

**Lamp measurement report – 5 Nov 2010**

LVS A05 GU10 3x3W Cree

by

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## Lamp measurement report – 5 Nov 2010

### Summary measurement data


parameter	meas. result	remark
Color temperature	2930 K	Warm white
Luminous intensity $I_v$	563 Cd	Measured straight underneath the lamp.
Illuminance modulation index	1 %	Measured straight underneath the lamp. Is a measure for the amount of flickering.
Beam angle	27 deg	27° for all C-planes since the lamp is symmetrical along its 1st axis.
Power P	4.3 W	
Power Factor	0.51	For every 1 kWh net power consumed, there has been 1.7 kVAhr for reactive power.
THD	161 %	Total Harmonic Distortion
Luminous flux	156 Lm	
Luminous efficacy	36 Lm/W	
EU-label classification	A	The energy class, from A (more efficient) to G (least efficient).
CRI_Ra	84	Color Rendering Index.
Coordinates chromaticity diagram	x=0.4438 and y=0.4094	
Fitting	GU10	This lamp is connected to the 230 V grid voltage.
PAR-value	5.4 $\mu\text{Mol/s/m}^2$	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	1.3	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	50 x 56 mm	External dimensions of the lamp, without pins.
D luminous area	40 mm	Dimensions of the luminous area (used in Eulumdat file). This is the surface of the smallest circle around the leds at the front of the lamp.
General remarks		<p>The ambient temperature during the whole set of illuminance measurements was 24.3-24.5 deg C.</p> <p>The temperature of the housing directly around the leds get about 40 degrees hotter than ambient temperature, on the ribs at the sides.</p> <p>Warm up effect: during the warm up time the illuminance decreases with 15 % and the consumed power with 11 %.</p> <p>Voltage dependency: the power consumption and illuminance vary when the power voltage varies between 200-250 V. This is understandable as the lamp is dimmable.</p>

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### Overview table

m.	Ø 50%		CO-180: 27° C90-270: 27° 	E (lux)	Luminaire Efficacy
	CO-180	C90-270			36 (lumen per Watt)
0.25	0.12	0.12		9007	Half-peak diam Co-180
0.5	0.24	0.24		2252	0.49 x diameter(m)
1	0.49	0.49		563	Half-peak diam C90-270
1.5	0.73	0.73		250	0.49 x diameter(m)
3	1.46	1.46		63	Illuminance
4	1.95	1.95		35	563 / distance <sup>2</sup> (lux)
5	2.44	2.44		23	Total Output
					156 (lumen)

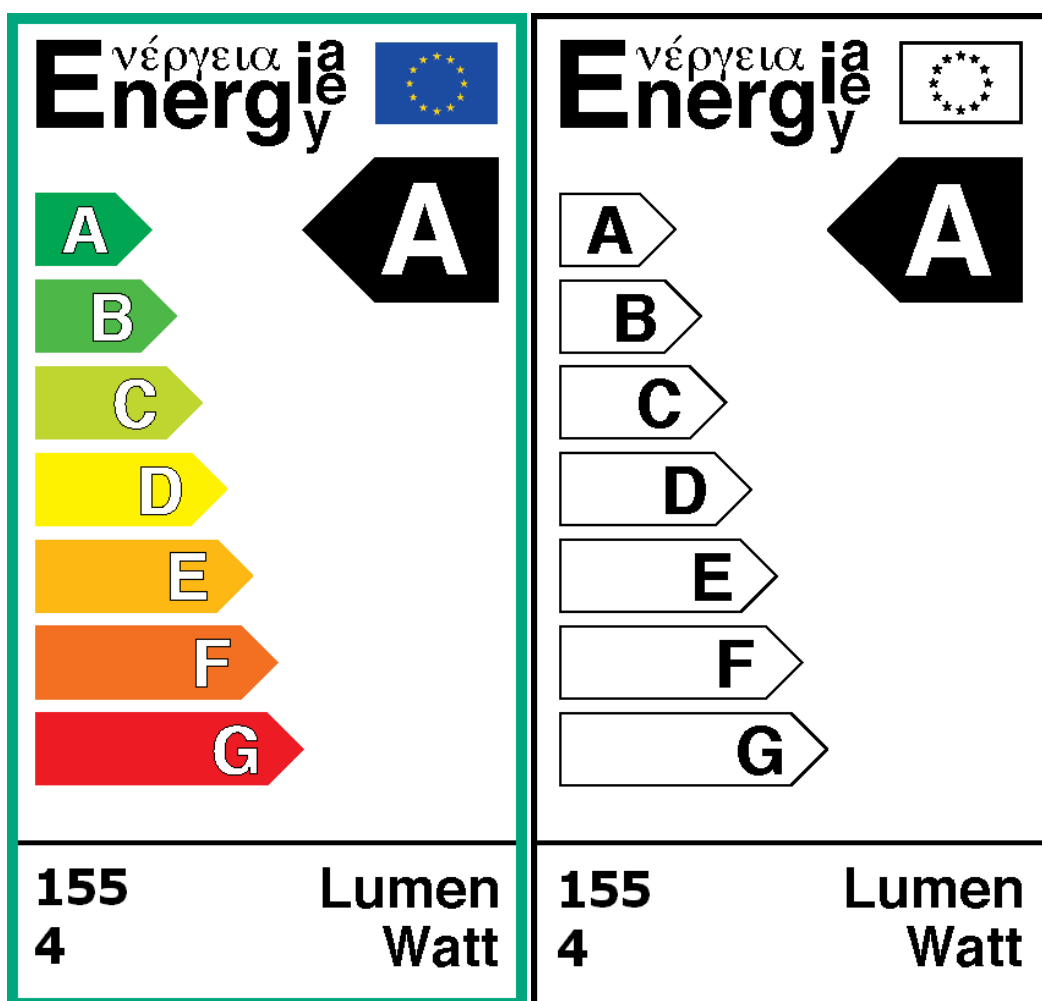
The overview table is explained on the OLiNo website.

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 40 mm ≈ 200 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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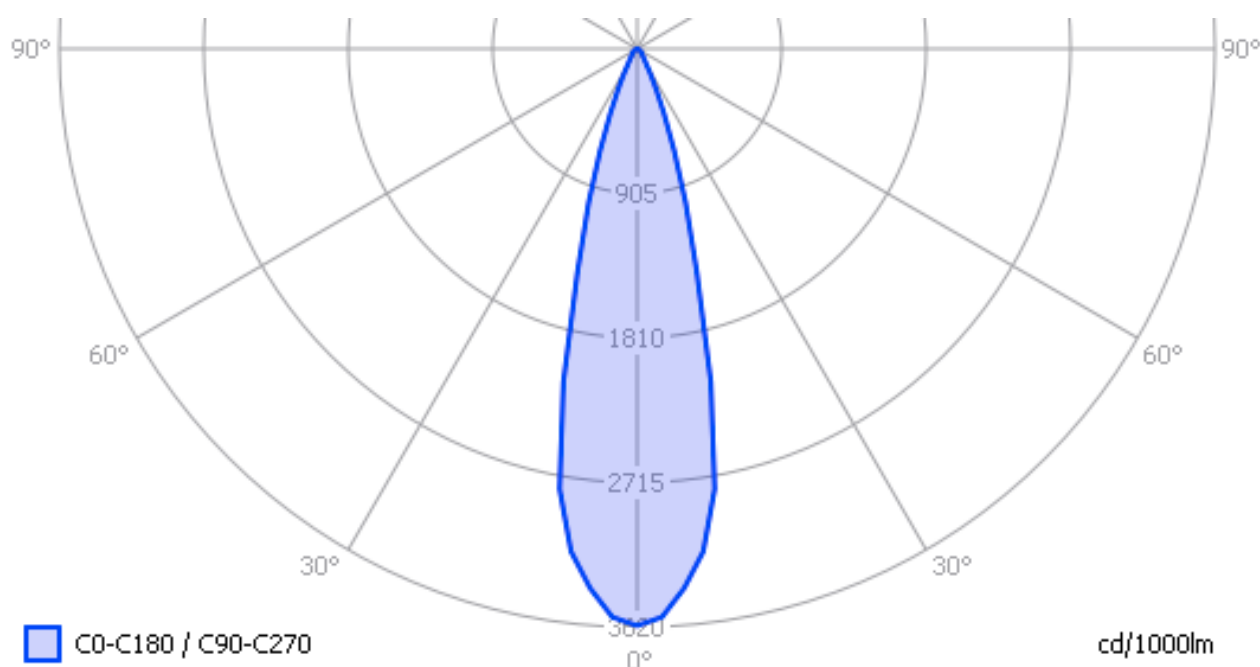


