

Lumencor Light Engine Manual

SPECTRA Light Engine



Regulatory Models

Lumencor utilizes regulatory model names for all certified and CE marked products. The regulatory model names are traceable to all regulatory documentation, third party reports and certifications.

“Regulatory Model: Spectra III” is used as a representative model for all certified and CE marked Gen III SPECTRA products.

Emissions

This equipment has been tested and found to comply with the limits of EMC directive 2014/30/EU and FCC part 15 (CISPR 11:+A1:2016). These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Safety Certifications

TÜV SÜD America, CB Certification (IEC 61010-1:2010)

TÜV SÜD America, NRTLus Certification (UL 61010-1:2012/R:2016-04)

TÜV SÜD America, cNRTL Certification (CAN/CSA-C22.2 No. 61010-1:2012/U2:2016-04)

TÜV SÜD America, EN Certification (EN 61010-1:2010)

CE Marking

Low Voltage Directive (2014/35/EU)

EMC Directive (2014/30/EU)

RoHS Directive (2011/65/EU+2015/863/EU)

REACH Regulation (EC) No. (1907/2006/EC)

EU Declarations of Conformity can be found at <https://lumencor.com/company/compliance>



For EU customers discarding end-of-life Lumencor electrical and electronic equipment: Please submit an RMA request with “Recycle product under WEEE” in the Description of Issues field.

For disposal in countries outside of the European Union: This symbol is only valid in the European Union (EU). If you wish to discard this product, please contact your local authorities or dealer and ask for the correct method of disposal.

Lumencor Light Engines as supplied, and as represented in this manual, meet safety and regulatory requirements For Research Use Only. If the Light Engine is incorporated into an instrument or system for a specific end-use application, it is the responsibility of the system integrator to verify that the Light Engine, and the system into which it is incorporated, meet all safety and regulatory requirements of that end-use application.

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1. Introduction

The SPECTRA Light Engine consists of 8 individually addressable solid-state light sources with integrated electronic control systems. The constituent light sources may be LEDs or luminescent light pipes. The outputs of the constituent light sources are refined by bandpass filters and merged into a common optical train directed to the light output port on the front panel. The light output port has a built-in adapter for connection to an SMA-terminated optical fiber or a liquid light guide (LLG). An onboard photodiode continuously monitors the light output and generates a reference signal that can be applied to the constituent sources in a feedback loop to maintain constant light output over time. The light sources within the SPECTRA Light Engine are controlled by an on-board microprocessor operating Lumencor firmware accessed via one of two serial interfaces, USB/RS-232 or TCP. The user can independently enable or disable each source by serial commands as well as change the intensity of each source. The SPECTRA Light Engine can either be controlled by third-party image acquisition software or by a GUI resident on the on-board microprocessor. Alternatively, the light sources may be turned on and off by TTL inputs from a trigger device such as a camera or real-time controller. Optimal internal operating temperature is maintained by negative pressure air cooling with the air intake at the front of the Light Engine and the exhaust fan at the rear.

2. Precautions and Warnings {Précautions et mises en garde}

A few simple practices will ensure trouble-free operation for the life of the Light Engine.

Les quelques règles simples suivantes permettront d'assurer un fonctionnement fiable pendant toute la durée de service de la source lumineuse.

Safety Instructions:

Please read and follow all safety instructions provided **BEFORE** using the SPECTRA Light Engine. Failure to comply with the safety instructions may result in fire, electrical shock, or personal injury and may damage or impair protection provided by equipment. Please save all safety instructions.

Instructions de sécurité:

Veiller à lire et à respecter toutes les instructions de sécurité fournies **AVANT** d'utiliser le SPECTRA Light Engine afin d'écartier les risques d'incendie, de décharge électrique, de blessure corporelle et de possibles dommages ou défaillance de la protection offerte par l'appareil. Conserver toutes les instructions de sécurité.



Safety Definitions {Définitions relatives à la sécurité}:

Warning: Statements identify conditions or practices that could result in personal injury.

Avertissement: déclarations qui identifient des situations ou des pratiques susceptibles d'entraîner des blessures corporelles.

Caution: Statements identify conditions or practices that could result in damage to your equipment.

Attention: déclarations qui identifient des situations ou des pratiques susceptibles d'endommager le matériel.

Safety Items {Mesures de sécurité}:

Warning: ONLY use the power supply provided by Lumencor. The Lumencor-supplied 24 VDC, 9.2 A external power supply is required for use with the SPECTRA Light Engine. The Light Engine is required to be supplied by an approved/certified DC power source meeting the minimum electrical ratings of the product. The DC power supply must have the AC power cord connected to a receptacle with a protective safety (earth) ground terminal.

Avertissement: utiliser uniquement l'alimentation fournie par Lumencor. Le Lumencor fourni 24 VDC/9.2 A alimentation externe est recommandé pour une utilisation avec le moteur de lumière SPECTRA Light Engine. Le moteur léger doit être alimenté par une source d'alimentation CC approuvée/certifiée répondant aux caractéristiques électriques minimales du produit. L'alimentation CC doit avoir le cordon d'alimentation CA connecté à une prise avec une borne de terre de sécurité (terre).



