



# Optogenetics TTL Pulse Generator

User Manual

Version 1.1.1

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## General Overview

### 1.1 Optogenetics TTL Pulse Generator



Figure 1.1: Optogenetics TTL Pulse Generator

The Doric Optogenetics TTL Pulse Generator (OTPG) allows the modulation of pulse signal trains as well as their triggering. The generator connects to a computer using a USB-B cable, while each channel can be connected to a device using a BNC cable. The most commonly used devices are *LED Drivers*, *Laser Drivers* and *Shutters*. This allows the coordination between many input/output signal between many different devices.

The generator comes in 4-channel (Fig. 1.1a) and 8-channel (Fig. 1.1b) models. For the 4-channel OTPG, all channels can either be used as an output, to deliver a pulse train, or as an input, to receive trigger signals. For the 8-channel OTPG, only channels 5-8 can be used as inputs (Fig. 1.2). The OTPG is controlled using the *Doric Neuroscience Studio* (see chapter 2).

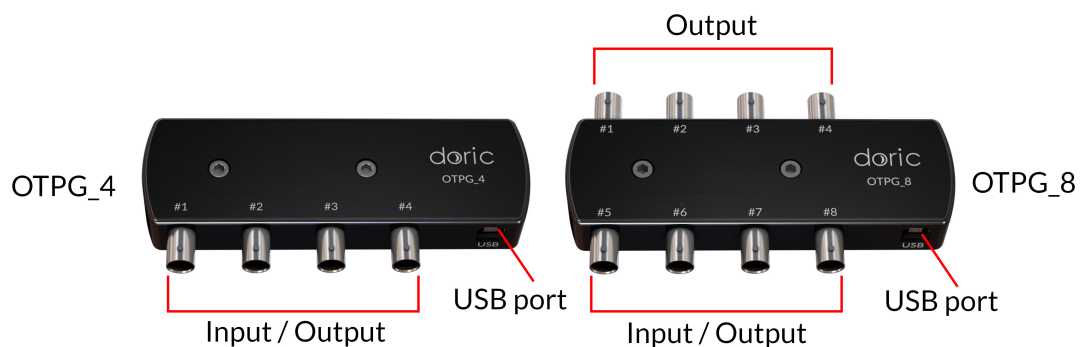


Figure 1.2: Input/Output Channels

## Operations Guide

### 2.1 Optogenetics TTL Pulse Generator

The *Optogenetics TTL Pulse Generator* (OTPG; 4 or 8 channels) are controlled from the *Doric Neuroscience Studio*. Various pulses train sequences can be designed for any experiment. Each channel can be used to generate pulses with relative phases that remain constant. Channels can be synchronized or started at the same time or independently. Channels 1 to 4 (OPTG 4) and channels 5 to 8 (OPTG 8) can be used as inputs.

The OTPG user interface (Fig. 2.1) is split into two main sections. This includes the **Controls & settings** and the **Acquisition view**. From these sections, the **Channel(s) configuration** window can be accessed to add and configure channels.

