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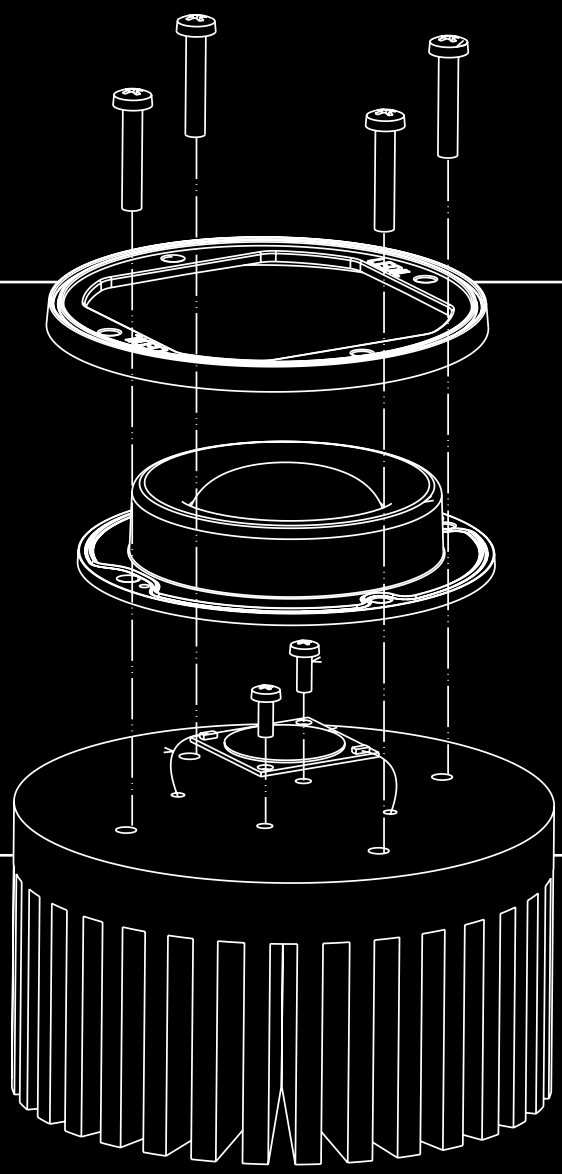
LEDiL®

INSTALLATION GUIDE



GENERAL INFORMATION ABOUT ASSEMBLING LEDIL PRODUCTS

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HEAT DURABILITY OF DIFFERENT MATERIALS

LED lighting consumes much less power compared to other light sources such as bulbs, fluorescent or energy saving lamps. These tiny light sources are at the focal point of worldwide continuous improvement constantly pushing the edge of heat resistance and luminous output.

If in the early days of LED lighting the power consumption produced around 80°C or 90°C of heat, today the extremely large COBs can produce around 150°C. This direction has led to a situation where luminaire materials need to handle and dispose of more and more heat to ensure safe operation.

Sources of heat

As a general rule 1/3 of an LED's power consumption is turned into visible light and 2/3 into heat. There are three sources that produce heat in LED lighting: **conduction**, **convection** and **radiation**. All of these are extremely important when a new luminaire design is made but there are also other things to consider regarding heat generation.

Some materials absorb more light than others. This means that an optic's efficiency has a direct link to how hot the lens will get. All sorts of **dirt**, **dust** and **grease** on the optical surface block some of the light rays generating more heat inside the luminaire. During the product lifetime both of these effects tend to increase and therefore speed up the aging process. Every luminaire element and component that stops or reflects some of the light such as **protective glass** and **shades**, may also increase heat inside the luminaire and therefore speed up the aging process.

Careful consideration should be given to all of these areas when designing a luminaire to ensure a safe and long product lifetime. LEDiL products are designed and manufactured to meet high efficiency values to help extend the product lifetime.

Choosing the right material

On the following page you can find a list of materials and recommended maximum service temperatures.

Please note that because of the complex nature and numerous variables involved in luminaire design and manufacturing that affect the final product heat control, LEDiL cannot take responsibility for third party solutions and designs we can't control. It is always the customer's responsibility to determine and verify there is sufficient cooling and maintenance in the final product and its components.

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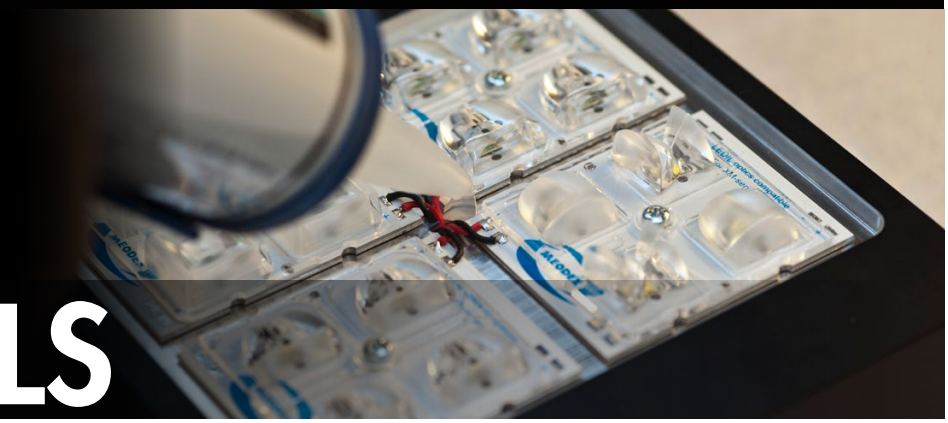

