Test Report issued under the responsibility of:

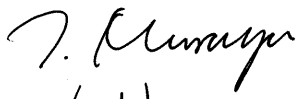
TÜVRheinland®

TEST REPORT
IEC 62471
Photobiological safety of lamps and lamp systems

Report Reference No. ..... :	50039441 001
Date of issue ..... :	2016-05-02
Total number of pages ..... :	29
Testing Laboratory ..... :	TÜV Rheinland Japan Ltd., Yokohama Laboratory
Address ..... :	Global Technology Assessment Center (GTAC), 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan
Applicant's name ..... :	CITIZEN ELECTRONICS CO., LTD.
Address ..... :	1-23-1 Kamikurechi, Fujiyoshida-shi, Yamanashi 403-0001, Japan
Test specification:	
Standard ..... :	IEC 62471:2006 (First Edition)
Test procedure ..... :	CB scheme
Non-standard test method..... :	N/A
Test Report Form No. ..... :	IEC62471A
TRF Originator ..... :	VDE Testing and Certification Institute
Master TRF ..... :	Dated 2009-05

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

Test item description	:	LED module
Trade Mark	:	(none)
Manufacturer	:	(same as Applicant)
Model/Type reference	:	CLUttt-uuvvC4-wwxyzab ttt = 028, 038, 048, 058; uu = 07, 09, 12, 13, 18, 36; vv = 01, 02, 03, 04, 05, 06, 08, 10, 12, 18, 25; ww = 27 – 40; x = 1 - 9 , A – Z; y = M, L, H; z = 1 – 9; a = A – Z; b = 1 – 9 (refer to pages 7-8 for available models)
Ratings	:	1) I_F = 110mA/die (for CLU048-1818C4-wwxyzab) 2) I_F = 120mA/die (for CLU028-1202C4-wwxyzab, CLU028-1203C4-wwxyzab, CLU028-1204C4-wwxyzab, CLU038-1208C4-wwxyzab, CLU038-1210C4, CLU058-uuvvC4-wwxyzab) 3) I_F = 160mA/die (except for models above) (refer to pages 7-8 for rating)

Testing procedure and testing location:		
☒ **Testing Laboratory:**	TÜV Rheinland Japan Ltd., Yokohama Laboratory	
Testing location/ address ..... :	Global Technology Assessment Center (GTAC), 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan	
☐ **Associated CB Laboratory:**		
Testing location/ address ..... :		
Tested by (name + signature)..... :	T.Muraya	
Approved by (+ signature)..... :	K.Horiuchi	
☐ Testing procedure: TMP		
Tested by (name + signature)..... :		
Approved by (+ signature)..... :		
Testing location/ address ..... :		
☐ Testing procedure: WMT		
Tested by (name + signature)..... :		
Witnessed by (+ signature)..... :		
Approved by (+ signature)..... :		
Testing location/ address ..... :		
☐ Testing procedure: SMT		
Tested by (name + signature)..... :		
Approved by (+ signature)..... :		
Supervised by (+ signature)..... :		
Testing location/ address ..... :		
☐ Testing procedure: RMT		
Tested by (name + signature)..... :		
Approved by (+ signature)..... :		
Supervised by (+ signature)..... :		
Testing location/ address ..... :		

List of Attachments:

- Photo Documentation (total 3 pages)
- Attachment 1 (included in this report): EU Group Differences
- Attachment 2 (included in this report): Furthermore remarks

Summary of testing:	
Tests performed: Source profile, irradiance measurement and radiance measurement were performed for Non-GLS conditions. (at the 200mm distance to the apparent source) Tests were conducted on the models below which represent the worst case in terms of LED package illuminance, density and spectrum in regard to the hazards identified in IEC 62471. 1) CLU048-1818C4-403Mzab (I_F = 110mA/die) 2) CLU058-3618C4-403Mzab (I_F = 120mA/die) 3) CLU048-1812C4-403Mzab (I_F = 160mA/die)	**Testing location:** (see “testing procedure and testing location“ on page 2)
Summary of compliance with National Differences: EU Group Differences based on EU Directive 2006/25/EC.	
Copy of marking plate: (none)	

Test item particulars ..... :	
Tested lamp ..... :	☒ continuous wave lamps ☐ pulsed lamps
Tested lamp system ..... :	LED
Lamp classification group ..... :	☐ exempt ☒ risk 1 ☐ risk 2 ☐ risk 3
Lamp cap ..... :	N/A
Bulb ..... :	N/A
Rated of the lamp ..... :	N/A
Furthermore marking on the lamp ..... :	N/A
Seasoning of lamps according IEC standard ..... :	N/A
Used measurement instrument ..... :	Bentham IDR300-PSL
Temperature by measurement ..... :	22-23 °C
Information for safety use ..... :	N/A
Possible test case verdicts:	
– test case does not apply to the test object ..... :	N/A
– test object does meet the requirement ..... :	P (Pass)
– test object does not meet the requirement ..... :	F (Fail)
Testing:	
Date of receipt of test item ..... :	2016-03-15
Date (s) of performance of tests ..... :	2016-04-20 – 2016-04-21

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	☒ Yes ☐ Not applicable

When differences exist; they shall be identified in the General product information section.

Name and address of factory (ies).....:	1. CITIZEN ELECTRONICS FUNEHIKI CO., LTD. 6-2, Kouyoudai, Funehiki-cho, Tamura-shi, Fukushima 963-4318, Japan 2. CITIZEN ELECTRONICS TIMEL CO., LTD. 539-21, Koasumi, Fujiyoshida-shi, Yamanashi 403-0002, Japan 3. JIANG XING ELECTRONICS LTD. Building B, 399 Jinxing Road, Jianghai District, Jiangmen, Guangdong 529000, P.R. China

General product information:

1) Application details / Description of the product:

The product is tested as LED module for use in luminaires.

