OSLON® UV — Details on properties, handling and processing

Application Note

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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 a disinfected and purified environment. 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 recommendation related to assembly, handling and solder pad design of UV-C LED products.

UV-C RISK GROUP 3

UV - C

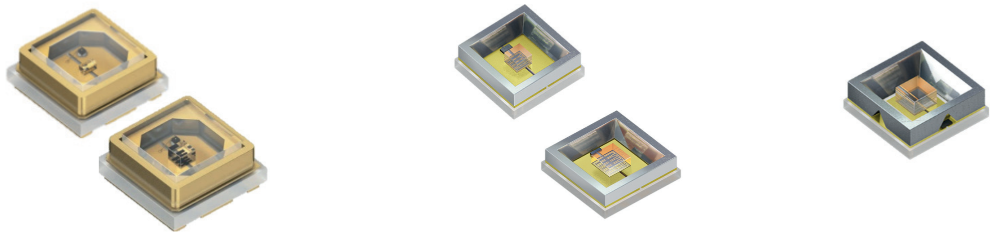
WARNING UV-C emitted from this product.
Avoid eye and skin exposure to unshielded product.
Follow installation instructions and user manual.

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.

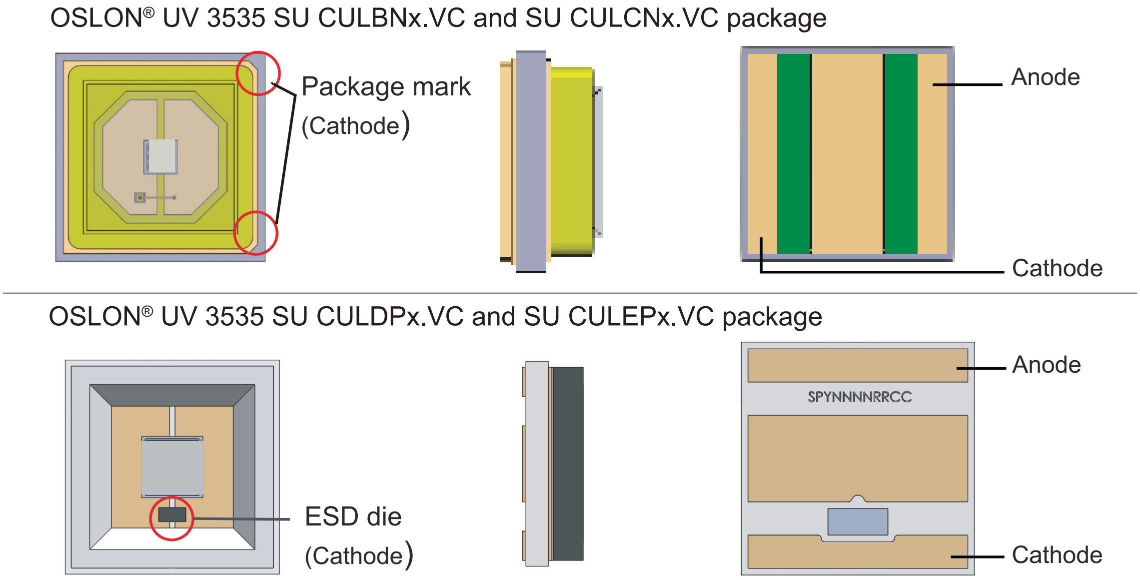
Figure 1: OSLON® UV LED product family



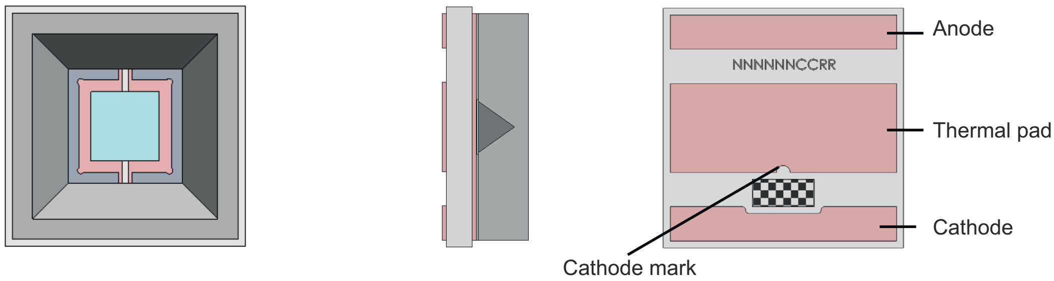
Low Power	Mid Power	High Power
(Φ_e < 30mW)	(30mW < Φ_e < 100mW)	(Φ_e >= 100mW)
SU CULBN2.VC SU CULCN1.VC	SU CULDP1.VC SU CULEP1.VC	SU CULFP1.VC

