

# Cree® XLamp® CXA2 Family LEDs



NVLAP Lab Code 500041-0

## InFoRMATIon REQuIRED By LM-80-08

Cree classifies XLamp CXA2 Family LEDs as “LED arrays” (Section 3.7) per Sep 9, 2011 ENERGY STAR® guidelines<sup>1</sup>: LeD arrays constructed as an assembly of LeD dies on a substrate with one common phosphor layer overlaying all dies.

|                                                                                 |                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Number of LED light sources tested                                           | See individual data sets on following pages.                                                                                                                                                                                                                                  |
| 2. Description of tested LeD light sources                                      | XLamp® CXB3050 & CXA3590 White LEDs (Series: CXB3050 & CXA3590)<br><br>See the Scaling For Applicable Products section for list of applicable order codes and currents. All measurements provided are LeD array measurements.                                                 |
| 3. Description of auxiliary equipment                                           | Instrument Systems ISP-500 Integrating Sphere<br>Instrument Systems CAS-140 Spectrometer<br>Keithley 2420 Sourcemeter                                                                                                                                                         |
| 4. Operating cycle                                                              | LeD arrays are driven at constant current.                                                                                                                                                                                                                                    |
| 5. Ambient conditions                                                           | LeD arrays are operated in environmental control chambers. The temperature of the ambient air around the LeD arrays is actively controlled by air flowing through the chamber.<br><br>$T_A$ : See individual data sets on following pages<br>RH : < 45%<br>Air flow : 800 CFM |
| 6. Case temperature                                                             | See individual data sets on following pages.                                                                                                                                                                                                                                  |
| 7. Drive current of the LeD light source during lifetime test.                  | See individual data sets on following pages.                                                                                                                                                                                                                                  |
| 8. Initial luminous flux and forward voltage at photometric measurement current | See individual data sets on following pages.                                                                                                                                                                                                                                  |
| 9. Lumen maintenance data for each individual LED light source                  | See individual data sets on following pages.<br>Ambient temperature during luminous flux testing set to 25°C ±2°C.                                                                                                                                                            |
| 10. Observation of LeD light source failures                                    | No failures occurred during testing.                                                                                                                                                                                                                                          |
| 11. LeD light source monitoring interval                                        | See individual data sets on following pages.                                                                                                                                                                                                                                  |
| 12. Photometric measurement uncertainty                                         | Cree maintains a tolerance of ±2.0% on flux measurements for LM-80 testing.                                                                                                                                                                                                   |
| 13. Chromaticity shift reported over the measurement time                       | See individual data sets on following pages.<br>Ambient temperature during chromaticity testing set to 25°C ±2°C.                                                                                                                                                             |
| Test Report Authorization                                                       | Amber Abare, Components Reliability Laboratory Manager                                                                                                                                                                                                                        |
| Sampling method                                                                 | Cree uses systematic sampling of production LeDs, with checks to ensure that the behavior of early samples are representative of the behavior of later samples.                                                                                                               |

1 [http://www.energystar.gov/ia/partners/prod\\_development/new\\_specs/downloads/luminaires/ENERGY\\_STAR\\_Final\\_Lumen\\_Maintenance\\_Guidance.pdf](http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/luminaires/ENERGY_STAR_Final_Lumen_Maintenance_Guidance.pdf)

## REvISIon HISToRy

| Revision | Date               | Change                                                                                                                                                |
|----------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0        | March 24, 2015     | Date of first issue                                                                                                                                   |
| 1        | September 28, 2015 | Removed data sets CXA3050-4, 4+, & 6. Added data sets CXB3050-1 & 2. Added CXB1830, CXB2540. Changed precision of the EPA tables to 2-place decimals. |
|          |                    |                                                                                                                                                       |

## RESuLTS SuMMARy FoR TESTED LED ARRAy: XLAMp CXB3050

| Data Set | Case Temp. [T <sub>s</sub> ] | Ambient Temp. [T <sub>A</sub> ] | Drive Current [I <sub>F</sub> ] | AnSI CCT Target | Sample Count | Test Duration | Reported TM-21 Lifetimes                                             |
|----------|------------------------------|---------------------------------|---------------------------------|-----------------|--------------|---------------|----------------------------------------------------------------------|
| B3050-1  | 105°C                        | 105°C                           | 1500 mA                         | 3000K           | 10           | 6,048 hrs     | L90(6k) > 33,300 hrs<br>L80(6k) > 33,300 hrs<br>L70(6k) > 33,300 hrs |
| B3050-2  | 85°C                         | 85°C                            | 2500 mA                         | 3000K           | 10           | 6,048 hrs     | L90(6k) = 31,500 hrs<br>L80(6k) > 33,300 hrs<br>L70(6k) > 33,300 hrs |

## SCALIng FoR AppLICABLE pRoDuCTS: XLAMp CXB3050

The data sets in this document meet the all criteria for one LM-80 data set to apply to a range of LED arrays, as defined in ENERGY STAR Sep 9, 2011 guidelines, Section 3.7.d. The table below defines the current values that apply to each product when scaled from the tested LM-80 product. The tested product is listed in bold text below.

| product name   | voltage Class | product order Code               | Applicable Currents      |                         |
|----------------|---------------|----------------------------------|--------------------------|-------------------------|
|                |               |                                  | Data Set B3050-1 (105°C) | Data Set B3050-2 (85°C) |
| CXB1304        | 9V            | CXB1304-xxxx-xxxNxxxxxxxx        | 460 mA                   | 768 mA                  |
| CXB1304        | 18V           | CXB1304-xxxx-xxxNxxxxxxxx        | 230 mA                   | 384 mA                  |
| CXB1304        | 36V           | CXB1304-xxxx-xxxNxxxxxxxx        | 115 mA                   | 192 mA                  |
| CXB1507        | 18V           | CXB1507-xxxx-xxxNxxxxxxxx        | 462 mA                   | 750 mA                  |
| CXB1507        | 36V           | CXB1507-xxxx-xxxNxxxxxxxx        | 231 mA                   | 375 mA                  |
| CXB1512        | 18V           | CXB1512-xxxx-xxxNxxxxxxxx        | 898 mA                   | 1200 mA                 |
| CXB1512        | 36V           | CXB1512-xxxx-xxxNxxxxxxxx        | 449 mA                   | 600 mA                  |
| CXB1816        | 36V           | CXB1816-xxxx-xxxNxxxxxxxx        | 462 mA                   | 769 mA                  |
| CXB1820        | 36V           | CXB1820-xxxx-xxxNxxxxxxxx        | 630 mA                   | 1040 mA                 |
| CXB1830        | 36V           | CXB1830-xxxx-xxxNxxxxxxxx        | 651 mA                   | 1084 mA                 |
| CXB2530        | 36V           | CXB2530-xxxx-xxxNxxxxxxxx        | 808 mA                   | 1346 mA                 |
| CXB2540        | 36V           | CXB2540-xxxx-xxxNxxxxxxxx        | 1142 mA                  | 1907 mA                 |
| <b>CXB3050</b> | <b>36v</b>    | <b>CXB3050-xxxx-xxxNxxxxxxxx</b> | <b>1500 mA</b>           | <b>2500 mA</b>          |

## RESuLTS SuMMARy FoR TESTED LED ARRAy: XLAMp CXA3590

| Data Set | Case Temp. [T <sub>s</sub> ] | Ambient Temp. [T <sub>A</sub> ] | Drive Current [I <sub>F</sub> ] | AnSI CCT Target | Sample Count | Test Duration | Reported TM-21 Lifetimes                                             |
|----------|------------------------------|---------------------------------|---------------------------------|-----------------|--------------|---------------|----------------------------------------------------------------------|
| 3590-1   | 105°C                        | 105°C                           | 1050 mA                         | 3000K           | 25           | 6,048 hrs     | L90(6k) > 36,300 hrs<br>L80(6k) > 36,300 hrs<br>L70(6k) > 36,300 hrs |
| 3590-2   | 85°C                         | 85°C                            | 1400 mA                         | 3000K           | 25           | 6,048 hrs     | L90(6k) > 36,300 hrs<br>L80(6k) > 36,300 hrs<br>L70(6k) > 36,300 hrs |

## SCALIng FoR AppLICABLE pRoDuCTS: XLAMp CXA3590

The data sets in this document meet the all criteria for one LM-80 data set to apply to a range of LED arrays, as defined in ENERGY STAR Sep 9, 2011 guidelines, Section 3.7.d. The table below defines the current values that apply to each product when scaled from the tested LM-80 product. The tested product is listed in bold text below.

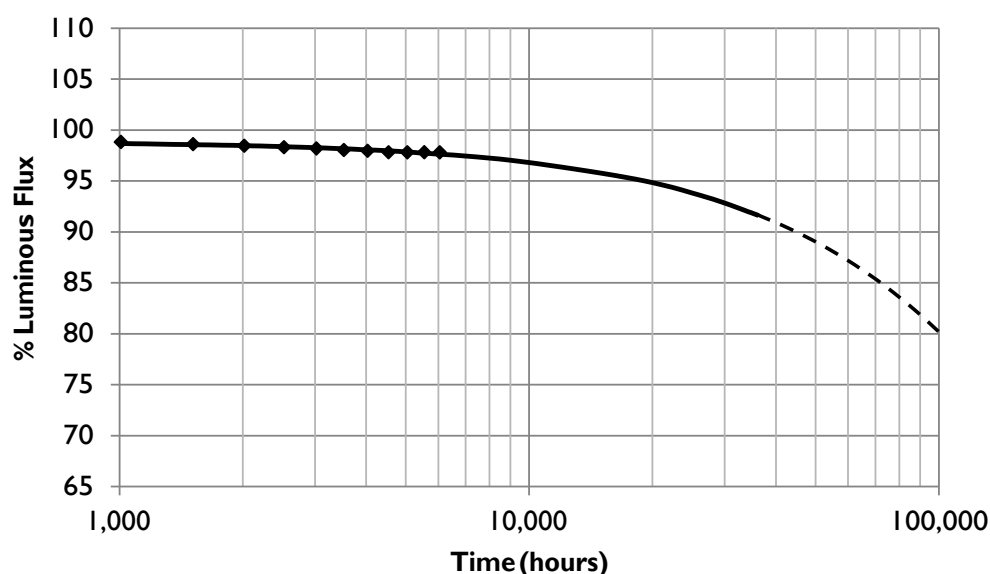
| product name   | voltage Class | product order Code        | Applicable Currents     |                        |
|----------------|---------------|---------------------------|-------------------------|------------------------|
|                |               |                           | Data Set 3590-1 (105°C) | Data Set 3590-2 (85°C) |
| CXB1830        | 36V           | CXB1830-xxxx-xxxNxxxxxxxx | 610 mA                  | 820 mA                 |
| CXB2540        | 36V           | CXB2540-xxxx-xxxNxxxxxxxx | 1070 mA                 | 1440 mA                |
| CXB3050        | 36V           | CXB3050-xxxx-xxxNxxxxxxxx | 1400 mA                 | 1900 mA                |
| CXB3070        | 36V           | CXB3070-xxxx-xxxNxxxxxxxx | 1400 mA                 | 1880 mA                |
| <b>CXA3590</b> | <b>72v</b>    | CXA3590-xxxx-xxxRxxxxxxxx | <b>1050 mA</b>          | <b>1400 mA</b>         |

