

**Change of the display output by absolute or relative gamma**  
IEC 61966-2-1 defines an absolute gamma  $g_a$ .  
ISO 9241-306 defines a relative gamma  $g_p = g_a / 2.4$ .  
If gamma is decreasing, then display output appear lighter.

The computer operating system *Mac OS X V10.7.5* allows a steering of the display output by the following options:  
*Apple, System Preferences, Display, Color, Calibrate, Expert Mode*  
After several *Continue* there is a ruler *Target Gamma*.  
The Gamma can be changed continuously between the absolute Gamma  $g_a=1.0$  and  $g_a=2.6$ .  
Then the contrast of the display output changes from low to high.  
ISO 9241-306 defines the corresponding contrast steps  
 $C_{YP1,00}$  for  $g_a=1.2$  or  $g_p=0.50$ , see Grab file AEX10-3N.PDF  
 $C_{YP3,25}$  for  $g_a=1.6$  or  $g_p=0.67$ , see Grab file AEX10-7N.PDF  
 $C_{YP5,50}$  for  $g_a=2.0$  or  $g_p=0.83$ , see Grab file AEX11-3N.PDF  
 $C_{YP8,00}$  for  $g_a=2.4$  or  $g_p=1.00$ , see Grab file AEX11-7N.PDF  
The application "Grab" shows **not** the display-output change.

AEX30-1N

**Change of the display output by absolute or relative gamma**  
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*Apple, System Preferences, Display, Color, Calibrate, Expert Mode*  
After several *Continue* there is a ruler *Target Gamma*.  
The Gamma can be changed continuously between the absolute Gamma  $g_a=1.0$  and  $g_a=2.6$ .  
Then the contrast of the display output changes from low to high.  
For 4 contrast steps the display output was captured by *Grab*.  
For  $g_a=1.2$  the file name is: *LCD\_12\_1080.tiff*.  
For  $g_a=1.6$  the file name is: *LCD\_16\_1080.tiff*.  
For  $g_a=2.0$  the file name is: *LCD\_20\_1080.tiff*.  
For  $g_a=2.4$  the file name is: *LCD\_24\_1080.tiff*.  
The file AEX30-5N.PDF shows the change to PS and PDF files.

AEX30-3N

**Transfer of the tiff display-output files to EPS and PDF files**  
The file AEX30-3N.PDF shows the creation of the tiff files.

For 4 contrast steps the display output was captured by *Grab*.  
For  $g_a=1.2$  the file name is: *LCD\_12\_1080.tiff*.  
For  $g_a=1.6$  the file name is: *LCD\_16\_1080.tiff*.  
For  $g_a=2.0$  the file name is: *LCD\_20\_1080.tiff*.  
For  $g_a=2.4$  the file name is: *LCD\_24\_1080.tiff*.  
The software *GraphicConverter X V5.2* has produced EPS files.  
The software *Win AdobeDistiller V3.0* has produced PDF files.  
In addition the file names have been changed as follows:  
*LCD\_12\_1080.tiff* → AEX10-3N.EPS → AEX10-3N.PDF  
*LCD\_16\_1080.tiff* → AEX10-7N.EPS → AEX10-7N.PDF  
*LCD\_20\_1080.tiff* → AEX11-3N.EPS → AEX11-3N.PDF  
*LCD\_24\_1080.tiff* → AEX11-7N.EPS → AEX11-7N.PDF  
For the study of these files go to the URL:  
<http://farbe.li.tu-berlin.de/AEX1/AEX1.HTM>.

AEX30-5N

**Modification of the EPS display output with four gamma values**  
The visual file output is equal for:  
AEX10-3N, AEX10-7N, AEX11-3N, and AEX11-7N.  
This is a failure of the Mac software *Grab*.  
This software uses the *rgb* values from the computer storage.  
*Grab* captures **not** the display-output change by four gamma values.  
The real visual file output is simulated in the folder AEX2.  
The file names have been changed as follows:  
AEX10-3N.EPS → AEX20-3N.EPS → AEX20-3N.PDF  
AEX10-7N.EPS → AEX20-7N.EPS → AEX20-7N.PDF  
AEX11-3N.EPS → AEX21-3N.EPS → AEX21-3N.PDF  
AEX11-7N.EPS → AEX21-7N.EPS → AEX21-7N.PDF  
For the study of these files go to the URL:  
<http://farbe.li.tu-berlin.de/AEX2/AEX2.HTM>.  
The differences of the EPS files in the folders AEX2 and AEX1 are shown in AEX30-6N.PDF. A PS-Gamma procedure, for example {0.5 exp} settransfer changes Gamma from 2.4 to 1.2.

