Lamp measurement report – 15 April 2010

2 x 150 cm led TL buis in luminaire
by
Luminesense

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Summary measurement data

parameter	meas. result	remark
Color temperature	5697 K	Cold white
Luminous intensity I_v	1454 Cd	Measured straight underneath the lamp
Illuminance modulation index	21 %	Measured straight underneath the lamp. Is a measure for the amount of flickering.
Beam angle	125 deg	125° for the C0-C180 plane (crossing length direction of the tubes) and 108° for the C90-C270 plane (length direction). This is virtually the same value.
Power P	62.0 W	
Power Factor	0.93	For every 1 kWh net power consumed, there has been 0.4 kVAhr for reactive power.
THD	14 %	Total Harmonic Distortion
Luminous flux	4888 Lm	
Luminous efficacy	79 Lm/W	
CRI_Ra	61	Color Rendering Index.
Coordinates chromaticity diagram	x=0.3278 and y=0.3589	
Fitting	FL-tube	This Tube Light is connected directly to the grid voltage of 230 V AC.
PAR-value	11.5 µMol/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	0.6 µMol/s/W_e	The toal emitted number of photons by this light, divided by its consumption in W. It indicates a kind of efficacy in generating photons.

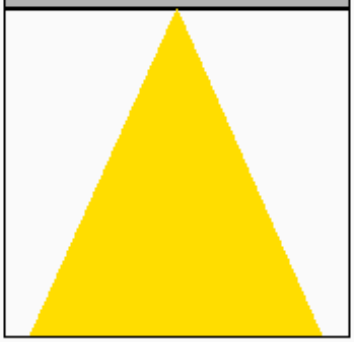
Lamp measurement report – 15 April 2010

S/P ratio	1.8	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (ow environmental light level).
L x W x H external dimensions	1560 x 165 x 95 mm	External dimensions of the lamp.
L x W x H luminous area	1550 x 145 x 45 mm	Dimensions of the luminous area (used in Eulumdat file). This is equal to the dimensions of the transparent cover around the led tubes.
General remarks		The ambient temperature during the whole set of measurements was 23.5-25.5 deg C. The temperature of the lamp gets about 19 degrees hotter than ambient, at the spot where the power supply most likely is situated. The cover itself around the tube gets 10 degrees hotter than ambient. Warm up effect: during the warm up time the illuminance decreased with 9 % and the consumed power with 4 %. Voltage dependency: the power consumption and illuminance do not vary significantly when the voltage is varied from 200 - 250 V.

Lamp measurement report – 15 April 2010

Overview table

m.	Ø 50% C0-180	Ø 50% C90-270
0.25	0.97	0.69
0.5	1.93	1.39
1	3.86	2.77
1.5	5.79	4.16
3	11.59	8.32
4	15.45	11.1
5	19.31	13.87



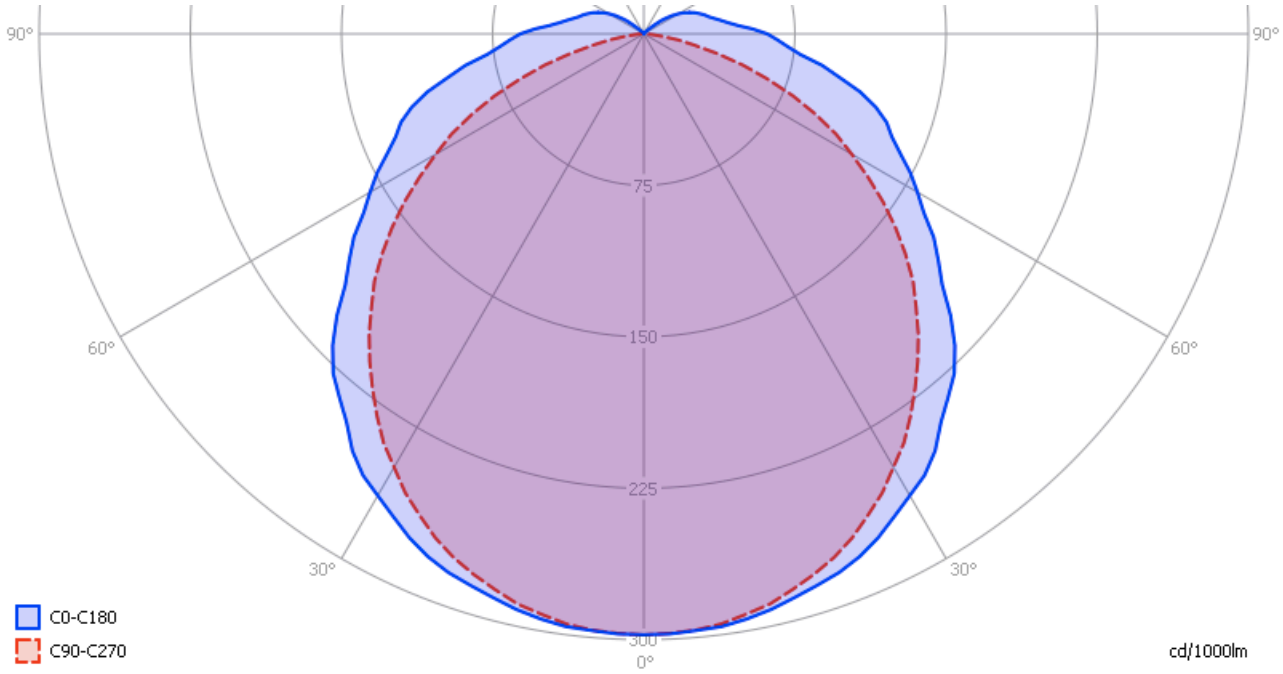
E (lux)
23266
5816
1454
646
162
91
58

Luminaire Efficacy
79 (lumens per Watt)
Half-peak diam C_{0-180}
3.86 x diameter(m)
Half-peak diam C_{90-270}
2.77 x diameter(m)
Illuminance
1454 / distance² (lux)
Total Output
4888 (lumens)

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 1550 mm ≈ 7800 mm. Within this distance from the lamp, the measured lux values willl be less than the computed values in this overview as the measurements are then within the near field of the lamp.

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.



