NEDA LD4H16T

Laser Diode, Thermal Phase Shifter and Temperature controller

User Manual

Warranty

Optagon Photonics warrants that this product will be free from defects in material and workmanship and will comply with the published specifications at the time of sale for a period of one year from the shipment date. If the product is found to be defective during the warranty period, the product will either be repaired or replaced.

In such a case, write or call Optagon Photonics, Athens, Greece and you will be given prompt assistance and return instructions, if required. Send the product, freight prepaid, back to us. The product will be repaired and returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days whichever occurs last.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Optagon's written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR USE. OPTAGON PHOTONICS SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM THE PURCHASE OR USE OF ITS PRODUCTS.

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Service Information

The user should not attempt any maintenance or service of the NEDA LD4H16T controller device beyond the default procedures outlined in this manual. For any problem that cannot be resolved you should refer to Optagon Photonics. When calling Optagon regarding a problem, please provide Tech Support with the following information:

- Your contact details.
- Device serial number.
- Description of problem.
- Type(s) of optoelectronic(s) or photonic component(s)/module(s)
- Environment the device is used
- Description of the problem and frequency of its occurrence.

RMA procedures and Returns

NEDA LD4H16T controller(s) that are being returned to Optagon Photonics must be assigned a RMA number by Optagon. This procedure requires the device's Serial Number. Any NEDA LD4H16T returned under RMA should be properly packaged for safe shipment and the original packaging should be reused, if possible.

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Safety

The device operates from a single DC 24V power supply, please select an AC/DC adaptor with at least 80W of power and DC 24V output at a standard 2.5mm jack. The following general safety measures must be followed when operating the device.

The device is intended for indoor use only. Failure to comply with these measures or with specific warnings in this manual violates safety standards of design and intended use of the device.

⚠ Please use an AC/DC adaptor with 24V DC voltage output, at least 80W of power and 2.5mm jack connector. Please ensure that there is no voltage dropout and 24V DC are supplied to the device.

⚠ Make sure the power adaptor connector jack makes good contact with the device's power port and do not force the connector to make it fit.

⚠ Place the device in such way that the power switch is easily accessible

⚠ Keep the air vents on the top cover free of obstructions to allow air circulation and proper cooling of the device

⚠ Do not operate this device in wet or damp conditions

⚠ Disconnect power before cleaning the device. Do not use liquids cleaners. Use only a damp cloth

⚠ Do not open the NEDA LD4H16T controller. There parts inside the controller are not user serviceable.

1. Introduction

NEDA LD4H16T is a versatile and highly capable controller for photonic modules and photonic integrated circuits, that offers multiple current and voltage sources and thermal regulation in a compact form. The controller is compatible with all mainstream photonic integration platforms such as silicon-on-insulator (SOI), silicon nitride (Si3N4), optical polymers, indium phosphide (InP), thin film lithium niobate (LNOI) etc. More specifically, the NEDA LD4H16T offers 4 current sources that can provide up to 500 mA, suited for laser diodes (LDs), super-luminescent diodes (SLDs), semiconductor optical amplifiers (SOAs), light emitting diodes (LEDs), 12 voltage sources of up to 20V and 200mA per channel for thermal phase shifters (TPS) and 4 voltage sources with a range of -10V to +10V and up to 20mA of current for biasing modulators, photodiodes or other optoelectronic components. In addition, it incorporates a thermo-electric cooler (TEC) controller for precise thermal regulation of the operated module or PIC.

NEDA LD4H16T builds upon the robustness of NEDA LD4-A current sources, that have safety features such as soft-start, adjustable current limits, adjustable voltage compliance limits and hot-plug protection. Each laser diode driving channel (current source) is independent and is based on a common cathode architecture, enabling the control of active elements that are in an array.

NEDA LD4H16T brings new features such as Arbitrary Waveform Generator (AWG) function for up to 12 voltage sources and up to 1.9 MSPS that allows the user to generate custom waveforms. The user can select from an internal sample clock, with the ability to change the sampling rate on the fly or use a sync clock signal from an external signal generator, thus locking the NEDA LD4H16T with another device. The figure below shows the AWG functionality on four channels. Any waveform can be programmed on any channel.

NEDA LD4H16T has been carefully designed for low noise operation, to ensure that the controller will not influence the spectral characteristics of the laser diode outputs.

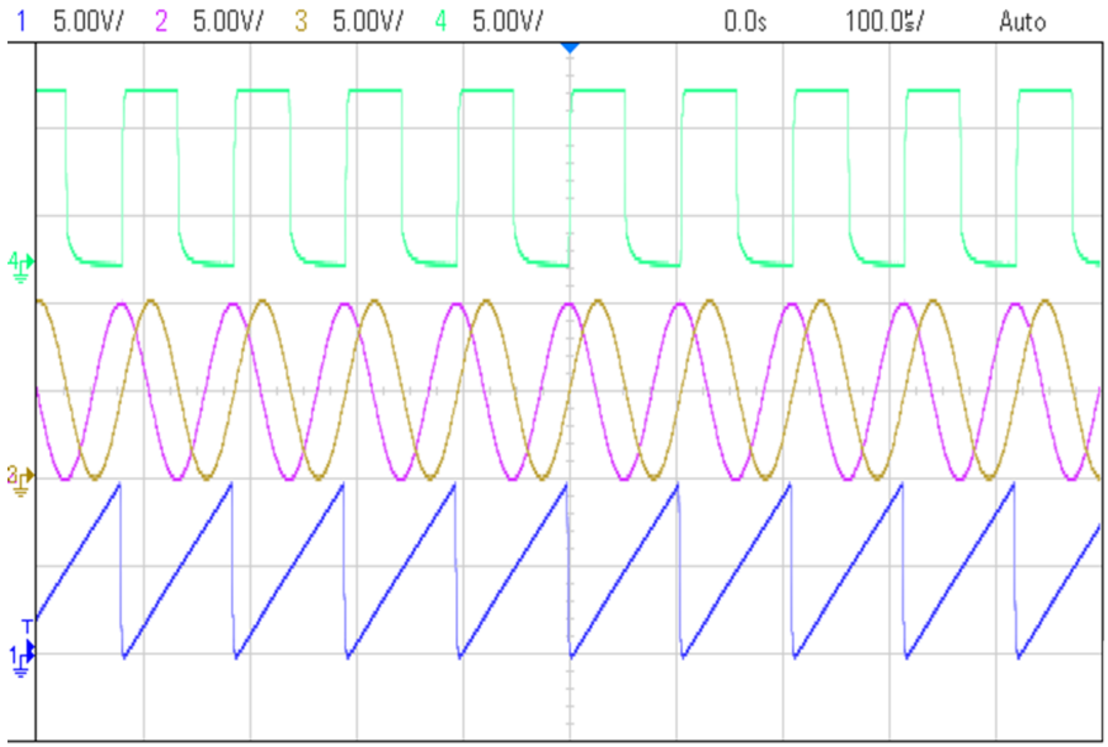


Figure 1. Arbitrary Waveform Functionality. Sawtooth, sine, cosine and square functions have been generated at 4 voltage sources' outputs.

Applications

Semiconductor lasers, external cavity lasers, optical transmitters and receivers, microwave photonics (mmWave/THz), OTDR/OFDR systems, LIDAR systems, optical coherence tomography (OCT), Raman spectroscopy, biochemical sensors.

Features

- 4 independent current sources
- 500 mA max output current per channel
- User defined current and voltage compliance limits per channel
- Soft-start output current ramp, 2s startup delay after powering on
- Hot-plug protection of the optoelectronic loads, interlock function
- 12 voltage sources up to 20V and 200mA
- 4 bipolar voltage sources from -10V to 10V and 20mA
- TEC controller included
- AWG functionality up to 2 MSPS

2. System Overview

2.1 Specifications

The following parameters are given for Vs = 24V and apply for each channel, unless stated otherwise.

PARAMETER	NOTES	MIN	TYP	MAX	UNIT
Operating Conditions					
Usage	Indoor use only				
Temperature		5		50	°C
Relative humidity		20		80	%
Altitude				2000	meters
Pollution degree	Pollution degree 2				
IP rating	IP 30				
Power Supply Requirements					
Voltage supply Vs		23.5	24	30	V
Current		0.3		3	A
Power consumption		7.5		80	W
Power connector	5.5 x 2.5mm barrel jack				
Current sources (4x channels)					
Type of connector	Screw terminals				
Load current*	Limited by firmware	0		500	mA
Voltage compliance		0		5	V
Soft Start	Current ramp		20		mA/ms
Turn-on delay	After power on		2		s
Voltage sources (12x channels)					
Type of connector	24-pin Headers 2.54mm				
Load Voltage		0		20	V
Load Current		0		200	mA
Output power**	Recommended	0		2	W
Arbitrary waveform generator speed				2	MSPS
Extern sync input voltage	TTL input	0	3.3	3.6	V
Bipolar voltage sources (4x channels)					
Type of terminals	8-pin headers 2.54mm				
Load Voltage		-10		10	V
Load Current		-20		20	mA
TEC controller (bidirectional)					
Type of connector	Screw terminals				
Voltage on load		-4.5		4.5	V

Current on load		-2.2		2.2	A
Thermistor value			10K		Ohm
TEC temperature range	Recommended	15	25	40	oC
Interlock					
Type of connector	2-pin headers				
Interlock pin voltage	Tie to GND to enable LDs	0	5	5.5	V
USB connection					
USB port type	USB2.0 Micro-B				

* Ultimate limit (by hardware) of the load current of each current source is 600 mA.

