Lamp measurement report - 28 April 2015

liniLED® PCB Green Deco

by

Triolight B.V.

Lamp measurement report - 28 April 2015

Summary measurement data

parameter	meas. result	remark
Luminous intensity I_v	47.9 Cd	Measured straight underneath the lamp.
Illuminance modulation index	0 %	Measured with a light sensor looking at the lamp (angle not defined). Is a measure for the amount of flickering.
Beam angle	111 deg	111 deg is the beam angle for the C0-C180-plane (perpendicular to the length direction of the lamp) and 111 deg is the beam angle for the C90-C270 plane, which is along the length direction of the lamp.
Power P	2.4 W	The net power consumed.
Power Factor	1.00	The tests were done with a DC power supply. This results in no blind power and as a result the power factor is always 1.0 but not relevant to mention.
THD	NaN %	Total Harmonic Distortion, is not present as a DC voltage was used to power the lamp so a DC current resulted which has no THD.
Luminous flux	135 lm	Measured with photogoniometer, calculation done as described in LM79-08.
Luminous efficacy	55 lm/W	Be aware that a DC power supply has been used. The found efficacy with this measurement is excluding the power supply that normally is needed to convert the grid voltage (230 V AC) to the used DC voltage. By excluding the consumption of the power supply the efficacy found here is higher than it would be when the power supply had been included.
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	-24	Color Rendering Index.
CQS	0.2	QCS (v9.0.3) is an improved indicator (over CRI) of how well colors are rendered.
Coordinates chromaticity diagram	x=0.7201 en y=0.1464	
Fitting	24V DC	This strip is connected to 24V DC.
PAR-value	0.2 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.

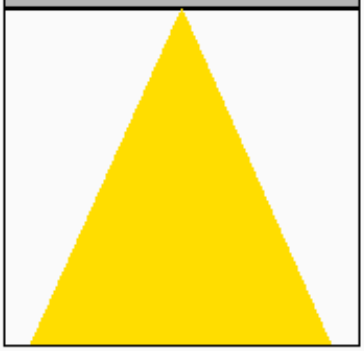
Lamp measurement report - 28 April 2015

parameter	meas. result	remark
PAR-photon efficacy	0.3 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	1.3 uMol/s	The total number of photons in the light of this lamp.
S/P ratio	3.1	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (low environmental light level).
L x W x H external dimensions	1000 mm x 8 mm x 2 mm	External dimensions of the lamp.
L x W luminous area	123 mm x 3 mm	Dimensions of the luminous area (used in Eulumdat file). It is the sum of all LED surfaces.
General remarks		The ambient temperature during the whole set of illuminance measurements was 23.9 - 24.6 deg C.The temperature of the lamp gets maximally about 14 degrees hotter than ambient temperature.Warm up effect: During the warmup time the illuminance doesn't vary significantly (< 5 %).During the warmup time the power doesn't vary significantly (< 5 %). The variation in efficacy (calculated as indication by simplydividing the illuminance by the power) during the warming up is 1 %. A very high negative value indicates a significant decrease for instance due to heating up of the lamp (decrease of lifetime). Voltage dependency: There is a non-constant dependency of the illuminance when the power voltage varies between 22 - 26 V DC. There is a constant dependency of the consumed power when the power voltage varies between 22 - 26 V DC. At the end of the article an additional photo.
Eff-variation	1 %	This is the variation in efficacy (calculated as indication by simply dividing the illuminance by the power) 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	0.566	According to pre-norm DIN V 5031-100:2009-06.
Blue Light Hazard risk group	0	0=exempt, 1=low, 2 = moderate, 3=high risk.
form factor	strip	
article number	12183	

Lamp measurement report - 28 April 2015

parameter	meas. result	remark
EAN code	8717693017476	

Overview table

m.	Ø 50%		C0-180: 111°	E (lux)	Luminaire Efficacy
	C0-180	C90-270	C90-270: 111°		55 (lumen per Watt)
1	2.92	2.89		48	Half-peak diam C0-180
1.5	4.39	4.34		21	2.92 x diameter(m)
2	5.85	5.79		12	Half-peak diam C90-270
3	8.77	8.68		5	2.89 x diameter(m)
4	11.69	11.57		3	Illuminance
6	17.54	17.36		1	48 / distance² (lux)
8	23.39	23.15		1	Total Output
					135 (lumen)

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 123 mm (maximal luminous size, eventually diagonally measured)= 615 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.

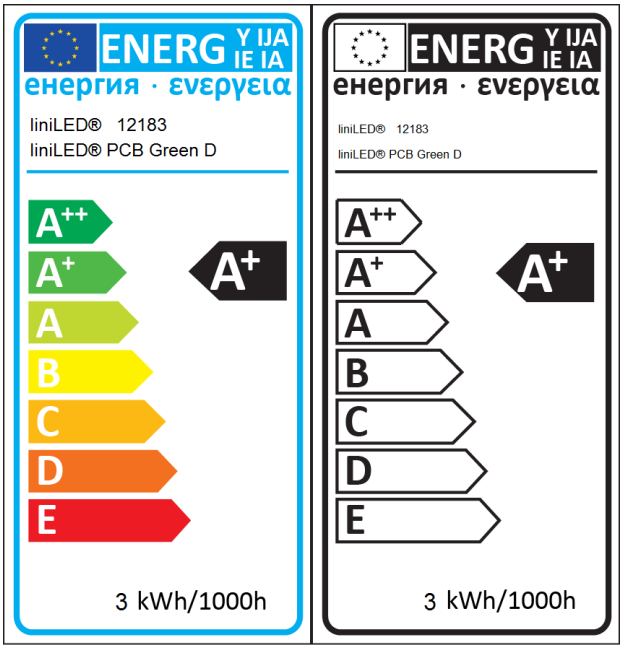
Lamp measurement report - 28 April 2015

EU 2013 Energy label classification

Since Sept 2013 these labels will be needed.

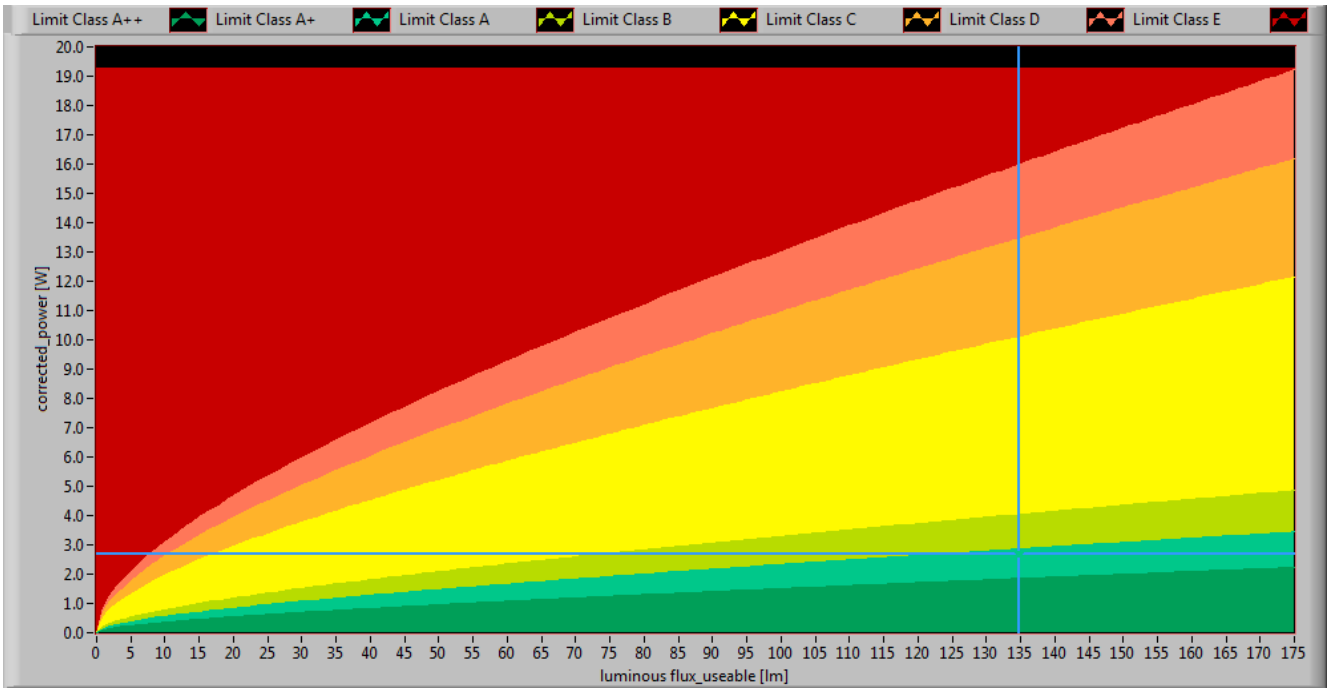
Important for the energy classification are the corrected rated power and the useful luminous flux.
The measured rated power is 2.4 W and might need to be corrected. The correction is dependent from the lamp type and whether or not the lamp control gear is included or not. The choice for this lamp is the following classification: **Lamps operating on external LED lamp control gear**. As a result the corrected rated power becomes: 2.7 W.
The luminous flux measured is 135 lm. The classification of this lamp needed to determine the useful flux is: **Non-directional lamps**. Then the useful flux becomes 135 lm. Now a reference power can be calculated.

