LUXEON®
never before possible

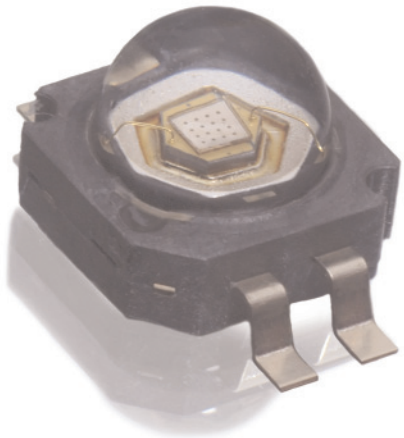
power light source

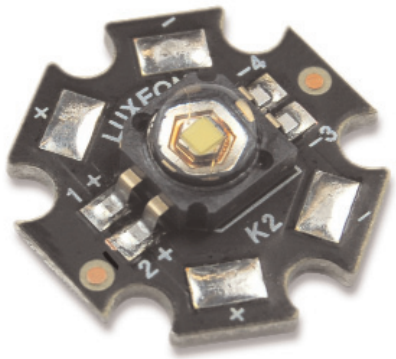
LUXEON® K2 with TFFC

Introduction

LUXEON® K2 with TFFC is the most robust and powerful LED available. With unprecedented thermal, drive current and light output capabilities, it offers lighting industry leading lumens per package and the opportunity to create never before possible lighting solutions. LUXEON K2 with TFFC is available in a wide range of colors, including cool-white, neutral-white, warm-white, blue, royal blue, green and cyan.

- deliver more useable light
- optimize applications to reduce size and cost
- engineer more robust applications
- reduce thermal management engineering
- utilize standard FR4 PCB technology in addition to MCPCB solutions
- simplify manufacturing through the use of surface mount technology.





LUXEON K2 with TFFC Technology Leadership

- Industry leading lumen performance, over 200 lumens in Cool-White at 1,000mA
- Over 55 lm/W at 1,000mA
- Highest operating junction temperature available, up to 185°C
- Highest Drive Currents—1500 mA
- Lowest Thermal Resistance—7°C/W
- Industry Best Moisture Sensitivity level—JEDEC 2a
- Lead free reflow solder JEDEC 020c compatible
- RoHS Compliant
- Autoclave compliant—JESD22 A-102
- Industry Best Lumen Maintenance—50,000 hours life at 1000 mA with 70% lumen maintenance

PHILIPS

LUMILEDS
LIGHT FROM SILICON VALLEY

Table of Contents

Product Nomenclature

The LUXEON K2 with TFFC is tested and binned at 1000mA.

The part number designation is explained as follows:
L X K 2 - A B C D - E F G H for Emitter
L 2 K 2 - A B C D - x x - E F G H for Star

Where:
A — designates radiation pattern (Value P for Lambertian emitter, M for Lambertian Star product)
B — designates color (see Philips Lumileds AB21)
C — designates color variant (1 for direct colors, C for Cool-White, N for Neutral-White, and W for Warm-White)
D — designates test current (value 4 for 1000 mA)
E — Reserved for future offerings
FGH — minimum luminous flux (lm) or radiometric power (mW) performance

x x - indicates array description for Level 2 Star Product (11 for 1x1 array)

Therefore, products tested and binned at 1000mA follow the part numbering scheme:
L X K 2 - P x x 4 - x x x x (L 2 K 2 - P x x 4 - 1 1 - x x x x for TFFC Star)

Average Lumen Maintenance Characteristics

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

Philips Lumileds projects that white LUXEON K2 with TFFC products will deliver, on average, TBD% lumen maintenance at TBD hours of operation at a forward current of TBD mA. This projection is based on constant current operation with junction temperature maintained at or below TBD°C. Philips Lumileds projects that green, blue, cyan and royal blue LUXEON K2 with TFFC products will deliver, on average, TBD% lumen maintenance at TBD hours of operation at a forward current of TBD mA. This projection is based on constant current operation with junction temperature maintained at or below TBD°C.

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

Environmental Compliance

Philips Lumileds is committed to providing environmentally friendly products to the solid-state lighting market. The LUXEON K2 with TFFC is compliant to the European Union directives on the Restriction of Hazardous Substances in electronic equipment, namely the RoHS directive. Philips Lumileds will not intentionally add the following restricted materials to the LUXEON K2 with TFFC: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

Flux Characteristics for LUXEON K2 with TFFC Junction and Case Temperature = 25ºC[5]

Table 1.

Minimum Performance at Test Current			Typical Performance at Indicated Current		
		Minimum Luminous Flux (lm) or Radiometric Power (mW) Φ_V	Typical Luminous Flux (lm) or Radiometric Power (mW) Φ_V		
Color	Part Number	at 1000mA	at 1500 mA	at 700 mA	at 350 mA
Cool-White	LXK2-PWC4-0220	220	300	190	110
	LXK2-PWC4-0200	200	275	170	95
	LXK2-PWC4-0180	180	250	150	85
	LXK2-PWC4-0160	160	220	135	75
Neutral-White	LXK2-PWN4-0200	200	275	170	95
	LXK2-PWN4-0180	180	250	150	85
	LXK2-PWN4-0160	160	220	135	75
	LXK2-PWN4-0140	140	195	120	65
Warm-White	LXK2-PWW4-0160	160	220	135	75
	LXK2-PWW4-0140	140	195	120	65
	LXK2-PWW4-0120	120	170	105	55
Green	LXK2-PM14-0200	200	275	170	95
	LXK2-PM14-0180	180	250	150	85
	LXK2-PM14-0160	160	220	135	75
	LXK2-PM14-0140	140	195	120	65
Cyan	LXK2-PE14-0180	180	250	150	85
	LXK2-PE14-0160	160	220	135	75
	LXK2-PE14-0140	140	195	120	65
	LXK2-PE14-0120	120	170	105	55
Blue	LXK2-PB14-0060	60	85	50	30
	LXK2-PB14-0050	50	75	40	25
	LXK2-PB14-0040	40	65	35	20
	LXK2-PB14-0030	30	45	25	15
Royal Blue	LXK2-PR14-0600	600 mW	780	480	275
	LXK2-PR14-0700	700 mW	910	560	315

Notes for Table 1:

1. Minimum luminous flux or radiometric power performance guaranteed within published operating conditions. Philips Lumileds maintains a tolerance of ± 10% on flux and power measurements of LUXEON K2 with TFFC.
2. Typical luminous flux or radiometric power performance when device is operated within published operating conditions.
3. LUXEON K2 with TFFC products with even higher luminous flux and radiometric power levels will become available in the future. Please consult Philips Lumileds or Future Electronics for more information.
4. Radiation Pattern for all LUXEON K2 with TFFC products is Lambertian.
5. LUXEON K2 with TFFC is tested and binned at 25°C with a 20ms monopulse test to avoid heating of the junction or case.
6. For Red, Red-Orange, and Amber products, please see LUXEON K2 datasheet, DS51.

Flux Characteristics for LUXEON K2 with TFFC Star Junction and Case Temperature = 25ºC[5]

Table 2.

Minimum Performance at Test Currents			Typical Performance at Indicated Current		
		Minimum Luminous Flux (lm) or Radiometric Power (mW) Φ_V	Typical Luminous Flux (lm) or Radiometric Power (mW) Φ_V		
Color	Part Number	at 1000mA	at 1500 mA	at 700 mA	at 350 mA
Cool-White	L2K2-MWC4-11-0220	220	300	190	110
	L2K2-MWC4-11-0200	200	275	170	95
	L2K2-MWC4-11-0180	180	250	150	85
	L2K2-MWC4-11-0160	160	220	135	75
Neutral-White	L2K2-MWN4-11-0200	200	275	170	95
	L2K2-MWN4-11-0180	180	250	150	85
	L2K2-MWN4-11-0160	160	220	135	75
	L2K2-MWN4-11-0140	140	195	120	65
Warm-White	L2K2-MWW4-11-0160	160	220	135	75
	L2K2-MWW4-11-0140	140	195	120	65
	L2K2-MWW4-11-0120	120	170	105	55

Notes for Table 2:

1. Minimum luminous flux or radiometric power performance guaranteed within published operating conditions. Philips Lumileds maintains a tolerance of ± 10% on flux and power measurements of LUXEON K2 with TFFC.
2. Typical luminous flux or radiometric power performance when device is operated within published operating conditions.
3. LUXEON K2 with TFFC products with even higher luminous flux and radiometric power levels will become available in the future. Please consult Philips Lumileds or Future Electronics for more information.
4. Radiation Pattern for all LUXEON K2 with TFFC products is Lambertian.
5. Luxeon K2 with TFFC is tested and binned at 25°C with a 20ms monopulse test to avoid heating of the junction or case.

Optical Characteristics

LUXEON K2 with TFFC at Test Current[1] Junction and Case Temperature = 25ºC[11]

Table 3.

Color	Dominant Wavelength [2] λ_D, Peak Wavelength [3] λ_P, or Color Temperature [4] CCT Min.	CCT Typ.	CCT Max.	Typical Spectral Half-width [6] (nm) $\Delta\lambda_{1/2}$	Typical Temperature Coefficient of Dominant Wavelength (nm/ºC) $\Delta\lambda_D / \Delta T_J$	Typical Total Included Angle [7] (degrees) $\theta_{0.90V}$	Typical Viewing Angle [8] (degrees) 2θ 1/2
Cool White	4500 K	6500 K	10000 K	-	-	160	120
Neutral White	3500K	4100K	4500K	-	-	160	120
Warm White	2670K	3000K	3500K	-	-	160	120
Green	520 nm	530 nm	550 nm	35	0.04	160	120
Cyan	490 nm	505 nm	520 nm	30	0.04	160	120
Blue	460 nm	470 nm	490 nm	25	0.04	160	120
Royal Blue[3]	440 nm	455 nm	460 nm	20	0.04	160	120

Notes for Table 3:

1. Test current is 1000 mA for all LXK2 - xxx4 - xxxx products (L2K2 - xxx4 - 11 - xxxx for TFFC Star).
2. Dominant wavelength is derived from the CIE 1931 Chromaticity diagram and represents the perceived color. Philips Lumileds maintains a tolerance of ± 0.5 nm for dominant wavelength measurements.
3. Royal blue product is binned by radiometric power and peak wavelength rather than photometric lumens and dominant wavelength. Philips Lumileds maintains a tolerance of ± 2nm for peak wavelength measurements.
4. CCT ±5% tester tolerance
5. Typical CRI (Color Rendering Index) for Cool-White product is 70, Neutral-White is 75, and Warm-White is 80.
6. Spectral width at ½ of the peak intensity.
7. Total angle at which 90% of total luminous flux is captured.
8. Viewing angle is the off axis angle from lamp centerline where the luminous intensity is ½ of the peak value.
9. All white, green, cyan, blue and royal blue products are built with Indium Gallium Nitride (InGaN).
10. White, Blue, and Royal Blue power light sources represented here are IEC60825 class 2 for eye safety.
11. Luxeon K2 with TFFC is tested and binned at 25°C with a 20ms monopulse test to avoid heating of the junction or case.

Electrical Characteristics

Electrical Characteristics at 1000mA
Part Numbers LXK2-xxx4-xxx, Junction and Case Temperature = 25ºC[4]

Table 4.

Color	Forward Voltage V_f [1] (V) Min.	Typ.	Max.	Typical Dynamic Resistance [2] (Ω) R_D	Typical Temperature Coefficient of Forward Voltage (mV/ºC) $\Delta V_F / \Delta T_J$	Typical Thermal Resistance Junction to Case (ºC/W) $R\theta_{J-C}$
Cool-White[3]	3.03	3.72	4.95	0.45	-2.8	7 (11 for Star)
Neutral-White[3]	3.03	3.72	4.95	0.45	-2.8	7 (11 for Star)
Warm-White[3]	3.03	3.72	4.95	0.45	-2.8	7 (11 for Star)
Green[3]	3.03	3.72	4.95	0.45	TBD	7
Cyan[3]	3.03	3.72	4.95	0.45	TBD	7
Blue[3]	3.03	3.72	4.95	0.45	TBD	7
Royal Blue[3]	3.03	3.72	4.95	0.45	TBD	7

Notes for Table 4:

1. Philips Lumileds maintains a tolerance of ±0.06V on forward voltage measurements
2. Dynamic resistance is the inverse of the slope in linear forward voltage model for LEDs. See figure 13.
3. The forward voltage of the LUXEON K2 with TFFC LED will reduce by up to 0.50V at 1000mA during the first few hours of operation after SMT reflow. Due to this effect, Philips Lumileds recommends current source drive for consistent and reliable performance. Cross connected series/parallel arrays or voltage drivers which could result in current hogging or variation in drive current are not recommended. Please consult your Philips Lumileds authorized distributor or Philips Lumileds Sales Representative for further information.
4. Luxeon K2 with TFFC is tested and binned at 25°C with a 20ms monopulse test to avoid heating of the junction or case.

