Methods for the production of analog ISO/IEC-test charts and applications

Bundesanstalt für Materialforschung und -prüfung

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ISO/IEC-test charts

There is an increasing number of ISO/IEC standards which are using and defining test charts. Some examples are:

- ISO/IEC 15775:1999 Method of specifying image reproduction of colour copying machines by analog test charts -- Realisation and application.
- ISO/IEC DTR 24705 Method of specifying image reproduction of colour devices by digital and analog test charts. (Nearly the same test charts are used in the related standard DIN 33866)
- ISO/IEC TR 19797:2004 Device Output of 16 colour scales, output linearization method (LM) and specification of the reproduction properties

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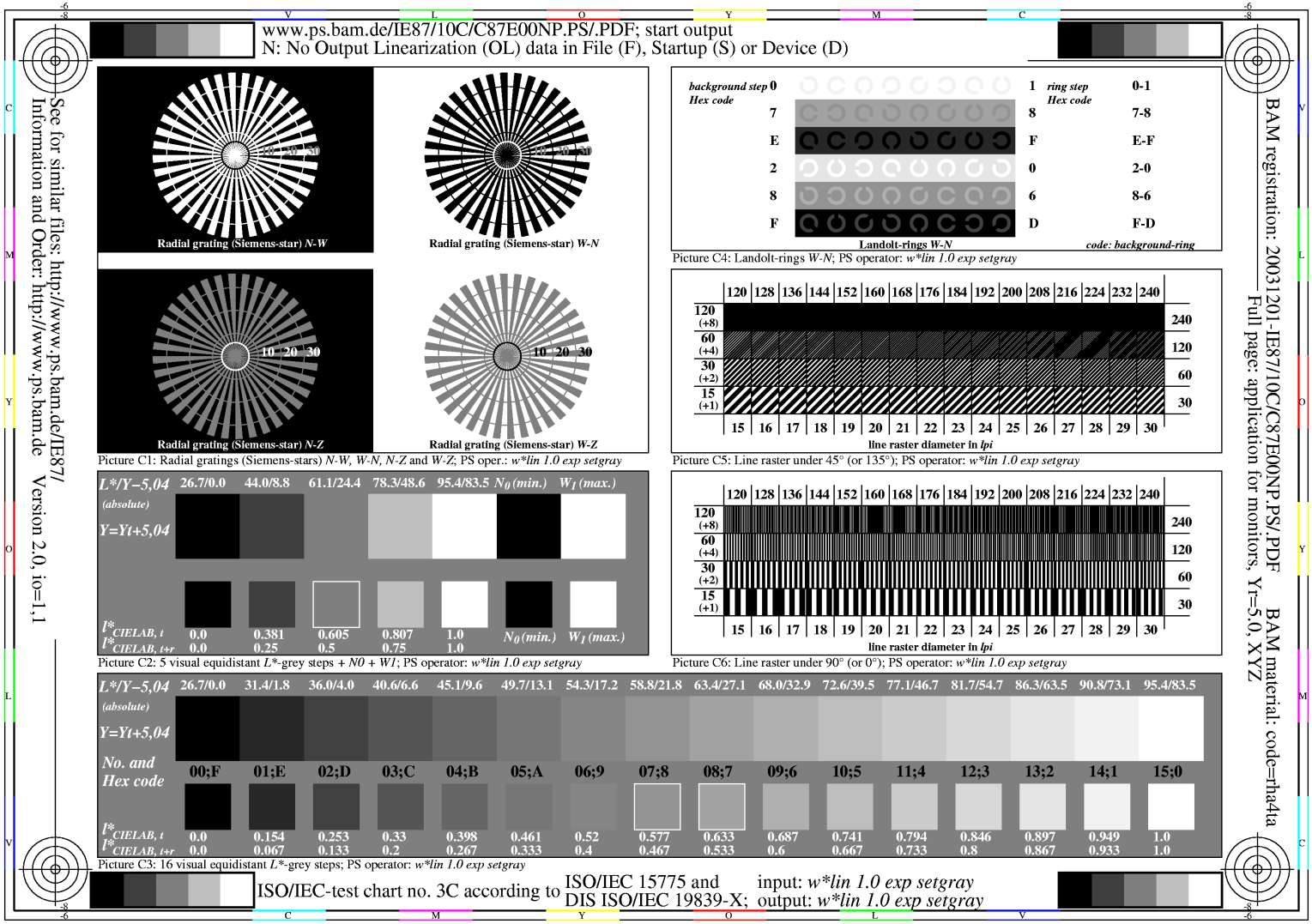
Jens Witt, 24 May 2004

ISO/IEC 15775 – test charts

- Achromatic test charts (no. 1+3)
- High contrast version ?L* ~ 85
- Medium contrast version ?L* ~ 77



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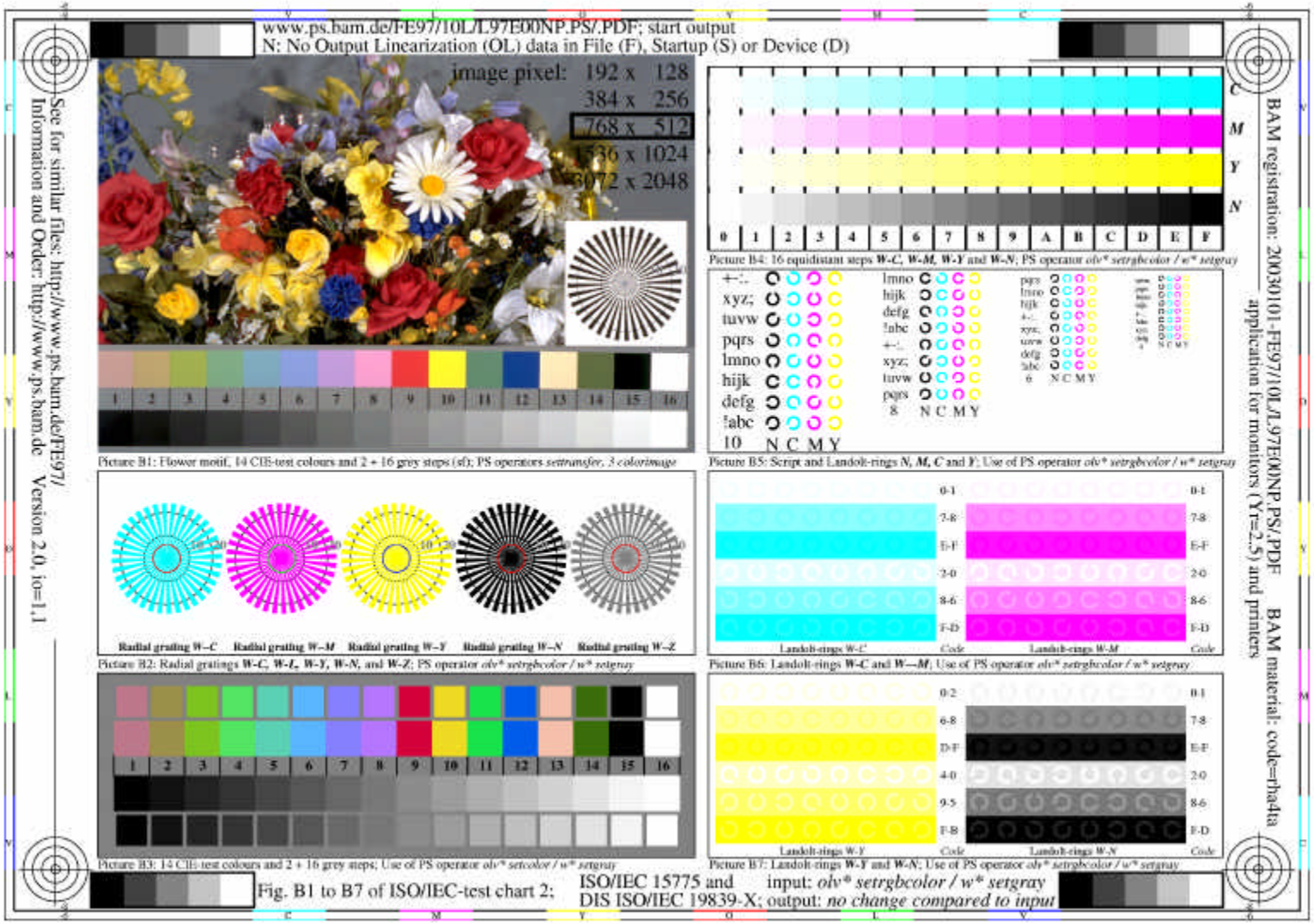
- High contrast version ?L* ~ 85
- Medium contrast version ?L* ~ 77
- Chromatic test chart (no. 2+4)
- CMYN layout



