

**Lamp measurement report – 22 Nov 2010**

Led lamp SLX-5WB2L-E27 warm white

by  
SoLuXima



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### Summary measurement data

parameter	meas. result	remark
Color temperature	3428 K	Warm white (close to neutral white)
Luminous intensity $I_v$	36.7 Cd	Measured straight underneath the lamp.
Illuminance modulation index	23 %	Measured straight underneath the lamp. Is a measure for the amount of flickering.
Beam angle	164 deg	164° for all C-planes.
Power P	4.9 W	
Power Factor	0.51	For every 1 kWh net power consumed, there has been 1.7 kVAhr for reactive power.
THD	134 %	Total Harmonic Distortion
Luminous flux	209 Lm	
Luminous efficacy	42 Lm/W	
EU-label classification	A	The energy class, from A (more efficient) to G (least efficient).
CRI_Ra	67	Color Rendering Index.
Coordinates chromaticity diagram	x=0.4053 and y=0.3844	
Fitting	E27	This lamp is connected to the 230 V grid voltage.
PAR-value	0.3 $\mu\text{Mol/s/m}^2$	The number of photons seen by an average plant when it is lit by the light of this light bulb. Value valid at 1 m distance from light bulb.
PAR-photon efficacy	0.3 $\mu\text{Mol/s/W}_e$	The total emitted number of photons by this light, divided by its consumption in W. It indicates a kind of efficacy in generating photons.

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S/P ratio	1.4	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (low environmental light level).
D x H external dimensions	59 x 120 mm	External dimensions of the lamp.
D x H luminous area	59 x 29 mm	Dimensions of the luminous area (used in Eulumdat file). This is the surface of glass surrounding the leds.
General remarks		<p>The ambient temperature during the whole set of illuminance measurements was 23-24.5 deg C.</p> <p>The temperature of the hottest area between the fins of the heatsink gets about 30 degrees hotter. Warm up effect: during the warm up time the illuminance decreases with 8 % and the consumed power with about 4 %.</p> <p>Voltage dependency: the power consumption and illuminance do not vary significantly when the power voltage varies between 200-250 V.</p>



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### Overview table

m.	Ø 50%		C0-180: 164° C90-270: 164°	E (lux)	Luminaire Efficacy
	C0-180	C90-270			42 (lumen per Watt)
0.25	3.58	3.58		587	Half-peak diam C0-180
0.5	7.16	7.16		147	14.33 x diameter(m)
1	14.33	14.33		37	Half-peak diam C90-270
1.5	21.49	21.49		16	14.33 x diameter(m)
3	42.98	42.98		4	Illuminance
4	57.3	57.3		2	37 / distance <sup>2</sup> (lux)
5	71.63	71.63		1	Total Output
					209 (lumen)

The overview table is explained on the OliNo website.

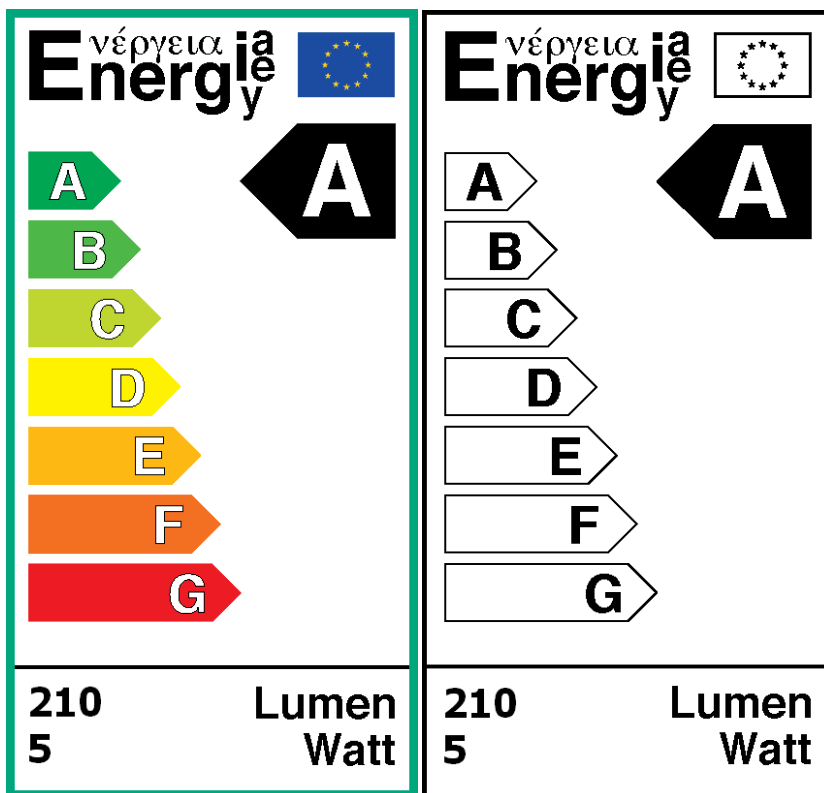
Please note that this overview table makes use of calculations, use this data with care as explained on the OliNo site. E (lux) values are not accurate, when within 5 x 59 mm (diagonal length) ≈ 300 mm. Within this distance from the lamp, the measured lux values will be less than the computed values in this overview as the measurements are then within the near field of the lamp.

### EU Energy label classification

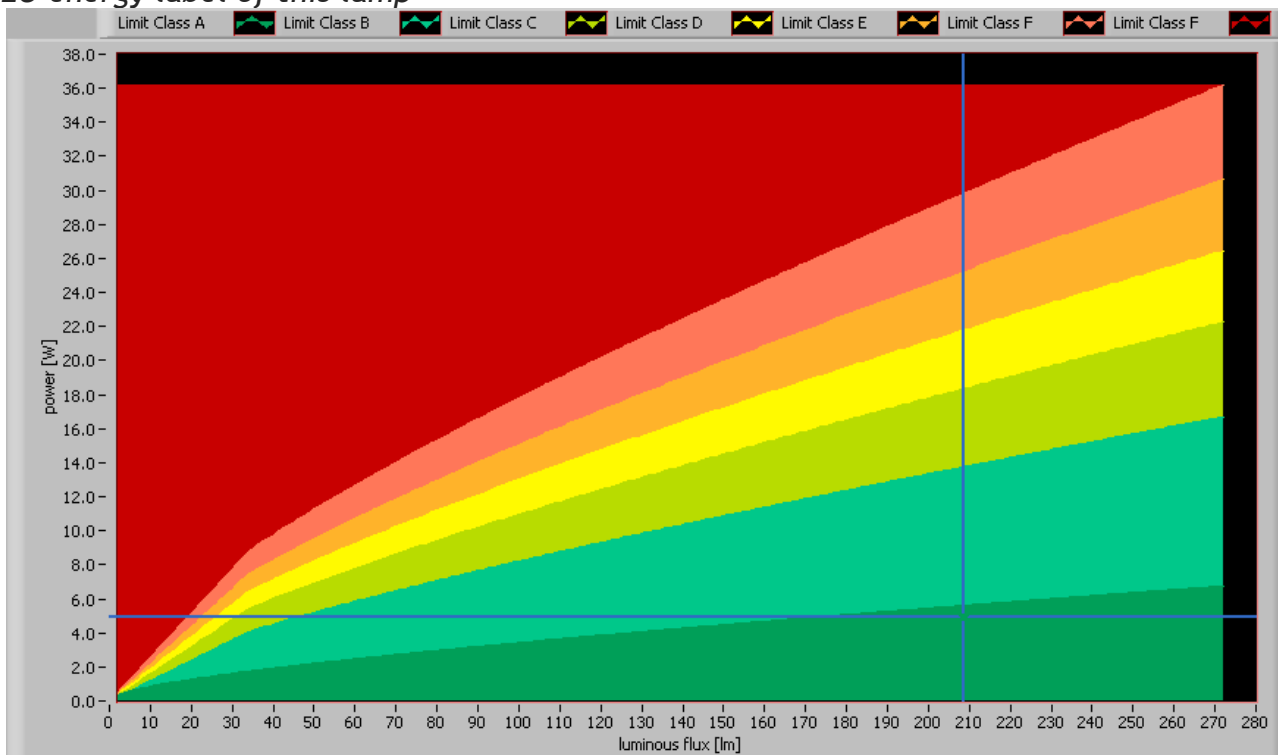
With the measurement results of the luminous flux and the consumed power the classification on energy of this lamp is calculated. This information is requested in the EU for certain household lamps, see also the OliNo site that explains for which lamps it is requested, how the label looks like and what information it needs to contain.

