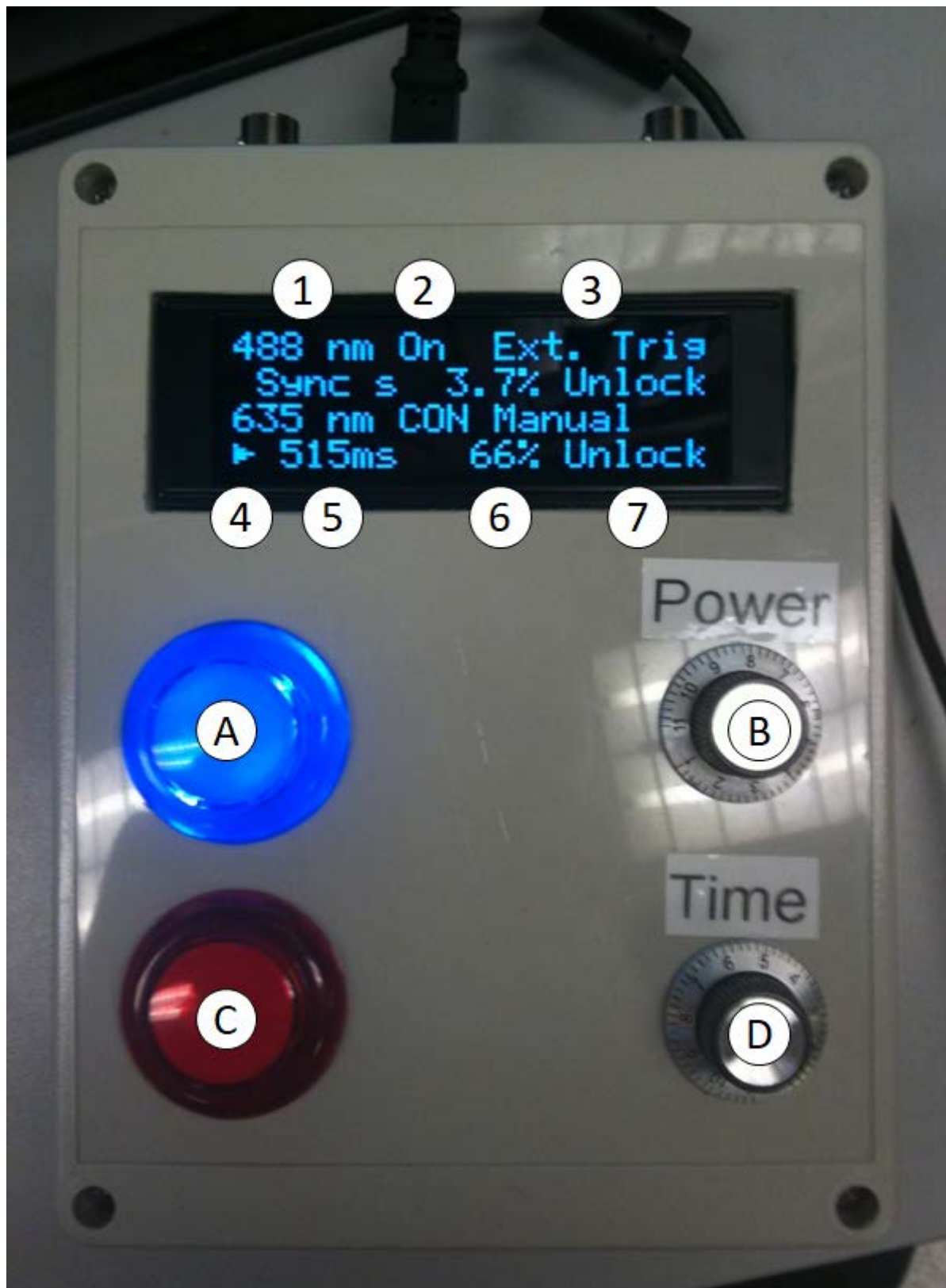# Dual Laser Controller User Manual

Display and Controls

Display:

1. The wavelength of the laser
2. The status of the laser
   a. On – The current mode is active.
   b. Off – The mode is turned off.
   c. CON – The laser is in configuration mode allowing the settings to be changed.
3. Current laser sync mode (see "Laser Sync Modes" for detailed explanation of modes)
   a. Manual – Push button operates the laser
   b. Scan-Sync – Laser sync to analog input
   c. Scan-Trig – Laser triggers off of the analog input
   d. Ext. Trig – Laser triggers off of a TTL pulse.
4. Arrow indicates which laser is being configured
5. Duration of laser pulse (1 - 9972 ms or sync)
6. Laser output (0 - 100% or sync)
7. Lock status of display

Controls:

A. Toggle button for blue laser
B. Adjusts the laser power
C. Toggle button for red laser
D. Adjusts laser pulse duration

Operation

Activate Display

To activate the display, briefly press either toggle button. This will not change any settings. Once the display is activated the laser settings can be changed as long as the display is active.

NOTE: While the display is active, the system timing jitter increases to about 20 us, so for tasks that require precise timing, such as laser scanning microscopy, be sure to wait until the display does dark.

Toggle Lasers

To toggle a laser on or off, first activate the display by briefly pressing one of the pushbuttons, and then briefly press the pushbutton corresponding to the laser you wish to toggle. If the laser is turned on, the pushbutton will light up and the display status will switch to "On." Conversely, if the laser is turned off, the pushbutton will go dark and the display status will switch to "Off."

