doric

Connectorized Laser Diode Module and Driver

User Manual

Version 1.2.3

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1

Safety Information

1.1 Laser Safety Information

If you are not familiar with laser light sources, seek advice from qualified personnel **BEFORE FIRST USE** and **READ CAREFULLY *Important Laser Safety Information*** in Application Note provided on the USB key. A copy of the Application Note is available from Doric Lenses on the website or by contacting (sales@doriclenses.com).

DANGER!

The Connectorized LD and LD Fiber Light Source are Class 3B & 4 laser products. Read Important Laser Safety Information in the Application Note BEFORE FIRST USE.

The *Connectorized LD and LD Fiber Light Source* are a Class 3B and 4 laser product emitting high power levels of visible light that can **PERMANENTLY DAMAGE THE EYES**. **NEVER LOOK** directly into the optical beam exiting from the output FC connector or any optical fiber connected to it. **NEVER LOOK** directly at specular or diffuse reflections of the output beam. Even when wearing laser safety glasses, **NEVER LOOK** directly into the optical beam exiting from the *Connectorized LD and LD Fiber Light Source* output FC connector, an optical fiber connected to it, or its specular reflections. It is essential to **WEAR LASER SAFETY GLASSES** (goggles) certified for the wavelength and power level of the light source. Follow all safety procedures to protect anyone working in the area. The *Connectorized LD Diver (LDMD) and LD Fiber Light Source (LDFLS)* are provided with a safety interlock connector on the rear panel. Its driver is enabled when the interlock circuit is shorted and the power key inserted (see Section 1.3). For safe use of the *Connectorized LD and LD Fiber Light Source*, the safety interlock connector should be connected to the laser safety interlock circuit of the laboratory. You should contact the laser safety officer of your institution or company to set a proper laser safety interlock circuit for your application and laboratory installation. Given that the wavelength and power of the laser diode is different for each model, the corresponding safety procedures are specific for each type of laser diode.

1.2 Laser Labels

The laser class labels are provided with the system and the laser aperture is clearly identified by laser warning label and/or the text *LASER APERTURE*.

(a) *Laser Classification Label Example*

(b) *Laser Warning Label*

(c) *Laser Aperture Identification*

Figure 1.1: *Safety Labels*

1.3 Activation Safety Features

The interlock plug is a safety features integrated into all light source drivers generated at Doric Lenses.

The interlock plug is designed to create a short-circuit, enabling the laser driver to function. The plug is positioned externally on the laser driver to comply with safety regulations. This setup allows the user to implement a short-circuit in the laboratory, ensuring the laser operates only under specific conditions, such as when lab doors are securely closed.

Note that the interlock plug has 2 terminals that need to be connected to the door interlock system.

To make this connection take the following steps:

1. Unscrew the two little screws located underneath the plug.
2. Remove the little wiring short-circuiting the plug.
3. Then replace the removed wiring with cables from your lab's Interlock Circuit.

The safety features block diagram is shown below (Fig. 1.2) with the relevant information following.

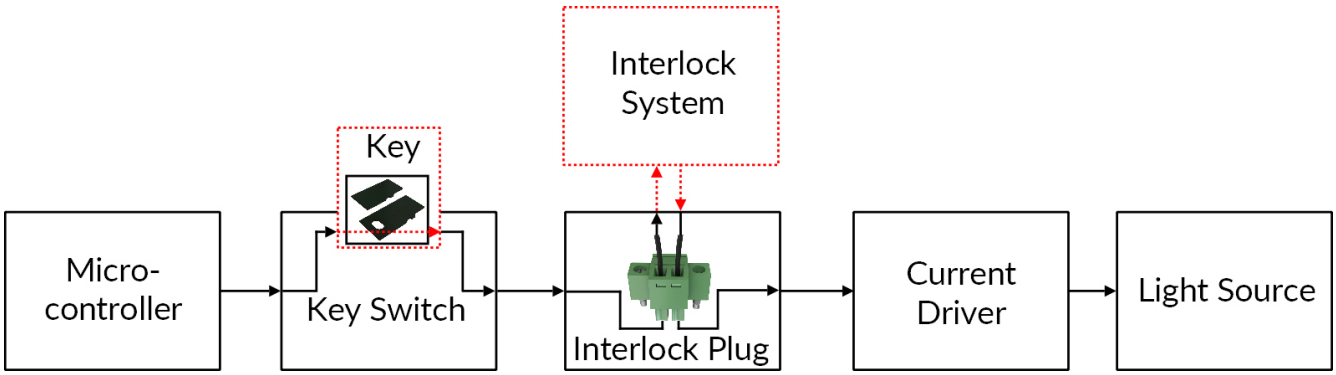
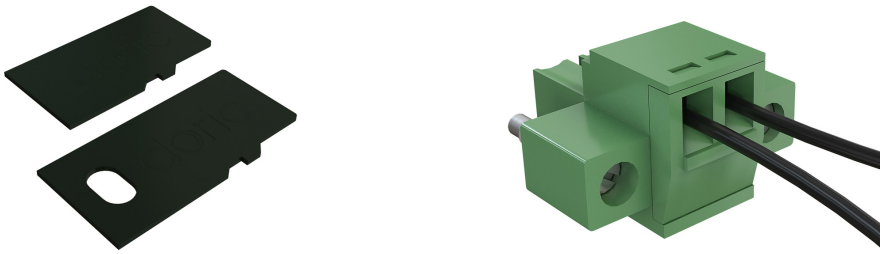


Figure 1.2: *Safety feature block diagram*

- The **Micro-controller**, **Key Switch**, **Interlock Plug** and **Current Driver** are connected in series. This means that if any single safety feature is not properly in place, the light source cannot be activated.
- The **Micro-controller** is used to control the light source driver.



(a) *Key Switch* (b) *Interlock Plug*

Figure 1.3: *Safety Feature Elements*

- The **Key Switch** (Safety feature 1) (Fig. 1.3a), located on the left side of the driver, is required to activate any light source. If removed, no data can be sent from the micro-controller to the **Current Driver**.
- The **Interlock plug** (Safety feature 2) (Fig. 1.3b) is used to integrate the driver into an **Interlock Circuit**.
  - The **Interlock Plug** comes with a small wire short-circuiting it. This wire must be removed before integrating it into an **Interlock Circuit**.
  - Connect the **Interlock circuit** in series with the **Interlock Plug** so the circuit may function properly.

- The **Current Driver** sends current to any connected light source. If the **Key** is absent or the **Interlock Plug** has an open circuit, it cannot receive signals from the micro-controller, preventing it from sending out current.

2

Devices Overview

2.1 Connectorized Laser Diode Module

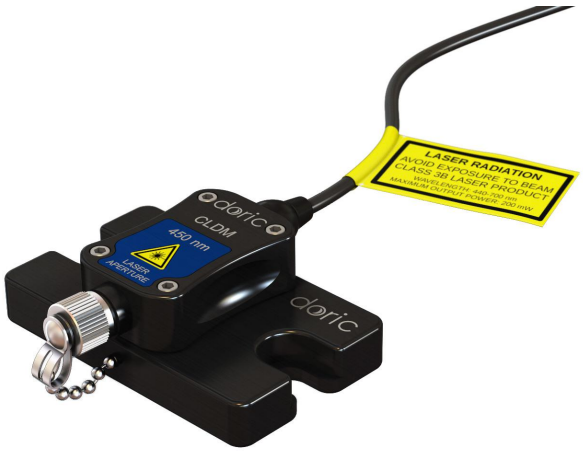


Figure 2.1: *Connectorized Laser Diode Module*

The *Connectorized Laser Diode (LD) Module* (Fig. 2.1) is a compact single laser diode source connectorized for use with FC/APC-connectorized patch cords. These modules are available for wavelengths from 405 nm to 638 nm.

- The output laser beam exits the **Beam Aperture**. It is integrated into an FC/APC receptacle. In the absence of a patch cord, it is recommended to leave the metal cap in place to block the laser beam. The *Laser diode modules* are not intended for use without an optical fiber patch cord.
- The **M8 electric cable** links the diode with its driver. The pin-out is found in Figure 5.1a.

2.2 Laser Diode Module Driver

Figure 2.2: *Laser Diode Module Drivers, 1-, 2- & 4- channel (from top to bottom)*

(a) *Driver Side* (b) *Driver Rear*

Figure 2.3: *Laser Diode Module Driver Views*

For safety precautions, the LD driver must be powered only by the power supply provided with the product.

The driver is designed and is tested to be used only with Doric light sources. For safety precautions, do not connect other devices in the M8 connectors.

The *Laser Diode Module Drivers* (Fig. 2.2) come in 1-, 2- or 4- channel models and are used to control the *Connectorized Laser Diode Module*. The different components of the driver are presented below.

- The **M8-4 female connectors** (Fig. 2.3a) are used to connect the driver to the *Laser Diode Modules* with an M8 cable (See Fig. 5.1b for pin-out).
- The **Control Knob** allows the user to change the laser diode driving current, which is shown on the **LCD Display** (Fig. 2.3a). Each knob is assigned to the corresponding channel. For drivers with multiple channels, each is controlled independently with its own knob.
- The **LCD Display** (Fig. 2.3a) displays the status of each channel.
- The **Key Switch** (Fig. 2.3a) can be removed to disable the activation of all laser sources connected to the driver.
- The **On/Off Switch** (Fig. 2.3a) activates/deactivates the *Laser diode module driver*.
- The **USB-A** port (Fig. 2.3a) is used, for some devices, to power the external light source module cooling fan. There is no data transfer possible with this port.
- Each channel has an **Output BNC** port and an **Input BNC** port (Fig. 2.3b). These allow the user to monitor the laser diode driving current and to control the laser diode driving current through an outside, analog source. Their values are between 0 V and 5 V.
- The green **Interlock Connector Plug** (Fig. 2.3a) allows the device to be attached to a laboratory's safety interlock system.
- The *Laser diode module driver* has a **12 VDC** (Fig. 2.3b) power input to which the user connects the power supply provided with the system.
- The **USB-B** port (Fig. 2.3b) connects the system to a computer using a USB-A/USB-B cable and allows the diode current to be controlled by a computer.