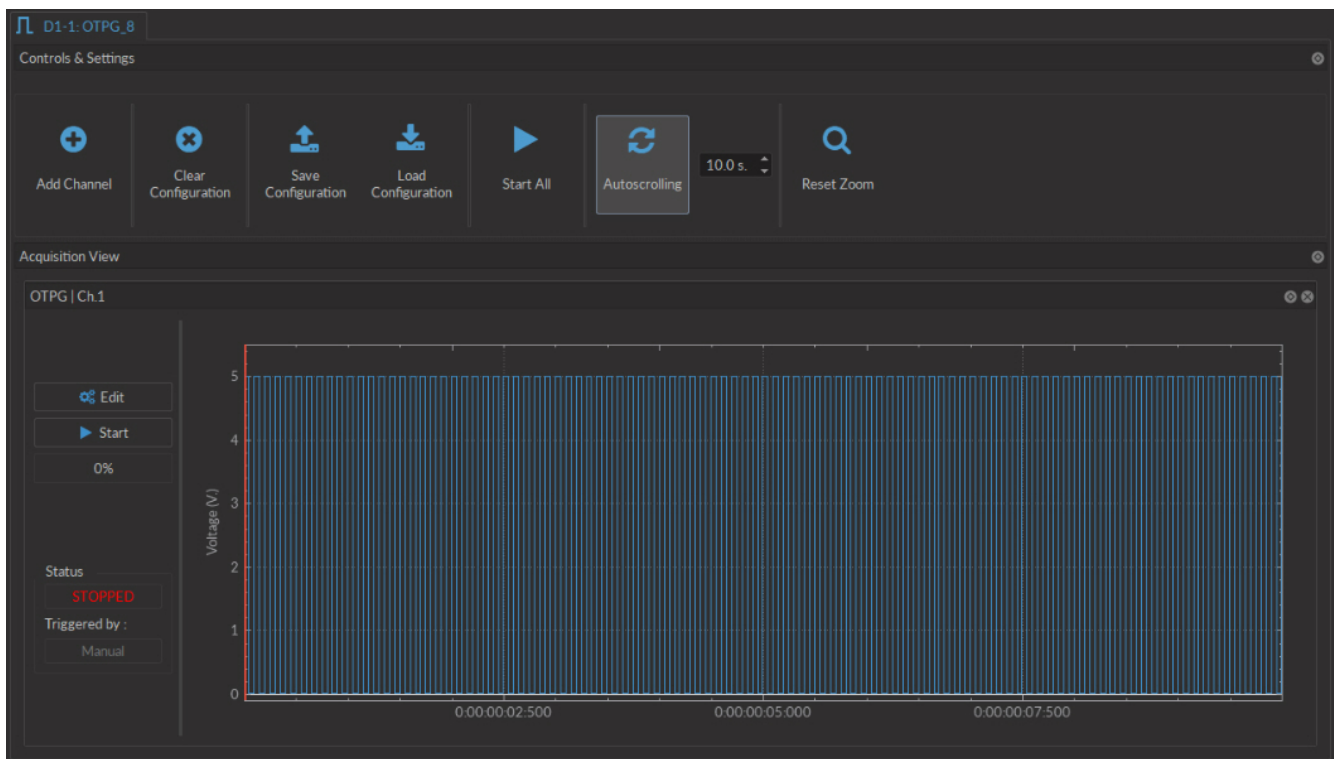


Figure 2.1: Optogenetics TTL Pulse Generator Interface

## 2.1.1 Channel configuration



Figure 2.2: Channels Configuration, Continuous Wave Interface

The **Channels configuration** window is used to configure each channel. The window can be accessed by either using the **Add channel** or **Edit** buttons. This window is separated into multiple boxes, defined here.

1. The **Channel Options** (Fig. 2.2) include the **Channel** drop-down list and the channel **Mode** list.
  - a) The **Channel** identifies which of the 4 channels available for each channel type is currently being modified. The channel can be changed by selecting a new one from the drop-down list.
  - b) The **Mode** identifies the type of signal sent.
    - The **CW(Continuous Wave)** channel mode allows the creation of a continuous TTL pulse sequence. The following elements appear in the **Sequence Options** box.
      - i. The **Starting Delay** (Fig. 2.2) defines the time between the activation of the pulse sequence and the beginning of the signal.
      - ii. The **Time ON** (Fig. 2.2) defines the length of time the continuous signal is active. Should the time chosen be 0, the signal will continue until the pulse sequence is stopped manually.
      - iii. The **Total Duration** (Fig. 2.2) shows the total expected duration of the pulse sequence. Should the duration be infinite, the box will display  $\infty$ . If there is an error in parameter selection, this box will display **N/A**.

