Lambda HPX

High-Power LED Light Source System
(Liquid Cooled)

Operation Manual

Rev. 1.04 ((20210128)

SUTTER INSTRUMENT®

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CE EU Declaration of Conformity

Application of Council Directives:
2014/30/EU (EMC), 2014/35/EU (LVD), and 2015/863/EU (RoHS 3)

Manufacturer's Name:	Sutter Instrument Company
Manufacturer's Address:	One Digital Drive Novato, CA. 94949 USA Tel: +1 415 883 0128
Equipment Tested:	**Lambda HPX** High-Power LED Light Source System (Liquid Cooled)
Model(s):	**HPX**
Conforms to Standards:	EMC Emissions: EN 61326-1:2013, including: EN 55011: 2009 Class A; EN 61000-3-2:2015, & EN 61000-3-3:2014
	EMC Immunity: EN 61000-4-2:2009, EN 61000-4-3:2011, EN 61000-4-4:2012, EN 61000-4-5:2014, EN 61000-4-6:2014, EN 61000-4-8:2010, & EN 61000-4-11:2004
	LVD (Safety): EN 61010-1:2010
	Photobiological Safety of Lamps & Lamp Systems: EN 62471: 2008 / IEC 62471, Ed 1.0 (2006-07)
Tested/Verified By:	ITC Engineering Services, Inc. 9959 Calaveras Road, PO Box 543 Sunol, CA 94586-0543 USA Tel. +1 925 862 2944 Fax: +1 925 862 9013 Email: itcemc@itcemc.com Web: www.itcemc.com
	Sutter Instrument
Test Report(s):	20150902-01, SI_HPX[-L5]_TF-A_(20150930), SI_EMC_LBHPX[-L5]_20160713; 20200520_REACH and RoHS Compliance Statement

Sutter Instrument Company hereby declares that the equipment specified above was tested and conforms to the EU Directives and Standards listed above, and further certifies conformation to the requirements of the European Union's Restriction on Hazardous Substances in Electronic Equipment Directive 2015/863 (2011/65/EU Annex II) for RoHS 3.

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DISCLAIMER

The **Lambda HPX** is a high-power LED illumination or light source device. The purpose of the system is to be an illuminator for microscopes. No other use is recommended.

This instrument is designed for use in a laboratory environment. It is not intended, nor should it be used in human experimentation or applied to humans in any way. This is not a medical device.

Unless otherwise indicated in this manual or by Sutter Instrument Technical Support for reconfiguration, do not open or attempt to repair the instrument.

Do not allow unauthorized and/or untrained operative to use this device.

Any misuse will be the sole responsibility of the user/owner and Sutter Instrument Company assumes no implied or inferred liability for direct or consequential damages from this instrument if it is operated or used in any way other than for which it is designed.

SAFETY WARNINGS AND PRECAUTIONS

Electrical

- **Operate the Lambda HPX using 110 – 240 VAC., 50-60 Hz line voltage. This instrument is designed for use in a laboratory environment that has low electrical noise and mechanical vibration. Surge suppression is always recommended.**
-  **Fuse Replacement: Replace only with the same type and rating:**

  2 Amp, 250V, 5 x 20mm, Time Delay fuse (EIC 60127-2)
  (Example: Bussmann GDC-2A or S506-2A (RoHS))

  A spare fuse is located in the power input module.

Avoiding Electrical Shock and Fire-related Injury

-  **Always use the grounded power supply cord set provided to connect the system's power adapter to a grounded/earthed outlet (3-prong). This is required to protect you from injury in the event that an electrical hazard occurs.**
- **Do not disassemble the system. Refer servicing to qualified personnel.**
-  **To prevent fire or shock hazard do not expose the unit to rain or moisture.**

Electromagnetic Interference

To comply with FDA and CE electromagnetic immunity and interference standards; and to reduce the electromagnetic coupling between this and other equipment in your lab always use the type and length of interconnect cables provided with the unit for the interconnection of its components (see the Technical Specifications appendix for more details).

Operational

Failure to comply with any of the following precautions may damage this device.

- Operate only in a location where there is a free flow of fresh air on all sides. NEVER ALLOW THE FREE FLOW OF AIR TO BE RESTRICTED.
- This instrument is designed for operation in a laboratory environment (Pollution Degree I) that is free from mechanical vibrations, electrical noise and transients.
- ⚠ DO NOT CONNECT OR DISCONNECT THE CABLES AND TUBING BETWEEN THE HPX AND THE HIGH-POWER LED ASSEMBLY WHILE POWER IS ON.
- Operate this instrument only according to the instructions included in this manual.
- Do not operate if there is any obvious damage to any part of the instrument.
- ⚠ Do not operate this instrument near flammable materials. The use of any hazardous materials with this instrument is not recommended and, if undertaken, is done so at the users' own risk.
- ⚠ Do not operate if there is any obvious damage to any part of the instrument.

