



## MEA2100-Mini-System Manual



## Impprint

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Printed: 16.08.2021

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# 1 Welcome to the MEA2100-Mini-System



The MEA2100-Mini-System is a miniaturized *in-vitro* recording system. The state of the art power saving electronics allows to benefit from almost all advantages of the MEA2100 platform and still be able to operate the system continuously in the incubator. Headstages have 60 or 120 recording channels and integrated stimulators. Amplifier, stimulators, and A/D converters are all directly on the headstage for low-noise, high quality data acquisition.

The system consists of a signal collector unit SCU for up to four MEA2100-Mini headstages. The SCU also contains a connector for up to four outputs for optical LED stimulation. The signal collector is connected via iX cable to the interface board IFB-C multiboot. It is possible to connect up to two signal collector units to one IFB-C interface board, so a MEA2100-Mini-2-System with two SCUs can operate up to eight headstages simultaneously.

Data is recorded, analyzed, graphed, and reviewed with the powerful and easy-to-use Multi Channel Suite program from Multi Channel Systems MCS GmbH. The control functions of the internal stimulator are also integrated into the software. The data format can be converted in other standard formats with integrated software tools.

The modular nature of the system allows an easy upscaling of the MEA-Mini-System.

## 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 Headstage MEA2100-Mini



The first element of the MEA2100-Mini-System is the headstage with small footprint and operable in a humid incubator. The MEA2100-Mini headstage is available with 60 or 120 channels and can be **ordered** with a cable length of 3 m.

The data acquisition integrated in the headstage supports 60 or 120 electrode channels. Sampling rate, signal range and bandwidth are adjusted via software control and are suitable for a broad range of applications, from single unit spike recordings to field potentials from whole heart preparations.

Amplifier, stimulators, and A/D converters are all directly on the headstage, which allow low-noise, high-quality data acquisition. Two stimulus generator units are also integrated in each headstage, which are able to independently deliver monophasic or biphasic rectangular pulses, ramps, sine waves or random waveforms as single pulses or pulse trains. You can choose between current and voltage driven stimulation and you can select each electrode for stimulation within the software. An integrated blanking circuit (BC) disconnects the electrodes from the amplifiers during the stimulation and reduces stimulus artifacts.

The cable of the MEA2100-Mini headstage connects to the signal collector unit SCU, please read next chapter "Signal Collector Unit SCU".

Up to four MEA2100-Mini headstages can be operated with one SCU and up to two signal collector units can be connected to one interface board IFB-C multiboot. Hence, in total a system can record from up to 480 electrodes (8 individual 60-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 with an iX cable.



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

## 3.2 Signal Collector Unit SCU



The second element of the MEA2100-Mini-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 [Multi Channel Experimenter](#) software.

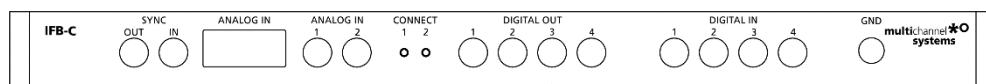
The signal collector unit and the interface board are connected with an iX cable, type B. Up to two SCU devices can be connected to one IFB-C multiboot interface board.

## 3.3 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.

### 3.3.1 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

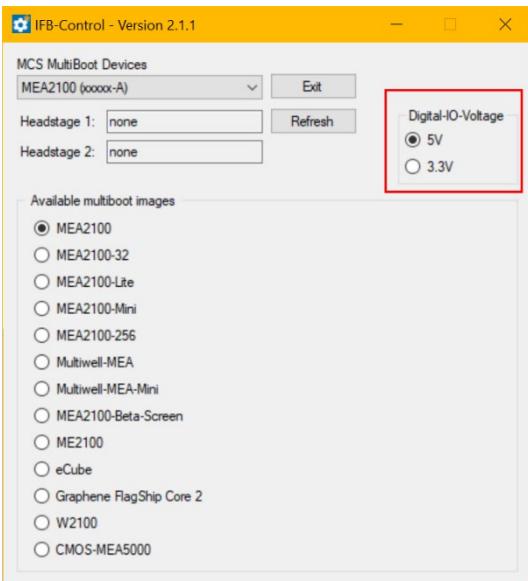
Two of these eight analog channels (Analog In No 1 and No 2) are separately available via Lemo connectors on the front panel of the interface board IFB-C.

## Two Status LEDs

The status LEDs indicate the link status of the headstages HS 1 and / or HS 2. They light up when one or both headstage is connected to the IFB-C interface board via iX-industrial cable, type B.

## 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 levels with the software IFB-Control, please read chapter "IFB-Control" in the Appendix.

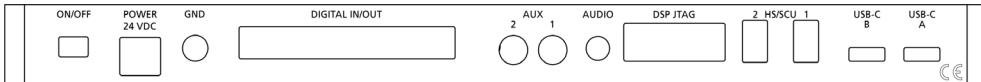


If access to more bits of the DIG IN / OUT channel is required, it is necessary to connect a Digital IN / OUT extension [Di/o board](#) with a 68-pin standard cable. This Di/o board is available as an optional accessory.

## Ground

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

### 3.3.2 Rear Panel



From left to the right:

#### Toggle Switch On / Off

Toggle switch for turning the device on and off. The MEA2100-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-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 interface board IFB-C and the headstage of the MEA2100-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 68-pin 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 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-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, please read chapter "Digital Signal Processor" below.

## **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).

## **JTAG Connector**

The JTAG connector has access to the digital signal processor DSP for real-time feedback. Please read chapter "Digital Signal Processor" below.

## **HS / SCU**

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

## **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 input 1, and connector B with iX 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 MEA2100-System.

