Cree® LMH2 LED Modules Design Guide

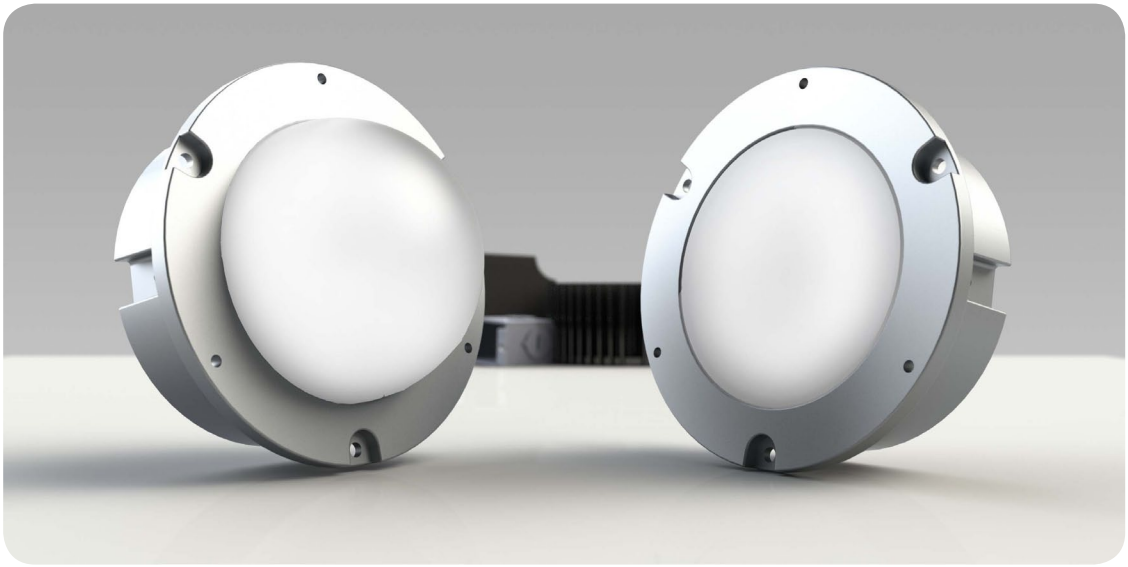


TABLE OF CONTENTS

Thank You **2**
About this Design Guide **3**
Cautions 3
About the LMH2 Series **4**
Electrical Design **6**
Protective Earth Ground 6
Electrostatic Discharge 6
Dimmer Selection 6
Power Requirements - WhiteLight Dimming 7
Power Requirements - Sunset Dimming 7
Wiring Strain Relief 7
Mechanical Design **8**
Physical Characteristics of the LMH2 8
LMH2 with Flat Lens 8
LMH2 with Dome Lens 8
Mounting Options 9
Thermal Design **10**
Over-Temperature Protection 10
Ambient Temperature Measurement 10
Thermocouple Attachment Method 10
Tc Measurement Method 11
Expected LMH2 Lifetime versus Temperature at Tc Point 11
Available Heat Sinks 12
Thermal Interface Material 14
Environmental Design **14**
Optical Design **15**
Photometry 15
Design Examples **16**
Table Lamp 16
6”/8” Commercial Downlight 17
Surface Mount 18
Track Light 19
Wall Sconce 20
Pendant 21
Safety and Regulatory Notes **22**
Safety Certification 22
ENERGY STAR® 22
Module Disposal 23

Cree, Inc.
4600 Silicon Drive
Durham, NC 27703
USA Tel: +1.919.313.5300

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 of up to 108 lm/W, measured at a case temperature (Tc) of 55 °C at steady state.
- Industry's first no-compromise sunset dimming experience that follows the black-body line similar to an incandescent lamp.
- 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. This guide includes information pertaining to all lumen levels and dimming capabilities of the LMH2 series of modules.

- 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 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 sinks 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.
- Cree recommends connecting the LMH2 sunset dimming LED module to a dimmer separate from the dimmer for an incandescent lamp. There are no safety issues with connecting an LMH2 sunset dimming LED module and an incandescent lamp to the same dimmer, however the two devices may dim to different lumen levels in response to a particular dimming adjustment. Connecting the devices to separate dimmers allows both to reach the same lumen level with the appropriate dimming input.

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

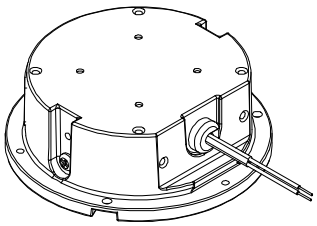
1 Select the Documentation tab on the LMH2 product page.

ABOUT THE LMH2 SERIES

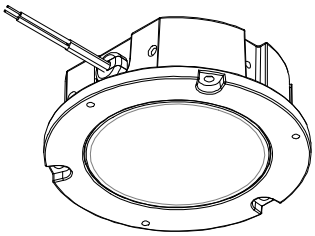
The LMH2 series of LED modules is engineered to allow lighting designers and luminaire manufacturers to quickly incorporate state-of-the-art LED technology into their luminaire designs. The LMH2 module is a complete LED lighting solution consisting of a light source and separate power supply. Cree's 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

