

Lamp measurement report - 7 April 2014
GU10 3x1W 2700K dimmable D35mm

by
TopLEDshop



Lamp measurement report - 7 April 2014

Summary measurement data

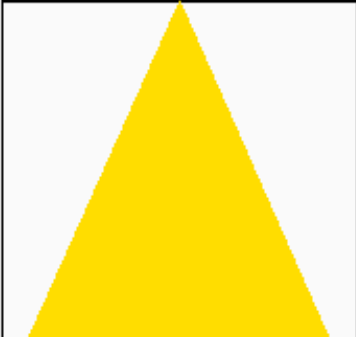
parameter	meas. result	remark
Color temperature	2673 K	warm white
Luminous intensity I _v	547.4 Cd	Measured straight underneath the lamp.
Illuminance modulation index	100 %	Measured with a light sensor looking at the lamp (angle not defined). Is a measure for the amount of flickering.
Beam angle	29 deg	29 deg is the beam angle for all C-planes since the lamp is symmetrical along its 1st axis.
Power P	3.5 W	Follow the link for more information on electrical properties.
Power Factor	0.90	An electrical load with this power factor means that for every 1 kWh net energy consumed, there has been 0.48 kVAhr for reactive energy.
THD	48 %	Total Harmonic Distortion.
Max inrush current	0.035 A	This current has been found at a voltage start angle of 100 degrees.
Luminous flux	187 lm	
Luminous efficacy	53 lm/W	
EU2013-label classification	A+	The energy class, from A++ (more efficient) to E (least efficient). This label is an update of the previous version, and compulsory from Sept 2013.
CRI _{Ra}	81	Color Rendering Index.
Coordinates chromaticity diagram	x=0.4608 en y=0.4084	
Fitting	GU10	This lamp is connected directly to the grid voltage.
PAR-value	5.4 uMol/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	0.5 uMol/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.
Photon current	3.1 uMol/s	The total number of photons in the light of this lamp.
S/P ratio	1.2	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (low environmental light level).

Lamp measurement report - 7 April 2014

parameter	meas. result	remark
D x H external dimensions	34 mm x 50 mm	External dimensions of the lamp.
D luminous area	23 mm	Dimensions of the luminous area (used in Eulumdat file). It is the surface of the lens at the front.
General remarks		<p>The ambient temperature during the whole set of illuminance measurements was 26.3 - 26.8 deg C. The temperature of the housing gets maximally about 46 degrees hotter than ambient temperature. The led gets 54 deg hotter, from al what is visible of it from the outside.</p> <p>Warm up effect: During the warmup time the illuminance varies during 19 minutes and decreases with 11 %.</p> <p>During the warmup time the power varies during 14 minutes and decreases with 6 %. the variation in efficacy during the warming up is -5 %. A very high negative value indicates a significant decrease for instance due to heating up of the lamp (decrease of lifetime).</p> <p>Voltage dependency: There is a constant dependency of the illuminance when the power voltage varies between 200 - 250 V AC.</p> <p>There is a constant dependency of the consumed power when the power voltage varies between 200 - 250 V AC.</p> <p>Also the dim-ability of this lamp has been tested, and the result is that the lamp is dim-able, see also the separate chapter in this test report.</p>
Eff-variation	-5 %	This is the variation in efficacy during the warming up. A very high negative value indicates a significant decrease for instance due to heating up of the lamp (decrease of lifetime).
Dimmable	yes	Info from manufacturer.
Biologic effect factor	0.311	According to pre-norm DIN V 5031-100:2009-06.
Blue Light Hazard risk group	1	0=exempt, 1=low, 2 = moderate, 3=high risk.
form factor	spot	

Lamp measurement report - 7 April 2014

Overview table

m.	Ø 50%		C0-180: 29° C90-270: 29°	E (lux)	Luminaire Efficacy
	C0-180	C90-270			53 (lumen per Watt)
1	0.51	0.51		547	Half-peak diam C0-180
1.5	0.76	0.76		243	0.51 x diameter(m)
2	1.02	1.02		137	Half-peak diam C90-270
3	1.52	1.52		61	0.51 x diameter(m)
4	2.03	2.03		34	Illuminance
6	3.05	3.05		15	547 / distance ² (lux)
8	4.07	4.07		9	Total Output
					187 (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 23 mm (maximal luminous size, eventually diagonally measured)= 115 mm. Within this distance from the lamp (data given in red), 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.

Lamp measurement report - 7 April 2014

EU 2013 Energy label classification

Since Sept 2013 these labels will be needed, see also this page for the explanation.

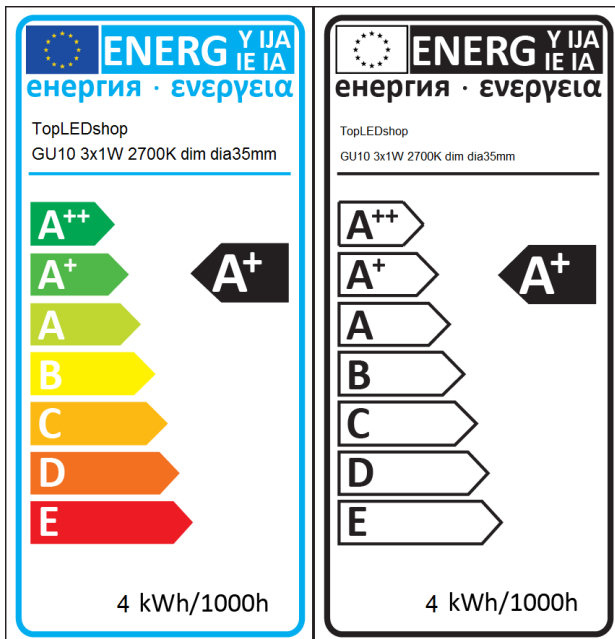
Important for the energy classification are the corrected rated power and the useful luminous flux.

The measured rated power is 3.5 W and might need to be corrected. The correction is dependent from the lamp type and whether or not the lamp control gear is included or not.

The choice for this lamp is the following classification: **Lamps with own control gear (external or internal)**. As a result the corrected rated power becomes: 3.5 W.

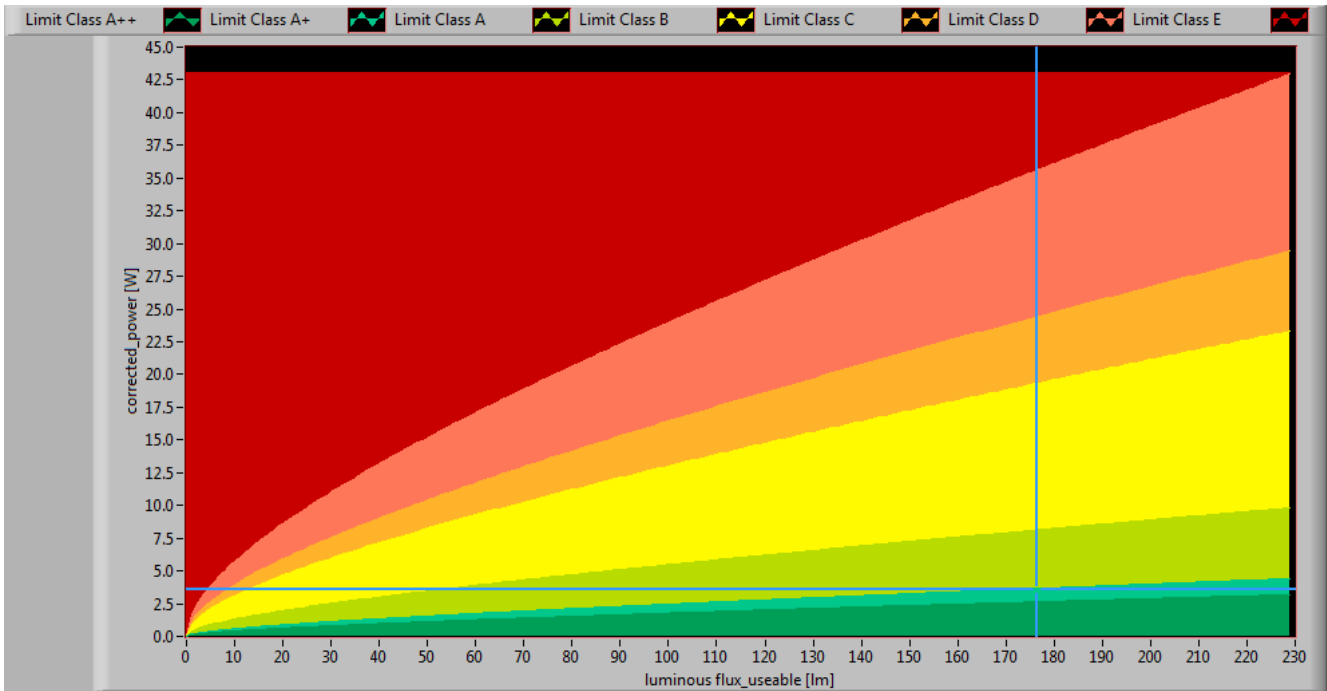
The luminous flux measured is 187 lm. The classification of this lamp needed to determine the useful flux is: **Other directional lamps**. Then the useful flux becomes 176 lm. Now a reference power can be calculated.

The energy efficiency coefficient is $P_{corr} / P_{ref} = 0.17$.



EU energy label for this lamp

Lamp measurement report - 7 April 2014

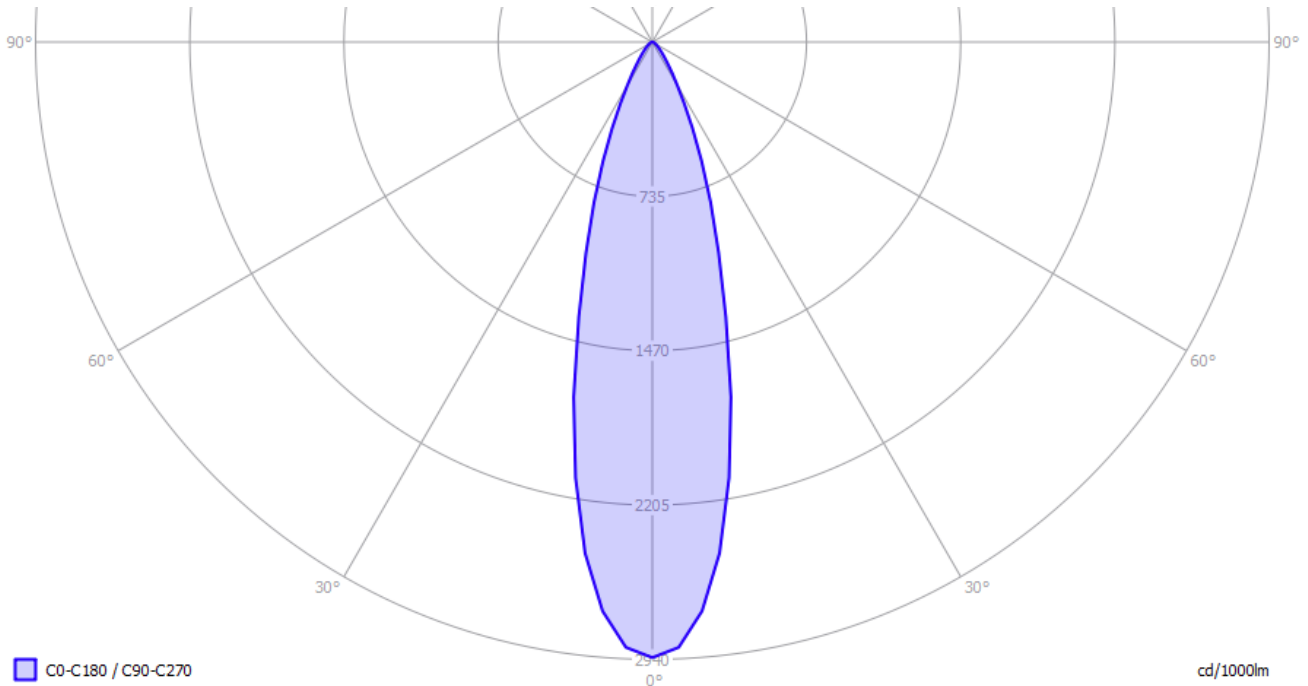


The lamp's performance in the lumen-Watt field, with the energy efficacy fields indicated.

