AN61 - Bridgelux OLM Series Design Guide

Design, Assembly and Handling Considerations for the OLM Series

Introduction

The deep integration offered by the Bridgelux OLM™ Series is driving transformation at every level of the lighting industry. The OLM subsystem introduces a simple method to develop outdoor luminaires by combining proprietary optics and environmental protection with an LED source. These highly innovative and integrated subsystems deliver world class performance and competitive cost, while reducing time to market, eliminating significant research and development costs, and improving manufacturing lead times.

Optimizing the performance and reliability of a lighting system using the Bridgelux OLM Series requires careful consideration of thermal management solutions, electronic drivers and other design aspects. It is equally important to use appropriate safe handling and manufacturing procedures, processes, and chemicals during the assembly of the Bridgelux OLM Series into the lighting system.

This design guide provides recommendations for proper mechanical and electrical installation of OLM subsystems into lighting systems. Guidelines for chemical exposure and handling of the products are included to avoid damaging the subsystems during the assembly process. Recommended assembly procedures to ensure a reliable electrical connection to the LED driver and a mechanically robust, thermally efficient contact between the subsystems and underlying heat sink are also provided.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Mechanical Assembly and Installation: OLM subsystems provide built-in environmental protection features for the LED arrays. The products have been manufactured to further protect from flames and impact. Proper mechanical management of the products is critical to ensure these characteristics remain unaffected in the assembly and installation processes. Recommended assembly procedures ensure a reliable electrical connection from the product to the LED driver and a mechanically robust, thermally efficient contact between the subsystem and the heat sink.

Thermal Management: Several performance characteristics of the OLM subsystems, including optical flux, forward voltage, color temperature and reliability are dependent upon the operating temperature of the OLM subsystems. This document provides guidelines for selecting a suitable heat sink to ensure effective heat transfer from the product to the ambient environment.

Electrical Management: OLM subsystems require a constant current DC input. The selection of a suitable electronic driver is dependent upon the desired current level, input and output voltage requirements and any dimming capability. Driver selection considerations are discussed including UL classification, regulatory issues and driver efficiency. A list of commercially available drivers is available for a range of drive current options. Guidelines are also documented for electrically connecting the driver to the socket. Contact your local Bridgelux Sales representative to obtain further details.

Optical Management: OLM subsystems are available with a variety of optics which create precise beam patterns for a variety of lighting applications. Optical characterization data are provided to enable lighting designers to select the appropriate product options to meet design requirements.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Table of Contents

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Replacing the high pressure sodium bulb

An LED streetlight using an OLM subsystem is expected to cost 10 to 20 percent less than a competitive LED streetlight, and once installed will see a payback in as soon as nine months when replacing a high-pressure sodium luminaire. The OLM Series enables low cost manufacturing through pre-packaged component integration. Environmental protection features simplify luminaire designs and reduce the overall cost, while the latest in thermal resistance and compact design allow cost advantages that extend to heat sink design. Precise optical patterns enable installations in multiple markets worldwide, empowering OEMs to compete at the highest level while saving time and money on research and development.

Product Description:

- Typical efficacy of 90 lm/W to 118 lm/W
- Typical lumen output ranges from 2100 to 4500 lumens
- Broad range of CCT options from 4000K to 5600K
- CRI options include minimum 70 and 80
- Reliable operation for outdoor use
- Asymmetric and symmetric lighting patterns
- IP66 rated protection from water and dust

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Table 1: Product Selection Guide

Part Number	Nominal CCT (K)	CRI	Drive Current(mA)	Typical Pulsed Flux[1] Tc = 25ºC (lm)	Typical Flux[2,3,4] Tc = 70ºC (lm)	Typical V_f[5] (V)	Typical Power (W)	Typical Pulsed Efficacy Tc = 25ºC (lm/W)	Typical Efficacy Tc = 70ºC (lm/W)
OLMA-50C000-xxxx-xx000	5000	70	350	2,438	2,144	53	18.6	131.1	115
			500	3,335	2,932	55.3	27.6	120.8	106
			700	4,429	3,894	58	40.6	109.1	96
OLMA-40E000-xxxx-xx000	4000	80	350	2,284	2,022	53	18.6	122.8	109
			500	3,123	2,765	55.3	27.6	113.2	100
			700	4,139	3,665	58	40.6	102.0	90
OLMA-40C000-xxxx-xx000	4000	70	350	2,389	2,115	53	18.6	128.4	114
			500	3,266	2,892	55.3	27.6	118.3	105
			700	4,329	3,833	58	40.6	106.6	94
OLMA-56C000-xxxx-xx000	5600	70	350	2,498	2,196	53	18.6	134.3	118
			500	3,417	3,005	55.3	27.6	123.8	109
			700	4,535	3,987	58	40.6	111.7	98

Notes for Table 1:

1. Subsystems are tested in pulsed conditions at the 350mA drive current, Tc = 25°C. Pulse width is 10 ms.
2. Typical performance when driven under DC (direct current) at test current with case temperature maintained at 70°C, mounted to heat sink with thermal interface material. Based on Bridgelux test setup, values may vary depending on the thermal design of the luminaire and/or the exposed environment to which the product is subjected.
3. Bridgelux maintains a ± 10% tolerance on flux values.
4. Typical stabilized DC performance values are provided as reference only and are not a guarantee of performance.
5. Bridgelux maintains a tester tolerance of ± 0.20 V on forward voltage measurements.