Herewith the labels for this lamp in color and black and white.

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EU energy label of this lamp



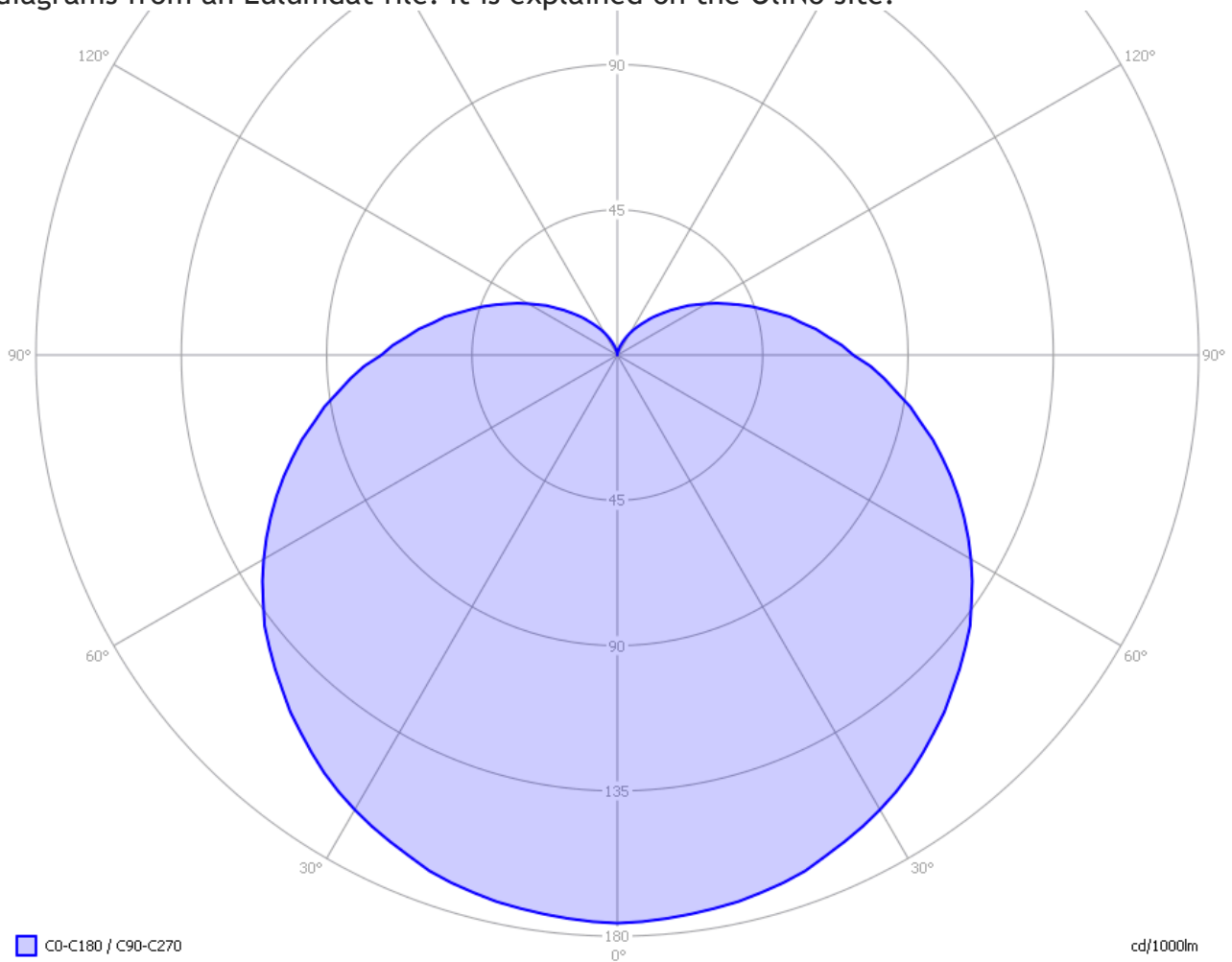
The lamp's performance in the lumen-Watt field, with the energy efficacy fields

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indicated.

### Eulumdat light diagram

This light diagram below comes from the program Qlumedit, that extracts these diagrams from an Eulumdat file. It is explained on the OliNo site.



*The light diagram giving the radiation pattern.*

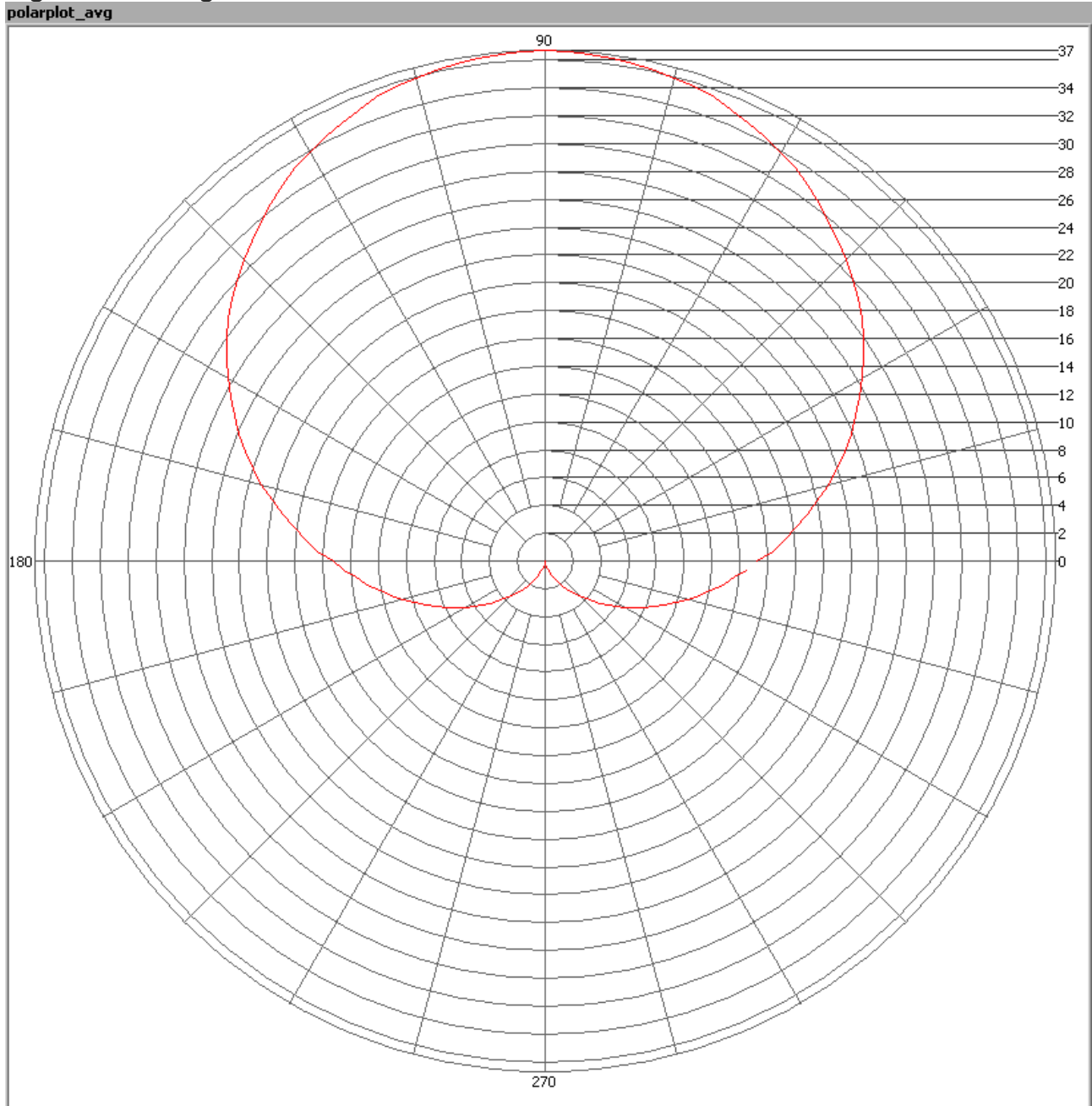
It indicates the luminous intensity around the light bulb. All the planes give the same results as the lamp is symmetrical along its 1st axis.

