OSLON™ UV — Details on properties, handling and processing

Application Note

Published by ams-OSRAM AG
Tobelbader Strasse 30,
8141 Premstaetten Austria
Phone +43 3136 500-0
ams-osram.com

OSLON™ UV — Details on properties, handling and processing

Application Note No. AN155

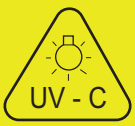
Valid for:
OSLON™ UV 3535

Abstract

The OSLON™ UV LED products enriches any application requiring ultraviolet-C (UV-C) radiation for disinfection or treatment. In addition to its compactness and instant-on functionality, the product family convinces with exceptional efficiency at superior lifetime and robustness.

The application note comprises general technical information and recommendations related to assembly, handling, and solder pad design of UV-C LED products.

UV-C RISK GROUP 3



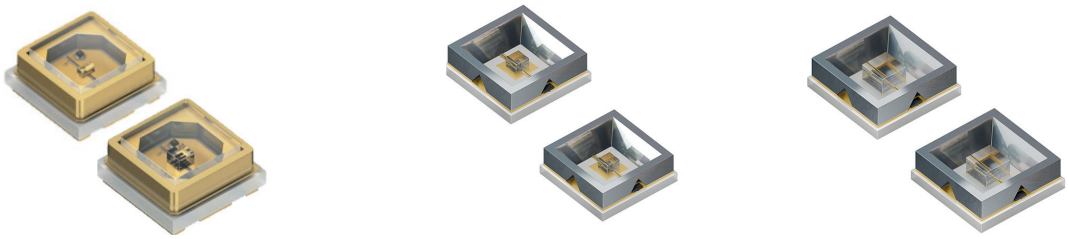
WARNING UV-C emitted from this product.
Avoid eye and skin exposure to unshielded product.
Follow installation instructions and user manual.

Table of contents

1 The product family - features and design

The OSLON™ UV LED product family (Figure 1) is a series of UV-C LEDs designed for any application which requires UV-C radiation.

Figure 1: OSLON™ UV LED product family

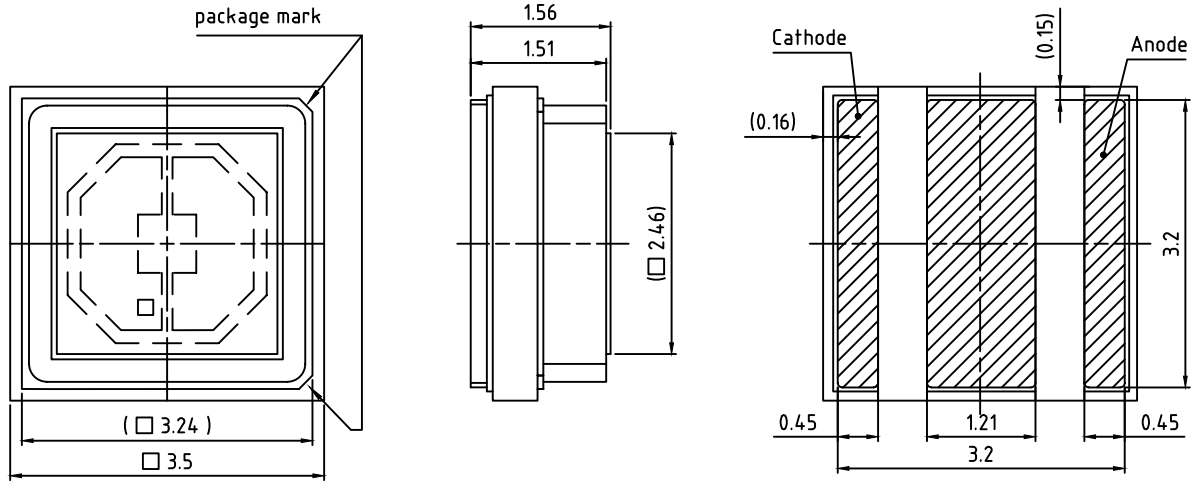


Low Power (Φ_e < 30mW)	Mid Power (30mW < Φ_e < 100mW)	High Power (Φ_e >= 100mW)
SU CULBN2.VC SU CULCN1.VC	SU CULDP2.VC SU CULCP1.VC	SU CULFP1.VC SU CULGP1.VC

