

Gernot Hoffmann

Color Printer Test Pages

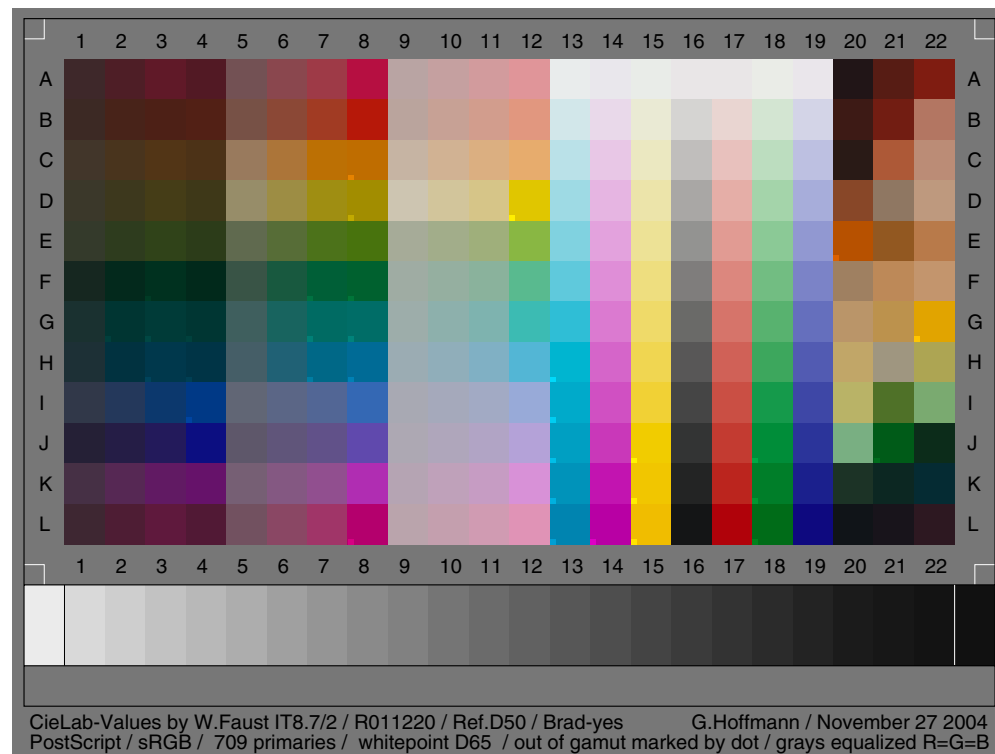


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Settings for Acrobat

Edit / Preferences / General / Page Display (since version 6)

Custom Resolution 72 dpi

Edit / Preferences / General / Color Management (full version only)

sRGB

EuroscaleCoated or ISOCoated or SWOP

GrayGamma 2.2

1.1 Introduction

Purpose: page 4 demonstrates many features for all kind of color laser, inkjet and dye sublimation printers. Especially helpful for testing a printer calibration.

Printable area: page alignment and printable area are shown by three frames.

Gray balance: the RGB graywedge 1 should be printed by rich black CMYK. This wedge is linear by numbers. At 0.5 we have $R=G=B=128$. Graywedge 2 (PostScript) should be printed by K-only. K is linear by numbers.

Linearity and ink transition: smoothness and linearity of primary inks CMY are shown top left by three wedges. Transitions of Magenta / LightMagenta and Cyan / Light Cyan for six-color-printers are also shown top left.

Saturation: fully saturated colors on the fan and on the wheel. Black $L=0.0$ to medium lightness $L=0.5$ and from $L=0.5$ to White $L=1.0$. Hue, Lightness and Saturation are defined by the HLS color order system. Linearly coded by numbers in sRGB.

Ink limit: problems with too much ink are apparent at the black end of the rich black graywedge, the black parts in the photo and in the ink limit swatch 300%. Depending on the paper, the total ink limit should not be higher than 300% or 320%.

Black generation: Undercolor Removal UCR or Gray Component Replacement GCR can be tested. The left gray portrait is RGB coded and should be printed by rich black. The right portrait is a grayscale, converted from the RGB image by 20% dot gain.

General appearance: color photo, bottom large image.

Rastered black text: text is printed by 100%, 75% and 50% K-only.

Color accuracy: pages 5-7 show an IT8 scanner target: page 5 coded by sRGB page 6 by ProPhotoRGB and page 7 coded by Lab.

For sRGB some colors are out of gamut. These are marked by a dot and the RGB values are clipped. Load in Photoshop any page in its specific color space and measure RGB and Lab values. The values are colorimetrically correct but a little rounded. Page 8 is used similarly.

Gray accuracy: page 9 shows a CIE Lab grayscale chart, coded by sRGB. This will be printed mostly by K-only because of an internal interpretation of $R=G=B$.

Page 10 shows a similar CIE Lab grayscale chart. B is a little modified. This page should be printed always by CMYK rich black, nearly as neutral gray.

Page 11 is defined as PostScript graphic with values $K=0$ to 100.

Grayscale conversions: chapter 6.2 shows several conversions.

Images 1 to 6 are grayscales, coded by 1 byte per pixel. According to chapter 8.1 each dot gain can be replaced by an equivalent gamma. Images 7 and 8 are in CMYK with three empty channels CMY, coded by 4 bytes per pixel.

An improved workflow is explained in chapter 6.3.

1.2 Introduction

The settings for Acrobat (Reader)

Color spaces	sRGB / Euroscale Coated / Gray Gamma=2.2 (but see ch.6.3)
Soft proof	Off

How to apply the test pages using a RIP (Raster Image Processor)

RGB source space	sRGB
CMYK source space	None
Destination space	Actual printer profile
Rendering Intent	Relative Colorimetric

This should show all components correctly printed. CMYK is passed through without any change. K-only should be printed by pure black.

How to apply the test pages using Photoshop

RGB color space	sRGB
CMYK space	Euroscale Coated
Grayscale	Gamma=2.2
Destination space	Actual printer profile
Rendering Intent	Relative Colorimetric

■ Open document in RGB working space

RGB values and Lab values are correctly indicated. CMYK values are converted to RGB using the actual color spaces. K-only components appear as rich black (the CMY channels are not empty).

This mode can be used for printing but the CMYK components cannot be reproduced correctly.

■ Open document in CMYK working space

CMYK values are correctly indicated. RGB values are converted to CMYK using the actual color spaces.

This mode can be used for printing but the RGB components cannot be reproduced correctly.

Resumed

Printing by a RIP retains all features of the test pages.

