

# Teleopt<sup>α</sup>

*Wireless Optogenetic Stimulator*

Updated on Oct 2018



# Teleopt<sup>o</sup>

*Wireless Optogenetic Stimulator*



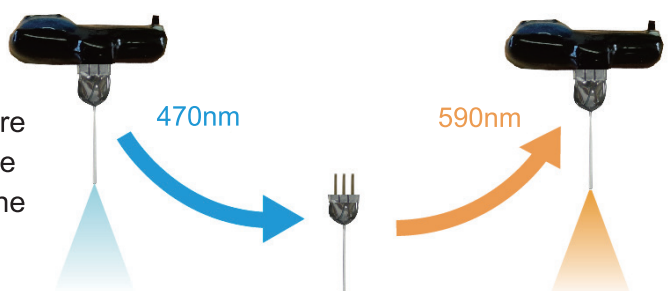
## Best Solution in Optogenetic Stimulation for Freely Moving Animals !

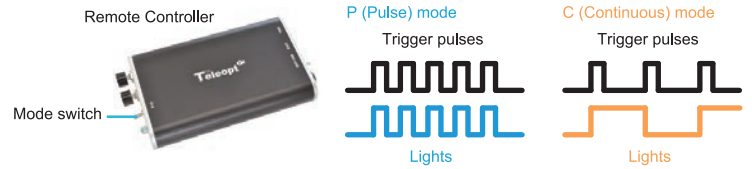
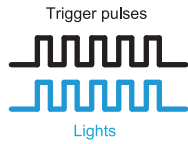
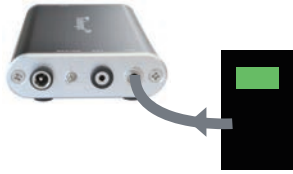
In optogenetics experiment, an optic fiber connected to the head of an animal restricts animal behavior especially in test cages with high walls, gates and other obstacles. Teleopto breaks this wall by enabling complete wireless environment for optogenetic stimulation, using very light receivers sitting perched on animal' s head.



Extra small, extra light receivers even suitable for mice.

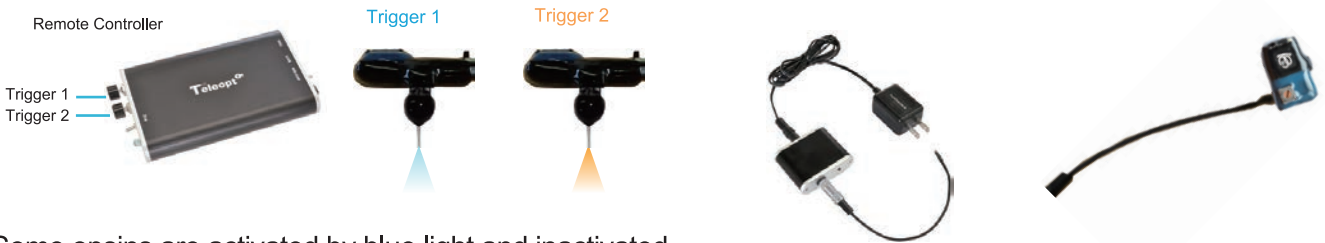
High brightness LED and optic fiber cannula are coupled to achieve mW order light power at the tip. Colors can be changed just by swapping the LED cannula component.





Remote controller accepts trigger signals from a stimulator, and sends the signals to the receiver. Synchronized light pulses are generated from the tip of the LED cannula (in pulse mode).

Receiver has two types, pulse and continuous, each for high frequency and continuous stimulation. The remote controller is compatible for both receivers, by switching the mode switch. Pulse receiver flashes at the same timing with trigger pulses, whereas continuous receiver alternates on and off upon a new pulse.



Some opsins are activated by blue light and inactivated by yellow light. Together with the 2 channel receiver and two color LED cannula, you can stimulate by two different colors at the same position. The remote controller accepts two independent triggers.

Receiver can be charged and re-used repeatedly, by a dedicated charger.



Bilateral stimulation is possible. If you want to stimulate both hemisphere simultaneously please use 1ch receiver. If you want to stimulate each hemisphere one by one, please use 2ch receiver.