The module consists of a LED package without driver circuits.

2) Differences between the models:

- Type nomenclature:

CLUttt-uuvvC4-wwxyzab

ttt = 028, 038, 048, 058 (Part Code)

uu = 07, 09, 12, 13, 18, 36 (Dies in series)

vv = 01, 02, 03, 04, 05, 06, 08, 10, 12, 18, 25 (Dies in parallel)

ww = 27 – 40 (Correlated color temperature)

x = 1 - 9 , A - Z (Internal code)

y = M, L, H (CRI)

z = 1 - 9 (CRI)

a = A - Z (Internal code)

b = 1 - 9 (Internal code)

(see below for available models)

1) Rating at I_F = 110mA/die

No.	Series	Product code	Ra min.	Forward current (mA)
1	CLU048	CLU048-1818C4-wwxLzab	70	1980
2		CLU048-1818C4-wwxMzab	80	
3		CLU048-1818C4-wwxHzab	90	

2) Rating at I_F = 120mA/die

No.	Series	Product code	Ra min.	Forward current (mA)
4	CLU028	CLU028-1202C4-wwxLzab	70	240
5		CLU028-1202C4-wwxMzab	80	
6		CLU028-1202C4-wwxHzab	90	
7		CLU028-1203C4-wwxLzab	70	360
8		CLU028-1203C4-wwxMzab	80	
9		CLU028-1203C4-wwxHzab	90	
10		CLU028-1204C4-wwxLzab	70	480
11		CLU028-1204C4-wwxMzab	80	
12		CLU028-1204C4-wwxHzab	90	
13	CLU038	CLU038-1208C4-wwxLzab	70	960
14		CLU038-1208C4-wwxMzab	80	
15		CLU038-1208C4-wwxHzab	90	
16		CLU038-1210C4-wwxLzab	70	1200
17		CLU038-1210C4-wwxMzab	80	
18		CLU038-1210C4-wwxHzab	90	
19	CLU058	CLU058-1825C4-wwxLzab	70	3000
20		CLU058-1825C4-wwxMzab	80	
21		CLU058-1825C4-wwxHzab	90	
22		CLU058-3618C4-wwxLzab	70	2160
23		CLU058-3618C4-wwxMzab	80	
24		CLU058-3618C4-wwxHzab	90	

3) Rating at I_F = 160mA/die

No.	Series	Product code	Ra min.	Forward current (mA)
25	CLU028	CLU028-0701C4-wwxMzab	80	160
26		CLU028-0901C4-wwxMzab	80	160
27		CLU028-1201C4-wwxLzab	70	160
28		CLU028-1201C4-wwxMzab	80	
29		CLU028-1201C4-wwxHzab	90	
30		CLU028-1301C4-wwxLzab	70	160
31		CLU028-1301C4-wwxMzab	80	
32		CLU028-1301C4-wwxHzab	90	
33	CLU038	CLU038-1205C4-wwxLzab	70	800
34		CLU038-1205C4-wwxMzab	80	
35		CLU038-1205C4-wwxHzab	90	
36		CLU038-1206C4-wwxLzab	70	960
37		CLU038-1206C4-wwxMzab	80	
38		CLU038-1206C4-wwxHzab	90	
39	CLU048	CLU048-1212C4-wwxLzab	70	1920
40		CLU048-1212C4-wwxMzab	80	
41		CLU048-1212C4-wwxHzab	90	
42		CLU048-1812C4-wwxLzab	70	1920
43		CLU048-1812C4-wwxMzab	80	
44		CLU048-1812C4-wwxHzab	90	

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Clause	Requirement + Test	Result - Remark	Verdict
4	**EXPOSURE LIMITS**		P
4.1	General		P
	The exposure limits in this standard is not less than 0,01 ms and not more than any 8-hour period and should be used as guides in the control of exposure		P
	Detailed spectral data of a light source are generally required only if the luminance of the source exceeds 10^4 cd·m^{-2}	(see clause 4.3)	P
4.3	Hazard exposure limits		P
4.3.1	Actinic UV hazard exposure limit for the skin and eye	Considered.	P
	The exposure limit for effective radiant exposure is 30 J·m^{-2} within any 8-hour period		P
	To protect against injury of the eye or skin from ultraviolet radiation exposure produced by a broad-band source, the effective integrated spectral irradiance , E_S, of the light source shall not exceed the levels defined by:		P
	$E_s \cdot t = \sum_{200}^{400} \sum_{t} E_\lambda(\lambda,t) \cdot S_{UV}(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 30$ J·m^{-2}		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye or skin shall be computed by:		P
	$t_{max} = \frac{30}{E_s}$ s		P
4.3.2	Near-UV hazard exposure limit for eye	Considered.	P
	For the spectral region 315 nm to 400 nm (UV-A) the total radiant exposure to the eye shall not exceed 10000 J·m^{-2} for exposure times less than 1000 s. For exposure times greater than 1000 s (approximately 16 minutes) the UV-A irradiance for the unprotected eye, E_{UVA}, shall not exceed 10 W·m^{-2}.		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye for time less than 1000 s, shall be computed by:		P
	$t_{max} \le \frac{10\,000}{E_{UVA}}$ s		P
4.3.3	Retinal blue light hazard exposure limit	Considered.	P