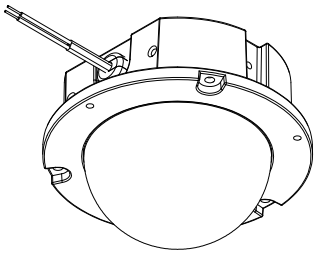
LMH2 - Top View



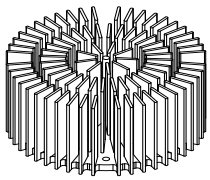
LMH2 - Flat Lens Option



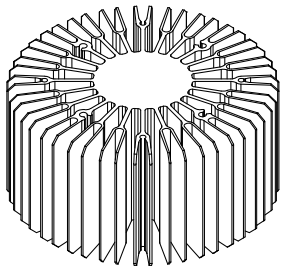
LMH2 - Dome Lens Option



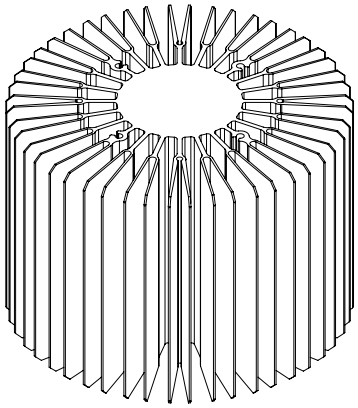
Optional Heat Sink 1
Order code LMH020-HS00-0000-0000001



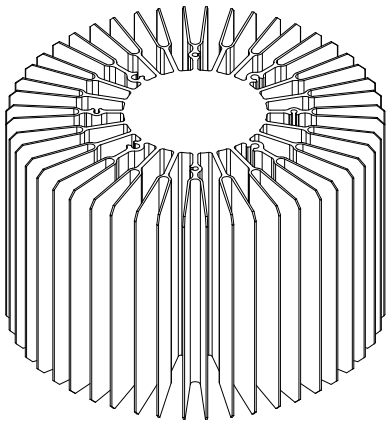
Optional Heat Sink 2
Order code LMH020-HS00-0000-0000002



Optional Heat Sink 3
Order code LMH020-HS00-0000-0000061

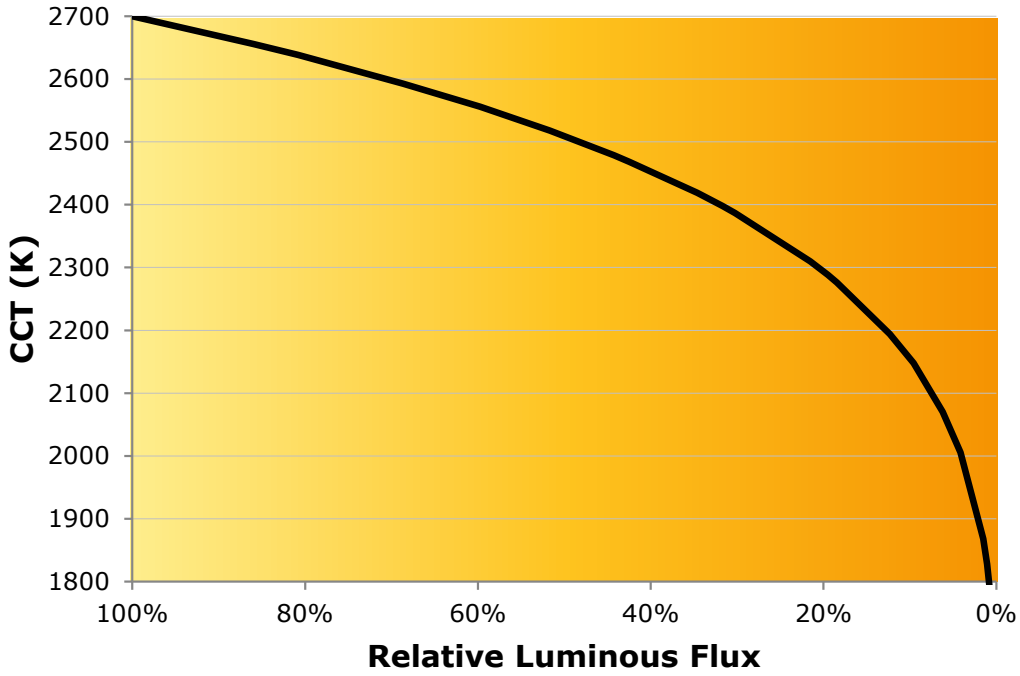


Optional Heat Sink 4
Order code LMH020-HS00-0000-0000081



The LMH2 series of LED modules provides a choice of dimming options.

- WhiteLight dimming provides consistent color across the entire dimming range.
- Sunset dimming provides warm, rich light from 2700 K down to 1800 K, as shown in the following diagram.



ELECTRICAL DESIGN

All LMH2 LED modules, regardless their dimming capability, are performance-optimized to operate with Cree's LED module drivers. Detailed driver dimensions and wiring diagrams can be found in the LED module driver data sheet.[2] The table below shows the correspondence between the LMH2 light sources and the Cree® LED module drivers. The electrical power requirements that enable a driver to operate the LMH2 LED module are listed on page 7. However, the 5-year warranty is extended to the LMH2 LED module only when it is used with a Cree LED module driver or a third-party qualified driver. The Cree website provides information on drivers that are compatible with the LMH2 LED modules.

Light Source	Nominal Lumens @ Tc = 55 °C *	Driver
LMH2 - WhiteLight Dimming	850	LMD125
	1250	
	2000	LMD300/LMD400
	3000	
	4000	LMD400
	6000	LMD600
	8000	LMD800
LMH2 - Sunset Dimming	850	LMD125
	1250	
	2000	LMD400
	3000	

* See the Thermal Design section for more information.

