Design-in guide

OLED Panel Brite 3 Curve Family

October 2018

OLEDWorks
Naturally Illuminating

Contents

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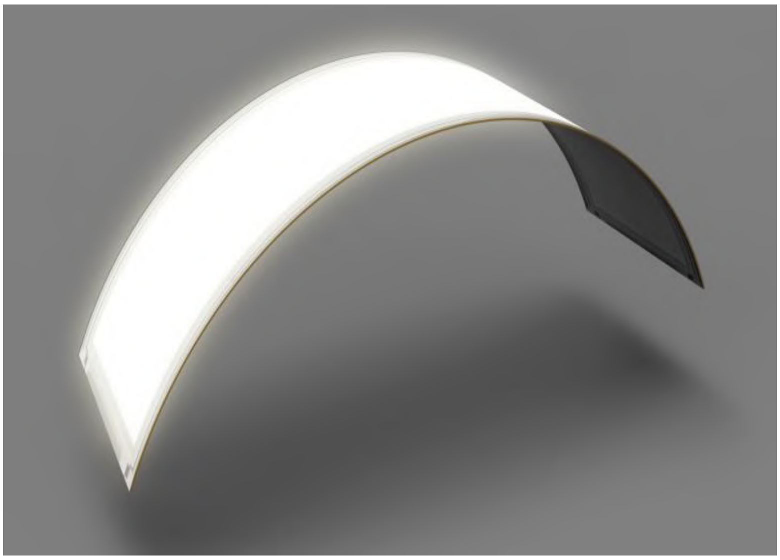
INTRODUCTION TO THIS GUIDE

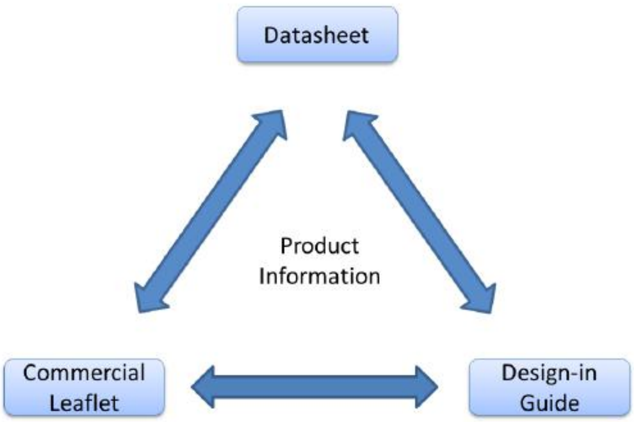


Thank you for choosing an OLEDWorks OLED Panel Brite 3 Curve product. This guide provides the necessary information for integrating this panel into a luminaire.

This manual covers the OLED Panel Brite 3 Curve family. Extensions to the product family will be added to this guide in future updates.

Note: OLED technology is continuously being improved. For the latest updates, please go to: www.oledworks.com

Documents required for a comprehensive information overview



To provide information as clearly as possible, OLEDWorks has structured its product documentation in the following way:

- The leaflet contains commercial information about the product family
- The datasheet contains the product specifications
- The design-in guide describes how the product can be integrated into an original luminaire design.

These documents can be downloaded from the website at: www.oledworks.com

For further information or support please contact OLEDWorks (see contact details at the end of the document).

INTRODUCTION TO THE BRITE 3 CURVE FAMILY

The OLED Panel Brite 3 Curve product family features efficient and high-brightness OLED panels at various integration levels and color temperatures. Additionally, OLEDWorks provides or recommends dedicated driver electronics to enable easy integration.

There are 4 different panel versions available of the Brite 3 Curve family, two different color temperatures and two different integration levels.

Product	Integration Level	Product code
OLED Panel Brite 3 FL300C ww Level 1	1	LPC1300R1WWL101
OLED Panel Brite 3 FL300C ww Level 1.5 (FFC)	1.5	LPC1300R1WWL105
OLED Panel Brite 3 FL300C nw Level 1	1	LPC1300R1NWL101
OLED Panel Brite 3 FL300C nw Level 1.5 (FFC)	1.5	LPC1300R1NWL105

Table 1 - products in the Brite 3 Curve family

Different types of dedicated drivers are available featuring different supply voltages as well as single and multiple output channels. Various interfaces (DMX, DALI, analog, TouchDim) allow a high level of flexibility in the design of all kinds of luminaires and lighting applications.

Product	Supply voltage	Output channels	Philips Code
Driver D230V 80W/0.1-0.5/1A/28V TD/A 8CH	120, 220-240, 277 V AC	8	925400010200
Driver D024V 10W/0.1A-0.4A/28V D/A	24 V DC	1	925400010100
Driver D024V 10W/0.1A-0.4A/28V DMX	24 V DC	1	925400012000

Table 2 - products in the Lumiblade driver family

Please consider that drivers with 24V supply voltage in Table 2 require a Molex PicoBlade connector. More details can be found in the driver product sheets.

Commercial names and terms for OLED products

The OLEDWorks Brite 3 Curve product family comprises different OLED components. The product names and terms are explained below:

OLED Panel Brite 3 FL300C ww Level 1

OLED Panel	light source
Brite 3	denotes the product family:
	- Brite = functional lighting
FL	denotes the main usage:
	- FL = functional lighting
300	technology level
C	rectangular bendable version ("Curve")
ww	denotes color temperature and surface finish:
	- ww = warm white standard finish
	- nw = neutral white standard finish
Level 1	letters reflect integration level,
	numbers reflect version diversifiers per integration level:
	- 1 = integration level 1
	- 1.5 = integration level 1.5
	= integration level 1 + FFC (flat flexible cable)

The product names and terms of the Philips Lumiblade OLED Driver family are explained below:

Philips Lumiblade D024V 10W 0.1-0.4A 28V D/A

D024V	input voltage of the driver
10W	maximum power supplied on output side
0.1-0.4A	range of current available on output side
28V	maximum voltage supplied on output side
D/A	dim protocols (separated by '/'), when applicable:
	- D = DALI
	- A = analog
	- DMX = DMX
	- TD = TouchDim (including DALI)
8CH	number of output channels

This guide

This design-in guide provides the necessary guidelines for configuring the OLED Panel Brite 3 Curve products into a system to meet customer needs. The OLED Panel Brite 3 Curve family is designed to enable all types of OLED based luminaires in functional indoor lighting.

The following sections cover

- safety and warnings
- OLED structure and interfaces
- mechanical integration guidelines
- optical integration guidelines
- electrical integration guidelines
- thermal integration guidelines

This guide is divided into six sections although many aspects are interrelated. We advise reading through all sections before beginning a luminaire design to understand how various aspects are interrelated, and to get the best out of the Brite 3 Curve family products.

SAFETY AND WARNINGS

All products of the OLEDWorks OLED Panels Brite 3 Curve family meet the requirements of IEC 62868 and UL 8752 and are intended for integration into luminaires. Details are provided in the relevant product datasheets. OLED panels are class III electrical appliances (in accordance with IEC 61140, IEC 60598-1) with accessible conductive parts. These parts require adequate insulation, provided, for example, by SELV/UL class 2 power supplies and the luminaire housing. The luminaire design must follow standards appropriate for the intended use of the luminaire, e.g. UL 1598, UL 153, UL 2108 and/or IEC/EN 60598.

Luminaire design should account for an increase in OLED voltage over life. Data is provided in the relevant datasheets. The safety standard requirements must also be fulfilled at these increased voltages.

In rare circumstances, OLED panels may fail due to a low-resistance conductive path within the light-emitting area (‘internal short circuit’). In this case heat (temperature may locally exceed 70 °C) will be generated at the location of the internal short circuit due to the residual resistance. The luminaire design must take this into account by providing adequate safeguards. Dedicated OLED drivers with built-in internal short circuit protection are available and are strongly recommended. Short-circuit-proof control gear in accordance with IEC 61347-1 does not automatically fulfill the requirements for OLED internal short circuits.

OLED panels are fragile components made of ultrathin glass. They must be integrated into the luminaire so that all parts of the panel are reliably secured to the product and cannot become loose. The glass parts of the OLED panel must be installed so that splinters cannot cause harm to the user in the event of breakage. Please use gloves always when handling the OLEDWorks OLED Panel Brite 3 FL300C products to avoid fingerprints or injuries by potentially sharp edges.

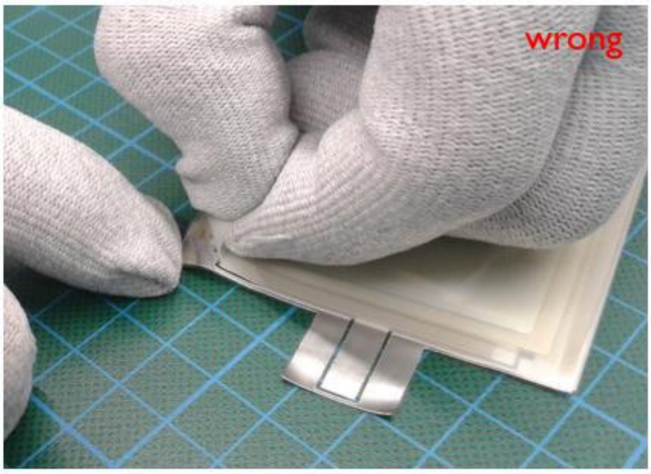
Defective OLED panels or panels with visible damage must not be used. Damaged OLED panels should be disconnected from the power supply and must be either disposed of or returned to the manufacturer. OLED panels are not user serviceable.