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Clause	Requirement + Test	Result - Remark	Verdict
	To protect against retinal photochemical injury from chronic blue-light exposure, the integrated spectral radiance of the light source weighted against the blue-light hazard function, B(λ), i.e., the blue-light weighted radiance , L_B, shall not exceed the levels defined by:		P
	$L_B \cdot t = \sum_{300}^{700} \sum_{t} L_\lambda(\lambda,t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 10^6$ J · m^{-2} · sr^{-1}	for t ≤ 10^4 s $t_{max} = \frac{10^6}{L_B}$	P
	$L_B = \sum_{300}^{700} L_\lambda \cdot B(\lambda) \cdot \Delta\lambda \le 100$ W · m^{-2} · sr^{-1}	for t > 10^4 s	P
4.3.4	Retinal blue light hazard exposure limit - small source		N/A
	Thus the spectral irradiance at the eye E_λ, weighted against the blue-light hazard function B(λ) shall not exceed the levels defined by:	(see appended table 4.2)	N/A
	$E_B \cdot t = \sum_{300}^{700} \sum_{t} E_\lambda(\lambda,t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 100$ J · m^{-2}	for t ≤ 100 s	N/A
	$E_B = \sum_{300}^{700} E_\lambda \cdot B(\lambda) \cdot \Delta\lambda \le 1$ W · m^{-2}	for t > 100 s	N/A
4.3.5	Retinal thermal hazard exposure limit		P
	To protect against retinal thermal injury, the integrated spectral radiance of the light source, L_λ, weighted by the burn hazard weighting function R(λ) (from Figure 4.2 and Table 4.2), i.e., the burn hazard weighted radiance, shall not exceed the levels defined by:		P
	$L_R = \sum_{380}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \le \frac{50\,000}{\alpha \cdot t^{0,25}}$ W · m^{-2} · sr^{-1}	(10 µs ≤ t ≤ 10 s)	P
4.3.6	Retinal thermal hazard exposure limit – weak visual stimulus		N/A
	For an infrared heat lamp or any near-infrared source where a weak visual stimulus is inadequate to activate the aversion response, the near infrared (780 nm to 1400 nm) radiance, L_{IR}, as viewed by the eye for exposure times greater than 10 s shall be limited to:		N/A
	$L_{IR} = \sum_{780}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \le \frac{6\,000}{\alpha}$ W · m^{-2} · sr^{-1}	t > 10 s	N/A
4.3.7	Infrared radiation hazard exposure limits for the eye	Considered.	P

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	The avoid thermal injury of the cornea and possible delayed effects upon the lens of the eye (cataracto-genesis), ocular exposure to infrared radiation, E_{IR}, over the wavelength range 780 nm to 3000 nm, for times less than 1000 s, shall not exceed:		P
	$E_{IR} = \sum_{780}^{3000} E_\lambda \cdot \Delta\lambda \le 18000 \cdot t^{-0,75}$ $W \cdot m^{-2}$	t ≤ 1000 s	P
	For times greater than 1000 s the limit becomes:		P
	$E_{IR} = \sum_{780}^{3000} E_\lambda \cdot \Delta\lambda \le 100$ $W \cdot m^{-2}$	t > 1000 s	P
4.3.8	Thermal hazard exposure limit for the skin	Considered.	P
	Visible and infrared radiant exposure (380 nm to 3000 nm) of the skin shall be limited to:		P
	$E_H \cdot t = \sum_{380}^{3000} \sum_{t} E_\lambda(\lambda,t) \cdot \Delta t \cdot \Delta\lambda \le 20000 \cdot t^{0,25}$ $J \cdot m^{-2}$		P

5	**MEASUREMENT OF LAMPS AND LAMP SYSTEMS**		P
5.1	Measurement conditions		P
	Measurement conditions shall be reported as part of the evaluation against the exposure limits and the assignment of risk classification.	(see above)	P
5.1.1	Lamp ageing (seasoning)	LED Source.	N/A
	Seasoning of lamps shall be done as stated in the appropriate IEC lamp standard.		N/A
5.1.2	Test environment		P
	For specific test conditions, see the appropriate IEC lamp standard or in absence of such standards, the appropriate national standards or manufacturer's recommendations.	Standard laboratory (dark room) condition.	P
5.1.3	Extraneous radiation	Considered.	P
	Careful checks should be made to ensure that ex-traneous sources of radiation and reflections do not add significantly to the measurement results.		P
5.1.4	Lamp operation		N/A
	Operation of the test lamp shall be provided in ac-cordance with:		N/A
	– the appropriate IEC lamp standard, or		N/A
	– the manufacturer' s recommendation		N/A
5.1.5	Lamp system operation		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The power source for operation of the test lamp shall be provided in accordance with:		P
	– the appropriate IEC standard, or		N/A
	– the manufacturer' s recommendation		P
5.2	Measurement procedure		P
5.2.1	Irradiance measurements		P
	Minimum aperture diameter 7mm.		P
	Maximum aperture diameter 50 mm.		P
	The measurement shall be made in that position of the beam giving the maximum reading.	Considered.	P
	The measurement instrument is adequate calibrated.	Measurement system calibrated with standard lamps.	P
5.2.2	Radiance measurements		P
5.2.2.1	Standard method		P
	The measurements made with an optical system.		P
	The instrument shall be calibrated to read in absolute radiant power per unit receiving area and per unit solid angle to acceptance averaged over the field of view of the instrument.		P
5.2.2.2	Alternative method		P
	Alternatively to an imaging radiance set-up, an irradiance measurement set-up with a circular field stop placed at the source can be used to perform radiance measurements.	For 100mrad L_B measurement.	P
5.2.3	Measurement of source size		P
	The determination of α, the angle subtended by a source, requires the determination of the 50% emission points of the source.	1) CLU048-1818C4-403Mzab 21.06 mm x 20.64 mm α = 100.0 mrad 2) CLU058-3618C4-403Mzab 23.86 mm x 22.89 mm α = 100.0 mrad 3) CLU048-1812C4-403Mzab 21.45mm x 21.40mm α = 100.0 mrad	P
5.2.4	Pulse width measurement for pulsed sources	Continuous Wave lamps.	N/A
	The determination of Δt, the nominal pulse duration of a source, requires the determination of the time during which the emission is > 50% of its peak value.		N/A
5.3	Analysis methods		P
5.3.1	Weighting curve interpolations		P

