

XLamp® ML-E LEDs



PRODUCT DESCRIPTION

The XLamp® ML-E LED brings lighting-class reliability and performance to ½-watt LEDs. The XLamp ML-E LED expands Cree LED's lighting-class leadership to LED bulbs and linear and distributed lighting applications. With XLamp LED lighting-class reliability, a wide viewing angle, uniform light output, and industry-leading chromaticity binning in a 3.5-mm X 3.5-mm package, the XLamp ML-E LED continues Cree LED's history of segment-focused product innovation in LEDs for lighting applications.

The XLamp ML-E LED brings high performance and a smooth look to a wide range of lighting applications, including linear lighting, LED light bulbs, fluorescent retrofits and retail-display lighting.

FEATURES

- Available in white (2600 K to 8300 K CCT), 80-, 85- and 90-CRI minimum
- Available in royal blue, blue, green, amber and red
- Available in parallel and series Vf configurations for white and color
- ANSI-compatible sub-bins
- Maximum drive current: 500 mA for parallel white, 167 mA for series white, 350 mA for parallel royal blue, blue, green and red, 250 mA for parallel amber, 120 mA for series blue and green, 65 mA for series amber, 88 mA for series red
- 120° viewing angle for white, 125° viewing angle for color
- Uniform chromaticity profile
- Electrically neutral thermal path
- RoHS and REACH compliant
- UL® recognized component (E349212)



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CHARACTERISTICS ($T_j = 25\text{ }^\circ\text{C}$)

| Characteristics | Unit | Minimum | Typical | Maximum |
|---|----------------------------|---------|---------|---------|
| Thermal resistance, junction to solder point - white ^o | $^\circ\text{C}/\text{W}$ | | 9 | |
| Thermal resistance, junction to solder point - royal blue, blue ^o | $^\circ\text{C}/\text{W}$ | | 8 | |
| Thermal resistance, junction to solder point - green ^o | $^\circ\text{C}/\text{W}$ | | 11 | |
| Thermal resistance, junction to solder point - amber ^o | $^\circ\text{C}/\text{W}$ | | 23 | |
| Thermal resistance, junction to solder point - red ^o | $^\circ\text{C}/\text{W}$ | | 19 | |
| Viewing angle (FWHM) - white | degrees | | 120 | |
| Viewing angle (FWHM) - royal blue, blue, green, amber, red | degrees | | 125 | |
| Temperature coefficient of voltage - parallel - white, royal blue | $\text{mV}/^\circ\text{C}$ | | -3.3 | |
| Temperature coefficient of voltage - parallel - blue | $\text{mV}/^\circ\text{C}$ | | -2 | |
| Temperature coefficient of voltage - series - white | $\text{mV}/^\circ\text{C}$ | | -10 | |
| Temperature coefficient of voltage - series - blue | $\text{mV}/^\circ\text{C}$ | | -5 | |
| Temperature coefficient of voltage - parallel - green | $\text{mV}/^\circ\text{C}$ | | -3 | |
| Temperature coefficient of voltage - series - green | $\text{mV}/^\circ\text{C}$ | | -9 | |
| Temperature coefficient of voltage - parallel - amber | $\text{mV}/^\circ\text{C}$ | | -1 | |
| Temperature coefficient of voltage - series - amber | $\text{mV}/^\circ\text{C}$ | | -3.2 | |
| Temperature coefficient of voltage - parallel - red | $\text{mV}/^\circ\text{C}$ | | -1.8 | |
| Temperature coefficient of voltage - series - red | $\text{mV}/^\circ\text{C}$ | | -5.4 | |
| ESD withstand voltage (HBM per Mil-Std-883D) - white, royal blue, blue, green | V | | | 8000 |
| ESD classification (HBM per Mil-Std-883D) - amber, red | | | Class 2 | |
| DC forward current - parallel - white | mA | | | 500 |
| DC forward current - series - white | mA | | | 167 |
| DC forward current - parallel - royal blue, blue, green, red | mA | | | 350 |
| DC forward current - series - blue, green | mA | | | 120 |
| DC forward current - parallel - amber | mA | | | 250 |
| DC forward current - series - amber | mA | | | 65 |
| DC forward current - series - red | mA | | | 88 |
| Reverse voltage | V | | | 1 |

CHARACTERISTICS ($T_j = 25\text{ }^\circ\text{C}$) - CONTINUED

| Characteristics | Unit | Minimum | Typical | Maximum |
|---|------------------|---------|---------|---------|
| Forward voltage (@ 150 mA) - parallel - white, royal blue | V | | 3.2 | 3.4 |
| Forward voltage (@ 50 mA) - series - white | V | | 9.6 | 10.2 |
| Forward voltage (@ 150 mA) - parallel - blue | V | | 3.0 | |
| Forward voltage (@ 50 mA) - series - blue | V | | 8.9 | |
| Forward voltage (@ 150 mA) - parallel - green | V | | 2.8 | |
| Forward voltage (@ 50 mA) - series - green | V | | 8.5 | |
| Forward voltage (@ 150 mA) - parallel - amber, red | V | | 2.4 | |
| Forward voltage (@ 37.5 mA) - series - amber, red | V | | 9.6 | |
| LED junction temperature | $^\circ\text{C}$ | | | 150 |

Note:

- ◇ Thermal resistance measurement was performed per the JEDEC JESD51-14 standard. See the [Thermal Resistance Measurement application note](#) for more details.

FLUX CHARACTERISTICS - PARALLEL WHITE (T_j = 25 °C)

The following table provides order codes for XLamp ML-E LEDs. For a complete description of the order-code nomenclature, please consult the Bin and Order Code Formats section (page 40).

| Chromaticity | | Minimum Luminous Flux (lm) @ 150 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | |
|--------------|--------|-------------------------------------|------|--|--------|-----------------------|----------------|
| Kit | CCT | Code | Flux | 350 mA | 500 mA | 75 CRI Typical | 80 CRI Minimum |
| DT | 7000 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005DT | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004DT | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003DT | |
| E0 | 7000 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005E0 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004E0 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E0 | |
| 51 | 6500 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-000551 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-000451 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-000351 | |
| E1 | 6500 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005E1 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004E1 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E1 | |
| 50 | 6200 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-000550 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-000450 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-000350 | |
| DV | 6000 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005DV | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004DV | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003DV | |
| E2 | 5750 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005E2 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004E2 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E2 | |
| DY | 5500 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005DY | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004DY | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003DY | |
| DZ | 5000 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005DZ | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004DZ | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003DZ | |

Notes:

- Cree LED maintains a tolerance of ±7% on flux and power measurements, ±0.005 on chromaticity (CCx, CCy) measurements and ±2 on CRI measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.
- Minimum CRI for 80-CRI White is 80.
- Minimum CRI for 85-CRI White is 85.
- Minimum CRI for 90-CRI White is 90
- * Calculated flux values are for reference only.

FLUX CHARACTERISTICS - PARALLEL WHITE (T_j = 25 °C) - CONTINUED

| Chromaticity | | Minimum Luminous Flux (lm) @ 150 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | |
|--------------|--------|-------------------------------------|------|--|--------|-----------------------|-----------------------|
| Kit | CCT | Code | Flux | 350 mA | 500 mA | 75 CRI Typical | 80 CRI Minimum |
| E3 | 5000 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005E3 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004E3 | MLEAWT-H1-0000-0004E3 |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E3 | MLEAWT-H1-0000-0003E3 |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002E3 | MLEAWT-H1-0000-0002E3 |
| F4 | 4750 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005F4 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004F4 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003F4 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002F4 | |
| E4 | 4500 K | N3 | 56.8 | 114.1 | 146.0 | MLEAWT-A1-0000-0005E4 | |
| | | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004E4 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E4 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002E4 | |

| Chromaticity | | Minimum Luminous Flux (lm) @ 150 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | | | |
|--------------|--------|-------------------------------------|------|--|--------|-----------------------|-----------------------|-----------------------|-----------------------|
| Kit | CCT | Code | Flux | 350 mA | 500 mA | 80 CRI Typical | 80 CRI Minimum | 85 CRI Minimum | 90 CRI Minimum |
| F5 | 4250 K | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004F5 | | | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003F5 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002F5 | | | |
| E5 | 4000 K | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004E5 | | | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E5 | MLEAWT-H1-0000-0003E5 | MLEAWT-P1-0000-0003E5 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002E5 | MLEAWT-H1-0000-0002E5 | MLEAWT-P1-0000-0002E5 | MLEAWT-U1-0000-0002E5 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001E5 | MLEAWT-P1-0000-0001E5 | MLEAWT-U1-0000-0001E5 |
| Z5 | 4000 K | N2 | 51.7 | 104.8 | 132.9 | MLEAWT-A1-0000-0004Z5 | | | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003Z5 | MLEAWT-H1-0000-0003Z5 | MLEAWT-P1-0000-0003Z5 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002Z5 | MLEAWT-H1-0000-0002Z5 | MLEAWT-P1-0000-0002Z5 | MLEAWT-U1-0000-0002Z5 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001Z5 | MLEAWT-P1-0000-0001Z5 | MLEAWT-U1-0000-0001Z5 |
| F6 | 3750 K | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003F6 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002F6 | MLEAWT-H1-0000-0002F6 | MLEAWT-P1-0000-0002F6 | MLEAWT-U1-0000-0002F6 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001F6 | MLEAWT-P1-0000-0001F6 | MLEAWT-U1-0000-0001F6 |

Notes:

- Cree LED maintains a tolerance of ±7% on flux and power measurements, ±0.005 on chromaticity (CCx, CCy) measurements and ±2 on CRI measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.
- Minimum CRI for 80-CRI White is 80.
- Minimum CRI for 85-CRI White is 85.
- Minimum CRI for 90-CRI White is 90
- * Calculated flux values are for reference only.

FLUX CHARACTERISTICS - PARALLEL WHITE (T_j = 25 °C) - CONTINUED

| Chromaticity | | Minimum Luminous Flux (lm) @ 150 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | | | |
|--------------|--------|-------------------------------------|------|--|--------|-----------------------|-----------------------|-----------------------|-----------------------|
| Kit | CCT | Code | Flux | 350 mA | 500 mA | 80 CRI Typical | 80 CRI Minimum | 85 CRI Minimum | 90 CRI Minimum |
| E6 | 3500 K | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E6 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002E6 | MLEAWT-H1-0000-0002E6 | MLEAWT-P1-0000-0002E6 | MLEAWT-U1-0000-0002E6 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001E6 | MLEAWT-P1-0000-0001E6 | MLEAWT-U1-0000-0001E6 |
| Z6 | 3500 K | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003Z6 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002Z6 | MLEAWT-H1-0000-0002Z6 | MLEAWT-P1-0000-0002Z6 | MLEAWT-U1-0000-0002Z6 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001Z6 | MLEAWT-P1-0000-0001Z6 | MLEAWT-U1-0000-0001Z6 |
| F7 | 3250 K | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003F7 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002F7 | MLEAWT-H1-0000-0002F7 | MLEAWT-P1-0000-0002F7 | MLEAWT-U1-0000-0002F7 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001F7 | MLEAWT-P1-0000-0001F7 | MLEAWT-U1-0000-0001F7 |
| | | K2 | 30.6 | 62.0 | 78.6 | | MLEAWT-H1-0000-0000F7 | MLEAWT-P1-0000-0000F7 | MLEAWT-U1-0000-0000F7 |
| E7 | 3000 K | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003E7 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002E7 | MLEAWT-H1-0000-0002E7 | MLEAWT-P1-0000-0002E7 | MLEAWT-U1-0000-0002E7 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001E7 | MLEAWT-P1-0000-0001E7 | MLEAWT-U1-0000-0001E7 |
| | | K2 | 30.6 | 62.0 | 78.6 | | MLEAWT-H1-0000-0000E7 | MLEAWT-P1-0000-0000E7 | MLEAWT-U1-0000-0000E7 |
| Z7 | 3000 K | M3 | 45.7 | 92.6 | 117.4 | MLEAWT-A1-0000-0003Z7 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002Z7 | MLEAWT-H1-0000-0002Z7 | MLEAWT-P1-0000-0002Z7 | MLEAWT-U1-0000-0002Z7 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001Z7 | MLEAWT-P1-0000-0001Z7 | MLEAWT-U1-0000-0001Z7 |
| | | K2 | 30.6 | 62.0 | 78.6 | | MLEAWT-H1-0000-0000Z7 | MLEAWT-P1-0000-0000Z7 | MLEAWT-U1-0000-0000Z7 |
| F8 | 2850 K | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002F8 | MLEAWT-H1-0000-0002F8 | | |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001F8 | MLEAWT-P1-0000-0001F8 | MLEAWT-U1-0000-0001F8 |
| | | K2 | 30.6 | 62.0 | 78.6 | | MLEAWT-H1-0000-0000F8 | MLEAWT-P1-0000-0000F8 | MLEAWT-U1-0000-0000F8 |
| E8 | 2700 K | M3 | 45.7 | 92.6 | 117.4 | | MLEAWT-H1-0000-0003E8 | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002E8 | MLEAWT-H1-0000-0002E8 | | |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001E8 | MLEAWT-P1-0000-0001E8 | MLEAWT-U1-0000-0001E8 |
| | | K2 | 30.6 | 62.0 | 78.6 | | MLEAWT-H1-0000-0000E8 | MLEAWT-P1-0000-0000E8 | MLEAWT-U1-0000-0000E8 |
| Z8 | 2700 K | M2 | 39.8 | 80.7 | 102.3 | MLEAWT-A1-0000-0002Z8 | | | |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLEAWT-H1-0000-0001Z8 | MLEAWT-P1-0000-0001Z8 | MLEAWT-U1-0000-0001Z8 |
| | | K2 | 30.6 | 62.0 | 78.6 | | MLEAWT-H1-0000-0000Z8 | MLEAWT-P1-0000-0000Z8 | MLEAWT-U1-0000-0000Z8 |

Notes:

- Cree LED maintains a tolerance of ±7% on flux and power measurements, ±0.005 on chromaticity (CCx, CCy) measurements and ±2 on CRI measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.
- Minimum CRI for 80-CRI White is 80.
- Minimum CRI for 85-CRI White is 85.
- Minimum CRI for 90-CRI White is 90
- * Calculated flux values are for reference only.

FLUX CHARACTERISTICS - SERIES WHITE ($T_j = 25\text{ }^\circ\text{C}$)

The following table provides order codes for XLamp ML-E LEDs. For a complete description of the order-code nomenclature, please consult the Bin and Order Code Formats section (page 40).

| Chromaticity | | Minimum Luminous Flux (lm) @ 50 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | |
|--------------|--------|------------------------------------|------|--|--------|-----------------------|-----------------------|
| Kit | CCT | Code | Flux | 117 mA | 166 mA | 75 CRI Typical | 80 CRI Minimum |
| DT | 7000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004DT | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003DT | |
| E0 | 7000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004E0 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E0 | |
| 51 | 6500 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-000451 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-000351 | |
| E1 | 6500 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004E1 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E1 | |
| 50 | 6200 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-000450 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-000350 | |
| DV | 6000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004DV | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003DV | |
| E2 | 5750 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004E2 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E2 | |
| DY | 5500 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004DY | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003DY | |
| DZ | 5000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004DZ | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003DZ | |
| E3 | 5000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004E3 | MLESWT-H1-0000-0004E3 |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E3 | MLESWT-H1-0000-0003E3 |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002E3 | MLESWT-H1-0000-0002E3 |
| F4 | 4750 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004F4 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003F4 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002F4 | |
| E4 | 4500 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004E4 | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E4 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002E4 | |

Notes:

- Cree LED maintains a tolerance of $\pm 7\%$ on flux and power measurements, ± 0.005 on chromaticity (CCx, CCy) measurements and ± 2 on CRI measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.
- Minimum CRI for 80-CRI White is 80.
- Minimum CRI for 85-CRI White is 85.
- Minimum CRI for 90-CRI White is 90
- * Calculated flux values are for reference only.

FLUX CHARACTERISTICS - SERIES WHITE (T_J = 25 °C) - CONTINUED

| Chromaticity | | Minimum Luminous Flux (lm) @ 50 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | | | |
|--------------|--------|------------------------------------|------|--|--------|-----------------------|-----------------------|-----------------------|-----------------------|
| Kit | CCT | Code | Flux | 117 mA | 166 mA | 80 CRI Typical | 80 CRI Minimum | 85 CRI Minimum | 90 CRI Minimum |
| F5 | 4250 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004F5 | | | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003F5 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002F5 | | | |
| E5 | 4000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004E5 | | | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E5 | MLESWT-H1-0000-0003E5 | MLESWT-P1-0000-0003E5 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002E5 | MLESWT-H1-0000-0002E5 | MLESWT-P1-0000-0002E5 | MLESWT-U1-0000-0002E5 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001E5 | MLESWT-P1-0000-0001E5 | MLESWT-U1-0000-0001E5 |
| Z5 | 4000 K | N2 | 51.7 | 104.8 | 132.9 | MLESWT-A1-0000-0004Z5 | | | |
| | | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003Z5 | MLESWT-H1-0000-0003Z5 | MLESWT-P1-0000-0003Z5 | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002Z5 | MLESWT-H1-0000-0002Z5 | MLESWT-P1-0000-0002Z5 | MLESWT-U1-0000-0002Z5 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001Z5 | MLESWT-P1-0000-0001Z5 | MLESWT-U1-0000-0001Z5 |
| F6 | 3750 K | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003F6 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002F6 | MLESWT-H1-0000-0002F6 | MLESWT-P1-0000-0002F6 | MLESWT-U1-0000-0002F6 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001F6 | MLESWT-P1-0000-0001F6 | MLESWT-U1-0000-0001F6 |
| E6 | 3500 K | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E6 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002E6 | MLESWT-H1-0000-0002E6 | MLESWT-P1-0000-0002E6 | MLESWT-U1-0000-0002E6 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001E6 | MLESWT-P1-0000-0001E6 | MLESWT-U1-0000-0001E6 |
| Z6 | 3500 K | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003Z6 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002Z6 | MLESWT-H1-0000-0002Z6 | MLESWT-P1-0000-0002Z6 | MLESWT-U1-0000-0002Z6 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001Z6 | MLESWT-P1-0000-0001Z6 | MLESWT-U1-0000-0001Z6 |
| F7 | 3250 K | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003F7 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002F7 | MLESWT-H1-0000-0002F7 | MLESWT-P1-0000-0002F7 | MLESWT-U1-0000-0002F7 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001F7 | MLESWT-P1-0000-0001F7 | MLESWT-U1-0000-0001F7 |
| | | K2 | 30.6 | 62.0 | 78.6 | | | MLESWT-P1-0000-0000F7 | MLESWT-U1-0000-0000F7 |
| E7 | 3000 K | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003E7 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002E7 | MLESWT-H1-0000-0002E7 | MLESWT-P1-0000-0002E7 | MLESWT-U1-0000-0002E7 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001E7 | MLESWT-P1-0000-0001E7 | MLESWT-U1-0000-0001E7 |
| | | K2 | 30.6 | 62.0 | 78.6 | | | MLESWT-P1-0000-0000E7 | MLESWT-U1-0000-0000E7 |
| Z7 | 3000 K | M3 | 45.7 | 92.6 | 117.4 | MLESWT-A1-0000-0003Z7 | | | |
| | | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002Z7 | MLESWT-H1-0000-0002Z7 | MLESWT-P1-0000-0002Z7 | MLESWT-U1-0000-0002Z7 |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001Z7 | MLESWT-P1-0000-0001Z7 | MLESWT-U1-0000-0001Z7 |
| | | K2 | 30.6 | 62.0 | 78.6 | | | MLESWT-P1-0000-0000Z7 | MLESWT-U1-0000-0000Z7 |

Notes:

- Cree LED maintains a tolerance of ±7% on flux and power measurements, ±0.005 on chromaticity (CCx, CCy) measurements and ±2 on CRI measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.
- Minimum CRI for 80-CRI White is 80.
- Minimum CRI for 85-CRI White is 85.
- Minimum CRI for 90-CRI White is 90
- * Calculated flux values are for reference only.

