16 Step Elementary Color Circle: *rgb**, CIELAB, and Spectral Reflectance Factor $R(\lambda)$

Version 1.2, (13 pages, 200 KB), /CIE_ECC_10.PDF

K. Richter: email: klaus.richter@mac.com

Internet: Berlin University of Technology (TUB): http://130.149.60.45/~farbmetrik
For recent publications of the TUB group see: http://130.149.60.45/~farbmetrik/XY91FEN.html

Abstract

The report CIE R1-47:2009 “Hue Angles of Elementary Colours” defines four elementary colours *RJGB* (Red, Yellow, Green and Blue). The four CIELAB hue angles of *RJGB* are h_{ab} = 26, 92, 162 and 272. These hue angle are identical to the hue angles of the CIE-test colours no. 9 to 12 according to CIE 13.3. For example these four hue angles of *RJGB* have been used in DIN 33872 (in print) to define a 16 step elementary colour circle in standard offset printing on standard offset paper for CIE standard illuminant D65 and the CIE 2 degree observer. In addition the *Relative Elementary Colour System (RECS)* with about 1200 colour samples uses the hue angle of *RJGB* as reference.

In this paper a method is given how to calculate the reflectance factors *R*(λ) of a 16 step elementary hue circle and many CIE data.

It is proposed that the spectral reflectance factors *R*(λ) of the 16 samples and/or the real samples of the elementary hue circle may be used to evaluate the colour rendition of light sources in CIE TC1-69.

At the same time the linear relations between *rgb** data and CIELAB data define a device independent *rgb** system which is based on the human visual *elementary hue angles in CIELAB,* and which may be used for many applications in image technology.

Introduction

The elementary hues are defined by visual criteria, for example *Yellow J* as neither greenish nor reddish. The four elementary hues are included as reference in the human visual system.

Achromatic colours	**Elementary colours** *"Neither-nor"-colours*	**Reproduction colours** *Television (TV), Print (PR) Photography (PH)*
five achromatic colours:	*four elementary colours:*	*six reproduction colours:*
N black (french noir)	*R* red *neither yellowish nor blueish*	*C* cyanblue
D dark grey	*G* green *neither yellowish nor blueish*	*M* magentared
Z central grey	*B* blue *neither greenish nor reddish*	*Y* yellow
H light grey	*J* yellow (french jaune) *neither greenish nor reddish*	*O* orangered
W white		*L* leafgreen
		V violetblue

YE980-3

Fig. 1: Elementary colours *RJGB* and device colours *OYLCVM*.

Fig. 1 shows elementary colours *RJGB* and device colours *OYLCVM* according to ISO/IEC 15775.

The elementary colours may be created by complementary colour “signals” in the visual system. A physiological and/or colorimetric model for the description of the four elementary colours is still missing.

Any display or print device can produce any hue and therefore an elementary hue circle can be produced by any colour device.

rgb* data and the CIELAB data of the 16 step hue circle

For standard offset on standard offset paper according to ISO/IEC 15775 the *rgb** data and the *adapted* CIELAB data of the 16 step hue circle and a 5 step grey scale (left) are given in Fig. 2.

In addition on the right side the mixture colours between the elementary colours *RJGB* and White *W*, and Black *N* are given.

NOTE:

For standard offset print on standard offset paper according to ISO/IEC 15775 the 16 samples of the 16 step colour circle will be available at the next meeting of CIE TC1-69 in 2010 for application studies in the field of colour rendition. For the colour circle layout, see for example (70 KB) http://www.ps.bam.de/De15/10L/L15e00NP.PDF

16 Step Elementary Color Circle: *rgb**, CIELAB, Spectral Reflectance Factor $R(\lambda)$

rgb –> rgb* and CIE data of a elementary hue circle according to CIE R1-47:2009 for offset print

16 step elementary hue circle: h_{ab} = 25.4 , 92.3 , 162.2 , 271.7

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	rgb –> rgb*
r00j=R	48.7	66.7	31.8	73.9	**25.4**	**1.00 0.00 0.00**
r25j	54.5	52.9	47.9	71.4	**42.2**	**1.00 0.25 0.00**
r50j	63.2	35.0	58.0	67.8	**58.9**	**1.00 0.50 0.00**
r75j	72.7	17.6	68.8	71.1	**75.5**	**1.00 0.75 0.00**
j00g=J	86.1	−3.3	83.2	83.3	**92.3**	**1.00 1.00 0.00**
j25g	77.8	−25.0	69.6	74.0	**109.8**	**0.75 1.00 0.00**
j50g	67.1	−40.9	53.7	67.6	**127.3**	**0.50 1.00 0.00**
j75g	59.6	−55.6	39.3	68.2	**144.7**	**0.25 1.00 0.00**
g00b=G	56.9	−61.5	19.6	64.5	**162.2**	**0.00 1.00 0.00**
g25b	59.3	−50.5	−8.5	51.2	**189.5**	**0.00 1.00 0.50**
g50b	61.3	−39.1	−29.4	49.0	**216.9**	**0.00 1.00 1.00**
g75b	56.0	−20.6	−43.0	47.7	**244.3**	**0.00 0.50 1.00**
b00r=B	41.2	1.3	−45.0	45.0	**271.7**	**0.00 0.00 1.00**
b25r	27.5	27.2	−46.9	54.2	**300.1**	**0.50 0.00 1.00**
b50r	37.4	50.1	−30.6	58.7	**328.5**	**1.00 0.00 1.00**
b75r	49.4	72.4	−3.7	72.5	**357.0**	**1.00 0.00 0.50**

5 step equidistant grey scale: L^* = 22.2 , 40.7 , 59.3 , 77.8 , 96.3

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	rgb –> rgb*
n000w=N	**22.5**	0.0	0.0	0.0	37.9	**0.00 0.00 0.00**
n025w	**40.8**	−0.3	−1.4	1.4	256.8	**0.25 0.25 0.25**
n050w	**59.2**	−0.3	−1.8	1.8	258.1	**0.50 0.50 0.50**
n075w	**77.8**	−0.2	−1.4	1.4	259.2	**0.75 0.75 0.75**
n100w=W	**96.4**	0.0	0.0	0.0	100.0	**1.00 1.00 1.00**

KE110−7N, Offset print, model separation cmyn6*

rgb –> rgb* and CIE data of a elementary hue circle according to CIE R1-47:2009 for offset print