Printing by Photoshop should be done in RGB mode. The result is easily affected by wrong settings.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
A	62.0	77.6	96.1	81.6	115.1	137.8	158.1	181.8	184.8	197.3	209.6	224.3	232.9	233.1	233.3	233.3	233.5	233.5	233.6	33.4	87.1	127.4	A	
	39.5	29.8	24.7	24.7	81.1	71.1	57.5	14.5	163.8	159.8	155.1	149.5	235.8	230.8	235.5	229.8	229.9	235.6	230.3	20.7	27.8	28.3		
	42.0	37.5	39.7	35.7	84.3	77.4	71.4	64.9	163.3	160.3	157.1	153.3	235.9	235.5	231.6	230.8	230.8	231.3	235.3	22.8	20.1	16.7		
B	60.5	72.5	76.8	81.5	118.9	139.3	160.9	182.3	186.1	198.6	210.3	224.9	210.3	233.1	233.1	234.1	213.1	233.3	211.3	210.9	60.7	114.1	178.8	B
	41.2	35.2	31.6	32.2	80.6	72.5	58.7	24.5	164.6	160.6	157.1	151.3	231.1	216.9	233.6	212.3	212.8	228.8	212.1	25.6	28.5	117.9		
	35.9	25.2	21.7	21.1	70.1	53.7	35.0	9.2	157.1	148.8	140.6	127.1	234.1	233.6	212.1	210.1	209.3	210.3	230.8	21.2	18.3	97.9		
C	66.0	72.5	81.8	75.6	152.6	171.8	187.6	191.3	198.3	209.3	218.9	230.6	185.8	232.1	235.1	192.1	231.9	188.6	189.1	41.4	172.6	187.3	C	
	54.2	51.4	53.2	50.5	122.0	116.6	111.6	109.0	180.1	177.8	174.6	172.1	225.3	198.9	231.6	189.9	193.3	221.1	192.1	25.7	88.9	139.8		
	42.0	29.1	22.6	23.1	93.0	56.5	3.9	0.0	162.8	146.6	129.3	108.6	231.8	230.1	192.5	187.9	188.8	190.8	224.9	21.9	54.9	118.3		
D	58.9	60.7	68.8	62.0	150.9	156.6	159.1	161.6	204.9	209.9	213.8	223.6	157.8	230.1	236.1	168.8	229.1	164.3	166.5	136.1	142.9	189.8	D	
	56.0	55.7	61.2	55.7	140.8	141.1	142.3	141.3	196.9	196.9	197.1	198.1	217.8	181.1	228.3	166.8	173.8	211.6	172.5	70.5	118.5	153.1		
	42.2	28.6	23.6	23.8	104.8	68.3	17.6	0.0	177.3	154.5	135.6	0.0	228.3	226.1	169.6	164.9	166.8	169.6	217.8	40.0	98.3	126.3		
E	51.5	45.9	48.5	44.0	96.3	87.5	76.1	71.6	166.3	161.8	158.6	136.9	127.9	227.1	237.3	147.5	225.1	139.3	144.6	183.1	145.6	183.8	E	
	57.9	59.7	67.1	59.7	105.5	109.5	114.1	114.8	171.3	173.1	174.9	182.6	209.6	161.6	225.6	146.6	154.6	200.8	151.8	80.5	88.5	121.9		
	42.5	29.6	24.7	25.2	78.8	55.4	26.2	12.7	151.6	137.9	122.6	66.5	224.3	220.8	150.1	144.8	147.3	149.8	209.1	0.0	33.2	74.5		
F	21.8	2.6	0.0	1.4	56.9	23.6	0.0	0.0	159.3	149.1	137.9	89.1	94.6	222.9	238.5	126.9	220.1	114.5	122.9	158.6	189.3	194.6	F	
	38.9	41.4	49.5	41.0	83.6	88.6	94.9	97.0	171.9	174.6	177.8	185.6	200.6	141.6	221.8	125.4	134.5	189.6	131.3	128.1	137.1	149.3		
	32.0	27.5	30.9	27.2	70.3	63.0	54.9	47.4	162.6	159.6	155.8	143.3	219.6	214.8	126.9	123.9	125.6	129.5	199.5	96.5	87.9	108.9		
G	25.6	0.0	0.0	0.0	63.4	24.3	0.0	0.0	156.6	141.1	125.9	59.9	47.2	218.5	239.5	105.8	214.5	87.8	101.0	185.5	187.8	225.1	G	
	49.2	52.9	59.2	53.9	94.9	99.6	106.8	109.4	172.6	175.8	179.1	186.6	190.5	122.0	217.9	105.5	115.9	177.8	110.8	149.1	145.8	164.3		
	47.9	49.9	55.7	51.0	93.5	95.0	98.6	102.9	170.3	172.1	175.3	178.9	213.8	208.3	104.6	104.1	105.6	110.6	188.8	104.8	76.5	0.0		
H	29.2	0.5	0.0	0.0	68.5	31.7	0.0	0.0	155.1	143.8	127.6	82.9	0.0	213.1	240.5	88.1	208.3	61.0	82.3	192.8	158.6	173.3	H	
	48.0	50.5	55.7	52.2	93.5	96.6	103.9	107.1	171.6	173.8	176.3	182.1	181.1	101.0	213.8	87.5	96.8	166.5	90.9	166.1	149.6	164.6		
	54.2	63.7	75.9	70.4	103.3	117.0	135.1	150.5	178.8	186.3	195.8	213.3	208.3	201.1	80.5	86.9	87.3	93.3	178.1	103.8	128.1	83.3		
I	49.2	36.4	12.3	0.0	97.3	91.0	82.1	52.2	167.6	165.3	161.8	152.3	0.0	207.6	240.8	68.6	202.3	20.7	61.9	184.9	79.0	122.4	I	
	55.9	56.4	56.2	56.7	102.4	101.9	102.1	104.0	168.8	168.9	169.5	170.3	170.3	79.8	209.3	69.0	78.9	153.9	71.1	178.8	113.5	169.9		
	73.0	91.3	109.5	134.1	116.6	133.8	149.1	180.3	178.8	187.1	196.3	215.9	201.6	193.6	53.2	68.8	68.1	75.3	166.3	102.5	39.5	112.1		
J	37.0	37.0	35.2	12.0	93.5	96.5	97.0	95.9	173.1	174.9	176.8	179.8	0.0	201.1	241.3	51.2	195.1	0.0	42.9	120.5	0.0	11.9	J	
	32.2	28.9	25.8	13.4	86.9	84.5	81.0	72.6	167.5	166.1	164.1	161.6	159.1	55.5	203.9	52.0	59.2	140.6	51.7	174.8	91.0	43.5		
	53.4	70.0	90.9	128.8	105.9	121.5	137.3	173.3	179.1	186.9	196.5	216.3	194.1	185.3	0.0	52.2	48.7	57.2	154.1	130.3	24.2	25.3		
K	69.9	85.6	97.0	101.6	118.0	132.3	144.8	176.3	180.8	190.8	198.1	216.3	0.0	193.6	241.1	34.9	186.8	0.0	26.8	27.5	12.6	5.2	K	
	48.4	40.2	26.1	18.1	95.4	87.9	78.9	45.0	164.5	161.1	155.9	145.3	146.8	20.1	197.6	35.9	36.7	125.8	32.0	50.7	38.5	42.5		
	69.5	84.1	99.3	105.8	115.5	129.8	142.6	178.3	178.5	186.3	194.6	215.1	185.8	175.8	0.0	36.4	30.2	40.9	141.1	38.2	34.2	50.7		
L	62.2	77.5	94.9	80.5	114.5	138.1	159.8	179.6	185.6	196.3	207.8	223.6	0.0	183.8	239.9	20.2	176.3	0.0	14.1	15.8	23.8	45.2	L	
	39.2	28.7	24.7	24.7	80.8	70.9	53.2	0.0	163.6	159.5	155.1	146.8	132.5	0.0	188.9	21.3	2.3	108.4	8.6	20.3	19.7	23.9		
	50.0	51.9	60.9	52.7	95.9	100.5	104.4	109.3	171.8	174.3	177.8	182.1	176.3	164.3	0.0	22.2	9.6	23.7	126.8	23.6	26.6	32.5		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
235.3	217.3	205.6	194.3	183.9	172.6	160.5	149.3	138.3	128.8	117.1	107.4	97.5	87.5	78.4	67.6	59.4	51.0	42.5	34.7	27.1	23.3	18.9	17.2	
235.3	217.3	205.6	194.3	183.9	172.6	160.5	149.3	138.3	128.8	117.1	107.4	97.5	87.5	78.4	67.6	59.4	51.0	42.5	34.7	27.1	23.3	18.9	17.2	
235.3	217.3	205.6	194.3	183.9	172.6	160.5	149.3	138.3	128.8	117.1	107.4	97.5	87.5	78.4	67.6	59.4	51.0	42.5	34.7	27.1	23.3	18.9	17.2	
Coded by sRGB numbers / Background 118.9																								

Coded by sRGB numbers / Background 118.9

CIELab-Values by W.Faust IT8.7/2 / R011220

PostScript coded by sRGB / D65 / Out of gamut marked by dot

G.Hoffmann / June 17 2007

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
A																							A
B																							B
C																							C
D																							D
E																							E
F																							F
G																							G
H																							H
I																							I
J																							J
K																							K
L																							L

