PHOTONMAKER, ULTIMATE

User manual version 0.1.0

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I.   WARNING! IMPORTANT SAFETY INFORMATION

- NEVER, under any circumstances, open the unit. High voltage inside. WARRANTY IS VOID once the cover is removed. There is a risk of high voltage shock (220-240 VAC, or 110 VAC, depending on the region). Do not disassemble.
- DO NOT insert any object into the ventilation area of the unit.
- DO NOT place any object in front of the fan or the ventilation area of the power supply unit that may obstruct or restrict airflow.
- Keep the unit in a dry environment, away from humidity.
- The unit is for not intended for external or outdoor usage.
- Please always take extreme care to the safety of the installation and operation of any instrument, specially the optical one.
- **Never look directly towards the light beam!** Extreme intensity of the light output from the light source or after the fiber may cause serious eye injury, including temporary blindness and permanent vision degradation. The shortest (UV-395) channel is much brighter than it looks like for human eyes and is the most dangerous light channel.
- **Do not connect the light source to the AC outlets without Ground!**
- The light source was designed to minimize risks of electric shock even in the unlucky case of breakdown due to external factors. All parts of the mainboard are powered with DC 12V or lower, but there is still AC-DC power supply (with dedicated extra protection metal box) that hold

dangerous voltage. For complete electrical protection we recommend using properly installed and verified electrical system.

II.   SPECIFICATIONS

Power requirement: 110-240 VAC 50/60 Hz

PC interface: USB type B, USB AM-BM cable included.

Input triggers port: DB15M.

Output triggers port: DB9F.

Optional combined IO-box available for 7x BNC trigger inputs and 4x BNC trigger outputs.

Optical power output* (after the liquid light guide):

Color	Peak wavelength, nm (at 100% power)	Peak wavelength, nm (at 1% power)	5 mm fiber, mW	3 mm fiber, mW
UV	398	399	125	80
Blue	452	454	320	100
Cyan	500	507	110	40
Green	515	528	120	40
Amber	601	594	55	20
RED	638	628	180	60
White	430-750**	430-750**	280	100

* Typical values, we recommend 5mm fiber for better power output.

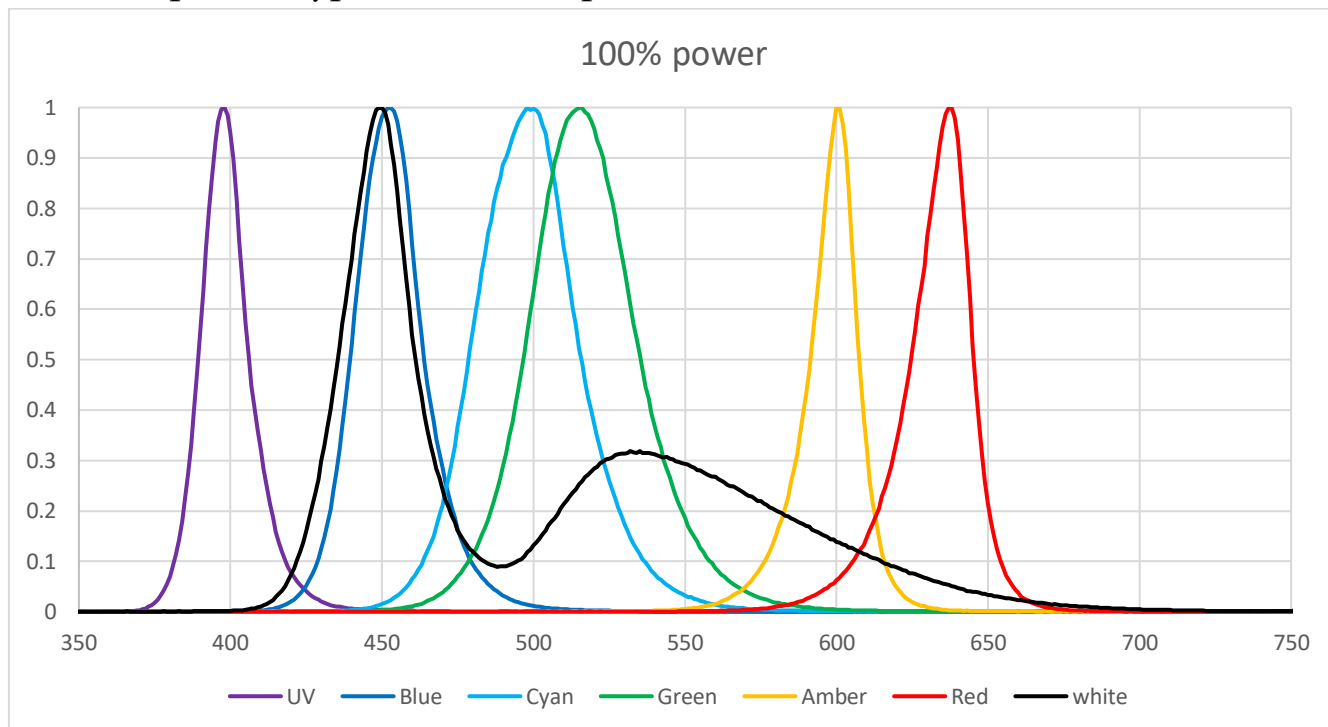** White is a broad-band with spectral coverage from 430 to 750nm (see spectrum)

Trigger speed <1 μs (external TTL mode)

Internal software sync <200 μs (typical <100 μs)

Power adjustment range: 0.1% to 100% with 0.1% increment

Linear range: 1% to 100%

Relative spectra (typical, at 100% power):

We are constantly improving the performance of the light source, so there may be minor changes to the specifications provided that may not be reflected in this manual.

We can also recommend filter sets for your application and the LLG microscope adapter for your model of the microscope and the fiber. You can buy it from us or directly from the manufacturer.

III.   INITIAL SETUP

You need to locate a place for the light source for your microscope configuration.

Do not place under the direct sunlight, less than 50 cm to the heating radiators, in the place where liquid may be spilled to the unit.