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Clause	Requirement + Test	Result - Remark	Verdict
	To standardize interpolated values, use linear interpolation on the log of given values to obtain intermediate points at the wavelength intervals desired.	(see appended table 4.1)	P
5.3.2	Calculations		P
	The calculation of source hazard values shall be performed by weighting the spectral scan by the appropriate function and calculating the total weighted energy.		P
5.3.3	Measurement uncertainty		P
	The quality of all measurement results must be quantified by an analysis of the uncertainty.		P
6	**LAMP CLASSIFICATION**		P
	For the purposes of this standard it was decided that the values shall be reported as follows:	(see appended table 6.1)	P
	– for lamps intended for general lighting service, the hazard values shall be reported as either irradiance or radiance values at a distance which produces an illuminance of 500 lux, but not at a distance less than 200 mm	Non-GLS	N/A
	– for all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200 mm		P
6.1	Continuous wave lamps		P
6.1.1	Exempt Group		N/A
	In the exempt group are lamps, which do not pose any photobiological hazard. The requirement is met by any lamp that does not pose:		N/A
	– an actinic ultraviolet hazard (E_S) within 8-hours exposure (30000 s), nor		N/A
	– a near-UV hazard (E_{UVA}) within 1000 s, (about 16 min), nor		N/A
	– a retinal blue-light hazard (L_B) within 10000 s (about 2,8 h), nor		N/A
	– a retinal thermal hazard (L_R) within 10 s, nor		N/A
	– an infrared radiation hazard for the eye (E_{IR}) within 1000 s		N/A
6.1.2	Risk Group 1 (Low-Risk)		P
	In this group are lamps, which exceeds the limits for the exempt group but that does not pose:		P
	– an actinic ultraviolet hazard (E_S) within 10000 s, nor		P

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Clause	Requirement + Test	Result - Remark	Verdict
	– a near ultraviolet hazard (E_{UVA}) within 300 s, nor		P
	– a retinal blue-light hazard (L_B) within 100 s, nor		P
	– a retinal thermal hazard (L_R) within 10 s, nor		P
	– an infrared radiation hazard for the eye (E_{IR}) within 100 s		P
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard (L_{IR}), within 100 s are in Risk Group 1.		P
6.1.3	Risk Group 2 (Moderate-Risk)		N/A
	This requirement is met by any lamp that exceeds the limits for Risk Group 1, but that does not pose:		N/A
	– an actinic ultraviolet hazard (E_S) within 1000 s exposure, nor		N/A
	– a near ultraviolet hazard (E_{UVA}) within 100 s, nor		N/A
	– a retinal blue-light hazard (L_B) within 0,25 s (aversion response), nor		N/A
	– a retinal thermal hazard (L_R) within 0,25 s (aversion response), nor		N/A
	– an infrared radiation hazard for the eye (E_{IR}) within 10 s		N/A
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard (L_{IR}), within 10 s are in Risk Group 2.		N/A
6.1.4	Risk Group 3 (High-Risk)		N/A
	Lamps which exceed the limits for Risk Group 2 are in Group 3.		N/A
6.2	Pulsed lamps	Continuous Wave lamps.	N/A
	Pulse lamp criteria shall apply to a single pulse and to any group of pulses within 0,25 s.		N/A
	A pulsed lamp shall be evaluated at the highest nominal energy loading as specified by the manufacturer.		N/A
	The risk group determination of the lamp being tested shall be made as follows:		N/A
	– a lamp that exceeds the exposure limit shall be classified as belonging to Risk Group 3 (High-Risk)		N/A
	– for single pulsed lamps, a lamp whose weighted radiant exposure or weighted radiance does is below the EL shall be classified as belonging to the Exempt Group		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	– for repetitively pulsed lamps, a lamp whose weighted radiant exposure or weighted radiance dose is below the EL, shall be evaluated using the continuous wave risk criteria discussed in clause 6.1, using time averaged values of the pulsed emission		N/A

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Clause	Requirement + Test	Result - Remark	Verdict

Table 4.1	Spectral weighting function for assessing ultraviolet hazards for skin and eye		P
Wavelength[1] λ, nm	**UV hazard function $S_{uv}(\lambda)$**	**Wavelength λ, nm**	**UV hazard function $S_{uv}(\lambda)$**
200	0.030	313*	0.006
205	0.051	315	0.003
210	0.075	316	0.0024
215	0.095	317	0.0020
220	0.120	318	0.0016
225	0.150	319	0.0012
230	0.190	320	0.0010
235	0.240	322	0.00067
240	0.300	323	0.00054
245	0.360	325	0.00050
250	0.430	328	0.00044
254*	0.500	330	0.00041
255	0.520	333*	0.00037
260	0.650	335	0.00034
265	0.810	340	0.00028
270	1.000	345	0.00024
275	0.960	350	0.00020
280*	0.880	355	0.00016
285	0.770	360	0.00013
290	0.640	365*	0.00011
295	0.540	370	0.000093
297*	0.460	375	0.000077
300	0.300	380	0.000064
303*	0.120	385	0.000053
305	0.060	390	0.000044
308	0.026	395	0.000036
310	0.015	400	0.000030

[1] Wavelengths chosen are representative: other values should be obtained by logarithmic interpolation at intermediate wavelengths.
* Emission lines of a mercury discharge spectrum.

