

# OPERATING INSTRUCTIONS FOR THE AIR-COOLED LED SYSTEM

Version 1.0 Getting started using your new air-cooled LED system

Innovative Scientific Solutions, Inc. 2021



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#### LM4X/LMX-DPS User Manual

### **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.

### **A** WARNING

Equipment and surface temperature may be high during use. Check for hot surface before handling.



- 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 UVEX SCT Orange lenses. Safety glasses utilizing these lenses block near 100% of the damaging retinal blue light. The LM4X 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 thought 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 UVEX SCT Orange lenses. Safety glasses utilizing these lenses block near 100% of the damaging retinal blue light.

## A WARNING

Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result.



**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).

# A WARNING

Electrical shock hazard. Do not open. No user servicable parts inside. Refer to manufacturer.

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- 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 las limites applicables aux appareils numériques de class A/de class B (selon le cas) prescrites dans le réglement 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 vvil 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 <b>in</b> 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 4-inch, air-cooled LED system. We hope it exceeds your expectations for experimental testing.



UM4X-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 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 LM4X features.
- A general overview of the LM4X-DPS features.
- Hookup diagrams depicting some of the more common setups.
- Listing and Description of Key Components



### **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 and 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**

The LM4X 4-inch, air-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. The larger heat sink and higher number of individual LEDs allows the system to be driven harder than the 2-inch, air-cooled LED systems, providing ~5 times the output power. Three parts comprise the 4-inch, air-cooled LED: the power supply, the LED module and the umbilical power cable.



#### **LED System Components**







### **Specifications**

AC Power Input	100-240 V, 50-60Hz
DC Input	31V 8A
Output Power	25 W (optical)
Stability	~0.2 % per hour after warmup
Wavelength (Standard)	*400-nm, 460-nm
Operating Temperature	-10-60 °C
Rise Time (10% - 90%)	< 100 µs
Fall Time (90% - 10%)	< 100 µs
Duty Cycle	100%
Maximum Pulse Width (Continuous ON time or TTL High Input)	300 s
Minimum Pulse Width	1 µs
FWHM	+/- 18-nm
ECCN	EAR99
Warranty	1 Year



### **Operating Instructions**

This air-cooled LED system is designed to be easy to set up and operate. There are only three parts of the 4-inch, air-cooled LED system. They consist of the LED module with driver module, power supply and the umbilical cable. The umbilical cable is connected from the power supply to the LED module.

## LM4X LED Module

The LM4X 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 a connection for power input on the driver section as well as a BNC connection for external trigger input. With a trigger input connected to the BNC connection, the LED will mirror the incoming pulse width and frequency. With a TTL High input pulse, the LED will remain on continuously. To avoid overheating and damage to the LEDs, *do not* exceed 5 minutes of continuous ON time for the LED.



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

### Cooling



Cooling for the LM4X is provided via dual fans that draw in cool air from the environment. For atmospheric tests, these fans are typically sufficient to cool the heat sink. For low static pressure environments



#### LM4X/LMX-DPS User Manual

(supersonic wind tunnels) there are two gas fittings on the rear cover. Air lines can be connected to these fittings to provide additional cooling where the atmospheric pressure is too low. Blue air lines of  $\frac{1}{4}$ " tubing will fit these fittings. One end of the provided cooling-air lines has the mating connection to connect to the air fittings. The other end has no connector. This end can be fitted to the appropriate connection for the cooling air setup at the end use facility or it can be connected to the nut and ferrule that are on the back of the LM4X housing. Input pressure to these cooling air lines, fully insert the open end of the air line into the open hole in the nut. Then, using a wrench, turn the nut  $1 + \frac{1}{4}$  turns. This will press the ferrule into place around the tubing, making an air tight connection.



Installing Nut and Ferrule on Cooling Air Tubing

2 cooling air tubing lines are supplied with each LM4X LED module.



1/4" Cooling Air Tubing



#### **Air Vents**

A series of vent holes are located around the perimeter of the LM4X LED module section. This allows transfer from the heat sink to help to cool the LEDs as air is drawn in from the cooling fans or cooling air supply. Keep these vent holes clear to avoid the unit from overheating.



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 bandpass filter is a glass filter on the LED module is used to reject wavelengths outside of the specified LED output spectrum to produce a narrow band output.



The bandpass filter is held in place with a set screw and retaining ring. The retaining ring can be removed or installed using a 0.050" hex wrench. Replacement filters can be purchased as spares or replacements for a broken filter. Take precautions when handling the LED module as to avoid damaging the filter. The thickness of this filter is 1mm so an impact to it could crack it.



The driver section of the LM4X has a connection for power input as well as a BNC connection for external trigger input. With a trigger input connected to the BNC connection, the LED will mirror the incoming pulse width and frequency. With a TTL High input pulse, the LED will remain on continuously. To avoid overheating and damage to the LEDs, *do not* exceed 5 minutes of continuous ON time for the LED.



Inputs to LM4X

## **LM4X-DPS Dual Power Supply**

### **Front Panel**

The dual power supply is a power supply for the LM4X LED modules. Each dual power supply can operate up to two LM4X LED modules. The power supply features two output power connections with keyed screw-and-lock connectors for LED modules, a power input screw-and-lock connector for connection to wall power (universal power 115-250VAC, 50/60 Hz) and a fuse rated for universal power as well.



Front Panel of Dual Power Supply

The power supply also has a cooling fan each side to draw in and exhaust air for cooling of the power supply. One draws air into the power supply while the other provides an exhaust to the atmosphere. The cooling fan on the front panel draws air into the power supply. When the dual power supply is located in a low static pressure environment, cooling air must be supplied to it to prevent overheating.



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A ¼" cooling line with mating connector is supplied with the dual power supply. This cooling line will connect directly to the brass fitting. Tighten by hand and then tighten with a wrench ¼ of a rotation. The other end of the tube has no connector. An appropriate mating connector to fit the supply air can be added to the open end of the tubing. The nut and ferrule assembly that is supplied on the dual power supply can be added to the open end of the tube using the instructions shown on page 8.



**Cooling Air Supply Line** 

### **AC Power**

AC input power to the LM4X-DPS is provided via the power inlet connector on the front panel.



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



#### **AC Power Cable**

The LM4X-DPS 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 LM4X-DPS 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.



### **Rear Panel**

The rear panel has an exhaust fan to draw out warm cooling air that is fed into the cooling port and inlet cooling fan.



**Rear Panel of LM4X-DPS Power Supply** 

**Caution:** Do not use any other means to connect to the LM4X modules other than the cables provided. If you believe you require a different length or cable configuration for your application, please consult the manufacturer. Do not block cooling fans.



## **LED Power Cable**

A power cable to connect the LM4X to the dual power supply is supplied with each LED module.



UM4X-10 Power Cable

Each LM4X connects to the LM4X-DPS via this power cable with screw-and-lock connector on each end. Connections can only be made one way so the cable cannot be incorrectly installed.



**Connector to LM4X-DPS** 



**Connector to LM4X LED Module** 





**Connecting the LED Module to the Power Supply** 



### **Typical Waveforms**



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



## **D**rawings



LM4X LED Head



LM4X-DPS Dual Power Supply



### **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.