pressures of the lamination as LR material flows into lens cavities engraved into the lamination plate. The focal length of the lenticules is defined by the pitch, P, and lens radius, R. Although Figure C.2 shows a card with lens areas on the front and back, this symmetrical structure is not a requirement.