CHEMICALS

GLUES / ADHESIVES / POTTING / THREAD LOCK

We strongly recommend that every customer fully tests and takes the necessary precautions to ensure there is complete chemical compatibility with each particular product, LEDs and other components. Testing and verifying adhesives, potting agents, coatings and their combinations are always the responsibility of the customer. Please also see sealing and ingress protection chapter on page 29.

General instructions of use

All surfaces where adhesive is applied must be clean, dry and free from grease and dirt. If the PCB surfaces need to be cleaned, please follow the LED manufacturer cleaning instructions carefully – this is important as cleaning should, under no circumstances, damage LEDs or other electronic components on the PCB. Please note **optical components should not be cleaned with chemicals** – only a micro fiber cloth should be used to remove fingerprints or other traces from handling. To clean silicone lenses use a low-pressure stream of water. We recommend cleaning metallized reflectors with gentle air pressure or an air ionizer. When using adhesive, please follow the detailed instructions of the adhesive manufacturer. E.g. note that different humidity and/or temperature levels may slow down the curing process of the adhesive bond or shorten its lifetime

LEDiL Disclaimer:

LEDiL cannot take responsibility for the results obtained by third party methods we cannot control. It is always the customer's responsibility to determine the chemicals suitability for their product and to take precautions for protection of property and persons against any hazards that may be involved in the handling and use such of chemicals. LEDiL disclaims all warranties, including warranties of merchantability or suitability for a particular purpose, arising from use of any adhesive product. LEDiL disclaims any liability for consequential or incidental damages of any kind, including lost profits.

More information about bonding by DELO®
www.ledil.com/delo-adhesives

Tested materials and test procedure by CREE™
www.ledil.com/cree-chemical-compatibility

NOTE: These tests have been made only with LEDs and are not necessarily compatible with optical materials. Compatibility must be tested in advance by the customer.

LEDiL®

PC

General chemical behaviour

The chemical resistance of Makrolon® depends on the concentration of the substance, the temperature, contact time and internal tension level of the polycarbonate sheet depending on fabrication. The following types of damage can arise, sometimes more than one at the same time.

• Dissolving / Swelling

Low-molecular, aromatic, halogenated and polar components migrate into the plastic. The damage can range from a sticky surface to complete dissolving.

• Stress cracking

Some chemicals migrate to a minor extend and in very low quantity into the surface, and lead to relaxation of tensions in the material. This results in stress cracking, which can be optically disturbing. Because of increased notch occurance, some mechanical properties are negatively influenced. Stress cracking is usually easy to see in transparent sheets.

• Molecular reduction

Some properties of materials are determined by the molecular weight. If a substance initiates a molecular reduction through a chemical reaction, the impact resistance and elastic properties of the material will be influenced. Electrical properties are usually not influenced, thermal properties are only slightly influenced by the molecular weight.

In the following tables (pages 9-14) you can find the resistance of Makrolon® to chemicals and several other substances. The test results have been obtained at samples with low internal tensions, which have been stored during 6 months in the substance at a temperature of 20°C, without any mechanical load.

Apart from the nature of the substances, the chemical resistance also depends on the concentration of the substance, the temperature during the contact, the contact time and the internal tension of the tested specimen. This means that our products can be resistant to a number of chemicals for short contacts, but are not resistant in the case of long exposure, such as performed in these tests. Therefore, it is always recommended to execute a test in the actual application conditions. The tested substances have been chosen according to their importance in several areas. In a lot of cases it is possible to assume similar results for other chemically comparable substances, even if these have not been tested.

Our UV-protected materials (Makrolon® UV) are slightly more sensitive to chemicals in comparison to unprotected materials, but in general the results shown in the table still comply.