## 4 Software Multi Channel Suite

The Multi Channel Suite software, which is needed to operate the MEA2100-Mini-System, is provided on a CD with the system. However, the latest version is always available for free [download](#) from the MCS web site. Please check for updates on a regular basis to get all the latest features and bugfixes. The Multi Channel Suite consists of three individual programs:

1. The Multi Channel Experimenter is the online data acquisition software.
2. The Multi Channel Analyzer is for offline analysis of data generated with the Multi Channel Experimenter.
3. The Multi Channel DataManager allows to export Multi Channel Experimenter data to 3rd party file formats.

### 4.1 Software Installation

For installation, download the respective \*.exe files and follow the instructions on the screen.

The screenshot shows a navigation bar with links for Products, Downloads, Service, News, Contact, and Sales. Below the navigation bar, the URL is Home > Downloads > Software. The main title is "Software Download". A sub-section title "Software Download" is shown. A note says "For older versions of our software please contact our support." There is a search bar with a "Reset" button. A "Filter" section includes buttons for In vitro / In vivo Systems, Multi Channel Suite, MC\_Rack, Cardio2D, LTP-Director, Multowell-Screen, CMOS-MEA-Control, Xenopus Oocyte Products, Roboject, Roboocyté, HiClamp, and Control Tools. A "Sort by" dropdown is set to "Name". Below these are three software entries:

Icon	Name	Version	Release Date	Action
Multi Channel Analyzer	Multi Channel Analyzer	V 2.7.3	2017-12-12	<a href="#">Download</a>
Multi Channel DataManager	Multi Channel DataManager	V 1.9.8	2017-12-08	<a href="#">Download</a>
Multi Channel Experimenter	Multi Channel Experimenter	V 2.7.3	2017-12-12	<a href="#">Download</a>

At the bottom, there is a link for "Multi Channel VideoControl" with version V 2.0.3 and release date 2017-07-11, with a "Download" link.

### System Requirements

For the Multi Channel Suite software, Microsoft Windows ® 10 or 8.1 operating systems are required. English and German versions supported. Other language versions may lead to software errors.

A computer with low performance may lead to performance limits more often; therefore, MCS recommends an up-to-date computer optionally with a separate hard disk.

Please note that there are sometimes hardware incompatibilities of the MEA2100-Mini-System and computer components; or that an inappropriate computer power supply may lead to artifact signals. Please contact your local retailer for more information on recommended computer hardware.

**Important:** You need to have installed the latest MEA2100-Mini-System driver to operate the MEA2100-Mini-System, which is automatically installed with the data acquisition software. The installation may be invalid if the MEA2100-Mini-System does not respond. Please contact Multi Channel Systems or your local retailer in this case.

## **Recommended BIOS 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 the data acquisition software. These routines were designed for use on office computers, but are not very useful for a data acquisition computer.

- Turn off Screen Saver.
- Turn off manual management of automatic Windows Update.
- Power Options: Power scheme: 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.
- Be careful when using a Virus Scanner.

These programs are known to disturb the software and even data loss may occur. When using a MEA2100-Mini-System, it is recommended to connect a high performance computer with a separate hard disk for program files and data storage. The provided possibility to use up to 480 channels with up to 50 kHz needs high memory capacity, therefore a SSD hard drive is recommended. Please remove data and defragment the hard disk regularly to ensure optimal performance.

### **4.1.1 Multi Channel Experimenter**

Open the Multi Channel Experimenter software. The Multi Channel Experimenter is the online data acquisition software of the Multi Channel Suite package. Please read also the [Multi Channel Experimenter](#) manual.

