Cree® LMH2 LED Modules Design Guide

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THANK YOU

Thank you for choosing to incorporate the LMH2 series of LED modules into your luminaire designs.

If you need assistance, Cree will support you with:

- Engineering assistance for product design and manufacturability.
- Thermal testing assistance for lifetime analysis.
- Thermal design assistance.

The LMH2 is a fully functioning module that delivers:

- TrueWhite® technology, a revolutionary way to generate white light with LEDs that delivers high efficiency with beautiful light characteristics and color accuracy while maintaining color consistency over the life of the product.
- Industry-leading efficacy at 95 lm/W, measured at a case temperature (Tc) of 55 °C at steady state.
- Known and predictable correlated color temperature (CCT).
- L_{70} of 35,000 - 50,000 hours, depending on the Tc.

Again, thank you, and we look forward to working with you.

ABOUT THIS DESIGN GUIDE

This design guide is intended to provide luminaire manufacturers an introduction to the LMH2 series of modules. This design guide also provides critical design guidelines for successfully integrating the LMH2 into your existing and new luminaire designs.

- For additional information please contact your Cree modules distributor or Cree sales representative as appropriate.
- For technical information and support, visit us on the web at www.cree.com/modules or e-mail us at modules_support@cree.com.
- All dimensions are in millimeters unless otherwise noted.
- Dimension tolerances are as follows:
  - ◇ Angular: machined ± 0.5°, bend ± 1°.
  - ◇ All inside bend radii equal the material thickness unless otherwise noted.
  - ◇ One-place decimal number: ± 0.5.
  - ◇ Two-place decimal number: ± 0.05.
- 3-D models (.STEP files) for the LMH2 light sources and optional heat sink are available on the Cree website.[1]

Cautions

- Do not power on an LMH2 LED module when the lens is blocked, for example, when the module is face-down on a surface. Irreparable damage may occur and will void the product warranty.
- The LMH2 light source must not be electrically connected to an energized driver, commonly referred to as hot plugging. Irreparable damage may occur and will void the product warranty.
- Wiring and electrical information in this design guide is for reference only. All installations and applications of module-based luminaires are subject to the electrical, construction and building codes in effect in the final installation location. Installation by professionals having experience in the area of electrical lighting and formal inspection by the Authorities Having Jurisdiction (AHJ) is strongly recommended.
- Thermal characteristics of LMH2 LED modules are affected by the luminaire and by the conditions in which the luminaire is installed. Whether a heat sink is required depends on the final luminaire design and the operating conditions surrounding the module. All final luminaire products should be evaluated in actual worst case installation conditions. Thermal limits of the module components must be maintained for warranty consideration.
- LMH2 LED module surfaces may be hot during operation. Take care during handling to avoid burns.

Failure to follow the design guidelines in this document may void the product warranty.

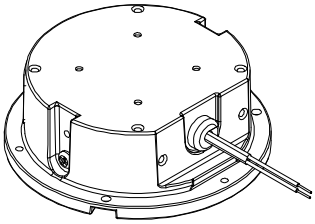
1 Select the Documentation tab at www.cree.com/modules/lmh2.

ABOUT THE LMH2 SERIES

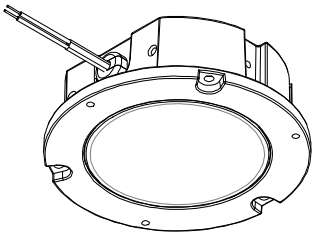
The LMH2 series of LED modules is engineered to allow lighting designers and luminaire manufacturers to quickly incorporate state-of-the-art LED technology into their luminaire designs. The LMH2 module is a complete LED lighting solution consisting of a light source and separate power supply. Cree's light source incorporates an internal thermal management system in a single, compact form factor. The LMH2 LED modules are designed to be used in residential and commercial lighting applications where high efficacy and color rendering index (CRI) values are important.