Typical Electrical Characteristics
Part Numbers LXK2-xxx4-xxx, Junction and Case Temperature = 25ºC

Table 5.

Color	Typical Forward Voltage V_f (V) at 1500mA	at 700mA	at 350mA
Cool-White	3.85	3.6	3.42
Neutral-White	3.85	3.6	3.42
Warm-White	3.85	3.6	3.42
Green	3.85	3.6	3.42
Cyan	3.85	3.6	3.42
Blue	3.85	3.6	3.42
Royal Blue	3.85	3.6	3.42

Absolute Maximum Ratings[3]

Table 6.

Parameter	Cool-White/Neutral-White/ Warm-White Value	Green/Cyan Blue/Royal Blue Value
DC Forward Current (mA)	1500	1500
Peak Pulsed Forward Current (mA)	1500	1500
Average Forward Current (mA)	1500	1500
ESD Sensitivity	> 2,000 V HBM Class 2 JESD22-A114-B	> 2,000 V HBM Class 2 JESD22-A114-B
LED Junction Temperature[1]	150°C	185°C
Storage Temperature	-40°C - 185°C	-40°C - 185°C
Soldering Temperature	JEDEC 020c 260°C	JEDEC 020c 260°C
Allowable Reflow Cycles	3	3
Autoclave Conditions	121°C at 2 ATM, 100% RH for 72 hours max	121°C at 2 ATM, 100% RH for 72 hours max
Reverse Voltage (Vr)	See Note 2	See Note 2

Notes for Table 6:

1. Proper current derating must be observed to maintain junction temperature below the maximum.
2. LEDs are not designed to be driven in reverse bias.
3. Stresses in excess of the absolute maximum ratings can cause damage to the emitter. Maximum Rating limits apply to each parameter in isolation, all parameters having values within the Current Derating Curve. It should not be assumed that limiting values of more than one parameter can be applied to the product at the same time. Exposures to the absolute maximum ratings for extended periods can adversely affect device reliability. See Allowable Use Condition profiles below.

JEDEC Moisture Sensitivity

Table 7.

Level	Floor Life		Soak Requirements			
			Standard		Accelerated Environment	
	Time	Conditions	Time (hours)	Conditions	Time (hours)	Conditions
2a	4 weeks	≤ 30°C / 60% RH	696 [1] + 5/-0	30°C / 60% RH	120 +1/-0	60°C / 60% RH

Notes for Table 7:

1. The standard soak time includes a default value of 24 hours for semiconductor manufacturer's exposure time (MET) between bake and bag and includes the maximum time allowed out of the bag at the distributor's facility.

Reflow Soldering Characteristics[1]

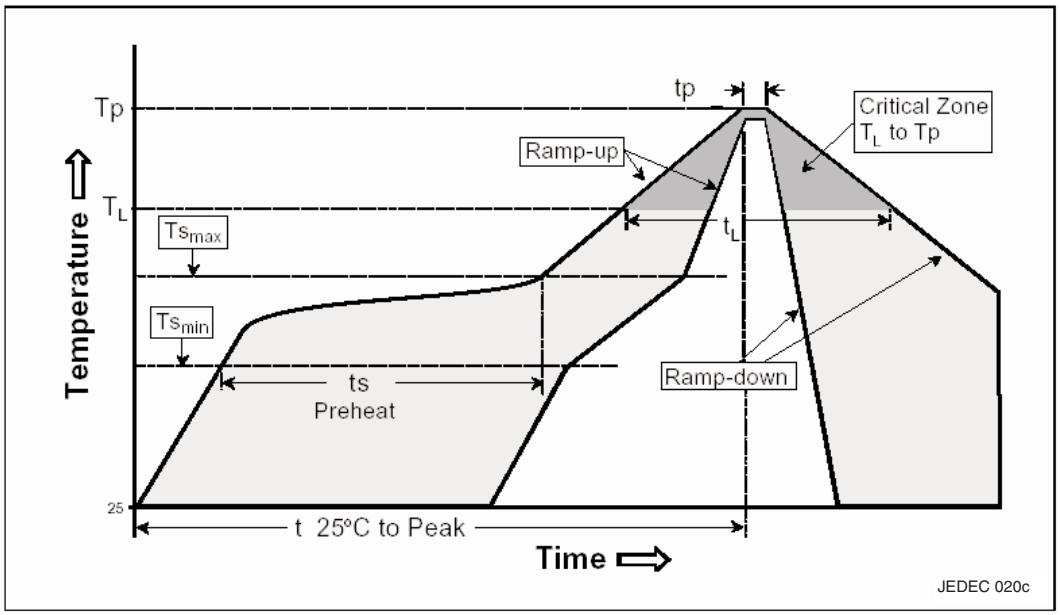


Table 8.

Profile Feature	Lead Free Assembly
Average Ramp-Up Rate (Ts_{max} to T_p)	3°C / second max
Preheat Temperature Min (Ts_{min})	150°C
Preheat Temperature Max (Ts_{max})	200°C
Preheat Time (ts_{min} to ts_{max})	60 - 180 seconds
Temperature (T_L)	217°C
Time Maintained Above Temperature (T_L)	60 - 150 seconds
Peak / Classification Temperature (T_P)	260°C
Time Within 5°C of Actual Peak Temperature (T_P)	20 - 40 seconds
Ramp - Down Rate	6°C / second max
Time 25°C to Peak Temperature	8 minutes max

Notes for Table 8:

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

Mechanical Dimensions—SMT 4-Lead Gullwing Form

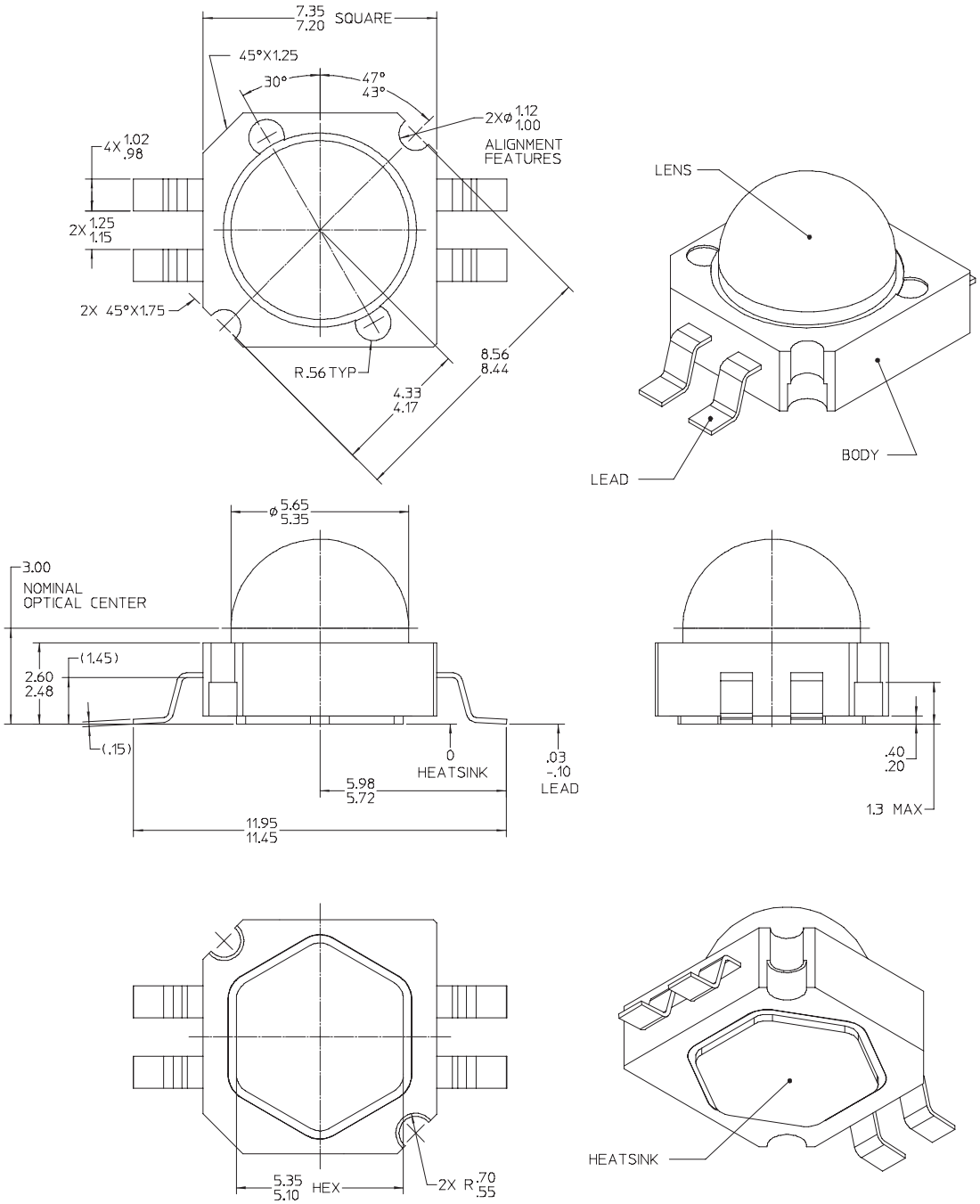


Figure 1. 4-lead Gullwing Package Outline Drawing.

Notes for Figure 1:

1. The anode side of the device is denoted by the chamfer on the part body. Electrical insulation between the case and the board is required—slug of the device is not electrically neutral. Do not electrically connect either the anode or cathode to the slug.
2. Do not handle the device by the lens except as described in Philips Lumileds document AB29.
3. Drawings not to scale.
4. All dimensions are in millimeters.
5. All dimensions without tolerances are for reference only.
6. Recommended solder paste thickness of 0.15mm.

Solder Pad Design—SMT Lead Form

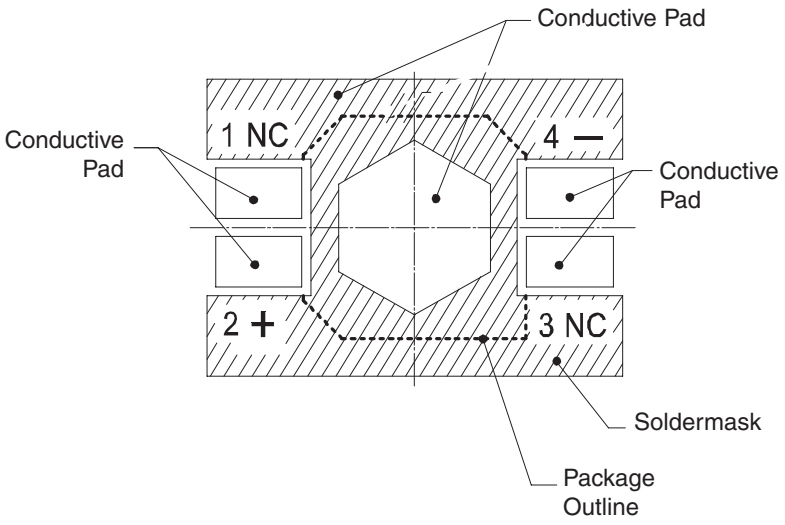


Figure 2. 4-Lead Gullwing Solder Pad Design.

Notes for Figure 2:

1. Electrical isolation is required between signal leads and hexagonal heat slug contact.
2. For optimal thermal performance, maximize board metallization at hexagonal heat slug contact.