LEDiL®

SUBSTANCE	PC	PMMA
Carbon acid, wet	R	-
Carbon dioxide	-	R
Carbon disulphide	X	X
Carbon monoxide	R	R
Carbon tetrachloride	-	X
Castor oil	R	-
Cellux-sticking foils ®	R	-
Cement	R	R
CHINOSOL, up to 1%	-	R
Chlor. lime paste (sas)	-	R
CHLORAMIN, paste	-	X
CHLORAMIN, solution	-	R
Chlorine benzene	X	-
Chlorine gas, dry	O	-
Chlorine gas, wet	X	-
Chlorine lime slurry	R	-
Chlorine lime, 2% in water	R	-
Chlorine vapours, dry	-	O
Chloroamine	R	-
Chloroform	X	-
Chrom alum, saturated aqueous solution	R	-
Chromic acid, 20% in water	R	-
CILLIT-GRON	-	R
Citric acid	R	-
Citric acid, up to 20% (sas)	-	R
Cleaning gasoline	R	-
CLOPHEN T 55, A 60	-	R
Coal gas, natural gas	-	R
Cod-liver oil	R	-
Contact oil 61	R	-
Copper sulphate, saturated aqueous solution	R	-
Corrosive sublimate	-	R
Cresol	X	-
Cupric chloride, saturated aqueous solution	R	-
Cuprous chloride, saturated aqueous solution	R	-
Cyclo hexane	X	-
Cyclo hexanol	O	-
Cyclo hexanone	X	-
DDT	X	-
DEKALIN	-	O
Dekaline	R	-
Delegol ®, 5%	R	-
Delu-Antistatiklösung ®	R	-
Diamyl phthalate	X	-

SUBSTANCE	PC	PMMA
Dibutyl phthalate (plasticizer)	X	-
DIEGEL liquid film 23922	-	R
Diesel oil	O	-
Diethylene glykol	R	-
Diethylether	X	-
Diglycolic acid, saturated aqueous solution	R	-
Dimamin T, 5%	O	-
Dimethyl formamide	X	-
Dinonyl phthalate (plasticizer)	O	-
Dioctyl phthalate (plasticizer)	O	-
Dioxane	X	-
Diphyl 5,3	O	-
Dor ®	R	R
DOSYL	-	R
DOSYLAN	-	R
Drilling oil	X	-
E 605 ®, 0,5% (pesticide)	X	-
E 605 ®, conc.	X	-
Electroplating baths	-	R
ELMOCID GAMMA, up to 2%	-	R
Esso Estic 42-45 ®	R	-
Ether	X	-
Ethyl alcohol, 96% pure	R	-
Ethyl amine	X	-
Ethyl bromide	X	-
Ethylene chlorhydrine	X	-
Ethylene chloride	X	-
Ethylene glykol	R	-
FAKO polish	-	R
FAKO polishing paste	-	R
Ferritrichloride, saturated aqueous solution	R	-
Ferro bisulphate	R	-
Fewa ®	R	R
Final-photo developer (normal use concentration)	R	-
Fish oil	R	-
Foam plastics	-	R
Foam plastics, plasticise	-	X
Formaline, 10%ig	R	-
Formic acid, 30%	O	-
FRAPPIN	-	R
Freon ® TF (propellant)	R	-
Freon ® T-WD 602 (propellant)	R	-
Frigen ® 113, R113 (propellant)	R	-
FRIGEN A 12 (CF2 Cl2)	-	O

R = Resistant
O = Limited resistance
X = No resistance

v = Vapour
c = Concentrate
g = Gas

m = Metallic
sas = Saturated aqueous solution
i.w. = In water

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SUBSTANCE	PC	PMMA
Motor fuel blend, free from benzene	-	R
Multi-Marker (Faber-Castell)	O	-
Nato-Turbine oil 0-250	R	-
Natril ®	R	-
Natural rubber	R	-
Nekal BX ®, 2% (moisturizing agent)	R	-
NEOMOSCAN M, M-powder	-	R
Neutol ® photo developer (normal use concentration)	R	-
NEXION stable spray	-	R
Nickel sulphate (sas)	-	R
Niroklar GR liquid	-	R
Niroklar GR powder	-	R
Nitric acid, 10%	R	-
Nitric acid, 10-20%	O	-
Nitric acid, 20 to 70% i.w.	-	O
Nitric acid, 20%	X	-
Nitric acid, over 70% i.w.	-	X
Nitric acid, up to 20% i.w.	-	O
Nitric Gas, dry	X	-
Nitrobenzene	X	-
Nitrocellulose lacquers	-	X
Nitrogen dioxide	-	R
Nitrogen monoxide	-	R
O Sprays (in the surroundings)	-	O
Oil paints, pure	-	R
Oktozon ®, 1%	R	-
Oleic acid, conc.	R	-
Omo ®	R	-
Orthozid ® 50, 0,5% (pesticide)	R	-
Oxalic acid (sas)	-	R
Oxalic acid, 10% in water	R	-
Oxygen	R	R
Ozone	R	R
P 3	-	R
P 3 basic cleaner	-	O
P3 Asepto ®	X	-
PALATINOL K	-	R
PALATINOL O, BB neu	-	O
Pantex ®, 2%	R	-
Paraffin oil	R	-
PATTEX special glue	-	O
Pelikan Royal Blue 4001	R	-
Pentane	R	-
PERBUNAN	-	R

