Gamma Evaluation in ViPer

This application note instruction describes how to do a gamma evaluation in ViPer software. ViPer provides four different evaluation methods for gamma determination. There is also the possibility to set initial fit parameters and to parametrize and display tolerance curves.

APPLICATION
NOTE

\\ 1. INTRODUCTION

The gamma value is a measure for the tone characteristics of a display. So, for most monitors, TVs and cellphone displays, the EOTF (electro-optical transfer function), i.e. the luminance over the input gray level or RGB level, resp., is specified by the gamma value.
If a display has a higher gamma value, it shows less picture details and it appears kind of dark. However, a display with lower gamma value appears lighter and picture details are more visible, but shadows are less pronounced ("washed-out" picture).

Now, with ViPer, an extensive gamma evaluation is provided, including four different gamma determination methods.

ViPer Evaluation

\\ 2. GAMMA DETERMINATION METHODS

2.1 Point-gamma

This method, which is also referred to as "local-gamma", is the simplest gamma evaluation method. For each gray level, except for 0 and 255, it calculates the local slope, i.e. the local gamma value, of the gray scale or color scale curve, resp., in the logarithmic domain, each between two adjacent points:

$$\Gamma_i = \frac{log(l_{i+1}) - log(l_i)}{log(v_{i+1}) - log(v_i)}$$

Equation (1)

,where l_i and v_i are the normalised luminance and gray level values. So, for each gray level, except for 0 and 255, a gamma value Γ_i is calculated [1].

2.2 2 point-gamma

This method is also quite simple, but more refined as the point-gamma. For each gray level, except for 0 and 255, it calculates the slope of the gray scale or color scale curve, resp., in the logarithmic domain, related to the maximum gray level and to maximum luminance, denoted as "W" (L is luminance, V is gray level):

$$\Gamma_i = \frac{log(L_w) - log(L_i)}{log(V_w) - log(V_i)}$$

Equation ('2)

So, for each gray level, except for 0 and 255, a gamma value Γ_i is calculated [1].

2.3 LOG-LOG-model

This method is more refined, since it takes all data points into account to calculate a single gamma value:

$$log(L_j - L_k) = \Gamma log(V_j - V_k) + log(\mathrm{a})$$

Equation (3)

, where L_K is the luminance for gray level V_K = 0, i.e. the black state of display. The gamma value Γ is the slope of the gray scale or color scale curve, resp., in the logarithmic domain. $log(a)$ is the intercept of the fit curve with y axis [1], [2].

2.4 GOGO-model

This method is also more refined. Just as the LOG-LOG model, it takes all data points into account to calculate a single gamma value:
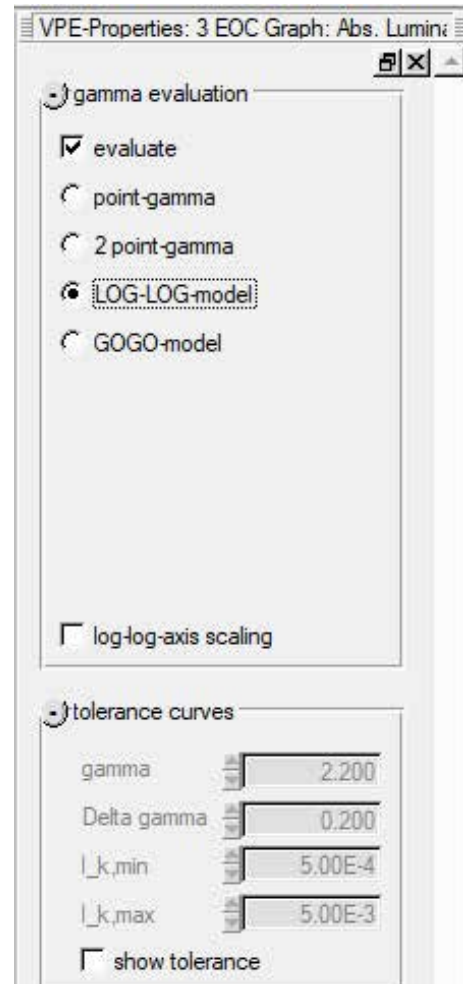
$$l_i = l_0 + g \left(\frac{v_i}{v_w} + v_0\right)^{\mathrm{r}} \cong \frac{L_i}{L_w}$$

Equation (4)

The gamma value Γ is determined by fitting the gray scale or color-scale curve, resp. , by a four parameter fit function [1], [2].

Figure 1: VPE-Properties panel for gamma evaluation.