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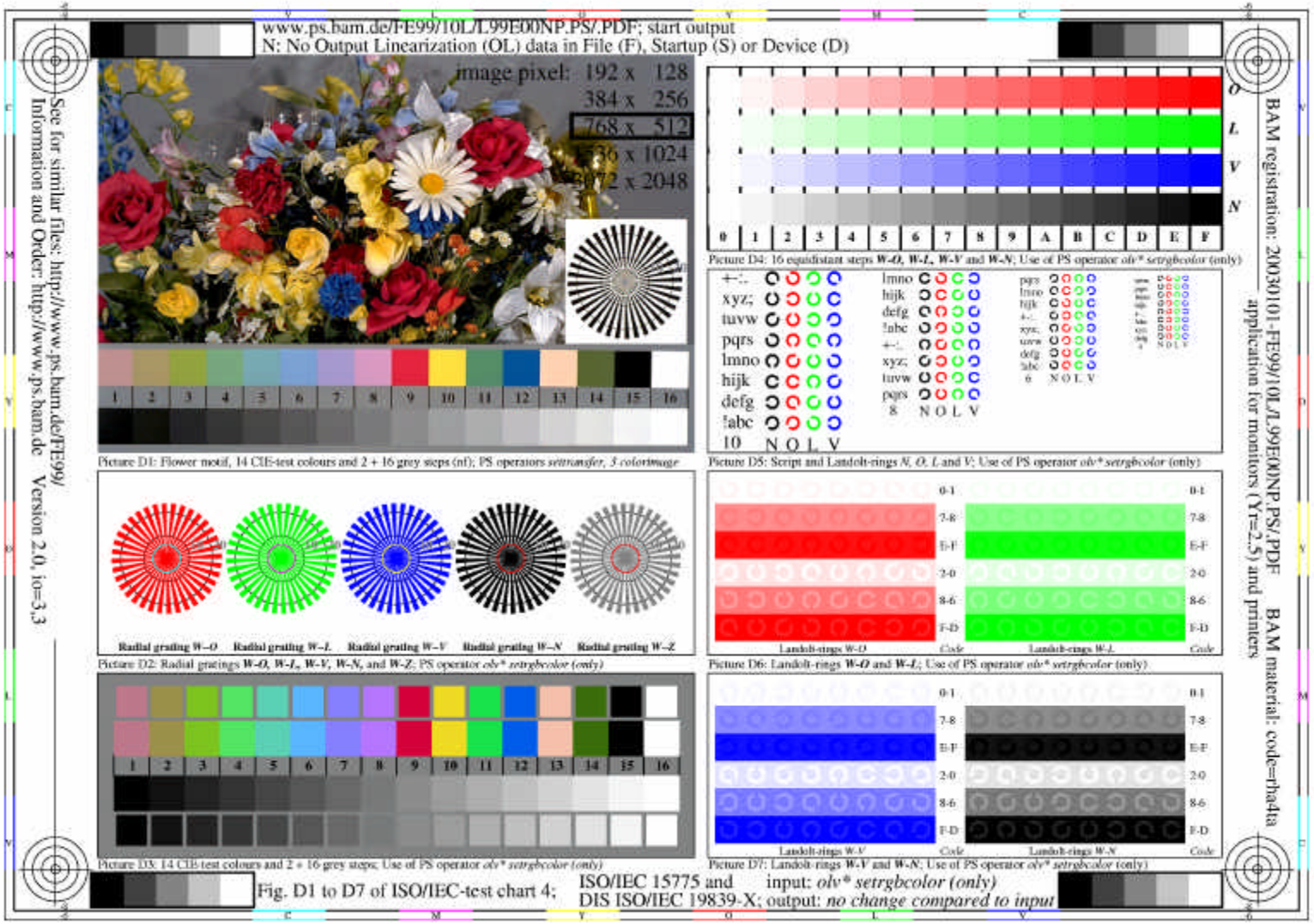

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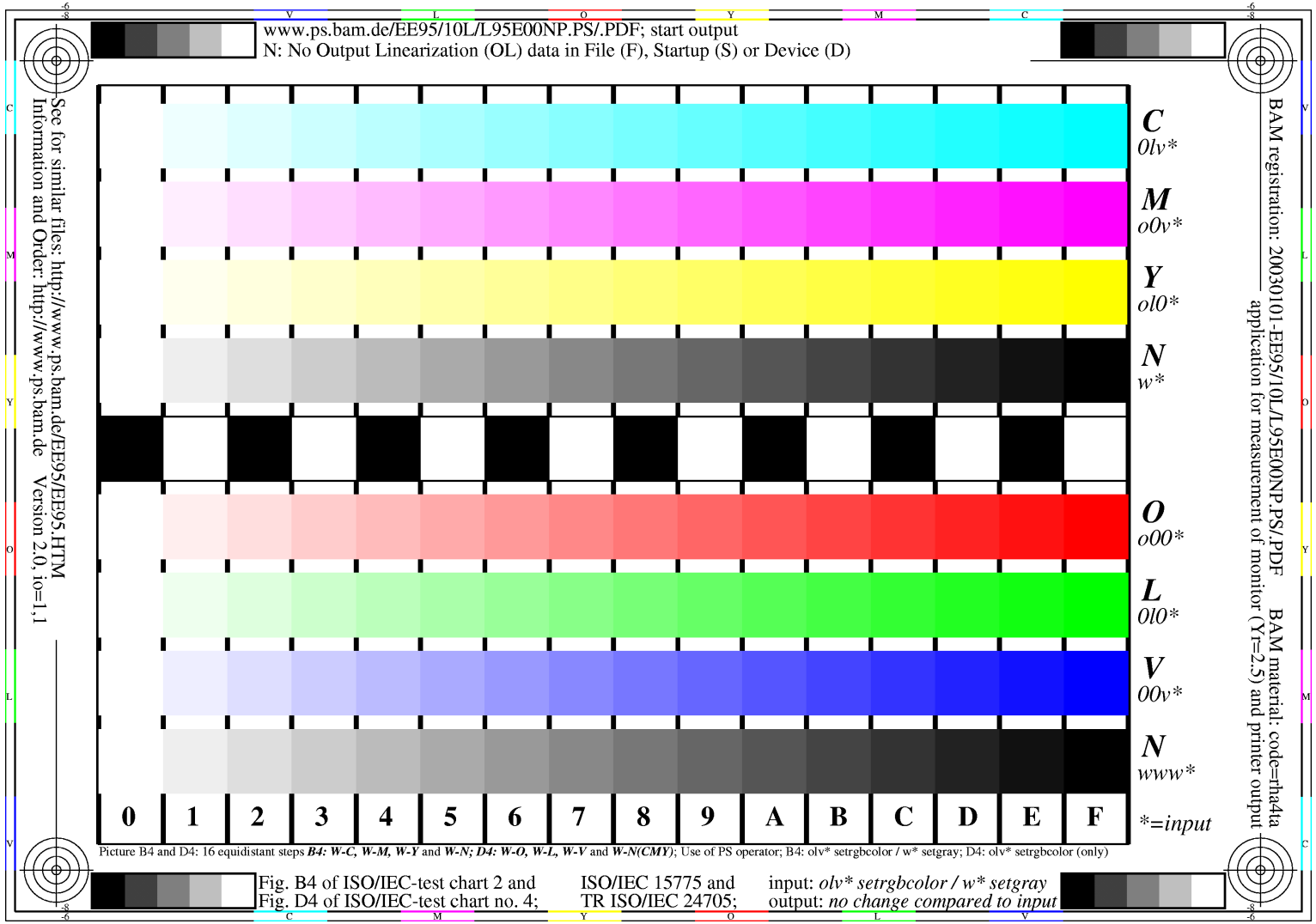
ISO/IEC TR 19797



Analog ISO/IEC-test charts: specifications

Technique:	Halftone and continuous tone (photographic) technique.
Material:	- fine art paper, glossy, natural white, 150 g/m² (halftone) - photographic paper, 85 g/m² (halftone) - glossy photographic paper, 225 g/m² (continuous tone)
Size:	The layout is defined in the standard format A4 (210 mm x 297 mm).
Resolution:	„High“, e.g. 3600 dpi in halftone technique and 300 dpi in continuous tone technique.
Lifetime:	Due to time, temperature and humidity the test charts change and therefore they should be discarded after three years, beginning with the ISO identification date.
Digital test charts:	All test charts are available in a digital version as Postscript- and PDF-Files at www.ps.bam.de.

Analog ISO/IEC-test charts: colorimetric specifications

Colour space: CIELAB D65, 2º-standard observer, 45º/0º-standard geometry

L*-range:

	Halftone	Photographic
Achromatic Medium / High	18 to 95 / 10 to 95	13 to 91 / 7 to 91
Chromatic	18 to 95	7 to 91

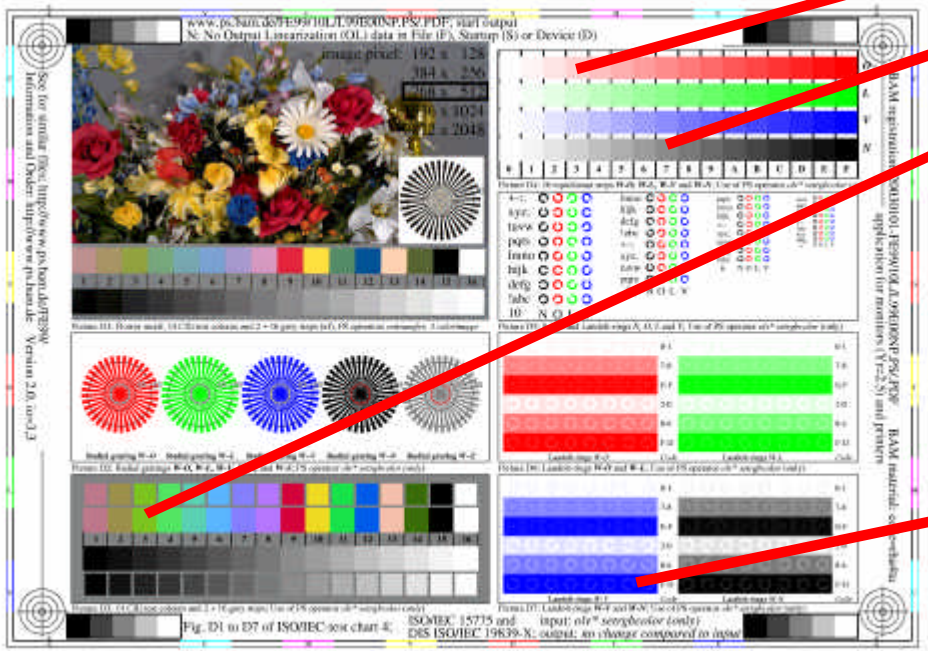
Printing colours: CMYOLVWN - Intended colours of offset printing on standard non fluorescent paper (ISO 2846 and ISO/IEC 15775).