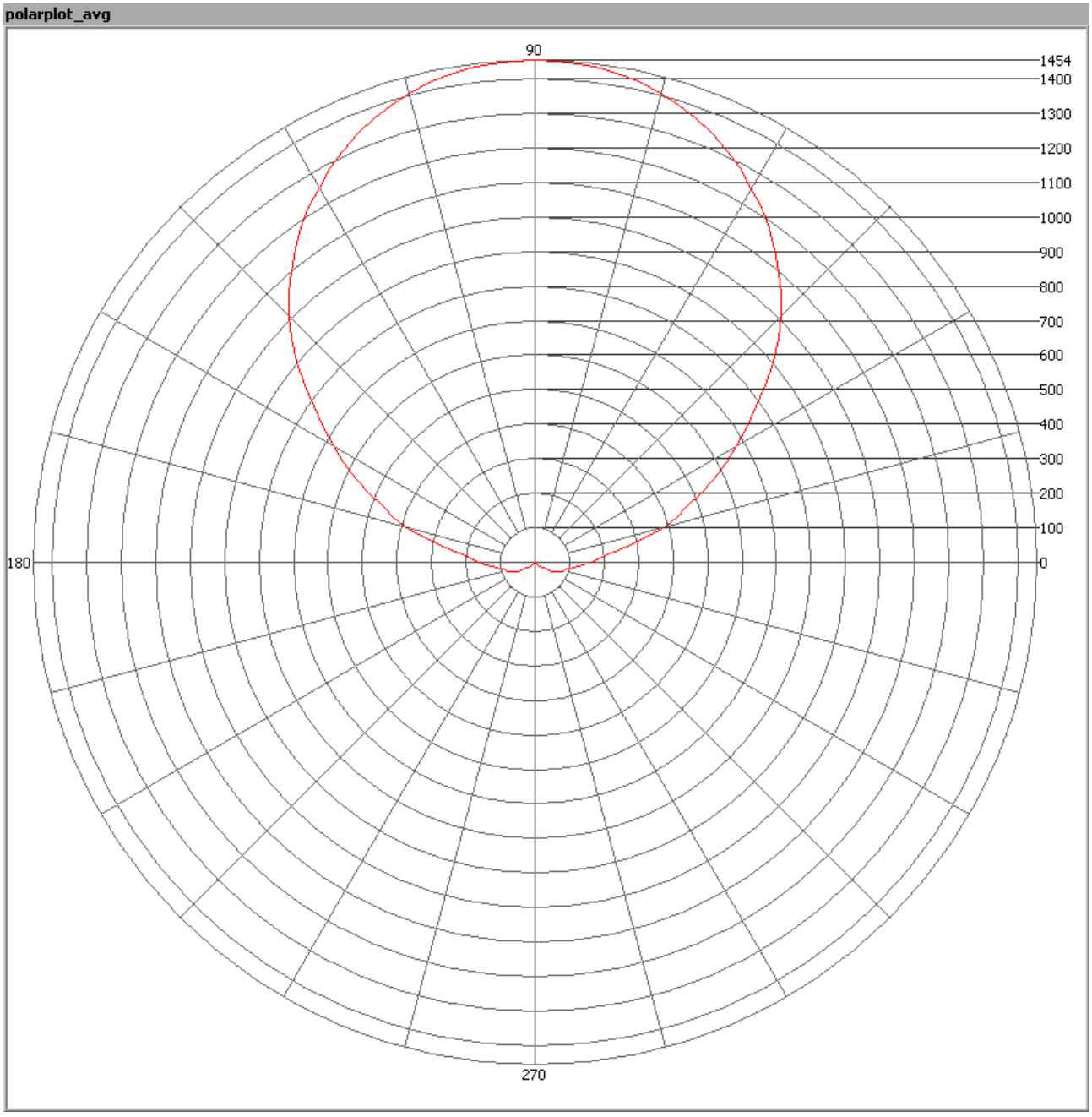
The light diagram giving the radiation pattern.

It indicates the luminous intensity around the light bulb. The direction or plane C0-C180 (crossing the length direction of the tube) emits light in a wider beam than the C90-C270 (along the length direction of the tube).

Illuminance Ev at 1 m distance, or luminous intensity Iv

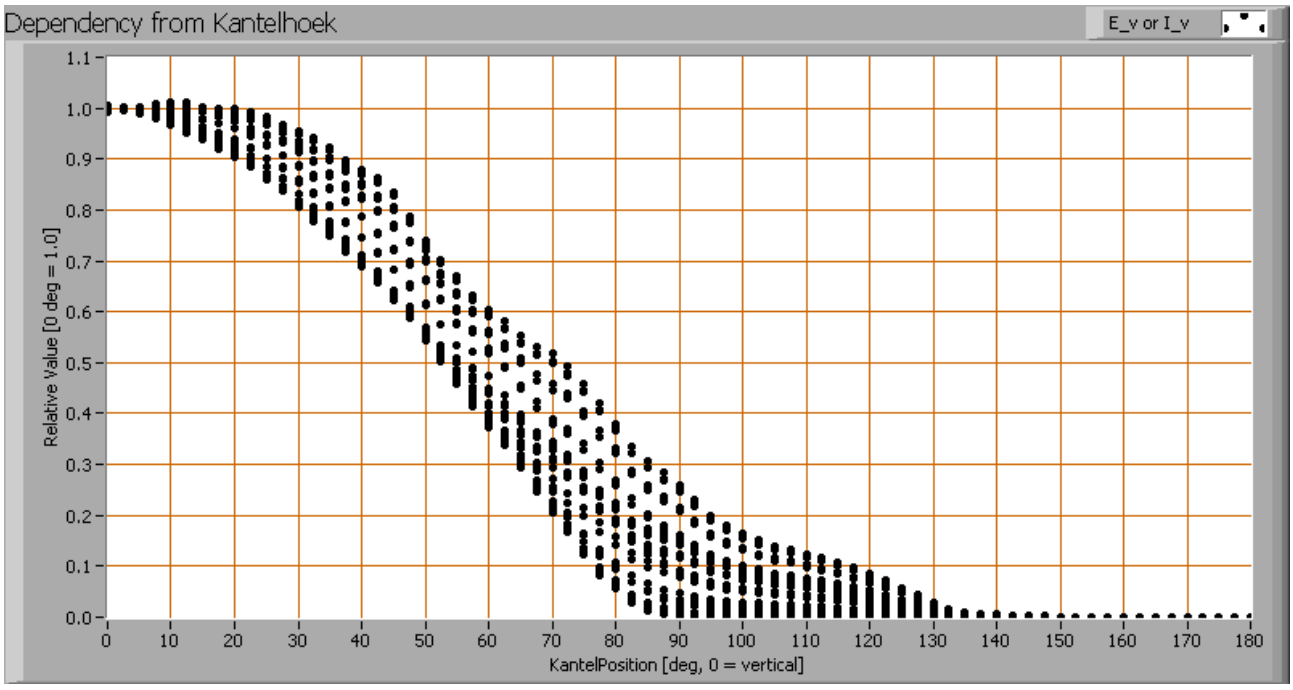
Herewith the plot of the *averaged* luminous intensity Iv as a function of the inclination angle with the light bulb.

Lamp measurement report – 15 April 2010



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.

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 129° in the C0-C180 plane and 108° in the C90-C270 plane.

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 4888 Lm.

Luminous efficacy

The luminous flux being 4888 Lm, and the power of the light bulb being 62.0 W, yields a luminous efficacy of 79 Lm/W.