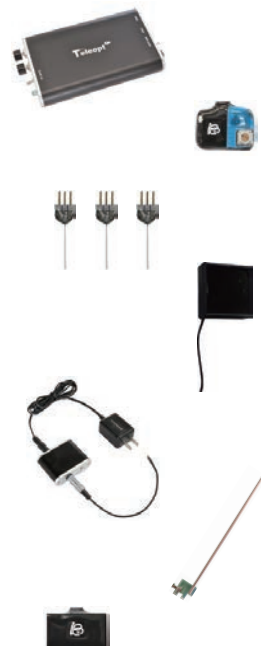


Two color LED probe for surface stimulation

### Teleopto Standard Set

model: **Teleopto-set**

- 1x Teleopto remote controller
- 1x Teleopto receiver
  - \*Please specify receiver type.
  - 2g/pulse will come without specifying.
- 3x LED cannula
  - \*Please specify cannula type.
  - Blue/10mm/φ250 will come without specifying.
- 1x Infrared emitter
- 1x Teleopto charger
- 1x Cannula insertion tool
- 1x Dummy receiver
- 1x Trigger Cable



#### Specifications

Communication	Infrared
Transmission Range	Controller: 1m, directional Infrared Emitter: 3m, directional
Receiver	
1g Receiver	approx. 1.4g, standby time: 17h
2g Receiver	approx. 2.0g, standby time: 28h
3g Receiver	approx. 3.0g, standby time: 49h
Controller I/O	
Trigger Input	3-5V TTL, 2ch P/2P mode: On@Hi, Off@Lo C mode: Toggle On/Off@rising
Ext Port	For extending Infrared emitter or TeleHub6
LED Cannula Size	φ250, 500 or 750μm
Power Source	Controller: DC6V Charger: DC5V

# Teleopt<sup>c</sup> Receivers



size: 13 x 18 x 7mm  
weight (approx.): 1.4g  
standby time: 17h

Teleopto receiver 1g / pulse

model: **TeleR-1-P**



size: 17 x 19 x 7mm  
weight (approx.): 2.0g  
standby time: 28h

Teleopto receiver 2g / pulse

model: **TeleR-2-P**



size: 18 x 22 x 8mm  
weight (approx.): 3.0g  
standby time: 49h

Teleopto receiver 3g / pulse

model: **TeleR-3-P**



size: 13 x 18 x 7mm  
weight (approx.): 1.5g  
standby time: 17h

Teleopto receiver 1g / 2ch pulse

model: **TeleR-1-2P**



size: 17 x 19 x 7mm  
weight (approx.): 2.1g  
standby time: 28h

Teleopto receiver 2g / 2ch pulse

model: **TeleR-2-2P**



size: 18 x 22 x 8mm  
weight (approx.): 3.1g  
standby time: 49h

Teleopto receiver 3g / 2ch pulse

model: **TeleR-3-2P**



size: 13 x 18 x 7mm  
weight (approx.): 1.4g  
standby time: 17h

Teleopto receiver 1g / continuous

model: **TeleR-1-C**



size: 17 x 19 x 7mm  
weight (approx.): 2.0g  
standby time: 28h

Teleopto receiver 2g / continuous

model: **TeleR-2-C**



size: 18 x 22 x 8mm  
weight (approx.): 3.0g  
standby time: 49h

Teleopto receiver 3g / continuous

model: **TeleR-3-C**



size: 17 x 19 x 7mm  
weight (approx.): 2.1g  
standby time: 28h

Teleopto receiver 2g / 2ch continuous

model: **TeleR-2-2C**

typical power	(tested with <b>TeleR-2-P, TeleLC, LPM-100</b> )		
Blue / $\phi$ 250 $\mu$ m	5.5mW (=121.6mW/mm <sup>2</sup> )	Red / $\phi$ 250 $\mu$ m	6.5mW (=144.3mW/mm <sup>2</sup> )
Blue / $\phi$ 500 $\mu$ m	16.0mW (=88.5mW/mm <sup>2</sup> )	Red / $\phi$ 500 $\mu$ m	16.0mW (=88.5mW/mm <sup>2</sup> )
Green / $\phi$ 250 $\mu$ m	2.0mW (=40.8mW/mm <sup>2</sup> )		
Green / $\phi$ 500 $\mu$ m	4.0mW (=22.1mW/mm <sup>2</sup> )		
Yellow / $\phi$ 250 $\mu$ m	2.0mW (=40.8mW/mm <sup>2</sup> )		
Yellow / $\phi$ 500 $\mu$ m	4.0mW (=22.1mW/mm <sup>2</sup> )		

## LED Cannulas



LED cannula

model: **TeleLC-c-I-d**

Single cannula.  
Hard enough for insertion  
without a guide.



Bilateral LED cannula

model: **TeleLCD-c-I-d-i**

For bilateral stimulation.



Two color LED cannula

model: **TeleLCT-c/c-I**

Two 250 $\mu$ m cannulas are  
bundled like one cannula.



LED probe

model: **TeleLP-c**

LED without cannula.  
For brain surface stimulation.



Two color LED probe

model: **TeleLPD-c/c**

Two color version of  
the LED probe.

Note: how to identify specifications from the model number:

**c**: color. **B** (blue 470nm) / **G** (green 525nm) / **Y** (yellow 590nm) / **R** (red 630nm) ... for other colors please contact us.

