

Technical Report BAM(8930/40/50/60/70/80/90)E

Transformation of absolute LAB^* coordinates (CIELAB colour space) to olv^* , cmv^* , nru^* and rtu^* coordinates for 16 step equidistant colour series in CIELAB colour space between White W or Black N and 6 colours $CMYOLV$ or 16 CIE-test colours ($i=0$ to 14) including Black N ($L^*=0$) and White W ($L^*=100$)

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This BAM Technical Report exists as pdf- and html-file. Click for change to the other version:

<http://o2.ps.bam.de/INFVM03/8930/BAM8930E.PDF>

<http://o2.ps.bam.de/INFVM03/8930/BAM8930E.HTM>

Data and URL addresses:

The Technical Reports 8930, 8940, 8950, 8960, 8970, 8980, and 8990 transform LAB^* coordinates into cmv^* , olv^* , nru^* , and rtu^* data. In most cases 16-step equally spaced colour series in *linear* LAB^* arrangement are transformed. But also the LAB^* coordinates of the CIE-test colours are transformed.

The $CMYOLVNW$ colour space of printing (PR) or television (TV) is defined by 8 CIELAB colour coordinates in a 3-dimensional space. Both spaces look like a double pyramid with White W at the top and Black N at the bottom and an colour hexagon of the 8 colours $CMYOLV$ perpendicular to the achromatic axis $N-W$. If we use absolute coordinates LAB^* (identical to the 3 coordinates $L^*a^*b^*$ of CIELAB colour space) then the space looks irregular but in relative coordinates (lab^* , small letters) the space is a regular double pyramid with a regular hexagon as basis. The following two figures show this regular spacing in two dimensions with the colours between White W and the hexagon $CMYOLV$ (the whitish colours w) or the colours between Black N and the hexagon $CMYOLV$ (the blackish colours n)

<http://o2.ps.bam.de/INFVM03/8370/E4370-2N.PDF>

<http://o2.ps.bam.de/INFVM03/8370/E4370-3N.PDF>

There are different reference systems for the calculations:

The Standard PRint system (SPR) contains the 8 colours $CMYOLVNW(PR)$ defined in ISO/IEC 15775. The lightness range is in the standard defined between $L^*=18$ and $L^*=95$. One may call this $SPR(L^*=18-95) = PR18$. The photographic test chart no. 1 in continuous tone has according to ISO/IEC 15775 a lightness range between $L^*=10$ and $L^*=94$. One may call this $DPR(L^*=10-94) = DPR10-94$ (D=Device)

Other systems used here are $DPR(L^*=14-95) = PR14$, $DPR(L^*=10-95) = PR10$, $DPR(L^*=0-95) = PR0$, and $DPR(L^*=0-100) = CPR$. The last one with the limits $L^*=0$ and $L^*=100$ is of special colorimetric interest and is called here the colorimetric print system (CPR). PR18 and CPR are the important ones here.

The Standard Television system (STV) contains the 8 colours $CMYOLVNW(TV)$ tabled in ISO/IEC 15775. The lightness L^* normalisation for White W is the same as for offset colours according to the standard. In offices with daylight illumination actual Black N on a screen is far from $L^*=0$ mainly because of the about 4% surface reflection on the screen surface which is very much depending on the device. One may choose $L^*=18$ as in SPR for simplicity of the calculations. This system is called $STV(L^*=18-95) = TV18$.

Others systems used here are $DTV(L^*=10-95) = TV10$, $DTV(L^*=0-95) = TV0$, and $DTV(L^*=0-100) = CTV$. TV18 and CTV are the important ones here.

System and device adaptation (sa and da) for the calculations.

A system adaptation (sa) and/or a device adaptation (da) to CIE illuminant D65 is used. According to ISO/IEC 15775 the 8 colours $CMYOLVNW$ defining the system output show for television (TV) zero CIELAB coordinates for both Black N and White W but not for printing (PR). Therefore for printing (PR) a chromatic adaptation is necessary for the

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system coordinates. Any device output may deviate from zero CIELAB coordinates for both Black *N* and White *W*. For comparison of coordinates both a system adaptation and a device adaptation may be necessary.