Lamp measurement report - 7 April 2014

Eulumdat light diagram

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



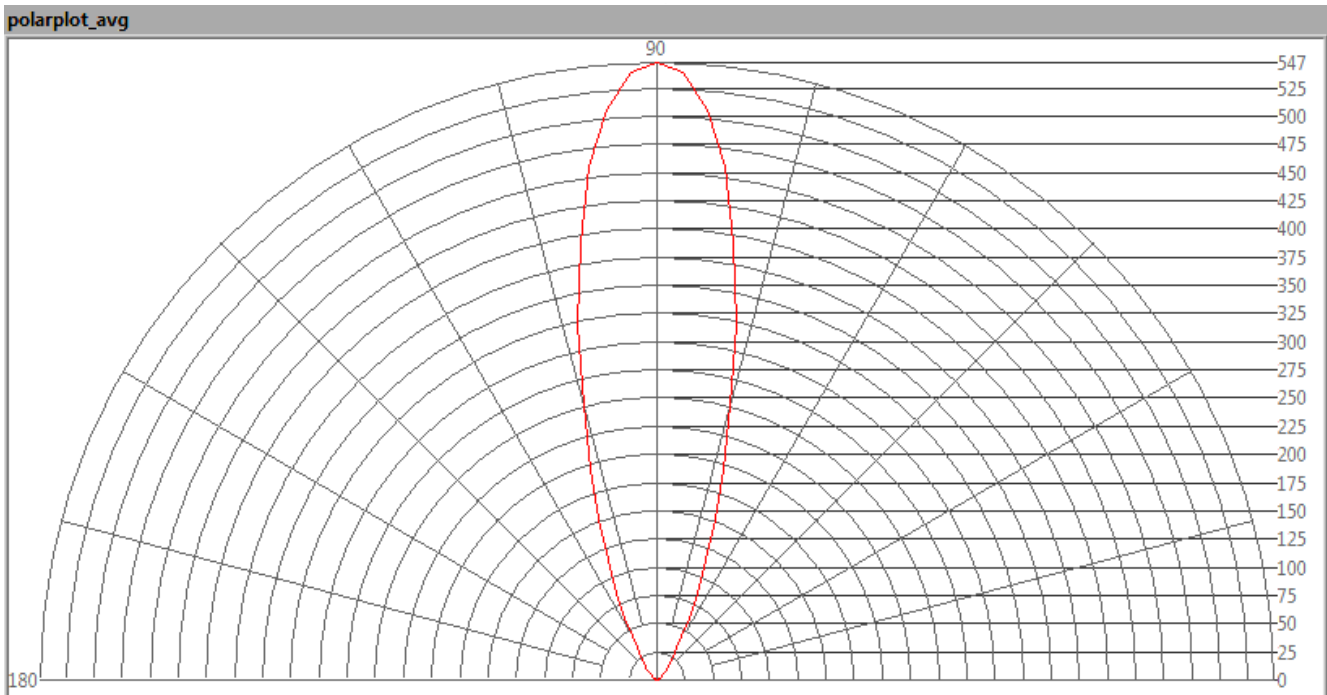
The light diagram giving the radiation pattern.

The light diagram indicates the beam in the C0-C180 plane and in the plane perpendicular to that, the C90-C270 plane. These beams are equal as the lamp has symmetry over its first axis (the vertical axis).

Lamp measurement report - 7 April 2014

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.

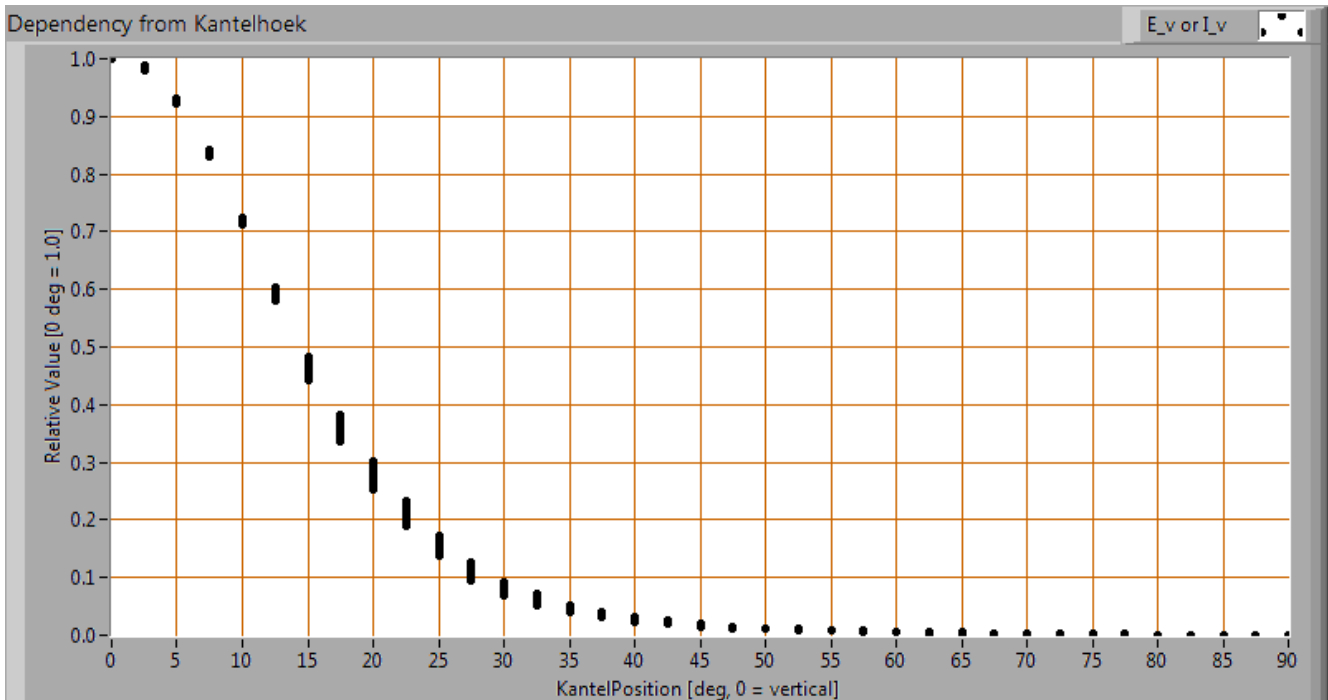


The radiation pattern of the light bulb.

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.

Lamp measurement report - 7 April 2014



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 29 deg for the C0-C180 plane and 29 deg for 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 187 lm.

Luminous efficacy

The luminous flux being 187 lm, and the consumed power of the lamp being 3.5 Watt, results in a luminous efficacy of 53 lm/Watt.

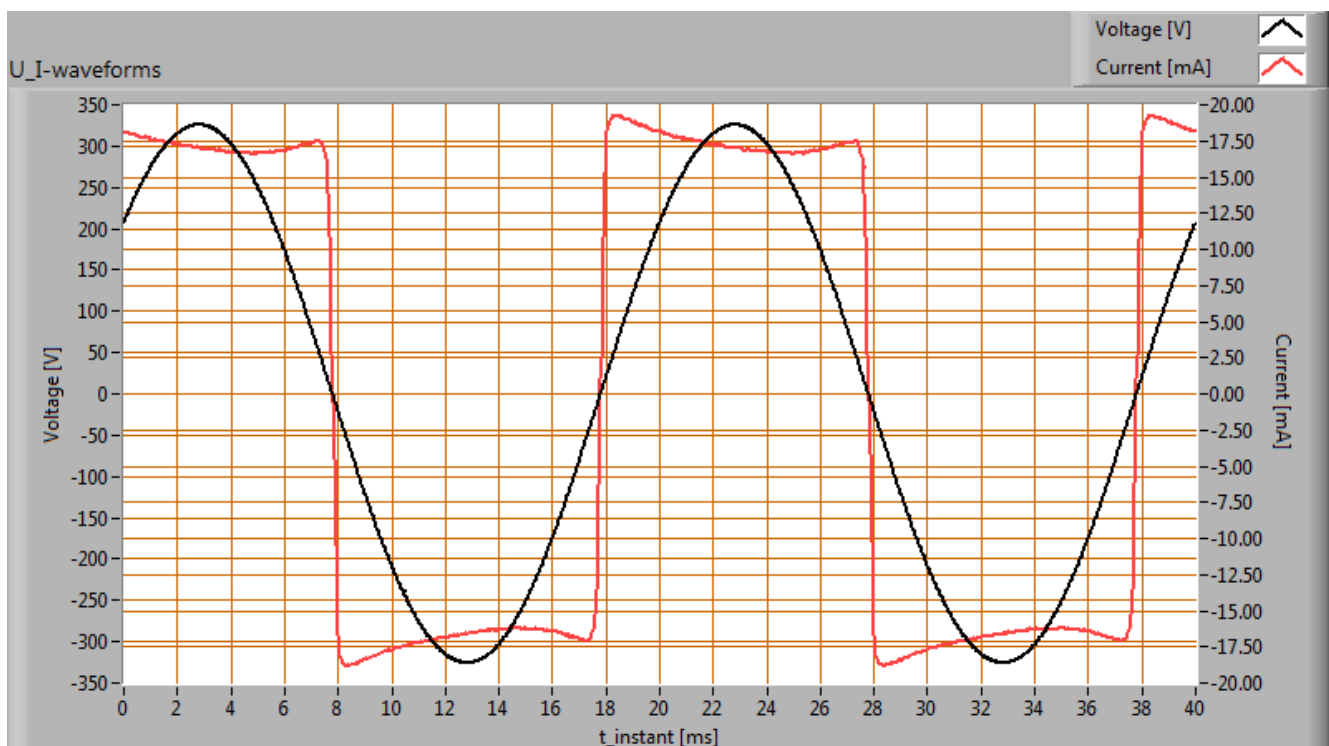
Lamp measurement report - 7 April 2014

Electrical properties

The power factor is 0.90. An electrical load with this power factor means that for every 1 kWh net energy consumed, there has been 0.48 kVAhr for reactive energy.

Lamp voltage	230.25 V
Lamp current	0.017 A
Power P	3.5 W
Apparent power S	3.9 VA
Power factor	0.90

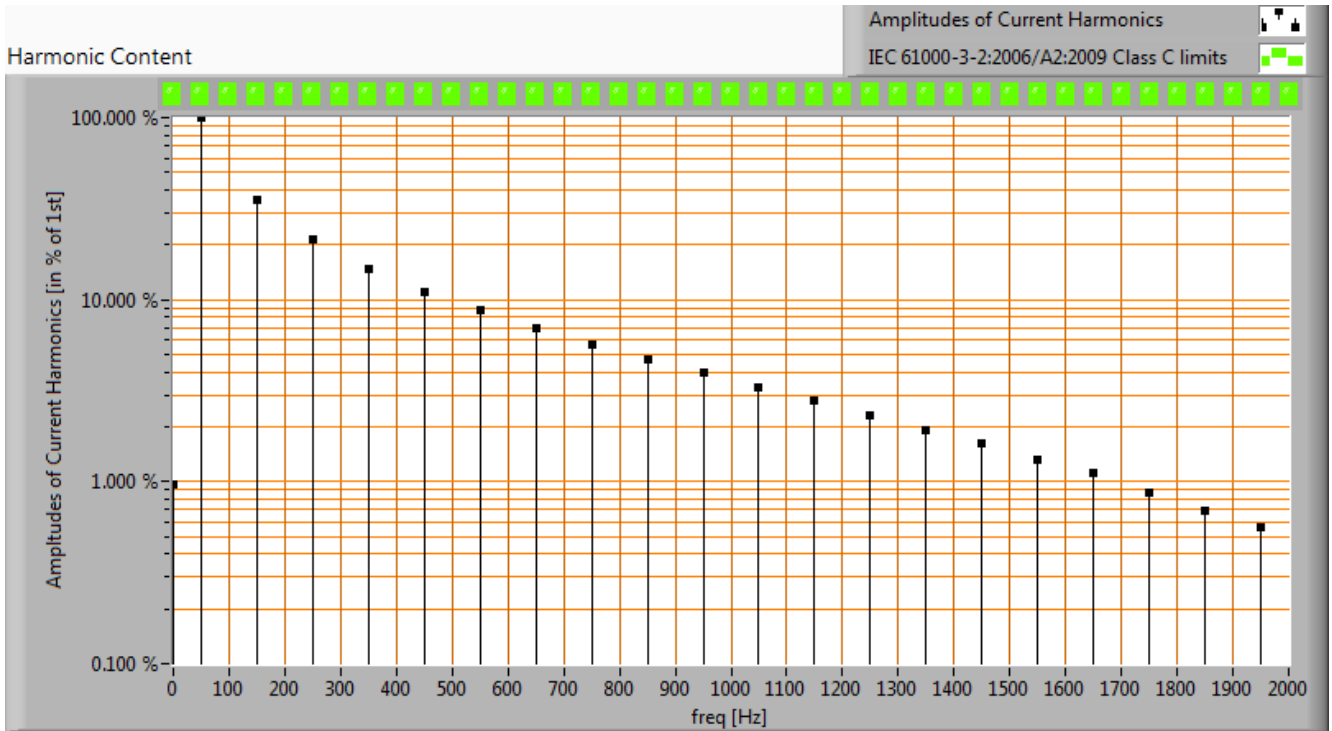
Of this lamp the voltage across and the resulting current through it are measured and graphed. See the UI acquisition on the OliNo site how this is obtained.