LMH2 Light Sources

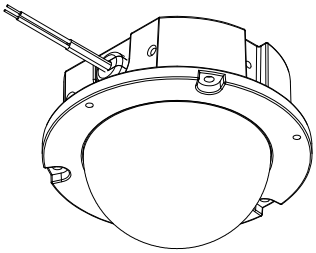
LMH2 - Top View



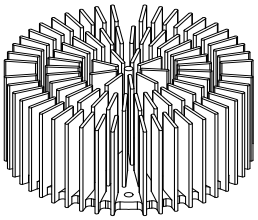
LMH2 - Flat Lens Option



LMH2 - Dome Lens Option



Optional Heat Sink (for all Light Sources)



ELECTRICAL DESIGN

LMH2 LED modules are performance-optimized to operate with Cree's LMD125 or LMD300 LED module drivers. Detailed driver dimensions and wiring diagrams can be found in the LMD125 and LMD300 data sheets.[2] The table below shows the correspondence between the LMH2 light sources and the Cree LMD125 and LMD300 LED module drivers. In addition, the Cree website provides information on other drivers that may be compatible with the LMH2 LED modules.[3]

Light Source	Nominal Lumens @ Tc = 55 °C *	Driver
LMH2	850	LMD125
	1250	
	2000	LMD300
	3000	

* See the Thermal Design section for more information.

2 Cree LMD125 LED Module Drivers Data Sheet, DS13, www.cree.com/modules_data_sheets/LMH2_LMD125
Cree LMD300 LED Module Drivers Data Sheet, DS14, www.cree.com/modules_data_sheets/LMH2_LMD300

3 www.cree.com/drivercompatibility

The LMH2 LED module lead wires are 200 mm long, 18 AWG with the ends stripped 10 mm.

> **Caution** - Do not connect a light source to a driver when the driver is energized, commonly known as hot-plugging. Connecting a light source to an energized driver can damage the light source and will void the warranty.

Protective Earth Ground

The LMH2 LED module must be properly earth grounded. A secure electrical connection must be made between the cast housing or heat sink mounting screws and the luminaire's protective earth ground connection.

Electrostatic Discharge

No special electrostatic discharge (ESD) precautions are required for handling LMH2 LED modules in a production environment.

Power Requirements

Light Source	Input Voltage (VAC)	Frequency (Hz)	Input Current (mA)	Power Factor	Nominal Power (W)
850 lm	120	60	88	.97	10.5
	230	50/60	46	.90	10.5
	277	60	38	.92	10.5
1250 lm	120	60	130	.99	15.5
	230	50/60	67	.95	15.5
	277	60	55	.98	15.5
2000 lm	120-277	50/60	213-92	.96	25.5
	220-240	50/60	109	.95	25
3000 lm	120-277	50/60	312-135	.98	37.5
	220-240	50/60	157	.98	37.5

Wiring Strain Relief

LMH2 LED modules must not be suspended directly by the leads. Though the wiring from the LMH2 light source is internally strain relieved, additional strain relief methods must be employed if the luminaire is to be suspended solely by the wiring, as in a pendant luminaire.

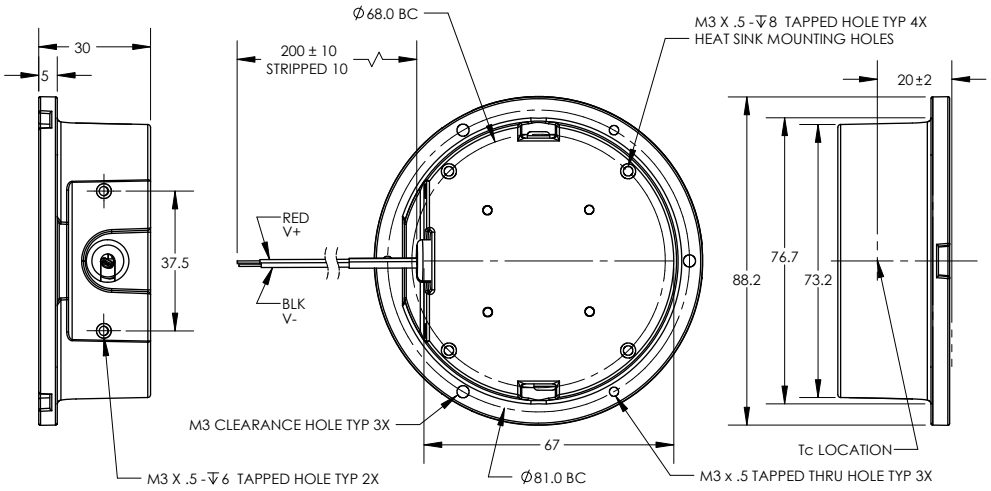
MECHANICAL DESIGN

The compact form factor of the LMH2 allows the module to be easily incorporated into new and existing lighting designs.

