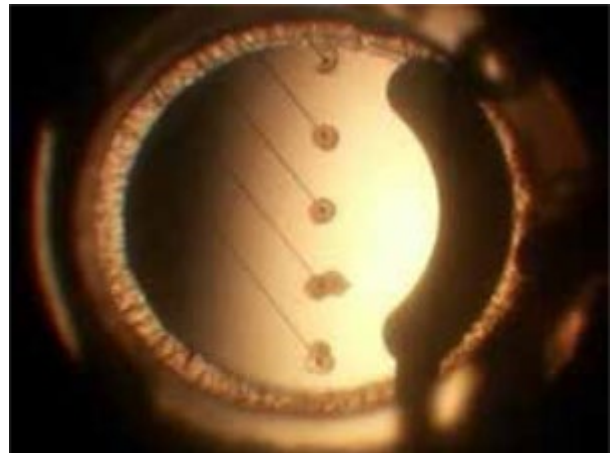




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MEA2100-Beta-Screen-System Manual



Imprint

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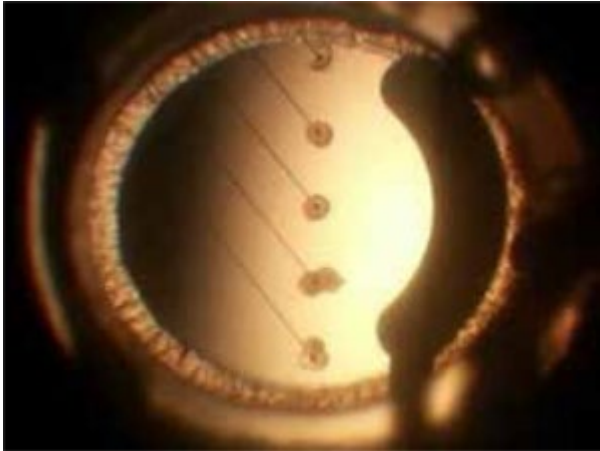
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1 Welcome to the MEA2100-Beta-Screen-System



Application

Electrophysiological recordings of multiple islets of Langerhans optimized for drug screening.

The MEA2100-Beta-Screen-System is a MEA-based parallelized screening system for islets of Langerhans:

Glucose-dependent electrical oscillatory activity in beta cells within islets of Langerhans is important for understanding their physiology and pathophysiology. The electrical activity of the cells is triggered by Ca^{2+} channels.

Electrophysiological recordings are both, time consuming and technically challenging. This limits academic research and industrial drug development. Therefore, we developed a MEA based parallelized recording system for multiple acute recordings on primary or stem cell derived islets of Langerhans. The current layout of the Beta-Screen MEA chip allows to record electrical oscillations from up to 40 intact islets of Langerhans simultaneously.

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 for example during the progression of diabetes.

The Beta-Screen software is available for two recording systems, the MEA2100-Beta-Screen-System and the MEA2100-Mini-System.

Acute recordings with the MEA2100-Beta-Screen-System



The MEA2100-Beta-Screen headstage is easy to use for non-invasive electrophysiological recordings of up to forty islets of Langerhans simultaneously, five per headstage. The islets are secured using suction for best recording results.

Chronic recordings with incubator-ready system with the MEA2100-Mini-System



The MEA2100-Mini headstage is an ideal solution for continuous, undisturbed recordings and stimulation of samples in the incubator or on a microscope stage with environmental control. There is the possibility for parallel operation of four or eight headstages.

2 Before You Start

2.1 Important Safety Advice



Warning: Make sure to read the following advice prior to installation or use of 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: Always obey 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.

Grounding

This product is grounded through the grounding conductor on the power cord. To avoid electric shock, the grounding conductor must be connected to earth.

Orient the Equipment Properly

Do not orient the equipment so that it is difficult to manage the disconnection device.

Explanation of the Symbol used



Caution / Warning



DC, direct current

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 power 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. Always keep the device and the power cords 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, so that the air can circulate freely.

2.2 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 / her 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 Hardware Components

3.1 MEA2100-Beta-Screen Headstage



The first element of the MEA2100-Beta-Screen-System is the headstage with 5 electrodes on the special MEA (microelectrode array) for MEA2100-Beta-Screen. The MEA is made as consumable. The headstage is equipped with a heating plate for a constant temperature in the MEA chamber.

The cable of the MEA2100-Beta-Screen headstage connects to the signal collector unit SCU.

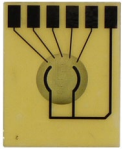
Up to four MEA2100-Beta-Screen headstages can be operated with one signal collector unit SCU and up to two signal collector units can be connected to one interface board IFB-C. Hence, in total a system can record from up to 40 electrodes (8 individual 5-channel headstages). Electrode raw data acquired from the probe is amplified and digitized by the analog / digital converter that is integrated in the headstage at sampling rates of up to 50 kHz per channel. Data is transferred via signal collector unit to the interface board via iX cable.

Note: Do not remove the tiny wires inside the tubes of the headstage adapter! These wires guarantee perfect grounding. Please use additionally a silver wire to ground the MEA chamber.

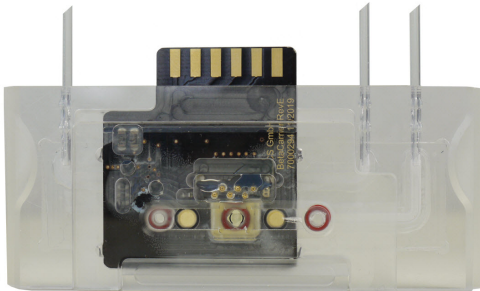


Warning: It is recommended to switch off the MEA2100-Beta-Screen-System on the interface board whenever connecting or disconnecting headstages.

3.2 MEA2100-Beta-Screen MEA Chip

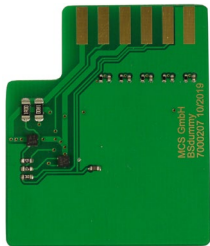


The chamber for the microelectrode array MEA is made of plexiglass and should be used as consumable. The MEA on the chip contains 5 TiN (Titanium Nitride) electrodes with a diameter of 30 μm and one reference electrode, which is connected to ground. Around these electrodes there are holes (10 μm) to apply low pressure from the bottom side. Perforated MEAs have two advantages: They allow a perfusion of the tissue from both sides at the same time, thereby optimizing the oxygen supply of the Langerhans cells on one hand and keeping the islets on the electrode for better recording on the other hand.



The MEA chamber is constantly heated to a level of 37° degree. The fluidics through each MEA chamber is realized via PPS2 pump for the inflow and the drain of the culture medium and a Constant Vacuum Pump CVP with pressure control for the low pressure from below. This helps to keep the Langerhans islets in place on the recording electrodes.

Test Chip for MEA2100-Beta-Screen-System

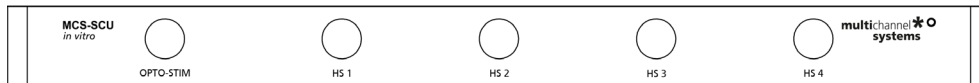


The provided test model probe Test-5MEA simulates a MEA with a resistor of 220 $\text{k}\Omega$ and a 1 nF capacitor between ground and electrode for each of the 5 electrodes. It can be used for testing the noise level of the electrodes of a MEA2100-Beta-Screen-System.

3.3 Signal Collector Unit SCU

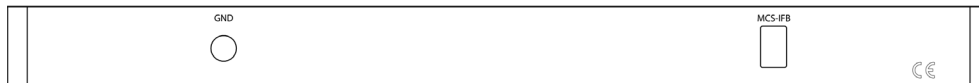


Front Panel



The second element of the MEA2100-Beta-Screen-System is the signal collector unit SCU for up to four headstages. The SCU also contains a connector to control up to four independent optical stimulation devices. The control functions are integrated into the [Beta-Screen Experimenter](#) software.

Rear Panel



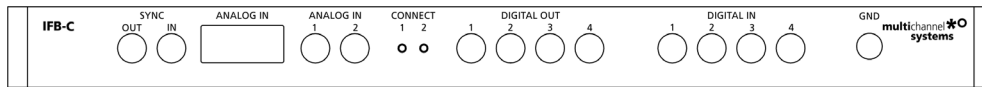
The signal collector unit and the interface board are connected with an iX-industrial cable. Up to two SCUs can be connected to one IFB-C interface board.

3.4 Interface Board IFB-C Multiboot



The multiboot interface board IFB-C facilitates operation of all MCS *in vitro* and *in vivo* headstages within the entire 2100 amplifier solution suite. This suite includes: MEA2100-HS, Multiwell-MEA-HS, CMOS-MEA-HS, MEA2100-Beta- Screen-HS, W2100-HS and ME2100-HS. The modular 2100 amplifier solution suite design makes it easy to modify your lab equipment generally with modest hardware upgrade investments.

3.4.1 Front Panel



From left to the right:

SYNC OUT / IN

Two or more interface boards IFB-C can be daisy-chained by use of the SYNC Out / SYNC In connectors. All daisy-chained interface boards run on the same clock – to allow perfectly synchronized recordings in large settings.

Analog Channels

Up to eight Analog In channels are available via 10-pin connector. Please read chapter [10-Pin Connector for Analog IN](#) in the Appendix for more information about the pin layout.

The additional analog inputs are intended for recording additional information from external devices, for example, for recording patch clamp in parallel to the MEA recording.

Analog Channels 1 and 2

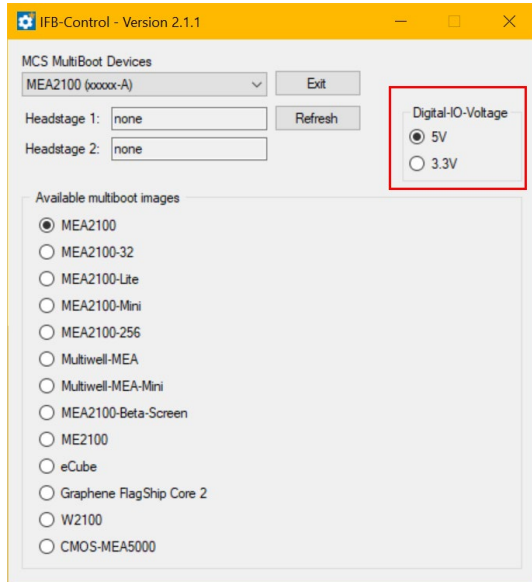
Two of these eight analog channels (Analog In No 1 and No 2) are separately available via Lemo connectors on the front panel of the interface board IFB-C.

Two Status LEDs

The status LEDs indicate the link status of SCU 1 and / or SCU 2. They light up when one or both signal collector units are connected to the IFB-C interface board via iX-industrial cable.

Digital IN / OUT

A Digital IN / OUT for 16 digital in- and output bits is available (Honda-PCS-XE68LFD) on the rear panel of the interface board. On the front panel four Digital IN and four Digital OUT bits are also accessible via Lemo connector (DIG IN bit 0 to bit 3 and DIG OUT bit 0 to bit 3). The Digital OUT delivers TTL pulses with 3.3 V or 5 V. The voltage can be switched between these two voltages with the software IFB-Control, please read chapter “IFB-Control” in the Appendix.

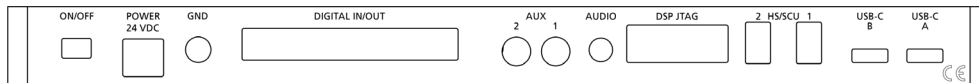


If access to more bits of the DIG IN / OUT channel is required, it is necessary to connect a Digital IN / OUT extension [Di/o board](#) with a 68-pin standard cable. This Di/o board is available as an optional accessory.

Ground

If an additional ground connection is needed, you can connect this plug with an external ground using a standard common jack (4 mm).

3.4.2 Rear Panel



From left to right:

Toggle Switch On / Off

Toggle switch for turning the device on and off. The MEA2100-Beta-Screen-System is switched to status "ON" when the toggle switch is switched to the left. The device is switched "OFF" when the toggle switch is switched to the right. If the MEA2100-Beta-Screen-System is "ON", and the device is connected to the power line, the Power LED on the front panel of the interface board should light up. If not, please check the power source and cabling.

Power 24 VDC

Connect the power supply unit here. This power supply powers both, the signal collector unit SCU and the interface board IFB-C of the MEA2100-Beta-Screen-System. The device needs 24 V and 2.5 A / 60 W.

Ground

If an additional ground connection is needed, you can connect this plug with an external ground using a standard common jack (4 mm).

Digital IN / OUT

A Digital IN / OUT for 16 digital in- and output bits is available via Honda-PCS-XE68LFD connector. Please read chapter [Digital IN / OUT Connector](#) in the Appendix for more information about the pin layout of the connector. The Digital IN / OUT connection accepts or generates standard TTL signals. The Digital OUT delivers TTL pulses with 3.3 V or 5 V. The voltage can be switched between these two levels with the software IFB-Control, please read chapter "IFB-Control" in the Appendix.

TTL stands for Transistor-Transistor Logic. 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 or 5 V means 1 (HIGH).

The Digital OUT allows generating a digital signal with up to 16 bits and read it out, for example, by using a Digital IN / OUT extension Di/o board. You can utilize this digital signal to control and synchronize other devices with the MEA2100-Beta-Screen-System.

Bit 0 to 3 of the Digital OUT are separated and available as Lemo connector DIG OUT 0 to 3 on the front panel of the interface board. So the [Di/o extension](#) is only necessary if more than four trigger inputs or outputs are needed.

The Digital IN can be used to record additional information from external devices as a 16 bit encoded number. The Digital IN is most often used to trigger recordings with a TTL signal. The 16 bit digital input channels is a stream of 16 bit values. The state of each bit (0 to 15) can be controlled separately. Standard TTL signals are accepted as input signals on the digital inputs.



Warning: A voltage that is higher than +3.3 Volts or +5 Volts or lower than 0 Volts, that is, a negative voltage, applied to the digital input would destroy the electronics. Make sure that you apply only TTL pulses (0 to 3.3 V or 5 V) to the digital inputs.

Auxiliary Channels

Two reserve auxiliary channels are available for future use. They have no function at the moment. It is possible to use them in conjunction with the Digital Signal Processor DSP for real-time feedback, but this feature is not available for MEA2100-Beta-Screen-Systems.

Audio OUT

To the Audio Out (3.5 mm phone jack) you can connect an audio system to make one or two of the electrode channels audible. This audio output is real-time. Headphones or speakers can be connected directly to the AUDIO OUT. Select the audible channels via software. Only two channels at a time can be converted into sound (Stereo). The Audio Out is not in use in MEA2100-Beta-Screen-Systems.

JTAG Connector

The JTAG connector has access to the digital signal processor DSP, but the DSP is not yet in use in MEA2100-Beta-Screen-Systems.

HS / SCU

Sockets for connecting up to two signal collector units SCU via iX-industrial cable(s).

USB-C Connectors B and A

Both USB-C connectors are used to transfer the amplified and digitized data from all data channels and the additional digital and analog channels to any connected data acquisition computer via USB-C cable.

Connector A corresponds with connector iX-industrial input 1, and connector B with iX-industrial input 2. If both iX inputs are used, also both USB-C connections must be used. Both USB cables must be connected to different USB-C ports of the computer, do not use an USB hub! Only use high grade USB-C cables, as provided with the system.

3.6 Fluidic Periphery

3.6.1 PPS2



Peristaltic perfusion system PPS2 with one inlet and one outlet pump. Both pumps can be operated independently, or inflow and outflow can be linked, the percentaged difference is adjustable. For setting up the pump, please read the "[PPS2 Manual](#)".

3.6.2 CVP



Constant vacuum pump CVP with pressure control. Vacuum pump with a precision differential pressure sensor to measure the target pressure in relation to the actual ambient pressure. Please read the "[CVP Manual](#)" for setting up the vacuum pump correctly.

4 Setup of the System

4.1 Setting up the MEA2100-Beta-Screen-System

Connecting Headstages (HS), Signal Collector Unit (SCU), Interface Board (IFB-C) and Computer

1. Provide a power supply in the immediate vicinity of the installation site.
2. Place all devices on a stable and dry surface, where the air can circulate freely and the devices are not exposed to direct sunlight.
3. Set up the computer with installed Beta-Screen program.
4. Install the software from the installation volume if it is not already installed. The MEA2100-Beta-Screen-System is a plug and play device. The driver is automatically installed together with the data acquisition program.
5. Set up the MEA2100-Beta-Screen headstage(s) on a solid table or workbench.
6. Setup the Peristaltic Perfusion System(s) PPS2 to control the fluidic.
7. Setup the Constant Vacuum Pump(s) CVP to apply low pressure to the MEA chamber below the electrodes.
8. Connect the headstage/s via the provided cable/s to the signal collector unit SCU. Connect the signal collector unit SCU via iX-industrial, type B cable to the IFB-C interface board.



Warning: Do not stack the SCU device onto the IFB-C or any other device, because of heat development!

9. Connect the one or both USB-C ports of the interface board to a free USB 3.0 port of the data proceeding acquisition computer. Do not use an USB hub and also avoid USB ports on the front panel of the computer, as they are often connected to the mainboard via an internal hub.
10. Connect the interface board via power supply unit to a power outlet of the same electrical system (connected to the same ground / earth wire) as all other components of the setup, for example, the computer or shielding.
11. If necessary, connect the system to an external ground.
12. Turn the toggle switch at the rear panel of the interface board on.
13. Check the power LED. It should light up as soon as the power line is connected, and the toggle switch is switched on. If not, check the power source and cabling.
14. Start the data acquisition program and select the MEA2100-Beta-Screen-System as data source.