Avoiding Physical Injury while Powered up and Emitting Light.

WARNING

DO NOT LOOK DIRECTLY INTO THE OUTPUT OF THE LIGHT APERTURE OF THE HIGH-POWER LED ASSEMBLY! Always direct the output of the light aperture into the microscope using the appropriate adapters, directed away from anyone's eyes, and not directed toward any reflective surface.

-  INFRARED AND ULTRAVIOLET RADIATION: The infrared radiation (and ultraviolet radiation) generated by this lamp can cause significant skin burns and eye damage.

Avoiding Physical Injury and Equipment Damage while Using High-Power LED

WARNING

Before removing the High-Power LED Assembly from the HPX controller, make certain that the system is powered down. To maximize LED life, run the system for five minutes with the LED off before disconnecting the cooling hoses.

Other

- Retain the original packaging for future transport of the instrument.
- Sutter Instrument reserves the right to change specifications without prior notice.
- This device is intended only for research purposes.

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PRE-FILLED LIQUID COOLING
DIMMING VIA PWM OR CURRENT CONTROL
FRONT MOUNTED CONNNECTORS FOR EASE OF ACCESS
LONG STABLE LAMP LIFE
TTL AND ANALOG EXTERNAL CONTROL
INTEGRAL SHUTTERING

1.2 Description

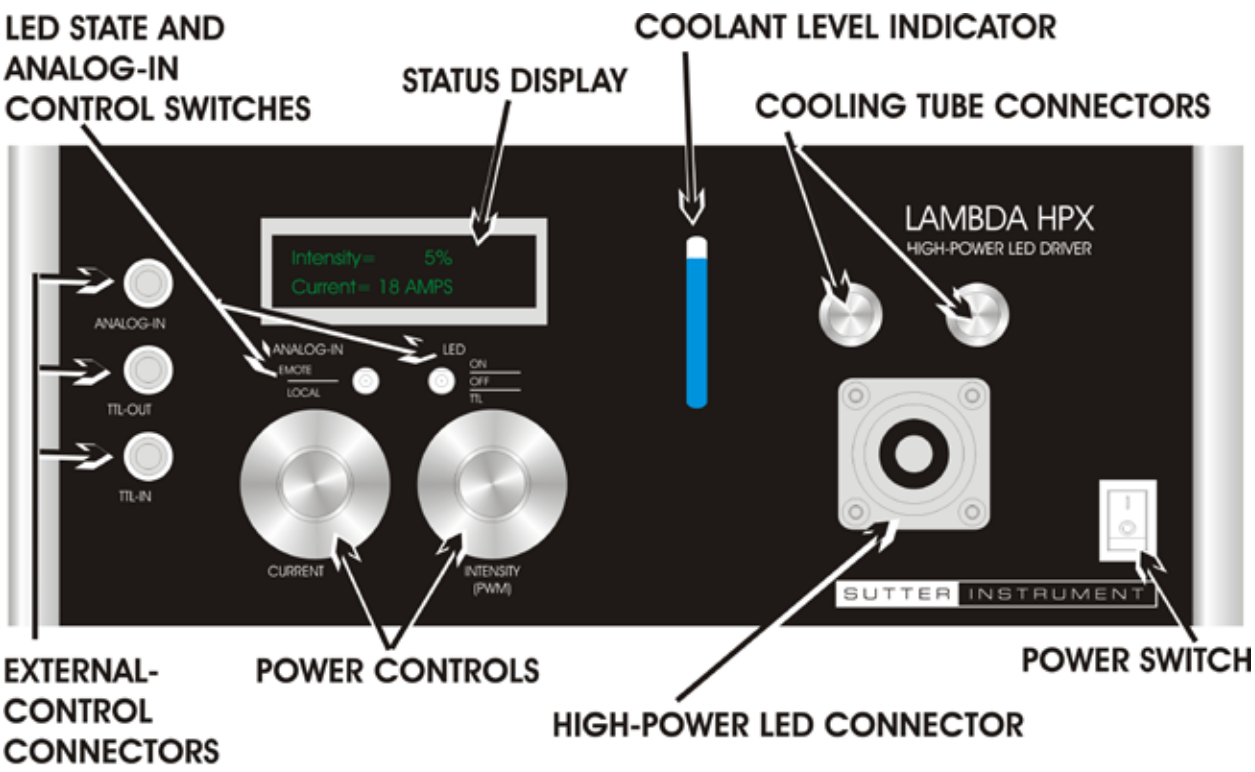

Figure 1-1. HPX indicators, controls, and connectors.