3 colours of the elementary hues RJGB: h_{ab} = 25.4 , 92.3 , 162.2 , 271.7

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	rgb –> rgb*
r00j=R	48.7	66.7	31.8	73.9	**25.4**	**1.00 0.00 0.00**
0,5(R+N)	35.5	33.3	15.9	36.9	**25.4**	**0.50 0.00 0.00**
0,5(R+W)	72.5	33.3	15.9	36.9	**25.4**	**1.00 0.50 0.50**
j00g=J	86.1	−3.3	83.2	83.3	**92.3**	**1.00 1.00 0.00**
0,5(J+N)	54.2	−1.6	41.6	41.6	**92.3**	**0.50 0.50 0.00**
0,5(J+W)	91.2	−1.6	41.6	41.6	**92.3**	**1.00 1.00 0.50**
g00b=G	56.9	−61.5	19.6	64.5	**162.2**	**0.00 1.00 0.00**
0,5(G+N)	39.6	−30.7	9.8	32.2	**162.2**	**0.00 0.50 0.00**
0,5(G+W)	76.6	−30.7	9.8	32.2	**162.2**	**0.50 1.00 0.50**
b00r=B	41.2	1.3	−45.0	45.0	**271.7**	**0.00 0.00 1.00**
0,5(B+N)	31.7	0.6	−22.5	22.5	**271.7**	**0.00 0.00 0.50**
0,5(B+W)	68.8	0.6	−22.5	22.5	**271.7**	**0.50 0.50 1.00**

5 step equidistant grey scale: L^* = 22.2 , 40.7 , 59.3 , 77.8 , 96.3

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	rgb –> rgb*
n000w=N	**22.5**	0.0	0.0	0.0	37.9	**0.00 0.00 0.00**
n025w	**40.8**	−0.3	−1.4	1.4	256.8	**0.25 0.25 0.25**
n050w	**59.2**	−0.3	−1.8	1.8	258.1	**0.50 0.50 0.50**
n075w	**77.8**	−0.2	−1.4	1.4	259.2	**0.75 0.75 0.75**
n100w=W	**96.4**	0.0	0.0	0.0	100.0	**1.00 1.00 1.00**

KE110−8N, Offset print, model separation cmyn6*

Fig.2: *rgb data and adapted CIELAB data of a 16 step hue circle and a 5 step grey scale for standard offset on standard offset paper**

Fig 2 shows *rgb** data and the CIELAB data of the 16 step hue circle and a 5 step grey scale for the standard offset print on the standard *non fluorescent* offset paper.

The data are calculated from a 48 step device hue circle (data see Fig. 3) of a real print. In the example the achromatic colours are printed by only the black offset colorant.

In addition Fig. 3 shows the CIE data X, Y, Z and the chromaticity coordinates x, y and the *standard* CIELAB data $L^*, a^*,$ and b^* for the CIE 2 degree observer and for the CIE standard illuminant D65.

The equations between standard and adapted CIELAB data use the *relative* CIELAB lightness l^*_r:

$$l^*_r = (L^* - L^*_N) / (L^*_W - L^*_N)$$

$$L^*_a = L^*$$

$$a^*_a = a^* - a^*_N - l^*_r\,(a^*_W - a^*_N)$$

$$b^*_a = b^* - b^*_N - l^*_r\,(b^*_W - b^*_N)$$

Is valid $(a^*_N, a^*_N) = (a^*_W, a^*_W) = (0, 0)$ and similar for b^*, see Fig. 3.

rgb* and CIE data of a elementary hue circle according to CIE R1-47:2009 for offset print

16 step elementary hue circle with intended elementary hues: h_{ab} = 25.4 , 92.3 , 162.2 , 271.7

Code	*X*	*Y*	*Z*	*x*	*y*	*L**	*a**	*b**	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	*rgb**
r00j=R	31.4	17.3	6.6	0.566	0.313	48.7	66.5	32.9	48.7	66.7	31.8	73.9	**25.4**	**1.00 0.00 0.00**
r25j	34.5	22.5	5.1	0.555	0.361	54.5	52.6	49.2	54.5	52.9	47.9	71.4	**42.2**	**1.00 0.25 0.00**
r50j	40.5	31.9	6.2	0.514	0.405	63.2	34.6	59.5	63.2	35.0	58.0	67.8	**58.9**	**1.00 0.50 0.00**
r75j	48.6	44.8	7.6	0.48	0.443	72.7	17.1	70.4	72.7	17.6	68.8	71.1	**75.5**	**1.00 0.75 0.00**
j00g=J	63.1	68.2	10.2	0.445	0.481	86.1	−4.0	85.1	86.1	−3.3	83.2	83.3	**92.3**	**1.00 1.00 0.00**
j25g	41.3	53.0	10.1	0.396	0.507	77.8	−25.6	71.3	77.8	−25.0	69.6	74.0	**109.8**	**0.75 1.00 0.00**
j50g	24.2	36.8	9.3	0.344	0.523	67.1	−41.3	55.2	67.1	−40.9	53.7	67.6	**127.3**	**0.50 1.00 0.00**
j75g	14.9	27.7	9.8	0.285	0.527	59.6	−56.0	40.7	59.6	−55.6	39.3	68.2	**144.7**	**0.25 1.00 0.00**
g00b=G	12.2	24.9	15.6	0.232	0.471	56.9	−61.7	20.9	56.9	−61.5	19.6	64.5	**162.2**	**0.00 1.00 0.00**
g25b	15.6	27.3	35.0	0.2	0.35	59.3	−50.8	−7.1	59.3	−50.5	−8.5	51.2	**189.5**	**0.00 1.00 0.50**
g50b	19.3	29.6	57.3	0.181	0.279	61.3	−39.4	−28.0	61.3	−39.1	−29.4	49.0	**216.9**	**0.00 1.00 1.00**
g75b	18.4	23.9	62.3	0.176	0.228	56.0	−20.9	−41.7	56.0	−20.6	−43.0	47.7	**244.3**	**0.00 0.50 1.00**
b00r=B	11.6	12.0	39.6	0.183	0.19	41.2	1.3	−44.0	41.2	1.3	−45.0	45.0	**271.7**	**0.00 0.00 1.00**
b25r	7.5	5.3	24.3	0.203	0.142	27.5	27.4	−46.1	27.5	27.2	−46.9	54.2	**300.1**	**0.50 0.00 1.00**
b50r	16.8	9.8	24.6	0.327	0.191	37.4	50.1	−29.6	37.4	50.1	−30.6	58.7	**328.5**	**1.00 0.00 1.00**
b75r	33.8	17.9	20.9	0.465	0.247	49.4	72.2	−2.5	49.4	72.4	−3.7	72.5	**357.0**	**1.00 0.00 0.50**

