

LUXEON Rebel ES

Leading lumen output

Technical Datasheet DS61

L U X E N[®]
never before possible



LUXEON[®] Rebel ES

Energy Saving

Introduction

LUXEON[®] Rebel ES delivers high lumen performance and efficacy to address the world's need for more efficient lighting solutions that:

- require high lumen output
- deliver high quality light that people appreciate
- cost less to own
- deliver over 200 lumens at 700 mA
- are REACH and RoHS Compliant
- use less electricity to operate while achieving the desired lumen output.

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General Product Information

Product Nomenclature

LUXEON Rebel ES is tested and binned at 700 mA, with current pulse duration of 20 ms. All characteristic charts where the thermal pad is kept at constant temperature (25°C typically) are measured with current pulse duration of 20 ms. Under these conditions, junction temperature and thermal pad temperature are the same.

The part number designation is explained as follows:

L X M L - A B C B

Where:

- A — designates radiation pattern (value P for Lambertian)
- B — designates color (W for White)
- C — designates color variant (C for Cool-White, N for Neutral-White)
- D — designates test current (value 2 for 700 mA)

Therefore products tested and binned at 700 mA follow the part numbering scheme:

L X M L - P W × 2

Average Lumen Maintenance Characteristics

Lumen maintenance for solid state lighting devices (LEDs) is typically defined in terms of the percentage of initial light output remaining after a specified period of time. Philips Lumileds projects that LUXEON Rebel ES products will deliver, on average, 70% lumen maintenance (L70) at 50,000 hours of operation at a forward current of 1000 mA. This projection is based on constant current operation with junction temperature maintained at or below 135°C. This performance is based on independent test data, Philips Lumileds historical data from tests run on similar material systems, and internal LUXEON reliability testing. Observation of design limits included in this data sheet is required in order to achieve this projected lumen maintenance.

Environmental Compliance

Philips Lumileds is committed to providing environmentally friendly products to the solid-state lighting market. LUXEON Rebel ES is compliant to the European Union directives on the restriction of hazardous substances in electronic equipment, namely the RoHS and REACH directives. Philips Lumileds will not intentionally add the following restricted materials to the LUXEON Rebel ES: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

Luminous Flux

Luminous Flux Characteristics for LUXEON Rebel ES Thermal Pad Temperature = 25°C

Table 1.

Performance at Test Current			
Color	Part Number	Minimum Luminous Flux (lm) ^{[1] [2]}	Test Current (mA)
Neutral-White	LXML-PWN2	200	700
Cool-White	LXML-PWC2	200	700

Notes for Table 1:

1. Minimum luminous flux performance within published operating conditions. Philips Lumileds maintains a tolerance of $\pm 6.5\%$ on luminous flux measurements.
2. LUXEON Rebel ES products with even higher luminous flux levels will become available in the future. Please consult Philips Lumileds or Future Electronics for more information.

Typical Luminous Flux Characteristics at 350 mA, 700 mA, and 1000 mA for LUXEON Rebel ES, Thermal Pad Temperature = 25°C

Table 2.

Color	Typical Luminous Flux (lm) @ 350 mA Forward Current	Typical Luminous Flux (lm) @ 700 mA Forward Current	Typical Luminous Flux (lm) @ 1000 mA Forward Current
Neutral-White	125	220	300
Cool-White	130	225	310

Optical Characteristics

LUXEON Rebel ES at Test Current ^[1] Thermal Pad Temperature = 25°C

Table 3.

Color	Color Temperature ^[2] CCT			Typical Total Included Angle ^[4] (degrees) $\theta_{0.90V}$	Typical Viewing Angle ^[5] (degrees) 2 θ 1/2
	Min.	Typ.	Max.		
Neutral-White	3500 K	4100 K	4500 K	160	120
Cool-White	4500 K	5650 K	10000 K	160	120

Notes for Table 3:

1. Test current is 700 mA for all LXML-PWx2 products.
2. CCT \pm 5% tester tolerance.
3. Minimum CRI (Color Rendering Index) for Cool-White is 60, Neutral-White is 60. Typical CRI for Neutral-White is 65, Cool-White is 70.
4. Total angle at which 90% of total luminous flux is captured.
5. Viewing angle is the off axis angle from lamp centerline where the luminous intensity is $\frac{1}{2}$ of the peak value.
6. All white products are built with Indium Gallium Nitride (InGaN).

Electrical Characteristics

Electrical Characteristics at 700 mA for LUXEON Rebel ES Thermal Pad Temperature = 25°C

Table 4.

Color	Forward Voltage V_f [1] (V)			Typical Temperature Coefficient of Forward Voltage [2] (mV/°C) $\Delta V_f / \Delta T_j$	Typical Thermal Resistance Junction to Thermal Pad (°C/W) $R\theta_{j-c}$
	Min.	Typ.	Max.		
Neutral-White	2.5	3.0	3.5	-2.0 to -4.0	6
Cool-White	2.5	3.0	3.5	-2.0 to -4.0	6

Notes for Table 4:

1. Philips Lumileds maintains a tolerance of $\pm 0.06V$ on forward voltage measurements.
2. Measured between $25^\circ C = T_j = 110^\circ C$ at $I_f = 700$ mA.

* Dynamic resistance is the inverse of the slope in linear forward voltage model for LEDs. See Figure 6.

Typical Electrical Characteristics at 350 mA, 700 mA, and 1000 mA for LUXEON Rebel ES, Thermal Pad Temperature = 25°C

Table 5.

Color	Typical Forward Voltage V_f (V) @ 350 mA Forward Current	Typical Forward Voltage V_f (V) @ 700 mA Forward Current	Typical Forward Voltage V_f (V) @ 1000 mA Forward Current
Neutral-White	2.85	3.00	3.1
Cool-White	2.85	3.00	3.1

Notes for Table 5:

1. Philips Lumileds maintains a tolerance of $\pm 0.06V$ on forward voltage measurements.

Absolute Maximum Ratings

Table 6.

Parameter	Cool-White / Neutral-White
DC Forward Current (mA)	1500
Peak Pulsed Forward Current (mA)	1500
Average Forward Current (mA)	1500
ESD Sensitivity	< 8000V Human Body Model (HBM) Class 3A JESD22-A114-E < 400V Machine Model (MM) Class B JESD22-A115-B
LED Junction Temperature ^[1]	150°C
Operating Case Temperature at 350 mA	-40°C - 135°C
Storage Temperature	-40°C - 135°C
Soldering Temperature	JEDEC 020c 260°C
Allowable Reflow Cycles	3
Autoclave Conditions	121°C at 2 ATM 100% Relative Humidity for 96 Hours Maximum
Reverse Voltage (Vr)	See Note 2

Notes for Table 6:

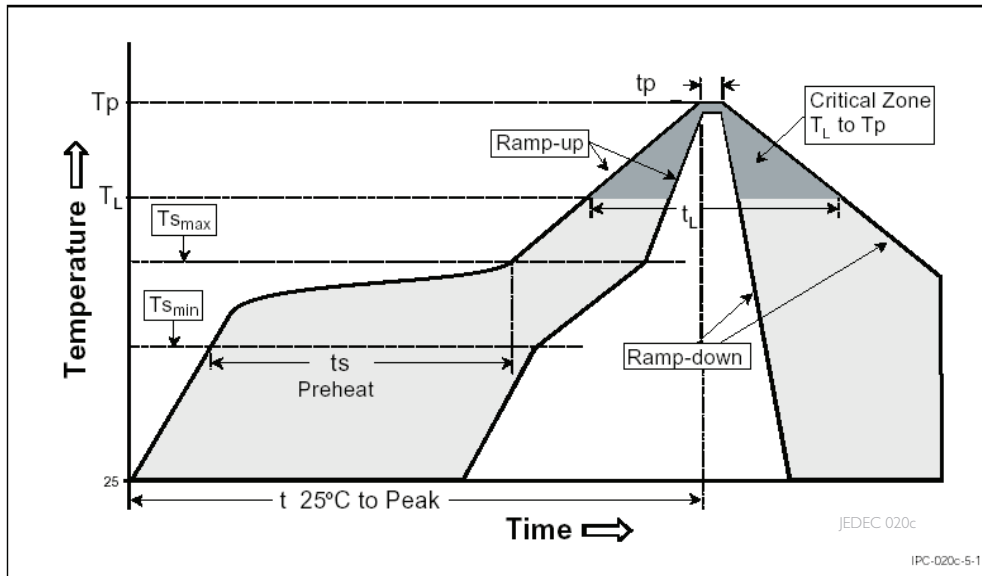
1. Proper current derating must be observed to maintain junction temperature below the maximum.
2. LUXEON Rebel ES LEDs are not designed to be driven in reverse bias.