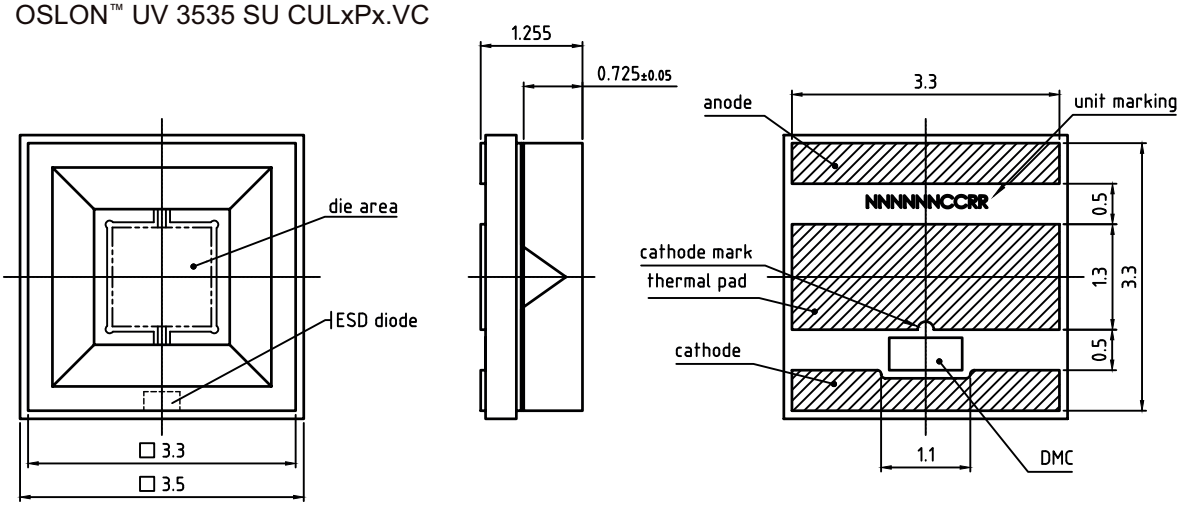
The high-energy UV emission increases the irradiance stress on the package. Thus a ceramic material is chosen because it offers good lifetime and reliability performance. Figure 2 shows the various designs of the OSLON™ UV LED product family. For information on ESD capability, please refer to product data sheet. The LED products fulfill the current RoHS guidelines (European Union and China), containing no lead or other hazardous substances.

Figure 2: Design of OSLON™ UV

OSLON™ UV 3535 SU CULxNx.VC



OSLON™ UV 3535 SU CULxPx.VC



2 Design considerations

2.1 Mechanical and optical design resources

For detailed information on the mechanical dimensions, please refer to the drawings available in the respective data sheet. To obtain CAD data and optical rayfile, please visit the "Optical Simulation / Ray Files + Package CAD Data" webpage on the ams OSRAM website.

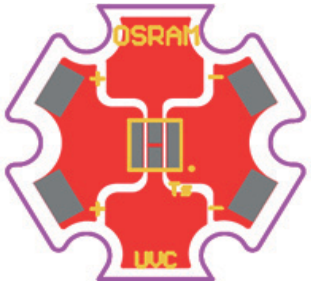
For more information on importing rayfiles and ray-measurement files, please refer to the application note "Importing rayfiles and ray-measurement files of LEDs".

2.2 Electrical connection

OSLON™ UV LED products have two electrical pads - the anode and the cathode pad. Adequate clearance and creepage distances between the traces are essential to avoid flash-over or tracking.

The absolute maximum electrical rated values are specified in the data sheet, and each device must be operated below these limits to ensure a proper and reliable performance. It is recommended to operate the LED in serial connection. If a parallel configuration is necessary, an additional electronic circuit, for example a current mirror, should be implemented. Figure 3 shows a PCB layout of a single OSLON™ UV LED on an MCPCB.

