

ACULED VHL

Standard White, Monochromatic and Multi-Colored
Four-Chip LED Products



The ACULED VHL (Very High Lumen) provides superior mixing, low thermal resistance, best-in-class heat sinking and adjustable color temperature all in a compact, easy to assemble package.

Overview

The ACULED® VHL™ (Very High Lumen) is the standard product line in the growing ACULED family of high power LED solutions based on superior Chip-on-Board (COB) technology.

The ACULED VHL offerings provide excellent color mixing and luminous efficacy, 4 separate addressable chips, and adjustable color temperatures. It is based on an enhanced ACULED board utilizing an Insulated Metal Core Substrate (IMS) made of copper and a highly sophisticated isolation material with low thermal resistance between copper and chip pads.

Excelitas' ACULED VHL is compact in size, easy to assemble and has a superior optical design. Each chip has a separate anode and cathode, allowing them to be driven individually, this increasing flexibility in electrical layout.

The ACULED VHL is available standard in monochromatic (White, UV, Blue, Green, Yellow, Red, IR) as well as multi-color four-chip combinations. This includes RGBW versions, which offer a higher color rendering index than our basic ACULED RGGB, as well as additional multi-color / white options. Optics can be easily attached.

For ESD-sensitive chip types, safe and reliable ESD protection is enabled using Zener diodes.

The ACULED VHL — as well as all members of the ACULED product family — is fully RoHS-compliant.

Key Features and Benefits














- Superior Color Mixing
- Based on multi Chip-on-Board (COB) technology
- 4 separate addressable chips
- Low thermal resistance
- Best-in-class heat sinking
- Superior “Through-Looking” (TL) mounting design
- Ultra-compact footprint
- Adjustable color temperature
- Outstanding brightness and luminous efficacy
- Designed for high current applications
- Fully RoHS-compliant

Applications

- Illumination
- Medical lighting
- Aircraft lighting
- Analytical lighting
- Signaling

®

Table 1. Ordering Information and Characteristics

Optical Characteristics Board temperature $T_b=25^{\circ}\text{C}$; $I_f=700\text{ mA}$ (350 mA for UV)						
ACULED VHL	Product Number	Type	Peak Wavelength λ_{peak} Typ. [nm]	Dominant Wavelength λ_{dom} Typ. [nm]	Luminous flux Φ_v , Radiant flux Φ_e Typ. [lm] (mW for UV, IR)	Luminous Intensity I_v Typ. [cd]
Monochromatic						
	E001698	ACL01-SC-UUUU-E05-C01-L-U000*	402	—	1100	—
	E001744	ACL01-SC-DDDD-E10-C01-L-L000*	450	455	55	17
	E001699	ACL01-SC-BBBB-E10-C01-L-M000*	455	460	65	20
	E001746	ACL01-SC-CCCC-E10-C01-L-Q000*	499	500	180	48
	E001700	ACL01-SC-GGGG-E10-C01-L-T000*	518	523	320	85
	E001701	ACL01-SC-YYYY-007-C01-L-Q000*	598	595	170	39
	E001745	ACL01-SC-AAAA-007-C01-L-R000*	625	615	190	54
	E001702	ACL01-SC-RRRR-007-C01-L-R000*	635	624	200	57
	E001703	ACL01-SC-IIII-005-C01-L-T000*	855	—	880	—
	E001747	ACL01-SC-JJJJ-005-C01-L-Q000*	950	—	390	—
Multi-color						
	E001796	ACL01-MC-RGBG-E10-C01-L-R000*				
Red			635	624	50	14
Green			518	523	160	44
Blue			455	460	16	5
	E001704	ACL01-MC-RGYB-E08-C01-L-R000*				
Red			635	624	50	14
Green			518	523	80	22
Yellow			598	595	43	10
Blue			455	460	16	5
	E001936	ACL01-MD-RBGP-E06-C01-L-P000*				
Red			635	624	50	14
Blue			455	460	16	5
Green			518	523	80	22
Photo-Diode						

* See individual datasheets for ACULED VHL.
























Average Lumen Maintenance Characteristics

Typically, the lifetime for solid-state lighting devices, or LEDs, is derived from the percentage of initial light output that remains after a specific time period — generally referred to as lumen maintenance.

Excelitas projects that ACULED VHL products will average 70% lumen maintenance after 30,000 hours of constant current operation with junction temperature maintained at or below 85°C.

This performance is based on three criteria — independent test data, Excelitas historical data from tests run on similar material systems, and internal ACULED reliability testing. To achieve this level of lumen maintenance, all design limits included in this brochure must be adhered to carefully.

Table 2. Electrical and Thermal Characteristics

Electrical and Thermal Characteristics Board temperature $T_B=25^{\circ}\text{C}$; $I_F=700\text{ mA}$ (350 mA for UV)					
ACULED VHL	Product Number	Type	Maximum Current I_F per Chip Typ. [mA]	Voltage DC U_F per Chip Typ. [V]	Maximum Total Power Consumption P_{tot} [W]
Monochromatic					
UV 	E001698	ACL01-SC-UUUU-E05-C01-L-U000*	350	3.9	6.3
Deep Blue 	E001744	ACL01-SC-DDDD-E10-C01-L-L000*	700	3.5	12.6
Blue 	E001699	ACL01-SC-BBBB-E10-C01-L-M000*	700	3.5	12.6
Cyan 	E001746	ACL01-SC-CCCC-E10-C01-L-Q000*	700	3.9	12.6
Green 	E001700	ACL01-SC-GGGG-E10-C01-L-T000*	700	3.9	12.6
Yellow 	E001701	ACL01-SC-YYYY-007-C01-L-Q000*	700	2.4	9.8
Amber 	E001745	ACL01-SC-AAAA-007-C01-L-R000*	700	2.3	9.8
Red 	E001702	ACL01-SC-RRRR-007-C01-L-R000*	700	2.3	9.8
IR 1 	E001703	ACL01-SC-III-005-C01-L-T000*	700	1.6	7
IR 2 	E001747	ACL01-SC-JJJ-005-C01-L-Q000*	700	1.6	7
Multi-color					
RGBG 	E001796	ACL01-MC-RGBG-E10-C01-L-R000*			6
Red 			700	2.3	
Green 			700	3.9	
Blue 			700	3.5	
RGYB 	E001704	ACL01-MC-RGYB-E08-C01-L-R000*			11.2
Red 			700	2.3	
Green 			700	3.9	
Yellow 			700	2.4	
Blue 			700	3.5	
RBGP 	E001936	ACL01-MD-RBGP-E06-C01-L-P000*			9
Red 			700	2.3	
Green 			700	3.9	
Blue 			700	3.5	
Photo-Diode					

* See individual datasheets for ACULED VHL.