### Illuminance $E_v$ at 1 m distance, or luminous intensity $I_v$

Herewith the plot of the *averaged* luminous intensity  $I_v$  as a function of the inclination

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angle with the light bulb.

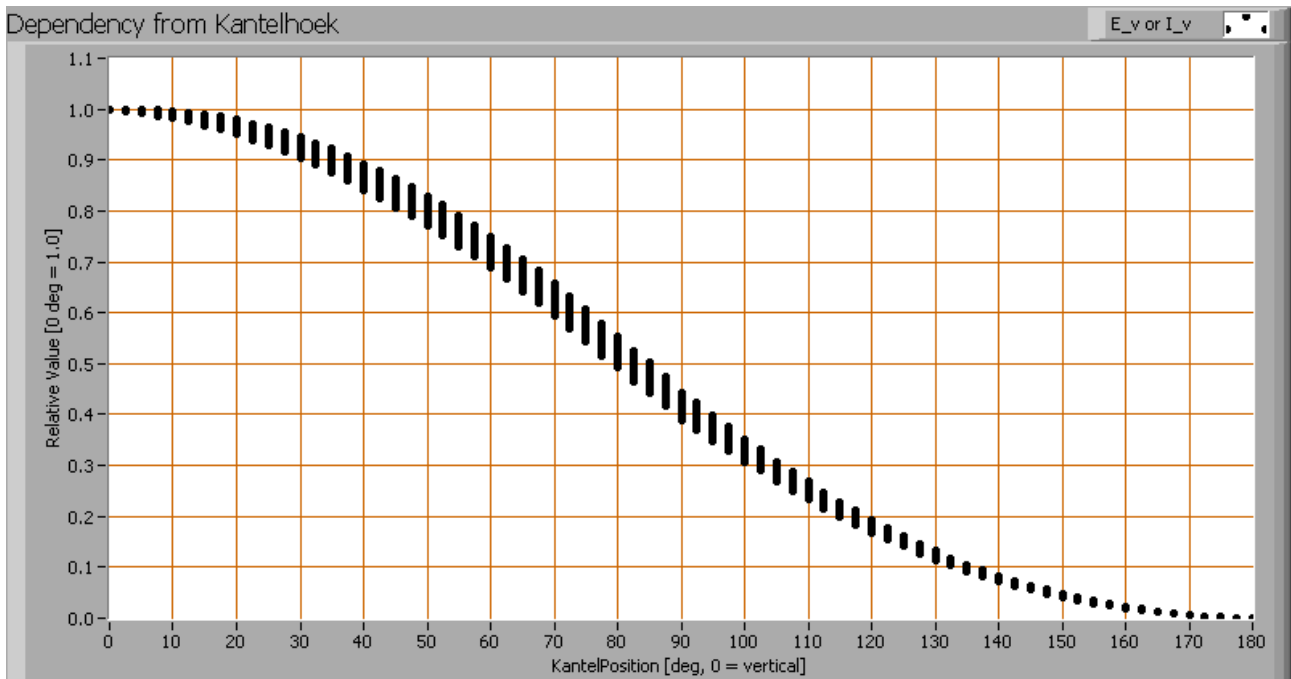


*The radiation pattern of the light bulb.*

This radiation pattern is the average of the light output of the light diagram given earlier. Also, in this graph the luminous intensity is given in Cd.

These averaged values are used (later) to compute the lumen output.

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*Intensity data of every measured turn angle at each inclination angle.*

This plot shows per inclination angle the intensity measurement results for each turn angle at that inclination angle. There normally are differences in illuminance values for different turn angles. However for further calculations the averaged values will be used. When using the average values per inclination angle, the beam angle can be computed, being 164° for all C-planes looked at.

### Luminous flux

With the averaged illuminance data at 1 m distance, taken from the graph showing the averaged radiation pattern, it is possible to compute the luminous flux.

The result of this computation for this light spot is a luminous flux of 209 Lm.

### Luminous efficacy

The luminous flux being 209 Lm, and the power of the light bulb being 4.9 W, yields a luminous efficacy of 42 Lm/W.



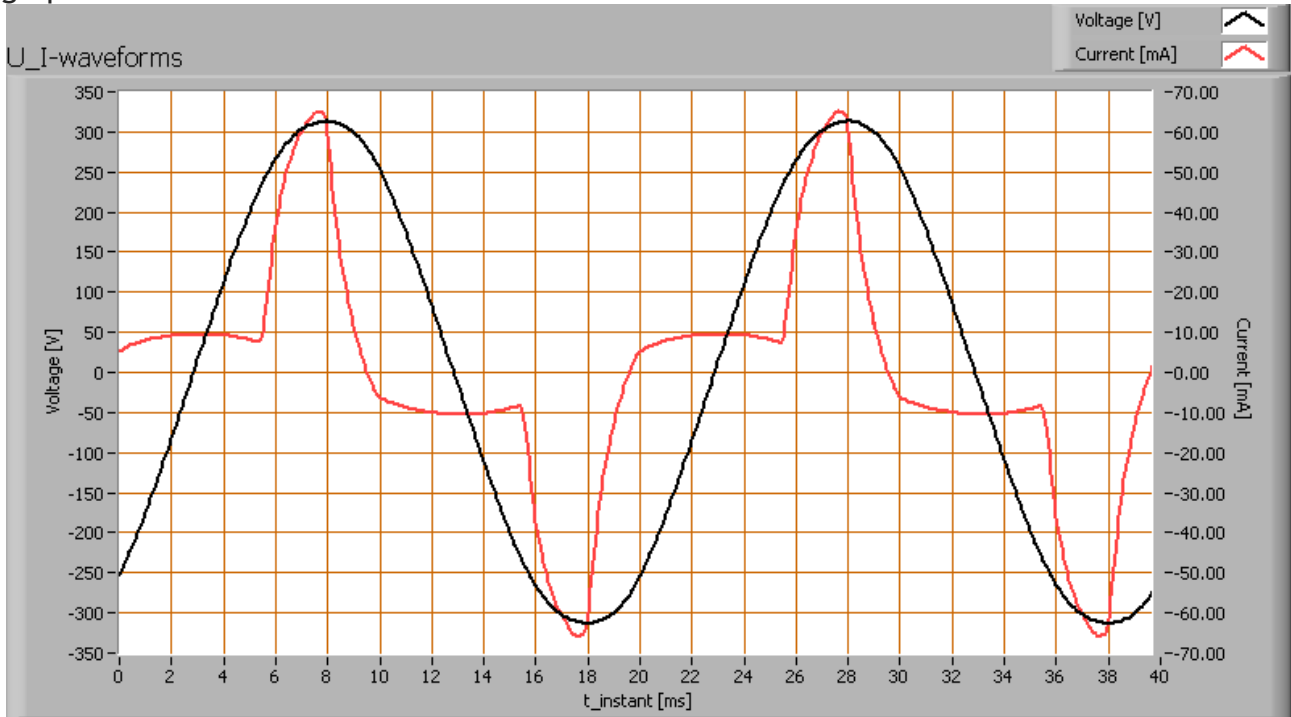
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### Electrical properties

A power factor of 0.51 means that for every 1 kWh net power consumed, a reactive component of 1.7 kVAR was needed.

