Relative CIELAB output by display systems of ISO TC 159 at daylight workplaces

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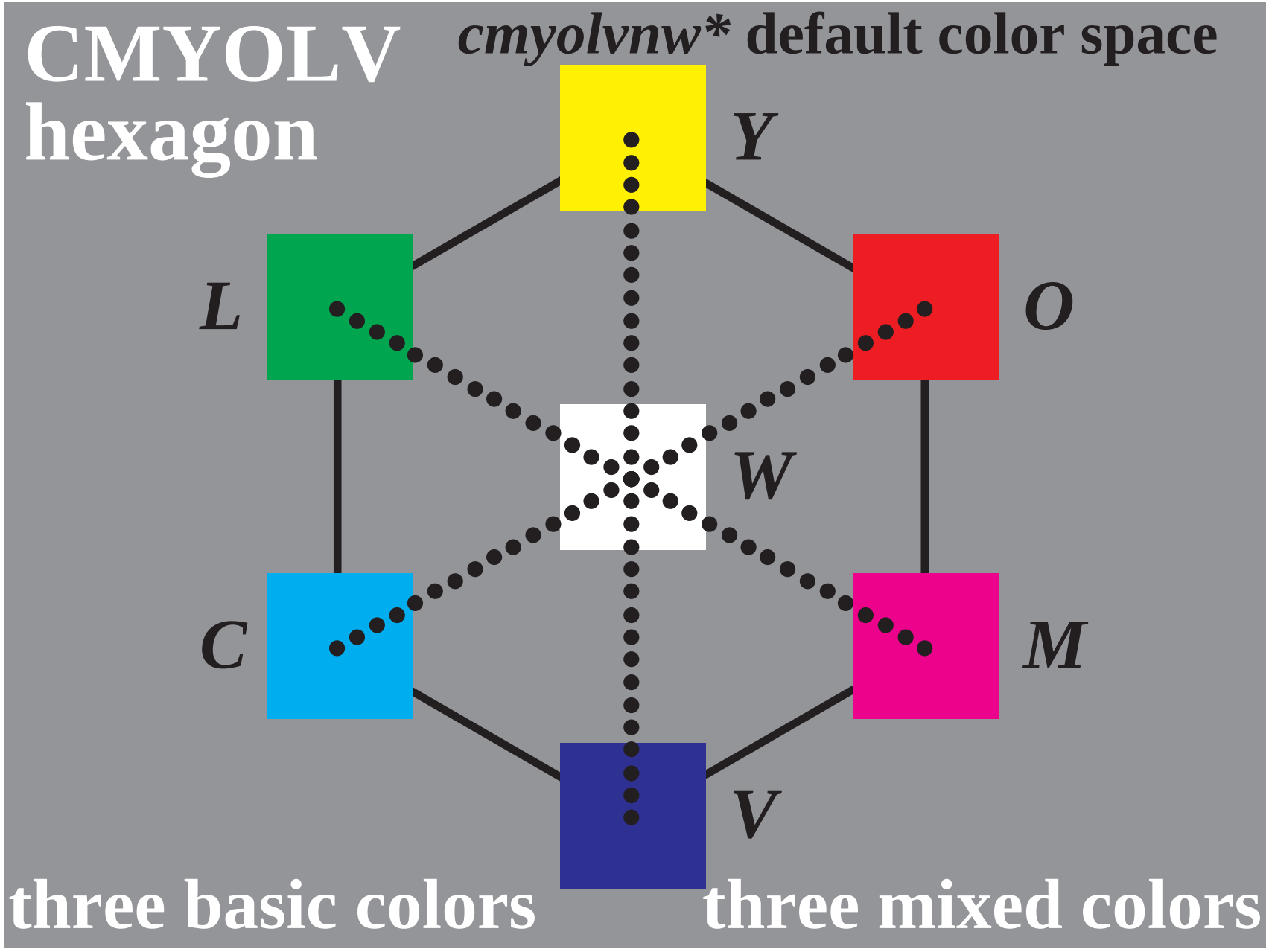
Overview

- Eight basic colours and colour hexagon
- Linear relationships between colour coordinates
- 16 step output equally spaced in relative CIELAB
- Reflective colours and display surface properties
- Equally spaced output on displays with NO reflection
- Equally spaced output on displays at work places
- PDF file output of eigth pages to determine the equally spaced output on displays at work places
- Change of equally spaced input data for equally spaced display output at work places by a filter

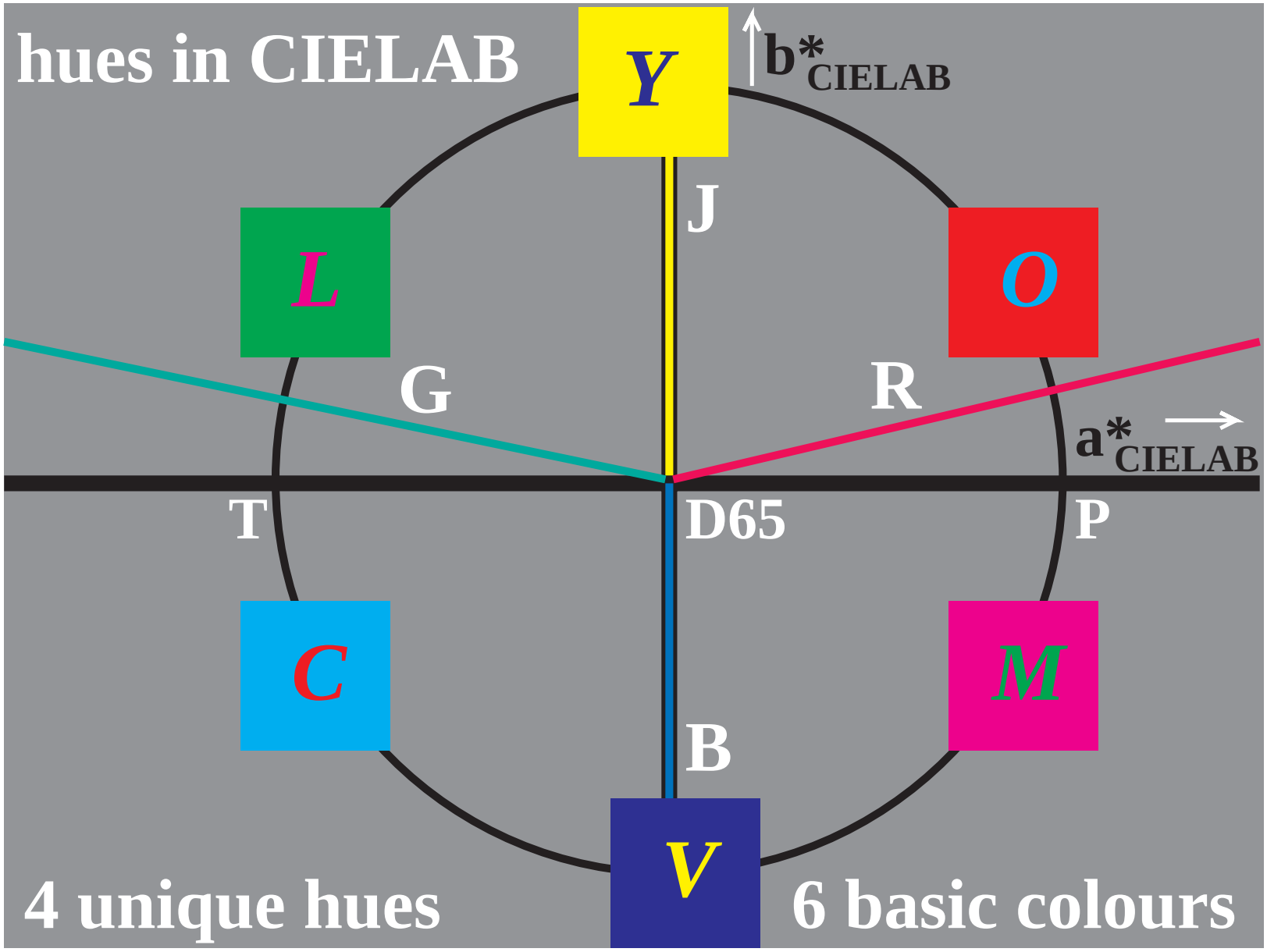
Summary

Colour Hexagon



E8370-1Z

Elementary Colour Circle and Hexagon in CIELAB



DIN-Workshop: ISO-test charts, 2004, May 24, Nuernberg

Standards and Technical Reports

Input	Output	Input and output media and applications Input media	Output media	Application	Technical Report (TR) or Standard
–	–	–	–	**Basis**	**ISO/IEC TR 24705**
analog	**analog**	ISO/IEC-test chart (hardcopy)	Hardcopy	**Copier**	**ISO/IEC 15775**
analog	**digital**	ISO/IEC-test chart (hardcopy)	File	**Scanner**	**ISO/IEC TR 24705**
digital	**analog**	ISO/IEC-test chart (file)	Hardcopy Softcopy	**Printer** **Monitor**	**ISO/IEC TR 24705** **ISO/IEC TR 24705**

WINWS04/T1TA000.PS

Input	Output	Input and output media and applications Input media	Output media	Application	Standard
-	-	-	-	**Basis**	**DIN 33866-1**
analog	**analog**	DIN-test chart (hardcopy)	Hardcopy	**Copier**	**DIN 33866-2**
analog	**digital**	DIN-test chart (hardcopy)	File	**Scanner**	**DIN 33866-4**
digital	**analog**	DIN-test chart (file)	Hardcopy Softcopy	**Printer** **Monitor**	**DIN 33866-3** **DIN 33866-5**

DINWS04/T1TADIN.PS

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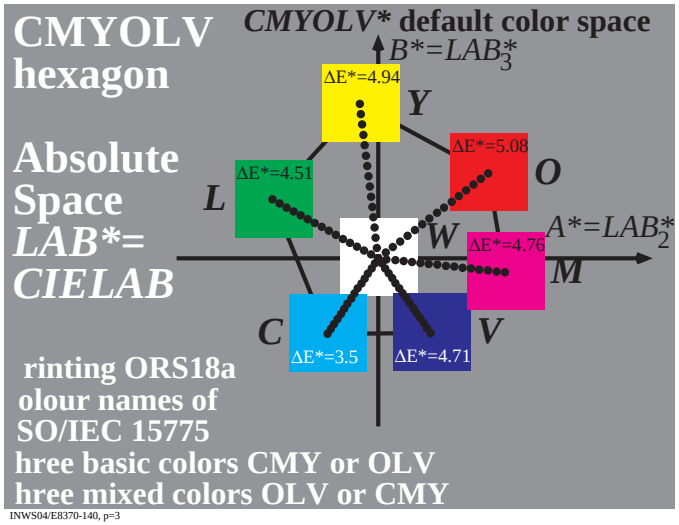
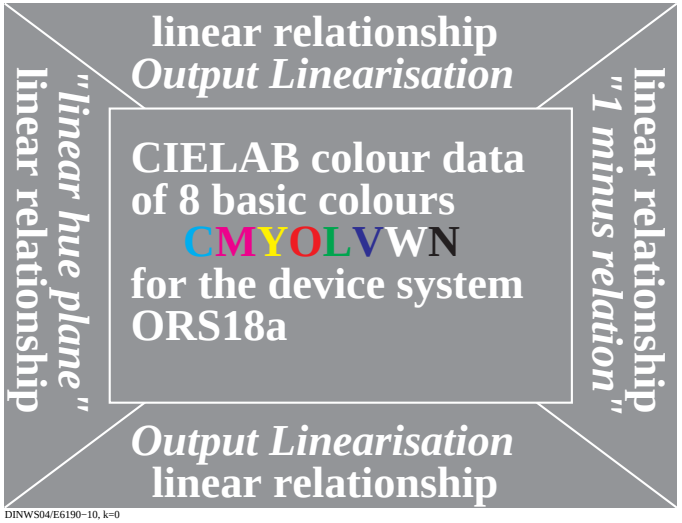
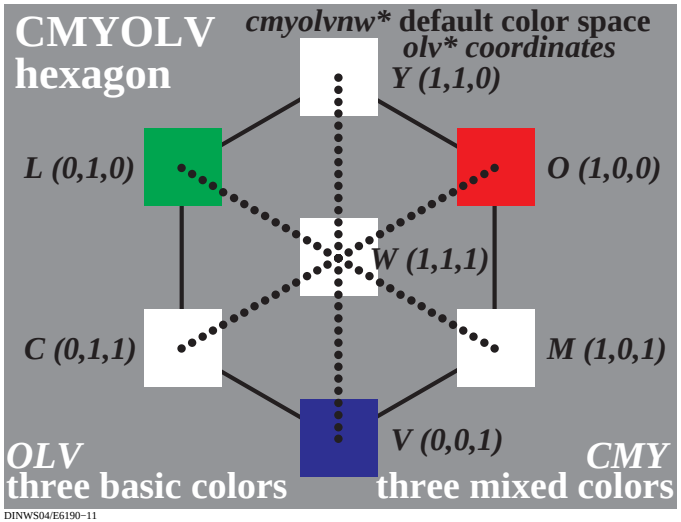
Linear relationship of colour coordinatesn