5 step equidistant grey scale with intended lightness: *L = 22.2 , 40.7 , 59.3 , 77.8 , 96.3**

Code	*X*	*Y*	*Z*	*x*	*y*	*L**	*a**	*b**	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	*rgb**
n000w=N	3.5	3.6	3.8	0.317	0.332	22.5	0.2	0.7	**22.5**	0.0	0.0	0.0	37.9	**0.00 0.00 0.00**
n025w	11.1	11.7	12.9	0.31	0.327	40.8	−0.3	−0.4	**40.8**	−0.3	−1.4	1.4	256.8	**0.25 0.25 0.25**
n050w	25.7	27.2	30.0	0.31	0.328	59.2	−0.6	−0.4	**59.2**	−0.3	−1.8	1.8	258.1	**0.50 0.50 0.50**
n075w	49.9	52.9	57.3	0.311	0.33	77.8	−0.8	0.2	**77.8**	−0.2	−1.4	1.4	259.2	**0.75 0.75 0.75**
n100w=W	86.0	91.0	95.9	0.315	0.333	96.4	−0.8	2.1	**96.4**	0.0	0.0	0.0	100.0	**1.00 1.00 1.00**

KE100−7N, Page 1 /1, %BEG 'KK0X'REM OFFS04 080929 3.TXT

Fig. 3: *rgb data, *adapted* and *standard* CIELAB data and CIE data *X, Y, Z, x, y* of a 16 step hue circle and a 5 step grey scale**

16 Step Elementary Color Circle: *rgb**, CIELAB, Spectral Reflectance Factor *R*(λ)

48 step circle with interpretation *rgb −> olv device hue steps of 1080 standard colours**

*rgb −> olv**			$h_{ab,a}$	L^*	a^*_a	b^*_a
1.0	0.0	0.0	31.3	48.4	66.2	40.3
1.0	0.12	0.0	38.9	52.8	56.7	45.9
1.0	0.25	0.0	47.6	57.4	46.7	51.2
1.0	0.37	0.0	58.1	62.8	35.8	57.6
1.0	0.5	0.0	68.6	68.6	25.0	64.1
1.0	0.62	0.0	78.2	74.5	14.6	70.8
1.0	0.75	0.0	85.6	80.0	5.8	76.6
1.0	0.87	0.0	91.4	85.1	−2.0	82.0

*rgb −> olv**			$h_{ab,a}$	L^*	a^*_a	b^*_a
1.0	1.0	0.0	96.2	90.2	−9.6	88.3
0.87	1.0	0.0	99.9	86.4	−14.5	83.3
0.75	1.0	0.0	103.4	82.7	−18.9	79.6
0.62	1.0	0.0	110.2	77.5	−25.5	69.0
0.5	1.0	0.0	116.8	73.3	−31.7	62.8
0.37	1.0	0.0	124.3	68.7	−38.7	56.8
0.25	1.0	0.0	137.9	62.4	−48.6	43.9
0.12	1.0	0.0	145.4	59.3	−56.5	38.9

*rgb −> olv**			$h_{ab,a}$	L^*	a^*_a	b^*_a
0.0	1.0	0.0	152.5	55.8	−65.2	33.9
0.0	1.0	0.12	159.4	56.7	−62.6	23.5
0.0	1.0	0.25	167.8	57.5	−59.1	12.7
0.0	1.0	0.37	179.0	58.5	−54.5	0.8
0.0	1.0	0.5	190.1	59.3	−50.3	−8.9
0.0	1.0	0.62	201.4	60.1	−45.8	−18.0
0.0	1.0	0.75	213.2	61.0	−40.8	−26.7
0.0	1.0	0.87	223.3	61.9	−36.1	−34.0

*rgb −> olv**			$h_{ab,a}$	L^*	a^*_a	b^*_a
0.0	1.0	1.0	233.9	63.0	−30.5	−41.9
0.0	0.87	1.0	239.6	59.1	−24.9	−42.6
0.0	0.75	1.0	245.5	55.3	−19.6	−43.1
0.0	0.62	1.0	253.6	50.4	−12.9	−43.9
0.0	0.5	1.0	262.6	45.7	−5.7	−44.6
0.0	0.37	1.0	272.8	40.7	2.2	−45.0
0.0	0.25	1.0	281.3	36.6	9.2	−45.9
0.0	0.12	1.0	289.8	32.4	16.8	−46.6

*rgb −> olv**			$h_{ab,a}$	L^*	a^*_a	b^*_a
0.0	0.0	1.0	298.7	27.5	26.0	−47.3
0.12	0.0	1.0	308.4	29.6	34.0	−42.7
0.25	0.0	1.0	317.1	31.3	40.8	−37.8
0.37	0.0	1.0	322.4	35.4	44.8	−34.5
0.5	0.0	1.0	331.5	38.3	52.7	−28.5
0.62	0.0	1.0	339.4	40.9	59.1	−22.2
0.75	0.0	1.0	343.4	44.9	63.2	−18.7
0.87	0.0	1.0	348.3	47.4	68.2	−14.0

*rgb −> olv**			$h_{ab,a}$	L^*	a^*_a	b^*_a
1.0	0.0	1.0	353.0	49.5	73.5	−8.9
1.0	0.0	0.87	357.1	49.4	72.3	−3.6
1.0	0.0	0.75	0.8	49.2	71.2	1.1
1.0	0.0	0.62	5.8	49.3	69.7	7.0
1.0	0.0	0.5	10.6	48.9	69.3	13.0
1.0	0.0	0.37	15.7	48.9	68.2	19.2
1.0	0.0	0.25	22.0	48.8	67.1	27.1
1.0	0.0	0.12	26.9	48.6	66.5	33.8

RJGB$_{ton}$, 25.4 , 92.3 , 162.2 , 271.7 ***RJGB***$_{all}$: 25.4 42.1 58.8 75.6 92.3 109.7 127.2 144.7 162.2 189.6 216.9 244.3 271.7 300.1 328.6 357.0 ***LAB*Nio***: 22.2 , 0.2 , 0.6 ***LAB*Wio***: 96.3 , −0.8 , 2.0