Colour series: Visually equally spaced (equal steps in CIELAB).

Tolerance: Only an orientation tolerance is given in the standard by an example test production. The accuracy of the 8 basic colours is ?E*$_{ab}$ = 2.5 and the mean for the 14 CIE-test colours is 10.

Methods for the production I: Lookup-Table (LUT)

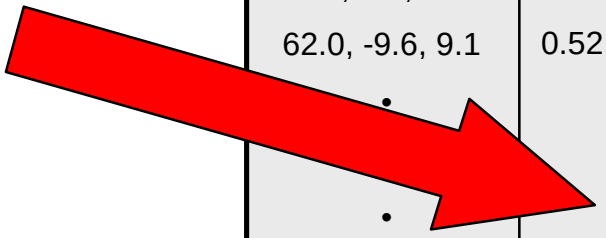
- Build up a LUT with an entry for every intended CIELAB value, except for the picture part.



CIELAB	CMYK
71.5, 0.5, 1.7	
40.7, 0.1, 28.9	
62.0, -9.6, 9.1	
•	
•	
•	
•	
•	
•	
•	
•	
50.0, 3.2, 1.6	

Methods for the production I: Lookup-Table (LUT)

- Build up a LUT with an entry for every intended CIELAB value, except for the picture part.
- Fill up the LUT with a first approximation of the corresponding device colour space values.



CIELAB	CMYK
71.5, 0.5, 1.7	0.34, 0.22, 0.88, 0.10
40.7, 0.1, 28.9	0.24, 0.85, 0.11, 0.00
62.0, -9.6, 9.1	0.52, 0.10, 0.17, 1.00
•	•
•	•
•	•
•	•
•	•
•	•
•	•
50.0, 3.2, 1.6	0.69, 0.54, 0.00, 0.12

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- Build up a LUT with an entry for every intended CIELAB value, except for the picture part.
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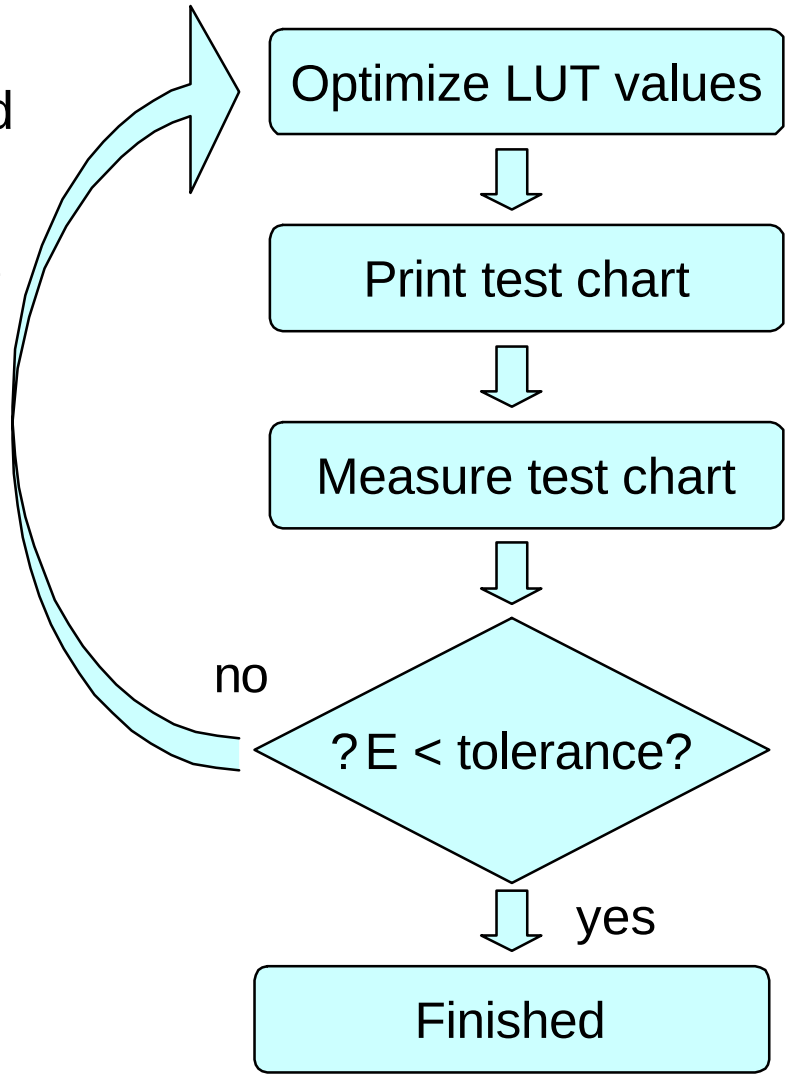
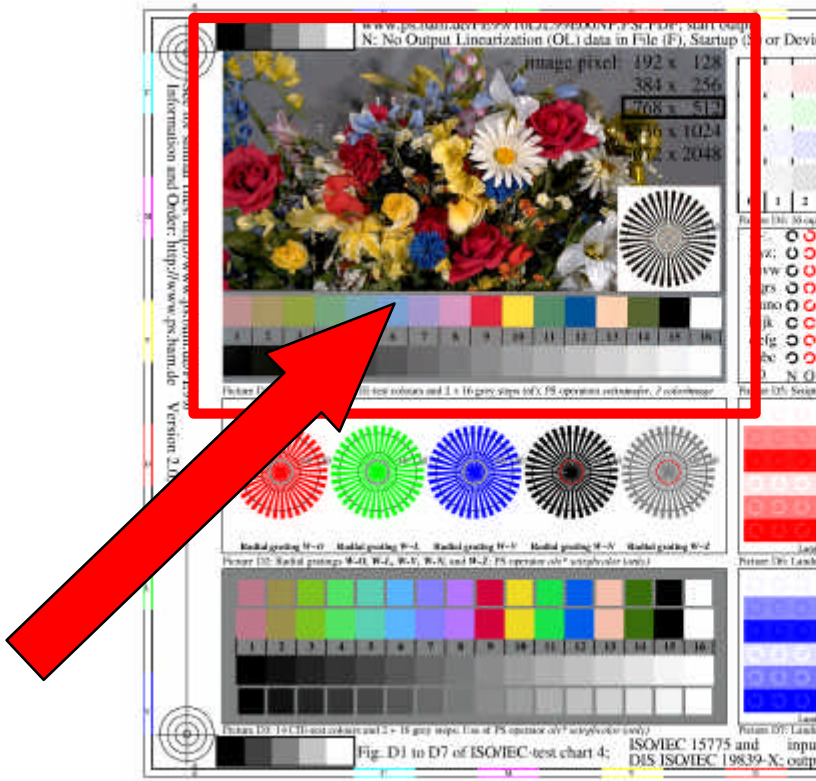
- Optimize the LUT by recursive output and measurement until desired colorimetric tolerance is reached.



Methods for the production I: Lookup-Table (LUT)

- Build up a LUT with an entry for every intended CIELAB value, except for the picture part.
- Fill up the LUT with a first approximation of the corresponding device colour space values.
- Optimize the LUT by recursive output and measurement until desired colorimetric tolerance is reached.
- If the picture part is also defined in CIELAB, all appearing colours can be linear interpolated from the LUT. To achieve a picture in CIELAB colour space a colour management workflow is necessary.



Methods for the production I: Lookup-Table (LUT)

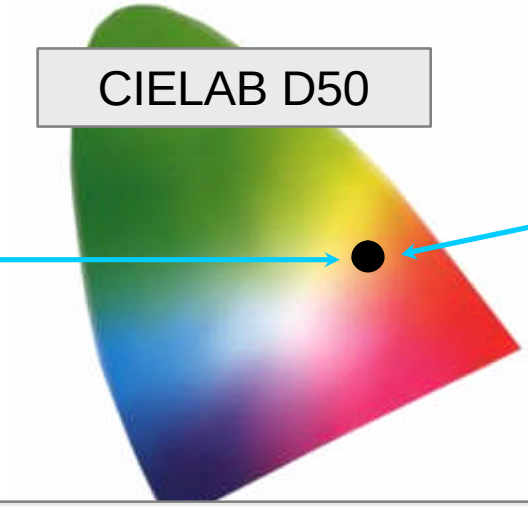
Advantage:

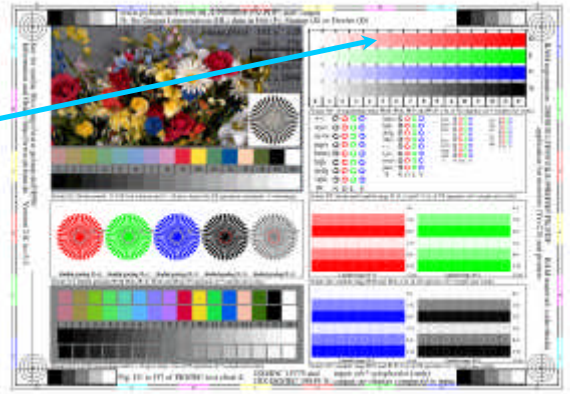
- High accuracy can be reached.