The Lambda HPX is a liquid-cooled, high-output, LED light source (illuminator). Designed around a single 90W 4.25mm LED die, the Lambda HPX provides light output comparable to a 200W xenon arc lamp. The system includes a quiet, vibration-free, liquid cooling head (pre-filled at the factory) that allows for the low-junction temperatures required to reach the LED

bulb manufacturer's projected life of 60,000 hours. The system has an expected original output retention rate of 95% at 5,000 hours and 80% at 10,000 hours. The lightweight precision-machined LED head mounts directly on the epifluorescence port of a microscope using one of Sutter Instrument's custom microscope adapters. Because LEDs exhibit color shift with electrical current change, the Lambda HPX has the ability to dim the LED using either PWM (pulse width modulation) or current control. The PWM method of dimming is generally preferred for most applications and allows the LED to run cooler. For applications that are intolerant of pulsed output, current control is available instead. Dynamically updated PWM and Current dimming control status information is displayed on the front panel; either is manually selectable via control knobs on the front panel. Effective shuttering is integrated into the system with the very fast on and off ("open" and "close") times of 5 and 2.5 microseconds, respectively. TTL input and output allows for software triggering. In addition to manual control on the front panel, external PWM control is available via analog input. The LED control/power cable and cooling tubing are easily installed and removed to and from the controller's front panel via no-drip quick connectors. Active temperature monitoring ensures maximized LED life.

Light output is in the visible spectrum from 400 – 729 nm. Both a cool white and "tungsten" white LEDs are available. Special order units are available with 623, 525, 460, 405, and 385 nm wavelength specific LEDs. A two-channel system with any combination of wavelengths can be configured by combining a Lambda HPX and Lambda TLED/TLED+.

1.3 Technical Support

Sutter Instrument Company at no charge provides unlimited technical support to our customers. Our technical support staff is available between the hours of 8:00 AM and 5:00 PM (Pacific Time) at **(415) 883-0128**. You may also e-mail your queries to **info@sutter.com**. Furthermore, as this manual is currently under construction, if there are any areas that you feel should be covered in detail, we would like to hear from you.

2. INSTALLATION

2.1 Unpacking

The Lambda HPX and associated hardware comes packed in a single carton. The following is a list of the components found there. If you believe that any of these components are missing or show obvious signs of damage from shipping, please contact the factory.

1. Controller cabinet
2. High-Power LED Assembly attached to the controller's front panel. The assembly consists of the LED housing to which are attached the high-power control cable for the LED and two clear tubes containing coolant fluid.
3. Adapter
4. Power Cord
5. Extra cooling fluid
6. Manual
7. One or more additional High-Power LED Assemblies containing different wavelength LEDs, if ordered.

2.2 Installation Instructions

1. Turn power switch to OFF ("0") position.
2. Plug power cable into the mains outlet.
3. Connecting the High-Power LED Assembly to the HPX:
   a) Connect the power cable of the High-Power LED assembly into the High-Power LED Connector" on the front panel of the HPX. Position the top of the connector slightly to the left, gently push inwards toward the connector, and then twist the connector toward the right (clockwise) until it snaps into position, and then release. Gently pull on the connector to make sure that it is well seated and connected.
   b) Connect one of the cooling tube connectors to one of the Cooling Tube Connectors on the front panel of the HPX, and then connect the second tube to the other connector. The fluid connectors are non-specific.
4. The Analog-IN and/or TTL-IN connections can be made to an external signaling source at stage if desired.

Once all connections have been verified, the system is ready to be turned on.

2.3 Configuring Input and Output TTL Logic

Input and output TTL logic is configured using the first three switches of the four-switch DIP bank located on the control board inside the controller cabinet. To access the DIP switch

bank, remove left-side panel (left-side while viewing the front panel) by unscrewing the six screws.

Figure 2-1. Lambda HPX-series left-side panel removed for access to configuration DIP switches.

While viewing the left side of the cabinet, the location of the DIP switch bank on the vertically mounted control board as shown in the following figure.

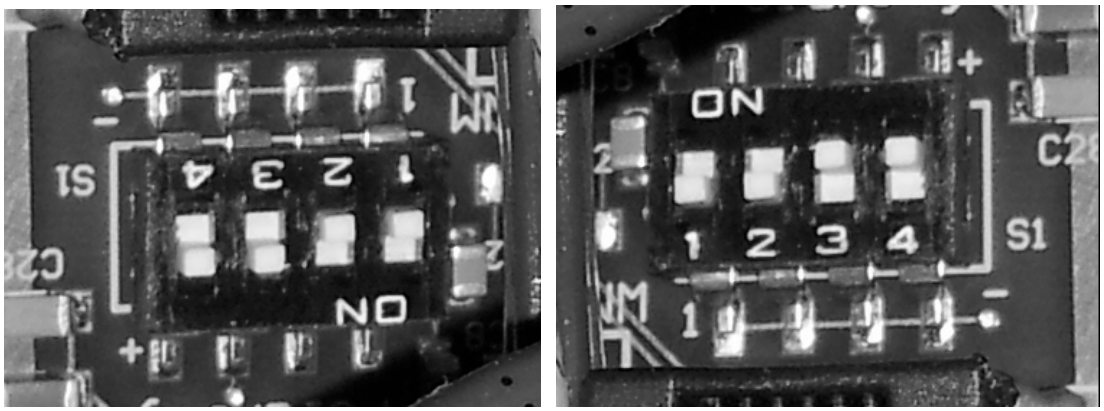

Figure 2-2. Configuration DIP switch bank as viewed head on and top-down.