The energy efficiency coefficient is P_corr / P_ref = 0.16.



EU energy label for this lamp

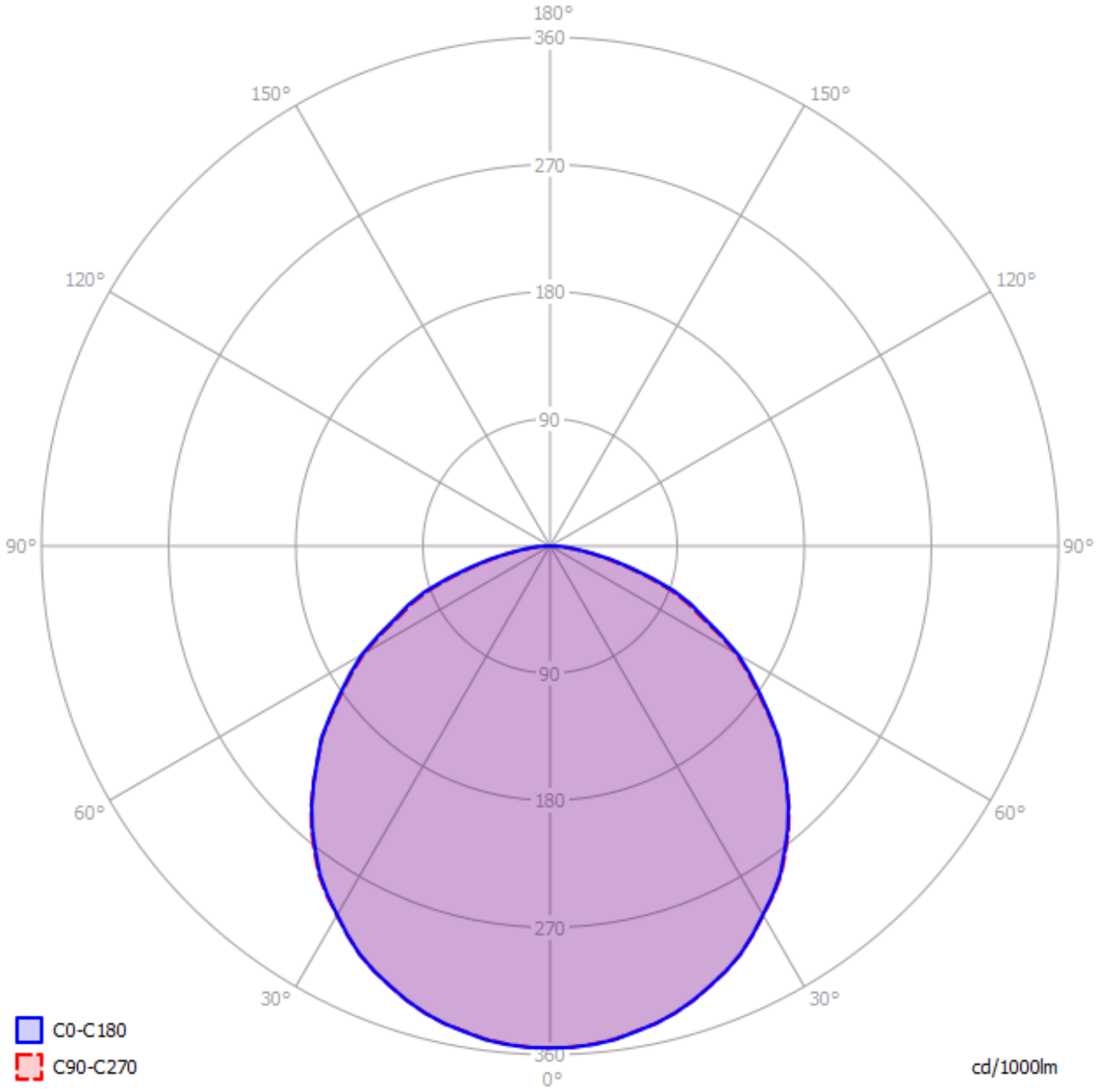
Lamp measurement report - 28 April 2015



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

Eulumdat light diagram

This light diagram below comes from the program Qlumedit, that extracts these diagrams from an Eulumdat file.



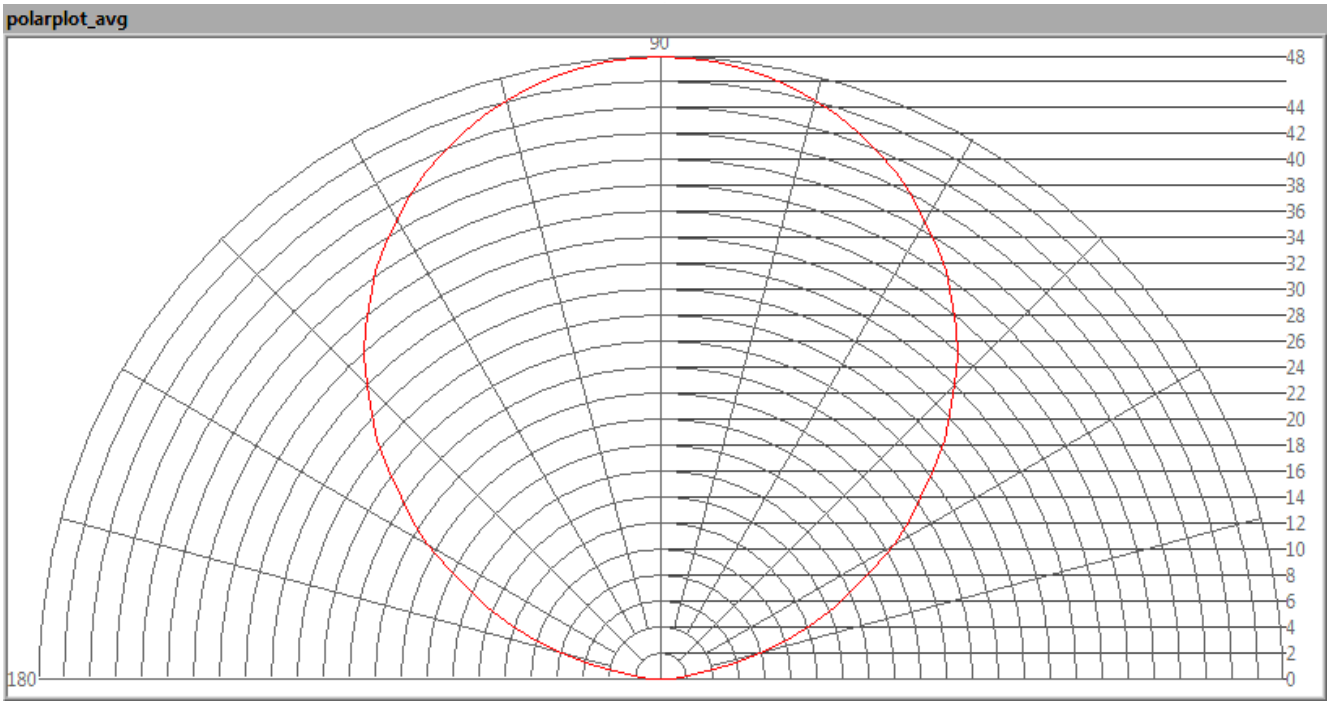
The light diagram giving the radiation pattern.

The light diagram indicates the beam in the C0-C180 plane (perpendicular to the length direction of the lamp) and in the plane perpendicular to that, the C90-C270 plane (along the length direction of the lamp).

Lamp measurement report - 28 April 2015

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.

