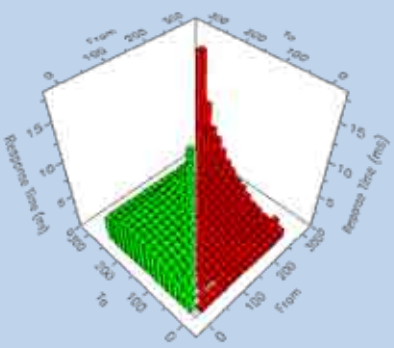
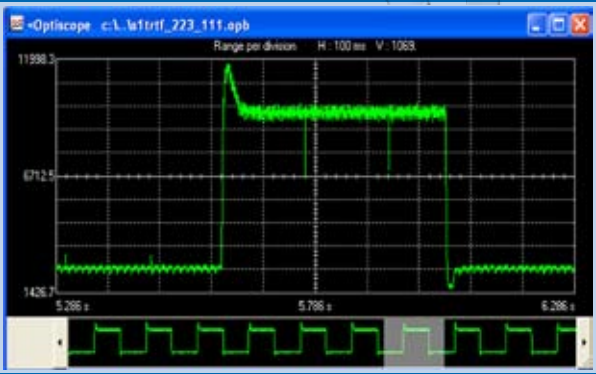
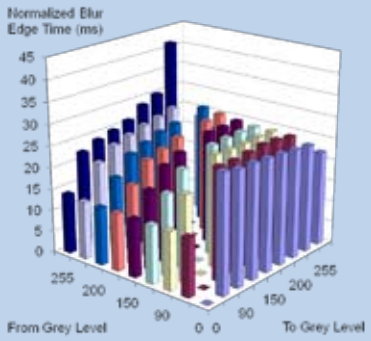
Response Time

Luminance, MPRT, Gamma, Flicker





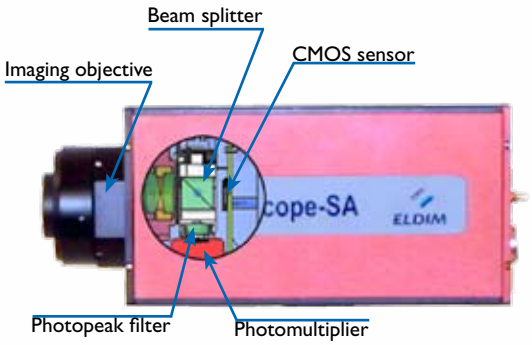


World leader system for full analysis of display temporal behavior

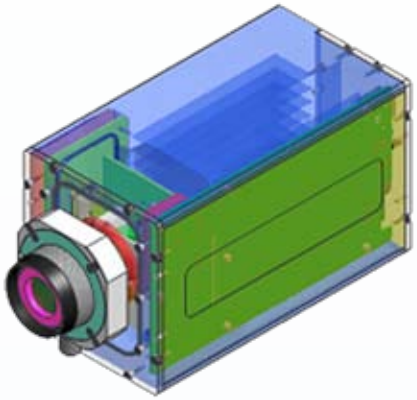
OPTIScope-SA & OPTIScope-Lite

ADVANCED LIGHT ANALYSIS by ELDIM

OPTIScope-SA system



Cross section



Side view

OPTIScope-Lite system

Light collection and temporal analysis

OPTIScope-SA looks like a conventional camera but includes all the hardware needed for temporal and luminance measurements. An imaging objective collects the light in a angular aperture of ±1° following VESA standard. An image of the target is obtained with a color CMOS sensor.
Part of the light goes on a photomultiplier across a photo peak filter. The system can also measure absolute luminance measurements thanks to an internal autocalibration device that readjust the photomultiplier sensitivity on a reference photodiode. The OPTIScope-SA can be used at various distances from the display down to ~30cm.

Easy to use

OPTIScope-SA comes with a easy to use software for adjustment and automated measurements. Driving of any type of display can be realized using standard signal generators or ELDIM dedicated FPDLite or FPDDrive solutions.

