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ADVANCED MEASUREMENT SYSTEMS

Brontes colorimeter display measurement application note

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1 The Brontes colorimeter

- **Absolute colour measurement according to the human eye (CIE1931).**
- **High speed measurement (18000 luminance measurements per second, 5500 colour measurements per second).**
- **Measure colour point and luminance in various colour spaces (XYZ, Yxy, CIELab, Yuv, LCH etc...).**
- **Trigger input for in line applications. General Purpose I/O for control.**
- **Direct measurement or through fiber optics.**
- **Measure via a PC (also embedded via I^2C) or stand alone mode.**
- **Windows, Linux and MAC OSX compatible.**
- **SCPI command interface for easy integration in other applications.**
- **Directly supported in Labview / Labwindows / Visual Studio via VISA library. Other programming languages that support VISA can be used.**
- **USBTMC standard compliant.**

2 LCD measurements

LCD's on the market today can be categorized in two basic categories :

- Passive (STN/CSTN)
- Active (TFT or AMLCD)

The Brontes was developed by Admesy specifically to perform measurements on LCD's in a mass production environment.
Basic parameters that can be measured on LCD's are :

- Colour
- Luminance (including related items like crosstalk)
- Contrast
- Flicker
- Switching time

In combination with the LCD control unit a full system can be made to perform adjust of the LCD panel. In most cases it is necessary to create custom

software to control the display control unit and the Brontes in one software program. For standard displays with VGA connection Admesy can deliver standard software but often LCD manufacturers have their own control units. Admesy can advice on implementation on such sets as well and also supply the necessary software.

Some adjustments that can be performed on an LCD can be seen below :

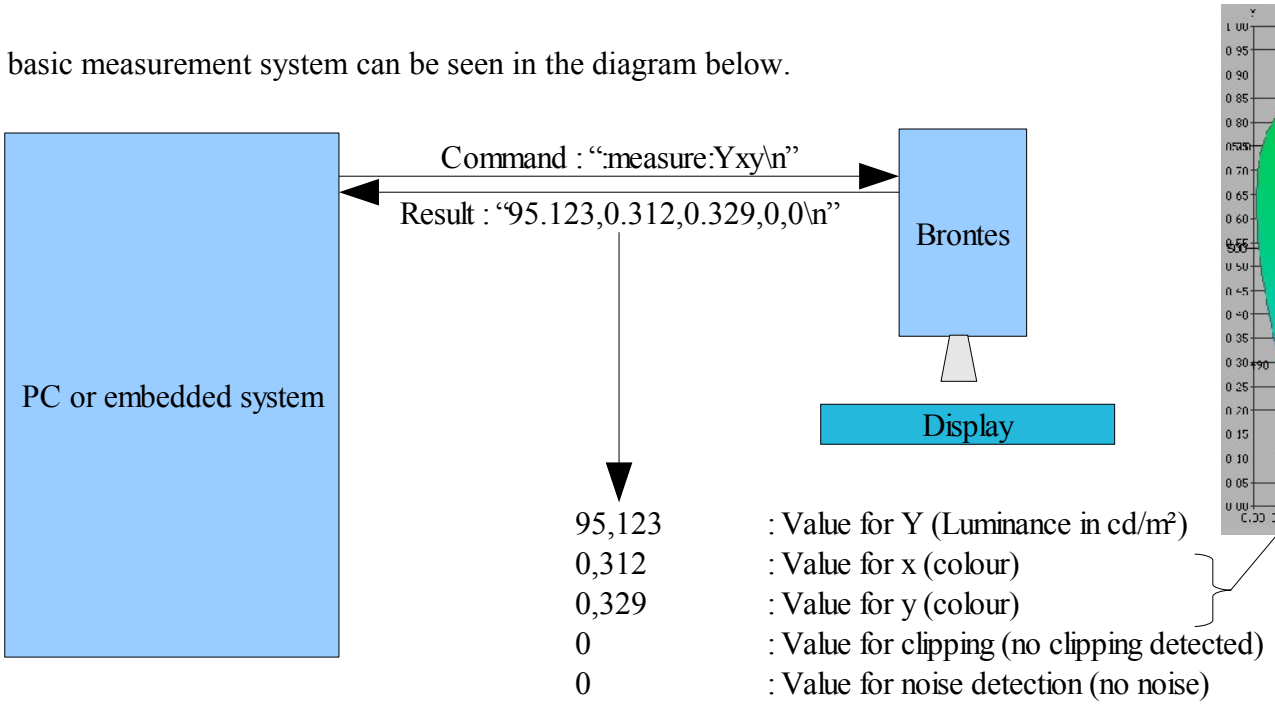
- White point adjustment
- Gamma correction (measure gamma and adjust)
- Contrast trimming (find optimum contrast setting)
- Flicker trimming (adjust to lowest flicker level)

