



LED & Maintenance Factors

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With all lighting designs it is important to understand the maintenance regime. This ensures that the lighting design provided will achieve the target lighting levels at the end of the determined maintenance programme for a particular project.

Whether the maintenance programme has been defined within a specification or not, it is up to the lighting designer to provide details of the maintenance cycle used within their lighting design.

Unlike traditional light sources there are currently no defined industry standards for calculating a Maintenance Factor for an LED light source. Because luminaire construction and temperature management have a major impact on LED performance, the end user must rely more on the luminaire manufacturer for this data.

LEDs offer a great opportunity to save energy and extend the maintenance service life of a project. A regular, robust, sensible and realistic maintenance regime must be adopted to ensure expected light levels at the end of the maintenance cycle are achieved. This means that as with a conventional light source, the following four parameters need to be considered when calculating the Maintenance Factor of an installation:

$$\begin{aligned} \text{MF} = & \text{LLMF (Lamp Lumen Maintenance Factor)} \\ & \times \text{LMF (Luminaire Maintenance Factor)} \\ & \times \text{RSMF (Room Surface Maintenance Factor)} \\ & \times \text{LSF (Lamp Survival Factor)} \end{aligned}$$

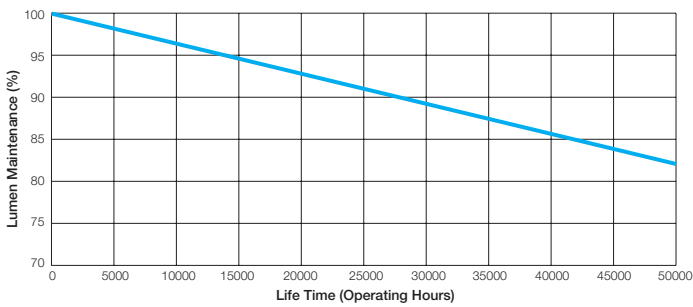
On the following pages is a breakdown of our recommendations and explanation for calculating the MF for an LED light source as well as recommendations for the best maintenance regimes.

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LLMF - Lamp Lumen Maintenance Factor

Sol IV Semiconductor only selects LEDs from manufacturers that provide third party LM80 data. By designing luminaires for optimal thermal performance and carrying out thermal analysis of the LED light engine to BSEN60598, SolIVSemiconductor can accurately predict the lumen depreciation for the specified life of the luminaire.

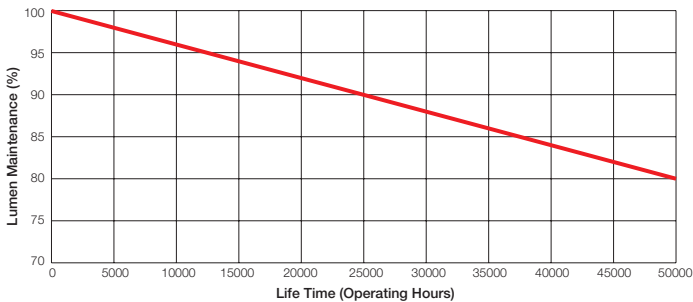
Typical Lumen Depreciation of Paragon LE Light Engine Type A (L82 B50)



Typical Luminaires:

LED Troffer, LED Commercial Channel, LED Strip Fixture, other open, semi-open or large cavity luminaires

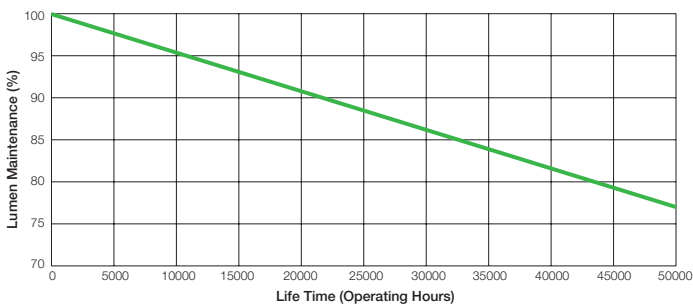
Typical Lumen Depreciation of Paragon LE Light Engine Type B (L80 B50)



Typical Luminaires:

Linear LED High Bay, LED vaportite IP65/IP67, other enclosed small cavity luminaires

Typical Lumen Depreciation of Paragon LE Light Engine Type C (L77 B50)



Typical Luminaires:

LED downlight, round LED high bays, LED flood lights, architectural luminaires with high lum/sq. inch LED engine requirements

So an LED scheme is not penalised because of the exceptional life rating the designer could consider using the 30,000 hour LLMF value within a maintenance programme.

Because of anticipated technological advances, luminaire/ LED board replacement is likely to be viable, cost effective, and appropriate at this point.

This equates to the following number of years in certain applications:

Education (1,500 hours a year) = 20 years*

Offices (3,000 hours a year) = 10 years*

Retail (4,000 hours a year) = 7.5 years*

*excluding controls savings (daylight and presence control will extend life and increase LLMF value)

Sol IV Semiconductor recommends designing luminaires well within the maximum recommended junction temperatures. Therefore the LLMF for Paragon LE configured luminaires are typically very high. Specific LLMF values can be determined for all OEM luminaires. Please see curves opposite for further details of LLMF values through life to 50,000 hours).

The typical LLMF values below show the performance of the majority of Paragon LE configured luminaires:

LLMF	30,000 Hrs	50,000 Hrs
Type A	0.89	0.82
Type B	0.88	0.80
Type C	0.86	0.77

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LMF – Luminaire Maintenance Factor

To make the most of any installation we recommend a six month luminaire cleaning regime.

