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 Proferences, 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 correponding 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 "Grap" shows **not** the display-output change.

AEX30−1N

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 Proferences, 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 correponding 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

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

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

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 Proferences, 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

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 Proferences, 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

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	x_{D65}	y_{D65}
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

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	x_{D65}	y_{D65}
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

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

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

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	*rXYZ*	0,449	0,234	0,007
Green Phosphor	*gXYZ*	0,370	0,698	0,062
Blue Phosphor	*bXYZ*	0,146	0,069	0,755
Media white point	*wpt*	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)g*

$$f(x) = \begin{cases} (ax + b)^{\gamma}, & x \geq d \\ cx, & x < d \end{cases}$$

γ = 2,4, 1024 points
a =0,9479, b=0,0521, c=0,0774, d=0,0393

AEX31−5N

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	*rXYZ*	0,515	0,242	-0,001
Green Phosphor	*gXYZ*	0,294	0,699	0,042
Blue Phosphor	*bXYZ*	0,155	0,059	0,784
Media white point	*wpt*	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:

$$f(x) = \begin{cases} (ax + b)^{\gamma}, & x \geq d \\ cx, & x < d \end{cases}$$

γ = 2,4, 1024 points
a =0,948, b=0,052, c=0,077, d=0,040

AEX31−6N

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 folgers 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

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 folgers 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

Conclusion of the display output by the absolute gamma
The figures AEX31−1N, AEX31−2N, until AEX31−6N show:
1. How to create an idividual 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 γ 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 γ.
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

AEX31−7N

Conclusion of the display output by the absolute gamma
The figures AEX31−1N, AEX31−2N, until AEX31−6N show:
1. How to create an idividual 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 γ changes.

Two computer operating systems of 2010 and 2020 have been used.
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One can not create any more profiles for different Gamma γ.
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 2020 to the same folder of the system 2010.
An example is the profile with the name: LCD_D65_2020.icc,
see http://farbe.li.tu-berlin.de/profiles/LCD_D65_2020.icc

AEX31−8N