Disadvantages:

- Very time-consuming optimization (several prints and measurement are necessary). Possible solution: Use a multispectral camera.
- If there is a colour drift in one component the completive LUT has to be corrected.

Methods for the production II: ICC-workflow





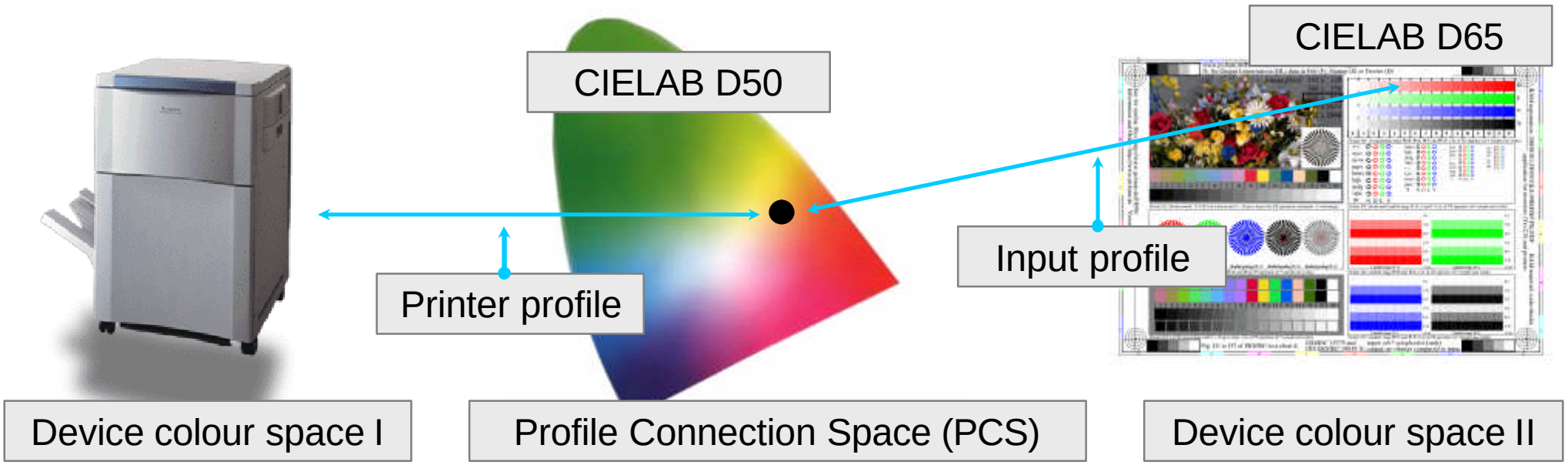
Device colour space I

Profile Connection Space (PCS)

Device colour space II

- ICC colour management connects different device dependent colour spaces via a profile connection space (PCS).
- Any device needs his own ICC-Profile, which describes the connection between device colour space and PCS.
- In the current specification ICC.1:2003-09 File Format for colour Profiles (Version 4.1.0) the PCS is CIELAB D50.

Methods for the production II: ICC-workflow



- To use an ICC-workflow for the production of test charts we need two profiles: one describing the printer and one describing the input colour space.
- The printer can be profiled with appropriate software or the manufacturer profile can be used.
- The test charts are defined in CIELAB D65. So the input profile has to do D50-to-D65 chromatic adaptation (e.g. with Bradford or Von Kries transformation).

Methods for the production II: ICC-workflow

Advantages:

- Easy profiling with existing tools.
- A colour drift just needs a new printer profiling.

Disadvantages:

- Due to the global character of the calibration single colours can produce larger errors.
- Chromatic adaptation transformation can produce additional errors. One possible solution: Ignore the ICC-specification and profile the printer with D65 measurements.

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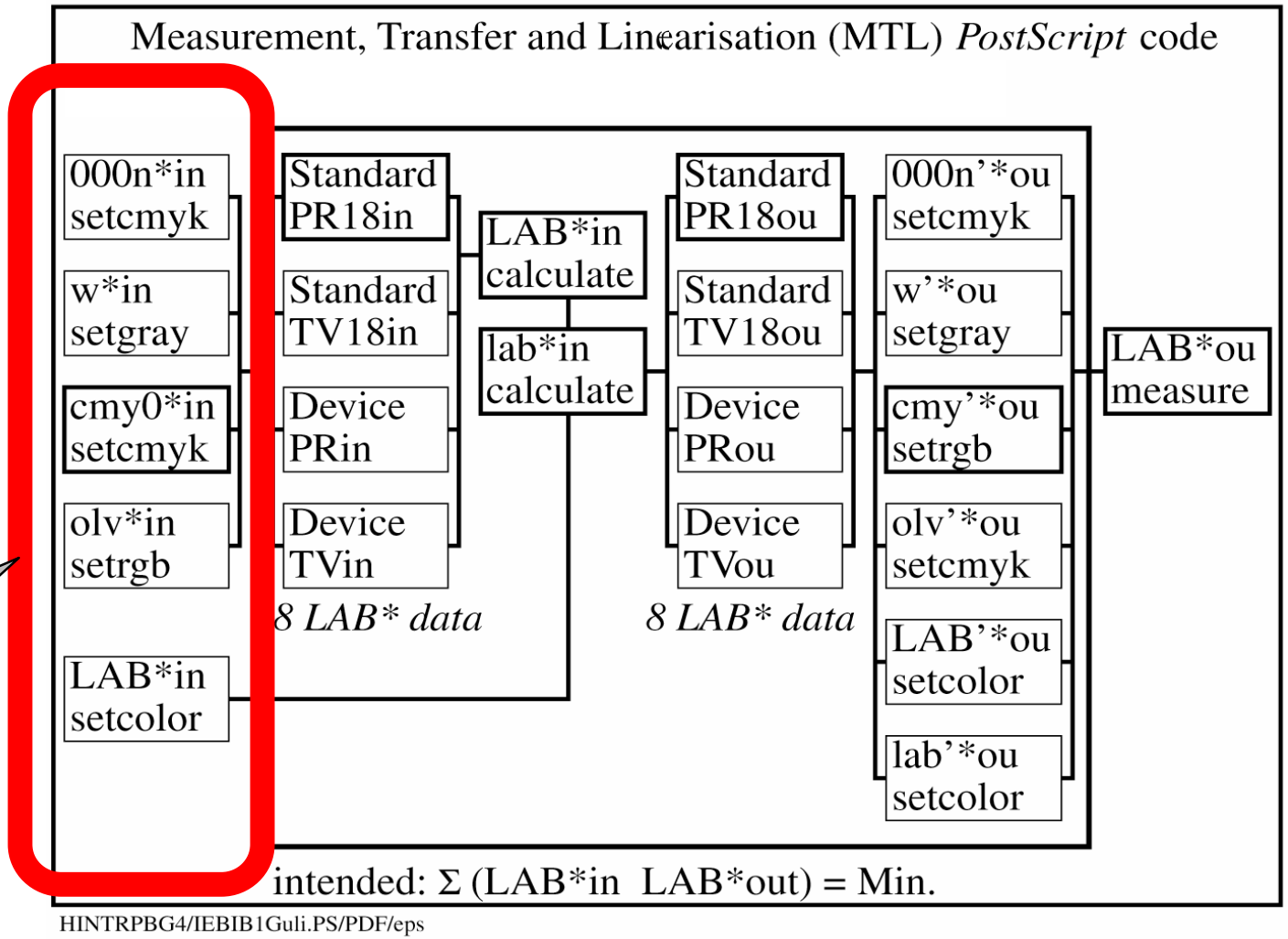
Methods for the production III: MTL-Code (ISO/IEC TR 19797)

ISO/IEC TR 19797:

Describes a method to produce a linear relationship between digital input data and the output data for a visual relative CIELAB scale.

