



# STG3008-FA Manual



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# 1 Introduction

## 1.1 About this Manual

This manual comprises all important information about the installation and operation of the stimulus generator STG3000 series and MC\_Stimulus II software. It is assumed that you have already a basic understanding of technical and software terms. No special skills are required to read this manual.

This documentation refers only to the STG hardware and **MC\_Stimulus II** software. For more information on the STG's DLL functions and programming of custom programs, please read the separate documentation in the documentation folder in the MC\_Stimulus II program directory.

If you are using the STG for the first time, please read the **important safety advice** before **installing** the **hardware** and **software** (see chapter "Important Safety Advice", where you will find important information about the installation and first steps).

The **printed manual** and **help** are basically the same, so it is up to you which one you will use. The help offers you the advantage of scrolling through the text in a non-linear fashion, picking up all information you need, especially if you use the **index** and the **search** function. If you are going to read larger text passages, however, you may prefer the printed manual.

The device and the software are part of an ongoing developmental process. Please understand that the provided documentation is not always up to date.

Check also the MCS web site ([www.multichannelsystems.com](http://www.multichannelsystems.com)) from time to time for downloading up-to-date manuals and new software versions.

## 2 Important Information and Instructions

### 2.1 Terms of Use for MC\_Stimulus II

You are free to use MC\_Stimulus II for its intended purpose. You agree that you will not decompile, reverse engineer, or otherwise attempt to discover the source code of the software.

### 2.2 Important Safety Advice



Warning: Make sure to read the following advice prior to install or to use the device and the software. If you do not fulfill all requirements stated below, this may lead to malfunctions or breakage of connected hardware, or even fatal injuries.



Warning: Obey always the rules of local regulations and laws. Only qualified personnel should be allowed to perform laboratory work. Work according to good laboratory practice to obtain best results and to minimize risks.

The product has been built to the state of the art and in accordance with recognized safety engineering rules. The device may only

- be used for its **intended purpose**;
- be used when in a **perfect condition**.
- Improper use could lead to serious, even fatal injuries to the user or third parties and damage to the device itself or other material damage.



Warning: The device and the software are **not** intended for medical uses and **must not** be used on humans. MCS assumes no responsibility in any case of contravention.

Malfunctions which could impair safety should be rectified immediately.

#### High Voltage

Electrical cords must be properly laid and installed. The length and quality of the cords must be in accordance with local provisions.

Only qualified technicians may work on the electrical system. It is essential that the accident prevention regulations and those of the employers' liability associations are observed.

- Each time before starting up, make sure that the **mains supply** agrees with the specifications of the product.
- Check the **power cord** for damage each time the site is changed. Damaged power cords should be replaced immediately and may never be reused.
- Check the **leads** for damage. Damaged leads should be replaced immediately and may never be reused.
- Do not try to insert anything sharp or metallic into the vents or the case.
- Liquids may cause short circuits or other damage. Keep the device and the power cords always **dry**. Do **not** handle it with wet hands.

## Requirements for the installation

Make sure that the device is not exposed to direct sunlight. Do not place anything on top of the device, and do not place it on top of another heat producing device. Otherwise, the device may overheat.

## 2.3 Limitation of Liability

Multi Channel Systems MCS GmbH makes no guarantee as to the accuracy of any and all tests and data generated by the use of the MC\_Stimulus II software. It is up to the user to use good laboratory practice to establish the validity of his findings.

To the maximum extent permitted by applicable law, in no event shall Multi Channel Systems MCS GmbH or its suppliers be liable for any special, incidental, indirect, or consequential damages whatsoever (including, without limitation, injuries, damages for data loss, loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use MC\_Stimulus II or the provision of or failure to provide Support Services, even if Multi Channel Systems MCS GmbH has been advised of the possibility of such damages.

## 2.4 Operator's Obligations

The operator is obliged to allow only persons to work on the device, who

- are familiar with the safety at work and accident prevention regulations and have been instructed how to use the device;
- are professionally qualified or have specialist knowledge and training and have received instruction in the use of the device;
- have read and understood the chapter on safety and the warning instructions in this manual and confirmed this with their signature.

It must be monitored at regular intervals that the operating personnel are working safely.

Personnel still undergoing training may only work on the device under the supervision of an experienced person.

## 2.5 Guarantee and Liability

The *General conditions of sale and delivery* of Multi Channel Systems MCS GmbH always apply. The operator will receive these no later than on conclusion of the contract. Multi Channel Systems MCS GmbH makes no guarantee as to the accuracy of any and all tests and data generated by the use of the device or the software. It is up to the user to use good laboratory practice to establish the validity of his findings.

Guarantee and liability claims in the event of injury or material damage are excluded when they are the result of one of the following.

- Improper use of the device.
- Improper installation, commissioning, operation or maintenance of the device.
- Operating the device when the safety and protective devices are defective and/or inoperable.
- Non-observance of the instructions in the manual with regard to transport, storage, installation, commissioning, operation or maintenance of the device.
- Unauthorized structural alterations to the device.
- Unauthorized modifications to the system settings.
- Inadequate monitoring of device components subject to wear.
- Improperly executed and unauthorized repairs.
- Unauthorized opening of the device or its components.
- Catastrophic events due to the effect of foreign bodies or acts of God.



## 3 First Use of the Stimulus Generator

### 3.1 Welcome to the STG3008-FA and MC\_Stimulus II



#### Product Line Overview

Stimulus generators of the 3000 series are general purpose stimulators designed for a wide variety of applications, both *in vitro* and *in vivo*. The STG3008-FA is a special version for use with cardiovascular catheter microelectrodes for animals.

The STG is additionally equipped with a filter amplifier FA and has the advantage that the device can be used for both, for stimulation and for recording. You switch software controlled between the two operation modes recording and stimulation.

**Note:** While featuring an amplification function (FA filter amplifier), **the STG3008-FA needs to be connected to a data acquisition for recording.**

The filter amplifier of the STG3008-FA provides four different gain factors 100, 200, 500, or 1000 and has a band pass filter with a bandwidth of 1 Hz to 2.2 kHz.

The stimulus generator STG3008-FA is available for simultaneous stimulation on up to eight completely independent stimulation channels. Each channel is freely programmable, combination of channels to achieve complex stimulation patterns is not necessary.

Flexible and easy-to-use MC\_Stimulus II software enables complex stimulus waveforms (both current and voltage) in Download mode and Streaming mode. Waveforms designed in the program or imported from an external ASCII file are converted into pulses, which are sent to the stimulation electrodes.

**Note:** Please note that not all software features of MC\_Stimulus II are supported by the hardware.

A trigger input and a Sync output for TTL signals allow to synchronize the stimulus generator with other instruments. Triggering of other devices via programmable TTL pulses (**Sync Out**) is possible as well as triggering of the STG by external devices via the **Trigger In** input. For example, you can synchronize **stimulation** and **recording** with a TTL signal sent from the **Sync Out** output of the STG to the data acquisition system, for example, the MC\_Card or an USB based data acquisition system.

The real-time stimulus generator STG3008-FA operates in **Download** mode.

In **Download** mode, you can control the STG either by the **MC\_Stimulus II** or by a custom program. Stimulus protocols are created in **MC\_Stimulus II** or the custom program; complete protocols are downloaded onto the STG, and can after the download be executed without a computer connection.

Custom applications for the **Download** mode can be programmed in Matlab, Labview, C/C++, and Visual Basic. This documentation refers only to the STG hardware and **MC\_Stimulus II** software. For more information on the STG's DLL functions and programming of custom software, please read the separate documentation of the **Documentation** folder in the MC\_Stimulus II program directory.

## MC\_Stimulus II

Stimuli are created user-friendly by entering the desired pulses (**rectangular**, **ramp**, or **sine** waveforms) into a **worksheet**. Waveforms can be combined freely to create virtually any stimulus pattern.

For even more convenience, **repetitive** stimulus patterns do not have to be entered separately, but can be **grouped** and **looped**. You can also **import** waveforms in **ASCII** file format and use them for stimulation. You can **print** and **save** stimuli and **comments** for later use and documentation of your experiments.

Created stimuli are displayed in a **WYSIWYG stimulus display**. All channels are set up separately.

**Creating Stimuli**  
**Menu Toolbar**      **Stimulus protocol worksheet: Generate and edit protocols.**      **Combine pulse types: Use a separate row for each pulse type.**      **You can repeat rows and groups of rows.**

The screenshot shows the MC\_Stimulus II software interface. At the top, there is a menu bar (File, Edit, STG, Batch, Signal, View, Window, Settings, Help) and a toolbar. Below the toolbar, there are status indicators for STG (00005), Connect, Programmed, and Sweep. The main window is titled "MC\_Stimulus II - MC\_Stim\_STG3008-FA.stm".

Below the title bar, there are several control panels:

- Channel:** 5
- Signal Length:** 440.00 ms
- max. Amplitude:** 300  $\mu$ A
- min. Amplitude:** -200  $\mu$ A
- Last Download:** (empty)
- Cont. Mode:** On (radio button), Off (radio button)
- Output Mode:** Voltage (radio button), Current (radio button)
- Download Channel:** 1, 2, 3, 4, 5, 6, 7, 8 (checkboxes)
- Download Sync:** 1 (checkbox)
- Comment:** (text field)

The main area is a **Worksheet** with columns for Channel 1 through Channel 8 and Sync 1. The columns are labeled **Pulse**, **value**, **Unit**, **time**, **Unit**, **value**, **Unit**, **time**, **Unit**, **value**, **Unit**, **time**, **Unit**, **Row rep**, and **Group r**.

Channel	Pulse	value	Unit	time	Unit	value	Unit	time	Unit	value	Unit	time	Unit	Row rep	Group r
1	rectangular	-200	$\mu$ A	60	ms	0	$\mu$ A	60	ms	300	$\mu$ A	100	ms	2	
2	rectangular		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		
3	rectangular		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		
4	rectangular		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		
5	rectangular		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		
6	rectangular		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		$\mu$ A		$\mu$ s		

Below the worksheet is the **WYSIWYG Stimulus Protocol Display**, which shows a multi-channel waveform plot. The x-axis represents time in hh:mm:ss.zzz format, ranging from 00:00:00.000 to 00:00:00.450. The y-axis represents voltage in  $\mu$ A, ranging from -200 to 200. The plot shows various waveforms: rectangular pulses, ramps, and sine waves. A red trace at the bottom represents the Sync signal.

At the bottom of the window, there is a toolbar with various icons for zooming, scrolling, and other functions. The status bar shows "Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7 Ch8 Sync1".

## 3.2 Setting Up and Connecting the STG

Note: You can use an USB hub for connecting the STG to the computer, for example, if you have no free USB port or if you need to extend the USB cable. This does not matter if you want to use the **Download** mode (via MC\_Stimulus II or custom program) only.

Provide a **power supply** and a **computer** with USB port in the immediate vicinity of the installation site. Make sure the STG is **switched off** before you connect it to the power supply.

Place the STG on a stable surface, where the air can circulate freely and the STG is not exposed to direct sunlight.

Connect the external power supply to the STG.

Connect the external power supply to the power outlet.

Connect the USB connector to the USB port of the computer. The computer connection is necessary for programming the STG, but not for operating it (except in Batch mode).

Connect the device to ground. Please use a 4 mm connector, standard common jack.

Connect the catheter to the Stimulus IN / Raw data OUT connector of the STG3008-FA.

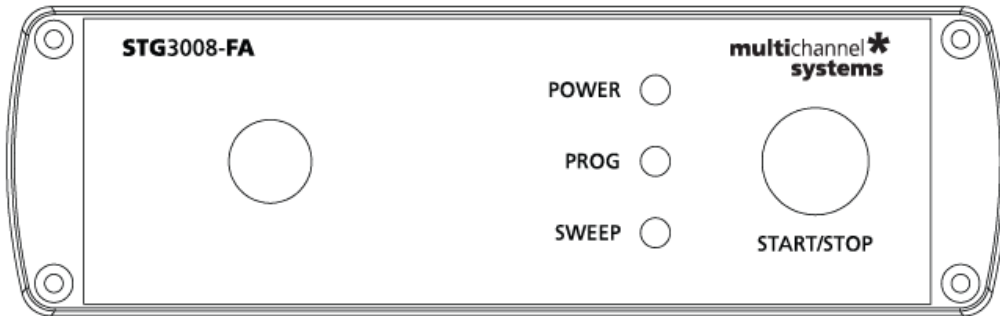
(Optional) Connect the required Trigger In input with BNC cables to instruments that produce TTL signals for triggering the STG.

(Optional) Connect the Sync Out output with BNC cables to following instruments that you want to be triggered by TTL signals from the STG, for example to one of the 16 digital inputs of the MC\_Card, or of an USB based data acquisition.

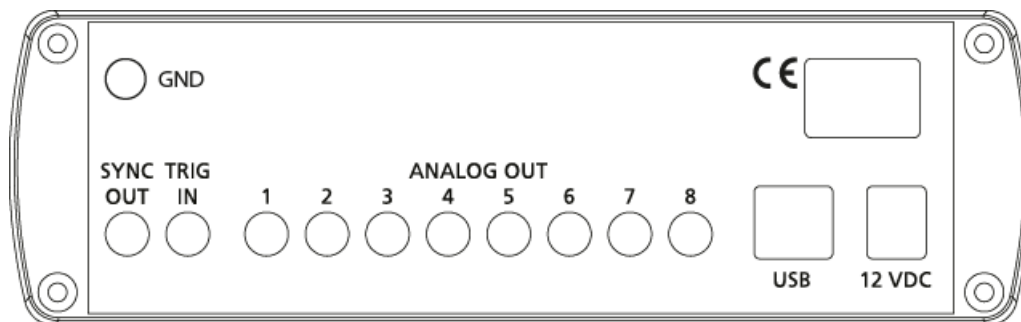
Switch the STG on by pressing the toggle switch on the rear panel.

Illustration of the STG3008-FA front and rear panel with connectors

STG3008-FA Front Panel



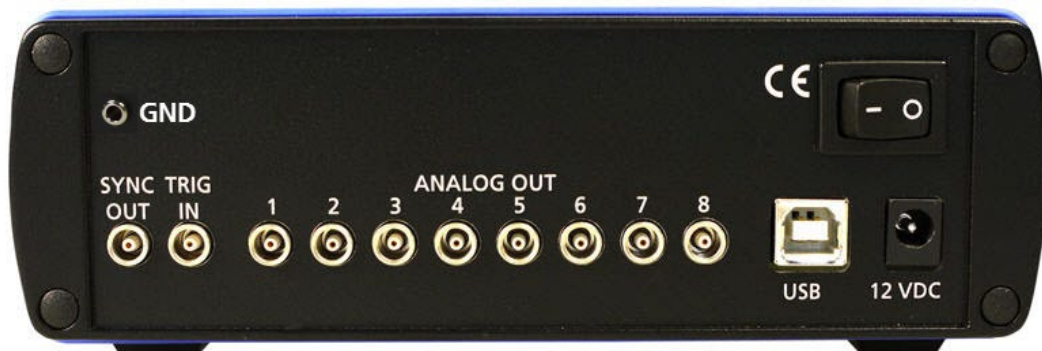
STG3008-FA Rear Panel



STG3008-FA Front Panel



STG3008-FA Rear Panel



### 3.3 Driver Installation

The stimulus generator is a plug and play device. The driver is automatically installed together with the MC\_Stimulus II program.

The Windows operating system detects a new hardware when the stimulus generator is connected to the computer, if the program has not been installed beforehand. Simply cancel the driver installation and proceed with the installation of the MC\_Stimulus II program.

**Important:** Please make sure that you have full control over your computer as an **administrator**. Otherwise, it is possible that the installed hardware does not work properly.

If there are any problems, and you need to install or update the driver manually, please see the MC\_Stimulus II Help for more information.

### 3.4 Installing the Software

#### System requirements

Software: One of the following Microsoft Windows ® operating systems is required: **Windows 10, 8.1, Windows 7, (English and German versions supported).**

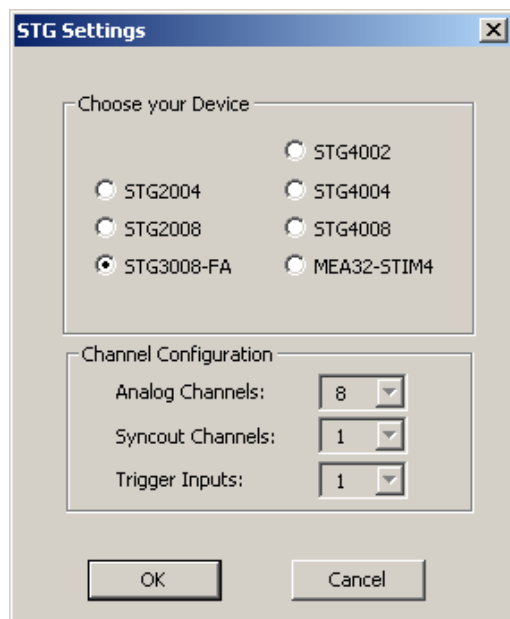
Hardware: **USB** port (2.0 High Speed)

#### Installing the software

Please check the system requirements before you install the software. MCS cannot guarantee that the software works properly if these requirements are not fulfilled.

**Important:** Please make sure that you have full control over your computer as an **administrator**. Otherwise, it is possible that the installed software does not work properly.

Double-click **Setup**.exe on the installation volume. The installation assistant will show up and guide you through the installation procedure. Follow the instructions of the installation assistant.



Select radio button "STG3008-FA". When you have finished the installation of the MC\_Stimulus II software and the STG driver, you can now operate the STG3008-FA.

## 4 Operating the STG

### 4.1 Operation Overview



Warning: Make sure that you do not come in contact with the cables or the connectors of the STG after you have started the STG. The high voltage and power can lead to **injuries**.



Warning: Do not start the STG if you are unsure about the channel configuration or the nature of the downloaded file.

1. Set up your experiment.
2. Switch the STG3008-FA on.
3. Set up your stimuli with the MC\_Stimulus II program.
4. Send the stimulus sequence from a MC\_Stimulus II file to the STG.
5. Start the STG either manually by pressing the **Start / Stop** button on the front panel, with the **software controls**, or with an **external trigger**.

#### Creating stimuli

Stimuli are created user-friendly by entering the desired pulses (rectangular, ramp, or sine waveforms) into a MC\_Stimulus worksheet. Waveforms can be combined freely to create virtually any stimulus pattern. Created stimuli are displayed in a WYSIWYG window.

#### Starting stimulation



**Note:** You need a computer connection only when you are using the software controls for starting and stopping the stimulus generator. When you are using the STG interface or an external control (trigger, you can disconnect the stimulus generator from the computer and operate it independently. But you cannot remove the STG from the power connection. The memory is cleared when the STG has lost power.


**Important:** Please use voltage pulses if possible! Current pulses may lead to temporary baseline shifts at the beginning and end of the stimulation paradigm due to switching artefacts.

After the download of the stimulus file on the STG, you can start the stimulation. There are several ways to start the STG.


#### MC\_Stimulus II interface:

You can start the stimulation directly after the download (with the command

**Download and Start**  or also later with the command **Start** . You can

stop stimulation with the command **Stop** . Starting the STG by using the **Start** command is considered as activating the trigger input and the Sync Out output. Likewise, **all** channels are stopped when you click **Stop**.

You can start the stimulation after download  on the trigger. Please use the

combined LED / Start / Stop buttons . You can start and stop the stimulation **manual** whenever you want by clicking the corresponding LED / Start / Stop button. The LED indicates the status: Grey means trigger off, red means trigger on. In STG3008-FA only trigger 1 is available.

**STG interface:** You can start the stimulation by pressing the **Start / Stop** button on the **front panel** of the STG. Press the button again to stop the stimulation. Starting the STG by pressing the **Start / Stop** button is considered as activating the trigger input, that is, **all** channels are started and stopped, and the **Sync Out** output is active when the STG is started. Pressing the **Start / Stop** button **stops** the stimulation if at least **one** channel is still active in the moment of the trigger event (indicated by the lighting SWEEP LED). Pressing the button **starts** stimulation only if **no** channel is active (dark SWEEP LED)

**External control:** You can start the stimulation on a trigger from an external device, for example, a switch. You can use the trigger input to trigger the analog output channels that you have assigned to it. The trigger works in a similar way as when you press the Start / Stop button. You can choose the action that will be taken when one of the channels that are assigned to the trigger input is still active. Either the stimulus protocols on the triggered channels are stopped or restarted; or the trigger event is ignored. You can assign the Sync Out to the trigger input. The default settings define that Sync Out is active when Trigger In is triggered. Please see chapter "Trigger Settings" for more details.

### STG status control

Three status control LEDs (light-emitting diode) are present on the front panel of the STG to give you a quick overview on its status.

**POWER** STG has been switched on.

**PROG** Stimulus file was downloaded to STG. STG is now ready for operation.

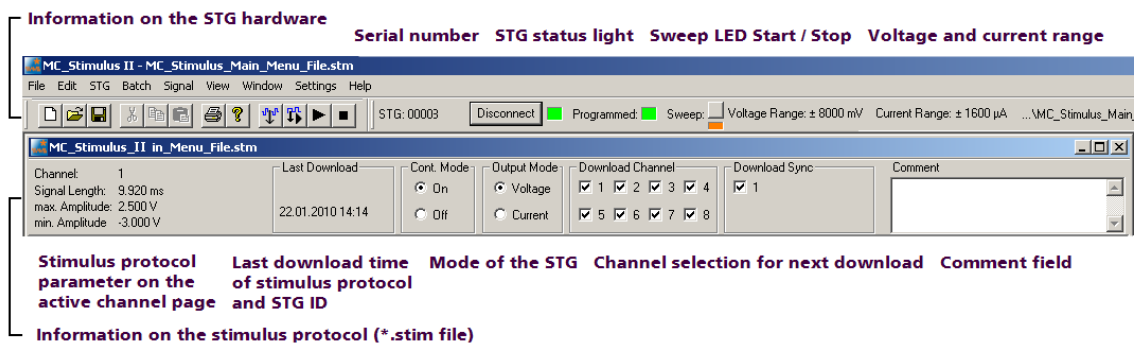
**SWEEP** Stimulation is running, that is, at least one output channel is active.

### MC\_Stimulus II status control

The top part of the MC\_Stimulus II status control refers to the active instance of the MC\_Stimulus II program instance and the STG that is controlled by this instance. All information in this part is saved on the STG. The information is updated in the MC\_Stimulus II main window when the connection to the STG is changed or interrupted.

Status light	Color	Meaning
<b>Connected</b>	Green	STG is connected and switched on. The serial number serves as an ID for the controlled STG and is displayed on the left. On the <b>STG</b> menu, click <b>Select Device</b> to select another STG connected to a different USB port from the drop-down list to switch STGs.
<b>Programmed</b>	Green	Stimulus file in voltage mode has been downloaded to STG. STG is now ready for operation. File name and path of the "*.stm" file that was downloaded onto the STG are displayed on the right.
	Orange	Stimulus file in current mode has been downloaded to STG. STG is now ready for operation. File name and path of the "*.stm" file that was downloaded onto the STG are displayed on the right.
<b>Sweep</b>	Red	Indicates the active <b>trigger</b> (up to eight). Each stimulation channel can be assigned to any trigger. If all eight channels are assigned to trigger one for example, only one sweep indicator will light up, even though all stimulation channels can be active. See also chapter "Triggering Stimulation".

## STG and Stimulus Protocol Information:

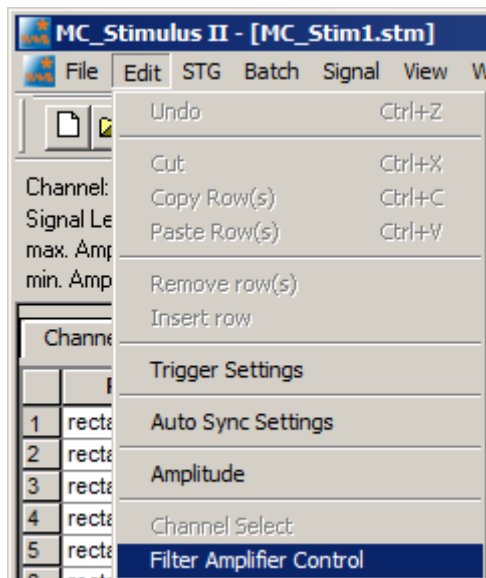


## 4.2 Operating the Amplifier

### Switching between Stimulation and Recording Mode

The STG3008-FA is a stimulus generator of STG3000 series combined with a filter amplifier with four selectable gain factors: 100, 200, 500, or 1000.

Please click "Edit" menu and select "Filter Amplifier Control".



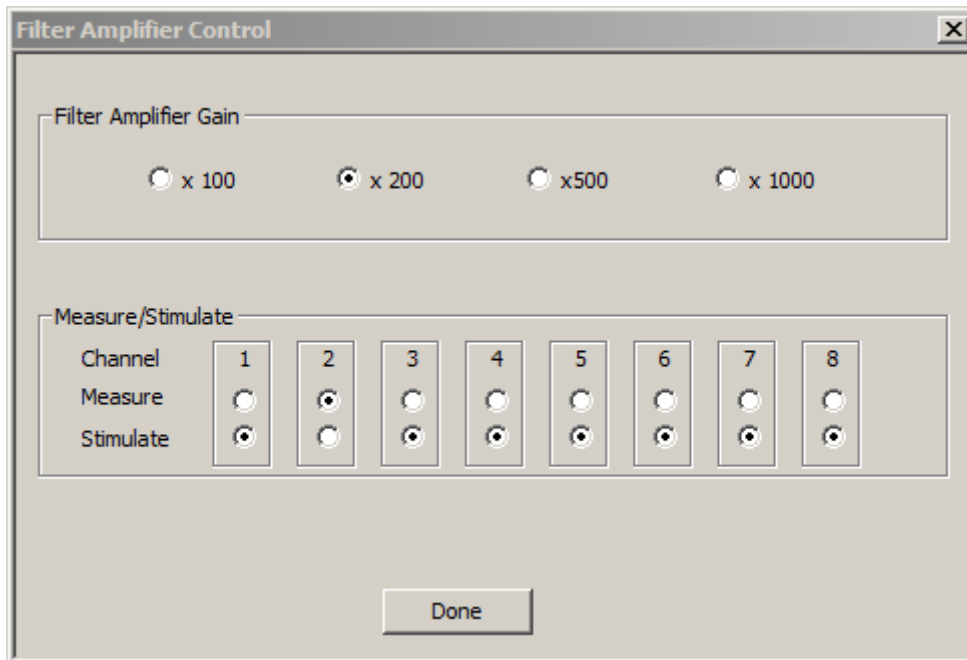
The "Filter Amplifier Control" settings are saved in the current MC\_Stimulus II protocol. After download, the STG3008-FA is set accordingly.