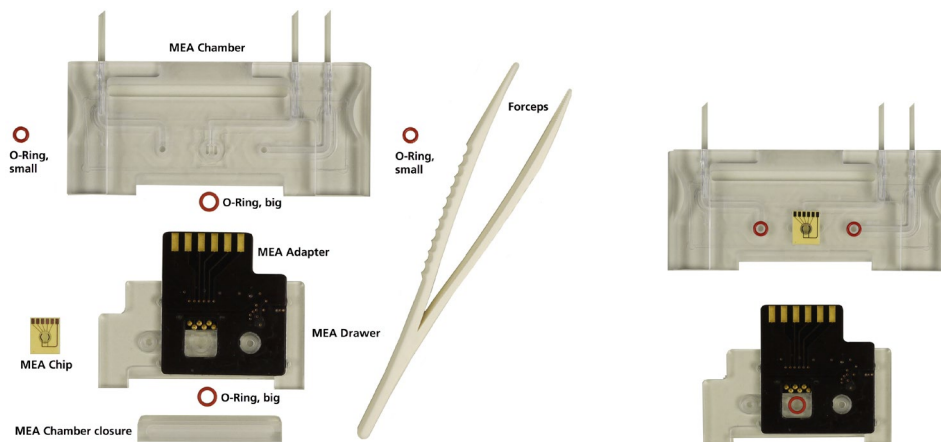
4.2 Setup of the Beta-Screen MEA Chamber



Please follow the instructions with great care!

Configuration of the components:

- MEA chip
- MEA chamber
- MEA drawer
- MEA adapter
- MEA chamber closure
- O-rings, two smaller, two bigger rings
- Forceps



Place the components of the Beta-Screen MEA chamber on a flat table surface as shown on the picture. Insert the respective o-rings into the provided slots with the forceps. Do not mistake the different sizes of the o-rings! Use the forceps to insert the MEA in correct orientation over one of the bigger o-rings. Turn the drawer so that the other big o-ring is oriented to the side of the MEA and push the drawer with the MEA contact adapter carefully into the MEA chamber. Use the MEA chamber closure to complete the setup of the Beta-Screen chamber. Shut the chamber with the MEA chamber closure of the drawer to complete the setup.

Complete MEA Chamber



Connect the complete MEA chamber to the MEA2100-Beta-Screen headstage. Insert the tubes carefully into the respective slots and connect the adapter to the provided plug in.

5 Software

5.1 Software Installation

System Requirements

Software: The following Microsoft Windows ® operating systems is required: 64-Bit Windows 10 and Windows 8.1 (English and German versions supported) with the NT file system. Other language versions may lead to software errors.

Hardware: MEA2100-Beta-Screen-System or MEA2100-Mini-System and a data acquisition computer.

Due to the amount of recorded data, a computer with low performance may lead to performance problems; therefore, Multi Channel Systems recommends an up-to-date computer with a SSD data memory. Please contact MCS or your local retailer for more information on recommended computer hardware specification. Please note that there are sometimes hardware incompatibilities of the data acquisition system and computer components; or that an inappropriate computer power supply may lead to artefact signals. It is not recommended to run any applications in the background when using the Beta-Screen software. Please remove all applications from the Autostart folder.

Important: You need to have installed the latest data acquisition driver to operate the device, which is automatically installed with Beta-Screen software. The installation may be invalid if the data acquisition does not respond. Please contact Multi Channel Systems MCS GmbH or your local retailer in this case.

If a computer was acquired from MCS, the Beta-Screen software will be preinstalled. Updates are available for free download on a regular basis from the MCS web site. It is recommended always to install the latest software version. To install the software, download and start the respective *.exe file and follow the instructions on the screen.

Recommended Operating System Settings

The following automatic services of the Windows operating system interfere with the data storage on the hard disk and can lead to severe performance limits in Beta-Screen software. These routines were designed for use on office computers but are not very useful for a data acquisition computer.

- Turn off the screen saver.
- Turn off automatic Windows update.
- Be careful when using a virus scanner.
- Power Options: Set power scheme to high performance. Never turn on system standby.

It is also not recommended to run any applications in the background when using the data acquisition 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.

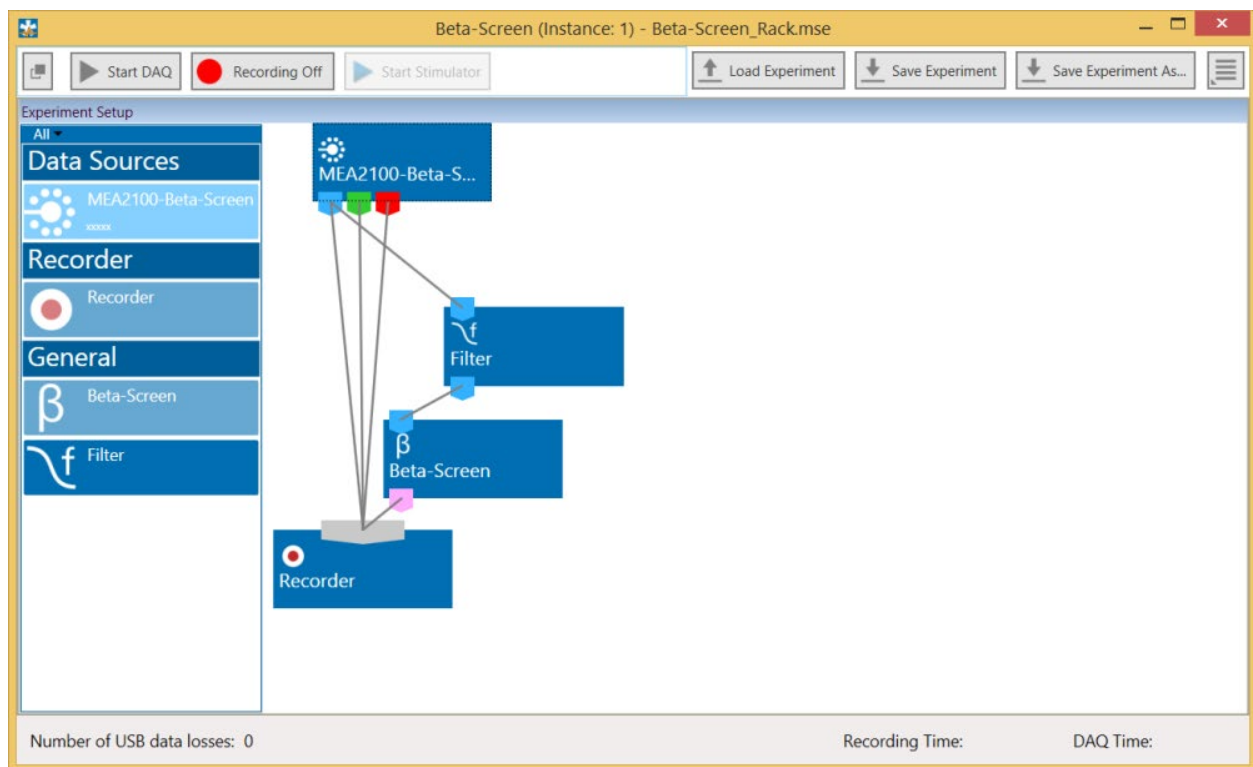
5.2 Beta-Screen Experimenter

The Beta-Screen software is developed to control the MEA2100-Beta-Screen-System from Multi Channel Systems MCS GmbH. Operate the Beta-Screen software together with the special MEA2100-Beta-Screen headstage or with the 60-electrode headstage of the MEA2100-Mini-System. Use the MEA2100-Beta-Screen-System for acute recording. The advantage of the MEA2100-Mini-System is the possibility of measuring directly in the incubator during chronic long term experiments with beta cell cultures.

5.3 Beta-Screen Software

Main Menu

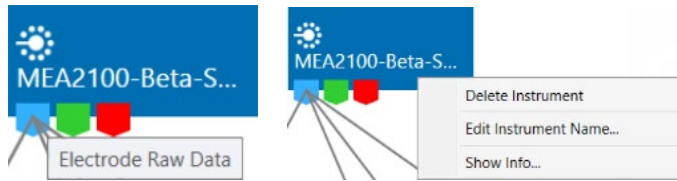
The MEA2100-Beta-Screen software operates with virtual instruments, which can be combined and saved as so called "Experiments" for later use. When opening the software, all available instruments are shown as blue icons on the left hand side of the screen. Each instrument can be dragged and dropped into the main window. Double clicking an instrument in the instrument tree will open a tabbed page containing its control elements and data displays.



All instruments have data ports that are color coded, reflecting different types of data. Ports on the upper side represent data input to the instrument, ports on the lower side represent data outputs of the instrument. Ports with matching colors can be connected by drawing a connection line between a data output and one or more data inputs. Data flows along those lines from the data source through the instruments. Each input port can be connected to a single output port only, whereas an output port can be connected to many input ports of different instruments. The only exception is the "Recorder" instrument, which accepts any type of data and more than one input connection.

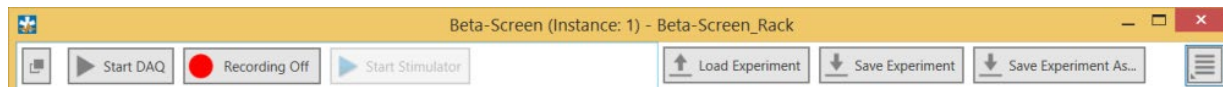
Instruments operate as independent units. They process the data from the respective input port and generate one or more data streams in the output port(s). Settings have to be done separately for each instrument in the respective control window tabbed page. An instrument without connected data input is not functional.

In the example pictured above, the streams of raw data, analog and digital data coming from the data source MEA2100-Beta-Screen into the recorder directly and will consequently be recorded into a file. The same raw data stream is processed through the "Filter" and the "Beta-Screen" instruments and then connected to the "Recorder" resulting in Beta-Screen time stamp events that are also recorded.



Hovering the mouse pointer over an output port will give you a tooltip with the data type the port provides. A right click on a data connection allows to delete the connection. A right click on an instrument brings up a menu which allows to delete or rename the instrument.

5.3.1 Main Tool Bar

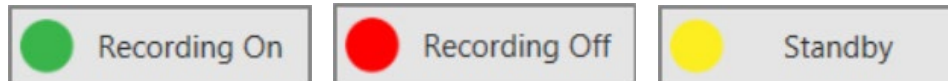


The uppermost tool bar contains the major control functions for

- starting and stopping data acquisition
- starting and stopping data recording
- loading or saving experiment configurations
- accessing general settings

The "Start / Stop" controls can be undocked from the main menu and be dragged anywhere. They will always stay on top of all other windows.

The "Start / Stop DAQ" button controls the data acquisition, but does not yet start recording data. The "Recording" button switches the "Recorder" instrument between "On", "Standby" and "Off" depending on the configuration.



5.3.2 Data Types

The types of data occurring in the "Beta-Screen" software, as indicated by the color-coded ports are:

Blue: Electrode data, raw or filtered. These data types have the same structure and the same compatibility with instruments.

Green: Auxiliary analog data from the additional analog inputs on the Interface Board.

Red: Digital data, the 16 bit digital data stream from the Interface Board.

Pink: Trigger events.

Grey: Recorder input port.

5.3.3 File Types

The types of files occurring in the "Beta-Screen" software are:

*.mse: Experiment file, a configuration of instruments. Created manually by the user.

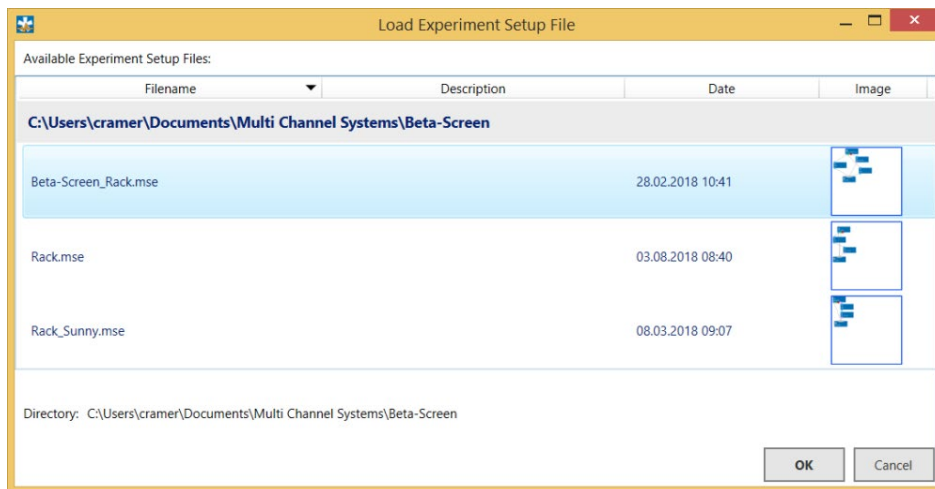
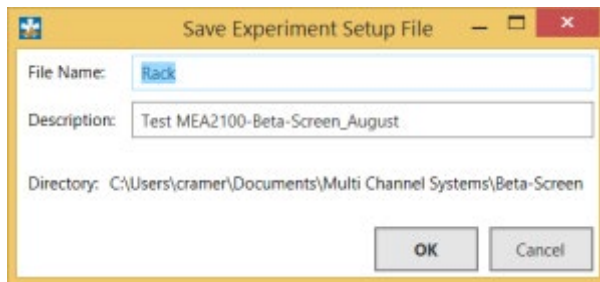
*.msrd: Data file, generated by the Recorder, contains the raw data of all data streams that are connected to the input of the Recorder.

*.msrs: Settings file, generated by the Recorder, must also be present to open a data file in the Multi Channel Analyzer.

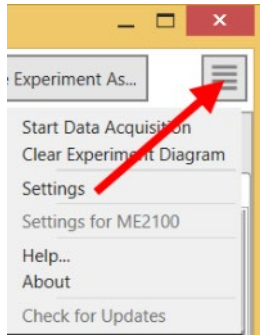
*.bsl: log file, generated by the Beta-Screen instrument, must be present for Beta-Screen analysis in the Beta-Screen Analyzer.

5.3.4 Save and Load an Experiment

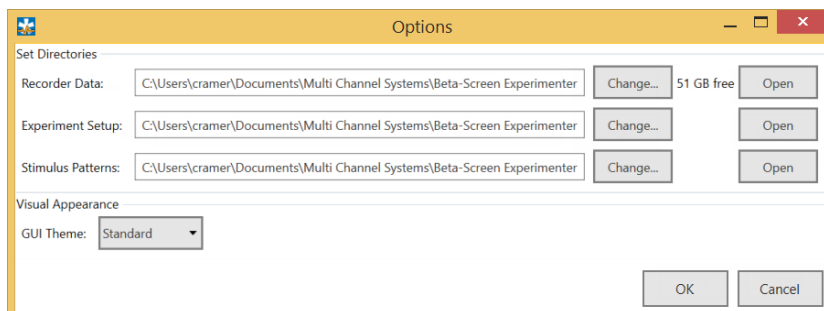
Once a configuration of instruments has been designed, it can be saved for later use. Such a configuration is called "Experiment", and can be saved and loaded from the main menu bar. The file extension for an experiment file is *.mse. The "Save and Load Experiment" functions do not save or load data, just the setup, the combination of instruments in that experiment.



5.3.5 General Settings

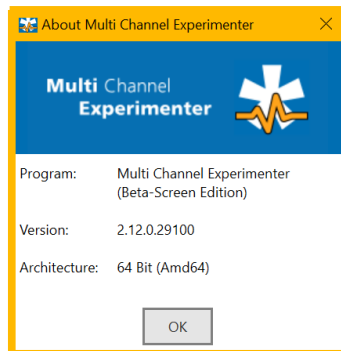


Click "Settings" to change file path settings. The MEA2100-Beta-Screen uses a default file path for data and experiment files, which can be defined in this menu.

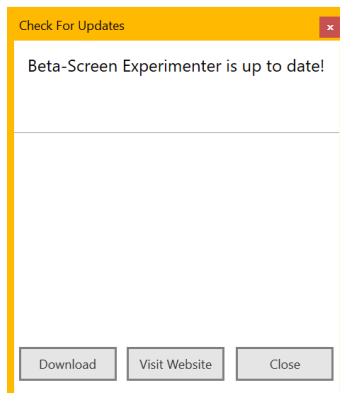


"Help" will open the latest version of the manual directly from the MCS web site.

Click "About" to view the version of the Beta-Screen edition.



It is recommended to use the "Check for Updates" function on a regular basis. Free upgrades of the MEA2100-Beta-Screen software are released on a regular basis.



5.4 Data Source MEA2100-Beta-Screen

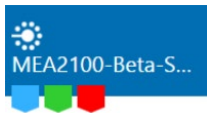


Once the MEA2100-Beta-Screen-System is connected to the computer, it will also become available as an instrument in the Beta-Screen software.

A yellow warning triangle indicates if the device is currently connected to a potentially problematic USB port which could lead to losses during data transfer.

5.4.1 Data Ports and Export Options

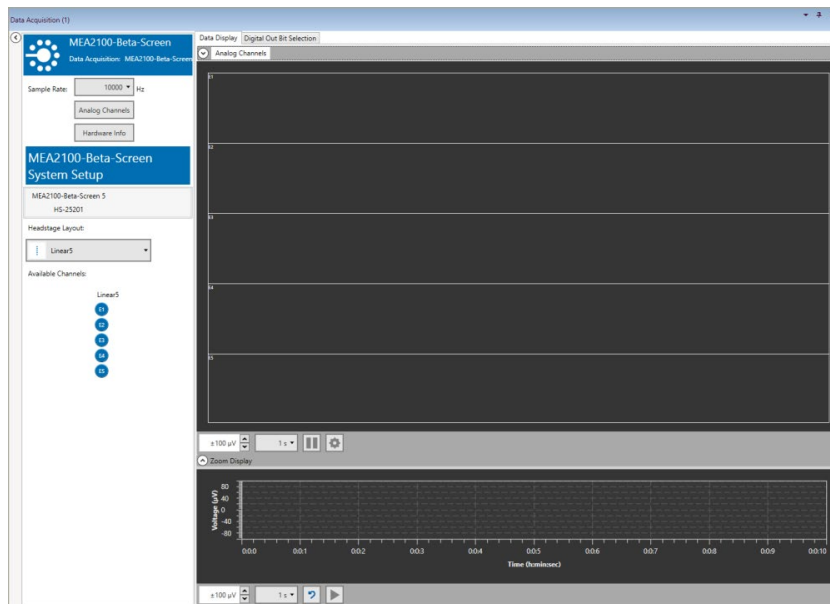
The MEA2100-Beta-Screen-System has three output ports: Electrode Raw Data (blue), Analog Data (green) and Digital Data (red). There are no input ports. The MEA2100-Beta-Screen-System can be connected directly to the "Beta-Screen" and to the "Filter" instruments with blue input port. There are no export options.