Solder Pad Layout—SMT Lead Form

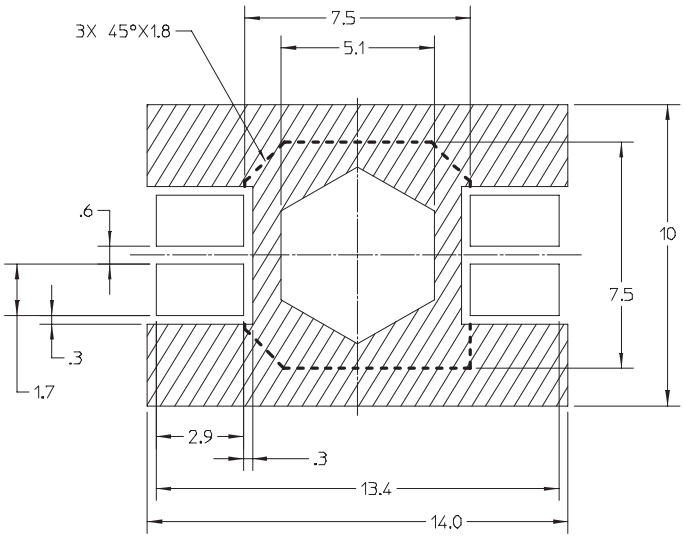
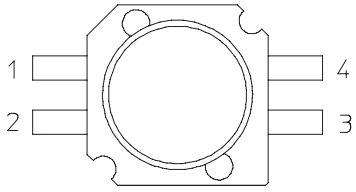


Figure 3. 4-Lead Gullwing Package Solder Pad Layout.

Pin Out Diagram



PIN	FUNCTION
1	NC
2	ANODE
3	NC
4	CATHODE

Figure 4. 4-Lead Gullwing Pin Out Diagram.

Mechanical Dimensions—2-Lead Gullwing Form[8]

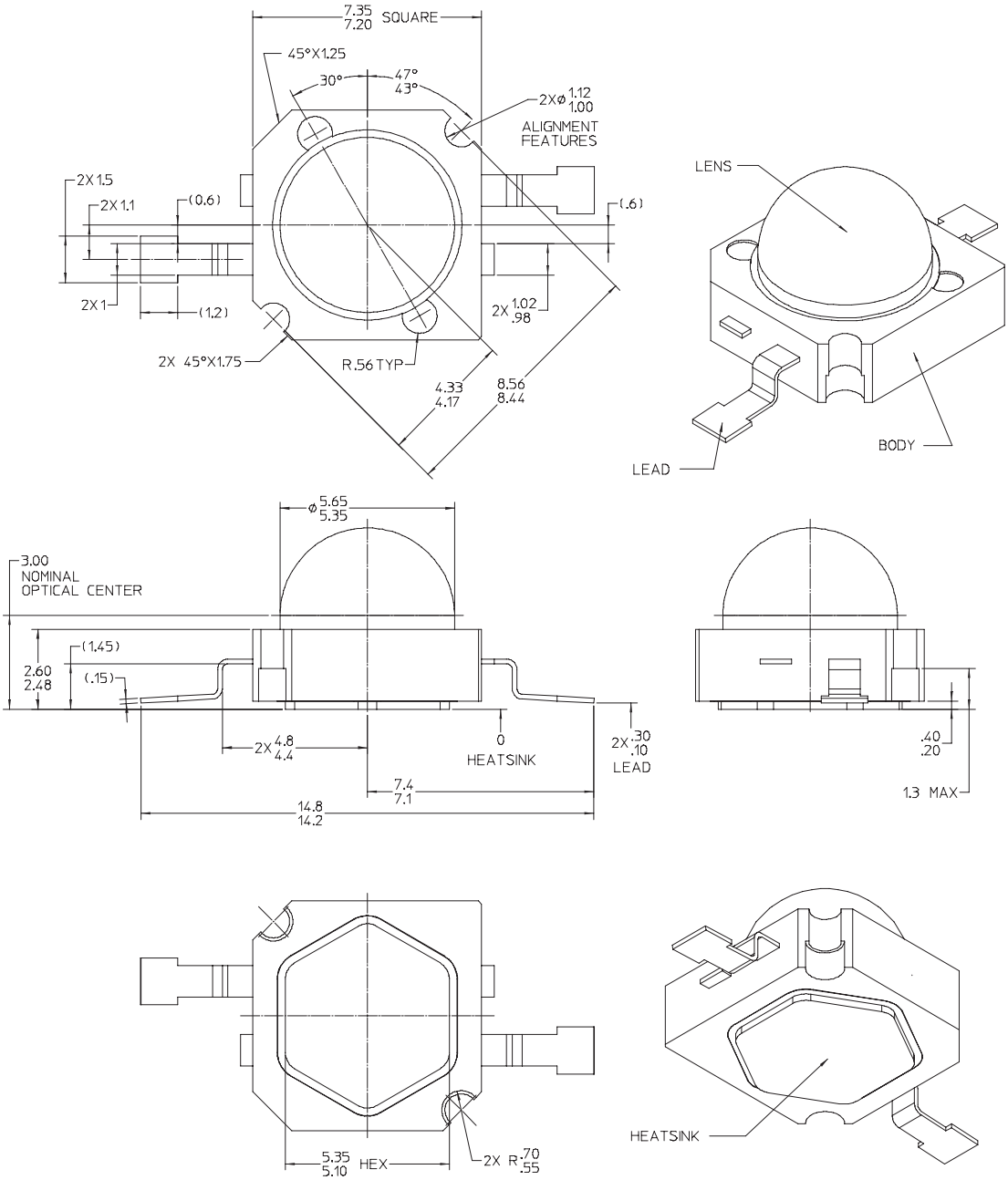


Figure 5. 2-Lead Gullwing Package Outline Drawing.

Notes for Figure 5:

1. The anode side of the device is denoted by the chamfer on the part body. Electrical insulation between the case and the board is required—slug of the device is not electrically neutral. Do not electrically connect either the anode or cathode to the slug.
2. Do not handle the device by the lens except as described in Philips Lumileds document AB29—care must be taken to avoid damage to the lens or the interior of the device that can be damaged by excessive force to the lens.
3. Drawings not to scale.
4. All dimensions are in millimeters.
5. All dimensions without tolerances are for reference only.
6. Recommended solder paste thickness of 0.15mm.
7. Available as a custom part number, contact your local sales representative for more information.
8. The 2-Lead Gullwing part is not recommended for use in solder re-flow systems. Mount these parts with a thermal adhesive and hot bar soldering. For conventional reflow surface-mounting, use 4-Lead Gullwing Form.

Solder Pad Design—2-Lead Gullwing

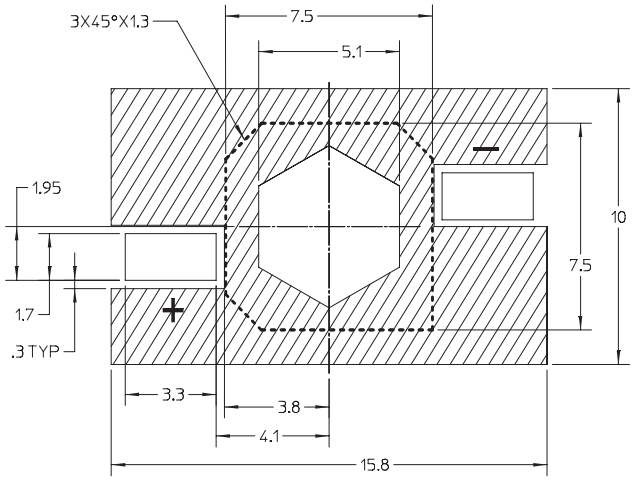


Figure 6. 2-Lead Gullwing Package Solder Pad Layout.

Notes for Figure 6:

1. Electrical isolation is required between signal leads and hexagonal heat slug contact.
2. For optimal thermal performance, maximize board metallization at hexagonal heat slug contact.

Solder Pad Layout—2-Lead Gullwing

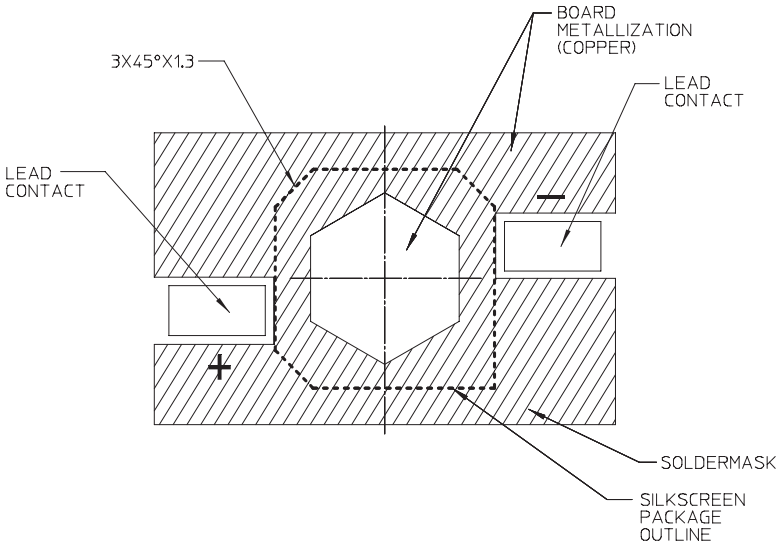
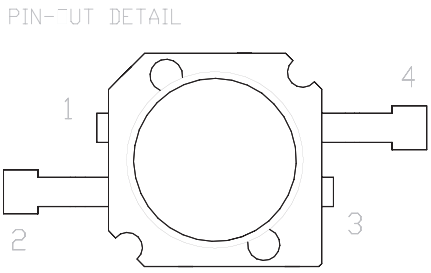


Figure 7. Solder Pad Layout 2-Lead Gullwing.

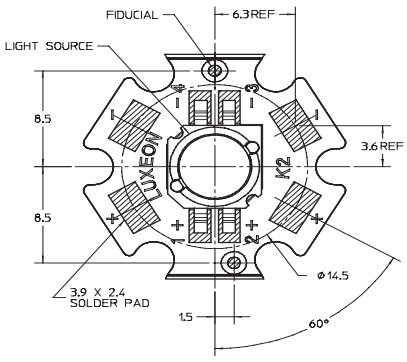
Pin Out Diagram—Gullwing Form



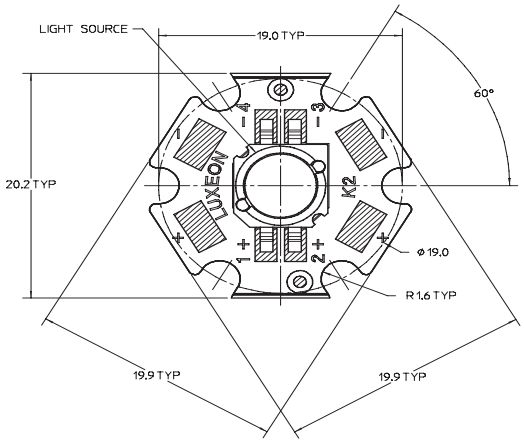
PIN	FUNCTION
1	NC (TRIMMED)
2	ANODE
3	NC (TRIMMED)
4	CATHODE

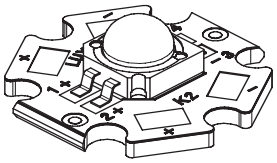
Figure 8. 2-Lead Gullwing Pin Out Diagram.

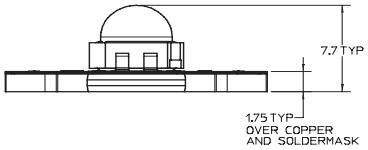
Mechanical Dimensions— LUXEON K2 with TFFC Star



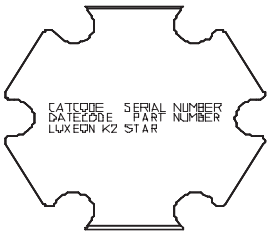
PAD LOCATIONS







PHYSICAL LAYOUT

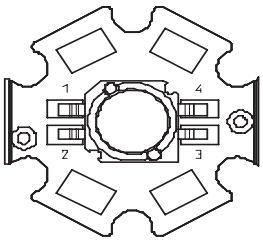


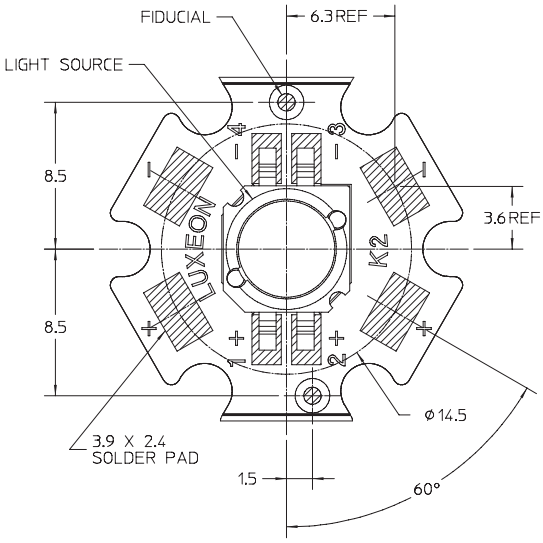
LABEL	FORMAT
CATCODE	FLUX. COLOR. VF BIN
SERIAL NUMBER	SERIAL NUMBER
DATECODE	PRODUCTION WEEK & YEAR
PART NUMBER	PART NUMBER

BACK VIEW

PIN OUT DIAGRAM

PIN	FUNCTION
1	NC
2	ANODE
3	NC
4	CATHODE





PAD LOCATIONS

Figure 9. TFFC Star Package Outline Drawing.