Do not…
… bend the OLED below the specified bending radius
… fold the OLED
… exert mechanical force to the OLED edge
… twist the OLED / integrate the OLED so that torsion occurs at either room or other temperatures
… apply point loads to either the front or back of the device
… write on the device with a pen or similar implement
… expose the device to high temperatures
… use defective products
… use products that have been dropped, even if there is no visible alteration
… use products that something has been dropped upon, even if there is no visible alteration

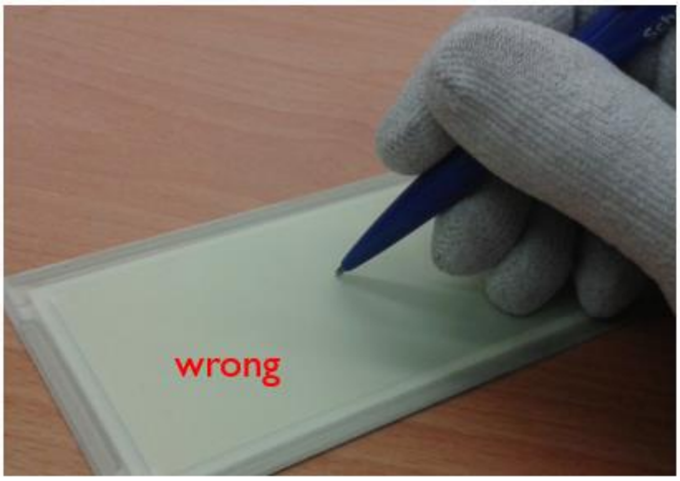
Do not bend below specified bending radius

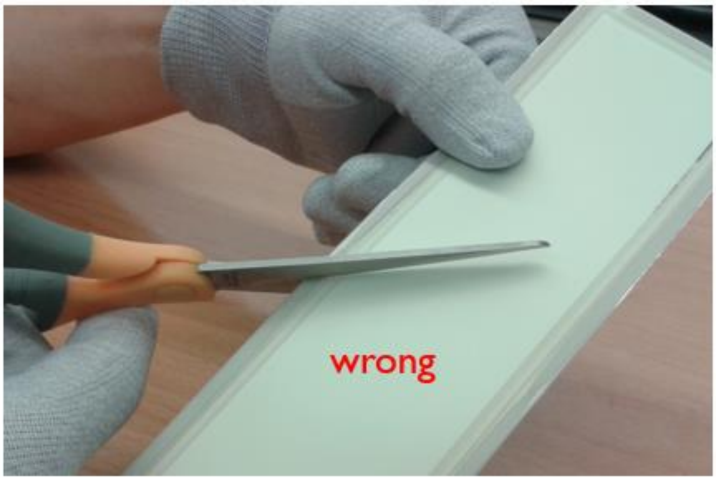
Do not twist

Do not press

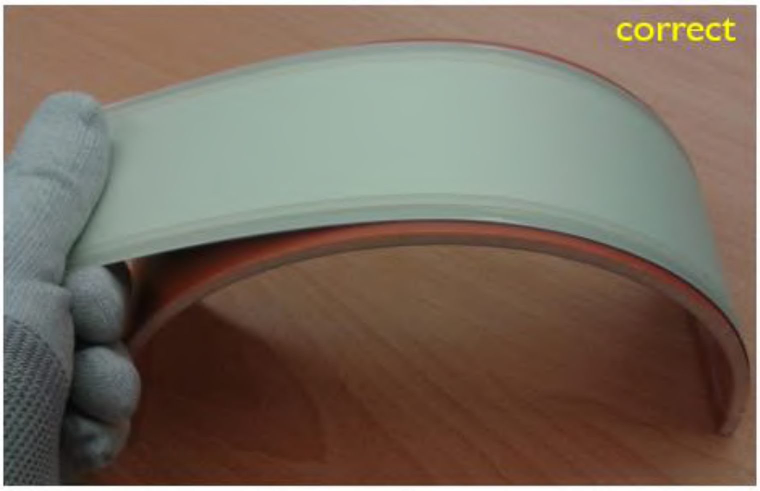


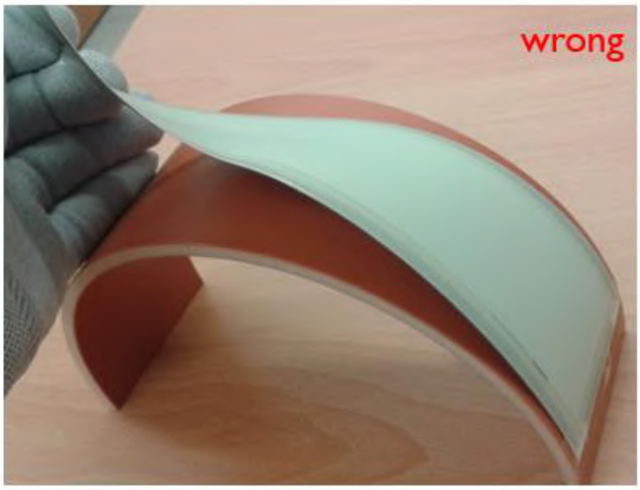
Left: Always wear gloves when handling OLED devices. Right: Do not peel off the front foil or the backside flexible printed circuit (FPC). They protect the ultrathin glass.



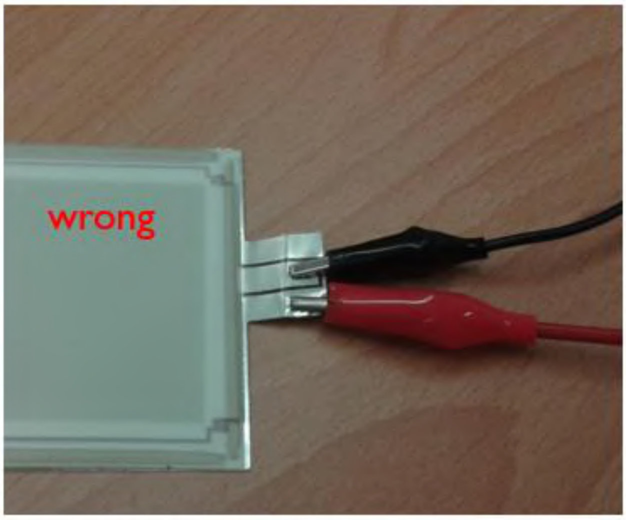


Left: Do not apply point loads (e. g. with a pen). Right: Do not cut the device



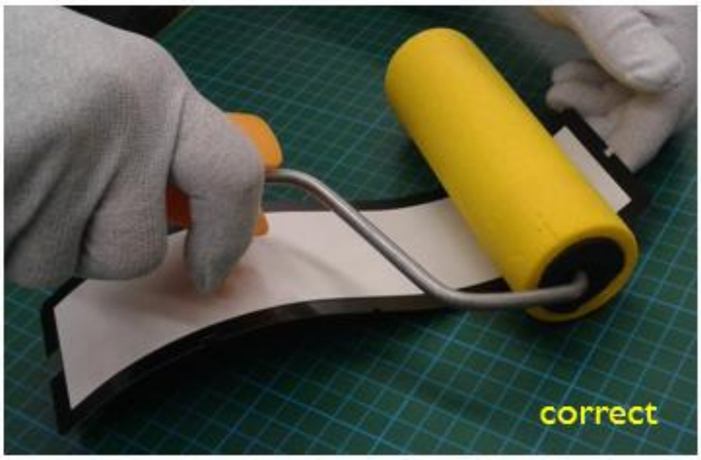


Left: Bend the OLED device with a radius equal to or larger than the specified minimum radius. Right: Do not apply torsion to the OLED device

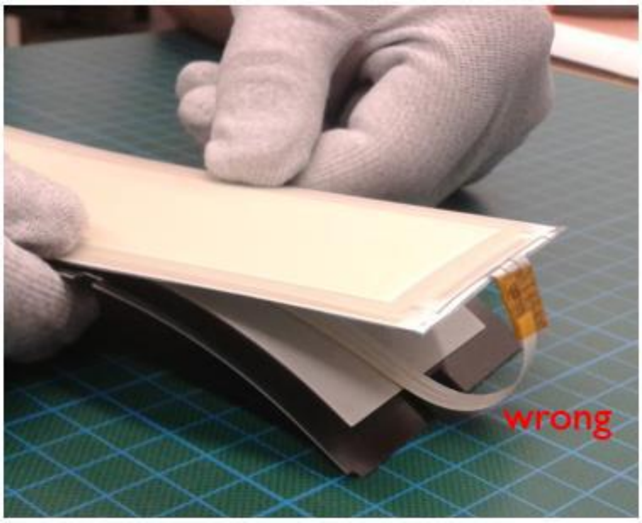


Left: Do not remove the electrical connection tab. Right: do not use clamping for electrical connection. Instead, use the prepared surface for solder connection.

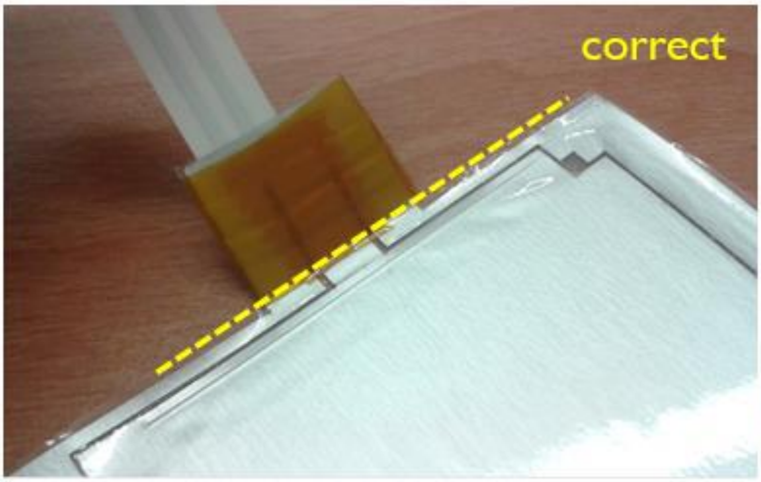
Left: Do not fold the device. Do not bend it with a radius smaller than specified. Right: Do not clean the OLED with water.

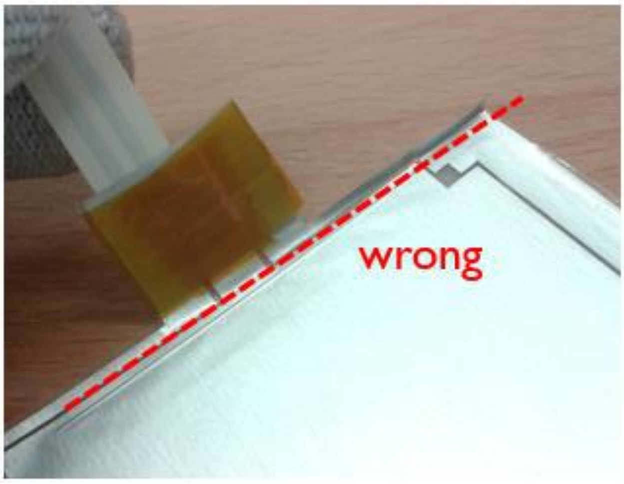


Left: Use a double-sided adhesive (DSA) tape with high thermal conductivity (heat pad) to fasten the OLED device to a surface. First, apply the DSA to the mounting surface. Right: In a second step, fasten the OLED by gently wiping across the device surface or by using a soft roller as in the left picture.



Above: Flipping back the flat flexible cable (FFC) connector before applying the OLED to the DSA (or to another surface) causes stress in the ultrathin glass and may lead to glass breakage. It is necessary to compensate any height differences in the mounting surface.





Take care to bend the connection tab along the edge of the flexible printed circuit (FPC) to avoid torsion in the metal tracks of the FPC.

STRUCTURE OF AN OLED AND BRITE 3 FL300C INTERFACES

The following gives a brief description of the Brite 3 FL300C.

OLEDs consist of various layers of organic semiconductor material sandwiched between two electrode layers. At least one electrode layer is transparent. When voltage is applied to both electrodes, positively and negatively charged holes and electrons are injected into the layer stack. When those recombine they initiate a process that generates light. This happens everywhere between the two electrodes, so the entire area lights up. This is a fundamental difference between OLEDs and conventional light sources, which generate light in a limited area (e.g. point or line sources).

