

Comparison of properties of the International Standard series ISO/IEC 15775 or DIS ISO/IEC 19839-1 to -4 and IEC 61966-X in the field of Image Technology

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ABSTRACT

The International Standard series ISO/IEC 15775 [1] and ISO/IEC DIS 19839-1 to 4 [2] of the committee ISO/IEC JTC1/SC28 and IEC 61966-X (e. g. X=2,7) [3] of the committee IEC TC100 TA2 are compared.

Keywords: Image reproduction, ISO/IEC-test charts, copiers, printers, scanners, monitors

ISO/IEC Standards of JTC1/SC28

The different standards ISO/IEC 15775 and DIS ISO/IEC 19839-1 to 4 and their relationship is shown in table 1

Table 1: Realisation and application of ISO/IEC-test charts for specifying image reproduction

Input	Output	Input and output media and applications			Standard
		Input media	Output media	Application	
–	–	–	–	Basis	ISO/IEC 19839–1
analog	analog	ISO/IEC-test chart (hardcopy)	Hardcopy	Copier	ISO/IEC 15775
analog	digital	ISO/IEC-test chart (hardcopy)	File	Scanner	ISO/IEC 19839–3
digital	analog	ISO/IEC-test chart (file)	{ Hardcopy Softcopy	Printer Monitor	ISO/IEC 19839–2 ISO/IEC 19839–4

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Table 1 describes the application and realisation of ISO/IEC-test charts and the methods for the specification of reproduction properties of colour image devices “**analog - analog**” (copiers), “**analog - digital**” (scanners, Photo-CD-systems) and “**digital - analog**” (printers, monitors) and may therefore be used as a basis for the comparison and the choice of such devices.

The produced **analog** ISO/IEC-test charts are compared visually with the **analog** original. One must reproduce the **analog** ISO/IEC-test charts on copiers or the **digital** ISO/IEC-test charts on printers and monitors. There is also an ISO/IEC colorimetric method for comparison (Examples, see Annex G of ISO/IEC 15775)

For scanners one must use the **analog** ISO/IEC-test charts for input. A colorimetric scanner which produces CIELAB data can use equations to transform the CIELAB data into *cmy**-data or *olv**-data of the default colour space *CMYOLVNW** of the ISO/IEC standards (*compare [1]*).

IEC Standards of IEC TC100 TA2

The different standards IEC 61966-X (e. g. X=2, 7) will not be described here in detail. More information is given on the web side:

<http://www.iec.ch/TC100/txt/100struc-ta2.htm>

Comparison of the different International Standards of ISO/IEC JTC1/SC28 and IEC TC100 TA2

The comparison is done by Tables 2 to 4 and Figure

1. This is a very rough comparison of the different advantages and disadvantages. The terms ISO/IEC and IEC standards are used as abbreviation.

Table 2: Image reproduction properties of standards ISO/IEC JTC1/SC28 and IEC TC100 TA2

Image reproduction property	ISO/IEC JTC1/SC28 – Information Technology – Office Systems ISO/IEC 15775:1999-12 (analog–analog) DIS ISO/IEC 19839-1 to -4: 2000-04 process: analog–digital, digital–analog		IEC TC100, Techn. Area 2 Colour Measurement and Colour Management IEC 61966-2-1: 1999-10 (Basis) IEC 61966-X, e. g. CDV 61966-7-1	
	Property	Remarks	Property	Remarks
analog and digital test charts and many test elements	YES	ISO/IEC 15775: 1999-12: Analog test charts produced by DIN (Germany) and JBMA (Japan)	NO	No analog test charts possible as hardcopy for the sRGB luminous TV (television) colours
Visual test of colour devices by reproduction properties	YES	Analog and digital cmyolvnw* (see www.ps.bam.de) reference test charts for PR (print) colours and D65	NO	No analog test charts possible in sRGB coordinates
Colorimetric test of devices by reproduction properties	YES	for 16step scales cmyolvnw* and for CIE-test colours in ISO/IEC-reference test charts Measure & calculate differences	(NO)	e. g. measure output of RGB-test chart (tiff, html) no reference and tolerance in CDV 61966-7-1
simple transformation of coordinates	(YES)	transformation in colour hexagon in CIELAB cmyolvnw* <-> CIELAB	YES	transformation in colour triangle in CIEXYZ sRGB <-> CIELAB

M6320-3, Image reproduction properties in standards

According to Table 2 there are no analog test charts in the IEC standards which reproduce the sRGB coordinates. Reference test charts of *cmy** coordinates of ISO/IEC standards have been produced by DIN (German Standard Institute) and JBMA (Japan Business Machines Makers Association).

