

# **Manual**

# **mStim**

**stimulation and automated experiment control**

PRELIMINARY VERSION

**Edition: 12. January 2011**

**© 2008 - 2011, Frank Würriehausen**  
**Max-Planck-Institut für biophysikalische Chemie**  
**Abt. Membranbiophysik**  
**D-37077 Göttingen Germany**  
**E-mail: [fwuerri@gwdg.de](mailto:fwuerri@gwdg.de)**



## Table of Contents

1	Introduction.....	1
2	Description of the Hardware.....	1
2.1	Front Panel.....	1
2.2	Detailed Description.....	2
2.3	Rear Panel.....	2
3	Commands for the mStim Stimulator.....	3
3.1	Description of the command syntax.....	3
3.2	List of the Commands.....	3
3.2.1	Commands for general settings.....	3
3.2.2	Commands for channel settings.....	4
3.2.3	Commands for port settings.....	6
3.2.4	Commands for trigger settings.....	6
3.2.5	Commands for programming.....	6

# 1 Introduction

The mStim is designed to load templates of pulses from a host computer and run them. This is called Template-Mode. A template defines interval values in milliseconds with a resolution of 100  $\mu$ s. The first value is the delay from the trigger, and can be zero. All other values defines the intervals of the pulses. For example, if a template contains the values (0; 5.0; 3), that means, the first pulse occurs directly after the trigger, the second 5 ms after the beginning of the first (here from the trigger), and the third runs 3 ms after the beginning of the second. The interval is defined as the time from the beginning of a pulse to the beginning of the next one. Random Pulses can be generated on a computer and loaded as a text file to the mStim.

If a fixed interval is needed, the mStim can run in Pulse-Mode. In this mode a fixed interval is set and a number of cycles. The mStim begins to send out the first pulse with the trigger and stops after the last pulse. If not only one pulse is needed per interval the Burst-Mode is used. In Burst-Mode the mStim sends out a defined number of pulses per interval, which are specified by their interval (burst interval) and the number of cycles (burst cycles).

Different Pulse-Mode or Burst-Mode settings can be recorded and then run as a program. For example, if a stimulus with 100 cycles of 33 ms interval and 1 ms pulse width should run 2 s after the trigger and then after 20 s the same stimulus with 200 cycles and so on, a program is the way to record these stimuli. In such a program, also the ports can be set to low or high at any time. This is useful for controlling other equipment in the setup.

## 2 Description of the Hardware

### 2.1 Front Panel

The mStim is a stimulator which has four channels of output. Each channel can run pulses from  $\pm 10.24$  V. It has also 24 TTL Ports. Each Port can be set to a level of 0 V or 5 V. Four TTL inputs and one analog input are available. The stimulator can be triggered from two TTL Trigger inputs. It has an LCD-Display with 4 \* 20 Characters. For a quick information there is a two color status LED. For input it has a five key navigation keyboard. It can run standalone or connected to a host computer via USB to use all features of the stimulator.



### 2.2 Detailed Description

**Channels:** The channels are the main interest of the mStim. It can output pulses and bursts with a predefined interval for every pulse, or templates, which will be loaded from the connected computer, where a separate interval can be defined for every pulse. The minimum interval is 100  $\mu$ s

and the maximum is 6.5 seconds. The minimum pulse width is 20  $\mu$ s and the maximum can be as long as the interval.

**Ports:** The 24 Ports can be set to 0 (0 V) and 1 (5 V). The main use of the ports is in programming mode.

**Triggers:** There are two triggers available. Both triggers are equal. If nothing is running the triggered channel will start immediately after the trigger occurred. If one or more channels are already running, the triggered channel starts relative to the internal timebase, with a resolution of 100  $\mu$ s. The independent triggered channels will then run synchronously.

**TTL In and Analog In:** These inputs can be read at any time.

**Keyboard:** The keyboard has four navigation keys and one OK-key. With the OK-key you select the upper first menu, you see in the display. The left navigation key brings you back to the previous menu. The left key has also another function. When the stimulator is running and it is held down for more then one second, all channels are stopped immediately. With the upper and lower navigation key you change the value of the selected menu. The right navigation key toggles the display from menu mode to info mode and back.

**Status LED:** The status LED gives a quick overview of the channels. It has two colors, red and green. If a channel is configured right and ready for running it lights green, otherwise red. If some channels are ready and others not, it lights orange (green and red together). The status LED has also a second function. When a channel is in use, it flashes green.

**Display:** The Display has four lines with 20 Characters each. It has two modi, the menu mode and the info mode. Menu mode enters, when the mStim is switched on. The info mode enters, when the mStim is running. The modes can be toggled with the right key. Every other key switches the display back to menu mode and settings can be changed. If no key is pressed for five seconds, and the mStim is still running, it switches back to info mode.