*EU energy label of this lamp*

### Eulumat light diagram

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

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*The light diagram giving the radiation pattern.*

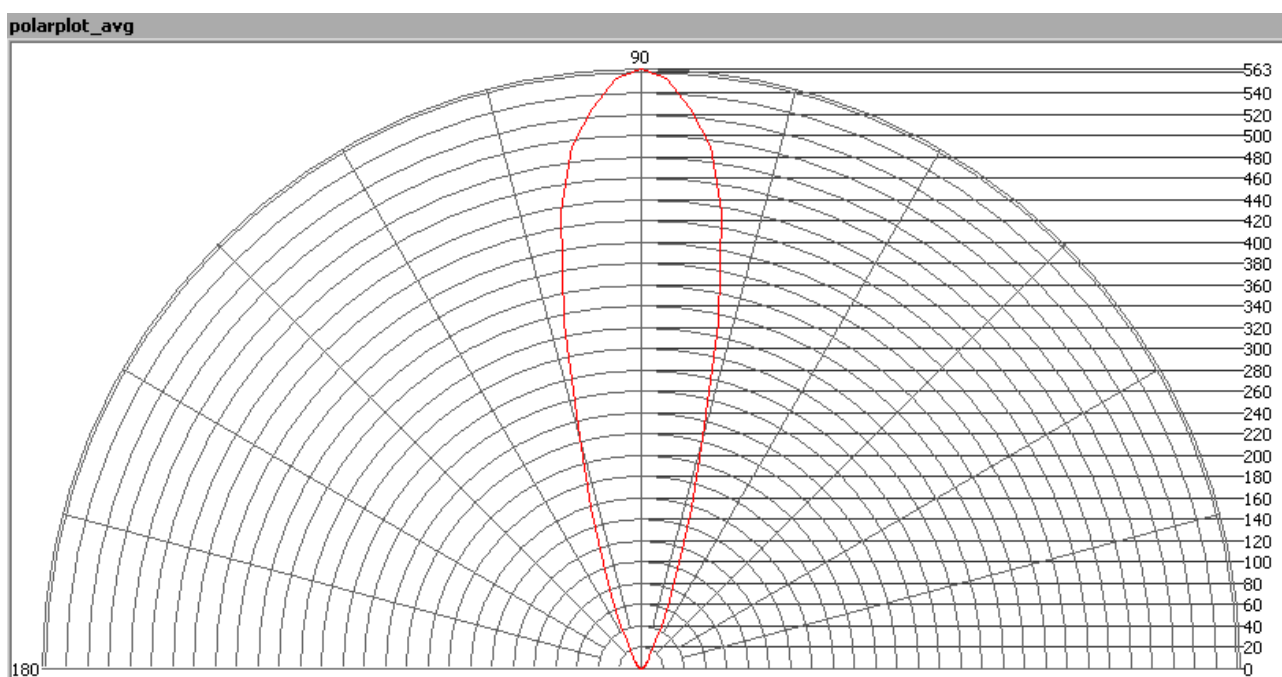
It indicates the luminous intensity around the light bulb. All the planes give the same results as the lamp is symmetrical along its 1st axis.

### 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 angle with the light bulb.



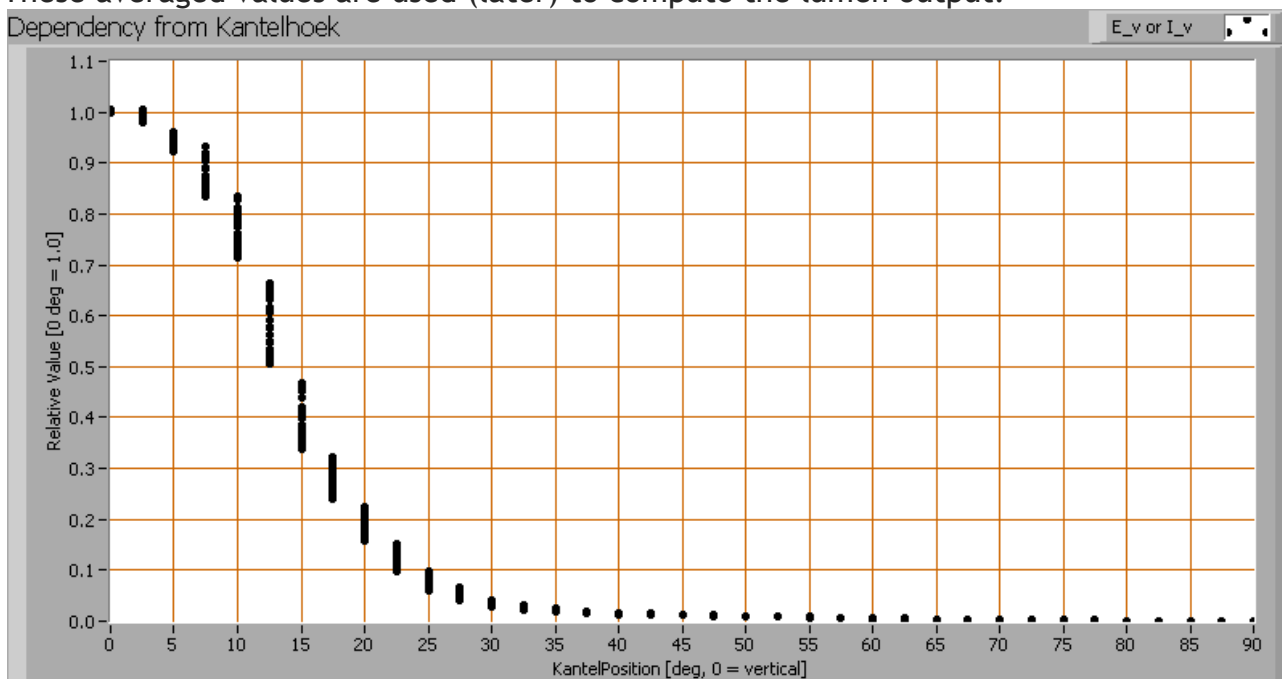
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*The radiation pattern of the light bulb.*

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.



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



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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 27° 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 156 Lm.