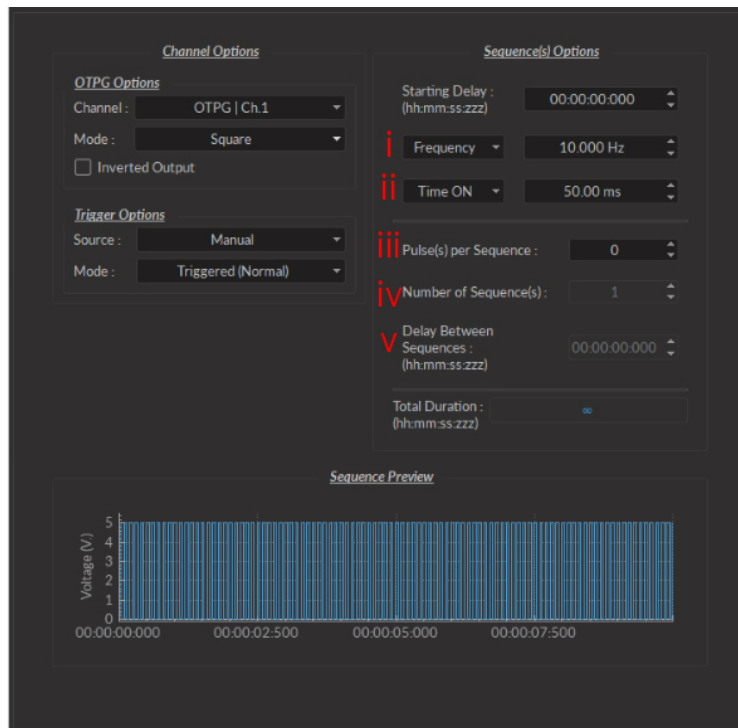


Figure 2.3: Channels Configuration, Square Interface

- The **Square** channel mode allows the creation of a square TTL pulse sequence. This includes all sequence options as the **CW** mode, with the following additions.
  - i. The **Frequency** (Fig. 2.3) sets the frequency (in Hz), which is the number of pulses per second. The frequency can also be changed to the **Period**. For example, a signal at 10 Hz (frequency) will output one pulse every 100 ms (period), whereas a signal at 0.5 Hz (frequency) will output one pulse every 2 seconds (period).
  - ii. The **Time ON** (Fig. 2.3) defines the length of a single pulse. This time can also be converted to a **Duty Cycle**, which represents the % of the period the pulse duration corresponds to.
  - iii. The **Pulse(s) per sequence** (Fig. 2.3) set the number of pulses per sequence. If it is set to 0, the number of pulses will be infinite.
  - iv. The **Number of sequence(s)** (Fig. 2.3) sets the number of times that the sequence will be repeated.
  - v. The **Delay between sequences** (Fig. 2.3) sets the delay between each sequence.