Voltage across and current through the lightbulb

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

Lamp measurement report - 7 April 2014



Harmonics in the current waveform and checked against IEC61000-3-2:2006 and A2:2009

When the consumed power is ≤ 25 W there are no limits for the harmonics.

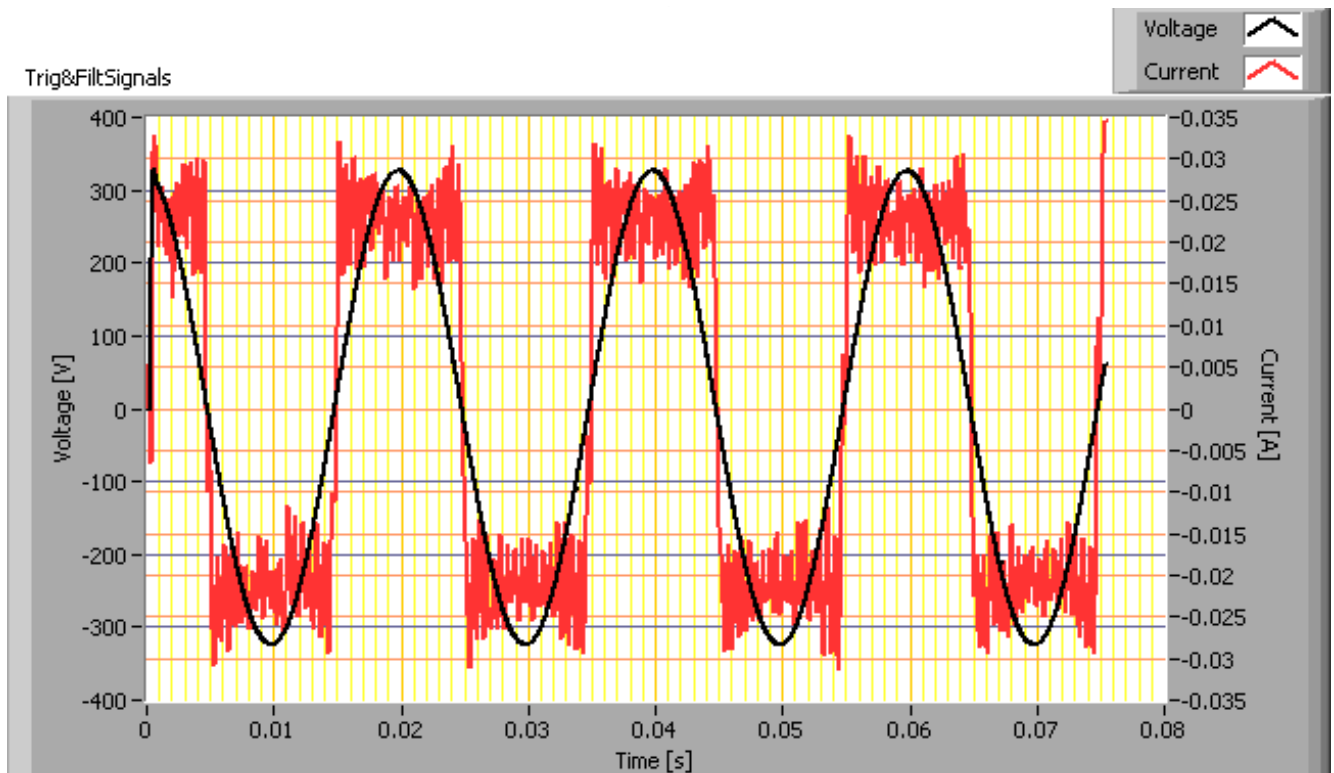
The Total Harmonic Distortion of the current is computed and its value is 48 %.

Lamp measurement report - 7 April 2014

Inrush current

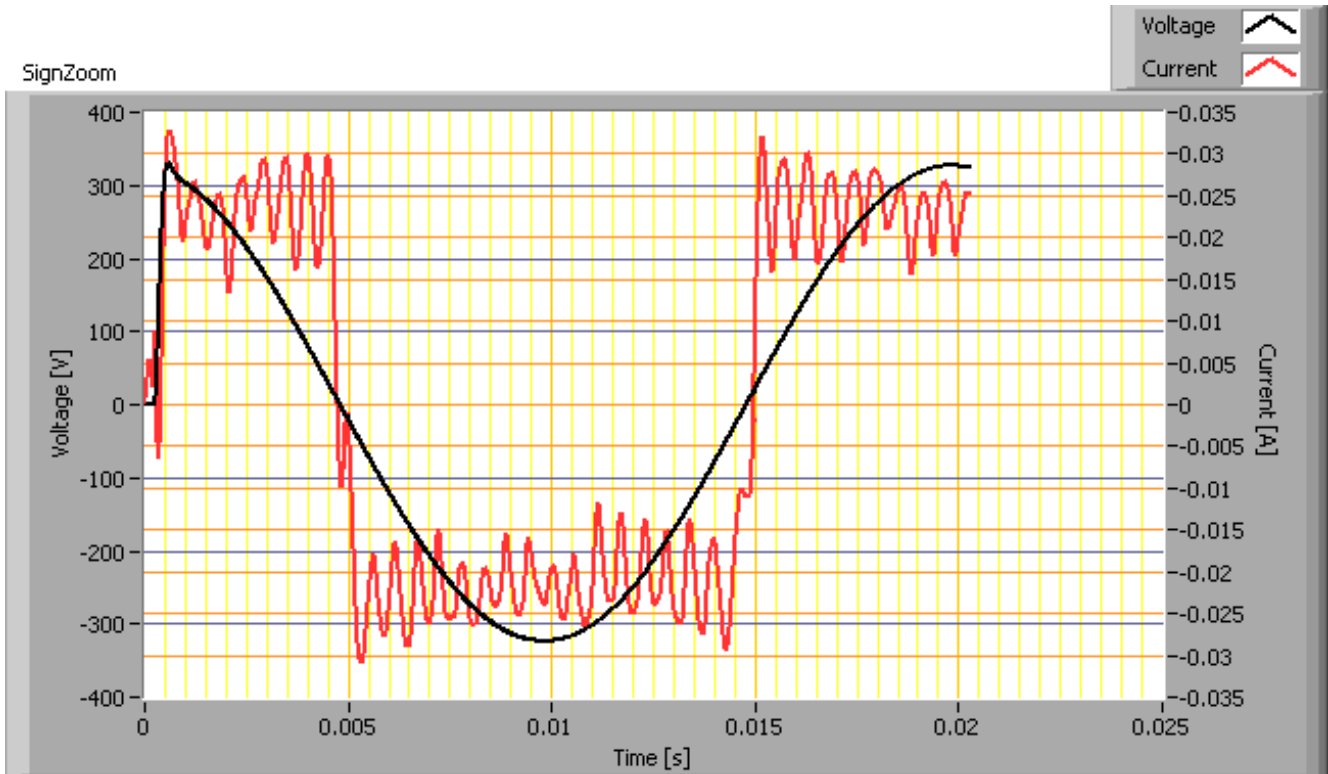
The inrush current has been measured for different voltage start angles; from 0 - 170 degrees with a 10 degrees step. The current- and voltage values have been acquired at a sample speed of 39.9 kS/s. Then this data has been fed into a second order 2kHz low pass Butterworth filter. This removes the current spikes that do not represent relevant values. The lamp was two minutes off before every inrush current measurement was made.

Test voltage	230.0 V	
Frequency of the voltage	50.0 Hz	
Maximum inrush current	0.035 A	This current has been found at a voltage start angle of 100 degrees.
Pulse width of max inrush current	4.0E-4 s	This is the time that the pulse is higher than 66 % of the max inrush current.
Minimal inrush current	0.032 A	This current has been found at a voltage start angle of 50 degrees.
$I^2 \times t$ after 10 ms at 0 deg voltage start angle	5.000E-6 A	This is the $I^2 \times t$ value when a zero crossing detector is used to start the voltage from 0 degrees.

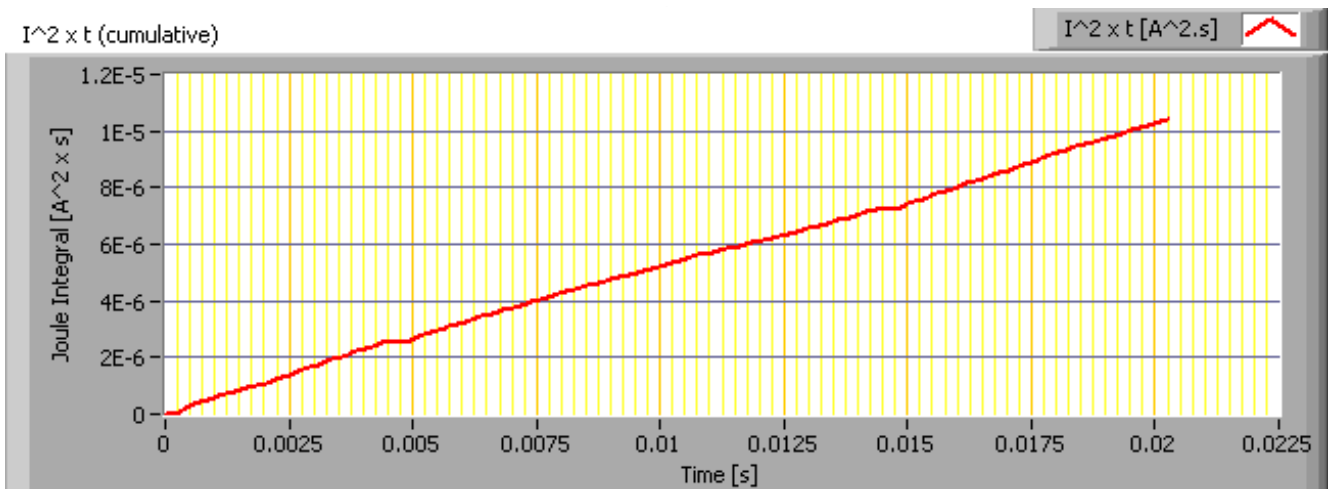


Inrush current found at worst-case voltage start angle

Lamp measurement report - 7 April 2014



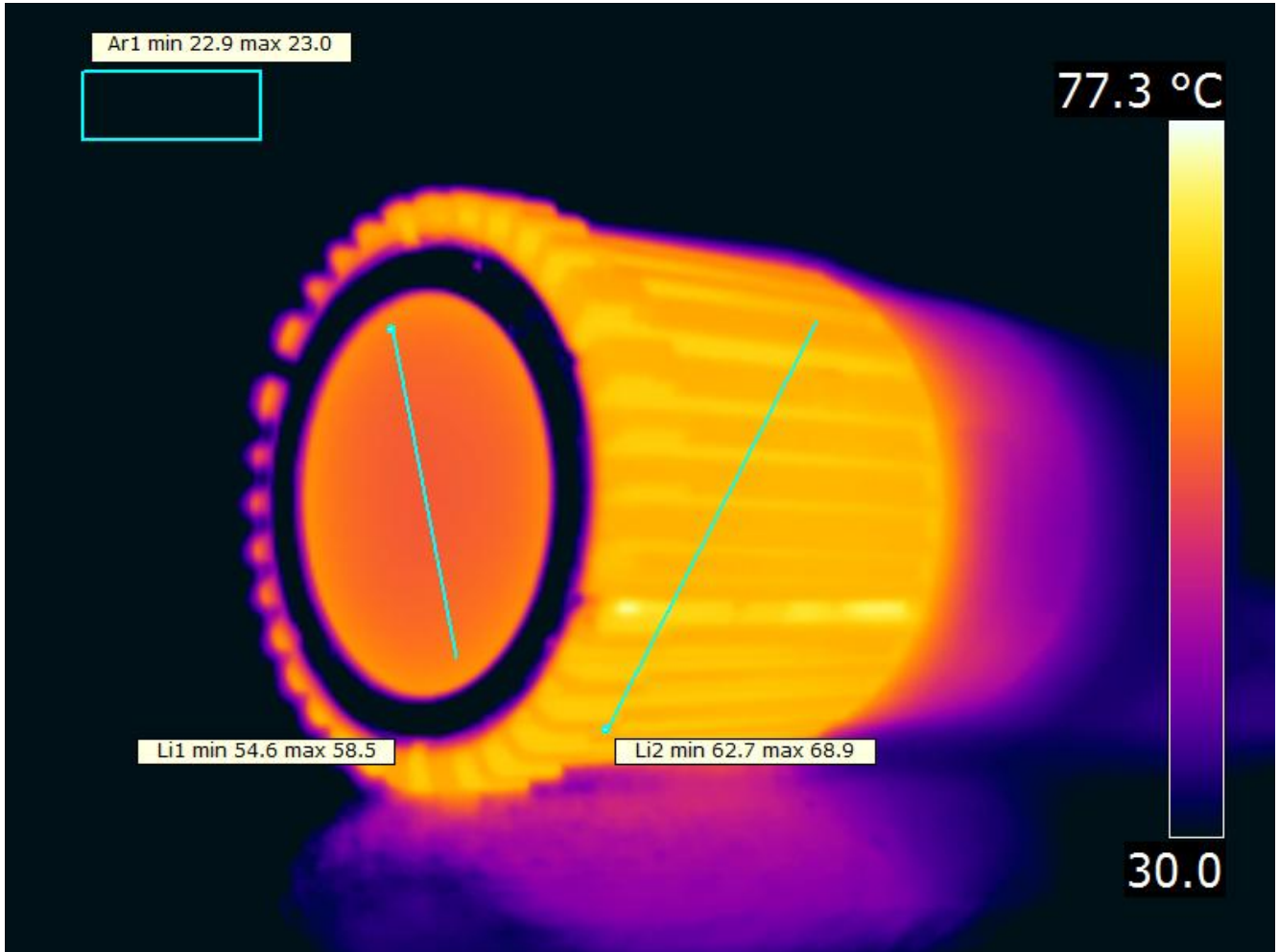
First cycle of the maximum inrush current