Lamp voltage	230 VAC
Lamp current	42 mA
Power P	4.9 W
Apparent power S	9.7 VA
Power factor	0.51

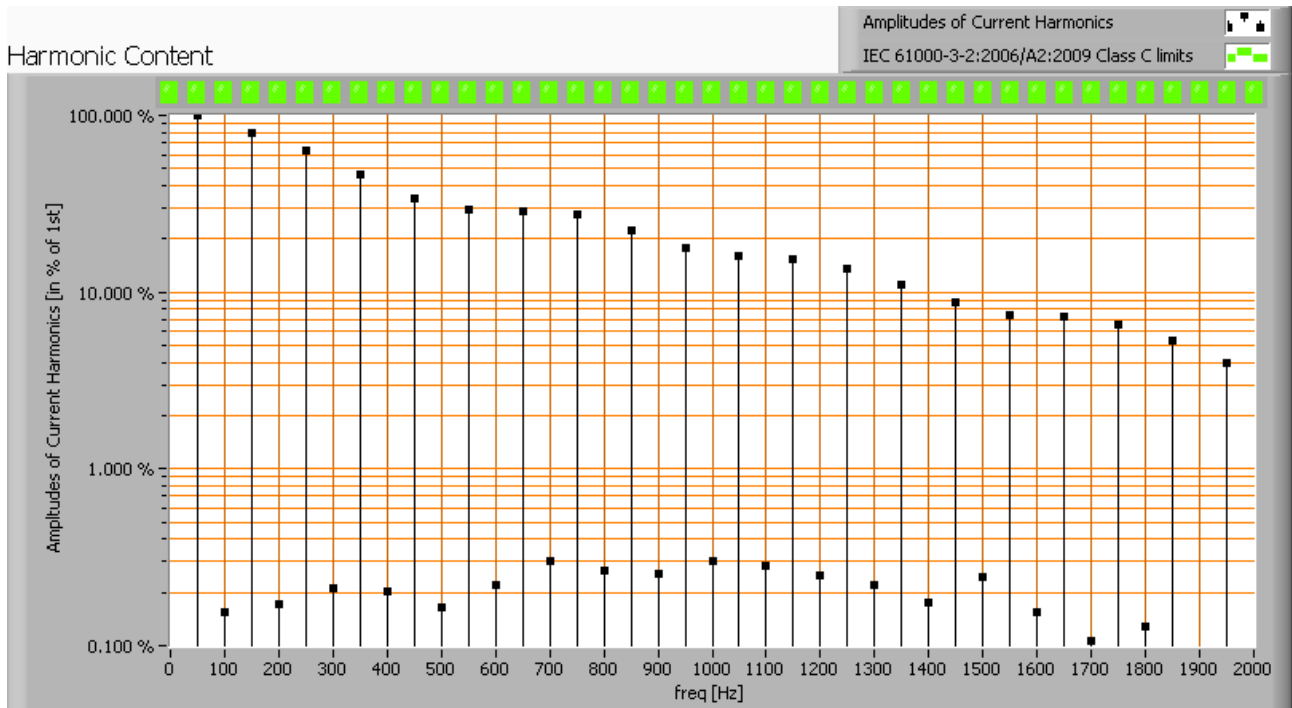
Of this light bulb the voltage across and the resulting current through it are measured and graphed. See the OliNo site how this is obtained.



*Voltage across and current through the lightbulb*

This waveforms have been checked on requirements posed by the norm IEC 61000-3-2:2006 (including up to A2:2009). See also the explanation on the OliNo website.

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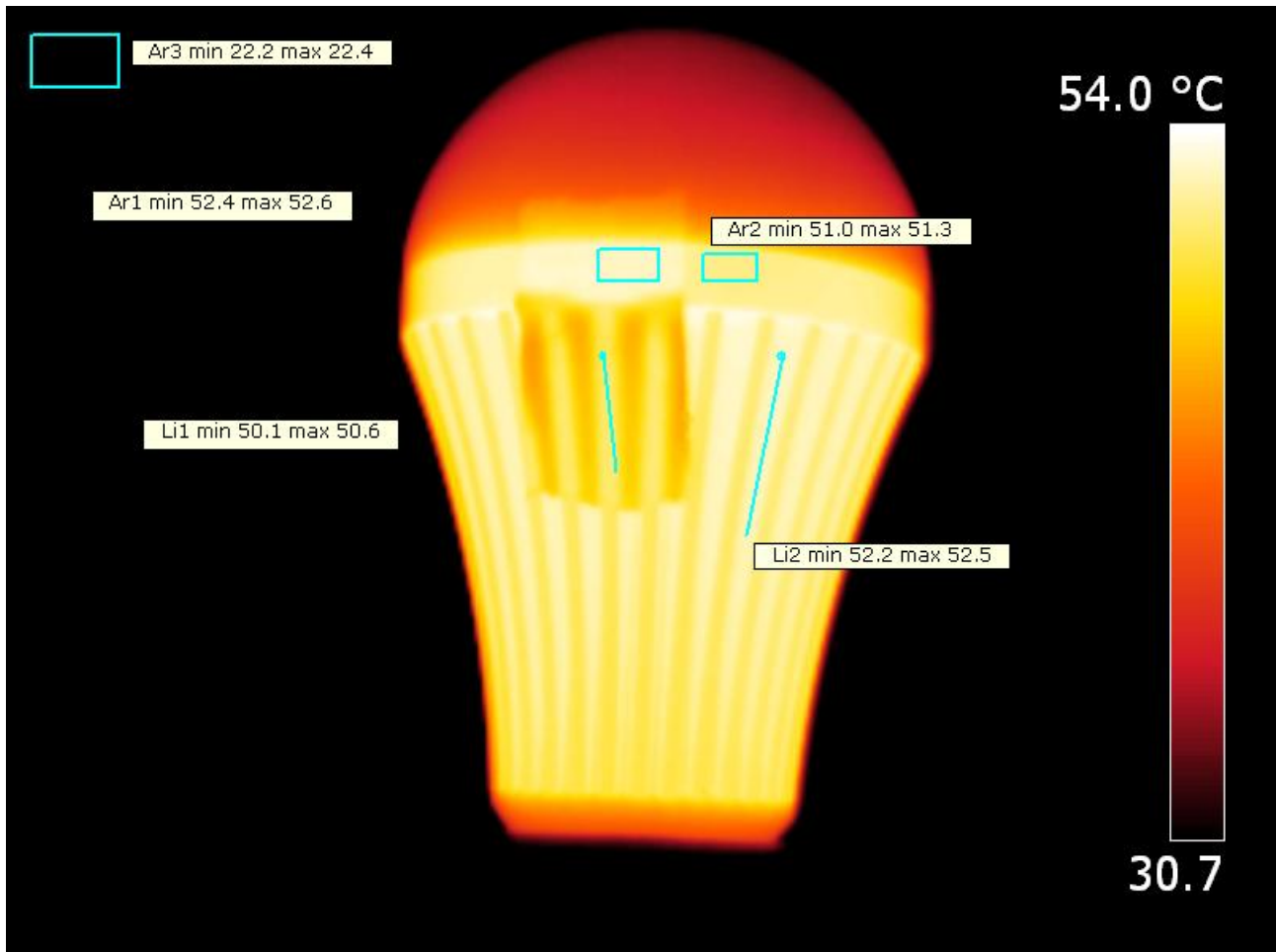
*Harmonics in in the current waveform and checked against IEC61000-3-2:2006*

There are no limits for the harmonics for lighting equipment  $\leq 25$  W.

The Total Harmonic Distortion of the current is computed as 134 %.

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### Temperature measurements lamp



Overview image and determination of the correct emissivity.

