

Metamorfoze Preservation Imaging Guidelines

**Test Version 0.8
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Introduction

In this version of the *Metamorfoze Preservation Imaging Guidelines*, the technical criteria and tolerances for preservation imaging are specified. In the next months, the National Library of the Netherlands (Koninklijke Bibliotheek) will be employing the criteria and tolerances as a starting point for various tests and pilot projects with the Universal Test Target (UTT), the Scan Reference Chart (SRC) and the UTT software made by Image Engineering Dietmar Wueller.

This version 0.8 of the guidelines does not apply to current KB digitization projects. This version is a continuation of the Dutch draft version of the *Metamorfoze Preservation Imaging Guidelines* of September 2007 and the English version of June 2007.

This version 0.8 is concise. It includes all formulas used for preservation imaging within the Metamorfoze program, and contains no or hardly any technical clarifications. An extensive, final version is expected by the end of 2010.

The guidelines are input oriented and relate to the image quality of the first image only. All the desired output (derivatives), intended for print and/or the internet, can be made from this first image. The first image is referred to as: preservation master. The guidelines do not give information regarding metadata, file format or file name.

The guidelines are intended for the digitization of two dimensional materials such as manuscripts, archives, books, newspapers and periodicals. They may also be applied for the digitization of photographs, paintings and technical drawings.

Questions and comments

The Bureau Metamorfoze welcomes any comments and suggestions to the version 0.8 of the *Metamorfoze Preservation Imaging Guidelines*.

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New in Version 0.8

- In these guidelines the technical tolerances are given for sizes DIN A4 to DIN A0.
- In these guidelines the Metamorfoze exposure tolerances are indicated for the neutrals of the following test charts: Universal Test Target (UTT), the Scan Reference Chart (SRC), the Kodak Gray Scale, the ColorChecker SG, the Device-Level Target and the Object-Level Target. The tolerances are indicated in L^* values and 8 bit count values applying to eciRGBv2, gamma 2,2 color spaces like Adobe RGB (1998) and gamma 1,8 color spaces like ProPhoto RGB.
- The guidelines are divided in three categories: Metamorfoze, Metamorfoze Light and Metamorfoze Extra Light.
- Correct exposure tolerances are based on ΔL^* .
- The highlight gamma has been given a new name: Gain Modulation.
- Gain Modulation is calculated with ΔL^* according to the following formula: Sample ΔL^* / Reference ΔL^* .
- In the categories Metamorfoze and Metamorfoze Light the Gain Modulation is calculated for the entire gray scale.
- The tolerances for color cast are specified in ΔC^* and ΔE^* .
- The tolerances for uniform illumination are specified for all sizes from DIN A4 to DIN A0 and expressed in ΔL^* .
- The SNR is canceled (for the time being).

Three categories of guidelines

By dividing the guidelines into different categories, digitization according to the Metamorfoze Preservation Imaging Guidelines becomes more realistic. Thus, digitization according to the guidelines can be applied on a wider scale. All tolerances for technical criteria cited in the guidelines are listed for each category separately. The three categories are:

- 1. Metamorfoze**
- 2. Metamorfoze Light**
- 3. Metamorfoze Extra Light**

Metamorfoze

In this category, the color accuracy of the digital images plays an important role. For these images it is important that the tonal capture, including the Gain Modulation, up to $L^* 3$, is within the specifications. In this category guidelines are giving for digitizing works of art.

Metamorfoze Light

In this category the color accuracy of the digital images plays a less important role. The tonal capture, including the Gain Modulation, is analyzed up to $L^* 20$. In this category guidelines are giving for digitizing originals with a maximum optical density that does not exceed 1.52 (L^* value 20), like newspapers, books, periodicals and manuscripts.

Metamorfoze Extra Light

In this category, the color accuracy of the digital images plays a less important role. The tonal capture, excluding the Gain Modulation, is analyzed up to $L^* 20$. In this category guidelines are given for digitizing bitonal books only.

