

Series C  
Recommended BetaLED® Lumen Maintenance Factors (LMF)

# Series C

**PRODUCTS INCLUDE:**  
The EDGE (XAL, XAR, XCL, XPS, XSE, XBP), 304 Series (XCP Recessed Soffit)

| Ambient Temp* | Drive Current (mA) | Initial LMF | 25K hr LMF | 50K hr LMF | 100K hr LMF |
|---------------|--------------------|-------------|------------|------------|-------------|
| 5°C (41°F)    | 350mA              | 1.05        | 0.99       | 0.94       | 0.85        |
|               | 525mA              | 1.05        | 0.92       | 0.84       | 0.69        |
| 10°C (50°F)   | 350mA              | 1.04        | 0.96       | 0.91       | 0.82        |
|               | 525mA              | 1.04        | 0.89       | 0.81       | 0.66        |
| 15°C (59°F)   | 350mA              | 1.03        | 0.93       | 0.88       | 0.78        |
|               | 525mA              | 1.03        | 0.87       | 0.78       | 0.62        |
| 20°C (68°F)   | 350mA              | 1.01        | 0.91       | 0.85       | 0.74        |
|               | 525mA              | 1.01        | 0.84       | 0.76       | 0.59        |
| 25°C (77°F)   | 350mA              | 1.00        | 0.88       | 0.82       | 0.71        |
|               | 525mA              | 1.00        | 0.81       | 0.73       | 0.55        |

**PRODUCTS INCLUDE:**  
LEDway (XSL, XIL), 227 Series (XCR Recessed Canopy & Recessed Soffit), 304 Series (XCP Recessed Canopy, Parking Structure, & Flood)

| Ambient Temp* | Drive Current (mA) | Initial LMF | 25K hr LMF | 50K hr LMF | 100K hr LMF |
|---------------|--------------------|-------------|------------|------------|-------------|
| 5°C (41°F)    | 350mA              | 1.05        | 1.01       | 0.97       | 0.89        |
|               | 525mA              | 1.05        | 0.96       | 0.90       | 0.77        |
|               | 700mA              | 1.05        | 0.90       | 0.81       | 0.64        |
| 10°C (50°F)   | 350mA              | 1.04        | 0.96       | 0.95       | 0.86        |
|               | 525mA              | 1.04        | 0.94       | 0.87       | 0.74        |
|               | 700mA              | 1.04        | 0.88       | 0.79       | 0.60        |
| 15°C (59°F)   | 350mA              | 1.03        | 0.96       | 0.92       | 0.83        |
|               | 525mA              | 1.03        | 0.91       | 0.84       | 0.71        |
|               | 700mA              | 1.03        | 0.85       | 0.76       | 0.57        |
| 20°C (68°F)   | 350mA              | 1.01        | 0.94       | 0.89       | 0.80        |
|               | 525mA              | 1.01        | 0.88       | 0.81       | 0.67        |
|               | 700mA              | 1.01        | 0.83       | 0.73       | 0.53        |
| 25°C (77°F)   | 350mA              | 1.00        | 0.91       | 0.86       | 0.76        |
|               | 525mA              | 1.00        | 0.86       | 0.79       | 0.64        |
|               | 700mA              | 1.00        | 0.80       | 0.70       | 0.50        |

To determine light loss factor for lighting calculations, start by determining the annual average ambient temperature for your application's location (check the average ambient temperature on Environment Canada's National Climate Data Archive - under Climate Normals & Averages - this will include daytime ambient) [www.climate.weatheroffice.gc.ca](http://www.climate.weatheroffice.gc.ca)

**What about LDD (Luminaire Dirt Depreciation)?**

Dirt depreciation is extremely low on BetaLED products: no internal dirt buildup is possible because the BetaLED NanoOptic™ is sealed and IP66 rated. On the exterior of the luminaire, BetaLED's NanoOptic™ lenses operate at very low temperatures, avoiding the baked-on dirt typically experienced with HID lenses.



**\*Average Nighttime Temperature**  
Use the LMF values in this chart when performing lighting calculations for BetaLED products ONLY.

