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Information technology — Method of measuring gloss uniformity on printed pages

Technologies de l'information — Méthode de mesure de l'uniformité de lustre des pages imprimées

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Foreword

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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.

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ISO/IEC 19799 was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

Introduction

The purpose of this International Standard is to provide a process for measuring objective print quality attributes for gloss non-uniformity on printed pages in reflection mode.

This International Standard prescribes the following:

— a definition of gloss uniformity attributes representative of the print quality on reflection prints;

— a procedure for gloss uniformity testing and the analysis of the resulting data;

— a method for evaluating and grading these measurements and deriving an assessment of gloss uniformity, enabling a means to correlate the objective gloss uniformity measurement to subjective impression of gloss uniformity if appropriate; and

— the appropriate method of describing the gloss uniformity of printing and copying systems in documentation supplied to the consumer by the manufacturer.

Information technology — Method of measuring gloss uniformity on printed pages

1 Scope

The scope of this International Standard is to define methods and processes of measuring objective print-quality attributes for the assessment of gloss non-uniformity on printed pages in reflection mode, and to provide transforms, when applicable, that relate the objective results to subjective responses, if appropriate. There are many existing standards (see Normative references and Bibliography for details) typically used for gloss measurement. Our intent is to leverage the existing standards and adapt those for use on gloss uniformity measurements where appropriate.

This International Standard is composed of a standardized test methodology, which is based on established gloss measurement methodologies as noted in Clause 2 and in the Bibliography. The methodologies have been modified so that, when applied to printed pages created by different marking technologies and imaging algorithms on different substrates, the results indicate the level of the objective gloss uniformity of the printed pages (in reflection mode). If the objective measurement can be linked to the subjective impression of gloss uniformity, then the linkage from objective measurement to subjective impression via mathematical transforms is provided. The reflection prints that are to be used as the subject of these tests can be created via printers or copiers (analog and digital). This International Standard should be applied only to electro-photographic bases prints. When more reflection prints made by other printing technologies become available for follow-up study, one may consider including those printing technologies in this International Standard as a revision. This International Standard does not address the measurement of gloss attributes of printed pages in transmission mode.

Gloss uniformity attributes currently included in this International Standard are: differential gloss, gloss uniformity within a page, and gloss consistency within a run. Due to the current level of immaturity of commercially available objective micro-gloss measurement instruments, gloss artefact attributes (such as gloss grain, gloss spot, gloss streak, gloss band, gloss mottle/cloud, gloss moiré) are not included in this International Standard at the present time, since instrumented measurement procedure cannot be recommended at present. As instrumented measurement capability becomes available, they will be considered for adoption into this International Standard as a revision.

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.

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°*

ISO 8254-1:1999, *Paper and board — Measurement of specular gloss — Part 1: 75° gloss with a converging beam, TAPPI method*

3 Terms and definitions

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

3.1
gloss value
pertains to front surface reflection of incident light from an image or non-image area that varies with angle relative to the normal-to-the-receiver surface

NOTE Images whose front surface exhibits a highly specular reflection are considered to be high gloss while those whose front surface exhibits more of a lambertian (matte) reflection characteristic are considered to be low gloss. Gloss values can differ depending on the measurement methodology (such as measurement angle of gloss instruments and the size of the sampled area) and the magnitude of gloss level in the area of interest.

3.2
differential gloss
spread of the gloss readings on a single test target

NOTE Differential gloss, when present, is an image content and substrate dependent effect. Colorant area coverage ranging from 0 % to high area coverage must be considered as that coverage difference which is commonly observed in typical images. The effective range of minimum and maximum gloss can vary dependent upon substrate gloss. Thus, an image with variable spatial colorant laydown can exhibit variation in gloss level, and this variation may be large enough to be observed and considered to be objectionable. Differential gloss, in this context, is most easily quantified when observing adjacent flat-field image regions of different content (density, colour, etc.).

3.3
within page (flat-field) gloss variability
attribute that often takes the form of a large-scale gloss gradient (gloss value change), or fade, from one side of the image (at the same colorant laydown) to the other or from top to bottom of the image

NOTE This is generally evaluated within large flat field regions, since the same level of colorant laydown is needed over the entire region to correctly quantify this type of gloss variability.

3.4
page-to-page (flat-field) gloss variability
variability in the gloss value of the document from page to page (one-sided printing as well as two-sided printing), or between adjacent pages (of the same image contents)

NOTE This gloss value variation can be accompanied by any of the other gloss categories defined here, such as within page gloss variability or sundry gloss artefacts, and can probably only be meaningfully evaluated between pages with the same image content. The magnitude of this attribute can be deduced from the measurement of gloss consistency within a run.