The used tape has an emissivity of 0.95. The ribs on the heat sink at the sides of the lamp give an equal temperature so will have an emissivity about equal to this value. The ring between the heat sink and the glass has a somewhat lower emissivity as the temperature reads lower when directly measured on the metal ring itself, meaning more reflection from the lower ambient temperature.

status lamp	> 2 hours on
ambient temperature	22.5 deg C
reflected background temperature	22.5 deg C
camera	Flir T335
emissivity	0.95

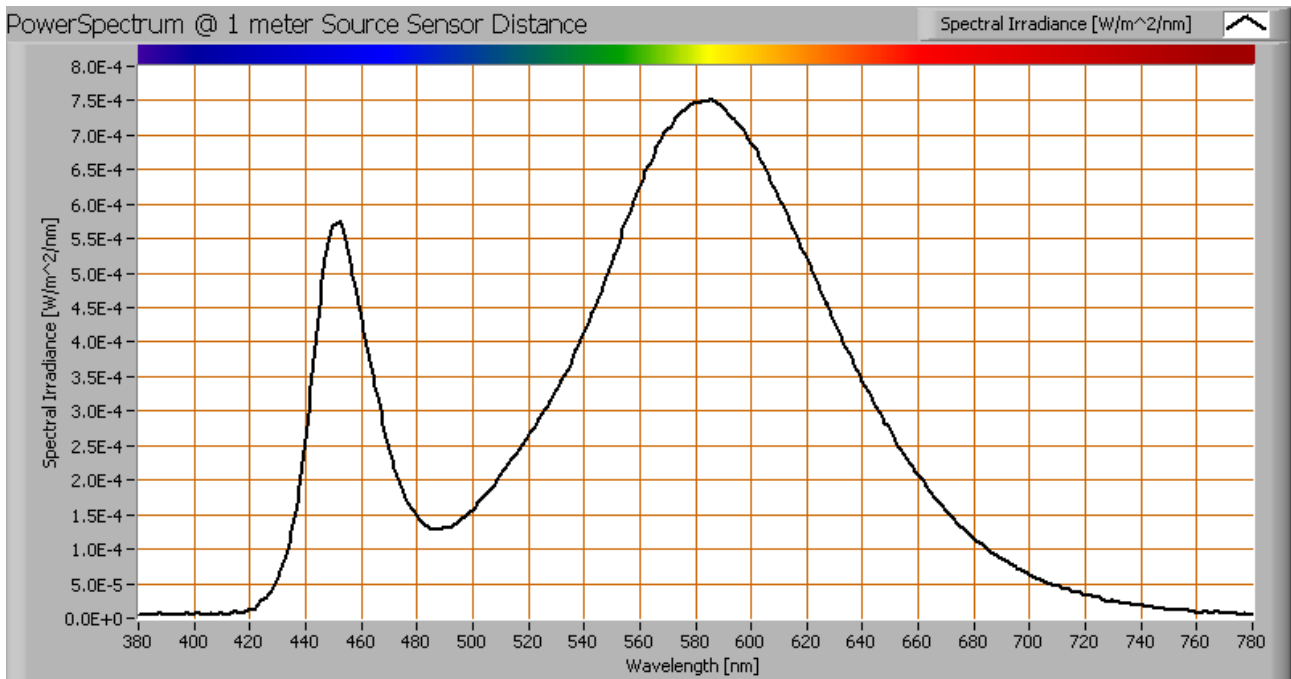


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measurement distance	0.3 m
IFOV <sub>geometric</sub>	0.136 mm for each 0.1 mm distance
NETD (thermal sensitivity)	50 mK

The hottest temperature on the lamp is at the ring just underneath the glass.

### Color temperature and Spectral power distribution

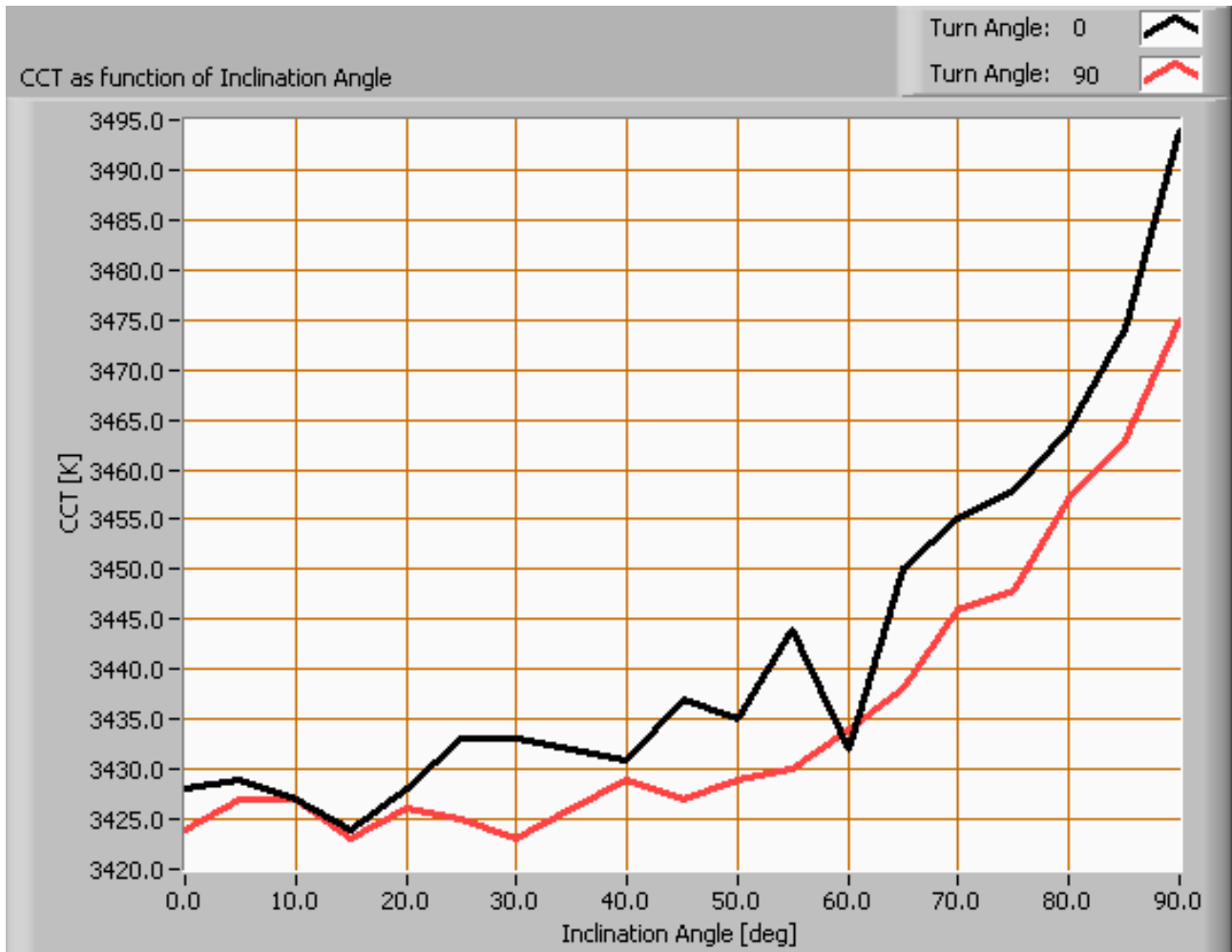


*The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.*

The measured color temperature is about 3450 K which is warm white (close to neutral white).

This color temperature is measured straight underneath the light bulb. Below a graph showing the color temperature for different inclination angles.

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*Color temperature as a function of inclination angle.*