As they are very sensitive to humidity, the functional layers must be hermetically sealed to prevent defects caused by moisture or other particles, which would terminate the operation of the device.

The degree of conversion of electrical energy into light defines the efficiency of the OLEDs. Typically, a certain amount of electrical energy is also transformed into thermal energy. Temperature needs to be kept at a similar level over the device's entire active area (area of light emission) as this affects the operation of the device (described in more detail in the related sections below). Hence, the Brite 3 FL300C has a temperature spreader fitted to the back of the device. Please refer to the related section for recommendations regarding additional means for temperature spreading for operation at higher driving currents.

The illustrations below show the principle structure of the Brite 3 FL300C. A transparent anode layer is applied to the back of a transparent substrate made from ultrathin glass. This is followed by a set of organic layers and a metallic cathode which also acts as a reflector. Thin-film encapsulation (TFE) is applied to the back of the cathode. The heat spreader made from a metal foil is attached to the encapsulation layer. A flexible printed circuit (FPC) is applied to the backside for electrical contacting and additional heat spreading. A schematic illustration is shown in Figure 1.

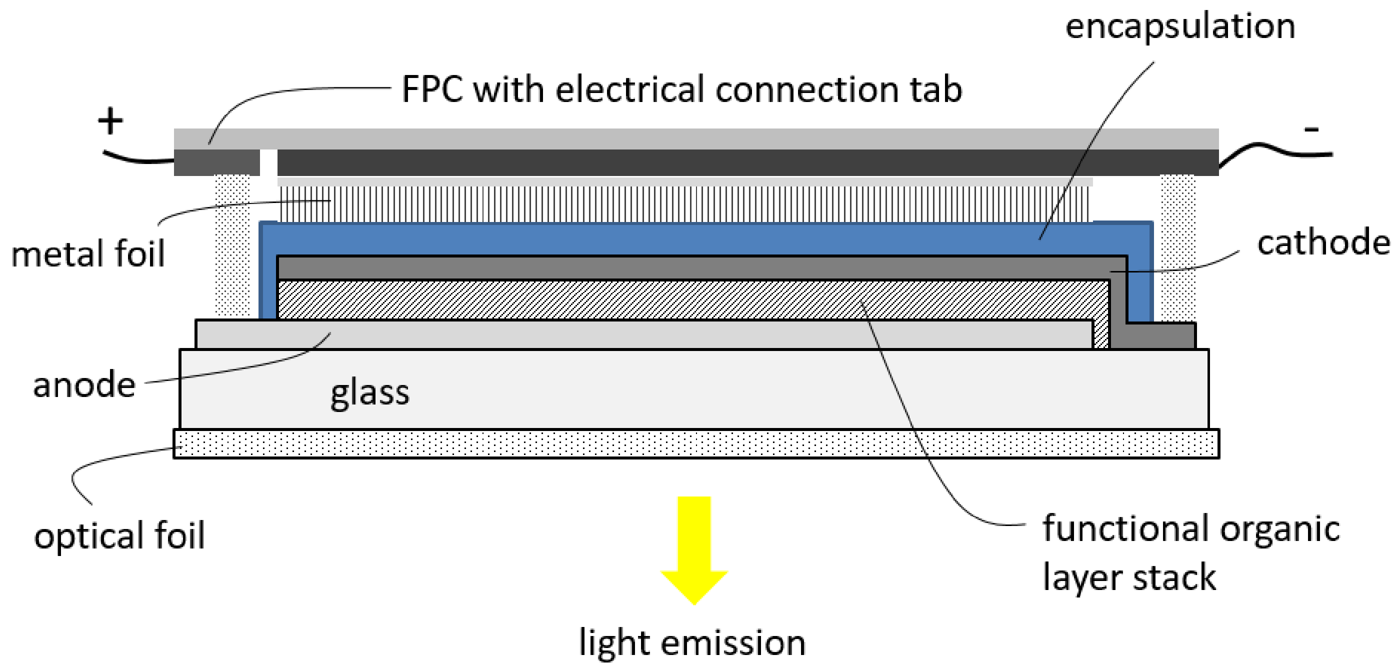


Figure 1 - schematic illustration of the Brite 3 FL300C

The Brite 3 FL300C is available in two integration levels, levels 1 and level 1.5. Integration level 1.5 is based on level 1 with an additional flat flexible cable (FFC) connected to the connection tab.

Three interfaces need to be considered:

- Thermal/mechanical interface:
  the back of the OLED acts as a thermal and mechanical interface. The back of both integration levels is the backside of the FPC which consists of polyamide.
- Optical interface:
  the OLED glass front acts as an emission 'window' and performs the function of the substrate on which the OLED is built. It must not be used as a mechanical interface. An optical foil is attached to the glass front of the Brite 3 FL300C to improve the extraction of light and the color over angle stability.
- Electrical interface:
  The electrical interface for integration level 1 comprises an electrical connection tab offering a surface for the solder connection of cables. The electrical interface for integration levels 1.5 comprises a flat flexible cable.

MECHANICAL INTEGRATION

The OLED Panel Brite 3 FL300C product range incorporates the newest lighting technology to combine bright, homogeneous lighting with a super-thin and sleek product appearance. This enables the design of unique, innovative and functional luminaires. Several mechanical and handling aspects arise due to the special characteristics of the OLED Panel Brite 3 FL300C product family.

With an extreme thinness of 0.5 mm, the light panels demand careful handling. To achieve this the light panels are based on ultrathin glass encapsulated by thin-film encapsulation making them electronic components sensitive to mechanical impact and e.g. ESD. To guarantee optimal operation, the panel may not be altered by any means (torsion, pressure, bending with a radius smaller than specified, electrical connections, etc.). Potentially sharp glass edges are no issue in handling because they are covered by the optical foil and the FPC.

Integration aspects

When designing a luminaire with a Brite 3 FL300C product please ensure that the following aspects are considered.

General recommendations for Brite 3 FL300C product family

The OLED Panel Brite 3 FL300C in both integration levels is optimized to enable sleek luminaire designs. However, special attention should be paid when designing mechanical fixation. The panel is particularly sensitive to mechanical impacts such as:

- point loads resulting from forces from either side, including front edges caused by a housing unit or frame
- (local) stress to any component of the device
- any force on the soldering pads
- tension due to torsion or excessive bending caused either by the luminaire design or by non-matching CTEs[1] of mounting materials and OLED panel

The luminaire design needs to provide the light source with a good thermal interface (see section on thermal integration).

Point loads: Please prevent exerting point loads on the OLED light source of your luminaire. For example, point loads of 4N applied with a round shaped tip with a 0.25 mm radius can lead to local damage on the back. This can be caused e.g. by forces to both the light emitting front or the encapsulated back.

Solder joints can locally increase the thickness of the light source and may result in point loads when mounted or temporarily placed into flat, rigid constructions. Figure 2 on page 17 shows how particles or locally increased thicknesses may lead to point loads and/or deformation.

Scratching: Please avoid any type of scratching (e.g. with a pen), pressure or other temporary forces on the light source as this can also result in temporary, local point loads and may damage the product.

[1] CTE – coefficient of thermal expansion

Environmental conditions: The Brite 3 FL300C product family is designed to operate optimally in indoor luminaire applications as defined in the product datasheet. Any usage outside the recommended environmental conditions, including high humidity, contact with water or dew, can lead to the product's damage and malfunction. Suitable protection is therefore necessary to help guarantee the product's reliability.

Mechanical fixation: Brite 3 FL300C products are designed to be mechanically fixed into luminaire housing units. Due to the fragility of the components the mechanical interfaces need to be designed with care. Please consider the following recommendations:

- Avoid clamping or any other mounting methods that create local forces that may damage the light source.
- Design the mounting structure so that it provides additional stability to the fragile light source. Do not design a mechanical fixture that holds the light source with a single touch point.
- The connection tab and/or the flat flexible cable (FFC) for electrical connection are not meant to be used for mechanical fixation and must not be exposed to pulling forces of any kind as no strain relief is provided by the product.
- The use of double sided adhesive tape with high thermal conductivity (heat pad) is recommended for mounting OLED Panel Brite 3 FL300C products to luminaire housing units.

Double-sided adhesive tape

Use a double-sided adhesive (DSA) tape for mounting the OLED Panel Brite 3 FL300C to a surface. It is recommended to use soft, foam-like tapes with good thermal conductivity. First, the DSA tape should be applied to the mounting surface, and the OLED panel should be attached in a second step. Please ensure that the DSA tape is present below almost the entire area of the OLED panel to ensure safe mechanical mounting and a homogeneous thermal interface. Avoid any high mechanical forces and do not use any metal tools (like scrapers, spatulas, knives, or alike) when fastening the OLED. Gently wipe across the OLED surface or use a soft roller for attaching the panel to the DSA to avoid breakage of the ultrathin glass.

Products recommended by OLEDWorks as DSA tape for attaching the OLED to a surface include

- 3M 8708-05

Use only mounting parts with a smooth surface. Particles, protrusions, local plateaus or spikes may lead to local mechanical stress which can cause damage (see Figure 2). Any cables, screws, labels, stickers, or other objects must not be present between the OLED panel and the installation surface for the same reason. In particular, do not fold back the connection tab with the flat flexible cable (FFC) to the panel backside before fastening the panel to the surface without any compensation measures for resulting thickness differences.

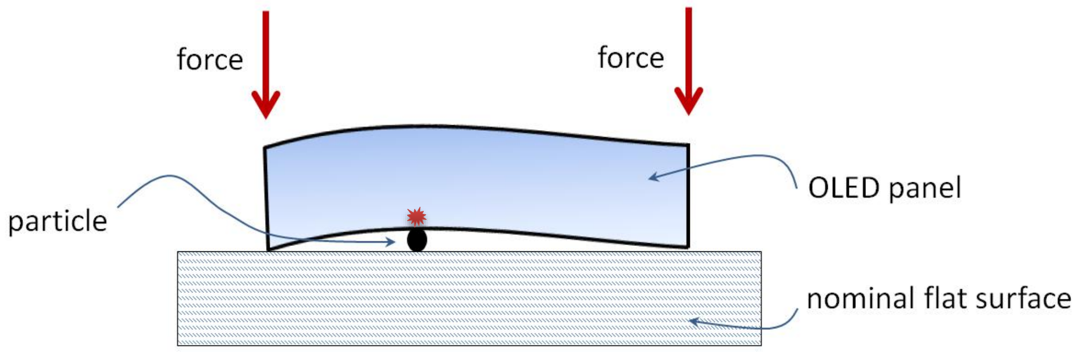


Figure 2 - example of unintended local point loads due to particles and force to the front

For a curved installation, use only mounting surfaces with parallel bending axes having a bending radius that is equal to or higher than the specified minimum bending radius. Both convex and concave bending direction are allowed. We strongly recommend a fixed installation as FL300C is not designed for multiple bending.