### Luminous efficacy

The luminous flux being 156 Lm, and the power of the light bulb being 4.3 W, yields a luminous efficacy of 36 Lm/W.

### Electrical properties

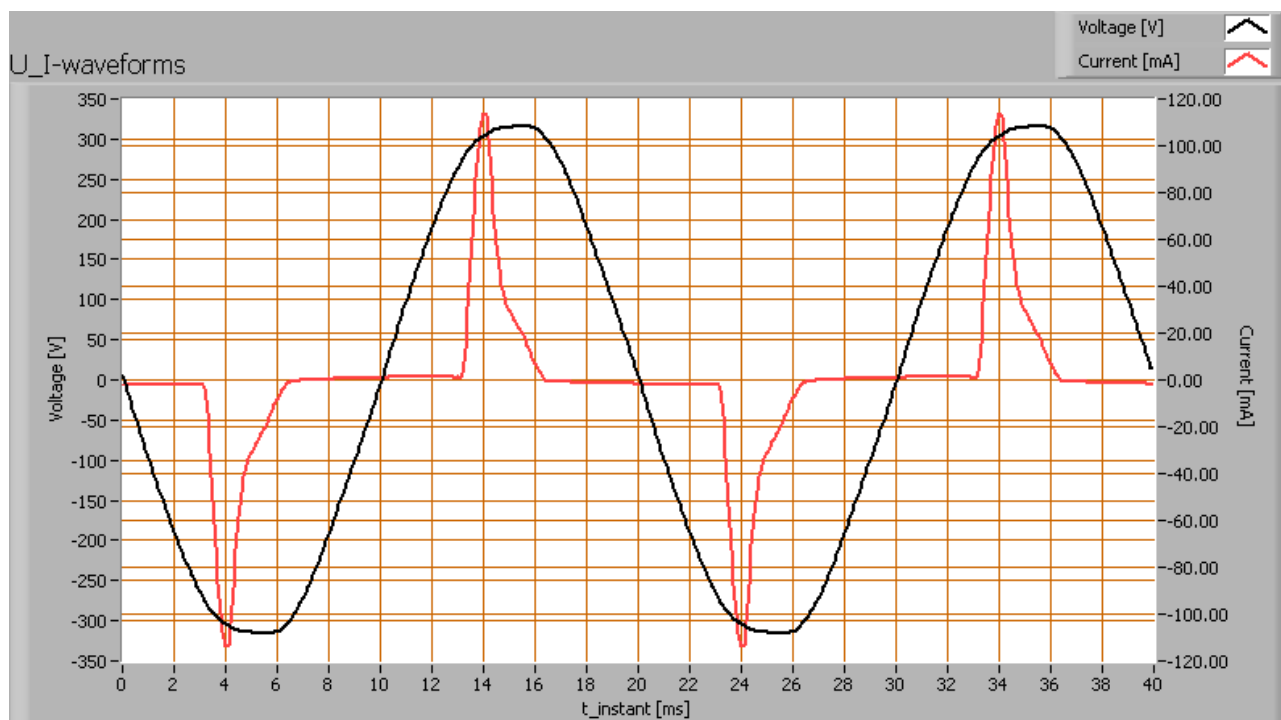
A power factor of 0.51 means that for every 1 kWh net power consumed, a reactive component of 1.7 kVAr was needed.

Lamp voltage	230 VAC
Lamp current	37 mA
Power P	4.3 W
Apparent power S	8.5 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.

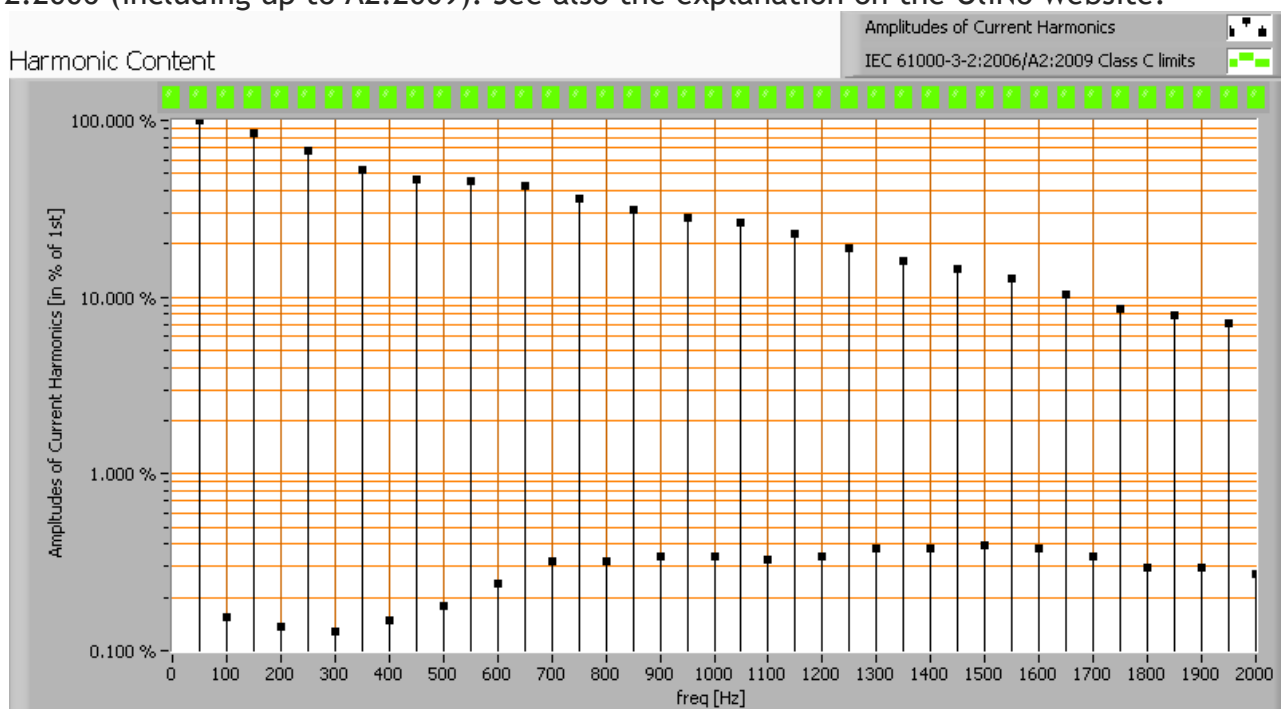


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*Voltage across and current through the lightbulb*

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.