Thus, it is easy to switch between different measuring or stimulation settings by loading several MC\_Stimulus II worksheets. Then you can download the protocol with the desired settings.

If the STG3008-FA is switched off and on again, the settings for all eight channels are reset to "Measure", and the last downloaded filter amplifier gain is retained. This reset enables measurements with the STG3008-FA without using the MC\_Stimulus II software, of course without stimulation, respectively.



The "Filter Amplifier Control" dialog.



### Selecting the "Filter Amplifier Gain"

You can choose among four gain settings from factor 100 to 1000.

In the "Filter Amplifier Gain" window, please click one of the radio buttons to select the gain factor.

Choose the "Channel" status in the "Measure / Stimulate" window.

**Important:** When starting a new experiment, all channels are automatically switched to "Measure". Please switch each channel to "Stimulate" and back to "Measure" status to be sure the filter amplifier device in the STG3008-FA has switched to "Measure" mode.

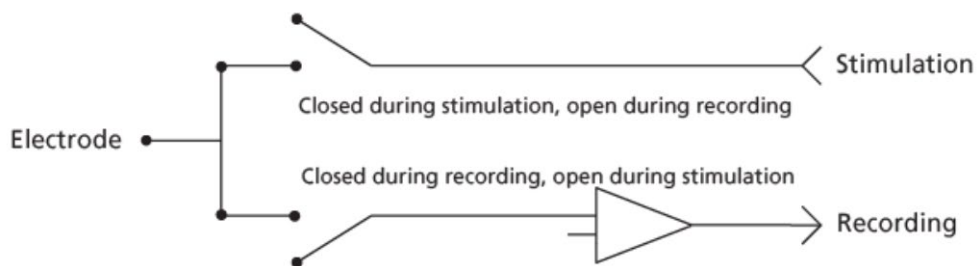
### Selecting the "Measure / Stimulate" mode

In the "Measure / Stimulate" window you can toggle between stimulation and recording mode for each of the eight channels separately.

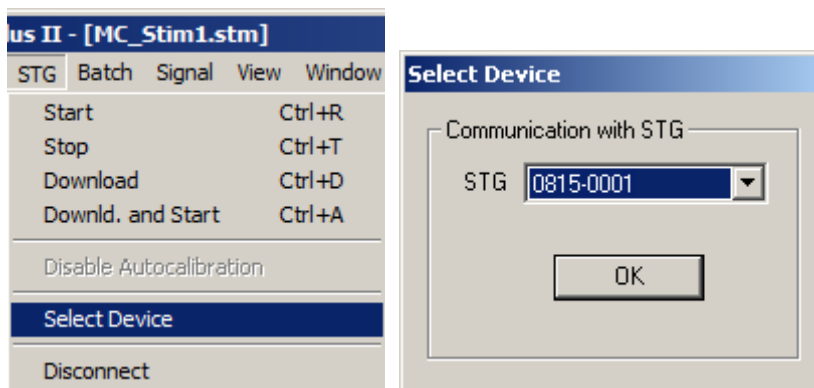
Please click the respective radio buttons for the channels in use.

**Important:** A **ground electrode** connected to the ground of the STG3008-FA amplifier is required for proper use. The ground of the stimulation is connected to the ground of the amplifier inside the device. The amplifier ground is the reference point for both stimulation and recording. Without an appropriate grounding, the behavior of the system becomes unpredictable. The ground electrode should have a large surface area, for example, a liquid gel adhesive electrode. It is best positioned in an electrically inactive region (not near muscle, nor heart), but as near to the recording site as possible, for example, at the belly.

### Internal switch positions during stimulation and recording



## 4.3 Operating Multiple STGs



If you have more than one STG connected to the same computer, please click "Select Device" under "STG" in main menu. In the "Select Device" dialog you can choose via serial number which STG you like to control from the currently active MC\_Stimulus II program.

- The serial number is printed on the STG's case. The **serial number** of the currently active STG is displayed on the status bar of the currently active instance of the MC\_Stimulus II program.



- Click **Select Device** under "STG" in main menu. Select the serial number of the desired STG from the **STG** list.
- You can open multiple instances of the MC\_Stimulus II program and control multiple STGs at the **same** time. Please make sure that you control **each** STG only by **one** MC\_Stimulus II instance.
- You can also open only **one** MC\_Stimulus II instance and control multiple STGs one **after** the other by the same instance. Simply change the settings in the **Select Device** dialog and select the next STG when you have finished to program the first. The STGs can be operated without a computer connection.

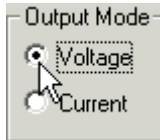
## 5 Programming Stimulus Protocols

### 5.1 MC\_Stimulus II Worksheet

You can freely combine any pulse types. Use a separate row for each pulse type.

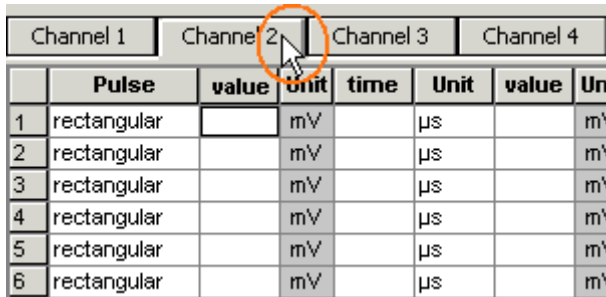
**Hint:** Several tools are provided for editing whole columns at once or autocreating entries.

1. Select the desired **output type** first. Click either **Voltage** or **Current** under **Output Mode** on the file window of MC\_Stimulus.



**Note:** In current mode, a protection switch disconnects the current source from the electrode, to avoid leak currents. The switch opens as soon as the stimulation pattern starts. To allow some time for the switch to open, it is recommended to start current pulses with a short period of 0  $\mu$ A. 40  $\mu$ s is sufficient.

2. Click a tab to select an **output channel**. The according channel worksheet is brought to front.



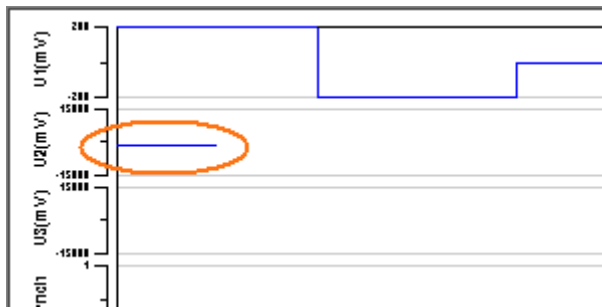
	Pulse	value	unit	time	Unit	value	Un
1	rectangular		mV		$\mu$ s		mV
2	rectangular		mV		$\mu$ s		mV
3	rectangular		mV		$\mu$ s		mV
4	rectangular		mV		$\mu$ s		mV
5	rectangular		mV		$\mu$ s		mV
6	rectangular		mV		$\mu$ s		mV

3. Now you can enter the pulses into the worksheet. Select a **Pulse** type (either **rectangular**, **ramp**, or **sine**).

4. Enter the desired voltage steps and a time length for each step.

	Channel 1	Channel 2	Channel 3	Channel 4			
	Pulse	value	Unit	time	Unit	value	Un
1	rectangular	-1000	mV	10	ms		mV
2	rectangular		mV		us		mV
3	rectangular		mV		ms		mV
4	rectangular		mV		s		mV
5	rectangular		mV		min		mV
6	rectangular		mV		h		mV

The according pulse is displayed in the WYSIWYG display at once.



## 5.2 Pulse Types

Three basic pulse types are available in MC\_Stimulus II. You can create virtually any pulse by combining different types.

- Rectangular
- Ramp
- Sine wave

**Note:** The **time resolution** is **20  $\mu$ s**. When you enter time steps that are not a multiple of 20  $\mu$ s, the length of the step is **internally** adjusted (rounded arithmetically, that is, 249  $\mu$ s would be rounded down to 240  $\mu$ s, 250 would be rounded up to 260  $\mu$ s) to a valid value. The **minimum voltage resolution** is **1 mV**, the **current resolution** is **200 nA**. Please regard also the **minimum and maximum output voltage / current** of your STG version. If you enter voltage or current values outside the STG's limit, the invalid value will be changed automatically when you download the protocol. Cells with changed values will be highlighted in yellow.

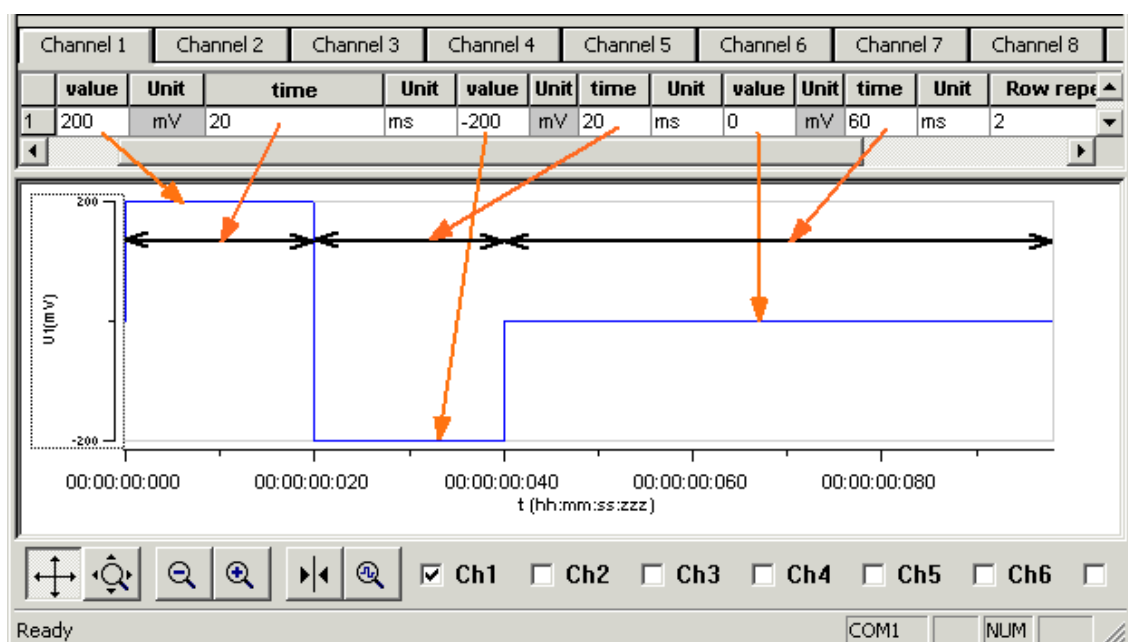
**Note:** If you work **near** the resolution **limits** of the STG, the **output pulses** may **differ** from the **programmed pulses**. In this case, you should check the output with an oscilloscope. Please see also the "Analog Output Signals" chapter.

2	Channel 3	Ch
Unit	time	Unit
mV	30	$\mu$ s
mV		$\mu$ s
mV		$\mu$ s

Please note that the memory of the STG3008-FA is limited (64 MB). You will get an error message if the memory is full.

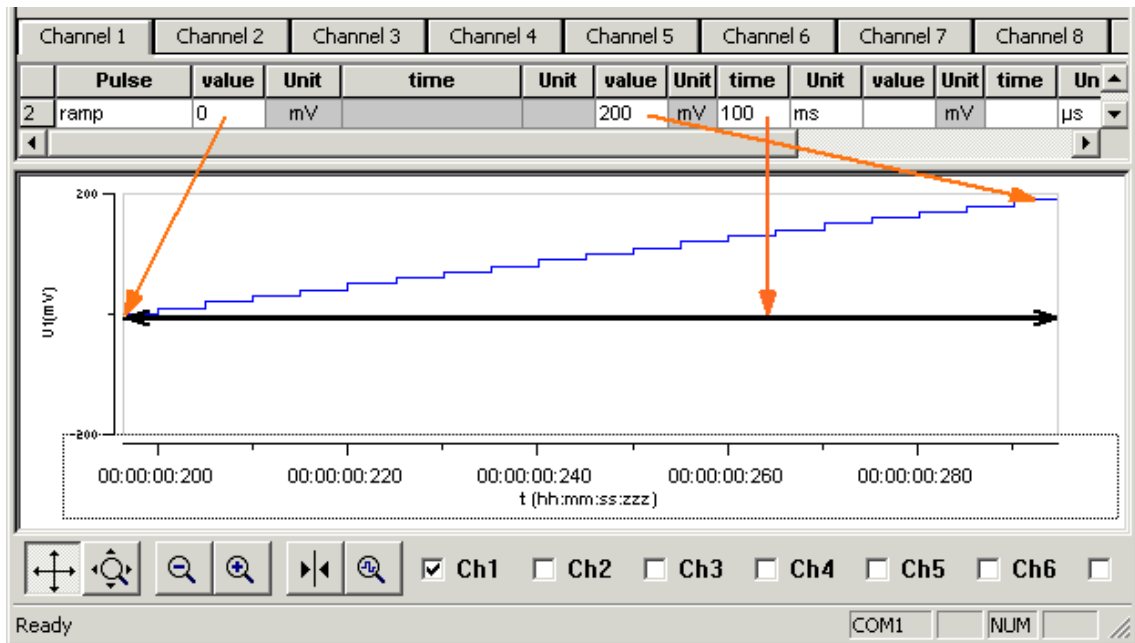
For the digital **Sync Out** channel, only TTL pulses with bit patterns of 0 (LOW) and 1 (HIGH) can be programmed. A logical state of **1 (HIGH)** results in a **3.3 V** output signal, and a logical state of **0 (LOW)** results in a **0 V** output. Please note that the digital output is sent about **20  $\mu$ s** faster than the analog output. Please see also the "Triggering Stimulation" chapter.

### Rectangular pulse type



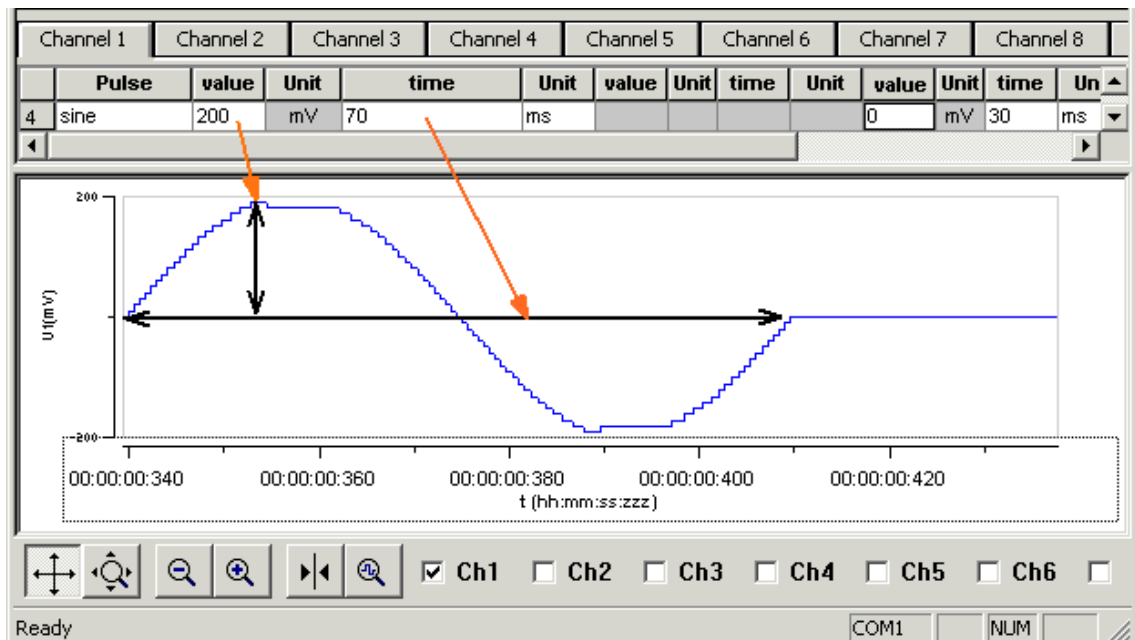
- Enter each voltage / current **level** and the **duration** of the pulse. The voltage / current jumps directly to the specified level. In one row, you can enter up to three voltage / current levels. Use the next row for programming more levels.

### Ramp pulse type



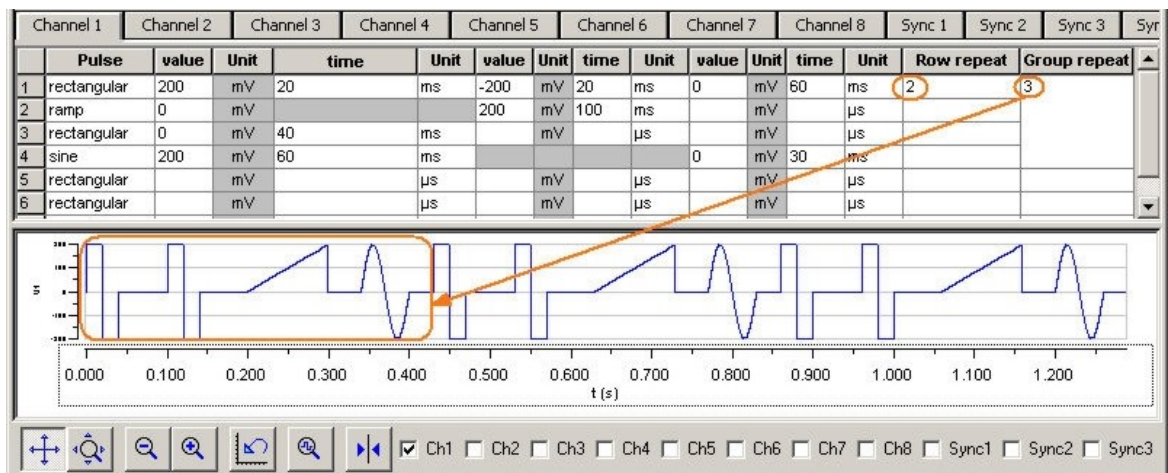
- Define the **starting point**, **end point**, and the **length** of the ramp. The ramp is then build according to these parameters in small single steps of 20  $\mu$ s.

### Sine wave pulse type



- Define the **amplitude** and the **period** of the sine wave. The sine wave is then computed according to these parameters with a minimum resolution of 1 mV and 20  $\mu$ s. If you enter a negative amplitude, the sine wave starts with its negative alternation.

## 5.3 Autorepeating Pulses and Protocols



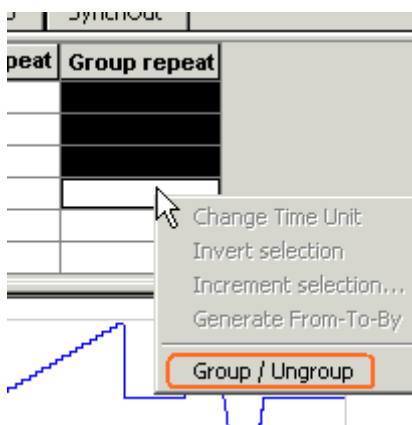
For entering complex stimuli easier and faster, you can **repeat rows** and **groups** instead of entering the pulses several times into the worksheet. You can repeat each single row. In the preceding example, the rectangular pulse in row 1 is repeated twice. You can also group several rows and repeat them altogether. In the example, pulses from rows 1 to 4 are grouped and repeated three times.

### Repeating rows

→ Type the number of repeats into the **Row Repeat** cell of the appropriate row. The pulses of the complete row are repeated the specified number of times.

### Grouping and repeating groups

1. Select several cells by clicking and dragging cells in the **Group Repeat** column. Selected cells are highlighted in black.
2. Point to the selected cells and right-click to open the context menu.



3. Click **Group / Ungroup**. The corresponding rows are grouped now. This is indicated by a merging of the **Group Repeat** cells.

4. Type the number of repeats into the merged **Group Repeat** cell.

Repeat	Group repeat
	3

### Repeating complete pulse protocols (autorepeat function), Continuous Mode

You can repeat the complete stimulus on all output channels that are triggered by the same **trigger**. This means, each time when a trigger event occurs, the complete stimuli on all corresponding output channels are repeated for the specified number of times. If the stimuli have different lengths, the starting points are **synchronized**. For example, if channel 1 has a stimulus with a length of 500 ms, and channel 2 of 1000 ms, and both are triggered by the same trigger event, channel 1 waits 500 ms for the repeat until the output stream of channel 2 has been finished.

**Note:** The Sync Out signal for the corresponding trigger is repeated as well each time the stimulus is repeated.

**Hint:** You can repeat the complete stimulus protocol that is assigned to a trigger **continuously** by using the **Continuous Mode** setting. Continuous mode can be activated in the main window or under Trigger Settings. The STG has then to be stopped manually by the user. You can use this feature regardless whether you use an external trigger input or not. When you press the **Start** button, this is considered as if all four trigger inputs were active. When you use Continuous Mode, the repeats entered in the Trigger Settings dialog box are disabled.

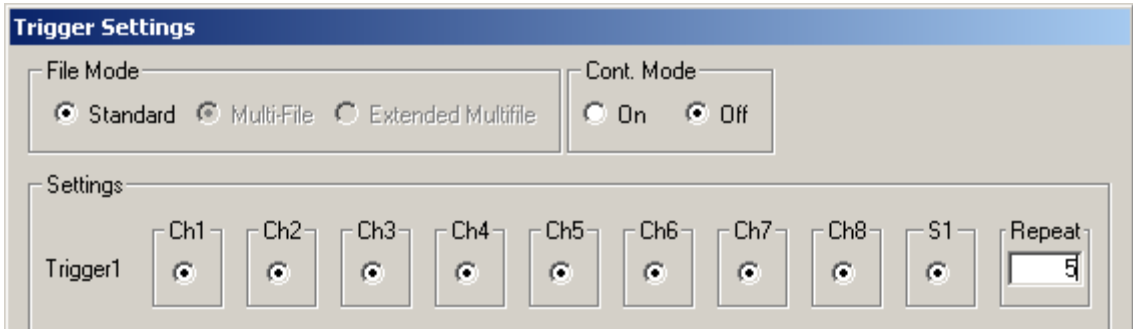
Last Download 000008 05.08.2011 13:48	Cont. Mode <input checked="" type="radio"/> On <input type="radio"/> Off	Output Mode <input checked="" type="radio"/> Voltage <input type="radio"/> Current
---	--	--

Trigger Settings										
File Mode <input checked="" type="radio"/> Standard <input type="radio"/> Multi-File <input type="radio"/> Extended Multifile					Cont. Mode <input checked="" type="radio"/> On <input type="radio"/> Off					
Settings	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	S1	Repeat
Trigger1	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	1

1. On the **STG** menu, click **Trigger Settings**.
2. Enter the number of repeats for each trigger separately. 0 repeats the output signals continuously.

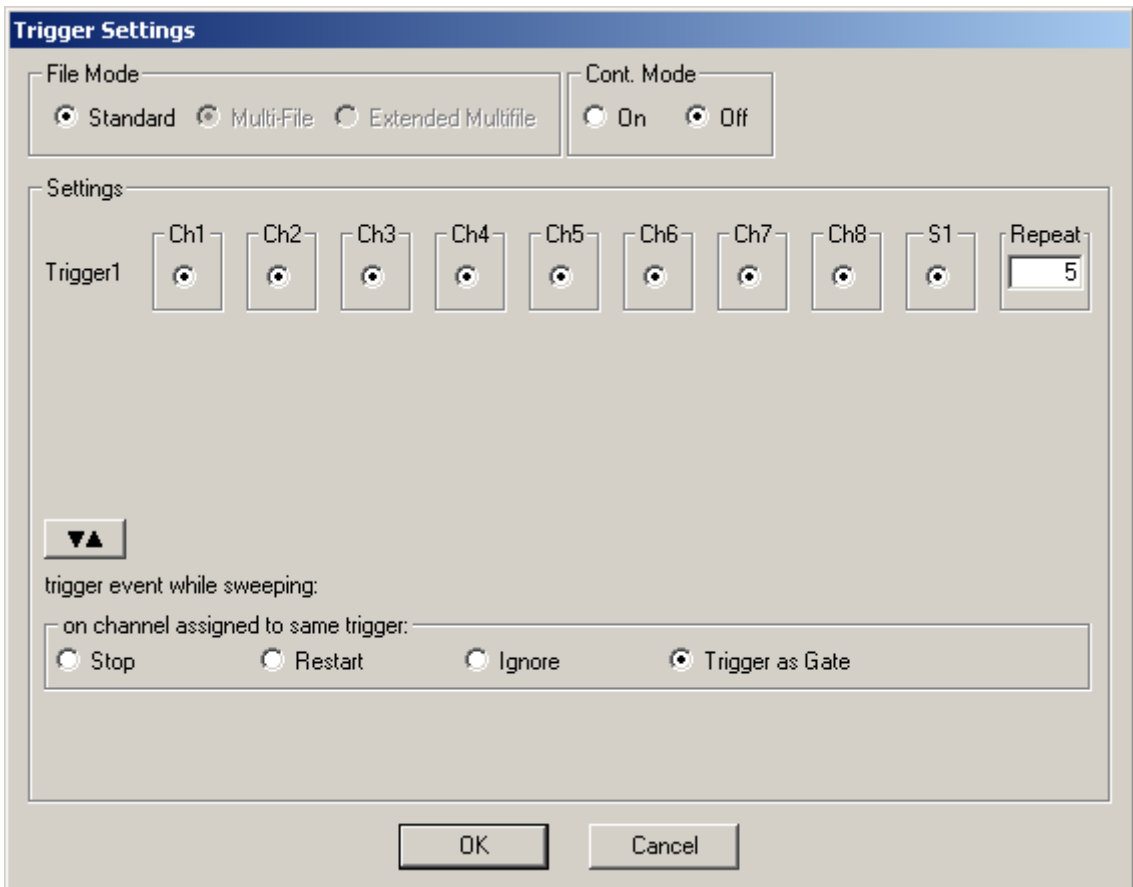


In the following example, the stimuli on output channels 1, 2, 4, 5 and channel 7 and 8, that are all triggered by Trigger 1, are repeated five times after the trigger event, each time accompanied by the Sync Out 1 output.