Rev. E Expires: 01/2012

Series D  
Recommended BetaLED® Lumen Maintenance Factors (LMF)

# Series D

**PRODUCTS INCLUDE:**  
The EDGE (XAL, XAR, XCL, XPS, XSE, XBP), 304 Series (XCP 304 Series Recessed Soffit)

| Ambient Temp* | Drive Current** (mA) | Initial LMF | 25K hr LMF | 50K hr LMF | 100K hr LMF |
|---------------|----------------------|-------------|------------|------------|-------------|
| -20°C† (-4°F) | 350mA                | 1.11        | 1.07       | 1.03       | 0.95        |
|               | 525mA                | 1.11        | 1.07       | 1.02       | 0.93        |
|               | 700mA                | 1.11        | 1.06       | 1.01       | 0.91        |
| -10°C† (14°F) | 350mA                | 1.09        | 1.05       | 1.00       | 0.92        |
|               | 525mA                | 1.09        | 1.04       | 0.99       | 0.89        |
|               | 700mA                | 1.09        | 1.03       | 0.98       | 0.87        |
| 5°C (41°F)    | 350mA                | 1.05        | 1.01       | 0.96       | 0.87        |
|               | 525mA                | 1.05        | 1.00       | 0.95       | 0.84        |
|               | 700mA                | 1.05        | 0.99       | 0.93       | 0.81        |
| 10°C (50°F)   | 350mA                | 1.04        | 0.99       | 0.95       | 0.86        |
|               | 525mA                | 1.04        | 0.98       | 0.93       | 0.83        |
|               | 700mA                | 1.04        | 0.98       | 0.92       | 0.80        |
| 15°C (59°F)   | 350mA                | 1.03        | 0.98       | 0.93       | 0.84        |
|               | 525mA                | 1.03        | 0.97       | 0.92       | 0.81        |
|               | 700mA                | 1.03        | 0.96       | 0.90       | 0.78        |
| 20°C (68°F)   | 350mA                | 1.01        | 0.97       | 0.92       | 0.82        |
|               | 525mA                | 1.01        | 0.96       | 0.90       | 0.79        |
|               | 700mA                | 1.01        | 0.95       | 0.88       | 0.76        |
| 25°C (77°F)   | 350mA                | 1.00        | 0.95       | 0.90       | 0.81        |
|               | 525mA                | 1.00        | 0.94       | 0.89       | 0.77        |
|               | 700mA                | 1.00        | 0.93       | 0.87       | 0.74        |

\*\* Consult spec sheet for actual drive current availability for all listed products

**PRODUCTS INCLUDE:**  
LEDway (XSL, XIL), SLM Series (X6A, X6S), 227 Series (XCR Recessed Canopy), 304 Series (XCP Recessed Canopy, Parking Structure, & Flood), OL Series (XFR Flood)

