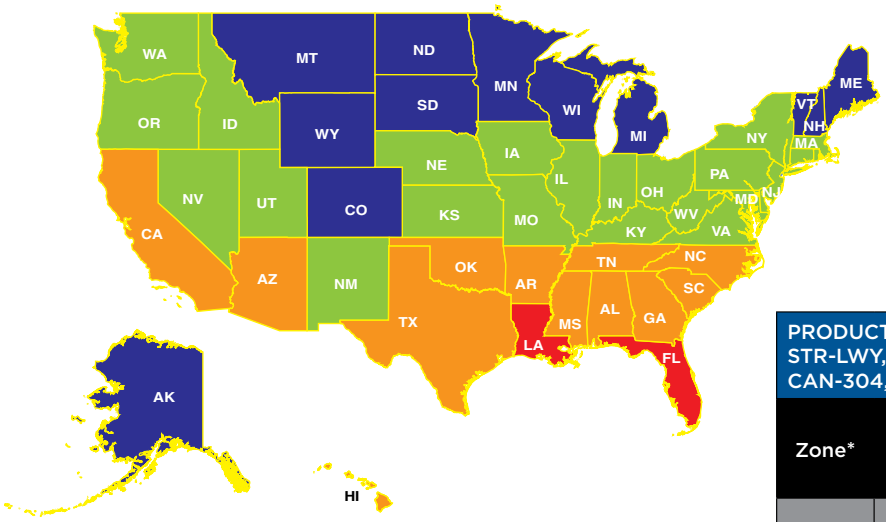
Series D – Recommended Cree® Outdoor Luminaire Lumen Maintenance Factors (LMF)



Series D

PRODUCTS INCLUDE:
ARE-EDG, ARE-EDR, SEC-EDG, CAN-EDG, PKG-EDG, INT-EDR, PWY-EDG, SFT-304, FLD-EDG

Zone*	Drive Current[1] (mA)	Initial LMF	25K hr LMF (Projected[3])	50K hr LMF (Projected[3])	100K hr LMF (Calculated[4])
-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
40˚C (104˚F)	350mA	0.96	0.91	0.86	0.76
	525mA	0.96	0.90	0.84	0.72
	700mA	0.96	0.89	0.82	0.67

PRODUCTS INCLUDE:
STR-LWY, STR-SLM, STR-SLM66, ARE-SLM66, BXAB, CAN-227, CAN-304, PKG-304, FLD-OL, INT-304, SFT-227

Zone*	Drive Current[2] (mA)	Initial LMF	25K hr LMF (Projected[3])	50K hr LMF (Projected[3])	100K hr LMF (Calculated[4])
-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
	1000mA	1.05	0.98	0.90	0.75
10˚C (50˚F)	350mA	1.04	0.99	0.95	0.87
	525mA	1.04	0.99	0.94	0.84
	700mA	1.04	0.98	0.92	0.81
	1000mA	1.04	0.96	0.88	0.73
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
	1000mA	1.03	0.94	0.86	0.70
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
	1000mA	1.01	0.93	0.84	0.67
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
	1000mA	1.00	0.91	0.82	0.65
40˚C (104˚F)	350mA	0.96	0.92	0.87	0.77
	525mA	0.96	0.91	0.85	0.74
	700mA	0.96	0.89	0.83	0.69
	1000mA	0.96	0.86	0.76	0.55

1 Consult spec sheet for actual drive current availability for all listed products

* Average Nighttime Temperature

† Provided for freezer applications only
Use the LMF values in this chart when performing lighting calculations for Cree® products ONLY.

2 1000mA available on 20-40 SLM, SLM66 and BXAB only

3 In accordance with IESNA TM-21-11, **Projected Values** represent interpolated values based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. the packaged LED chip).

4 In accordance with IESNA TM-21-11, **Calculated Values** represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. the packaged LED chip)

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Explanation of Calculations for Recommended Cree® Outdoor Luminaire Lumen Maintenance Factors (LMF), TD-13

The following is an explanation of how the Recommended Cree Outdoor Luminaire Lumen Maintenance Factors (LMF) are derived. The example calculations do not need to be repeated – refer to the map and zone charts, contained in the TD-13 document, to select the appropriate Lumen Maintenance Factor based on your specific anticipated application life (in hours), average ambient nighttime temperature, product family and selected drive current.