### Repeating complete pulse protocols, Gating Trigger

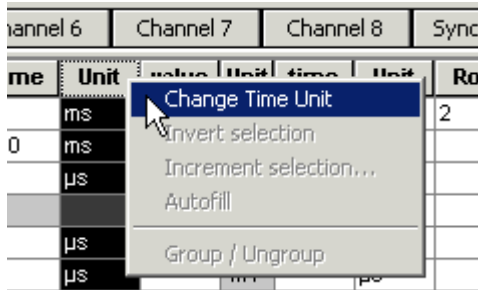
Repeated stimulation of complete protocols can also be controlled by a gating trigger. Channels associated with the Trigger input will be active as long as the condition of the Trigger is 1 (HIGH) and switched off as soon as the condition becomes 0 (LOW). Gating trigger function can be enabled in the Trigger Settings menu.



## 5.4 Autocreating Entries and Editing Columns

### Changing time units for a complete column

1. Click any **Unit** column header to select a column. The selected column is highlighted in black.
2. Right-click and click **Change Time Unit**.



3. Select the desired time unit.



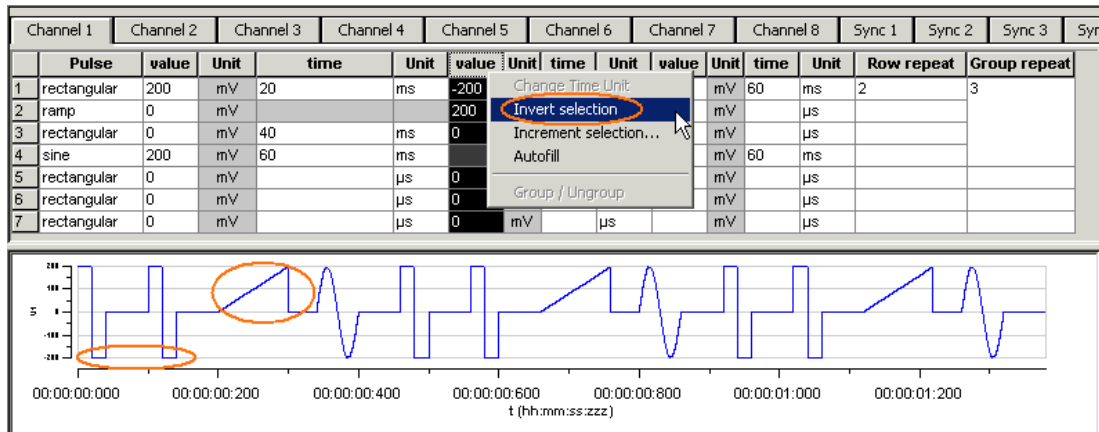
All units in the column are set to the selected time unit.

A screenshot of the data table showing the result of changing the time unit. The 'Unit' column header is highlighted in black. The 'Unit' column contains the value 's' for all rows. The 'Value' column contains the value '0' for all rows.

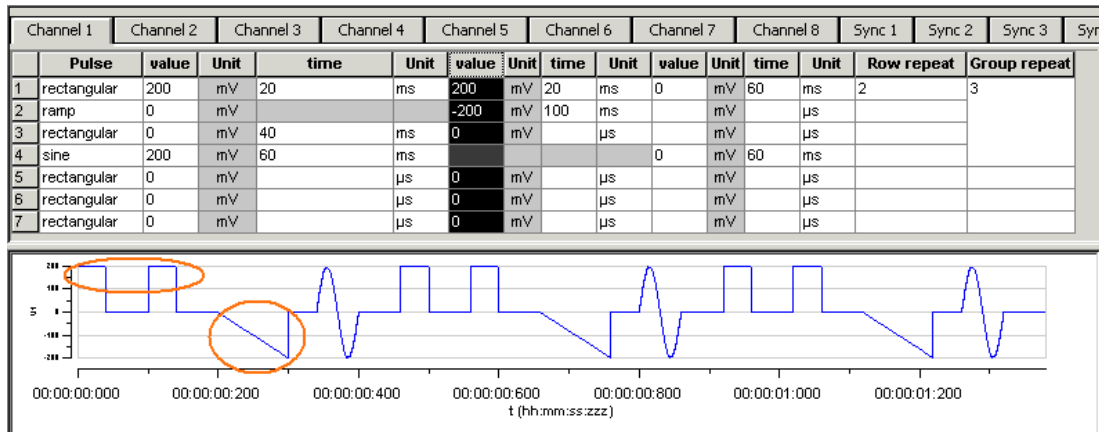
Channel 6	Channel 7	Channel 8	Sync	Name	Unit	Value	Unit	Time	Unit	Row
					s	0				1
					s					2
					s					3
					s	0				4
					s					5
					s					6

## Inverting pulses in a column

1. Click any **Value** column header to select a column. The selected column is highlighted in black.
2. Right-click and click **Invert Selection**.



The polarity of the signals is switched from positive to negative and vice versa.



## Incrementing columns

This feature is very convenient for setting up long and complex stimuli without entering each value manually. You can enter and edit multiple voltage values or time lengths.

You can keep all zero values **unchanged** with the option **Keep Zero**.

Apart from an absolute shift or increment factor, you can modify values by the **percentage** as well.

## Shifting time or voltage / current values

You enter a value, which is added arithmetically to all values in the selected column. For example, if you enter "-50", -50 is added to all values.

1. Click any **Value** or **Time** column header to select a column. The selected column is highlighted in black.

- Right-click and click **Increment Selection**.

	Pulse	value	Unit	time	Unit	value	Unit	time	Unit	value	Unit	time	Unit	Row rep	Group r
1	rectangular						mV		µs		mV		µs		
2	rectangular						mV		µs		mV		µs		
3	rectangular						mV		µs		mV		µs		
4	rectangular						mV		µs		mV		µs		
5	rectangular						mV		µs		mV		µs		
6	rectangular						mV		µs		mV		µs		

00:00:00.000 t (hh:mm:ss:zzz) 00:00:00.001

- Under **Type of Increment**, select **Shift**.
- Enter the desired value.

Increment selected column(s)

Increment selected values

by: 100 %

Type of Increment

Count  Keep Zero

Shift

Absolute value

OK Cancel

	Pulse	value	Unit	time	Unit	value	Unit	time	Unit	value	Unit	time	Unit	Row rep	Group r
1	rectangular		mV		µs										
2	rectangular		mV		µs										
3	rectangular		mV		µs										
4	rectangular		mV		µs										
5	rectangular		mV		µs										
6	rectangular		mV		µs										

00:00:00.000 t (hh:mm:ss:zzz) 00:00:00.001

All values in the selected column are modified by the selected factor. In the example, 100 is added to all values, resulting in a total of 100 because the initial value has been 0.

	Pulse	value	Unit	time	Unit	value	Unit	time	Unit	value	Unit	time	Unit	Row rep	Group r
1	rectangular	100	mV		µs		mV		µs		mV		µs		
2	rectangular	100	mV		µs		mV		µs		mV		µs		
3	rectangular	100	mV		µs		mV		µs		mV		µs		
4	rectangular	100	mV		µs		mV		µs		mV		µs		
5	rectangular	100	mV		µs		mV		µs		mV		µs		
6	rectangular	100	mV		µs		mV		µs		mV		µs		

00:00:00.000 t (hh:mm:ss:zzz) 00:00:00.001

## Creating time or voltage / current increments

With this option, you enter a base value for modification of all values in the selected column. The first row is modified by the base value. The second row is modified by the double value, the third row by thrice the base value, and so on. With this feature, you can easily set up time or voltage increments.

1. Under **Type of Increment**, select **Count**.
2. Enter the desired start value.

The screenshot shows the 'Increment selected column(s)' dialog box. The 'by' field is set to 10, and 'Count' is selected under 'Type of Increment'. The background shows a table with 6 rows of pulse data.

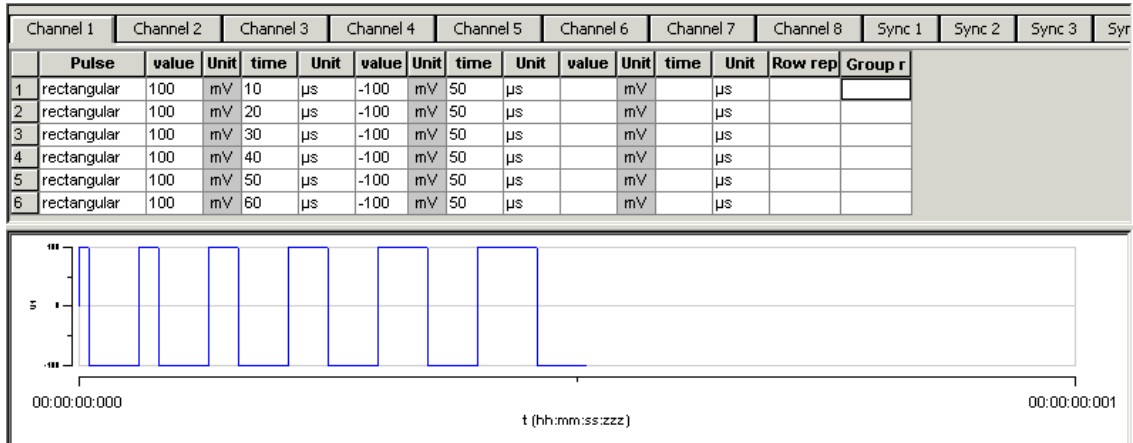
	Pulse	value	Unit	time	Unit
1	rectangular	100	mV		μs
2	rectangular	100	mV		μs
3	rectangular	100	mV		μs
4	rectangular	100	mV		μs
5	rectangular	100	mV		μs
6	rectangular	100	mV		μs

The value in the first row is incremented by the selected start value of 10. The next value is modified by the double value (20), and so on.

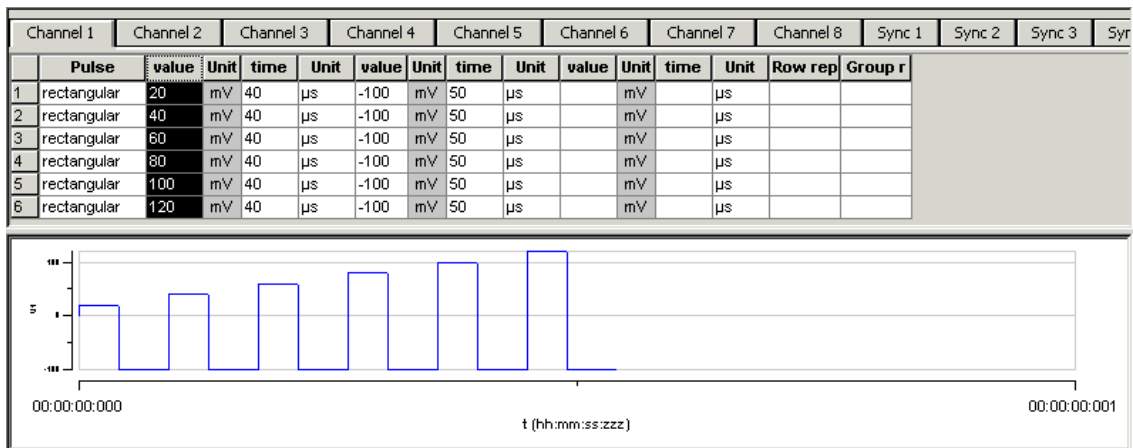
The screenshot shows the main software interface with the updated pulse table. The 'time' column values are now 10, 20, 30, 40, 50, and 60. The waveform plot below shows a single rectangular pulse.

	Pulse	value	Unit	time	Unit	value	Unit	time	Unit	value	Unit	time	Unit	Row rep	Group r
1	rectangular	100	mV	10	μs		mV		μs		mV		μs		
2	rectangular	100	mV	20	μs		mV		μs		mV		μs		
3	rectangular	100	mV	30	μs		mV		μs		mV		μs		
4	rectangular	100	mV	40	μs		mV		μs		mV		μs		
5	rectangular	100	mV	50	μs		mV		μs		mV		μs		
6	rectangular	100	mV	60	μs		mV		μs		mV		μs		

You can now fill further columns in the same way. Thus, you can easily set up a stimulus with incremented pulse lengths like this with only a few mouse-clicks.



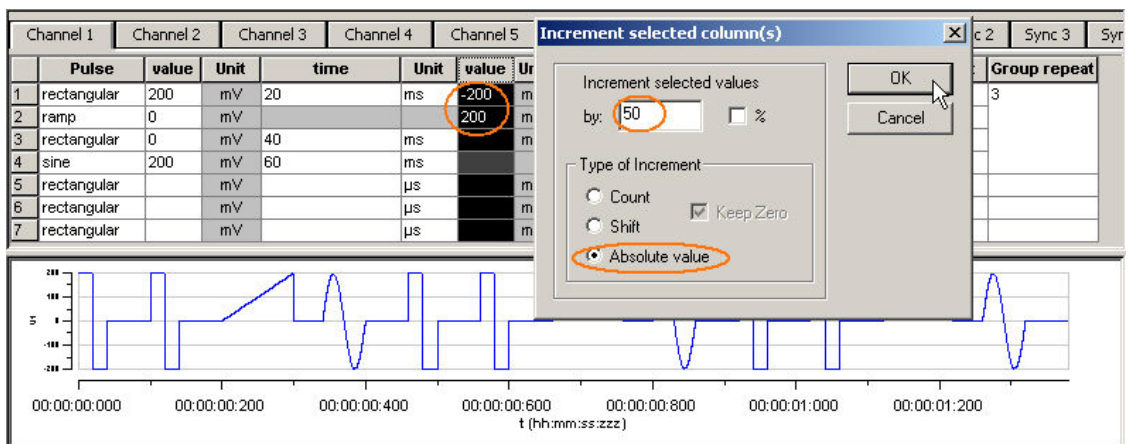
In the same way, you can set up a stimulus with voltage / current increments.



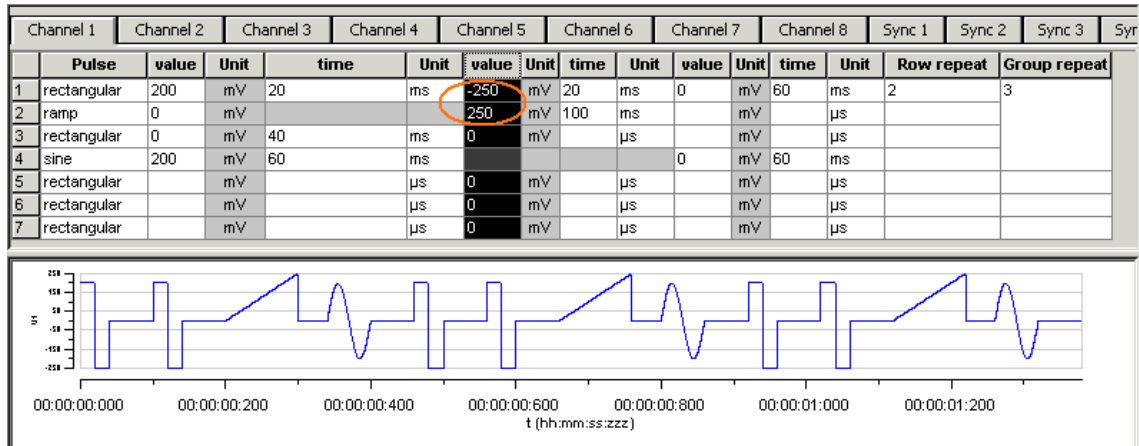
### Shifting absolute time or voltage values

With this option, the signs of the selected values are ignored. Zeros are never changed, that is, the option **Keep Zero** cannot be deselected.

1. Under **Type of Increment**, select **Absolute Value**.
2. Enter the desired shift factor.



The absolute values of 200 and 200 are both 200. This absolute value of 200 is modified by the shift factor of 50, resulting in 250. The negative value is now 250, and the positive value is 250. (If you had chosen the option **Shift** instead, the computed result would have been  $200 + 50 = 150$ .) All zero values are not changed.

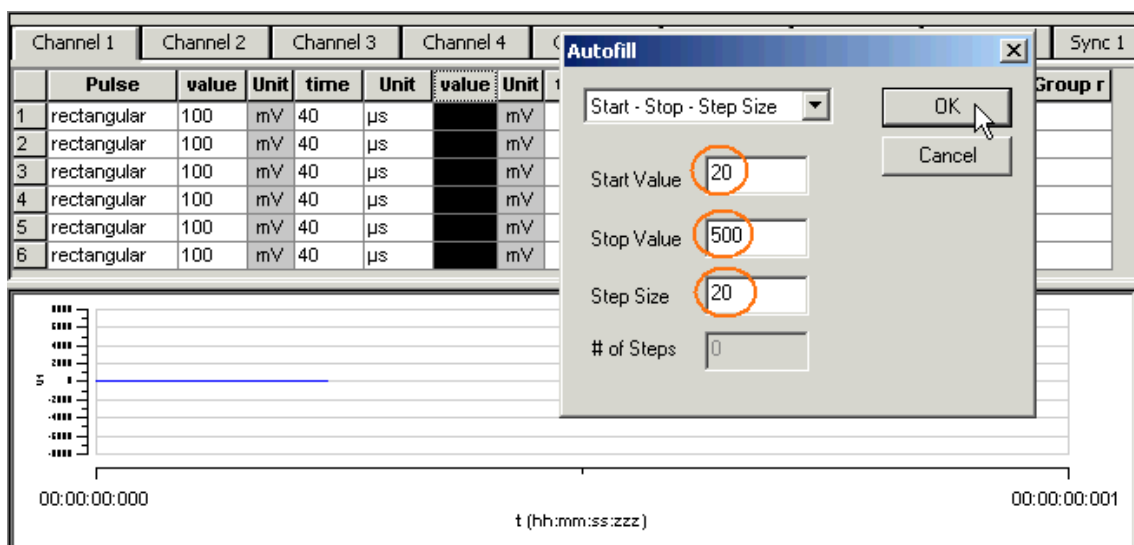


### Autocreating entries

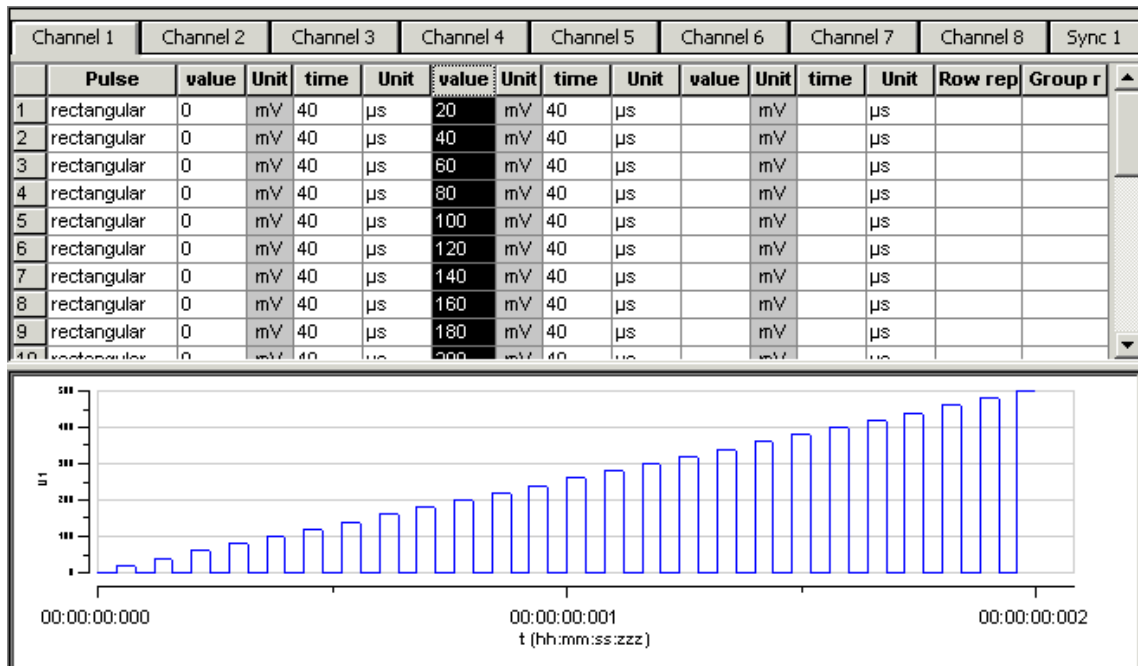
You can use the **Autofill** feature to set up advanced time or voltage/current increments. You define the **Start** and **End** value and either the **Step Size (Start - Stop - Step Size)** or the number of **Steps (Start - Stop - # of Steps)**. Alternatively, you can enter the **Step Size** and the **Number of Steps (Start - Step Size - # of Steps)**. According to these specifications, rows are inserted and the column is filled automatically.

In the following example, the **Autofill** feature has been used to create a voltage step series from 20 mV to 500 mV with an increment of 20 mV.

1. Click any **Value** or **Time** column header to select a column. The selected column is highlighted in black.
2. Right-click and click **Autofill**.
3. Select one out of three commands and fill in the white text boxes.



The column is filled according to the specifications.

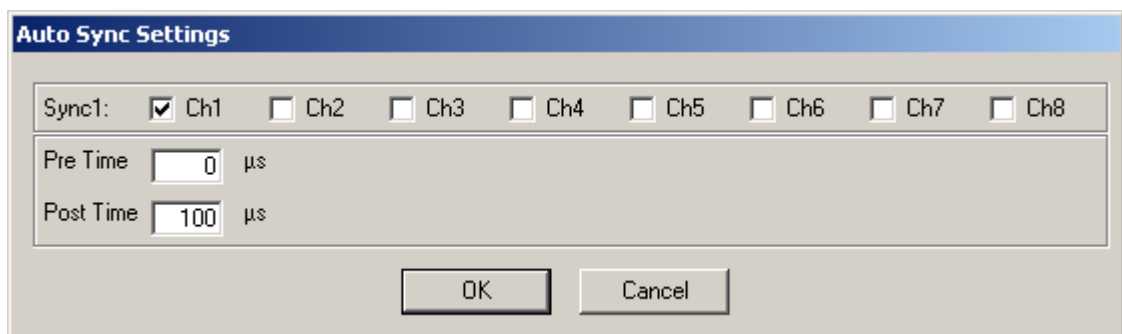


## 5.5 Auto Sync for Autocreating Trigger Pulses

If you want to synchronize other devices with the stimulus generator STG3008-FA, you have to set up the digital output of the Sync Out channel in synchrony to the stimulus pulses. This may sometimes be a bit tricky and time consuming, especially for complex stimulus protocols.

The **Auto Sync** feature is intended for making the work with MC\_Stimulus II more efficient: Digital Sync Out TTL pulses synchronous to stimulus pulses are generated automatically by this feature. Each time an analog channel generates a pulse (that is, its value is not equal to zero), the logical state of the Sync Out channel is set to HIGH (=1). You can set the time offset of the TTL's rising edge before the stimulus pulse and of the TTL's falling edge after the pulse. If you change the stimulus protocol, corresponding Auto Sync pulses are updated on the fly.

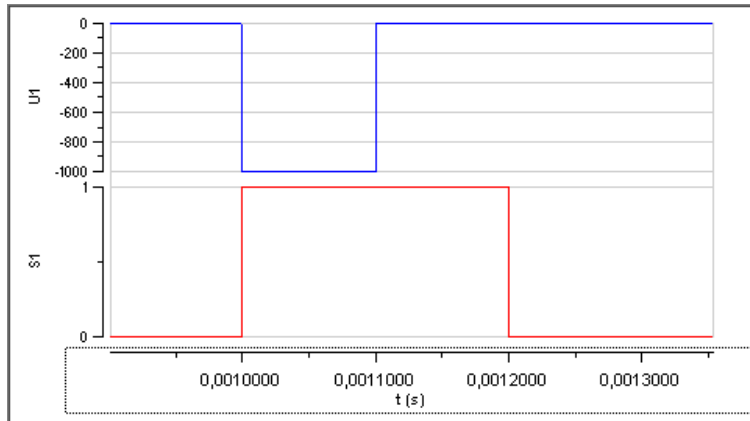
On the **Edit** menu, click **Auto Sync Settings**. The **Auto Sync Settings** dialog box appears.



1. Assign the analog stimulus channels that will be used as the basis for autocreating the protocols on the Sync Out channel. For example, if you use only stimulus channel 1, select **Ch1** in **Sync1**.
2. Set the time offset of the TTL's rising edge before the stimulus pulse (**Pre Time**) and of the TTL's falling edge after the pulse (**Post Time**)



- On the **Settings** menu, click **Auto Sync** to enable the **Auto Sync** feature. The Sync Out protocols will be autocreated in synchrony with the pulse protocols on the assigned channels, will show up in the **WYSIWYG window** immediately, and will be downloaded onto the STG with your next download. (Please make sure that the display and download options are appropriate, that is, all necessary Sync Out channels are selected.) The **worksheets** of the Sync Out channels assigned to the **Auto Sync** feature will be **unavailable**, that is, you cannot edit them manually. The following screen shot shows an example of a monophasic 100  $\mu$ s voltage pulse on channel 1 and the corresponding Auto Sync pulse (Pre Time 0  $\mu$ s, Post Time 100  $\mu$ s) on Sync Out 1.



- If you later choose to edit the Sync Out worksheets of the active file manually, you can deselect the **Auto Sync** feature on the **Settings** menu. Any information in the Sync Out worksheets that was there **before** the **Auto Sync** option was enabled will be **restored**; and all worksheets will be available for manual editing.