The standard length of the liquid light guide is 1.2 m (4 ft), while other options are available. Is it not allowed to bend LLG with the radius smaller than 20 cm (8”).

Microscopy adapter installation:

please refer to your microscope manual or ask our service support for help.

LLG attachment to the light source main unit: insert fully the light guide and tighten the screw.

After setting up an optical connection, please connect USB type B cable to the unit and the other side (type A) to the PC.

Then connect the AC power cord.

To configure the light source, you need to install the software. It is possible to run the unit in several use scenarios without connection to the PC, but PC connection is necessary for full potential of the light source and for configuration. For special use cases you may always ask our support and we will recommend you the best solution. Depending on the specific configuration task you may need to attach TTL extension cables or TTL box.

V. CONFIGURATION.

All 7 LED channels may be configured independently for different operation modes via software.

External mode: LED will operate triggered by external TTL signal. LED will remain OFF if external input cable is not connected or the TTL signal LOW (voltage < 1.6 V, and will remain ON if the trigger voltage is higher than 1.6V). TTL input is 5V tolerant. (**Warning: Do not invert the voltage signal! This may damage the input port!**)

Protocol mode: LED will be controlled through built-in real-time controller to execute protocols, configured in the software, or manually switched ON/OFF for test purpose.

It is possible to set up batch of independent protocols for different channels and start them simultaneously after pressing 'start all selected' button. When chosen 'start immediately' the selected channels will run protocols immediately after pressing the button. When a channel (that must be in external mode) is selected the selected protocols will start immediately after arrival of the first TTL trigger pulse to the selected port. For debugging convenience, if the channel is configured in external mode it will always provide light output after trigger arrival. When light pulse is not needed, user may tune the light power to 0 for this channel to operate as dedicated trigger port.

For ease of integration to complex systems the unit is capable of controlling additional 4 TTL External Output channels for synchronization use and to control external devices (e.g. electrical stimulator, imaging camera, laser, etc.)

Linked mode: LED pattern will duplicate the pattern of selected LED channel that is configured to external mode. This mode is added for wiring convenience to avoid frequent rewiring or use TTL cable splitters to run several channels simultaneously with control through single TTL input.

External IO connection.

To connect external trigger input and/or output TTL signals you need to use our DB15-7BNC and DB09-4BNC cables, BNC combo breakout box, or make your custom cable according to pinout provided on one end (attached to light source) and your custom purpose solution on the other end of the cable.

Warning! Please always check the integrity of the cables you use and avoid short circuits of TTL outputs when making your custom cable. Please always check the voltage of the TTL input and make sure is does not exceed 5V. Recommended TTL level is 3.3V or 5V. Do not invert the voltage, negative voltage provided to the TTL input may damage the input port.

pin	Function (DB-15M) TTL trigger IN
1	Red channel TTL trigger in signal
2	Green channel TTL trigger in signal
3	Blue channel TTL trigger in signal
4	Amber channel TTL trigger in signal
5	White channel TTL trigger in signal
6	Cyan channel TTL trigger in signal
7	UV channel TTL trigger in signal
8	Reserved (not connected)
9-15	Signal ground for TTL inputs

pin	Function (DB-09F) TTL trigger OUT
1	first channel TTL trigger out signal
2	second channel TTL trigger out signal
3	third channel TTL trigger out signal
4	forth channel TTL trigger out signal
5	Reserved (not connected)
6-9	Signal ground for TTL outputs
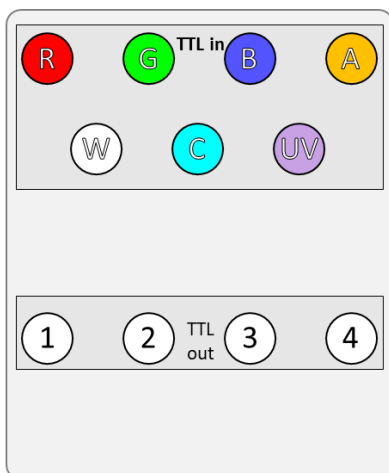
BNC layout of the TTL combo box:

Upper group of 7 BNCs are inputs corresponding to colors: Red, Green, Blue, Amber, White, Cyan and UV

Lower group of 4 are TTL outputs.

In case you have any questions regarding connection or operation of the Light source, please contact out service support.

IV. SOFTWARE CONTROL (GUI)

1. **Software Installation**
a. System Requirements:
A 64-bit version of Windows operating system is required. The system should be able to run Java 8; for
recommended Windows versions, please check
https://www.java.com/en/download/help/sysreq.xml.

b. Screen resolution:
The recommended resolution of the screen to be used is 1920*1080. This interface is designed to adapt
its behavior depending on the resolution of the computer screen. The software performance might
be non-optimal under resolutions that are too far from the recommended resolution.

c. Installation & Launching the program
This is a list of files after extracting the software package (actual file names may be different for
different versions):
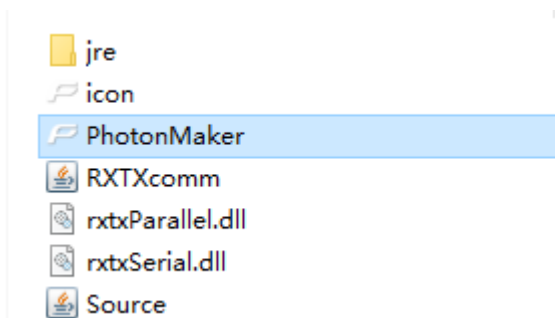
Double click on PhotonMaker.exe to launch the program. To check control over the firmware, make
sure that the firmware is already connected to the computer via a USB cable before launching the
program.