2.3 Laser Diode Fiber Light Source

Figure 2.4: *Laser Diode Fiber Light source, 1, 2 & 4-channel (from top to bottom)*

(a) *Fiber Light Source Top* (b) *Fiber Light Source Rear*

Figure 2.5: *Laser Diode Fiber Light Source Views*

For safety precautions, the LD Fiber Light Source must be powered only by the power supply provided with the product.

The Doric *Laser Diode Fiber Light Source* (Fig. 2.4) is a compact multiple-source laser system with 1, 2, or 4 channels.

- The **Beam Aperture** (Fig. 2.5a) outputs the laser beam.
  - The output is an FC/APC optical fiber receptacle. The related optical patch cord connector is identified by a green strain relief.
  - It is important to leave the cap screwed onto the output when not in use.
- The **Control Knob** allows the user to change the diode current, shown on the **LCD Display** (Fig. 2.5a).
- The **Safety Key** (Fig. 2.5a), when removed, prevents the activation of the laser.
- The **On/Off Switch** (Fig. 2.5a) activates/deactivates the fiber light source.
- The **USB-A** port (Fig. 2.5a) is used, for some devices, to power the external light source module cooling fan. There is no data transfer possible with this port.
- Each channel has an **Output BNC** port and an **Input BNC** port (Fig. 2.3b). These allow the user to monitor the laser diode driving current and to control the laser diode driving current through an outside, analog source. Their values are between 0 V and 5 V.
- The green **Interlock Connector Plug** (Fig. 2.5b, short-circuited on the figure) allows the device to be attached to a laboratory's interlock system.
- The light source has a **12 VDC** (Fig. 2.5b) power input to which the user connects the power supply provided with the system.
- The **USB-B** port (Fig. 2.5b) connects the system to a computer and allows the device to be controlled by the *Doric Neuroscience Studio* software.

3

Operations Guide

This chapter explains how to set up and operate the Connectorized Diode Laser Module. The procedure below should be followed carefully.

3.1 Getting Started

Warning!

The *Connectorized Laser Diode Module* is sensitive to electrostatic discharges. When handling, use proper ESD conditions to avoid any risk of electrostatic discharge (wrist strap,...).

1. Unpack the *Laser Diode Fiber Light Source* or the *Connectorized Laser Diode Module* and the *Laser Diode Module Driver*.
    - Remove the device from the ESD protective bag.
    - Allow sufficient time for the device to reach ambient temperature.
2. Connect the interlock circuit to the *Laser Diode Module Driver* or the *Laser Diode Fiber Light Source*.
    - The current driver CAN NOT be operational if the safety interlock circuit is open.
    - When unpacking, a temporarily shorted interlock connector plug is already secured in the rear panel green interlock connector.
    - It is highly recommended to remove the shorting electric wire and connect the interlock connector to a proper interlock circuit in the laboratory.
    - See the *Safety Information* section (Chapter 1) for more information.

Warning!

Be aware that a shorted interlock plug DISABLES this safety feature AT YOUR OWN RISKS. A safety interlock circuit is highly recommended.

3. If using the *Connectorized Laser Diode Module*, secure it on a proper heat sink.
    - For optimal performance, the laser diode module should be mounted on a proper heat sink.
    - Secure the *Connectorized Laser Diode Module* on an optical table.

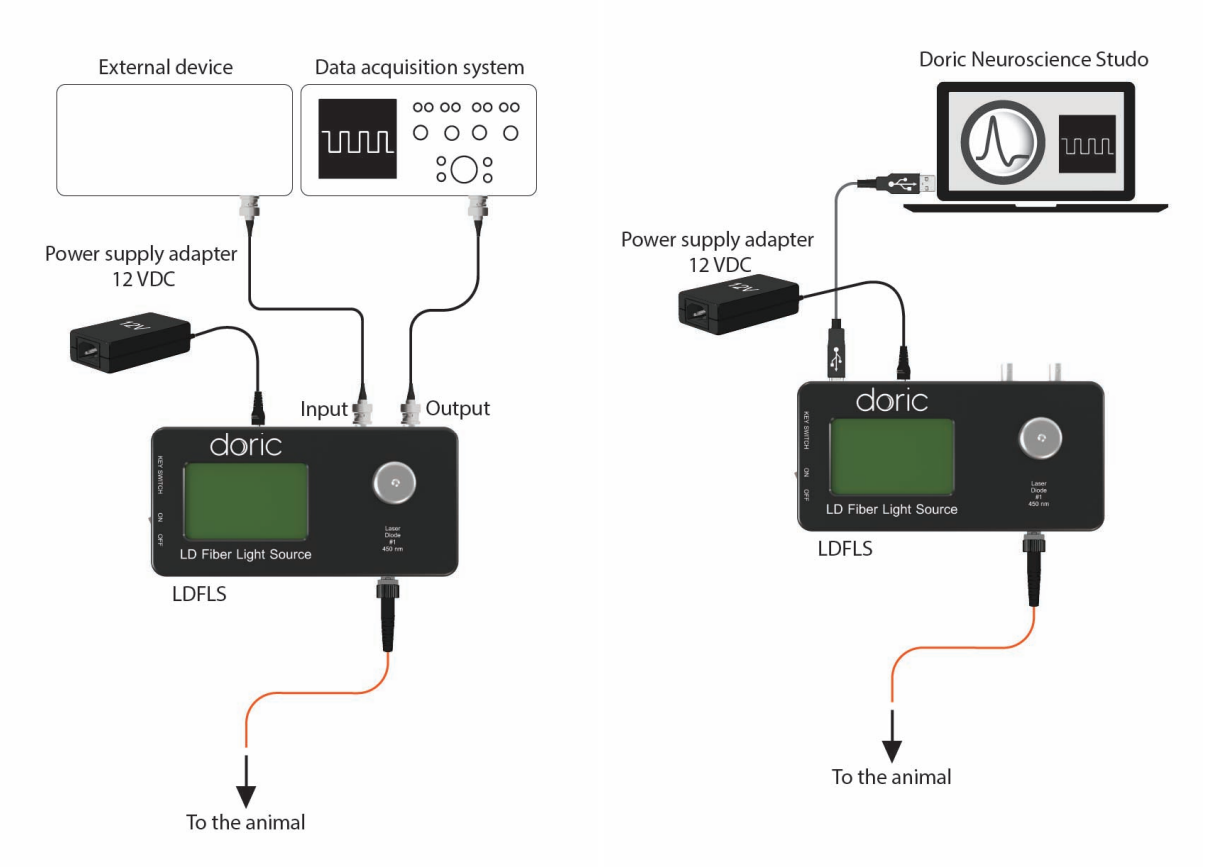
CAUTION!

The proper heat sink is a function of operating conditions. An improper thermal management may shorten the lifetime of the *Laser Diode Module*.

DANGER!
DO NOT OPEN the driver enclosure. Electrical hazards may result.
The driver contains no user-serviceable components.

3.2 Connecting the System

1. Connect the *Connectorized Laser Diode Module* to the *Laser Diode Module Driver* M8 Connector (When both devices are connected, they are equivalent to the Laser Diode Fiber Light Source (LDFLS) system. To lighten the text and the diagrams, LDFLS will be used in the rest of the document).



(a) *In Stand-alone mode* (b) *USB Connected to Doric Neuroscience Studio*

Figure 3.1: *Connections of a Laser Diode Fiber Light Source*

2. Connect the power supply to the device.
   - Verify that the main power switch is set to OFF.
   - Using the proper power cable, connect the electrical plug of the power supply to the wall outlet.
   - Connect the 12 V power jack of the power supply to the device.
3. Connect the optical fiber to the *Laser Aperture*. Use an FC/APC connectorized patch cord on the FC *Laser Aperture*. These can be identified by their green strain relief.

DANGER!
The laser beam or any connected optical fiber should be confined BEFORE turning ON the driver.

4. Ensure that all laser safety procedures are followed.
5. Insert the safety keys in the key switch.
6. Turn ON the device.

Notes:

- The system is ready for stand-alone operation. See the section for *Stand-alone Operating Instructions* (Section 3.4).
- If the system is used with computer control (see Fig. 3.1b), the driver must be connected to the computer using a USB-A/USB-B cable instead of an analog source through the BNC connector. See Chapter 4 for details on using the *Doric Neuroscience Studio* software.

3.3 FC Connector Installation

1. Clean the optical fiber connector before insertion. Use isopropanol and a lint-free wipe.
2. With an FC connector, the connector key must be oriented to enter within the receptacle slot to ensure proper connection (Fig. 3.2).

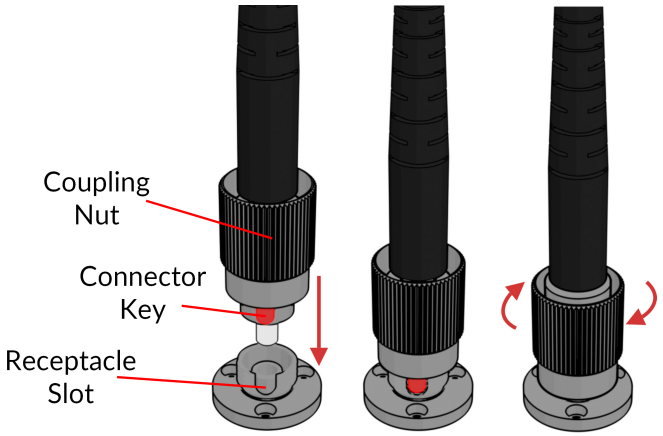


Figure 3.2: *FC connector, Fiber Installation*

To reduce the risk of eye injury, it is sound practice to NOT CONNECT/DISCONNECT OPTICAL FIBERS when the light source is turned on

3.4 Stand-alone Mode (without Doric Neuroscience Studio Software)

The following section details the stand-alone operation of the *LD driver* and *LDFLS*. For installation of the device in stand-alone mode, see sections 3.1 and 3.2.

If the light source driver is used as a stand-alone device, 3 modes are available: Continuous Wave (CW), External TTL (Ext. TTL), and External Analog (Ext. Ana). The operating mode is changed by pressing the **Control Knob** and the maximum driving current is set by turning the Control knob. Use a fast/slow rotation for coarse/fine adjustment. The operating mode and the maximum driving current setting are independently adjusted for each channel.