JEDEC Moisture Sensitivity

Table 7.

Level	Floor Life		Soak Requirements	
	Time	Conditions	Standard	Standard
I	unlimited	≤ 30°C / 85% RH	168h + 5 / -0	85°C / 85% RH

Reflow Soldering Characteristics



Temperature Profile for Table 8.

Table 8.

Profile Feature	Lead Free Assembly
Average Ramp-Up Rate ($T_{s_{max}}$ to T_p)	3°C / second max
Preheat Temperature Min ($T_{s_{min}}$)	150°C
Preheat Temperature Max ($T_{s_{max}}$)	200°C
Preheat Time ($t_{s_{min}}$ to $t_{s_{max}}$)	60 - 180 seconds
Temperature (T_L)	217°C
Time Maintained Above Temperature (T_L)	60 - 150 seconds
Peak / Classification Temperature (T_p)	260°C
Time Within 5°C of Actual Peak Temperature (t_p)	20 - 40 seconds
Ramp - Down Rate	6°C / second max
Time 25°C to Peak Temperature	8 minutes max

Notes for Table 8:

- I. All temperatures refer to the application Printed Circuit Board (PCB), measured on the surface adjacent to the package body.

Mechanical Dimensions

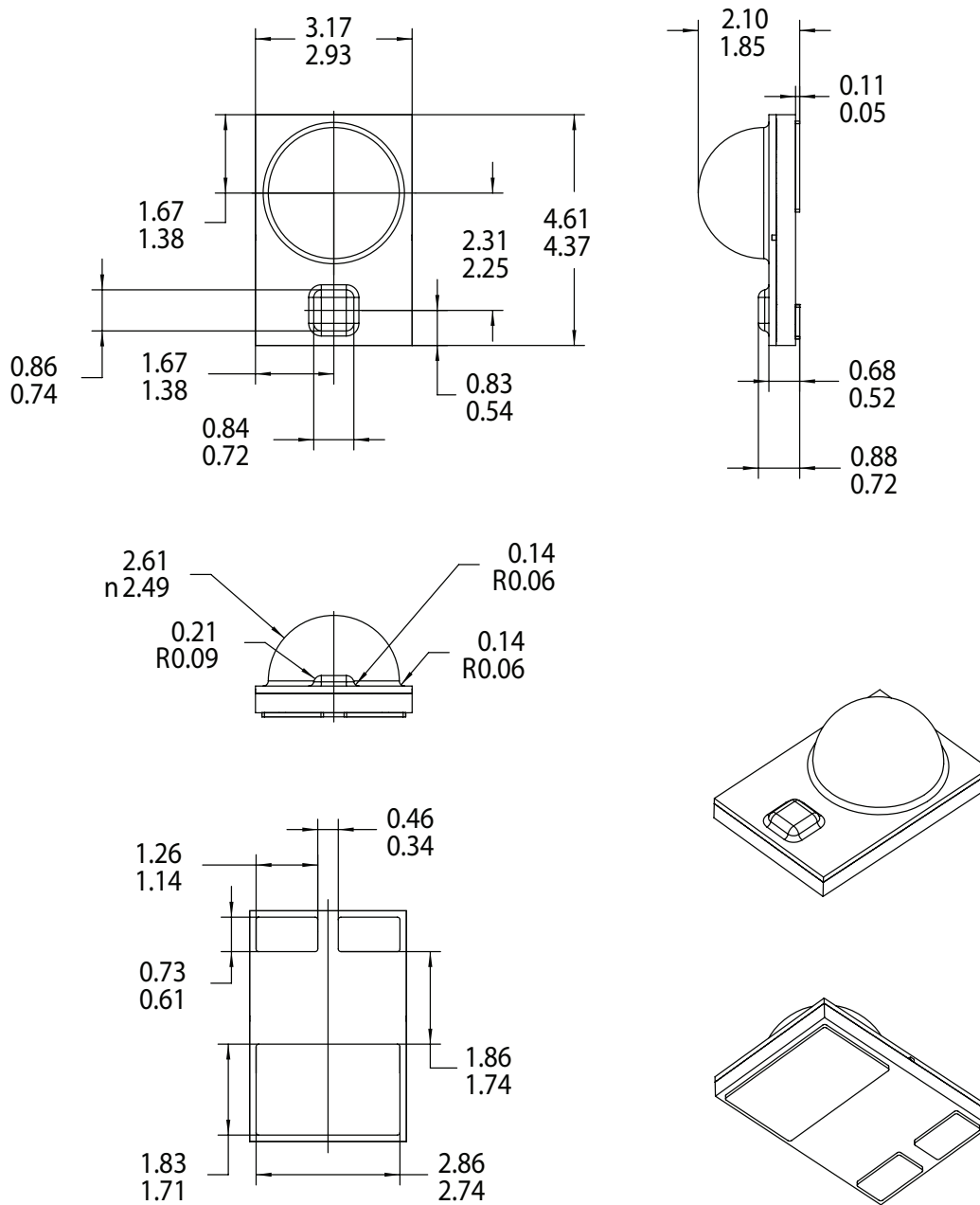


Figure 1. Package outline drawing.

Notes for Figure 1:

1. Care should be taken to avoid damage to the lens or the interior of the device that can be damaged by excessive force to the lens.
2. Drawings not to scale.
3. All dimensions are in millimeters.
4. The Thermal Pad is electrically isolated from the Anode and Cathode contact pads.

Pad Configuration

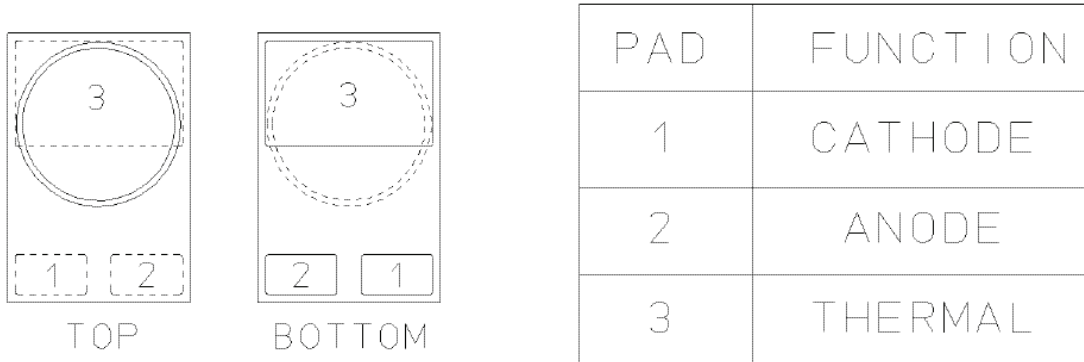


Figure 2. Pad configuration.

