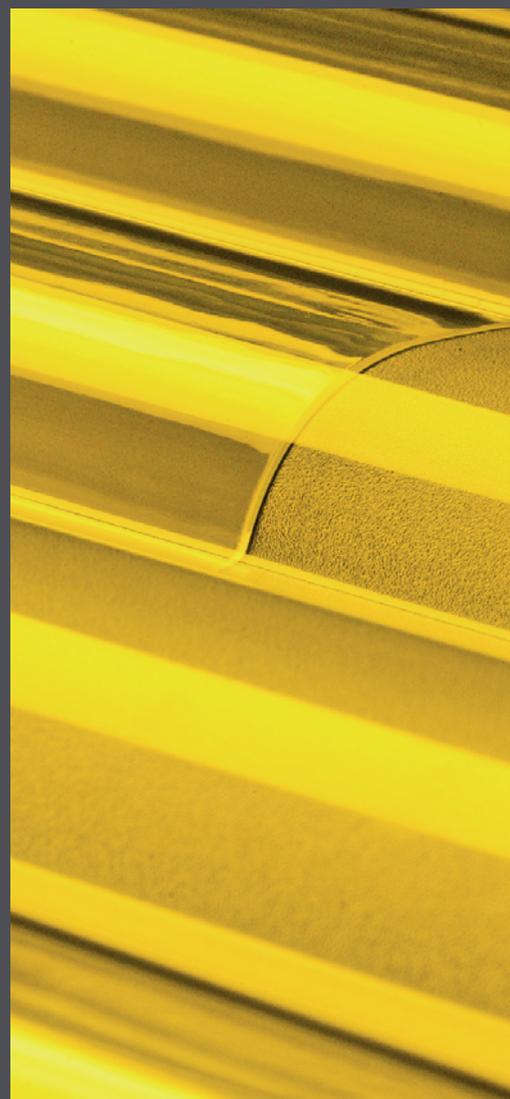
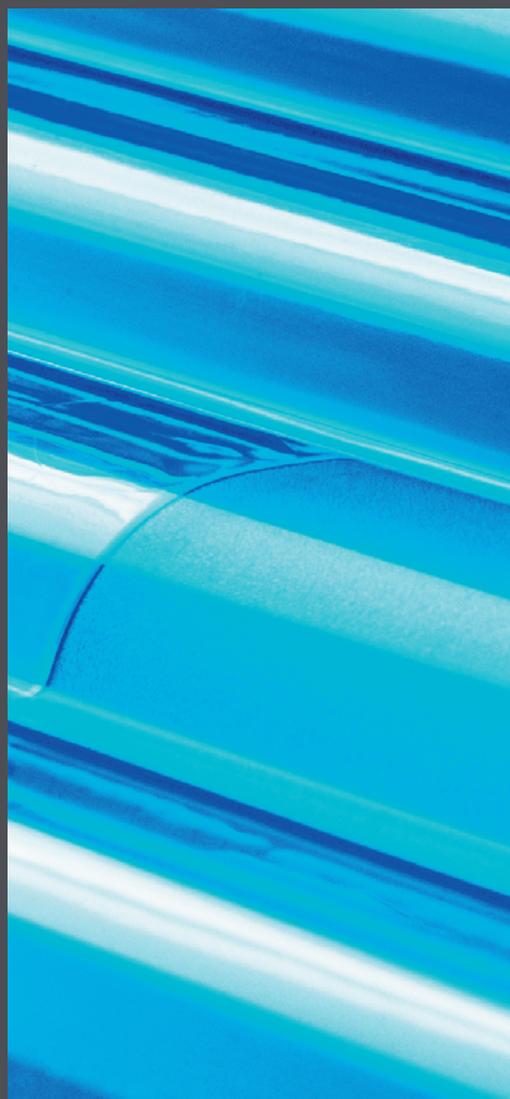
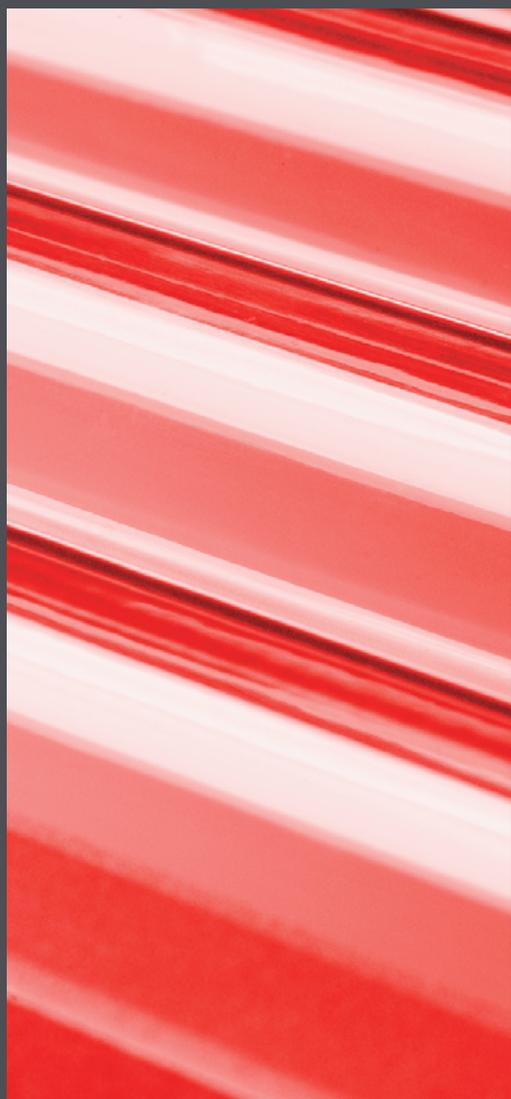
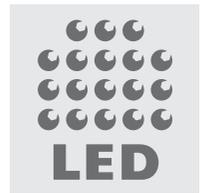




WE-EF LEUCHTEN
European Edition
2014–2016



TECHNICAL INFORMATION LED



WE-EF DEVELOPMENT PROCESS

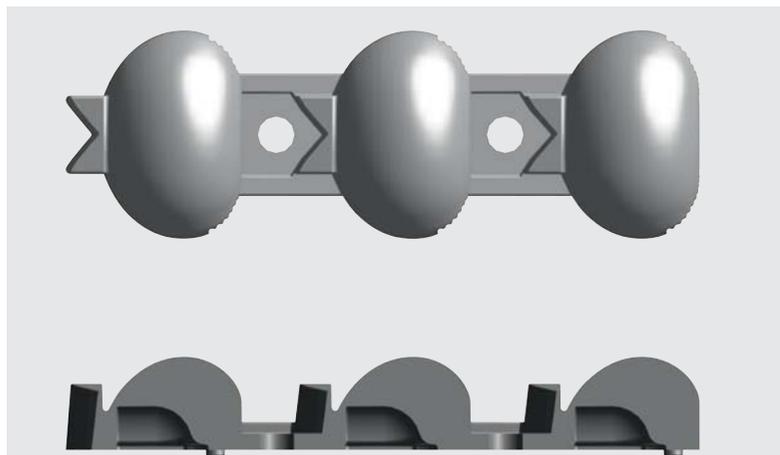
The terms and definitions used in this section are based on the document entitled 'Guidelines for project design safety in LED lighting' (Leitfaden Planungssicherheit in der LED-Beleuchtung) as published by the German Electrical and Electronic Manufacturers' Association (ZVEI) in November 2013.