25.4	42.1	58.8	75.6	92.3	109.7	127.2	144.7	162.2	189.6	216.9	244.3	271.7	300.1	328.6	357.0
46	1	3	4	7	10	13	14	17	19	22	25	28	32	35	40
15.7 22.0	31.3 38.9	47.6 58.1	58.1 68.6	85.6 91.4	99.9 103.4	116.8 124.3	124.3 137.9	152.5 159.4	167.8 179.0	201.4 213.2	233.9 239.6	253.6 262.6	289.8 298.7	317.1 322.4	348.3 353.0
26.9 31.3	47.6 58.1	68.6 78.2	78.2 85.6	96.2 99.9	110.2 116.8	137.9 145.4	145.4 152.5	167.8 179.0	190.1 201.4	223.3 233.9	245.5 253.6	272.8 281.3	308.4 317.1	331.5 339.4	357.1 0.8
0.703	0.369	0.074	0.722	0.183	0.928	0.217	0.908	0.33	0.952	0.369	0.798	0.888	0.144	0.673	0.984
651 650	648 657	666 675	675 684	702 711	639 558	396 315	315 234	72 73	74 75	77 78	80 71	53 44	17 8	170 251	575 656
649 648	666 675	684 693	693 702	720 639	477 396	234 153	153 72	74 75	76 77	79 80	62 53	35 26	89 170	332 413	655 654
507 506	504 531	558 585	585 612	666 693	477 234	468 225	225 702	216 217	218 219	221 222	224 197	143 116	35 8	494 17	269 512
505 504	558 585	612 639	639 666	720 477	711 468	702 459	459 216	218 219	220 221	223 224	170 143	89 62	251 494	260 503	511 510

16 step elementary hue circle with intended elementary hues: $h_{ab,a}$ = 25.4 , 92.3 , 162.2 , 271.7

r00j=R	1335	1118	883	730	636	605	600	609	630	591	531	566	678	701	590	497	468	417
	328	285	489	1960	4762	6931	8011	8461	8649	8744	8799	8809	8819	8821	8839	8859	8855	8871
r25j	1241	997	748	565	451	404	389	405	459	467	455	581	898	1184	1219	1160	1140	1076
	946	860	1123	2711	5340	7236	8147	8519	8679	8762	8807	8815	8823	8823	8839	8857	8854	8873
r50j	1399	1144	864	646	503	438	417	439	520	555	570	786	1354	2017	2325	2364	2373	2316
	2167	2056	2349	3874	6109	7614	8315	8598	8725	8791	8832	8836	8841	8838	8852	8870	8866	8879
r75j	1583	1325	1010	743	568	490	459	488	596	663	706	1033	1913	3079	3802	4013	4086	4061
	3925	3820	4095	5365	7005	8027	8486	8673	8762	8815	8848	8844	8845	8845	8857	8875	8867	8884
j00g=J	1933	1642	1262	928	702	598	550	589	746	862	953	1460	2847	4868	6383	6984	7209	7298
	7283	7277	7410	7891	8370	8632	8759	8819	8863	8897	8920	8914	8913	8910	8921	8937	8928	8943
j25g	1430	1343	1125	864	658	562	527	571	735	859	962	1498	2960	5049	6458	6750	6560	6189
	5730	5364	5122	5003	4898	4827	4825	4843	4880	4975	5103	5166	5138	5064	4951	4859	4902	5126
j50g	979	1028	952	764	590	512	487	535	689	809	904	1409	2792	4683	5749	5683	5161	4471
	3730	3164	2823	2650	2517	2427	2413	2430	2470	2581	2741	2832	2801	2711	2564	2449	2512	2793
j75g	740	919	927	788	629	556	540	594	759	882	978	1488	2831	4539	5310	4989	4269	3411
	2543	1907	1548	1372	1243	1158	1147	1164	1200	1307	1466	1561	1531	1447	1307	1201	1267	1547
g00b=G	760	1072	1250	1214	1089	1049	1070	1161	1353	1487	1582	2076	3314	4758	5248	4762	3938	3000
	2073	1406	1038	862	738	657	648	667	703	808	967	1065	1038	956	820	719	785	1066
g25b	1061	1702	2237	2523	2535	2646	2848	3069	3313	3457	3526	3905	4752	5541	5551	4890	4008	3037
	2088	1407	1033	854	729	649	642	664	701	807	966	1064	1036	953	817	719	790	1072
g50b	1374	2257	3200	3874	4120	4462	4950	5363	5612	5726	5740	5865	6129	6198	5780	4976	4044	3049
	2082	1389	1011	833	709	632	627	648	688	795	951	1048	1020	939	803	707	780	1061
g75b	1370	2308	3342	4166	4552	5041	5674	6129	6216	6146	5981	5745	5428	4984	4395	3711	3016	2263
	1520	1004	771	722	678	624	624	645	683	787	940	1034	1007	928	795	700	774	1049
b00r=B	998	1643	2320	2834	3087	3423	3843	4071	3978	3736	3438	3132	2808	2431	2013	1643	1327	975
	626	417	383	493	575	567	572	592	624	717	858	945	920	847	724	634	701	951
b25r	757	1189	1584	1888	2053	2283	2557	2650	2462	2141	1800	1489	1200	909	642	475	381	272
	173	151	200	370	540	573	586	604	634	720	855	939	916	846	728	643	700	941
b50r	1651	1834	1994	2146	2261	2436	2638	2661	2445	2101	1748	1435	1151	870	621	478	417	333
	236	207	329	1018	2095	2728	3002	3121	3201	3325	3486	3575	3551	3471	3336	3227	3285	3555
b75r	2481	2281	2106	2058	2071	2152	2246	2216	2027	1731	1430	1192	990	774	571	466	440	389
	307	281	497	1945	4721	6890	7983	8444	8642	8741	8797	8809	8821	8825	8843	8865	8865	8883