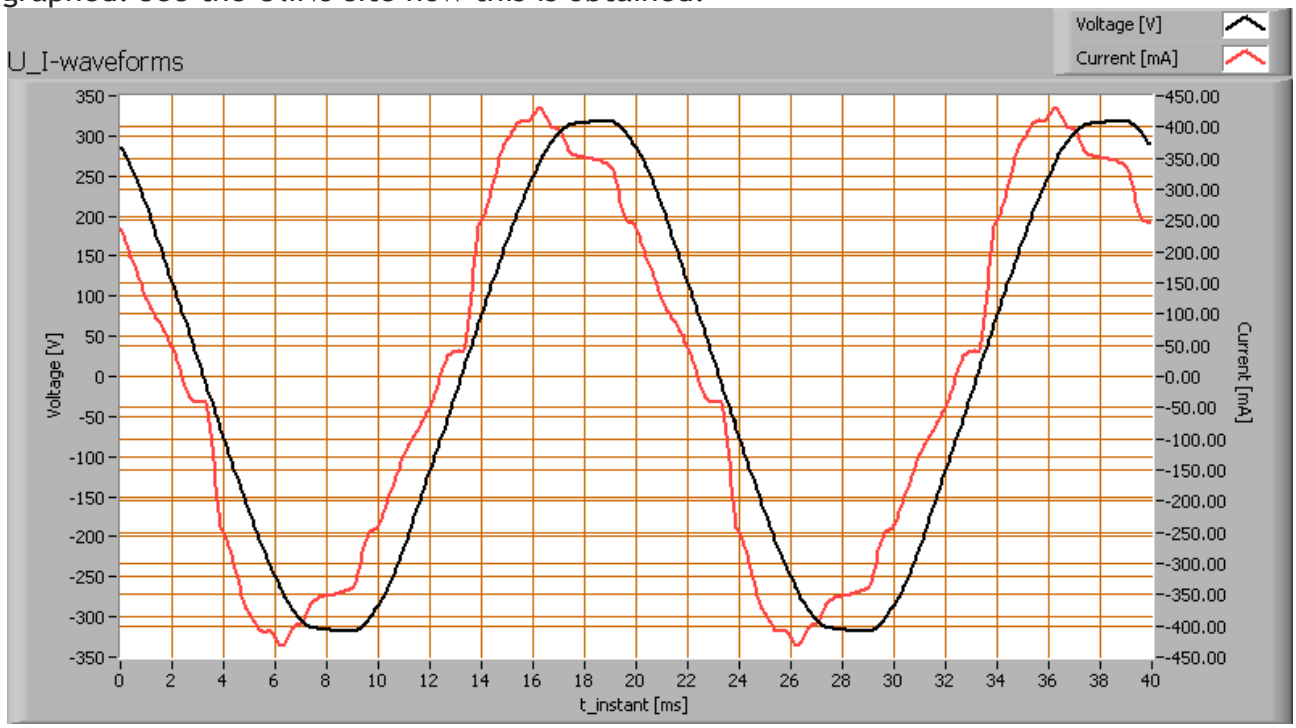
Lamp measurement report – 15 April 2010

Electrical properties

A power factor of 0.93 means that for every 1 kWh net power consumed, a reactive component of 0.4 kVAr was needed.

Lamp voltage	230 VAC
Lamp current	290 mA
Power P	62.0 W
Apparent power S	66.7 VA
Power factor	0.93

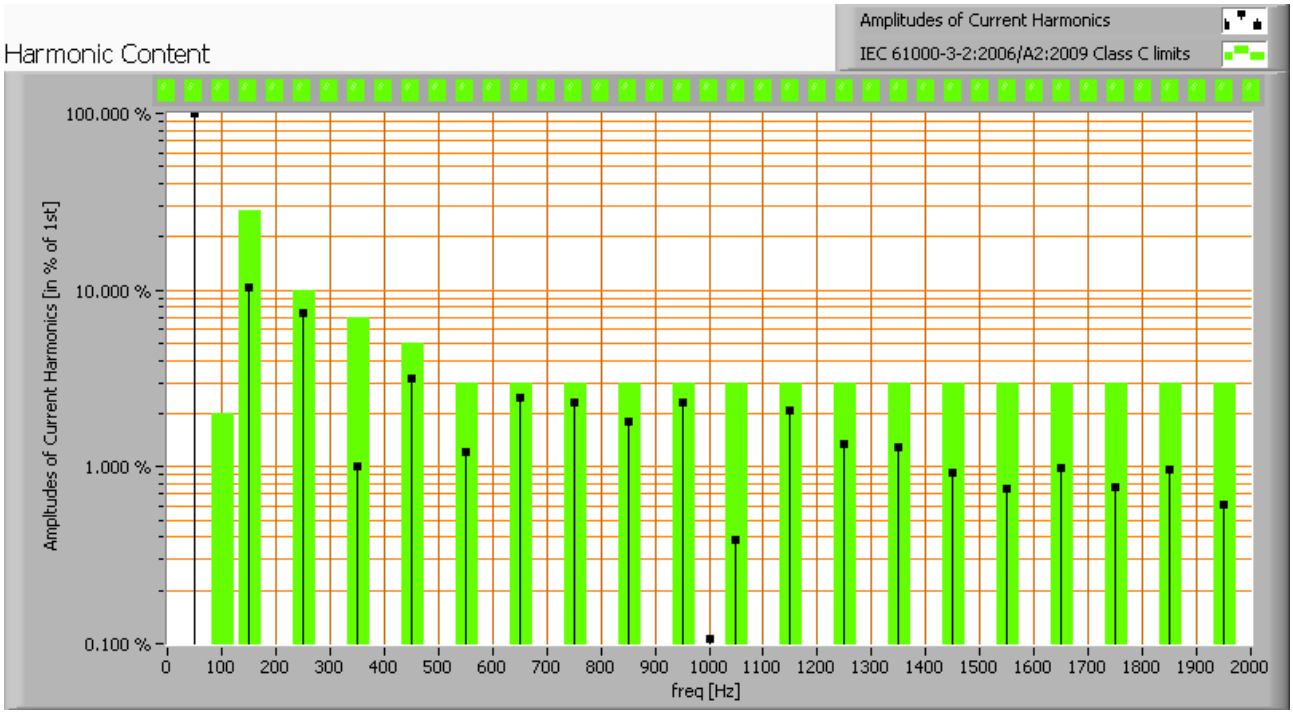
Of this light bulb the voltage across ad the resulting current through it are measured and graphed. See the OliNo site how this is obtained.



Voltage across and current through the lightbulb

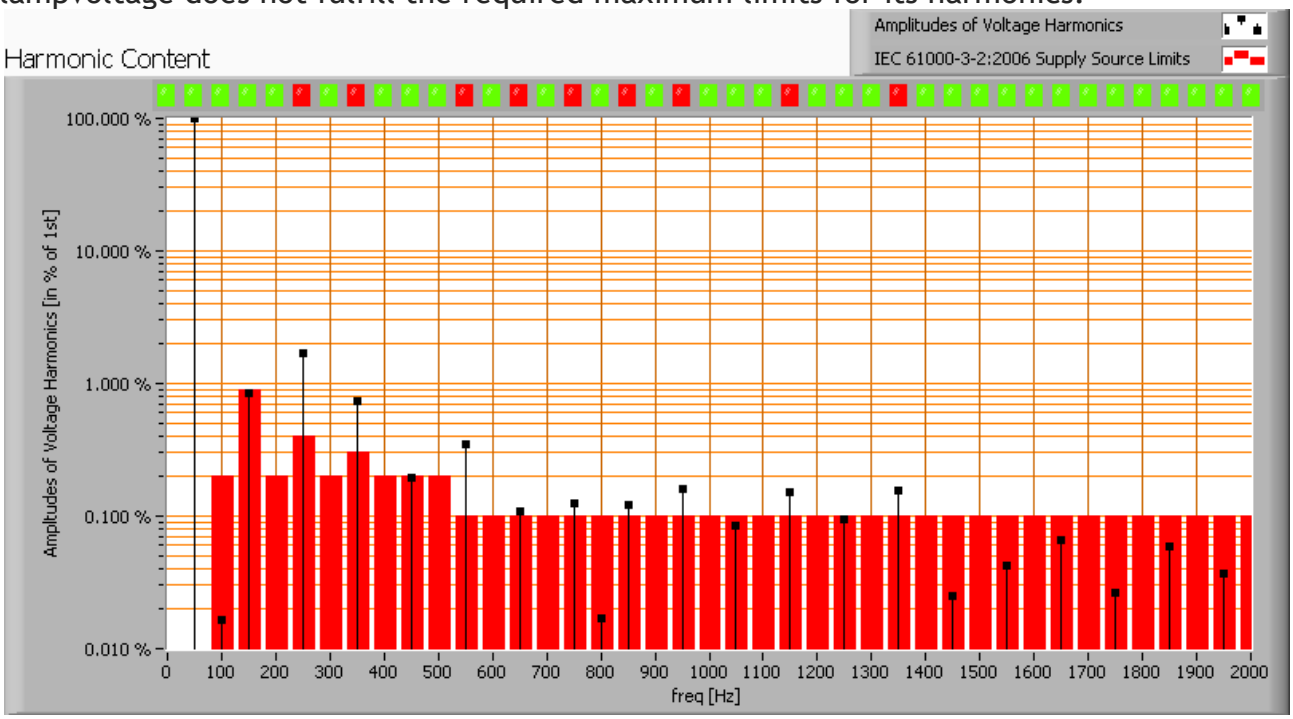
This waveforms have been checked on requirements posed by the norm IEC 61000-3-2:2006 (including up to A2:2009). See also the explanation on the OliNo website.

