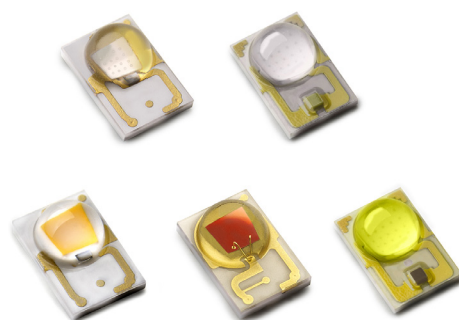




# LUXEON Rebel & LUXEON Rebel ES Colors

High flux and efficacy on industry's most widely used color platform

The LUXEON Rebel Colors of LUXEON Rebel and LUXEON Rebel ES has leading light output, color stability, flux density, and clear saturated colors. The color LEDs are ideal for a wide variety of lighting, signaling, signage and entertainment applications. Every LUXEON Rebel and LUXEON Rebel ES emitter has built-in quality, reliability, lumen maintenance and the ease of manufacturing needed to create a superior high quality light. The color portfolio gives designers an endless pallet of colors to work with, adding interest, dimension, and liveliness to all your lighting projects.



## FEATURES AND BENEFITS

- Full color pallet for a wider spectrum range
- Highest efficacy available for colors allows for lower power consumption
- High flux and leading hot and cold performance for saturated colors
- Fully developed ecosystem for LUXEON Rebel platforms

## PRIMARY APPLICATIONS

- Architectural
- Lamps
- Specialty Lighting

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# General Information

## Product Nomenclature

LUXEON Rebel ES Lime is tested at 350mA/85°C. LUXEON Rebel ES Royal Blue and Blue are tested at 700mA/25°C. All other LUXEON Rebel Color emitters are tested at 350mA/25°C.

The part number designation is explained as follows:

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

L X M 2 - A B C D - E F G H

L X M 3 - A B C D - E F G H

L X M 5 - A B C D

Where:

A — designates radiation pattern (value P for lambertian)

B — designates color (see LUXEON Rebel color binning and labeling section)

C — designates color variant (0 for color variants)

D — designates diode size (1 for 1mm<sup>2</sup>; 2 for 2mm<sup>2</sup>)

EFGH — minimum luminous flux (lm) or radiometric power (mW) performance

## Average Lumen Maintenance Characteristics

LUXEON Rebel color emitters are tested and binned at 350mA and LUXEON Rebel ES color emitters at 700mA, with current pulse duration of 20ms. All characteristic charts where the thermal pad is kept at constant temperature are measured with current pulse duration of 20 ms. Under these conditions, junction temperature and thermal pad temperature are the same.

Lumileds projects that green, cyan, blue and all royal blue LUXEON Rebel color products will deliver, on average, 70% lumen maintenance (B50, L70) at 50,000 hours of operation at a forward current of 700mA. This projection is based on constant current operation with junction temperature maintained at or below 135°C. Red, red-orange and amber LUXEON Rebel color products will also deliver, on average, 70% lumen maintenance (B50, L70) at 50,000 hours of operation at a forward current of 350mA and is based on constant current operation with junction temperature maintained at or below 110°C. LUXEON Rebel PC amber delivers, on average, 70% lumen maintenance (L70) at 50,000 hours of operation at a forward current of up to 700mA. This projection is based on constant current operation with junction temperature maintained at or below 130°C.

This performance is based on independent test data, Lumileds historical data from tests run on similar material systems, and internal LUXEON Rebel reliability testing. Observation of design limits included in this data sheet is required in order to achieve this projected lumen maintenance.

## Environmental Compliance

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

# Product Selection & Optical Characteristics

Product Selection Guide for LUXEON Rebel and LUXEON Rebel ES Colors at Junction Temperature <sup>[3]</sup>

Table 1.

| Color      | Part Number    | Performance @ 350mA                                  |                                                      |                                             |
|------------|----------------|------------------------------------------------------|------------------------------------------------------|---------------------------------------------|
|            |                | Minimum Luminous Flux (lm) or Radiometric Power (mW) | Typical Luminous Flux (lm) or Radiometric Power (mW) | Typical Efficacy (lm/W) or Radiant Efficacy |
| Lime       | LXML-PX02-0000 | 190                                                  | 192                                                  | 201                                         |
|            |                | 180                                                  | 183                                                  | 190                                         |
|            |                | 170                                                  | 174                                                  | 181                                         |
|            |                | 160                                                  | 167                                                  | 174                                         |
|            |                | 150                                                  | 157                                                  | 163                                         |
|            |                | 140                                                  | 148                                                  | 154                                         |
| Green      | LXML-PM01-0100 | 100                                                  | 102                                                  | 100                                         |
|            | LXML-PM01-0090 | 90                                                   | 95                                                   | 93                                          |
|            | LXML-PM01-0080 | 80                                                   | 88                                                   | 86                                          |
|            | LXML-PM01-0070 | 70                                                   | 79                                                   | 78                                          |
| Cyan       | LXML-PE01-0080 | 80                                                   | 83                                                   | 81                                          |
|            | LXML-PE01-0070 | 70                                                   | 76                                                   | 75                                          |
|            | LXML-PE01-0060 | 60                                                   | 67                                                   | 66                                          |
| Blue       | LXML-PB01-0040 | 40.0                                                 | 41                                                   | 38                                          |
|            | LXML-PB01-0030 | 30.0                                                 | 35                                                   | 33                                          |
|            | LXML-PB01-0023 | 23.5                                                 | 28                                                   | 26                                          |
|            | LXML-PB01-0018 | 18.1                                                 | 22                                                   | 21                                          |
| Royal Blue | LXML-PR01-0500 | 500 mW                                               | 520 mW                                               | 48%                                         |
| Deep Red   | LXM3-PD01      | 350 mW                                               | 360 mW                                               | 46%                                         |
|            |                | 300 mW                                               | 320 mW                                               | 41%                                         |
|            |                | 260 mW                                               | 290 mW                                               | 37%                                         |
| Red        | LXM2-PD01-0060 | 60                                                   | 62                                                   | 83                                          |
|            | LXM2-PD01-0050 | 50                                                   | 53                                                   | 75                                          |
|            | LXM2-PD01-0040 | 40                                                   | 48                                                   | 65                                          |
|            | LXML-PD01-0050 | 50                                                   | 52                                                   | 53                                          |
|            | LXML-PD01-0040 | 40                                                   | 46                                                   | 47                                          |
|            | LXML-PD01-0030 | 30                                                   | 38                                                   | 37                                          |
|            | LXM5-PD01      | 80                                                   | 82                                                   | 112                                         |
|            |                | 70                                                   | 72                                                   | 98                                          |
|            |                | 60                                                   | 64                                                   | 87                                          |
|            |                | 50                                                   | 54                                                   | 73                                          |
| Red-Orange | LXM2-PH01-0070 | 70                                                   | 72                                                   | 98                                          |
|            | LXM2-PH01-0060 | 60                                                   | 67                                                   | 91                                          |
|            | LXML-PH01-0060 | 60                                                   | 62                                                   | 63                                          |
|            | LXML-PH01-0050 | 50                                                   | 56                                                   | 57                                          |
|            | LXM5-PH01      | 80                                                   | 82                                                   | 112                                         |
|            |                | 70                                                   | 74                                                   | 101                                         |
|            |                | 60                                                   | 62                                                   | 84                                          |
|            |                | 50                                                   | 53                                                   | 72                                          |
| PC Amber   | LXM2-PL01-0000 | 110                                                  | 112                                                  | 105                                         |
|            |                | 100                                                  | 102                                                  | 96                                          |
|            |                | 90                                                   | 95                                                   | 89                                          |
|            |                | 80                                                   | 86                                                   | 80                                          |
| Amber      | LXML-PL01-0060 | 60                                                   | 61                                                   | 60                                          |
|            | LXML-PL01-0050 | 50                                                   | 54                                                   | 51                                          |
|            | LXML-PL01-0040 | 40                                                   | 48                                                   | 46                                          |
|            | LXML-PL01-0030 | 30                                                   | 38                                                   | 37                                          |
|            | LXM5-PL01      | 80                                                   | 83                                                   | 113                                         |
|            |                | 70                                                   | 72                                                   | 98                                          |
|            |                | 60                                                   | 64                                                   | 87                                          |
|            |                | 50                                                   | 52                                                   | 71                                          |

Notes for Table 1:

1. Minimum luminous flux or radiometric power performance guaranteed within published operating conditions. Lumileds maintains a tolerance of  $\pm 6.5\%$  on flux and power measurements.
2. LUXEON Rebel ES Lime is tested and binned at thermal pad temperature = 85°C, all other LUXEON Rebel Color emitters are tested and binned with thermal pad temperature = 25°C.
3. LUXEON Rebel ES Lime, ES Blue, Deep Red and PC Amber may also be sold under part numbers which denote a minimum flux level, similar to other parts in the portfolio, specified by digits 9 through 12 of the part number.

# Product Selection & Optical Characteristics

## Product Selection Guide for LUXEON Rebel and LUXEON Rebel ES Colors at Junction Temperature <sup>[3]</sup>

Table 2.

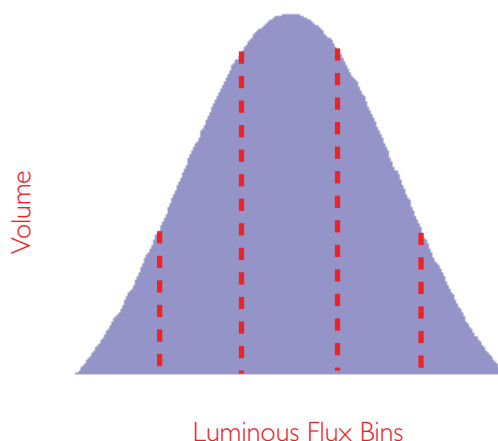
| Color      | Part Number                   | Performance @ 700mA                                  |                                                      |                                             |
|------------|-------------------------------|------------------------------------------------------|------------------------------------------------------|---------------------------------------------|
|            |                               | Minimum Luminous Flux (lm) or Radiometric Power (mW) | Typical Luminous Flux (lm) or Radiometric Power (mW) | Typical Efficacy (lm/W) or Radiant Efficacy |
| Blue       | LXML-PB02                     | 50                                                   | 58                                                   | 28                                          |
|            |                               | 60                                                   | 67                                                   | 32                                          |
|            |                               | 70                                                   | 75                                                   | 36                                          |
|            |                               | 80                                                   | 83                                                   | 40                                          |
| Royal Blue | LXML-PR02-1100                | 1100 mW                                              | 1120 mW                                              | 53%                                         |
|            | LXML-PR02-1050                | 1050 mW                                              | 1070 mW                                              | 51%                                         |
|            | LXML-PR02-1000                | 1000 mW                                              | 1030 mW                                              | 49%                                         |
|            | LXML-PR02-0950                | 950 mW                                               | 970 mW                                               | 46%                                         |
|            | LXML-PR02-0900                | 900 mW                                               | 940 mW                                               | 44%                                         |
|            | LXML-PR02-0800                | 800 mW                                               | 890 mW                                               | 42%                                         |
|            | LXML-PR02-A900 <sup>[1]</sup> | 900 mW                                               | 1030 mW                                              | 49%                                         |

Notes for Table 2:

1. LXML-PR02-A900 is a selection of color Bins 4,5 only.
2. Minimum luminous flux or radiometric power performance guaranteed within published operating conditions. Lumileds maintains a tolerance of  $\pm 6.5\%$  on flux and power measurements.
3. LUXEON Rebel ES Lime is tested and binned at thermal pad temperature = 85°C, all other LUXEON Rebel Color emitters are tested and binned with thermal pad temperature = 25°C.
4. LUXEON Rebel ES Lime, ES Blue, Deep Red and PC Amber may also be sold under part numbers which denote a minimum flux level, similar to other parts in the portfolio, specified by digits 9 through 12 of the part number.

## 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, 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 Lumileds sales representative.