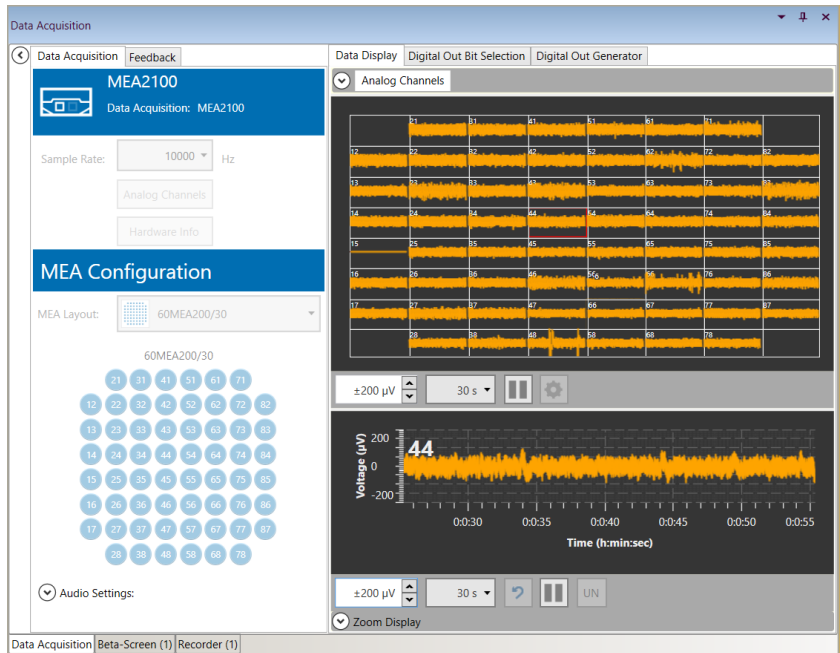


5.4.2 Operation

Doubledclick the MEA2100-Beta-Screen icon to open the data source control window in a separate tabbed page. This window shows all available data channels and optionally also the additional "Analog Input" channels from the interface board. The MEA2100-Beta-Screen headstage has five electrodes, arranged in a linear row.

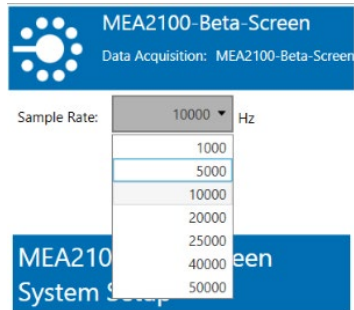
Please adapt your settings in the "Control" window on the left side. The "Data Display" window on the right side contains three tabbed pages: "Data", "Digital Out Bit Selection" and "Digital Out Generator".





5.4.3 Control Window

Sample Rate



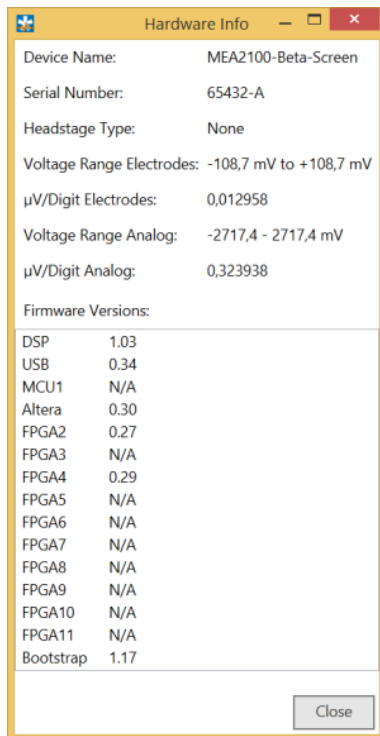
Select the "Sample Rate" in "Hz" from the drop down window.

Analog Channels



Activate the "Analog Channels" on the interface board via check box, if needed.

Hardware Information



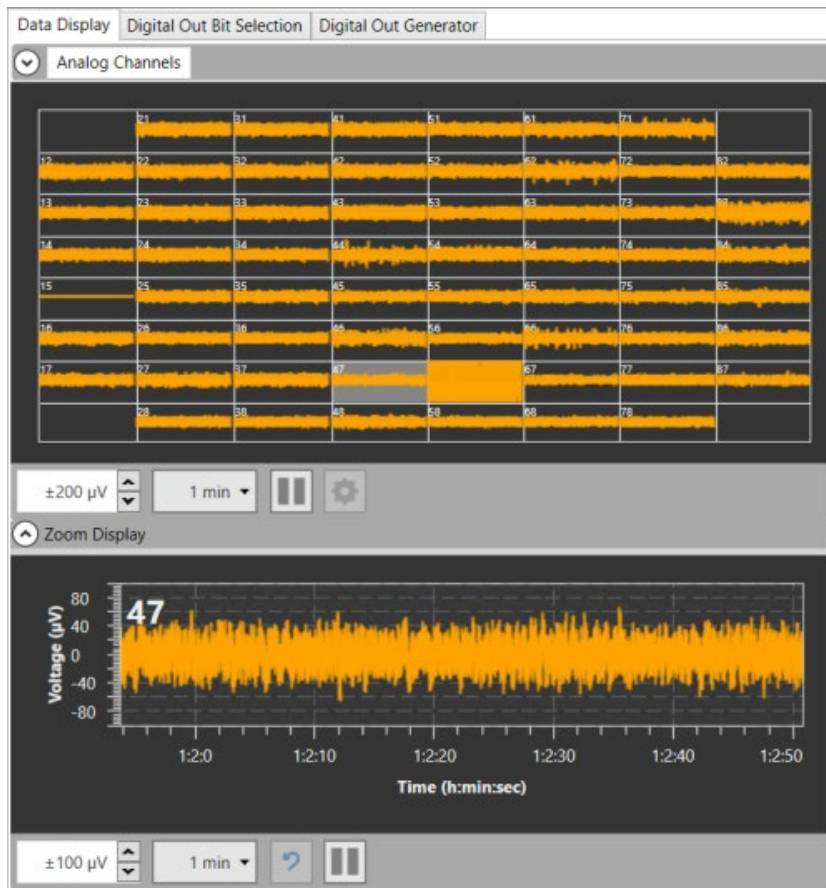
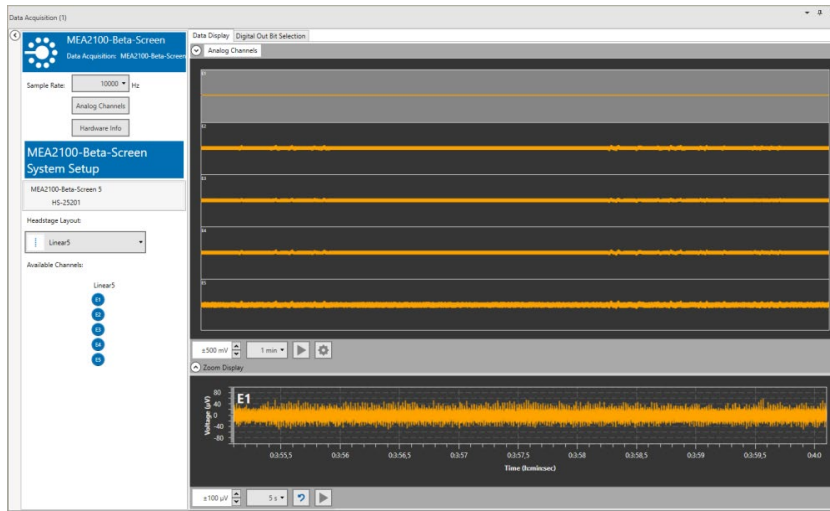
The "Hardware Info" dialog holds information about the device.

Electrode Array



Individual channels can be toggled by clicking on them. Deactivated channels will neither be displayed nor recorded.

5.4.4 Data Display Window



5.5 Instrument: Beta-Screen



The "Beta-Screen" instrument has a blue "Electrode Raw Data" input and a pink output of experiment event time stamps that can be used as trigger.

Doubleclick the Beta-Screen icon to open the data display and control window in a separate tabbed page. This window contains all instrument specific settings and control elements on the panel on the left and displays for electrode raw data and analysis results on the right.



Warning: It is mandatory to connect the event output of the "Beta-Screen" instrument to the input of the "Recorder" instrument. Otherwise, irrecoverable information about your experiments will be missing in the recorded files.

The Beta-Screen instrument is designed to

- visualize beta cell activity over a long period
- perform spike and burst analysis
- define and conduct dose-response experiments
- control the integrated heating device of a connected Beta-Screen headstage

Long term displays allow monitoring cell activity of up to one hour.

A set of spike detectors extract spike time stamps from incoming data for each electrode.

These time stamps are then processed by a set of burst analyzers.

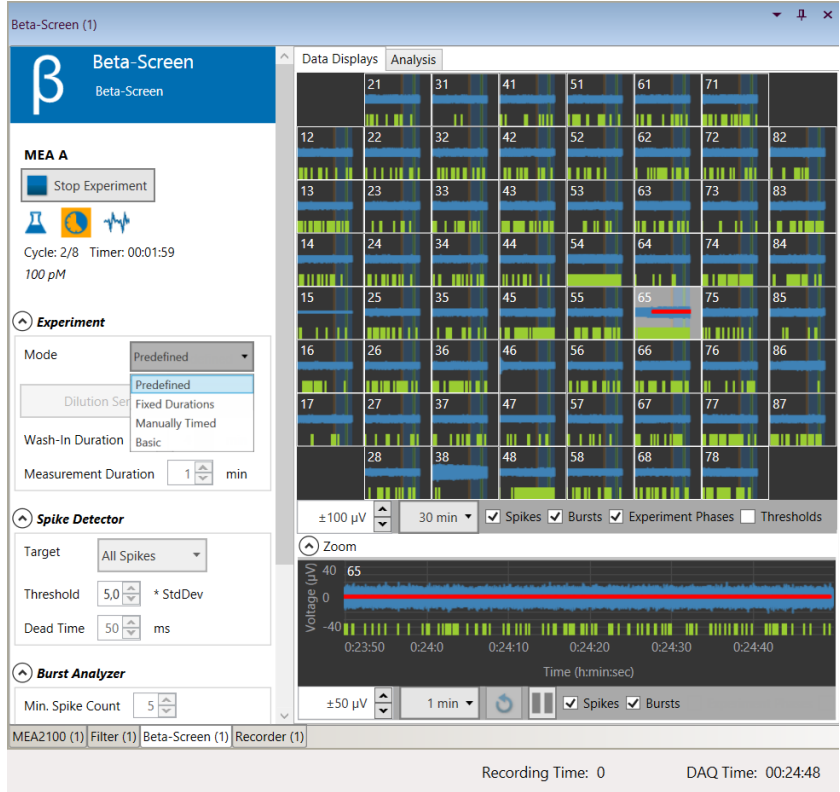
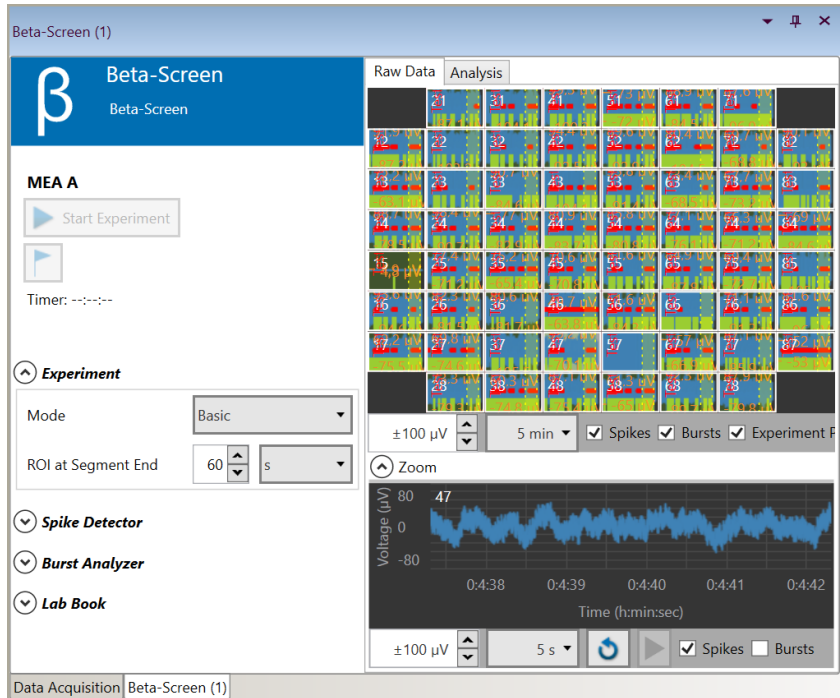
"Spike detectors" and "burst" analyzers are always active, as soon as data gets added via the electrode raw data input. The results are instantly being visualized in the instrument's raw data displays.

At the end of each measurement, the following parameters are extracted, all based on spike time stamps and burst data:

- spike count
- burst count
- burst durations
- fraction of plateau phase (FOPP)
- inter burst intervals
- spikes per burst

After finishing an experiment, a log and all analysis results are automatically exported in an Excel compatible format.

Please adapt your settings in the "Control" window on the left side. The "Data Display" window on the right side contains two tabbed pages: "Data Display" and "Analysis". All parameters provided under the data displays are visible when the respective check box is selected or hidden, if not.



5.5.1 Control Window

The screenshot shows the control window for the Beta-Screen instrument. At the top, there is a blue header with a white Greek letter β and the text "Beta-Screen" and "Beta-Screen". Below the header, the main area is white and contains several sections:

- Headstage 1 (37190)**: A section with a "Stop Experiment" button, four icons (flask, globe, waveform, and double arrows), and the text "Cycle: 6 Timer: 00:01:04".
- Temperature Control**: A section with a "Target Temperature" input field set to "36,0" and a unit selector set to "°C".
- Experiment**: A section with a "Mode" dropdown menu set to "Fully Manual".
- Spike Detector**: A section with three input fields: "Target" set to "All Spikes", "Threshold" set to "5,0" with a "* StdDev" multiplier, and "Dead Time" set to "50" with a "ms" unit.
- Burst Analyzer**: A section with a downward arrow icon.
- Lab Book**: A section with a downward arrow icon.

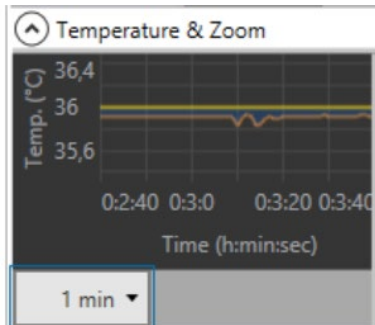
Schedule and control your experiments in the "Control Window" of the "Beta-Screen" instrument. Please find on top information about the connected "Headstage", elements to control the temperature and the experimental process.

5.6 Experimental Parameters

5.6.1 Temperature Control



The MEA2100-Beta-Screen headstage is equipped with an internal temperature controller. That is, why the "Temperature Control" starts automatically when the "Beta-Screen" instrument is connected to the "Data Source". Please set the temperature value in the "Control" window.



Changes in temperature set point will be directly sent to the device. The actual temperature is measured one time a second and displayed in the "Temperature" window. The difference between actual and set temperature is indicated by blue (negative) and red (positive) fill color. Define the time span to be displayed from the drop down menu below the "Temperature" window.

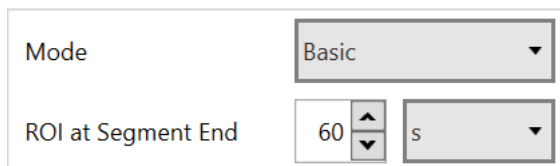
5.6.2 Experiment

There are four different experiment modes available: "Predefined", "Fixed Durations", "Manually Timed", and "Basic".

The following tooltip illustrates the different modes.

Predefined: run experiments with a predefined dilution series and predefined timing of the experiment phases.
Fixed Durations: run experiments with a flexible number of cycles (definition on the fly) but a predefined timing of the experiment phases.
Manually Timed: just like the Fixed Durations mode, except for the timing being completely manual.
Basic: continuous measurement (no cycles or phases) using user defined markers only to indicate events.

"Basic" is the default experiment mode. Please define the ROI at the end of the segment from the up-down box in minutes or seconds.



With the exception of the "Basic" mode, they all share the rule that an experiment is divided into cycles, one for each test condition, that are further broken down into the three phases "Apply", "Wash-In", and "Measurement".

1. "Apply" phase for establishing the desired condition.
2. "Wash-In" phase to wait for an effect of the new condition.
3. "Measurement" phase.

In "Predefined" experiments, the complete experimental flow must be determined beforehand. This includes the definition of a dilution series as well as timing information for "Wash-In" and "Measurement" phases. Only the duration of the "Apply" phase must be controlled by the user.