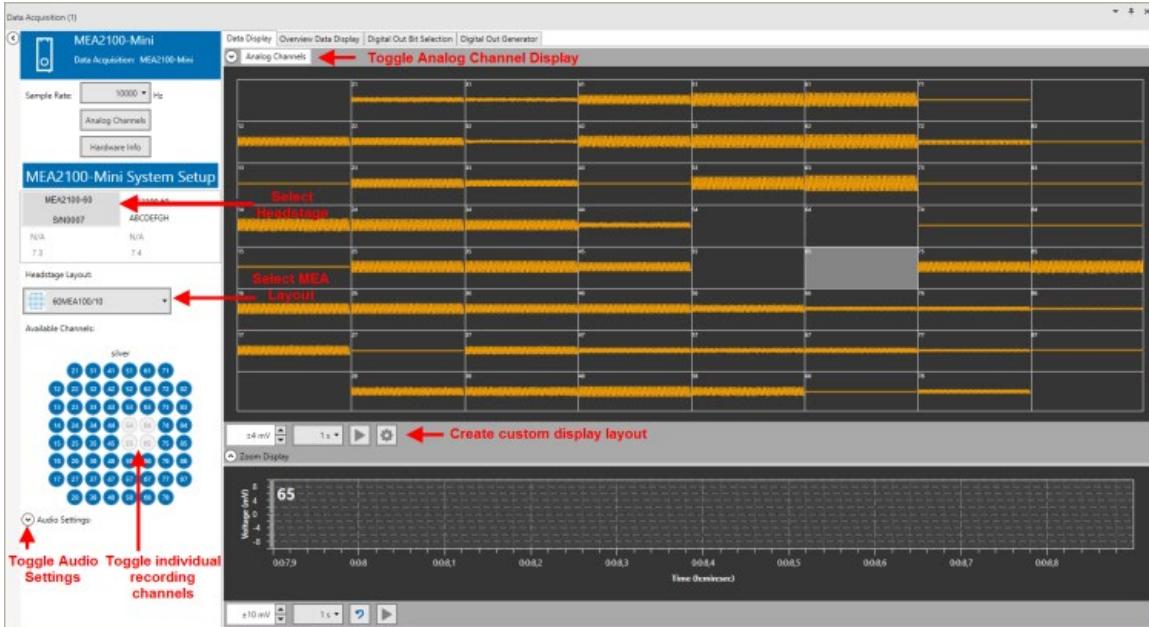


The software supports the MEA2100-Mini-System in all available headstage variations. One signal collector unit SCU with all attached headstages is always operated independently by one instance of the software. The icon indicates which SCU it represents. 1 and 2 indicate the signal collector unit connected to port 1 or 2 of the interface board. Once the MEA2100-Mini-System is added to the instrument configuration, the MEA2100-Mini stimulator and the SCU stimulator will also become available as instruments.



The MEA2100-Mini-System has three output ports: Electrode Raw Data (blue), Analog Data (green) and Digital Data (red). MEA2100-Mini data sources have no input ports. The MEA2100-Mini-System can be connected directly with any number of other instruments with blue or red input ports. The green port can only be connected to the "Recorder" at the moment. There are no export options.

Drag the MEA2100-Mini data source icon into the main window and double click it to open the control window.

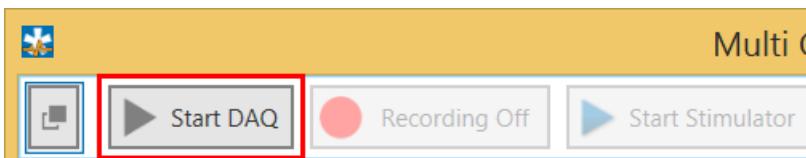


The MEA2100-Mini data source control window shows all available data channels for all connected headstages, and optionally also the additional analog input channels from the interface board. One headstage is visible at a time. All headstages are shown with their serial number. Click on the headstage to see the respective data. This has no influence on recording, all active channels from all active headstages will be recorded, independently from the display.

The MEA layout, the settings for the MEA2100-Mini stimulator and other instruments connected to the data source depend on the currently selected headstage. All settings apply only to the selected headstage, which makes individual changes per headstage possible, and allows the independent control of the stimulators in each headstage. For example, a filter connected to the MEA2100-Mini data source can have different filter settings for each headstage. To adjust them, select the respective headstage and the individual settings will be shown in the filter tool. The same applies to the MEA2100-Mini stimulator. The stimulation paradigm can be different for each headstage, changes only apply to the stimulator of the currently selected headstage.

## Start the Test

Insert the provided “Test Model Probe” and click the “Start DAQ” button in the main menu.



The control window shows the raw data for all channels of the currently selected data source. Click on any channel to see it magnified in the zoom display below. You should see a noise level of approximately 20 µV peak to peak on all channels. In case of 50 Hz noise, shield the “Test Model Probe” with a piece of aluminum foil connected to the ground connector on the interface board. Repeat the procedure with all attached headstages.

## 5 System Setup

### 5.1 Connecting the Hardware Components

The setup of the MEA2100-Mini-System is very simple. Familiarize yourself with the components as described in the chapters above, then go through the step-by-step setup instruction below.



- Provide a power supply in the immediate vicinity of the installation site.
- Place all devices on a stable and dry surface, where the air can circulate freely, and the devices are not exposed to direct sunlight.
- Set up the computer with installed data acquisition program.
- Install the software from the installation volume if it is not already installed. The MEA2100-Mini-System is a plug and play device. The driver is automatically installed together with the data acquisition program. Connect the headstage/s via the provided cable/s to the signal collector unit SCU. The Lemo connector of the cable is not symmetrically and has a red dot as a marker.

The red dot on the Lemo connector must face upwards. Do not twist the Lemo connector in the socket. Do not mistake the headstage inputs (HS1 to HS4) with the Opto Stim output.

- If the headstages are operated in the incubator, route the cables through the access port available in the back of most incubators. Do not route the cables through the rubber seal of the front door. The SCU und the IFB-C must remain outside the incubator.
- Connect the signal collector unit SCU via the iX cable, type B 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!

- Connect one or both USB-C ports of the interface board to a free USB 3.0 port of the data proceeding acquisition computer. Connector A corresponds to iX input 1 on the back panel, and connector B to the iX input 2. If both iX inputs are used, also both USB connections must be used. 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.

Connect the interface board IFB-C via the power supply unit to a power outlet. For optimal grounding, connect the IFB-C interface board, all periphery devices and the computer to the same power outlet.

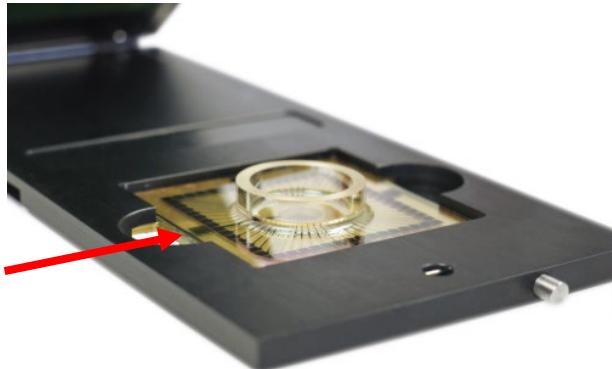
- Turn the toggle switch at the rear panel of the interface board on.
- Check the power LED. It should light up as soon as the power line is connected, and the toggle switch is switched on. If not, check the power source and cabling.