Rated input power P (W): the effective input of a luminaire, comprising the power consumption of all components integrated in the luminaire.

Rated luminous flux Φ_v (lm): the total radiant flux of a luminaire in its visible range, also known as the initial luminous flux.

Luminaire efficacy η_v (lm/W): the quotient of the rated luminous flux and the rated input power.

Rated ambient operating temperature T_a (°C): the maximum ambient temperature at which a luminaire can be operated whilst still maintaining all safety-relevant parameters. In this catalogue, $T_a = 25^\circ\text{C}$. However, please note that the majority of the luminaires listed have a significantly higher rated temperature T_a .



CAD design, optical simulations, prototypes, verification and injection moulding tooling are all used in WE-EF's development and production facilities.



For every LED lens type a prototype is prepared in WE-EF's tooling shop, which is then measured and optimised.

Contact WE-EF to request data for a particular luminaire.

Rated ambient performance temperature T_q (°C): the maximum ambient temperature at which a luminaire reaches the specified values for luminous flux and service life, for example. All of the data in this catalogue is based on a rated ambient temperature of $T_q = 25^\circ\text{C}$.

Rated service life L_{xByCz} (h): the number of hours after which

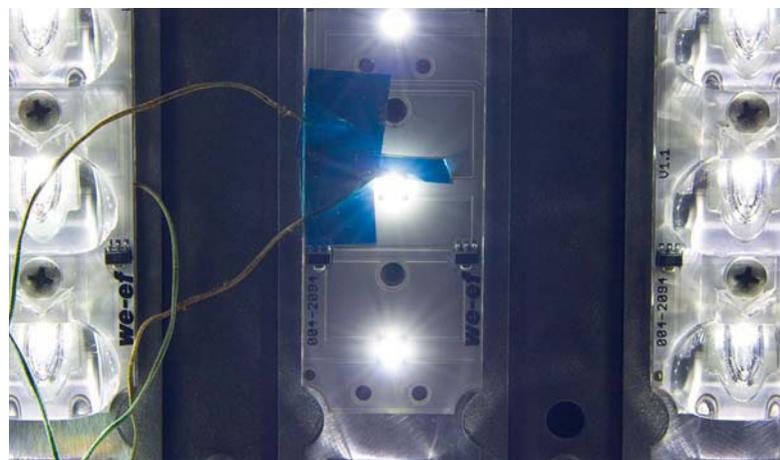
- a) a group of LED luminaires have dropped to a luminous flux of x (%)
- b) a number y (%) of LED luminaires have dropped below the specified luminous flux
- c) a number z (%) of LED luminaires have totally failed.

Example:

Requirement $L_{70B_{10}C_1} - 60,000$ h means that after 60,000 hours the group of LED luminaires in question must still provide 70% of the initial luminous flux, whereby 10% of the LED luminaires in question are permitted to provide less than 70% of the initial luminous flux and 1% of the luminaires may have totally failed.



WE-EF LED boards fitted with high-quality LEDs, which have narrowly-defined binning tolerances, guarantee high-visual comfort.



The junction temperature T_j of the LEDs in operation is important for defining lumen depreciation and lifetime.

The development of high quality and efficient LED lenses is one of WE-EF's core competencies. WE-EF possesses the expertise for design, engineering and production.

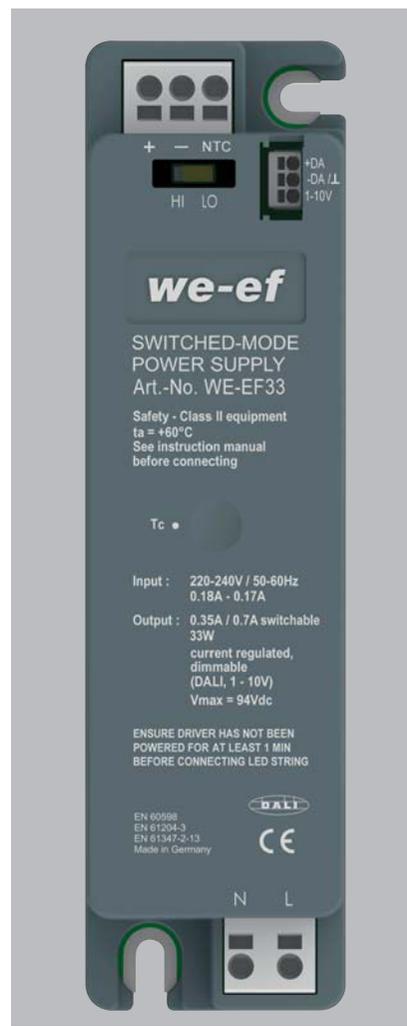
WE-EF is able to apply its expertise gained from a long experience in the development and operation of LEDs. For example, at the SONY Center in Berlin, 12 years ago, WE-EF was involved with one of the first major LED projects. It was an invaluable advantage, both in understanding today's possible LED technology and in converting this knowledge into innovative lighting solutions.



Using either a 1-10V or DALI interface with electronic converter, the light output and energy usage of the individual luminaires can be controlled.



In all WE-EF luminaires the LED boards can be individually exchanged without special tools.



All components of the luminaire are engineered for reliability and longevity.

IOS® INNOVATIVE OPTICAL SYSTEM

Supported by an in-house lighting laboratory that develops high-performance innovative optical systems IOS®, WE-EF combines the latest advances in LED technology with specially-designed reflectors and lenses. When applied to streetlighting, IOS® optimises luminaire spacing while ensuring the best lighting result.

IOS® with Lens Technology

WE-EF has taken the unique and critical features of LEDs (e.g., long lifetime) as the basis for OLC® One LED Concept. The current trend in LED streetlighting has the LEDs with either a symmetric or elliptical distribution in order to achieve uniformity. The interaction and overlapping of the beams from the individually-oriented LEDs provides the overall light level and, to some extent, uniform distribution. This standard solution is known as the multi-spot technique. However, WE-EF has moved away from this thinking and adopted, via OLC® technology, the multi-layer principle. Each LED, in combination with the special 'butterfly' lens, illuminates the same area. The sum of all the layers provides a uniform output.

