

Analog and digital ISO/IEC-test charts according to ISO/IEC 15775

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Abstract

The committees ISO/IEC JTC1/SC28 and DIN-NI-28, „Information technology, Office equipment“ have worked together to develop the International Standard ISO/IEC 15775 [2]. The new national standards DIN 33866-1 to 5 [1] (in print, drafts May to Nov. 1999) and the International Standard ISO/IEC 15775 are based on equivalent colour series. Both use the same colour series both in **digital** and **analog** test charts and approximately the same layout.

New colorimetric technologies of Germany and Japan have been used to produce the four DIN- and ISO/IEC-test charts in offset printing (3600 dpi) which are in application for colour devices now.

The different productions will be shown, e. g. in halftone and continuous tone and in reflectance and transmittance mode. Some problems of measurement (e. g. fluorescent photographic material) and the accuracy of production is important for applications.

A flat area lamp which is shown at the conference has the chromaticity of D65. With transparent ISO/IEC-test chart material on top this equipment defines a reference monitor for comparison with display output. For additional information see the URL: www.ps.bam.de

Introduction

The International Standard ISO/IEC 15775 „Information technology – Office machines – Machines for colour image reproduction - *Method of specifying image reproduction of colour copying machines by analog test charts – Realisation and application*“ was prepared by DIN (as DIN 33866-2). DIN 33866-2 was published in 1998 and ISO/IEC 15775 in 1999 [2].

Remark: The standards ISO/IEC 15775 and DIN 33866-X define requirements for the quality of the image reproduction and the standards of the series IEC 61966 define measurable transfer properties of homogeneous colour areas.

This paper describes the creation, production, application and accuracy of digital and analog test charts. The application of analog and digital test charts for automatic colour management is described in a separate paper [7] of this conference.

1. Digital and analog test charts

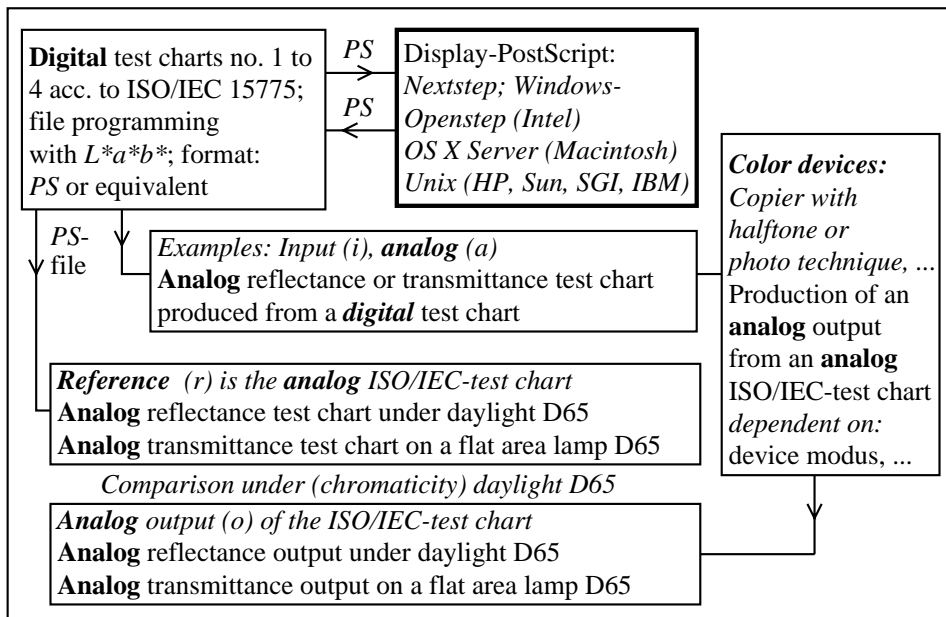
1.1 General

The **digital** and **analog** test charts for the assessment of copier outputs are defined in ISO/IEC 15775. The **digital** test charts are designed by display *PostScript* systems. The original digital file format *PostScript* (PS) is transformed to different equivalent formats, e. g. *Portable Document Format* (PDF).

