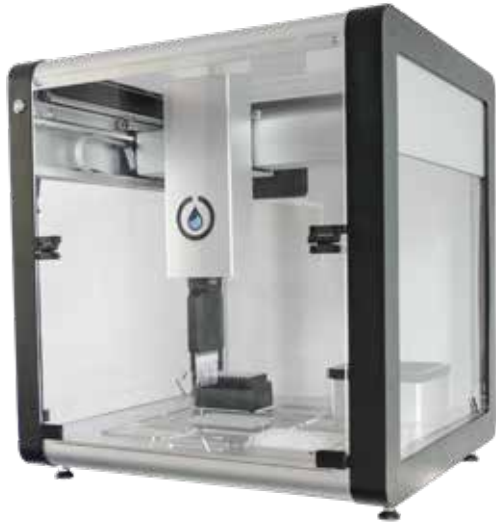# Product Overview

- Data Acquisition and Analysis Software
- *In vivo* & *in vitro* Electrophysiology
- Microelectrode Arrays
- Patch Clamp
- *Xenopus* Oocyte Electrophysiology
- Diabetes Research
- Stimulus Generators
- Electrophysiological Laboratory Equipment

## Automated Liquid Handling

- Automated compound application for 96-well plates
- Integrated recording system: undisturbed experiments
- High speed: 96 wells within 20 seconds
- Liquid handling and data recording within one software: complete data set for analysis

## MEA2100-Mini-System

More information on page 13

- 60 or 120 recording channels per headstage
- Can be operated in incubators
- Up to 50 kHz sampling rate
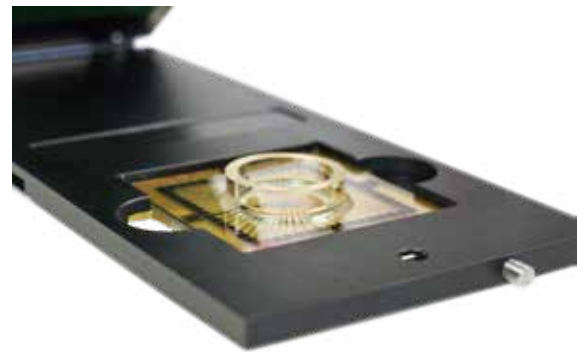
## MEA2100-Beta-Screen-System

More information on page 18

- Electrophysiology for diabetes research
- Screening system for intact islets of Langerhans
- Recordings of up to 40 islets simultaneously

# Contents

**multi**channel ✱
**systems**

# Software
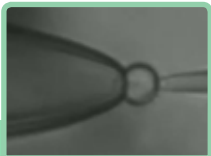
- **Multi Channel Suite**
  Flexible toolbox for recording and analysis with most MCS systems

- **Multiwell-Screen/Multiwell-Analyzer**
  Streamlined tool for screening experiments on Multiwell MEAs

- **Beta-Screen Experimenter/Beta-Screen Analyzer**
  A specialized toolbox for diabetes research based on the Multi Channel Suite

- **CMOS-MEA-Control/CMOS-MEA-Tools**
  Specialized solution for recordings from thousands of channels on CMOS MEAs

- **Cardio2D**
  The optional toolbox for cardio applications on MEA systems

- **LTP-Director/LTP-Analyzer**
  The optional toolbox for LTP or LTD experiments on MEA systems

# Flexible and powerful



# Multi Channel Suite

## Application

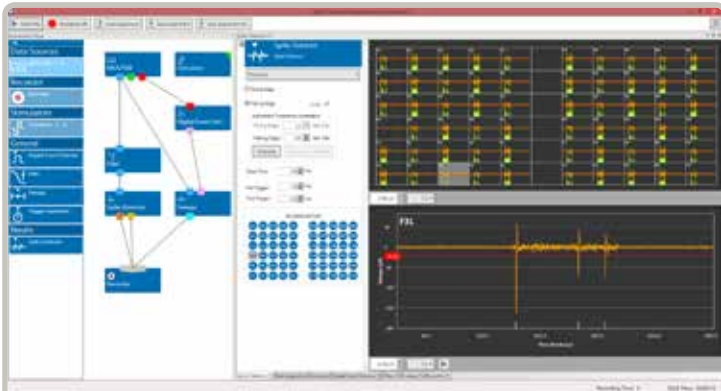Multi Channel Suite is a complete software solution for reliable acquisition and analysis of electrophysiological data. It operates most MCS *in vivo* and *in vitro* systems.

Real-time recording, graphing, and analysis of extracellular activity of excitable cells for *in vivo* and *in vitro* applications.

## Product Features

- Consists of three tools:
  - **Experimenter** for recording and online analysis
  - **Analyzer** for offline analysis
  - **DataManager** for exporting to other programs (Python, Matlab, Neuroexplorer etc)
- Free software updates from our website
- Free support via email or phone

## Technical Data

| | |
|---|---|
| Operating system | Microsoft Windows® 10, 8.1 or 7 (64 bit) English and German versions supported |
| Data can be converted to: | HDF5 (*.h5) (Matlab, Python, R, etc.), NeuroExplorer/Plexon Offline Sorter (*.nex), Spike2 (*.smr), ASCII file (*.txt), European Data Format (*bdf+,*edf+) |

## Introduction

The data acquisition and analysis program Multi Channel Suite  is highly adaptable with unlimited possibilities.

With daily lab work in mind, the program is set up like an instrument rack on a workbench, allowing you to combine virtual instruments (e.g. recorder, filter, event detector, spike detector, stimulus generator or signal-triggered TTL pulse) in any way you want. The experimental set-up is very flexible and intuitive. All you have to do is choose the instruments by drag'n'drop and connect them, the way you want. Changes to the set-up are always possible.

Data is easily exported into HDF5 format, which is compatible with analysis tools like Matlab or Python. Or you can analyze the recorded data in the Multi Channel Analyzer. This tool also offers the import of video data, which can be connected to the recorded data by time stamps.

The Multi Channel Suite is an easy-to-use, flexible, yet powerful tool for online and offline data analysis.

# Software

## Medium and high throughput screening experiments

### Application

The Multiwell-Screen software package is designed specifically for the needs of screening experiments with the Multiwell-MEA-System. It is the ideal solution for drug screening and discovery as well as safety pharmacology. Specific toolboxes for cardio and neuro applications are selectable.
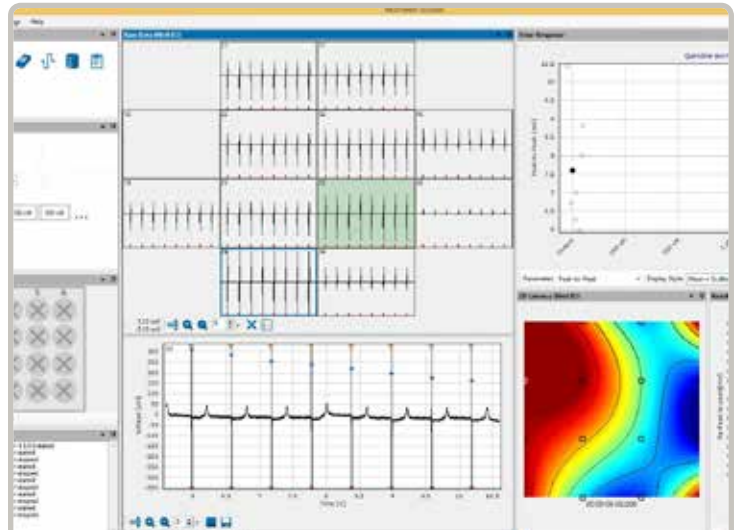


## Multiwell-Screen

**Data acquisition and analysis**

### Introduction

With both tool sets, you can display your data in real-time on the entire well plate, zoom into one single well and see the signal on one single electrode. You can also filter the data (high-pass, low-pass, Butterworth, Notch etc.) and record digital events.

The software gives you the option to input information on the applied compounds and then calculates the corresponding dose-response curves automatically. Thereby, you can choose if you want to analyze your data for:

- Cardio module: RR-intervall, QT-intervall conduction velocity, electrode latencies, …
- Neuro module: Spike frequencies, burst analysis, network burst analysis, …

Within the same software, you can design the stimulation patterns and decide when and where you want to stimulate.

The separate analysis software (Multiwell-Analyzer), which is also included in the system, provides further tools for detailed offline analysis.

