

CBT-90 LEDs

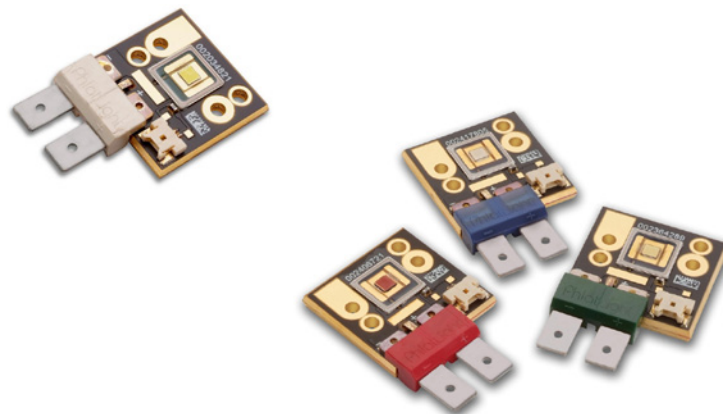


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Features:

- Extremely high optical output:
 - Over 1,800 White Lumens
 - Over 810 Red Lumens
 - Over 1,800 Green lumens
 - Over 450 Blue Lumens
- High thermal conductivity package - junction to heat sink thermal resistance of only 0.9 2°C/W
- Large, monolithic chip with uniform emitting area of 9 mm²
- Unencapsulated die with low profile protective window optimizes optical coupling in extendue-limited applications
- Lumen maintenance of greater than 70% after 60,000 hours
- Variable drive current: less than 1 A through 13.5 A for white and 22.5 A for RGB
- Environmentally friendly: RoHS compliant

Applications

- Fiber-coupled Illumination
- Architectural and Entertainment Lighting
- Medical Lighting
- Machine Vision
- Microscopy
- Displays and Signage
- General Illumination
- Spot Lighting
- Emergency Vehicle Lighting
- Projection Systems

Technology Overview

Luminus Big Chip LEDs™ benefit from a suite of innovations in the fields of chip technology, packaging and thermal management. These breakthroughs allow illumination engineers and designers to achieve solutions that are high brightness and high efficiency.

Photonic Lattice Technology

Luminus' photonic lattice technology enables large area LED chips with uniform brightness over the entire LED chip surface. The optical power and brightness produced by these large monolithic chips enable solutions which replace arc and halogen lamps where arrays of traditional high power LEDs cannot.

For red, green and blue LEDs, the photonic lattice structures extract more light and create radiation patterns that are more collimated than traditional LEDs. Having higher collimation from the source increases optical collection efficiencies and simplifies optical designs.

Packaging Technology

Thermal management is critical in high power LED applications. With a thermal resistance from junction to heat sink of 0.92° C/W, Luminus CBT-90 LEDs have the lowest thermal resistance of any LED on the market. This allows the LED to be driven at higher current densities while maintaining a low junction temperature, thereby resulting in brighter solutions and longer lifetimes.

Reliability

Designed from the ground up, Luminus Big Chip LEDs are one of the most reliable light sources in the world today. Big Chip LEDs have passed a rigorous suite of environmental and mechanical stress tests, including mechanical shock, vibration, temperature cycling and humidity, and have been fully qualified for use in extreme high power and high current applications. With very low failure rates and median lifetimes that typically exceed 60,000 hours, Luminus Big Chip LEDs are ready for even the most demanding applications.

Environmental Benefits

Luminus LEDs help reduce power consumption and the amount of hazardous waste entering the environment. All Big Chip LED products manufactured by Luminus are RoHS compliant and free of hazardous materials, including lead and mercury.

Understanding Big Chip LED Test Specifications

Every Luminus LED is fully tested to ensure that it meets the high quality standards expected from Luminus' products.

Testing Temperature

Luminus core board products are typically measured in such a way that the characteristics reported agree with how the devices will actually perform when incorporated into a system. This measurement is accomplished by mounting the devices on a 40°C heat sink and allowing the device to reach thermal equilibrium while fully powered. Only after the device reaches equilibrium are the measurements taken. This method of measurement ensures that Luminus Big Chip LEDs perform in the field just as they are specified.

Luminus surface mount LEDs are typically tested with a 20mSec input pulse and a junction temperature of 25°C. Expected flux values in real world operation can be extrapolated based on the information contained within this product data sheet.

Multiple Operating Points (3.15 A, 9.0 A, 13.5 A, 22.5 A)

The tables on the following pages provide typical optical and electrical characteristics. Since the LEDs can be operated over a wide range of drive conditions (currents from less than 1A to 22.5A, and duty cycle from <1% to 100%), multiple drive conditions are listed.

CBT-90 White and RGB LEDs are production tested at 9.0 A and 13.5 A respectively. The values shown at other current conditions such as 3.15 A and 22.5 are for additional reference at other possible drive conditions.

CBT-90 White Binning Structure

CBT-90 white LEDs are tested for luminous flux and chromaticity at a drive current of 9.0 A (1.0 A/mm²) and placed into one of the following luminous flux (FF) and chromaticity (WW) bins:

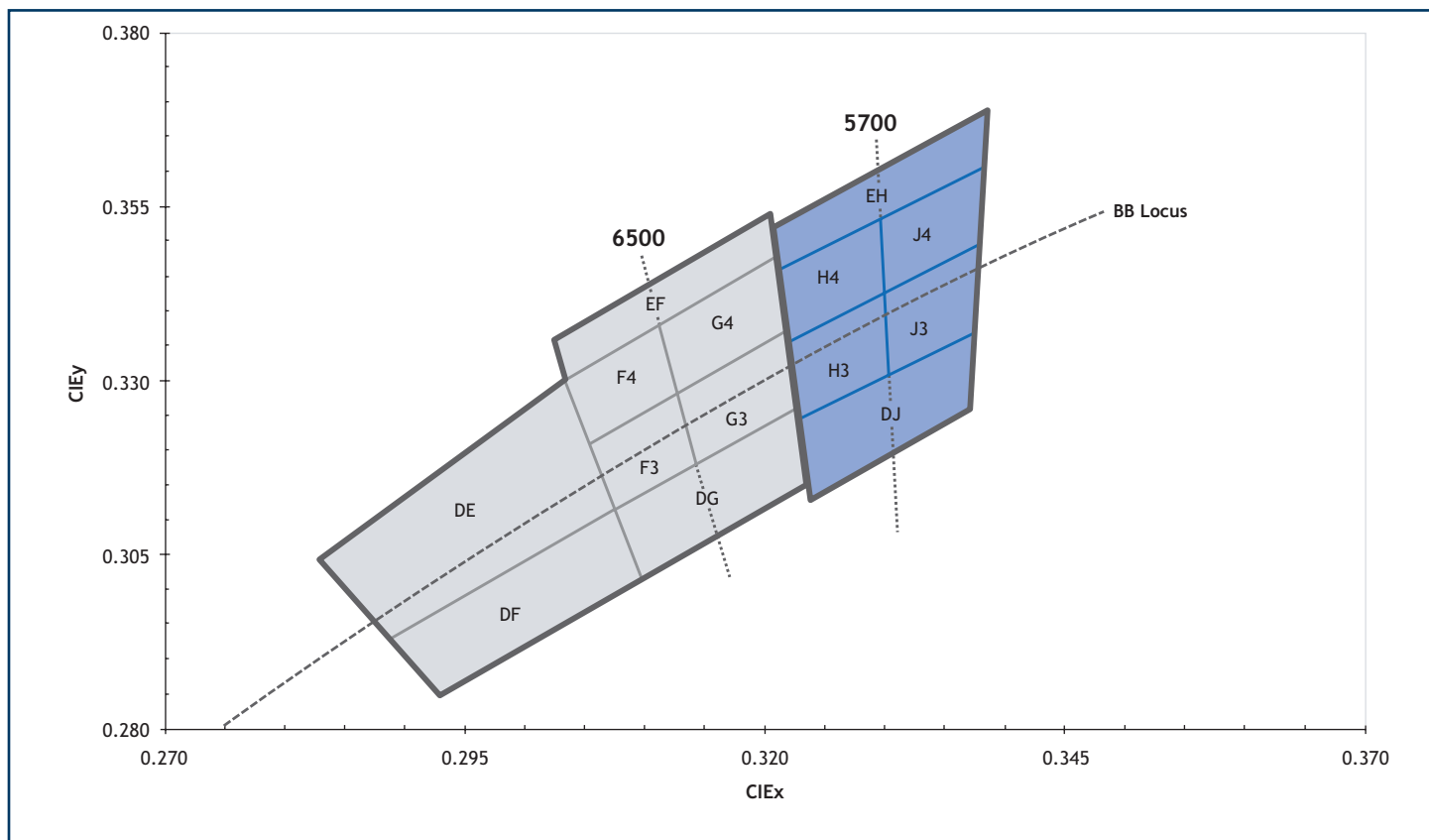
Flux Bins

Color	Flux Bin (FF)	Minimum Flux (lm) at 9.0A	Maximum Flux (lm) at 9.0A
W65S 6500K, Standard CRI (typ. 70)	MA	1,380	1,485
	MB	1,485	1,590
	NA	1,590	1,710

*Note: Luminus maintains a +/- 6% tolerance on flux measurements.

Chromaticity Bins

Luminus' Standard Chromaticity Bins: 1931 CIE Curve



CBT-90 White Chromaticity Bins

The following tables describe the four chromaticity points that bound each chromaticity bin. Chromaticity bins are grouped together based on the color temperature.

6500K Chromaticity Bins		
Bin Code (WW)	CIEx	CIEy
DG	0.307	0.311
	0.322	0.326
	0.323	0.316
	0.309	0.302
F3*	0.305	0.321
	0.313	0.329
	0.315	0.319
	0.307	0.311
F4*	0.303	0.330
	0.312	0.339
	0.313	0.329
	0.305	0.321
G3*	0.313	0.329
	0.321	0.337
	0.322	0.326
	0.315	0.319
G4*	0.312	0.339
	0.321	0.348
	0.321	0.337
	0.313	0.329
EF	0.302	0.335
	0.320	0.354
	0.321	0.348
	0.303	0.330
DE	0.283	0.304
	0.303	0.330
	0.307	0.311
	0.289	0.293
DF	0.289	0.293
	0.307	0.311
	0.309	0.302
	0.293	0.285

5700K Chromaticity Bins		
Bin Code (WW)	CIEx	CIEy
DJ	0.322	0.324
	0.337	0.337
	0.336	0.326
	0.323	0.314
H3*	0.321	0.335
	0.329	0.342
	0.329	0.331
	0.322	0.324
H4*	0.321	0.346
	0.329	0.354
	0.329	0.342
	0.321	0.335
J3*	0.329	0.342
	0.337	0.349
	0.337	0.337
	0.330	0.331
J4*	0.329	0.354
	0.338	0.362
	0.337	0.349
	0.329	0.342
EH	0.320	0.352
	0.338	0.368
	0.338	0.362
	0.321	0.346

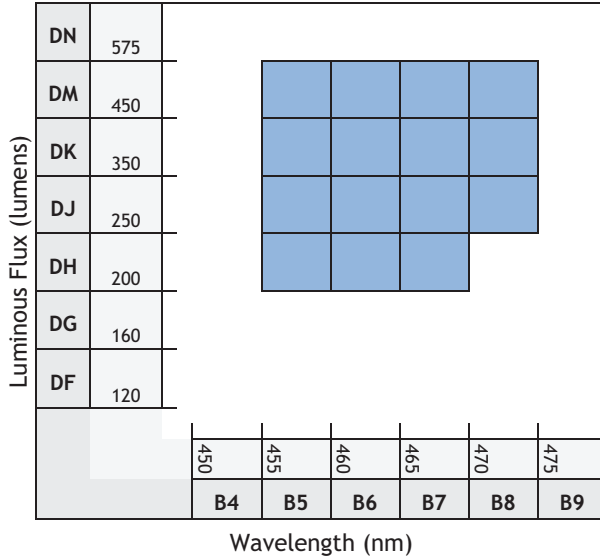
*Sub-bins within ANSI defined quadrangles per ANSI C78.377-2008



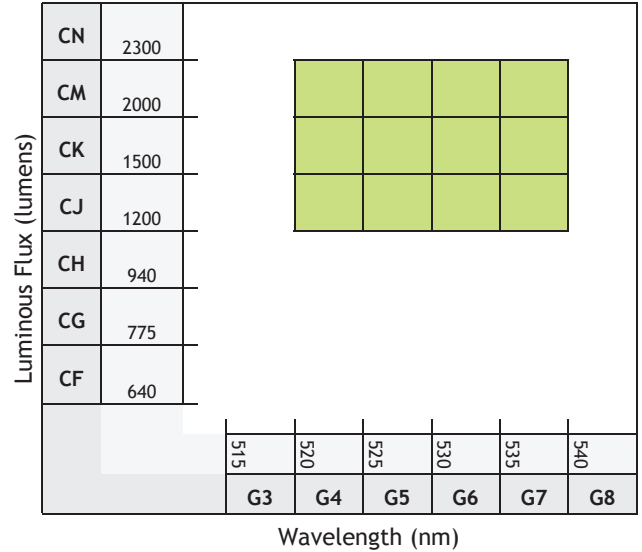
CBT-90 Red/Green/Blue Bin Structure

CBT-90 RGB LEDs are specified for luminous flux and wavelength at a drive current of 13.5 A (1.5 A/mm²) and placed into one of the following luminous flux (FF) and wavelength (WW) bins:

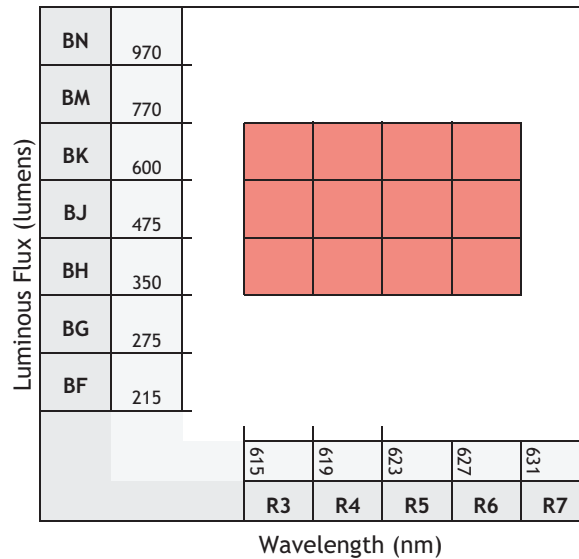
Blue Bins



Green Bins



Red Bins



Note 1: Luminus maintains a +/- 6% tolerance on flux measurements.