According to ISO/IEC 15775 the **digital** ISO/IEC-test charts (digital files) are on the web server with the URL: <http://o2.ps.bam.de>, www.ps.bam.de and others. The **analog** ISO/IEC-test charts according to ISO/IEC 15775 will be produced in reflectance and transmittance mode for D65 illumination.

Fig. 1 shows both the creation and production (output) of an analog ISO/IEC-test chart from the digital ISO/IEC-test chart (*left side*) and the copy of an analog ISO/IEC-test chart (*right side*). It is necessary to compare the analog copier output with the corresponding analog ISO/IEC-test chart. There are definitions for analog test charts in reflectance and transmittance mode within the standard.

An analog transmittance output is in general viewed on top of a flat area lamp with the chromaticity of daylight D65. Flat area lamps have a luminance of up to 10 000 cd/square meter. The lamps can be dimmed by the user in a wide range. The lamps have been produced in the different sizes used for computer displays and they are mainly used for backlighting of LCD computer displays. The analog test charts in transmittance mode on top of a flat area lamp serve as a reference monitor for display output (compare DIN 33866-5).



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Figure 1: Creation and colour output techniques for the analog test charts on colour copiers

2. Content of test charts

2.1 Content of achromatic ISO/IEC-test chart no. 3

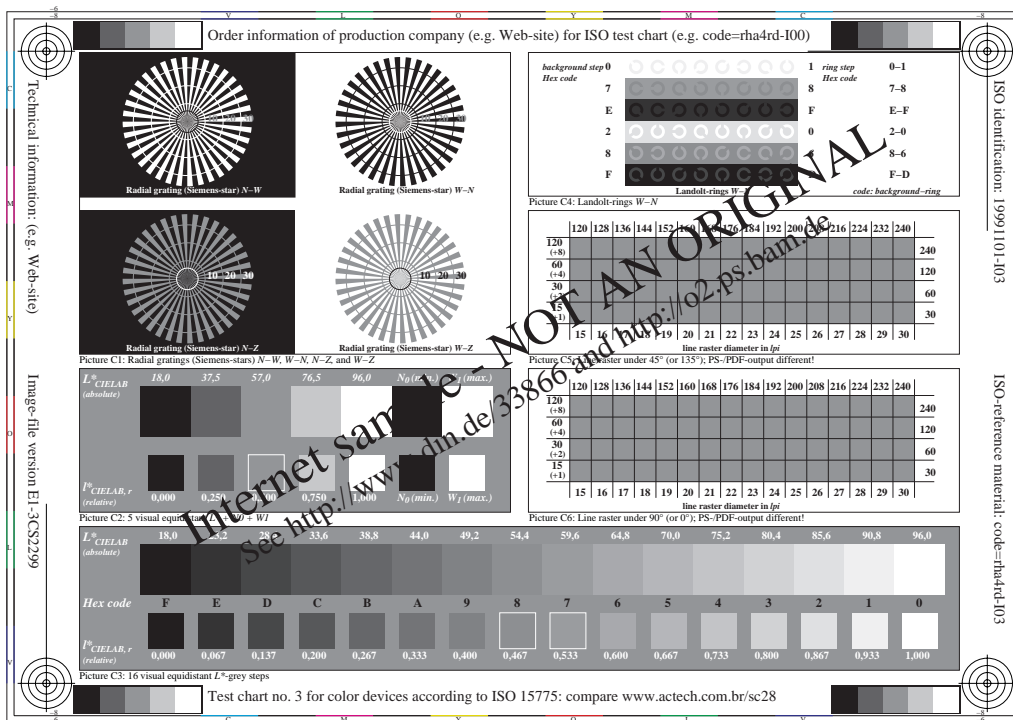


Figure 2: Frame and picture area of ISO/IEC-test chart no. 3 according to ISO/IEC 15775

2.2 Content of chromatic ISO/IEC-test chart no. 4 with OLV-colours



Figure 3: Frame and picture area of ISO/IEC-test chart no. 4 according to ISO/IEC 15775
 The test charts include a frame and picture area with different test elements like Siemens-stars, Landolt-rings, line screens, characters in different sizes and colours. All colours in the standard are defined by CIELAB parameters based on the CIELAB coordinates of offset printing for D65 [3].