## Optical Characteristics

### LUXEON Rebel and LUXEON Rebel ES Colors at 350mA or 700mA, Test Temperature <sup>[1]</sup>

Table 3.

| Color                         | Dominant Wavelength <sup>[2]</sup> $\lambda_D$ ,<br>or Peak Wavelength <sup>[3]</sup> $\lambda_P$ |          |          | Typical Spectral<br>Half-width <sup>[5]</sup><br>$\Delta\lambda_{1/2}$ | Typical Temperature<br>Coefficient<br>of Dominant or Peak<br>Wavelength (nm/°C)<br>$\Delta\lambda_D / \Delta T_J$ | Typical Total<br>Included Angle <sup>[5]</sup><br>(degrees)<br>$\theta_{0.90V}$ | Typical Viewing<br>Angle <sup>[6]</sup><br>(degrees)<br>$2\theta_{1/2}$ |
|-------------------------------|---------------------------------------------------------------------------------------------------|----------|----------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------|
|                               | Minimum                                                                                           | Typical  | Maximum  |                                                                        |                                                                                                                   |                                                                                 |                                                                         |
| Lime <sup>[7] [9]</sup>       | 566.0 nm                                                                                          | 567.5 nm | 569.0 nm | 100                                                                    | 0.01                                                                                                              | 160                                                                             | 125                                                                     |
| Green <sup>[7]</sup>          | 520.0 nm                                                                                          | 530.0 nm | 540.0 nm | 30                                                                     | 0.05                                                                                                              | 160                                                                             | 125                                                                     |
| Cyan <sup>[7]</sup>           | 490.0 nm                                                                                          | 505.0 nm | 515.0 nm | 30                                                                     | 0.04                                                                                                              | 160                                                                             | 125                                                                     |
| Blue <sup>[7]</sup>           | 460.0 nm                                                                                          | 470.0 nm | 485.0 nm | 20                                                                     | 0.05                                                                                                              | 160                                                                             | 125                                                                     |
| Royal Blue <sup>[3] [7]</sup> | 440.0 nm                                                                                          | 447.5 nm | 460.0 nm | 20                                                                     | 0.04                                                                                                              | 160                                                                             | 125                                                                     |
| Red <sup>[8]</sup>            | 620.0 nm                                                                                          | 627.0 nm | 645.0 nm | 20                                                                     | 0.05                                                                                                              | 160                                                                             | 125                                                                     |
| Deep Red <sup>[3] [8]</sup>   | 650.0 nm                                                                                          | 655.0 nm | 670.0 nm | 20                                                                     | 0.05                                                                                                              | 160                                                                             | 125                                                                     |
| Red-Orange <sup>[8]</sup>     | 610.0 nm                                                                                          | 617.0 nm | 620.0 nm | 20                                                                     | 0.08                                                                                                              | 160                                                                             | 125                                                                     |
| Amber <sup>[8]</sup>          | 584.5 nm                                                                                          | 590.0 nm | 594.5 nm | 20                                                                     | 0.10                                                                                                              | 160                                                                             | 125                                                                     |
| PC Amber <sup>[7] [9]</sup>   | 587.8 nm                                                                                          | 591.0 nm | 592.0 nm | 80                                                                     | -0.01                                                                                                             | 160                                                                             | 120                                                                     |

Notes for Table 3:

- LXML-PR02-xxxx and LXML-PB02-xxxx emitters are tested and binned at 700mA, all other LUXEON Rebel Color emitters are tested at 350mA.
- Dominant wavelength is derived from the CIE 1931 Chromaticity diagram and represents the perceived color. Lumileds maintains a tolerance of  $\pm 0.5$  nm for dominant wavelength measurements.
- Royal blue and deep red LEDs are binned by peak wavelength. Lumileds maintains a tolerance of  $\pm 2$  nm for peak wavelength measurements.
- Spectral width at  $1/2$  of the peak intensity.
- Total angle at which 90% of total luminous flux or radiometric power is captured.
- Viewing angle is the off axis angle from lamp centerline where the luminous intensity is  $1/2$  of the peak value.
- Lime, PC Amber, green, cyan, blue and royal blue products are built with Indium Gallium Nitride (InGaN).
- All red, deep red, red-orange, and amber are built with Aluminum Indium Gallium Phosphide (AlInGaP).
- Lime and PC Amber are binned by chromaticity coordinates.

# Electrical Characteristics

## Electrical Characteristics for LUXEON Rebel and LUXEON Rebel ES Colors at Test Current and Temperature <sup>[1]</sup>

Table 4.

| Color      | Part Number | Forward Voltage V <sub>f</sub> (V) |         |         | Typical Temperature Coefficient of Forward Voltage <sup>[2]</sup><br>(mV/°C)<br>$\Delta V_F / \Delta T_J$ | Typical Thermal Resistance Junction to Thermal Pad<br>(°C/W)<br>R <sub>θ J-C</sub> |
|------------|-------------|------------------------------------|---------|---------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|            |             | Minimum                            | Typical | Maximum |                                                                                                           |                                                                                    |
| Lime       | LXML-PX02   | 2.60                               | 2.75    | 3.00    | -2.0 to -4.0                                                                                              | 6                                                                                  |
| Green      | LXML-PM01   | 2.55                               | 2.90    | 3.51    | -2.0 to -4.0                                                                                              | 10                                                                                 |
| Cyan       | LXML-PE01   | 2.55                               | 2.90    | 3.51    | -2.0 to -4.0                                                                                              | 10                                                                                 |
| Blue       | LXML-PB02   | 2.50                               | 2.95    | 3.50    | -2.0 to -4.0                                                                                              | 6                                                                                  |
|            | LXML-PB01   | 2.55                               | 2.95    | 3.51    | -2.0 to -4.0                                                                                              | 10                                                                                 |
| Royal Blue | LXML-PR02   | 2.50                               | 2.90    | 3.50    | -2.0 to -4.0                                                                                              | 6                                                                                  |
|            | LXML-PR01   | 2.55                               | 2.95    | 3.51    | -2.0 to -4.0                                                                                              | 10                                                                                 |
| Red        | LXML-PD01   | 2.31                               | 2.90    | 3.51    | -2.0 to -4.0                                                                                              | 12                                                                                 |
|            | LXM2-PD01   | 1.80                               | 2.10    | 2.80    | -2.0 to -4.0                                                                                              | 8                                                                                  |
|            | LXM5-PD01   | 1.80                               | 2.10    | 2.60    | -2.0 to -4.0                                                                                              | 6.5                                                                                |
| Deep Red   | LXM3-PD01   | 1.80                               | 2.10    | 2.80    | -2.0 to -4.0                                                                                              | 8                                                                                  |
| Red-Orange | LXML-PH01   | 2.31                               | 2.90    | 3.51    | -2.0 to -4.0                                                                                              | 12                                                                                 |
|            | LXM2-PH01   | 1.80                               | 2.10    | 2.80    | -2.0 to -4.0                                                                                              | 8                                                                                  |
|            | LXM5-PH01   | 1.80                               | 2.10    | 2.60    | -2.0 to -4.0                                                                                              | 6.5                                                                                |
| PC Amber   | LXM2-PL01   | 2.55                               | 3.05    | 3.51    | -2.0 to -4.0                                                                                              | 10                                                                                 |
| Amber      | LXML-PL01   | 2.31                               | 2.90    | 3.51    | -2.0 to -4.0                                                                                              | 12                                                                                 |
|            | LXM5-PL01   | 1.80                               | 2.90    | 3.51    | -2.0 to -4.0                                                                                              | 6.5                                                                                |

Notes for Table 4:

- LUXEON Rebel ES Lime is tested at 350mA/85°C. LUXEON Rebel ES Royal Blue and ES Blue are tested at 700mA/25°C. All other LUXEON Rebel color emitters are tested at 350mA/25°C.
- Measured between T<sub>J</sub> = 25°C and T<sub>J</sub> = 110°C at test current.
- Lumileds maintains a tolerance of ±0.06V on forward voltage measurements.

## Absolute Maximum Ratings

Table 5.

| Parameter                               | Green/Cyan/Blue/<br>Royal Blue                                                   | ES Royal Blue/ES<br>Blue/Lime | Red/Deep Red<br>Red-Orange/Amber | PC Amber         |
|-----------------------------------------|----------------------------------------------------------------------------------|-------------------------------|----------------------------------|------------------|
| DC Forward Current (mA)                 | 1000                                                                             | 1000                          | 700                              | 700              |
| Peak Pulsed Forward Current (mA)        | 1000                                                                             | 1200                          | 700                              | 700              |
| Average Forward Current (mA)            | 1000                                                                             | 1000                          | 700                              | 700              |
| ESD Sensitivity                         | < 8000V Human Body Model (HBM) Class 3A JESD22-A114-B                            |                               |                                  |                  |
| LED Junction Temperature <sup>[1]</sup> | 150°C                                                                            | 150°C                         | 135°C                            | 130°C            |
| Operating Case Temperature              | -40°C - 135°C                                                                    | -40°C - 135°C                 | -40°C - 120°C                    | -40°C - 110°C    |
| Storage Temperature                     | -40°C - 135°C                                                                    | -40°C - 135°C                 | -40°C - 135°C                    | -40°C - 135°C    |
| Soldering Temperature                   | JEDEC 020c 260°C                                                                 | JEDEC 020c 260°C              | JEDEC 020c 260°C                 | JEDEC 020c 260°C |
| Allowable Reflow Cycles                 | 3                                                                                | 3                             | 3                                | 3                |
| Autoclave Conditions                    | 121°C at 2 ATM<br>100% Relative Humidity for 96 Hours Maximum                    |                               |                                  |                  |
| Reverse Voltage (Vr)                    | LUXEON Rebel Color Portfolio LEDs are not designed to be driven in reverse bias. |                               |                                  |                  |

Notes for Table 5:

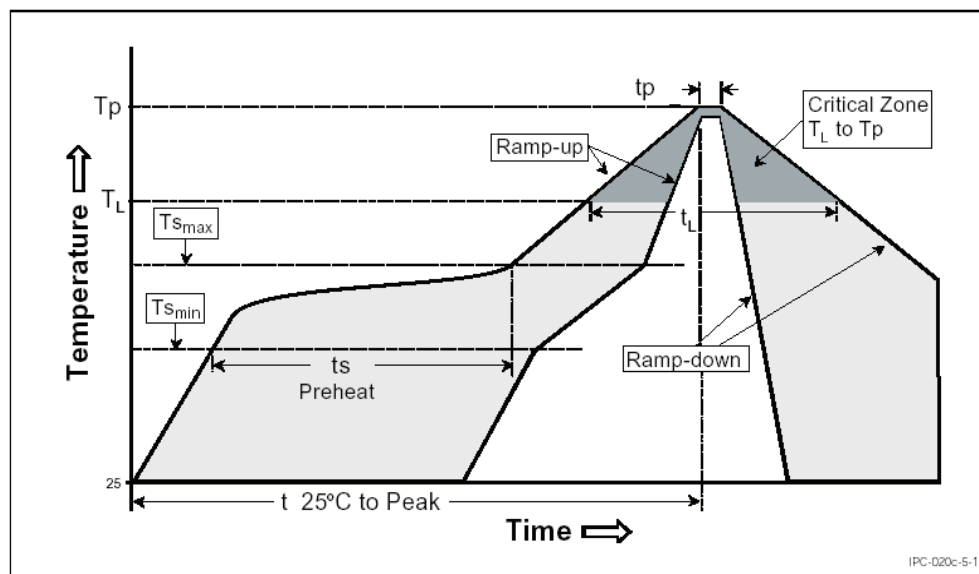
- Proper current derating must be observed to maintain junction temperature below the maximum.
- Pulsed operation of Rebel ES Colors with a peak drive current of 1200 mA is acceptable if the pulse on-time is ≤ 5 ms per cycle and the duty cycle is ≤ 50%.

# JEDEC Moisture Sensitivity

Table 6.

| Level | Floor Life |                                             | Soak Requirements      |                                        |
|-------|------------|---------------------------------------------|------------------------|----------------------------------------|
|       |            |                                             | Standard               |                                        |
|       | Time       | Conditions                                  | Time                   | Conditions                             |
| 1     | unlimited  | $\leq 30^{\circ}\text{C} / 85\% \text{ RH}$ | 168 Hrs. + 5 / -0 Hrs. | $85^{\circ}\text{C} / 85\% \text{ RH}$ |

## Reflow Soldering Characteristics



Temperature Profile for Table 7.