UTT procedure

UTT is a technical test target, designed by Hans van Dormolen on behalf of the National Library of the Netherlands, Dietmar Wueller on behalf of Image Engineering Dietmar Wueller and Volker Jansen on behalf of Fachverband für Multimediale Informationsverarbeitung e.V. (FMI). UTT is designed to gain an insight into the calibration of a camera or scanner, on a daily base before production is started. UTT gives an insight into the following aspects: Opto-Electronic Conversion Function (OECF), Modulation Transfer Function (MTF), uniform illumination (shading), geometric distortion, noise, color cast and color accuracy. The technical output of a camera or a scanner is assessed following the tolerances stated in these guidelines. The originals can only be digitized if the camera or scanner complies with all given criteria and corresponding tolerances. UTT is produced by Image Engineering Dietmar Wueller.

Digital ColorChecker SG procedure

This test target can be used to calibrate a camera or a scanner for the following aspects: white balance, tonal curve correction, color correction profile and measuring the color accuracy.

SRC procedure

The Scan Reference Chart is designed to be scanned together with the originals. This enables one to technically assess individual scans of originals, if necessary. The use of the SRC is obligatory for digitization according to the categories *Metamorfoze* and *Metamorfoze Light*. According to the category *Metamorfoze Extra Light* the use of SRC is optional. The German company Image Engineering Dietmar Wueller is developing software that can be used to analyze the SRC. The Scan Reference Chart is produced by Image Engineering Dietmar Wueller.

Kodak Gray Scale, QA-62, QA-2 procedure

The Kodak Gray Scale can be used to assess the OECF. Once UTT and SRC are applied full-scale, the Kodak Gray Scale will no longer be used. In the future, the QA-62 (MTF measurement) and the QA-2 (geometric distortion) will also no longer be applied as a standard in the *Metamorfoze* digitization work flow.

Metamorfoze Preservation Imaging Guidelines, version 0.8, July 2010

	Metamorfoze	Metamorfoze Light	Metamorfoze Extra light
Neutrals of the UTT are analyzed up to	L* 3	L* 20	L* 20
Color space	eciRGBv2	eciRGBv2	eciRGBv2 ¹
Bit depth	16/8 bit	8 bit	8 bit
Tonal Capture See next pages for general values Metamorfoze Exposure Tolerances	$\Delta L^* 2$ $\Delta E^* 2,83$	$\Delta L^* 2$ $\Delta E^* 2,83$	$\Delta L^* 2$ $\Delta E^* 2,83$
Gain Modulation, L* 95 – L* 90	0,8 – 1,08	0,8 – 1,08	0,8 – 1,08
Gain Modulation, Neutral L* 90 – L* 85	0,8 – 1,08	0,8 – 1,08	0,8 – 1,08
Gain Modulation, From L* 85 – L* 80 to L* 25 – L* 20	0,60 – 1,40	0,60 – 1,40	0,10 – 2,00
Gain Modulation, From L* 85 – L* 80 to L* 20 – L* 5	0,60 – 1,40	0,10 – 2,00	0,10 – 2,00
Noise, STD Luminance channel, 16 bit/8 bit	STD < 1024 STD < 4	STD < 4	STD < 4
Uniform illumination DIN A4 – DIN A3	$\Delta L^* 3$	$\Delta L^* 3$	$\Delta L^* 3$
Uniform illumination DIN A2	$\Delta L^* 4$	$\Delta L^* 4$	$\Delta L^* 4$
Uniform illumination DIN A1	$\Delta L^* 6$	$\Delta L^* 6$	$\Delta L^* 6$
Uniform illumination DIN A0	$\Delta L^* 7$	$\Delta L^* 7$	$\Delta L^* 7$
Color cast	$\Delta C^* 2$	$\Delta C^* 2$	$\Delta C^* 2$
Color accuracy, cie 1976, UTT	Mean $\Delta E < 5$ Max $\Delta E < 10$	Mean $\Delta E < 12$ Max $\Delta E < 25$	Mean $\Delta E < 12$ Max $\Delta E < 25$
Color accuracy, cie 1976, Colorchecker SG	Mean $\Delta E < 4$ Max $\Delta E < 10$	Mean $\Delta E < 12$ Max $\Delta E < 25$	Mean $\Delta E < 12$ Max $\Delta E < 25$
300 ppi, MTF10, originals DINA4 – DINA2	≥ 5 lp/mm	≥ 5 lp/mm	≥ 5 lp/mm
600 ppi, MTF10, Originals < DINA5²	≥ 10 lp/mm	≥ 10 lp/mm	≥ 10 lp/mm
150 ppi, MTF10, Originals > DINA2³	$\geq 2,5$ lp/mm	$\geq 2,5$ lp/mm	$\geq 2,5$ lp/mm
Sampling Efficiency, horizontal and vertical (Allways)	$\geq 85\%$	$\geq 85\%$	$\geq 85\%$
Tolerance aim ppi	$\leq +/- 2\%$	$\leq +/- 2\%$	$\leq +/- 2\%$
Sharpening, not allowed	Max Modulation $\leq 1,05$	Max Modulation $\leq 1,05$	Max Modulation $\leq 1,05$
Geometric distortion	Horizontal and vertical $\leq 2\%$	Horizontal and vertical $\leq 2\%$	Horizontal and vertical $\leq 2\%$
Color Misregistration	+/- 0,50	+/- 0,50	+/- 0,50
Artifacts	None	None	None