SUBSTANCE	PC	PMMA
Perbunan C ®	R	-
Perchloric acid, 10% in water	R	-
Perchloric acid, concentrated	O	-
Perchloro ethylene	X	X
Perhydrol	R	R
Perhydrol, 30%	R	-
PERODIN	-	R
Persil ®	O	R
Persoftal ®, 2%	R	-
Perspex Polish 3 ®	R	-
Petrol ether	-	R
Petrol, contg. aromatic substances	-	X
Petrol, non-aromatic	-	R
Petrol, pure	-	R
Petroleum	O	O
Petroleum ether	O	-
Petroleum spirit	R	-
Phenol	X	-
Phenols	-	X
Phenyl ethyl alcohol	X	-
Phosphates	-	R
Phosphonc acid, up to 10% i.w.	-	R
Phosphor trichloride	X	-
Phosphoric acid, conc.	R	-
Phosphoric oxichloride	X	-
Phosphorus trichloride	-	X
Phosphorus, white	-	X
Photochemical baths	-	R
Picric acid, 1% i.w.	-	R
Plaster	R	-
Plasticiserfree glazing kit	R	-
Plexiklar ®	R	R
PLEXISOL adhesive	-	O
PLEXIT	-	O
PLEXTOL adhesive	-	R
PLK 4 (wood protection agent)	R	-
Polifac grinding paste ®	R	-
Polishing wax	R	-
Polyamide	R	R
Polyethylene	R	R
Polymer plasticizer O	O	-
Polyran ® MM 25 (lubricant)	R	-
Polyvinylchloride (plasticizer free)	R	-
Polyvinylchloride, (containing plasticizer)	O	-

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SUBSTANCE	PC	PMMA
Sublimate, (sas)	R	-
Sulphur	R	-
Sulphur (c)	-	R
Sulphur dioxide	O	-
Sulphur dioxide (dry)	-	R
Sulphur dioxide, liquid	-	X
Sulphuric acid, 50%	R	-
Sulphuric acid, 70%	O	-
Sulphuric acid, conc.	X	-
Sulphuric acid, up to 30% i.w.	-	R
Sulphurous acid, 10%	X	-
Sulphurous acid, (c)	-	O
Sulphurous acid, up to 5%	-	R
Sulphuryl chloride	X	R
Suwa ®	R	-
Sweat, acid (pH 4,7)	R	-
sweat, alkaline (pH 9,5)	O	-
Tanigan ® CLS, 30%	O	-
Tanigan ® CV	O	-
Tannic acid	X	-
Tanning oil Brunofix ®	R	-
Tartaric acid, 10%	R	-
Tartaric acid, 50% i.w	-	R
TB Lysoform	X	-
TERAPIN	-	R
Terostat ®	R	-
Tesafilm ®	R	-
Tesamoll ®	R	-
Test fuel	X	-
Tetrachlorocarbon	X	-
Tetrachloroethane	X	-
Tetrahydrofurane	X	-
Tetralin	-	X
Tetraline	X	-
Texaco Regal Oil BRUO ®	R	-
Texaco Regal Oil CRUO ®	R	-
Thenocalor N	R	-
Thinners in general	-	X
Thiokol rubber (one- and two-component grades)	-	X
Thionyl chloride	-	X
Thiophene	X	-
Tincture of iodine, 5%	-	X
Toluene	X	X
Trichloro acetic acid, 10%	O	-

SUBSTANCE	PC	PMMA
Trichloroacetic acid	-	X
Trichloroethyl amine	X	-
Trichloroethyl phosphate (plasticizer)	O	-
Trichloroethylene	X	-
Tricresyl phosphate	-	R
Tricresyl phosphate (plasticizer)	X	-
Triethylamine	-	R
Trosilin F ® extra, 2%	R	-
Trosilin G extra ®, 1,5%	R	-
Tuba ® carpet shampoo, (c)	O	-
Turbo oil 29	R	-
Turpentine	-	O
Turpentine ersatz	R	-
Turpentine substitute	-	O
Urea, (sas)	R	-
VALVANOL, up to 2%	-	O
Valvoline WA 4-7	O	-
Varnish	O	-
Waste gases contg. hydrochloric acid	-	R
Waste gases contg. sulphuric acid	-	R
Water	R	-
WC-00	-	R
Whale fat	R	-
Visor-Pen 7 blau	R	-
WK 60 ® (Kron-Chemie)	R	-
X Sprays (applied directly)	-	X
Xylene	X	X
Zephirol ®	O	-
ZEPHIROL, up to 5%	-	R
Zinc chloride, (sas)	R	-
Zinc oxide	R	-
Zinc sulphate, aqueous	-	R
Zinc sulphate, (sas)	R	-
Zinc sulphate, solid	-	R
ÄTHROL, up to 5%	-	O