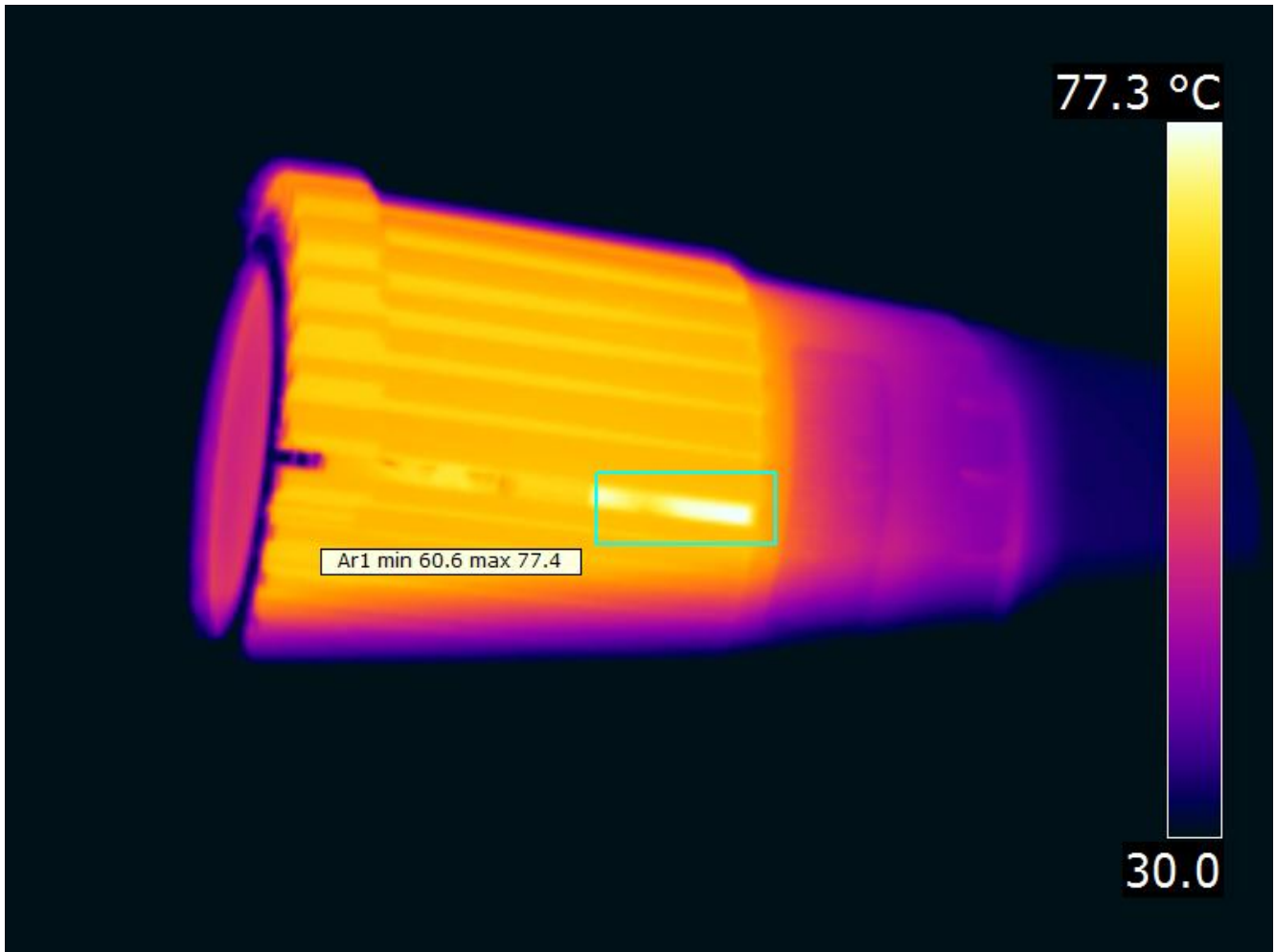
The energy I^2t during the first 10 ms of the first current cycle

Lamp measurement report - 7 April 2014

Temperature measurements lamp



Lamp measurement report - 7 April 2014

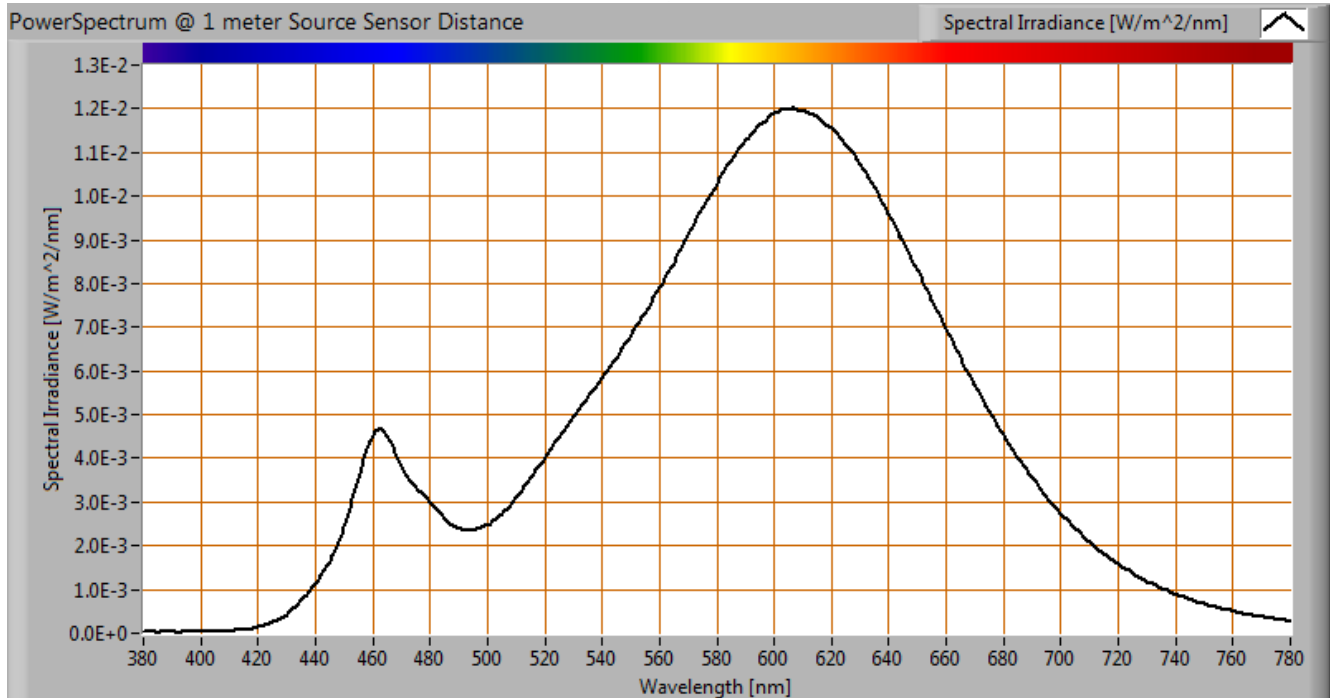


Temperature image(s).

status lamp	> 2 hours on
ambient temperature	23 deg C
reflected background temperature	23 deg C
camera	Flir T335
emissivity	0.95
measurement distance	0.5 m
IFOV_geometric	0.136 mm per 0.1 m distance
NETD (thermal sensitivity)	50 mK

Lamp measurement report - 7 April 2014

Color temperature and Spectral power distribution

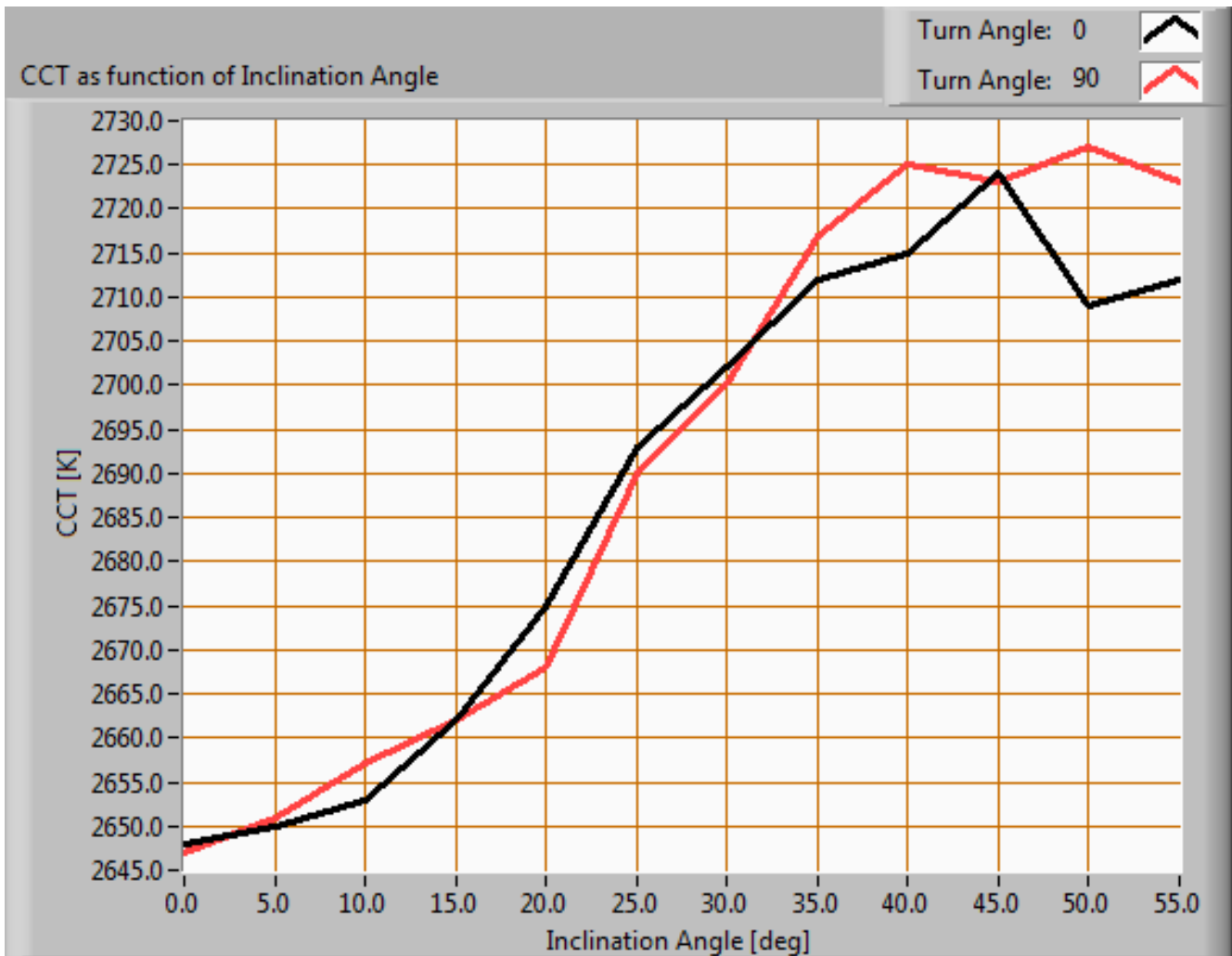


The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.

The measured color temperature is 2673 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.

Lamp measurement report - 7 April 2014



Color temperature as a function of inclination angle.

The color temperature is given for inclination angles up to 55 deg. Beyond that value the illuminance is so low (< 5 lux) that it has not been used for color determination of the light.