CIELab-Values by W.Faust IT8.7/2 / R011220

PostScript coded by sRGB / D65 / Out of gamut marked by dot

G.Hoffmann / June 17 2007

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
A	18.8	18.8	21.7	18.6	38.4	38.9	39.5	39.5	69.0	69.3	69.4	69.6	93.0	91.9	92.9	91.5	91.5	92.9	91.8	8.4	20.1	28.5	A
	11.2	23.6	33.4	27.7	15.0	29.3	43.2	62.4	7.8	14.4	21.1	29.2	-0.9	1.4	-1.3	1.4	1.3	-1.3	1.8	6.9	27.5	41.9	
	2.9	6.5	9.6	7.6	4.2	9.8	15.1	20.2	3.2	5.3	7.4	10.2	-0.5	-2.0	1.6	-0.1	0.0	1.8	-2.0	1.2	20.3	33.9	
B	18.8	18.9	18.7	19.7	38.4	39.0	39.7	39.7	69.3	69.4	69.5	69.6	90.1	88.4	92.1	85.0	86.8	89.1	85.3	14.4	25.7	55.7	B
	8.6	17.2	21.2	22.9	15.5	27.7	42.2	59.7	7.2	13.2	18.7	26.5	-6.7	7.9	-2.6	0.0	6.9	-8.6	2.3	17.2	37.5	22.8	
	7.2	14.9	17.2	19.2	13.0	24.5	37.2	51.0	6.9	11.8	16.7	24.6	-3.9	-6.0	10.5	1.2	4.4	7.0	-9.4	11.5	29.3	21.3	
C	23.7	23.5	25.2	23.6	53.7	54.0	54.7	54.5	74.5	74.6	74.5	74.9	86.9	83.8	91.4	77.0	81.5	85.1	78.3	11.2	47.7	62.5	C
	3.9	7.6	10.7	9.4	9.2	17.9	26.3	28.9	4.7	8.4	12.3	16.8	-12.3	15.9	-3.4	0.5	13.7	-15.4	3.9	7.5	32.9	16.5	
	9.7	17.9	24.2	21.8	20.6	41.4	60.9	65.5	11.3	20.3	29.7	41.0	-7.7	-10.9	19.6	1.3	7.6	11.1	-16.7	5.9	35.4	18.8	
D	23.5	23.3	25.9	23.5	58.7	58.9	59.2	59.0	79.8	79.8	79.9	80.1	83.1	79.3	90.3	68.5	76.0	80.5	71.3	37.9	51.7	66.1	D
	-0.8	-1.1	-0.7	-0.8	-0.4	-1.1	-2.4	-1.2	0.4	-0.2	-0.4	-2.3	-17.9	23.7	-3.8	0.4	20.1	-22.1	5.2	26.6	7.5	11.3	
	9.1	17.7	23.9	20.7	20.7	40.4	59.7	68.1	11.0	23.2	33.0	82.9	-11.6	-15.5	29.7	1.2	11.9	15.6	-23.7	30.9	14.9	19.6	
E	23.3	23.2	26.1	23.1	43.2	43.4	43.9	43.7	69.3	69.1	69.1	69.1	79.1	74.4	89.4	60.9	70.8	75.6	63.7	47.5	43.5	57.0	E
	-5.3	-10.5	-13.9	-11.9	-7.6	-15.9	-24.7	-27.2	-4.6	-8.8	-12.6	-29.2	-23.2	31.7	-3.8	0.0	26.5	-28.2	7.3	40.0	20.8	21.2	
	8.6	16.7	22.7	18.9	13.9	27.2	40.9	44.9	9.6	16.7	24.8	51.7	-15.6	-20.1	38.5	1.1	15.1	19.1	-30.5	57.7	40.7	35.9	
F	13.9	13.9	16.7	13.7	33.0	33.2	33.9	33.7	69.0	69.0	69.0	68.8	75.1	69.3	88.3	52.7	65.3	70.8	56.2	55.9	61.5	65.5	F
	-8.9	-17.2	-22.9	-17.6	-13.0	-26.3	-40.7	-51.5	-6.0	-11.4	-17.2	-37.4	-27.7	39.7	-3.2	0.4	32.9	-33.9	9.7	8.8	16.5	13.7	
	2.2	5.2	6.7	5.1	4.5	8.7	14.4	18.2	3.2	4.7	6.6	12.4	-19.3	-24.5	48.4	0.9	19.3	22.7	-36.7	21.8	34.4	28.2	
G	18.5	18.7	20.6	18.7	37.7	37.7	38.7	38.5	69.3	69.0	69.1	68.9	70.8	64.5	87.1	44.5	60.2	65.6	48.7	64.4	63.5	71.8	G
	-9.9	-19.1	-25.7	-22.9	-12.3	-24.1	-38.4	-49.2	-6.1	-12.8	-18.7	-36.9	-32.0	47.0	-2.3	-0.1	38.7	-39.4	12.5	9.8	10.6	14.6	
	-2.3	-3.4	-4.6	-4.3	-3.1	-4.3	-5.4	-8.4	-0.8	-2.2	-4.0	-6.8	-22.9	-28.2	57.4	0.8	23.7	25.7	-42.9	28.7	42.5	87.3	
H	18.5	18.6	20.1	18.6	37.9	37.7	38.9	39.2	69.0	69.0	68.9	69.1	66.8	59.5	86.0	37.2	55.2	60.9	41.4	69.5	62.2	67.0	H
	-6.4	-11.9	-16.8	-15.8	-7.7	-15.7	-24.7	-31.6	-4.8	-8.5	-13.1	-23.2	-35.5	54.4	-1.1	0.2	44.5	-43.9	16.2	4.0	0.8	-5.0	
	-6.5	-13.0	-18.9	-17.5	-8.8	-17.8	-26.9	-36.0	-5.8	-10.1	-15.4	-25.1	-26.2	-31.7	66.4	0.4	27.7	28.5	-48.4	35.9	12.6	42.7	
I	23.3	23.3	23.2	23.5	43.2	43.2	43.2	43.5	69.3	69.4	69.5	69.5	62.4	54.9	84.8	29.2	50.7	55.9	33.9	72.0	43.9	65.0	I
	0.7	0.9	2.5	5.3	0.4	1.9	2.2	2.5	1.0	1.4	1.4	1.4	-38.4	60.9	0.4	-0.2	49.5	-48.2	20.2	-5.7	-22.6	-25.1	
	-11.7	-23.7	-35.7	-50.9	-8.8	-19.2	-28.3	-46.4	-5.3	-9.8	-14.7	-25.5	-29.2	-34.7	74.8	0.1	32.9	31.2	-53.5	39.5	35.5	24.6	
J	13.7	13.6	14.1	13.9	38.2	38.2	37.9	37.5	69.4	69.4	69.3	69.5	57.9	50.4	83.4	21.7	46.2	50.5	26.5	66.6	32.9	15.0	J
	6.8	13.3	20.7	36.0	5.9	11.3	16.7	29.3	3.8	6.3	9.4	15.0	-40.5	66.9	2.5	-0.3	54.2	-51.9	25.1	-25.6	-36.5	-16.1	
	-13.2	-24.8	-38.4	-63.5	-9.9	-19.2	-29.2	-51.5	-5.3	-9.6	-14.9	-25.5	-32.0	-37.2	83.5	-0.2	38.5	33.5	-58.2	16.9	29.8	8.2	
K	23.2	24.1	24.2	24.5	43.2	43.5	43.5	44.7	69.3	69.5	69.3	69.4	53.2	45.7	81.6	14.1	41.9	44.5	19.6	18.8	13.3	15.2	K
	13.2	26.7	39.2	44.0	12.3	24.2	35.4	63.2	8.1	14.5	20.9	35.7	-41.5	72.3	5.0	-0.4	58.4	-54.5	30.9	-12.2	-11.4	-10.8	
	-9.1	-17.5	-26.9	-30.7	-7.7	-15.9	-23.3	-42.4	-5.0	-8.7	-13.7	-24.7	-34.7	-38.9	91.1	-0.5	43.7	34.5	-61.5	4.9	-0.3	-9.3	
L	18.9	18.9	21.9	18.7	38.5	39.5	39.9	38.9	69.4	69.4	69.6	69.5	47.7	40.9	79.4	6.9	37.4	37.9	13.0	6.2	6.9	11.5	L
	12.6	25.6	34.5	28.7	16.3	31.8	48.0	67.5	9.3	15.9	22.7	33.4	-40.2	76.1	8.4	-0.4	61.0	-54.5	37.5	-1.3	3.3	12.0	
	-2.4	-3.4	-4.8	-4.1	-3.0	-3.8	-5.1	-9.0	-1.1	-2.4	-3.7	-5.9	-37.5	-39.9	97.8	-0.7	48.9	34.5	-63.5	-2.8	-4.0	-1.2	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
93.1	86.8	82.5	78.5	74.8	70.5	66.0	61.9	57.7	53.9	49.2	45.4	41.2	37.2	33.2	28.7	25.1	21.2	17.2	13.6	9.8	7.9	5.9	5.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Coded by Lab numbers / Background L=50

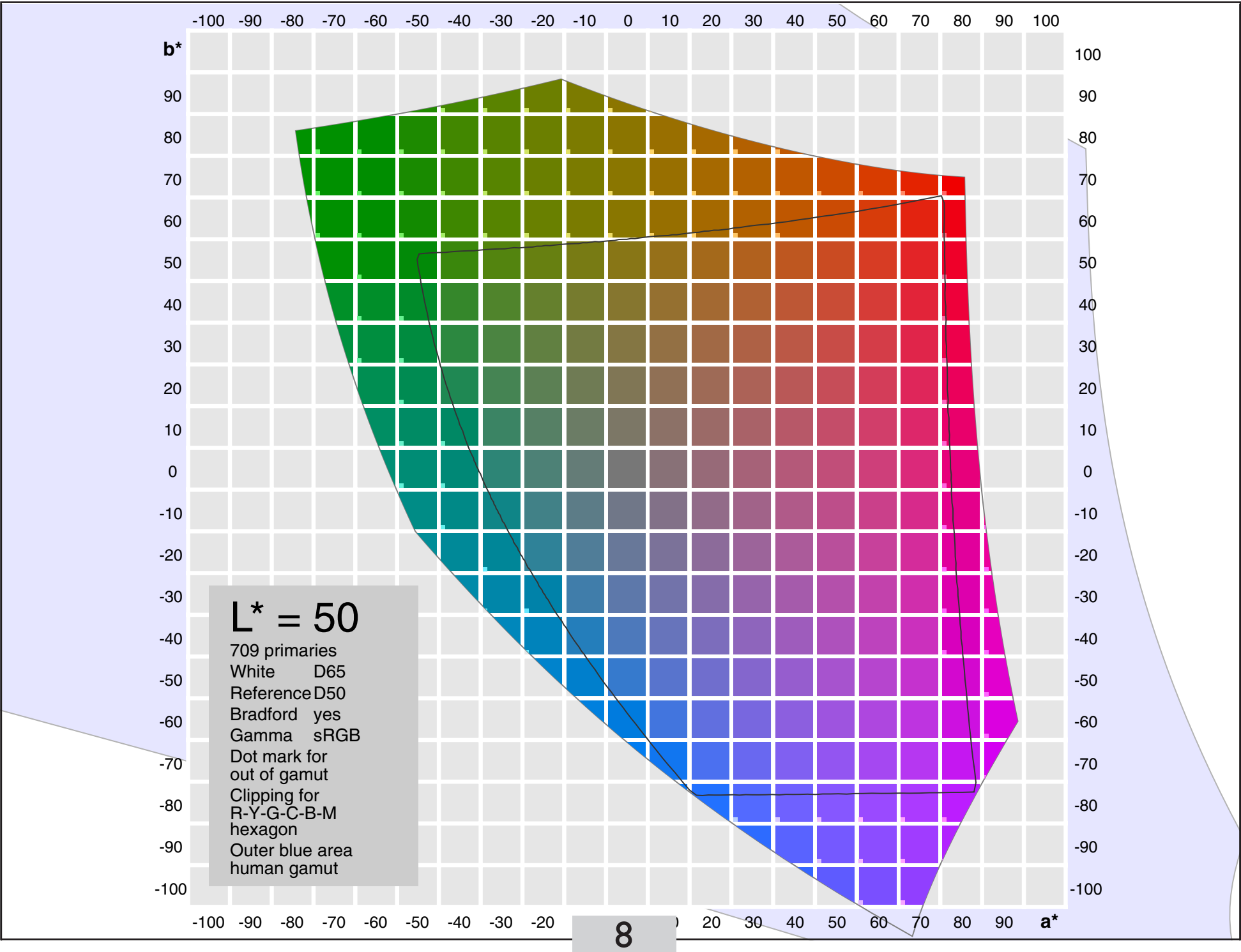
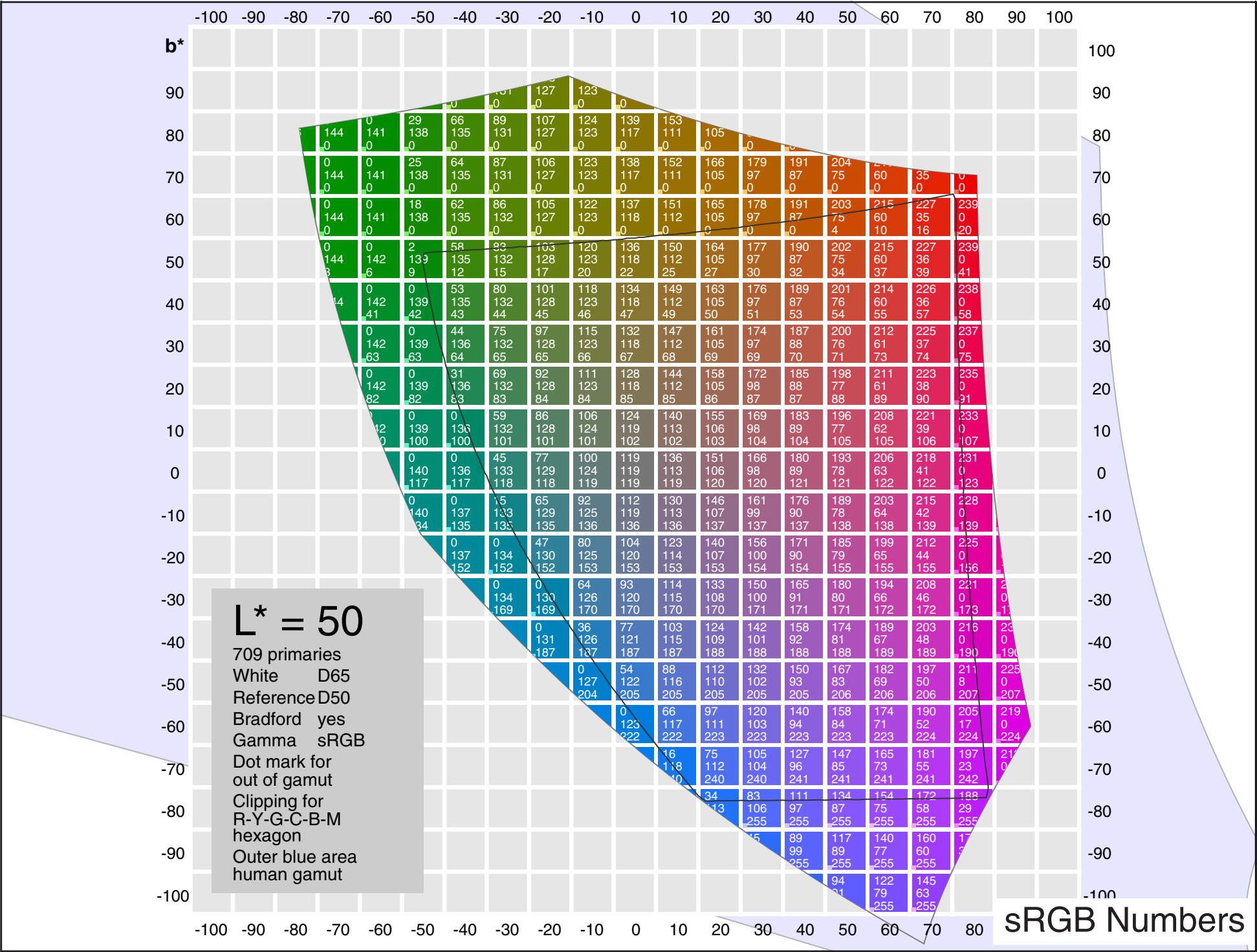
CIELab-Values by W.Faust IT8.7/2 / R011220
PostScript / CIELab coded / Reference white D50