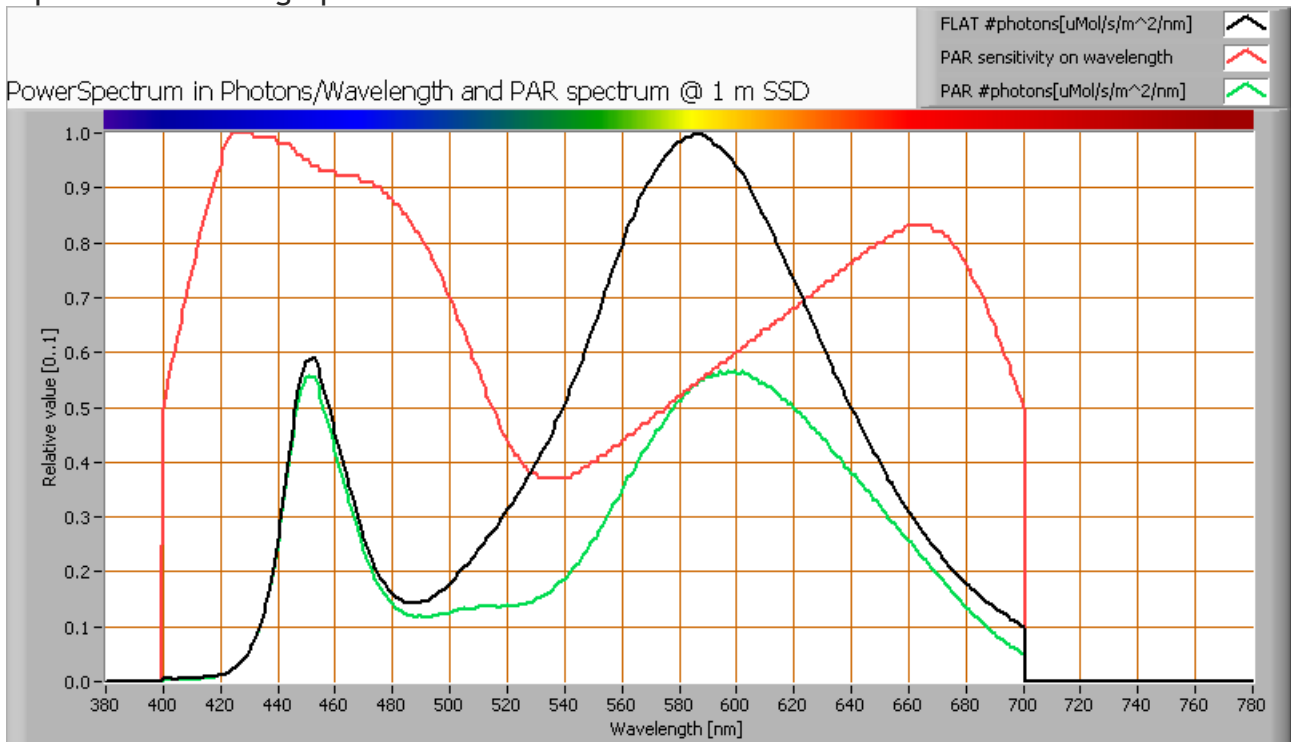
The measurement of CCT is measured for inclination angles up to 90°.

The maximum beam angle is 164°, meaning a 82° inclination angle. In this area most of the light is present. The variation in correlated color temperature in this area is about 1 %.

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### PAR value and PAR spectrum

To make a statement how well the light of this light bulb is for growing plants, the PAR-area needs to be determined. See the OliNo website how this all is determined and the explanation of the graph.



*The photon spectrum, then the sensitivity curve and as result the final PAR spectrum of the light of this light bulb*

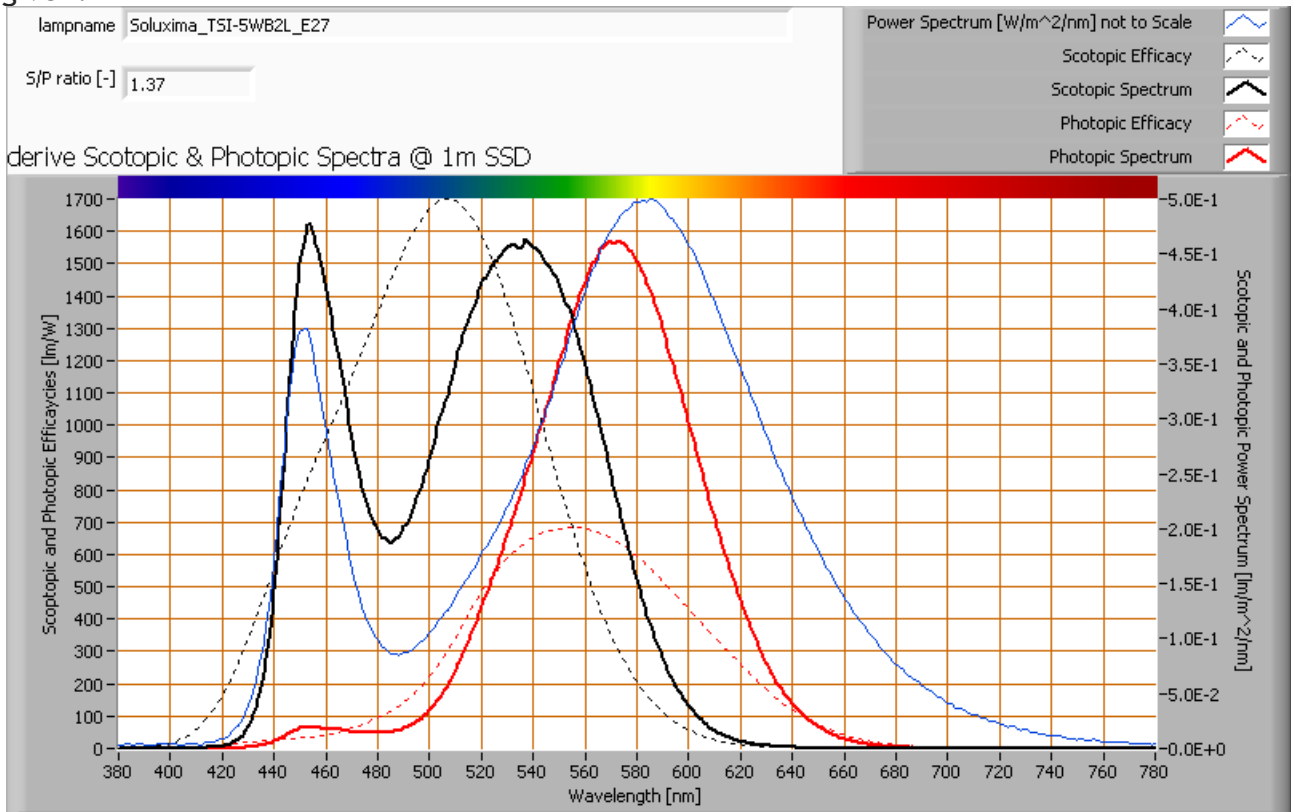
parameter	value	unit
PAR-number	0.3	μMol/s/m <sup>2</sup>
PAR-photon current	1.7	μMol/s
PAR-photon efficacy	0.3	μMol/s/W

The PAR efficiency is 63 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 63 % of the total of photons in the light is effectively used by the average plant (since the plant might not take 100 % of the photons at the frequency where its relative sensitivity is 100 %).

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### S/P ratio

The S/P ratio and measurement is explained on the OliNo website. Here the results are given.



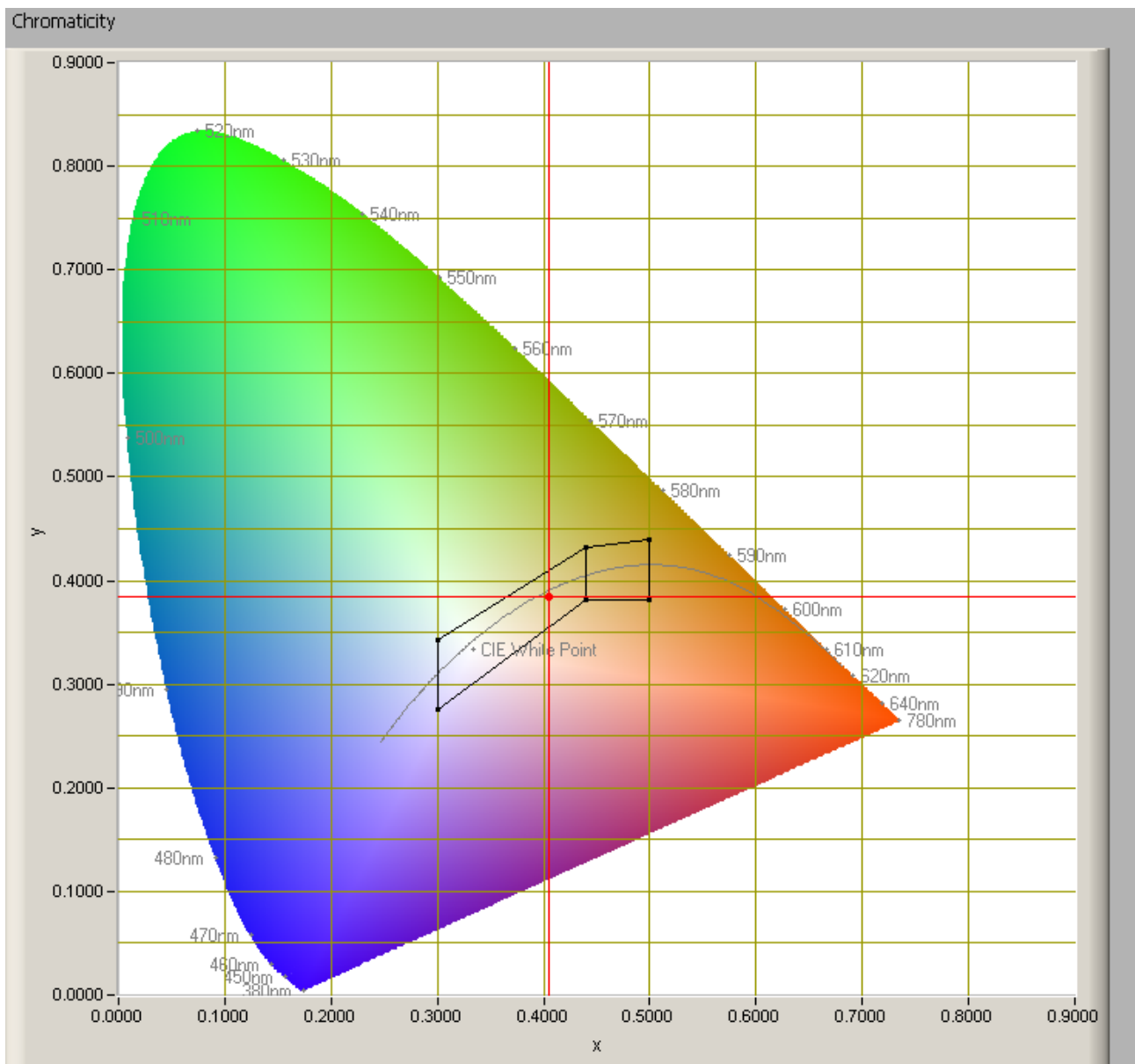
*The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).*