3.4.1 Continuous Wave (CW)

When using the CW mode, the user simply sets the driving current applied to the light source using the control knob. The light source is activated and an output beam will be visible as long as the driving current is above the minimum driving current (Fig. 3.3).

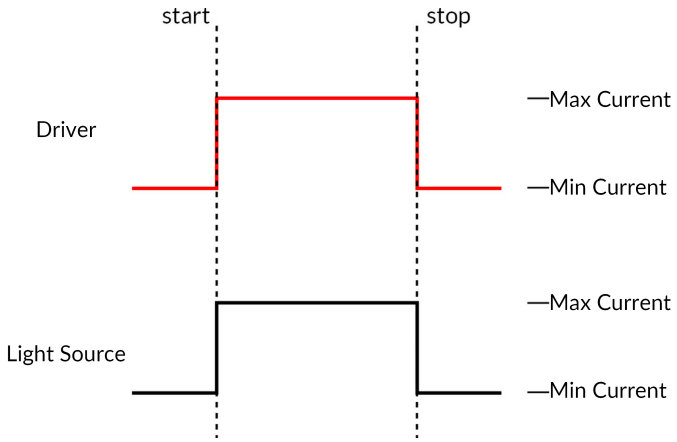


Figure 3.3: *Continuous Wave Mode Driver Signal*

3.4.2 External TTL (Ext. TTL)

In the External TTL mode, the laser light source is activated by an input TTL signal coming from an external device. This activation will follow the TTL pulse waveform (the signal will be considered as ON if the tension is between 3.6 V and 5 V). The driving current is set with the control knob and is constant during each TTL activation pulse (Fig. 3.4).

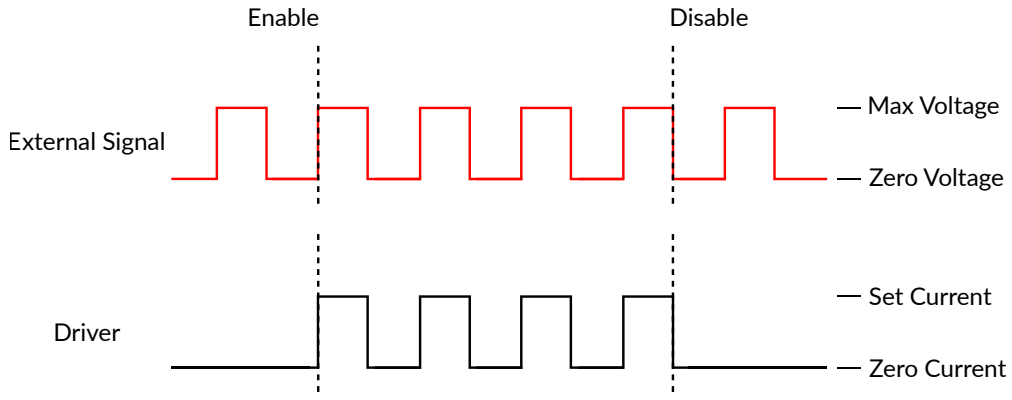
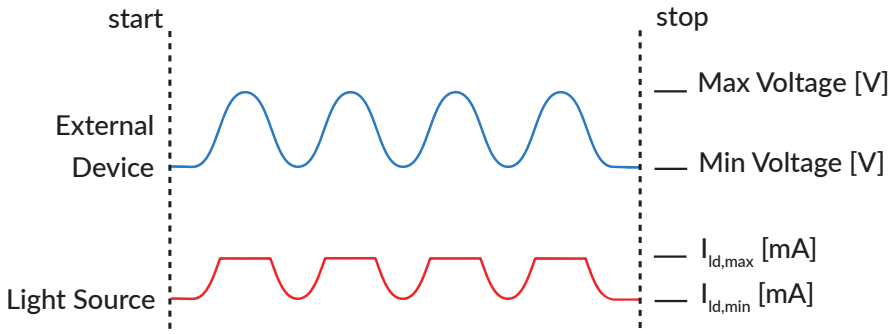


Figure 3.4: *Driver Signal Response to External Source in External TTL Mode*

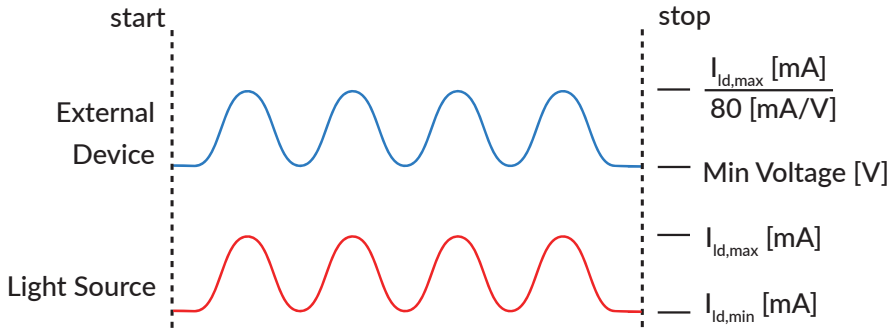
3.4.3 External Analog (Ext. Ana.)

The External Analog mode is similar to the External TTL, except that the driving current is proportional to the voltage applied to the BNC input connector (Fig. 3.5b). On the input BNC, a maximum voltage signal corresponds to a maximum of 400 mA current. Most laser light sources have a maximum current below this value which could result in a clipping to the current output (see Fig. 3.5a).

To avoid this clip on the output waveform, the maximum voltage setting must be equal to the maximal current divided by 80 mA/V (the value of the relationship between current and input voltage) (Fig. 3.5b). For square modulations, it is preferable to use External TTL mode instead of External Analog mode.



(a) *Clipping of light source current output*



(b) *Adjusted tension to maximum current*

Figure 3.5: *Driver Signal Response to External Source in External Analog Mode*

4

Doric Neuroscience Studio

Doric Light Sources can be controlled by the Doric Neuroscience Studio software. These include *LED Modules*, *Laser Diode Modules*, and *⋆LISER™ Light Source*[1]. The interface is separated into two main sections, **Control & Settings** and the **Acquisition View**. Each light source driver has several **Channels**, each one controlling a light source of its given type.

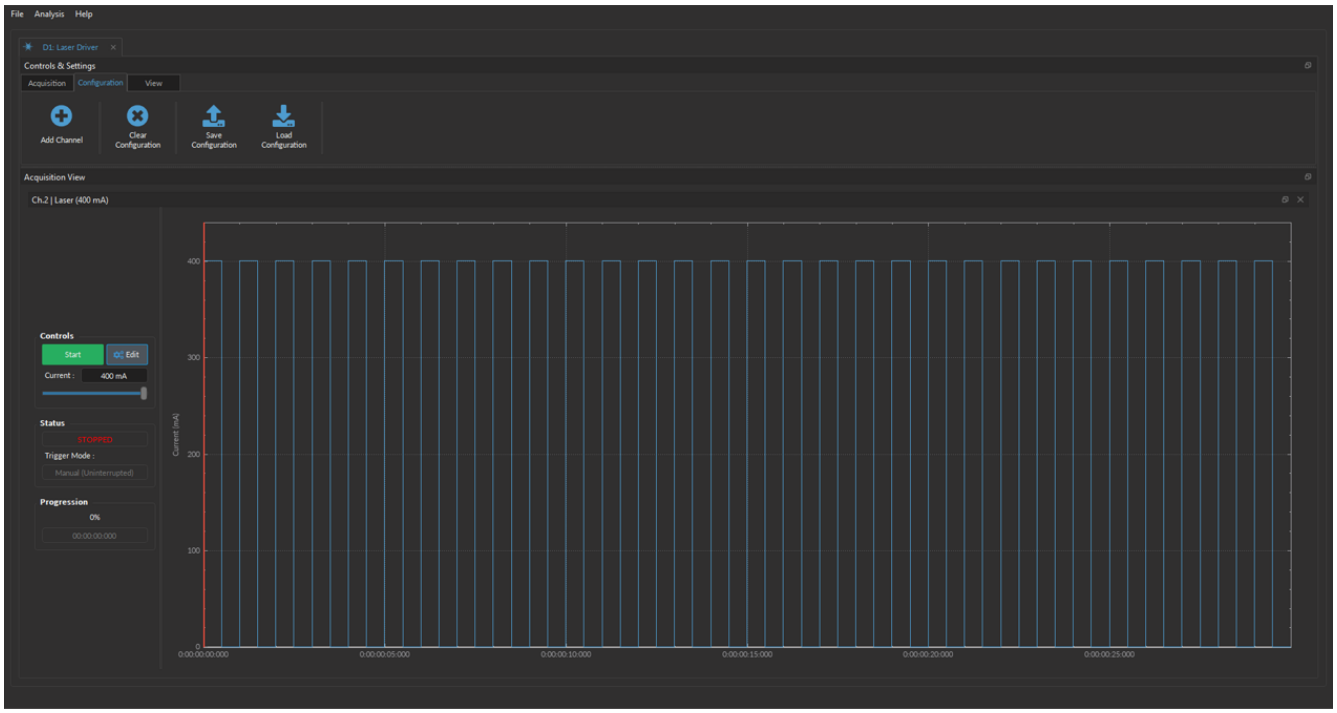


Figure 4.1: *Light Source Driver Tab*

[1]The ⋆LISER™ Light Source are also known in older models as Ce: YAG Fiber Light Source.

4.1 Controls and setings

The **Control and Settings** box is used to manage the different parts of the software. It contains three tabs, the **Acquisition**, **Configuration**, and **View** Tabs.

4.1.1 Acquisition Tab

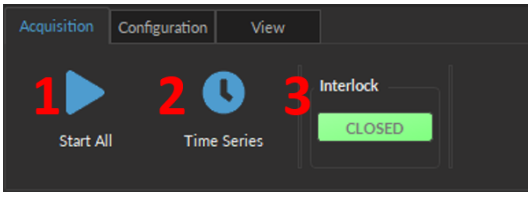


Figure 4.2: *Acquisition Tab*

The different buttons of the **Acquisition Tab** are shown in Figure 4.2 and their functions are explained below.