The multi-layer principle has five advantages:

- If one LED fails and the light level drops, uniformity is retained.
- As well as dimming, it is possible to simply switch off individual or groups of LEDs to reduce the light level.
- The system ensures through modular engineering that groups of LEDs can be simply and quickly exchanged if there is a failure. The same linear board system means that when more efficient LEDs become available, they can simply be retrofitted. The photometric performance remains the same.
- OLC® technology has been developed with the future in mind.
- Light is strictly controlled, and any light pollution is kept to an absolute minimum through the exact aiming of the LEDs in combination with the unique 'butterfly' lens.



Standard Solution: Multi Spot



WE-EF Solution: Multi Layer

OLC® TECHNOLOGY

The OLC® technology (multi-layer principle) is the ideal method for achieving a uniform and energy saving lighting solution, particularly for streetlighting, providing highest safety in ensuring that the failure of individual LEDs does not lead to an adverse affect in the lighting. It balances the needs for safety with visual comfort and energy savings.

[P65] Lens – The advantages of this lens are:

- Optimised for illuminance-based design work (maximum spacing). The 65–70 references the nominal angle of peak intensity from nadir (downward vertical).
- Pedestrian and bicycle lane distribution.
- No light above the horizontal (ILE Class E1/E0). Ideal for pedestrian and bicycle lanes according to the criteria for illuminance EN DIN 13201, Class S2 – S4.

[S60] and [S65] Lenses – The advantages of these lenses are:

- Optimised for luminance-based design work (high visual comfort). The '60' references the nominal angle of peak intensity from nadir (downward vertical).
- Streetlighting distribution.
- No light above the horizontal (ILE CLASS E1/E0). Ideal for streetlighting according to the criteria for luminance EN DIN 13201, Class ME3-ME6. For a one-sided arrangement, guaranteed spacing = $5-5.5 \times \text{MH UI} \geq 0.4$, $\text{Ti} < 15$ per cent.

[S70] Lens – The advantages of this lens are:

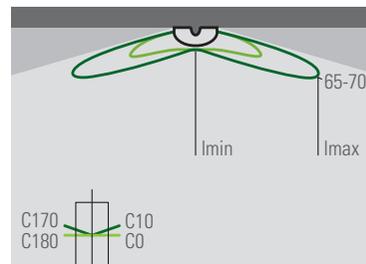
- Optimised for illuminance-based design work (maximum spacing). The '70' references the nominal angle of peak intensity from nadir (downward vertical).
- Streetlighting distribution.
- No light above the horizontal (ILE CLASS E1/E0). Ideal for streetlighting according to the criteria for illuminance EN DIN 13201, Class S1-S6. For a one-sided arrangement, guaranteed spacing = $7-9 \text{ MH Uniformity } U_0 \geq 0.2-0.4$, with good visual comfort (the norm does not provide specific values for glare limitation).

[A60] and [R65] Lenses – The advantages of these lenses are:

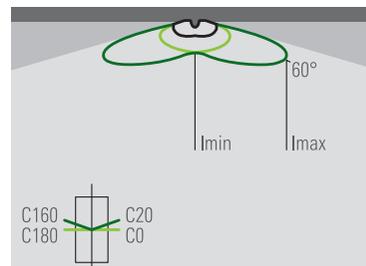
- A comparable performance to conventional asymmetric 'forward throw' HID reflectors.
- Nominal angle of peak intensity through C0 60-65°.
- Rearward spill limited to an angle of 10°.
- No light above the horizontal (ILE CLASS E1/E0). Ideal for lighting public spaces where visual comfort (glare) is a critical factor.

[C50] and [R] Lenses – The advantages of these lenses are:

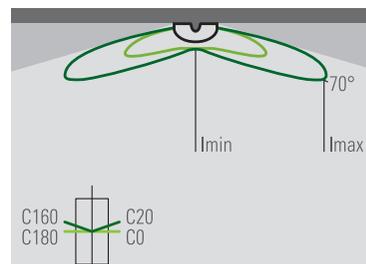
- Optimised for illuminance-based design work (maximum spacing) with good visual comfort.
- Symmetric and rectangular distribution
- For [C50] maximum angle of peak intensity through C0 50°. For [R] maximum angle peak intensity through C0 65°, C90 45°. The [R] distribution has a forward to side ratio of 1:2. No light above the horizontal (ILE Class E1/E0). Ideal for lighting public spaces where both uniformity and visual comfort are critical factors.



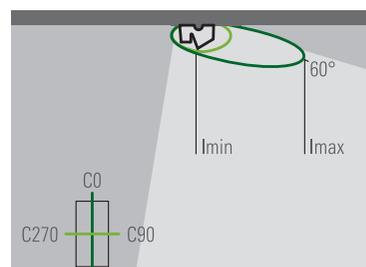
[P65]



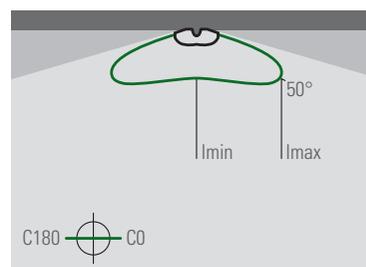
[S60]



[S70]



[A60]



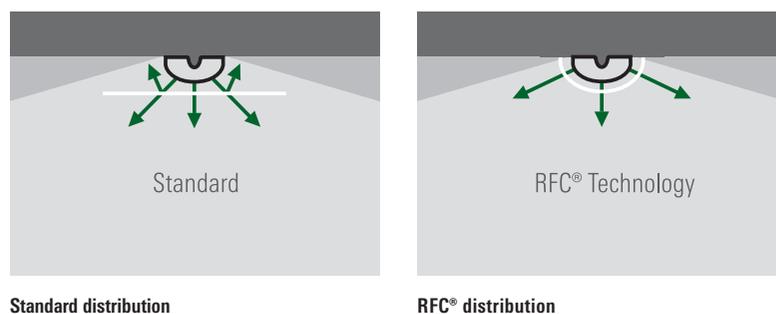
[C50]



RFC® TECHNOLOGY

RFC® technology is designed to complement the streetlighting versions and it is an important method of further enhancing system performance.

- The conventional flat-glass panel or cover is replaced by a UV-stabilised acrylic panel which has a contoured surface, contoured in a way that imitates the shape of the 'butterfly' lens; the goal is to minimise the loss of light that normally occurs due to internal reflection. The RFC® technology is available for all WE-EF lens systems [P65] [S60] [S65] [S70] [A60] [R65] [C50] [R].
- In the case of the [S60] lens, the benefits include the transmission factor at the critical 60° (downwards vertical), which is improved by ~20 per cent. With the [S70] lens, at the critical 70°, the transmission factor is improved by ~30 per cent. As much as 5 per cent will be added to the light output ratio (LOR) of both luminaires.
- In the case of the [S60] lens, this means there is a modest improvement in spacing due to it being a luminance-optimised luminaire. In the case of the [S70] lens, which is optimised for illuminance design work, important increases have been achieved in spacing. This adds to the economic and environmental case favouring the OLC® One LED Concept technology with the special 'butterfly' lens.



