SPECTRA TUNE LAB

Light Engine for Scientists

www.ledmotive.com
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DESCRIPTION

The SPECTRA TUNE LAB device is the most versatile LED light engine from LEDMOTIVE. The system can deliver either white light or any light spectrum obtained from the modulation of each of its different wavelength channels. No warm up time is required, and light can be dimmed from 0% to 100% for each channel with a resolution depth of 12 bits (4096 steps).

The standard SPECTRA TUNE LAB is equipped with 10 different types of colored LEDs. Optionally, the customer can tailor its own wavelength configurations (up to 12 different LED channels) by filling a Customer Special Request form.

LEDMOTIVE patented technology (Patent PCT/EP2011/050002) warrants spectral precision and accuracy as well as stability over time, through a CMOS-based onboard spectroradiometer.

The system can emit different spectrum every 10 milliseconds on average.¹

SPECTRA TUNE LAB – Features

- High power multi-spectral LED light engine
- Independent color channel dimming
- Precise, accurate and stable light emission
- Fast spectral transition in asynchronous operation mode
- Compact and light weight system
- No warm up required
- Mounting accessories compatible w/ standard optical tables & ¼ thread for tripod mounting
- Compatible with LIGHT CREATOR© digital light IoT and spectral sharing platform
- µWAVE Software© with the SPECTRA TUNE LAB basic operation controls
- Optional: RESTful API
- Optional: C-mount adaptor that allow to connect standard compatible light guide connectors
- Multiple SPECTRA TUNE LAB can be connected in serial using the data in, data out connector

¹ asynchronous operation mode
LED-ENGINE: STANDARD CONFIGURATION

Below is a summary of the standard configuration. Values may change slightly depending on the current availability of the different wavelength (color) or flux bins.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Nº of LEDs</th>
<th>Color</th>
<th>Peak Emission (nm)</th>
<th>radiometric value (W)</th>
<th>Photometric Value (lm)</th>
<th>FWHM (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 1</td>
<td>2</td>
<td>UV</td>
<td>429</td>
<td>0.74</td>
<td>13.4</td>
<td>16</td>
</tr>
<tr>
<td>CH 2</td>
<td>2</td>
<td>Royal Blue</td>
<td>446</td>
<td>0.95</td>
<td>35.8</td>
<td>22</td>
</tr>
<tr>
<td>CH 3</td>
<td>3</td>
<td>Dark Blue</td>
<td>465</td>
<td>0.94</td>
<td>73.9</td>
<td>27</td>
</tr>
<tr>
<td>CH 4</td>
<td>3</td>
<td>Blue</td>
<td>475</td>
<td>0.89</td>
<td>97.5</td>
<td>27</td>
</tr>
<tr>
<td>CH 5</td>
<td>5</td>
<td>Cyan</td>
<td>505</td>
<td>0.98</td>
<td>319.3</td>
<td>34</td>
</tr>
<tr>
<td>CH 6</td>
<td>5</td>
<td>Green</td>
<td>525</td>
<td>0.77</td>
<td>389.2</td>
<td>37</td>
</tr>
<tr>
<td>CH 7</td>
<td>10</td>
<td>Lime</td>
<td>550</td>
<td>2.75</td>
<td>1256.4</td>
<td>115</td>
</tr>
<tr>
<td>CH 8</td>
<td>12</td>
<td>PC Amber</td>
<td>595</td>
<td>2.76</td>
<td>990.9</td>
<td>81</td>
</tr>
<tr>
<td>CH 9</td>
<td>2</td>
<td>Red</td>
<td>638</td>
<td>0.62</td>
<td>101.9</td>
<td>21</td>
</tr>
<tr>
<td>CH 10</td>
<td>4</td>
<td>Deep Red</td>
<td>660</td>
<td>1.25</td>
<td>81.4</td>
<td>23</td>
</tr>
</tbody>
</table>

All active channels are mixed at the exit plane of the LED module, which provides the SPECTRA TUNE LAB with a smooth (highly uniform in color) light with a Lambertian pattern profile.

