



OPERATING INSTRUCTIONS FOR THE WATER-COOLED LED SYSTEM

Version 2.0

Getting started using your new vortex-cooled LED system for pressure sensitive paint

Innovative Scientific Solutions, Inc.
2021

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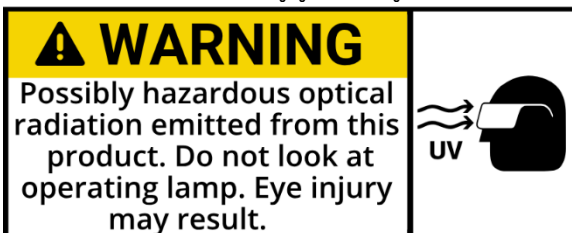
Revision Date: 9/15/2021

Important Safety Instructions

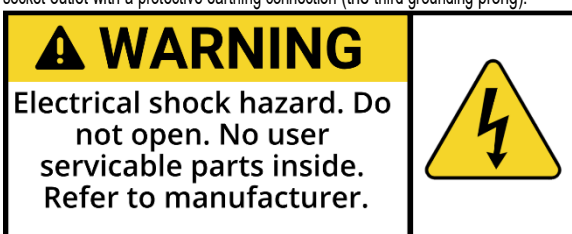
1. Read these instructions.
2. Keep these instructions.
3. Heed all warnings.
4. Follow all instructions.
5. Do not use this device near water.
6. Clean only with a dry cloth.
7. Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.



8. Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus that produce heat.
9. Use only the supplied power cord. Consult manufacturer for replacement if lost or damaged.
10. Protect the power cord from being walked on or pinched particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.
11. Only use attachments/accessories specified by the manufacturer.
12. Refer all servicing to manufacturer. Servicing is required when the apparatus has been damaged in any way, such as power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.
13. This apparatus shall not be exposed to dripping or splashing, and no object filled with liquids, such as vases or beer glasses, shall be placed on the apparatus.
14. Do not overload wall outlets and extension cords as this can result in a risk of fire or electric shock.
15. Wear appropriate safety glasses at all times. ISSI recommends UVEK SCT Orange lenses. Safety glasses utilizing these lenses block near 100% of the damaging retinal blue light. The LM3X series of LED Illuminators have a high optical output power. The light they produce is in the blue to UV wavelength which in substantial amounts can be very damaging to the eye. It is though that severe exposure may lead to age related macular degeneration (AMD), and possible blindness. Wear appropriate safety glasses at all times during use. ISSI recommends UVEK SCT Orange lenses. Safety glasses utilizing these lenses block near 100% of the damaging retinal blue light.



16. This apparatus has been designed with Class-I construction and must be connected to a mains socket outlet with a protective earthing connection (the third grounding prong).



17. This apparatus has been equipped with an all-pole, rocker-style AC mains power switch. This switch is located on the front panel and should remain readily accessible to the user.

18. NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference **will** not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

CAUTION: Changes or modifications to this device not expressly approved by Innovative Scientific Solutions,

Inc. could void the user's authority to operate the equipment under FCC rules.

19. This apparatus does not exceed the Class A/Class B (whichever is applicable) limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications.

ATTENTION — *Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de class A/de class B (selon le cas) prescrites dans le règlement sur le brouillage radioélectrique édicté par les ministere des communications du Canada.*

20. Exposure to extremely high noise levels may cause permanent hearing loss. Individuals vary considerably in susceptibility to noise-induced hearing loss, but nearly everyone **will** lose some hearing if exposed to sufficiently intense noise for a period of time. The U.S. Government's Occupational Safety and Health Administration (OSHA) has specified the permissible noise level exposures shown in the following chart.

According to OSHA, any exposure in excess of these permissible limits could result in some hearing loss. To ensure against potentially dangerous exposure to high sound pressure levels, it is recommended that all persons exposed to equipment capable of producing high sound pressure levels use hearing protectors while the equipment is in operation. Ear plugs or protectors in the ear canals or over the ears must be worn when operating the equipment in order to prevent permanent hearing loss if exposure is in excess of the limits.

Duration, per day in hours	Sound Level dBA, Slow Response	Typical Example
8	90	Duo in small club
6	92	
4	95	Subway Train
3	97	
2	100	Motorcycle (Riding)
1.5	102	
1	105	Sporting Event
0.5	110	
0.25 or less	115	Loudest parts at a rock concert

Welcome

Thank you for purchasing the water-cooled LED system. We hope it exceeds your expectations for experimental testing.



LM2XX-XXX



DC2XX



UM2XX-10

The first section of this user manual serves as a quick-start guide to getting the LED system set up. The remaining pages describe the hardware side of things in more detail, and is intended to be used as a reference.

About This Guide

This guide is designed to be accessible, with subsections as complete as practical to minimize the need to scan back and forth to find what's needed.

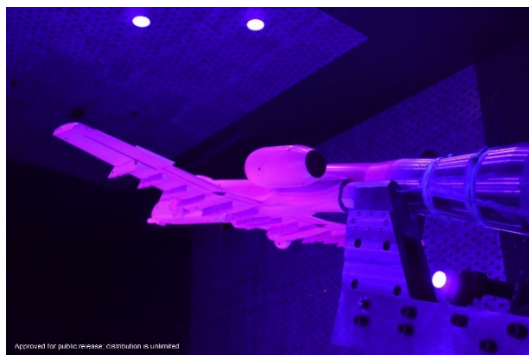
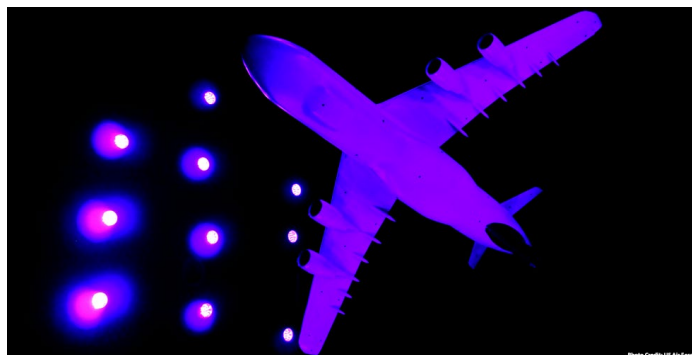
This guide provides the following resources:

- A general overview of the DC2XX features.
- A general overview of the LM2XX features.
- Hookup diagrams depicting some of the more common setups.
- Listing and Description of Key Components
- Hookup diagrams depicting some of the more common setups.