**l**: Length. Specify in mm.

**d**: Fiber diameter. **250** ( $\phi$ 250 $\mu$ m) / **500** ( $\phi$ 500 $\mu$ m) / **750** ( $\phi$ 750 $\mu$ m)

**i**: Fiber interval. Specify in mm. **-Glass**: Glass fiber instead of the regular plastic fiber. Only available for  $\phi$ 250 $\mu$ m Fiber.

## Accessories



Teleopto Charger

model: **TeleCharger**  
**TeleCharger-4** (4ch)

Additional chargers would be  
useful if you use several receivers.



Infrared Emitter

model: **TeleEmitter**

Longer transmission, 3m.



Infrared Emitter (Clip type)

model: **TeleEmitter-C**

1m transmission.



Cannula Insertion tool

model: **TeleTool**

For use with a steleotaxic  
for insertion.  $\phi$  1.3mm.



Dummy Receiver

model: **TeleDummy**

For habituation.

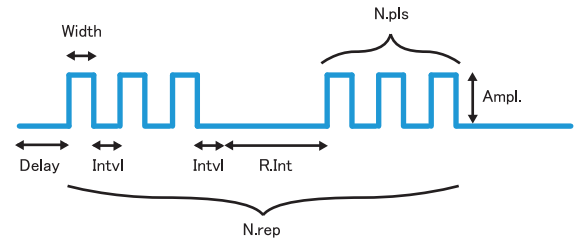


Specification	
Stim Channel	2ch (Independent)
Trigger In	2ch (Independent)
Parameter	
Delay	100 $\mu$ s - 999s
Width	100 $\mu$ s - 999s
Interval	100 $\mu$ s - 999s
Pulse number	1 - 999
Repeat interval	100 $\mu$ s - 999s
Repeat number	1 - 999
Amplitude	0.1 - 5.0V
Memory	Yes
Endless Repeat	Yes
Power	DC5V

## Stimulator for optogenetics

model: **STOmk-2**

STO mk-II is a pulse generator developed for optogenetics. By connecting the STO mk-II to TRG port on the Teleopto Remote Controller via a trigger cable, you can control the timing of light stimulation by TTL pulses. Pulses are defined by the parameters illustrated below.



Specification	
Wavelength	470nm (blue) 525nm (green) 590nm (yellow) 630nm (red)
Display	Liquid crystal
Resolution	0.01mW
Analog out	0 - 5V
Power	2x AA batteries

## Light power meter

model: **LPM-100**

In optogenetics, it is important to measure the light power at the tip of optic fiber cannula, and the LPM-100 is best suited for this purpose. LPM-100 covers three colors, blue, green, yellow and red which are commonly used in optogenetics.

Easy to use, mobile by the battery-powered design.

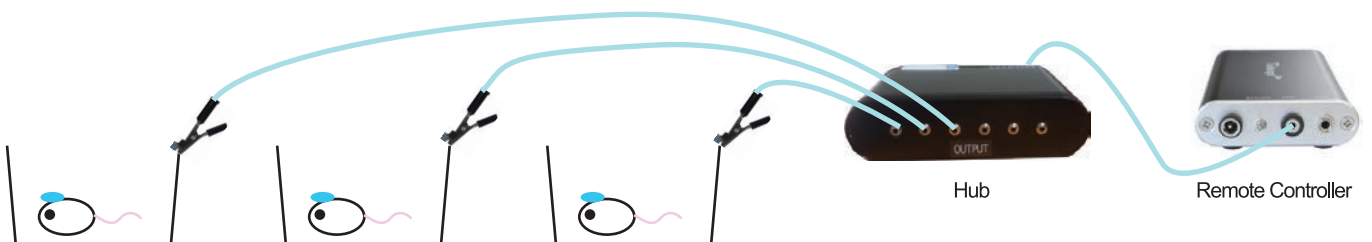


## 6 channel Hub

model: **TeleHub6**

By connecting the TeleHub6 to the EXT port on the Teleopto Remote controller, you can use up to 6 infrared emitters at the same time so that you can increase the throughput of your experiment. This device is also useful if you use a maze with many branches or high walls which block infrared signal and prevent a good transmission. By putting several infrared emitters at several positions, it ensures more stable light stimulation.

Note: All infrared emitters send a signal at the same timing.



