

# Stimulus Generators

... the Next Generation



**\* Flexible waveforms and stimulation**

- Unlimited duration of stimulus protocol and number of pulses, perfect for long-term stimulation
- Freely programmable waveforms (mono- or biphasic, square pulses, ramps, sine wave) with individual time rates and duration of pulses
- Time resolution 20  $\mu$ s
- ASCII Import of stimulation protocols (e. g. biopotential wave patterns)

**\* Functional and compact hardware**

- Stimulus isolation units integrated for each channel, each channel optically isolated, no additional costs
- Additional trigger input and output (TTL) for external control
- Separate voltage and current output mode
- Plug and play hardware
- No need for batteries

**\* Easy to use software**

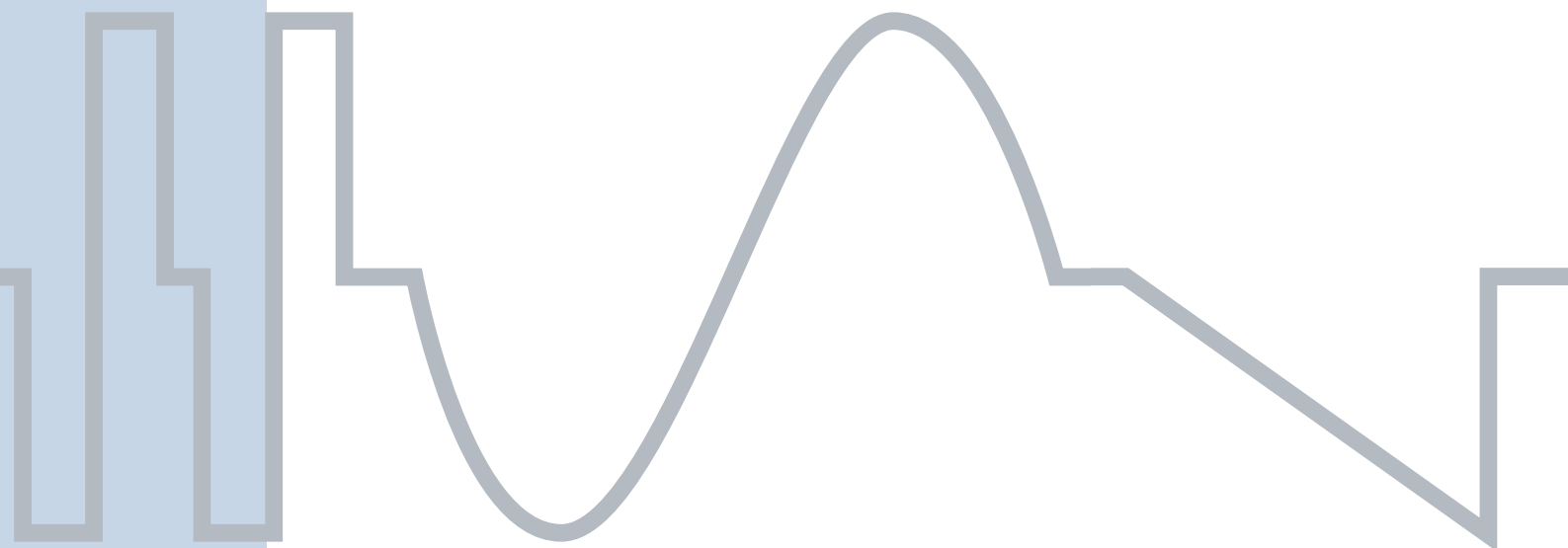
- Downloaded paradigms stored in internal memory and transformed by the STG's internal computer into analog pulse streams, advanced microprocessor technology
- Very flexible design of simple and complex stimulation protocols via graphical user interface and WYSIWYG editor (for Windows), no complicated keyboard/button input
- Tools for setting up complex stimuli like autocreating wizards, editing multiple pulses at once, grouping and looping pulses

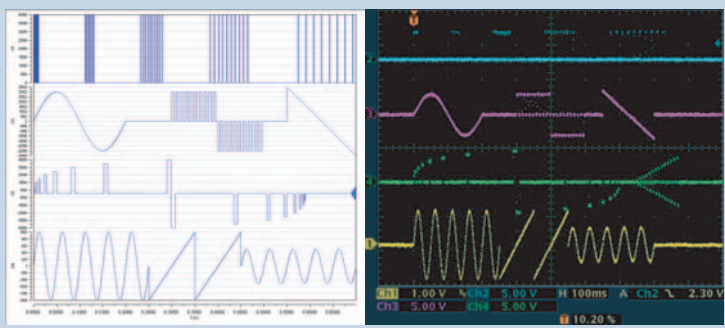
**\* STG 2000 series - new features**

- USB 1.1 interface
- The world's first stimulator with dynamic online changes and downstreaming of pulse protocols
- 4 additional trigger inputs and outputs, channels can be triggered independently
- STG can be controlled from custom programs