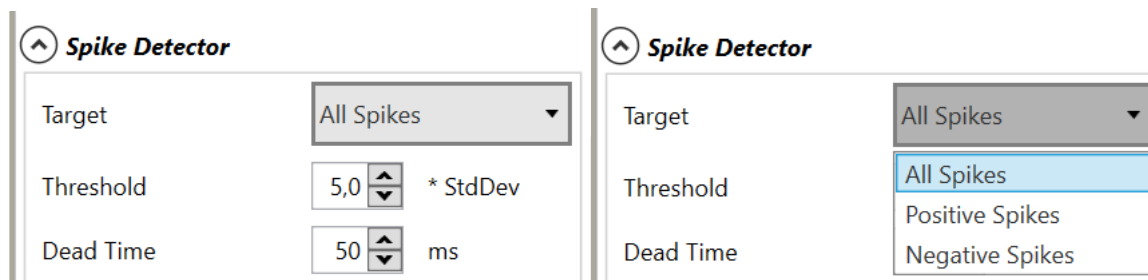
The "Fixed Durations" mode requires information for the timing of "Wash-In" and "Measurement" phases only, whereas the dilution series may be defined while the experiment is running.

Maximum flexibility is provided when running experiments in "Fully Manual" mode. The dilution series may be defined while the experiment is running, and all experiment phases must be timed manually.

"Wash-In Duration" may be set to zero, if no "Wash-In" phase is required.

In "Basic" mode the recording is continuous without cycles or phases. Set user defined "Markers" to split the recording into segments. Regions of interest (ROI) are calculated automatically for each segment. Any analysis apart from spike and burst detection is only performed on measurement phases or ROIs.

5.6.3 Spike Detector



Spike time stamps and amplitudes are directly derived from global extrema of intervals during which the signal exceeds a given positive threshold or is below a given negative threshold.

Select the admissible polarity of spike detections using the "Target" property.

The positive and negative thresholds used for spike detection are calculated by multiplying the signal's standard deviation by a factor which can be set in the "Threshold" up down box.

An optional dead time after each spike prevents multiple detections of the same event. After a successful spike detection, any further spike activity within this interval will be ignored. Spike timestamps are to apply for this calculation. This constraint may be deactivated by setting the value to zero.

5.6.4 Burst Analyzer

Burst Analyzer

Min. Spike Count	5	
Min. Duration	5	s
Min. Start Spike Rate	1,0	Hz
Min. End Spike Rate	0,5	Hz
Min. Burst Interval	5	s

The “Burst Analyzer” option allows the detection and analysis of spike bursts. The spikes must be detected first. The quality of the burst analysis therefore depends on the accuracy of the spike detection.

Whether an accumulation of spikes is considered as burst, when exactly a burst starts and when it ends, can be defined by several constraints:

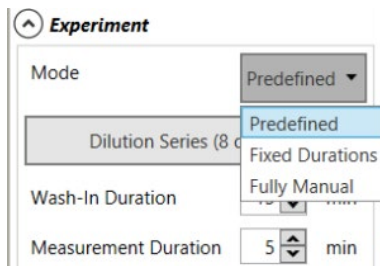
Each burst consists of a minimum number of spikes.

A burst may have a minimum duration. Set this value to zero if duration is not an important parameter.

Spikes within a burst must appear with a certain frequency. Beta cell bursts tend to start at higher spike rates than how they end. This circumstance is reflected by two separate parameters for minimum spike rate.

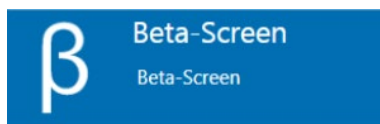
Closely spaced bursts may be interpreted as single interrupted burst and therefore be merged. This is determined by defining a minimum interval between bursts.

5.6.5 Experiment: Course of Action



Four different experimental modes are available: "Predefined", "Fixed Duration", "Fully Manual", and "Basic".

Experiment Mode: Predefined



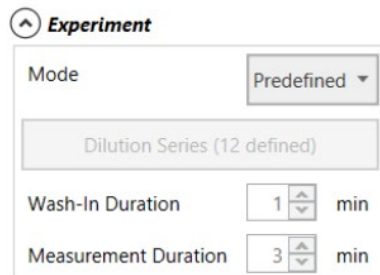
Headstage 1 (37190)

Stop Experiment



Cycle: 6/12 Timer: 00:00:50

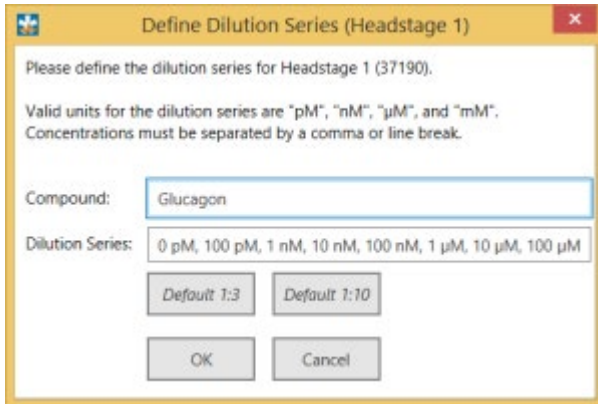
Glucagon (30 nM)



The experimental mode "Predefined" requires a definition of the "Dilution Series".

Dilution Series

Click the button "Dilution Series" to open the dialog "Define Dilution Series".



The dialog box "Define Dilution Series (Headstage 1)" contains the following elements:

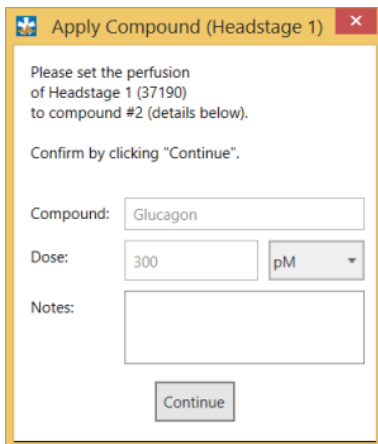
- Title bar: Define Dilution Series (Headstage 1)
- Text: Please define the dilution series for Headstage 1 (37190).
- Text: Valid units for the dilution series are "pM", "nM", "µM", and "mM". Concentrations must be separated by a comma or line break.
- Compound: Input field containing "Glucagon".
- Dilution Series: Input field containing "0 pM, 100 pM, 1 nM, 10 nM, 100 nM, 1 µM, 10 µM, 100 µM".
- Buttons: "Default 1:3", "Default 1:10", "OK", and "Cancel".

Select one of the "Default" series, 1:10 or 1:3. When creating custom dilution series, you have to consider the requirements for series written in the dialog: Valid units are pM, nM, µM and mM. The concentrations must be separated by comma or line break.

Additionally, you have to define the length of the "Wash-In Phase" and the "Measurement Duration" via up down boxes.

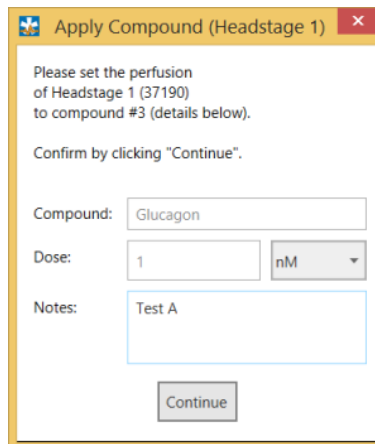
Start the predefined experiment by clicking the button "Start Experiment".

A pop up dialog at the start of each "Apply Phase" will inform you which experiment condition is the next to be tested. After establishing of the requested condition, please click the button "Continue" to proceed to the next experiment phase.



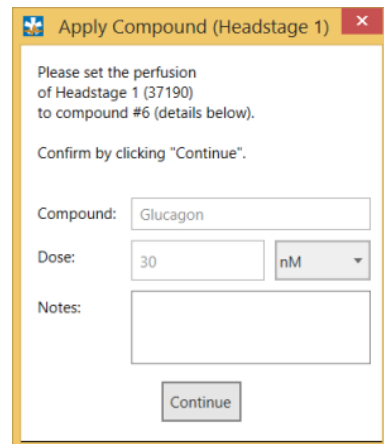
The dialog box "Apply Compound (Headstage 1)" for compound #2 contains the following elements:

- Title bar: Apply Compound (Headstage 1)
- Text: Please set the perfusion of Headstage 1 (37190) to compound #2 (details below).
- Text: Confirm by clicking "Continue".
- Compound: Input field containing "Glucagon".
- Dose: Input field containing "300" and a dropdown menu set to "pM".
- Notes: Empty text area.
- Button: "Continue".



The dialog box "Apply Compound (Headstage 1)" for compound #3 contains the following elements:

- Title bar: Apply Compound (Headstage 1)
- Text: Please set the perfusion of Headstage 1 (37190) to compound #3 (details below).
- Text: Confirm by clicking "Continue".
- Compound: Input field containing "Glucagon".
- Dose: Input field containing "1" and a dropdown menu set to "nM".
- Notes: Text area containing "Test A".
- Button: "Continue".



The dialog box "Apply Compound (Headstage 1)" for compound #6 contains the following elements:

- Title bar: Apply Compound (Headstage 1)
- Text: Please set the perfusion of Headstage 1 (37190) to compound #6 (details below).
- Text: Confirm by clicking "Continue".
- Compound: Input field containing "Glucagon".
- Dose: Input field containing "30" and a dropdown menu set to "nM".
- Notes: Empty text area.
- Button: "Continue".

Headstage 1 (37190)

Stop Experiment

Cycle: 6/12 Timer: 00:00:57
Glucagon (30 nM)

Experiment

Mode: Predefined

Dilution Series (12 defined)

Wash-In Duration: 1 min

Measurement Duration: 3 min

The experiment follows a pattern which is predefined: Twelve dilutions are defined in this "Dilution Series". The "Cycle" count informs about the actual repeats and the dilution of the compound is displayed. The "Timer" indicates the duration in the "Apply" phase or the remaining time in the "Wash-In" or "Measurement" phase of the current phase, which is highlighted in orange.

"Wash-In" and "Measurement" phase are automatically ended after the respective time.

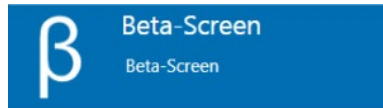
The experiment is automatically ended after the last dilution has been measured.

Headstage 1 (37190)

Stop Experiment

Cycle: 8/12 Timer: 00:02:06
Glucagon (300 nM)

Experiment Mode: Fixed Duration



MEA A

Stop Experiment



Cycle: 11 Timer: 00:00:39

Glucagon (450 pM)

Experiment

Mode: Fixed Durations

Wash-In Duration: 3 min

Measurement Duration: 1 min

Schedule the experiment via up down boxes "Wash-In Duration" and "Measurement Duration". Repeat the experimental cycles manually as often as necessary. Compound and dose can be defined at the start of each cycle.

Apply Compound (MEA A)

Please set the perfusion of MEA A () to compound #2.

You may enter details below.

Confirm by clicking "Continue". Finish the experiment by clicking "Stop" instead.

Compound: Glucagon

Dose: 150 nM

Notes: Test C

Continue Stop

Apply Compound (MEA A)

Please set the perfusion of MEA A () to compound #3.

You may enter details below.

Confirm by clicking "Continue". Finish the experiment by clicking "Stop" instead.

Compound: Glucagon

Dose: 300 pM

Notes: Test C

Continue Stop

Apply Compound (MEA A)

Please set the perfusion of MEA A () to compound #4.

You may enter details below.

Confirm by clicking "Continue". Finish the experiment by clicking "Stop" instead.

Compound: Glucagon

Dose: 450 pM

Notes: Test C

Continue Stop

MEA A

Stop Experiment

Cycle: 5 Timer: 00:01:51

Glucagon (450 pM)

The "Cycle" count informs about the actual repeats and the dilution of the compound is displayed. As in "Predefined" mode, the "Timer" indicates the duration in the "Apply" phase or the remaining time in the "Wash-In" or "Measurement" phase of the current phase, which is highlighted in orange.

"Wash-In" and "Measurement" phase are automatically ended after the respective time. The experiment must be stopped manually.

Experiment Mode: Fully Manual

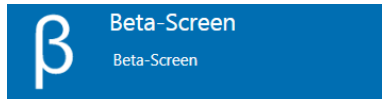
The screenshot shows the Beta-Screen software interface. At the top, there is a blue header with a white Greek letter β and the text "Beta-Screen". Below the header, the text "ME A" is displayed. A "Stop Experiment" button is visible. Below the button are four icons: a flask, a moon, a pulse line, and a double arrow. The text "Cycle: 7 Timer: 00:00:05" and "Glucose (500 nM)" is shown. Below this, there is a section titled "Experiment" with a dropdown menu set to "Fully Manual".

Please schedule the experiment completely manual. The time spans of the experiment are variable. Change from phase to phase by clicking on the double arrow. Compound and dose can be defined at the start of each cycle.

This screenshot is similar to the one above but shows the "Cycle: 7 Timer: 00:02:22" text highlighted with a red box. A red arrow points from the bottom of the box to the "Glucose (500 nM)" text below it.

The "Cycle" count informs about the actual repeats and the dilution of the compound is displayed. In this mode the "Timer" counts the durations of all phases.

Experiment Mode: Basic



Headstage 1 (37190)

Stop Experiment



Timer: 00:01:31

Experiment

Mode: Basic

ROI at Segment End: 60 s

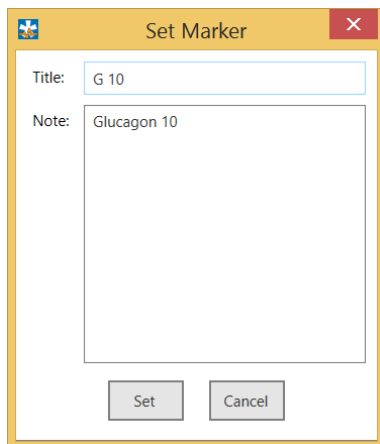
In "Basic" mode the recording is continuously without cycles or phases. Set user defined "Markers" to split the recording into segments. Regions of interest ROIs are calculated automatically for each segment.

Select the "ROI at Segment End" in seconds or minutes from the up-down box. ROIs are end-aligned to the segments and will automatically be shortened to match segment duration, if necessary.

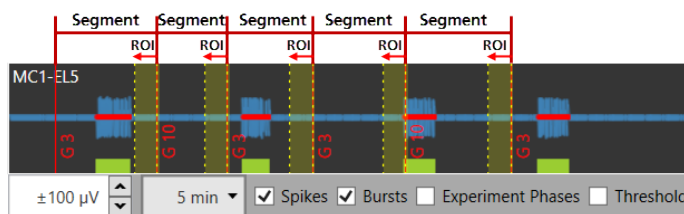
During an experiment, click the „Set Marker“ button, to set an user defined marker.



Repeat the splitting of the recording via marker as often as necessary. In the raw data display, the start of a segment is indicated by a vertical dashed red line labeled with the "Title" in the "Set Marker" dialog.



See the analysis of the ROIs in the "Analysis" tab of the data display. ROIs are indicated in the raw data displays in yellow.



5.6.6 Lab Book

Please fill in data referring to your experiment. The "Lab Book" entries will be stored in the Beta-Screen log file *.bsl.

Lab Book

Project/Study ID

Experiment ID

Institution

Scientific Director

Assistant

Compound(s)

Medium

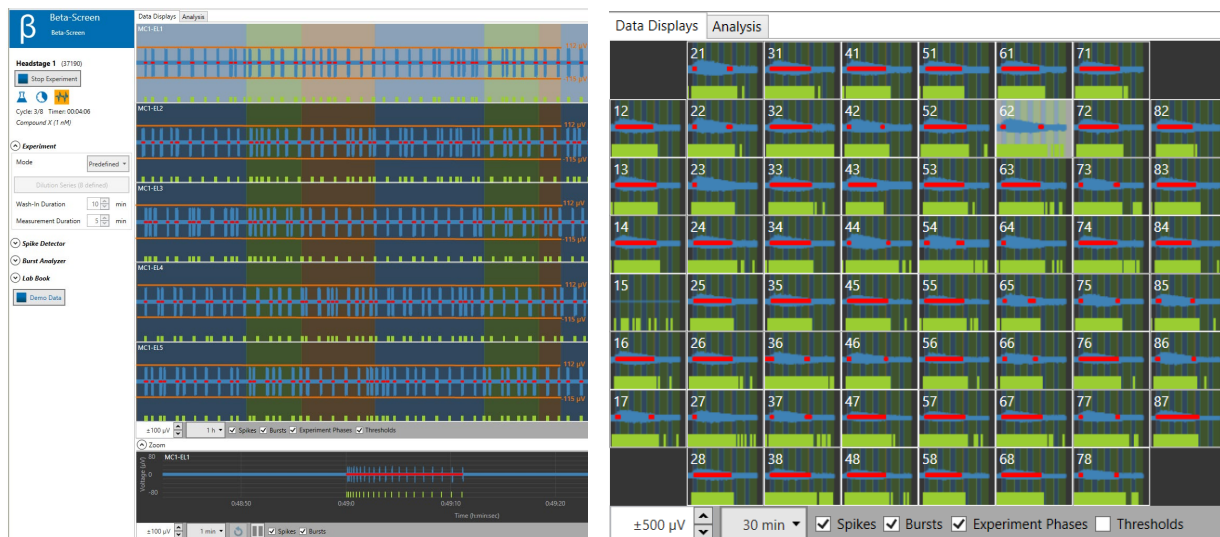
Notes

5.6.7 Display Window

The "Display" window has two tabbed pages: "Data Display" and "Analysis". The number and layout of displayed data channels is conform to the settings in the "Data Source" instrument.

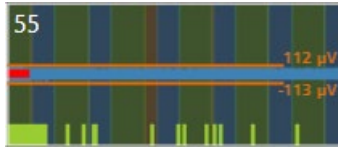
Data Display

In dependency of the connected device, a Beta-Screen headstage or a MEA2100-Mini headstage, the number of displayed data channels differ.