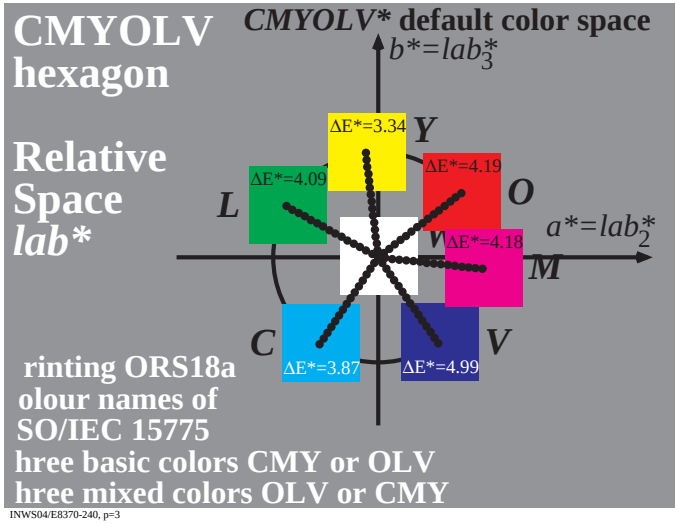
INWS04/E8370-140, p=3



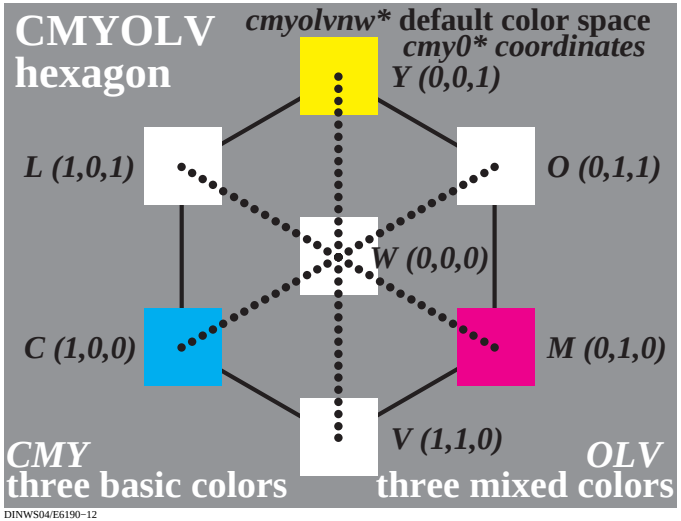
DINWS04/E6190−10, k=0



DINWS04/E6190−11



INWS04/E8370-240, p=3



DINWS04/E6190−12

Linear relationship of colour coordinates

5 steps of grey series black - white (N - W)	Colour space, colour space coordinates and PostScript operator calculations according to ISO/IEC 15775:1999-12											
Linear mixture between black and white in CIELAB colour space	***L** CIE w* = l**** ***setgray***	**CMYN (CMYK) *000n**** ***setcmykcolor***				**CMYN (CMYK) *cmy0**** ***setcmykcolor***				**OLV (RGB) *www**** ***setrgbcolor***		
1,00 N + 0,00 W (black N)	0,00	0,00	0,00	0,00	1,00	1,00	1,00	1,00	0,00	0,00	0,00	0,00
0,75 N + 0,25 W	0,25	0,00	0,00	0,00	0,75	0,75	0,75	0,75	0,00	0,25	0,25	0,25
0,50 N + 0,50 W	0,50	0,00	0,00	0,00	0,50	0,50	0,50	0,50	0,00	0,50	0,50	0,50
0,25 N + 0,75 W	0,75	0,00	0,00	0,00	0,25	0,25	0,25	0,25	0,00	0,75	0,75	0,75
0,00 N + 1,00 W (white W)	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,00	1,00	1,00

DINWS04/DESERCW0.PS

5 steps of colour series cyan blue - white (C - W)	Colour space, colour space coordinates and PostScript operator calculations according to ISO/IEC 15775:1999-12											
Linear mixture between cyan blue and white in CIELAB colour space	**CIELAB *LAB* (absolute) LAB* setcolor***			**CMYN (CMYK) *cmy0* (relative) cmy0* setcmykcolor***				**OLV (RGB) *olv* (relative) olv* setrgbcolor***				
1,00 C + 0,00 W (cyan blue C)	58.62	-30.62	-42.74	1,00	0,00	0,00	0,00	0,00	1,00	1,00		
0,75 C + 0,25 W	67.82	-23.21	-30.86	0,75	0,00	0,00	0,00	0,25	1,00	1,00		
0,50 C + 0,50 W	77.02	-15.80	-18.98	0,50	0,00	0,00	0,00	0,50	1,00	1,00		
0,25 C + 0,75 W	86.21	-8.39	-7.11	0,25	0,00	0,00	0,00	0,75	1,00	1,00		
0,00 C + 1,00 W (white W)	95.41	-0.98	4.76	0,00	0,00	0,00	0,00	1,00	1,00	1,00		

DINWS04/DESERCW1.PS

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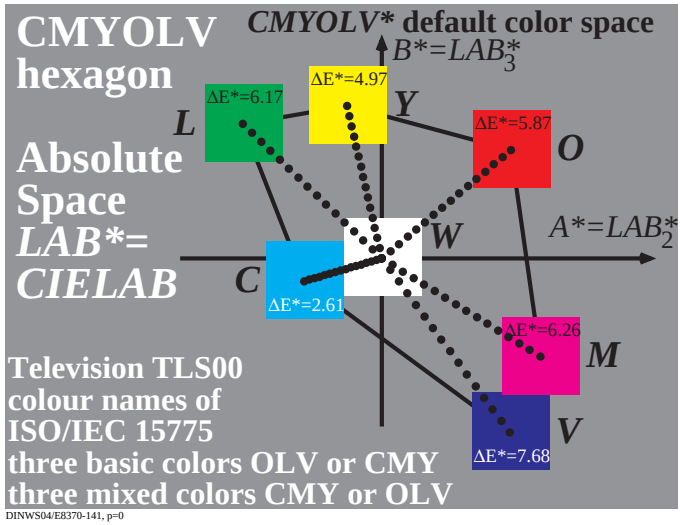
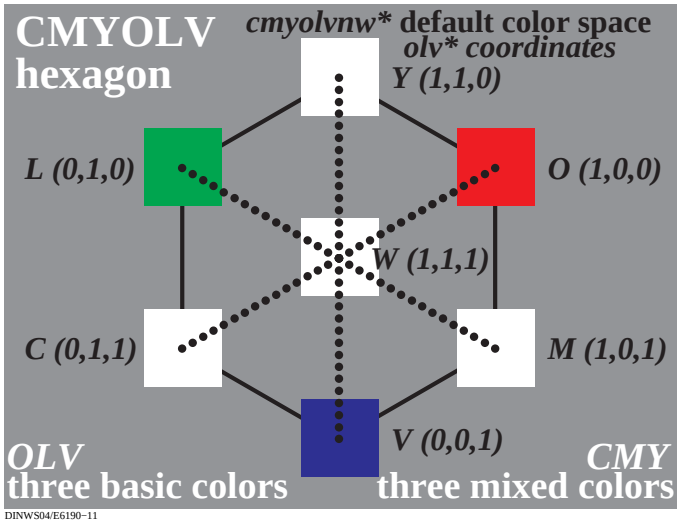
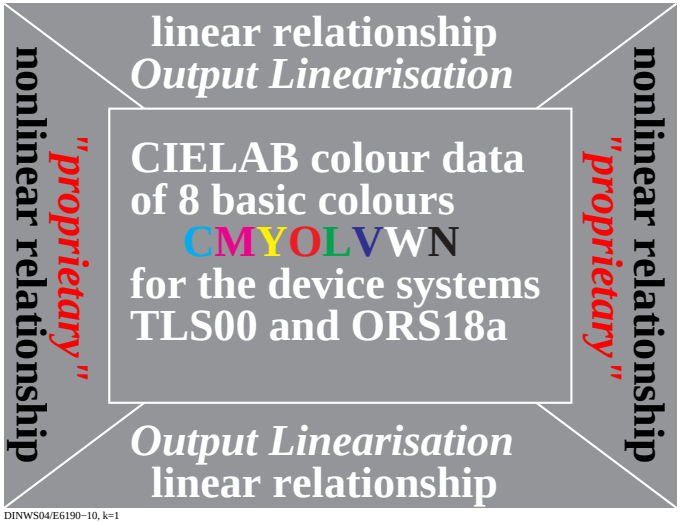
relationship of display and printer colour coordinates



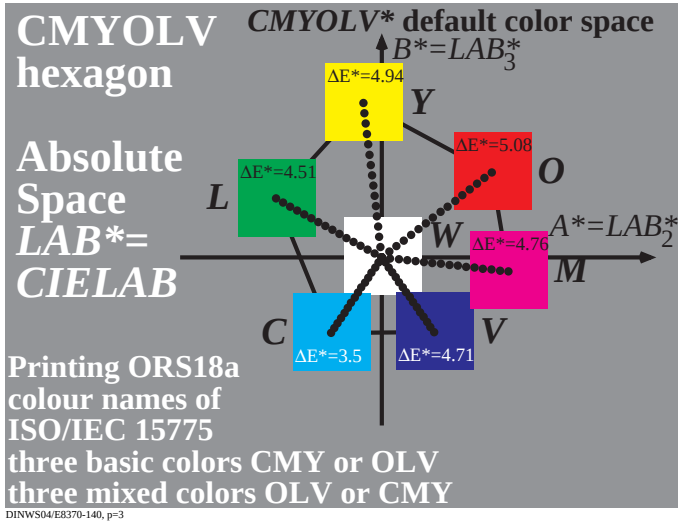
DINWS04/E8370-141, p=0



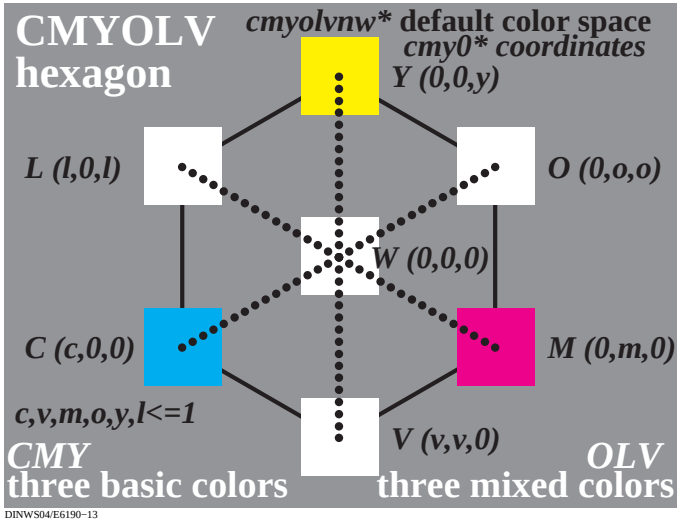
DINWS04/E6190−11



DINWS04/E6190−10, k=1



DINWS04/E8370-140, p=3



DINWS04/E6190−13

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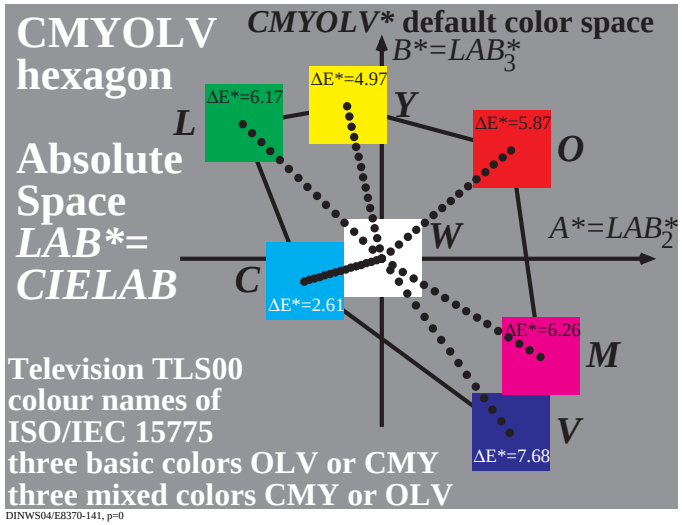
relationship of display and printer colour coordinates



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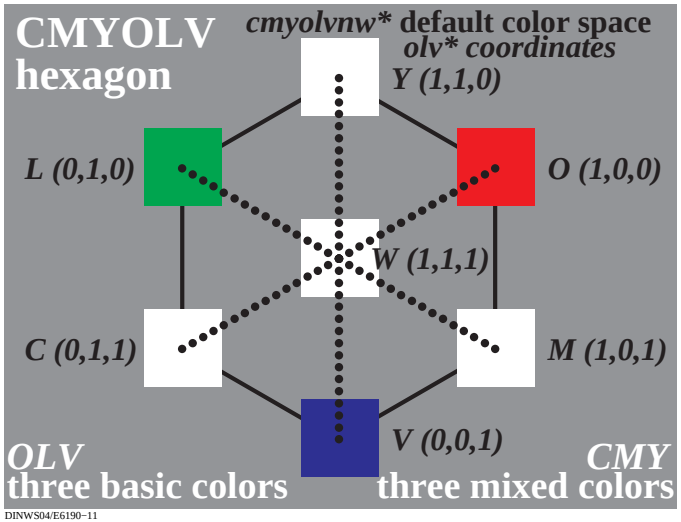