### DATA SET B3050-1: 105°C; 1500 mA

|                                |                                                                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Tested LED Array Series        | XLamp CXB3050 White LEDs (Series: CXB3050)<br>See the Scaling For Applicable Products section for list of applicable order codes and currents. |
| Tested Model Number            | CXB3050-0000-000N00Z430F                                                                                                                       |
| Tested Drive Current [ $I_F$ ] | 1500 mA                                                                                                                                        |
| Average Current-Per-Die        | 115.4 mA per die                                                                                                                               |
| Testing Initiation Date        | November 06, 2014                                                                                                                              |
| Case Temperature [ $T_s$ ]     | 105°C                                                                                                                                          |
| Ambient Temperature [ $T_A$ ]  | 105°C                                                                                                                                          |
| Failures observed              | None                                                                                                                                           |

#### projection generated By Cree's Internal TM-21 Calculator:

|                                   |                                  |
|-----------------------------------|----------------------------------|
| Test duration                     | 6,048 hours                      |
| Test duration used for projection | $t=1,008$ to $t=6,048$           |
| $\alpha$                          | 2.098E-06                        |
| $\beta$                           | 9.888E-01                        |
| Reported Lifetimes                | <b>L90(6k) &gt; 33,300 hours</b> |
|                                   | <b>L80(6k) &gt; 33,300 hours</b> |
|                                   | <b>L70(6k) &gt; 33,300 hours</b> |



#### LM-80 Data For The Official TM-21 Calculator\*

| Time (hours) | Lumen Maintenance |
|--------------|-------------------|
| 0            | 100.00%           |
| 168          | 99.33%            |
| 1008         | 98.83%            |
| 1512         | 98.62%            |
| 2016         | 98.46%            |
| 2520         | 98.32%            |
| 3024         | 98.20%            |
| 3528         | 98.04%            |
| 4032         | 97.96%            |
| 4536         | 97.82%            |
| 5040         | 97.82%            |
| 5544         | 97.82%            |
| 6048         | 97.81%            |
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\* <http://www.energystar.gov/TM-21calculator>

Suggestion for exporting the LM-80 data:

1. Copy above table from PDF & paste into Microsoft Word.
2. Copy table out of Word & paste into Microsoft Excel (Match destination formatting)

### DATA SET B3050-1: 105°C; 1500 mA

| Lamp # | Initial (0 hrs) |                    |           |             | Lumen Maintenance (%) |       |       |       |       |       |       |       |       |       |       |       |
|--------|-----------------|--------------------|-----------|-------------|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | LF (lm)         | V <sub>F</sub> (V) | Calc. CCT | ANSI Target | 168                   | 1008  | 1512  | 2016  | 2520  | 3024  | 3528  | 4032  | 4536  | 5040  | 5544  | 6048  |
| 1      | 7672            | 36.04              | 2876      | 3000        | 99.43                 | 98.89 | 98.65 | 98.38 | 98.18 | 98.08 | 98.11 | 98.09 | 98.05 | 98.02 | 98.22 | 98.07 |
| 2      | 7708            | 36.15              | 2898      | 3000        | 99.68                 | 99.11 | 98.88 | 98.80 | 98.70 | 98.56 | 98.54 | 98.52 | 98.30 | 98.23 | 98.11 | 98.25 |
| 3      | 7682            | 36.38              | 2979      | 3000        | 99.33                 | 98.95 | 98.85 | 98.50 | 98.43 | 98.40 | 98.34 | 98.34 | 98.15 | 98.26 | 98.07 | 98.02 |
| 4      | 7852            | 36.12              | 2983      | 3000        | 99.51                 | 98.93 | 98.60 | 98.52 | 98.53 | 98.50 | 98.31 | 98.32 | 98.16 | 98.08 | 97.94 | 98.18 |
| 5      | 7748            | 37.40              | 2972      | 3000        | 99.50                 | 98.72 | 98.57 | 98.35 | 98.20 | 97.89 | 97.74 | 97.66 | 97.53 | 97.55 | 97.67 | 97.53 |
| 6      | 7709            | 35.62              | 2891      | 3000        | 99.37                 | 98.91 | 98.73 | 98.61 | 98.09 | 98.03 | 97.63 | 97.48 | 97.34 | 97.51 | 97.34 | 97.31 |
| 7      | 7655            | 35.43              | 2875      | 3000        | 99.15                 | 98.88 | 98.70 | 98.49 | 98.45 | 98.30 | 98.20 | 97.97 | 97.85 | 97.81 | 97.89 | 98.08 |
| 8      | 7737            | 36.85              | 2961      | 3000        | 99.23                 | 98.63 | 98.51 | 98.43 | 98.40 | 98.23 | 97.96 | 97.76 | 97.50 | 97.48 | 97.65 | 97.44 |
| 9      | 7724            | 37.49              | 2974      | 3000        | 99.00                 | 98.76 | 98.21 | 98.14 | 97.93 | 97.92 | 97.83 | 97.81 | 97.71 | 97.77 | 97.97 | 97.89 |
| 10     | 7710            | 36.90              | 2969      | 3000        | 99.13                 | 98.57 | 98.45 | 98.39 | 98.28 | 98.06 | 97.77 | 97.68 | 97.62 | 97.46 | 97.39 | 97.36 |
| n      | 10              | 10                 | 10        | 10          | 10                    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    |
| Mean   | 7720            | 36.44              |           |             | 99.33                 | 98.83 | 98.61 | 98.46 | 98.32 | 98.20 | 98.04 | 97.96 | 97.82 | 97.82 | 97.82 | 97.81 |
| Median | 7710            | 36.27              |           |             | 99.35                 | 98.88 | 98.62 | 98.46 | 98.34 | 98.15 | 98.04 | 97.89 | 97.78 | 97.79 | 97.91 | 97.95 |
| σ      | 55              | 0.70               |           |             | 0.21                  | 0.16  | 0.20  | 0.17  | 0.23  | 0.24  | 0.30  | 0.34  | 0.33  | 0.31  | 0.30  | 0.36  |
| Min.   | 7655            | 35.43              |           |             | 99.00                 | 98.57 | 98.21 | 98.14 | 97.93 | 97.89 | 97.63 | 97.48 | 97.34 | 97.46 | 97.34 | 97.31 |
| Max.   | 7852            | 37.49              |           |             | 99.68                 | 99.11 | 98.88 | 98.80 | 98.70 | 98.56 | 98.54 | 98.52 | 98.30 | 98.26 | 98.22 | 98.25 |

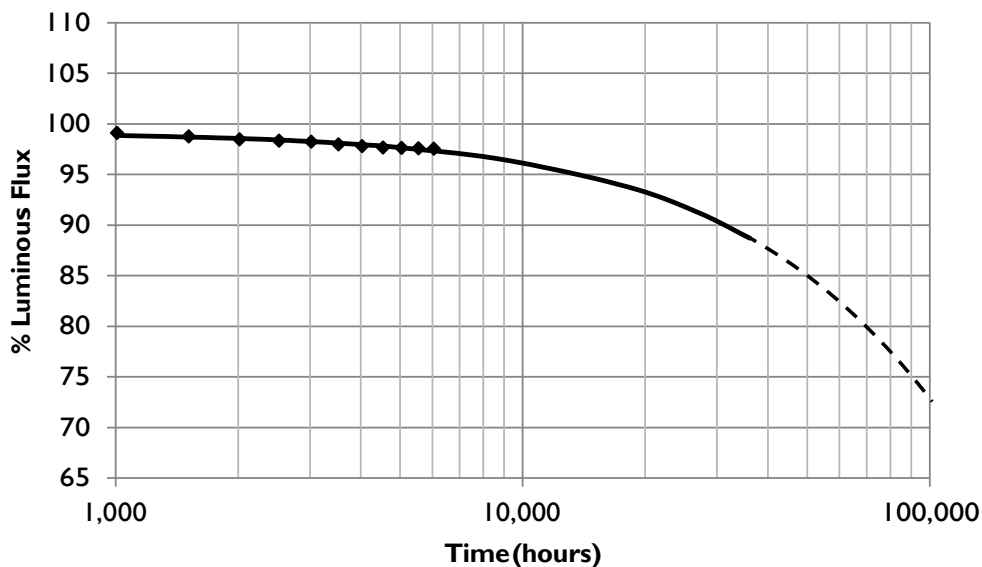
| Lamp # | Initial (0 hrs) |        |           |             | Chromaticity Shift (Δu'v') |        |        |        |        |        |        |        |        |        |        |        |
|--------|-----------------|--------|-----------|-------------|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|        | CCx             | CCy    | Calc. CCT | ANSI Target | 168                        | 1008   | 1512   | 2016   | 2520   | 3024   | 3528   | 4032   | 4536   | 5040   | 5544   | 6048   |
| 1      | 0.4429          | 0.4006 | 2876      | 3000        | 0.0007                     | 0.0007 | 0.0010 | 0.0011 | 0.0012 | 0.0011 | 0.0011 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |
| 2      | 0.4429          | 0.4034 | 2898      | 3000        | 0.0006                     | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |
| 3      | 0.4401          | 0.4075 | 2979      | 3000        | 0.0007                     | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0007 | 0.0007 | 0.0007 | 0.0008 | 0.0007 |
| 4      | 0.4414          | 0.4105 | 2983      | 3000        | 0.0007                     | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0007 | 0.0007 | 0.0007 | 0.0008 | 0.0008 |
| 5      | 0.4419          | 0.4103 | 2972      | 3000        | 0.0007                     | 0.0008 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |
| 6      | 0.4450          | 0.4066 | 2891      | 3000        | 0.0005                     | 0.0008 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| 7      | 0.4462          | 0.4068 | 2875      | 3000        | 0.0006                     | 0.0008 | 0.0008 | 0.0009 | 0.0009 | 0.0008 | 0.0007 | 0.0007 | 0.0006 | 0.0006 | 0.0007 | 0.0007 |
| 8      | 0.4418          | 0.4087 | 2961      | 3000        | 0.0007                     | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0009 | 0.0008 | 0.0007 | 0.0008 | 0.0008 | 0.0009 |
| 9      | 0.4421          | 0.4108 | 2974      | 3000        | 0.0006                     | 0.0008 | 0.0009 | 0.0009 | 0.0011 | 0.0010 | 0.0010 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0009 |
| 10     | 0.4407          | 0.4074 | 2969      | 3000        | 0.0007                     | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0009 | 0.0008 | 0.0009 | 0.0009 | 0.0009 |
| n      | 10              | 10     | 10        | 10          | 10                         | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     |
| Mean   |                 |        |           |             | 0.0006                     | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0009 |
| Median |                 |        |           |             | 0.0007                     | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0009 |
| σ      |                 |        |           |             | 0.0001                     | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Min.   |                 |        |           |             | 0.0005                     | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0008 | 0.0007 | 0.0007 | 0.0006 | 0.0006 | 0.0007 | 0.0007 |
| Max.   |                 |        |           |             | 0.0007                     | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0011 | 0.0011 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |

### DATA SET B3050-2: 85°C; 2500 mA

|                                |                                                                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Tested LED Array Series        | XLamp CXB3050 White LEDs (Series: CXB3050)<br>See the Scaling For Applicable Products section for list of applicable order codes and currents. |
| Tested Model Number            | CXB3050-0000-000N00Z430F                                                                                                                       |
| Tested Drive Current [ $I_F$ ] | 2500 mA                                                                                                                                        |
| Average Current-Per-Die        | 192.3 mA per die                                                                                                                               |
| Testing Initiation Date        | November 06, 2014                                                                                                                              |
| Case Temperature [ $T_s$ ]     | 85°C                                                                                                                                           |
| Ambient Temperature [ $T_A$ ]  | 85°C                                                                                                                                           |
| Failures observed              | None                                                                                                                                           |

#### projection generated By Cree's Internal TM-21 Calculator:

|                                   |                                  |
|-----------------------------------|----------------------------------|
| Test duration                     | 6,048 hours                      |
| Test duration used for projection | $t=1,008$ to $t=6,048$           |
| $\alpha$                          | 3.085E-06                        |
| $\beta$                           | 9.917E-01                        |
| Reported Lifetimes                | <b>L90(6k) = 31,500 hours</b>    |
|                                   | <b>L80(6k) &gt; 33,300 hours</b> |
|                                   | <b>L70(6k) &gt; 33,300 hours</b> |



#### LM-80 Data For The Official TM-21 Calculator\*

| Time (hours) | Lumen Maintenance |
|--------------|-------------------|
| 0            | 100.00%           |
| 168          | 99.46%            |
| 1008         | 99.10%            |
| 1512         | 98.74%            |
| 2016         | 98.47%            |
| 2520         | 98.34%            |
| 3024         | 98.24%            |
| 3528         | 97.97%            |
| 4032         | 97.80%            |
| 4536         | 97.66%            |
| 5040         | 97.62%            |
| 5544         | 97.58%            |
| 6048         | 97.55%            |
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\* <http://www.energystar.gov/TM-21calculator>

Suggestion for exporting the LM-80 data:

1. Copy above table from PDF & paste into Microsoft Word.
2. Copy table out of Word & paste into Microsoft Excel (Match destination formatting)

# DATA SET B3050-2: 85°C; 2500 mA

| Lamp # | Initial (0 hrs) |                    |           |             | Lumen Maintenance (%) |       |       |       |       |       |       |       |       |       |       |       |
|--------|-----------------|--------------------|-----------|-------------|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | LF (lm)         | V <sub>F</sub> (V) | Calc. CCT | ANSI Target | 168                   | 1008  | 1512  | 2016  | 2520  | 3024  | 3528  | 4032  | 4536  | 5040  | 5544  | 6048  |
| 1      | 11910           | 38.14              | 2977      | 3000        | 99.54                 | 99.32 | 98.92 | 98.45 | 98.38 | 98.22 | 97.95 | 97.77 | 97.49 | 97.40 | 97.42 | 97.37 |
| 2      | 11697           | 38.51              | 2993      | 3000        | 99.20                 | 98.90 | 98.35 | 98.11 | 97.90 | 97.82 | 97.60 | 97.45 | 97.25 | 97.20 | 97.18 | 97.22 |
| 3      | 11843           | 39.61              | 2985      | 3000        | 99.31                 | 99.05 | 98.61 | 98.44 | 98.37 | 98.33 | 98.06 | 98.11 | 97.91 | 97.91 | 97.87 | 97.92 |
| 4      | 11584           | 39.86              | 2976      | 3000        | 99.72                 | 99.27 | 98.88 | 98.75 | 98.59 | 98.59 | 98.21 | 98.11 | 97.86 | 97.81 | 97.62 | 97.62 |
| 5      | 12509           | 37.71              | 2998      | 3000        | 99.72                 | 99.35 | 99.21 | 98.79 | 98.78 | 98.72 | 98.51 | 98.30 | 98.24 | 98.21 | 98.20 | 98.06 |
| 6      | 11746           | 37.21              | 2968      | 3000        | 99.83                 | 99.30 | 99.07 | 98.46 | 98.05 | 97.90 | 97.53 | 97.34 | 97.30 | 97.28 | 97.17 | 97.10 |
| 7      | 11562           | 38.75              | 2892      | 3000        | 99.20                 | 98.94 | 98.44 | 98.14 | 98.11 | 97.85 | 97.68 | 97.64 | 97.63 | 97.74 | 97.61 | 97.50 |
| 8      | 12055           | 38.15              | 2989      | 3000        | 99.92                 | 99.18 | 98.68 | 98.29 | 98.08 | 98.04 | 97.58 | 97.36 | 97.18 | 97.09 | 97.18 | 97.12 |
| 9      | 11848           | 39.56              | 2981      | 3000        | 99.10                 | 98.80 | 98.66 | 98.54 | 98.49 | 98.37 | 98.30 | 98.10 | 97.94 | 97.86 | 97.86 | 97.95 |
| 10     | 11471           | 38.70              | 2906      | 3000        | 99.06                 | 98.93 | 98.75 | 98.74 | 98.59 | 98.55 | 98.27 | 97.77 | 97.77 | 97.71 | 97.73 | 97.66 |
| n      | 10              | 10                 | 10        | 10          | 10                    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    |
| Mean   | 11823           | 38.62              |           |             | 99.46                 | 99.10 | 98.75 | 98.47 | 98.34 | 98.24 | 97.97 | 97.80 | 97.66 | 97.62 | 97.58 | 97.55 |
| Median | 11794           | 38.60              |           |             | 99.42                 | 99.11 | 98.72 | 98.45 | 98.38 | 98.28 | 98.01 | 97.77 | 97.70 | 97.73 | 97.62 | 97.56 |
| σ      | 299             | 0.86               |           |             | 0.32                  | 0.20  | 0.27  | 0.24  | 0.29  | 0.33  | 0.35  | 0.35  | 0.35  | 0.36  | 0.35  | 0.35  |
| Min.   | 11471           | 37.21              |           |             | 99.06                 | 98.80 | 98.35 | 98.11 | 97.90 | 97.82 | 97.53 | 97.34 | 97.18 | 97.09 | 97.17 | 97.10 |
| Max.   | 12509           | 39.86              |           |             | 99.92                 | 99.35 | 99.21 | 98.79 | 98.78 | 98.72 | 98.51 | 98.30 | 98.24 | 98.21 | 98.20 | 98.06 |