FLUX CHARACTERISTICS - SERIES WHITE (T_J = 25 °C) - CONTINUED

| Chromaticity | | Minimum Luminous Flux (lm) @ 50 mA | | Calculated Minimum Luminous Flux (lm)* | | Order Codes | | | |
|--------------|--------|------------------------------------|------|--|--------|-----------------------|-----------------------|-----------------------|-----------------------|
| Kit | CCT | Code | Flux | 117 mA | 166 mA | 80 CRI Typical | 80 CRI Minimum | 85 CRI Minimum | 90 CRI Minimum |
| F8 | 2850 K | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002F8 | | | |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001F8 | MLESWT-P1-0000-0001F8 | MLESWT-U1-0000-0001F8 |
| | | K2 | 30.6 | 62.0 | 78.6 | | | MLESWT-P1-0000-0000F8 | MLESWT-U1-0000-0000F8 |
| E8 | 2700 K | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002E8 | | | |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001E8 | MLESWT-P1-0000-0001E8 | MLESWT-U1-0000-0001E8 |
| | | K2 | 30.6 | 62.0 | 78.6 | | | MLESWT-P1-0000-0000E8 | MLESWT-U1-0000-0000E8 |
| Z8 | 2700 K | M2 | 39.8 | 80.7 | 102.3 | MLESWT-A1-0000-0002Z8 | | | |
| | | K3 | 35.2 | 71.4 | 90.5 | | MLESWT-H1-0000-0001Z8 | MLESWT-P1-0000-0001Z8 | MLESWT-U1-0000-0001Z8 |
| | | K2 | 30.6 | 62.0 | 78.6 | | | MLESWT-P1-0000-0000Z8 | MLESWT-U1-0000-0000Z8 |

Notes:

- Cree LED maintains a tolerance of ±7% on flux and power measurements, ±0.005 on chromaticity (CCx, CCy) measurements and ±2 on CRI measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.
- Minimum CRI for 80-CRI White is 80.
- Minimum CRI for 85-CRI White is 85.
- Minimum CRI for 90-CRI White is 90
- * Calculated flux values are for reference only.

FLUX CHARACTERISTICS - PARALLEL COLOR ($T_j = 25\text{ }^\circ\text{C}$)

The following table provides order codes for XLamp ML-E color LEDs. For a complete description of the order-code nomenclature, please consult the Bin and Order Code Formats section (page 40).

| Royal Blue | | Minimum Radiant Flux (lm) @ 150 mA | | Order Codes |
|------------|--------------------------|------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (mW) | |
| 01 | 450 - 465 | 10 | 175 | MLEROY-A1-0000-000501 |
| | | 9 | 147 | MLEROY-A1-0000-000401 |
| 02 | 450 - 460 | 10 | 175 | MLEROY-A1-0000-000502 |
| | | 9 | 147 | MLEROY-A1-0000-000402 |
| 03 | 455 - 465 | 10 | 175 | MLEROY-A1-0000-000503 |
| | | 9 | 147 | MLEROY-A1-0000-000403 |
| 04 | 450-455 | 10 | 175 | MLEROY-A1-0000-000504 |
| | | 9 | 147 | MLEROY-A1-0000-000404 |
| 05 | 455-460 | 10 | 175 | MLEROY-A1-0000-000505 |
| | | 9 | 147 | MLEROY-A1-0000-000405 |
| 06 | 460-465 | 10 | 175 | MLEROY-A1-0000-000506 |
| | | 9 | 147 | MLEROY-A1-0000-000406 |

| Blue | | Minimum Luminous Flux (lm) @ 150 mA | | Order Codes |
|------|--------------------------|-------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 465 - 485 | G2 | 13.9 | MLEBLU-A1-0000-000U01 |
| | | F2 | 10.7 | MLEBLU-A1-0000-000T01 |
| 02 | 465 - 480 | G2 | 13.9 | MLEBLU-A1-0000-000U02 |
| | | F2 | 10.7 | MLEBLU-A1-0000-000T02 |
| 05 | 470 - 480 | G2 | 13.9 | MLEBLU-A1-0000-000U05 |
| | | F2 | 10.7 | MLEBLU-A1-0000-000T05 |

Note:

- Cree LED maintains a tolerance of $\pm 7\%$ on flux and power measurements, ± 0.005 on chromaticity (CCx, CCy) measurements and ± 2 on CRI measurements and ± 1 nm on dominant wavelength measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.

FLUX CHARACTERISTICS - PARALLEL COLOR (T_j = 25 °C) - CONTINUED

| Green | | Minimum Luminous Flux (lm) @ 150 mA | | Order Codes |
|-------|--------------------------|-------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 520 - 535 | K3 | 35.2 | MLEGRN-A1-0000-000101 |
| | | K2 | 30.6 | MLEGRN-A1-0000-000001 |
| | | J3 | 26.8 | MLEGRN-A1-0000-000X01 |
| 02 | 520 - 530 | K3 | 35.2 | MLEGRN-A1-0000-000102 |
| | | K2 | 30.6 | MLEGRN-A1-0000-000002 |
| | | J3 | 26.8 | MLEGRN-A1-0000-000X02 |
| 03 | 525 - 535 | K3 | 35.2 | MLEGRN-A1-0000-000103 |
| | | K2 | 30.6 | MLEGRN-A1-0000-000003 |
| | | J3 | 26.8 | MLEGRN-A1-0000-000X03 |

| Amber | | Minimum Luminous Flux (lm) @ 150 mA | | Order Codes |
|-------|--------------------------|-------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 585 - 595 | J3 | 26.8 | MLEAMB-A1-0000-000X01 |
| | | J2 | 23.5 | MLEAMB-A1-0000-000W01 |

| Red | | Minimum Luminous Flux (lm) @ 150 mA | | Order Codes |
|-----|--------------------------|-------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 620 - 630 | J2 | 23.5 | MLERED-A1-0000-000W01 |
| | | H2 | 18.1 | MLERED-A1-0000-000V01 |
| 02 | 620 - 625 | J2 | 23.5 | MLERED-A1-0000-000W02 |
| | | H2 | 18.1 | MLERED-A1-0000-000V02 |
| 03 | 625 - 630 | J2 | 23.5 | MLERED-A1-0000-000W03 |
| | | H2 | 18.1 | MLERED-A1-0000-000V03 |

- Note:**
- Cree LED maintains a tolerance of ±7% on flux and power measurements, ±0.005 on chromaticity (CCx, CCy) measurements and ±2 on CRI measurements and ±1 nm on dominant wavelength measurements. See the Measurements section (page 42).
 - XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.

FLUX CHARACTERISTICS - SERIES COLOR ($T_J = 25\text{ }^\circ\text{C}$)

The following table provides order codes for XLamp ML-E color LEDs. For a complete description of the order-code nomenclature, please consult the Bin and Order Code Formats section (page 40).

| Blue | | Minimum Luminous Flux (lm) @ 50 mA | | Order Codes |
|------|--------------------------|------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 465 - 485 | G2 | 13.9 | MLESBL-A1-0000-000U01 |
| | | F2 | 10.7 | MLESBL-A1-0000-000T01 |
| 02 | 465 - 480 | G2 | 13.9 | MLESBL-A1-0000-000U02 |
| | | F2 | 10.7 | MLESBL-A1-0000-000T02 |
| 05 | 470 - 480 | G2 | 13.9 | MLESBL-A1-0000-000U05 |
| | | F2 | 10.7 | MLESBL-A1-0000-000T05 |

| Green | | Minimum Luminous Flux (lm) @ 50 mA | | Order Codes |
|-------|--------------------------|------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 520 - 535 | K3 | 35.2 | MLESGN-A1-0000-000101 |
| | | K2 | 30.6 | MLESGN-A1-0000-000001 |
| | | J3 | 26.8 | MLESGN-A1-0000-000X01 |
| 02 | 520 - 530 | K3 | 35.2 | MLESGN-A1-0000-000102 |
| | | K2 | 30.6 | MLESGN-A1-0000-000002 |
| | | J3 | 26.8 | MLESGN-A1-0000-000X02 |
| 03 | 525 - 535 | K3 | 35.2 | MLESGN-A1-0000-000103 |
| | | K2 | 30.6 | MLESGN-A1-0000-000003 |
| | | J3 | 26.8 | MLESGN-A1-0000-000X03 |

| Amber | | Minimum Luminous Flux (lm) @ 37.5 mA | | Order Codes |
|-------|--------------------------|--------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 585 - 595 | J3 | 26.8 | MLESAM-A1-0000-000X01 |
| | | J2 | 23.5 | MLESAM-A1-0000-000W01 |

Note:

- Cree LED maintains a tolerance of $\pm 7\%$ on flux and power measurements, ± 0.005 on chromaticity (CCx, CCy) measurements and ± 2 on CRI measurements and ± 1 nm on dominant wavelength measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.

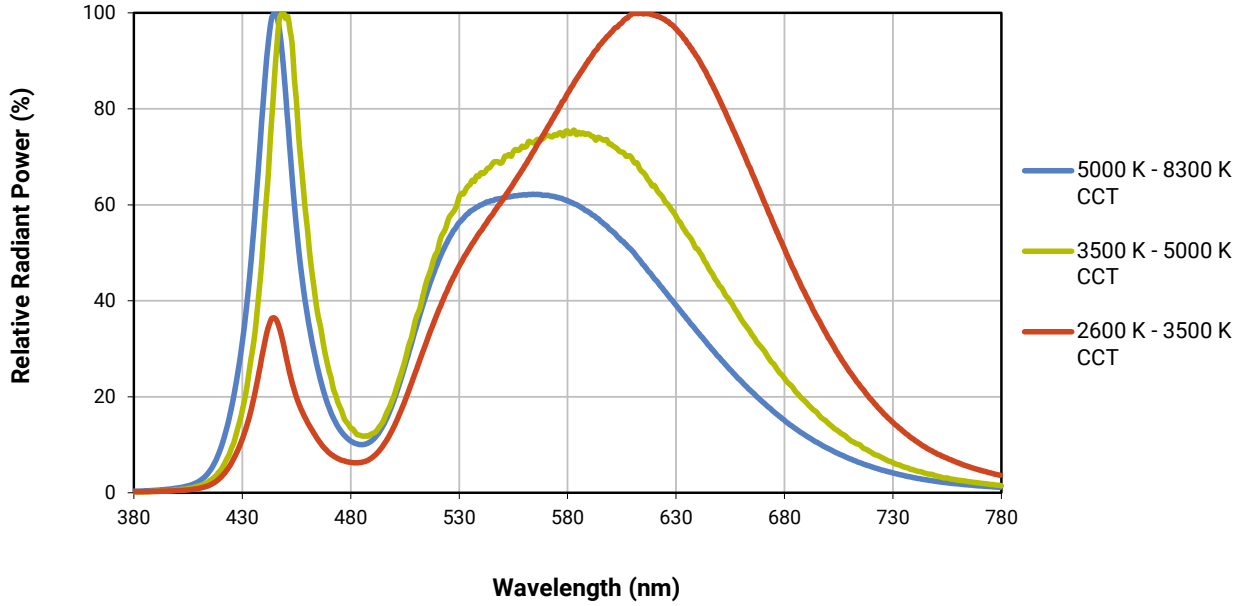
FLUX CHARACTERISTICS - SERIES COLOR ($T_j = 25\text{ }^\circ\text{C}$) - CONTINUED

| Red | | Minimum Luminous Flux (lm) @ 37.5 mA | | Order Codes |
|-----|--------------------------|--------------------------------------|-----------|-----------------------|
| Kit | Dominant Wavelength (nm) | Code | Flux (lm) | |
| 01 | 620 - 630 | J2 | 23.5 | MLESRD-A1-0000-000W01 |
| | | H2 | 18.1 | MLESRD-A1-0000-000V01 |
| 02 | 620 - 625 | J2 | 23.5 | MLESRD-A1-0000-000W02 |
| | | H2 | 18.1 | MLESRD-A1-0000-000V02 |
| 03 | 625-630 | J2 | 23.5 | MLESRD-A1-0000-000W03 |
| | | H2 | 18.1 | MLESRD-A1-0000-000V03 |

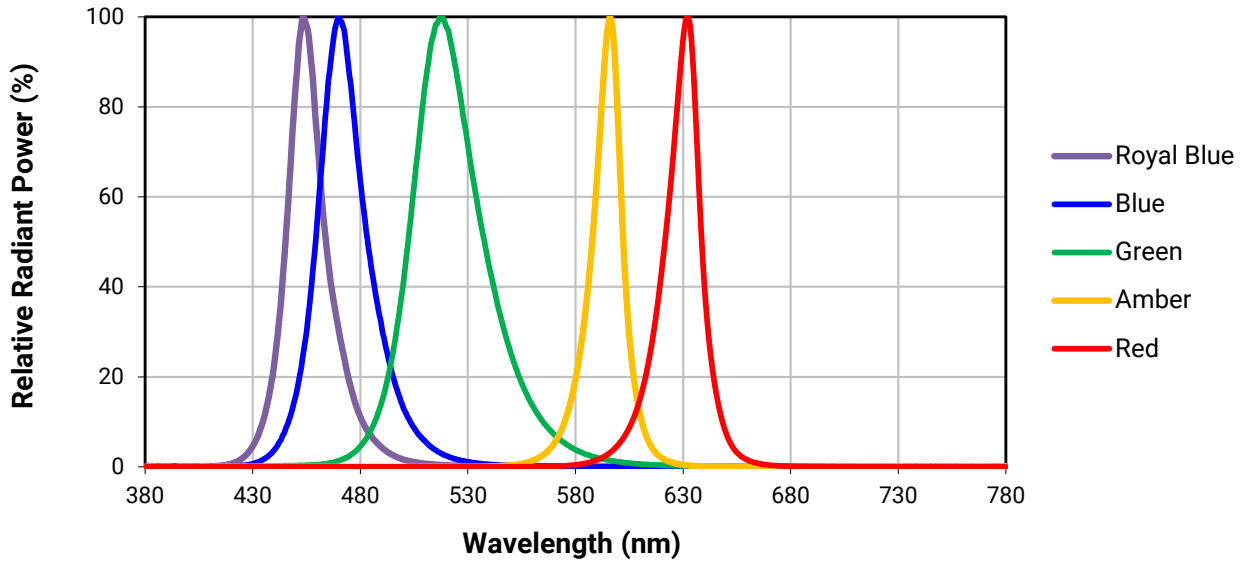
Note:

- Cree LED maintains a tolerance of $\pm 7\%$ on flux and power measurements, ± 0.005 on chromaticity (CCx, CCy) measurements and ± 2 on CRI measurements and ± 1 nm on dominant wavelength measurements. See the Measurements section (page 42).
- XLamp ML-E LED order codes specify only a minimum flux bin and not a maximum. Cree LED may ship reels in flux bins higher than the minimum specified by the order code without advance notice. Shipments will always adhere to the chromaticity or DWL bin restrictions specified by the order code.

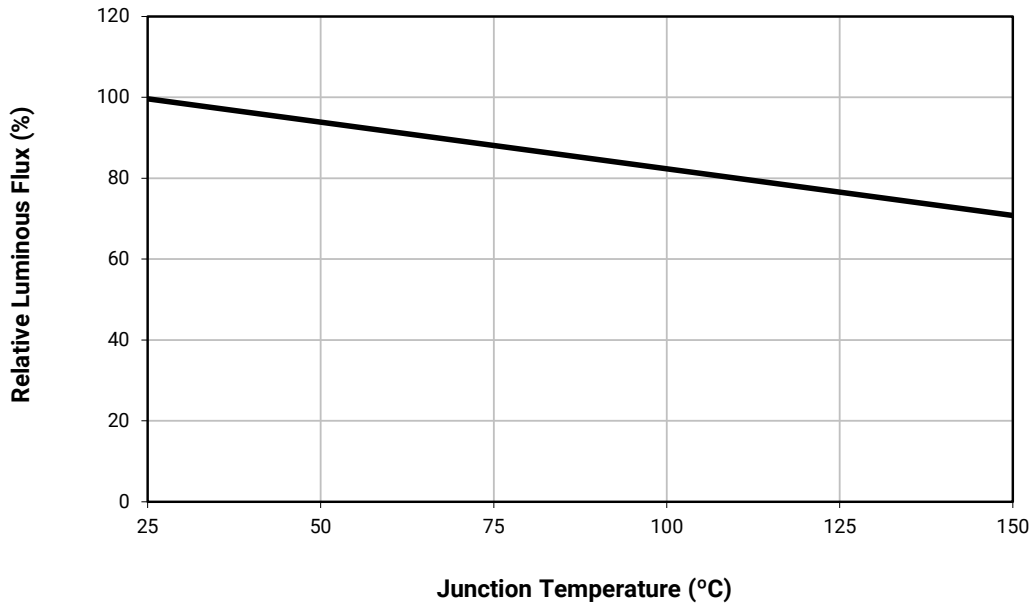
RELATIVE SPECTRAL POWER DISTRIBUTION - WHITE



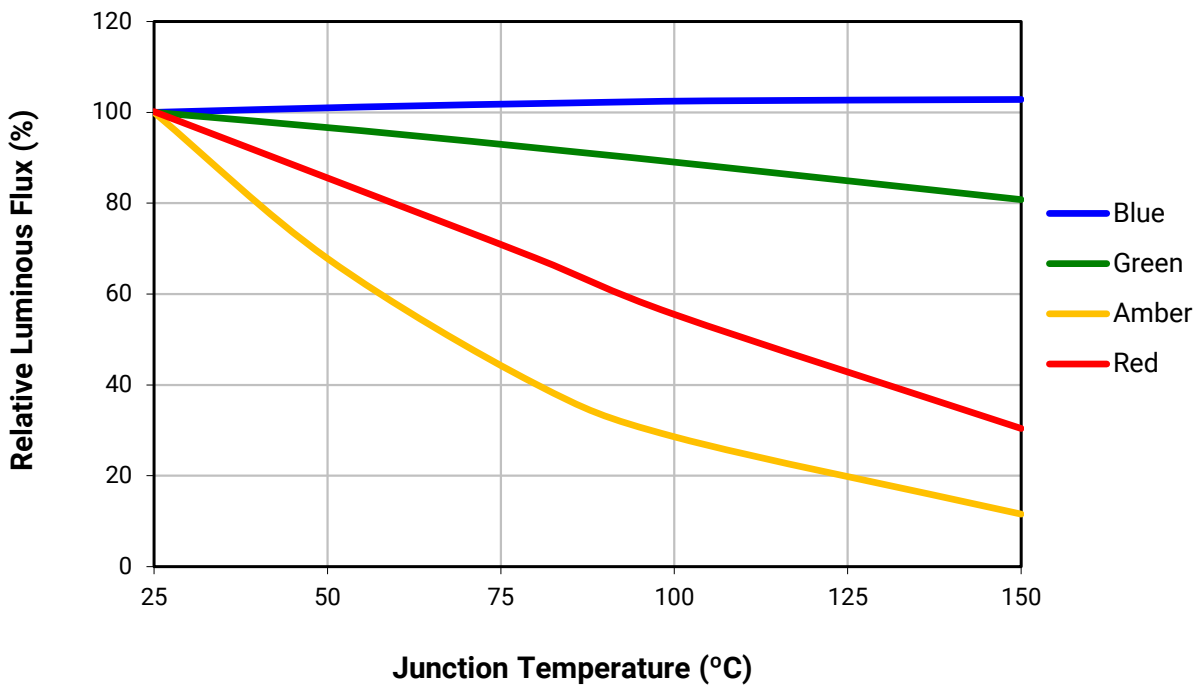
RELATIVE SPECTRAL POWER DISTRIBUTION - COLOR