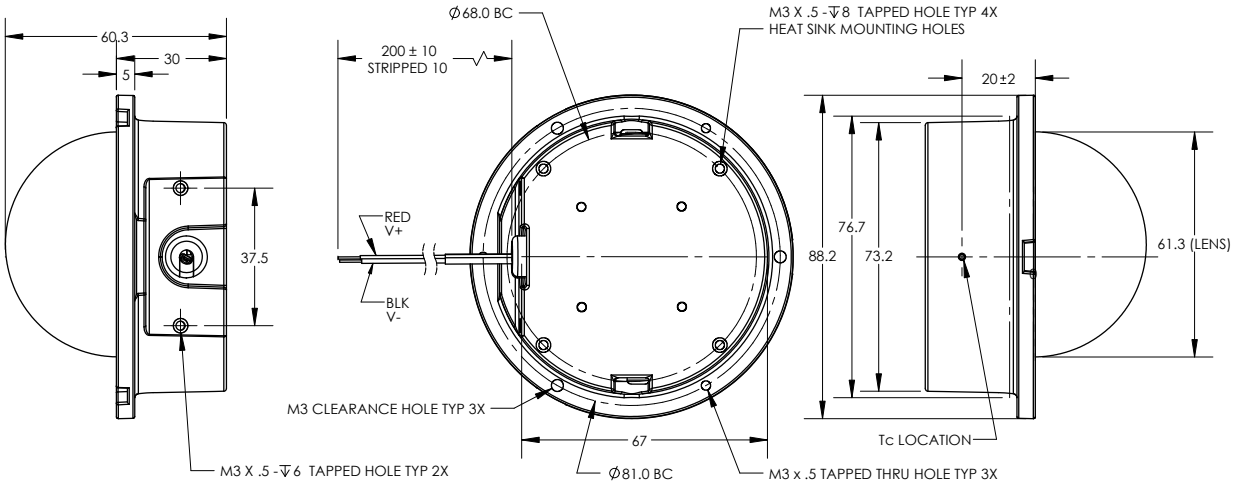
Physical Characteristics of the LMH2

Physical Characteristic	Light Source with Flat Lens	Light Source with Dome Lens	Heat Sink
Weight (g)	178	190	160
Maximum height (mm)	30	60.3	40
Maximum diameter/width (mm)	88.2	88.2	87.2
Lens aperture (mm)	58	61.3	-

LMH2 with Flat Lens[4]



LMH2 with Dome Lens



Note - The flange of the LMH2 has the same mechanical dimensions as in the LMR2 product line.

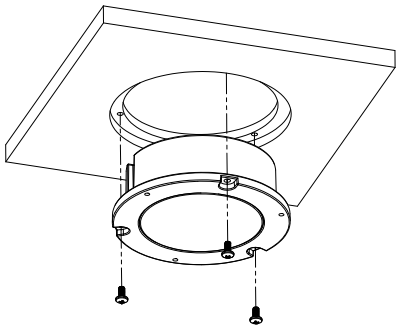
4 Dimensions for the LMH2 diagrams are in mm and are for reference only. For exact dimensions and tolerances, refer to the 3-D models (.STEP files) for the LMH2 light sources available by selecting the Documentation tab at www.cree.com/modules/lmh2.

Mounting Options

The LMH2 LED module has been engineered for multiple mounting options, provided the thermal design guidelines are followed and the temperature at the Tc point remains below the specified maximum. (See the Thermal Design section for details.) There are four (4) options for properly securing the LMH2 LED module to the luminaire. For technical assistance in determining which option is best for a particular design, please contact the Cree Modules team directly at modules_support@cree.com.

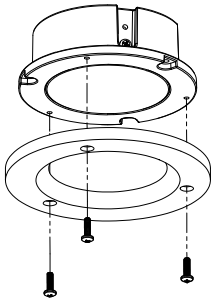
Option 1

Three (3) through-holes in the casting face are recessed in 3.5 mm by 9.5 mm slots. The holes provide clearance for M3 screws. The slots are 120° apart. The holes are on an 81.0-mm bolt circle and the slots are suitable for locking a keyed reflector or mounting your components in place.