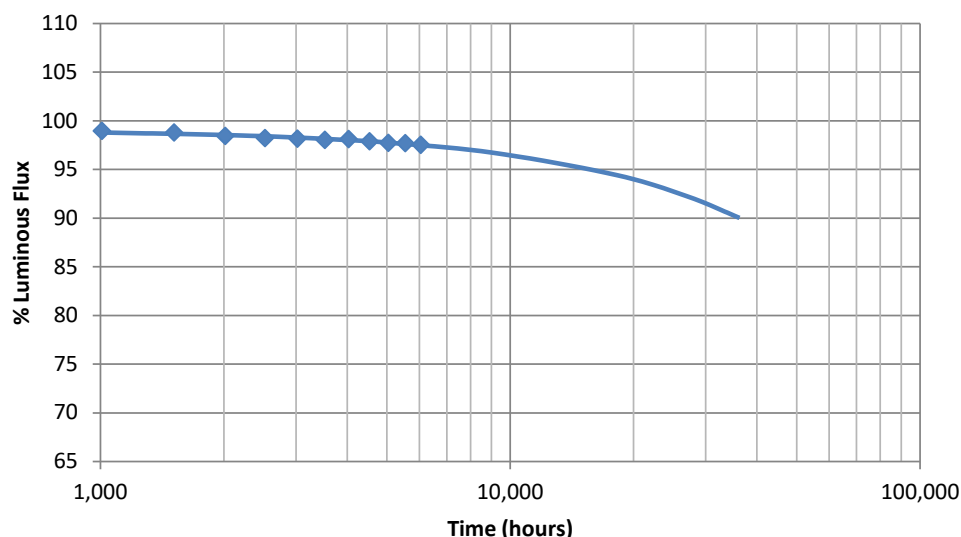
| Lamp # | Initial (0 hrs) |        |           |             | Chromaticity Shift (Δu'v') |        |        |        |        |        |        |        |        |        |        |        |
|--------|-----------------|--------|-----------|-------------|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|        | CCx             | CCy    | Calc. CCT | ANSI Target | 168                        | 1008   | 1512   | 2016   | 2520   | 3024   | 3528   | 4032   | 4536   | 5040   | 5544   | 6048   |
| 1      | 0.4417          | 0.4104 | 2977      | 3000        | 0.0006                     | 0.0007 | 0.0008 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0007 | 0.0007 | 0.0008 |
| 2      | 0.4392          | 0.4072 | 2993      | 3000        | 0.0006                     | 0.0007 | 0.0009 | 0.0009 | 0.0009 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 |
| 3      | 0.4407          | 0.4094 | 2985      | 3000        | 0.0006                     | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| 4      | 0.4416          | 0.4103 | 2976      | 3000        | 0.0005                     | 0.0006 | 0.0007 | 0.0008 | 0.0008 | 0.0009 | 0.0008 | 0.0007 | 0.0007 | 0.0007 | 0.0008 | 0.0009 |
| 5      | 0.4393          | 0.4083 | 2998      | 3000        | 0.0006                     | 0.0007 | 0.0007 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0007 | 0.0007 |
| 6      | 0.4411          | 0.4082 | 2968      | 3000        | 0.0006                     | 0.0008 | 0.0008 | 0.0009 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |
| 7      | 0.4445          | 0.4057 | 2892      | 3000        | 0.0004                     | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| 8      | 0.4412          | 0.4110 | 2989      | 3000        | 0.0007                     | 0.0008 | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0009 | 0.0008 | 0.0008 | 0.0007 | 0.0008 | 0.0008 |
| 9      | 0.4412          | 0.4099 | 2981      | 3000        | 0.0006                     | 0.0008 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0007 | 0.0007 | 0.0008 |
| 10     | 0.4433          | 0.4049 | 2906      | 3000        | 0.0005                     | 0.0007 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0009 |
| n      | 10              | 10     | 10        | 10          | 10                         | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     | 10     |
| Mean   |                 |        |           |             | 0.0006                     | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| Median |                 |        |           |             | 0.0006                     | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| σ      |                 |        |           |             | 0.0001                     | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0001 |
| Min.   |                 |        |           |             | 0.0004                     | 0.0006 | 0.0007 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 |
| Max.   |                 |        |           |             | 0.0007                     | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |

### DATA SET 3590-1: 105°C; 1050 mA

|                                |                                                                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Tested LED Array Series        | XLamp CXA3590 White LEDs (Series: CXA3590)<br>See the Scaling For Applicable Products section for list of applicable order codes and currents. |
| Tested Model Number            | CXA3590-0000-000R00AD30F                                                                                                                       |
| Tested Drive Current [ $I_F$ ] | 1050 mA                                                                                                                                        |
| Average Current-Per-Die        | 150 mA per die                                                                                                                                 |
| Testing Initiation Date        | August 14, 2013                                                                                                                                |
| Case Temperature [ $T_s$ ]     | 105°C                                                                                                                                          |
| Ambient Temperature [ $T_A$ ]  | 105°C                                                                                                                                          |
| Failures observed              | None                                                                                                                                           |

#### projection generated By Cree's Internal TM-21 Calculator:

|                                   |                         |
|-----------------------------------|-------------------------|
| Test duration                     | 6,048 hours             |
| Test duration used for projection | t=1,008 to t=6,048      |
| $\alpha$                          | 2.640E-06               |
| $\beta$                           | 9.906E-01               |
| Calculated Lifetime               | L70(6k) > 109,000 hours |
| Reported Lifetime                 | L70(6k) > 36,300 hours  |



#### LM-80 Data For The Official TM-21 Calculator\*

| Time (hours) | Lumen Maintenance |
|--------------|-------------------|
| 0            | 100.00%           |
| 168          | 99.67%            |
| 1008         | 98.96%            |
| 1512         | 98.80%            |
| 2016         | 98.44%            |
| 2520         | 98.22%            |
| 3024         | 98.16%            |
| 3528         | 98.04%            |
| 4032         | 98.12%            |
| 4536         | 97.89%            |
| 5040         | 97.73%            |
| 5544         | 97.70%            |
| 6048         | 97.53%            |
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\* <http://www.energystar.gov/TM-21calculator>

Suggestion for exporting the LM-80 data:

1. Copy above table from PDF & paste into Microsoft Word.
2. Copy table out of Word & paste into Microsoft Excel (Match destination formatting)

# DATA SET 3590-1: 105°C; 1050 mA

| Lamp # | Initial (0 hrs) |                    |           |             | Lumen Maintenance (%) |        |        |        |        |        |       |        |       |       |       |       |
|--------|-----------------|--------------------|-----------|-------------|-----------------------|--------|--------|--------|--------|--------|-------|--------|-------|-------|-------|-------|
|        | LF (lm)         | V <sub>F</sub> (V) | Calc. CCT | ANSI Target | 168                   | 1008   | 1512   | 2016   | 2520   | 3024   | 3528  | 4032   | 4536  | 5040  | 5544  | 6048  |
| 1      | 11162           | 74.39              | 3144      | 3000        | 100.78                | 100.52 | 100.05 | 100.28 | 100.08 | 99.91  | 99.32 | 100.07 | 99.53 | 99.58 | 99.28 | 99.46 |
| 2      | 11004           | 74.76              | 3156      | 3000        | 100.51                | 100.39 | 100.23 | 100.07 | 100.26 | 100.15 | 99.63 | 99.88  | 99.86 | 99.84 | 99.86 | 99.95 |
| 3      | 11422           | 77.55              | 3149      | 3000        | 100.12                | 98.88  | 98.98  | 98.34  | 98.46  | 97.97  | 97.65 | 97.49  | 96.85 | 96.76 | 96.60 | 96.20 |
| 4      | 11424           | 77.45              | 3156      | 3000        | 100.14                | 99.21  | 99.08  | 98.71  | 98.42  | 98.08  | 97.21 | 97.43  | 97.77 | 97.45 | 97.31 | 97.97 |
| 5      | 11847           | 75.66              | 3171      | 3000        | 99.72                 | 98.93  | 99.14  | 98.72  | 98.25  | 98.71  | 98.26 | 98.39  | 98.09 | 98.28 | 97.89 | 97.96 |
| 6      | 11831           | 75.44              | 3173      | 3000        | 99.62                 | 98.62  | 98.97  | 98.21  | 97.40  | 97.46  | 97.58 | 97.80  | 97.65 | 97.35 | 97.30 | 97.95 |
| 7      | 11320           | 75.07              | 3045      | 3000        | 99.98                 | 100.23 | 99.71  | 99.15  | 99.22  | 99.65  | 98.91 | 99.10  | 99.44 | 98.89 | 98.51 | 98.64 |
| 8      | 11943           | 76.42              | 3179      | 3000        | 99.46                 | 99.11  | 98.75  | 98.64  | 98.52  | 98.56  | 98.02 | 98.42  | 98.39 | 97.98 | 97.83 | 97.37 |
| 9      | 11855           | 76.33              | 3184      | 3000        | 99.31                 | 99.16  | 98.83  | 98.37  | 98.66  | 98.56  | 98.42 | 98.19  | 98.36 | 97.80 | 97.73 | 97.79 |
| 10     | 11149           | 75.66              | 3159      | 3000        | 99.20                 | 99.60  | 99.34  | 99.45  | 98.74  | 99.59  | 98.73 | 99.56  | 99.10 | 99.16 | 98.96 | 99.15 |
| 11     | 11124           | 75.74              | 3173      | 3000        | 99.50                 | 99.40  | 99.36  | 98.96  | 98.63  | 98.68  | 98.64 | 98.54  | 98.53 | 98.46 | 98.55 | 98.33 |
| 12     | 11942           | 77.27              | 2999      | 3000        | 99.48                 | 98.78  | 98.05  | 98.05  | 97.76  | 97.20  | 97.96 | 97.61  | 97.43 | 97.37 | 97.69 | 97.02 |
| 13     | 11436           | 78.64              | 3051      | 3000        | 99.02                 | 98.01  | 97.81  | 97.75  | 97.79  | 97.07  | 97.61 | 97.47  | 97.31 | 96.81 | 97.27 | 96.67 |
| 14     | 11340           | 76.60              | 3078      | 3000        | 98.99                 | 97.75  | 97.63  | 97.75  | 97.95  | 97.62  | 97.77 | 97.68  | 97.63 | 96.95 | 97.53 | 96.50 |
| 15     | 11400           | 79.31              | 2994      | 3000        | 99.67                 | 98.11  | 98.63  | 97.80  | 97.95  | 97.65  | 97.62 | 97.83  | 97.25 | 96.87 | 97.33 | 96.96 |
| 16     | 11365           | 79.34              | 2953      | 3000        | 99.56                 | 98.45  | 97.78  | 97.76  | 97.37  | 96.97  | 97.55 | 97.28  | 97.18 | 97.02 | 97.26 | 96.93 |
| 17     | 11778           | 77.20              | 3179      | 3000        | 98.57                 | 97.97  | 97.68  | 97.11  | 97.61  | 97.46  | 97.09 | 96.86  | 96.55 | 96.80 | 96.81 | 96.70 |
| 18     | 11491           | 76.29              | 3035      | 3000        | 99.48                 | 98.29  | 98.03  | 97.70  | 97.75  | 97.04  | 97.68 | 97.49  | 96.79 | 96.44 | 96.16 | 95.17 |
| 19     | 11752           | 77.16              | 3144      | 3000        | 98.96                 | 97.09  | 97.20  | 96.66  | 96.06  | 95.98  | 96.60 | 96.33  | 95.86 | 95.84 | 96.01 | 95.30 |
| 20     | 11008           | 77.46              | 3207      | 3000        | 99.55                 | 98.51  | 96.54  | 96.85  | 96.47  | 96.19  | 96.43 | 96.30  | 95.89 | 95.63 | 95.89 | 95.52 |
| 21     | 11836           | 75.71              | 3159      | 3000        | 100.21                | 99.07  | 99.91  | 98.90  | 98.11  | 98.75  | 98.69 | 99.02  | 98.54 | 98.61 | 98.30 | 98.32 |
| 22     | 11769           | 75.62              | 3179      | 3000        | 100.82                | 100.05 | 100.25 | 99.65  | 99.57  | 99.22  | 98.97 | 99.26  | 98.85 | 98.92 | 98.68 | 98.62 |
| 23     | 11782           | 76.05              | 3154      | 3000        | 99.68                 | 98.94  | 99.46  | 98.65  | 97.86  | 98.59  | 98.13 | 98.37  | 98.05 | 97.97 | 97.68 | 98.07 |
| 24     | 11135           | 75.65              | 3156      | 3000        | 99.08                 | 99.44  | 99.37  | 98.79  | 98.61  | 98.50  | 98.30 | 98.49  | 98.41 | 98.48 | 98.38 | 98.27 |
| 25     | 11535           | 77.69              | 3128      | 3000        | 100.40                | 99.59  | 99.54  | 98.70  | 98.08  | 98.52  | 98.17 | 98.21  | 98.02 | 97.99 | 97.69 | 97.53 |
| n      | 25              | 25                 | 25        | 25          | 25                    | 25     | 25     | 25     | 25     | 25     | 25    | 25     | 25    | 25    | 25    | 25    |
| Mean   | 11506           | 76.58              |           |             | 99.67                 | 98.96  | 98.80  | 98.44  | 98.22  | 98.16  | 98.04 | 98.12  | 97.89 | 97.73 | 97.70 | 97.53 |
| Median | 11436           | 76.33              |           |             | 99.56                 | 98.94  | 98.98  | 98.64  | 98.11  | 98.50  | 98.02 | 98.19  | 98.02 | 97.80 | 97.69 | 97.79 |
| σ      | 307             | 1.31               |           |             | 0.58                  | 0.85   | 0.99   | 0.91   | 0.95   | 1.10   | 0.78  | 0.99   | 1.06  | 1.11  | 0.99  | 1.24  |
| Min.   | 11004           | 74.39              |           |             | 98.57                 | 97.09  | 96.54  | 96.66  | 96.06  | 95.98  | 96.43 | 96.30  | 95.86 | 95.63 | 95.89 | 95.17 |
| Max.   | 11943           | 79.34              |           |             | 100.82                | 100.52 | 100.25 | 100.28 | 100.26 | 100.15 | 99.63 | 100.07 | 99.86 | 99.84 | 99.86 | 99.95 |