Depending on the mounting surface, electrical insulation may be necessary to prevent electric short circuits at the connection tab of the FPC.

Assembly/handling notes

Most of the recommendations below are directly related to the requirements discussed above.

Do's

Please use gloves always when handling the OLED Panel Brite 3 FL300C products to avoid fingerprints.

Don'ts

When mounting OLED Panel Brite 3 FL300C products into the luminaire avoid bending below the specified bending radius, torsion or pulling forces which may cause damage to the OLED.

Please also avoid any kind of point loads caused, for example, by writing on the product with a pen.

Do not scratch the light source with any hard or sharp objects.

Do not drop the light source and do not let anything fall on top of it. Discontinue use of the product if this happens, even if there is no visible alteration.

Defective OLED panels or panels with visible damage must not be used.

Cleaning instructions

Please avoid scratching the front surface with any hard or sharp objects. Do not use any other chemical than isopropanol or ethanol to remove stains and fingerprints. OLEDs can be cleaned with any soft textile.

For everyday cleaning, the use of a compressed air de-duster is recommended. Should fingerprints or more persistent contamination have occurred, isopropyl alcohol should be applied to a lint-free cloth. Apply a little of the liquid to the cloth and gently wipe the surface of each OLED with a circular movement, beginning at the center and moving towards the edge. Never use water on the OLEDs as this may shorten the lifetime or reliability of the product.

Optical integration

In contrast to all other light sources, OLED technology provides diffuse and homogeneous light emission. The light source can be used to distribute the light without additional optical means, which reduces losses in efficiency in optical systems. The OLED Panel Brite 3 FL300C product family thus enables extremely thin luminaire designs with homogeneous light emission.

Luminaire designs or lighting applications using the Brite 3 FL300C may include the integration of other optical elements, be it for aesthetical reasons, safety or to intentionally alter the optical performance (e.g. color). These alterations can affect the performance of color, luminance, efficiency, and angular dependency of color and luminance.

This section shows the effects that need to be considered when integrating additional optical elements. It is not intended to provide quantitative dependencies for a combination of optical elements.

Brite 3 FL300C warm white versus neutral white

The OLED Panel Brite 3 FL300C is available in two different color temperatures:

- Brite 3 FL300C ww – warm white – 3000K
- Brite 3 FL300C nw – neutral white – 4000K

Both Brite 3 FL300C products feature an optical foil with diffusive properties on the light emitting side. This foil increases the light output and optimizes color over angle. Due to this foil it has a matte white surface when not in use.

Figure 3 shows the effect of the difference in color temperature. Luminance is shown as a function of the viewing angle[2] for both versions of the Brite 3 FL300C.

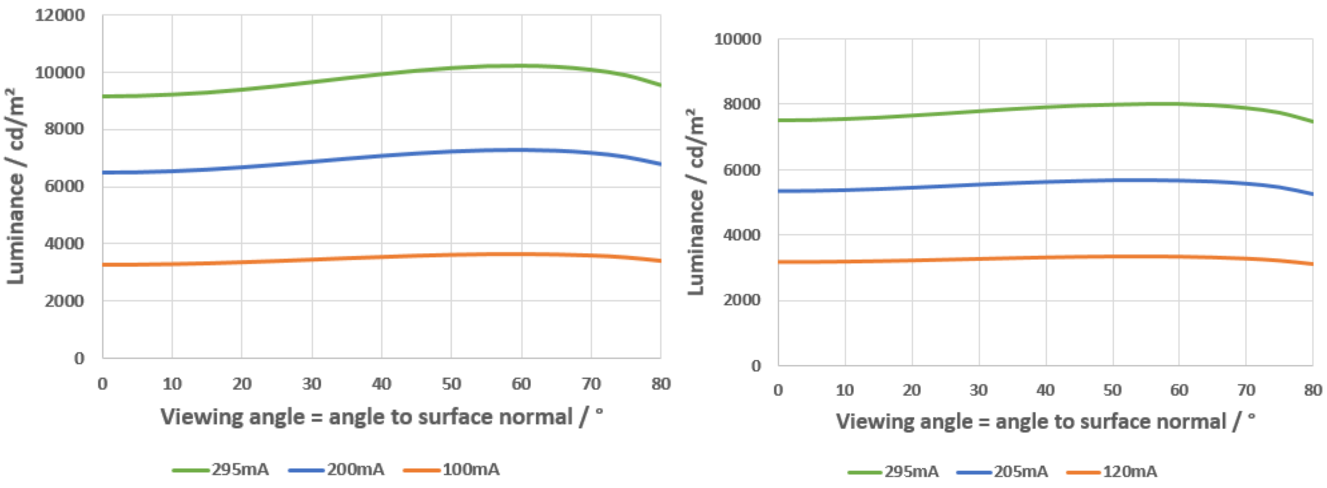


Figure 3 - Brite 3 FL300C ww (left) and Brite 3 FL300C nw (right): luminance versus viewing angle for different currents

[2] The viewing angle is measured between the surface normal and the direction of light.

Figure 4 shows the difference in the color over viewing angle. Please refer as well to the product data sheets.

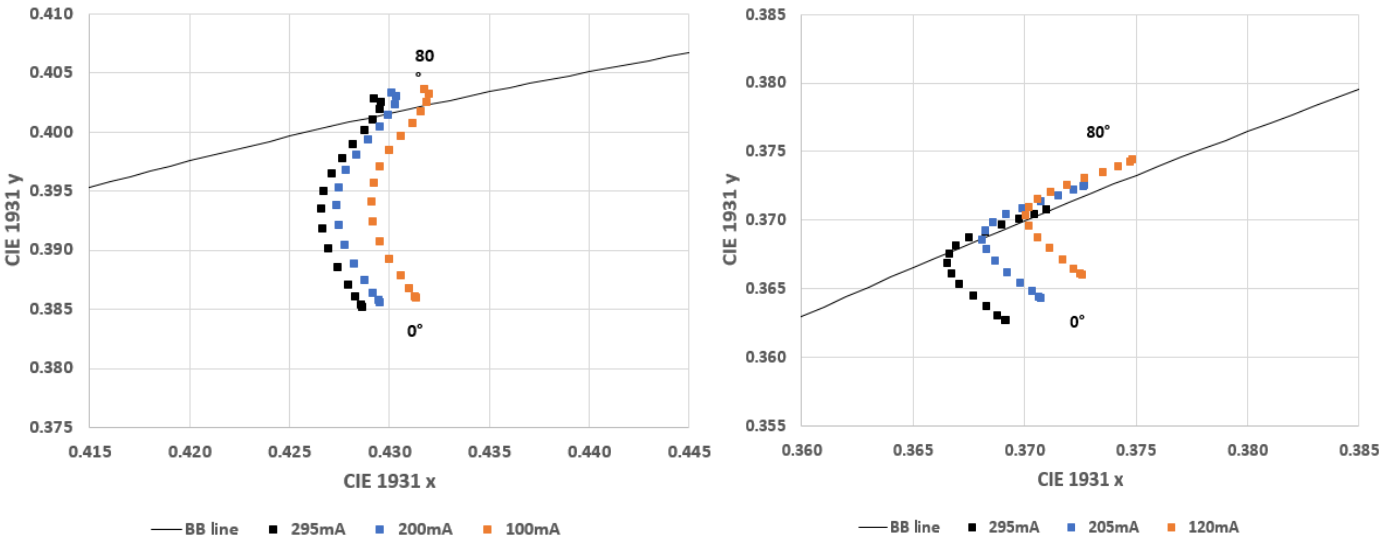


Figure 4 - Brite 3 FL300C ww (left) and Brite 3 FL300C nw (right): color coordinates for different currents and viewing angles

Types of optical elements

Luminaire manufacturers are free to integrate additional optical elements to optimize performance with respect to the requirements of the specific application. Properties such as beam shape, efficacy, luminous flux, color point, color rendering, color over angle and appearance when not in use can be adjusted by applying additional optical elements.

Please note that the direct attachment of additional optical elements by optical gluing to the diffusor foil could significantly alter the scattering properties of the standard foil of the panels with a standard surface finish.

A small gap left between the panel and the optical element can limit these changes. However, the interfaces towards the gap may also generate losses due to the difference in refractive indices. A possible solution is offered by optical elements with anti-reflective surfaces which can minimize optical loss at the additional surfaces created by the gap.

Combining different optical elements is possible but interactions (see below for different types of optical elements) must be considered in the individual design.

During assembly, inclusions (air bubbles, dust or other contamination must be avoided as they will remain constantly visible and may also alter the performance of the optical element. Please also refer to the precautions in the section on mechanical integration (see page 15).

Scattering elements

Scattering elements can be attached to tune the light extraction or the stability of color over angle. They are not suitable for concentrating the light; they can only be used for diffusing it. The non-light-emitting area of an OLED panel or the active areas between an array of panels can be concealed by spreading the light with a scattering element. Scattering elements are available as foils or plates. Plates add to the overall thickness of the luminaire design but can improve robustness.

Brite 3 FL300C panels come with a scattering element in the form of a diffusor foil attached to the glass surface of the OLED panel using an optically clear adhesive (OCA), see Figure 1. They are optimized for high light output and minimal color change over angle.

Refractive elements

Refractive elements like optical plates with dedicated structures can be applied in order to control and/or narrow the beam shape. Leaving a gap between the optical plate and OLED panel is recommended for this purpose.

Refractive elements cannot be used to improve the stability of color over angle. Refractive elements can also be used together with scattering elements (taking the recommendations mentioned above into account).

Absorbing elements

Similarly, to colored transparent plates, foils or semitransparent printed layers, absorbing elements can be applied to the front of the OLED to tune the emission color and the color-rendering index. These elements all have the intrinsic drawback of reducing the overall luminous efficacy of the system.

Shielding elements

Next to beam shaping with refractive elements, glare reduction can also be achieved by the attachment of optical shielding (with lamellas or raster configurations as used in TL luminaires). However, this option can result in low system efficiency and increased thickness to the luminaire depending on the material attached

If an application requires precise limitation or a customized structuring of the light emitting area, optical shielding can be applied parallel to the panel surface. Shielding elements such as nontransparent foils, printed layers or sheets are suitable in this case.

ELECTRICAL INTEGRATION

This chapter introduces basic concepts on how to integrate Brite 3 FL300C panels into a luminaire with respect to driver selection, electrical wiring and contacting recommendations.

Driver selection

Dedicated Lumiblade OLED drivers are recommended because they meet all the requirements given in the list below:

1. Current control is recommended
   Current control offers the most stable way of powering OLED panels due to the OLED current-voltage characteristic and the relationship between luminous flux and current.

2. Output current ripple should be low
   The DC current should have a low ripple. High current ripples could lead to inhomogeneity within the OLED, as well as to reduced lifetime and reliability. Typically, switch mode power supplies require a current ripple running through the current sense feedback resistor to work properly. Small ripple values are acceptable. A safe measure would be to keep the peak-to-peak value of the ripple below 30% of the mean value.

