Opto Stim Ware

Wireless Optical Stimulation
User's Manual

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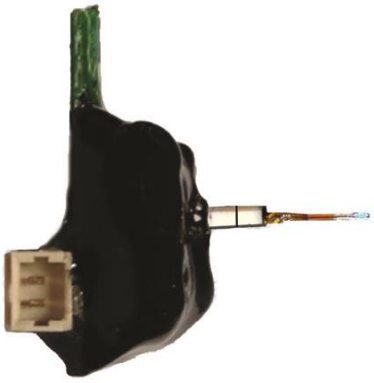
Document Overview

This document will demonstrate how to use the TBSI OptoStimWare hardware and software. The program controls a single 2 channel headstage that allows researchers to generate and download two separately customizable waveform patterns via a wireless USB dongle. The headstage is battery operated therefore only needs to be connected to the charging plug for recharging.

Shipped Items List

- 2 Channel Optogenetic Stimulation Headstage
- OptoStimWare Installation CD
- USB Dongle
- Headstage charger
- Trigger Cables
- Optrode

Headstage



USB Dongle

Optrode

Trigger Cables | Charger | Installation CD

Figure 1: Images of Items

Headstage Pinout

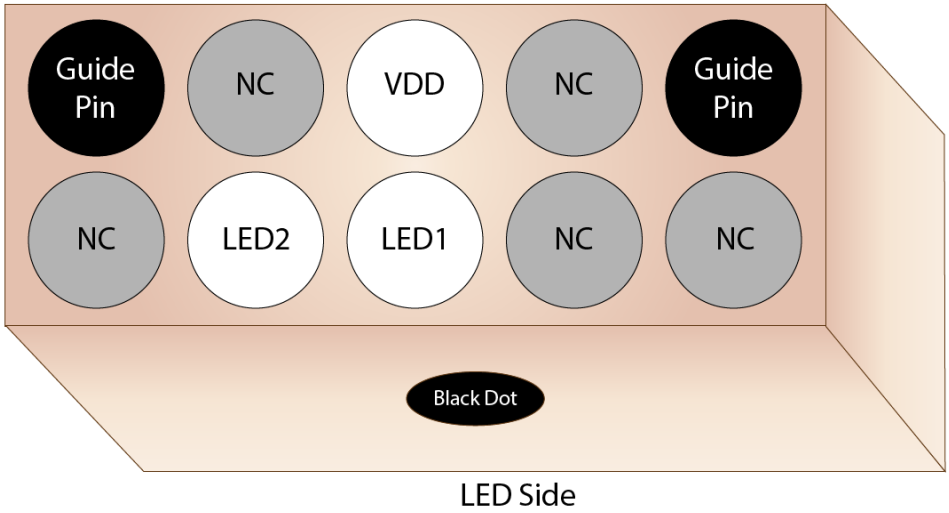


Figure 2: Pin Mapping

LED Optrode Diagram

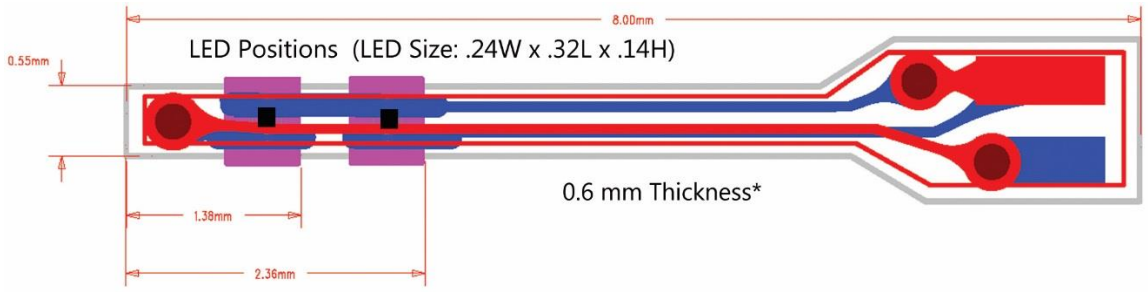


Figure 3: LED Optrode Diagram

*Also Available in 4mm Length

Mating Connector

- Omnetics A70010-801

Hardware Installation

1. Screw the USB Dongle Antennae onto the USB Dongle.
2. Connect the LED Optrode to the Headstage ensuring the alignment of pins and omnetics logo.
3. It is recommended to charge the Headstage until the indicator light on the Charger goes from red to green.

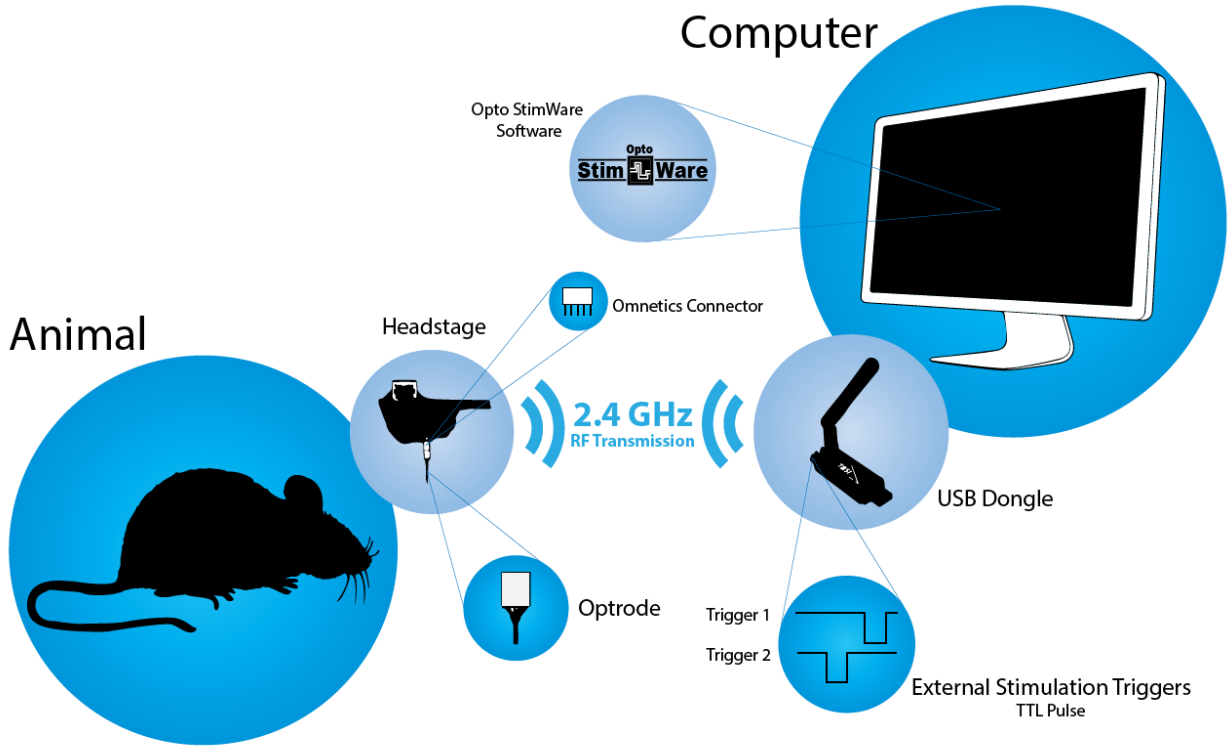


Figure 4: System Setup Diagram

Software Installation

Minimum System Requirements

- At least 1.0 GHz Processor
- 2 GB of storage memory
- 1 GB RAM
- (1) USB 2.0 port
- Windows 7

OptoStimWare Installation

To install and run OptoStimWare:

1. Insert the OptoStimware® installation disc into your computer. Navigate to OptoStimware Installer folder within the installation disc and double click setup.exe, then follow the prompts until installation is complete.