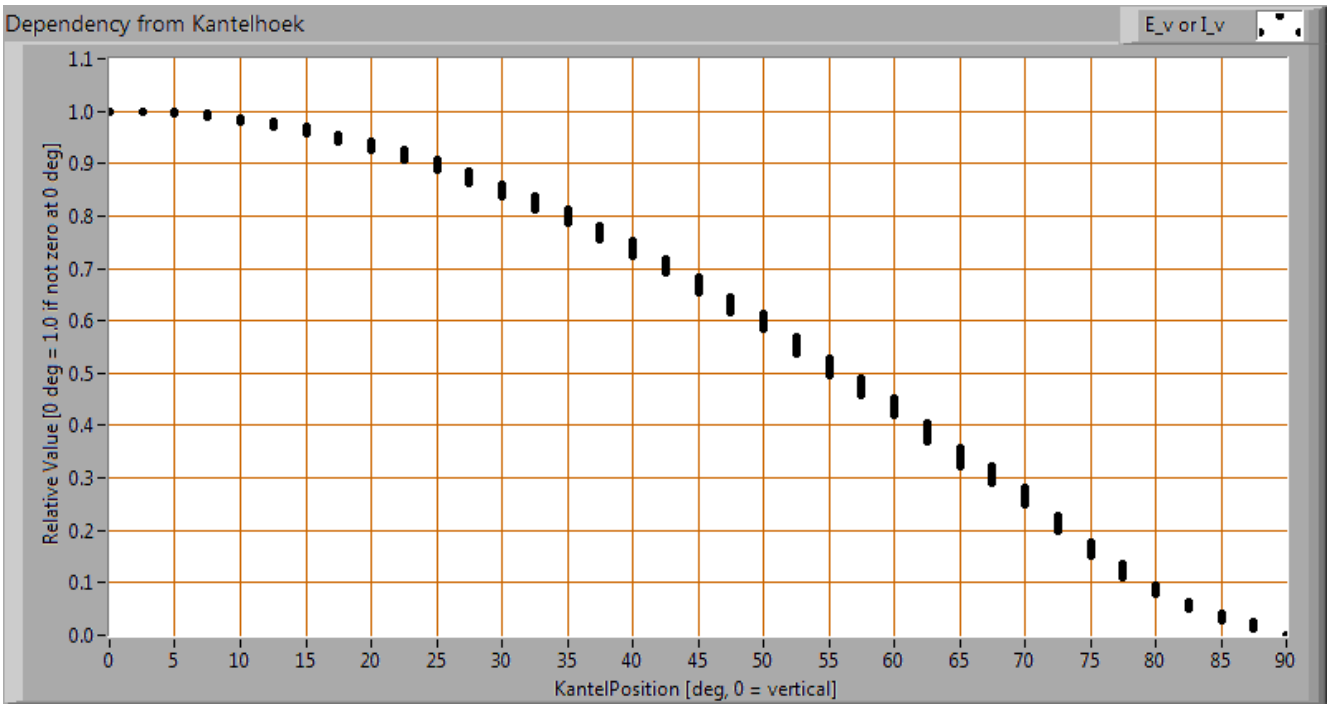


The radiation pattern of the light bulb.

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 - 28 April 2015



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 111 deg for the C0-C180 plane and 111 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 135 lm.

Luminous efficacy

The luminous flux being 135 lm, and the consumed power of the lamp being 2.4 Watt, results in a luminous efficacy of 55 lm/Watt.

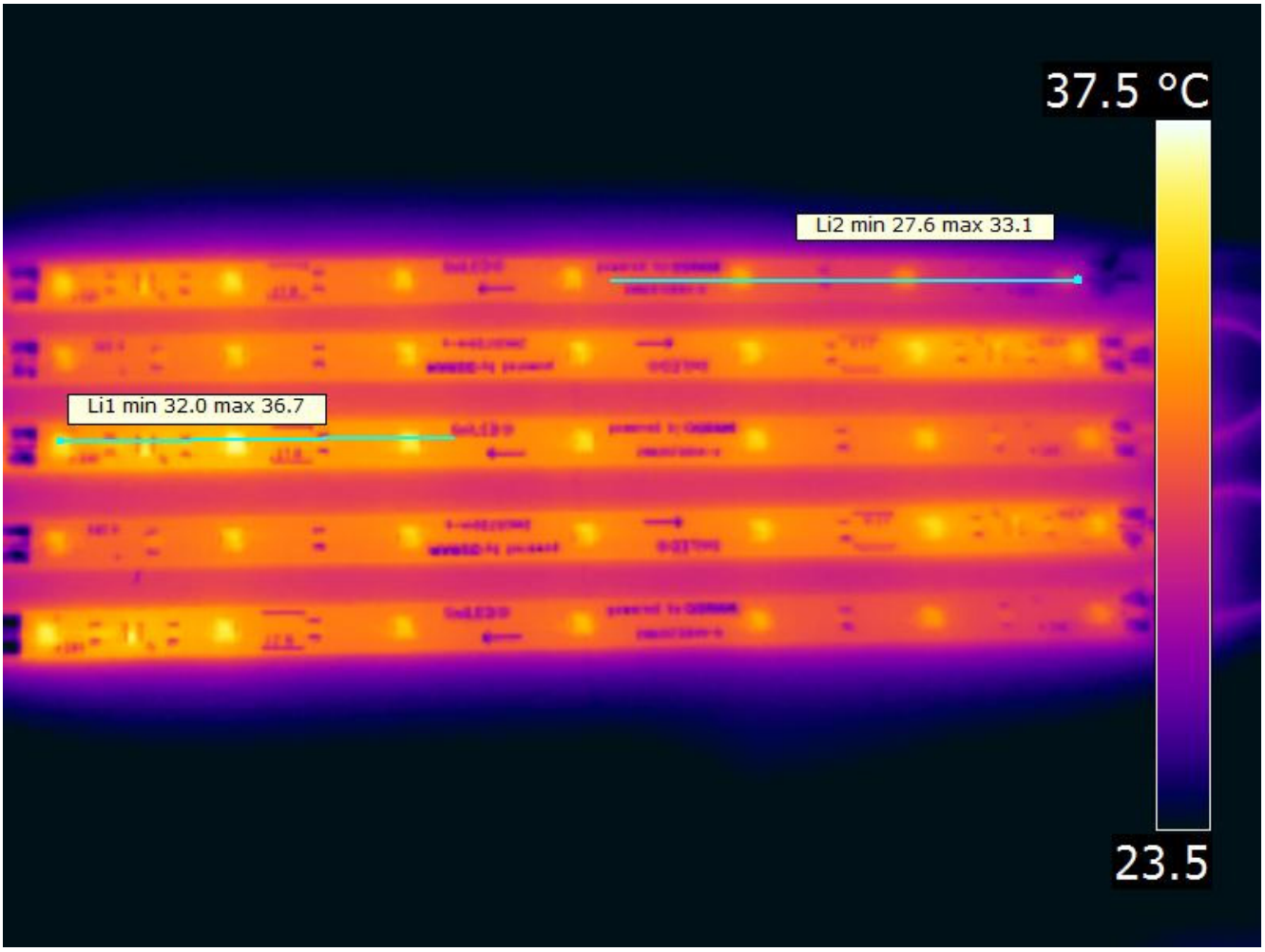
Lamp measurement report - 28 April 2015

Electrical properties

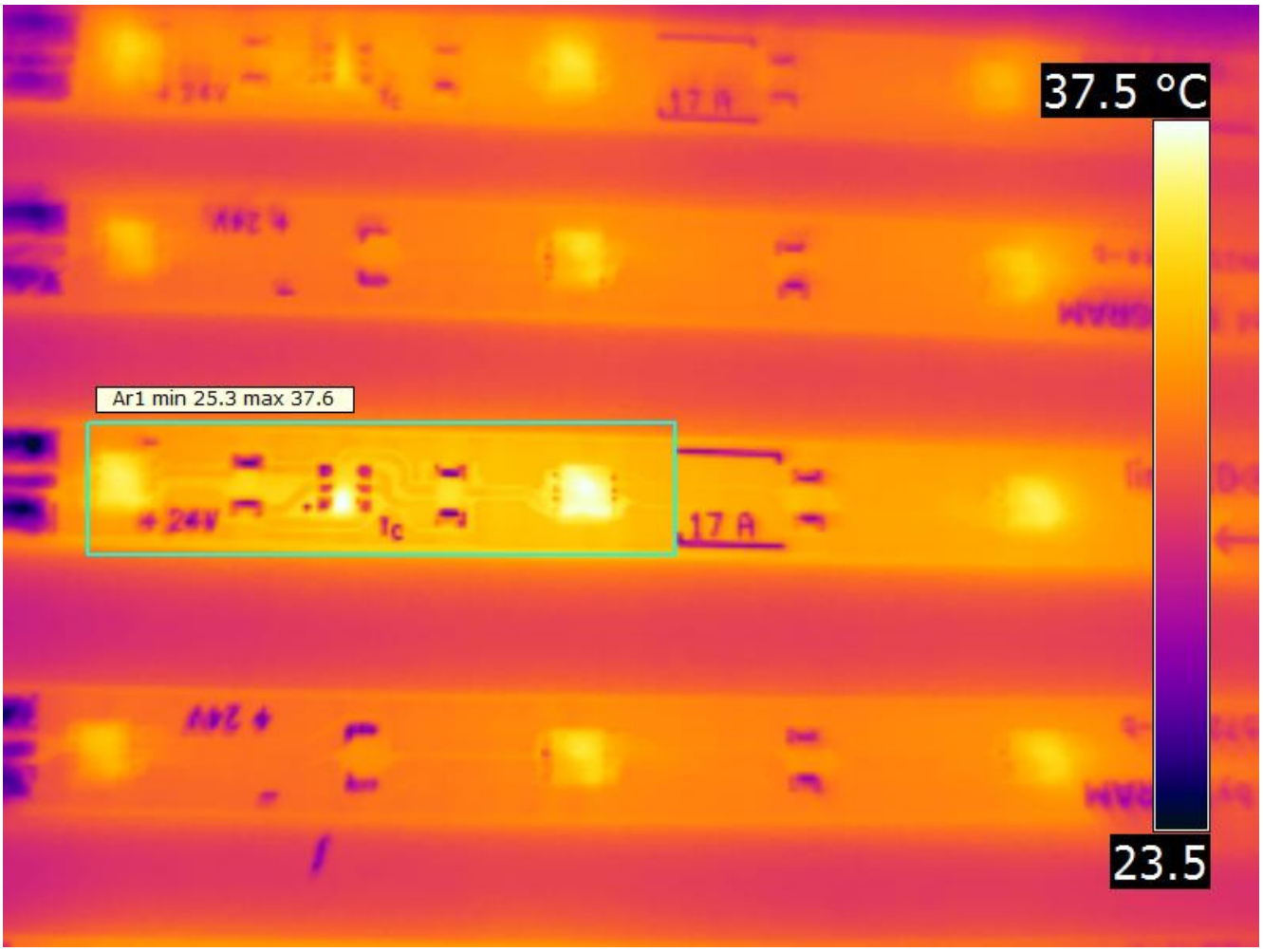
The power factor is 1.00. The tests were done with a DC power supply. This results in no blind power and as a result the power factor is always 1.0 but not relevant to mention.