Lamp measurement report – 15 April 2010



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

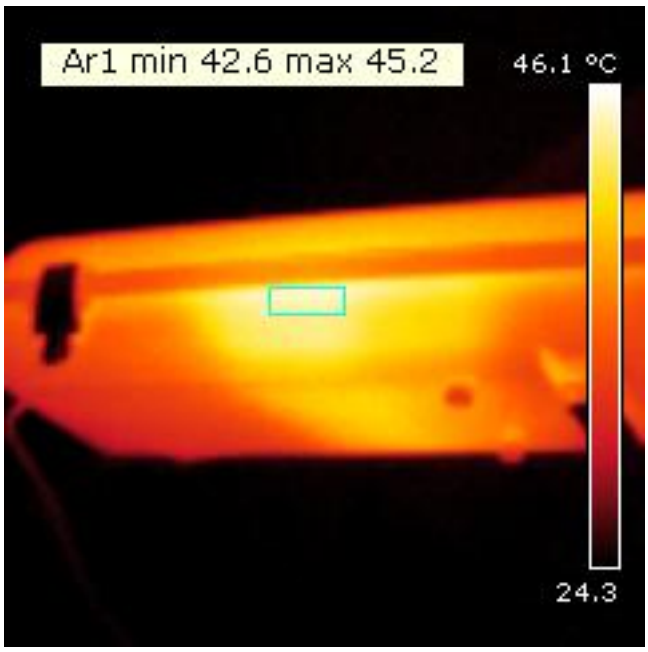
There are limits for the harmonics for lighting equipment > 25 W. This lamp has less harmonics than the limits posed in this norm. Even when considering that the used lampvoltage does not fulfill the required maximum limits for its harmonics.



Harmonics in the used lamp voltage

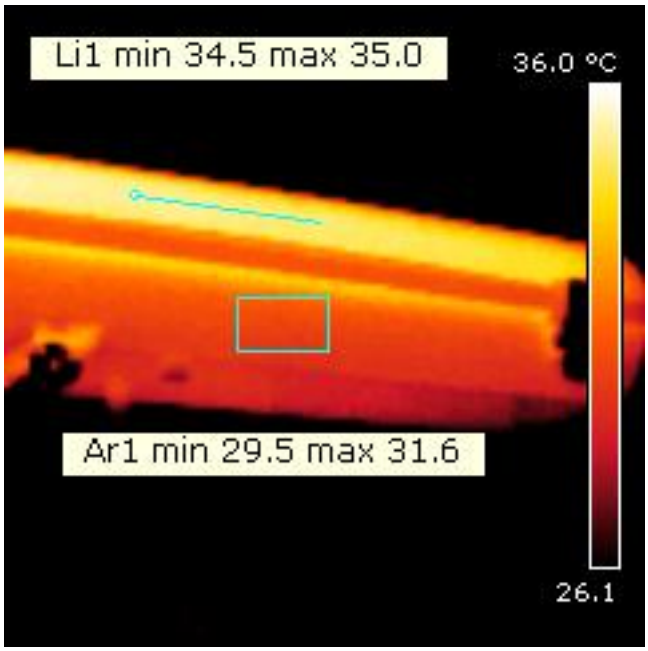
As stated before, even with the used lamp voltage with more harmonics than specified in the norm, this lamp's current fulfills the norm's requirement on harmonic content. The Total Harmonic Distortion of the current is computed as 15 %.

Temperature measurements lamp



Temperature image of the position of the lumnaire where most likely the power supply is positioned.

Lamp measurement report – 15 April 2010



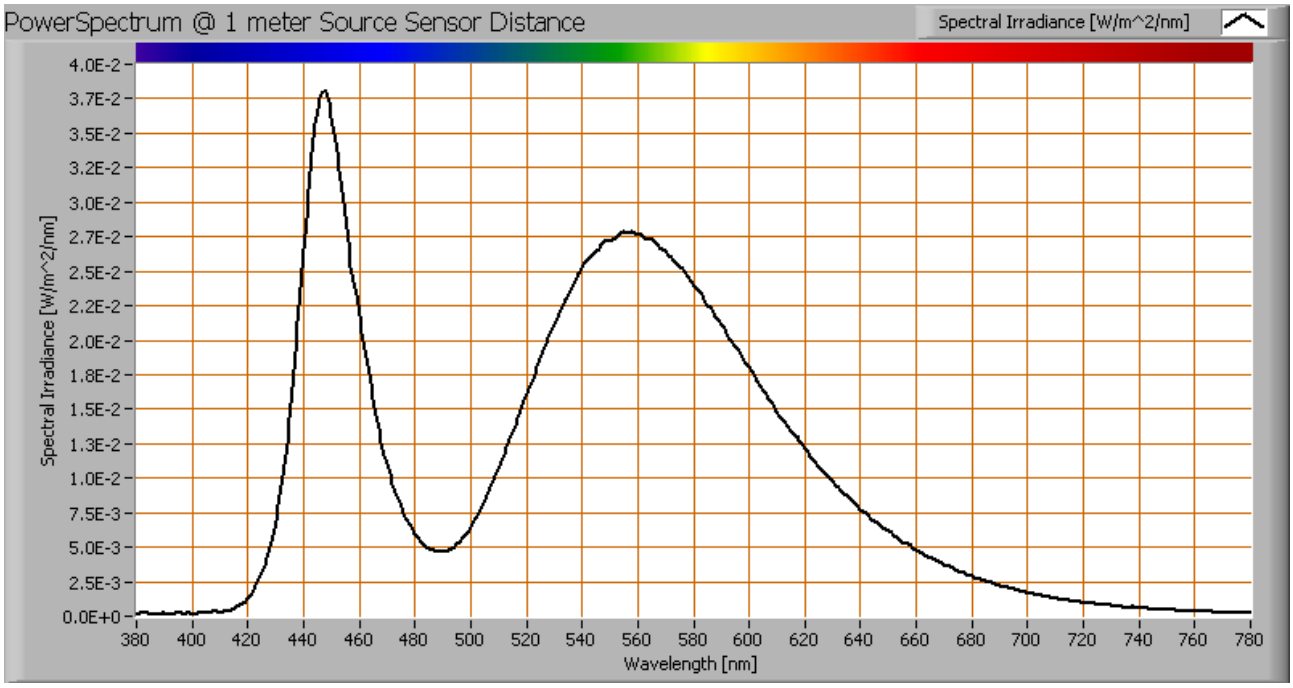
Measurement of the temperature on the lamp cover and part of the luminaire (where no power supply is located)

status lamp	> 2 hours on
ambient temperature	24 deg C
reflected background temperature	24 deg C
camera	Flir BCAM
emissivity	0.95[1]
measurement distance	0.40 m (on photo of power supply)
$IFOV_{geometric}$	1.5 mm
NETD (thermal sensitivity)	100 mK

[1] The emissivity is set at 0.95 which is close to the value of both the transparent cover (tape was used and was not visible) and the luminaire material.
The position of the power supply is the hottest with 19 degrees higher than ambient temperature. The cover gets 10 degrees hotter than ambient.