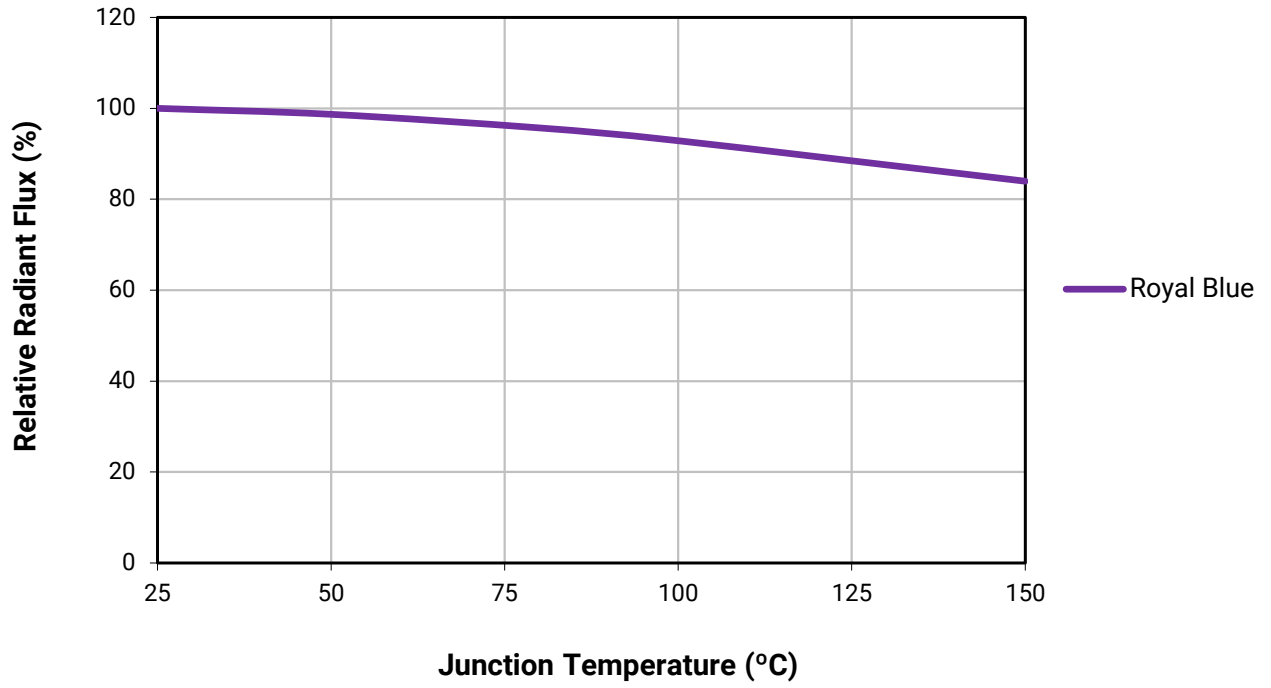
RELATIVE LUMINOUS FLUX VS. JUNCTION TEMPERATURE - WHITE (PARALLEL: $I_F = 150$ mA, SERIES: $I_F = 50$ mA)



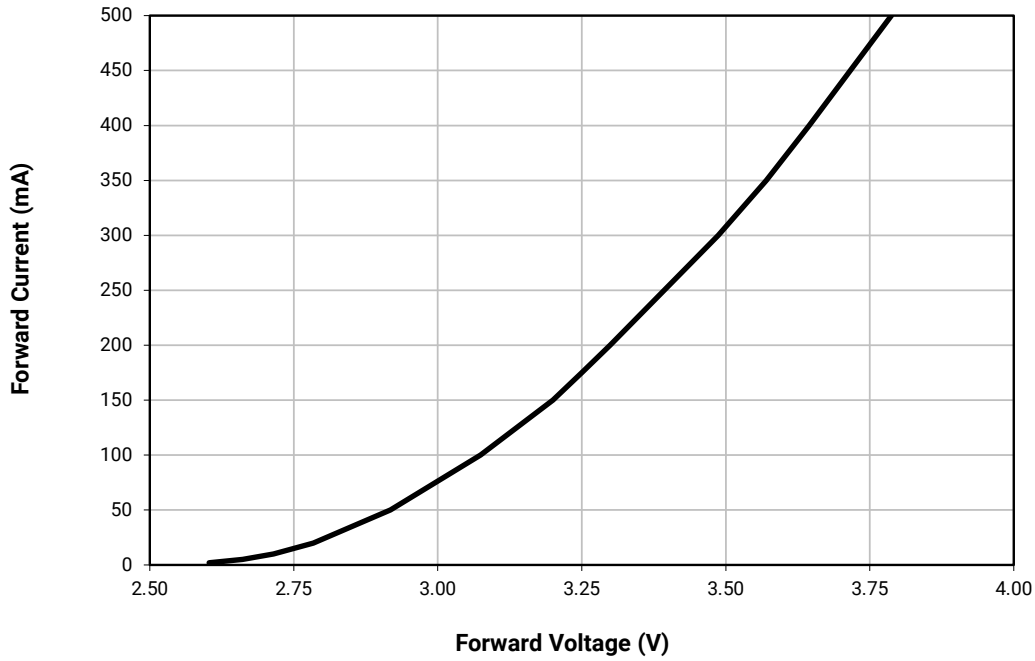
RELATIVE LUMINOUS FLUX VS. JUNCTION TEMPERATURE - PARALLEL: BLUE, GREEN, AMBER, RED ($I_F = 150$ mA), SERIES: BLUE, GREEN ($I_F = 50$ mA), AMBER, RED ($I_F = 37.5$ mA)



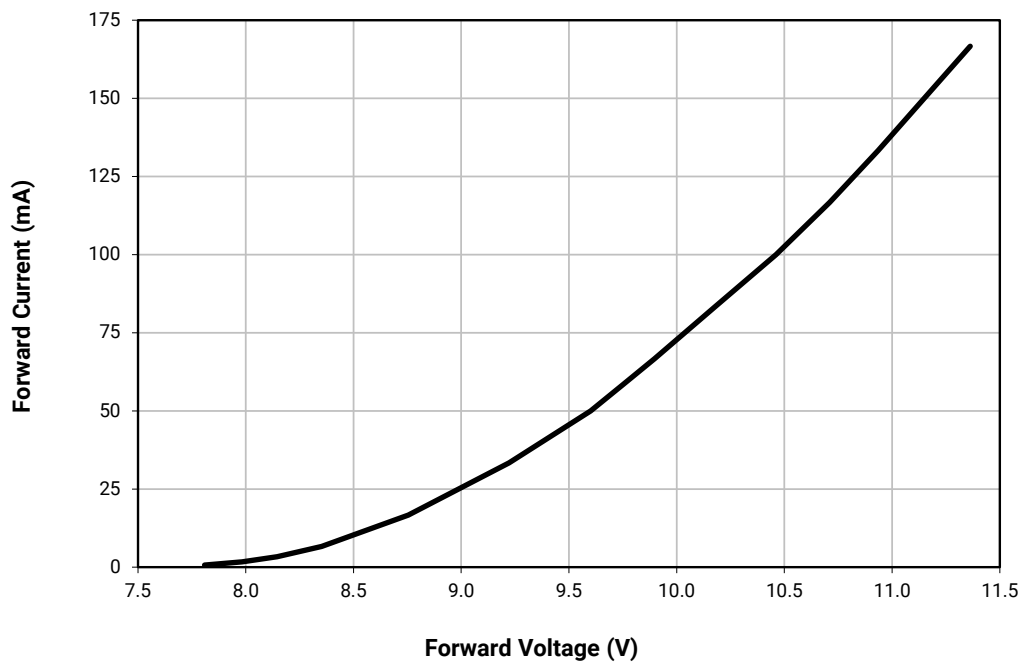
RELATIVE RADIANT FLUX VS. JUNCTION TEMPERATURE - PARALLEL ROYAL BLUE ($I_f = 150 \text{ mA}$)



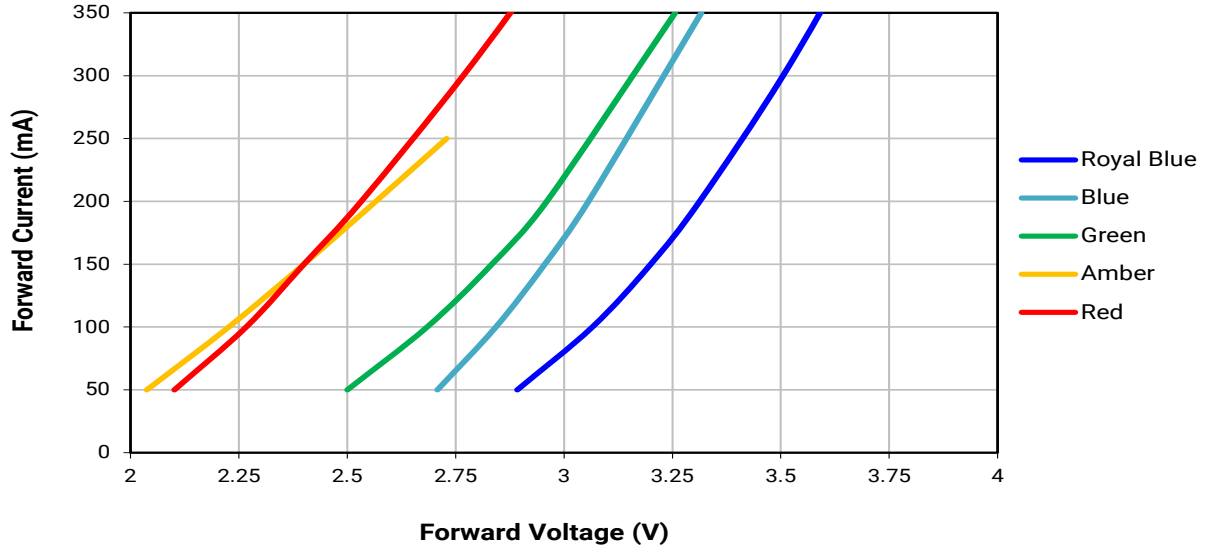
ELECTRICAL CHARACTERISTICS - PARALLEL WHITE ($T_j = 25\text{ }^\circ\text{C}$)



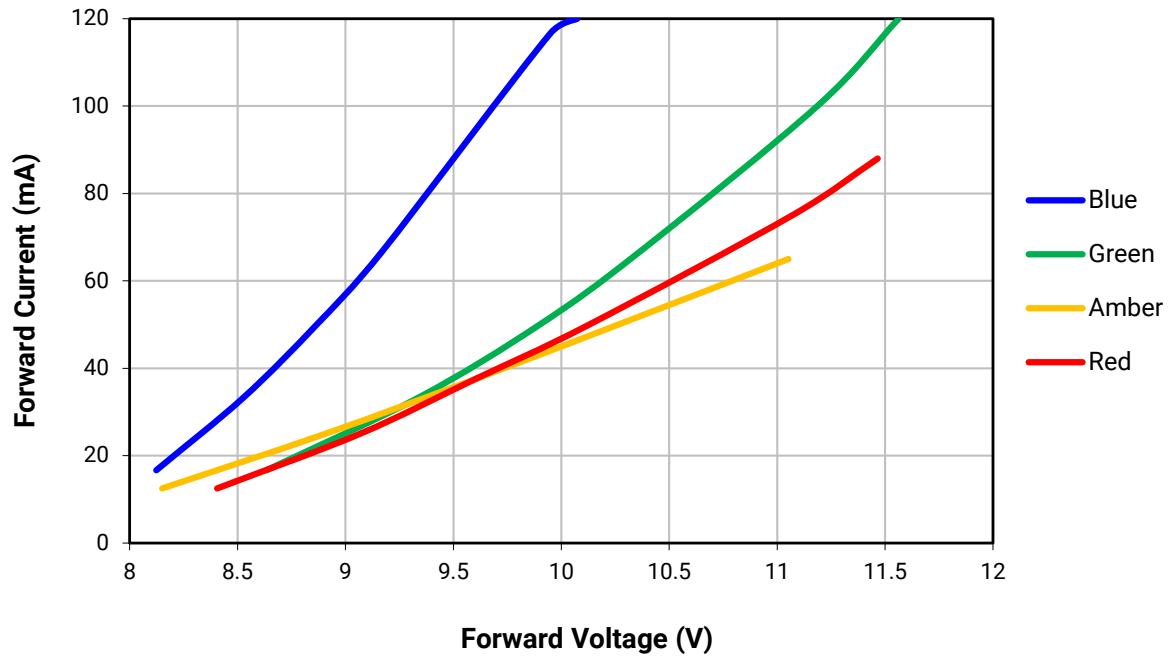
ELECTRICAL CHARACTERISTICS - SERIES WHITE ($T_j = 25\text{ }^\circ\text{C}$)



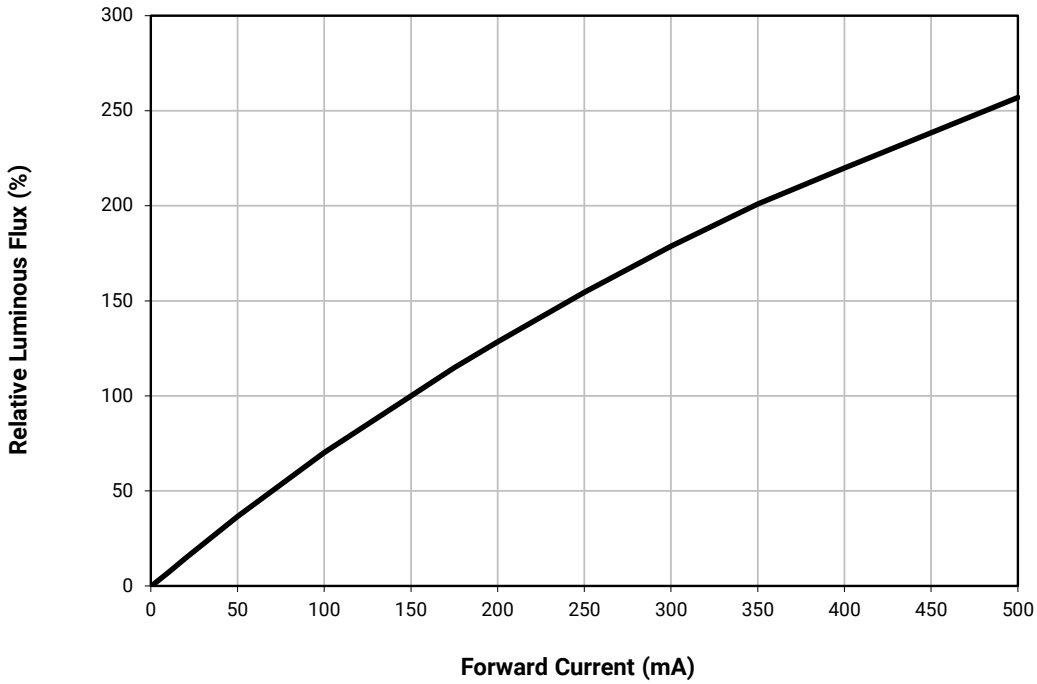
ELECTRICAL CHARACTERISTICS - PARALLEL COLOR ($T_j = 25\text{ }^\circ\text{C}$)



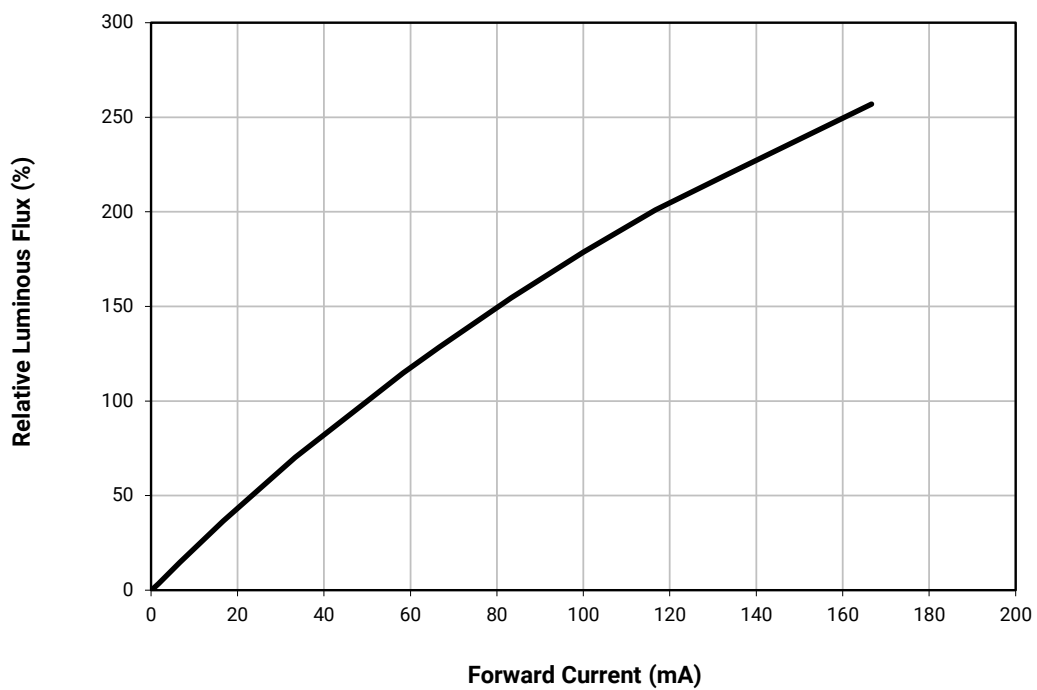
ELECTRICAL CHARACTERISTICS - SERIES COLOR ($T_j = 25\text{ }^\circ\text{C}$)