The LMH2 LED module lead wires are 200 mm long, 22 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.

Dimmer Selection

Electronic low voltage (ELV) dimming controls have demonstrated repeatable and acceptable performance when used with Cree LED module drivers and Cree® LED modules in test conditions. Cree testing has shown that ELV controls

2 Cree LMD125 LED Module Drivers Data Sheet
Cree LMD300, LMD400 & LMD600 LED Module Drivers Data Sheet
Cree LMD800 LED Module Driver Data Sheet

operate WhiteLight and sunset dimming products satisfactorily in most applications. Regardless of the type of dimming control used with an LMH2 LED module or LMD driver, Cree recommends testing the luminaire to verify that its dimming performance is satisfactory.

Power Requirements - WhiteLight Dimming

Following are the electrical power requirements for a driver to operate the LMH2 LED module with the WhiteLight dimming option.

LMH2 Light Source	Open Circuit Voltage (VDC)	Nominal Output Current ± 10% (mA)	Minimum Output Voltage (VDC)	Maximum Output Voltage (VDC)	Ripple Current (mA)	Peak Current (mA)
850 lm	≤ 60	440	≤ 19	≥ 23	≤ 40%	≤ 1000
1250 lm	≤ 60	440	≤ 29	≥ 34	≤ 40%	≤ 1000
2000 lm	≤ 60	900	≤ 22	≥ 26	≤ 40%	≤ 2000
3000 lm	≤ 60	900	≤ 33	≥ 38	≤ 40%	≤ 2000
4000 lm	≤ 60	940	≤ 35.5	≥ 43	≤ 40%	≤ 2000
6000 lm	≤ 60	1700	≤ 38	≥ 46	≤ 40%	≤ 2100
8000 lm	≤ 60	2000*	≤ 41	≥ 52	≤ 40%	≤ 2650

* +5%, -10%

Power Requirements - Sunset Dimming

Following are the electrical power requirements for a driver to operate the LMH2 LED module with the sunset dimming option.

LMH2 Light Source	Open Circuit Voltage (VDC)	Nominal Output Current ± 10% (mA)	Minimum Output Voltage (VDC)	Maximum Output Voltage (VDC)	Ripple Current (mA)	Peak Current (mA)	Minimum Dimming Level
850 lm	≤ 60	440	≤ 19	≥ 23	≤ 40%	≤ 1000	N/A
1250 lm	≤ 60	440	≤ 29	≥ 34	≤ 40%	≤ 1000	N/A
2000 lm	≤ 60	940	≤ 22	≥ 26	≤ 40%	≤ 2000	5%
3000 lm	≤ 60	940	≤ 33	≥ 38	≤ 40%	≤ 2000	5%

Note: LMH2 Sunset Dimming 2000-lm and 3000-lm modules should not be dimmed below 5% light output.

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.

