YOON LAB
MICHIGAN ENGINEERING

NeuroNex MINT

OSC1 LITE

MANUAL

Request Sample Probes and OSC1Lite

V2.0.4

Warning: µLEDs are not ESD protected

About

OSC1Lite (OSC = Optical Stimulation Controller) was designed to drive µLED optoelectrodes[1] (see **Figure 1**), featuring 12 10x15µm LEDs (hence, µLED). µLED optoelectrodes are useful for optogenetic experiments requiring high spatial and temporal resolution (with simultaneous recording). The software for the system has been open-sourced[2], and the hardware is intended to be open-sourced soon.

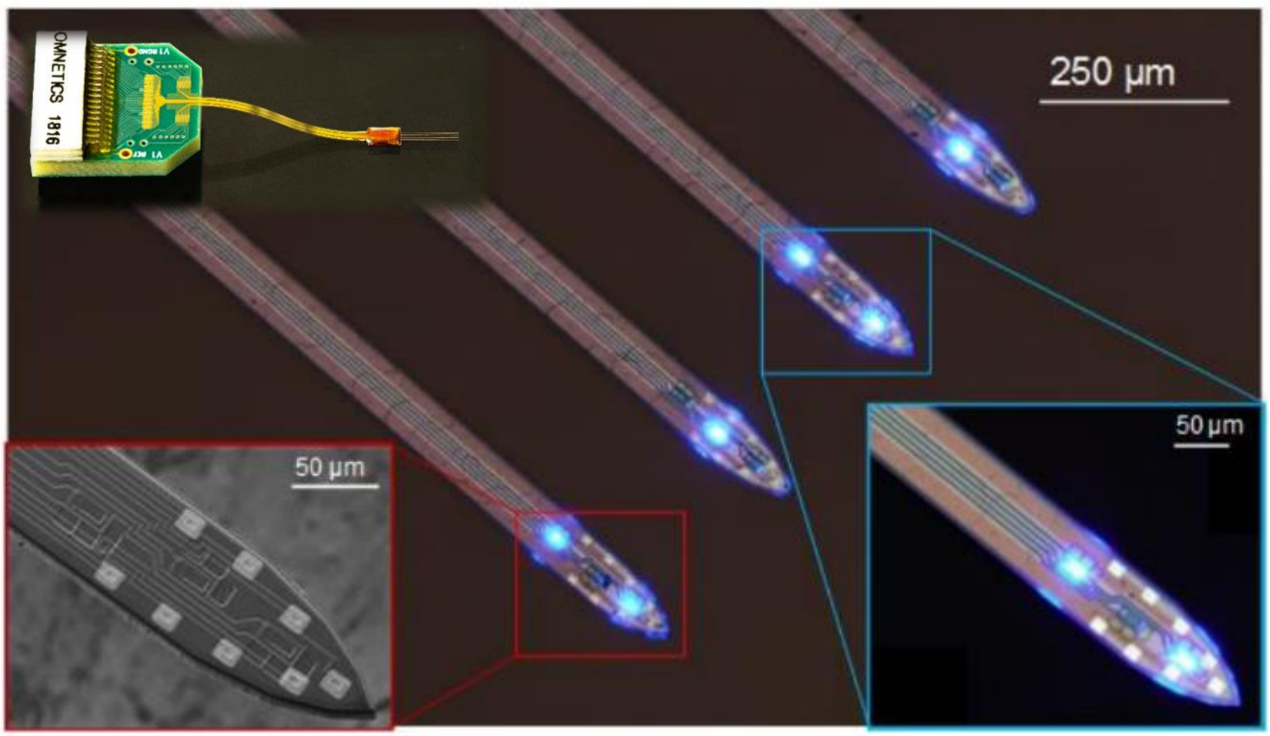

Figure 1. µLED optoelectrodes

System Specifications and Features

Table 1. OSC1Lite System Specifications and Features

	Min	Max
Current time step resolution	8 µs	
Current resolution	400 nA	
Current accuracy	1 µA[3]	400 nA
Current range	0	100 µA

[1] https://mint.engin.umich.edu/technology-platforms/#optoelectrodes
[2] https://github.com/YoonGroupUmich/osc1lite
[3] After 6 months

Zero-scale current[4]		0
Battery Life	12 hours	16+ hours
Trigger In		Yes
Trigger out		Yes
Individual waveform visualization[4]		Yes
Trapezoidal/square waveform[5]		Yes