LED Illumination Lamps

Light emitting diode (LED) arrays are the most convenient and cost-effective means to excite fluorescent dyes in experimental measurement studies including pressure and temperature sensitive paints to and particle shadow velocimetry. Using the correct light source is critical to the accuracy of the measurement. Optical measurement techniques require a sufficiently energetic, low noise, stable illumination source if quality data is to be acquired. Any variation in output illumination from the excitation source will cause measurement errors. ISSI LED arrays contain proprietary optical and electrical filtering to achieve very stable, narrow-band illumination.

All models of LEDs are available in 400- and 460-nm wavelengths standard. Other wavelengths are available upon request.



**ISSI LEDs Mounted in AEDC 16T Wind Tunnel During Pressure Sensitive Paint Tests,
Photo Credit US Air Force**

Uses

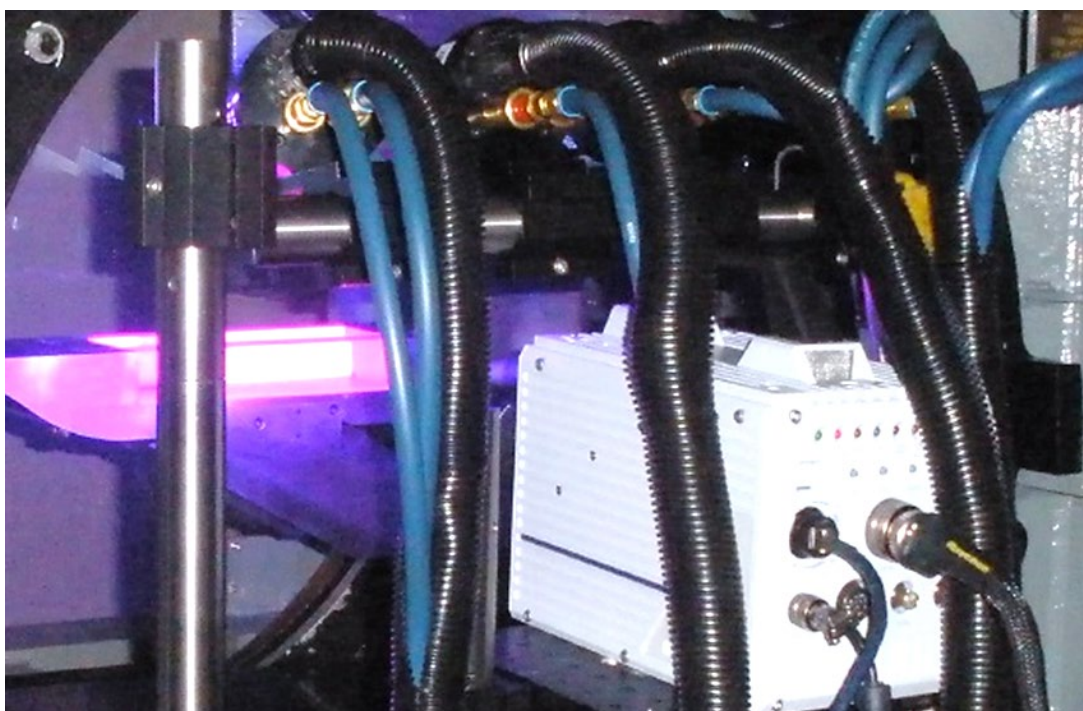
Molecules within **pressure sensitive paint** are excited by a narrow band LED light source of a specific peak wavelength. Once excited, these molecules will either fluoresce, emitting a photon of a longer wavelength, are quenched by local oxygen molecules (pressure sensitive paint) or are thermally quenched (temperature sensitive paint). This quenching rate determines the fluorescent intensity of the paint layer. The fluorescent levels can be used to estimate pressure or temperature using a previously determined calibration of the paint.

Particle Shadow Velocimetry uses a pulsed LED light source to characterize seeded flow fields near surfaces in small regions of interest in water and air. The technique is a cost-effective alternative to some Particle Image Velocimetry (PIV) applications that uses shadows cast by particles to track movement rather than the traditional light scattering PIV technique using expensive lasers.

Schlieren photography is a technique utilized to image fluid density gradients. The density gradient of the fluid gives rise to refractive index changes which distort the collimated beam of light between two mirrors and thus the point of focus. Using a knife edge, variable density slide or color slides at the focus to exploit this effect allows high-contrast imaging of otherwise nearly invisible density gradients.

Description & Specifications

Water-cooled LEDs provide a significant increase in output power needed in large test facilities or for fast pressure sensitive paint measurements. Large test sections require more excitation light because the model is further from the data acquisition system and fast PSP systems require significantly shorter camera exposure times. Water cooling allows the LEDs to be driven harder than the air-cooled LED systems. Water-cooled LEDs provide ~3 times the output power of their comparable air-cooled versions. Three parts compose the water-cooled LED: the control box, the LED head and the umbilical cable. The control box houses the drive electronics, power supply and water-circulation system. The umbilical supplies the cooling water and the electrical connection between the control box and the LED head. Umbilical cables are available in 10-, 20- and 30-foot lengths. Extension cables for existing systems are also available. External water is supplied to the control module via a tap water source or a refrigerated chiller.