The high energetic UV radiation that is emitted increases the stress on the package. For this reason, a ceramic material is selected for the UV-C, as this provides good lifetime and reliability performance. Figure 2 show the various designs of the OSLON® UV LED product family. For information on ESD capability, please refer to product datasheet. 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 CULFPx.VC package



2 Design considerations

2.1 Mechanical and optical design resources

For detailed information on the mechanical dimensions, you may refer to the detailed drawings available in the data sheet. Please visit the "Optical Simulation / Ray Files + Package CAD Data" ams-OSRAM AG webpage to obtain CAD data and optical rayfiles.

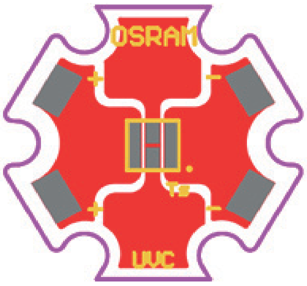
Please refer to the application note "Importing rayfiles and ray-measurement files of LEDs" for information on importing rayfiles and ray measurement files.

2.2 Electrical connection

OSLON® UV LED products have two electrical pads - the anode and the cathode pad. The clearance and creepage distance between the traces is critical to avoid flash-over or tracking between these electrical conductors.

The absolute maximum electrical rated values are specified in the datasheet. Each device must be operated below the maximum rated values to ensure a proper and reliable function. It is recommended to operate the LED in serial connection. If a parallel connection is required, an additional electronic circuit is recommended to ensure a uniform current distribution (for example a current mirror). Figure 3 shows a PCB layout of a single OSLON® UV LED on MCPCB.

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



OSLON® UV 3535

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]

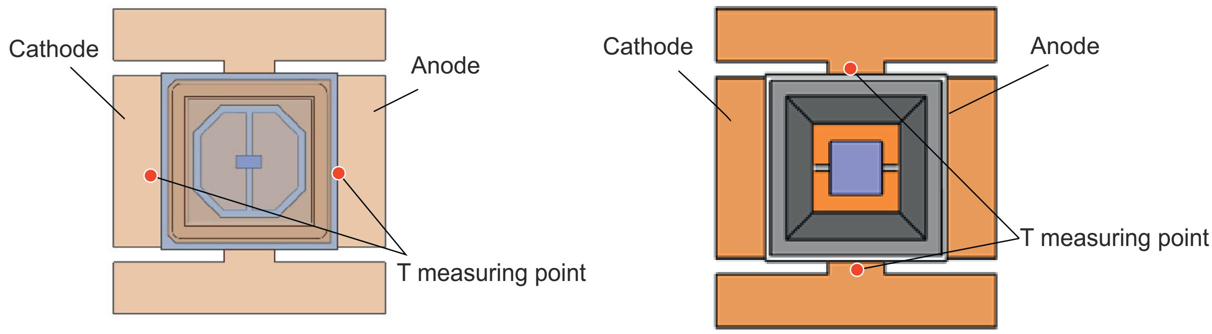
I_F is the forward current of the LED [A]

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]

Due to difficulties in direct measurement of the solder temperature (T_S) under the LED, an alternate measuring point (T_{mp}) is recommended. Figure 4 shows the recommended measuring points T_{mp} for the various UV-C products. In the calculation the $R_{th\ jmp\ el}$ is then used instead of $R_{thJS\ el}$. Please note that T_{mp} must be as close as possible to the LED.

Figure 4: Measuring point temperature T_{mp}



With this information, the junction temperature, T_J can be calculated according to the following equation:

$T_J = T_{mp} + I_F \cdot V_F \cdot R_{th\ jmp\ el}$

Where:

T_J = the junction temperature of the LED [°C]

T_{mp} = the measuring point temperature on the PCB [°C]

I_F = the forward current of the LED [A]

V_F = the forward voltage of the LED [V]

$R_{th\ jmp\ el}$ = the thermal resistance of the LED according to the data sheet [K/W]

The $R_{th\ jmp\ el}$ values for different MCPCBs are stated in Table 1 to Table 5. For example:

The thermal resistance $R_{th\ jmp\ el}$ between the UV-C low-power (SU CULBN2.VC) junction and the measuring point is approximately 41.3 K/W on an MCPCB with 2.2 W/mK, 75 µm dielectric thickness and 1 oz copper foil thickness.