System Setup

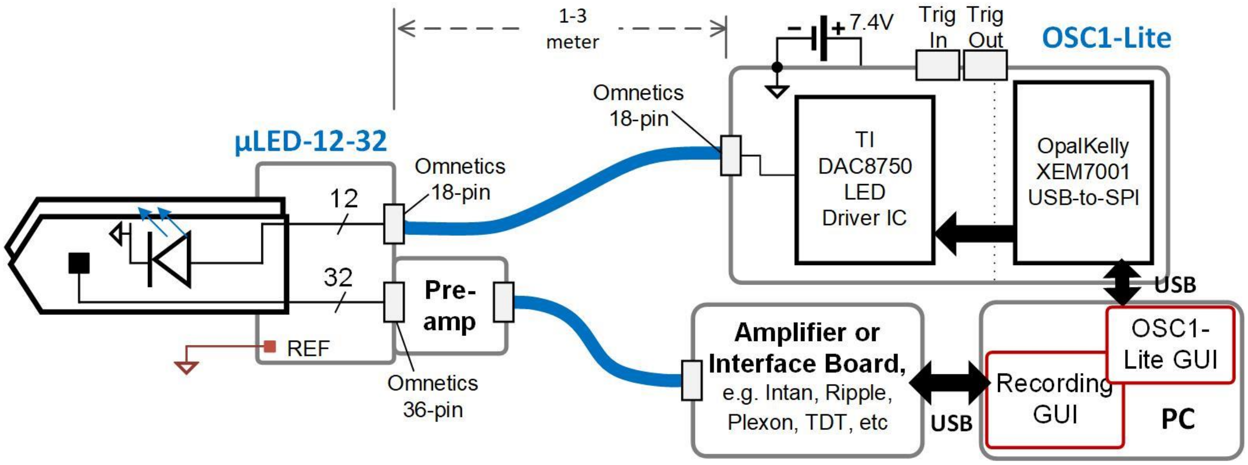

Figure 2. Typical system configuration with OSC1Lite

Included Items

1 OSC1Lite board
1 USB cable
2 18650 li-Ion batteries
1 18650 battery charger
1 Cable with 18-pin Omnetics connectors (1 meter long)

System Requirements

Windows 10 OS
Screen resolution above 1280x720

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[4] Output current when channel is set to 0uA (for example, during the off-phase of a waveform pulse). If you see LEDs lighting up when current is set to 0, either the LED is dead, or the channel has malfunctioned. Send an email to ContactMINT@umich.edu for resolution.
[5] Custom waveform and multi-waveform visualization coming soon

Software Installation

The GUI source code can be found at the osc1lite GitHub page[6].

Step 1 Install the Opal Kelly USB driver **version 4.5.6 or later**, FrontPanelUSB-Win-x64-4.5.6.exe. Note: you may have to reboot your computer for this to take effect. **FrontPanelUSB 4.5.5 will not work[7].**

Step 2 Download and unzip oscgui-win64.zip. Open the GUI by running oscgui.exe.

Hardware Setup

Before setup, please be aware that when the batteries have low charge, the green ON LEDs will turn off, indicating that you must recharge the batteries. Please also make sure that the switch on the Opal Kelly is set to "USB", not "EEPROM". Additionally, if the epoxy on the Omnetics connector is not opaque and brown, it has not been cured --contact MINT for a repair.

Step 1 Charge both batteries using the provided charger, then insert them into the battery holder on the bottom of the PCB (**Figure 3**). Notice the orientation of the +/- indents on the battery holder, as well as the positive terminals (indented) on each battery in **Figure 3**. Please do not drop OSC1Lite, as the batteries may fall out. Please read the user manual for the battery charger and adhere to all the cautions and warnings (**lithium ion batteries are extremely dangerous if not properly handled**).