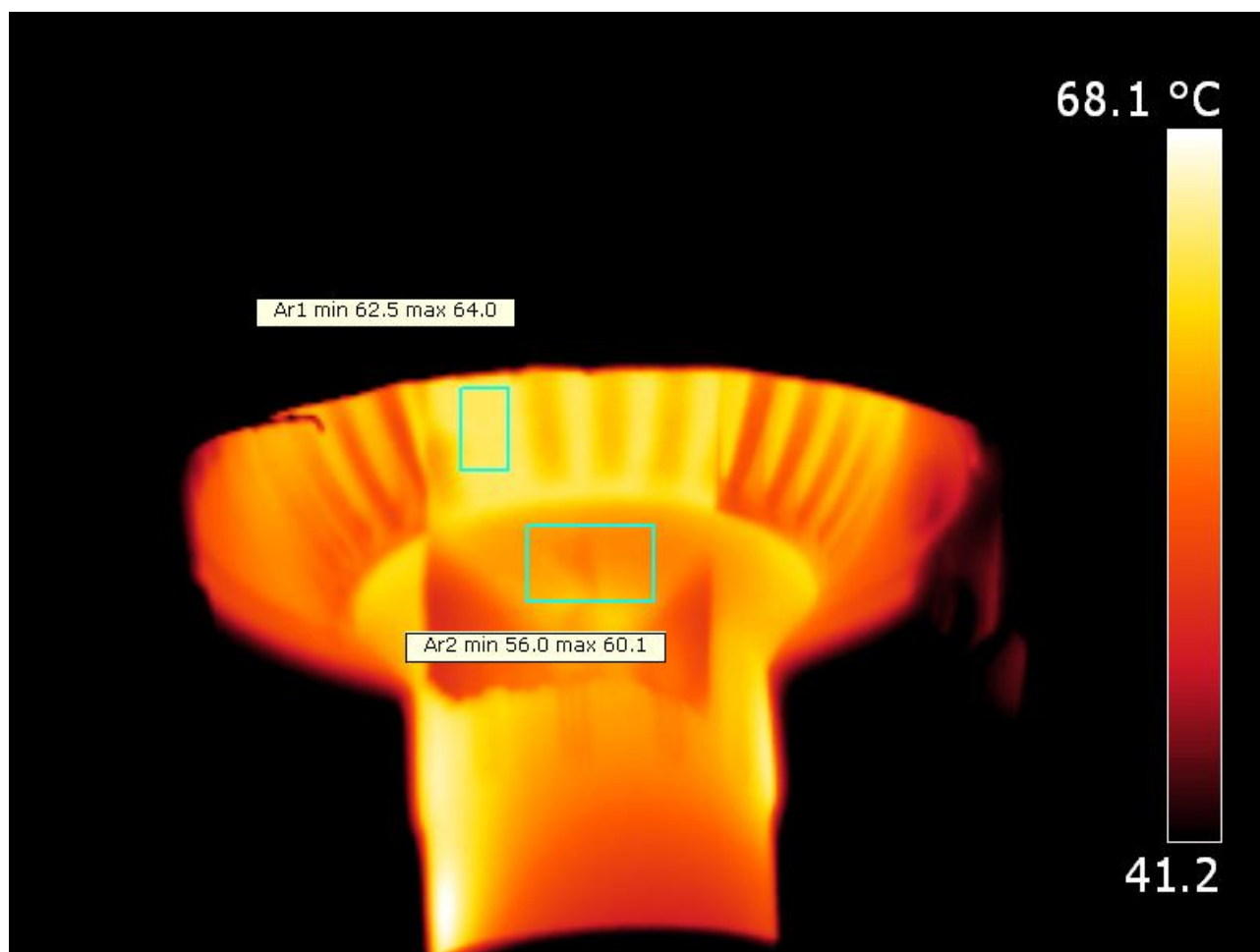
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*Harmonics in the current waveform and checked against IEC61000-3-2:2006*

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

The Total Harmonic Distortion of the current is computed as 161 %.

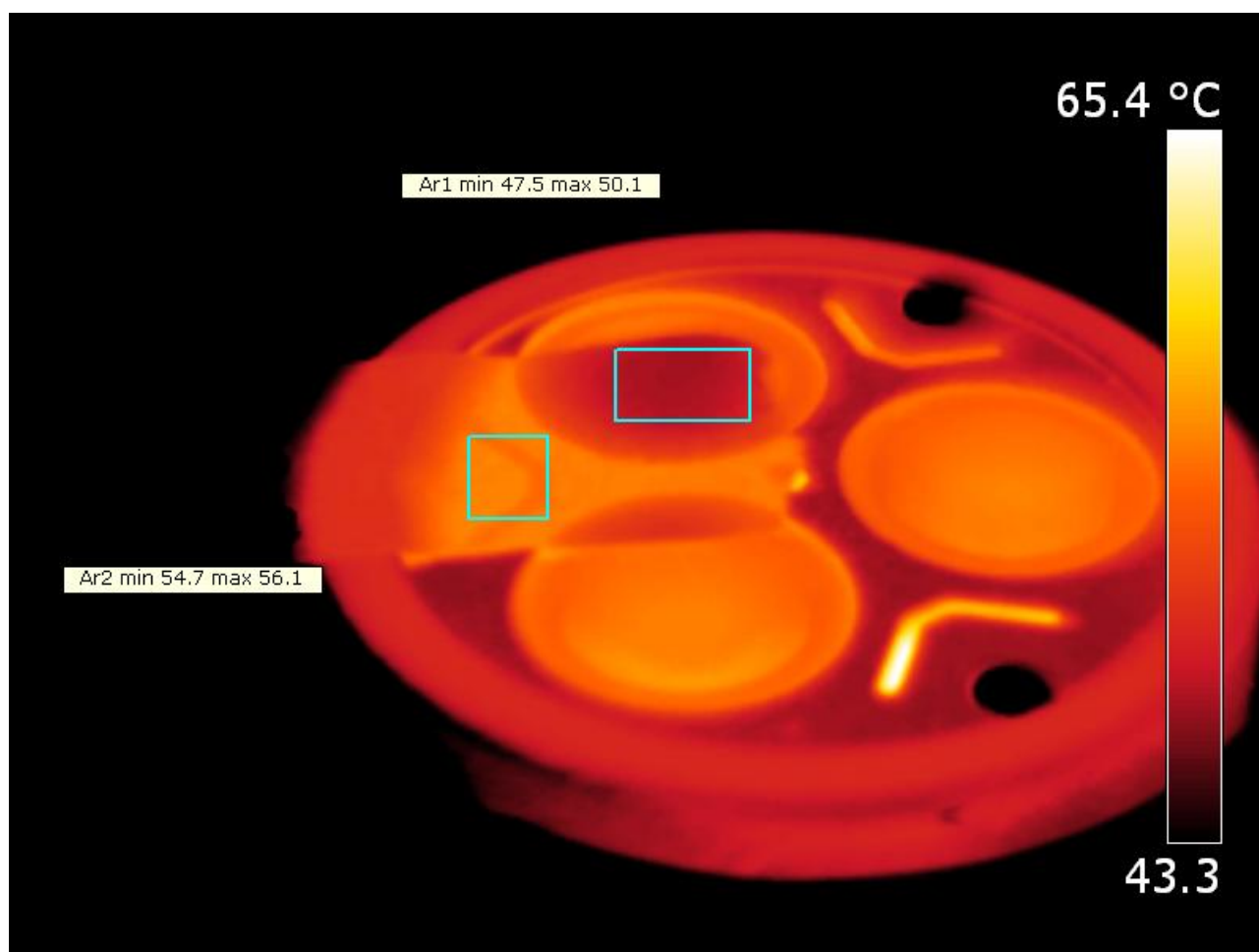
### Temperature measurements lamp



*IR image from the side of the lamp*

The used tape has an emissivity of about 0.95. The metal on the side has a lower emissivity (darker color on this IR photo) and the white material on the base has a (comparable) high emissivity.

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*The top of the lamp.*

Tape has been used to not have an issue with reflections of temperature of the surroundings. The photo shows temperature difference between the taped parts and the temperature of the parts directly measured. While the temperature is significantly higher than ambient, this difference in temperature shows a difference in emissivity.