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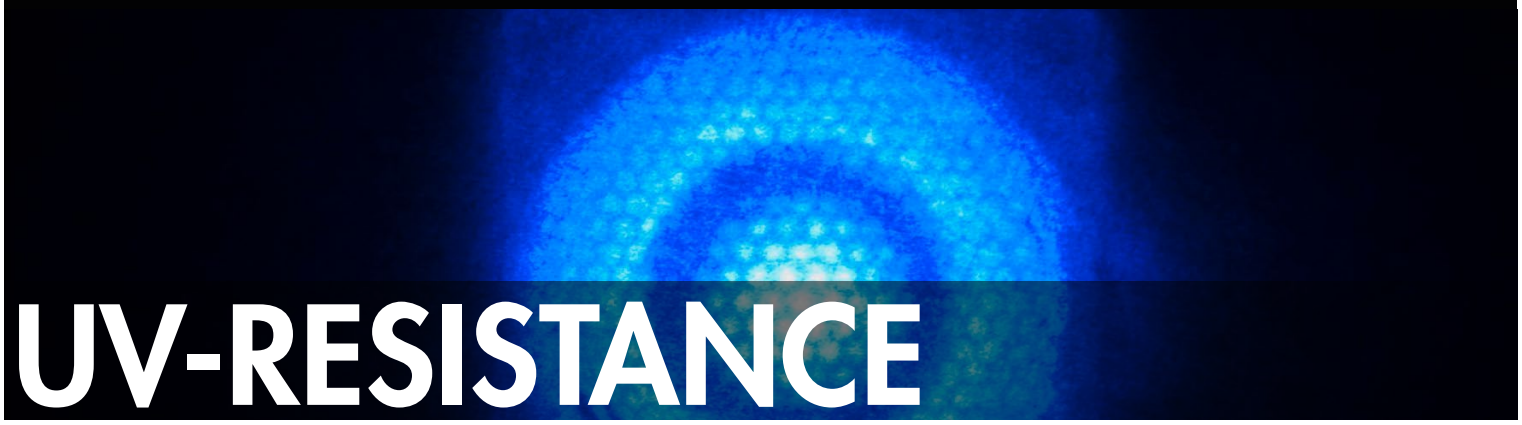

UV-RESISTANCE

Plastics degenerate differently when exposed to UV-light. Some plastics may show dramatic changes, turning yellow or losing some of their transmission properties over a long period of time. This must be considered when choosing materials for your application.

LEDiL has conducted extensive UV-testing over the years for various different materials and found that even materials that tend to have very heavy yellowing will not significantly suffer from efficiency loss. However yellowing may cause the colour temperature to change to warmer tones.

Plexiglas guarantee

PLEXIGLAS® guarantees their materials will not show yellowing and will retain a high level of light transmission for 30 years.

For more information:
www.ledil.com/plexiglas_guarantee

PMMA

High UV-resistance with no yellowing. For better impact resistance protective glass is needed.

SILICONE

Dow Corning ® MS silicones have very high UV-resistance with no yellowing, and are highly transparent to radiation all the way down to IR-wavelengths.

PC

Good for applications that require higher impact resistance, but will show noticeable yellowing over time when exposed to UV-radiation. Therefore LEDiL does not recommend using products made of PC in applications where exposure to UV-radiation is high. To avoid yellowing special filtering glasses can be used to block out all the damaging UV from sunlight. After a very long period of time ultraviolet light may also cause some brittleness in the material and LEDiL recommends using plastic washers with fasteners to decrease mechanical stresses.

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HOT WIRE IGNITION (HWI)

Test specimens are wrapped with resistance wire that dissipates a specified level of energy. HWI is the time it takes to either ignite or burn through a specimen. Performance Level Categories (PLC) were introduced to avoid excessive implied precision and bias.

HWI Mean Ignition Time (sec)	
PLC0	120 and longer
PLC1	60 through 119
PLC2	30 through 59
PLC3	15 through 29
PLC4	7 through 14
PLC5	<7

HIGH AMP ARC IGNITION (HAI)

The number of arc rupture exposures necessary to ignite a material when they are applied at a standard rate on the surface of the material. Performance Level Categories (PLC) were introduced to avoid excessive implied precision and bias.

HAI Mean Number of Arcs	
PLC0	120 and greater
PLC1	60 through 119
PLC2	30 through 59
PLC3	15 through 29
PLC4	<15

OUTDOOR SUITABILITY

Materials considered suitable for outdoor use have been subjected to ultraviolet (UV) light exposure and/or water immersion. UV exposure is performed by using either a twin-enclosed carbon weatherometer for 720 hours, or a xenon-arc weatherometer for 1000 hours. Water immersion testing is performed for 7 days at 70°C. Specimens are tested before and after exposure for flammability, mechanical impact and mechanical strength. Materials whose properties are not significantly degraded in any of these areas are considered to have passed and are suitable for outdoor use.

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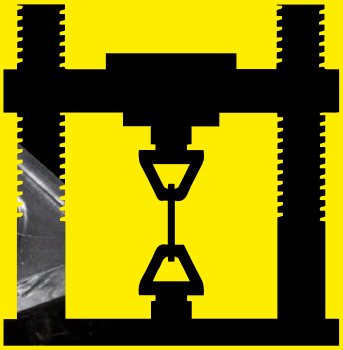


TENSILE STRENGTH

LEDiL tests its products to meet or exceed tensile strength requirements and standards; this includes tape fastening, third party adhesives and mechanical structures such as pins.

LEDiL Disclaimer:

LEDiL cannot take responsibility for the results obtained by third party methods we cannot control. It is always the customer's responsibility to determine and verify the sufficient tensile strenght in the final product and its components.