Figure 3: PCB layout of a single OSLON™ UV LED on an MCPCB



2.3 Thermal management

The junction temperature of LEDs can be calculated by using the following equation:

$T_j = T_s + I_F \cdot V_F \cdot R_{thJS\ el}$

Where,

T_j is the junction temperature of the LED [°C]

T_s is the solder pad temperature under the LED [°C]

I_F is the forward current of the LED [A]

V_F is the forward voltage of the LED [V]

$R_{thJS\ el}$ is the thermal resistance of the LED according to the datasheet [K/W]

Depending on the design, it can be difficult to measure the solder point temperature in the application. For detailed instructions and guidance please refer to the application note “The thermal measurement point of LEDs”.

2.4 Chemical and environmental considerations

The optical performance and stability of the LED may be affected by exposure to unsuitable chemical environments. Such issues may arise from incompatible materials used for the purpose of potting, coating, soldering, adhesion, or other elements within the luminaire design. Therefore, material compatibility with the LED must be carefully evaluated during the fixture design stage. It is strongly recommended to protect the LED from humidity stress and from materials that releases volatile organic compounds. For further information please refer to the application notes “Chemical compatibility of LEDs” and “Preventing LED failures caused by corrosive materials”.

3 Assembly and processing

3.1 Handling precautions

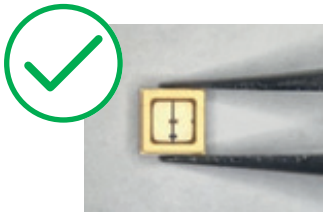
In accordance with the general guidelines on LEDs handling, there must be a minimum to no mechanical stress (e.g., shear force) imposed on the sealing glass.

Sharp objects can cause impairment and spontaneous failure to the LED package. Any type of sharp objects (e.g., forceps, fingernails, etc.) must be avoided in order to prevent stress or encapsulant penetration. For manual handling, the use of vacuum tweezers is recommended (Figure 4). The effective mechanical stress on the LED is minimized by means of soft rubber suction tips. By using vacuum tweezers, the vacuum stylus creates a vacuum by pushing a button, with which the component (e.g., the LED) can be lifted.

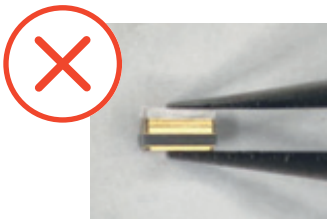
Figure 4: Examples of vacuum styluses for manual handling

If there is no alternative to the exceptional use of tweezers (anti-static), the LED must be picked up and handled at the ceramic surface as shown in Figure 5.

Figure 5: Manual handling of the LED



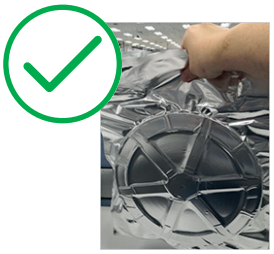
Pick the LED only on the sides towards the bottom



Do not touch the glass lens or the frame

Tapes and reel sealed packages must be handled as shown in Figure 6. Avoid imposing any force by holding the reel area. Force on the reel will cause damage to the sprocket holes.

Figure 6: Manual handling of the tape and reel package



Hold the package by the bag area without pressing the reel area.

Do not hold the reel area.

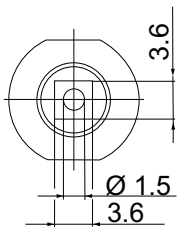
Do not hold the reels in stack.

3.2 Pick-and-place process

To avoid any damage during the pick-and-place process, the process parameters should conform to the package characteristics. The default settings of the machine may be a good starting point. The placement force, for example, can be tested with 2.0 N at the beginning, but should afterwards be less than 2.0 N if possible. When placing the LED, the forces should be applied evenly over the entire area.

During machine setup, make sure to teach the package image (Figure 2) with the camera before continuing the pick-and-place. Table 7 shows the recommended nozzle for OSLON™ UV LED products.