** Total power dissipation on the loads of the 12 unipolar voltage sources should remain <30 W

CS: Current Source, UVS: Unipolar Voltage Source, BVS: Bipolar Voltage Source

PARAMETER	NOTES	MIN	TYP	MAX	UNIT
ABSOLUTE MINIMUM/MAXIMUM RATINGS					
Voltage Supply Voltage	-	23.5		32	V
CS Output Current	Per channel			600	mA
CS Voltage Compliance	Per channel	0		5	V
CS internal power dissipation	Per channel			2	W
UVS output power	Per channel			4	W
BVS output current	Per channel			50	mA
TEC Peltier voltage				5	V
TEC Peltier current				2.2	A
Interlock input signal				7	V
Clock sync signal				4	V
Storage Temperature	T_A	-25		70	°C
Storage Altitude				4500	meters

2.2 Front Panel Description

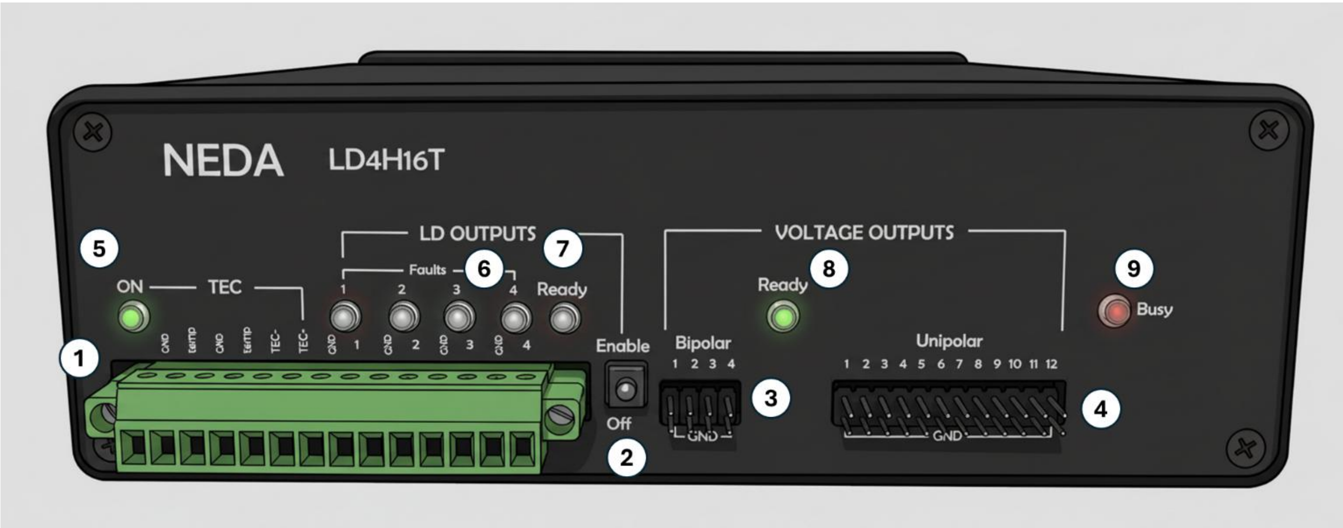


Figure 2. NEDA LD4H16T front panel

Description of the NEDA LD4H16T front panel:

1 Screw terminal with connections for the Thermistor, Peltier element and the 4 laser diode anodes/cathodes.
2 LD ENABLE switch. It enables/disables the Current Source hardware output stages. Must be in ENABLE position for the Current Sources to be operational.
3 Bipolar Voltage Sources headers.
4 Unipolar Voltage Sources headers.
5 TEC ENABLED LED indicator. It lights green when TEC hardware output is enabled.
6 LD FAULT LED indicators. The corresponding channel's led indicator lights red when a fault is detected in a LD channel and the LD driver output is disabled. LD circuits must be reset by either the LD ENABLE switch or the GUI to resume operation.
7 LD ENABLE LED indicator. It lights green when the LD driving circuits are enabled by the LD ENABLE switch.
8 POWER GOOD and Thermal Phase Shifter divining circuits ON LED indicator. It lights green when the Thermal Phase Shifter driving circuits are initialized and operational.
9 BUSY LED indicator. It flashes twice each time a command is successfully sent from the GUI to the NEDA LD4H16T to verify correct communication.

⚠ The TEC controller is designed to properly bias 10K thermistors/NTCs and it will not work correctly with other values.

For detailed pinout of the screw terminal and headers, please check *Appendix I: Input/Output description*.

2.3 Rear panel Description

Figure 3. NEDA LD4H16T rear panel

Description of the NEDA LD4H16T rear panel:

1 External SYNC input. Takes as input a TTL external clock signal to sync the AWG functionality.
2 5.5x2.5mm barrel jack for 24DC 80W power supply.
3 ON/OFF SWITCH for powering ON and OFF the NEDA LD4H16T.
4 USB2.0 Micro-B type port. Connects the NEDA LD4H16T and a computer with a USB cable.
5 INTERLOCK pin. Interlock function for the device. (+) pin must be connected to GND for the current sources' hardware to be operational. Pulling (+) pin high (5V) disables the current sources, and sets the unipolar and bipolar voltage sources to zero. Leaving (+) pin floating will disable the outputs.

ⓘ The communication protocol between the laptop and the controller is serial (UART). This means that the device will be discovered as a COM port in the Windows Device Manager and in the GUI software.

3. Operation of NEDA LD4H16T and quick start guide

3.1 Operation of the device

NEDA LD4H16T is based on Optagon Photonics' in-house robust and reliable analog current and voltage source architecture (visit www.optagon-photonics.eu for the NEDA analog engine's datasheet and technical specs). Safety features such as 2s delay, soft start, current limits and voltage compliance limits are all hardware implemented. This ensures excellent analog performance and maximum load protection under all operating conditions.

In the normal Power-ON or Power-OFF procedure, there is a 2s delay applied when the user enables the Current Sources from software, and before the device applies any current to the load, to avoid any current surges. A soft-start ramp of 20mA/ms applies the current to the laser diode. In case the voltage supply to the device is lost or it falls below 23 V DC the protective circuitry on the device shuts down the current to the loads to protect them.

ⓘ When the device is powered ON and the Current Sources are enabled, it is possible that one or more of the LD output fault indicator LEDs lights up indicating a fault operation condition to the channels that are floating (there is no load connected to them). This can be ignored and the user can proceed with the operation of the rest of the channels.

3.2 Quick start guide

The following paragraphs guide the user on how to make the connections and start using the NEDA LD4H16T.

Plug the 2.5mm jack of the AC/DC adapter to the back of the NEDA LD4H16T controller as seen in the figure below.

Figure 4. DC power connection to NEDA

Plug the USB cable into the USB IN port. Connect the interlock pin as required depending on your application.

It is recommended that all connections of components like laser diodes and resistive loads (thermal phaser shifters) to the NEDA LD4H16T are established before powering ON the device.

Using a flat screwdriver (max 2.4 mm) connect the cables (max 0.75mm^2 or AWG 18 cable) of the loads to the current source channels, as well as the Peltier and thermistor. The screw terminal block provides robust connection of the loads to the device and is more versatile as it does not require connectors of any kind.

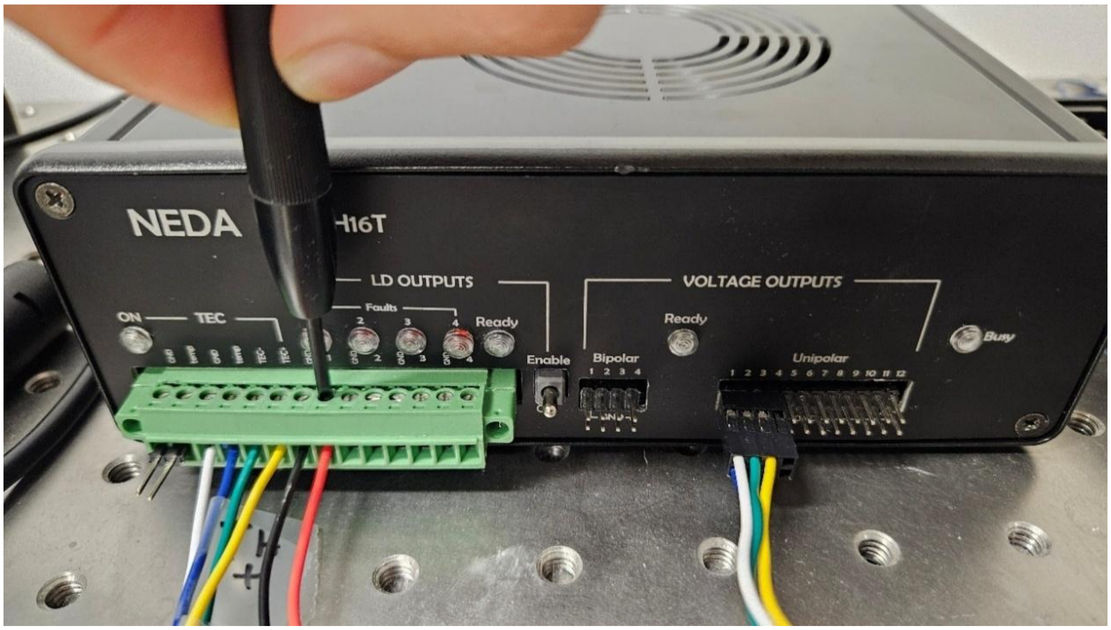


Figure 5. Screw terminal connections

Use cables with 2.54mm female pin-header spacing for connecting the loads to the Unipolar and Bipolar Voltage Sources as shown in the figure below.