The switches on the DIP bank are numbered 1 through 4 left to right. The definitions of these switches and their positions are described in the following paragraphs and are summarized in the table that follows.

2.3.1 TTL IN to TTL OUT Logic (Switch 1)

DIP Switch 1 determines the TTL OUT logic as synchronized with TTL IN.

When ON (default), the state of TTL OUT is the **same** as that of TTL IN (i.e., when TTL IN goes low, TTL OUT also goes low; when TTL IN goes high, TTL OUT also goes high).

When OFF, the state of TTL OUT is the **inverse** of that of TTL IN (i.e., when TTL IN goes low, TTL OUT then goes high; when TTL IN goes high, TTL OUT then goes low).

2.3.2 LED On/Off State Control by TTL IN (Switch 2)

DIP Switch 2 determines how the state at TTL IN determines the on/off state of the lamp when the LED Control Switch is in the TTL position.

When ON, TTL IN going HIGH turns the LED on; TTL IN going LOW turns the LED off.

When OFF (default), TTL IN going LOW turns the LED on; TTL IN going HIGH turns the LED off.

2.3.3 LED On/Off State while Transitioning Between LED Switch Positions ON and TTL (Switch 3)

DIP Switch 3 determines the on/off state of the lamp when switching between manually adjustable and TTL modes (from the LED switch's ON or OFF position to TTL).

When ON (default), lamp turns on.

When OFF, lamp turns off.

After switching from manual control to TTL, TTL control of the lamp's on/off state resumes on the next transition of logic state at TTL IN.

Note that because the OFF position of the LED switch is located in between ON and TTL, the lamp turns off while traversing the OFF position when switching from ON to TTL.

2.3.4 Firmware and Lambda HPX Model (Switch 4)

The position of DIP Switch 4 informs the control board's firmware of the specific Lambda HPX model it is controlling. This switch must be OFF (Lambda HPX with liquid-cooled lamp).

Table 2-1. DIP Switch configuration settings.

Switch	Definition	Position	Definition
1	**TTL OUT logic**	**ON***	Same as TTL IN: TTL IN=low → TTL OUT=low; TTL IN=high → TTL OUT=high
		OFF	Inverse of TTL IN: TTL IN=low → TTL OUT=high; TTL IN=high → TTL OUT=low
2	**TTL IN logic**	ON	TTL IN=high turns lamp on
		OFF*	TTL IN=low turns lamp on
3	**Lamp state when switching from manual control to TTL**	**ON***	Lamp turns on (Notes 1 and 2)
		OFF	Lamp turns off (Note 1)
4	**Lambda HPX model-specific operation (Note 3)**	ON	Lambda HPX-L5
		OFF*	Lambda HPX

"*" = Default

NOTE 1: After switching from manual mode (LED switch position ON or OFF) to TTL mode (LED switch position TTL), TTL control of the lamp's on/off state will resume with the next change of logic state at TTL IN.

NOTE 2: While using the LED switch to switch from ON to TTL, the lamp turns off while transitioning through the OFF position (the OFF position is located in between ON and TTL).

NOTE 3: Switch 4 must be OFF for proper operation of the Lambda HPX (liquid-cooled lamp).

3. OPERATIONS

This chapter describes the operation of the Lambda HPX. The locations of the individual indicators, controls, and connectors are indicated in the following figure.