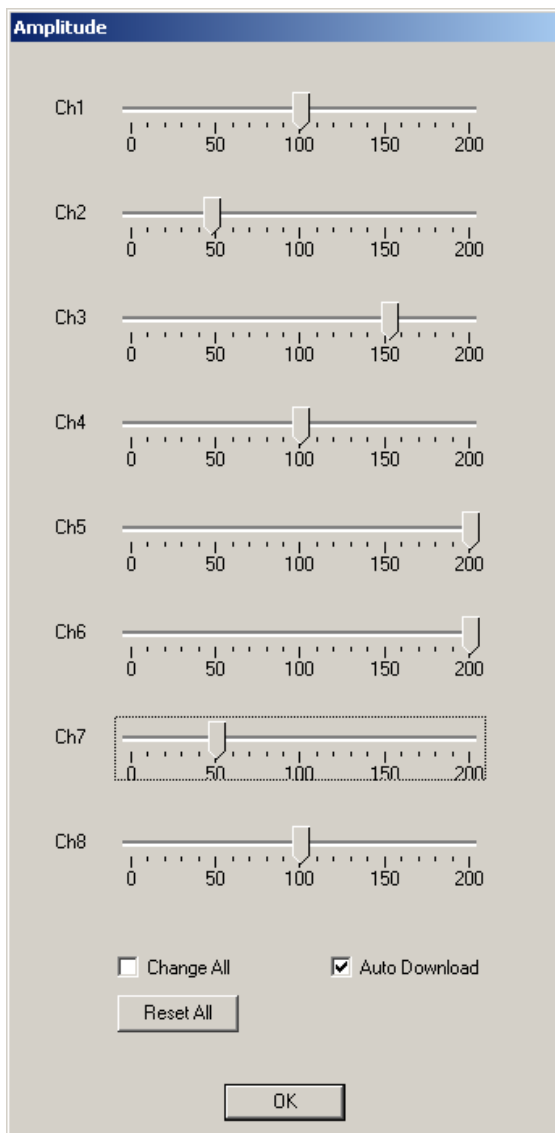
## 5.6 Adjusting the Stimulus Intensity Level

After having programmed the stimulus protocol, you can either download the protocol "as is", or you can adjust the **stimulus intensity level**, that is, choose a percentage (from 0 to 200 percent) of the programmed amplitudes, independently for each of the up to 8 channels. You can adjust the level **offline** and **download** the information onto the stimulus generator manually afterward, or you can adjust the level **on-the-fly**, without stopping the running stimulation. This feature is especially convenient for testing out thresholds that evoke a biological response.

**Note:** The **error messages** that are displayed when the stimulus amplitude is not set to zero at the end of the protocol or when the time length of stimulus protocols is different on individual channels can present a nuisance when adjusting the level on-the-fly. These error messages can be switched off by deselecting the option **Enable Compiler Warnings** on the **Settings** menu.

- On the **Edit** menu, click **Amplitude**. The **Amplitude** dialog box opens. You can drag and drop it anywhere you like on the screen, also outside the main window of the MC\_Stimulus II program. This is especially convenient when you are using two monitors.
- Select the option **Auto Download** if you want to adjust the stimulus intensity level **on-the-fly**. Deselect the option if you want to download the changes manually later.
- Select the option **Change All** if you want to adjust the stimulus intensity to the **same** level on all channels. Deselect the option if you want to set individual channels to different levels.
- Drag the slider with the mouse for adjusting the stimulus intensity in the range of **0 to 200 percent** of the programmed stimulus amplitudes. The WYSIWYG display is updated automatically. The worksheet is **not** updated. It always relates to the stimulus protocol that you programmed initially. If **Auto Download** is selected, changes are **immediately** downloaded onto the stimulator after releasing the slider, and the stimulus protocol is **restarted** from the beginning, with the adjusted stimulus intensity level.

5. If **Auto Download** was not selected, you need to download the stimulus protocol manually for changes to take place.
6. You can click the **Reset All** button to set the level on all channels back to 100 percent.



### Stimulus Intensity dialog box of the STG3008-FA

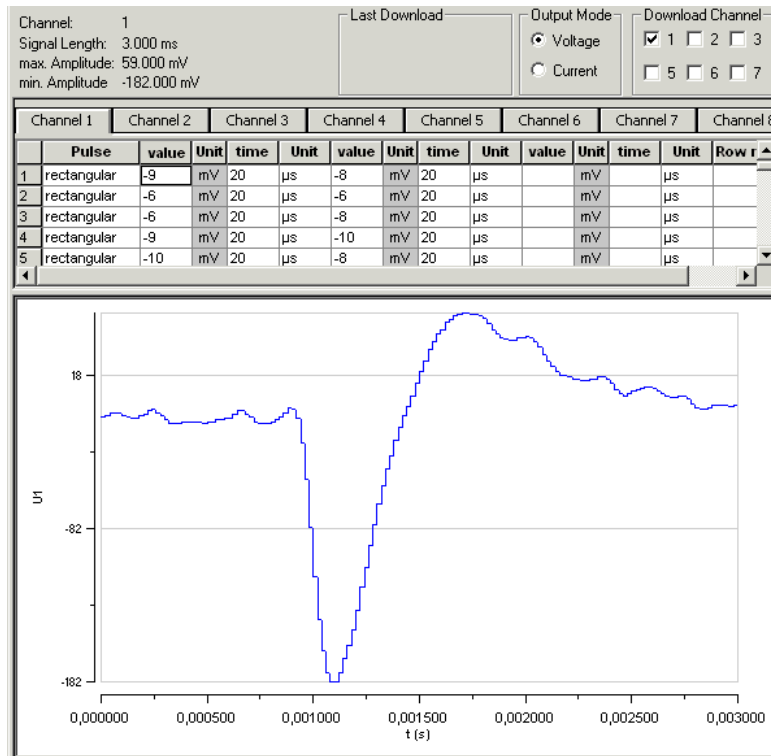
Channel 1 is set to 100 %, that is, the stimulus protocol will be downloaded onto the stimulus generator as it was programmed in the worksheet. Channel 2 is set to 50 %, that is, all stimulus amplitudes programmed on channel 2 are half, channel 3 is set to 150 %, and channel 4 is set to 100 %, channel 5 and 6 are set to 200, that is, all stimulus amplitudes are doubled.

## 6 ASCII Import/Export

### 6.1 Loading Files

The ASCII import filter is used to load stimulus protocols from an ASCII file into the stimulus worksheet of MC\_Stimulus II. You can use this feature for feeding recorded signals (for example exported from MC\_Rack, see the MC\_Rack manual) into the stimulus generator. You can also export the data from MC\_Stimulus, modify it with your custom text or spreadsheet editor, and reimport it into MC\_Stimulus II.

The current version of the import filter is version 3.1.2



#### ASCII import example: Stimulating with biopotential waveforms

Shown is a single spike recorded from an organotypic hippocampal culture. The spike waveform was exported as ASCII from MC\_Rack and imported into the MC\_Stimulus II program.



**Warning:** All previous records in the active MC\_Stimulus II file (\*.stm) file are overwritten. Please create a new file and import the data into an empty worksheet to avoid data loss.

1. On the **File** menu, click **Import ASCII File**. The **Open** dialog box appears.
2. Select an appropriate ASCII file and click **Open**. The stimuli from the ASCII file are loaded into the active MC\_Stimulus worksheet. All previous records are overwritten. Channels that are not present in the ASCII file are empty. You can now edit and download the stimulus file as usual.

If the file does not fulfill the requirements of a stimulus file, an error message will show up and tell you in which line the first error occurs. See "Supported File Format" for more information about supported ASCII files.

## 6.2 Exporting Files

1. On the **File** menu, click **Export ASCII File**. The **Save As** dialog box appears.
2. Browse to the target folder and enter a file name.
3. Click **Save** to generate the ASCII file.

All pulse protocols from the active file will be saved in ASCII file format. The MC\_Stimulus II ASCII format type is **format type 4**. For your convenience, the generated ASCII file includes the header that is required for reimporting the file into MC\_Stimulus II.

Supported File Formats

The ASCII text must exactly follow the specifications below. The parameters in angle brackets are placeholders for any valid numbers or strings.

**Hint:** You can set up files conveniently in any standard spreadsheet program and save them as tab-delimited ASCII.

### General

- The **file name** and the file name **extension** are not important. You can use any extension you like, for example \*.txt, or \*.dat, or any other.
- **Comments** are introduced by the number sign #. The rest of the line after # is only for your information; it is completely ignored when executing the stimulus file. (You do not need comments, of course, but it is convenient for documentation.)

**Hint:** Use # to comment lines out. That is, you can disable lines without removing it from the file. Thus, you can keep the lines for later uses.

- Blank lines are **ignored**.
- The **spelling** is strict. The MC\_Stimulus II program does not recognize a keyword if it is misspelled or if even only one character is missing, but it is **not** case-sensitive.
- The file has the following structure.
  1. File header
  2. Data

### File header

The **first two** non comment lines have to be the following lines. Files for older versions of the import filter (version 1.00) can be imported with the current version as well.

```
Multi Channel Systems MC_Stimulus II
ASCII import Version 1.10
```

The **next three** lines have to be the following lines (in any order).

```
channels: <number>
output mode: <mode>
format: <format number>
```

Make sure you define the total number of channels for the used STG properly (4 channels for a STG with 4 channels, 8 channels for a STG with 8 channels, and so on), according to the **software** version. You can select the maximum number of channels during the installation of MC\_Stimulus II. On the **Help** menu, click **About MC\_Stimulus II** to check your current software version.

### Example:

You have to include the following line in the ASCII file if you have installed **MC\_Stimulus II for STG3008-FA**

channels: 4

Output mode is either voltage or current.

### Example:

*output mode: voltage*

Six different format types are available: 1, 2, 3, 4, 5, 6.

### Example:

*format: 3*

### Data

Preceding the data, the output channel number has to be specified by the following line.

channel: <channel number>

You can specify **analog** output channels from 1 to 8 (limited by the number of analog output channels of the connected STG, of course).

The data follows after the channel specification line; three format types are available. All format types follow the MC\_Stimulus II worksheet's structure of rows and columns. See the description of the worksheet for more details. Columns are separated by blanks or tabs. The first line has to contain the column headers. The following lines contain the voltage / current and time values. Rows / lines are separated by a carriage return or line feed (CR / LF). This is the Windows standard control character inserted when you press the ENTER key.

The voltage unit is mV and the current unit is  $\mu\text{A}$ . Please make sure that all values are in the ranges specified for the STG you use. For the Sync Out channel, only values of 0 and 1 are allowed.

The time unit is  $\mu\text{s}$ . Time values can be in the range from 20 to 18.000.000.000 (20  $\mu\text{s}$  to 5 h). Time base of the STG is **20  $\mu\text{s}$** , so only times that are **multiples of 20  $\mu\text{s}$**  are valid.

**Note:** Please make sure that there are no additional tabs or characters, which would lead to an error message. Show tabs and spaces in your text editor and check the file before importing it.

### Format type 1

This is a basic format with two columns of **Value** and **Time** each, without **Repeat** functionality.

value    time            value            time

### Format type 2

With this format, you can repeat rows in the same way as described for the worksheet. Group repeat is not available.

value    time            value            time            repeat

### Format type 3

This format type is available only in the current version of the import filter. It allows you to use a **third column** of **Value** and **Time**.

value    time                    value                    time                    value                    time                    repeat

#### Example:

The following picture shows an ASCII stimulus file opened in a standard spreadsheet program.

	A	B	C	D	E	F	G
1	# Demo file						
2							
3	Multi Channel Systems MC_Stimulus						
4	ASCII import Version 1.10						
5							
6	channels:	8					
7	output mode:	voltage					
8	format:	3					
9							
10	channel:	1					
11	value	time	value	time	value	time	repeat
12	200	20000	-200	20000	0	60000	2
13	0	40000	0	0	0	0	0
14	200	20000	-200	20000	0	60000	2
15	0	40000	0	0	0	0	0
16							
17	channel:	2					
18	value	time	value	time	value	time	repeat
19	200	20000	-200	20000	0	60000	2
20	0	40000	0	0	0	0	0
21	200	20000	-200	20000	0	60000	2
22	0	40000	0	0	0	0	0
23							

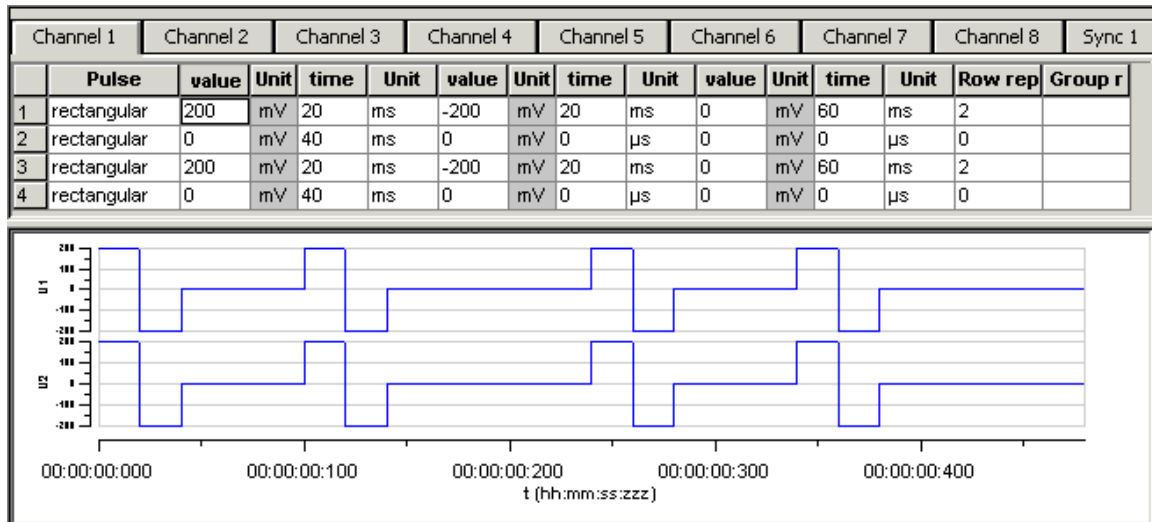
The same file would look like this in a standard text editor program. You can see the tabs, spaces, and CR/LF.

```

1 #·Demo·file
2
3 Multi·Channel·Systems·MC_Stimulus
4 ASCII·import·Version·1.10
5
6 channels:» 8
7 output·mode:» voltage
8 format:» 3
9
10 channel:» 1
11 value» time» value» time» value» time» repeat
12 200»20000» -200» 20000» 0» 60000» 2
13 0» 40000» 0» 0» 0» 0» 0
14 200»20000» -200» 20000» 0» 60000» 2
15 0» 40000» 0» 0» 0» 0» 0
16
17 channel:» 2
18 value» time» value» time» value» time» repeat
19 200»20000» -200» 20000» 0» 60000» 2
20 0» 40000» 0» 0» 0» 0» 0
21 200»20000» -200» 20000» 0» 60000» 2
22 0» 40000» 0» 0» 0» 0» 0

```

After loading the file into the MC\_Stimulus II worksheet, you can edit and download the file as usual.



#### Format type 4

This format type is available only in the current version of the import filter. It is the plainest format with only **one column** for the **voltage / current values** and **one column** for the **time** lengths. This format is the standard format if you want to import data for example from Excel.

This format type is generated when exporting MC\_Stimulus II files as ASCII.

value time

#### Format type 5

This format type is available only in the current version of the import filter. It allows you to use **ramp** and **sine** waveforms as well as **rectangular** waveforms. You specify the **Pulse** type in the first column, and the waveform in the three following columns. The general rules for setting up ramp and sine waveforms fully apply (see also Pulse Types). The pulse types are defined by the following numbers: Rectangular = 0, ramp = 1, sine = 2.

You can only use the rectangular type (0) for the Sync Out channels.

Important: When setting up **rectangular** or **sine** waveforms in this format type, you need only one value column for defining the amplitude, but you have to define both value columns even so. The **first** value column is **ignored** for rectangular and sine pulse types by the MC\_Stimulus II program.

pulse (0, 1, 2) value value time

## Example:

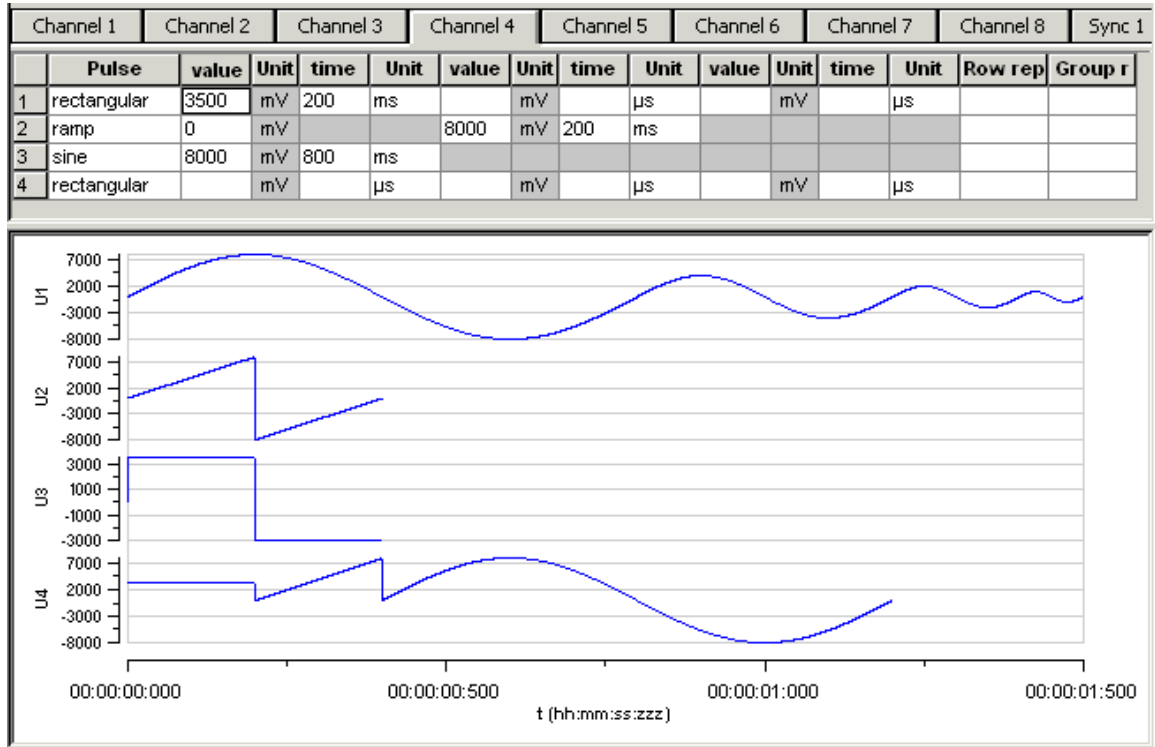
This is an ASCII file viewed in a standard text editor program. You can see the tabs, spaces, and CR / LF.

For demonstration purposes, a ramp type pulse was programmed on the first channel, a sine wave on the second channel, a rectangular waveform on the third channel, and mixed pulse types on the fourth channel.

```
1 #.file:.example.dat
2 #.Copyright.(c).2005.Multi.Channel.Systems
3 #.this.is.an.example.file.for.MC_Stimulus.ASCII.import
4
5 Multi.Channel.Systems.MC_Stimulus
6 ASCII.import.Version.1.10
7
8 #.this.is.a.comment.line
9
10 channels:.8
11
12 output.mode:.voltage
13
14 format:.5
15
16 channel:.1
17
18 pulse» value» value» time
19 2» 0» 8000» 800000
20 2» 0» 4000» 400000
21 2» 0» 2000» 200000
22 2» 0» 1000» 100000
23
24 channel:.2
25
26 pulse» value» value» time
27 1» 0» 8000» 200000
28 1» -8000» 0» 200000
29
30 channel:.3
31
32 pulse» value» value» time
33 0» 0» 3500» 200000
34 0» 0» -3000» 200000
35
36 channel:.4
37
38 pulse» value» value» time
39 0» 0» 3500» 200000
40 1» 0» 8000» 200000
41 2» 0» 8000» 800000
42
43
```



After loading the file into the MC\_Stimulus II worksheet, you can edit and download the file as usual.



### Format type 6

**Note:** This file format is used by **MC\_Rack ASCII export!**

This format type is available only in the current version of the import filter. This is a basic format with two columns: The absolute time in seconds, and the absolute value of voltage in microvolts ( $\mu\text{V}$ ) or current in microampere ( $\mu\text{A}$ ). This file format is used by MC\_Rack ASCII export. You can directly import the MC\_Rack export files into MC\_Stimulus II.

time                    value

You can use this format with or without header.

*Example:*

The following picture shows a file of format type 6 without header.

```

T                    elec0001 29
[s]                [µV]
0.000040            8.541667
0.000080            2.187500
0.000120            12.708333
0.000160            8.854166
0.000200            7.083333
0.000240            5.729167
0.000280            15.104167
0.000320            13.854166
0.000360            12.500000
0.000400            1.875000

```

The following picture shows a file of format type 6 with header.

```
Multi Channel Systems MC_Stimulus
ASCII import Version 1.10

channels: 8

output mode:

format: 6

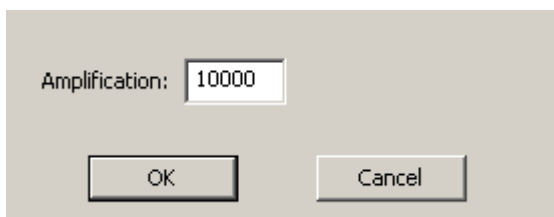
channel: 1

time          value
[s]           [µV]
0.000040     8.541667
0.000080     2.187500
0.000120    12.708333
0.000160     8.854166
0.000200     7.083333
0.000240     5.729167
0.000280    15.104167
0.000320    13.854166
0.000360    12.500000
0.000400     1.875000
```

Using the format type 6 without header, only the first channel of the MC\_Rack raw data file can be imported.

Using the format type 6 with header you choose how many channels are imported in "channels", line 3. The output mode in line 4 has to be voltage. You choose which channel should be imported first in "channels" line 6. You can add the channels you also want to import one after the other in any order.

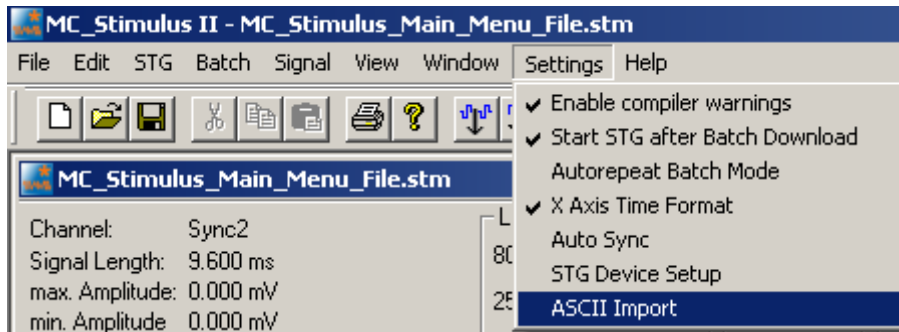
The value microvolt is normally used for data recording in voltage mode of MC\_Rack. The STG generates voltage pulses in values of millivolt. Please use the "Amplification" factor of the ASCII Import Dialog to convert  $\mu\text{V}$  in mV, otherwise the output of the STG is zero.



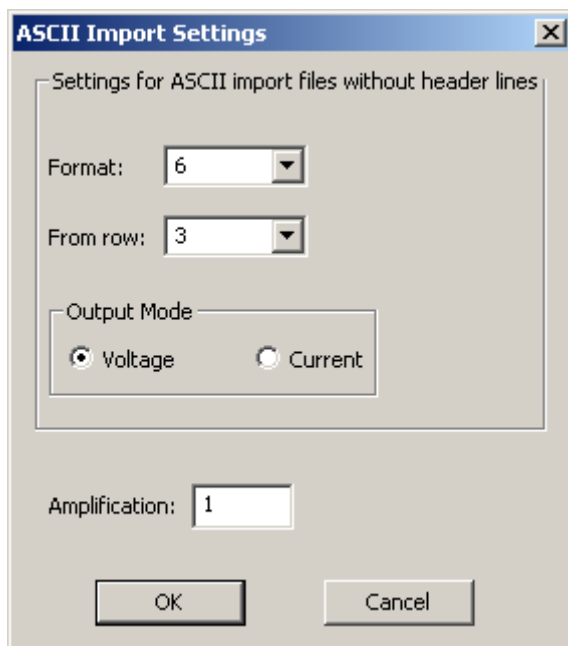
The amplification factor is generally applied in files with and without header.

## ASCII Import of Files

For ASCII import of files, please use the command **ASCII Import** in main menu "Settings".



The dialog "**ASCII Import Settings**" will open.



Settings for ASCII import files **without header**:

Select the format type from one to six from the drop down menu "Format".

Select the number of the row from which the file should be imported. Row numbers are available from one to ten from the drop down menu "From row".

Select the "Output Mode" in the check boxes: Voltage or Current.

Settings for ASCII import files **with or without header**:

Please choose the factor of amplification in "Amplification". This is very helpful, for example, for importing data recorded in microvolt  $\mu\text{V}$  and now needed in millivolt  $\text{mV}$ . That means, the factor is 1000 or – for higher stimulation signals - may be 10000. Please see chapter "Format Type 6" above.

**Important:** MC\_Stimulus II uses the header of an ASCII import file, if a header is available. If no header is available, MC\_Stimulus II applies the settings of the dialog "ASCII Import Setting".