Lamp voltage	24.11 V
Lamp current	0.102 A
Power P	2.4 W
Apparent power S	2.4 VA
Power factor	1.00

Temperature measurements lamp



Lamp measurement report - 28 April 2015

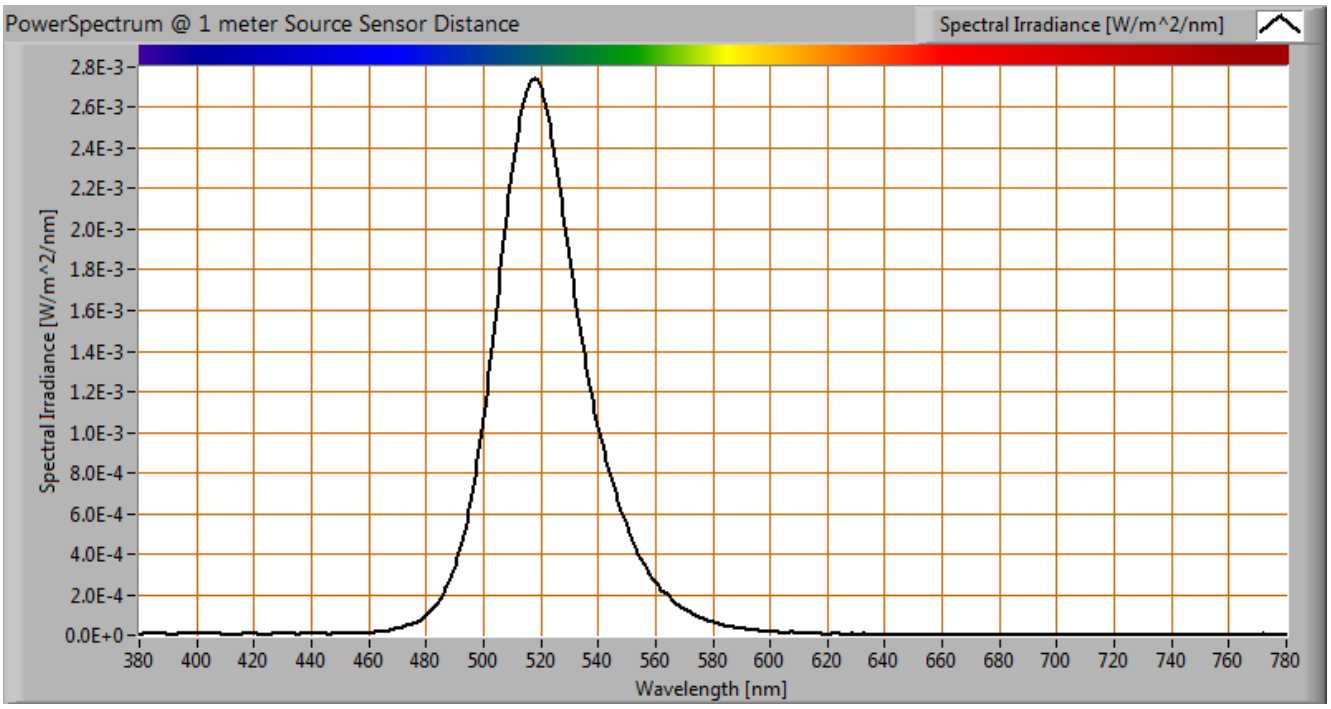


Temperature image(s).

status lamp	> 2 hours on
ambient temperature	23.6 deg C
reflected background temperature	23.6 deg C
camera	Flir T335
emissivity	0.95
measurement distance	0.5, 1 m
IFOV_geometric	0.136 mm per 0.1 m distance
NETD (thermal sensitivity)	50 mK

Lamp measurement report - 28 April 2015

Spectral power distribution

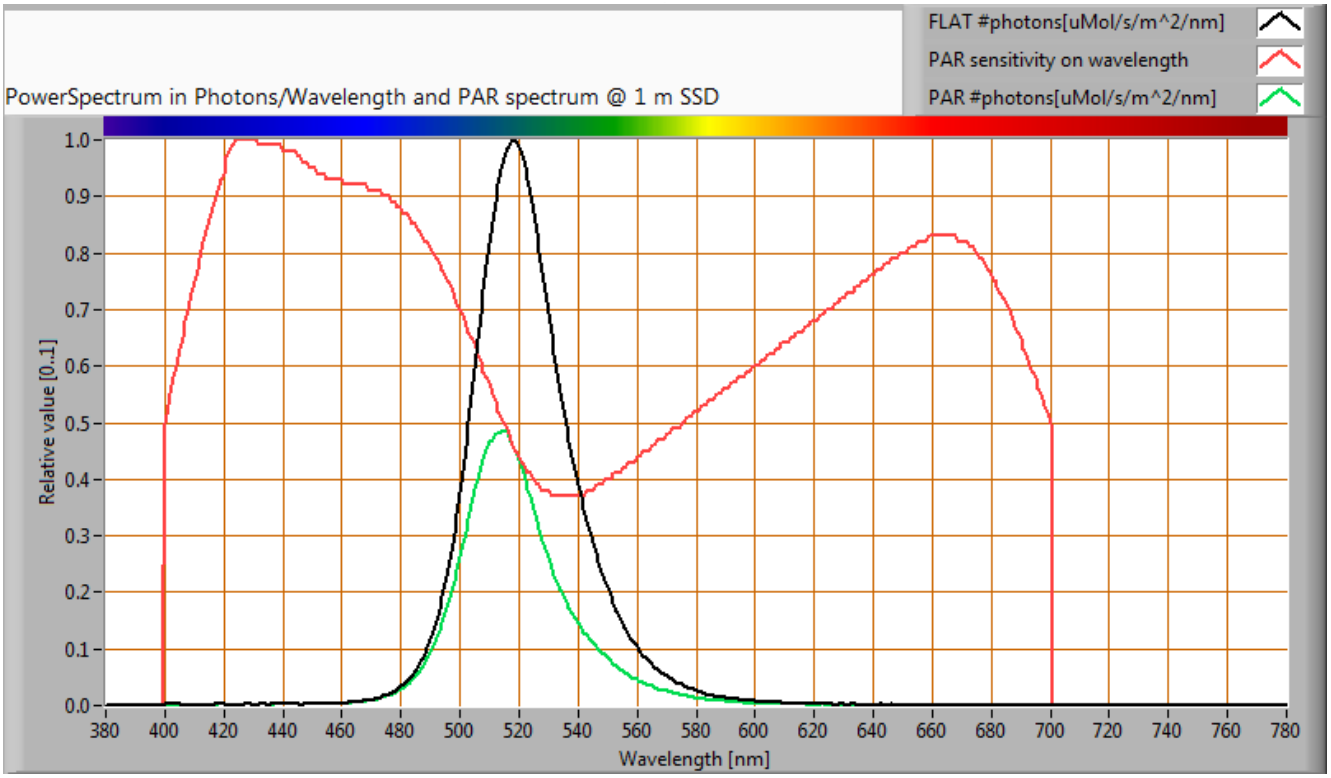


The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.

Lamp measurement report - 28 April 2015

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.