For the printing system (PR) then Black *N* ($A^*CIE=0.5$, $B^*CIE=-0.46$) and White *W* ($A^*CIE=-0.98$, $B^*CIE=4.76$) and all gray colours get the coordinates $A^*CIE=0.0$, $B^*CIE=0.0$

Similar for any output device then Black *N* ($A^*CIE=0.5$, $B^*CIE=-0.46$ or other values) and White *W* ($A^*CIE=-0.98$, $B^*CIE=4.76$ or other values) and all gray colours in CIELAB space linear between Black *N* and White *W* get the coordinates $A^*CIE=0.0$, $B^*CIE=0.0$. Within a tolerance of 1 of the 16 gray steps (5.2 CIELAB units) a linear shift in CIELAB space depending on lightness L^*CIE is used for the transformations.

For a 16 step gray colour series in offset printing with device colours PR18 ($L^*=18$ to 95 and Black *N* with $A^*CIE=0.5$, $B^*CIE=-0.46$ and White *W* with $A^*CIE=-0.98$, $B^*CIE=4.76$) in system PR18sa ($L^*=18$ to 95 and for both Black *N* and White *W* with $A^*CIE=0.0$, $B^*CIE=0.0$) see the simple *colour data by the URL:

<http://o2.ps.bam.de/INFVM03/7130/E3130-3N.PDF>

<http://o2.ps.bam.de/INFVM03/7130/E3130-3N.EPS>

<http://o2.ps.bam.de/INFVM03/7130/E3130-7N.PDF>

<http://o2.ps.bam.de/INFVM03/7130/E3130-7N.EPS>

Absolute measurement or theoretical *colour data in CIELAB colour space are called L^*CIE , A^*CIE , B^*CIE and device adapted (da) *colour data are called L^*CIE_{da} , A^*CIE_{da} , B^*CIE_{da} .

Relative measurement or theoretical *colour data in CIELAB colour space are called l^*CIE , a^*CIE , b^*CIE and device adapted (sa) *colour data are called l^*CIE_{da} , a^*CIE_{da} , b^*CIE_{da} .

Calculations of olv^* , cmv^* and nru^* data are based on relative data l^*CIE_{da} , a^*CIE_{da} , b^*CIE_{da} .

For the technical basis of this transformations see the at the end of the technical report

<http://o2.ps.bam.de/INFVM03/8650/BAM8650E.PDF>

<http://o2.ps.bam.de/INFVM03/8650/BAM8650E.HTM>

Series 8930: Standard offset PR18 colours ($n^*=0.25$ or $w^*=0.25$ or $n^*=w^*=0.25$) in system TV18sa.

The PostScript files of this report include LAB^* coordinates of standard offset colours $CMYOLVNW$ as input

1. Standard offset colours $CMYOLVNW$ (PR18) in system TV18sa ($L^*=18-95$) (E8930-3N.EPS)
2. Standard offset colours $CMYOLVNW$ (PR18, $n^*=0.25$) in system TV18sa ($L^*=18-95$) (E8930-7N.EPS)
3. Standard offset colours $CMYOLVNW$ (PR18, $w^*=0.25$) in system TV18sa ($L^*=18-95$) (E8931-3N.EPS)
4. Standard offset colours $CMYOLVNW$ (PR18, $n^*=w^*=0.25$) in system TV18sa ($L^*=18-95$) (E8931-7N.EPS)

All four are found in:

<http://o2.ps.bam.de/INFVM03/8930/A4Q8930E.PDF>

<http://o2.ps.bam.de/INFVM03/8930/A4Q8930E.PS>

Remark: The calculations give $o^*_{nTV18}=-0.55$ for the standard printing colour cyanblue C. This indicates that Cyanblue C is outside the television colour gamut and can not be reproduced on the screen. One can expect that only 11 steps of the 16-step series $W-C$ can be reproduced on the screen (-0.55 is 33% outside the range between 0 and 1). Please compare series 8940 for verification.

Series 8940: Cyan and Magenta whitish (index w) and blackish (index n) PR18 and TV18 colours in system TV18sa.

The PostScript files of this report include LAB^* coordinates of standard offset or television colours $CMYOLVNW$ as input. The 16 steps colour series $w-c^*$, $n-c^*$ and $w-m^*$, $n-m^*$ of the standard are transformed. The SGcode (Standard Gamut) olv^* , cmv^* , nru^* and WGcode (Wide Gamut 77-177) olv^* , cmv^* is calculated for the device adapted coordinates L^*CIE_{da} , A^*CIE_{da} , B^*CIE_{da} .