Figure 7: Recommended pick-and-place nozzle dimensions

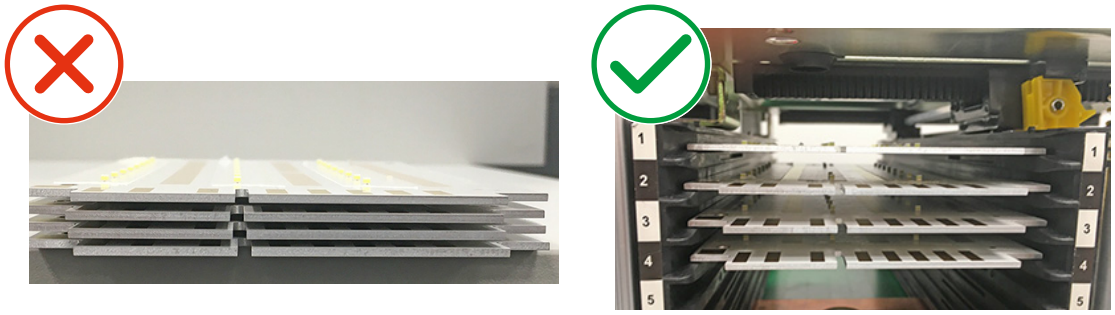
Product	Recommended nozzle design	Nozzle recommendation
OSLON™ UV 3535		SIPLACE 3077709

3.3 Storage

The OSLON™ UV LED products are generally supplied on tape with dry pack. According to the ams-OSRAM AG standard, the LEDs should be factory-sealed when stored. The hermetic moisture barrier bag should only be opened for immediate mounting and processing, after which the rest of the LEDs should be properly sealed.

Force applied to the mounted components may lead to damage, therefore it is not advisable to stack the LEDs. A proper storage system should be used (see Figure 8). No direct touching on the LED is recommended. Before subsequent handling or next processing step, all LED assemblies can return to room temperature after soldering in general.

Figure 8: Correct storage



3.4 Cleaning

OSLON™ UV LED products are not hermetically sealed. Therefore, direct mechanical or chemical cleaning of products shall be avoided. A wet cleaning process is not recommended. Cleaning liquids may penetrate through the glass cover and result in component degradation or failure.

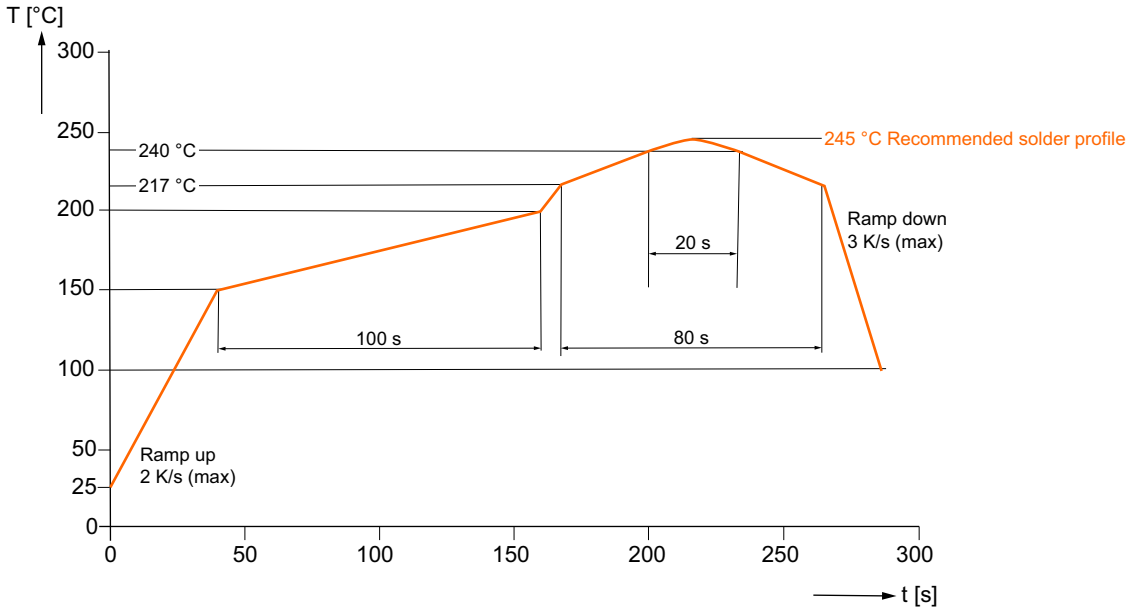
Dusty LEDs can be cleaned by using clean compressed air (e.g., spray can). Any cleaning agents and methods should be tested for suitability. As is the standard in the electronics industry, ams OSRAM recommends low- residue or no-clean solder paste, so that PCB cleaning after soldering is not required.

