

power light source

# LUXEON® Rebel

## Introduction

LUXEON® Rebel is an ultra-compact, surface-mount, high-power LED that delivers elevated standards for light output, flux density and manufacturability. Offering industry-leading flux density, lumens per package and power handling capabilities, LUXEON Rebel enables you to create never before possible lighting applications and:

- ♦ deliver more useable light and higher flux density
- ♦ optimize applications to reduce size and cost
- ♦ tightly pack the LEDs for color mixing applications
- ♦ engineer more robust applications
- ♦ utilize standard FR4 PCB technology
- ♦ simplify manufacturing through the use of surface mount technology.



## LUXEON Rebel Technology Leadership

- ♦ 150°C Junction Temperature
- ♦ Industry leading lumen performance, > 100 lumens in cool white at 350mA
- ♦ 350mA — 1000mA drive current
- ♦ High efficacy, flux density and lumens per package
- ♦ Industry best moisture sensitivity level—JEDEC Level 1 unlimited floor life - no need for reconditioning
- ♦ Lead-free reflow solder JEDEC 020c compatible
- ♦ RoHS Compliant
- ♦ Autoclave compliant—JESD22 A-102
- ♦ Industry best lumen maintenance—50,000 hours life at 700 mA with 70% lumen maintenance
- ♦ Electrically isolated thermal pad
- ♦ Available in all colors.

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## Product Nomenclature

LUXEON Rebel is tested and binned at 350mA.

The part number designation is explained as follows:

L X M L - A B C D - E F G H

Where:

- A — designates radiation pattern (value P for Lambertian)
- B — designates color (see LUXEON Rebel Binning and Labelling section)
- C — designates color variant (0 for direct colored variants, C for Cool-White, N for Neutral-White and W for Warm-White)
- D — designates test current (value 1 for 350 mA)
- E — reserved for future product offerings
- FGH — minimum luminous flux (lm) or radiometric power (mW) performance

Therefore products tested and binned at 350 mA follow the part numbering scheme:

L X M L - P x x 1 - x x x x

## Average Lumen Maintenance Characteristics

Lifetime for solid-state lighting devices (LEDs) is typically defined in terms of lumen maintenance—the percentage of initial light output remaining after a specified period of time.

Philips Lumileds projects that cool-white, neutral-white, warm-white, green, cyan, blue and royal-blue LUXEON Rebel products will deliver, on average, 70% lumen maintenance (B50, L70) at 50,000 hours of operation at a forward current of 700 mA. This projection is based on constant current operation with junction temperature maintained at or below 135°C.

Philips Lumileds projects that red, red-orange and amber LUXEON Rebel products will deliver, on average, 70% lumen maintenance (B50, L70) at 50,000 hours of operation at a forward current of 350 mA. This projection is based on constant current operation with junction temperature maintained at or below 110°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 is compliant to the European Union directives on the restriction of hazardous substances in electronic equipment, namely the RoHS directive. Philips Lumileds will not intentionally add the following restricted materials to the LUXEON Rebel: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

## Visual Appearance of LUXEON Rebel

All lighted LUXEON Rebel product will provide comparable Lambertian beam performance, suitable for use with commercially available optical systems. Without power, LED die within different reels may appear visually different. Please contact your Philips Lumileds or Future Electronics representative for further information.

## Flux Characteristics for LUXEON Rebel – Thermal Pad Temperature = 25°C

Table 1.

| Performance at Test Current |                |   |                   | Typical Performance at Indicated Current  |                    |
|-----------------------------|----------------|---|-------------------|---|--------------------|
| Color                       | Part Number    | Minimum Luminous Flux (lm) or Radiometric Power (mW)<br>$\Phi_V$ <sup>[1] [3]</sup> | Test Current (mA) | Typical Luminous Flux (lm) or Radiometric Power (mW)<br>$\Phi_V$ <sup>[2] [3]</sup> | Drive Current (mA) |
| Cool-White                  | LXML-PWC1-0040 | 40  | 350               | 80  | 700                |
|                             | LXML-PWC1-0050 | 50  | 350               | 95  | 700                |
|                             | LXML-PWC1-0070 | 70  | 350               | 130   | 700                |
|                             | LXML-PWC1-0080 | 80  | 350               | 145   | 700                |
|                             | LXML-PWC1-0090 | 90  | 350               | 160   | 700                |
|                             | LXML-PWC1-0100 | 100   | 350               | 180   | 700                |
| Neutral-White               | LXML-PWN1-0040 | 40  | 350               | 80  | 700                |
|                             | LXML-PWN1-0050 | 50  | 350               | 95  | 700                |
|                             | LXML-PWN1-0070 | 70  | 350               | 130   | 700                |
|                             | LXML-PWN1-0080 | 80  | 350               | 145   | 700                |
| Warm-White                  | LXML-PWW1-0040 | 40  | 350               | 80  | 700                |
|                             | LXML-PWW1-0050 | 50  | 350               | 95  | 700                |
|                             | LXML-PWW1-0060 | 60  | 350               | 110   | 700                |
| Green                       | LXML-PM01-0040 | 40  | 350               | 80  | 700                |
|                             | LXML-PM01-0050 | 50  | 350               | 95  | 700                |
|                             | LXML-PM01-0070 | 70  | 350               | 130   | 700                |
|                             | LXML-PM01-0080 | 80  | 350               | 145   | 700                |
| Cyan                        | LXML-PE01-0030 | 30  | 350               | 65  | 700                |
|                             | LXML-PE01-0040 | 40  | 350               | 80  | 700                |
|                             | LXML-PE01-0060 | 60  | 350               | 110   | 700                |
|                             | LXML-PE01-0070 | 70  | 350               | 130   | 700                |
| Blue                        | LXML-PB01-0008 | 8.2   | 350               | 19  | 700                |
|                             | LXML-PB01-0010 | 10.7  | 350               | 22  | 700                |
|                             | LXML-PB01-0013 | 13.9  | 350               | 27  | 700                |
|                             | LXML-PB01-0018 | 18.1  | 350               | 38  | 700                |
|                             | LXML-PB01-0023 | 23.5  | 350               | 48  | 700                |
| Royal-Blue                  | LXML-PR01-0175 | 175 mW  | 350               | 325 mW  | 700                |
|                             | LXML-PR01-0225 | 225 mW  | 350               | 400 mW  | 700                |
|                             | LXML-PR01-0275 | 275 mW  | 350               | 525 mW  | 700                |

Notes for Table 1:

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

## Flux Characteristics for LUXEON Rebel Continued Thermal Pad Temperature = 25°C

Table 1. Continued

| Performance at Test Current |                |  |                   | Typical Performance at Indicated Current                             |                    |
|-----------------------------|----------------|--|-------------------|--|--------------------|
| Color                       | Part Number    | Minimum Luminous Flux (lm)<br>$\Phi_v$ <sup>[1]</sup> <sup>[3]</sup> | Test Current (mA) | Typical Luminous Flux (lm)<br>$\Phi_v$ <sup>[2]</sup> <sup>[3]</sup> | Drive Current (mA) |
| Red                         | LXML-PD01-0030 | 30   | 350               | 65   | 700                |
|                             | LXML-PD01-0040 | 40   | 350               | 85   | 700                |
| Red-Orange                  | LXML-PH01-0040 | 40   | 350               | 85   | 700                |
|                             | LXML-PH01-0050 | 50   | 350               | 100  | 700                |
| Amber                       | LXML-PL01-0023 | 23.5   | 350               | 50   | 700                |
|                             | LXML-PL01-0030 | 30.0   | 350               | 65   | 700                |

Notes for Table 1:

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

## Optical Characteristics

### Lambertian LUXEON Rebel at Test Current<sup>[1]</sup> Thermal Pad Temperature = 25°C

Table 2.

| Color                     | Dominant Wavelength <sup>[2]</sup> $\lambda_D$ ,<br>Peak Wavelength <sup>[3]</sup> $\lambda_P$ ,<br>or Color Temperature <sup>[4]</sup><br>CCT |        |          | Typical<br>Spectral<br>Half-width <sup>[6]</sup><br>(nm)<br>$\Delta\lambda_{1/2}$ | Typical<br>Temperature<br>Coefficient of<br>Dominant<br>Wavelength<br>(nm/°C)<br>$\Delta\lambda_P / \Delta T_J$ | Typical<br>Total<br>Included<br>Angle <sup>[7]</sup><br>(degrees)<br>$\theta_{0.90V}$ | Typical<br>Viewing<br>Angle <sup>[8]</sup><br>(degrees)<br>$2\theta_{1/2}$ |
|---------------------------|--|--------|----------|---|---|---|--|
|                           | Min.   | Typ.   | Max.     |   |   |   |  |
| Cool-White                | 4500 K   | 6500 K | 10,000 K | N/A   | N/A   | 160   | 140  |
| Neutral-White             | 3500 K   | 4100 K | 4500 K   | N/A   | N/A   | 160   | 140  |
| Warm-White                | 2670 K   | 3100 K | 3500 K   | N/A   | N/A   | 160   | 140  |
| Green                     | 520 nm   | 530 nm | 550 nm   | 30  | 0.05  | 160   | 140  |
| Cyan                      | 490 nm   | 505 nm | 520 nm   | 30  | 0.04  | 160   | 140  |
| Blue                      | 460 nm   | 470 nm | 490 nm   | 33  | 0.05  | 160   | 140  |
| Royal-Blue <sup>[9]</sup> | 440 nm   | 455 nm | 460 nm   | 24  | 0.04  | 160   | 140  |
| Red                       | 620.5 nm   | 627 nm | 645 nm   | 29  | 0.05  | 160   | 140  |
| Red-Orange                | 613.5 nm   | 617 nm | 620.5 nm | 28  | 0.08  | 160   | 140  |
| Amber                     | 584.5 nm   | 590 nm | 597 nm   | 28  | 0.10  | 160   | 140  |

Notes for Table 2:

1. Test current is 350 mA for all LXML-Pxx1-0xxx products.
2. Dominant wavelength is derived from the CIE 1931 Chromaticity diagram and represents the perceived color. Philips Lumileds maintains a tolerance of  $\pm 0.5$  nm for dominant wavelength measurements.
3. Royal-Blue product is binned by radiometric power and peak wavelength rather than photometric lumens. Philips Lumileds maintains a tolerance of  $\pm 2$ nm for peak wavelength measurements.
4. CCT  $\pm 5\%$  tester tolerance.
5. Typical CRI (Color Rendering Index) for Cool-White is 70, Neutral-White is 75 and Warm-White is 80.
6. Spectral width at  $1/2$  of the peak intensity.
7. Total angle at which 90% of total luminous flux is captured.
8. Viewing angle is the off axis angle from lamp centerline where the luminous intensity is  $1/2$  of the peak value.
9. All white, green, cyan, blue and royal-blue products are built with Indium Gallium Nitride (InGaN).
10. All red, red-orange, and amber are built with Aluminum Indium Gallium Phosphide (AlInGaP).
11. Cool-White, Neutral-White, Warm-White, Blue and Royal-Blue power light sources represented here are IEC825 class 2 for eye safety.

