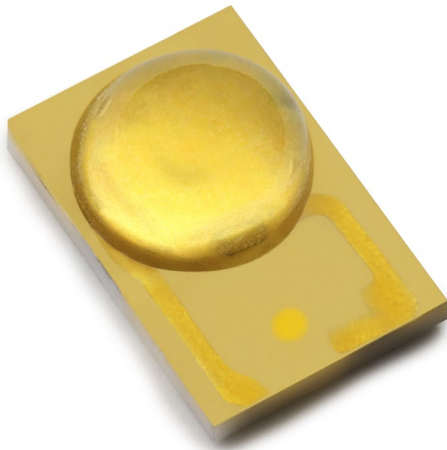




LUXEON Rebel PLUS

*Freedom From Binning
Hot Tested
Superior Quality of Light*

Technical Datasheet DS107

LUXEON
NEVER BEFORE POSSIBLE



LUXEON® Rebel PLUS

Freedom From Binning

Introduction

LUXEON® Rebel PLUS LEDs from Philips Lumileds are a product family with a rich history of use in just about every possible illumination application. LUXEON Rebel PLUS LEDs are designed to offer single emitter, Illumination Grade LED light sources with the highest possible efficacy and light output. With hot testing and color binning, every LUXEON Rebel PLUS is tested and specified at real world operating conditions, $T_j = 85^\circ\text{C}$. Our exceptional color control enables design simplicity for luminaire manufacturers and ensures that they can be confident in color consistency from LED to LED. The superior quality of light, light output, and real world efficacy enable leading performance and efficient solution development in a wide variety of indoor lighting segments including retrofit bulbs, office, hospitality, school, and home lighting. LUXEON Rebel PLUS comes in an industry standard 4530 package with a 2.55mm dome that is optimized for maximum light output.

- Superior efficacy, color consistency and high light output
- Hot tested at real world conditions at $T_j = 85^\circ\text{C}$
- LM80 compliant
- Typical V_f of 2.76V at 350 mA, 85°C
- Optically compatible with LUXEON Rebel platform
- Available in 3-step and 5-step MacAdam Ellipse.

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General Product Information

Product Nomenclature

LUXEON Rebel PLUS emitters are tested and binned “hot” under conditions comparable to those found in “real-world” lighting products. The test conditions for LUXEON Rebel PLUS are 350 mA D.C. with junction temperature at 85°C.

The part number designation for the LUXEON Rebel PLUS emitters is explained as follows:

L X I 8 - P I X X - Y

Where:

8 — designates minimum CRI performance (value 8 = 80 minimum)

P — designates radiation pattern (value P for Lambertian)

1 — 80 CRI min designation

XX — designates nominal ANSI CCT (value 27 = 2700K, 30 = 3000K, 35 = 3500K, 40 = 4000K, and 50 = 5000K)

Y — 3 for 3-step and 5-step MacAdam Ellipse

Lumen Maintenance

LUXEON Rebel PLUS products are tested in compliance with LM-80. Please visit www.philipslumileds.com/support/documentation/lumen-maintenance or contact your local Philips Lumileds Technical Solutions Manager for TM-21 extrapolations or other support.

Environmental Compliance

Philips Lumileds is committed to providing environmentally friendly products to the solid-state lighting market. LUXEON Rebel PLUS 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 PLUS: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

Product Selection & Optical Characteristics

Product Selection Guide for LUXEON Rebel PLUS Emitters Junction Temperature = 85°C

Table 1.

Part Number	Nominal ANSI CCT	CRI Min	Performance @ 350 mA Test Current		Typ. Luminous Flux (lm)		Typ. Forward Voltage (V)		Typ. Efficacy (lm/W)	
			Min	Test	350 mA	700 mA	350 mA	700 mA	350 mA	700 mA
			Luminous Flux (lm)	Condition						
LX18-PI27-Y	2700K	80	80	T _j = 85°C	85	156	2.76	2.85	88	78
LX18-PI30-Y	3000K	80	85	T _j = 85°C	95	166	2.76	2.85	98	83
LX18-PI35-Y	3500K	80	90	T _j = 85°C	98	172	2.76	2.85	101	86
LX18-PI40-Y	4000K	80	90	T _j = 85°C	103	180	2.76	2.85	107	90
LX18-PI50-Y	5000K	80	95	T _j = 85°C	106	186	2.76	2.85	110	93

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

Optical Characteristics

LUXEON Rebel PLUS at Test Current ^[1], Junction Temperature = 85°C

Table 2.

Nominal ANSI CCT	Part Number	Color Temperature CCT	Typical Total Included Angle ^[2] (degrees) $\theta_{0.90V}$	Typical Viewing Angle ^[3] (degrees) $2\theta_{1/2}$
		Typical		
2700K	LX18-PI27-Y	2725K	160	120
3000K	LX18-PI30-Y	3045K	160	120
3500K	LX18-PI35-Y	3465K	160	120
4000K	LX18-PI40-Y	3985K	160	120
5000K	LX18-PI50-Y	5028K	160	120

Notes for Table 2:

1. Test current is 350 mA D.C. for all LX18-PIxx emitters.
2. Total angle at which 90% of total luminous flux is captured.
3. Viewing angle is the off axis angle from lamp centerline where the luminous intensity is $\frac{1}{2}$ of the peak value.

