ISOLED KNOWLEDGE

# THERMAL MANAGE-MENT

ISOLED®

CUSTOMISED LIGHT SOLUTIONS

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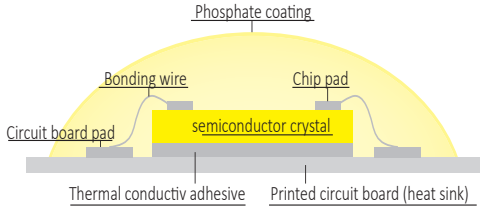
# LED THERMAL MANAGEMENT
# IMPACT ON LIGHTING QUALITY AND QUALITY OF LIFE

## Degradation

In the course of the usual aging process of an LED chip, impurities are created on the semiconductor crystal. The increasing number of imperfections leads to a non-linear decrease of the light output of the LED illuminant or the LED light with integrated LED chip. This decrease in luminous flux is called degradation.

In contrast to conventional illuminants, which suddenly fail at the end of their service life, LEDs continuously lose luminous flux and therefore shine less and less brightly. For this reason, LEDs are not referred to as service life, but as nominal or useful life (certain minimum luminous flux at a defined point in time).




**The service life of LEDs is significantly influenced by the following factors:**

- Operating and ambient temperatures
- Power supply (driver current)
- Manufacturing process of the LED chips
- LED chip components and materials used
- Electronics
- Nature and chemical composition of the silicone that serves as a lens in the LED chip
- the quality of the phosphorus used and the process by which it is applied

## Artificial aging process in continuous test operation

First, the luminous flux of an LED illuminant or luminaire with integrated lamp (permanently installed) is measured in the integrating sphere. This is followed by a continuous test operation with 6,000 hours in a climate chamber with constant ambient temperature. To simulate the aging process, the LEDs are subjected to constant temperatures of 55° C, 85° C and a temperature freely selectable by the manufacturer (25° C for ISOLED®). Random samples are taken at least every 1,000 hours for intermediate measurements of the luminous flux.

The values determined during continuous test operation form the basis for further calculations of the valid prognosis of luminous flux maintenance using the TM-21 method. If, as prescribed in the TM-21 procedure, the average values from the various measurement data are entered into the xy coordinate system, they result in an exponential curve (x = operating hours; y = luminous flux in %).

## Test method for classifying the nominal lifetime of LEDs (LM-80, TM-21)

The nominal service life of ISOLED® lamps and luminaires is determined and specified with the manufacturer-independent LM-80 method or according to the TM-21 standard.

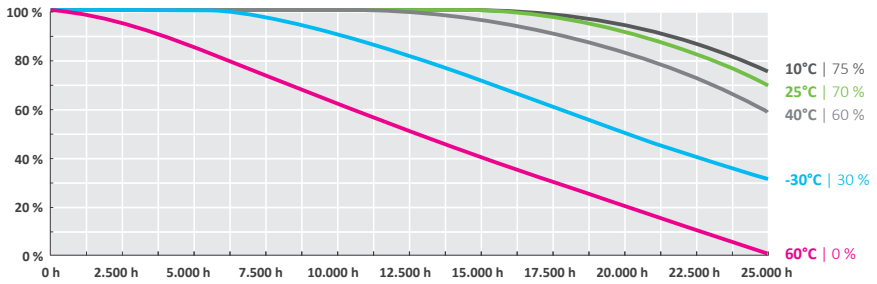
The LM-80 method is an industry standard for determining the reduction in luminous flux of LED lamps and LED luminaires. This method specifies in detail how and under which conditions (especially defined ambient temperatures) lamps have to be tested in order to provide valid comparative data for the calculation of the nominal life by means of the TM-21 method.

**TM-21 Procedure**

Loss of luminous flux under the influence of different ambient temperatures

Measurement results refer to the nominal service life of 25,000 operating hours

ISOLED® quality standard is L70(6K)/B10




## Note

The calculated useful life must not exceed a maximum of six times the duration of the endurance test period. Otherwise, the test period must be extended. For example, to specify a nominal service life of 50,000 h according to the LM-80 test, a continuous test operation with min. 8,333 hours must be performed.

## For ISOLED® L70(6k)/B10 applies!

The ISOLED® quality standard for the service life of LED lamps/luminaires is L70(6k)/B10. This value means,

» (L70) that the luminous flux (lumen) of an LED illuminant/luminaire at the end of the specified nominal service life (information in the product data sheet) does not fall below 70 % of the defined performance value and

» (B10) that at least 90 % of LED lamps/luminaires achieve a result above 70 % of the specified luminous flux at the end of their service life. This means that a maximum of 10 % of the LED illuminants/luminaires drop to 70 % light output after the end of their nominal service life.