Table 7.

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

Note 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

## LUXEON Rebel Color

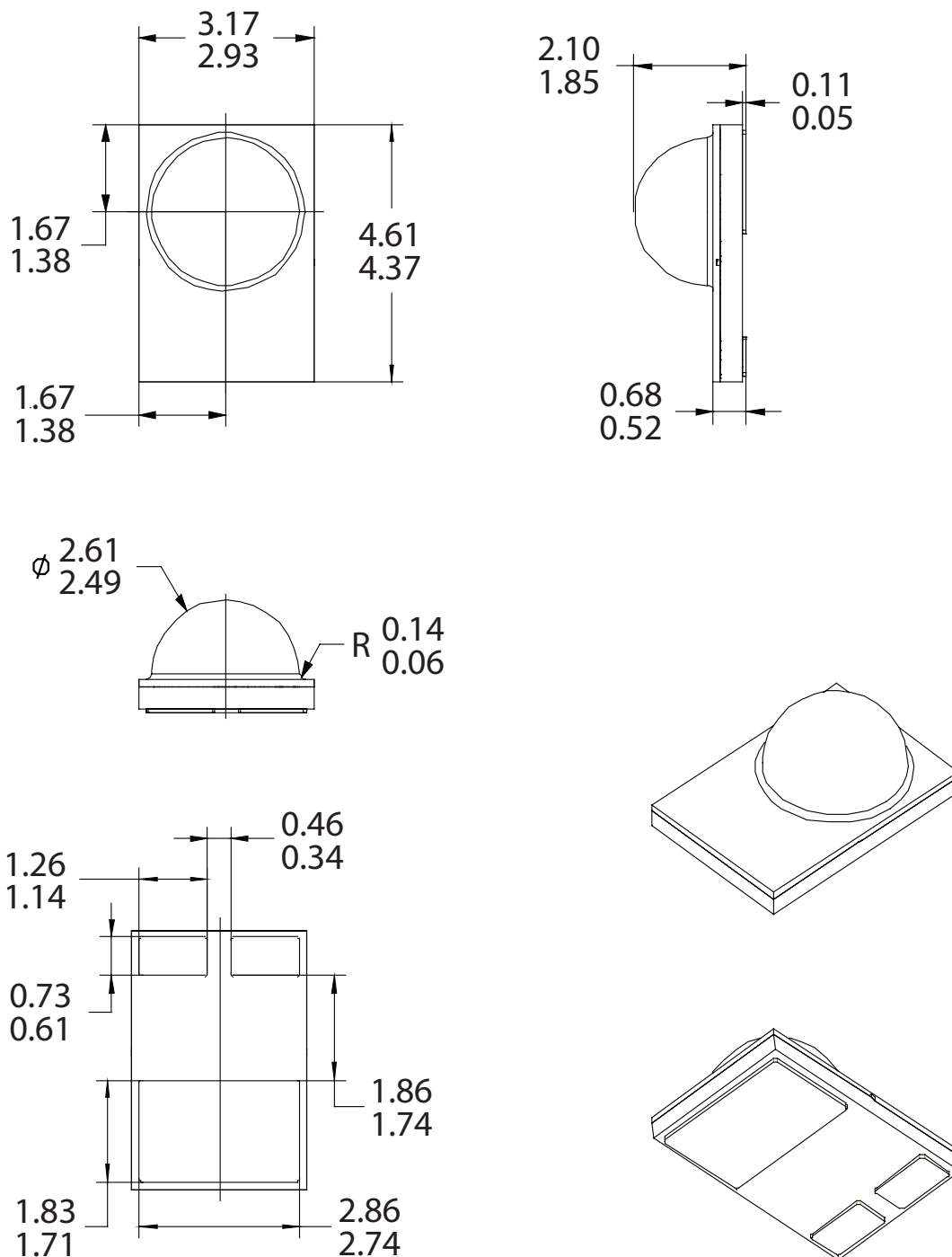


Figure 1. Package outline drawing.

### Notes for Figure 1:

1. To avoid damage, do not handle the device by the emitter 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.

# Mechanical Dimensions

## LUXEON Rebel ES Color

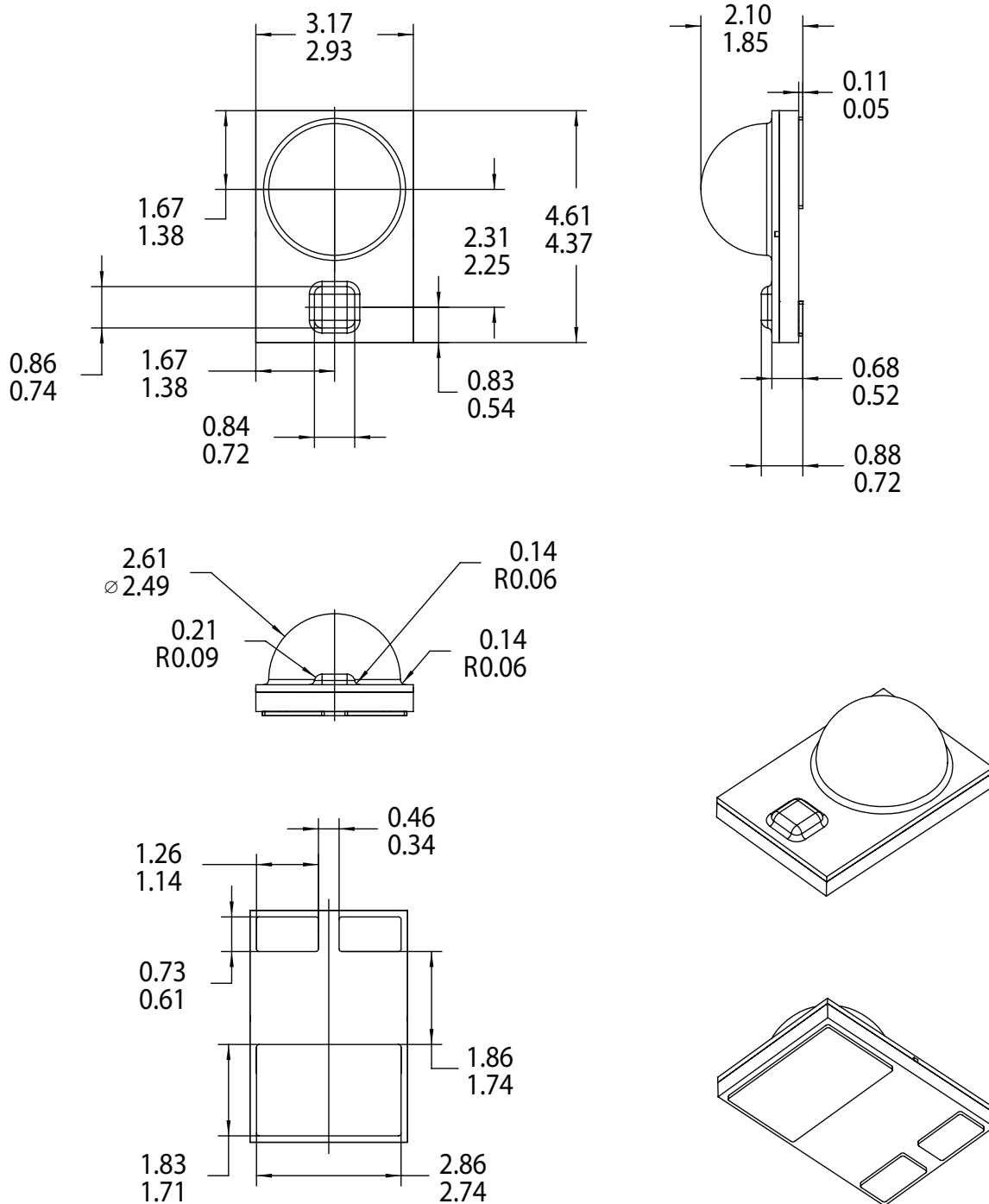


Figure 2. Package outline drawing.

### Notes for Figure 2:

1. To avoid damage, do not handle the device by the emitter 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

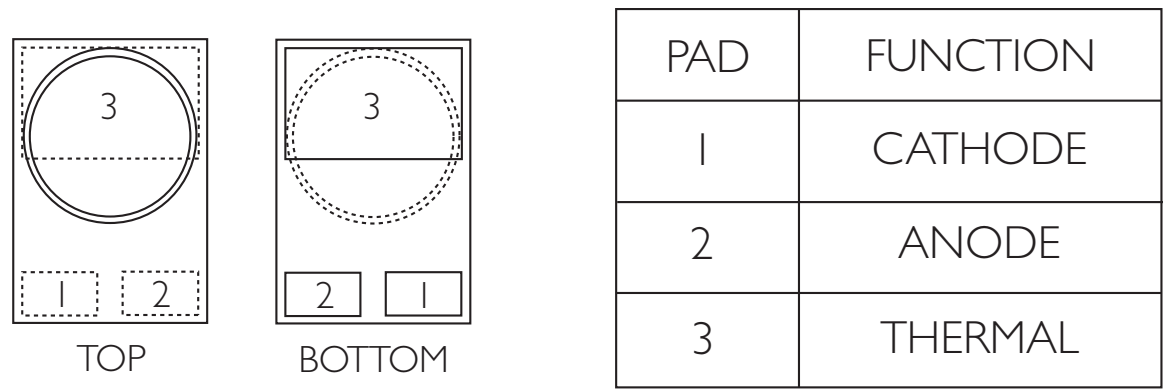


Figure 3. Solder pad layout.

Note for Figure 3:

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

# Solder Pad Design

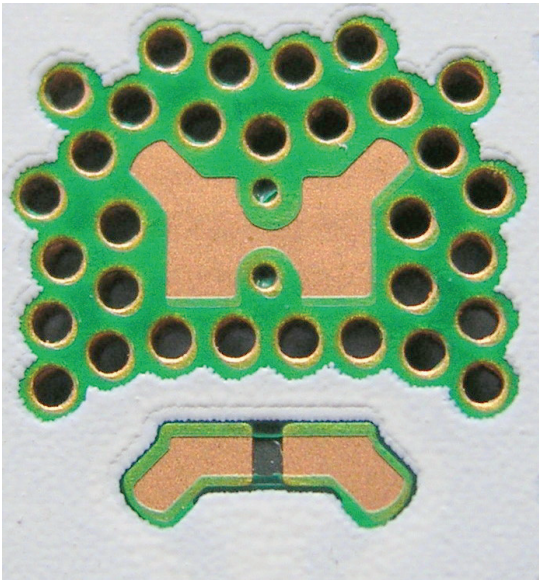


Figure 4. Solder pad layout.

Note for Figure 4:

1. The photograph shows the recommended LUXEON Rebel Color Portfolio layout on printed circuit board (PCB). This design easily achieves a thermal resistance of 7K/W.

Application Brief AB32 provides extensive details for this layout. In addition, the .dwg files are available at [www.lumileds.com](http://www.lumileds.com).