Figure 1. Typical Spectral Distribution ($I_F = 700\text{ mA}$, $T_B = 25^{\circ}\text{C}$)

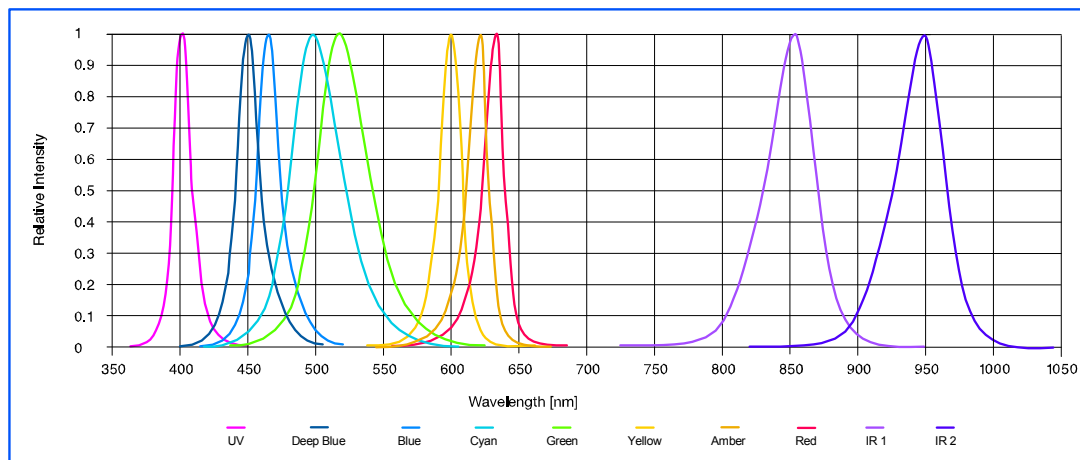


Table 3. Optical Characteristics

Optical Characteristics Board temperature $T_B=25^\circ\text{C}$; $I_F=700\text{ mA}$						
ACULED VHL	Product Number	Specialty	Type	Correlated Color Temperature CCT [K]	Color Rendering Index Typ.	Luminous flux Φ_v Typ. [lm]
All White						
5555 5000 K White	E002026	Neutral White	ACL01-SC-5555-E10-C01-V-TM00*	5000	77	360
5555 5700 K White	E001741	Neutral White	ACL01-SC-5555-E10-C01-V-TL00*	5700	77	360
6666 6500 K White	E001742	Cold White	ACL01-SC-6666-E10-C01-V-TK00*	6500	77	360
Multi-Color / White						
666R 6500 K White 6500 K White 6500 K White Red	E001748	White, Best CRI	ACL01-MC-666R-E09-C01-V-TK00*	~(5000-6500)	85-90	90 90 90 45
R5G5 Red 5700 K White Green 5700 K White	E001940	White, tunable across a broad color spectrum (from 2700-6500K)	ACL01-MC-R5G5-E09-C01-V-SL00*	~(2700-6500)	Up to 90	45 90 65 90
RBG4 Red Blue Green 4500 K White	E001938	Wide color space tunability High CRI for Warm White	ACL01-MC-RBG4-E09-C01-L-R000*	- - - 4500	- - - 88	50 16 80 58
RBG6 Red Blue Green 6500 K White	E001939	Wide color space tunability High CRI for Cold White	ACL01-MC-RBG6-E09-C01-L-S000*	- - - 6500	- - - 77	50 16 80 90
666N 6500 K White 6500 K White 6500 K White NTC	E001937	White with chip temperature control via NTC	ACL01-MD-666N-E07-C01-V-S000*	6500 6500 6500 -	77 77 77 -	90 90 90 -

* See individual datasheets for ACULED VHL.

Commitment to the Environment

Excelitas is proud of its commitment to providing the best in environmentally-friendly, energy-efficient products to customers in the solid state lighting market.

The ACULED product family offers eco-friendly design solutions for a wide range of applications including illumination, medical lighting, aircraft lighting, projection and signaling.

All products in the ACULED family comply with the European Union directives on the restriction of hazardous substances in electronic equipment as stated within the RoHS directive. The following restricted materials will not intentionally be added to the ACULED VHL — lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

Table 4. Electrical and Thermal Characteristics

Electrical and Thermal Characteristics Board temperature $T_B=25^{\circ}\text{C}$; $I_F=700\text{ mA}$						
ACULED VHL	Product Number	Specialty	Type	Maximum Current I_F per Chip Typ. [mA]	Voltage DC U_F per Chip Typ. [V]	Maximum Total Power Consumption Typ. P_{tot} [W]
All White						
5555 5000 K White	E002026	Neutral White	ACL01-SC-5555-E10-C01-V-TM00*	700	3.5	12.6
5555 5700 K White	E001741	Neutral White	ACL01-SC-5555-E10-C01-V-TL00*	700	3.5	12.6
6666 6500 K White	E001742	Cold White	ACL01-SC-6666-E10-C01-V-TK00*	700	3.5	12.6
Multi-Color / White						
666R 6500 K White 6500 K White 6500 K White Red	E001748	White, Best CRI	ACL01-MC-666R-E09-C01-V-TK00*	700	3.5 3.5 3.5 2.3	11.9
R5G5 Red 5700 K White Green 5700 K White	E001940	White, tunable across a broad color spectrum (from 2700-6500K)	ACL01-MC-R5G5-E09-C01-V-SL00*	700	2.3 3.5 3.9 3.5	11.9
RBG4 Red Blue Green 4500 K White	E001938	Wide color space tunability High CRI for Warm White	ACL01-MC-RBG4-E09-C01-L-R000*	700	2.3 3.5 3.9 3.5	11.9
RBG6 Red Blue Green 6500 K White	E001939	Wide color space tunability High CRI for Cold White	ACL01-MC-RBG6-E09-C01-L-S000*	700	2.3 3.5 3.9 3.5	11.9
666N 6500 K White 6500 K White 6500 K White NTC	E001937	White with chip temperature control via NTC	ACL01-MD-666N-E07-C01-V-S000*	700	3.5 3.5 3.5 -	9.5

* See individual datasheets for ACULED VHL.