## Electrical Characteristics

### Electrical Characteristics at 350mA for LUXEON Rebel, Part Numbers LXML-Pxx1-0xxx, Thermal Pad Temperature = 25°C

Table 3.

| Color         | Forward Voltage $V_f$ <sup>[1]</sup> |      |      | Typical<br>Dynamic<br>Resistance <sup>[2]</sup><br>( $\Omega$ )<br>$R_D$ | Typical<br>Temperature<br>Coefficient of<br>Forward<br>Voltage <sup>[3]</sup><br>(mV/°C)<br>$\Delta V_f / \Delta T_J$ | Typical<br>Thermal<br>Resistance<br>Junction to<br>Thermal Pad (°C/W)<br>$R\theta_{J-C}$ |
|---------------|--------------------------------------|------|------|--|---|--|
|               | Min.                                 | Typ. | Max. |  |   |  |
| Cool-White    | 2.55                                 | 3.15 | 3.99 | 0.3  | -3.0  | 10   |
| Neutral-White | 2.55                                 | 3.15 | 3.99 | 0.3  | -3.0  | 10   |
| Warm-White    | 2.55                                 | 3.15 | 3.99 | 0.3  | -3.0  | 10   |
| Green         | 2.55                                 | 3.15 | 3.99 | 0.3  | -6.0  | 10   |
| Cyan          | 2.55                                 | 3.15 | 3.99 | 0.3  | -3.0  | 10   |
| Blue          | 2.55                                 | 3.15 | 3.99 | 0.2  | -3.0  | 10   |
| Royal-Blue    | 2.55                                 | 3.15 | 3.99 | 0.2  | -5.0  | 10   |
| Red           | 2.31                                 | 2.9  | 3.51 | 1.65   | -3.5  | 12   |
| Red-Orange    | 2.31                                 | 2.9  | 3.51 | 1.5  | -3.0  | 12   |
| Amber         | 2.31                                 | 2.9  | 3.51 | 1.3  | -2.5  | 12   |

Notes for Table 3:

1. Philips Lumileds maintains a tolerance of  $\pm 0.06V$  on forward voltage measurements.
2. Dynamic resistance is the inverse of the slope in linear forward voltage model for LEDs. See figures 8 and 9.
3. Measured between  $25^\circ C = T_J = 110^\circ C$  at  $I_f = 350$  mA.

### Typical Electrical Characteristics at 700mA for LUXEON Rebel, Part Numbers LXML-Pxx1-0xxx, Thermal Pad Temperature = 25°C

Table 4.

| Color         | Typical Forward Voltage $V_f$<br>(V) |
|---------------|--------------------------------------|
| Cool-White    | 3.40                                 |
| Neutral-White | 3.40                                 |
| Warm-White    | 3.40                                 |
| Green         | 3.40                                 |
| Cyan          | 3.40                                 |
| Blue          | 3.40                                 |
| Royal-Blue    | 3.40                                 |
| Red           | 3.60                                 |
| Red-Orange    | 3.60                                 |
| Amber         | 3.60                                 |

Notes for Table 4:

1. Philips Lumileds maintains a tolerance of  $\pm 0.06V$  on forward voltage measurements.
2. Dynamic resistance is the inverse of the slope in linear forward voltage model for LEDs. See figures 8 and 9.
3. Measured between  $25^\circ C = T_J = 110^\circ C$  at  $I_f = 700$  mA.

## Absolute Maximum Ratings

Table 5.

| Parameter                               | Cool-White / Neutral-White / Warm-White<br>/ Green / Cyan / Blue / Royal-Blue                                 | Red / Red-Orange / Amber  |
|---|---|---|
| DC Forward Current (mA)                 | 1000  | 700   |
| Peak Pulsed Forward Current (mA)        | 1000  | 700   |
| Average Forward Current (mA)            | 1000  | 700   |
| ESD Sensitivity                         | < 8000V Human Body Model (HBM)<br>Class 2 JESD22-A114-B<br>< 400V Machine Model (MM)<br>Class 2 JESD22-A115-B | < 8000V Human Body Model (HBM)<br>Class 2 JESD22-A114-B<br>< 400V Machine Model (MM)<br>Class 2 JESD22-A115-B |
| LED Junction Temperature <sup>(1)</sup> | 150°C   | 135°C   |
| Operating Case Temperature at 350mA     | -40°C - 135°C   | -40°C - 120°C   |
| Storage Temperature                     | -40°C - 135°C   | -40°C - 135°C   |
| Soldering Temperature                   | JEDEC 020c 260°C  | JEDEC 020c 260°C  |
| Allowable Reflow Cycles                 | 3   | 3   |
| Autoclave Conditions                    | 121°C at 2 ATM<br>100% Relative Humidity for 96 Hours Maximum   |   |
| Reverse Voltage (Vr)                    | See Note 2  | See Note 2  |

Notes for Table 5:

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

## JEDEC Moisture Sensitivity

Table 6.

| Level | Floor Life |                    | Soak Requirements |                  |
|-------|------------|--------------------|-------------------|------------------|
|       | Time       | Conditions         | Standard          |                  |
|       |            |                    | Time (hours)      | Conditions       |
| 1     | unlimited  | ≤ 30°C /<br>85% RH | 168<br>+ 5/-0     | 85°C / 85%<br>RH |



## Reflow Soldering Characteristics

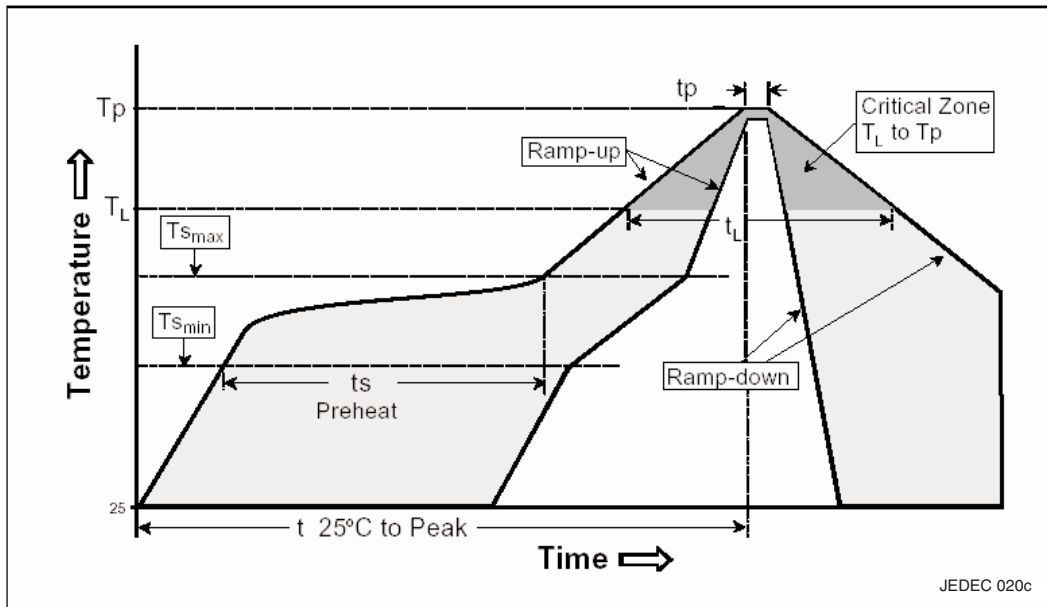


Table 7.

| 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   |
| Time Maintained Above Temperature ( $T_L$ )          | 217°C              |
| Time Maintained Above Time ( $t_L$ )                 | 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 7:

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

## Mechanical Dimensions

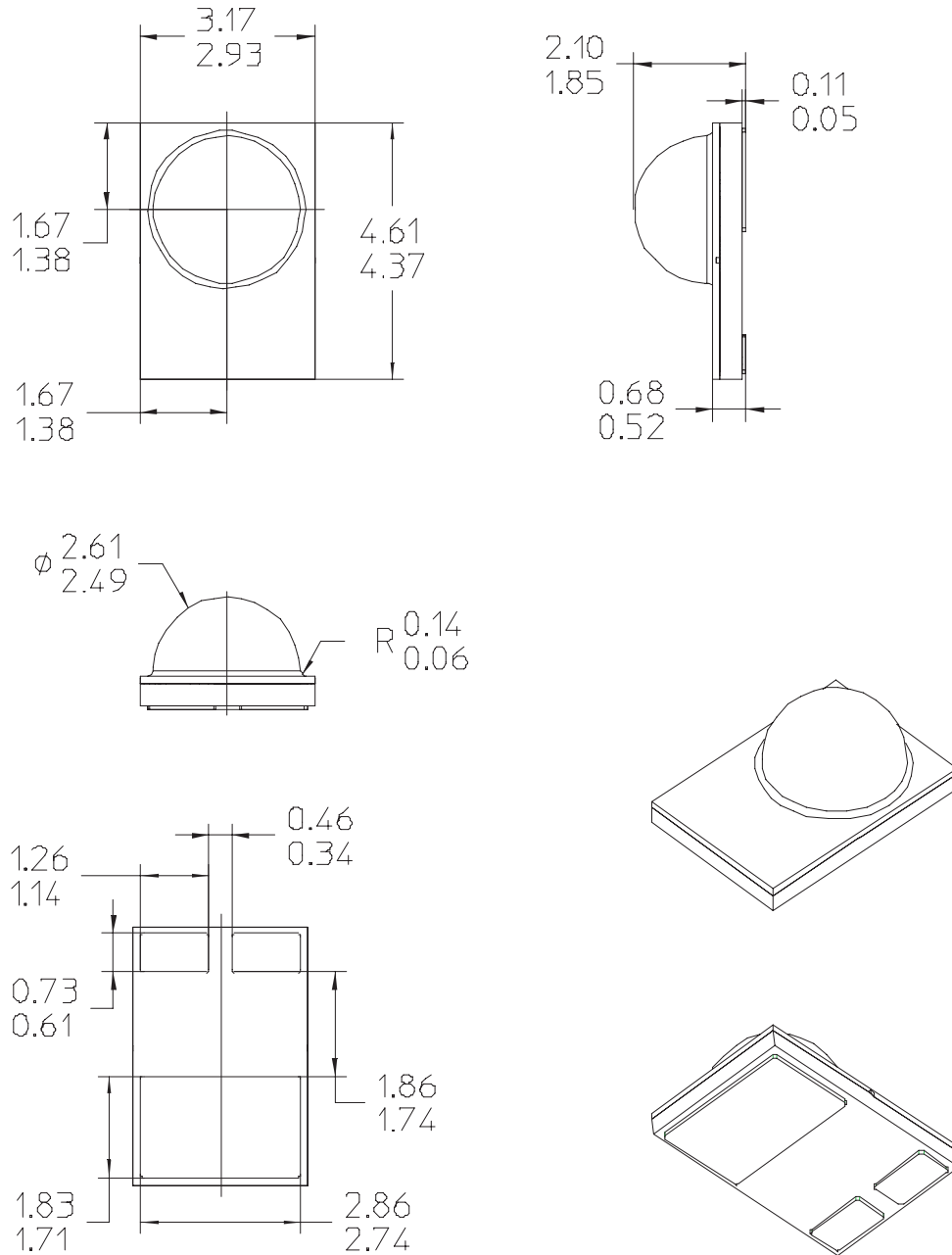


Figure 1. Package Outline Drawing.

Notes for Figure 1:

1. Do not handle the device by the lens—care must 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

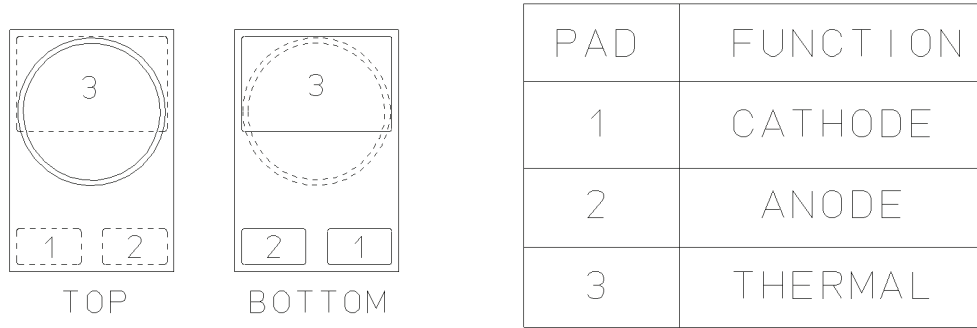


Figure 2. Pad Configuration.

Note for Figure 2:

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

## Solder Pad Design

Note for Figure 3:

The photograph below shows the recommended LUXEON Rebel 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 upon request.