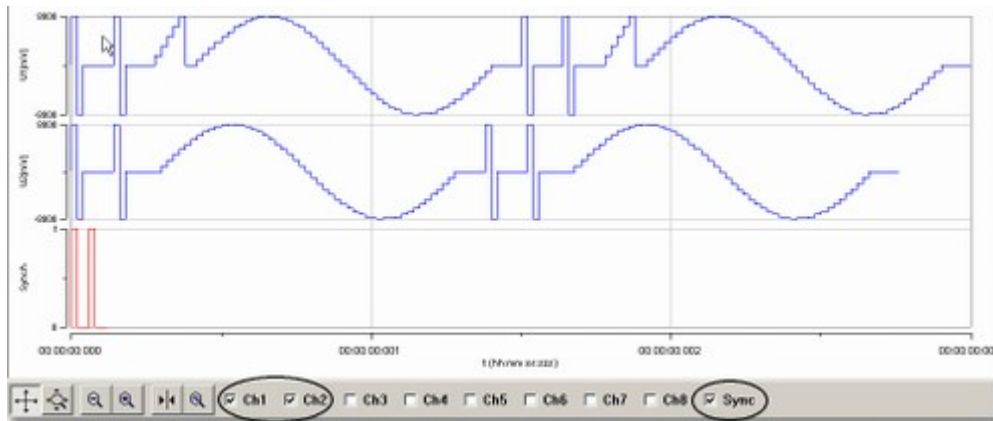
## 7 Stimulus Display

### 7.1 Selecting Channels

To enlarge the display size of the channels, we suggest that you show only those channels you are currently working with.

**Note:** This will affect only the **display**. It has **no effect** on the **download** of signals. To select or deselect channels for downloading, click the **Download Channel** check boxes in the main window of the program.

- Clear the check box of all channels that are not in use. All channels that are not selected are removed from the display.



### 7.2 Display Settings








You can toggle between a **decimal time scale** in seconds (floating point numbers) and a **time of day scale** in the format hh:mm:ss:zzz, where **h** means hour, **m** is minute, **s** is second, and **z** is millisecond.

- Under **Settings**, click **X Axis Time Format**. Select the option to enable the time of day scale. Deselect the option to switch to the decimal time scale.

## 7.3 Display Tools


- Several tools are provided to optimize the graphical presentation of the stimuli. If you later choose to display channels, the axes of the new displays are set to the default values.
- The time axis can display only positive values.
- The y-axis of the Sync Out channels cannot be adjusted, because only values of 0 and 1 are available for these channels.

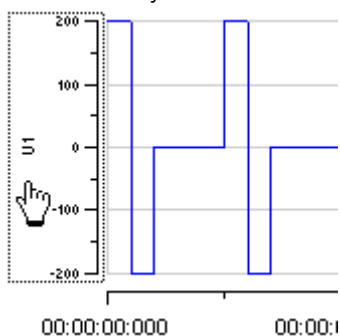


	<b>Enable scrolling</b>	Scroll the axes by clicking and dragging with your mouse.
	<b>Enable scaling</b>	Zoom the axes by clicking and dragging with your mouse.
	<b>Zoom out</b>	Reduces the time scale.
	<b>Zoom in</b>	Magnifies the time scale.
	<b>Reset</b>	Resets the axes of all channels to the default values.
	<b>Size to fit</b>	Adjusts the ranges to fit the largest displayed stimulus.
	<b>Show measure tool</b>	A horizontal bar is shown that displays the current / voltage and the time value of the intersection point. Drag the bar with the mouse.

### Scrolling the axes


You can scroll the stimuli forward and backward along the time axis, and up and down along the voltage / current axis.

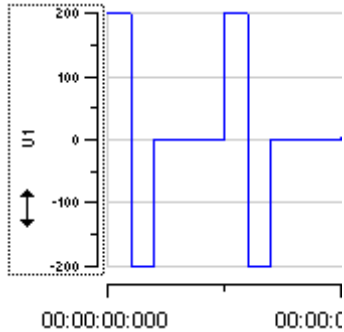
1. Click  to enable the **scrolling**.
2. Click the axis you like to scroll. The mouse pointer becomes a hand.



3. While holding down the mouse button, move the axis to the left and right, or up and down.
  - OR -
  - You can use the keyboard: Press LEFT ARROW or DOWN ARROW to move the axis to the left (down), RIGHT ARROW or UP ARROW to move the axis to the right (up).
  - OR -
  - Use the PAGE UP and PAGE DOWN keys for a faster scrolling (larger steps): PAGE DOWN to move to the left (down), PAGE UP to move to the right (up).


## Zooming the display

1. Click  to enable the **scaling**.
2. Click the axis you like to scale. The mouse pointer becomes an arrow.



3. While holding down the mouse button, move the mouse up/right to zoom the axis in, and move the mouse down/left to zoom the axis out.  
- OR -  
You can use the keyboard: Press LEFT ARROW or DOWN ARROW to zoom the axis out, RIGHT ARROW or UP ARROW to zoom the axis in.  
- OR -  
Use the PAGE UP and PAGE DOWN keys for a faster scrolling (larger steps): PAGE DOWN to zoom out, PAGE UP to zoom in.

## Size to fit

- Click  to size the display to fit. The ranges are automatically adjusted to fit the maximum amplitude of each stimulus. The range of the time axis will be set to fit the longest signal.

## 8 Downloading Stimuli

### 8.1 Downloading Stimulus Files

After having set up the stimulus file, you can download the file to the connected STG. You can **select** the channels that you want to download or download the **complete** file.



You can start the stimulation **directly** after the download, or start it **manually** with the software or hardware controls, or start it **on a trigger**. See also chapter "Operating the STG" for more information.



**Warning:** Check the file thoroughly before downloading it on the STG. The stimulus display is independent from the worksheet and from the download. Verify that you download **only** the channels that you want to use. Do **not** start the STG if you are not sure about the channel configuration or the nature of the downloaded file.

Select the channels for downloading under **Download Channel** and **Download Sync**.

Download Channel	Download Sync
<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 1
<input checked="" type="checkbox"/> 2	
<input checked="" type="checkbox"/> 3	
<input checked="" type="checkbox"/> 4	
<input checked="" type="checkbox"/> 5	
<input checked="" type="checkbox"/> 6	
<input checked="" type="checkbox"/> 7	
<input checked="" type="checkbox"/> 8	

On the **STG** menu, click **Download** or click  on the toolbar to download only the selected channels onto the STG or **Download and Start**  to download only the selected channels and start the stimulation directly after the complete download.

When downloading files created in MC\_Stimulus II software to a stimulus generator of the STG3000 series for each download all channels are stopped and cleared before the new paradigm is downloaded. All available channels are downloaded one after the other regardless of the space each channel needs, which means that the available memory is optimally used. This mode should always be used when large and complicated stimulation patterns are used, for example white noise stimulation.

#### Disable / enable warning messages

Cancel this option to disable the message boxes displaying compiler warnings during stimulus download.

The two error messages that can be disabled are: "warning: signal length shorter than the maximum" and "warning: non zero last amplitude value". They may present a nuisance if you download multiple stimulus files in batch mode.

→ On the **Settings** menu, select or deselect **Enable Compiler Warnings**.

## 9 General Software Features

### 9.1 Customizing the Main Window

You can customize the size and position of open file windows and the toolbar in MC\_Stimulus II.

- You can **hide** the **toolbar** and the **status bar** by deselecting them on the **View** menu.
- You can **arrange** the **windows** with the commands on the **Window** menu.
- **Cascade**: Use this command to arrange multiple opened windows in an overlapped fashion. The windows are resized to the standard size.
- **Tile**: Use this command to arrange the windows so that they are not overlapping.
- **Arrange Icons**: Use this command to line up minimized windows.
- You can **resize** the windows with your mouse.
- Click an empty area on the toolbar, and then **drag** the **toolbar** to a new position.
- 

### 9.2 Menu Bar

You will find most software features in the pull-down menus of the main window. Each menu displays a list of commands. Commands that are **not available** at the moment appear **shaded**.

#### Use the ...













- **File** menu to create new files, save files, import ASCII files, and print the stimulus worksheet.
- **Edit** menu for general editing features like copy and paste rows, remove the last entered value (**Undo**), remove and insert rows into the active worksheet. You can also **right-click** on a row and select these commands. Click **Clear Signal** to delete all values in the active worksheet. You can also specify the output ranges according to the connected STG on this menu. Please see the technical specifications of your STG.
- The **STG** menu contains all commands directly relating to the hardware, for example download commands, start and stop the STG, and trigger configurations.
- You can open, start, and stop a batch run of several files on the **Batch** menu.
- **Signal** menu for nice editing features like editing whole columns, and autcreate signals. You can also **right-click** on a column and select these commands.
- **View** and **Window** menu to customize the main window.
- **Settings** menu to define general settings of the software.
- **Help** menu to open the **MC\_Stimulus II Help** and to display the **About** dialog where you can find information about the hardware, software, and firmware versions. You will need this information when you contact the support.



## 9.3 Toolbar

For your convenience, you will find some of the more commonly used commands as a button on the toolbar.



	<b>New File</b>	Creates a new MC_Stimulus II file (*.stm) file.
	<b>Open File</b>	Opens a previously saved MC_Stimulus II file (*.stm) file.
	<b>Save File</b>	Saves the *.stm file to the chosen destination.
	<b>Cut Row</b>	Deletes selected row(s) and sends deleted row(s) to clipboard.
	<b>Copy Row</b>	Sends selected row(s) to clipboard.
	<b>Paste Row</b>	Pastes row(s) from clipboard and overwrites row(s) starting at the selected row.
	<b>Print</b>	Prints active channel of active worksheet.
	<b>Information</b>	Opens the <b>About</b> dialog, where you can find information about the hardware, software, and firmware versions.
	<b>Download</b>	Downloads stimulation file to the connected STG (only available if STG has active computer connection).
	<b>Download and Start</b>	Downloads and starts stimulation file to the connected STG (only available if STG has active computer connection).
	<b>Start</b>	Starts downloaded stimulation file (only available if STG has active computer connection).
	<b>Stop</b>	Stops downloaded stimulation file (only available if STG has active computer connection).

## 9.4 Shortcut Keys

Shortcut keys offer you another way to accomplish common tasks. Using a shortcut key usually consists of pressing and holding one key while pressing a second key.

See the list of shortcut keys available in the software.

### Shortcut key

CTRL+C	<b>Copy Row</b>
CTRL+D	<b>Download</b>
CTRL+A	<b>Download and Start</b>
CTRL+N	<b>Create New File</b>
CTRL+O	<b>Open File</b>
CTRL+P	<b>Print</b>
CTRL+R	<b>Start</b>
CTRL+S	<b>Save file</b>
CTRL+T	<b>Stop</b>
CTRL+V	<b>Paste Row</b>
CTRL+X	<b>Cut Row</b>
CTRL+Z	<b>Undo</b>


Hint: Shortcut key combinations are also listed on the toolbar menus. For example, the **File** menu shows that the shortcut key for **Save** is **CTRL+S**.

## 9.5 File Menu

You can save MC\_Stimulus II files for later use. This is very convenient if you have various similar experimental setups, or if you like to repeat an experiment later.

### Open a file

You may open previously saved files for similar experimental setups.

1. On the **File menu** or on the toolbar, click **Open** .
2. Browse your folders and choose the desired file. You may only open MC\_Stimulus II files (\*.stm).
3. Click **Open**. The selected file opens.

### Save a file

1. On the **File** menu or on the toolbar, click **Save** . The currently active worksheet is now saved.

You may open the file using MC\_Stimulus II later on to continue your experiment.

### Save as

Use this command to save your file under a new name, for example, if you like to use a file as a template for a new file.

1. On the **File** menu, click **Save As**.
2. Browse your folders and enter a file name.
3. Click **Save**. The current worksheet is now saved under the new name.

You may open the file using MC\_Stimulus II later on to continue your experiment.


### Import ASCII File

Please see the chapter "ASCII Import / Export".

Export ASCII File

Please see chapter "ASCII Import / Export"

### Printing a channel

1. On the **File** menu, click **Print Setup** to select a printer, paper format, and so on.
2. Click **Print Preview** to preview the print output.
3. Click **Print**  to print out the active channel of the active worksheet.

## 9.6 Settings Menu

### Enable Compiler Warnings

Cancel this option to disable the message boxes displaying compiler warnings during stimulus download.

The two error messages that can be disabled are: "Warning: Signal length shorter than the maximum" and "Warning: Non zero last amplitude value". They may present a nuisance if you download multiple stimulus files in batch mode, or if you want to adjust the stimulus intensity level on the fly.

- On the **Settings** menu, select or deselect **Enable Compiler Warnings**.

## 10 Synchronizing Events

### 10.1 Digital Output Signals (Sync Out)

The output of the digital **Sync Out** output is a **3.3 V TTL** signal. A logic state of **1** means 3.3 V, and a logic state of **0** means 0 V. Please note that the digital output is about **15 µs faster** than the analog output. This small offset is generally sufficient to make sure that the Sync Out signal precedes the stimulation, which is important for synchronizing events.

You can program the output signal of the Sync Out channel in the same way as the analog output signals, but due to the nature of a digital signal, only values of 0 and 1 are allowed. A Sync Out signal is generated each time when the STG is started.

The output signal can be used for **triggering external devices**, for example, the any data acquisition devices.

**Note:** Please note that if you use it for triggering the MC\_Card, you should use output signals that have a **duration** of at least **200 µs**. Otherwise, it can happen that the MC\_Card ignores trigger events.

The Sync Out output is active when the STG is started by pressing the **Start / Stop** button, or by using the software command **Start** on the **STG** menu.

If you are using the **Trigger In input** for starting the STG, the **Sync Out** channel is controlled by the Trigger In channel. **Sync Out 1** is active when **Trigger In 1** is triggered.

If you use the **Repeat** feature in the **Trigger Settings** dialog box, the Sync Out signal is repeated as well as the selected analog output signals.

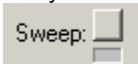
**Note:** No Sync Out signal is sent when the STG is stopped on a trigger event or by pressing the **Start / Stop** button, that is, if the trigger event occurs or the button is pressed when the STG has still been active.

### 10.2 Triggering Stimulation (Trigger In)

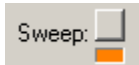
The external trigger input has to be a **TTL signal** of at least **40 ±10 µs** length. TTL pulses shorter than that may not be recognized by the stimulus generator.

A TTL pulse is defined as a digital signal for communication between two devices. A voltage between 0 V and 0.8 V is considered as a logical state of 0 (LOW) and a voltage between 2 V and 3.3 V means 1 (HIGH). It is the same kind of signal as the output signal of the **Sync Out** output of the STG.

In STG3008-FA there is one Sync Out output for one trigger input. You can assign the Sync Out and the analog channels to the trigger input in the Trigger Settings dialog box. The default settings is that Sync Out 1 is active when Trigger In 1 is triggered. See also "Digital Output Signals" for more information on the Sync Out channel. The **Sweep** status display (LED Start /

Stop buttons) in the main window  of the program shows active sweeps that were started by the trigger. That means, the status lamp that corresponds to trigger 1 lights red as long as any channel triggered by trigger 1 is active. Please note that the number of the analog output channel is irrelevant, the **Sweep** status lamp refers only to the trigger.

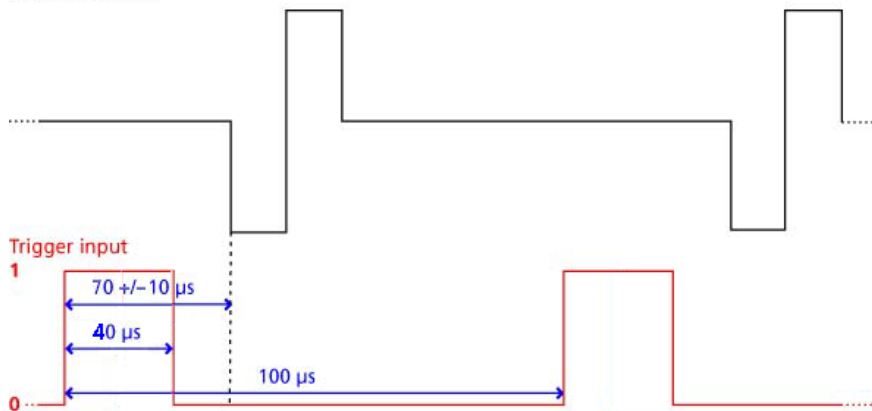
Example: Assume that **channel 4** is assigned to **trigger 1**. When channel 4 is active, the **Sweep**

lamp lights red , because the **Sweep** lamp refers to trigger 1.

You can start and stop the trigger manually at any time using the LED Start / Stop buttons.

### Timing limits

Stimulus output

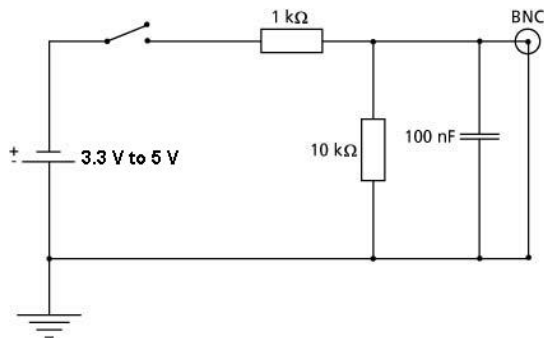


### Custom switch for "remote-controlling" of the STG

You can connect any device that produces TTL outputs to the **Trigger In** connector of the STG, for example a switch. For example, you can use a trigger for remote controlling the STG if it is not within reach during an experiment. It is also possible to set up advanced experiments where stimulation depends on preceding activities of the studied object.

The following picture shows a suggested circuit diagram for a switch used for remote controlling. The resistor and capacitor work as a low-pass filter on the TTL signal and are necessary to reduce ringing of the signal.

Suggested switch for triggering the STG

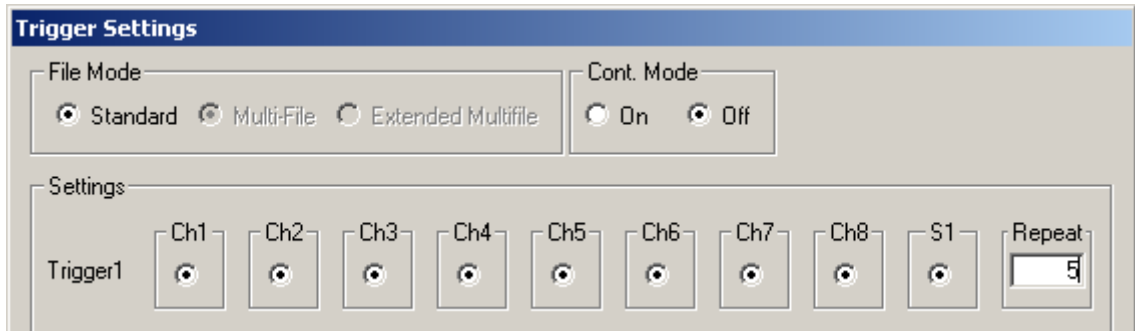


## 10.3 Trigger Settings


### Triggering output channels (Standard mode)

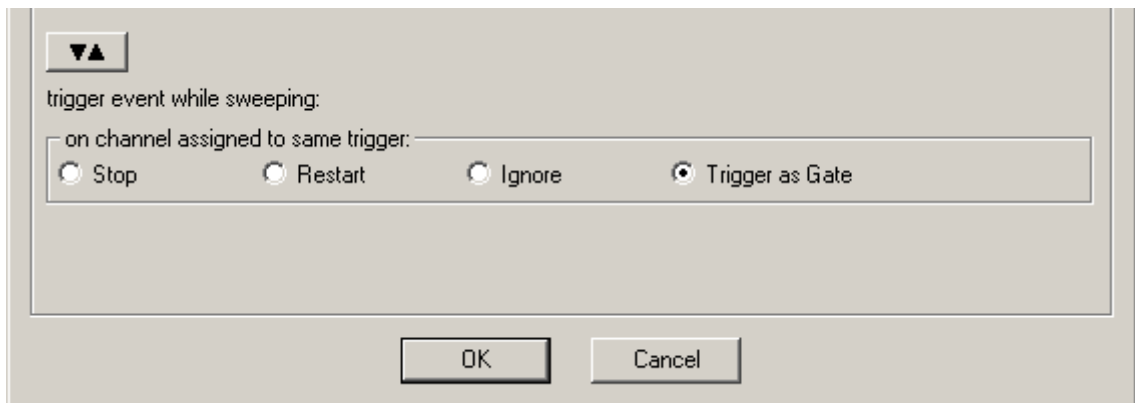
You can use the trigger input for triggering the output channel. The trigger settings are saved in the currently active MC\_Stimulus output file (\*.stm). All eight analog output channels are assigned to "Trigger 1" by default in the "Trigger Settings" dialog box in the "Edit" menu.

The "Multi-File" and the "Extended Multi-File" mode are not available in STG3008-FA.



### Triggered action when channel(s) still active

You can define what action should be taken when any of the channels assigned to the trigger are still active. Please click the expand button  to show the advanced options:



**Stop:** A following trigger input **stops** the stimulation on the assigned channels if at least one channel that has been assigned to this particular trigger is still active in the moment of the trigger event. The trigger event starts stimulation only if **no** channel that has been assigned to this trigger is active.

**Restart:** The stimulus protocols on all channels assigned to this trigger are **started** at the trigger event, regardless of the activity on these channels.

**Ignore:** The trigger event is **ignored** when any channel assigned to this trigger is active. The trigger event starts stimulation only if **no** channel that has been assigned to this trigger is active.

## Use Trigger as Gate

Channels associated with a Trigger input will be active as long as the condition of that trigger is 1 (HIGH) and switched off as soon as the condition becomes 0 (LOW). If the stimulation protocol is **shorter** than the gate, it will stop at the predefined time, regardless of the gating trigger. If the stimulation protocol is **longer** than the gating trigger, stimulation will stop when the gating trigger ends. For example, if you want to produce a repeated rectangular pulses that last as long as the gating trigger is HIGH, you can do the following: program a single rectangular pulse and activate the continuous mode.

The pulses will start as soon as the gating trigger becomes HIGH, and stop as soon as the gating trigger becomes LOW. If the voltage of the stimulation channel is different from 0 at the time the gating trigger ends, the channel will be switched off immediately. If you **stop** the stimulating protocol **manually** during the gating trigger in HIGH, stimulation is stopped but immediately restarted, and goes on until the gating trigger ends.



**Warning:** Once selected, this setting will become the default setting for all opened files, until unselected. So if you observe unexpected behaviour when triggering the STG, check the Trigger settings.

## Sweep Count

The number of sweeps are counted and displayed for each of the four triggers at the bottom of the main window.



Please note that **not the number of stimuli** but the number of sweeps is counted, whereby one sweep is defined as one complete run of the programmed stimulation pattern, as displayed in the main window. So, if five stimuli are programmed, and the repeat rate in the Trigger Setting menu is set to six, 30 stimuli will be delivered but the sweep count will be six.

Sweeps are **not counted online**, the final number is displayed after the STG has been stopped. The number of sweeps per channel is **not put to zero** automatically every time the stimulation is started. Instead, a reset only happens if a trigger is again used in the new stimulation. So, if a stimulation file uses trigger one and two with a repeat of three each, the display will show 1:3 2:3 3:0 4:0 at the **end of the stimulation**. If afterwards for example a stimulation file is started which uses only trigger four in continuous mode, and this file is stopped after 15 repeats of the programmed stimulation pattern, the display will show 1:3 2:3 3:0 4:15.

## 10.4 Batch Mode

You can download and run several stimulus files one after the other in the **Batch** mode. The first file in the list is downloaded and started directly after the download, or started manually with the software or hardware controls, or started on a trigger. After the first file has been run, the next file in the list is downloaded, and so on, until the last file in the batch list has been run.

### Triggering a sequence of stimulation protocols

The **Batch** mode is useful if you want to start a **sequence** of **different** stimulation protocols one after the other on the **same** trigger (Trigger 1). Please make sure that you have assigned all channels to Trigger 1 in the **Trigger Settings** dialog box. You set up the protocols and save them as separate stimulus files. Then, you set up a batch file with a list of the desired stimulus files.

- The first trigger event starts the first file in the list.
- When a file has been **completed**, the **next** file in the list is **downloaded** automatically.
- When a trigger event occurs **after** the file has been run, the next file is started, and so on.
- When a trigger event occurs **during** the run of a file, the run is **stopped**, and the **next** file in the list is **downloaded**. The next trigger event **starts** the next file.
- Deselect the option **Start STG after Batch Download** on the **Settings** menu if you want to start the protocols **on a trigger** or **manually** with the software or hardware controls. If the option **Start STG after Batch Download** on the **Settings** menu is selected, the STG starts each file **directly** after the download without waiting for a trigger event.

**Note:** Only **Trigger 1** is available for triggering in **Batch** mode. Do not use any other trigger inputs.

### Splitting up stimulation protocols to circumvent the memory limitation

If the option **Start STG after Batch Download** on the **Settings** menu is selected, the STG starts each file directly after the download, which is only useful in the (unlikely) case that you need to circumvent the memory limitation of the STG. Split up your pulse protocol into several stimulus files and run them in **Batch** mode.

### Setting up a batch file

You have to set up a batch file (.stb) first, which lists the full path of all files that you like to download as a batch. The batch file has to be exactly in the following format. This example is a batch list with three different pulse protocols. Replace the file paths with the correct path of the files of your choice.