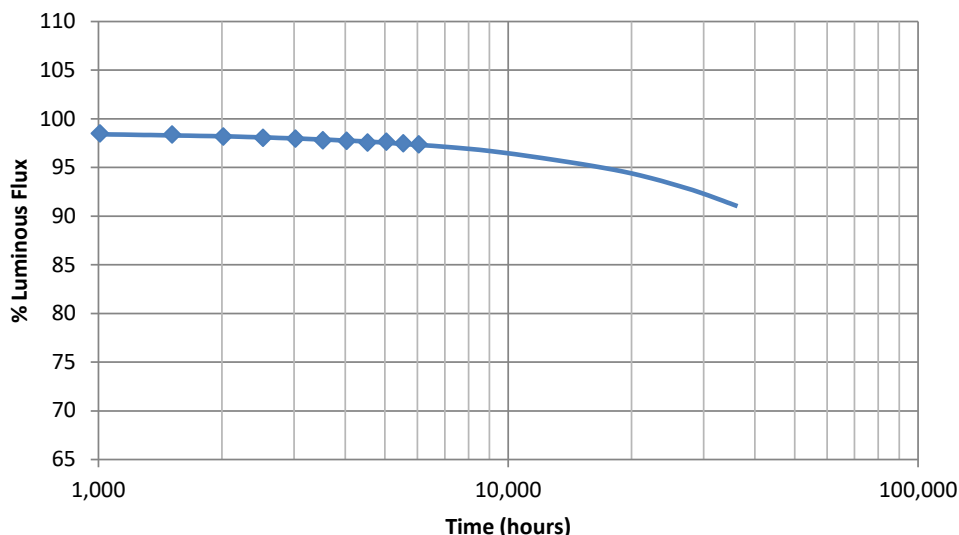
| Lamp # | Initial (0 hrs) |        |           |             | Chromaticity Shift (Δu'v') |        |        |        |        |        |        |        |        |        |        |        |
|--------|-----------------|--------|-----------|-------------|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|        | CCx             | CCy    | Calc. CCT | ANSI Target | 168                        | 1008   | 1512   | 2016   | 2520   | 3024   | 3528   | 4032   | 4536   | 5040   | 5544   | 6048   |
| 1      | 0.4295          | 0.4051 | 3144      | 3000        | 0.0004                     | 0.0007 | 0.0006 | 0.0008 | 0.0008 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0012 | 0.0013 |
| 2      | 0.4289          | 0.4052 | 3156      | 3000        | 0.0004                     | 0.0006 | 0.0006 | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0011 | 0.0013 |
| 3      | 0.4303          | 0.4075 | 3149      | 3000        | 0.0005                     | 0.0006 | 0.0006 | 0.0007 | 0.0007 | 0.0008 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 |
| 4      | 0.4296          | 0.4070 | 3156      | 3000        | 0.0005                     | 0.0007 | 0.0007 | 0.0008 | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0011 | 0.0010 | 0.0012 | 0.0014 |
| 5      | 0.4289          | 0.4071 | 3171      | 3000        | 0.0007                     | 0.0009 | 0.0009 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0017 |
| 6      | 0.4282          | 0.4057 | 3173      | 3000        | 0.0008                     | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0014 | 0.0014 | 0.0015 | 0.0016 | 0.0016 | 0.0017 | 0.0018 |
| 7      | 0.4288          | 0.3916 | 3045      | 3000        | 0.0005                     | 0.0007 | 0.0007 | 0.0011 | 0.0008 | 0.0011 | 0.0009 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0014 |
| 8      | 0.4273          | 0.4045 | 3179      | 3000        | 0.0006                     | 0.0007 | 0.0008 | 0.0009 | 0.0007 | 0.0010 | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0013 | 0.0013 |
| 9      | 0.4256          | 0.4013 | 3184      | 3000        | 0.0006                     | 0.0007 | 0.0008 | 0.0008 | 0.0007 | 0.0009 | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0012 | 0.0013 |
| 10     | 0.4319          | 0.4123 | 3159      | 3000        | 0.0006                     | 0.0006 | 0.0007 | 0.0008 | 0.0006 | 0.0008 | 0.0007 | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0011 |
| 11     | 0.4306          | 0.4112 | 3173      | 3000        | 0.0005                     | 0.0006 | 0.0006 | 0.0007 | 0.0006 | 0.0009 | 0.0008 | 0.0010 | 0.0011 | 0.0010 | 0.0012 | 0.0012 |
| 12     | 0.4413          | 0.4124 | 2999      | 3000        | 0.0007                     | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0013 | 0.0013 | 0.0013 | 0.0015 | 0.0015 | 0.0016 | 0.0017 |
| 13     | 0.4405          | 0.4173 | 3051      | 3000        | 0.0006                     | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0015 | 0.0016 |
| 14     | 0.4296          | 0.3973 | 3078      | 3000        | 0.0007                     | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0015 | 0.0016 | 0.0016 | 0.0017 |
| 15     | 0.4415          | 0.4121 | 2994      | 3000        | 0.0006                     | 0.0010 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0013 | 0.0014 | 0.0014 | 0.0015 |
| 16     | 0.4441          | 0.4123 | 2953      | 3000        | 0.0007                     | 0.0011 | 0.0012 | 0.0013 | 0.0014 | 0.0015 | 0.0015 | 0.0016 | 0.0018 | 0.0019 | 0.0019 | 0.0020 |
| 17     | 0.4295          | 0.4095 | 3179      | 3000        | 0.0009                     | 0.0010 | 0.0010 | 0.0010 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0015 | 0.0015 | 0.0016 |
| 18     | 0.4423          | 0.4192 | 3035      | 3000        | 0.0008                     | 0.0011 | 0.0013 | 0.0014 | 0.0015 | 0.0017 | 0.0017 | 0.0018 | 0.0019 | 0.0020 | 0.0021 | 0.0021 |
| 19     | 0.4317          | 0.4101 | 3144      | 3000        | 0.0008                     | 0.0011 | 0.0013 | 0.0013 | 0.0014 | 0.0016 | 0.0016 | 0.0017 | 0.0018 | 0.0020 | 0.0020 | 0.0021 |
| 20     | 0.4193          | 0.3892 | 3207      | 3000        | 0.0009                     | 0.0011 | 0.0014 | 0.0016 | 0.0017 | 0.0018 | 0.0017 | 0.0020 | 0.0021 | 0.0022 | 0.0022 | 0.0022 |
| 21     | 0.4295          | 0.4069 | 3159      | 3000        | 0.0005                     | 0.0008 | 0.0008 | 0.0008 | 0.0009 | 0.0011 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0013 |
| 22     | 0.4276          | 0.4053 | 3179      | 3000        | 0.0004                     | 0.0006 | 0.0007 | 0.0007 | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 |
| 23     | 0.4296          | 0.4066 | 3154      | 3000        | 0.0005                     | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0011 | 0.0012 |
| 24     | 0.4288          | 0.4050 | 3156      | 3000        | 0.0005                     | 0.0008 | 0.0010 | 0.0012 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0014 | 0.0014 |
| 25     | 0.4316          | 0.4078 | 3128      | 3000        | 0.0006                     | 0.0009 | 0.0010 | 0.0010 | 0.0011 | 0.0013 | 0.0013 | 0.0014 | 0.0015 | 0.0015 | 0.0015 | 0.0016 |
| n      | 25              | 25     | 25        | 25          | 25                         | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     |
| Mean   |                 |        |           |             | 0.0006                     | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0015 |
| Median |                 |        |           |             | 0.0006                     | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0014 |
| σ      |                 |        |           |             | 0.0001                     | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| Min.   |                 |        |           |             | 0.0004                     | 0.0006 | 0.0006 | 0.0007 | 0.0006 | 0.0008 | 0.0007 | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0011 |
| Max.   |                 |        |           |             | 0.0009                     | 0.0011 | 0.0014 | 0.0016 | 0.0017 | 0.0018 | 0.0017 | 0.0020 | 0.0021 | 0.0022 | 0.0022 | 0.0022 |