### Product Features

- Automated report generation (dose-response data, raw data plots and overlay plots)
- CiPA compliant plate layout as predefined template
- Flexible export of results and raw data – Direct export into CiPA reporting forms
- Software supports single and cumulative dosing
- Automated locking mechanism – Easy to integrate into your existing liquid handling platform
- Result export as ASCII or in Excel format

### Technical Data

| Operating system | Microsoft Windows® 10, 8.1; English and German versions supported |
|---|---|
| Data acquisition, stimulation, and online monitoring | Multiwell-Screen |
| Data analysis, display, report generation | Multiwell-Analyzer |
| Raw data export | Multi Channel DataManager |

# Network analysis by electrical imaging
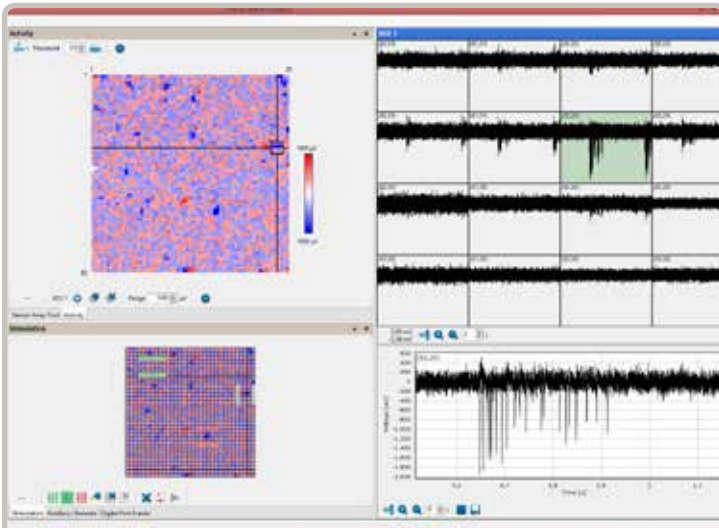
## Application

The CMOS-MEA-Control/CMOS-MEA-Tools software package is designed for the analysis of spontaneous or evoked spikes and LFPs in tissue preparations or cell culture with unparalleled temporal and spatial resolution.

# CMOS-MEA-Control

**Data acquisition and analysis**

## Product Features

- User friendly
- Adaptive filtering
- Flexible recording control
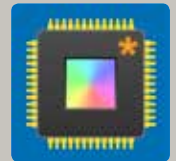- Stimulation with highest spatial resolution
- On-line spike detection and streaming
- Activity summary generation
- Spike triggered average movies
- Automated, unsupervised spike sorting
- Activity based reconstruction of neuronal connections

## Technical Data

| Operating system | Microsoft Windows ® 10, 8.1; English and German versions supported |
|---|---|
| Data acquisition, stimulation, and online monitoring | CMOS-MEA-Control |
| Data analysis, display, report generation | CMOS-MEA-Tools |
| Raw data export | Multi Channel DataManager |

## Introduction

Data acquisition with the CMOS-MEA5000-System is controlled by CMOS-MEA-Control. The software gives an online, real-time activity overview on the complete chip. The intuitive false color plot allows easy identification of active areas on the chip. Regions of interest can be defined to look at the raw data of any area in real time. Data is recorded directly in the open source HDF5 format, which is compatible with Matlab and Python.

Off-line analysis of CMOS data can be done in the program CMOS-MEA-Tools. Results can be exported in ASCII or HDF5 format to other applications. The software provides multiple filtering options, as well as spike detection, spike triggered average movies and fully automated spike sorting.

# Software

## Application

Cardio2D is used to acquire and analyze field potential data from cardiac cells, tissue and whole organs via microelectrode arrays (MEA) and flexible MEAs. The software has a mapping module for the analysis and visualization of cardiac signal propagation patterns and the measurement of conduction velocity. There is also a module that allows analysis of the field potential duration – a surrogate marker for the action potential duration and QT-Interval in the ECG.
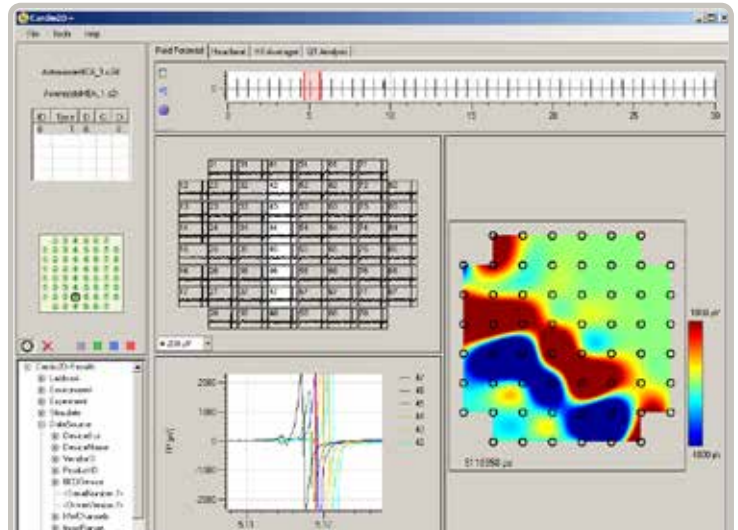


# Cardio2D

**Data acquisition and analysis**

## Introduction

Cardio2D has a data acquisition and an analysis module. It is used to analyze cardiac cell and tissue cultures for signal propagation properties and proarrhythmic events. This includes conduction velocity, local activation time maps, and signal propagation movies. The software can be used to map activation patterns on the surface of a heart, in a cardiac slice or in cardiac cell cultures.

Cardio2D allows monitoring for re-entry cycles – an important indicator in the generation of atrial fibrillation. It can also be used to evaluate the integration of stem cell derived cardiomyocytes into cardiac tissue *in vitro* and *in vivo*. It is suitable for drug testing on cultured cardiomyocytes and ES or iPS cell-derived cardiomyocytes. Cells cultured on multi-well microelectrode arrays can increase the throughput of the assay. The Cardio2D software will measure the field potential duration (corresponds to QT interval in ECG) and sodium peak, as well as analyze for proarrhythmic events. The software will also calculate dose response curves. Experiments can be supported in multi-well format up to 24 wells in parallel.

## Product Features

- Map cardiac field potential propagation
- Create local activation time plots
- Measure conduction velocity
- Create false color plots
- Display cardiac waves as a movie
- Increase throughput via multi-well microelectrode arrays

## Technical Data

| Operating system | Microsoft Windows® 10, 8.1 or 7; English and German versions supported |
|---|---|
| Data acquisition, online monitoring, and movie generation | Cardio2D |
| Data analysis, display, and movie generation | Cardio2D+ |
| Raw data export | Multi Channel DataManager |

## Long-term potentiation and depression studies
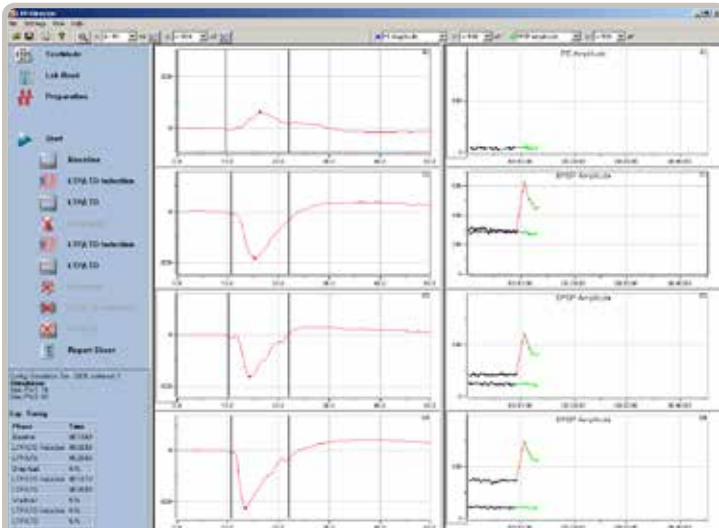


# LTP-Director

## Application

LTP-Director is a specialized software solution to run standardized LTP (long-term potentiation) or LTD (long-term depression) experiments in hippocampal slices. It features complete control of recording and stimulation, as well as automated perfusion, online data analysis, and documentation of the experiments.

