

LUXEON[®] Rebel

Photobiological Safety Report

Introduction

Light Emitting Diodes (LEDs) are incoherent, broad-band optical light sources that span the visible wavelength from 400nm to 780nm. Lasers, unlike LEDs, are coherent, monochromatic light sources. In the past, LEDs were included in the laser eye safety standards (IEC 60825), but with new LED-based applications, LEDs are now included in the Photobiological Safety of Lamps and Lamp Systems, CEI/IEC 62471, 2006-07 lamp standard.

Philips Lumileds does not recommend staring directly into any LED lamp or luminaire.

Table of Contents

Photobiological Safety Standards.....3

Measurement and Sample Preparation3

Test Results4

Spectral Result..... 10

Explanation of Risk Groups 11

Photobiological Safety Standards

The European standard, IEC 62471:2006 for Photobiological Safety of Lamps and Lamp Systems, is used to evaluate LED photobiological safety. The scope of this standard applies to lamps and lamp systems safety, including the safety of luminaires. The following information is provided by Philips Lumileds to assist manufacturers who use LUXEON LEDs in their end products. The information in this report can be used to help manufacturers evaluate component level safety and provide manufacturers some indication of the risk factor classification of standalone LUXEON LED emitters. It is still the lamp system and luminaire manufacturer's responsibility to ensure that the final product is fully assessed for photobiological safety as required by local or national regulatory requirements.

In the USA, the ANSI/IESNA RP-27 standard, parts 1 to 3 are used to evaluate the photobiological safety of lamps and lamps systems. The IEC 62471:2006 standard was based largely on the ANSI/IESNA RP-27 standard.

LUXEON Rebel products were evaluated in this report according to the IEC 62471:2006 standard.

Measurement and Sample Preparation

In assessing the safety of a LUXEON LED, it is necessary to determine the spectral distribution of the LEDs at maximum irradiance ($\text{W}\cdot\text{m}^{-2}$) or radiance ($\text{W}\cdot\text{m}^{-2}\cdot\text{sr}^{-1}$). The wavelength measurement must cover 200 nm to 3000 nm.

Continuous wave (DC) emission was tested when the LUXEON Rebel device under test was operating at its maximum permissible current (according to Philips Lumileds' product specification) and according to the IEC 62471 guidelines.

Philips Lumileds commissioned an independent accredited laboratory (KEMA Quality B.V., Netherlands) to perform the measurement analysis and to issue IEC 62471 standards reports.

Every product in the LUXEON Rebel White product range (as of January 2011) is covered by the safety ratings presented in this Application Brief. Where two or more LUXEON Rebel White parts share similar optical characteristics in respect of eye safety, Philips Lumileds has submitted for testing the part that presents the greatest hazard to users; the other parts with the same optical characteristics can therefore safely be assumed to merit an IEC 62471 risk rating that is no higher than that of the most hazardous part.

Test Results for LUXEON Rebel ES LXML-PWC2

Table 1. LUXEON Rebel ES LXML-PWC2* LED Samples Tested by Philips Lumileds (for information only)

LED Type	LXML-PWC2*
Luminous flux at 350 mA, 25°C	121 lm
Radiant flux at 350 mA, 25°C	372 mW
1931 CIE color points at 350 mA, 25°C	(0.3267, 0.3427)
CCT 350 mA, 25°C	5754 K

* The optical output of the LXML-PWC2 part is considered to be more hazardous than that of the other LUXEON Rebel parts with similar optical characteristics. This classification is therefore also valid for the LXML-PW31, LXML-PW21, LXML-PW11 and LXML-PWC1-xxxx (where xxxx refers to minimum flux. See datasheet DS64 for more detail.)

Testing Summary Result Based on IEC 62471:2006 Testing

Testing Laboratory: KEMA Quality B.V., Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.
 Date of issue: 26th Oct 2010
 Report Reference No.: 2138821-QUA/PHO 10-164-02A
 Distance to detector: 200 mm
 Small Source: YES
 Risk Group Classification: Risk Group 2 (Moderate Risk)

Table 2. Risk Group Categories for 1500 mA Continuous Wave (DC)

RISK Factor	RISK Group Result
Actinic UV, E_s (200 – 400 nm)	Exempt
Near UV, E_{UVA} (315 – 400 nm)	Exempt
Blue Light, L_B (300 – 700 nm)	Exempt (N/A)
Blue Light Small Source, E_B (300 – 700 nm)	Risk Group 2 (Moderate Risk)
Retinal Thermal, L_R (380 – 1400 nm)	Exempt
Retinal Thermal Weak Stimulus, L_{IR} (780 – 1400 nm)	Exempt (N/A)
IR Radiation, Eye, E_{IR} (780 – 3000 nm)	Exempt

This sample is categorized as Risk Group 2 based on the measurement of blue light irradiance (EB). The maximum permissible exposure time is 44 seconds (when the user is looking at the light source). This applies in the test conditions described above, in which the sample unit was operated at 1500 mA at a distance of 200 mm from the detector.