2. **User Interface**
a. Regular mode (firmware connected)
When the firmware (PhotonMaker) is already connected before launching the program, the user should
see the main window popping up:

Note: If the connection to the firmware fails, a message "Device not found! The program will run in
demo mode" will pop up before the program window appears; in that case, refer to the section
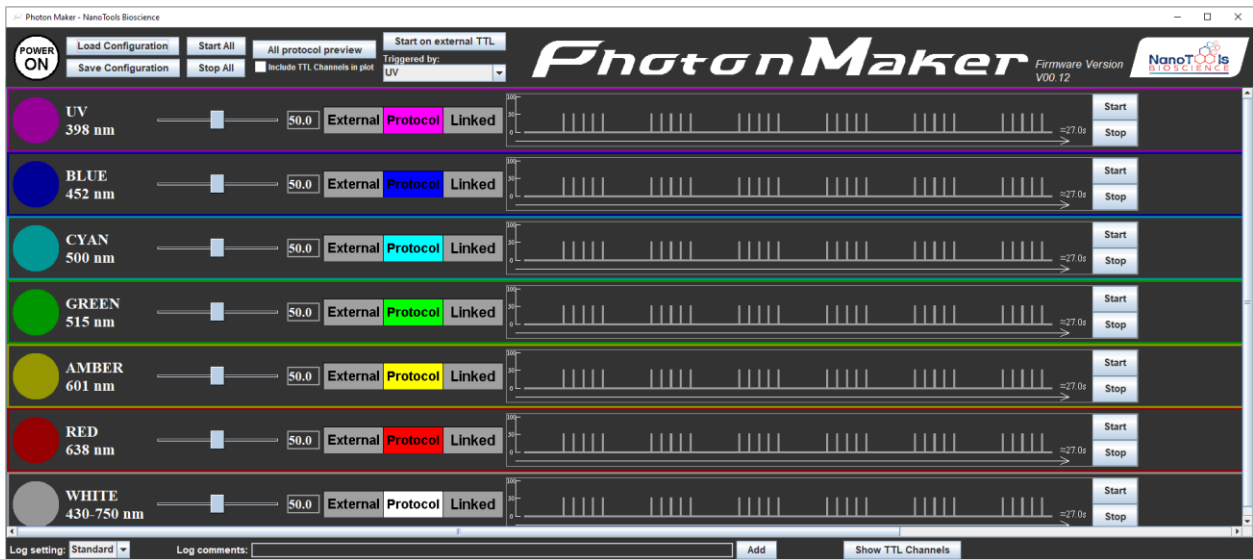
"Connection problem troubleshoot" for resolving the connection issues and more details on the demo mode.

Please refer to the following sections for a description of the different components of the program.

Program window Description
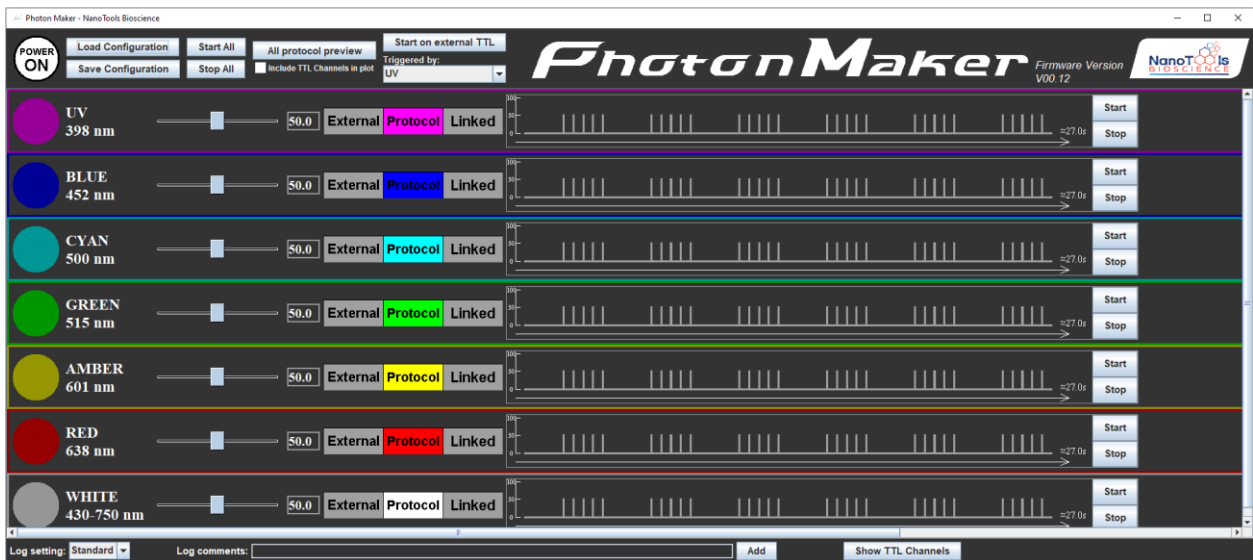
The main software window is shown above. It has "firmware power", "load/save configuration" and "start/stop all protocols" buttons at the top of the program. The top of the program also includes an "all protocol preview" button to visualize all currently specified protocols, start protocols on external TTL trigger functionality related components, and the firmware version information.

The main components of the program are located in the middle section where all the Light channel panels and Trigger (TTL) channel panels are. Please use the horizontal and vertical scrollbars

(scrollbar's behavior depends on screen resolution) to see all the channels. This section allows users to set-up and adjust all available stimulation and light control parameters.

The bottom of the program enables the user to change settings of the log file, add custom comments to the log file as well as show/hide the Trigger channels from the main program window.

i.   Firmware power light/button

In the top-left corner of the program, there is a button indicating the on/off status of the PhotonMaker firmware. This button can also be used to turn the firmware on or off.

ii.   Load Configuration
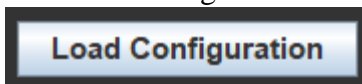
The "load configuration" button allows the user to load a previously saved configuration file for fast retrieval of the settings of channels.

1. Manual Load Configuration from file

To manually load a configuration file, click on the "Load Configuration" button on the top of the program. A window will pop up, asking the user the file to be loaded. A message will pop up once the configuration file is successfully loaded.

Note: Do NOT modify the configuration files or load any other files as the configuration file.