\\ 3. IMPLEMENTATION IN VIPER

For an EOC measurement with photometric intensities (luminance) and gray levels as the varied property (x-axis is then labeled with Level, V), a complete gamma evaluation can be carried out in ViPer. The parametrization for gamma evaluation is done in the VPE-Properties panel:

The gamma evaluation is carried out as follows:

» To start the gamma evaluation, activate the *evaluate* checkbox in the *VPE-Properties* panel.
» To select the gamma evaluation method, click on one of the four radio buttons: *point-gamma*, *2 point-gamma*, *LOG-LOG-model* or *GOGO-model*.

Point-gamma evaluation

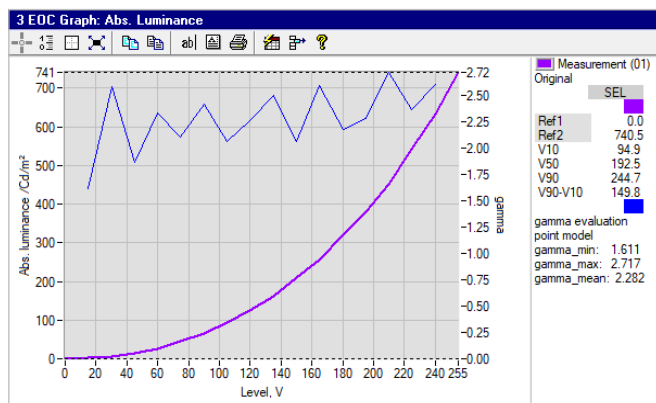In the following figure, the point-gamma evaluation of a smartphone EOC measurement is shown:

▲
Figure 2: Point-gamma evaluation.

In the EOC graph view with point-gamma evaluation, following curves are displayed:

» EOC measurement curve (thick, purple line). The left y-axis is the luminance axis.
» Point-gamma evaluation curve (thin, blue line). The right y-axis is the gamma value axis.

To the right of the graph, a table with following results of point-gamma evaluation is displayed:

» gamma-min, i.e. minimum gamma value
» gamma-max, i.e. maximum gamma value
» gamma-mean, i.e. mean gamma value

2 point-gamma evaluation

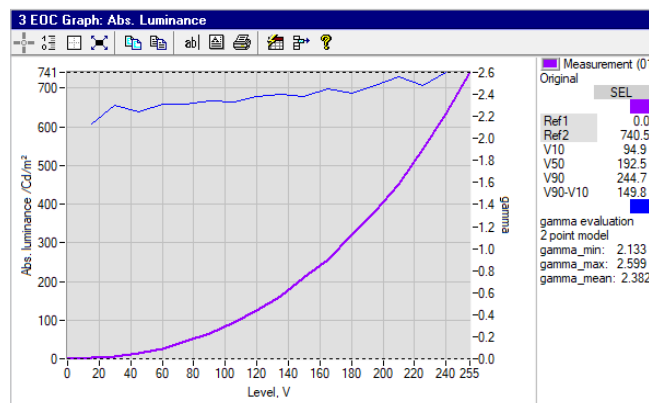In the following figure, the 2 point-gamma evaluation of a smartphone EOC measurement is shown:

▲
Figure 3: 2 Point-gamma evaluation.

In the EOC graph view with 2 point-gamma evaluation, following curves are displayed:

» EOC measurement curve (thick, purple line). The left y-axis is the luminance axis.
» 2 point-gamma evaluation curve (thin, blue line). The right y-axis is the gamma value axis.

To the right of the graph, a table with following results of 2 point-gamma evaluation is displayed:

» gamma-min, i.e. minimum gamma value
» gamma-max, i.e. maximum gamma value
» gamma-mean, i.e. mean gamma value

LOG-LOG-model evaluation

In the following figure, the LOG-LOG-model evaluation of a smartphone EOC measurement is shown:
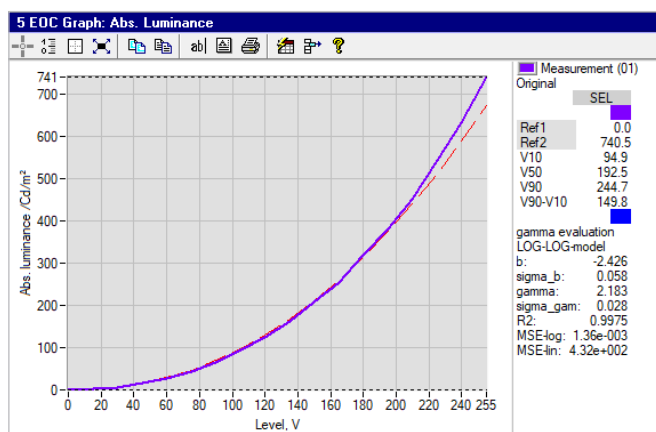

Figure 4: LOG-LOG-model evaluation.