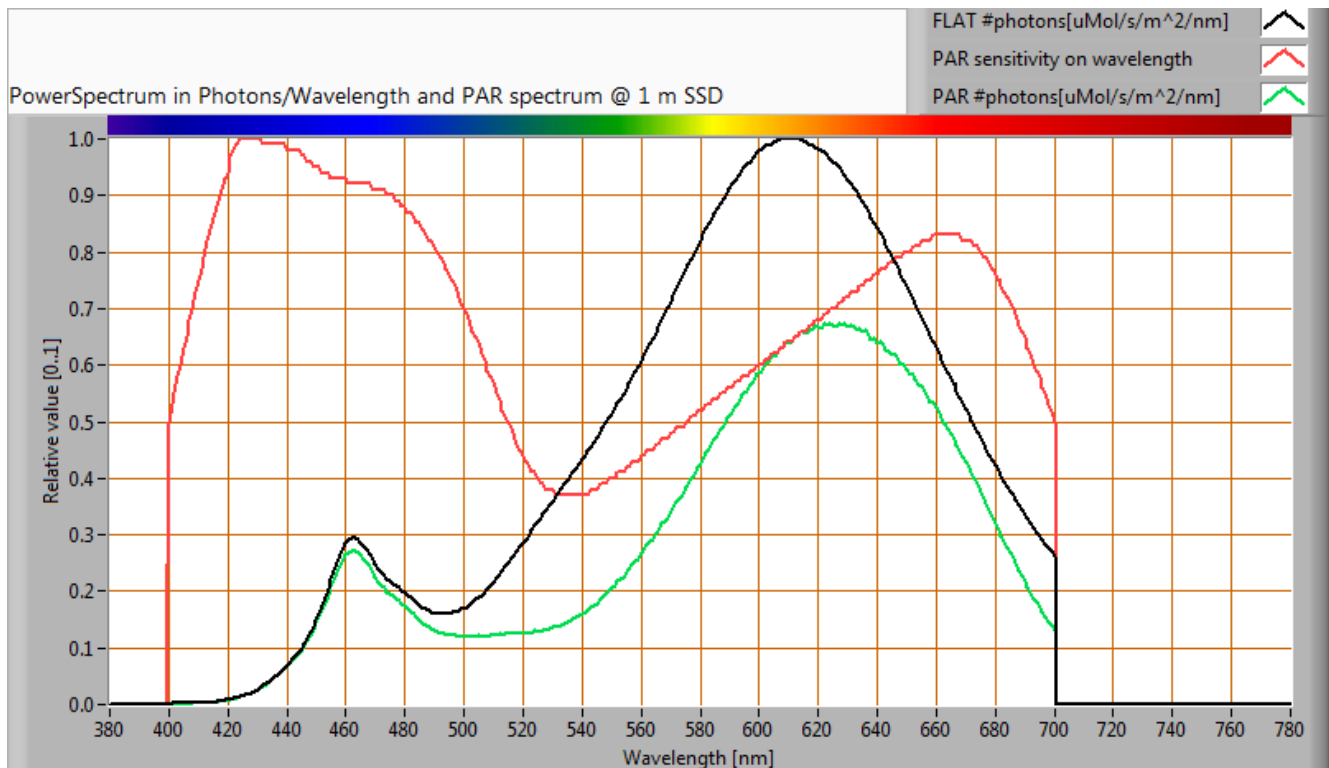
For the C0-C180 plane: the beam angle of 29 deg is equivalent to 14.3 deg inclination angle, which is the area where most of the light falls within. The maximum variation of color temperature in this inclination area is about 1 %.

For the C90-C270 plane: the beam angle of 29 deg is equivalent to 14.3 deg inclination angle, which is the area where most of the light falls within. The maximum variation of color temperature in this inclination area is about 0 %.

Lamp measurement report - 7 April 2014

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 explanation about PAR on 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

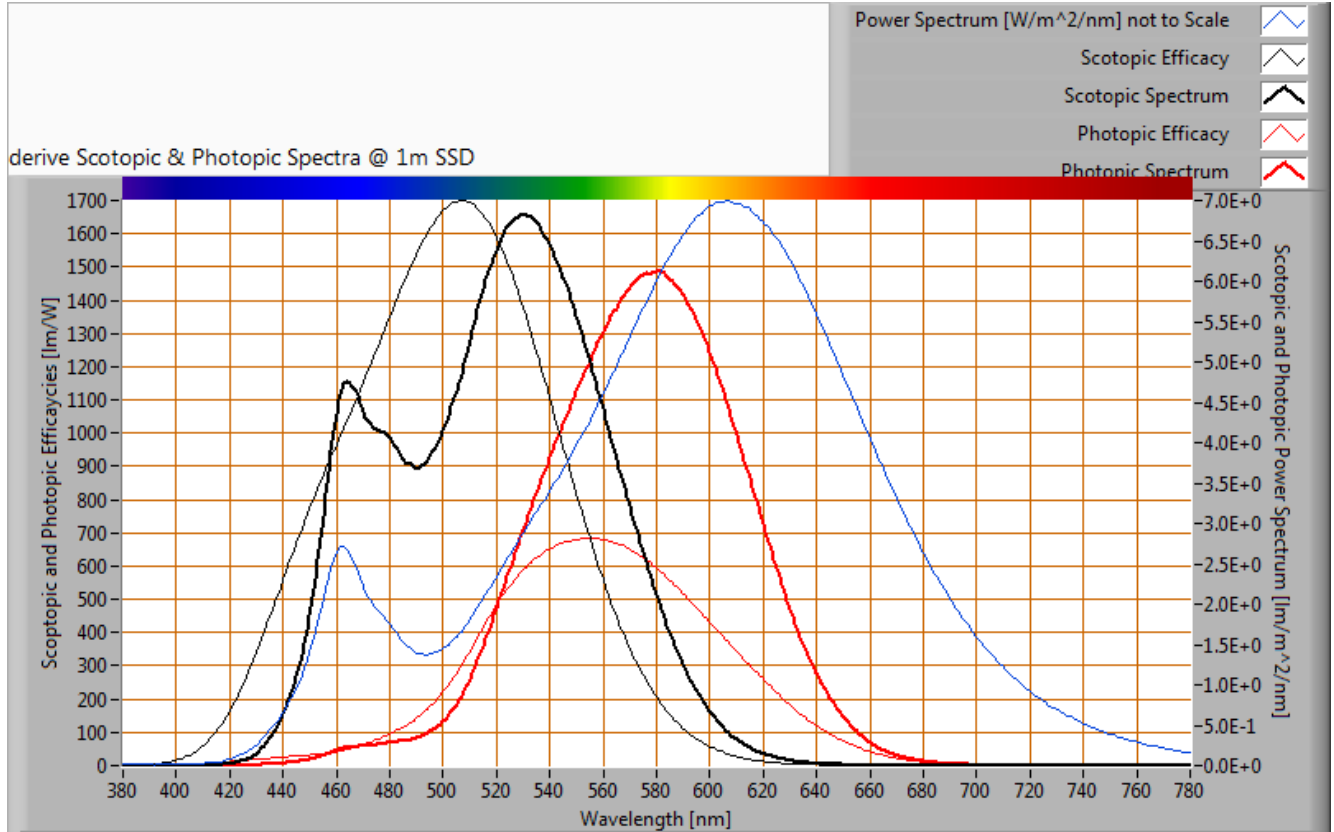
parameter	value	unit
PAR number	5.4	uMol/s/m ²
PAR photon current	1.8	uMol/s
PAR photon efficacy	0.5	uMol/s/W

The PAR efficiency is 64 % (valid for the PAR wave length range of 400 - 700 nm). This is the maximum percentage of the total of photons in the light that 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 - 7 April 2014

S/P ratio

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



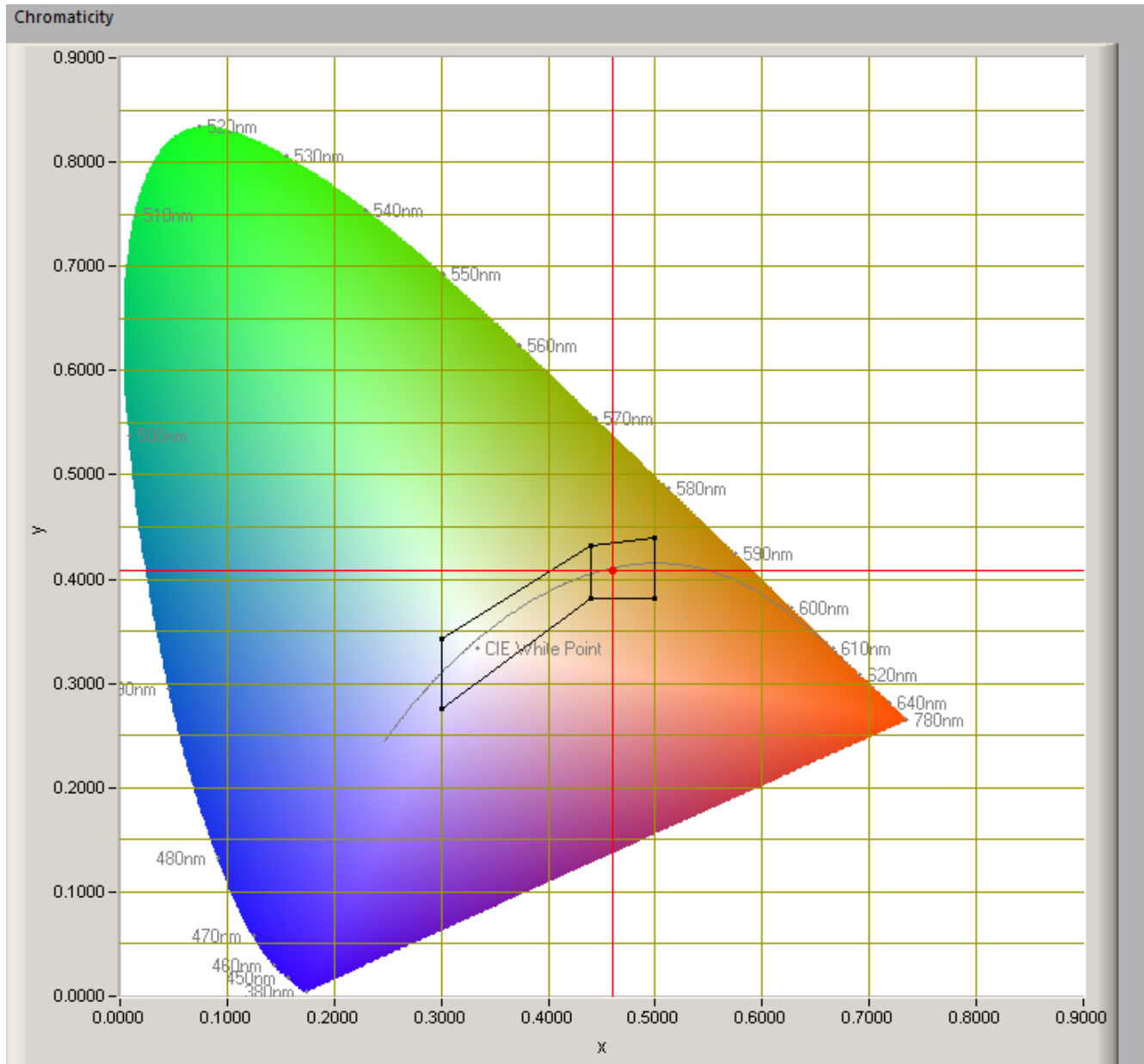
The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).

The S/P ratio of the light coming from this lamp is 1.2.

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

Lamp measurement report - 7 April 2014

Chromaticity diagram



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

The point of the light in this diagram is inside the area indicated with class B. This area indicates an area for signal lamps, see also the article on signal lamps and color areas on the OliNo website.

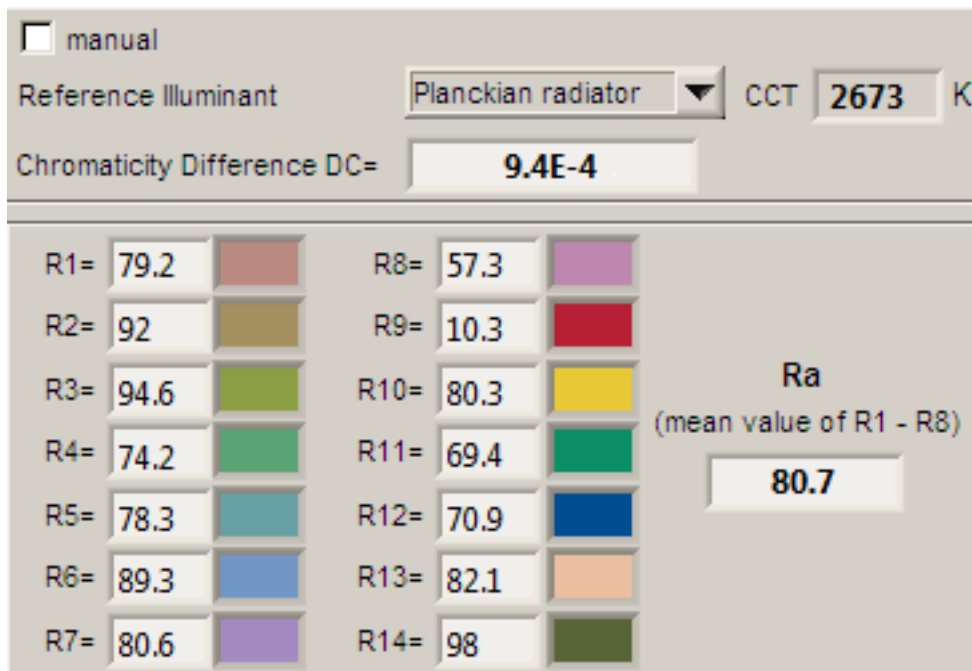
The color coordinates are $x=0.4608$ and $y=0.4084$.