Note for Figure 2:

1. The Thermal Pad is electrically isolated from the Anode and Cathode contact pads.

Solder Pad Design

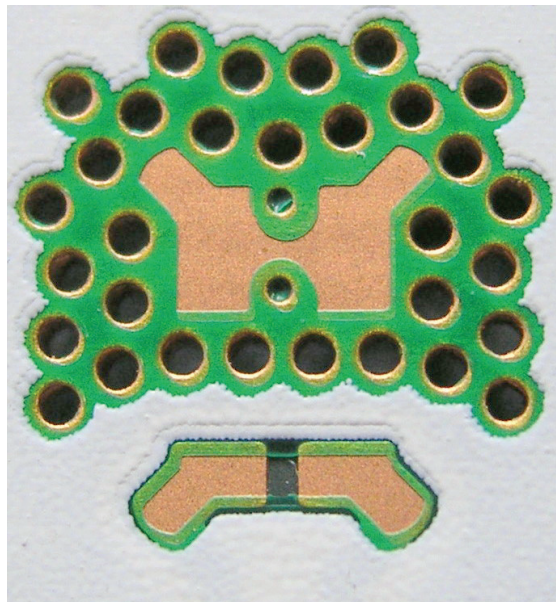


Figure 3. Solder pad layout.

Note for Figure 3:

The photograph below shows the recommended LUXEON Rebel ES layout on Printed Circuit Board (PCB). This design easily achieves a thermal resistance of 7K/W.

Application Brief AB32 provides extensive details for this layout. In addition, the .dwg files are available at www.luxeon.com.

Relative Spectral Distribution vs. Wavelength Characteristics

Neutral-White at Test Current, Thermal Pad Temperature = 25°C

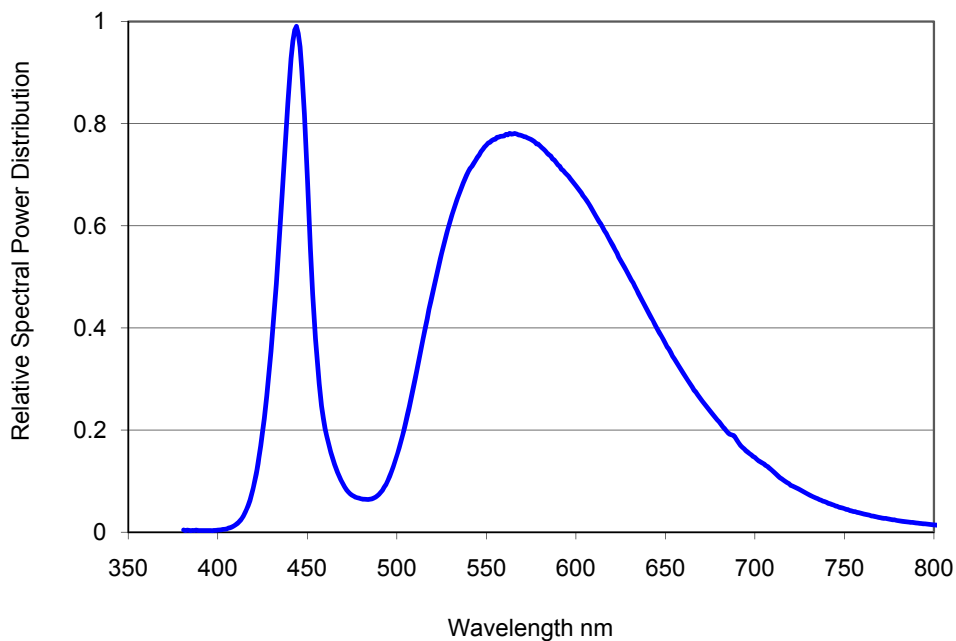


Figure 4a. Neutral-White color spectrum of typical CCT part, integrated measurement.

Cool-White at Test Current, Thermal Pad Temperature = 25°C

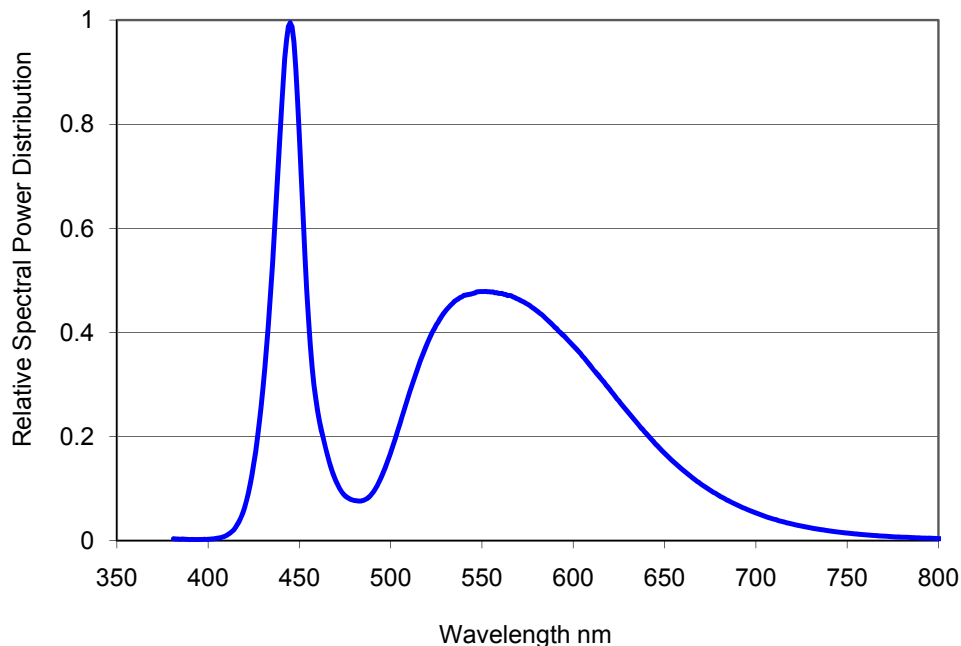


Figure 4b. Cool-White color spectrum of typical CCT part, integrated measurement.

Typical Light Output Characteristics over Temperature

Neutral-White and Cool-White at Test Current

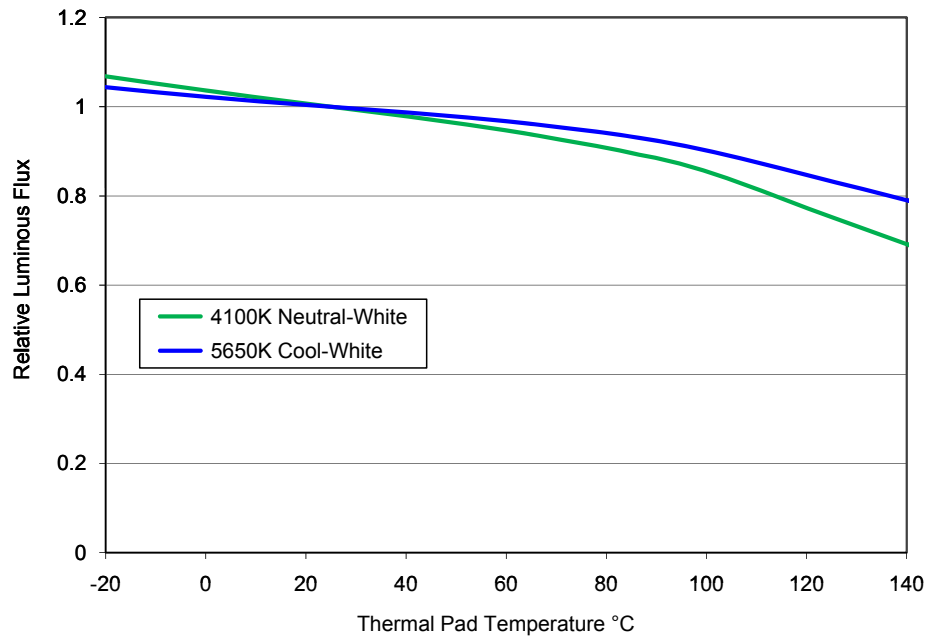


Figure 5. Relative light output vs. thermal pad temperature.