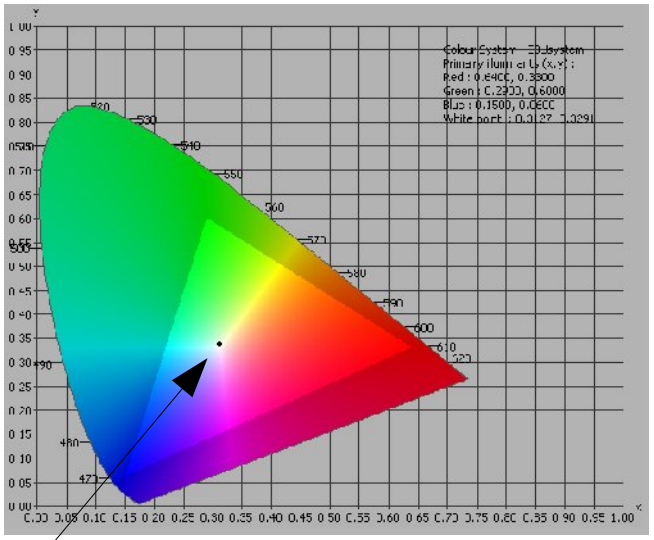
3 CRT measurements

Regarding CRT it's also possible to measure colour, contrast and gamma curves.

4 Measurement system

The basic measurement system can be seen in the diagram below.





The Brontes can be used on a PC for data logging or be connected to an embedded system to allow for a small size setup.

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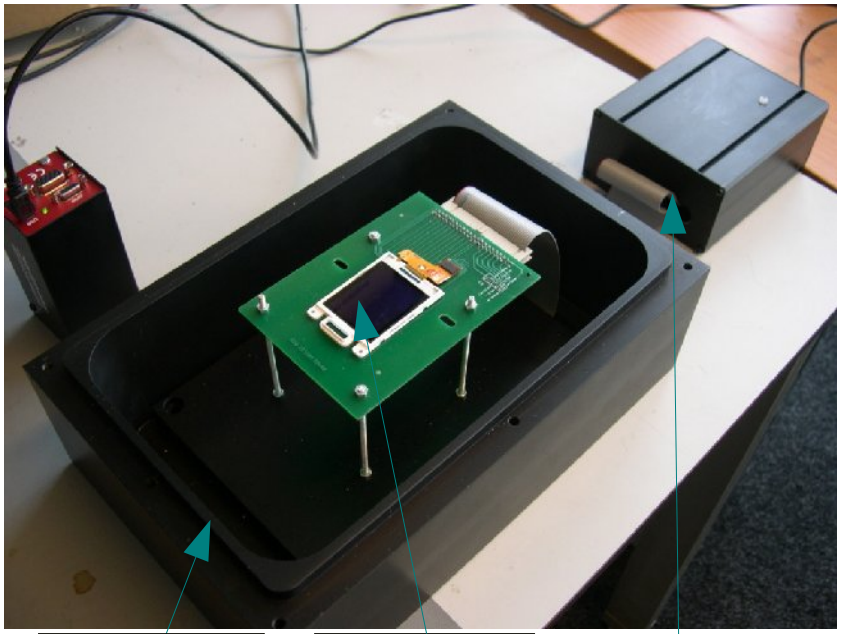
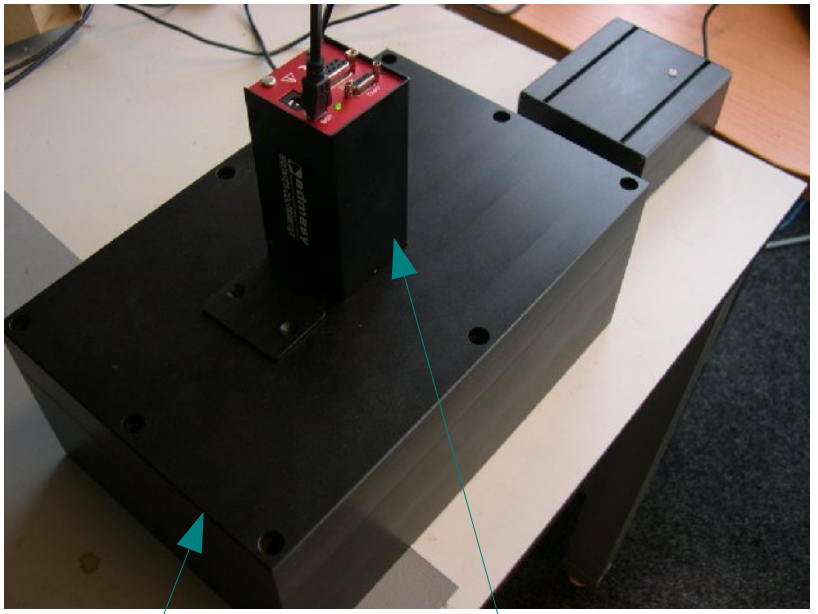
The pictures below show an example configuration to measure small LCD displays (mobile phone). Of course, measurement examples also apply to large displays.