AEX30-7N

**Production of ICC Profiles with absolute or relative gamma**  
IEC 61966-2-1 defines an absolute gamma  $g_a$ .  
ISO 9241-306 defines a relative gamma  $g_p = g_a / 2.4$ .  
If gamma is decreasing, then display output appear lighter.

The computer operating system *Mac OS X V10.7.5* allows a steering of the display output by the following options:  
*Apple, System Preferences, Display, Color, Calibrate, Expert Mode*  
After several *Continue* there is a ruler *Target Gamma*.  
The Gamma can be changed continuously between the absolute Gamma  $g_a=1.0$  and  $g_a=2.6$ .  
Then the contrast of the display output changes from low to high.  
ISO 9241-306 defines the corresponding contrast steps  
 $C_{YP1}$  for  $g_a = 1.2$  or  $g_p = 0.5$ .  
 $C_{YP8}$  for  $g_a = 2.4$  or  $g_p = 1.0$ .  
The display output *Target Gamma* is shown in figure AEX11-3N.PDF.

AEX30-2N

**Change of the display output by absolute or relative gamma**  
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ISO 9241-306 defines a relative gamma  $g_p = g_a / 2.4$ .  
If gamma is decreasing, then display output appear lighter.

The computer operating system *Mac OS X V10.7.5* allows a steering of the display output by the following options:  
*Apple, System Preferences, Display, Color, Calibrate, Expert Mode*  
After several *Continue* there is a ruler *Target Gamma*.  
The Gamma can be changed continuously between the absolute Gamma  $g_a=1.0$  and  $g_a=2.6$ .  
Then the contrast of the display output changes from low to high.  
For 4 contrast steps the display output was captured by *Grab*.  
For  $g_a=1.2$  the file name is: *LCD\_12\_MAC.tiff*.  
For  $g_a=1.6$  the file name is: *LCD\_16\_MAC.tiff*.  
For  $g_a=2.0$  the file name is: *LCD\_20\_MAC.tiff*.  
For  $g_a=2.4$  the file name is: *LCD\_24\_MAC.tiff*.  
The file AEX30-5N.PDF shows the change to PS and PDF files.

AEX30-4N

**Transfer of the tiff display-output files to EPS and PDF files**  
The file AEX30-3N.PDF shows the creation of the tiff files.

For 4 contrast steps the display output was captured by *Grab*.  
For  $g_a=1.2$  the file name is: *LCD\_12\_MAC.tiff*.  
For  $g_a=1.6$  the file name is: *LCD\_16\_MAC.tiff*.  
For  $g_a=2.0$  the file name is: *LCD\_20\_MAC.tiff*.  
For  $g_a=2.4$  the file name is: *LCD\_24\_MAC.tiff*.  
The software *GraphicConverter X V5.2* has produced EPS files.  
The software *Win AdobeDistiller V3.0* has produced PDF files.  
In addition the file names have been changed as follows:  
*LCD\_12\_MAC.tiff* → AEX40-3N.EPS → AEX40-3N.PDF  
*LCD\_16\_MAC.tiff* → AEX40-7N.EPS → AEX40-7N.PDF  
*LCD\_20\_MAC.tiff* → AEX41-3N.EPS → AEX41-3N.PDF  
*LCD\_24\_MAC.tiff* → AEX41-7N.EPS → AEX41-7N.PDF  
For the study of these files go to the URL:  
<http://farbe.li.tu-berlin.de/AEX4/AEX4.HTM>.

AEX30-6N

**Modification of the EPS display output with four gamma values**  
The visual file output is equal for:  
AEX40-3N, AEX40-7N, AEX41-3N, and AEX41-7N.  
This is a failure of the Mac software *Grab*.  
This software uses the *rgb* values from the computer storage.  
*Grab* captures **not** the display-output change by four gamma values.  
The real visual file output is simulated in the folder AEX5.  
The file names have been changed as follows:  
AEX40-3N.EPS → AEX50-3N.EPS → AEX50-3N.PDF  
AEX40-7N.EPS → AEX50-7N.EPS → AEX50-7N.PDF  
AEX41-3N.EPS → AEX51-3N.EPS → AEX51-3N.PDF  
AEX41-7N.EPS → AEX51-7N.EPS → AEX51-7N.PDF  
For the study of these files go to the URL:  
<http://farbe.li.tu-berlin.de/AEX5/AEX5.HTM>.  
The differences of the EPS files in the folders AEX5 and AEX4 are shown in AEX30-6N.PDF. A PS-Gamma procedure, for example {0.5 exp} settransfer changes Gamma from 2.4 to 1.2.