2.3 Colours CMYOLVNW in test charts

Basic test colour name	Intended CIELAB CMYN (ISO 2846-1) Reference (r)			Produced CIELAB Pictures B2 and C2 Output (o)			CIELAB differences of test colours Difference (o-r)			CIELAB-test colour difference ΔE^*_{ab}
	L^*_r	a^*_r	b^*_r	L^*_o	a^*_o	b^*_o	ΔL^*_{o-r}	Δa^*_{o-r}	Δb^*_{o-r}	
C	58.62	-30.62	-42.74	59.96	-27.8	-43.15	1.34	2.82	-0.4	3.15
M	48.13	75.2	-6.79	49.19	74.03	-7.4	1.06	-1.16	-0.6	1.69
Y	90.37	-11.15	96.17	87.12	-5.58	105.61	-3.24	5.57	9.44	11.43
O	47.94	65.31	52.07	47.94	65.31	52.07	0.0	0.0	0.0	0.01
L	50.9	-62.96	36.71	50.9	-62.96	36.71	0.0	0.0	0.0	0.01
V	25.72	31.45	-44.35	25.72	31.45	-44.35	0.0	0.0	0.0	0.01
N	18.01	0.5	-0.46	17.16	-0.06	-2.71	-0.84	-0.56	-2.24	2.47
W	95.41	-0.98	4.76	94.98	-0.58	3.28	-0.42	0.4	-1.47	1.59
Average CIELAB colour difference:									$\Delta E^*_{ab,m} = 2.5$	

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Table 1: Intended printing colours CMYOLVNW and comparison with produced colours
 Table 1 shows intended colours CMYOLVNW compared to produced colours of DIN 33866. The

intended colours are additionally compared with television colours acc. to ITU-R BT709.2 in Table 2.

ISO-2846-1: 1997 defines in Annex D in Table D.3 the intended colours of offset printing. Five colours $CMYNW_{PR}$ (PR = Print) are given for CIE-standard illuminant D65, the 2°-standard observer and the 45°/0°-standard geometry. Additionally a nonfluorescent reference paper is described. The chromatic colours OLV_{PR} are not given.

The DIN 33866 test charts 2 to 4 are produced on this ISO-reference paper W and with chromatic inks $CMYN_{PR}$ acc. to ISO 2846.

The colorimetric data $L^*a^*b^*$ of reference (r = ISO 2846-1:1997, Table D.3) and the average colorimetric data of production (o = output) are given in Table 2. The differences between reference and production (output) are small for the colours $CMYNW_{PR}$. The largest difference is $\Delta E^*_{ab} = 11,43$ for yellow Y and the average difference is $\Delta E^*_{ab,m} = 2,5$. One must have in mind that less than three units between pictorial images cannot be detected by human viewers. Therefore we can add the colours OLV of production to get the colorimetric $L^*a^*b^*$ -data for the full intended colour set $CMYOLVNW_{PR}$.

Basic test colour name	Intended CIELAB data CMYN (ISO 2846-1) Reference (r)			Intended CIELAB data RGB (ITU-R BT.709-2) Output (o)			CIELAB differences of test colours Difference (o-r)			CIELAB-test colour difference ΔE^*_{ab}
	L^*_r	a^*_r	b^*_r	L^*_o	a^*_o	b^*_o	ΔL^*_{o-r}	Δa^*_{o-r}	Δb^*_{o-r}	
C	58.62	-30.62	-42.74	86.88	-46.17	-13.56	28.26	-15.54	29.18	43.5
M	48.13	75.2	-6.79	57.3	94.35	-20.7	9.17	19.15	-13.9	25.38
Y	90.37	-11.15	96.17	92.66	-20.7	90.75	2.29	-9.54	-5.41	11.22
O	47.94	65.31	52.07	50.5	76.92	64.55	2.56	11.61	12.48	17.24
L	50.9	-62.96	36.71	83.63	-82.76	79.9	32.73	-19.79	43.19	57.69
V	25.72	31.45	-44.35	30.39	76.06	-103.59	4.67	44.61	-59.23	74.31
N	18.01	0.5	-0.46	1.57	0.0	0.0	-16.43	-0.49	0.47	16.45
W	95.41	-0.98	4.76	95.41	0.01	0.01	0.0	1.0	-4.74	4.85
Average CIELAB colour difference:									$\Delta E^*_{ab,m} = 31.3$	