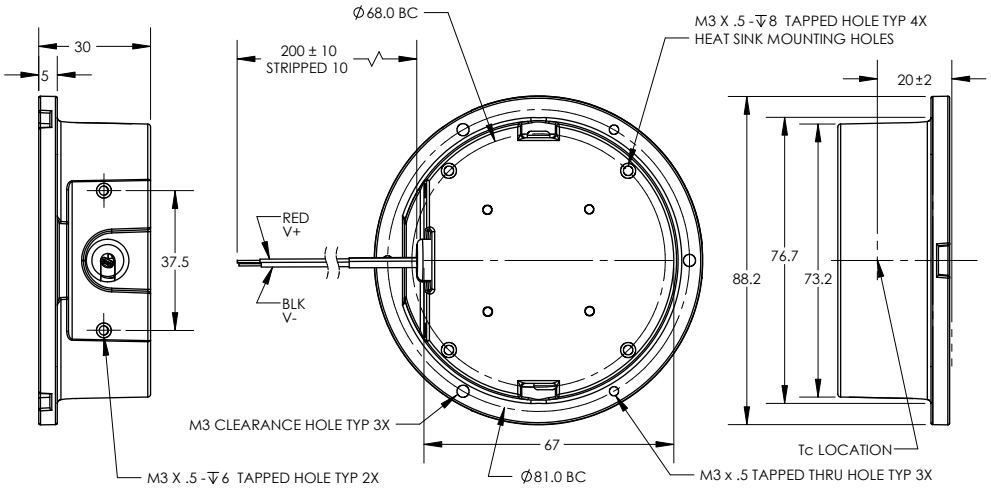
MECHANICAL DESIGN

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

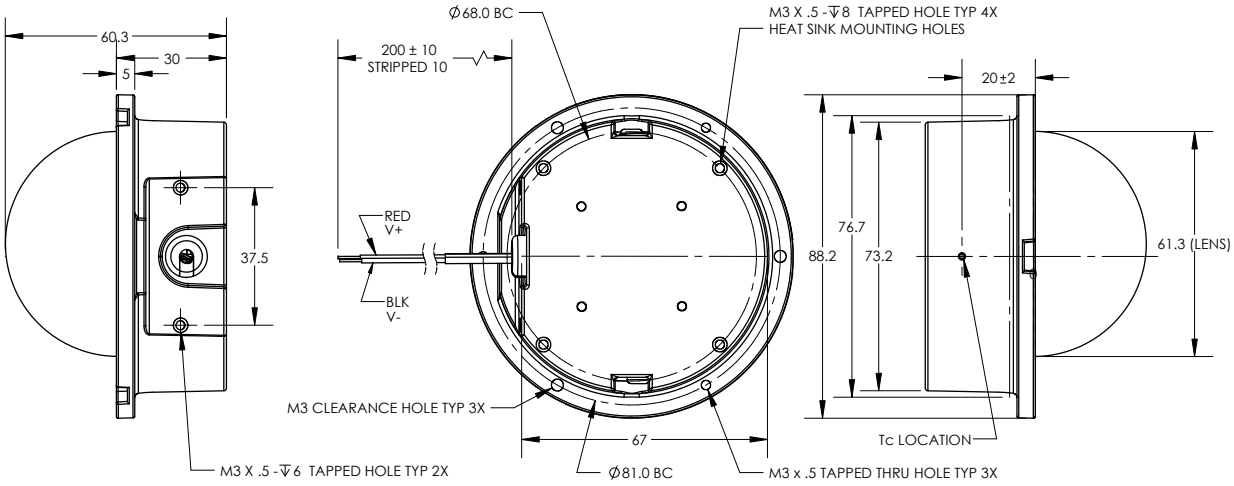
Physical Characteristics of the LMH2

Physical Characteristic	Light Source with Flat Lens	Light Source with Dome Lens	Optional Heat Sink 1	Optional Heat Sink 2	Optional Heat Sink 3	Optional Heat Sink 4
Weight (g)	178	190	160	440	1055	1268
Maximum height (mm)	30	60.3	40	55	100	100
Maximum diameter/width (mm)	88.2	88.2	87.2	110	138	153
Lens aperture (mm)	58	61.3	-	-	-	-

LMH2 with Flat Lens[3]



LMH2 with Dome Lens



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

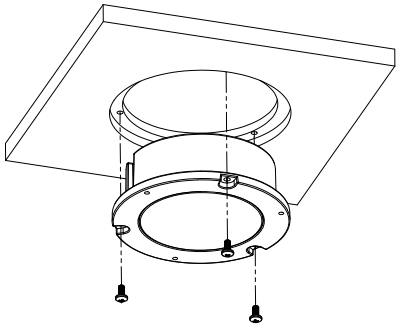
3 Dimensions for the LMH2 diagrams are in mm and are for reference only. For exact dimensions and tolerances, refer to the 3-D models (.STEP files) for the LMH2 light sources available by selecting the Documentation tab on the LMH2 product page.

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.

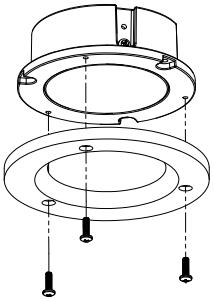
Option 1

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.



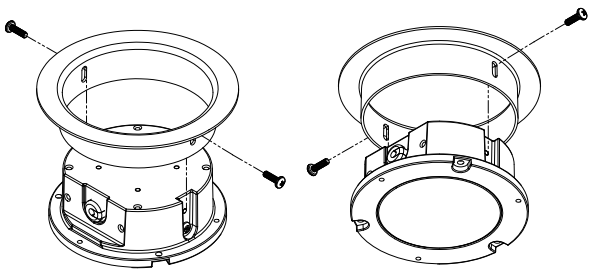
Option 2

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.



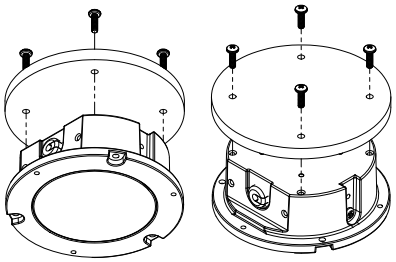
Option 3

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 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

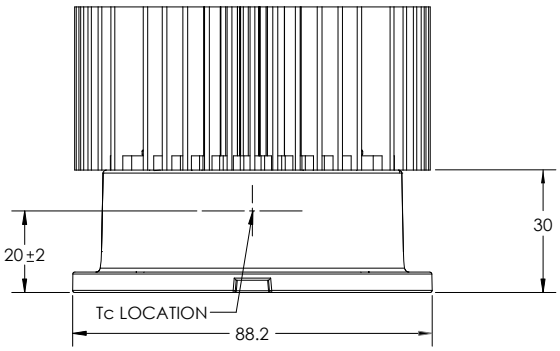
Attach a thermocouple to the indicated Tc location. The attachment method described in UL1598-2008 Rev January 11, 2010, Section 19.7.4 is preferred; using silver-filled thermal epoxy is an acceptable alternative. Ensuring that the tip of the thermocouple properly contacts the module at the Tc location 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. Refer to Cree's Chemical Compatibility application note for compounds that are safe to use with Cree LEDs.

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 of the LMH2 light source when attached to one of the optional heat sinks, after thermal stabilization in a 25 °C environment with the light source suspended face down.