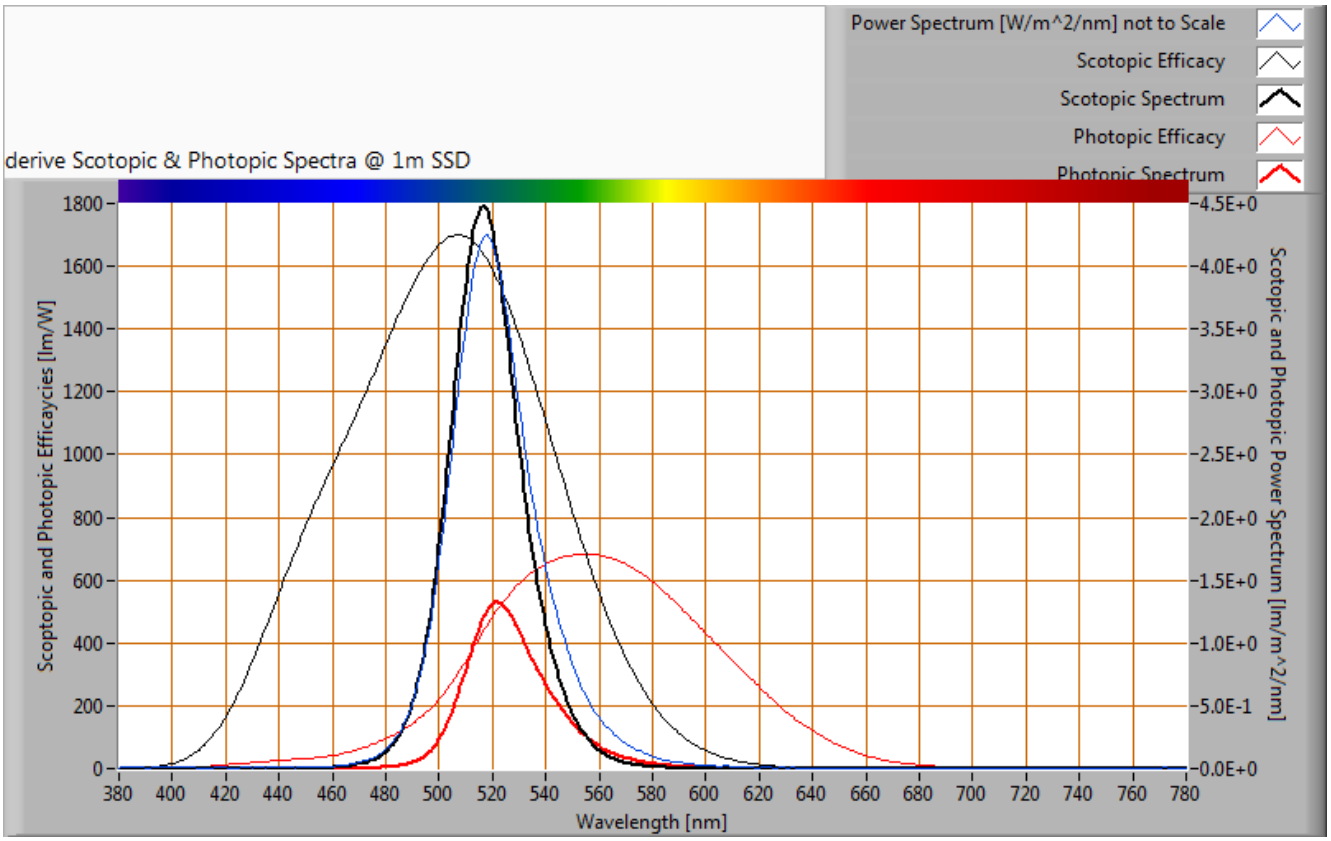
The photon spectrum, then the sensitivity curve and as result the final PAR spectrum of the light of this light bulb

parameter	value	unit
PAR number	0.2	uMol/s/m^2
PAR photon current	0.6	uMol/s
PAR photon efficacy	0.3	uMol/s/W

The PAR efficiency is 49 % (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 - 28 April 2015

S/P ratio

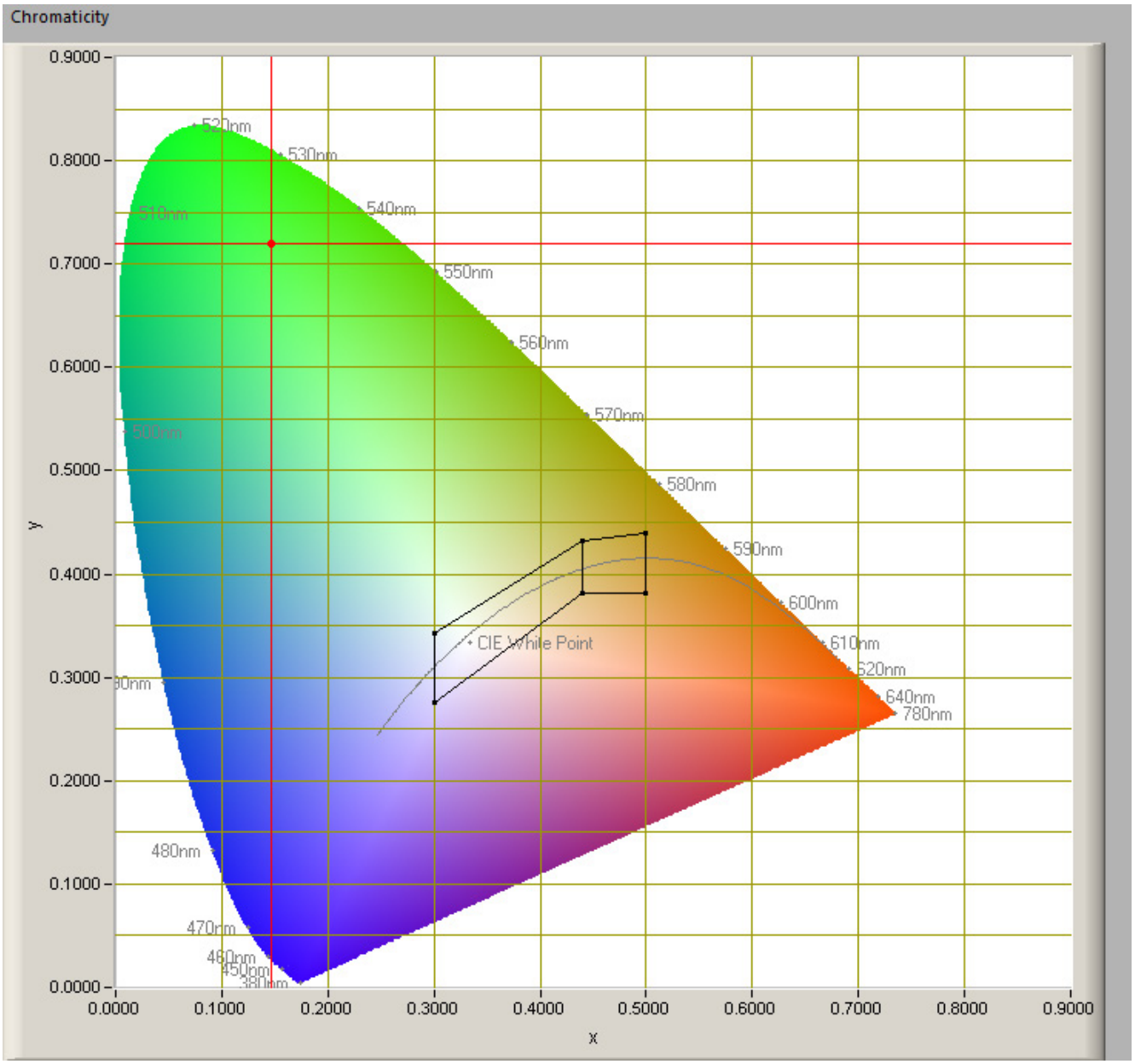


The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).

The S/P ratio of the light coming from this lamp is 3.1.

Lamp measurement report - 28 April 2015

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 outside the area indicated with class A. This area indicates an area for signal lamps.

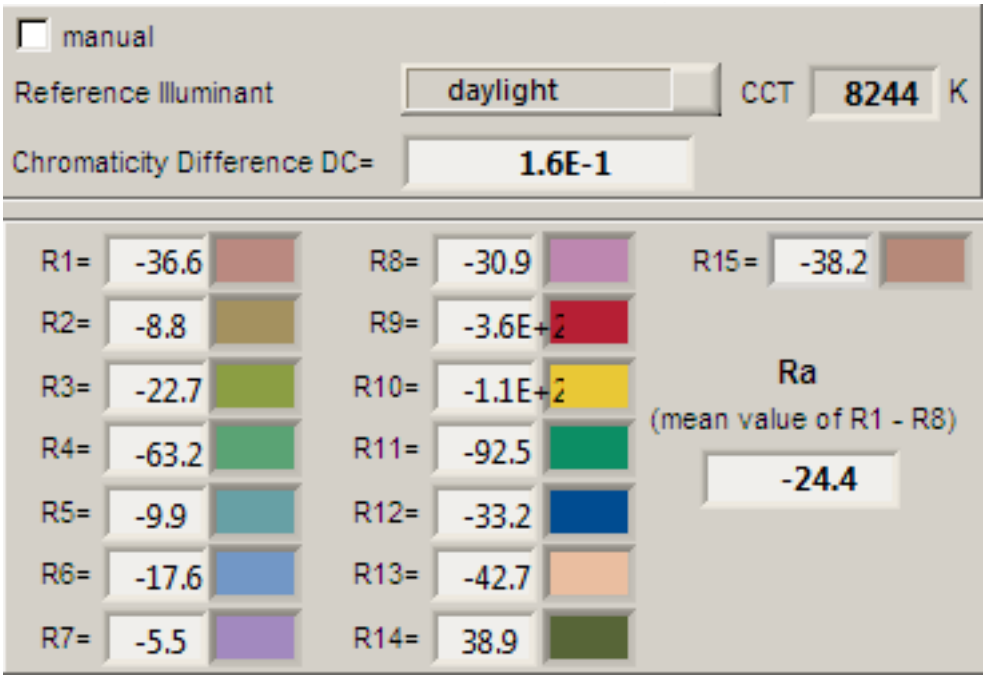
The color coordinates are x=0.7201 and y=0.1464.