## Product Features

- User friendly
- Standardized experiments
- Control stimulation
- Control drug delivery and perfusion
- Automated report sheet generation

## Technical Data

| Operating system | Microsoft Windows ® 10, 8.1, 7 or wXP with NTFS; English and German versions supported |
|---|---|
| Data acquisition, stimulation, and online monitoring | LTP-Director |
| Data analysis, display, report sheet generation | LTP-Analyzer |

## Introduction

The LTP-Director/LTP-Analyzer software package is designed to run and analyze standardized LTP and LTD experiments in hippocampal slices. You can control the recording, stimulation, and perfusion equipment from a single program. It is possible to set up the complete experiment in advance and then run it automatically. All relevant experimental parameters are documented and saved together with the acquired data in one file.

Multiple parameters, for example EPSP slopes and population spike amplitudes, can be analyzed in parallel, on- or offline. Results can be normalized to control conditions directly within the software and exported to a database as ACSII data. The software's main advantages are user friendliness and reproducibility of experimental conditions. The LTP-Director/LTP-Analyzer software package is compatible with all MEA-Systems with blanking circuit and the MEA2100-System.

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# *In vivo* Electrophysiology
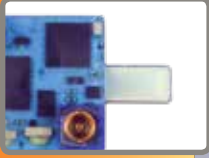


- **Wireless *in vivo* System**

  The wireless recording system with flexible headstage configuration and options for electrical or optical stimulation and synchronized video recording
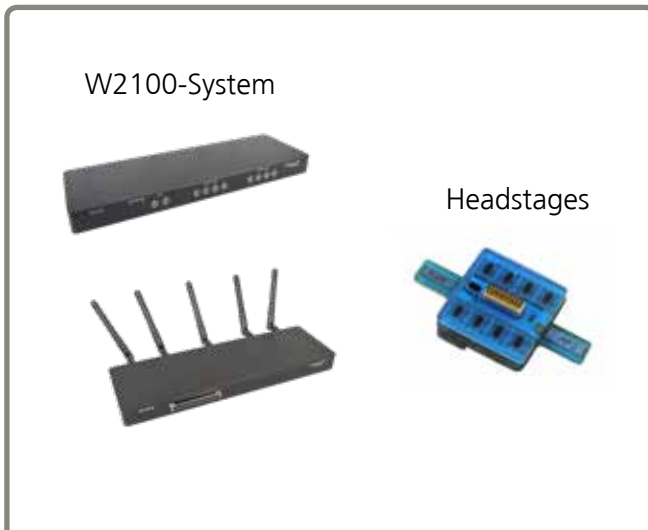


- **Portable-ME-System**

  The basic, low-cost tethered recording system for 16 or 32 recording channels



- **Tethered ME2100-System**

  The high-end tethered recording system with flexible headstage configuration and options for integrated electrical stimulation with closed loop real-time control
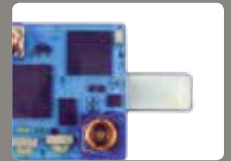
# Wireless *in vivo* system

W2100-System

Headstages

## Application

Recording and stimulation of neuronal activity in freely moving animals.

# W2100-System

**Amplifying, recording, analyzing, and stimulating**

## Product Features

- 4, 8, 16 or 32 channels
- Lightweight headstages
- Wide effective range (5 m)
- Excellent signal-to-noise ratio
- Options for electrical and optical stimulation

- Option to access analog data
- Parallel recordings possible
- Synchronized video-to-data recording possible
- Integrated accelerometer and gyroscope sensor

## Introduction

The W2100-System is the all-in-one solution for amplifying, recording, and analyzing *in vivo* data from up to 32 channels.

The system includes everything you need: compact headstage with integrated A/D converter, digitized transmission, powerful receiver, batteries, as well as the software package Multi Channel Suite.

The most advantageous feature of the W2100-Sytem is the amplification and digitization of the data on the headstage itself. This way, only digital data is sent to the receiver, which ensures that your data is not diluted or distorted.

With its excellent signal-to-noise ratio, it is the ideal solution for spikes, LFP, EEG, ECG, and ECoG.

MCS uniquely provides headstages for optical and electrical stimulation. You do not need to give up valuable recording information while stimulating; the headstages allow you to record and stimulate simultaneously!

## Headstage Types

| Number of channels | Recording only | Recording + optical stimulation | Recording + electrical stimulation |
|---|---|---|---|
| W2100-HS4 | x | x | x |
| W2100-HS8 | x | x | x |
| W2100-HS16 | x | x | x |
| W2100-HS32 | x | x | x |

# In vivo Electrophysiology

## Tethered *in vivo* recording system with 16 or 32 channels

### Application

Non-invasive extracellular multisite recording with microelectrode arrays *in vivo*.



# Portable-ME-System

**Amplifying, recording, and analyzing**

### Introduction

For a multitude of applications we offer a small and compact solution. The USB-ME-FAI-System is a complete plug-and-play data acquisition system. It includes all components you need to start your experiment immediately, so you can acquire data from either 16 or 32 channels. The system includes headstages with 8, 16 or 32 channels and a compatible filter amplifier. A standard USB-cable establishes the connection to any PC or notebook.

The systems are portable and can travel with you. Multi Channel Suite data acquisition software is included and provides the necessary flexibility for many types of experiments. This is a complete all-in-one solution for a variety of *in vivo* and some *in vitro* applications. The size, cost, and ease of use make it an ideal system for many different applications.

### Product Features

- All-in-one solution
- Portable and flexible
- Real-time signal detection and feedback
- Lightweight miniature preamplifiers
- Adapters for almost all available acute and chronic probes

### Technical Data

| Headstage | |
|---|---|
| Input channels | 8, 16 or 32 |
| Bandwidth | DC to 50 kHz |
| Gain | 10 |
| **Filter amplifier** | |
| Input channels | 16 or 32 |
| Input voltage | ± 4 V |
| Digital input channels | 16 |
| Digital output channels | 16 |
| Sampling frequency | up to 50 kHz/channel |
| Data resolution | 16 bit |
| Bandwidth | 1 Hz - 5 kHz |
| Gain | 100 |

# Tethered *in vivo* recording system with 32-256 channels



# ME2100-System

Amplifying, recording, analyzing, and stimulating



## Application

The integrated stimulation capabilities of the ME2100-System allow high quality acute recordings with direct closed loop stimulation, either by electrical or optical stimulation. A freely programmable on board DSP allows stimulation latencies as short as 1ms.

## Product Features

- Up to eight 32-channel headstages
- Filter bandwidth adjustable via software
- Integrated stimulation and real-time feedback
- Programmable output for optical stimulation

## Technical Data

| Electrode channels | up to 256 |
|---|---|
| Input voltage | ± 230 mV |
| Digital input channels | 16 |
| Digital output channels | 16 |
| Sampling frequency | up to 50 kHz/channel |
| Data resolution | 24 bit |

## Introduction

The ME2100-System is a tethered *in vivo* recording system. It is the complete setup for anesthetized/head-fixed animals, including everything you need for your experiment.

The system consists of a signal collector unit for up to four headstages, which also controls up to four optical stimulation units including high power LED. The signal collector unit is connected via eSATA cable to the interface board. Up to two signal collectors can be connected to one interface board.

Headstages have 32 recording channels plus ground and reference inputs. Amplifier, stimulators and A/D converters are all directly on the headstage, which allows low-noise, high quality data acquisition.

We also offer lightweight miniature preamplifiers with 16 or 32 electrodes for recording only purposes.

# In vitro Electrophysiology



- **MEA2100-Mini-System**
  The incubator compatible small footprint system with easy upscaling options



- **MEA2100-System**
  The flexible all-round system with headstages and arrays for all applications



- **CMOS-MEA5000-System**
  Recording and stimulation with highest resolution



- **Multiwell-MEA-System**
  The high throughput system for screening experiments



- **MEA2100-Beta-Screen-System**
  The MEA-System specialized on pancreatic islet cell and diabetes research



- **IFB 3.0 Multiboot**
  Universal data acquisition

## Small footprint MEA-System for the incubator



# MEA2100-Mini-System

**Amplifying, recording, analyzing, and stimulating**

### Application

The small footprint, low heat emission, and possibility for parallel operation of many headstages make the MEA2100-Mini-System the ideal solution for continuous, undisturbed recordings and stimulation of samples in the incubator or on a microscope stage with environmental control.