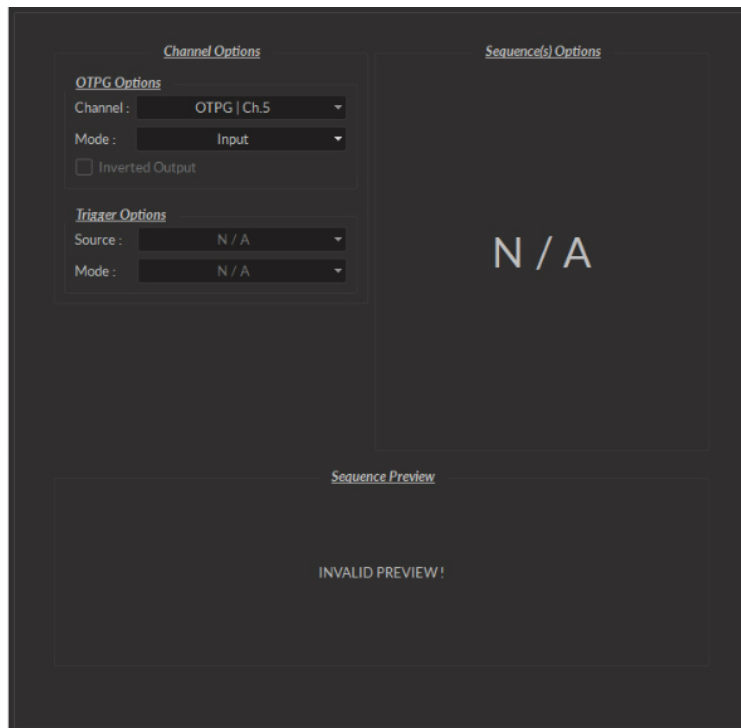


Figure 2.4: Channels Configuration, Input Interface

- The **Input** mode (Fig 2.4) records a signal as long as there is a high TTL signal on the chosen console channel. The channel can then be used as a trigger source for all the other channels of the console. No **Sequence Options** or **Sequence Previews** are available for this mode.
- c) The **Inverted Output** checkbox changes the signal output. When selected, the **ON** TTL signal will send 0 V, while the **OFF** TTL signal will send 5 V.
2. The **Trigger Options** (Fig. 2.2) define the trigger methods. These options include the trigger **Source** and **Mode**.
    - a) The **Source** trigger option allows the choice of a **Manual Trigger** (activated by a user) or an **Input** trigger, coming from an input on a channel.
    - b) The **Mode** defines how the trigger activates a sequence..
      - In **Triggered** mode, the sequence is started manually or by a trigger source from an input channel. Once the trigger source is received, the sequence will continue until the end or until **Stop** is pressed.
      - In **Gated mode**, the sequence will play as long as there is a high TTL signal (4 V or more) on the input modulation BNC. This signal comes from a different light source or device driver. When the TTL signal is low (0.4 V or less), the sequence stops and waits for another high TTL signal to continue. If a pulse is cut, a new one will start at the next activation signal.
  3. The **Sequence Options** (Fig. 2.2) define the parameters of each pulse sequence for output channels. These parameters are defined with each channel type. Should a parameter chosen be impossible to apply to a sequence (For example, a **Time ON** greater than  $1/\text{Frequency}$ ), the color of the option boxes will turn **RED**.
  4. The **Sequence Preview** (Fig. 2.2) section allows visualization of the output sequence that will play by selecting the channel in the graph.

## 2.1.2 Control and Settings

The **Control and Settings** box is used to manage the different parts of the software module.

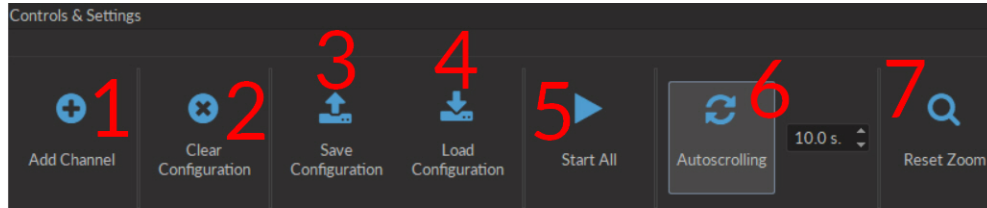


Figure 2.5: Control & Settings Box

1. The **Add Channel** button (Fig. 2.5) opens the **Channels configuration** window. This window is detailed in section 2.1.1.
2. The **Clear configuration** button (Fig. 2.5) resets the acquisition view and all other parameters set. Any configurations already set will be lost.
3. The **Save configuration** button (Fig. 2.5) allows an OTPG configuration to be saved in the **.doric** format.
4. The **Load configuration** button (Fig. 2.5) allows an OTPG configuration in **.doric** format to be loaded.
5. The **Start All** button (Fig. 2.5) activates all prepared channels.
6. The **Autoscrolling** button (Fig. 2.5), when clicked, makes the graphs scroll as new data appears. The duration (in s) kept on display is defined in the box beside the button.
7. The **Reset Zoom** button (Fig. 2.5) resets the horizontal axis of all graphs displayed in the **Acquisition View** to the duration chosen in the **Autoscrolling** box.

## 2.1.3 Acquisition View

The **Acquisition View** box displays all information concerning active channels. Each channel chosen using **Add Channel** is displayed in this section, occupying a rectangular box.