Warning: DO NOT look into the output of the Light Engine. The brightness of this light source is higher than most commercial lighting fixtures and is intended to couple directly into a microscope or other bioanalytical instrument.

Avertissement: NE PAS regarde directement la sortie de la source lumineuse. L'intensité lumineuse de cette source est supérieure à celle de la majorité des appareils d'éclairage disponibles dans le commerce et est conçue pour un raccordement direct à un microscope ou autre appareil de bioanalyse.

Warning: DO NOT apply/remove power or turn on the light without the output end of the light guide safely directed into an enclosed optical path. DO NOT point the light output directly onto any flammable or burn-susceptible material. This includes all animal or vegetable tissues, plastics, fabrics, paper and liquids.

Avertissement: NE PAS appliquer/couper l'alimentation ou allumer la lumière sans l'extrémité de sortie du guide de lumière dirigée en toute sécurité dans un chemin optique fermé. NE PAS pointer la sortie de lumière directement sur un matériau susceptible d'être inflammable ou susceptible de brûler. Cela comprend tous les tissus, les plastiques, les tissus, le papier et les liquides animaux ou végétaux.

RISK GROUP 3

 <p>RISK GROUP 3</p> <p>WARNING Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result.</p> <p>Groupe de risque 3</p> <p>AVERTISSEMENT Ce produit émet un rayonnement optique potentiellement dangereux. Ne regardez pas la lampe lorsqu'elle est allumée. Des lésions oculaires peuvent en résulter.</p> <p><small>Label PN: 06-10297</small></p>	 <p>RISK GROUP 3</p> <p>WARNING IR emitted from this product. Do not look at operating lamp. Avoid eye exposure. Use appropriate shielding or eye protection.</p> <p>Groupe de risque 3</p> <p>AVERTISSEMENT Ce produit émet un rayonnement infrarouge. Ne regardez pas la lampe lorsqu'elle est allumée. Évitez toute exposition aux yeux. Utilisez un écran ou dispositif de protection oculaire approprié.</p> <p><small>Label PN: 06-10228</small></p>	 <p>RISK GROUP 3</p> <p>WARNING UV emitted from this product. Avoid eye and skin exposure to unshielded product.</p> <p>Groupe de risque 3</p> <p>AVERTISSEMENT Ce produit émet un rayonnement ultraviolet. Évitez d'exposer les yeux et la peau à un produit sans protection.</p> <p><small>Label PN: 06-10298</small></p>
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Warning: Possibly hazardous optical radiation emitted from this product. Do not look at operating lamp. Eye injury may result.

Warning: Infrared (IR) emitted from this product. Do not look at operating lamp.

Warning: UV emitted from this product. Avoid eye and skin exposure to unshielded product.

GROUPE DE RISQUE 3

Avertissement: Infrarouge (IR) émise par ce produit. Ne regardez pas la lampe d'exploitation.

Avertissement: Rayonnement optique Peut-être dangereux émis par ce produit . Ne regardez pas la lampe d'exploitation. Une blessure oculaire peut entraîner.

Avertissement: UV émis par ce produit . Évitez les yeux et la peau exposition au produit non blindé.

Caution: DO NOT open the unit. There are no serviceable parts inside and opening the Light Engine enclosure will void the manufacturer's warranty.

Attention: NE PAS ouvrir l'appareil. Il ne contient aucune pièce réparable et l'ouverture de son boîtier a pour effet d'annuler la garantie.

Caution: DO NOT set liquids on the Light Engine. Spilled liquids may damage your Light Engine.

Attention: NE PAS placer de liquide sur la source lumineuse. Les liquides renversés peuvent endommager la source lumineuse.

Caution: DO NOT drop the Light Engine. It contains glass optical components that could be damaged or misaligned by the shock produced by a drop onto a hard surface.

Attention: NE PAS laisser tomber la source lumineuse. Elle contient des composants optiques en verre susceptibles d'être endommagés ou désalignés par le choc résultant d'une chute sur une surface dure.

DISCLAIMER: Lumencor shall not be liable for injury to the user or damage to the product resulting from the SPECTRA Light Engine being used in a way for which it was not intended and in complete disregard for any posted safety precautions and warnings.

AVIS DE NON-RESPONSABILITÉ: Lumencor décline toute responsabilité pour les blessures corporelles ou les dommages au produit résultant d'une utilisation du SPECTRA Light Engine autre que celle prévue et du mépris total de les mesures de sécurité et mises en garde affichées.

