CBT-90 LEDs

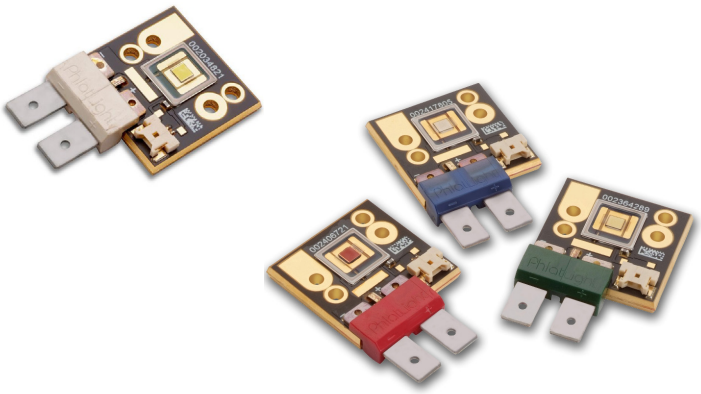

Table of Contents

Features:

- Extremely high optical output:
  Over 2,250 White Lumens
  Over 810 Red Lumens
  Over 1,800 Green lumens
  Over 650 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 mm^2
- Unencapsulated die with low profile protective window optimizes optical coupling in etendue-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

PDS-001230 Rev 09

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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.

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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/mm^2) and placed into one of the following luminous flux (FF) and chromaticity (WW) bins:

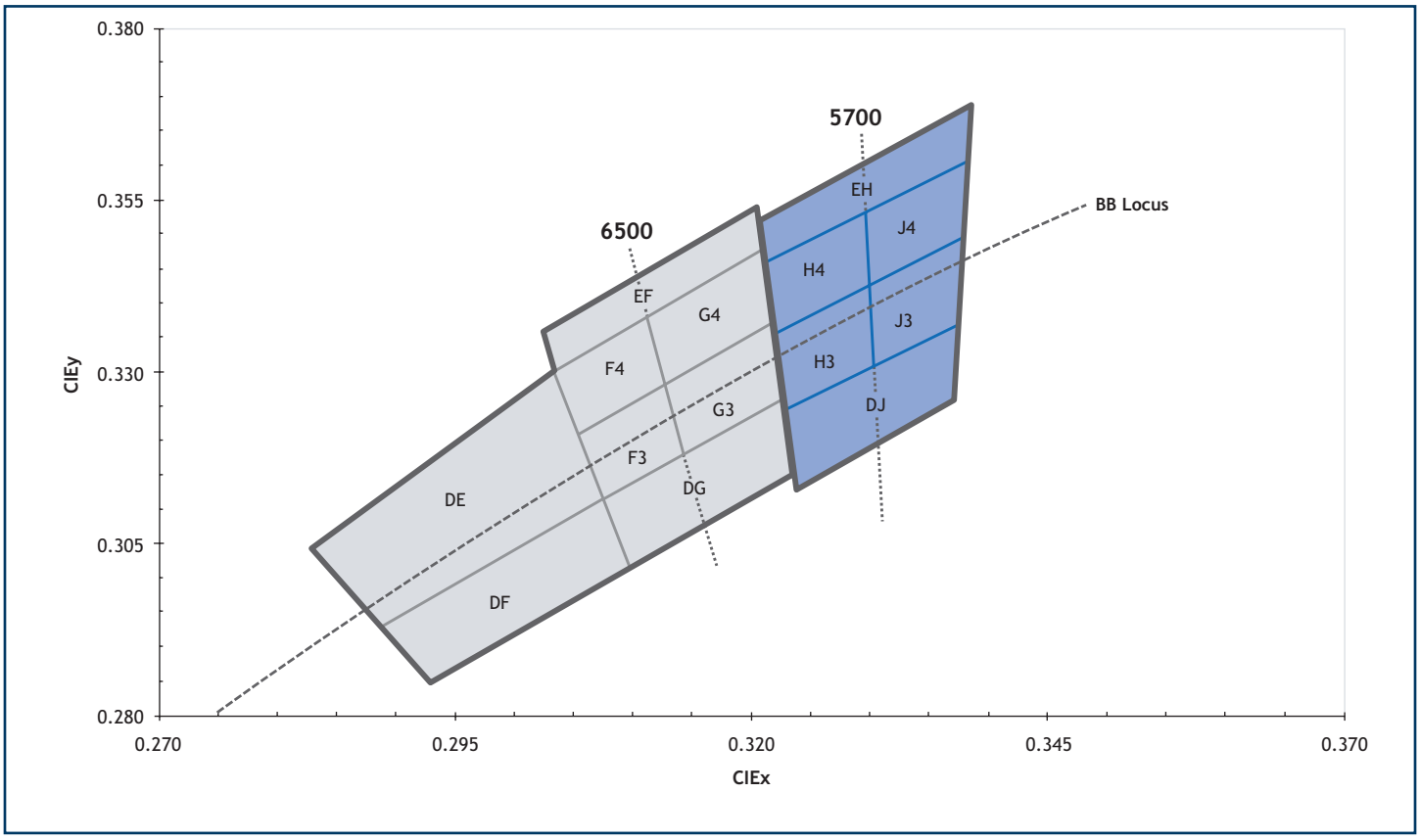
Flux Bins

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
W57H 5700K, High CRI (typ. 92)	KA	1,080	1,120
	KB	1,120	1,200
	LA	1,200	1,290

