

**TEST REPORT**  
**IEC 62471**  
**Photobiological safety of lamps and lamp systems**

**Report Reference No.**.....: EED31J001645

**Compiled by (+ signature)**.....: Carrie Lin

**Reviewed by (+ signature)**.....: Torres He

**Approved by (+ signature)**.....: Amo Liu

Lab Supervisor

**Date of issue**.....: Jun. 20, 2017



*Carrie Lin*

*Torres He*

*Amo Liu*

**Testing Laboratory**.....: Centre Testing International Group Co., Ltd.

**Address**.....: Hongwei Industrial Zone, Bao' an 70 District, Shenzhen, Guangdong, China

**Applicant's name**.....: SHENZHEN REFOND OPTOELECTRONICS CO., LTD.

**Address**.....: 8/F, Building 1, 10th Industrial Zone, Tian Liao Community, Gong Ming, Guang Ming New District, Shenzhen, Guangdong, China

**Manufacture's name**.....: SHENZHEN REFOND OPTOELECTRONICS CO., LTD.

**Address**.....: 8/F, Building 1, 10th Industrial Zone, Tian Liao Community, Gong Ming, Guang Ming New District, Shenzhen, Guangdong, China

**Test specification:**

**Standard**.....: IEC 62471:2006

**Test procedure**.....: Test report

**Non-standard test method**.....: N/A

**Test Report Form No.**.....: IEC62471A

**TTRF Originator**.....: CTI

**Master TTRF**.....: Dated 2009-05

**Test item description**.....: LED 3030

**Model/Type reference**.....: 3030

**Ratings**.....: 3,0VDC, 300mA

Check No.: 2457544222

<b>Test item particulars</b> ..... :	
Tested lamp..... :	<input checked="" type="checkbox"/> continuous wave lamps <input type="checkbox"/> pulsed lamps
Tested lamp system..... :	N/A
Lamp classification group..... :	<input checked="" type="checkbox"/> exempt <input type="checkbox"/> risk 1 <input type="checkbox"/> risk 2 <input type="checkbox"/> risk 3
Lamp cap..... :	N/A
Bulb..... :	N/A
Rated of the lamp..... :	See page 1
Furthermore marking on the lamp..... :	N/A
Seasoning of lamps according IEC standard..... :	N/A
Used measurement instrument..... :	Lamps and lamp system Photobiological safety performance test systems
Temperature by measurement..... :	25°C
Information for safety use..... :	N/A
<b>Possible test case verdicts:</b>	
- 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)
<b>Testing</b>	
Date of receipt of test item..... :	Jun. 12, 2017
Date (s) of performance of tests..... :	Jun. 20, 2017
<b>General remarks:</b>	
<p>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.          The tested sample(s) and the sample information are provided by the client.          Throughout this report a comma (point) is used as the decimal separator.          When determining the test conclusion, the Measurement Uncertainty of test has been considered.</p>	
<b>General product information:</b>	
The test current is 300mA DC.	

IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict
<b>4</b>	<b>EXPOSURE LIMITS</b>		P
<b>4.1</b>	<b>General</b>		P
	The exposure limits in this standard is not less than 0.01ms 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 $10^4 \text{ cd}\cdot\text{m}^{-2}$ .	luminance of the source exceeds $10^4 \text{ cd}\cdot\text{m}^{-2}$	P
<b>4.3</b>	<b>Hazard exposure limits</b>		P
<b>4.3.1</b>	<b>Actinic UV hazard exposure limit for the skin and eye</b>		P
	The exposure limit for effective radiant exposure is $30 \text{ J}\cdot\text{m}^{-2}$ within any 8-hour period.		P
	To protect against injury of the eye or skin from ultraviolet radiation exposure produced by a broadband source, the effective integrated spectral irradiance, $E_s$ , of the light source shall not exceed the levels defined by:		P
	$E_s \cdot t = \sum_{200}^{400} \sum_t E_\lambda(\lambda, t) \cdot S_{UV}(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 30 \quad \text{J}\cdot\text{m}^{-2}$		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye or skin shall be computed by:		P
	$t_{\max} = \frac{30}{E_s} \quad \text{s}$		P
<b>4.3.2</b>	<b>Near-UV hazard exposure limit for the eye</b>		P
	For the spectral region 315nm to 400nm (UV-A) the total radiant exposure to the eye shall not exceed $10000 \text{ J}\cdot\text{m}^{-2}$ for exposure times less than 1000s. For exposure times greater than 1000s (approximately 16 minutes) the UV-A irradiance for the unprotected eye, $E_{UVA}$ , shall not exceed $10 \text{ W}\cdot\text{m}^{-2}$ .		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye for times less than 1000s, shall be computed by:		P

IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict
	$t_{\max} \leq \frac{10000}{E_{UVA}} \quad \text{s}$		P
4.3.3	Retinal blue light hazard exposure limit		P
	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, $B(\lambda)$ , i.e., the blue light weighted radiance, $L_B$ , shall not exceed the levels defined by:		P
	$L_B \cdot t = \sum_{300}^{700} \sum_t L_{\lambda}(\lambda, t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 10^6 \quad \text{J} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	for $t \leq 10^4 \text{s}$ $t_{\max} = \frac{10^6}{L_B}$	N/A
	$L_B = \sum_{300}^{700} L_{\lambda} \cdot B(\lambda) \cdot \Delta \lambda \leq 100 \quad \text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	for $t > 10^4 \text{s}$	P
4.3.4	Retinal blue light hazard exposure limit - small source		N/A
	Thus the spectral irradiance at the eye $E_{\lambda}$ , weighted against the blue-light hazard function $B(\lambda)$ (see Table 4.2) shall not exceed the levels defined by:		N/A
	$E_B \cdot t = \sum_{300}^{700} \sum_t E_{\lambda}(\lambda, t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 100 \quad \text{J} \cdot \text{m}^{-2}$		N/A
	$E_B = \sum_{300}^{700} E_{\lambda} \cdot B(\lambda) \cdot \Delta \lambda \leq 1 \quad \text{W} \cdot \text{m}^{-2}$		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, $L_{\lambda}$ , weighted by the burn hazard weighting function $R(\lambda)$ (from Figure 4.2 and Table 4.2), i.e., the burn hazard weighted radiance, shall not exceed the levels defined by:		P
	$L_R = \sum_{380}^{1400} L_{\lambda} \cdot R(\lambda) \cdot \Delta \lambda \leq \frac{50000}{\alpha \cdot t^{0.25}} \quad \text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	( $10\mu\text{s} \leq t \leq 10\text{s}$ )	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 (780nm to 1400nm) radiance, $L_{IR}$ , as viewed by the eye for exposure times greater than 10s shall be limited to:		N/A

IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict

	$L_{IR} = \sum_{780}^{1400} L_{\lambda} \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{6000}{\alpha} \quad \text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	for t > 10s	N/A
4.3.7	Infrared radiation hazard exposure limits for the eye		N/A
	To avoid thermal injury of the cornea and possible delayed effects upon the lens of the eye (cataractogenesis), ocular exposure to infrared radiation, $E_{IR}$ , over the wavelength range 780nm to 3000nm, for times less than 1000s, shall not exceed:		N/A
	$E_{IR} = \sum_{780}^{3000} E_{\lambda} \cdot \Delta\lambda \leq 18000 \cdot t^{-0,75} \quad \text{W} \cdot \text{m}^{-2}$	for t ≤ 1000s	N/A
	For times greater than 1000s the limit becomes:		N/A
	$E_{IR} = \sum_{780}^{3000} E_{\lambda} \cdot \Delta\lambda \leq 100 \quad \text{W} \cdot \text{m}^{-2}$	for t > 1000s	N/A
4.3.8	Thermal hazard exposure limit for the skin		P
	Visible and infrared radiant exposure (380nm to 3000nm) of the skin shall be limited to:		P
	$E_H \cdot t = \sum_{380}^{3000} \sum_t E_{\lambda}(\lambda, t) \cdot \Delta\lambda \leq 20000 \cdot t^{0,25} \quad \text{J} \cdot \text{m}^{-2}$		P