3. Avoid transient overshoot
   When turning OLED and power supply on and off and due to other transient conditions, e.g. PWM switching, voltage and current overshoots may occur. These overshoots should be avoided and kept as low as possible. A soft start is recommended.

4. Take varying OLED voltage into account
   The forward voltage of an OLED may vary due to forward current, ambient temperature and self-heating. Additionally, the forward voltage will increase during nominal operational lifetime. Forward voltage data are provided in the OLED panel datasheet.

5. Provide Short Circuit Protection (SCP)
   Be aware that if the OLED fails the device may become much hotter locally at same current than in normal mode. In this case the OLED panel should be turned off. This can be done with dedicated OLED short circuit protection in the driver.

6. End of Life (EOL) protection
   The driver output voltage increases over lifetime of the OLED in constant current mode. The higher voltage leads to higher power consumption at constant current and hence to higher temperatures. An optional voltage limiter for the protection and safety of the driver and OLED can be used.

A list of available Lumiblade OLED drivers can be found at the beginning of this document (see Table 2). Drivers are available for single and multi-channel outputs as well as for mains and 24 V supplies. All drivers comprise a variety of possible control protocols such as DALI, TD, DMX. Please consider that drivers with 24V supply voltage in Table 2 require a Molex PicoBlade connector. More details can be found in the driver product sheets.

In addition to the guidelines above, please ensure that your application design maintains current, voltage and power within the specified range to help protect the OLEDs even in case of misuse of the luminaire, e.g. powering with wrong voltage settings or in fault conditions that exceed the limits given in the datasheet. Both may lead to safety risks or damage of the OLED.

Additional details about OLED failure mode

In contrast to most other light sources OLEDs can go into a short condition when they fail. In this case a low ohm bypass between the anode and cathode is formed. While the light output may be reduced or even zero, current may still flow through the OLED. Due to the reduced resistivity the OLED voltage drops to a lower value.

If current is still applied to the OLED it may result in a local hotspot, i.e. the OLED temperature may locally exceed 70°C. If this happens the current through the OLED must be turned off.

The Lumiblade OLED drivers can be configured for automatic detection of this failure mode and turn the output off.

Electrical wiring and contacting

OLEDs can only be operated at DC current and in a forward direction. Reverse polarity may damage the product.

Serial interconnection

Technically, OLEDs can be connected in series. In practice, certain safety standards and regulations need to be considered:

- Connecting multiple OLEDs in series requires a higher output voltage from the driver. If voltages become higher than the safety extra low voltage limits (SELV) additional precautions are necessary.
- Short circuit protection is necessary for individual OLEDs and this can be difficult to implement. Alternatively, the complete series must be switched off if just one OLED fails.

Please note that Lumiblade OLED drivers are constructed in a way to deal with one OLED per output channel.

Parallel interconnection

We advise against connecting OLEDs in parallel. This may result in asymmetrical current distribution to the OLEDs and lead to the damage of individual OLEDs. The safety aspects mentioned for general use and serial interconnection still apply and are even harder to implement technically.

OLED identification

Lumiblade OLED drivers (see Table 2) support the option to automatically detect the necessary driving current and the output voltage window for your OLED panel. This requires a special connector cable with two integrated resistors (R_{set}/R_{win}) that encode these parameters. Using this special cable in combination with the Lumiblade OLED drivers ensures that the proper lumen package is provided and that the failure detection is correctly configured.

Brite 3 FL300C products in the standard version (Level 1 see Figure 5, Level 1.5 see
) are available only without R_{set}/R_{win}, and the driver must be configured to match the device requirements. Please contact OLEDWorks to check possibilities for a customized solution if you want to use the OLED identification feature of the Lumiblade OLED drivers. For more detailed information about R_{set} and R_{win} please refer to the datasheets on the Lumiblade OLED drivers.

OLED current setting

The driver output settings must be configured and the driver needs to be designed correctly to deliver the correct brightness level, lumen package and fault protection. Please refer to the product data sheets of the Brite 3 FL300C OLED panel and of the drivers for more details.

Establishing electrical connections (soldering recommendations)

Brite 3 FL300C Integration Level 1 comprises a contact tab for electrical connection, with the contacting surface being on the same side as the lit area. Wires should be soldered to the predefined plus and minus pole solder pads to establish an electrical connection (see Figure 5, indicated solder areas).

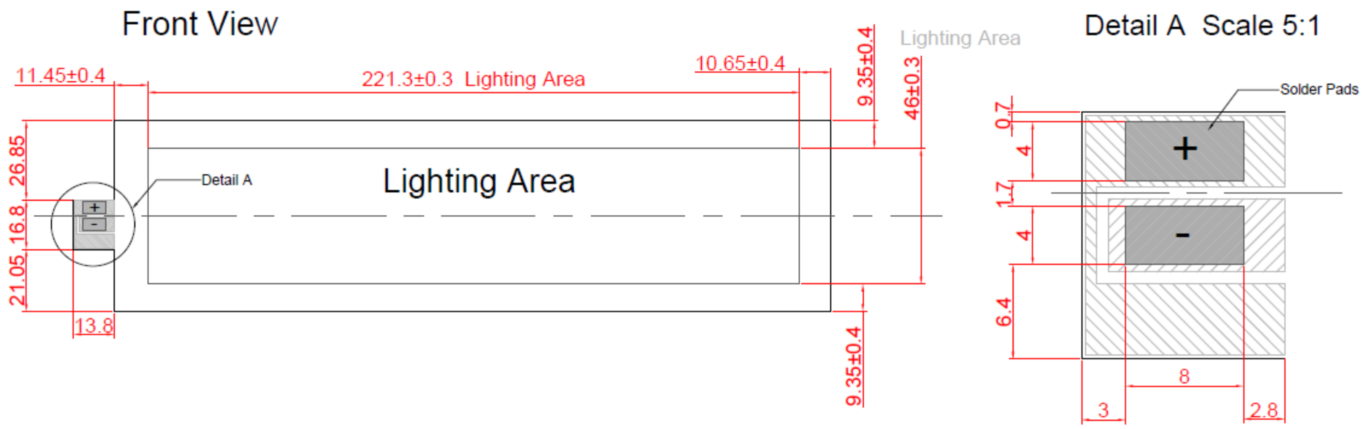


Figure 5: Brite 3 FL300C Level 1 and detail A showing the solder pads

We recommend soldering to establish an electrical contact. As high temperatures may damage the OLED panel, we recommend not to exceed the following parameters:

- maximum temperature of the soldering tip: 350 °C
- maximum soldering time: 2 seconds

For the soldering of the individual wires, please allow the temperature of the OLED contact area to cool down before soldering the next wire.

Brite 3 FL300C Integration Level 1.5 comprises a flat flexible cable (FFC) for electrical connection (see Figure 6)

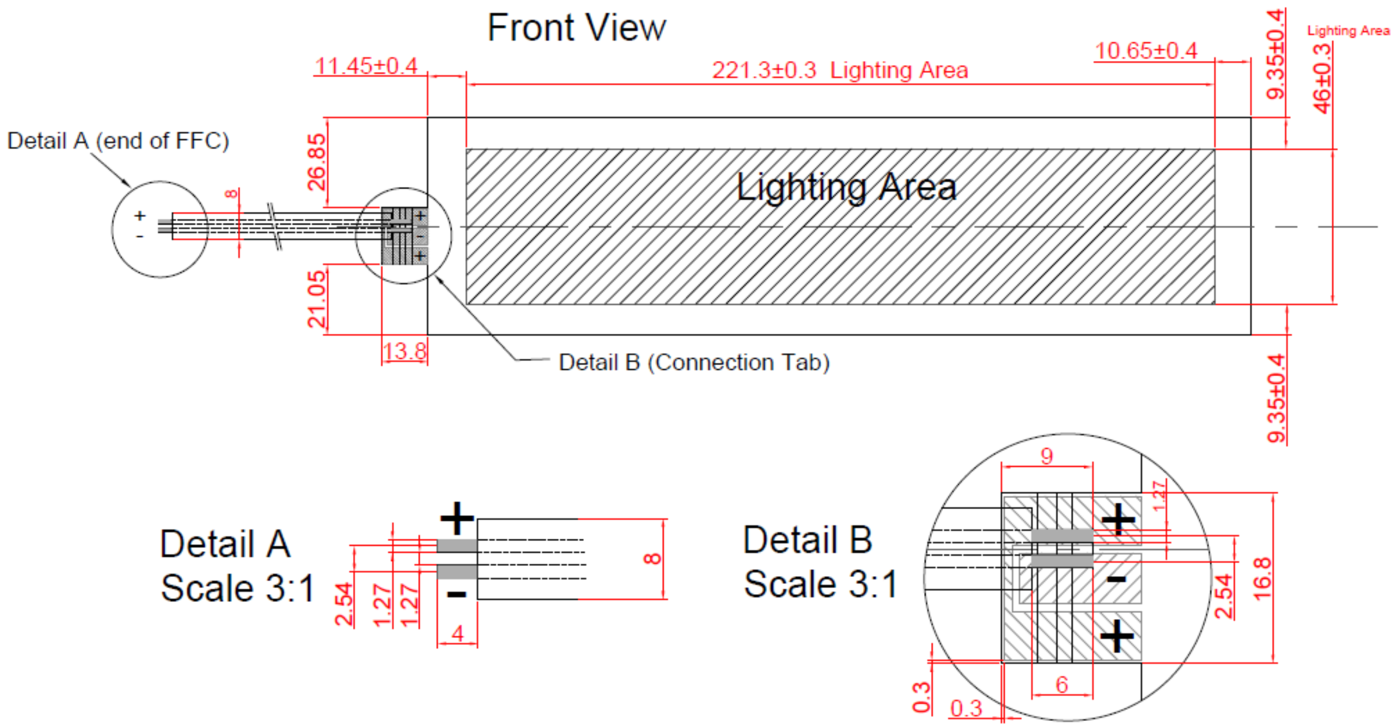


Figure 6: Brite 3 FL300C Level 1.5 – front view (top); Detail A (left) and Detail B (right)

Cables

The length and type of cable needs to be considered in the design process of an application. Electrical loss due to the resistivity of the cables affects two aspects of the system (OLED <> driver):

- Wire resistivity leads to electrical loss and a voltage drop depending on wire lengths. When operating at a constant current the driver increases output voltage to reach the requested target driving current. Device performance is not instantly affected; however, the system will reach end of life more quickly as the upper voltage limit of the driver output window is reached faster.
- An OLED fault leads to reduced voltage (see above). However, increased voltage level during normal operation also increases voltage in the case of OLED failure. Consequently, if the voltage is too high the driver may not detect the failure and therefore not turn the OLED off.