# Wavelength Characteristics

LUXEON Rebel Green, Cyan, Blue, Royal Blue, Red, Red-Orange, Amber at Test Current, 25°C

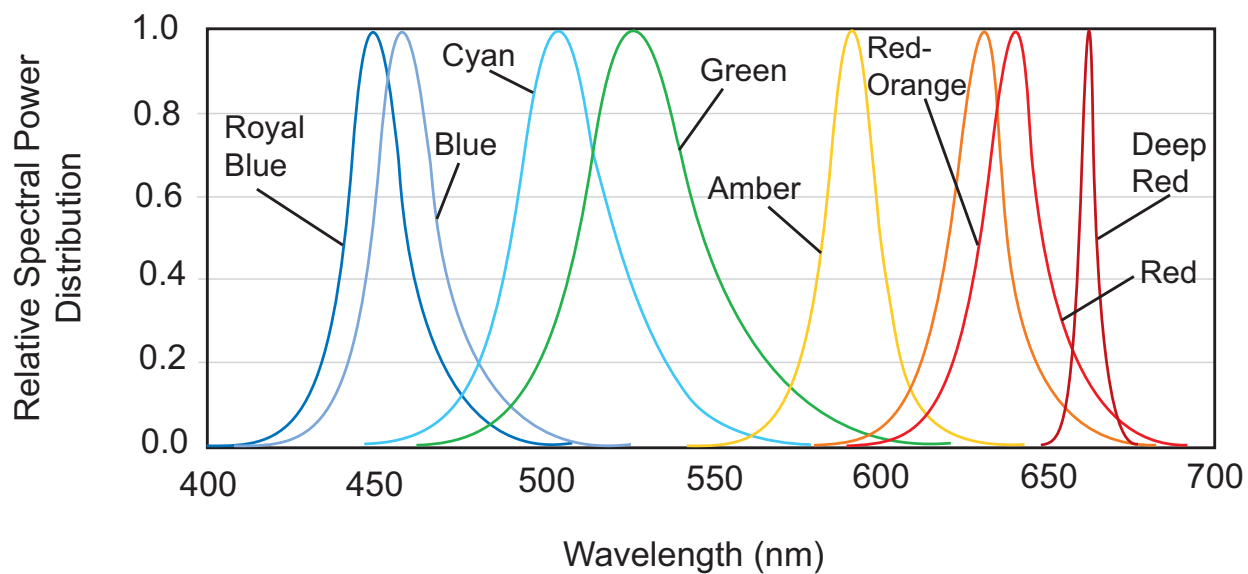


Figure 5. Relative intensity vs. wavelength.

LUXEON Rebel ES Lime and LUXEON Rebel PC Amber at 350mA, 25°C or 85°C

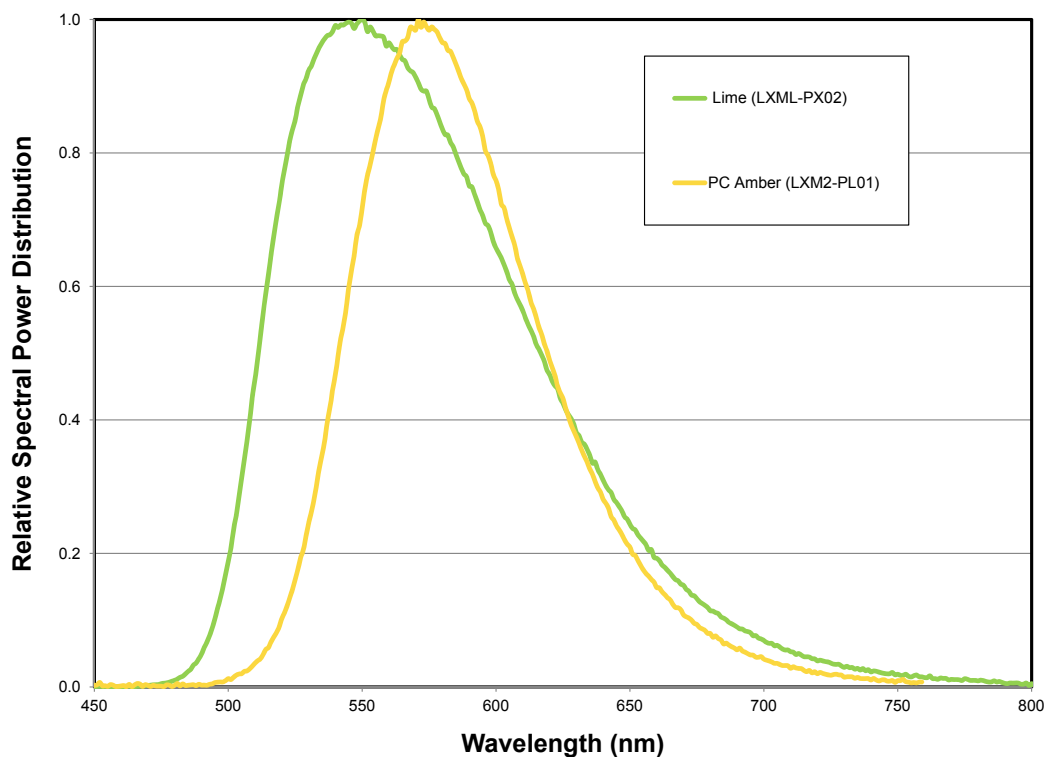
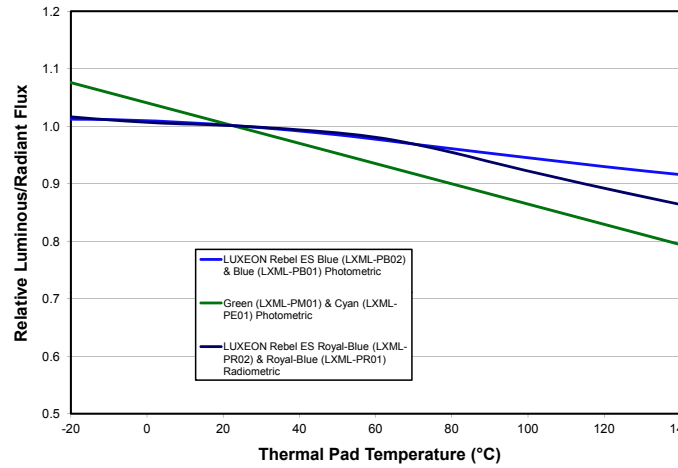


Figure 6. Relative intensity vs. wavelength.

# Typical Light Output Characteristics



\*LXML-PR02 and LXML-PB02 values are based on 700mA drive current.

Figure 7. Relative light output vs. thermal pad temperature for green, cyan, blue and royal blue.

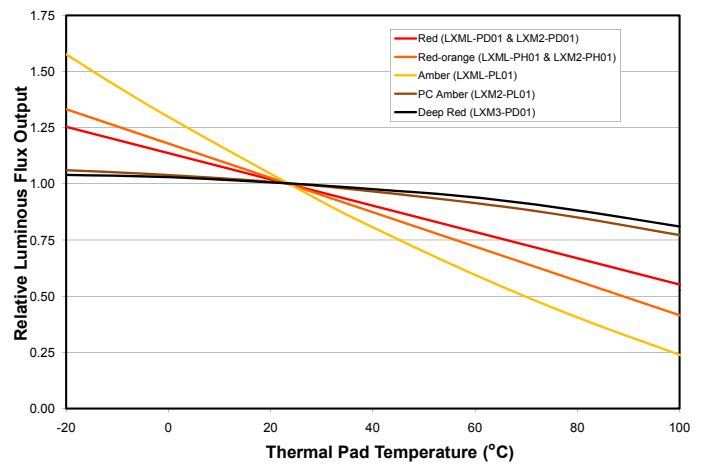
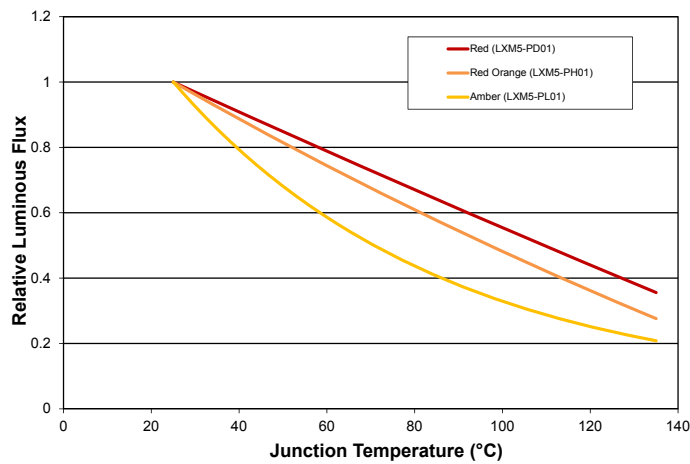


Figure 8. Relative light output vs. thermal pad temperature for red, deep red, red-orange and amber.

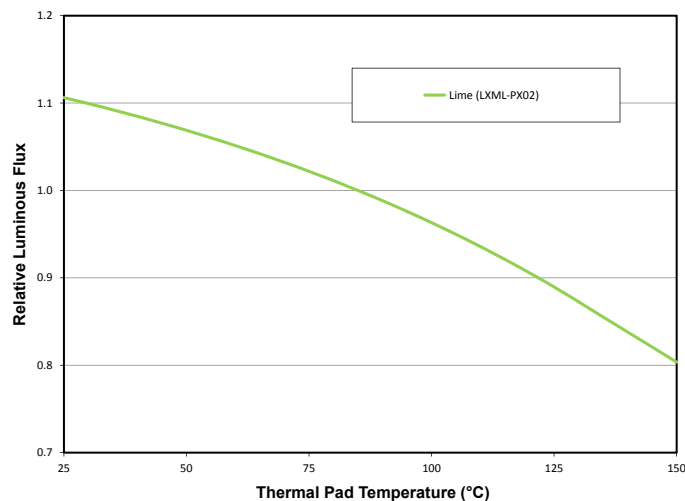


Figure 9. Relative light output vs. thermal pad temperature for lime.

# Typical Forward Current Characteristics

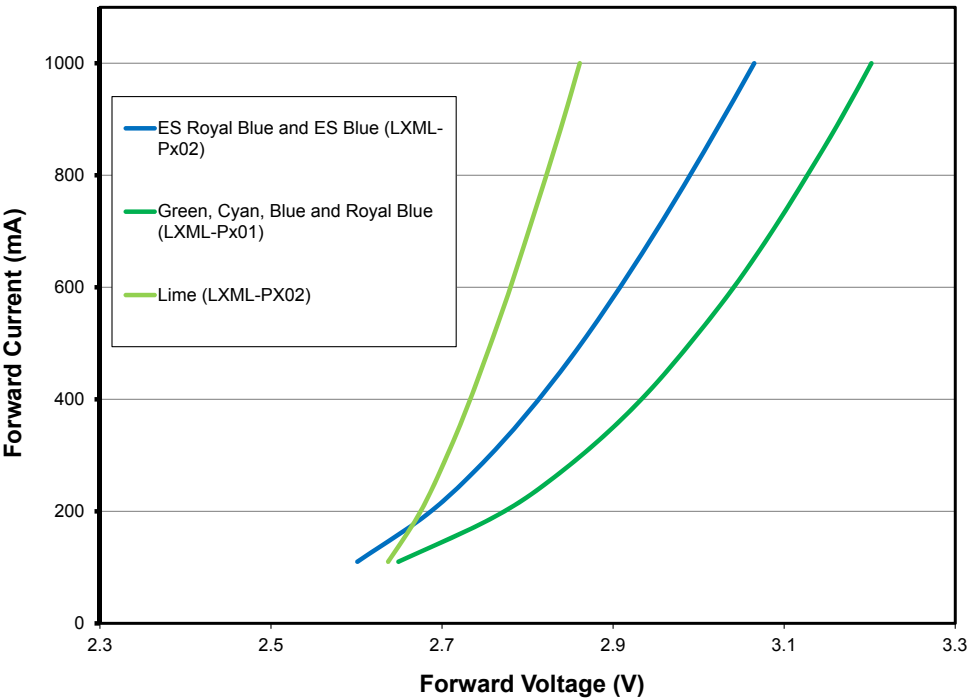


Figure 10. Forward current vs. forward voltage for green, cyan, blue and royal blue at test temperature = 25°C and lime at test temperature = 85°C.