The T_{mp} point is a predetermined location on the PCB in close contact to the package and it is measured by a thermocouple. Therefore, a thermally conductive epoxy or solder is recommended to ensure good heat transfer from the board to the thermocouple. The thermocouple must be in direct contact with the copper thermal pad (i.e. any solder mask must be removed first before mounting the thermocouple onto the PCB copper pad). Figure 5 shows the R_{th} Network for OSLON® UV package.

Figure 5: Rth Network for the OSLON® UV

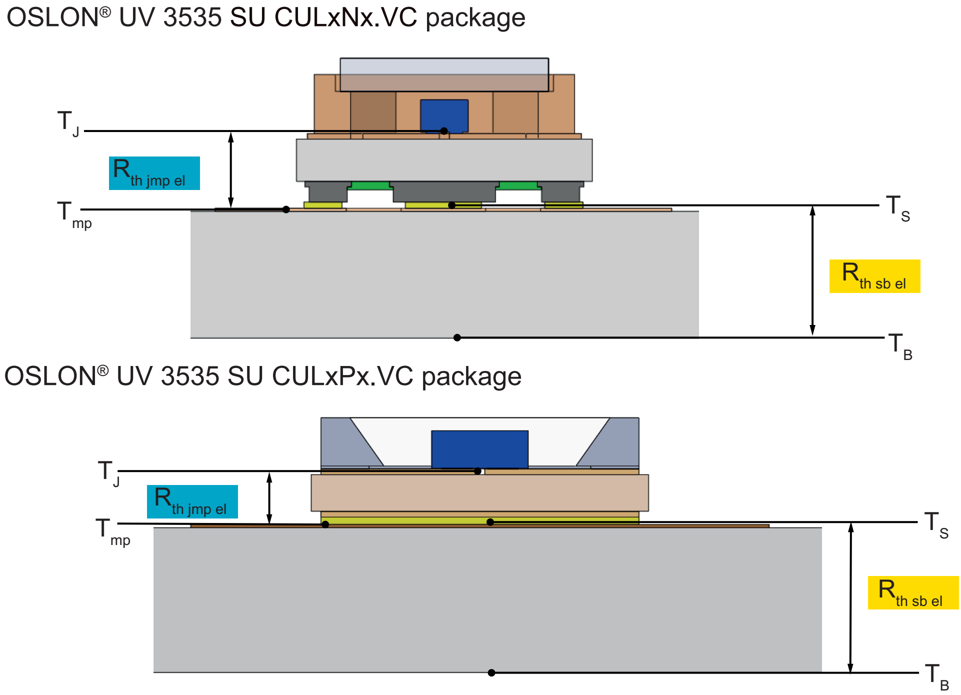


Table 1: Simulation result for the OSLON® UV 3535 SU CULBN2.VC R_{th} with various dielectrics and copper foils

PCB Technology	Details	Cu Foil	$R_{thsb\ el}$ (K/W)	$R_{thjmp\ el}$ (K/W)
Al-core MCPCB	38 µm dielectric (3.0 W/mK)	35 µm (1oz)	3.3	40.8
Al-core MCPCB	75 µm dielectric (2.2 W/mK)	35 µm (1oz)	4.9	41.3
Al-core MCPCB	100 µm dielectric (1.3 W/mK)	35 µm (1oz)	7.7	41.6

Table 2: Simulation result for the OSLON® UV 3535 SU CULCN1.VC R_{th} with various dielectrics and copper foils

PCB Technology	Details	Cu Foil	$R_{thsb\ el}$ (K/W)	$R_{thjmp\ el}$ (K/W)
Al-core MCPCB	38 µm dielectric (3.0 W/mK)	35 µm (1 oz)	4.8	18.8
Al-core MCPCB	75 µm dielectric (2.2 W/mK)	35 µm (1 oz)	6.5	19.0
Al-core MCPCB	100 µm dielectric (1.3 W/mK)	35 µm (1 oz)	9.2	19.3

Table 3: Simulation result for the OSLON® UV 3535 SU CULDP1.VC R_{th} with various dielectrics and copper foils