Lamp measurement report - 28 April 2015

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)

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.

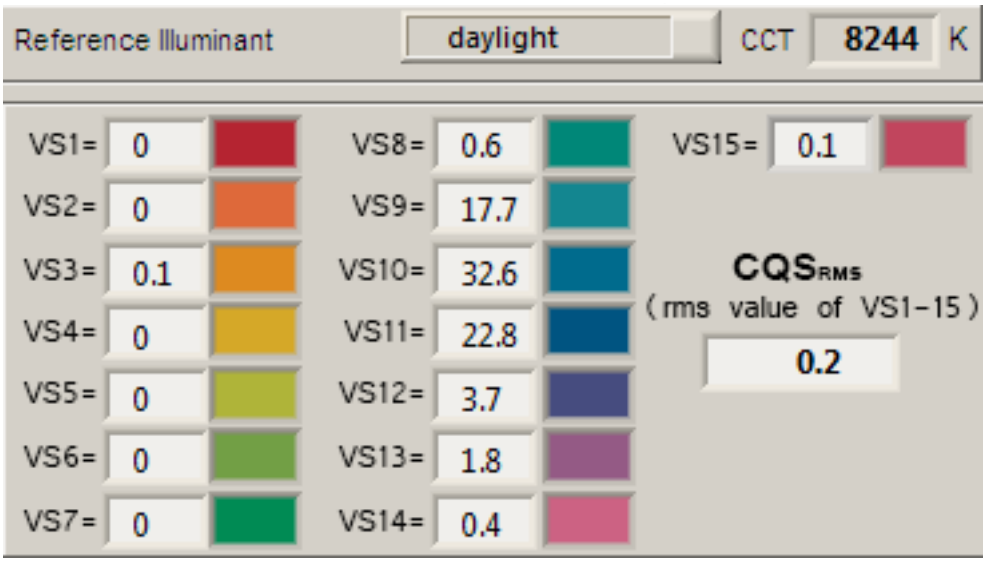
This value of -24 indicates how well the light of this lamp can render well a set of reference colors, this in comparison with the light of a reference source (for color temperatures < 5000K a black radiator is used as reference and for color temperatures > 5000K the sun or the light outside during the day).

The value of -24 is smaller than the value of 80 that is considered as a minimum for working areas in general.

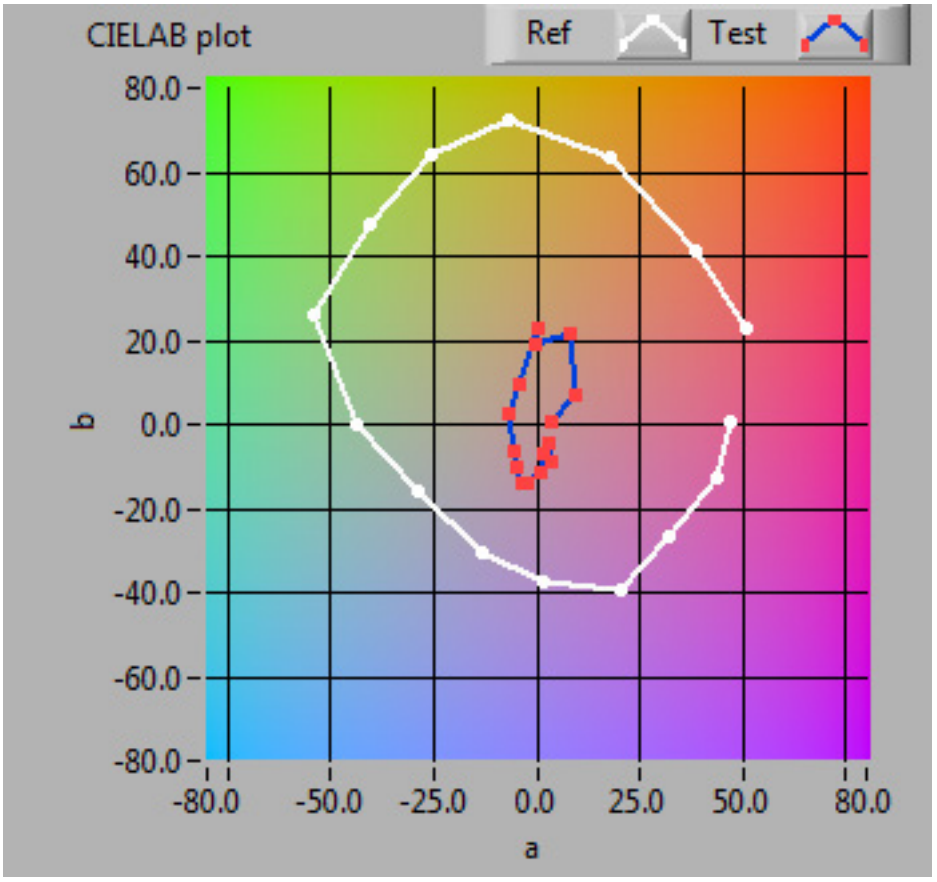
Note: the chromaticity difference is 0.1635 and indicates the distance to the Planckian Locus. There is a value mentioned of max 5.4E-3 in section 5.3 of CIE 13.3-1995 however not further explanation of it.
An other reference with signal lights as a reference is given in the chromaticity diagram.

Color Quality Scale

(v9.0.3) is an improved indicator (over CRI) of how well colors are rendered.



CQS-values of the light of this light bulb.

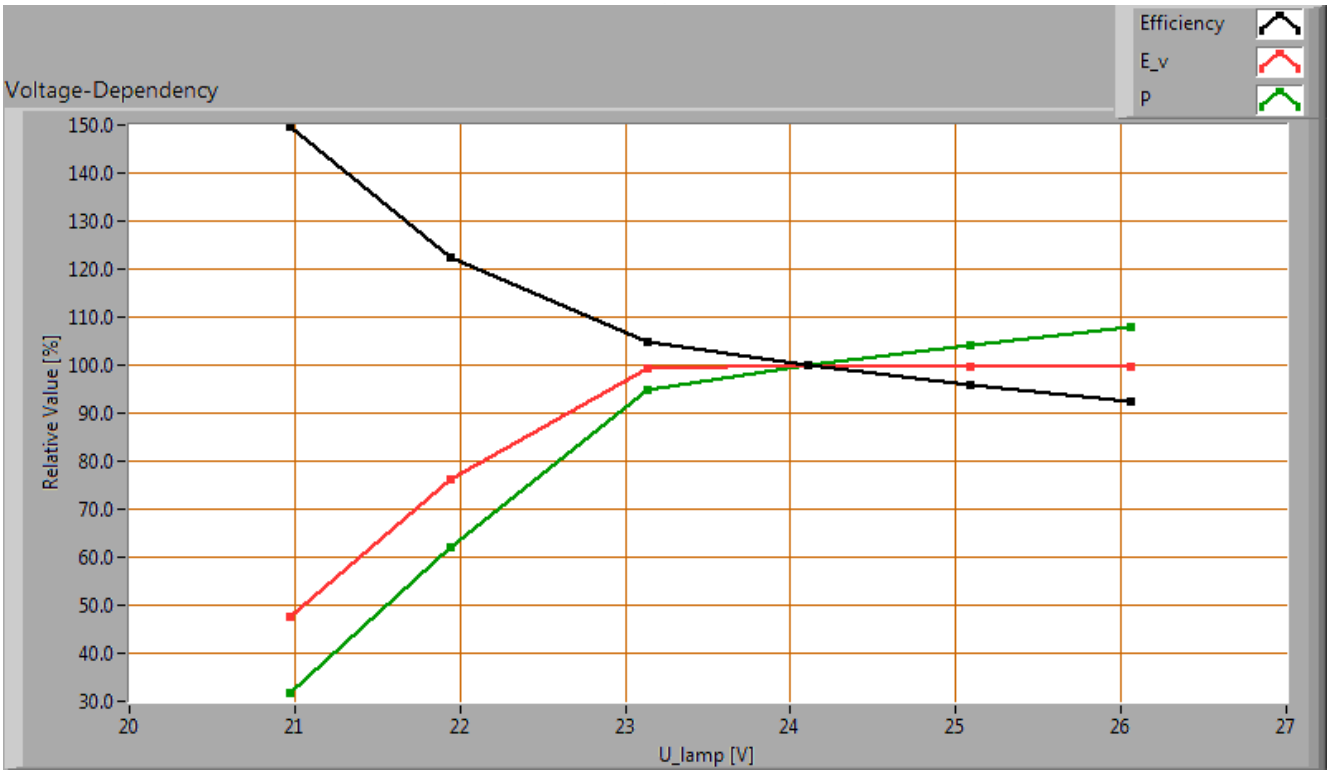


CQS-values for the light of this light bulb compared with those of a reference source with the same color temperature.