2. Initial Configuration loading

The program automatically loads its auto-saved configuration file to restore the setting the user left with. If no auto-saved configuration file is found (for instance, this is the first time launching this program on this computer), the default setting will be applied to the program.

Note: To revert to the default parameters for all the channels when launching, please delete the "initConfig.ini" file in the program folder.

iii.   Save Configuration
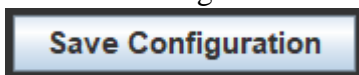
The "Save Configuration" button can save the following information into a configuration file that can be loaded later for fast retrieval of the settings:

For each Light channel, the power level, protocol parameters, and channel mode can be saved; for each Trigger channel, the channel's name and protocol parameters can be saved.

1. Manual Save Configuration to file

To manually save the current configurations to a file, click on the "Save Configuration" button on the top of the program. A window will pop up, asking the place to save the configuration file and the file name.

2. Automatic saving

The program automatically saves its configuration into a file on exiting; this auto-saved configuration file will be loaded upon the next launching of the program.
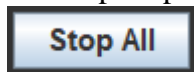
iv.   Start all protocols
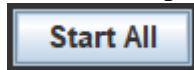
Start All

The "Start All" button can be used to start the protocols for all Light channels that are in the protocol mode and all Trigger channels simultaneously. Disabled when a channel's protocol is running.

Notes:

(i) the "Start All" button may be disabled for an extended time after the current protocols finish running. The software uses this time period to confirm the status of the firmware.

(ii) the parameters changed after the start of the protocols will not have effect on the running protocols; it is strongly recommended not to change channel settings while the protocols are running.

v.   Stop all protocols

Stop All

The "Stop All" button can be used to stop the protocols for all Light channels that are in the protocol mode and all Trigger channels simultaneously. It can also be used to abort if channel protocols are set (by the "Start on external TTL" button) to start upon the arrival of an external trigger.

vi.   Visualize all protocols

All protocol preview
☐ Include TTL Channels in plot
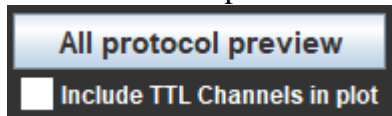
The "All protocol preview" button can be used to open a new window which contains visualizations of the protocols of all the Light channels that are in the protocol mode. Those plot visualizations are put in the same horizontal time axis.
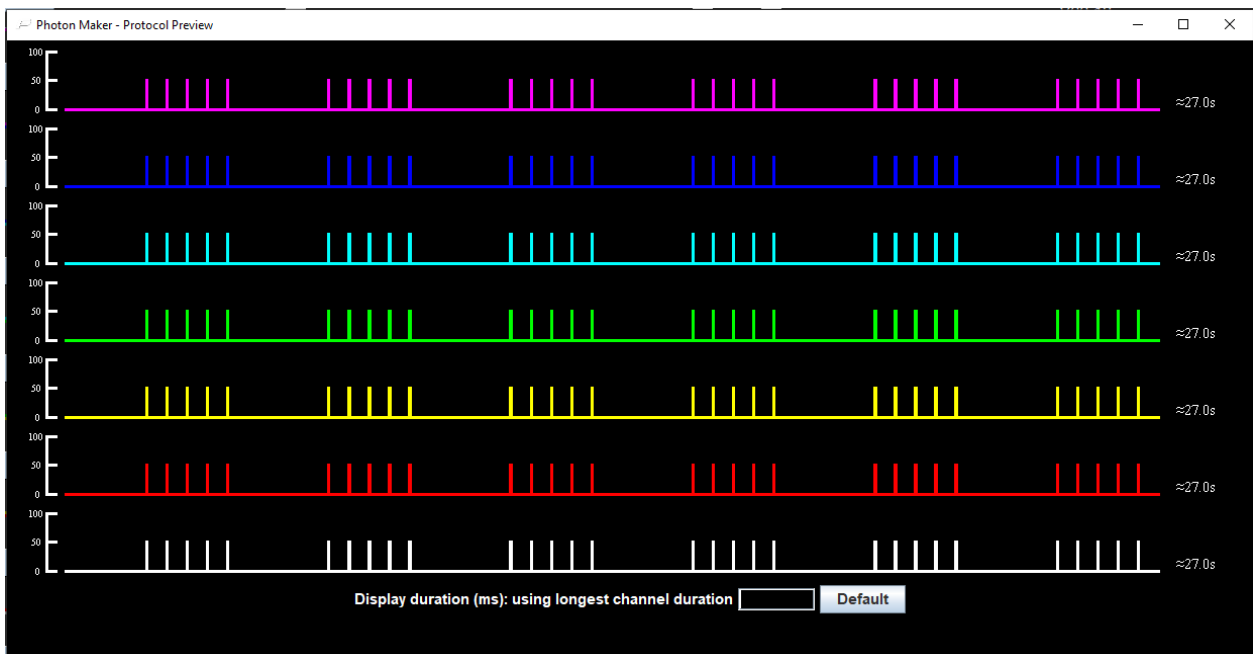