STG

Features	1000 Series	2000 Series
Number of analog output channels	1, 2, 4, or 8	4/8
Integrated stimulus isolation units (SIU) for each channel	✓	✓
Separate voltage and current output mode	✓	✓
Freely programmable waveforms on each channel	✓	✓
Unlimited duration and pulse number	✓	✓
Dynamic online changes and downstreaming		✓
Independent external triggering of each channel		✓
Additional trigger input/output channels (TTL)	1/1	4/4
ASCII Import (e. g. biopotential wave patterns)	✓	✓
Batch mode for combining separate standard pulse protocol files	✓	✓
Time resolution	20 $\mu$ s	20 $\mu$ s
Interface	RS232	USB
User-friendly WYSIWYG editor / graphical user interface	✓	✓
Pulse protocols edited/stored/managed on standard computer	✓	✓
Download rate (from computer to stimulus generator)	56 Kbps	12 Mbps
Extra large memory and extra fast download		✓
No need for batteries	✓	✓





### Freely programmable waveforms

General purpose stimulus generators of the 1000 or 2000 series feature extremely flexible stimulation with monophasic or biphasic current or voltage waveforms. Pulse duration, amplitude, and interval are all up to the user's choice. Rectangular, ramp, or sine waveforms can be combined freely to design virtually any stimulus pattern.

With the free MC\_Stimulus program, stimuli are created user-friendly by entering the desired values into a worksheet. Waveforms are displayed in a WYSIWYG window. All channels (up to 8) are set up separately. Repetitive stimulus patterns do not have to be entered separately, but can be grouped and looped for more convenience.

Tools for auto-creating ramps, shifting and inverting pulses are provided as well. You can print and save stimuli and comments for later use.

### Functional and compact hardware design

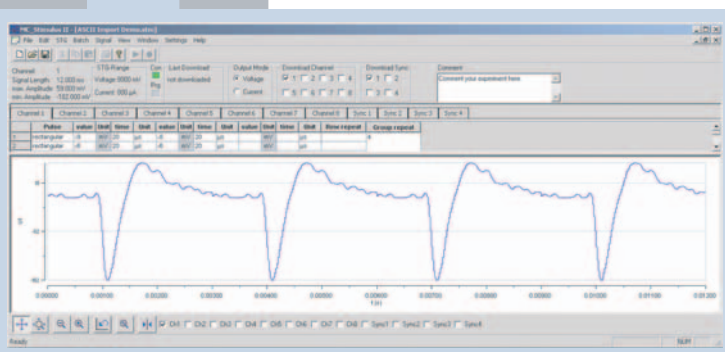
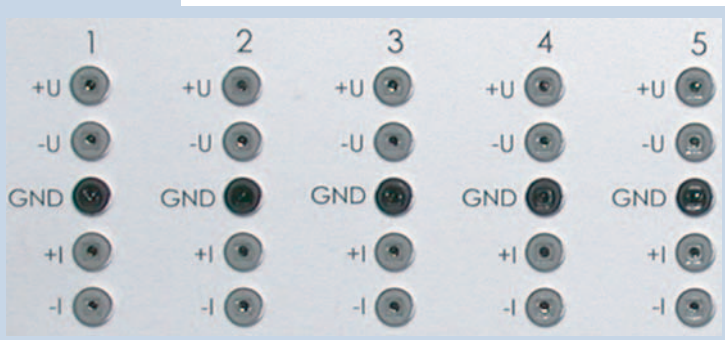
All other commercially available multichannel stimulators have one serious limitation - they need a separate stimulus isolation unit (SIU) for each channel. The stimulus generators of the 1000 and 2000 series overcome this problem by having integrated the complete hardware including SIUs for **each** of the up to 8 channels in a single compact instrument. No hassle with various units and cables, no additional costs! Each channel is optically isolated and has an independent ground; there is no cross-talk among channels. The stimulus generator operates in voltage and current mode and has a separate current and voltage output for each channel. In current mode, the stimulus generator guarantees a stable current output independent of the electrode impedance, where the voltage is defined by Ohm's law. In voltage mode, the voltage level is held constant and the current output depends on the electrode impedance.