Lamp measurement report - 28 April 2015

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] (this latter is estimated here by dividing the found E_v value by P).



Lamp voltage dependencies of certain light bulb parameters

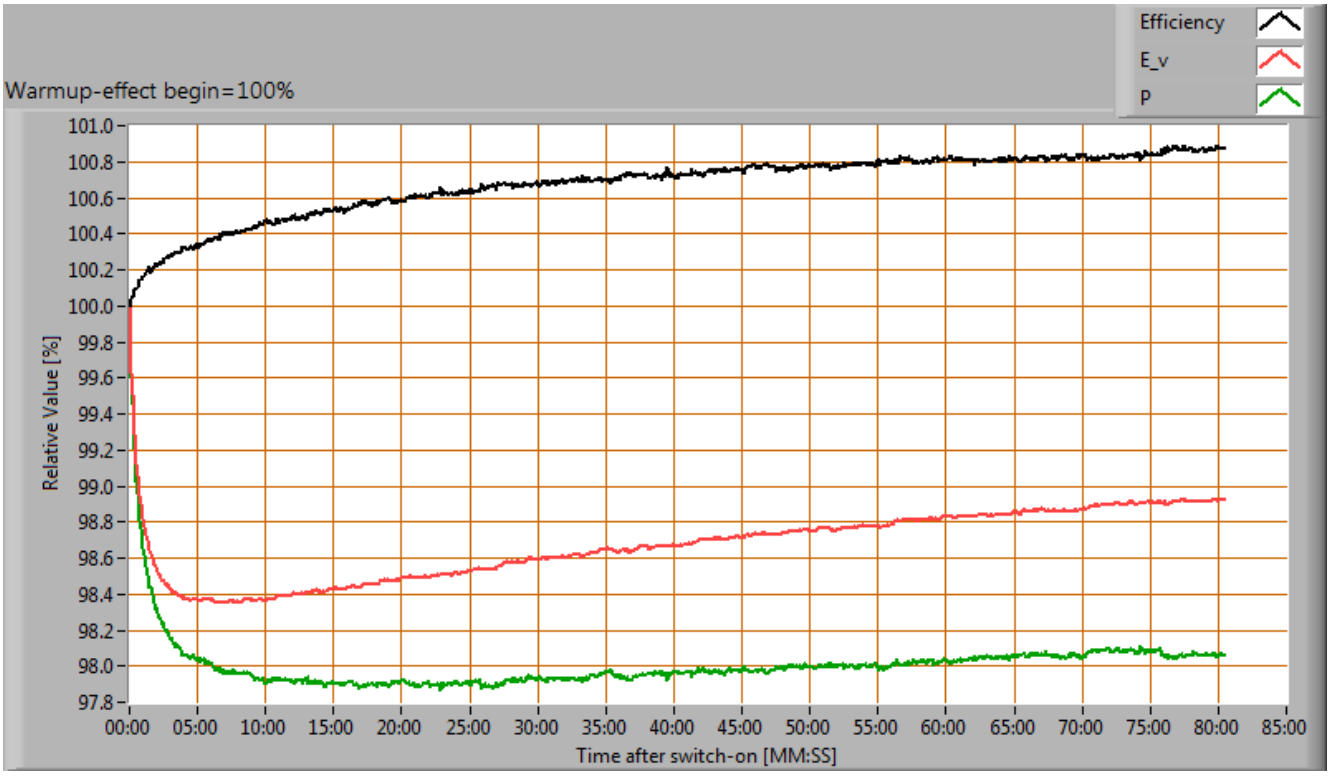
There is a non-constant dependency of the illuminance when the power voltage varies between 22 - 26 V DC.
There is a constant dependency of the consumed power when the power voltage varies between 22 - 26 V DC.

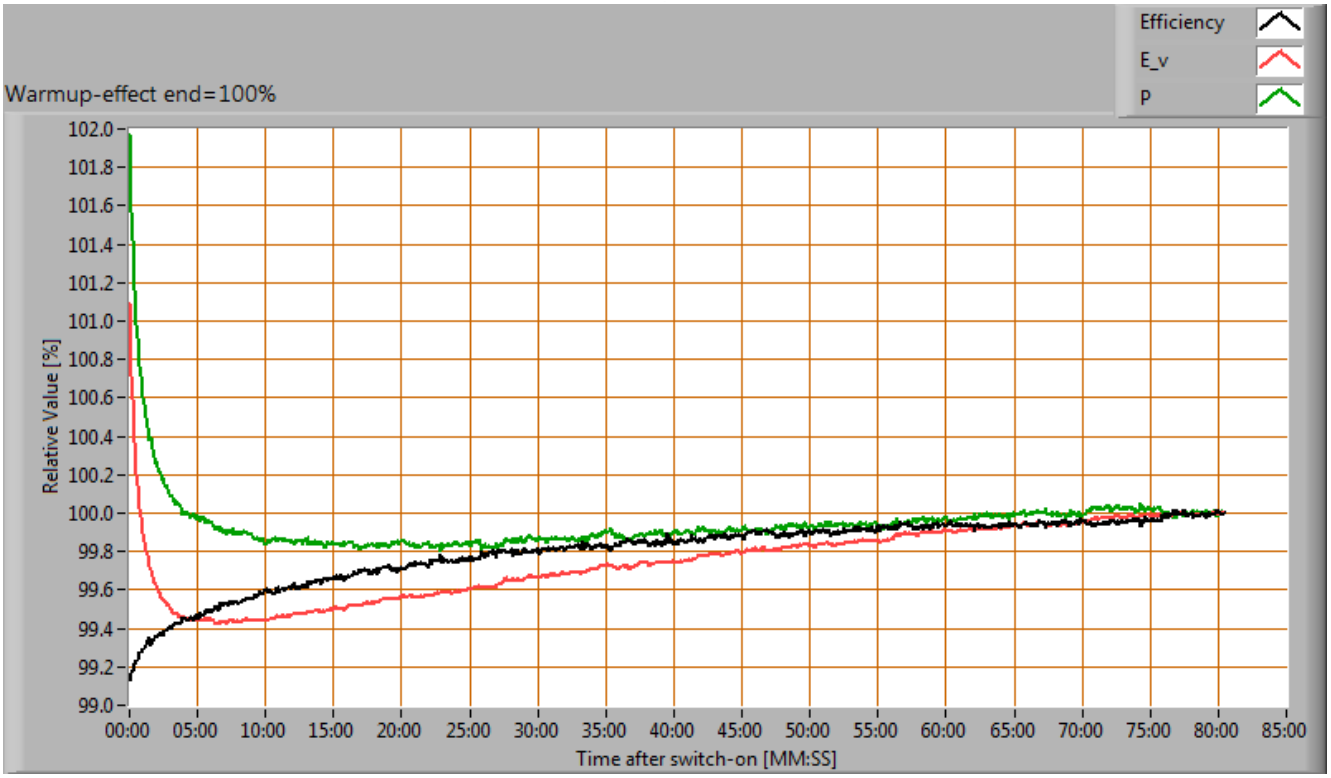
When the voltage varies abruptly with + or - 0.5 V DC then this results in a variation of the illuminance of maximally 0.3 %. This difference in illuminance is not visible (when it occurs abruptly).

Lamp measurement report - 28 April 2015

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].





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.