Note 2: Only specific bins are available for large orders, contact Luminus sales team for more information.

Product Shipping & Labeling Information

All CBT-90 products are packaged and labeled with their respective bin as outlined in the tables and charts on pages 3, 4, & 5. When shipped, each package will only contain one bin. The part number designation is as follows:

CBT-90 White										
CBT	—	90	—	WNNX	—	C11	—	FF	—	WW
Product Family	Chip Area	Color	Package Configuration	Flux Bin	Chromaticity Bin					
CBT: Chip on Board (window)	90: 9.0 mm ²	CCT & CRI See Note 1 below	Internal Code	See page 3 for bins	See page 4 for bins					

Note 1: WNNX nomenclature corresponds to the following:

W = White

NN = color temperature, where:

65 corresponds to 6500K

X = color rendering index, where:

S (standard) corresponds to a typical CRI of 70

Example 1:

The part label CBT-90-W65S-C11-LA-G4 refers to a 6500K standard CRI white, CBT-90 emitter, with a flux range from 1,200 to 1,290 lumens and a chromaticity value within the box defined by the four points (0.313, 0.329), (0.321, 0.337), (0.321, 0.348), (0.312, 0.339).

CBT-90 Red/Green/Blue											
CBT		—	90	—	X	—	C11	—	FF	—	WW
Product Family	Chip Area	Color		Package Configuration		Flux Bin		Wavelength Bin			
CBT: Chip on Board (window)	90: 9.0 mm ²	R: Red G: Green B: Blue		Internal Code		See page 5 for bins		See page 5 for bins			

Note 2: Some flux and chromaticity/ wavelength bins may have limited availability. Application specific bin kits, consisting of multiple bins, may be available.

For ordering information, please refer to page 17 and reference PDS-001694: CBT-90 Binning & Labeling document.

Example 2:

The part number CBT-90-R-C11-BK-R4 refers to a red, CBT-90 module, with a flux range of 770-970 lumens and a wavelength range of 619 nm to 623 nm.

CBT-90 White Electrical Characteristics¹
Optical and Electrical Characteristics ($T_{\text{heat sink}} = 40^{\circ}\text{C}$)

Drive Condition ²		3.15 A Continuous	9.0 A Continuous	13.5 A Continuous	
Parameter	Symbol	Typical Values at Indicated Current ³	Values at Test Currents	Typical Values at Indicated Current ³	Unit
Current Density	j	0.35	1.0	1.5	A/mm ²
Forward Voltage	$V_{F, \text{min}}$		2.9		V
	$V_{F, \text{typ}}$	3.2	3.6	3.7	V
	$V_{F, \text{max}}$		4.3		V

Common Characteristics

Parameter	Symbol	Values	Unit
Emitting Area		9.0	mm ²
Emitting Area Dimensions		3 x 3	mm×mm
Color Temperature ⁴	CCT	6,500	K
Color Rendering Index (Typical)	R_a	70	
Dynamic Resistance	Ω_{dyn}	0.050	Ω
Forward Voltage Temperature Coefficient ⁴		-5.47	mV/°C

Absolute Maximum Ratings

Parameter	Symbol	Values	Unit
Maximum Current ⁵		18.0	A
Maximum Junction Temperature ⁶	$T_{J-\text{max}}$	150	°C
Storage Temperature Range		-40/+100	°C

Note 1: All ratings are based on operation with a constant heat sink temperature $T_{\text{hs}} = 40^{\circ}\text{C}$. See Thermal Resistance section for T_{hs} definition.

Note 2: Listed drive conditions are typical for common applications. CBT-90 white devices can be driven at currents ranging from 1A to 13.5A and at duty cycles ranging from 1% to 100%. Drive current and duty cycle should be adjusted as necessary to maintain the junction temperature desired to meet application lifetime requirements.

Note 3: Unless otherwise noted, values listed are typical.

Note 4: CCT value based off of CIE measurement. CIE measurement uncertainty for white devices is estimated to be +/- 0.01.

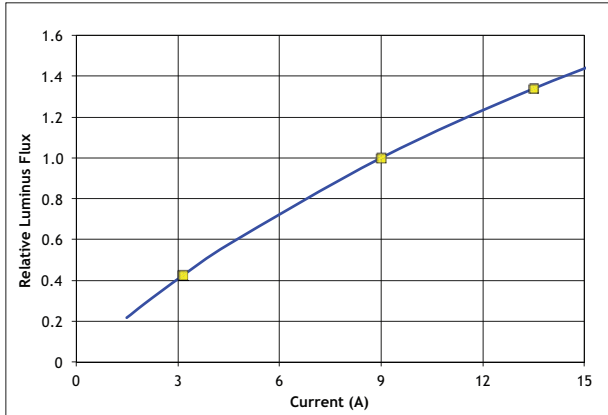
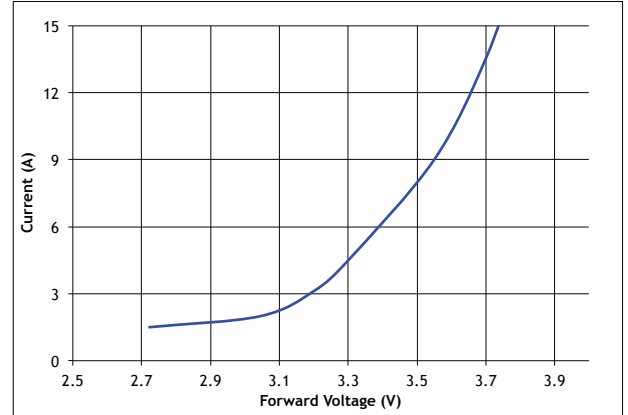
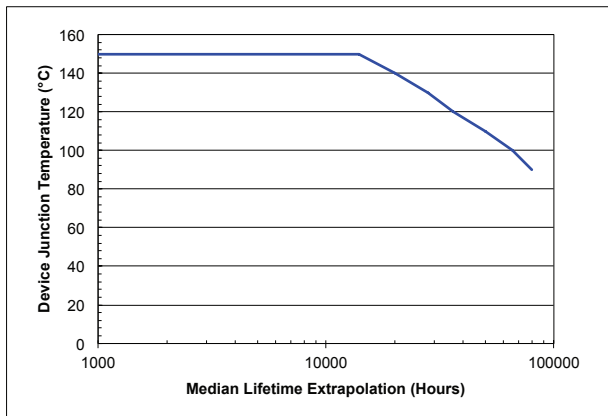
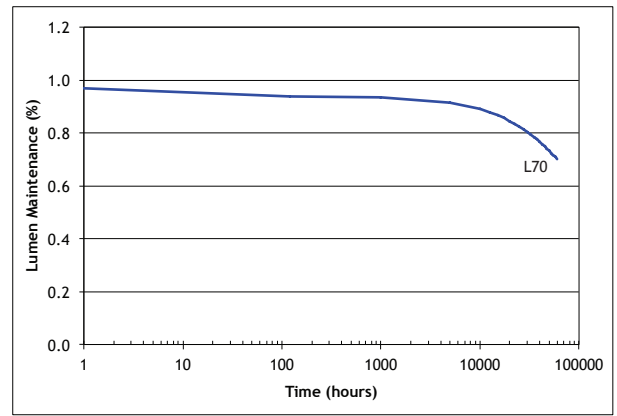
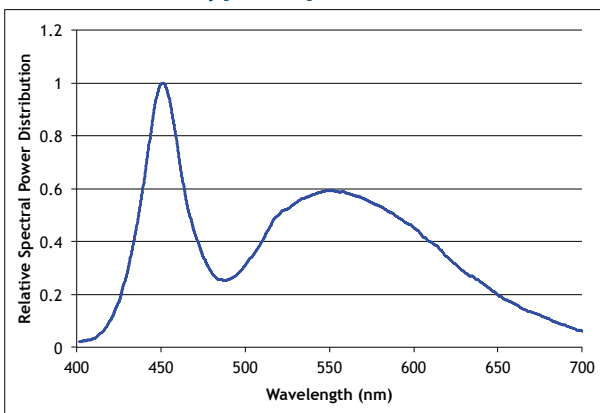
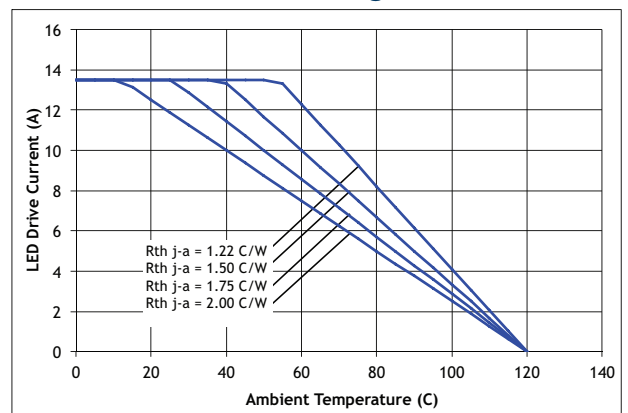
Note 5: Forward voltage temperature coefficient at current density of 1.0 A/mm². Contact Luminus for value at other drive conditions.