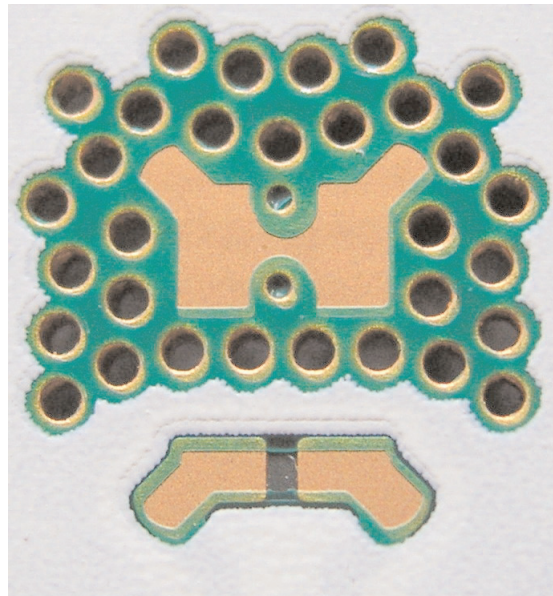


Figure 3. Solder Pad Layout.

## Wavelength Characteristics

### Green, Cyan, Blue, Royal-Blue, Red, Red-Orange and Amber at Test Current Thermal Pad Temperature, $T_J = 25^\circ\text{C}$

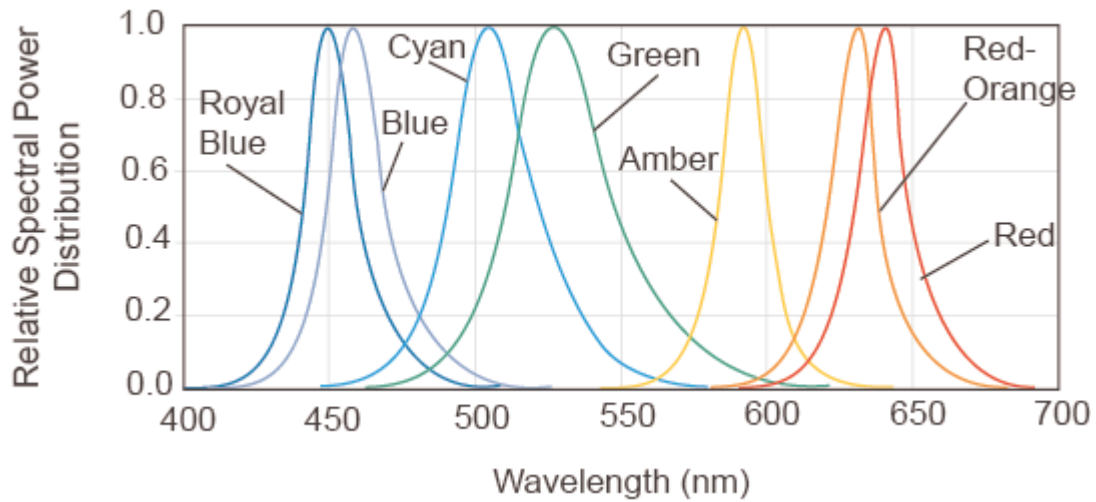


Figure 4. Relative intensity vs. wavelength.

### Cool-White at Test Current Thermal Pad Temperature = $25^\circ\text{C}$

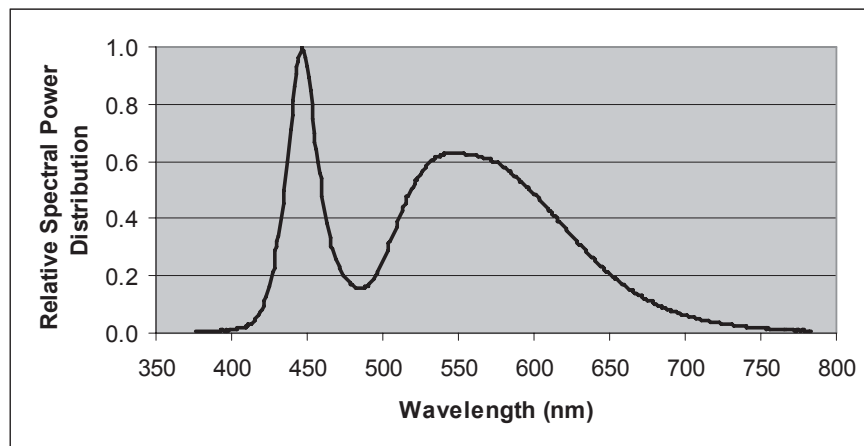


Figure 5a. Cool-White color spectrum of typical CCT part, integrated measurement.

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

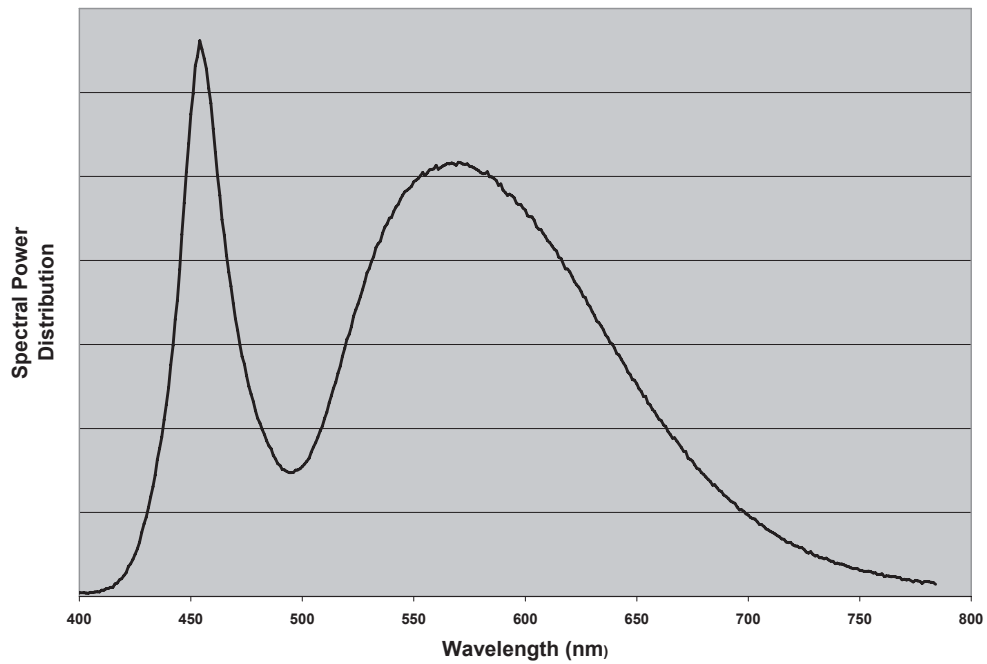


Figure 5b. Neutral-White color spectrum of typical CCT part, integrated measurement.

## Warm-White at Test Current Thermal Pad Temperature = 25°C

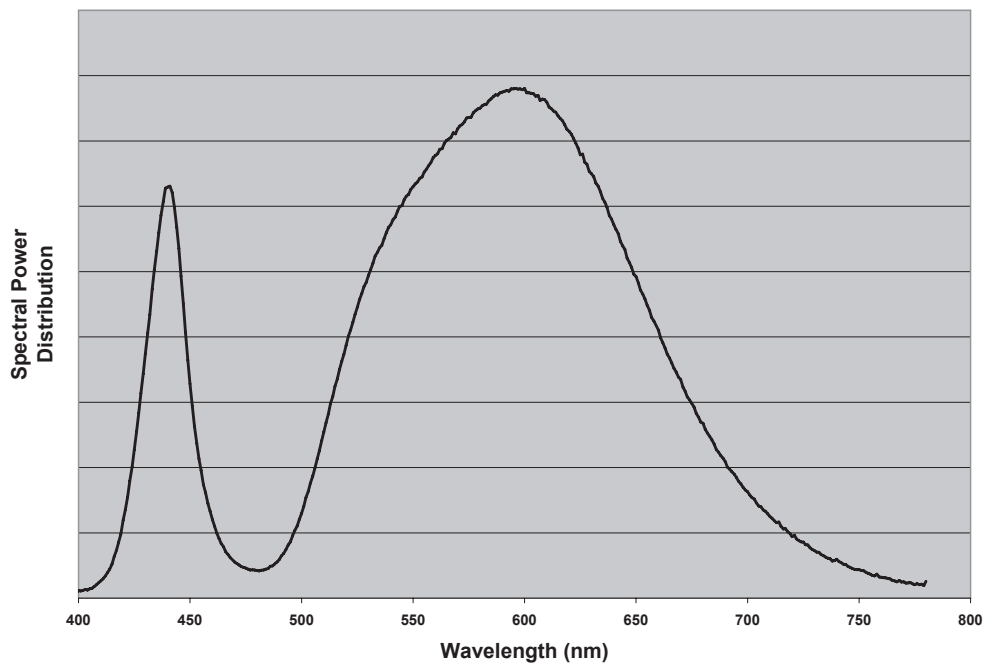


Figure 5c. Warm-White color spectrum of typical CCT part, integrated measurement.

## Typical Light Output Characteristics over Temperature

Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue at Test Current.

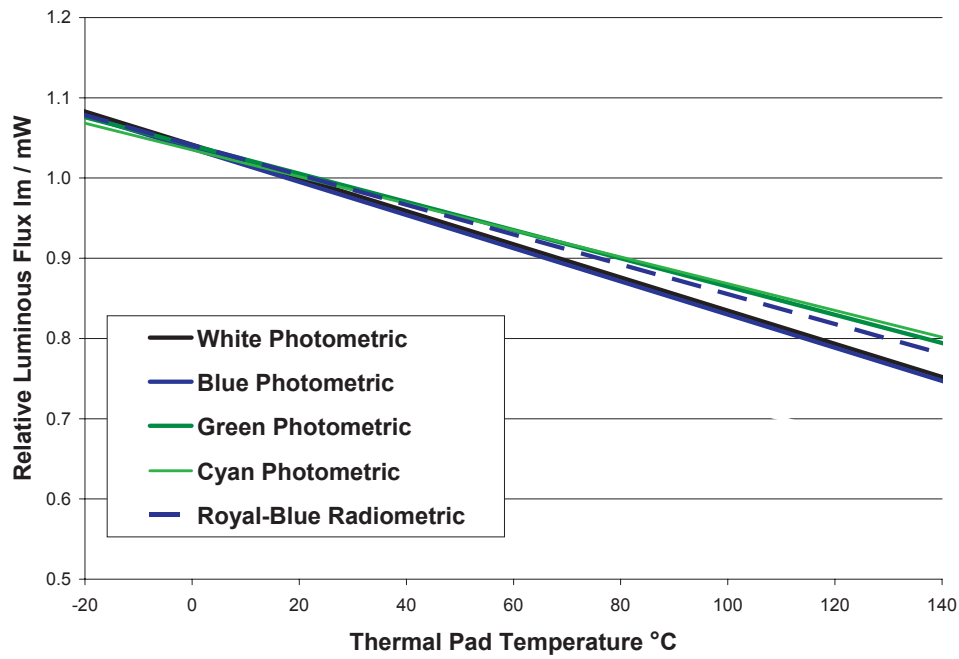


Figure 6. Relative light output vs. Thermal Pad temperature for White, Green, Cyan, Blue and Royal-Blue.

Red, Red-Orange and Amber at Test Current

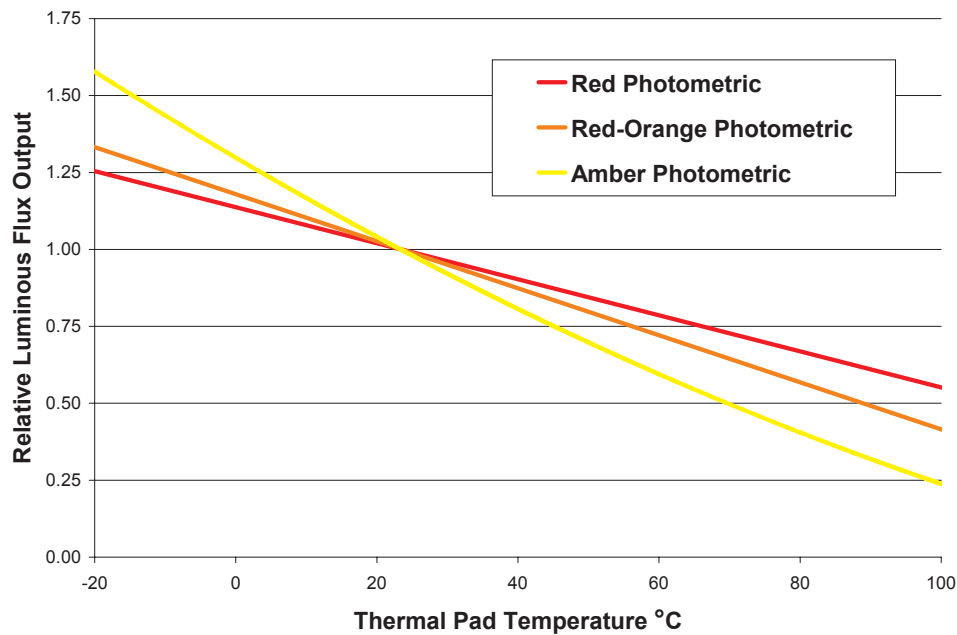


Figure 7. Relative light output vs. Thermal Pad temperature for Red, Red-Orange and Amber.