DINWS04/E6190−11

linear relationship
Output Linearisation

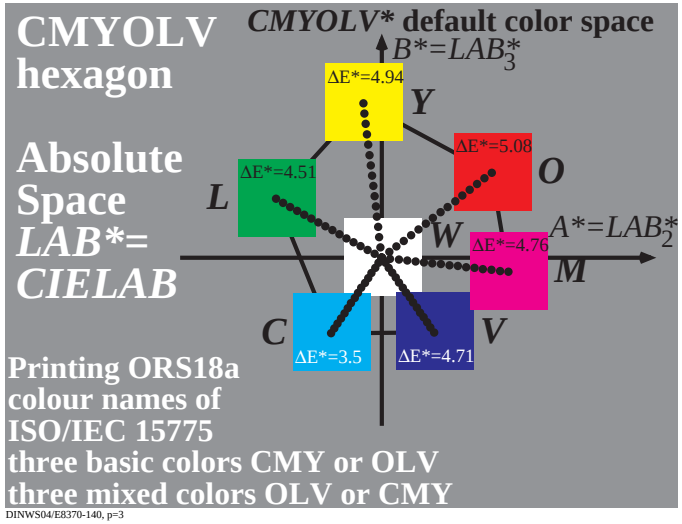
nonlinear relationship
"proprietary"

linear relationship
"1 minus relation"

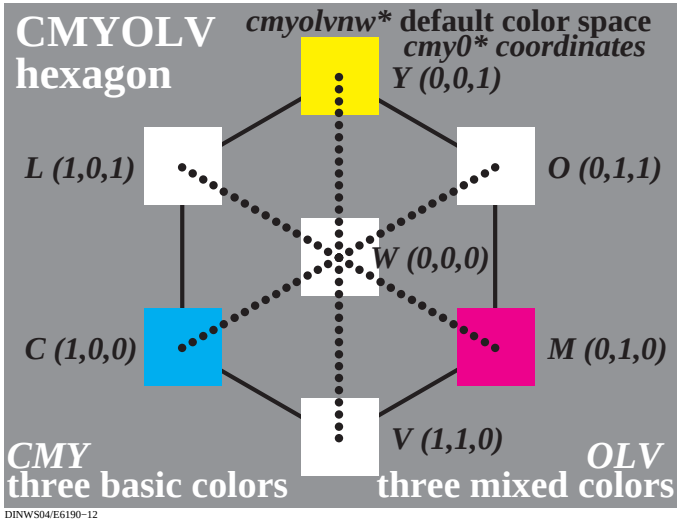
CIELAB colour data
of 8 basic colours
CMYOLVWN
for the device systems
TLS00 and ORS18a

Output Linearisation
linear relationship

DINWS04/E6190−10, k=2



DINWS04/E8370-140, p=3



DINWS04/E6190−12

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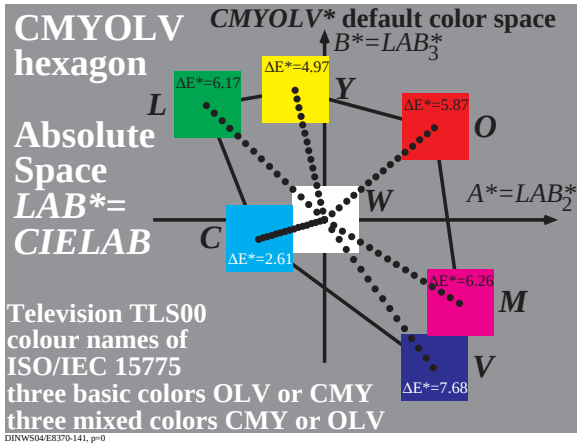
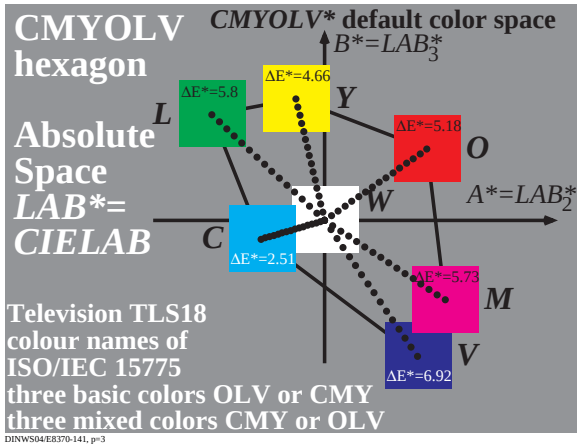
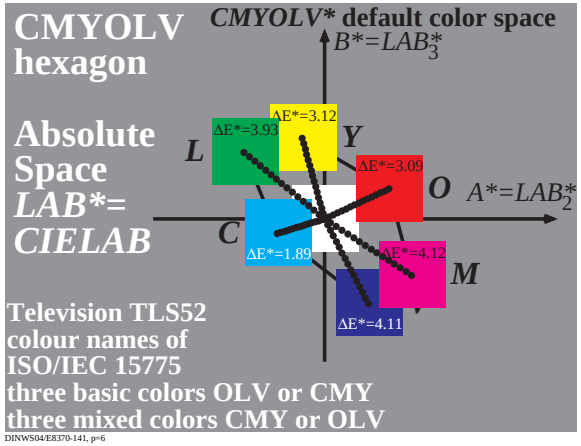
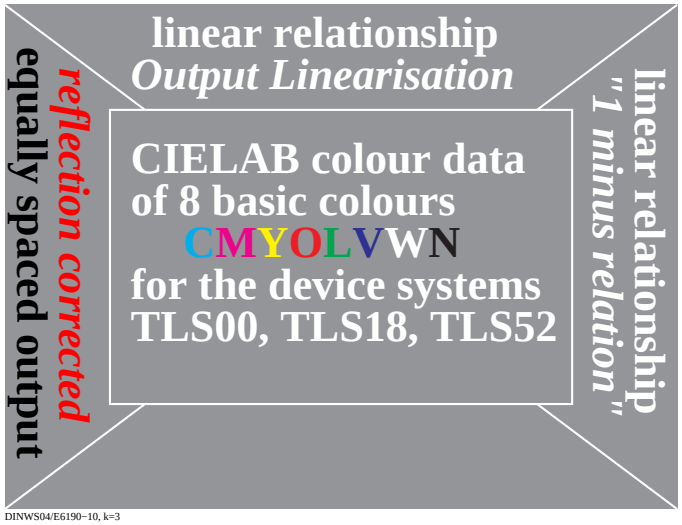
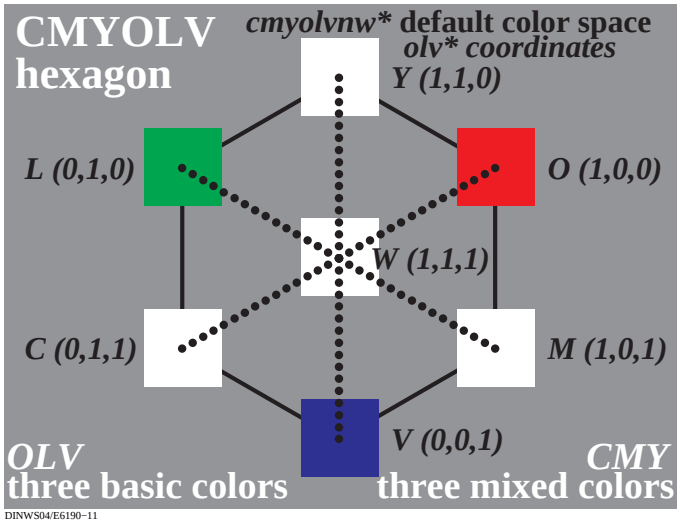
relationship of display reflection colour coordinates

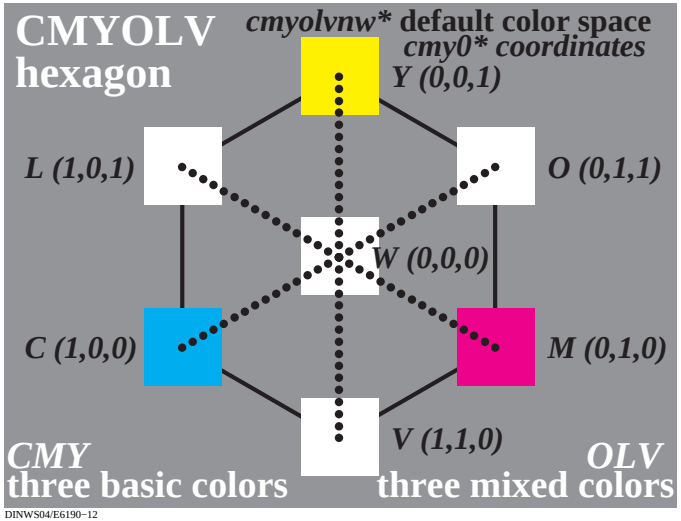












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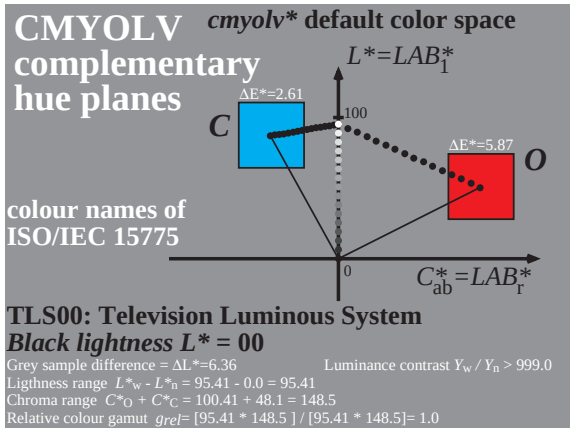
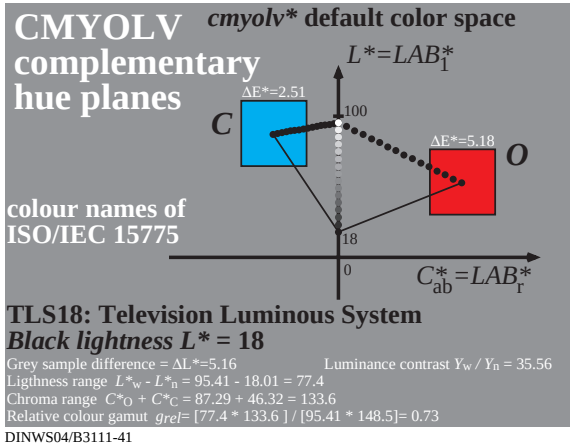
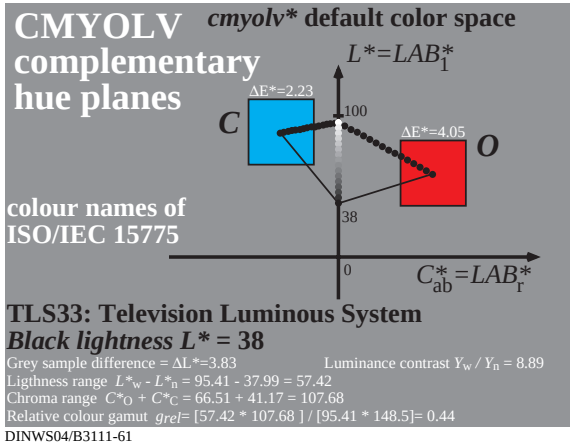
relationship of display reflection colour coordinates