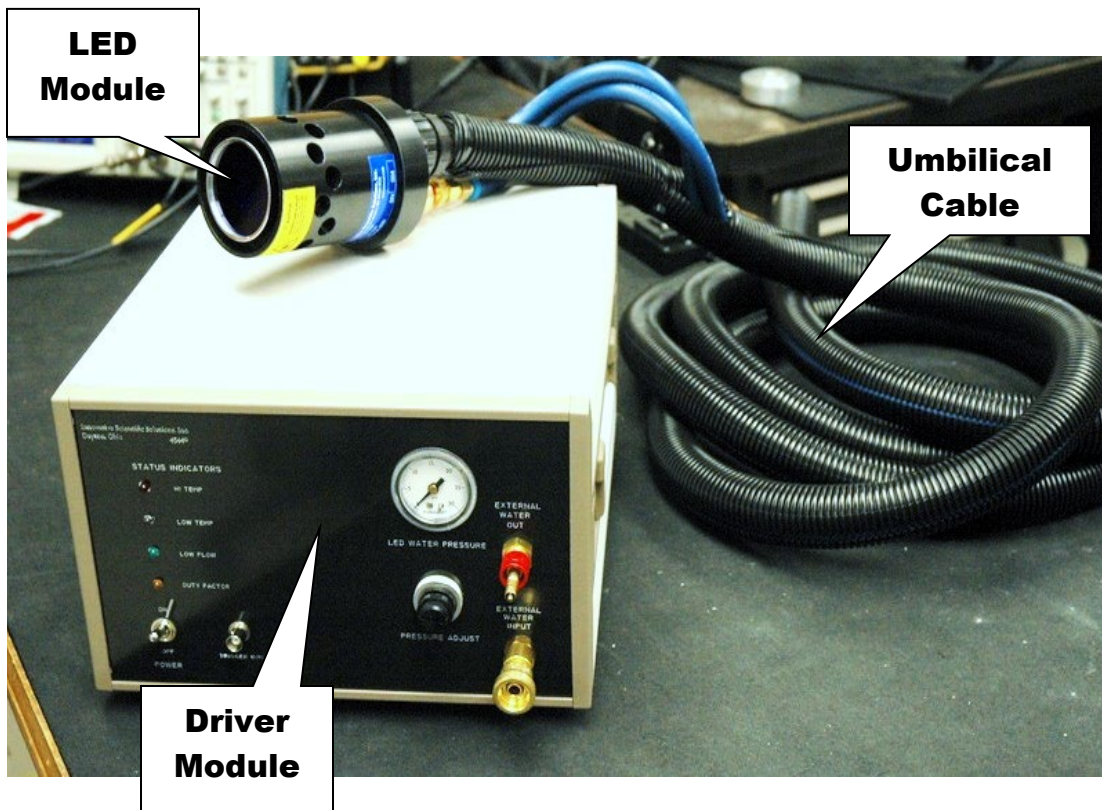
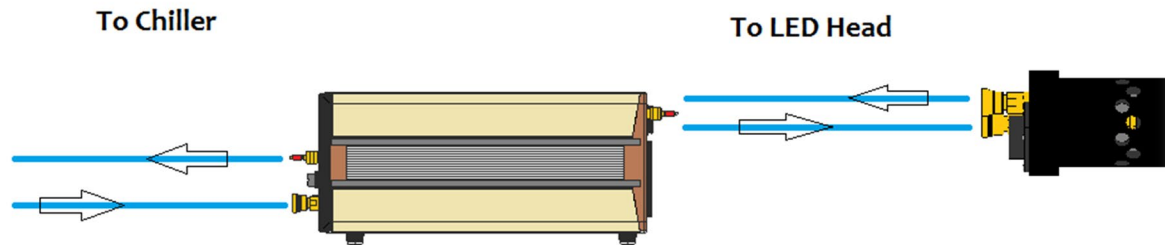


Specifications

Output power	12-14 W (optical)
Input	24VDC, 8.2A
Stability	~0.1 % per hour after warm-up
Maximum duty cycle	100%
Rise time (10% - 90%)	< 600 ns
Fall time (90% - 10%)	< 300 ns
Operating temperature range	-10°C to 60°C
Wavelength	400-nm and 460-nm (Standard)
FWHM	+/- 18-nm
Warranty	12-months
ECCN	EAR99

Operating Instructions

The water-cooled LED system is designed to be easy to set up and operate. There are only three parts of the water-cooled LED system. They consist of the LED module, driver module, and the umbilical cable. The umbilical cable is connected from the power supply to the LED module. This cable contains the drive coaxial cables and the water lines to cool the LED module.



Assembled LED System

DC2XX Driver Module

Front Panel

The front of the drive module has the input water connections on the right side of the panel. The input and output are marked accordingly and must be adhered to because there is a flow meter inside the drive box that needs to have the water flowing in the proper direction for correct operation. Adjacent to the water input connections are the water regulator and the water pressure gauge. The input water pressure can be anywhere between 0 to 300 psi. When the water is applied to the input the operator should adjust the regulator to 10 to 20 psi. If the LED module is placed much higher pressure than the drive module the higher pressure will be required. Any pressure over approximately 5 psi will provide sufficient water flow to operate the LED system. The output of the water port must **always** be at atmospheric pressure. The operator should connect all the water lines before applying water pressure to the system. When disconnecting the water lines make sure that the water flow has been stopped. The quick disconnects are not meant to be used to stop water flow but will contain any remaining water in the lines when disconnected. The water temperature should be around room temperature for best LED performance. If lower temperature water is used the light output of the LED system will be increase. It is important that the temperature selected will not cause condensation in more humid atmospheres.



Front Panel of Driver Module

The lower left side of the panel has the power switch and the BNC trigger input connector. Above those are the LED status indicators that give the operator an indication of what faults have occurred. Along with the indication, the drive module will control the output of the LED lamp. If the high temperature or low flow indicators are activated, the lamp will stop operating until the fault is cleared. If the low temperature indicator activates because the water temperature is below the set point the water flow will be halted by a solenoid in the drive module. This will keep condensation from occurring in a humid atmosphere. The LED lamp will continue to pulse with that condition. When the temperature of the LED lamp gets above the low temperature shutoff, point the water flow will begin to flow.

Status Indicators

Hi Temp – LED heat sink temperature too high, LED will stop emitting

Low Flow – Flow rate of cooling water to the driver module is too low

Open RTD – Umbilical cable RTD not connected

Duty Factor - No longer used. DM and DMHP capabilities now in a single driver circuit

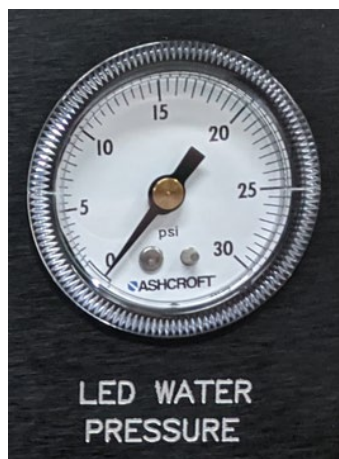


Trigger Input – Input TTL trigger to LED Driver Module

Fault Output – Output (5V TTL) signal for fault indication. The intent of the output is to provide the operator with remote feedback in a multi-unit setup. If while in operation, either LM2XX LED module exceeds a safe operating temperature or low-flow condition, the output of the LED will disable and a 5V high signal will be present at this output.

The Driver module will operate in either DC or pulsed mode. To operate in pulsed mode, connect a TTL input trigger to **Trigger Input** and the LED will pulse synchronously with the input trigger. To operate DC (continuously), connect a BNC cable between **Trigger Input** and **Fault Output**.

The flow meter displays the water pressure of the water supplied to the External Water Input connection. The input water pressure can be anywhere between 0 to 300 psi.



The Pressure Adjust regulator allows the operator to adjust the pressure to the system. When the water is applied to the input, it should be adjusted with the regulator to 10-20 psi.

Water Fittings

Cooling water is supplied to the DC2XX Driver Module via brass quick-disconnect fittings. These fittings are designed to click and lock together with their mating connector, providing a water-tight connection. The input and output are marked accordingly and must be adhered to because there is a flow meter inside the drive box that needs to have the water flowing in the proper direction for correct operation.



Caution: Supply water for the DC2XX should be filtered and free of debris and particulates.

Rear Panel

The rear panel contains the water connections to the LED lamp head and a large connector with the electrical connections (power/trigger) to the LED module. The AC input along with the fusing for the electrical input on the rear center of the drive module are also located here. There are two fan ports on the rear that should remain clear of obstructions at all times. One draws air into the drive module while the other provides an exhaust to the atmosphere.