PCB Technology	Details	Cu Foil	$R_{thsb\ el}$ (K/W)	$R_{thjmp\ el}$ (K/W)
Al-core MCPCB	38 µm dielectric (3.0 W/mK)	35 µm (1oz)	2.9	10.1
Al-core MCPCB	75 µm dielectric (2.2 W/mK)	35 µm (1oz)	4.5	10.5
Al-core MCPCB	100 µm dielectric (1.3 W/mK)	35 µm (1oz)	7.0	11.0

Table 4: Simulation result for the OSLON® UV 3535 SU CULEP1.VC R_{th} with various dielectrics and copper foils

PCB Technology	Details	Cu Foil	$R_{thsb\ el}$ (K/W)	$R_{thjmp\ el}$ (K/W)
Al-core MCPCB	38 µm dielectric (3.0 W/mK)	35 µm (1oz)	3.0	7.4
Al-core MCPCB	75 µm dielectric (2.2 W/mK)	35 µm (1oz)	4.5	7.8
Al-core MCPCB	100 µm dielectric (1.3 W/mK)	35 µm (1oz)	7.1	8.3

Table 5: Simulation result for the OSLON® UV 3535 SU CULFP1.VC R_{th} with various dielectrics and copper foils

PCB Technology	Details	Cu Foil	$R_{thsb\ el}$ (K/W)	$R_{thjmp\ el}$ (K/W)
Al-core MCPCB	38 µm dielectric (3.0 W/mK)	35 µm (1oz)	2.9	7.2
Al-core MCPCB	75 µm dielectric (2.2 W/mK)	35 µm (1oz)	4.5	7.7
Al-core MCPCB	100 µm dielectric (1.3 W/mK)	35 µm (1oz)	7.0	8.2

2.4 Chemical and environmental considerations

The optical performance and stability of the LED may be affected by the presence of undesired chemical conditions. This could be due to incompatible materials used for the purpose of potting, coating, soldering, adhesion, etc. in a luminaire design. Therefore, the compatibility of material vs. the LED shall be considered during the fixture design stage. It is strongly recommended to protect the LED from humidity stressed condition and material which releases volatile organic compound. For further information please refer to the application notes "Chemical compatibility of LEDs" and "Preventing LED failures caused by corrosive materials".

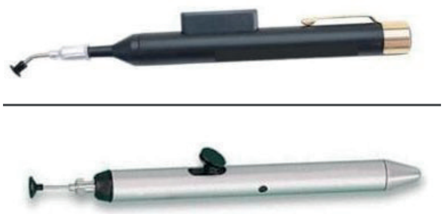
3 Assembly and processing

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.

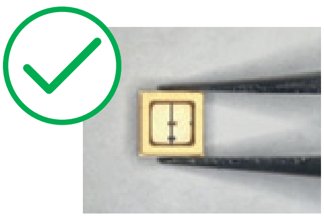
Sharp objects can cause impairment and spontaneous failure to the LED package. Any type of sharp objects (e.g., forceps, fingernails, etc.) must be avoided in order to prevent stress or encapsulant penetration. For manual handling, the use of vacuum tweezers is recommended (Figure 6). The effective mechanical 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 6: Examples of vacuum styluses for manual handling

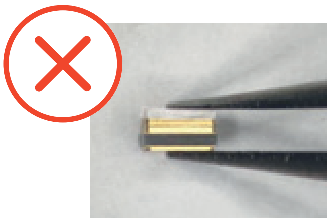


If there is no alternative to the exceptional use of tweezers (anti-static), the LED must be picked and handled at the ceramic surface as shown in Figure 7.

Figure 7: Manual handling of the LED



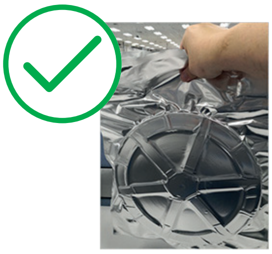
Pick the LED only on the sides towards the bottom



Do not touch the glass lens or the frame

For LEDs in tape and reel sealed package it is recommended to handle the pack as shown in Figure 8. Avoid imposing any force by holding the reel area. Force on the reel will cause damage to the sprocket holes.

Figure 8: Manual handling of the tape and reel package

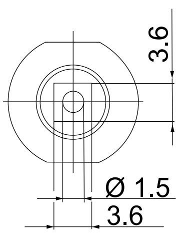
	Hold the package by the bag area without pressing the reel area.
	Do not hold the reel area.
	Do not hold the reels in stack.