G.Hoffmann / June 15 2007

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
A																							A
B																							B
C																							C
D																							D
E																							E
F																							F
G																							G
H																							H
I																							I
J																							J
K																							K
L																							L
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

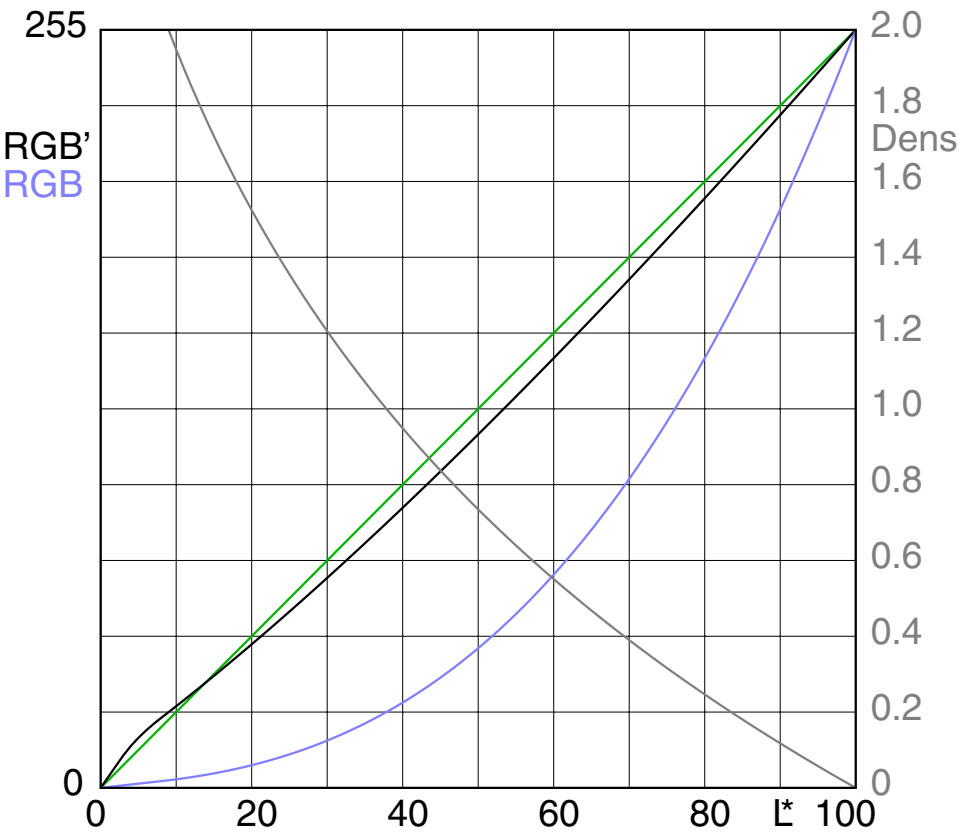
CIELab-Values by W.Faust IT8.7/2 / R011220
PostScript / CIELab coded / Reference white D50

G.Hoffmann / June 15 2007



5.1 CIELab / sRGB Grayscale Chart

Left numbers in the swatches are the CIELab lightness values $L^*=0$ to 100 . Right numbers are the sRGB values $C'=R'=G'=B'=0.0$ to 255.0 . The sRGB values in the file are rounded.

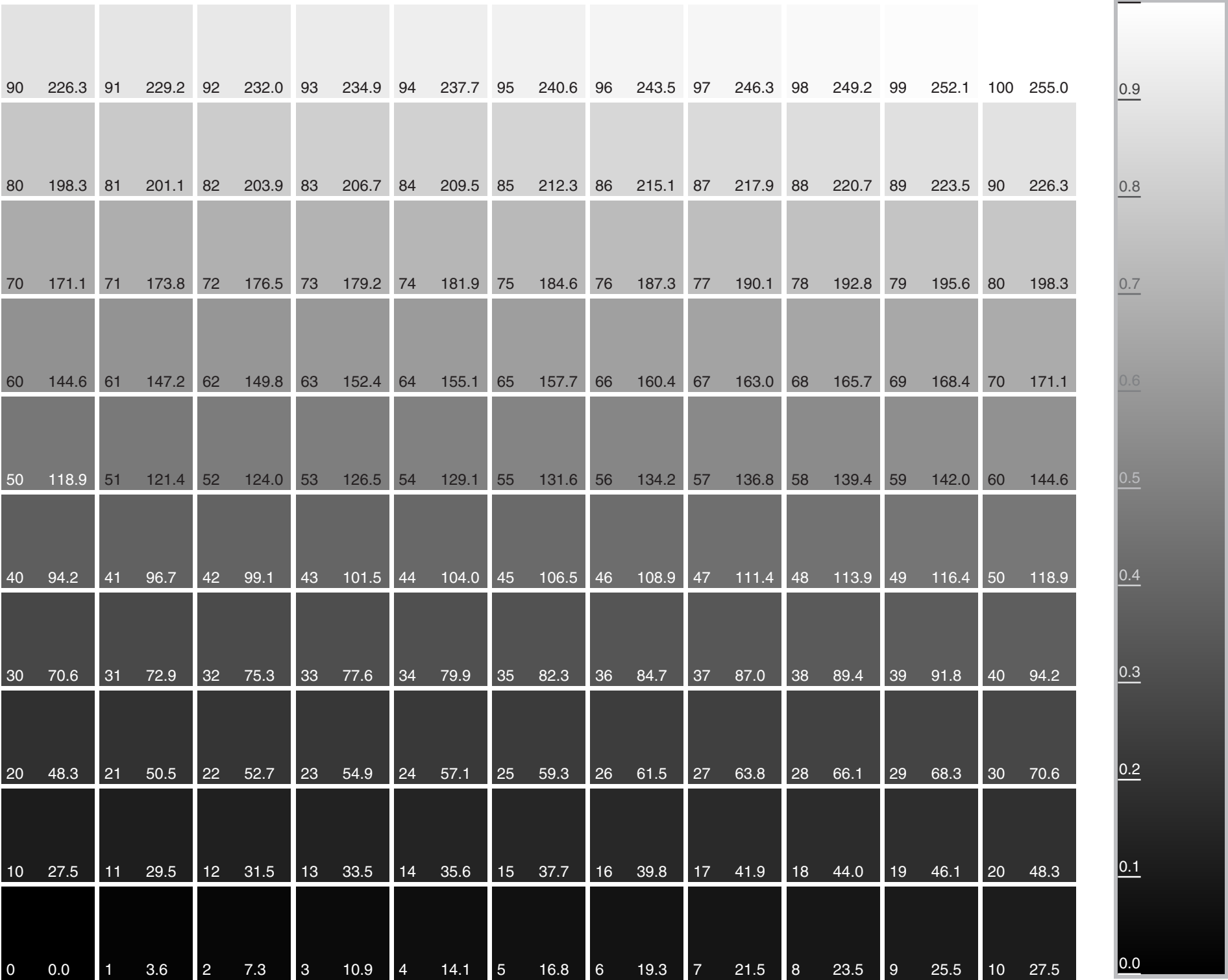


The Tone Reproduction Curve (TRC) from L^* to C' is surprisingly nearly linear

- Black Curve for gamma-encoded values $C'=RGB'$ for sRGB
- Green Linear function, comparison
- Blue Curve for values without gamma-encoding $C=RGB$
- Gray Density