AEX30-8N

**Creation of an own profile with the name: LCD\_D65\_24\_2010**  
Computer operating system *Mac OS Version 10.7.5 of 2010, created 2020-06-25*  
Choose the following menue steps:  
*Apple, system preferences, display, colours, calibration*

The last menue shows the following steps:  
1. *Introduction*, 2. *Set up*, 3. *Native Gamma*, 4. *Target Gamma*  
5. *Target White Point*, 6. *Admin*, 7. *Name*, 8. *Conclusion*.  
Go to Menue: 1. *Introduction*. Choose the option *Expert Mode*.  
Go to Menue: 4. *Target Gamma*. Use the Gamma slider for changes.  
Between Gamma=1,0 and 2,6 the contrast changes  
from low to high by a slider. Choose the value: 2.4  
Go to Menue: 5. *Target White Point*. Choose the option D65.  
Go to Menue: 6. *Admin*. Choose the option:  
*Allow other users to use this calibration*.  
Go to Menue: 7. *Name*. Input the name *LCD\_D65\_24\_2010*.  
The profile is stored and can be chosen in the display profile list.

AEX31-1N

**Conclusion: Display calibration**  
Computer operating system *Mac OS Version 10.7.5 of 2010, created 2020-06-25*  
A new calibrated display profile has been created and set to be the current profile for the display.  
**Profile Summary:**  
Name: LCD\_D65\_22\_2010  
Native Gamma: 1,981, approximate  
Target Gamma: 2,203  
**Chromaticities**  
Red Phosphor: 0,645 0,340  
Green Phosphor: 0,307 0,627  
Blue Phosphor: 0,146 0,064  
Native White Point: 0,313 0,329  
Target White Point: 6507°K  
to quit the calibrator, click the Done button

AEX31-3N

**Some parameters which are shown for the option open profile**  
If the produced profile *LCD\_D65\_22\_2010* is opened, then many data and Gamma curves are shown.  
Only a few colorimetric data are listed in the following.  
**Colorant and tristimulus values**  

	$X_{D50}$	$Y_{D50}$	$Z_{D50}$
Red Phosphor	$r_{XYZ}$ 0,449	0,234	0,007
Green Phosphor	$g_{XYZ}$ 0,370	0,698	0,062
Blue Phosphor	$b_{XYZ}$ 0,146	0,069	0,755
Media white point	$w_{pt}$ 0,950	1,000	1,090

**Matrix for chroma adaptation, name: chad**  
$$\begin{bmatrix} X_{pcs} \\ Y_{pcs} \\ Z_{pcs} \end{bmatrix} = \begin{bmatrix} 1,048035 & 0,022980 & -0,050323 \\ 0,029687 & 0,990463 & -0,017105 \\ -0,009262 & 0,015106 & 0,751083 \end{bmatrix} \begin{bmatrix} X_{src} \\ Y_{src} \\ Z_{src} \end{bmatrix}$$
**Gamma curve, parameter type 3, name: aa(r/g/b)**  
$$f(x) = \begin{cases} (ax + b)^{\gamma}, & x \geq d \\ cx, & x < d \end{cases} \quad \gamma = 2.4, 1024 \text{ points}$$
  
$$a = 0.9479, b = 0.0521, c = 0.0774, d = 0.0393$$

AEX31-5N

**Conclusion of the display output by the absolute gamma**  
The figures AEX31-1N, AEX31-2N, until AEX31-6N show:  
1. How to create an individual ICC-profile and store it.  
2. How to open an existing or created ICC-profile.  
3. How colorimetric data of the four colours RGB and W are stored.  
4. How the exponent of the Gamma curve is stored.  
5. Depending on the parameters a, b, c, d the value  $\gamma$  changes.  
Two computer operating systems of 2010 and 2020 have been used.  
Since 2019 the option to change the Gamma by a slider is deleted.  
One can not create any more profiles for different Gamma  $\gamma$ .  
However, on can create profiles for different Gamma with the older computer operating system until 2018.  
These profiles can be copied from the folder  
*Apple, Library, ColorSync, Profiles, Displays*  
of the system 2010 to the same folders of the system 2020.  
An example is the profile with the name: *LCD\_D65\_22\_2010.icc*, see [http://farbe.li.tu-berlin.de/profiles/LCD\\_D65\\_22\\_2010.icc](http://farbe.li.tu-berlin.de/profiles/LCD_D65_22_2010.icc)