Digital input data



Methods for the production III: MTL-Code (ISO/IEC TR 19797)

Standard colour definitions

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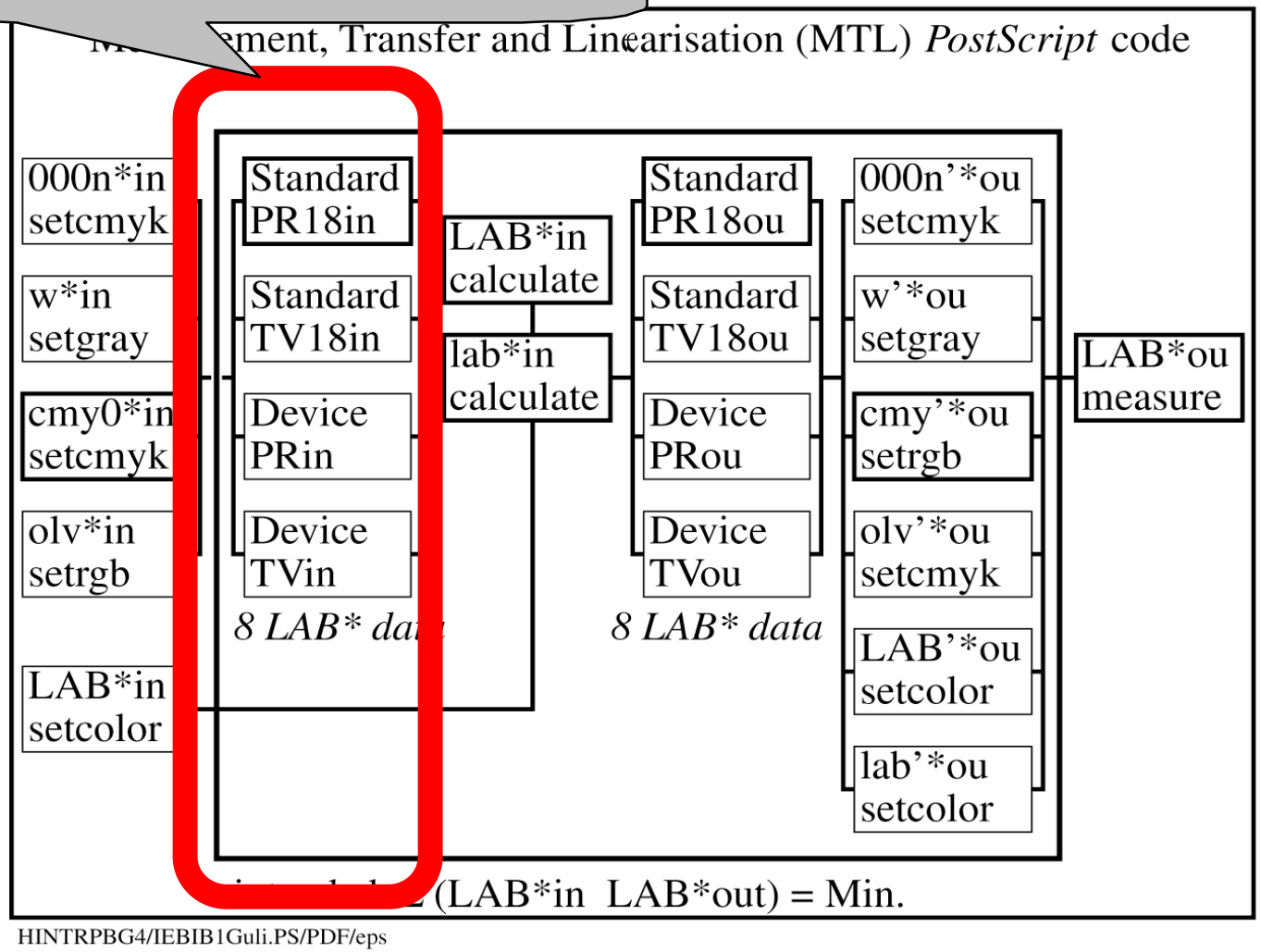

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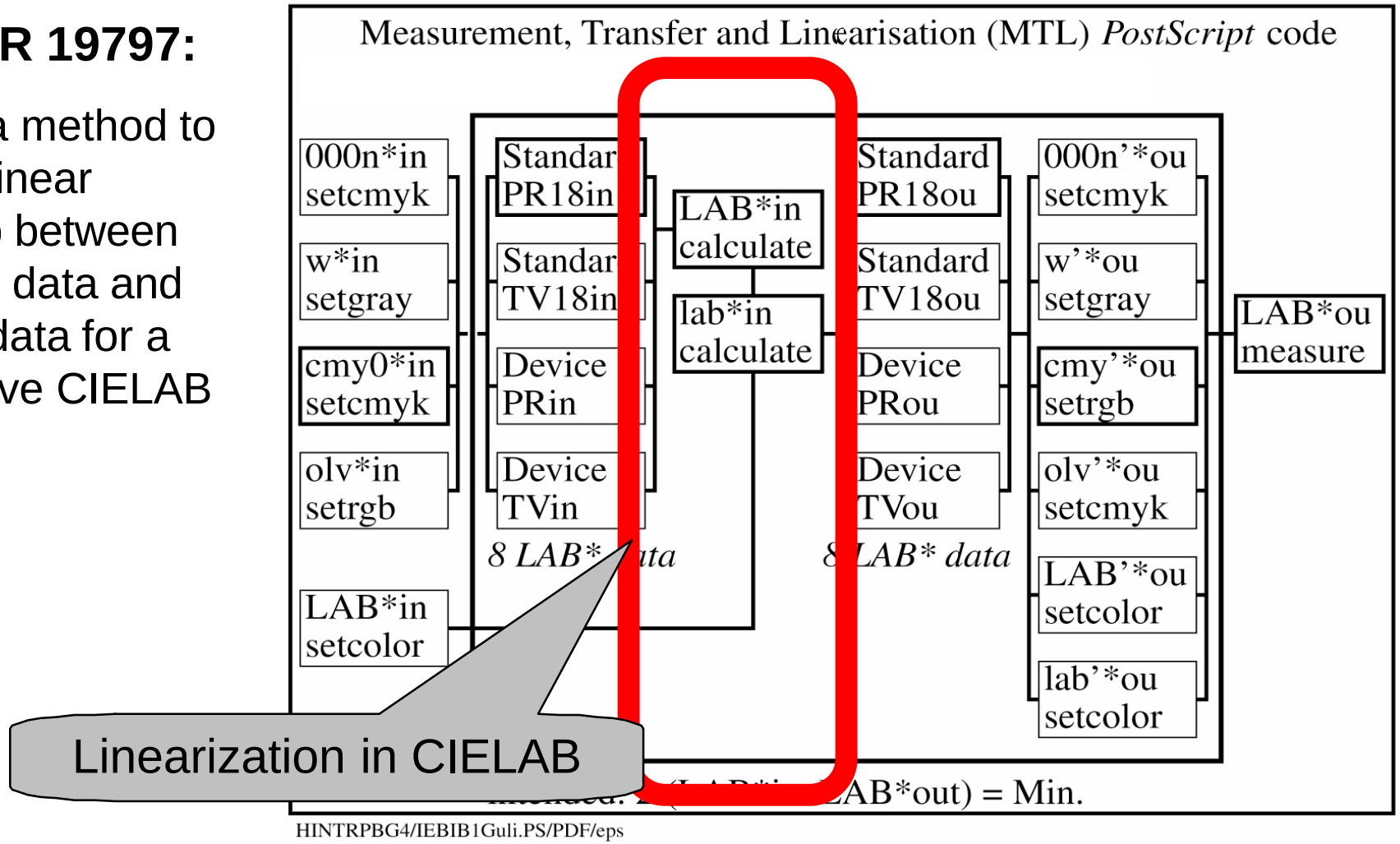

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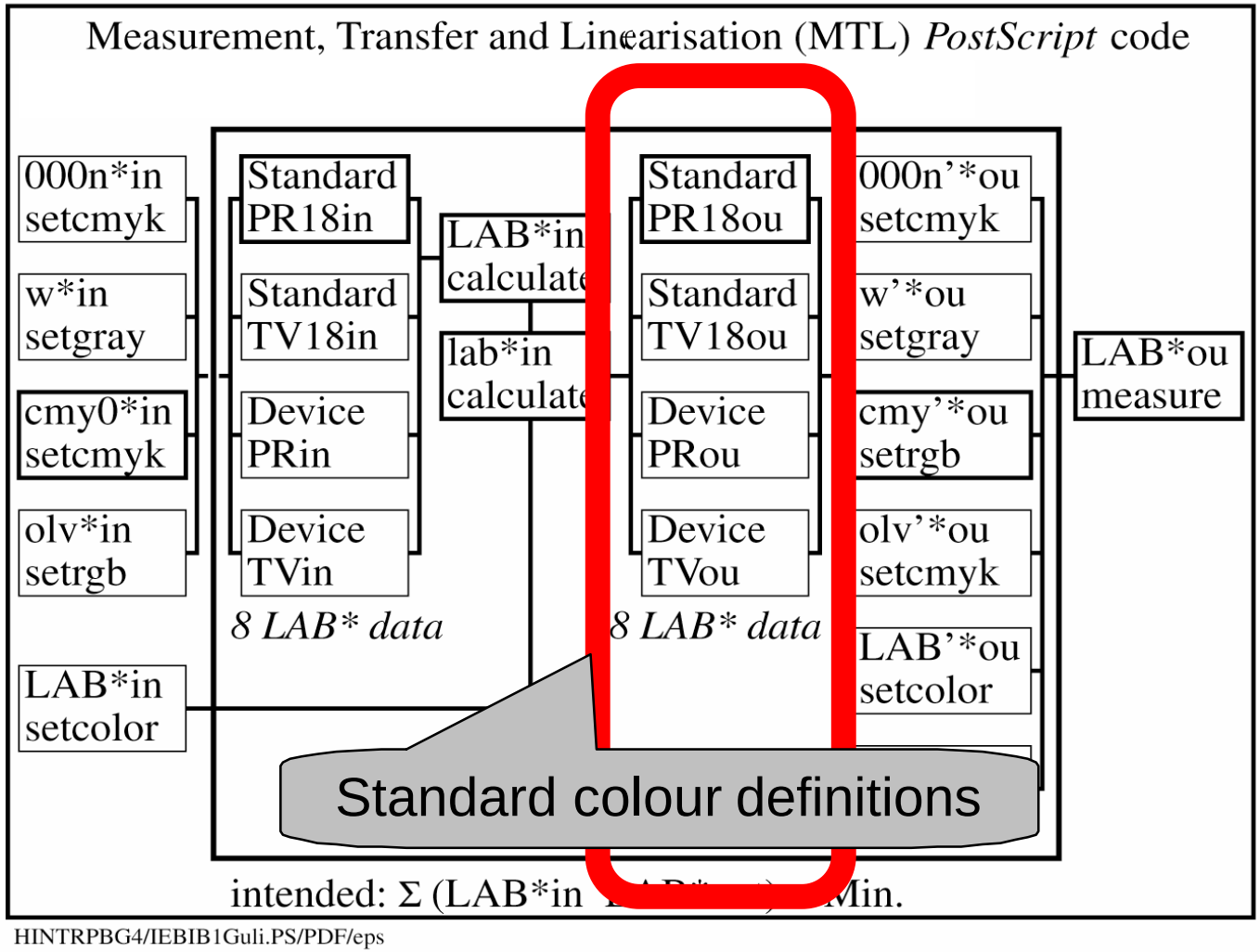