Rear Panel of DC2XX Drive Module

Multi-Pin Circular Connectors

The multi-pin circular connectors at the top center of the DC2XX rear panel provide power and cooling water for the LM2XX LED module. The connections to the LED are made using the provided umbilical cables.



Caution: Do not use any other means to connect to the LM2XX modules other than the cables provided. If you believe you require a different length or cable configuration for your application, please consult the manufacturer.

The connectors are keyed to prevent improper insertion, and are locked in place by a clockwise twist lock mechanism. Note that the genders of the connectors on the DC2XX Drive and Control Assembly differ from the LM2XX module and therefore are not interchangeable from end to end.

Cooling Water to LED Module

Mating connector on the umbilical cable connect to the LED Cooling Water connections to provide cooling water to the LED module and circulate this water back through the system.



AC Power

AC input power to the DC3X is provided via the IEC C14 power inlet connector to the right on the rear panel.



A power cord has been provided. Do not substitute the provided cable. If you require a replacement cable, please consult the manufacturer.

The DC2XX has been designed to operate on international power. The allowable input voltage range is 115 to 250 V at 50 to 60 Hz. The power supply is auto-sensing and does not require any change of settings to operate anywhere in the above range.

Fuse



AC power for the DC2XX is current limited by a fuse. The fuse is integrated into the power input module. If you believe the fuse needs to be replaced due to suspected fault with the hardware, please consult the manufacturer.

Air Vents

There are two fan ports on the rear that should remain clear of obstructions at all times. One draws air into the drive module while the other provides an exhaust to the atmosphere.



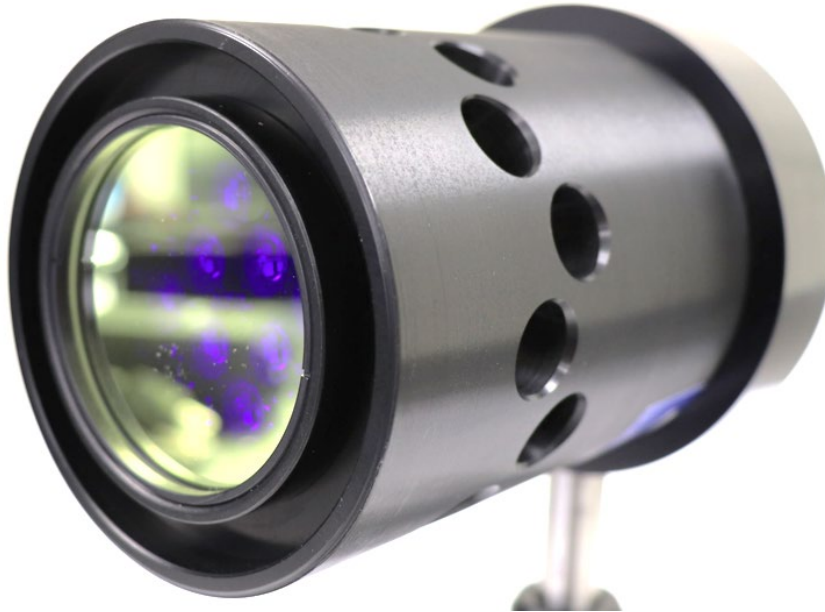
Cooling Flow Inlet for Power Supply

If the LED system is operating in a low static pressure environment, it is best to place the driver module outside of this in a more climate controlled area if possible. If this is not possible, the DC2XX will need cooling air provided directly to the fan inlet to prevent overheating of the power supply.

Caution: Do not block the air vents on rear panel.

LM2XX LED Module

The LM2XX LED module is a special purpose LED light source that is specifically designed to provide the optimal illumination source for all pressure sensitive paint applications using ISSI proprietary paint formulations. The unit has two connectors on the rear cover of the housing, one circular connector for electrical connections and two quick-disconnect water fittings for cooling.



Caution: Possibly hazardous radiation emitted from this product. Do not stare at operating lamp. May be harmful to the eyes.

Multi-Pin Circular Connector



The multi-pin circular connector at the top of LM2XX rear cover supplies DC power to the integrated LED array. Also provided is the temperature feedback to the DC2XX for the purpose of over-temperature protection.

Cooling for the LM2XX is provided via the two quick-disconnect water fittings on the bottom of the rear cover. The cooling and electrical connections should be made directly to the umbilical cable provided. Do not substitute the cable or use adapter fittings unless provided by the manufacturer.

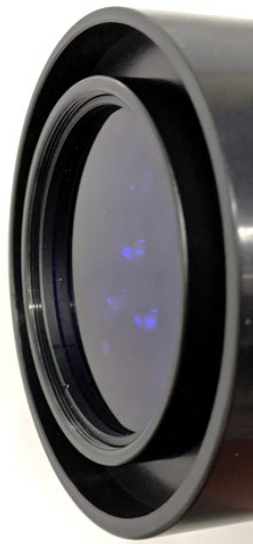
Air Vents

Vent Holes



Caution: Do not cover vent holes. Covering the vent holes will cause the unit to overheat and over-temp protection circuit will engage.

Filter and Filter Holder Assembly



The filter glass is held in place with a 52mm filter ring housing and retaining ring. The retaining ring can be removed or installed using the provided spanner wrench. See maintenance section for details on installing or removing this filter.

Electronics and Cooling Umbilical Cable



Each LM2XX connects to the DC2XX via an umbilical cable which provides power and trigger to the LM2XX as well as cooling water to the LED module. Connections can only be made one way so the cable cannot be incorrectly installed.



Cooling Water Requirements

To provide proper cooling water to the driver module, the LED system needs to be connected to either a clean tap water source or a refrigerated chiller. The refrigerated chiller must have the proper pump capacity (positive displacement pump) to provide cooling water. Below is a list of compatible ThermoChill refrigerated chillers from Thermo-Fisher Scientific. This can be used as a reference when selecting a chiller.