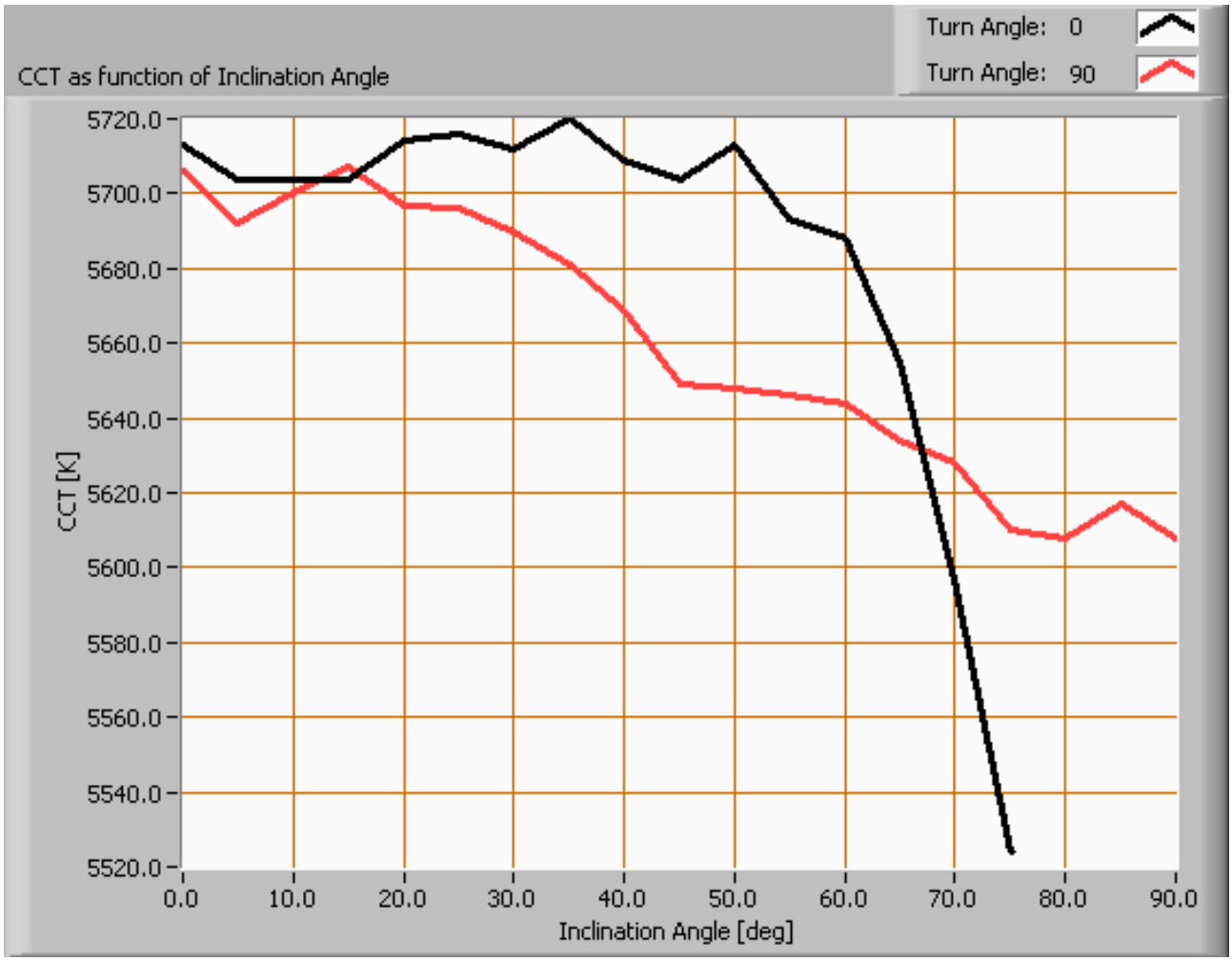
Lamp measurement report – 15 April 2010

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 5700 K which is cold white.
This color temperature is measured straight underneath the light bulb. Below a graph showing the color temperature for different inclination angles.



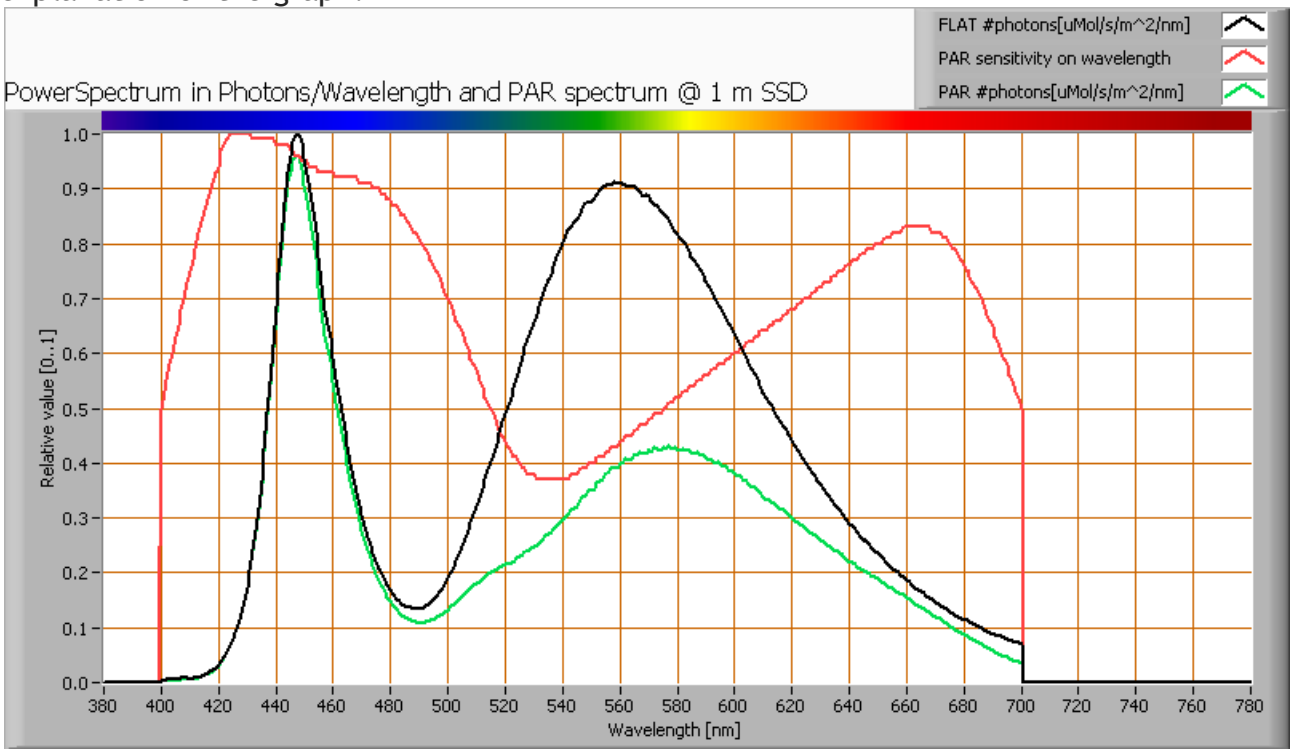
Color temperature as a function of inclination angle.