### Product Features

- 60 or 120 recording channels per headstage
- Two integrated stimulators per headstage
- Up to 50 kHz sampling rate
- Up to four headstages on one signal collector
- Can be operated in incubators

### Technical Data

| Amplifier | |
|---|---|
| Data resolution | 24 bit |
| Number of recording channels | 8x60 or 8x120 |
| **Stimulus Generator** | |
| Current mode | ± 1.5 mA |
| Voltage mode | ± 10 V |
| **Data converter and USB interface** | |
| Sampling rate per channel | up to 50 kHz |

### Introduction

The MEA2100-Mini-System is a miniaturized *in vitro* recording system. The state of the art power saving electronics allow to benefit from almost all advantages of the MEA2100 platform and still be able to operate the system continuously in the incubator. The system consists of a signal collector unit for up to four headstages, which can also control up to four optical stimulation units . The signal collector unit is connected via eSATA cable to the MCS-IFB interface board. Up to two signal collectors can be connected to one interface board. Headstages have 60 or 120 recording channels and two integrated stimulators each. Amplifier, stimulators, and A/D converters are all directly on the headstage, which allows low-noise, high quality data acquisition. The modular nature of the system allows easy upscaling.
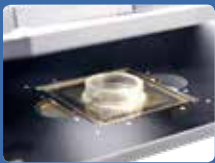
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# *In vitro* Electrophysiology

## Versatile MEA-System with integrated stimulation

### Application

Non-invasive extracellular multisite recording with microelectrode arrays from neuronal and cardiac slice preparations or cultures, including stem cells and cell lines.

Perfectly suited for basic research and validation experiments.

# MEA2100-System

**Amplifying, recording, analyzing, and stimulating**

### Introduction

The MEA2100-System is a versatile *in vitro* recording system with integrated stimulation and follows the tradition of high-quality, low-noise amplifiers.

It is the complete setup for extracellular recordings from microelectrode arrays (MEAs), including everything you need for your experiment: interface board; MEA-headstage with integrated stimulation; MEAs; as well as temperature controller and perfusion heating. Thanks to its compact design you can position the MEA-headstage on any inverted or upright microscope. It is connected via a single eSATA cable to the interface board, which offers various analog inputs and digital in-/outputs for synchronization with other instruments.

### Flexibility

The main advantage of the MEA2100-System is its flexibility. Multi Channel Systems offers various contact units for the MEA-headstage. Variants for one 60-electrode MEA, one 120-electrode MEA, one 256-electrode MEA or even two 60-electrode MEAs are available. The contact unit of the MEA-headstage can be changed according to your experimental needs. The rest of the setup is not affected, so changing the contact unit is simple, quick, and cost-effective.

The flexibility of the MEA-2100-System allows you to connect two MEA-headstages to one interface board. By using two headstages with two 60-electrode MEAs each, you have a four-fold system and increased throughput. Multi-well MEAs raise the throughput even more. The headstages are controlled independently by opening multiple instances of the data acquisition software.
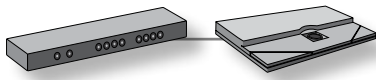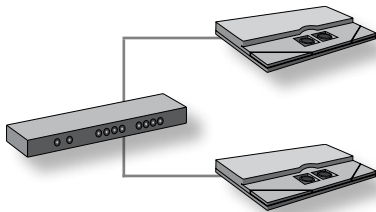
- 60 channels
- 120 channels
- 256 channels
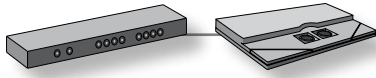
- 2 x 60 channels
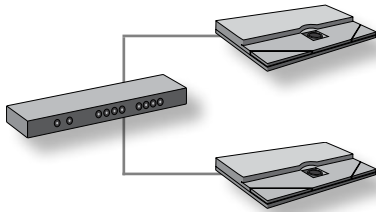
- 60 + 60 channels
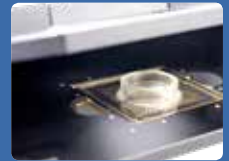- 120 + 120 channels
- 256 + 256 channels

- 2 x 60 + 2 x 60 channels

## Product Features

- Integrated stimulation
- Adjustable bandwidth via software
- Variable contact unit
- Expandable to multiple amplifier system
- Unlimited and free: flexible data acquisition and analysis software Multi Channel Suite

# MEA2100-System

**Amplifying, recording, analyzing, and stimulating**

## Real-time signal detection and feedback

The real-time signal detection/feedback is essential if you need fast and predictable reactions related to recorded analog signals without time delay. Normally, the signal must be analyzed by the computer, which leads to an unpredictable time delay of the stimulus of at least 100 ms. By moving the analysis from the PC to the DSP (Digital Signal Processor) integrated in the interface board of the MEA2100-System, the detour is obsolete and the time delay reduced well below 1 ms. Simply define the condition for the feedback and download it to the interface board (1). During recording (2), the DSP filters the data and detects spikes (3), checking whether your condition is fulfilled. When a designated event is detected, the integrated stimulus generator generates the stimulus pulse (4).

Personal Computer/Laptop **1**

Download settings before experiment

Filtering/Signal detection **3**

**2** Recording

**4**

Sending out stimulus
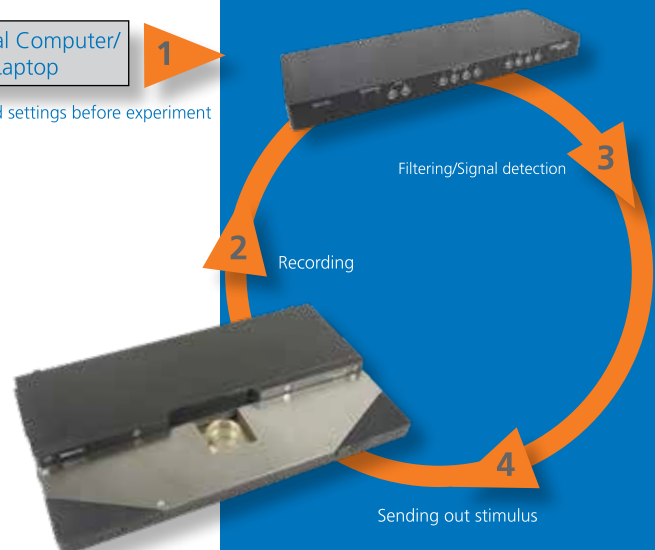
## Technical Data

| Amplifier | |
|---|---|
| Data resolution | 24 bit |
| Number of recording channels | 60, 120 or 252 |
| **Stimulus Generator** | |
| Number of stimulation signals | up to 3 per MEA |
| Current mode | ± 1.5 mA |
| Voltage mode | ± 10 V |
| **Data converter and USB interface** | |
| Sampling rate per channel | up to 50 kHz |

# *In vitro* Electrophysiology

## High resolution electrophysiology

### Application

Non-invasive extracellular multisite recording with active CMOS chip from neuronal cell cultures, slices or *ex vivo* retina. Allows recordings at sub-cellular level.



# CMOS-MEA5000-System

**Amplifying, recording, analyzing, and stimulating**

### Introduction

Based on the complementary metal-oxide semiconductor technology, the CMOS-MEA5000-System from Multi Channel Systems opens up new possibilities in electrophysiological research.

With more than 4000 recording sites, each of them sampled at 25 kHz, the chip allows extracelullar recordings at a very high spatio-temporal resolution. By including amplification on the chip itself, noise is minimized and a high signal quality is guaranteed.

As stimulation sites are included in the chip and a stimulus generator in the headstage.

The CMOS-MEA5000-System is controlled and its data recorded by the software package CMOS-MEA-Control. The software gives an online, real-time activity overview on the complete chip. You can then define regions of interest and zoom into the areas, where you see most activity. You can also switch off areas to decrease file size.

The software controls the integrated stimulator. You can freely define 3 independent stimulus patterns, using and adjusting the drag'n'drop modules.

### Product Features

- Active microelectrode arrays for recording and stimulation
- 4,225 recording and 1,024 stimulation sites
- Outstanding signal quality
- Recordings at sub-cellular level
- Powerful recording and analysis software

### Technical Data

| Amplifier | |
|---|---|
| Data resolution | 14 bit |
| Number of recording channels | 4,225 |
| **Stimulus Generator** | |
| Number of stimulation signals | 3 |
| Stimulation sites | 1,024 |
| Output voltage | 3.4 V amplitude |
| **Data converter and USB interface** | |
| Sampling rate per channel | up to 25 kHz |

# High throughput electrophysiology
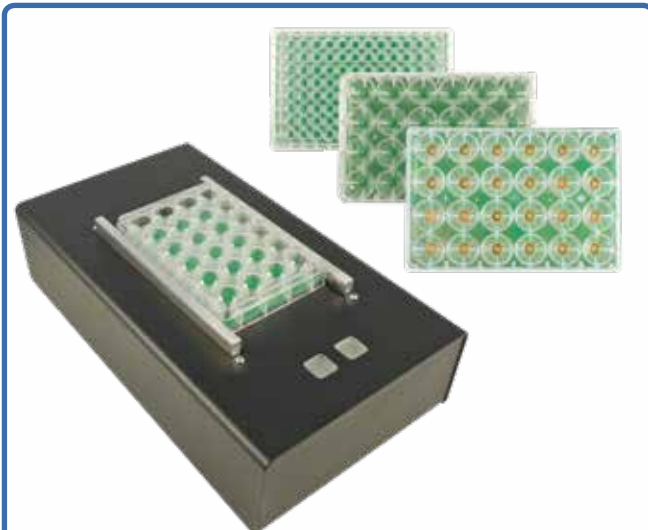
## Application

Non-invasive extracellular multisite recording with microelectrode arrays from neuronal and cardiac cultures, including stem cells and cell lines.