By default, the Trigger (TTL) channels are not included. The user can select/unselect the "Include TTL channels" checkbox to include/exclude the TTL channels in this visualization window.
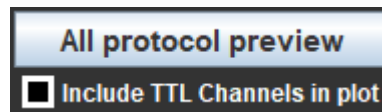
By default, the length of the displayed protocol corresponds to the longest duration among all the protocol plots currently in this window. The user can specify a custom duration that corresponds to the full length of the planned recording to zoom in/zoom out horizontally. To specify a value, enter the desired duration in the text box at the bottom of this window and then hit <ENTER>. If the value update is successful, the text box will be emptied, the message to the left of the text box will be updated, and the visualization plots will be updated accordingly; if the value update is unsuccessful, the text the user
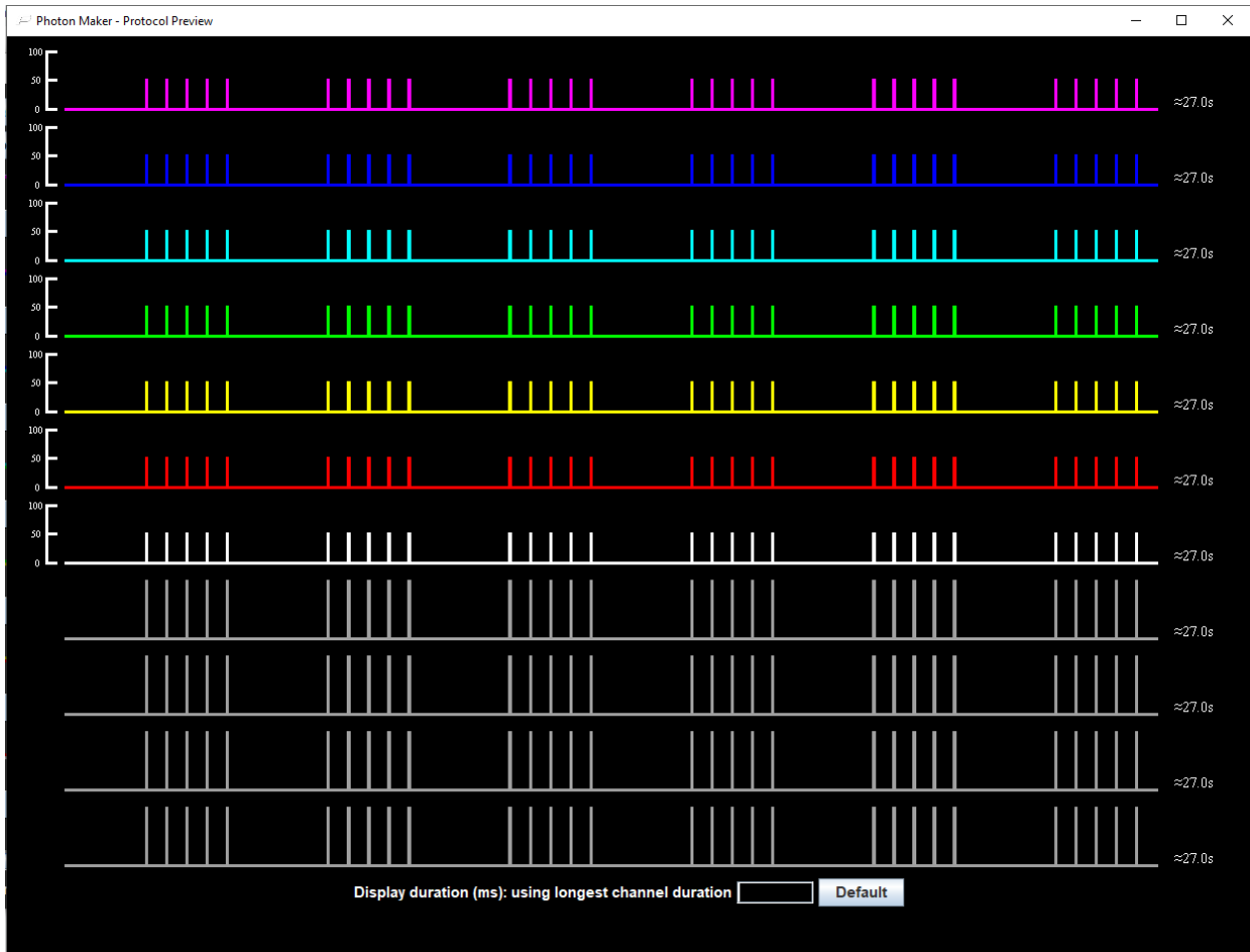
entered will remain in the text box, the message will not change, and the plots remain unchanged (in this case, please check if the text entered is a positive number). At any time, to return to the default plots, click on "Default".
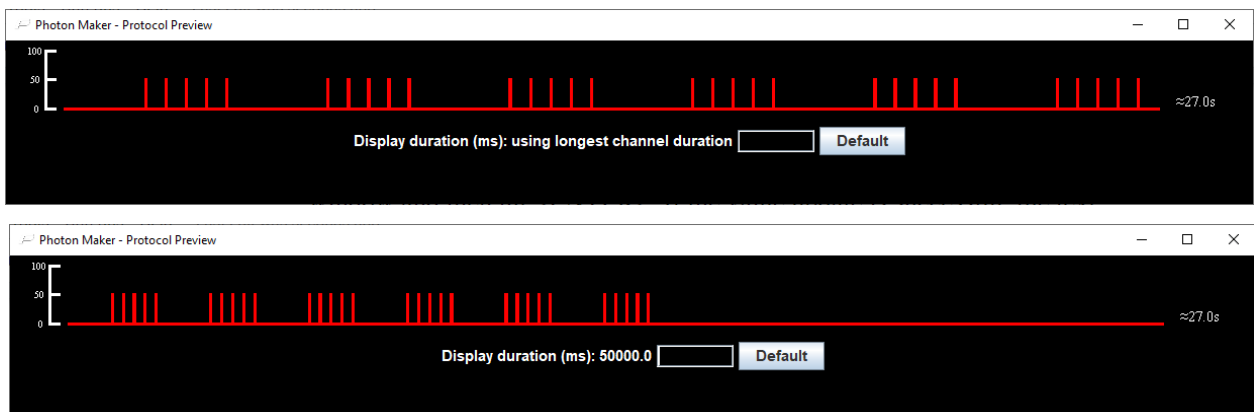
The number to the right of each channel always indicates the duration of the protocol specified for that channel.

vii. Start on external TTL trigger
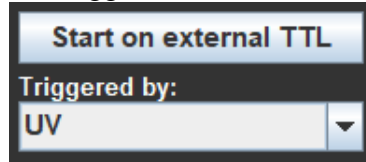
The "Start on external TTL" button can be used to put all protocol mode Light channels and TTL channels protocols in a "waiting mode": those protocols will start once the firmware receives a TTL trigger from the channel specified by the selection box below the button.