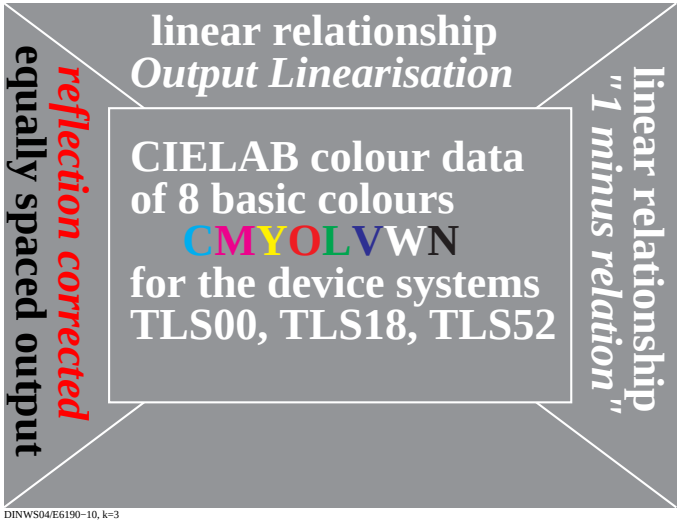
DINWS04/B3111-11



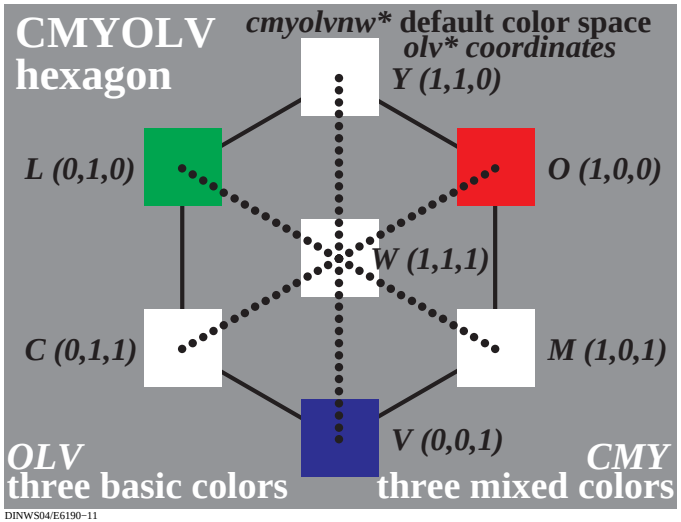
DINWS04/B3111-41



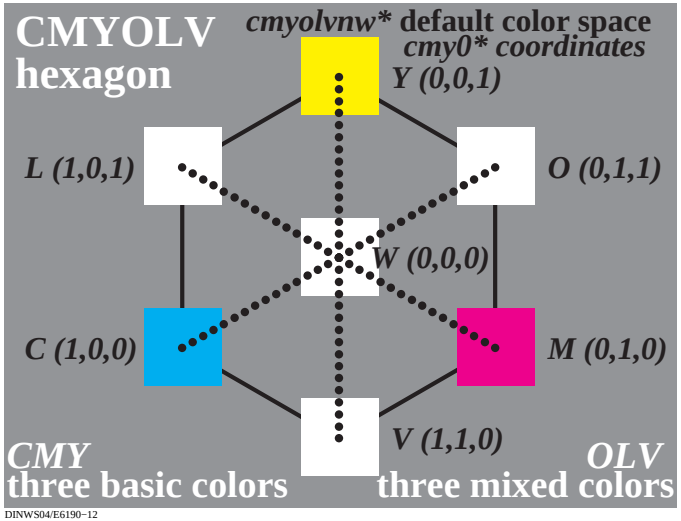
DINWS04/B3111-61



DINWS04/E6190−10, k=3



DINWS04/E6190−11



DINWS04/E6190−12

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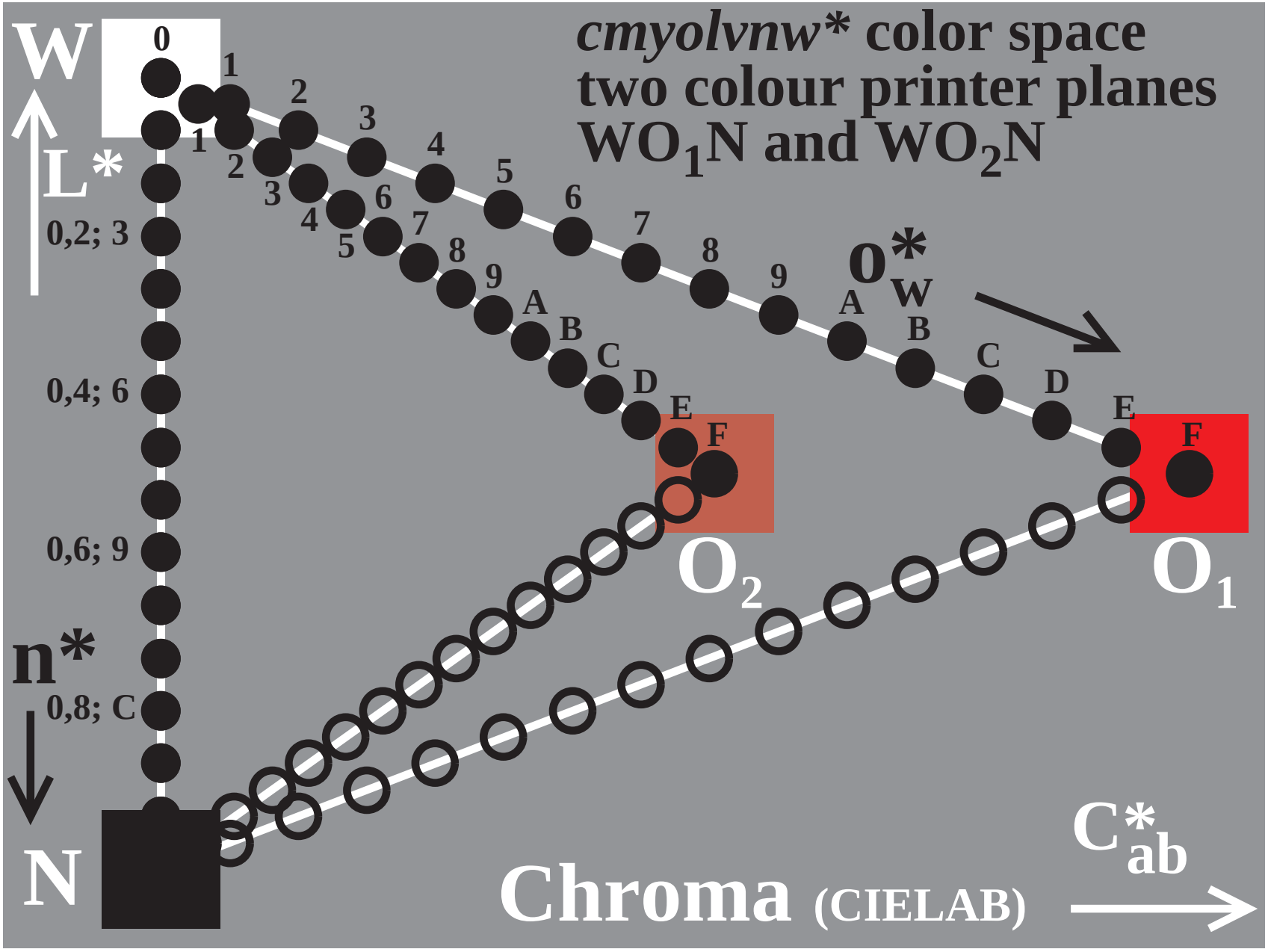
Equidistant Colour Output of a16 steps Colour series with two Colour Printers of two different Chroma

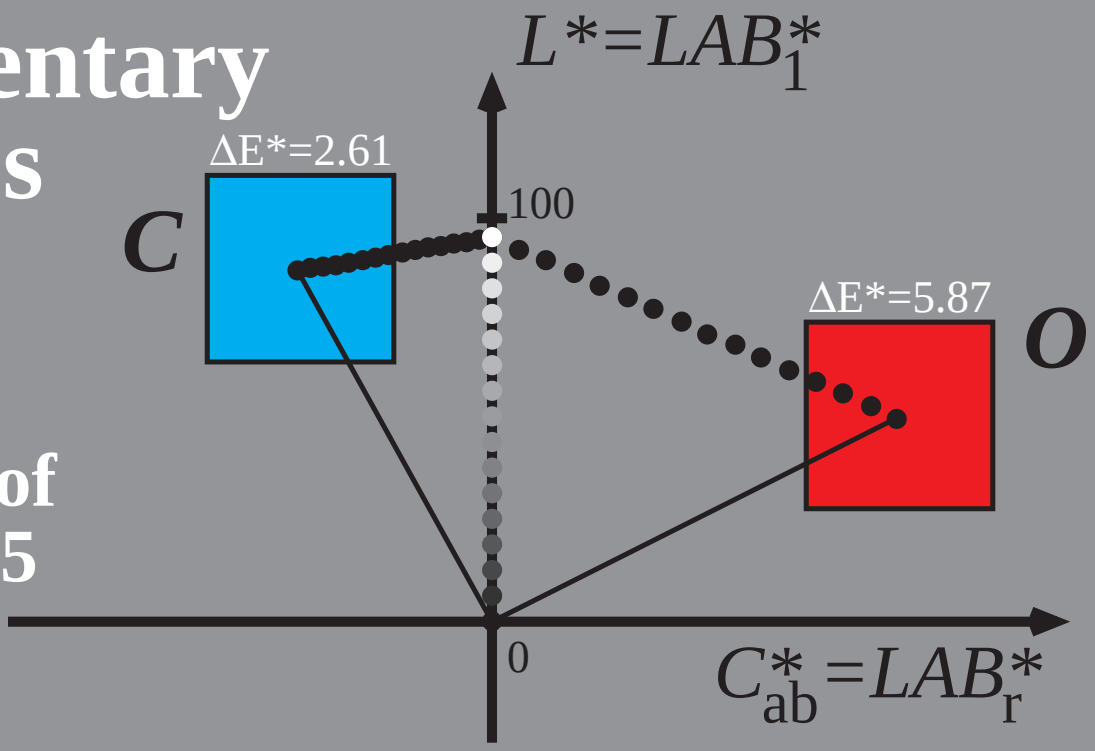


DFZBAM/E6190-2Z.PS/PDF/eps

Television Space: Hue plane O-C, no display reflection

CMYOLV complementary hue planes

*cmyolv** default color space



colour names of ISO/IEC 15775

TLS00: Television Luminous System

*Black lightness L** = 00

Grey sample difference = ΔL*=6.36 Luminance contrast $Y_w / Y_n > 999.0$

Ligthness range $L^*_w - L^*_n = 95.41 - 0.0 = 95.41$

Chroma range $C^*_O + C^*_C = 100.41 + 48.1 = 148.5$

Relative colour gamut g_{rel}= [95.41 * 148.5] / [95.41 * 148.5]= 1.0

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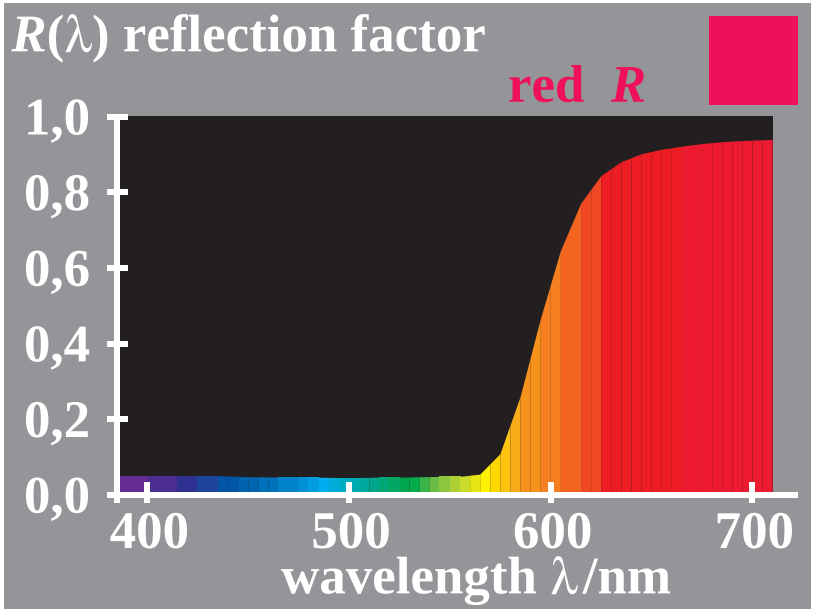
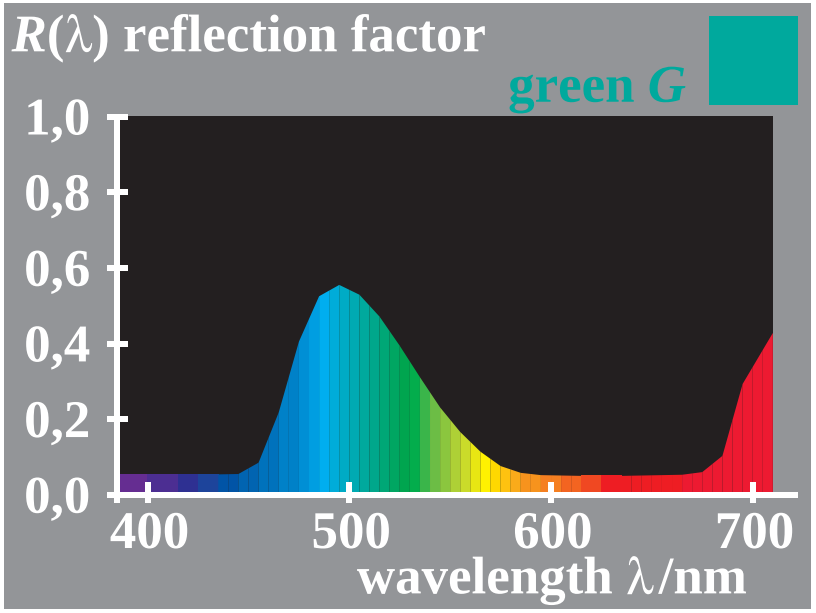
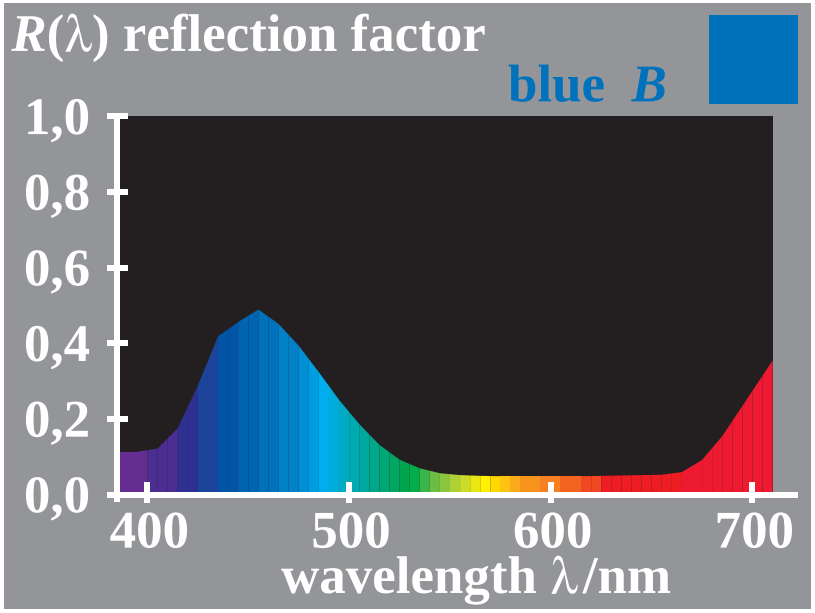
Mate surface colours with reflection Yr=4.0