2. Navigate to the *Silabs-CDC_Install* folder within the installation disc and double click *Silabs-CDCInstaller_x64.exe* if Operation System is 64bit or *Silabs-CDCInstaller_x86.exe* if Operation System is 32bit, then follow the prompts until installation is complete.

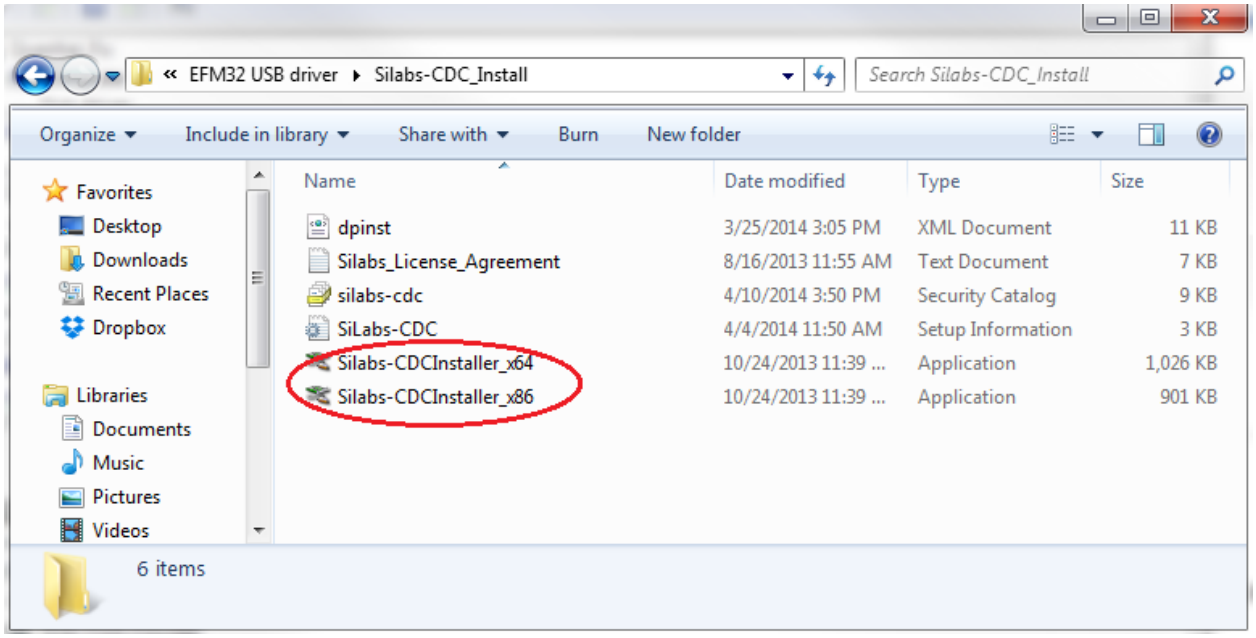


Figure 5: Select dongle driver

3. Plug the USB dongle into PC. **Silicon Labs CDC Serial port** driver will be installed.

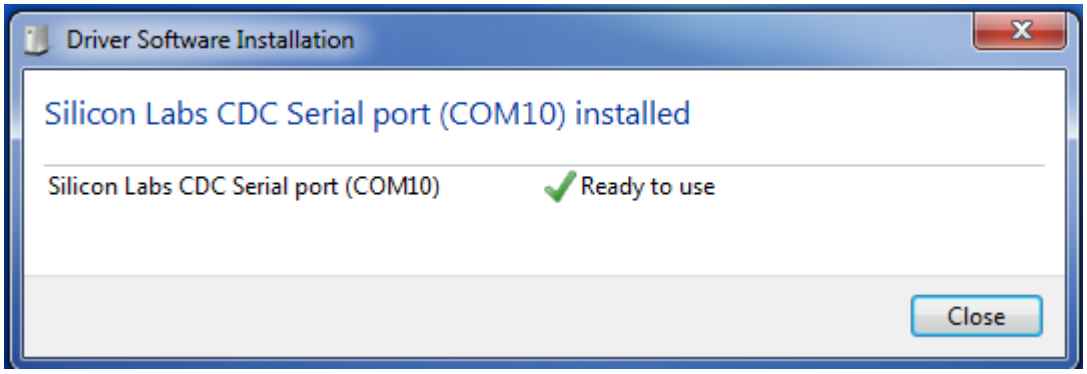


Figure 6: Dongle driver installation done

4. Right click on "My computer" and select "Manage" to open the Device Manager. If you do not have "My computer" on your desktop click the start button then right click on "Computer" and select "Device Manage". Dongle should be indicated by "**Silicon Labs CDC Serial port** (COM#)" under "COM and LTP"

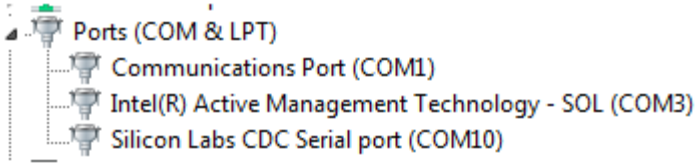


Figure 7: Information in Device Manager

Software Navigation

Launch the OptoStimware software application. OptoStimware is in '**Run**' mode once launched.