Light Source	Tc (°C)			
	Optional Heat Sink 1	Optional Heat Sink 2	Optional Heat Sink 3	Optional Heat Sink 4
850 lm	39.9	35.1	NA	NA
1250 lm	44.4	40.0	NA	NA
2000 lm	56.8	43.0	NA	NA
3000 lm	69.5	51.7	NA	NA
4000 lm	NA	55.7	NA	NA
6000 lm	NA	NA	61.2	57.4
8000 lm	NA	NA	NA	64.2

NA = not applicable

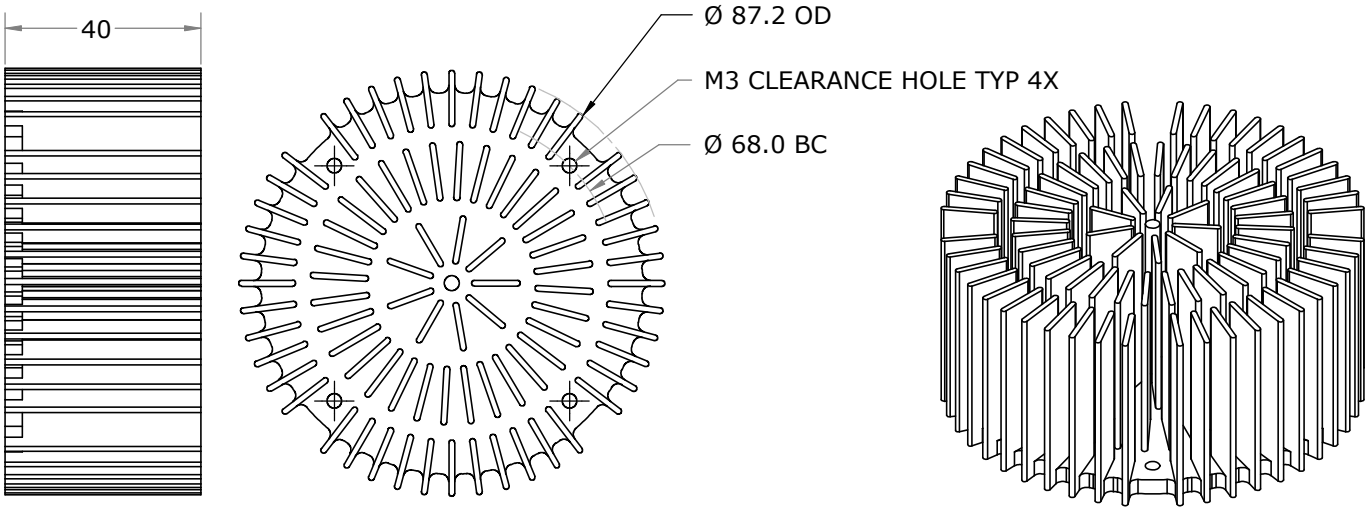
The use of a thermal interface material between the heat sink and the module can result in a decrease in case temperature. Environmental conditions around the module and the specific thermal interface material can greatly affect the Tc. Thermal testing is strongly recommended.

Available Heat Sinks

Cree designed three optional heat sinks for use with both the WhiteLight and Sunset dimming LMH2 light sources. These heat sinks, available from Cree, provide a simple and cost-effective method to improve the LMH2 thermal performance in various applications. Each heat sink attaches to the upper face of the module with four (4) screws, included in the purchase of the heat sink.[4] Most luminaire designs, regardless of source lumens, require the additional heat dissipation that can be provided by a heat sink. The use of a thermal interface material between the LMH2 LED module housing and the heat sink can improve a luminaire's thermal performance.

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.

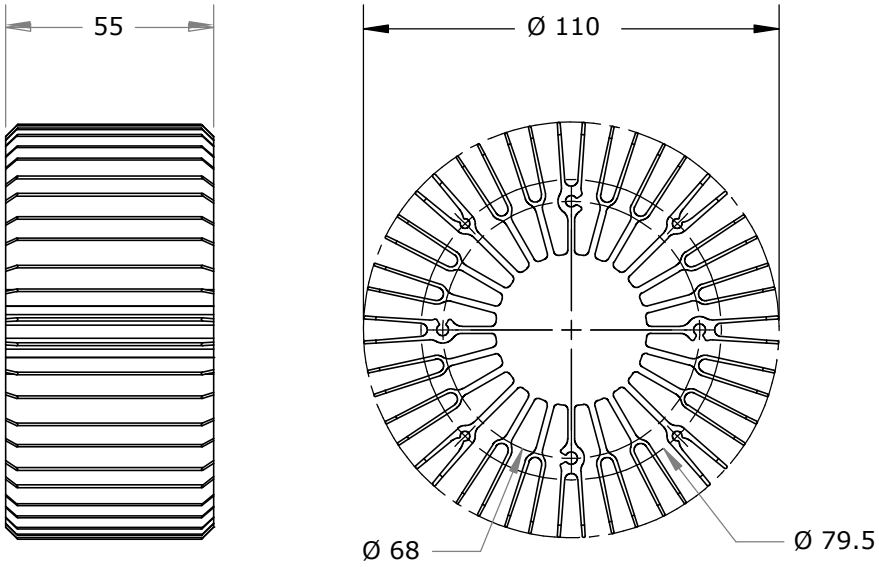
Optional Heat Sink 1[5] - order code LMH020-HS00-0000-0000001

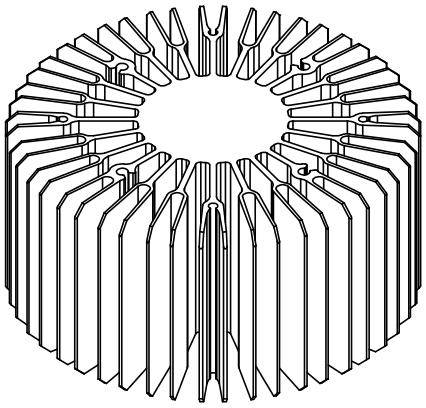


4 Optional heat sink 1 attaches with M3-0.5 x 8 screws. Optional heat sink 2 attaches with M3-0.5 x 60 screws. Optional heat sinks 3 and 4 attach with M3-0.5 x 100 screws.