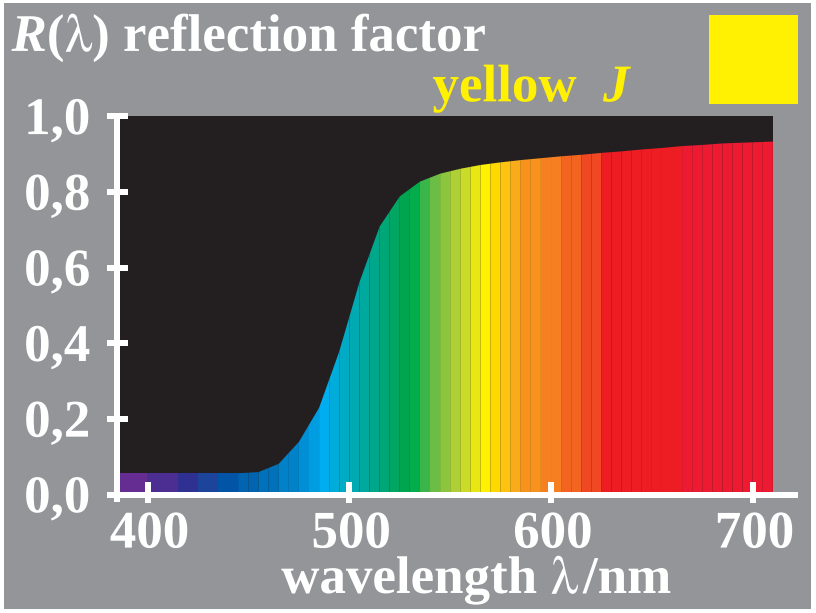
TR24705/E8141−7N



TR24705/E8150−1N



TR24705/E8141−8N

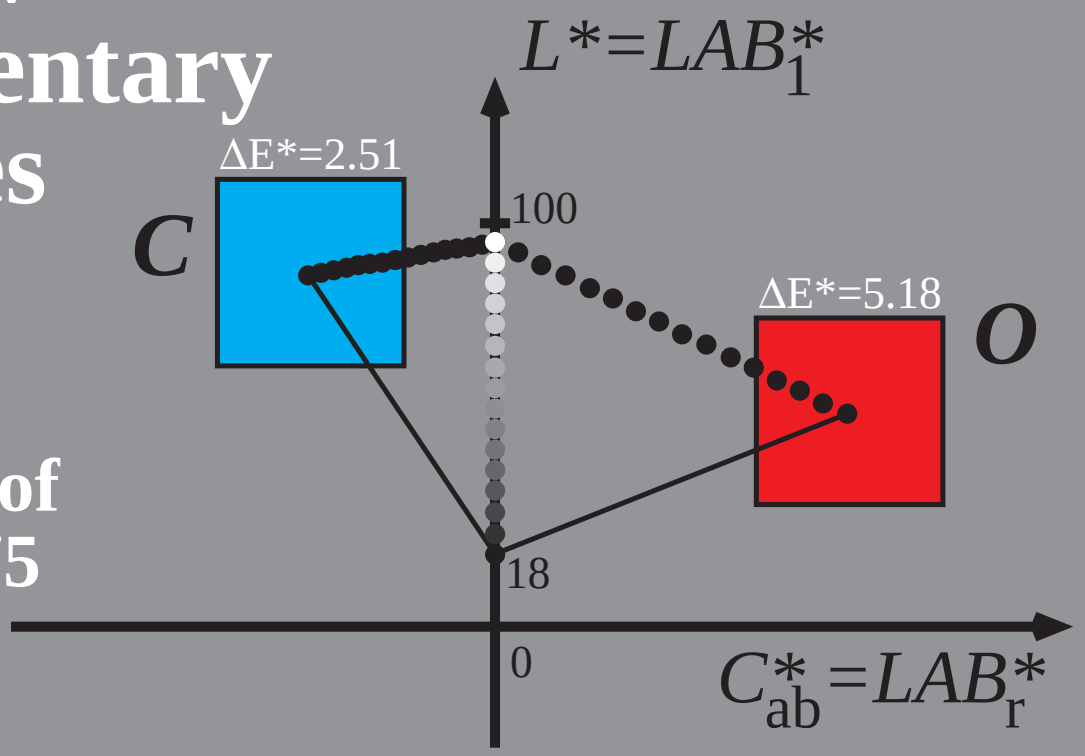


TR24705/E8141−6N

Television Space: Hue plane O-C, display reflection Yr=2.5

CMYOLV complementary hue planes

*cmyolv** default color space



colour names of ISO/IEC 15775

TLS18: Television Luminous System

*Black lightness L** = 18

Grey sample difference = ΔL*=5.16 Luminance contrast Y_w / Y_n = 35.56

Ligthness range $L^*_w - L^*_n = 95.41 - 18.01 = 77.4$

Chroma range $C^*_O + C^*_C = 87.29 + 46.32 = 133.6$

Relative colour gamut g_{rel}= [77.4 * 133.6] / [95.41 * 148.5]= 0.73

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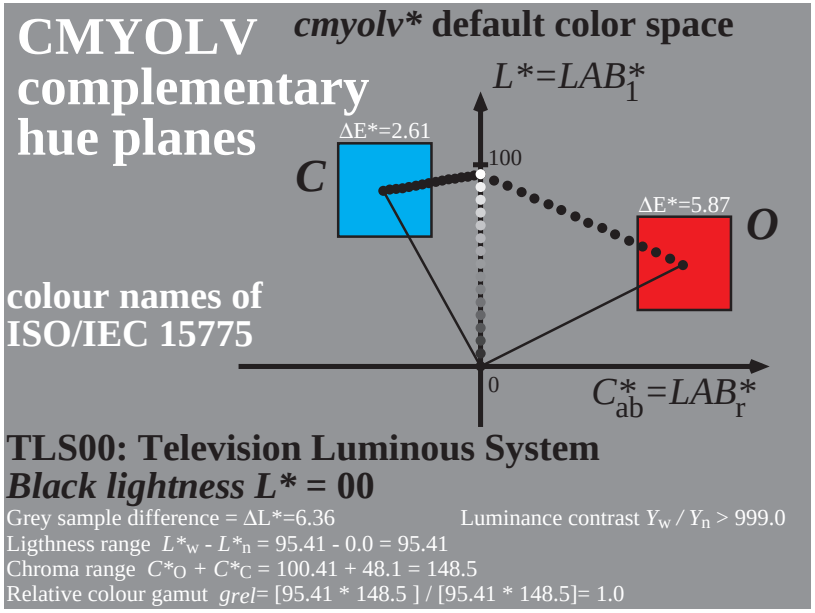
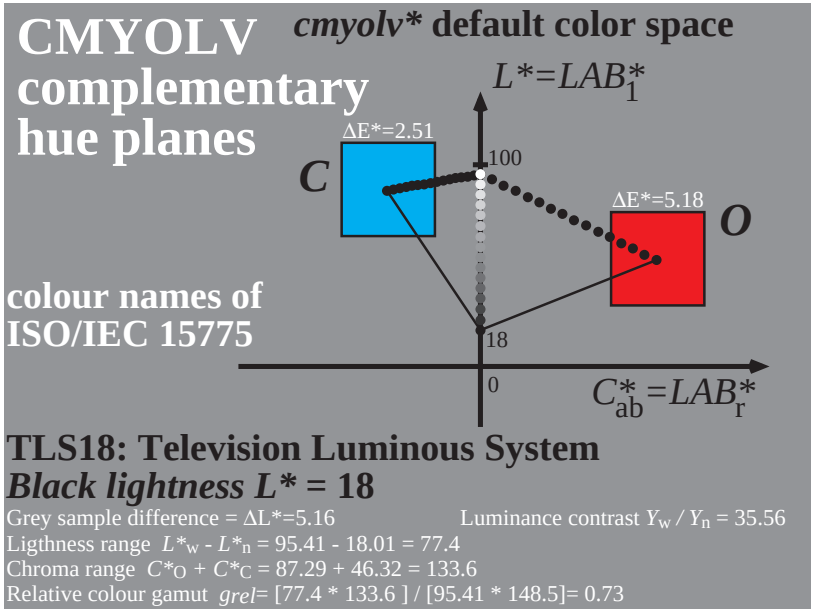
Television Space: Hue plane O-C, no display reflection



DINWS04/B3111-11



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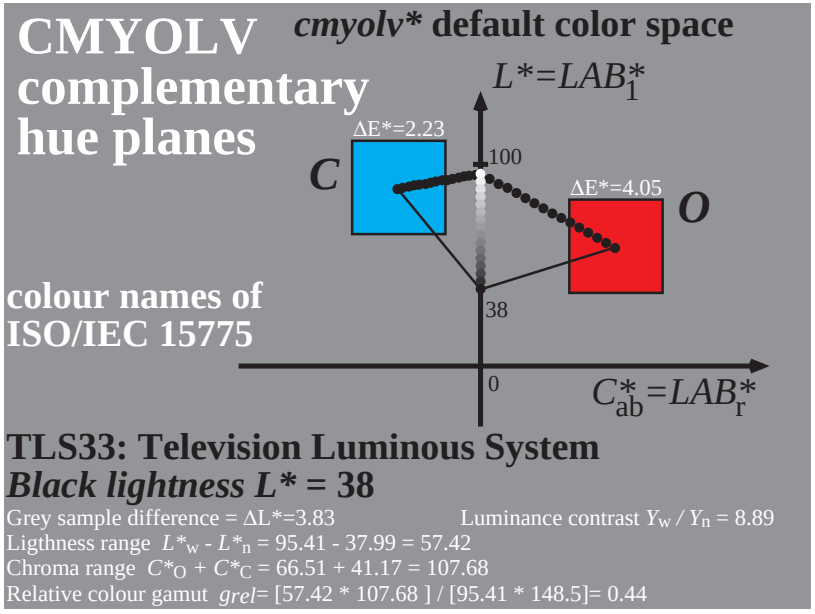

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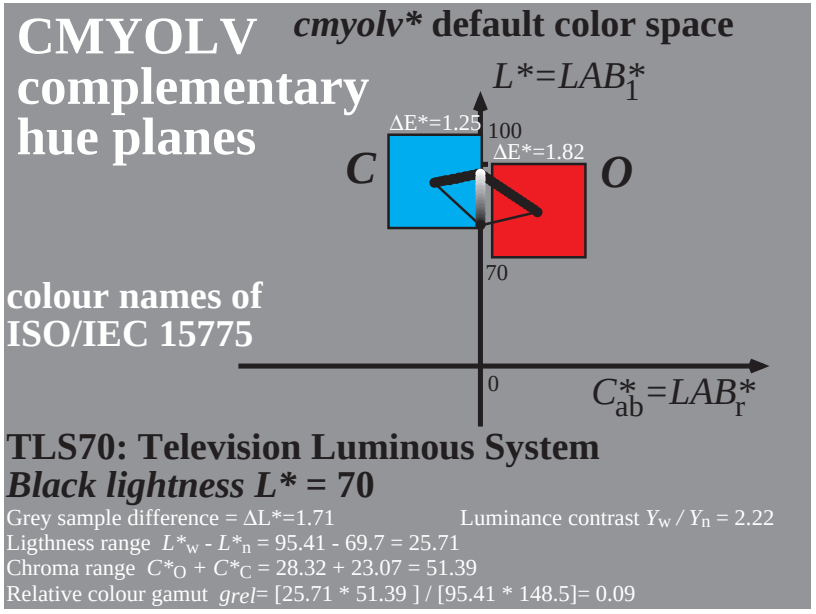

DINWS04/B3111-81

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CIE coordinatesof television displays, no display reflection (Yr=0)