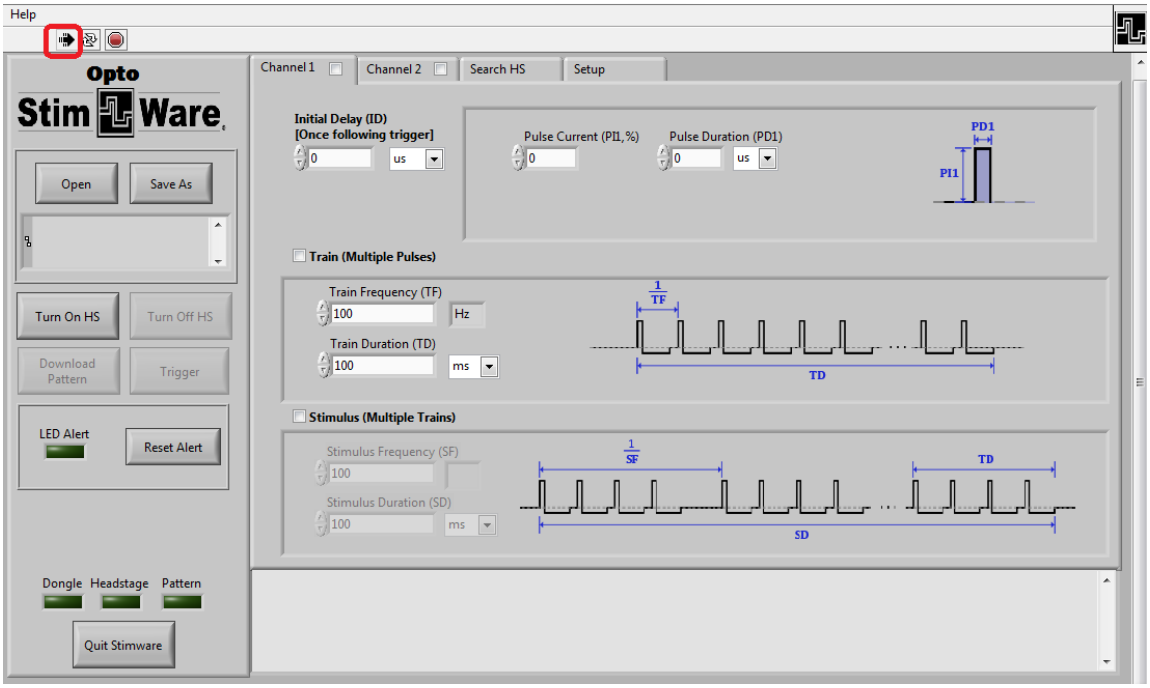


Figure 8: OptoStimWare Launch Screen

Loading/Saving Configurations

Default parameters are loaded into OptoStimWare from the configuration (.ini) file located on your computer:

➔ *C:\2Ch OptoStimware\Default Config File OptoStimware.ini*

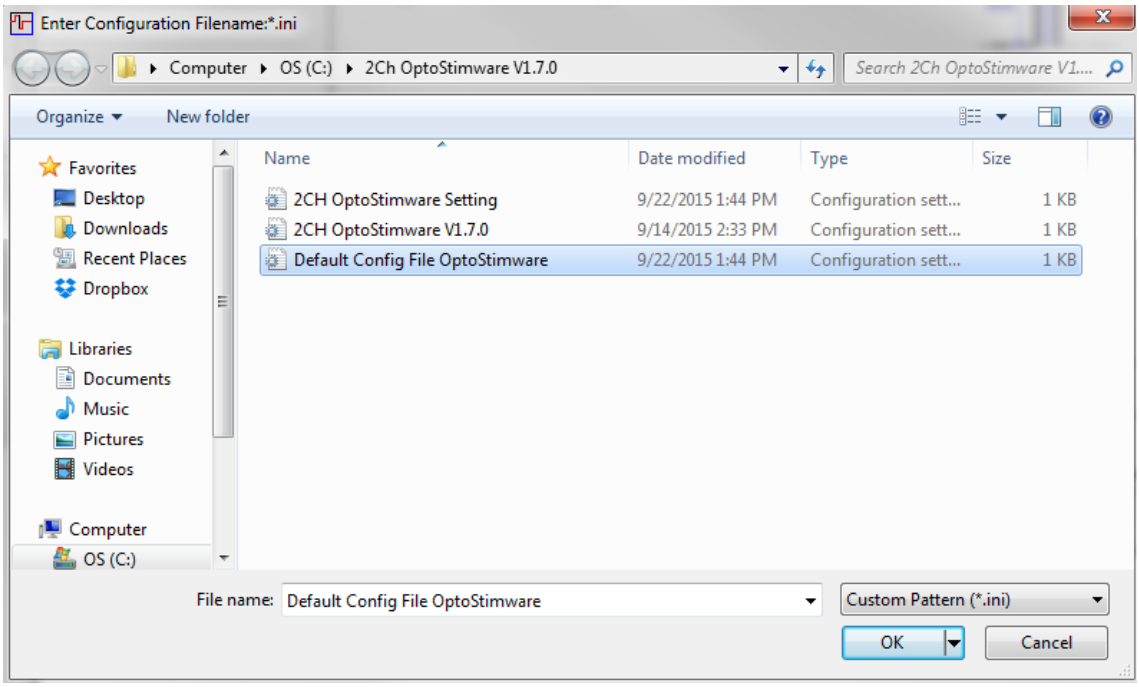


Figure9: Loading Configuration File

Customized pattern parameters can be saved by pressing the 'Save As' button. The new configuration file, by default, will be saved to *C:\2Ch OptoStimware*

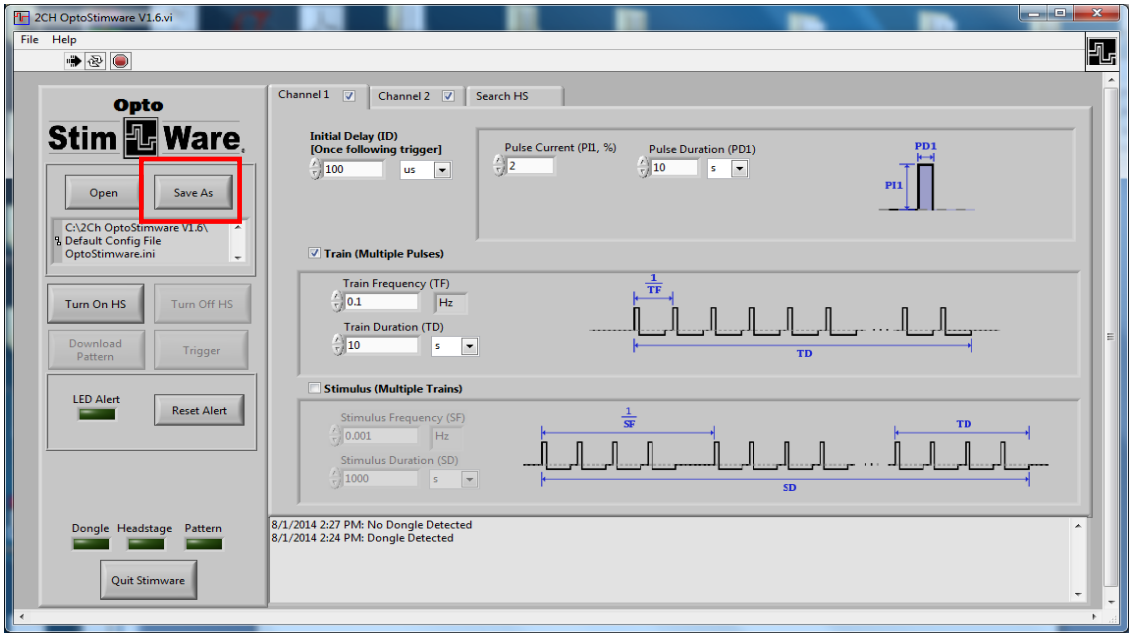


Figure 10: Saving Parameters

Programming the Stim Channels

The two stim channels can be enabled and programmed separately from each other. To enable a channel, select the checkbox next to its name. A channel that is unchecked will not output any signal, so it may be advantageous to disable an unused channel to conserve battery life.