Table 2: Electrical Characteristics and Driver Selection Voltages

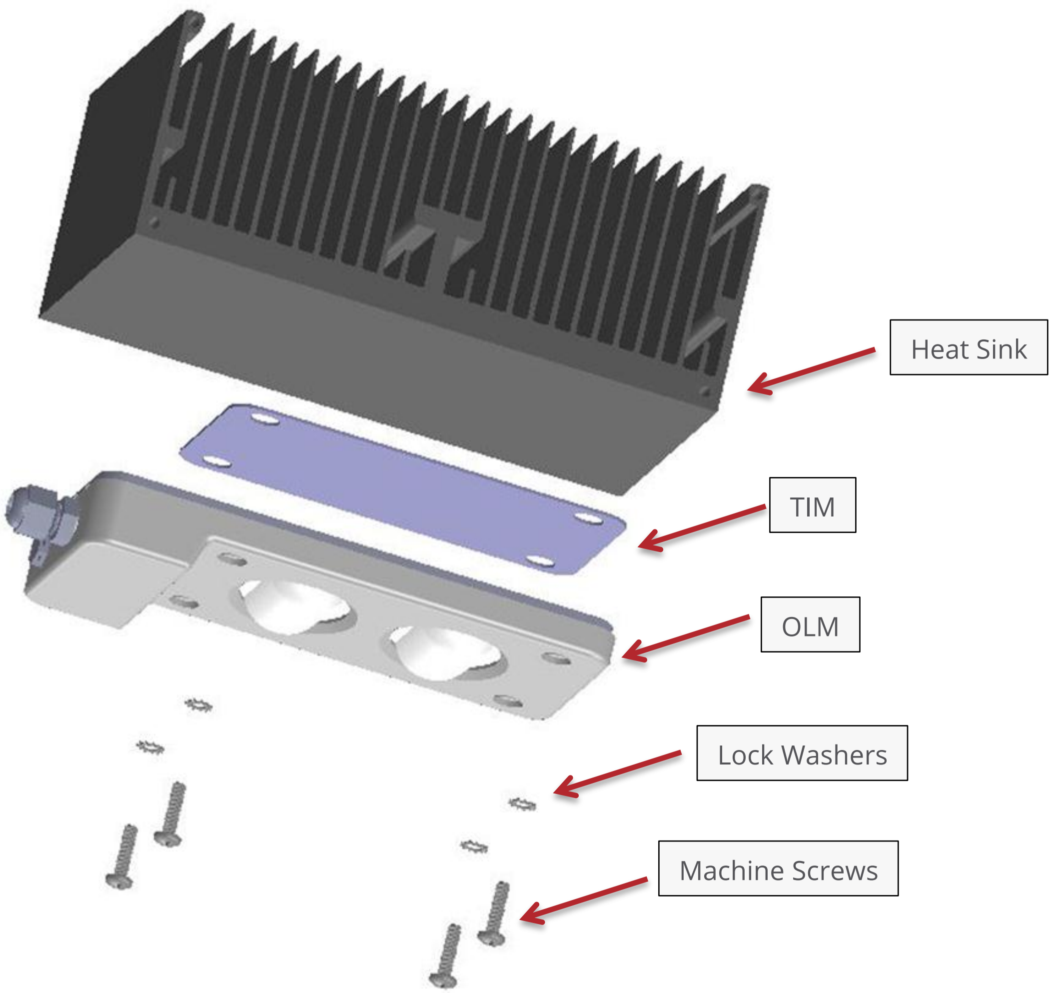
Drive Current (mA)	Forward Voltage Pulsed, T_c = 25°C (V)			Typical Coefficient of Forward Voltage $\Delta V_f / \Delta T_c$ (mV/°C)	Typical Thermal Resistance Array case to Module case, R_{OLM}, (C/W)
	Minimum	Typical	Maximum		
350	49	53	57	-28	0.41
700	53	58	62.4	-28	0.47

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Incorporating OLM Subsystems in Luminaires: A System Overview

OLM subsystems can be easily incorporated into a luminaire that includes the following components: heatsink, thermal interface material, mounting screws, constant current driver, and enclosure when required to meet local regulatory compliance requirements. An example of how this system might be put together is shown in figure below.

Figure 1: Typical Mechanical Assembly to Heat Sink



© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Mechanical Assembly and Installation

Handling

Subsystems are engineered to be extremely robust, but the products should still be handled with care. Products should be held from the sides or from the white housing material, and should not be held from the wires or the lens area. Touching the lens area of the OLM product could result in damage or degradation in the radiation pattern and light output.

The product trays come with notched areas that surround the subsystems to accommodate fingers for grabbing the subsystems properly on the sides. To manually handle the subsystems simply lift from the tray by gripping the edges. Figure 2 illustrates a suitable method of removing a OLM subsystem from the shipping tray

Figure 2: OLM Series packaging and basic handling

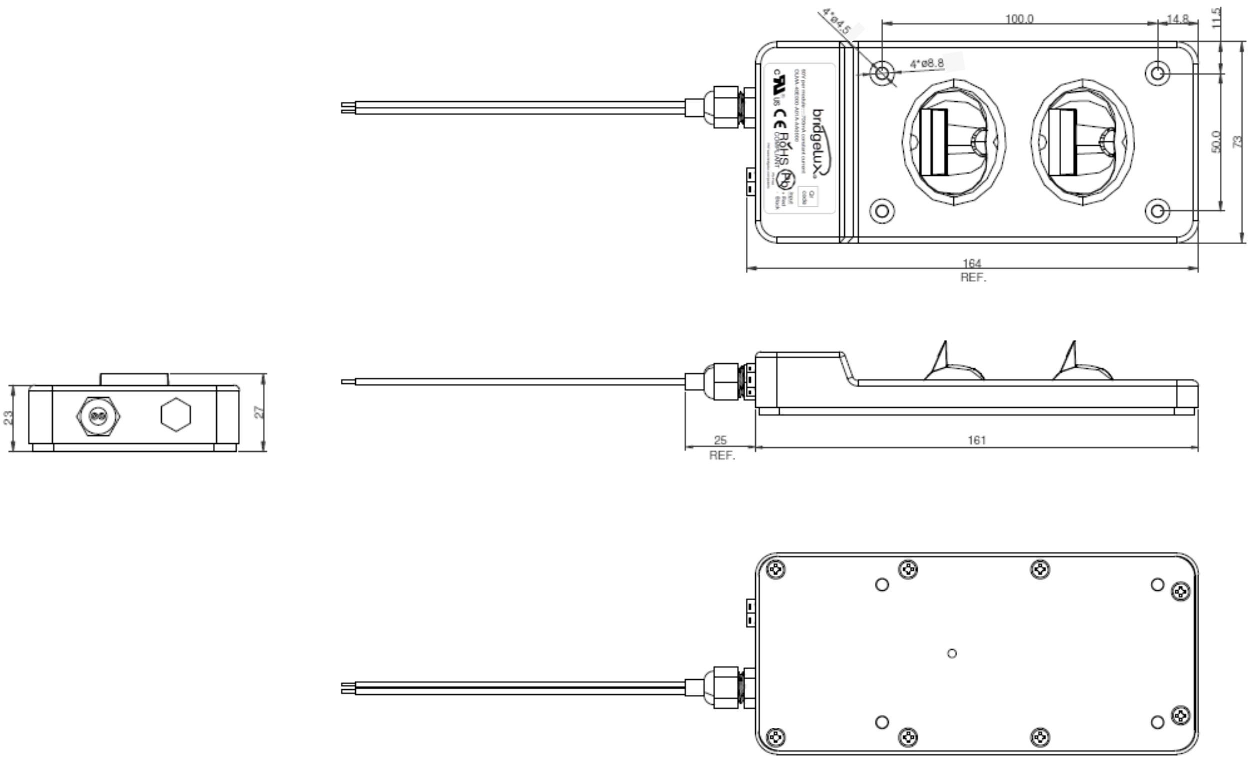
The OLM Series has passed ESD testing to levels which do not require special handling for most assembly processes. However, to prevent inadvertent damage, Bridgelux recommends using appropriate ESD grounding procedures while handling the OLM Series.