## Typical Forward Current Characteristics

Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue, Thermal Pad Temperature = 25°C

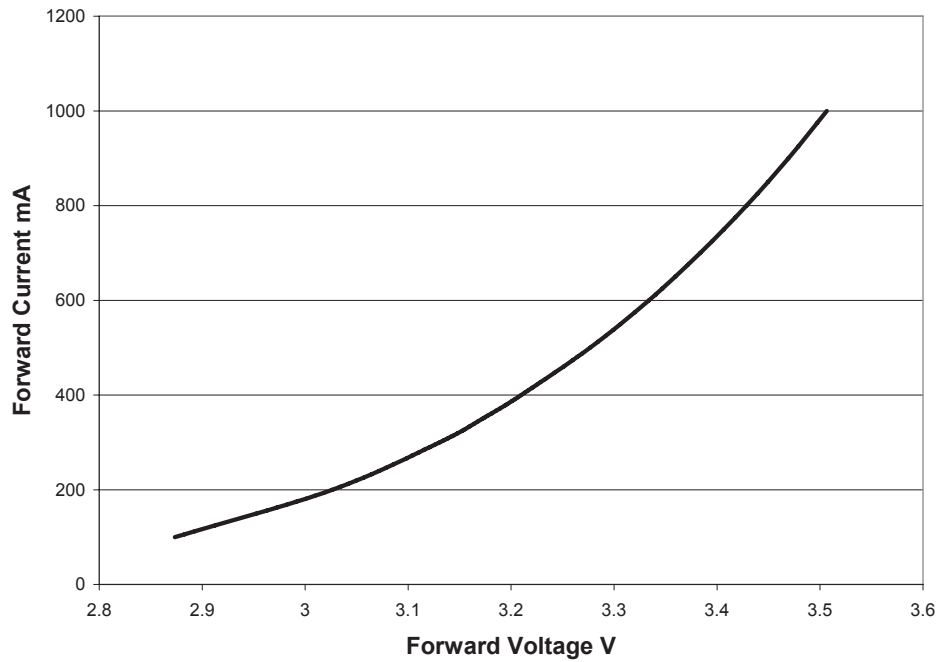


Figure 8. Forward current vs. forward voltage for White, Green, Cyan, Blue and Royal-Blue.

Red, Red-Orange and Amber, Thermal Pad Temperature = 25°C

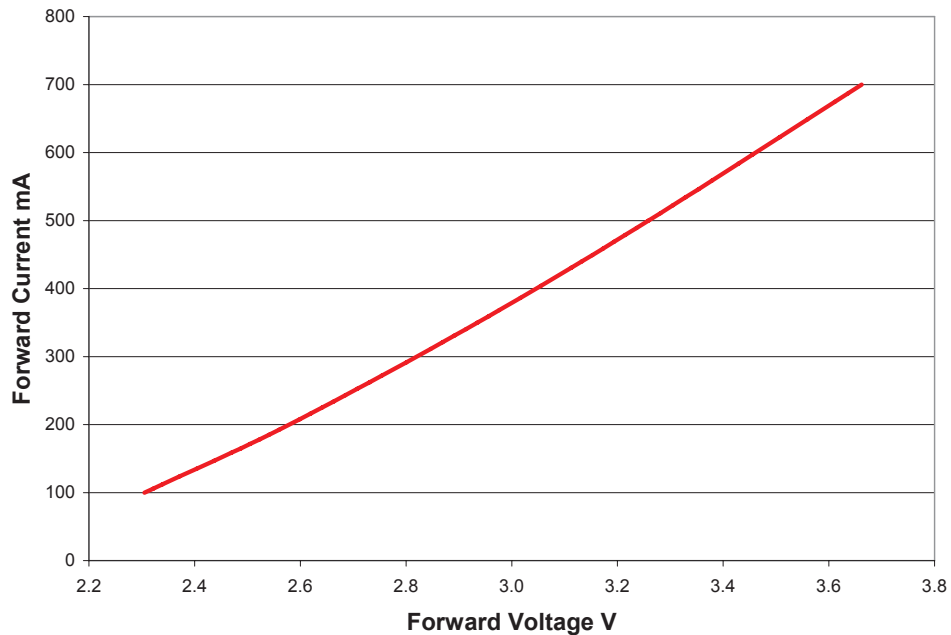


Figure 9. Forward current vs. forward voltage for red, red-orange and amber.

## Typical Relative Luminous Flux

### Typical Relative Luminous Flux vs. Forward Current for Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue, Thermal Pad Temperature = 25°C

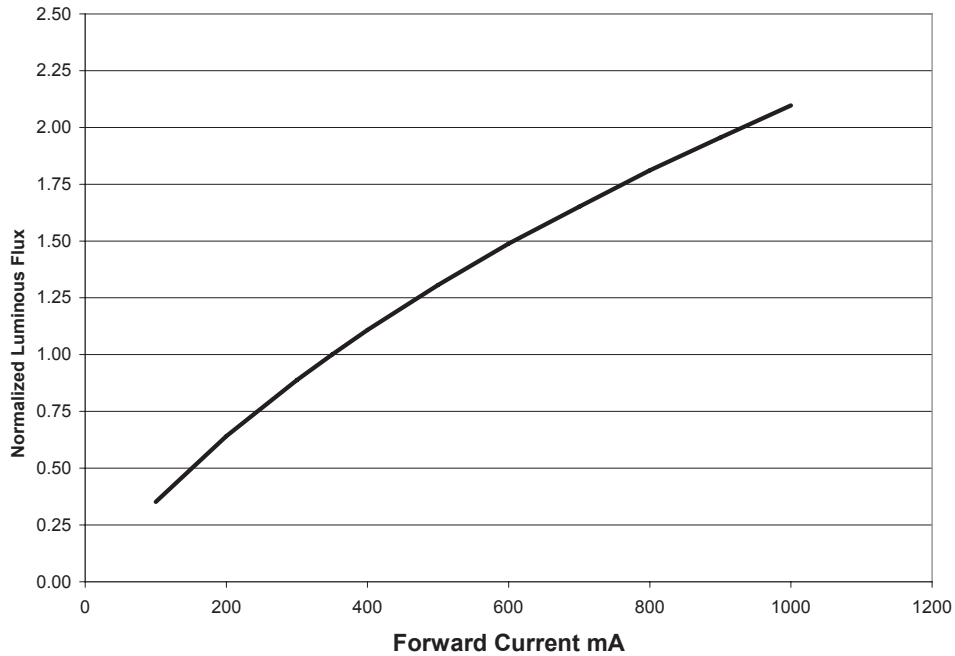


Figure 10. Relative luminous flux or radiometric power vs. forward current for white, green, cyan, blue and royal blue at Thermal Pad = 25°C maintained, test current 350 mA.

### Typical Relative Luminous Flux vs. Forward Current for Red, Red-Orange, Amber, Thermal Pad Temperature = 25°C

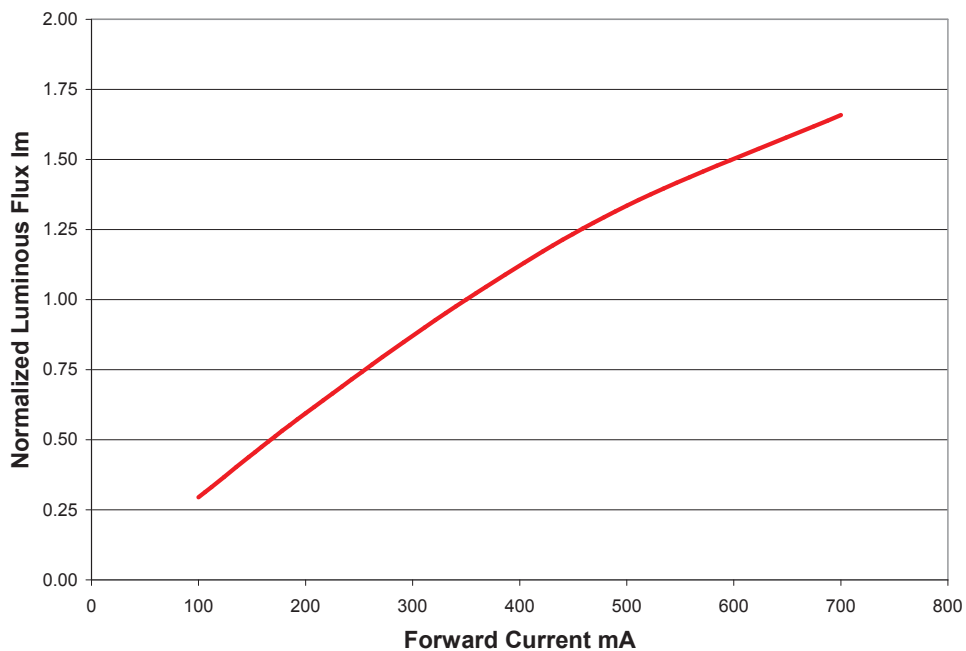


Figure 11. Relative luminous flux vs. forward current for red, red-orange and amber at Thermal Pad = 25°C maintained, test current 350 mA.



## Current Derating Curves

### Current Derating Curve for 350 mA drive current Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue

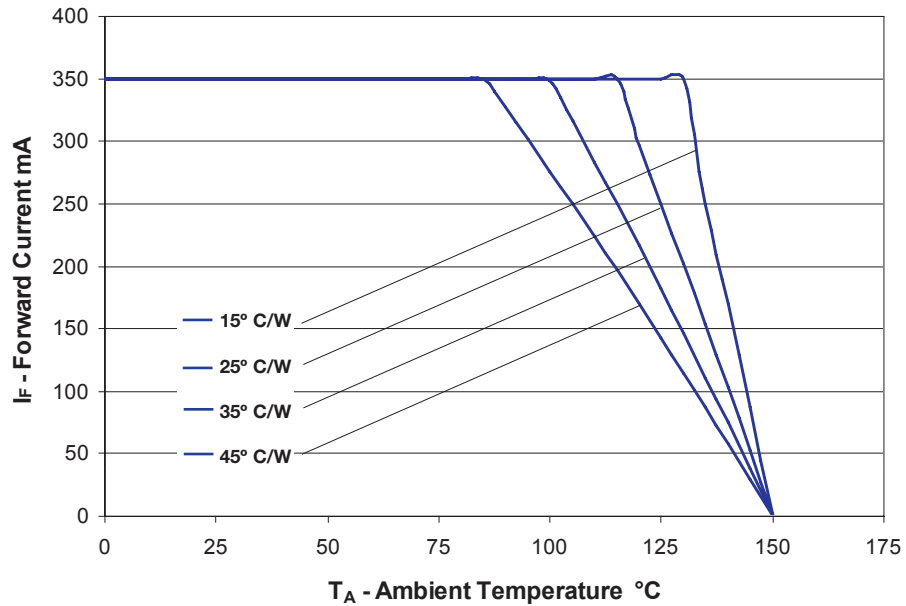


Figure 12: Maximum forward current vs. ambient temperature, based on T<sub>JMAX</sub> = 150°C.