Figure 2. Typical Spectral Distribution, White ($I_F = 700\text{ mA}$, $T_B = 25^{\circ}\text{C}$)

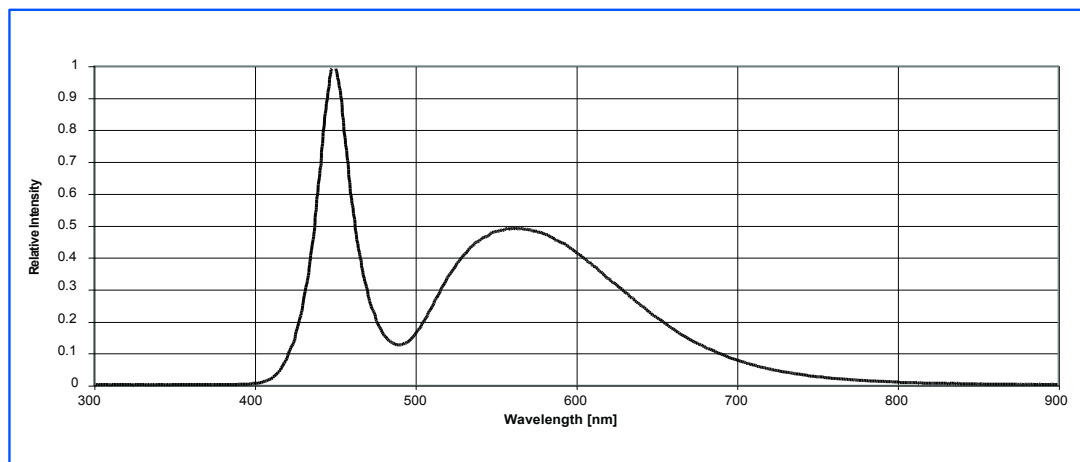


Figure 3. Mechanical and Electrical Specifications

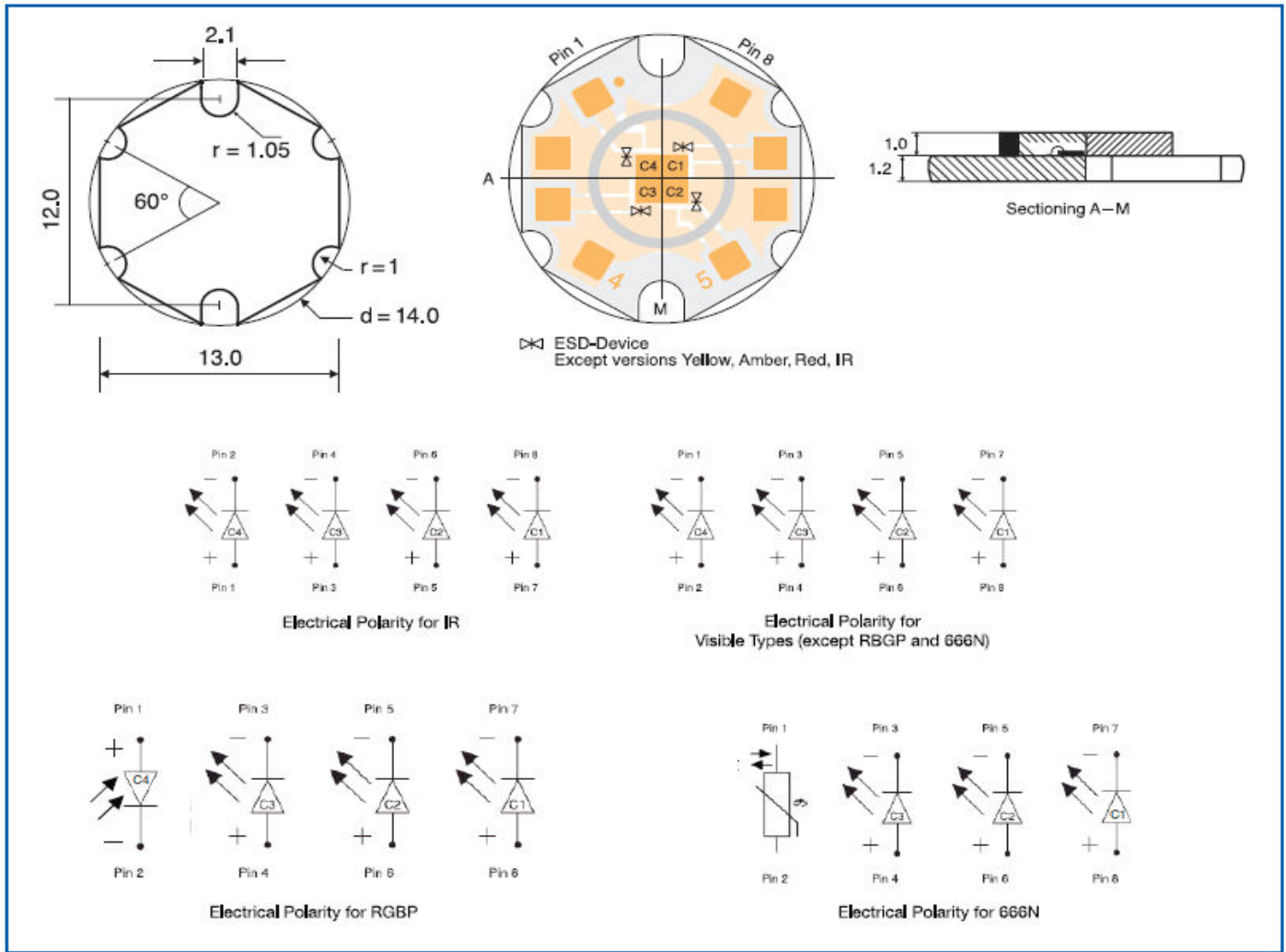


Table 5. Maximum Ratings at $T_B=25^\circ\text{C}$

Parameter	Symbol	Value	Units	Materials	
Operating temperature range	T_{op}	-40 to 80	$^\circ\text{C}$	Package: IMS (copper) Encapsulating Resin: Silicone Ring: PPA based Electrodes: Au Plating	
Storage temperature	T_{st}	-40 to 80	$^\circ\text{C}$		
Junction temperature	T_j	125	$^\circ\text{C}$		
Reverse voltage per chip	V_R	5	V		
Reverse current ($V_R = 0.5\text{ V}$)	I_R	2	μA		
ESD sensitivity		2	kV		
Soldering temperature:	Reflow (10 sec)	T_{sdd}	260		$^\circ\text{C}$
	Hand (3 sec)	T_{sold}	400		$^\circ\text{C}$

Thermal Resistance

For the ACULED VHL, the thermal resistance of the package can be as low as 4.5 K/W, depending on the chip configuration. The special separated pad-geometry of the ACULED VHL reduces thermal cross-talk amongst the LED chips when operated simultaneously.

This allows optimized stable working conditions, especially for multi-color ACULEDs like RGYB or one of the many custom combination possibilities with the ACULED[®] DYOTM (Design-Your-Own). Please refer to the separate Application Notes about thermal management as well as the ACULED DYO Custom Design Guide