¹ Adobe RGB (1998) by permission only

² By permission only

³ By permission only, and only when the lower case letter 'e' in the originals is bigger than or as big as 2 mm.

Metamorfoze Exposure Tolerances ΔL^* 2 neutrals UTT en SRC

The values referred to below have been calculated starting from the general L^* values of the neutrals of UTT and SRC. The $L^*a^*b^*$ values of test targets may be mutually divergent. However, when applying UTT and SRC in a preservation imaging workflow, the true $L^*a^*b^*$ values must be specified. These true $L^*a^*b^*$ values must be used as reference values for the calculation of the ΔL^* , ΔC^* and ΔE^* .

Patch	L^*	8 bit count value eciRGBv2	8 bit count value Adobe RGB (1998)	Patch	L^*	8 bit count value eciRGBv2	8 bit count value Adobe RGB (1998)
1 (SRC)	97	247	246	11 (SRC)	47	120	111
	95	242	240		45	115	106
	93	237	234		43	110	101
2 (SRC)	92	235	231	12	42	107	99
	90	230	226		40	102	94
	88	224	220		38	97	90
3 (SRC)	87	222	217	13	37	94	88
	85	217	211		35	89	83
	83	212	205		33	84	79
4	82	209	203	14	32	82	77
	80	204	197		30	77	72
	78	199	191		28	71	68
5	77	196	189	15	27	69	66
	75	191	183		25	64	62
	73	186	178		23	59	58
6	72	184	175	16 (SRC)	22	56	56
	70	179	170		20	51	52
	68	173	164		18	46	48
7	67	171	162	17	17	43	46
	65	166	156		15	38	42
	63	161	151		13	33	39
8	62	158	148	18 (SRC)	12	31	37
	60	153	143		10	26	33
	58	148	138		8	20	30
9 (SRC)	57	145	136	19 (SRC)	7	18	28
	55	140	131		5	13	24
	53	135	126		3	8	19
10 (SRC)	52	133	123	20 (SRC)	5	13	24
	50	128	118		3	8	19
	48	122	113		1	3	12

Metamorfoze Exposure Tolerances ΔL^* 2 Kodak Gray Scale

The values referred to below have been calculated starting from the general L^* values of the gray scale patches of the Kodak Gray Scale. The $L^*a^*b^*$ values of test targets may be mutually divergent.

Patch	L^*	8 bit count value eciRGBv2	8 bit count value Adobe RGB (1998)	Patch	L^*	8 bit count value eciRGBv2	8 bit count value Adobe RGB (1998)
A	97,63	249	248	10	37,82	96	89
	95,63	244	242		35,82	91	85
	93,63	239	236		33,82	86	81
1	89,39	228	224	11	33,99	87	81
	87,39	223	218		31,99	82	77
	85,39	218	212		29,99	76	72
2	81,75	208	202	12	30,45	78	73
	79,75	203	196		28,45	73	69
	77,75	198	191		26,45	67	65
3	74,68	190	182	13	27,16	69	66
	72,68	185	177		25,16	64	62
	70,68	180	171		23,16	59	58
4	68,12	174	165	14	24,12	62	60
	66,12	169	159		22,12	56	56
	64,12	164	154		20,12	51	52
5	62,06	158	149	15	21,31	54	54
	60,06	153	143		19,31	49	50
	58,06	148	138		17,31	44	47
6	56,55	144	134	16	18,70	48	49
	54,55	139	129		16,70	43	45
	52,55	134	124		14,70	37	42
7	51,24	131	121	17	16,28	42	45
	49,24	126	116		14,28	36	41
	47,24	120	111		12,28	31	37
8	46,42	118	110	18	14,04	36	40
	44,42	113	105		12,04	31	37
	42,42	108	100		10,04	26	33
9	41,95	107	99	19	11,97	31	37
	39,95	102	94		9,97	25	33
	37,95	97	90		7,97	20	30