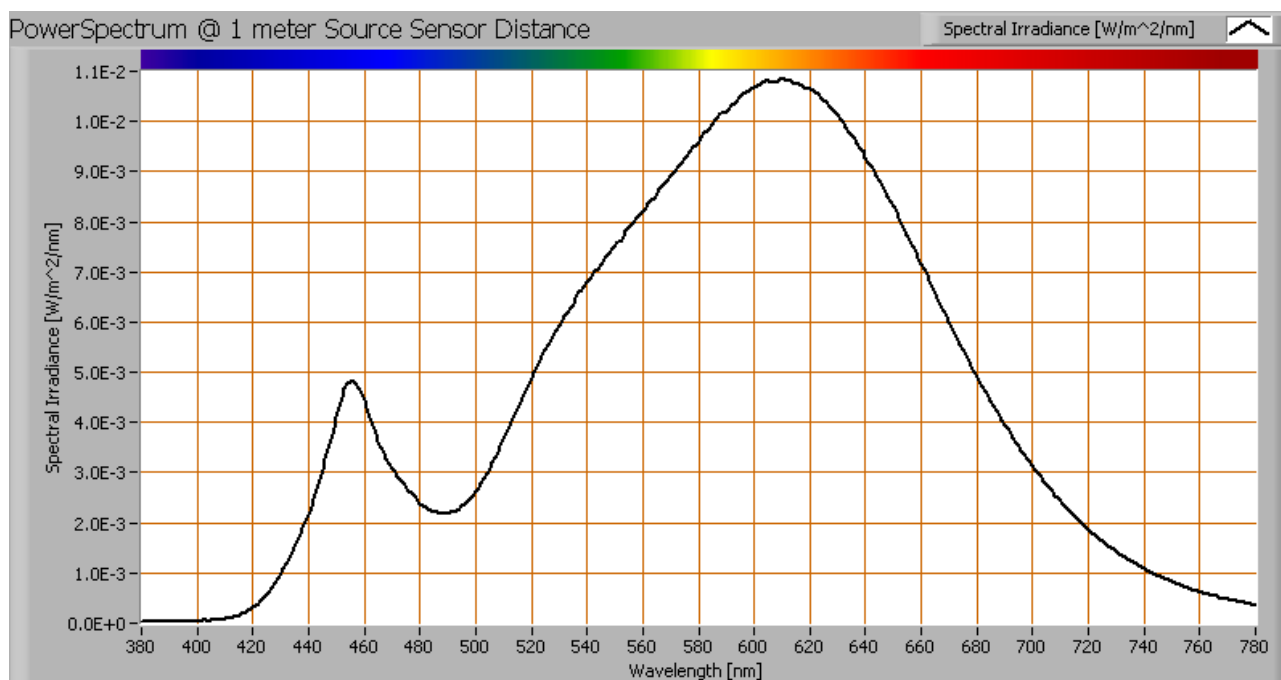
status lamp	> 2 hours on
ambient temperature	23.5 deg C
reflected background temperature	23.5 deg C
camera	Flir T335
emissivity	0.95 <sup>(1)</sup>
measurement distance	0.4 m
IFOV <sub>geometric</sub>	0.5 mm

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NETD (thermal sensitivity)	50 mK
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<sup>(1)</sup> See text for explanation.

### Color temperature and Spectral power distribution

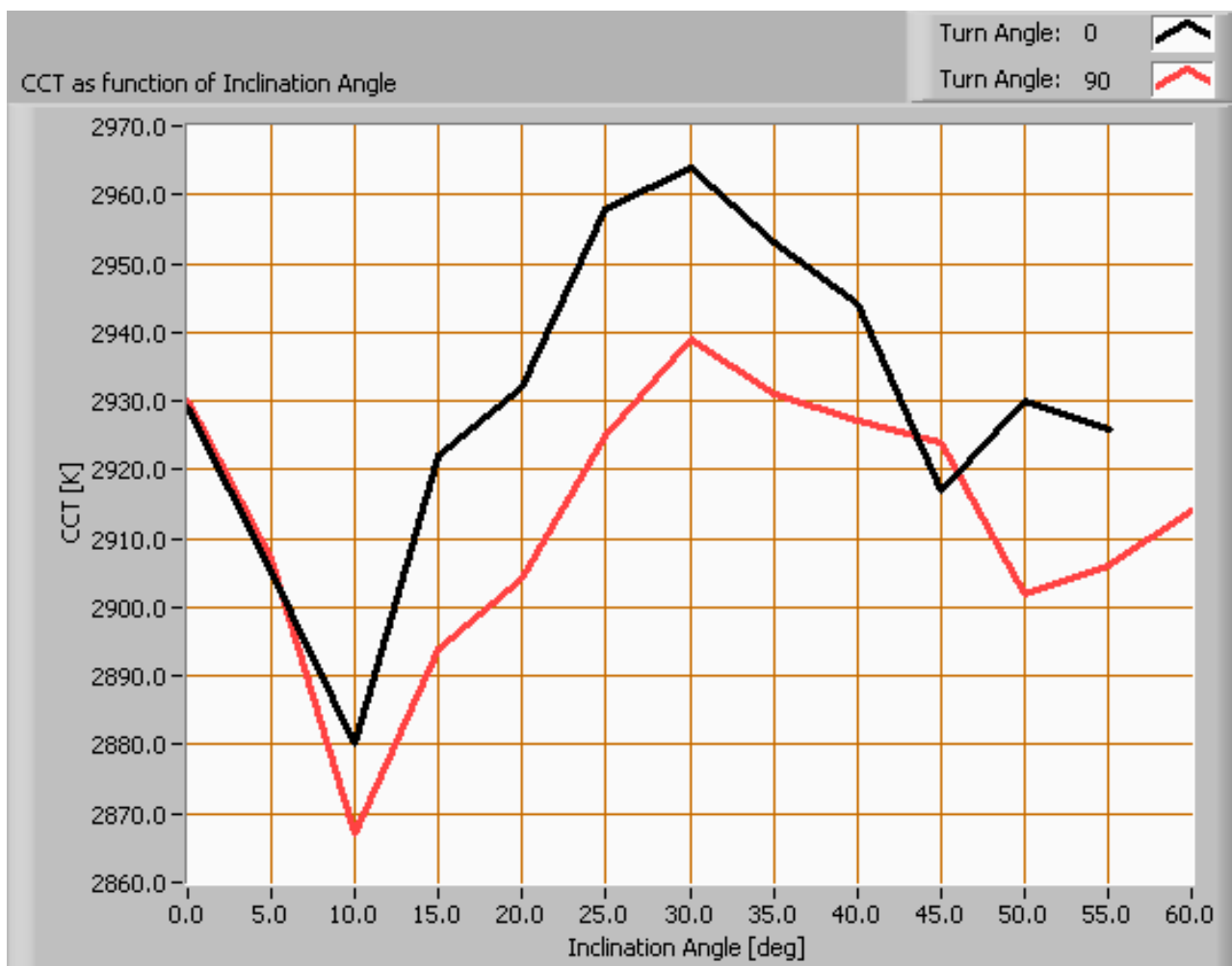


*The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.*

The measured color temperature is about 2925 K which is warm 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.*