Notes:

(i) The "Stop All" button can be used to abort no matter the channels are waiting for the external trigger or the channels have started to run the protocols.

(ii) The channel specified to receive the trigger must be in the "external mode"; because that channel is in the external mode, that channel will also provide light output after the arrival of the trigger. If that light pulse from the triggering channel is unwanted, please set the power level of that channel to 0 before triggering.

viii. Firmware version information
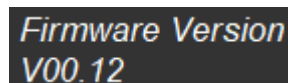
To the right of the "PhotonMaker" logo, the program shows the firmware version of the connected firmware. It will display the message: "Firmware Version: Device not found" if the connection to the firmware cannot be correctly established when launching the program.

ix. Light channel Set-up Controls (using the RED channel as an example)

Individual Light channels are used to generate light stimulation patterns. PhotonMaker provides highly flexible control over the light channels intensity and waveform shapes.

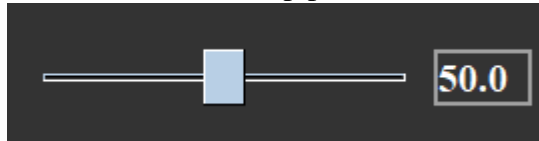Light control panel description:

1. On/off switch

The on/off switch can be used to manually turn the corresponding light channel "On" or "Off" when the channel is in the protocol mode.

2. Channel information

Shows the color of the light of this channel and its corresponding wavelength.

3. Power level Set-up panel.

Both the slider bar and the text box can be used to adjust the percent of maximum power to be used for this light channel when the channel is "On" or generating impulses.
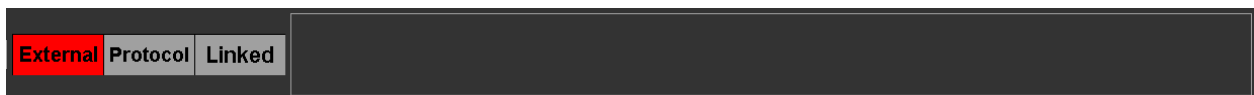
4. Channel mode switch and channel message panel

Each Light channel has three modes: External, Protocol, and Linked. The switch is used to change the mode of the corresponding light channel; information related to the mode selected will be displayed in the mode message panel to the right of the switch.

Mode descriptions:

a. External Mode:

In this mode, the channel is triggered by another external source instead of this software. The message panel is empty when the channel is in the External Mode.

b. Protocol Mode:
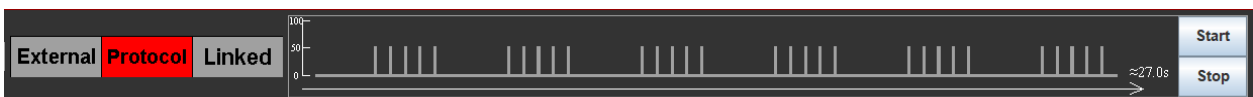
In this mode, the software has maximum control over the light channel. The "on/off switch" is only enabled in this mode to turn the Light channel on or off by clicking. This is also the only mode where the user-defined protocols can be directly executed.

When in the Protocol Mode, the message panel contains a plot visualization of the protocol as well as the "Start" and "Stop" buttons to start/stop the protocol of the corresponding light channel.

i. Protocol Plot:

This is a visualization of the protocol set by the user. Each vertical bar indicates a pulse to be generated. The height of each vertical bar indicates the power level of the light channel (a vertical axis is provided which indicates the power level in terms of percentage); the width of the bars and the spaces between them provides a visualization of the relative relationship between the duration of the pulses and the duration of the intervals. A horizontal axis indicating the time axis is provided together with a number indicating the duration of the current protocol set for this channel.

ii. Start/Stop button
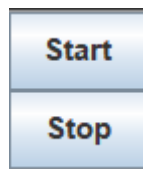
The "Start" button is used to start the protocol of the corresponding channel. It cannot be used to start the protocols of multiple channels.

Notes:

(i) To start multiple channels simultaneously, please set the channels to be run to the Protocol Mode and the others to the External Mode and then use the "Start All" button at the top of the program.

(ii) the parameters changed after the start of the protocols will not have effect on the running protocols; it is strongly recommended not to change channel settings while the protocols are running

The "Stop" button is used to stop the protocol of the corresponding channel and only the protocol of that channel. It cannot be used: (1) to stop multiple running protocols or (2) when the channel's protocol is evoked by clicking the "Start All" Button.

iii.   Protocol
    The protocol of each channel is a set of pulses to be generated by the firmware. A set of parameters specifies the initial delay before the first pulse, the duration of the pulses, the frequency of the pulses, and the total number of pulses.

iv.   Show/hide parameters
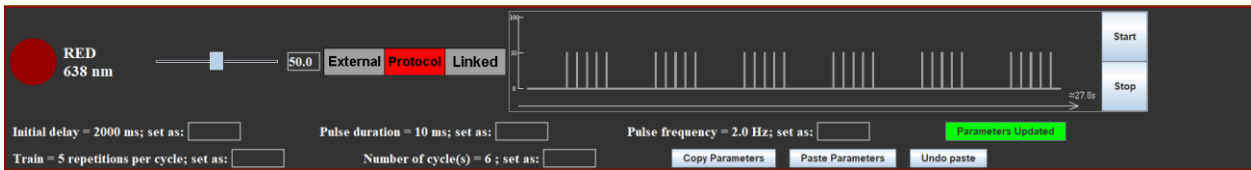
    By default, the numeric values of stimulation parameters of the protocol of the channel are hidden. When the channel is in the protocol mode, the user can show/hide the control panel of the parameters of this channel by clicking on the protocol plot area.

v.   Parameters:
    There are 5 parameters to be specified for the current version:

    1.   Initial delay: the waiting time before the first pulse and the interval between cycles of pulses
    2.   Pulse duration: the duration of each pulse
    3.   Pulse frequency: the frequency of each pulse
    4.   Train: the number of pulses in each cycle
    5.   Repeat: the number of pulse cycles