3.5 Soldering process

OSLON™ UV LED products are supplied in tape and reel format. Each reel contains only one brightness group, one wavelength and / or one forward voltage group. The LEDs are generally compatible with existing industrial SMT processing methods, meaning that current state of the art techniques can be used for assembly. For component assembly, a standard reflow soldering process with typical lead-free SnAgCu metal alloy solder and forced convection under standard

N_2 atmosphere is recommended. Figure 9 shows the solder requirements and temperature profiles for the lead-free soldering of OSLON™ UV.

Figure 9: Temperature profile for lead-free reflow soldering



In this context, it is recommended to check the profile on all new PCB materials and designs. The recommended temperature profile provided by the solder paste manufacturer can be used as a good starting point. The maximum temperature for the profile as specified in the data sheet should not be exceeded.

In general, it is recommended that twisting, warping, bending and any other forms of stress to the circuit board should be avoided after soldering to prevent breakage at the LED housing or solder joints. Therefore, the circuit boards should not be separated manually, but should be separated exclusively with a specially designed tool.

3.6 PCB type

PCBs are not only a mechanical substrate and electrical contact element for the components. State of the art circuit boards should also ensure the stable temperature characteristics of the circuitry. Efficient heat dissipation is necessary and the selection of appropriate materials and designs for the circuit board is important.

Materials or composites with an insufficient thermal capacity and/or conductivity can lead to a loss of reliability and/or result in limited operating parameters, since the heat generated may not be sufficiently dissipated. With an increasing duty cycle of the application, proper thermal design and management is of highest importance.

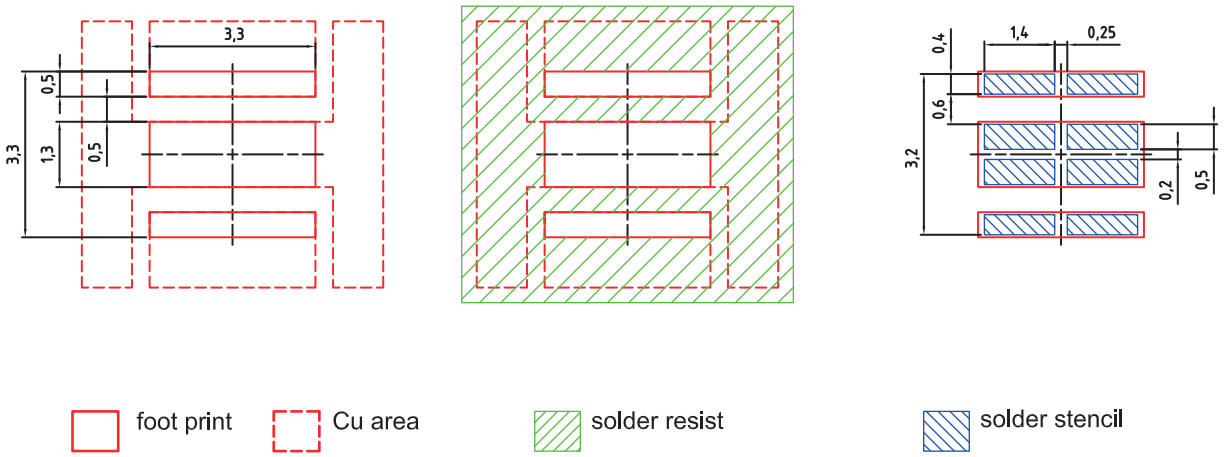
The junction temperature T_j of the LED is the relevant parameter for judging the suitability of the thermal design. The maximum allowed junction temperature T_{j_max} is always indicated in the

datasheet and should not be exceeded during operation. For further information please refer to the application note “Thermal management of light sources based on SMT LEDs”.

3.7 Solder pad

In SMT process, solder paste is usually applied by stencil printing. The amount to be applied, the quality of the paste deposits and the entire printing are primarily influenced and determined by the design of the printing stencil. Effects such as solder bridges, solder spray and/or other soldering defects are largely determined by the design of the stencil apertures and the quality of the stencil printing (e.g., positioning, cleanliness of the stencil, etc.). The stencils and their apertures are thus specially designed for the respective application. The recommended design and dimensions of the stencil apertures for the solder pad for the OSLON™ UV LED products are shown in Figure 10.