NOTE: The provided Arduino code prevent two lasers from being turned on at the same time. Therefore if one laser is turned on while the other is still on, the other laser will be turned off automatically.

Configure Laser

To configure a laser, press and hold the pushbutton for that laser until the laser status switches to "CON" and the toggle button begins flashing. In configure mode, the laser mode, power, and duration can be changed. To exit the configuration, briefly press the same pushbutton, and the pushbutton should stop flashing and the laser status will return to On/Off. See "Configuration" for more details.

Display Lock/Unlock

The buttons and display can be locked out by briefly pressing both pushbuttons at the same time and the status will switch to "Locked", and unlocked by pressing and holding both pushbuttons until the same time until the status switches to "Unlock".

When the display is locked, the pushbuttons can be used to activate the display, but all other inputs are locked out. This is useful to prevent a laser from accidentally being toggled or changed.

NOTE: For safety reasons, a laser cannot be locked while turned on in Manual mode.

<u>Configuration</u>

In configuration mode, the power, duration, and operational mode of a laser can be changed. To enter the configuration mode, press and hold the pushbutton for the laser you with to configure until its status says "CON" and the pushbutton begins flashing. To exit configuration mode, briefly press the same pushbutton.

Laser Power:

The laser power can be adjusted by turning the power knob (the knob closest to the OLED display). If the knob is turned all the way clockwise, past the switch detent, then the power will be at 0.0%. As the knob is turned counter-clockwise the output can be adjusted from 0.0% to 100% power. The OLED display will automatically refresh as the knob is turned.

NOTE: A gamma function has been applied to the knob that results in a logarithmic response.

Laser Duration:

The duration of a laser pulse after a trigger event can be adjusted by turning the time knob (the knob furthest from the OLED display). If the knob is turned all the way clockwise, past the switch detent, then the pulse duration will be synced to the input trigger (see "Laser Sync Modes" for more details). As the knob is turned counter-clockwise the pulse duration can be adjusted from 1.0 ms to 9972 ms. The OLED display will automatically refresh as the knob is turned.

NOTE: A gamma function has been applied to the knob that results in a logarithmic response.

Laser mode:

The laser sync mode can be changed by briefly pressing the pushbutton opposite the laser you are configuring (i.e. if you are configuring the blue laser, press the red button and vice versa). The modes will cycle in the following order with each button press: Manual -> Scan-Sync -> Scan-Trig -> Ext. Trig. See "Laser Sync Modes" for more details.

Laser I/O

Input

1. Trig – 5V TTL digital input
2. Scan – 0-5V analog input
3. USB – Connection to Arduino USB port for programming
4. 12V – power jack for Arduino.
   a. NOTE: Use the power jack for primary power to ensure a stable voltage output.

Output

1. 488nm – 0-5V analog output 1
2. 635nm – 0-5V analog output 2

Laser Sync Modes

Manual

In manual mode, the pushbuttons are used to trigger the lasers.

Power - The power can be adjusted from 0-100%.

Timing - The timing sets how long the laser stays on after the pushbutton is pressed, and can be set from 1 – 9972 ms, or "sync". The laser and display will then reset to the off state once the laser has turned back off. When the knob is turned to the off detent position, the timing will switch to "sync" which means that the laser will be synced to the pushbutton. This means that the laser can be toggled on/off indefinitely by briefly pressing the pushbutton.

NOTE: The display cannot be locked while a laser is on in Manual mode, for safety purposes.

Scan-Sync

In Scan-Sync mode, both the power and timing of the laser output is synced to the input. In short, the output mirrors the input. In this mode, the power and timing knobs do not change anything.

NOTE: There is a 10 us delay between the analog input and output, due to the time it takes for the ADC to read a value (5 us), then write the value to the DAC (2 us), and then for the DAC to go to that value (0-4 us depending on magnitude of change).

Scan-Trig

In Scan-Trig mode, the timing of the laser is synced to the analog input, and is triggered on or off when the analog input rises above or falls below a set value. These set values can be changed in the Arduino code. The variables are in the "CONSTANTS" section and are named "syncOn" and "syncOff". By having two variables, this allows for hysteresis if necessary.

Power - The power can be adjusted from 0-100%.

Timing - The timing sets how long the laser stays on after the analog input rises above the set value, and can be set from 1 – 9972 ms, or "sync". When the knob is turned to the off detent position, the timing will switch to "sync" which means that the laser will be synced to the analog input. This means the laser will come on when the analog signal rises above the set value, and stay on until the analog signal falls below the set off value.

NOTE: There is a 5-9 us delay between the analog input and trigger, due to the time it takes for the ADC to read a value (5 us) and then for the DAC to go to the set value (0-4 us depending on magnitude of change).

Ext. Trig

In Ext. Trig mode, the timing of the laser is synced to the digital input (0-5V TTL), and is triggered on or off when the digital input is high or low respectively.

Power - The power can be adjusted from 0-100%.

Timing - The timing sets how long the laser stays on after the digital input goes high, and can be set from 1 – 9972 ms, or "sync". When the knob is turned to the off detent position, the timing will switch to "sync" which means that the laser will be synced to the digital input. This means the laser will come on when the digital signal goes high, and stay on until the digital signal goes low.

NOTE: There is a 1-5 us delay between the analog input and trigger, due to the time it takes for the trigger even to be recorded (1 us) and then for the DAC to go to the set value (0-4 us depending on magnitude of change).