Basic television colour or mixture colour for D65 **TLS00:** Yw = 88,60 + 0,00	**chromaticity**		**tristimulus values** *(Y = 88,60 for white D65)*			***L*a*b**-CIELAB data** *(L* = 95,42 for white D65)*		
	x	***y***	***X***	***Y***	***Z***	***L****	***a****	***b****
three additive basic colours: television colours acc. to ITU-R BT.709−3								
O(R) Orange red (Red)	0,6400	0,3300	36,54	18,84	1,72	50,50	76,92	64,55
L(G) Leaf green (Green)	0,3000	0,6000	31,69	63,37	10,57	83,64	−82,77	79,90
V(B) Violett blue (Blue)	0,1500	0,0600	15,00	6,40	84,22	30,40	76,06	−103,59
three additive mixture colours: television colours acc. to ITU-R BT.709−3								
C cyan-blue	0,2246	0,3287	47,68	69,77	94,78	86,88	−46,18	−13,57
M magenta-red	0,3209	0,1542	52,53	25,24	85,93	57,31	94,35	−58,42
Y yellow	0,4193	0,5053	68,22	82,21	12,28	92,67	−20,71	90,75
achromatic colours:								
W1 (ideal white, 100,0%)	0,3127	0,3290	95,05	100,00	108,90	100,00	0,00	0,00
W (white monitor, 88,60%)	0,3127	0,3290	84,22	88,60	96,49	95,42	0,00	0,00
N (black monitor, 0,00%)	–	–	0,00	0,00	0,00	0,00	0,00	0,00
N0 (ideal black, 0,00%)	–	–	0,00	0,00	0,00	0,00	0,00	0,00

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CIE coordinatesof television displays,display reflection Yr=2,52

Basic television colour or mixture colour for D65 **TLS18:** Yw = 86,08 + 2,52	**chromaticity**		**tristimulus values** *(Y = 88,60 for white D65)*			***L*a*b**-CIELAB data** *(L* = 95,42 for white D65)*		
	x	***y***	***X***	***Y***	***Z***	***L****	***a****	***b****
three additive basic colours: television colours acc. to ITU-R BT.709−3								
O(R) Orange red (Red)	0,6003	0,3299	37,90	20,83	4,41	52,76	71,64	49,88
L(G) Leaf green (Green)	0,3009	0,5812	33,18	64,09	13,01	84,01	−79,02	73,94
V(B) Violett blue (Blue)	0,1612	0,0785	17,94	8,74	84,57	35,47	64,92	−95,09
three additive mixture colours: television colours acc. to ITU-R BT.709−3								
C cyan-blue	0,2278	0,3287	48,72	70,30	94,83	87,15	−44,45	−13,15
M magenta-red	0,3205	0,1622	53,43	27,04	86,23	59,01	89,34	−55,70
Y yellow	0,4144	0,4971	68,68	82,39	14,67	92,75	−20,06	84,97
achromatic colours:								
W1 (ideal white, 100,0%)	0,3127	0,3290	95,05	100,00	108,90	100,00	0,00	0,00
W (white monitor, 88,60%)	0,3127	0,3290	84,22	88,60	96,49	95,42	0,00	0,00
N (black monitor, 2,52%)	0,3127	0,3290	2,40	2,52	2,75	18,01	0,00	0,00
N0 (ideal black, 0,00%)	–	–	0,00	0,00	0,00	0,00	0,00	0,00

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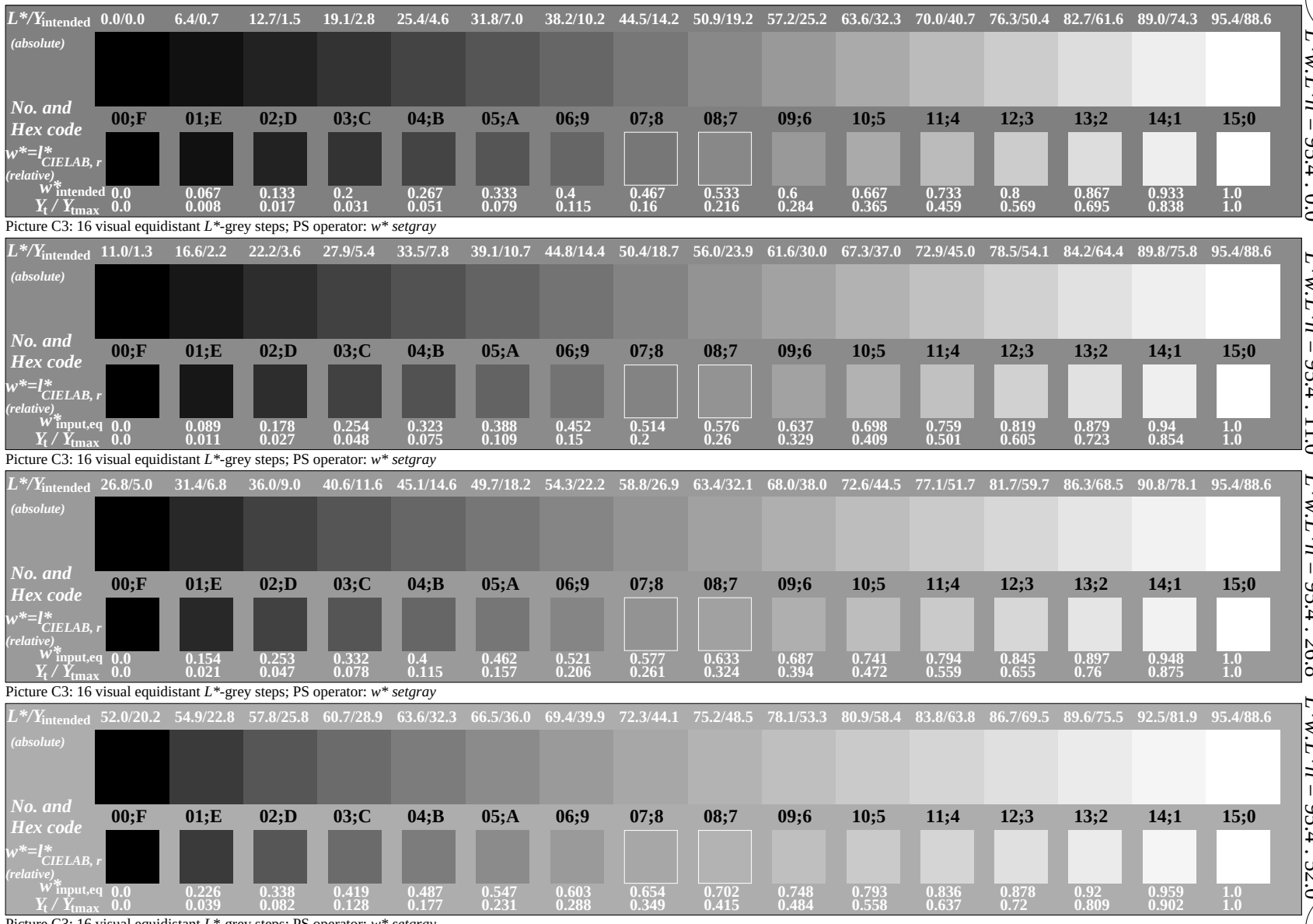
Equally spaced CIE coordinatesof displays, four display reflections

www.ps.bam.de/CE68/10L/L68E00FP.PS/.PDF; linearized output
F: Output Linearization (OL) data CE68/10L/L68E00FP.DAT in File (F)

BAM registration: 20040101-CE68/10L/L68E00FP.PS/.PDF BAM material: code=rha4ta
Application for achromatic display output with CIELAB contrast range

See for similar files: http://www.ps.bam.de/CE68/
Technical information: http://www.ps.bam.de/9241 Version 2.0, io=1,1, CIEXYZ, 1.0 exp



ISO 9241-test chart for four different contrast ranges
Ergonomics − Visual Displays − Field Assessment Methods

input: *w* setgray*
output: *no change compared to input*

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Reproduction properties of the Achromatic Test Chart Output

Test of 16 visual equidistant *L**-grey steps acc. to picture A3

Are the steps on the upper row distinguishable?		Yes/No
If No: How many steps can be distinguished?	of the given 16 steps:	..... Steps

Test of the Landolt-rings *N–W* acc. to picture A4

Is the recognition frequency of the Landolt-rings > 50% (5 of 8 at least)?

background – ring	
0 – 1	Yes/No
7 – 8	Yes/No
E – F	Yes/No
2 – 0	Yes/No
8 – 6	Yes/No
F – D	Yes/No

Test of the line screen under 45° acc. to picture A5

Can equally spaced lines be seen?		
Visual testing: for radial diameter from 15 to 60 lpi		Yes/No
Test with a magnifying glass (e.g. 6x):	- from 15 lpi:	to ..... lpi

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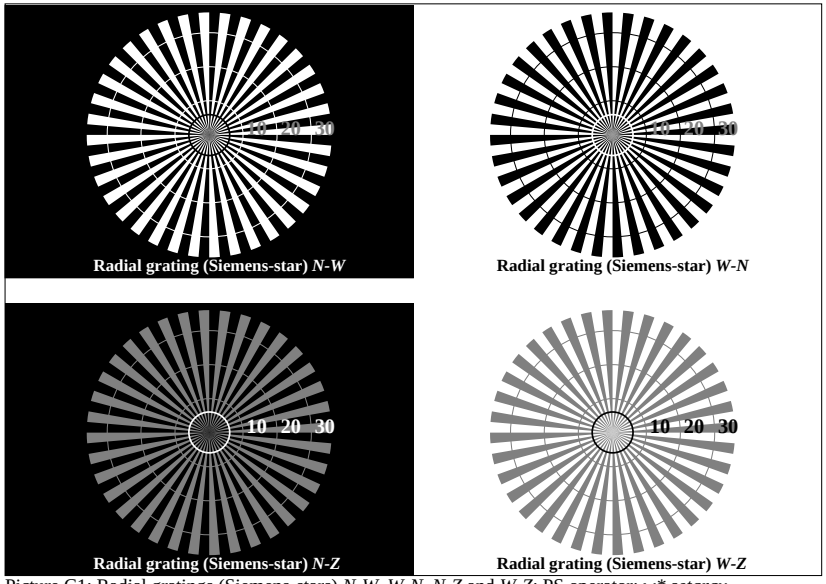
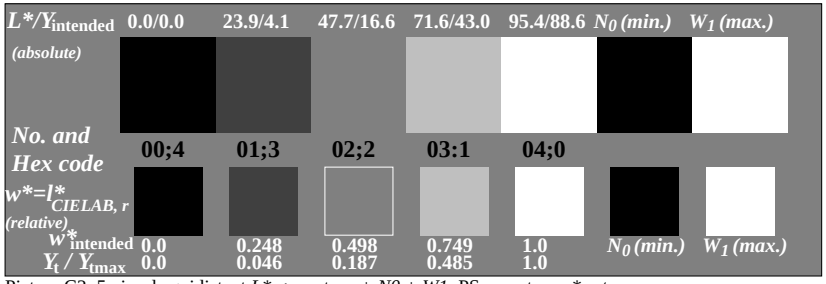
ISO/IEC-test chart no. 1, no display reflection (Yr=0)

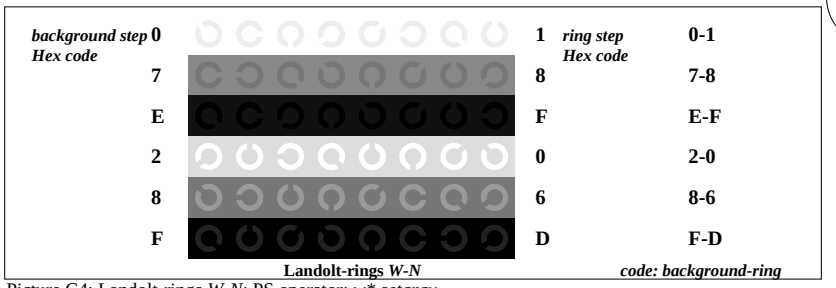
www.ps.bam.de/CE65/10L/L65E00FP.PS/.PDF; linearized output
F: Output Linearization (OL) data CE65/10L/L65E00FP.DAT in File (F)



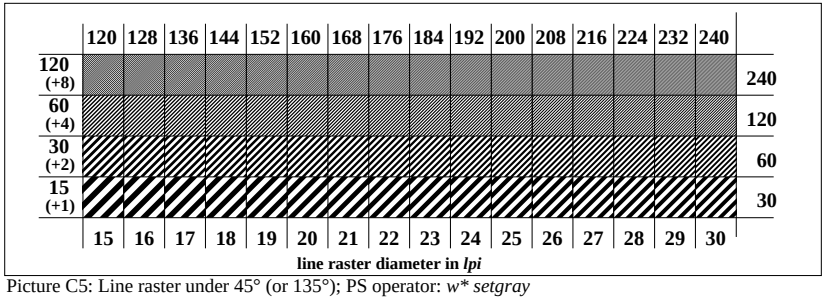
Picture C1: Radial gratings (Siemens-stars) *N-W*, *W-N*, *N-Z* and *W-Z*; PS operator: *w* setgray*



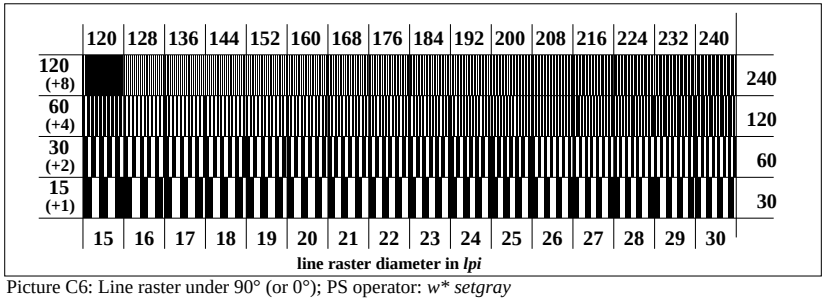
Picture C2: 5 visual equidistant *L**-grey steps + *N0* + *W1*; PS operator: *w* setgray*