3.5
gloss consistency within a run
gloss variation (flat-field) of the same colorant coverage on a similar substrate within a print run of a pre-defined run length

3.6
gloss artefacts
such items as gloss grain, gloss spot, gloss streak, gloss band, gloss mottle/cloud and gloss moiré

NOTE More detailed descriptions of these artifacts can be found in the Normative references and the Bibliography. Due to the current level of immaturity of objective measurement equipment for these gloss artefacts, an instrumented measurement procedure cannot be recommended at present. As instrumented measurement capability becomes available, this will be considered for adoption into this International Standard.

3.7
mean gloss
attribute that quantifies the overall level of glossiness of the print

NOTE The mean gloss value is calculated from the gloss values for the 40 individual printed patches (see the test chart in Annex A) on the print under test. The mean gloss value of the 40 patches is considered to be the mean gloss of the print. Mean gloss, for the purposes of ISO 19799, refers only to the mean gloss of the test chart provided in Annex A. The mean gloss, which is image content dependent, will not necessarily be the same for other images.

4 Test Parameters and Conditions

4.1 Set-up

Place the copier or printer on a horizontal surface and set-up the copier/printer according to the installation guide provided in the user's manual. Use the most recent copier/printer driver available from the manufacturer. The driver version will be specified on the test report.

All image and print quality modifiers should be at their factory pre-set configuration for the copier/printer and default installed condition for the driver. If the printer/copier and driver differ, then the driver defaults should be used. Deviation from the above conditions should be noted in the test report. For the printer, to assure that the test page is rendered correctly, no page size modifiers such as "Fit to Page" should be used and font substitution should be turned off. The file should be printed using the fonts embedded in the file and should be rendered on the page in a size corresponding to the dimensions in the test page description. Page placement modifiers such as page centering can be used to place the image properly on the page. The test(s) shall be performed in the following environment.

Temperature: 18 °C to 25 °C

Relative humidity 30 % to 70 %

4.2 Sample Size

For the differential gloss and gloss uniformity within-page tests, only one set of representative test prints (for printer) or copies (for copier) is required. For the gloss consistency within a run test, ten sets of test prints are needed (the test set can have multiple pages).

4.3 Print Mode

For reporting gloss uniformity, the test shall be run after the engine has warmed up in ready mode. The engine settings (simplex mode, duplex mode, paper selection, fuser setting, print speed, quality setting etc) of the Printer/copier should be noted in the report.

4.4 Paper

The paper used in this test should represent a compatible paper for the engine, and must conform to the manufacturer's list of approved papers unless otherwise noted in the report. The paper manufacturer, weight, coated/uncoated, paper gloss and size, A4 or equivalent, used in the test will be noted on the report.

4.5 Maintenance

Print engine maintenance shall be performed per the user's manual.

4.6 Original test charts for copiers

This standard addresses the gloss uniformity of reflection prints regardless of whether the print comes from a printer or a copier. Therefore, both an electronic test file (described in section 4.7) for the printer and a hardcopy reflection test chart original to be used by copiers (analog and digital) shall be specified. The originals for the copier can be produced by several methods using the test charts (in electronic form) shown in Annex A, Annex E.1 and Annex E.2. The aim is to produce a large enough color gamut to cover a large range of colorant coverage. The differential gloss test chart can be produced using RGB test files in Annex A.3 (an annotation of its content is shown in Annex A.4) on Silver Halide paper (such as Kodak Edge 8, Fuji Crystal Archive or equivalent) printed with a digital AgX imaging system (such as Durst Lambda, Fuji Frontier, Noritsu or equivalent). The colour values (D65 illuminant, 2 degree observer, black backing) of a differential gloss colour test chart original (with printed colour tolerance of +/– 3 deltaE) are shown in Annex A.5. In this case, it was created with a Durst Lambda printer using Kodak Edge 8 paper. An example of differential gloss measurement results for a copier (as compared with the results from the printer function of the same engine

using a Durst Lamda/Kodak Edge 8 original) is shown in Annex B). The colour values (D65 illuminant, 2 degree observer, black backing) of the gloss-uniformity within-page original test charts (Annex E.1) produced by the same method are shown in Annex E.2. Other methods of creating the copier original are acceptable if the colour values of the test charts are within 3 deltaE of the specified values.