1. The **Start All** button starts all currently configured channels.
2. The **Time Series** button opens the Time Series window (Fig. 4.3). This tool allows all channels to share the same timing. The window is composed of:

Figure 4.3: *Time Series Window*

a) The **Number of series** sets the number of times that the sequence will be repeated, with a minimum of 1.

b) The **Time Active** sets the duration of each series in hh:mm:ss:zzz format. The **Time series** can be used in combination with a sequence such as the Square Sequence(s) or the Complex Sequence(s) Mode. If the **Time Active** duration is shorter than the sequence time length, the sequence will stop at the end of the **Time Active** time length.

c) The **Interval between series** sets the duration between each series in hh:mm:ss:zzz format.

d) The **Total Duration** displays the total duration of the sequence in d:hh:mm:ss:zzz format.

e) The **Progression** bar displays the progression of the sequence in %, while the **Time Elapsed** counter displays the progression in hh:mm:ss:zzz format.

f) The **Launch** button starts the sequence.

3. The **Interlock** indicator displays 

when the interlock is correctly connected, and 

when disconnected (more details in the section 1.3).

4.1.2 Configuration Tab

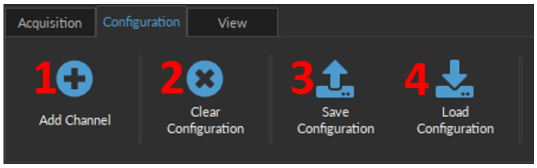


Figure 4.4: *Configuration Tab*

The different buttons of the **Configuration Tab** are shown in Figure 4.4 and their functions are explained below.

1. The **Add Channel** button opens the **Channels Configuration** window to set up the channels. This window is detailed in the section 4.2.
2. The **Clear Configuration** button resets the acquisition view and all other parameters set. Any configurations already set will be lost.
3. The **Save Configuration** button is used to save the Light Source configuration in a **.doric** format.
4. The **Load Configuration** button allows a Light Source configuration in **.doric** format to be loaded. Recorded data files also contain the configuration used during the experiment and this configuration can be loaded using this button.

4.1.3 View Tab

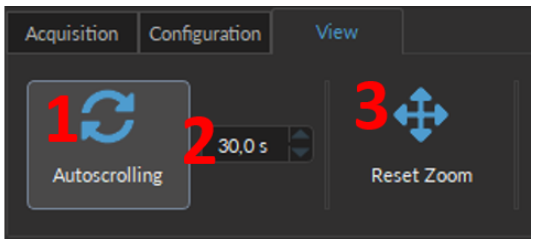


Figure 4.5: *View Tab*

The different buttons and fields of the **View Tab** are shown in Figure 4.5.

1. The **Autoscrolling** button, when clicked, makes the graphs scroll as new data appears.
2. The duration (in seconds) kept on display by the Autoscrolling function.
3. The **Reset Zoom** button resets the horizontal axis of all graphs displayed in the **Acquisition View** to the duration chosen in the **Autoscrolling** field.

4.2 Channel Configuration

4.2.1 Channel Configuration Window Overview

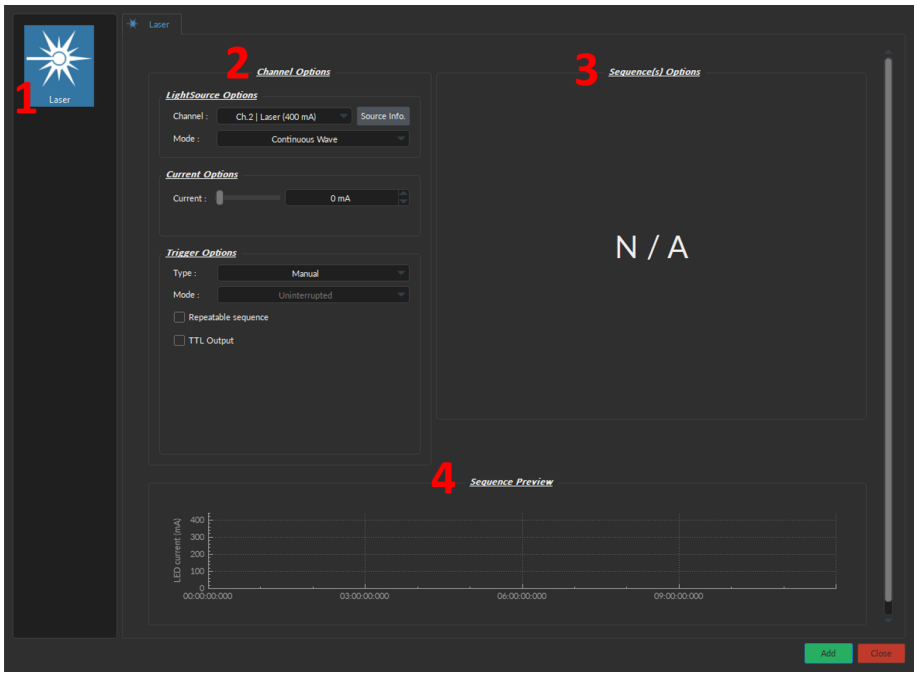


Figure 4.6: *Channels Configuration Main Interface*

The **Channels Configuration** window is used to configure each channel. The window can be accessed by using either the **Add Channel** or **Edit** buttons. This window is separated into multiple sections shown in Figure 4.6 that are defined below.

1. The **Channel Types** are displayed on the left side of the window. These include the ⋆**LISER**^{TM} light sources, the **LED** light sources and the **Laser Diode** light sources.
2. The **Channel Options** section allows you to define the Light Source Options, the Current Options, and the Triggering Options. The different fields of this section are explained in more detail in section 4.2.2.
3. The **Sequence Options** defines the parameters of each pulse sequence for the channel. These parameters are different for each Channel Mode. The different fields for the different Channel Mode are explained in more detail in section 4.2.3.
4. The **Sequence Preview** section shows a visualization of the output sequence that will be generated by the current configuration.
5. The **Add** button will save the current channel configuration and enables a new channel to be configured. The **Close** button will close the window without saving the current channel configuration.

4.2.2 Channel Options Section

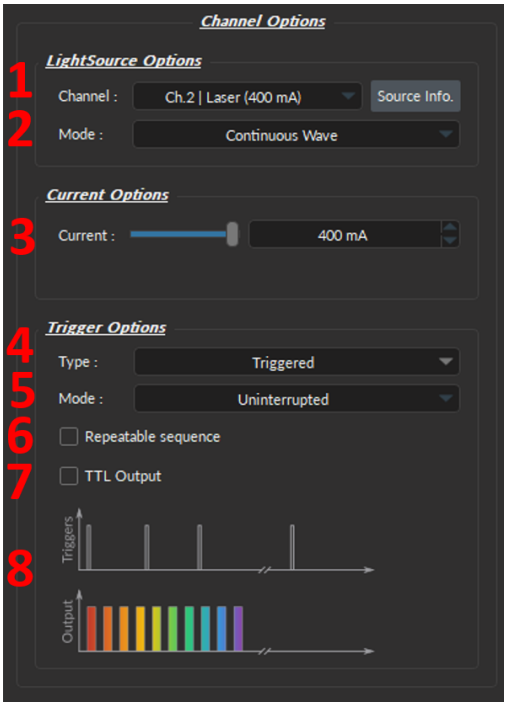


Figure 4.7: *Channel Options of the Channel Configuration Window*

The Channel Option section (Fig. 4.7) is separated into 3 sub-sections, the **Light Source Options** section that defines the channel and its mode, the **Current Options**, and the **Trigger Options** section that controls the trigger method of the selected channel.

Light Source Options

1. The **Channel** field identifies which of the available channels is currently being modified. The Light Source can be changed by selecting a new one from the drop-down list.
2. The **Mode** field identifies the mode used to generate the light. Five modes are available, **Continuous Wave** (fix current), **External TTL** (external digital command), **External Analog** (external analog command), **Square Sequence(s)** (internal digital command), **Complex Sequences(s)** (internal analog command) and **Custom File sequense(s)**. Each mode enables different options in the Sequence Option section that are explained in more detail in section 4.2.3.

Current Options

3. The **Current Options** includes the slider used to control the current sent to the light source.

Some other options can be available depending on the light source:

- The **Overdrive** checkbox appears when the light source is compatible with the overdrive option. When selected, this allows the system to exceed the normal safe current limit of the light source. **THIS SHOULD ONLY BE USED WITH PULSED SIGNALS, AS IT CAN OTHERWISE DAMAGE THE LIGHT SOURCE.**
- When using a *CLED* module, a *CLED_HP* module or a *LEDFLS* module, the **Low-Power** checkbox will appear. When selected, this allows reduced-power signaling for the same voltage. This allows low-power signals to be more stable in time. The maximal current is reduced to one-tenth of the light source's normal maximal current. If the **BNC Output** is used to monitor the LED power, its output voltage is proportional to the current passing through the light source, and not the voltage sent to it. For example, a driver with a normal maximum current of 2000 mA for a 5 V signal (400 mA/V) will have a maximum current of 200 mA for a 5 V signal (40 mA/V) in low power mode. The **BNC output** of the driver will still relate the LED current with a 400 mA/V conversion factor.

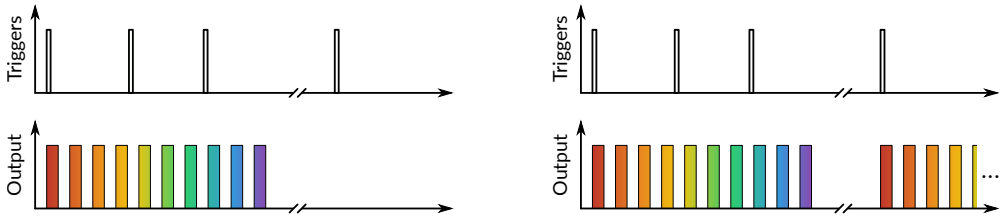
- In External Analog mode, the current is set at the maximum current and can't be changed.

Trigger Options

4. The **Type** defines the type of trigger that is used to start/stop a sequence. The **Triggered** type can start and stops a sequence at a rising edge while the **Gated** type can start the sequence at a rising edge and stops it at a falling edge. A more refined interaction of the trigger with the defined sequence can be set up using the **Mode** field. Not all Trigger Types are available for each combination of Trigger Mode and Repeatability. The different combinations are shown in Figure 4.12.