[6] https://github.com/YoonGroupUmich/osc1lite

[7] For example, OSC GUI might attempt to connect to an Intan Opal Kelly board if using 4.5.5

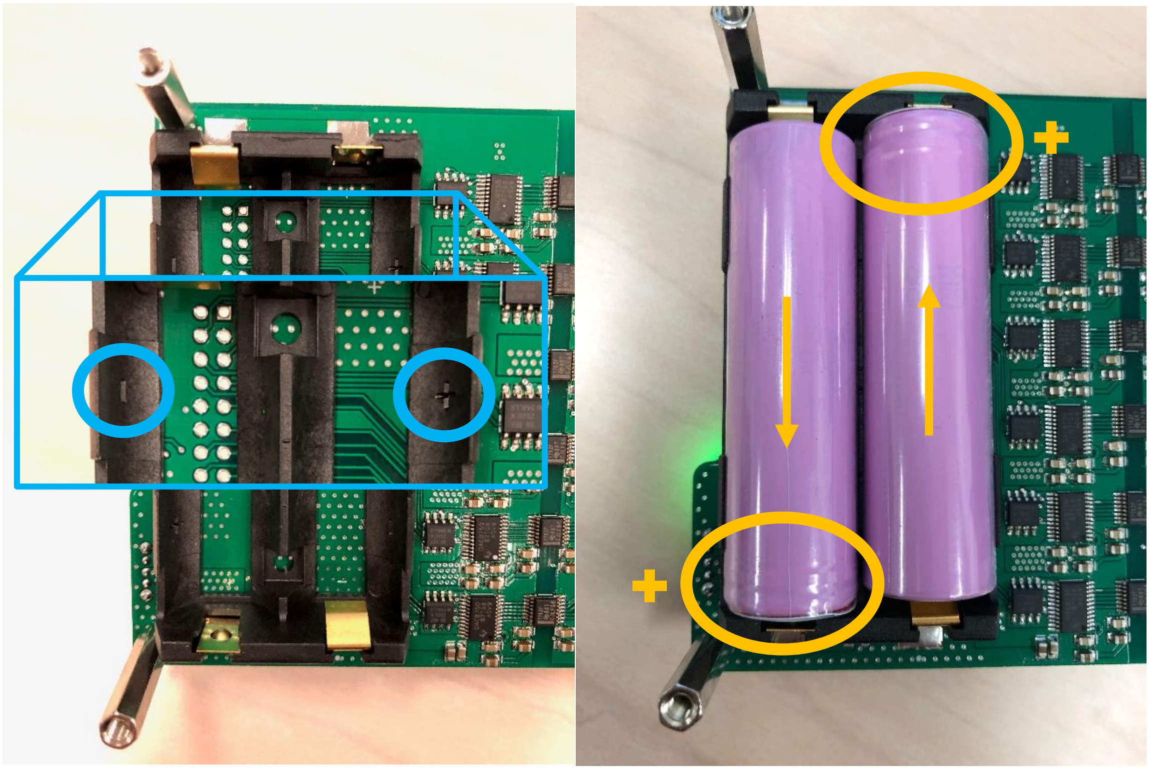


Figure 3. Bottom of OSC1Lite board (right: two 18650 batteries installed)

Step 2 Flip the switch on the bottom right of the board (**Figure 4**). Two green LEDs should turn on. If you do not see any LEDs turn on:

1. Please ensure the batteries are charged, installed firmly, and in the correct orientation
2. Try pushing the batteries in the direction of the yellow arrows in **Figure 3**.
3. Try bending the battery holder's metal clips on the negative terminals in the direction of the yellow arrows

Step 3 Connect your computer to the Opal Kelly board using the USB cable provided (**Figure 4**). Take note of the last 3 alphanumeric characters of the Opal Kelly module as seen next to the barcode (**Figure 4**). Run the open source software and ensure that all channels are OFF (see GUI usage below). Make sure the switch is set to USB, not EEPROM (**Figure 4**).
Step 4 Connect the 18-pin Omnetics cable provided to the board (subsequently grounding the cable, hence avoiding ESD from the cable to the probe)[8].
Step 5 Connect the (no-longer-floating) 18-pin Omnetics cable to the probe.
Step 6 Connect OSC1Lite ground to the recording ground of the system (typically to the ground of an Intan RHD2000 USB board).

[8] It is recommended to "wiggle" the connector horizontally back and forth to connect/disconnect the Omnetics cables.

