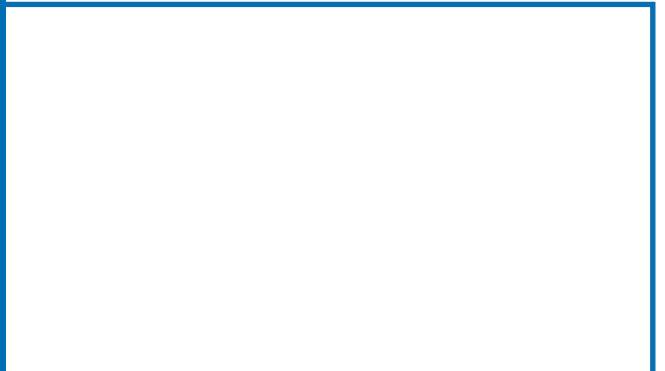


Voltage output	-8 V to +8 V @ +/-20 mA
Voltage output resolution	1 mV
Voltage output slope	> 4 V/μs
Current output	-1.6 mA to +1.6 mA @ 120 V
Current output resolution	100 nA
Current output slope	100 μA/μs
Resolution	14 bit
Time resolution	20 μs
Output signals	Freely programmable (rectangular, ramp, sinewave)
Maximum frequency (rectangular waveform)	25 kHz
Interface (connection to computer)	USB 2.0 High Speed
Download rate	480 Mbps

Software:

Operating system	Windows Vista or XP
Data import	ASCII file format
LabView interface available	

Distributed by:



Multi Channel Systems
MCS GmbH
Aspenhastrasse 21
72770 Reutlingen
Germany

Fon +49-7121-90 92 5-0
Fax +49-7121-90 92 5-11

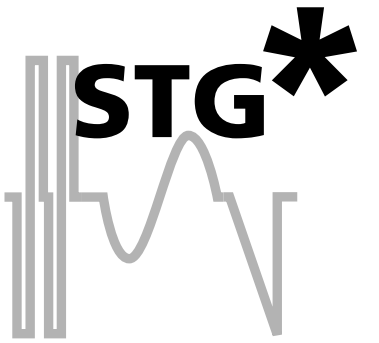
info@multichannelsystems.com
www.multichannelsystems.com

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Stimulus Generators

4000 Series



- Completely Software Driven
- Current and Voltage Driven Stimulation
- Arbitrary Analog Waveforms
- Integrated Isolation Units
- Each Channel - All Features - Full Flexibility



STG

Three functions- One device:

The stimulus generators of the 4000 series fulfill three functions in one device:

- Current driven stimulation
- Voltage driven stimulation
- Controlling and timing



backside of the STG4008 with 8 digital in- and outputs

With the MC_Stimulus software you can choose between current or voltage driven stimulation.

Decide in favour of 2, 4 or even 8 completely independent stimulus outputs. Every single output has the ability to provide any arbitrary analog waveform as stimulation signal.

For every single stimulus output there is one TTL in- and output, so you can synchronize your data acquisition or trigger other devices.

Current driven stimulation:

In current mode, the stimulus generator guarantees a stable current output in the range of -1.6 mA to +1.6 mA independent of the electrode impedance @ 120V compliance voltage. On request, a version with an extended output range of ± 16 mA is available.

Voltage driven stimulation:

In voltage mode, the voltage level in the range of -8 V to +8 V is held constant and the current output depends on the electrode impedance. The lower the electrode impedance - the higher the output current. The maximum output current is ± 20 mA.

For a broad range of applications:

Neuronal networks:

- Long time stimulation
- Feedback stimulation
- White noise stimulation
- Biological signals as stimulation patterns
- Multiple files can be applied to one or more electrodes

Brainslices:

- Flexible LTP induction patterns
- Studies of synaptic plasticity

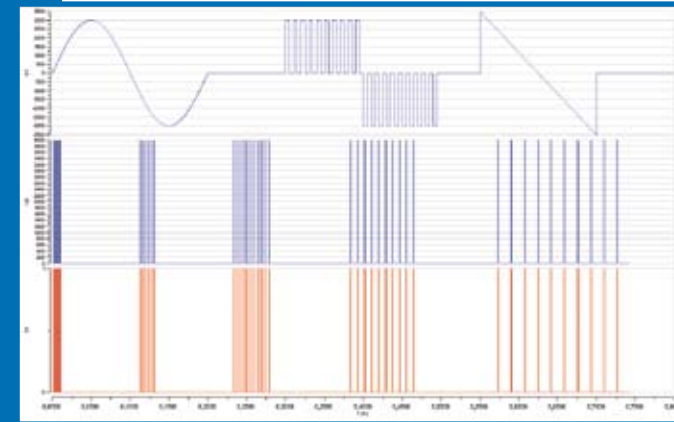
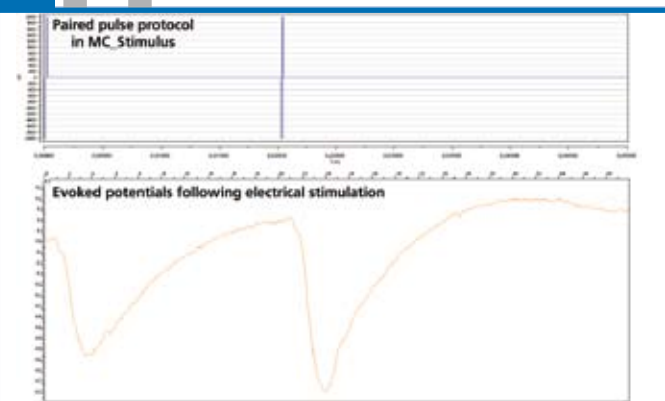
Skeletal Muscle:

- Evoke isometric and isotonic contractions

Cardiac cells and tissues:

- Study influence of artificial pacemakers
- Pace cardiac cell cultures
- Pace tissue preparations like slices, purkinje fibers, or papillary muscle
- Mimic cardiac environment during stem cell differentiation

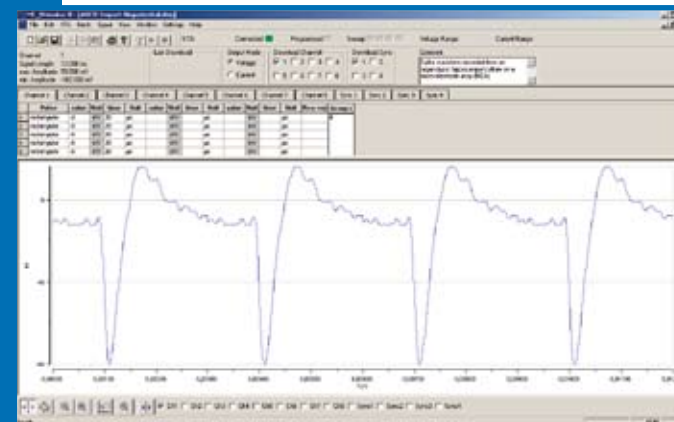
The Stimulators can receive and deliver TTL pulses via BNC connectors for every single stimulation output. These triggers allow you to control and synchronize other instruments like imaging systems, LED-lights, data acquisition systems and many more - at a 20µs precision.



Freely programmable waveforms:

You can easily design your own waveforms with the WYSIWYG editor of the included stimulus software: freely combine mono- or biphasic rectangular pulses, ramps, or sine waveforms to design stimulation patterns of unlimited complexity on each output channel.

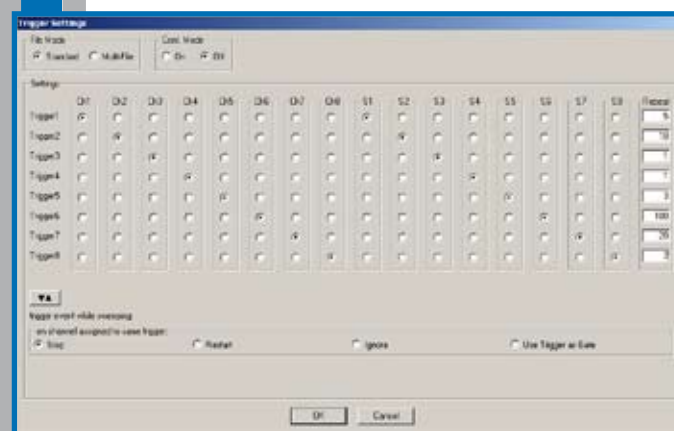
The STG4000 series operates with a resolution of 1 mV in voltage mode or 100 nA in current mode, and a time resolution of 20 µs. Single pulses can be grouped and looped to generate pulse trains with individual timing and intervals. You can apply a completely different protocol to each of the up to 8 stimulation outputs. Repeat your stimulation protocol as many times as you need or let it run infinitely and then stop it manually or on a trigger event. An internal quartz-controlled clock guarantees precise timing over a long period.