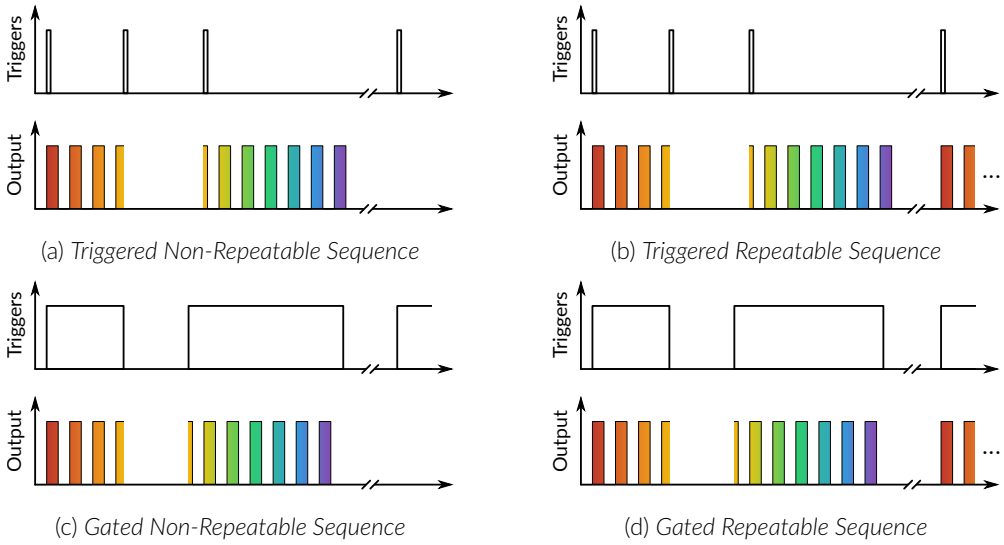
5. The **Mode** field defines how the trigger activates a sequence. Each mode is not compatible with each combination of trigger type and repeatability. Figure 4.12 shows the different available combinations for the different Trigger Modes. Four Modes are available and are the following:

    - **Uninterrupted**: This mode activates the channel sequence when an input greater than 3.3 V is detected by the BNC input. Following input pulses will be ignored while the sequence is running (Fig. 4.8). When the **Repeatable sequence** checkbox is checked, the sequence will restart with the arrival of the first input pulse after the sequence has finished (Fig. 4.8b). This mode is available for *Triggered* pulse only.
    - **Pause**: This mode activates the channel sequence when a rising edge greater than 3.3 V is detected on the BNC input (Fig. 4.9). Following input pulses (when *Triggered*, Fig. 4.9a) or falling edge (when *Gated*, Fig. 4.9c) will pause the sequence and the sequence will continue when the next rising edge is received. When the **Repeatable sequence** checkbox is checked, the sequence will restart with the arrival of the first input pulse after the sequence has finished (Figs. 4.9b and 4.9d).
    - **Continue**: This mode activates the channel sequence when a rising edge greater than 3.3 V is detected on the BNC input (Fig. 4.10). The following input pulse (when *Triggered*, Fig. 4.10a) or a falling edge (when *Gated*, Fig. 4.10c) will turn off the output, but the sequence will continue. The output will be turned back on at the reception of the following rising edge. Triggers only affect the output voltage value. When the **Repeatable sequence** checkbox is checked, the sequence will restart with the arrival of the first input pulse after the sequence has finished (Figs. 4.10b and 4.10d).
    - **Restart**: This mode activates the channel sequence when a rising edge higher than 3.3 V is detected on the BNC input. The following input pulse (when *Triggered*, Fig. 4.11a) or falling edge (when *Gated*, Fig. 4.11b) will stop the sequence and the sequence will restart from the beginning when the next rising edge is received. When the sequence is completed, it will restart with the next input pulse.



(a) *Triggered Non-Repeatable Sequence* (b) *Triggered Repeatable Sequence*

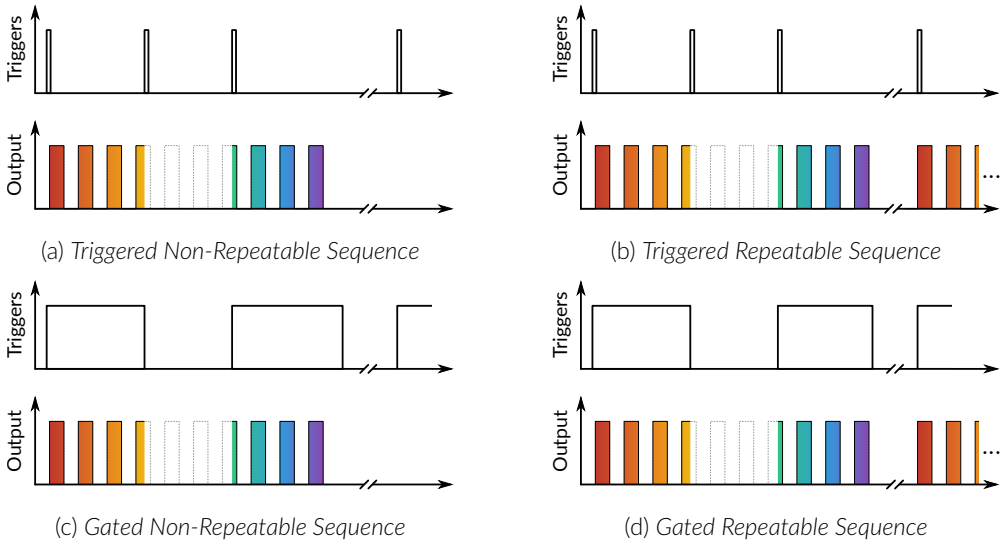
Figure 4.8: *Uninterrupted Sequence Mode*



(a) *Triggered Non-Repeatable Sequence* (b) *Triggered Repeatable Sequence*

(c) *Gated Non-Repeatable Sequence* (d) *Gated Repeatable Sequence*

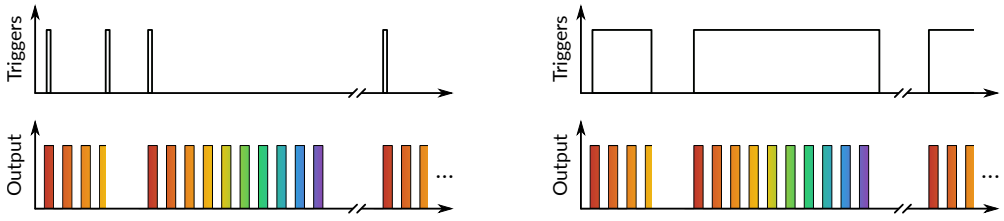
Figure 4.9: *Pause Sequence Mode*



(a) *Triggered Non-Repeatable Sequence* (b) *Triggered Repeatable Sequence*

(c) *Gated Non-Repeatable Sequence* (d) *Gated Repeatable Sequence*

Figure 4.10: *Continue Sequence Mode*



(a) *Triggered Repeatable Sequence* (b) *Triggered Gated Sequence*

Figure 4.11: *Restart Sequence Mode*

6. The **Repeatable sequence** checkbox, when selected, allows a sequence to be repeated. Not all modes and trigger types can be repeated. Please refer to Figure 4.12 to know the repeatable sequence combinations.

7. The **TTL Output** checkbox, when selected, allows the output BNC channel to be used as a TTL generator. The monitoring signal will provide a TTL signal instead of an analog voltage output proportional to the LED current. The output will send out a 5 V signal whenever the input current is >0 mA. This can be used even if a light source is not connected.

8. The **Sequence Visualisation** shows a graphical representation of the behavior of the selected Trigger Option Type, Mode, and Repeatability.

	Triggered		Gated	
	Non-repeatable sequence	Repeatable sequence	Non-repeatable sequence	Repeatable sequence
Uninterrupted	✓	✓		
Pause	✓	✓	✓	✓
Continue	✓	✓	✓	✓
Restart		✓		✓

Figure 4.12: *Trigger options possibilities*

4.2.3 Sequence options

The **Sequence options** box (Fig. 4.6, number 3) is where sequence options are defined depending on the mode. The **Continuous wave, External TTL** and **External Analog** modes have no additional sequence options.

Continuous Wave

The **Continuous Wave** mode (Fig. 4.13) produces a continuous signal at the chosen current. This mode can only be triggered manually. When this mode is active, the driver channel will show **CW** under **MODE**. This mode has no additional sequence options.

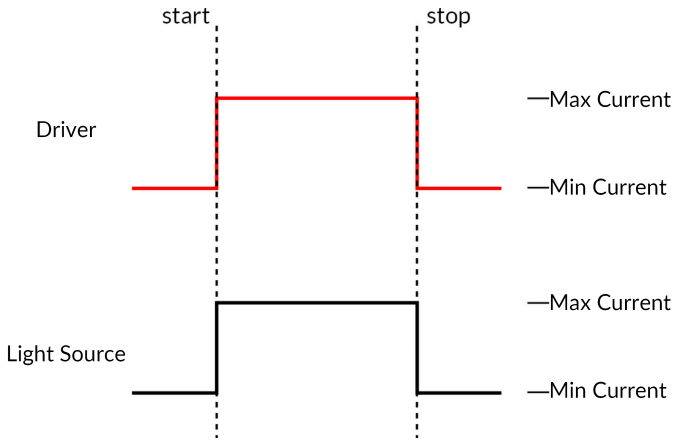


Figure 4.13: *Constant Current Mode Driver Signal*

External TTL

The **External TTL** mode (Fig. 4.14) has the light source follow a TTL signal provided by an external source connected to the **BNC Input**. When this mode is active, the driver channel will show **ExTTL** under **MODE**. This mode has no additional sequence options.