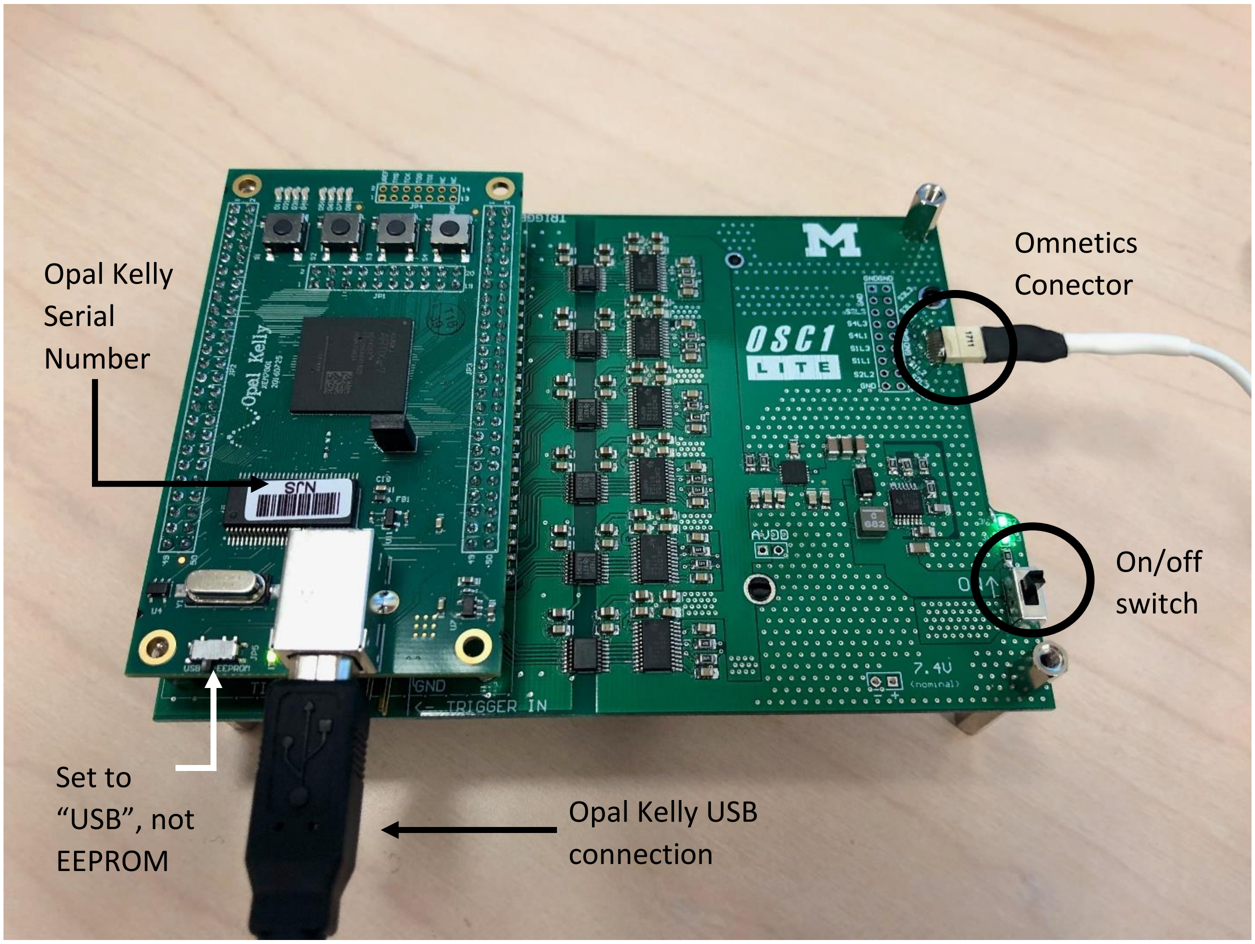


Figure 4. Top of OSC1Lite board

GUI Usage

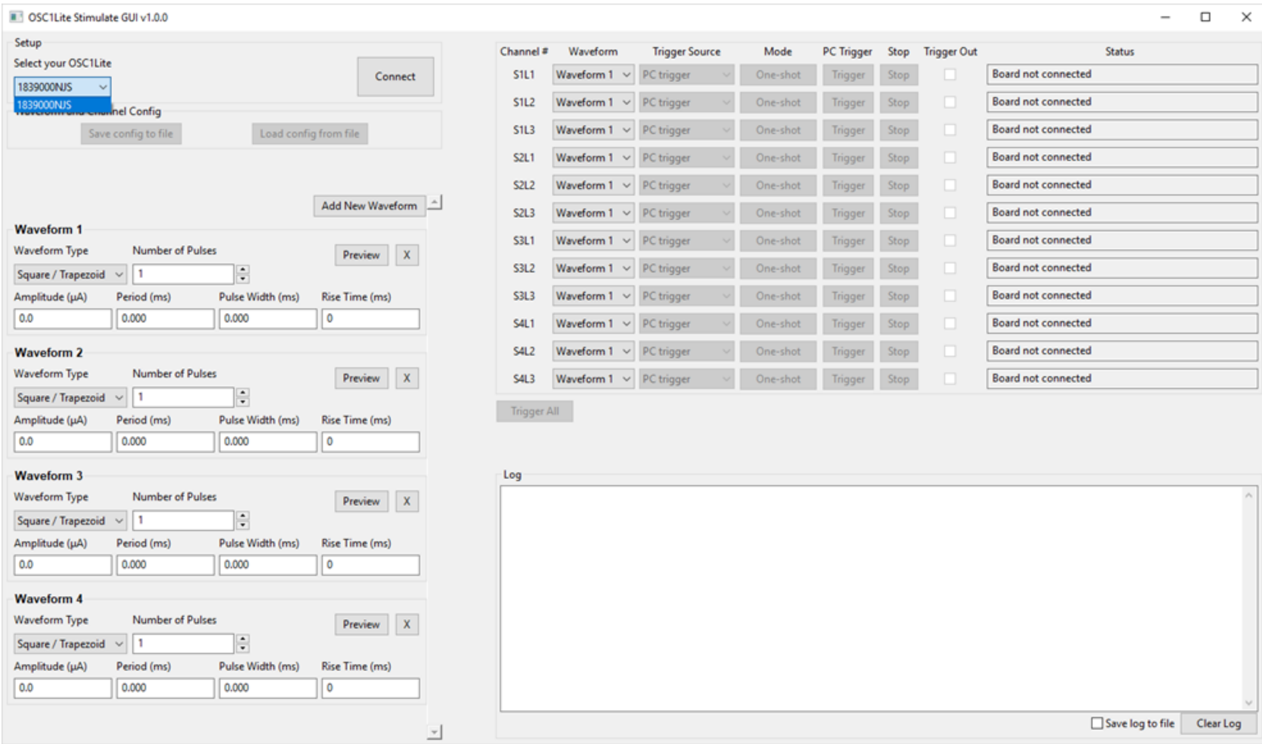
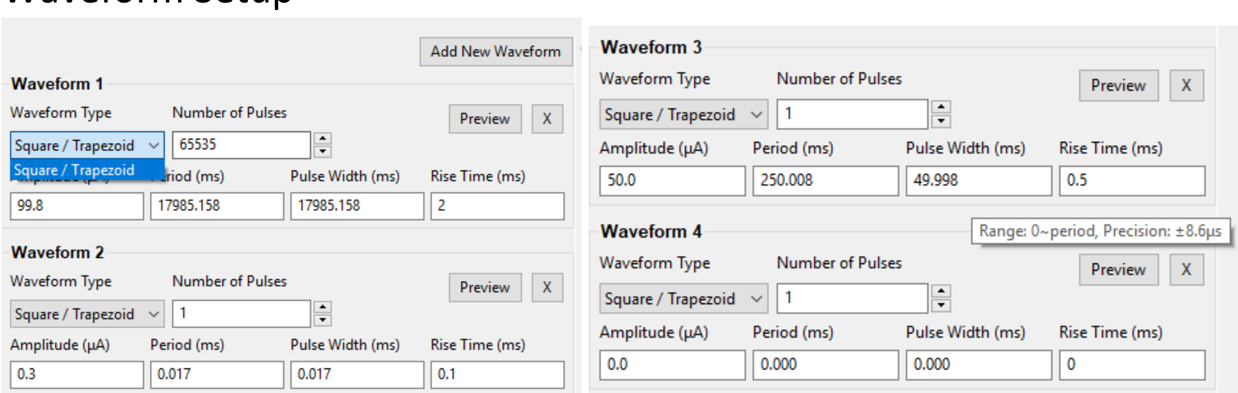


Figure 5 OSC1Lite GUI

The first step to complete upon opening the GUI is selecting which Opal Kelly to connect with. A "drop-box" of all connected Opal Kelly devices (connected via USB cable) (**Figure 5**) allows you to select your Opal Kelly based on its serial number. The last 3 alphanumeric characters of the Opal Kelly module can be seen next to the barcode of the Opal Kelly module (**Figure 4**). If you do not see your Opal Kelly device:

1. Please ensure the green LED beside the USB connector on Opal Kelly board is on,
2. Check if the board is being used by other software, for example another OSCGUI.