In the EOC graph view with LOG-LOG-model evaluation following curves are displayed:

» EOC measurement curve (thick, purple line).
» LOG-LOG-model fit curve (thin, dashed, red line)

To the right of the graph, a table with following results of LOG-LOG-model evaluation is displayed:

» b, i.e. intercept of gamma fit curve (corresponds to log(a), see equation (3))
» sigma-b, i.e. uncertainty of intercept of gamma fit curve
» gamma, i.e. gamma value
» R2, i.e. correlation coefficient
» MSE-log, i.e. mean square error, based on logarithmized values
» MSE-lin, i.e. mean square error, based on original ("linear") values

GOGO-model evaluation

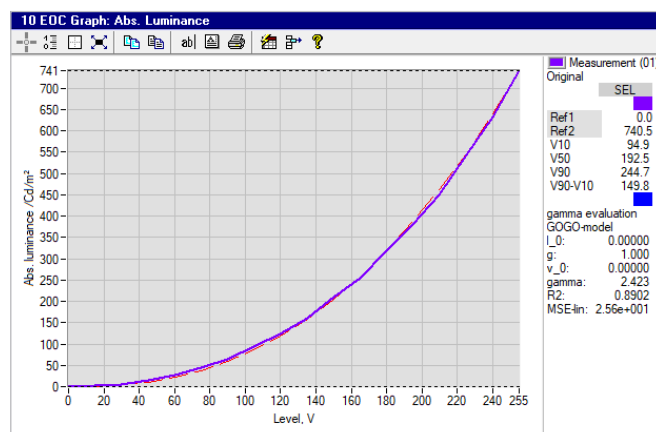In the following figure, the GOGO-model evaluation of a smartphone EOC measurement is shown:

Figure 5: GOGO-model evaluation.

In the EOC graph view with GOGO-model following curves are displayed:

» EOC measurement curve (thick, purple line).
» GOGO-model fit curve (thin, dashed, red line)

To the right of the graph, a table with following results of GOGO-model evaluation is displayed:

» l_0, i.e. first offset
» g, i.e. gain
» v_0, i.e. second offset
» gamma, i.e. gamma value
» R2, i.e. correlation coefficient
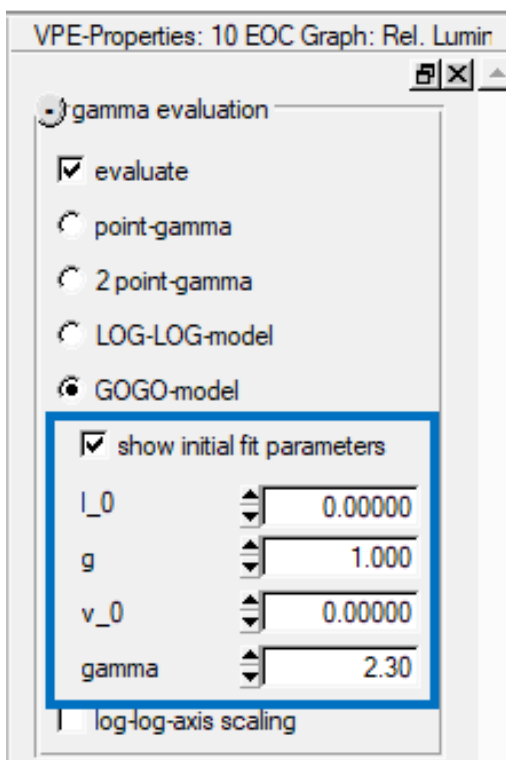» MSE-lin, i.e. mean square error, based on original ("linear") values

Note:
» The MSE-lin values of LOG-LOG-model and GOGO-model are directly comparable.
» The smaller the MSE-lin value, the better the fit.

For the GOGO-model, the initial fit parameters can be shown and changed:

» Activate the *show initial fit* parameters checkbox to access the fit parameters section:

Figure 6: Fit parameters section for GOGO-model evaluation.

» Set the fit start parameters to the desired values.
» Deactivate the *evaluate* checkbox.
» Activate the *evaluate* checkbox to start GOGO-model evaluation again, based on the prior set initial fit parameters.