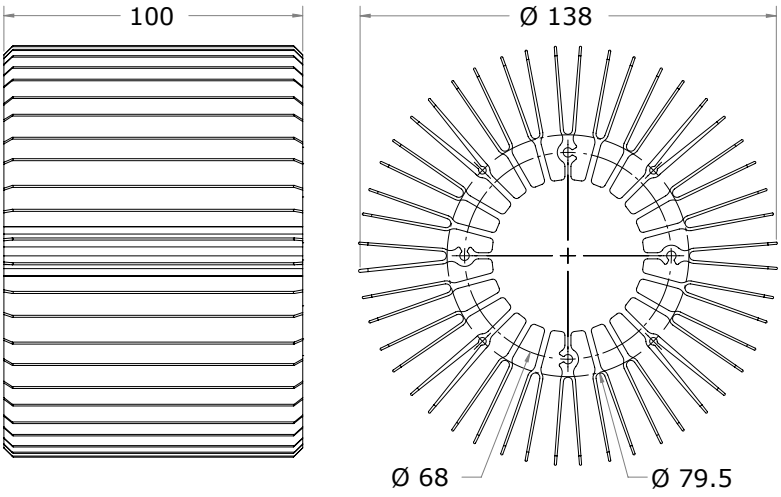
5 Dimensions for the heat sink diagrams are in mm and are for reference only. For exact dimensions and tolerances, refer to the 3-D models (.STEP file) for the optional heat sinks available by selecting the Documentation tab on the LMH2 product page.

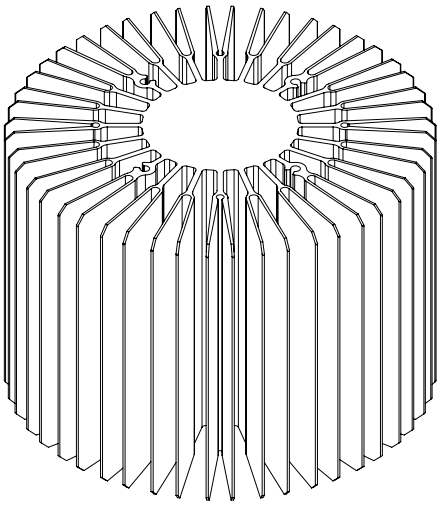
Optional Heat Sink 2 - order code LMH020-HS00-0000-0000002



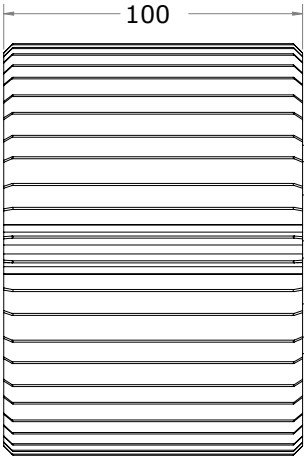


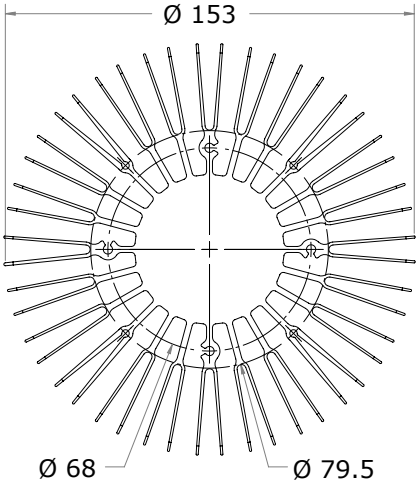
Optional Heat Sink 3 - order code LMH020-HS00-0000-0000061

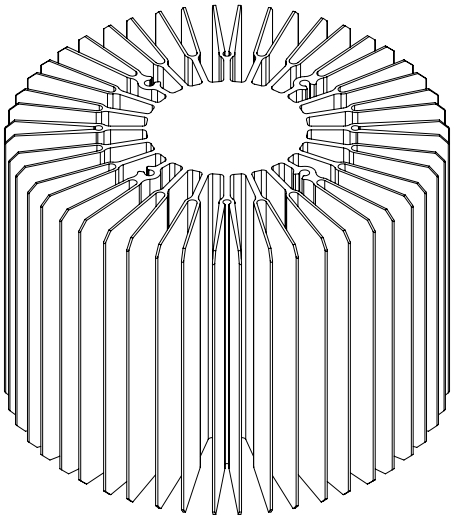




Optional Heat Sink 4 - order code LMH020-HS00-0000-0000081







Thermal Interface Material

Cree has worked closely with Bergquist, one of Cree's Thermal Solution Providers, and WPG, one of Cree's distributors, to provide die-cut thermal interface material (TIM) pads for the LMH2. Pads are provided for both the back and for the front face of the LMH2 LED module. Take care to ensure that a pad does not contact the LMH2 lens when applying these pads.

TIM Pad	Part Number	
	Bergquist	WPG
Back of LMH2 LED module	BG430355	RBCP-100776-PACK
Front face of LMH2 LED module	BG430356	

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).

Cree offers 4-in/110-mm, 6-in/150-mm and 8-in/190-mm reflectors in diffuse, white, semi-specular and faceted, specular finishes. See the Reflectors for Cree LMH2 LED Modules Product Guide for details.