Test Results for LUXEON Rebel ES LXML-PWN2

Table 3. LUXEON Rebel ES LXML-PWN2 LED Samples Tested by Philips Lumileds (for information only)

LED Type	LXML-PWN2
Luminous flux at 350 mA, 25°C	118 lm
Radiant flux at 350 mA, 25°C	340 mW
1931 CIE color points at 350 mA, 25°C	(0.3950, 0.4052)
CCT at 350 mA, 25°C	3843 K

Testing Summary Result Based on IEC 62471:2006 Testing

Testing Laboratory:	KEMA Quality B.V., Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.
Date of issue:	26th Oct 2010
Report Reference No.:	2138821-QUA/PHO 10-164-01A
Distance to detector:	200 mm
Small Source:	YES
Risk Group Classification:	Risk Group 2 (Moderate Risk)

Table 4. Risk Group Categories for 1500 mA Continuous Wave (DC) Testing

RISK Factor	RISK Group Result
Actinic UV, E_s (200 – 400 nm)	Exempt
Near UV, E_{UVA} (315 – 400 nm)	Exempt
Blue Light, L_b (300 – 700 nm)	Exempt (N/A)
Blue Light Small Source, E_b (300 – 700 nm)	Risk Group 2 (Moderate Risk)
Retinal Thermal, L_R (380 – 1400 nm)	Exempt
Retinal Thermal Weak Stimulus, L_{IR} (780 – 1400 nm)	Exempt (N/A)
IR Radiation, Eye, E_{IR} (780 – 3000 nm)	Exempt

This sample is categorized as Risk Group 2 based on the measurement of blue light irradiance (EB). The maximum permissible exposure time is 81 seconds (when the user is looking at the light source). This applies to the test conditions described above, in which the sample unit was operated at 1500 mA at a distance of 200 mm from detector.

Test Results for LUXEON Rebel LXML-PWNI*

Table 5. LUXEON Rebel LXML-PWNI LED Samples Tested by Philips Lumileds (for information only)

LED Type	LXML-PWNI*
Luminous flux at 350 mA, 25°C	117 lm
Radiant flux at 350 mA, 25°C	344 mW
1931 CIE color points at 350 mA, 25°C	(0.3816, 0.3873)
CCT at 350 mA, 25°C	4044 K

* The optical output of the LXML-PWNI part is considered to be more hazardous than that of the other LUXEON Rebel parts with similar optical characteristics. This classification is therefore also valid for the LXML-PW51 and LXML-PWNI-xxxx parts (where xxxx refers to minimum flux. See datasheets DS63 and DS64 for more details).

Testing Summary Result Based on IEC 62471:2006 Testing

Testing Laboratory: KEMA Quality B.V., Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.
 Date of issue: 26th Oct 2010
 Report Reference No.: 2138821-QUA/PHO 10-164-06A
 Distance to detector: 200 mm
 Small Source: YES
 Risk Group Classification: Risk Group 2 (Moderate Risk)

Table 6. Risk Group Categories for 700 mA Continuous Wave (DC) Testing

RISK Factor	RISK Group Result
Actinic UV, E_s (200 – 400 nm)	Exempt
Near UV, E_{UVA} (315 – 400 nm)	Exempt
Blue Light, L_B (300 – 700 nm)	Exempt (N/A)
Blue Light Small Source, E_B (300 – 700 nm)	Risk Group 2 (Moderate Risk)
Retinal Thermal, L_R (380 – 1400 nm)	Exempt
Retinal Thermal Weak Stimulus, L_{IR} (780 – 1400 nm)	Exempt (N/A)
IR Radiation, Eye, E_{IR} (780 – 3000 nm)	Exempt

This sample is categorized as Risk Group 2 based on the measurement of blue light irradiance (EB). The maximum permissible exposure time is 98 seconds (when the user is looking at the light source). This applies to the test conditions described above, in which the sample unit was operated at 700 mA at a distance of 200 mm from the detector.

Test Results for LUXEON Rebel LXM3-PW5I*

Table 7. LUXEON Rebel LXM3-PW5I LED Samples Tested by Philips Lumileds (for information only)

LED Type	LXM3-PW5I*
Luminous flux at 350 mA, 25°C	77 lm
Radiant flux at 350 mA, 25°C	249 mW
1931 CIE color points at 350 mA, 25°C	(0.3786, 0.3759)
CCT at 350 mA, 25°C	4045 K

* The optical output of the LXM3-PW5I part is considered to be more hazardous than that of the LXM3-PW6I, which has similar optical characteristics. This classification is therefore also valid for the LXM3-PW6I.