Chemical compatibility for the OLM Series is discussed in Appendix B.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Attaching an OLM subsystem to a Heat Sink

Figure 3: Mechanical Drawings



Notes for Mechanical Drawings

1. Mounting holes (4X) accommodate M4 or #8 screws.
2. Screws with flat shoulders (pan, dome, button, round, truss, mushroom) provide optimal torque control. Do NOT use flat, countersink, or raised head screws.
3. Drawing dimensions are in millimeters.
4. Dimensions with 0 decimals have +/- 1mm tolerance.
5. Dimensions with 1 decimal have +/- 0.3 mm tolerance
6. Dimensions with 2 decimals have +/-0.1 mm tolerance

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

OLM subsystems feature holes to facilitate mounting the subsystems using screws. Figure 3 shows the OLM form factor and identifies the hole locations for mounting to a heat sink or lighting fixture. There are four mounting screw locations. It is recommended that all locations are used for mounting to ensure mechanical and thermal contact with a lighting fixture and/or heat sink. The holes are sized to fit a wide variety of standard machine screws or thread forming screws. Refer to the mechanical drawings included in the Bridgelux OLM Series Product Data Sheet and 3D CAD files for additional information regarding screw hole size and position with tolerances.

Screw Torque

It is critical to ensure proper torque is applied to the fasteners when mounting an OLM subsystem to a heat sink. If too little torque is applied, the thermal path between the product and the heat sink will be compromised while excessive torque may result in damage to the OLM subsystem. Many variables affect the actual torque required to seat the screw such as thread friction, materials of the heat sink and screw, screw head friction, etc. For example, a machine screw with typical thread friction can be seated with 8 lbf-in of torque, which the subsystems were designed to handle, but it may take much higher torque to seat a thread forming screw. Table 3 below defines the suggested torque value based on the screw size shown and typical friction factors for machine screws in a pre-tapped hole. It is the responsibility of the customer to test and ensure the correct torque values are specified and used during the assembly process.

Flat Washers, Lock Washers, Self-Locking Fasteners, and Thread Sealants

To prevent the screws from loosening during normal use, especially in high vibration applications such as bridges or overpasses, washers should be used that will help prevent the screw from backing out. Typical washers that can be used to preload the joint are toothed, split ring, and Belleville (conical). Additionally, thread-locking compounds are effective at preventing a fastener from backing out. Thread-locking compounds can be used, but should be approved by the supplier for use in LED applications as some thread-locking compounds can outgas and cause damage to the LED (see Appendix B).

Table 3: OLM Series Mounting Specifications

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Product	Nominal Diameter (mm)	Suggested Screw Size	Suggested Torque(N-cm (lbf-in))
OLM Subsystem	4.5	M4 x 0.70	90 (8)

Management of the Electrical Cable

The Bridgelux OLM Series has a two-wire harness designed for direct power for the LED. The RED wire is for the positive input power from a constant current driver. The BLACK wire is the return. Connection of the driver to the wire harness should be in compliance with standard electrical connection practices for the application of the luminaire. Wire nuts, connectors, terminal blocks and soldering are all common connections methods.

Thermal Management

Effective thermal management is critical to achieve optimum performance and reliability of an OLM subsystems. As shown in various figures and tables in the Data sheet, several performance characteristics including optical flux, forward voltage and color temperature are dependent upon the operating temperature of the subsystem. This design guide provides recommendations for selecting a suitable thermal management solution and provides guidance for accurately measuring the temperature of the OLM subsystem under operating conditions.

Considerations for Heat Sink Design or Selection

There are many commercially available components, including heat sinks and heat pipes, which may be used with an OLM subsystems. The most commonly used components are heat sinks, typically made of aluminum or copper.

Heat sinks conduct heat from a heat source and then distribute the heat to the ambient environment. The required size of the heat sink depends on many variables, including application specific temperature requirements such as maximum ambient and case temperature limitations, the material composition of the heat sink, surface characteristics of the heat sink, and physical constraints for the application.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Considerations for heat sink selection:

- Use heat sinks with the largest surface area that is physically and economically feasible. As a general rule of thumb, for a well-ventilated aluminum heat sink, there should be 10 square inches of heat sink surface area for every 1W of energy dissipated. This area may be provided as a flat plate or via a finned extruded heat sink to maximize total surface area per unit volume and reduce the overall volume of the thermal management solution.
- The exact requirement for heat sink surface area must be determined and validated by the luminaire designer and will depend on many design variables, including fin orientation and cold and hot air flow paths.
- Direct the heat sink fins in a manner allowing hot air to flow upward and away from the heat sink and allowing cold air to flow onto the surfaces of the heat sink.
- Avoid any obstructions in the airflow paths surrounding the heat sink and the luminaire
- If possible, use natural convection to transfer heat from the heat sink to the ambient.
- If natural convection is insufficient, then consider using fans, heat pumps, or liquid cooling elements that can dramatically increase the convection heat transfer coefficient and hence dramatically increase heat transfer. Active heat sinks can also significantly reduce the heat sink footprint.
- Use heat sinks with surfaces that have rough surface finish for areas of air contact.
- For the area on the heat sink where it is in contact with the OLM, surfaces should be specified to maintain a flatness tolerance of 0.1mm and a surface roughness tolerance of RMS √16 or smoother.

For further information regarding heat sink design, please reference Bridgelux Application Note AN30 and contact a Bridgelux Sales representative for a list of heat sink manufacturers and examples.

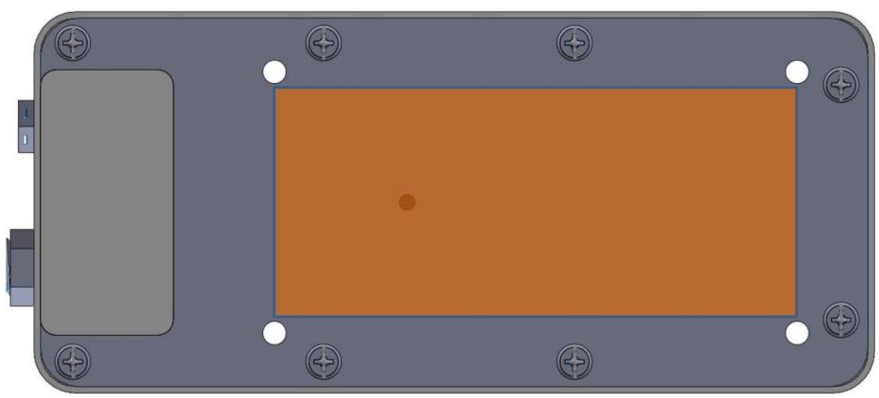
© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Thermal Interface Materials

An OLM subsystems must be carefully attached to a heat sink with screws and using a thermal interface material to ensure full thermal contact with the underlying heat sink. Attachment of the product to a heat sink is fully described in the "Mechanical Assembly and Installation" section of this design guide.