	X	*Y*	*Z*	*x*	*y*	L^*	a^*	b^*	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	$h_{ab,a}$	*rgb −> rgb**
r00j=R	31.4	17.3	6.6	0.566	0.313	48.7	66.5	32.9	48.7	66.7	31.8	73.9	**25.4**	**1.00 0.00 0.00**
r25j	34.5	22.5	5.1	0.555	0.361	54.5	52.6	49.2	54.5	52.9	47.9	71.4	**42.2**	**1.00 0.25 0.00**
r50j	40.5	31.9	6.2	0.514	0.405	63.2	34.6	59.5	63.2	35.0	58.0	67.8	**58.9**	**1.00 0.50 0.00**
r75j	48.6	44.8	7.6	0.48	0.443	72.7	17.1	70.4	72.7	17.6	68.8	71.1	**75.5**	**1.00 0.75 0.00**
j00g=J	63.1	68.2	10.2	0.445	0.481	86.1	−4.0	85.1	86.1	−3.3	83.2	83.3	**92.3**	**1.00 1.00 0.00**
j25g	41.3	53.0	10.1	0.396	0.507	77.8	−25.6	71.3	77.8	−25.0	69.6	74.0	**109.8**	**0.75 1.00 0.00**
j50g	24.2	36.8	9.3	0.344	0.523	67.1	−41.3	55.2	67.1	−40.9	53.7	67.6	**127.3**	**0.50 1.00 0.00**
j75g	14.9	27.7	9.8	0.285	0.527	59.6	−56.0	40.7	59.6	−55.6	39.3	68.2	**144.7**	**0.25 1.00 0.00**
g00b=G	12.2	24.9	15.6	0.232	0.471	56.9	−61.7	20.9	56.9	−61.5	19.6	64.5	**162.2**	**0.00 1.00 0.00**
g25b	15.6	27.3	35.0	0.2	0.35	59.3	−50.8	−7.1	59.3	−50.5	−8.5	51.2	**189.5**	**0.00 1.00 0.50**
g50b	19.3	29.6	57.3	0.181	0.279	61.3	−39.4	−28.0	61.3	−39.1	−29.4	49.0	**216.9**	**0.00 1.00 1.00**
g75b	18.4	23.9	62.3	0.176	0.228	56.0	−20.9	−41.7	56.0	−20.6	−43.0	47.7	**244.3**	**0.00 0.50 1.00**
b00r=B	11.6	12.0	39.6	0.183	0.19	41.2	1.3	−44.0	41.2	1.3	−45.0	45.0	**271.7**	**0.00 0.00 1.00**
b25r	7.5	5.3	24.3	0.203	0.142	27.5	27.4	−46.1	27.5	27.2	−46.9	54.2	**300.1**	**0.50 0.00 1.00**
b50r	16.8	9.8	24.6	0.327	0.191	37.4	50.1	−29.6	37.4	50.1	−30.6	58.7	**328.5**	**1.00 0.00 1.00**
b75r	33.8	17.9	20.9	0.465	0.247	49.4	72.2	−2.5	49.4	72.4	−3.7	72.5	**357.0**	**1.00 0.00 0.50**

5 step equidistant grey scale with intended lightness: L^* = 22.2 , 40.7 , 59.3 , 77.8 , 96.3

n000w=N	277	301	310	313	325	333	345	350	361	372	377	385	386	385	380	372	361	354
	348	348	350	356	362	373	388	402	421	441	461	484	510	539	570	605	634	666
n025w	1036	1084	1107	1126	1144	1161	1174	1189	1204	1209	1218	1223	1224	1220	1212	1194	1178	1161
	1148	1144	1139	1143	1148	1158	1173	1191	1211	1234	1257	1283	1309	1339	1373	1411	1444	1476
n050w	2421	2537	2593	2640	2678	2710	2735	2760	2784	2792	2800	2807	2809	2802	2792	2765	2742	2719
	2695	2687	2675	2674	2675	2685	2702	2718	2741	2768	2795	2816	2842	2870	2903	2941	2973	3003
n075w	4546	4783	4913	5022	5097	5163	5223	5269	5314	5331	5347	5361	5367	5368	5365	5337	5315	5288
	5257	5254	5237	5232	5230	5237	5257	5275	5301	5331	5357	5370	5387	5409	5435	5473	5489	5520
n100w=W	7373	7810	8068	8301	8459	8596	8717	8817	8904	8946	8987	9026	9060	9088	9119	9111	9120	9115
	9099	9125	9110	9110	9103	9113	9140	9155	9182	9209	9226	9215	9208	9204	9208	9226	9210	9229

	X	*Y*	*Z*	*x*	*y*	L^*	a^*	b^*	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	$h_{ab,a}$	*rgb −> rgb**
n000w=N	3.5	3.6	3.8	0.317	0.332	22.5	0.2	0.7	**22.5**	0.0	0.0	0.0	37.9	**0.00 0.00 0.00**
n025w	11.1	11.7	12.9	0.31	0.327	40.8	−0.3	−0.4	**40.8**	−0.3	−1.4	1.4	256.8	**0.25 0.25 0.25**
n050w	25.7	27.2	30.0	0.31	0.328	59.2	−0.6	−0.4	**59.2**	−0.3	−1.8	1.8	258.1	**0.50 0.50 0.50**
n075w	49.9	52.9	57.3	0.311	0.33	77.8	−0.8	0.2	**77.8**	−0.2	−1.4	1.4	259.2	**0.75 0.75 0.75**
n100w=W	86.0	91.0	95.9	0.315	0.333	96.4	−0.8	2.1	**96.4**	0.0	0.0	0.0	100.0	**1.00 1.00 1.00**

KE070−7N: Measurement: %BEG 'KK0X'REM_OFFS04_080929_3.TXTOffset print, model separation cmyn6*, Page 1 /1

Fig. 4: Reflectance factor *R*(λ) between λ=380 and 730nm, *rgb data, and CIE data of Fig. 3 of a 16 step hue circle and a 5 step grey scale**

Fig. 4 shows the reflectance factor between λ = 380 and 730nm, the *rgb** data, and all the CIE data of Fig. 3 for a 16 step hue circle and a 5 step grey scale

The CIELAB data are calculated for the given interpolated reflectance factors. However, the real output of the elementary colour circle has been measured too. The printed colour circle includes CIELAB data od the standard offset print.

The reflectance factor of the 5 grey steps are approximately flat because only the achromatic colorant of offset has been used for the production.

Another example for a 3 dye photo printer show 3 maxima and minima of the reflectance factor curve for the grey colours (except for white), see

http://130.149.60.45/~farbmetrik/KE06/KE060-7N.PDF

Annex A includes the data of a 48 step device hue circle, which is used to interpolate the CIE data and the reflectance factor for the *rgb** data.

Summary

A method is given how to calculate the spectral reflectance factors *R*(λ) and many CIE data including CIELAB for a 16 step elementary hue circle in standard offset printing according to ISO/IEC 15775.

For this goal a 48 step device colour scale is used as start output which has 9 step colour series, for example between device Orange red *O* and device Yellow *Y*.

It is proposed that the spectral reflectance factors *R*(λ) of the 16 samples and /or the real samples of the elementary hue circle may be used to specify the colour rendition of light sources in CIE TC1-69.

At the same time the linear relations between *rgb** data and CIELAB data define a device independent *rgb** system which is based on the human visual *elementary hue angles* in CIELAB, see the report CIE R1-47:2009.

The *Relative Elementary Colour System RECS* shows about 2000 colour samples in standard offset print on standard offset paper according to ISO/IEC 15775. This System includes a realization of the *16 step elementary hue circle* which is proposed here.

Annex A

Fig. A.1 and Fig. A.2 show examples of measured reflectance factor of different sample pairs and shows the samples in CIELAB *(a*, b*)*.