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Table 2: Intended printing and television colours and comparison

Table 2 shows the printing colours compared to the television colours defined in ITU-R BT709.2 for CIE-standard illuminant D65 and the 2°-standard observer. The normalization to $L^* = 95,41$ for white D65 as defined in ISO-2846 for white is used (see tables in DIN 33866-1). This part shows the differences between the colours $CMYOLVNW_{PR}$ and $CMYOLVNW_{TV}$. There are differences up to $\Delta E^*_{ab} = 74$ for the colour violet blue V (called blue B in television) and the average difference is $\Delta E^*_{ab,m} = 31,5$.

In ISO/IEC 15775 the short terms OLV are used for the colours OLV_{PR} . These short terms help to keep in mind that there are very large differences compared to the colours OLV_{TV} which are in standards usually called RGB . The short terms RGB used for colours on monitors conflict with the short terms R , G , and B for elementary colours (see Annex K of ISO/IEC 15775 [2]).

3. Production of test charts

3.1 Accuracy of achromatic test chart no. 3

Two spectrophotometers (one high precision and one low cost) and one colorimeter (low cost) have been used to measure the production of the **achromatic** test chart 3 in offset printing on nonfluorescent ISO reference paper of offset printing.

i	LAB*ref			LAB*out			LAB*ouc			ΔE*	
1	18.01	0.5	-0.46	17.6	-0.18	-2.48				2.17	Specification according to ISO/IEC 15775 Annex G
2	23.17	0.4	-0.11	24.42	-0.28	-2.85				3.09	
3	28.33	0.3	0.23	32.26	-0.29	-2.54				4.85	
4	33.49	0.2	0.58	39.75	-0.6	-2.43				7.0	
5	38.65	0.1	0.92	43.92	-0.55	-2.31				6.22	
6	43.81	0.0	1.27	48.7	-0.84	-1.64				5.76	Regularity
7	48.97	-0.09	1.62	53.42	-0.89	-1.38				5.43	$g^* = 63.7$
8	54.13	-0.19	1.97	56.77	-0.88	-1.11				4.12	
9	59.29	-0.28	2.32	61.21	-0.99	-0.94				3.86	Lightness gamut
10	64.45	-0.38	2.67	66.66	-0.82	-0.68				4.04	$f^* = 92.1$
11	69.61	-0.48	3.02	70.51	-0.87	-0.21				3.38	
12	74.77	-0.58	3.37	75.46	-0.76	0.49				2.96	
13	79.93	-0.68	3.71	79.81	-0.72	1.05				2.67	
14	85.09	-0.78	4.06	87.32	-0.78	1.98				3.05	
15	90.25	-0.88	4.41	91.66	-0.6	2.61				2.3	Mean colour difference (16 samples)
16	95.41	-0.98	4.76	95.0	-0.59	3.3				1.57	$\Delta E^*_{CIELAB} = 3.9$
17	18.01	0.5	-0.46	17.6	-0.18	-2.48	18.01	-0.18	-2.48	2.13	
18	37.36	0.13	0.84	42.88	-0.56	-2.34	43.29	-0.56	-2.34	6.77	
19	56.71	-0.24	2.15	58.99	-0.94	-1.03	59.4	-0.94	-1.03	4.22	
20	76.06	-0.61	3.45	76.55	-0.75	0.63	76.96	-0.75	0.63	2.97	Mean colour difference (5 samples)
21	95.41	-0.98	4.76	95.0	-0.59	3.3	95.41	-0.59	3.3	1.51	$\Delta L^*_{CIELAB} = 3.5$
Mean colour reproduction index:										$R^*_{ab,m} = 82$	

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Table 3: Colorimetric data of the series W-N in DIN 33866 test chart no. 3, picture A3

Table 3 shows the colorimetric data of the series W-N measured by a high precision spectrophotometer (high precision Zeiß DMC 25).