An OLM subsystem must be installed with a thermal interface material. A thermal grease, thermal pad or phase change material can be used, but must cover the heat transfer area of the subsystem. See Figure 4 below that shows the primary heat transfer area for the OLM subsystem. Covering the full area of the OLM is acceptable since the entire bottom surface of the OLM is an aluminum alloy and will conduct heat from the OLM subsystem to the heat sink surface.

Figure 4: Primary heat transfer area of OLM shown in orange



© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Measurement of Case Temperature (T_c)

After a luminaire has been designed it is critical to experimentally validate the effectiveness of the thermal management solution. Typically this is achieved through building a prototype, simulating worst-case use conditions, and measuring T_c. When simulating worst-case use conditions ensure the following:

- Convection conditions are realistic depending on actual assumed use conditions.
- Material properties and dimensions, including wall thicknesses, surface areas, and component sizes are representative of the design.
- Surface properties, including color and roughness properties, are representative of the design.
- Additional heat sources that may impact the thermal performance are included, such as a power supply that is placed inside a luminaire enclosure or imbedded into the heat sink.

Once the representative prototype is built, and realistic use conditions are simulated, T_c may be measured to validate the design.

Special care is required when measuring the case temperature to maximize measurement accuracy. To minimize measurement errors, the following approach is recommended for attaching the thermocouple to the temperature measurement area of the OLM subsystem:

- Use a 36 gauge or smaller diameter thermocouple.
- Ensure the thermocouple is properly calibrated.
- Attach the thermocouple bead, or junction, to the T_c measurement area shown in figure. To do this, place the thermocouple bead (use the thinnest possible type of thermocouple, e.g. 36 gauge or smaller if available) on the prescribed temperature measurement area. Temporarily secure the thermocouple wire using Kapton tape.
- Bend the end of the thermocouple to create a "spring effect" which will keep the thermocouple bead in contact with the base plate or alternatively, use the back of a thin diameter wood stick, such as a tooth pick or the wooden end of a cotton swab, press on the thermocouple bead to ensure contact with the aluminum base plate.
- Apply a small amount of a fast curing, low viscosity, and thermally conductive adhesive around the base of the thermocouple bead. Allow the adhesive to cure. Remove as much of the wooden stick as possible.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

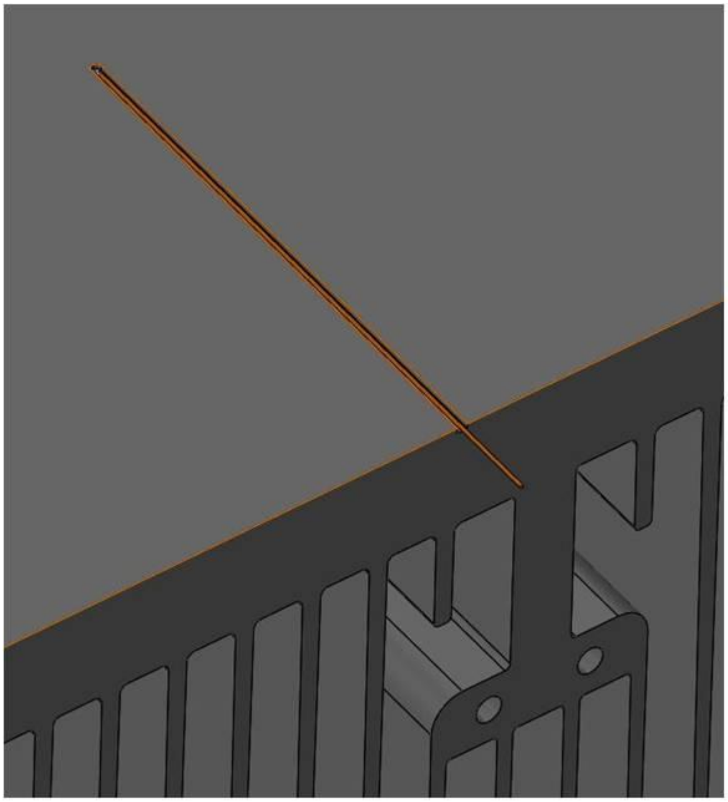
- It is critical that the entire thermocouple bead is secured tightly against the base plate. There should be no air gaps between the thermocouple tip and the plate.
- The thermocouple wire will need to be able to be routed out from between the bottom of the OLM product and the heat sink. It is not advised to sandwich the thermocouple wire between the OLM product and the heatsink as this will cause an air gap between the OLM product and heat sink. Two options that can be used are either to create a channel in the heat sink that the thermocouple wire can be routed or drill a hole through the heatsink base and route the thermocouple wire out of the hole. See figure for illustration purposes.

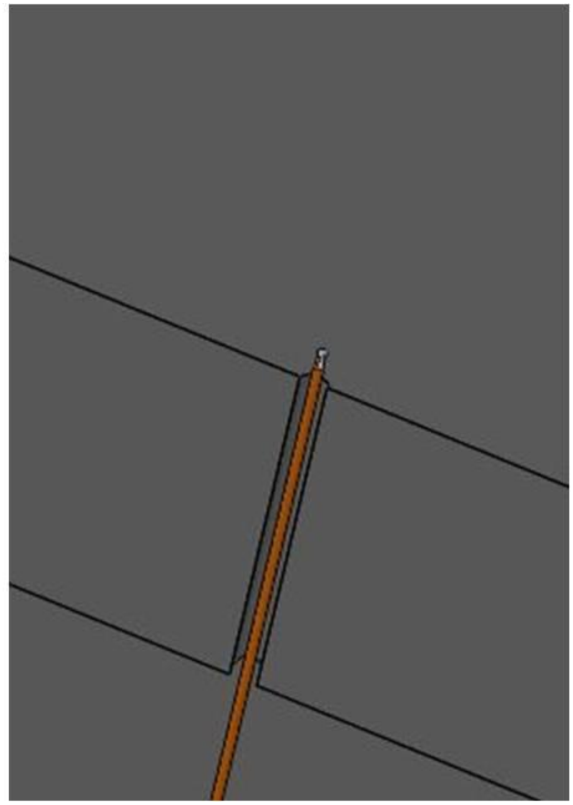
After applying power to the product, T_c will increase with time as the assembly heats up. Eventually the lighting assembly will reach a steady state temperature. The time required to reach a steady state temperature depends on the thermal time constant of the assembly, but is likely to be in the range of 45 minutes or more, depending on the physical size of the heat sink and luminaire. Maintain the OLM product T_c at or below the maximum case temperature listed in the maximum product ratings table in the OLM Series Data Sheet for functionality and reliability.