Once everything is connected, the user can start using the device by turning the switch at the DEVICE ON position. After two seconds the Ready LED within the Voltage Outputs frame should light green, indicating that the device is ready for operation.

4. Software and Graphical User Interface (GUI)

4.1 Software installation

The Graphical User Interface is a standalone executable that runs on a Windows computer, without any installation process required. The user can download the GUI executable in zip file. Please visit www.optagon-photonics.eu for the latest software version. It is suggested to unzip the executable file in a folder that is easily accessible. The zip contains a .exe file named “NEDA_LD4H16T”. Running the executable starts the program.

The software is also available for other Linux and MAC operating systems as it is Python based. Please contact Optagon Photonics for Linux or MAC support.

4.2 Graphical User Interface (GUI)

4.2.1 Overview

When double-clicking the executable file, the following GUI window pops up showing the basic functionality of the NEDA LD4H16T device.

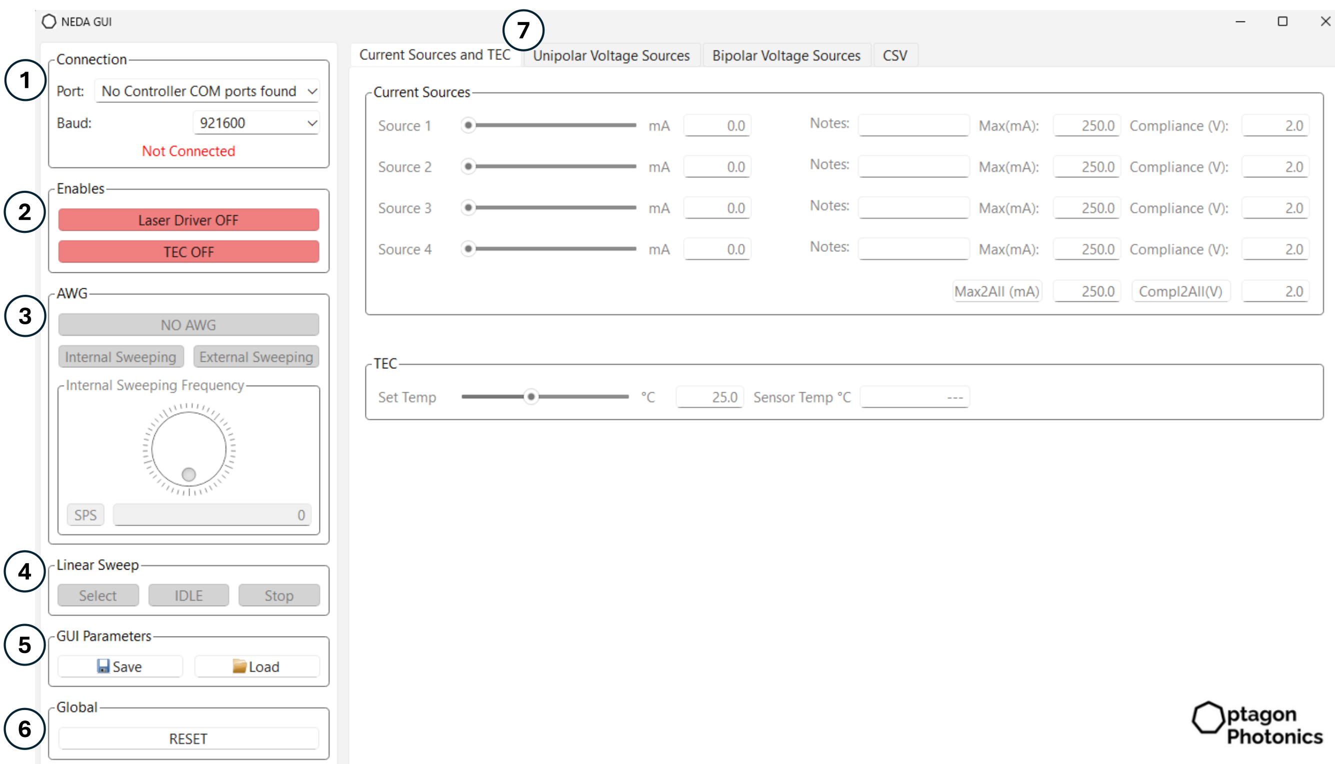


Figure 6. NEDA LD4H16T GUI window showing the Current Sources and TEC tab

The GUI has the following functionalities listed:

1 **Connection:** The COM port of the NEDA device can be selected, as well as the baud rate of the connection. When inserting the USB cable to the laptop, the GUI automatically finds the COM port of the powered-on device and auto connects. The status of the connection changes from “Not Connected” to “Connected”.

The GUI detects and connects only to the NEDA LD4H16T controller, even if other unrelated USB devices are present. If a second NEDA is added to the same computer, a second GUI must be opened, which will automatically connect to the second device. If a second GUI is opened when only one NEDA is present, the GUI will not show available ports to connect to.

2 **Enables**: Laser Driver button enables the current sources and changes to green. The laser enable and disable acts on the hardware output stage of the channel to enable or disable the output. In case the switch on the front panel is not at the enable position, the button will change to CHECK SWITCH. The Laser Driver enable button will indicate INTERLOCK, when an interlock event occurs and the outputs are disabled. If both conditions are present, the button changes to SWITCH and INTK. The TEC button enables the TEC hardware and changes to green. The temperature setpoint is automatically set to 25 oC when enabling the TEC hardware.

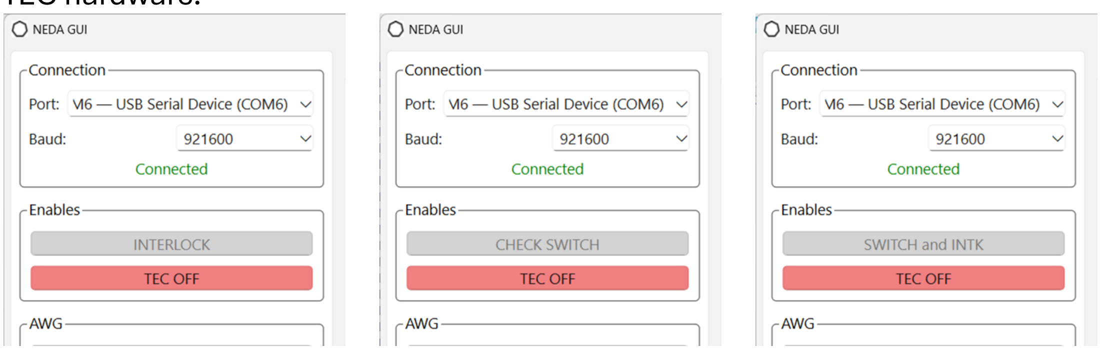


Figure 7. GUI frames showing the Interlock notification (left), check switch notification (middle), and both notifications (right).

3 **AWG**: Controls the AWG functionality of the device. The top button in the AWG frame starts and stops the AWG functionality. When no functionality is present, the button reads NO AWG. After the csv is sent to the device, the user selects the clock from where the AWG will run. *Internal* selects a free running mode based on the internal microcontroller clock and provides a maximum sample rate of 2 MSPS with 1SPS resolution. The user can adjust the frequency of the AWG from the knob or type the desired frequency directly in the input field. The internal sampling can be selected to be SPS or KSPS from the respective SPS/KSPS button. *External* selects the clock signal that is present at the SMA sync port at the rear panel of the device. Please see subsection *4.2.5 Arbitrary Waveform Generator (AWG) function* for more details.

4 **Linear Sweep**: The user can select any of the channels of the current sources, voltage sources or even the TEC to perform a linear sweep. The IDLE button pauses and resumes the linear sweep. The STOP button stops the linear sweep completely while the channel value stays at the last linear sweep value. Pressing "Select" button brings up a menu to select the parameters of the sweep. After stopping, the parameters remain as they were set in the last sweep.

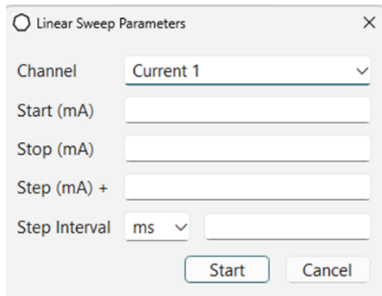


Figure 8. The user can select the parameters of the linear sweep from this pop-up window

The user can select from a drop down list the channel to run the linear sweep, provide the start and stop values of the sweep, the step value and the step interval value (in ms, sec, min, h). The start value can be either smaller or larger than the stop value, so the linear sweep can go both ways. The sign of the step (plus or minus) changes accordingly. Pressing the Start button initiates the sweep. The linear sweep is independent and can run at the same time with the AWG functionality. While the linear sweep is active, the user can see the linear sweep parameters by hovering the mouse cursor over the Running/Pause button.