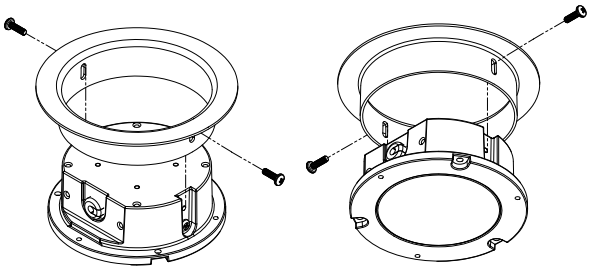
Option 2

Three (3) tapped M3-0.5 holes are in the casting face. The holes are 120° apart, on an 81.0-mm bolt circle and are suitable for mounting a cone or flange.



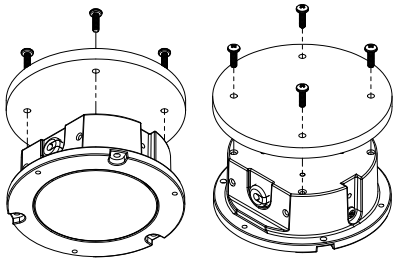
Option 3

Two (2) vertical slots are 180° apart in the side of the casting. Each slot has a minimum width of 8.0 mm and is recessed 3.9 mm into the casting with two (2) tapped M3-0.5 mounting holes in each side. Each hole is 20.1 mm above the mounting face.



Option 4

Four (4) tapped M3-0.5 x 8 holes are in the upper casting face. The holes are 90° apart, on a 68.0-mm bolt circle and are suitable for mounting a cone to the module or the module to a plate or a custom heat sink.



THERMAL DESIGN

LMH2 LED modules are designed to perform in a variety of environments and their expected lifetimes are highly dependent on their operating temperature. The LMH2 light source is designed to transfer heat away from the LEDs through the housing. When designing a luminaire that incorporates the LMH2 LED module, careful consideration must be taken to ensure a sufficient thermal path to ambient is provided. Verification of a proper thermal path is done through the placement of a thermocouple at the specified Tc location. The LMH2 light source must not exceed 70 °C at the Tc point in thermal equilibrium to ensure proper performance and expected lifetime and to maintain warranty terms.

The use of a heat sink will increase thermal performance in luminaire designs and help meet minimum expected lifetimes. A heat dissipation path is required; the LMH2 family of modules should not be operated without a properly tested heat dissipation path. Luminaire designs with a direct thermal path to ambient are desired and will provide the best results.

LEDs and LED modules are affected by their thermal environment. Nominal lumen values are typical at a Tc of 55 °C and subject to a build tolerance of ±10%. As the Tc rises, the optical performance of the module decreases. The acceptable Tc operating range of the LMH2 LED module, based on current thermal loss testing technology, is estimated to be 0 - 70 °C.

Photometric testing should be performed in situ.

Over-Temperature Protection

The LMH2 light source contains over-temperature protection that shuts down the light source if the monitored temperature on the LED board exceeds safety limits. If this occurs, cycle the power to the driver to resume operation. If the module shuts down repeatedly, the thermal design of the luminaire should be reviewed.

Ambient Temperature Measurement

The ambient temperature of the test environment must be monitored and recorded with the required data during a temperature test. The preferred ambient temperature measurement apparatus is described in UL1598-2008 Rev January 11, 2010, Section 19.5. The intent of this requirement is to ensure that the temperature monitored does not fluctuate. The ambient temperature of the space must be 25 °C ± 5 °C. Note that bare thermocouple wires in open air is not an acceptable method of recording the ambient temperature.

