Micro-LED Optoelectrode and Interface System

µLED-12-32 Optoelectrode

**Features**

- 12 µLEDs with dimensions 10 x 16 µm each, 3 per shank
  - Emission Peak $\lambda = 460$ nm and FWHM = 40 nm
  - Typical irradiance @ 100µA is 125 mW/mm$^2$, recommend maximum
- 32 recording channels, 8 per shank
  - Electrode impedance of 100 - 1500 kΩ at 1 kHz
  - Noise floor $\leq 5\mu$V$_{rms}$ using an Intan RHD2132 Amplifier Board
- PCB dimension 10 x 20 mm, weight $< 2$ g
- 36-pin Omnetics connector for recording and 18-pin Omnetics connector for stimulation

**Description**

The µLED-12-32 optoelectrode integrates the smallest LED technology with high-density recording electrodes. The silicon substrate makes a convenient form factor for animal research with use in many labs. The recording channels are connected to an Omnetics 36-ch connector and works with most recording systems on the market. We recommend a current source with resolution of 1 µA and a range of up to 100 µA. While many configurations are possible of electrode and µLED position, this version is a 4-shank layout as shown above. The shank length is 5 mm and center-center spacing is 250 µm. Each probe is connected to the PCB via a flexible cable and is microdrive compatible. The electrodes are on a 20-µm vertical pitch.

Two versions currently available

**µLED-12-32-A**

**µLED-12-32-F (flexible)**

Questions? [ContactMINT@umich.edu](mailto:ContactMINT@umich.edu)

For samples, complete order form at mint.engin.umich.edu/technology-platforms/#optoelectrodes
Recording System Compatibility

Pre-amplifiers are required to ensure low-noise and are widely available. Any 36-pin Omnetics male headstage is compatible with the µLED-12-32 recording electrode. All testing to date has used an Intan RHD2132 amplifier board (www.intantech.com). Also any other amplifier board with this connector would work including products from Ripple, TDT, Plexon, Neuralynx, Triangle Biosystems, etc.

Applications

- optogenetic-control of local neural circuits in awake behaving studies
- square-wave excitation for precise timing control
- sine-wave excitation for graded modulation
- chronic optogenetics where a microdrive is used to fine-tune position
- example of typical tissue depth when driving with 100 µA (right)
- References: Mendrela et. al, IEEE BioCAS, 2018; English, et. al, Neuron 2017; Wu et. al, Neuron 2015

Microdrive

- Optional for chronic use where position control is desired
- Total travel –
  - Mouse – 2.6 mm
  - Rat – 5.7 or 8.9 mm
- Resolution, distance per turn – 280 µm
- 3D printable CAD files are available for download at this GitHub page
Typical System Configuration

Description

The passive µLED-12-32 allows for greater compatibility. Internally we use an Intan RHD2132 pre-amp headstage and RHD2000 interface board. We recognize many labs use other commercial systems and software. Please contact to discuss your application. Control of the OSC1-36 can be done through Matlab via a USB connection. A link for all required software will be made available on our website mint.engin.umich.edu and hosted on GitHub.

OSC1-36 µDriver

Features

- 36-channel independent drivers
- Current range 1 µA - 1024 µA (10-bit res)
- Customizable waveforms at an update rate of 11.72 kHz
- Trigger in/out available via DB connector
- USB 2.0 communication with PC
- PCB dimensions 10 x 20 cm, 9VDC
- Easy-to-use software interface

Description

This optical stimulation chip provides 36 current drivers all independently controlled through an easy-to-use GUI or with external triggers. The level of precision provided by this driver is critical for precise illumination of local neurons in optogenetic experiments. Download a stand-alone executable or the MatLab code at our GitHub page. An example of the GUI is shown below.

** Due to limited supply, we recommend that most labs refer to our list of commercially available options for multi-channel drivers below. We are not affiliated nor promoting any of these vendors. Please let us know if these products lack compatibility and still require the OSC1-36.
Example of OSC1-36 µDriver Software Interface

Commercially Available Drivers

<table>
<thead>
<tr>
<th>Vendor *</th>
<th>Plexon</th>
<th>Pulse Pal v2</th>
<th>OSC1-36 (for reference)</th>
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<tbody>
<tr>
<td># Channels</td>
<td>16</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Current/Voltage</td>
<td>Current</td>
<td>Voltage</td>
<td>Current</td>
</tr>
<tr>
<td>LED Protection Circuit</td>
<td>Yes</td>
<td>Contact vendor</td>
<td>Yes</td>
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<tr>
<td>Isolation Circuit</td>
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<td>Contact vendor</td>
<td>Yes</td>
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<tr>
<td>Output Range</td>
<td>100nA – 1mA</td>
<td>±10V</td>
<td>1µA – 1mA</td>
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<tr>
<td>Resolution</td>
<td>16 bit</td>
<td>12 bit</td>
<td>12 bit</td>
</tr>
<tr>
<td>Arbitrary waveform</td>
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<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Temporal resolution</td>
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<td>100µs</td>
<td>100µs</td>
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<tr>
<td>TTL input/output</td>
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<td>In only</td>
<td>In/Out</td>
</tr>
<tr>
<td>Software control</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cost</td>
<td>$8500</td>
<td>$595</td>
<td>$1000 (MTA)</td>
</tr>
</tbody>
</table>

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µLED-12-32 Connectors

Recording system connector is the 36-pin Omnetics (A79024-001/NPD-36-AA-GS, pictured at right)

Stimulation connector is the 18-pin polarized Omnetics (PZN-18-AA)

µLED-12-32 Mapping Details

Optoelectrode tip top view

PCB rear view

Suggested connection w/ Intan headstage

Intan channel mapping w/ suggested connection

Depending on your setup, you can tie REC and LED GNDs or not

References


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