3. Installation and Operating Instructions

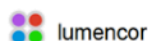
3.1 Contents

The SPECTRA Light Engine ships with the following list of standard components:

1. The SPECTRA Light Engine, configured with 8 output channels (colors) and an output adapter for connection to an SMA-terminated optical fiber **or** a liquid light guide (LLG) as documented on the certificate of conformance (Figure 1).
2. A 24 V/9.2 A DC power supply (Lumencor part number 27-10019).
3. A region-specific AC power cord for the power supply (see adjacent table).
4. RJ45 ethernet cable.
5. Control key, external gate jumper and remote interlock jumper (Figure 2).
6. Quickstart Guide instruction document (85-10049)

AC Power Cords

Region	Part Number
North America	29-10002
Europe	29-10005
United Kingdom	29-10004
Israel	29-10008
Australia/New Zealand	29-10024



Certificate of Conformance

Performance Measurements For Lumencor Light Engine S/N 0902

Color Channel	Bandpass Filter	Power (mW)
Cyan	no filter	450
Red	no filter	205
NIR	no filter	217
Yellow	no filter	1025
n/a	n/a	n/a
n/a	n/a	n/a
n/a	n/a	n/a
Total Power		2151

Burn-in Pattern Cycle Definition

1. Each color is on at 100% for 5 seconds, then off for 5 seconds.
2. Pattern is repeated 20 times for a total of 10 minutes.
3. Next, all colors are turned on at 100% for 10 minutes.
4. Total time per cycle = 20 minutes.

Repeat cycle 60 times.

COC Output Adapter: none
Beam Divergence (NA): n/a

Measurement Method

This product was measured using the custom output adapter installed on the light engine. The output power was directed at a Coherent thermopile sensor head, model number PM10, S/N 0329C148, attached to a Coherent FieldMax10, Power Meter, S/N 07818148. The measurement system was calibrated on May 5, 2015. The meter scale was set to average mode and the meter zeroed for each measurement. Measurements were taken at room temperature and at initial turn-on.

Lumencor Build Recipe:

Product Part Number: 80-10100 Rev B
Packaged Assembly: 90-10170 Rev A

Model Name:

Customer Deviation: n/a

Customer Part Number:

Customer Specification:

Inspected By:

Signature:

Document Part Number: 50-10027 rev E

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Figure 1. Example certificate of conformance (C of C) for SPECTRA Light Engine. The C of C identifies the color channels installed, and the bandpass filters associated with each channel. Full (100%) power outputs measured at the terminus of the liquid light guide (LLG) or optical fiber are recorded in the third column.

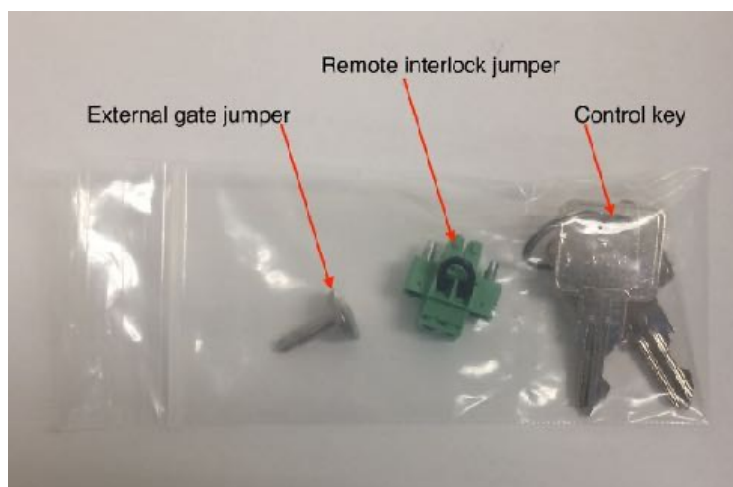


Figure 2. Control key, remote interlock jumper and external gate jumper. These items are packed in a plastic bag inside the shipping box. Their functions are described in Section 3.3.1

The model name, unique 4- or 5- digit serial number and certification markings of the Light Engine are carried on a label affixed to the rear panel . Performance specifications for individual Light Engines are listed on the certificate of conformance included with the shipping documents e-mailed to the customer (Figure 1).

3.2 Installation

NOTE: Any end-product/system incorporating or coupled to a Lumencor Light Engine shall be fully evaluated to verify all applicable safety and regulatory compliance requirements prior to use.

When setting the SPECTRA Light Engine up for use, place the unit on a hard surface and avoid blocking or restricting airflow at the air inlets (front panel; Figure 3) or exhaust ports (rear panel) on the enclosure. Restricting the airflow will cause the unit to operate at elevated temperatures and will result in decreased product life and/or premature failure.