Notes for Figure 9:

1. Slots in aluminum core PCB for M3 or #4 mounting screw.
2. Electrical interconnection pads labeled on the aluminum core PCB with "+" and "-" to denote positive and negative, respectively. All positive pads are interconnected, as are all negative pads, allowing for flexibility in array interconnection.
3. Drawings not to scale.
4. All dimensions are in millimeters.

Wavelength Characteristics

Green, Cyan, Blue and Royal Blue at Test Current Junction and Case Temperature = 25°C

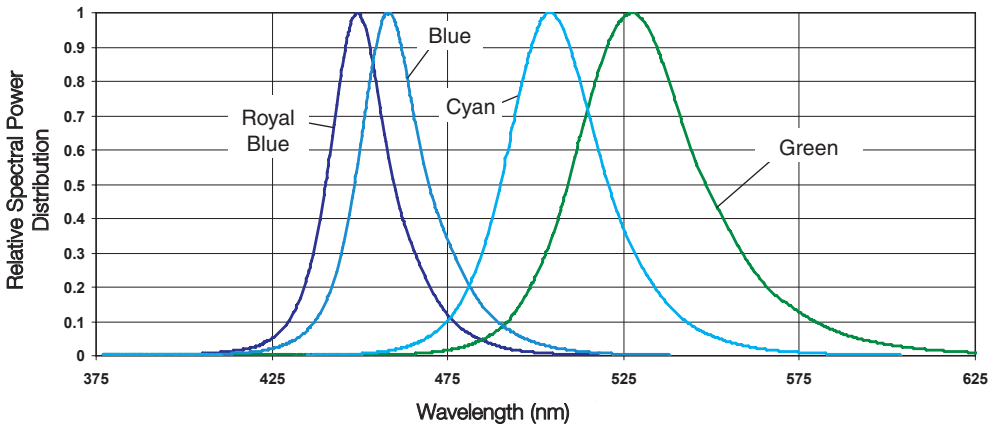


Figure 10. Relative intensity vs. wavelength.

Cool-White at Test Current Junction and Case Temperature = 25°C

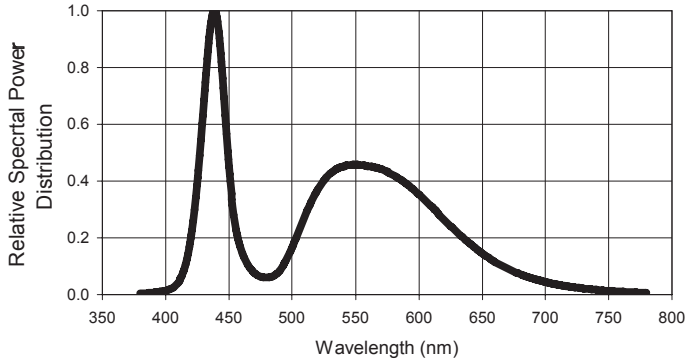


Figure 11a. Cool-White color spectrum of typical CCT part, integrated measurement.

Neutral-White at Test Current Junction and Case Temperature = 25°C

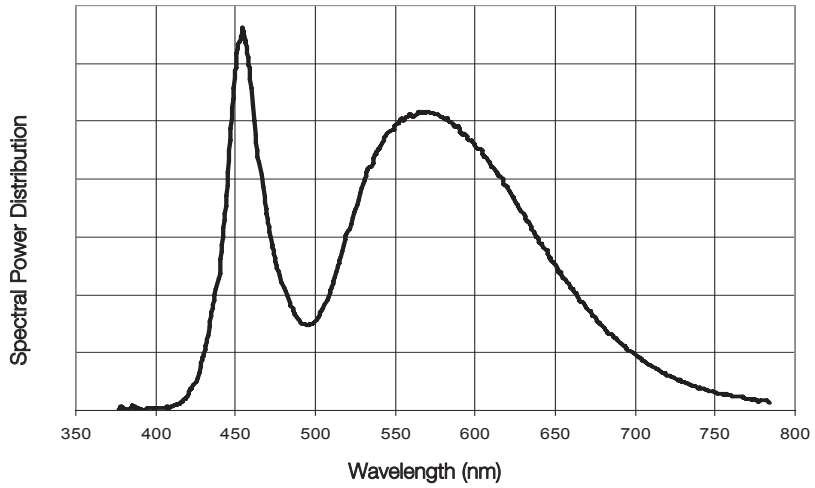


Figure 11b. Neutral-White color spectrum of typical CCT part, integrated measurement.

Warm-White at Test Current Junction and Case Temperature = 25°C

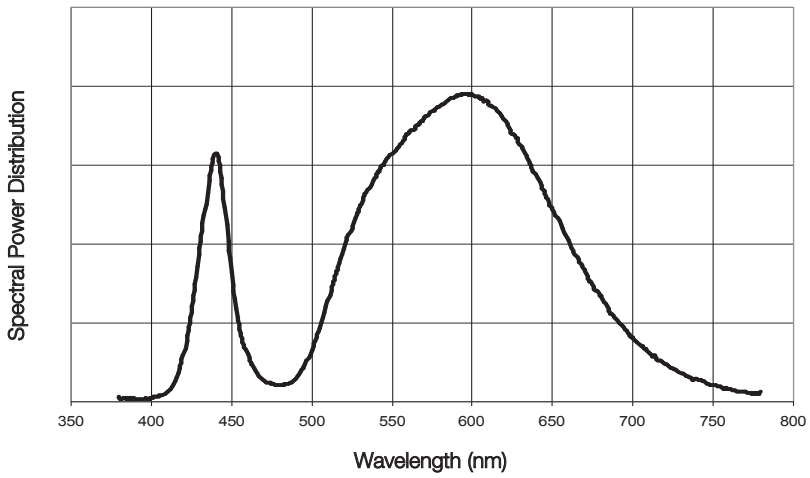


Figure 11c. Warm-White color spectrum of typical CCT part, integrated measurement.

Typical Light Output Characteristics Over Temperature

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

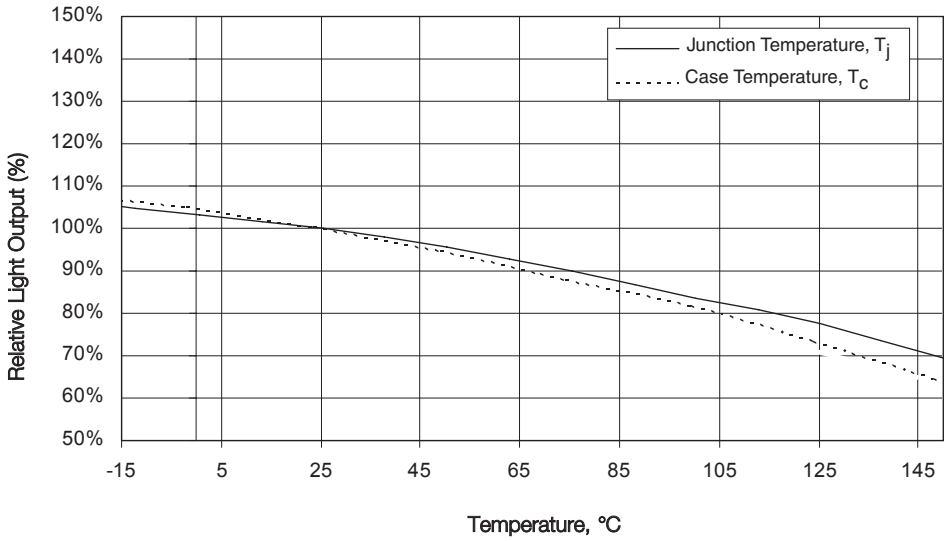


Figure 12a. Relative light output vs. temperature for white

Green at Test Current

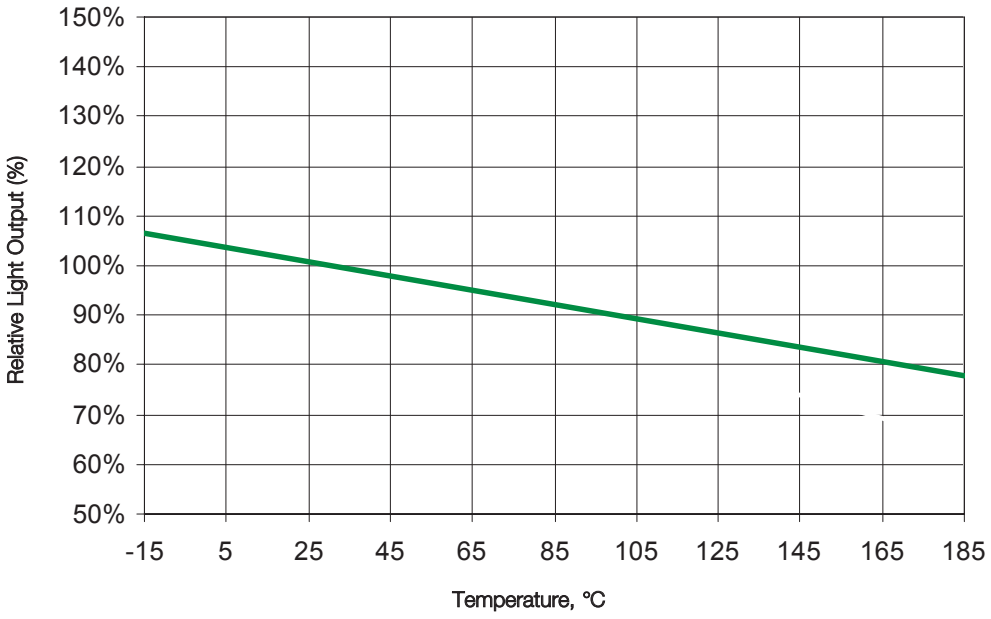


Figure 12b. Relative light output vs. junction temperature for green.

Typical Light Output Characteristics Over Temperature, Continued

Cyan at Test Current

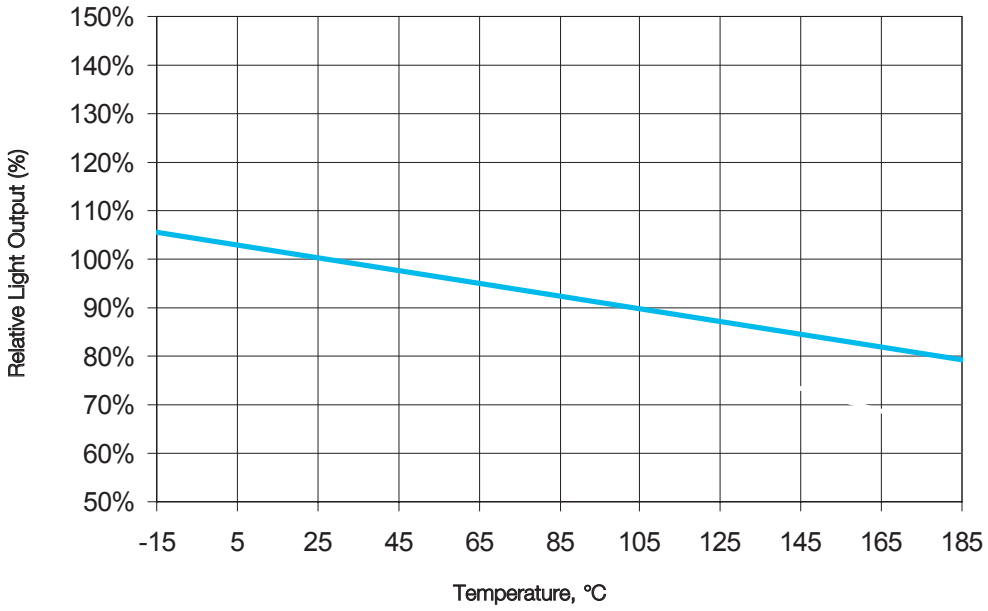


Figure 12c. Relative light output vs. junction temperature for cyan.