# Video Tracking Stimulator

model: VTS-4

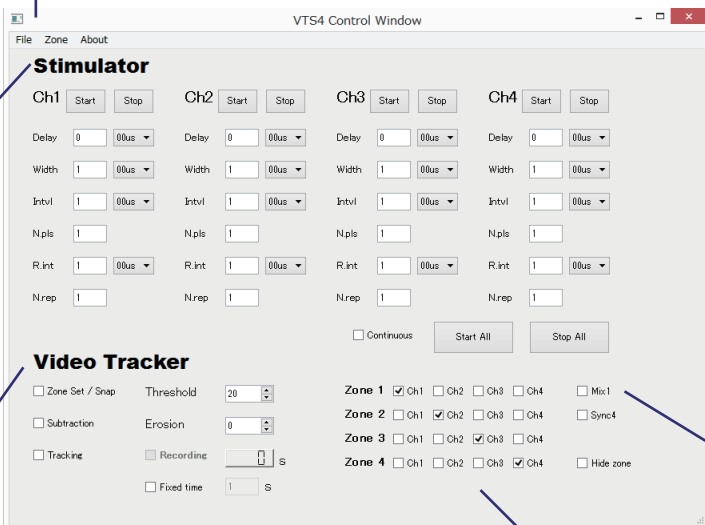


VTS-4 Video Tracking Stimulator is literally a USB stimulator equipped with a video tracking function, developed for optogenetics experiment. By defining Zones on the video image from a general USB camera, it tracks an animal and outputs pulse trains defined by a dedicated software. Pulse trains can be easily designed by manipulating the stimulation parameters (Delay, Width, Interval, Number of Pulses, etc.) This also can be used as a PC controlled universal 4 channel stimulator. You can establish closed-loop optogenetic stimulation system by combining Teleopto or wired optogenetics system from any third parties.

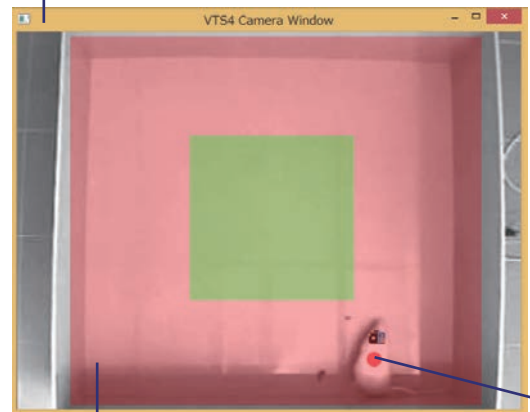


## ● Software

Control Window: Controls for stimulation and video tracking



Camera Window: Display for camera images and Zones

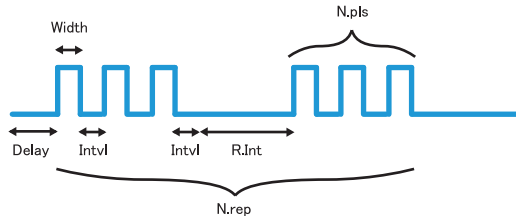


Zones: Up to 4 zones can be defined as polygon by clicking the Camera Window.

Track Mark: A red dot is put on the center of the animal detected by background subtraction.

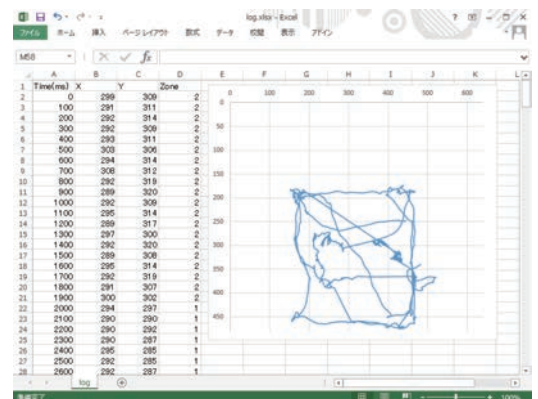
Stimulator Panel: Defines stimulation parameters.

Stimulation Assignment: Assign stimulation for each Zone.



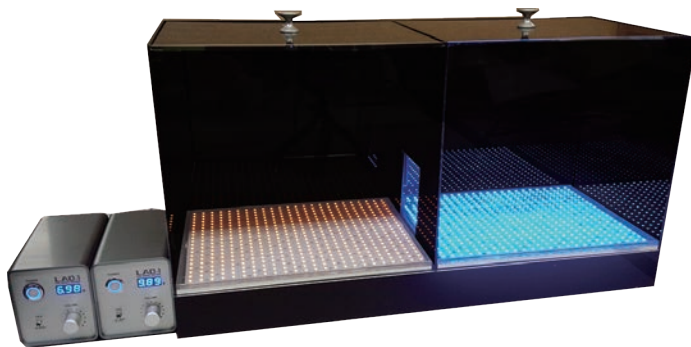
Mix Mode: Uses only one output port for stimulation, and stimulation will be switched in each zone by referring the stimulation parameters from the same number of channel.

Video Tracker Panel: Zone, snapshot, detection threshold and erosion settings, tracking on/off etc.



Elapsed time, X & Y axis, Zone data can be recorded by ASCII. Tracks can be visualized by XY plot in Excel etc.