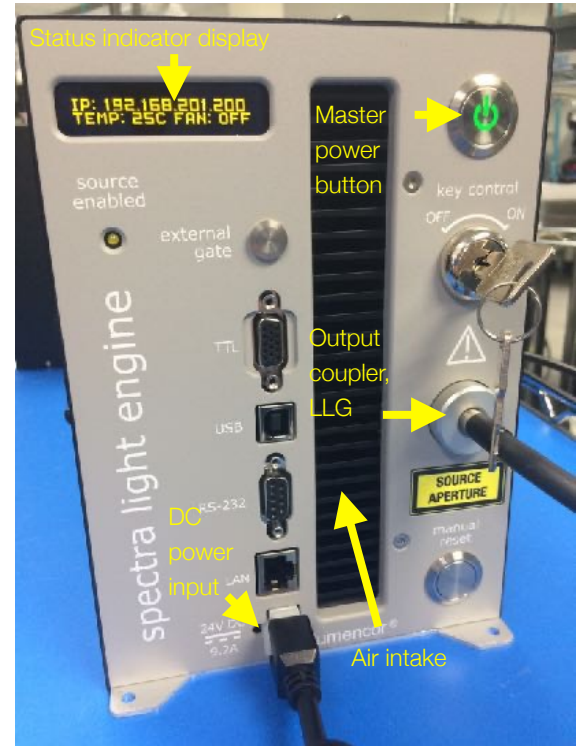


Figure 3. SPECTRA Light Engine front panel

The SPECTRA Light Engine must be operated in a non-condensing environment (dew point <10°C with controlled ambient temperature <30° C). Thermal overload protection is provided by the onboard microprocessor in conjunction with an onboard temperature sensor. If the internal temperature registered by the sensor exceeds 50°C **or** the fan rotor is stopped, all light output channels automatically turn OFF and are locked in this state until the internal temperature is below 50°C and/or the fan restarts. The current reading of the onboard temperature sensor is displayed on the front panel status display (Figure 3) and in the GUI (Section 3.3.3).

The SPECTRA Light Engine may be configured for light delivery via a 3 mm liquid light guide or an SMA-terminated optical fiber. The output couplers are built into the Light Engine front panel and are not field-exchangeable (Figure 3). The 3 mm liquid light guide output coupler incorporates an electrical power interlock switch in the back of the receptacle. The liquid light guide must be fully inserted in the receptacle to activate the interlock. Electrical power supply to the Light Engine cannot be turned on via front panel power switch until the interlock is activated. After fully inserting the liquid light guide, lock it in position using the set screw on the side of the receptacle to prevent inadvertent disconnection of the light guide during use.

Connect the DC power supply to a grounded AC wall outlet using the power cord supplied with the Light Engine. Connect the DC output to the 6-pin receptacle on the front of the Light Engine (Figure 3). Turn the Light Engine on using the master power switch. The embedded green indicator will illuminate (if applicable, ensure that the liquid light guide is inserted and secured; see below).

3.3 Operation

3.3.1 Controls and Interlocks

The **Master Power Switch** button on the front panel (Figure 3) turns the electrical power to the unit on or off. A green power indicator embedded in the button is lit when the power supply is connected to the Light Engine and the power button is in the on position. Initialization of the onboard computer takes about 30 seconds after the master power switch is turned on. When initialization is complete, the status indicator display (Figure 3) will activate.

The **Key Control** (Figure 3) must be in the on position before light output can be turned on. The key must be removed and stored in a secure location when the product is not in use. **ONLY** trained individuals should use and have access to the key. The **Master Power Switch** button, **Key control** and **Remote interlock** (Figures 3,4) can be used to shut off light output.

The **Source Enabled** indicator LED (below the status indicator display, Figure 3) provides a warning indication that one or more light sources are active and emitting invisible and/or visible radiation.

The **Remote Interlock Connector**: (Figure 4) is provided to allow for connection of a remote interlock. When this interlock is open it will shut off light output. After the interlock has been opened, the **Manual Reset** button will need to be pushed to resume light output.

WARNING: The Remote Interlock relies on a passive continuity circuit for proper operation. It does not provide a voltage source for external circuitry, nor can external voltage sources be applied to it. **UNDER NO CIRCUMSTANCES** should a voltage or voltage source be applied to the Remote Interlock circuit. **APPLYING A VOLTAGE OF EITHER POLARITY MAY RESULT IN ANOMALOUS OPERATION AND/OR DAMAGE THE**



Figure 4. SPECTRA Light Engine rear panel.

PRODUCT, AND COULD IMPACT SAFETY.

Customers planning to connect multiple Light Engine remote interlocks together will need to contact Lumencor prior to integration. **INTERCONNECTING Light Engines OR USING THE REMOTE INTERLOCK INCORRECTLY CAN RESULT IN ANOMALOUS BEHAVIOR AND/OR DAMAGE TO THE PRODUCTS.**

AVERTISSEMENT : Le verrouillage à distance repose sur un circuit de continuité passif pour un fonctionnement correct. Il ne fournit pas de source de tension pour les circuits externes, et aucune source de tension externe ne peut lui être appliquée. **EN AUCUN CAS**, une tension ou une source de tension ne doit être appliquée au circuit de verrouillage à distance. **L'APPLICATION D'UNE TENSION DE POLARITÉ OU DE POLARITÉ PEUT ENTRAÎNER UN FONCTIONNEMENT ANOMAL ET/OU ENDOMMAGER LE PRODUIT, ET POURRAIT AVOIR UN IMPACT SUR LA SÉCURITÉ.**