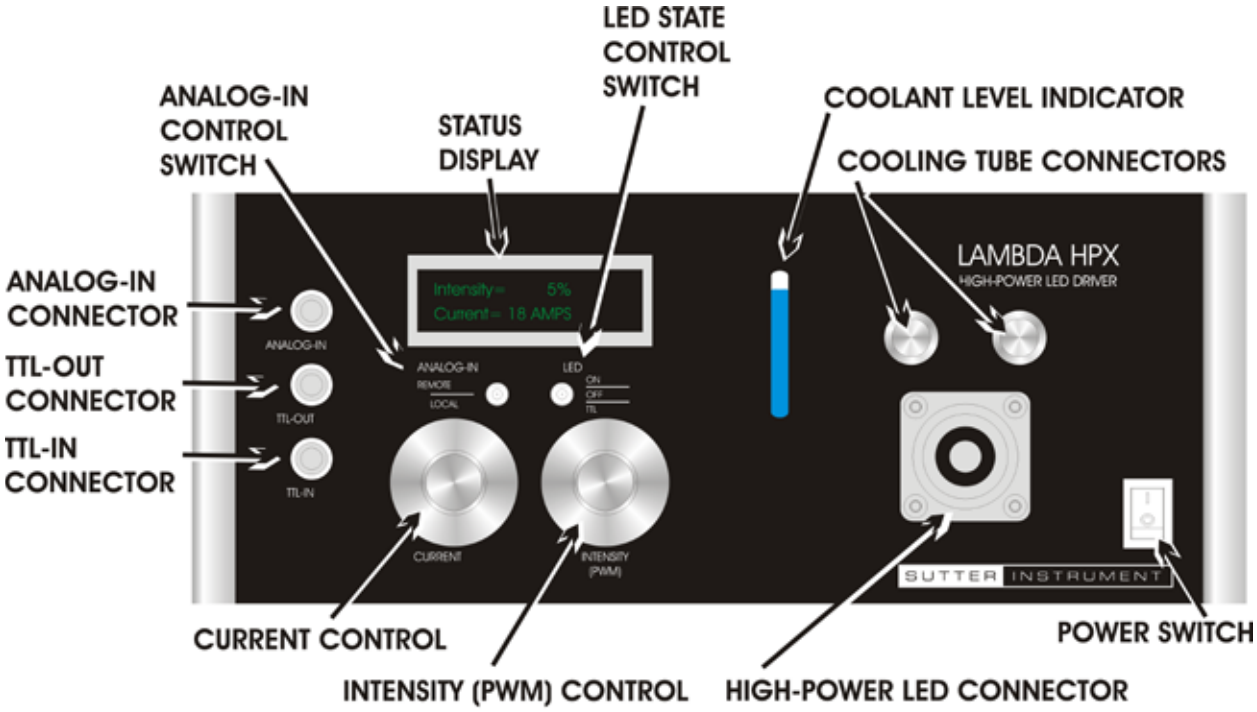

Figure 3-1. Locations of individual indicators, controls, and connectors on the Lambda HPX controller.

3.1 Indicators

3.1.1 Status Display

Displays intensity as a percentage and current level in terms of amperes.

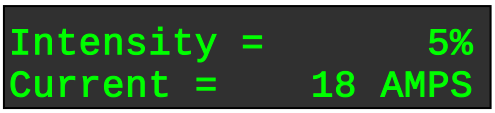

Figure 3-2. Status display.

Intensity ranges from 0 to 100%.

Current ranges from 4 to 18 Amps.

3.1.2 Coolant Level Indicator

This indicator is a liquid-level window through which blue coolant liquid should always be visible. When the cooling fluid level becomes low, refill to top through the cap on top of the unit. Additional cooling fluid is included in the shipping box. Additional fluid is available for purchase from Sutter Instrument.

3.2 Controls

3.2.1 Power Switch

Main power switch turns unit off/on.

3.2.2 LED Control Switch

This is a three-position toggle switch that is used to manually turn the LED on, off, or activate TTL switching through the TTL-IN BNC connector.

ON: Manually turns on the LED for manual control.

OFF: The intensity of the LED is controlled via voltage range of 0-5 VDC applied to ANALOG-IN.

TTL: LED on/off state is controlled by TTL triggering (via TTL-IN). Note that remote analog control (via ANALOG-IN) is turned off when using TTL-IN.

3.2.3 ANALOG-IN Control Switch

Selects between LED dimming control through the ANALOG-IN BNC connector (REMOTE) or manually using the INTENSITY (PWM) control knob (LOC-1).

REMOTE: Allows for the dimmed state of the LED to be controlled by a voltage (0 – 5 VDC) applied to ANALOG-IN. The LED Control Switch must be set to OFF in order for dimming via analog remote input to function properly. When controlling the LED's dimmed state in this mode, the status display turns blue.

LOC-1: Allows the INTENSITY (PWM) knob to control the dimmed state of the LED. For the INTENSITY (PWM) knob to be effective, the LED Control Switch must be set to ON or TTL.

3.2.4 INTENSITY (PWM) Control Knob

Intensity (PWM) Knob: This knob dims the LED via Pulse Width Modulation. In essence, the LED is being switched at 30KHz. This is the preferable mode of dimming for most applications, as the LED will run cooler, and exhibit no color shift in the special output as the light is dimmed. For the INTENSITY (PWM) knob to be effective, the LED Control Switch must be set to ON or TTL.

The control of the intensity via PWM can also be controlled externally by connecting a 0-5 VDC source to ANALOG-IN connector. This external control is enabled by turning the ANALOG-IN switch to the LOC-1 position and the LED switch to either ON or TTL. Note that when PWM intensity control is set up for external control, the INTENSITY (PWM) knob is disabled.

3.2.5 CURRENT Control Knob

Current Knob: Dims LED by adjusting the current delivered to the LED. Current control may cause color shift in the LED's spectral output. However, current-controlled dimming may be preferable in situations involving the use of ultra high-speed cameras. For the CURRENT knob to be effective, the LED Control Switch must be set to ON or TTL.

Note that the CURRENT knob is functional regardless of the positions of the LED and ANALOG-IN switches, and manual or external state of intensity via PWM (manually adjusting INTENSITY (PWM) knob or applying 0-5 VDC on ANALOG-IN input).