Standard distribution

RFC® distribution

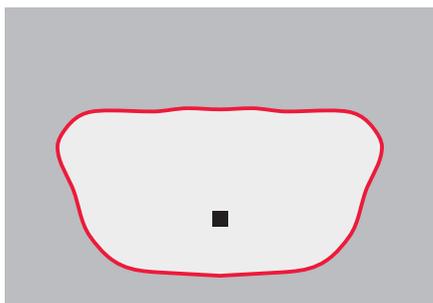


The contour of the cover follows the shape of the lens, thereby minimising the internal reflection within the luminaire caused by the light hitting the cover.



LED BEAM DISTRIBUTIONS

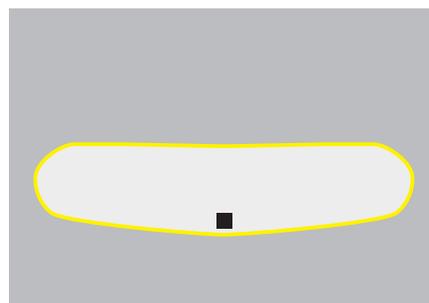
The modular construction of WE-EF LED luminaires makes optimised distribution possible for different lighting solutions.



[S60] Streetlighting distribution, luminance-optimised lens, based on Class ME3-ME6 from EN 13201.

Spacing 5 to 5.5 times the mounting height; $T_i < 15$ per cent.

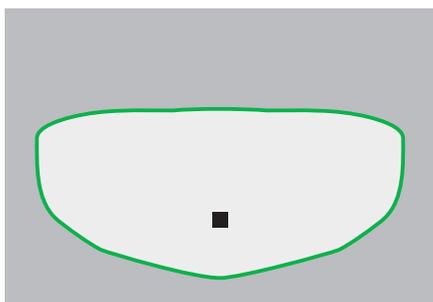
Typical mounting height 3 m to 6 m.



[P65] Pedestrian / bicycle lane distribution. Illuminance optimised lens, based on Class S2-S4 from EN 13201.

Spacing 5 – 7 x mounting height.

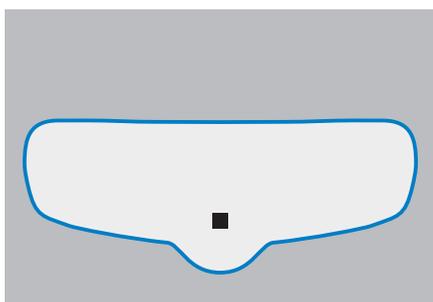
Typical mounting height 3 – 5 m.



[S65] Streetlighting distribution including intersections and public spaces, luminance-optimised lens, based on Class ME3-ME6 from EN 13201.

Spacing 5 to 5.5 times the mounting height; $T_i < 15$ per cent.

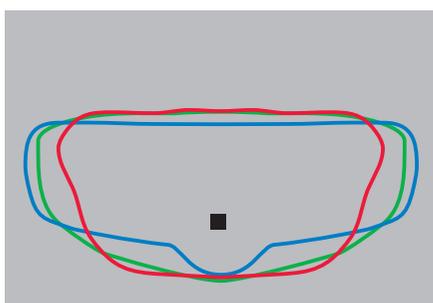
Typical mounting height 6 m to 10 m.



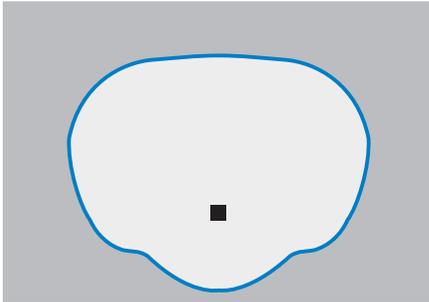
[S70] Streetlighting distribution, illuminance-optimised lens, based on Class S1-S6 from EN 13201.

Spacing 7 to 9 times the mounting height; $T_i < 15$ per cent.

Typical mounting height 3 m to 6 m.



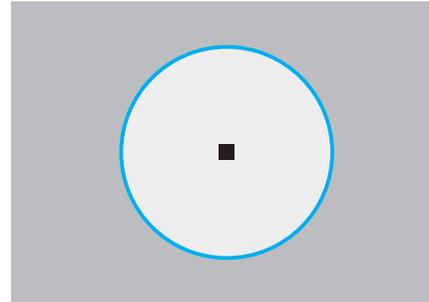
[S60] [S65] [S70] light distributions in comparison.



[R65]
 Rectangular forward throw distribution
 for lighting public spaces and car parks.

Maximum angle of peak intensity
 (side and forward) approximately under
 65°. Rearward spill limited to an angle
 of 10°.

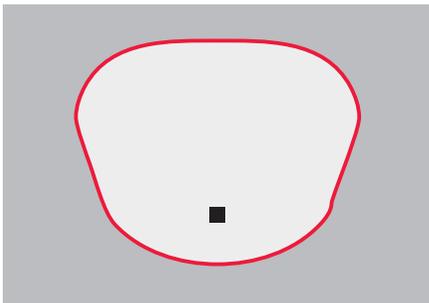
Typical mounting height 4 m to 8 m.



[C50]
 Symmetric distribution for lighting
 public spaces and car parks.

Maximum angle of peak intensity
 approximately 50°.
 Glare index G1 from EN 13201.

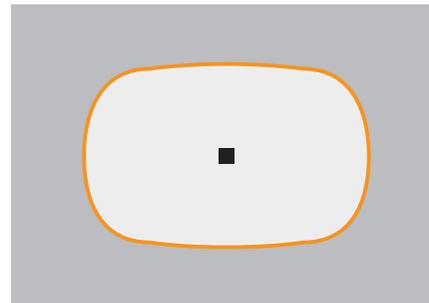
Typical mounting height 4 – 6 m.



[A60]
 Asymmetric forward throw distribution
 for lighting public spaces.

Maximum angle of peak intensity
 60°-65°. Rearward spill limited to an
 angle of 10°.

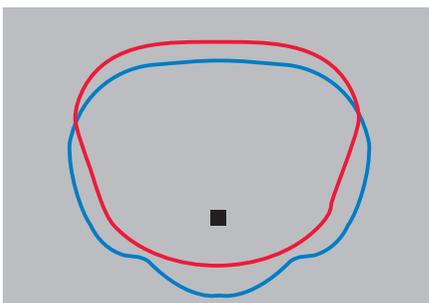
Typical mounting height 4 m to 8 m.



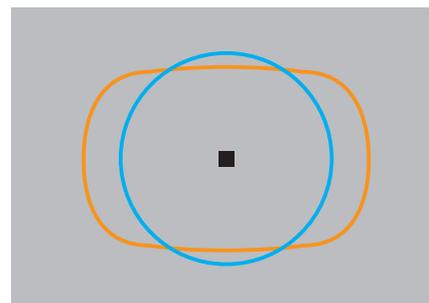
[R]
 Rectangular distribution for lighting
 public spaces and car parks.