### Current Derating Curve for 350 mA drive current Red, Red-Orange, Amber

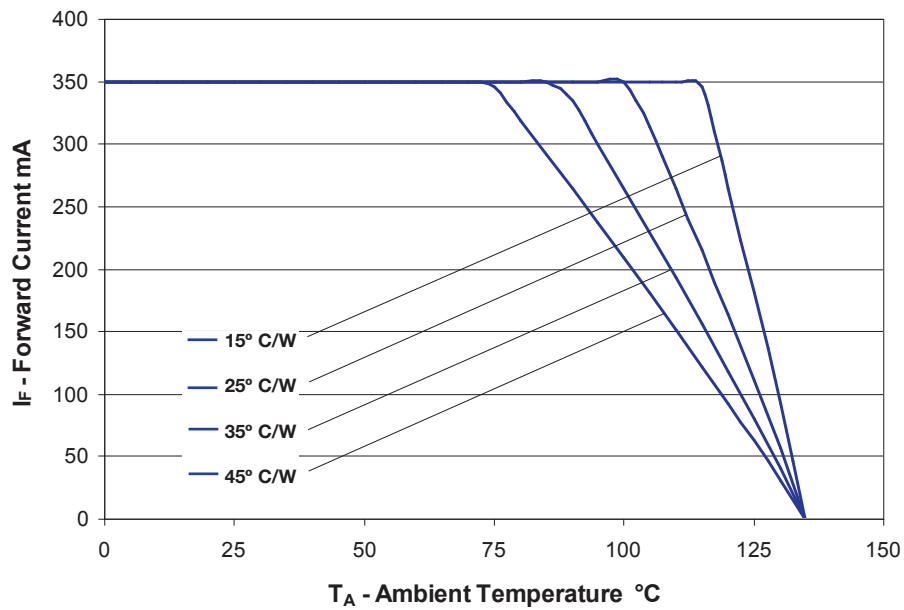


Figure 13: Maximum forward current vs. ambient temperature, based on T<sub>JMAX</sub> = 135°C.

## Current Derating Curve for 700 mA drive current Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue

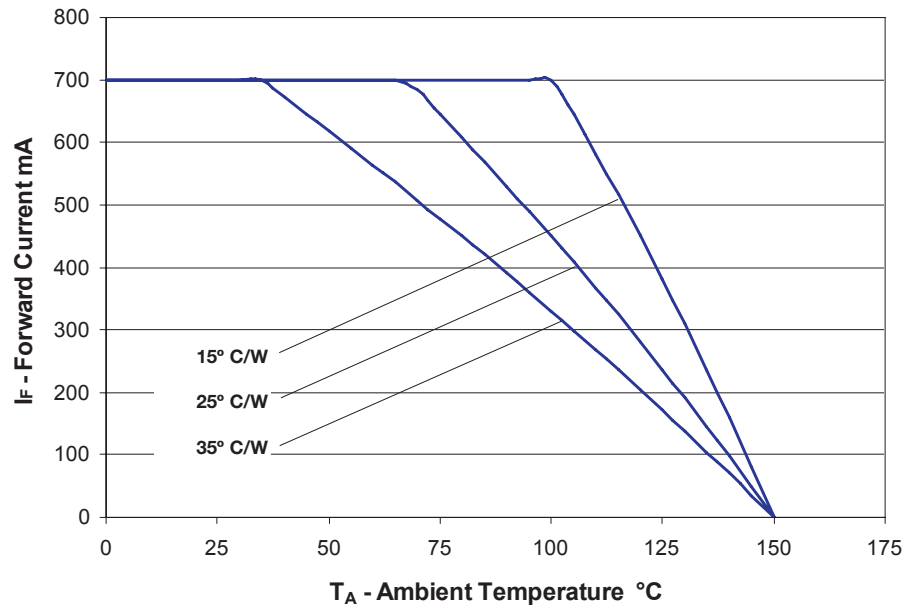


Figure 14: Maximum forward current vs. ambient temperature, based on  $T_{JMAX} = 150^{\circ}C$ .

## Current Derating Curve for 700 mA drive current Red, Red-Orange, Amber

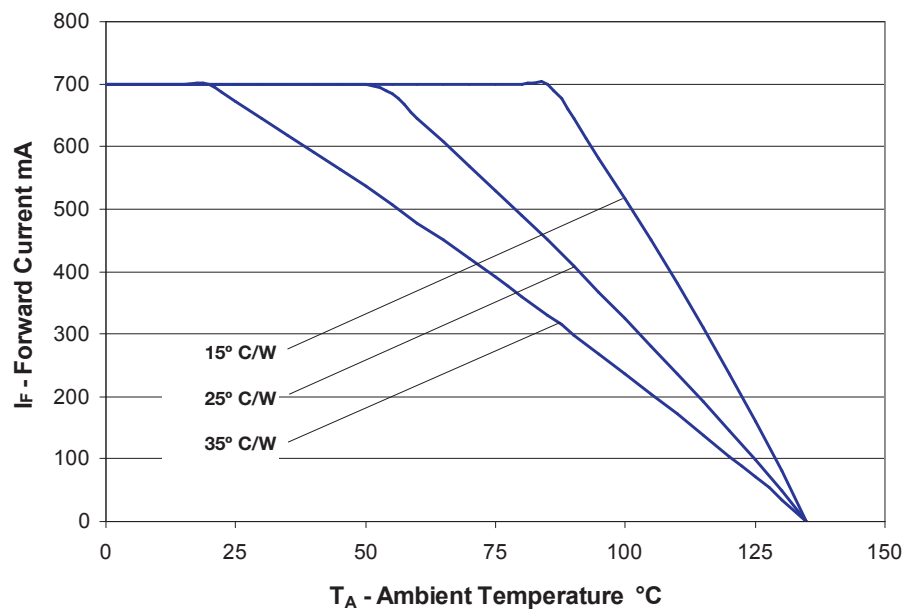


Figure 15: Maximum forward current vs. ambient temperature, based on  $T_{JMAX} = 135^{\circ}C$ .

## Current Derating Curve for 1000mA drive current Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal-Blue

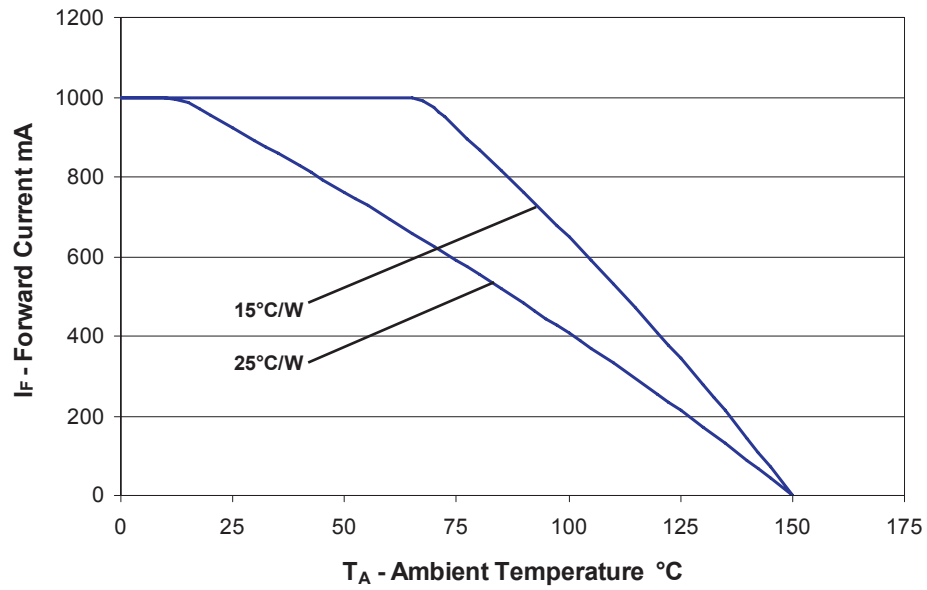


Figure 16: Maximum forward current vs. ambient temperature, based on  $T_{JMAX} = 150^{\circ}\text{C}$ .

## Typical Radiation Patterns

### Typical Representative Spatial Radiation Pattern for Cool-White, Neutral-White and Warm-White Lambertian

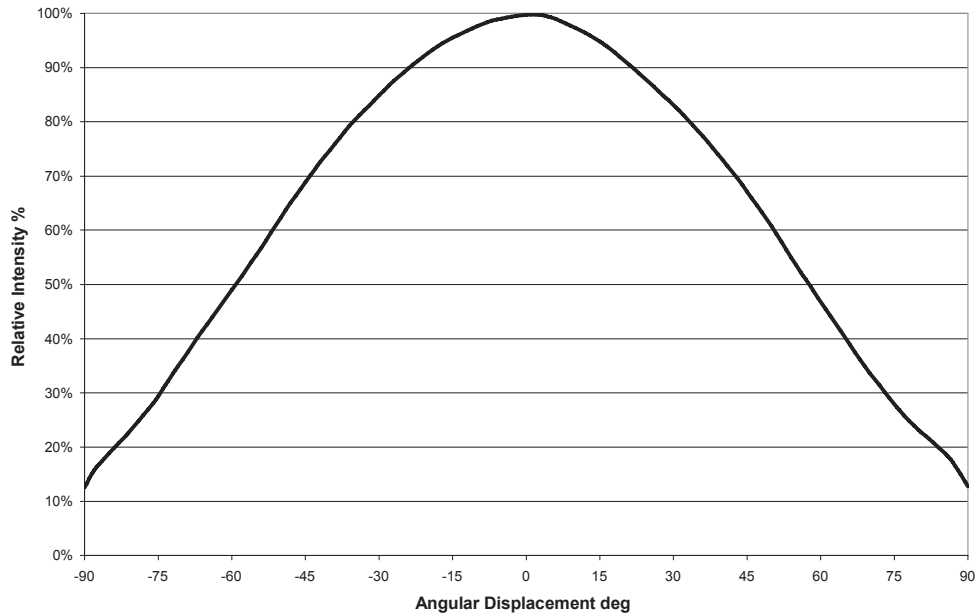


Figure 17: Typical Representative Spatial Radiation Pattern for Cool-White, Neutral-White and Warm-White Lambertian.

### Typical Polar Radiation Pattern for White Lambertian

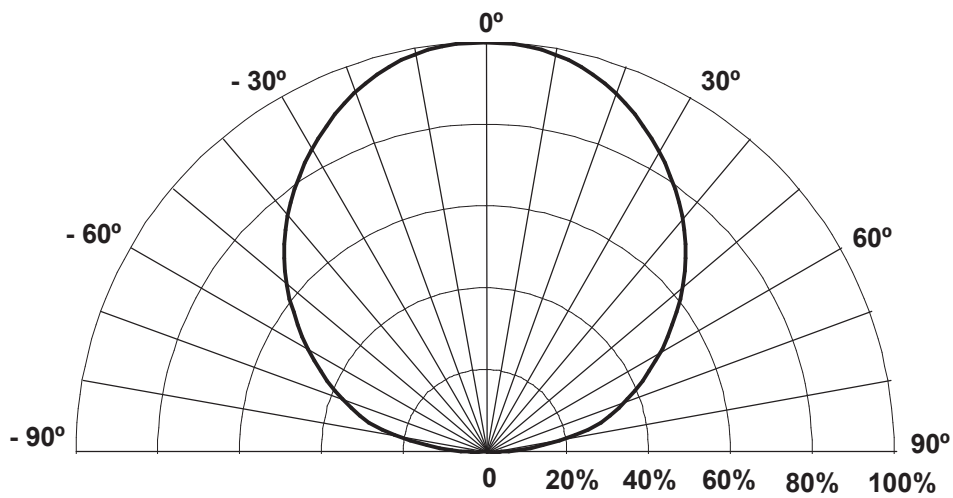


Figure 18: Typical Polar Radiation Pattern for Cool-White, Neutral-White and Warm-White Lambertian.