Blue at Test Current

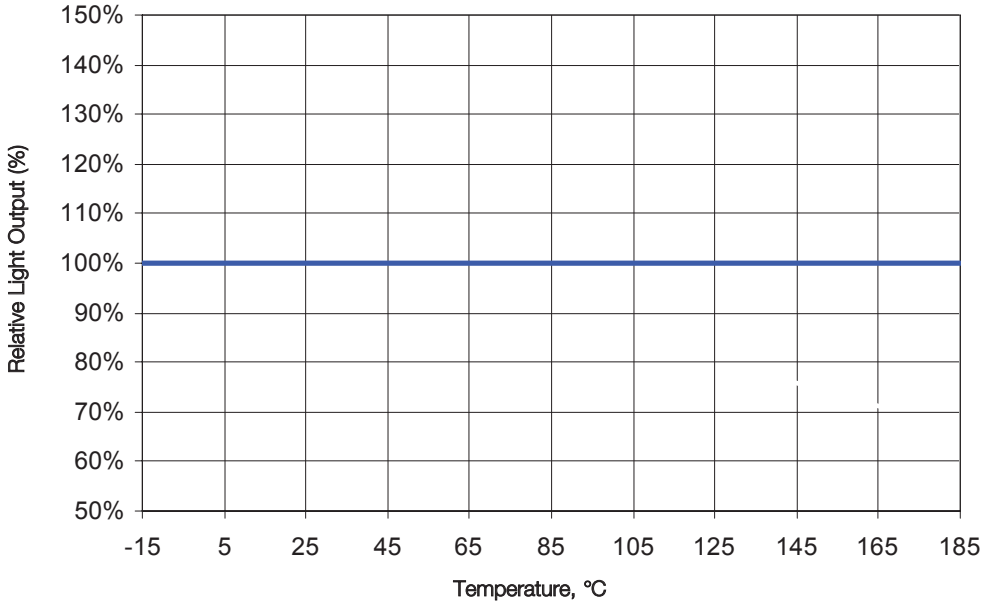


Figure 12d. Relative light output vs. junction temperature for blue.

Typical Light Output Characteristics Over Temperature, Continued

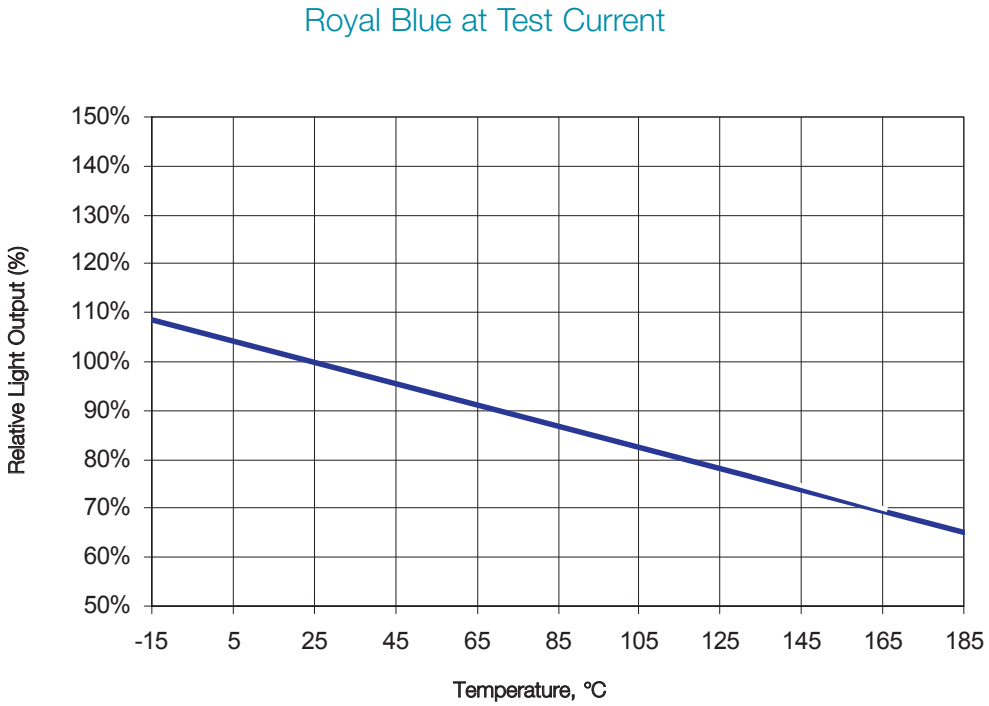


Figure 12e. Relative light output vs. junction temperature for royal blue.

Typical Forward Current Characteristics

Junction and Case Temperature = 25°C

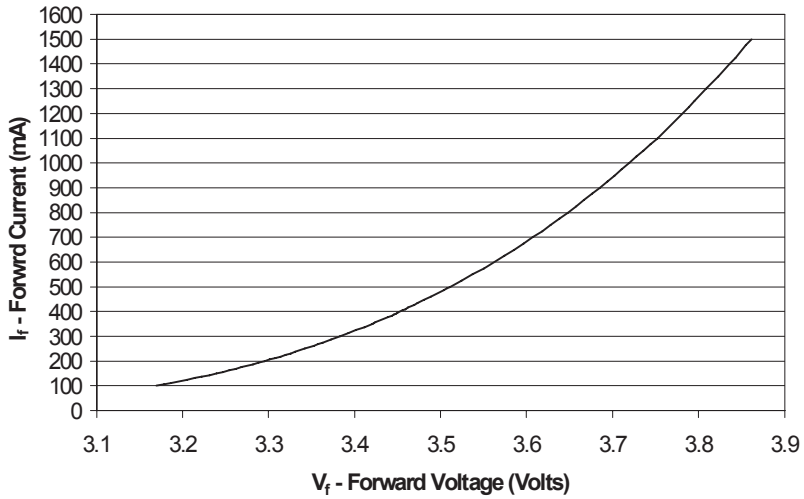


Figure 13. Forward current vs. forward voltage for white, green, cyan, blue and royal blue.

Notes for Figure 13:

1. Driving these high power devices at currents less than the test condition (1000 mA) may produce unpredictable results and may be subject to variation in performance. Pulse width modulation (PWM) is recommended for dimming effects.
2. Luxeon K2 with TFFC is tested and binned at 25°C with a 20ms monopulse test to avoid heating of the junction or case.

Typical Relative Luminous Flux

Relative Luminous Flux vs. Forward Current Junction and Case Temperature = 25°C

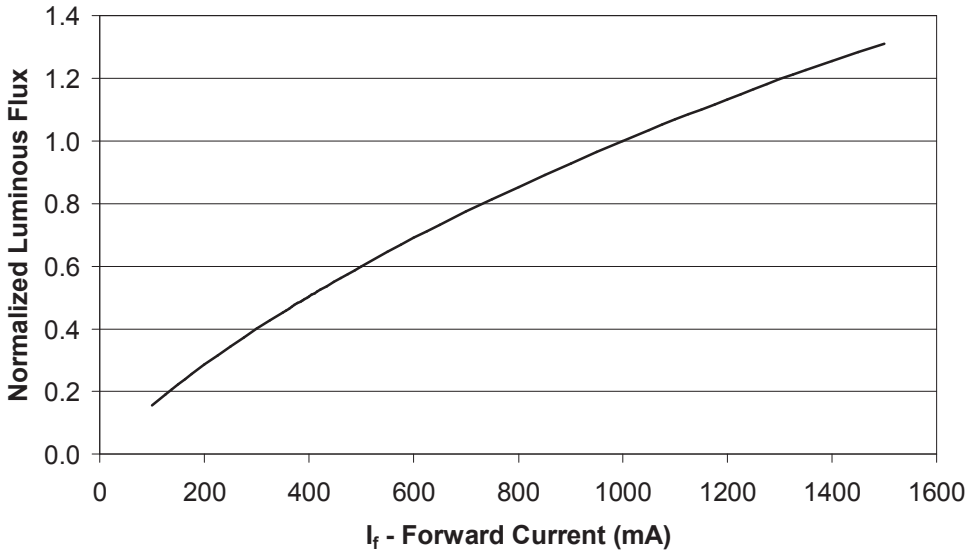


Figure 14. Relative luminous flux or radiometric power vs. forward current for white, green, cyan, blue and royal blue at 20ms monopulse, test current 1000 mA.

Notes for Figure 14:

1. Driving these high power devices at currents less than the test condition (1000 mA) may produce unpredictable results and may be subject to variation in performance. Pulse width modulation (PWM) is recommended for dimming effects.
2. Luxeon K2 with TFFC is tested and binned at 25°C with a 20ms monopulse test to avoid heating of the junction or case.

Current Derating Curves

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

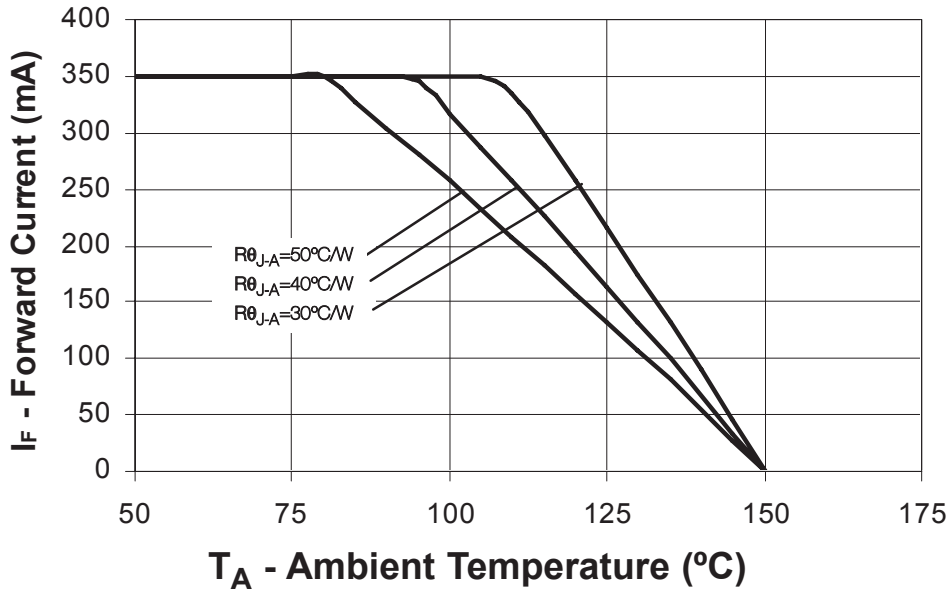


Figure 15: Maximum forward current vs. ambient temperature, based on T_{JMAX} = 150ºC.

Current Derating Curve for 350 mA Drive Current Green, Cyan, Blue and Royal Blue

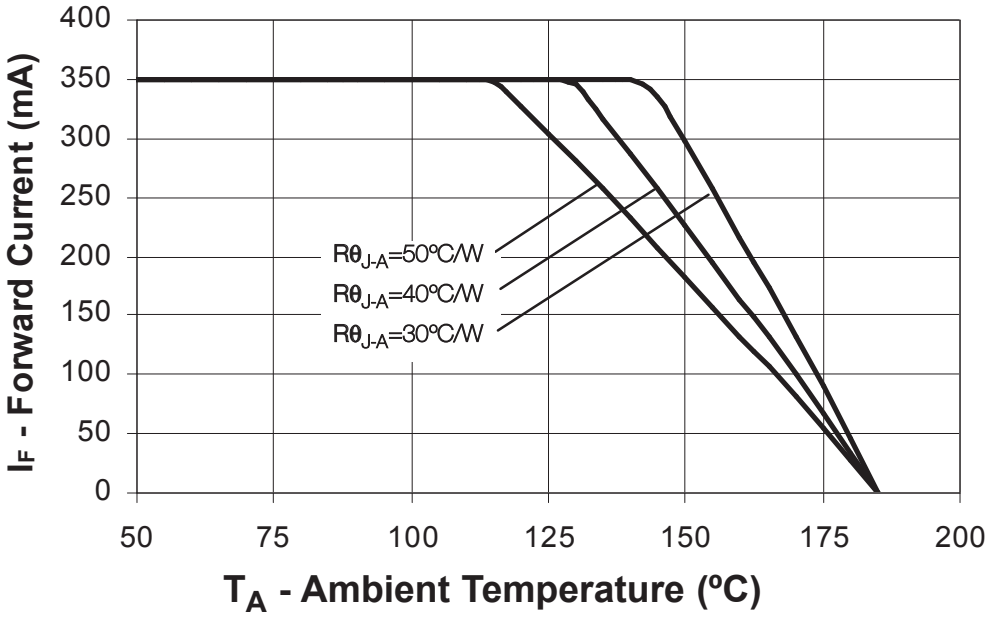


Figure 16: Maximum forward current vs. ambient temperature, based on T_{JMAX} = 185ºC.