The ideal solution for drug screening and discovery as well as safety pharmacology in the field of cardiac and neuronal research.

# Multiwell-MEA-System

**Amplifying, recording, analyzing, and stimulating**

## Product Features

• 24- and 96-well plates with up to 1152 electrodes

• Total of 288 channels

• Up to 50 kHz sampling rate

• Integrated stimulator

• Fully climate controlled recording chamber

• 24 bit data resolution

• Different well plate variants

• Automated liquid handling available

## Technical Data

| Amplifier | |
|---|---|
| Data resolution | 24 bit |
| Number of recording channels | 288 |
| **Stimulus Generator** | |
| Number of stimulation signals | 2 different patterns per plate, amplitudes can differ between wells |
| Current mode | ± 500 µA |
| Voltage mode | ± 10 V |
| **Data converter and USB interface** | |
| Sampling rate per channel | up to 50 kHz per channel |

## Introduction

Featuring a 24- and 96-well plate format, the Multiwell-MEA-System from Multi Channel Systems is the perfect tool for medium and high throughput electrophysiology. Being based on the MEA2100-technology, it includes high-quality, low-noise amplifiers, freely-programmable stimulators, and a digital signal processor for individual analyses.

Integrated heating as well as a connection to $CO_2$ supply enable full climate control of the recording chamber.

One big advantage of the Multiwell-MEA-System is the high sampling rate. Your data is sampled at up to 50 kHz per channel. Thus, the accuracy of your data is guaranteed, whether you record from cardiac or neuronal samples.

# *In vitro* Electrophysiology

## Beta cell screening

## Application

Acute and chronic recordings of glucose induced electrical activity in pancreatic beta cells.



# MEA2100-Beta-Screen-System

**Amplifying, recording, analyzing**

## Introduction

Glucose-dependent electrical oscillatory activity in beta cells within islets of Langerhans is important for understanding their physiology and pathophysiology. Traditional electrophysiological recordings are both time consuming and technically challenging thus limiting academic research and industrial drug development. We offer MEA-based parallelized recording systems for multiple acute recordings on primary or stem cell derived islets of Langerhans and chronic recordings in an incubator system.

The MEA technology opens a new route to support the development of new drugs for the treatment of type 2 diabetes mellitus, as well as to elucidate beta cell pathophysiology e.g. during the progression of diabetes.
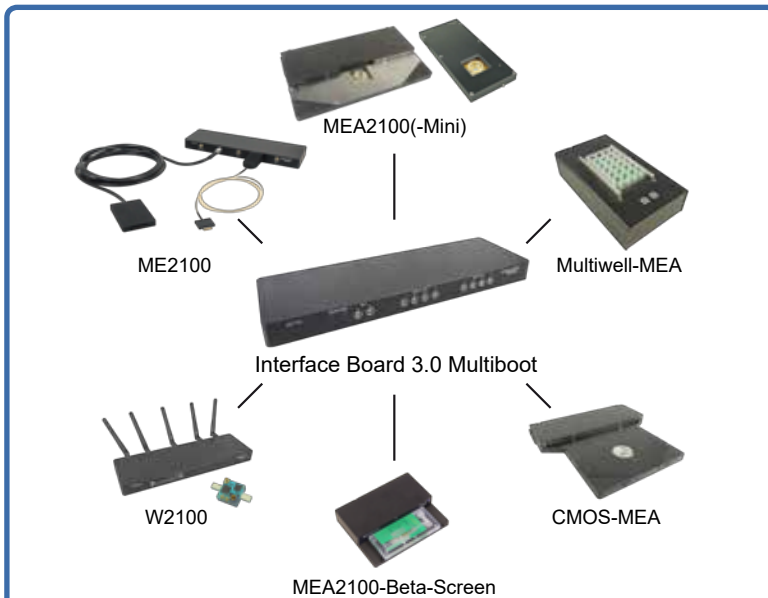
## Product Features

- Easy to use for electrophysiological recordings of up to 40 islets simultaneously
- Non-invasive and fast, medium throughput screening device
- Beta cell specific analysis software included
- Islets secured using suction
- Drug screening also possible with human beta cells

## Technical Data

| Amplifier | |
|---|---|
| Data resolution | 24 bit |
| Number of recording channels | up to 40 |
| **Data converter and USB interface** | |
| Sampling rate per channel | up to 50 kHz |

## Modular design



MEA2100(-Mini)

ME2100

Multiwell-MEA

Interface Board 3.0 Multiboot

W2100

CMOS-MEA

MEA2100-Beta-Screen

## Application

*In vitro* and *in vivo* experiments

# IFB 3.0 Multiboot

**Universal data acquistion**

## Introduction

Most recording systems from MCS operate with one common component, the Interface Board 3.0 Multiboot. As any headstage or receiver can be connected to the same IFB, this platform solution allows cost-effective combinations of *in vitro* and *in vivo* sytems, for example. Likewise, it's possible to bundle the flexibility of a single-well MEA-System with the increased throughput of a Multiwell-System. Or any other system combination which suits your research needs.
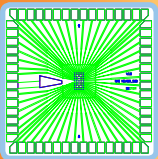
## One data acquisition system

• For *in vivo* amplifiers (W2100-System, ME2100-System)

• For *in vitro* amplifiers (MEA2100-System, Multiwell-MEA-System, CMOS-MEA5000-System, MEA2100-Mini-System, MEA2100-Beta-Screen-System)

• Modular setup

• One software program

# Microelectrode Arrays
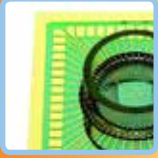
- **Contacting**
  Where they come from: Material and Production

- **Contacting**
  Available for a variety of applications: MEA-Layouts

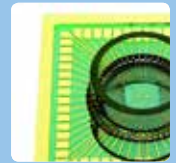- **Contacting**
  Suit your needs: MEA-Types

# Where they come from

## Application

Extracellular recording *in vitro* from almost all excitable or electrogenic cells and tissues, e.g. central or peripheral neurons, cardiomyocytes, whole-heart preparations, retina or stem cells.

# Material and Production

**Contacting**

## Product Features

- Available with opaque (titanium) or transparent (indium tin oxide) tracks and contact pads
- Long life, can be reused many times
- Electrode layouts for all applications
- Electrodes with very low impedance
- Substrate-integrated reference electrode for almost all MEAs
- Electrodes as small as 8 µm in diameter

## Technical Data

| Dimensions | 49 x 49 mm |
|---|---|
| Number of electrodes | 60, 120 or 256 |
| Interelectrode distances (µm) | 30, 60, 100, 200, 300, 500, 700 |
| Electrode diameters (µm) | 8, 10, 30, 100 |
| Track options | Ti, ITO, Au |
| Electrode grids | 8x8, 6x10, 12x12, 16x16, 2x(5x6), hexagonal, 6x(3x3), 9x(6x5), special layouts |

## Introduction

The Natural and Medical Sciences Institute (NMI) in Reutlingen, Germany (www.nmi.de) is a research institute which produces high-quality MEAs using the most biocompatible materials. The NMI and Multi Channel Systems have collaborated on multiple projects over many years.

State-of-the-art quality controls and production processes ensure that MEAs are always of excellent and consistent quality. The electrodes are coated with titanium nitride (TiN), a very stable material, which guarantees that the MEAs can be reused many times.