Figure 5: Tc Measurement Point

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Figure 6: Thermocouple Routing Options for Measuring Tc – Groove or Hole through Heatsink





Typical Light Output Characteristics vs. Temperature

Please refer to the charts and tables in the OLM Series Data Sheet to understand how performance varies with temperature. Of particular interest are the charts and tables that show how flux, color, and forward voltage, vary with temperature.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Electrical Management

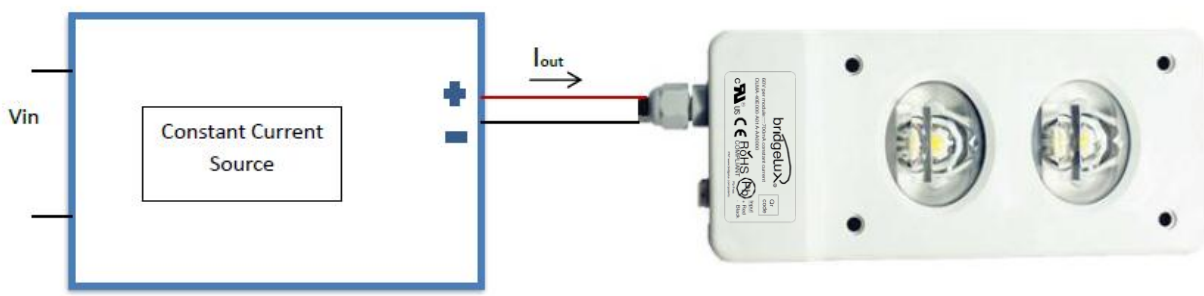
The selection of a suitable electronic driver is critical to achieve optimal performance from an OLM subsystem. Proper driver design allows for interchangeability of products with varying beam angles, intensity and color in the luminaire without changing the driver.

General Driver Recommendations

LED drivers convert available input power into the required output current and voltage, and are analogous to ballasts used with fluorescent and other conventional light sources. Figure 7 illustrates a constant current source driven by a mains power supply. When selecting a driver for use with an OLM product, follow basic guidelines:

- Drive the OLM subsystem using constant current sources, not constant voltage sources.
- Do not apply a reverse voltage to the OLM subsystem.

Figure 7: Illustration of a driver accommodating a mains input voltage requirement



Dimming

The OLM Series is compatible with dimming drivers. Dimming can be used to control the lighting environment by reducing light output, simultaneously reducing energy consumption and operating costs.

When dimming an OLM subsystem, we recommend the designer choose the appropriate kind of dimming technology depending on the actual application requirements. Some of these dimming technologies include PWM method, 0-10V method, and TRIAC method, which is common in residential settings. The first two of these methods are described in further detail below.

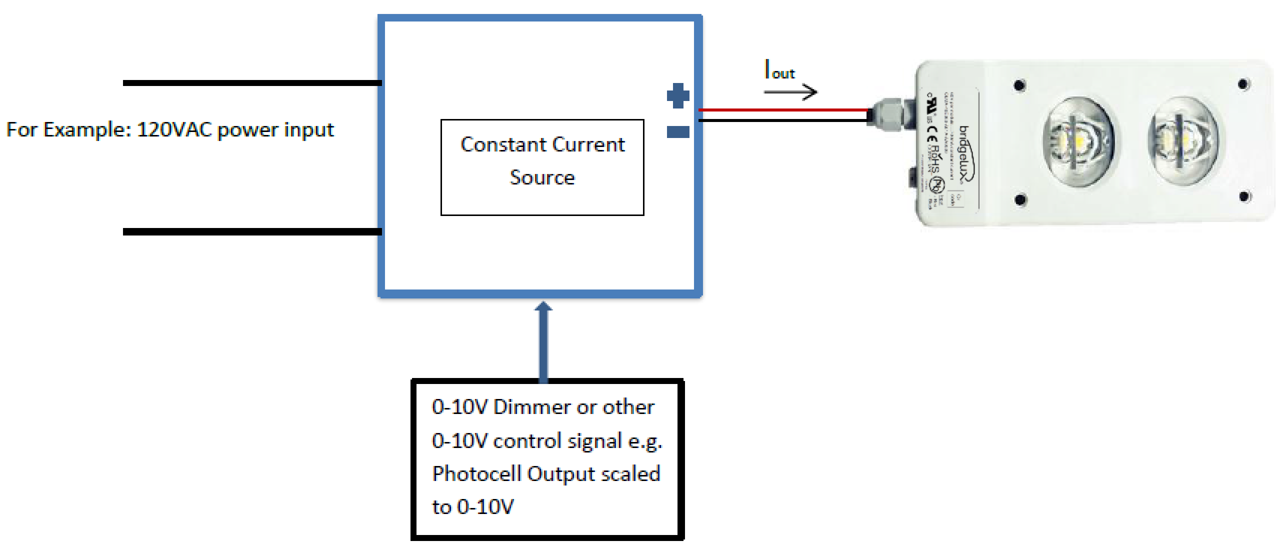
© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

OLM subsystems can be dimmed using pulse width modulation (PWM) method, which provides a pulsed current to the light source with a varying frequency; or controlled constant current level type of dimming technology.

The use of PWM dimming ensures luminaire to luminaire consistency over a wide range of output levels. Sometimes, as a result of the switching nature of the PWM dimming technology, stroboscopic effects may occur; therefore this type of dimming technology may not be safe to use in certain application environments.

Another common dimmer is the 0 to 10V control dimmer, shown in Figure 8. In addition to the mains input, these drivers require an analog control voltage in the range 0V to 10V. This voltage signal controls the constant current output to the light source either by managing the pulse width in a PWM driver or more commonly by regulating the magnitude of the DC current. Dimmers which are 0V to 10V are generally considered to be more cumbersome to implement compared to TRIAC dimmers in residential applications due to the additional wiring requirements; however they are used frequently in new industrial and commercial applications as they can deliver a higher efficiency solution.

Figure 8: Illustration of an LED driver with 0 to 10 V dimming



© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Driver Selection

A driver should be selected to enable operation over the entire voltage range of the OLM subsystem. The typical voltage for each OLM subsystem is included in the performance tables in the OLM Series Data Sheet. Note that the voltage range of the driver should be selected to allow sufficient guard band for a ±15% tolerance on the typical voltages shown in the OLM Series Data Sheet. Additional guard band will be required if the product is operated at a case temperature other than the temperature values listed.