These data are here produced by the *start output* using *rgb* input data which are interpreted as device data *olv**, compare “interpretation” of *rgb* data as *olv** data (symbol *rgb -> olv**) in Fig. 4.

These sample pairs are from the *start output* of the 48 step hue circle.

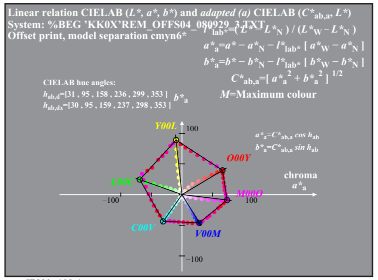
Always one sample pair is used for the interpolation of the reflectance factor of one sample of the 16 step elementary hue circle.

Fig. A.1 shows the intermediate reflectance factors and the 3 reflectance factors of the three samples *r00j=R, r25j,* and *r50j*.

Fig. A.2 shows the 16 reflectance factors, and the CIE data of all samples of the 16 step elementary colour circle which are also given in Fig. 4.

Fig. A.1 includes the 48 step colour circle in a (a^*_a, b^*_a) chroma diagram and in addition Fig. A.2 the 16 step colour circle in (a^*_a, b^*_a).

16 Step Elementary Color Circle: *rgb**, CIELAB, Spectral Reflectance Factor $R(\lambda)$



JE890−4 N, 1

48 step device hue circle and
3 steps of a 16 step elementary hue circle
with equal CIELAB hue steps

no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a
648	31.3	48.4	66.2	40.3	720	96.2	90.2	−9.6	88.3	72	152.5	55.8	−65.2	33.9	80	233.9	63.0	−30.5	−41.9	8	298.7	27.5	26.0	−47.3	656	353.0	49.5	73.5	−8.9
657	38.9	52.8	56.7	45.9	639	99.9	86.4	−14.5	83.3	73	159.4	56.7	−62.6	23.5	71	239.6	59.1	−24.9	−42.6	89	308.4	29.6	34.0	−42.7	655	357.1	49.4	72.3	−3.6
666	47.6	57.4	46.7	51.2	558	103.4	82.7	−18.9	79.6	74	167.8	57.5	−59.1	12.7	62	245.5	55.3	−19.6	−43.1	170	317.1	31.3	40.8	−37.8	654	0.8	49.2	71.2	1.1
675	58.1	62.8	35.8	57.6	477	110.2	77.5	−25.5	69.0	75	179.0	58.5	−54.5	0.8	53	253.6	50.4	−12.9	−43.9	251	322.4	35.4	44.8	−34.5	653	5.8	49.3	69.7	7.0
684	68.6	68.6	25.0	64.1	396	116.8	73.3	−31.7	62.8	76	190.1	59.3	−50.3	−8.9	44	262.6	45.7	−5.7	−44.6	332	331.5	38.3	52.7	−28.5	652	10.6	48.9	69.3	13.0
693	78.2	74.5	14.6	70.8	315	124.3	68.7	−38.7	56.8	77	201.4	60.1	−45.8	−18.0	35	272.8	40.7	2.2	−45.0	413	339.4	40.9	59.1	−22.2	651	15.7	48.9	68.2	19.2
702	85.6	80.0	5.8	76.6	234	137.9	62.4	−48.6	43.9	78	213.2	61.0	−40.8	−26.7	26	281.3	36.6	9.2	−45.9	494	343.4	44.9	63.2	−18.7	650	22.0	48.8	67.1	27.1
711	91.4	85.1	−2.0	82.0	153	145.4	59.3	−56.5	38.9	79	223.3	61.9	−36.1	−34.0	17	289.8	32.4	16.8	−46.6	575	348.3	47.4	68.2	−14.0	649	26.9	48.6	66.5	33.8

RJGB*$_{ton}$**, 25.4 , 92.3 , 162.2 , 271.7 ***RJGB*$_{all}$:** 25.4 42.1 58.8 75.6 92.3 109.7 127.2 144.7 162.2 189.6 216.9 244.3 271.7 300.1 328.6 357.0 ***LAB*Nio: 22.2 , 0.2 , 0.6 ***LAB*Wio:*** 96.3 , −0.8 , 2.0

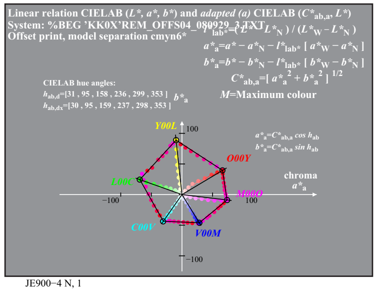
25.4	42.1	58.8	75.6	92.3	109.7	127.2	144.7	162.2	189.6	216.9	244.3	271.7	300.1	328.6	357.0
46	1	3	4	7	10	13	14	17	19	22	25	28	32	35	40
15.7 22.0	31.3 38.9	47.6 58.1	58.1 68.6	85.6 91.4	99.9 103.4	116.8 124.3	124.3 137.9	152.5 159.4	167.8 179.0	201.4 213.2	233.9 239.6	253.6 262.6	289.8 298.7	317.1 322.4	348.3 353.0
26.9 31.3	47.6 58.1	68.6 78.2	78.2 85.6	96.2 99.9	110.2 116.8	137.9 145.4	145.4 152.5	167.8 179.0	190.1 201.4	223.3 233.9	245.5 253.6	272.8 281.3	308.4 317.1	331.5 339.4	357.1 0.8
0.703	0.369	0.074	0.722	0.183	0.928	0.217	0.908	0.33	0.952	0.369	0.798	0.888	0.144	0.673	0.984
651 650	648 657	666 675	675 684	702 711	639 558	396 315	315 234	72 73	74 75	77 78	80 71	53 44	17 8	170 251	575 656
649 648	666 675	684 693	693 702	720 639	477 396	234 153	153 72	74 75	76 77	79 80	62 53	35 26	89 170	332 413	655 654
507 506	504 531	558 585	585 612	666 693	477 234	468 225	225 702	216 217	218 219	221 222	224 197	143 116	35 8	494 17	269 512
505 504	558 585	612 639	639 666	720 477	711 468	702 459	459 216	218 219	220 221	223 224	170 143	89 62	251 494	260 503	511 510