Gamma encoded values are indicated by an apostroph only on *this* page

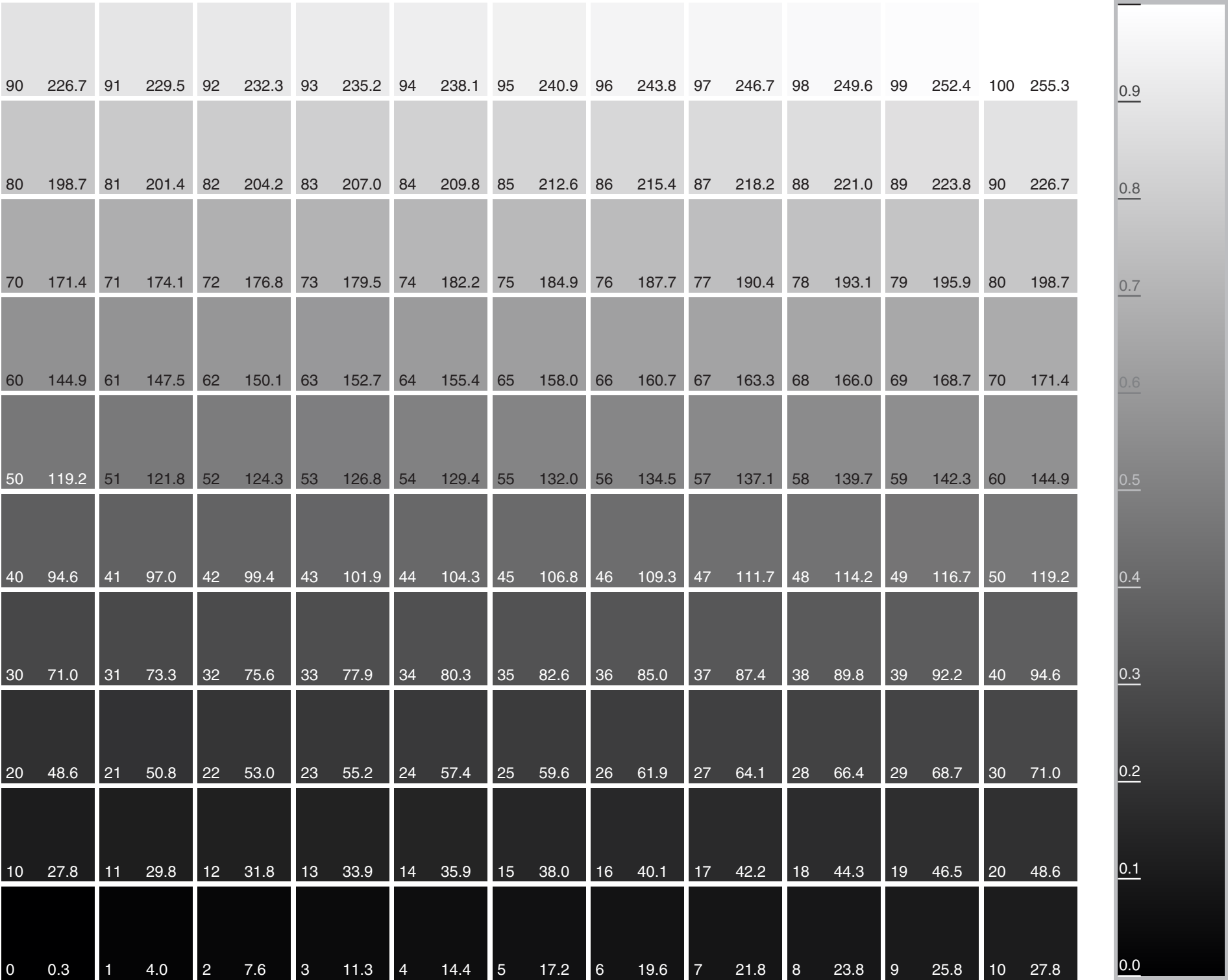
Bottom right:
RGB graywedge, linear by numbers



5.2 CIELab / sRGB Rich Gray Chart

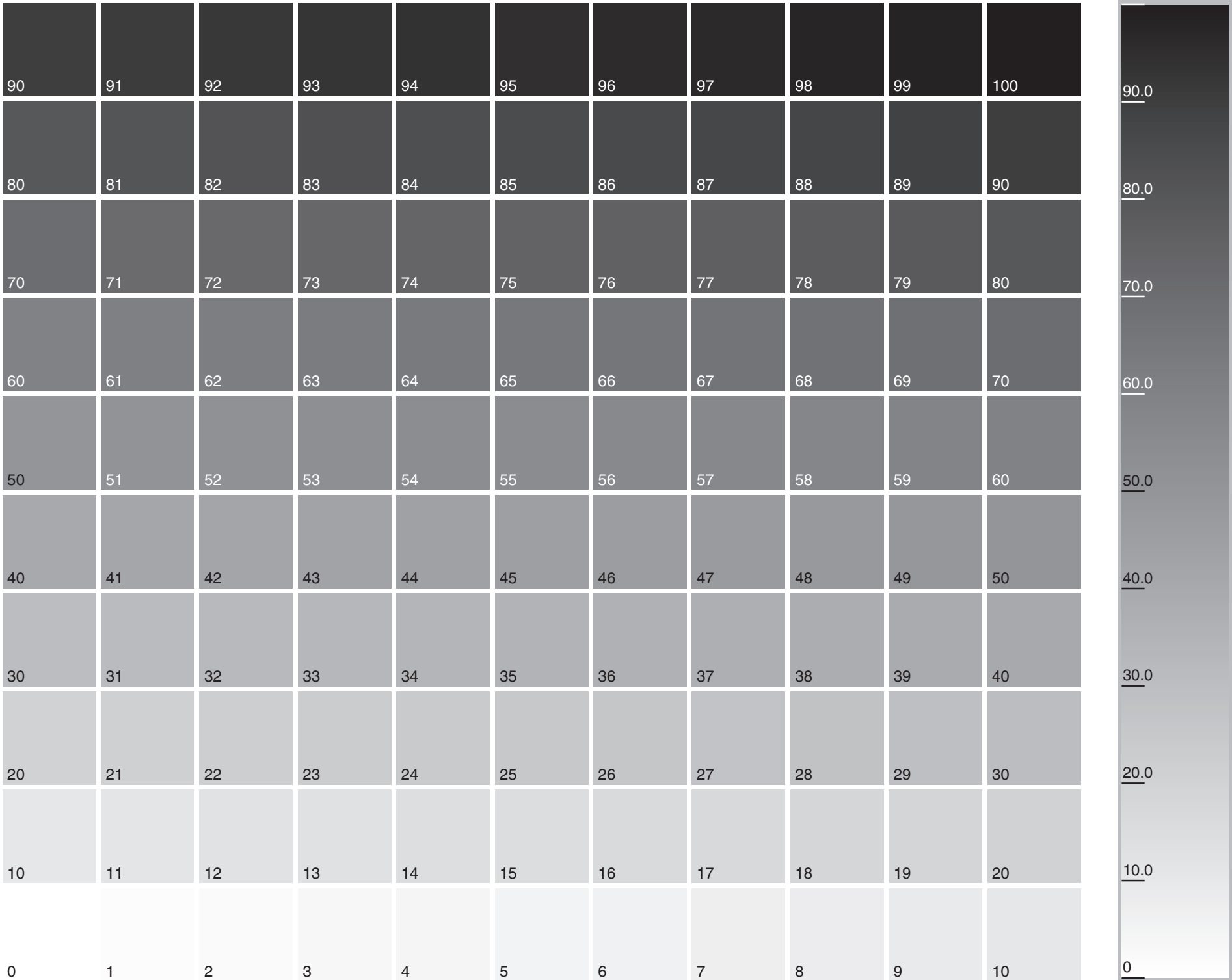
The gray chart on the previous page is printed either by K-only or by rich black CMYK. Desktop printers print mostly by K-only.

The printer can be forced to print by rich black CMYK if the values RGB are slightly different. Here we have added 1 unit of 255 to the B channel. The gray is not accurate, but good enough for a gray balance test.



5.3 K-only Gray Chart

A PostScript printer should print these charts by K-only. The patches can be used to measure the dot gain.



6.1 Grayscale Conversions

A color images contains additionally a patch which is filled in Photoshop in sRGB mode by RGB=128/128/128. The image is then converted to grayscale by several different dot gains. The image does not change the appearance.

If we choose in the color settings the same Gray Gamma 2.2 as a standard then the newly loaded images will look different.

The next page shows the converted images including the patch top right. The large number in the patch is the gray number after the conversion as measured by Photo-shop. R=G=B=128 is equivalent to L*=54 in the gray charts.

Dot gain %	Gamma	R=G=B	
0	1.00	55	
10	1.32	80	
15	1.51	93	
20	1.74	105	
25	2.00	118	
28.2	2.20	128	
30	2.32	132	
EC		104	Black Ink Euroscale Coated v2

The grayscale conversions work as follows:

1. Remove gamma encoding for sRGB.
This is essentially a power function with gamma $g_1=2.2$.
The numbers are converted by $c_2=c_1^{g_1}$.
2. Apply dot gain encoding.
Each dot gain has an equivalent gamma value g_2 (simplified model).
The numbers are converted by $c_3=c_2^{1/g_2}$.
3. Altogether we get new numbers $c_3=c_1^{g_1/g_2}$
For Gray Gamma=2.2 we get $c_3=c_1$.

For offset printing by K-only we have to use an appropriate dot gain, as recommended by the service provider/printer. The images 7 and 8 (next page) show two versions, executed by modified profiles with Black Generation=Maximum (empty plates CMY)

Color settings for Export to PDF:

Settings File None / Leave Color Unchanged / Rendering Intent Default (or Rel.Col.).

Grayscales by Photoshop should be saved by one of these formats

- EPS without PostScript color management, with 8-bit TIFF preview
- K-only CMYK

TIFF can cause shifts by Export to PDF in PageMaker 6.52 and 7.01.

Export to PDF by PageMaker 6.52 should be done in mode CMYK.

This does not affect RGB images.

Vector graphics should be defined by CMYK anyway.

6.2 Grayscale Conversions / Saved as EPS

The grayscales were saved as EPS. PageMaker's Export to PDF in CMYK mode retains CMYK numbers *and* RGB numbers *and* gray numbers in grayscales.



1. Grayscale DG=10%



2. Grayscale DG=15%



3. Grayscale DG=20%



4. Grayscale DG=25%



5. Grayscale DG=30%



6. Grayscale
Black Ink - Euroscale C. v2



7. Left: CMYK K-only
Black Ink - Euroscale Coated v2
CMYK with three empty plates CMY
Coded by four bytes per pixel
Executed by Eurostandard Coated
Dot gain = 9%
Black Generation=Maximum

8. Right: CMYK K-only
Black Ink - Euroscale Coated v2
CMYK as above
Executed by Eurostandard Coated
Dot gain = 15%
Black Generation=Maximum
(not available for Euroscale Coated)



6.3 Grayscale K-only Printing / PDF/X-1a

This chapter describes a workflow which is entirely based on one offset profile, here for instance ISO Coated. The description follows Adobe CS2 with Acrobat7 Professional.