| Ambient Temp* | Drive Current** (mA) | Initial LMF | 25K hr LMF | 50K hr LMF | 100K hr LMF |      |
|---------------|----------------------|-------------|------------|------------|-------------|------|
| -20°C† (-4°F) | 350mA                | 1.11        | 1.07       | 1.03       | 0.96        |      |
|               | 525mA                | 1.11        | 1.07       | 1.03       | 0.94        |      |
|               | 700mA                | 1.11        | 1.06       | 1.01       | 0.92        |      |
| -10°C† (14°F) | 350mA                | 1.09        | 1.05       | 1.01       | 0.93        |      |
|               | 525mA                | 1.09        | 1.04       | 1.00       | 0.91        |      |
|               | 700mA                | 1.09        | 1.04       | 0.99       | 0.88        |      |
| 5°C (41°F)    | 350mA                | 1.05        | 1.01       | 0.97       | 0.88        |      |
|               | 525mA                | 1.05        | 1.00       | 0.95       | 0.86        |      |
|               | 700mA                | 1.05        | 0.99       | 0.94       | 0.83        |      |
| 10°C (50°F)   | 350mA                | 1.05        | 0.98       | 0.90       | 0.76        |      |
|               | 350mA                | 1.04        | 0.99       | 0.95       | 0.87        |      |
|               | 525mA                | 1.04        | 0.99       | 0.94       | 0.84        |      |
| 10°C (50°F)   | 700mA                | 1.04        | 0.98       | 0.92       | 0.81        |      |
|               | 1000mA               | 1.04        | 0.96       | 0.89       | 0.74        |      |
|               | 15°C (59°F)          | 350mA       | 1.03       | 0.98       | 0.94        | 0.85 |
| 525mA         |                      | 1.03        | 0.98       | 0.93       | 0.82        |      |
| 700mA         |                      | 1.03        | 0.97       | 0.91       | 0.79        |      |
| 15°C (59°F)   | 1000mA               | 1.03        | 0.95       | 0.87       | 0.71        |      |
|               | 20°C (68°F)          | 350mA       | 1.01       | 0.97       | 0.92        | 0.83 |
|               |                      | 525mA       | 1.01       | 0.96       | 0.91        | 0.81 |
| 700mA         |                      | 1.01        | 0.95       | 0.89       | 0.77        |      |
| 20°C (68°F)   | 1000mA               | 1.01        | 0.93       | 0.85       | 0.69        |      |
|               | 25°C (77°F)          | 350mA       | 1.00       | 0.96       | 0.91        | 0.82 |
|               |                      | 525mA       | 1.00       | 0.95       | 0.90        | 0.79 |
| 700mA         |                      | 1.00        | 0.94       | 0.88       | 0.75        |      |
| 25°C (77°F)   | 1000mA               | 1.00        | 0.92       | 0.83       | 0.66        |      |

\*\* 1000mA available on 20-40 SLM and SLM66 only



\*Average Nighttime Temperature  
† Provided for freezer applications only  
Use the LMF values in this chart when performing lighting calculations for BetaLED products ONLY.

Rev. E Expires: 01/2012



## Explanation of Calculations for Recommended BetaLED® Lumen Maintenance Factors (LMF)

*This is an explanation of how the Recommended BetaLED® Lumen Maintenance Factors (LMF) are derived. These calculations do not need to be repeated – refer to the map and zone charts to select the appropriate Lumen Maintenance Factor based on your specific anticipated application life, average ambient nighttime temperature, product family and selected drive current.*

### Applied Standards

- **IESNA LM-79 (Initial Photometric Performance Data)**  
Photometric data per IESNA LM-79 (i.e. IES Photometric File formatted per IESNA LM-63)  
**Note:** Test performed at 25°C ambient operating condition (per IESNA LM-79 standard)
- **IESNA LM-80 (Lumen Depreciation Performance Data)**  
LED Luminaire Lumen Depreciation Data sets are created using correlated in-situ luminaire test methods (i.e. LED chip package temperature ( $T_c$ ) measurement obtained with the LED chip package operating in given luminaire and in a given stabilized ambient environment. The  $T_c$  temperature is correlated directly to the LED chip package manufacturer's LM-80 data to form data sets predicting luminaire lumen depreciation for various luminaire average ambient operating conditions.).

### Outdoor Average Ambient Conditions (Temperature Zones)

- In Canada, consult Environment Canada's National Climate Data Archive.

### Application Life Assumptions

*(Refer to chart contained in **Recommended BetaLED Lumen Maintenance Factors (LMF)** document)*

- Initial LD – Initial luminous flux performance
- 25K hr LD (~dusk to dawn operation over a 6-year period)
- 50K hr LD (~dusk to dawn operation over a 12-year period)
- 100K hr LD (~dusk to dawn operation over a 25-year period)

### Derived LMF Calculation Example

#### **Application Example:**

Location: Lethbridge, AB (5°C average nighttime ambient per Environment Canada data)

Anticipated Application Life: 50K hours (approx. 12 years dusk-to-dawn operation)

BetaLED Product: Series D LEDway® streetlight – 700mA drive current



#### **Step One:**

**Adjust initial photometric performance to account for nighttime average ambient operating temperature less than the photometric test ambient environment (i.e. 25°C)**

**Statement of Fact:** The LED chip package used in BetaLED luminaires gains 0.25% in luminous flux (lumen output) for **each degree** below the photometric test ambient temperature (i.e. 25°C).