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 of the lens.

During machine setup, make sure to teach the package image (Figure 2) with the camera before continuing the pick-and-place. Table 9 shows the recommended nozzle for OSLON® UV LED products.

Figure 9: Recommended pick-and-place nozzle dimensions

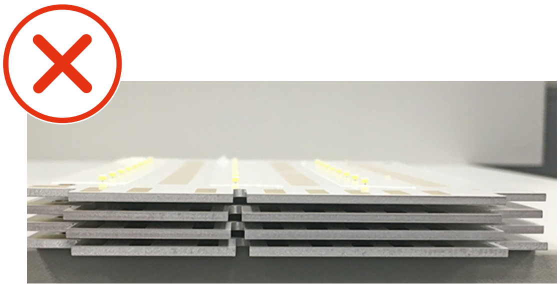
Product	Recommended nozzle design	Nozzle recommendation
OSLON® UV 3535		SIPLACE 3077709

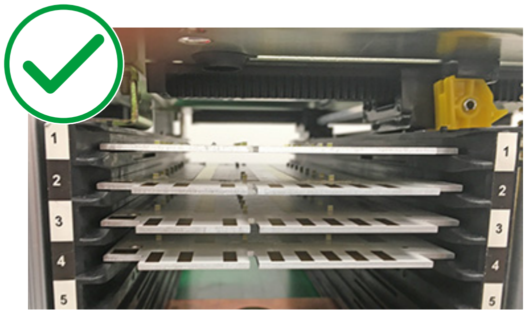
3.3 Storage

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 10). 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 10: 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.

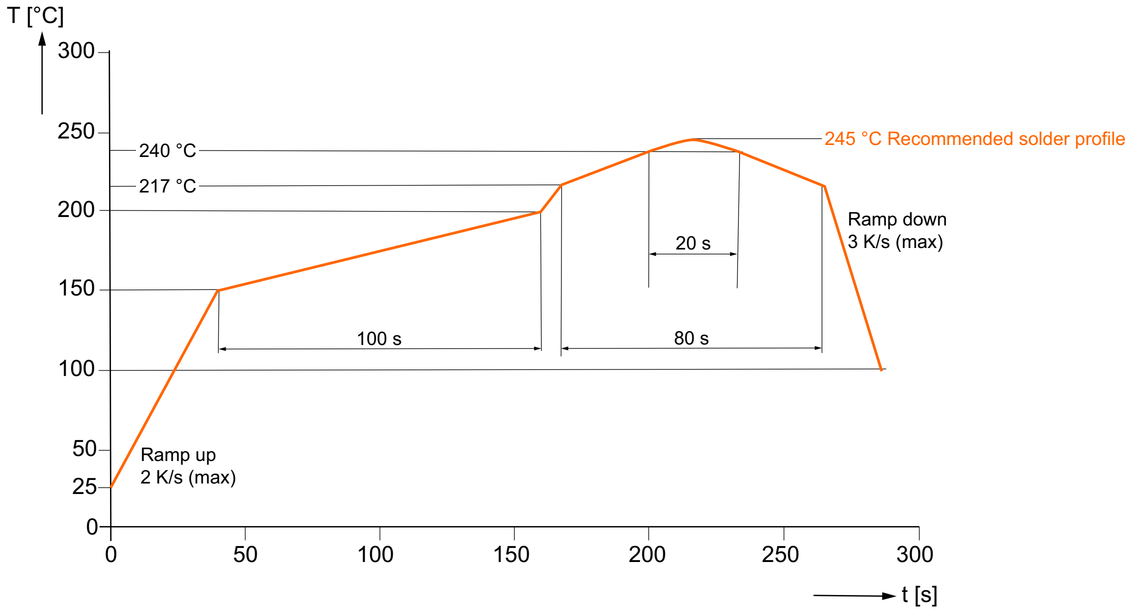
Dusty LEDs can be cleaned by using clean compressed air (e.g., spray can). Any cleaning agents and methods should be tested for suitability. As is the standard in the electronics industry, ams-OSRAM AG recommends low- residue or no-clean solder paste, so that PCB cleaning after soldering is not required.

4 Processing

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 11 shows the solder requirements and temperature profiles for the lead-free soldering of OSLON® UV.

Figure 11: 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.

4.1 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.