<b>5</b>	<b>MEASUREMENT OF LAMPS AND LAMP SYSTEMS</b>		P
<b>5.1</b>	<b>Measurement conditions</b>		P
	Measurement conditions shall be reported as part of the evaluation against the exposure limits and the assignment of risk classification.		P
5.1.1	Lamp ageing (seasoning)		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 the absence of such standards, the appropriate national standards or manufacturer's recommendations.	Temperature maintained at 25 ± 1°C; Relative humidity maintained to less than 65%; Airflow minimized when measuring	P
5.1.3	Extraneous radiation		P

IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict
	Careful checks should be made to ensure that extraneous sources of radiation and reflections do not add significantly to the measurement results.		P
5.1.4	Lamp operation		P
	Operation of the test lamp shall be provided in accordance with:		P
	- the appropriate IEC lamp standard, or		P
	- the manufacturer's recommendation		N/A
5.1.5	Lamp system operation		N/A
	The power source for operation of the test lamp shall be provided in accordance with:		N/A
	- the appropriate IEC standard, or		N/A
	- the manufacturer's recommendation		N/A
<b>5.2</b>	<b>Measurement procedure</b>		P
5.2.1	Irradiance measurements		P
	Minimum aperture diameter 7mm.		P
	Maximum aperture diameter 50mm.		P
	The measurement shall be made in that position of the beam giving the maximum reading.		P
	The measurement instrument is adequate calibrated.		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 incident radiant power per unit receiving area and per unit solid angle of acceptance averaged over the field of view (FOV) 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.		P
5.2.3	Measurement of source size		P

IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict
	The determination of $\alpha$ , the angle subtended by a source, requires the determination of the 50% emission points of the source.		P
5.2.4	Pulse width measurement for pulsed sources		N/A
	The determination of $\Delta t$ , 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
<b>5.3</b>	<b>Analysis methods</b>		P
5.3.1	Weighting curve interpolations		P
	To standardize interpolated values, use linear interpolation on the log of given values to obtain intermediate points at the wavelength intervals desired.		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.	See Annex C in the norm	P
<b>6</b>	<b>LAMP CLASSIFICATION</b>		P
	For the purposes of this standard it was decided that the values shall be reported as follows:	see table 6.1	P
	- for lamps intended for general lighting service (GLS), see definition 3.11, 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 200mm	299mm, 500 lux	P
	- for all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200mm		N/A
<b>6.1</b>	<b>Continuous wave lamps</b>		P
6.1.1	Exempt group		P
	In the exempt group is the lamp, which does not pose any photobiological hazard. This requirement is met by any lamp that does not pose:		P

IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict
	- an actinic ultraviolet hazard ( $E_s$ ) within 8-hours exposure (30000s), nor		P
	- a near-UV hazard ( $E_{UVA}$ ) within 1000s (about 16min), nor		P
	- a retinal blue-light hazard ( $L_B$ ) within 10000 s (about 2,8 h), nor		P
	- a retinal thermal hazard ( $L_R$ ) within 10s, nor		P
	- an infrared radiation hazard for the eye ( $E_{IR}$ ) within 1000s		P
6.1.2	Risk Group 1 (Low-Risk)		N/A
	In this group is the lamp, which exceeds the limits for the Exempt Group but that does not pose:		N/A
	- an actinic ultraviolet hazard ( $E_s$ ) within 10000s, nor		N/A
	- a near ultraviolet hazard ( $E_{UVA}$ ) within 300s, nor		N/A
	- a retinal blue-light hazard ( $L_B$ ) within 100s, nor		N/A
	- a retinal thermal hazard ( $L_R$ ) within 10s, nor		N/A
	- an infrared radiation hazard for the eye ( $E_{IR}$ ) within 100s		N/A
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard ( $L_{IR}$ ), within 100s are in Risk Group 1.		N/A
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 (Low-Risk), but that does not pose:		N/A
	- an actinic ultraviolet hazard ( $E_s$ ) within 1000s exposure, nor		N/A
	- a near ultraviolet hazard ( $E_{UVA}$ ) within 100s, nor		N/A
	- a retinal blue-light hazard ( $L_B$ ) within 0,25s (aversion response), nor		N/A
	- a retinal thermal hazard ( $L_R$ ) within 0,25s (aversion response), nor		N/A
	- an infrared radiation hazard for the eye ( $E_{IR}$ ) within 10s		N/A