Applied Standards, Data and Assumptions

- **IESNA LM-79-08 (Initial Photometric Performance Data)**
  Photometric data per IESNA LM-79-08 (i.e. IES Photometric File formatted per IESNA LM-63-02)
  Note: Test performed at 25˚C ambient operating condition (per IESNA LM-79-08 standard)

- **IESNA LM-80-08 and IESNA TM-21-11 (Lumen Maintenance Performance Data)**
  Cree Outdoor Luminaire Lumen Maintenance Data sets are created using correlated in-situ luminaire test methods (i.e. LED chip package temperature (T_S) measurement(s) obtained with the LED chip package(s) operating in given luminaire and in a given stabilized ambient environment. The T_S temperature(s) is correlated directly to the LED chip package manufacturer's LM-80-08 data, in conjunction with TM-21-11 described extrapolation and interpolation methods, to form data sets predicting luminaire lumen maintenance for various luminaire average ambient operating conditions.).

Outdoor Average Ambient Conditions (Temperature Zones)

- Average dusk to dawn (i.e. nighttime) temperature data per National Oceanic and Atmospheric Administration (NOAA)

Application Life Descriptions/References

*(Refer to chart contained in **Recommended Cree Outdoor Luminaire Lumen Maintenance Factors (LMF)** document)*

- Initial LMF – Initial luminous flux performance
- 25K hr projected LMF (approx. dusk to dawn operation over a 6-year period)
- 50K hr projected LMF (approx. dusk to dawn operation over a 12-year period)
- 100K hr calculated LMF (approx. dusk to dawn operation over a 25-year period)

Derived LMF Calculation Example

APPLICATION EXAMPLE:

Location: Wisconsin (5˚C average nighttime ambient per NOAA data)

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

Cree 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. less than 25˚C)

Statement of Fact: The LED chip package selected for use in Cree Outdoor luminaires gains 0.25% in luminous flux (lumen output) for each degree (˚C) below the photometric test ambient temperature (i.e. each degree below 25˚C).

For a location in the 5˚C average nighttime ambient operating temperature zone (e.g. Wisconsin) the delivered initial luminous flux is approx. 5% higher at 5˚C nighttime average ambient operating temperature compared to 25˚C photometric test ambient.

Initial Luminous Flux Change Calculation:
a. 25˚C – 5˚C = 20˚C cooler than the 25˚C photometric test ambient
b. 20˚C x 0.25 %/˚C = 5% or 0.05 (gain in initial luminous flux due to lower ambient temperature)
c. 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.

STEP TWO

Determine appropriate correlated lumen maintenance multiplier to be applied to the "Initial LMF" based on in-situ luminaire test methods and IESNA LM-80-08 and IESNA TM-21-11 Standards and Practices (as described above), for the predicted application duration (i.e. 50K hours for this example).

Cree 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.

Note: This value is derived from in-situ luminaire temperature measurement testing and correlation to the chip package manufacturer's IESNA LM-80-08 data sets in conjunction with TM-21-11 described extrapolation and interpolation methods, as explained in the **Applied Standards, Data and Assumptions** section of this document.

Therefore, the Corresponding Lumen Maintenance Factor (LMF) is derived as follows:
0.90 (5˚C **correlated lumen maintenance multiplier**) **X** 1.05 (initial luminous flux increase due to ambient 20°C less than photometric test ambient) = 0.94 (value listed in the **Projected 50K hr LMF column for 700mA drive current**)

CONCLUSION

The appropriate TM-21-11 Projected LMF for a 700mA Cree® LEDway product in a 50K hour application environment and a 5˚C average nighttime ambient zone would be 0.94. Applying this recommended 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, may also be referred to as the "lowest in service values."

Be sure to identify the correct LMF chart for the Cree Outdoor Luminaire product you have selected (i.e. LEDway streetlight, THE EDGE®, CAN-227, CAN-304, PKG-304, etc).