HINTRPBG4/IEBIB1Guli.PS/PDF/eps

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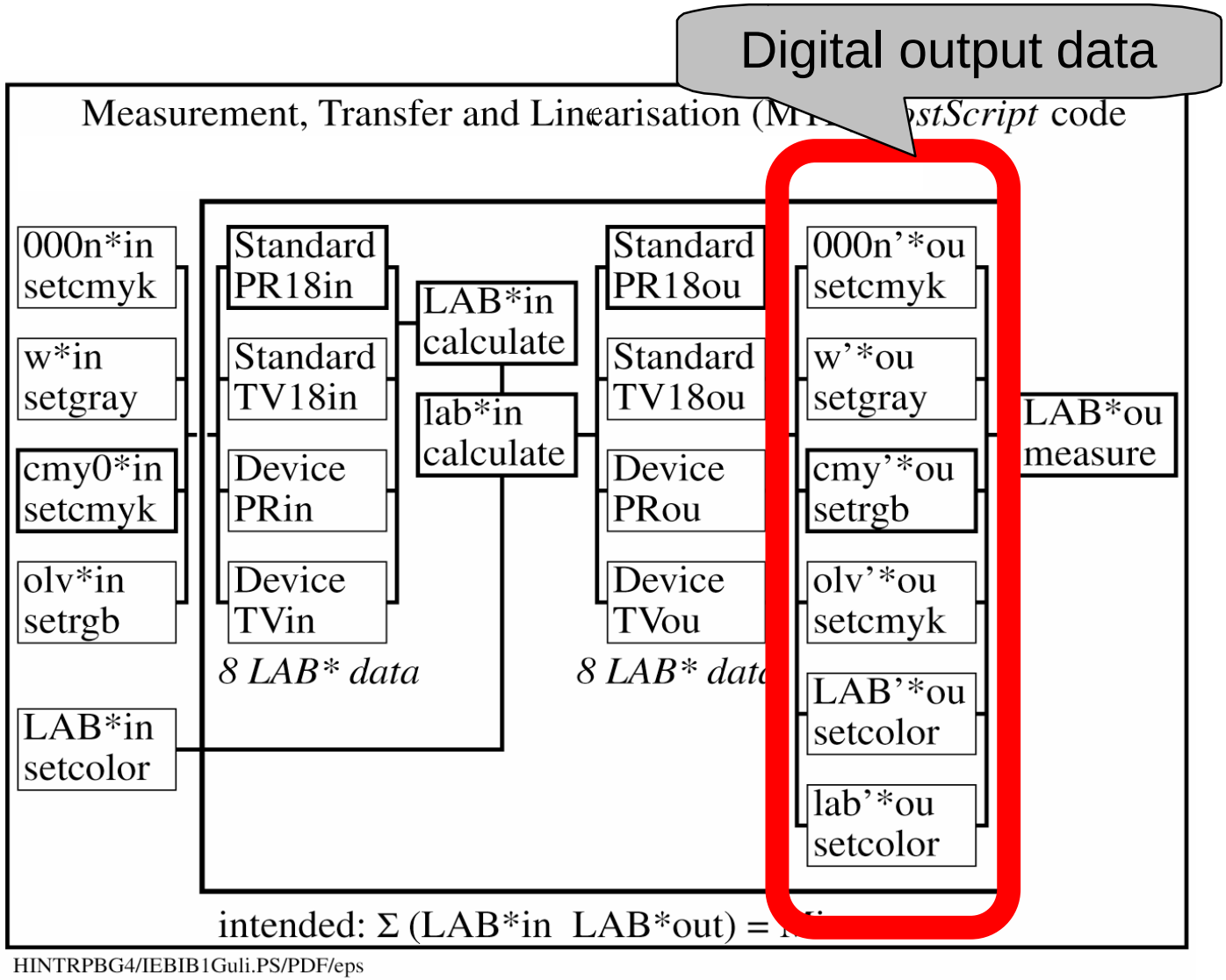
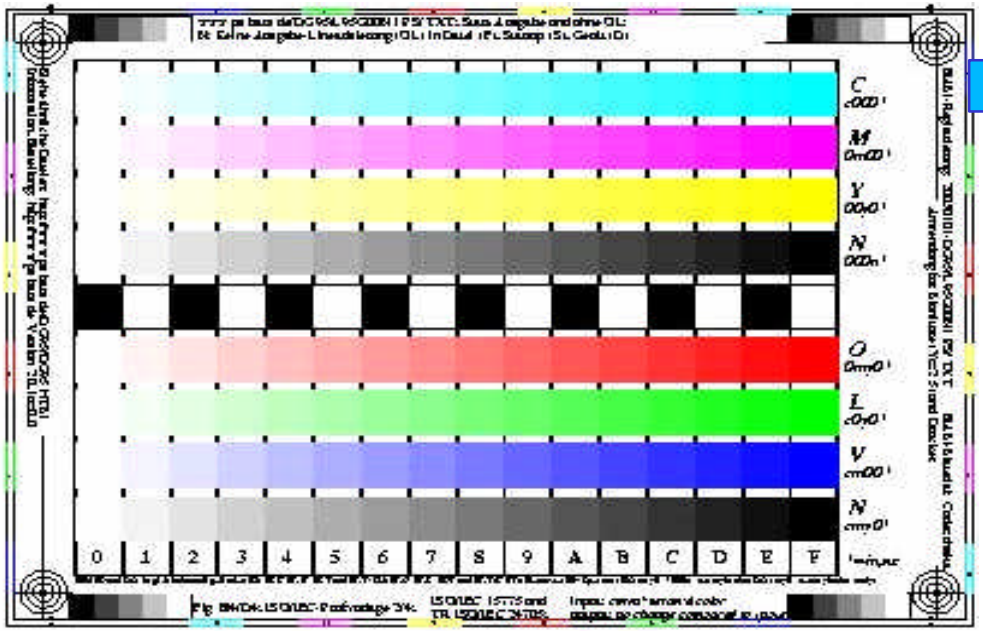
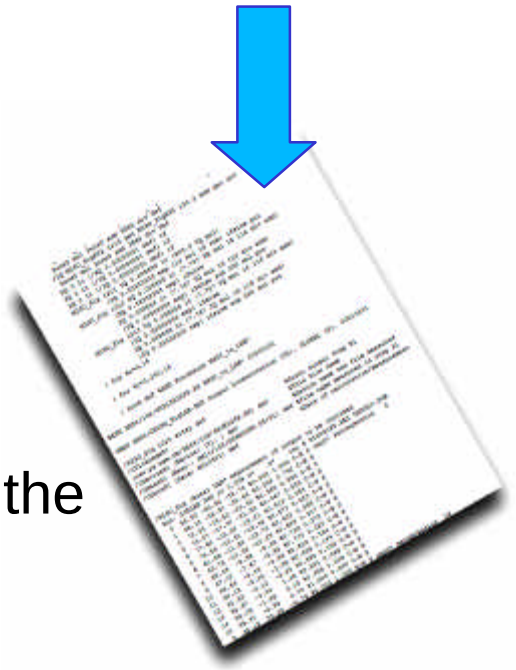


Methods for the production III: MTL-Code (ISO/IEC TR 19797)