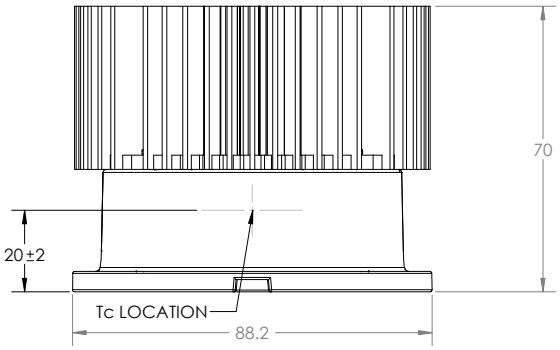
Thermocouple Attachment Method

Attach a thermocouple to the indicated Tc location. The attachment method described in UL1598-2008 Rev January 11, 2010, Section 19.7.4 is preferred; using silver-filled thermal epoxy is an acceptable alternative. Ensuring that the tip of the thermocouple properly contacts the module at the Tc location and that the attachment method does not add thermal resistance to the test is critical to correct and acceptable testing.

> **Note** - Quick-drying adhesives and other cyanoacrylate-based products are known to be destructive, over time, to the components and adhesives used in solid-state lighting products. The use of cyanoacrylate-based products is at the discretion of the testing organization. Cyanoacrylate adhesives should not be used in any luminaire design or for any long-term testing.

Tc Measurement Method

Once the thermocouple is properly attached at the Tc location, assemble the module into the luminaire. The luminaire must then be tested in its intended environment or that environment which will result in the highest recorded temperature. Take care during assembly to ensure that the thermocouple remains properly attached. Energize the luminaire and allow the assembly to reach thermal equilibrium. Thermal stabilization may require up to 7.5 hours, depending on the mechanical design. Once thermal equilibrium is achieved, record the room ambient and case temperatures. Acceptable test results require the ambient temperature to be between 20 °C and 30 °C (25 °C± 5 °C). Recorded variations above or below 25 °C must be added to or subtracted from the recorded temperatures. The table below can be used to determine the expected luminaire operating life.



Tc location is midway up the casting side and approximately 90° from the mounting slots.

Expected LMH2 Lifetime versus Temperature at Tc Point

Expected Operation Life (Hours)	Tc (°C) @ 25 °C Room Ambient
	LMH2 Light Source
35,000	70
50,000	60

The table below shows the typical Tc temperature of the LMH2 light source when attached to the optional heat sink, after thermal stabilization in a 25 °C environment with the light source suspended face down.

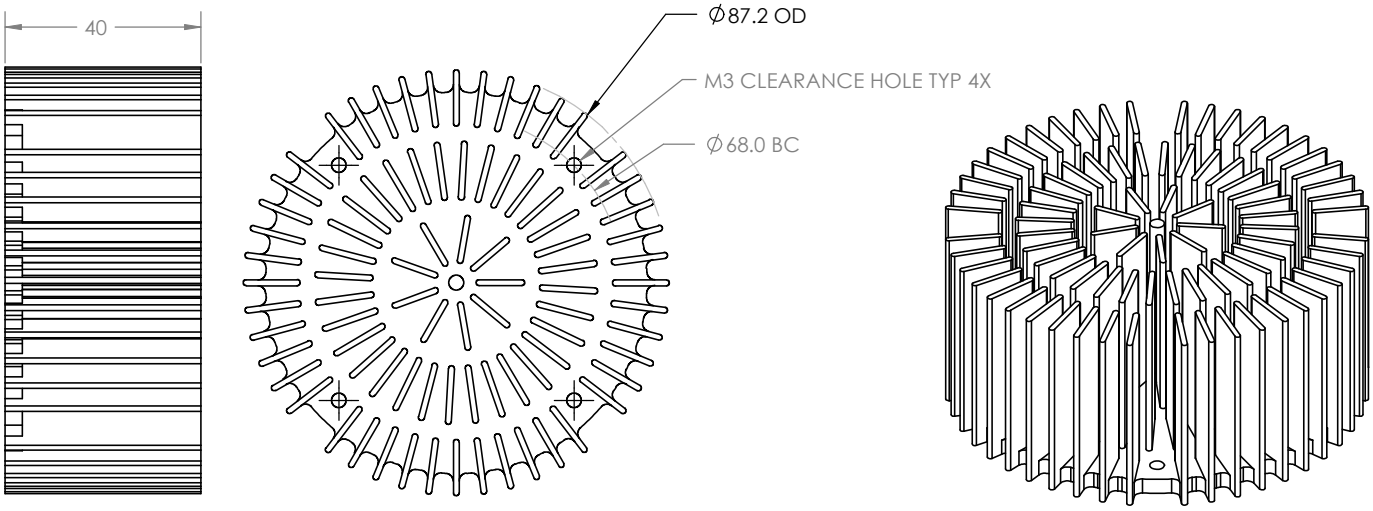
Light Source	T_c (°C)
850 lm	39.9
1250 lm	44.4
2000 lm	56.8
3000 lm	69.5