Figure 4. Reflow Soldering Profile (Schematic)

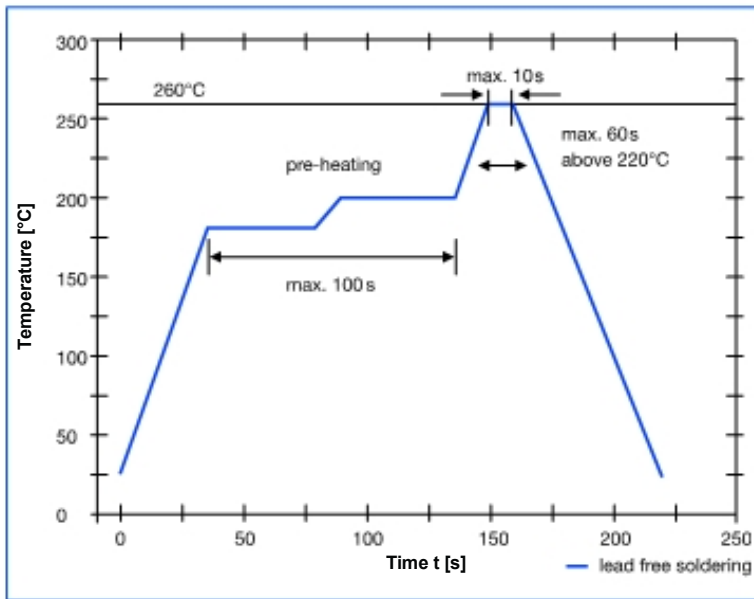
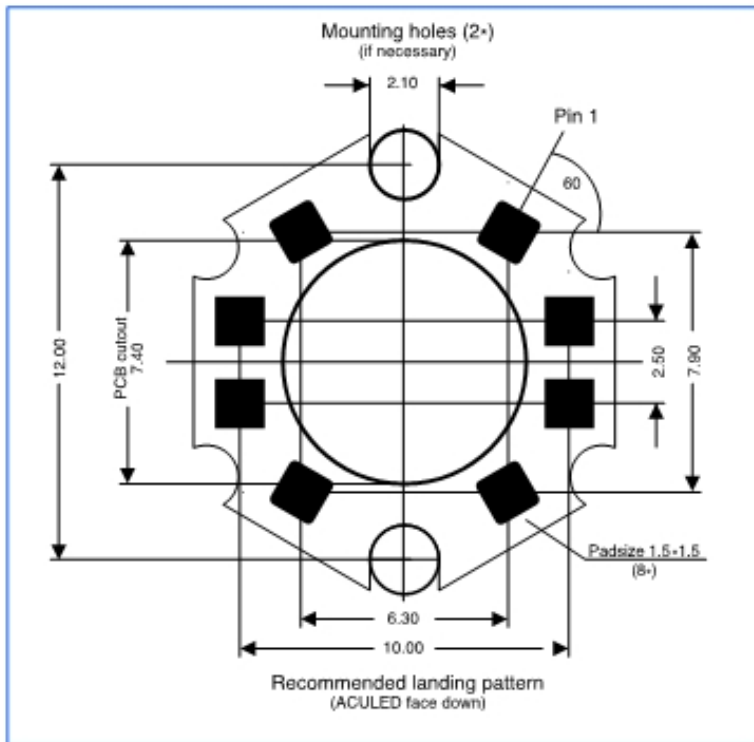


Figure 5. Recommended Solder Pad Geometry



Hand Soldering

- Pre-heat ACULED on a hot plate at 100°C.
- Cover silicone surface with protection cap or similar.
- Use 95 W soldering iron.
- Apply soldering temperature of 400°C for max. three seconds.

Cautions

For eye safety aspects the standard CIE S009/E:2002 ("photobiological safety of lamps and lamp systems") has to be followed. The visible LEDs specified in this data sheet fall into the "low risk" group of the standard (relating to devices in the visible spectrum with an exposure time of 100 s). Under real circumstances (for exposure time, eye pupils, observation distance), it is assumed that no endangerment to the eye exists from these devices. As a matter of principle, however, it should be mentioned that intense light sources have a high secondary exposure potential due to their blinding effect. When viewing directly to the operated LEDs a temporary reduction in visual acuity and afterimages can occur, leading to irritation, annoyance, visual impairment, and even accidents, depending on the situation.