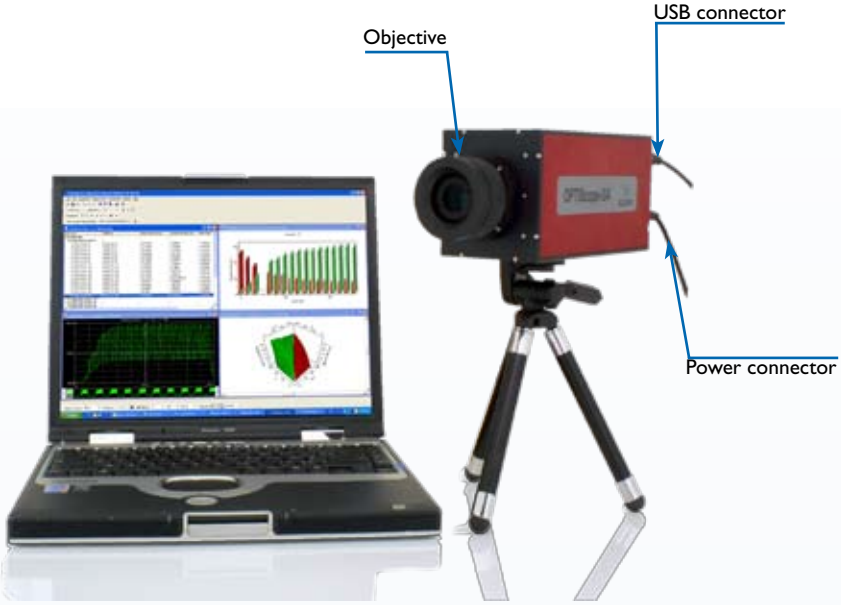
High sensitivity

OPTIScope-SA includes a high sensitivity photomultiplier to allows reliable measurements even for very low light levels. Luminance down to 0.0001Cd/m2 can be measured easily.

Absolute self calibration

The system includes a dedicated filter to match Y CIE curve as closely as possible. Self calibration of the photomultiplier response is made using a calibrated photodiode and a LED source included in the system. These features allow an excellent accuracy and repeatability even for very low light levels.

OPTIScope-Lite is a cost effective version of OPTIScope-SA which includes the same light detection and electronics without self calibration and CMOS camera. It is dedicated to flicker adjustment and response time measurements only.



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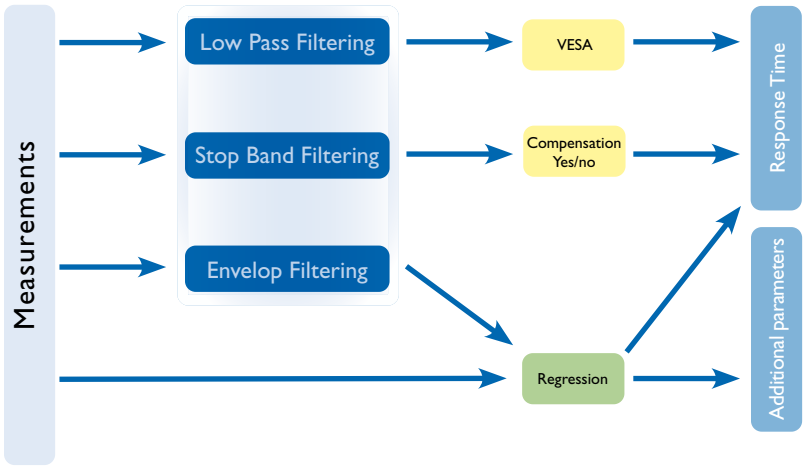
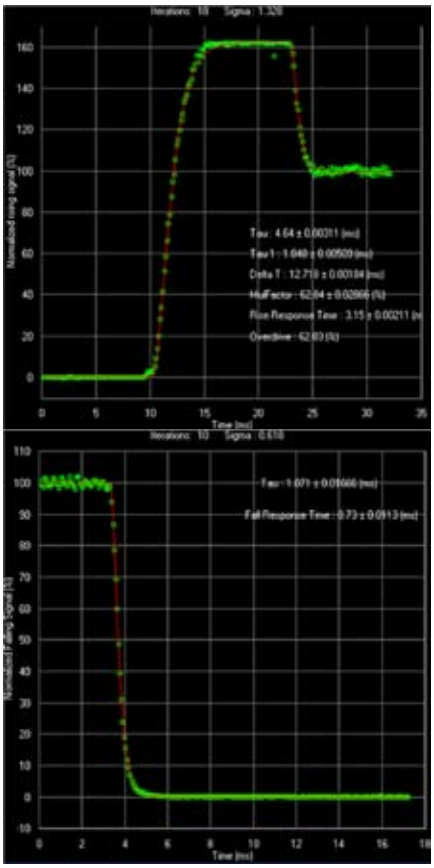
Signal analysis and grey to grey response time