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

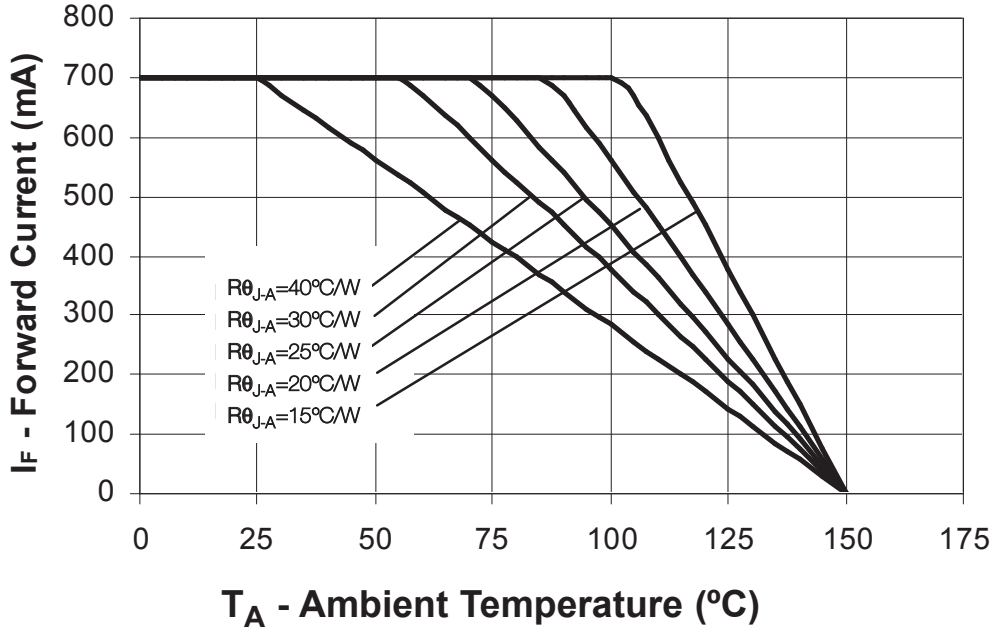


Figure 17: Maximum forward current vs. ambient temperature, based on T_{JMAX} = 150ºC.

Current Derating Curve for 700 mA Drive Current Green, Cyan, Blue and Royal Blue

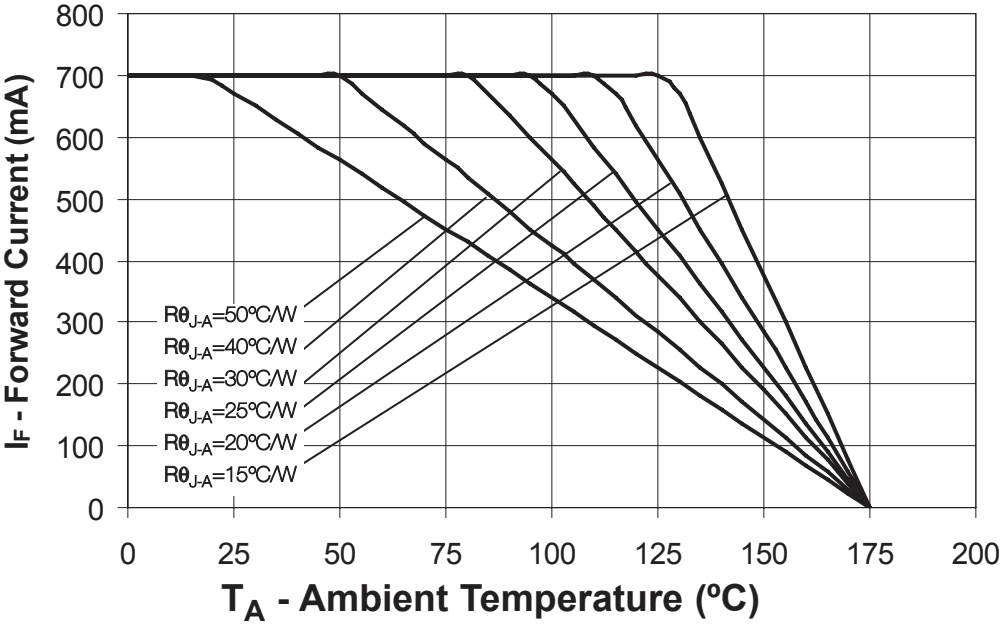


Figure 18: Maximum forward current vs. ambient temperature, based on T_{JMAX} = 175ºC.

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

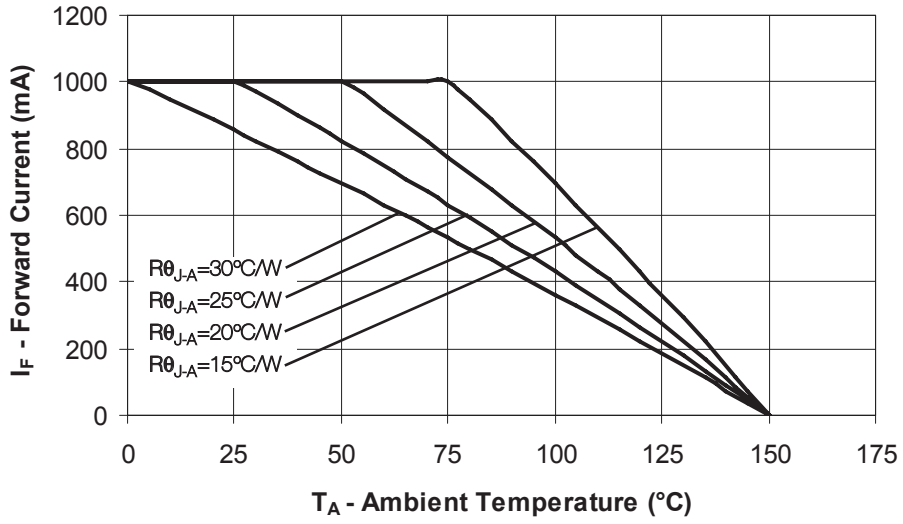


Figure 19: Maximum forward current vs. ambient temperature, based on T_{JMAX} = 150°C.

Current Derating Curve for 1500 mA Drive Current
Cool-White, Neutral-White, Warm-White, Green, Cyan, Blue and Royal Blue

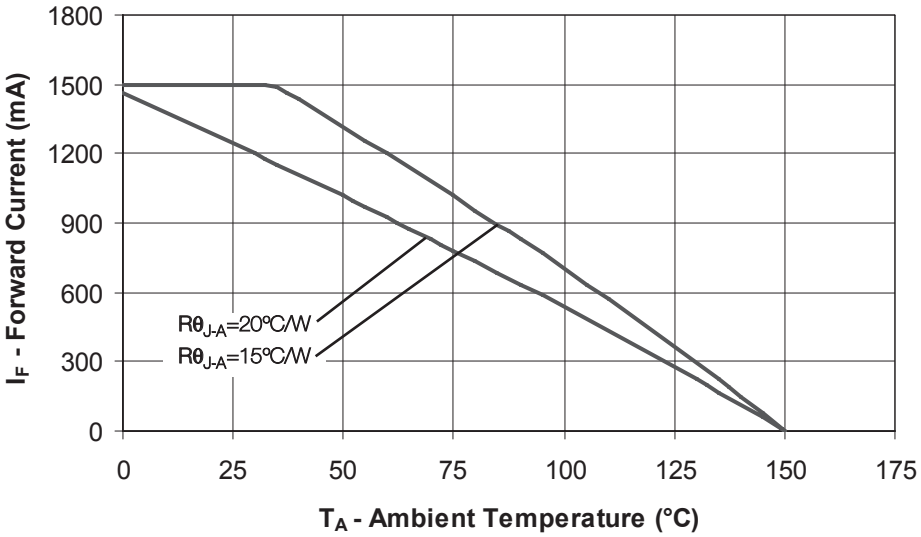


Figure 20: Maximum forward current vs. ambient temperature, based on T_{JMAX} = 150°C.

Typical Radiation Patterns

Typical Representative Spatial Radiation Pattern for White Lambertian

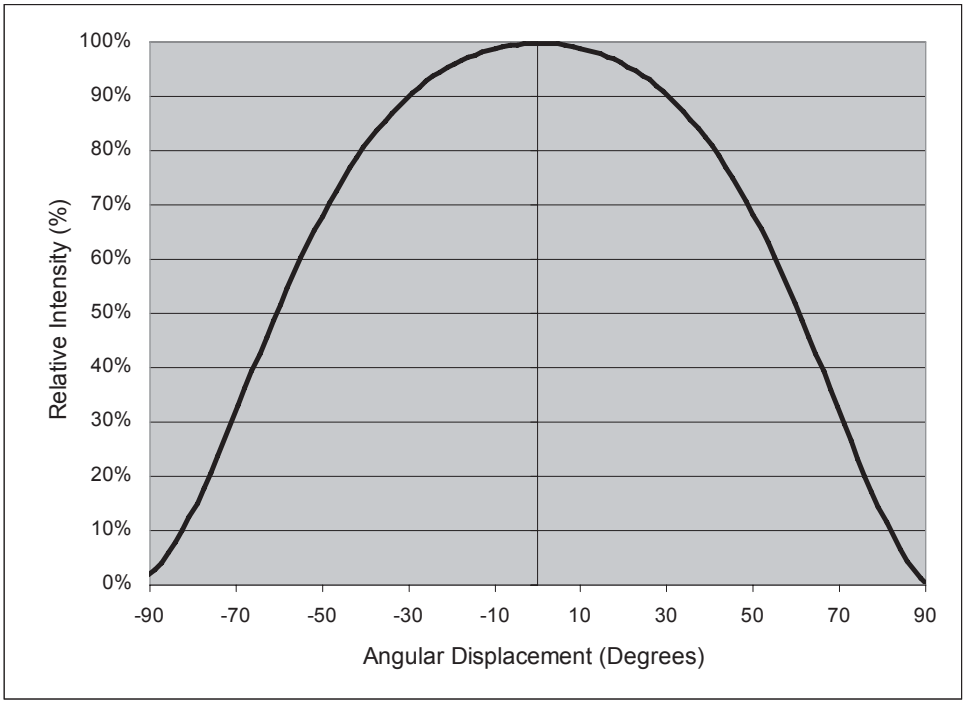


Figure 21: Typical Representative Spatial Radiation Pattern for White Lambertian.

Typical Polar Radiation Pattern for White Lambertian

TBD

Figure 22: Typical Polar Radiation Pattern for White Lambertian.

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

TBD

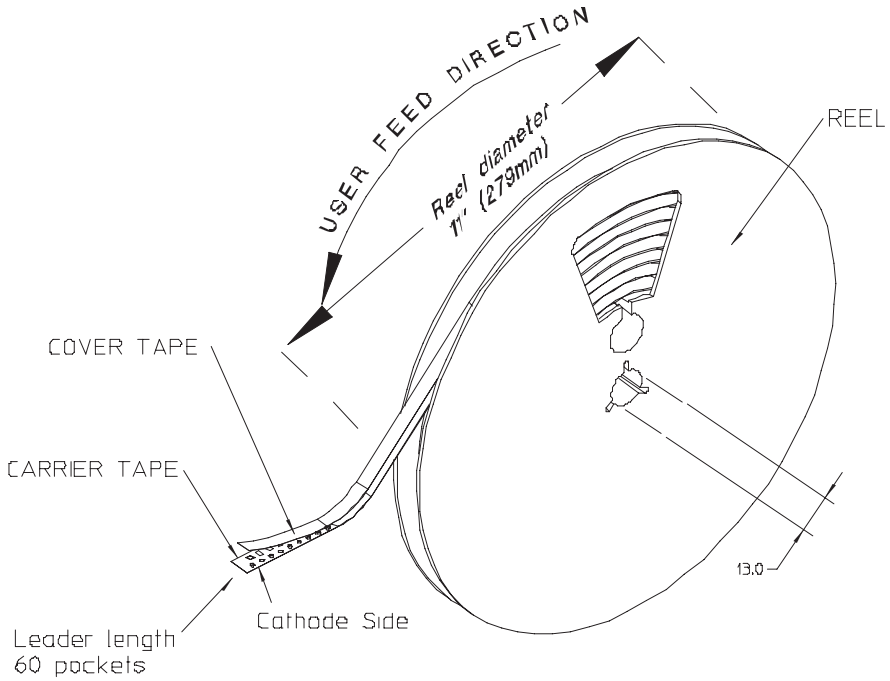
Figure 23: Typical Representative Spatial Radiation Pattern for Green, Cyan, Blue and Royal Blue Lambertian.