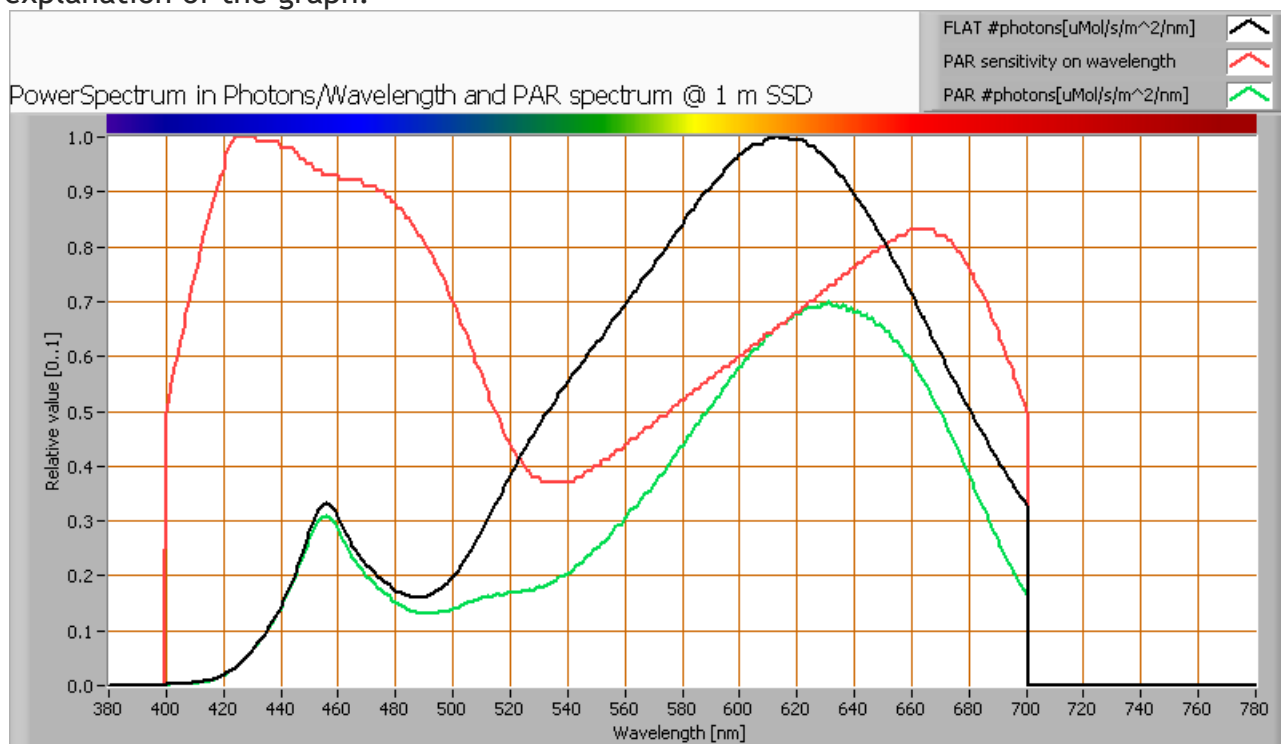
The measurement of CCT is measured for inclination angles up to 55°. Beyond that angle the illuminance was very low (< 5 lux).

The beam angle is 27°, meaning a 13.5° inclination angle. In this area most of the light is present. The variation in correlated color temperature in this area is about 2 %.

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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*

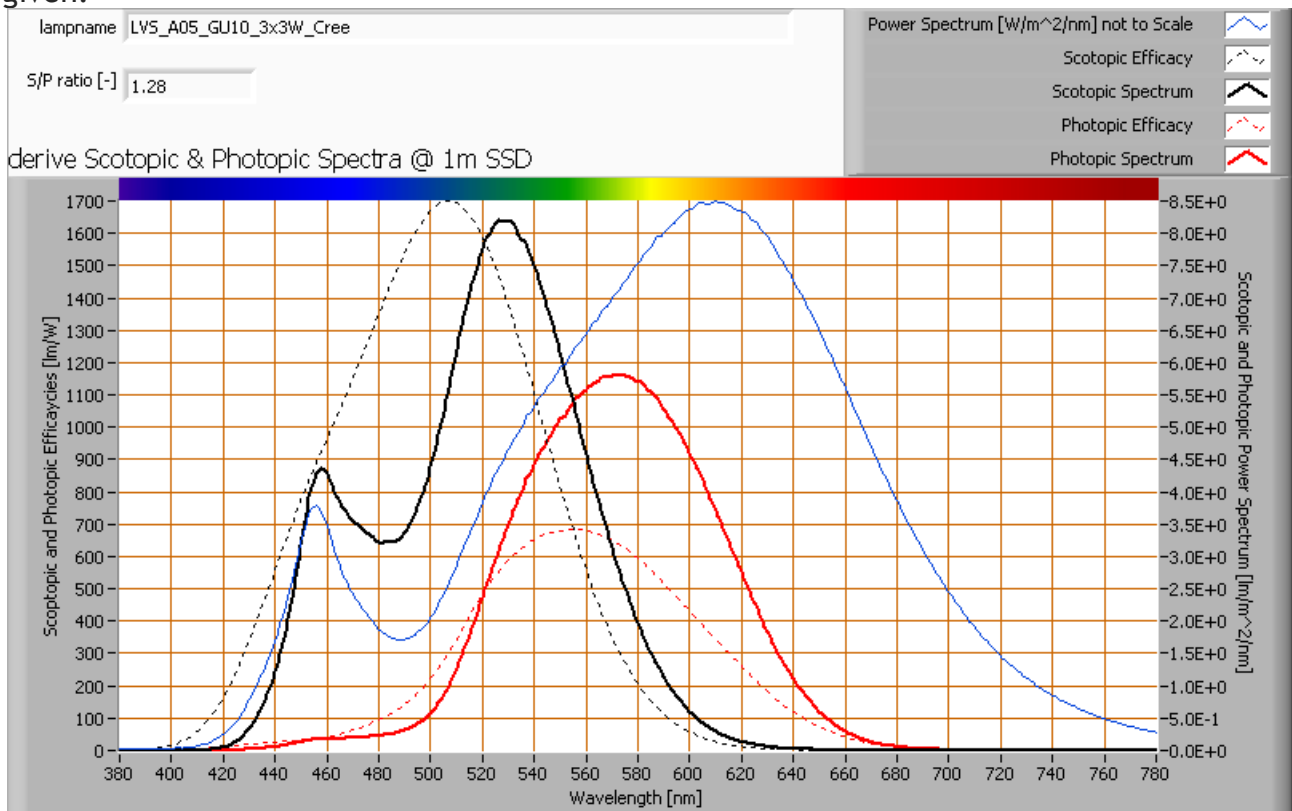
parameter	value	unit
PAR-number	5.4	μMol/s/m <sup>2</sup>
PAR-photon current	1.5	μMol/s
PAR-photon efficacy	0.3	μMol/s/W

The PAR efficiency is 64 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 64 % 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).*