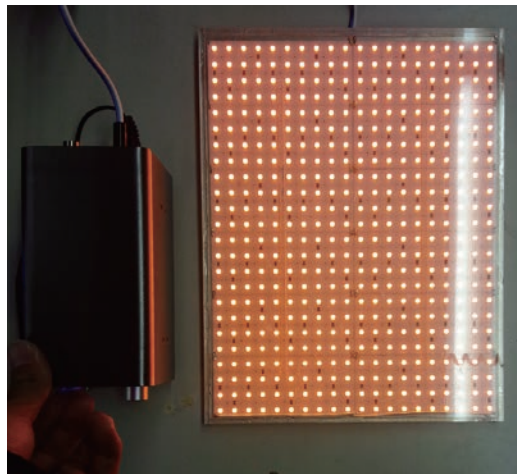
# Optogenetic Place Aversion System



In 2014, Lyer et al. published a work using a new pain test model, combining optogenetics technique and conventional place aversion test:

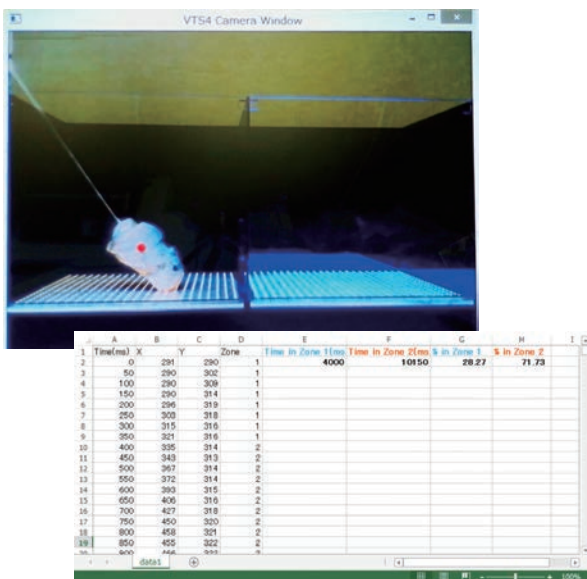
*Virally mediated optogenetic excitation and inhibition of pain in freely moving nontransgenic mice. Nat Biotechnol*

In this Optogenetic Place Aversion (=OPA) test, the result does not depend on experimenters skill unlike the traditional Von-Frey test. In addition, you can evaluate pain sensory neuron-specifically (e.g. A-beta, A-delta, C fiber, etc.), by expressing Chr2 on specific neurons. Our OPA system uses 480 pieces of high power LED for each array so that enough light can reach sensory neuron under animals' skin, thus enables non-invasive and objective test.



## ● LED Array for OPA

- 480 pieces LED per array
- Dedicated high-power LED Array driver (LAD-1-OPA)
- Minimized heat generation: the "air layer" between LED and top plate blocks heat. Most heat goes to aluminum body under the LED array, maximizing heat dissipation.
- Blue (470nm) and Yellow (590nm) by default.
- Other colors are possible on request.



## ● Data Recording

Using a camera from side or top of the test box, animal position is continuously tracked and recorded. Total time in each side, the time ratio between blue and yellow zone can be calculated. These are main parameters which can be used as quantified pain evaluation index.

## ● Contents

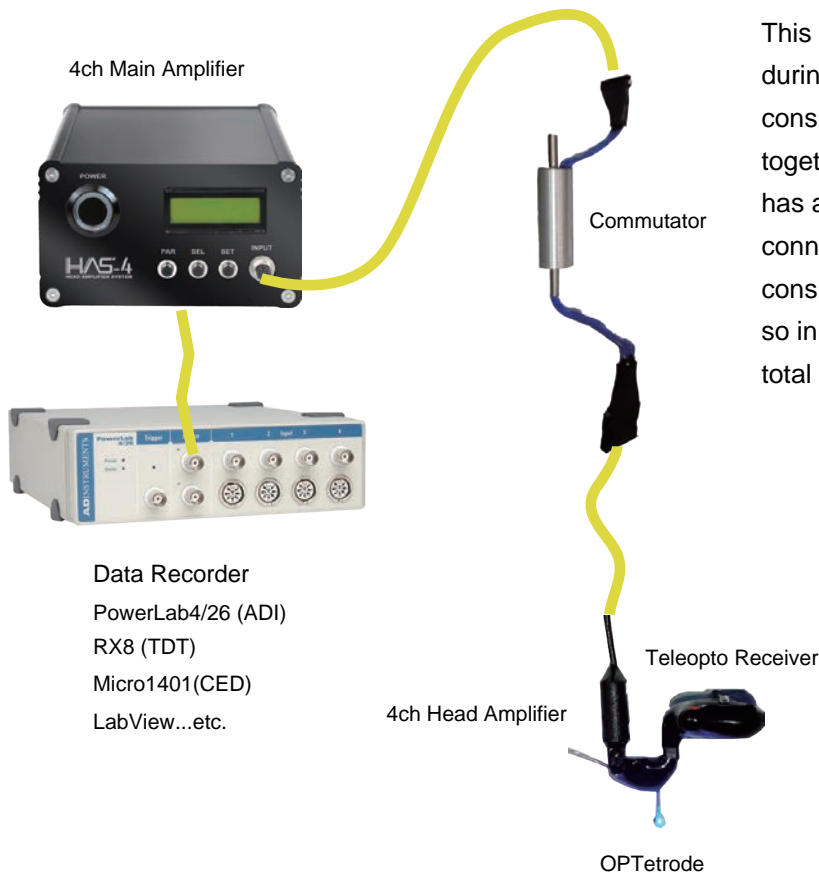
OPA-SYSTEM Optogenetic Place Aversion System (includes:)

