ESSENTIA™ INTERIOR LED

BetaLED® Essentia Lumen Maintenance Factors (LMF)

14 LED Light Engine

Ambient Temp.	Current	Aperture*	Type	Initial LMF	25K hr LMF	35K hr LMF	50K hr LMF
25°C (77°F)	525mA	4" or 6"	Downlight	1.00	0.90	0.87	0.83
	525mA	6"	Adjustable	1.00	0.88	0.85	0.81
	525mA	6"	Wallwash	1.00	0.89	0.87	0.83
30°C (86°F)	525mA	4" or 6"	Downlight	0.99	0.87	0.85	0.80
	525mA	6"	Adjustable	0.99	0.85	0.82	0.78
	525mA	6"	Wallwash	0.99	0.87	0.84	0.80
40°C (104°F)	525mA	4" or 6"	Downlight	0.96	0.82	0.79	0.75
	525mA	6"	Adjustable	0.96	0.80	0.77	0.72
	525mA	6"	Wallwash	0.96	0.82	0.79	0.74

28 LED Light Engine

Ambient Temp.	Current	Aperture*	Type	Initial LMF	25K hr LMF	35K hr LMF	50K hr LMF
25°C (77°F)	525mA	6" or 8"	Downlight	1.00	0.90	0.87	0.83
	525mA	8"	Adjustable	1.00	0.88	0.85	0.80
	525mA	8"	Wallwash	1.00	0.85	0.87	0.77
30°C (86°F)	525mA	6" or 8"	Downlight	0.99	0.87	0.84	0.80
	525mA	8"	Adjustable	0.99	0.85	0.82	0.78
	525mA	8"	Wallwash	0.99	0.87	0.84	0.80
40°C (104°F)	525mA	6" or 8"	Downlight	0.96	0.82	0.79	0.74
	525mA	8"	Adjustable	0.96	0.80	0.77	0.72
	525mA	8"	Wallwash	0.96	0.82	0.79	0.74

42 LED Light Engine

Ambient Temp.	Current	Aperture*	Type	Initial LMF	25K hr LMF	35K hr LMF	50K hr LMF
25°C (77°F)	525mA	8"	Downlight	1.00	0.89	0.86	0.82
30°C (86°F)	525mA	8"	Downlight	0.99	0.86	0.83	0.79
40°C (104°F)	525mA	8"	Downlight	0.96	0.81	0.78	0.73

56 LED Light Engine

Ambient Temp.	Current	Aperture*	Type	Initial LMF	25K hr LMF	35K hr LMF	50K hr LMF
25°C (77°F)	525mA	8"	Downlight	1.00	0.87	0.84	0.80
30°C (86°F)	525mA	8"	Downlight	0.99	0.84	0.81	0.77
40°C (104°F)	525mA	8"	Downlight	0.96	0.79	0.76	0.71

*This document is for Essentia round and square luminaires

Expires: 01/2012

ESSENTIA™ INTERIOR LED

Performance Data

Power Consumption (Watts)									
		BetaLED@120V		BetaLED@277V		Lutron@120V		Lutron@277V	
Drive Current	# LED's	Power (Watts)	Current (Amps)	Power (Watts)	Current (Amps)	Power (Watts)	Current (Amps)	Power (Watts)	Current (Amps)
525mA	14	28.1	0.24	29.4	0.20	30.6	0.27	31.2	0.20
525mA	28	56.1	0.48	57.4	0.30	58.0	0.50	58.7	0.32
525mA	42	83.1	0.72	84.4	0.42	N/A	N/A	N/A	N/A
525mA	56	106.3	0.91	108.2	0.51	N/A	N/A	N/A	N/A

With standard dimming driving: when fully dimmed using 0-10V controls, there will be 10% of the current delivered to the LEDs, which equates to 12% of the input power and 11% relative light output. These values take power factor and efficiency at dimmed levels into consideration.

Color Temperature	Lumen Multiplier
2700K	0.93
3000K	1.00
3500K	1.00
4250K	1.14

beta LED®

Expires: 01/2012

Explanation of Calculations for Recommended Essentia Lumen Maintenance Factors (LMF)

The following is an explanation of how the Recommended BetaLED® Essentia Lumen Maintenance Factors (LMF) are derived. These steps do not need to be repeated – refer to the BetaLED Essentia Lumen Maintenance Factors (LMF) charts to select the appropriate Lumen Maintenance Factor based on your specific light engine configuration (i.e. number of LEDs), product type (Downlight, Adjustable or Wallwash), anticipated application life, average luminaire ambient operating temperature condition and drive current.