Testing Summary Result Based on IEC 62471:2006 Testing

Testing Laboratory: KEMA Quality B.V., Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.
 Date of issue: 26th Oct 2010
 Report Reference No.: 2138821-QUA/PHO 10-164-05A
 Distance to detector: 200 mm
 Small Source: YES
 Risk Group Classification: Exempt

Table 8. Risk Group Categories for 700 mA Continuous Wave (DC) Testing

RISK Factor	RISK Group Result
Actinic UV, E_s (200 – 400 nm)	Exempt
Near UV, E_{UVA} (315 – 400 nm)	Exempt
Blue Light, L_b (300 – 700 nm)	Exempt (N/A)
Blue Light Small Source, E_b (300 – 700 nm)	Exempt
Retinal Thermal, L_R (380 – 1400 nm)	Exempt
Retinal Thermal Weak Stimulus, L_{IR} (780 – 1400 nm)	Exempt (N/A)
IR Radiation, Eye, E_{IR} (780 – 3000 nm)	Exempt

Test Results for LUXEON Rebel LXM8-PW30*

Table 9. LUXEON Rebel LXM8-PW30 LED Samples Tested by Philips Lumileds (for information only)

LED Type	LXM8-PW30*
Luminous flux at 350 mA, 25°C	90 lm
Radiant flux at 350 mA, 25°C	282 mW
1931 CIE color points at 350 mA, 25°C	(0.4336, 0.4017)
CCT at 350 mA, 25°C	3038 K

* The optical output of the LXM8-PW30 part is considered to be more hazardous than that of the other LUXEON Rebel parts with similar optical characteristics. This classification is therefore also valid for the LXM3-PW71, LXML-PW71 and LXML-PWW1.

Testing Summary Result Based on IEC 62471:2006 Testing

Testing Laboratory: KEMA Quality B.V., Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.
 Date of issue: 26th Oct 2010
 Report Reference No.: 2138821-QUA/PHO 10-164-03A
 Distance to detector: 200 mm
 Small Source: YES
 Risk Group Classification: Exempt

Table 10. Risk Group Categories for 700 mA Continuous Wave (DC) Testing

RISK Factor	RISK Group Result
Actinic UV, E_s (200 – 400 nm)	Exempt
Near UV, E_{UVA} (315 – 400 nm)	Exempt
Blue Light, L_b (300 – 700 nm)	Exempt (N/A)
Blue Light Small Source, E_b (300 – 700 nm)	Exempt
Retinal Thermal, L_R (380 – 1400 nm)	Exempt
Retinal Thermal Weak Stimulus, L_{IR} (780 – 1400 nm)	Exempt (N/A)
IR Radiation, Eye, E_{IR} (780 – 3000 nm)	Exempt

Test Results for LUXEON Rebel LXM8-PW27*

Table 11. LUXEON Rebel LXM8-PW27 LED Samples Tested by Philips Lumileds (for information only)

LED Type	LXM8-PW27*
Luminous flux at 350 mA, 25°C	80 lm
Radiant flux at 350 mA, 25°C	254 mW
1931 CIE color points at 350 mA, 25°C	(0.4597, 0.4106)
CCT at 350 mA, 25°C	2702 K

* The optical output of the LXM8-PW27 part is considered to be more hazardous than that of the LXM3-PW81, which has similar optical characteristics. This classification is therefore also valid for the LXM3-PW81 part.

Testing Summary Result Based on IEC 62471:2006 Testing

Testing Laboratory: KEMA Quality B.V., Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.
 Date of issue: 26th Oct 2010
 Report Reference No.: 2138821-QUA/PHO 10-164-04A
 Distance to detector: 200 mm
 Small Source: YES
 Risk Group Classification: Exempt

Table 12. Risk Group Categories for 700 mA Continuous Wave (DC) Testing

RISK Factor	RISK Group Result
Actinic UV, E_s (200 – 400 nm)	Exempt
Near UV, E_{UVA} (315 – 400 nm)	Exempt
Blue Light, L_b (300 – 700 nm)	Exempt (N/A)
Blue Light Small Source, E_b (300 – 700 nm)	Exempt
Retinal Thermal, L_R (380 – 1400 nm)	Exempt
Retinal Thermal Weak Stimulus, L_{IR} (780 – 1400 nm)	Exempt (N/A)
IR Radiation, Eye, E_{IR} (780 – 3000 nm)	Exempt

Spectral Result

The chart below (for information purposes only) from Philips Lumileds shows the spectral power distribution of the LEDs that were submitted to KEMA for testing.

