



LUXEON Rebel  
General Purpose White  
Portfolio

*High flux  
and color stability*

Technical Datasheet DS64

L U X E  N<sup>®</sup>  
never before possible

# LUXEON<sup>®</sup> Rebel

## General Purpose White Portfolio

### Introduction

The LUXEON<sup>®</sup> Rebel General Purpose White Portfolio LEDs in this datasheet are ideal for all lighting and illumination applications. These flux differentiated parts, like all other LUXEON Rebel LEDs, provide the industry's best lumen maintenance, superior reliability and quality white light that make them the most widely used power LEDs today. Using the information in this document you can start designing applications to your unique specifications.

### LUXEON Rebel General Purpose White LEDs

- Deliver more usable light and higher flux density
- Optimize applications to reduce size and cost
- Tightly pack the LEDs for mixing
- Engineer more robust applications
- Utilize standard FR4 PCB technology
- Simplify manufacturing through the use of surface mount technology.

**PHILIPS**  
**LUMILEDS**

# Table of Contents

|                                                            |    |
|------------------------------------------------------------|----|
| Product Nomenclature.....                                  | 3  |
| Average Lumen Maintenance Characteristics .....            | 3  |
| Environmental Compliance.....                              | 3  |
| Visual Appearance of LUXEON Rebel.....                     | 3  |
| Flux Characteristics.....                                  | 4  |
| Flux Performance, Binning, and Supportability .....        | 5  |
| Optical Characteristics.....                               | 6  |
| Electrical Characteristics.....                            | 7  |
| Absolute Maximum Ratings .....                             | 8  |
| JEDEC Moisture Sensitivity.....                            | 8  |
| Reflow Soldering Characteristics .....                     | 9  |
| Mechanical Dimensions .....                                | 10 |
| Pad Configuration .....                                    | 11 |
| Solder Pad Design.....                                     | 11 |
| Wavelength Characteristics.....                            | 12 |
| Typical Light Output Characteristics over Temperature..... | 14 |
| Typical Forward Current Characteristics.....               | 15 |
| Typical Relative Luminous Flux .....                       | 16 |
| Current Derating Curves.....                               | 17 |
| Typical Radiation Patterns.....                            | 19 |
| Emitter Pocket Tape Packaging.....                         | 21 |
| Emitter Reel Packaging .....                               | 22 |
| Product Binning and Labeling .....                         | 23 |
| Luminous Flux Bins.....                                    | 24 |
| Cool-White Bin Structure .....                             | 25 |
| Neutral-White Bin Structure .....                          | 27 |
| Warm-White Bin Structure.....                              | 28 |
| Forward Voltage Bins.....                                  | 30 |

## Product Nomenclature

LUXEON Rebel is tested and binned at 350 mA.

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 Labeling section)
- C — designates color variant (0 for direct colored variants)
- D — designates test current (value I 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 0 I - 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 and warm-white 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.

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

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

**Table I.**

| Performance at Test Current |                |                                              |                   | Typical Performance at Indicated Current     |                    |
|-----------------------------|----------------|----------------------------------------------|-------------------|----------------------------------------------|--------------------|
| Color                       | Part Number    | Minimum Luminous Flux (lm)<br>$\Phi_v^{[1]}$ | Test Current (mA) | Typical Luminous Flux (lm)<br>$\Phi_v^{[2]}$ | Drive Current (mA) |
| Cool White                  | LXML-PWCI-0040 | 40                                           | 350               | 80                                           | 700                |
|                             | LXML-PWCI-0050 | 50                                           | 350               | 95                                           | 700                |
|                             | LXML-PWCI-0080 | 80                                           | 350               | 145                                          | 700                |
|                             | LXML-PWCI-0090 | 90                                           | 350               | 160                                          | 700                |
|                             | LXML-PWCI-0100 | 100                                          | 350               | 180                                          | 700                |
| Neutral-White               | LXML-PWNI-0040 | 40                                           | 350               | 80                                           | 700                |
|                             | LXML-PWNI-0050 | 50                                           | 350               | 95                                           | 700                |
|                             | LXML-PWNI-0080 | 80                                           | 350               | 145                                          | 700                |
|                             | LXML-PWNI-0090 | 90                                           | 350               | 160                                          | 700                |
|                             | LXML-PWNI-0100 | 100                                          | 350               | 180                                          | 700                |
| Warm-White                  | LXML-PWWI-0040 | 40                                           | 350               | 80                                           | 700                |
|                             | LXML-PWWI-0050 | 50                                           | 350               | 95                                           | 700                |
|                             | LXML-PWWI-0060 | 60                                           | 350               | 110                                          | 700                |

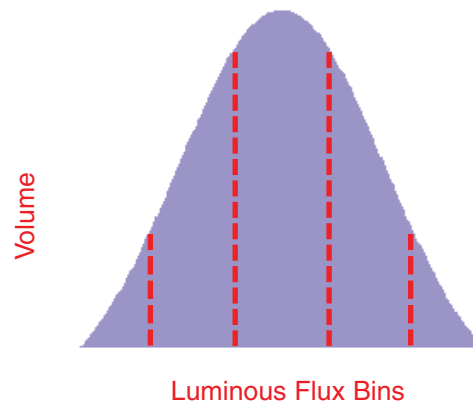
### Notes for Table I:

1. Minimum luminous flux performance guaranteed within published operating conditions. Philips Lumileds maintains a tolerance of  $\pm 6.5\%$  on flux measurements.
2. Typical luminous flux performance when device is operated within published operating conditions.

# Flux Characteristics, Continued

## Flux Performance, Binning, and Supportability

LEDs are produced with semiconductor technology that is subject to process variation, yielding a range of flux performance that is approximately Gaussian in nature. In order to provide customers with fine granularity within the overall flux distribution, Philips Lumileds separates LEDs into fixed, easy to design with, minimum luminous flux bins. To verify supportability of parts chosen for your application design, please consult your Philips Lumileds/Future Lighting Solutions sales representative.



# Optical Characteristics

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

Table 2.

| Color         | Color Temperature <sup>[3] [4]</sup> |             |         | Typical<br>Total<br>Included<br>Angle <sup>[5]</sup><br>(degrees)<br>$\theta_{0.90V}$ | Typical<br>Viewing<br>Angle <sup>[6]</sup><br>(degrees)<br>2 $\theta_{1/2}$ |
|---------------|--------------------------------------|-------------|---------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
|               | Min.                                 | CCT<br>Typ. | Max.    |                                                                                       |                                                                             |
| Cool-White    | 4500K                                | 6500K       | 10,000K | 160                                                                                   | 120                                                                         |
| Neutral-White | 3500K                                | 4100K       | 4500K   | 160                                                                                   | 120                                                                         |
| Warm-White    | 2540K                                | 3100K       | 3500K   | 160                                                                                   | 120                                                                         |

Notes for Table 2:

- 1. Test current is 350 mA for all LXML-PxxI-0xxx products.
- 2. CCT  $\pm 5\%$  tester tolerance.
- 3. Typical CRI (Color Rendering Index) for cool-white is 70, neutral-white is 70 and warm-white is 85.
- 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).
- 7. Cool-white, neutral-white and warm-white power light sources represented here are IEC825 class 2 for eye safety.

# Electrical Characteristics

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

**Table 3.**

| Color         | Forward Voltage $V_f$ <sup>[1]</sup> |      |      | Typical Temperature<br>Coefficient of<br>Forward Voltage <sup>[2]</sup> | Typical Thermal<br>Resistance<br>Junction to<br>Thermal Pad (°C/W) |
|---------------|--------------------------------------|------|------|-------------------------------------------------------------------------|--------------------------------------------------------------------|
|               | Min.                                 | Typ. | Max. | (mV/°C)<br>$\Delta V_f / \Delta T_j$                                    | $R\theta_{j-c}$                                                    |
| Cool-White    | 2.55                                 | 3.15 | 3.99 | -2.0 to -4.0                                                            | 10                                                                 |
| Neutral-White | 2.55                                 | 3.15 | 3.99 | -2.0 to -4.0                                                            | 10                                                                 |
| Warm-White    | 2.55                                 | 3.15 | 3.99 | -2.0 to -4.0                                                            | 10                                                                 |

Notes for Table 3:

1. Philips Lumileds maintains a tolerance of  $\pm 0.06V$  on forward voltage measurements.
  2. Measured between 25°C =  $T_j$  = 110°C at  $I_f$  = 350 mA.
- \* Dynamic resistance is the inverse of the slope in linear forward voltage model for LEDs. See figure 6.