Lamp measurement report - 7 April 2014

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.



CRI of the light of this lightbulb.

This value of 81 indicates how well the light of this lamp can render well a set of reference colors, this in comparison with the light of a reference source (for color temperatures $< 5000\text{K}$ a black radiator is used as reference and for color temperatures $> 5000\text{K}$ the sun or the light outside during the day).

The value of 81 is bigger than the value of 80 that is considered as a minimum for working areas in general.

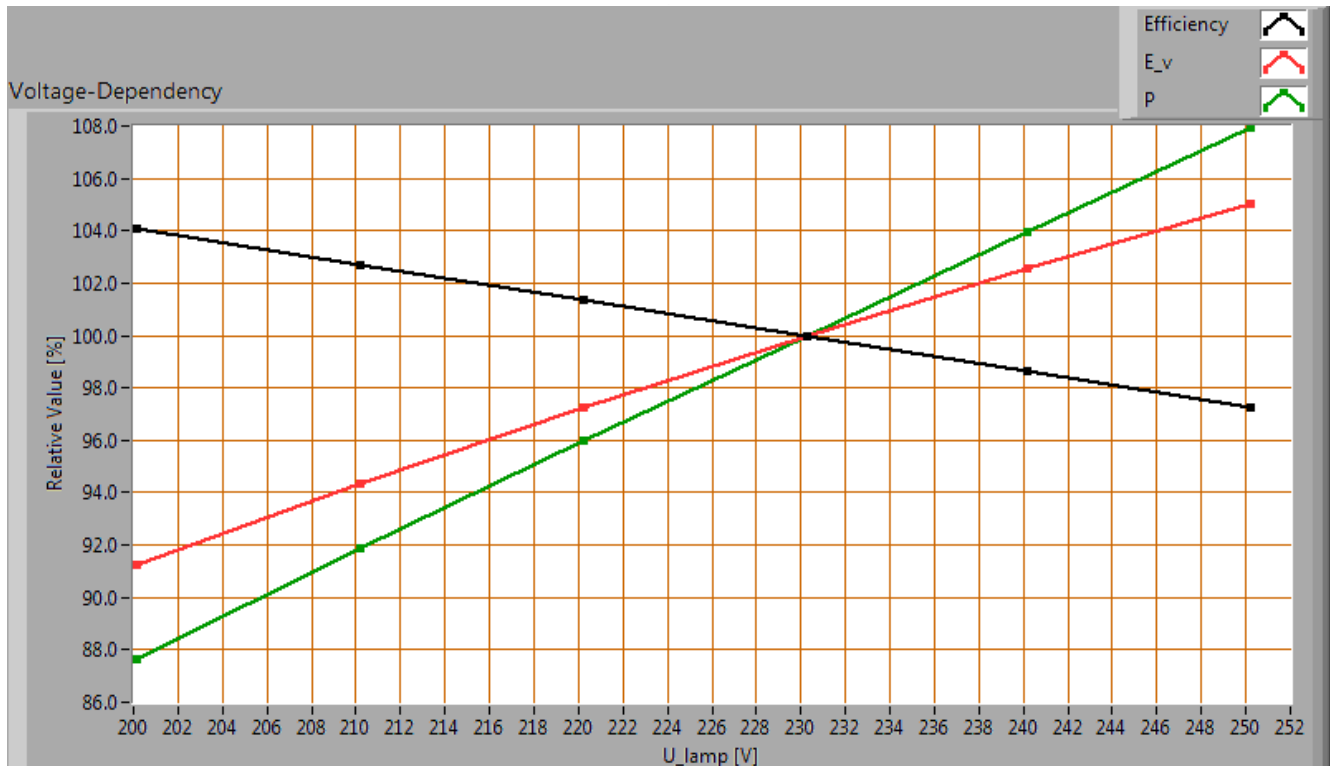
Note: the chromaticity difference is 0.0009 and indicates the distance to the Planckian Locus. There is a value mentioned of max $5.4\text{E-}3$ in section 5.3 of CIE 13.3-1995 however not further explanation of it.

An other reference with signal lights as a reference is given in the chromaticity diagram.

Lamp measurement report - 7 April 2014

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 efficacy [lm/W] (this latter is estimated here by dividing the found E_v value by P).



Lamp voltage dependencies of certain light bulb parameters

There is a constant dependency of the illuminance when the power voltage varies between 200 - 250 V AC.

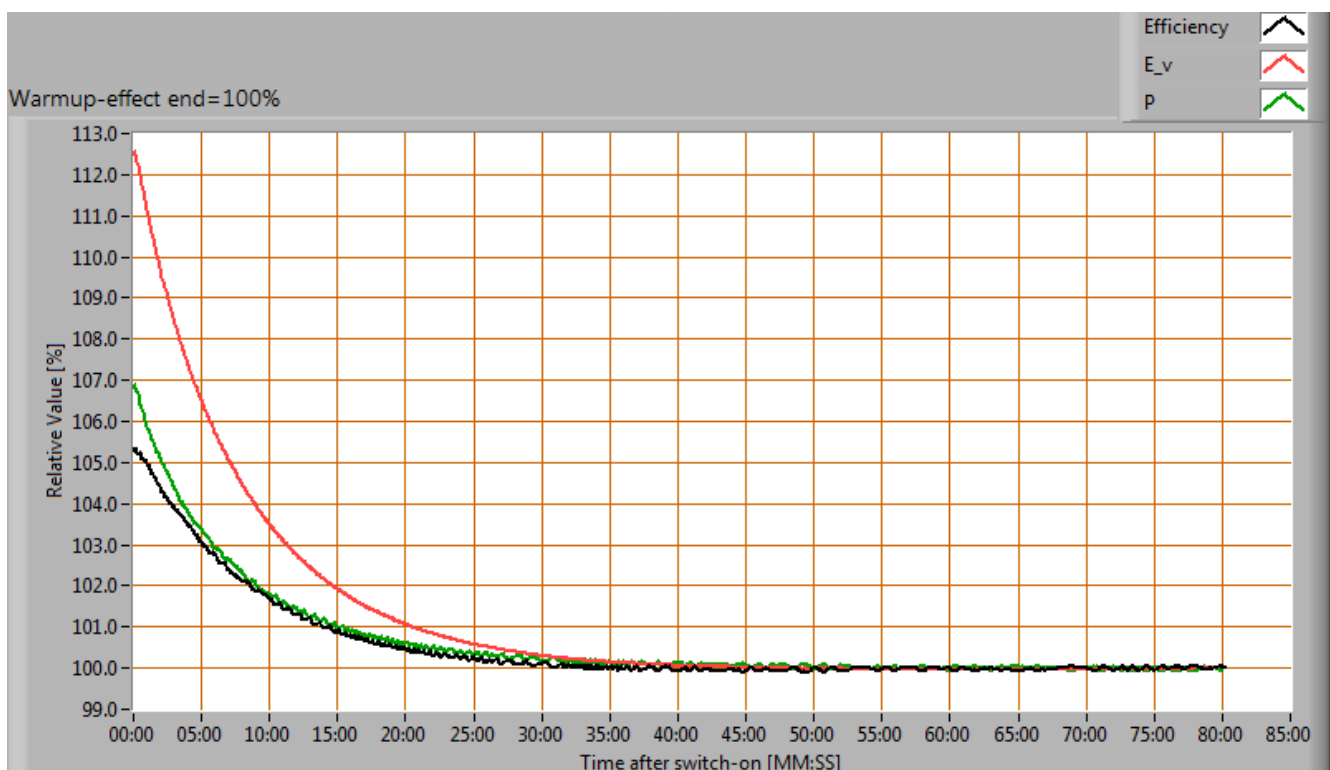
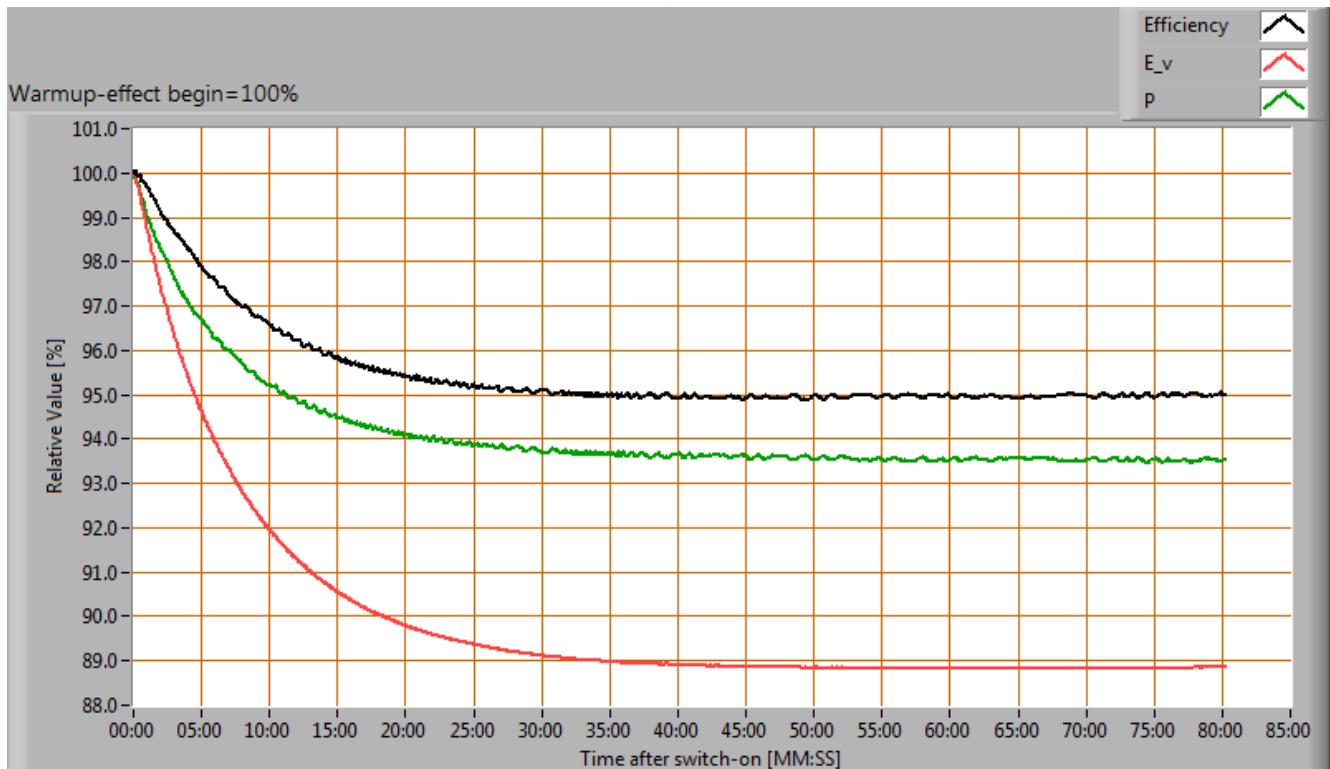
There is a constant dependency of the consumed power when the power voltage varies between 200 - 250 V AC.

When the voltage varies abruptly with + or - 5 V AC then this results in a variation of the illuminance of maximally 1.4 %. This difference in illuminance is not visible (when it occurs abruptly).

Lamp measurement report - 7 April 2014

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].