ⓘ If the AWG functionality is active, the channels running the AWG are excluded from the drop-down list and cannot be selected to perform a linear sweep. Priority is always given to the AWG functionality.

5 **Save / Load** buttons: Save button saves the current configuration of the sources to a .json file in the same folder as the executable of the device. The user can select a stored configuration file to load from the load button. Each time, a dialog box pops up and the user can select the file to save / load. See *Appendix II: Json file structure* for the structure of the json file.

6 **Global reset:** Resets all the values of all channels back to their defaults and disables the Current Sources and TEC (from the Enables frame) and clears the selected csv.

7 **Sources Tab:** Selects a specific tab from the Current Sources, Voltage Sources, Bipolar Voltage Sources and shows its functionalities.

4.2.2 Current sources and TEC tab

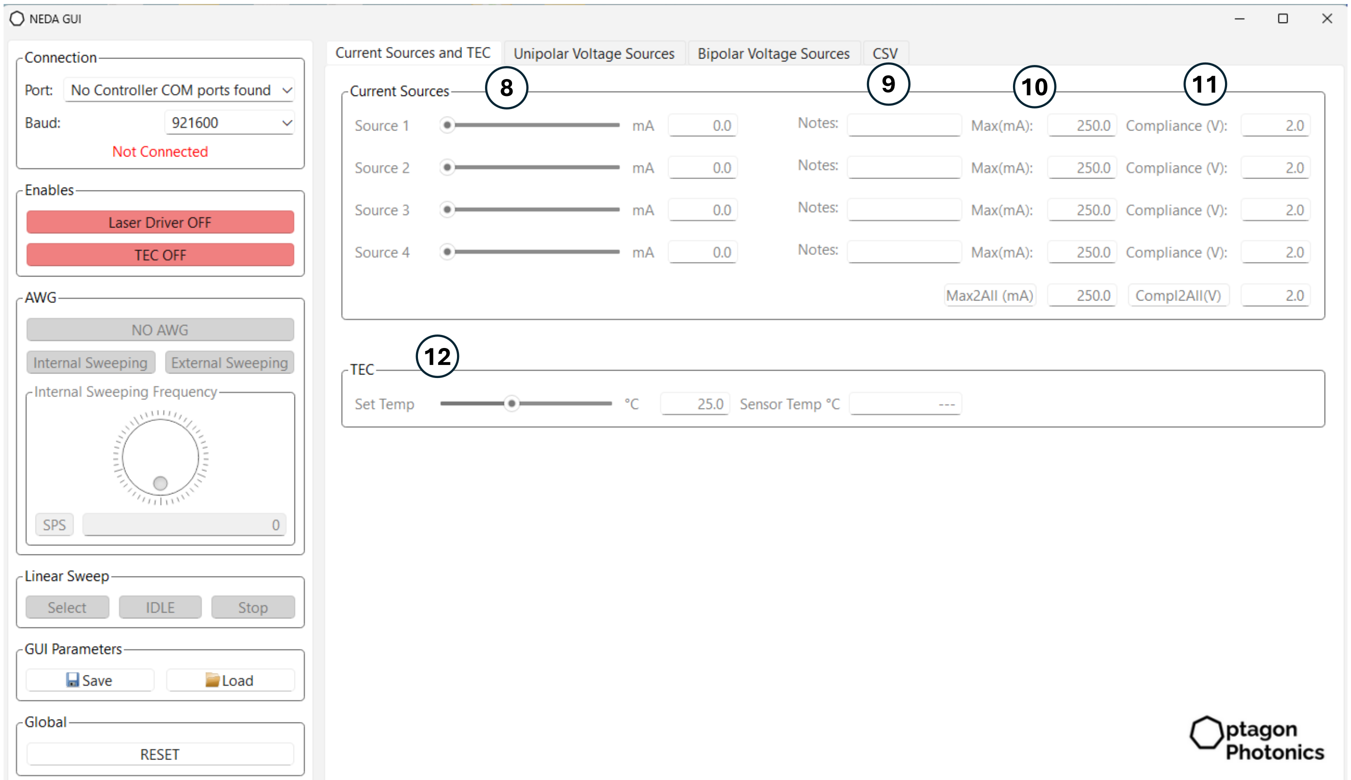


Figure 9. Current Sources and TEC tab

The Current Sources are ideal for driving Laser Diodes, Gain Diodes and Semiconductor Optical Amplifiers with currents up to 500mA per channel. The adjustable Voltage Compliance limit protects the diode from overvoltage.

ⓘ The Current Sources must be enabled in hardware by pressing the Laser Driver enable button, otherwise the software controls will not have an effect.

8 **Current sources names and sliders:** Controls the current output of each channel. Use the slider to the selected current or enter the value directly at the input field. Increments/decrements of 0.1 mA can be also realized by pressing the right/up arrow or left/down arrow of the keyboard.

9 **Notes**: The user can input notes/labels regarding the channel that is being used.

10 **Max output current** setting: Limits the current output value to the selected value in mAs. If the user tries to surpass the max value, the ER/MAX message is printed to the field and the slider returns to the previous setting.

11 **Compliance voltage** limit: Limits the compliance voltage value in Volts to protect the laser diode from overvoltage.

12 **TEC**: Sets the temperature of the TEC from the slider or by writing the value directly in the field. The sensor Temp field reads out the current thermistor temperature.

ⓘ The TEC must be enabled by pressing the TEC button at the Enables group, otherwise the software controls will be greyed out and cannot be operated.

⚠ The TEC controller has been designed to work with 10K thermistors or NTCs. Other thermistor values will cause the TEC controller to not operate correctly.

4.2.3 Unipolar Voltage Sources tab

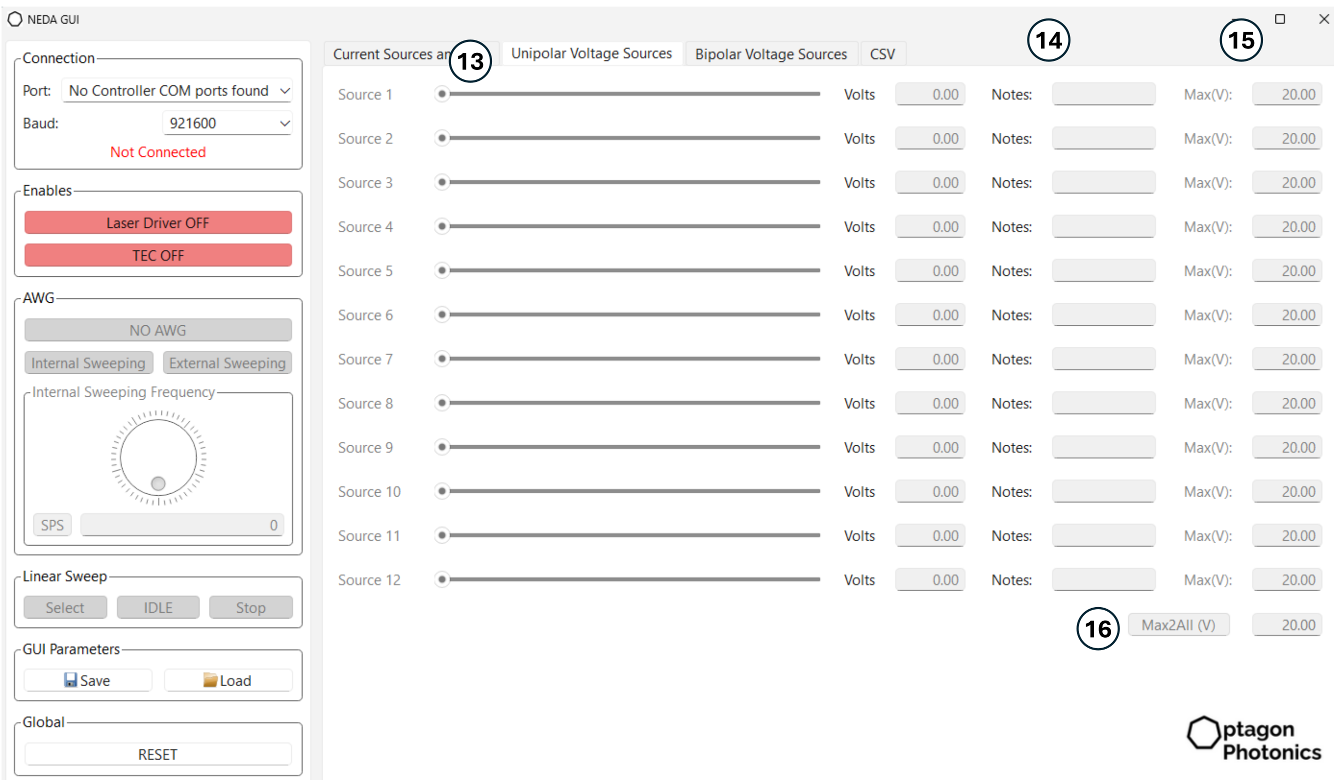


Figure 10. Unipolar Voltage Sources tab

The Unipolar Voltage Sources are ideal for driving Thermal Phase Shifter or other resistive loads to values from 0 to 20V and max 200mA per channel. The tab has similar arrangement. More specifically:

13 **Unipolar voltage sources names and sliders:** Controls the voltage output of each channel. Use the slider to change the voltage or enter the value directly at the input field. Increments/decrements of 0.01V can be also realized by pressing the right/up arrow or left/down arrow of the keyboard.