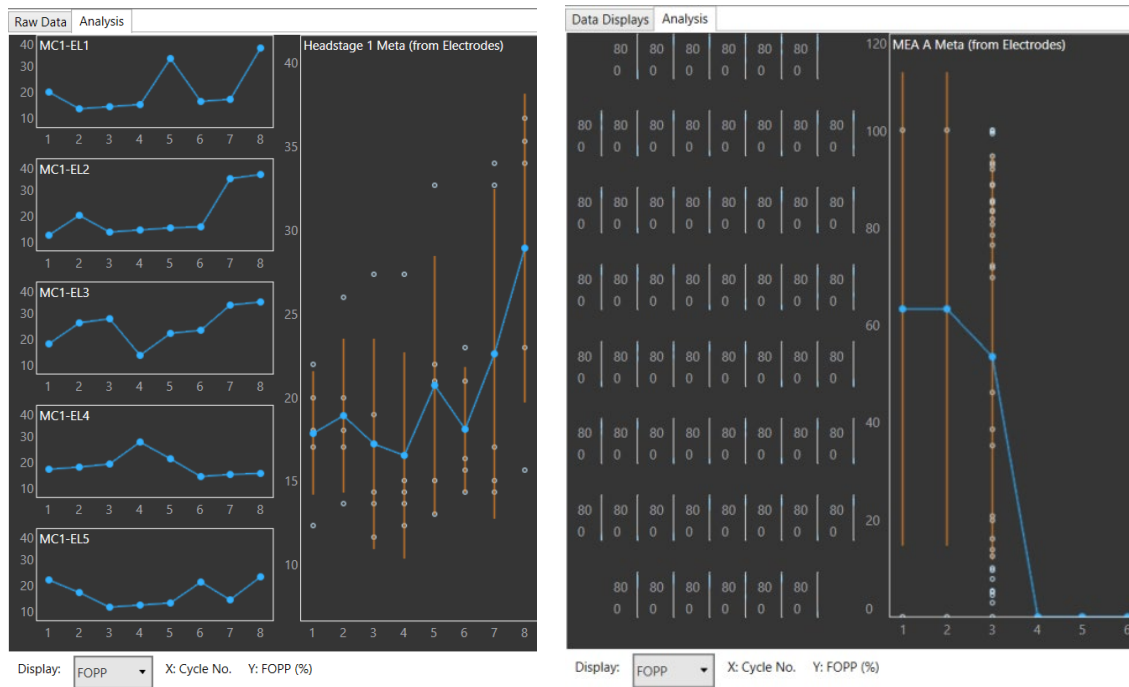
Enable the check boxes "Spikes" and "Bursts" to display one or both events. Spikes are indicated in green bars at the bottom of each electrode channel display, bursts are indicated in red in overlay with the blue raw data. See the spike detector threshold bars and the value of the threshold displayed in raw data displays.

Experimental Phases



See the color coded experimental phases for a better determination: The compound apply phase is indicated in red, the "Wash-In" phase is color coded in blue and the measurement phase appears in green. See the spike detector threshold bars and the value of the threshold displayed in raw data displays.

Analysis Display



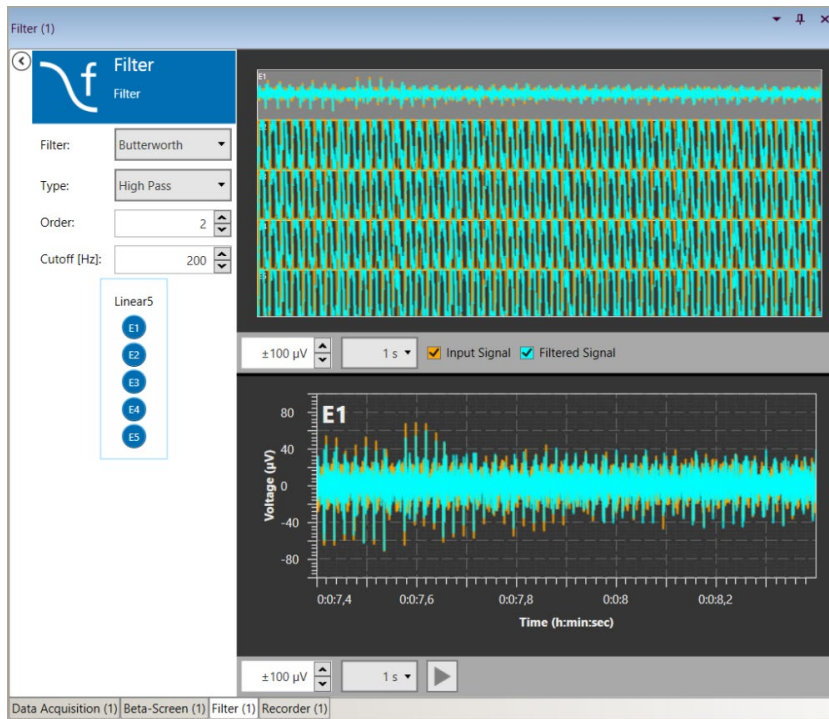
For online analysis, please use the "Analysis" tab.

Based on input spike and burst data, the following parameters are extracted and visualized for each electrode:

- spike count
- burst count
- fraction of plateau phase (FOPP)
- burst duration
- inter burst Interval
- spikes per burst

A meta-analysis over the above mentioned values mean from each electrode is added. Analysis is automatically performed at the end of each measurement phase of an experiment. Display labels hold information about the displayed blue main value. When plotting mean values, standard deviation is added as orange bars, underlying values are displayed as white circles. At the end of an experiment, all extracted values are automatically exported in an Excel compatible format as "[filename] Beta-Screen Analysis.xlsx". There is no direct export option.

5.7 Instrument: Filter



The instrument "Filter" can apply time based filters with different characteristics to the raw data. More than one filter can be used in one experiment, the filters can be used in series or in parallel. Please also see the [movie "Filter"](#) on the Multi Channel Systems web site for illustration.

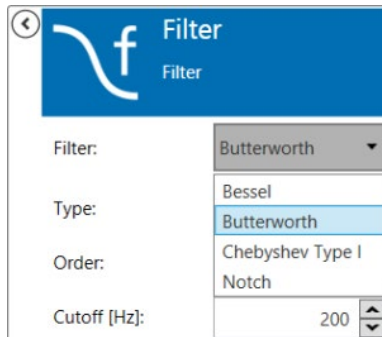
The "Filter" has a blue "Electrode Raw Data" input and a similar blue "Filter Data" output. The input data can be directly from the data source, or from another instrument with a blue output, for example another filter. Likewise, the "Filter Data" output is compatible with any other blue input port. There are no direct export options.

5.7.1 Operation

The "Filter" instrument shows raw data and filtered data for all channels in overlay. Both traces can be toggled with check boxes. Different filter types and characteristics are available.

A 2nd order Butterworth low pass filter with a cutoff frequency between 20 to 100 Hz is recommended when processing data recorded from beta cells.

Filter Characteristics



A "Bessel" filter is a type of linear filter with a maximally flat group delay (maximally linear phase response). Analog "Bessel" filters are characterized by almost constant group delay across the entire passband, thus preserving the wave shape of filtered signals in the passband.

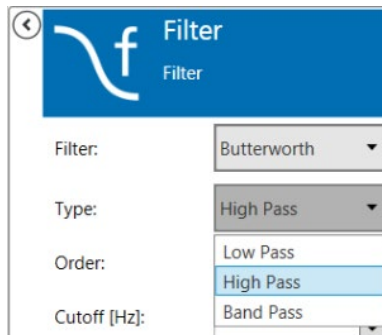
The "Butterworth" filter is designed to have a frequency response which is as flat as mathematically possible in the passband.

"Chebyshev" filters are analog or digital filters having a steeper roll-off than "Butterworth" filters.

"Chebyshev" filters have the property that they minimize the error between the idealized filter characteristic and the actual over the range of the filter, but with ripples in the passband. Because of the passband ripple inherent in "Chebyshev" filters, filters which have a smoother response in the passband but a more irregular response in the stop band are preferred for some applications.

A "Notch" filter is designed to remove a certain frequency, 50 Hz or 60 Hz are available.

High Pass



A "High Pass" filter will remove all frequencies below the "Cutoff". For high pass filters, just select the "Order" and the "Cutoff" frequency from the respective drop down menus.

Low Pass

Filter: Butterworth

Type: Low Pass

Order: 2

Cutoff [Hz]: 200

60MEA100/10

Downsampling

A "Low Pass" filter will remove all frequencies above the "Cutoff". For low pass filters, also select the "Order" and the "Cutoff" frequency from the respective drop down menus. Additionally, "Downsampling" is available. If the "Downsampling" feature is active, the sampling rate for the downsampled data will adjust automatically, based on the "Cutoff" frequency. The outgoing "Filtered Data" stream will then have the lower sampling rate.

Band Pass

Filter: Butterworth

Type: Band Pass

Order: 2

Frequency Band: Alpha (8 - 13 Hz)

Alpha (8 - 13 Hz)

Beta (13 - 30 Hz)

Gamma (30 - 120 Hz)

Delta (0.5 - 4 Hz)

Theta (4 - 8 Hz)

Band Pass filters remove all frequencies outside the selected frequency band. Fixed Band Pass options are available.

5.8 Instrument: Recorder



The "Recorder" is essential to record acquired data. Only one recorder can be used in an experiment. All data streams which are directly connected to the "Recorder" will be recorded. Data from instruments not connected to the recorder will be lost. Please also see the [movie "Recorder"](#) on the Multi Channel Systems web site for illustration.



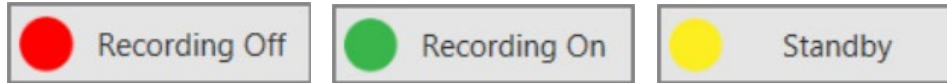
The "Recorder" has a unique input port which accepts connections from all other ports in unlimited number. One file is generated containing all connected data streams. There are no direct export options.

5.8.1 Operation

Instrument	Stream
Data Acquisition	Electrode Raw Data (1)
Beta-Screen	Beta-Screen Events (1)
Filter	Filter Data (1)

The "Recorder" is mandatory to record data. The simplest experiment would consist of the "Data Source" connected to the "Recorder". The default file path is set in the main window settings. A file name is generated from an arbitrary file core, and an optional pre and/or postfix. If the same file name is used repetitively, nothing will be overwritten. Instead, the following files will be labeled with an additional increasing number at the end of the file name. A number of files with meta information, like instrument settings, will be generated with each recording. The actual data is in the *.msrd file. All recorded data streams are listed in "Recorded Data Streams".

The "Start" and "Stop" condition for recording can be a "Manual" command, an "Event" or a "Timer". Manual start or stop commands are given with the "Recording" button in the main window:



If the "Start" condition is "Manual", and the "DAQ" is running, the recording will start immediately once the "Recording" button is pressed. If the DAQ is stopped, the "Recorder" will go to "Standby" till the DAQ is started again.

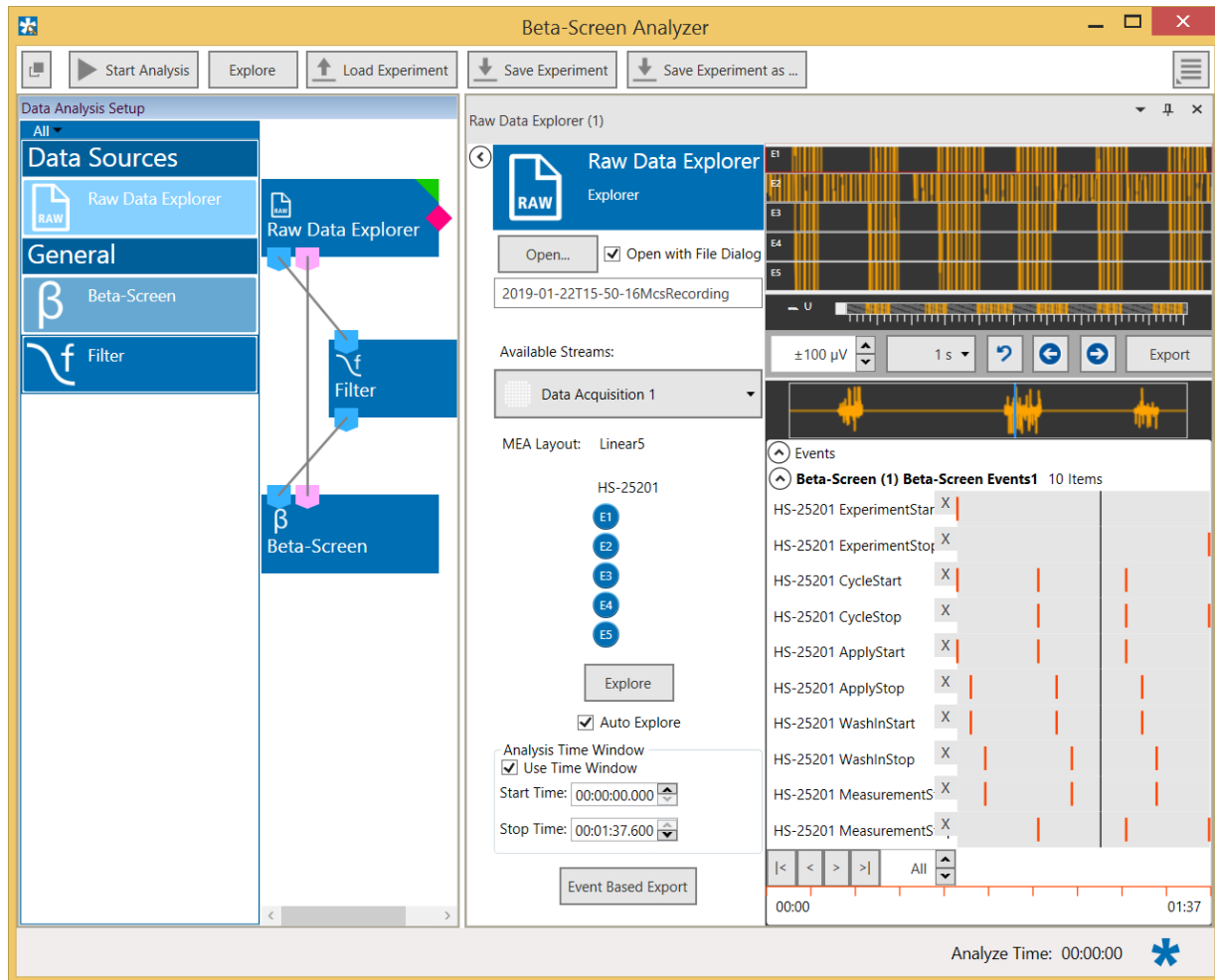
Likewise, if the recorder should be started on an "Event", the "Recording" needs to be set to "Standby" manually. It will remain so till the "Start Event" starts recording. If the start condition is "Timer", the recording will be started with a delay.

The Beta-Screen instrument generates a multitude of events and hence multiple options for start and stop commands. We recommend setting the start trigger to "ExperimentStart" and the stop trigger to "ExperimentStop". Selecting other events may lead to important data not being recorded!

Stopping the recorder manually can have two effects: if the "Start" condition is also "Manual", the "Recorder" will be "Off". If the start condition is an "Event", it will go to "Standby", and wait for the next start command. Likewise, if a recording is stopped by an "Event" or a "Timer", recording will be "Off" or in "Standby" afterwards, depending on what the "Start" condition is set.

6 Beta-Screen Analyzer

The Beta-Screen Experimenter is for online data acquisition, the Beta-Screen Analyzer is the offline tool for data analysis.



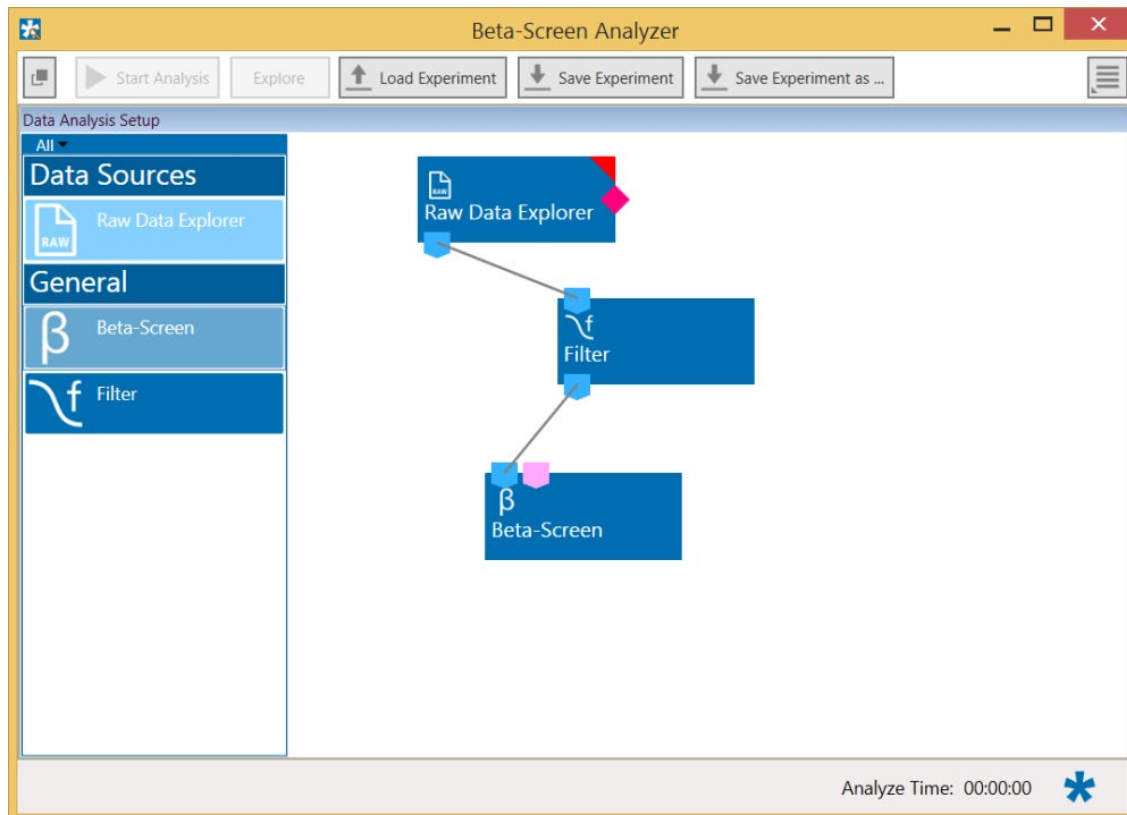
6.1 Workflow for Analyzing Data

To analyze data files with the Beta-Screen Analyzer it's mandatory to follow a specific workflow. After designing an experiment and opening a file there are several options to review the data. It is recommended to use first the "Explore" function to optimize the settings of the analysis instruments, before analyzing the whole file with the "Start Analysis" function.