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

Chromaticity Bins

Luminus' Standard Chromaticity Bins: 1931 CIE Curve



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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

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CBT-90 Red/Green/Blue Bin Structure

All CBT-90 monochromatic LEDs are tested for luminous flux/ dominant wavelength and placed into one of the following flux/ wave length bins. The binning structure is universally applied across each monochromatic color of the CBT-90 product line. Consult the local sales person for the available flux/ wavelength bins for the product:

Flux Bins

Color	Luminous Flux Bin (FF)	Minumum Flux (lm) @ 13.5A	Maximum Flux (lm) @ 13.5A
Red	BH	350	475
	BJ	475	600
	BK	600	770
Green	CH	940	1,200
	CJ	1,200	1,500
	CK	1,500	2,000
Blue	DJ	250	350
	DK	350	450
	DM	450	575

Wavelength Bins

Color	Wavelength Bin (FF)	Minumum Wavelength @ 13.5A	Maximum Wavelength @ 13.5A
Red	R2	611	615
	R3	615	619
	R4	619	623
	R5	623	627
	R6	627	631
	R7	631	635
Green	G2	510	515
	G3	515	520
	G4	520	525
	G5	525	530
	G6	530	535
	G7	535	540
	G8	540	545
Blue	B4	450	455
	B5	455	460
	B6	460	465
	B7	465	470
	B8	470	475

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

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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
H (High) corresponds to a typical CRI of 92

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.

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CBT-90 White Electrical Characteristics[1]

Optical and Electrical Characteristics ($T_{heat\ sink}$ = 40 °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	$V_{F,\ min}$		2.9		V
	$V_{F,\ typ}$	3.2	3.6	3.7	V
	$V_{F,\ max}$		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_{hs} =40°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/mm^2. 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/mm^2. 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.

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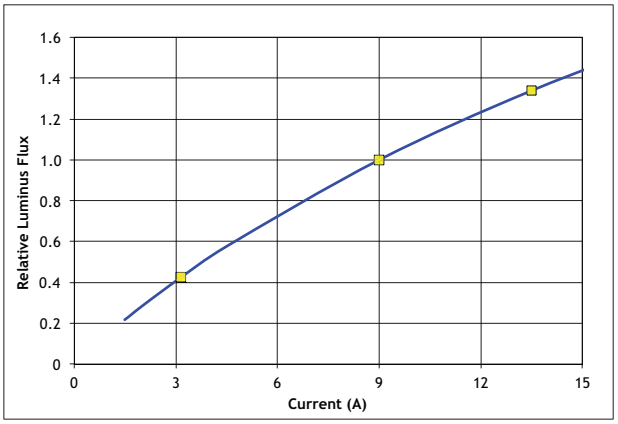
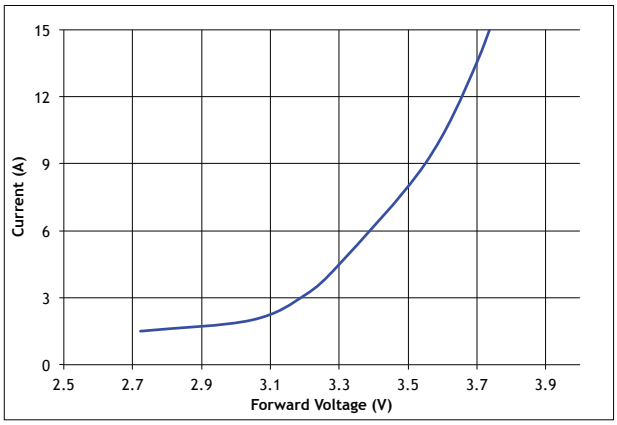
CBT-90 White Optical & Electrical Characteristics[1]

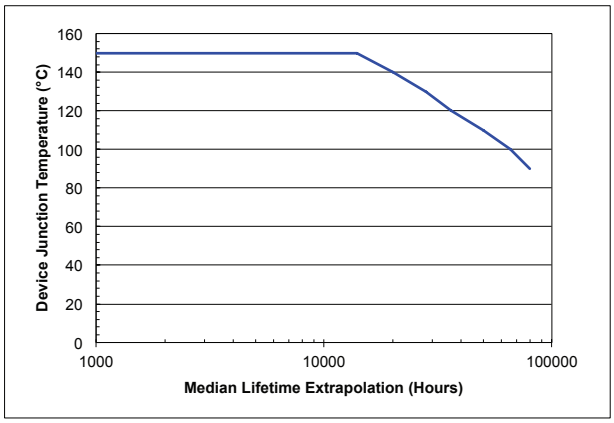
Relative Output Flux vs. Forward Current[1]