Profiling the MTL-Code



2. Measure the printed test chart

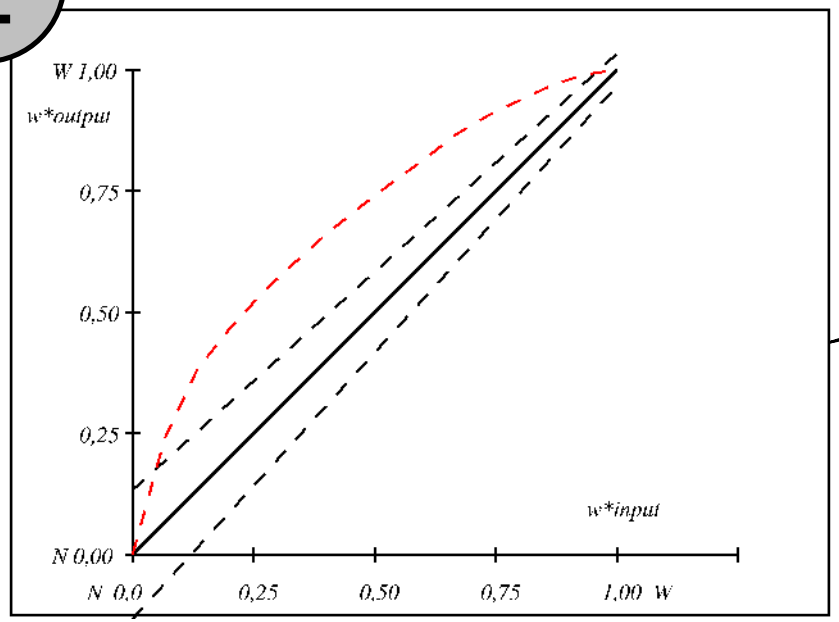


1. Print the digital ISO/IEC 19797 test chart

3. Insert measured data in the MTL PostScript code

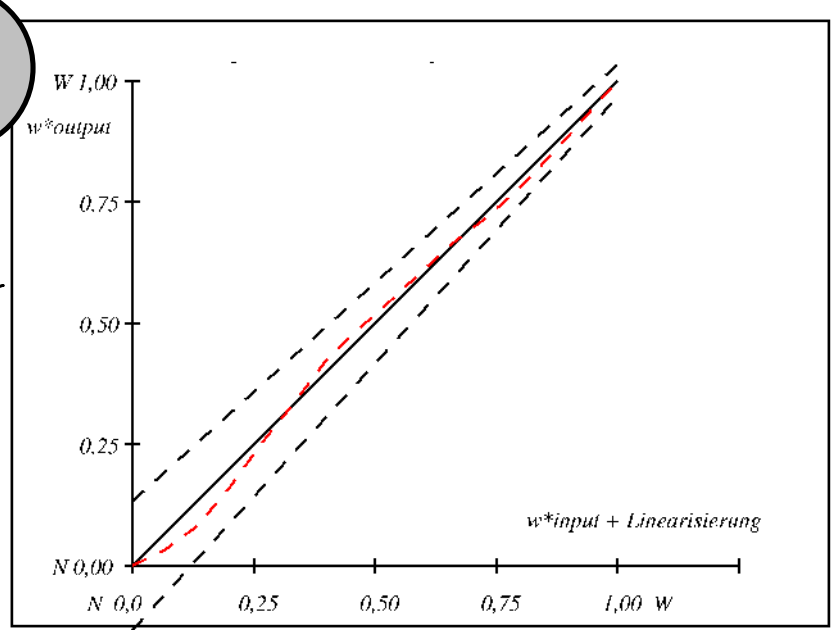
Methods for the production III: MTL-Code (ISO/IEC TR 19797)

1



Input-output relationship for a red to white colour series without linearization

2



Input-output relationship for a red to white colour series with linearization

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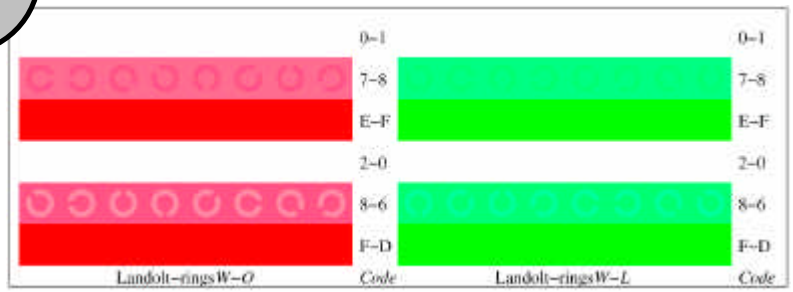
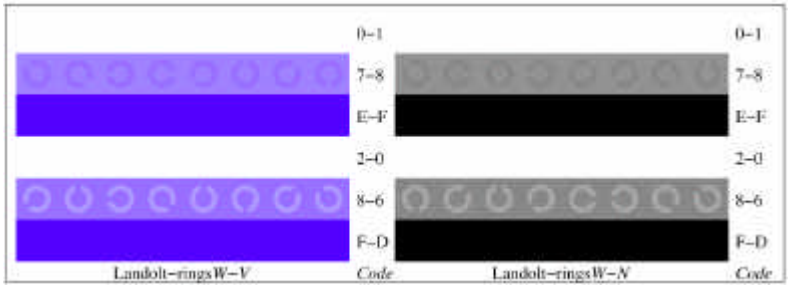
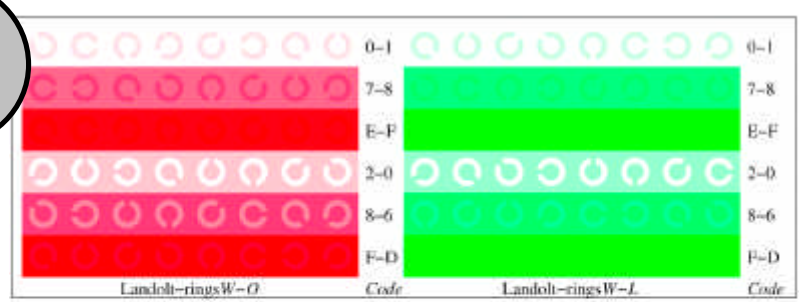
1

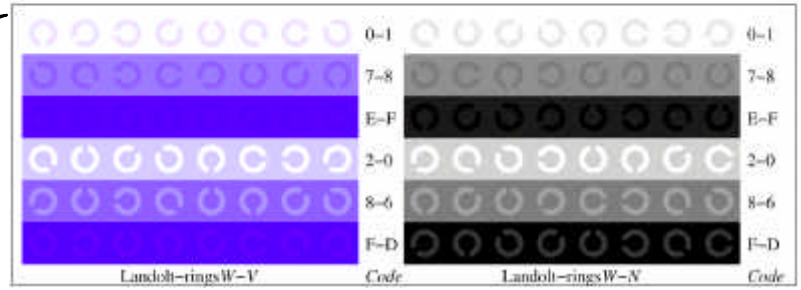




Without Linearization: The Landolt-rings are not recognized.

2





With Linearization: The Landolt-rings are recognized.

Methods for the production III: MTL-Code (ISO/IEC TR 19797)

Advantages:

- The linearization gives a high accuracy (?E<2) for the relative CIELAB colour definitions (16-step colour scales).
- The relative scaling maintains all details for instance Landolt rings on every device.
- Easy calibration.

Disadvantage:

- An absolute CIELAB reproduction is not intended. Absolute CIELAB colours (e.g. CIE test colours, picture part) can produce larger errors (?E˜ 10).

Applications for ISO/IEC-test charts

The applications of ISO/IEC-test charts for specifying image reproduction properties given in ISO/IEC DTR 24705:2004(E) are:

Input	Output	Input media	Output media	Application
analog	analog	ISO/IEC-test chart (hardcopy)	Hardcopy	Copier
analog	digital	ISO/IEC-test chart (hardcopy)	File	Scanner
digital	analog	ISO/IEC-test chart (file)	Hardcopy Softcopy	Printer Monitor