### DATA SET 3590-2: 85°C; 1400 mA

|                                |                                                                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Tested LED Array Series        | XLamp CXA3590 White LEDs (Series: CXA3590)<br>See the Scaling For Applicable Products section for list of applicable order codes and currents. |
| Tested Model Number            | CXA3590-0000-000R00AD30F                                                                                                                       |
| Tested Drive Current [ $I_F$ ] | 1400 mA                                                                                                                                        |
| Average Current-Per-Die        | 200 mA per die                                                                                                                                 |
| Testing Initiation Date        | August 21, 2013                                                                                                                                |
| Case Temperature [ $T_s$ ]     | 85°C                                                                                                                                           |
| Ambient Temperature [ $T_A$ ]  | 85°C                                                                                                                                           |
| Failures observed              | None                                                                                                                                           |

#### projection generated By Cree's Internal TM-21 Calculator:

|                                   |                         |
|-----------------------------------|-------------------------|
| Test duration                     | 6,048 hours             |
| Test duration used for projection | t=1,008 to t=6,048      |
| $\alpha$                          | 2.216E-06               |
| $\beta$                           | 9.865E-01               |
| Calculated Lifetime               | L70(6k) > 109,000 hours |
| Reported Lifetime                 | L70(6k) > 36,300 hours  |



#### LM-80 Data For The Official TM-21 Calculator\*

| Time (hours) | Lumen Maintenance |
|--------------|-------------------|
| 0            | 100.00%           |
| 168          | 98.92%            |
| 1008         | 98.50%            |
| 1512         | 98.38%            |
| 2016         | 98.18%            |
| 2520         | 98.05%            |
| 3024         | 97.97%            |
| 3528         | 97.79%            |
| 4032         | 97.74%            |
| 4536         | 97.56%            |
| 5040         | 97.65%            |
| 5544         | 97.48%            |
| 6048         | 97.37%            |
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\* <http://www.energystar.gov/TM-21calculator>

Suggestion for exporting the LM-80 data:

1. Copy above table from PDF & paste into Microsoft Word.
2. Copy table out of Word & paste into Microsoft Excel (Match destination formatting)

# DATA SET 3590-2: 85°C; 1400 mA

| Lamp # | Initial (0 hrs) |                    |           |             | Lumen Maintenance (%) |        |       |       |       |       |       |       |       |       |       |       |
|--------|-----------------|--------------------|-----------|-------------|-----------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | LF (lm)         | V <sub>F</sub> (V) | Calc. CCT | ANSI Target | 168                   | 1008   | 1512  | 2016  | 2520  | 3024  | 3528  | 4032  | 4536  | 5040  | 5544  | 6048  |
| 1      | 14274           | 78.53              | 3146      | 3000        | 98.71                 | 99.48  | 98.76 | 99.36 | 98.67 | 98.96 | 98.91 | 99.12 | 98.79 | 99.00 | 98.65 | 98.58 |
| 2      | 13975           | 80.19              | 3215      | 3000        | 99.95                 | 100.13 | 99.92 | 99.90 | 99.15 | 99.32 | 99.45 | 99.38 | 99.39 | 99.28 | 98.99 | 98.84 |
| 3      | 14086           | 80.76              | 3138      | 3000        | 98.77                 | 98.91  | 98.59 | 98.66 | 98.05 | 97.66 | 98.11 | 98.32 | 97.81 | 98.06 | 98.17 | 98.08 |
| 4      | 13883           | 80.85              | 3189      | 3000        | 98.79                 | 98.82  | 98.55 | 98.63 | 98.30 | 97.69 | 98.13 | 98.50 | 97.98 | 98.21 | 98.02 | 98.23 |
| 5      | 14382           | 78.25              | 3112      | 3000        | 98.58                 | 98.76  | 99.06 | 98.14 | 98.33 | 98.05 | 97.44 | 97.75 | 97.51 | 98.03 | 97.92 | 97.65 |
| 6      | 14613           | 79.08              | 3136      | 3000        | 99.15                 | 99.02  | 99.03 | 98.85 | 98.67 | 99.11 | 98.28 | 98.98 | 98.76 | 99.12 | 98.58 | 98.69 |
| 7      | 14166           | 79.21              | 2935      | 3000        | 97.67                 | 96.71  | 97.17 | 97.58 | 96.94 | 97.37 | 97.61 | 97.01 | 96.95 | 96.46 | 96.70 | 96.34 |
| 8      | 14133           | 78.96              | 3177      | 3000        | 99.59                 | 98.92  | 99.40 | 98.20 | 98.50 | 98.13 | 98.01 | 97.13 | 96.40 | 97.12 | 96.74 | 96.24 |
| 9      | 14902           | 82.27              | 3173      | 3000        | 99.49                 | 99.25  | 98.87 | 98.98 | 99.17 | 98.70 | 98.16 | 98.79 | 98.37 | 98.54 | 97.77 | 98.33 |
| 10     | 15296           | 79.64              | 3149      | 3000        | 99.91                 | 98.54  | 98.63 | 98.02 | 98.10 | 98.06 | 98.10 | 97.53 | 97.09 | 97.44 | 97.33 | 97.32 |
| 11     | 15282           | 79.62              | 3176      | 3000        | 99.96                 | 98.61  | 98.51 | 97.94 | 98.10 | 97.83 | 98.12 | 97.54 | 97.09 | 97.29 | 97.24 | 97.36 |
| 12     | 14755           | 80.04              | 2945      | 3000        | 99.71                 | 98.50  | 98.49 | 98.16 | 98.42 | 98.21 | 97.02 | 97.44 | 96.67 | 96.71 | 96.82 | 96.54 |
| 13     | 14024           | 78.56              | 2950      | 3000        | 98.96                 | 98.53  | 98.67 | 98.29 | 97.56 | 98.04 | 98.30 | 98.22 | 97.99 | 97.31 | 97.04 | 97.32 |
| 14     | 14120           | 78.51              | 2932      | 3000        | 98.43                 | 98.42  | 98.89 | 98.42 | 97.73 | 98.21 | 98.38 | 98.19 | 97.73 | 97.57 | 97.53 | 97.71 |
| 15     | 14828           | 81.85              | 3168      | 3000        | 99.45                 | 97.84  | 96.95 | 96.57 | 97.40 | 96.78 | 96.31 | 96.36 | 96.42 | 96.25 | 95.67 | 96.17 |
| 16     | 14865           | 80.17              | 2927      | 3000        | 97.83                 | 97.21  | 97.24 | 97.21 | 96.35 | 96.39 | 96.43 | 95.95 | 96.23 | 95.86 | 95.35 | 95.55 |
| 17     | 14037           | 79.48              | 2877      | 3000        | 97.71                 | 97.48  | 97.12 | 97.22 | 97.27 | 96.95 | 96.17 | 96.87 | 96.30 | 96.16 | 96.32 | 96.06 |
| 18     | 14510           | 81.32              | 3155      | 3000        | 99.18                 | 98.04  | 96.89 | 96.36 | 96.87 | 97.12 | 96.16 | 96.30 | 96.61 | 96.85 | 96.76 | 96.23 |
| 19     | 14976           | 80.51              | 3169      | 3000        | 97.67                 | 96.63  | 96.23 | 96.86 | 97.24 | 96.62 | 96.44 | 96.09 | 96.12 | 96.31 | 96.78 | 96.21 |
| 20     | 14432           | 81.64              | 3169      | 3000        | 97.49                 | 97.58  | 97.06 | 97.33 | 97.51 | 97.14 | 96.99 | 96.68 | 96.97 | 96.87 | 96.18 | 95.98 |
| 21     | 14374           | 80.49              | 3218      | 3000        | 99.07                 | 98.77  | 99.24 | 98.94 | 98.19 | 98.62 | 98.96 | 98.44 | 99.07 | 99.05 | 99.11 | 98.79 |
| 22     | 14627           | 80.02              | 3187      | 3000        | 98.66                 | 98.79  | 98.74 | 98.76 | 97.98 | 98.54 | 98.09 | 97.82 | 97.76 | 97.77 | 98.02 | 97.69 |
| 23     | 15019           | 82.17              | 3164      | 3000        | 99.19                 | 99.09  | 99.23 | 98.76 | 98.90 | 98.36 | 98.01 | 98.46 | 97.82 | 98.42 | 98.28 | 98.38 |
| 24     | 14052           | 79.71              | 3166      | 3000        | 99.30                 | 98.87  | 99.25 | 98.29 | 98.64 | 98.35 | 98.44 | 98.17 | 97.87 | 98.30 | 98.32 | 97.97 |
| 25     | 14268           | 79.75              | 3220      | 3000        | 99.81                 | 99.50  | 99.11 | 99.00 | 99.10 | 98.98 | 98.80 | 98.32 | 99.20 | 99.20 | 98.72 | 98.08 |
| n      | 25              | 25                 | 25        | 25          | 25                    | 25     | 25    | 25    | 25    | 25    | 25    | 25    | 25    | 25    | 25    | 25    |
| Mean   | 14475           | 80.06              |           |             | 98.92                 | 98.50  | 98.38 | 98.18 | 98.05 | 97.97 | 97.79 | 97.73 | 97.56 | 97.65 | 97.48 | 97.37 |
| Median | 14382           | 80.02              |           |             | 99.07                 | 98.76  | 98.67 | 98.29 | 98.10 | 98.06 | 98.10 | 97.82 | 97.73 | 97.57 | 97.53 | 97.65 |
| σ      | 419             | 1.16               |           |             | 0.77                  | 0.86   | 0.98  | 0.88  | 0.76  | 0.81  | 0.93  | 0.98  | 0.99  | 1.06  | 1.03  | 1.04  |
| Min.   | 13883           | 78.25              |           |             | 97.49                 | 96.63  | 96.23 | 96.36 | 96.35 | 96.39 | 96.16 | 95.95 | 96.12 | 95.86 | 95.35 | 95.55 |
| Max.   | 15296           | 82.27              |           |             | 99.96                 | 100.13 | 99.92 | 99.90 | 99.17 | 99.32 | 99.45 | 99.38 | 99.39 | 99.28 | 99.11 | 98.84 |