Applied Standards

- **IESNA LM-79 (Initial Photometric Performance Data)**
  Photometric data per IESNA LM-79-08 (i.e. IES Photometric File Formatted per IESNA LM-63)
  Note: Testing is performed at 25°C ambient operating condition (per IESNA LM-79-08 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 (TS) measurement obtained with the LED chip package operating in a given luminaire and in a given stabilized ambient environment.
  The TS 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.).

Average Ambient Ceiling Cavity or Plenum Conditions (i.e. Ambient Temperature)

- Defined as the average temperature the luminaire is exposed to above and below the ceiling surface in which the luminaire is installed.
  Note: Typical installed conditions yield above ceiling temperatures higher than below ceiling temperatures.

Application Life Descriptions/References

(Refer to charts contained in BetaLED Essentia Lumen Maintenance Factors (LMF) document)

- Initial LMF – Initial luminous flux performance
- 25K hr LMF[1] (~3 hour per day operation over a 23-year (365 days/year) period)
- 35K hr LMF[2] (~12 hour per day operation over a 12-year (250 days/year) period)
- 50K hr LMF (~12 hour per day operation over a 12-year (365 days/year) period)

Derived LMF Calculation Example

Application Example:

Ambient Temperature Condition: 30°C ceiling cavity
Application Life Assumption: 50K hours (approximately 12 years of 12 hour per day operation)
Product: Essentia 6" 28 LED Downlight – 525mA Drive Current

Step One:

Adjust initial photometric performance (initial luminous flux) to account ambient operating temperature above or below 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). Conversely, the chip package loses 0.25% luminous flux for each degree above the test temperature.
For a luminaire operating in a 30°C average ambient environment, the delivered initial luminous flux is 1.25% less than the delivered luminous flux recorded during the IESNA LM-79-08 testing procedure, conducted in the required 25°C ambient condition.

Initial Luminous Flux Change Calculation:

1. 25°C – 30°C = -5°C (i.e. 5°C warmer than the 25°C photometric test ambient)
2. -5°C x 0.25 %/°C = -1.25% or -0.0125
   (loss in initial luminous flux due to ambient condition higher than photometric test condition)
3. 1.00 (initial photometric performance factor) - 0.0125 (initial luminous flux decrease)
   = 0.9875

The result of this calculation is represented by the "**0.99**" value listed in the "**Initial LMF**" column.

Step Two:

Determine appropriate Lumen Maintenance Factor (LMF) to be applied to initial photometric data based on lumen depreciation data acquired from the LED chip package manufacturer's IESNA LM-80-08 test report and the selected application duration (i.e. 50K hours for our example).

BetaLED Essentia product in a 30°C ambient environment using standard 525mA drive current will experience 81.5% lumen maintenance (or 18.5% lumen depreciation) after 50K hours of operation.
Note: *This value is derived from in-situ luminaire temperature measurement testing and correlation to the chip package manufacturers IESNA LM-80-08 data sets, as described in the **Applied Standards** section of this document.*

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

0.815 (30°C ambient correlated lumen depreciation rate from the LED chip package manufacturer's IESNA LM-80-08 test report) **X 0.9875** (initial luminous flux decrease due to ambient 5°C higher than photometric test ambient)
= **0.80 (value listed in the 50K hr LMF column)**

Conclusion

The LMF for a 6" 28 LED 525mA BetaLED Essentia Downlight luminaire in a 50K hour application with a 30°C average ambient environment would be 0.80. Applying this Lumen Maintenance Factor (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."