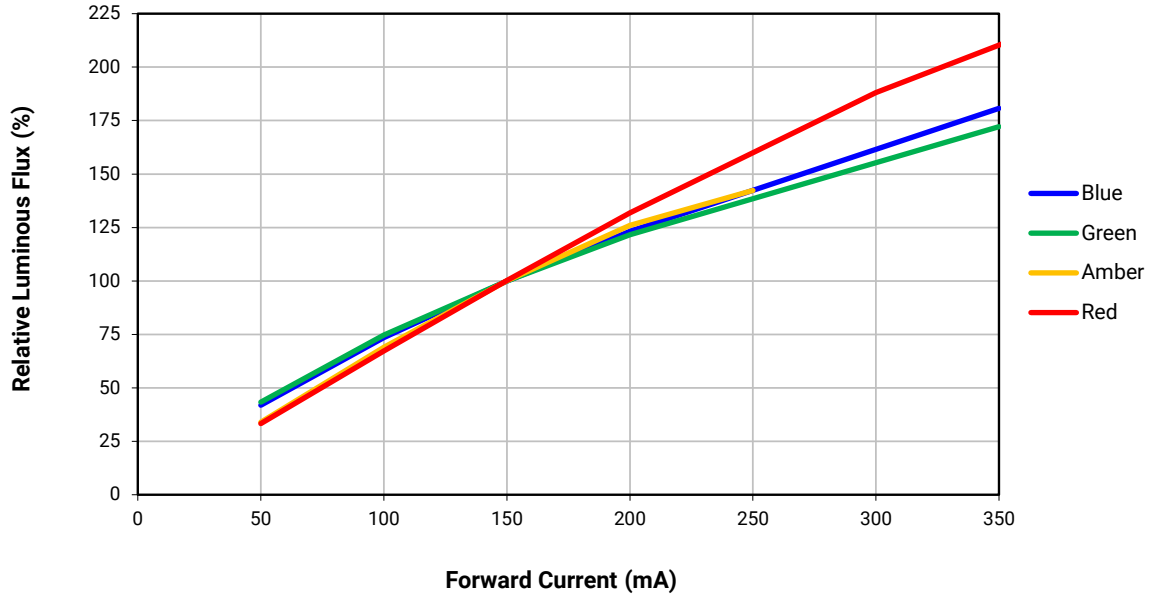
RELATIVE LUMINOUS FLUX VS. CURRENT - PARALLEL WHITE ($T_j = 25\text{ }^\circ\text{C}$)



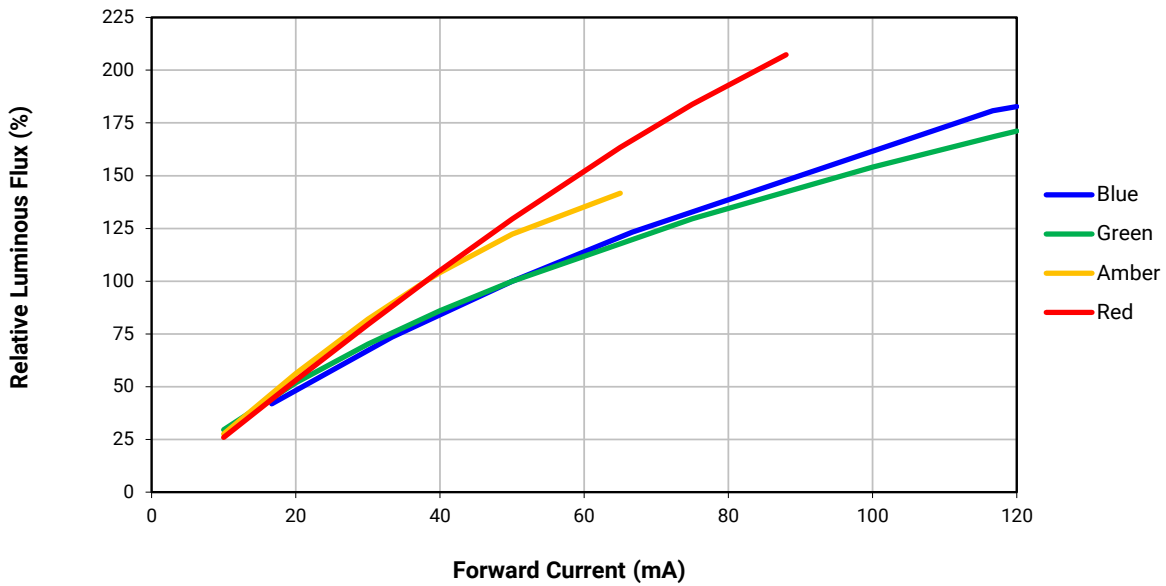
RELATIVE LUMINOUS FLUX VS. CURRENT - SERIES WHITE ($T_j = 25\text{ }^\circ\text{C}$)



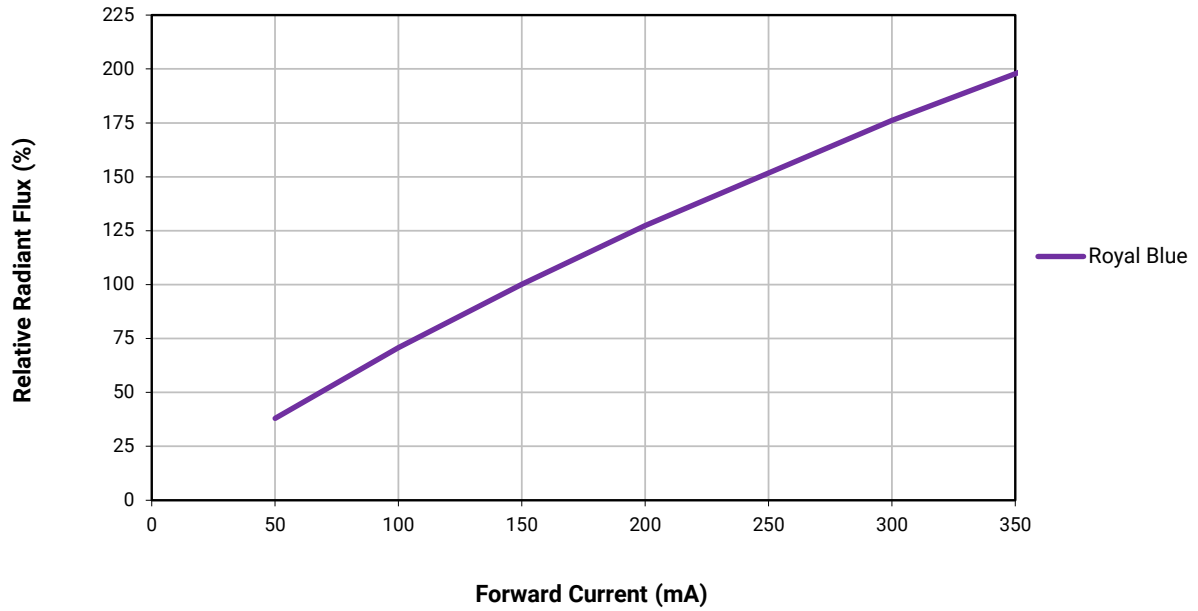
RELATIVE LUMINOUS FLUX VS. CURRENT - PARALLEL BLUE, GREEN, AMBER, RED ($T_j = 25\text{ }^\circ\text{C}$)



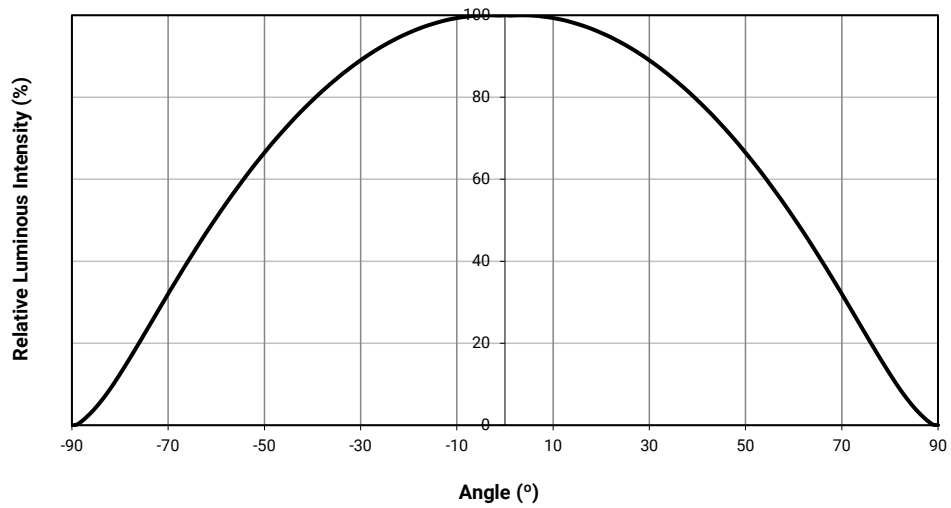
RELATIVE LUMINOUS FLUX VS. CURRENT - SERIES BLUE, GREEN, AMBER, RED ($T_j = 25\text{ }^\circ\text{C}$)



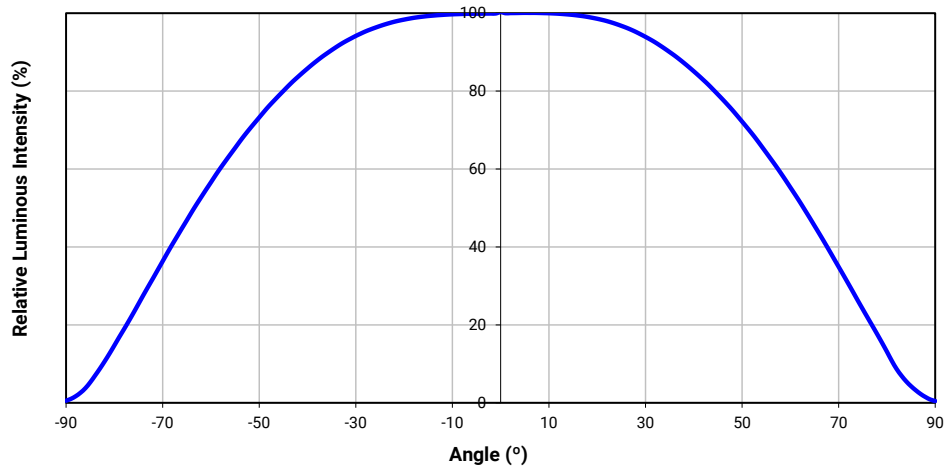
RELATIVE RADIANT FLUX VS. CURRENT - PARALLEL ROYAL BLUE (T_j = 25 °C)



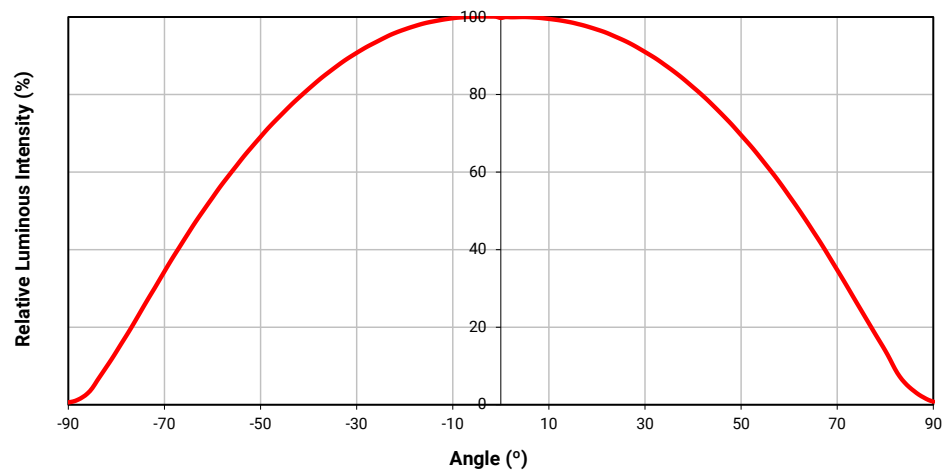
TYPICAL SPATIAL DISTRIBUTION - WHITE



TYPICAL SPATIAL DISTRIBUTION - ROYAL BLUE, BLUE, GREEN

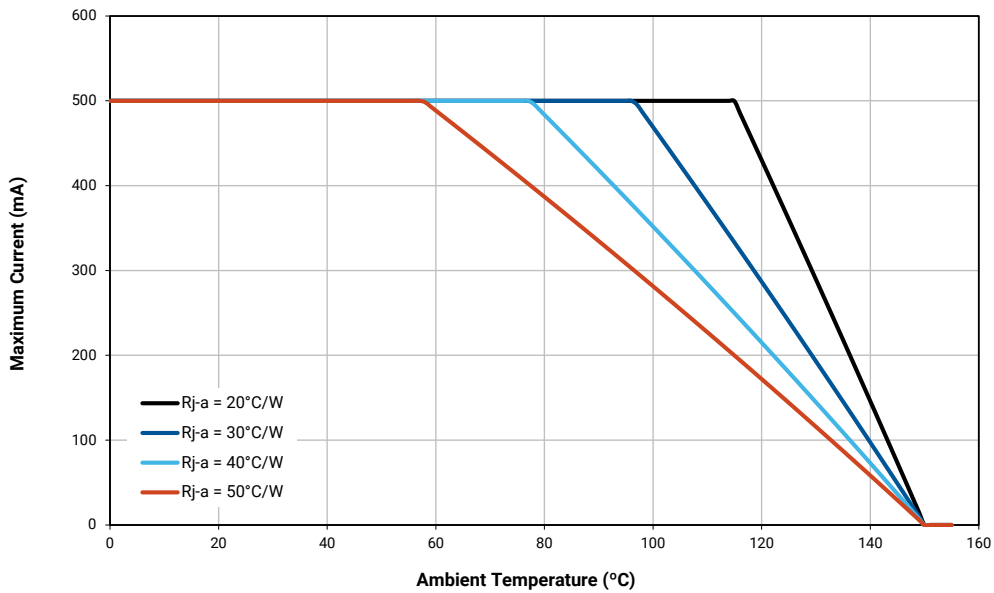


TYPICAL SPATIAL DISTRIBUTION - AMBER, RED

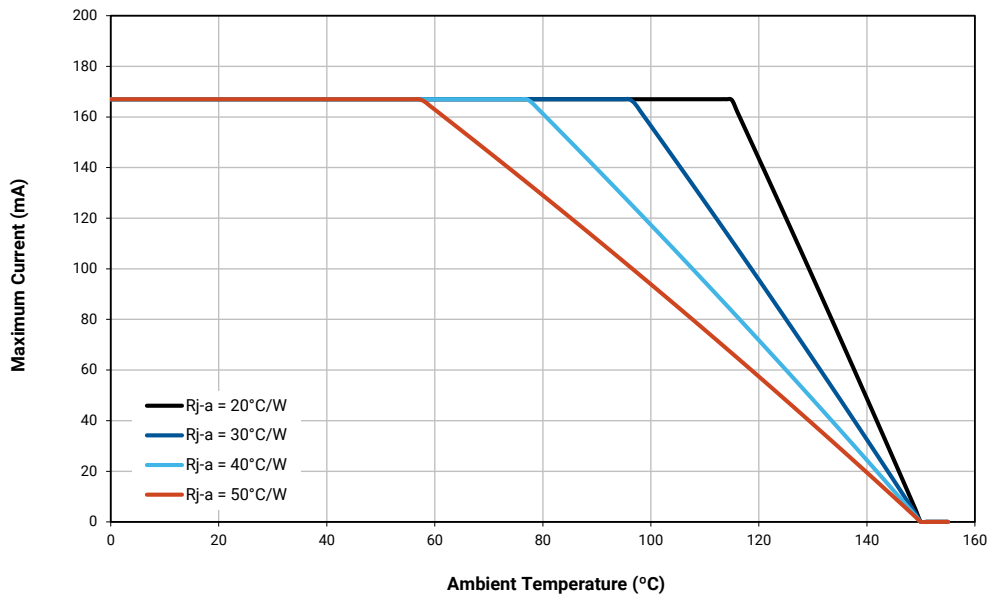


THERMAL DESIGN - PARALLEL WHITE

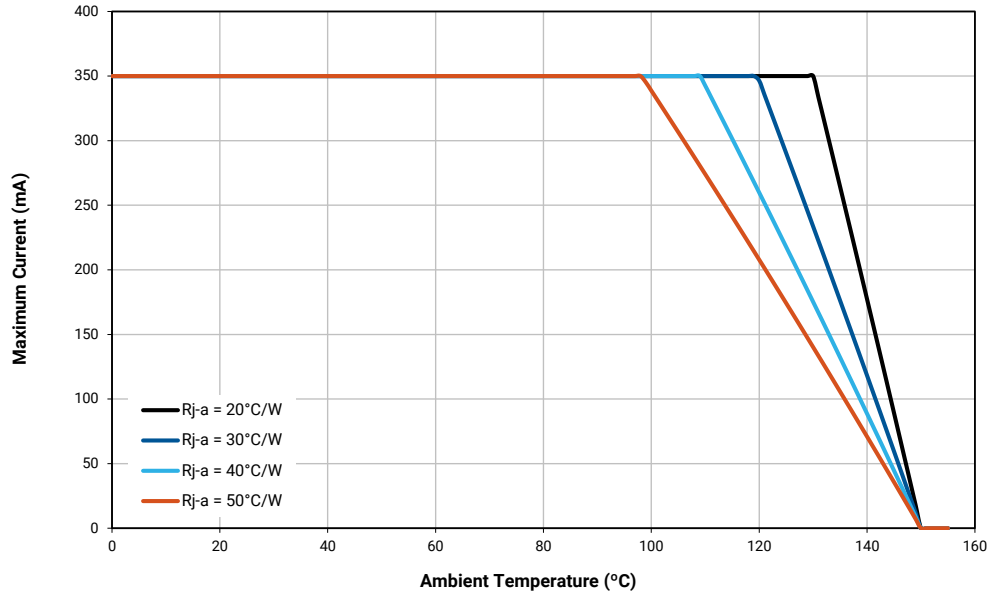
The maximum forward current is determined by the thermal resistance between the LED junction and ambient. It is crucial for the end product to be designed in a manner that minimizes the thermal resistance from the solder point to ambient in order to optimize lamp life and optical characteristics.