## Typical Electrical Characteristics at 700 mA for LUXEON Rebel, Part Numbers LXML-PxxI-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                                 |

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 figure 6.
3. Measured between 25°C =  $T_j$  = 110°C at  $I_f$  = 700 mA.

## Absolute Maximum Ratings

**Table 5.**

| Parameter                            | Cool-White/Neutral-White/Warm-White                                                                           |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------|
| DC Forward Current (mA)              | 1000                                                                                                          |
| Peak Pulsed Forward Current (mA)     | 1000                                                                                                          |
| Average Forward Current (mA)         | 1000                                                                                                          |
| ESD Sensitivity                      | < 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[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<br>100% Relative Humidity for 96 Hours Maximum                                                 |
| Reverse Voltage (Vr)                 | 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 |                  |
|-------|------------|--------------------|-------------------|------------------|
|       | Standard   |                    | Standard          |                  |
|       | Time       | Conditions         | Time              | Conditions       |
| 1     | unlimited  | ≤ 30°C /<br>85% RH | 168h<br>+ 5 / -0  | 85°C / 85%<br>RH |

# Reflow Soldering Characteristics

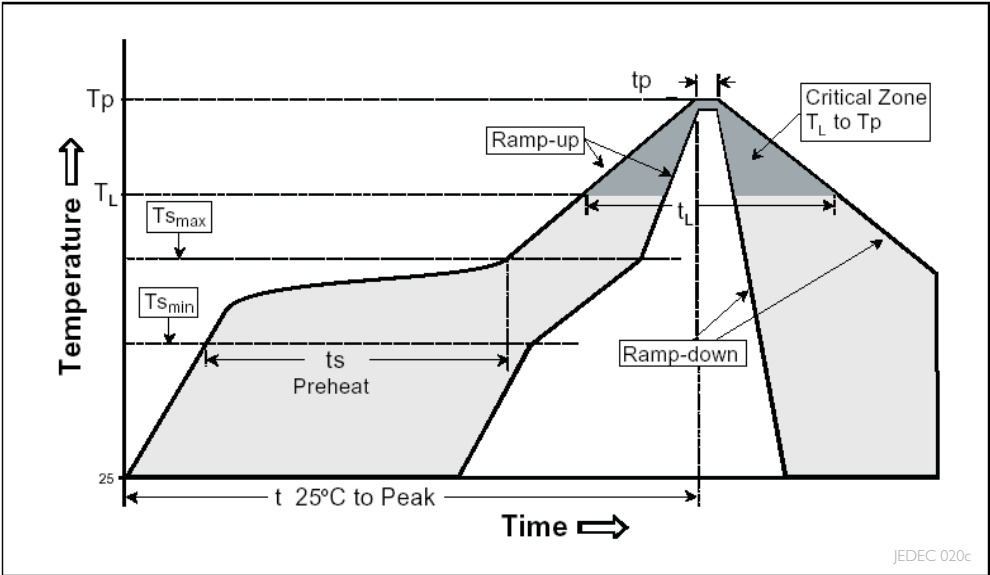


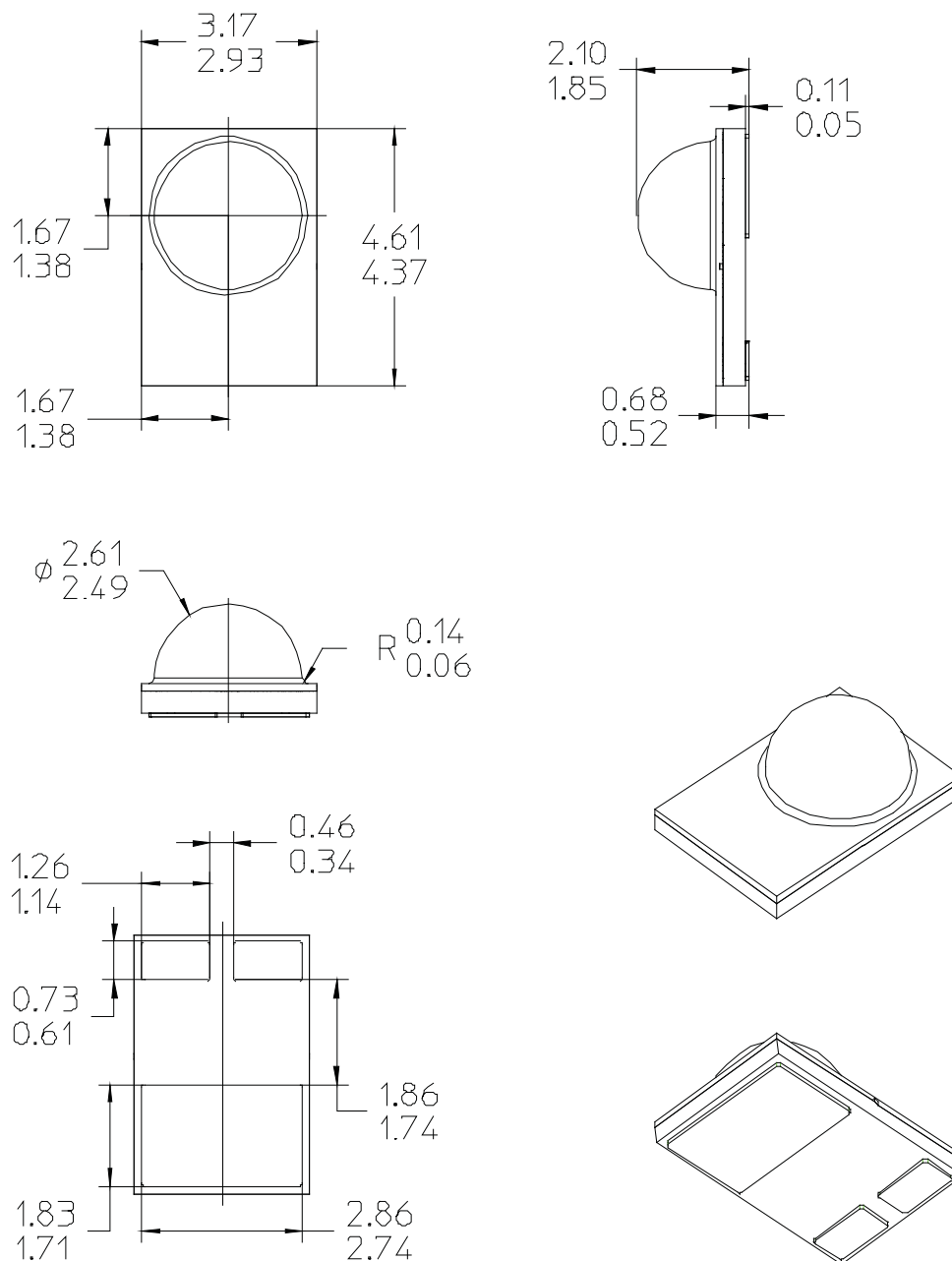
Table 7.

| 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 $T_L$ ( $t_L$ )    | 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      |

Note for Table 7:

- 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

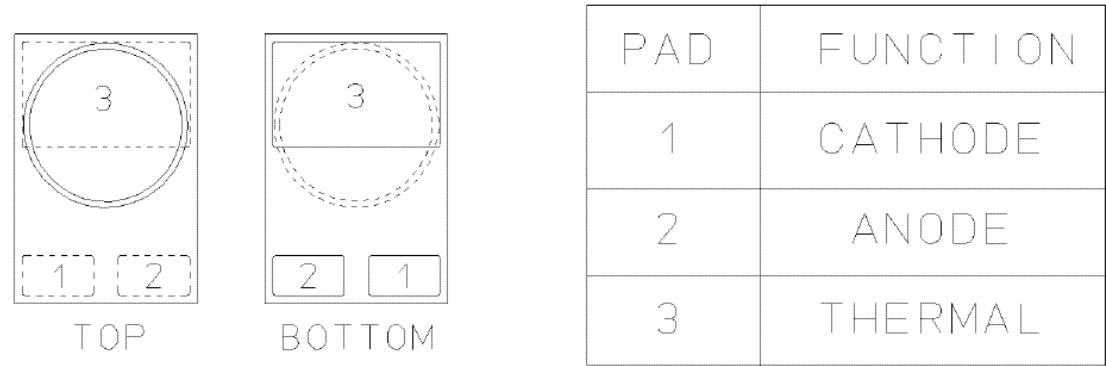


Figure 2. Pad configuration.