SFS 3947

GENERAL TOLERANCES FOR EXTRUDED PRODUCTS (SFS 3947)	
Dimensions (mm)	(mm)
0.1 < a ≤ 0.4	± 0.05
0.5 < a ≤ 0.9	± 0.1
1 < a ≤ 2.9	± 0.2
3 < a ≤ 5.9	± 0.3
6 < a ≤ 9.9	± 0.35
10 < a ≤ 15.9	± 0.45
16 < a ≤ 21.9	± 0.55
22 < a ≤ 29.9	± 0.7
30 < a ≤ 49.9	± 0.8
50 < a ≤ 80	± 1.2
> 80	± 1.6

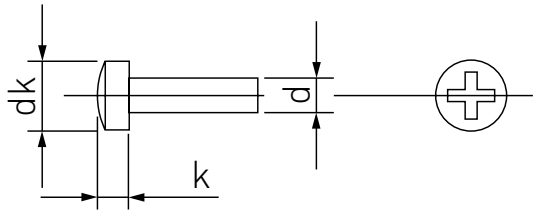
SCREW

The following is only general information and for more details about tightening and exceptions please download the datasheet for each product.

For most of the products screws are of type M3. (DIN 7985, ISO 7045/ISO 14583 TX), with maximum tightening torque of 0.6 Nm.

Countersunk screws are not allowed, and self-tapping screws are not recommended. Thread forming or rolling screws are not allowed due to lack of control of the tightening torque.

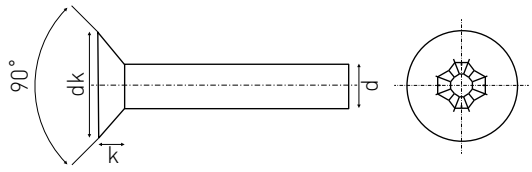
LEDiL recommends using M3 nylon washers (DIN 125 / ISO 7089) between the screws and the lens to minimize stresses induced by fastening torque.



DIN 7985 / ISO 7045 / SFS 2976	
Thread Size	M3
dk	6 mm
d	3 mm
k max	2.52 mm
L	4-22 mm

Please note:

Differing from other lenses, the **CS14145_STRADA-IP-2X6-DWC-90** module needs countersunk screws of type M3 (DIN 965) for fastening the PCB to the heatsink.



DIN 965 / ISO 7046 / SFS 2977	
Thread Size	M3
dk	5.6 mm
d	3 mm
k max	1.65 mm
L	4 – 22 mm

If the design requires it, it is possible to use ultra-low head cap screws.

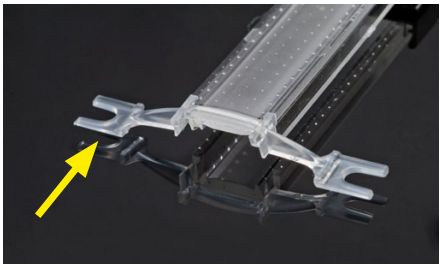
For more information:
www.ledil.com/ultra-low-screw

PROFILES

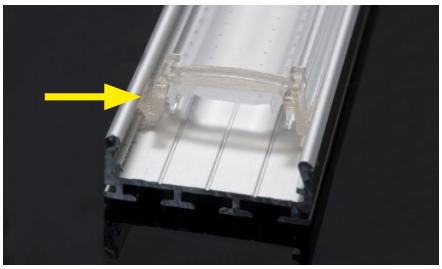
Some LEDiL lenses are designed to fit existing aluminium profiles like GIZA from Klus for example. (https://klusdesign.com/product/42)

Currently supported product families:

- FLORENCE-1R
- FLORENTINA
- ZENIA



C14353_FLORENCE-1R-CLIP-A



C14409_FLORENCE-1R-CLIP-B

LEDiL Clips:

Achieve a sleak and uniform luminaire exterior by connecting lenses in continuous rows with LEDiL retaining clips.

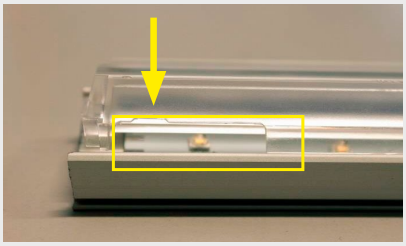
Clip A and C for installation on a plate and Clip B for profile installation

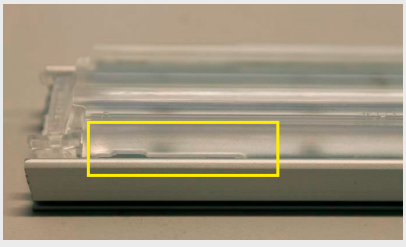
- **C14353_FLORENCE-1R-CLIP-A** for 40 mm wide PCB´s (like Philips Fortimo) and screw mount
- **C14409_FLORENCE-1R-CLIP-B** fits straight into aluminum profile, no screws needed.
- **C14751_FLORENCE-1R-CLIP-C** for 24 mm wide PCB´s and screw mount

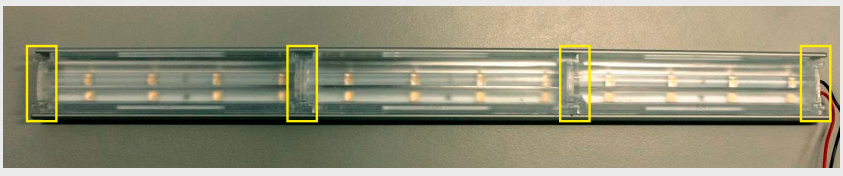
FLORENCE-1R assembly

Place the lens in the aluminium profile and fasten it with the clips. Make sure the whole lens is evened out and that every hole reserved for connectors are hidden inside the profile.