Graphs showing the relationship between current, optical flux and forward voltage can be found in the OLM data sheet and in Appendix A of this document.

It is the responsibility of the designer to ensure that the selected LED driver meets all local regulatory requirements. We also recommend consideration of the following specifications when selecting or designing an LED driver.

- Power Factor – Power factors greater than 0.9 are recommended.
- Efficiency – Design or select drivers that are highly efficient over the range of loads expected in the lighting system.
- Reliability – The expected life of the LED driver should match that of the lighting system.
- Safety – Ensure compliance to all regulatory and approbation requirements.
- Feedback Features – Some applications may benefit, or require, LED drivers that include active feedback.
- Ripple – Ripple is the small and unwanted residual periodic variation of the direct current output of an AC to DC LED driver. Ripple values that are less than ± 10% are recommended.
- Noise – Specify an LED driver with low noise to avoid interference and/or violation of regulated standards.
- Dimming – Carefully consider the type of dimming technology used per application.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

UL Class 2 and CIE/LPS Drivers

The OLM Series may be driven with both Class 2 and non-Class 2 UL designated drivers. Please consult with UL when determining the best method or design to meet UL regulatory requirements. Requirements can vary considerably based on final use conditions. Additionally, please refer to UL specifications for current definitions and detailed information on drivers.

For **dry indoor applications** Class 2 drivers have the following characteristics:

- They are isolated from the input supply with double insulation
- The output voltage is less than 60V DC or less than 30V AC rms in the US
- The output voltage is less than 42V DC or less than 30V AC rms in Canada (therefore the drivers suitable to be used to drive OLM products may be non-Class 2 by in Canada)
- They provide limited output power, which is dependent on the output voltage:
  - 0-20V, output current is limited to 5A max and output power rating must be less than 5 x V_{outmax}
  - 20-30V, output current is limited to 100/V_{outmax} Amp and output power rating must be less than 100VA
  - 30-60V, output current is limited to 100/V_{outmax} Amp and output power rating must be less than 100VA

When placed in wet environments, Class 2 driver requirements change considerably. For example, the allowable voltage and power is reduced by half of that which is allowed in dry indoor environments. Therefore, for wet outdoor applications, a luminaire using OLM products will require use of non-Class 2 drivers, mostly likely resulting in the need of an enclosure. Please consult with UL to determine specific application requirements.

Please refer to UL specifications for definitions and detailed information on drivers.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

CE and Other Regulatory Compliance Agency Requirements

Regulatory compliance requirements vary dramatically from country to country and from region to region. In countries where CIE specifications apply, LPS (Limited Power Supply) drivers are recommended. Note that SELV (Safe Extra Low voltage) drivers may or may not be Class 2. Also, please do not confuse UL Class 2 with UL Class II. UL Class II only refers to the level of isolation.

Commercially Available Drivers

Designers have options when it comes to selecting commercially available LED drivers. Many manufacturers produce drivers which work well with OLM subsystems to enable rapid system design. Please contact your Bridgelux sales representative for a list of drivers whose output voltage, power, and output matches the needs of the OLM products. Check with the supplier of the LED driver for the latest information in specifications and availability. Any LED driver that is selected must be thoroughly evaluated by the customer to ensure that all application specific requirements are met.

Optical Management

Beam Intensity Over Angle

OLM subsystems are uniquely designed to produce a variety of precision controlled beam patterns well suited for many outdoor and industrial lighting applications. This broad range of optical performance options allows the designer to maximize the effective performance of the light source based on application specific requirements. Table 6 shows the characterization of each optic as defined by IESNA RP-8, EN 13201 and NEMA. Refer to Figures 9 and 10 for photometric performance of the A01A and A06A products.

Table 6: Optical Pattern Descriptions

Optical Code	Description	IES Classification	NEMA Classification	EN 13-201 Guidance
A01A – Released	Asymmetric; Narrow, Short/Med Width	Type II, Short/Med	7H x 7V	ME2 – ME4
A02A – Coming Soon	Asymmetric; Narrow, Medium Width	Type III, Med	7H x 6V	ME1 – ME3
A03A – Coming Soon	Asymmetric; Medium, Medium Width	Type IV, Med	7H x 7V	ME3 – ME4; CE
A04A – Coming Soon	Asymmetric; Medium, Medium Width	Type III, Med	7H x 7V	ME3 – ME4; CE
A06A – Released	Asymmetric; Medium, Medium Width	Type III, Med	7H x 7V	ME2 – ME4

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Figure 9: Photometric Performance (Optical Code: A01A)

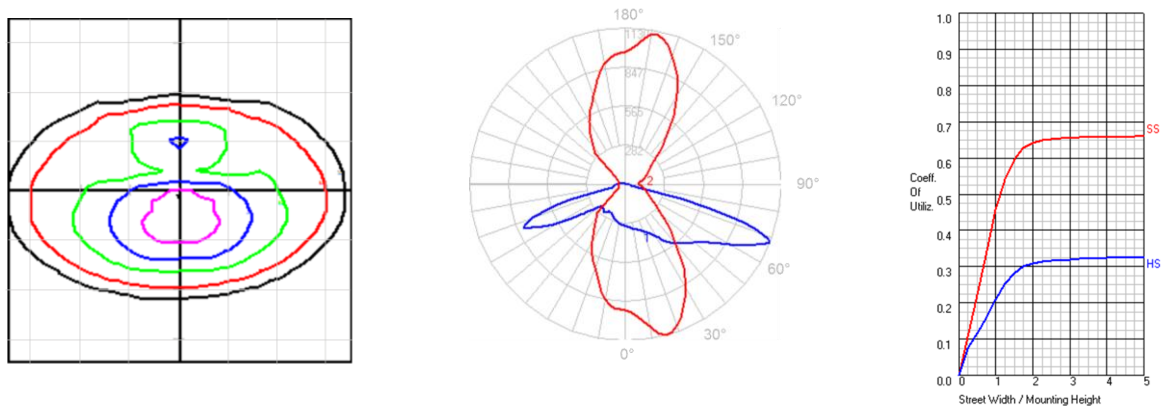
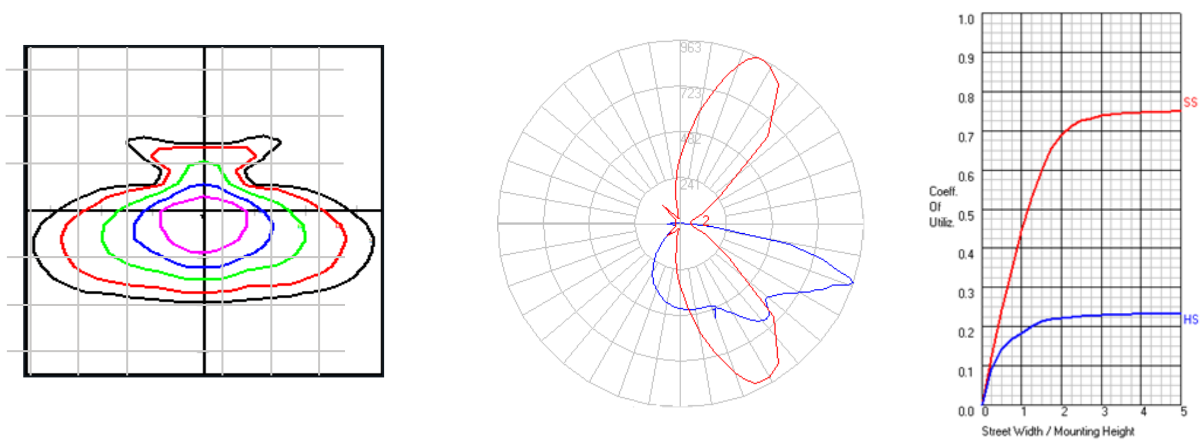