Note for Figure 2:

- I. 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.

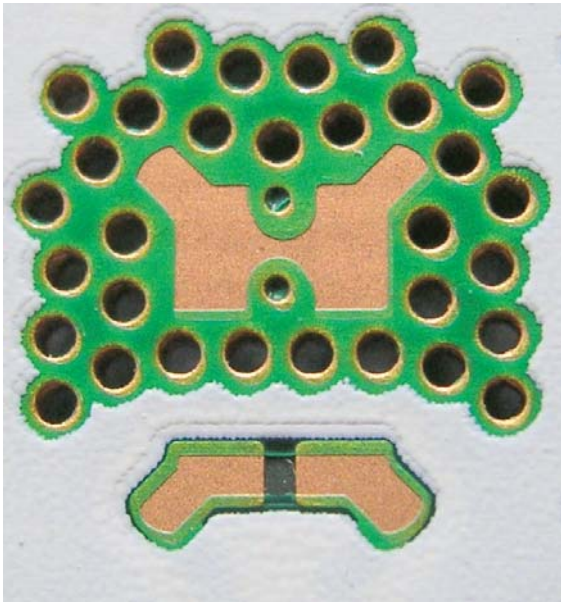


Figure 3. Solder pad layout.

# Wavelength Characteristics

## Cool-White at Test Current

Thermal Pad Temperature = 25°C

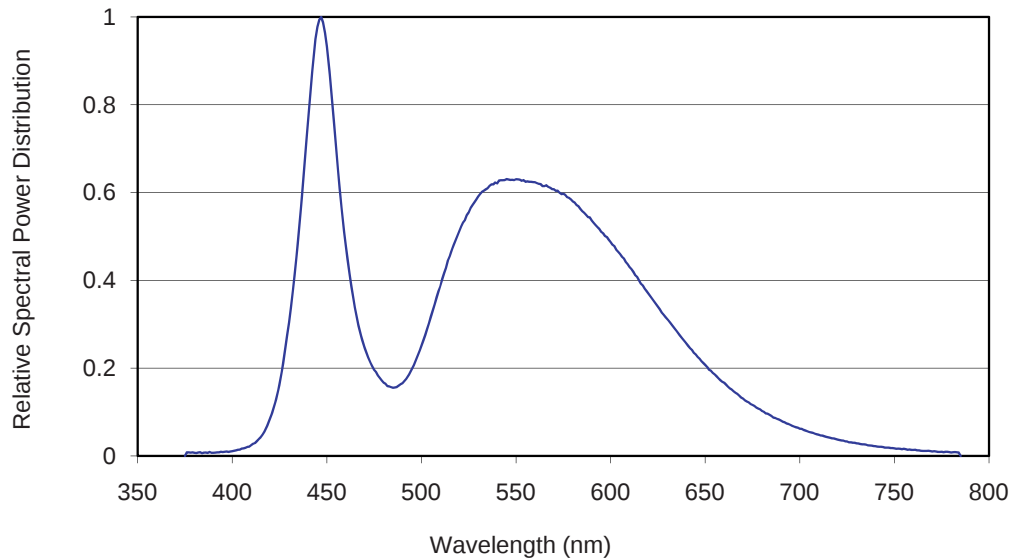


Figure 4a. Cool-white color spectrum of typical CCT part, integrated measurement

## Neutral-White at Test Current

Thermal Pad Temperature = 25°C

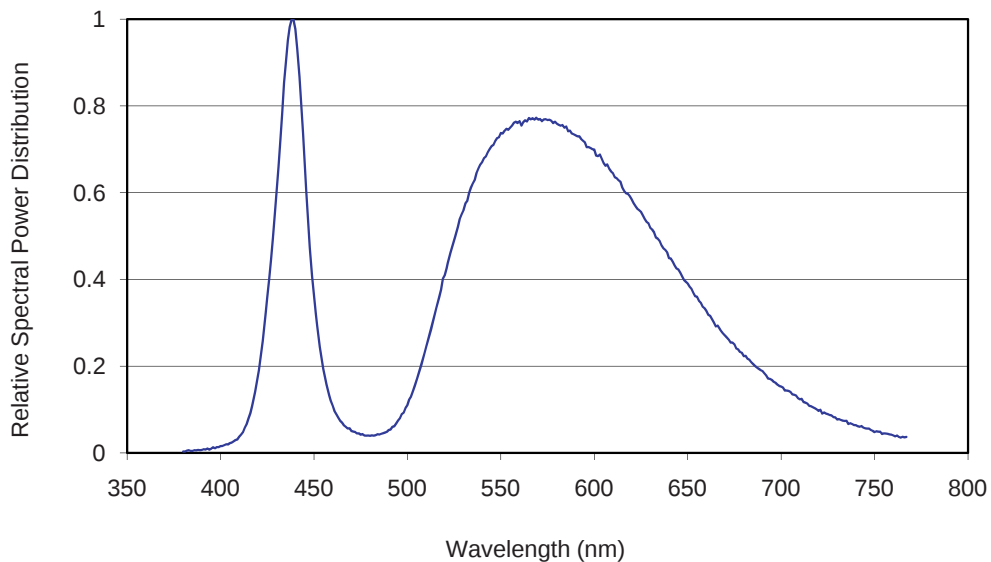
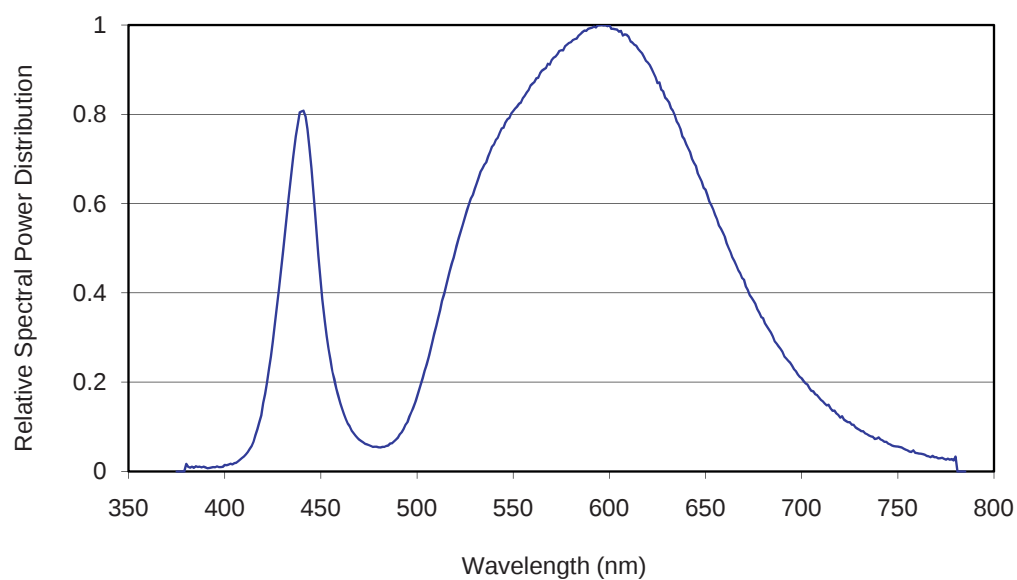


Figure 4b. Neutral-white color spectrum of typical CCT part, integrated measurement.