temporal response of an over-drived LCD between two grey levels

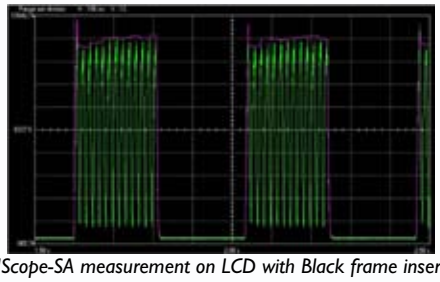
OPTIScope comes with a complete and sophisticated solution for measurement analysis and response time extraction. VESA procedure and low pass and stop band filtering can be applied. Response time compensation due to low pass filtering is also available. Direct regression with different mathematical models can be used to extract more precisely response time values and additional parameters related to the shape of the temporal behaviors (overdrive, underdrive…). Dedicated algorithms adapted to specific signals are also available. Displays with black frame insertion can be analysed with envelop filtering for example.



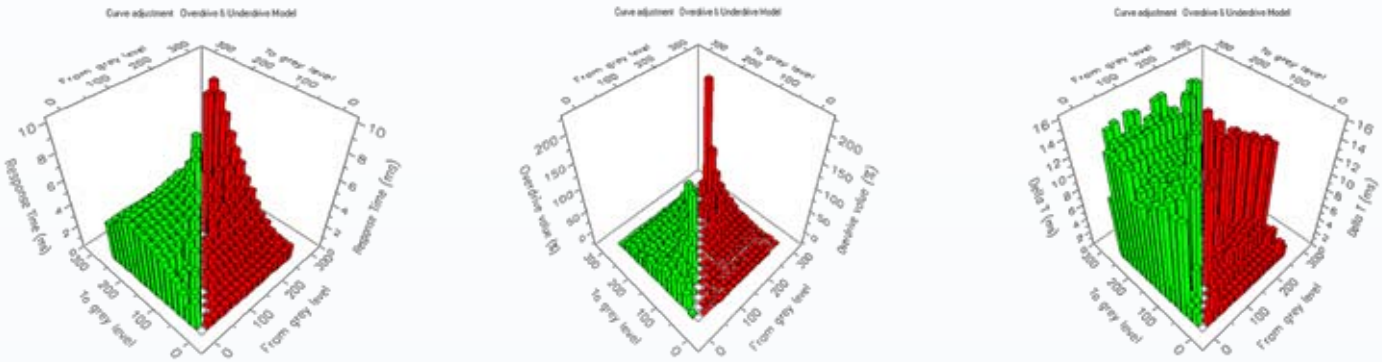


Regression with over-drive for rising edge and with simple model for falling edge

Direct regression of theoretical behaviors on measured profiles present many advantages. The response time is more precisely determined with a direct estimation of the error. More parameters can be extracted like over-drive and under-drive amplitudes, time delay for over-drive application… and custom behaviors can be treated.

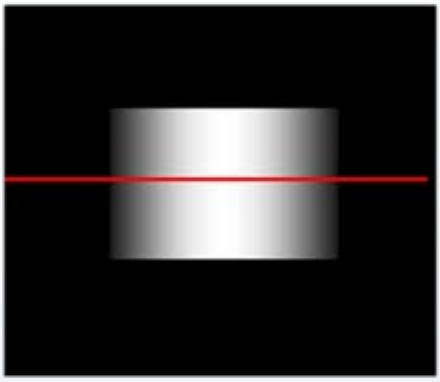


OPTIScope-SA measurement on LCD with Black frame insertion. Envelop filter is applied to determine the response times.