Note 6: CBT-90 White LEDs are designed for operation to an absolute maximum forward drive current density of 2.0 A/mm². Product lifetime data is specified at recommended forward drive currents. Sustained operation at absolute maximum currents will result in a reduction of device lifetime compared to recommended forward drive currents. Actual device lifetimes will also depend on junction temperature. Refer to the lifetime derating curves for further information. In pulsed operation, rise time from 10-90% of forward current should be larger than 0.5 microseconds.

Note 7: Lifetime dependent on LED junction temperature. Input power and thermal system must be properly managed to ensure lifetime. See charts on pg 8 for further information.

Note 8: Special design considerations must be observed for operation under 1 A. Please contact Luminus for further information.

Note 9: Caution must be taken not to stare at the light emitted from these LEDs. Under special circumstances, the high intensity could damage the eye.

CBT-90 White Optical & Electrical Characteristics¹
Relative Output Flux vs. Forward Current¹

Forward Current vs. Forward Voltage

Mean Lifetime²

Lumen Maintenance vs. Time³

Typical Spectrum⁴

Current Derating Curve


Note 1: Yellow squares indicate typical operating conditions.

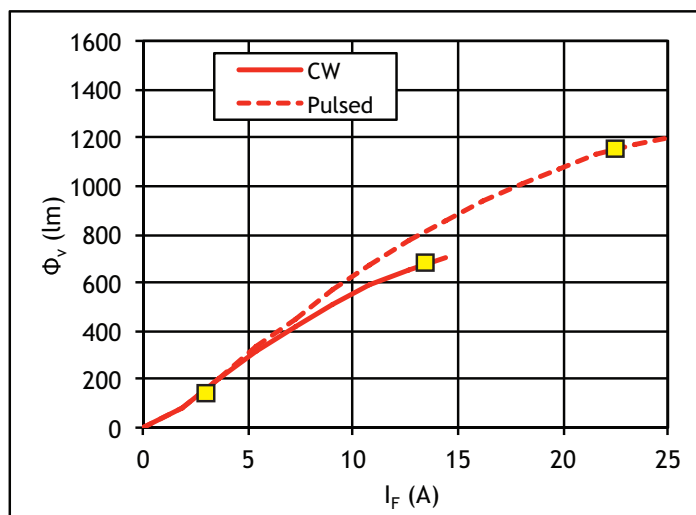
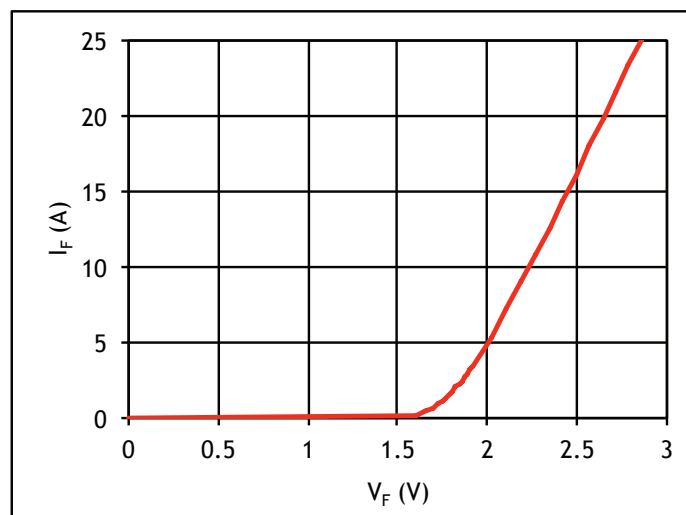
Note 2: Mean expected lifetime in dependence of junction temperature at 1.0 A/mm² in continuous operation. Lifetime defined as time to 70% of initial intensity. Based on lifetime test data. Data can be used to model failure rate over typical product lifetime (contact Luminus for lifetime reliability test data for 1A/mm² condition).

Note 3: Lumen maintenance in dependence of time at 1.0 A/mm² in continuous operation with junction temperatures of 130 °C.

Note 4: Typical spectrum at current density of 1.0 A/mm² in continuous operation.