Figure 2. Generic features of the standard SPECTRA TUNE LAB light engine

Figure 3. (left) CIE 1931 xy coordinates of the 10 channels that define the color gamut and (right) Spectral Power Distributions (SPDs) of the LED channels
SPECTRAL MODULATION

Example of two different spectral modulations that best reproduce a blackbody radiation curve at two different temperatures (2700 K and 6500 K):

*Figure 4. Example of two different spectral fittings (2700 K and 6500 K blackbody radiators)*
LED-ENGINE: CUSTOMER SPECIAL REQUEST

Even though the standard version comes with 10 wavelength channels, the SPECTRA TUNE LAB has indeed 12 physical drivers which can be grouped in different channels. Each of these drivers can control a specific number of LEDs as shown in the table below.

<table>
<thead>
<tr>
<th>Physical Driver</th>
<th>Nº of LEDs</th>
<th>LED type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr 1</td>
<td>2</td>
<td>See Table A</td>
</tr>
<tr>
<td>Dr 2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Dr 3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr 4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr 5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Dr 6</td>
<td>5</td>
<td>See Table B</td>
</tr>
<tr>
<td>Dr 7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Dr 8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Dr 9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Dr 10</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Dr 11</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Dr 12</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table A | peak wavelength range
---------|------------------------
UV-VIS   | from 380 nm to 425 nm
VIS      | from 440 nm to 670 nm
NIR      | 850 nm, 940 nm

Table B | peak wavelength range
---------|------------------------
VIS      | from 440 nm to 750 nm

Figure 5. Different types of LEDs and number of LEDs in each driver for a Customer Special Request option

Based on a Customer Specific Request (CSR), different wavelength channel arrangements can be ordered to build a customized light engine, with wavelength channels spanning from the long ultraviolet to the near infrared (please contact sales for a quotation). Further developments may require a full new design of the LED PCB and need to be discussed in detail with our technical team.

Please contact our Sales team at sales@ledmotive.com to find out more about how to define your special requests and get the perfect multi-channel solution that suits best your needs.
SPECTRA TUNE LAB
Light Engine for Scientists

SPECTRAL PRECISION, ACCURACY and STABILITY

LEDMOTIVE patented technology allows the SPECTRA TUNE HCL to emit light spectra with unprecedented accuracy and precision. It also offers perfect stability over time thanks to the on-board CMOS spectrophotometer and the associated feedback loop control algorithms.

The proper indicator for the goodness of a spectral fit is the Mean Absolute Percentage Deviation (MAPD). The MAPD gives an idea of the percentage error measurement between a target spectrum (after applying a non-negative least square method to the channel’s PWM signal) and the measured spectrum. The MAPD expression is given by

\[
MAPD = \frac{100}{n_0 \text{ of points}} \sum_{i=0}^{n_0 \text{ of points}} \left| \frac{SPD_{\text{actual}}^i - SPD_{\text{target}}^i}{SPD_{\text{target}}^i} \right|
\]

The table below shows MAPD values obtained from different light spectra and output powers. When the feedback loop is enabled, a significant improvement can be seen and a very low MAPD is obtained.

Spectral errors are kept below 3% with the optical feedback ON. In cases, this translates into color deviations Duv’ lower than 10^-4 or well below a 4-step Mac Adam (ANSI C78.377-2015 specifications).