### 2.3 Rear Panel

On the rear panel there is the power connector with the power switch and the USB connector for the connection to the computer. The connection to the computer is done with a “Virtual COM Port” short “VCP” on the USB connection. The VCP-Divers will be supplied with the Distribution CD. The folder, containing the drivers, should be copied to the computer, where the mStim is connected to. Also on this CD you will find a description for installing the drivers. Please follow these description.



## 3 Commands for the *mStim* Stimulator

### 3.1 Description of the command syntax

The command itself must be written in full, but the names can be abbreviated, e.g. “**setmode pulse**” can be written as “**setmode pul**”. Expressions in brackets [] must be replaced with a number or name, e.g. “**start [trigger channel]**” must be written as “**start 1**”. Expressions in braces {} must not be written, e.g. “**setmode 1 pulse**” can be written as “**setmode pulse**”, if the channel is selected with “**setchannel 1**”.

Times can be set in microseconds (us), milliseconds (ms), seconds (s), or as hours, minutes and seconds (hh:mm:ss or hh:mm:ss.mmmuuu). If no scale unit is given, seconds are used. Between the number and the scale unit must be a blank. Otherwise it is read as a name.

### 3.2 List of the Commands

#### 3.2.1 Commands for general settings

##### help

Prints a help screen with all available commands:

##### version

Print the firmware version

##### baud [baud rate]

Change the baud rate of the serial interface. The stimulator uses a Virtual COM Port (VCP) with the USB interface from the computer. The default Baud rate is set to 115200 baud, 8 data bits, 1 stop bit, no parity. Only the baud rate can be changed, the other parameters are fixed. If you changed the baud rate, you must also change the baud rate of your computer, otherwise you cannot communicate anymore with the mStim. You can also change the baud rate from the front panel of the mStim.

##### start [trigger channel]

Simulate a trigger. Works like a trigger pulse for the interface. All channels and ports with the selected [trigger channel] set will start immediately

##### stop

Stop all running channels and ports immediately. This can also be done by pressing the left-arrow-key for more than 1 second.

##### pause

Pause all channels and ports. All channels and ports hold, until the resume command is entered.

##### resume

Resume the channels and ports. Channels and ports which hold will resume working.

##### read [-ad][average]{channel}

Read the analog or digital input. If a channel is given with the digital input, this channel is returned, all channels else. The average is used for the analog input only. It reads [average] times the analog input and calculates the average.

##### load {-ar}[name]CRn1;n2;...nn;CR

Load an interval, active-, or resting-level template into memory. After the name follows a carriage return and then a list of intervals in milliseconds (with 0.1 ms resolution), or a list of levels in volts (-10.24 V – 10.235 V). The active- or resting-level templates are optionally. If they don't exist, the

active- or resting-level of the channel is set. The active- and resting-level files which belong to an interval template must have the same name with “\_act” or “\_rest” at the end.

**get [name]**

Print the values of a stored file

**ls {-al}[name]**

List one or all files. If no name is given, all stored files are listed. If “-l” is used the file size in bytes will be showed and also a little “o” in front of the text, if the file is already open. If “-a” is used, also the hidden files are listed which begin with a dot.

**rm {name}**

Remove one or all files. If no name is given, all files will be deleted.

**clearall**

Clear the channels, the ports, the triggers, and the files

**firmware {-q}**

Load a new firmware version. Be very carefully with this command. It can make the mStim unusable. The loading of new firmware cannot initiated from the front panel. If -q is given, the software is directly loaded without any asks. Be very careful with this command. The firmware is immediately erased and, if no firmware is available, the stimulator is unusable.

## 3.2.2 Commands for channel settings

**setchannel [n]**

Set the channel number for settings. This channel will be used for every setting, where a channel must be selected.

**setmode {channel}{template}{pulse}{burst}**

Set the mode for a channel. In template mode a file must be assigned to the channel, which holds the interval template.

**assign {channel}[name]**

Assign a stored data file to a channel

**include {-ar}{channel}**

Includes an active- or resting-level file to a channel. If a template file with the same base name and the extension \_act or \_rest as the template file is found, the levels from this file will be used instead of the active- or resting-level.

**exclude {-ar}{channel}**

Excludes an active- or resting-level file from a channel. A loaded template file with the same base name and the extension \_act or \_rest as the template file will be ignored and the active- or resting-level will be used instead.

**setlevel {-ar}{channel}[volts]**

Set the active or resting output voltage for a channel (-10.24 V – 10.235 V).

**setwidth {channel}[width][{us}{ms}{s}]**

Set the pulse width for a channel. The minimum is 20 us.