3.3 Connectors

3.3.1 Main LED Connector

This connector attaches the power leads and sensors for the LED to the main unit. The connector is a twist connector and must be rotated 20 degrees after plugging in until a snap is heard. Connector can be released by pulling back on the silver-colored thumb release.

3.3.2 Cooling Tube Connectors

These are the liquid cooling disconnects: These dripless quick disconnects allows removal of the cooling tubes from the front of the unit. Pulling back on the spring-loaded collar disconnects the plug and automatically seals the ends of the cooling hose. This allows for ease of setup and routing of lines through Faraday cages.

CAUTION: THE COOLING HOSES MUST BE CONNECTED BEFORE POWERING ON UNIT. The cooling tubes are interchangeable, but both must be plugged before operation. Powering on unit without the cooling tubes attached may damage the fluid pump. Additionally, powering the LED with the liquid cooling disconnected may burn out the LED.

3.3.3 ANALOG-IN BNC Connector

An analog input from 0-5v controls intensity through PWM dimming.

3.3.4 TTL-IN BNC Connector

Allows for the control of the LED like a shutter. When the LED switch is in the TTL position, TTL-IN is gated low, which keeps the LED in the OFF state. Once TTL-IN receives a high signal, the LED turns on for the duration that TTL-IN is held high.

3.3.5 TTL-OUT BNC Connector

Outputs a triggering signal for external software. When the LED is off, TTL-OUT is high; when the LED is on, TTL-OUT is held low the duration that the LED is on.

3.4 Fault Conditions

The Lambda HPX is equipped with temperature and flow monitors to maximize the life of the LED. Should a fault occur, the screen turns red and the lamp is turned off automatically. If the screen turns red, and the text is unchanged, the LED temperature has exceeded its safe operating temperature. If the corner of the screen displays “Pump” or “Fan” when turning red, it means that the fan or pump has failed, and is no longer turning.

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4. MAINTENANCE

4.1 Routine Maintenance

Routine cleaning of the Lambda HPX-L5 system is required to prevent excessive dust accumulations. Wipe all exterior surfaces with a dry, soft, cotton cloth.

Periodically inspect all cables ensuring that all connections are made well, and connectors are evenly seated.

4.2 Liquid Coolant Replacement

If the level of liquid coolant runs low, additional coolant can be poured into the cooling system. Use only Koolance LIQ-702 High Performance UV Blue Liquid Coolant (LIQ-702BU-B) or as directed by Sutter Instrument.

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APPENDIX A. LIMITED WARRANTY

- Sutter Instrument Company limits the warranty on this instrument to repair and replacement of defective components for two years from date of shipment, provided the instrument has been operated in accordance with the instructions outlined in this manual.
- Abuse, misuse, or unauthorized repairs will void this warranty.
- Warranty work will be performed only at the factory.
- The cost of shipment both ways is paid for by Sutter Instrument during the first three months this warranty is in effect, after which the cost is the responsibility of the customer.
- The limited warranty is as stated above and no implied or inferred liability for direct or consequential damages is intended.
- An extended warranty for up to three additional years can be purchased at the time of ordering, or until the original warranty expires. For pricing and other information, please contact Sutter Instrument.

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APPENDIX B. ACCESSORIES

4.4 High-Power LED Assemblies

The following high-powered LED assemblies are available.

WC-L5-HPX	**LED, Cool White**
460-L5-HPX	**LED, 460nm**
530-L5-HPX	**LED, 530nm**
630-L5-HPX	**LED, 630nm**

Please contact Sutter Information for wavelength availability and other information.

4.5 Microscope Adapters

Liquid-cooled LED housing adaptors for various microscopes are available. Please contact Sutter Instrument for more information.

4.6 TTL Triggering

A USB-controlled trigger box is available for TTL control of the Lambda HPX series. Please contact Sutter Instrument for more information.

4.7 Liquid Coolant

Additional liquid coolant may be obtained from Sutter Instrument or from a qualified source. Please contact Sutter Instrument for more information.

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APPENDIX C. TECHNICAL SPECIFICATIONS

Shuttering:	
Turn on time:	5 μs
Turn off Time	2.5 μs
PWM frequency:	28 KHz
Light Output:	400 – 729 nm (white light)
Bulb life:	>25,000 hours at 80% original output
Input / Output:	TTL or analog for input; TTL for output
Dimming:	PWM or Current Control
LED Wavelength:	Cool white, Tungsten white. Options: 623, 525, 460, 405, and 385 nm
Electrical:	
Input (Mains)	100 - 240 VAC, 50/60 Hz .
Output	3 - 3.5V DC, 4 - 18A, 70W Max..
Mains fuses	T2.0A, 250V, 5 x 20mm, Time Delay fuse (EIC 60127-2) (E.g., Bussmann GDC S506-2-R or S506-2A (RoHS))

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APPENDIX D. COOLANT FLUID SAFETY DATA SHEET

www.koolance.com

Manufacturer Safety Data Sheet

LIQ-702 Coolant Fluid

Last Updated: Feb, 2014

1. Product and Manufacturer Information

Company: Koolance Korea

Address: Anyang-dong, Dongyoung Venturestel 3rd, RM801, 45, Deokcheon-ro, Manan-gu, Anyang-si, Gyeonggi-do, Korea 730-728

Telephone: (U.S.) +01 253-249-7669, Fax: (U.S.) +01 253-249-7453

Appearance: Liquid for cooling systems. Available in various colors and shipped in plastic bottles or containers.