The measurement of CCT is measured for inclination angles up to 75° as beyond that angle the illuminance values are very low (< 5 lux).
The beam angle is maximally 125°, meaning a 62.5° inclination angle. In this area most of the light is present. The variation in correlated color temperature in this area is ≈ 1 %.

Lamp measurement report – 15 April 2010

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

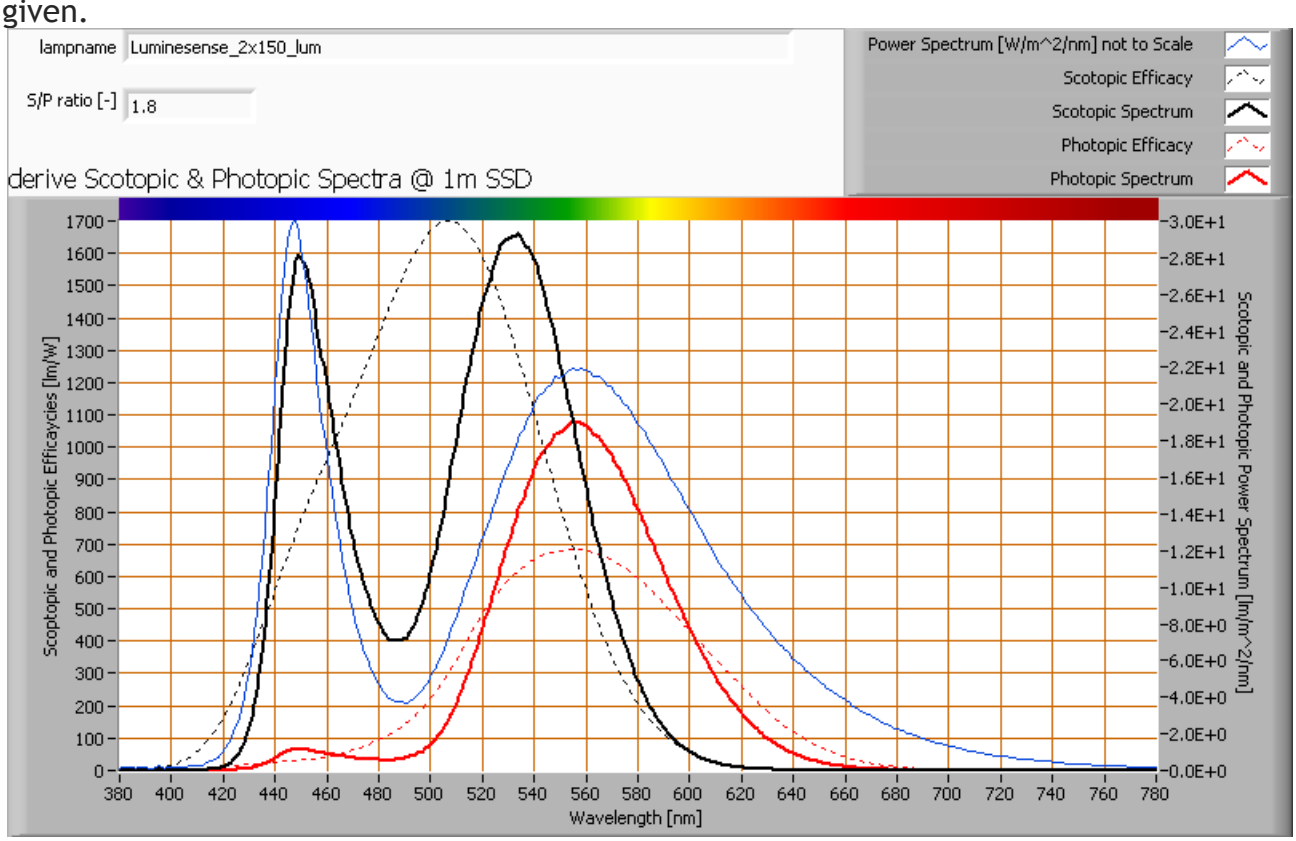
parameter	value	unit
PAR-number	11.5	µMol/s/m²
PAR-photon current	38.7	µMol/s
PAR-photon efficacy	0.6	µMol/s/W

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 %).

Lamp measurement report – 15 April 2010

S/P ratio

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

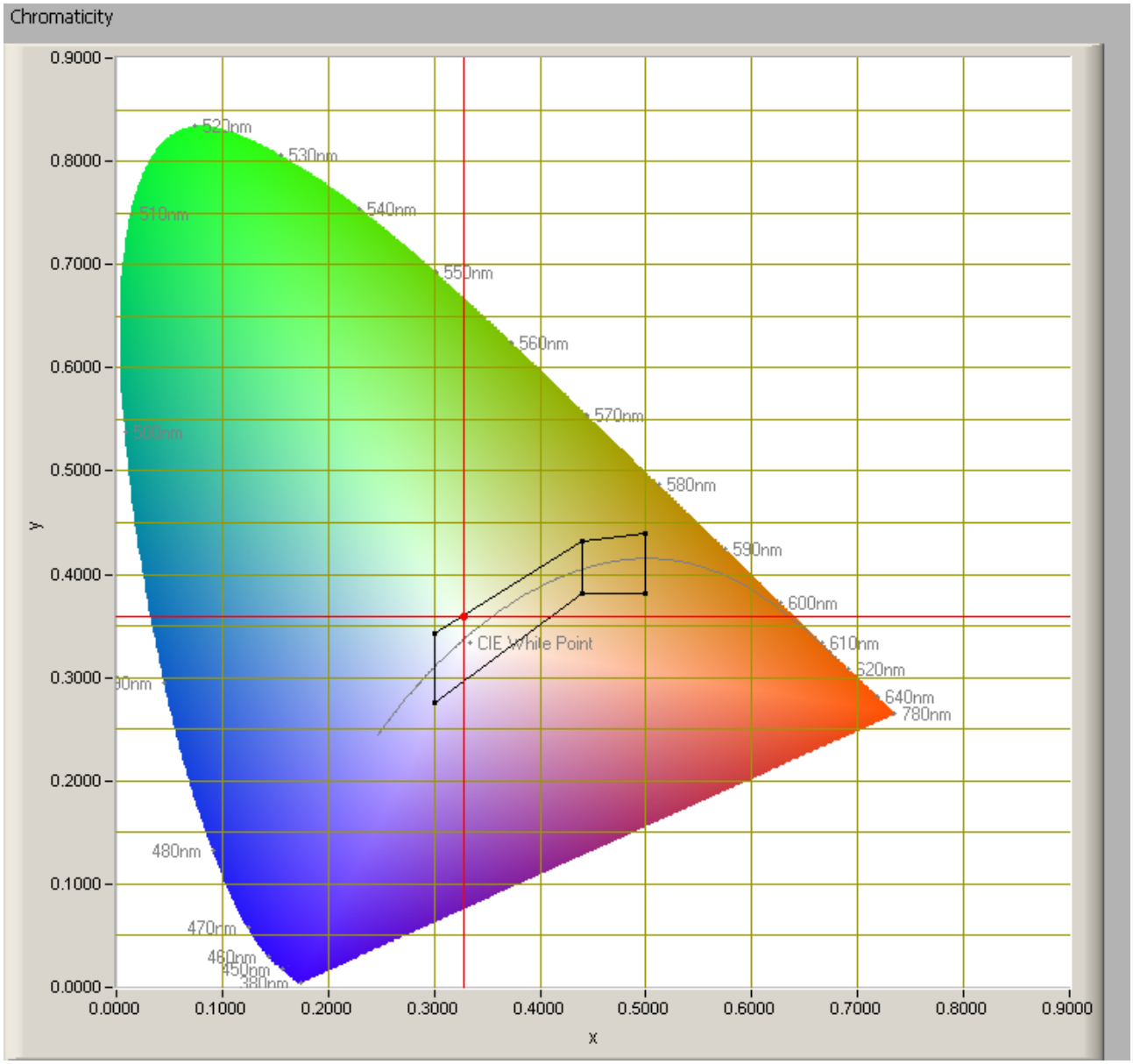


The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).