CBT-90 Red/Green/Blue Optical & Electrical Characteristics
 $(T_{\text{heat sink}} = 40^{\circ}\text{C})^1$

Red					
Drive Condition ²		3.2 A Continuous	13.5 A Continuous	22.5 A Pulsed 50% D.F. ³	
Parameter	Symbol	Values ⁴			Unit
Current Density	J	0.35	1.5	2.5	A/mm ²
Forward Voltage	V _F min		2.0		V
	V _f	1.8	2.4	2.7	V
	V _F max		3.0		V
Luminous Flux ⁵	$\Phi_{V\text{typ}}$	170	650	1150	lm
Radiometric Flux	Φ_R	TBD	3.9	TBD	W
Luminous Efficacy	η	26	20	18	lm/W
Dominant Wavelength ⁶	λ_d	624	624	623	nm
Peak Wavelength	λ_p	625	628	629	nm
FWHM	$\Delta\lambda_{1/2}$	16	19	20	nm
Chromaticity Coordinates ^{7,8}	x	0.695	0.699	0.702	-
	y	0.305	0.301	0.298	-

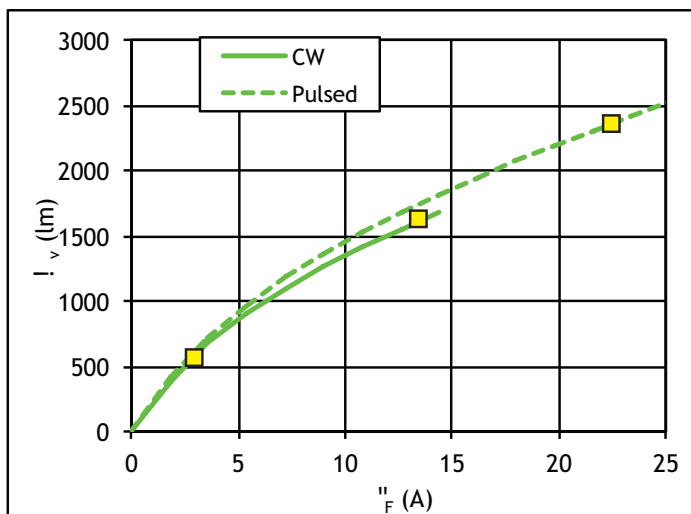
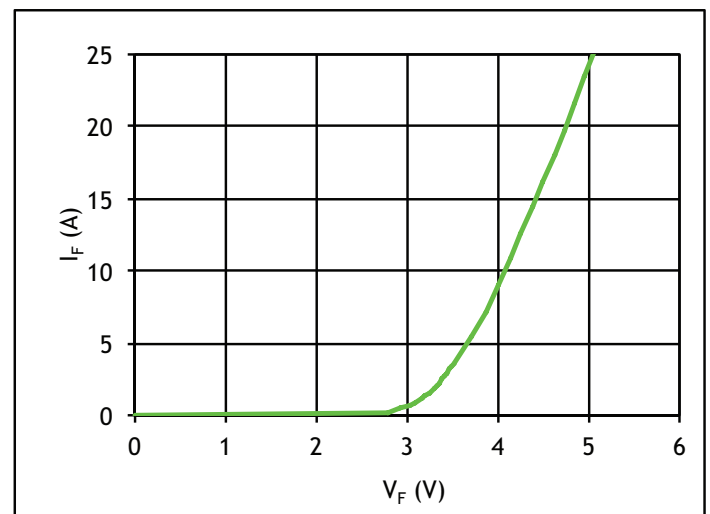
Relative Output Flux vs. Forward Current¹

Forward Current vs. Forward Voltage


Yellow squares indicate reference drive conditions

Notes: See page 12

CBT-90 Red/Green/Blue Optical & Electrical Characteristics
 $(T_{\text{heat sink}} = 40^{\circ}\text{C})^1$

Green					
Drive Condition ²		3.2 A Continuous	13.5 A Continuous	22.5 A Pulsed 50% D.F. ³	
Parameter	Symbol	Values ⁴			Unit
Current Density	J	0.35	1.5	2.5	A/mm ²
Forward Voltage	V _F min		3.6		V
	V _F	3.5	4.3	4.9	V
	V _F max		5.3		V
Luminous Flux ⁵	Φ _v	600	1,650	2,350	lm
Radiometric Flux	Φ _r	TBD	3.7	TBD	W
Luminous Efficacy	η	55	28	21	lm/W
Dominant Wavelength ⁶	λ _d	535	529	526	nm
Peak Wavelength	λ _p	530	524	521	nm
FWHM	Δλ _{1/2}	35	39	40	nm
Chromaticity Coordinates ^{7,8}	x	0.205	0.175	0.161	-
	y	0.740	0.730	0.722	-

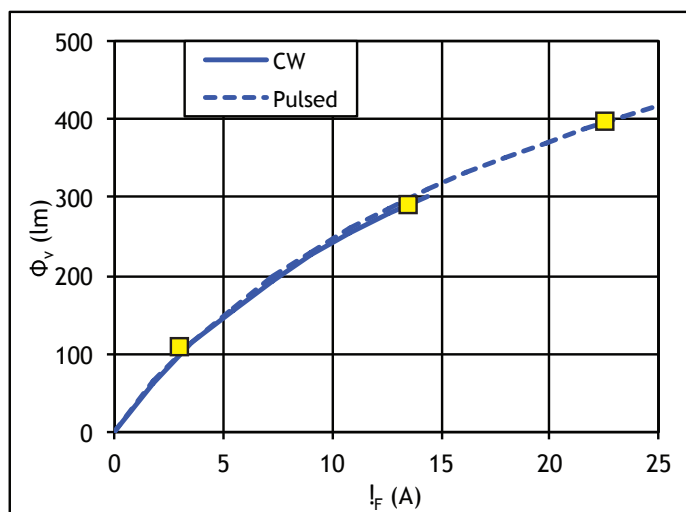
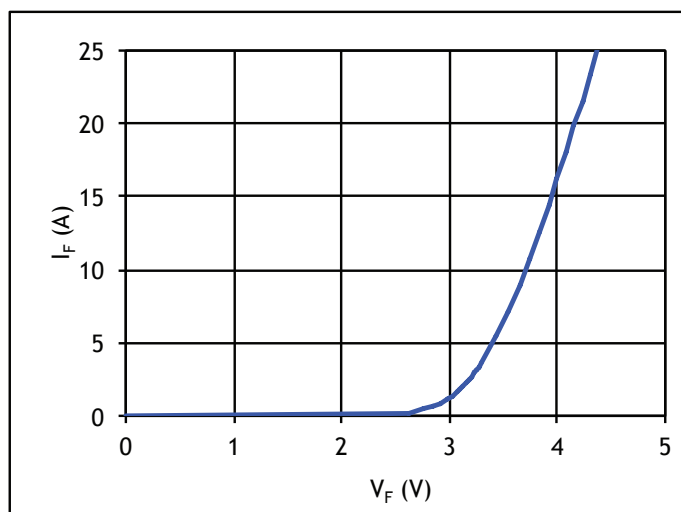
Relative Output Flux vs. Forward Current¹

Forward Current vs. Forward Voltage


Yellow squares indicate reference drive conditions

Notes: See page 12

CBT-90 Red/Green/Blue Optical & Electrical Characteristics
 $(T_{\text{heat sink}} = 40^{\circ}\text{C})^1$

Blue					
Drive Condition ²		3.2 A Continuous	13.5 A Continuous	22.5 A Pulsed 50% D.F. ³	
Parameter	Symbol	Values ⁴			Unit
Current Density	J	0.35	1.5	2.5	A/mm ²
Forward Voltage	$V_{F \min}$		3.2		V
	V_f	3.4	3.9	4.5	V
	$V_{F \max}$		4.8		V
Luminous Flux ⁵	$\Phi_{V \text{ typ}}$	100	310	400	lm
Radiometric Flux	Φ_r	TBD	6.7	TBD	W
Luminous Efficacy	η	11	6	5	lm/W
Dominant Wavelength ⁶	λ_d	464	464	462	nm
Peak Wavelength	λ_p	459	460	460	nm
FWHM	$\Delta\lambda_{1/2}$	22	25	27	nm
Chromaticity Coordinates ^{7,8}	x	0.142	0.142	0.142	-
	y	0.036	0.038	0.038	-