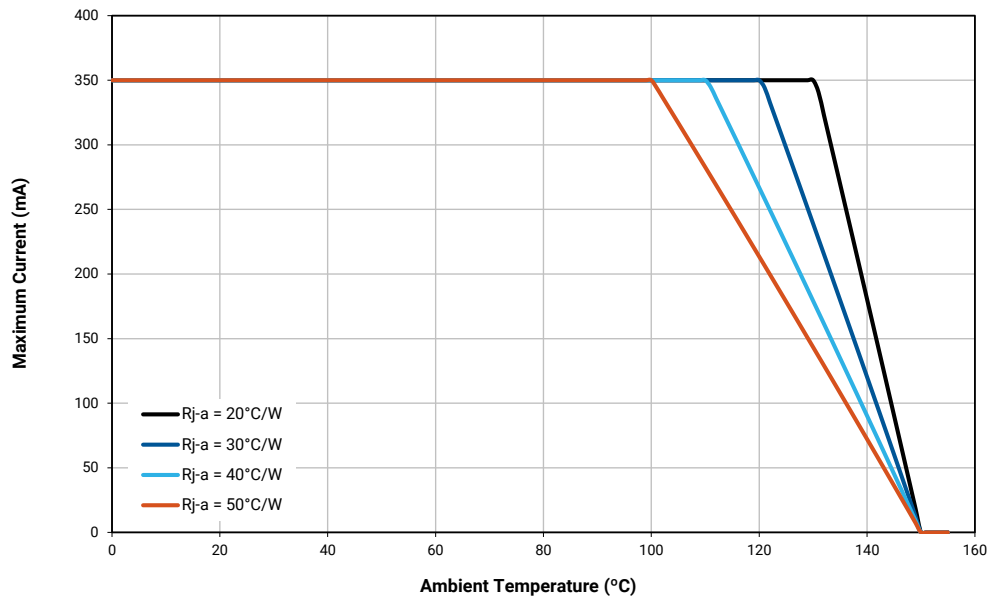
THERMAL DESIGN - SERIES WHITE



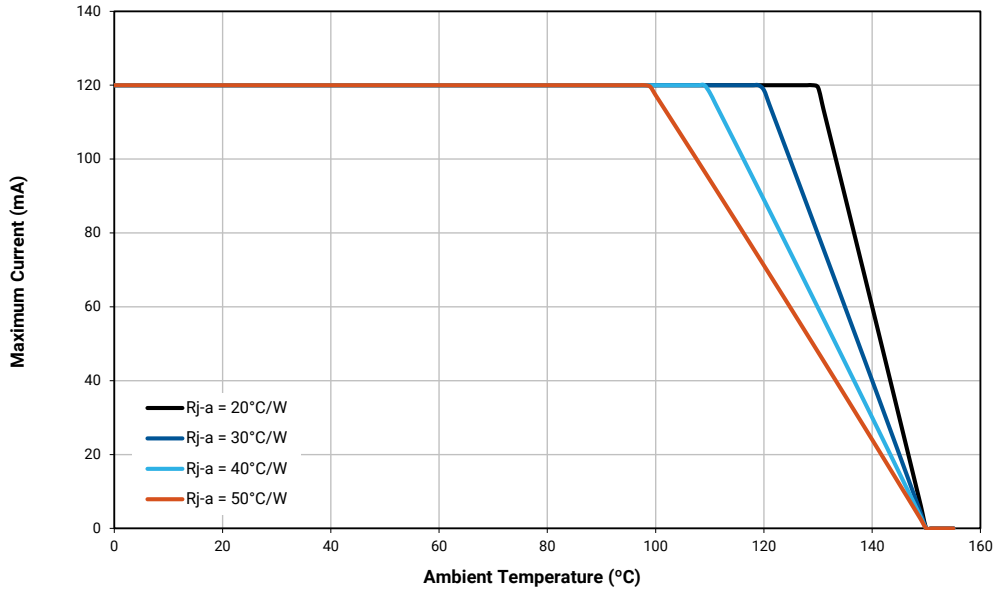
THERMAL DESIGN - PARALLEL ROYAL BLUE



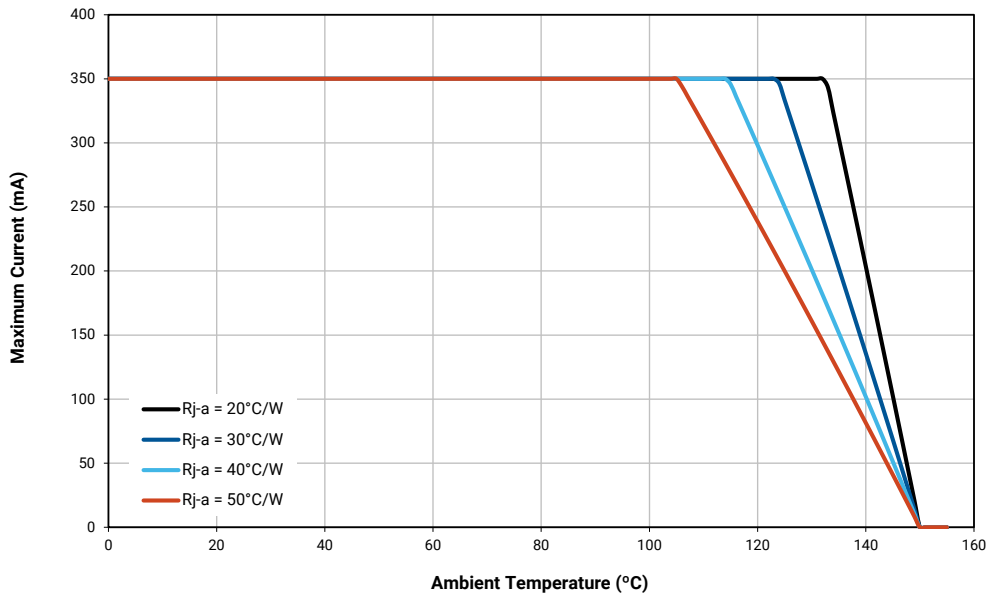
THERMAL DESIGN - PARALLEL BLUE



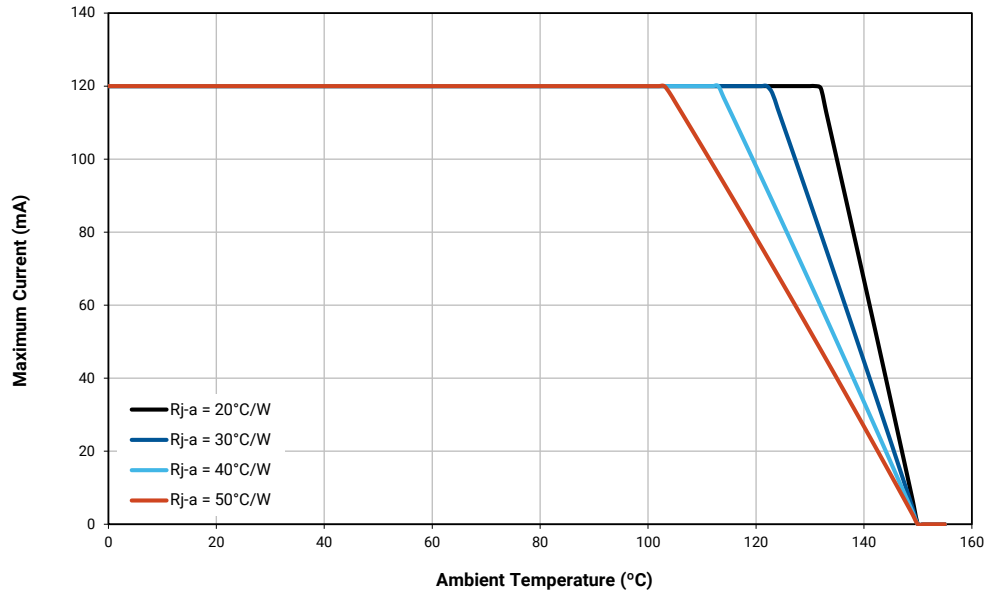
THERMAL DESIGN - SERIES BLUE



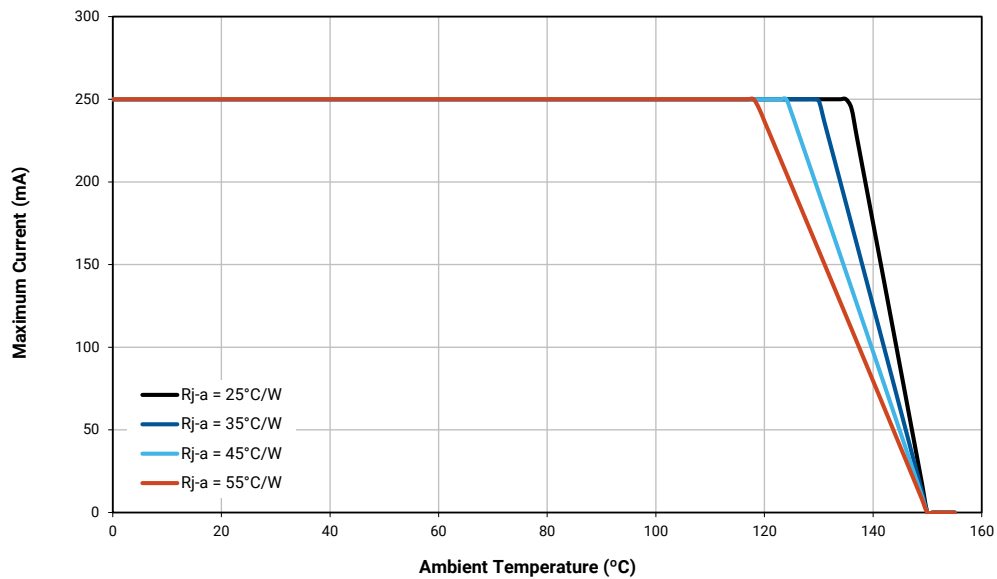
THERMAL DESIGN - PARALLEL GREEN



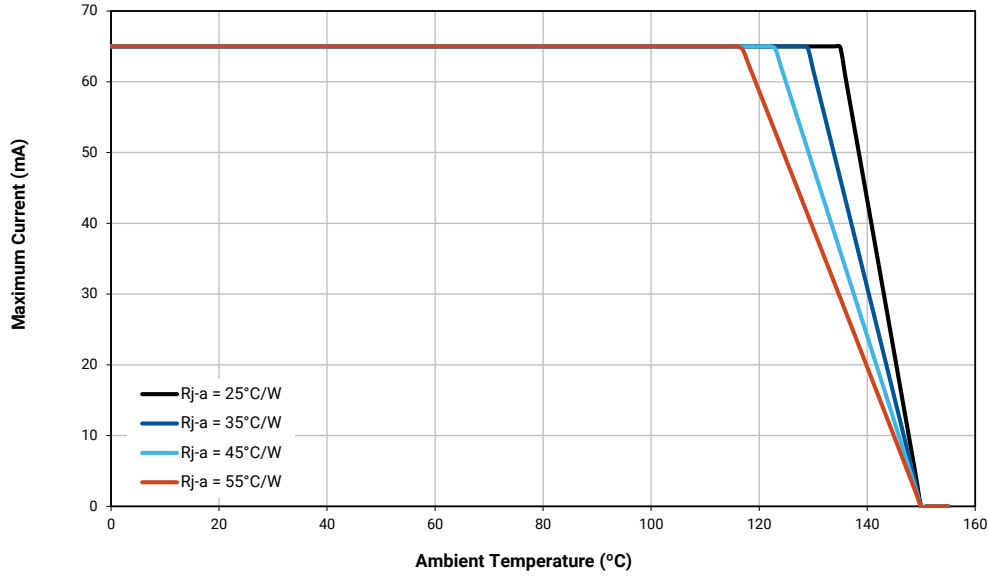
THERMAL DESIGN - SERIES GREEN



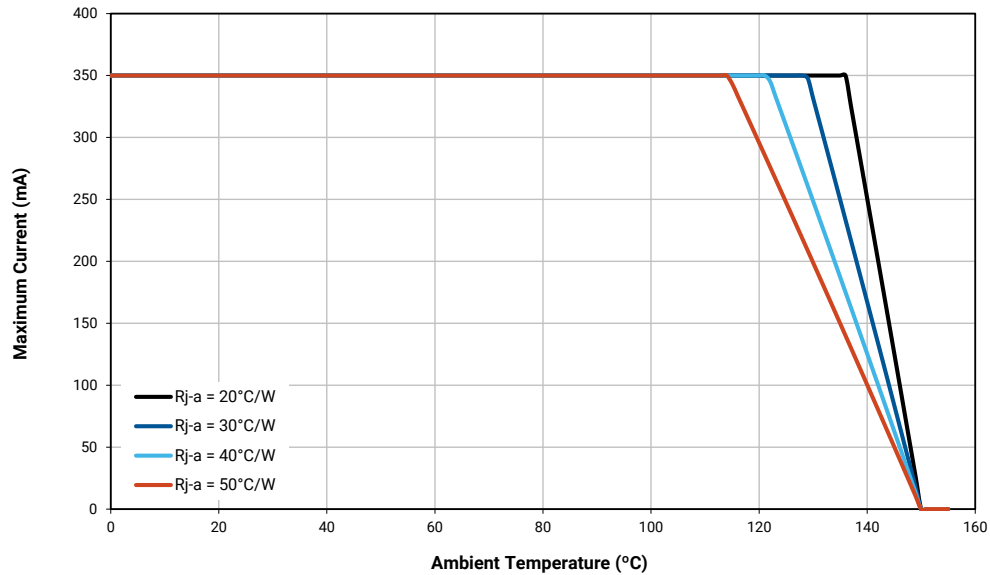
THERMAL DESIGN - PARALLEL AMBER



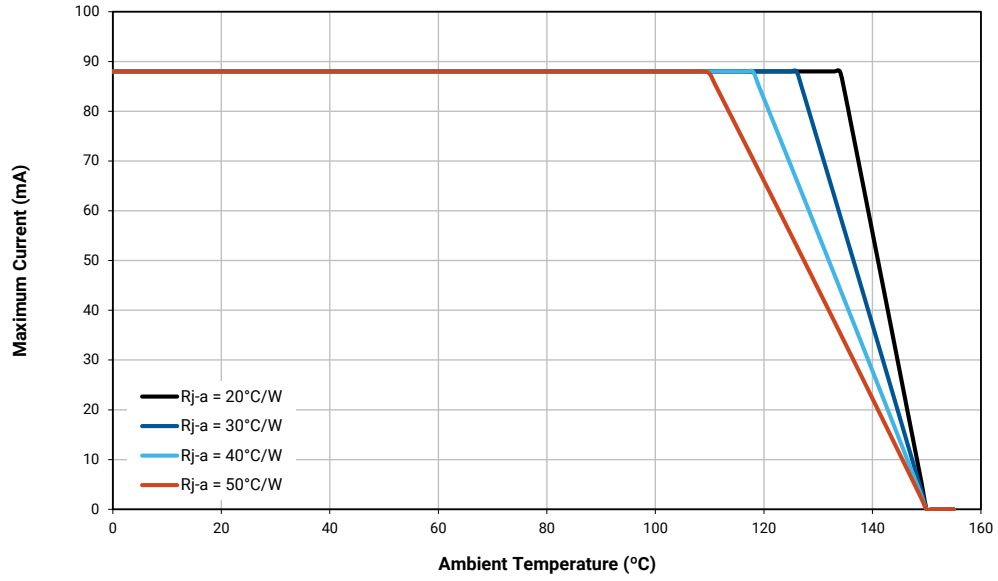
THERMAL DESIGN - SERIES AMBER



THERMAL DESIGN - PARALLEL RED



THERMAL DESIGN - SERIES RED



PERFORMANCE GROUPS – LUMINOUS OR RADIANT FLUX

White and color ML-E LEDs (except for royal-blue) are tested for luminous flux and placed into one of the following luminous-flux groups:

| Group Code | Minimum Luminous Flux (lm) | Maximum Luminous Flux (lm) |
|------------|----------------------------|----------------------------|
| F2 | 10.7 | 12.3 |
| F3 | 12.3 | 13.9 |
| G2 | 13.9 | 15.8 |
| G3 | 15.8 | 18.1 |
| H2 | 18.1 | 20.6 |
| H3 | 20.6 | 23.5 |
| J2 | 23.5 | 26.8 |
| J3 | 26.8 | 30.6 |
| K2 | 30.6 | 35.2 |
| K3 | 35.2 | 39.8 |
| M2 | 39.8 | 45.7 |
| M3 | 45.7 | 51.7 |
| N2 | 51.7 | 56.8 |
| N3 | 56.8 | 62 |
| N4 | 62 | 67.2 |
| P2 | 67.2 | 73.9 |
| P3 | 73.9 | 80.6 |

Royal-blue ML-E LEDs are tested for radiant flux and sorted into one of the following radiant-flux bins.

| Group | Minimum Radiant Flux (mW) | Maximum Radiant Flux (mW) |
|-------|---------------------------|---------------------------|
| 09 | 147 | 175 |
| 10 | 175 | 210 |
| 11 | 210 | 250 |

PERFORMANCE GROUPS – DOMINANT WAVELENGTH

ML-E color LEDs are tested individually for dominant wavelength (DWL) and sorted into one of the DWL bins defined below.

| Color | DWL Group | Minimum DWL (nm) | Maximum DWL (nm) |
|------------|-----------|------------------|------------------|
| Royal Blue | D36 | 450 | 452.5 |
| | D37 | 452.5 | 455 |
| | D46 | 455 | 457.5 |
| | D47 | 457.5 | 460 |
| | D56 | 460 | 462.5 |
| | D57 | 462.5 | 465 |
| Blue | B3 | 465 | 470 |
| | B4 | 470 | 475 |
| | B5 | 475 | 480 |
| | B6 | 480 | 485 |
| Green | G2 | 520 | 525 |
| | G3 | 525 | 530 |
| | G4 | 530 | 535 |
| Amber | A2 | 585 | 590 |
| | A3 | 590 | 595 |
| Red | R2 | 620 | 625 |
| | R3 | 625 | 630 |

PERFORMANCE GROUPS – CHROMATICITY

| Region | x | y | Region | x | y | Region | x | y | Region | x | y |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0A | 0.2950 | 0.2970 | 0B | 0.2920 | 0.3060 | 0C | 0.2984 | 0.3133 | 0D | 0.2984 | 0.3133 |
| | 0.2920 | 0.3060 | | 0.2895 | 0.3135 | | 0.2962 | 0.3220 | | 0.3048 | 0.3207 |
| | 0.2984 | 0.3133 | | 0.2962 | 0.3220 | | 0.3028 | 0.3304 | | 0.3068 | 0.3113 |
| | 0.3009 | 0.3042 | | 0.2984 | 0.3133 | | 0.3048 | 0.3207 | | 0.3009 | 0.3042 |
| 0R | 0.2980 | 0.2880 | 0S | 0.2895 | 0.3135 | 0T | 0.2962 | 0.3220 | 0U | 0.3037 | 0.2937 |
| | 0.2950 | 0.2970 | | 0.2870 | 0.3210 | | 0.2937 | 0.3312 | | 0.3009 | 0.3042 |
| | 0.3009 | 0.3042 | | 0.2937 | 0.3312 | | 0.3005 | 0.3415 | | 0.3068 | 0.3113 |
| | 0.3037 | 0.2937 | | 0.2962 | 0.3220 | | 0.3028 | 0.3304 | | 0.3093 | 0.2993 |
| 1A | 0.3048 | 0.3207 | 1B | 0.3028 | 0.3304 | 1C | 0.3115 | 0.3391 | 1D | 0.3130 | 0.3290 |
| | 0.3130 | 0.3290 | | 0.3115 | 0.3391 | | 0.3205 | 0.3481 | | 0.3213 | 0.3373 |
| | 0.3144 | 0.3186 | | 0.3130 | 0.3290 | | 0.3213 | 0.3373 | | 0.3221 | 0.3261 |
| | 0.3068 | 0.3113 | | 0.3048 | 0.3207 | | 0.3130 | 0.3290 | | 0.3144 | 0.3186 |
| 1R | 0.3068 | 0.3113 | 1S | 0.3005 | 0.3415 | 1T | 0.3099 | 0.3509 | 1U | 0.3144 | 0.3186 |
| | 0.3144 | 0.3186 | | 0.3099 | 0.3509 | | 0.3196 | 0.3602 | | 0.3221 | 0.3261 |
| | 0.3161 | 0.3059 | | 0.3115 | 0.3391 | | 0.3205 | 0.3481 | | 0.3231 | 0.3120 |
| | 0.3093 | 0.2993 | | 0.3028 | 0.3304 | | 0.3115 | 0.3391 | | 0.3161 | 0.3059 |
| 2A | 0.3215 | 0.3350 | 2B | 0.3207 | 0.3462 | 2C | 0.3290 | 0.3538 | 2D | 0.3290 | 0.3417 |
| | 0.3290 | 0.3417 | | 0.3290 | 0.3538 | | 0.3376 | 0.3616 | | 0.3371 | 0.3490 |
| | 0.3290 | 0.3300 | | 0.3290 | 0.3417 | | 0.3371 | 0.3490 | | 0.3366 | 0.3369 |
| | 0.3222 | 0.3243 | | 0.3215 | 0.3350 | | 0.3290 | 0.3417 | | 0.3290 | 0.3300 |
| 2R | 0.3222 | 0.3243 | 2S | 0.3196 | 0.3602 | 2T | 0.3290 | 0.3690 | 2U | 0.3290 | 0.3300 |
| | 0.3290 | 0.3300 | | 0.3290 | 0.3690 | | 0.3381 | 0.3762 | | 0.3366 | 0.3369 |
| | 0.3290 | 0.3180 | | 0.3290 | 0.3538 | | 0.3376 | 0.3616 | | 0.3361 | 0.3245 |
| | 0.3231 | 0.3120 | | 0.3207 | 0.3462 | | 0.3290 | 0.3538 | | 0.3290 | 0.3180 |
| 3A | 0.3371 | 0.3490 | 3B | 0.3376 | 0.3616 | 3C | 0.3463 | 0.3687 | 3D | 0.3451 | 0.3554 |
| | 0.3451 | 0.3554 | | 0.3463 | 0.3687 | | 0.3551 | 0.3760 | | 0.3533 | 0.3620 |
| | 0.3440 | 0.3427 | | 0.3451 | 0.3554 | | 0.3533 | 0.3620 | | 0.3515 | 0.3487 |
| | 0.3366 | 0.3369 | | 0.3371 | 0.3490 | | 0.3451 | 0.3554 | | 0.3440 | 0.3427 |
| 3R | 0.3366 | 0.3369 | 3S | 0.3381 | 0.3762 | 3T | 0.3480 | 0.3840 | 3U | 0.3440 | 0.3428 |
| | 0.3440 | 0.3428 | | 0.3480 | 0.3840 | | 0.3571 | 0.3907 | | 0.3515 | 0.3487 |
| | 0.3429 | 0.3307 | | 0.3463 | 0.3687 | | 0.3551 | 0.3760 | | 0.3495 | 0.3339 |
| | 0.3361 | 0.3245 | | 0.3376 | 0.3616 | | 0.3463 | 0.3687 | | 0.3429 | 0.3307 |
| 4A | 0.3530 | 0.3597 | 4B | 0.3548 | 0.3736 | 4C | 0.3641 | 0.3804 | 4D | 0.3615 | 0.3659 |
| | 0.3615 | 0.3659 | | 0.3641 | 0.3804 | | 0.3736 | 0.3874 | | 0.3702 | 0.3722 |
| | 0.3590 | 0.3521 | | 0.3615 | 0.3659 | | 0.3702 | 0.3722 | | 0.3670 | 0.3578 |
| | 0.3512 | 0.3465 | | 0.3530 | 0.3597 | | 0.3615 | 0.3659 | | 0.3590 | 0.3521 |