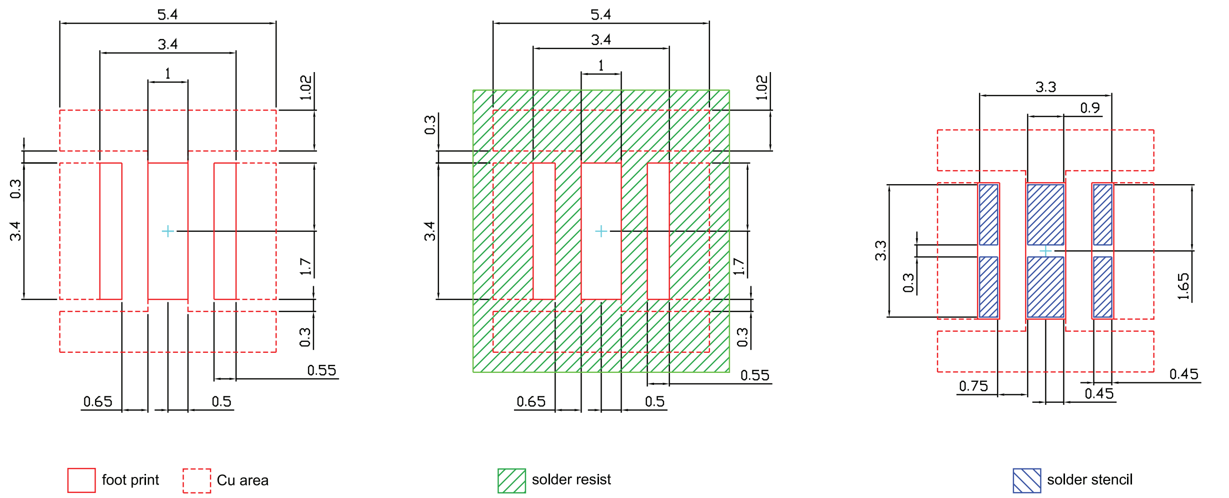
The junction temperature T_J of the LED is the relevant parameter for judging the suitability of the thermal design. The maximum allowed junction temperature T_{J_max} is always indicated in the datasheet and should not be exceeded during operation. For further information please refer to the application note "Thermal management of light sources based on SMT LEDs".

4.2 Solder pad

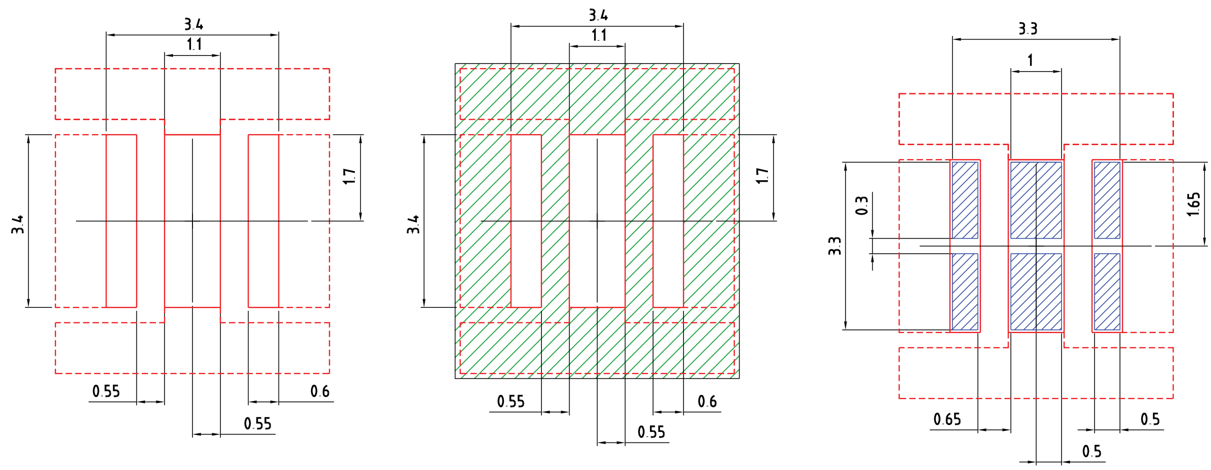
In SMT process, solder paste is usually applied by stencil printing. The amount to be applied, the quality of the paste deposits and the entire printing are primarily influenced and determined by the design of the printing stencil. Effects such as solder bridges, solder spray and/or other soldering defects 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 12.