In the screen under the "Channel" tab you will see the items that define the stim pulse by setting the following settings:

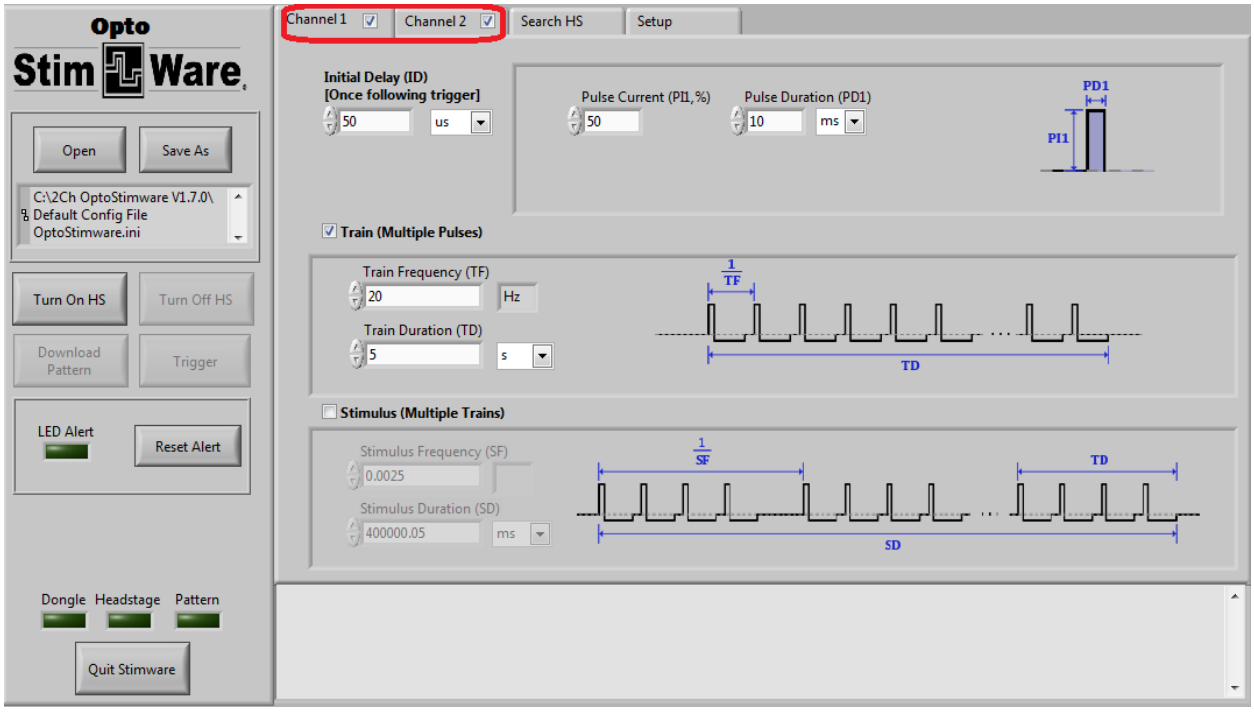


Figure 11:Distinguishing Separate Channels

The graphics in the OptoStimWare interface are intended as conceptual references and do not reflect the actual pattern set by the user-defined parameters.

"Initial Delay (ID)"

ID is the user defined delay between the trigger, and the start of the stimulation pulse. In most circumstances this should be set to the minimum which is 50uS. It can, however, be used to stagger the stim channels so that only 1 channel is stimulating at a time.

"Pulse Current (PI1, %)"

PI is the amount of current driven through the OPTRODE LED. The lower the PI, the less current is driven through the LED. The dimmer the LED Illuminates. 100% = 13.32 mW at 10 mA

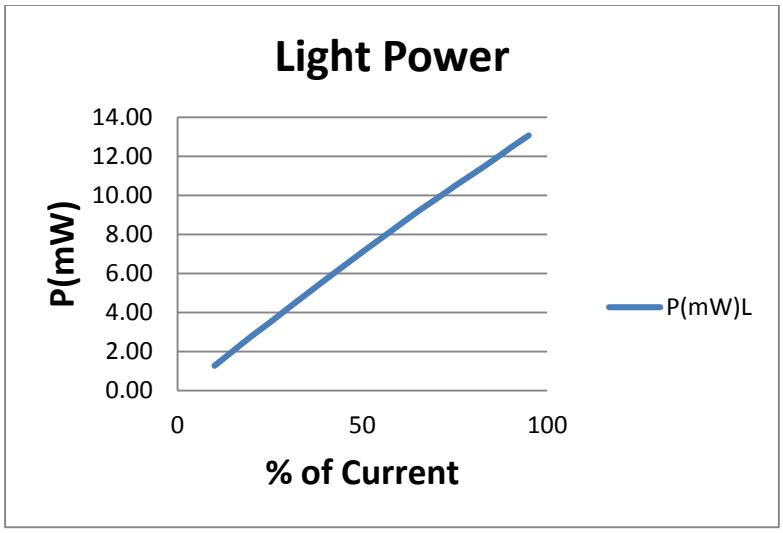


Figure 12: Power by Current Percentage Graph

"Pulse Duration (PD1)"

PD is the time that the LED is "on". The shorter the PD, the less current is driven through the LED over whatever period of time that is set by the TF. Together PD and TF make up the Duty Cycle that the LED is driven. The greater the Duty Cycle (the longer the PD) the brighter the LED will illuminate.

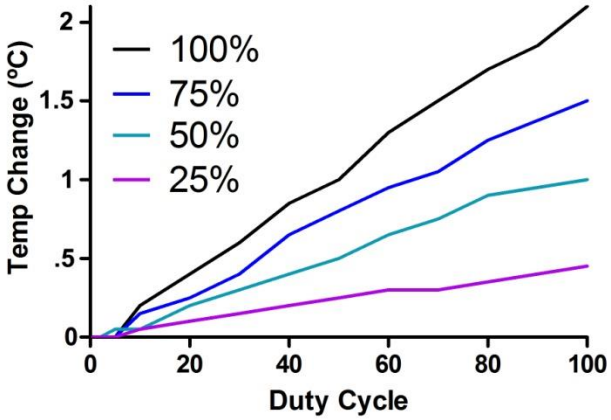


**Figure 53: Temperature by Duty Cycle Graph*

"Train Frequency (TF)"

TF sets the number of individual pulses that occur per second and is measured in Hz. Hz= 1/Time

"Train Duration (TD)"

TD sets the total duration of stimulation event and is measured in microseconds, milliseconds, or seconds.

"Stimulus (Multiple Trains)"

SF or Stimulus Frequencyis actually the length of time from the start of the Train, to the end of 1 cycle. By setting this number low relative to the train duration (low because it is the reciprocal of time), you can create a blank period between stimulation trains.
SF <= 1/TD or Train Duration. Example: If TD = 5S, SF can be equal to or less than 0.2Hz.

Certain parametric limitations are programmed into the software to ensure signal consistency and prevent saturation of the headstage amplifiers. If a parameter has exceeded its allowed range (ex. current percentage is too high), it will automatically be reset to its highest allowed value. **PI1 range is 1% to 100%. Typical current for the LED is from 5mA to 10mA. Current for custom LEDs can be as high as 50mA.**

*Rossi MA, Go V, Murphy T, Fu Q, Morizio J, Yin HH (2015). A wirelessly controlled implantable LED system for deep brain optogenetic stimulation. Frontiers in Integrative Neuroscience 9(8), 1-7.