# Wavelength Characteristics, Continued

## Warm-White at Test Current

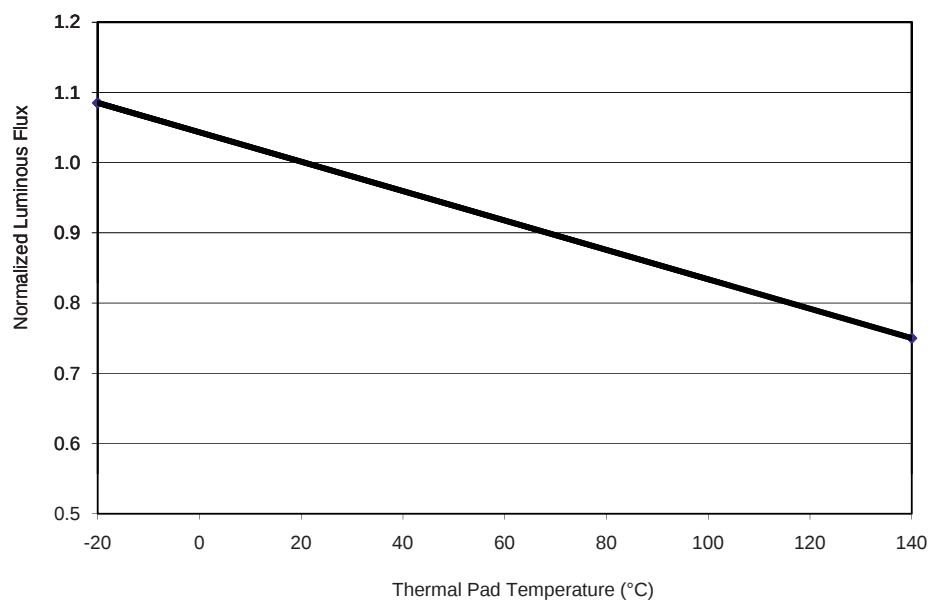
Thermal Pad Temperature = 25°C



**Figure 4c. Warm-white color spectrum of typical CCT part, integrated measurement.**

# Typical Light Output Characteristics over Temperature

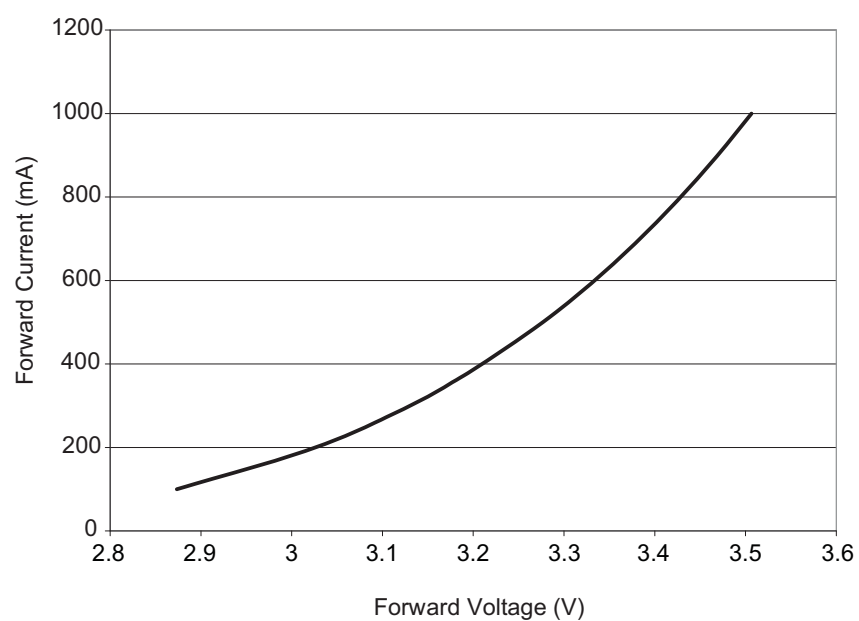
## Cool-White, Neutral-White, and Warm-White at Test Current



**Figure 5. Relative luminous flux vs. thermal pad temperature.**

# Typical Forward Current Characteristics

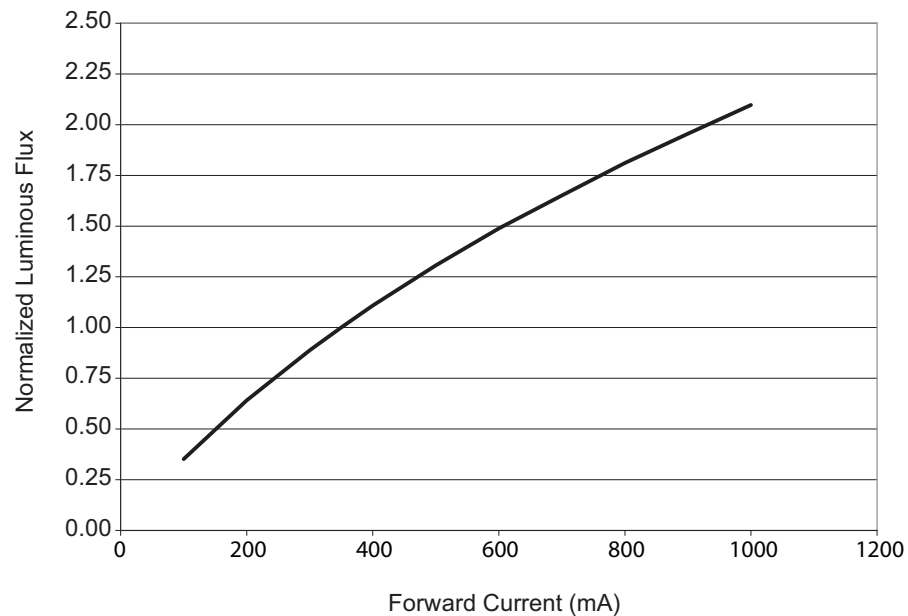
Cool-White, Neutral-White and Warm-White  
Thermal Pad Temperature = 25°C



**Figure 6. Forward current vs. forward voltage.**

# Typical Relative Luminous Flux

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



**Figure 7. Relative luminous flux or radiometric power vs. forward current for cool-white, neutral-white and warm-white Thermal Pad = 25°C maintained, test current 350 mA.**

# Current Derating Curves

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

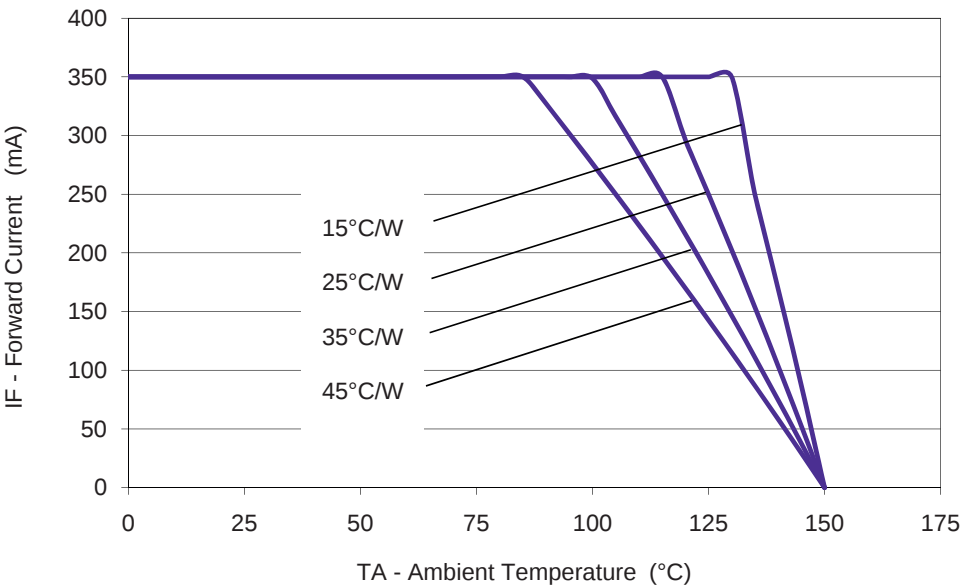


Figure 8. Maximum forward current vs. ambient temperature, based on  $T_{JMAX} = 150^{\circ}\text{C}$ .