The S/P ratio is 1.4.

More info on S/P ratio can be found on the OliNo website.

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### Chromaticity diagram



*The chromaticity space and the position of the lamp's color coordinates in it.*

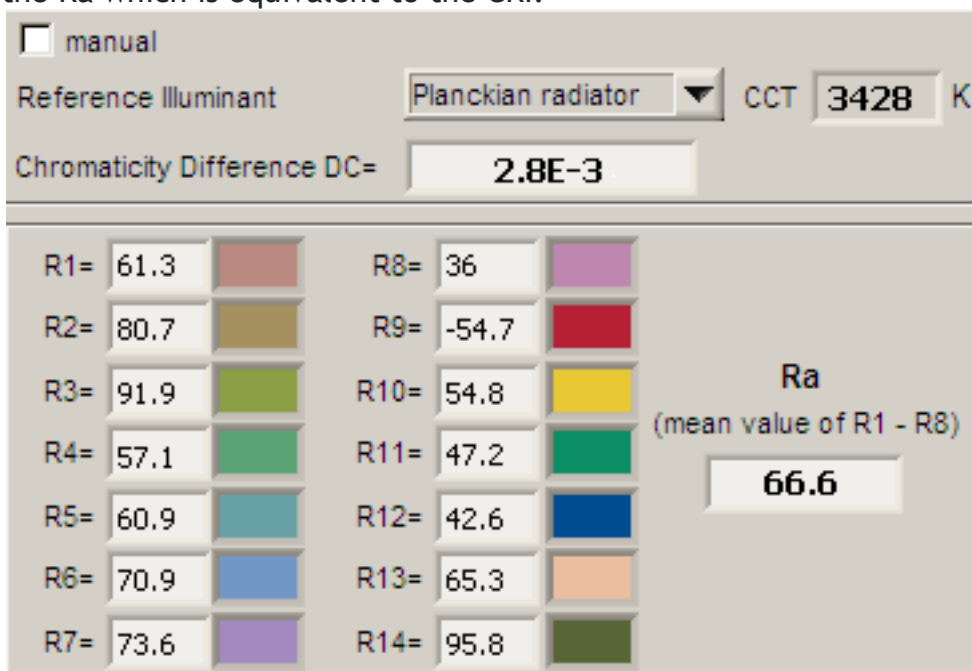
The light coming from this lamp is inside the area designated with class A. This class A is an area that is defined for signal lamps, see also the OliNo website. Its coordinates are  $x=0.4053$  and  $y=0.3844$ .



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### Color Rendering Index (CRI) or also Ra

Herewith the image showing the CRI as well as how well different colors are represented (rendered). The higher the number, the better the resemblance with the color when a black body radiator would have been used (the sun, or an incandescent lamp). Practical information and also some critics about the CRI can be found on the OliNo website. Each color has an index  $R_x$ , and the first 8 indexes (R1 .. R8) are averaged to compute the Ra which is equivalent to the CRI.



CRI of the light of this lightbulb.

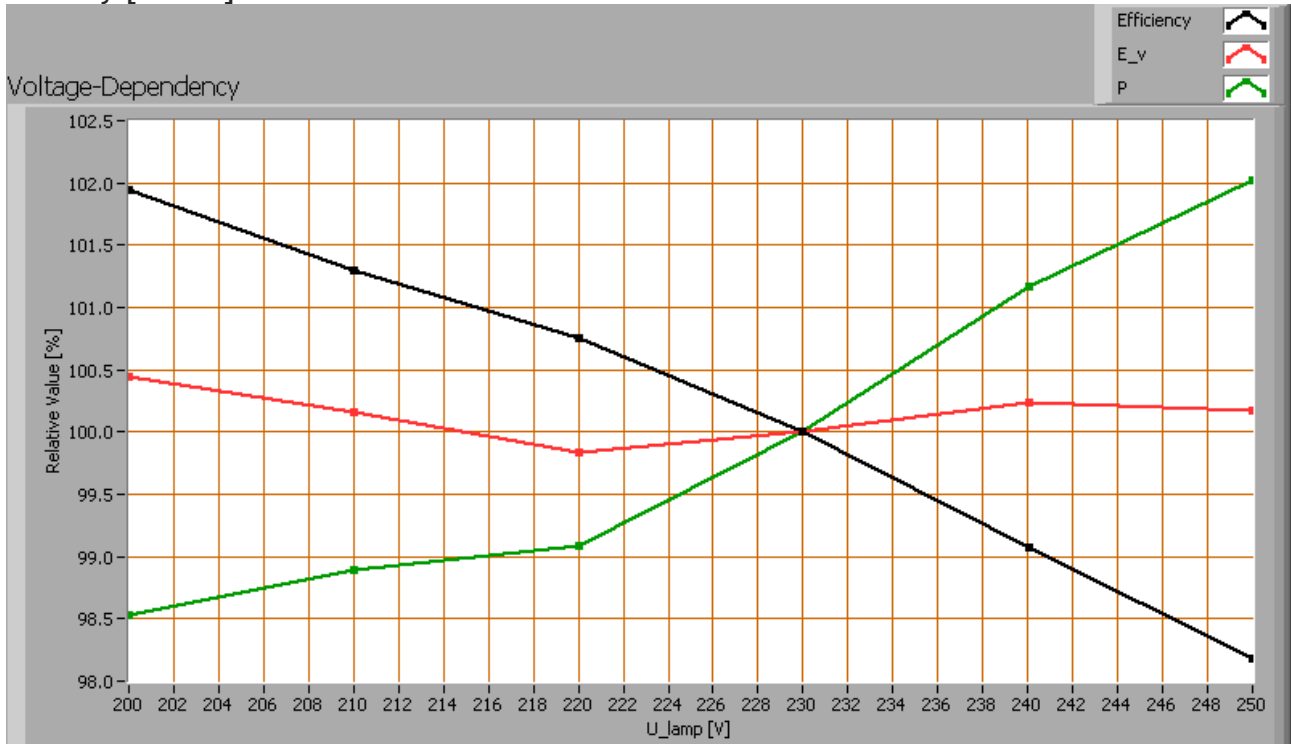
The value of 67 is lower than 80 which is considered a minimum value for indoor usage. Note: the chromaticity difference is 0.0028 indicates the distance to the Planckian Locus. There is no norm yet that states what the max deviation from white light is allowed to be. A reference with signal lights as a reference is given in the chromaticity diagram.

### Voltage dependency

The dependency of a number of lamp parameters on the lamp voltage is determined. For this, the lamp voltage has been varied and its effect on the following light bulb parameters measured: illuminance  $E_v$  [lx], the lamp power  $P$  [W] and the luminous

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efficacy [lm/W].