The fastening clips will be installed on both sides of every lens. This allows lenses to be connected in a continuous row to achieve uniform appearance.







SEE OUR VIDEO ABOUT FLORENCE-1R ASSEMBLY

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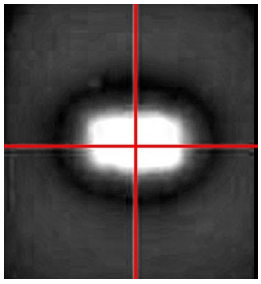
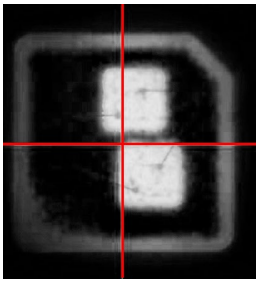
LED CHIP POSITIONS

Pleae note that due to varying asymmetric chip locations, especially on mid-power LEDs, the exact source of light is not always located at the centre of the LED packet. Take this into account when making or choosing PCB designs.

If maximum uniformity is required LEDiL recommends rotating such LEDs on the PCB in a regular pattern for smoother results.





LED COMPATIBILITY TOLERANCES

For an LED to be mechanically compatible with our lenses there must be 0.2 mm safety distance between the LED and the closest part of he lens design. With products that come with installation tape this safety margin must be 0.3 mm. These numbers come from the fact that the TIM or soldering paste between the LED and the heat sink is approximately 0.1 mm thick, and installation tape requires an additional 0.1 mm for natural shrinkage.

DISTANCE BETWEEN LENSES

Many LEDiL products have a module based structure and can be installed next to each other without any noticeable shading. Some lenses from the same product family can even be mixed together and used inside the same luminaire.

As a general guideline, we recommend lens distances follow the same pattern as the LED pitches inside one module. Usually the easiest way to calculate position to the next module is between the centre points, rather than using sides or optics.

Please remember to visit our website www.ledil.com to see if there are more recent installation guides or application notes available for individual products.

LEDiL®

THERMAL MANAGEMENT

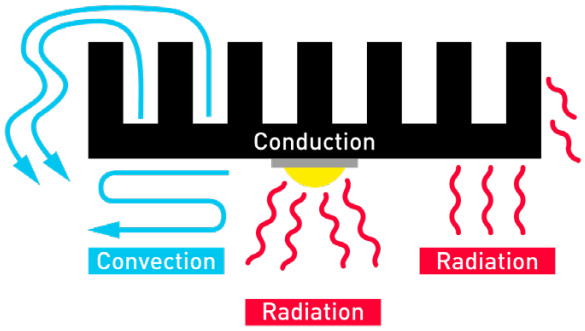
When working with LED lighting one important issue to take into consideration is heat. Good thermal design plays a key role in the performance and lifetime of the application. There are three different ways for heat to transfer: conduction, convection and radiation. Always make sure that the thermal management is sufficient enough for the application.

Conduction is the transfer of heat through solid materials with direct contact. For example the heat from an LED junction to the heat sink is transferred by conduction.

Convection is the transfer of heat through the movement of gases or fluids. A typical example in LED applications is the heat transferred from heat sink to air.

Radiation is the transfer of thermal energy by electromagnetic radiation. This radiation causes thermal motion of charged particles in matter. In LED applications transfer through radiation is found in the light itself. This is extremely important to remember since LEDs keep getting more and more powerful.

The best choice of optic is not always the material that can handle more heat, because some materials absorb more radiant flux than others. This basically means that an optics efficiency is directly linked to how hot the lens will get.



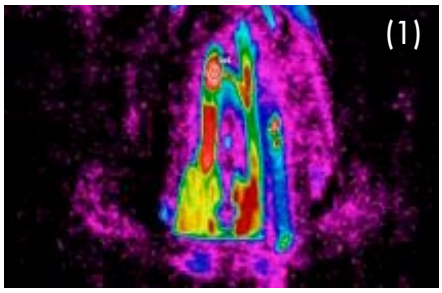
LEDiL SECONDARY OPTICS ARE DESIGNED AND MANUFACTURED TO MEET THE HIGHEST POSSIBLE EFFICIENCY RATES. THIS NOT ONLY PROVIDES GOOD LIGHTING RESULTS, BUT GIVES THE PRODUCT A LONGER LIFETIME AS WELL.