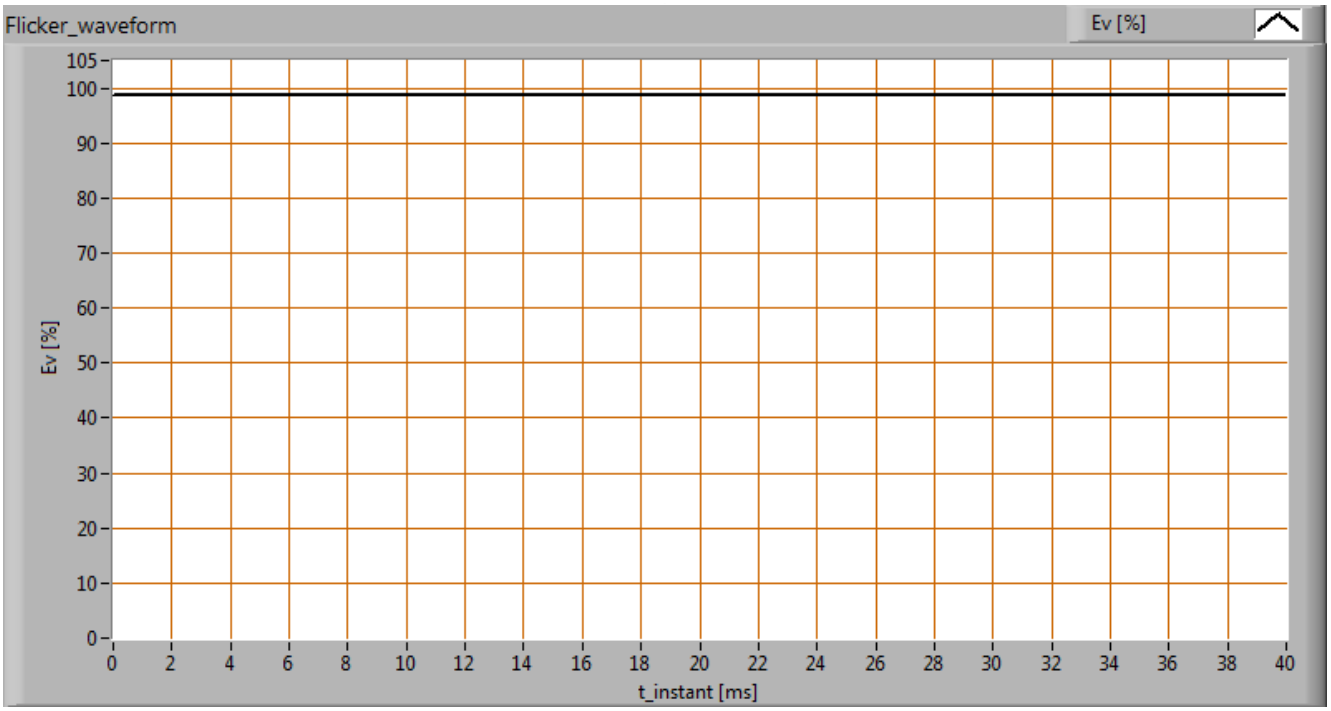
Lamp measurement report - 28 April 2015

During the warmup time the illuminance doesn't vary significantly (< 5 %).

During the warmup time the power doesn't vary significantly (< 5 %).
The variation in efficacy (calculated as indication by simplydividing the illuminance by the power) during the warming up is 1 %. 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.



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

parameter	value	unit
Flicker frequency	44.6	Hz
Illuminance modulation index	0	%

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

Lamp measurement report - 28 April 2015

Biologic effect

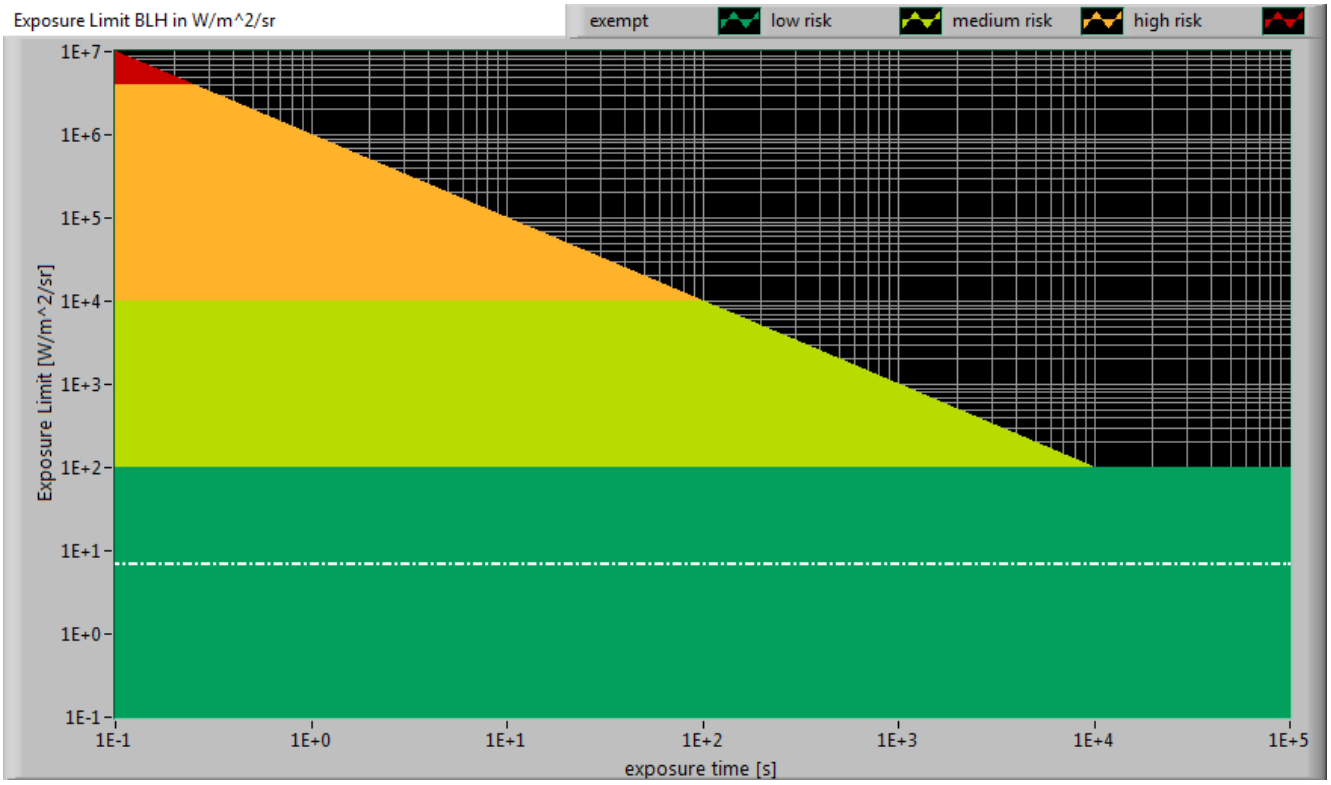
The biologic effect shows the level of impact the light of this lamp can have on the day-night rhythm of human beings (as well as the suppression of melatonin production).
The important parameters (according to prenorm DIN V 5031-100:2009-06):

biologic effect factor	0.566
k_biol trans (25 years)	1.000
k_biol trans (50 years)	0.868
k_biol trans (75 years)	0.688
k_pupil(25 years)	1.000
k_pupil(50 years)	0.740
k_pupil(75 years)	0.519

Lamp measurement report - 28 April 2015

Blue Light Hazard

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



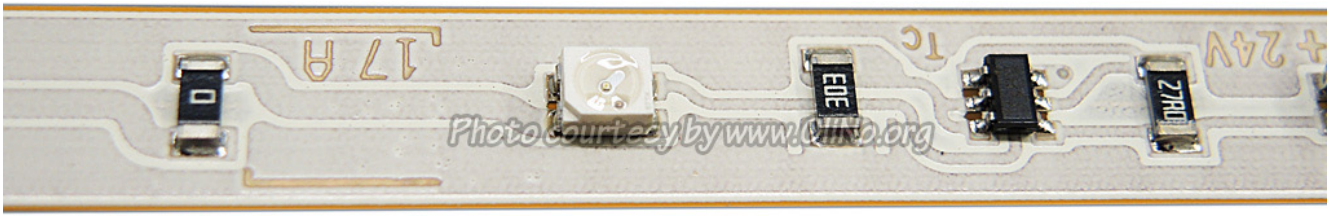
The level of blue light of this lamp related to the exposure limit and the different classification areas.

L_lum0 [mm]	3	Dimension of brightest part of lamp in C0-C180 direction.
L_lum90 [mm]	123	Dimension of brightest part of lamp in C90-C270 direction.
SSD_500lx [mm]	309	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]	615	Minimum distance at which the lamp can be seen as apoint 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]	0.010	(Apparent) source angle in C0-C180 direction.
alpha_C90-C270 [rad]	0.398	(Apparent) source angle in C90-C270 direction.

Lamp measurement report - 28 April 2015

alpha_AVG [rad]	0.055	Average (apparent) source angle. If average >= 0.011 rad then the exposure limit is computed with radiance Lb. Otherwise with irradiance Eb.
Exposure value [W/m^2/sr]	6.85E+0	Blue Light Hazard value for this lamp, measured straight underneath the lamp. Computation is referenced to Lb. Because the distance at 500 lux is in the near field, then this exposure value is too pessimistic and should be lower.
Blue Light Hazard risk group	0	0=exempt, 1=low, 2 = moderate, 3=high risk.

Extra



Additional photos.

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