<table>
<thead>
<tr>
<th>MAPD</th>
<th>W/O feedback loop</th>
<th>W/ feedback loop</th>
<th>Duv’ (color matching feedback)</th>
<th>% improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST spectrum 1- low power</td>
<td>4</td>
<td>3</td>
<td>8.00E-04</td>
<td>25%</td>
</tr>
<tr>
<td>TEST spectrum 1- medium power</td>
<td>2</td>
<td>2</td>
<td>9.00E-04</td>
<td>0%</td>
</tr>
<tr>
<td>TEST spectrum 1- high power</td>
<td>3</td>
<td>2</td>
<td>2.30E-03</td>
<td>33%</td>
</tr>
<tr>
<td>TEST spectrum 2- low power</td>
<td>6</td>
<td>4</td>
<td>3.50E-03</td>
<td>33%</td>
</tr>
<tr>
<td>TEST spectrum 2- medium power</td>
<td>3</td>
<td>2</td>
<td>4.00E-04</td>
<td>33%</td>
</tr>
<tr>
<td>TEST spectrum 2- high power</td>
<td>2</td>
<td>2</td>
<td>8.00E-04</td>
<td>0%</td>
</tr>
<tr>
<td>TEST spectrum 3- low power</td>
<td>8</td>
<td>4</td>
<td>4.70E-03</td>
<td>50%</td>
</tr>
<tr>
<td>TEST spectrum 3- medium power</td>
<td>3</td>
<td>2</td>
<td>5.00E-04</td>
<td>33%</td>
</tr>
<tr>
<td>TEST spectrum 3- high power</td>
<td>2</td>
<td>2</td>
<td>2.00E-03</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Figure 6. MAPD values for different spectra with and without the feedback loop control respectively and its % of improvement*
**SPECTRAL SWITCHING TIME**

The SPECTRA TUNE LAB works in synchronous mode by default.

In this mode, the SPECTRA TUNE LAB acknowledges receipt of all the commands sent by the LIGHT HUB before it accepts a new instruction, so that “collisions” between messages can be detected and duly corrected. Typical response times of this operation mode is 250 milliseconds approximately. Most of the commands in the SPECTRA TUNE LAB are programmed to work in synchronous mode.

Whenever the application requires fast switching times, the SPECTRA TUNE LAB can be set to work in asynchronous mode. In that case, the SPECTRA TUNE LAB does not send an acknowledge receipt signal to the LIGHT HUB, making it possible a sort of spectral streaming in real time. Typical average time between consecutive light spectra operating under the asynchronous mode is less than 10 milliseconds (1 spectrum every 10 milliseconds).

**THERMAL PROTECTION**

The SPECTRA TUNE LAB incorporates a temperature protection control that is enabled by default. In the unlikely event of PCB overheating (fan or dissipation failure, harsh environments, etc.), the LED module will automatically reduce its luminous flux and consequently the consumed electrical power to keep the temperature within a safety range. In this way, the optimal working conditions that warrant the lifespan of the LED engine and its components are always preserved.

**ELECTRICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Nominal Input Voltage</th>
<th>24 V DC (Constant Voltage) ±5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Power Input</td>
<td>80 W (limited by firmware)</td>
</tr>
<tr>
<td>Max. Current Input</td>
<td>2.5 A* (limited by firmware)</td>
</tr>
<tr>
<td>Data connector</td>
<td>RJ9</td>
</tr>
<tr>
<td>Data communication control</td>
<td>LEDMOTIVE proprietary protocol**</td>
</tr>
</tbody>
</table>

* fuse protection at 3.5 A
** based on a communication bus EIA-485 (also known as RS-485)

Together with the SPECTRA TUNE LAB, a power adaptor is provided to convert from a 100-240 V AC, 50/60 Hz, 1.3 A to a 24 V DC, 3.75 A (90 W max) used in the light engine and another power adaptor to convert from a 100-240 V AC, 50/60 Hz, 1.3A to a 5 V DC, 2.4 A (12 W max) used in the LIGHT HUB.

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² The optional RESTful API is necessary to make use of the asynchronous mode. Go to page #10 for more details
CONTROL SOFTWARE

With every SPECTRA TUNE LAB, a PC/Laptop a µWAVE Software© license is provided to control the device properly. For research applications that need advanced programmatic functionalities please check the optional RESTful API described in Appendix 2).