Les clients prévoyant de connecter plusieurs verrouillages à distance Light Engine ensemble devront contacter Lumencor avant l'intégration. **L'INTERCONNEXION DE MOTEURS LÉGERS OU L'UTILISATION INCORRECTE DU VERROUILLAGE À DISTANCE PEUT ENTRAÎNER UN COMPORTEMENT ANOMAL ET/OU ENDOMMAGER LES PRODUITS.**

WARNING: Prior to applying/removing power or turning the light output on, be sure the output end of the liquid light guide or optical fiber is safely directed into an enclosed optical path (e.g. a beam dump).

AVERTISSEMENT : Avant d'appliquer/de couper l'alimentation ou d'activer la sortie de lumière, assurez-vous que l'extrémité de sortie du guide de lumière liquide ou de la fibre optique est dirigée en toute sécurité dans un chemin optique fermé (par exemple, une décharge de faisceau).

Note: In the event of **ANY** normal or abnormal interlock fault condition (including high ESD/EMP/EFT conditions ~2kV) you **MUST** clear the latch fault condition, either by depressing the manual reset button or by cycling the power switch.

3.3.2 Start Up

1. Insert the light guide and secure it with the set screw¹.
2. Insert the external gate jumper (Figure 2) in the labeled socket on the front panel (Figure 3). Insert the interlock jumper in the labeled socket in the lower left corner of the rear panel² (Figure 4).
3. Insert the control key, turn it to the **ON** position.
4. Connect the isolated DC power supply to the Light Engine.

5. Connect the AC power cord to the DC power supply.
6. As soon the DC power supply is energized, the master power button (top right) will automatically light up. The Light Engine automatically starts when the power is connected; there is no need to push the master power button³.
7. Wait 30–45 seconds for the initiation sequence (onboard microprocessor boot-up) to complete. Do not press any buttons or insert any plugs during this time.
8. When the initiation sequence completes, “LUMENCOR” will flash on front display panel and then be replaced by a display showing the current Light Engine IP address, the internal temperature and the fan status. At the same time, the fan will come on at HI for about 2 seconds and then shut off automatically. The Light Engine is now ready for use. Prior to turning the light output on, verify the output end of the liquid light guide or optical fiber is safely directed into an enclosed optical path (e.g. a beam dump).

Notes:

- 1** Ensure that the distal end of the light guide or optical fiber is safely directed into an enclosed optical path (e.g. microscope epi-illuminator or a beam dump) before turning the light output on. If the Light Engine is equipped with an output adapter for an SMA-terminated optical fiber, connect the fiber to the output adapter using the integral threaded sleeve.
- 2** To enable light output of the SPECTRA Light Engine the external gate jumper, control key, remote interlock jumper, and Liquid light guide must be inserted.
- 3** For subsequent start ups, use the master power button to start or shut down the Light Engine. Shut down can also be accomplished using the “Shut Down” button in the GUI (Figure 5, left).

3.3.3 Ethernet Connection and Control GUI

The Web GUI provides a quick and easy way to control the Light Engine, providing the ability to turn each source on/off, adjust the power of each source independently from off to full power (Figure 5). The GUI also tracks the total on time and displays real-time power sensor readings. To set up the Web GUI, follow the follow protocol below:

1. Go to Start menu > Control Panel > Network & Internet and/ or Network & Sharing Center
2. Click Change Adapter Settings
3. Right-click on Local Area Connection
4. Click on Properties (in pop-up)
5. Select Internet Protocol Version 4 (TCP/IPv4)
6. Click Properties button
7. Use the following IP addresses:
 - IP Address: 192.168.201.201
 - Subnet Mask: 255.255.255.0
 - Default gate way and DNS Server are OK to leave blank

8. Connect the RJ45 cable (supplied with the Light Engine) between the LAN port on the Light Engine and an Ethernet port on the computer.

9. Type the Light Engine IP address (Figure 3) into any web browser address bar to access the resident Web GUI. The factory default IP address is 192.168.201.200