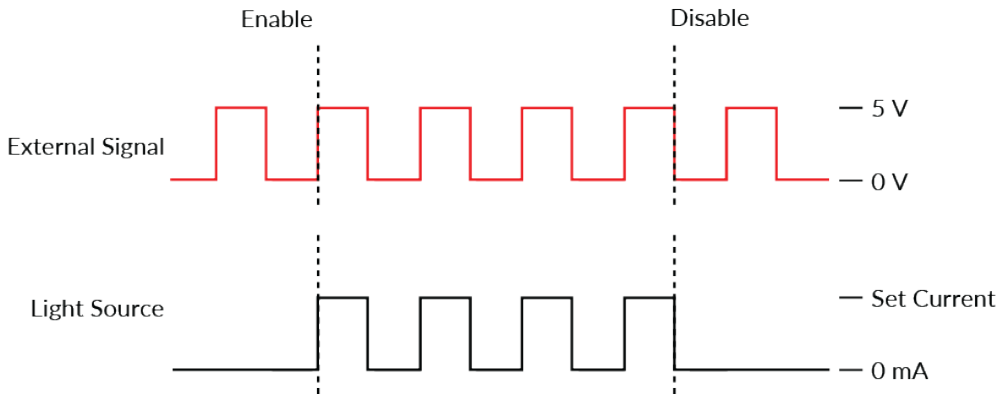
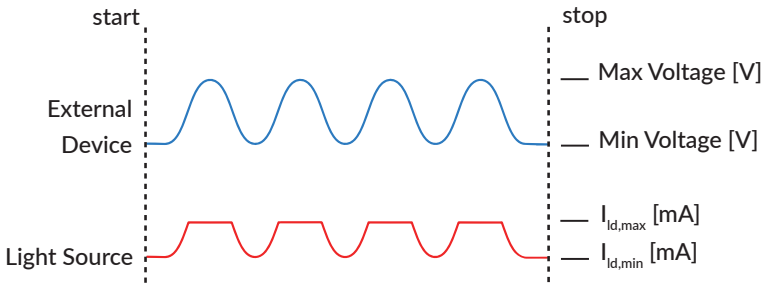


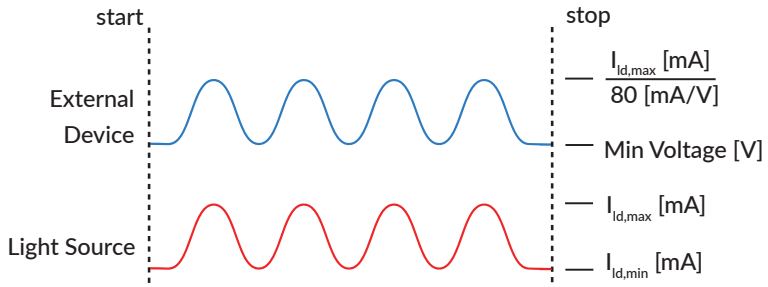
Figure 4.14: *Driver Signal Response to External Source in External TTL Mode*

External Analog

The **External Analog** mode is similar to the **External TTL**, except that the driving current is proportional to the voltage applied to the BNC input connector (Fig. 4.15b). On the input BNC, a maximum voltage signal corresponds to a maximum of 400 mA current. Most laser light sources have a maximum current below this value which could result in a clipping to the output signal (see Fig. 4.15a).



(a) *Clipping of light source current output*



(b) *Adjusted tension to maximum current*

Figure 4.15: *External Analog output is proportional to the External Device voltage*

To avoid this clip on the output waveform the maximum voltage setting must be equal to the maximal current divided by 80 mA/V (the value of the relationship between current and input voltage) (Fig. 4.15b). For square modulations, it is preferable to use External TTL mode instead of External Analog mode.

Square Sequences

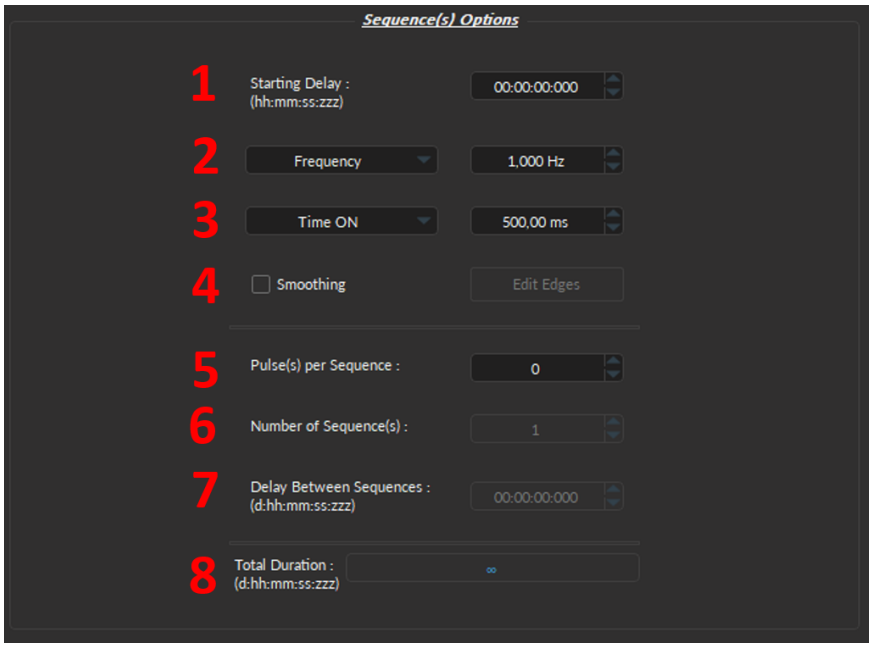


Figure 4.16: *Light Source Channel Configuration Window, Square Sequence Options*

The **Square Sequences** mode has the light source following a square pulse sequence.

1. The **Starting Delay** (Fig. 4.16) sets the delay (in hh:mm:ss:zzz format) before the first pulse.
2. The **Frequency/Period** (Fig. 4.16) sets the frequency (in Hz) or period (in ms) for the pulse sequence. For example, a signal at 10 Hz (frequency) will output one pulse every 100 ms (period), whereas a pulse sequence at 0.5 Hz (frequency) will output one pulse every 2000 ms (period).
3. The **Time ON/Duty Cycle** (Fig. 4.16) sets the time (in ms) or the duty cycle (in %) for each pulse. The **Time ON** must be lower than (1/frequency)+0.005 ms, while the **Duty cycle** must be below 100 %. These squares will appear red should an impossible **Frequency**/**time ON** be selected. Should the **Smoothing** option be selected, this feature becomes inaccessible.
4. The **Smoothing** option is used to change the pulse slope in square pulse sequences. The **Edit Edges** button opens the **Smoothing Edge(s)** window (Fig. 4.17).

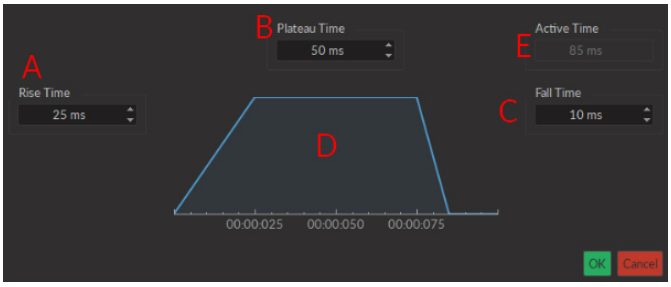


Figure 4.17: *Light Source Smoothing Edge(s) Window*

a) The **Rise Time** box is used to define the duration to rise from 0 to the pulse maximum.

b) The **Plateau Time** box is used to define the duration the pulse is at its maximum value.

c) The **Fall Time** box is used to define the duration to descend from the pulse maximum to 0.

d) The **Pulse Graph** displays the pulse shape.

e) The **Active Time** box displays the total duration of the pulse. While the **Smoothing** option is active, the **Time ON** is fixed at this value.

5. The **Pulses per sequence** (Fig. 4.16) sets the number of pulses per sequence. If it is set to 0, the pulse will be repeated indefinitely.

6. The **Number of sequences** (Fig. 4.16) sets the number of times that the sequence will be repeated. If it is set to 0, the sequence will be repeated indefinitely.

7. The **Delay between sequences** (Fig. 4.16) sets the delay (in hh:mm:ss:zzz format) between each sequence if the **Number of Sequences** is greater than 1.

8. The **Total Duration** (Fig. 4.16) displays the total time of the experiment. The different values can be *Inf* for infinite, a valid time value or *Err* if the **Time ON** value is greater than 1/frequency.

Complex Sequences

The **Complex Sequences** mode allows the design of complex pulse sequences. Multiple sequences can be combined to create a more elaborate pulse sequence. These are displayed in a spreadsheet format.