Define color settings in Photoshop:

RGB sRGB (for instance)
CMYK ISO Coated
Gray Black Ink ISO Coated (by loading ISO Coated)
Spot Dot gain 20%
Save as sRGB-ISO-ISO-20.csf

Synchronization by Bridge delivers in InDesign:

RGB sRGB
CMYK ISO Coated
Gray Undefined (probably gamma=2.2)
Spot Undefined

Manual synchronization for Acrobat delivers:

RGB sRGB
CMYK ISO Coated
Gray Black Ink ISO Coated
Spot Undefined

Image processing by Photoshop:

Color image
Mode Grayscale
Make new doc in CMYK with white background and the same size by pixels
Color management: Use ISO Coated (the purpose is not clear, probably not wrong)
Grayscale: select all, copy
CMYK: paste into channel K
Save CMYK as uncompressed TIFF, without embedding the ICC profile

Workflow in InDesign:

Make document
Place TIFF
Save as PDF/X-1a, with modified joboptions:
Downsample to 288dpi if above / use ZIP 8 bits per channel / Leave color unchanged
Use Rendering Intent ISO Coated (this is merely an information)

Now we have a PDF/X-1a compliant PDF. Pure CMYK, but the channels CMY are empty, which should be told to the press people. The viewing conditions in Photoshop, InDesign and Acrobat are consistently defined by CMYK.

An example for file size:

Grayscale 458 kB, CMYK 1832 kB, ZIP8-PDF 519 kB. The compression ratio isn't good for ZIP-8, but empty channels don't contribute much to file size.

7.1 Reflectance / Density / Visual Dot Area

The table on the next page shows the density D , the reflectance factor R , the CIE 1931 luminance Y , the Lab lightness L^* and the visual dot area A for different black densities D_b .

All this is valid for assumed ideal conditions:

	Density D	Reflectance R	CIE Y	Lab L^*
Darkness	infinite	0	0	0
Paper white	0	1	100	100

In matrix calculations the range for Y is 0 to 1. Here we have, as in many programs, the range 0 to 100. Hence, Y is merely R multiplied by 100.

The visual dot area A is calculated by the Murray-Davies model.

Toner printers may have black at $D=1.5$.
Offset and inkjet densities can be above $D=2$.

Calculation

$$D = -\log(R)$$

$$R = 10^{-D}$$

$$Y = 100R$$

$$A = \frac{1 - 10^{-D}}{1 - 10^{-D_b}}$$

$$\left\{ \begin{array}{ll} Y_1 = R^{1/3} & \text{if } R > 0.008856 \\ Y_1 = 7.787 R + 16/116 & \text{else} \end{array} \right\}$$