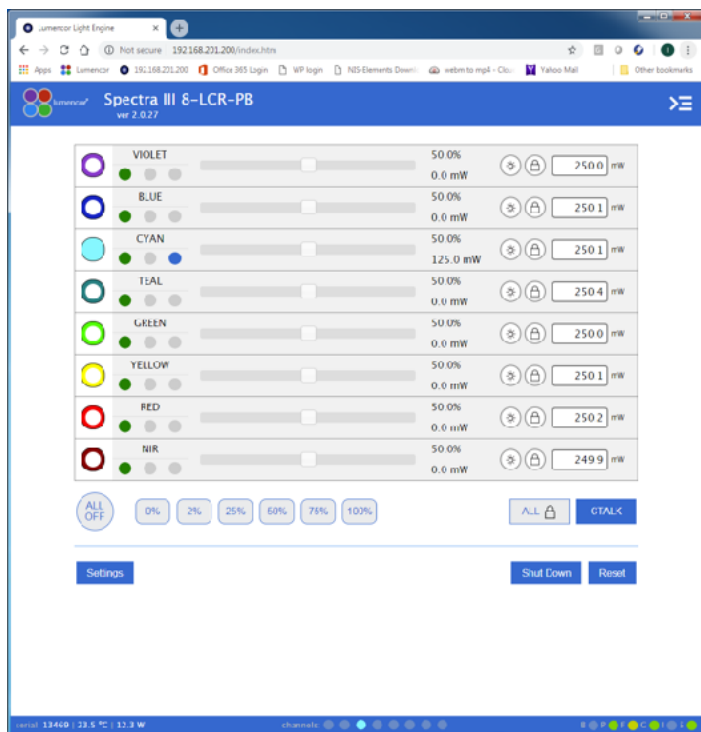


Figure 5. SPECTRA GUI, Control Tab. The GUI is accessed by typing the Light Engine IP address (198.168.201.200 in this example) into a web browser.

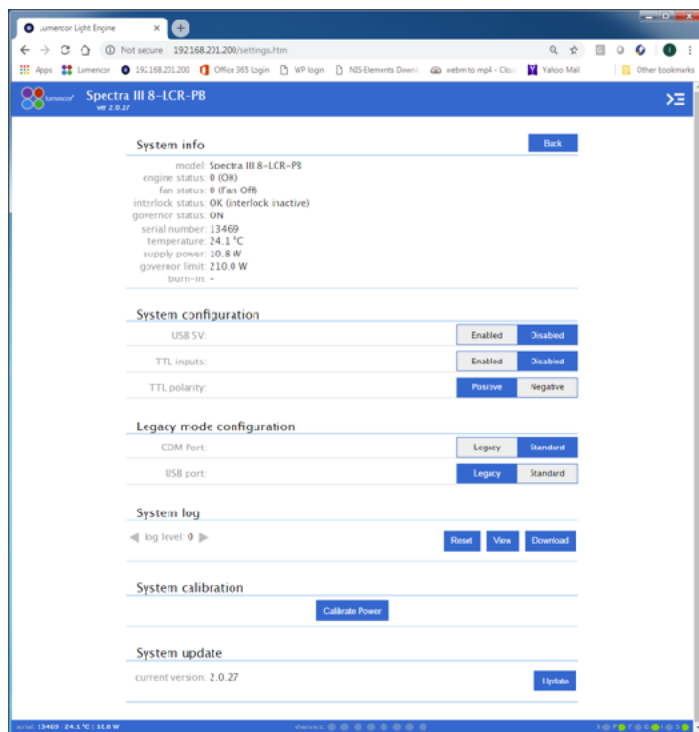


Figure 6. SPECTRA GUI, Settings Tab. The GUI is accessed by typing the Light Engine IP address (198.168.201.200 in this example) into a web browser.

Output power regulation allows users to eliminate variations in light output due to temperature fluctuations and other environmental factors in photometric and quantitative imaging applications where reproducibility and accuracy are essential. To use power regulation, a desired power reference value in milliwatts is entered in the onboard control GUI. To activate power regulation, simply click the padlock icon next to the reference power value. Gray shading of the padlock icon and the reference power value shows that power regulation is active for the selected output channel. When power regulation is active, the intensity setting for the channel is controlled by the onboard microprocessor, based on feedback from the Light Engine's reference photodiode array. The microprocessor continuously adjusts the intensity setting so that the output power matches the power reference value set by the user.

3.3.4 Control via Serial Ports

SPECTRA Light Engines have two serial ports, labeled USB and RS-232 (Figure 3), which can be set to receive either LEGACY or STANDARD mode commands. Connection to the computer requires a USB-A-to-USB B cable (29-10058) or USB-to-RS-232 cable (29-10011). LEGACY commands are limited to controlling on/off switching and intensity adjustment of individual color channels. Only one of the two ports can be set to LEGACY mode at one time. The STANDARD mode command set gives access to an extensive panel of operating status reports and configuration settings in addition to the the basic control functions of the LEGACY command set. A complete listing of STANDARD mode commands is provided in *Lumencor Light Engine Command Reference* (Document number 57-10018). Note that LEGACY and STANDARD mode communications use different serial protocols (9600,8,N,1 and 115200,8,N,1 respectively). Changes to the command mode setting for a serial port can be made via the **Settings** screen of Web GUI (Figure 6). Changes are applied instantaneously and are retained between power cycles.



Figure 7. BNC breakout cable (p/n 29-10156). The same cable configuration with SMB connectors instead of BNC is also available (29-10216)

In the Web GUI, select the serial port command mode setting that is compatible with the Light Engine device driver in the control software. The COM port address assigned by the computer to the Light Engine USB serial port must be correctly registered. These selections are typically found under the “Devices” tab in the control software.