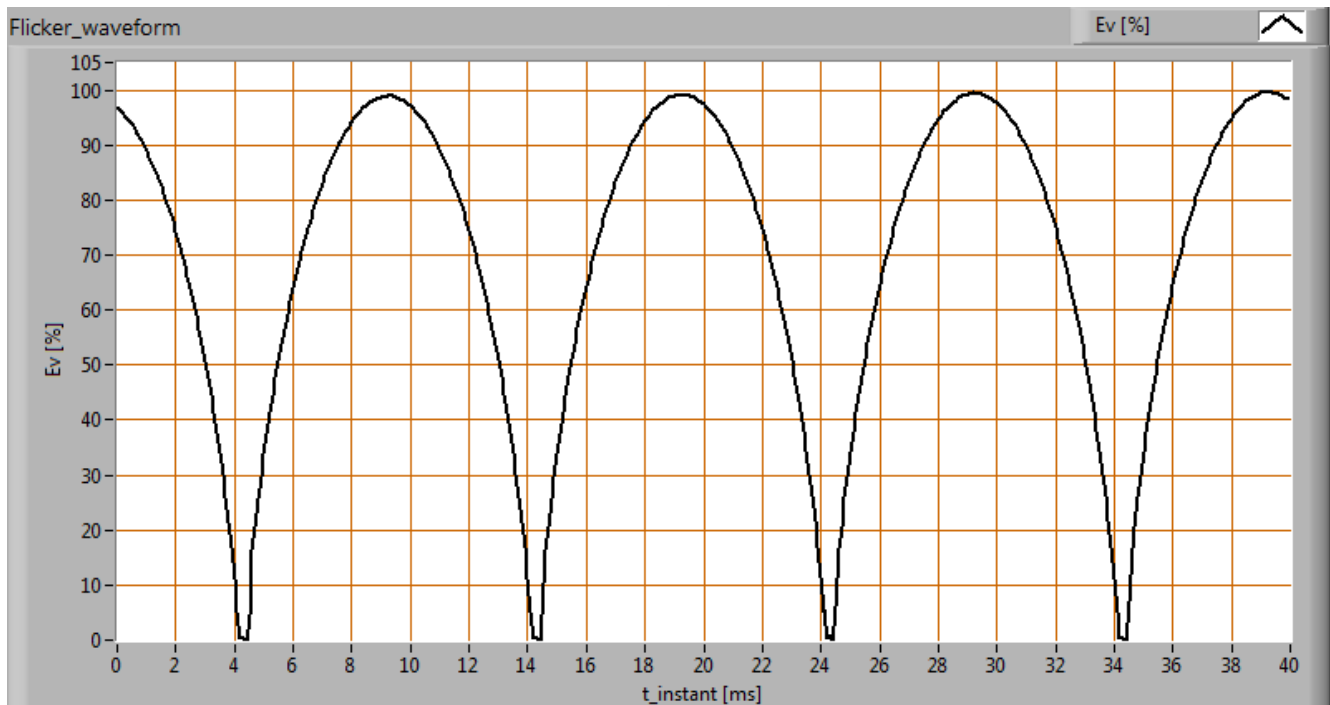
Effect of warming up on different light bulb parameters. In the first graph the 100 % level is put at begin, and in the last graph the 100 % level is put at the end.

Lamp measurement report - 7 April 2014

During the warmup time the illuminance varies during 19 minutes and decreases with 11 %. During the warmup time the power varies during 14 minutes and decreases with 6 %. the variation in efficacy during the warming up is -5 %. A very high negative value indicates a significant decrease for instance due to heating up of the lamp (decrease of lifetime).

Measure of flickering

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



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

parameter	value	unit
Flicker frequency	100.0	Hz
Illuminance modulation index	100	%

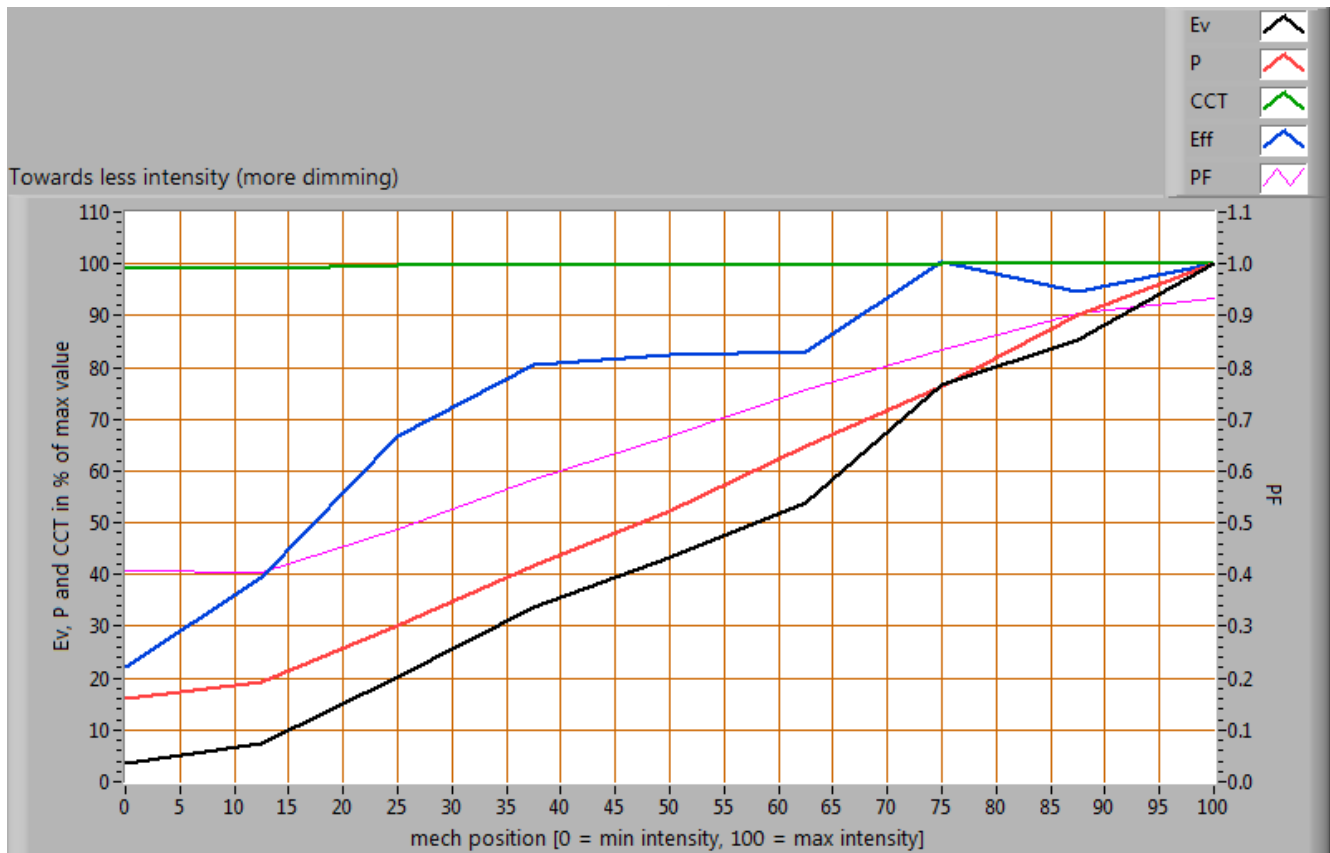
The illuminance modulation index is computed as: $(\max_Ev - \min_Ev) / (\max_Ev + \min_Ev)$.

Lamp measurement report - 7 April 2014

Dim-ability

The lamp has been tested on the following dimmer(s): the Busch Jaeger 6523 U, Lumeo Domus LR, Low Cost LR , Berker RC dimmer. See for a description and their specification the practical dimmer explanation article on OliNo.

The Busch Jaeger 6523 U.



Dimming with the Busch Jaeger 6523 U.

When inserting the dimmer at its no dimming position and the comparing with the situation without dimmer, then the influence on the following parameters is measured (negative value is increase):

- the illuminance: 8 %;
- the consumed power: 6 %.

The intensity is variable in the mechanical area between 0.0 - 100.0 %.

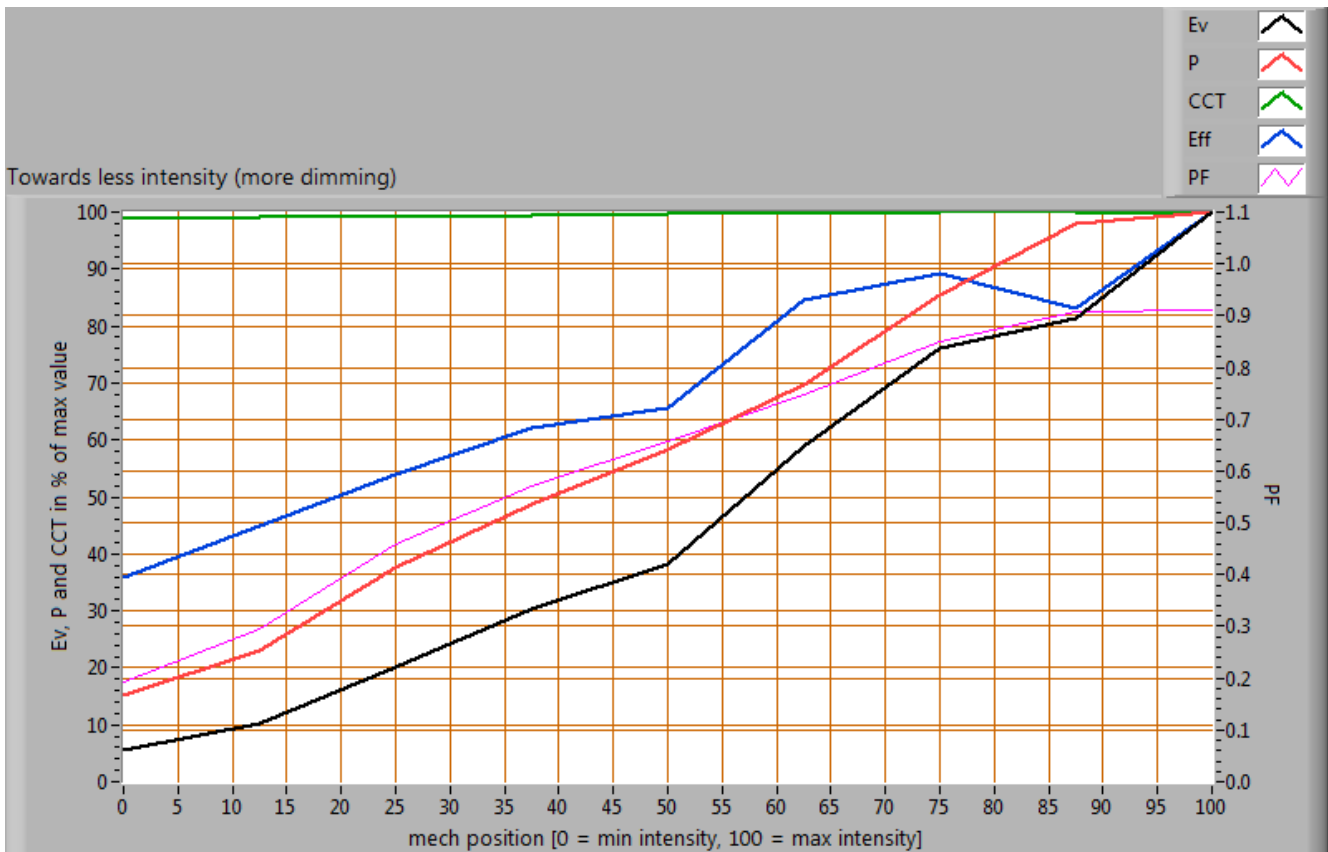
The dimmer set in that area results in a variation of the illuminance between 4 - 100 % (note that in that 100 % the drop in illuminance when inserting the dimmer is not counted, see for that value above).

There is no effect on the color temperature when dimming is increased.

The remaining power consumption at maximal dimming position is 0.5 W.

The Lumeo Domus LR.

Lamp measurement report - 7 April 2014



Dimming with the Lumeo Domus LR.

When inserting the dimmer at its no dimming position and the comparing with the situation without dimmer, then the influence on the following parameters is measured (negative value is increase):

- the illuminance: 25 %;
- the consumed power: -1 %.

The intensity is variable in the mechanical area between 0.0 - 100.0 %.