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

### 5.1.1 Setting up the MEA

Open the lid of the headstage. Place the convenient MEA chip inside the MEA2100-Mini headstage. MEA2100-Mini-60-Systems need MEAs with 60 electrodes, MEA2100-Mini-120-Systems need MEAs with 120 electrodes. The MEA is not rotationally symmetrical, so take care for the orientation of the MEA. Please read the respective datasheet for the MEA layout and orientation.



Important: MEAs are not symmetrical! That is, why the writing (for example NMI, or MEA type) on the MEA chip should be on the right side viewed from the front, when the headstage is open. MEAs with one big internal reference electrode should be placed with reference electrode to the left side in the headstage. Otherwise, the MEA layout will not match with the pin layout of the channel map in the data acquisition software.

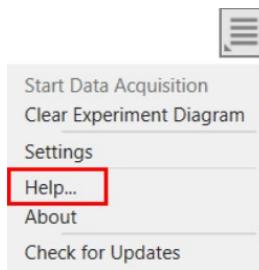


Warning: Spilled liquid can damage or even completely destroy the electronics of the MEA2100-Mini headstage. Please be careful when setting up your perfusion system and when starting the perfusion. Take care that the flow rates of the inlet and outlet flow match so that flooding of the amplifier is efficiently prevented.

## 5.1.2 First Functional Tests

Each MEA2100-Mini-System has been thoroughly tested at the factory site before delivery. However, you may want to perform some tests yourself before you begin your experiment to exclude any damage that might have occurred during transportation. Multi Channel Systems recommends running these tests after the setup of your system before actually starting experiments on animals.

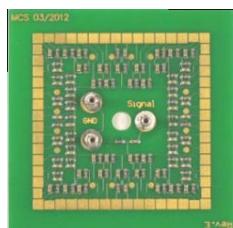
The detailed function of the software package Multi Channel Suite, Multi Channel Experimenter, Multi Channel Analyzer, and Multi Channel DataManager is described in the respective manuals. The manuals are available on the [MCS web site](#) or directly from a link, provided in the option "Help" of the "Settings" section of each software. Please see the screenshot below.



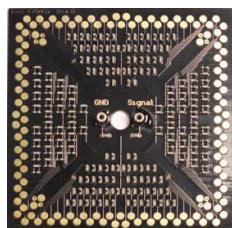
Please read also chapter "Software" on page [13](#) in this manual.

### Test Model Probe

Please use the provided test model probe to test the functionality of the MEA2100-Mini-System. Connect the test model probe "Test-60MEA" to MEA2100-Mini-HS60 headstage. The test model probe simulates a MEA with a resistor of  $220\text{ k}\Omega$  and a  $1\text{ nF}$  capacitor between ground and electrode for each of the 60 electrodes. Connect the test model probe "Test-120MEA" to MEA2100-Mini-HS120 headstage. It can be used for testing the noise level of the electrodes of the MEA2100-Mini-System.



Test-60MEA

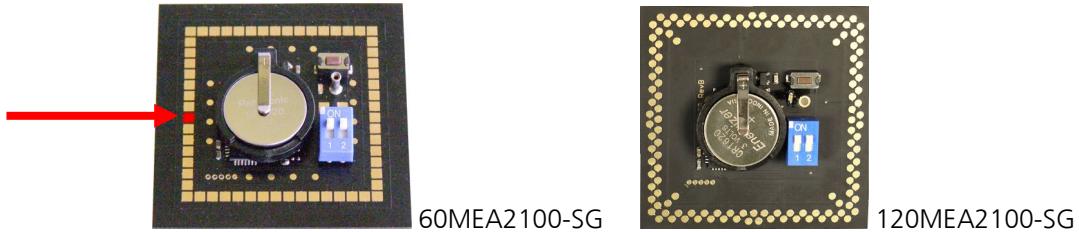


Test-120MEA

For the intention to check the noise level of the MEA2100-Mini-System without external signals, please connect "Signal Source" and "Signal Ground" sockets for a short circuit. The second ground pin must be connected to the headstages ground. For ground connection and for short circuit please use the provided cable CB-GND. Please read also the respective datasheets "Test-60MEA" and "Test-120MEA".

## Signal Generator 60MEA2100-SG

A MEA Signal Generator is a convenient tool adapted for MEA2100-Mini-Systems. Use the respective MEA2100-SG instead of setting up an experiment with biological sample for training, controlling, and troubleshooting purposes. This reduces the number of animal experiments and saves laboratory equipment. Please read also the "[Signal Generator](#)" manual and datasheets "[60MEA2100-SG](#)" or "[120MEA-SG](#)".

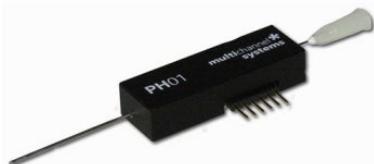


## Temperature Controller TC02



The MEA2100-Mini-System features a heating element with a PT100 temperature sensor. If you connect a temperature controller TC02 for example, to the heating element via D-Sub 9 connector, the heating element guarantees constant temperature conditions for the biological sample, placed on the MEA. Please read the manual [Temperature Controller TC01/02](#).