In both cases the maximum voltage drop due to the cables should not exceed 1 V.

Cables need to be selected in accordance with regulations and safety standards.

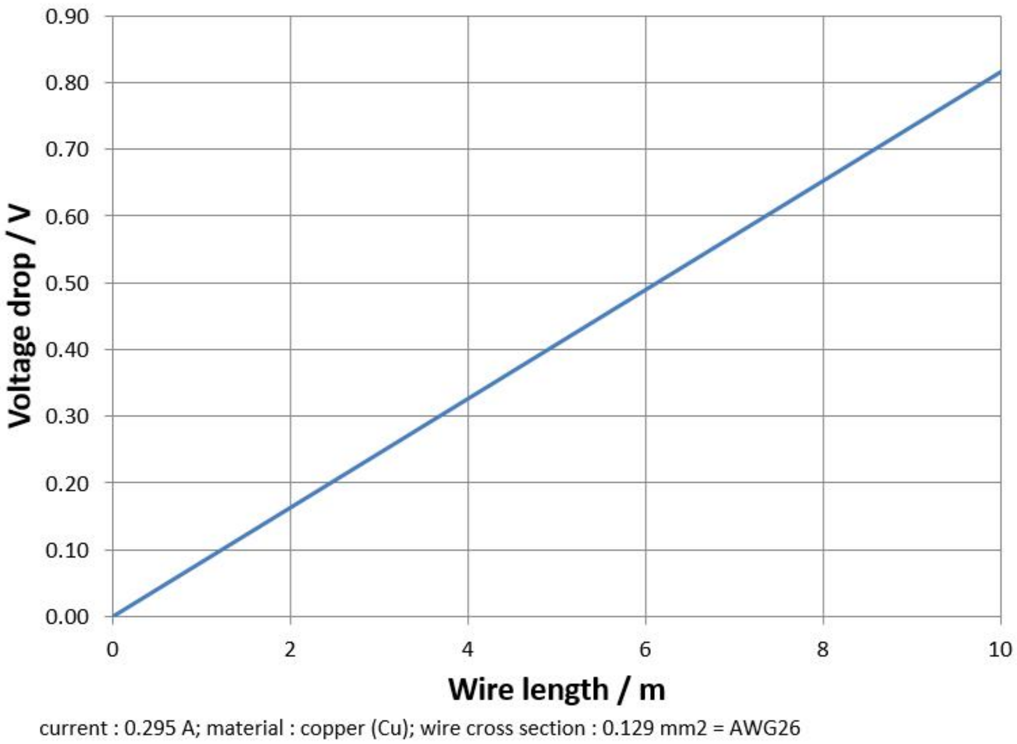


Figure 7 – theoretical estimation of the voltage drop vs. wire length for a copper wire of 0.129 mm² cross-section and $I_{in\ rated}$ = 0.295 A

The resistance (and consequently the voltage drop for a given current) of a cable can be theoretically estimated taking the wire cross-section, the material (specific resistance) and its length into account. An example is given above for a copper wire with a 0.129 mm^2 cross section. Please note that translating AWG values into wire cross-sections is not as dependable if stranded wires are used.

Be aware that it is the overall length of the wires and not the distance between driver and OLED that is relevant.

Assembly

Electrostatic discharge (ESD)

Introduction to ESD

Electro Static Discharge (ESD) can damage electronic components such as LED chips or OLED panels, resulting in early failures. Avoiding ESD damage to finished end products requires extensive measures when implementing electronic components. This is also valid for the implementation of OLED electronic components.

ESD in production environment

Reduction of ESD is required in the production environment, and ESD-vulnerable products should be packaged and delivered in ESD-safe packaging. The purpose of an effective ESD control strategy is the reduction of line failures, final inspection failures and field failures.

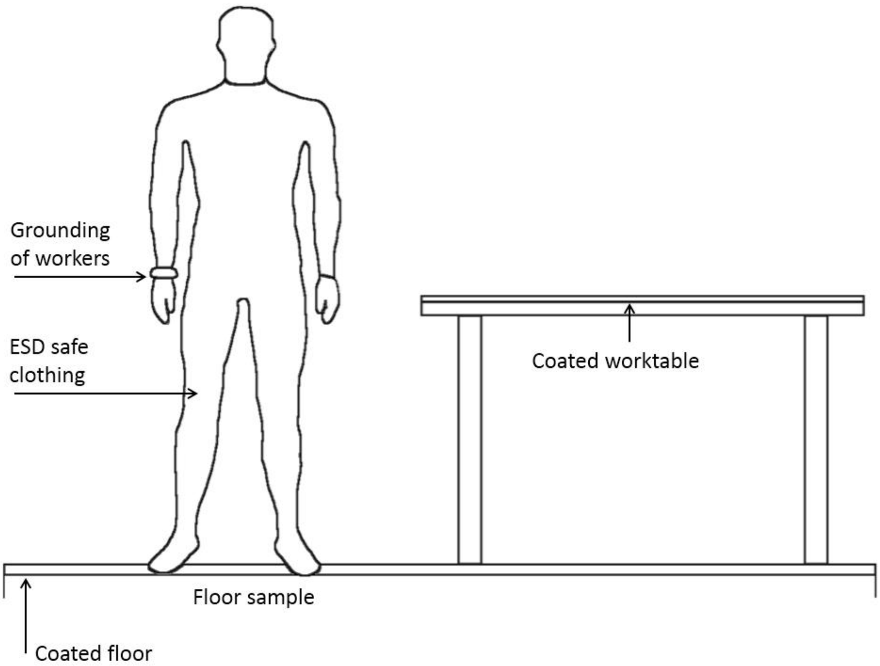


Figure 8 – Protection against ESD in manufacturing environments [source: Philips]

General recommendations in assembly

- Buildup of static friction between the product and surroundings should be minimized and all equipment (including floor, worktops etc.) should be electrically grounded.
- As shown in Figure 8, workers should be grounded and wear ESD-safe clothing
- Low levels of humidity also increase buildup of electrostatic and should be avoided. A level of 50% or more is recommended.
- Use of antistatic packaging for storage and transport is recommended.

For further information, please contact OLEDWorks (see contact details at the end of this guide).

THERMAL INTEGRATION

OLEDs are solid-state lighting components. Like other electronic components the behavior of an OLED depends on its thermal state. The ambient temperature conditions as well as the driving conditions of the OLED itself influence the operating temperature.

Operating temperature has an impact on a several parameters including:

- driving voltage at a given current
- achievable lifetime (lumen maintenance)
- achievable reliability [3] (abrupt, catastrophic failures)

Local organic temperature differences in the OLED Panel may result in inhomogeneity. As the OLED itself also generates thermal energy depending on the driving current, the current directly impacts the parameters given above.

Thermal requirements must be considered thoroughly in the design of the luminaire to achieve proper optical results and the targeted lifetime.

This chapter

- provides information on the general requirements for reliable operation
- gives indications on how to measure organic temperature
- lists typical aspects that may influence device temperature and performance

[3] Reliability - the ability of the OLED panel to perform its required functions under stated conditions for a specified period.

Integration aspects

General remarks

Description of the Brite 3 FL300C

Regardless of the integration level, the Brite 3 FL300C comprises one major interface on the back which needs to be considered for thermal integration. The back consists of a flexible printed circuit (FPC), with the polyamide carrier foil of the FPC being the outer surface. In the following the term 'thermal interface' relates to this surface on the back.

The Brite 3 FL300C comprises only very basic thermal functionality as it is designed to minimize OLED panel thickness for minimum element thickness and allow the highest degree of freedom in the design of luminaires. The metal foil only spreads the heat while heat dissipation needs to be accounted for in the luminaire design.

Reliable operation

Products must be operated below a certain temperature level to achieve reliable operation throughout the targeted timeframe.

Apart from the likelihood of abrupt failures, (gradual) lumen maintenance is also temperature dependent. The Brite 3 FL300C was designed for L70B50[4] = 10,000 hours at an organic temperature of 45°C. This temperature is reached when the product is used at a rated current in vertical position at room temperature. Any other temperature results in lower or higher L70B50. The actual organic temperature is affected by power dissipation (driving current), thermal dissipation (thermal design) and ambient temperature.

Reducing temperature can significantly extend the expected lumen maintenance (for more information please see Figure 10, page 32).

The driving conditions, ambient conditions and the thermal design contribute to the actual organic temperature of the panel, which determines lifetime. This can generally be controlled by:

- control of ambient temperature (of the luminaire, consequently also of the OLED)
- active cooling (within the luminaire)
- reduction of driving current (affects light generation)

Each of these approaches has a drawback:

- ambient temperature control options limited to customer requirements may interfere with the recommended OLED panel temperature.
- active cooling options may add to the thickness of the luminaire design, limiting freedom of design.

[4] L70B50 describes the point in time when 50 % of the remaining population yields at least 70% of the initial luminous flux.

- current control affects the amount of light generated and the brightness of the product. While this may be undesirable for some applications it may be a desired for others.

A thorough assessment of customer needs and application requirements and choosing from a combination of the measures mentioned above best suited to the design is therefore recommended.

Reduction of current may be the only way to reduce temperature for a given environment and design.

How to measure organic temperature

The organic temperature is the temperature of the organic layers which determine the lifetime of the product. The temperature at the center of the device should be approximately the same as the temperature on the glass at the front.

When the term ‘organic temperature’ is mentioned in this document it always refers to the temperature at the center of the light emitting area on the front measured with a thermo-couple, for example 5TC-TT-KI-36-2M type K (nickel-chrome/nickel) directly attached to the surface (Figure 9, position B).

Note: To improve accuracy of measurement a small amount of thermal paste may be used. Be aware that the paste may leave stains on the product.

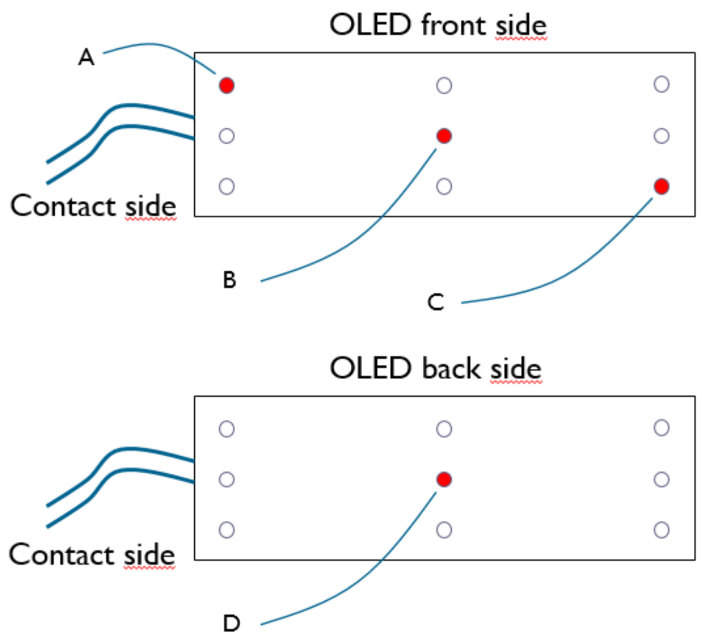


Figure 9 - measurement positions used throughout this guide

Please note that mounting the OLED panels in a vertical position when measuring the organic temperature may lead to convection and thus alter the results.