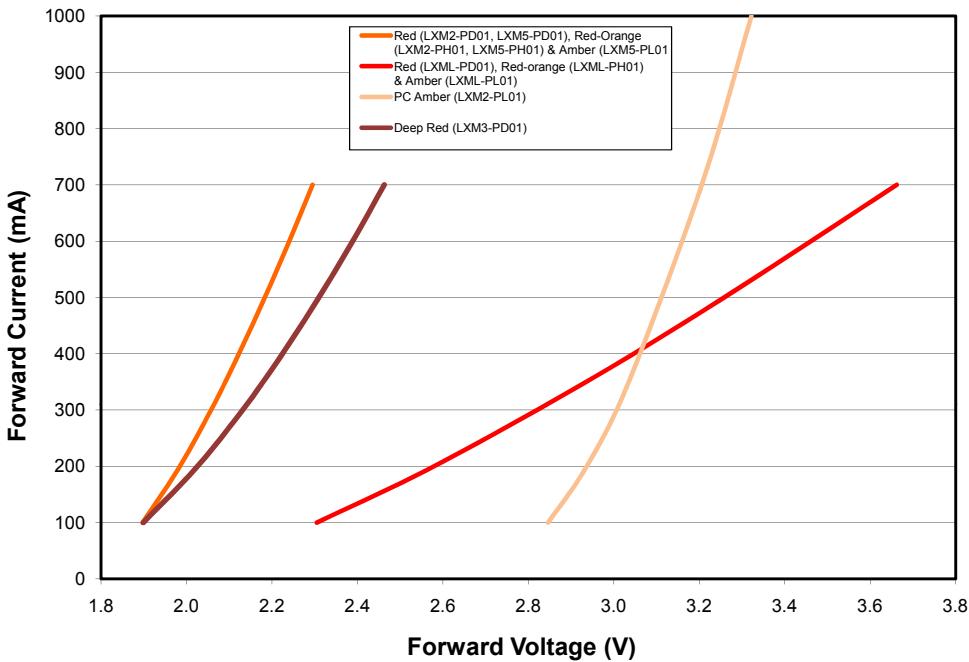


Figure 11. Forward current vs. forward voltage for red, deep red, red-orange, amber, and PC amber at thermal pad temperature = 25°C.

# Typical Relative Luminous Flux

## Relative Flux vs. Forward Current for LUXEON Rebel ES Royal Blue and Blue

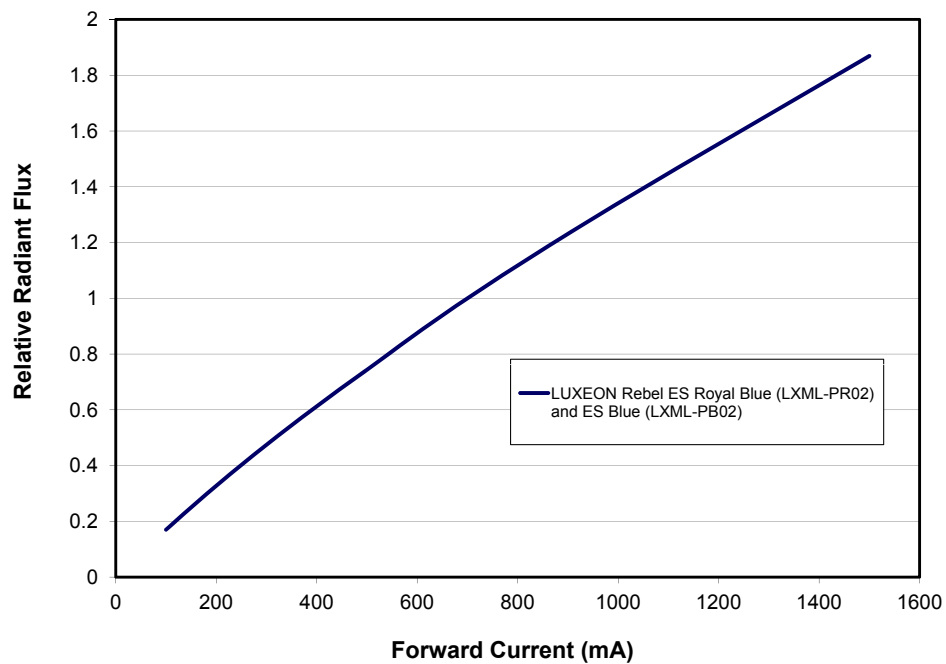


Figure 12. Relative luminous flux or radiometric power vs. forward current for Rebel ES Royal Blue and ES Blue at thermal pad temperature = 25°C.

## Relative Luminous Flux vs. Forward Current for LUXEON Rebel ES Lime and LUXEON Rebel Green, Cyan, Blue and Royal Blue

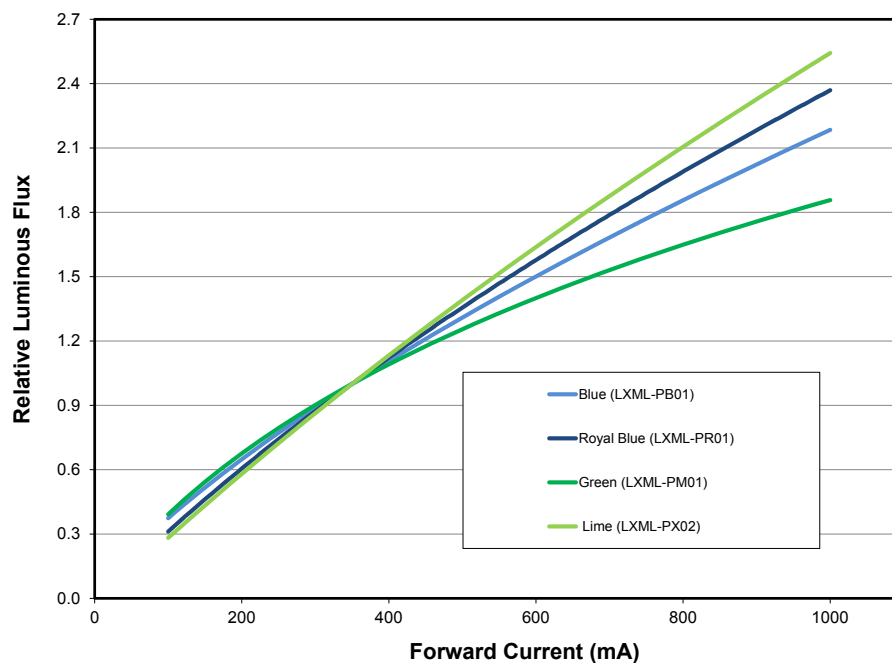


Figure 13. Relative luminous flux or radiometric power vs. forward current for green, cyan, blue and royal blue at thermal pad temperature = 25°C and Rebel ES Lime at thermal pad temperature = 85°C.

Relative Luminous Flux vs. Forward Current for LUXEON Rebel Red, Deep Red, Red-Orange, Amber, Junction Temperature = 25°C

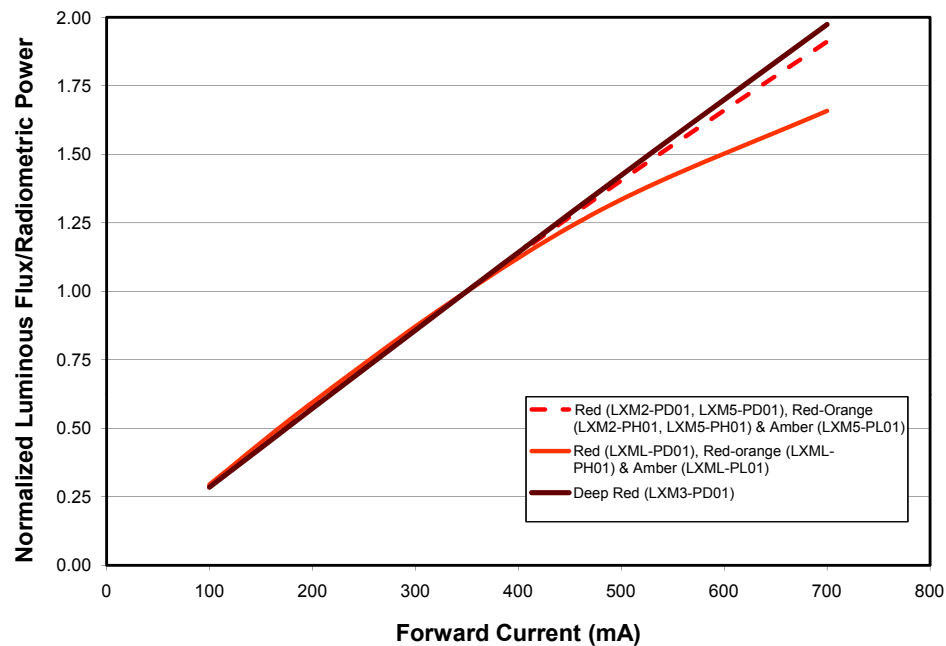


Figure 14. Relative luminous flux vs. forward current for red, deep red, red-orange and amber at Thermal Pad = 25°C maintained.

Relative Luminous Flux for LUXEON Rebel PC Amber  
Junction Temperature = 25°C

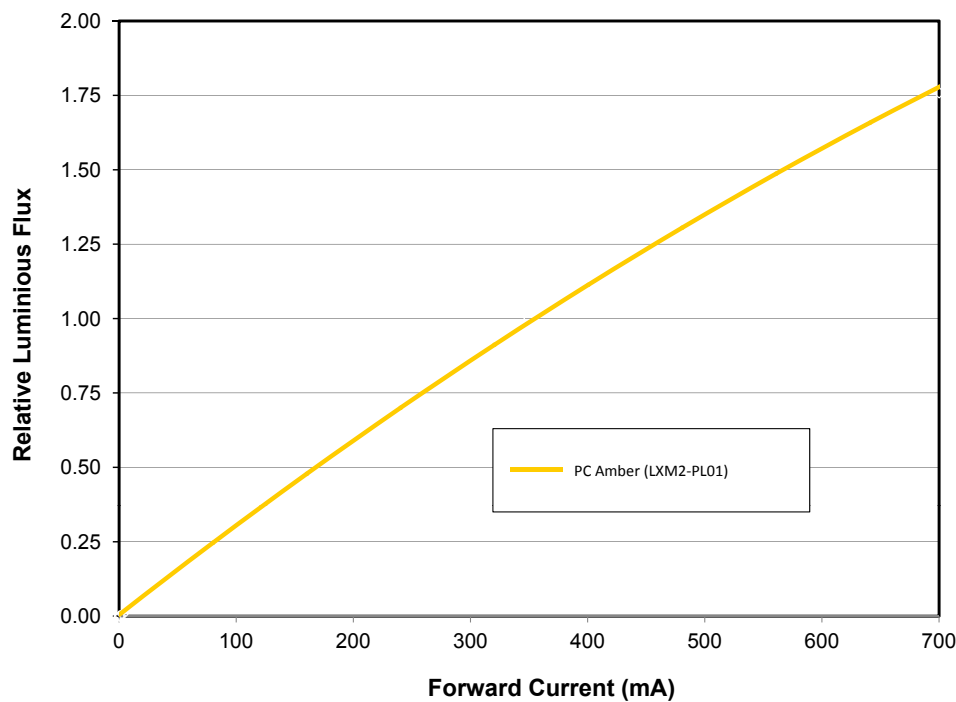


Figure 15. Relative luminous flux vs. forward current for PC amber LXM2-PL01 emitters.

# Typical Radiation Patterns

Spatial Radiation Pattern for LUXEON Rebel Green, Cyan, Blue, Royal Blue and LUXEON Rebel ES Royal Blue and Blue

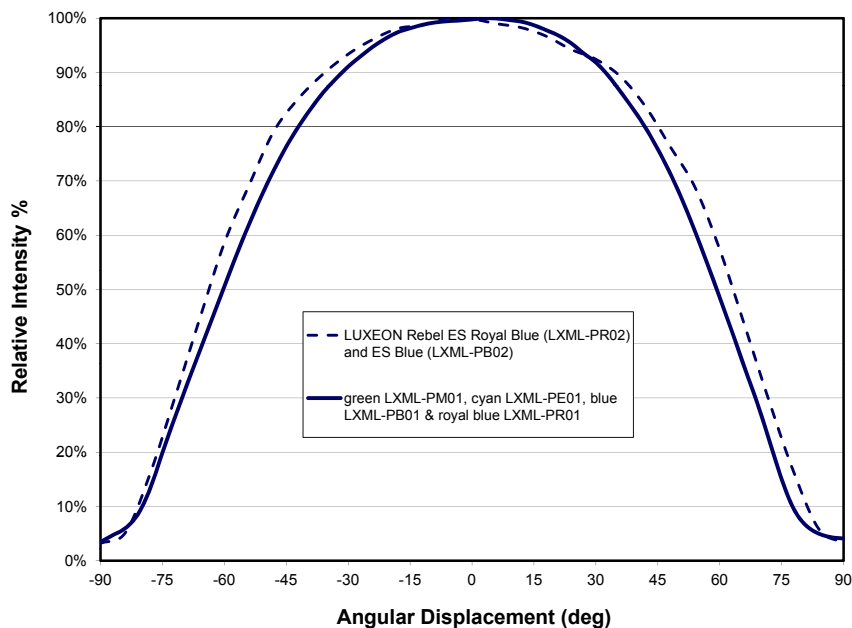


Figure 16. Spatial radiation pattern for LUXEON Rebel green, cyan, blue, royal blue, LUXEON Rebel ES Royal Blue and blue lambertian.