Usage: For use in cooling systems only. Do not use in foodstuffs, beverages, or in other applications.

2. Hazard Identification

Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

- ☐ Physical Hazard: Not applicable
- ☐ Health Hazard: Skin Irritation – Category 2
Eye Irritation – Category 2
- ☐ Environmental Hazard: Not applicable

Label elements including precautionary statements.

Symbol: Single word: Warning

Hazard statement: H315 – May cause irritation to the skin.

H319 – May cause serious irritation to the eyes.

Prevention: P264 - Wash thoroughly after handling

P280 - Wear protective gloves, clothing, and eye protection.

Responses:

- ☐ P302+P352 If on skin: Wash exposure area with plenty of water and soap.
- ☐ P305+P351+P338 If in eyes: Rinse continuously with water for several minutes. Remove contact lenses if present and easy to do so. Continue rinsing.

- ☐ P337+P313: If skin or eye irritation persists, seek medical attention immediately.
- ☐ P362: Remove contaminated clothing and wash before reuse.

Storage / Disposal: P501: Refer to all federal, provincial, state, and local regulation prior to disposition of container and unused contents by reuse, recycle, or disposal.

NFPA Rating (estimated)

Health: 1

Flammability: 1

Reactivity: 0

Water Reactivity: 0

3. Composition / Information on Ingredients

Ingredients	CAS No.	EINECS No.	Conc. %
Distilled Water	7732-18-5	231-791-2	70 – 75
Propylene glycol	57-55-6	200-338-0	25 – 30
Others (Proprietary)	-	-	0.2 – 2.0

4. First Aid Measures

- ☐ In case of eye contact: Rinse thoroughly with plenty of water for at least 20 minutes. If irritation remains, consult a medical doctor immediately.
- ☐ In case of skin contact: Remove contaminated clothing. Wash with soap and plenty of water for at least 20 minutes. If irritation remains, consult a medical doctor immediately.
- ☐ If inhaled: Move person to fresh air. If not breathing, give artificial respiration and immediately contact emergency medical assistance.
- ☐ If ingested: Never give anything by mouth to an unconscious person. Rinse mount with water and consult a medical doctor immediately.

Other medical attention: Medical persons should be aware of protective measures for handling.

Potential health effects: May be harmful or fatal if swallowed.

5. Fire-Fighting Measures

- ☐ Flash Point: 118°C (Cleveland open cup)
- ☐ Suitable extinguishing media: Water spray, alcohol-resistant foam, dry chemical, carbon dioxide
- ☐ Specific hazards arising from the chemical: No data available
- ☐ Special protective equipment for fire fighters:
  - - Use water spray to cool unopened containers.
  - - Fire fighters should enter area wearing respiratory protection and protective equipment.

6. Accidental Release Measures

Personal Precautions:

- ☐ Ensure adequate ventilation.

- ☐ Remove all sources of ignition.
- ☐ Avoid contact with skin and eyes.
- ☐ Avoid inhalation of vapor, mist, or gas.

Environmental Precautions:

- ☐ Follow local regulations.

Methods and materials for containment and clean-up:

- ☐ Collect with non-combustible absorbent materials (sand and soil).

7. Handling and Storage

Precautions for safe handling:

- ☐ Wear protective gloves, clothing, and eye/face protection.
- ☐ Do not spray on an open flame or other ignition source.
- ☐ Provide forced air ventilation in tanks and confined spaces.
- ☐ Avoid contact with skin and eyes.
- ☐ Avoid inhalation of vapor, mist, or gas.
- ☐ Keep away from sources of ignition. No smoking.
- ☐ Conditions for safe storage:
- ☐ Keep container tightly closed.
- ☐ Keep in a dry and well-ventilated place.
- ☐ Keep cool.
- ☐ Avoid direct sunlight, heat sources, and strong oxidizing agents.