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Clause	Requirement + Test	Result - Remark	Verdict

Table 4.2	Spectral weighting functions for assessing retinal hazards from broadband optical sources	P

Wavelength nm	**Blue-light hazard function B (λ)**	**Burn hazard function R (λ)**
300	0.01	
305	0.01	
310	0.01	
315	0.01	
320	0.01	
325	0.01	
330	0.01	
335	0.01	
340	0.01	
345	0.01	
350	0.01	
355	0.01	
360	0.01	
365	0.01	
370	0.01	
375	0.01	
380	0.01	0.1
385	0.013	0.13
390	0.025	0.25
395	0.05	0.5
400	0.10	1.0
405	0.20	2.0
410	0.40	4.0
415	0.80	8.0
420	0.90	9.0
425	0.95	9.5
430	0.98	9.8
435	1.00	10.0
440	1.00	10.0
445	0.97	9.7
450	0.94	9.4
455	0.90	9.0

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Clause	Requirement + Test	Result - Remark	Verdict

Table 4.2	Spectral weighting functions for assessing retinal hazards from broadband optical sources	P

Wavelength nm	**Blue-light hazard function B (λ)**	**Burn hazard function R (λ)**
460	0.80	8.0
465	0.70	7.0
470	0.62	6.2
475	0.55	5.5
480	0.45	4.5
485	0.40	4.0
490	0.22	2.2
495	0.16	1.6
500-600	$10^{[(450-\lambda)/50]}$	1.0
600-700	0.001	1.0
700-1050		$10^{[(700-\lambda)/500]}$
1050-1150		0,2
1150-1200		$0.2 \cdot 10^{0,02(1150-\lambda)}$
1200-1400		0.02

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Clause	Requirement + Test	Result - Remark	Verdict

Table 5.4	Summary of the ELs for the surface of the skin or cornea (irradiance based values)	P

Hazard Name	Relevant equation	Wavelength range nm	Exposure duration sec	Limiting aperture rad (deg)	EL in terms of constant irradiance $W \cdot m^{-2}$
Actinic UV skin & eye	$E_S = \sum E_\lambda \cdot S(\lambda) \cdot \Delta\lambda$	200 – 400	< 30000	1.4 (80)	30/t
Eye UV-A	$E_{UVA} = \sum E_\lambda \cdot \Delta\lambda$	315 – 400	≤1000 >1000	1.4 (80)	10000/t 10
Blue-light small source	$E_B = \sum E_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	300 – 700	≤100 >100	< 0.011	100/t 1.0
Eye IR	$E_{IR} = \sum E_\lambda \cdot \Delta\lambda$	780 –3000	≤1000 >1000	1.4 (80)	$18000/t^{0.75}$ 100
Skin thermal	$E_H = \sum E_\lambda \cdot \Delta\lambda$	380 – 3000	< 10	2π sr	$20000/t^{0.75}$

Table 5.5	Summary of the ELs for the retina (radiance based values)	P

Hazard Name	Relevant equation	Wavelength range nm	Exposure duration sec	Field of view radians	EL in terms of constant radiance $W \cdot m^{-2} \cdot sr^{-1}$)
Blue light	$L_B = \sum L_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	300 – 700	0.25 – 10 10-100 100-10000 ≥ 10000	$0.011 \cdot \sqrt{(t/10)}$ 0.011 $0.0011 \cdot \sqrt{t}$ 0.1	$10^6/t$ $10^6/t$ $10^6/t$ 100
Retinal thermal	$L_R = \sum L_\lambda \cdot R(\lambda) \cdot \Delta\lambda$	380 – 1400	< 0.25 0.25 – 10	0.0017 $0.011 \cdot \sqrt{(t/10)}$	$50000/(\alpha \cdot t^{0.25})$ $50000/(\alpha \cdot t^{0.25})$
Retinal thermal (weak visual stimulus)	$L_{IR} = \sum L_\lambda \cdot R(\lambda) \cdot \Delta\lambda$	780 – 1400	> 10	0.011	6000/α

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Clause	Requirement + Test	Result – Remark	Verdict

Table 6.1	**Emission limits for risk groups of continuous wave lamps**									P
1) CLU048-1818C4-403Mzab										
Risk	Action spectrum	Symbol	Units	Emission Measurement						
				Exempt		Low risk		Mod risk		
				Limit	Result	Limit	Result	Limit	Result	
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	0.000079	0.003	N/A	0.03	N/A	
Near UV		E_{UVA}	$W \cdot m^{-2}$	10	0.02	33	N/A	100	N/A	
Blue light	B(λ)	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	6310	10000	4970	4000000	N/A	
Blue light, small source	B(λ)	E_B	$W \cdot m^{-2}$	1.0*	N/A	1.0	N/A	400	N/A	
Retinal thermal	R(λ)	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α = 280000	85200	28000/α	N/A	71000/α	N/A	
Retinal thermal, weak visual stimulus**	R(λ)	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	6000/α	N/A	6000/α	N/A	6000/α	N/A	
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0.95	570	N/A	3200	N/A	
* Small source defined as one with α < 0,011 radian. Averaging field of view at 10000 s is 0,1 radian. ** Involves evaluation of non-GLS source										