Waveform Setup



Warning: µLEDs are not ESD protected

Figure 6 Waveform parameters

At the moment, only square/trapezoidal waveforms are available. You can paramterize these in as many waveforms as you'd like by adding more waveforms via the 'Add New Waveform' button. Hover over parameters to see their valid ranges. Warning: when a new parameter is entered, all channels affected are paused, awaiting re-trigger. Custom waveform and multi-waveform previews are coming soon.

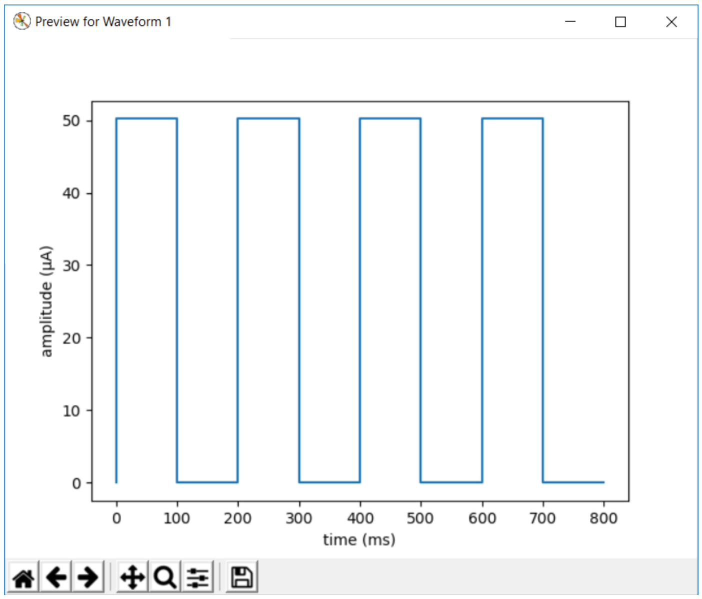


Figure 7 Waveform preview

Table 2 Valid waveform parameter ranges

Parameter	**Valid Range**	**Precision (nominal)**
Waveform Type	Square / Trapezoid	
Number of Pulses	Integers from 1 to 65535	
Amplitude	0 to 100 (µA)	±0.31µA
Pulse Width	0 to 17,900.000 ms	±8.6µs
Pulse Period	0 to 17,900.000 ms	±8.6µs
Rise Time	0, 0.1ms, 0.5ms, 1ms, 2ms	

Calibration

Each board is calibrated at the Yoon Lab. If you believe your board is outputting incorrect current beyond the specifications please send an email to ContactMINT@umich.edu for re-calibration.

Channel Control

Channel to LED mapping

Each channel has a corresponding ‘Channel #’ (see **Figure 5**) to indicate which LED on the probe the channel is stimulating. For example, S1L1 corresponds to shank 1, µLED 1, as seen below in **Figure 9**.