i	LAB*ref			LAB*out			LAB*ouc			ΔE*	
1	18.01	0.5	-0.46	16.14	1.76	-6.05				6.03	Specification according to ISO/IEC 15775 Annex G
2	23.17	0.4	-0.11	23.44	1.22	-4.52				4.49	
3	28.33	0.3	0.23	31.5	0.54	-3.24				4.71	
4	33.49	0.2	0.58	38.5	0.31	-2.63				5.95	
5	38.65	0.1	0.92	43.25	-0.05	-2.2				5.57	
6	43.81	0.0	1.27	47.64	0.19	-1.85				4.95	Regularity
7	48.97	-0.09	1.62	53.31	0.22	-1.25				5.22	$g^* = 65.8$
8	54.13	-0.19	1.97	56.73	-0.22	-0.88				3.87	
9	59.29	-0.28	2.32	61.53	-0.1	-0.3				3.46	Lightness gamut
10	64.45	-0.38	2.67	66.41	-0.19	0.32				3.06	$f^* = 93.7$
11	69.61	-0.48	3.02	70.54	-0.21	0.93				2.3	
12	74.77	-0.58	3.37	75.26	-0.2	1.53				1.94	
13	79.93	-0.68	3.71	79.96	-0.21	2.48				1.32	
14	85.09	-0.78	4.06	87.55	-0.01	3.63				2.61	
15	90.25	-0.88	4.41	91.64	0.04	4.44				1.67	Mean colour difference (16 samples)
16	95.41	-0.98	4.76	94.88	0.09	5.07				1.24	$\Delta E^*_{CIELAB} = 3.7$
17	18.01	0.5	-0.46	16.14	1.76	-6.05	17.34	1.76	-6.05	5.77	
18	37.36	0.13	0.84	42.06	0.03	-2.31	43.26	0.03	-2.31	6.69	
19	56.71	-0.24	2.15	59.13	-0.16	-0.59	60.33	-0.16	-0.59	4.54	
20	76.06	-0.61	3.45	76.44	-0.2	1.77	77.64	-0.2	1.77	2.34	Mean colour difference (5 samples)
21	95.41	-0.98	4.76	94.88	0.09	5.07	96.08	0.09	5.07	1.31	$\Delta L^*_{CIELAB} = 4.1$
Mean colour reproduction index:										$R^*_{ab,m} = 83$	

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Table 4: Colorimetric data of the series W-N in DIN 33866 test chart no. 3, picture A3

Table 4 shows the colorimetric data of the series W-N measured by a spectrophotometer (low cost from Colour Savvy, Colour Mouse CM3S). The mean differences between intended and produced colours are for the 16 grey steps near 4 CIELAB units.

3.2 Accuracy of chromatic test chart no. 4

Three colorimeters have been used to measure the production of the achromatic test chart no. 4 in offset printing on nonfluorescent ISO reference paper.

i	LAB*ref	LAB*out	LAB*ouc	ΔE^*	
1	90.37 -11.15 96.17	87.03 -5.95 106.41		11.96	Specification according to ISO/IEC 15775 Annex G
2	90.71 -10.47 90.08	87.66 -6.89 100.86		11.76	
3	91.04 -9.79 83.98	88.26 -7.86 92.89		9.53	
4	91.38 -9.12 77.89	88.8 -8.26 86.78		9.3	
5	91.71 -8.44 71.79	89.53 -8.18 74.26		3.3	
6	92.05 -7.76 65.7	90.33 -7.67 65.45		1.74	Regularity
7	92.39 -7.08 59.61	90.64 -6.22 56.35		3.79	$g^* = 53.6$
8	92.72 -6.4 53.51	90.6 -7.4 53.99		2.39	
9	93.06 -5.73 47.42	91.33 -7.13 47.88		2.27	Lightness gamut
10	93.39 -5.05 41.32	91.77 -6.62 41.32		2.26	$f^* = 11.1$
11	93.73 -4.37 35.23	92.56 -5.84 33.91		2.3	
12	94.07 -3.69 29.14	93.22 -5.25 28.23		1.99	
13	94.4 -3.01 23.04	93.84 -4.3 21.31		2.23	
14	94.74 -2.34 16.95	95.09 -2.8 13.03		3.96	
15	95.07 -1.66 10.85	95.29 -2.11 9.52		1.42	Mean colour difference (16 samples)
16	95.41 -0.98 4.76	96.39 -0.54 3.41		1.73	$\Delta E^*_{CIELAB} = 4.5$
17	90.37 -11.15 96.17	87.03 -5.95 106.41	88.21 -5.95 106.41	11.69	
18	91.63 -8.61 73.32	89.35 -8.2 77.39	90.53 -8.2 77.39	4.24	
19	92.89 -6.07 50.47	90.97 -7.26 50.94	92.15 -7.26 50.94	1.49	
20	94.15 -3.52 27.61	93.38 -5.01 26.5	94.56 -5.01 26.5	1.9	Mean colour difference (5 samples)
21	95.41 -0.98 4.76	96.39 -0.54 3.41	97.57 -0.54 3.41	2.58	$\Delta L^*_{CIELAB} = 4.4$
Mean colour reproduction index:					$R^*_{ab,m} = 79$