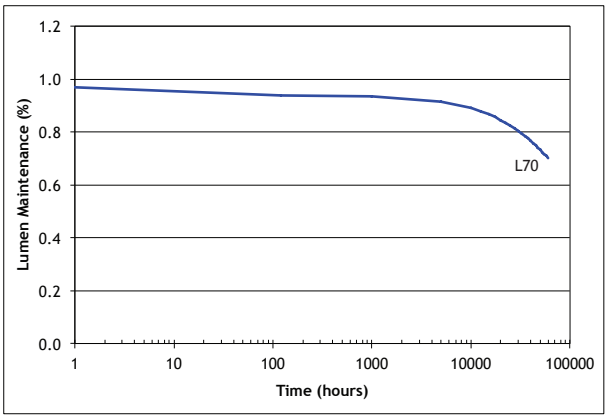
Forward Current vs. Forward Voltage



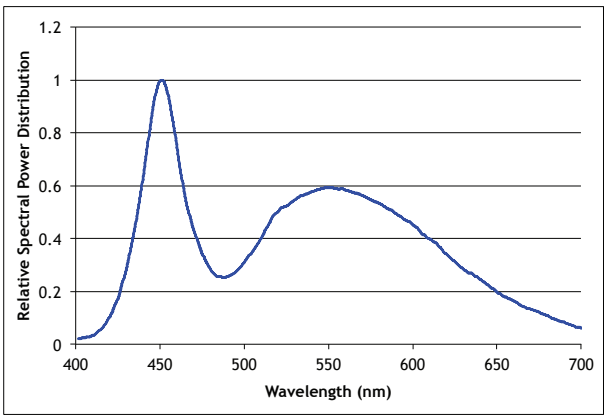
Mean Lifetime[2]



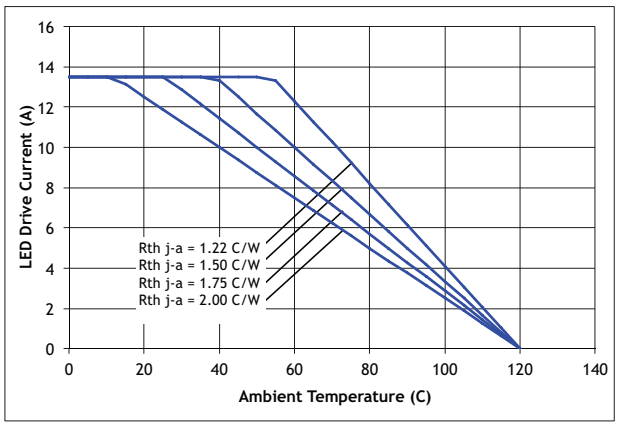
Lumen Maintenance vs. Time[3]



Typical Spectrum[4]



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.

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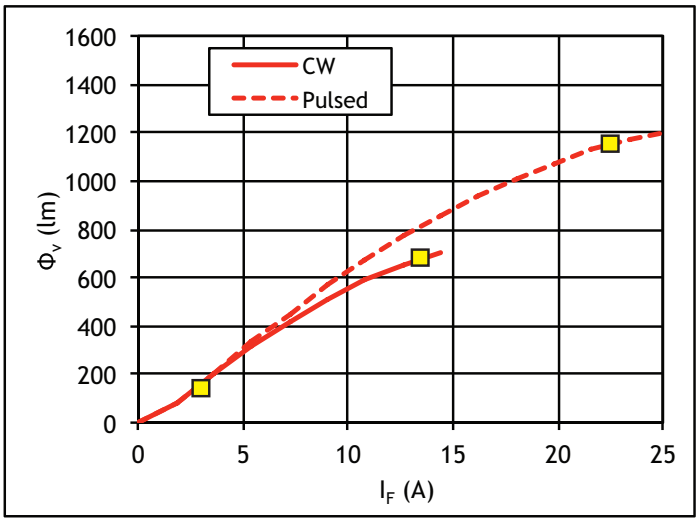
CBT-90 Red/Green/Blue Optical & Electrical Characteristics