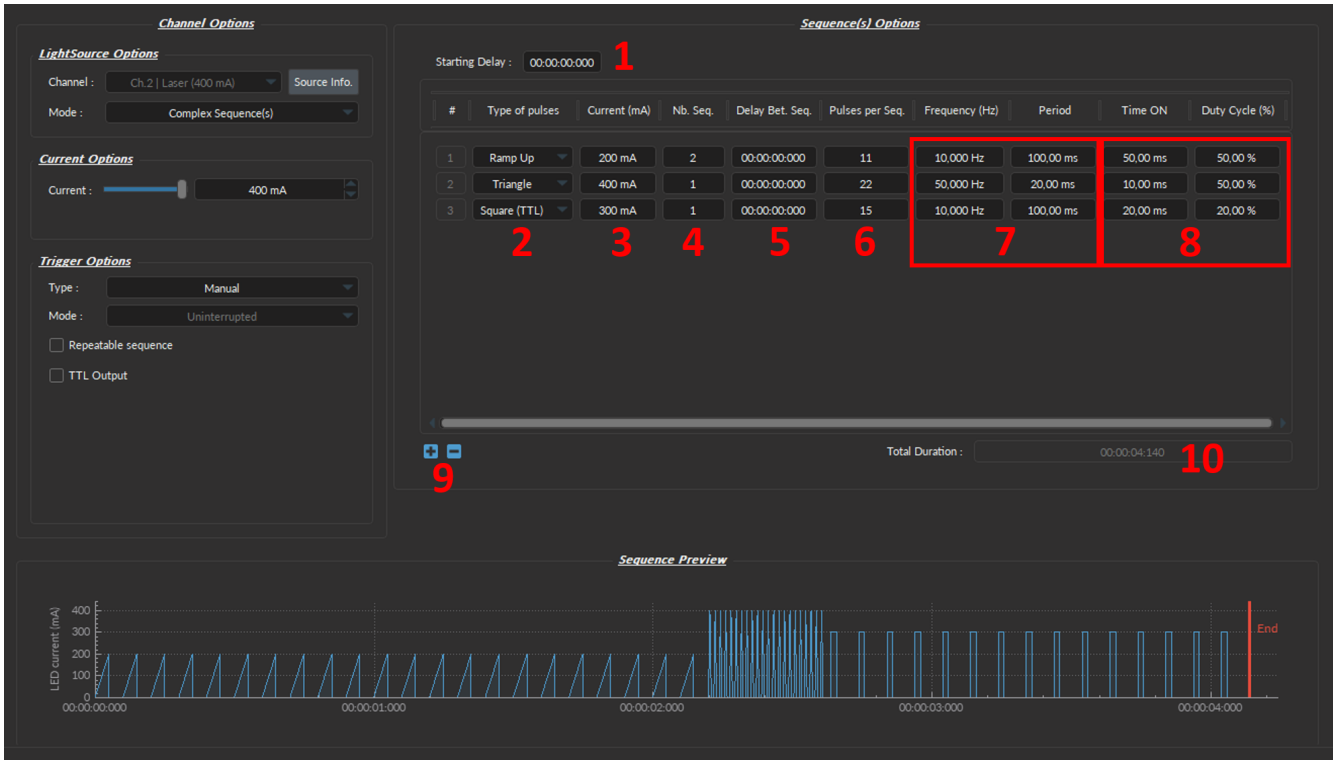


Figure 4.18: *Complex Sequences Window*

1. The **Starting Delay** (Fig. 4.18) sets the delay (in hh:mm:ss:zzz format) before the first pulse sequence.

2. The **Types of pulses** (Fig. 4.18) sets the pulse type. Pulses can be **Square**, triangular (**Triangle**), **Ramp up Ramp down** or **Delay**. The **Delay** pulse type is used to create a delay between different sequences.

3. The **Max Current** (Fig. 4.18) sets the maximum current (in mA) for the given sequence.

4. The **Number of sequences** (Fig. 4.18) sets the number of times that the sequence will be repeated, with a minimum of 1.

5. The **Delay between sequences** (Fig. 4.18) sets the delay (in hh:mm:ss:zzz format) between each sequence if the **Number of Sequences** is greater than 1.
6. The **Pulses per sequence** (Fig. 4.18) sets the number of pulses per sequence, with a minimum of 1.
7. The **Frequency/Period** (Fig. 4.18) sets the frequency (in Hz) or period (in ms) for the pulse sequence. These two values are linked, and when one is changed the other will adjust automatically. For example, a signal at 10 Hz (frequency) will output one pulse every 100 ms (period), whereas a pulse sequence at 0.5 Hz (frequency) will output one pulse every 2000 ms (period).
8. The **Time ON/Duty Cycle** (Fig. 4.18) sets the time (in ms) or the duty cycle (in %) for each pulse. These two values are linked, and when one is changed the other will adjust automatically. The **Time ON** must be lower than (1/frequency)+0.005 ms, while the **Duty cycle** must be below 100 %.
9. The **Sequence controls** (Fig. 4.18) allow the addition (**+**) or removal (**-**) of sequences to the spreadsheet.
10. The **Total Duration** (Fig. 4.18) displays the total time of the experiment. The different values can be *Inf* for infinite, a valid time value or *Err* if the **Time ON** value is greater than 1/frequency.

Custom File Sequence(s)

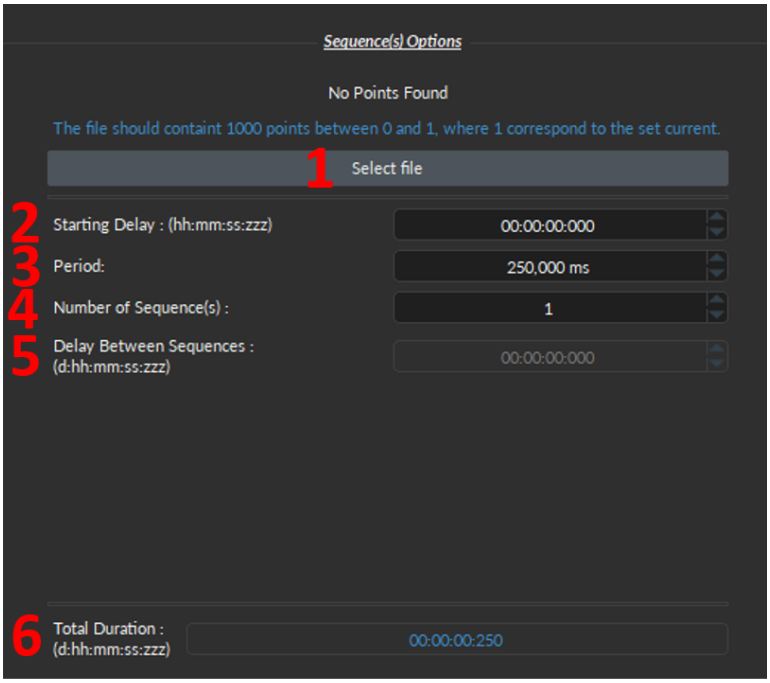


Figure 4.19: *Light Source Channel Setup Window, Custom Sequence File Mode*

1. The **Select file** button allows to import a CSV file with 1000 values between 0 and 1 contained in one column.
   Notes:
   - If the file contains less than 1000 values, the missing data will be replaced by 0 to reach the 1000 values.
   - If the file contains more than 1000 values, the extra values will be ignored.
   - If the file contains negative values, they will be set to 0.
   - If the file contains values greater than 1, they will be reduced to 1.
2. The **Starting Delay** (Fig. 4.19) sets the delay (in hh:mm:ss:zzz format) before the first pulse sequence.
3. The **Period** (Fig. 4.19) sets the period (in ms) for the pulse sequence contained in the file.

4. The **Number of Sequences** (Fig. 4.19) sets the number of times that the sequence will be repeated, with a minimum of 1.
5. The **Delay Between Sequences** (Fig. 4.19) sets the delay (in hh:mm:ss:zzz format) between each sequence if the **Number of Sequences** is greater than 1.
6. The **Total Duration** (Fig. 4.19) displays the total time of the experiment. The displayed values can be *Inf* for infinite or a valid time value.

4.2.4 Preview

The **Preview** box (Fig. 4.6, number 4) displays a preview of the chosen sequence while in the **Continuous Wave**, **Square Sequences**, **Complex Sequences** and **Custom File Sequence(s)** mode.

4.3 Acquisition view

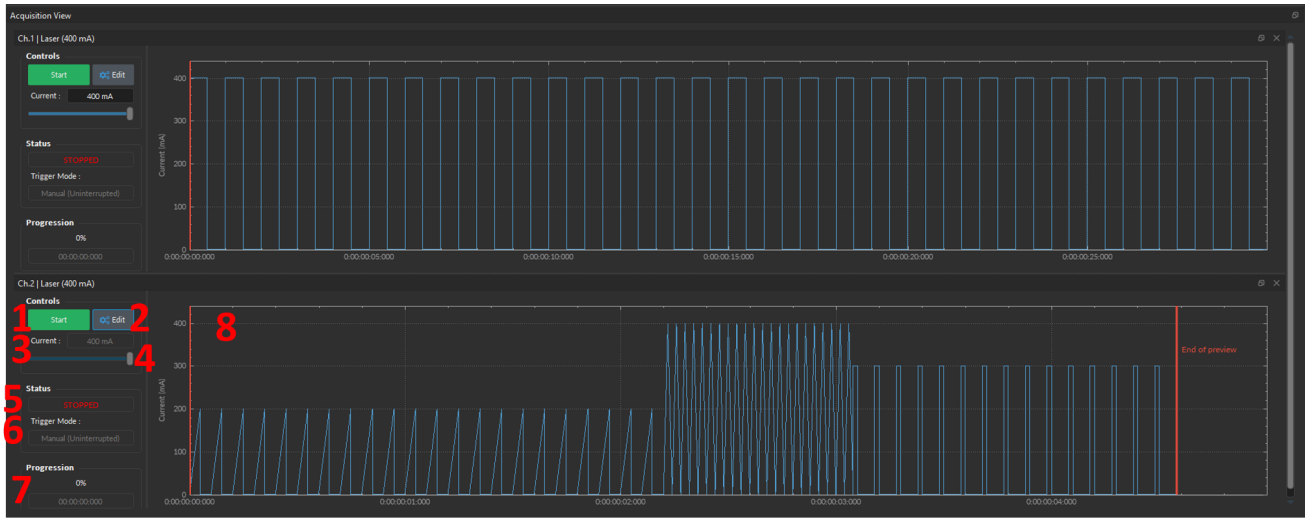


Figure 4.20: *Acquisition View, Light Source Channel*

The **Acquisition View** box is used to display information related to the usage of each channel. This section allows limited control of the light source while it is active. The elements displayed to control and configure the channels are explained below.

1. The **Start/Stop** button activates/deactivates the light source connected to the **Light Source Channel**.
2. The **Edit** button opens the **Channel configuration** window to edit the pulse sequence. This button is only accessible when the channel is deactivated.
3. The **Current** box allows the current to be changed exactly (in mA).
4. The **Current Slider** allows the light source current to be adjusted.
5. The **Status** box displays the status of the channel. The **Status** will display RUNNING... when active and STOPPED when deactivated.
6. The **Trigger Mode** of the light source is displayed in this box.
7. The **Progression** box displays the progression of the pulse sequence. The advancement of the sequence is displayed in % on the **Progression bar**, and in hh:mm:ss:zzz format on the **Time Elapsed** box.
8. The **Graph View** displays either a preview of the pulse sequence for **Light Source Channels**.