Figure 10: Recommended solder pad and solder stencil for the OSLON™ UV 3535 family



Since the solder pad effectively creates direct contact between the LED and the circuit board, the design of the solder pad contributes decisively to the performance of the solder connection. The design has an influence on the solder joint reliability, the self-centering effect and heat dissipation. In most cases, it is advantageous to use the recommended solder pad since it is individually adapted to the properties and conditions of the LED. The corresponding solder pad can be found in the LED product datasheet.

In general, the requirements for proper thermal management should be taken into consideration when designing the solder pads. The copper area should be kept as large as possible. This serves to dissipate and spread the heat generated over the PCB and is typically covered with a layer of solder resist.

When printing with a stencil, the amount of solder paste is determined by the thickness of the stencil. For OSLON™ UV LED products, a thickness of 120 µm ±10 µm is suitable. However, the stencil thickness used may also depend on the other SMD components on the PCB.

3.8 Voids

For a good thermal connection and a proper board level reliability, it is recommended that voids and bubbles should be eliminated in all solder joints. The total elimination of voids, particularly for the larger thermal pad, is difficult. Therefore, the design of the stencil aperture is crucial for the minimization of voids. The recommended design openings in the stencil enable the outgassing of the solder paste during the reflow soldering process and serve to regulate the final solder thickness. A typical solder paste coverage of 60 % – 80 % is recommended.

According to industry standards such as IPC-A-610 D or J-STD-001D (which only refer to surface mount area array components such as BGA, CSP, etc.) the number of voids (verified by the x-ray pattern) should be less than 25 % of the total solder pad area. The limit of the acceptable void can vary for each application and depends on the power dissipation and the total thermal performance of the system, which is affected by the PCB materials used.

4 UV-C dose calculation method

The UV-C dose plays a crucial role in the treatment of pathogens. The dose can be calculated by the irradiance and the irradiation time:

$H = E_e \cdot t$

Where,

H = dose [J/m²]

E_e = Irradiance [W/m²]

t = Irradiation time [s]

For the equation above, the irradiation time required is calculated from the dose H and the irradiance E_e. In accordance with the equation, it is possible to reach the same dose with a longer time t and lower irradiance and vice versa.

5 Safety topics

5.1 Eye and skin safety

LEDs are consequently evaluated and categorized in terms of optical safety in accordance with the photobiological safety standards for lamps and lamp systems IEC 62471:2006 (photo biological safety of lamps and lamp systems). In the risk grouping system of this IEC standard, OSLON™ UV LED products fall into high risk group – RG3.

Table 1 provides an overview of the data relevant to LEDs in accordance with IEC 62471 and the safety factors underpinning the Risk Groups. The assignment of an LED to a Risk Group indicates the limit value concerned must not be exceeded over the specified exposure period subject to a minimum distance of 200 mm.

Table 1: Overview of the data relevant to LEDs in accordance with IEC 62471 and the safety factors underpinning the Risk Groups

Risk Group	Safety message	Exposure periods to determine (emission limits)	
		Actinic ultraviolet hazard	Near ultraviolet hazard
“exempt” (RG0)	N/A	30000 s ($0.001\ W \cdot m^{-2}$)	1000 s ($10\ W \cdot m^{-2}$)
“low” (RG1)	Minimize exposure to eye and skin. Use appropriate shielding.	10000 s ($0.003\ W \cdot m^{-2}$)	300 s ($33\ W \cdot m^{-2}$)
“moderate” (RG2)	Eye or skin irritation may result from exposure. Use appropriate shielding.	1000 s ($0.03\ W \cdot m^{-2)}$	100 s ($100\ W \cdot m^{-2}$)
“high” (RG3)	Avoid eye and skin exposure to unshielded product.	Lamp which exceed the limits for Risk Group 2.	

6 Lifetime and reliability

6.1 Intrinsic reliability period

The intrinsic reliability period describes the so-called wear-out period of the component at the end of the product lifecycle. This phase is characterized by progressive material aging, which leads to measurable changes in performance, collectively referred to as degradation. For UV-C LEDs, the most significant degradation parameters are the changes in radiant flux, forward voltage increase and abrupt failure. Other parameters play a secondary role.