ThermoChill I	ThermoChill II	ThermoChill III
+5°C to +30°C (+41°F to +86°F)	+5°C to +30°C (+41°F to +86°F)	+5°C to +30°C (+41°F to +86°F)
+10°C to +35°C (+50°F to +95°F)	+10°C to +35°C (+50°F to +95°F)	+10°C to +35°C (+50°F to +95°F)
±0.1°C	±0.1°C	±0.5°C
700 W / 2391 BTU	1000 W / 3415 BTU	2000 W / 6830 BTU
600 W / 2049 BTU	900 W / 3074 BTU	1900 W / 6489 BTU
9.5 liters (2.5 gallons)	9.5 liters (2.5 gallons)	19.0 liters (5.0 gallons)
R134A	R134A	R134A
23.8 x 14.0 x 23.0 in (60.5 x 35.6 x 58.4 cm)	23.8 x 14.0 x 23.0 in (60.5 x 35.6 x 58.4 cm)	28.0 x 17.0 x 23.0 in (71.1 x 43.2 x 58.4 cm)
1.4 gpm @ 60 psid (5.3 lpm @ 4.1 bar)	1.4 gpm @ 60 psid (5.3 lpm @ 4.1 bar)	1.4 gpm @ 60 psid (5.3 lpm @ 4.1 bar)
1.2 gpm @ 60 psid (4.5 lpm @ 4.1 bar)	1.2 gpm @ 60 psid (4.5 lpm @ 4.1 bar)	1.2 gpm @ 60 psid (4.5 lpm @ 4.1 bar)

Hoses with mating connectors for the external water input and output are provided with the system. The hoses will be shipped with a garden hose connection on one end for tap water connection. This can be removed to connect to a chiller if needed. The opposite end will have the mating connector for the front panel connections.



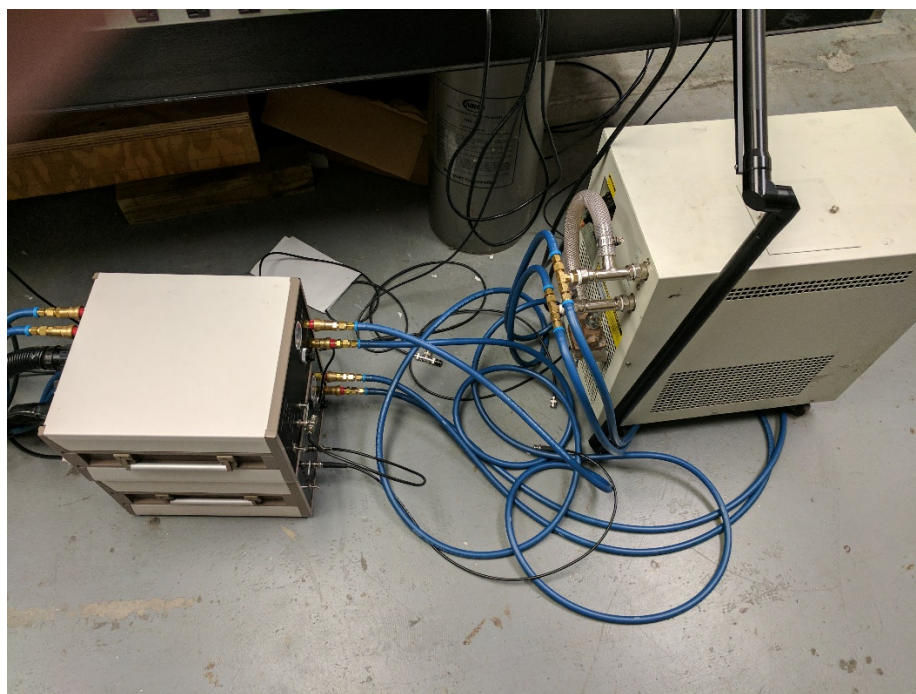
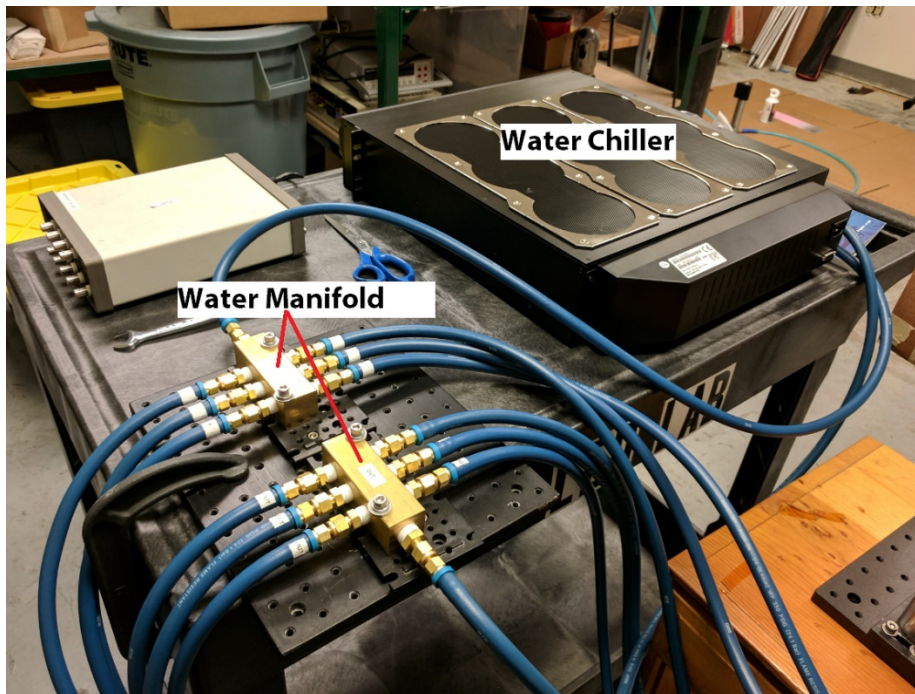
Water Output Hose



Water Input Hose

Setup Examples

Multiple LED systems can be connected to a single chiller using a manifold system (sold separately) as long as the chiller or water source has sufficient capacity for the number of LED systems to be connected.



Accessories

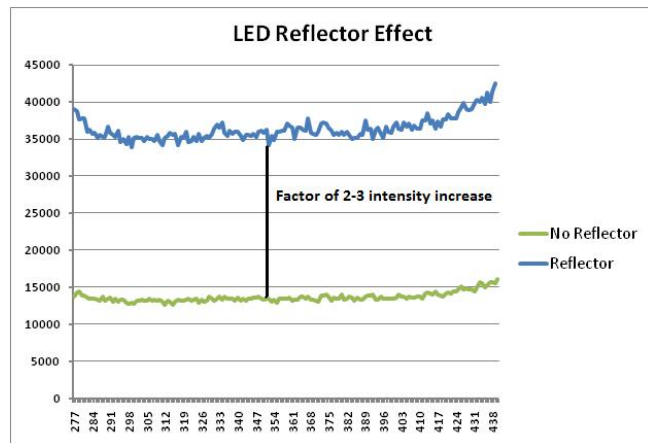
LM2X Clamp (LM2X-CL)