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Clause	Requirement + Test	Result – Remark	Verdict

Table 6.1	**Emission limits for risk groups of continuous wave lamps**									P
2) CLU058-3618C4-403Mzab										
Risk	Action spectrum	Symbol	Units	Emission Measurement						
				Exempt		Low risk		Mod risk		
				Limit	Result	Limit	Result	Limit	Result	
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	0.000003	0.003	N/A	0.03	N/A	
Near UV		E_{UVA}	$W \cdot m^{-2}$	10	0.068	33	N/A	100	N/A	
Blue light	B(λ)	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	6250	10000	5240	4000000	N/A	
Blue light, small source	B(λ)	E_B	$W \cdot m^{-2}$	1.0*	N/A	1.0	N/A	400	N/A	
Retinal thermal	R(λ)	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α = 280000	82500	28000/α	N/A	71000/α	N/A	
Retinal thermal, weak visual stimulus**	R(λ)	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	6000/α	N/A	6000/α	N/A	6000/α	N/A	
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	2.03	570	N/A	3200	N/A	
* Small source defined as one with α < 0,011 radian. Averaging field of view at 10000 s is 0,1 radian. ** Involves evaluation of non-GLS source										

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Clause	Requirement + Test	Result – Remark	Verdict

Table 6.1	**Emission limits for risk groups of continuous wave lamps**									P
3) CLU048-1812C4-403Mzab										
Risk	Action spectrum	Symbol	Units	Emission Measurement						
				Exempt		Low risk		Mod risk		
				Limit	Result	Limit	Result	Limit	Result	
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	0.000021	0.003	N/A	0.03	N/A	
Near UV		E_{UVA}	$W \cdot m^{-2}$	10	0.035	33	N/A	100	N/A	
Blue light	B(λ)	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	5640	10000	4590	4000000	N/A	
Blue light, small source	B(λ)	E_B	$W \cdot m^{-2}$	1.0*	N/A	1.0	N/A	400	N/A	
Retinal thermal	R(λ)	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α = 280000	76400	28000/α	N/A	71000/α	N/A	
Retinal thermal, weak visual stimulus**	R(λ)	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	6000/α	N/A	6000/α	N/A	6000/α	N/A	
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0.85	570	N/A	3200	N/A	
* Small source defined as one with α < 0,011 radian. Averaging field of view at 10000 s is 0,1 radian. ** Involves evaluation of non-GLS source										

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Clause	Requirement + Test	Result - Remark	Verdict

ATTACHMENT TO TEST REPORT IEC 62471 **EUROPEAN GROUP DIFFERENCES AND NATIONAL DIFFERENCES** Photobiological safety of lamps and lamps systems	
Differences according to.....:	EN 62471:2008
Attachment Form No.....:	EU_GD_IEC62471A
Attachment Originator .....:	IMQ S.p.A.
Master Attachment .....:	2009-07
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	CENELEC COMMON MODIFICATIONS (EN)		P
4	**EXPOSURE LIMITS**		P
	Contents of the whole Clause 4 of IEC 62471:2006 moved into a new informative Annex ZB		—
	Clause 4 replaced by the following:		P
	Limits of the Artificial Optical Radiation Directive (2006/25/EC) have been applied instead of those fixed in IEC 62471:2006	See appended Table 6.1	P
4.1	General		P
	First paragraph deleted		—

IEC62471A – ATTACHMENT 1			
Clause	Requirement + Test	Result – Remark	Verdict

Table 6.1	**Emission limits for risk groups of continuous wave lamps (based on EU Directive 2006/25/EC)**								P
1) CLU048-1818C4-403Mzab									
Risk	Action spectrum	Symbol	Units	Emission Measurement					
				Exempt		Low risk		Mod risk	
				Limit	Result	Limit	Result	Limit	Result
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	0.000079	-	-	-	-
Near UV		E_{UVA}	$W \cdot m^{-2}$	0.33	0.02	-	-	-	-
Blue light	$B(\lambda)$	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	6310	10000	4970	4000000	N/A
Blue light, small source	$B(\lambda)$	E_B	$W \cdot m^{-2}$	0.01*	N/A	1.0	N/A	400	N/A
Retinal thermal	$R(\lambda)$	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α = 280000	85200	28000/α	N/A	71000/α	N/A
Retinal thermal, weak visual stimulus**	$R(\lambda)$	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	545000 0.0017≤ α ≤ 0.011	N/A				
				6000/α 0.011≤ α ≤ 0.1	N/A				
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0.95	570	N/A	3200	N/A
* Small source defined as one with α < 0,011 radian. Averaging field of view at 10000 s is 0,1 radian. ** Involves evaluation of non-GLS source NOTE The action functions: see Table 4.1 and Table 4.2 The applicable aperture diameters: see 4.2.1 The limitations for the angular subtenses: see 4.2.2 The related measurement condition 5.2.3 and the range of acceptance angles: see Table 5.5.									