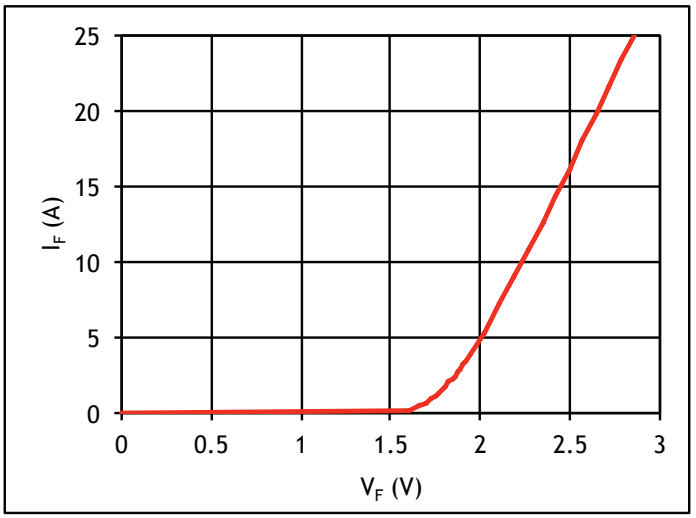
($T_{heat\ sink}$ = 40°C)[1]

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/mm²
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]	$\Phi_{V\,typ}$	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 Current[1]



Forward Current vs. Forward Voltage



Yellow squares indicate reference drive conditions

Notes: See page 12

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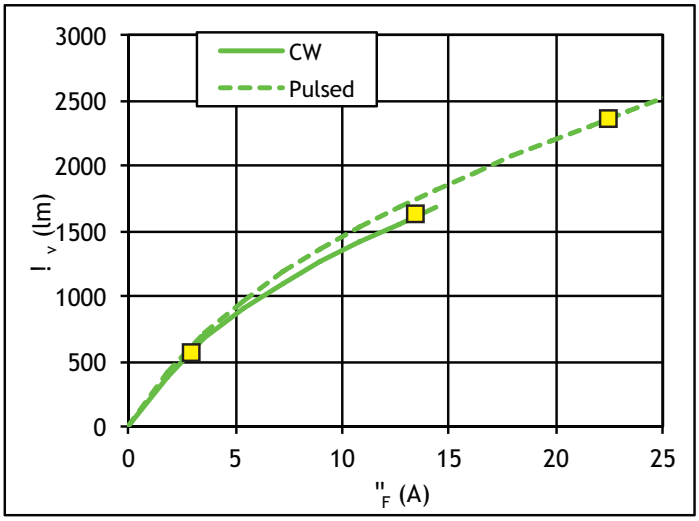
CBT-90 Red/Green/Blue Optical & Electrical Characteristics

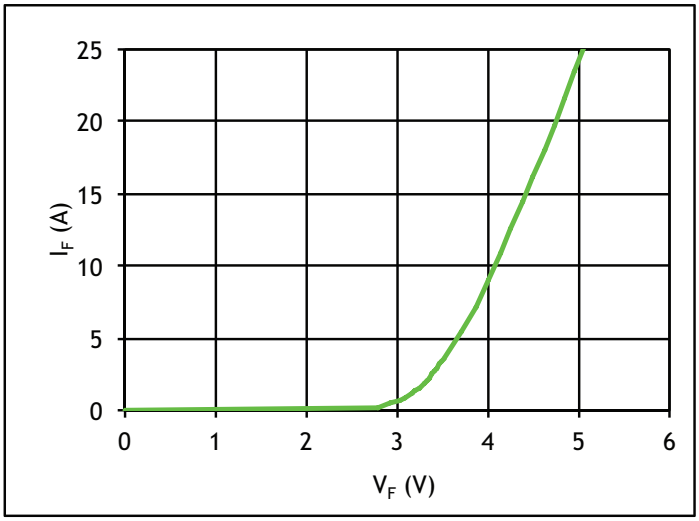
($T_{heat\ sink}$ =40°C)[1]

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/mm²
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	$\Delta\lambda_{1/2}$	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 Current[1]



Forward Current vs. Forward Voltage



Yellow squares indicate reference drive conditions

Notes: See page 12

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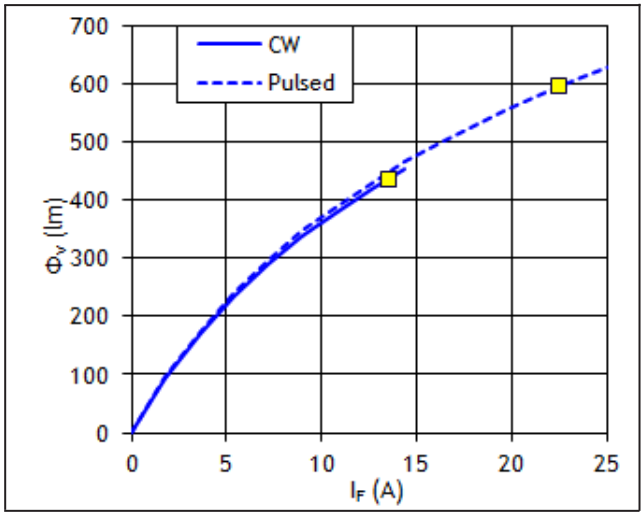
CBT-90 Red/Green/Blue Optical & Electrical Characteristics