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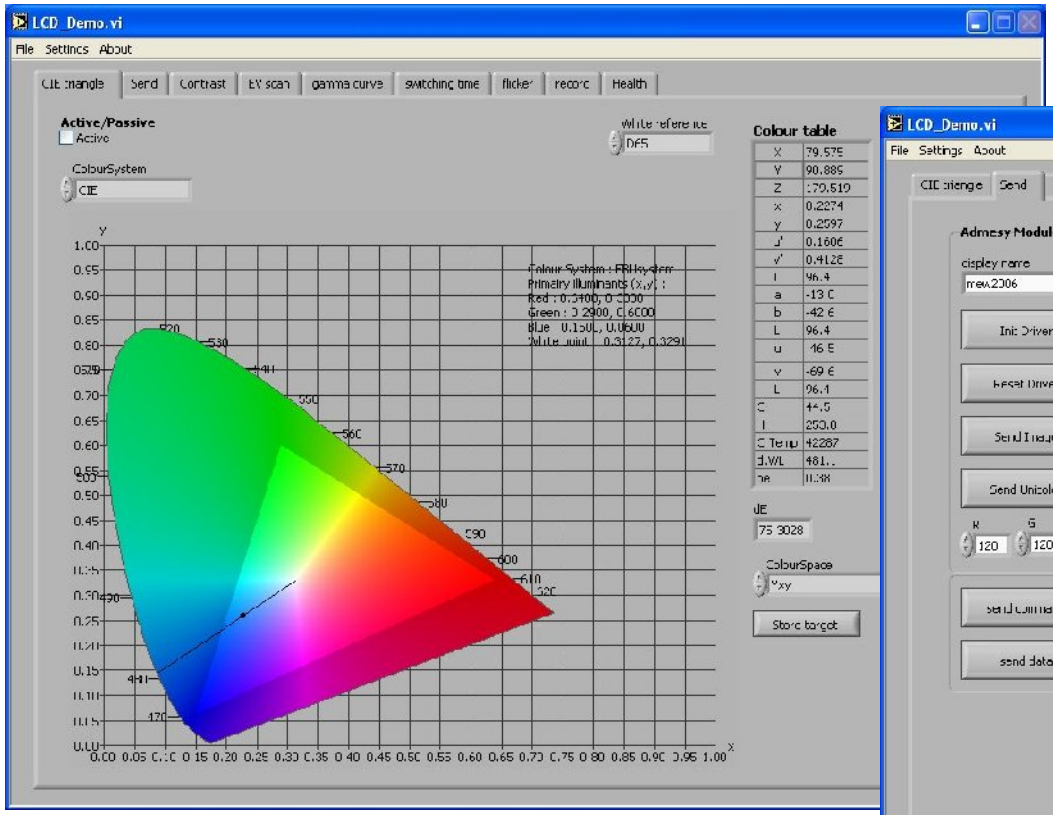
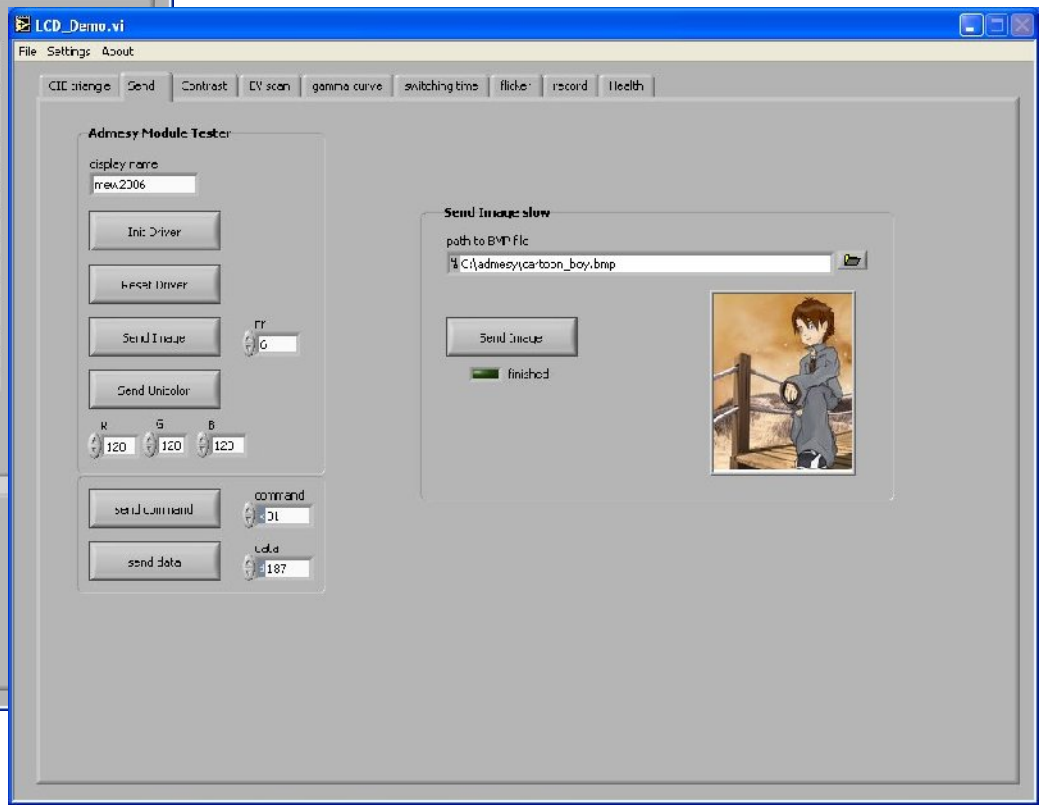