Typical Forward Current Characteristics

Neutral-White and Cool-White, Thermal Pad Temperature = 25°C

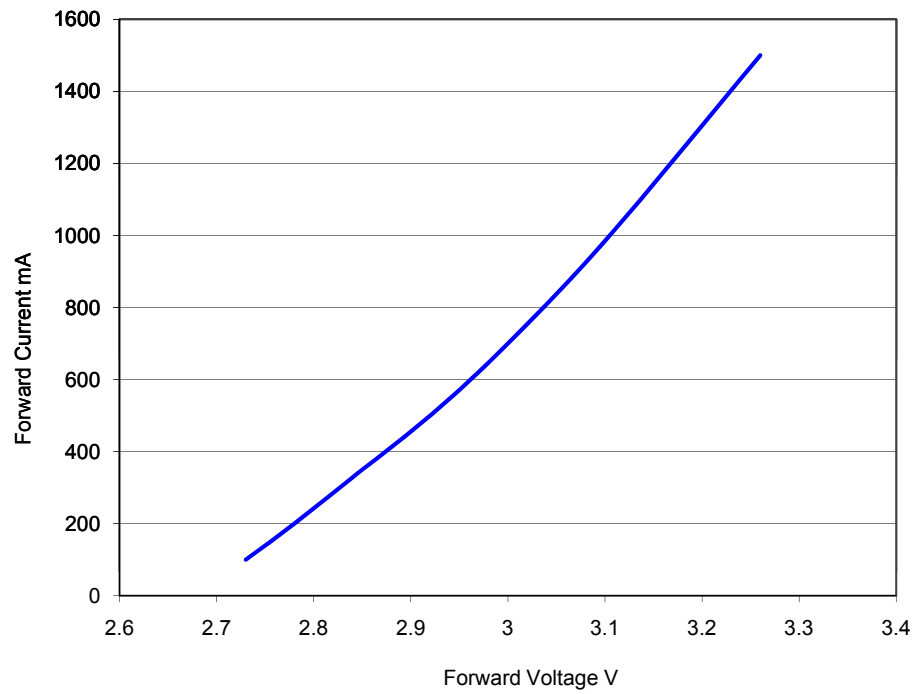


Figure 6. Forward current vs. forward voltage.

Typical Luminous Efficacy

Typical Luminous Efficacy Characteristic vs. Forward Current, Neutral-White and Cool-White

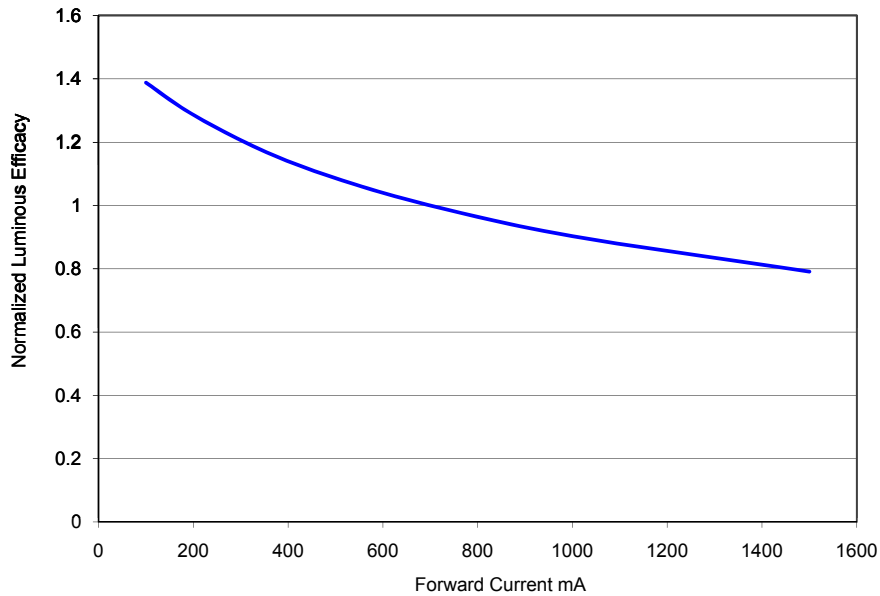


Figure 7. Typical luminous efficacy characteristic vs. forward current, thermal pad temperature = 25°C.

Typical Relative Luminous Flux vs. Forward Current for Neutral-White and Cool-White, Thermal Pad Temperature = 25°C

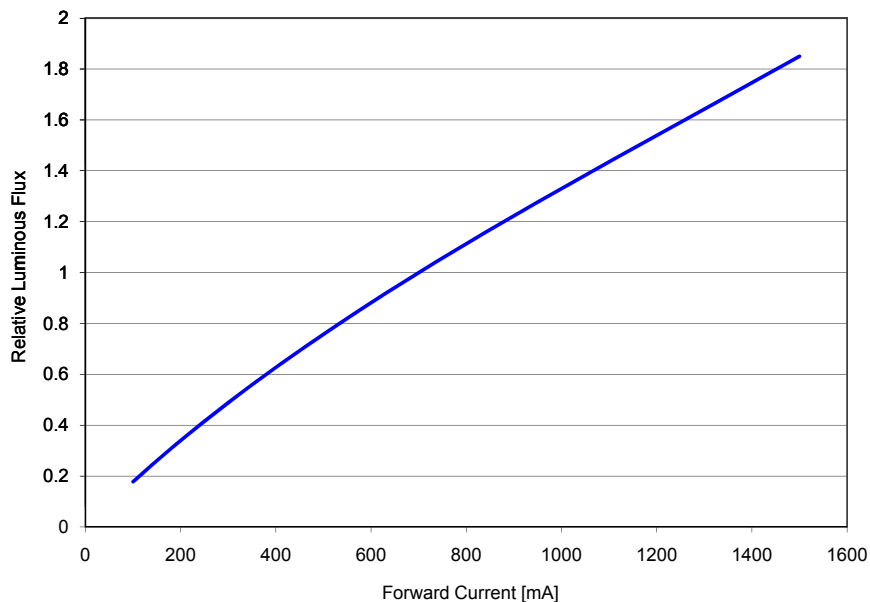


Figure 8. Typical relative luminous flux vs. forward current, thermal pad temperature = 25°C.

Typical Luminous Efficacy, Continued

Relative Luminous Efficacy vs. Temperature

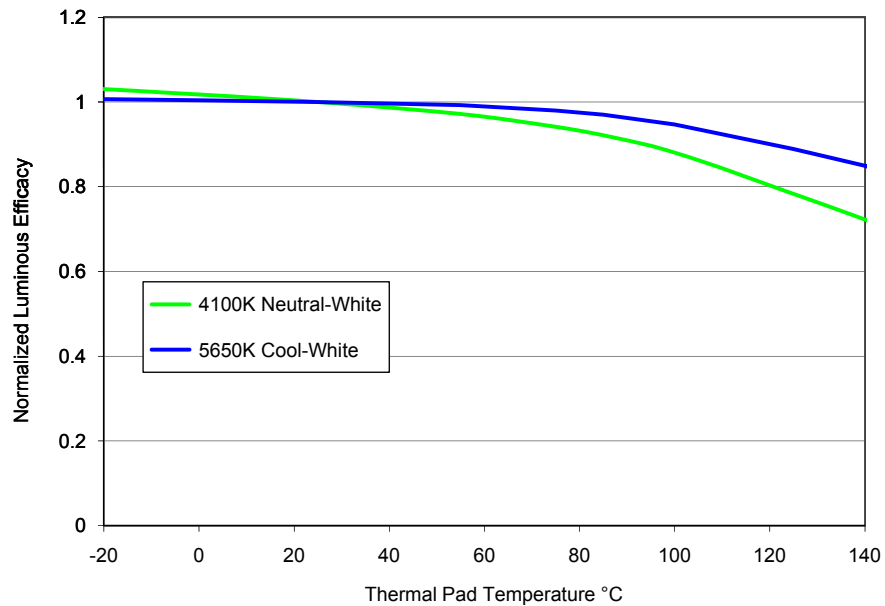


Figure 9. Relative luminous efficacy vs. thermal pad temperature, test current at 700 mA.