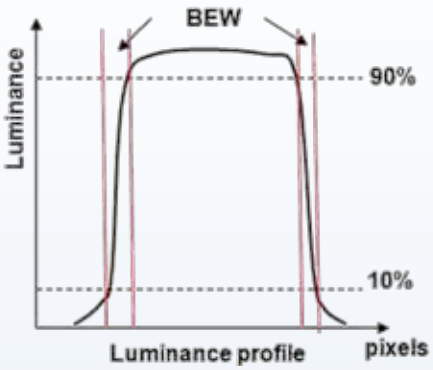


Grey to grey full analysis with under-drive and over-drive model

Original object



Perceived object



Moving Picture Response Time (MPRT)

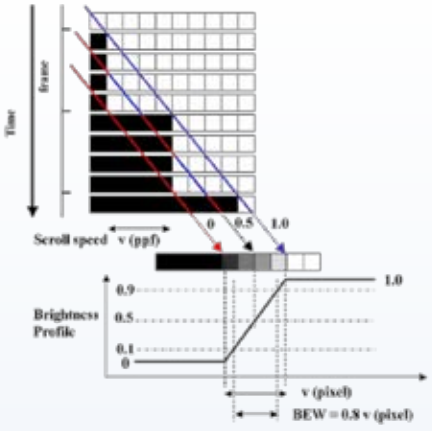
One of the main motion artifacts on flat panel displays is motion blur. The new VESA FPDM section addressing this problem introduces moving edge-blur that can be measured by various instruments like pursuit cameras. This evaluation is near the real conditions but generally tedious and expensive due to the cost of the instruments and their complexity. It results in moving picture response time behaviors versus gray levels generally measured in very strict moving configurations. OPTIScope offers the possibility to simulate moving edge blur taking into account the driving properties for the display and the measured grey to grey temporal behaviors. The simulation module is included in the measurement and analysis DisplaySpec software provided with OPTIScope.

If Y(x,t) is the luminance temporal dependence of pixel x from gray level 1 to gray level 2, and if we assume that the response time is lower than the time frame Tf, the light intensity profile V(x) as perceived by the eyes of a block of pixels v pixels moving at a scroll velocity of v pixels/frame can be calculated by :

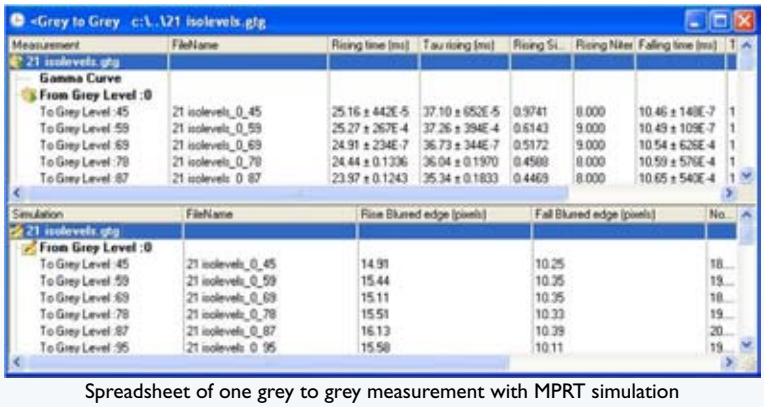
$$V_0(x) = \frac{1}{T_f} \sum_{x'=0}^{n-1} \int_{(x'-x)T_f/n}^{(x'-x+1)T_f/n} Y(x',t)dt$$

If the LCD has an ideal response time the result is schematically represented in the figure below. In general it is not the case and the Blurred Edge width (BEW) is bigger than 0.8 v. If the response time is higher than the time frame Tf, we apply the same formula for a number of frames comparable to the response time. No assumption is made on the luminance temporal dependence and we take directly the mean profile measured by OPTIScope-SA.

Calculation are made automatically between each gray levels used during the measurement. The scroll velocity is a parameter. The time frame is supposed known. Blurred edge widths are then evaluated (generally between 10 and 90% of the luminance) both for rising and falling edges. Normalized blurred edge time (NBET=BEW/v) can be also deduced which are quasi independent of the scrolling velocity.