6.2 Beta-Screen Analyzer

Designing an Experiment

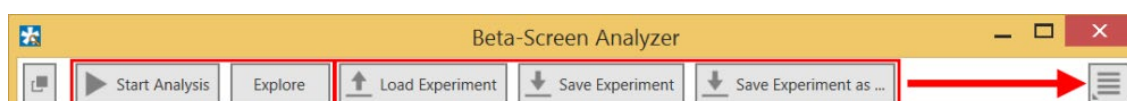
The MEA2100-Beta-Screen software operates with virtual instruments, which can be combined and saved as so called "Experiments" for later use. When opening the Beta-Screen Analyzer software, all available instruments are shown as blue icons on the left hand side of the screen. Each instrument can be dragged and dropped into the main window. Double clicking an instrument in the instrument tree will open a tabbed page containing its control elements and data displays.



Most instruments have color coded data ports. Ports on the upper side represent data input to the instrument, ports on the lower side represent data outputs of the instrument. Only ports with matching colors can be connected by drawing a connection line between a data output and one or more data inputs. Data flows along those lines from the data source through the instruments. An instrument without connected data inputs is not functional.

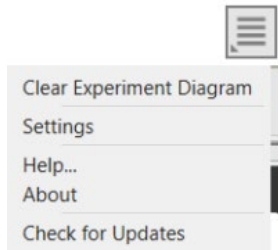
Note: The event output of the "Raw Data Explorer" will only be available if a file containing event data has been opened before. Any experiment info apart from electrode raw data will only be available in the "Beta-Screen" instrument if the event ports have been connected.

Once a configuration of instruments has been designed, it can be saved for later use. Such a configuration is called "Experiment" and can be saved and loaded from the main menu bar. The file extension for an "Experiment" file is *.msa. The "Save" and "Load Experiment" functions do not save or load data, just the combination of instruments.



The "Start Analysis" function will process the complete loaded data file through all analysis instruments. "Explore" will only analyze the segment of data currently visible in the "Raw Data Explorer" instrument.

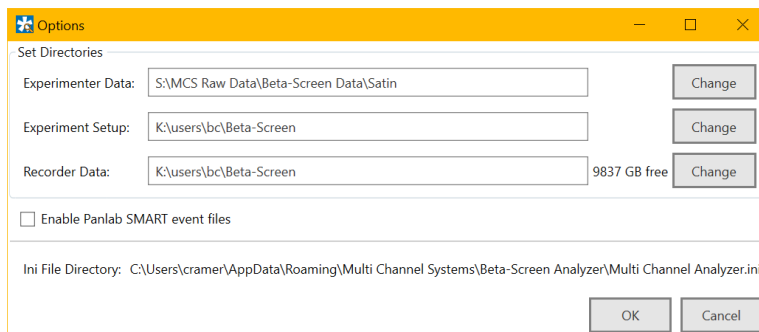
Settings Menu



Click the icon to open the "Settings" menu.

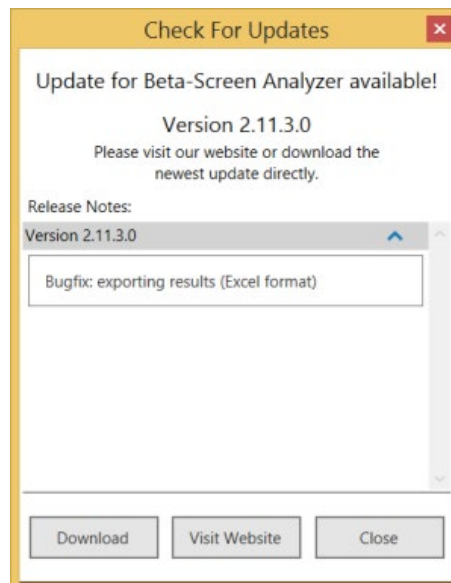
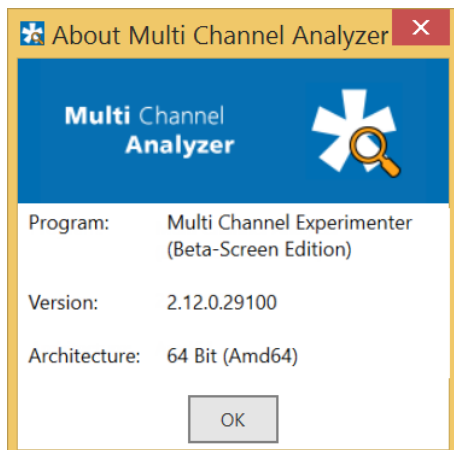
It is possible to delete all instruments currently in the main window with the "Clear Experiment Diagram" command.

The "Settings" allow to change the default source path for the data files to replay, the data files generated by the "Recorder", and the directory where the experiment files are stored.



The "Help" command will open the MEA2100-Beta-Screen manual.

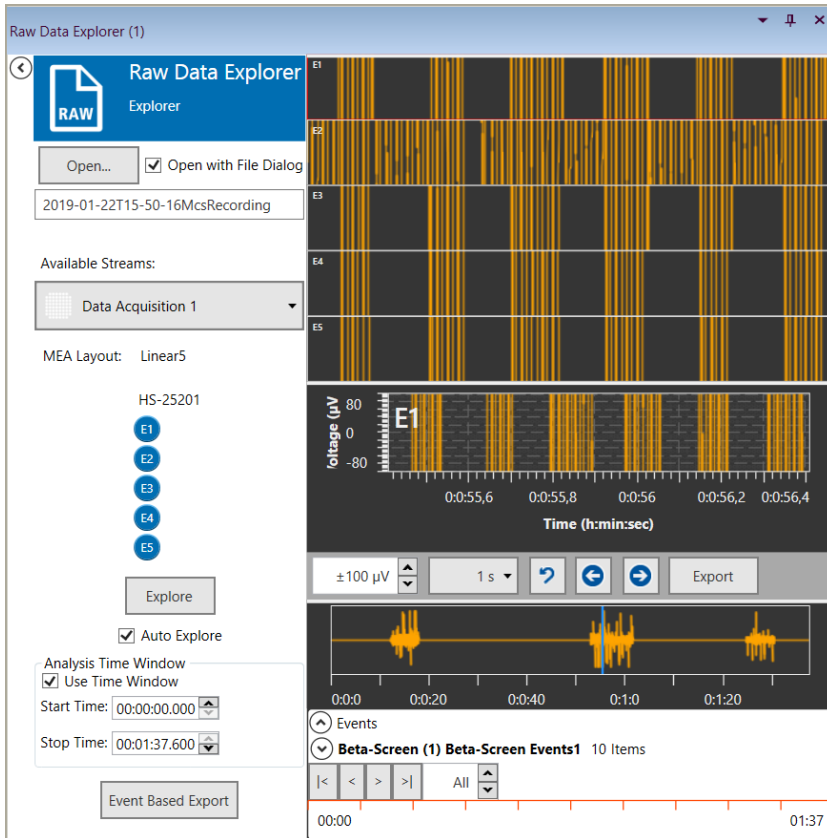
"About" will show the software version.



"Check for Updates" will connect to the MCS web site download section and automatically search for newer versions of the Beta-Screen Analyzer.

6.2.1 Data Source: Raw Data Explorer

Double click the "Raw Data Explorer" button to open the respective tabbed page.

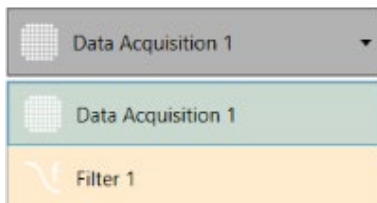


Control Window

Click "Open " to select the file to be analyzed. The name of the file is displayed below the "Open " button.

Available Streams

Available Streams:



Select the data stream which should be displayed in the windows beside from the drop down menu.

MEA Layout

MEA Layout: Linear5

HS-25201

E1
E2
E3
E4
E5

Explore

Auto Explore

Analysis Time Window

Use Time Window

Start Time: 00:00:00.000

Stop Time: 00:01:37.600

Event Based Export

The "MEA-Layout" of the Beta Screen MEA used in that experiment is displayed.

Explore

Click the "Explore" button to send only the fragment of data currently visible in the "Raw Data Explorer" display through the attached analysis instruments. This allows to adjust parameters before proceeding with the analysis of the complete file.

Select the check box "Auto Explore" and the analysis of every new data segment is automatically started, when navigating through the file by arrow keys, slider, or by events.

Analysis Time Window

Please deselect the "Auto Explore" function before activating the check box "Use Time Window". Select the "Start Time" and the "Stop Time" via up down boxes. Click the "Start Analysis" button to analyze the defined time window.

Event based Export

Define the "Method" the events should be exported. Please define the parameter for the export.

Export of "Raw Data around Events" and "Raw Data between Events"

The "Event Based Export" can export raw data in ASCII format based on digital events (Triggers). "Raw Data around Events" will generate a segment of data with selectable length around each event of the selected event channel. "Pre" is the length of data before, and "Post" the length of data after each event.

"Raw Data between Events" will split the raw data at each event of the selected event channel. "Pre" and "Post" time can be added to each data segment. This will lead to overlapping segments of data.

The screenshot shows the 'Export' dialog box with the 'Method' section set to 'Raw Data around Events'. The 'Event' list contains ten entries, all labeled 'Beta-Screen Events 1'. The 'Interval' section has 'Pre' set to 10 ms and 'Post' set to 50 ms. An 'Export' button is located at the bottom left.

Export of "Raw Data between paired Events"

"Raw Data between paired Events" operates with trigger events on two different events. Data segments starting from the first event on "Event 1" to each following event on event channel 2 will be generated, till the time distance between event on channel 1 and event on channel 2 is higher than the selected "Timeout". "Pre" and "Post" time can be added to each data segment. This will lead to overlapping segments of data. Then the same procedure will be repeated for the second event on event channel 1 and so on.

The screenshot shows the 'Export' dialog box with the 'Method' section set to 'Raw Data between paired Events'. The 'Event 1' and 'Event 2' lists each contain ten entries, all labeled 'Beta-Screen Events 1'. The 'Interval' section has 'Pre' set to 10 ms, 'Post' set to 50 ms, and 'Timeout' set to 10 s. An 'Export' button is located at the bottom left.

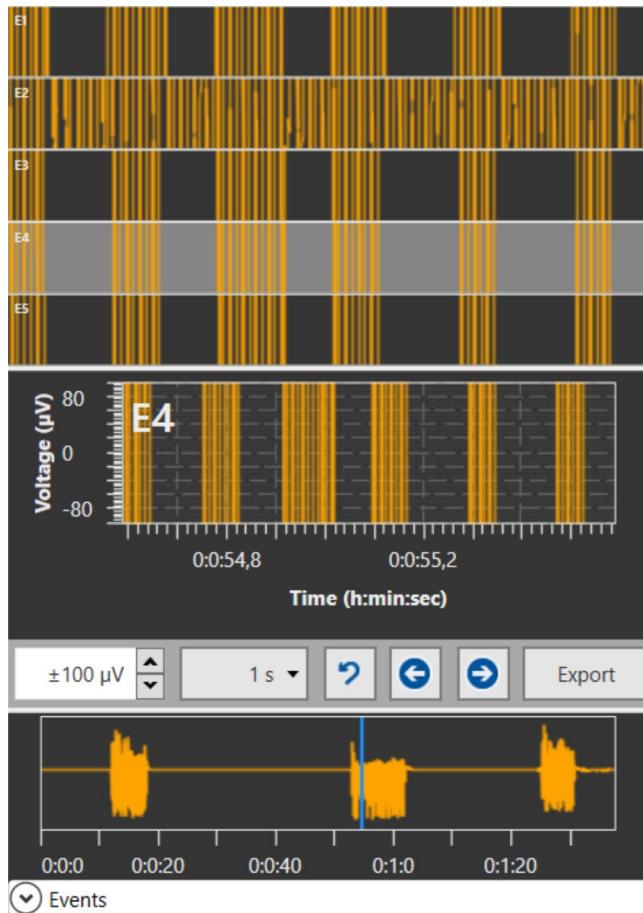
Export of "Event Timestamps"

The screenshot shows the 'Export' dialog box with the 'Method' section set to 'Event Timestamps'. The 'Event' list contains ten entries, all labeled 'Beta-Screen Events 1'. The 'Interval' section has 'Pre' set to 10 ms and 'Post' set to 50 ms. An 'Export' button is located at the bottom left.

In all cases, all segments of ASCII data will be exported to a single file. Segments are separated by empty lines. Event Time stamps will export the time stamps of all events on the selected event channel to an ASCII file.

Data Display Window

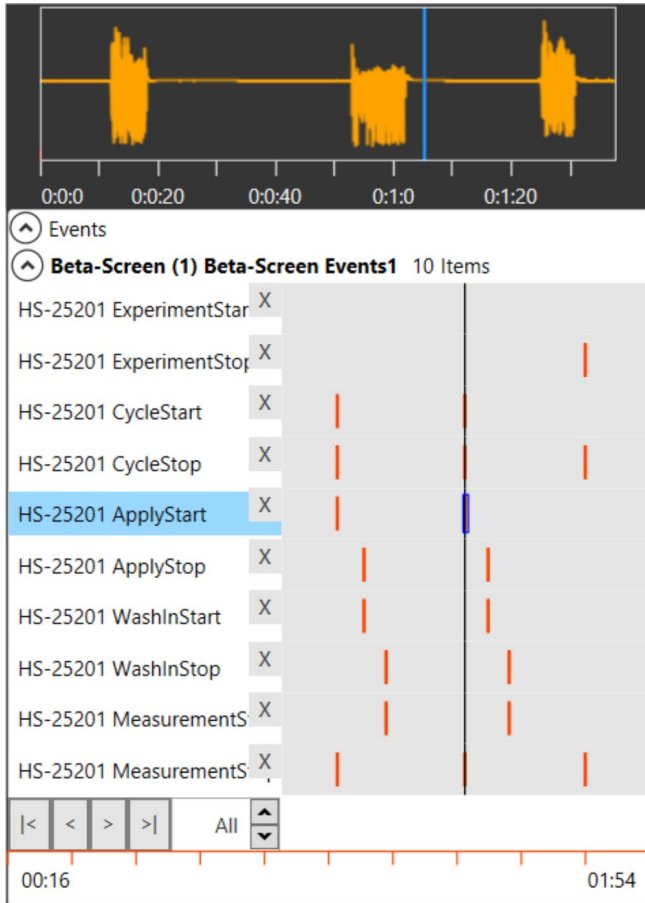
Raw data are displayed in three different windows: The overview of all involved electrodes, the single view of one of these electrodes and the event view.



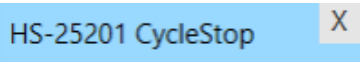
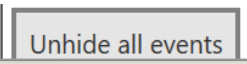
The "Raw Data Explorer" instrument allows to jump back and forth in the respective data file. There are different options to navigate the file. It is possible to go through the file frame by frame with the arrow buttons. Each click will move forward one selected time window. The second option is to use the "Full File" display, which shows the complete length of the loaded file for any one selected channel. A blue slider allows to move to any point in time on that display, the data shown for all channels will jump to that point.