Current Derating Curves

Current Derating Curve for 350 mA Drive Current Neutral-White and Cool-White

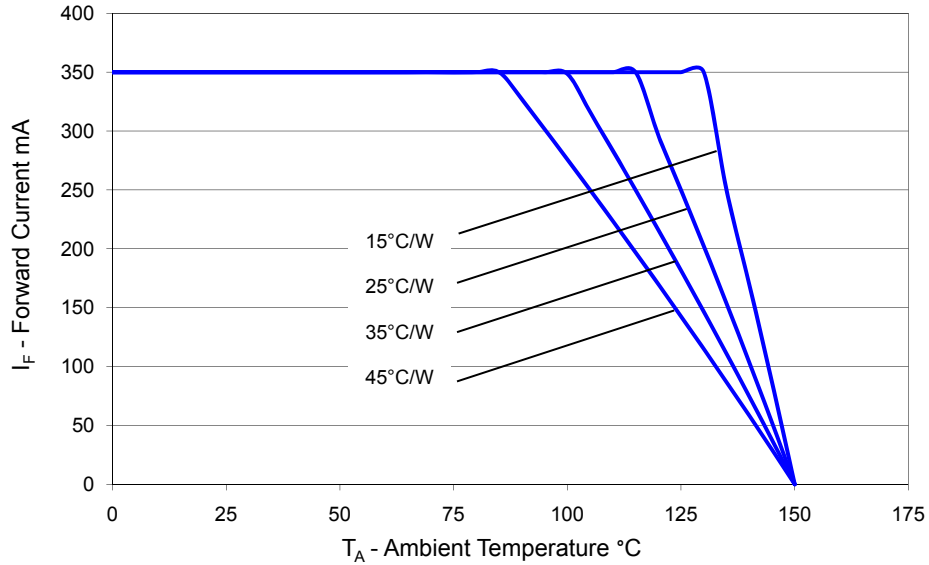


Figure 10. Maximum forward current vs. ambient temperature, based on $T_{JMAX} = 150^\circ\text{C}$.

Current Derating Curve for 700 mA Drive Current Neutral-White and Cool-White

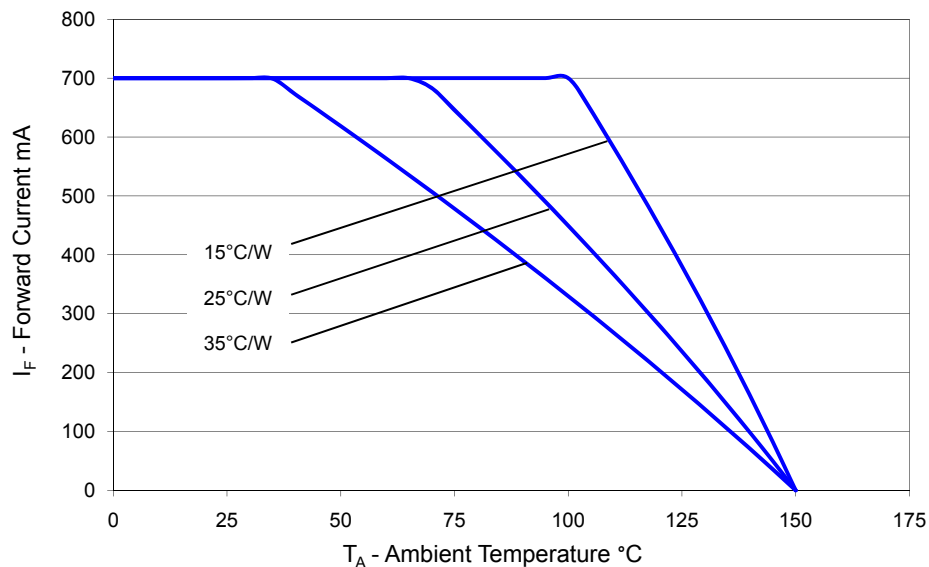


Figure 11. Maximum forward current vs. ambient temperature, based on $T_{JMAX} = 150^\circ\text{C}$.

Current Derating Curves, Continued

Current Derating Curve for 1000 mA Drive Current Neutral-White and Cool-White

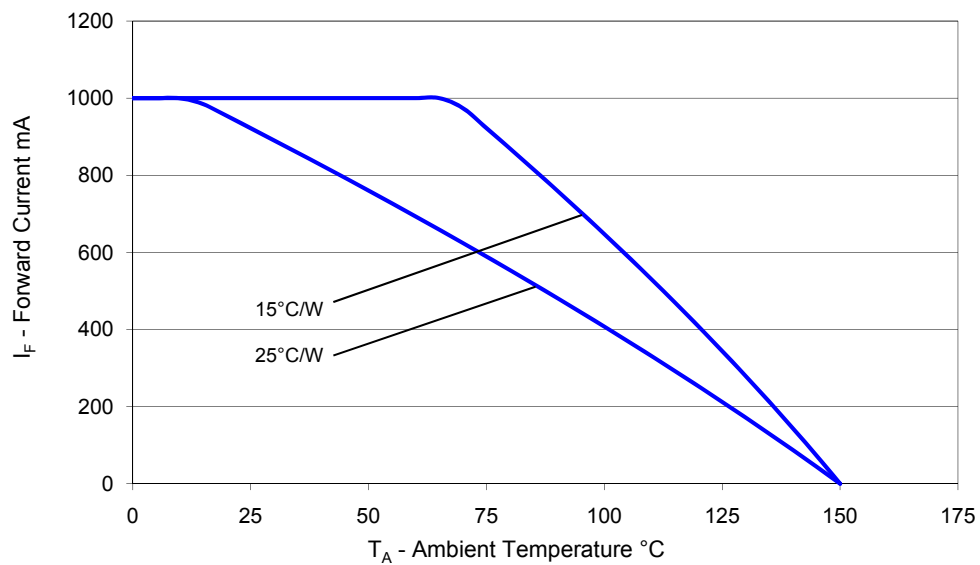


Figure 12. Maximum forward current vs. ambient temperature, based on $T_{JMAX} = 150^{\circ}\text{C}$.