The majority of the MEAs have glass carriers, which facilitate the examination of the sample under any upright or inverted microscope. Tracks and contact pads are available in opaque and transparent versions and most MEAs have internal reference electrodes.
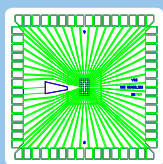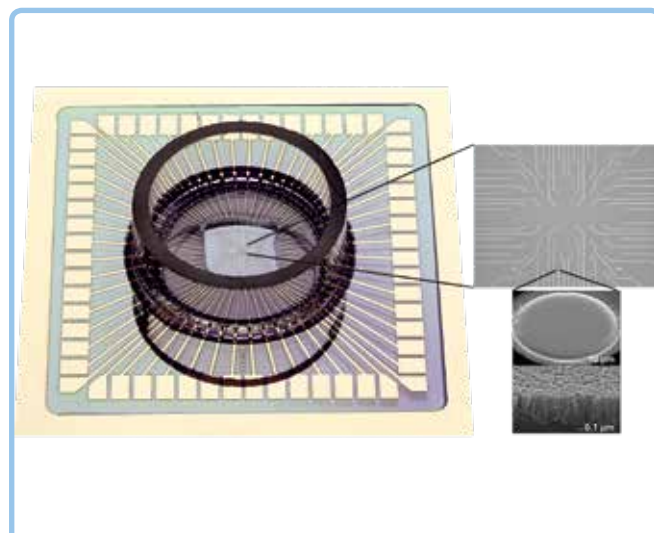
# Microelectrode Arrays

## Available for a variety of applications

### Introduction

The broad range of applications is reflected by the variety of MEAs with different geometries that have been developed to cover as many applications as possible.

# MEA-Layouts

### Standard 8x8 layout

The 8 by 8 electrode configuration is the most versatile. Applications range from neuronal networks to brain slices and from stem cell derived cardiomyocytes to cardiac tissue preparations. Electrode spacings of 100 and 200 μm are available, providing a square-shaped recording area of 700 μm and 1.4 mm respectively.

The electrodes are available with diameters of 10 μm and 30 μm. The advantage of 30 μm diameter electrodes is their low impedance and low noise level. 10 μm electrodes enable recording from single neurons or single cardiomyocytes.

Many MEAs feature internal reference electrodes. The integrated reference allows the culture to be kept sterile during recording to enable repeated recordings of long-term cultures. Stimulation of each electrode is also possible.

### 6x10 layout

The 6 by 10 layout features an interelectrode distance of 500 μm. This creates a recording field of 4.5 mm by 2.5 mm, allowing larger tissue samples to be be recorded on one array. Each electrodes can also be used for stimulation. All MEAs with the 6 by 10 layout also feature internal reference electrodes. The electrode material is TiN. The micro-column structure of each electrode minimizes impedance and allows low-noise recordings. The extremely durable material allows as many as 50 re-use cycles with acute experiments.

### Hexagonal layout

- 60 electrodes
- Available with equal or varying electrode diameter and distance
- Layout perfect for retina recordings
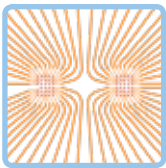
### High Dense layout
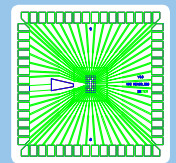
- 60 electrodes in two recording areas
- Interelectrode spacing of only 30 μm, electrode diameter of only 10 μm
- High resolution recording of individual neurons in neuronal networks

# MEA-Layouts

**Contacting**
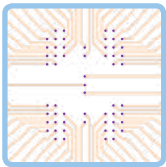
### Special layouts

- Wide range of special electrode layouts developed together with customers
- Specially shaped stimulation electrodes or layout with four quadrants of high density recording areas
- Custom layouts on request

### Multi-well layouts

- 60 electrodes divided into 6 wells
- 256 electrodes divided into 9 wells
- Multiwell-plates with 288 electrodes in 24 or 96 wells and 1152 electrodes in 96 wells
- Ideal for toxicology, neurobiology, stem cell research, and safety pharmacology

# Microelectrode Arrays

## Suit your needs

### Application

Several MEA geometries and materials are provided for a wide variety of applications. Almost all excitable or electrogenic cells a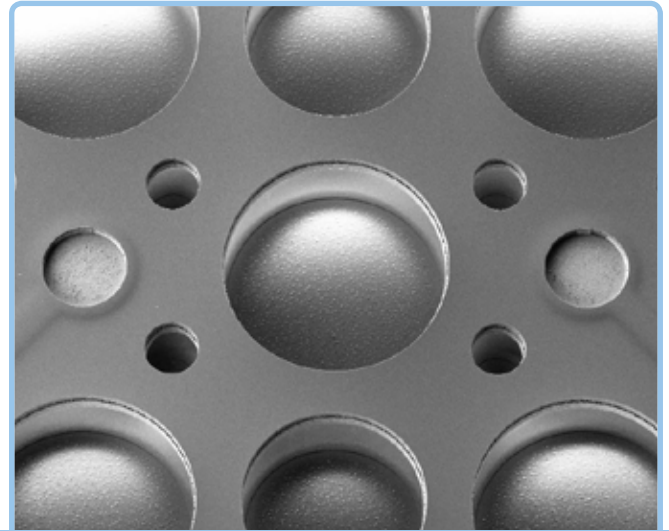nd tissues can be used for extracellular recording *in vitro*, e.g. central or peripheral neurons, cardiomyocytes, whole-heart preparations or retinas.

# MEA-Types

### Perforated MEAs

Perforated MEAs (pMEAs) are manufactured on a thin polyimide foil, which is fixed on a glass carrier for physical stability. Surrounding the electrode field, is a circular area where the foil is perforated (see image, dark spots).

pMEAs were designed to enable perfusion of the tissue on the array from the bottom.

When recording from an acute slice preparation with MEA electrodes, signals are detected from cells at the bottom of the slice. These cells are probably less healthy than the ones on the top, because they get less oxygen and nutrients from the perfusion solution. Perfusion from the bottom solves this problem and enables better signals and improved long-term survival of your acute slices. In addition, slices can be held in stable contact with the MEA surface by applying a negative pressure with the constant vacuum pump available from MCS.

If you wish to work with pMEAs, all you need to do is to equip your MEA-System with a perfusion ground plate/perfusion element (PGP or PE) and start recording.

### MEAs with 256 electrodes

The increased number of electrodes provides three major advantages:

• Higher spatial resolution

• Larger recording area

• Higher throughput

By reducing the electrode spacing it is possible to map a distinct area with a higher spatial resolution. In a 16 by 16 electrode array grid electrode spacings of 30, 60, 100, and 200 µm are available. For the 30 µm spacing, the electrode diameter is 8 µm, for the 60 µm spacing the electrode diameter is 10 µm. For 100 µm and 200 µm spacing 30 µm diameter electrodes are used. All 256MEA layouts have four internal reference electrodes.

### ThinMEAs

- Recording area is as thin as a coverslip glass (180 μm)
- Facilitates use of low working distance objectives with high magnification
- UV transmission possible
- Transparent tracks, perfect vision
- Available with 60 or 256 electrodes

### MEA with 120 electrodes

- For MEA2100-System
- 120 electrodes in a 12 by12 grid
- 4 internal reference electrodes
- Ideal for stimulation
- Available as standard glass MEAs and perforated MEAs

# MEA-Types

Contacting
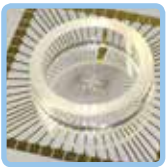
### EcoMEAs

- Low cost option for routine experiments
- Gold electrodes (very robust, many re-use cycles)
- 100 μm diameter electrodes, 700 μm spacing
- Either float glass carrier or printed circuit board
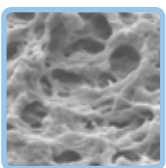
### Pedot-CNT-MEAs

- Electrodes with a composite of carbon nanotubes and PEDOT
- Reproducible low impedance
- High signal-to-noise ratio
- Excellent biocompatibility and cell adhesion
- Ideal for stimulation

### Flexible MEAs

- Made of flexible polyimide foil (12 or 50 μm thick)
- Available with 24, 36 and 72 electrodes
- For *in vivo/ex vivo* experiments and specific *in vitro* applications
- Titanium nitride or gold electrodes
- Can easily be connected to MCS headstages

# Patch Clamp

- **Automated Patch Clamp**
  Pipette-based automatic patch clamp system: PatchServer

# Pipette-based automatic patch clamp system

**Application**

Automation of a classical patch clamp setup

# Patch Server

**Automated patch clamp**

## Product Features

- Makes manual patch clamp easier and more efficient

- Single cells can be visually evaluated before experiment

- Automated cell supply and Giga-Ohm sealing

- Automatically establishes whole-cell recording configuration

- Works with standard glass pipettes

- Highest data quality at low running costs

- Simultaneous recording from up to 4 patch pipettes

- Ultra-fast-application system (< 1 ms) optionally available

## Technical Data

| | |
|---|---|
| Number of recording channels | 1 or 4 |
| Seal quality | > GigaOhm |
| Supported patch clamp amplifiers | HEKA EPC 10USB (Single or Quadro) |
| Supported micromanipulators | Scientifica Patchstar |
| Usable cell types | Single cells in suspension |
| Cell density | ~ 200.000 cells/ml |
| Cell consumption per experiment | < 500 cells |

## Introduction

The PatchServer is an automatic patch clamp system that can establish whole-cell recording or excised-patch configurations using tools and techniques from the manual patch approach.