Photometry

IES (LM-63-2002) files and the optical source model for the LMH2 LED module are available on the Cree website.[6]

6 Select the Documentation tab on the LMH2 product page.

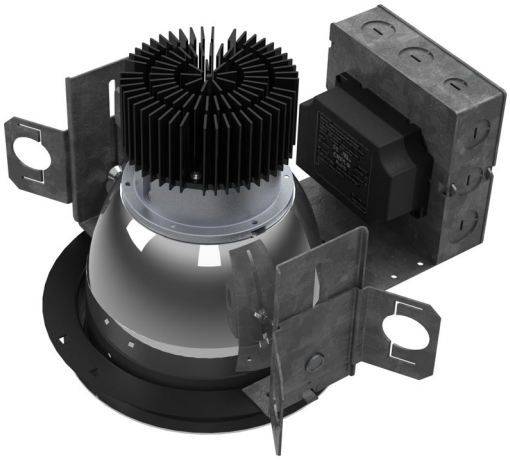
DESIGN EXAMPLES

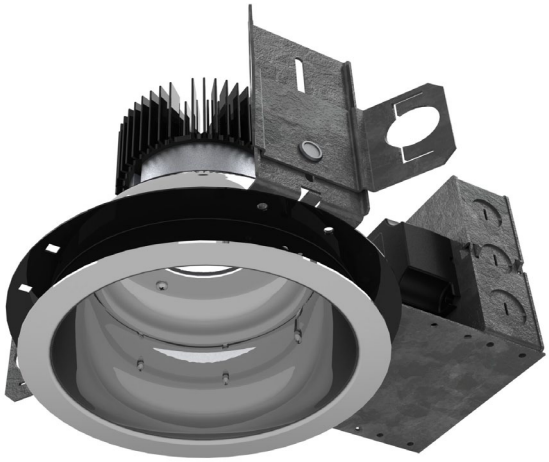
This section contains design proposals for luminaires that incorporate the LMH2 LED module. Please note the various attachment methods employed.

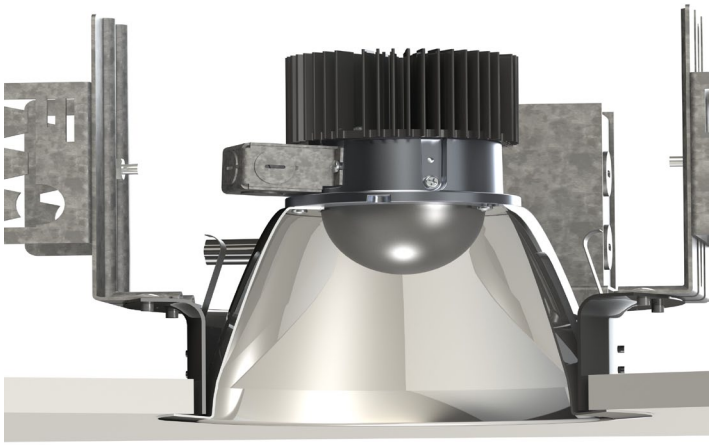
> **Note** - The examples depicted below are conceptual only. The inclusion of a concept in this group does not imply agency approval. The exclusion of any concept from this group should not be seen as a limitation. These examples are not proprietary or protected and may be reproduced wholly or in part 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