For all four gamma evaluation methods, the x-axis (luminance) and the y-axis (Level, V) can be scaled double logarithmically:

The double logarithmic scaling helps to judge the linearity of the EOC data, when the x and y values are logarithmized.

» Activate the *log-log axis scaling* checkbox to activate the double logarithmic scaling of the axes:
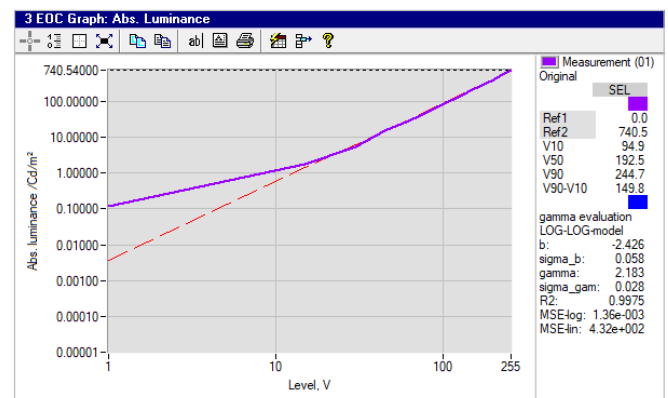
Figure 7: Log-log axis scaling.

Tolerance curves can be displayed for each of the four gamma evaluation methods:

The tolerance curves help to judge e.g. the waviness of the luminance curve.

» Activate the *show tolerance* checkbox:
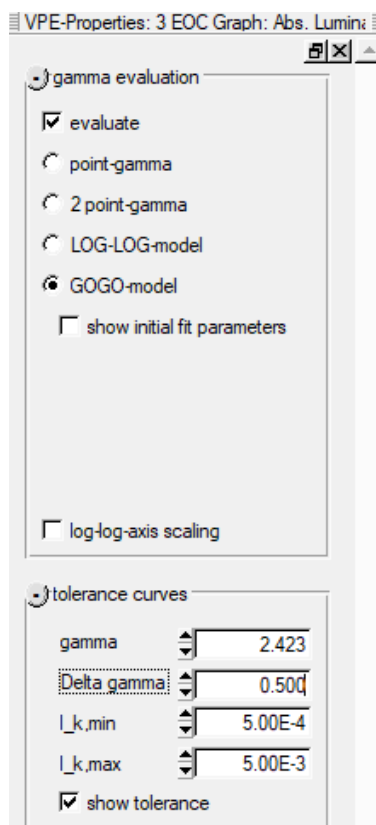

Figure 8: Tolerance curves parameters

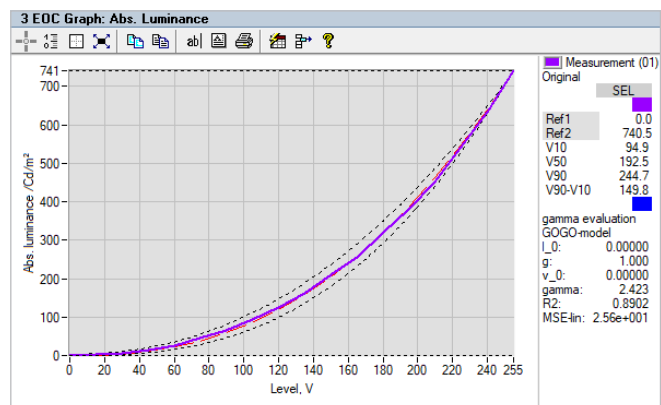Now, the tolerance curves are displayed (dashed lines):

Figure 9: Gamma tolerance curves (dashed lines).

» For *gamma* enter e.g. the fitted gamma value. In this case it is 2.423.
» For *Delta gamma* enter the delta value for gamma. In this case it is 0.5. The upper dashed curve has a gamma value of *gamma – Delta gamma*, in this case 1.923. The lower dashed curve has a gamma value of *gamma + Delta gamma*, in this case 2.923.
» For *I_k*, min enter the y axis intercept for the lower tolerance curve.
» For *I_k*, max enter the y axis intercept for the upper tolerance curve.

\\\\ BIBLIOGRAPHY

[1] T. Deguchi et al, Clarification of "Gamma" and the Accurate Characterization of CRT Monitors, SID, Volume 30, Issue 1, May 1999.
[2] International Committee for Display Metrology, Information Measurements Standard, June 2012.
[3] H. U. Lauer, SID-ME 2000

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an_Gamma Evaluation in ViPer_en_V1.0