Event Display Window

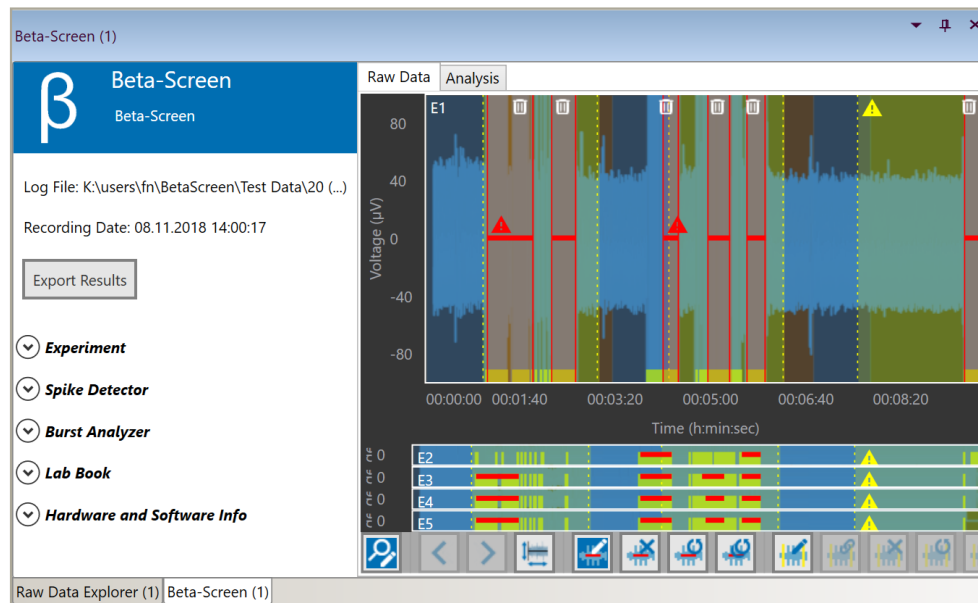
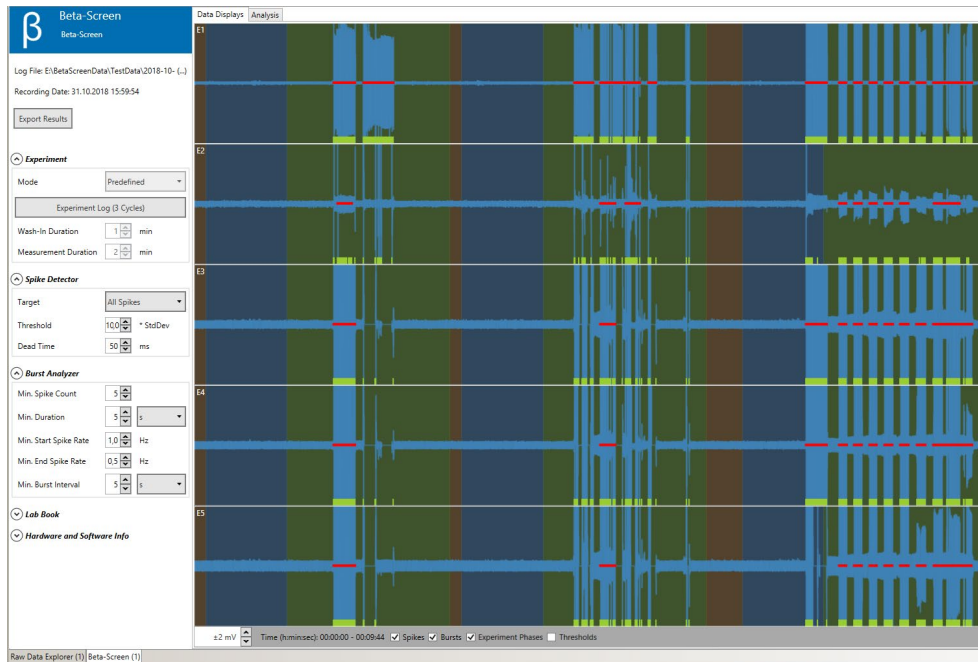
Open the "Event" display by clicking the small icon  Events.



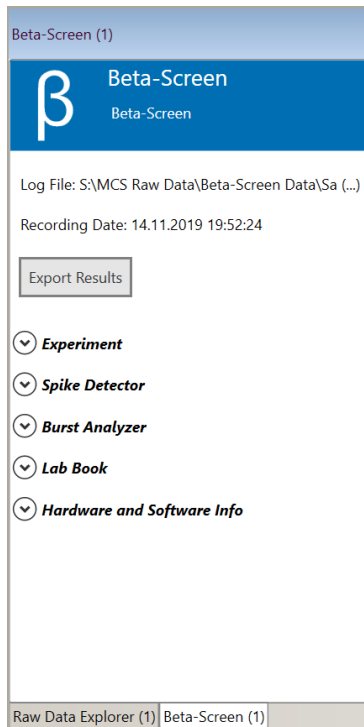
Another option is available for files containing trigger events. These trigger events will be displayed in the event display as red markers. One can either click on any of those trigger markers to move the whole file to that point or jump from one trigger to the next using the arrow buttons. A black slider in the digital event display marks the current position of the data display in relation to the digital events. This slider cannot be moved actively.

See the list of events one below the other. Click the icon  to hide events from the list. Click this button  to make them visible again.

6.3 Instrument: Beta Screen



6.3.1 Control View



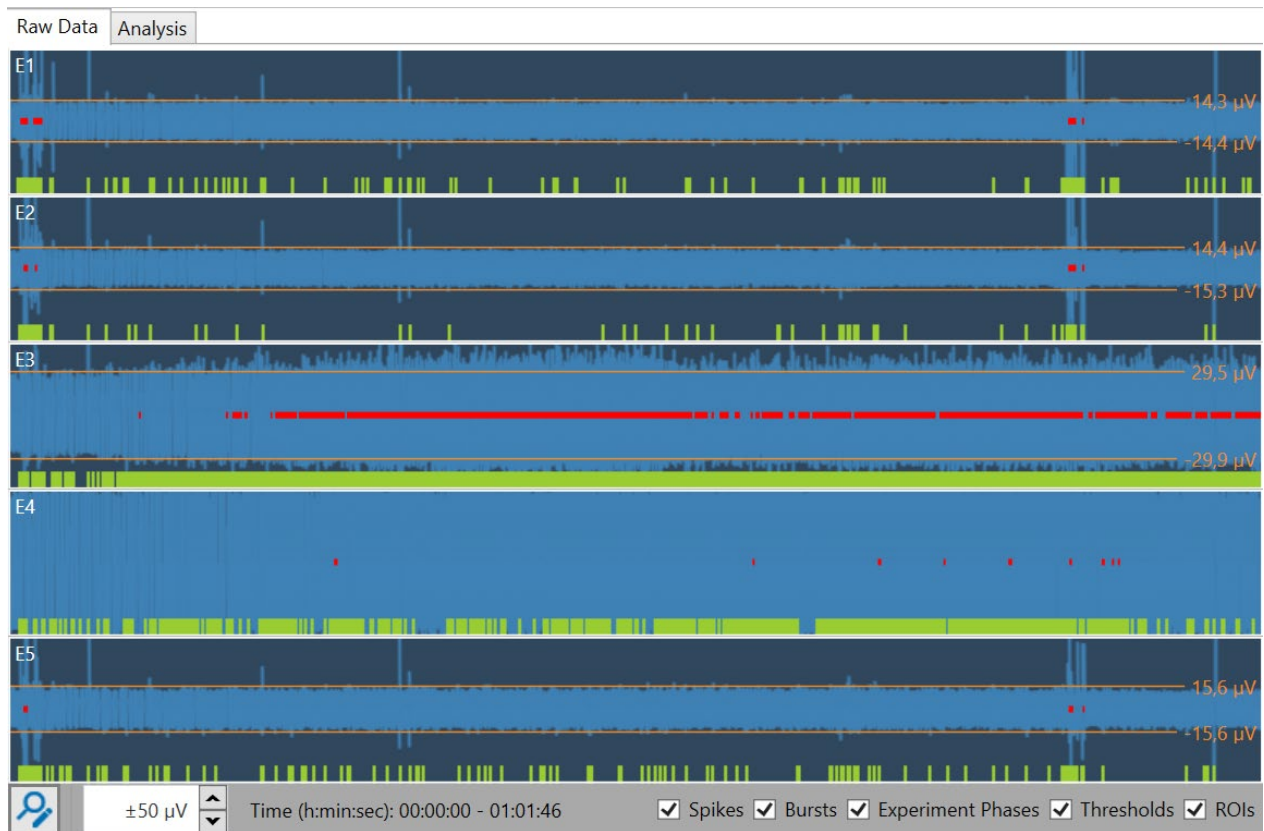
Read information about the experimental file to be analyzed. This information is displayed after loading a file and clicking "Explore" or "Start Analysis".

Apart from the ability to configure and control experiments, the "Beta Screen" instrument in the "Beta Screen Analyzer" software has the same functionality as in the "Beta Screen Experimenter".

Please refer to the respective chapters 5.5 and 5.6 [Instrument Beta-Screen](#) in this manual for information about settings in "Experiment", "Spike Detector", "Burst Analyzer", "Lab Book" and "Hardware and Software Info".

6.3.2 Beta-Screen Display

Tabbed Page: Raw Data



Please click "Explore" or "Start Analysis" to run the designated file.















The toolbar in the footer of the display allows to vary the voltage range in the y-axis via up down box. The "Time" is displayed in the x-axis.

To view or to hide "Spikes", "Bursts", "Experiment Phases", "Thresholds" or "ROIs" in the "Raw Data" display, click the respective check boxes in the footer.

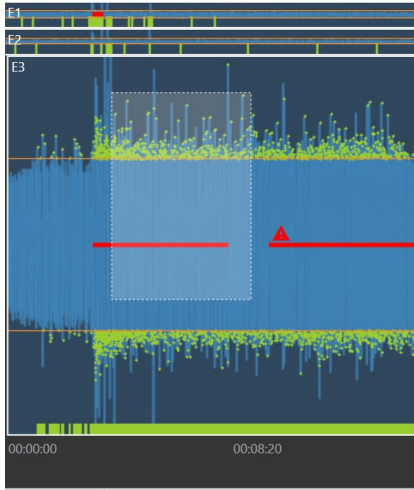
Click the button on the left  "Enable Zoom and Burst/ROI Editor". Now you can see the complete toolbar.




Table: From left of the toolbar to the right

	Enable Zoom and Burst/ROI Editor.
	Arrow buttons to move zoom cutout back and forth.
	Reset axes.
	Enable burst editor.
	Clear bursts for selected electrode.
	Restore bursts for selected electrode.
	Restore bursts for all electrodes.
	Enable ROI editor.
	ROIs are linked / duplicated for all electrodes, click to deactivate.
	Clear ROIs for selected electrode.
	Restore ROIs for selected electrode.
	Restore ROIs for all electrodes.
	Recalculate ROI and burst based statistics.
 ROIs	Activate the check boxes to display "Spikes", "Bursts", "Experiment Phases", "Thresholds" and "ROIs". Deactivate the check boxes to hide them.

Display Zooming




Important: Press button  "Enable Zoom and Burst/ROI Editor" first or double click on any electrode raw data display.

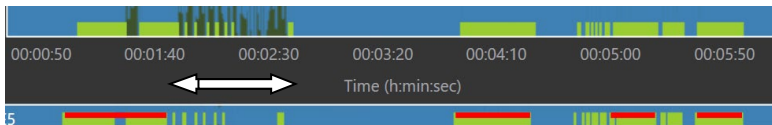
Then draw a rectangle with the left mouse button into any region of the display to zoom in.



Use the arrows buttons in the toolbar of the footer to move a zoom cutout back and forth. Double click to zoom out again.

Double click on any non zoomed display to toggle between zoomed channels. Double click on the currently zoomed display or press button  to zoom out and stop zooming or editing.

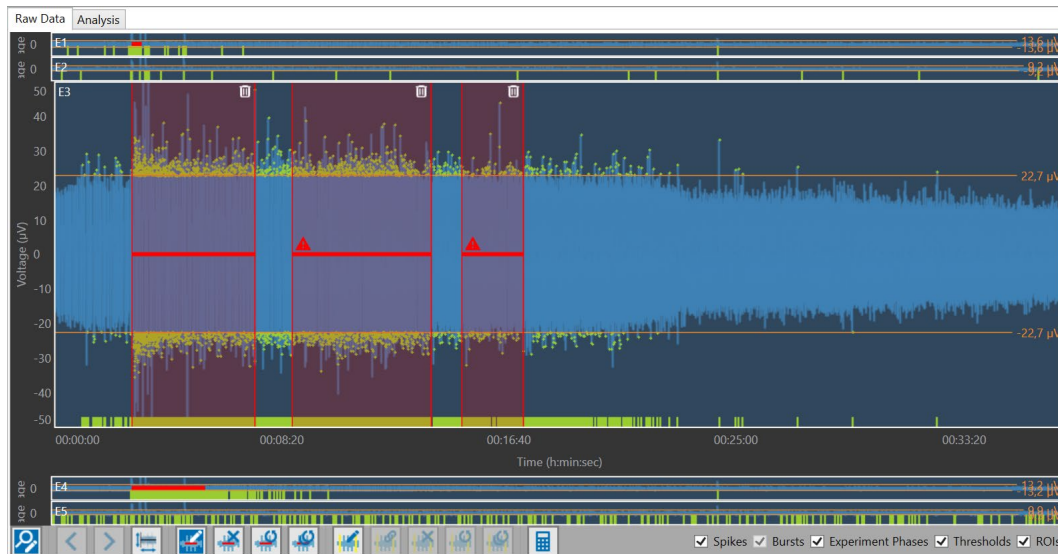
Move and Zoom the Axes



Click with the left mouse button onto the x- and y-axes and a white double arrow appears.

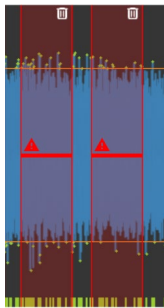
To move the axis, keep the left mouse button pressed and move the mouse pointer, or simply use the mouse wheel. To zoom the visible axis range, keep the "Control" key pressed while performing the before mentioned mouse commands.

Burst Editor



Click the button „Enable Burst Editor“ first.


If the check box “Bursts” is not activated, the software will activate it automatically. Bursts are color coded in red, the area of the bursts is boarded with two red lines and transparent red color in between. It is possible that bursts overlap each other. Overlapping bursts will be merged by the software when recalculating results.



Use the “Waste Bin” icon to delete a burst region from the display. To add a new burst, draw a rectangle with the left mouse button into the display at the desired position.

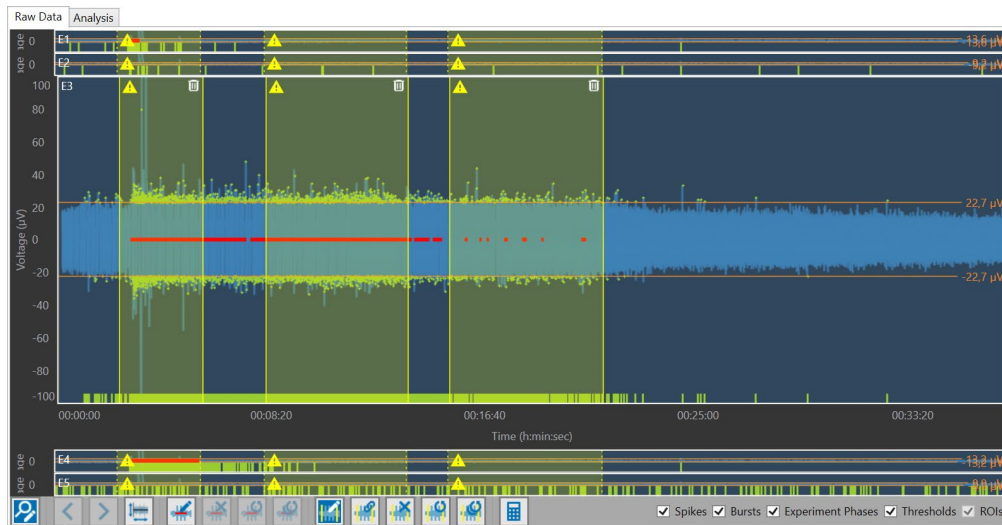
Modify any existing burst marker's duration by moving the respective border lines, using the left mouse button.

Move a complete burst marker without changing its duration, using the left mouse button anywhere in the transparent red area. Restore default burst markers by clicking the respective toolbar button.

The red “Warning Signal”  indicates, that this burst is manipulated manually: Maybe the borders of the burst are modified or the complete burst is created by the user.

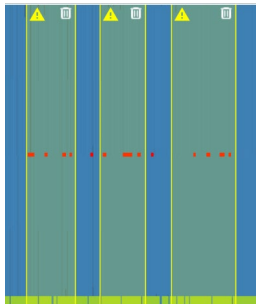
Note: Burst modifications in the raw data display will not automatically have an effect on the subsequent analysis. For the changes to be effective, please click the “Recalculate” button.

ROI Editor



Click the button „Enable ROI Editor“ first.


If the check box “ROIs” is not activated, the software will activate it automatically. ROIs are color coded in yellow, the area of the ROIs is boarded with two yellow lines and transparent yellow color in between. It is possible that ROIs overlap each other. Overlapping ROIs will be merged by the software when recalculating results.



Use the “Waste Bin” icon to delete a ROI region from the display. To add a new ROI, draw a rectangle with the left mouse button into the display at the desired position.

Modify any existing ROI marker's duration by moving the respective border lines, using the left mouse button.

Move a complete ROI marker without changing its duration, using the left mouse button anywhere in the transparent yellow area. Restore default ROI markers by clicking the respective toolbar button.

The yellow “Warning Signal”  indicates, that this ROI is manipulated manually: Maybe the borders of the ROI are modified or the complete ROI is created by the user.

Note: ROI modifications in the raw data display will not automatically have an effect on the subsequent analysis. For the changes to be effective, please click the “Recalculate” button.

Linking ROIs

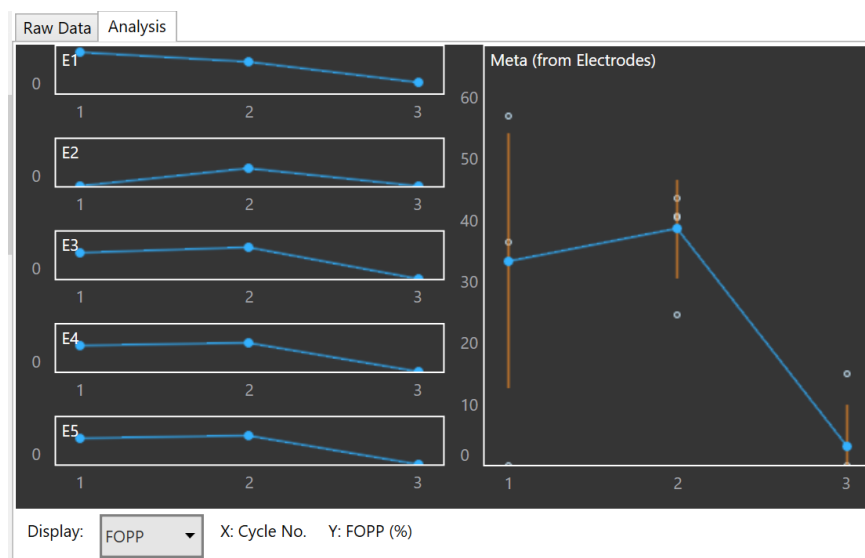


These buttons “ROIs are linked / duplicated for all electrodes, click to deactivate” can be used for a transfer from one adjustment of a ROI of one electrode to all electrodes. Disable the link between all electrodes to adjust the ROIs of each electrode separately.