Figure 12: Recommended solder pad and solder stencil for the OSLON® UV

OSLON® UV 3535 SU CULxNx.VC package



OSLON® UV 3535 SU CULxPx.VC package



Since the solder pad effectively creates the 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.

4.3 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.

5 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.

6 Safety topics

6.1 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 6 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 6: 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.	

7 Lifetime and reliability

7.1 Intrinsic reliability period

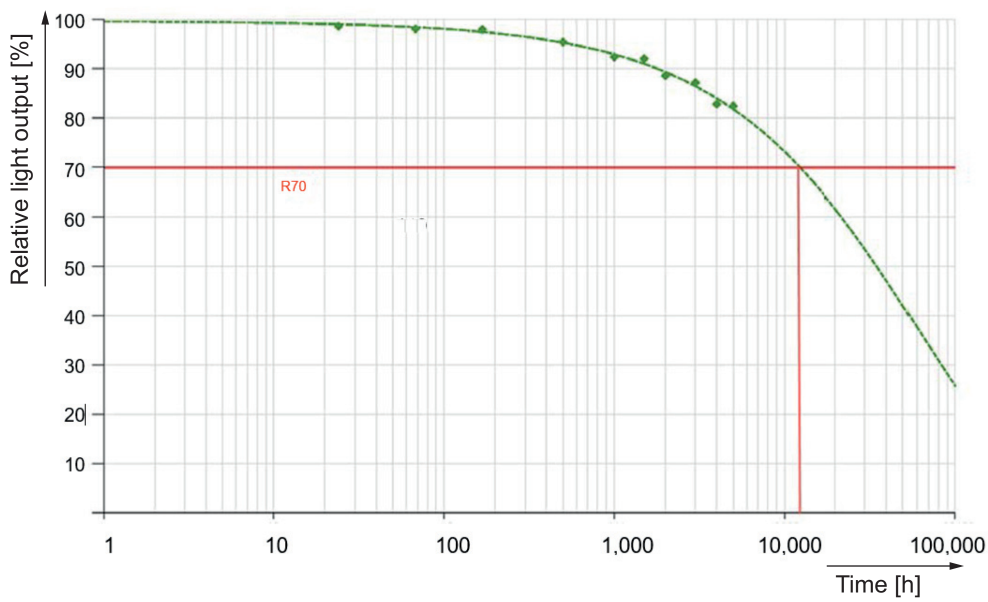
The intrinsic reliability period describes the so-called wear-out period of the component at the end of the product lifecycle. It is based on increased wear and aging of the material. This continuous change over time is generally measurable and is referred to as degradation. For UV-C LEDs, the most significant degradation parameters are the changes in radiant flux, forward voltage increase and abrupt failure. Other parameters play a subordinate role.

During operation, LEDs experience a gradual decrease in radiant flux (Figure 13). The acceleration depends on the operating current and the temperature. This means when the LED is operated under maximum current and temperature, the lifetime of the LED will be significantly shorter compared to the lifetime at binning condition.

Mechanical changes on the LED package may occur depending on the operating conditions. Under some circumstances, different color impression may be observed from the LED. In most cases, this does not affect the radiant flux performance of the LED itself. Please contact your ams-OSRAM AG representative for further information.

The term “Radiant flux maintenance” (R) is used in connection with the continous degradation of LEDs. This describes the remaining radiant flux over time, with respect to the original radiant flux of the LED. Due to continuous degradation, a failure criterion must be established to obtain a concrete evaluation of the LED failure. The point in time at which the radiant flux of the LED reaches the failure criterion is then described as the lifetime of the LED. As a rule, the failure criterion is determined by the application. Typical values are 50 % (R50) or 70 % (R70), depending on the application need of the respective LED product.

Figure 13: Degradation curve



Since aging is based on a change 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 or F). A value of B50 or F50 thus describes the point in time at which 50 % of the components have failed. This value is generally specified as typical median lifetime, t 50 or tml, for LEDs. In addition to the median value (B50 or F50), value B10 or F10 can also be specified once 10 % of the components have failed.

7.2 Validation and confirmation of reliability and lifetime

All ams-OSRAM AG 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 ams-OSRAM AG 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”.

8 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, please avoid any contact of eyes and skin with the unshielded product.

OSLON® UV LED products have two electrical pads which are anode and cathode. Care should be taken to avoid flashovers or tracking between these electrical pads. The LEDs should neither be operated in parallel nor above the absolute maximum electrical ratings indicated in the product datasheet.

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 tech-nologies. 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.

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

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