$$L^* = 116Y_1 - 16$$

Linearization for $L^* < 8$

$$D > 2.0528$$

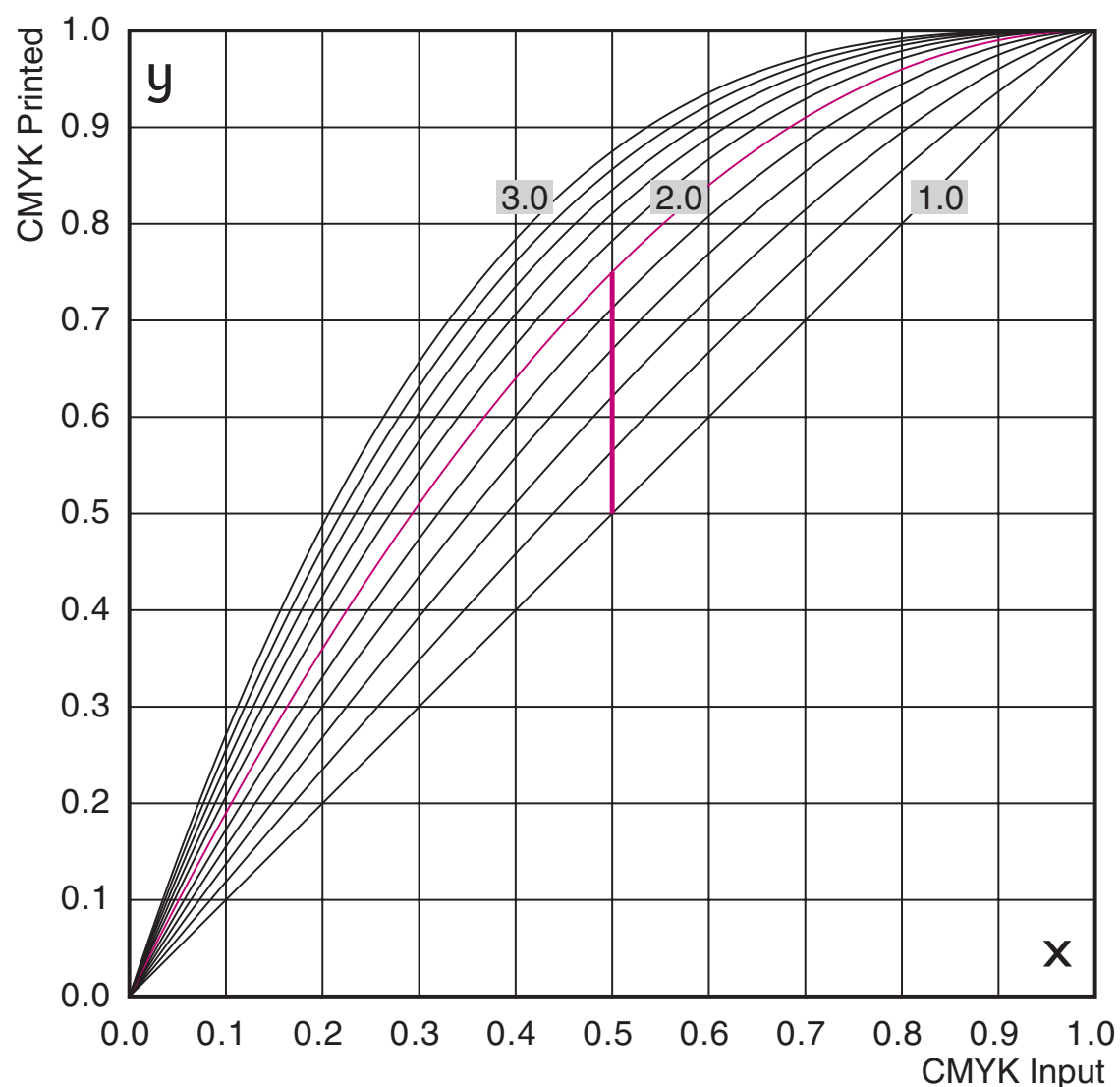
$$L^* = 903.29 R$$

$$L^* = 9.03 Y$$

7.2 Reflectance ... / Table

Dens.D	Refl.R	CIE Y	Lab L*	Area A Db=1.4	Area A Db=1.6	Area A Db=1.8	Area A Db=2.0	Area A Db=2.2	Area A Db=2.4	Area A Db=2.6	Area A Db=2.8
0...2.8	0...1	0...100	0...100								
2.8000	0.0015	0.15	1.43								1.0000
2.7500	0.0017	0.17	1.60								0.9998
2.7000	0.0020	0.20	1.80								0.9995
2.6500	0.0022	0.22	2.02								0.9993
2.6000	0.0025	0.25	2.26							1.0000	0.9990
2.5500	0.0028	0.28	2.54							0.9996	0.9987
2.5000	0.0031	0.31	2.85							0.9993	0.9984
2.4500	0.0035	0.35	3.20							0.9989	0.9980
2.4000	0.0039	0.39	3.59						1.0000	0.9985	0.9976
2.3500	0.0044	0.44	4.03						0.9995	0.9980	0.9971
2.3000	0.0050	0.50	4.52						0.9989	0.9974	0.9965
2.2500	0.0056	0.56	5.08						0.9983	0.9968	0.9959
2.2000	0.0063	0.63	5.70					1.0000	0.9976	0.9961	0.9952
2.1500	0.0070	0.70	6.39					0.9992	0.9968	0.9954	0.9944
2.1000	0.0079	0.79	7.17					0.9983	0.9960	0.9945	0.9936
2.0500	0.0089	0.89	8.05					0.9973	0.9950	0.9935	0.9926
2.0000	0.0100	1.00	8.99				1.0000	0.9962	0.9939	0.9924	0.9915
1.9500	0.0112	1.12	9.97				0.9987	0.9950	0.9927	0.9912	0.9903
1.9000	0.0125	1.25	10.98				0.9973	0.9936	0.9913	0.9898	0.9889
1.8500	0.0141	1.41	12.04				0.9958	0.9921	0.9898	0.9883	0.9874
1.8000	0.0158	1.58	13.13			1.0000	0.9940	0.9904	0.9880	0.9866	0.9857
1.7500	0.0177	1.77	14.27			0.9980	0.9921	0.9884	0.9861	0.9846	0.9837
1.7000	0.0199	1.99	15.46			0.9958	0.9899	0.9862	0.9839	0.9825	0.9816
1.6500	0.0223	2.23	16.69			0.9933	0.9874	0.9838	0.9815	0.9800	0.9791
1.6000	0.0251	2.51	17.97		1.0000	0.9905	0.9847	0.9810	0.9787	0.9773	0.9764
1.5500	0.0281	2.81	19.30		0.9968	0.9874	0.9816	0.9779	0.9757	0.9742	0.9733
1.5000	0.0316	3.16	20.68		0.9933	0.9839	0.9781	0.9745	0.9722	0.9708	0.9699
1.4500	0.0354	3.54	22.11		0.9893	0.9800	0.9742	0.9706	0.9683	0.9669	0.9660
1.4000	0.0398	3.98	23.60	1.0000	0.9849	0.9756	0.9698	0.9662	0.9640	0.9626	0.9617
1.3500	0.0446	4.46	25.15	0.9949	0.9799	0.9707	0.9649	0.9613	0.9591	0.9577	0.9568
1.3000	0.0501	5.01	26.76	0.9892	0.9743	0.9651	0.9594	0.9559	0.9536	0.9522	0.9513
1.2500	0.0562	5.62	28.44	0.9828	0.9680	0.9589	0.9532	0.9497	0.9475	0.9461	0.9452
1.2000	0.0631	6.31	30.18	0.9757	0.9610	0.9519	0.9463	0.9428	0.9406	0.9392	0.9383
1.1500	0.0708	7.08	31.98	0.9677	0.9531	0.9441	0.9385	0.9351	0.9329	0.9315	0.9306
1.1000	0.0794	7.94	33.86	0.9587	0.9442	0.9353	0.9298	0.9264	0.9242	0.9228	0.9220
1.0500	0.0891	8.91	35.81	0.9486	0.9343	0.9255	0.9200	0.9166	0.9145	0.9131	0.9123
1.0000	0.1000	10.00	37.84	0.9373	0.9231	0.9144	0.9090	0.9057	0.9035	0.9022	0.9014
0.9500	0.1122	11.22	39.94	0.9246	0.9106	0.9020	0.8967	0.8934	0.8913	0.8900	0.8892
0.9000	0.1259	12.59	42.13	0.9103	0.8966	0.8881	0.8829	0.8796	0.8776	0.8763	0.8754
0.8500	0.1412	14.12	44.41	0.8943	0.8808	0.8725	0.8674	0.8641	0.8621	0.8609	0.8601
0.8000	0.1584	15.84	46.77	0.8764	0.8631	0.8550	0.8500	0.8468	0.8448	0.8436	0.8428
0.7500	0.1778	17.78	49.23	0.8562	0.8433	0.8354	0.8304	0.8273	0.8254	0.8242	0.8234
0.7000	0.1995	19.95	51.78	0.8336	0.8211	0.8133	0.8085	0.8055	0.8036	0.8024	0.8017
0.6500	0.2238	22.38	54.43	0.8083	0.7961	0.7886	0.7839	0.7810	0.7792	0.7780	0.7773
0.6000	0.2511	25.11	57.19	0.7798	0.7681	0.7608	0.7563	0.7535	0.7518	0.7506	0.7500
0.5500	0.2818	28.18	60.05	0.7479	0.7366	0.7297	0.7254	0.7227	0.7210	0.7199	0.7193
0.5000	0.3162	31.62	63.03	0.7121	0.7013	0.6947	0.6906	0.6881	0.6865	0.6854	0.6848
0.4500	0.3548	35.48	66.12	0.6719	0.6618	0.6555	0.6517	0.6492	0.6477	0.6468	0.6462
0.4000	0.3981	39.81	69.33	0.6268	0.6174	0.6115	0.6079	0.6057	0.6043	0.6034	0.6028
0.3500	0.4466	44.66	72.67	0.5762	0.5675	0.5622	0.5589	0.5568	0.5555	0.5547	0.5541
0.3000	0.5011	50.11	76.14	0.5194	0.5116	0.5068	0.5038	0.5019	0.5008	0.5000	0.4996
0.2500	0.5623	56.23	79.74	0.4558	0.4489	0.4447	0.4420	0.4404	0.4394	0.4387	0.4383
0.2000	0.6309	63.09	83.49	0.3843	0.3785	0.3749	0.3727	0.3713	0.3705	0.3699	0.3696
0.1500	0.7079	70.79	87.38	0.3041	0.2995	0.2967	0.2950	0.2939	0.2932	0.2927	0.2925
0.1000	0.7943	79.43	91.43	0.2142	0.2109	0.2089	0.2077	0.2069	0.2064	0.2061	0.2060
0.0500	0.8912	89.12	95.63	0.1132	0.1115	0.1105	0.1098	0.1094	0.1091	0.1090	0.1089
0.0000	1.0	100.00	100.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

8.1 Dot Gain



This diagram shows the growth of the area of printed dots on the paper.

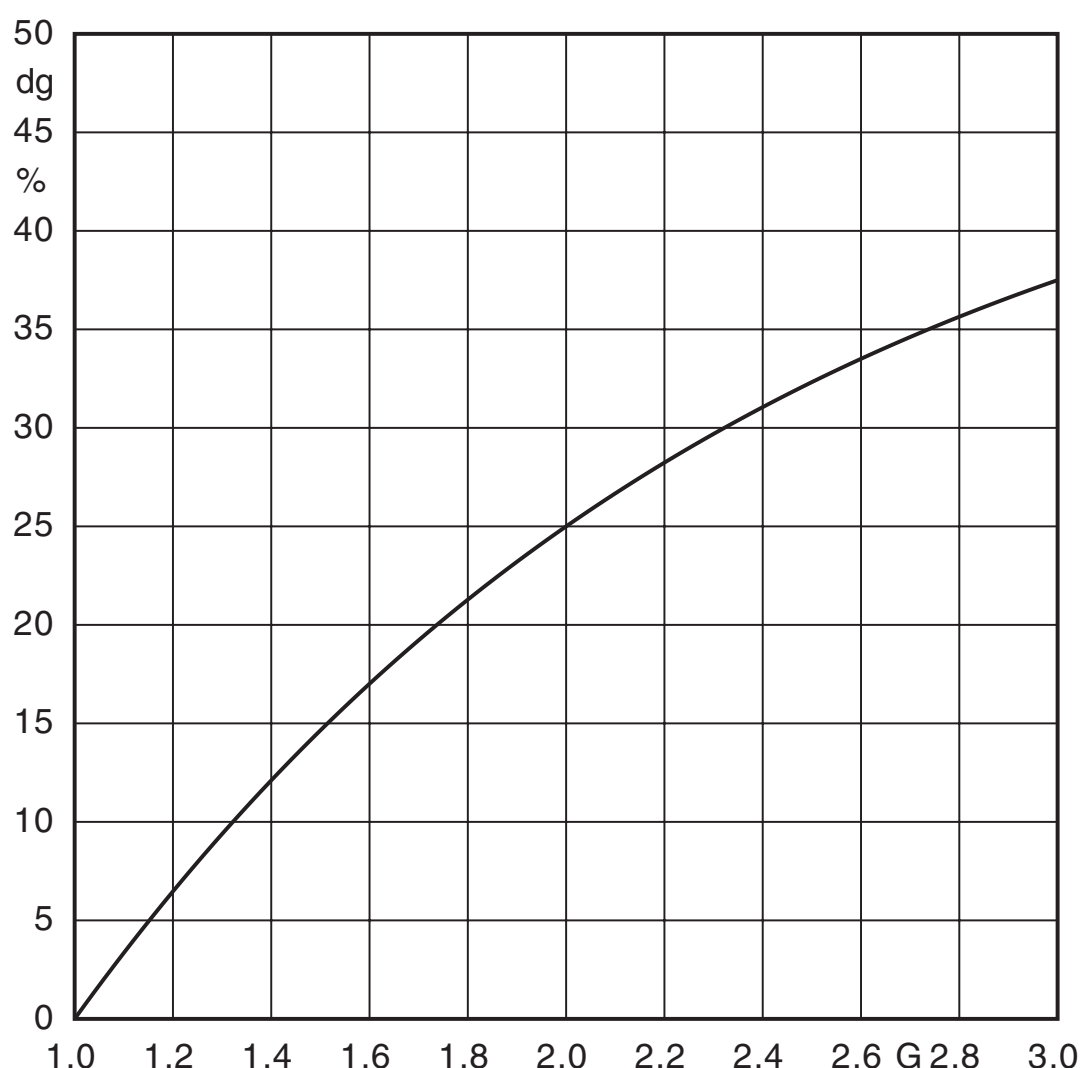
A printer tone reproduction curve is often similar to a power function, like the so-called Gamma function for a monitor, but shown somewhat mirrored.

For Gamma=2.0 we read for the input 0.50 (50%) the output value 0.75 which is interpreted as dot gain 25%.

According to ISO the dot gain has to be measured at 40%.

Photoshop seems to use 50%.

The lower diagram shows the dot gain as a function of Gamma.



G	dg	G	dg
1.00	0.0	1.00	0.0
1.10	3.3	1.07	2.5
1.20	6.5	1.15	5.0
1.30	9.4	1.23	7.5
1.40	12.1	1.32	10.0
1.50	14.6	1.42	12.5
1.60	17.0	1.51	15.0
1.70	19.2	1.62	17.5
1.80	21.3	1.74	20.0
1.90	23.2	1.86	22.5
2.00	25.0	2.00	25.0
2.10	26.7	2.15	27.5
2.20	28.2	2.32	30.0
2.30	29.7	2.51	32.5
2.40	31.1	2.74	35.0
2.50	32.3	3.00	37.5
2.60	33.5		
2.70	34.6		
2.80	35.6		
2.90	36.6		
3.00	37.5		