Electrical Characteristics

Electrical Characteristics at 350 mA for LUXEON Rebel PLUS Junction Temperature = 85°C

Table 3.

Nominal ANSI CCT	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.	Max.		
2700K	2.5	3.00	-1.0 to -3.0	9
3000K	2.5	3.00	-1.0 to -3.0	9
3500K	2.5	3.00	-1.0 to -3.0	9
4000K	2.5	3.00	-1.0 to -3.0	9
5000K	2.5	3.00	-1.0 to -3.0	9

Notes for Table 3:

1. Philips Lumileds maintains a tolerance of $\pm 0.06V$ on forward voltage measurements.
2. Measured between $T_j = 25^\circ C$ and $T_j = 110^\circ C$ at $I_f = 350$ mA.

Absolute Maximum Ratings

Table 4.

Parameter	LUXEON Rebel PLUS
DC Forward Current (mA)	1000 ^[2]
Peak Pulsed Forward Current (mA)	1000 ^[3]
ESD Sensitivity	< 8000V Human Body Model (HBM) Class 3A JESD22-A114-E
LED Junction Temperature ^[1]	150°C
Operating Case Temperature at 700 mA	-40°C - 135°C
Storage Temperature	-40°C - 135°C
Soldering Temperature	JEDEC 020c 260°C
Allowable Reflow Cycles	3
Reverse Voltage (Vr)	LUXEON Rebel PLUS LEDs are not designed to be driven in reverse bias

Notes for Table 4:

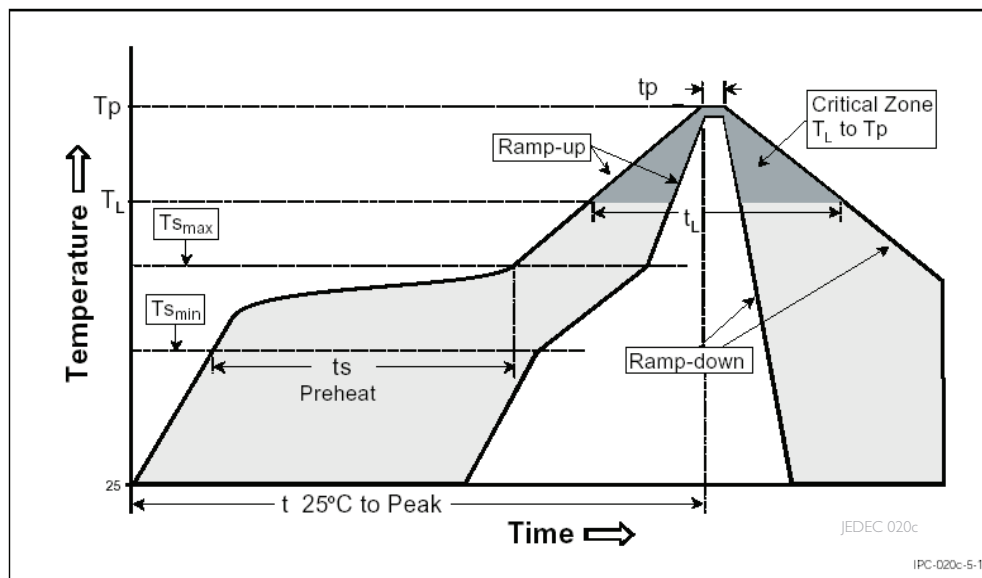
1. Proper current derating must be observed to maintain junction temperature below the maximum. For additional information on thermal measurement guidelines please refer to Application Brief AB33.
2. Residual periodic variations due to power conversion from alternating current (AC) to direct current (DC), also called "ripple", with frequencies ≥ 100 Hz and amplitude ≤ 300 mA are acceptable, assuming the average current throughout each cycle does not exceed 1000 mA.
3. Pulsed operation with a peak drive current of 1000 mA is acceptable if the pulse on-time is ≤ 5 ms per cycle and the duty cycle is $\leq 50\%$.

JEDEC Moisture Sensitivity

Table 5.

Level	Floor Life		Soak Requirements Standard	
	Time	Conditions	Time	Conditions
1	unlimited	$\leq 30^\circ C$ / 85% RH	168h + 5 / -0	85°C / 85% RH

Reflow Soldering Characteristics



Temperature Profile for Table 6.

Table 6.

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 6:

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

Mechanical Dimensions

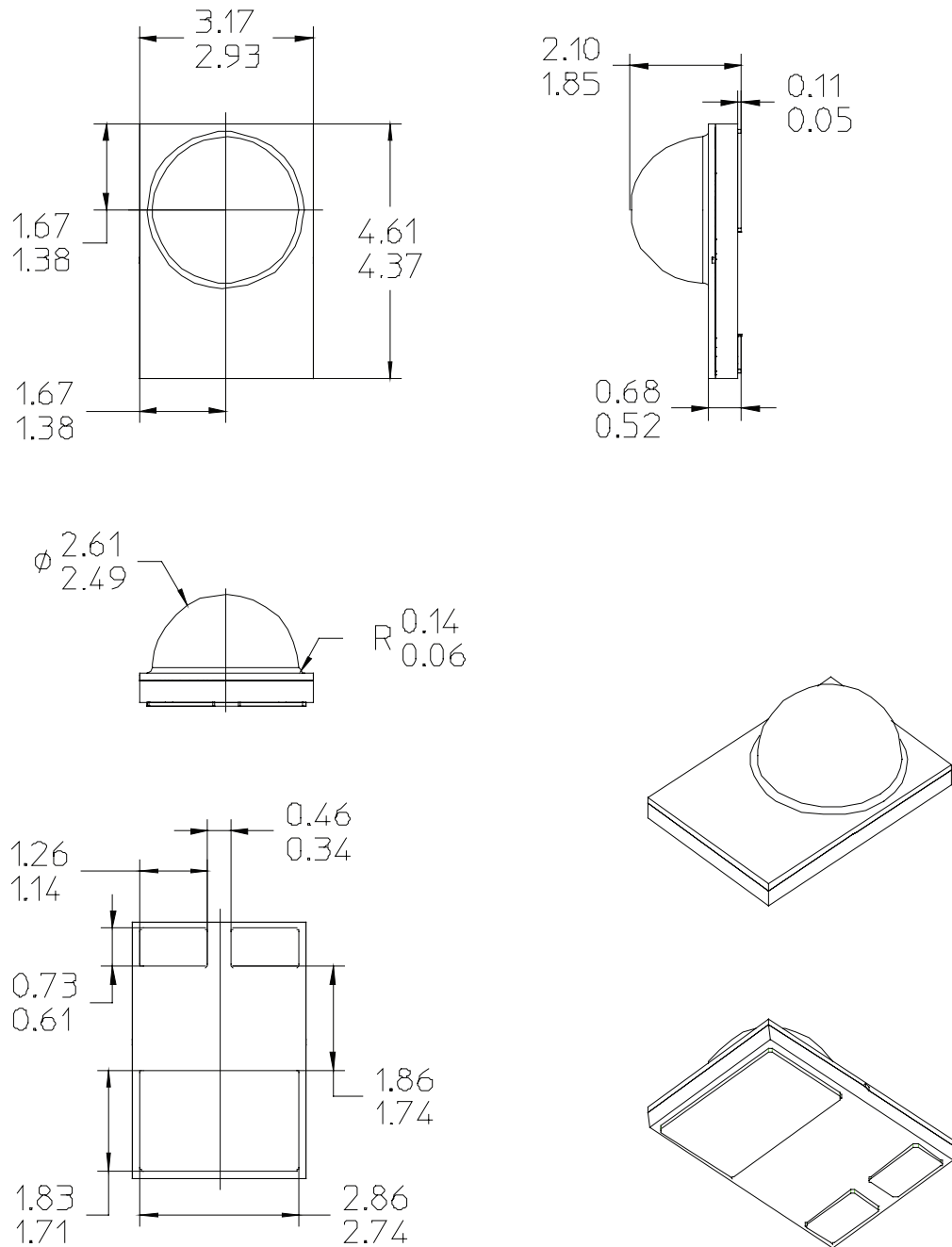


Figure 1. Package outline drawing.

Notes for Figure 1:

- Do not handle the device by the lens, as the lens or the interior of the device can be damaged by excessive force to the lens.
- Drawings not to scale. All dimensions are in millimeters.
- The thermal pad is electrically isolated from the anode and cathode contact pads.

Pad Configuration

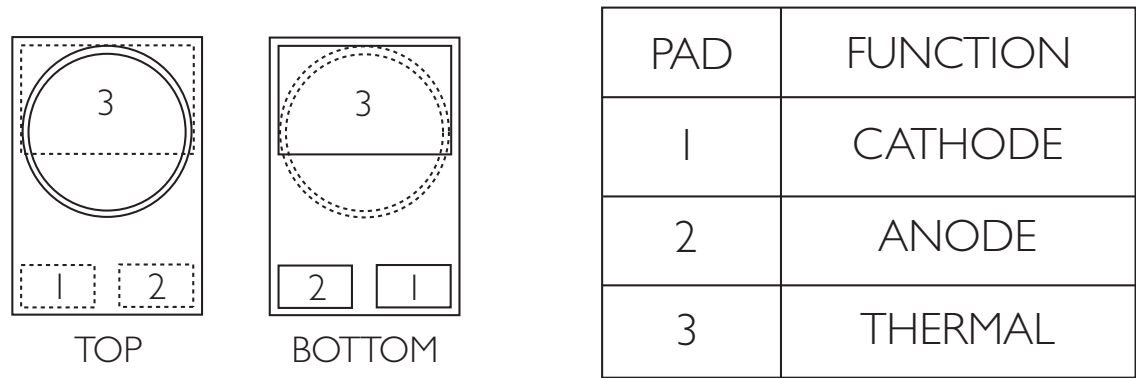


Figure 2. Pad configuration.

Note for Figure 2:

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

Solder Pad Design

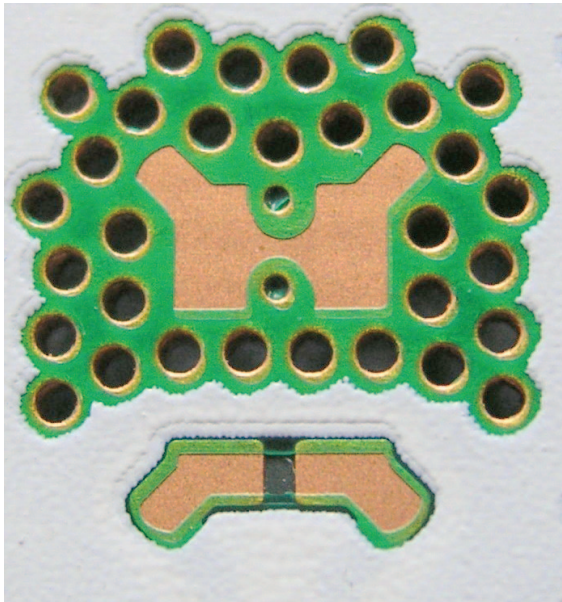


Figure 3. Solder pad layout.