![Figure 7. Screenshot of the µWAVE Software](image)

**Computer requirements:**

- 64-bit Operating System
- Windows version; preferred WIN 8 and above

**Features:**

- Change the amplitude of each channel to create a specific spectrum
- Dim the light output
- Save and import light spectra
- Playback spectra from the spectral database
- Create, save and reproduce light sequences (dynamic streaming of light spectra) by adding different light spectra to the sequence pool

Please contact our sales team at sales@ledmotive.com if an executable version with special requests (MAC version or 32-bit OS) is needed.
OPTIONAL: RESTful API

To provide the user with full programming flexibility in the operation of the SPECTRA TUNE LAB, a RESTful API is available for the LIGHT HUB. The LIGHT HUB can be accessed using the HTTP protocol under any programming language (C, C++, C#, Python, MATLAB, Java, JavaScript, etc.).

Some details are provided in Appendix 2, but an Application Note explaining in full the RESTful API commands is available on request. Please contact the sales team at sales@ledmotive.com to request a quotation on this optional item.

PRODUCT PARTS

The SPECTRA TUNE LAB includes the following Hardware and Software items:

- **Spectrally tunable** LIGHT ENGINE & power adaptor
- LIGHT HUB & power adaptor
- Standard optical tables compatible mounting holes adaptors
- Communications cable
- End-of-line (EOL) device
- USB cable
- µWAVE Software©
- IP67 rugged carrying suitcase

OPTIONAL:

- C-mount adaptor
- RESTful API
Figure 9. SPECTRA TUNE LAB dimensions
OPTIONAL: C-MOUNT ADAPTOR

LEDMOTIVE can provide a C-mount adaptor to attach it to the SPECTRA TUNE LAB optical area.

C-mount is a market standard in optics. This C-mount adaptor is designed to allow the connection of compatible standard light guide connectors (Liquid Light Guide and/or Optic Fiber) to the SPECTRA TUNE LAB. Please contact our sales team at sales@ledmotive.com for further information.

Figure 10. C-mount adaptor dimensions
QUICK START - OPERATING INSTRUCTIONS

1. Connect all the items together as shown below

![Diagram of SPECTRA TUNE LAB connections](image)

*Figure 11. Schematics of the SPECTRA TUNE LAB connections. Instead of a USB cable, an ethernet cable can be used to connect a PC and the LIGHT HUB (not provided)*

2. Make sure the End-Of-Line (EOL) is connected to the data out connector
3. Connect all power adaptors to the main electrical socket
4. TURN ON the device
5. Run the provided Control Software
6. Play and discover what you can do with the SPECTRA TUNE LAB

There may be cases when several SPECTRA TUNE LAB are being used together with the same LIGHT HUB. In this case it is possible to connect different devices in serial as show in *Figure 12* using the data in-data out connections.
As part of a Customer Special Request, a Wi-Fi LIGHT HUB can be used to reduce the number of cables. Please contact our sales team at sales@ledmotive.com for further information.

*Figure 12. Schematics on how several SPECTRA TUNE LAB devices can be connected.*
### FEATURES - SUMMARY

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source type</td>
<td>Multiple high-power LED</td>
</tr>
<tr>
<td>Output</td>
<td>10 different spectral bands</td>
</tr>
<tr>
<td>Max Radiometric Power</td>
<td>12.7 W (all channels at full power)</td>
</tr>
<tr>
<td>Max Luminous Flux</td>
<td>3360 lumens</td>
</tr>
<tr>
<td>Spectral range</td>
<td>400-700 nm</td>
</tr>
<tr>
<td>Light output pattern</td>
<td>Lambertian</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>0 ºC to +35 ºC</td>
</tr>
<tr>
<td>Synchronous operation mode speed</td>
<td>250 milliseconds</td>
</tr>
<tr>
<td>Feedback control loop</td>
<td>Enabled by default</td>
</tr>
<tr>
<td>Nominal Input voltage</td>
<td>24 V DC (Constant voltage) ± 5%</td>
</tr>
<tr>
<td>Max Input current</td>
<td>2.5 A (limited by firmware)</td>
</tr>
<tr>
<td>Max Input electrical power</td>
<td>80 W (limited by firmware)</td>
</tr>
<tr>
<td>Communications protocol</td>
<td>bus EIA-485</td>
</tr>
<tr>
<td>Control software</td>
<td>Basic version</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td>156 x 126 x 130</td>
</tr>
<tr>
<td>IP</td>
<td>20</td>
</tr>
<tr>
<td>Insolation Class</td>
<td>Class II</td>
</tr>
</tbody>
</table>