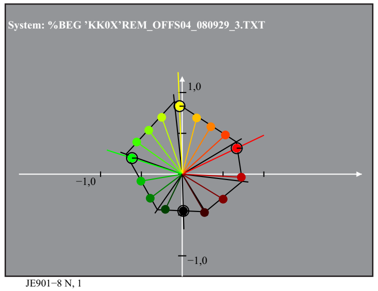
no./Code	***R (380nm − 725nm)***																	***X***	***Y***	***Z***	L^*	a^*	b^*	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	$h_{ab,a}$
506	1471	1238	999	859	771	746	747	752	757	697	617	629	715	714	592	499	469	418										
	329	287	493	1966	4764	6933	8015	8465	8656	8750	8805	8819	8829	8832	8850	8870	8864	8882	31.6	17.4	7.9	48.8	67.0	28.3	48.8	67.1	27.1	95.0	22.0
505	1277	1067	835	678	582	550	543	553	580	549	497	540	662	695	588	496	467	416										
	328	284	487	1957	4760	6930	8009	8459	8646	8742	8797	8805	8815	8817	8834	8854	8851	8867	31.2	17.3	6.1	48.6	66.4	34.9	48.6	66.5	33.8	94.1	26.9
r00j=R	1335	1118	883	730	636	605	600	609	630	591	531	566	678	701	590	497	468	417										
	328	285	489	1960	4762	6931	8011	8461	8649	8744	8799	8809	8819	8821	8839	8859	8855	8871	31.4	17.3	6.6	48.7	66.5	32.9	48.7	66.7	31.8	73.9	25.4
531	1210	968	726	552	442	397	384	400	449	451	436	543	812	1031	1023	952	928	866										
	746	669	917	2489	5181	7156	8113	8505	8673	8758	8806	8814	8823	8825	8841	8859	8857	8874	33.4	20.8	4.9	52.8	56.5	47.1	52.8	56.7	45.9	80.2	38.9
558	1289	1045	785	590	469	419	400	417	479	496	491	646	1043	1445	1561	1527	1515	1450										
	1310	1212	1492	3079	5592	7360	8200	8543	8690	8769	8812	8818	8825	8823	8838	8857	8851	8873	36.4	25.3	5.5	57.4	46.5	52.5	57.4	46.7	51.2	66.1	47.6
r25j	1241	997	748	565	451	404	389	405	459	467	455	581	898	1184	1219	1160	1140	1076										
	946	860	1123	2711	5340	7236	8147	8519	8679	8762	8807	8815	8823	8823	8839	8857	8854	8873	34.5	22.5	5.1	54.5	52.6	49.2	54.5	52.9	47.9	71.4	42.2
585	1391	1137	859	642	501	436	416	438	517	551	565	776	1331	1975	2267	2300	2308	2250										
	2101	1991	2283	3814	6071	7596	8308	8595	8724	8791	8832	8836	8841	8838	8852	8870	8866	8879	40.2	31.4	6.2	62.8	35.4	59.0	62.8	35.8	57.6	50.6	58.1
612	1508	1245	944	701	538	468	441	466	563	615	646	923	1663	2594	3116	3242	3282	3238										
	3089	2975	3268	4687	6614	7849	8410	8640	8744	8802	8837	8838	8840	8839	8855	8872	8863	8882	44.8	38.7	7.0	68.6	24.6	65.6	68.6	25.0	64.1	35.4	68.6
r50j	1399	1144	864	646	503	438	417	439	520	555	570	786	1354	2017	2325	2364	2373	2316										
	2167	2056	2349	3874	6109	7614	8315	8598	8725	8791	8832	8836	8841	8838	8852	8870	8866	8879	40.5	31.9	6.2	63.2	34.6	59.5	63.2	35.0	58.0	67.8	58.9

JE890−7N: Measurement: %BEG 'KK0X'REM_OFFS04_080929_3.TXTOffset print, model separation cmyn6*

Fig. A.1: Two adjacent start and the interpolated reflectance factors of 3 samples *r00j=R, r25j, r50j,* and CIE data. 48 samples in *(a^*_a, b^*_a)*

16 Step Elementary Color Circle: *rgb**, CIELAB, Spectral Reflectance Factor $R(\lambda)$





48 step device hue circle and
16 step elementary hue circle
with equal CIELAB hue steps

no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a	no.	$h_{ab,a}$	L^*	a^*_a	b^*_a
648	31.3	48.4	66.2	40.3	720	96.2	90.2	−9.6	88.3	72	152.5	55.8	−65.2	33.9	80	233.9	63.0	−30.5	−41.9	8	298.7	27.5	26.0	−47.3	656	353.0	49.5	73.5	−8.9
657	38.9	52.8	56.7	45.9	639	99.9	86.4	−14.5	83.3	73	159.4	56.7	−62.6	23.5	71	239.6	59.1	−24.9	−42.6	89	308.4	29.6	34.0	−42.7	655	357.1	49.4	72.3	−3.6
666	47.6	57.4	46.7	51.2	558	103.4	82.7	−18.9	79.6	74	167.8	57.5	−59.1	12.7	62	245.5	55.3	−19.6	−43.1	170	317.1	31.3	40.8	−37.8	654	0.8	49.2	71.2	1.1
675	58.1	62.8	35.8	57.6	477	110.2	77.5	−25.5	69.0	75	179.0	58.5	−54.5	0.8	53	253.6	50.4	−12.9	−43.9	251	322.4	35.4	44.8	−34.5	653	5.8	49.3	69.7	7.0
684	68.6	68.6	25.0	64.1	396	116.8	73.3	−31.7	62.8	76	190.1	59.3	−50.3	−8.9	44	262.6	45.7	−5.7	−44.6	332	331.5	38.3	52.7	−28.5	652	10.6	48.9	69.3	13.0
693	78.2	74.5	14.6	70.8	315	124.3	68.7	−38.7	56.8	77	201.4	60.1	−45.8	−18.0	35	272.8	40.7	2.2	−45.0	413	339.4	40.9	59.1	−22.2	651	15.7	48.9	68.2	19.2
702	85.6	80.0	5.8	76.6	234	137.9	62.4	−48.6	43.9	78	213.2	61.0	−40.8	−26.7	26	281.3	36.6	9.2	−45.9	494	343.4	44.9	63.2	−18.7	650	22.0	48.8	67.1	27.1
711	91.4	85.1	−2.0	82.0	153	145.4	59.3	−56.5	38.9	79	223.3	61.9	−36.1	−34.0	17	289.8	32.4	16.8	−46.6	575	348.3	47.4	68.2	−14.0	649	26.9	48.6	66.5	33.8

RJGB*$_{ton}$**, 25.4 , 92.3 , 162.2 , 271.7 ***RJGB*$_{all}$:** 25.4 42.1 58.8 75.6 92.3 109.7 127.2 144.7 162.2 189.6 216.9 244.3 271.7 300.1 328.6 357.0 ***LAB*Nio: 22.2 , 0.2 , 0.6 ***LAB*Wio:*** 96.3 , −0.8 , 2.0