Note for Figure 3:

- The photograph shows the recommended LUXEON Rebel PLUS 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. Printed Circuit Board layout files (.dwg) are available at www.philipslumileds.com and www.philipslumileds.cn.com.

Typical Light Output Characteristics over Temperature

All LUXEON Rebel PLUS Emitters at Test Current, 350 mA

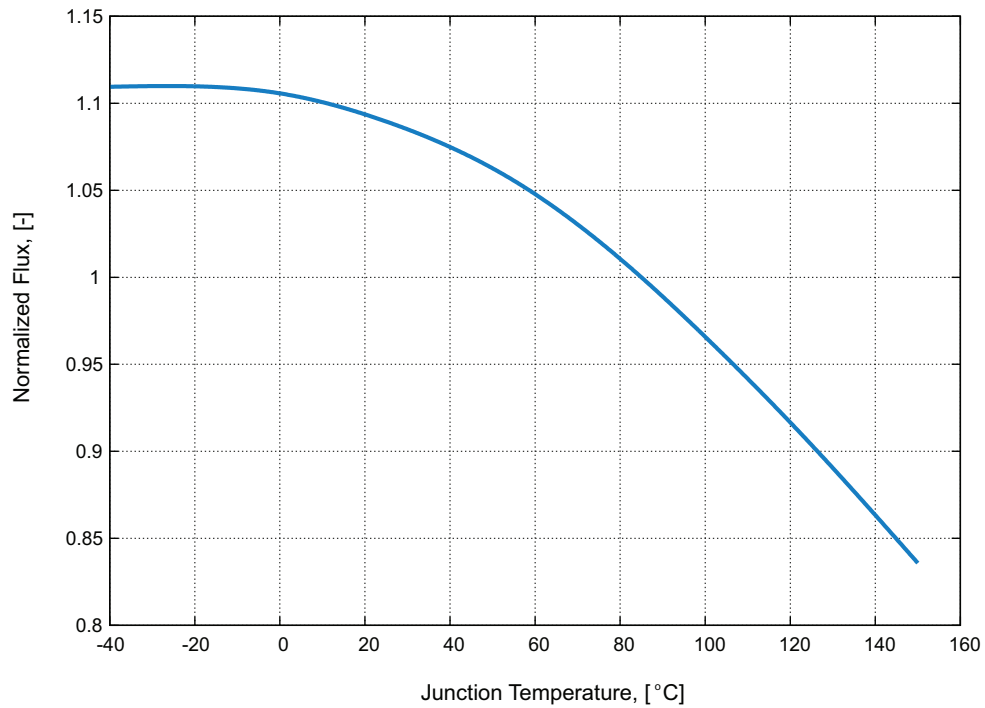


Figure 4. Relative light output vs. junction temperature.

Typical Forward Current Characteristics

All LUXEON Rebel PLUS Emitters, Junction Temperature = 85°C

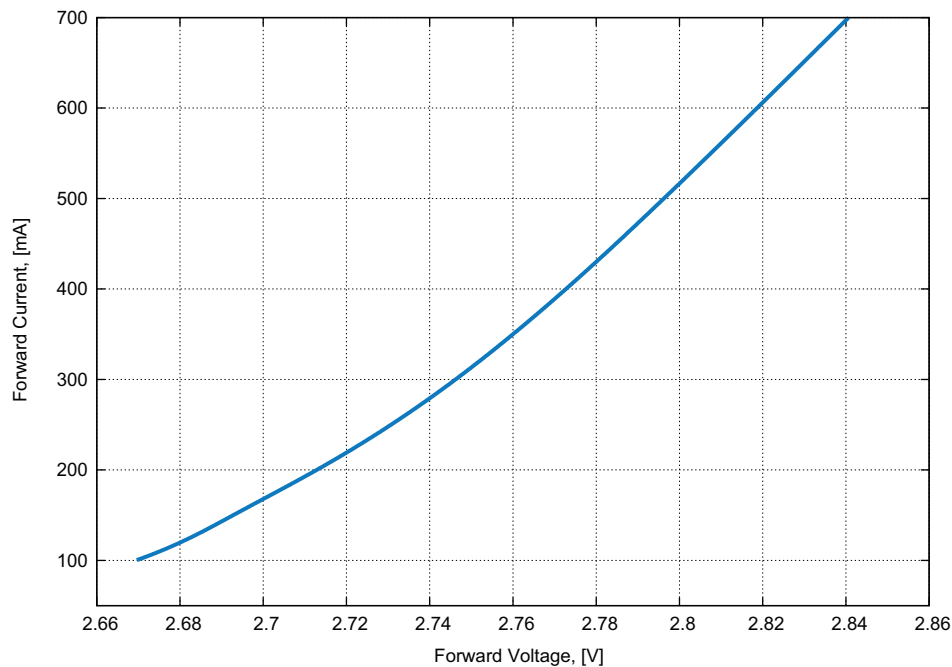


Figure 5. Forward current vs. forward voltage.