## Perfusion Cannula PH01



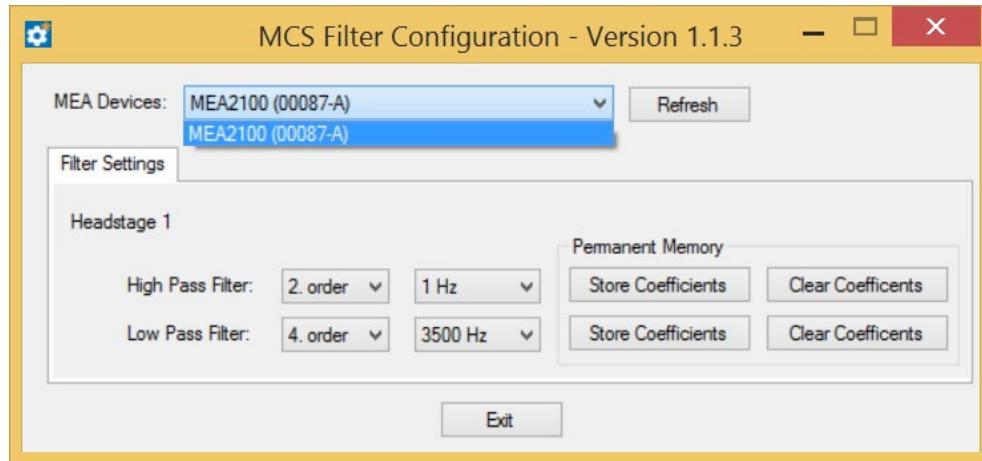
When using a perfusion system, the perfusion cannula PH01 with heating element and sensor can be connected to a temperature controller TC02. The perfusion cannula for controlled fluid temperature is very useful for general perfusion purposes, whenever the fluid stream needs to be temperature controlled. Magnetic holders for the PH01 and a suction cannula are available as optional accessory. A steel plate fitting the headstage of the MEA2100-Mini for the magnetic holders is included in the scope of delivery. Please read the manual [PH01](#).

## 5.2 MCS Filter Configuration

The MCS Filter Configuration software is an add-on program for changing hardware filter settings via software. No firmware update is necessary. You can operate the software with MEA2100 (-Mini)-Systems and ME2100-Systems.

Please install the MCS Filter Configuration software by clicking the "McsFilterConfig.exe" file. Follow the installation guide as usual.

### Main Window of the MCS Filter Configuration Program



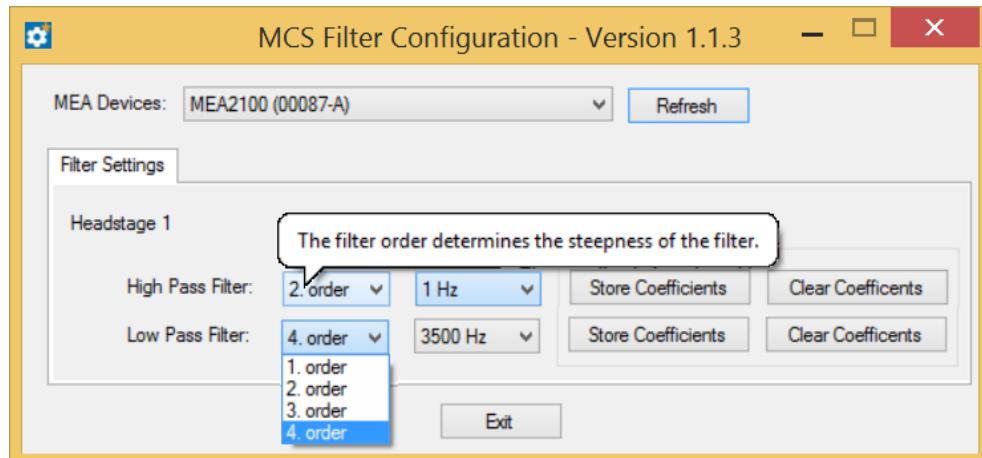
The MCS Filter Configuration program for changing the hardware filter setting of the MEA2100-System is self-explanatory via tool tips. It is possible to control each connected headstage and each MEA slot separately.

Define the "MEA Devices" from the drop-down box if two headstages or headstages with two MEA slots are available. Press "Refresh" button to update the settings.

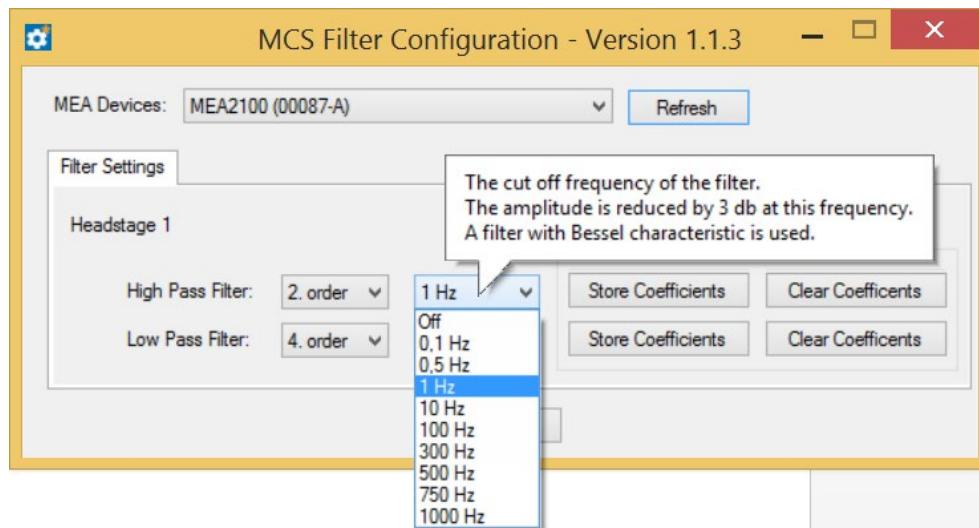
#### Filter Settings

The actual settings are available for each headstage separately. "High and Low Pass Filter" for the selected headstage are displayed. If the actual settings are not on the drop-down list, "Custom" will be displayed.