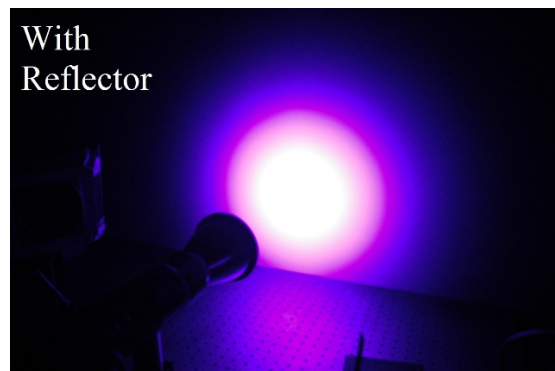
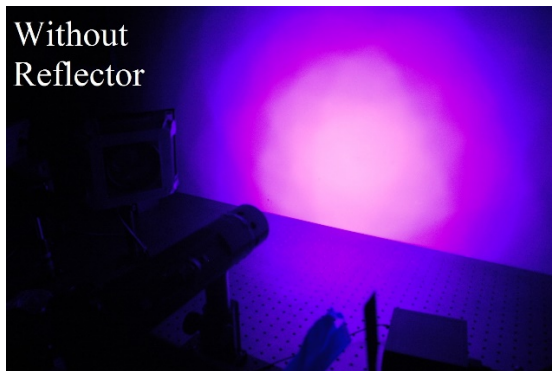
The LM2X-CL is an optional accessory for the LM2XX that securely clamps to the LED housing for extra grip during mounting. It is compatible with the SL20 ball mount base from Thorlabs. This is a strongly recommended accessory as it makes mounting much faster and adjusting the LED position much easier than a single threaded hole and post method.

Parabolic Reflector and Diffuser (LM2X-10R40-D)

In areas where more light is needed on a surface, the parabolic reflector and diffuser can be used on any LM2 series LED to narrow the output angle from 120-degrees down to 40-degrees. This reflector also uses a diffuser for a more uniform output from the LED module. The reflector and diffuser is simply screwed onto the front of the filter housing of the LED module.

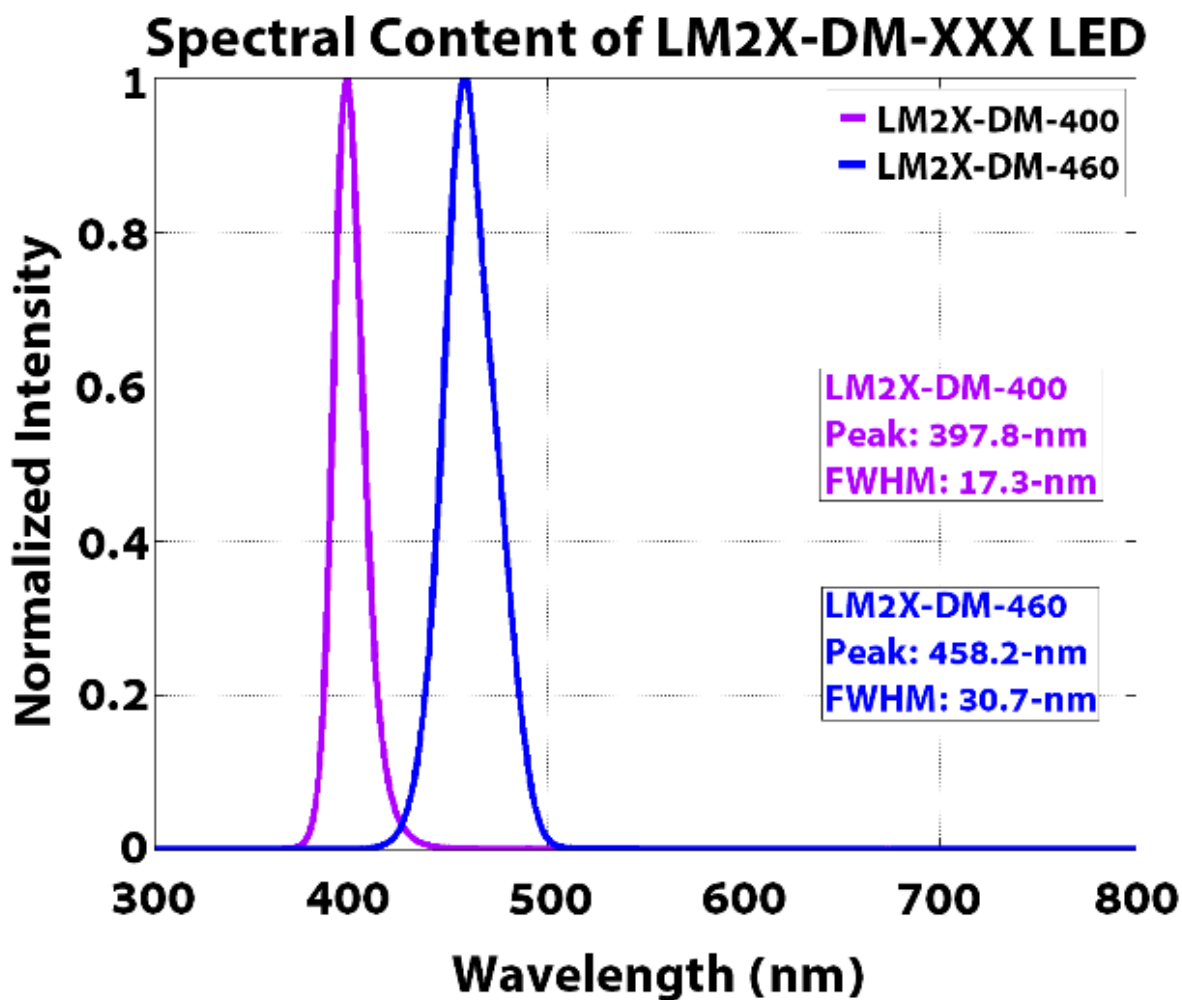


The addition of the parabolic reflector and diffuser gives a factor of 2-3 increase in peak output power at the center point.



The above graphic shows the effect of the parabolic reflector and diffuser on an LM2X-DM-400 module.