The abbreviation 6k in the designation L70(6k)/B10 means that the data was determined in a continuous test operation with 6,000 hours. These endurance tests produce valid values for the luminous flux retention of the LEDs (Rated Lumen Maintenance Life) and form the basis for calculating the nominal life of the LED lamps/luminaires.

**Example: E27 LED bulb 8 W | 1,000 lumen | operating hours according to data sheet: 20,000 h**

After 20,000 hours of operation, 100% of these E27 LED bulbs still emit at least 700 lumens of luminous flux. At least 90 % of all articles of this product type have a much higher output and produce more than 700 lumens.

## ATTENTION - IMPORTANT NOTES

**Full nominal service life with correct thermal management**

1. Observe and Adhere to the manufacturer's specifications regarding ambient temperature limits!
2. Ensure sufficient natural air circulation (convection)!
   a. Closed LED lights: ideally, the warm air must be able to escape through an opening at the top or be dissipated via an integrated heat conducting bridge or heat sink. Maintain the distance between lamp and housing according to the manufacturer's instructions. Do not cover the back of integrated heat sinks!
   b. LED recessed luminaires in the building structure or false ceilings: allow sufficient space between the rear heat sink and the building structure for heat exchange - DO NOT cover with insulating materials or other materials!
3. Avoid continuous direct and indirect (via reflectors such as reflective metal or glass surfaces) solar radiation!

### Note: Physical late effects

Strangely enough, the physical damage and impairments to the LED illuminant/luminaire caused by excessive temperature (e.g. defects in the dielectric of the installed capacitors) may only become noticeable at temperatures below zero. The illuminants may start flashing because the forward resistance of the capacitors and ICs may have changed.

## Natural convection and cooling

LED chips as well as the entire electronics of an LED illuminant/lamp generate heat during operation. In some cases, temperatures of up to 70° C can be reached inside a closed luminaire, even in the case of intelligent/efficient heat dissipation by e.g. an integrated heat sink.

Outdoors, LED luminaires can reach indoor temperatures of more than 80° C even when switched off, e.g. on sunny days. They are exposed to external influences such as outside air temperature and direct and indirect (through metal, glass and other reflective surfaces) solar radiation. The metal/glass housing is thus heated up even more.

If LED illuminants are operated at too high or too low an ambient temperature, the performance, light colour and, of course, service life are considerably reduced! Especially the light emitting diodes, electrolytic capacitors and driver ICs typically used in LED lamps suffer from this.

**In any case, natural air circulation or cooling must be provided to maintain a balanced thermal balance!**

## Frequent effects due to excessive ambient temperature

- Increased flickering (subconsciously perceptible)
- Visible flashing (consciously perceptible)
- Audible whirring
- Massive deterioration in colour rendering (CRI value falls)
- Color location shift (the color temperature becomes significantly colder)
- Higher inrush currents
- Worsened dimming behaviour
- Partial to complete failure of LED chips
- Burn-through of LED chips

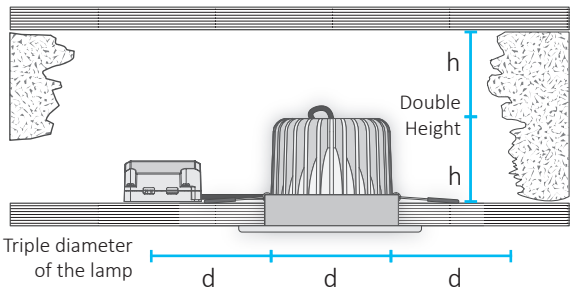
These negative effects can occur after a very short operating time.

**Therefore please note our recommended ambient temperatures in the data sheets!**

Within the scope of the obligatory QA tests as well as for classification of the nominal service life, ISOLED® measures all LED lamps/luminaires with integrated LED chip in one of the two integrating spheres (diameter 0.5 m and 1.7 m).

## RECOMMENDTION

Double height
Triple Diameter



## Avoiding heat accumulation using the example of recessed luminaires in false ceilings

1. **Sufficient distance between recessed luminaire and Building fabric**

   When installing recessed luminaires in false ceilings, particular attention must be paid to ensuring that there is sufficient free space for dissipating the waste heat from the rear heat sink. We therefore recommend that the distance between the two ceilings should ideally be at least twice the height of the luminaire at the rear and that the free lateral area to the building structure or to the insulating material should be at least twice the base area of the (cool) body of the luminaire.

2. **Recessed lights with external transformer (ballast)**

   The external transformer must not be mounted on the rear heat sink, nor must it be covered with insulation or other materials. Ideally, the transformer should be placed next to the recessed luminaire in a free space. The prescribed ambient temperature limits are printed on the transformer. Attention: Separate regulations apply for fire protection ceilings and installation next to easily flammable materials (e.g. blow-in insulation)!

Compliance with these specifications should ensure sufficient air circulation for the required thermal balance.