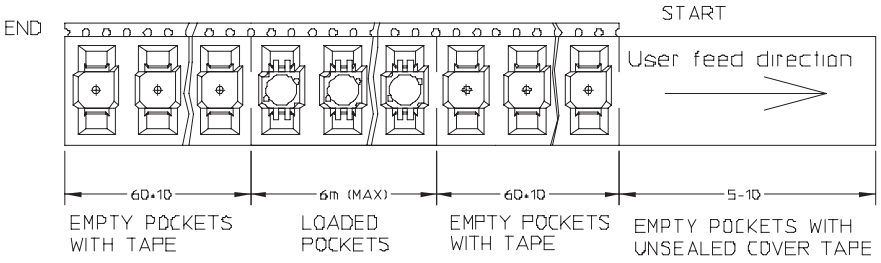
Typical Polar Radiation Pattern for Green, Cyan, Blue and Royal Blue Lambertian

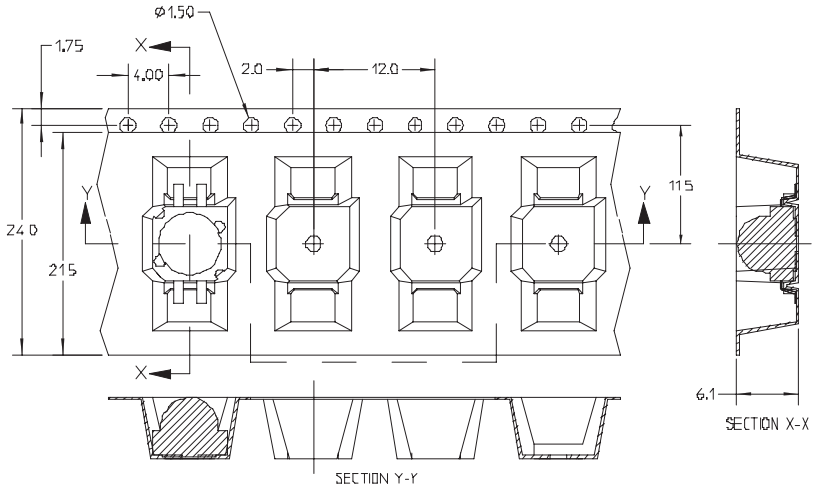
TBD

Figure 24: Typical Polar Radiation Pattern for Green, Cyan, Blue and Royal Blue Lambertian.

Emitter Reel Packaging







Product Binning and Labeling

Purpose of Product Binning

In the manufacturing of semiconductor products, there is a variation of performance around the average values given in the technical data sheets. For this reason, Philips Lumileds bins the LED components for luminous flux, color and forward voltage (V_F).

Decoding Product Bin Labeling

LUXEON K2 with TFFC 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 and Royal-Blue Emitters are labeled with a three digit alphanumeric CAT code following the format below.

ABC

A = Flux bin (J, H, J, K etc.)
B = Color bin (2, 4, 6 etc.)
C = V_F bin (D, E, F, G etc.)

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

ABCD

A = Flux bin (J, H, J, K etc.)
B and C = Color bin (W0, U0, V0 etc.)
C = V_F bin (D, E, F, G etc.)

Luminous Flux Bins

Table 11 lists the standard photometric luminous flux bins for LUXEON K2 with TFFC emitters (at test current).

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 9.

Flux Bins - All Colors (except Royal-Blue)		
Bin Code	Minimum Photometric Flux (lm)	Maximum Photometric Flux (lm)
A	8.2	10.7
B	10.7	13.9
C	13.9	18.1
D	18.1	23.5
E	23.5	30
F	30	40
G	40	50
H	50	60
J	60	70
K	70	80
L	80	90
M	90	100
N	100	120
P	120	140
Q	140	160
R	160	180
S	180	200
T	200	220
U	220	260
V	260	300
W	300	350
X	350	400

Note: Please see Table 1 for binning parameters and tolerances.

Table 10.

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

Forward Voltage Bins

Although several bins are outlined, product availability in a particular bin varies by production run and by product performance.

Table 11.

V_F Bins		
Bin Code	Minimum Forward Voltage (V)	Maximum Forward Voltage (V)
A	2.31	2.55
B	2.55	2.79
C	2.79	3.03
D	3.03	3.27
E	3.27	3.51
F	3.51	3.75
G	3.75	3.99
H	3.99	4.23
J	4.23	4.47
K	4.47	4.71
L	4.71	4.95

Note: Please see Table 4 for more information on Forward Voltage binning.

White Binning Information

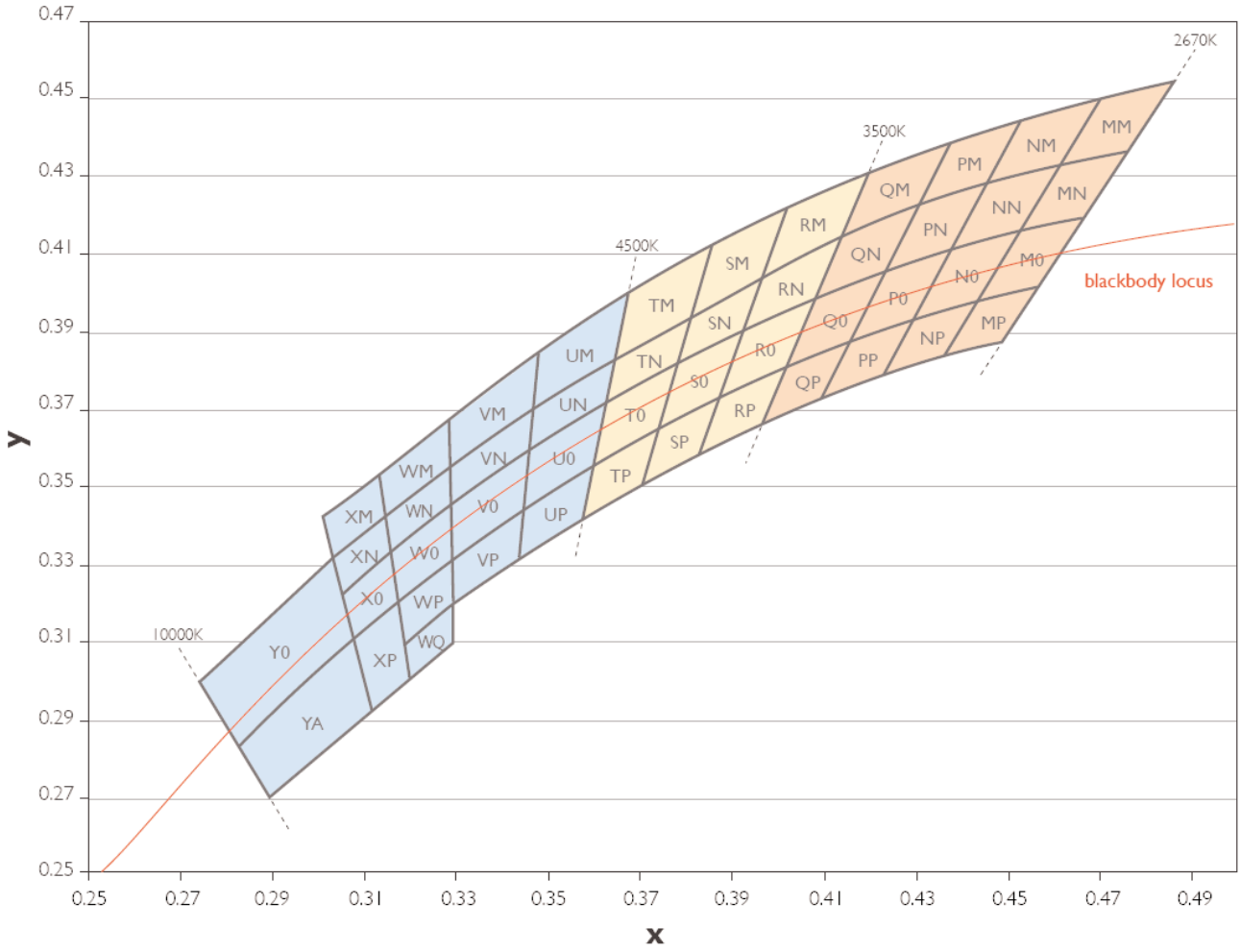


Figure 25: White Binning Structure

LUXEON K2 with TFFC Cool-White Bin Structure

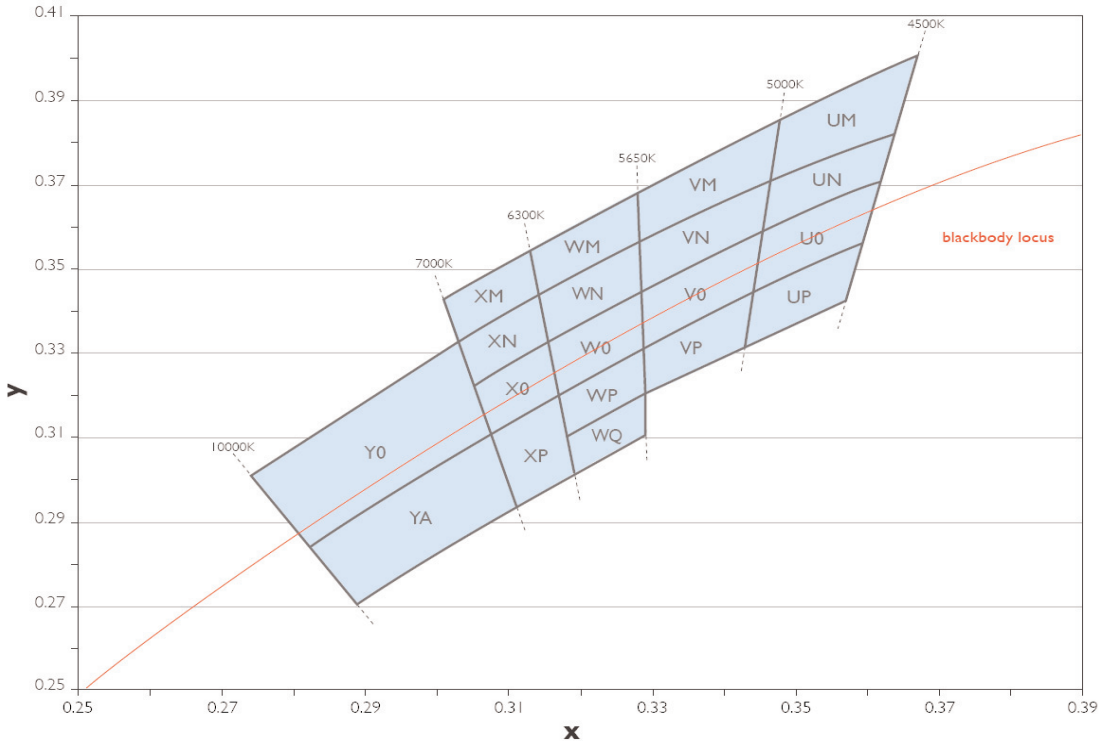


Figure 26: Cool-White Bin Structure

LUXEON K2 with TFFC Cool-White Bin Structure, Continued

Cool-White LUXEON K2 with TFFC Emitters are tested and binned by x,y coordinates.

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

Table 12.