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

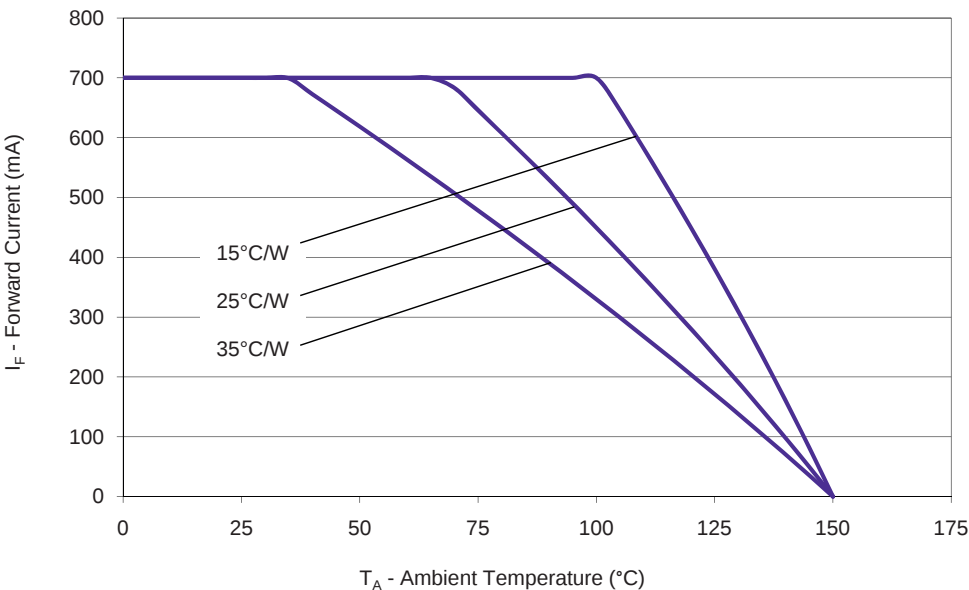


Figure 9. Maximum forward current vs. ambient temperature, based on  $T_{JMAX} = 150^{\circ}\text{C}$ .

I. Current derating curves represent constant current operation condition.

# Current Derating Curves, Continued

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

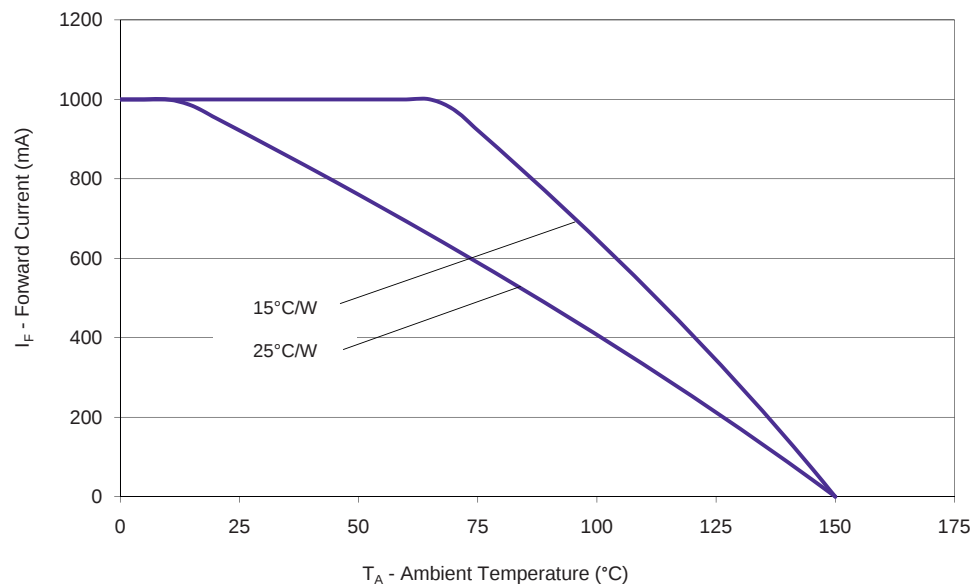


Figure 10. Maximum forward current vs. ambient temperature, based on  $T_{JMAX} = 150^{\circ}\text{C}$ .

# Typical Radiation Patterns

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

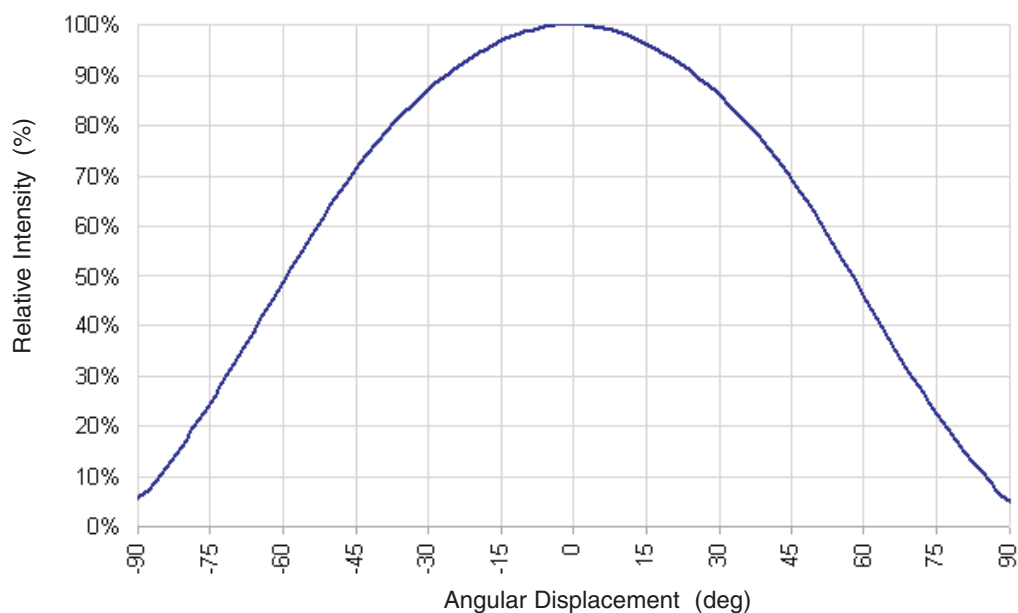


Figure 11a. Typical representative spatial radiation pattern for cool-white, neutral-white and warm-white lambertian.

## Typical Polar Radiation Pattern for White Lambertian

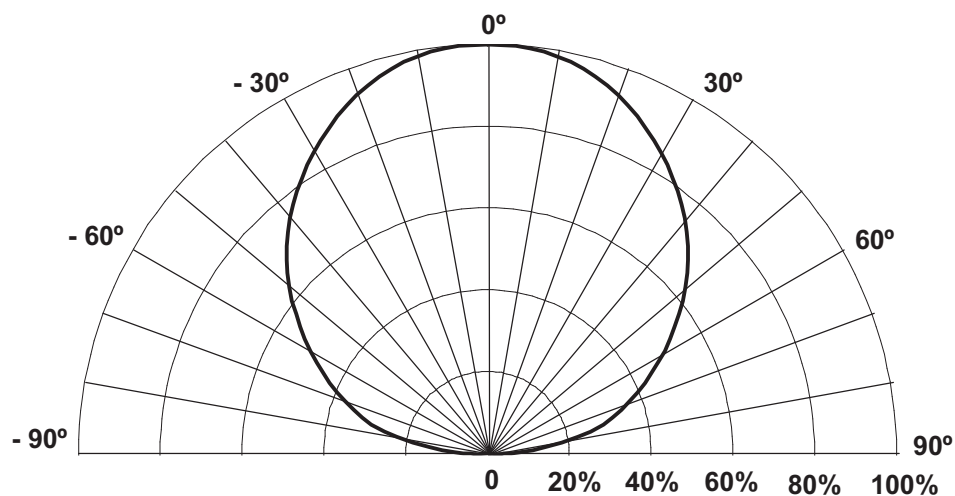
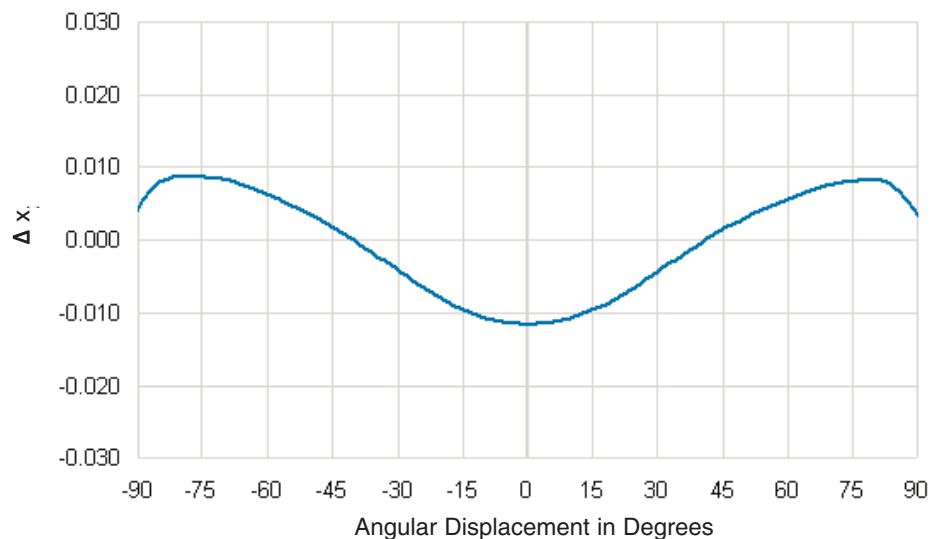