IEC 62471			
Clause	Requirement – Test	Result - Remark	Verdict
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near infrared retinal hazard ( $L_{IR}$ ) within 10s 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 Risk Group 3.		N/A
<b>6.2</b>	<b>Pulsed lamps</b>		N/A
	Pulsed lamp criteria shall apply to a single pulse and to any group of pulses within 0,25s.	Continuous wave lamps	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 dose is below the EL shall be classified as belonging to the Exempt Group		N/A
	- 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

## IEC 62471

Clause	Requirement – Test	Result - Remark	Verdict
--------	--------------------	-----------------	---------

<b>Table 4.1</b>		Spectral weighting function for assessing ultraviolet hazards for skin and eye		--
Wavelength <sup>1</sup> $\lambda$ , nm	UV hazard function $S_{UV}(\lambda)$	Wavelength $\lambda$ , 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	
2,54*	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	

<sup>1</sup> Wavelengths chosen are representative: other values should be obtained by logarithmic interpolation at intermediate wavelengths.

\* Emission lines of a mercury discharge spectrum.

## IEC 62471

Clause	Requirement – Test	Result - Remark	Verdict
--------	--------------------	-----------------	---------

<b>Table 4.2</b>		Spectral weighting functions for assessing retinal hazards from broadband optical sources	--
<b>Wavelength nm</b>	<b>Blue-light hazard function B(<math>\lambda</math>)</b>	<b>Burn hazard function R(<math>\lambda</math>)</b>	
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	
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	--	$0,2 \times 10^{0,02(1150-\lambda)}$	
1200-1400	--	0,02	

## IEC 62471

Clause	Requirement – Test	Result - Remark	Verdict
--------	--------------------	-----------------	---------

Table 5.4 Summary of the ELs for the surface of the skin or cornea (irradiance based values)					--
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	$\leq 1000$ $> 1000$	1,4 (80)	10000/t 10
Blue-light small source	$E_B = \sum E_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	300 – 700	$\leq 100$ $> 100$	< 0,011	100/t 1,0
Eye IR	$E_{IR} = \sum E_\lambda \cdot \Delta\lambda$	780 – 3000	$\leq 1000$ $> 1000$	1,4 (80)	18000/t <sup>0.75</sup> 100
Skin thermal	$E_H = \sum E_\lambda \cdot \Delta\lambda$	380 – 3000	< 10	2π sr	20000/t <sup>0.75</sup>

Table 5.5 Summary of the ELs for the retina (radiance based values)					--
Hazard Name	Relevant equation	Wavelength range nm	Exposure duration sec	Field of view radians	EL in terms of constant irradiance $W \cdot m^{-2} \cdot sr^{-1}$
Blue light	$L_B = \sum L_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	300 – 700	0,25 – 10 10-100 100-10000 $\geq 10000$	$0,011 \cdot \sqrt{(t/10)}$ 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

## IEC 62471

Clause	Requirement – Test	Result - Remark	Verdict
--------	--------------------	-----------------	---------