Select the order of the filter from the first drop-down box. The message "The filter order determines the steepness of the filter" is shown. The higher the order, the steeper the cut off.



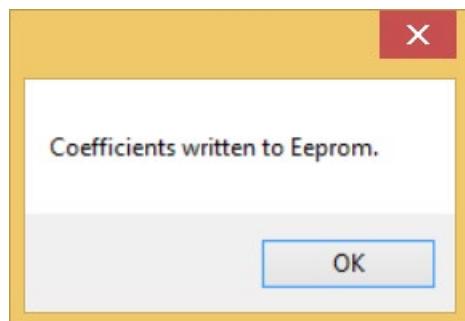
Select the cut off frequency of the filter from the second drop-down box. The message "The cut off frequency of the filter. The amplitude is reduced by 3 db at this frequency. A filter with Bessel characteristic is used." is shown.



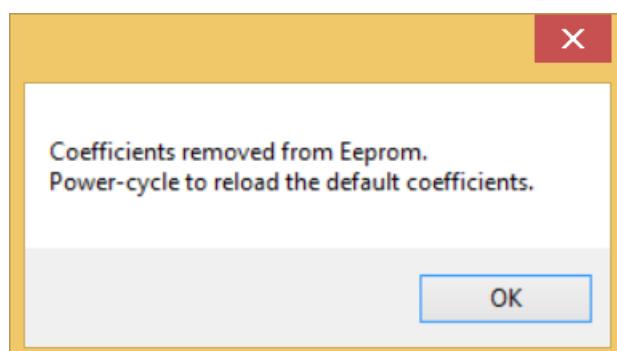
If you need a frequency which is not available on the list, please contact the MCS support team.  
[support@multichannelsystems.com](mailto:support@multichannelsystems.com).

The selected settings are automatically downloaded to the ME2100 / MEA2100 device as soon as you select them. If the "Store Coefficients" button is not used, the device will be back to the last saved settings after a reset.

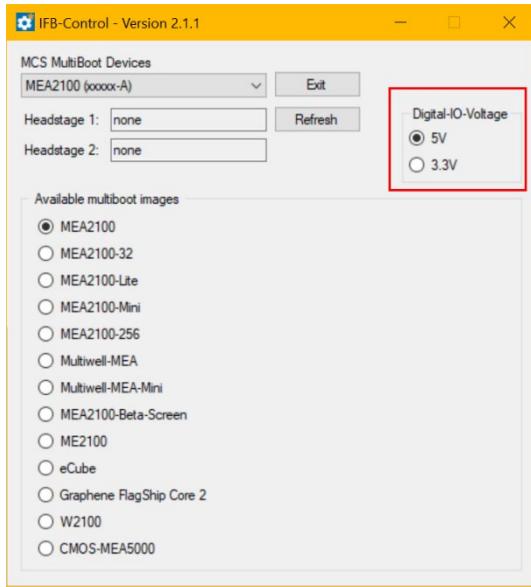
Click the button "Store Coefficients" to store the selected filter settings permanently in the Eeprom memory (electrically erasable programmable read-only memory).



Click the button "Clear Coefficients" to remove the coefficients from Eeprom and to refresh the factory default settings via power-cycle.



## 5.3 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.

## 6 Service and Maintenance

### Cleaning the Connector



Warning: Please be very careful when handling the headstage or cleaning the device!  
The pins can be damaged easily.

You should clean the contact pins of the MEA2100-Mini headstage carefully with a soft tissue and alcohol or isopropanol from time to time, especially if you have problems with the noise level. For handling and cleaning of the MEA, please refer to the MEA manual or to MEA Cleaning Quick Guide on the MCS web site. [www.multichannelsystems.com](http://www.multichannelsystems.com)

### Sterilization



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

MEA2100-Mini 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.

## 6.1 Troubleshooting

The following hints are provided to solve problems that have been reported by users. Most problems occur seldom and only under specific circumstances. Please check the mentioned possible causes carefully when you have any trouble with the product. In most cases, it is only a minor problem that can be easily avoided or solved.

If the problem persists, please contact your local retailer. The highly qualified staff will be glad to help you. Please inform your local retailer as well, if other problems that are not mentioned in this documentation occur, even if you have solved the problem on your own. This helps other users, and it helps MCS to optimize the instrument and the documentation. Please pay attention to the safety and service information in the separate user manuals of the related products and in the software help. Multi Channel Systems has put all effort into making the product fully stable and reliable, but like all high-performance products, it has to be handled with care.

### 6.1.1 No Computer Connection / No Recording Possible

You cannot establish a connection to the computer. The MEA2100-Mini-System channel layout is not available in the data acquisition software. When loading a previously saved virtual rack file, you will get an error message. You get an error message when starting the recording in Multi Channel Experimenter after a successful computer connection.

Possible causes:

? The power LED is not lightning. The supply power is not connected or there is a technical problem with the instrument.

Check the power source and the cable connections. If this does not solve the problem, contact your local retailer for support.

? The power LED is lighting. The USB port might not support USB 3.0 or might not be working.

Check the USB 3.0 port. Only high speed USB 3.0 ports can be used. Try another USB 3.0 port.

? You can establish a connection but get an error message when starting the recording. The bandwidth of the USB port is not sufficient for recording. This can be the case if the MEA2100-Mini-System is connected via USB hub, and a second device that sends or receives continuous data streams, for example, a web cam or USB speakers, is connected to the same USB port.

Connect the MEA2100-Mini-System directly to a USB 3.0 port, not via hub.