Typical Radiation Patterns

Typical Spatial Radiation Pattern for Neutral-White and Cool-White Lambertian

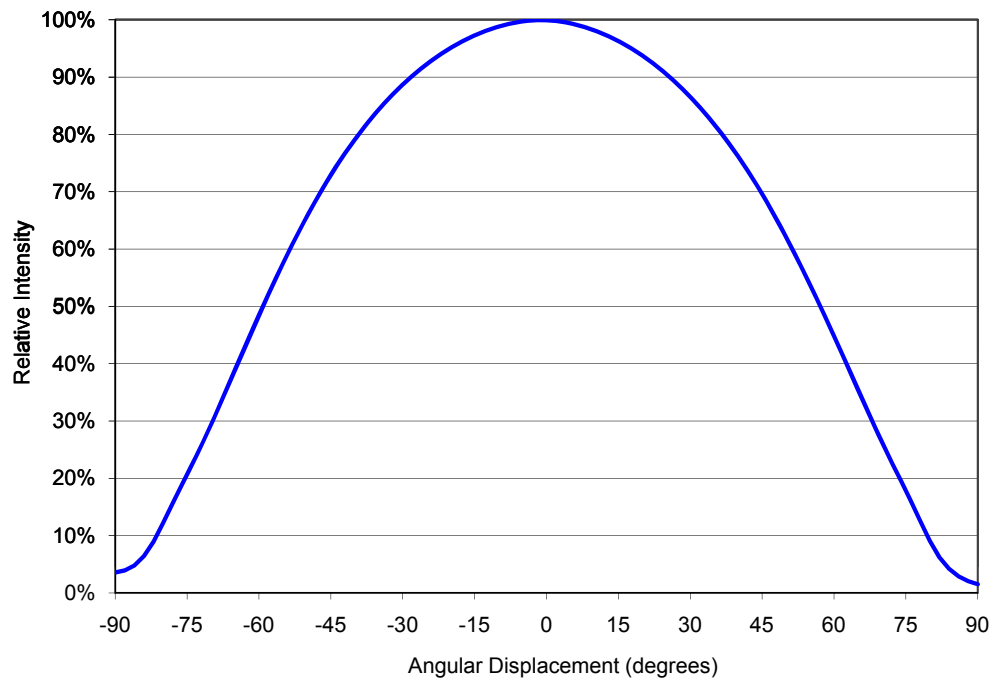
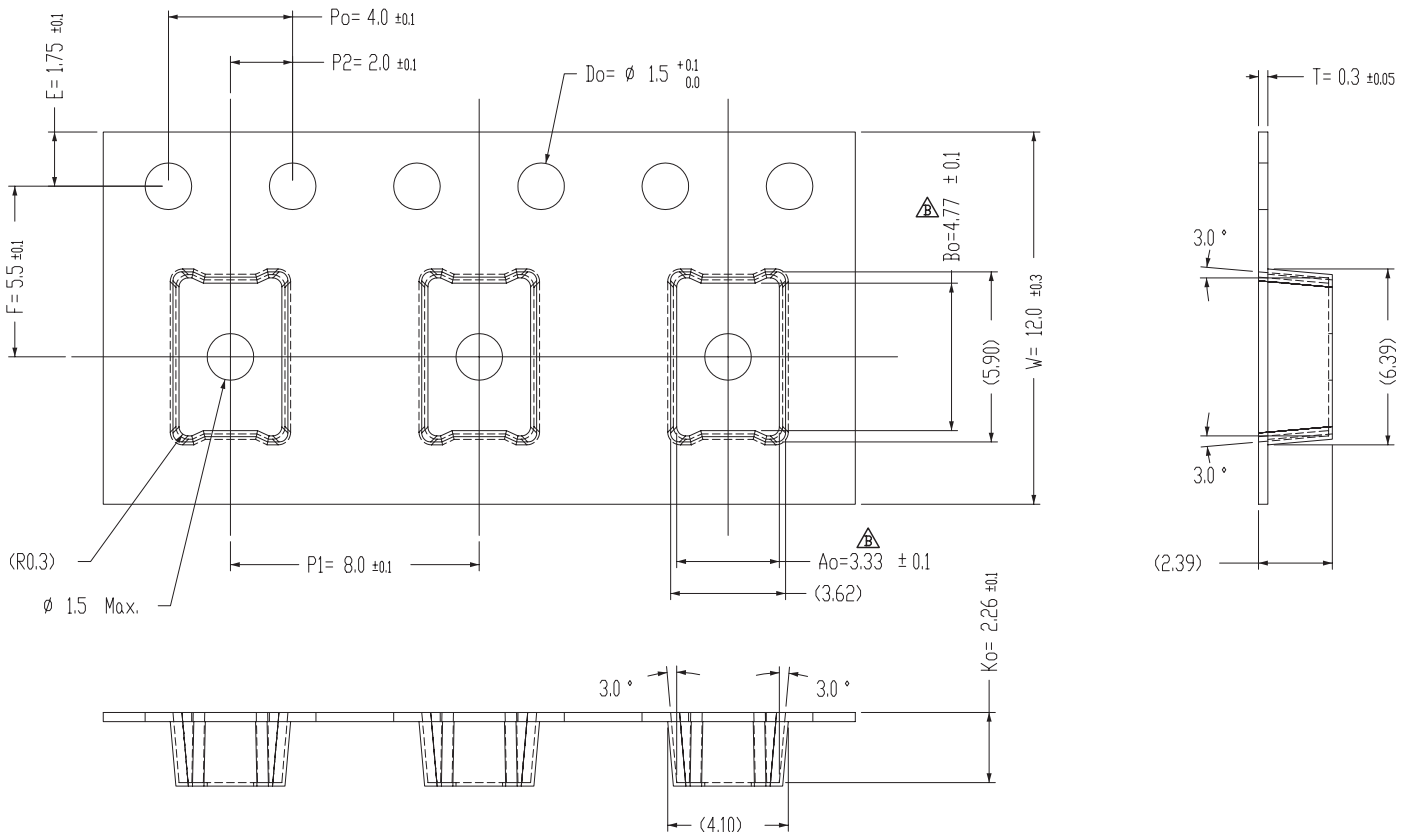
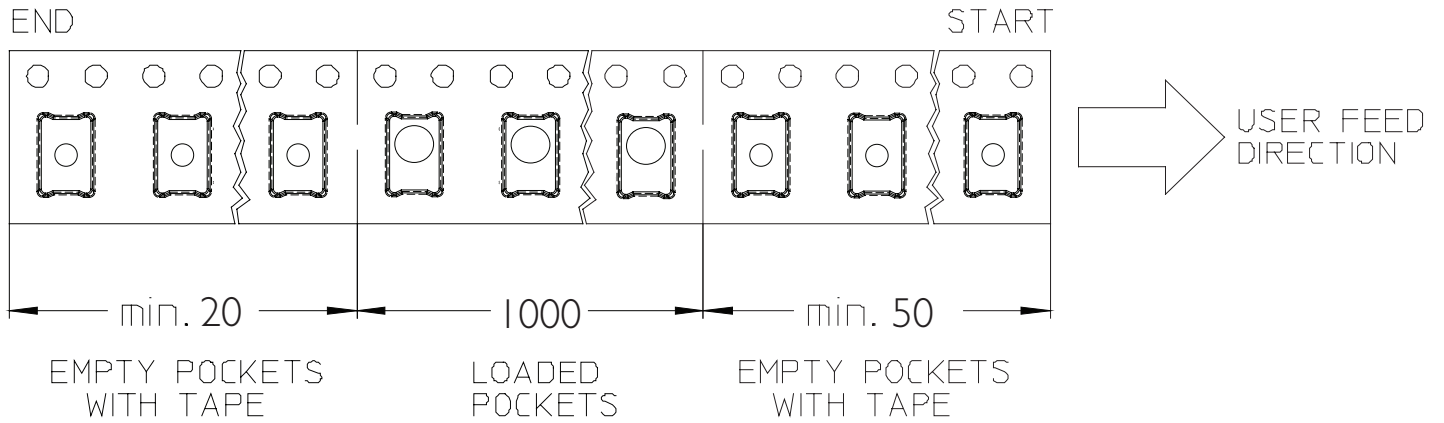
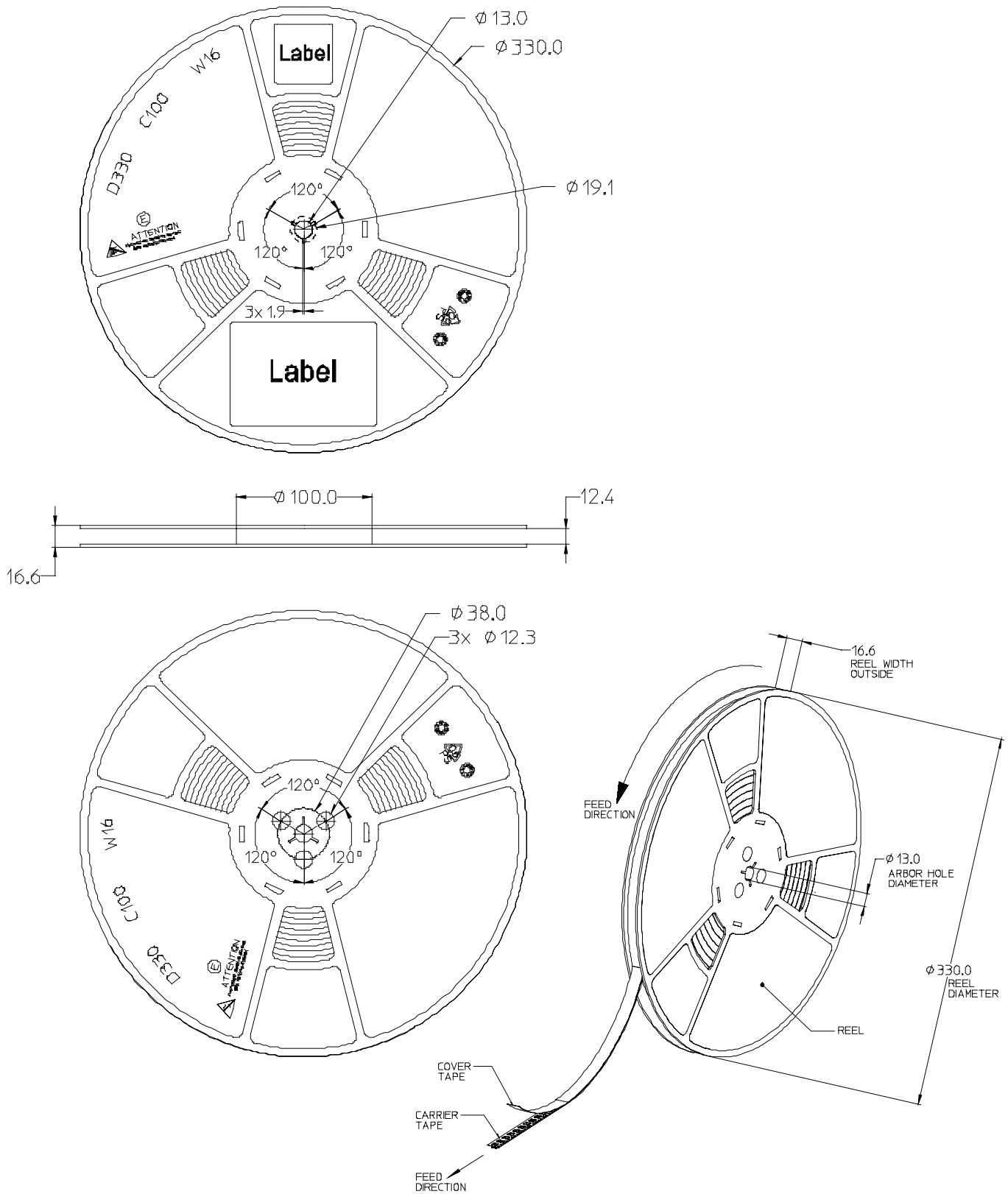