The S/P ratio is 1.8.
More info on S/P ratio can be found on the OliNo website.

Lamp measurement report – 15 April 2010

Chromaticity diagram

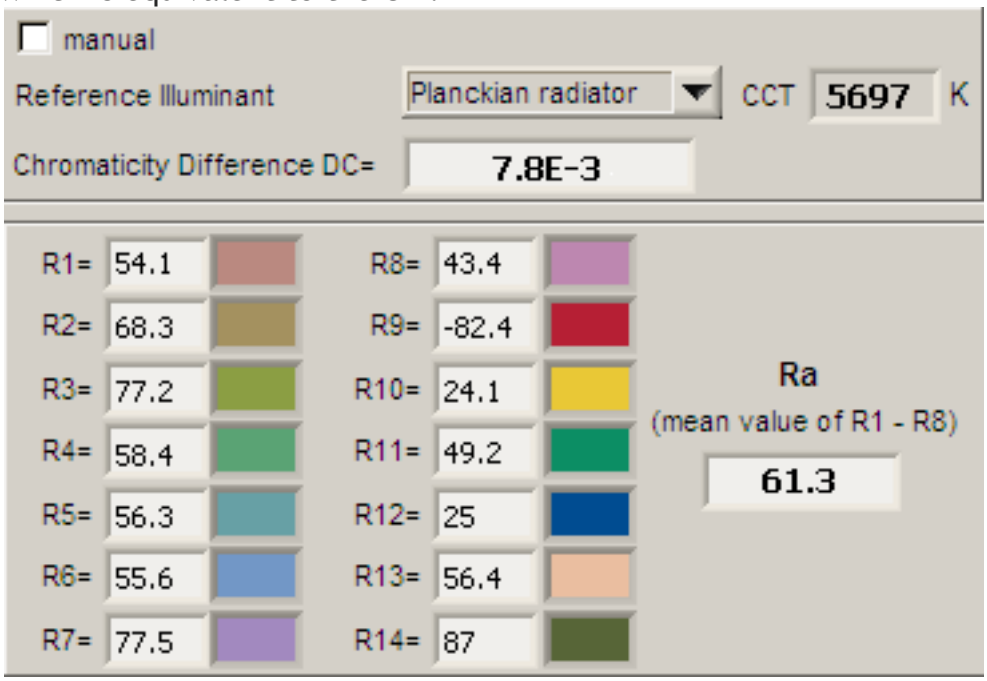


The chromaticity space and the position of the lamp's color coordinates in it.

The light coming from this lamp is on the edge of 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=0.3278 and y=0.3589.

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 Rx, and the first 8 indexes (R1 .. R8) are averaged to compute the Ra which is equivalent to the CRI.



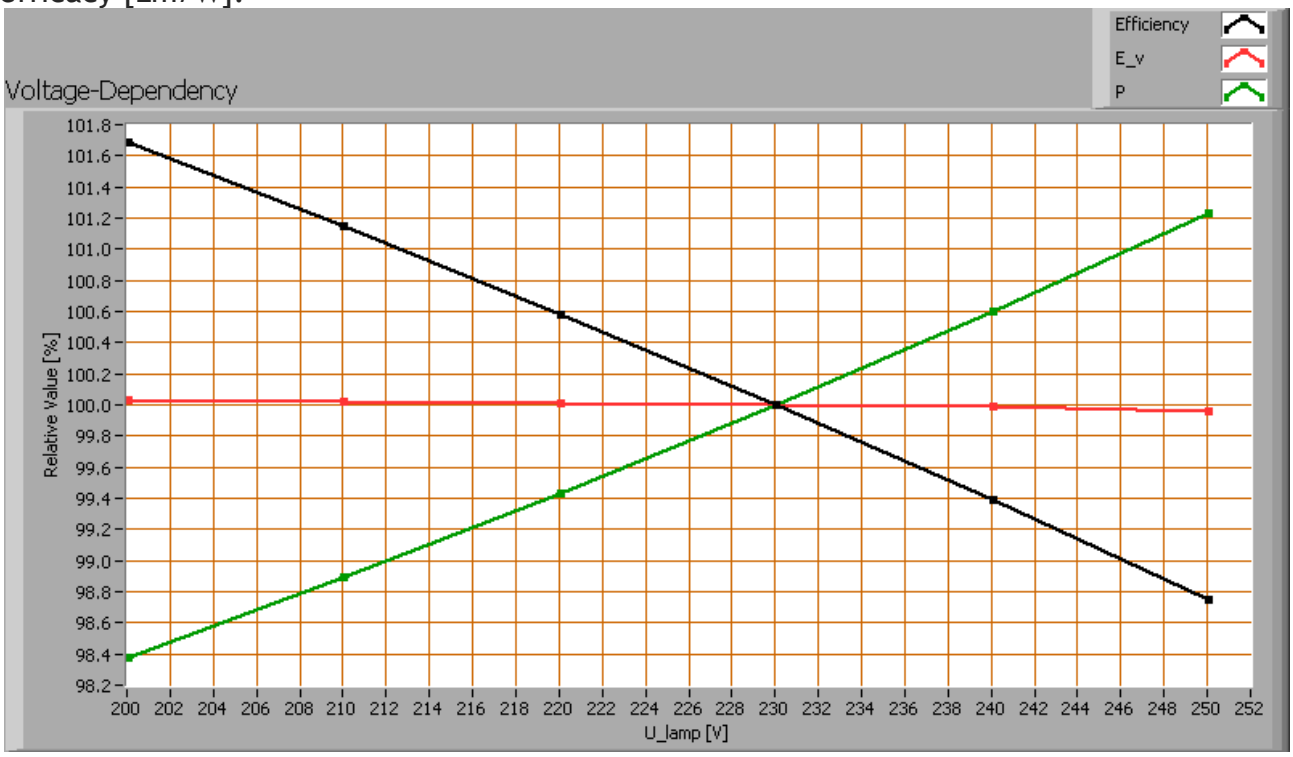
CRI of the light of this lightbulb.

The value of 61 is lower than 80 which is considered a minimum value for indoor usage. Note: the chromaticity difference is 0.0078 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 lamppower P [W] and the luminous

efficacy [Lm/W].