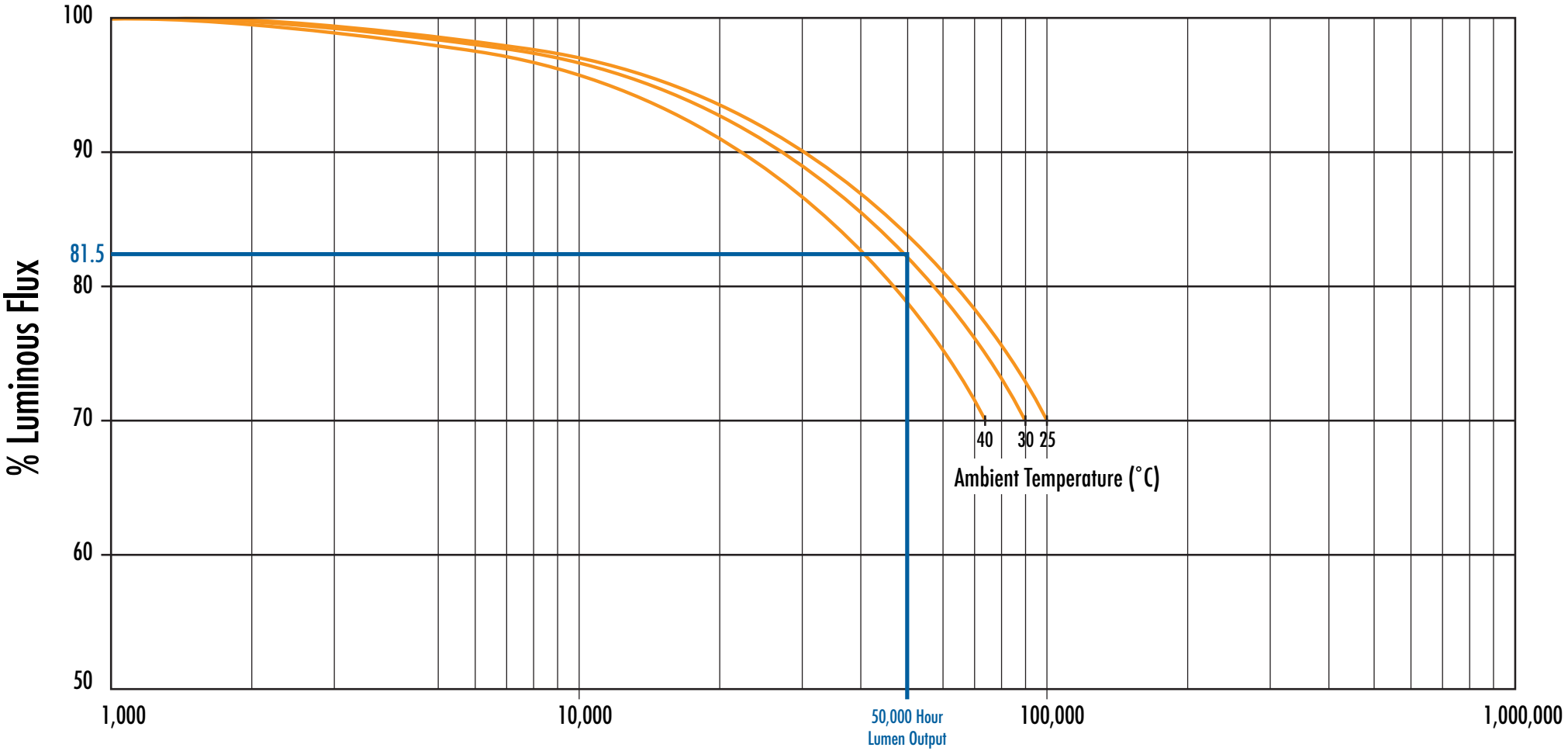
Be sure to select the correct LMF chart value for the BetaLED Essentia product and conditions specific to your application (i.e the correct Light Engine LED count, ambient temperature, drive current, type (i.e. downlight, adjustable or wallwash), Aperture (i.e. 4, 6 or 8") and the application duration being considered.

[1] Residential L_{70} Limit (i.e. 70% lumen Maintenance Threshold) Per ENERGY STAR®
[2] Commercial L_{70} Limit (i.e. 70% lumen Maintenance Threshold) Per ENERGY STAR®

ESSENTIA™ INTERIOR LED

LED LMF Multiplier Example: 525mA @ 30°C

6" 28 LED Downlight, 525mA Lumen Maintenance Predictions vs. Ambient Temperature



0.815	x	0.9875	=	0.80
Value obtained from above (see "Step Two" on previous page for more info)		LEDs drop 0.25% lumen output for each degree C above 25°C 25°C - 30°C = -5°C -5°C x 0.25 = -1.25% drop 1.000 - 0.0125 = 0.9875		New multiplier for this example

23 March, 2011

Cree®, 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 Sates Environmental Protection Agency (EPA) to perform LM-80 testing for Energy Star® 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® XLamp® LED IES LM-80 Testing Results.

BetaLED® has used the Cree lumen maintenance projections to create Technical Document TD-13, "Recommended BetaLED Lumen Maintenance Factors (LMF)" and TD-14, "BetaLED Essentia™ 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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