If a climate chamber is used to simulate certain ambient conditions be aware that integrated ventilation may alter the results due to forced convection.

A thermo-couple near the device but shielded from temperature created by the device itself should be used to make ambient temperature readings.

Impact factors

Current

The relationship between luminous flux and driving current is almost linear. Increase of driving current also increases temperature (increased power consumption)

Organic temperature

Organic temperature determines lumen maintenance and reliability. Elevated temperatures accelerate the aging of the device which primarily results in lower lumen output and voltage increase. Voltage increase at constant current driving also leads to increased power consumption and increased temperature.

Expected lifetime (lumen maintenance)

Figure 10 and Figure 11 show the approximate expected lumen maintenance L70B50 for different points of operation: luminous flux (equivalent to current) and organic temperature. This gives an indication of how an increase in organic temperature at a given current affects lifetime and vice versa.

Current reduction has two effects: It directly increases the lifetime of the OLED due to reduced electrical stress and indirectly extends the lifetime by decreasing the organic temperature.

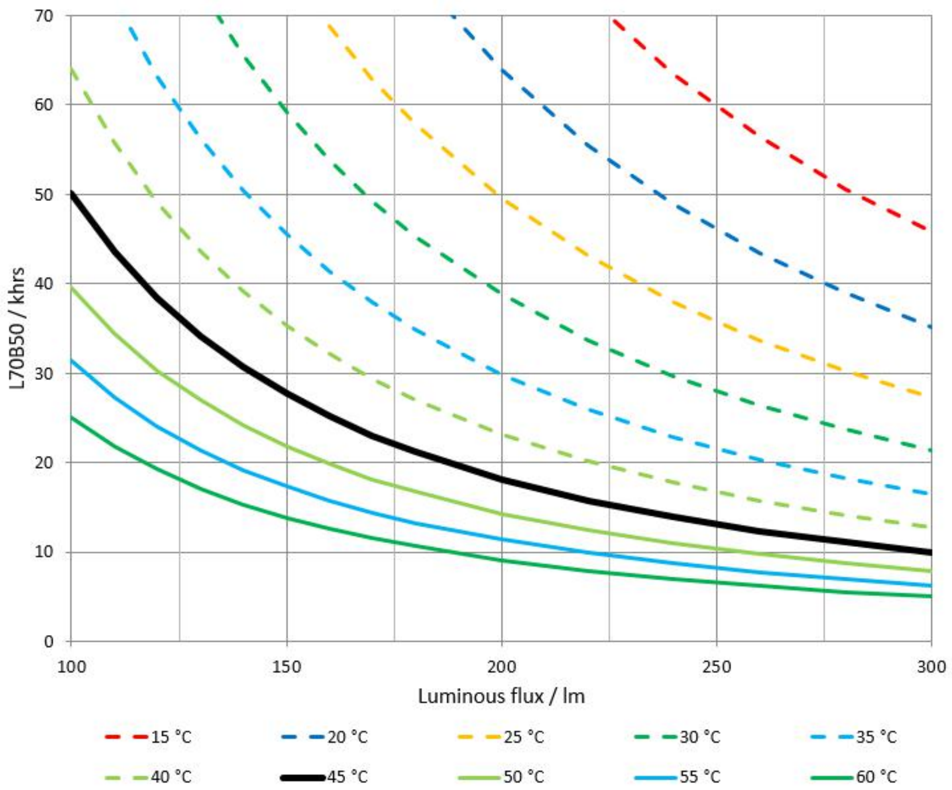


Figure 10 – L70B50 vs. luminous flux and organic temperature for FL300C ww

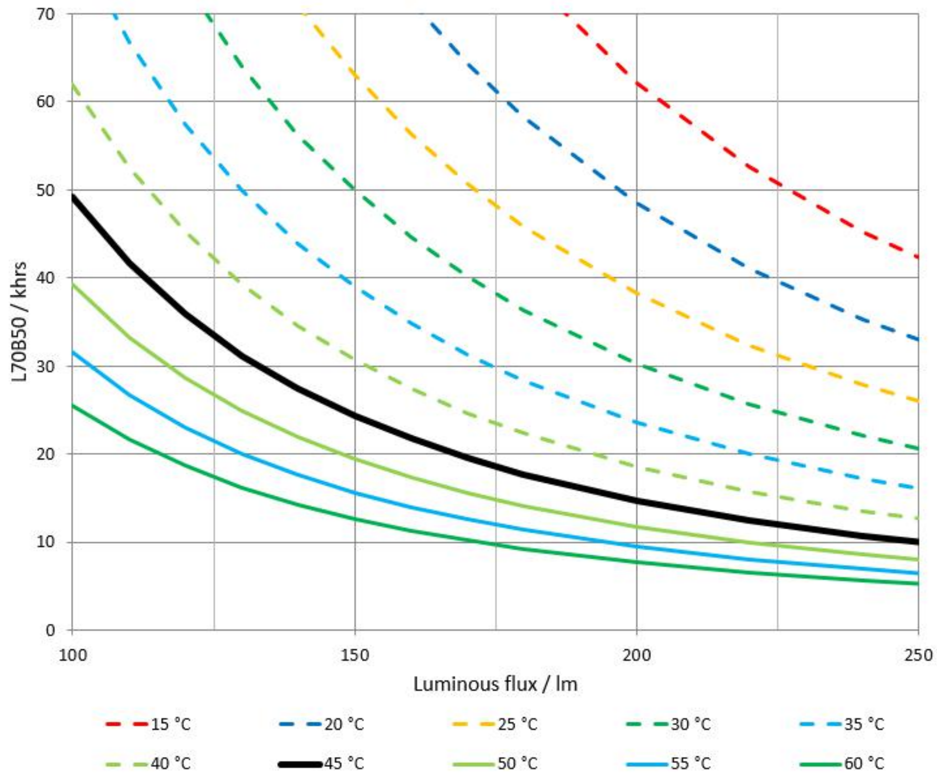


Figure 11 – L70B50 vs. luminous flux and organic temperature for FL300C nw

Example:

<u>Question</u>: Is it possible for an OLED device FL300C nw to achieve a L70B50 of 50,000 hours if the current is reduced from 0.295 A to 0.120 A?

<u>Answer</u>: An ambient temperature of 25 °C with a driving current of 0.295 A (approx. 250 lm for FL300C nw) and a resulting organic temperature of approx. 45 °C would result in an expected lumen maintenance of L70B50 = 10,000 hours for a Brite 3 FL300C nw. By reducing the current to 0.120 A (approx. 100 lm) the expected lumen maintenance would be extended to L70B50 = 48,000 hours. This alone seems insufficient for achieving L70B50 = 50,000 hours. However, as the power consumed and therefore the heat generated by the panel is also reduced, the organic temperature decreases to about 35 °C. Selecting the appropriate curve for 35 °C organic temperature (light blue dashed) results in a L70B50 beyond 50,000 hours. So, the answer to the question is 'yes'.

Figure 12 (below) shows the dependency between organic temperature and ambient temperature at different currents. This is only an orientation; air movement, mounting options etc. have a significant impact on resulting organic temperature. The graph shows mean values of temperature measurements taken from Brite 3 FL300C nw panels in air in vertical orientation (not mounted on a surface), measured at spot B on the front. The device had warmed up to steady state before the temperature measurement was made.

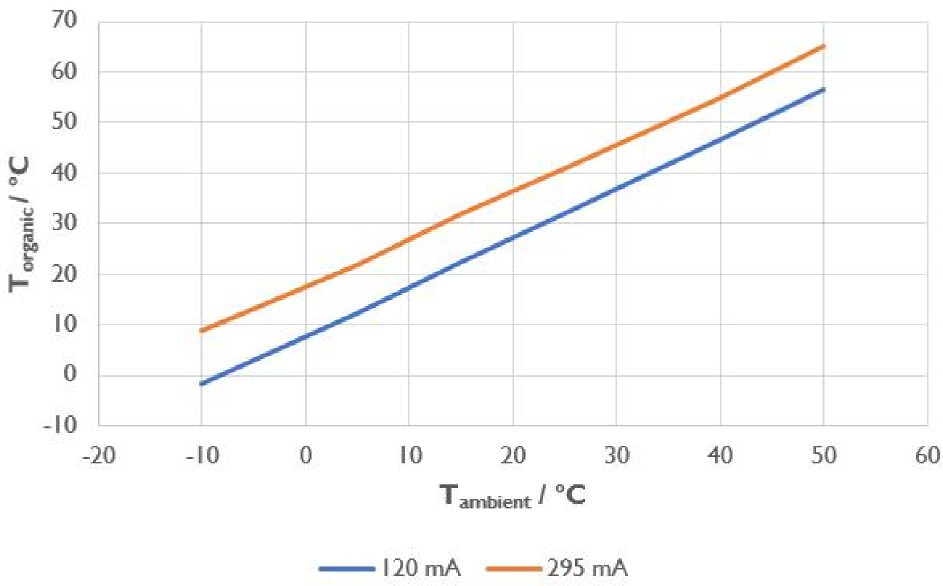


Figure 12 – Indicative relationship between $T_{organic}$ and $T_{ambient}$ at different driving currents (I= 120 mA, 295 mA) for FL300C, mounted vertically in air. Actual relationship strongly depends on thermal interface.

Device aging

During the lifetime of the OLED panel the voltage increases. Therefore, the power consumed and heat generated by the OLED panel increases in constant current driving mode.

Ensure that sufficient thermal management is designed into the luminaire to keep the device at required temperature levels, particularly when approaching the end of lifetime. Detailed data on voltage at end of life are given in the relevant datasheets.
As a rule of thumb an increase of ~3 °C in temperature for each additional Watt consumed by the OLED Panel Brite 3 FL300C mounted vertically and exposed directly to air can be expected.

Device orientation on temperature and homogeneity

Brite 3 FL300C primarily dissipates thermal energy by convection. As device orientation has an impact on convection it also influences the organic temperature distribution and therefore the homogeneity of light emission.

In general, all measures to improve heat dissipation by other means than convection (e.g. radiation and conduction) decrease the impact of device orientation on homogeneity and are therefore recommended in the luminaire design.

Mounting components

The Brite 3 FL300C main thermal interface is on the back. The provided integration levels simply spread heat and require additional measures to remove thermal energy.

This section briefly describes the impact that selected mounting components applied to the thermal interface of the Brite 3 FL300C may have. The data given are exemplary and to be considered as indicative. To ensure reliable operation the luminaire design itself needs to be assessed with respect to the resulting organic temperature at targeted currents and ambient conditions. See above on how to measure organic temperature.