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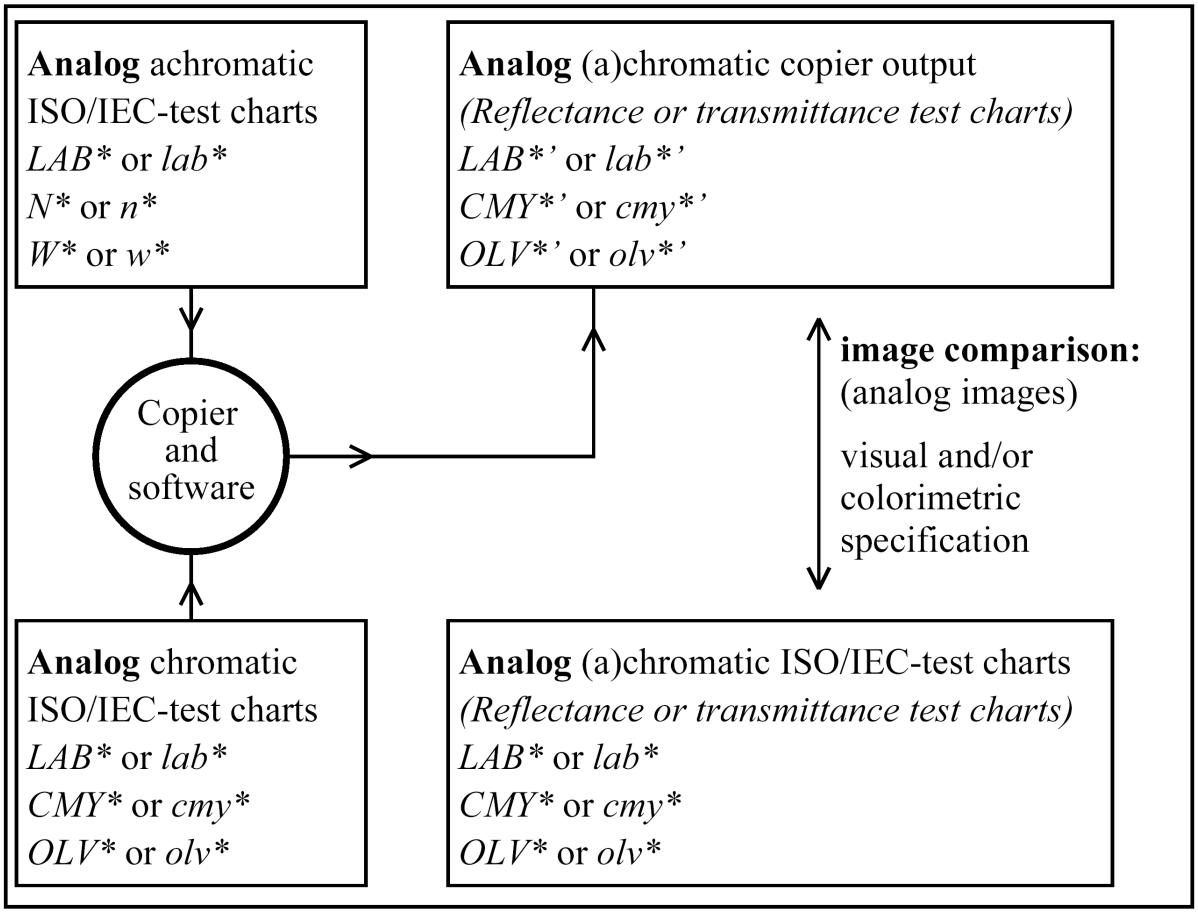

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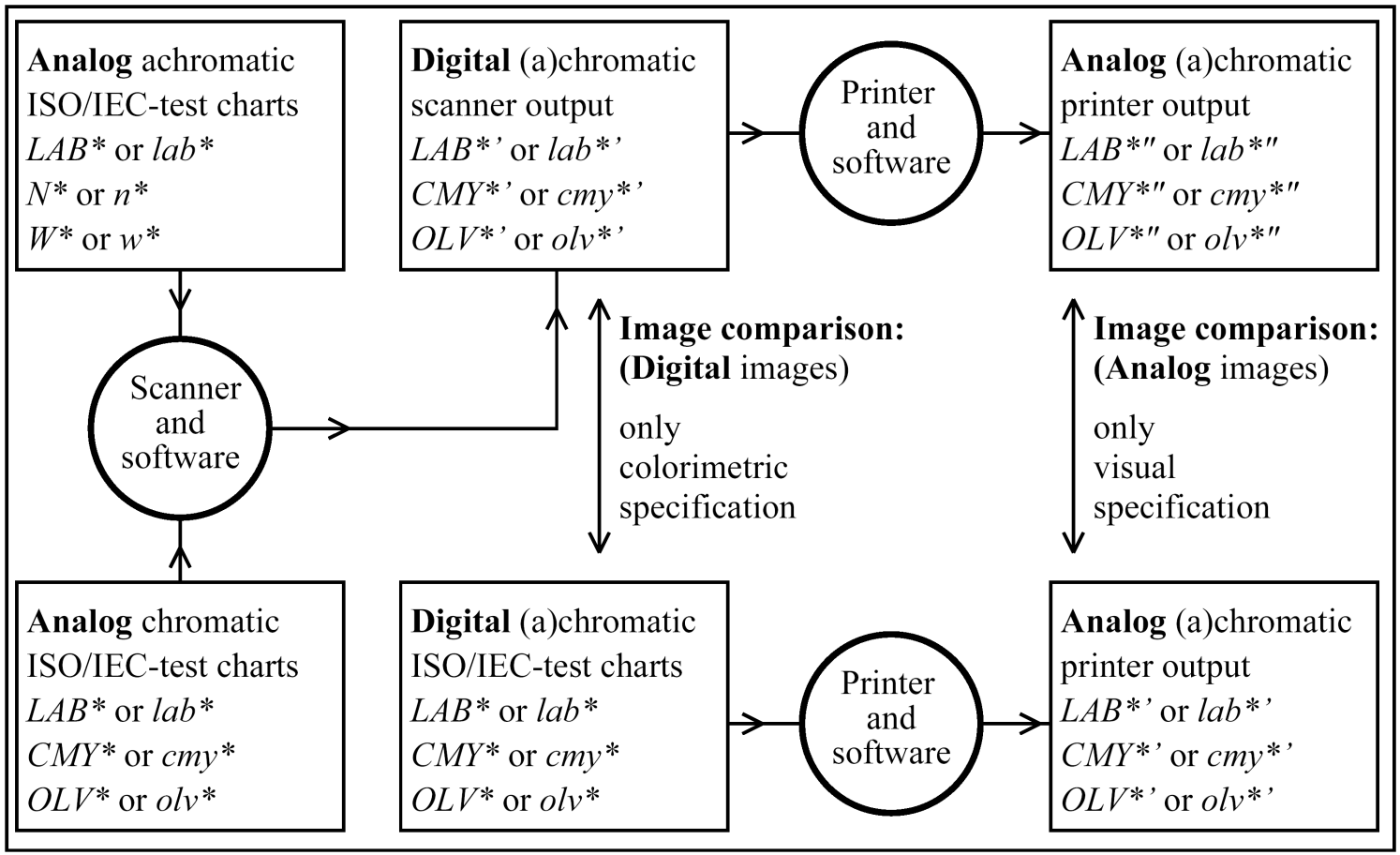

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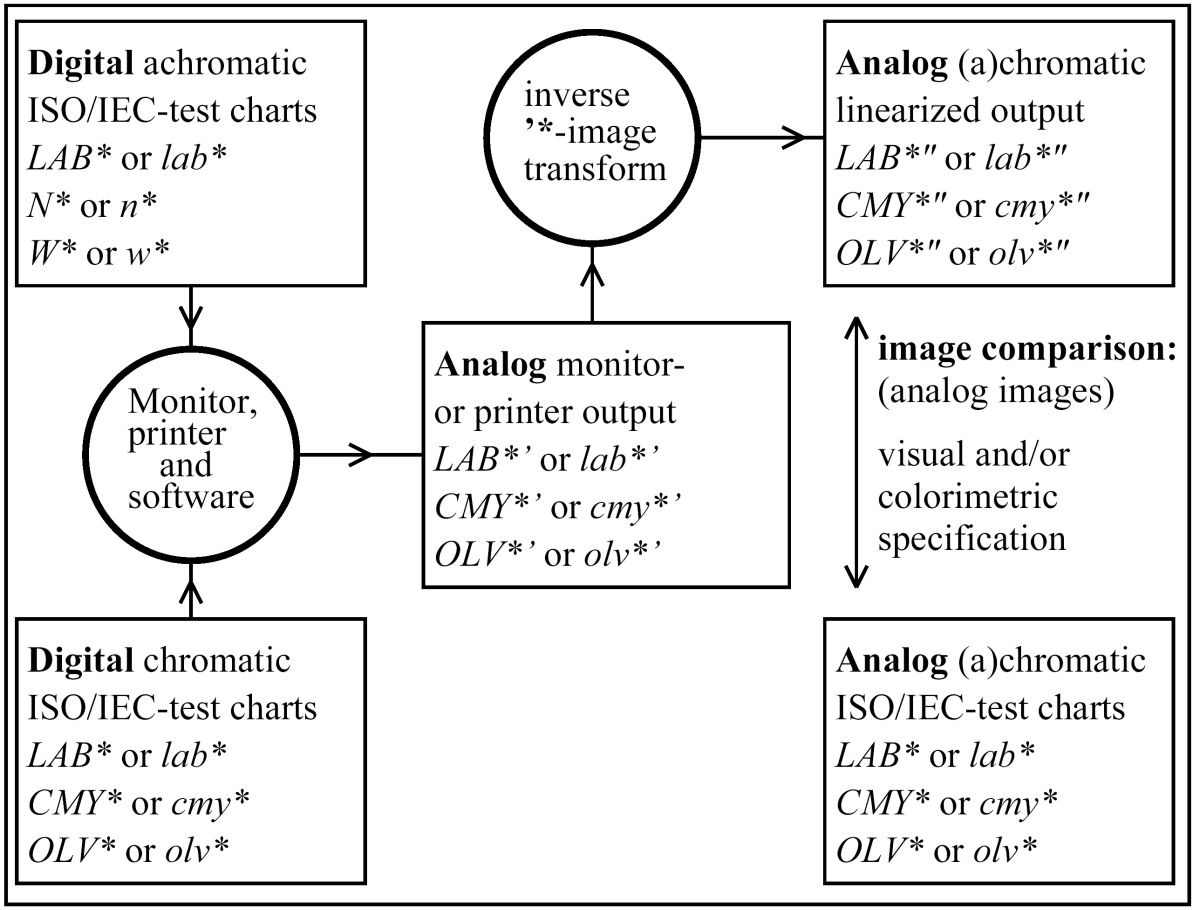

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Thank you!