System Setup and Testing

1) Connect USB Dongle to computer

Open the OptoStimWare program application. If the dongle is successfully recognized by your computer, the '**Dongle**' LED will illuminate in OptoStimWare.

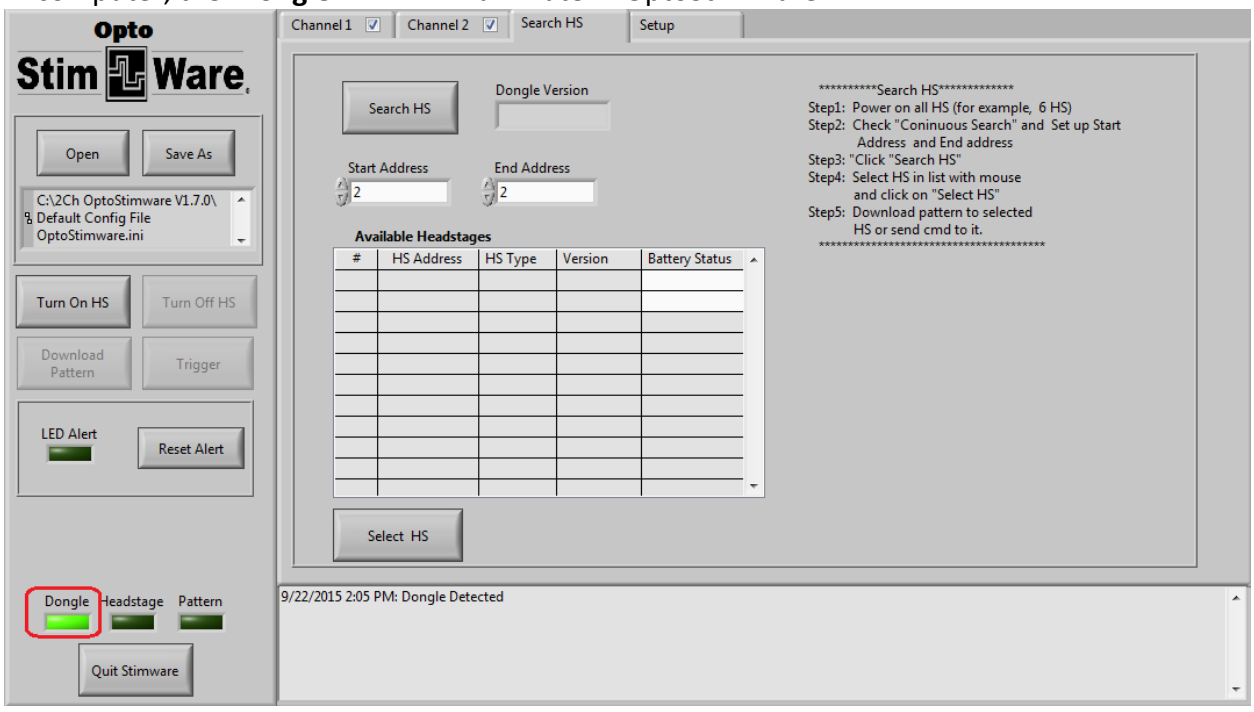


Figure 64: Dongle Recognition

2) Search and Turn 'ON' Headstage

Once the headstage is charged; Click the **'Search HS'** tab**.** Press the **'Search HS'** button on that window and you will see your headstage # under **'Available Headstages'**. Once your HS is visible, press the **'Select HS'** button or "**Turn On HS**" and the green **'Headstage'** light at the bottom will illuminate and turn on Headstage.

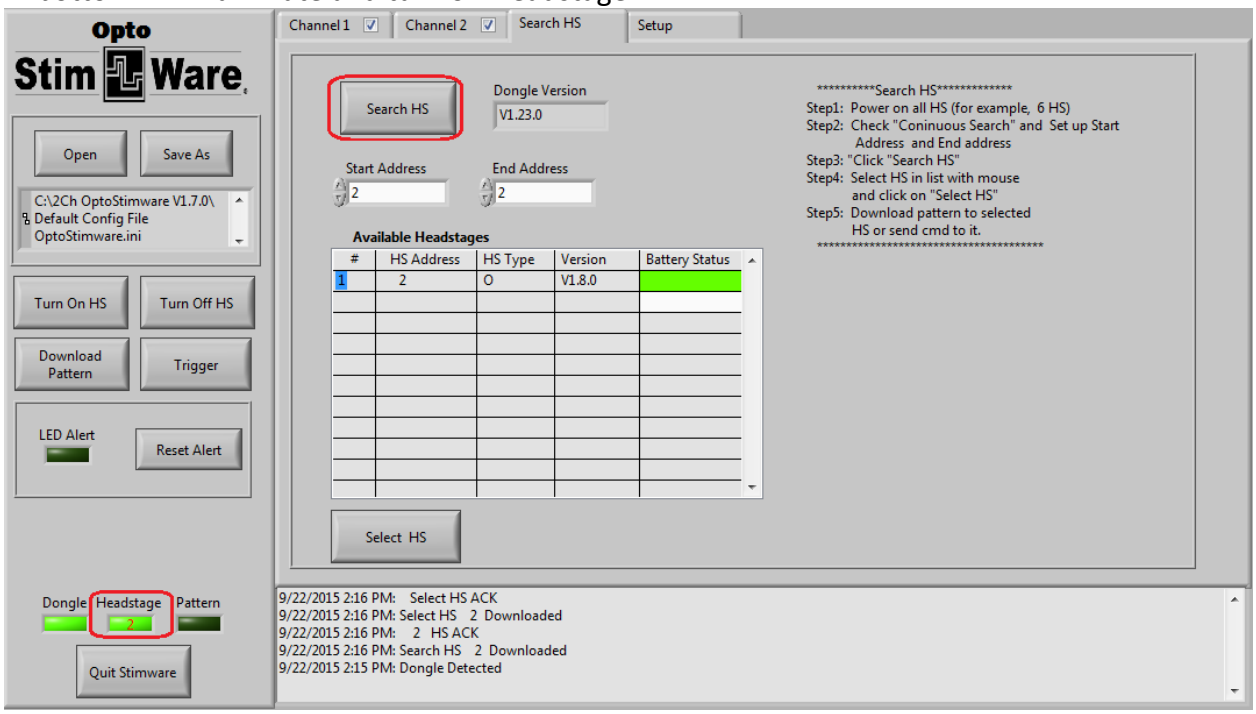


Figure 7:Search and Select Headstage

Multiple Headstage

If you have multiple headstages with different address, you will be able to control each headstage with OptoStimWare. At one time, dongle can only communicate with one headstage. Once the headstages are charged; Set up 'Start Address' and 'End Address' based on headstage's address range ; Click the 'Search HS' tab; Press the 'Search HS' button on that window and you will see your headstage listed in 'Available Headstages' table. Once your headstages are visible, click on headstage '#' that you want to control with mouse ;Press the 'Select HS' button .The green 'Headstage' indicator at the bottom will illuminate and elected headstage address will be shown right inside indicator.