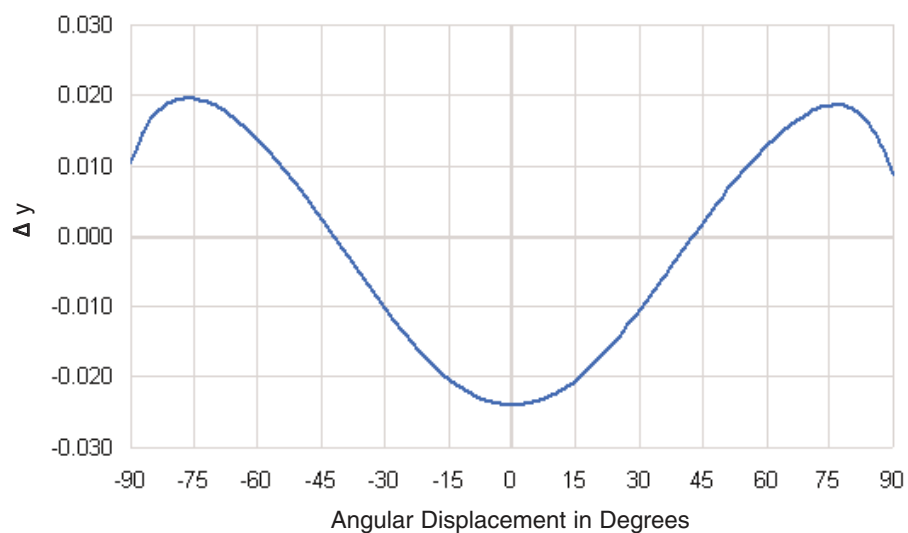
Figure 11b. Typical polar radiation pattern for cool-white, neutral-white and warm-white lambertian.