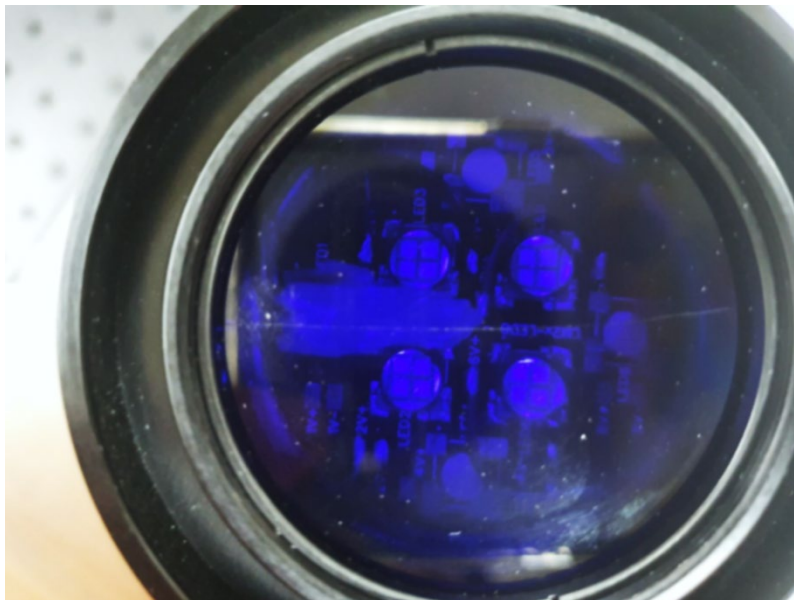
Typical Waveforms



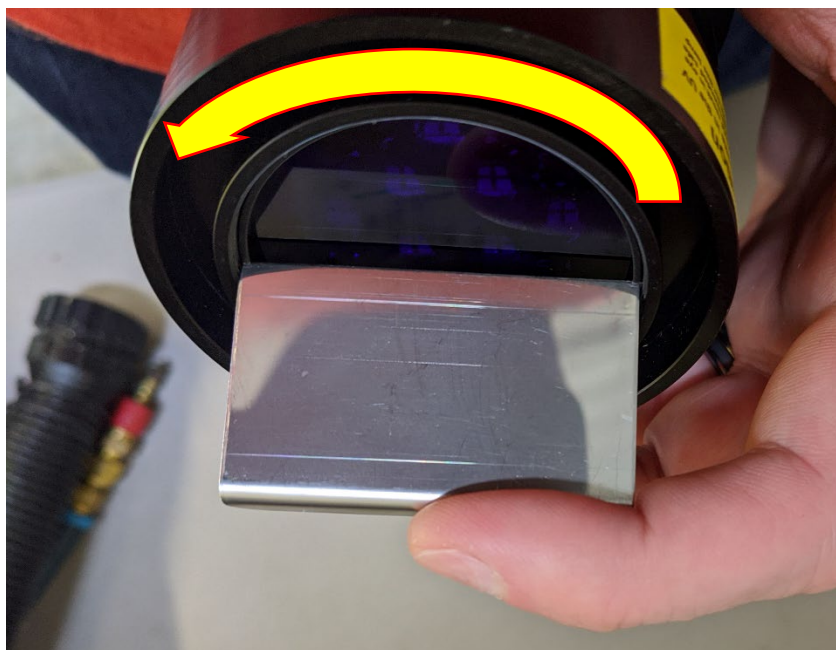
Note: Other wavelengths are available upon request. Cost and output power may vary from the standard depending on the wavelength.

Maintenance

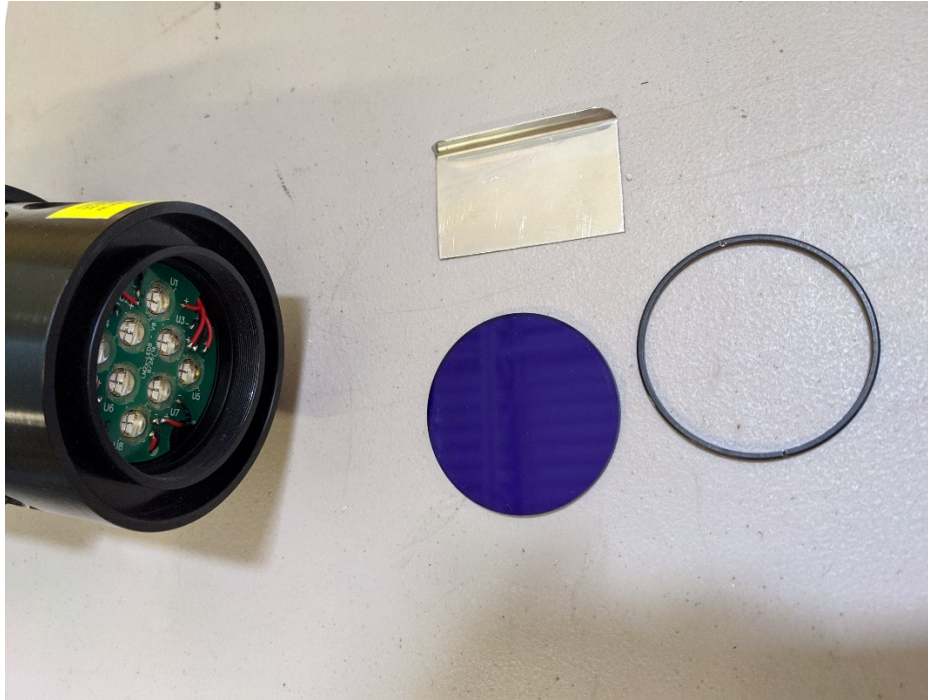
In the case of a broken glass filter, it can be removed and easily replaced with a new one.



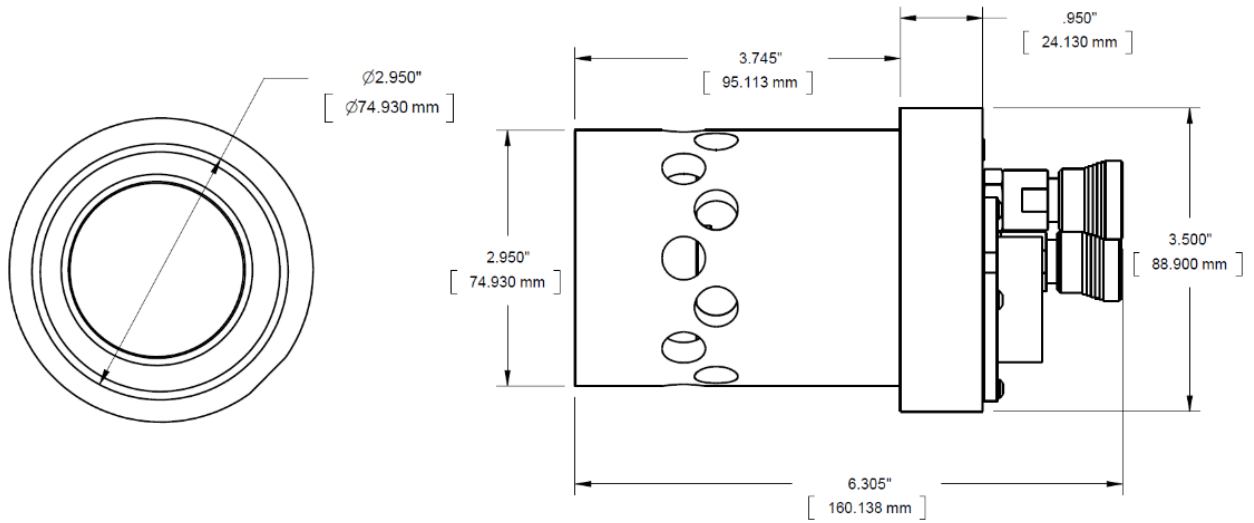
Using the provided spanner wrench tool, the damaged filter can be removed from the filter housing. Turn the wrench counter-clockwise as shown below to remove the filter.