Lamp voltage dependencies of certain light bulb parameters, where the value at 230 V is taken as 100 %.

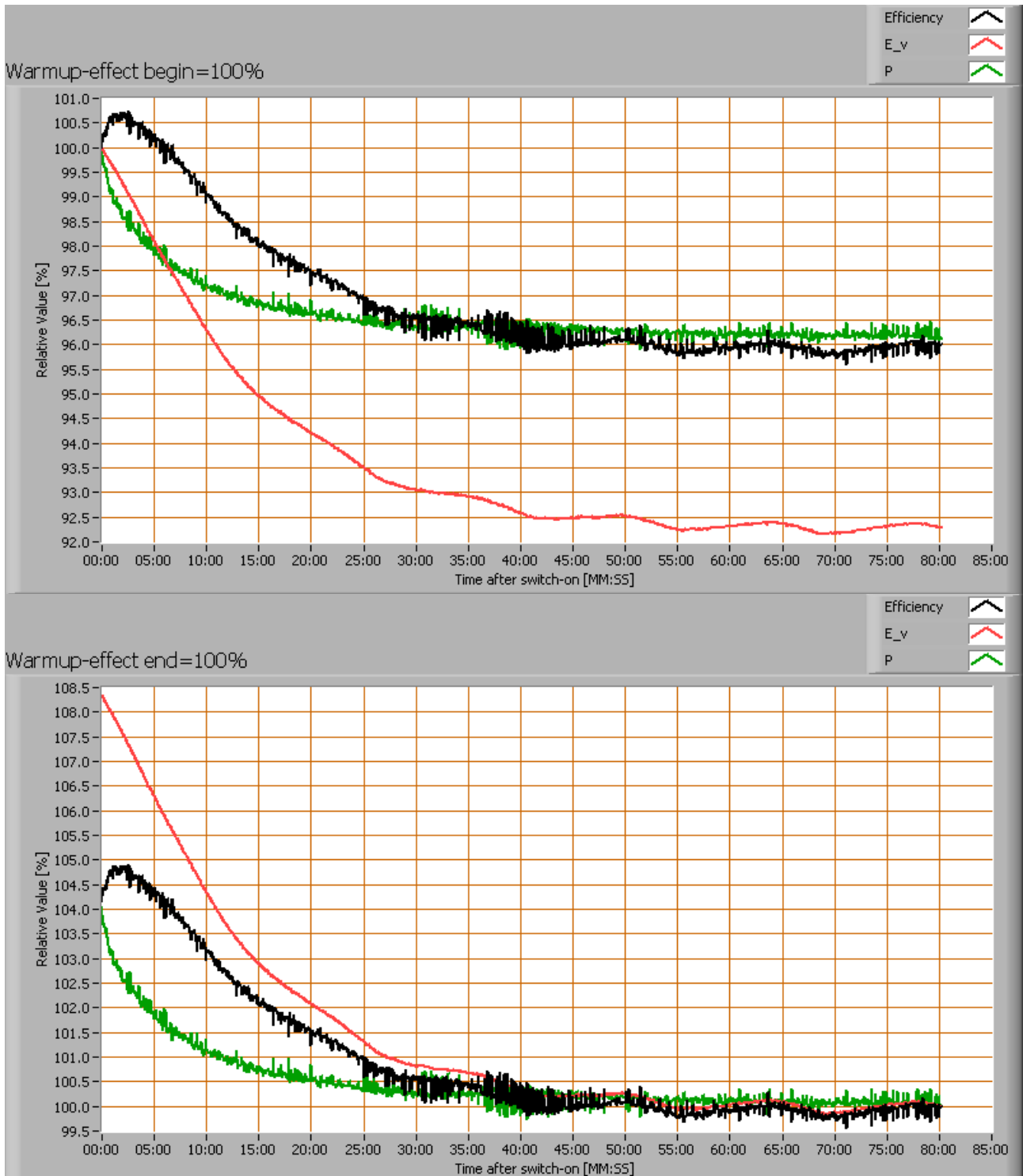
The illuminance and consumed power do not vary significantly when the voltage is varied.

When the voltage at 230 V varies with + and - 5 V, then the illuminance varies < 0.25 %, so when abrupt voltage changes occur this effect is not visible in the illuminance output.

### Warm up effects

After switch on of a cold lamp, the effect of heating up of the lamp is measured on illuminance E\_v [lx], the lamp power P [W] and the luminous efficacy [lm/W].

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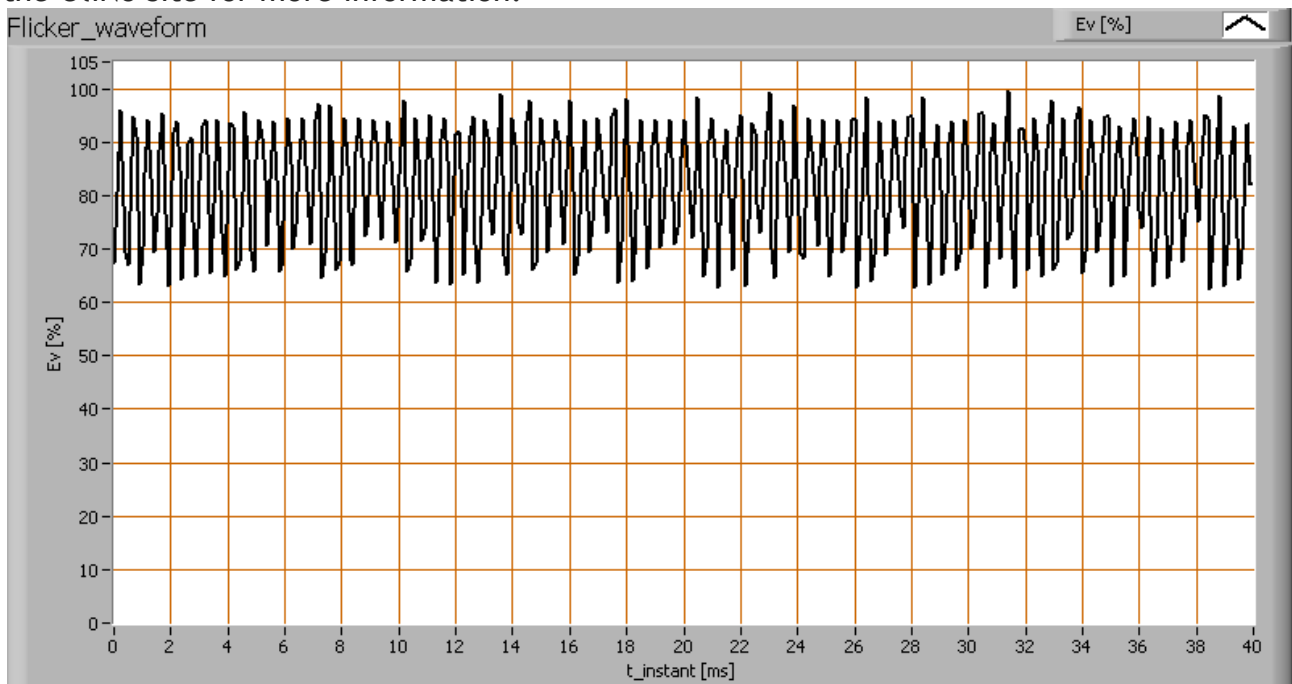
*Effect of warming up on different light bulb parameters. At top the 100 % level is put at begin, and at bottom at the end.*

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The warm up time is about 25 minutes. During that time the illuminance decreases with 8 % and the consumed power with about 5 %.

### Measure of flickering

An analysis is done on the measure of flickering of the light output by this light bulb. See the OliNo site for more information.



*The measure of fast illuminance variation of the light of the light bulb*

parameter	value	unit
Flicker frequency	2022	Hz
Illuminance modulation index	23	%

The illuminance modulation index is computed as:  $(\max_{Ev} - \min_{Ev}) / (\max_{Ev} + \min_{Ev})$ .

The modulation index of 23 % at a flicker frequency of > 2 kHz will not be perceived as the frequency is too high.



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