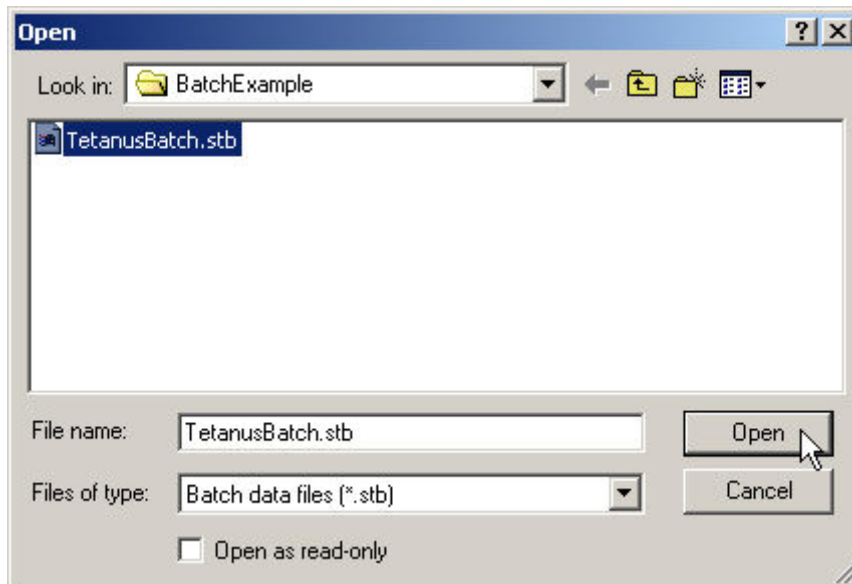
```
Multi Channel Systems MCS MC_Stimulus
Batch Control File
Version 1.00
c:\Program Files\Multi Channel Systems\MC_Stimulus
II\BatchExample\Baseline.stm
c:\Program Files\Multi Channel Systems\MC_Stimulus
II\BatchExample\Tetanus.stm
c:\Program Files\Multi Channel Systems\MC_Stimulus
II\BatchExample\TestResponse.stm
```



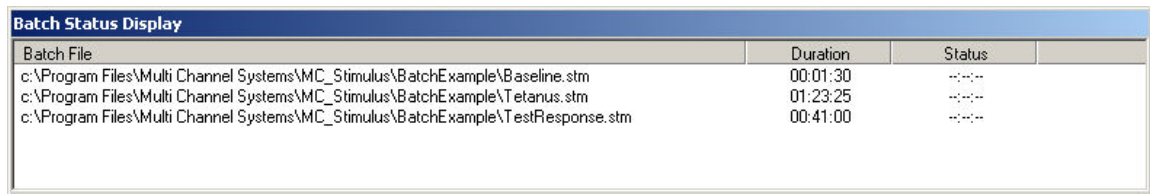
## Operating the STG in Batch mode

**Important:** You can operate the STG in **Batch mode** only with a **valid computer connection**. A file in the batch list is only downloaded **after** the preceding file has been run.

1. On the **Batch** menu, click **Open** to open a batch file. The **Open** dialog box appears.
2. Browse your folders and select a valid batch file, for example the sample file TetanusBatch.stb in the MC\_Stimulus II program folder.



3. The **Batch Status Display** opens. It lists all stimulus files in the batch and the duration of stimulation.



Batch File	Duration	Status
c:\Program Files\Multi Channel Systems\MC_Stimulus\BatchExample\Baseline.stm	00:01:30	----
c:\Program Files\Multi Channel Systems\MC_Stimulus\BatchExample\Tetanus.stm	01:23:25	----
c:\Program Files\Multi Channel Systems\MC_Stimulus\BatchExample\TestResponse.stm	00:41:00	----

4. On the **Batch** menu, click **Start** to start the download of the first file in the batch list and the STG if the option **Start STG after Batch Download** on the **Settings** menu is selected. The progress of the pulse protocol is displayed in the **Status** column of the **Batch Status Display**.
5. Click **Stop** on the **Batch** menu to stop the batch if necessary.
6. Close the **Batch Status Display** with the **Close** command.



**Warning:** The STG starts immediately after the download if the option **Start STG after Batch Download** on the **Settings** menu has been selected. Make sure to deselect this option if you do not want to start the stimulation right away.

### Autorepeat option

If you select the **Autorepeat Batch Mode** option on the **Settings** menu, the batch is restarted with the first file after the last file in the batch has been finished.

# 11 Analog Output Signals

## 11.1 Output Modes

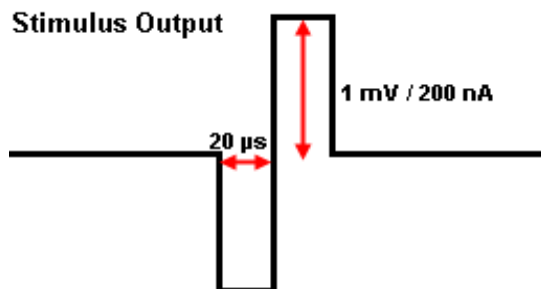
The stimulus generator operates in voltage and current mode. Choose voltage or current mode in the main window of MC\_Stimulus II. Please make sure that you use the appropriate stimulation mode for your experiment. The difference between current and voltage controlled stimulation is described in the following.

In **voltage mode**, the **voltage** level is held constant and the current output depends on the electrode resistance (the **higher** the electrode resistance, the **lower** is the output current).

In **current mode**, the stimulus generator guarantees a stable **current** output independent of the electrode resistance, where the voltage is defined by Ohm's law. The **higher** the electrode resistance, the **higher** is the output voltage. Therefore, the **kinetic properties** of the stimulus output is affected by the load resistance, which is usually the **electrode resistance**. If the resistance is too high, the output current is **limited** by the **compliance voltage**, that is, too high resistances will result in a **clipping** of the output signal.

Please consider the **time** and **voltage / current resolution** of the stimulus generator. The minimum pulse has an amplitude of **1 mV** in voltage mode or **200 nA** in current mode (supported by MC\_Stimulus II; the firmware / DLL supports a 14 bit resolution, which means 200 nA for an output current range of 0.8 mA, and a time length of **20 μs**). Please note that if you work near these limits, that is, if you use very small amplitudes or very short pulses, the output waveform may not exactly match the programmed waveform.

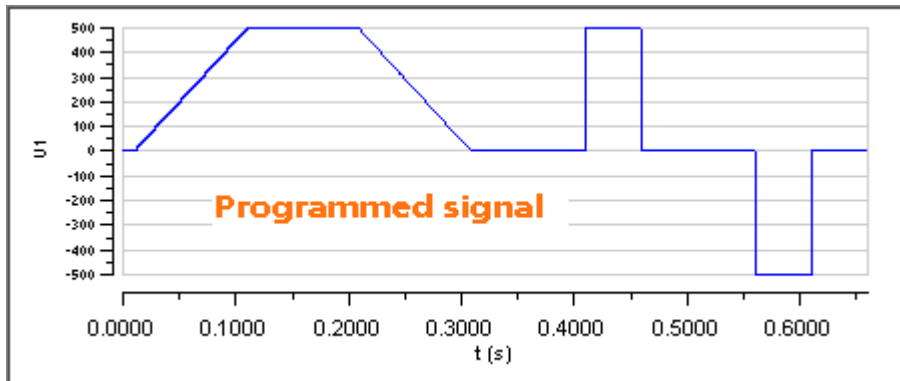
### Resolution Limits



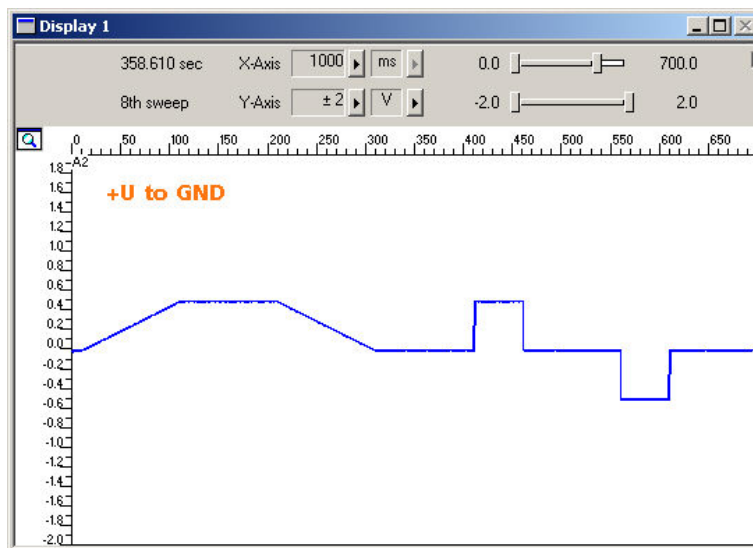
## 11.2 Voltage Mode

- If you want to operate the STG in voltage mode, you have to select "Voltage" in Output Mode of the main window of MC\_Stimulus II. You will usually use the + and **GND** outputs. The output signal is identical with the programmed signal in the normal ranges of the electronics' accuracy. The output signals are **inverted** (multiplied by -1) if you use the - outputs.
- In the **following example**, you see a signal in the MC\_Stimulus II display and the resulting output signals for the different connection options (viewed in a MC\_Rack **Data Display**).

Programmed stimulus protocol viewed in MC\_Stimulus:

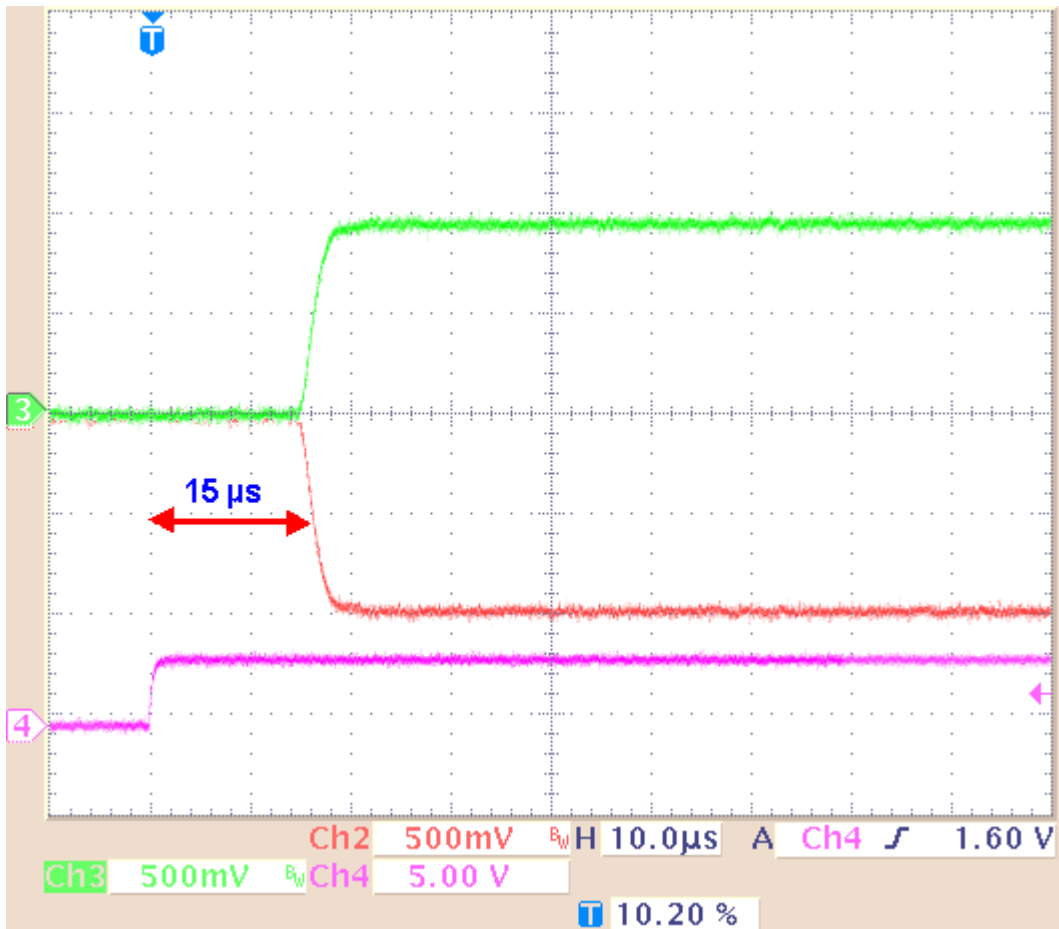


STG output signals:



Programmed stimulus protocol viewed in MC\_Stimulus II.

Voltage output 1 V and Sync Out.



The **time lag** between the **Sync Out output**, the trigger, and the **voltage output** is approximately **15 μs (±2 μs)**

## 11.3 Current Mode

- If you want to operate the STG in current mode, you have to select "Current" in Output Mode of the main window of MC\_Stimulus II.
- The output signals are **inverted** (multiplied by -1) if you use the - outputs.

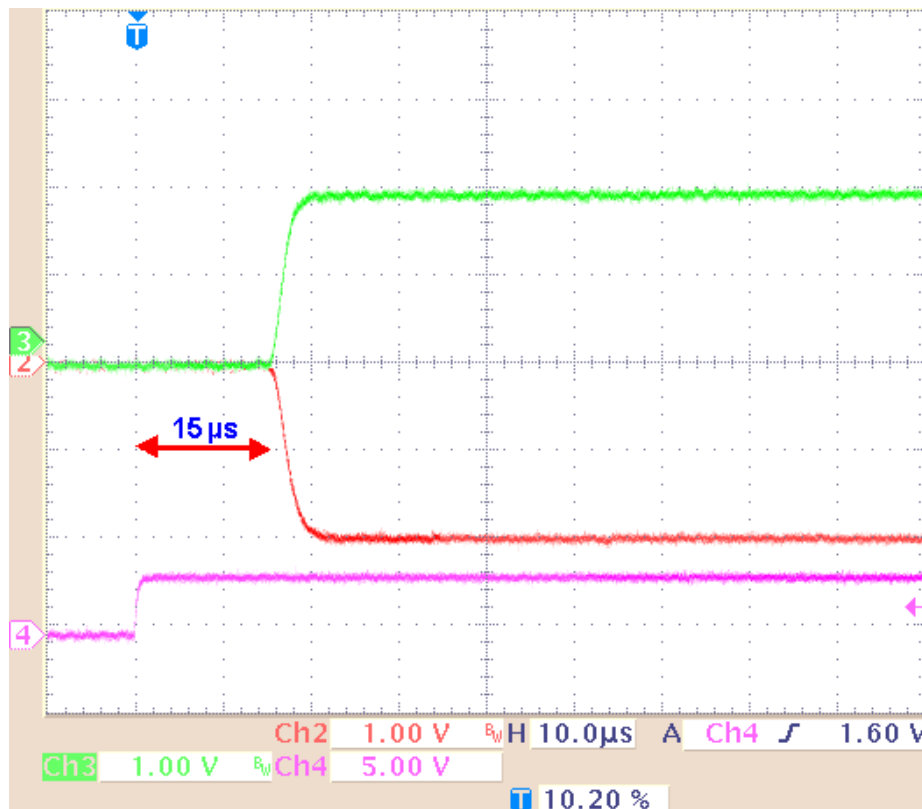
Note: In current mode, a protection switch disconnects the current source from the electrode, to avoid leak currents. The switch opens as soon as the stimulation pattern starts. To allow some time for the switch to open, it is recommended to start current pulses with a short period of 0  $\mu$ A. 40  $\mu$ s is sufficient.

If the **load resistance**, that is, the **electrode impedance** is very high, the **output voltage** can get very high, too. The stimulus generator **limits** the output voltage to **75 V** between + or - and GND. The guaranteed compliance voltage is  **$\pm 60$  V**.

- The **current output** of the STG is **limited** by the **compliance voltage** and the **electrode impedance**. If the maximum load resistance for a given current output is exceeded, the compliance voltage (60 V between +I and GND) of the STG will not be sufficient for delivering enough current, and the output will be **clipped**. You can calculate the maximum load resistance by Ohm's law. For example, if you want to program a 100  $\mu$ A pulse, the maximum load resistance will be 600 k $\Omega$ . According to Ohm's law:  $R = U / I = 60 \text{ V} / 100 \mu\text{A} = 600 \text{ k}\Omega$ , that is, 60 V are sufficient for delivering a current of 100  $\mu$ A at a load resistance of 600 k $\Omega$ . Therefore, if you use current driven stimulation, you should always take the impedance of the stimulating electrodes into account when planning your stimulus protocol. You should also keep in mind that most electrodes or amplifiers support only limited voltages.

Screen shot from a standard oscilloscope triggered on the Sync Out pulse. Green trace = current output (+I), red trace = inverted current output (I), pink trace = TTL output from the Sync Out.

Current output 200  $\mu$ A and Sync Out.



The **time lag** between the **Sync Out output** and the **current output** is approximately **15  $\mu$ s ( $\pm 2$   $\mu$ s)**.

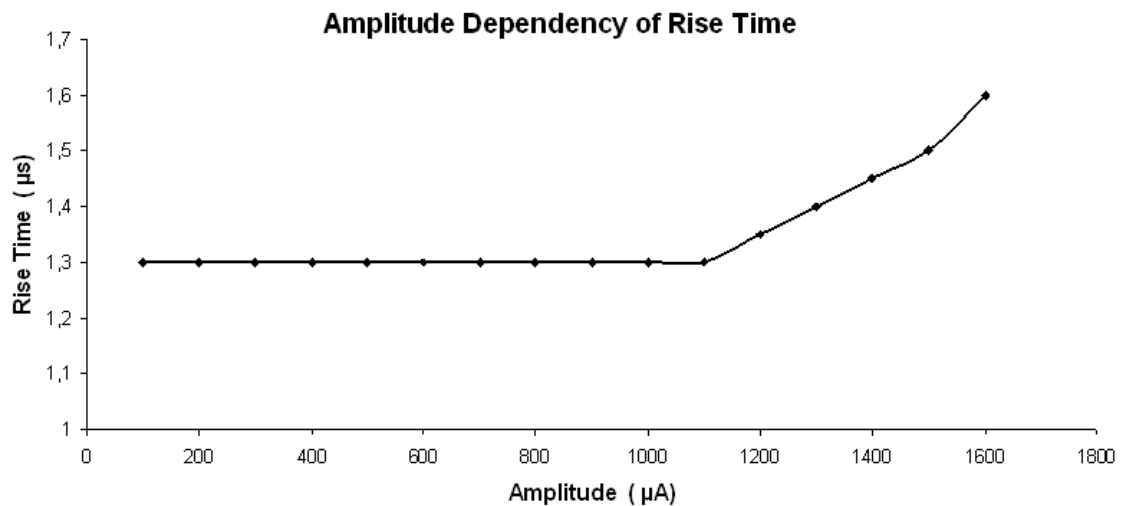
## 11.4 Rise Time

The **rise time** of the **voltage output** is **constant** and independent from the stimulus protocol. The **rise time** of the **current output** is no fixed hardware property. The kinetics depend on the **amplitude** of the current pulse and the **load resistance**, that is, generally the electrode impedance. The resistance affects the kinetics much stronger than the amplitude.

Generally, this does not make much difference for biological applications. If you have **very time-critical applications**, or if you use **very short pulses**, you should **check** the **output** of the STG with an **oscilloscope** before starting the experiment.

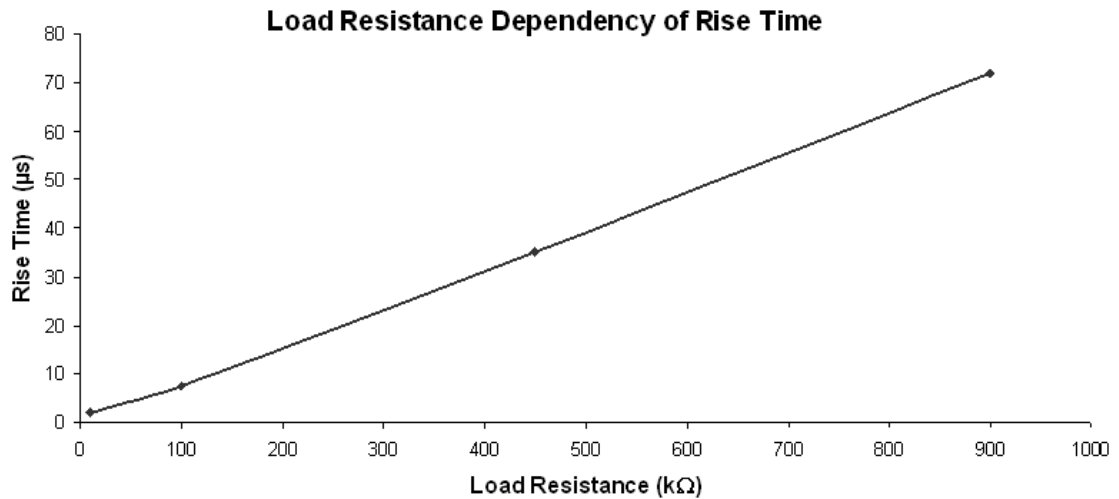
### Amplitude dependency of rise time

The **rise time** is independent from the current amplitude in the common range of amplitudes. The rise time (10 % / 90 %) was measured with increasing current amplitudes (100  $\mu\text{A}$  to 1600  $\mu\text{A}$ ) and a constant load resistance of 10  $\text{k}\Omega$ . The **output current** is nearly constant up to amplitudes of 1100  $\mu\text{A}$ , but increases about 0.3  $\mu\text{s}$  until the maximum of 1600  $\mu\text{A}$  amplitude is reached. The relationship is not linear as shown by the following curve.



### Resistance dependency of rise time

The **higher** the **load resistance**, the **higher** will be the **rise time**. The rise time (10 % / 90 %) was measured with increasing load resistances and a constant current amplitude of 50  $\mu\text{A}$ . For 50  $\mu\text{A}$  pulses, the relationship is linear up to the maximum load resistance (please see "Current Mode") as shown by the following curve. Not shown are the results of the same measurement under the same conditions, except of the amplitude with a constant current amplitude of 100  $\mu\text{A}$ . Up to a load resistance of 450  $\text{k}\Omega$ , the results are congruent with 50  $\mu\text{A}$  amplitude.



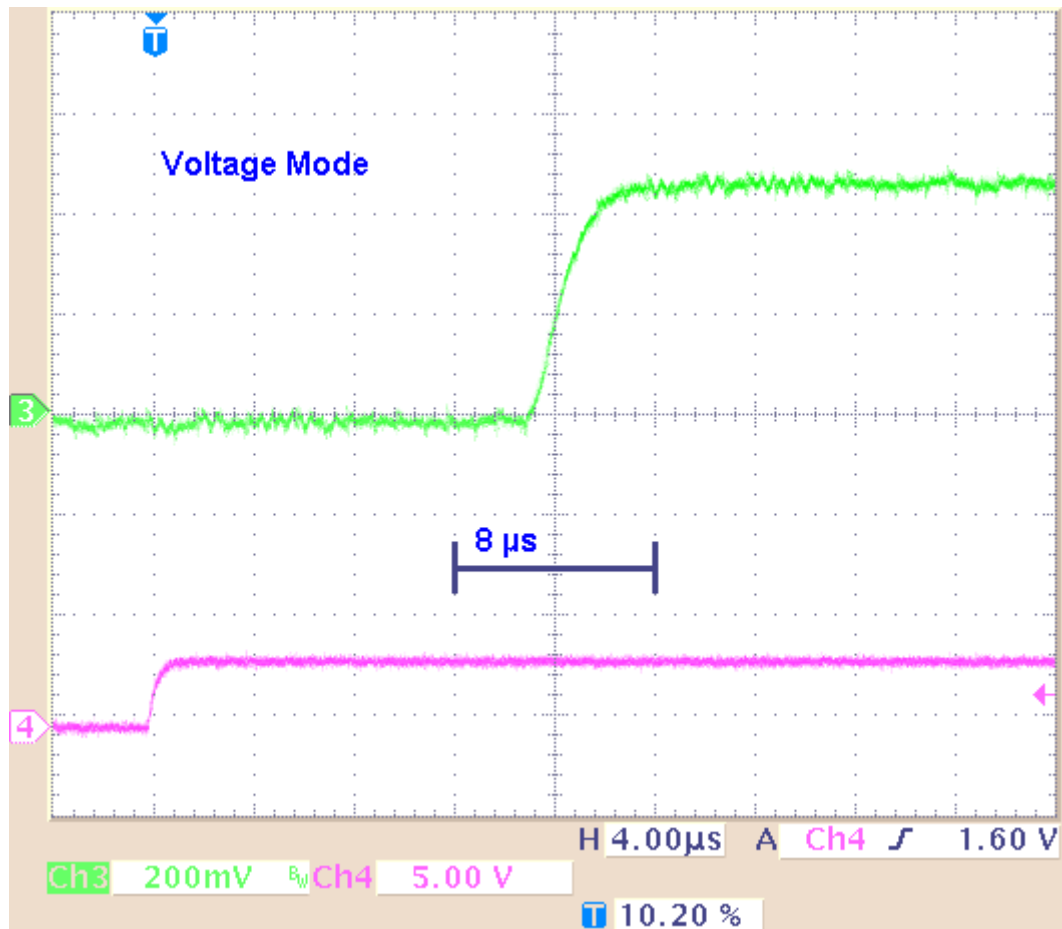
### Stimulus output comparison

The following figures are examples for demonstrating how the **amplitude** and **resistance** will affect the **kinetics** of a **current pulse**. These images document also that in contrast to the current mode, in **voltage mode**, the **rise time** is **constant** and not dependent on the amplitude or load resistance.

The graphs were generated by a standard oscilloscope. The devices were set up according to the recommendations under "Voltage Mode" and "Current Mode". The same pulse protocol and the same channel number of the STG outputs were used for measuring the voltage and the current output.

**Example 1a:** Voltage Mode: The **green** trace shows the voltage (+U) output; and the **pink** trace shows the TTL output from the **Sync Out** that was used for triggering the oscilloscope.