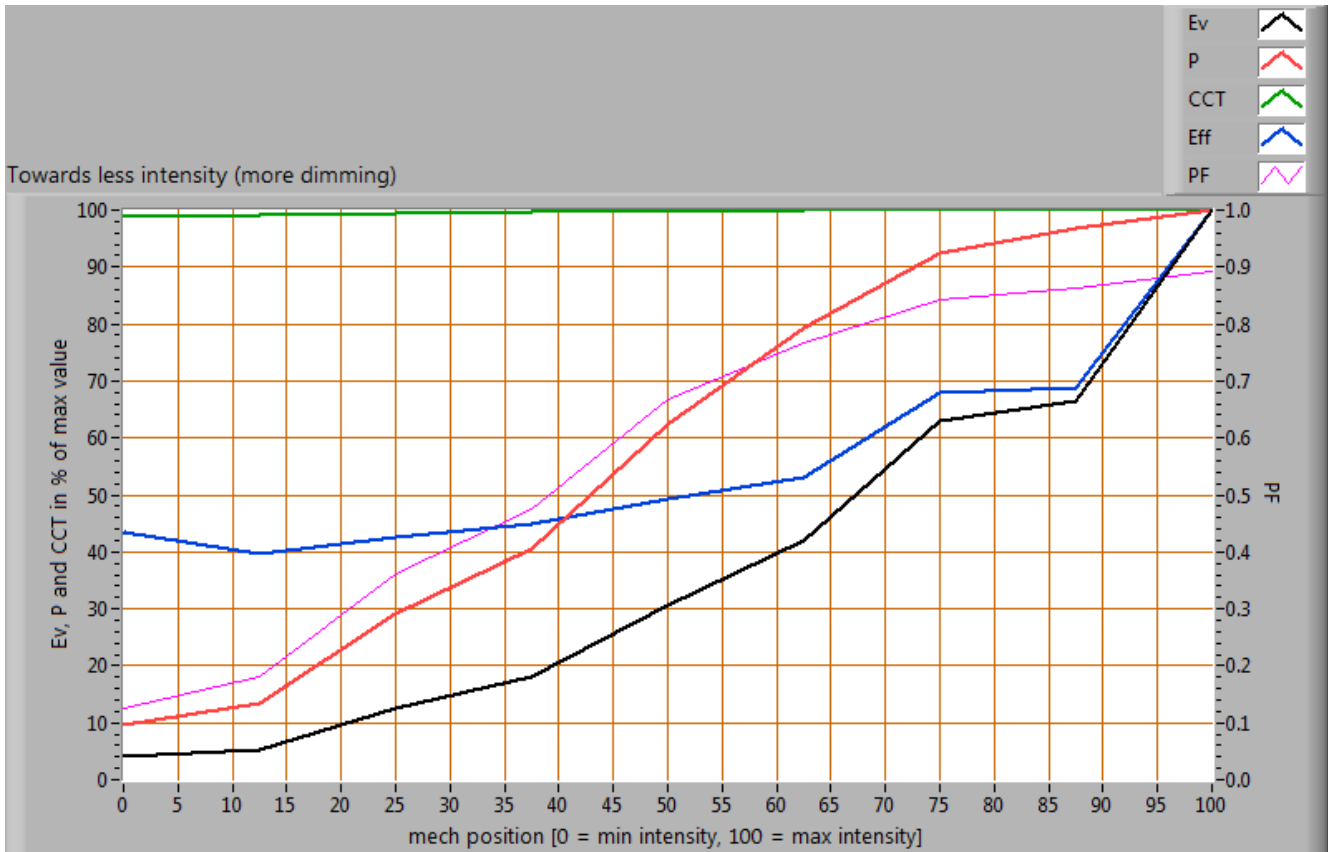
The dimmer set in that area results in a variation of the illuminance between 5 - 100 % (note that in that 100 % the drop in illuminance when inserting the dimmer is not counted, see for that value above).

There is no effect on the color temperature when dimming is increased.

The remaining power consumption at maximal dimming position is 0.6 W.

The Low Cost LR .

Lamp measurement report - 7 April 2014



Dimming with the Low Cost LR .

When inserting the dimmer at its no dimming position and the comparing with the situation without dimmer, then the influence on the following parameters is measured (negative value is increase):

- the illuminance: 12 %;
- the consumed power: -1 %.

The intensity is variable in the mechanical area between 0.0 - 100.0 %.

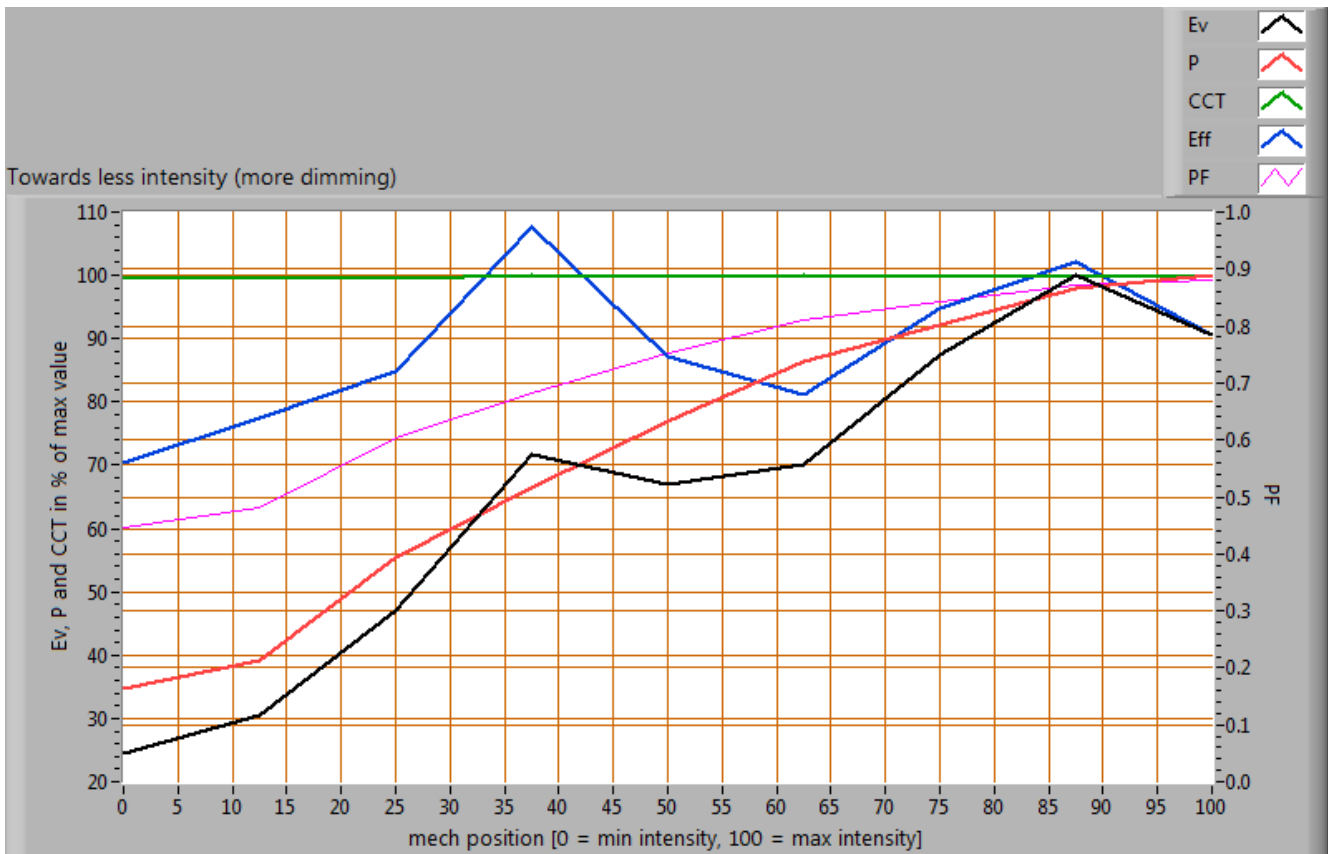
The dimmer set in that area results in a variation of the illuminance between 4 - 100 % (note that in that 100 % the drop in illuminance when inserting the dimmer is not counted, see for that value above).

There is no effect on the color temperature when dimming is increased.

The remaining power consumption at maximal dimming position is 0.3 W.

The Berker RC.

Lamp measurement report - 7 April 2014



Dimming with the Berker RC.

When inserting the dimmer at its no dimming position and the comparing with the situation without dimmer, then the influence on the following parameters is measured (negative value is increase):

- the illuminance: 18 %;
- the consumed power: 11 %.

The intensity is variable in the mechanical area between 0.0 - 87.5 %.

The dimmer set in that area results in a variation of the illuminance between 24 - 100 % (note that in that 100 % the drop in illuminance when inserting the dimmer is not counted, see for that value above).

There is no effect on the color temperature when dimming is increased.

The remaining power consumption at maximal dimming position is 1.1 W.

Lamp measurement report - 7 April 2014

Biologic effect

The biologic effect shows the level of impact the light of this lamp can have on the day-night rhythm of human beings (as well as the suppression of melatonin production). See also the explanatory article on biologic effect on OliNo.

The important parameters (according to prenorm DIN V 5031-100:2009-06):

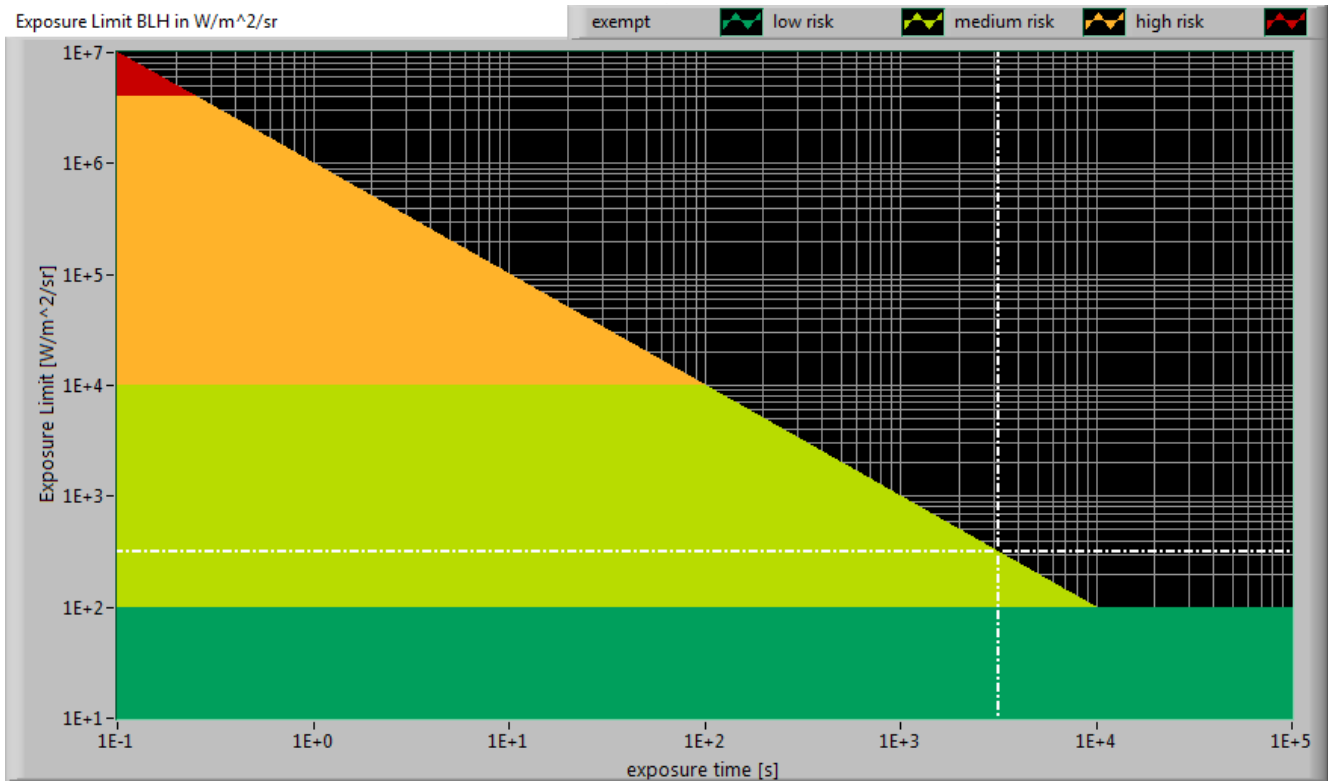
biologic effect factor	0.311
k_biol trans (25 years)	1.000
k_biol trans (50 years)	0.781
k_biol trans (75 years)	0.531
k_pupil(25 years)	1.000
k_pupil(50 years)	0.740
k_pupil(75 years)	0.519

Lamp measurement report - 7 April 2014

Blue Light Hazard

The amount of blue light and the harm it can cause on the retina has been determined. Herewith the results.

See for more info the explanation about blue light hazard on the OliNo site.



The level of blue light of this lamp related to the exposure limit and the different classification areas.

L_lum0 [mm]	23	Dimension of brightest part of lamp in C0-C180 direction.
L_lum90 [mm]	23	Dimension of brightest part of lamp in C90-C270 direction.
SSD_500lx [mm]	1046	Calculated distance where Ev = 500 lux. This computation is valid when it is in the far field of the lamp. Note: if this value < 200 mm then the distance of 200 mm is taken as proposed in the norm IEC 62471:2006.
Start of far field [mm]	163	Minimum distance at which the lamp can be seen as a point source. In this area the Ev is linearly dependent from (1/distance) ² .
300-350 nm values stuffed with 0s	yes	In the event OliNo has measured with a SpB1211 spectrometer without UV option then the irradiance data of 300-349 nm is missing. For lamps where there is already no energy content near 350 nm, the values 300-349 can also be set at zero then.
alpha_C0-C180 [rad]	0.022	(Apparent) source angle in C0-C180 direction.

Lamp measurement report - 7 April 2014

alpha_C90-C270 [rad]	0.022	(Apparent) source angle in C90-C270 direction.
alpha_AVG [rad]	0.022	Average (apparent) source angle. If average ≥ 0.011 rad then the exposure limit is computed with radiance L_b . Otherwise with irradiance E_b .
Exposure value [$W/m^2/sr$]	3.15E+2	Blue Light Hazard value for this lamp, measured straight underneath the lamp. Computation is referenced to L_b .
Blue Light Hazard risk group	1	0=exempt, 1=low, 2 = moderate, 3=high risk.

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