Polar Radiation Pattern for LUXEON Rebel Green, Cyan, Blue, Royal Blue and LUXEON Rebel ES Royal Blue and Blue

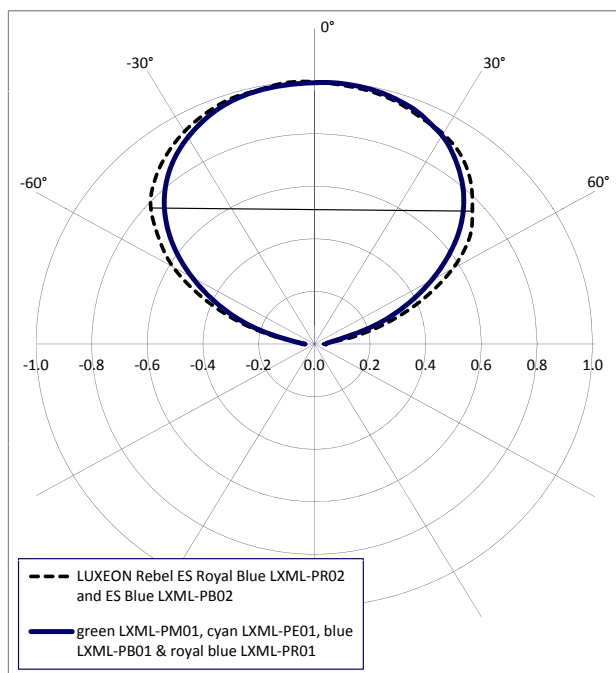


Figure 17. Polar radiation pattern for LUXEON Rebel green, cyan, blue, royal blue and LUXEON Rebel ES royal blue lambertian.

# Typical Radiation Patterns, Continued

## Spatial Radiation Pattern for LUXEON Rebel Red, Red-Orange and Amber

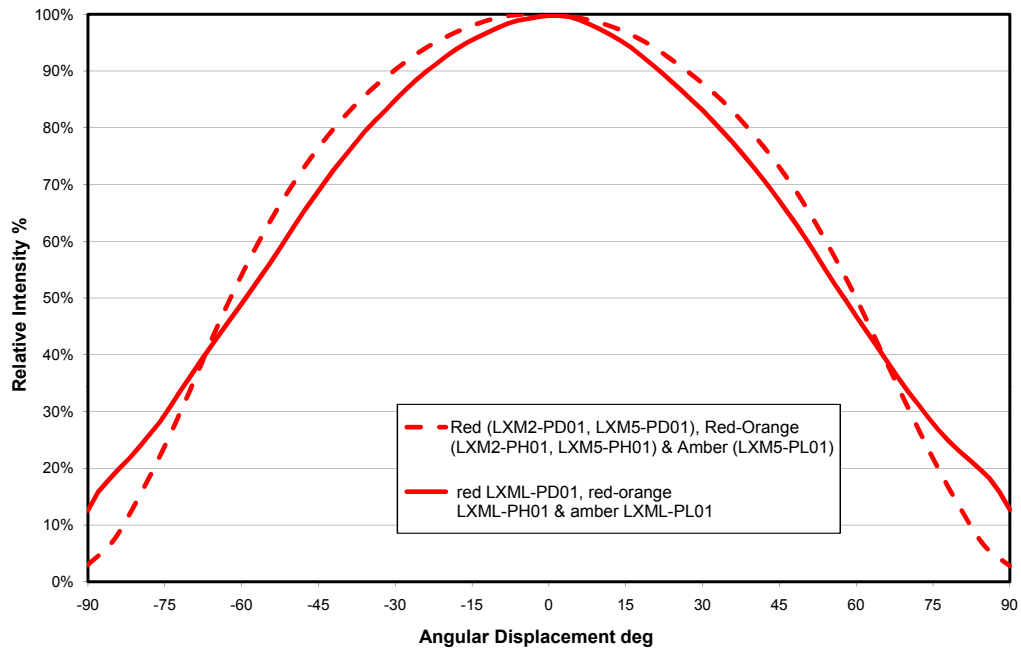


Figure 18. Spatial radiation pattern for red, red-orange and amber lambertian.

## Polar Radiation Pattern for LUXEON Rebel Red, Red-Orange and Amber

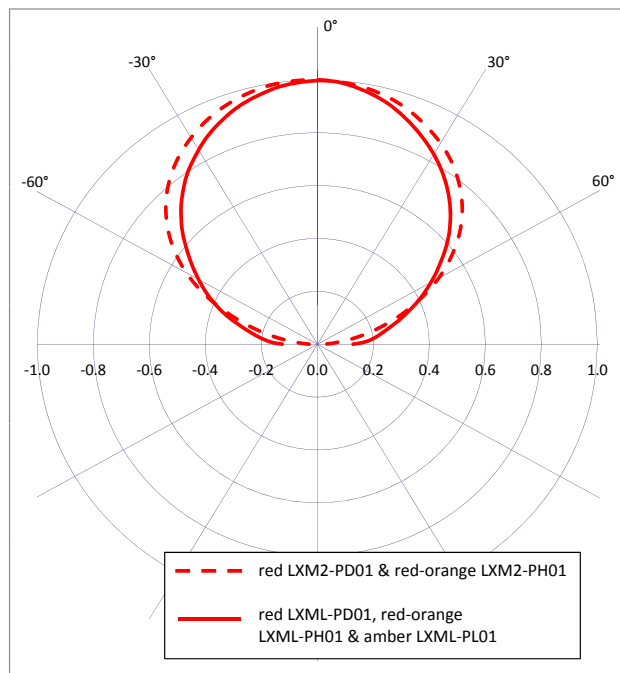


Figure 19. Polar radiation pattern for red, red-orange and amber lambertian.

# Typical Radiation Patterns, Continued

## Spatial Radiation Pattern for LUXEON Rebel Deep Red

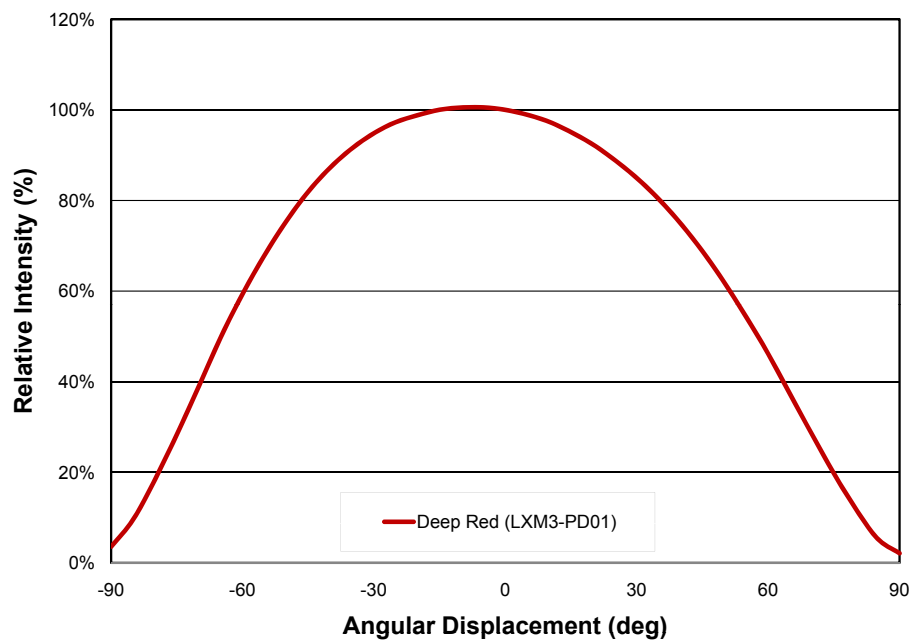


Figure 20. Spatial radiation pattern for deep red lambertian.

## Polar Radiation Pattern for LUXEON Rebel Deep Red

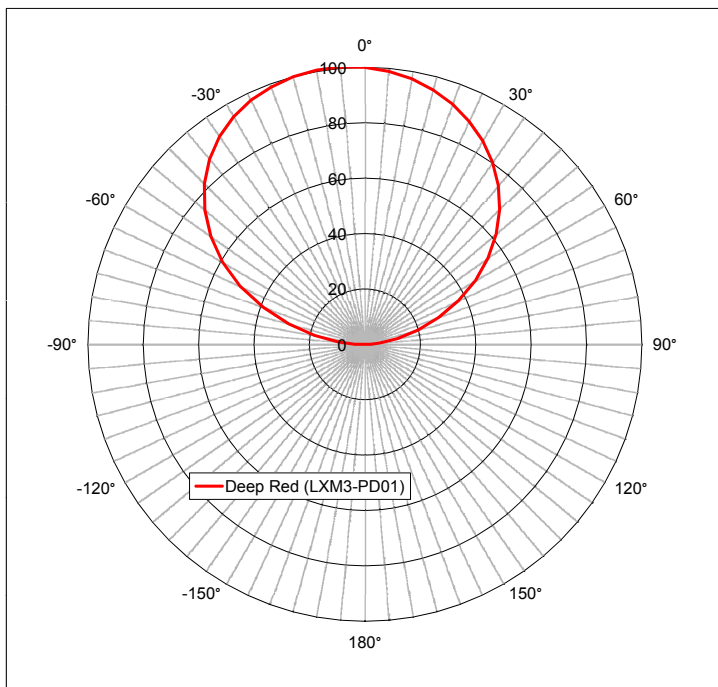


Figure 21. Polar radiation pattern for deep red lambertian.

# Typical Radiation Patterns, Continued

## Spatial Radiation Pattern for LUXEON Rebel PC Amber

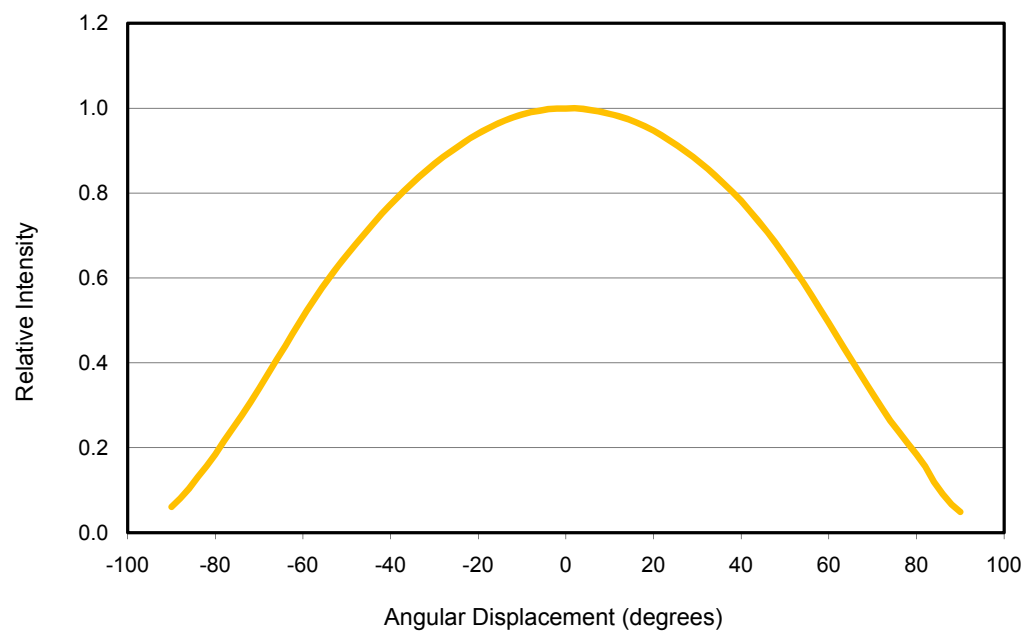


Figure 22. Spatial radiation pattern, PC amber, LXM2-PL01.