Schematic diagram of the MPRT simulation



Spreadsheet of one grey to grey measurement with MPRT simulation

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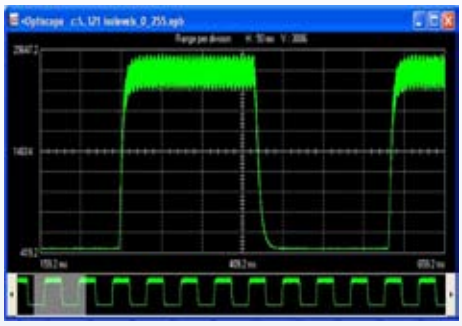
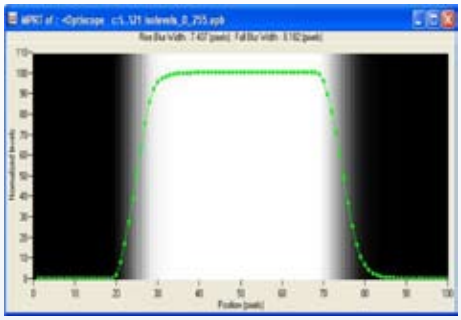
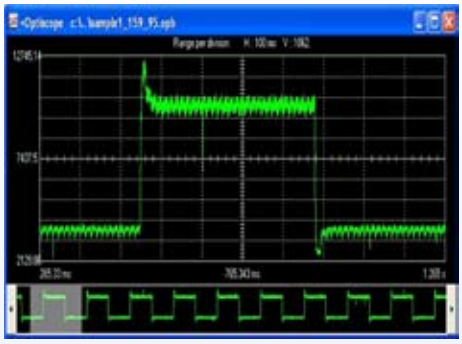


Measured temporal behavior for LCD1

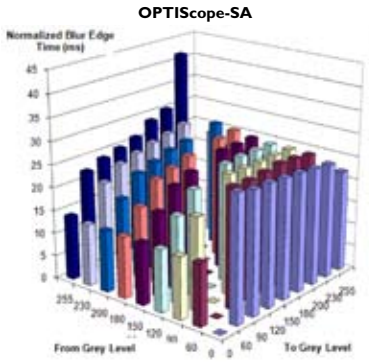


Simulation MPRT profile for LCD1

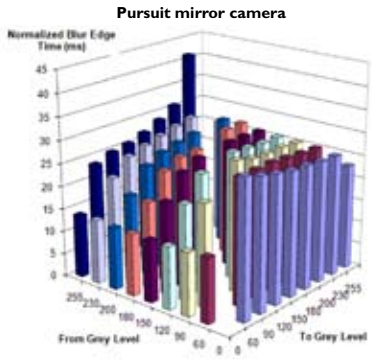


Measured temporal behavior for LCD2

Comparison of MPRT simulation using OPTIScope-SA and direct measurement using Pursuit mirror camera from Dedicated MPRT system has been realized on different displays.

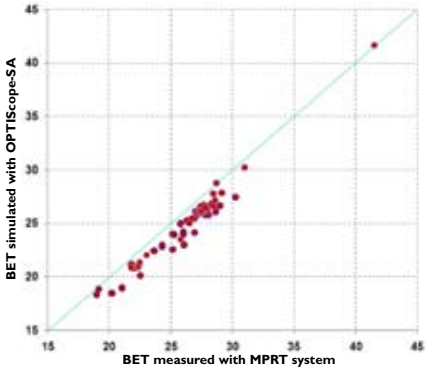


MPRT blur edge time calculated with OPTIScope-SA measurements

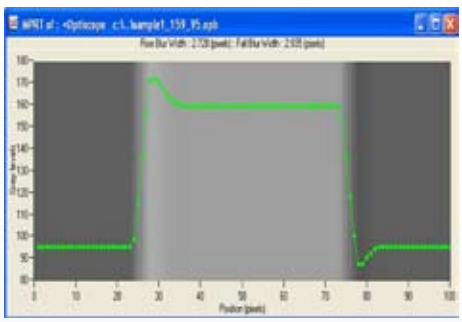


MPRT blur edge time calculated with Dedicated MPRT system

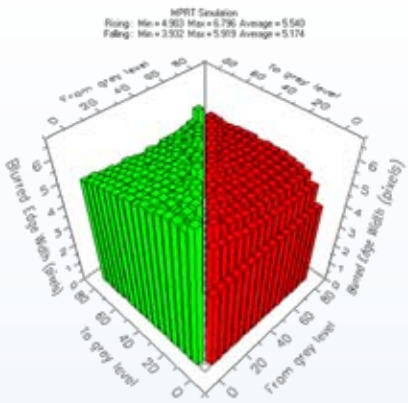
Results agree generally reasonably well for all the grey levels used in the measurements. There is nevertheless always some underestimation of the calculation using OPTIScope-SA data since driving and pursue process are always assumed ideal in the computation.