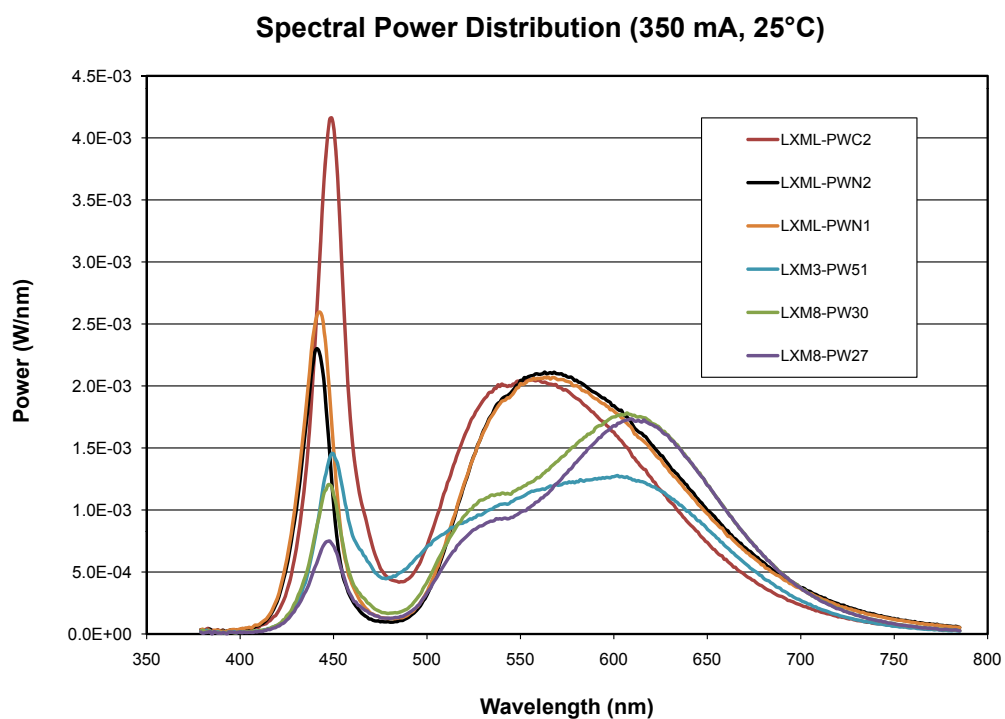


Figure I. Spectral Power

Explanation of Risk Groups

The following IEC table¹ describes the control measures taken for each hazard type by risk group factor during lamp and lamps systems manufacturing.

Table 13. Explanation of Labelling Information and Guidance on Control Measures

Hazard	Exempt Risk	Risk Group 1	Risk Group 2	Risk Group 3
Ultraviolet hazard 200 nm to 400 nm	Not required	Minimize exposure to eyes or skin. Use appropriate shielding.	Eye or skin irritation may result from exposure. Use appropriate shielding.	Avoid eye and skin exposure to unshielded product.
Retinal blue light hazard 300 nm to 400 nm	Not required	Not required	Do not stare at operating lamp. May be harmful to the eyes.	Do not look at operating lamp. Eye injury may result.
Retinal blue light or thermal hazard 400 nm to 780 nm	Not required	Not required	Do not stare at operating lamp. May be harmful to the eyes.	Do not look at operating lamp. Eye injury may result.
Cornea/lens infrared hazard 780 nm to 3000 nm	Not required	Use appropriate shielding or eye protection.	Avoid eye exposure. Use appropriate shielding or eye protection.	Avoid eye exposure. Use appropriate shielding or eye protection.
Retinal thermal hazard, weak visual stimulus 780 nm to 1400 nm	Not required	Do not stare at operating lamp.	Do not stare at operating lamp.	Do not look at operating lamp.

Notes:

1. International Electrotechnical Commission, IEC 62471-2/TR (1st edition, 2009), Table 2 page 17.

Company Information

Philips Lumileds is a leading provider of power LEDs for everyday lighting applications. The company's records for light output, efficacy and thermal management are direct results of the ongoing commitment to advancing solid-state lighting technology and enabling lighting solutions that are more environmentally friendly, help reduce CO₂ emissions and reduce the need for power plant expansion. Philips Lumileds LUXEON® LEDs are enabling never before possible applications in outdoor lighting, shop lighting, home lighting, automotive lighting, display and digital imaging.

Philips Lumileds is a fully integrated supplier, producing core LED material in all three base colors, (Red, Green, Blue) and white. Philips Lumileds has R&D centers in San Jose, California and in the Netherlands, and production capabilities in San Jose, Singapore and Penang, Malaysia. Founded in 1999, Philips Lumileds is the high flux LED technology leader and is dedicated to bridging the gap between solid-state technology and the lighting world. More information about the company's LUXEON LED products and solid-state lighting technologies can be found at www.philipslumileds.com.

Disclaimer

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