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Table 5: Colorimetric data of the series W-Y in DIN 33866 test chart no. 2, picture B2

Table 5 shows the colorimetric data of the series W-Y measured by a spectrophotometer (high precision and cost, Zeiß DMC 25).

i	LAB*ref	LAB*out	LAB*ouc	ΔE^*	
1	90.37 -11.15 96.17	86.87 -4.68 108.16		14.07	Specification according to ISO/IEC 15775 Annex G
2	90.71 -10.47 90.08	87.48 -6.18 103.17		14.15	
3	91.04 -9.79 83.98	88.05 -6.89 95.43		12.18	
4	91.38 -9.12 77.89	88.62 -7.16 85.41		8.25	
5	91.71 -8.44 71.79	89.17 -7.13 75.57		4.74	
6	92.05 -7.76 65.7	89.53 -6.92 69.04		4.27	Regularity
7	92.39 -7.08 59.61	90.06 -6.64 60.84		2.67	$g^* = 80.9$
8	92.72 -6.4 53.51	90.58 -6.41 54.1		2.22	
9	93.06 -5.73 47.42	91.14 -6.17 47.39		1.97	Lightness gamut
10	93.39 -5.05 41.32	91.67 -5.79 41.29		1.88	$f^* = 9.9$
11	93.73 -4.37 35.23	92.31 -5.12 34.08		1.98	
12	94.07 -3.69 29.14	92.94 -4.37 27.33		2.23	
13	94.4 -3.01 23.04	93.66 -3.47 20.08		3.09	
14	94.74 -2.34 16.95	94.4 -1.95 12.24		4.74	
15	95.07 -1.66 10.85	94.72 -1.17 8.34		2.59	Mean colour difference (16 samples)
16	95.41 -0.98 4.76	95.21 0.34 2.3		2.8	$\Delta E^*_{CIELAB} = 5.2$
17	90.37 -11.15 96.17	86.87 -4.68 108.16	88.72 -4.68 108.16	13.72	
18	91.63 -8.61 73.32	89.03 -7.14 78.03	90.88 -7.14 78.03	4.99	
19	92.89 -6.07 50.47	90.86 -6.29 50.75	92.71 -6.29 50.75	0.4	
20	94.15 -3.52 27.61	93.12 -4.15 25.52	94.97 -4.15 25.52	2.33	Mean colour difference (5 samples)
21	95.41 -0.98 4.76	95.21 0.34 2.3	97.06 0.34 2.3	3.25	$\Delta L^*_{CIELAB} = 4.9$
Mean colour reproduction index:					$R^*_{ab,m} = 76$

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Table 6: Colorimetric data of the series W-Y in DIN 33866 test chart no. 2, picture B2

Table 6 shows the colorimetric data of the series W-Y measured by a spectrophotometer (low cost from Colour Savvy, Colour Mouse CM3S).