Maximum angle of peak intensity
 approximately 45° and 65°.
 Glare index G1 from EN 13201.

Typical mounting height 4 – 6 m.



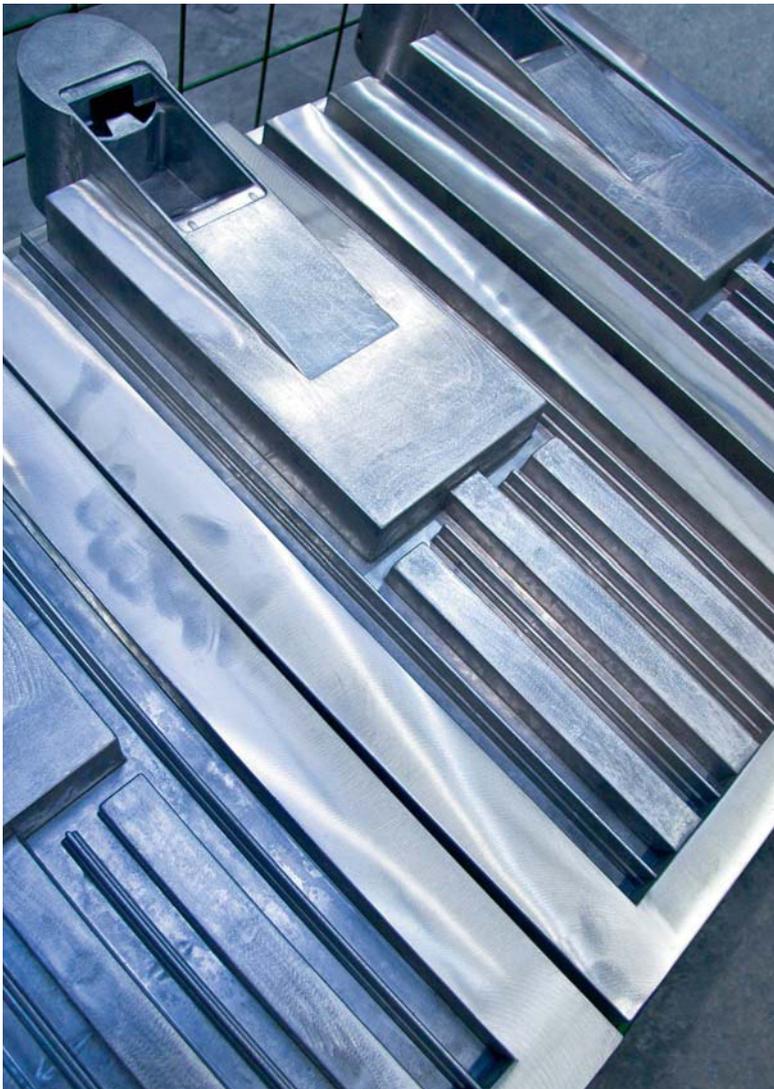
[A60] [R65]
 light distributions in comparison



[C50] [R]
 light distributions in comparison

THERMAL MANAGEMENT

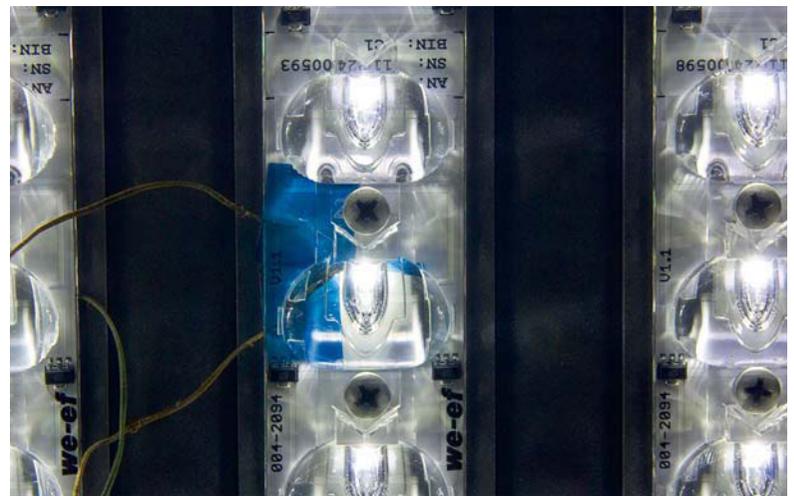
Long service life and maximum efficiency can only be achieved with perfectly coordinated thermal management. WE-EF products discharge the heat generated by the LEDs through the enclosure that contains a built-in heat sink. As part of a first development step, thermal conditions are simulated with the relevant computer programs and optimised at a theoretical level. Once this optimisation process is complete, prototypes are produced for each luminaire, which are then subjected to intensive testing until they provide results that meet the requirements. WE-EF guarantees optimised heat discharge with maximum service life and minimal reduction in luminous flux.



The luminaire housing is made from die-cast aluminium with integrated heat sink. This, in addition to the excellent heat-conducting properties of aluminium, helps to optimise thermal management.



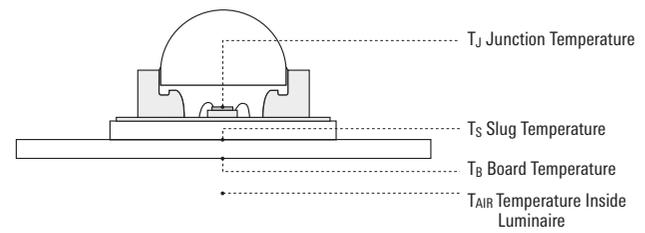
Thermal simulation results are verified using prototypes and actual products before a new luminaire is introduced to the market.



Extensive stress testing is carried out under extreme operating conditions. Products tested in this manner perform exceptionally well under normal field conditions.

LIGHTING EMITTING DIODES – LED

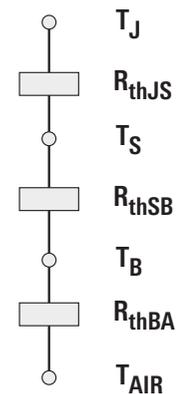
As a luminaire manufacturer, WE-EF aims to shape the thermal conditions in the luminaire so as to ensure that the LEDs are operated at the optimum working point and overloads can be avoided. The product data sheets of the LED manufacturers, which are based on the results of tests and mathematical calculations, form the foundation for ensuring that these tasks can be performed successfully. An assessment of whether an LED in a luminaire is operated in an optimum manner and the effects on service life and reduction in luminous flux is much more complex than for conventional lamps, and therefore requires more attention.