Available Heat Sink[5]

Cree designed the LMD125 and LMD300 heat sinks for use with all LMH2 light sources. These heat sinke, available from Cree, provide a simple and cost-effective method to improve the LMH2 thermal performance in various applications. The heat sinks attach to the upper face of the module with four (4) M3-0.5 x 8 screws, included in the purchase of the heat sink. Most luminaire designs, regardless of source lumens, require the additional heat dissipation that can be provided by a heat sink.

A luminaire manufacturer is free to develop a custom heat sink. Proper operation of the heat sink requires it to be mounted to the module with four (4) screws at 90°. Failure to follow this hole pattern may result in uneven cooling of the module and unpredictable thermal performance.

5 Dimensions for the heat sink diagrams are in mm and are for reference only. For exact dimensions and tolerances, refer to the 3-D model (.STEP file) for the optional heat sink available by selecting the Documentation tab at www.cree.com/modules/lmh2.



ENVIRONMENTAL DESIGN

The LMH2 LED module is suitable for damp locations and is rated IP-20. If the LMH2 LED module is to be used in an outdoor luminaire classified other than "suitable for damp location; covered ceilings," the luminaire manufacturer must ensure proper intrusion protection and appropriate regulatory-compliance testing.

OPTICAL DESIGN

The LMH2 LED module is supplied with a lens to provide a uniform light source. To maintain the warranty and for proper performance, the lens and reflector cone must not be altered or removed from the LMH2 LED module. A secondary optic is not required. If a secondary optic is used, the following trade-offs may occur:

- Reduced light output (luminous flux).
- Reduced efficacy (lumens/watt).
- Possible changes in color characteristics (CCT, CRI).

Photometry

IES (LM-63-2002) files and the optical source model for the LMH2 LED module are available at www.cree.com/led-components-and-modules/products/modules/non-integrated/lmh2.

DESIGN EXAMPLES

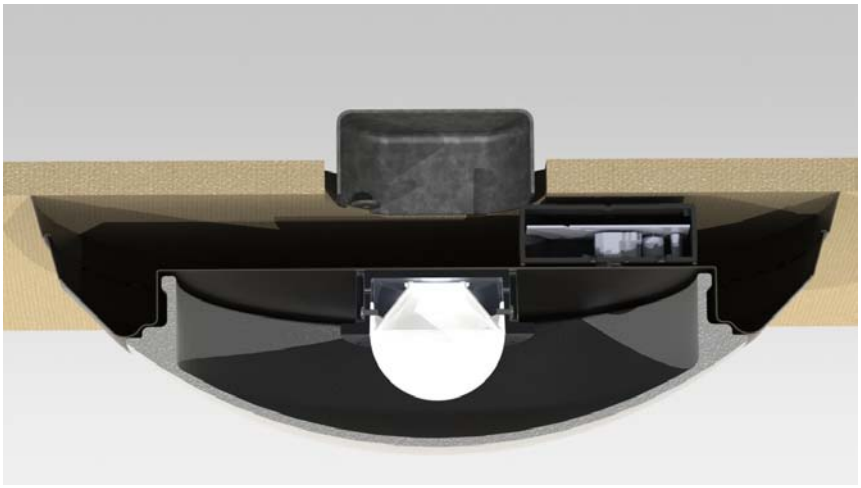
This section contains design proposals for luminaires that incorporate the LMH2 LED module. Please note the various attachment methods employed.

> **Note** - The examples depicted below are conceptual only. The inclusion of a concept in this group does not imply agency approval. The exclusion of any concept from this group should not be seen as a limitation. These examples are not proprietary or protected and may be reproduced wholly or in part as desired by a given luminaire manufacturer. Final agency approval(s) and confirmation of acceptable operating parameters is solely the responsibility of the luminaire manufacturer.