Similar reproductions are not possible for IEC standards as the sRGB coordinates belong to luminous television colours which can not be reproduced as hardcopy. Therefore there is no possibility and no method for a visual test in TC100 standard. A colorimetric comparison with original test charts is only possible by ISO/IEC standards.

The transformation between CIELAB and *cmy** or sRGB coordinates and vice versa is slightly more simple in IEC standards. According to the ISO/IEC standards one of the six sectors of the colour hexagon defined by the six reproduction colours OLVCMY must be determined first. Then the coordinates *cmy** can be calculated within a triangle, e. g. OYW (Orangered, Yellow, White) in CIELAB space.

According to Table 3 a user expects that an input or output coordinate 0.5 is used e. g. for a mean gray (visual and colorimetric mean) between white and black with coordinates 0 and 1. This leads to a **linear**

relationship between input and output coordinates.

The ISO/IEC standards take this user requirement and set tolerances for the input-output relationship. The ISO/IEC standards take another user requirement for user friendly coordinates which are similar to the coordinates of the Swedish Natural Colour System (NCS). The NCS system uses the coordinates radial chromaticness R^* , blackness N^* and unique hue U^* , e. g. G40B (green with visual 40% blue). The ISO/IEC standards adapt the basic ideas of the NCS system to the reference offset reproduction process and define user friendly coordinates.

Only 8bit coordinates in perceptive space (*space) are used in ISO/IEC standards. For the achromatic colours Black-White (N-W) 6bit, 7bit or 8bit out of 8bit can be used in relative or absolute coordinates (*cmy** or *CMY**). Then there is space for coding of more chromatic colours ($R^* > 100$) and for colours with negative blackness N^* (e.g. fluorescent colours and highlights). The accuracy for 6 bit coding is 0.6 CIELAB units which is still much less compared to the user requirement of 3 CIELAB units for comparison of colours in images. The spacing in *cmy** coordinates is compatible to the CIELAB spacing but the sRGB spacing is incompatible to the CIELAB spacing.

Table 3: Image reproduction properties of

standards ISO/IEC JTC1/SC28 and IEC TC100 TA2

Image coordinate property	ISO/IEC JTC1/SC28 – Information Technology – Office Systems ISO/IEC 15775:1999-12 (analog–analog) DIS ISO/IEC 19839-1 to -4: 2000-04 process: analog–digital, digital–analog		IEC TC100, Techn. Area 2 Colour Measurement and Management IEC 61966-2-1: 1999-10 (Basis) IEC 61966-X, e. g. CDV 61966-7-1	
	property	remarks	property	remarks
linear input-output relationship; and user friendly coordinates	YES	tolerance of +/- 3 CIELAB units in standards; user friendly coordinate NRU* <-> CIELAB blackness, chroma, hue: G40B	NO	no tolerance in standards and no user friendly coordinates
8bit, n/8bit * coordinates cmy*, CMY*, olv*, OLV*, ...	YES	cmyolvnw* for standard PR, for standard TV, and any device; transformations for all n/8bit: cmyolvnw* <-> CIELAB	NO	sRGB only for the limited TV colour gamut, e. g. 5 of 16 PR-colours White–Cyan outside gamut
for N–W: 6/8bit * coordinates; include all real PR & TV colours	YES	the 6/8bit two times extended PR system defined by cmyolvnw* <-> CIELAB Accuracy: 0.6 / 3 CIELAB units	NO	CD 61966-2-x: linear 16bit coding system accuracy: 0.3 CIELAB units
compatibility to the CIELAB spacing	YES	coordinate spacing of cmyolvnw* and CMYOLVNW* proportional to CIELAB	NO	sRGB spacing only for gray similar to CIELAB