**OPTIONAL**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapters</td>
<td>C-Mount adaptor</td>
</tr>
<tr>
<td>Advanced control software</td>
<td>RESTful API</td>
</tr>
<tr>
<td>Asynchronous operation mode speed</td>
<td>10 milliseconds (API required)</td>
</tr>
</tbody>
</table>

---

3 Radiometric power may slightly change depending on the currently available LED binning
MAINTENANCE AND SERVICE

- If a fingerprint mark or dirt is observed at the diffuser, you may clean it. Before cleaning, disconnect from the main supply and allow the system to cool down. Wipe the surface of the diffuser gently with a tissue containing ethanol.
- Do not open, disassemble or manipulate the SPECTRA TUNE LAB system.

WARNING AND SAFETY

- All necessary measures must be taken to avoid electric shock when handling electrical and/or electronic equipment. In case of doubt disconnect the main power supply when handling lighting equipment.
- The SPECTRA TUNE LAB is intended for use in dry interiors only. It is not water resistant and must be protected from adverse weather conditions (hot and humid).
- To avoid damage, do not expose it to spray, liquids, dust, or chemical products.
- This LED-based module must not be operated in explosive environments.
- To prevent injury, use this product in accordance with the International Standard "Photobiological Safety of Lamps & Lamp Systems" IEC 62471. This light engine falls under Risk Group RG1 – Low Risk Group in accordance to the standard IEC 62471:2008. Regardless of the risk factor classification, LEDMOTIVE does not recommend staring directly into any LED lamp or luminaire.
- During normal operation, the fixture can achieve high temperature, be careful when handling it to avoid burning.
- The SPECTRA TUNE LAB device uses an active cooling system to dissipate the heat produced by the LEDs when they are on. Do not manipulate the luminaire when it is connected to the mains and ensure there are always free space around the device to allow prevent any contact with the moving parts (cooling fan).
- All statements regarding safety of operation, warranty and technical data only apply when the unit is operated correctly according to its specifications. The safety of any system incorporating the equipment is the responsibility of the assembler of the system. This system must not be operated in explosive environments.

DISPOSAL

- In accordance with EU Directive WEEE (Waste Electrical and Electronic Equipment), this scientific equipment must not be disposed of with another household waste.
- At the end of their life, it must be taken to the appropriate local facility available for the disposal or recycling of electronic products.
WARRANTY

- This product has passed the EU regulations and directives. See Appendix 1 for further details. LEDMOTIVE offers a one-year limited warranty.
APPENDIX 1: Compliance with directives and norms

This product complies with the following directives and norms:

DIRECTIVES:

- 2014/35/EU: Low Voltage Directive (LV)
- 2014/30/EU: Electromagnetic Compatibility (EMC) Directive
- 2011/65/EU: RoHS Directive

NORMS:

- EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use.
- EN 62471:2008 Photobiological safety of lamps and lamp systems
- EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
APPENDIX 2: Light programmatic control with the RESTful API

To be able to control the lights, a RESTful API is available to send the proper commands to the SPECTRA TUNE LAB.

Once the LIGHT HUB is powered on and connected to a computer, it will start the REST API automatically and will begin to listen to a specific port.

With the API the user can:

- Read the temperature from the PCB Board
- Switch on the system with a default spectrum
- Send a specific spectrum
- Read a spectrum
- Read the current luminous flux of the system
- Switch off the lights
- Define a default spectrum
- Define parameters settings
- Work the luminaire in asynchronous mode
- And much more…