3.3.5 Control From Light Engine Control Pod

1. Connect SPECTRA Light Engine to pod (p/n 83-10007) using USB A-to-USB B cable (p/n 29-10058).
2. Open the Web GUI control interface as described in Section 3.3.3.
3. Go to the SETTINGS page in the Web GUI. Make sure that the USB port configuration is set to LEGACY mode and USB 5V is set to ENABLED.
4. The pod must be set in SPECTRA control mode. The Light Engine control mode setting is shown in green letters at the bottom of the pod display screen. If the pod is not in SPECTRA control mode, change the setting by holding down the MODE button on the pod until the Light Engine selection menu appears. Move the cursor to “SPECTRA” by turning the pod control knob. Press the MODE button again to select SPECTRA control mode and return to the main control screen.

5. Follow the instructions on Lumencor's Light Engine Control Pod Operation sheet (p/n 54-10036). In brief, press the COLOR button to select output light output channel, press the MODE button to toggle light output on and off and turn the control knob to adjust intensity for the current light output channel selection.

3.3.6 TTL Control

The TTL Interface provides users with a faster method of switching color channel outputs on and off. The TTL interface does not control source output intensity, which remains under serial (RS-232/USB/TCP) control. Note that TTL and serial on/off commands have a logical OR relationship. Therefore source on/off controls on the Light Engine control pod, in the Web GUI or in third-party image acquisition control software must be set in the "OFF" state when using TTL control. Individual TTL inputs are provided for each color channel, as shown in the adjacent table. As a safeguard against unintended light output when the inputs are initially connected, the Light Engine TTL port is disabled and must be enabled by a serial command. To enable the TTL input, click the **Enabled** button next to "TTL inputs" in the GUI under the **Settings** tab (Figure 6) or send the standard mode command SET TTLENABLE to the LAN port. Input TTL signals can be conveniently addressed using an accessory BNC breakout cable (Lumencor part no. 29-10156 or 29-10216; Figure 7) connected to the front panel TTL port. The breakout cable also provides a global shutter input (labeled "shutter"). TTL signals input to the global shutter will synchronously toggle all currently enabled source channels on and off.

4. Light Output Characteristics

SPECTRA Light Engine may incorporate different types of solid state light sources. Constituent light sources may include LEDs or luminescent light pipes. The light sources installed and the bandpass filters associated with each are shown on the Certificate of Conformance included with the shipping documents e-mailed by Lumencor to the customer. The certificate of conformance also shows full (100%) power outputs for each source measured at the terminus of the liquid light guide (LLG) or optical fiber (Figure 1). Not all sources may be turned on simultaneously. To prevent exceeding the capacity of the DC power supply, power consumption is tracked by the onboard microprocessor. If a set limit (see **Governor**, Figure 6) is exceeded, either by increasing intensity settings for sources that are already on, or by turning on additional sources, all light output is terminated and an error message will be displayed on the control screen. To clear the error condition, click on the **System** tab in the GUI and then click the **Restart** button under **Governor**.

Light source outputs are refined by bandpass filters. The specifications of these bandpass filters are recorded on the certificate of conformance as CWL/FWHM where CWL =center wavelength and FWHM = full width at half-maximum transmission, both measure in nanometers (nm). In fluorescence microscopy applications, it is usual to remove the exciter from the microscope filter

cube to facilitate fast electronic excitation switching. Compatibility of the bandpass filters with the transmission characteristics of the dichroic beamsplitter and emission filter in the microscope cube is required to maximize transmission of excitation light to the sample and to avoid excitation bleed-through. Bandpass filters installed in the SPECTRA Light Engine are not user-exchangeable. Changes to the filter configuration require return of the Light Engine to Lumencor's factory for service (see Section 7). Since changing bandpass filters will result in source output power changes, a new certificate of conformance will be provided as part of this service.

TTL Connector Pin Definitions

OUTPUT COLOR	Pin#	OUTPUT COLOR	Pin#
RED	1	BLUE	12
GREEN	2	VIOLET	13
CYAN	3	nIR	14
TEAL	11	YELLOW	15
Gnd	6,7,8,10		
$V_{\text{high}} (\text{min}) = 2.0\text{V}$, $V_{\text{high}} (\text{max}) = 5.5\text{V}$ $V_{\text{low}} (\text{min}) = 0.0\text{V}$, $V_{\text{low}} (\text{max}) = 0.8\text{V}$			

5. Operational Specifications

The SPECTRA Light Engine must be operated and stored within the environmental conditions specified in the table below. Performance specifications for individual Light Engines are listed on the certificate of conformance included with the shipping documents e-mailed to the customer (see example shown in Figure 1). It is important to retain the certificate of conformance for reference. In the event that the Light Engine is sold, the certificate of conformance should be transferred to the new owner. Certificates of conformance are also recorded in Lumencor's database and copies can be requested by e-mail to techsupport@lumencor.com. The request message must include the 5-digit serial number of the Light Engine.