AEX31-7N

**Creation of an own profile with the name: LCD\_D65\_2020**  
Computer operating system *Mac OS Version 10.15.5 of 2020, created 2020-06-25*  
Choose the following menue steps:  
*Apple, system preferences, display, colours, calibration*

The last menue shows the following steps:  
1. *Introduction*, 2. *Set up*, 3. *Color temperature (goal)*  
4. *Admin*, 5. *Name*, 6. *Conclusion*.  
Go to Menue: 4. *Color temperature (goal)*.  
Between 5000 and 9300 the color temperature can be chosen by a slider. Choose the value: D65  
Go to Menue: 4. *Admin*. Choose the option:  
*Allow other users to use this calibration*.  
Go to Menue: 5. *Name*. Input the name *LCD\_D65*.  
The profile is stored and can be chosen in the display profile list.  
The profile is stored as *LCD\_D65.icc* in the folder:  
*Library, ColorSync, Profiles, Displays*  
and can be copied to other computers and used.

AEX31-2N

**Conclusion: Display calibration**  
Computer operating system *Mac OS Version 10.15.5 of 2020, created 2020-06-25*  
A new calibrated display profile has been created and set to be the current profile for the display.  
**Profile Summary:**  
Name: LCD\_D65  
Monitor Gamma: 2.2  
Gamma correction: Native  
**Chromaticities**  
Red Phosphor: 0,68 0,32  
Green Phosphor: 0,265 0,69  
Blue Phosphor: 0,149 0,055  
Native White Point: 0,312 0,329  
Color temperature (goal): 6500°K  
to quit the calibrator, click the Done button

AEX31-4N

**Some parameters which are shown for the option open profile**  
If the produced profile *LCD\_D65\_2020* is opened, then many data and Gamma curves are shown.  
Only a few colorimetric data are listed in the following.  
**Colorant and tristimulus values**  

	$X_{D50}$	$Y_{D50}$	$Z_{D50}$
Red Phosphor	$r_{XYZ}$ 0,515	0,242	-0,001
Green Phosphor	$g_{XYZ}$ 0,294	0,699	0,042
Blue Phosphor	$b_{XYZ}$ 0,155	0,059	0,784
Media white point	$w_{pt}$ 0,950	1,000	1,089

**Matrix for chroma adaptation, name: chad**  
$$\begin{bmatrix} X_{pcs} \\ Y_{pcs} \\ Z_{pcs} \end{bmatrix} = \begin{bmatrix} 1,047867 & 0,022903 & -0,050717 \\ 0,029572 & 0,990479 & -0,017089 \\ -0,009232 & 0,015060 & 0,751831 \end{bmatrix} \begin{bmatrix} X_{src} \\ Y_{src} \\ Z_{src} \end{bmatrix}$$
**Gamma curve, parameter type 3:**  
$$f(x) = \begin{cases} (ax + b)^{\gamma}, & x \geq d \\ cx, & x < d \end{cases} \quad \gamma = 2.4, 1024 \text{ points}$$
  
$$a = 0.948, b = 0.052, c = 0.077, d = 0.040$$

AEX31-6N

**Conclusion of the display output by the absolute gamma**  
The figures AEX31-1N, AEX31-2N, until AEX31-6N show:  
1. How to create an individual ICC-profile and store it.  
2. How to open an existing or created ICC-profile.  
3. How colorimetric data of the four colours RGB and W are stored.  
4. How the exponent of the Gamma curve is stored.  
5. Depending on the parameters a, b, c, d the value  $\gamma$  changes.  
Two computer operating systems of 2010 and 2020 have been used.  
Since 2019 the option to change the Gamma by a slider is deleted.  
One can not create any more profiles for different Gamma  $\gamma$ .  
However, on can create profiles for different Gamma with the older computer operating system until 2018.  
Profiles can be copied from the folder  
*Apple, Library, ColorSync, Profiles, Displays*  
of the system 2010 to the same folder of the system 2020.  
An example is the profile with the name: *LCD\_D65\_2020.icc*, see [http://farbe.li.tu-berlin.de/profiles/LCD\\_D65\\_2020.icc](http://farbe.li.tu-berlin.de/profiles/LCD_D65_2020.icc)

AEX31-8N