i	LAB*ref	LAB*out	LAB*ouc	ΔE*
1	90.37 -11.15 96.17	87.01 -4.74 112.32		17.7
2	90.71 -10.47 90.08	87.85 -4.95 94.16		7.44
3	91.04 -9.79 83.98	87.35 -2.42 85.54		8.39
4	91.38 -9.12 77.89	88.83 -5.19 80.13		5.19
5	91.71 -8.44 71.79	89.28 -5.11 73.38		4.42
6	92.05 -7.76 65.7	89.77 -5.2 66.85		3.62
7	92.39 -7.08 59.61	90.27 -5.47 60.51		2.81
8	92.72 -6.4 53.51	90.93 -5.03 52.31		2.56
9	93.06 -5.73 47.42	91.49 -5.51 47.53		1.59
10	93.39 -5.05 41.32	91.97 -5.6 42.74		2.08
11	93.73 -4.37 35.23	92.61 -6.39 38.42		3.94
12	94.07 -3.69 29.14	93.48 -5.5 30.03		2.1
13	94.4 -3.01 23.04	94.04 -4.57 23.24		1.61
14	94.74 -2.34 16.95	94.88 -3.54 15.69		1.75
15	95.07 -1.66 10.85	95.3 -2.58 11.03		0.97
16	95.41 -0.98 4.76	95.3 -2.49 3.85		1.77
17	90.37 -11.15 96.17	87.01 -4.74 112.32	88.75 -4.74 112.32	17.45
18	91.63 -8.61 73.32	89.17 -5.13 75.07	90.9 -5.13 75.07	3.96
19	92.89 -6.07 50.47	91.21 -5.27 49.92	92.95 -5.27 49.92	0.97
20	94.15 -3.52 27.61	93.62 -5.27 28.33	95.36 -5.27 28.33	2.24
21	95.41 -0.98 4.76	95.3 -2.49 3.85	97.04 -2.49 3.85	2.4

Specification according to ISO/IEC 15775 Annex G
Regularity
 $g^* = 69.7$
Lightness gamut
 $f^* = 9.9$
Mean colour difference (16 samples)
 $\Delta E^*_{CIELAB} = 4.2$
Mean colour difference (5 samples)
 $\Delta L^*_{CIELAB} = 5.4$
Mean colour reproduction index: $R^*_{ab,m} = 79$

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Table 7: Colorimetric data of the series W-Y in DIN 33866 test chart no. 2, picture B2

Table 7 shows the colorimetric data of the series W-Y measured by a colorimeter (low cost from *Colour Savvy*, *Colour Mouse CM3C*).

i	LAB*ref	LAB*out	LAB*ouc	ΔE*
1	90.37 -11.15 96.17	91.32 -15.43 109.05		13.61
2	90.71 -10.47 90.08	91.68 -14.88 95.79		7.28
3	91.04 -9.79 83.98	91.95 -14.16 83.4		4.5
4	91.38 -9.12 77.89	92.32 -13.67 75.59		5.19
5	91.71 -8.44 71.79	92.71 -12.93 67.03		6.62
6	92.05 -7.76 65.7	93.02 -12.23 59.71		7.54
7	92.39 -7.08 59.61	93.49 -11.28 51.1		9.55
8	92.72 -6.4 53.51	93.95 -10.68 45.87		8.84
9	93.06 -5.73 47.42	94.36 -9.52 38.99		9.33
10	93.39 -5.05 41.32	94.83 -8.5 32.73		9.37
11	93.73 -4.37 35.23	95.26 -7.29 26.6		9.24
12	94.07 -3.69 29.14	95.74 -6.14 21.46		8.23
13	94.4 -3.01 23.04	96.03 -4.64 16.08		7.33
14	94.74 -2.34 16.95	96.29 -3.51 11.78		5.52
15	95.07 -1.66 10.85	96.87 -1.96 6.0		5.18
16	95.41 -0.98 4.76	96.89 -0.21 1.87		3.34
17	90.37 -11.15 96.17	91.32 -15.43 109.05	90.11 -15.43 109.05	13.58
18	91.63 -8.61 73.32	92.61 -13.12 69.17	91.4 -13.12 69.17	6.13
19	92.89 -6.07 50.47	94.16 -10.1 42.43	92.94 -10.1 42.43	8.99
20	94.15 -3.52 27.61	95.81 -5.77 20.12	94.6 -5.77 20.12	7.84
21	95.41 -0.98 4.76	96.89 -0.21 1.87	95.68 -0.21 1.87	3.0

Specification according to ISO/IEC 15775 Annex G
Regularity
 $g^* = 65.0$
Lightness gamut
 $f^* = 6.6$
Mean colour difference (16 samples)
 $\Delta E^*_{CIELAB} = 7.5$
Mean colour difference (5 samples)
 $\Delta L^*_{CIELAB} = 7.9$
Mean colour reproduction index: $R^*_{ab,m} = 65$

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Table 8: Colorimetric data of the series W-Y in JBMA test chart no. 2, picture B2

Table 8 shows the colorimetric data of the series W-Y measured by a colorimeter (low cost from *Colour Savvy*, *Colour Mouse CM3C*). This series has been produced in test chart no. 2 of the Japan Business Machine Makers association (JBMA) in 1999. The JBMA-production consist of three test charts in offset printing and will be shown at the conference together with productions of DIN.