    Note: the interval between cycles of pulses is *initial delay + (1 / pulse frequency) - pulse duration*

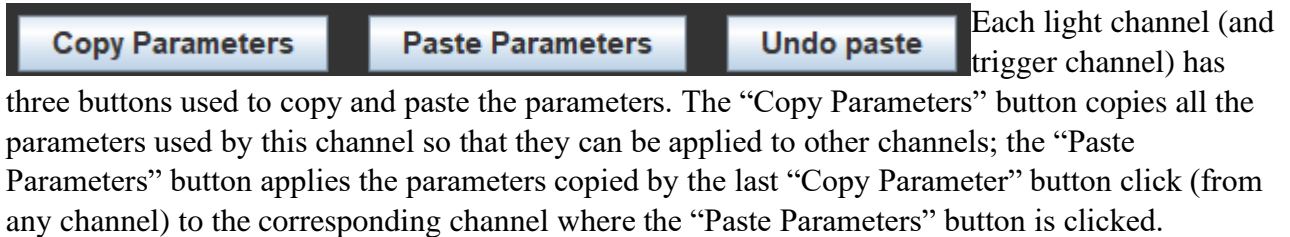vi.   Changing parameter values:

    Each parameter has a text box next to it used for changing its value. To change a parameter's value, click on the text box, and enter the value desired (only need to specify values for the parameters that need to be changed); after all needed changes to the parameters have been specified, click on the "update parameter" button on the right to send the changes to the program. If the values are successfully updated, the values to the left of the text boxes will be replaced by the newly specified values, the text boxes will be emptied and the update parameter button will become green; if the specified values for some of the parameters cannot be recognized as a number or cannot be used, those parameters will not be updated, their text box will still hold the user's input and the update parameter button will remain red (in this case, the parameters whose new value can be recognized and applied will still be updated).

The button is green when all the parameters are up-to-date; the button is red when (a) the user has made some changes to at least one of the parameters but the parameters have yet to be updated to the program or (b) the user has entered non-number text or number that cannot be used for a parameter after clicking on this button.

vii. Copy/paste parameters

 Each light channel (and trigger channel) has three buttons used to copy and paste the parameters. The "Copy Parameters" button copies all the parameters used by this channel so that they can be applied to other channels; the "Paste Parameters" button applies the parameters copied by the last "Copy Parameter" button click (from any channel) to the corresponding channel where the "Paste Parameters" button is clicked.

To undo the previous parameter paste, click on the "Undo paste" button (note: this can only undo one parameter pasting action; in other words, parameters copied before at least two parameter copying actions cannot be retrieved).

c. Linked Mode (functionality to be added in a future release):

This mode enables the light channel to be linked to another light channel in external mode, denoted here as channel X, so that any trigger used to trigger channel X can also trigger this light channel. The message panel of this mode contains a selection list from which the user can choose which channel in the External Mode to link to.

x. Trigger (TTL) channels Set-up Controls (using Trigger channel 1 as an example)
Note: By default, the program hides the Trigger channels from the program window. To show/hide the TTL channels, click on the "Show TTL channels"/"Hide TTL channels" button at the bottom of the program window. The Trigger channels' set-up controls are located right below the Light channel set-up controls once shown.

PhotonMaker has 4 connectivity channels designed to connect with and trigger other hardware. This software provides flexible control over these channels in a similar way to how the light channels can be controlled.

1. On/off switch

The on/off switch is used to turn the corresponding external out channel on/off.

2. Channel information/name

TTL Channel 1

This place stores the information/name of the corresponding external channel. The text here can be easily customized by clicking on the text box, entering the desired text, and pressing <ENTER>.

Custom Name 1

3. Parameters and protocols

The way the protocols are defined for the Trigger channels is the same as that of the Light channels. The parameters and the way to change parameters are also the same as those of the Light channels. Please refer to the corresponding sections of the "Light channel Set-up Controls" above.

Note: There are some differences between the Light channels and Trigger channels that are worthwhile pointing out here. The Trigger channels, unlike the Light channels, don't allow power level adjustments and channel mode switching. Therefore, it can be viewed that the Trigger channels are always in the "Protocol Mode"; a consequence is that the Trigger channels' protocols will always be executed if the user clicks on the "Start All" button.

xi. **Log File**

The program helps the user to keep track of the actions in modifying the program stimulation parameters. The program stores that information in a log text file named "PhotonMaker_log.log" in the program folder (each time the program appends new entries to the end of this file). To clear up the history, delete this file; the program will automatically create a new log file each time it doesn't find that log file in its directory (including the first time running the program).

There are two levels of specificity of the log entries that the user can choose:

- Standard (default): in this level, the following information is written to the log file:
  ○ The time the user turns any channel on/off
  ○ The time and parameters used when the user starts a protocol
  ○ The time the user switches channel modes and to which mode
  ○ The time the firmware power is turned on/off
  ○ The time the user adds custom comments (see below) and the content of the comments
- Detailed: in this level, the following information is written to the log file:
  ○ All information which was written by the standard mode above
  ○ The time the user changes any parameter of any channel and the new value used

The components related to the file are located at the bottom of the program window:

The selection box enables the user to switch between the "standard" and "detailed" log modes mentioned above (with "standard" being the default mode each time the program launches).

The log comment panel enables the user to add any custom comments to the log file. To add a comment, type or paste the comment to the text box and then click "Add". The comment text box should be cleared once the comment is successfully added to the log file.

xii.   Show/hide Trigger channels
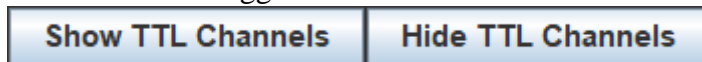
By default, the program hides the Trigger channels when launching. To show their control panels in the program window, click on "Show TTL Channels". To hide them again, click on "Hide TTL Channels". Showing/hiding TTL channels is achieved by the same button; its text content depends on the current status of the Trigger channels.