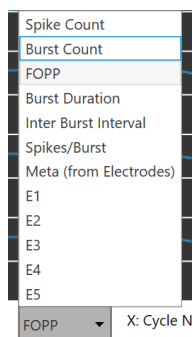
Recalculation of ROI and Burst based Statistics

After ROI or burst modifications are finished, in order to recalculate ROI and burst based statistical evaluation on the "Analysis" tabbed page and in the results structure that can be exported, please click the respective toolbar button.

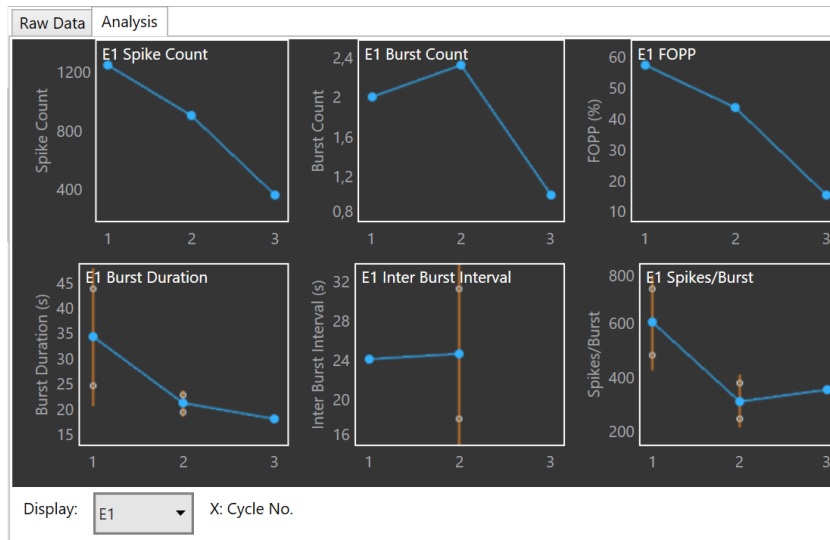
Tabbed Page Analysis



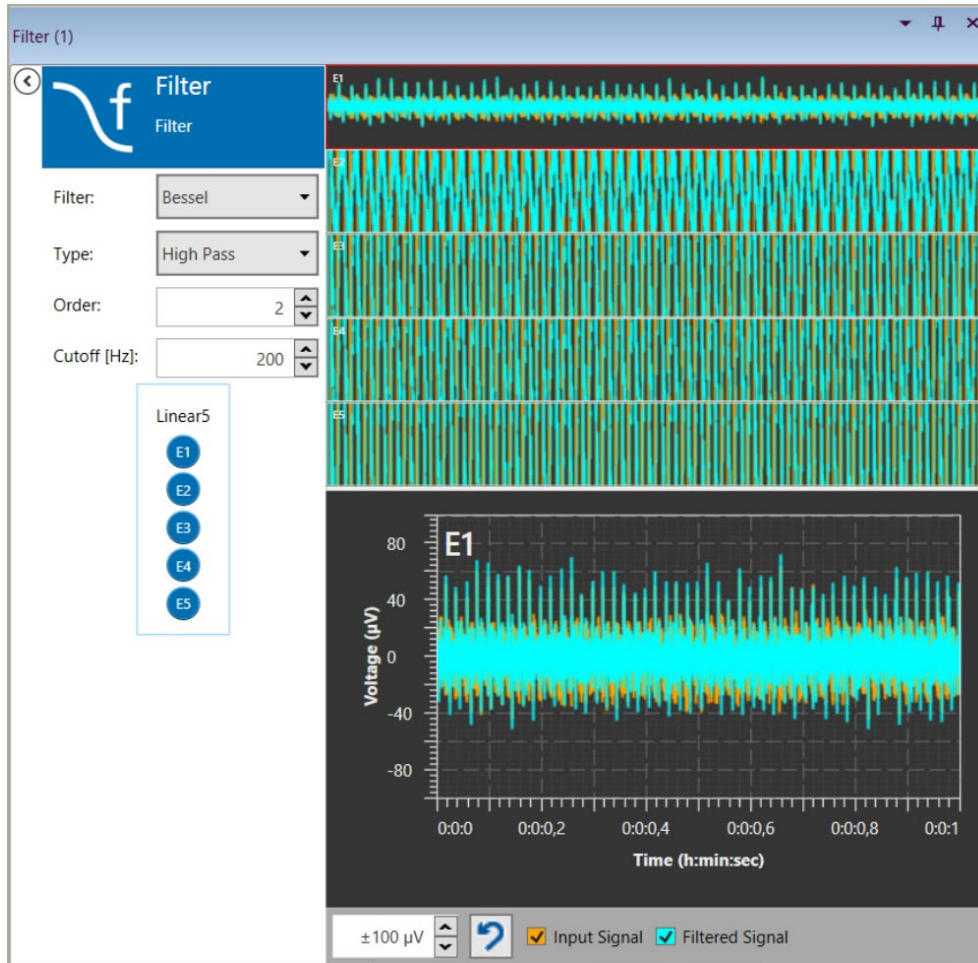
Select the display presentation from the “Display” drop down menu. Additionally, different parameters belonging to the selected parameter which is displayed are shown, for example, the number of the cycle in the experiment “X: Cycle No.”.



For Example: Electrode E1



6.4 Instrument: Filter



The “Filter” instrument in the “Beta Screen Analyzer” software has the same functionality as in the “Beta Screen Experimenter”. Please refer to chapter 5.7 [Instrument: Filter](#)

7 Service and Maintenance

Cleaning the Connector



Warning: Please be very careful when handling the headstage or cleaning the device!

You should clean the connectors of the MEA2100-Beta-Screen headstage carefully with a soft tissue and alcohol from time to time, especially if you have problems with the noise level. Clean the tube entrances with a cotton swab. The Beta-Screen MEA should be used as consumable.

www.multichannelsystems.com.

Cleaning of the System

Always unplug the MEA2100-Beta-Screen-System prior to cleaning. To clean the exterior surfaces, use a lint-free cloth to remove loose dust. For more efficient cleaning, use a soft cloth dampened (not soaked) with an aqueous solution of 75 % isopropyl alcohol, or a mild detergent.

Sterilization

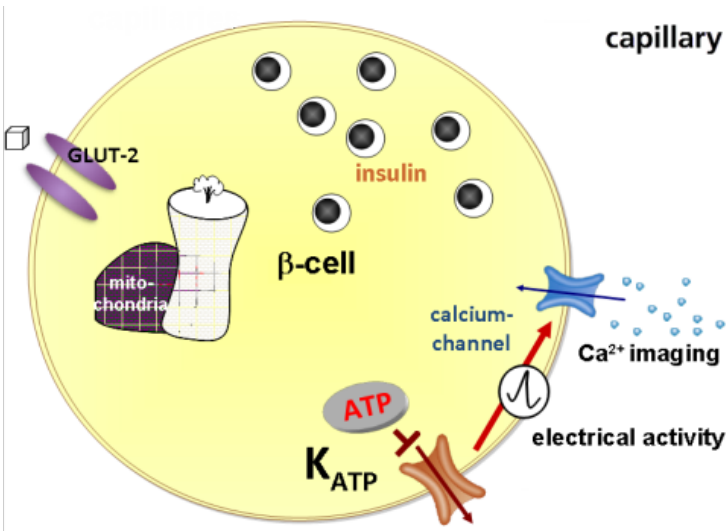


Warning: Do not autoclave or sterilize The MEA2100-Beta-Screen headstage by high heat (above 70 °C) or vapor. Vapor can lead to a corrosion of the electronics.

MEA2100-Beta-Screen headstages can be sterilized with standard methods that are not based on high heat or vapor, for example, with 70 % ethanol, UV-light, or by thermal sterilization in an oven at 56 °C with an incubation time of 8 hours.

8 Theoretical Background

Diabetes Type 2



Diabetes type 2

About 90 % of diabetes mellitus patients have diabetes type 2. This type of diabetes is developed over a long time span and often in the second half of life. The patient demonstrates a combination from resistant against insulin and a disturbance of insulin release, which normally is a process over a long time.

The hormone insulin is produced in the beta cells of the Langerhans islets of the pancreas. Beta cells release insulin into the blood to reduce the level of blood sugar. The alpha cells of the Langerhans islets produce the hormone glucagon which is an insulin antagonist and increases the level of blood sugar.

The increase of the amount of glucose in the blood circulation is the trigger for the beta cells to spill out insulin and the blood sugar decreases.

9 Appendix Technical Specifications

MEA2100-Beta-Screen-System



Warning: The device may only be used together with microelectrode arrays (MEAs) from Multi Channel Systems MCS GmbH and only for the specified purpose. Damage of the device and even fatal injuries can result from improper use. Do not open the headstage, the signal collector unit or the interface board and do not change hardware configuration as it could lead to improper behavior of the system.

General Characteristics

Operating temperature	10 °C to 50 °C
Storage temperature	0 °C to 50 °C
Humidity	10 % to 95 %, non-condensing

Headstage

Dimensions (W x D x H)	125 mm x 100 mm x 22 mm
Weight with cable, without MEA chamber	444 g
Weight with cable and MEA chamber	484 g
Cable length	3 m
Type of headstage	MEA2100-Beta-Screen headstage MEA2100-Mini headstage, suitable for incubator

Integrated Amplifier

Number of analog recording channels	5
Data resolution	24 bit
Signal input voltage range	± 70 mV
Bandwidth	DC to 10 kHz, software controlled
Sampling frequency per channel	up to 50 kHz, software controlled
Input impedance	450 MΩ 10 pF

Integrated Stimulus Generators

Not in Use in MEA2100-Beta-Screen-Systems!

Output current	± 1.5 mA
Current output compliance voltage	± 16 V
Output voltage	± 10 V
Voltage output compliance current	± 20 mA
Stimulation pattern	Almost arbitrary patterns
Number of stimulation channels	2 independent stimulation patterns per 60 channels
Resolution	16 bit

Integrated Heating Element

Temperature sensor type	Resistive sensor
Accuracy	± 0.1 °C

Signal Collector Unit SCU

up to 2 SCUs can be connected to 1 IFB-C

Dimensions (W x D x H)	250 mm x 83 mm x 25 mm
Weight	300 g
Front Panel	
4 Inputs for headstages (HS1 to HS 4)	Lemo connector, EPG.0B.307.HLN
1 Connector with 4 analog outputs for LED driver	Lemo connector, EPG.0B.304.HLN
Voltage output of each analog output	0 - 5 V
Rear Panel	
Signal Collector Unit to Interface Board connector	iX-B cable
Ground	Common jack 4 mm, banana plug

IFB-C Interface Board

Dimensions (W x D x H)	250 mm x 83 mm x 25 mm
Weight	300 g
Front Panel	
2 Sync In and Sync Out	Lemo connector, EPL.00.250 NTN
1 8-Channel Analog IN	10-pin connector, DIL10Header-100mil
2 Analog Inputs, Channel 1 and Channel 2	Lemo connector, EPL.00.250 NTN
Signal input range for analog channels	± 10 V voltage input range @ 24 bit ADC
Gain for analog channels	2
2 Control LEDs	LED light is on, while link to SCU is working
4 Digital inputs	Lemo connector, EPL.00.250 NTN
4 Digital outputs	Lemo connector, EPL.00.250 NTN
Ground	Common jack 4 mm, banana plug
Rear Panel	
Switch I/O	Switch On / Off
Power supply	MPU 30, scope of delivery, PWR DC 0.65 x 2.75 mm
Ground	Common jack 4 mm, banana plug
1 16 bit Digital In / Out	68-pin connector Honda-PCS-XE68LFD
2 Auxiliary channels	Not in use!
1 Audio Output	Stereo jack 3.5 mm Not in use for Beta-Screen!
1 Digital Signal Processor DSP connector	14-pin connector, DIL14Header-100mil-angeled Not in use for Beta-Screen!
2 Interface board to headstage connectors	iX industrial, type B connectors
2 USB-C ports	USB-C cable

Power supply unit (MPU 30)

Voltage range	100 - 240 VAC
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Output voltage	24 VDC
Frequency	50 – 60 Hz
Max. Power	60 W

Mark of conformity

CE

European standards

EN61010-1

Software

Operating system

Microsoft Windows® 10, 8.1, 32 or 64 bit,
English and German version supported

Data acquisition and analysis software

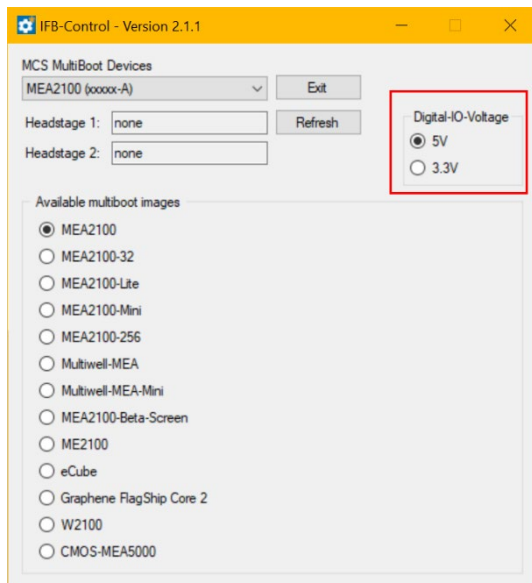
Beta-Screen Experimenter
Beta Screen Analyzer

Version 2.12.0 and higher
Version 2.12.0 and higher

Data export software
Multi Channel DataManager

Version 1.10.1 and higher HDF5 (Matlab, Python),
NEX (NeuroExplorer), CED (Spike2), ASCII

9.1 IFB-Control Software



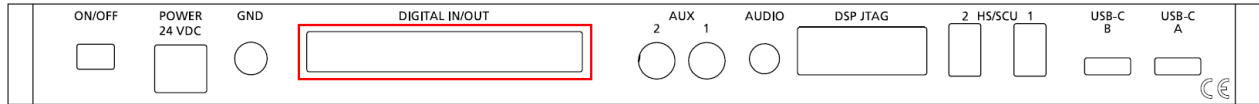
Software to control the MCS multiboot devices: Select the connected device and the headstages in the “MCS Multiboot Devices” window from the drop down menu. Toggle between 5 V to 3.3 V in “Digital I/O Voltage”.

Switch between system firmware available on the multiboot interface board IFB-C in “Available multiboot images” window.

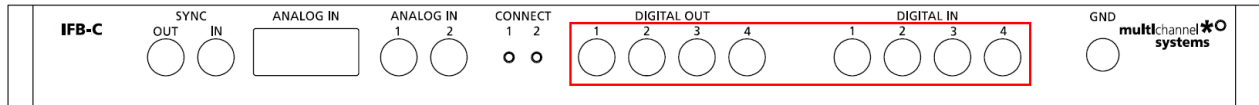
9.2 Pin Layout

Interface Board IFB-C

Pin Layout Interface Board (Rear Panel): Digital IN / OUT Connector

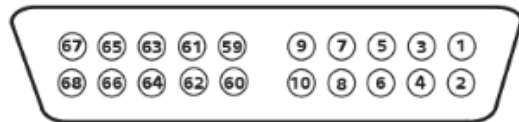


Interface Board (Front Panel): Separate Digital IN / OUT Lemo Connectors



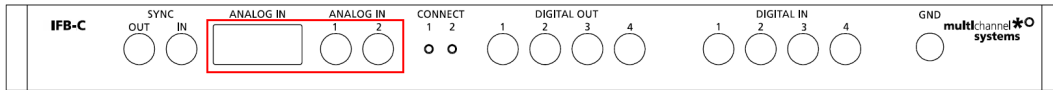
Bit 0 to 3 of the Digital OUT are separated and available as Lemo connector DIG OUT 0 to 3 on the front panel of the interface board.

68-Pin Connector Honda-PCS-XE68LFD



Pin 1	GND
Pin 2	GND
Pin 3 - 10	Digital output channels bit 0 - 7
Pin 11 - 14	GND
Pin 15 - 22	Digital output channels bit 8 - 15
Pin 23 - 26	GND
Pin 27 - 34	Digital input channels bit 0 - 7
Pin 35 - 38	GND
Pin 39 - 46	Digital input channels bit 8 - 15
Pin 47 - 48	GND
Pin 49 - 63	Internal use (do not connect)
Pin 64 - 66	GND
Pin 67	Positive supply voltage output +3.3 V
Pin 68	GND

Pin Layout Interface Board: Analog IN Connector



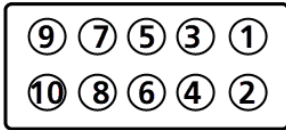
Two of the eight analog channels are additionally separate available via Lemo Connectors

Analog IN 1, Channel 1, Pin 3

Analog IN 2, Channel 2, Pin 4

The gain factor for amplification of all analog channels is 2.

MEA2100 Interface Board: 10-Pin Connector (Analog IN)



10-Pin Connector for Analog IN and Ground 10-Pin Analog Connector Analog IN

Pin 1	GND
Pin 2	GND
Pin 3	Analog channel 1
Pin 4	Analog channel 2
Pin 5	Analog channel 3
Pin 6	Analog channel 4
Pin 7	Analog channel 5
Pin 8	Analog channel 6
Pin 9	Analog channel 7
Pin 10	Analog channel 8

10 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 MCS web site.

www.multichannelsystems.com