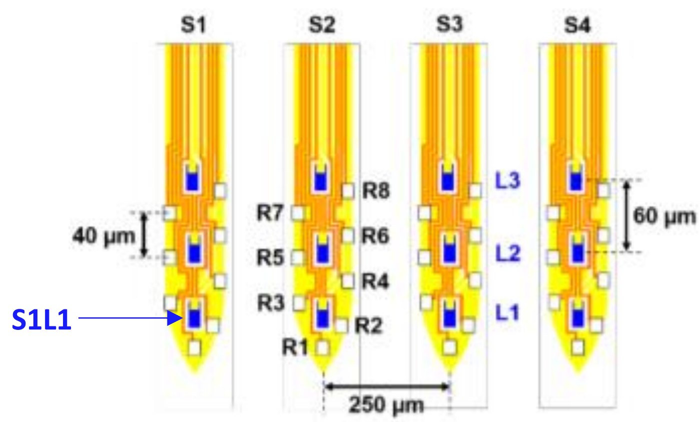


Figure 9 Optoelectrode LED map

Waveform selection

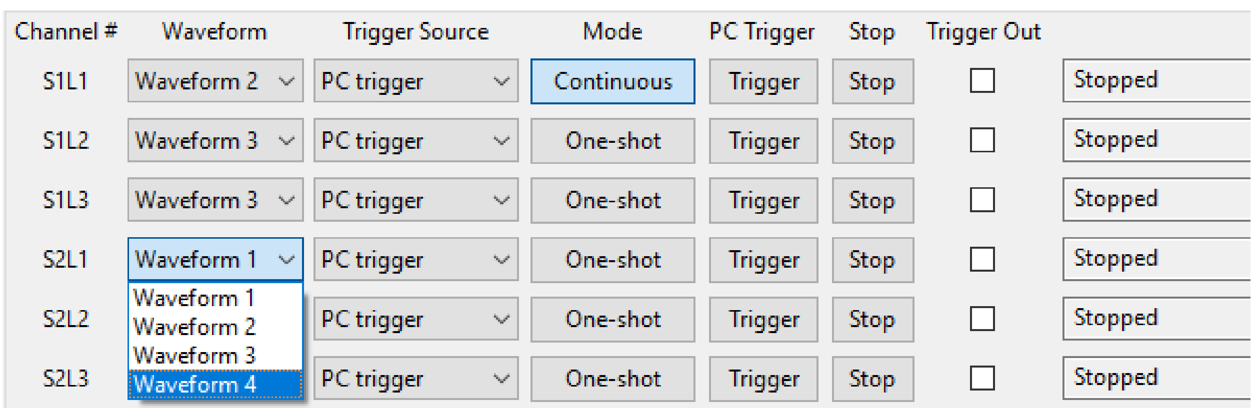


Figure 10 Waveform selection

Assign any waveform to any channel. Warning: selecting a new waveform will pause that channel.

Trigger source

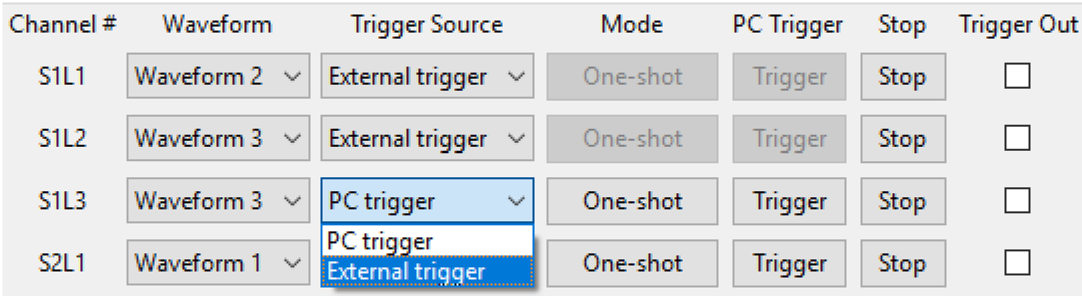


Figure 11 Trigger source

Select how channels should begin stimulation:

1. PC trigger: the channel shall start stimulating upon clicking the "Trigger [All]" button
2. External trigger: the channel shall start stimulating whenever a TLL (3.3-5V OK) is seen on the corresponding **Trigger In** pin (see **Figure 12** below).

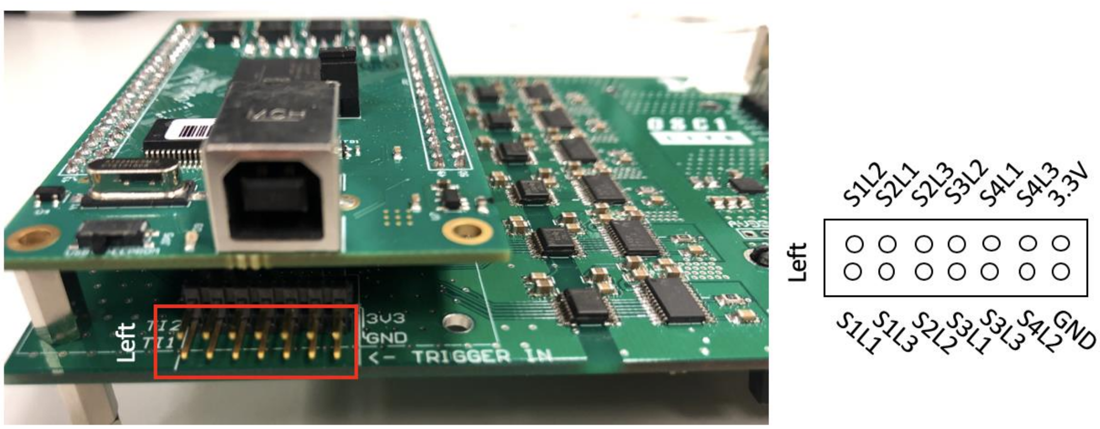


Figure 12 Trigger in pins

To stop stimulation on a channel, click the corresponding "Stop" button. Otherwise to stop all channels, disconnect from the board.