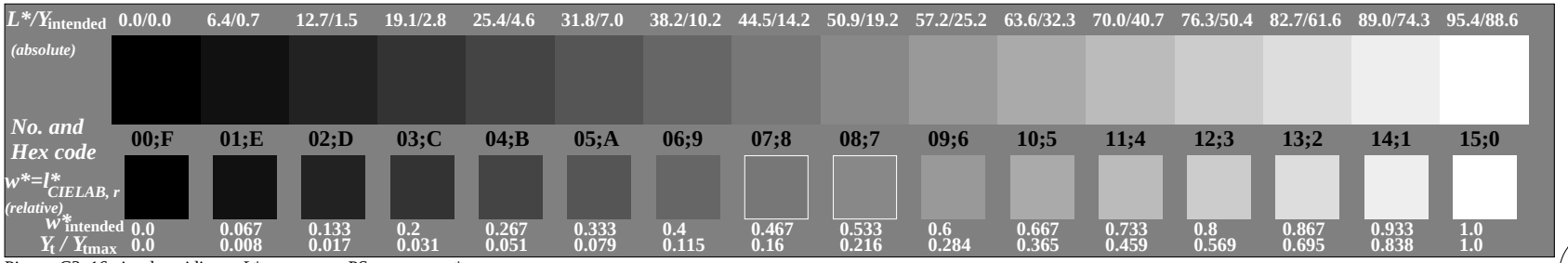
Picture C4: Landolt-rings *W-N*; PS operator: *w* setgray*



Picture C5: Line raster under 45° (or 135°); PS operator: *w* setgray*



Picture C6: Line raster under 90° (or 0°); PS operator: *w* setgray*



Picture C3: 16 visual equidistant *L**-grey steps; PS operator: *w* setgray*

ISO 9241-test chart for contrast range *Yw:Yn* = 88.6 : 0.0
Ergonomics − Visual Displays − Field Assessment Methods

input: *w* setgray*
output: *no change compared to input*

See for similar files: http://www.ps.bam.de/CE65/
Technical information: http://www.ps.bam.de/9241

Version 2.0, io=1,1, CIEXYZ, 1.0 exp

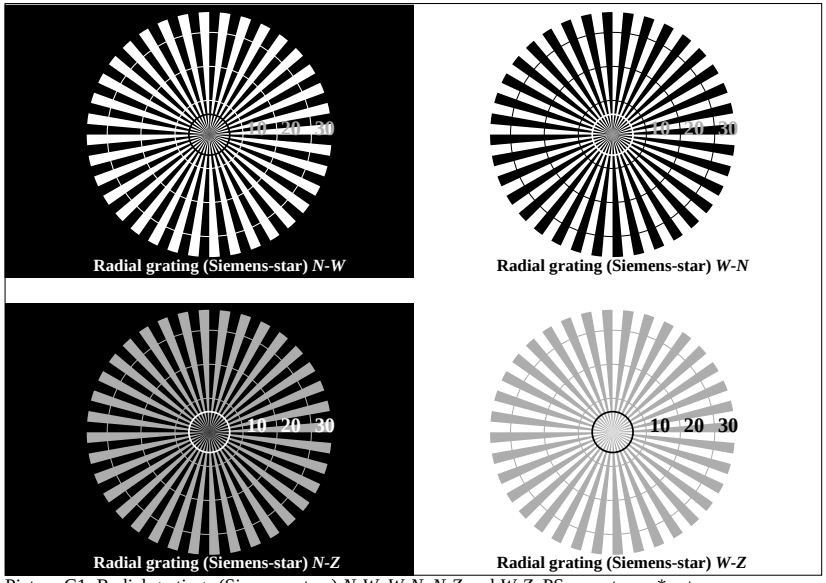
BAM registration: 20040101-CE65/10L/L65E00FP.PS/.PDF
Application for achromatic display output with CIELAB contrast range *L*w:L*n* = 95.4 : 0.0

BAM material: code=rha4ta

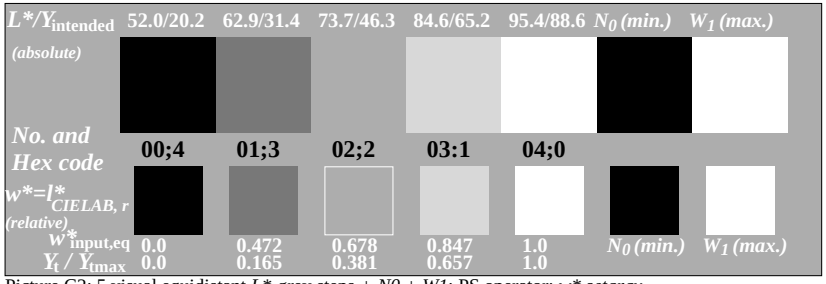
DIN-Workshop: ISO-test charts, 2004, May 24, Nuernberg

ISO/IEC-test chart no. 1, display reflection (Yr=20)

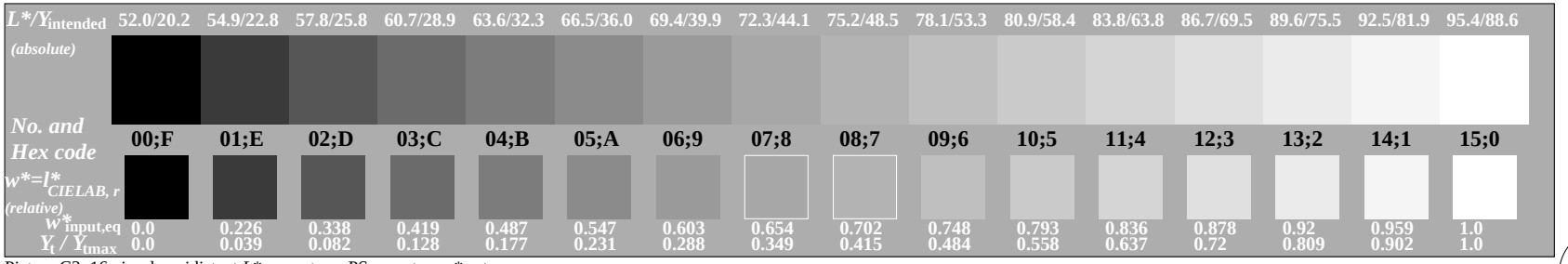
www.ps.bam.de/CE65/10L/L65E60FP.PS/.PDF; linearized output
F: Output Linearization (OL) data CE65/10L/L65E60FP.DAT in File (F)



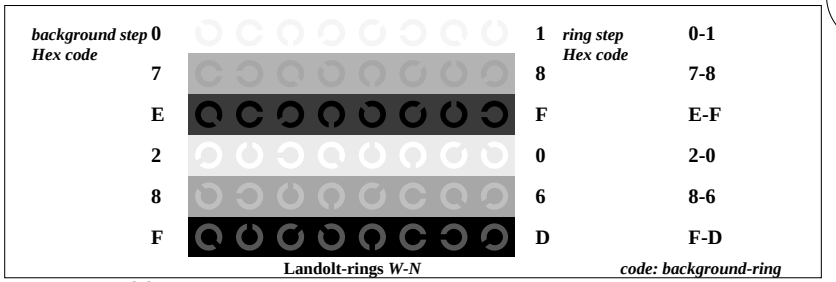
Picture C1: Radial gratings (Siemens-stars) *N-W, W-N, N-Z* and *W-Z*; PS operator: *w* setgray*



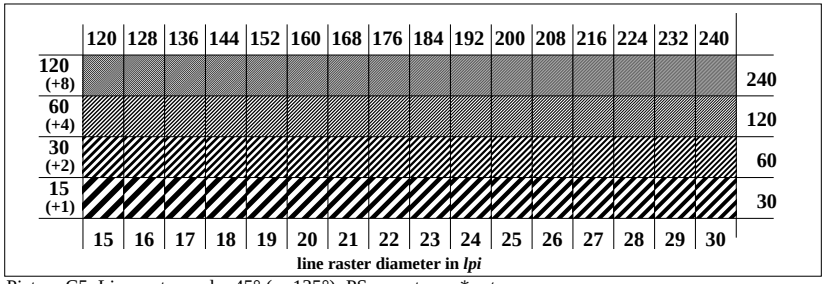
Picture C2: 5 visual equidistant *L**-grey steps + *N0* + *W1*; PS operator: *w* setgray*



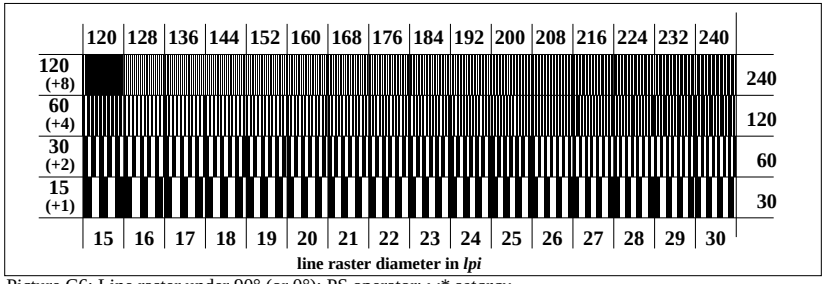
Picture C3: 16 visual equidistant *L**-grey steps; PS operator: *w* setgray*



Picture C4: Landolt-rings *W-N*; PS operator: *w* setgray*



Picture C5: Line raster under 45° (or 135°); PS operator: *w* setgray*



Picture C6: Line raster under 90° (or 0°); PS operator: *w* setgray*

See for similar files: http://www.ps.bam.de/CE65/
Technical information: http://www.ps.bam.de/9241 Version 2.0, io=1,1, CIEXYZ, 1.0 exp

BAM registration: 20040101-CE65/10L/L65E60FP.PS/.PDF BAM material: code=rha4ta
Application for achromatic display output with CIELAB contrast range *L*w:L*n* = 95.4 : 52.0

ISO 9241-test chart for contrast range *Yw:Yn* = 88.6 : 20.2
Ergonomics − Visual Displays − Field Assessment Methods

input: *w* setgray*
output: *no change compared to input*

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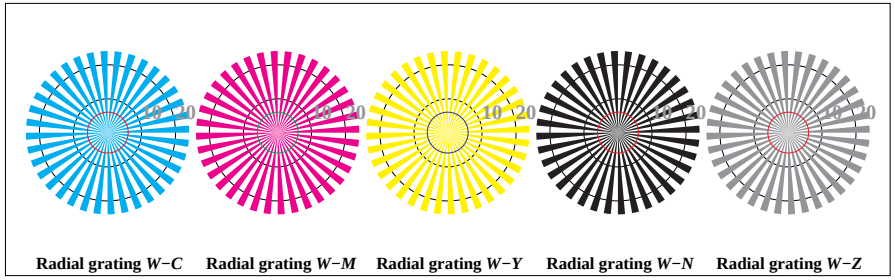
Chromatic ISO/IEC-Test Chart

www.ps.bam.de/DE96/10L/L96E02NP.PS/.PDF; start output and no OL
N: No Output Linearization (OL) data in File (F), Startup (S) or Device (D)

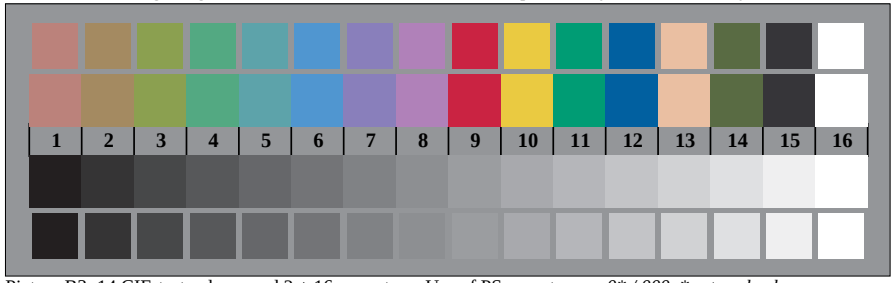
Information and Order: http://www.ps.bam.de Image file version 1.9, 20020101-DE96

BAM registration: 20020101-DE96/10L/L96E02NP.PS/.PDF BAM material: code=rha4ta

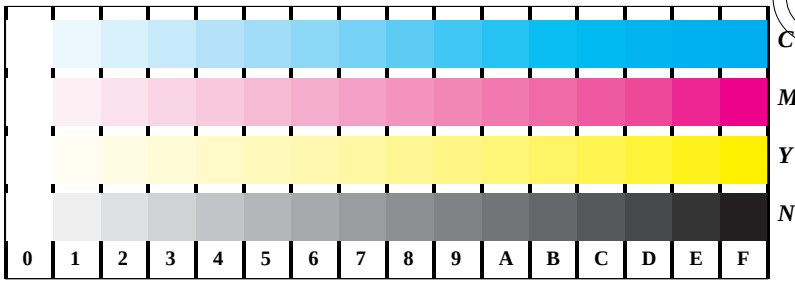
Picture B1: Flower motif, 14 CIE-test colours and 2 + 16 grey steps (sf); PS operators *settransfer*, *3 colorimage*