Specification	Detail
Temperature	
Operating / Non-operating	32 to 95° F (0 to 35° C) / -4 to 158° F (-20 to 70° C)
Humidity	
Operating and non-operating	0 to 80% relative humidity, non-condensing ¹
Dew Point	
Operating	32 to 59° F (0 to 15° C)
Altitude	
Operating	0 to 10,000 feet (3,048 meters)
Non-operating	0 to 45,000 feet (13,176 meters)
Dimensions	
Size (W x L x H)	145 mm x 340 mm x 203 mm (5.7 in x 13.4 in x 8.0 in)
Weight	8.7 kg / 19.1 lbs
Lifetime	Time for Light Engine output to decrease to 70% of the values recorded on the original certificate of conformance ²
Power supply	24VDC / 9.2A
Warm-up Period	1 s

Specification	Detail
Protection	Thermal overload (Section 3.2). Power overdraw (Section 4)
Sound Level	Sound level at 1 meter < 65db(A)
Control Interfaces	USB, RS-232, TCP, TTL
Warranty	24 months parts and labor
¹ The SPECTRA Light Engine must be operated in a non-condensing environment. ² The corresponding number of days/months/years may vary considerably depending on the duty cycle implemented by the user and the prevailing environmental conditions during operation.	

6. Routine Maintenance and Trouble Shooting

No routine maintenance is required. There are no user-replaceable components or sub-assemblies in the SPECTRA Light Engine. Opening the Light Engine enclosure will void the manufacturer's warranty. If problems are encountered during installation or routine operation, review the troubleshooting procedures described below. If the problem remains unresolved, please contact Lumencor Technical Support for assistance, as directed in Section 7.

Troubleshooting Procedures	
Problem	Check the following
No response to serial (USB or RS-232) commands	Check that the LEGACY or STANDARD command mode selection (GUI Settings; Figure 6) is compatible with the software driver.
No response to TTL trigger commands	Check that TTL inputs are ENABLED (GUI Settings; Figure 6) and that the TTL polarity setting is consistent with the trigger inputs. Also check that all serial ON/OFF controls are in the OFF state.
No light output in response to source ON command (serial or TTL).	There are 4 interlocks that need to be closed, check all of these: <ol style="list-style-type: none"> 1. Liquid light guide must be inserted in light output receptacle¹. 2. Remote interlock jumper must be inserted in rear panel¹. 3. External gate jumper must be inserted in front panel (Figure 3) 4. Control key must be inserted in front panel and turned to "on" position¹.
Unusually weak fluorescence signals across all detection channels	Weak fluorescence in all detection channels (DAPI, FITC, TRITC, Cy5 etc) is likely to be due to poor light transmission by the liquid light guide, the collimating adaptor or another distal component of the microscope optical path and not to abnormally low light output from the Light Engine.
Unusually weak fluorescence signals in a single detection channel (e.g. DAPI)	<ol style="list-style-type: none"> 1. Check that the Light Engine power output reading in the Web GUI (Figure 5) is normal. 2. Check that the dichroic beamsplitter and emission bandpass filter in the microscope are compatible with Light Engine excitation filter specifications shown on the certificate of conformance (Figure 1)².
High, spatially uniform fluorescence background	Check that the dichroic beamsplitter and emission bandpass filter in the microscope are compatible with Light Engine excitation filter specifications shown on the certificate of conformance (Figure 1) ² .
¹ If a safety interlock is open, the condition will be indicated by a red status indicator in the lower right corner of the GUI control screen (Figure 5). ² Excitation filters are installed in the Light Engine. Excitation filters installed in the microscope cube are generally redundant and it is recommended that they are removed.	

7. Customer Support

For technical support of the SPECTRA Light Engine, please contact Lumencor by phone at 503-213-4269 or through e-mail at techsupport@lumencor.com. Please be prepared to provide the 5-digit serial number of the Light Engine. Any Light Engine returned to Lumencor for repairs or upgrades requires a pre-issued return material authorization (RMA) number. To request an RMA number, fill out and submit the [online request form](#). It is the customer's responsibility to properly package and safely ship products to Lumencor. Instructions for shipping will be provided in the e-mail giving notification of the RMA number.

8. Warranty

SPECTRA Light Engine come with an 24 month warranty, starting on the original date of shipment from Lumencor. Light Engines qualifying for warranty service must be verifiably delivering performance that is substantially at variance with the levels documented in the certificate of conformance. The Light Engine must also have been used and maintained under operating conditions consistent with the specifications given in Section 5, and observing all the Precautions and Warnings notified in Section 2. This warranty does not extend to Light Engines that have been subject to misuse, accident, tampering or improper installation. Accessories including (but not limited to) liquid light guides, optical fibers, collimators, cables and control consoles are not covered by the warranties attached to Light Engines. Please fill out and submit the [online warranty registration form](#). This will facilitate provision of warranty service should it be required.