14 **Notes** box.

15 **Max output voltage:** Limits the output voltage of each channel individually.

16 **Max2all:** Applies the max voltage value to all channels. If the AWG is running, the Max2all value cannot be updated. In order to update the Max2all to a new value, the AWG must be paused.

The voltage sources channels that are in use by another functionality e.g. AWG or linear sweep are greyed-out and their values cannot be changed while the AWG is running. When the AWG is stopped, the voltage sources that were used stay at their last manually configured value (before the AWG start) and the indication “AWG” is written in their value field. This is to prompt the user to manually configure the voltage source channels to a known value, because when the AWG function was stopped the channel could be in any of the csv values.

If the power supply voltage drops below 23V, the controller automatically sets all unipolar and bipolar voltage sources to zero. This is also reflected in the GUI, where all channels are set to default and become disabled.

4.2.4 Bipolar Voltage Sources tab

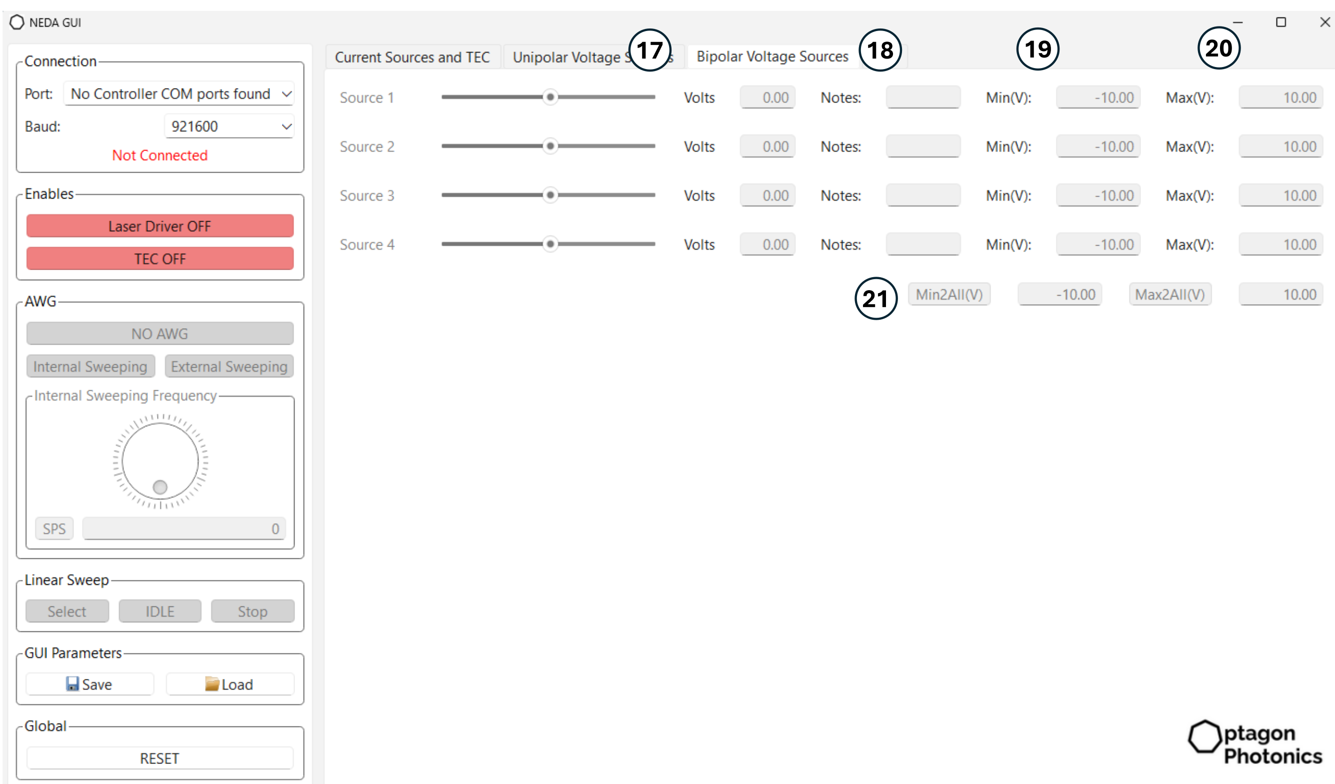


Figure 11. Bipolar Voltage Sources tab

The Bipolar Voltage Sources are ideal for providing bias to components such as Photodiodes, Mach-Zehnder Modulators, IQ-modulators etc which often require negative voltages with values from -10V to 10V. The tab has similar arrangement as the unipolar voltage sources tab.

17 **Bipolar voltage sources names and sliders:** Controls the output voltage of each channel. Use the slider to the selected voltage or enter the value directly at the input field. Increments/decrements of 0.01V can be also realized by pressing the right/up arrow or left/down arrow of the keyboard.

18 **Notes** box.

19 **Min bipolar voltage output:** Limits the minimum voltage output of the channel.

20 **Max bipolar voltage output**: Limits the maximum voltage output of the channel.

21 **Min2all – Max2all:** Sets the min and max voltage values to all channels.

4.2.5 Arbitrary Waveform Generator (AWG) function

The AWG allows the user to program his own arbitrary waveform(s) that will be the output of one or more Unipolar Voltage Source channels simultaneously. Up to 12 independent AWG waveforms can be output in any of the 12 Unipolar Voltage Source channels of the device. This function is useful for applying custom driving signals to the Thermal Phase Shifters of a module. The maximum sample rate is 2 MSPS multiplexed to the channels. The user can select freely any of the 12 channels as output(s) of the arbitrary waveforms. In total up to 12000 samples (e.g. 12-ch x 1000 samples) can be used for the AWG functionality.

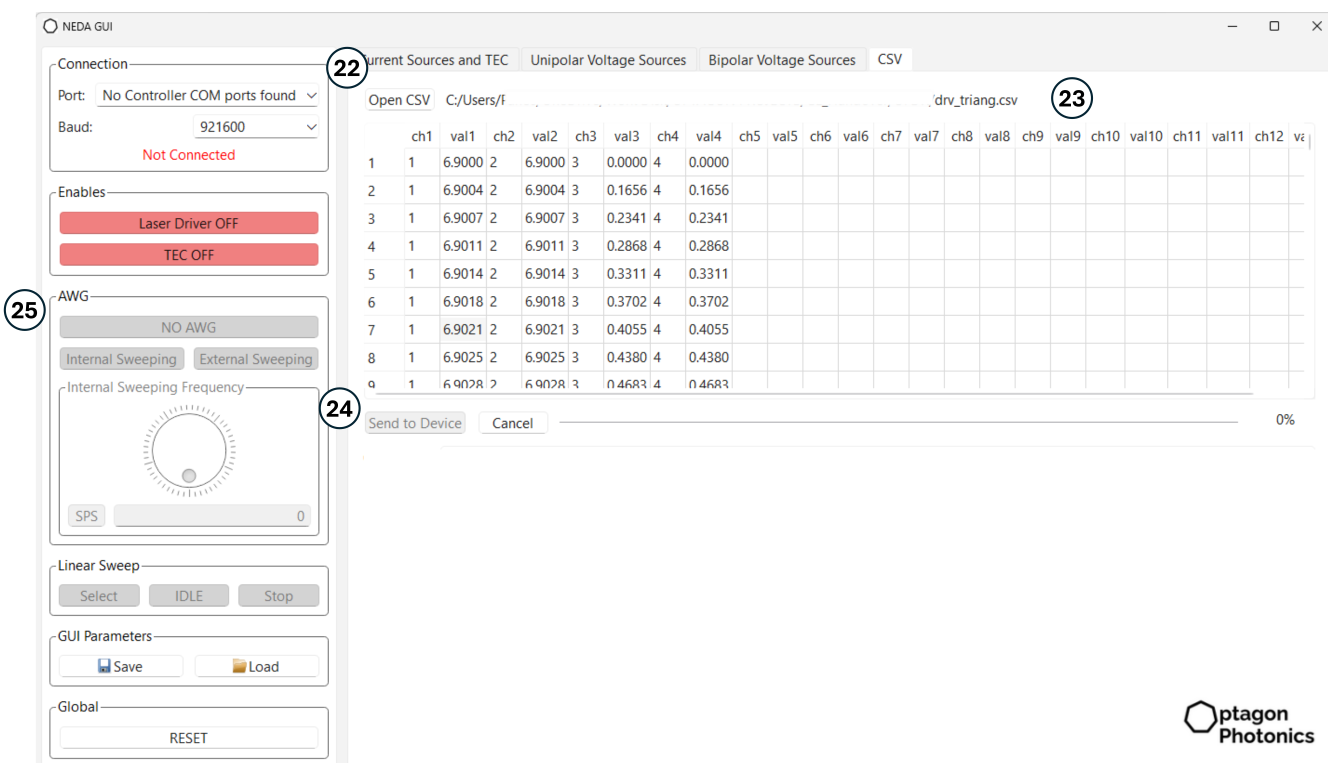


Figure 12. CSV tab for loading custom samples for the AWG

22 **Open CSV**: Opens a dialog box for the user to select the csv file to load. Once selected, the absolute path to the loaded file is shown next to the button.