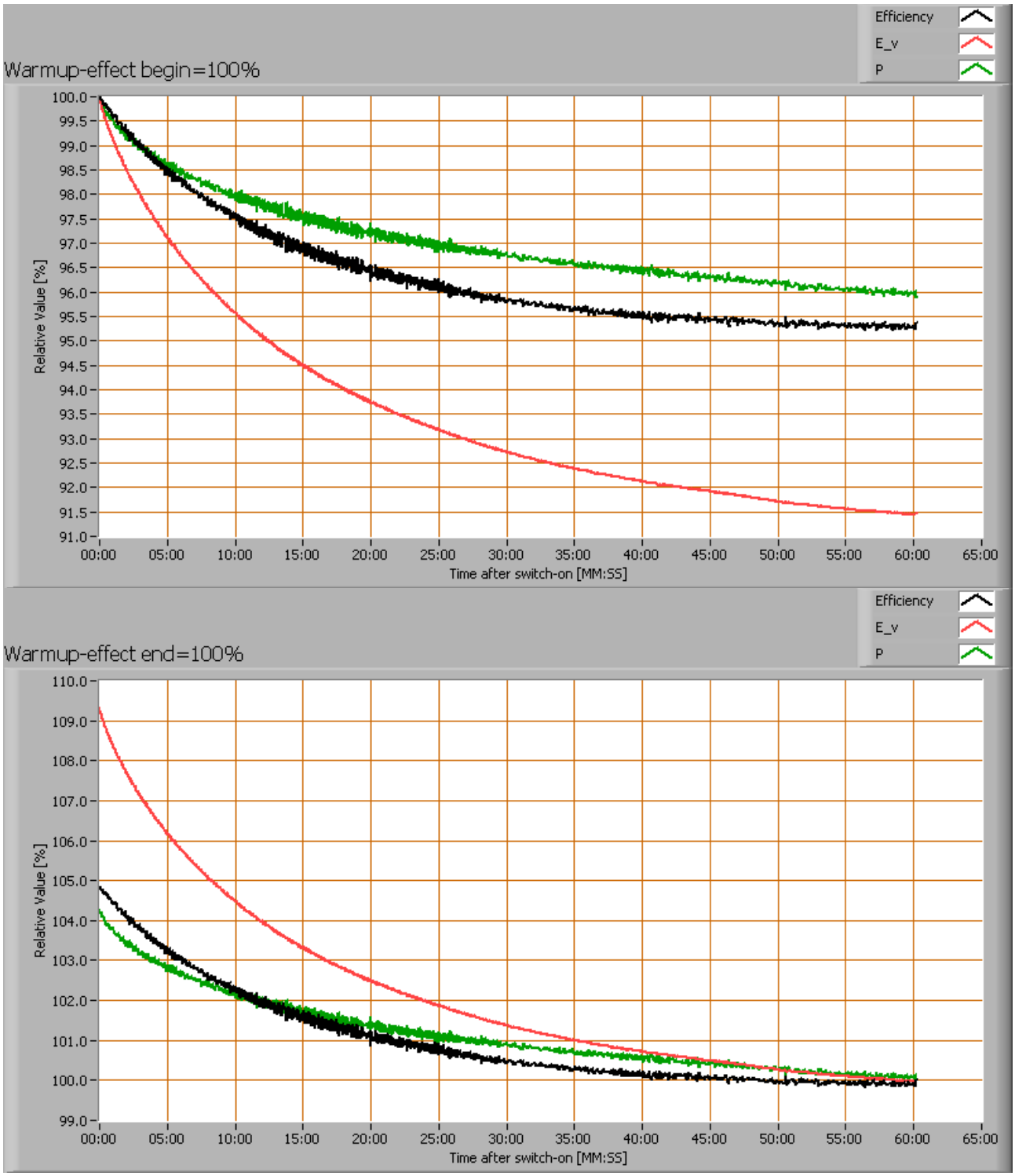
Lamp voltage dependencies of certain light bulb parameters, where the value at 230 V is taken as 100 %.

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 < 0.1 %, 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 lamppower P [W] and the luminous efficacy [lm/W].

Lamp measurement report – 15 April 2010

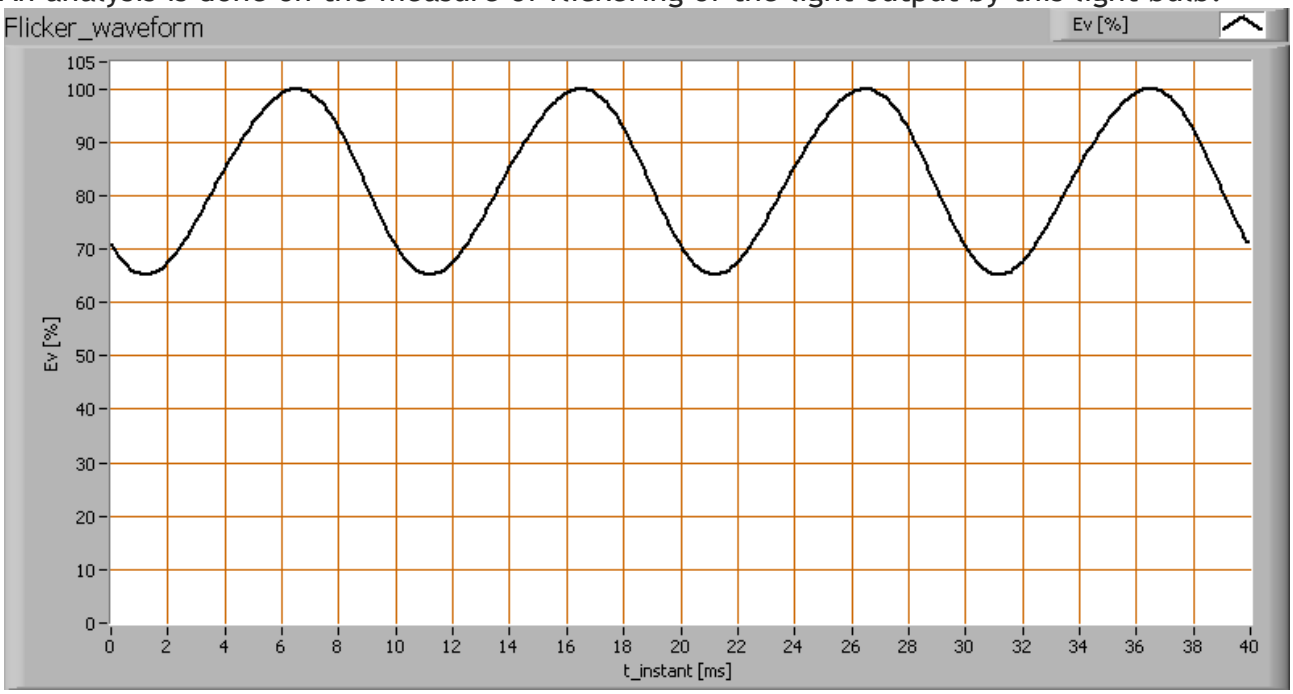


Effect of warming up on different light bulb parameters. At top the 100 % level is put at begin, and at bottom at the end.

The warm up time is about 1 hour. During that time the the illuminance decreases with 9 % and the consumed power with 4 %.

Measure of flickering

An analysis is done on the measure of flickering of the light output by this light bulb.



The measure of fast illuminance variartion of the light of the light bulb

parameter	waarde	eenheid
Flicker frequency	100.0	Hz
Illuminance modulation index	21	%

The illuminance modulation index is computed as: (max_Ev - min_Ev) / (max_Ev + min_Ev).

Disclaimer