The products ACULED VHL UV and ACULED VHL IR mainly emit invisible radiation that can cause severe damage to human eye. Precautions have to be taken to protect the eye from direct or scattered light when being operated.

LED RADIATION
DO NOT STARE INTO BEAM
PRECAUTIONS HAVE TO BE TAKEN

LED RADIATION
DO NOT VIEW DIRECTLY
WITH OPTICAL INSTRUMENTS
PRECAUTIONS HAVE TO BE TAKEN

ACULED Through-Looking (TL) Mounting — The Principle of TL-Mounting The Superior SMD Technology

The construction and layout of the ACULED allows it to be mounted by a superior Through-Looking (TL), upside down technology called TL-Mounting. The ACULED is directly mounted to a heat sink and is driven by a standard, more cost effective printed circuit board (PCB) as shown in the figure to the right. This allows for fewer thermal bottlenecks between the pn-junction of the LED and the heat sink and eliminates the need for expensive metal core or ceramic boards required when using standard SMD-LEDs.

The figure to the right shows the principles of TL-Mounting: the ACULED is soldered upside down on a standard PCB in a standard reflow process. This PCB needs a cut-out of $\text{Ø} 7.4 \text{ mm}$, where the ACULED can look through. Now the whole package, ACULED with PCB, can easily be mounted on a heat sink. For more information on mounting of the ACULED, please refer to the detailed datasheets and Application Notes, including the solder pattern and PCB cut-out for TL-Mounting.

For more details please refer to the Application Note “Mounting of the ACULED Product Family”.

Figure 6. TL-Mounting: ACULED with TL-PCB Mounted on Standard Heat Sink

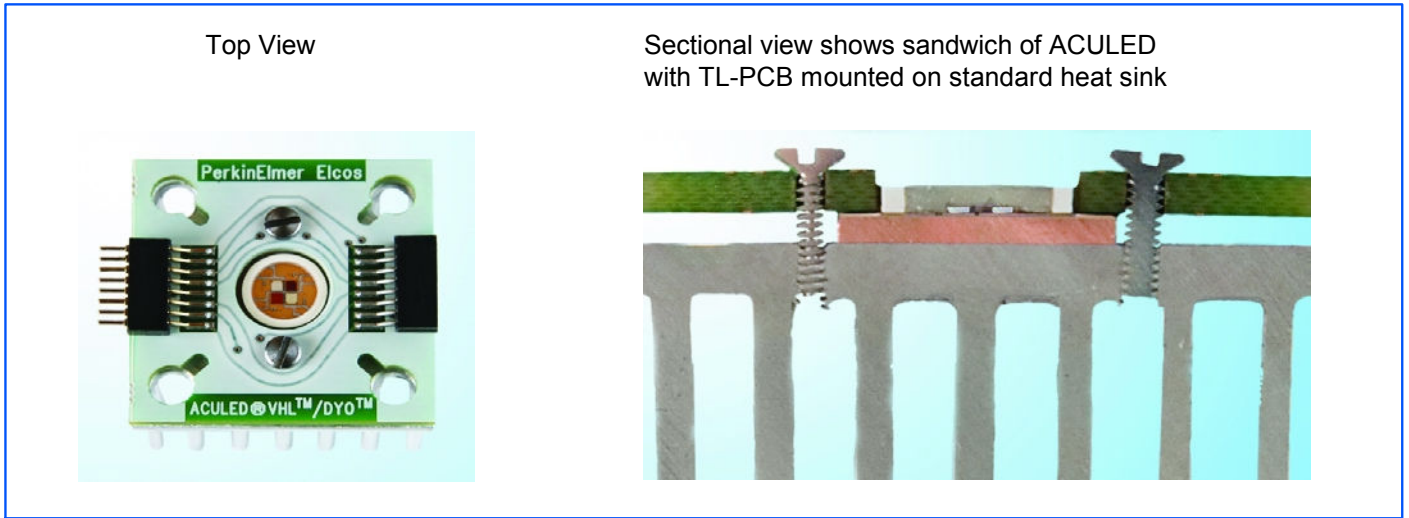
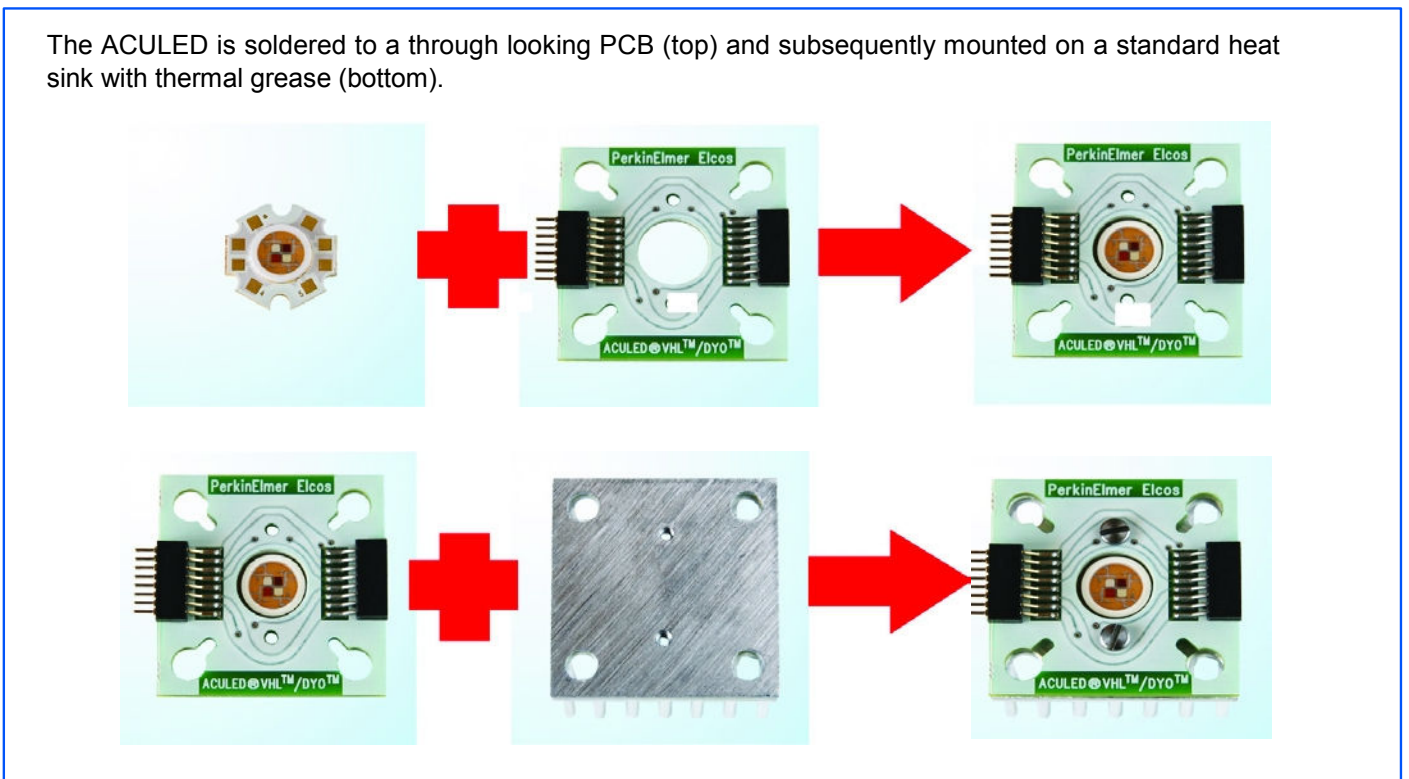