Typical Relative Luminous Flux vs. Forward Current for All LUXEON Rebel PLUS Emitters, Junction Temperature = 85°C

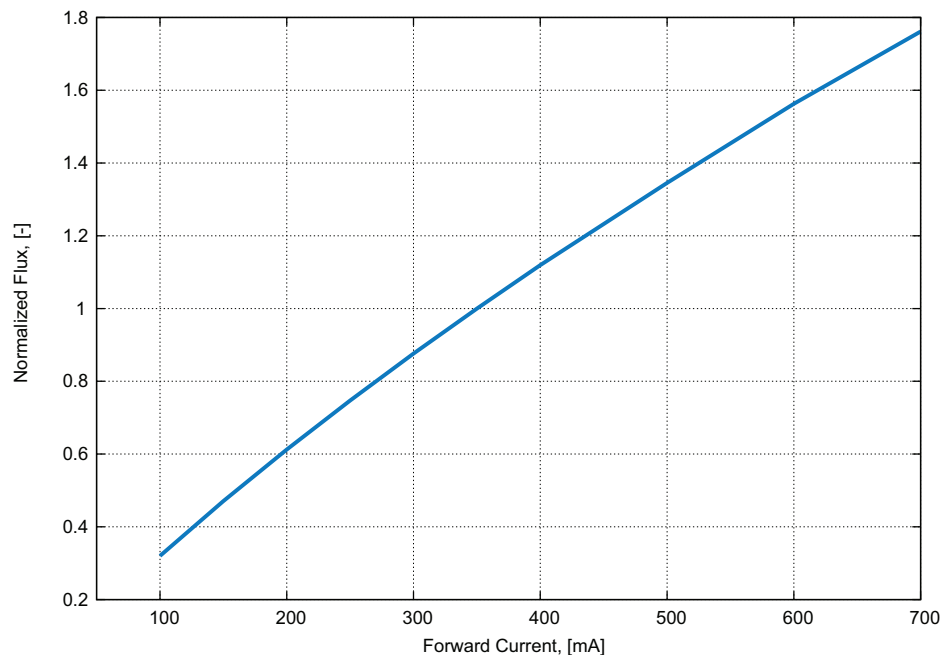


Figure 6. Typical relative luminous flux vs. forward current, junction temperature = 85°C.

Typical Radiation Patterns

Relative Spectral Distribution for LUXEON Rebel PLUS Emitters

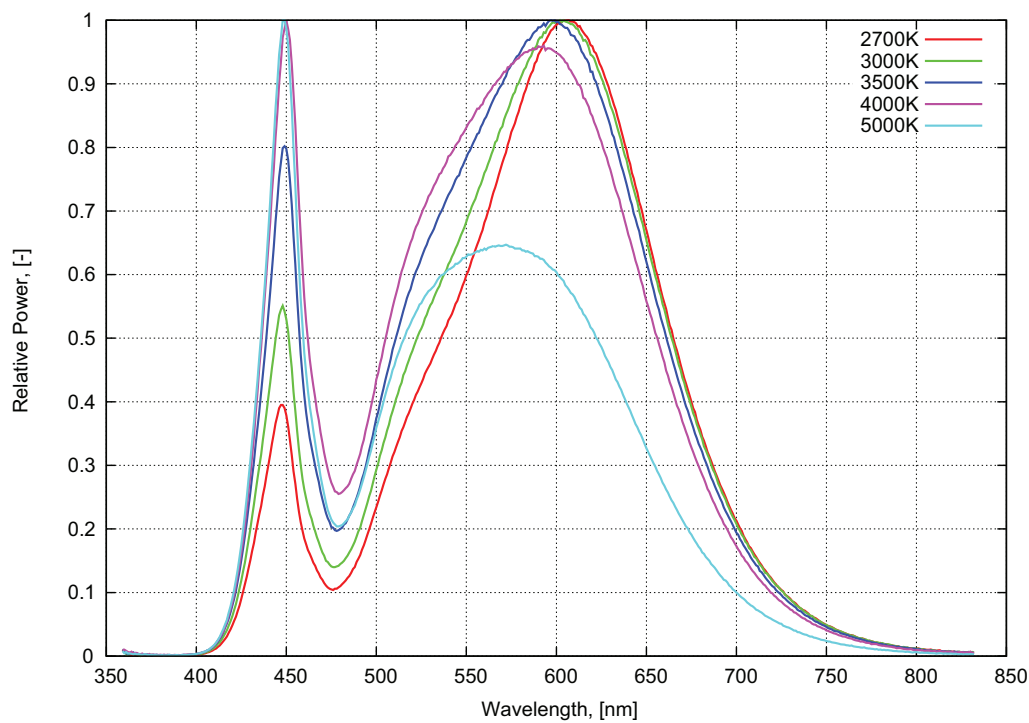


Figure 7. Cartesian plot of typical luminous intensity.