4.7 Print Files

The print test files are outlined and specified in Annex A (both an RGB file {Annex A.3} and a CMYK file {Annex A.1}, and their corresponding annotation files {Annex A.4 and Annex A.2} that define their contents are provided). Annex E shows the file contents for the within-page test charts (the annotation files for these test charts are defined in the INCITS W1.1 references listed in the Bibliography). The RGB file is intended for printers requiring RGB files and the CMYK file is intended for printers requiring CMYK files. The test must be conducted using the most recent official electronic test files as the input. The most recent official files are available in PDF format and are located at http://www.iso.org/jtc1/sc28. Failure to use the most recent official electronic test files will invalidate test results. In addition to the test files, the latest version of Adobe™ Acrobat Reader or equivalent will be used with the printer driver to generate the output data. The version of the test file and Acrobat will be included in the test report.

Currently, it is suggested that a CMYK file be used for 4 colour printers. For other printers, the default condition is RGB files. The file format used shall be included in the test report.

5 Test Methodology

5.1 Testing Procedure for copiers

1) Install the copier following the user's manual and put the system into ready mode.

2) Set the system parameters (such as paper weight selection, paper size and feed orientation, quality mode) for test. Record the engine model, configuration (hardware and software version number), default condition and variant selected.

3) For the differential gloss and gloss uniformity within-page tests put each of the six test charts (one for the differential gloss test, five for the gloss uniformity within-page test) on the copying platen one at a time (or in the automatic document feeder if one is available) and make one set of copies with at least a 5-second interval between the completion of one copy and the start of the next copy.

4) For the test for gloss consistency within a run, place each of the five-page gloss uniformity within-page test charts on the platen one at a time (or in the automatic document feeder if one is available) and make n sequential copies of each of the test charts with at least a 5-second interval between the completion of one n copy run and the start of the next n copy run. Specified copy count, n and time variations could be highly dependent upon intended market target for the copier/printer and it is therefore preferred to vary this interval as a function of copier/printer rated speed (in K ppm). At least 10 sets of test charts should be printed. Also from a statistical analysis viewpoint, minimum of 5 sample sets (from the collected n print sets) are needed for measurements and analysis. The 5 sets of data for measurement should include the 1st set, the last set and 3 other sets that are substantially evenly distributed in the test job stream (for example, close to the ¼, ½ and ¾ mark of the each of the test run).

   n1 = Integer (K * 10),

   If n1 >= 10,

   n = n1, else

   n = 10.

5.2 Testing Procedure for printers

1) Install the printer following the user's manual and put the system into ready mode.

2) Set the system parameters (such as paper weight selection, paper size and feed orientation, quality mode) for test. Record the engine model, configuration (hardware and software version number), default condition and variant selected.

3) For the differential gloss and gloss uniformity within-page test, send each of the six electronic files (one for the differential gloss test, five for the gloss uniformity within-page test) to the printer and make one set of prints with at least a 5-second interval between the completion of one print and the start of the next print.

4) For the gloss consistency within run tests, send each of the five pages of the gloss uniformity within-page test charts to the printer and make n sequential prints of each of the test pages with at least a 5-second interval between the completion of one n print run and the start of the next n print run. Specified copy count, n and time variations could be highly dependent upon the intended market target for the copier/printer and it is therefore preferred to vary this interval as a function of copier/printer rated speed (in K ppm). At least 10 sets of test charts should be printed. Also for statistical analysis, a minimum of 5 sample sets (from the collected n print sets), is needed for measurements and analysis. The 5 sets of data for measurement should include the 1st set, the last set and 3 other sets that are substantially evenly distributed in the test job stream (for example, close to the ¼, ½ and ¾ mark of the each of the test runs).

   n1 = Integer (K * 10),

   If n1 >= 10,

   n = n1, else

   n = 10.