Figure 7. The Principle of TL-Mounting of the ACULED for Easiest Heat Management



Comparison of TL-Mounting vs. Standard-SMD-LED

The advantage of upside down TL-Mounting is the easy reflow process and the ability to use inexpensive PCB materials and standard heat sinks. The figure below shows the comparison between the ACULED utilizing TL-mounting vs. a standard high power SMD-LED package.

The blue (top) and dark grey (bottom) areas represent the ACULED and show how the thermal bottlenecks (in red) for the high power, standard SMD-LED package are reduced with TL-Mounting, as a result of the direct attachment of the ACULED to the heat sink.

Figure 8. Comparison of TL-Mounting (left) to Standard SMD Soldering (right)

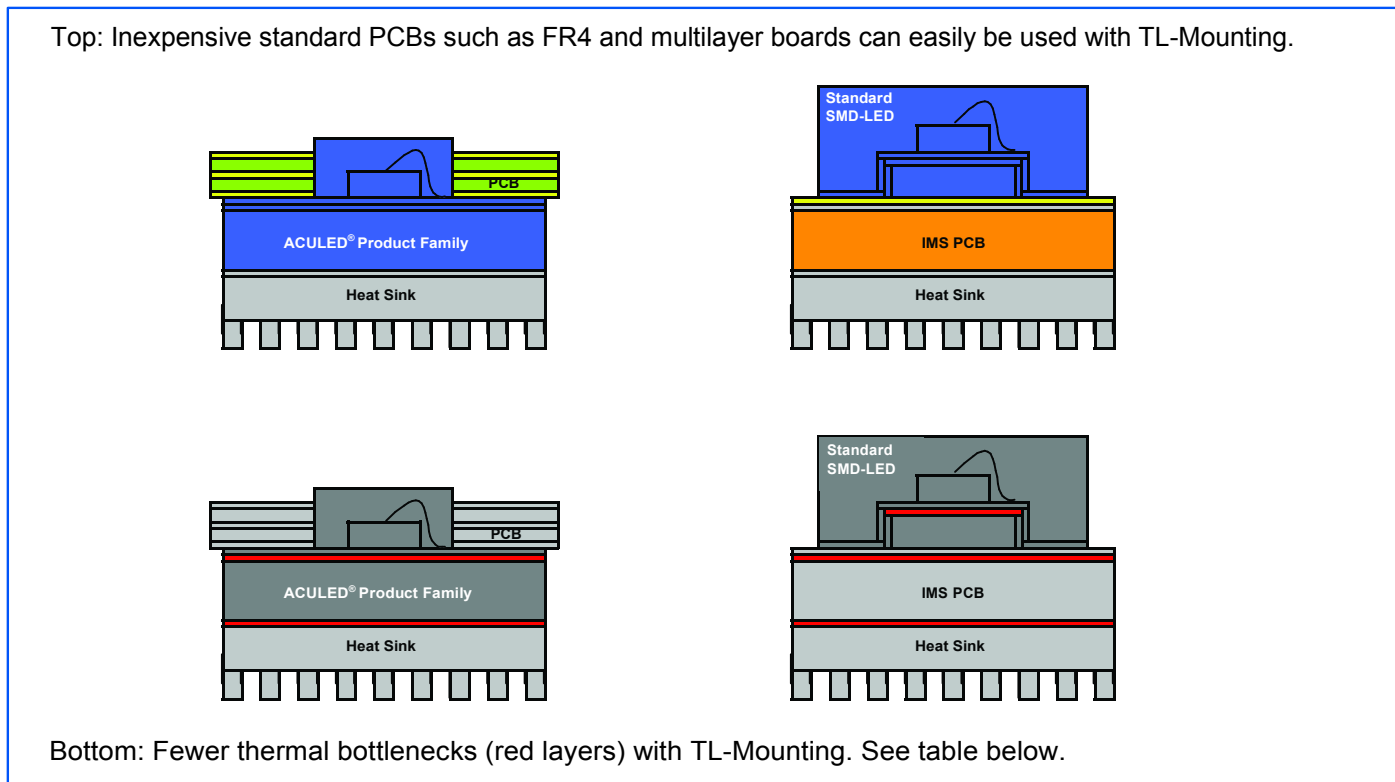
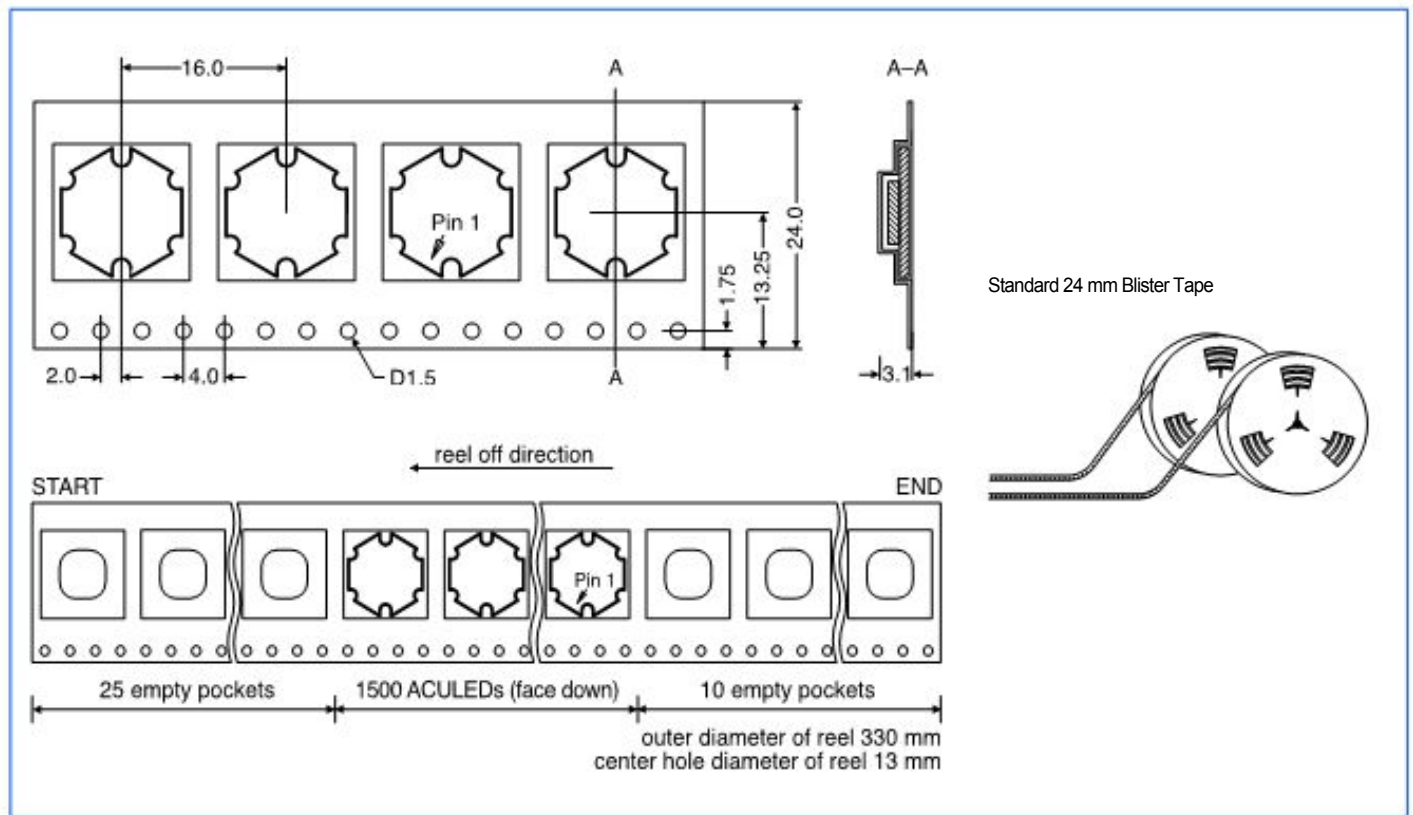


Table 6. Advantages of TL-Mounting

ACULED TL-Mounting	Conventional High-Power SMD-LED Mounting
Inexpensive PCBs can be used	High thermal conductive PCBs as metal core or ceramics needed
Multi layer boards can easily be applied	Only single layer board are possible
Fewer thermal bottlenecks (2)	More thermal bottlenecks (23)
Thinner assembly	Thinner assembly
Cost saving	Higher cost

Figure 9. Packaging



Notes

1. Excelitas maintains a tolerance of $\pm 5\%$ on flux and power measurements.
2. ACULED VHL products with even higher luminous flux and radiometric power levels will become available in the future.
3. Dominant wavelength is derived from the CIE 1931 chromaticity diagram and represents the perceived color.
4. Excelitas maintains a tolerance of ± 2 nm for dominant wavelength measurements.
5. Excelitas maintains a tolerance of ± 1 nm for peak wavelength measurements.
6. Excelitas maintains a tolerance of ± 2 K/W for thermal resistance measurements depending on chip properties.