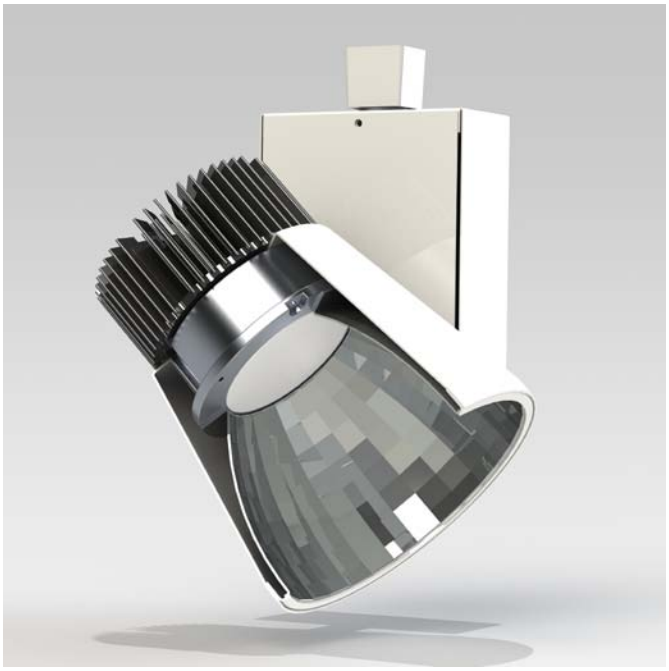
Table Lamp

6”/8” Commercial Downlight

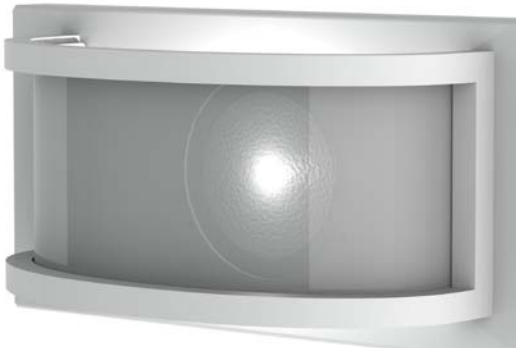
Surface Mount



Track Light



Wall Sconce



Pendant

SAFETY AND REGULATORY NOTES

Caution - Do not look directly into an LMH2 light source in operation! Eye injury can result. See the LED Eye Safety application note at www.cree.com/xlamp_app_notes/led_eye_safety.

The following tables show the safety and regulatory certifications for the LMH2 light sources.

	LMH2 Light Source (850 lm, 1250 lm, 2000 lm, 3000 lm)	
	Standard	**File Number**
Safety	UL/cUL recognized (UL8750)	E337484
	IEC 60598-1 (lens glow wire)	
	EN62471	RSZ111109550-03 (850 lm) RSZ111109551-03 (1250 lm) RSZ120312550-03 (2000 lm) RSZ120312551-03 (3000 lm)
	EN62031	RSZ120410550-03 (850 lm) RSZ120410551-03 (1250 lm) RSZ120327550-03 (2000lm) RSZ120327550-03 (3000lm)
Electromagnetic compatibility	EN 55015	RSZ111109550-01M1 (850 lm) RSZ111109551-01M1 (1250 lm) RSZ120312550-01M1 (2000 lm) RSZ120312551-01M1 (3000 lm)
	IEC 61000-3-2	
	IEC 61000-3-3	
	IEC 61547	
	FCC 47 CFR Part 15 Class B/ ICES 03	
Environmental	RoHS	

Safety Certification

Together, the LMH2 light source combined with the LMD125 or LMD300 LED module driver are "suitable for damp locations; covered ceilings." Final luminaire designs should go through safety certification as required, which is the responsibility of the luminaire manufacturer.

ENERGY STAR®

ENERGY STAR is a U.S. government-backed program that defines energy-efficiency standards for products. Qualification of the final luminaire design for ENERGY STAR certification is the responsibility of the luminaire manufacturer. The final luminaire must be submitted for testing to an independent, certified test facility. Cree can and will assist in the process by providing LM-80 component data for submission to ENERGY STAR.

Note - If a luminaire incorporating the LMH2 3000-lm light source will be submitted to ENERGY STAR, a Tc maximum of 68 °C is required.

Module Disposal

LMH2 LED modules should be disposed of properly at the end of their useful lifetime in accordance with local regulations. The LMH2 LED module is classified as "Electronic Equipment."