3. Notes
a. "Parameters don't match" / "Parameters Impossible to match"

Error ✕

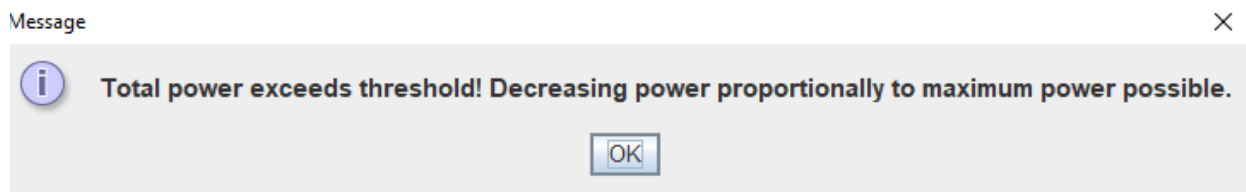❌ **Parameters of the TTL channel 1 impossible to match**

OK
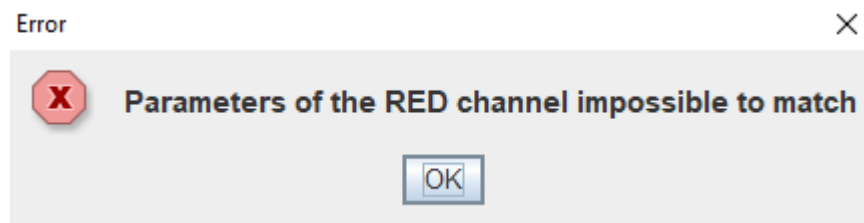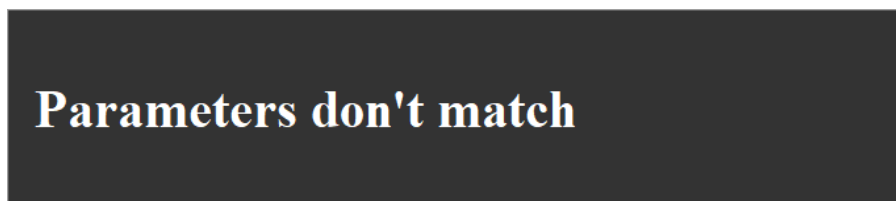
If one of these messages show up in the message panel in the protocol mode or when trying to run a protocol, please check the parameters specified. It is very likely that the duration of each pulse makes the frequency of pulses impossible to achieve.

b. Power Control

To protect the firmware, the total power allowed for all the Light channels is limited to 400% of the maximum power of a single Light channel. The program will pop up a message if the user is attempting to exceed this limit and select the maximum possible power level to avoid exceeding this limit.
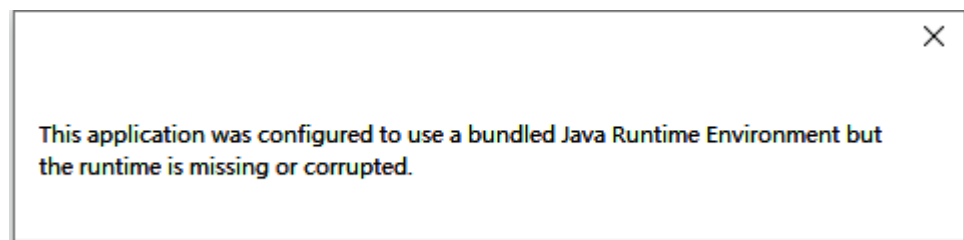
Message ✕

ⓘ **Total power exceeds threshold! Decreasing power proportionally to maximum power possible.**

OK

Troubleshooting

c. Java Runtime Environment missing

If the user sees the following message when launching the program:

✕

This application was configured to use a bundled Java Runtime Environment but the runtime is missing or corrupted.

Make sure that the user has not changed any file names within the program folder. Also, make sure the directory path in which the entire program folder is put in can be correctly recognized by the system (it is recommended to put the program folder inside a path entirely consisting of English).

d. Connections problem troubleshoot

If the user sees the following message when launching the program:
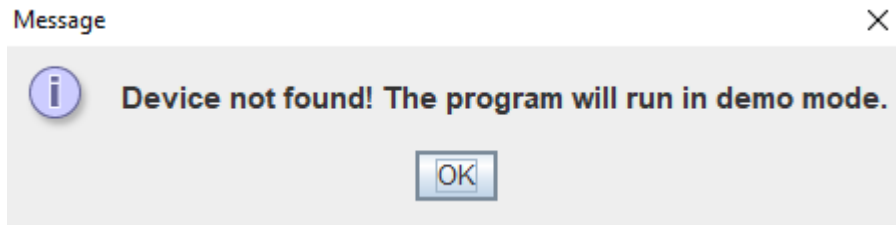
Then firmware connection failed to be established when launching the program. In this case, the program still launches, but it's in the "demo mode". In this mode, the title of the program window will say "Demo version: device not found" and the firmware version text will say "Firmware Version: Device not found" to inform the user that the program is in the demo mode.

In the demo mode, the user may still control the program components, but none of the commands will be sent to the firmware. Loading/saving configurations, saving to log files, changing channel settings, and previewing protocols are still functional but it is recommended to change the settings when the firmware is connected.

VIII. Warranty

Warranty: 12 months

Warranty covers the light sources beginning from the date of purchase, against defects in materials or workmanship. During the warranty period, Nanotools maintains the discretion to either repair units or replace broken components with parts of similar or equal performance, provided that:

- The product is returned to the point of purchase, postage prepaid.
- The product was properly used according to the manufacturer's intended purposes.
- The product was not damaged due to acts of nature, such as lightening, flood or fire.
- The product's cover was never removed and the warranty sticker was not broken.

IX. Disclaimer

All efforts have been made to ensure accuracy of all information provided herein. Nanotools Bioscience assumes no liability, expressed or implied, for any damage(s) occurring to your system's components or other devices as a result of any mistake or omission during power supply installation or removal, or due to any defect or failure of the product itself.

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