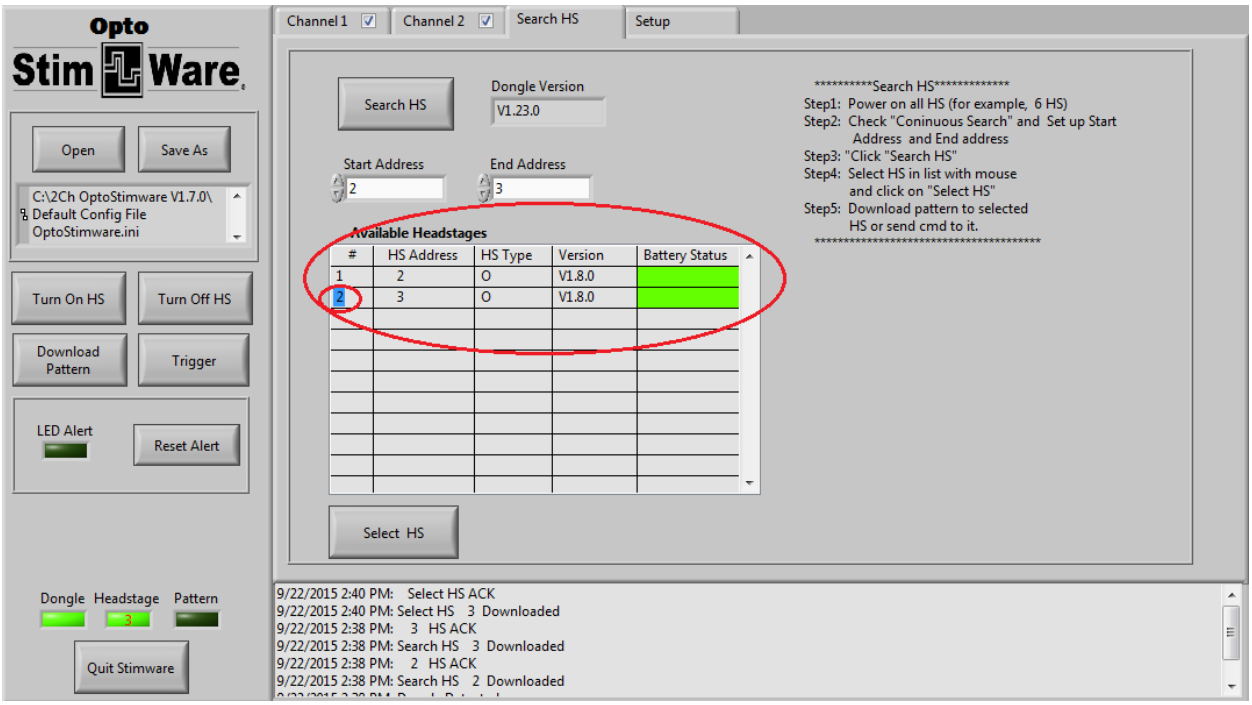


Figure16: Multiple Headstage Detection

3) Generate and download pattern in OptoStimWare

Choose the stim signal parameters you wish to download to the headstage. (Refer to the **Programming the Stim Channels**section of this document for more pattern programming instructions.) When finished, click the '**Download Pattern**' button to send the pattern data to the headstage.

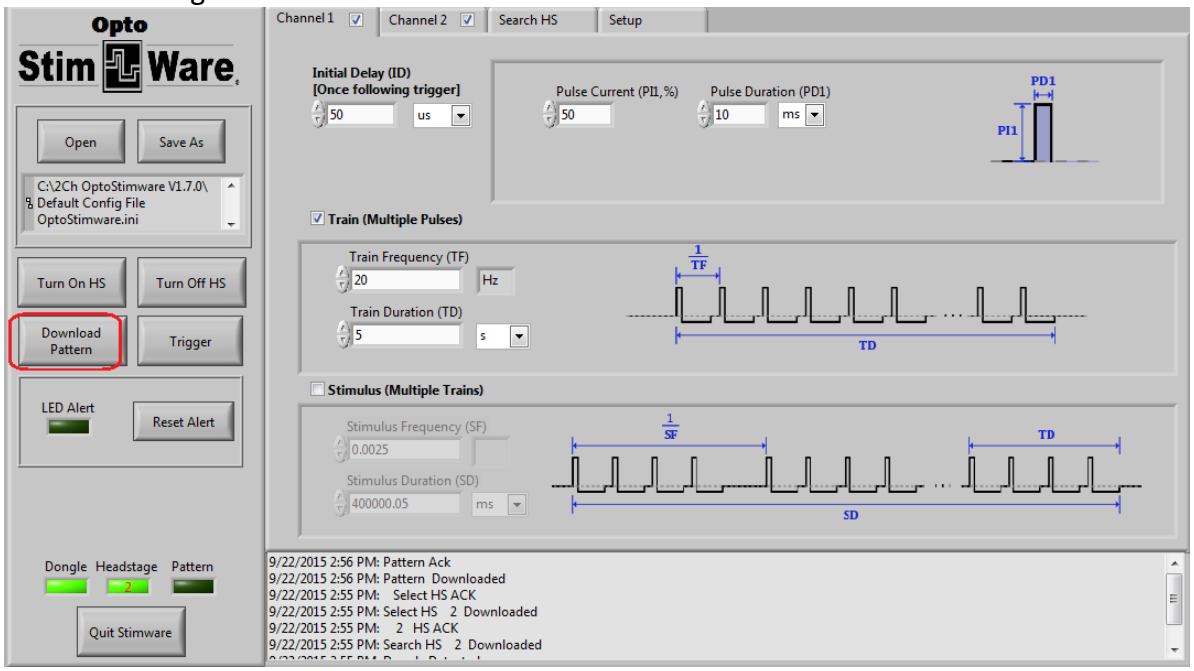


Figure17:Download and Trigger Illumination Pattern

3.1) Software Trigger

Press '**Trigger**' to start the pattern. The '**Pattern**' light will illuminate and blink while the pattern is running and will stop blinking when pattern is over.