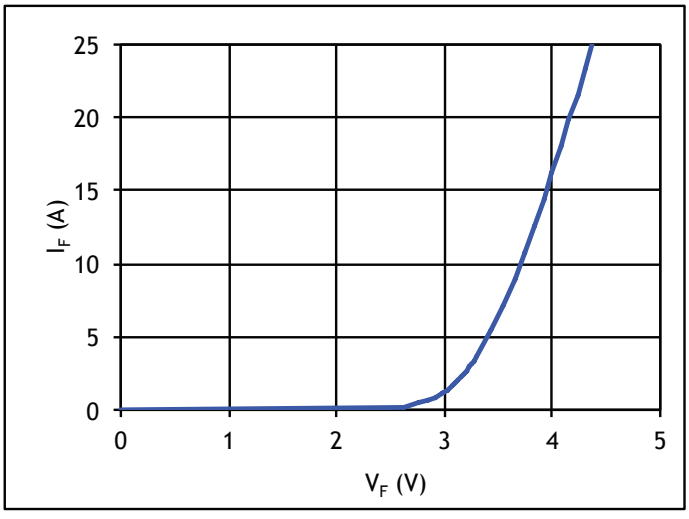
($T_{heat\ sink}$ = 40°C)[1]

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/mm²
Forward Voltage	$V_{F\ min}$		2.9		V
	V_f	3.4	3.2	4.5	V
	$V_{F\ max}$		4.3		V
Luminous Flux[5]	$\Phi_{V\ typ}$	150	450	600	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 Current[1]



Forward Current vs. Forward Voltage



Yellow squares indicate reference drive conditions

Notes: See page 12

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CBT-90 Red/Green/Blue Reference Optical & Electrical Characteristics ($T_{heat\ sink}$ = 40 °C)[1]

Common Characteristics

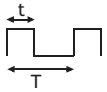
	Symbol	Red	Green	Blue	Unit
Emitting Area		9.0	9.0	9.0	mm^2
Emitting Area Dimensions		3.0x3.0	3.0x3.0	3.0x3.0	mmxmm
Dynamic Resistance	Ω_{dyn}	0.03	0.04	0.02	Ω
Thermal Coefficient of Photometric Flux		-0.96	-0.18	-0.007	%/ °C
Thermal Coefficient of Radiometric Flux		-0.52	-0.20	-0.17	%/ °C
Thermal Coefficient 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_{hs} =40°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/mm^2. Rated at 50% duty cycle and Pulsed operation frequency of f>360Hz;* $DC = \frac{t}{T}$



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.*

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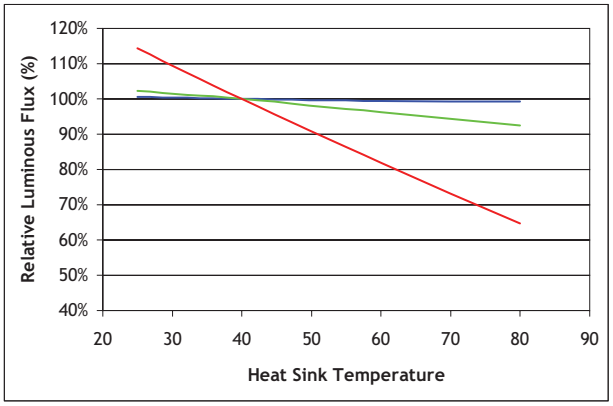
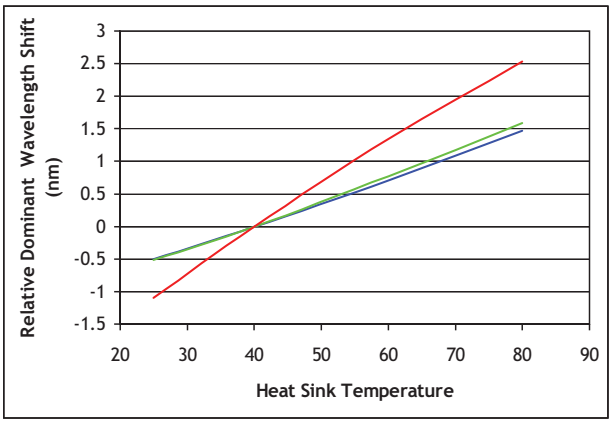
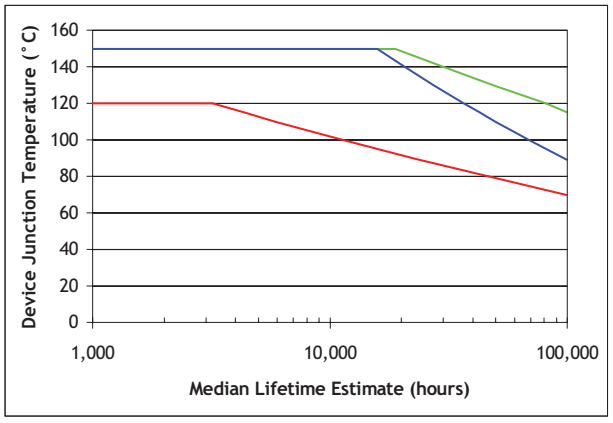
CBT-90 Red/Green/Blue Electrical Characteristics