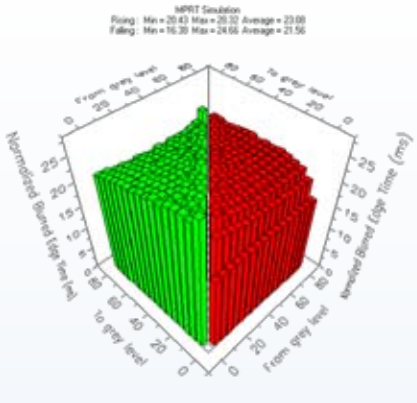
Comparaison of MPRT calculated with OPTIScope-SA data and MPRT measured with Pursuit mirror camera system equipment



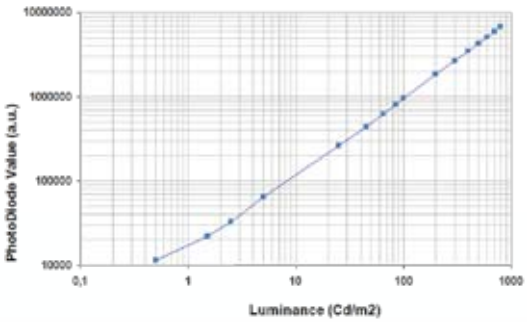
Simulation MPRT profile for LCD2



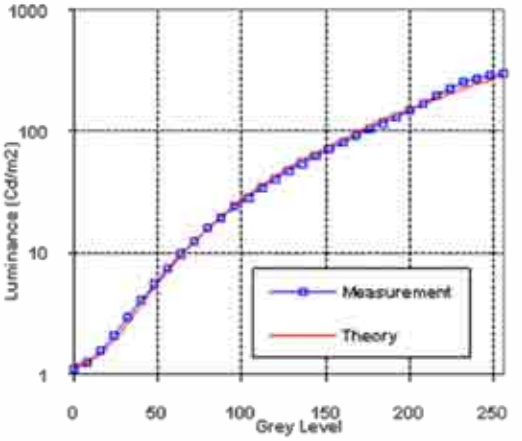
Normalized blurred edge width versus grey levels



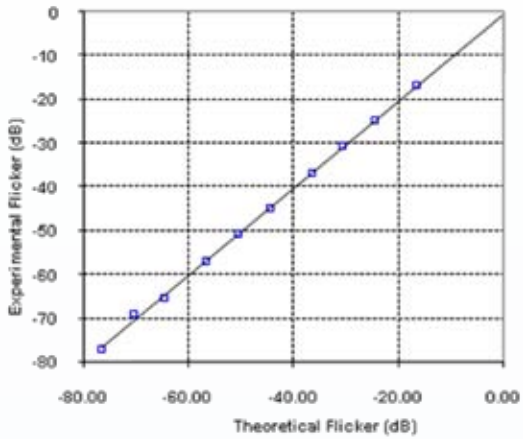
Normalized blurred edge time versus grey levels



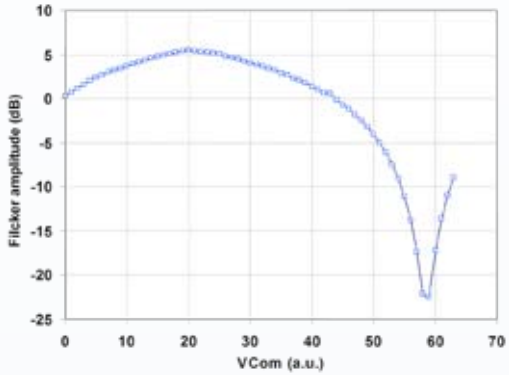
Photodiode calibration



Measured gamma curve of a LCD display



Measured flicker versus theoretical flicker generated on LED source



OPTIScope measurement of flicker versus Vcom voltage : accurate adjustment of Vcom voltage becomes possible

Luminance, Gamma curves and Flicker

Response time measurements are generally made between one grey level to another grey level. Complete analysis is made with a step in grey levels from 0 to 255 (for example 16 levels). Nevertheless, the observer is not concerned by the grey level value but moreover with the luminance emitted by the display for this grey level. It is more efficient to make the response time analysis with fixed steps in luminance instead of fixed steps in grey level.