Figure 13. Typical representative spatial radiation pattern for cool-white and neutral-white lambertian.

Emitter Pocket Tape Packaging



Emitter Reel Packaging



Product Binning and Labeling

Purpose of Product Binning

In the manufacturing of semiconductor products, there is a variation of performance around the average values given in the technical data sheets. For this reason, Philips Lumileds bins the LED components for luminous flux, color and forward voltage (V_f).

Decoding Product Bin Labeling

LUXEON Rebel ES Emitters are labeled using a four digit alphanumeric code (CAT code) depicting the bin values for emitters packaged on a single reel. All emitters packaged within a reel are of the same 3-variable bin combination. Using these codes, it is possible to determine optimum mixing and matching of products for consistency in a given application.

Reels of Neutral-White and Cool-White LUXEON Rebel ES emitters are labeled with a four digit alphanumeric CAT code following the format below.

ABCD

A = Flux bin (T, U, V etc.)

B and C = Color bin (W0, U0, V0 etc.)

D = V_f bin (P, R, S, T etc.)

Luminous Flux Bins

Table 9 lists the standard photometric luminous flux bins for LUXEON Rebel ES emitters (tested and binned at 700 mA).

Although several bins are outlined, product availability in a particular bin varies by production run and by product performance. Not all bins are available in all colors.

Table 9.

Flux Bins

Bin Code	Minimum Photometric Flux (lm)	Maximum Photometric Flux (lm)
T	200	220
U	220	240
V	240	260
W	260	280
X	280	300

Neutral-White Bin Structure

Neutral-White LUXEON Rebel ES emitters are tested and binned by x,y coordinates. 12 Color Bins, CCT Range 3,500K to 4,500K.

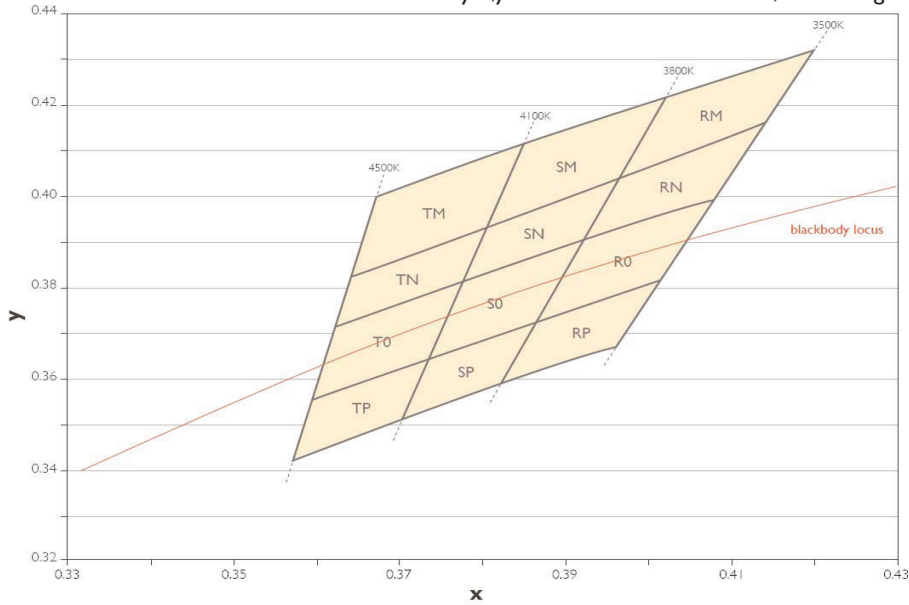


Figure 14. Neutral-White bin structure.

Table 10.

Neutral-White Bin Coordinates							
Bin Code	X	Y	Typical CCT (K)	Bin Code	X	Y	Typical CCT (K)
TM	0.367294	0.400290	4300	SO	0.378264	0.382458	3950
	0.385953	0.412995			0.392368	0.390932	
	0.381106	0.393747			0.387071	0.373899	
	0.364212	0.382878			0.374075	0.365822	
TN	0.364212	0.382878	4300	SP	0.374075	0.365822	3950
	0.381106	0.393747			0.387071	0.373899	
	0.378264	0.382458			0.382598	0.359515	
TO	0.362219	0.371616	4300	RM	0.402270	0.422776	3650
	0.378264	0.382458			0.420940	0.432618	
	0.374075	0.365822			0.414776	0.416097	
	0.359401	0.355699			0.396279	0.403508	
TP	0.359401	0.355699	4300	RN	0.396279	0.403508	3650
	0.374075	0.365822			0.414776	0.416097	
	0.370582	0.351953			0.408593	0.399525	
SM	0.385953	0.412995	3950	RO	0.392368	0.390932	3650
	0.402270	0.422776			0.408593	0.399525	
	0.396279	0.403508			0.402113	0.382156	
	0.381106	0.393747			0.387071	0.373899	
SN	0.381106	0.393747	3950	RP	0.387071	0.373899	3650
	0.396279	0.403508			0.402113	0.382156	
	0.392368	0.390932			0.396564	0.367284	
	0.378264	0.382458			0.382598	0.359515	

Note for Table 10:

- Philips Lumileds maintains a tester tolerance of ± 0.005 on x,y color coordinates.