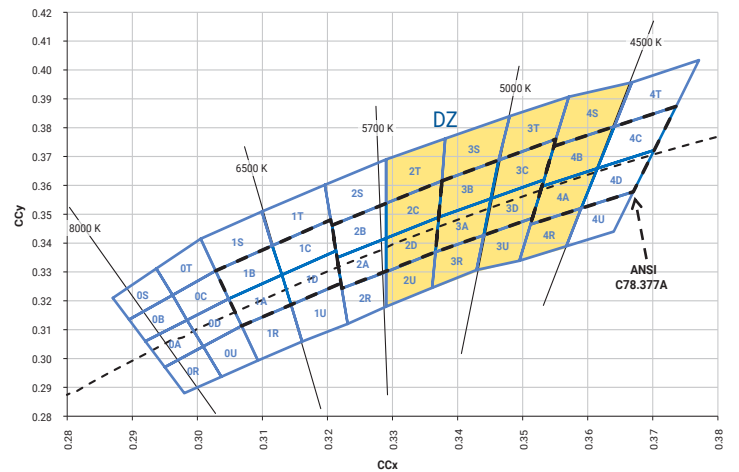
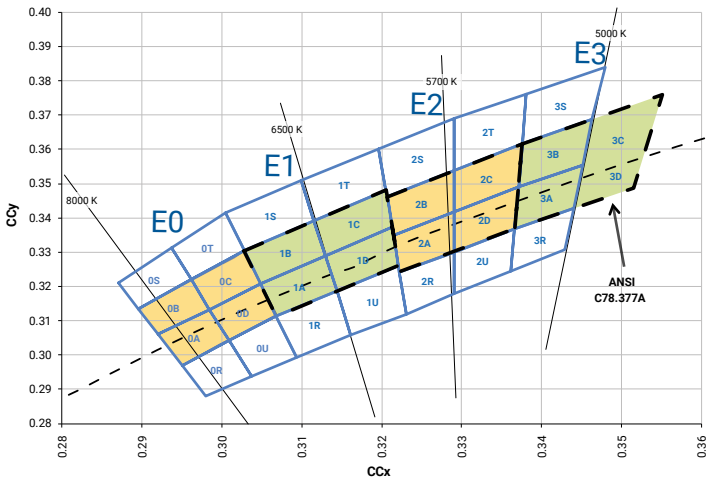
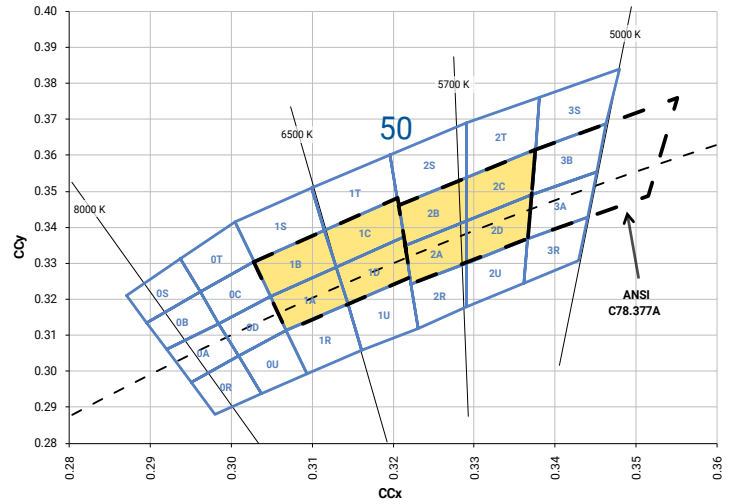
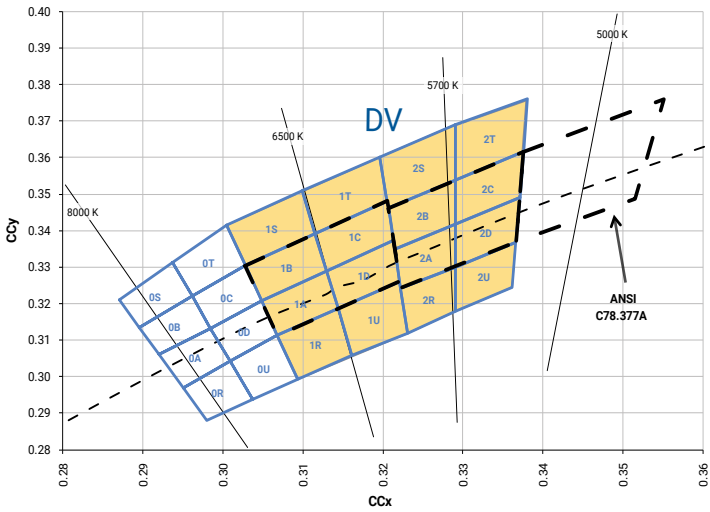
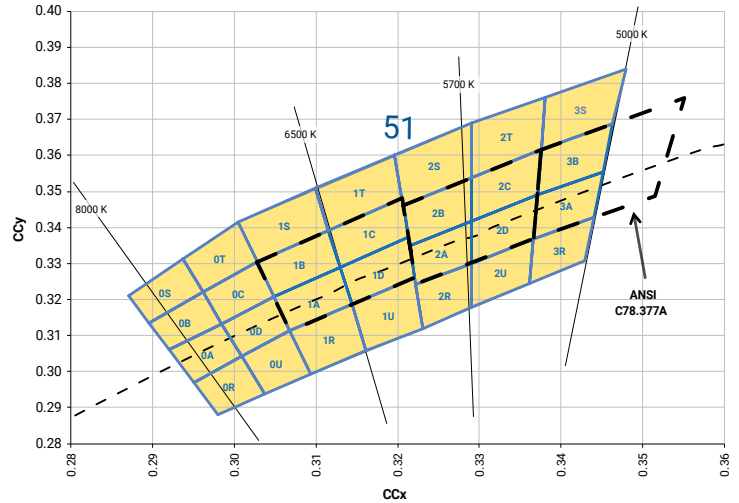
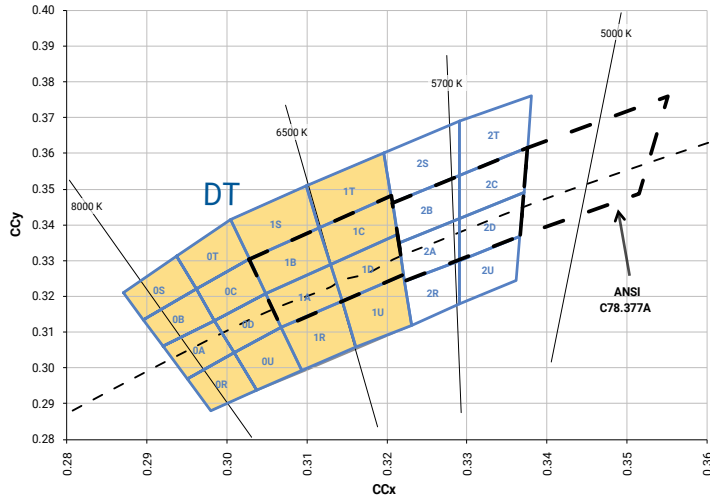
PERFORMANCE GROUPS – CHROMATICITY (CONTINUED)

| Region | x | y | Region | x | y | Region | x | y | Region | x | y |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 4R | 0.3512 | 0.3465 | 4S | 0.3571 | 0.3907 | | | | | | |
| | 0.3590 | 0.3521 | | 0.3668 | 0.3957 | | | | | | |
| | 0.3567 | 0.3389 | | 0.3641 | 0.3804 | | | | | | |
| | 0.3495 | 0.3339 | | 0.3548 | 0.3736 | | | | | | |
| 5A1 | 0.3670 | 0.3578 | 5A2 | 0.3686 | 0.3649 | 5A3 | 0.3744 | 0.3685 | 5A4 | 0.3726 | 0.3612 |
| | 0.3686 | 0.3649 | | 0.3702 | 0.3722 | | 0.3763 | 0.3760 | | 0.3744 | 0.3685 |
| | 0.3744 | 0.3685 | | 0.3763 | 0.3760 | | 0.3825 | 0.3798 | | 0.3804 | 0.3721 |
| | 0.3726 | 0.3612 | | 0.3744 | 0.3685 | | 0.3804 | 0.3721 | | 0.3783 | 0.3646 |
| 5B1 | 0.3702 | 0.3722 | 5B2 | 0.3719 | 0.3797 | 5B3 | 0.3782 | 0.3837 | 5B4 | 0.3763 | 0.3760 |
| | 0.3719 | 0.3797 | | 0.3736 | 0.3874 | | 0.3802 | 0.3916 | | 0.3782 | 0.3837 |
| | 0.3782 | 0.3837 | | 0.3802 | 0.3916 | | 0.3869 | 0.3958 | | 0.3847 | 0.3877 |
| | 0.3763 | 0.3760 | | 0.3782 | 0.3837 | | 0.3847 | 0.3877 | | 0.3825 | 0.3798 |
| 5C1 | 0.3825 | 0.3798 | 5C2 | 0.3847 | 0.3877 | 5C3 | 0.3912 | 0.3917 | 5C4 | 0.3887 | 0.3836 |
| | 0.3847 | 0.3877 | | 0.3869 | 0.3958 | | 0.3937 | 0.4001 | | 0.3912 | 0.3917 |
| | 0.3912 | 0.3917 | | 0.3937 | 0.4001 | | 0.4006 | 0.4044 | | 0.3978 | 0.3958 |
| | 0.3887 | 0.3836 | | 0.3912 | 0.3917 | | 0.3978 | 0.3958 | | 0.3950 | 0.3875 |
| 5D1 | 0.3783 | 0.3646 | 5D2 | 0.3804 | 0.3721 | 5D3 | 0.3863 | 0.3758 | 5D4 | 0.3840 | 0.3681 |
| | 0.3804 | 0.3721 | | 0.3825 | 0.3798 | | 0.3887 | 0.3836 | | 0.3863 | 0.3758 |
| | 0.3863 | 0.3758 | | 0.3887 | 0.3836 | | 0.3950 | 0.3875 | | 0.3924 | 0.3794 |
| | 0.3840 | 0.3681 | | 0.3863 | 0.3758 | | 0.3924 | 0.3794 | | 0.3898 | 0.3716 |
| 6A1 | 0.3889 | 0.3690 | 6A2 | 0.3915 | 0.3768 | 6A3 | 0.3981 | 0.3800 | 6A4 | 0.3953 | 0.3720 |
| | 0.3915 | 0.3768 | | 0.3941 | 0.3848 | | 0.4010 | 0.3882 | | 0.3981 | 0.3800 |
| | 0.3981 | 0.3800 | | 0.4010 | 0.3882 | | 0.4080 | 0.3916 | | 0.4048 | 0.3832 |
| | 0.3953 | 0.3720 | | 0.3981 | 0.3800 | | 0.4048 | 0.3832 | | 0.4017 | 0.3751 |
| 6B1 | 0.3941 | 0.3848 | 6B2 | 0.3968 | 0.3930 | 6B3 | 0.4040 | 0.3966 | 6B4 | 0.4010 | 0.3882 |
| | 0.3968 | 0.3930 | | 0.3996 | 0.4015 | | 0.4071 | 0.4052 | | 0.4040 | 0.3966 |
| | 0.4040 | 0.3966 | | 0.4071 | 0.4052 | | 0.4146 | 0.4089 | | 0.4113 | 0.4001 |
| | 0.4010 | 0.3882 | | 0.4040 | 0.3966 | | 0.4113 | 0.4001 | | 0.4080 | 0.3916 |
| 6C1 | 0.4080 | 0.3916 | 6C2 | 0.4113 | 0.4001 | 6C3 | 0.4186 | 0.4037 | 6C4 | 0.4150 | 0.3950 |
| | 0.4113 | 0.4001 | | 0.4146 | 0.4089 | | 0.4222 | 0.4127 | | 0.4186 | 0.4037 |
| | 0.4186 | 0.4037 | | 0.4222 | 0.4127 | | 0.4299 | 0.4165 | | 0.4259 | 0.4073 |
| | 0.4150 | 0.3950 | | 0.4186 | 0.4037 | | 0.4259 | 0.4073 | | 0.4221 | 0.3984 |
| 6D1 | 0.4017 | 0.3751 | 6D2 | 0.4048 | 0.3832 | 6D3 | 0.4116 | 0.3865 | 6D4 | 0.4082 | 0.3782 |
| | 0.4048 | 0.3832 | | 0.4080 | 0.3916 | | 0.4150 | 0.3950 | | 0.4116 | 0.3865 |
| | 0.4116 | 0.3865 | | 0.4150 | 0.3950 | | 0.4221 | 0.3984 | | 0.4183 | 0.3898 |
| | 0.4082 | 0.3782 | | 0.4116 | 0.3865 | | 0.4183 | 0.3898 | | 0.4147 | 0.3814 |
| 7A1 | 0.4147 | 0.3814 | 7A2 | 0.4183 | 0.3898 | 7A3 | 0.4242 | 0.3919 | 7A4 | 0.4203 | 0.3833 |
| | 0.4183 | 0.3898 | | 0.4221 | 0.3984 | | 0.4281 | 0.4006 | | 0.4242 | 0.3919 |
| | 0.4242 | 0.3919 | | 0.4281 | 0.4006 | | 0.4342 | 0.4028 | | 0.4300 | 0.3939 |
| | 0.4203 | 0.3833 | | 0.4242 | 0.3919 | | 0.4300 | 0.3939 | | 0.4259 | 0.3853 |

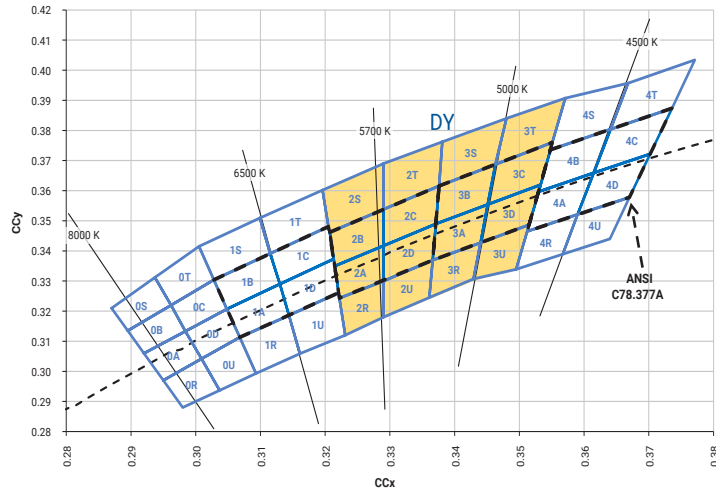
PERFORMANCE GROUPS – CHROMATICITY (CONTINUED)

| Region | x | y | Region | x | y | Region | x | y | Region | x | y |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 7B1 | 0.4221 | 0.3984 | 7B2 | 0.4259 | 0.4073 | 7B3 | 0.4322 | 0.4096 | 7B4 | 0.4281 | 0.4006 |
| | 0.4259 | 0.4073 | | 0.4299 | 0.4165 | | 0.4364 | 0.4188 | | 0.4322 | 0.4096 |
| | 0.4322 | 0.4096 | | 0.4364 | 0.4188 | | 0.4430 | 0.4212 | | 0.4385 | 0.4119 |
| | 0.4281 | 0.4006 | | 0.4322 | 0.4096 | | 0.4385 | 0.4119 | | 0.4342 | 0.4028 |
| 7C1 | 0.4342 | 0.4028 | 7C2 | 0.4385 | 0.4119 | 7C3 | 0.4449 | 0.4141 | 7C4 | 0.4403 | 0.4049 |
| | 0.4385 | 0.4119 | | 0.4430 | 0.4212 | | 0.4496 | 0.4236 | | 0.4449 | 0.4141 |
| | 0.4449 | 0.4141 | | 0.4496 | 0.4236 | | 0.4562 | 0.4260 | | 0.4513 | 0.4164 |
| | 0.4403 | 0.4049 | | 0.4449 | 0.4141 | | 0.4513 | 0.4164 | | 0.4465 | 0.4071 |
| 7D1 | 0.4259 | 0.3853 | 7D2 | 0.4300 | 0.3939 | 7D3 | 0.4359 | 0.3960 | 7D4 | 0.4316 | 0.3873 |
| | 0.4300 | 0.3939 | | 0.4342 | 0.4028 | | 0.4403 | 0.4049 | | 0.4359 | 0.3960 |
| | 0.4359 | 0.3960 | | 0.4403 | 0.4049 | | 0.4465 | 0.4071 | | 0.4418 | 0.3981 |
| | 0.4316 | 0.3873 | | 0.4359 | 0.3960 | | 0.4418 | 0.3981 | | 0.4373 | 0.3893 |
| 8A1 | 0.4373 | 0.3893 | 8A2 | 0.4418 | 0.3981 | 8A3 | 0.4475 | 0.3994 | 8A4 | 0.4428 | 0.3906 |
| | 0.4418 | 0.3981 | | 0.4465 | 0.4071 | | 0.4523 | 0.4085 | | 0.4475 | 0.3994 |
| | 0.4475 | 0.3994 | | 0.4523 | 0.4085 | | 0.4582 | 0.4099 | | 0.4532 | 0.4008 |
| | 0.4428 | 0.3906 | | 0.4475 | 0.3994 | | 0.4532 | 0.4008 | | 0.4483 | 0.3919 |
| 8B1 | 0.4465 | 0.4071 | 8B2 | 0.4513 | 0.4164 | 8B3 | 0.4573 | 0.4178 | 8B4 | 0.4523 | 0.4085 |
| | 0.4513 | 0.4164 | | 0.4562 | 0.4260 | | 0.4624 | 0.4274 | | 0.4573 | 0.4178 |
| | 0.4573 | 0.4178 | | 0.4624 | 0.4274 | | 0.4687 | 0.4289 | | 0.4634 | 0.4193 |
| | 0.4523 | 0.4085 | | 0.4573 | 0.4178 | | 0.4634 | 0.4193 | | 0.4582 | 0.4099 |
| 8C1 | 0.4582 | 0.4099 | 8C2 | 0.4634 | 0.4193 | 8C3 | 0.4695 | 0.4207 | 8C4 | 0.4641 | 0.4112 |
| | 0.4634 | 0.4193 | | 0.4687 | 0.4289 | | 0.4750 | 0.4304 | | 0.4695 | 0.4207 |
| | 0.4695 | 0.4207 | | 0.4750 | 0.4304 | | 0.4813 | 0.4319 | | 0.4756 | 0.4221 |
| | 0.4641 | 0.4112 | | 0.4695 | 0.4207 | | 0.4756 | 0.4221 | | 0.4700 | 0.4126 |
| 8D1 | 0.4483 | 0.3919 | 8D2 | 0.4532 | 0.4008 | 8D3 | 0.4589 | 0.4021 | 8D4 | 0.4538 | 0.3931 |
| | 0.4532 | 0.4008 | | 0.4582 | 0.4099 | | 0.4641 | 0.4112 | | 0.4589 | 0.4021 |
| | 0.4589 | 0.4021 | | 0.4641 | 0.4112 | | 0.4700 | 0.4126 | | 0.4646 | 0.4034 |
| | 0.4538 | 0.3931 | | 0.4589 | 0.4021 | | 0.4646 | 0.4034 | | 0.4593 | 0.3944 |