Figure 10: Photometric Performance (Optical Code: A06A)



© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Secondary Enclosures – Guidance

Secondary enclosures might be required to meet regional regulatory compliance requirements that are unique to the application. The function of the enclosure can vary by region and may include:

- Protection against impact.
- Protection against damage from sun exposure.
- Protection from sparks or fire that originate from current carrying elements located within the enclosure.
- Protection from ingress of water and/or dust.
- Protection from risk of shock.

It is very important that the design requirements of the enclosure be understood before enclosure materials and design, including the design of assembly components, are finalized.

Some materials that may be considered for secondary enclosures are appropriately rated optically clear silicone, polycarbonate, and glass. The index of refraction of the enclosure material and physical dimension, shape, and wall thicknesses, are all critical components to a good enclosure design, as these will impact the optical performance of the system and determine if other design requirements can be met.

When designing an enclosure, please also consider the following:

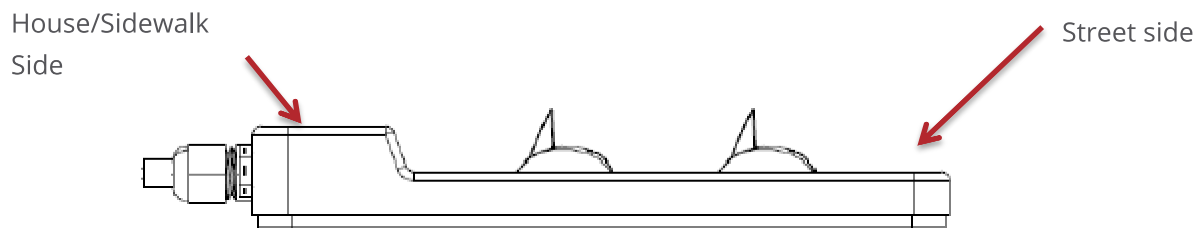
- Rays of light that strike the enclosure at a 90 degree angle, at an angle that is perpendicular to the lens surface, are the most transmitted and result in minimal losses due to the internal reflection.
- Rays of light that strike at angles greater than the critical angle get internally reflected.

The shape of the secondary enclosure will change both the light output and pattern or directionality of the light. The amount and impact of the change in light output and pattern is a function of the enclosure design. Placing an OLM subsystem deep inside a box that has dark interior side walls and a clear cover may result in greater optical losses and changes to the optical pattern as compared to enclosing an OLM subsystem using a domed shaped cover.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

OLM Orientation

Figure 11: OLM subsystem orientation



Optical Files

Additional design resources are under development to assist in successful optical designs. Please contact your local sales representative for the latest information regarding the availability of IES or LDT files.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Appendix A: Product Performance at Alternative Drive Currents

Typical product performance data is shown in the product data sheet for drive currents of 350mA, 500mA and 700mA. There are many commercially available drivers from multiple suppliers. Contact your local Bridgelux sales representative for more information. The figures below can help when choosing the desired driver characteristics for alternative drive currents. One figure illustrates the variation of optical flux with drive current. The second figure shows the variation of forward voltage with drive current.

Figure 12: Typical Relative Luminous Flux vs Pulsed Drive Current (Tc = 25C)

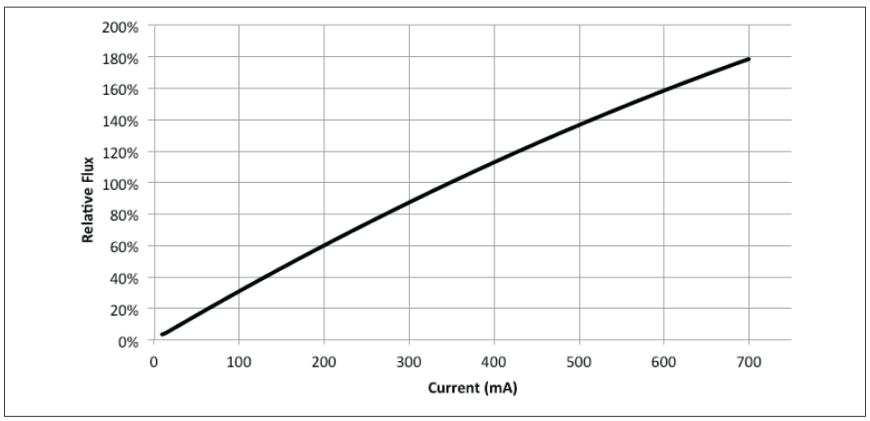
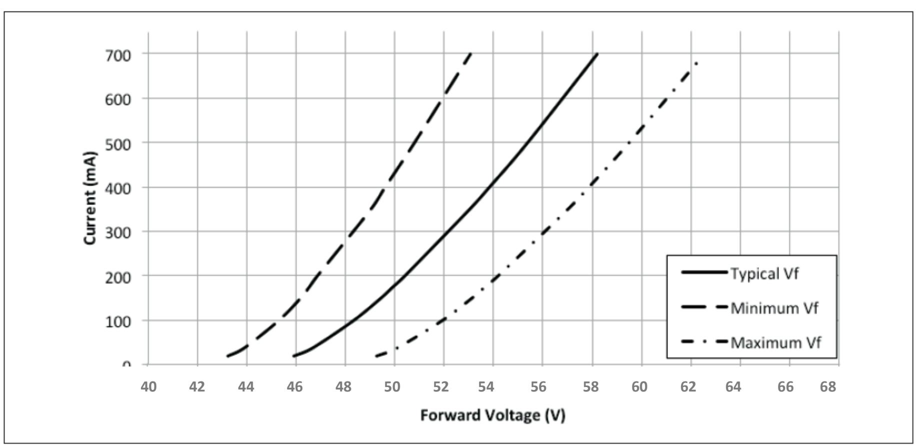


Figure 13: Pulsed Drive Current vs Forward Voltage (Tc = 25C)



© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Appendix B: Chemical Compatibility

Optimizing performance and reliability of a lighting system using Bridgelux OLM Series subsystems requires safe handling and use of appropriate manufacturing procedures and materials during the assembly of the product into the lighting system. Careful consideration must be given to the materials and chemicals used when processing the Bridgelux OLM Series subsystems and to materials that are incorporated into a luminaire. This section provides a list of commonly used chemicals that should be avoided or carefully managed during processing of Bridgelux OLM Series subsystems and during their subsequent use.