Importing external ASCII files:

You can also import files generated by external programs, for example biological signals 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 included stimulus software MC_Stimulus 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 microelectrode array (MEA) at a sampling rate of 50 kHz after the ASCII import into the MC_Stimulus program.



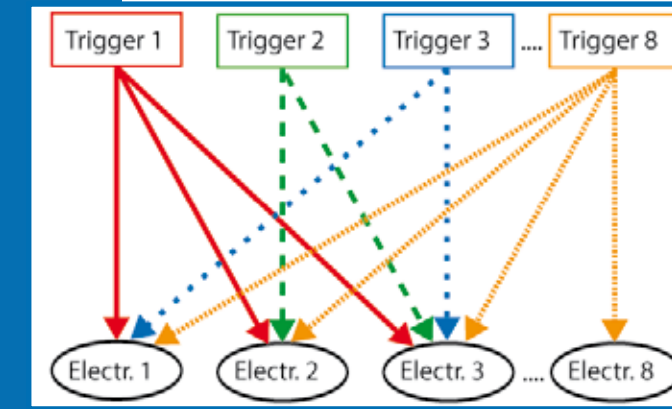
Triggering stimulation:

Every stimulation pattern can be started and stopped manually or on an external trigger (TTL), for example from a switch or any other external control.

The STG4000 series allows you to trigger each of the up to 8 analog output channels independently.

Each stimulator is equipped with one TTL output and one TTL input for each stimulation channel. The stimulation on up to 8 channels can be controlled by the same trigger (synchronous operation), or by different triggers (independent or asynchronous operation).

This way, you can apply up to 8 complex stimulation patterns to separate stimulating electrodes with a precise timing based on different trigger sources or criteria.



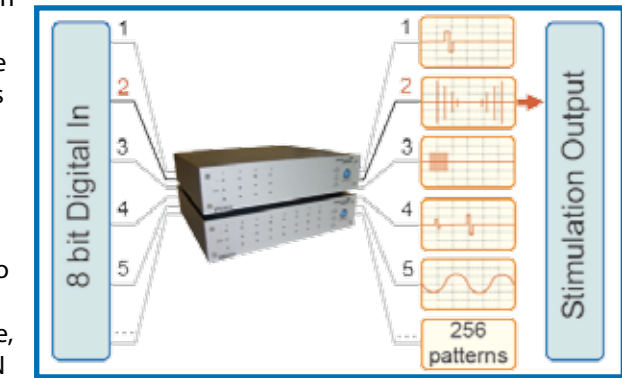
Multi File Mode:

In addition to switching between different stimulation protocols on separate channels, the Multi File mode makes it possible to switch between different patterns on the same electrode(s). You can load up to 8 different stimulation files, each containing the individual program for up to 8 separate stimulating electrodes. Each stimulation file is controlled by a separate trigger. This feature allows you to switch rapidly between up to 8 different stimulation protocols on the same or overlapping channels. For example, you can control stimulation pattern A (red arrows in the figure) by trigger 1 on electrode 1, 2, 3, and stimulation pattern B (green arrows) by trigger 2 on electrode 2 and 3, and so on. With this feature, you can react with different pulse patterns in response to the biological behavior.

Extended Multi File Mode:

The extended Multi File Mode is controlled through the Digital In (D-IN) of the Stimulus Generator. The D-IN has an 8 bit resolution and can assume 256 different states. Correspondingly, up to 256 stimulation patterns (files) can be downloaded to the Stimulus Generator, and each pattern can be assigned to one state of the D-IN. Each of these stimulation patterns can define the output of one or more of the STGs stimulation and SyncOut channels.

With the D-IN interface you can now automatically switch between different stimulation patterns with a latency of only a few microseconds. There are two modes available for the Extended Multi File function, continuous and triggered. In continuous mode, the STG continuously monitors the state of the D-IN and starts the assigned stimulation pattern as soon as the state of the D-IN changes. In triggered mode, the same happens only when an additional external trigger is applied.



Dynamic online changes and downstreaming:

The stimulus generators of the 4000 series are the only commercially available pulse generators that can dynamically change the output signal and downstream pulses during stimulation. Thus, you can stimulate continuously over several days, weeks, even months, and generate stimulation sequences on the fly during the experiment.

Imagine the possibilities of the system, like feedback studies or modulated white-noise stimulation. The Stimulus Streamer, a basic program for loading and playing ASCII and MP3 files will be provided, but you can integrate the program controls (DLL) into your custom program as well. For example, you can use biological signals recorded with your custom data acquisition system and feed the data directly into the stimulus generator, making it perfect for neuronal network studies.