## Typical Representative Spatial Radiation Pattern for Green, Cyan, Blue and Royal-Blue Lambertian

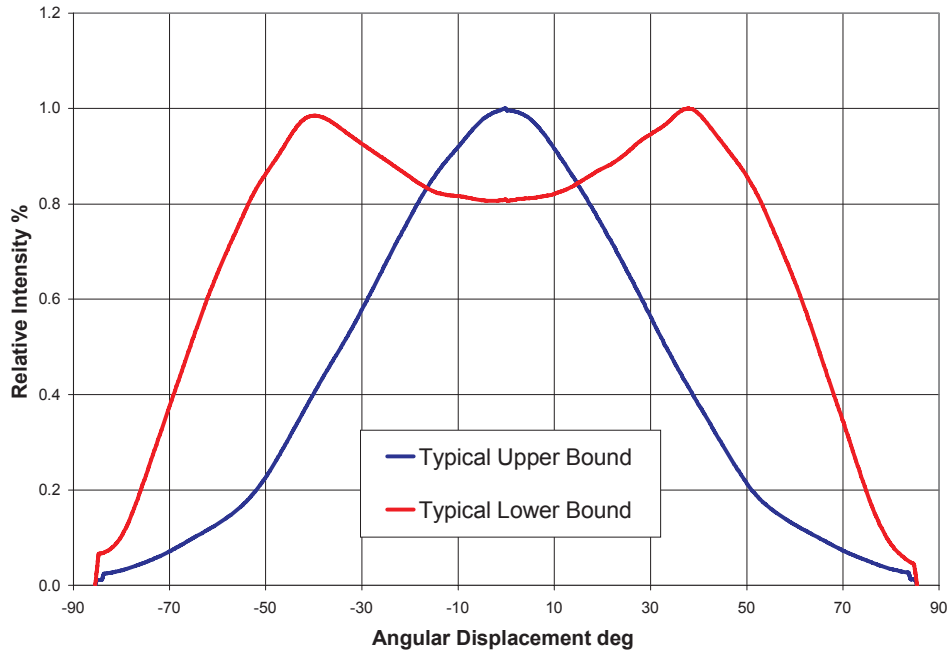


Figure 19: Typical Representative Spatial Radiation Pattern for Green and Royal Blue Lambertian.

## Typical Polar Radiation Pattern for Green, Cyan, Blue and Royal-Blue Lambertian

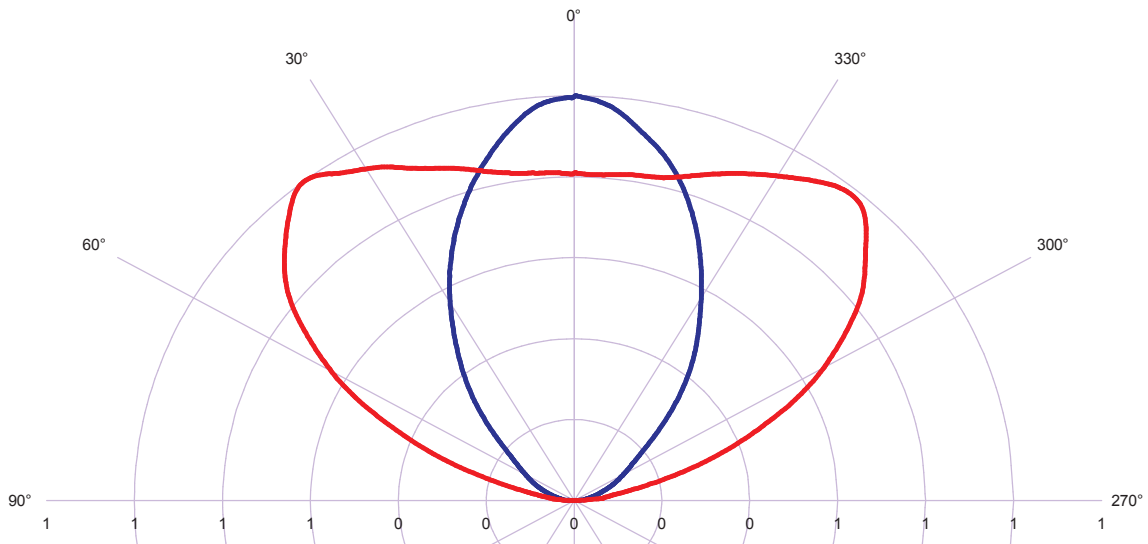


Figure 20: Typical Polar Radiation Pattern for Green and Royal Blue Lambertian.

## Typical Representative Spatial Radiation Pattern for Red, Red-Orange and Amber Lambertian

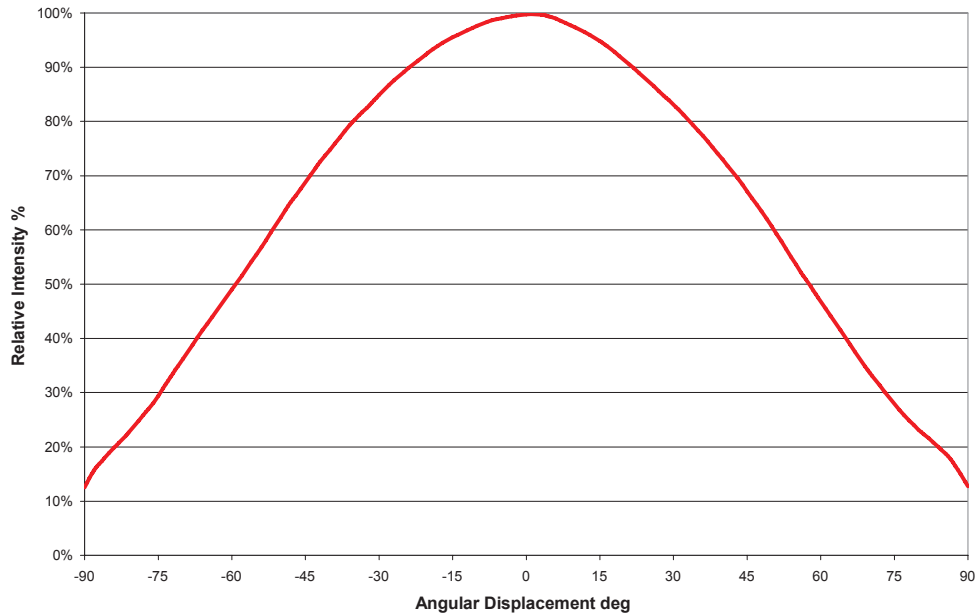


Figure 21: Typical Representative Spatial Radiation Pattern for Red, Red-Orange and Amber Lambertian.

## Typical Polar Radiation Pattern for Red, Red-Orange and Amber Lambertian

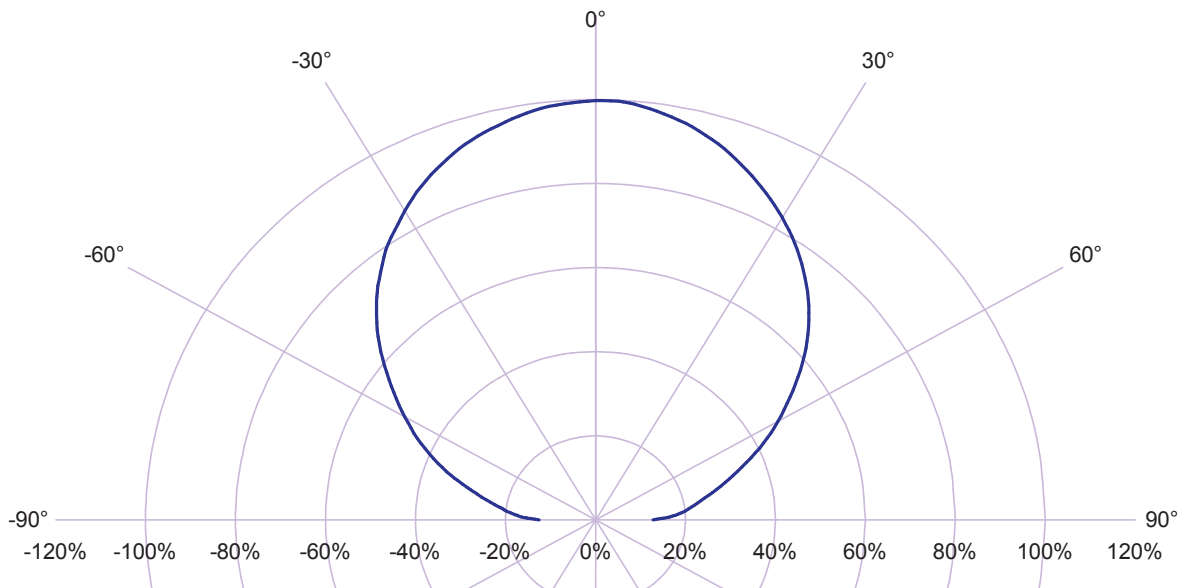
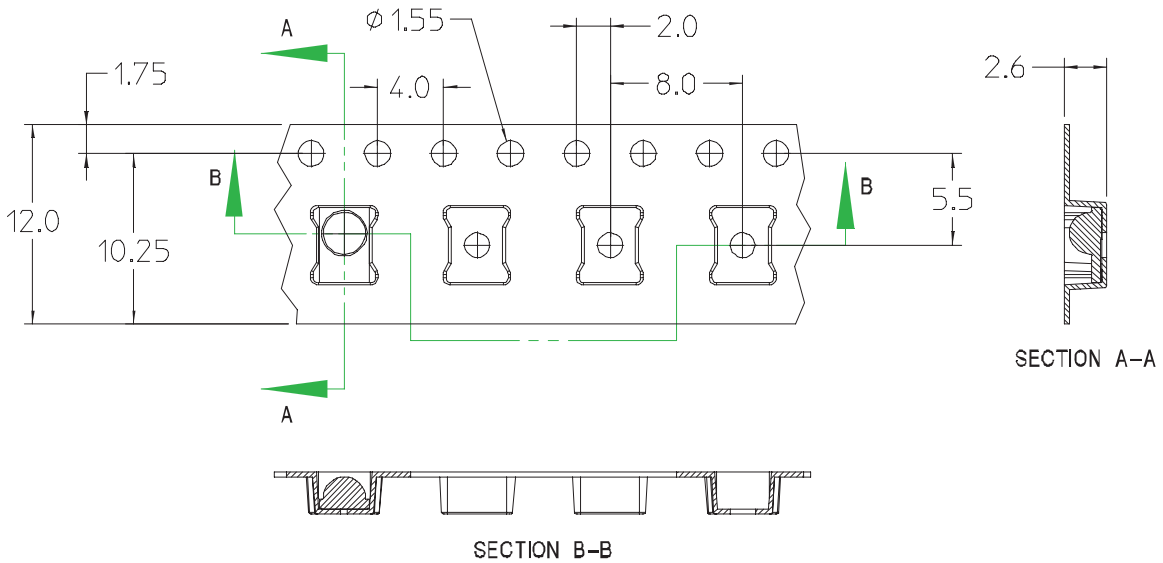
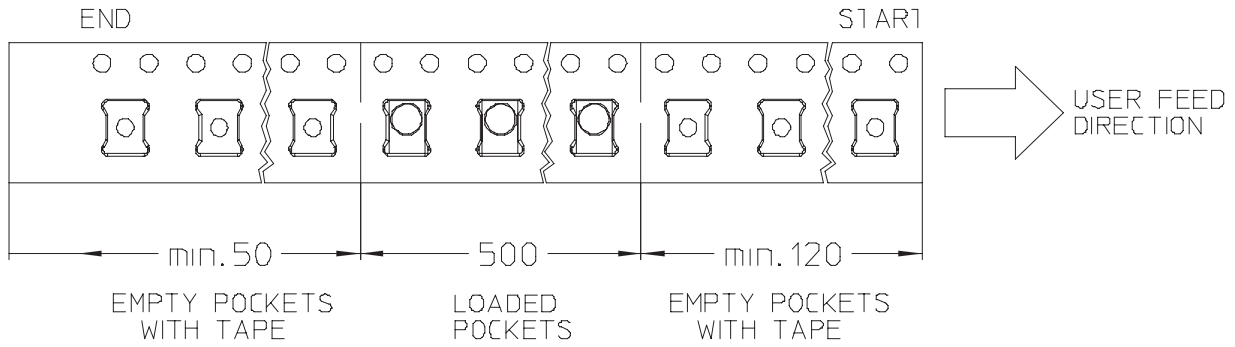
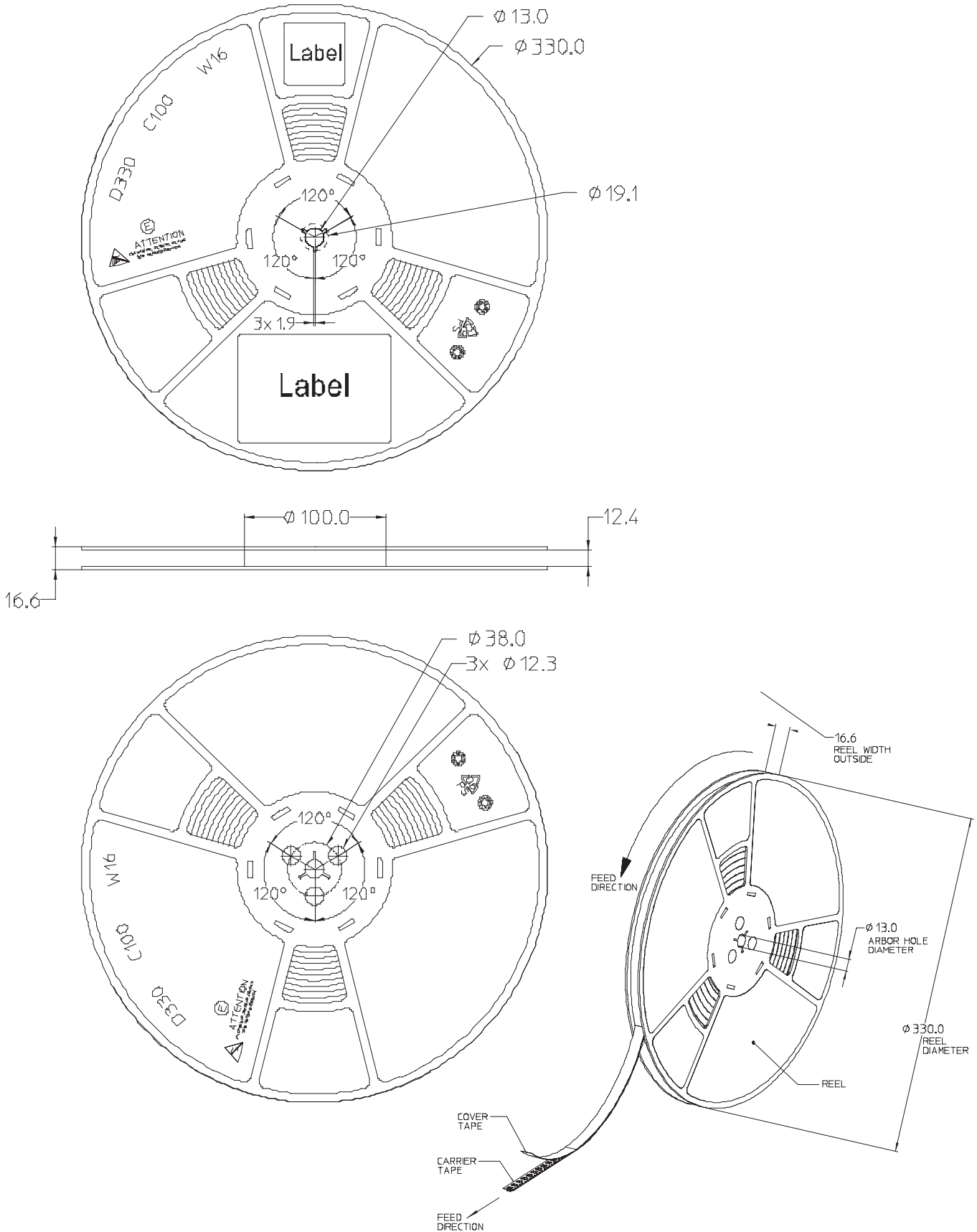