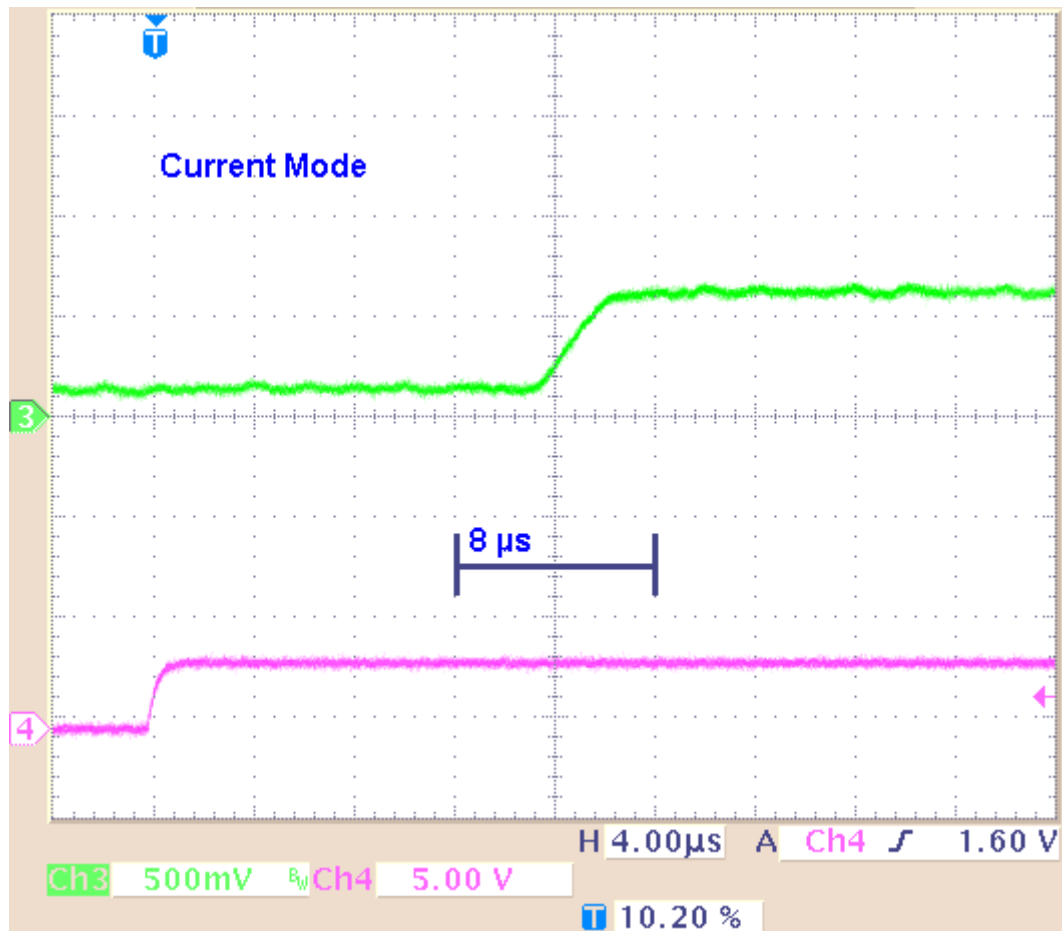
Rise time with programmed 500 mV and 50  $\mu$ A pulses, 10 k $\Omega$  load resistance.  
Rise time (10 % / 90 %) = 3  $\mu$ s



**Example 1b:** Current Mode: The **green** trace shows the current output (+I) with a load resistance of 10 k $\Omega$ , and the **pink** trace shows the TTL output from the **Sync Out** that was used for triggering the oscilloscope.



Rise time with programmed 500 mV and 50  $\mu$ A pulses, 10 k $\Omega$  load resistance.  
Rise time (10 % / 90 %) = 3  $\mu$ s

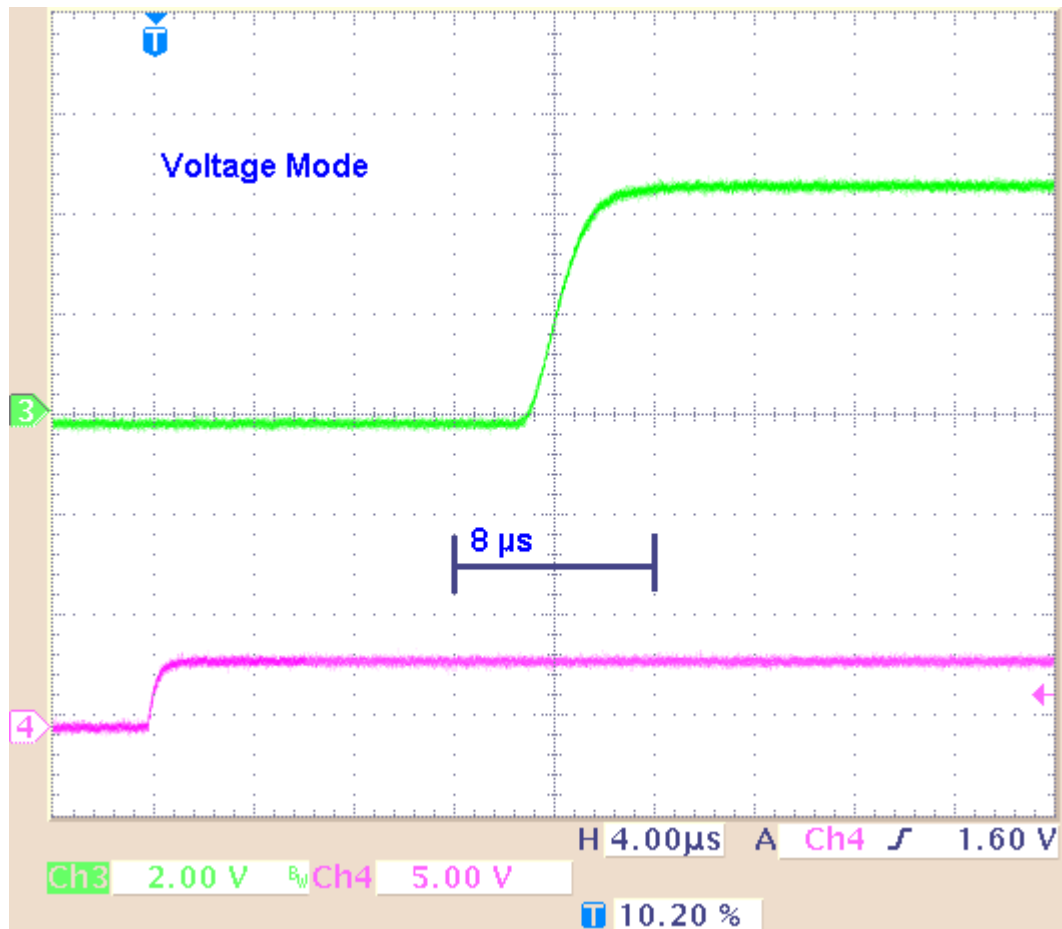


**Result of Example 1:** The rise time is about 3  $\mu$ s for the 500 mV voltage pulse, and about 3  $\mu$ s for the 50  $\mu$ A current pulse.

**Example 2a:** Voltage Mode: The **green** trace shows the voltage (+U) output; and the **pink** trace shows the TTL output from the **Sync Out** that was used for triggering the oscilloscope.

Rise time with programmed 5 V and 500  $\mu$ A pulses, 10 k $\Omega$  load resistance.

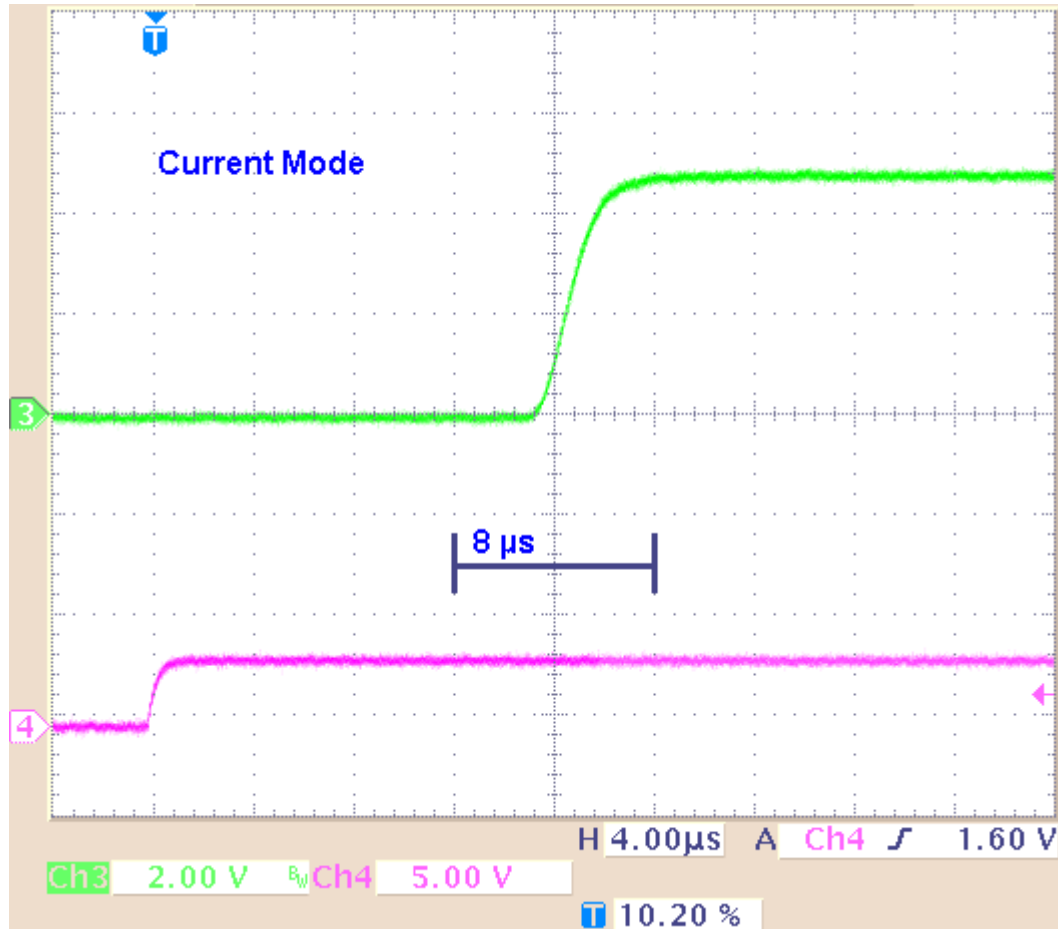
Rise time (10 % / 90 %) = 3  $\mu$ s



**Example 2b:** Current Mode: The **green** trace shows the current output (+I) with a load resistance of **10 k $\Omega$** ; and the **pink** trace shows the TTL output from the **Sync Out** that was used for triggering the oscilloscope.

Rise time with programmed 5 V and 500  $\mu$ A pulses, 10 k $\Omega$  load resistance.

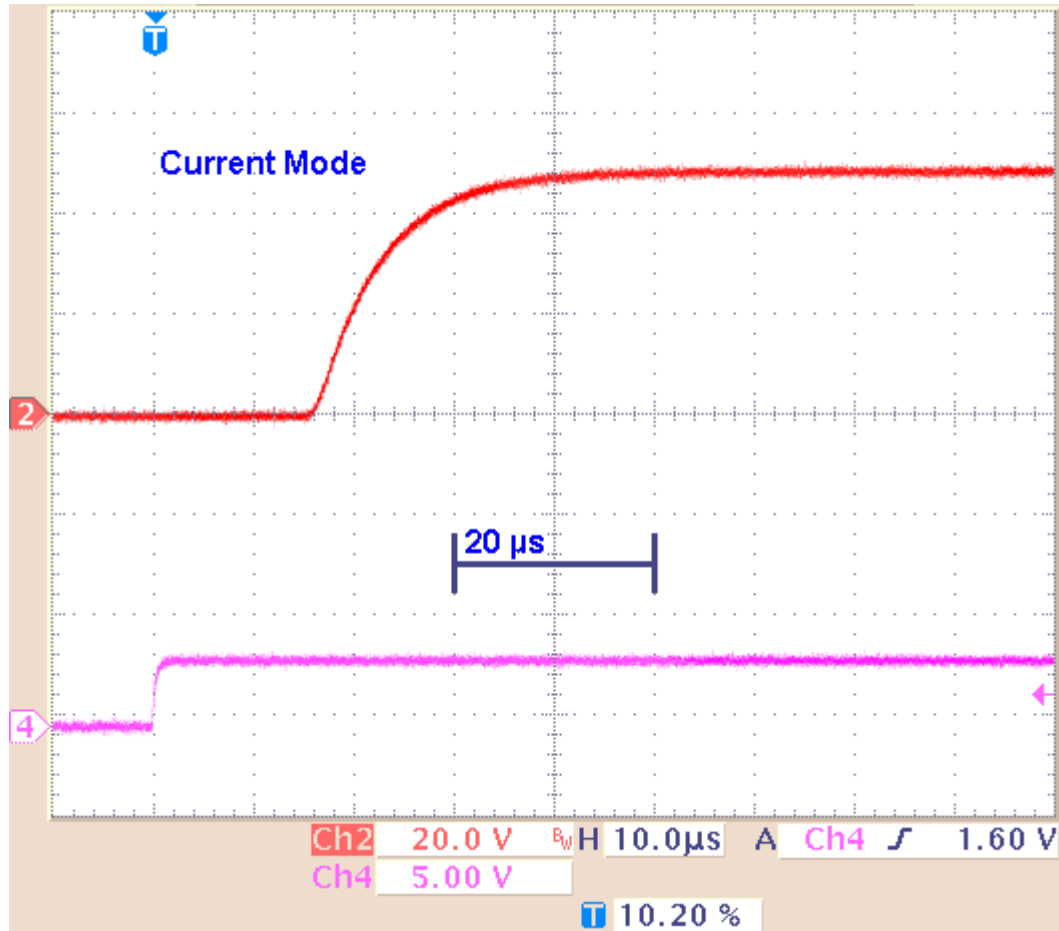
Rise time (10 % / 90 %) = 3  $\mu$ s



**Result of Example 2:** The kinetics and the rise time of the 5 V voltage pulse are comparable to the 500 mV pulse. The approximate 3  $\mu$ s rise time of the 500  $\mu$ A current pulse is not higher than the rise time of the 50  $\mu$ A pulse.

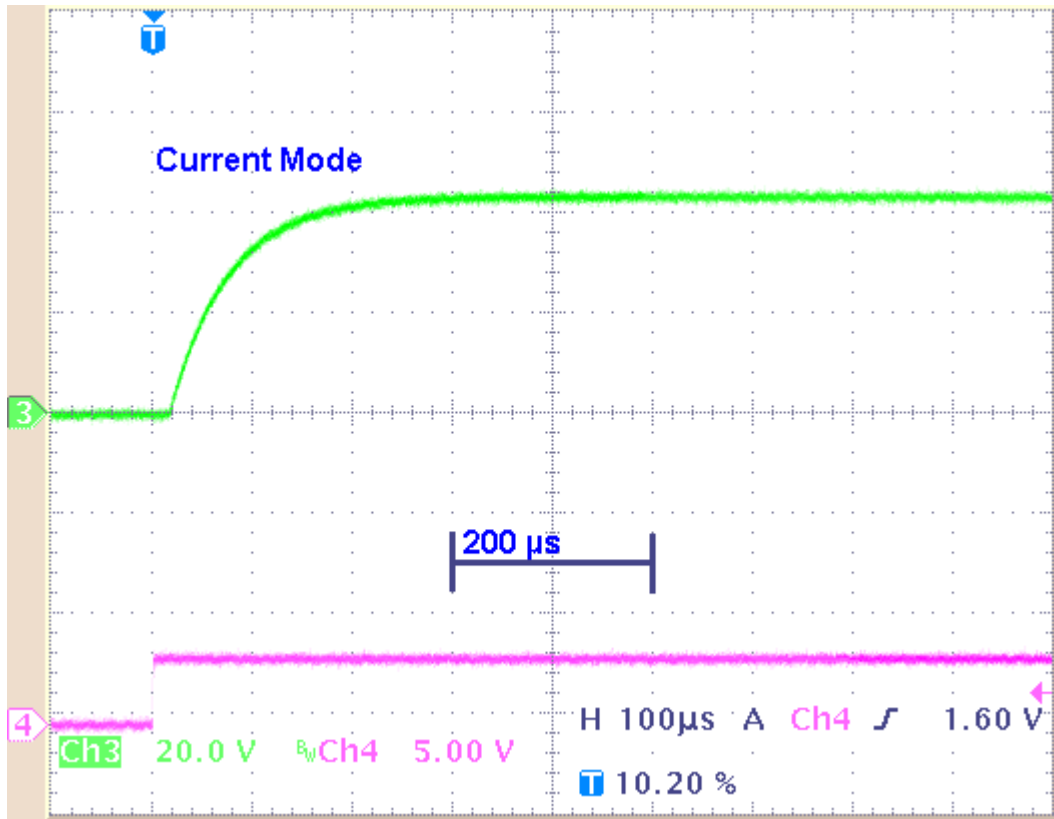
**Example 3a:** Current Mode: The **red** trace shows the current output (**+I**) with a load resistance of **100 k $\Omega$** ; and the **pink** trace shows the TTL output from the **Sync Out** that was used for triggering the oscilloscope.

Rise time with programmed 5 V and 500  $\mu$ A pulses, 100 k $\Omega$  load resistance.  
Rise time (10 % / 90 %) = 12  $\mu$ s



**Example 3b:** Current Mode: The **green** trace shows the current output (+I) with a load resistance of **1 M $\Omega$** , and the **pink** trace shows the TTL output from the **Sync Out** that was used for triggering the oscilloscope.

Rise time with programmed 5 V and 500  $\mu$ A pulses, 1 M $\Omega$  load resistance.  
Rise time (10 % / 90 %) = 120  $\mu$ s



**Result of Example 3:** With a higher load resistance, the current pulse shows a different kinetic behavior: The rise time increases significantly (about 100  $\mu$ s). Please keep in mind that the resistance of the oscilloscope probe with 10 M $\Omega$  is parallel to the 1 M $\Omega$  load resistance. That means, that the maximum of the load resistance is reduced to 900 k $\Omega$  only.

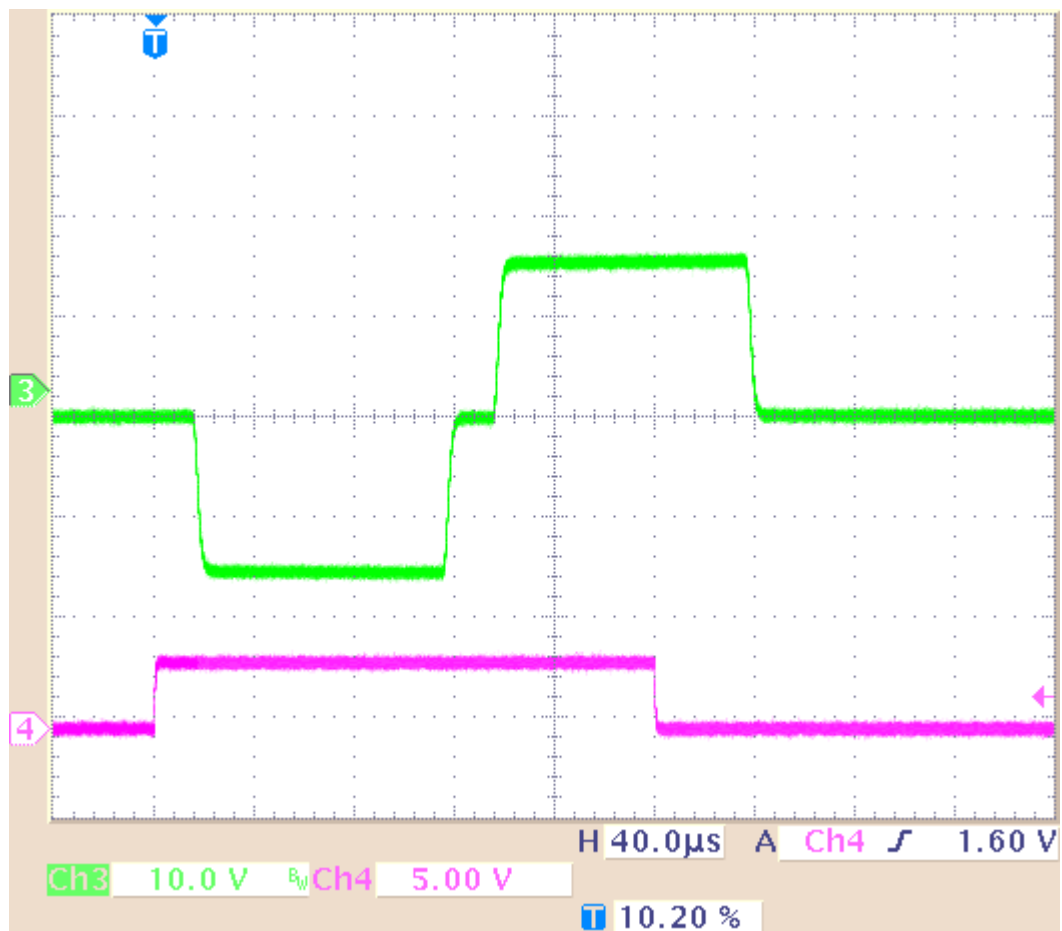
## 11.5 Comparison of Output Signals in Current Mode

To show the different behavior of the output signals in current mode, there are some examples to get an idea how the stimulus generator will deliver the stimulus pulses. The screen shots are from a standard oscilloscope triggered on the Sync Out pulse

**Example 1:** Influence of the length of a current pulse 100  $\mu\text{s}$  versus 20  $\mu\text{s}$  with an amplitude of 1600  $\mu\text{A}$ , which is at the maximum capacity of the STG3000 series (constant amplitude and load resistance).

**Example 1a:** Current pulse with programmed 1600  $\mu\text{A}$  for 100  $\mu\text{s}$  and 20  $\mu\text{s}$  interval and 10  $\text{k}\Omega$  load resistance.

The pulse is biphasic, and 1600  $\mu\text{A}$  which is the limit of the maximum capacity of the STG3000 series. Green trace = current output (+I), pink trace = TTL trigger output from the Sync Out.



**Example 1b:** Current pulse with programmed 1600  $\mu\text{A}$  for 20  $\mu\text{s}$  and 20  $\mu\text{s}$  interval and 10  $\text{k}\Omega$  load resistance.

The pulse is biphasic, and 1600  $\mu\text{A}$  which is the limit of the maximum capacity of the STG3000 series. Green trace = current output (+I), pink trace = TTL trigger output from the Sync Out.

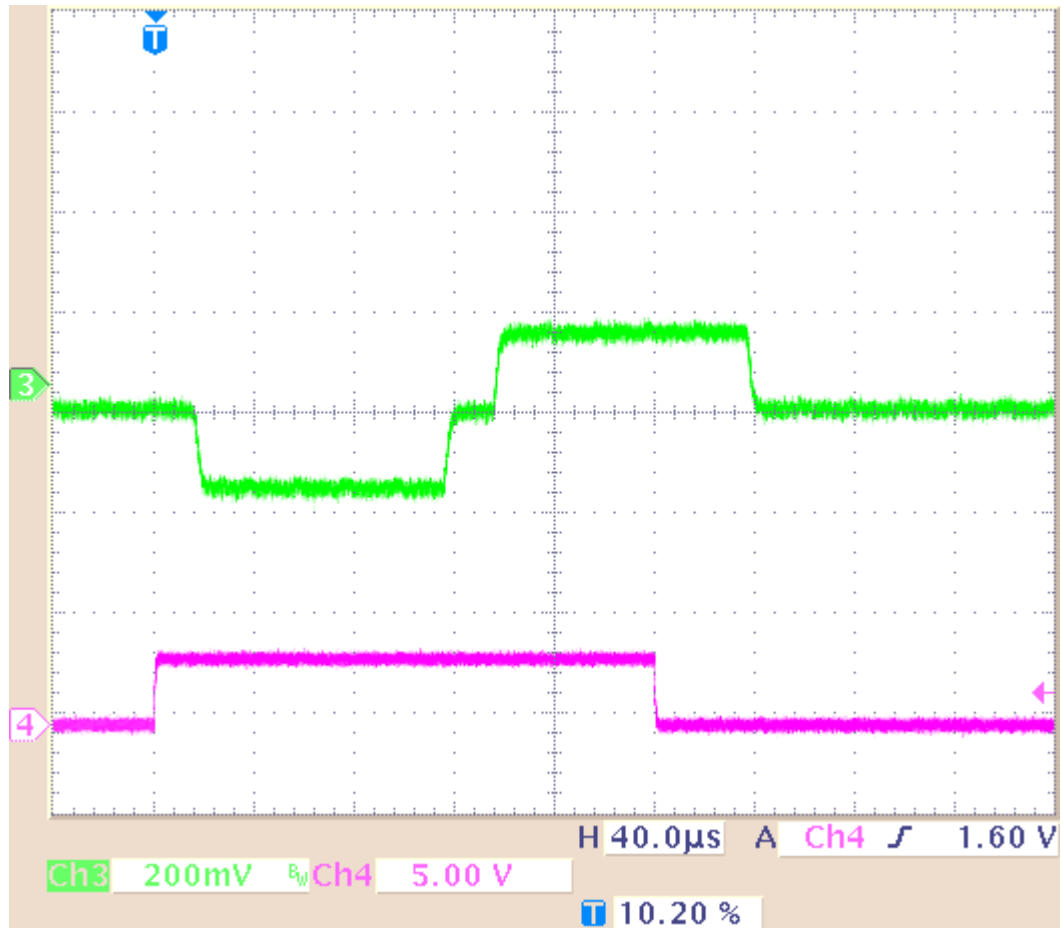


**Result of Example 1:** The current output signal is delivered unmodified without any influence of the length of the pulse with an amplitude of 1600  $\mu\text{A}$  which is at the maximum capacity of the STG3000 series.

**Example 2:** Influence of the length of a current pulse 100  $\mu\text{s}$  versus 20  $\mu\text{s}$  with an amplitude of 16  $\mu\text{A}$  which is a hundredth of the limit of the maximum capacity of the STG3000 series (constant amplitude and load resistance).

**Example 2a:** Current pulse with programmed 16  $\mu\text{A}$  for 100  $\mu\text{s}$  and 20  $\mu\text{s}$  interval and 10  $\text{k}\Omega$  load resistance.