- OPA-BOX OPA test box
- LAD-1-OPA LED Array Driver for OPA x2
- LEDA-B-OPA LED Array for OPA, Blue
- LEDA-Y-OPA LED Array for OPA, Yellow
- VTS-4 Video Tracking Stimulator

model: OPA-SYSTEM  
 OPA-BOX  
 LAD-1-OPA  
 LEDA-B-OPA  
 LEDA-Y-OPA

# Opto-Tetrode System

# OPTetrode



This Opto-Tetrode system enables neural recording during in-vivo optogenetic experiment. The OPTetrode consists of an optic fiber and a tetrode, bundled together for making one integrated probe. OPTetrode has a connector for Teleopto receiver and another connector for head amplifier. Our 4ch head amplifier consists of extremely light body (0.3g) and thin cable, so in combination with the Teleopto 1g receiver the total weight is still under 2g. Perfect for mice.

Model: OPTetrode-sys

(includes:)

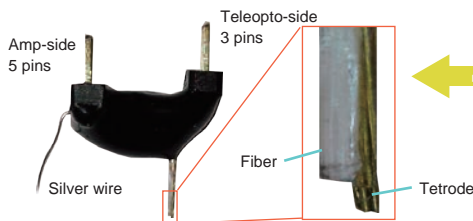
- OPTR-c-I OPTetrode, 3 pcs
- Teleopto-set Teleopto standard set
- HAS-4 4ch Head Amplifier System (includes 1x main amp and 1x head amp)
- SL-OPTR Commutator for OPTetrode

\* Data Recorder is optional.

## OPTetrode

**model:** OPTR-c-I \*c: color B/G/Y/R, I: length in mm

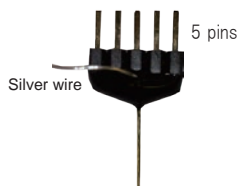
Bundled probe consisting of  $\phi 250\mu\text{m}$  fiber and 4x  $\phi 50\mu\text{m}$  stainless wires.



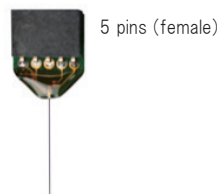
### Tetrode

**model:** TR-I \*I: length in mm

4x  $\phi 50\mu\text{m}$  stainless wires.  
Implantable without a guide tube.



Q tetrode  
Silicon probe from NeuroNexus.  
Mates via male-male header.



### 4ch Head Amplifier System

**model:** HAS-4



### 4ch Head Amplifier

**model:** HAS-4-HEAD

Extra light, 0.3g  
\*included in HAS-4

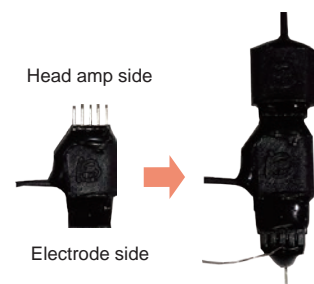


### Switching Module

**model:** SM-4



The switching head should be put in between head amplifier and electrode. It can shut the amplifier line and connect a constant current source via BNC. Suitable for electrolytic lesioning.





# 4ch Head Amplifier System



This HAS-4 head amplifier system can amplify up to 4 channel of neural signals (spikes, LFP, EEG) or EMG signal from animals. It consists of a head amplifier and a main amplifier. The head amplifier has gain 1x enabling low noise recording even from high impedance electrode. Main amplifier has variable gain / high pass / low pass filter enabling flexible control for each experiment design, and flexible compatibility for each experimental setup.