**setint {channel}[interval][{us}{ms}{s}]**

Set the interval for a channel. The interval can be in the range from 100 us to ~ 6.5 s.

**setcyc {channel}[cycles]**

Set the number of cycles for a channel:

**setburstint {channel}[interval] [{us}{ms}{s}]**

Set the burst interval for a channel.

**setburstcyc {channel}[cycles]**

Set the burst cycles for a channel.

**setdelay1 {channel}[delay] [{us}{ms}{s}]**

Set the delay for a channel. Delay1 is set before every pulse train. It is the time from the trigger to the first pulse and then from the end of every pulse train to the next one. In template mode it is set before every pulse.

**setdelay2 {channel}[delay] [{us}{ms}{s}]**

Set the delay for a channel. Delay2 is set after every pulse train. It is the time from the last pulse cycle in a train to the beginning of the next pulse train.

**setrepeat {channel} [{n} {forever}]**

Set the number of repeats for a channel. The pulse train can be repeated. The repeat number can be set from 0 to 65534 and it can be set to "forever".

**store {channel}[name]**

Store the settings of the channel in a file. The settings can be read back with the assign command.

**init**

Perform a check for all channel settings. All channels will be checked, if they are ready to run. The "status led" will be set:

**clearchannel {channel}**

Clear the settings of a channel. All the settings will be cleared and the channel is set to the default values.

**geterror {channel}**

Print the last error that occurred for the channel. The "Status LED" only sign that there is something wrong with one channel, why will not run. What is wrong, you will see with this command.

**info {channel}**

Print the channel and port settings.

### 3.2.3 Commands for port settings

**porthigh [-ai] [{n}{0xn}{0n}{bn}]**

Set the port high. You can type the port number directly e.g. "porthigh 1,5", or you can type an absolute number like "porthigh -a 17", or a octal number like "porthigh -a 021", or a hex number like "porthigh -a 0x11", or a binary number "porthigh -a b10001". All examples set the same ports 1 and 5 to high. With the immediate option (-i), the port will be set immediately.

**portlow [-ai] [{n}{0xn}{0n}{bn}]**

Set the port low. This command works like "porthigh", but it sets the selected ports low.

**clearports**

Clear the settings of all ports



### 3.2.4 Commands for trigger settings

**settrig [{channel}{'port'}] [trigger]**

Assign a trigger to a channel. E.g. “settrig 2 1” assigns trigger 1 to channel 2, “settrig port 1” assigns trigger 1 to the ports. In record mode the trigger set triggers the recorded sequence, so it cannot be assigned to a channel or the ports. It has to be set before the first channel or ports are added.

**settrigmode [trigger][{triggered}{gated}]**

Set the mode for a trigger. In “pulse” mode and in “burst” mode the trigger can function as a gate. While the trigger is in the active polarity (can be set with “settrigpol”) the pulse or burst trains are send out, if the trigger is in the passive polarity, the train stops.

**settrigpol [trigger][{negative}{positive}]**

Set the polarity for a trigger. The trigger can set to negative or positive polarity. Negative polarity means that the trigger is in high level (+5 V) and the mStim is triggered with the low edge (0 V). In positive polarity the trigger-level is normally low and the high edge triggers the mStim, when

**triginfo [trigger channel]**

Print the trigger settings

**cleartrigger [trigger channel]**

Clear the settings of a trigger channel

### 3.2.5 Commands for programming

**record [-o][name]**

Start the record mode. In record mode, you can set a channel or the ports like in normal mode, but a file with the selected name is opened and with the command “addchannel” or “addport” it is written to the file. With the command “end” the record mode is stopped. If the option “-o” is used, an existing file with that name will be overwritten.

**channeldelay [-ar][time]**

Set the channel delay from trigger (-a = absolute) or last event (-r = relative). In “record mode” a delay between the trigger and the first channel event or between two channel events can be set with “channeldelay”.

**portdelay [-ar][time]**

Set the port delay from trigger (-a=absolute) or last event (-r=relative). In “record mode” a delay between the trigger and the first port event or between two port events can be set with “portdelay”.

**addchannel**

In record mode recorded channel settings are stored

**addport**

In record mode recorded port settings are stored

**show**

In record mode the settings to record are showed. Before you store the settings, you can have a look on it, if everything is set correct.

**proglis [-o][name]**

Start the record mode for program names, -o=overwrite. With this command you can make a list of programs, which will run one after the other.

**addname [name]**

In record mode adds a name of a program to the list

**setproglsttrig [{entry}{once}]**

Every program entry is triggered or the list is triggered once. You can select, if the list should be triggered once or every entry in the list should be triggered separately.

**end**

The record mode is stopped.

**loadprog [name]**

Loads a stored program name for running. At the next trigger the loaded program runs.

**unloadprog**

Unload the program.