Typical Polar Radiation Pattern

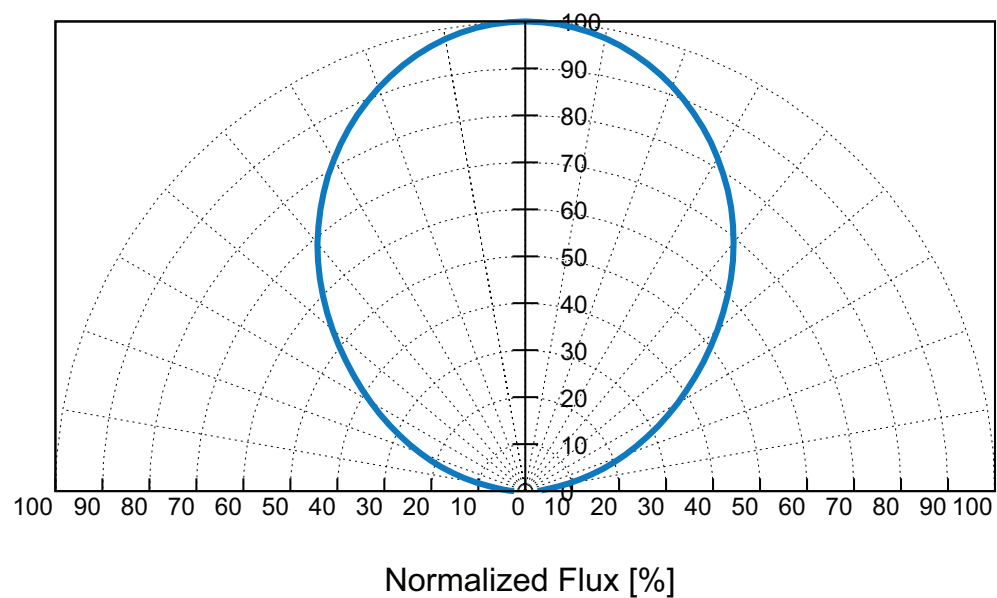
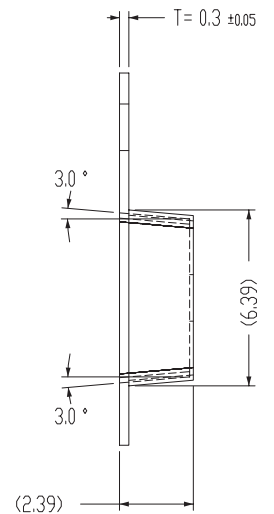
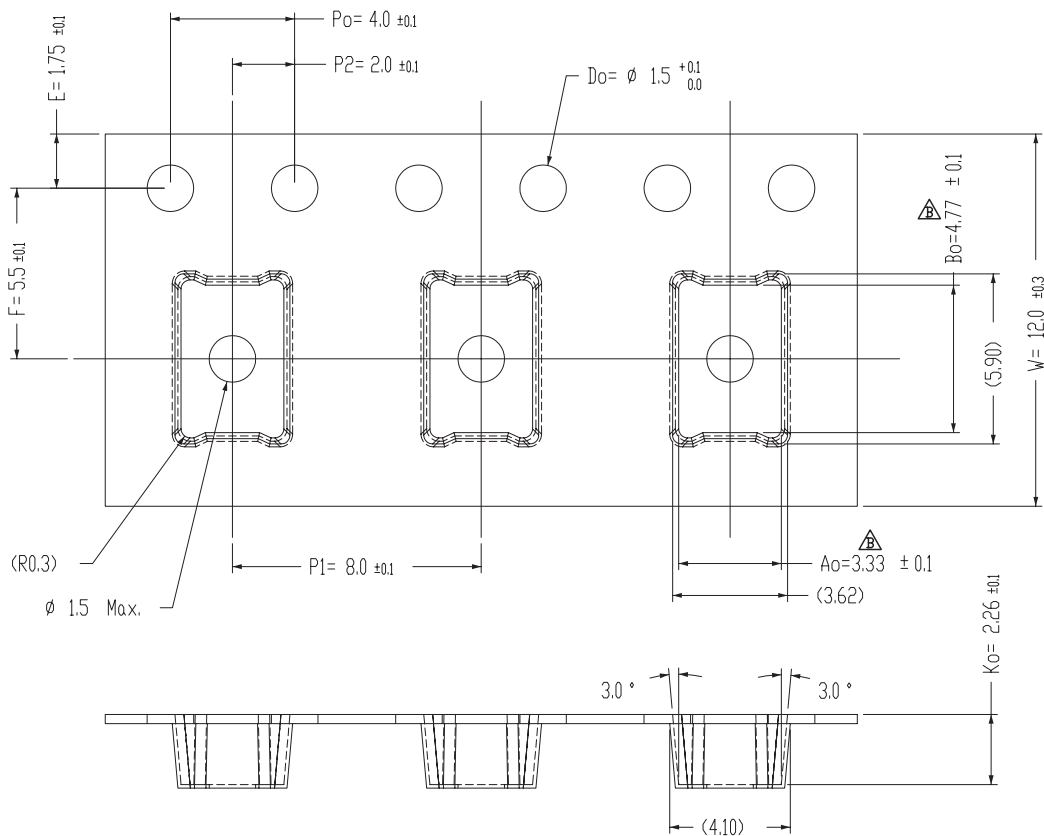