7. Correlated color temperatures are derived from the CIE 1931 Chromaticity Diagram. CCT $\pm 5\%$ Tester tolerance
8. All green, cyan, blue, and UV products are built with Indium Gallium Nitride (InGaN).
9. All red and yellow products are built with Aluminum Indium Gallium Phosphide (AlInGaP).
10. All infrared products are built with Aluminum Gallium Arsenide (AlGaAs).
11. Proper current derating must be observed to maintain junction temperature below the maximum.
12. LEDs are not designed to be driven in reverse bias.
13. Stresses in excess of the absolute maximum ratings can cause damage to the emitter. Maximum rating limits apply to each parameter in isolation, all parameters having values within the current derating curve. It should not be assumed that limiting values of more than one parameter can be applied to the product at the same time. Exposures to the absolute maximum ratings for extended periods can adversely affect device reliability.
14. Due to the special conditions of the LED manufacturing process, the typical data or calculated correlations of technical parameters can only reflect statistical figures. These do not necessarily correspond to the actual parameters of each single product, which could differ from the typical data and calculated correlations or the typical characteristic line. If requested, e.g. because of technical improvements, these typical data will be changed without any further notice.
15. All drawings are not to scale.
16. All dimensions are specified in mm.
17. For general mounting instructions and thermal management requirements, please refer to our Application Notes accordingly. ,

Please consult Excelitas or its distributors for more information.