Self calibration

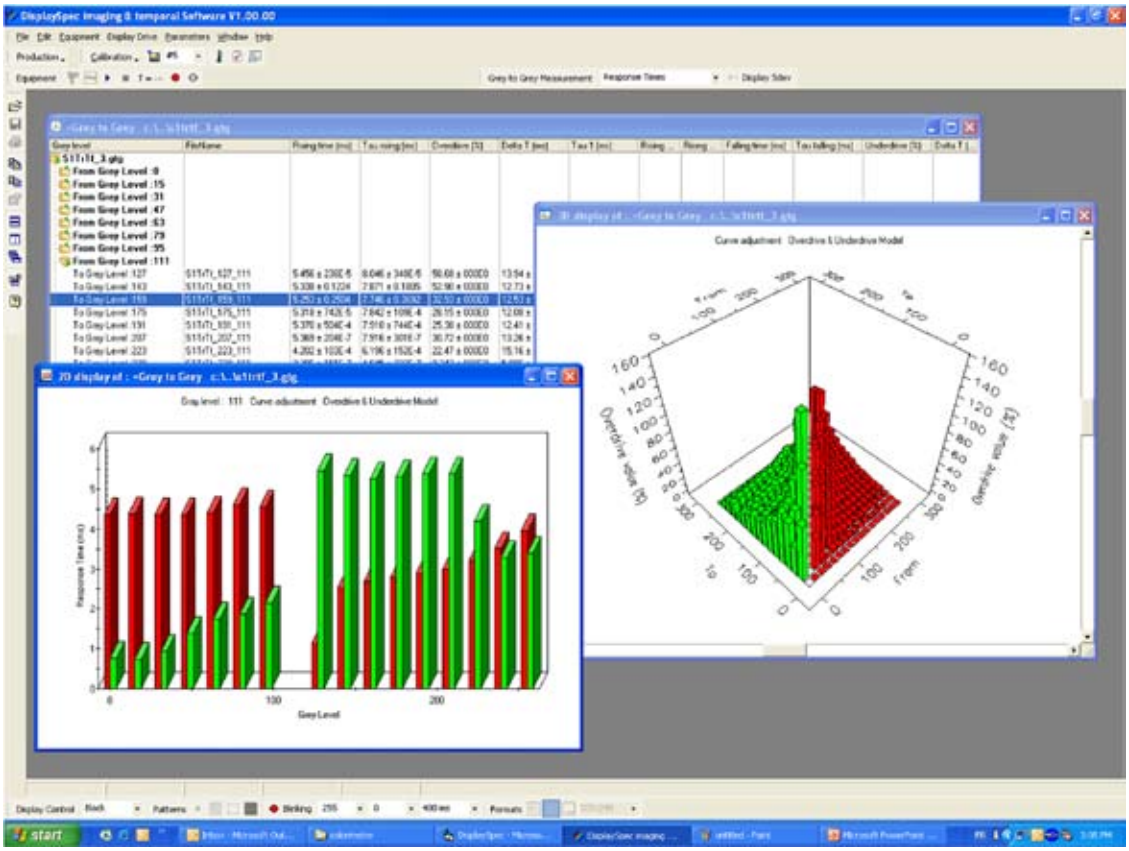
OPTIScope-SA includes a photopeak filter adapted to the photomultiplier spectral response and a self calibration device that allows to measure the light detected by the photomultiplier directly in luminance. Before making a luminance measurement the amplification of the photomultiplier is adapted to the signal and corresponding absolute amplification is measured with a calibrated photodiode.

Ultra high sensitivity

OPTIScope includes one of the most sensitive photomultiplier tube available on the market up to now. Very low intensities down to 0.0001 Cd/m^2 can be measured accurately with this system.

Flicker measurement

Very low flicker levels can be detected down to -80dB as demonstrated using a computer driven LED source.



OPTIScope comes with a complete software solution for automated measurement and data analysis. All the features can be also addressed by other softwares using ActiveX capacities. Programming examples are provided with the software.

Some characteristics of the DisplaySpec software package

Features	Details	ActiveX	Version	System
Visualisation	Color video mode	No	Standard	SA
Display Control	Use of FPDDrive and FPDLite ELDIM generators	Yes	Standard	SA & Lite
	Use ASTRO generators	Yes	Standard	SA & Lite
	Custom generators via DLL link	Yes	Standard	SA & Lite
Measurement Capacities	Grey to grey response time	Yes	Standard	SA & Lite
	Luminance & Gamma curve	Yes	Standard	SA
	Iso-Luminance grey to grey response time	Yes	Standard	SA
	Flicker	Yes	Standard	SA & Lite
Measurement Analysis	Data filtering (low pass, stop band, envelop,…)	Yes	Standard	SA & Lite
	Regression (standard shape, over-drive and under-drive)	Yes	Standard	SA & Lite
	VESA standard	Yes	Standard	SA & Lite
	Export of 2D and 3D graphs and data to Excel	Yes	Standard	SA & Lite
MPRT calculation	For one grey to grey response time	Yes	Option	SA & Lite
	For one grey level to all others	Yes	Option	SA & Lite
	For all grey levels to all grey levels	Yes	Option	SA & Lite
	Blur edge width and blur edge time	Yes	Option	SA & Lite
	Export of 2D and 3D graphs and data to Excel	Yes	Option	SA & Lite