Figure 22: Typical Polar Radiation Pattern for Red, Red-Orange and Amber Lambertian.

# Emitter Pocket Tape Packaging



# Emitter Reel Packaging





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## 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 Emitters are labeled using a three or 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.

### Format of Labeling for Emitters

Reels of Green, Cyan, Blue, Royal-Blue, Red, Red-Orange and Amber Emitters are labeled with a three digit alphanumeric CAT code following the format below.

ABC

A = Flux bin (J, H, J, K etc.)

B = Color bin (2, 4, 6 etc.)

C =  $V_F$  bin (D, E, F, G etc.)

Reels of Cool-White, Neutral-White and Warm-White Emitters are labeled with a four digit alphanumeric CAT code following the format below.

ABCD

A = Flux bin (J, H, J, K etc.)

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

C =  $V_F$  bin (D, E, F, G etc.)

## Luminous Flux Bins

Table 8 lists the standard photometric luminous flux bins for LUXEON Rebel emitters (tested and binned at 350mA).

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 8.

| Flux Bins - All Colors (except Royal-Blue) |                               |                               |
|--|-------------------------------|-------------------------------|
| Bin Code                                   | Minimum Photometric Flux (lm) | Maximum Photometric Flux (lm) |
| A  | 8.2                           | 10.7                          |
| B  | 10.7                          | 13.9                          |
| C  | 13.9                          | 18.1                          |
| D  | 18.1                          | 23.5                          |
| E  | 23.5                          | 30                            |
| F  | 30                            | 40                            |
| G  | 40                            | 50                            |
| H  | 50                            | 60                            |
| J  | 60                            | 70                            |
| K  | 70                            | 80                            |
| L  | 80                            | 90                            |
| M  | 90                            | 100                           |
| N  | 100                           | 120                           |
| P  | 120                           | 140                           |
| Q  | 140                           | 160                           |
| R  | 160                           | 180                           |
| S  | 180                           | 200                           |
| T  | 200                           | 220                           |
| U  | 220                           | 240                           |
| V  | 240                           | 260                           |
| W  | 260                           | 280                           |
| X  | 280                           | 300                           |

Table 9.

| Flux Bins - Royal-Blue Only (tested and binned at 350mA) |                               |                               |
|--|-------------------------------|-------------------------------|
| Bin Code   | Minimum Radiometric Flux (mW) | Maximum Radiometric Flux (mW) |
| A  | 175                           | 225                           |
| B  | 225                           | 275                           |
| C  | 275                           | 350                           |
| D  | 350                           | 425                           |
| E  | 425                           | 500                           |
| F  | 500                           | 600                           |
| G  | 600                           | 700                           |
| H  | 700                           | 800                           |
| J  | 800                           | 900                           |
| K  | 900                           | 1000                          |

### Cool-White Bin Structure

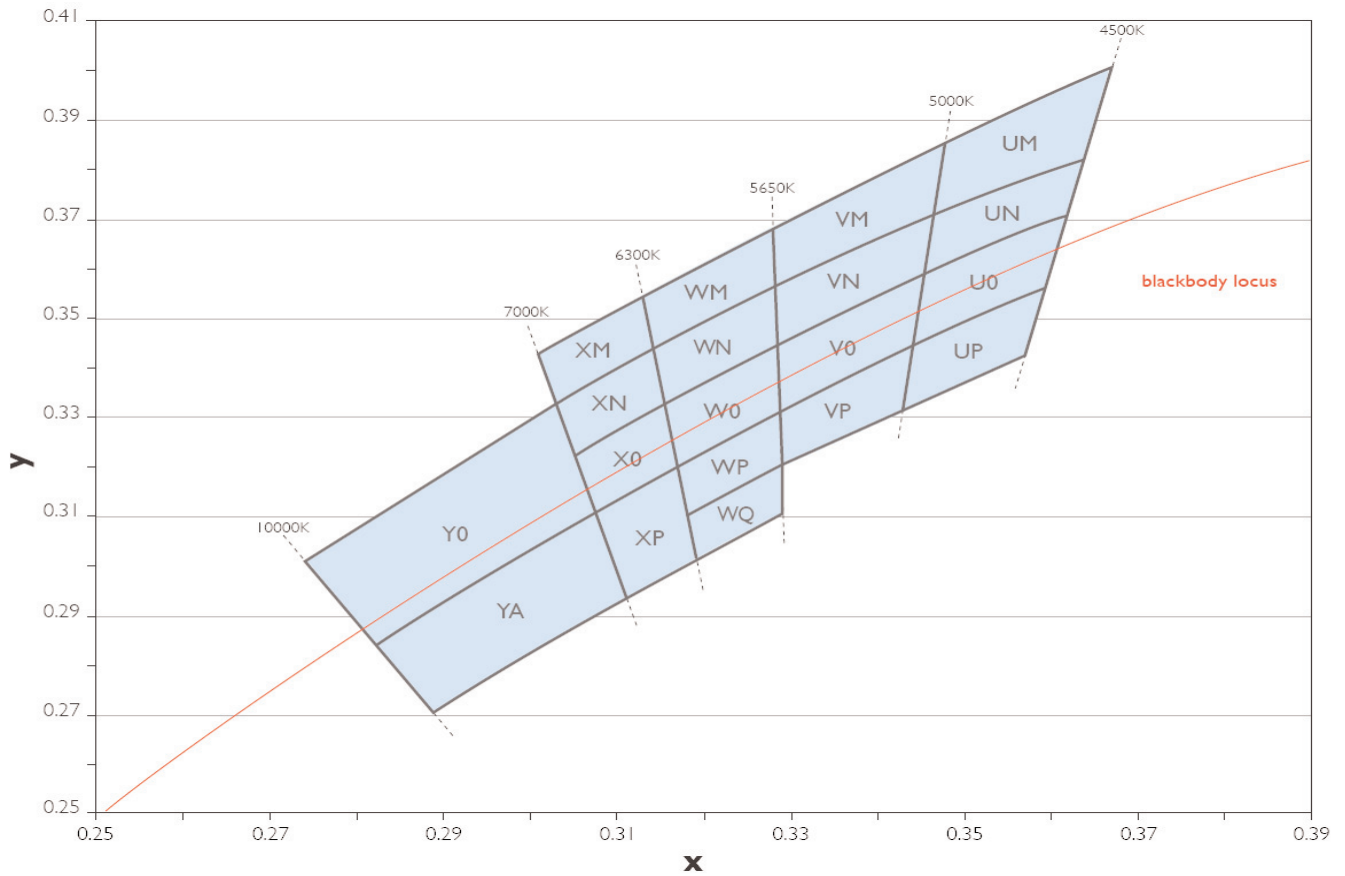


Figure 23: Cool-White Bin Structure.

## Cool-White Bin Coordinates

Cool-White LUXEON Rebel Emitters are tested and binned by x,y coordinates.

19 Color Bins, CCT Range 10,000K to 4,500K

Table 10.

| 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 10:

1. Philips Lumileds maintains a tester tolerance of  $\pm 0.005$  on x, y color coordinates.

## Neutral-White Bin Structure

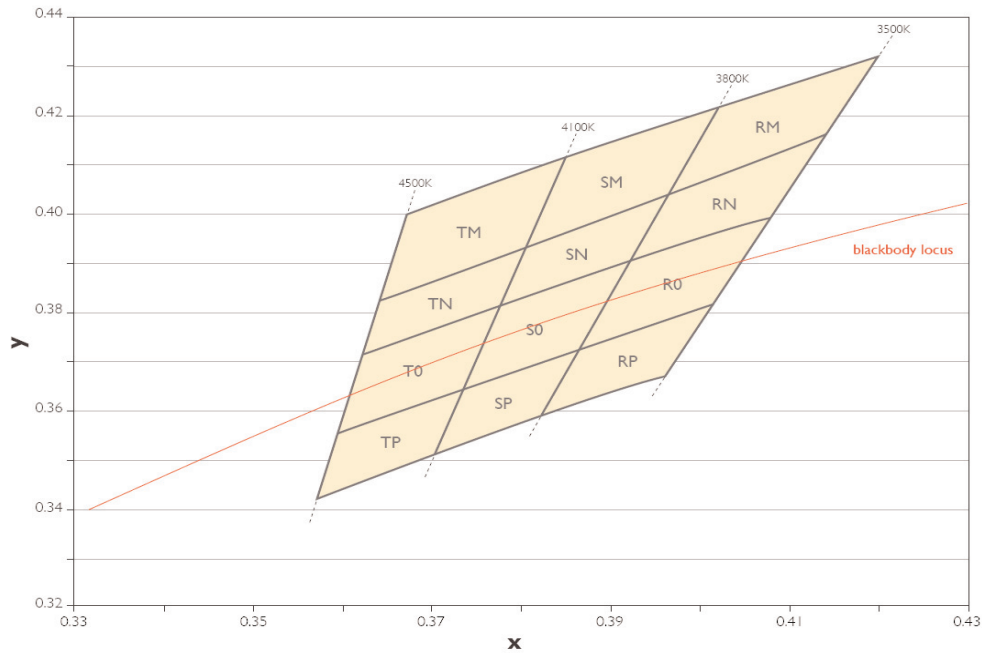


Figure 24: Neutral-White Bin Structure.