## Polar Radiation Pattern for LUXEON Rebel PC Amber

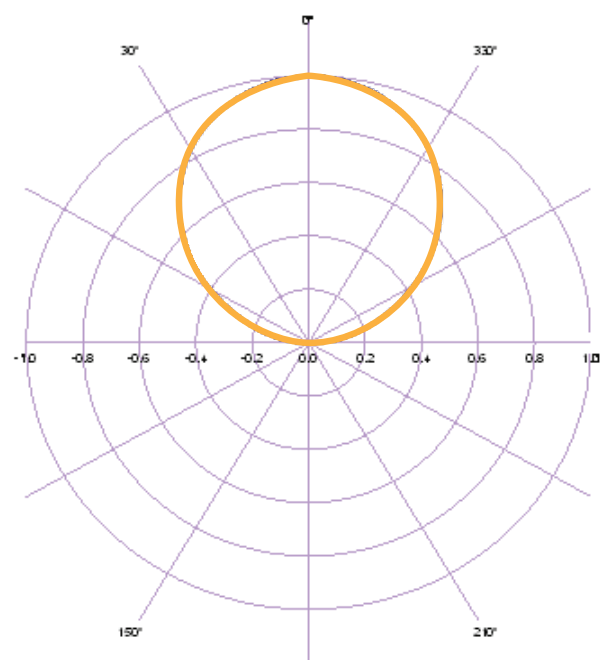


Figure 23. Polar radiation pattern, PC amber, LXM2-PL01.

# Typical Chromaticity Characteristics

## Chromaticity Characteristics vs. Temperature

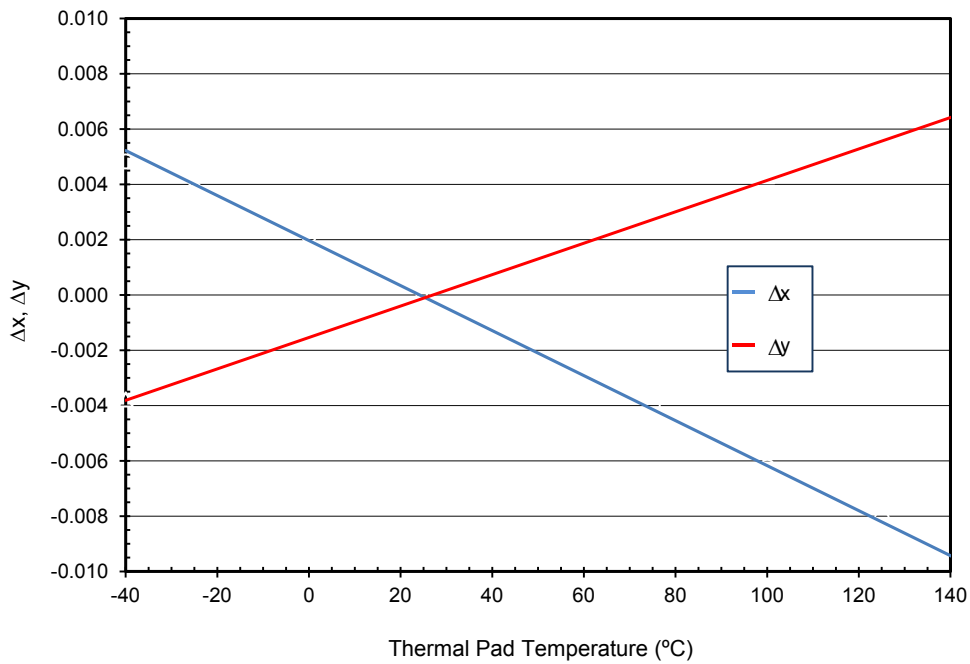


Figure 24. Chromaticity coordinate vs. thermal pad temperature. Test current: 350mA.

## Chromaticity Characteristics vs. Forward Current, Junction Temperature = 25°C

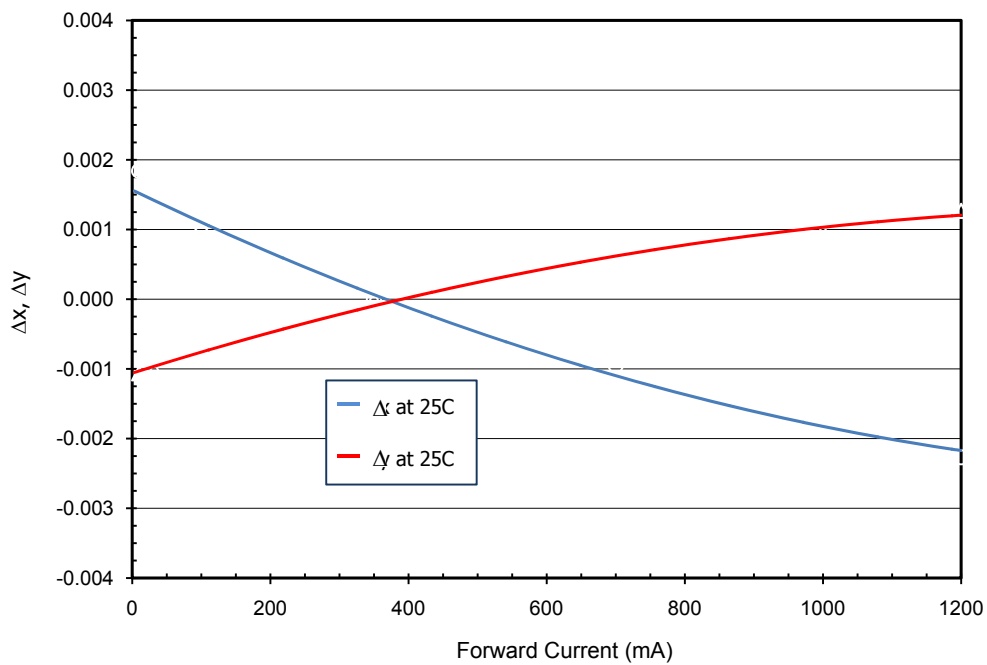


Figure 25. Chromaticity coordinate vs. forward current.

# Emitter Pocket Tape Packaging

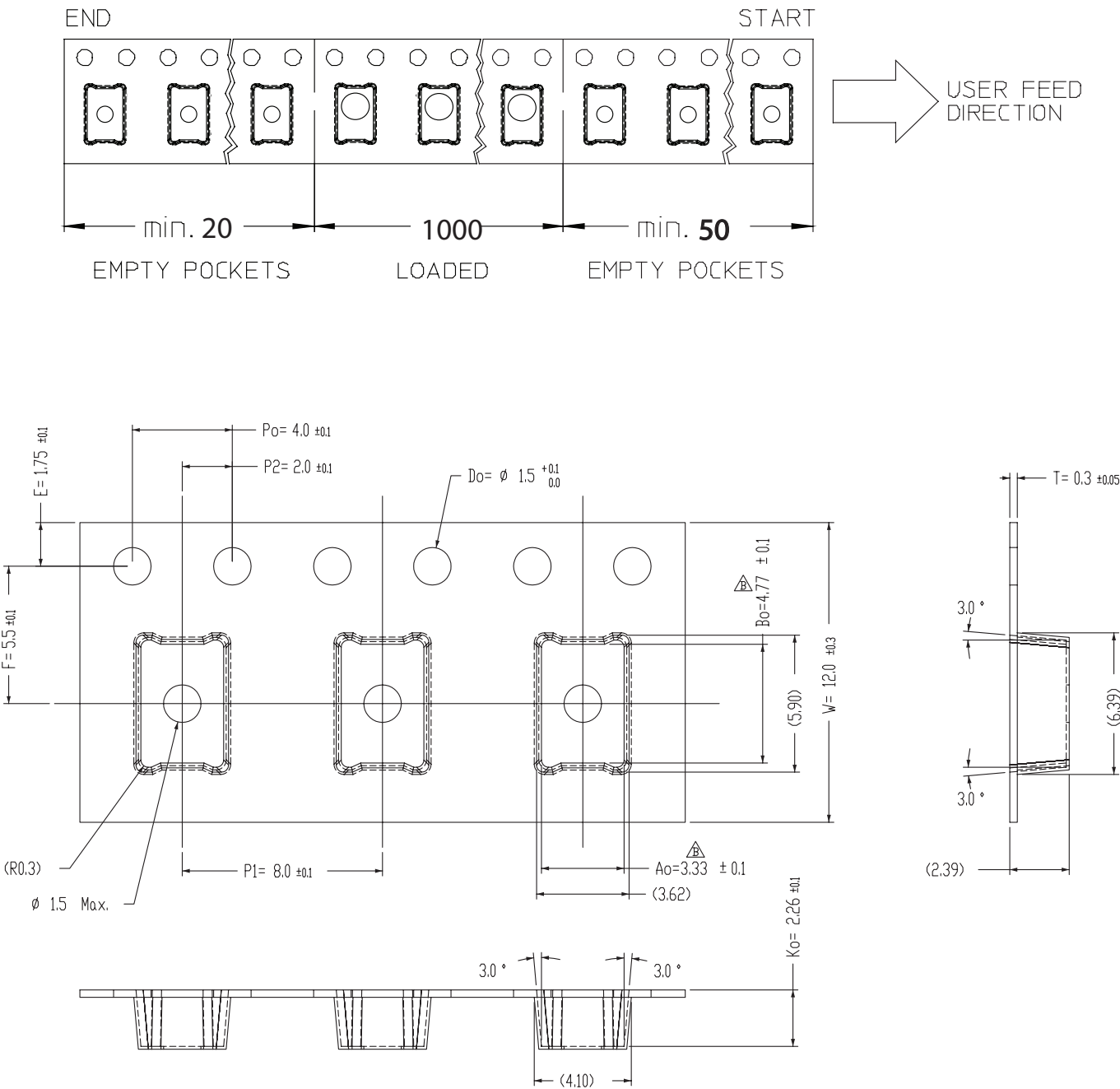


Figure 26. Emitter pocket tape packaging.