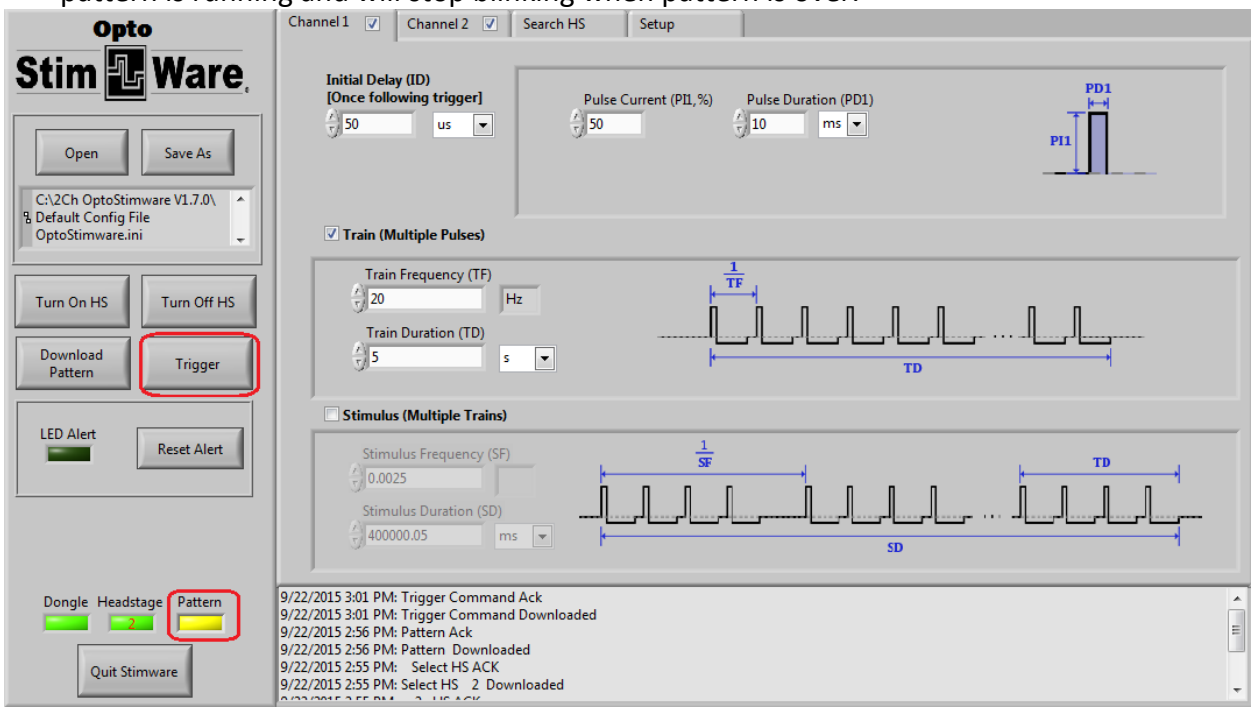


Figure 88: Triggering Pattern

3.2) External Trigger

Two external triggers are supported. As Figure1 shows, one end of trigger cable can be plugged in dongle and the other end are two bare wires that can be connected with external system in which external trigger signals are generated. Red wire is external trigger signal whose voltage is up to 5V. Black wire is ground and should be connected with the ground of external system.

All external trigger settings are located in "**Set up** " tab of StimWare as Figure16 shows. Either rising edge or falling edge can be selected as active trigger edge. The channel should be disabled to avoid false trigger when you finish experiment or when you don't use external trigger. Trigger setting won't take effective until you click "**Set Up External Trigger**" button.

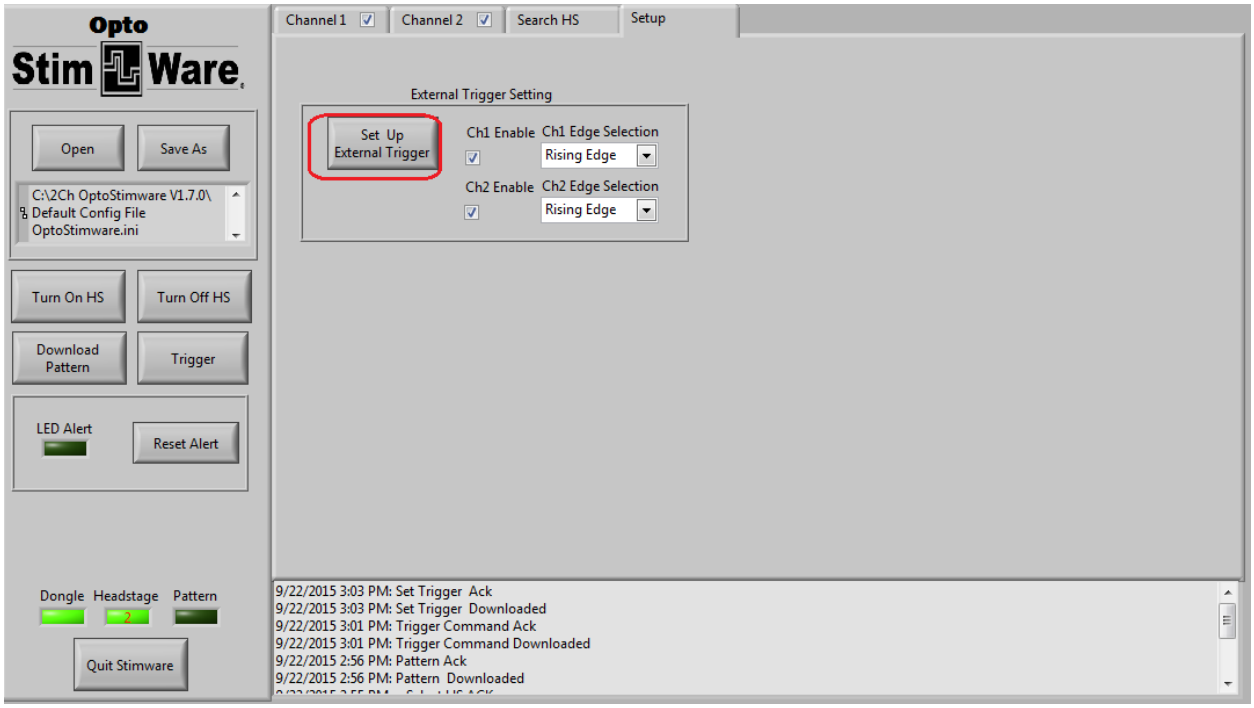


Figure 19: External Trigger Setting

When valid external trigger is detected, it will trigger the pattern loaded in headstage. '**Trigger Cable#**' will show up in log window and **Pattern** indicator starts blinking as Figure17 shows.

Figure 20: External Triggering

- **Rising edge active**

If **Rising Edge** is selected in "**Ch# Edge Selection**", the rising edge of external trigger signal will trigger pattern. If the positive pulse T1 is more than 4ms, it's regarded as valid trigger. The pattern will start after delay T2. If the positive pulse T1 is less than 4ms, it's regarded as false trigger and ignored and the pattern won't start. T3 is interval between the end of pattern and the next coming trigger edge. Users should set up the reasonable pattern duration by considering T4, which is interval between the two consecutive trigger pulses.