Channel mode

1. One-shot: stimulation stops after the # of specified pulses are sent on the channel
2. Continuous: stimulation continues indefinitely (nominally)

Trigger out

When this box is selected, a TTL pulse (with the same width as the waveform width) is sent out on the corresponding pin (see **Figure 13** below).

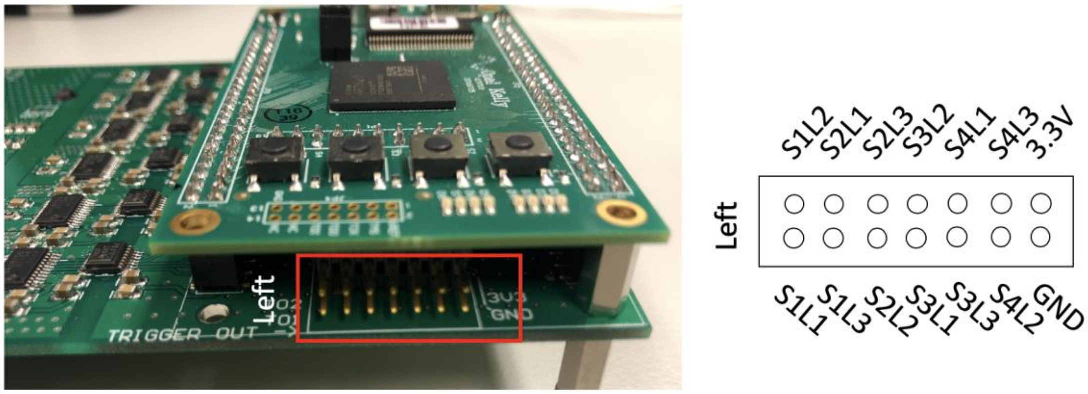


Figure 13 Trigger out pins

Channel status

Each channel may indicate a unique status, as outlined below in **Table 3**.

Table 3. Channel status descriptions

Status	Description
Board not connected	The board is not connected to the GUI. Click the 'Connect' button on GUI.
Stopped	The channel is outputting 0 current.
Normal	The channel is sending the waveform.
Alarm	The alarm will provide explicit error information. Please refer to **Table 4**.

Table 4. Alarm descriptions

Alarm	Description
DAC open circuit or compliance voltage violation	There is an open circuit or a compliance voltage violation in IOUT loading. The user can check the circuit and wire connection.
DAC die temperature over 142 degC	The DAC die temperature is over 142°C. The user can restart the whole system.
DAC code is slewing	DAC code is slewing as determined by SRCLK and SRSTEP. The user can restart the whole system.
DAC watchdog timer timeout	There is watchdog timer timeout. The user can restart the whole system.
DAC SPI CRC error	There is CRC error on SPI frame. The user can restart the whole system.

Troubleshooting

If you have any questions, please make sure you've read this manual as well as the µLED datasheet. You can then post a question on our google group, only after searching for a similar question. If no one responds within a few days, then feel free to send an email to ContactMINT@umich.edu.

Dead channels and alarms

If any of the alarms on a channel are persistent, try checking the health of the LED (see below). One way to test if channels are operating correctly is by setting non-zero parameters (amplitude, pulses, pulse width, period) and triggering all channels with no probe attached –All channels should indicate "Open Circuit" –Any channel that indicates "Normal" is not operating correctly. If this happens send an email to ContactMINT@umich.edu for resolution.

Dead µLEDs

See our google group. OSC1Lite has been tested on µLED optoelectrodes which have survived overnight stimulation of 100, 200 and 300 µA of current (12 hours continuously). However, µLED failure does occur; MINT is currently working on performing longevity testing and characterization to better understand and improve µLED optoelectrode durability and performance.

Noisy µLEDs (stimulation artifact)

See our google group. Recently we have introduced a grounded metal layer for shielding the recording traces from the stimulation traces on the probe, which significantly reduces the stimulation artifact. However, there are some µLEDs that seem to couple to every channel –we are working to find the root cause and fix it.

Calibration

Each board is calibrated at the Yoon Lab. If you believe your board is outputting incorrect current beyond the specifications please send an email to ContactMINT@umich.edu for re-calibration.