It utilizes standard glass pipettes and employs step-by-step procedures that would be applied by human experimenters as well.

The PatchServer combines the advantages from automatic and manual patch clamp, respectively. Automation improves ease of use and throughput, while still providing the high data quality of the glass-pipette based manual patch method. The PatchServer with its modular design adds automation to a classical patch clamp setup. I.e., the setup can still be used manually without modification.

In collaboration with:

**NMI**
achieving results

# *Xenopus* Oocyte Electrophysiology

- **Automated injection**
  Injection goes automatic: Roboinject

- **Automated two-electrode voltage-clamp**
  Solution exchange based on perfusion: Roboocyte2

- **Automated electrophysiology**
  Non-destructive usage of compounds: HiClamp

# Injection goes automatic

## Application

Injection of nanoliter volumes (e.g. DNA or RNA) into *Xenopus laevis* oocytes or other cells of similar size.

# rob✳inject

**Automated injection**

## Product Features

- Fully automated injection using industry standard 96, 384, and custom well plates
- Sequential injection without user intervention
- Injection of up to 4 different samples per well and up to 8 different samples per plate
- Injection volume freely adjustable from 1 to 100 nl per cell
- Variable injection depth and sample uptake speed
- Automated sample uptake

## Technical Data

| Usable well plates | Disposable standard 96, 384, and custom well plates |
|---|---|
| Positioning accuracy | 20 µm in x/y and z-direction |
| x/y movement speed | 80 mm/s |
| z-axis speed | 40 mm/s |
| Injection volume | 1 - 100 nl |
| Average time needed for 96 injections | 5 min |

## Introduction

Until now, injection of nanoliter volumes into cells or embryos has been time-consuming and required highly qualified personnel in order to get satisfactory and reproducible results.

Multi Channel Systems is proud to present the Roboinject, the first and only commercially available fully-automated injector for *Xenopus* oocytes, eggs, and embryos using industry standard 96, 384, and custom well plates.

The automation of cell injection not only saves time and money, but also greatly enhances reproducibility of injection and survival of cells. It allows your highly qualified personnel to do away with routine work and concentrate on science.

# *Xenopus* Oocyte Electrophysiology

## Solution exchange based on perfusion

### Application

Screening of ion channels and electrogenic transporters.



# robo✱cyte2

**Automated electrophysiology**

### Introduction

Oocytes of the toad Xenopus laevis are widely used as an expression system for ion channels, transporters, and receptors in drug development. Xenopus oocytes are big, robust cells (about 1 – 1.2 mm in diameter), can be obtained in large numbers, and are easy to handle.

Nevertheless, the low throughput of manually performed electrophysiology prevents its use for secondary functional screening of drug targets.

More than ten years ago, Multi Channel Systems (MCS) presented the first commercially available fully-automated system for Xenopus oocyte screening, the Roboocyte. In 2011, it was time for the Roboocyte2.

The Roboocyte2 is a fully-automated all-in-one solution for medium throughput screenings of ligand-gated and voltage-gated ion channels, as well as electrogenic transporters based on the well-established Xenopus oocyte expression system. All necessary tasks are accomplished by a single robot.

### Product Features

- Recording of 96 oocytes without supervision
- TEVC recording of voltage-gated and ligand-gated ion channels and electrogenic transporters
- Flexible design of automated recording sequences
- Automated cell wash
- Automated compound application
- Small footprint 32 x 32 cm
- 12-channel perfusion system included
- Recording and analysis software included

### Technical Data

| Amplifier | |
|---|---|
| Max. sampling rate | 20 kHz |
| Data resolution | 16 bit |
| **Current electrode output** | |
| Output range | -105 µA to +105 µA |
| Current resolution | 1 nA |
| Voltage range | -100 V to +100 V |
| **Voltage electrode input** | |
| Typical rise time | <1 ms |
| Voltage electrode input | -500 mV to +500 mV |
| Voltage resolution | 0.015 mV |

# Non-destructive compound usage

**HiClamp\***

**Automated electrophysiology**

## Application

Screening of ion channels and electrogenic transporters.

## Introduction

The HiClamp is built around an entirely new concept: Instead of applying solutions to the oocytes, the HiClamp carries each cell from one compound to the next. Oocytes are transferred automatically one after the other from a 96-well plate into a silver wire basket serving as reference electrode. After automatic impalement of the intracellular glass microelectrodes, the basket is moved together with the oocyte from one compound-containing well to the next. Programmable washing steps effectively prevent cross-contamination between different compounds. The built-in digital amplifier guarantees a stable and accurate voltage-clamp resulting in precise and reproducible current recordings.

## Product Features

- Fast drug application
- Minimal compound usage
- Non-destructive usage of compounds
- Works with 200 µl sample volume
- Fully-automated system

## Technical Data

| Amplifier | |
|---|---|
| Max. sampling rate | 20 kHz |
| Data resolution | 16 bit |
| **Current electrode output** | |
| Output range | -105 µA to +105 µA |
| Current resolution | 1 nA |
| Voltage range | -100 V to +100 V |
| **Voltage electrode input** | |
| Typical rise time | <1 ms |
| Voltage electrode input | -500 mV to +500 mV |
| Voltage resolution | 0.015 mV |

# Stimulus Generators

- **Current and voltage driven stimulation**
  Stimulus generators with integrated isolation units

# Stimulus generators with integrated isolation units



# STG4000-Series



**Current and voltage driven stimulation**

## Application

**Neuronal networks:**
- Long-term, feedback, and white noise stimulation
- Biological signals as stimulation patterns

**Brain slices:**
- Flexible LTP induction patterns
- Studies of synaptic plasticity

**Skeletal muscle:**
- Evoke isometric and isotonic contractions

**Cardiac cells and tissues:**
- Pace cardiac cell cultures, slices, purkinje fibers, or papillary muscle

**Stem cells:**
- Mimic cardiac or neuronal environment

**Optogenetics:**
- Control optical stimulation with high power LEDs with STG-opto

## Product Features

- Current and voltage controlled stimulation
- Completely software driven
- Integrated isolation units for each channel
- Each channel optically isolated
- Each channel has one TTL input and output
- Arbitrary analog waveforms
- STG-opto version for LED stimulation (current controlled stimulation only)

## Technical Data

| Analog output channels | 2, 4 or 8 (STG-opto only 2) |
|---|---|
| Voltage output | -8 V to +8 V @ ± 20 mA |
| Voltage output resolution | 1 mV |
| Voltage output slope | > 4 V/µs |
| Current output options | -160 µA to +160 µA @ 120 V |
| | -1.6 mA to +1.6 mA @ 120 V |
| | -16 mA to +16 mA @ 120 V |
| | 0 to +1.6 A @ max. 5.5 V (for LED stimulation only) |
| Resolution | 14 bit |
| Time resolution | 20 µs |

## Introduction

The 4000 series stimulus generators operate in voltage or current mode, as selected via software. 2, 4 or 8 completely independent stimulus outputs are available. Every output is optically isolated and can provide any arbitrary analog waveform as a stimulation signal. Every STG comes with MC_Stimulus II software.

Furthermore, for every single stimulus output there is one TTL input and output, so you can synchronize your data acquisition or trigger other devices. You can dynamically change the output signal and downstream pulses during stimulation.

The standard multi-file mode allows you to switch between different stimulus patterns on the same electrode. You can have as many files as your specific STG has output channels. The extended multi file mode for the STGs with 4 and 8 output channels allows even more: up to 256 stimulation patterns can be assigned to one or more outputs of the stimulus generator.

# Electrophysiological Laboratory Equipment

- **Complete solutions for electrophysiology**
  Everything you need in your lab

# Everything you need in your lab

## Application

Fundamental accessories for your setup in any electrophysiological experiment.