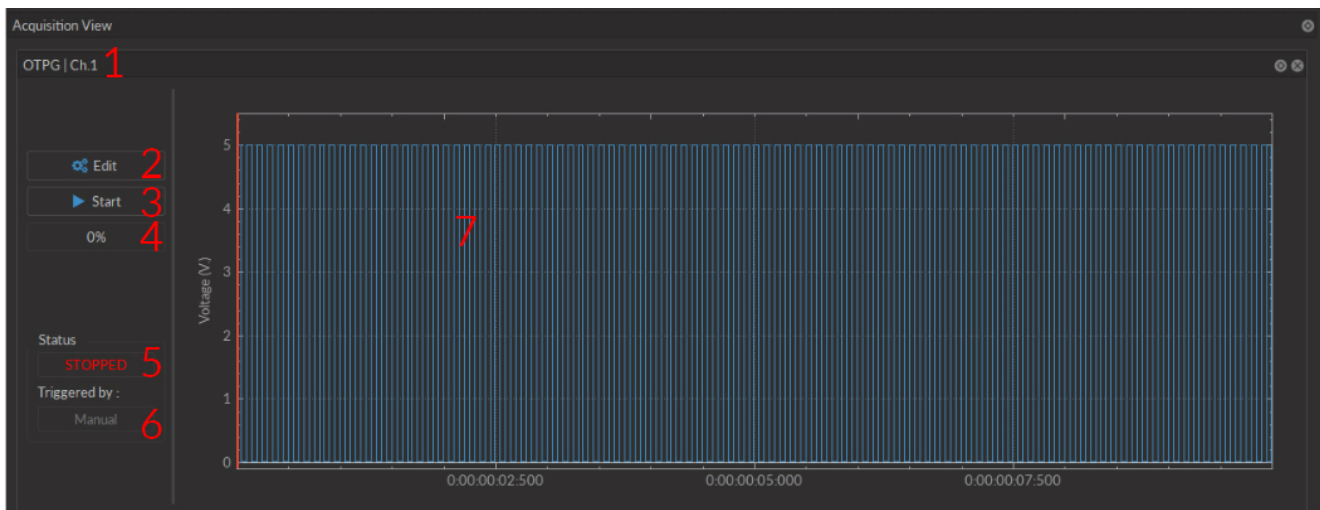


Figure 2.6: Acquisition View Box

Each **Channel box** shows the following basic elements, with additional elements available for specific channel types.

1. The **Channel name** is located on the upper left of the **Channel box** (Fig. 2.6), identifying the type of channel and its number, corresponding to that on the OTPG.



- The **Edit** button (Fig. 2.6) allows the editing of channel parameters, opening the **Channel configuration** window. For further information, see section 2.1.1.
- The **Start** button (Fig. 2.6) activates the chosen channel without activating any other channel. The button is **Green** (Fig. 2.6 when inactive, **Red** (Fig. 2.8) when active and **Gray** (Fig. 2.7) when disabled.
- The **Progress Bar** (Fig. 2.6) will indicate the progress of the chosen sequence. Should the sequence be infinite, a scrolling blue bar (Fig. 2.8) is displayed.