Cool White Bin Structure

Bin Code	X	Y	Typical CCT (K)	Bin Code	X	Y	Typical CCT (K)
Y0	0.274238 0.303051 0.307553 0.282968	0.300667 0.332708 0.310778 0.283772	8000	WQ	0.318606 0.329393 0.329544 0.319597	0.310201 0.320211 0.310495 0.301303	6000
YA	0.282968 0.307553 0.311163 0.289922	0.283772 0.310778 0.293192 0.270316	8000	VM	0.328636 0.348147 0.346904 0.328823	0.368952 0.385629 0.371742 0.356917	5300
XM	0.301093 0.313617 0.314792 0.303051	0.342244 0.354992 0.344438 0.332708	6700	VN	0.328823 0.346904 0.345781 0.329006	0.356917 0.371742 0.359190 0.345092	5300
XN	0.303051 0.314792 0.316042 0.305170	0.332708 0.344438 0.333222 0.322386	6700	V0	0.329006 0.345781 0.344443 0.329220	0.345092 0.359190 0.344232 0.331331	5300
X0	0.305170 0.316042 0.317466 0.307553	0.322386 0.333222 0.320438 0.310778	6700	VP	0.329220 0.344443 0.343352 0.329393	0.331331 0.344232 0.332034 0.320211	5300
XP	0.307553 0.317466 0.319597 0.311163	0.310778 0.320438 0.301303 0.293192	6700	UM	0.348147 0.367294 0.364212 0.346904	0.385629 0.400290 0.382878 0.371742	4750
WM	0.313617 0.328636 0.328823 0.314792	0.354992 0.368952 0.356917 0.344438	6000	UN	0.346904 0.364212 0.362219 0.345781	0.371742 0.382878 0.371616 0.359190	4750
WN	0.314792 0.328823 0.329006 0.316042	0.344438 0.356917 0.345092 0.333222	6000	U0	0.345781 0.362219 0.359401 0.344443	0.359190 0.371616 0.355699 0.344232	4750
W0	0.316042 0.329006 0.329220 0.317466	0.333222 0.345092 0.331331 0.320438	6000	UP	0.344443 0.359401 0.357079 0.343352	0.344232 0.355699 0.342581 0.332034	4750
WP	0.317466 0.329220 0.329393 0.318606	0.320438 0.331331 0.320211 0.310201	6000				

Note for Table 12:

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

LUXEON K2 with TFFC Neutral-White Bin Structure

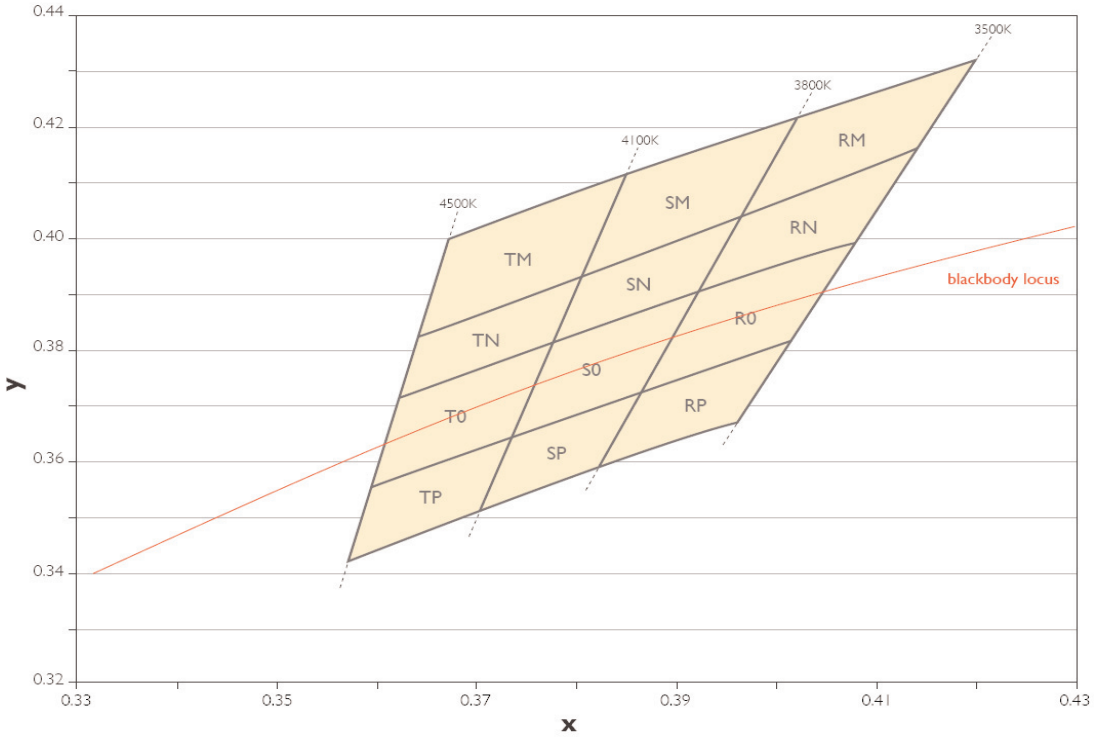


Figure 27: Neutral-White Bin Structure.

LUXEON K2 with TFFC Neutral-White Bin Structure, Continued

Neutral-White LUXEON K2 with TFFC Emitters are tested and binned by x,y coordinates.
12 Color Bins, CCT Range 4,500K to 3,500K

Table 13.

Neutral-White Bin Structure

Bin Code	X	Y	Typical CCT (K)	Bin Code	X	Y	Typical CCT (K)
TM	0.367294 0.385953 0.381106 0.364212	0.400290 0.412995 0.393747 0.382878	4300	S0	0.378264 0.392368 0.387071 0.374075	0.382458 0.390932 0.373899 0.365822	3950
TN	0.364212 0.381106 0.378264 0.362219	0.382878 0.393747 0.382458 0.371616	4300	SP	0.374075 0.387071 0.382598 0.370582	0.365822 0.373899 0.359515 0.351953	3950
T0	0.362219 0.378264 0.374075 0.359401	0.371616 0.382458 0.365822 0.355699	4300	RM	0.402270 0.420940 0.414776 0.396279	0.422776 0.432618 0.416097 0.403508	3650
TP	0.359401 0.374075 0.370582 0.357079	0.355699 0.365822 0.351953 0.342581	4300	RN	0.396279 0.414776 0.408593 0.392368	0.403508 0.416097 0.399525 0.390932	3650
SM	0.385953 0.402270 0.396279 0.381106	0.412995 0.422776 0.403508 0.393747	3950	R0	0.392368 0.408593 0.402113 0.387071	0.390932 0.399525 0.382156 0.373899	3650
SN	0.381106 0.396279 0.392368 0.378264	0.393747 0.403508 0.390932 0.382458	3950	RP	0.387071 0.402113 0.396564 0.382598	0.373899 0.382156 0.367284 0.359515	3650

Note for Table 13:

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

LUXEON K2 with TFFC Warm-White Bin Structure

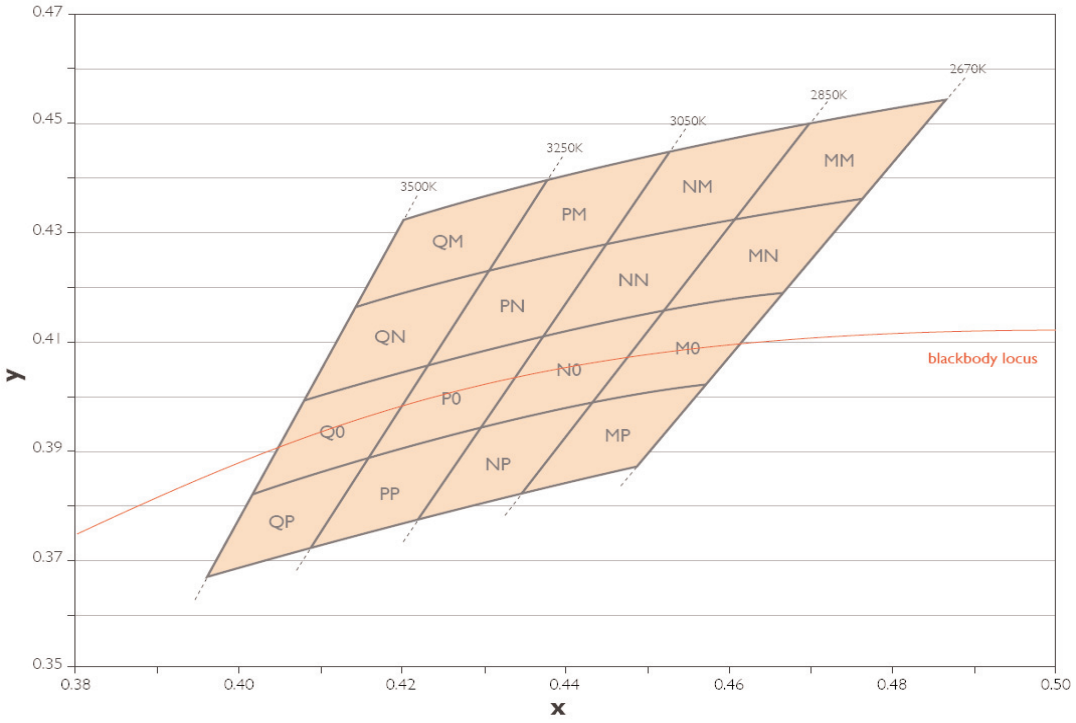


Figure 28: Warm-White Bin Structure.

LUXEON K2 with TFFC Warm-White Bin Structure, Continued

Warm-White LUXEON K2 with TFFC Emitters are tested and binned by x,y coordinates.
16 Color Bins, CCT Range 3,500K to 2,670K

Table 14.

Warm-White Bin Structure

Bin Code	X	Y	Typical CCT (K)	Bin Code	X	Y	Typical CCT (K)
QM	0.420940 0.438458 0.431186 0.414776	0.432618 0.440399 0.423386 0.416097	3375	NM	0.453820 0.470507 0.461404 0.445639	0.445980 0.450832 0.433334 0.428680	2950
QN	0.414776 0.431186 0.423956 0.408593	0.416097 0.423386 0.406472 0.399525	3375	NN	0.445639 0.461404 0.452512 0.437578	0.428680 0.433334 0.416241 0.411632	2950
Q0	0.408593 0.423956 0.416487 0.402113	0.399525 0.406472 0.389001 0.382156	3375	N0	0.437578 0.452512 0.443600 0.429373	0.411632 0.416241 0.399111 0.394281	2950
QP	0.402113 0.416487 0.409996 0.396564	0.382156 0.389001 0.373814 0.367284	3375	NP	0.429373 0.443600 0.435591 0.422124	0.394281 0.399111 0.383714 0.378952	2950
PM	0.438458 0.453820 0.445639 0.431186	0.440399 0.445980 0.428680 0.423386	3150	MM	0.470507 0.486648 0.476733 0.461404	0.450832 0.454191 0.436634 0.433334	2760
PN	0.431186 0.445639 0.437578 0.423956	0.423386 0.428680 0.411632 0.406472	3150	MN	0.461404 0.476733 0.467132 0.452512	0.433334 0.436634 0.419632 0.416241	2760
P0	0.423956 0.437578 0.429373 0.416487	0.406472 0.411632 0.394281 0.389001	3150	M0	0.452512 0.467132 0.457663 0.443600	0.416241 0.419632 0.402866 0.399111	2760
PP	0.416487 0.429373 0.422124 0.409996	0.389001 0.394281 0.378952 0.373814	3150	MP	0.443600 0.457663 0.448994 0.435591	0.399111 0.402866 0.387515 0.383714	2760

Note for Table 14:

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

Color Bins

Dominant Wavelength Bin Structure for Green Emitters

Table 15.

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

Dominant Wavelength Bin Structure for Cyan Emitters

Table 16.

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

Dominant Wavelength Bin Structure for Blue Emitters

Table 17.

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

Peak Wavelength Bin Structure for Royal-Blue Emitters

Table 18.

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

Note: Please see Table 3 for binning parameters and tolerances.

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Company Information

Philips Lumileds Lighting Company is a world class supplier of Light Emitting Diodes (LEDs) and produces billions of LEDs annually. Philips Lumileds is a fully integrated supplier producing core LED material in all three base colors (red, green, blue) and white. Philips Lumileds has R&D centers in San Jose, California and in The Netherlands as well as production capabilities in San Jose, Penang Malaysia and Singapore. Founded in 1999, Philips Lumileds is the high-flux LED technology leader and is dedicated to bridging the gap between solid-state LED technology and the lighting world. Philips Lumileds technologies, LEDs and systems are enabling new applications and markets in the lighting world.

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

NORTH AMERICA:
1 888 589 3662
AMERICAS@FUTURELIGHTINGSOLUTIONS.COM

EUROPE:
00 800 443 88 873
EUROPE@FUTURELIGHTINGSOLUTIONS.COM

ASIA PACIFIC:
800 5864 5337
ASIA@FUTURELIGHTINGSOLUTIONS.COM

JAPAN:
800 5864 5337
JAPAN@FUTURELIGHTINGSOLUTIONS.COM