4. Future developments

The produced colours series of ISO/IEC-test charts are **linear** in CIELAB colour space, e. g. between White *W* and Cyanblue *C* for the 16 equally spaced steps both in L^* (lightness) and C^* (chroma).

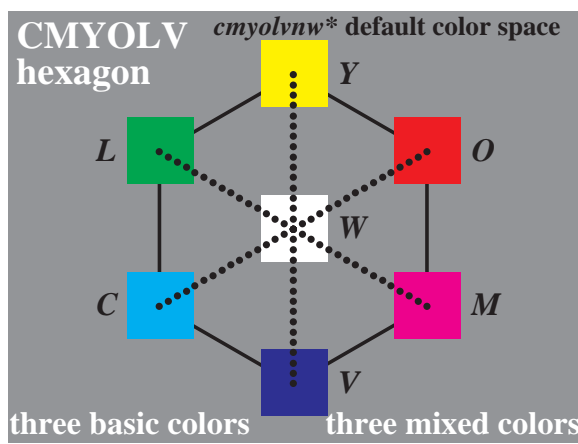


Figure 4: Hexagon of CMYOLV colours with 16 steps produced in ISO/IEC-test charts

Figure 4 shows the main six different colour series. Manufacturers of colour devices are changing the firmware (or software in the device) to reach a linear input-output relationship for printers, scanners and others by using the ISO/IEC test charts. Devices with approximately these properties will simplify colour management very much as shown by K. Richter [7] in another paper of this conference.

5. References

- [1] DIN 33866 „Information technology – Office machines – Machines for colour image reproduction“ : Part 1: *Method of specifying image reproduction by **digital** and **analog** DIN-test charts – Classification and principles, draft May 1999, standard DIN 33866-1 in print.*
Part 2: *Method of specifying image reproduction of colour copying machines by **analog** test charts – Realisation and application. (May 1998, revised standard DIN 33866-2 in print)*
Part 3: *Method of specifying image reproduction with **digital** input and **analog** output as **hardcopy** of colour image devices: “**digital – analog**” (printers) – Realisation and application, draft May 1999, standard DIN 33866-3 in print.*
Part 4: *Method of specifying image reproduction with **analog** input and **digital** output of colour image devices: “**analog – digital**” (scanners) – Realisation and application, draft Nov. 1999, standard DIN 33866-4 in print.*
Part 5: *Method of specifying image reproduction with **digital** input and **analog** output as **softcopy** of colour image devices: “**digital – analog**” (monitors) – Realisation and application, draft Nov. 1999, standard DIN 33866-5 in print.*
- [2] ISO/IEC 15775 „Information technology – Office machines – Machines for colour image reproduction - *Method of specifying image reproduction of colour copying machines by analog test charts – Realisation and application*“, 1999-12-01
- [3] ISO 2846–1:1997, *Graphic technology – Colour and transparency of ink sets for four-colour-printing – Part 1: Sheetfed and heat-set web offset lithographic printing.*
- [4] ITU-R BT.709–2:1995, *Parameter Values for the HDTV Standards for Production and International Programme Exchange.*
- [5] Klaus Richter, *Computergrafik und Farbmatrik*, VDE-Verlag GMBH, Berlin, 1996, including CD-ROM with 500 colour figures in PS- and PDF-format for educational purposes, ISBN 3–8007–1775–1, Colour figures also in different languages in Internet, see URL: www.ps.bam.de
- [6] Klaus Richter, *Automatic colour management for variable processes between original scene and reproduction using 16 colours of ISO/IEC 15775*, Colour Image Science Conference, Derby, 2000.