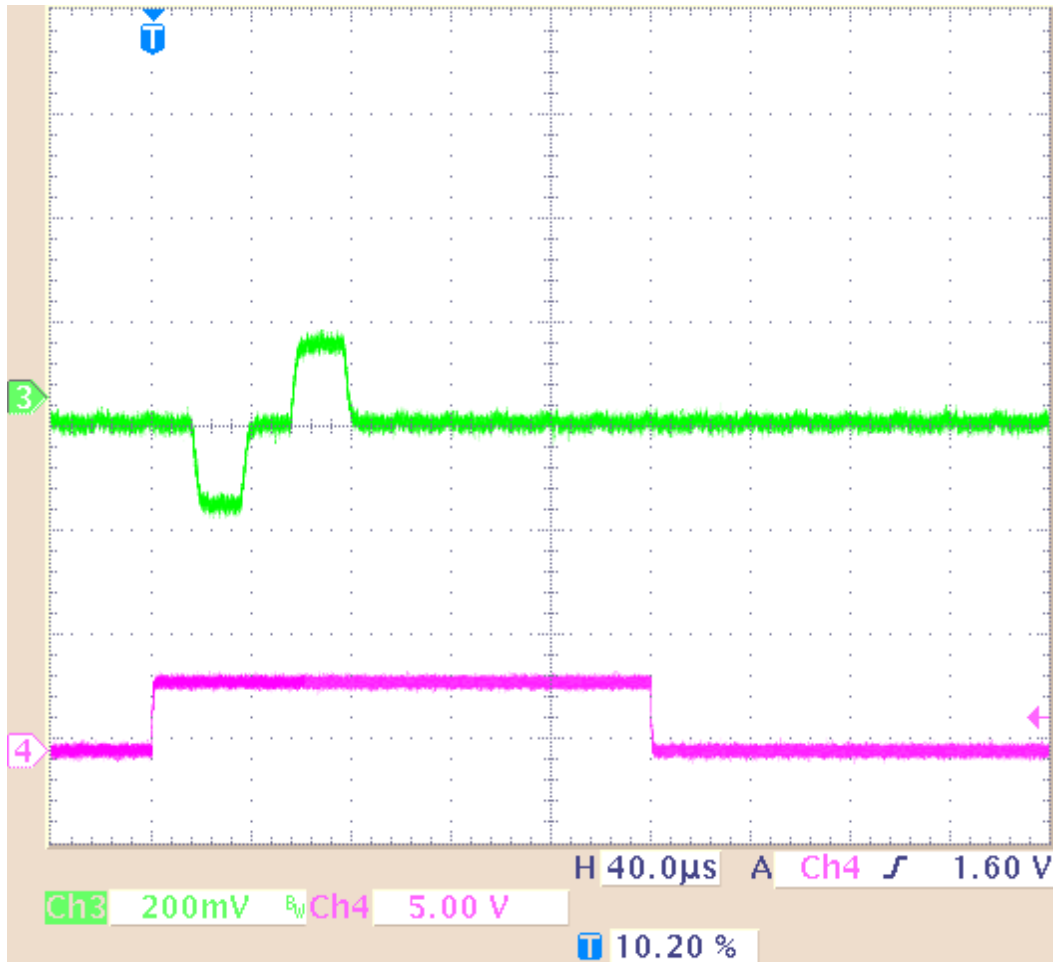
The pulse is biphasic, 16  $\mu\text{A}$ . Green trace = current output (+I), pink trace = TTL trigger output from the Sync Out.





**Example 2b:** Current pulse with programmed 16  $\mu\text{A}$  for 20  $\mu\text{s}$  and 20  $\mu\text{s}$  interval and 10  $\text{k}\Omega$  load resistance.

The pulse is biphasic, 16  $\mu\text{A}$ . Green trace = current output (+I), pink trace = TTL trigger output from the Sync Out.



**Result of Example 2:** The current output signal is delivered unmodified without any influence of the length of the pulse, and an amplitude of 16  $\mu\text{A}$  which is a hundredth of the limit of the maximum capacity of the STG3000 series

**Example 3:** Influence of the length of a current pulse and a high load resistance. Current pulse with programmed 16  $\mu\text{A}$  for 100  $\mu\text{s}$  and 20  $\mu\text{s}$  interval and 1  $\text{M}\Omega$  load resistance. The load resistance is very high. Please keep in mind that the load resistance of 1  $\text{M}\Omega$  is parallel to 10  $\text{M}\Omega$  of the probe of the oscilloscope. That means, the load resistance is reduced to 900  $\text{k}\Omega$  only.

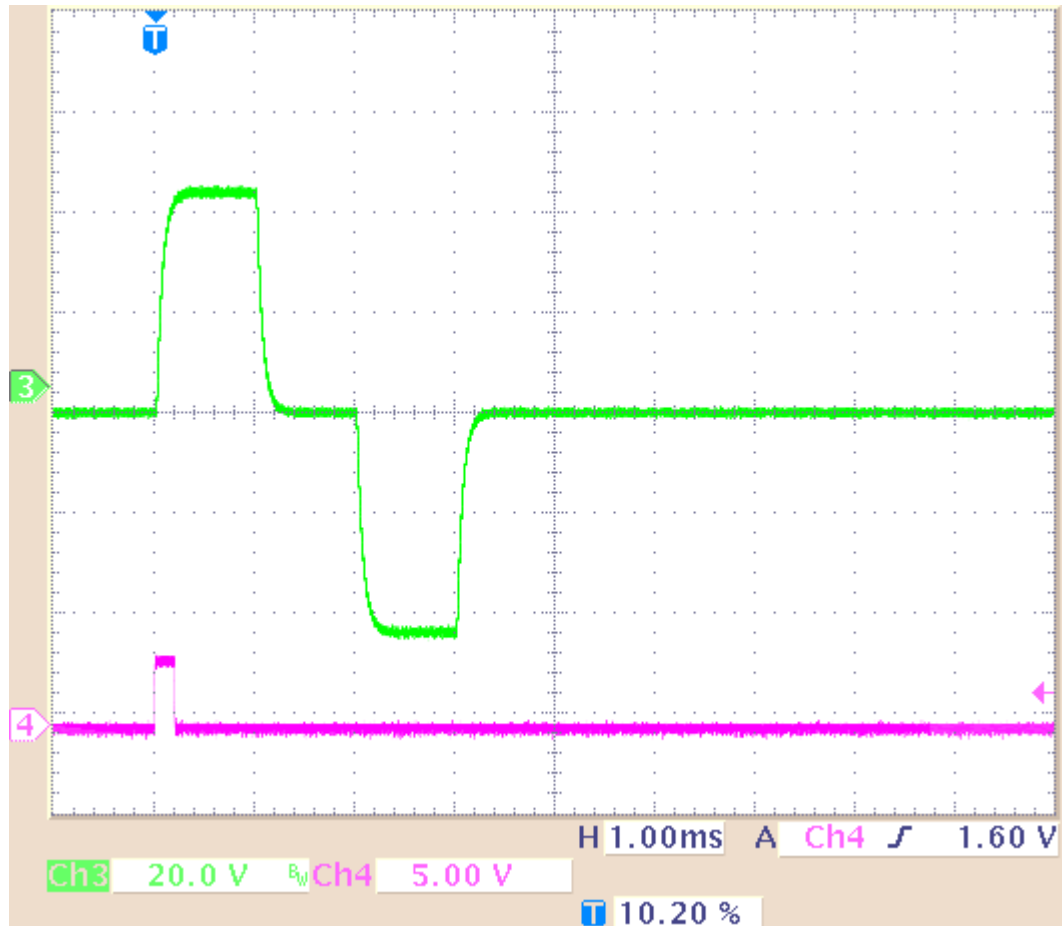
The pulse is biphasic, and 16  $\mu\text{A}$  which is a hundredth of the limit of the maximum capacity of the STG3000 series. Green trace = current output (+I), pink trace = TTL trigger output from the Sync Out.



**Result of Example 3:** The current output signal is delivered strongly modified because of the high load resistance of 1  $\text{M}\Omega$ , and the duration of the pulse, 100  $\mu\text{s}$  and the interval. Before the pulse is reaching its maximum, it has to turn into its invert phase. Before the pulse is reaching its minimum, it is cut off. Please see example 4: If the duration of pulse and interval is much longer, 1 ms, the pulse shape of the delivered signal is much better.

**Example 4:** Influence of the length of a current pulse and a high load resistance. Current pulse with programmed 50  $\mu\text{A}$  for 1 ms and 1 ms interval and 1  $\text{M}\Omega$  load resistance. The load resistance is very high, the duration of the pulse and the interval are long. Please keep in mind that the load resistance of 1  $\text{M}\Omega$  is parallel to 10  $\text{M}\Omega$  of the probe of the oscilloscope. That means, the load resistance is reduced to 900  $\text{k}\Omega$  only.

The long pulse is biphasic, 50  $\mu\text{A}$ . Green trace = current output (+I), pink trace = TTL trigger output from the Sync Out.



**Result of Example 4:** The current output signal is delivered negligible modified when the duration of the signal and the duration of the interval is long, for example 1 ms.

## 11.6 Capacitive Behavior of Stimulation Electrodes

Regarding the generally used stimulus pulses, stimulating electrodes behave as plate capacitors. They need some time to discharge themselves after stimulation. As a result, artifacts interfere with the recording, and electrodes deteriorate over time due to electrolysis. This effect takes place especially in **current** mode because the current cannot flow back to the stimulus generator due to the high output resistance in current mode and thus is kept in the electrode. A current source can constantly produce small currents, even though the current is set to zero. This might damage the connected electrodes over time. To avoid this problem, the STG3008-FA is equipped with switches that automatically disconnect the current outputs from the current source 1s after each programmed current stimulus. For the next stimulus, the current source is automatically reconnected.

To reduce the effect described above in **current mode**, you should use **biphasic pulses** for stimulation. The stimulus signal should be immediately followed by an **inverse** signal of the **same** area (product of current and time), which helps to discharge the electrode. The easiest way is to use the same signal amplitude with an opposite polarity.

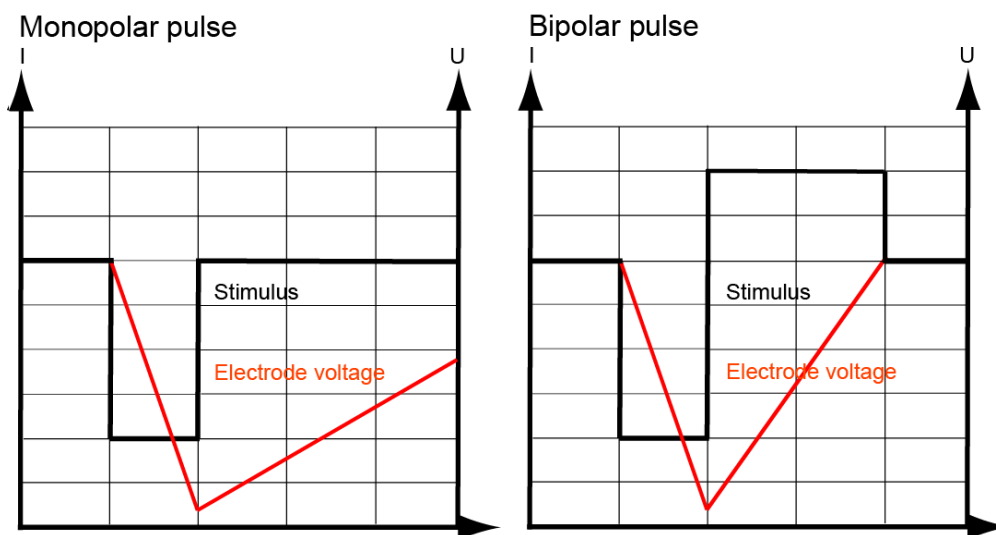
Multi Channel Systems recommends using voltage driven stimulation. In **voltage mode**, it is **not** necessary to use biphasic stimulation for discharging the electrodes, because the electrode should be discharged at a voltage of 0, that is, it would be sufficient to apply the negative phase only.



**Warning:** When using MEA electrodes of **TiN** material, stimulation with higher amplitudes is possible if you apply the **negative pulse first**. Also, regard the **safe charge-injection limit** as described in the MEA manual. Otherwise, electrodes can be damaged during stimulation.

The following illustration shows the effect of a biphasic current pulse on the discharge of the stimulation electrode. As you can see, the first monophasic pulse is followed immediately by a pulse of the opposite polarity and the same product of current and time.

### Effect of a bipolar current pulse on the electrode voltage



## 12 Troubleshooting

### 12.1 About Troubleshooting

Most problems occur seldom and only under specific circumstances. In most cases, it is only a minor problem that can be easily avoided or solved.

If the problem persists, please contact your local retailer. The highly qualified staff will be glad to help you. Please inform your local retailer as well, if other problems that are not mentioned in this documentation occur, even if you have solved the problem on your own. This helps other users, and it helps MCS to optimize the instrument and the documentation.

Please pay attention to the safety and service information (chapter "Important Safety Advice" in the manual or help). Multi Channel Systems MCS GmbH has put all effort into making the product fully stable and reliable, but like all high-performance products, it has to be handled with care.

**Important:** Please use voltage pulses if possible! Current pulses may lead to temporary baseline shifts at the beginning and end of the stimulation paradigm due to switching artefacts.

### 12.2 Technical Support

Contact your local retailer immediately if the cause of trouble remains unclear. Please understand that information on your hardware and software configuration is necessary to analyze and finally solve the problem you encounter.

If you have any questions or if any problem occurs that is not mentioned in this document, please contact your local retailer. The highly qualified staff will be glad to help you.

#### **Please keep information on the following at hand**

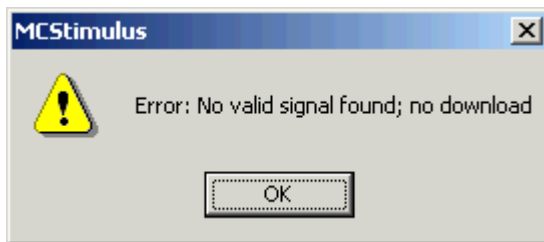
- **Description** of the **error** (the error message text or any other useful information) and of the context in which the error occurred. Try to remember all steps you had performed immediately before the error occurred. The more information on the actual situation you can provide, the easier it is to track the problem.
- The **serial number** of the device. You will find it on the device or click on the **Help** menu, click **About**.
- The **software (SW) and hardware (HW) version** you are currently using. On the **Help** menu, click **About**. The displayed dialog box shows the version numbers.
- The **operating system** and service pack number on the connected **computer**.
- The **hardware configuration** (microprocessor, frequency, main memory, hard disk) of the connected **computer**. This information is especially important if you have modified the computer or installed new hard- or software recently.

## 12.3 Error Messages

This chapter explains error messages to you that may occur during normal operation. They do not present a reason to worry and can be easily avoided.

### Download

These error messages may occur during download on the STG. Please note that you can switch off some of these messages if they disturb your experiment. See chapter "Downloading Stimuli" for more details on downloading.



The worksheet is empty. No data is present that can be downloaded.



There is no stimulus generator connected to the computer or the STG may be switched off. Please check the computer connection and the status lamp of the STG.



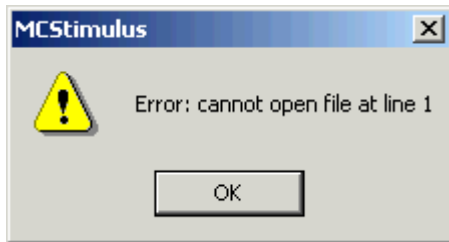
There is no valid connection to an STG. Download of data is not possible. Please check the computer connection and the status lamp of the STG.



The last voltage / current values of the named channels are not zero. The current / voltage levels are set to **zero** after the last value. The last used values of these channels are **kept** until the STG is stopped.

## ASCII Import

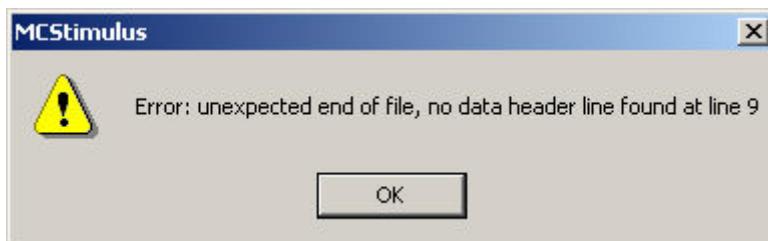
These error messages relate to a wrong file format. Please see chapter "Supported File Format" for more information.



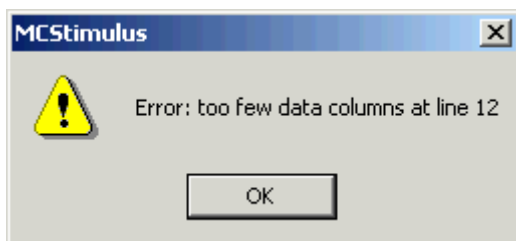
The named line contains an unexpected character.



The channel number specification has to precede the data. The channel number either lacks or the specified number does not exist (for example, number 13).



Each data column must have a header (*value*, *time*, or *repeat*).



The number of data columns has to be consistent for all lines in a given ASCII file (for example, *value*, *time*, *value*, *time*). This error message indicates that there is a current / voltage value or a time point missing in line 12.



The ASCII file contains current / voltage values outside the STG's range. For example, if the STG's output range is  $+8000$  mV, all values above  $+8000$  mV are set to  $+8000$  mV.

## 12.4 Signal terminated when using Trigger In

If you use the **Trigger In** to start the STG and the stimulation protocol is terminated right after start, check the Trigger Settings. If the **Use Trigger as Gate** function is selected, a protocol will only be active as long as the Trigger is HIGH. If the Single Trigger function is selected, the STG is armed and waits for an external trigger to execute the stimulus protocol one time only. Switch to **Stop, Restart** or **Ignore**.

## 12.5 Signal is not Repeated / Pulse Train Fails

The STG fails to generate a train of pulses. When a pulse is programmed in MC\_Stimulus II and then repeated (in the Trigger Settings dialog box) (with the Repeat option), the STG abruptly stops after it has generated the waveform only once. (If another STG is connected to the computer to run the same protocol, the stimulator has no problems on repeating the pulse.)

Possible causes:

- ? If you change the stimulus protocol after the download, even if only the number of repeats were changed, you need to download the modified stimulus protocol to the STG. Otherwise the changes will not be applied. (If another STG is connected to the computer, you will have to download the stimulus protocol, including the changes, to be able to stimulate at all.)
- Select Download or Download and Start on the STG menu (or on the toolbar) after you made any changes to the stimulus protocol in the MC\_Stimulus program.



## 12.6 Output Signal Does not Match Programmed Signal

The amplitude or the duration of the output pulses differs from the programmed signal.

Possible causes:

- ? The stimulus protocol works near the resolution limits of the STG, that is, the pulses are very short or the amplitudes very low (**smaller than 50 mV or 10  $\mu$ A**).
- Check the output signals with an oscilloscope and modify the pulse protocol so that the amplitude and timing of the pulses will match your requirements.
- ? You operate the STG in **current mode**, and the **electrode resistance** of the **stimulating electrodes** is **too high**. According to Ohm's law, the electrode resistance directly affects the kinetics of the current output. The rise time increases with an increasing electrode resistance. If the electrode resistance is too high for the compliance voltage, the output signal will be clipped.
- Try to stimulate in **voltage mode**.
- Try to use stimulating electrodes with **lower impedance**.
- Check the output signals with an oscilloscope and modify the pulse protocol so that the amplitude and timing of the pulses will match your requirements.

## 12.7 Strong Peak Artifacts

Strong discharges or other artefacts of the output voltage or current.

Possible causes:

- ? One or both current outputs are open, that is, nothing is connected to them. The stimulus generator tries to hold a stable current against the indefinite resistance of the open current output. Therefore, the stimulus generator will increase the output voltage on the open current outputs to its maximum, which will result in a heavy load on the power supply. This situation may cause the power supply to become unstable, which may lead to artifacts on all channels.
- In current mode: Connect the unused current output to ground (GND). Please see also the recommended setups in the chapter "Current Mode".
- Important: Please use voltage pulses if possible! Current pulses may lead to temporary baseline shifts at the beginning and end of the stimulation paradigm due to switching artefacts.

## 13 Appendix

### 13.1 Technical Specifications STG3008-FA

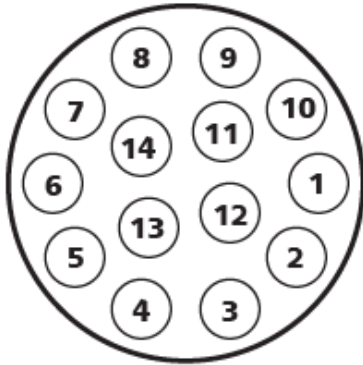
European Standard: EN 55011, EN 61000-6-1

<b>General characteristics</b>	
Operating temperature	10 °C to 50 °C
Storage temperature	0 °C to 70 °C
Dimensions (W x D x H)	220 mm x 170 mm x 60 mm
Weight	1050 g
Fuse	internal, 3.15 A slow blow
Supply voltage (external power supply)	100 to 240 VAC @ 47 to 63 Hz
<b>Stimulus Generator</b>	
Number of stimulus generators	8
Output voltage range	-8 V to + 8 V @ max. $\pm$ 20 mA
Output voltage resolution	1 mV
Rise time (10 % - 90 %) voltage	1.7 $\mu$ s @ $\Delta$ U = 8 V
Time lag between Sync Out and voltage output	15 $\mu$ s $\pm$ 2 $\mu$ s for continuous pulses 40 $\mu$ s $\pm$ 5 $\mu$ s for a first or a single pulse
Output current	-1.6 mA to +1.6 mA @ max. $\pm$ 120 V compliance voltage (between +I and I)
Output current resolution	200 nA
Output current slope	600 $\mu$ A/ $\mu$ s @ $R_L = 10$ k $\Omega$
Time lag between Sync Out and current output, 0 - 100 $\mu$ A	15 $\mu$ s $\pm$ 2 $\mu$ s @ $R_L = 10$ k $\Omega$
Rise time (10 % - 90 %) current, 0 - 100 $\mu$ A	1.4 $\mu$ s @ $R_L = 10$ k $\Omega$
Resolution	14 bit
Time resolution	20 $\mu$ s
Output signals	Freely programmable (rectangular, ramp, sinus, arbitrary)
Maximum frequency (rectangular waveform)	25 kHz
Memory capacity for stores waveforms	64 MB

<b>Timing on external trigger</b>	
Minimum time length of trigger input (TTL)	40 $\mu$ s
Time lag between trigger input and Sync Out	70 $\pm$ 10 $\mu$ s
Maximum trigger input frequency	10 kHz
<b>Interface and connectors</b>	
Sync Out for synchronization with following devices	1 Lemo connector
Trigger In for synchronization with preceding devices	1 Lemo connector
Analog Out for analog channels	8 Lemo connectors
Interface (connection to computer)	USB 2.0 High Speed
Ground	4 mm connector, standard common jack
<b>Filter Amplifier</b>	
Number of amplifier	8
Input voltage range	$\pm$ 500 mV
Input impedance	$>10^9 \Omega$ parallel to 10 pF
Input noise	$< 1 \mu$ V RMS (full bandwidth, inputs short circuited)
Noise density	$e_n = 9 \text{ nV} / \sqrt{\text{Hz}}$
Output voltage range	$\pm 5 \text{ V}$
Output current	10 mA
Bandwidth	1 Hz to 2200 Hz
Gain options	100, 200, 500 or 1000
<b>MC_Stimulus program</b>	
MC_Stimulus II	Version 3.4.0 and higher
Operating system	Microsoft Windows <sup>®</sup> 10, 8.1, Windows 7 with NTFS English and German versions supported
Data import and export	ASCII file format

## 13.2 Pin Layout

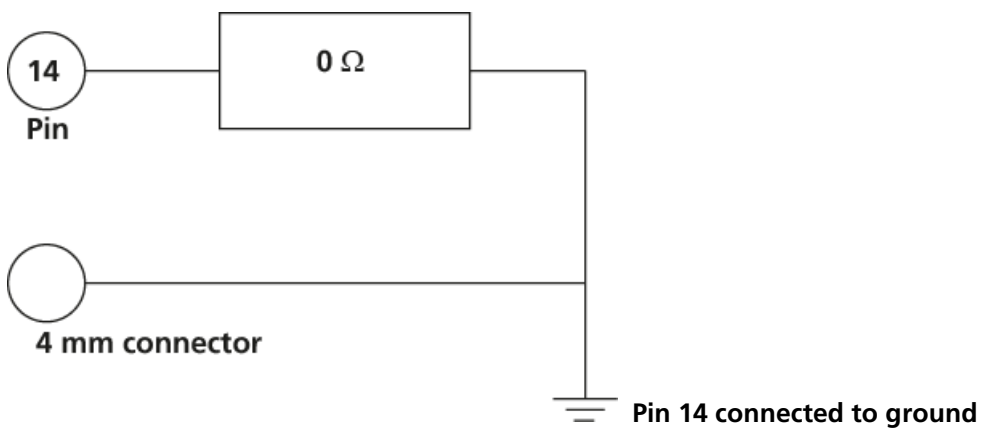
### Pin layout of the STG3008-FA Amplifier



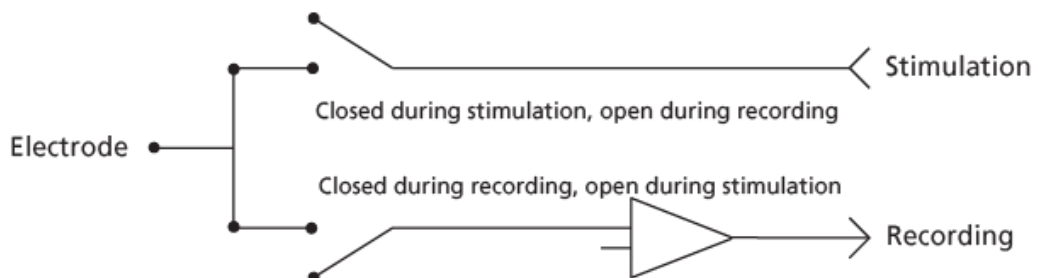
#### Stimulus Out and Electrode IN

Pin	1 to 8	Electrode IN 1 to 8 and Stimulus OUT 1 to 8 (+U / +I)
Pin	9 to 13	Not connected
Pin	14	Ground (GND)

The STG3008-FA can software controlled toggle between recording and stimulation mode on pins 1 to 8.



#### Internal switch positions during stimulation and recording



## 13.3 Contact Information

### **Local retailer**

Please see the list of official MCS distributors on the MCS web site.

### **Mailing list**

If you have subscribed to the newsletter you will be automatically informed about new software releases, upcoming events, and other news on the product line. You can subscribe to the list on the contact form of the MCS web site.

[www.multichannelsystems.com](http://www.multichannelsystems.com)

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