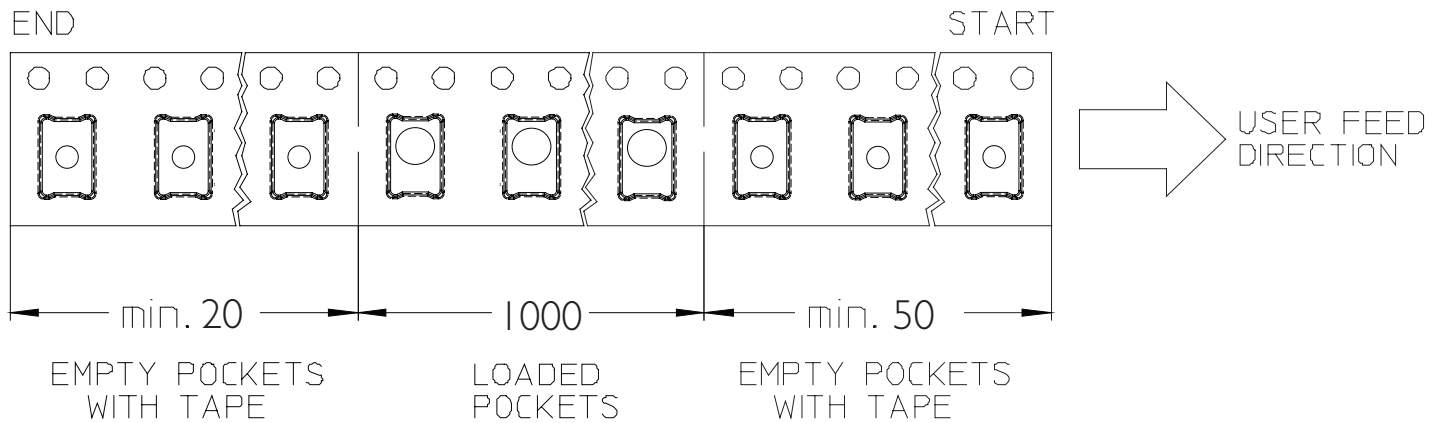
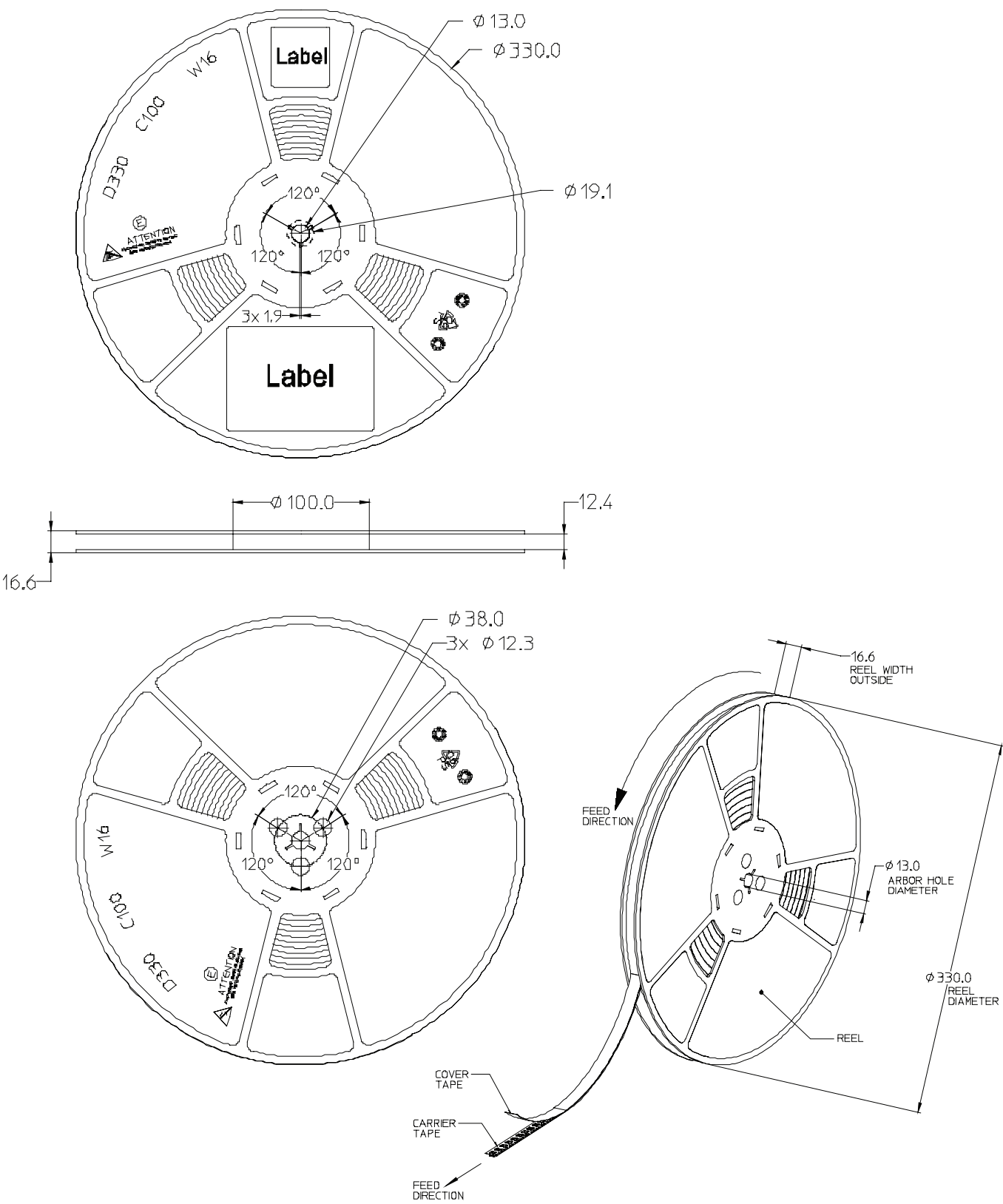


Figure 8. Typical polar radiation pattern.