23 **CSV values table**: A table showing the contents of the csv file. The voltage values to be uploaded to each channel are shown. The table has columns for each channel and its values. The loaded csv values are rounded to 4 decimal places before sending them to the device.

The ch1, ch2 etc do not refer to the NEDA LD4 channel numbering, rather indicate the number of reserved channels that will operate in AWG mode. Any NEDA unipolar voltage source can operate in AWG mode in any order, as explained in the csv file format below.

24 **Send to Device**: The button starts the upload of the values to the NEDA LD4H16T controller. The time to upload depends on the size of the csv file. A progress bar shows the progress of the upload operation. Once the values have been uploaded, the AWG functionality buttons become active, and the user is prompted to select the clock source.

25 **AWG functionality**: Once the user selects the clock source, the AWG mode starts and the button turns to "Running AWG" showing the status. The voltage source channels that are in AWG mode are greyed-out and not configurable in the corresponding tabs. When the AWG is paused the reserved channels become again manually configurable until the AWG is resumed. The knob adjusts the free running (internal) sampling rate of the device. The user can pause/resume the AWG functionality anytime by pressing the "Running AWG" button. If stopped, the greyed-out voltage source buttons become active again, but AWG is shown at each channel's value to indicate that the channel has stopped at a random value. The user must configure the channel value again to determine the exact value.

If the user wants to change the clock source (internal or external) of the AWG, the csv file must be sent again to the device by pressing the respective button. If the user wants to change the max limit for the AWG reserved channels, the AWG should be paused, then set the new max limits, and then send the csv file again to the device.

The csv file stores the channel numbers and voltage values in the following format. The channel numbers are only given in the first row.

```
3,6.9,4,6.9,1,0,2,0
,6.901761032,,6.901761032,,0.370419603,,0.370419603
,6.903521615,,6.903521615,,0.523852427,,0.523852427
,6.905281748,,6.905281748,,0.641585573,,0.641585573
,6.907041434,,6.907041434,,0.740839207,,0.740839207
,6.908800671,,6.908800671,,0.828283413,,0.828283413
,6.91055946,,6.91055946,,0.907339019,,0.907339019
,6.912317801,,6.912317801,,0.980038151,,0.980038151
,6.914075696,,6.914075696,,1.047704853,,1.047704853
,6.915833144,,6.915833144,,1.11125881,,1.11125881
```

Figure 13. Screenshot from the csv file showing 10 out of N samples for 4 voltage sources (can be up to 12).

In a spreadsheet the file would look like the table below:

3	6.9	4	6.9	1	0.0000	2	0.0000
	6.901761032		6.901761032		0.370419603		0.370419603
	6.903521615		6.903521615		0.523852427		0.523852427
	6.905281748		6.905281748		0.641585573		0.641585573
	6.907041434		6.907041434		0.740839207		0.740839207
	6.908800671		6.908800671		0.828283413		0.828283413
	6.91055946		6.91055946		0.907339019		0.907339019
	6.912317801		6.912317801		0.980038151		0.980038151
	6.914075696		6.914075696		1.047704853		1.047704853
	6.915833144		6.915833144		1.11125881		1.11125881
	…		…		…		…

4.2.6 Exiting the GUI

The user can exit the GUI by clicking on the close button on the top right of the window. The GUI pops a window and prompts the user to verify the exit option, as can be seen in the figure below.

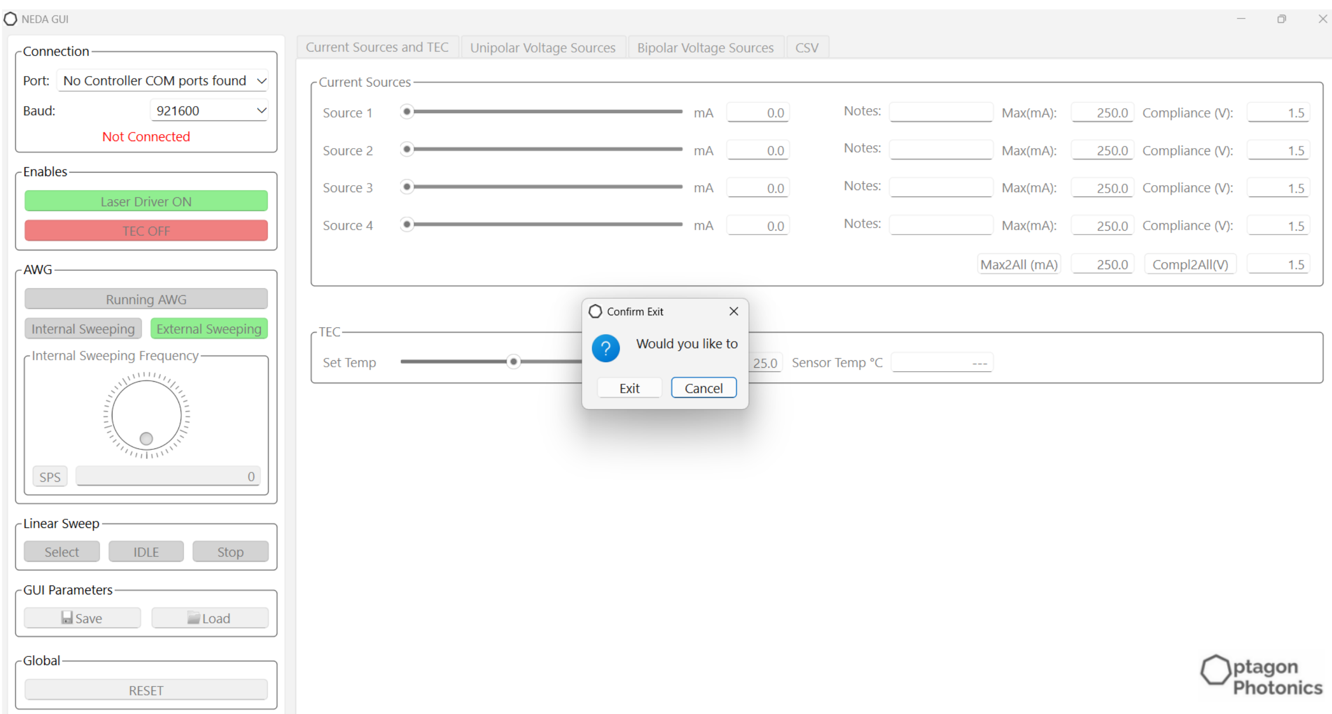


Figure 14. Exiting the GUI window asking for confirmation

The firmware has been designed to provide fail safe operation to the controller. The onboard TEC controller stays at its last state when exiting the GUI. That means that if it was left enabled when exiting the software, it will continue to operate until the device is powered off by the power switch. If it was disabled by the user, it stays disabled.

When pressing the exit button, the GUI sets all sources to zero and then exits. The user could also switch off the device from the power button; the GUI will detect a “Device Connection Lost” event and pop up a window.

The firmware also offers protection from accidental disconnection of the device from the computer e.g. by removing the USB cable by mistake. If the GUI detects that the connection is lost, it pops up a message window and prompts the user to select how to continue. The device itself continues to operate at its last state, as if the USB cable has not been disconnected. This is shown in the figure below.

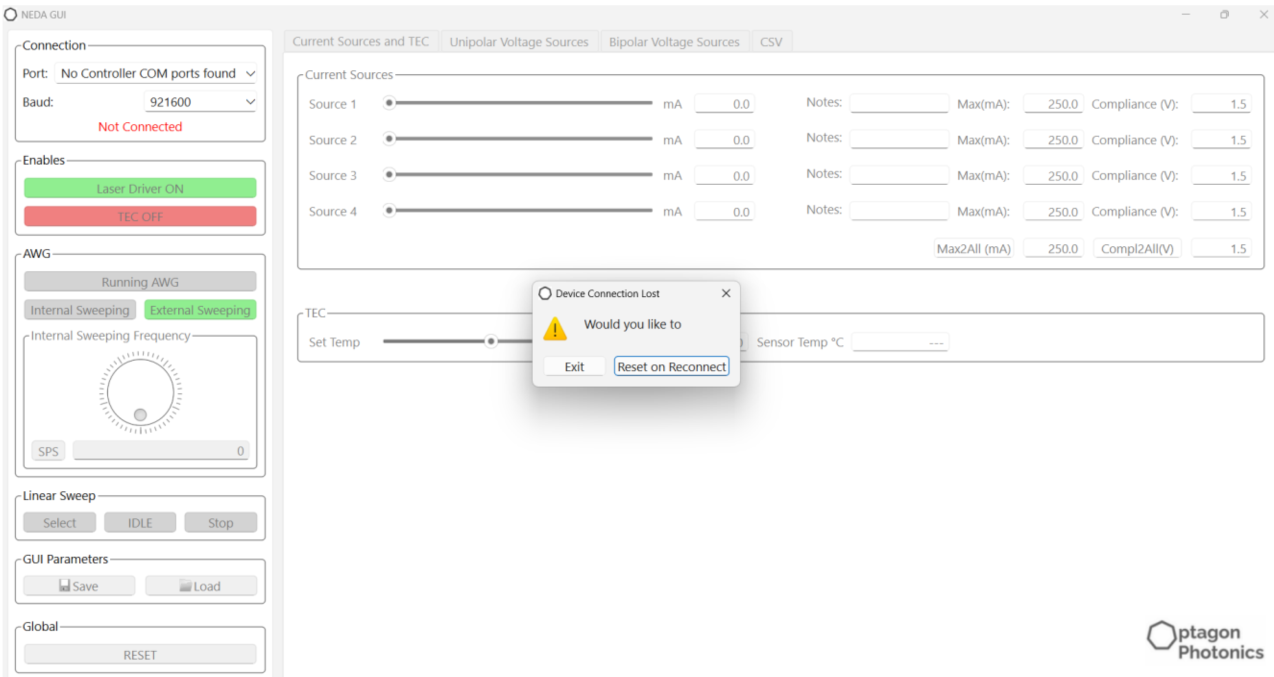


Figure 15. Device connection lost window

A Device Connection Lost event could be detected in the following cases:

Case I: The USB cable has been removed on purpose because the user wants to power off the device or the device has been already powered off. In this case the user just needs to press the “Exit” button to close the GUI.