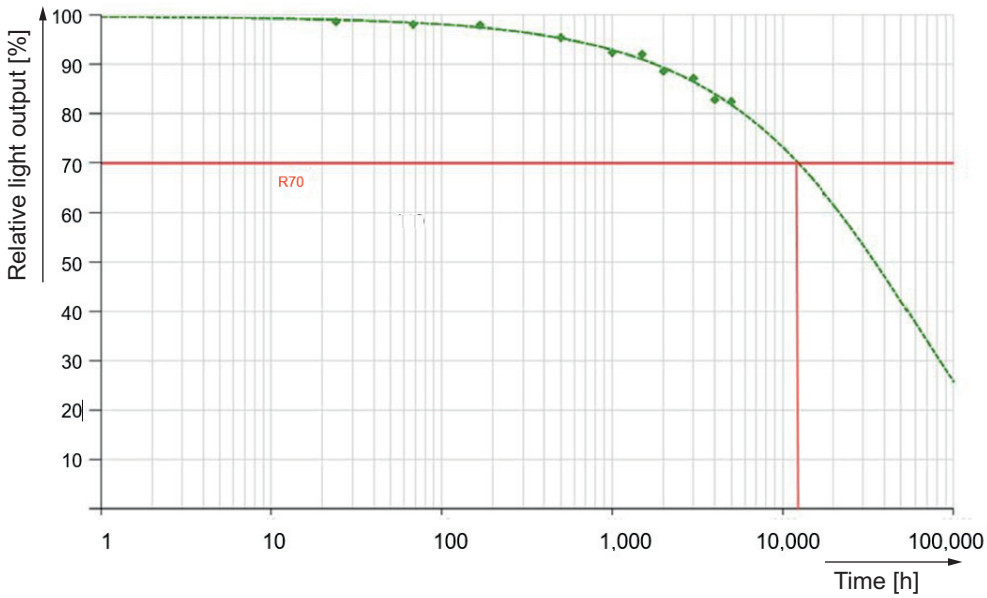
During operation, LEDs experience a gradual decrease in radiant flux (Figure 11). The rate of this decline depends on both the operating current and the temperature. Consequently, operating the LED at maximum current and elevated temperatures significantly shortens its lifetime compared to operating under binning conditions.

Depending on the operating conditions, mechanical changes may occur to the LED housing. In certain cases, this may result in a change in color perception, but this has no effect on the radiant flux performance of the LED. For further information, please contact the ams OSRAM technical support.

The term “Radiant flux maintenance” (R) describes the radiant flux remaining over time in relation to the original radiant flux of the LED. Since degradation progresses continuously, a failure

criterion must be defined to determine the functional life of the LED. The point at which the radiant flux reaches this failure criterion is described as the lifetime of the LED. It is usually application-dependent, with typical values of 50% (R50) or 70% (R70) of the original radiant flux.

Figure 11: Degradation curve



Since aging results on changes in the material properties and is subjected to statistical processes, the lifetime values are based on a statistical distribution.

The percentage of components that have failed is described by the term “mortality” (B). A value of B50 therefore indicates the point in time at which the weakest 50% of components have failed and is generally specified as typical median lifetime. Besides the median value (B50), the B10 value can also be reported, defining the time at which 10 % of the components have failed.

6.2 Validation and confirmation of reliability and lifetime

All ams OSRAM LED products passes various number of tests to validate and confirm the reliability and lifetime. The tests, test conditions and test duration are selected based on internal qualification specification in accordance with JEDEC, MIL and IEC standards. In addition, the requirement profile of the component is included.

For detailed information on LED reliability and lifetime, refer to the generic application note “Reliability and lifetime of LEDs”.

7 Summary

OSLON™ UV is a series of UV-C LEDs designed for all applications requiring UV-C radiation, such as disinfection. UV-C disinfection effectiveness is influenced by dose, which can be calculated with irradiance and duration applied.

The OSLON™ UV LED products are categorized in accordance with the IEC 62471:2006 standard and fall into the high risk-group - RG3. Therefore, avoid any contact between the eyes and skin and the unprotected product.

Care should be taken to avoid flashovers or tracking between the electrical pads. It is recommended to operate the LED in serial connection and within the electrical ratings indicated in the product datasheet. Correct handling is important to avoid mechanical damage.