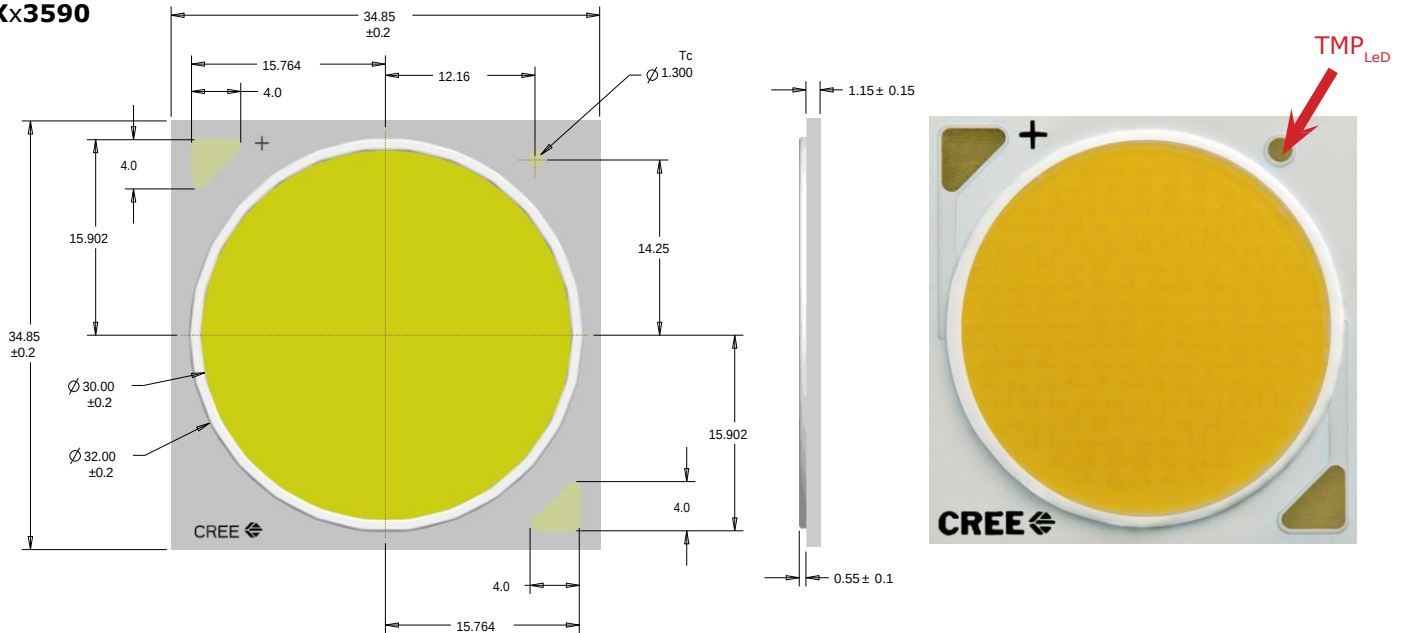
| Lamp # | Initial (0 hrs) |        |           |             | Chromaticity Shift (Δu'v') |        |        |        |        |        |        |        |        |        |        |        |
|--------|-----------------|--------|-----------|-------------|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|        | CCx             | CCy    | Calc. CCT | ANSI Target | 168                        | 1008   | 1512   | 2016   | 2520   | 3024   | 3528   | 4032   | 4536   | 5040   | 5544   | 6048   |
| 1      | 0.4327          | 0.4125 | 3146      | 3000        | 0.0006                     | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0013 |
| 2      | 0.4203          | 0.3926 | 3215      | 3000        | 0.0004                     | 0.0007 | 0.0007 | 0.0008 | 0.0009 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0011 | 0.0012 |
| 3      | 0.4304          | 0.4063 | 3138      | 3000        | 0.0006                     | 0.0007 | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0014 | 0.0015 | 0.0015 | 0.0016 | 0.0017 | 0.0017 |
| 4      | 0.4222          | 0.3941 | 3189      | 3000        | 0.0006                     | 0.0008 | 0.0009 | 0.0010 | 0.0012 | 0.0012 | 0.0013 | 0.0014 | 0.0015 | 0.0015 | 0.0014 | 0.0015 |
| 5      | 0.4351          | 0.4136 | 3112      | 3000        | 0.0006                     | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0015 |
| 6      | 0.4339          | 0.4139 | 3136      | 3000        | 0.0007                     | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0012 |
| 7      | 0.4451          | 0.4120 | 2935      | 3000        | 0.0005                     | 0.0010 | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0015 |
| 8      | 0.4299          | 0.4101 | 3177      | 3000        | 0.0005                     | 0.0009 | 0.0009 | 0.0011 | 0.0012 | 0.0014 | 0.0014 | 0.0016 | 0.0017 | 0.0017 | 0.0017 | 0.0018 |
| 9      | 0.4292          | 0.4081 | 3173      | 3000        | 0.0005                     | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0009 | 0.0010 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0011 |
| 10     | 0.4299          | 0.4066 | 3149      | 3000        | 0.0007                     | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0015 | 0.0015 | 0.0015 | 0.0016 |
| 11     | 0.4274          | 0.4044 | 3176      | 3000        | 0.0006                     | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0013 | 0.0014 | 0.0014 | 0.0015 |
| 12     | 0.4428          | 0.4087 | 2945      | 3000        | 0.0004                     | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0014 | 0.0015 | 0.0015 |
| 13     | 0.4422          | 0.4082 | 2950      | 3000        | 0.0004                     | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 |
| 14     | 0.4442          | 0.4101 | 2932      | 3000        | 0.0004                     | 0.0011 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0014 |
| 15     | 0.4297          | 0.4084 | 3168      | 3000        | 0.0005                     | 0.0008 | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0014 | 0.0014 | 0.0014 | 0.0015 | 0.0015 | 0.0015 |
| 16     | 0.4434          | 0.4077 | 2927      | 3000        | 0.0004                     | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0016 | 0.0017 |
| 17     | 0.4477          | 0.4102 | 2877      | 3000        | 0.0008                     | 0.0010 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0016 | 0.0016 | 0.0016 | 0.0016 |
| 18     | 0.4287          | 0.4046 | 3155      | 3000        | 0.0006                     | 0.0009 | 0.0011 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0014 | 0.0015 | 0.0015 | 0.0014 | 0.0014 |
| 19     | 0.4288          | 0.4067 | 3169      | 3000        | 0.0007                     | 0.0013 | 0.0016 | 0.0015 | 0.0016 | 0.0016 | 0.0018 | 0.0018 | 0.0018 | 0.0019 | 0.0019 | 0.0019 |
| 20     | 0.4292          | 0.4075 | 3169      | 3000        | 0.0009                     | 0.0011 | 0.0013 | 0.0012 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0015 | 0.0015 | 0.0015 | 0.0016 |
| 21     | 0.4215          | 0.3958 | 3218      | 3000        | 0.0005                     | 0.0008 | 0.0008 | 0.0009 | 0.0010 | 0.0012 | 0.0011 | 0.0012 | 0.0012 | 0.0011 | 0.0012 | 0.0012 |
| 22     | 0.4247          | 0.3994 | 3187      | 3000        | 0.0006                     | 0.0008 | 0.0009 | 0.0009 | 0.0010 | 0.0011 | 0.0012 | 0.0013 | 0.0014 | 0.0014 | 0.0015 | 0.0015 |
| 23     | 0.4286          | 0.4056 | 3164      | 3000        | 0.0007                     | 0.0007 | 0.0007 | 0.0008 | 0.0008 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0011 |
| 24     | 0.4244          | 0.3961 | 3166      | 3000        | 0.0007                     | 0.0010 | 0.0012 | 0.0012 | 0.0013 | 0.0014 | 0.0014 | 0.0015 | 0.0016 | 0.0015 | 0.0016 | 0.0017 |
| 25     | 0.4217          | 0.3966 | 3220      | 3000        | 0.0004                     | 0.0007 | 0.0008 | 0.0008 | 0.0009 | 0.0009 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0014 | 0.0014 |
| n      | 25              | 25     | 25        | 25          | 25                         | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     | 25     |
| Mean   |                 |        |           |             | 0.0006                     | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0014 | 0.0015 |
| Median |                 |        |           |             | 0.0006                     | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0015 |
| σ      |                 |        |           |             | 0.0001                     | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| Min.   |                 |        |           |             | 0.0004                     | 0.0007 | 0.0007 | 0.0008 | 0.0008 | 0.0009 | 0.0010 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0011 |
| Max.   |                 |        |           |             | 0.0009                     | 0.0013 | 0.0016 | 0.0015 | 0.0016 | 0.0016 | 0.0018 | 0.0018 | 0.0018 | 0.0019 | 0.0019 | 0.0019 |

## MECHANICAL DIMENSIONS & TEMPERATURE MEASUREMENT POINT

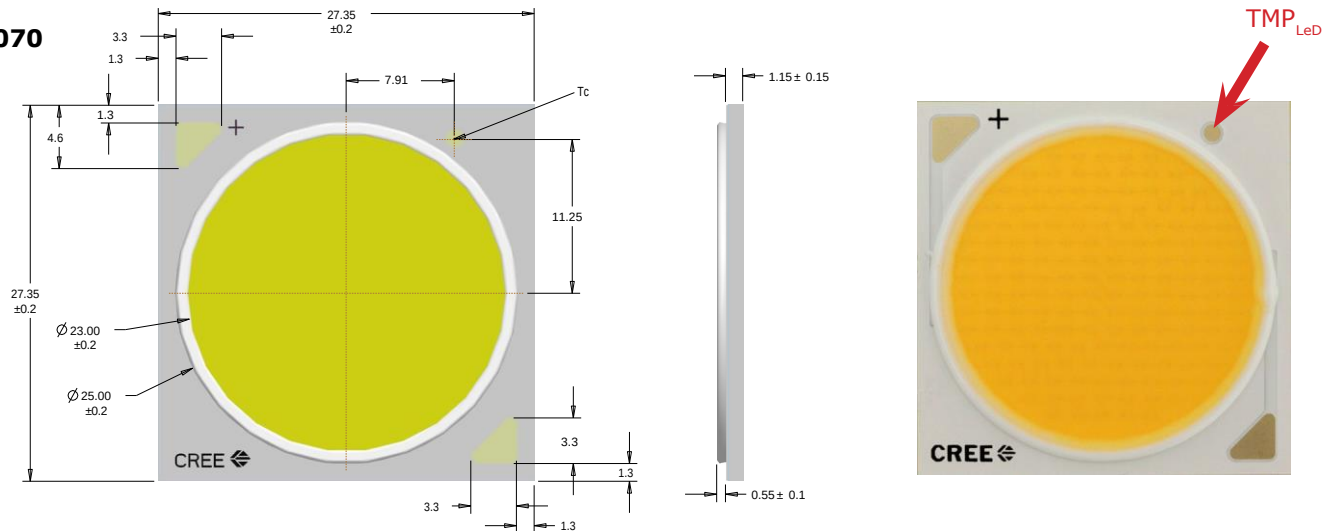
Dimensions are in mm. Tolerances unless otherwise specified:

.x  $\pm .10$ , .xx  $\pm .03$ , .xxx  $\pm .010$ ,  $x^\circ \pm 1^\circ$ , x  $\pm .10$

### CXx3590

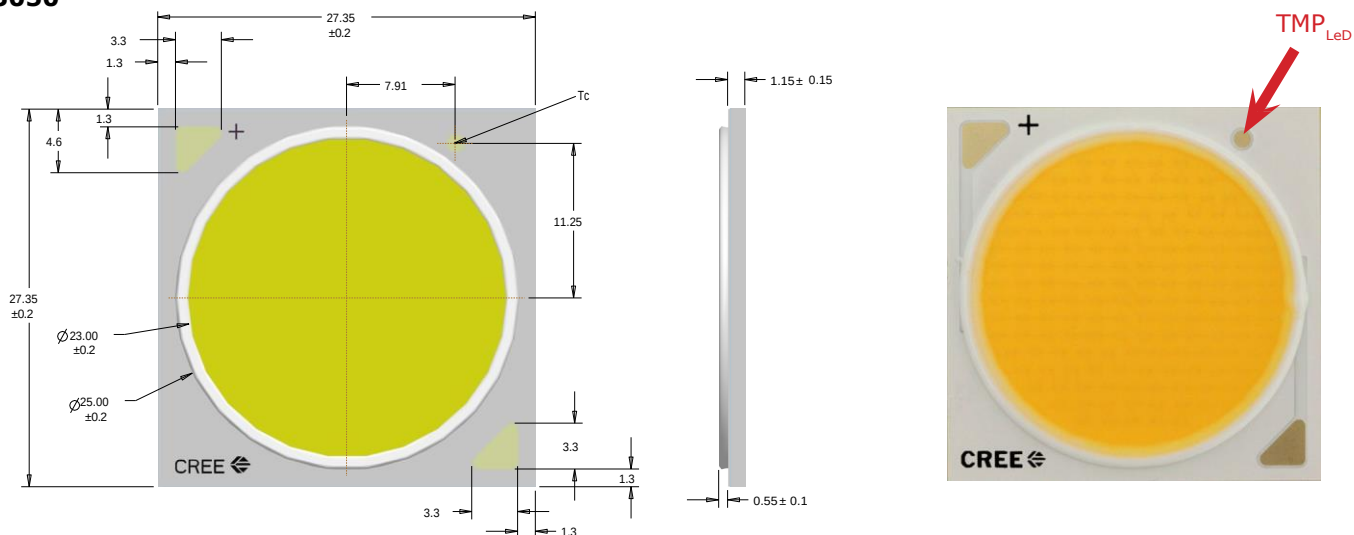
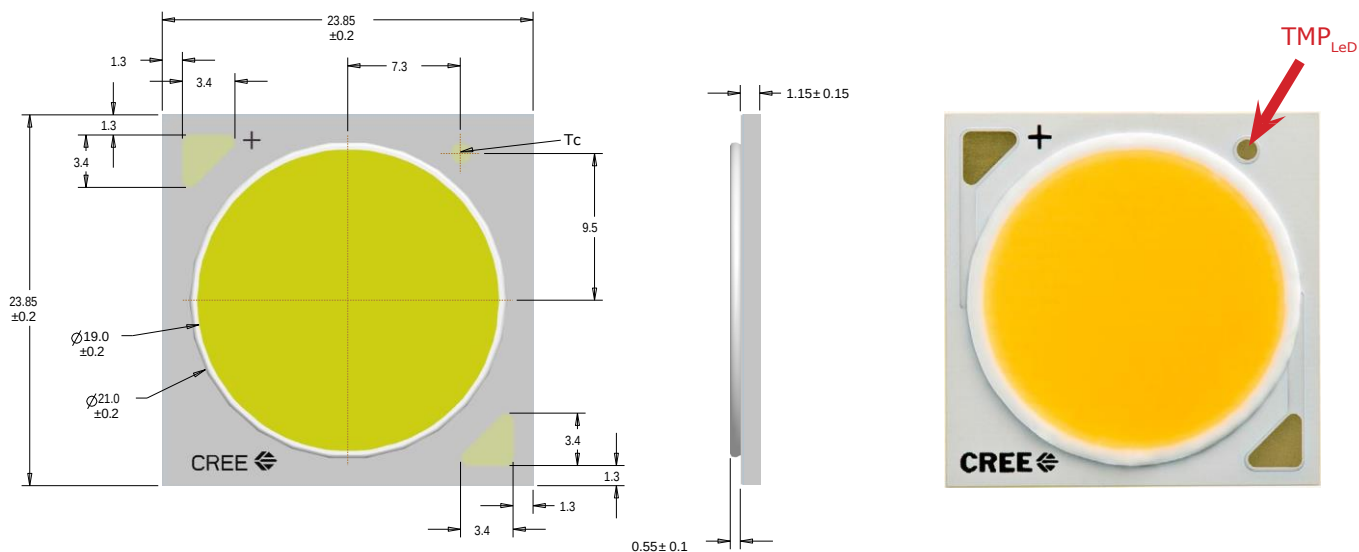


### CXx3070



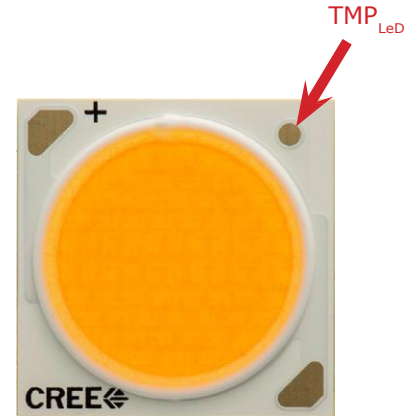
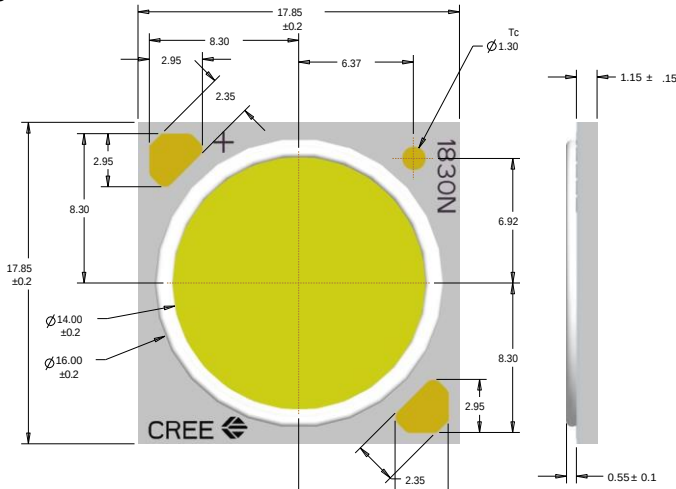
## MECHANICAL DIMENSIONS & TEMPERATURE MEASUREMENT POINT - CONTINUED

## CX<sub>x</sub>3050

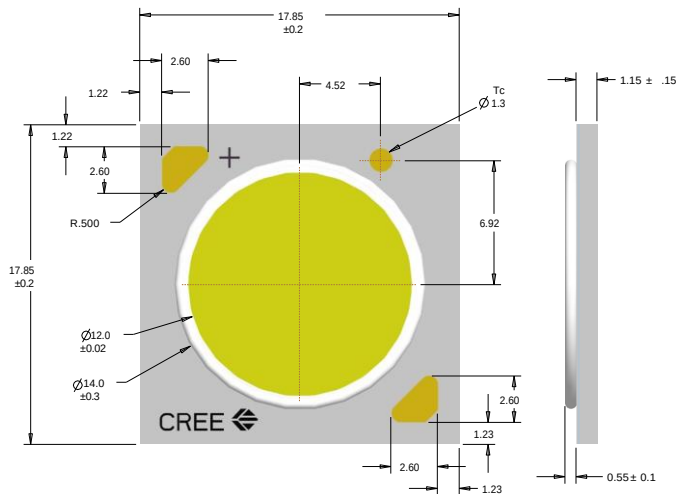
**CXx25xx**

## MECHANICAL DIMENSIONS & TEMPERATURE MEASUREMENT POINT - CONTINUED

### CXB1830

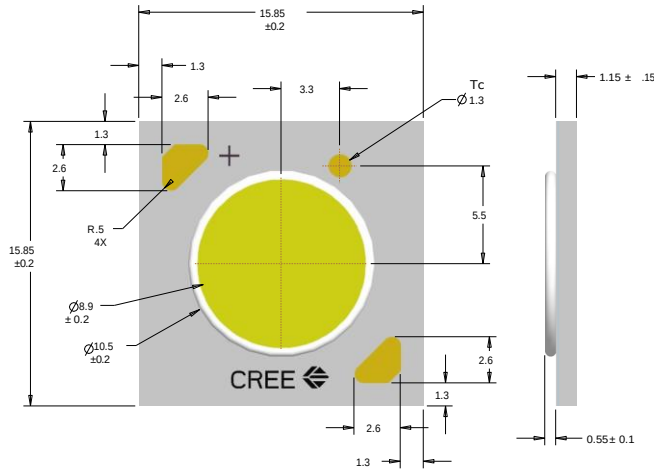


### CXx1816, CXx1820



## MECHANICAL DIMENSIONS & TEMPERATURE MEASUREMENT POINT - CONTINUED

### CX15XX



### CX1304