M6320–7, Image coordinate properties in standards

Table 4: Image reproduction properties of

standards ISO/IEC JTC1/SC28 and IEC TC100 TA2

Image processing property	ISO/IEC JTC1/SC28 – Information Technology – Office Systems ISO/IEC 15775:1999-12 (analog–analog) DIS ISO/IEC 19839-1 to -4: 2000-04 process: analog–digital, digital–analog		IEC TC100, Techn. Area 2 Colour Measurement and Colour Management IEC 61966-2-1: 1999-10 (Basis) IEC 61966-X, e. g. CDV 61966-7-1	
	Property	Remarks	Property	Remarks
Variable process management, e. g. colour photography	YES	Picture of the ISO/IEC-test chart as reference picture, e. g. as first film picture with 16step gray scale	NO	not possible to handle variable processes, e. g. from under to over exposure of film
Transformation between standard PR, TV, and device coordinates	YES	Equations for standard PR, standard TV, and any linearized device in *space cmyolvnw* <-> CIELAB	NO	sRGB only for the limited TV colour gamut, e. g. 5 of 16 PR-colours White–Cyan outside gamut
Necessary colour measurements: 3 CIELAB user tone tolerance	16 steps	standard colour space "surface" measurements and linearization in CIELAB space for 16 steps: 77/15x0.5=2.6 CIELAB units	6 or 9 steps 21 in gray	standard sRGB "cube" data of 6x6x6 allow only low accuracy in CIELAB space: 77/5x0.5=7.8 CIELAB units
Accuracy of tone quantisation in CIELAB	d8/8bit: D8/8bit: d6/8bit:	38.5/255 = 0.15 CIELAB units 100/255x0.5 = 0.2 CIELAB units 154/255 = 0.6 CIELAB units	sRGB	50/255 = 0.2 CIELAB units

M6321–3, Image processing property in standards

According to Table 4 the ISO/IEC standards can manage variable reproduction processes, e. g. the photographic process including a Photo-CD-scanning process of the analog film material. The digital data of this reproduction process can be corrected if a reference picture is taken as a first picture. It is intended to use an ISO/IEC-test chart for

a reference picture and then the original *cmy** coordinates (or CIELAB coordinates) in the original are known and the output *cmy** (star-dash) coordinates can be corrected. There are transformation equations between the standard PR, standard TV and any device coordinates *cmyolvnw** (of linearized devices) and the CIELAB coordinates.

The user requirement for accuracy of 3 CIELAB units leads to a reproduction and measurement of at least 16 steps for the tone scales, e. g. White-Cyan. There are cut offs near black and white for every device which then result to a failure of 2.6 CIELAB units. This is below the user requirement.