Relative Output Flux vs. Forward Current¹

Forward Current vs. Forward Voltage


Yellow squares indicate reference drive conditions

Notes: See page 12

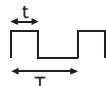
CBT-90 Red/Green/Blue Reference Optical & Electrical Characteristics ($T_{\text{heat sink}} = 40^{\circ}\text{C}$)¹
Common Characteristics

	Symbol	Red	Green	Blue	Unit
Emitting Area		9.0	9.0	9.0	mm ²
Emitting Area Dimensions		3.0x3.0	3.0x3.0	3.0x3.0	mmxmm
Dynamic Resistance	Ω_{dyn}	0.03	0.04	0.02	Ω
Thermal Coefficient of Photometric Flux		-0.96	-0.18	-0.007	%/ °C
Thermal Coefficient of Radiometric Flux		-0.52	-0.20	-0.17	%/ °C
Thermal Coefficient of Junction Voltage		-1.3	-4.6	-3.5	mV/ °C

	Symbol	Red	Green	Blue	Unit
Maximum Current		27	27	27	A
Maximum Junction Temperature	T_{jmax}	125	150	150	°C
Storage Temperature Range		-40/+100	-40/+100	-40/+100	°C

Note 1: All ratings are based on operation with a constant heat sink temperature $T_{\text{hs}} = 40^{\circ}\text{C}$. See Thermal Resistance section for T_{hs} definition.

Note 2: Listed drive conditions are typical for common applications. CBT-90 RGB devices can be driven at currents ranging from <1 A to 13.5 A and at duty cycles ranging from 1% to 100%. Drive current and duty cycle should be adjusted as necessary to maintain the junction temperature desired to meet application lifetime requirements.

Note 3: Current Density of 2.5 A/mm². Rated at 50% duty cycle and Pulsed operation frequency of $f > 360\text{Hz}$; $DC = \frac{t}{T}$ 

Note 4: Unless otherwise noted, values listed are typical. Devices are production tested and specified at 13.5 A. Values at 3.2 A and 22.5 A are for reference only.

Note 5: Total flux from emitting area at listed dominant wavelength. Reported performance is included to show trends for a selected power level. For specific minimum and maximum values, use bin tables. For product roadmap and future performance of devices, contact Luminus.

Note 6: Minimum and Maximum Dominant Wavelengths are based on typical values +/- 5nm for Red, +/- 8nm for Green and +/- 6nm for Blue.

Note 7: In CIE 1931 chromaticity diagram coordinates, normalized to $X+Y+Z=1$.

Note 8: For reference only.

Note 9: CBT-90 RGB LEDs are designed for operation to an absolute maximum current as specified above. Product lifetime data is specified at recommended forward drive currents. Sustained operation at or beyond absolute maximum currents will result in a reduction of device lifetime compared to recommended forward drive currents. Actual device lifetimes will also depend on junction temperature. Refer to the lifetime derating curves for further information. In pulsed operation, rise time from 10-90% of forward current should be larger than 0.5 microseconds.

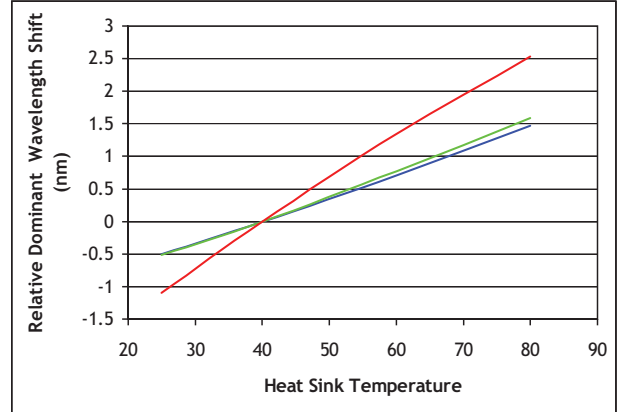
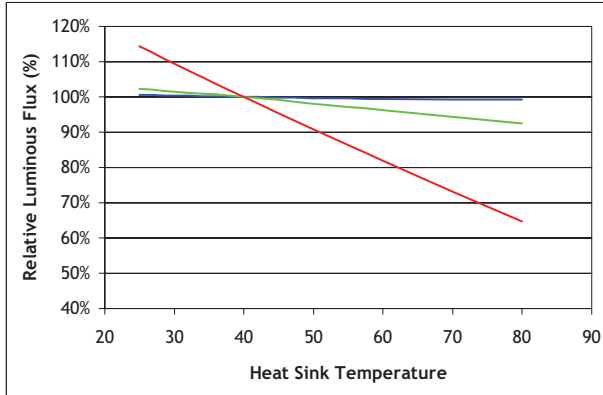
Note 10: Lifetime dependent on LED junction temperature. Input power and thermal system must be properly managed to ensure lifetime. See charts on pg 13 for further information.

Note 11: Special design considerations must be observed for operation under 1 A. Please contact Luminus for further information.

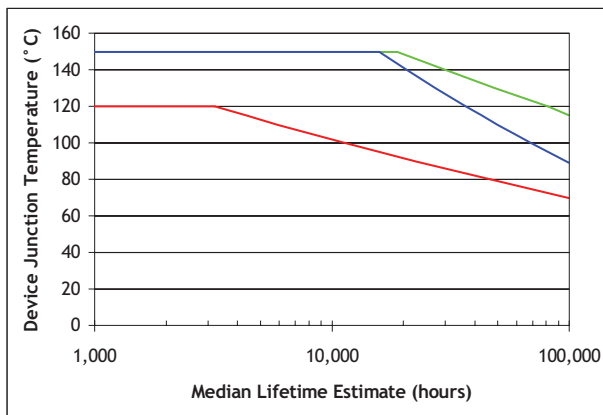
Note 12: Caution must be taken not to stare at the light emitted from these LEDs. Under special circumstances, the high intensity could damage the eye.

CBT-90 Red/Green/Blue Electrical Characteristics

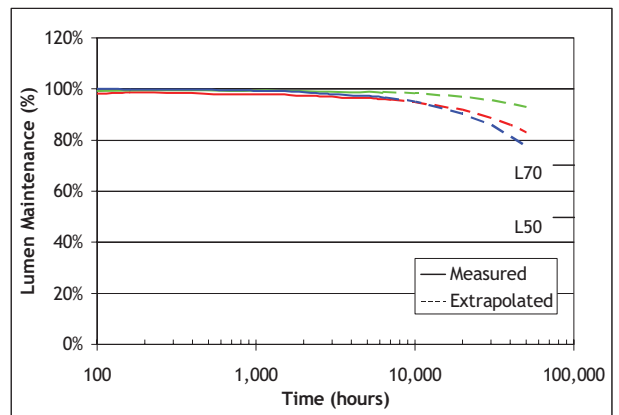
Light Output and Spectral Characteristics Over Heat Sink Temperature