Silicone encapsulation is commonly used by most High Brightness LED manufacturers, including Bridgelux. The silicone encapsulation is permeable to gas molecules. The gas molecules, including volatile organic compounds (VOC's), halogen and sulfur compounds, can interact with silicone and other components that comprise the Bridgelux OLM Series subsystems and cause degradation in performance. The possibility and extent of degradation is dependent on the type of chemical, the concentration of the chemical, the temperature during exposure, and the length of time the LED array is exposed to the chemical. Additional considerations should be given to IP rated or "sealed" luminaires that create "air tight environments" around the Bridgelux OLM Series subsystems. Luminaires sealed in this fashion can trap potentially damaging gas molecules from manufacturing processes or subsequent out-gassing of materials used in the luminaire which can result in long term exposure of the products to the contaminant. Careful considerations are taken during the manufacturing of the subsystems around the Vero LED array and in the environmental sealing process.

The source of the gas molecules can be out-gassing from polymeric materials such as glues, gaskets, paints and/or under-cured materials. Materials used inside a luminaire with a potential to outgas should be characterized as part of the luminaire design to understand the environment that will be surrounding the Bridgelux OLM Series subsystems during the luminaire lifetime. The silicone encapsulation is also vulnerable to non-polar fluids and solvents commonly used during the manufacturing process of the luminaire such as cleaning, oil assisted drilling, and any processes that would allow the subsystems to come into contact with the fluids or solvents. Care should be taken such that the products are protected from such chemicals to avoid ingress of small non-polar molecules into the encapsulation silicone.

Common chemicals that are known to be harmful to Bridgelux OLM Series subsystems are listed in Table 7 below. Note that the chemicals listed in Table 7 may be found in various states –

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

liquid, gas, and/or solid. All physical states of these chemicals can be harmful to the products, but those that are in a gaseous state, such as volatile organic compounds (VOCs), can readily permeate the lens material of the array and damage the array internally and/or externally.

Because it is impossible to determine all of the chemicals that may be detrimental to the performance of the Bridgelux OLM Series subsystems, the list of chemicals above may not be exhaustive. It is the responsibility of the luminaire manufacturer to ensure that any and all materials used in the luminaire design or manufacturing process does not cause damage to the subsystems.

For additional information on chemicals that are potentially hazardous to LED arrays please refer to the following industry resource:

Lighting Industry Association Technical Statement 13 http://www.thelia.org.uk

Table 7: Commonly used chemicals that will cause harm to Bridgelux OLM Series subsystems

Classification	Chemical Name	Possible Sources
Acids	Hydrochloric Acid Sulfuric Acid Nitric Acid Phosphoric acid	**Cleaners, cutting fluids**
Organic acids	Acetic acid	**RTV silicones, cutting fluids, degreasers, adhesives**
Bases	Sodium Hydroxide Potassium hydroxide Amines	**Detergents, cleaners**
Organic Solvents	Ethers such as glycol ether Ketones such as MEK, MIBK Aldehydes such as formaldehyde	**Cleaners, mineral spirits, petroleum, paint, gasoline**
Aromatic solvents	Xylene Toluene Benzene	**Cleaners**
Low Molecular Weight Organics (VOC's)	Acetates Acrylates AldehydesDienes	**Superglue, Loctite adhesives, thread lockers and activators, common glues, conformal coatings**
Petroleum Oils	Liquid hydrocarbons	**Machine oil, lubricants**
Non-petroleum Oils	Siloxanes, fatty acids	**Silicone oil, lard, linseed oil, castor oil**
Oxidizers/Reducers	Sulfur compounds	**gaskets, paints, sealants, petroleum byproducts**
Halogen compounds	**Cl, F,or Br containing organic and inorganic compounds**	**solder fluxes/pastes, flame retardants**

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

Design Resources

Optical Files

IES and LDT files are available for all OLM products. Please contact your Bridgelux sales representative for assistance.

3D CAD Models

Three dimensional CAD models depicting the product outline are available in both SAT and STEP formats. Please contact your Bridgelux sales representative for assistance.

Precautions

CAUTION: CONTACT WITH OPTICAL AREA

The OLM products are manufactured with molded polycarbonate lenses. These lenses are tested and qualified for outdoor use and exposure. The lenses are impact tested in accordance with IK-08. The lens is extremely durable, but not indestructible. Contact may cause damage to the LED array.

CAUTION: CHEMICAL EXPOSURE HAZARD

Exposure to some chemicals commonly used in luminaire manufacturing and assembly can cause damage to the LED array. Please consult Bridgelux Application Note AN31 for additional information.

CAUTION: EYE SAFETY

Eye safety classification for the use of Bridgelux Vero LED arrays and the OLM Series is in accordance with IEC specification EN62471: Photobiological Safety of Lamps and Lamp Systems. Vero LED arrays are classified as Risk Group 1 (Low Risk) when operated at or below the maximum DC forward current (2x the nominal rated test current as is defined in the data sheet). Please use appropriate precautions. It is important that employees working with LEDs are trained to use them safely.

CAUTION: RISK OF BURN

Do not touch the product during operation. Allow the product to cool for a sufficient period of time before handling.

Minor Product Change Policy

The rigorous qualification testing on products offered by Bridgelux provides performance assurance. Slight cosmetic changes that do not affect form, fit, or function may occur as Bridgelux continues product optimization.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.

About Bridgelux

At Bridgelux, we help companies, industries and people experience the power and possibility of light. Since 2002, we've designed LED solutions that are high performing, energy efficient, cost effective and easy to integrate. Our focus is on light's impact on human behavior, delivering products that create better environments, experiences and returns—both experiential and financial. And our patented technology drives new platforms for commercial and industrial luminaires.

Bridgelux and the Bridgelux stylized logo design are registered trademarks, and is a trademark, of Bridgelux, Inc. All other trademarks are the property of their respective owners.

© 2015 Bridgelux, Inc. All rights reserved. Product specifications are subject to change without notice.