Comparison of different exemplary counterparts

As a rule, if the mounting component is to function as a heat sink, optimizing the thermal contact between the thermal interface of the Brite 3 FL300C and the mounting unit is desirable. In this case mounting towards an element will generally improve performance as it cools the OLEDs or at least keeps it within a certain temperature range. Cooling efficiency is dependent on the quality of the thermal coupling between the panel and the mounting unit. Dedicated heat pads are recommended although from a purely thermal perspective thermal pastes could also be used. Before using pastes please refer to the section on mechanical integration (see page 15).

If mounting components are to function as thermal insulators, other design approaches may need to be considered to keep the OLED working reliably.

<u>Typical temperatures for some exemplary mounting materials</u>

This section provides some indicative measurements for an OLED panel mounted on different materials. Measurements have been executed at room temperature ($T_{ambient}$ = RT ~ 25 °C); the organic temperatures are shown below in Figure 13. Wood and aluminum plates have been chosen as typical mounting material that may be used in luminaire design[5]. Data is given for two different driving modes: one for a nominal current of 295 mA (corresponding to a luminous flux of 300 lm for ww and 250lm for nw), and one for 120 mA (corresponding to a luminous flux of 120 lm for ww and 100 lm for nw). Measurement accuracy is about ±1 °C.

[5] wood: thickness = 16 mm, type = plywood, lateral dimensions = 40 x 40 cm^2
aluminum metal : thickness = 1.5 mm, lateral dimensions = 40 x 40 cm^2

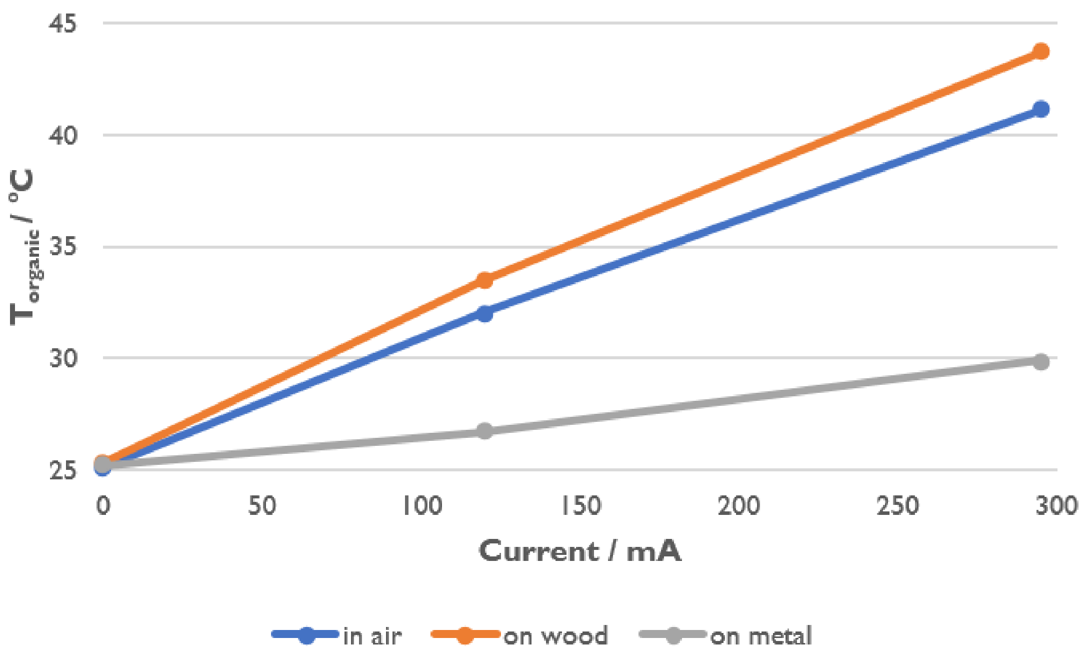


Figure 13 – FL300C nw indicative organic temperature vs. current for different mounting materials. 295mA corresponds to a luminous flux of 250 lm (300 lm for ww) and 120 mA corresponds to 100 lm (120 lm for ww)

Wood as mounting material suppresses heat dissipation by radiation and convection on the back side of the OLED device, resulting in higher temperatures than when directly exposed to air. This tendency is of varying importance depending on driving conditions (e.g. amount of generated heat).

Generally, mounting on a metal unit is always best as it conducts heat efficiently resulting in the lowest possible temperatures.

Please note that the choice of mounting material and the resulting temperatures have a significant impact on lifetime. Figure 10 and Figure 11 show the impact for FL300C ww and FL300C nw, respectively.

Notes on thermally active mounting element

So far, the examples given have based on passive mounting units. However, if an active element were mounted directly onto the thermal interface area of the Brite 3 FL300C, the temperature generated by this component would also need to be considered. An active component, for example a driver, not only limits heat dissipation but also adds thermal energy.

Due to the additional temperature, direct contact between thermally active components and an OLED panel is not advisable. Alternatively, organic temperature needs to be reduced by other means (see above).

Also note that Brite 3 FL300C panels mounted back-to-back also constitute active components adding to overall heat.

Impact of temperature on electrical properties

The electrical properties of OLEDs change with temperature.

This section describes the general impact of ambient temperature on OLED voltage for a given current. For accurate data on the specific OLED panel in use please refer to the product datasheet.

OLED resistivity is reduced with increasing organic temperature. This has two consequences on the voltage in constant current driving mode.

- First, at a given ambient temperature the voltage required to start up the OLED is higher than in a steady state. The voltage drops after turning on the device due to the heat caused by operation. When driving the Brite 3 FL300C at a rated current and room temperature the drop in voltage is typically around 1 V after the first 10 minutes of operation.
- Second, and in addition to this, the ambient temperature has the same impact on the OLED driving voltage but also leads to differences in the steady state after being turned on.

Figure 14 shows this dependency for the FL300C nw. While variation in ambient temperature leads to a shift in the overall voltage curve, it decreases towards a steady state within the first 5 minutes after the device being turned on.
Please note that with lower temperatures the difference in voltage from being turned on to achieving a steady state increases. If turning on at low temperatures is required, this needs to be considered in the choice of the driver.

This voltage increase adds to the overall voltage increase as the panel ages and may prevent a driver starting up an OLED even though there would be enough power in a steady state.

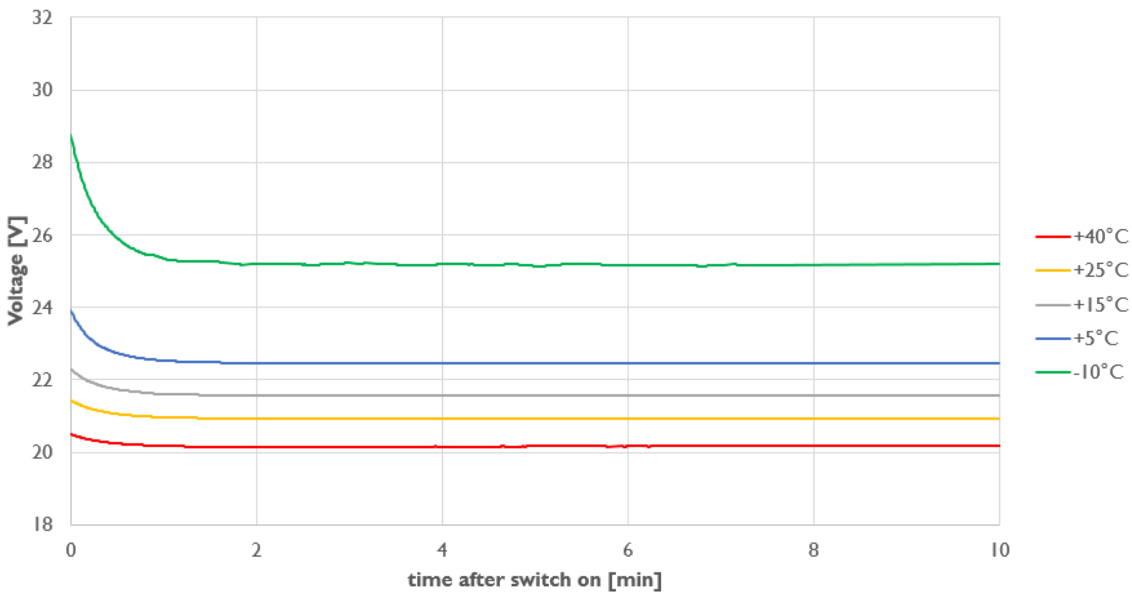


Figure 14 – Decrease of the driving voltage after switch-on of a FL300C nw at constant current (I = 295 mA) for different ambient temperatures

Optical performance changes (color points and luminous flux) during the warm-up phase are negligible.

Additional information

Tc

In contrast to driver electronics there is no Tc mark on the Brite 3 FL300C as the entire panel must fulfill the temperature requirements (see datasheet). Inhomogeneity may cause problems (see above). Temperatures should be measured at point B of the panel (see Figure 9).

Moisture / humidity

Be aware that relative humidity may increase if temperature changes to lower values. Recommended usage of the Brite 3 FL300C does not account for dew, moisture, water in direct contact with the device as this alters the extent of lifetime (see datasheet for use cases). If the application is exposed to rapidly changing temperatures and high relative humidity levels please take appropriate precautions.

Logistics data

OLED Panel Brite 3 FL300C family

These products are tuned for maximum performance and functional lighting applications.

Specification item	Value
Product name	OLED Panel Brite 3 FL300C ww Level 1
Order code	LPC1300R1WWL101
Pieces per box	2

Specification item	Value
Product name	OLED Panel Brite 3 FL300C ww Level 1.5 (FFC)
Order code	LPC1300R1WWL105
Pieces per box	2

Specification item	Value
Product name	OLED Panel Brite 3 FL300C nw Level 1
Order code	LPC1300R1NWL101
Pieces per box	2

Specification item	Value
Product name	OLED Panel Brite 3 FL300C nw Level 1.5 (FFC)
Order code	LPC1300R1NWL105
Pieces per box	2

Lumiblade OLED Drivers

Mains driver, 8 output channels, TouchDim/DALI and analog control

Specification item	Value
Product name	Driver D230V 80W/0.1-0.5/1A/28V TD/A 8CH
Order code	872790037921130
Logistics code 12nc	925400010201
EAN3	8727900379228
Pieces per box	10

Single channel low voltage drivers

Specification item	Value
Product name	Driver D024V 10W/0.1A-0.4A/28V D/A
Order code	872790037919840
Logistics code 12nc	925400010101
EAN3	8727900379204
Pieces per box	20

Specification item	Value
Product name	Driver D024V 10W/0.1A-0.4A/28V DMX
Order code	872790037977836
Logistics code 12nc	925400012002
EAN3	8727900379860
Pieces per box	16

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