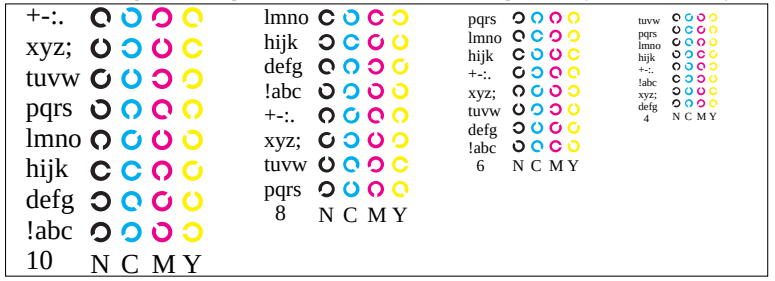
Picture B2: Radial gratings ***W-C, W-M, W-Y, W-N,*** and ***W-Z***; PS operator *cmy0* / 000n* setcmykcolor*



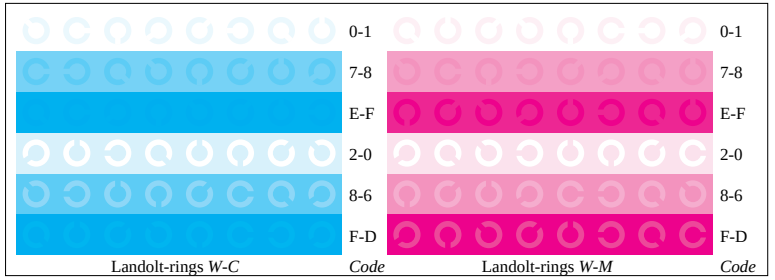
Picture B3: 14 CIE-test colours and 2 + 16 grey steps; Use of PS operator *cmy0* / 000n* setcmykcolor*



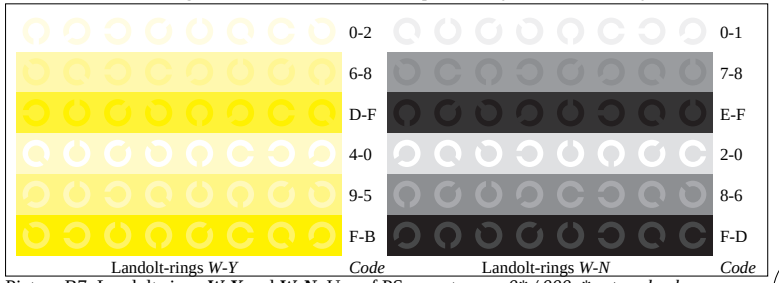
Picture B4: 16 equidistant steps ***W-C, W-M, W-Y*** and ***W-N***; PS operator *cmy0* / 000n* setcmykcolor*



Picture B5: Script and Landolt-rings ***N, M, C*** and ***Y***; Use of PS operator *cmy0* / 000n* setcmykcolor*



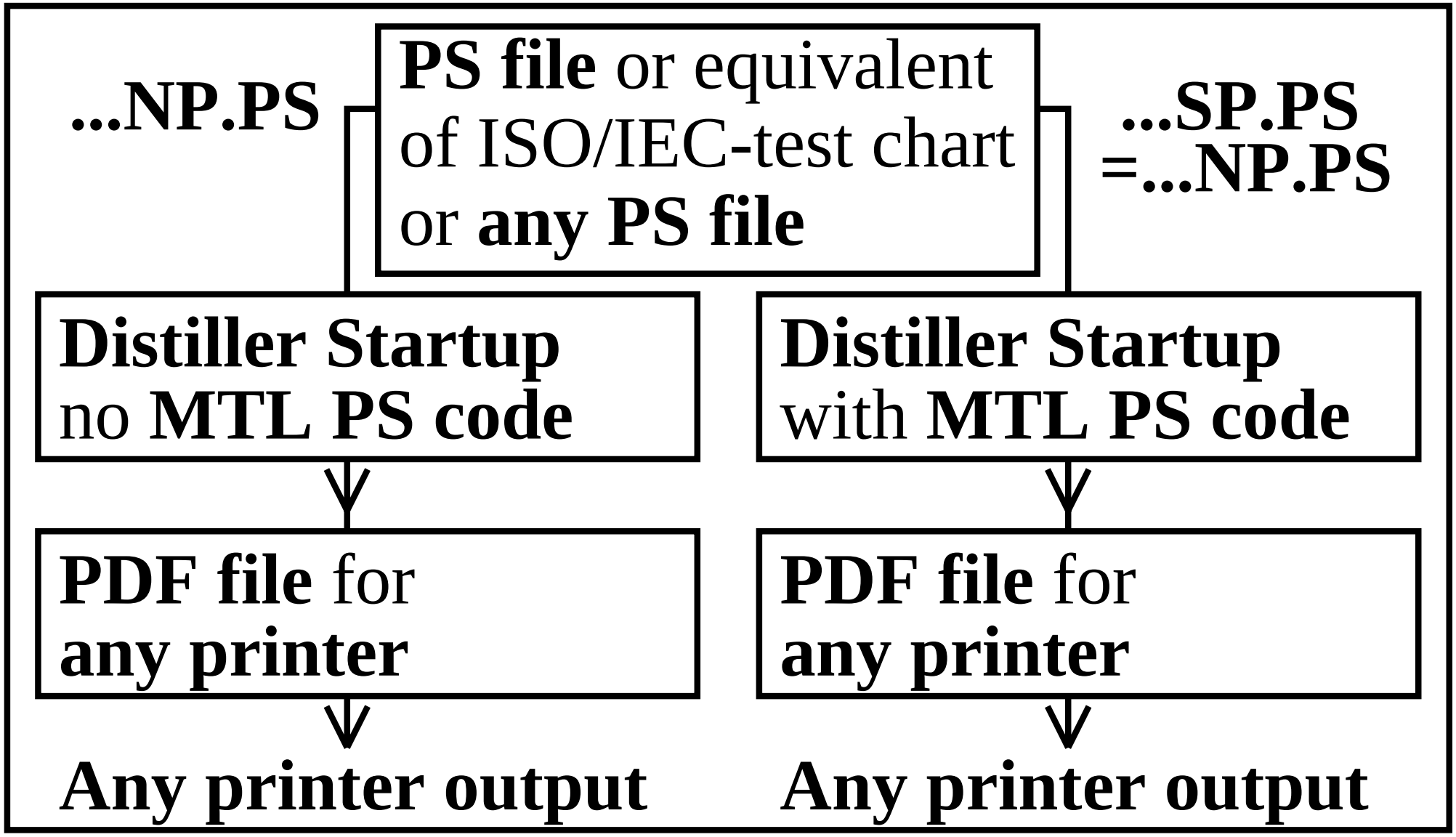
Picture B6: Landolt-rings ***W-C*** and ***W-M***; Use of PS operator *cmy0* / 000n* setcmykcolor*



Picture B7: Landolt-rings ***W-Y*** and ***W-N***; Use of PS operator *cmy0* / 000n* setcmykcolor*

Fig. B1 to B7 of ISO/IEC-test chart 2; ISO/IEC 15775 and DIS ISO/IEC 19839-X; input: different, see figure text output: different, see figure text

PDF-Output PS-Files without and with MTL-Code in Distiller Startup Directory



TUBild/E6321-78

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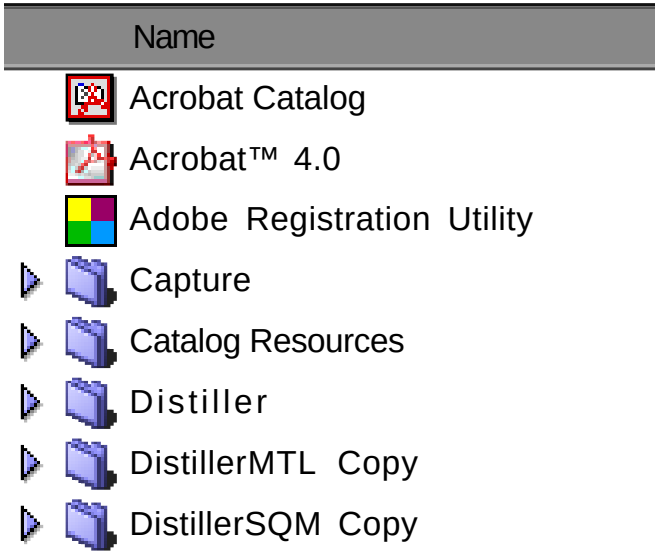
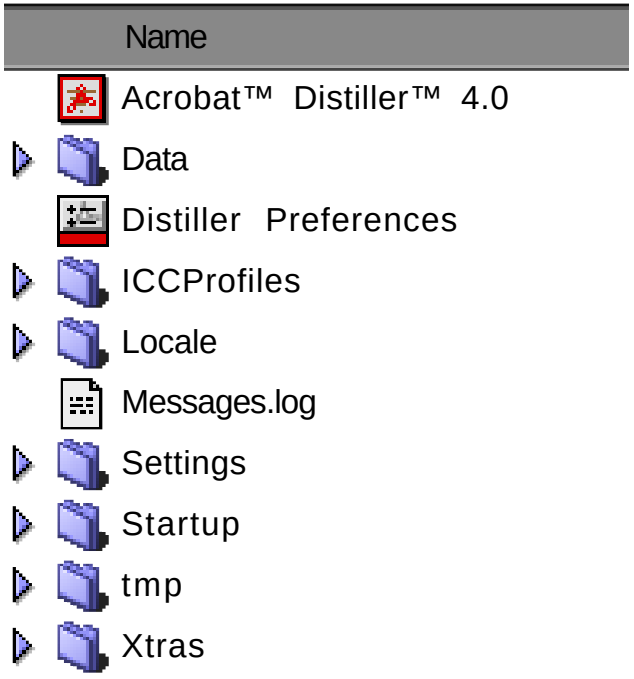
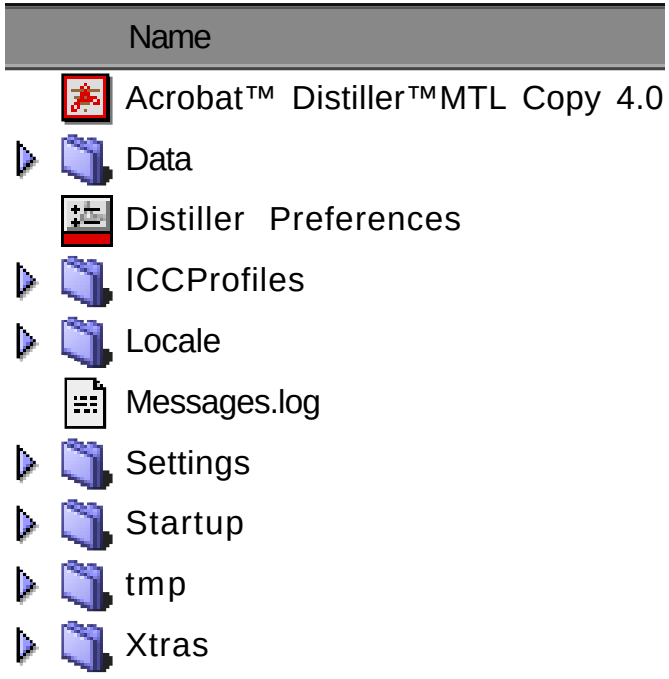
User Surface with Original and two Software Copies of Distiller with different Startup-PS codes







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Application of MTL-PostScript Code: Original and different PS-Codes in Startup

Distiller™ 4.0 A

Startup 4.0 A

Distiller™SQM Copy 4.0 A

StartupSQM Copy 4.0 A

Distiller™MTL Copy 4.0 A

StartupMTL Copy 4.0 A

Name
Example.ps

Name
Example.ps
MTLEXP05.PS

```
%MTLEXP05.PS
/MTLsetgray {setgray} bind def
/setgray {0.5 exp MTLsetgray} def
```

Name
Example.ps
MTL20000.PS

The user surface includes e. g. the following Distiller versions:

- **Distiller original with the file Example.ps (default) in Startup**
- **Distiller copy with file Example.ps and MTLEXP05.PS in Startup**
- **Distiller copy with file Example.ps and MTL20000.PS in Startup**

Result: Lighter PDF-output with two lines in MTLEXP05.PS.

Summary

- The Standards DIN 33866 and ISO/IEC 15775 define ISO/IEC-test charts and eight CIELAB colour data and names

- ISO/IEC TR 19797 defines an Output Linearisation Method to make the output on printers and displays equally spaced in CIELAB Advantage: Allows maximum detail recognition for any output

- The Output Linearisation Method for NO display reflection has been used to produce visually equally spaced output in CIELAB for eight known display reflections for ISO TC 159 “Ergonomics” If the display reflection is unknown it can be visually determined from eight pages of a PDF file output of an ISO/IEC-test chart.

- Colour Management needs to consider the display reflection and only “relative colour reproduction” seems to be appropriate for the white - black display luminance contrast ratios between > 500:1 and 2:1 which reduces the colour gamut by a factor 10.