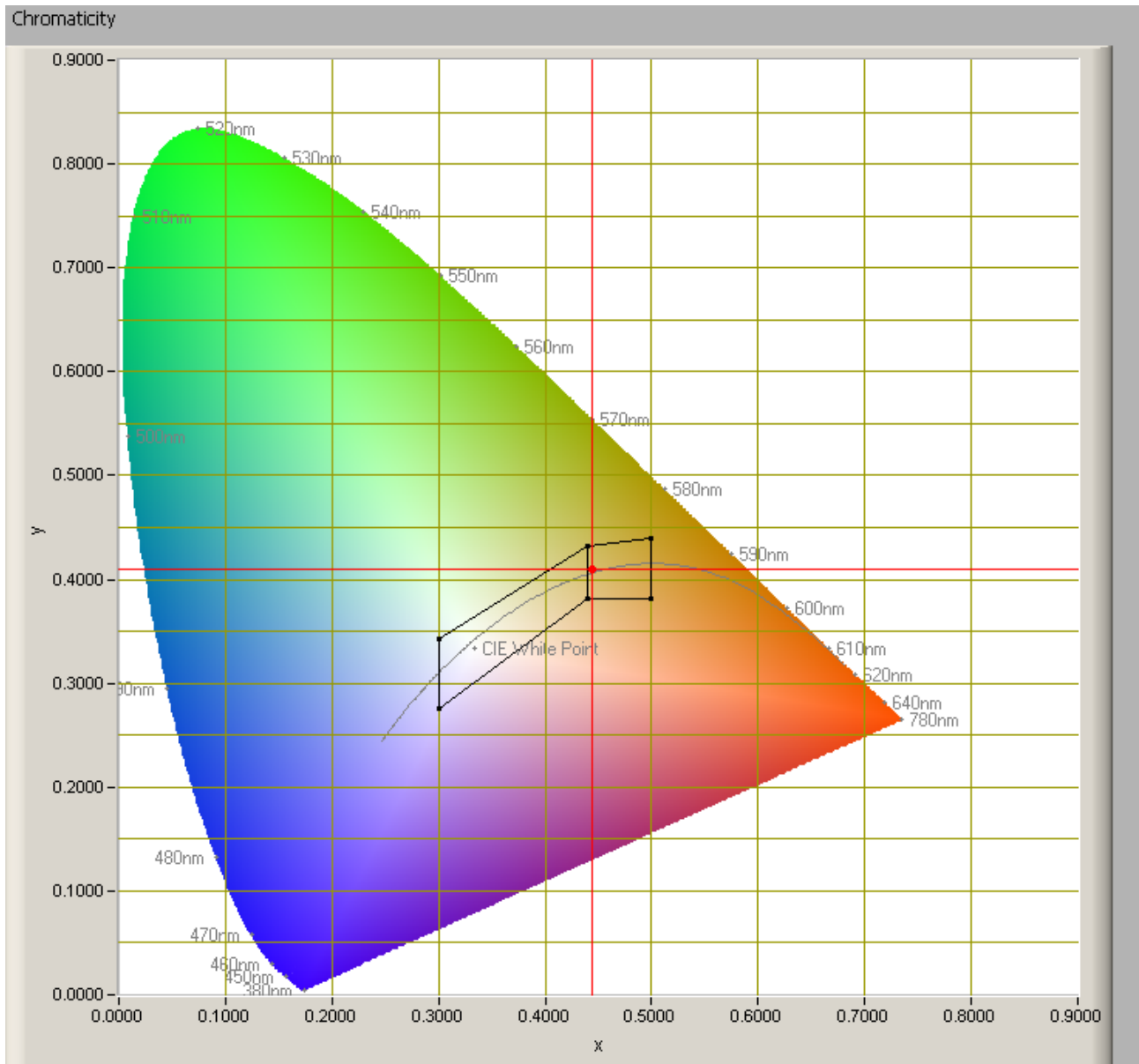
The S/P ratio is 1.3.

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 of class B. This class indicate an area that is defined for signal lamps, see also the OliNo website.  
Its coordinates are  $x=0.4438$  and  $y=0.4094$ .

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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 ( $R_1 \dots R_8$ ) are averaged to compute the  $R_a$  which is equivalent to the CRI.

☐ manual

Reference Illuminant: Planckian radiator CCT: 2930 K

Chromaticity Difference DC= 1.2E-3

R1= 82.2		R8= 68.4	
R2= 89.7		R9= 27.2	
R3= 94.6		R10= 73.8	
R4= 80.8		R11= 76.6	
R5= 80.5		R12= 63.8	
R6= 84.8		R13= 83.6	
R7= 87.9		R14= 96.2	

**Ra**  
(mean value of  $R_1 - R_8$ )  
**83.6**

*CRI of the light of this lightbulb.*

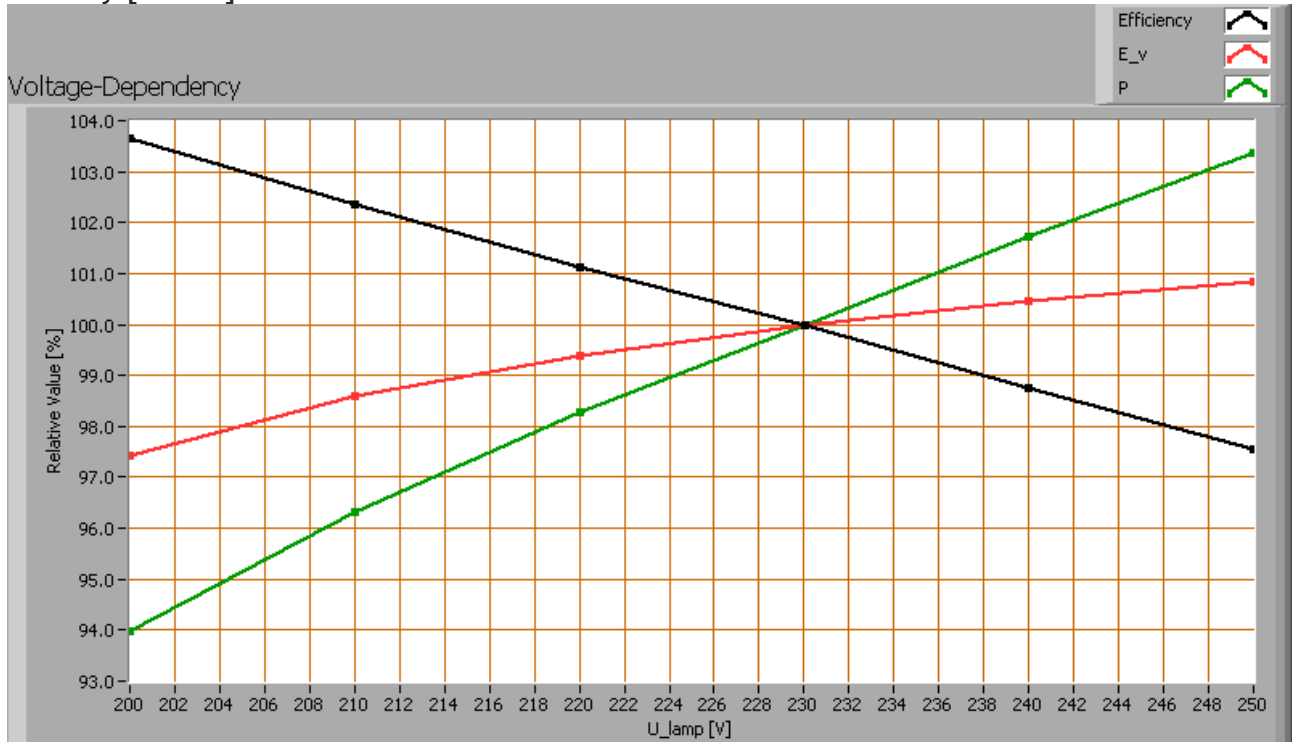
The value of 84 is higher than 80 which is considered a minimum value for indoor usage. Note: the chromaticity difference is 0.0012 indicates the distance to the Planckian Locus. There is no norm yet that states what the max deviation from white light is allowed to be. A reference with signal lights 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 %.