5

Specifications

Table 5.1: *General specifications for Laser Diode Module Drivers*

SPECIFICATION	VALUE	NOTE
Power supply	110 - 240 VAC; 50 - 60 Hz	Power supply adapter included
DC Power Supply		
1-channel model	12 VDC	20 W
2 & 4-channel model	12 VDC	36 W
Mass		
1-channel	580 g (1.28 lbs)	
2-channel	757 g (1.67 lbs)	
4-channel	1155 g (2.55 lbs)	
Dimensions (L x H x D)		
1-channel	17.5 cm x 8.0 cm x 10.5 cm	Including connectors
2-channel	23.4 cm x 8.0 cm x 10.5 cm	Including connectors
4-channel	35.1 cm x 8.0 cm x 10.5 cm	Including connectors
TTL input voltage	0 to +5 VDC	
Display Current Accuracy	2% @ maximum rated current	Error increases at lower current.
Analog input voltage	80 mA/V light source current	If applicable: see datasheet
BNC output voltage	12.5 V/A	If applicable: see datasheet
Maximum Output Current Range	LD Model dependent	If applicable: see datasheet
Maximum Forward Voltage	10 V	-
Minimum output current	25 mA	Model dependent; see datasheet
Rise/Fall time	<50 µs	Typical
Modulation Minimum Frequency	0.01 Hz	
Modulation Maximum Frequency	10 kHz	-3 dB attenuation
Minimum ON or OFF time	50 µs	
Maximum ON or OFF time	100 s	
Maximum number of pulses per sequence	65 535	
Maximum number of sequences	65 535	

Table 5.2: *General Specifications of the Connectorized Laser Diode Module*

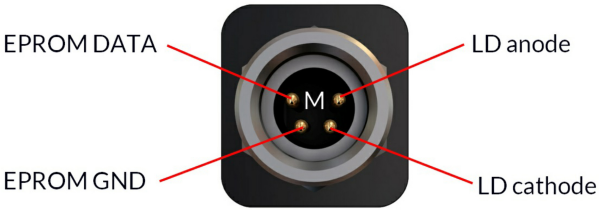
SPECIFICATION	VALUE	NOTE
Electrical Connector	M8-4 pins	see pinout below
Optical Connector	FC/APC	
Mass	104 g	
Dimensions		
Width	64 mm	
Depth	56 mm	+ pigtailed electrical cable
Height	22 mm	
Output NA	< 0.22	
Output Optical Fiber Core Size	> 50 µm	

Table 5.3: *General specifications for Laser Diode Fiber Light Source*

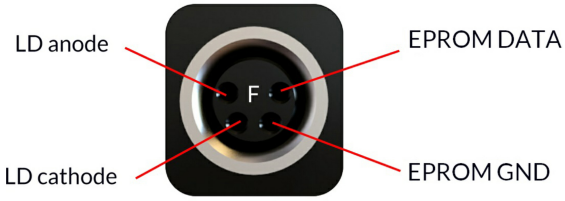
SPECIFICATION	VALUE	NOTE
Optical Connector	FC/APC	
Power supply	110 - 240 VAC; 50 - 60 Hz	Power supply adapter included
DC Power Supply		
1-channel model	12 VDC	20 W
2 & 4-channel model	12 VDC	36 W
Mass		
1-channel	640 g (1.28 lbs)	
2-channel	870 g (1.67 lbs)	
4-channel	1370 g (2.55 lbs)	
Dimensions (L x H x D)		
1-channel model	17.5 x 8.0 x 10.5 cm^3	Including connectors
2-channel model	23.4 x 8.0 x 10.5 cm^3	Including connectors
4-channel model	35.1 x 8.0 x 10.5 cm^3	Including connectors
TTL input voltage	0 to +5 VDC	
Display Current Accuracy	2% @ maximum rated current	Error increases at lower current.
Analog input voltage	80 mA/V light source current	If applicable: see datasheet
BNC output voltage	12.5 V/A	If applicable: see datasheet
Maximum Output Current Range	LD Model dependent	Maximum 400 mA
Maximum Forward Voltage	10 V	-
Minimum output current	25 mA	Model dependent; see datasheet
Rise/Fall time	<50 µs	Typical
Modulation Minimum Frequency	0.01 Hz	
Modulation Maximum Frequency	10 kHz	-3 dB attenuation
Minimum ON or OFF time	50 µs	
Maximum ON or OFF time	100 s	
Maximum number of pulses per sequence	65535	
Maximum number of sequences	65535	

Table 5.4: *Recommended Environmental Specifications*

DESCRIPTION	OPERATION	STORAGE
Use	Indoor	-
Temperature	20 to 30 ° C	-20 to 60 ° C
Humidity	40-60% RH, non condensing	40-60% RH, non condensing



(a) *Connectorized Laser Diode Module M8 Pinout*

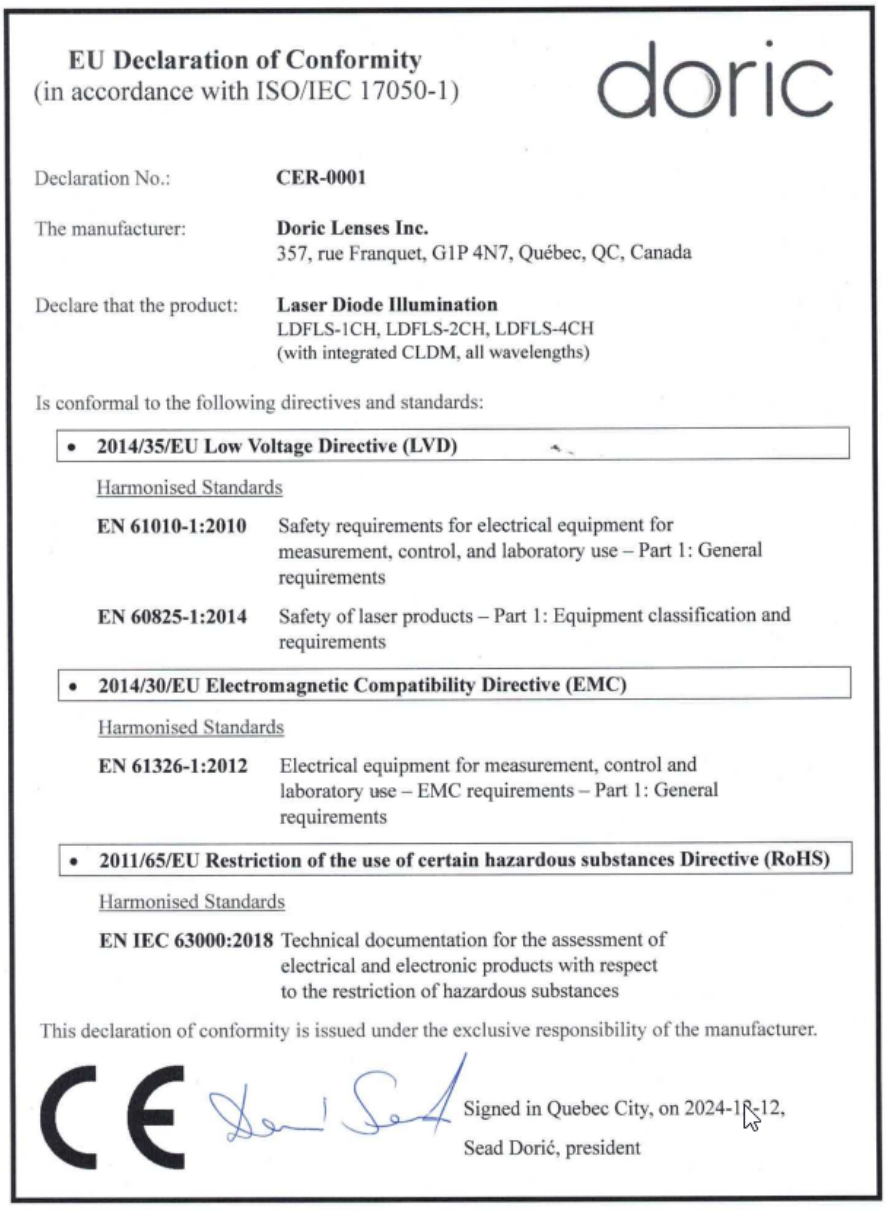


(b) *Laser Diode Module Driver M8 Pinout*

Figure 5.1: *M8-4 Pinout*

6

EU Declaration of Conformity



EU Declaration of Conformity
(in accordance with ISO/IEC 17050-1)

doric

Declaration No.: **CER-0001**

The manufacturer: **Doric Lenses Inc.**
357, rue Franquet, G1P 4N7, Québec, QC, Canada

Declare that the product: **Laser Diode Illumination**
LDFLS-1CH, LDFLS-2CH, LDFLS-4CH
(with integrated CLDM, all wavelengths)

Is conformal to the following directives and standards:

- **2014/35/EU Low Voltage Directive (LVD)**

Harmonised Standards

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements

EN 60825-1:2014 Safety of laser products – Part 1: Equipment classification and requirements

- **2014/30/EU Electromagnetic Compatibility Directive (EMC)**

Harmonised Standards

EN 61326-1:2012 Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements

- **2011/65/EU Restriction of the use of certain hazardous substances Directive (RoHS)**

Harmonised Standards

EN IEC 63000:2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

This declaration of conformity is issued under the exclusive responsibility of the manufacturer.

CE

Signed in Quebec City, on 2024-12-12,

Sead Dorić, president

7

Support

7.1 Maintenance

The product does not require any maintenance. Do not open the enclosure. Contact Doric Lenses for return instructions if the unit does not work properly and needs to be repaired.

7.2 Warranty

This product is under warranty for a period of 12 months. Contact Doric Lenses for return instructions. This warranty will not be applicable if the unit is damaged or needs to be repaired as a result of improper use or operation outside the conditions stated in this manual. For more information, see our Website.

7.3 Disposition

Figure 7.1: *WEEE directive logo*

According with the directive 2012/19/EU of the European Parliament and the Council of the European Union regarding Waste Electrical and Electronic Equipment (WEEE), when the product will reach its end-of-life phase, it must not be disposed with regular waste. Make sure to dispose of it with regards of your local regulations. For more information about how and where to dispose of the product, please contact Doric Lenses.

7.4 Contact us

For any questions or comments, do not hesitate to contact us by:

Phone 1-418-877-5600

Email sales@doriclenses.com

357 rue Franquet - Quebec, (Quebec)
G1P 4N7, Canada
Phone: 1-418-877-5600 - Fax: 1-418-877-1008
www.doriclenses.com