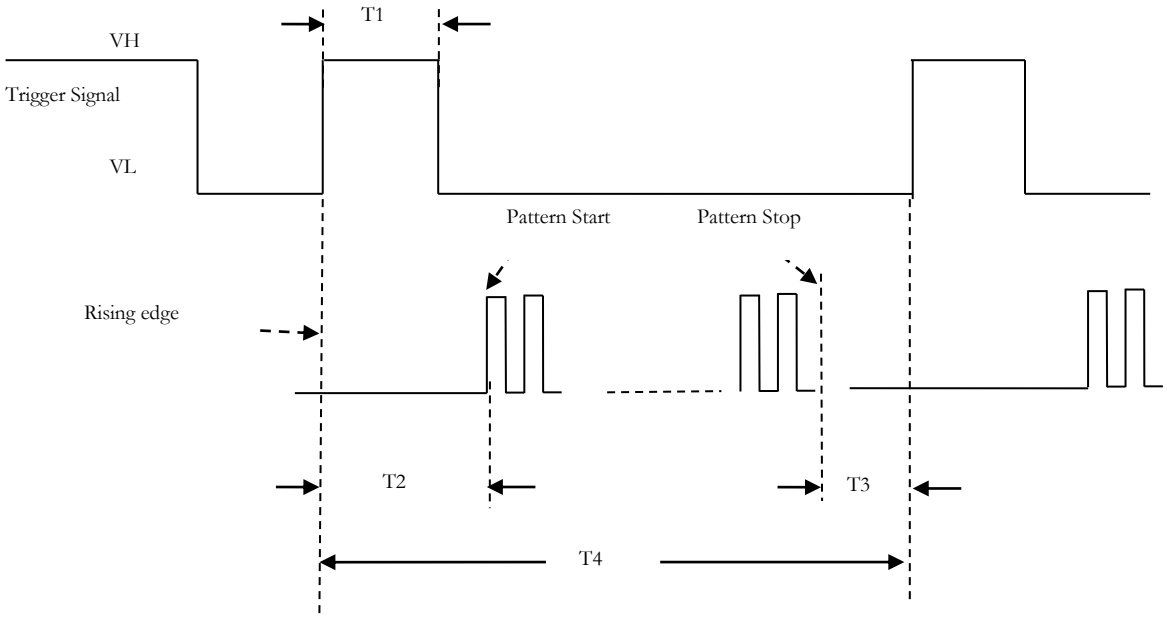


Figure 21: External Trigger Rising Edge Active

- **Falling edge active**

If **Falling Edge** is selected in "**Ch# Edge Selection**", the falling edge of external trigger signal will trigger pattern. If the negative pulse T1 is more than 4ms, it's regarded as valid trigger. The pattern will start after delay T2. If the negative pulse T1 is less than 4ms, it's regarded as false trigger and ignored and the pattern won't start. T3 is interval between the end of pattern and the next coming trigger edge. User should set up the reasonable pattern duration by considering T4 ,which is interval between the two consecutive trigger pulses.

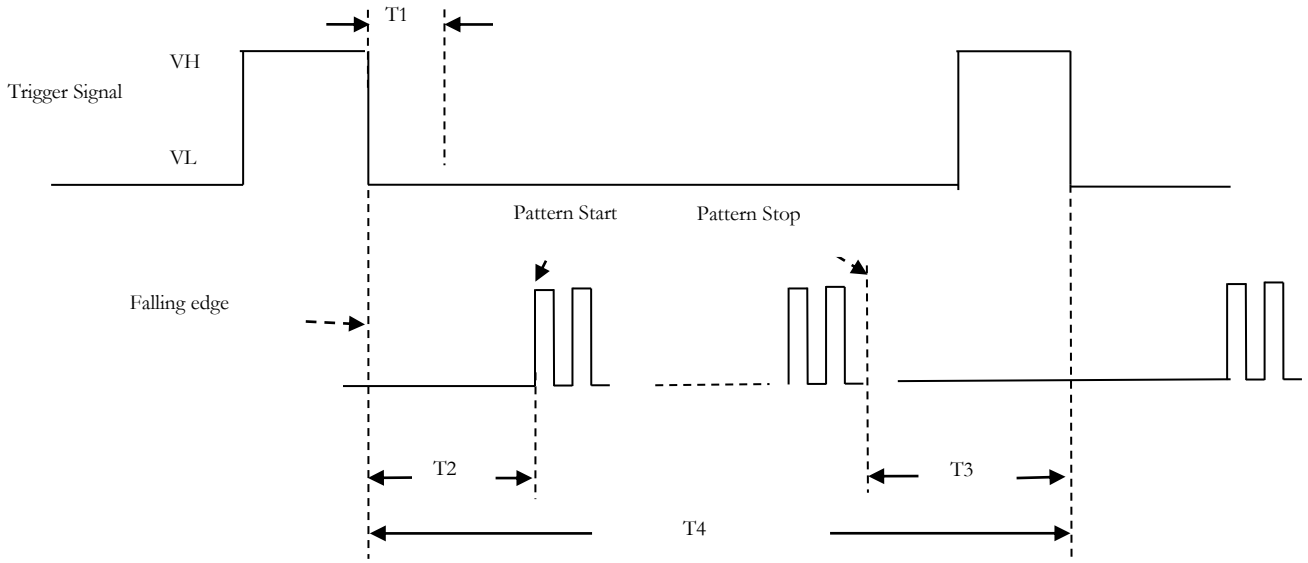


Figure 22: External Trigger Falling Edge Active

Parameter	Description	Min.	Max.	Unit	
VH	External Trigger High	2.1	5	V	
VL	External Trigger Low	0	0.95	V	
T1	Trigger Pulse width	4		ms	
T2	trigger edge to pattern start time	9	20	ms	
T3	pattern end to next trigger edge time	5		ms	
T4	Trigger interval	50		ms	20Hz

Figure 23 External Trigger Table

LED Detection

When you start Pattern either by "Trigger" button in OptoStimWare or external trigger on dongle, the status of LED will be detected before pattern is running. If optrode isn't there or LED is burned out, "LED Alert" indicator will be illuminated and you will see warning information in log section. If both LED are damaged, you will see warning "LED1/LED2 Voltage Abnormal". If Ch1 LED is damaged and Ch2 LED is fine, you will see warning "LED1 Voltage Abnormal" and must disable Ch1 if you still want to ran pattern on Ch2 LED. If Ch1 LED is fine and Ch2 LED is damaged, you will see warning "LED2 Voltage Abnormal" and must

disable Ch1 if you still want to ran pattern on Ch2 LED.

Figure24: LED Detection

4) Turn 'OFF" Headstage

Press the '**Turn Off HS**' button in **StimWare®**to turn off headstage when experiment is over . The **Headstage** indicator will go gray when headstage is off.

Figure25:Turning Off Headstage

Application Notes

Charging the Headstage Lithium Ion Battery

The wireless stimulator headstage includes an integrated rechargeable battery which should be recharged when not in use. Recharging is accomplished by the following procedure:

1. Connect supplied charging plug to the charge port on the headstage.
2. The LED on the charging plug will turn on.

Troubleshooting

Problem: The headstage won't turn on.
Suggestion: Charge the battery via the charging plug provided with the system. Refer to the section titled **Application Notes** for charging instructions.

Problem: One or more output signals are missing or incorrect.
Suggestion: Download the stim signal parameters to the headstage with OptoStimWare, making sure to follow all instructions within this manual. Check to make sure that the channels are enabled within the software prior to downloading. Check all equipment used to monitor the signal to ensure continuity.

FAQ

To see a large series of questions and answers regarding the ontogenetics systems please view this link.

Call TBSI customer support at (919) 361-2663 if there are any problems with system setup and function. You can also submit a Technical Issue report on our website here.

Version history for this manual

1.1 Initial release with Specifications 12/13
1.2 Added pattern creation description 5/14
1.3 Added Search HS function
1.4 See Scanned Changes file 3/30
1.5 Overhauled