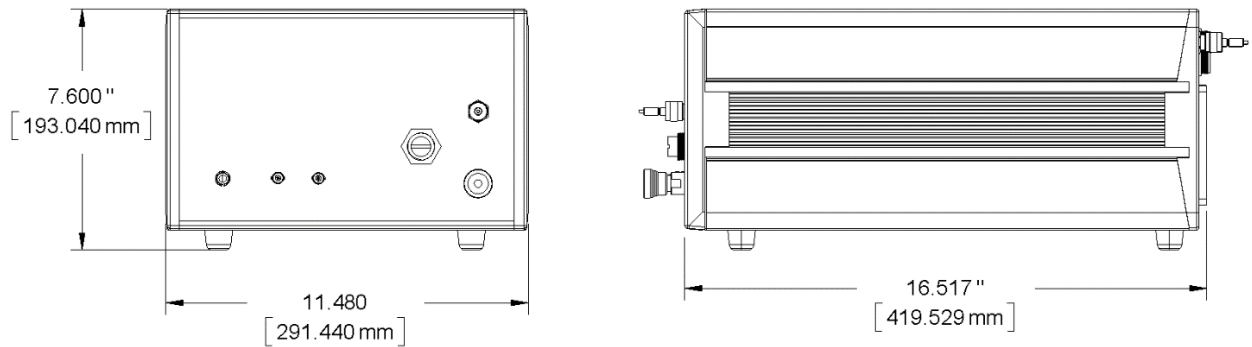
A small retaining ring holds the glass filter in place. The spanner wrench removes this ring and then the filter can be removed. Once the old filter has been removed, carefully place a new one in the filter housing and reattach the retaining ring using the spanner wrench and turning clockwise until tight.



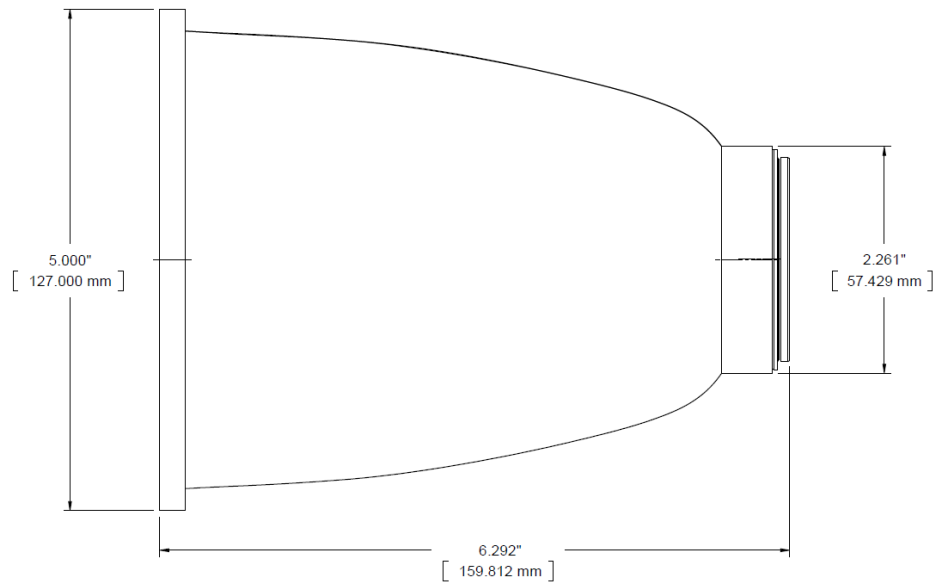
Drawings



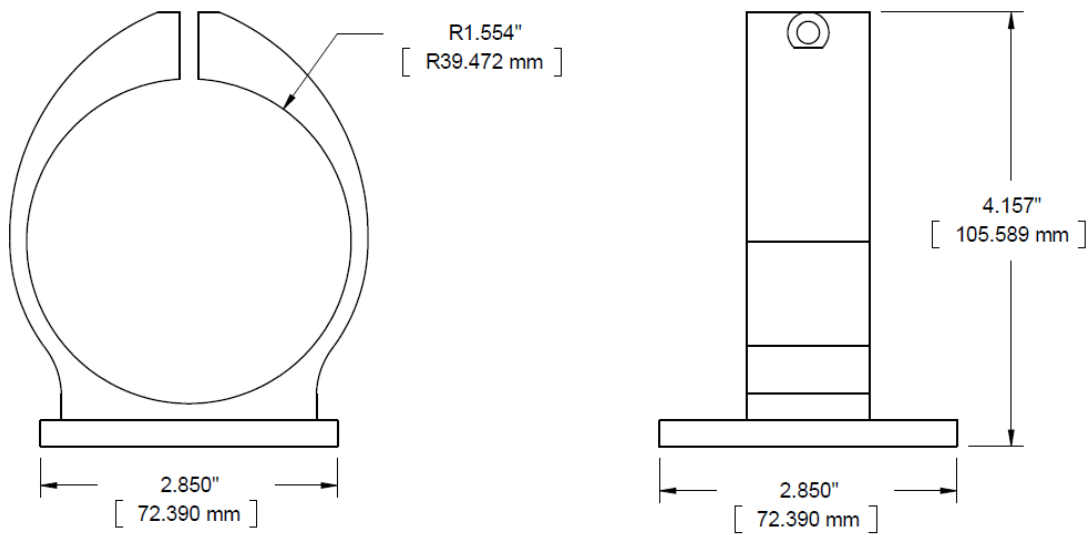
LM2XX- XXX LED Head



DC2XX Control Box



Parabolic Reflector and Diffuser



LM2 Series LED Mounting Clamp

Export Disclaimer

Any and all underlying information and technology contained in this document may be subject to U.S. export controls, including the Export Administration Act (50 U.S.C. Appx. §§ 2401 et seq.) and the Export Administration Regulations ("EAR", 50 C.F.R. Parts 730-774), and may be subject to export or import regulations in other countries. You are responsible for complying with all trade regulations and laws both foreign and domestic. Except as authorized by law or distributor agreement with ISSI, you agree and warrant not to export or re-export the information to any country, or to any person, entity, or end-user subject to U.S. export controls, including without limitation persons or entities listed on the U.S. Department of Commerce Bureau of Export Administration's Denied Parties List and the U.S. Department of Treasury's Specially Designated Nationals. You further represent and warrant that no U.S. federal agency has suspended, revoked, or denied your export privileges.