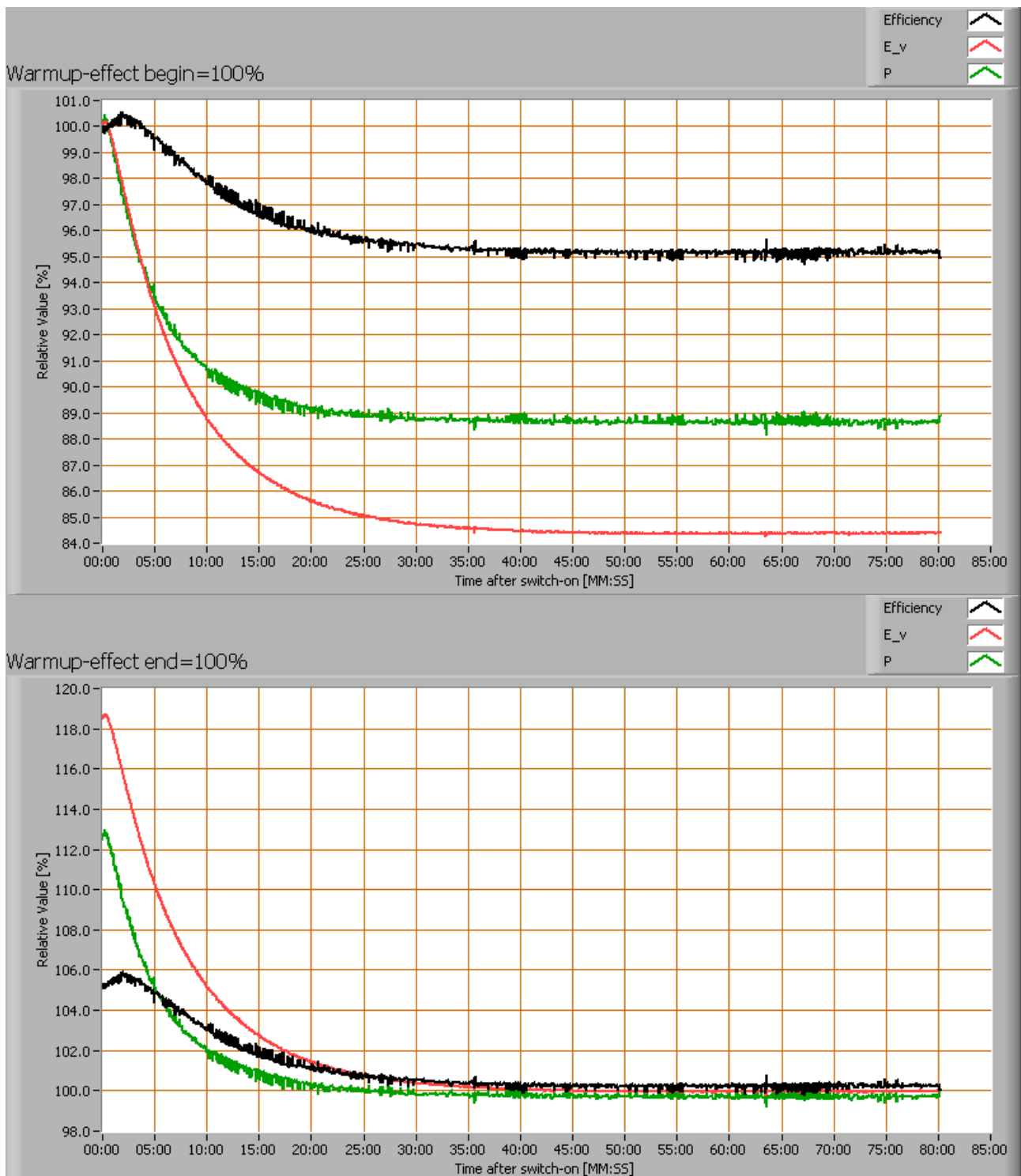
The illuminance and consumed power do vary a little when the voltage is varied.

When the voltage at 230 V varies with + and - 5 V, then the illuminance varies < 0.5 %, 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<sub>v</sub> [lx], the lamp power P [W] and the luminous efficacy [lm/W].

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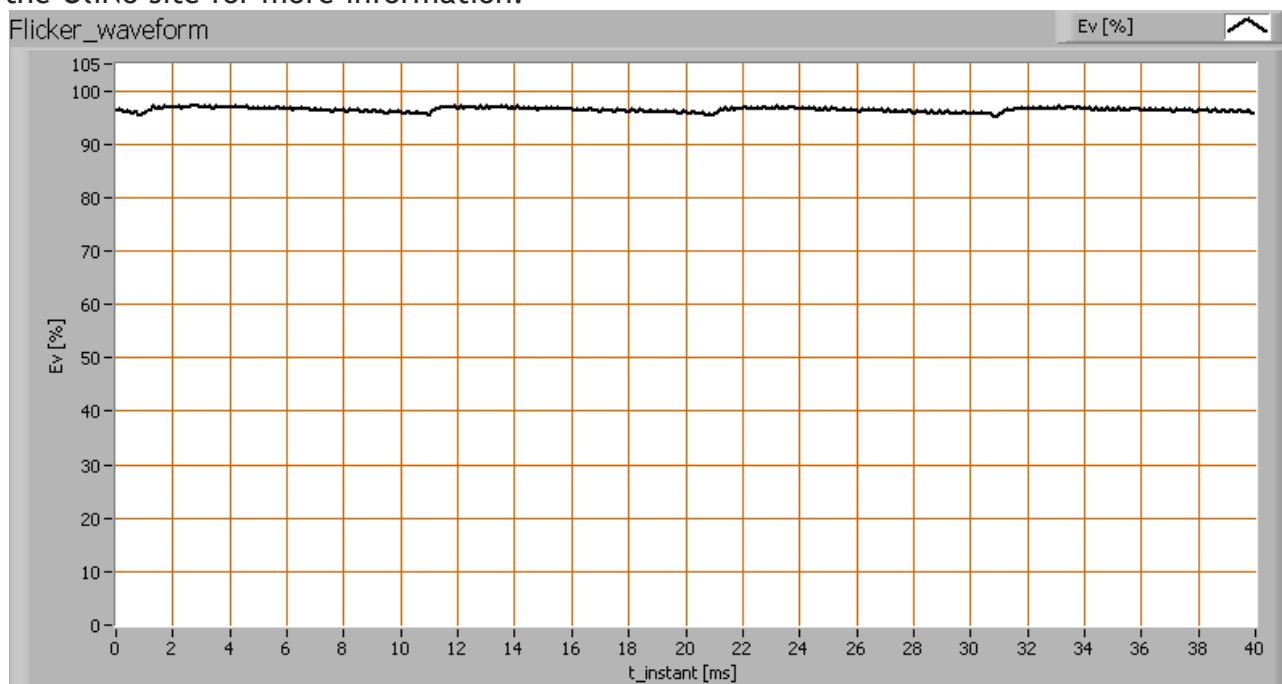
*Effect of warming up on different light bulb parameters. At top the 100 % level is put at begin, and at bottom at the end.*

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The warm up time is about 20 minutes, during which the illuminance decreases with 15 % and the consumed power with 11 %.

### 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	waarde	eenheid
Flicker frequency	99.3	Hz
Illuminance modulation index	1	%

The illuminance modulation index is computed as:  $(\max\_Ev - \min\_Ev) / (\max\_Ev + \min\_Ev)$ .

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