Table 6.1		Emission limits for risk groups of continuous wave lamps							P
Risk	Action spectrum	Symbol	Units	Emission limits					
				Exempt	Result	Low risk	Result	Mod risk	Result
Actinic UV	$S_{UV}(\lambda)$	$E_s$	$W \cdot m^{-2}$	0,001	2,895E-08	0,003	6,395E-06	0,03	--
Near UV	--	$E_{UVA}$	$W \cdot m^{-2}$	10	6,628E-04	33	1,020E-03	100	--
Blue light	$B(\lambda)$	$L_B$	$W \cdot m^{-2} \cdot sr^{-1}$	100	8,203E+01	10000	8,412E+03	4000000	--
Blue light, small source	$B(\lambda)$	$E_B$	$W \cdot m^{-2}$	1,0*	--	1,0	--	400	--
Retinal thermal	$R(\lambda)$	$L_R$	$W \cdot m^{-2} \cdot sr^{-1}$	28000/ $\alpha$	8,080E+04	28000/ $\alpha$	9,696E+04	71000/ $\alpha$	--
Retinal thermal, weak visual stimulus**	$R(\lambda)$	$L_{IR}$	$W \cdot m^{-2} \cdot sr^{-1}$	6000/ $\alpha$	0,000E+00	6000/ $\alpha$	7,793E+00	6000/ $\alpha$	--
IR radiation, eye	--	$E_{IR}$	$W \cdot m^{-2}$	100	0,000E+00	570	0,000E+00	3200	--

\* Small source defined as one with  $\alpha < 0,011$  radian. Averaging field of view at 10000 s is 0,1 radian.

\*\* Involves evaluation of non-GLS source

NOTE Angular subtense of apparent source:  $\alpha = 6,58$  mrad.

Photos Document

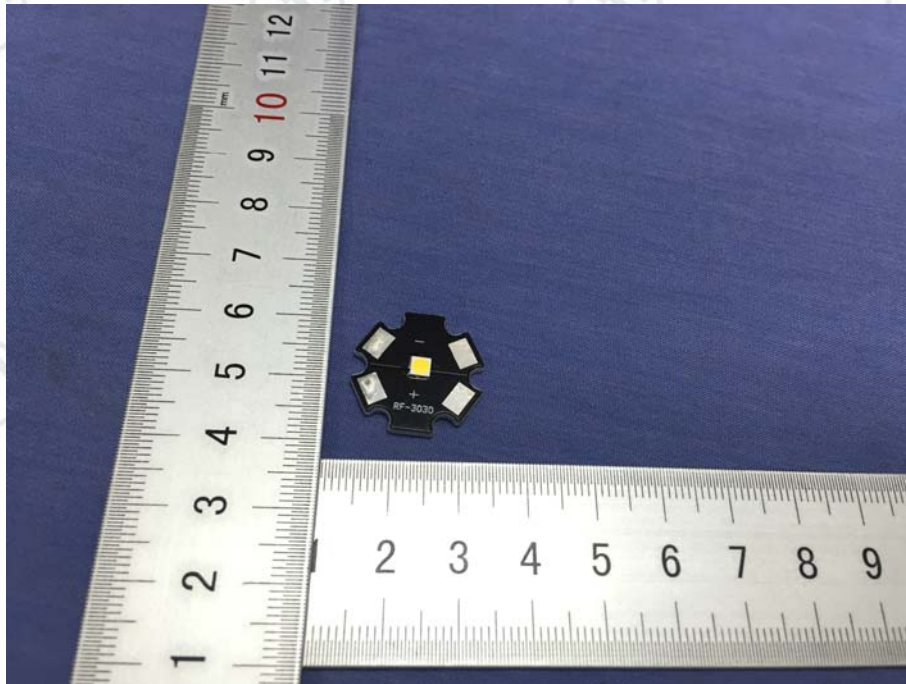


Fig. 1 - Front view of the sample

**\*\*\* End of Report \*\*\***

The test report is effective only with both signature and specialized stamp. The result(s) shown in this report refer only to the sample(s) tested. Without written approval of CTI, this report can't be reproduced except in full.