### Importing external ASCII files

You can easily design your own waveforms with the WYSIWYG editor of the MC\_Stimulus program. What's more, you can also import files generated by external programs, for example biopotential waveforms captured by a data acquisition system or curves derived from complex mathematical functions.

Imported signals can be further edited, grouped, or repeated directly in the MC\_Stimulus program and are simply downloaded onto the stimulus generator by a single mouse click.

The example shows a spike waveform recorded from an organotypic hippocampal culture on a micro-electrode array (MEA) at a sampling rate of 50 kHz after the ASCII import into the MC\_Stimulus program.



### Triggering stimulation

Besides a manual operation, you can also trigger the stimulation on a digital TTL pulse, for example from a switch or any other external control.

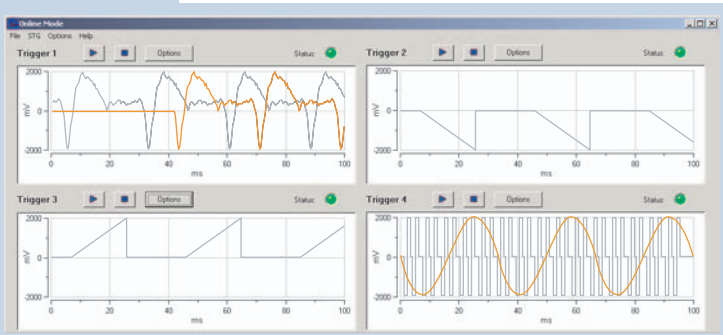
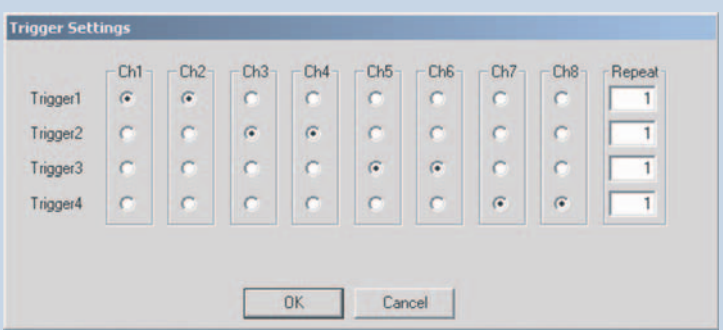
The programmable digital output (Sync Out) can be used for synchronizing other instruments with the stimulation, for example the data acquisition system. The 2000 series even allows you to trigger each of the up to 8 analog output channels **independently**. The timing of the separate pulse streams is precisely controlled by the separate trigger inputs and is completely independent from each other.

You can assign any of the 4 available trigger inputs to any permutation of the up to 8 channels. For each trigger input, a separate Sync Out channel is provided as well. This way, you can set up complex stimulation patterns based on different trigger sources or criteria.

### Dynamic online change and downstreaming

The stimulus generator 2000 series is the world's first pulse generator that can dynamically change and downstream pulses during stimulation. Thus, you can stimulate continuously over several days, weeks, even months, and set up stimulation sequences on the fly during the experiment. Imagine the possibilities of the system, like feedback studies or modulated white-noise stimulation.

A basic program for loading and playing ASCII files will be provided, but you can integrate the program controls (DLL) into your custom program as well. For example, you can use biopotential waveform patterns recorded with your custom data acquisition system and feed the data directly into the stimulus generator, making it perfect for neuronal network studies, for example.



### Technical specifications

Output voltage	-8 V to +8 V @ +/-20 mA
Output voltage resolution	2 mV
Output voltage slope	> 4 V/ $\mu$ s
Output current	-0.8 mA to +0.8 mA @ 100 V
Output current resolution	200 nA
Output current slope	100 $\mu$ A/ $\mu$ s
Resolution	13 bit
Time resolution	20 $\mu$ s
Output signals	Freely programmable (rectangular, ramp, sine wave)
Maximum frequency (rectangular waveform)	25 kHz
Interface (connection to computer)	USB 1.1 (2000 series), RS232 (1000 series)
Download rate	12 Mbps (2000 series), 56 Kbps (1000 series)
<b>Software</b>	
Operating system	Windows 2000 or XP (2000 series), Windows 98, ME, NT (1000 series)
Data import	ASCII file format

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**STG**