Case II: The USB has been accidentally disconnected. In this case the user has three options. i) Clicking the close (X) button, the GUI reinitiates the last operating state once the USB cable has been reconnected. ii) Clicking the “Reset on Reconnect” button resets all the sources when the USB cable is reconnected. iii) Clicking the “Exit” button resets all sources to zero and closes the GUI. The TEC remains at its last state as explained.

If the user reconnects the USB cable and re-establishes the connection to the device before pressing any buttons, the disconnect message window disappears and the controller reinitiates the configuration of its last state before the connection was lost. If a csv file has been sent to device, then the file is sent again to ensure proper operation.

Appendix I: Input/Output description

Front panel connections. Numbering on the headers is from left to right

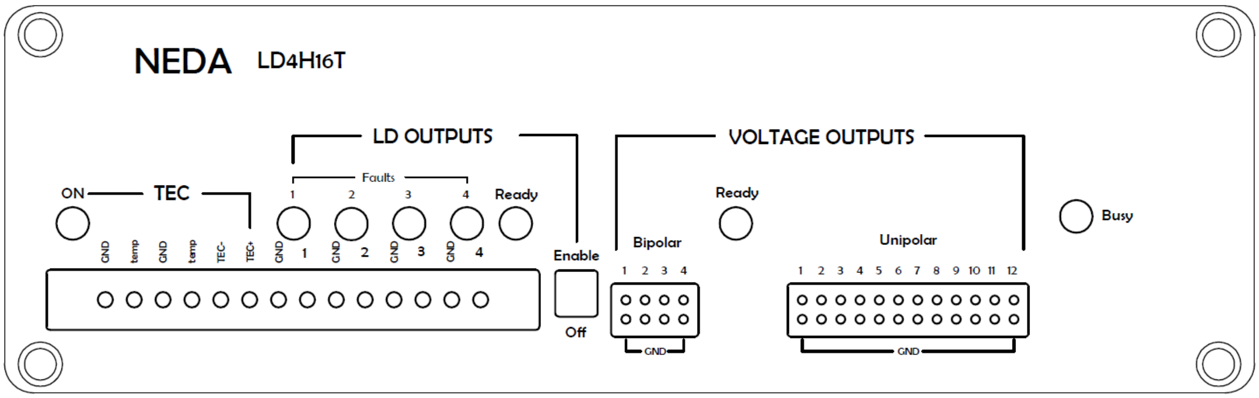


Figure 16. NEDA Front panel outputs

TEC and Laser Diode outputs			
Pin	**Description**	**Pin**	**Description**
1	Sensor monitor GND	8	LD 1 anode
2	Sensor monitor signal	9	LD 2 cathode
3	Sensor GND	10	LD 2 anode
4	Sensor signal	11	LD 3 cathode
5	TEC -	12	LD 3 anode
6	TEC +	13	LD 4 cathode
7	LD 1 cathode	14	LD 4 anode

Bipolar Voltage driver outputs	
Pin (Top row)	**Description**
1	Channel 1
2	Channel 2
3	Channel 3
4	Channel 4
All pins at bottom row are GNDs	

Unipolar Voltage driver outputs	
Pin (Top row)	**Description**
1	Channel 1
2	Channel 2
3	Channel 3
4	Channel 4
5	Channel 5
6	Channel 6
7	Channel 7
8	Channel 8
9	Channel 9
10	Channel 10
11	Channel 11
12	Channel 12
All pins at bottom row are GNDs	

Rear panel connections.

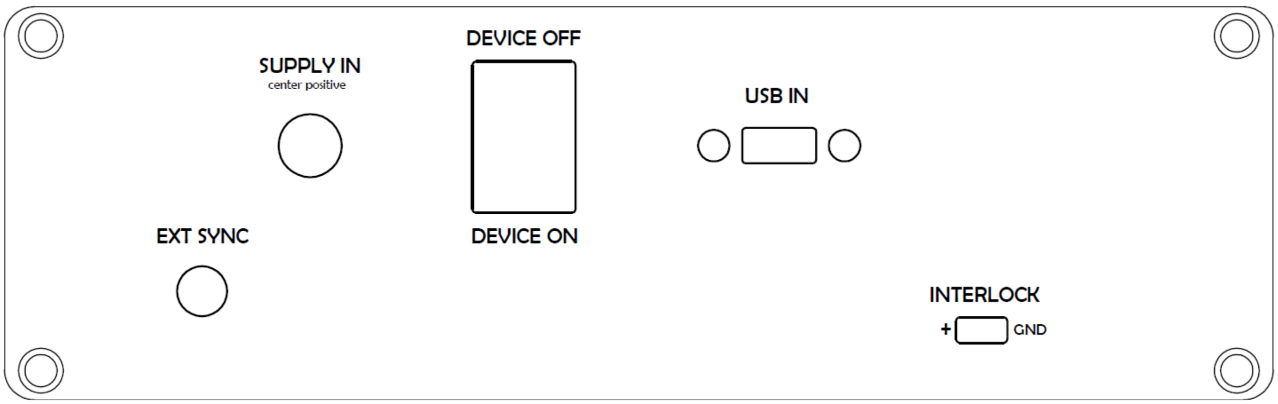


Figure 17. NEDA rear panel connections

EXT SYNC: Trigger signal connection for syncing the AWG function. Type SMA

SUPPLY IN: 24V DC power supply in

DEVICE ON/OFF SWITCH

USB IN: SUB2.0 type Micro-B port

INTERLOCK: Interlock port. Pull + pin to LOW to enable the current and voltage sources.

Appendix II: Json file structure

```
{
 "schema": "neda_gui_params",
 "version": 1,
 "saved_at": "2025-12-17 16:55:58",
 "unipolar": [                          # Unipolar voltage sources section
  {
   "ch": 1,                             # “Ch”: indicates the channel number
   "label": "Unipolar Source 1 (V)",    # “label”: the name of the channel
   "volts": 3.28,                       # “volts”: the channel value
   "max_volts": 20.0,                   # “max volts”: the channel’s max limit
   "note": ""                           # “note”: user’s notes
  },
  {
   "ch": 2,
   "label": "Unipolar Source 2 (V)",
   "volts": 1.9,
   "max_volts": 20.0,
   "note": ""
  },
```

.... (channels 3 to 11 implied)

```
  {
   "ch": 12,
   "label": "Unipolar Source 12 (V)",
   "volts": 1.9,
   "max_volts": 20.0,
   "note": ""
  }
 ],
 "bipolar": [                                # Bipolar voltage section
  {
   "ch": 1,                                  # "Ch": indicates the channel number
   "label": "Bipolar Source 1 (V)",          # "label": the name of the channel
   "volts": -2.92,                           # "volts": the channel value
   "min_volts": -10.0,                       # "min volts": the channel's min limit
   "max_volts": 10.0,                        # "max volts": the channel's max limit
   "note": ""                                # "note": user's notes
  },
  {
   "ch": 2,
   "label": "Bipolar Source 2 (V)",
   "volts": 3.11,
   "min_volts": -10.0,
   "max_volts": 10.0,
   "note": ""
  },
  {
   "ch": 3,
   "label": "Bipolar Source 3 (V)",
   "volts": -4.62,
   "min_volts": -10.0,
   "max_volts": 10.0,
   "note": ""
  },
  {
   "ch": 4,
   "label": "Bipolar Source 4 (V)",
   "volts": 3.4,
   "min_volts": -10.0,
   "max_volts": 10.0,
   "note": ""
  }
 ],
 "current_sources": [                        # Current sources section
  {
   "ch": 1,                                  # "Ch": indicates the channel number
   "label": "Current Source 1 (mA)",         # "label": the name of the channel
```

```
    "mA": 133.5,                              # “mA”: the channel value
    "max_mA": 250.0,                                  # “max_mA”: the channel’s max limit
    "compliance_V": 2.0,                              # “compliance_V”: compliance voltage value
    "note": ""                                        # “note”: user’s notes
   },
   {
    "ch": 2,
    "label": "Current Source 2 (mA)",
    "mA": 54.0,
    "max_mA": 250.0,
    "compliance_V": 2.0,
    "note": ""
   },
   {
    "ch": 3,
    "label": "Current Source 3 (mA)",
    "mA": 218.8,
    "max_mA": 250.0,
    "compliance_V": 2.0,
    "note": ""
   },
   {
    "ch": 4,
    "label": "Current Source 4 (mA)",
    "mA": 71.0,
    "max_mA": 250.0,
    "compliance_V": 2.0,
    "note": ""
   }
  ],
  "tec": {                                    # TEC section
   "label": "TEC",                            # “label”: the name of the channel
   "set_temp_c": 25.0,                # “set_temp_c”: the value of the channel
   "sensor_temp_c_text": "---"   # “sensor_temp_c_text”: the readout value of the sensor

  }
}
```