# Emitter Reel Packaging

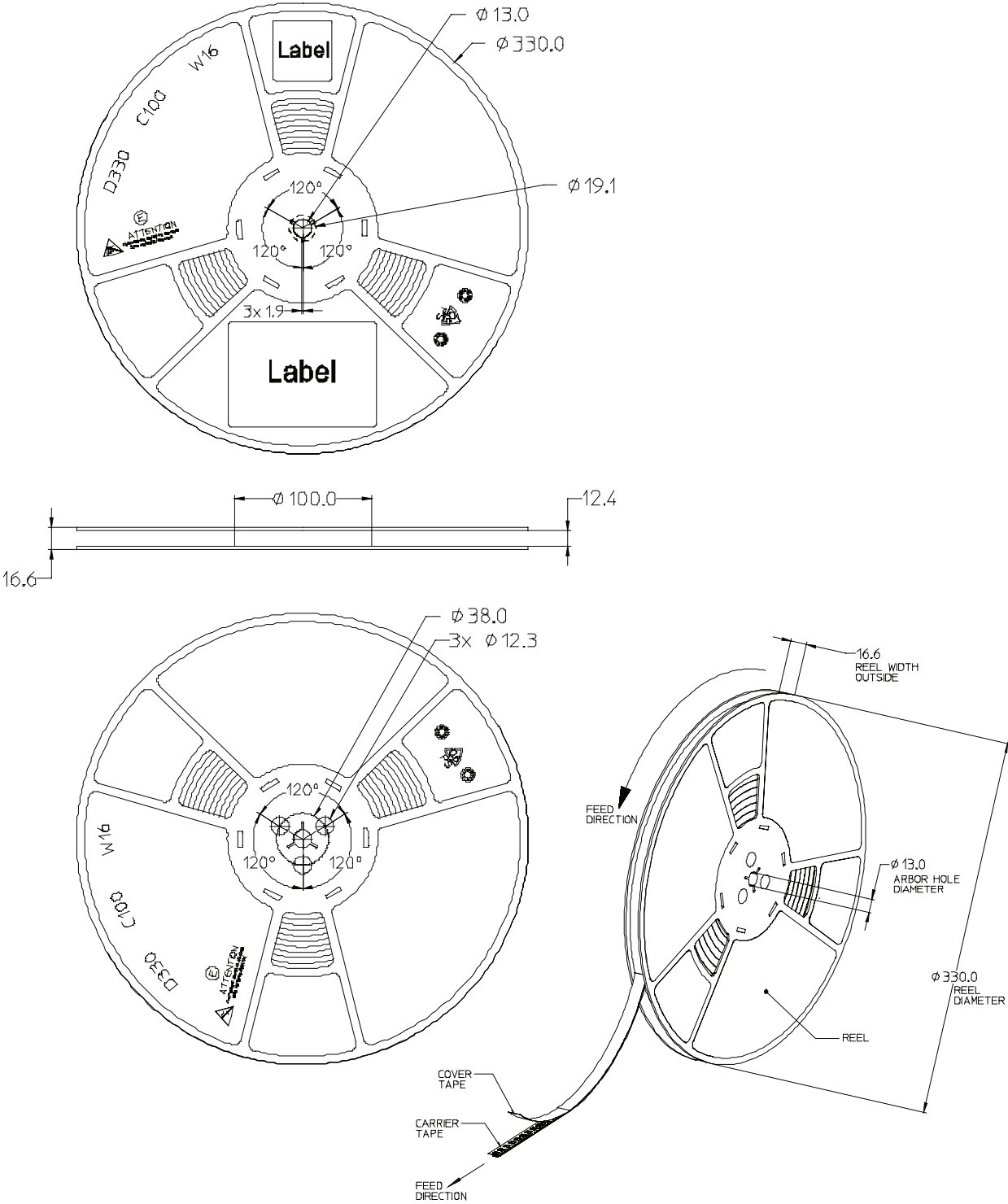


Figure 27. Emitter reel packaging.

# 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, Lumileds bins the LED components for luminous flux, color and forward voltage ( $V_f$ ).

## Decoding Product Bin Labeling

LUXEON Rebel Color Portfolio 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, amber and PC amber emitters are labeled with a three digit alphanumeric CAT code following the format below.

ABC

A = Flux bin (J, K, L, M etc.)

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

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

Reels of lime are labeled with the following CAT code format below.

ABCD

A = Flux bin (F, G, H, etc.)

BC = Color bin (A0)

D =  $V_f$  bin (P,R)

# Luminous Flux Bins

Tables 8 and 9 list the standard photometric luminous flux/radiometric power bins for LUXEON Rebel and LUXEON Rebel ES color emitters (tested and binned at different conditions). 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, Deep Red and Lime) -  $I_f = 350\text{mA}$  or  $700\text{mA}$  and  $T_j = 25^\circ\text{C}$**

| Bin Code | Minimum Flux (lm) | Maximum Flux (lm) |
|----------|-------------------|-------------------|
| 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               | 110               |
| X        | 110               | 120               |
| P        | 120               | 130               |
| Y        | 130               | 140               |

**Table 9. Flux Bins - LUXEON Rebel ES Lime at  $I_f = 350\text{mA}$  and  $T_j = 85^\circ\text{C}$**

| Bin Code | Minimum Luminous Flux (lm) | Maximum Luminous Flux (lm) |
|----------|----------------------------|----------------------------|
| E        | 140                        | 150                        |
| F        | 150                        | 160                        |
| G        | 160                        | 170                        |
| H        | 170                        | 180                        |
| J        | 180                        | 190                        |
| K        | 190                        | 200                        |
| L        | 200                        | 210                        |
| M        | 210                        | 220                        |

# Radiometric Flux Bins

Table 10. Flux Bins - LUXEON Rebel Royal Blue ( $I_f = 350\text{mA}$ ) and LUXEON Rebel ES Royal Blue ( $I_f = 700\text{mA}$ ) at  $T_j = 25^\circ\text{C}$

| Bin Code | Minimum Radiometric Flux (mW) | Maximum Radiometric Flux (mW) |
|----------|-------------------------------|-------------------------------|
| D        | 350                           | 425                           |
| E        | 425                           | 500                           |
| F        | 500                           | 600                           |
| G        | 600                           | 700                           |
| H        | 700                           | 800                           |
| J        | 800                           | 900                           |
| K        | 900                           | 950                           |
| Y        | 950                           | 1000                          |
| A        | 1000                          | 1050                          |
| B        | 1050                          | 1100                          |
| M        | 1100                          | 1200                          |
| N        | 1200                          | 1300                          |

Table 11. Flux Bins - LUXEON Rebel Deep Red at  $I_f = 350\text{mA}$  and  $T_j = 25^\circ\text{C}$

| Bin Code | Minimum Radiometric Flux (mW) | Maximum Radiometric Flux (mW) |
|----------|-------------------------------|-------------------------------|
| C        | 260                           | 300                           |
| D        | 300                           | 350                           |
| E        | 350                           | 400                           |

# Forward Voltage Bins

The following forward voltage bins include the minimum and maximum  $V_f$  bin values for the 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 - for LUXEON Rebel PC Amber (LXML-Pxx1 and LXM2-PL01) tested at  $I_f = 350\text{mA}$**

| 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                        |

**Table 13.  $V_f$  Bins - for LUXEON Rebel ES Royal Blue (LXML-PR02) and Blue (PXML-PB02) tested at  $I_f = 700\text{mA}$**

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

**Table 14.  $V_f$  Bins - for LUXEON Rebel Red, Red-Orange (LXM2-Pxx1, LXM5-Pxx1), Amber (LXM5-PL01) and Deep Red (LXM3-PD01) tested at 350mA.**

| Bin Code | Minimum Forward Voltage (V) | Maximum Forward Voltage (V) |
|----------|-----------------------------|-----------------------------|
| V        | 1.80                        | 2.00                        |
| W        | 2.00                        | 2.20                        |
| X        | 2.20                        | 2.40                        |
| Y        | 2.40                        | 2.60                        |
| Z        | 2.60                        | 2.80                        |

**Table 15.  $V_f$  Bins - for LUXEON Rebel ES Lime (LXML-PX02) tested at  $I_f = 350\text{mA}$ .**

| Bin Code | Minimum Forward Voltage (V) | Maximum Forward Voltage (V) |
|----------|-----------------------------|-----------------------------|
| P        | 2.60                        | 2.75                        |
| R        | 2.75                        | 3.00                        |

# Color Bins

Table 16. Dominant Wavelength Bin Structure for Green

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

Table 17. Dominant Wavelength Bin Structure for Cyan

| 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                              |

Table 18. Dominant Wavelength Bin Structure for LUXEON Rebel and LUXEON Rebel ES Blue

| 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                              |

Table 19. Peak Wavelength Bin Structure for LUXEON Rebel and LUXEON Rebel ES Royal Blue

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

## Color Bins, Continued

Table 20. Dominant Wavelength Bin Structure for Red

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 4        | 620                              | 630                              |
| 5        | 630                              | 645                              |

Table 21. Dominant Wavelength Bin Structure for Red-Orange

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 2        | 610                              | 620                              |

Table 22. Dominant Wavelength Bin Structure for Amber

| Bin Code | Minimum Dominant Wavelength (nm) | Maximum Dominant Wavelength (nm) |
|----------|----------------------------------|----------------------------------|
| 1        | 585                              | 587                              |
| 2        | 587                              | 590                              |
| 4        | 590                              | 592                              |
| 6        | 592                              | 595                              |

Table 23. Peak Wavelength Bin Structure for Deep Red

| Bin Code | Minimum Peak Wavelength (nm) | Maximum Peak Wavelength (nm) |
|----------|------------------------------|------------------------------|
| 6        | 650                          | 660                          |
| 7        | 660                          | 670                          |

# Color Bins for PC Amber and Lime

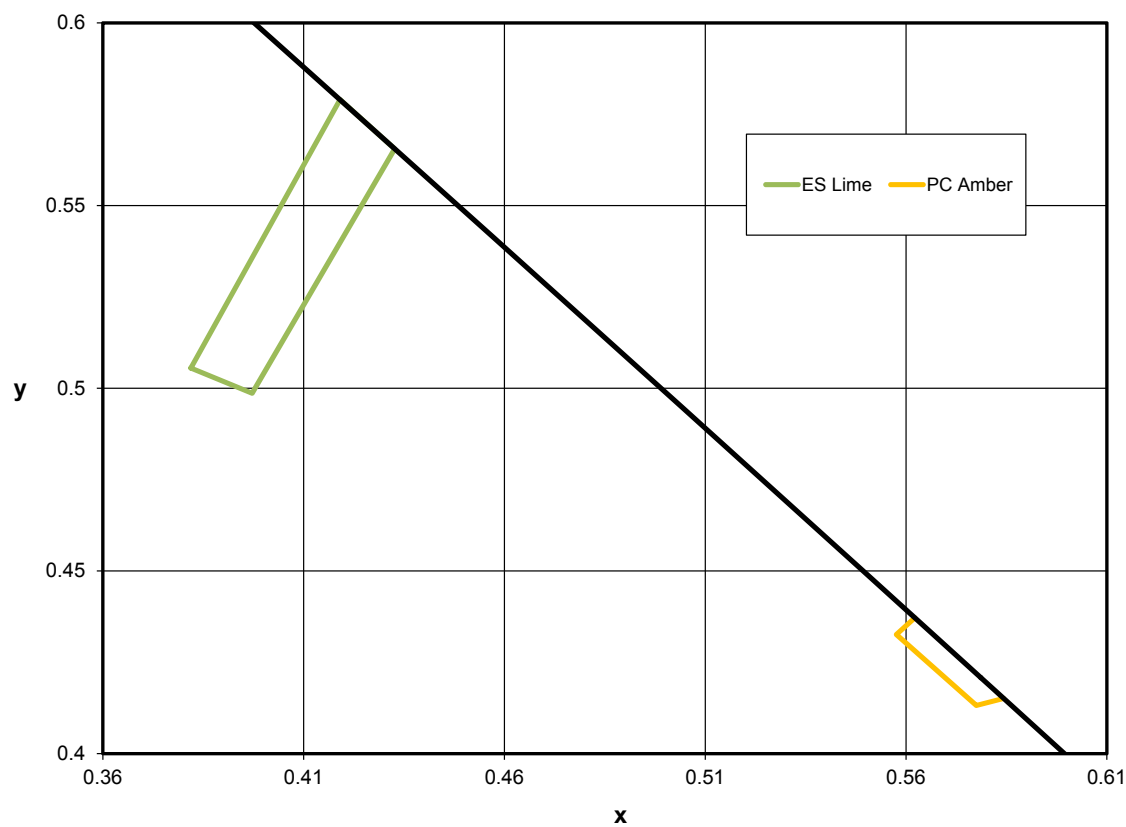


Figure 28. Color bin structure.

Table 24.

| LUXEON Rebel PC Amber Bin Coordinates |          |        |        |
|---------------------------------------|----------|--------|--------|
| Bin Code                              | Bin Code | x      | y      |
| PC Amber                              | 2        | 0.5622 | 0.4372 |
|                                       |          | 0.5576 | 0.4326 |
|                                       |          | 0.5775 | 0.4132 |
|                                       |          | 0.5843 | 0.4151 |
| Lime                                  | A0       | 0.3819 | 0.5055 |
|                                       |          | 0.4191 | 0.5790 |
|                                       |          | 0.4327 | 0.5655 |
|                                       |          | 0.3972 | 0.4986 |

Note for Table 24:

1. LUXEON Rebel PC amber and lime emitters are tested and binned by x,y coordinates.

# About Lumileds

Lumileds is the light engine leader, delivering innovation, quality, and reliability.

For 100 years, Lumileds commitment to innovation has helped customers pioneer breakthrough products in the automotive, consumer and illumination markets.

Lumileds is shaping the future of light with our LEDs and automotive lamps, and helping our customers illuminate how people see the world around them.

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