																			X	Y	Z	L^*	a^*	b^*	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	$h_{ab,a}$
r00j=R	1335	1118	883	730	636	605	600	609	630	591	531	566	678	701	590	497	468	417											
	328	285	489	1960	4762	6931	8011	8461	8649	8744	8799	8809	8819	8821	8839	8859	8855	8871	31.4	17.3	6.6	48.7	66.5	32.9	48.7	66.7	31.8	73.9	**25.4**
r25j	1241	997	748	565	451	404	389	405	459	467	455	581	898	1184	1219	1160	1140	1076											
	946	860	1123	2711	5340	7236	8147	8519	8679	8762	8807	8815	8823	8823	8839	8857	8854	8873	34.5	22.5	5.1	54.5	52.6	49.2	54.5	52.9	47.9	71.4	**42.2**
r50j	1399	1144	864	646	503	438	417	439	520	555	570	786	1354	2017	2325	2364	2373	2316											
	2167	2056	2349	3874	6109	7614	8315	8598	8725	8791	8832	8836	8841	8838	8852	8870	8866	8879	40.5	31.9	6.2	63.2	34.6	59.5	63.2	35.0	58.0	67.8	**58.9**
r75j	1583	1325	1010	743	568	490	459	488	596	663	706	1033	1913	3079	3802	4013	4086	4061											
	3925	3820	4095	5365	7005	8027	8486	8673	8762	8815	8848	8844	8845	8845	8857	8875	8867	8884	48.6	44.8	7.6	72.7	17.1	70.4	72.7	17.6	68.8	71.1	**75.5**
j00g=J	1933	1642	1262	928	702	598	550	589	746	862	953	1460	2847	4868	6383	6984	7209	7298											
	7283	7277	7410	7891	8370	8632	8759	8819	8863	8897	8920	8914	8913	8910	8921	8937	8928	8943	63.1	68.2	10.2	86.1	−4.0	85.1	86.1	−3.3	83.2	83.3	**92.3**
j25g	1430	1343	1125	864	658	562	527	571	735	859	962	1498	2960	5049	6458	6750	6560	6189											
	5730	5364	5122	5003	4898	4827	4825	4843	4880	4975	5103	5166	5138	5064	4951	4859	4902	5126	41.3	53.0	10.1	77.8	−25.6	71.3	77.8	−25.0	69.6	74.0	**109.8**
j50g	979	1028	952	764	590	512	487	535	689	809	904	1409	2792	4683	5749	5683	5161	4471											
	3730	3164	2823	2650	2517	2427	2413	2430	2470	2581	2741	2832	2801	2711	2564	2449	2512	2793	24.2	36.8	9.3	67.1	−41.3	55.2	67.1	−40.9	53.7	67.6	**127.3**
j75g	740	919	927	788	629	556	540	594	759	882	978	1488	2831	4539	5310	4989	4269	3411											
	2543	1907	1548	1372	1243	1158	1147	1164	1200	1307	1466	1561	1531	1447	1307	1201	1267	1547	14.9	27.7	9.8	59.6	−56.0	40.7	59.6	−55.6	39.3	68.2	**144.7**
g00b=G	760	1072	1250	1214	1089	1049	1070	1161	1353	1487	1582	2076	3314	4758	5248	4762	3938	3000											
	2073	1406	1038	862	738	657	648	667	703	808	967	1065	1038	956	820	719	785	1066	12.2	24.9	15.6	56.9	−61.7	20.9	56.9	−61.5	19.6	64.5	**162.2**
g25b	1061	1702	2237	2523	2535	2646	2848	3069	3313	3457	3526	3905	4752	5541	5551	4890	4008	3037											
	2088	1407	1033	854	729	649	642	664	701	807	966	1064	1036	953	817	719	790	1072	15.6	27.3	35.0	59.3	−50.8	−7.1	59.3	−50.5	−8.5	51.2	**189.5**
g50b	1374	2257	3200	3874	4120	4462	4950	5363	5612	5726	5740	5865	6129	6198	5780	4976	4044	3049											
	2082	1389	1011	833	709	632	627	648	688	795	951	1048	1020	939	803	707	780	1061	19.3	29.6	57.3	61.3	−39.4	−28.0	61.3	−39.1	−29.4	49.0	**216.9**
g75b	1370	2308	3342	4166	4552	5041	5674	6129	6216	6146	5981	5745	5428	4984	4395	3711	3016	2263											
	1520	1004	771	722	678	624	624	645	683	787	940	1034	1007	928	795	700	774	1049	18.4	23.9	62.3	56.0	−20.9	−41.7	56.0	−20.6	−43.0	47.7	**244.3**
b00r=B	998	1643	2320	2834	3087	3423	3843	4071	3978	3736	3438	3132	2808	2431	2013	1643	1327	975											
	626	417	383	493	575	567	572	592	624	717	858	945	920	847	724	634	701	951	11.6	12.0	39.6	41.2	1.3	−44.0	41.2	1.3	−45.0	45.0	**271.7**
b25r	757	1189	1584	1888	2053	2283	2557	2650	2462	2141	1800	1489	1200	909	642	475	381	272											
	173	151	200	370	540	573	586	604	634	720	855	939	916	846	728	643	700	941	7.5	5.3	24.3	27.5	27.4	−46.1	27.5	27.2	−46.9	54.2	**300.1**
b50r	1651	1834	1994	2146	2261	2436	2638	2661	2445	2101	1748	1435	1151	870	621	478	417	333											
	236	207	329	1018	2095	2728	3002	3121	3201	3325	3486	3575	3551	3471	3336	3227	3285	3555	16.8	9.8	24.6	37.4	50.1	−29.6	37.4	50.1	−30.6	58.7	**328.5**
b75r	2481	2281	2106	2058	2071	2152	2246	2216	2027	1731	1430	1192	990	774	571	466	440	389											
	307	281	497	1945	4721	6890	7983	8444	8642	8741	8797	8809	8821	8825	8843	8865	8865	8883	33.8	17.9	20.9	49.4	72.2	−2.5	49.4	72.4	−3.7	72.5	**357.0**

JE900−7N: Measurement: %BEG 'KK0X'REM_OFFS04_080929_3.TXTOffset print, model separation cmyn6*

Fig. A. 2: Interpolated reflectance factor of the 16 samples of the 16 step elementary colour circle and CIE data. 16 samples in *(a^*_a, b^*_a)*