For a location in the 5°C average nighttime ambient operating temperature zone (e.g. Lethbridge, AB) the delivered initial luminous flux is ~ 5% higher at 5°C nighttime average ambient operating temperature compared to 25°C photometric test ambient.

#### Initial Luminous Flux Change Calculation:

- 25°C – 5°C = 20°C cooler than the 25°C photometric test ambient
- 20°C x 0.25 %/°C = 5% or 0.05 (gain in initial luminous flux due to lower ambient temperature)
- 1.00 (initial photometric performance factor) + 0.05 (initial luminous flux increase) = 1.05

The result of this calculation is represented by the “1.05” value listed in the “**Initial LMF**” column.



## Explanation of Calculations for Recommended BetaLED® Lumen Maintenance Factors (LMF)



### **Step Two:**

**Determine appropriate amount of lumen maintenance to be applied to initial photometric data based on lumen depreciation data acquired from the LED chip package manufacturer's IESNA LM-80 test report and the predicted application duration (i.e. 50K hours for our example).**

BetaLED LEDway product in 5°C ambient using standard 700mA drive current will experience 10% lumen depreciation (or 90% lumen maintenance) after 50K hours of operation. See chart on page 5.

**Therefore**, Lumen Maintenance Factor (LMF) applied to initial photometric performance (i.e. the IES file data per IESNA LM-79) is as follows:

$0.90$  (5°C ambient correlated lumen depreciation rate from LM-80 Data)  $\times$   $1.05$  (initial luminous flux increase due to ambient 20°C less than photometric test ambient) = **0.94 (value listed in the 50K hr LLF column)**

### **Conclusion**

The LMF for a 700mA BetaLED LEDway product in a 50K hour application environment and a 5°C average nighttime ambient zone would be 0.94. Applying this LMF to your photometric calculations will account for the change in luminous flux (output) after 50K hours of operation. The light levels generated using this method are also known as the "lowest in service values."

Be sure to utilize the correct LMF chart for the BetaLED product you have selected.