THERMAL RESISTANCE (R_{th})

One of the main focus areas of LED developments in recent years was and is the reduction in thermal resistance $R_{th} = R_{thJS} + R_{thSB} + R_{thBA}$ (resistance between the LED's junction temperature and the temperature on the inside of the luminaire). The smaller the resistance, the smaller the LED's thermal load. This leads to higher luminous flux and reduced ageing, and hence to a longer service life. A luminaire manufacturer can influence thermal resistance by

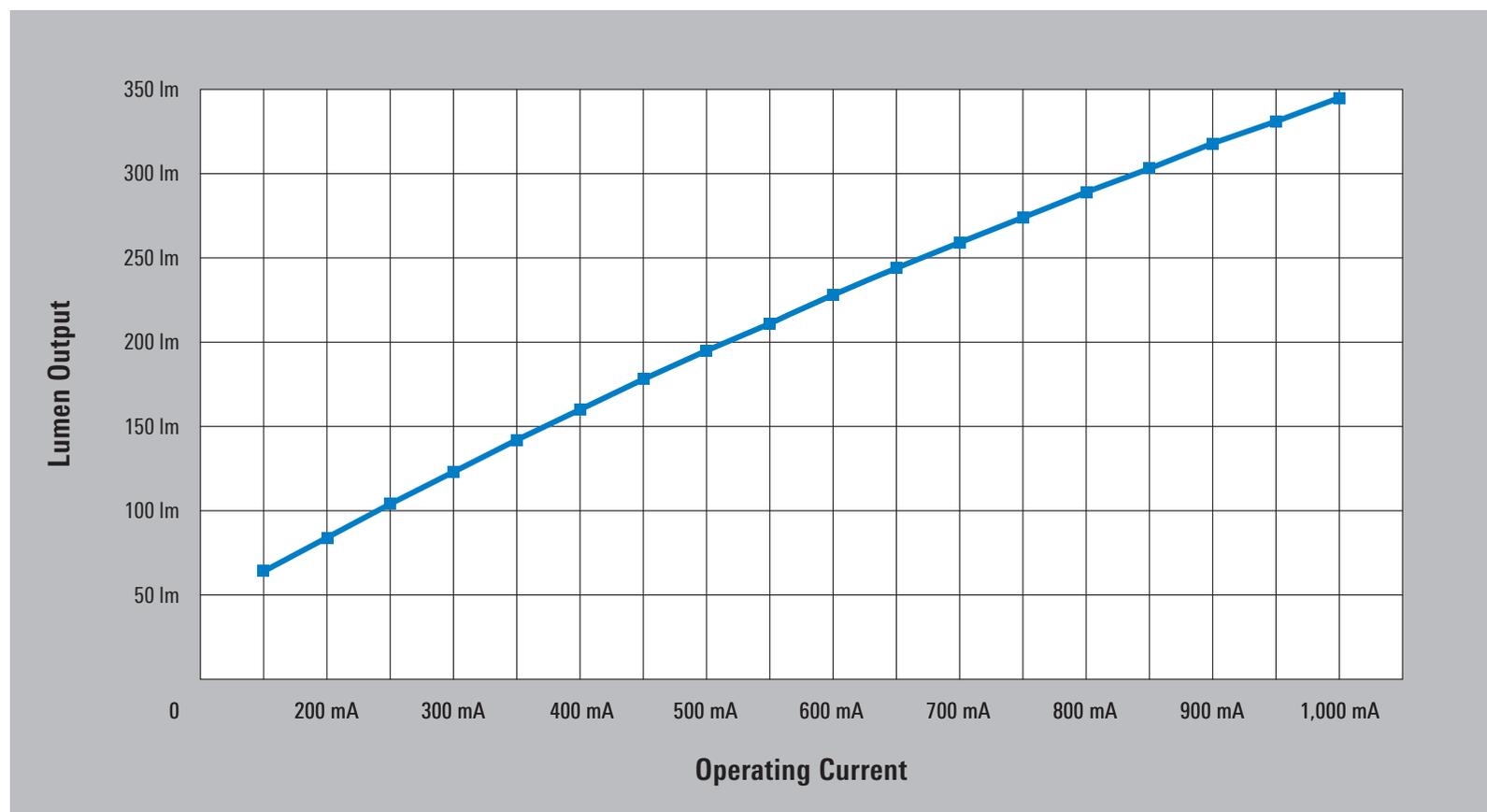
- developing optimised cooling elements for specific applications,
- guaranteeing clean and level contact surfaces between the LED circuit board and the heat sink, and
- selecting materials with very high thermal conductivity for the LED circuit boards, for example aluminium or ceramics. Circuit boards made of plastics are not suitable in this context.



OPERATING CURRENT (I_f)

LEDs can be operated with a variety of currents. While at present currents range between 350 mA, 500 mA, 700 mA and 1,050 mA, there is also a development trend towards 1,400 mA and up to 2,000 mA. The higher the operating current, the higher the luminous flux. Unfortunately, LEDs also feature a declining operating current / luminous flux characteristic line. In other words, increases in operating current are accompanied by disproportionately low increases in luminous flux, and luminaire efficacy (lumen per Watt) also decreases. The ideal situation is a proportional linear relationship between operating current and luminous flux.

The non-linearity between operating current and luminous flux increases as the temperature of the junction temperature (T_j) increases.



SERVICE LIFE AND JUNCTION TEMPERATURE (T_J)

The service life information provided by LED manufacturers is based on measurements pursuant to LM-80-08 (minimum testing 6,000 h). By combining these measurement values with mathematical calculation models according to TM-21, it is possible to make statements about the behaviour of LEDs during a significantly larger time frame. Today, it is possible to expect a rated service life according to TM-21 of up to 6 times the measured time period. This calculation can be used as a basis to extrapolate a service life curve and draw conclusions regarding the expected service life.

(It is now up to the luminaire manufacturer to transfer these results to the luminaires, which in turn requires him to conduct extensive testing on his luminaires.)*

The service life indications that are derived from this process are based on certain assumptions, which must be clearly documented. Information on the following is required:

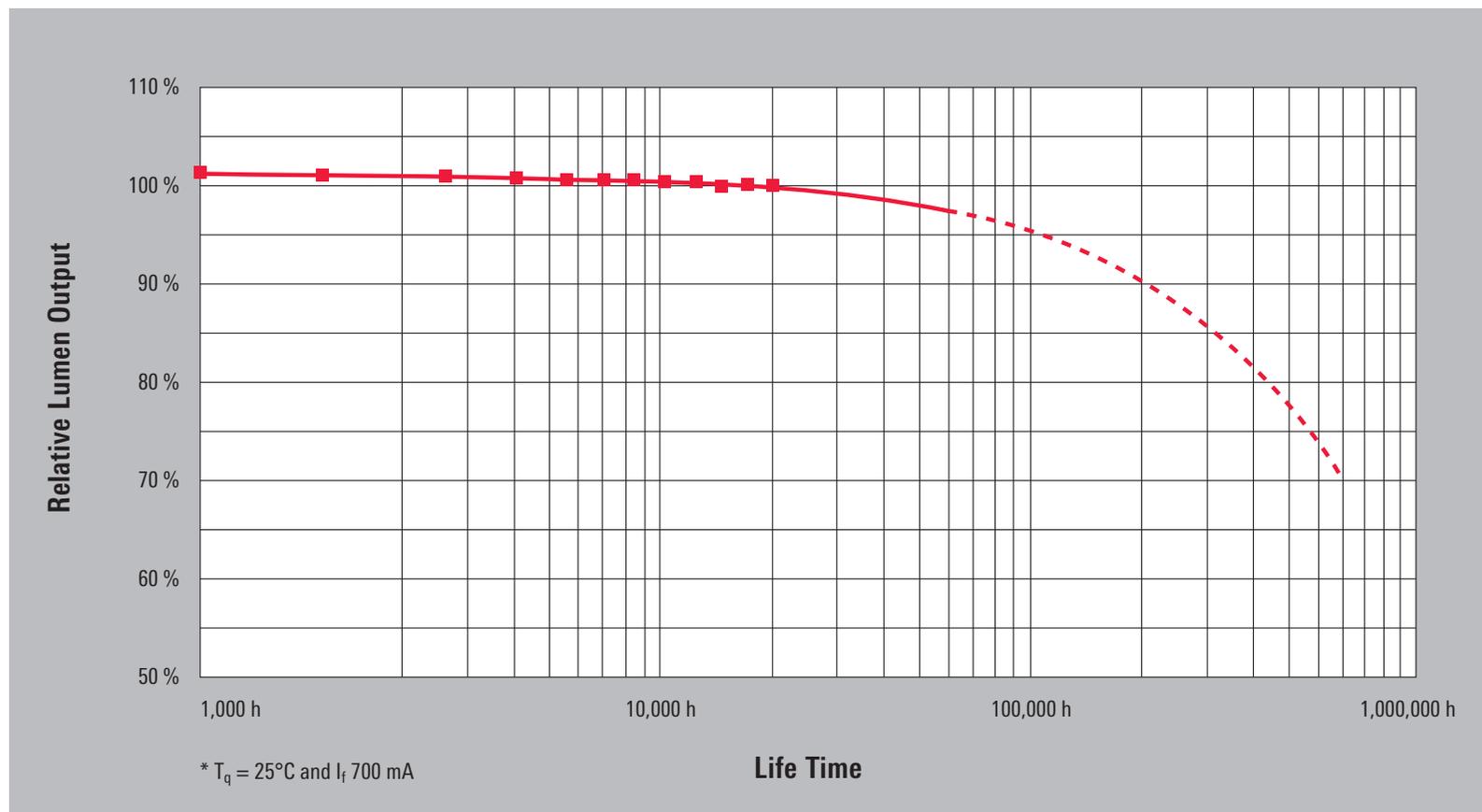
- Maximum rated ambient performance temperature (T_a);
- Operating current (I_f);
- Maximum luminous flux reduction for the LEDs (B_L);
- Service life (L_x - ii.iiih) = Lighting hours

If for example the average rated ambient performance temperature T_a is 30°C (basis $T_q = 25^\circ\text{C}$) for an application, then the so-called junction temperature T_J will also increase by the difference (30°C – 25°C).

The junction temperature T_J is different for each luminaire, depending on system performance and operating current. This temperature is a maximum of 85°C on average for all of the luminaires shown in this catalogue, which are fitted with the maximum number of LEDs and are operated with 700 mA at an average rated ambient performance temperature of 25°C.

LEDs also undergo an ageing process similar to conventional lamps, i.e. the initially available rated luminous flux decreases the longer the LED is in operation. The lower the LED's thermal load, the lower the reduction in luminous flux. The diagram below illustrates the dependency of an LED's luminous flux on the service life and the average rated ambient performance temperature at an operating current of 700 mA. The diagram below can be used to calculate the luminous flux that can be expected after a certain operating period.

* WE-EF data is based on continual testing of the luminaire for at least 10.000 h



MAINTENANCE FACTOR (MF)

When using conventional lamps, the luminaire manufacturer is only responsible for supplying information pertaining to the luminaire maintenance factor (LMF). With the introduction of LED this method of approach changed. All three values which provide the maintenance factor (MF), are to be provided by the luminaire manufacturer, as LEDs are now a fixed part of the luminaire.

In addition, in LED luminaires, the three factors in terms of how they are derived has changed, which is detailed as follows.

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

MF: Maintenance Factor

LLMF: Lamp Lumen Maintenance Factor

LSF: Lamp Survival Factor

LMF: Luminaire Maintenance Factor

LAMP LUMEN MAINTENANCE FACTOR (LLMF)

It is also possible to calculate the luminous flux that can be expected after a defined rated service life by multiplying the respective rated luminous flux with a lamp lumen maintenance factor that takes into account the ageing of the LEDs; this is easier than trying to read the information from the diagram.

Example: Luminaire: VFL540 [S70], 4000 K

Product ID: 108-0910 [ECG]

Nominal luminous flux: 8,294 lm

Rated luminous flux: 7,539 lm

Using the information in the table, we obtain a lamp lumen maintenance factor of LLMF = 0.98 for an average rated ambient performance temperature of 25°C, an operating current of 700 mA and a rated service life of 60,000 h. We obtain the following theoretical minimum rated luminous flux after 60,000 h. $7,539 \times 0.98 = 7,388$ lm.

$T_q = 25^\circ\text{C}$				
I_f [mA]	T_J *** [°C]	TM-21 [1,000 h]	LLMF at 60,000 h	Theoretically Expected Lifetime [1,000 h]
				L95
350*	45	>60	0,990	170
500*	55	>60	0,990	150
700*	69	>60	0,980	120
1.050**	77	>60	0,990	90

* based on XP-G2 LED
 ** based on XM-L2 LED
 *** measured, average junction temperature T_J in nominated luminaire series

LAMP SURVIVAL FACTOR (LSF)

According to the information provided by the LED manufacturer, due to SIC technology, the total failure rate of LEDs is very small. It is approximately 750ppm (after 60,000 h, if = 700mA/1,050mA).

LSF= 0,99925

LUMINAIRE MAINTENANCE FACTOR (LMF)

LED Luminaires operate differently to HID street & area lighting luminaires. Therefore, the factors applied in line with CIE 154:2003 for WE-EF street & area lighting luminaires have been adjusted.

The reasons for, are as follows:

- a) reduced insect build-up because of less thermal heat across the outer cover and less UW damage due to lamp source
- b) reduced obscuring/ageing of the outer lens due to reduced convection.