Metamorfoze Exposure Tolerances ΔL^* 2, neutrals ColorChecker SG

The values referred to below have been calculated starting from the general L^* values of the neutrals of the ColorChecker SG. The $L^*a^*b^*$ values of test targets may be mutually divergent.

Patch	L^*	8 bit count value eciRGBv2	8 bit count value Adobe RGB (1998)	Patch	L^*	8 bit count value eciRGBv2	8 bit count value Adobe RGB (1998)
E5	98,52	251	251	K7	47,60	121	112
	96,52	246	245		45,60	116	108
	94,52	241	239		43,60	111	103
J6	91,02	232	228	G6	42,15	107	99
	89,02	227	223		40,15	102	95
	87,02	222	217		38,15	97	90
F5	81,43	208	201	I5	37,27	95	88
	79,43	203	195		35,27	90	84
	77,43	197	190		33,27	85	79
I6	77,16	197	189	F6	32,68	83	78
	75,16	192	184		30,68	78	74
	73,16	187	178		28,68	73	69
K6	72,76	186	177	K8	22,31	57	56
	70,76	180	172		20,31	52	52
	68,76	175	166		18,31	47	48
G5	67,06	171	162	J5	17,95	46	48
	65,06	166	156		15,95	41	44
	63,06	161	151		13,95	36	40
H6	62,28	159	149	E6	8,75	22	31
	60,28	154	144		6,75	17	28
	58,28	149	139		4,75	12	23
H5	51,72	132	122				
	49,72	127	118				
	47,72	122	113				

Formulas & Paper sizes

Density = log O

O = Opacity

R = Reflection

Reflection = $10^{-\text{Density}}$

$L^* = 116 \sqrt[3]{R} - 16$

If $R \leq 0,008856$ then $L^* = 116 (7,787 \times R + 0,138) - 16$

Pixel value 8 bit eciRGBv2 = $2,55 \times L^*$

Pixel value 8 bit Adobe RGB (1998) = $255 (R^{1/\gamma})$, $\gamma = \text{gamma } 2,2$

Pixel value 8 bit ProPhoto RGB = $255 (R^{1/\gamma})$, $\gamma = \text{gamma } 1,8$

Cie 1976

$$\Delta E = \sqrt{(L1 - L2)^2 + (a1 - a2)^2 + (b1 - b2)^2}$$

1 is reference value and 2 is the sample value

Used white point is the embedded profile white.

In the conversion from RGB to $L^*a^*b^*$, the embedded profile is used.

Gain Modulation

Based on $\Delta L^* = \text{Sample } \Delta L^* / \text{Reference } \Delta L^*$

Based on $\Delta E^* = \text{Sample } \Delta E^* / \text{Reference } \Delta E^*$

DIN sizes

DIN	length x width in mm	length x width in inch
A0	1189 x 841	46.37 x 32.79
A1	841 x 594	32.79 x 23.16
A2	594 x 420	23.16 x 16.38
A3	420 x 297	16.38 x 11.58
A4	297 x 210	11.58 x 8.19
A5	210 x 148	8.19 x 5.77

Appendix 1

In this appendix, the Metamorfoze exposure tolerances for UTT, SRC and the Kodak Gray Scale for gamma 1,8 color spaces, like ProPhoto RGB, are indicated.