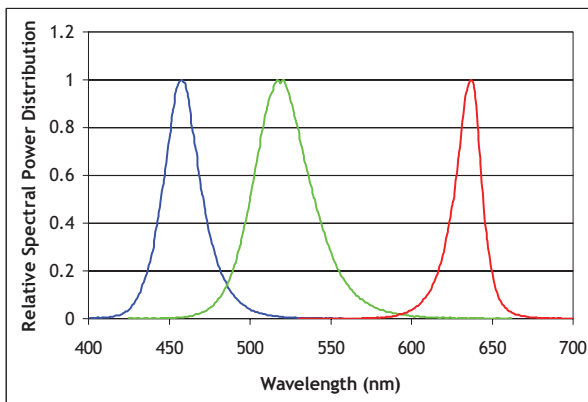
Median Lifetime Estimate vs. T_j^{13}



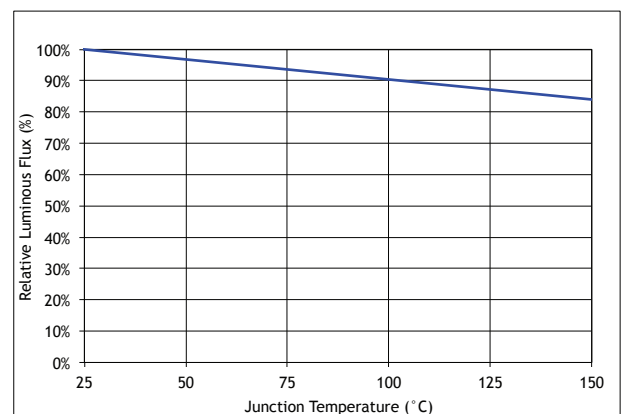
Lumen Maintenance¹⁴



Typical Spectrum¹⁵



Luminous Flux vs. Junction Temp



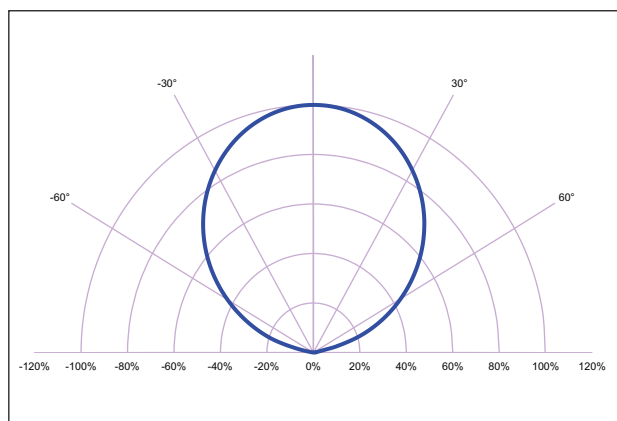
Note 13. Median lifetime estimate as a function of junction temperature at 0.35A/mm^2 in continuous operation. Lifetime defined as time to 70% of initial intensity. Based on preliminary lifetime test data. Data can be used to model failure rate over typical product lifetime.

Note 14. Lumen maintenance vs. time at 0.35A/mm^2 in continuous operation, Red junction temperature of 70°C , Green junction temperatures of 120°C , Blue junction temperatures of 100°C .

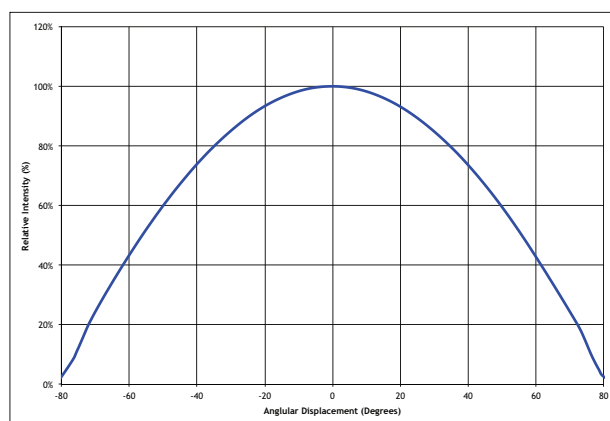
Note 15. Typical spectrum at current density of 0.35A/mm^2 in continuous operation.

Typical Radiation Patterns

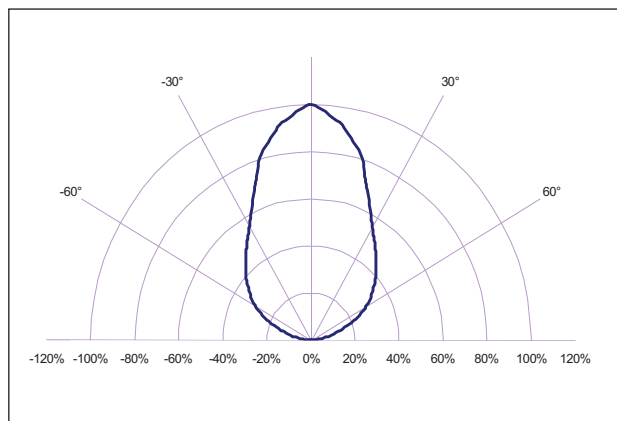
Typical Polar Radiation Pattern for White



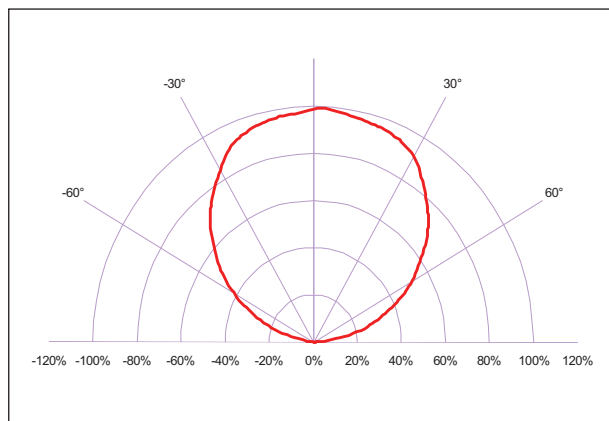
Typical Angular Radiation Pattern for White



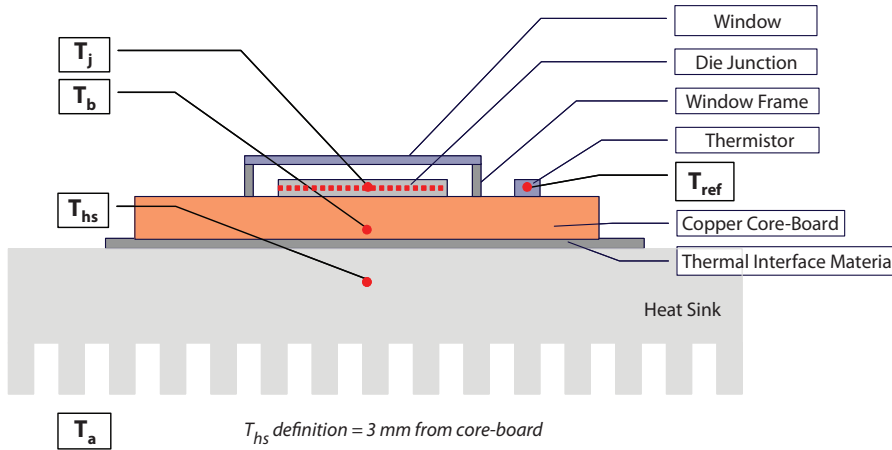
Typical Polar Radiation Pattern for Blue and Green



Typical Polar Radiation Pattern for Red



Thermal Resistance



Typical Thermal Resistance

$R_{\theta j-b}^1$	0.80 °C/W
$R_{\theta b-hs}^1$	0.12 °C/W
$R_{\theta j-hs}^2$	0.92 °C/W
$R_{\theta j-ref}^1$	0.83 °C/W

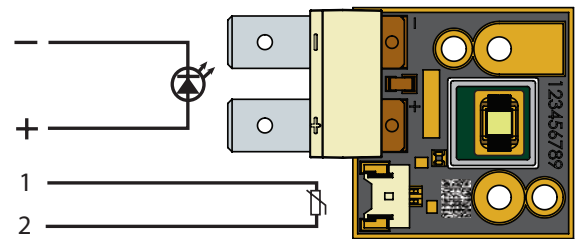
Note 1: Thermal resistance values are based on FEA model results correlated to measured $R_{\theta j-hs}$ data.