Cool-White Bin Structure

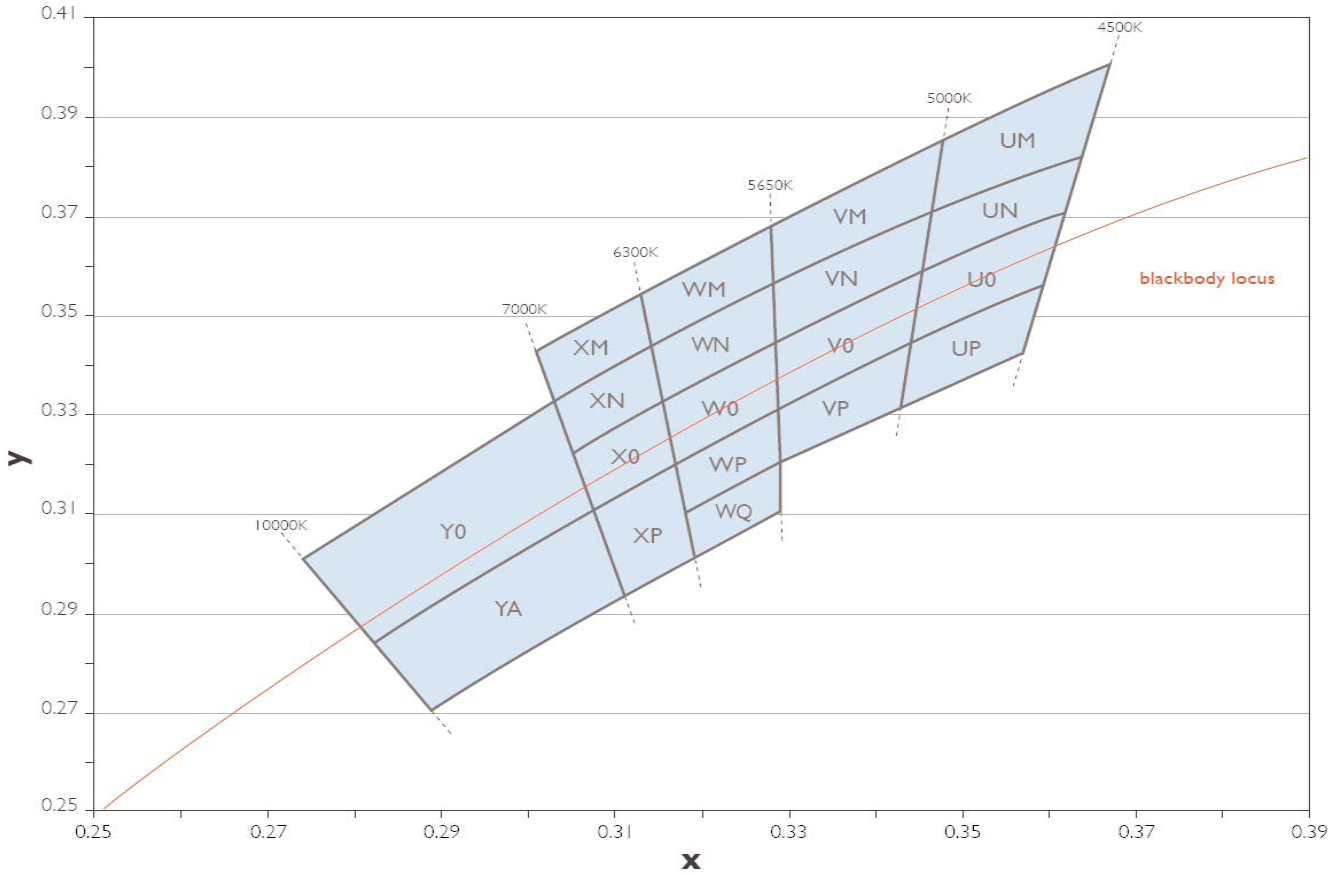


Figure 15. Cool-White bin structure.

Cool-White LUXEON Rebel ES emitters are tested and binned by x,y coordinates. 19 Color Bins, CCT Range 4,500K to 10,000K.

Table I I.

Cool-White Bin Coordinates							
Bin Code	X	Y	Typical CCT (K)	Bin Code	X	Y	Typical CCT (K)
Y0	0.274238	0.300667	8000	WQ	0.318606	0.310201	6000
	0.303051	0.332708			0.329393	0.320211	
	0.307553	0.310778			0.329544	0.310495	
	0.282968	0.283772			0.319597	0.301303	
YA	0.282968	0.283772	8000	VM	0.328636	0.368952	5300
	0.307553	0.310778			0.348147	0.385629	
	0.311163	0.293192			0.346904	0.371742	
	0.289922	0.270316			0.328823	0.356917	
XM	0.301093	0.342244	6700	VN	0.328823	0.356917	5300
	0.313617	0.354992			0.346904	0.371742	
	0.314792	0.344438			0.345781	0.359190	
	0.303051	0.332708			0.329006	0.345092	
XN	0.303051	0.332708	6700	V0	0.329006	0.345092	5300
	0.314792	0.344438			0.345781	0.359190	
	0.316042	0.333222			0.344443	0.344232	
	0.305170	0.322386			0.329220	0.331331	
X0	0.305170	0.322386	6700	VP	0.329220	0.331331	5300
	0.316042	0.333222			0.344443	0.344232	
	0.317466	0.320438			0.343352	0.332034	
	0.307553	0.310778			0.329393	0.320211	
XP	0.307553	0.310778	6700	UM	0.348147	0.385629	4750
	0.317466	0.320438			0.367294	0.400290	
	0.319597	0.301303			0.364212	0.382878	
	0.311163	0.293192			0.346904	0.371742	
WM	0.313617	0.354992	6000	UN	0.346904	0.371742	4750
	0.328636	0.368952			0.364212	0.382878	
	0.328823	0.356917			0.362219	0.371616	
	0.314792	0.344438			0.345781	0.359190	
WN	0.314792	0.344438	6000	U0	0.345781	0.359190	4750
	0.328823	0.356917			0.362219	0.371616	
	0.329006	0.345092			0.359401	0.355699	
	0.316042	0.333222			0.344443	0.344232	
W0	0.316042	0.333222	6000	UP	0.344443	0.344232	4750
	0.329006	0.345092			0.359401	0.355699	
	0.329220	0.331331			0.357079	0.342581	
	0.317466	0.320438			0.343352	0.332034	
WP	0.317466	0.320438	6000				
	0.329220	0.331331					
	0.329393	0.320211					
	0.318606	0.310201					

Note for Table I I:

- I. Philips Lumileds maintains a tester tolerance of ± 0.005 on x, y color coordinates.

Forward Voltage Bins

Table 12 lists minimum and maximum V_f bin values per emitter (tested and binned at 700 mA). Although several bins are outlined, product availability in a particular bin varies by production run and by product performance.

Table 12.

V_f Bins

Bin Code	Minimum Forward Voltage (V)	Maximum Forward Voltage (V)
P	2.50	2.75
R	2.75	3.00
S	3.00	3.25
T	3.25	3.50

Company Information

Philips Lumileds is the world's 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 and home lighting.

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.

www.philipslumileds.com
www.futurelightingsolutions.com

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