## 6.1.2 Triggering / Digital Input does not Work

You have connected a TTL source to one of the digital inputs of the interface board and configured the virtual rack in Multi Channel Experimenter for triggering displays or data acquisition by the TTL source, but you do not see any sweeps.

Possible causes:

? The TTL source does not generate true TTL signals (> 2 to 5 V TTL level), or the TTL pulse duration is too short in combination with the sampling rate, so that the pulse is missed in-between two data points.

The MEA2100-Mini-System can only accept TTL signals as a digital input stream. The TTL pulse needs to be optimized according to the sampling rate. Otherwise, a detection of the trigger cannot be guaranteed.

? The software settings for the Digital Event Detector do not match with the hardware configuration.

In Multi Channel Experimenter, add a Digital Event Detector to your virtual rack. Please see the Multi Channel Experimenter help or manual for more details.

## 6.1.3 Noise on Single Electrodes

The noise level on single electrodes is significantly higher than expected or you see artifact signals.

Possible causes:

? The electrode or the contact pin of the headstage may be defective. To test this, do the following.

Open the MEA2100-Mini headstage and turn the MEA by 90 degrees. Close the headstage again and start the recording.

If the same electrode in the MEA layout is affected, the amplifier's contact is not okay. If another electrode is now affected and the previously affected electrode is all right now, the MEA electrode is not okay, but the headstage is fine.

— OR —

Use the test model probe to test the MEA2100-Mini headstage. If the noise level is fine without the MEA, bad MEA electrodes cannot be the cause.

#### **6.1.4 MEA is defective**

MEAs wear out after multiple uses or over a longer time of use, for example, for long-term cultures. This is considered a normal behavior. MEAs are also easily damaged by mishandling, for example, if wrong cleaning solutions or too severe cleaning methods are used or if the recording area is touched. If you observe a bad long-term performance of MEAs, consider a more careful handling.

Possible causes:

? The contact pads are contaminated.

Clean the contact pads carefully with a swab or a soft tissue and pure (100 %) alcohol.

? The contact pads or the electrodes are irreversibly damaged. You could have a look at the electrodes under a microscope: If they appear shiny golden, the TiN is gone, and the electrode is irreversibly damaged. Electrodes may be damaged without changing their visual appearance, though.

Pick one of the bad channels after the other and ground it. In most cases, only one of the electrodes that appear bad is actually defective, and the other ones are only affected by the single defective electrode. Ground as many electrodes as you need for a good general performance. Grounded electrodes show a noise level that is lower than that of good electrodes. If too many electrodes are defective, use a new MEA.

#### **6.1.5 Overall Noise / Unsteady Baseline**

The baseline is unstable, signals are jumping or drifting.

Possible causes:

? Bath electrode is not connected to ground.

Check orientation of MEA with internal reference. The internal reference must be on the left side of the MEA when it is placed in the amplifier. If the MEA has an internal reference, use a Ag/AgCl bath electrode.

? AgCl bath electrode is not well-chlorided.

Rechloride the electrode or use a new one.

? 50 Hz hum: 50 Hz is the frequency of mains power in Europe. If the shielding and grounding of the setup is not sufficient, electrical signals are picked up from the environment.

Use a proper shielding. For example, you can place aluminum foil over and / or under the amplifier that is connected to the system ground (ground connectors of the headstage or ground connector in the back of the interface board). You can also use special shielding equipment like a Faraday cage.

### 6.1.6 Missing Spikes or Strange Signal Behavior

MEAs wear out after multiple uses or over a longer time of use, for example for long-term cultures. The insulation layer gets thin over time. This is considered a normal behavior.

Possible causes:

? The insulation layer is too thin. As a result, the MEA gets the behavior of a low pass filter. This means, that the signal frequency may be shifted to a lower frequency, and spikes are missing.

Optically control the MEA with a microscope. If concentric colored rings (Newton rings) are visible (due to light interference), the insulation layer is too thin and you should use a fresh MEA.

? The insulation layer has been abraded and is missing in parts. This will result in a short circuit between the electrodes or tracks and the bath. You will still see signals, but as an unspecific smear over the complete array.

Use a fresh MEA.

## 7 Technical Support

In case of technical problems, please contact [MCS support](#). Please understand that information on your hardware and software configuration is necessary to analyze and finally solve the problem you encounter. Please keep information on the following at hand:

- Description of the error (the error message text or any other useful information) and of the context in which the error occurred. Try to remember all steps you had performed immediately before the error occurred. The more information on the actual situation you can provide, the easier it is to track the problem.
- The serial number of the device. You will find it on the backside of the housing or click option "About" in "Help" in the main menu of the data acquisition software.
- The type and serial numbers of the connected headstages. You will find them on the devices.
- The operating system and service pack number of the connected computer.
- The hardware configuration (microprocessor, frequency, main memory, hard disk) of the connected computer. This information is especially important if you have modified the computer or installed new hard- or software recently.
- The version of the recording software. Click option "About" in "Help" in the main menu to display the software version.

## 8 Appendix

### 8.1 Maintenance

#### Cleaning of the System

Always unplug the MEA2100-Mini-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.