The construction of an LED luminaire and make-up of an LED differ from traditional luminaires. The impact of dirt deposits are not as significant as conventional source luminaires. For example there is a reduction in the surface area for dirt deposit on the lamps as they typically have no upward facing surface and are often enclosed. In addition, the impact of insects due to heat and UV radiation reduction is substantially lower.

From our experience and the reasons highlighted above the value within the SLL Code for lighting for a dustproof type luminaire are more appropriate for an LED luminaire. Below are the figures for a 6 month and annual luminaire clean:

	LMF	
	6 Month Clean	1 Year Clean
Very Clean	0.94	0.96
Clean	0.96	0.94
Normal	0.93	0.90
Dirty	0.91	0.86

RSMF – Room Surface Maintenance Factor

To ensure the most efficient lighting installation we recommend an annual room cleaning regime. Below are industry standard RSMF values for an annual and 3 Year Room Clean based on 70/50/20 reflectances:

	1 Year Room Clean		3 Year Room Clean	
	Direct Luminaires	Direct/ Indirect Luminaires	Direct Luminaires	Direct/ Indirect Luminaires
Very Clean	0.97	0.96	0.97	0.95
Clean	0.95	0.91	0.94	0.91
Normal	0.91	0.84	0.90	0.83
Dirty	0.86	0.75	0.86	0.75

*This value is unaffected by the type of lamp or luminaire being used.

LSF - Lamp Survival Factor

Spot Replacement is recommended in all instances to ensure light levels always maintained.

LSF = 1

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Maintenance Calculations

Below are a series of maintenance calculations* and regimes when using LED luminaires based on the information above.

$$MF = LLMF \times LMF \times RSMF \times LSF$$

1. 30,000 hour LED change (LLMF) 6 month luminaire clean (LMF), annual room clean 70/50/20 (RSMF), spot replacement (LSF)

	Direct Luminaires					Direct/Indirect Luminaires				
	LLMF	LMF	RSMF	LSF	MF	LLMF	LMF	RSMF	LSF	MF
Very Clean	0.88	0.94	0.97	1	0.8	0.88	0.94	0.96	1	0.79
Clean	0.88	0.96	0.95	1	0.8	0.88	0.96	0.91	1	0.77
Normal	0.88	0.93	0.91	1	0.74	0.88	0.93	0.84	1	0.69
Dirty	0.88	0.91	0.86	1	0.69	Unlikely for application				

2. 50,000 hour LED change (LLMF) 6 month luminaire clean (LMF), annual room clean 70/50/20 (RSMF), spot replacement (LSF)

	Direct Luminaires					Direct/Indirect Luminaires				
	LLMF	LMF	RSMF	LSF	MF	LLMF	LMF	RSMF	LSF	MF
Very Clean	0.8	0.94	0.97	1	0.73	0.8	0.94	0.96	1	0.72
Clean	0.8	0.96	0.95	1	0.73	0.8	0.96	0.91	1	0.7
Normal	0.8	0.93	0.91	1	0.67	0.8	0.93	0.84	1	0.62
Dirty	0.8	0.91	0.86	1	0.63	Unlikely for application				

3. 30,000 hour LED change (LLMF) 1 year luminaire clean (LMF), 3-year room clean 70/50/20 (RSMF), spot replacement (LSF)

	Direct Luminaires					Direct/Indirect Luminaires				
	LLMF	LMF	RSMF	LSF	MF	LLMF	LMF	RSMF	LSF	MF
Very Clean	0.88	0.96	0.97	1	0.82	0.88	0.96	0.95	1	0.80
Clean	0.88	0.94	0.94	1	0.78	0.88	0.94	0.91	1	0.75
Normal	0.88	0.90	0.90	1	0.72	0.88	0.9	0.83	1	0.66
Dirty	0.88	0.86	0.86	1	0.65	Unlikely for application				

4. 50,000 hour LED change (LLMF) 1 year luminaire clean (LMF), 3-year room clean 70/50/20 (RSMF), spot replacement (LSF)

	Direct Luminaires					Direct/Indirect Luminaires				
	LLMF	LMF	RSMF	LSF	MF	LLMF	LMF	RSMF	LSF	MF
Very Clean	0.8	0.96	0.97	1	0.74	0.8	0.96	0.95	1	0.73
Clean	0.8	0.94	0.94	1	0.71	0.8	0.94	0.91	1	0.68
Normal	0.8	0.90	0.90	1	0.65	0.8	0.9	0.83	1	0.6
Dirty	0.8	0.86	0.86	1	0.59	Unlikely for application				

*all calculations are based on Type B LLMF values.

Luminaire electronics, heat dissipation, optical systems, controls
Design and approvals assistance
Global OEM Solutions

Toronto Head Office

227 Wilkinson Avenue
Brampton ON L6T 4M2
Canada

Office (+1) 416-8000-985
Toll-Free 1-800-847-8714
24hr Text Only Svc. (+1) 647-235-2235
Fax (+1) 416-8001-053
Fax Toll- Free 1-800-878-9049
E-mail crm@SolivSemi.com

Europe Customer Centre

Levocska 109
08001 Presov
Slovakia

Office (+421) 517-715-065
SMS Text Only (+421) 903-108-422
E-mail eu.crm@SolivSemi.com

Asia Customer Centre

1B Hillier Commercial Building
89 Wing Lok Street
Hong Kong

Office (+86) 181-2393-7225
Fax (+86) 181-2393-8354
E-mail hk.crm@SolivSemi.com

Online
SolivSemi.com