RECOMMENDED MAINTENANCE FACTOR (MF) AFTER 60,000 h

I _f [mA]	T _J ^{***} [°C]	LLMF	LSF	LMF (4 Years, IP6x)			MF (N)	MF (M)
				N	M	H		
350*	45	0.990	0.99925	0.96	0.92		0.95	0.91
500*	55	0.990	0.99925	0.96	0.92		0.95	0.91
700*	69	0.980	0.99925	0.96	0.92		0.94	0.91
1,050**	77	0.990	0.99925	0.96	0.92		0.95	0.91
* based on XP-G2 LED ** based on XM-L2 LED *** measured, average junction temperature T _J in nominated luminaire series						N = area with low pollution M = area with moderate pollution H = area with high pollution		

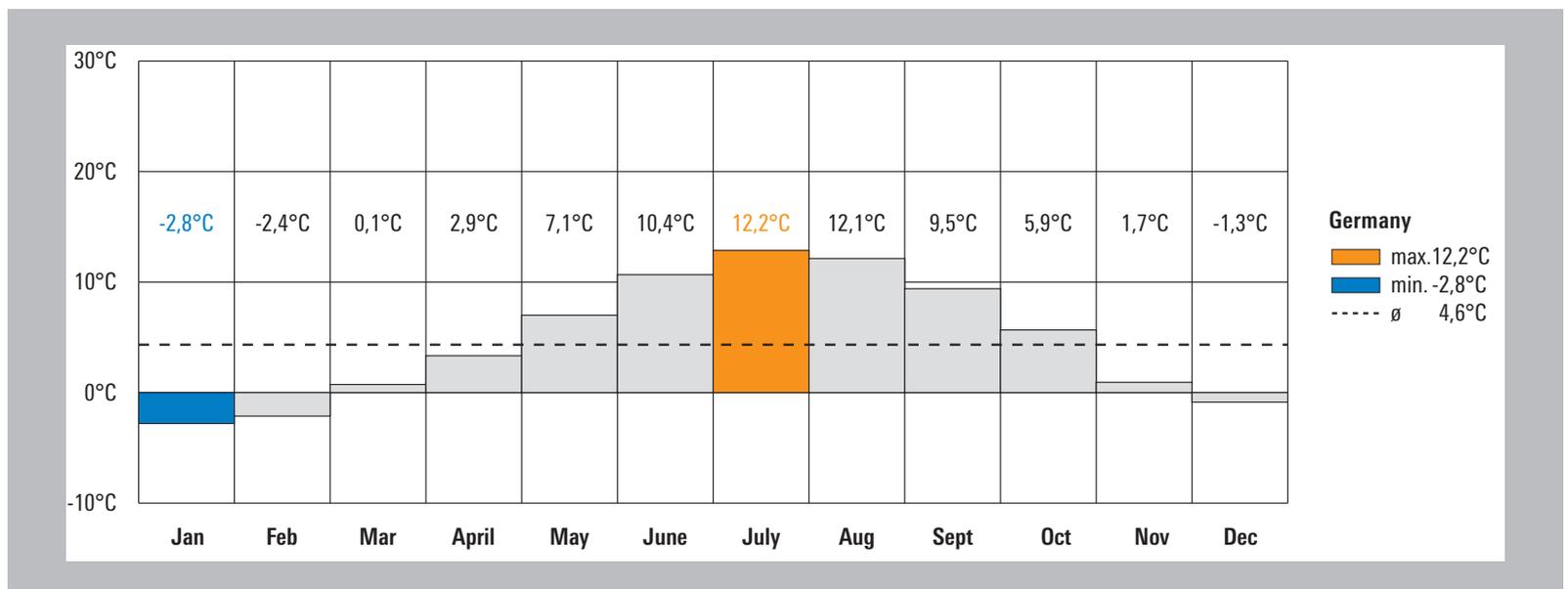
RATED AMBIENT PERFORMANCE TEMPERATURE T_q

The Isolux curves shown in this catalogue refer to an average rated ambient performance temperature of 25°C. However, conditions at a particular location will often deviate from this standard and can have a fairly significant influence on the technical lighting quality and service life of a system. If the average rated ambient performance temperature falls below 25°C, then the luminous flux and service life increase, and vice versa if the temperature increases above this level.

To obtain a more precise calculation, we recommend that the average rated ambient performance temperature that applies when the luminaire is in operation (i.e. night-time hours) during the hottest month of the year at its respective location is used as a measurement basis. The national weather services publish this type of data. The diagram and table show the average ambient temperature for several selected European countries.

You can use e.g. www.laenderdaten.info to obtain more comprehensive and detailed global data for selected cities and regions in Germany and Europe.

	Germany	Belgium	Finland	France	Ireland	Italy	Croatia	Netherlands	Norway	Austria	Portugal	Russian Federation	Sweden	Switzerland	Slovakia	Spain	Czech Republic	Ukraine	Hungary	U. K.
max. °C in July	12.2	12.7	10.8	15.0	11.7	20.7	19.2	12.4	8.5	10.8	17.7	10.3	11.0	13.5	9.7	18.3	12.3	15.5	14.6	11.9
min. °C in January	-2.8	0.1	-14.4	2.1	3.1	6.2	1.3	-0.6	-6.0	-7.4	9.2	-23.2	-10.8	-0.8	-9.4	8.0	-5.4	-7.7	-5.0	2.8
average temperature °C	4.6	6.1	-1.8	8.6	6.9	13.1	10.3	5.5	0.9	2.1	13.2	-6.5	0.4	5.9	1.0	12.7	4.2	4.3	5.0	7.0



LUMINOUS FLUX – NOMINAL VS. RATED LUMINOUS FLUX

The luminous flux values listed in this catalogue refer to so-called nominal luminous flux levels. They have been obtained from the data sheets of the LED manufacturers and relate to the set operating currents 350 mA, 500 mA, 700 mA or 1,050 mA at a junction temperature of 85°C. These values are derived from the laboratories of the LED manufacturers, from free-burning LEDs, with so-called pulsed currents. However, the junction temperature increases significantly once the LEDs are in operation inside a luminaire. This temperature is set at a maximum 85°C (based on a average rated ambient performance temperature $T_a = 25^\circ\text{C}$) for the WE-EF luminaires shown in this catalogue. This heating up of the LED leads to a reduction in luminous flux, hence a decrease in the luminous flux which must be recorded when the luminaire is measured in the lighting laboratory. All of the technical lighting data published by WE-EF takes this context into account. It means that technical lighting computer calculations using original WE-EF technical lighting data, such as is available worldwide via DIALUX, also render these correlations correctly. Current information regarding the luminous flux that can be achieved during the operation of the luminaire can be obtained from www.we-ef.com.

SURGE PROTECTION – SP10

WE-EF street & area lighting luminaires are fitted with electronic converters featuring 6/6 kV surge protection in accordance with EN 61006-4-5. For comprehensive protection of the luminaire against lightning and electrical surges (high risk areas), primary (Type 1) and secondary (Type 2) surge arrestors must be installed into the power supply. For installations in such high-risk areas, the optional WE-EF SP10 (10 kV) surge protection accessory is recommended. If the surge protector has been triggered by an adverse event, the luminaire is automatically disconnected from the mains.

The technical planner/installer is responsible for the proper selection, sizing and installation of the surge protection modules that must be provided on site.

430-0020	SP10 Integral	for ON/OFF versions
405-0124	SP10 Remote	for Eco Step Dim [®] versions