Light Output and Spectral Characteristics Over Heat Sink Temperature

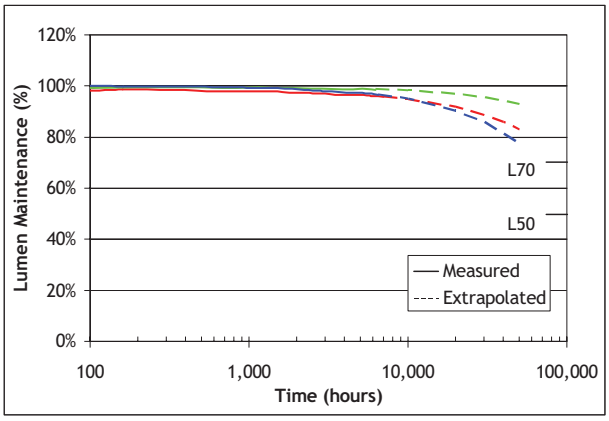




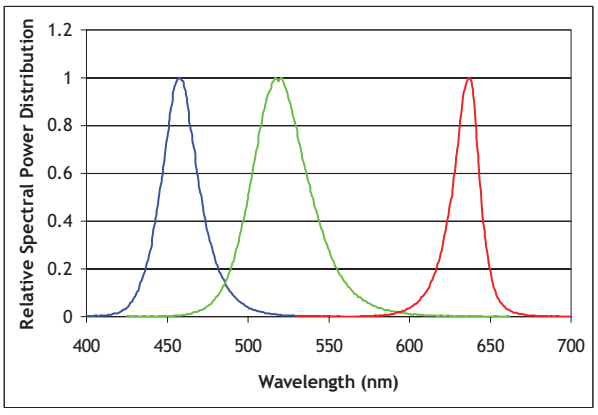
Median Lifetime Estimate vs. Tj[13]



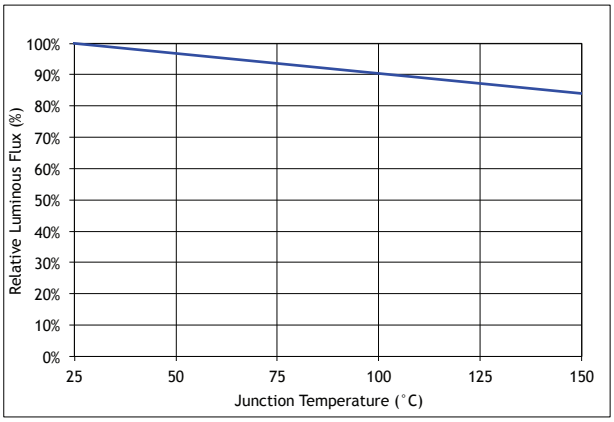
Lumen Maintenance[14]



Typical Spectrum[15]



Luminous Flux vs. Junction Temp



Note 13. Median lifetime estimate as a function of junction temperature at 0.35A/mm² 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/mm² 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 0.35 A/mm² in continuous operation.

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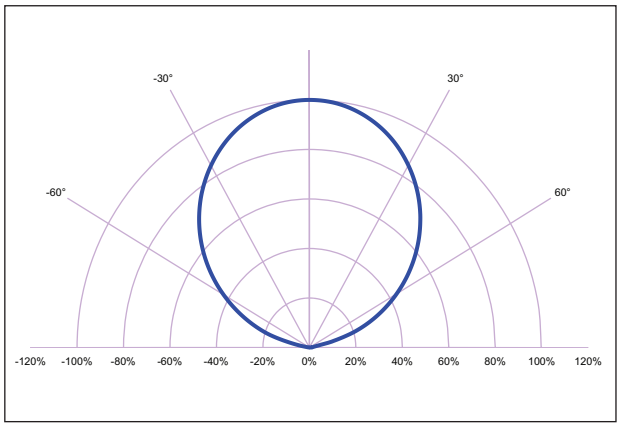
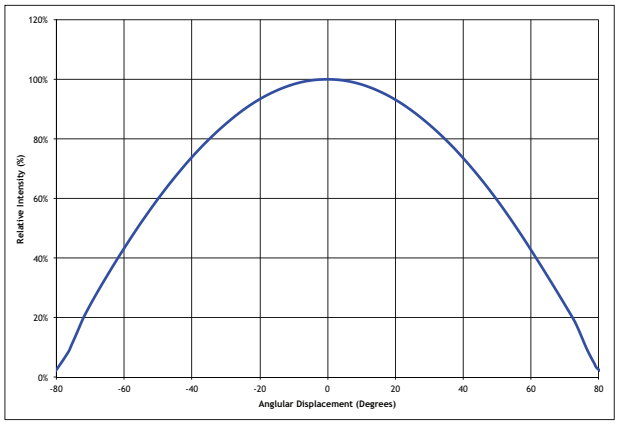
Typical Radiation Patterns