Display colour measurement

Controlling the display via the display control unit.



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5 LCD demo software

The information in this application note is based on a demo software package which includes an Admesy in-house build control unit to control small size LCD panels (mobile displays). Although the software is made specifically to control this type of display, Admesy can offer custom software for other types of display control units.

5.1 Luminance measurement

A display light output is mostly specified in cd/m² (or nit). The Brontes measuring luminance in this unit and can therefore be used directly as a luminance measurement device (unit of Y is cd/m²)

The Brontes also contains a fast luminance measurement mode, which is not in cd/m² but in raw ADC counts. This mode can be used to monitor for PWM of backlights or other frequency domain related parameters.

Effects like crosstalk in displays can often be measured using a correct test image and comparing luminance values between images. For example on passive LCD's a white image should out put the same luminance as just a small white square in the middle of the panel. Since each image causes a different load on the driver IC, it can be the cause for different luminance values in the two images.

5.2 Colour measurement

Colour measurement on displays usually consists of measuring it's primary colours (R,G and B) and it's white point.

The relation between R,G and B determines the display's white point. By measuring R, G and B, the white point can be calculated. The following formulas show this principle.

$$\begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{White} = \begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{Red} + \begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{Green} + \begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{Blue}$$

5.3 Contrast ratio measurement

Contrast ratio is defined as the ratio of luminance of the bright and dark state of a display.

$$CR = \frac{Ybright}{Ydark}$$

The bright state should be a full white image (R,G,B = 255) and the dark state should be a black image (R,G,B = 0).

Many displays contain settings for contrast optimisation. The below screenshot shows a measurement of a display scan of the contrast parameter.