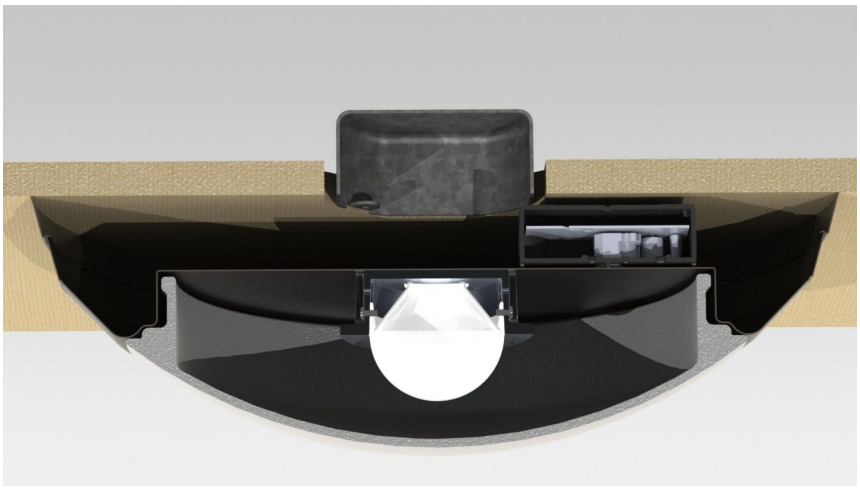
6”/8” Commercial Downlight



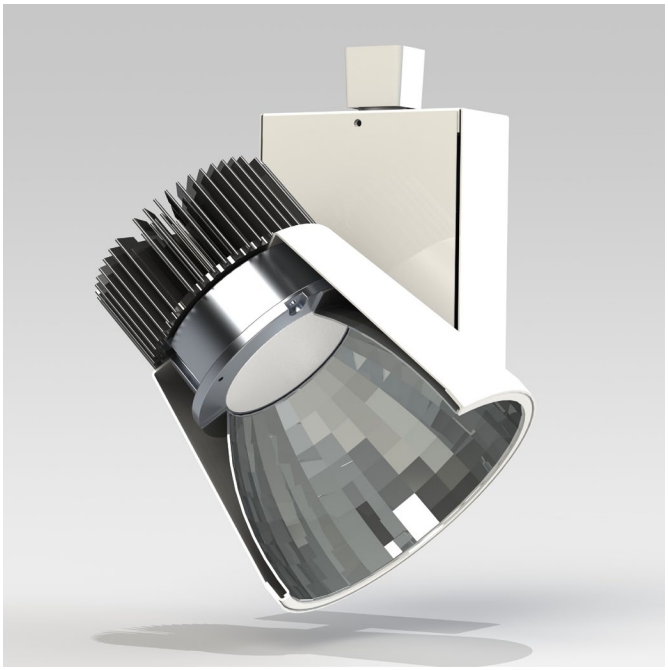




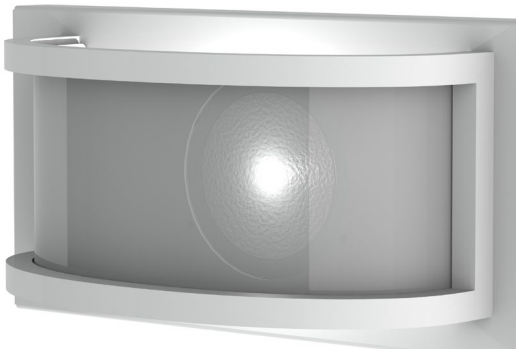
Surface Mount



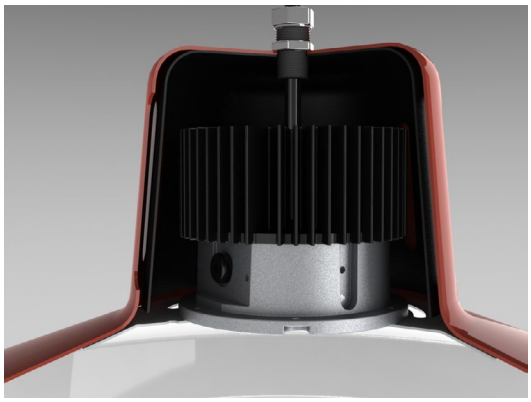
Track Light

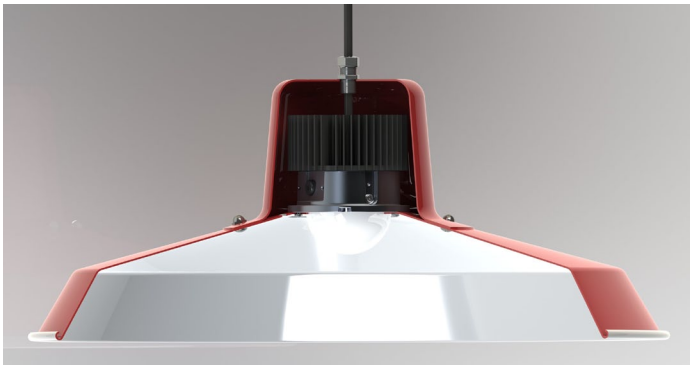


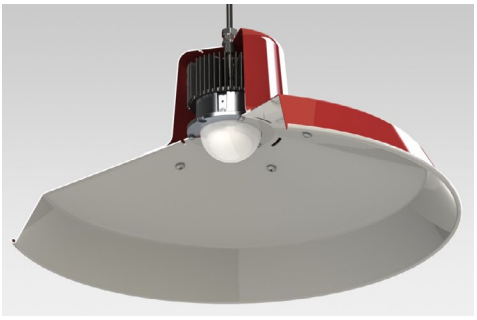
Wall Sconce



Pendant







SAFETY AND REGULATORY NOTES

Caution - Do not look directly into an LMH2 light source in operation! Eye injury can result. For more information about LEDs and eye safety, please refer to the LED Eye Safety application note.

The following table shows the safety and regulatory certifications for the LMH2 light sources.

	Standard	File Number	
Safety	UL®/cUL recognized (UL8750)	E337484	
	IEC 60598-1 (lens glow wire)		
	EN62471	850 lm WhiteLight dimming	RSZ111109550-03
		1250 lm WhiteLight dimming	RSZ111109551-03
		2000 lm WhiteLight dimming	RSZ120312550-03
		3000 lm WhiteLight dimming	RSZ120312551-03
	EN62031	850 lm WhiteLight dimming	RSZ120410550-03
		850 lm sunset dimming	CB certificate SE-74074 CB report 101264122CHI-001
		1250 lm WhiteLight dimming	RSZ120410551-03
		1250 lm sunset dimming	CB certificate SE-74074 CB report 101264122CHI-001
		2000 lm WhiteLight dimming	RSZ120327550-03
		2000 lm sunset dimming	CB certificate SE-74074 CB report 101264122CHI-001
		3000 lm WhiteLight dimming	RSZ120327550-03
		3000 lm sunset dimming	CB certificate SE-74074 CB report 101264122CHI-001
		4000 lm WhiteLight dimming	CB certificate SE-74074 CB report 101264122CHI-001
		6000 lm WhiteLight dimming	CB certificate SE-74074 CB report 101264122CHI-001
		8000 lm WhiteLight dimming	CB certificate SE-74074 CB report 101264122CHI-001
Electromagnetic compatibility	EN 55015	850 lm 1250 lm 2000 lm 3000 lm	RSZ111109550-01M1 RSZ111109551-01M1 RSZ120312550-01M1 RSZ120312551-01M1
	IEC 61000-3-2		
	IEC 61000-3-3		
	IEC 61547		
	FCC 47 CFR Part 15 Class B/ICES 003		
Environmental	RoHS		

Safety Certification

Together, an LMH2 light source combined with a Cree LED module driver is "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 a 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."