8. Exposure Control / Personal Protection

Conditions for safe storage:

- ☐ KOSHA: No data available
- ☐ US ACGIH: No data available

Appropriate engineering controls:

- ☐ Respiratory protection: Approved respirator equipped with cartridge for organic vapors
- ☐ Eye protection: Protective goggles
- ☐ Hand protection: Chemical resistant gloves

9. Physical and Chemical Properties

- ☐ State: Liquid at 20°C
- ☐ Flash Point: 118ºC (Cleveland open cup). No flash occurred under 93ºC (Tag closed cup)
- ☐ pH: 7.0 – 8.0 at 20°C; Sample H2O = 1:5 (V/V)
- ☐ Viscosity: 2.3 mPa x s (cP) at 20°C
- ☐ Density: 1.003 at 20°C
- ☐ Water solubility: Soluble at 20°C
- ☐ Explosive properties: No self-reaction hazard; UN TDG test & criteria – Test E3
- ☐ Autoignition temperature: No spontaneous combustion under 300°C
- ☐ Boiling point (initial): >98ºC
- ☐ Melting range: No data available

- ☐ Vapor pressure: No data available
- ☐ Oxidizing properties: No data available
- ☐ Partition coefficient (n-octanol/water): No data available
- ☐ Evaporation rate: No data available
- ☐ Decomposition temperature: No data available
- ☐ Lower explosion limit / Upper explosion limit: No data available

10. Stability and Reactivity

Chemical stability:

Stable under recommended storage conditions.

Conditions to avoid:

Direct sunlight, heat, flames, and sparks.

Materials to avoid:

Strong oxidizing agents.

Hazardous decomposition products:

Carbon oxides

11. Toxicological Information

- ☐ Acute toxicity (Calculated):
  - ☐ Oral rat LD50 : 23,779 mg/kg
  - ☐ Skin rabbit LD50 : 38,021 mg/kg
  - ☐ Inhalation rat LC50 : 145 mg/kg
- ☐ Skin irritation: Irritating (Calculated, Category 2)
- ☐ Eye irritation: Irritating (Calculated, Category 2)
- ☐ Respiratory sensitization: No data available
- ☐ Skin sensitization: No data available
- ☐ Germ cell mutagenicity: No data available
- ☐ Carcinogenicity: Not classifiable; from IARC / EC ESIS
- ☐ Reproductive Toxicity: No data available
- ☐ Specific target organ toxicity – single exposure (GHS): No data available
- ☐ Specific target organ toxicity – repeated exposure (GHS): No data available
- ☐ 帮 Aspiration hazard: No data available

12. Ecological Information

- ☐ Acute toxicity (Calculated):
  - ☐ Fish LC50 : 8,700mg/l 96hr Pimephales promelas
  - ☐ Crustacean LC50: 7,921mg/l 48hr Daphnia magna
  - ☐ Bird EC50: 1,634mg/l 72hr Selenastrum capricornutum
- ☐ 帮 Persistence and degradability: No data available
- ☐ Bioaccumulative potential: No data available
- ☐ Mobility in soil: No data available
- ☐ Other adverse effects: No data available

13. Disposal Considerations

Disposal consideration: Observe all environmental regulations.

Disposal precaution: Avoid disposing in the environment.

14. Transport Information

- ☐ TSCA: All ingredients are listed on the TSCA inventory
- ☐ DOT Classification: Not a DOT controlled material (U.S.)
- ☐ UN TDG: Not dangerous goods
- ☐ IMDG: Not dangerous goods
- ☐ IATA: Not dangerous goods
- ☐ Marine pollution: Not applicable
- ☐ Special precaution:
    - ☐ Fire EmS Guide: F-E (Recommendation)
    - ☐ Spillage EmS Guide: Not dangerous goods

15. Regulatory Information

- ☐ Korea Industrial Safety and Health Act (GHS): Eye irritation – Category 2
- ☐ Korea Industrial Safety and Health Act (GHS): Skin irritation – Category 2
- ☐ Korea Hazardous Materials Safety Control Act: Not hazardous material
- ☐ Korea Toxic Chemicals Control Act: Not a toxic chemical
- ☐ Korea Persistent Organic Pollutants Control Act: Not applicable
- ☐ US OSHA Hazards (GHS): Eye irritation
- ☐ US OSHA Hazards (GHS): Skin irritation

16. Other Information

References:

- ☐ GHS Classification: EC ESIS, US NLM
- ☐ Physical and chemical properties: EC ESIS, US NLM
- ☐ Transport information: EC ESIS, US NLM
- ☐ Toxic and ecological information: OECD SIDS, IUCLID, US NLM, IARC, EC ESIS, CCRIS

Acronyms and Websites:

- ☐ EC ESIS : European chemical Substances Information System, http://esis.jrc.ec.europa.eu/
- ☐ IUCLID : International Uniform Chemical Information Database, http://esis.jrc.ec.europa.eu/
- ☐ US NLM : U.S. National Library of Medicine, http://chem.sis.nlm.nih.gov/chemidplus/
- ☐ HSDB : US Hazardous Substances Data Bank, http://toxnet.nlm.nih.gov/
- ☐ CCRIS : US Chemical Carcinogenesis Research Information System, http://toxnet.nlm.nih.gov/
- ☐ IARC : International Agency for Research on Cancer, http://monographs.iarc.fr

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