### 8.2 Technical Specifications

#### MEA2100-Mini-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
Suitable for Incubator	Humidity: 10 % to 95 %, non-condensing

#### Headstage

Dimensions (W x D x H)	186 mm x 80 mm x 12 mm
Weight with cable	485 g
Cable length	3 m
Type of headstage	MEA2100-Mini-HS60 for 60-electrode MEAs MEA2100-Mini-HS120 for 120-electrode MEAs
Power consumption	1.5 W

### **Integrated Amplifier**

Number of analog recording channels	60 or 120
Data resolution	24 bit
Signal input voltage range	$\pm 70$ mV
Bandwidth	DC to 10 kHz, software controlled
Sampling frequency per channel	up to 50 kHz, software controlled
Input impedance	$450 \text{ M}\Omega \parallel 10 \text{ pF}$
Input noise	Typical $0.7 \mu\text{V}_{\text{RMS}}$ (1 Hz to 3.5 kHz, inputs connected to ground)

### **Integrated Stimulus Generators**

Output current	$\pm 1 \text{ mA} @ \pm 16 \text{ V}$ compliance voltage
Output voltage	$\pm 10 \text{ V} @ \pm 20 \text{ mA}$ max. compliance current
Number of stimulation patterns	2 independent stimulation patterns
Stimulation pattern	Almost arbitrary patterns
Resolution	16 bit
Time resolution	20 $\mu\text{s}$

### **Integrated Heating Element**

Temperature sensor type	Pt 100 (with four wire connection, compatible with TCX)
Accuracy	$\pm 0.1^\circ\text{C}$

### **Signal Collector Unit SCU**

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
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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      External power over iX-industrial, type B

### IFB-C Multiboot Interface Board

Dimensions (W x D x H)      250 mm x 83 mm x 25 mm

Weight      300 g

### Front Panel

2 Sync Out and Sync In      Lemo connector, EPL.00.250 NTN

1 8-Channel Analog In      10-pin connector, DIL10Header-100mil

2 Analog In, Channel 1, 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 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

1 Ground      Common jack 4 mm, banana plug

### Rear panel

1 I / O      Switch On / Off

1 Power supply      MPU 30, PWR DC 0.65 x 2.75 mm

1 Ground      Common jack 4 mm, banana plug

1 16 bit Digital In / Out      68-pin connector Honda-PCS-XE68LFD

1 Digital Signal Processor DSP connector  
Not in use in MEA2100-Mini-Systems!

2 USB-C ports      USB-C cable

2 Interface board to headstage connectors	iX-industrial cable, type B
Ground	Common jack 4 mm, banana plug
1 Audio Output	Stereo jack 3.5 mm

### **Power supply unit (MPU 30)**

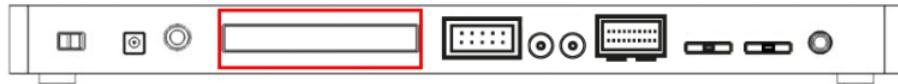
Voltage range	100 – 240 VAC
Output voltage	24 VDC
Frequency	50 – 60 Hz
Max. Power	60 W
Mark of conformity	CE
European standards	EN61010-1

### **Software**

Operating system	Microsoft Windows ® 10, 8.1, 32 or 64 bit, English and German version supported
Multi Channel Experimenter Multi Channel Analyzer	Version 2.13.5 and higher Version 2.13.5 and higher
Multi Channel DataManager	Version 1.9.7 and higher HDF5 (Matlab, Python), NEX (NeuroExplorer), CED (Spike2), ASCI

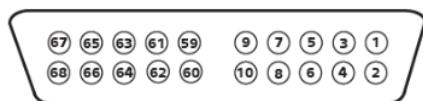
## 8.3 Pin Layout

### 8.3.1 IFB-C Multiboot Interface Board



#### IFB-C Multiboot Interface Board: Digital IN / OUT Connector

68-Pin MCS Standard Connector



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

### **Digital IN / OUT, separate available via Lemo Connectors**

Separate Digital IN Lemo Connectors

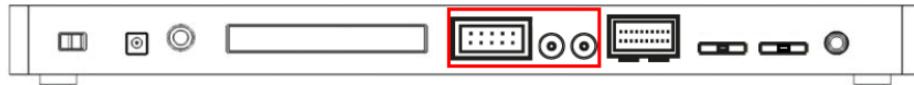
Digital IN 1	Bit 0 of the 16 bit digital input channels (Pin 27)
Digital IN 2	Bit 1 of the 16 bit digital input channels (Pin 28)
Digital IN 3	Bit 2 of the 16 bit digital input channels (Pin 29)
Digital IN 4	Bit 3 of the 16 bit digital input channels (Pin 30)

Separate Digital OUT Lemo Connectors

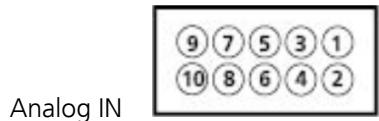
Digital OUT 1	Bit 0 of the 16 bit digital output channels (Pin 3)
Digital OUT 2	Bit 1 of the 16 bit digital output channels (Pin 4)
Digital OUT 3	Bit 2 of the 16 bit digital output channels (Pin 5)
Digital OUT 4	Bit 3 of the 16 bit digital output channels (Pin 6)

### **IFB-C Multiboot Interface Board: 10-Pin Connector for Analog IN**

10-Pin Connector for Analog IN and Ground



10-Pin Analog Connector



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

### **IFB-C Multiboot Interface Board: Lemo Connectors for Analog IN**

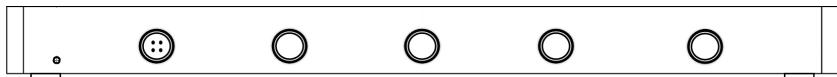
Two of the eight analog channels are additionally separately available via Lemo Connectors

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.

### **8.3.2 SCU Signal Collector Unit**



Four programmable outputs (left connector) for optical stimulation (optogenetics).

Up to four MEA2100-Mini headstages can be operated via Lemo connector with one MCS-SCU-in-vitro.

Up to two signal collector units can be connected to one interface board MCS-IFB-in-vitro.

## 9 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](http://www.multichannelsystems.com)