Note 2: Thermal resistance is measured using eGraf 1205 thermal interface material.

Thermistor Information

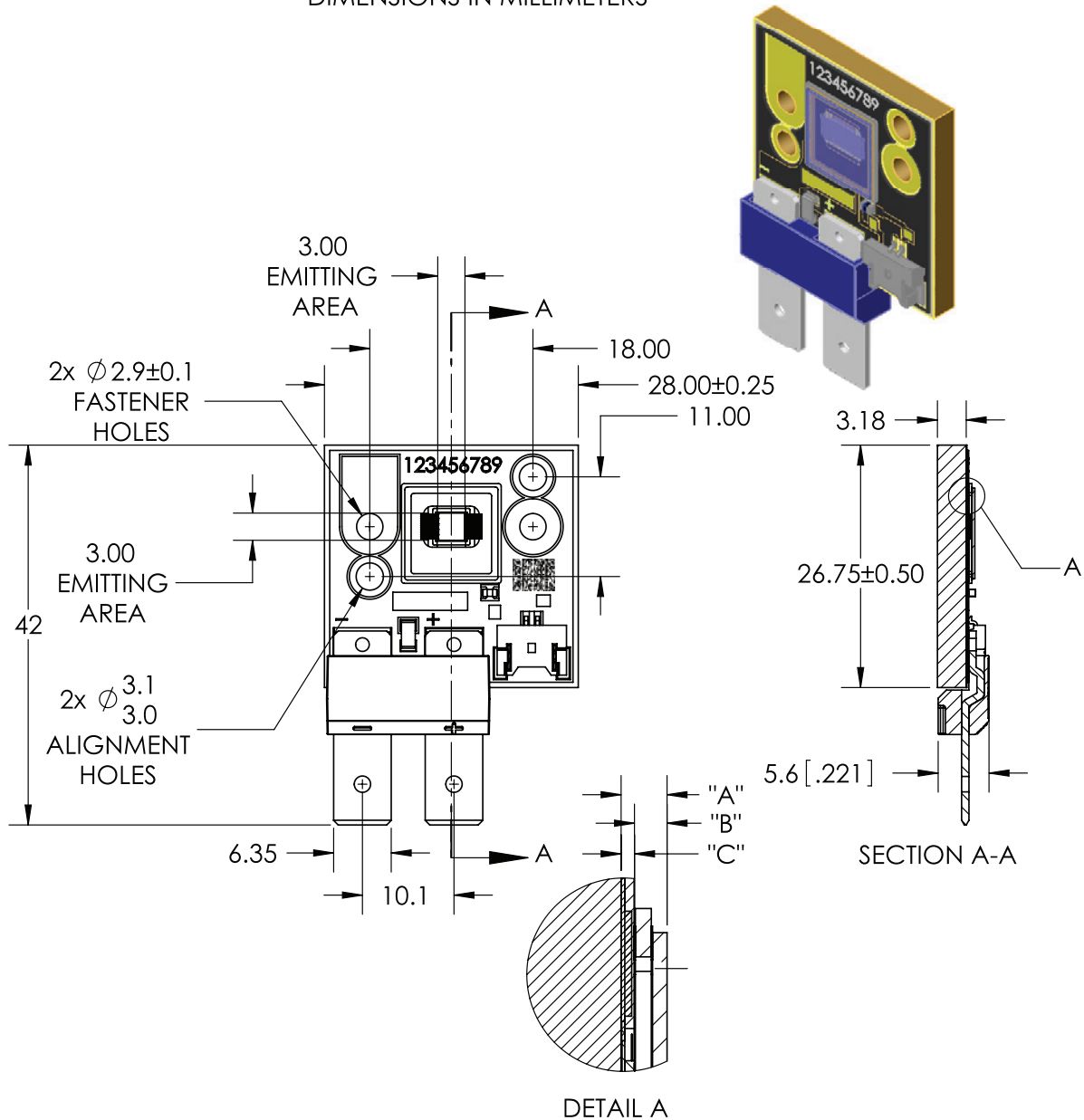
The thermistor used in CBT-90 LEDs mounted on core-boards is from Murata Manufacturing Co. The global part number is NCP15XH103J03RC. Please see <http://www.murata.com/> for details on calculating thermistor temperature.

Electrical Pinout



Mechanical Dimensions – CBT-90 Emitter

DIMENSIONS IN MILLIMETERS



DIMENSION NAME	DESCRIPTION	NOMINAL DIMENSION	TOLERANCE
"A"	TOP OF METAL SUBSTRATE TO TOP OF GLASS	0.95	±0.13
"B"	EMITTING AREA TO TOP OF GLASS	0.67	±0.16

Recommended connector for Anode and Cathode: Panduit Disco Lok™ Series P/N: DNG14-250FL-C
 Thermistor Connector: MOLEX P/N 53780-0270. Recommended Female: MOLEX P/N 51146-0200 or equivalent
 For detailed drawing please refer to DWG-001216 document

Ordering Information

Ordering Part Number ^{1,2}	Color	Description
CBT-90-W65S-C11-MA100	6500K White	White Big Chip LED™ CBT-90 consisting of a 9 mm ² LED, thermistor, and connector, mounted on a copper-core PCB
CBT-90-R-C11-HG100	Red	Red Big Chip LED™ CBT-90 consisting of 9 mm ² LED, thermistor, and connector, mounted on a copper-core PCB.
CBT-90-G-C11-JG200	Green	Green Big Chip LED™ CBT-90 consisting of 9 mm ² LED, thermistor, and connector, mounted on a copper-core PCB.
CBT-90-B-C11-KF300	Blue	Blue Big Chip LED™ CBT-90 consisting of 9 mm ² LED, thermistor, and connector, mounted on a copper-core PCB.

Note 1: MA100 - denotes a bin kit comprising of all flux bins with a minimum flux of 1,380 lumens and chromaticity bins at the 6500K color point.

*Note 2: HG100 - denotes a bin kit comprising of all red flux and wavelength bins as specified on page 5.
 JG200 - denotes a bin kit comprising of all green flux and wavelength bins as specified on page 5
 KF300 - denotes a bin kit comprising of all blue flux and wavelength bins as specified on page 5.*

Note 3: For ordering information on all available bin kits, please reference PDS-001694: CBT-90 Binning & Labeling document.

Note 4: Standard packaging increment (SPI) is 10.

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