# Complete solutions for electrophysiology

**Electrophysiological laboratory equipment**

## Introduction

When performing electrophysiological experiments, a crucial factor is the surroundings. The stability of the table, electric fields in the proximity of the sample, and the ability to fasten other instruments and accessories are vital.

Multi Channel Systems has more than 20 years of experience in the field of electrophysiology. We understand your needs, what details and product features to consider, and most importantly, we work with the best equipment suppliers.

We offer you a complete laboratory equipment setup, starting with vibration-free tables, faraday cages, micromanipulators, patch clamp-setups, and any other required accessories.

You will receive your complete system in one shipment, from one supplier. You do not have to worry about obtaining quotations and invoices, or juggling the various shipping dates. Everything arrives together. We take care of everything and you receive the entire setup from one source.

Service only available in MCS sales area. Please contact your local distributor for details in your country.
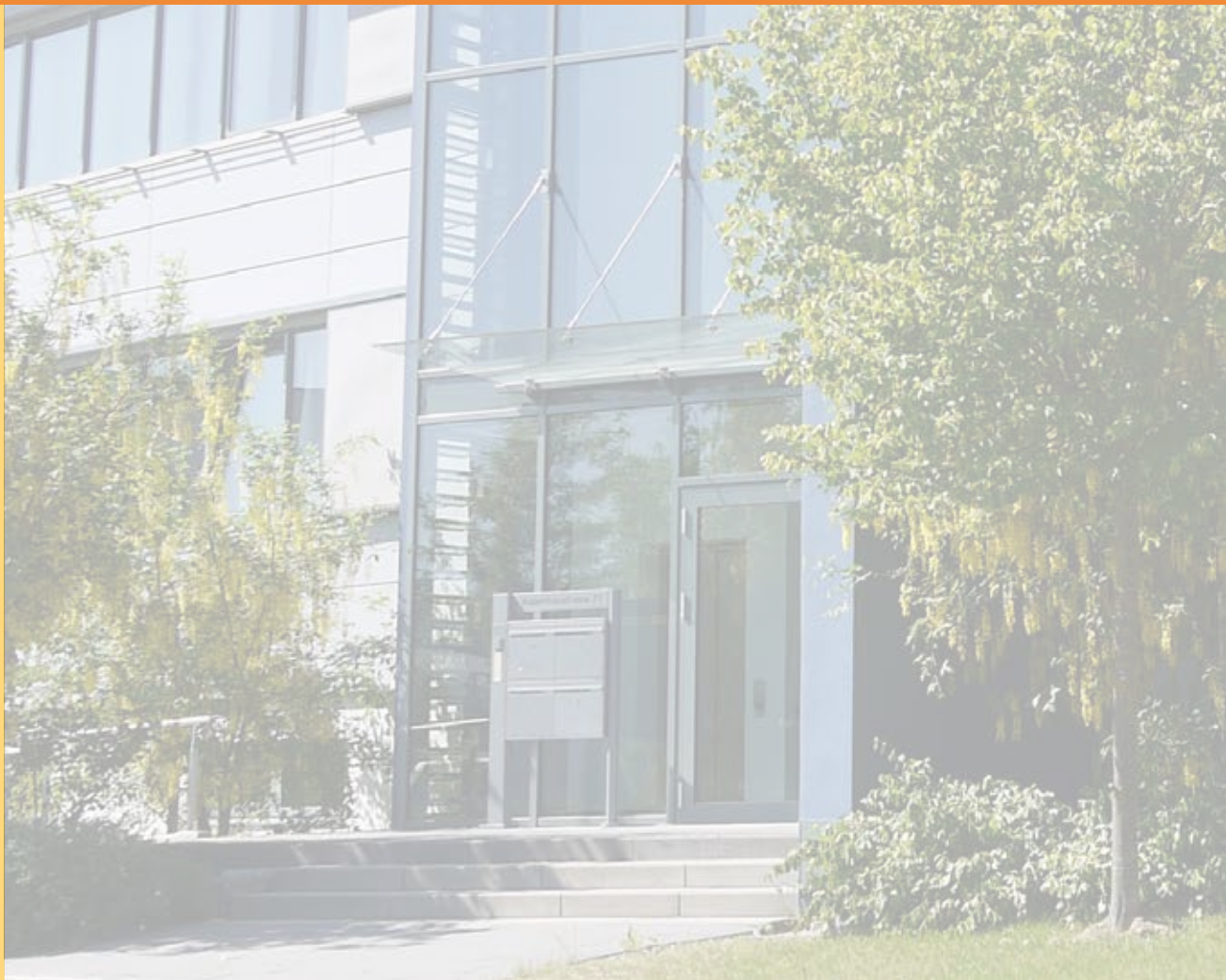
## Advantages

- Well-known manufacturers
- High quality products
- Convincing combination of compatible products
- Complete setup from one source

# About Us

- **Who we are: Multi Channel Systems**
  Always there to assist you: Our support team

# Who we are

Multi Channel Systems MCS GmbH was founded in 1996 and is based in the Science and Technology Park in Reutlingen in Southwest Germany. MCS operates globally from this location. Since Oct. 2014, MCS is a division of Harvard Bioscience, Inc.

The main focus of our company is the development of precise scientific measuring instrumentation in the field of electrophysiology for research groups at universities and for the pharmaceutical industry. Our modular product principle approach allows us to adjust our products to your specific experimental needs. MCS products are flexible and are designed to fit into tight laboratory spaces. Our main goal is to develop products that are focused on our customers' specific needs and applications. Our team includes basic science researchers so we know what it is like to work in a lab environment.

Our constant dialog with scientists helps us to be at the cutting edge of technology. We are also involved in several national and international research projects that are pushing the limits of technology for science.

With over 20 years of experience, a global distribution network, and over 1,000 publications with our equipment, MCS is the global market leader in the field of non-clinical microelectrode array electrophysiology.

**multi**channel **systems**

# Multi Channel Systems

Who we are

## Our support team

Our support team holds PhDs in biology, biophysics, and biochemistry. They have research experience in the fields of electrophysiology, cardiology, neuroscience, and ion channel studies. They understand your needs and have knowledge pertaining to your research. They will assist you with any experimental problems via e-mail, phone, or even come to your lab for training.

Our application-focused support team is assisted by their colleagues from the software and hardware departments. So whatever your question might be, we will do our best to help you. We strive to answer all your inquiries as quickly as possible, usually within 24 hours. In order to ensure that you receive the best answer as quickly as possible, we use the OTRS electronic ticket system.

In general, all support inquiries are free of charge. Free phone calls and e-mails are part of our customer-service oriented attitude. For whole-day trainings in your lab, we are happy to send you a quotation.
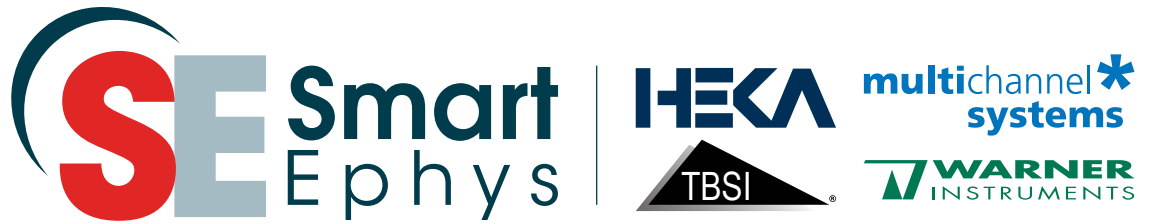
## Features

- Quick response (usually within 24 hours)
- E-mail, phone, and training
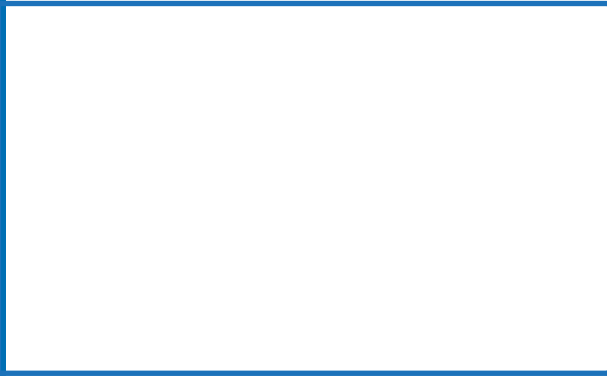- OTRS ticket support data base
- Free of charge

## Contact us

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|---|---|
| E-Mail | support@multichannelsystems.com |
| Contact form | www.multichannelsystems.com |

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