Metamorfoze Exposure Tolerances ΔL^* 2 neutrals UTT en SRC

The values referred to below have been calculated starting from the general L^* values of the neutrals of UTT and SRC. The $L^*a^*b^*$ values of test targets may be mutually divergent. However, when applying UTT and SRC in a preservation imaging workflow, the true $L^*a^*b^*$ values must be specified. These true $L^*a^*b^*$ values must be used as reference values for the calculation of the ΔL^* , ΔC^* and ΔE^* .

Patch	L^*	8 bit count value for gamma 1,8 color spaces	Patch	L^*	8 bit count value for gamma 1,8 color spaces
1 (SRC)	97	244	11 (SRC)	47	92
	95	237		45	87
	93	230		43	83
2 (SRC)	92	226	12	42	80
	90	219		40	76
	88	213		38	71
3 (SRC)	87	209	13	37	69
	85	202		35	65
	83	196		33	61
4	82	193	14	32	59
	80	186		30	55
	78	180		28	51
5	77	176	15	27	49
	75	170		25	45
	73	164		23	41
6	72	161	16 (SRC)	22	40
	70	155		20	36
	68	149		18	33
7	67	146	17	17	31
	65	140		15	28
	63	134		13	25
8	62	132	18 (SRC)	12	24
	60	126		10	21
	58	121		8	18
9 (SRC)	57	118	19 (SRC)	7	17
	55	113		5	14
	53	107		3	11
10 (SRC)	52	105	20 (SRC)	5	14
	50	100		3	11
	48	95		1	6

Appendix 1

Metamorfoze Exposure Tolerances ΔL^* 2 Kodak Gray Scale

The values referred to below have been calculated starting from the general L^* values of the gray scale patches of the Kodak Gray Scale. The $L^*a^*b^*$ values of test targets may be mutually divergent.

Patch	L^*	8 bit count value for gamma 1,8 color spaces	Patch	L^*	8 bit count value for gamma 1,8 color spaces
A	97,63	246	10	37,82	71
	95,63	239		35,82	67
	93,63	232		33,82	62
1	89,39	217	11	33,99	63
	87,39	210		31,99	59
	85,39	204		29,99	55
2	81,75	192	12	30,45	55
	79,75	185		28,45	52
	77,75	179		26,45	48
3	74,68	169	13	27,16	49
	72,68	163		25,16	45
	70,68	157		23,16	42
4	68,12	149	14	24,12	43
	66,12	143		22,12	40
	64,12	138		20,12	36
5	62,06	132	15	21,31	39
	60,06	126		19,31	35
	58,06	121		17,31	32
6	56,55	117	16	18,70	34
	54,55	111		16,70	31
	52,55	106		14,70	28
7	51,24	103	17	16,28	30
	49,24	98		14,28	27
	47,24	93		12,28	24
8	46,42	91	18	14,04	27
	44,42	86		12,04	24
	42,42	81		10,04	21
9	41,95	80	19	11,97	24
	39,95	76		9,97	21
	37,95	71		7,97	18

Appendix 1

Metamorfoze Exposure Tolerances ΔL^* 2, neutrals ColorChecker SG

The values referred to below have been calculated starting from the general L^* values of the neutrals of the ColorChecker SG. The $L^*a^*b^*$ values of test targets may be mutually divergent.

Patch	L^*	8 bit count value for gamma 1,8 color spaces	Patch	L^*	8 bit count value for gamma 1,8 color spaces
E5	98,52	250	K7	47,6	94
	96,52	242		45,6	89
	94,52	235		43,6	84
J6	91,02	223	G6	42,15	81
	89,02	216		40,15	76
	87,02	209		38,15	72
F5	81,43	191	I5	37,27	70
	79,43	184		35,27	65
	77,43	178		33,27	61
I6	77,16	177	F6	32,68	60
	75,16	171		30,68	56
	73,16	164		28,68	52
K6	72,76	163	K8	22,31	40
	70,76	157		20,31	37
	68,76	151		18,31	33
G5	67,06	146	J5	17,95	33
	65,06	140		15,95	30
	63,06	135		13,95	27
H6	62,28	132	E6	8,75	19
	60,28	127		6,75	17
	58,28	121		4,75	14
H5	51,72	104			
	49,72	99			
	47,72	94			

Appendix 2

In this appendix, the Metamorfoze exposure tolerances are indicated for two test targets by Image Science Associates: the Device-Level Target and the Object-Level Target.