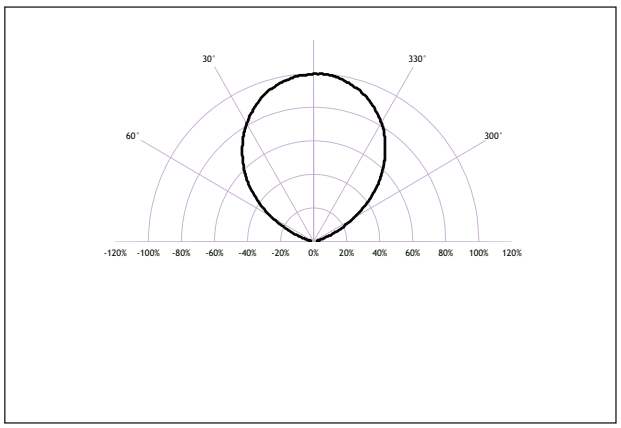
Typical Polar Radiation Pattern for White



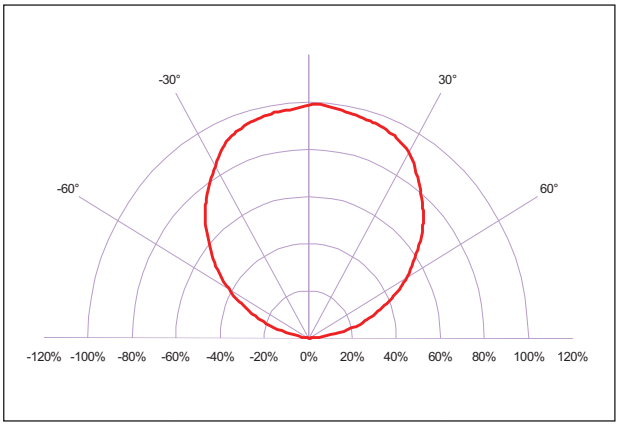
Typical Angular Radiation Pattern for White



Typical Polar Radiation Pattern for Blue and Green



Typical Polar Radiation Pattern for Red



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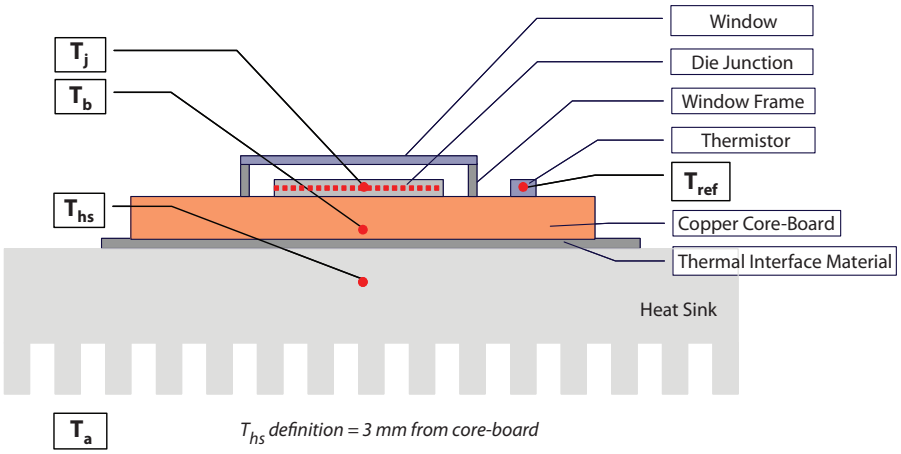
Thermal Resistance



Typical Thermal Resistance

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

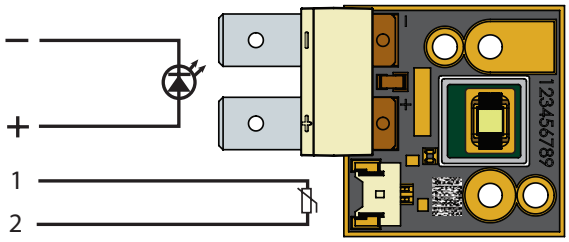
Note 1: Thermal resistance values are based on FEA model results correlated to measured $R_{\theta j\text{-}hs}$ data.