IEC62471A – ATTACHMENT 1			
Clause	Requirement + Test	Result – Remark	Verdict

Table 6.1	**Emission limits for risk groups of continuous wave lamps (based on EU Directive 2006/25/EC)**								P
2) CLU058-3618C4-403Mzab									
Risk	Action spectrum	Symbol	Units	Emission Measurement					
				Exempt		Low risk		Mod risk	
				Limit	Result	Limit	Result	Limit	Result
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	0.000003	-	-	-	-
Near UV		E_{UVA}	$W \cdot m^{-2}$	0.33	0.068	-	-	-	-
Blue light	$B(\lambda)$	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	6250	10000	5240	4000000	N/A
Blue light, small source	$B(\lambda)$	E_B	$W \cdot m^{-2}$	0.01*	N/A	1.0	N/A	400	N/A
Retinal thermal	$R(\lambda)$	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α = 280000	82500	28000/α	N/A	71000/α	N/A
Retinal thermal, weak visual stimulus**	$R(\lambda)$	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	545000 0.0017≤ α ≤ 0.011	N/A				
				6000/α 0.011≤ α ≤ 0.1	N/A				
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	2.03	570	N/A	3200	N/A
* Small source defined as one with α < 0,011 radian. Averaging field of view at 10000 s is 0,1 radian. ** Involves evaluation of non-GLS source NOTE The action functions: see Table 4.1 and Table 4.2 The applicable aperture diameters: see 4.2.1 The limitations for the angular subtenses: see 4.2.2 The related measurement condition 5.2.3 and the range of acceptance angles: see Table 5.5.									

IEC62471A – ATTACHMENT 1			
Clause	Requirement + Test	Result – Remark	Verdict

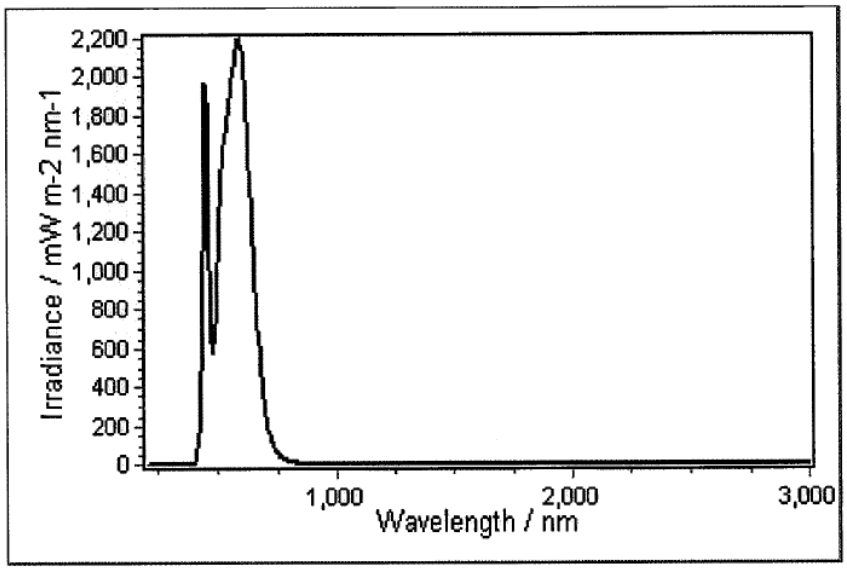
Table 6.1	**Emission limits for risk groups of continuous wave lamps (based on EU Directive 2006/25/EC)**								P
3) CLU048-1812C4-403Mzab									
Risk	Action spectrum	Symbol	Units	Emission Measurement					
				Exempt		Low risk		Mod risk	
				Limit	Result	Limit	Result	Limit	Result
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	0.000021	-	-	-	-
Near UV		E_{UVA}	$W \cdot m^{-2}$	0.33	0.035	-	-	-	-
Blue light	$B(\lambda)$	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	5640	10000	4590	4000000	N/A
Blue light, small source	$B(\lambda)$	E_B	$W \cdot m^{-2}$	0.01*	N/A	1.0	N/A	400	N/A
Retinal thermal	$R(\lambda)$	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α = 280000	76400	28000/α	N/A	71000/α	N/A
Retinal thermal, weak visual stimulus**	$R(\lambda)$	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	545000 0.0017≤ α ≤ 0.011	N/A				
				6000/α 0.011≤ α ≤ 0.1	N/A				
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0.85	570	N/A	3200	N/A
* Small source defined as one with α < 0,011 radian. Averaging field of view at 10000 s is 0,1 radian. ** Involves evaluation of non-GLS source NOTE The action functions: see Table 4.1 and Table 4.2 The applicable aperture diameters: see 4.2.1 The limitations for the angular subtenses: see 4.2.2 The related measurement condition 5.2.3 and the range of acceptance angles: see Table 5.5.									

IEC62471A – ATTACHMENT 2			
Clause	Requirement + Test	Result - Remark	Verdict

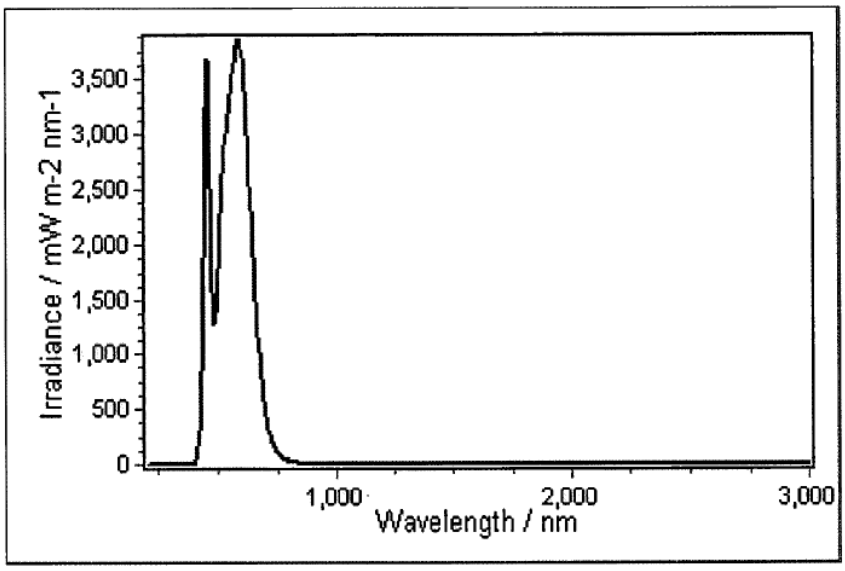
Furthermore remarks:

1. Spectra

Irradiance measurement:
1) CLU048-1818C4-403Mzab



2) CLU058-3618C4-403Mzab



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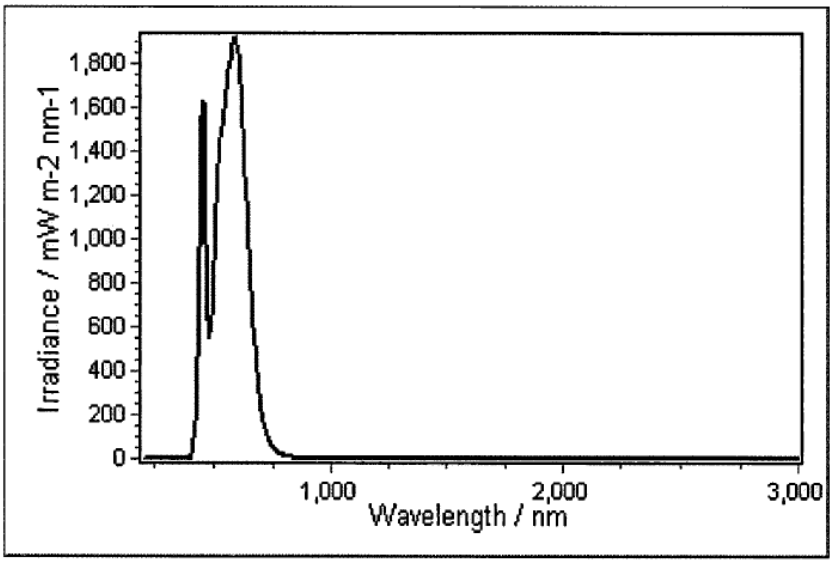
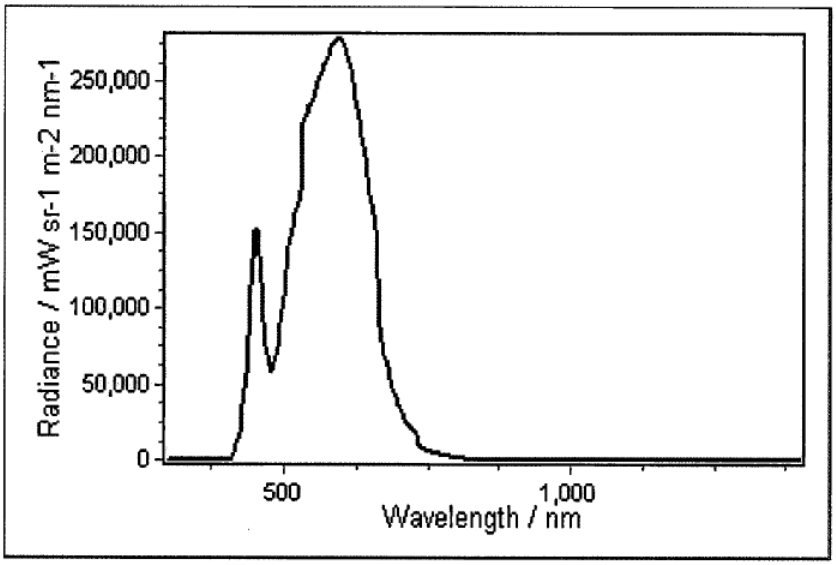
Clause	Requirement + Test	Result - Remark	Verdict

3) CLU048-1812C4-403Mzab

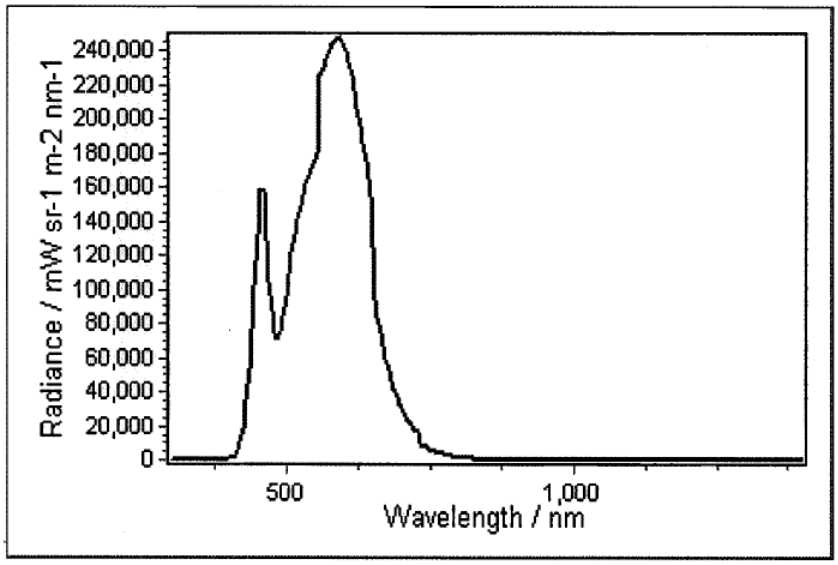


Radiance measurement:
1) CLU048-1818C4-403Mzab



IEC62471A – ATTACHMENT 2			
Clause	Requirement + Test	Result - Remark	Verdict

2) CLU058-3618C4-403Mzab



3) CLU048-1812C4-403Mzab