ABOUT ams OSRAM Group (SIX: AMS)

The ams OSRAM Group (SIX: AMS) is a global leader in intelligent sensors and emitters. By adding intelligence to light and passion to innovation, we enrich people's lives. With over 110 years of combined history, our core is defined by imagination, deep engineering expertise and the ability to provide global industrial capacity in sensor and light technologies. Our around 20,000 employees worldwide focus on innovation across sensing, illumination and visualization to make journeys safer, medical diagnosis more accurate and daily moments in communication a richer experience. Headquartered in Premstaetten/Graz (Austria) with a co-headquarters in Munich (Germany), the group achieved EUR 3.6 billion revenues in 2023. Find out more about us on https://ams-osram.com

Our UV-C LEDs emit ultraviolet radiation of extremely high intensity near their surface. Unprotected contact can cause skin and eye damage. Prolonged or direct contact should be avoided. Bare-eye observation and bare-hand handling of our UV-C LEDs is prohibited. To ensure your safety when working with our UV-C LEDs, please follow adequate safety precautions for assembly, testing and use. Our UV-C LEDs are not certified, approved, or intended for use in medical devices under the laws or regulations of any country. They are intended for disinfection and hygiene purposes only. Our UV-C LEDs are not intended to diagnose, treat, cure, or prevent any disease. By purchasing or using our UV-C LEDs, you acknowledge their non-medical status and agree not to use them for medical or therapeutic purposes. The manufacturers and distributors of our UV-C LEDs are not liable for any consequences resulting from improper or unauthorized use as medical devices. It is the responsibility of the customers to design their respective products to ensure the safety of the end users.

DISCLAIMER

PLEASE CAREFULLY READ THE BELOW TERMS AND CONDITIONS BEFORE USING THE INFORMATION SHOWN HEREIN. IF YOU DO NOT AGREE WITH ANY OF THESE TERMS AND CONDITIONS, DO NOT USE THE INFORMATION.

The information provided in this general information document was formulated using the utmost care; however, it is provided by ams-OSRAM AG or its Affiliates* on an "as is" basis. Thus, ams-OSRAM AG or its Affiliates* does not expressly or implicitly assume any warranty or liability whatsoever in relation to this information, including – but not limited to – warranties for correctness, completeness, marketability, fitness for any specific purpose, title, or non-infringement of rights. In no event shall ams-OSRAM AG or its Affiliates* be liable – regardless of the legal theory – for any direct, indirect, special, incidental, exemplary, consequential, or punitive damages arising from the use of this information. This limitation shall apply even if ams-OSRAM AG or its Affiliates* has been advised of possible damages. As some jurisdictions do not allow the exclusion of certain warranties or limitations of liabilities, the above limitations and exclusions might not apply. In such cases, the liability of ams-OSRAM AG or its Affiliates* is limited to the greatest extent permitted in law.

ams-OSRAM AG or its Affiliates* may change the provided information at any time without giving notice to users and is not obliged to provide any maintenance or support related to the provided information. The provided information is based on special conditions, which means that the possibility of changes cannot be precluded.

Any rights not expressly granted herein are reserved. Other than the right to use the information provided in this document, no other rights are granted nor shall any obligations requiring the granting of further rights be inferred. Any and all rights and licenses regarding patents and patent applications are expressly excluded.

It is prohibited to reproduce, transfer, distribute, or store all or part of the content of this document in any form without the prior written permission of ams-OSRAM AG or its Affiliates* unless required to do so in accordance with applicable law.

* ("Affiliate" means any existing or future entity: (i) directly or indirectly controlling a Party; (ii) under the same direct, indirect or joint ownership or control as a Party; or (iii) directly, indirectly or jointly owned or controlled by a Party. As used herein, the term "control" (including any variations thereof) means the power or authority, directly or indirectly, to direct or cause the direction of the management and policies of such Party or entity, whether through ownership of voting securities or other interests, by contract or otherwise.)

For further information on our products please see the Product Selector and scan this QR Code.

Published by ams-OSRAM AG
Tobelbader Strasse 30, 8141 Premstaetten, Austria

Published by ams-OSRAM AG
Tobelbader Strasse 30,
8141 Premstaetten Austria
Phone +43 3136 500-0
ams-osram.com