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



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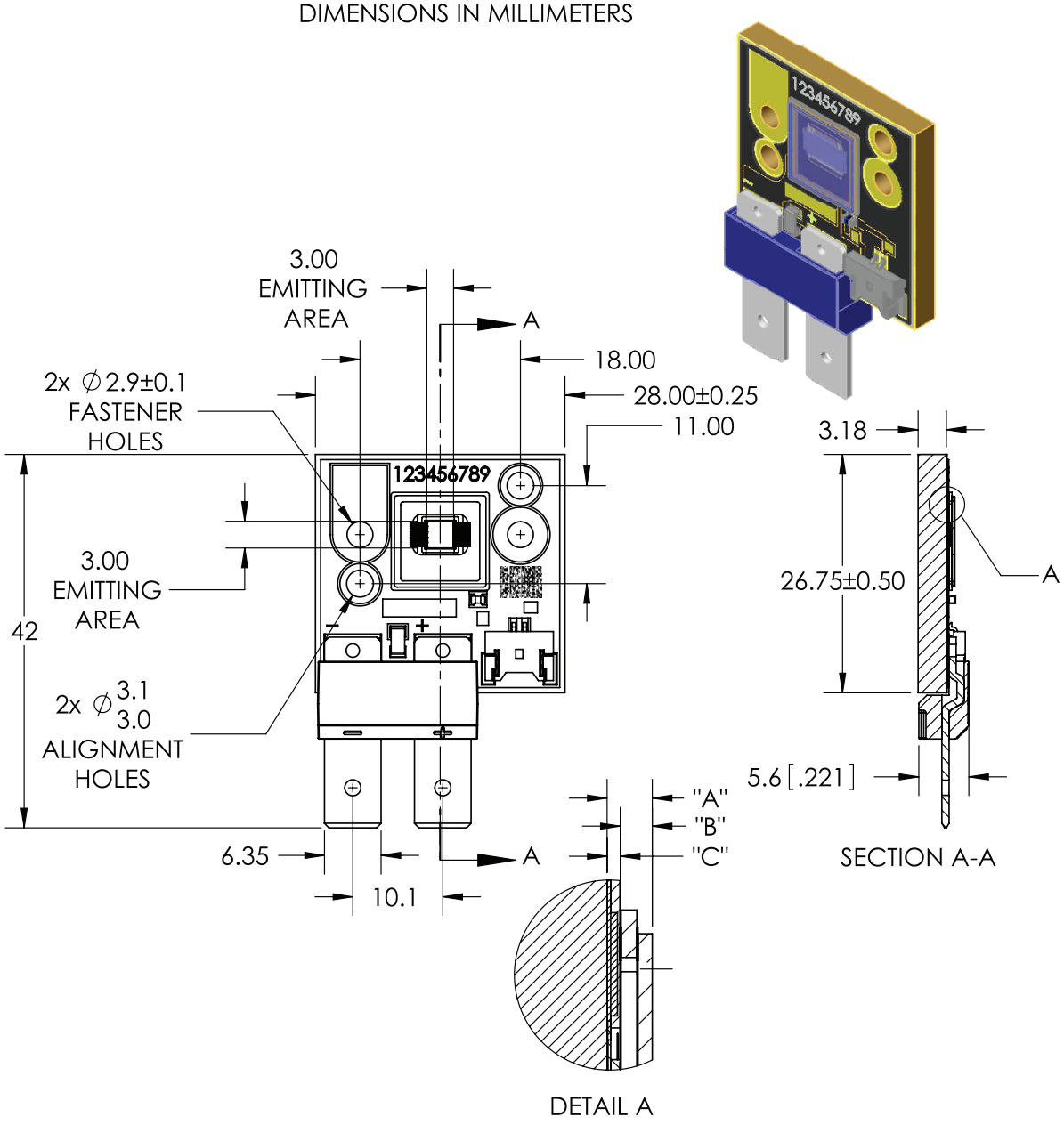
Mechanical Dimensions – CBT-90 Emitter

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

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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 mm² LED, thermistor, and connector, mounted on a copper-core PCB
CBT-90-W57H-C11-LA200	5700K White	White Big Chip LED™ CBT-90 consisting of a 9 mm² 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 mm² 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 mm² LED, thermistor, and connector, mounted on a copper-core PCB.
CBT-90-B-C11-KK300	Blue	Blue Big Chip LED™ CBT-90 consisting of 9 mm² 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: *LA200 - denotes a bin kit comprising of all flux bins with a minimum flux of 1,200 lumens and chromaticity bins at the 5700K color point.*

Note 3: *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
KK300 - denotes a bin kit comprising of all blue flux and wavelength bins as specified on page 5.

Note 4: *For ordering information on all available bin kits, please reference PDS-001694: CBT-90 Binning & Labeling document.*

Note 5: *Standard packaging increment (SPI) is 10.*

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