Metamorfoze Exposure Tolerances ΔL^* 2, neutrals Device-Level Target

The values referred to below have been calculated starting from the general L^* values of the neutrals of the Device-Level Target. The $L^*a^*b^*$ values of test targets may be mutually divergent.

Patch	L^*	8 bit count values eciRGBv2	8 bit count values Adobe RGB (1998)	8 bit count values for gamma 1,8 color spaces
1	98,00	250	249	248
	96,00	245	243	241
	94,00	240	237	233
2	95,53	244	242	239
	93,53	239	236	232
	91,53	233	230	225
3	85,77	219	213	205
	83,77	214	208	198
	81,77	209	202	192
4	73,06	186	178	164
	71,06	181	172	158
	69,06	176	167	152
5	63,70	162	153	136
	61,70	157	148	131
	59,70	152	142	125
6	51,00	130	121	102
	49,00	125	116	97
	47,00	120	111	92
7	32,77	84	78	60
	30,77	78	74	56
	28,77	73	70	52
8	20,06	51	52	36
	18,06	46	48	33
	16,06	41	44	30
9	12,63	32	38	25
	10,63	27	34	22
	8,63	22	31	19
10	7,73	20	29	18
	5,73	15	26	15
	3,73	10	21	12

Appendix 2

Metamorfoze Exposure Tolerances ΔL^* 2, neutrals Object-Level Target

The values referred to below have been calculated starting from the general L^* values of the neutrals of the Object-Level Target. The $L^*a^*b^*$ values of test targets may be mutually divergent.

Patch	L^*	8 bit count values eciRGBv2	8 bit count values Adobe RGB (1998)	8 bit count values for gamma 1,8 color spaces
1	99,06	253	252	252
	97,06	248	246	244
	95,06	242	240	237
2	94,02	240	237	233
	92,02	235	231	226
	90,02	230	226	219
3	89,34	228	224	217
	87,34	223	218	210
	85,34	218	212	204
4	84,14	215	209	200
	82,14	209	203	193
	80,14	204	197	186
5	74,06	189	181	167
	72,06	184	175	161
	70,06	179	170	155
6	64,15	164	154	138
	62,15	158	149	132
	60,15	153	144	126
7	51,25	131	121	103
	49,25	126	116	98
	47,25	120	112	93
8	40,62	104	96	77
	38,62	98	91	73
	36,62	93	87	68
9	30,86	79	74	56
	28,86	74	70	52
	26,86	69	66	49
10	18,19	46	48	33
	16,19	41	44	30
	14,19	36	41	27
11	10,29	26	34	21
	8,29	21	30	19
	6,29	16	27	16
12	5,44	14	25	15
	3,44	9	20	12
	1,44	4	14	7

References

- Metamorfoze Preservation Imaging Guidelines
<http://www.metamorfoze.nl/en/methodiek/conversion.html>
- Metamorfoze
<http://www.metamorfoze.nl/en/index.html>
- Koninklijke Bibliotheek, National Library of the Netherlands
<http://www.kb.nl/index-en.html>
- Image Engineering Dietmar Wueller
<http://www.image-engineering.de/>
- Universal Test Target (UTT):
<http://www.universaltesttarget.com/>
- UTT on YouTube by Zeuschel
<http://www.youtube.com/watch?v=KKAxJ3womcY>
- Artiq-engineering
<http://www.artiq-engineering.de/>
- Center for Digital Imaging
<http://www.cdiny.com/>
- European Color Initiative
<http://www.eci.org/doku.php?id=en:start>
- Federal Agencies, Digitization Guidelines Initiative
<http://www.digitizationguidelines.gov/stillimages/>
- Fachverband für Multimediale Informationsverarbeitung e.V. (FMI)
<http://fmi-ev.de/>
- Image Science Associates
<http://www.imagescienceassociates.com/>
- Bruce Lindbloom, Useful Color Information, Studies and Files
<http://www.brucelindbloom.com/>
- Archiving 2010 IS&T, June 1 - June 4, Den Haag, KB,
<http://www.imaging.org/IST/conferences/archiving/>

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