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

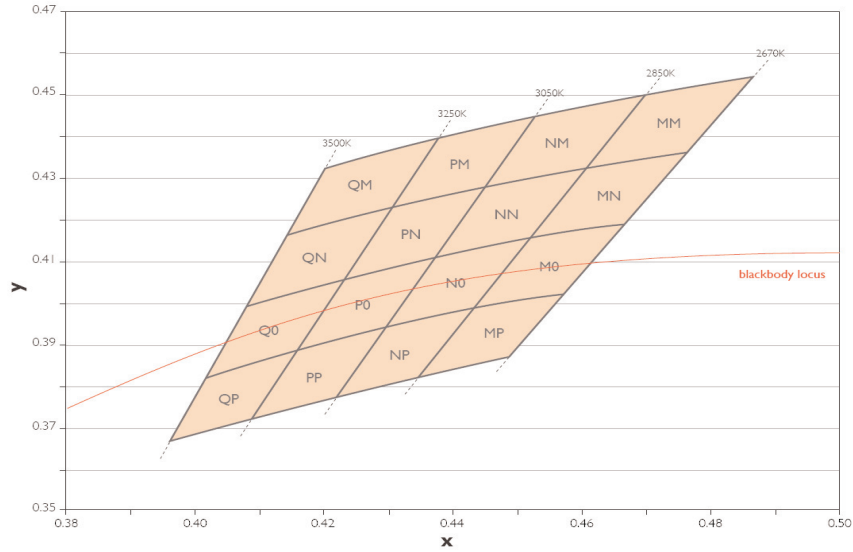
Table 11.

| Neutral-White Bin Coordinates |          |          |                 |          |          |          |                 |
|-------------------------------|----------|----------|-----------------|----------|----------|----------|-----------------|
| Bin Code                      | X        | Y        | Typical CCT (K) | Bin Code | X        | Y        | Typical CCT (K) |
| TM                            | 0.367294 | 0.400290 | 4300            | S0       | 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 |                 |
|                               | 0.362219 | 0.371616 |                 |          | 0.370582 | 0.351953 |                 |
| 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 |                 |
|                               | 0.357079 | 0.342581 |                 |          | 0.392368 | 0.390932 |                 |
| SM                            | 0.385953 | 0.412995 | 3950            | R0       | 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 11:

1. Philips Lumileds maintains a tester tolerance of  $\pm 0.005$  on x, y color coordinates.

## Warm-White Bin Structure



**Figure 25: Warm-White Bin Structure.**

Warm-White LUXEON Rebel Emitters are tested and binned by x,y coordinates. 16 Color Bins, CCT Range 3,500K to 2,670K

**Table 12.**

| Warm-White Bin Coordinates |          |          |                 |          |          |          |                 |
|----------------------------|----------|----------|-----------------|----------|----------|----------|-----------------|
| Bin Code                   | X        | Y        | Typical CCT (K) | Bin Code | X        | Y        | Typical CCT (K) |
| QM                         | 0.420940 | 0.432618 | 3375            | NM       | 0.453820 | 0.445980 | 2950            |
|                            | 0.438458 | 0.440399 |                 |          | 0.470507 | 0.450832 |                 |
|                            | 0.431186 | 0.423386 |                 |          | 0.461404 | 0.433334 |                 |
|                            | 0.414776 | 0.416097 |                 |          | 0.445639 | 0.428680 |                 |
| QN                         | 0.414776 | 0.416097 | 3375            | NN       | 0.445639 | 0.428680 | 2950            |
|                            | 0.431186 | 0.423386 |                 |          | 0.461404 | 0.433334 |                 |
|                            | 0.423956 | 0.406472 |                 |          | 0.452512 | 0.416241 |                 |
|                            | 0.408593 | 0.399525 |                 |          | 0.437578 | 0.411632 |                 |
| QO                         | 0.408593 | 0.399525 | 3375            | NO       | 0.437578 | 0.411632 | 2950            |
|                            | 0.423956 | 0.406472 |                 |          | 0.452512 | 0.416241 |                 |
|                            | 0.416487 | 0.389001 |                 |          | 0.443600 | 0.399111 |                 |
|                            | 0.402113 | 0.382156 |                 |          | 0.429373 | 0.394281 |                 |
| QP                         | 0.402113 | 0.382156 | 3375            | NP       | 0.429373 | 0.394281 | 2950            |
|                            | 0.416487 | 0.389001 |                 |          | 0.443600 | 0.399111 |                 |
|                            | 0.409996 | 0.373814 |                 |          | 0.435591 | 0.383714 |                 |
|                            | 0.396564 | 0.367284 |                 |          | 0.422124 | 0.378952 |                 |
| PM                         | 0.438458 | 0.440399 | 3150            | MM       | 0.470507 | 0.450832 | 2760            |
|                            | 0.453820 | 0.445980 |                 |          | 0.486648 | 0.454191 |                 |
|                            | 0.445639 | 0.428680 |                 |          | 0.476733 | 0.436634 |                 |
|                            | 0.431186 | 0.423386 |                 |          | 0.461404 | 0.433334 |                 |
| PN                         | 0.431186 | 0.423386 | 3150            | MN       | 0.461404 | 0.433334 | 2760            |
|                            | 0.445639 | 0.428680 |                 |          | 0.476733 | 0.436634 |                 |
|                            | 0.437578 | 0.411632 |                 |          | 0.467132 | 0.419632 |                 |
|                            | 0.423956 | 0.406472 |                 |          | 0.452512 | 0.416241 |                 |
| PO                         | 0.423956 | 0.406472 | 3150            | MO       | 0.452512 | 0.416241 | 2760            |
|                            | 0.437578 | 0.411632 |                 |          | 0.467132 | 0.419632 |                 |
|                            | 0.429373 | 0.394281 |                 |          | 0.457663 | 0.402866 |                 |
|                            | 0.416487 | 0.389001 |                 |          | 0.443600 | 0.399111 |                 |
| PP                         | 0.416487 | 0.389001 | 3150            | MP       | 0.443600 | 0.399111 | 2760            |
|                            | 0.429373 | 0.394281 |                 |          | 0.457663 | 0.402866 |                 |
|                            | 0.422124 | 0.378952 |                 |          | 0.448994 | 0.387515 |                 |
|                            | 0.409996 | 0.373814 |                 |          | 0.435591 | 0.383714 |                 |

Note for Table 12:

1. Philips Lumileds maintains a tester tolerance of  $\pm 0.005$  on x, y color coordinates.

## Color Bins

Green, Cyan and Blue LUXEON Rebel Emitters are tested and binned for dominant wavelength.

### Dominant Wavelength Bin Structure for Green Emitters

Table 13.

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 1        | 520                              | 525                              |
| 2        | 525                              | 530                              |
| 3        | 530                              | 535                              |
| 4        | 535                              | 540                              |
| 5        | 540                              | 545                              |
| 6        | 545                              | 550                              |

### Dominant Wavelength Bin Structure for Cyan Emitters

Table 14.

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 1        | 490                              | 495                              |
| 2        | 495                              | 500                              |
| 3        | 500                              | 505                              |
| 4        | 505                              | 510                              |
| 5        | 510                              | 515                              |
| 6        | 515                              | 520                              |

### Dominant Wavelength Bin Structure for Blue Emitters

Table 15.

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 1        | 460                              | 465                              |
| 2        | 465                              | 470                              |
| 3        | 470                              | 475                              |
| 4        | 475                              | 480                              |
| 5        | 480                              | 485                              |
| 6        | 485                              | 490                              |

Royal-Blue Luxeon Rebel Emitters are tested and binned for peak wavelength.

### Peak Wavelength Bin Structure for Royal-Blue Emitters

Table 16.

| Bin Code | Minimum Peak Wavelength (nm) | Maximum Peak Wavelength (nm) |
|----------|------------------------------|------------------------------|
| 3        | 440                          | 445                          |
| 4        | 445                          | 450                          |
| 5        | 450                          | 455                          |
| 6        | 455                          | 460                          |
| 7        | 460                          | 465                          |
| 8        | 465                          | 470                          |

Red, Red-Orange and Amber LUXEON Rebel Emitters are tested and binned for dominant wavelength.

## Dominant Wavelength Bin Structure for Red Emitters

Table 17.

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 4        | 620.5                            | 631.0                            |
| 5        | 631.0                            | 645.0                            |

## Dominant Wavelength Bin Structure for Red-Orange Emitters

Table 18.

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 2        | 613.5                            | 620.5                            |

## Dominant Wavelength Bin Structure for Amber Emitters

Table 19.

| Amber Dominant Wavelength Bins |                                  |                                  |
|--------------------------------|----------------------------------|----------------------------------|
| Bin Code                       | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
| 1                              | 584.5                            | 587.0                            |
| 2                              | 587.0                            | 589.5                            |
| 4                              | 589.5                            | 592.0                            |
| 6                              | 592.0                            | 594.5                            |
| 7                              | 594.5                            | 597.0                            |

## Forward Voltage Bins

Table 20 lists minimum and maximum  $V_F$  bin values per emitter. Although several bins are outlined, product availability in a particular bin varies by production run and by product performance.

Table 20.

| $V_F$ Bins |                             |                             |
|------------|-----------------------------|-----------------------------|
| Bin Code   | Minimum Forward Voltage (V) | Maximum Forward Voltage (V) |
| A          | 2.31                        | 2.55                        |
| B          | 2.55                        | 2.79                        |
| C          | 2.79                        | 3.03                        |
| D          | 3.03                        | 3.27                        |
| E          | 3.27                        | 3.51                        |
| F          | 3.51                        | 3.75                        |
| G          | 3.75                        | 3.99                        |





### Company Information

Philips Lumileds Lighting Company is a world class supplier of Light Emitting Diodes (LEDs) and produces billions of LEDs annually. 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 as well as production capabilities in San Jose, Penang Malaysia and Singapore. Founded in 1999, Philips Lumileds is the high-flux LED technology leader and is dedicated to bridging the gap between solid-state LED technology and the lighting world. Philips Lumileds technologies, LEDs and systems are enabling new applications and markets in the lighting world.

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FOR TECHNICAL ASSISTANCE OR THE LOCATION OF YOUR NEAREST SALES OFFICE CONTACT ANY OF THE FOLLOWING:

**NORTH AMERICA:**  
+1 888 589 3662 OR  
[ASKLUXEON@FUTUREELECTRONICS.COM](mailto:ASKLUXEON@FUTUREELECTRONICS.COM)

**EUROPE:**  
OO 800 443 88 873 OR  
[LUXEON.EUROPE@FUTUREELECTRONICS.COM](mailto:LUXEON.EUROPE@FUTUREELECTRONICS.COM)

**ASIA:**  
800 5864 5337 OR  
[LUMILEDS.ASIA@FUTUREELECTRONICS.COM](mailto:LUMILEDS.ASIA@FUTUREELECTRONICS.COM)