Appendix III: Programming API

The NEDA LD4H16T controller offers a programming API in Python, in order to allow the user to use the functions provided and develop his own scripts. The API consists of two libraries that contain all the functions required, the **nedaConnectionV2.py** and the **nedaSetValueV2.py.** The libraries are offered by Optagon Photonics upon request. The basic functions the user can call are the following:

- **Connect2Device()** Realizes a connection to the NEDA controller so that the rest of the control functions can be called.
- **laserEnable()** Enables the hardware output stage of the current sources. It should be called first to allow the user to control each channel by calling the relevant functions described below.
- **laserDisable()** Disables the current sources, by disabling the hardware output stage. The values of the current source channels are set to 0 and the outputs are then disabled.
- **tecEnable()** Enables the hardware of the TEC, so that the user can control the TEC temperature value.
- **tecRead()** Reads the thermistor of the module connected to NEDA and returns the temperature value in degrees Celsius.
- **tecDisable()** Disables the TEC controller hardware. When the function is called no power is sent to the peltier element and the thermistor value is not monitored.
- **setValue("channel", value)** This universal function sets the value of the selected channel that can be either the Current, Unipolar Voltage or Bipolar Voltage Sources.

  For the Current Sources, the user must give the argument **curN,** where N is the number of the channel (1 – 4). E.g cur1 to select the first channel, cur4 to select the fourth channel etc. The argument value can take any value from the available current range (0 – 500 mA) using one decimal place e.g. 125.0 for 125 mA. Thus, the command to set the 1st channel to 125 mA would be **setValue("cur1", 125.0)**

  To set the voltage compliance value for the current sources, the user must use the **setVCompliance("channel", value)** command.

  For the Unipolar Voltage Sources, the user must give the argument **uniN,** where N is the number of the channel (1 - 12). E.g uni1 to select the first channel, uni5 to select the fifth channel etc. The argument value can take any value from the available voltage range of the unipolar sources (0 – 10 V) using one decimal place e.g. 5.0 for 5V. Thus, the command to set the 5th channel to 5V would be **setValue("uni5", 5.0)**

  For the Bipolar Voltage Sources, the user must give the argument **biN,** where N is the number of the channel (1 - 4). E.g bi1 to select the first channel, bi2 to select the second channel etc. The argument value can take any value from the available voltage range of the bipolar sources (-10 – 10 V) using one decimal place e.g. -2.5 for -2.5V. Thus, the command to set the 2nd channel to -2.5V would be **setValue("bi2", -2.5)**

For the TEC, the user must use the argument **"tec"**, followed by the required temperature value in oC with one decimal accuracy, within the allowed temperature range. E.g. 25.0 for 25 oC. So, to set the tec temperature to 25oC, the command would be **setValue("tec", 25.0)**

- **setMax("channel", value)** This universal function sets the maximum value (limit) of the selected channel that can be either the current, unipolar voltage or bipolar voltage sources. The usage is the same as the setValue function.
- **setMin("channel", value)** This universal function sets the minimum value (limit) of the selected channel that can be either the current, unipolar voltage or bipolar voltage sources. The usage is the same as the setValue function.

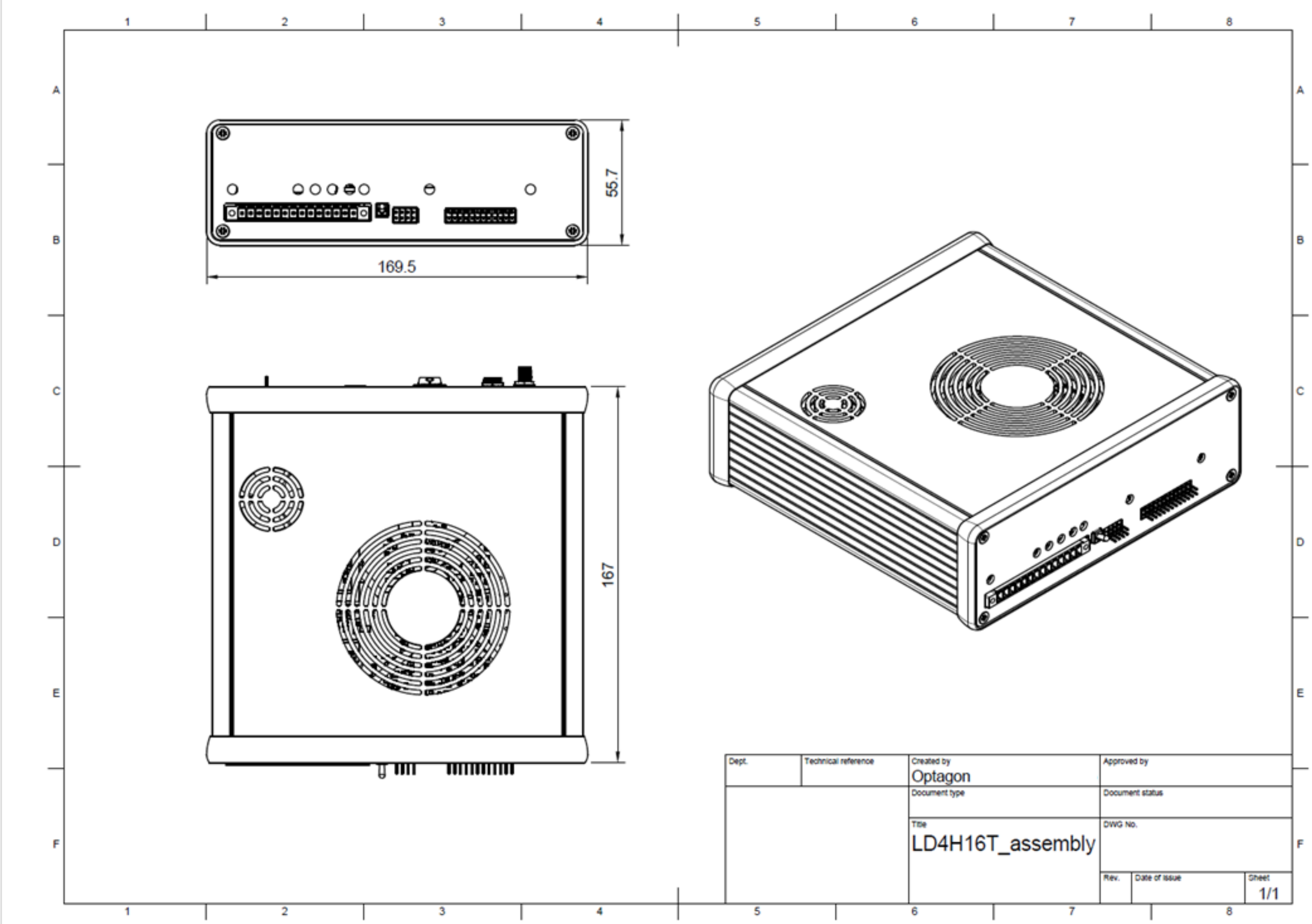
A basic example of a python script that imports the libraries and uses the above functions are:

```python
from nedaConnectionV2 import connect2Device
from nedaSetValueV2 import setValue, setVCompliance

ser = connect2Device()
if ser:
    setValue("uni1", 5.0)
    setValue("bi1", -2.5)
    setValue("current1", 120.0)  # mA
    setValue("tec", 25.0)        # °C
    setVCompliance("uni2", 3.0)

```

Appendix IV: Mechanical dimensions



The dimensions of the device are (L x W x H) 167 mm x 169.5 mm x 55.7 mm. The enclosure is made from aluminum with minimum thickness of 1.25 mm, except for the front and back panels which are 1 mm aluminum.

Appendix V: Certifications and compliances

CE

Declaration of Conformity

We	Optagon Photonics
of	Eleftheriou Venizelou 47, Pallini 15351, Attica

in accordance with the following Directive(s):

2014/30/EU	EMC Directive
2014/35/EU	LVD Directive
2011/65/EC	Restriction of Hazardous Substances (in electrical en electronic equipment) - RoHS2 - Directive

hereby declare that:

Equipment	**Laser Diode, Thermal Phase Shifter and temperature controller with digital interface**
Model number	**NEDA LD4H16T**

is in conformity with the applicable requirements of the following documents

Ref. No (Standard numbers)	**Standard Title, Year issue**
IEC/EN 61326-1:2021	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
IEC/EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
IEC/EN 63000:2016	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all applicable Essential Requirements of the Directives.

Signed by:	
Name:	Panagiotis Gkroumas
Position:	Managing Director
Location:	Pallini
Date:	04.12.2025