# Typical Radiation Patterns, Continued

## Typical Color Coordinates vs. Angle for Warm-White



**Figure 12a. X coordinate vs. angle for warm-white LUXEON Rebel.**



**Figure 12b. Y coordinate vs. angle for warm-white LUXEON Rebel.**

# Emitter Pocket Tape Packaging

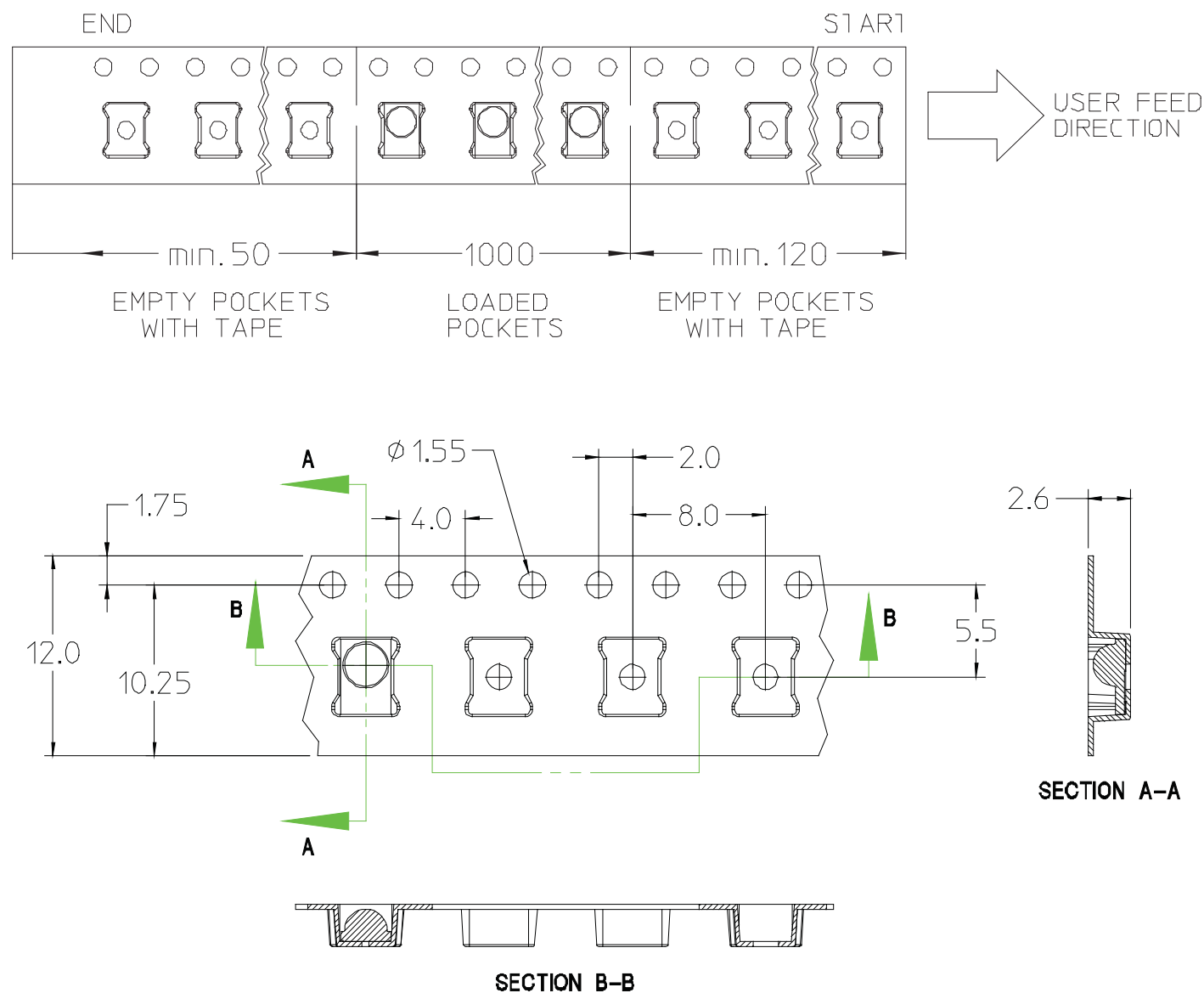


Figure 13. Emitter pocket tape packaging

# Emitter Reel Packaging

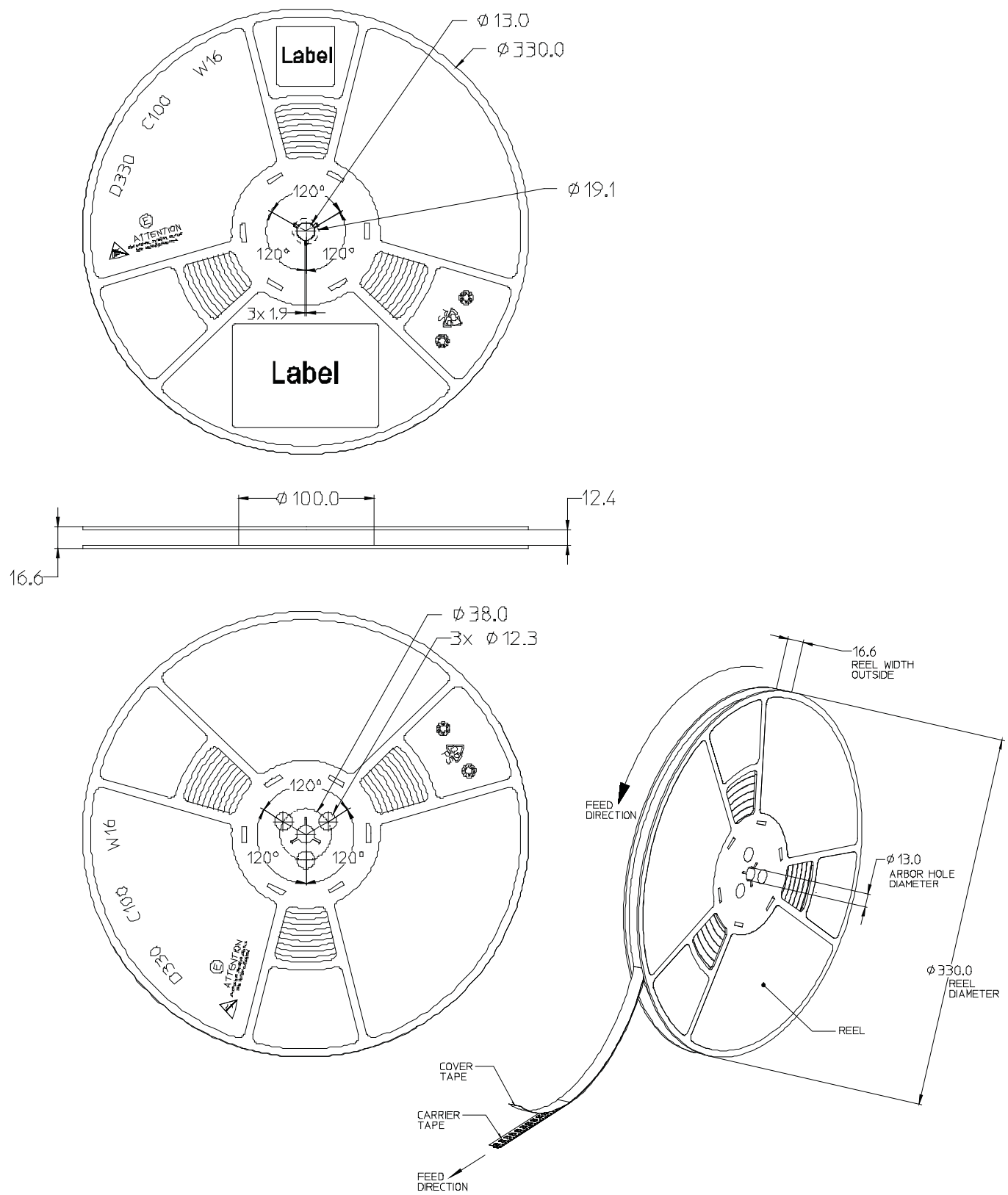


Figure 14. Emitter reel packaging

# 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 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.

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, K, L, M etc.)

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

D =  $V_f$  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 350 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 8.  |                               |                               |
|-----------|-------------------------------|-------------------------------|
| Flux Bins |                               |                               |
| Bin Code  | Minimum Photometric Flux (lm) | Maximum Photometric Flux (lm) |
| 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                           |

# Cool-White Bin Structure

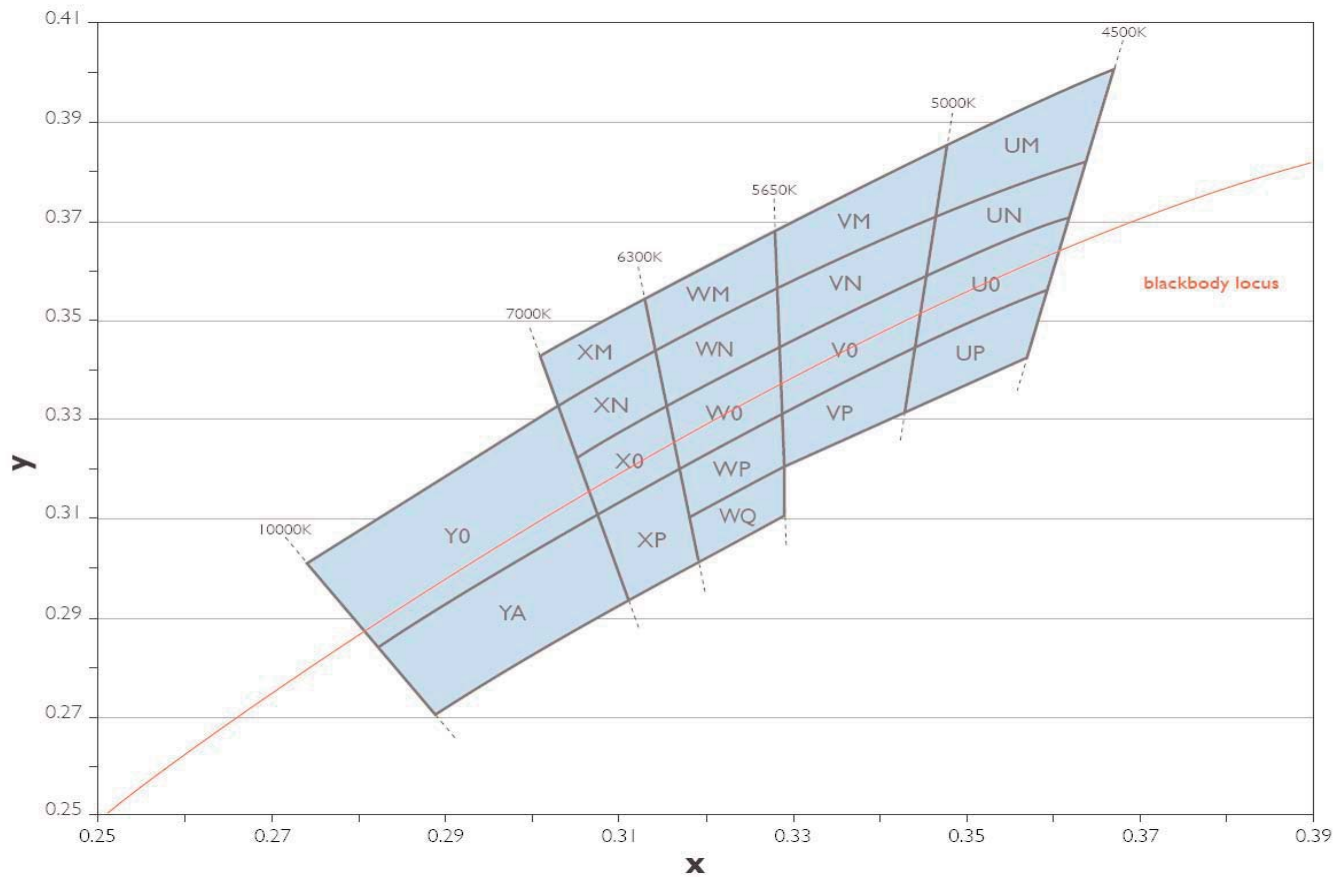


Figure 15. Cool-White bin structure.