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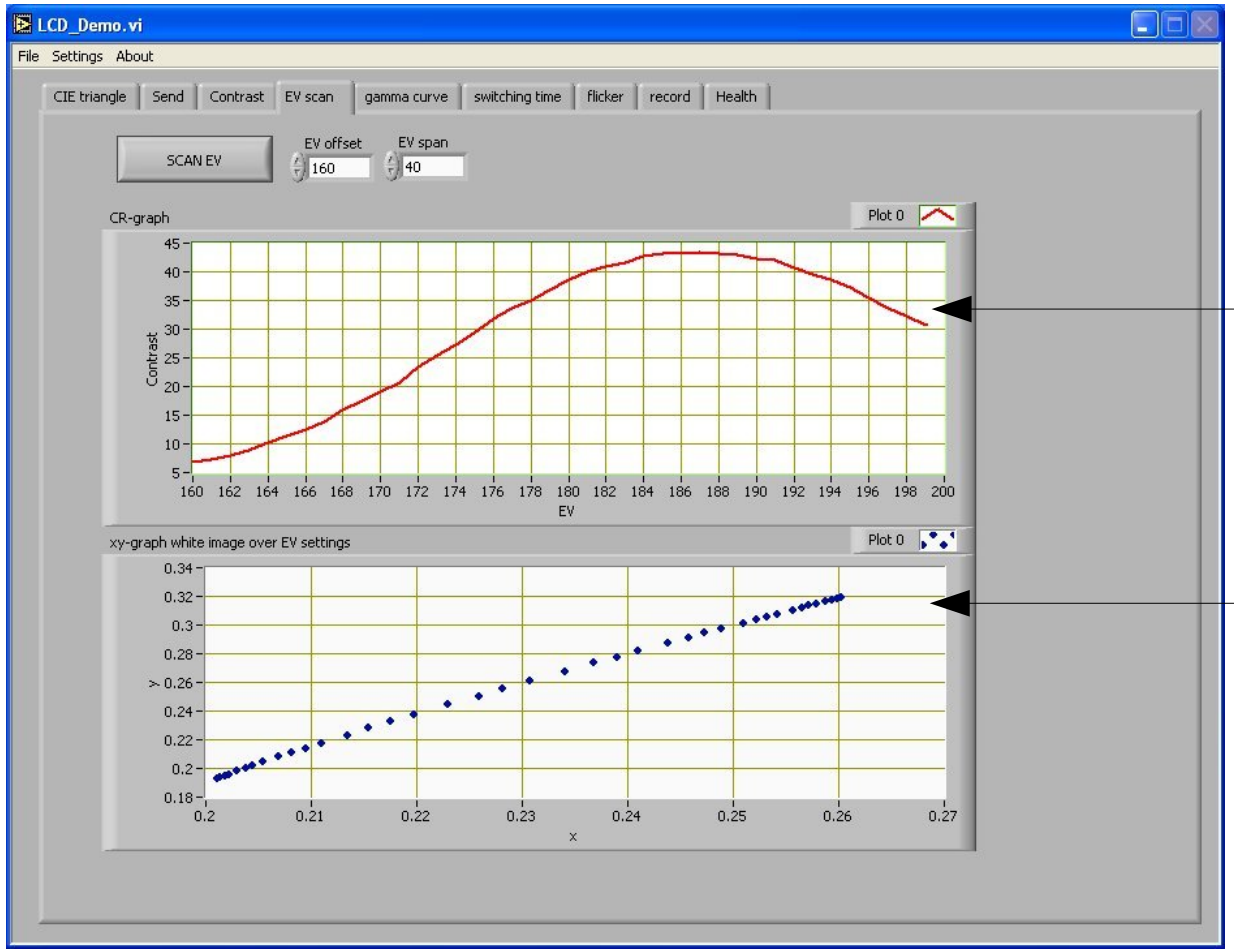

Contrast scan to find optimum setting

White point shift due to contrast parameter change.
Note : the measured sample is a low end CSTN display.