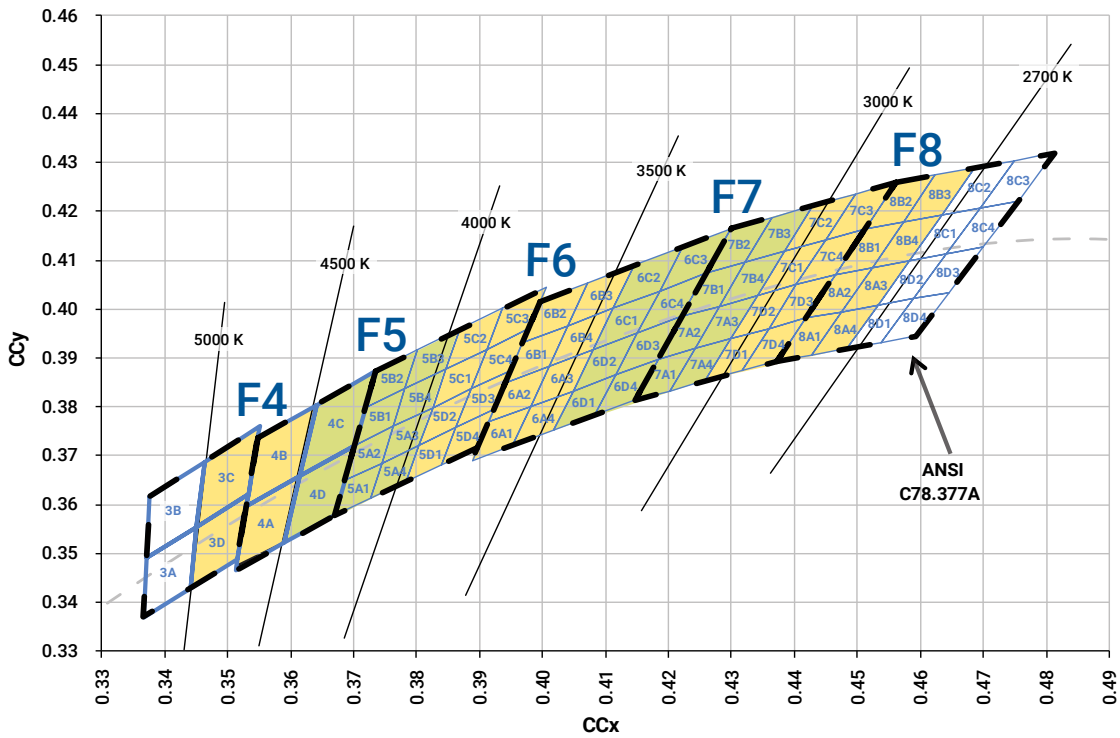
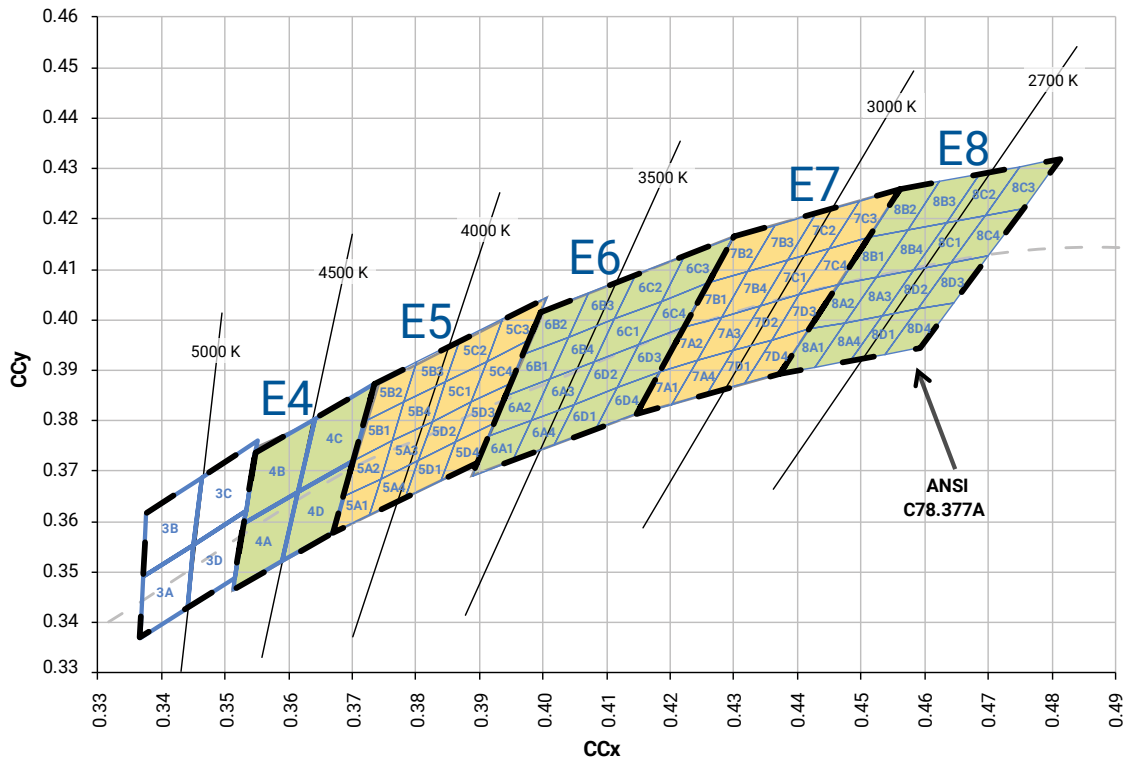
STANDARD COOL WHITE KITS PLOTTED ON ANSI STANDARD CHROMATICITY REGIONS



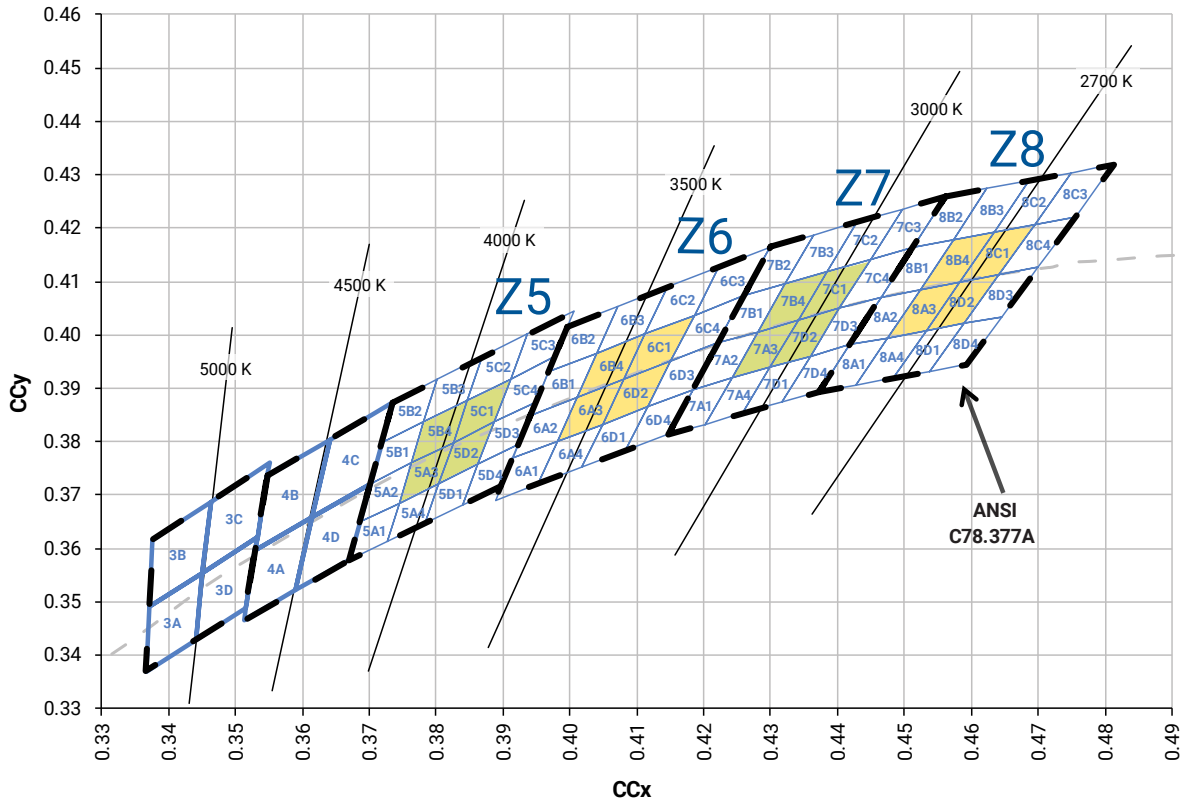
STANDARD COOL WHITE KITS PLOTTED ON ANSI STANDARD CHROMATICITY REGIONS - CONTINUED



STANDARD WARM AND NEUTRAL WHITE KITS PLOTTED ON ANSI STANDARD CHROMATICITY REGIONS



STANDARD WARM AND NEUTRAL WHITE KITS PLOTTED ON ANSI STANDARD CHROMATICITY REGIONS - CONTINUED



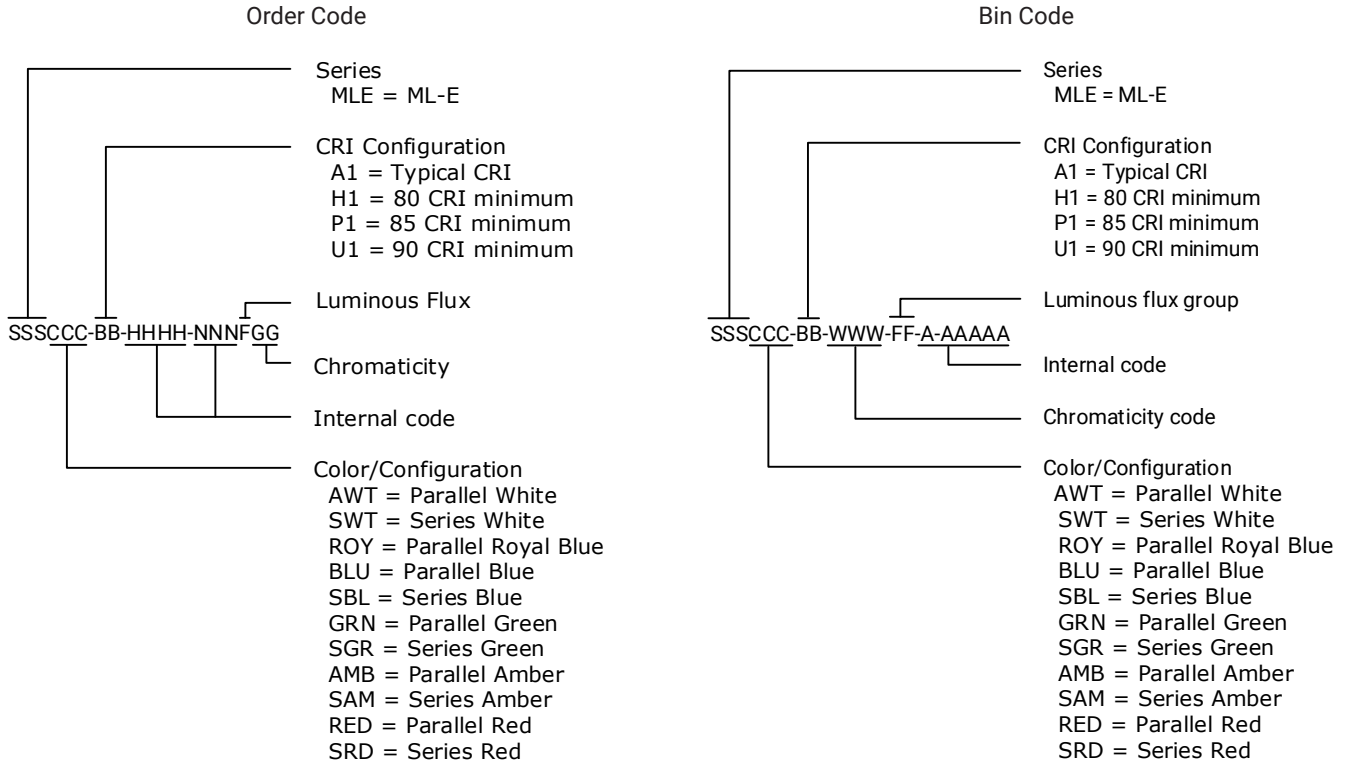
STANDARD CHROMATICITY KITS

The following table provides the chromaticity bins associated with chromaticity kits for the ML-E LEDs.

| Color | CCT | Kit | Chromaticity Bins |
|------------|--------|-----|--|
| Cool White | 7000 K | DT | 0A, 0B, 0C, 0D, 0R, 0S, 0T, 0U, 1A, 1B, 1C, 1D, 1R, 1S, 1T, 1U |
| | 7000 K | E0 | 0A, 0B, 0C, 0D |
| | 6500 K | S1 | 0A, 0B, 0C, 0D, 0R, 0S, 0T, 0U, 1A, 1B, 1C, 1D, 1R, 1S, 1T, 1U, 2A, 2B, 2C, 2D, 2R, 2S, 2T, 2U, 3A, 3B, 3R, 3S |
| | 6500 K | E1 | 1A, 1B, 1C, 1D |
| | 6200 K | S0 | 1A, 1B, 1C, 1D, 2A, 2B, 2C, 2D |
| | 6000 K | DV | 1A, 1B, 1C, 1D, 1R, 1S, 1T, 1U, 2A, 2B, 2C, 2D, 2R, 2S, 2T, 2U |
| | 5700 K | E2 | 2A, 2B, 2C, 2D |
| | 5500 K | DY | 2A, 2B, 2C, 2D, 2R, 2S, 2T, 2U, 3A, 3B, 3C, 3D, 3R, 3S, 3T, 3U |
| | 5000 K | DZ | 2C, 2D, 2T, 2U, 3A, 3B, 3C, 3D, 3R, 3S, 3T, 3U, 4A, 4B, 4R, 4S |
| | 5000 K | E3 | 3A, 3B, 3C, 3D |
| | 4750 K | F4 | 3C, 3D, 4A, 4B |
| | 4500 K | E4 | 4A, 4B, 4C, 4D |
| Warm White | 4250 K | F5 | 4C, 4D, 5A1, 5A2, 5A3, 5A4, 5B1, 5B2, 5B3, 5B4 |
| | 4000 K | E5 | 5A1, 5A2, 5A3, 5A4, 5B1, 5B2, 5B3, 5B4, 5C1, 5C2, 5C3, 5C4, 5D1, 5D2, 5D3, 5D4 |
| | 4000 K | Z5 | 5A3, 5B4, 5C1, 5D2 |
| | 3750 K | F6 | 5C1, 5C2, 5C3, 5C4, 5D1, 5D2, 5D3, 5D4, 6A1, 6A2, 6A3, 6A4, 6B1, 6B2, 6B3, 6B4 |
| | 3500 K | E6 | 6A1, 6A2, 6A3, 6A4, 6B1, 6B2, 6B3, 6B4, 6C1, 6C2, 6C3, 6C4, 6D1, 6D2, 6D3, 6D4 |
| | 3500 K | Z6 | 6A3, 6B4, 6C1, 6D2 |
| | 3250 K | F7 | 6C1, 6C2, 6C3, 6C4, 6D1, 6D2, 6D3, 6D4, 7A1, 7A2, 7A3, 7A4, 7B1, 7B2, 7B3, 7B4 |
| | 3000 K | E7 | 7A1, 7A2, 7A3, 7A4, 7B1, 7B2, 7B3, 7B4, 7C1, 7C2, 7C3, 7C4, 7D1, 7D2, 7D3, 7D4 |
| | 3000 K | Z7 | 7A3, 7B4, 7C1, 7D2 |
| | 2850 K | F8 | 7C1, 7C2, 7C3, 7C4, 7D1, 7D2, 7D3, 7D4, 8A1, 8A2, 8A3, 8A4, 8B1, 8B2, 8B3, 8B4 |
| | 2700 K | E8 | 8A1, 8A2, 8A3, 8A4, 8B1, 8B2, 8B3, 8B4, 8C1, 8C2, 8C3, 8C4, 8D1, 8D2, 8D3, 8D4 |
| | 2700 K | Z8 | 8A3, 8B4, 8C1, 8D2 |

BIN AND ORDER CODE FORMATS

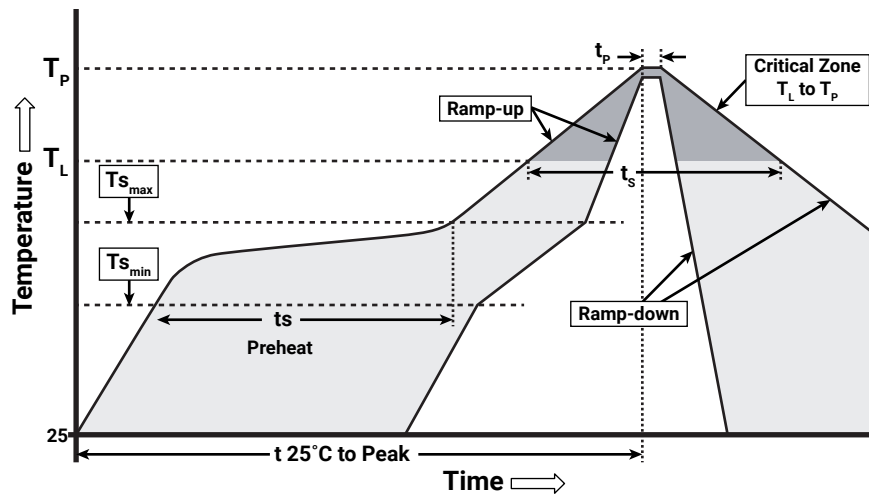
Bin codes and order codes are configured in the following manner:



REFLOW SOLDERING CHARACTERISTICS

In testing, Cree LED has found XLamp ML-E LEDs to be compatible with JEDEC J-STD-020C, using the parameters listed below. As a general guideline, Cree LED recommends that users follow the recommended soldering profile provided by the manufacturer of the solder paste used, and therefore it is the lamp or luminaire manufacturer’s responsibility to determine applicable soldering requirements.