1. Colour series $C-W$ and $C-N$ ($i=0$ to 7, PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8940-3N.EPS)
2. Colour series $C-W$ and $C-N$ ($i=8$ to F, PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8940-7N.EPS)
3. Colour series $M-W$ and $M-N$ ($i=0$ to 7, PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8941-3N.EPS)
4. Colour series $M-W$ and $M-N$ ($i=8$ to F, PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8941-7N.EPS)

All four are found in:

<http://o2.ps.bam.de/INFVM03/8940/A4Q8940E.PDF>

<http://o2.ps.bam.de/INFVM03/8940/A4Q8940E.PS>

Series 8950: Yellow and Black whitish (index w) and blackish (index n) PR18 and TV18 colours in system PR18sa.

The PostScript files of this report include LAB^* coordinates of standard offset or television colours $CMYOLVNW$ as input. The 16 steps colour series $w-y^*$, $n-y^*$ and $w-n^*$, $n-w^*$ of the standard are transformed. The SGcode (Standard Gamut) olv^* , cmv^* , nru^* and WGcode (Wide Gamut 77-177) olv^* , cmv^* is calculated for the device adapted coordinates L^*CIEda , A^*CIEda , B^*CIEda .

1. Colour series $Y-W$ and $Y-N$ ($i=0$ to 7 , PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8950-3N.EPS)
2. Colour series $Y-W$ and $Y-N$ ($i=8$ to F , PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8950-7N.EPS)
3. Colour series $N-W$ and $W-N$ ($i=0$ to 7 , PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8951-3N.EPS)
4. Colour series $N-W$ and $W-N$ ($i=8$ to F , PR18 and TV18) in system TV18sa ($L^*=18-95$) (E8951-7N.EPS)

All four are found in:

<http://o2.ps.bam.de/INFVM03/8950/A4Q8950E.PDF>

<http://o2.ps.bam.de/INFVM03/8950/A4Q8950E.PS>

Series 8960: TV18 and CIE-test colours (i=0 to F) colours in system TV18sa.

The PostScript files of this report include LAB^* coordinates of standard TV18 and CIE-test colours ($i=0-F$) as input. The SGcode (Standard Gamut) olv^* , cmv^* , nru^* and WGcode (Wide Gamut 77-177) olv^* , cmv^* is calculated for the device adapted coordinates L^*CIEda , A^*CIEda , B^*CIEda .

1. Standard television colours $CMYOLVNW$ (TV18) in system TV18sa ($L^*=18-95$) (E8960-3N.EPS)
2. Standard television colours $CMYOLVNW$ (TV18, $n^*=0.25$) in system TV18sa ($L^*=18-95$) (E8960-7N.EPS)
3. Standard CIE-test colours ($i=0$ to 7) in system TV18sa ($L^*=18-95$) (E8961-3N.EPS)
4. Standard CIE-test colours ($i=8$ to F) in system TV18sa ($L^*=18-95$) (E8961-7N.EPS)

All four are found in:

<http://o2.ps.bam.de/INFVM03/8960/A4Q8960E.PDF>

<http://o2.ps.bam.de/INFVM03/8960/A4Q8960E.PS>

Series 8970: TV14 and CIE-test colours (i=0 to F) colours in system TV14sa.

The PostScript files of this report include LAB^* coordinates of standard TV14 and CIE-test colours ($i=0-F$) as input. The SGcode (Standard Gamut) olv^* , cmv^* , nru^* and WGcode (Wide Gamut 77-177) olv^* , cmv^* is calculated for the device adapted coordinates L^*CIEda , A^*CIEda , B^*CIEda .

1. Standard television colours $CMYOLVNW$ (TV14) in system TV14sa ($L^*=14-95$) (E8970-3N.EPS)
2. Standard television colours $CMYOLVNW$ (TV14, $n^*=0.25$) in system TV14sa ($L^*=14-95$) (E8970-7N.EPS)
3. Standard CIE-test colours ($i=0$ to 7) in system TV14sa ($L^*=14-95$) (E8971-3N.EPS)
4. Standard CIE-test colours ($i=8$ to F) in system TV14sa ($L^*=14-95$) (E8971-7N.EPS)

All four are found in:

<http://o2.ps.bam.de/INFVM03/8970/A4Q8970E.PDF>

<http://o2.ps.bam.de/INFVM03/8970/A4Q8970E.PS>

Series 8980: TV10 and CIE-test colours (i=0 to F) colours in system TV10sa.