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 and forward voltage (V_f). Color is offered in a single 3-step or 5-step MacAdam ellipse color space centered on the ANSI CCT color bins. For additional information please review the MacAdam ellipse technical definition section.

Decoding Product Bin Labeling

LUXEON Rebel PLUS emitters are labeled using a two 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 2-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 LUXEON Rebel PLUS emitters are labeled with a two digit alphanumeric CAT code following the format below.

XY

X = Flux bins (A, B, C, D, E, F)

Y = Y = Voltage Bins (1, 2)

Luminous Flux and Forward Voltage Bins

Table 7 lists the standard photometric luminous flux bins for LUXEON Rebel PLUS emitters (tested and binned at 350 mA D.C., Junction Temperature = 85°C. Minimum luminous flux performance within published operating conditions. Philips Lumileds maintains a tolerance of $\pm 6.5\%$ on luminous flux measurements.

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 CCT's.

Table 7.

Flux Bins

Bin Code	Minimum Photometric Flux (lm)	Maximum Photometric Flux (lm)
A ^[2]	75	85
B	85	95
C	95	105
D	105	115
E	115	125
F	125	135

Note for Table 7:

1. Minimum luminous flux performance within published operating conditions. Philips Lumileds maintains a tolerance of $\pm 6.5\%$ on luminous flux measurements.
2. For LX18-PI27 minimum flux is 80 lm.
 - A is the cat code for 80-85 lm for the above emitters.
3. For LX18-PI35 and LX18-PI40 minimum flux is 90 lm.
 - B is the cat code for 90-95 lm for the above emitters.

Table 8 lists minimum and maximum V_f bin values per emitter (tested and binned at 350 mA). Although several bins are outlined, product availability in a particular bin varies by production run and by product performance.

Table 8.

V_f Bins

Bin Code	Minimum Forward Voltage (V)	Maximum Forward Voltage (V)
1	2.50	2.75
2	2.75	3.00

LUXEON Rebel PLUS 3-step and 5-step MacAdam Ellipse Color Definition

Tested at 350 mA D.C. & Junction Temperature = 85°C

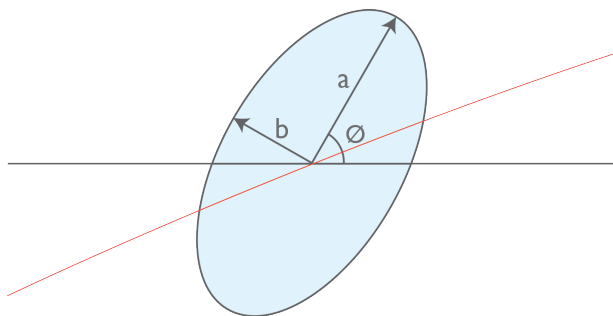


Table 9. LUXEON Rebel PLUS Product Characteristics for 3-step MacAdam Ellipse

Part Number	Nominal ANSI CCT	Color Space	Center Point (cx, cy)	Major Axis, a	Minor Axis, b	Ellipse Rotation Angle
LX18-PI27-3	2700K	Single 3-step MacAdam ellipse	(0.4578, 0.4101)	0.00810	0.00420	53.7
LX18-PI30-3	3000K	Single 3-step MacAdam ellipse	(0.4338, 0.4030)	0.00834	0.00408	53.2
LX18-PI35-3	3500K	Single 3-step MacAdam ellipse	(0.4073, 0.3917)	0.00927	0.00414	54.0
LX18-PI40-3	4000K	Single 3-step MacAdam ellipse	(0.3818, 0.3797)	0.00939	0.00402	53.7
LX18-PI50-3	5000K	Single 3-step MacAdam ellipse	(0.3447, 0.3553)	0.00822	0.00354	59.6

Table 10. LUXEON Rebel PLUS Product Characteristics for 5-step MacAdam Ellipse

Part Number	Nominal ANSI CCT	Color Space	Center Point (cx, cy)	Major Axis, a	Minor Axis, b	Ellipse Rotation Angle
LX18-PI27-5	2700K	Single 5-step MacAdam ellipse	(0.4578, 0.4101)	0.01350	0.00700	53.7
LX18-PI30-5	3000K	Single 5-step MacAdam ellipse	(0.4338, 0.4030)	0.01390	0.00680	53.2
LX18-PI35-5	3500K	Single 5-step MacAdam ellipse	(0.4073, 0.3917)	0.01545	0.00690	54.0
LX18-PI40-5	4000K	Single 5-step MacAdam ellipse	(0.3818, 0.3797)	0.01565	0.00670	53.7
LX18-PI50-5	5000K	Single 5-step MacAdam ellipse	(0.3447, 0.3553)	0.01370	0.00590	59.6

Note for Tables 9 & 10:

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

Company Information

Philips Lumileds is a leading provider of 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, consumer electronics, and automotive 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.