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

**Table 9.**

| 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 9:**

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

# 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.

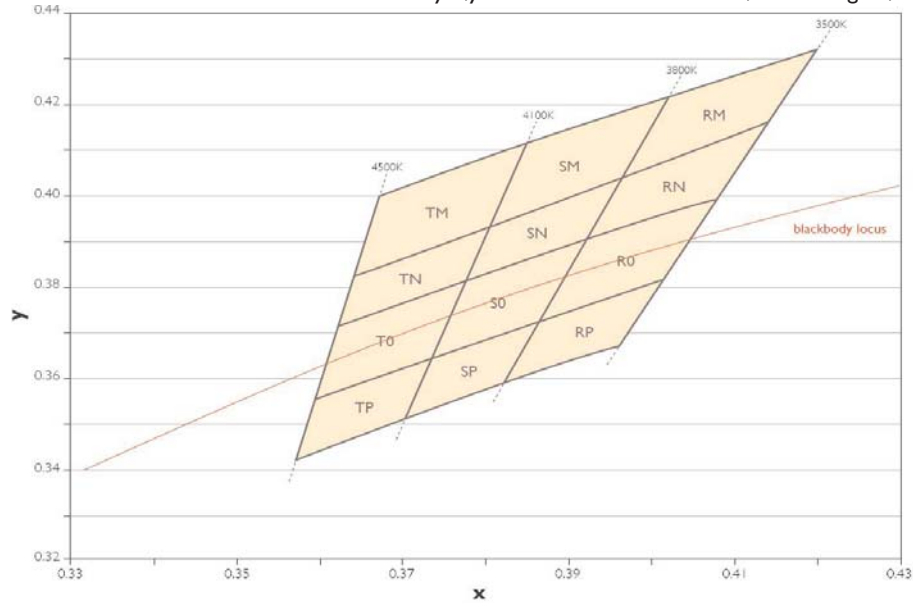


Figure 16. Neutral-White bin structure.

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 |                 |
|                               | 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            | 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  $\pm 0.005$  on x,y color coordinates.

## Warm-White Bin Structure

Warm-White LUXEON Rebel Emitters are tested and binned by x,y coordinates. 15 Color Bins, CCT Range 3,500K to 2,540K.

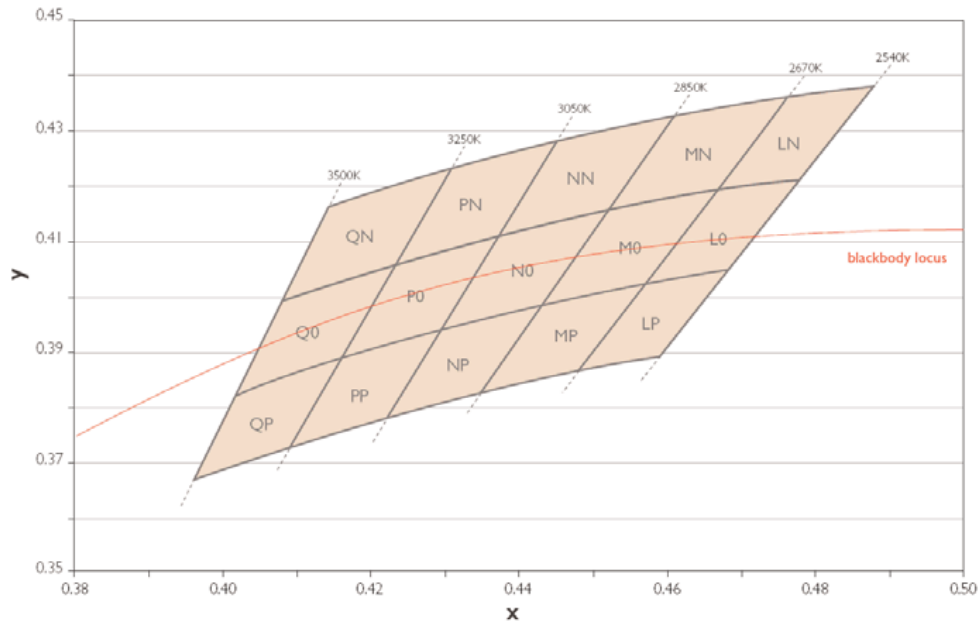


Figure 17. Warm-White bin structure.

**Table 11.**

| Warm-White Bin Coordinates |          |          |                 |          |          |          |                 |
|----------------------------|----------|----------|-----------------|----------|----------|----------|-----------------|
| Bin Code                   | X        | Y        | Typical CCT (K) | Bin Code | X        | Y        | Typical CCT (K) |
| QN                         | 0.414776 | 0.416097 | 3375            | NP       | 0.429373 | 0.394281 | 2950            |
|                            | 0.431186 | 0.423386 |                 |          | 0.443600 | 0.399111 |                 |
|                            | 0.423956 | 0.406472 |                 |          | 0.435591 | 0.383714 |                 |
|                            | 0.408593 | 0.399525 |                 |          | 0.422124 | 0.378952 |                 |
| QO                         | 0.408593 | 0.399525 | 3375            | MN       | 0.461404 | 0.433334 | 2760            |
|                            | 0.423956 | 0.406472 |                 |          | 0.476733 | 0.436634 |                 |
|                            | 0.416487 | 0.389001 |                 |          | 0.467132 | 0.419632 |                 |
|                            | 0.402113 | 0.382156 |                 |          | 0.452512 | 0.416241 |                 |
| QP                         | 0.402113 | 0.382156 | 3375            | MO       | 0.452512 | 0.416241 | 2760            |
|                            | 0.416487 | 0.389001 |                 |          | 0.467132 | 0.419632 |                 |
|                            | 0.409996 | 0.373814 |                 |          | 0.457663 | 0.402866 |                 |
|                            | 0.396564 | 0.367284 |                 |          | 0.443600 | 0.399111 |                 |
| PN                         | 0.431186 | 0.423386 | 3150            | MP       | 0.443600 | 0.399111 | 2760            |
|                            | 0.445639 | 0.428680 |                 |          | 0.457663 | 0.402866 |                 |
|                            | 0.437578 | 0.411632 |                 |          | 0.448994 | 0.387515 |                 |
|                            | 0.423956 | 0.406472 |                 |          | 0.435591 | 0.383714 |                 |
| PO                         | 0.423956 | 0.406472 | 3150            | LN       | 0.476733 | 0.436634 | 2605            |
|                            | 0.437578 | 0.411632 |                 |          | 0.488403 | 0.438170 |                 |
|                            | 0.429373 | 0.394281 |                 |          | 0.478372 | 0.421400 |                 |
|                            | 0.416487 | 0.389001 |                 |          | 0.467132 | 0.419632 |                 |
| PP                         | 0.416487 | 0.389001 | 3150            | LO       | 0.467132 | 0.419632 | 2605            |
|                            | 0.429373 | 0.394281 |                 |          | 0.478372 | 0.421400 |                 |
|                            | 0.422124 | 0.378952 |                 |          | 0.468646 | 0.405140 |                 |
|                            | 0.409996 | 0.373814 |                 |          | 0.457663 | 0.402866 |                 |
| NN                         | 0.445639 | 0.428680 | 2950            | LP       | 0.468646 | 0.405140 | 2605            |
|                            | 0.461404 | 0.433334 |                 |          | 0.457663 | 0.402866 |                 |
|                            | 0.452512 | 0.416241 |                 |          | 0.448994 | 0.387515 |                 |
|                            | 0.437578 | 0.411632 |                 |          | 0.459563 | 0.389955 |                 |
| NO                         | 0.437578 | 0.411632 | 2950            |          |          |          |                 |
|                            | 0.452512 | 0.416241 |                 |          |          |          |                 |
|                            | 0.443600 | 0.399111 |                 |          |          |          |                 |
|                            | 0.429373 | 0.394281 |                 |          |          |          |                 |

Note for Table 11:

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

# Forward Voltage Bins

Table 13 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 12.  |                             |                             |  |
|------------|-----------------------------|-----------------------------|--|
| $V_f$ Bins |                             |                             |  |
| Bin Code   | Minimum Forward Voltage (V) | Maximum Forward Voltage (V) |  |
| 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 is the world's leading provider of power LEDs for everyday lighting applications. The company's records for light output, efficiency 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 CO<sub>2</sub> 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](http://www.philipslumileds.com).

[www.philipslumileds.com](http://www.philipslumileds.com)  
[www.futurelightingsolutions.com](http://www.futurelightingsolutions.com)

For technical assistance or the location of your nearest sales office contact any of the following:

North America:  
1 888 589 3662  
[americas@futurelightingsolutions.com](mailto:americas@futurelightingsolutions.com)

Europe:  
00 800 443 88 873  
[europe@futurelightingsolutions.com](mailto:europe@futurelightingsolutions.com)

Asia Pacific:  
800 5864 5337  
[asia@futurelightingsolutions.com](mailto:asia@futurelightingsolutions.com)

Japan:  
800 5864 5337  
[japan@futurelightingsolutions.com](mailto:japan@futurelightingsolutions.com)

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