# Series D

## LED LMF MULTIPLIER EXAMPLE: 700mA @ 5°C

$$0.90 \times 1.05 = 0.94$$

obtained from chart below

New multiplier for this example

LEDs gain 0.25% lumen output for each degree C below 25%

See step 2

from previous page for more information

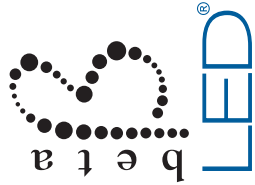
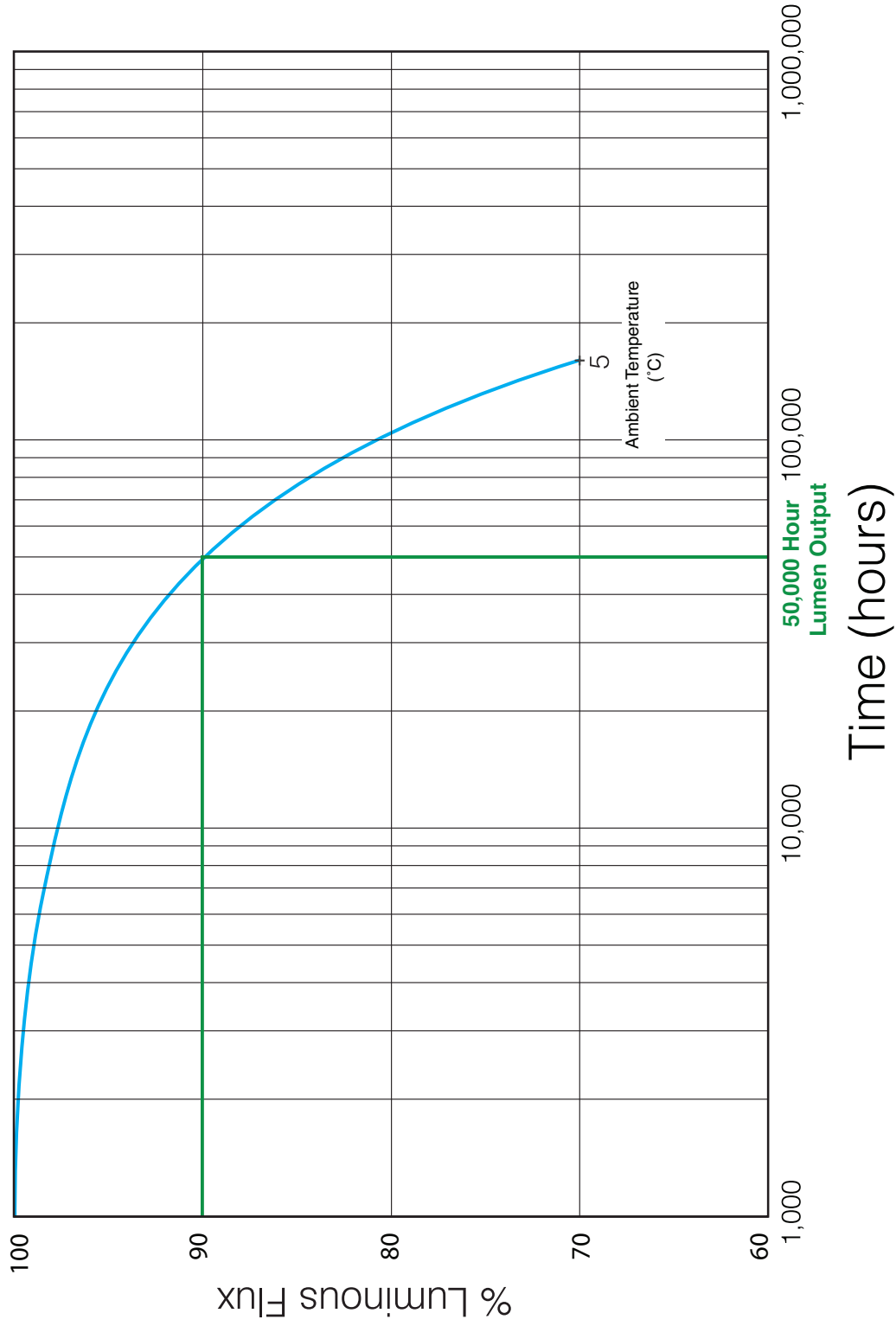
$$25 - 5 = 20$$

$$20 \times .25 = 5\%$$

$$0.05 + 1.000 = 1.05$$

### Series D BetaLED LEDway® 700mA Lumen Maintenance

#### Predictions vs. Ambient Temperature





23 March, 2011

Cree<sup>®</sup>, Inc. performs extensive testing of LEDs per IES LM-80-08, Measuring Lumen Maintenance of LED Light Sources. The Cree Solid State Lighting Test Laboratory has been accredited to ISO/IEC 17025:2005 by the United States Department of Commerce's *National Voluntary Laboratory Accreditation Program (NVLAP)*. As such Cree is recognized by the United States Environmental Protection Agency (EPA) to perform LM-80 testing for Energy Star<sup>®</sup> products.

With test data from this LM-80 testing, Cree has projected the long term lumen maintenance behavior of the XP-E and XP-G XLamp LEDs using current industry accepted methods. A summary of this test data can be found in the publicly available Cree<sup>®</sup> XLamp<sup>®</sup> LED IES LM-80 Testing Results.

BetaLED<sup>®</sup> has used the Cree lumen maintenance projections to create Technical Document TD-13, "Recommended BetaLED Lumen Maintenance Factors (LMF)" and TD-14, "BetaLED Essentia<sup>™</sup> Lumen Maintenance Factors (LMF)". The BetaLED Technical Documents use operating conditions – including ambient temperatures and drive currents – to develop lumen maintenance projections specific to their products that incorporate Cree XLamp LEDs.

A review of the BetaLED documents has found that both their technical approach and their lumen maintenance projections are consistent with those provided by Cree.

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