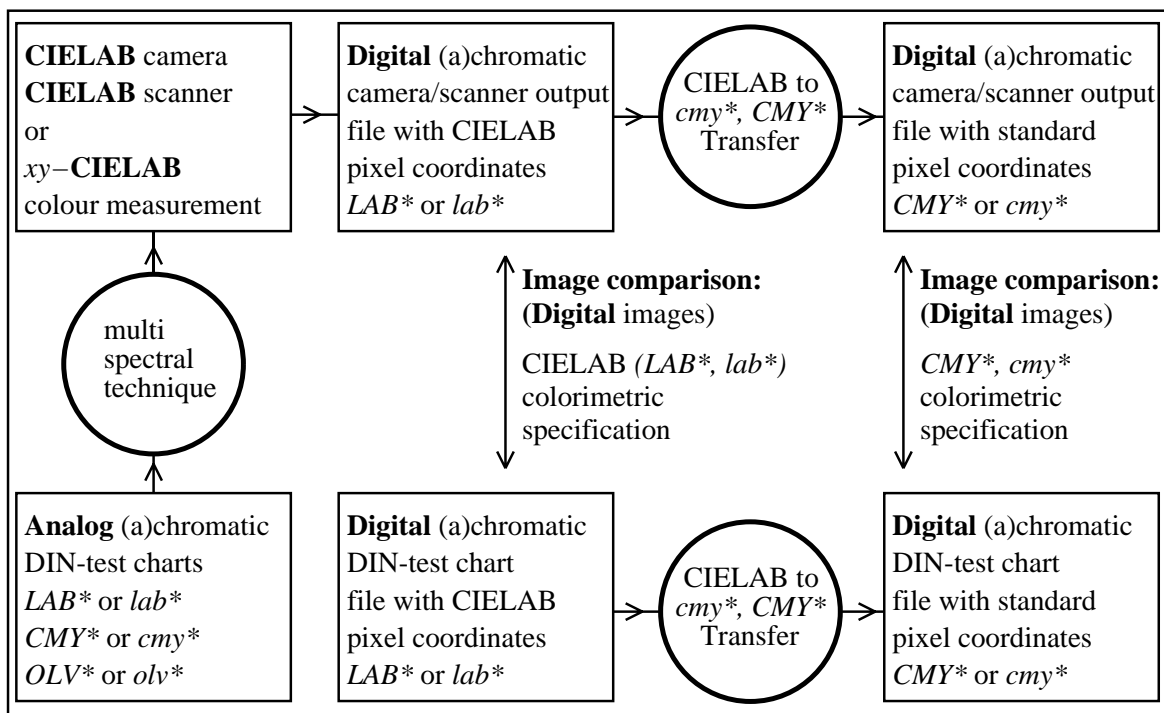
IEC standards, e. g. 61966-7-1 (printers), use only "cubic" data of 6x6x6 steps to produce ICC profiles. This will give a failure of 7.8 CIELAB units. This does not fulfil the user requirement of 3 CIELAB units.

Digital coding of 6bit out of 8bit does still agree to the user requirement of 3 CIELAB units in accuracy. A coding with more than 8 bit in *space is not

necessary. Coding of 8bit in *space is equivalent to 24bit (at least 20bit) coding in linear space (as lightness L^* is a cube root function of luminance L).

Using only 8bit in *space in ISO/IEC standards has the advantage that there is no need to produce new printer drivers and image software for the office environment. The more than 8bit spaces of IEC, e. g. 61966-2-0 with 16bit linear and 12bit nonlinear coding, can only work with new printer drivers and software.

Figure 1: Image reproduction properties in standards of ISO/IEC JTC1/SC28 and IEC TC100 TA2



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Figure 1 includes new devices which allow to produce CIELAB data for every pixel. There are scanners and cameras (black and white with liquid crystal spectral filters) which measure the spectral reflection or power distribution. These data of 16 pictures measured at 400nm, 420nm, ..., 700nm with a band width of 20 nm are used to calculate CIELAB data for CIE standard illuminant D65.

There are methods to transform the CIELAB coordinates of all the colours in ISO/IEC-test charts to the cmy^* coordinates and vice versa. ISO/IEC standards define a comparison method of LAB^* or lab^* coordinates (relative or absolute CIELAB) or of CMY^* or cmy^* coordinates of digital images. There is no such reference process in IEC standards.

References

[1] ISO/IEC 15775: 1999-12 „Information technology – Office machines – Machines for colour image reproduction” - Method of specifying image

reproduction of colour copying machines by analog test charts – Realisation and application“ [2] ISO/IEC DIS 19839-1 to 4: 2000-04 „Information technology – Office machines – Machines for colour image reproduction“;

Part 1: Method of specifying image reproduction by digital and analog DIN-test charts – Classification and principles

Part 2: Method of specifying image reproduction with digital input and analog output as hardcopy of colour image devices: “digital – analog” (printers) – Realisation and application

Part 3: Method of specifying image reproduction with analog input and digital output of colour image devices: “analog – digital” (scanners) – Realisation and application

Part 4: Method of specifying image reproduction with digital input and analog output as softcopy of colour image devices: “digital – analog” (monitors) – Realisation and application