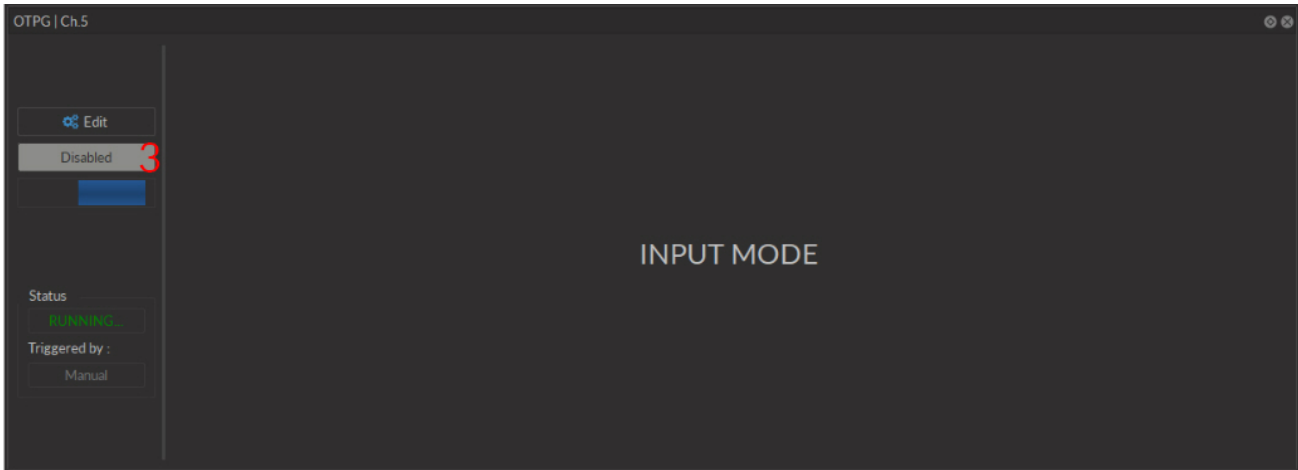


Figure 2.7: Acquisition View Box, Input Mode

- The **Status** box (Fig. 2.6) shows whether the channel is active, displaying **STOPPED** when inactive (Fig. 2.6) and **RUNNING...** (Fig. 2.8) when active.

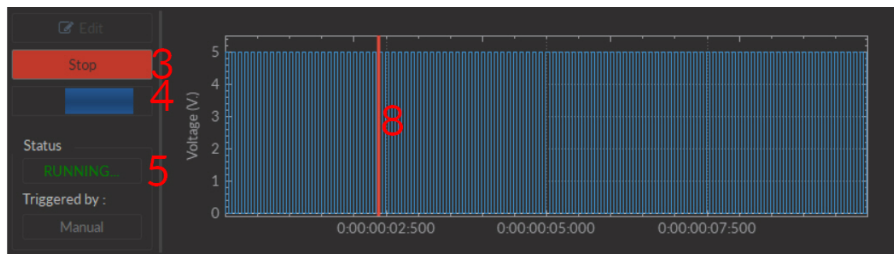


Figure 2.8: Acquisition View Box, Square Mode

- The **Triggered By** box (Fig. 2.6) shows the current trigger source of the channel sequence.
- The **Sequence Preview** box (Fig. 2.6) shows a graphed preview of the pulse sequence.
- The **Position Marker** (Fig. 2.7) is a red line on the **Sequence Preview** that indicates the position in time when the sequence is active.

## Specifications

Table 3.1: *General Specifications*

<b>SPECIFICATIONS</b>	<b>VALUES</b>	<b>NOTES</b>
Maximum On/Off Time	5 hours/Infinity	
Maximum Sequence Duration	Infinity (continuous) or $10^7$ Pulses	
Minimum Pulse Duration	0.017 ms	
Time Resolution Accuracy	$\pm 1 \mu\text{s} \times \#$ of channels running	
Maximum Value of Repeat	4 294 967 296	
Maximum/Minimum Pulse Frequency	30 kHz / $5.47e^{-5}$ Hz	
Pulse Stability	0.1 $\mu\text{s}$	
Voltage Output	5 V	
Maximum Input Voltage	5 V	
Current Consumption	<100 mA (4 ch)/ <200 mA (8ch)	Powered by computer USB port
Output Current	20 mA (Maximum)	
Dimensions		
4-channel OTPG	135 x 58 x 21 mm <sup>3</sup>	Depth includes connectors
8-channel OTPG	135 x 70 x 21 mm <sup>3</sup>	Depth includes connectors
Mass		
4-channel OTPG	174 g	
8-channel OTPG	199 g	

Table 3.2: *Recommended Environmental Specifications*

<b>DESCRIPTION</b>	<b>OPERATION</b>	<b>STORAGE</b>
Use	Indoor	Indoor
Temperature	0-40 ° C	0-40 ° C
Humidity	40-60% RH, non condensing	40-60% RH, non condensing

## Support

### 4.1 Maintenance

The product does not require any maintenance. Do not open the enclosure. Contact Doric Lenses for return instructions if the unit does not work properly and needs to be repaired.

### 4.2 Warranty

This product is under warranty for a period of 12 months. Contact Doric Lenses for return instructions. This warranty will not be applicable if the unit is damaged or needs to be repaired as a result of improper use or operation outside the conditions stated in this manual. For more information, see our [Website](#).

### 4.3 Contact us

For any questions or comments, do not hesitate to contact us by:

**Phone** 1-418-877-5600

**Email** [sales@doriclenses.com](mailto:sales@doriclenses.com)



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