- Gain: 10 steps (x1.2 / x5 / x10 / x50 / x100 / x500 / x1000 / x2000 / x5000 / x10000)
- High pass 10 steps (0.1Hz / 1Hz / 3Hz / 5Hz / 10Hz / 30Hz / 50Hz / 100Hz / 200Hz / 300Hz)
- Low pass 10 steps (30Hz / 50Hz / 100Hz / 300Hz / 500Hz / 1000Hz / 2000Hz / 3000Hz / 4000Hz / 7000Hz)
- 4ch single-end input / 3ch input - 1ch reference, differential



## ● HAS4-HEAD 4ch Head Amplifier

- Extra light weight, 0.3g
- Gain: x1 (Voltage follower)
- Single-end 4ch (If you select "Enable" in "CH4 REF" in the main amplifier, it goes in differential mode with CH1~3 + / CH4 -)
- Cable length customizable (1m by default)
- Commutator option



Front

Back

## ● HAS4-MAIN 4ch Main Amplifier

- Power supply for head amp / amplification / filtering
- Low noise DC power source
- Output: 4x BNC



Logo Side

## ● Input Connector

- Standard 1.27mm pitch, round pin, female
- The pin arrangement is compatible with the Q-trode from NeuroNexus. Note: you need to put a male pin header (HAS-4-CON-R) in between our head amplifier and Q-trode.



model: HAS-4

HAS-4-HEAD

HAS-4-MAIN

HAS-4-CON-R

# Wireless Opto-Tetrode System

# OPTetrode



W5 Wireless Receiver (TBSI)



W5 Wireless Headstage (TBSI)

Teleopto Receiver

OPTetrode

In this configuration, both optogenetics and neural recording are wireless. In combination with TBSI's W5 wireless headstage system tetrode data directly goes to your PC via USB (or can be equipped with analog output, instead of DAQ integrated version. Please specify). Our OPTetrode can be manufactured with the mating Omnetis connector for W5 headstage. (Add "-om" to the end of the ordering code). The weight of W5 headstage is 2.7g, so together with Teleopto 1g receiver the total weight is ~4g. Suitable for rats or larger animals.

Model : OPTetrode-W-sys

(includes:)

- OPTR-c-l-om OPTetrode, 3 pcs
- Teleopto-set Teleopto standard set
- W5 Wireless Headstage System (Headstage, Receiver with DAQ, Software)

## 4ch Teleopto

model: Teleopto-4

# Teleopto<sup>4</sup>

Teleopto-4 is newly designed wireless optogenetics platform utilizing 2.4GHz RF. The receiver is capable of controlling 4ch optogenetic stimulation independently, whereas the size and weight are comparable to our regular Teleopto receivers. PC software defines stimulation parameters which are sent to the receiver via a transmitter box connected to the PC by USB. You can trigger the stimulation by software, 4 trigger buttons or 4 trigger in BNCs on the transmitter box. The typical application of this device is for controlling bilateral two color stimulation in completely independent manner. However, we can provide any probe / cannula holding 4 LED sources on request.



Receiver  
Weight: 3g  
Size: 18 x 20 x 8mm

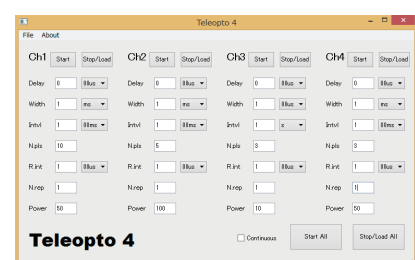
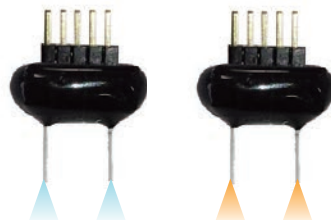


Transmitter box

Quad LED probe  
model: TeleLPO



Bilateral two color LED cannula  
model: TeleLCDT



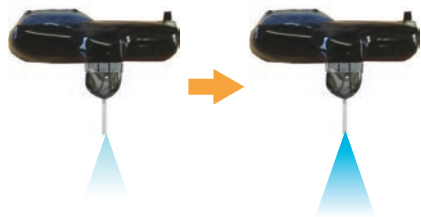
Teleopto 4 Software

\* contact us for detailed probe / cannula specifications.

## ■ Custom Order Examples

We can provide customized products for each of your application. Please feel free to ask any ideas!

### ● High Power Receiver



2g or larger receiver can enhance max output power ~1.5x. Note there is higher risk for damaging cannula and internal circuit in high power receiver - use pulse width <100ms in duty cycle less than 1:10.

### ● Vertical Receiver

Cannula connector



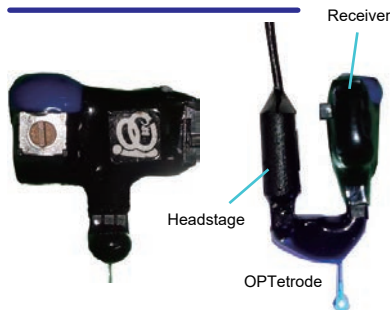
Normal receiver has cannula connector on long side of the receiver, but this receiver has it on short side. Customized for easier nose-poking into small hole.