6 Determination of the gloss uniformity for printed pages

6.1 Determination of differential gloss

Measure the gloss value of the 40 patches on the printed Differential Gloss chart (see the test chart on Annex A) using 60-degree gloss measurement geometry (G60) as specified by ISO 2813. The gloss measurement should be performed with the longer dimension of the gloss meter window aligned with the long dimension of the test patches. Take one gloss measurement per patch. Calculate the mean gloss (Gm) using the equation below.

$$G_m(Mean\_Gloss) = \frac{1}{40}\sum_{i=1}^{40} G_{60}^{i}$$

If the mean gloss (Gm) of the 40 patches is higher than 70 units, re-measure the gloss value of the 40 patches using the 20-degree gloss measurement geometry (G20) and recalculate a new mean. If the mean gloss (Gm) of the 40 patches is lower than 15 units, re-measure the gloss value of the 40 patches using the 75-degree gloss measurement geometry (G75) and recalculate a new mean. Identify the maximum (Gmax) and minimum (Gmin) gloss values among the 40 test patches. The objective differential gloss (Dg) is defined as

Dg = Gmax – Gmin

Note that (see Annex B) even though the colour of the patches on the copier's output (as based on the test chart original) can be quite different than that of the printer output (as based on the digital file), the Dg value obtained from the copier and printer function of the same engine are within an acceptable gloss tolerance of

each other based on a previous inter-lab round-robin experiment[5]. The values of Gmax, Gmin, Dg and Gm should be noted in the report.

If the G60 measurement was used, the objectively measured differential gloss can be linked to a subjective visual differential gloss scale (Sg) through a mathematical transform as shown in Annex C.1[4].

A multi-national round-robin experiment (Annex F) using a print of the differential gloss test chart (40 patches per chart) on 10 different papers using various gloss meter models has been completed. The data indicates that if only G60 measurements are used, good correlations have been obtained for all gloss meters tested. However in the case when G75 gloss measurements are performed (if the mean gloss level is low, G75 may provide better sensitivity than G60), the correlation of data is weak[10]. If only the data from G75 gloss meters following the TAPPI method according to ISO 8254-1 (or equivalent) is used, correlation is good as shown in Annex F. It is therefore suggested that, for G75 measurements, only results from gloss meters that use the TAPPI (or equivalent) method according to ISO 8254-1 Standard should be reported. For samples that are reporting G75 results (mean G60 gloss value <15), the G60 values of Gmax, Gmin, Dg and Gm should also be noted in the report. The gloss meter manufacturer, model number, serial number and the date of factory calibration should be reported irrespective of whether G20, G60 or G75 measurements are used.

6.2 Determination of gloss uniformity within-page

If from the mean gloss determined in the differential gloss test is greater than 70, the G20 measurement as specified by ISO 2813 should be used; if it is less than 15, the G75 measurement should be used; otherwise the G60 measurement should be used. The five test charts (shown in Annex E) consist of two sets of 24 color bands (one set runs horizontally, the other set runs vertically). Each band of the 48 bands should be measured at five locations (one gloss measurement for each location). The centre position of the locations is marked by a set of discontinuous black lines that are adjacent to the colour bands. One of the locations is at the center of the band. Two other locations are located at approximately 1/6 and 1/3 of the length of the band to one side from the center location, and the last two locations are located at approximately 1/6 and 1/3 of the length of the band to the other side from the center location. The gloss measurement should be performed with the longer dimension of the gloss meter window aligned with the long direction of the test bands in Targets 2-1 and 2-2, and along the short direction of the test bands in Targets 1-1, 1-2 and 1-3. This alignment ensures that the gloss measurement direction is consistent with the paper grain direction for the five pages measured. For each of the 48 bands, the average gloss value (of the five location measurements), the gloss standard deviation value and the maximum gloss variation value (max-min within a band) are reported. The first four columns on Table 2 in Annex E.1 (chart name/band number, average, Standard deviation, Max-Min) show an example of this data being reported. An objective gloss uniformity measurement table like this one can be used for G20 as well as for G60 and G75 measurements.

In the case of G60 measurements, the objective measurement data can be related to a subjective visual gloss uniformity metric such as a “just noticeable difference” (JND). A curve of visual JND vs. gloss value is shown in Annex D for reference.

The JND for the G60 measurement is estimated by the following equation[6]:

$$JND_{60} = 0.14 * (G60)^{0.96}$$

Columns 5 and 6 of Table 2 in Annex E.1 show the JND (based on the average G60 value of the color band) and (max-min)/JND respectively for each of the 48 color bands on an example target chart set. The (max-min)/JND subjective measure can be used as a comparison of gloss uniformity within-page between engines and is independent of the overall glossiness of the prints as long as each print meets the G60 measurement criteria.

Since equivalent G20 (for very glossy prints) or G75 (for very matte looking print) JND measurement have not been established, JND and (max-min)/JND should only be used for G60 measurement (when mean gloss is $>= 15$ and $=< 70$ using the G60 method).

The objective (max-min) measurement can still be used for G60, G75 and G20 measurements.