Note that this general guideline may not apply to all PCB designs and configurations of reflow soldering equipment.



IPC/JEDEC J-STD-020C

| Profile Feature | Lead-Free Solder |
|---|------------------|
| Average Ramp-Up Rate ($T_{s_{max}}$ to T_p) | 1.2 °C/second |
| Preheat: Temperature Min ($T_{s_{min}}$) | 120 °C |
| Preheat: Temperature Max ($T_{s_{max}}$) | 170 °C |
| Preheat: Time ($t_{s_{min}}$ to $t_{s_{max}}$) | 65-150 seconds |
| Time Maintained Above: Temperature (T_L) | 217 °C |
| Time Maintained Above: Time (t_L) | 45-90 seconds |
| Peak/Classification Temperature (T_p) | 235 - 245 °C |
| Time Within 5 °C of Actual Peak Temperature (t_p) | 20-40 seconds |
| Ramp-Down Rate | 1 - 6 °C/second |
| Time 25 °C to Peak Temperature | 4 minutes max. |

Note: All temperatures refer to topside of the package, measured on the package body surface.

Note: While the high reflow temperatures (above) have been approved, Cree LED’s best practice guideline for reflow is to use as low a temperature as possible during the reflow soldering process for these LEDs.

NOTES

Measurements

The luminous flux, radiant power, chromaticity, forward voltage and CRI measurements in this document are binning specifications only and solely represent product measurements as of the date of shipment. These measurements will change over time based on a number of factors that are not within Cree LED's control and are not intended or provided as operational specifications for the products. Calculated values are provided for informational purposes only and are not intended or provided as specifications.

Pre-Release Qualification Testing

Please read the [LED Reliability Overview](#) for details of the qualification process Cree LED applies to ensure long-term reliability for XLamp LEDs and details of Cree LED's pre-release qualification testing for XLamp LEDs.

Lumen Maintenance

Cree LED now uses standardized IES LM-80-08 and TM-21-11 methods for collecting long-term data and extrapolating LED lumen maintenance. For information on the specific LM-80 data sets available for this LED, refer to the public [LM-80 results document](#).

Please read the [Long-Term Lumen Maintenance application note](#) for more details on Cree LED's lumen maintenance testing and forecasting. Please read the [Thermal Management application note](#) for details on how thermal design, ambient temperature, and drive current affect the LED junction temperature.

Moisture Sensitivity

Cree LED recommends keeping XLamp ML-E LEDs in the provided, resealable moisture-barrier packaging (MBP) until immediately prior to soldering. Unopened MBPs that contain XLamp LEDs do not need special storage for moisture sensitivity.

Once the MBP is opened, XLamp ML-E LEDs should be handled and stored as MSL 2a per JEDEC J-STD-033, meaning they have limited exposure time before damage to the LED may occur during the soldering operation. The table on the right specifies the maximum exposure time in days depending on temperature and humidity conditions. LEDs with exposure time longer than the specified maximums must be baked according to the baking conditions listed below.

| Temp. | Maximum Percent Relative Humidity | | | | | | |
|-------|-----------------------------------|-----|-----|-----|-----|-----|-----|
| | 30% | 40% | 50% | 60% | 70% | 80% | 90% |
| 35 °C | - | - | - | 17 | 1 | .5 | .5 |
| 30 °C | - | - | - | 28 | 1 | 1 | 1 |
| 25 °C | - | - | - | - | 2 | 1 | 1 |
| 20 °C | - | - | - | - | 2 | 1 | 1 |

Baking Conditions

It is not necessary to bake all XLamp ML-E LEDs. Only the LEDs that meet all of the following criteria must be baked:

1. LEDs that have been removed from the original MBP.
2. LEDs that have been exposed to a humid environment longer than listed in the Moisture Sensitivity section above.
3. LEDs that have not been soldered.

NOTES - CONTINUED

LEDs should be baked at 70 °C for 24 hours. LEDs may be baked on the original reels. Remove LEDs from the MBP before baking. Do not bake parts at temperatures higher than 70 °C. This baking operation resets the exposure time as defined in the Moisture Sensitivity section above.

Storage Conditions

XLamp ML-E LEDs that have been removed from the original MBP but not soldered should be stored in one of the following ways:

- Store the parts in a rigid metal container with a tight-fitting lid. Verify that the storage temperature is <30 °C, and place fresh desiccant and an RH indicator in the container to verify that the RH is no greater than 60%.
- Store the parts in a dry, nitrogen-purged cabinet or container that actively maintains the temperature at <30° and the RH at no greater than 60%.
- For short-term store only: LEDs can be resealed in the original MBP soon after opening. Fresh desiccant may be needed. Use the included humidity indicator card to verify <60% RH.

If an environment of <60% RH is not available for storage, XLamp ML-E LEDs should be baked (described above) before reflow soldering.

RoHS Compliance

The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/EC (RoHS2), as implemented January 2, 2013. RoHS Declarations for this product can be obtained from your Cree LED representative or from the [Product Ecology](#) section of the Cree LED website.

REACH Compliance

REACH substances of very high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future, please contact a Cree LED representative to insure you get the most up-to-date REACH SVHC Declaration. REACH banned substance information (REACH Article 67) is also available upon request.

UL® Recognized Component

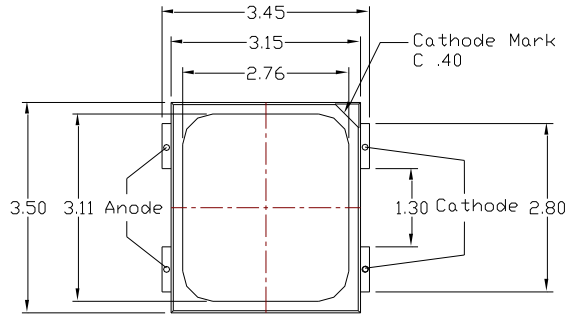
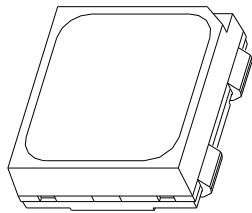
This product meets the requirements to be considered a UL Recognized Component with Level 4 enclosure consideration. The LED package or a portion thereof has been investigated as a fire and electrical enclosure per ANSI/UL 8750.

Vision Advisory

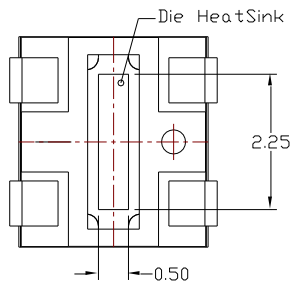
WARNING: Do not look at an exposed lamp in operation. Eye injury can result. For more information about LEDs and eye safety, please refer to the [LED Eye Safety application note](#).

MECHANICAL DIMENSIONS ($T_A = 25\text{ }^\circ\text{C}$)

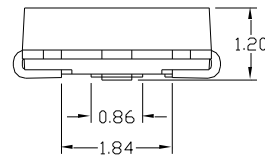
All measurements are ± 0.13 mm unless otherwise indicated.



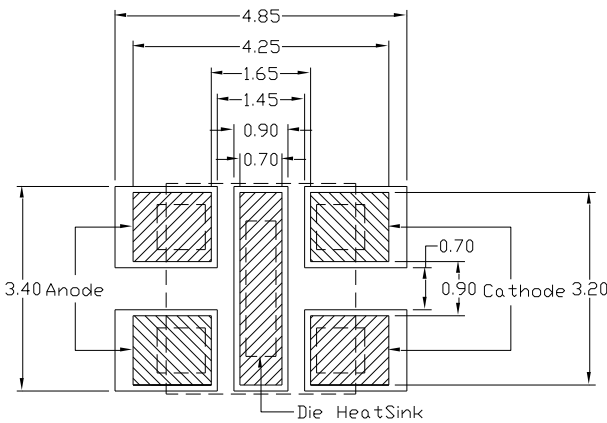
Top View



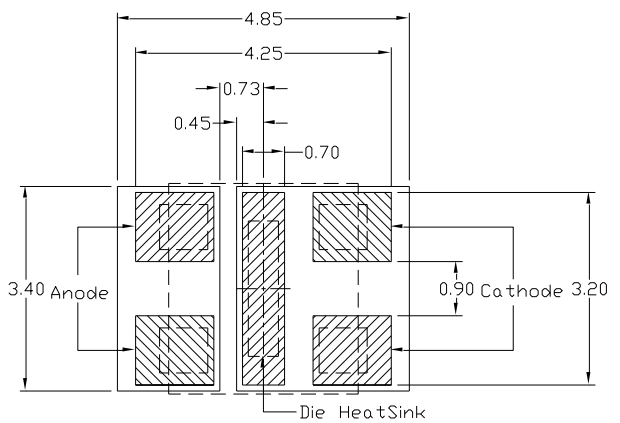
Bottom View



Side View



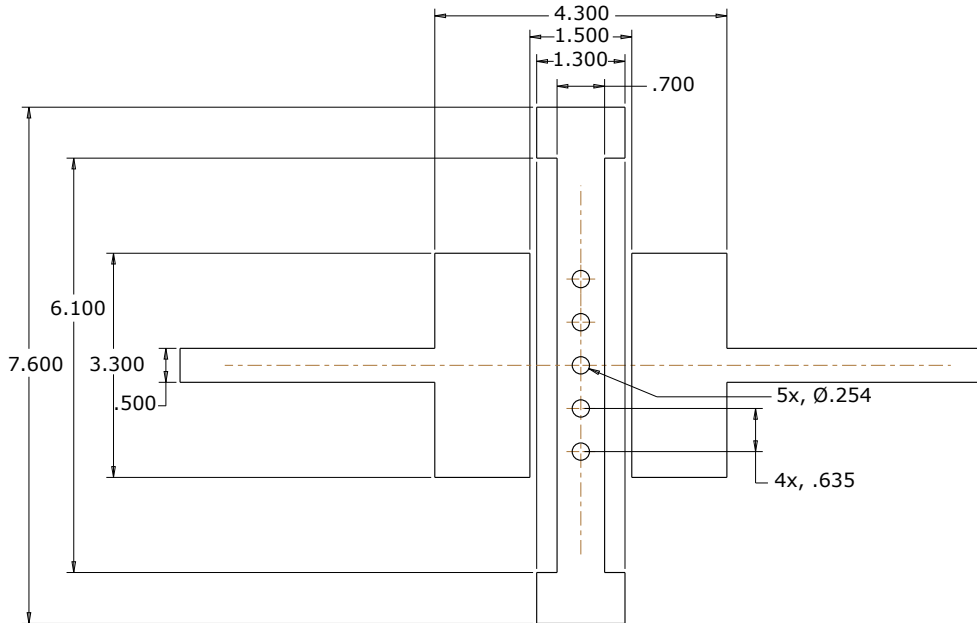
Recommended PCB Solder Pad



Alternate Solder Pad

MECHANICAL DIMENSIONS (T_A = 25 °C) - CONTINUED

All measurements are ±.13 mm unless otherwise indicated.

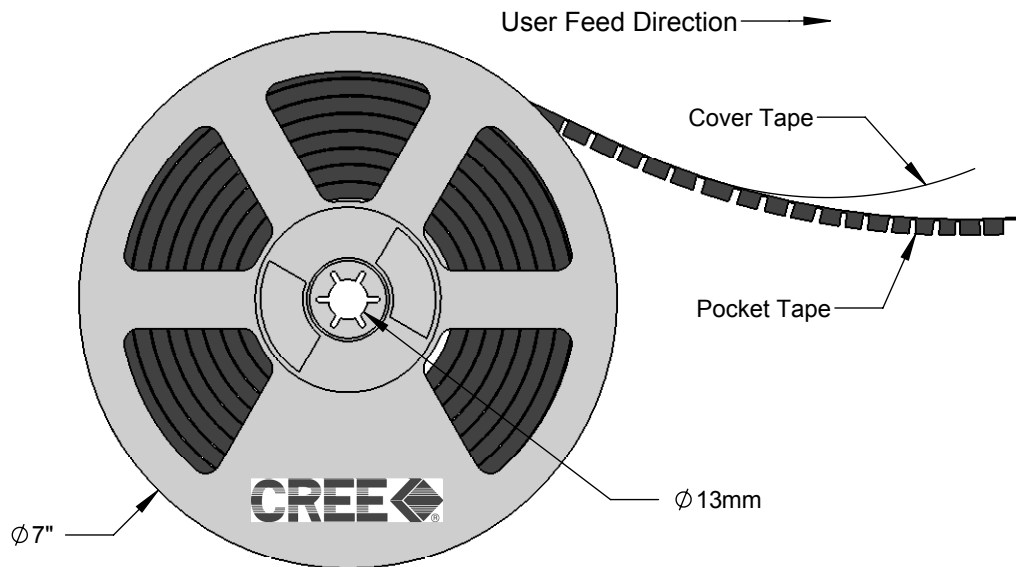
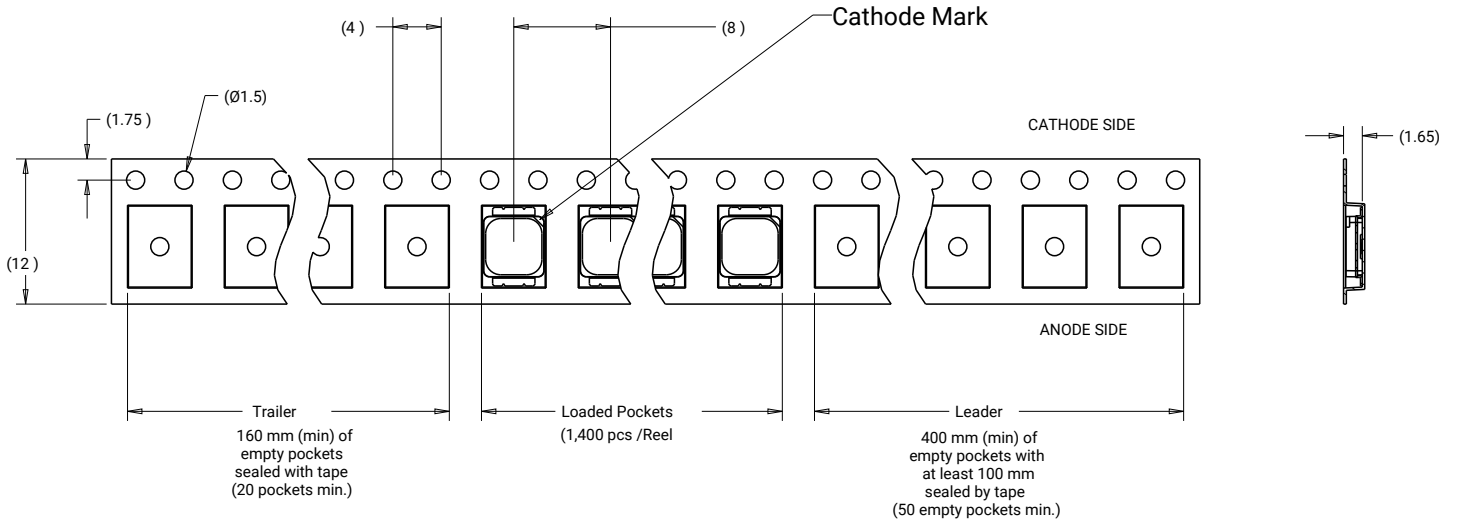


Recommended FR4 Solder Pad with Thermal Vias

TAPE AND REEL

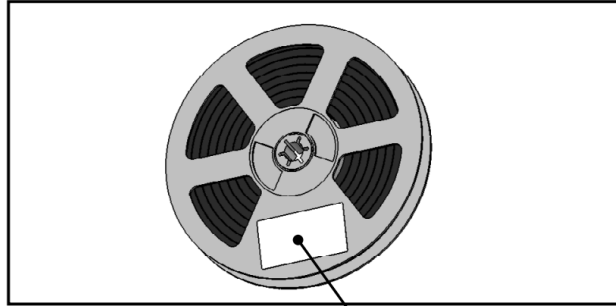
All Cree LED carrier tapes conform to EIA-481D, Automated Component Handling Systems Standard.

Except as noted, all dimensions in mm.



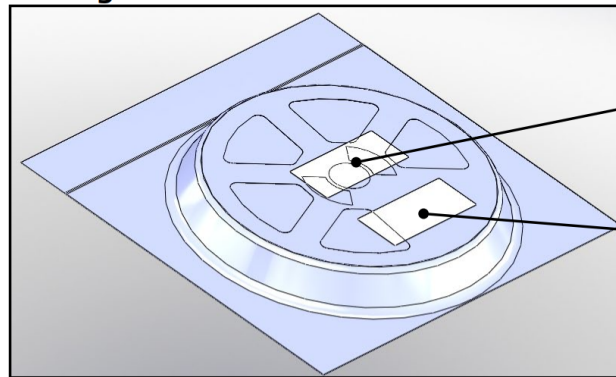
PACKAGING

Unpackaged Reel



Label with Cree LED Bin Code, Quantity, Reel ID

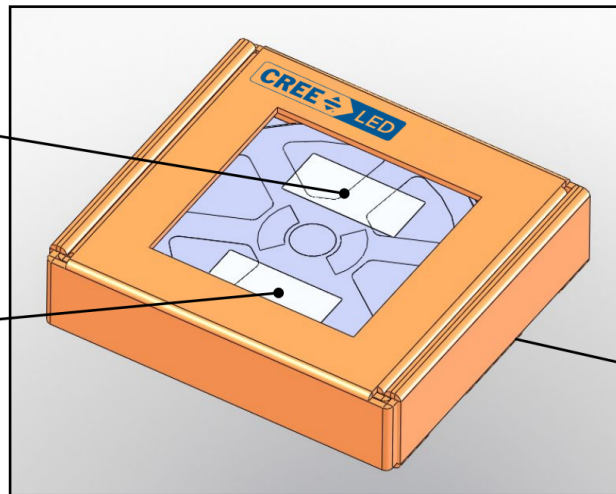
Packaged Reel



Label with Cree LED Order Code, Quantity, Reel ID, PO#

Label with Cree LED Bin Code, Quantity, Reel ID

Boxed Reel



Label with Cree LED Order Code, Quantity, Reel ID, PO#

Label with Cree LED Bin Code, Quantity, Reel ID

Patent Label (on bottom of box)