### ● LED Ferrule



1.25mm ferrule with core 240um / NA0.5 fiber inside. Standard 1.25mm ferrule cannula can be coupled using a sleeve.

### ● Upright Receiver



The direction of cannula connector is in parallel with the receiver. It can save space on the head so useful if you want to put a headstage together e.g. when OPTetrode is used.

### ● Ferrule OPTetrode



This OPTetrode has 1.25mm ferrule with core 240um / NA0.5 fiber. Useful if you want to use a general fiber light source.

## ■ Selected publications using **Teleopt<sup>®</sup>**



Excitatory connections between the prelimbic and infralimbic medial prefrontal cortex show a role for the prelimbic cortex in fear extinction  
*Roger Marek, Li Xu, Robert K. P. Sullivan, Pankaj Sah*  
*Nature Neuroscience (2018) 21(5):654-658. DOI: 10.1038*



Top-down cortical input during NREM sleep consolidates perceptual memory  
*Miyamoto D, Hirai D, Fung CCA, Inutsuka A, Odagawa M, Suzuki T, Boehringer R, Adaikkan C, Matsubara C, Matsuki N, Fukai T, McHugh TJ, Yamanaka A, Murayama M*  
*Science (2016) 352(6291):1315-8. DOI: 10.1126*



Htr2a-Expressing Cells in the Central Amygdala Control the Hierarchy between Innate and Learned Fear  
*Isosaka T, Matsuo T, Yamaguchi T, Funabiki K, Nakanishi S, Kobayakawa R, Kobayakawa K*  
*Cell (2015) 163(5):1153-64*



A Top-Down Cortical Circuit for Accurate Sensory Perception  
*Manita S, Suzuki T, Homma C, Matsumoto T, Odagawara M, Yamada K, Ota K, Matsubara C, Inutsuka A, Sato M, Ohkura M, Yamanaka A, Yanagawa Y, Nakai J, Hayashi Y, Larkum ME, Murayama M*  
*Neuron (2015) 86:1304-16*



The lateral parabrachial nucleus is actively involved in the acquisition of fear memory in mice  
*Sato M, Ito M, Nagase M, Sugimura YK, Takahashi Y, Watabe AM, Kato F*  
*Molecular Brain (2015) 8:22*

# LED Array System

Optogenetics became explosively popular for controlling animal behaviour in-vivo, however, recently this technology was applied for in-vitro cells or tissues for controlling gene expression. For this purpose, long-term and time-controlled light stimulation in a culture incubator is required. This full waterproof LED array fulfills all the requirements for the in-vitro optogenetics experiments



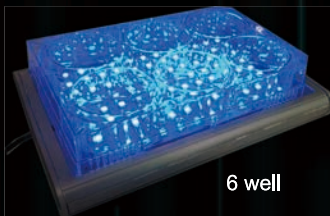
LED Array  
model: **LEDA-x**

x: color code, see bottom-left of this page

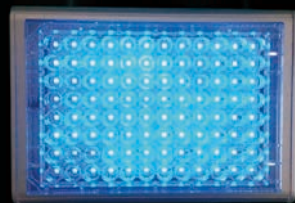


LED Array Driver  
model: **LAD-1**

- Fits perfectly for multi-well plate



6 well



Upper view with 96 well plate

It's designed for any of commercial multi-well plates so can be used together with e.g. 6, 12, 24, 48 and 96 well plates. Especially it's perfectly fits for 96 well plate because each LED element comes just under each well.

- Many color options



470nm



530nm



590nm



630nm



Two color LED Array  
model: **LEDA2-BY**

Color code

V: 400nm / B: 470nm / G: 530nm / Y: 590nm / R: 630nm / I: 940nm

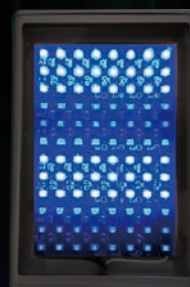
\* contact us for other colors

- Trigger input



By the mode switch of LAD-1 LED Array Driver you can choose constant mode or trigger mode. In trigger mode, the Trg In BNC on the back panel is used for receiving trigger TTL pulses from a stimulator so that it enables time-controlled pulsed stimulation in-vitro.

## 4 Section LED Array System



model: **LEDA4-x**



model: **LAD-4**

LED4-x has 4 independently controllable sections each having 24 LED. LAD-4 is independent 4ch LED array driver designed for controlling LED4-x.

In US & Canada:

### AMUZA INC

10060 Carroll Canyon Road, Suite 100, San Diego, California, USA, 92131  
URL: <https://amuzainc.com>  
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Other Countries:

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