Optics

Currently, the ACULED lens holder system offers two different collimating optics. With an opening angle of approximately 32° , the ACULED LHS-AL25-L32 (E000525) provides a medium opening, whereas the LHS-AL25-L22 (E000524) has a tight collimating optic with an aperture angle of approximately 22° .

Due to their superior optical quality, both optics increase luminous intensity and, thereby, enable new application fields for the ACULED. Please contact us for further information or to receive the datasheet for the ACULED LHS-AL25.

Heat Sink Recommendations

The maximum junction temperature of the ACULED should not exceed 125°C . Therefore, an adequate heat sink is required for operating the LED with currents between 50 mA and 700 mA. Due to the ACULED's superior thermal management, heat dissipation is optimized when the LED is screwed down with thermal grease onto a planar substrate. For details please refer to the Application Note "Thermal Management of the ACULED VHL".

ACULED Designer Kit

Excelitas has created a Designer Kit to run and test the ACULED in your application. It is easy to use and does not require specialized technical know-how. Please contact us to receive a product description and additional information on how to obtain the Designer Kit.

ACULED DYO—Flexibility to "Design-Your-Own" High Power LED

In addition to the ACULED VHL, Excelitas' line of standard white, monochromatic and multi-colored high powered LEDs, Excelitas also has its exclusive "Design-Your-Own" line, the ACULED DYO.

The ACULED DYO gives customers the total flexibility to design their own four-chip LED configuration to suit their specific application.

For more information on our ACULED DYO line, please refer to the ACULED DYO Custom Design Guide.

Figure 10. Opening Angle: Example RGB with Lens

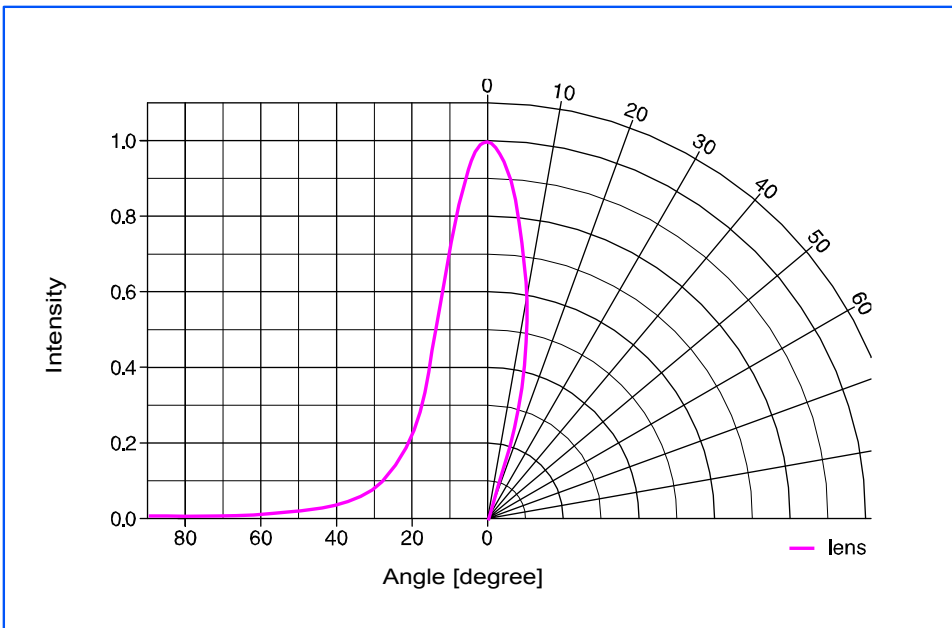


Table 7. Product Nomenclature

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					
Order Number	A	C	L	0	1	-	P	F	-	M	C	O	-	C1	C2	C3	C4	-	P	W	C	-	C	0	1	-	L	-	B	I	N	S					
Example	A	C	L	0	1	-	M	C	-	0	0	0	-	R	G	Y	B	-	E	0	8	-	C	0	1	-	L	-	R	2	5	0					
<p>Position 1-3: Product name</p> <p>Position 4-5: Product generation 01 = VHL</p> <p>Position 7-8: Product family SC: Single color MC: Multi-color OD: On demand (Design Your Own) MD: Multi-die</p> <p>Position 10-12: Manufacturing code (BOM) Design-Your-Own: alpha-numerical code VHL: 000 (will typically be left out in datasheets)</p>														<p>Position 14-17: Pads C1-C4 U = UV D = Deep blue B = Blue C = Cyan G = Green Y = Yellow A = Amber R = Red I = Near infrared J = Infrared W = White 4 ≈ 4000 K 5 ≈ 5000 K/ 5700 K 6 ≈ 6500 K</p> <p>Sensors P = Photo diode N = NTC</p>								<p>Position 19: ESD-protection 0 = none E = ESD protection</p>					<p>Position 20-21: Input-Power in Watts (TB = 25°C at rated current)</p>					<p>Position 23-25: Package type 23: Substrate material C = copper IMS 24 + 25: 00 undefined 01 dielectric layer VHL-version</p> <p>Position 27: Beam pattern: 0 = not defined L = Lambertian V = Volume Coating White</p> <p>Position 29: Intensity bin alpha-numerical (0 = open)</p>					<p>Position 30-31: Color bin (00 = open): SC colored: wavelength (1, 2, 3, ...) SC white: area in xy diagram (A, B, C, ...) MC: wavelength combination (0, 1, 2, ...) OD: 00 MD: 00 Position 32: not used = 0</p>

ACULED DYO - Flexibility to "Design-Your-Own" High Power LED.

In addition to the ACULED VHL, Excelitas' line of standard white, monochromatic and multi-colored high powered LEDs, Excelitas also has its exclusive "Design-Your-Own" line, the ACULED DYO.

The ACULED DYO gives customers the total flexibility to design their own four-chip LED configuration to suit their specific application. Custom combinations that include white chips are available.

For more information on our ACULED DYO line, please refer to the ACULED DYO Custom Design Guide.

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