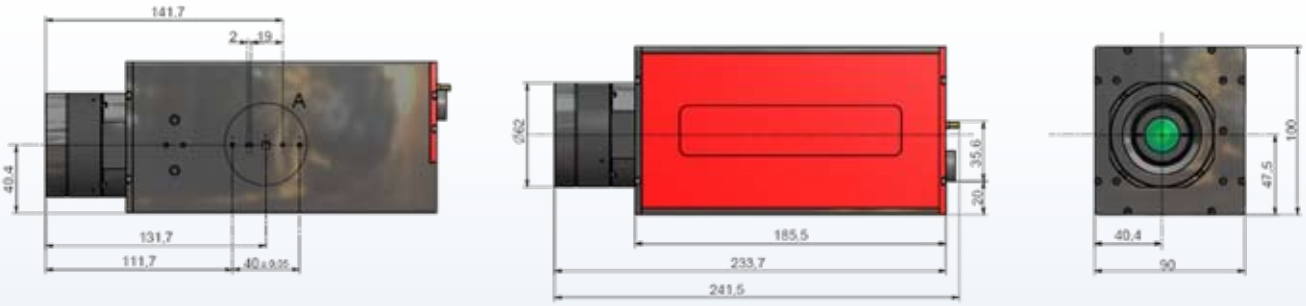
Major specifications of OPTIScope Series

Common specifications		OPTIScope-SA	OPTIScope-Lite
Detector	*Low noise photomultiplier*	Autorange or fixed range for PM Autozero and noise correction by shutter	
Light collection	*Angular aperture* *Working distance* *Spot size diameter*	±1° (VESA) 30cm - 100cm 17mm at 50cm	±5° 5cm - 30cm 17mm at 10cm
Imaging	*For spot location*	Color CMOS sensor	Not available
Digitizer	*bits number* *Sampling interval* *Memory* *Triggering*	16 bits + digital filtering and subsampling 5-20µs (typical 16µs) 4M on board memory Internal or external	
Luminance	*Calibration* *Accuracy* *Repeatability* *Minimum Luminance* *Maximum Luminance*	Autocalibration with internal LED and photodiode ±3% (*) ±1% (*) 0.0001Cd/m² 10000	Not available
Interface		USB 2.0	
Power		AC adapter (100-240V 50/60Hz)	
Current consumption		30W	
Weight		2Kg	1.5Kg

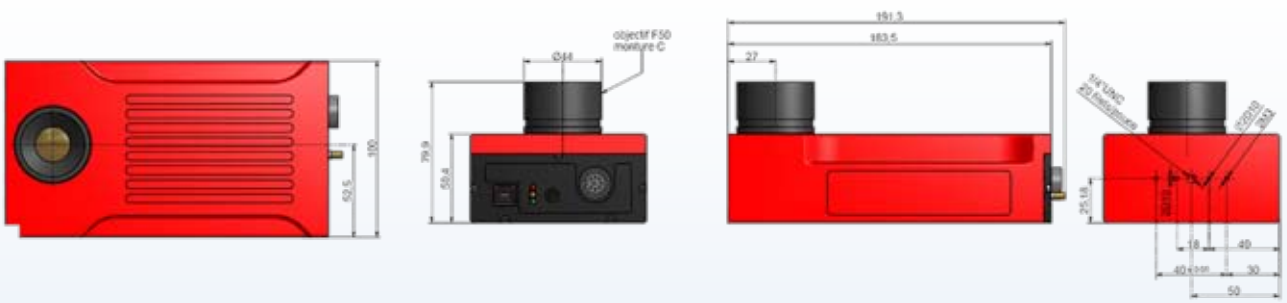
* For A type illuminant with 100Cd/m²

Outer dimension (unit mm)

OPTIScope-SA



OPTIScope-Lite



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