Formulas

$$(1-y) = (1-x)^G$$

$$y = 1 - (1-x)^G$$

At x_0

$$dg = y(x_0) - x_0$$

$$dg = 1 - (1-x_0)^G - x_0$$

For $x_0 = 0.5$

(left diagram + table)

$$dg = 0.5 - 0.5^G$$

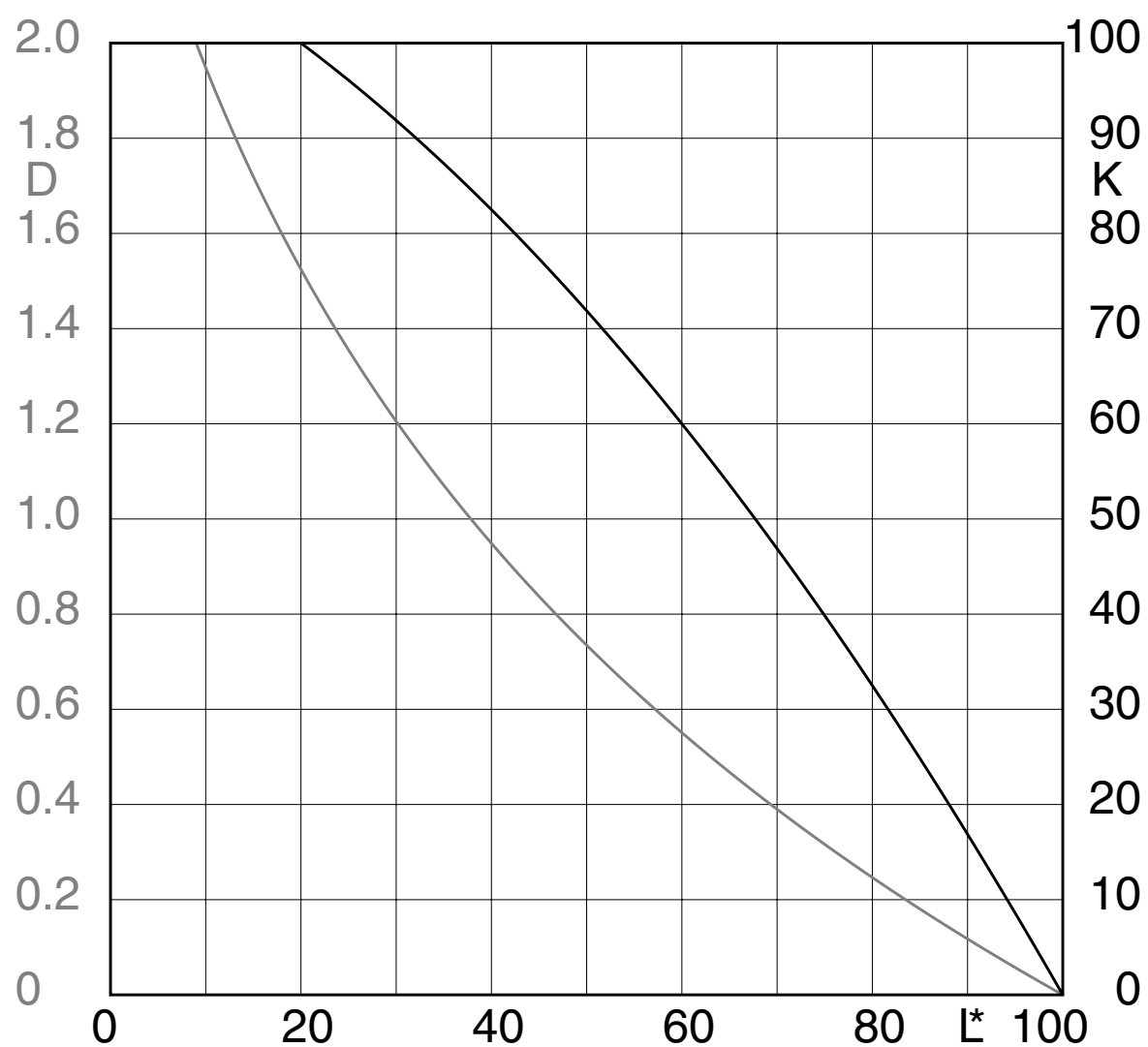
For $x_0 = 0.4$

$$dg = 0.6 - 0.6^G$$

Multiply dg by 100%

A gray profile can be derived from a color CMYK profile. But it seems that the dot gain is different for rich black and K-only.

8.2 Dot Gain



This diagram shows the density D and the value K as functions of the CIELab lightness.

The function $K(L^*)$ is based on measurements L^* in a swatch book for Euroscale Coated v2. A simple quadratic function was used for curve fitting.

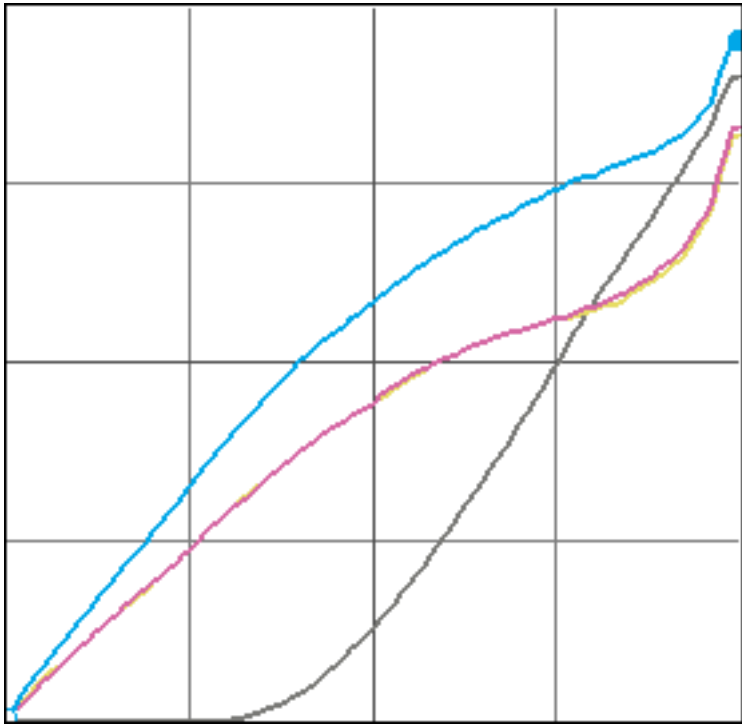
$L^* = 0$ means darkness

$L^* = 100$ means paper white

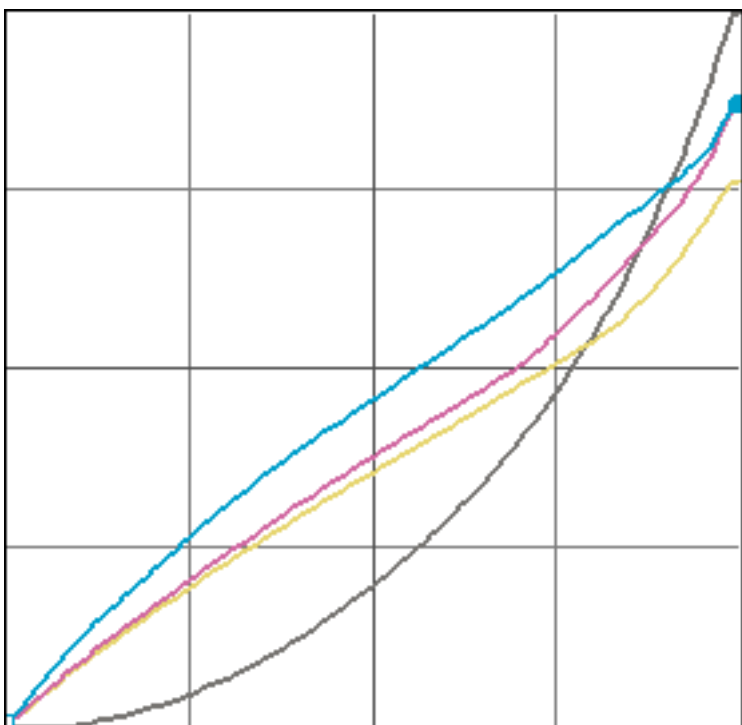
$$L = L^* / 100$$

$$K = 100 (1.125 - 0.5L - 0.625L^2)$$

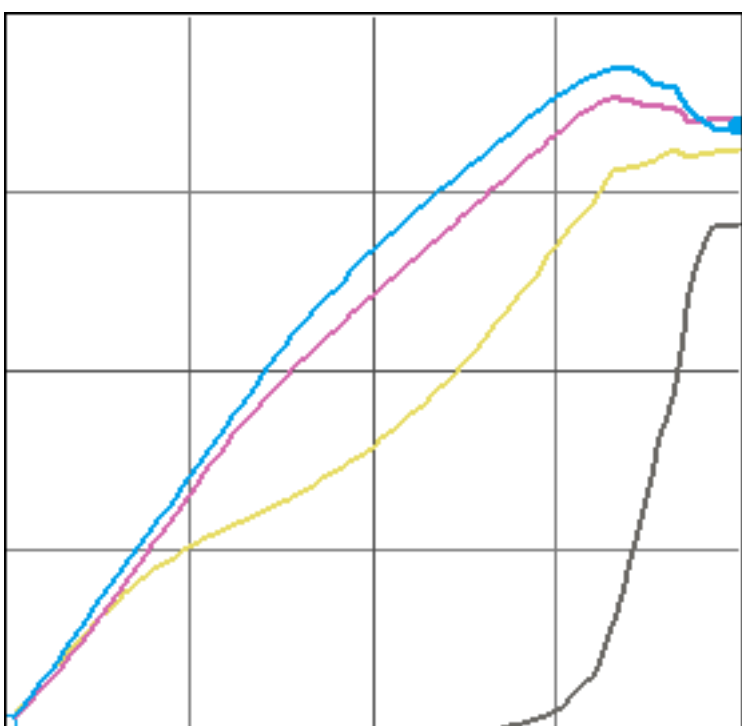
9. Black Generation



Offset Profile Euroscale Coated



Offset Profile ISO Coated



Inkjet Profile for Mutoh 6100

Black Generation means the strategy how to replace CMY ink by K ink in dark areas.

UCR (Undercolor Removal):

Equal amounts of color ink are replaced by K ink in neutral areas.

GCR (Gray Component Replacement):

Equal amounts of color ink above a certain level are replaced by K ink everywhere.

The curves were created by Gretag Macbeth Profile Editor, mode Graybalance:

'The Gray Balance window indicates the curve of the Lab lightness axis for each color channel. The L^* range (= Lightness axis) is from 0 to 100.'

This cannot be true. At least are the axes in reverse direction.

Euroscale Coated v2 uses medium GCR, ISO Coated heavy GCR and the inkjet was profiled for light GCR. This is necessary in order to avoid the so-called pepper effect. Stronger GCR stabilizes the graybalance.

Characterizations like medium, heavy or light are not standardized.

10. Files

This document is available in two versions:

Web Preview / about 300 kB

<http://www.fho-emden.de/~hoffmann/a3gencolortest.pdf>

High Quality JPEG / ZIP 144dpi / about 2 MB

<http://www.fho-emden.de/~hoffmann/a3gencolorhigh.pdf>

EPS file for the IT8 target 50 kB

<http://www.fho-emden.de/~hoffmann/targetrgb.txt>

Please rename to targetrgb.eps

The file contains a reference data table

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January 26 / 2008

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