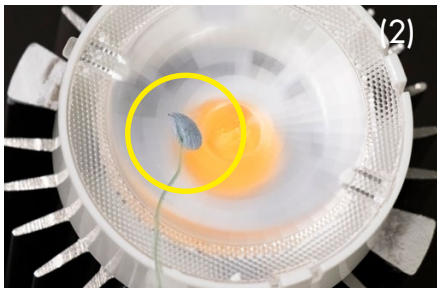
LEDiL®

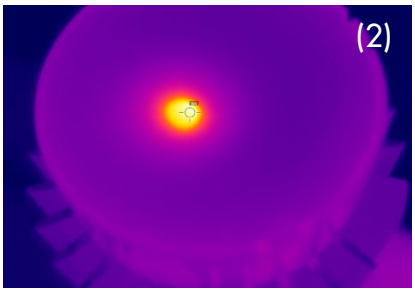
THERMAL MEASUREMENTS

Infrared (IR) imaging and thermocouple measurement systems can be used for monitoring temperatures in LED applications, but the following must be acknowledged.

- IR imaging is a preferred method for lens and reflector temperature measurements
- Low emissivity surfaces are challenging to measure with an IR camera because reflected temperatures can also be seen in thermal image **(1)**
- Thermocouples cannot be placed on top of a lens due to the absorption of the radiant flux **(2)**
- Tiny thermocouples (AWG 40 recommended) can be used to measure LED case, PCB and heat sink temperatures where radiant flux doesn't interfere, and target surfaces cannot be exposed to the IR camera







LENSES

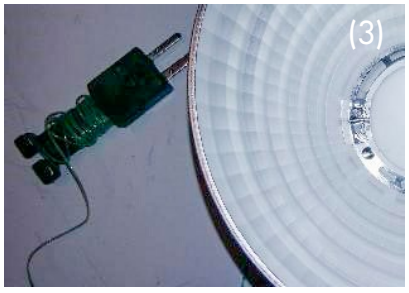
Switch on the light and let temperatures rise until they stabilize. Remove any obstacles (e.g. glass cover) quickly to expose the target surface and take an image on the top surface of the lens. Start to record video sequence and turn the lens over quickly to catch the maximum temperature from the bottom side of the lens.

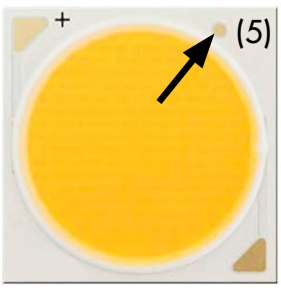
REFLECTORS

Attach a thermocouple on the surface of the reflector with a small aluminum tape and monitor temperatures until they stabilize **(3)**. Paint the target area, attach a tape with known emissivity or remove metallization on the outer surface of the reflector and take an IR image from that area **(4)**.

COB LEDs

LED case temperature, Tc, can be measured with a thermocouple that is firmly glued/soldered to the Tc measurement point of the LED module **(5)**.





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VACUUM EVAPORATION PVD

LEDiL uses vacuum evaporation PVD (Physical Vapor Deposition) to add a reflective aluminum coating to PC reflectors. Before aluminum can be added, adhesion between the reflectors and the aluminum coating must be improved. This is conventionally done by adding a layer of lacquer to the reflector surfaces.

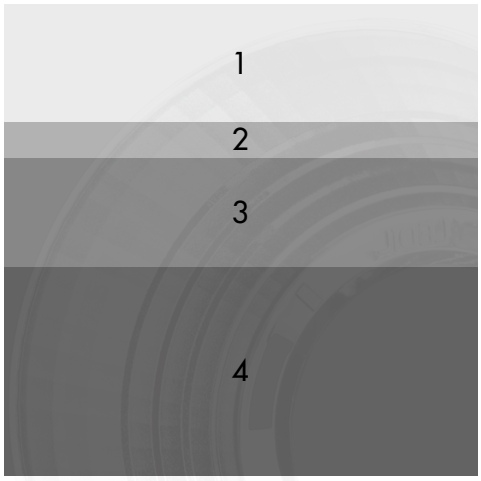
- High quality both functionally and decoratively
- Reflectors will not be subject to chemical of thermal stress
- Good performance in cross-cut test

1) **Top lacquer** (to protect surface)

2) **Al coat** (in vacuum)

3) **Base lacquer** (to improve adhesion)

4) **Substrate** (part to be coated)



HMDS

HMDS is a simplified name for a glow polymerization method. Plasma treatment is first used to clean the reflector surfaces of any unfavorable materials to improve adhesion. Then the aluminum coating is added via vacuum evaporation and finally HMDS-monomers are added and a polymerization reaction takes place.

- Thin and protective layer
- Good optical performance
- Good durability against heat

1) **HMDS plasmapolymerisation** (to protect surface)

2) **Al coat** (in vacuum)

3) **Glow discharge activation of surface** (to improve adhesion)

4) **Substrate** (part to be coated)

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