The PostScript files of this report include LAB^* coordinates of standard TV10 and CIE-test colours ($i=0-F$) as input. The SGcode (Standard Gamut) olv^* , cmv^* , nru^* and WGcode (Wide Gamut 77-177) olv^* , cmv^* is calculated for the device adapted coordinates L^*CIEda , A^*CIEda , B^*CIEda .

1. Standard television colours $CMYOLVNW$ (TV10) in system TV10sa ($L^*=10-95$) (E8980-3N.EPS)
2. Standard television colours $CMYOLVNW$ (TV10, $n^*=0.25$) in system TV10sa ($L^*=10-95$) (E8980-7N.EPS)
3. Standard CIE-test colours ($i=0$ to 7) in system TV10sa ($L^*=10-95$) (E8981-3N.EPS)
4. Standard CIE-test colours ($i=8$ to F) in system TV10sa ($L^*=10-95$) (E8981-7N.EPS)

All four are found in:

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<http://o2.ps.bam.de/INFVM03/8980/A4Q8980E.PDF>

<http://o2.ps.bam.de/INFVM03/8980/A4Q8980E.PS>

Series 8970: TV0 and CIE-test colours (i=0 to F) colours in system TV0sa.

The PostScript files of this report include *LAB** coordinates of standard TV0 and CIE-test colours (i=0-F) as input. The SGcode (Standard Gamut) *olv**, *cmv**, *nru** and WGcode (Wide Gamut 77-177) *olv**, *cmv** is calculated for the device adapted coordinates *L**CIEda, *A**CIEda, *B**CIEda.

1. Standard television colours *CMYOLVNW* (TV0) in system TV0sa (*L**=0-95) (E8990-3N.EPS)
2. Standard television colours *CMYOLVNW* (TV0, n*=0.25) in system TV0sa (*L**=0-95) (E8990-7N.EPS)
3. Standard CIE-test colours (i=0 to 7) in system TV0sa (*L**=0-95) (E8991-3N.EPS)
4. Standard CIE-test colours (i=8 to F) in system TV0sa (*L**=0-95) (E8991-7N.EPS)

All four are found in:

<http://o2.ps.bam.de/INFVM03/8990/A4Q8990E.PDF>

<http://o2.ps.bam.de/INFVM03/8990/A4Q8990E.PS>

Similar data:

The Technical Reports 7110, 7120, 7130, 7140, 7150, 7160, 7170, 7180, 7190 include similar data. The SGcode (Standard Gamut) *olv**, *cmv**, *nru** and WGcode (Wide Gamut 86-168) *olv**, *cmv** is calculated for the device adapted coordinates *L**CIEda, *A**CIEda, *B**CIEda. See for instance the technical report:

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<http://o2.ps.bam.de/INFVM03/7110/BAM7110E.PDF>

or one example;

<http://o2.ps.bam.de/INFVM03/7110/A4Q7110E.PDF>

<http://o2.ps.bam.de/INFVM03/7110/A4Q7110E.PS>

These technical reports include all important basic transformations in colour systems PR18sa (*L**=18-95), TV18sa (*L**=18-95), CPR (colorimetric PR, *L**=0-100), and CTV (Colorimetric TV, *L**=0-100). The series 7180 and 7190 show transformations to the *sRGB* tristimulus value and the *sRGB** perceptive *colour space.

The Technical Reports 8650,8750,8870,8880,8890 include similar. The SGcode (Standard Gamut) *olv**, *cmv**, *nru** and WGcode (Wide Gamut 77-177) *olv**, *cmv** is calculated for the device adapted coordinates *L**CIEda, *A**CIEda, *B**CIEda. See for instance the technical report:

<http://o2.ps.bam.de/INFVM03/8650/BAM8650E.PDF>

or one example;

<http://o2.ps.bam.de/INFVM03/8650/A4Q8650E.PDF>

<http://o2.ps.bam.de/INFVM03/8600/A4Q8650E.PS>

These technical reports include transformations in colour systems PR18sa (*L**=18-95), PR14sa (*L**=14-95), PR10sa (*L**=10-95), PR0sa (*L**=0-95)