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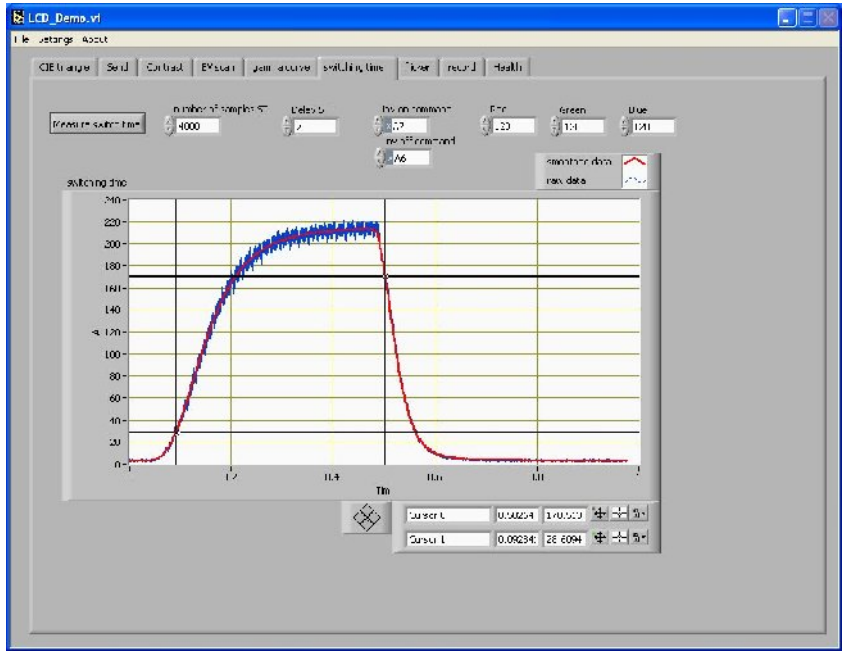
5.4 Switching time

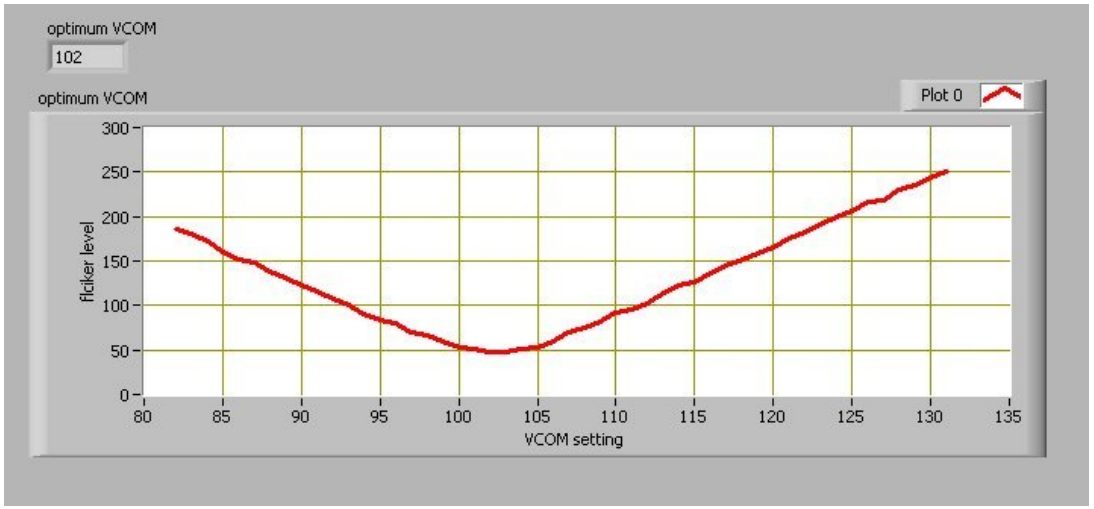
Measuring switching time requires a fast measurement device. Most spectrometers are not fast enough to measure accurate switching times of todays LCD panels. The Brontes can measure luminance at 18kHz, which is fast enough to measure complete transition curves of an LCD switching on and off. The screenshot below shows the switching characteristic of a CSTN display (mobile phone application).



5.5 Flicker measurement

Offset in DC levels in TFT displays can cause flickering of the display. This effect can be seen by the human eye in case the frequency is low enough and it can also be a cause for effects like image retention or reduce lifetime of the display. Same as for switching time, this measurement requires fast measurement which can not be offered by spectrometers.

Since this effect is a frequency domain effect, the Brontes should be used in fast luminance mode to measure this effect. It is possible to measure flicker based on FFT or by RMS behaviour of the signal. The below graph shows a flicker adjust application which adjusts the display to it's lowest flicker level by adjusting the common voltage level (Vcom).



5.6 Other frequency domain measurements

Driving schemes and the LCD backlight PWM may cause other optical effects, which often can be analysed using a fast optical measurement. The below screenshot shows a measurement of an LCD panel with a particular driving scheme that causes a high frequency optical variation. With the use of FFT, the signal can be analysed and judged.

6 Considerations

The LCD application presented in this paper allows LCD manufacturers to test and adjust their display. It is not meant to generate ICC profiles. In case this is a necessity, please contact Admesy B.V. for an appropriate solution.