ME2100-System

USER MANUAL

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BEFORE YOU START

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.

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.

The ME2100-System is the latest development in the MEA product family of Multi Channel System MCS GmbH. The ME2100-System is a compact and portable stand-alone system for *in vivo* and *ex vivo* recordings from a multitude of probe, for example flexible microelectrode arrays FlexMEAs). The ME2100-System is equipped with integrated amplification, data acquisition, online signal processing, as well as integrated stimulus generators. Measuring the impedance of the electrodes of the connected probe will be an additional feature in near future. Please check the MCS web site.

The system consists of a signal collector unit SCU for up to four headstages, which also contains a connector for up to four outputs for optical LED stimulation. This feature is coming soon. The signal collector is connected via iX cable to the interface board IFB-C. With the ME2100-2-System you can connect up to two signal collector units to one IFB-C Multiboot interface board and up to eight headstages.

Headstages have 32 recording channels and additional ground and reference inputs. Amplifier, stimulators and A/D converters are all directly on the headstage, which allows low-noise, high quality data acquisition and impedance measuring via MEA-IT software. Use each of the 32 internal channels for recording or stimulation. The stimulator units can be assigned by software command to any of the recording channels, or to an external stimulation electrode, which can be connected directly to the headstage.

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.

HARDWARE COMPONENTS

HARDWARE COMPONENTS

Headstage ME2100-HS32

The first element of the ME2100-System is the headstage. At the moment, two types of 32-channel headstages with external stimulation are available: ME2100-HS32-M and ME2100-HS32-S. Other types are under development. Please check the MCS web site. Headstages can be ordered with different cable length, 3, 5, and 10 m. The headstage comes with a rod mount attached, to connect it to a manipulator.

The data acquisition integrated in the headstage supports 32 electrode channels. Sampling rate and bandwidth can be adjusted via software control. The front end connector features 32 recording channel inputs, plus ground (GND) and reference inputs (REF). On the side panel, there is an additional connector to plug in one or two external stimulation electrodes, which can be used with the integrated stimulator. Please see chapter "ME2100-HS32 Headstage: Connector for External Stimulation" on page 28 in the Appendix for details.

Amplifier, stimulators, and A/D converters are all directly on the headstage, which allows low-noise, high-quality data acquisition and impedance measuring. Two stimulus generator units are also integrated in each headstage, which can 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. Alternatively, external stimulation electrodes can be used, as described above. An integrated blanking circuit (BC) disconnects the electrodes from the amplifiers during the stimulation and reduces stimulus artifacts.

Use, for example the EcoFlexMEA36 from Multi Channels Systems MCS GmbH connected to the headstage. Probes from other manufacturers might need an adapter. For help on adapter, please contact MCS support. The cable of the ME2100 headstage connects to the signal collector unit SCU, please see next chapter "Signal Collector Unit SCU".

Up to four ME2100 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 256 electrodes (eight individual 32-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 SCU to the interface board via iX-industrial cable.

For orientation of the ME2100 headstage with adapter, for example: The side without screws is defined to be the top side of the headstage.

⚠ Warning: It is recommended to switch off the ME2100-System on the interface board whenever connecting or disconnecting headstages

Headstages ME-µPa

The first element of the ME2100-System is the headstage. At the moment, two types of headstages without external stimulation are available: ME2100-µPA32 and ME2100-µPA16. Other types are under development. Please check the MCS web site. Headstages can be ordered with different cable length, 3, 5, and 10 m. The headstage comes with a rod mount attached, to connect it to a manipulator.

The data acquisition integrated in the headstage supports 32 or 16 analog channels, the A/D converters are integrated in the connector to the signal collector unit SCU. Sampling rate and bandwidth can be adjusted via software control. The ME2100-µPA Omnetics connector features 32 or 16 recording channel inputs, plus grounds (GND) and reference input (REF).

Use, for example the FlexMEA36-OM from Multi Channels Systems MCS GmbH connected to the headstage. Probes from other manufacturers might need an adapter. For help on adapter, please contact MCS support. The cable of the ME2100-µPA32 headstage connects to the signal collector unit SCU, please see next chapter "Signal Collector Unit SCU".

HARDWARE COMPONENTS

Up to four ME2100-µPA32 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 256 electrodes (eight individual 32-channel headstages). Electrode raw data acquired from the probe is amplified and digitized by the analog / digital converter that is integrated in the connector to the SCU at sampling rates of up to 50 kHz per channel. Data is transferred via SCU to the interface board via an iX-industrial cable.

For orientation of the ME2100 headstage with adapter, for example: The side without screws is defined to be the top side of the headstage.

⚠️ **Warning: It is recommended to switch off the ME2100-System on the interface board whenever connecting or disconnecting headstages.**

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.

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.

Front Panel
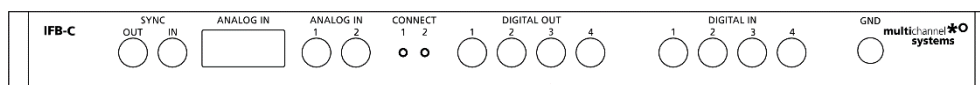
From left to the right:

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.
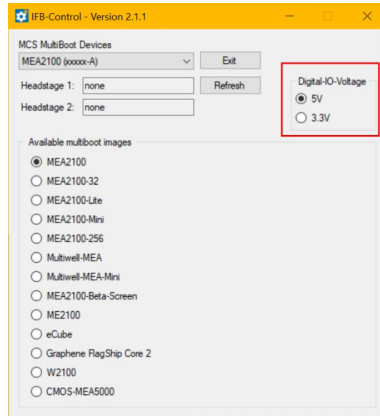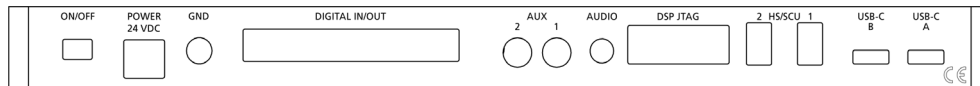

If access to more bits of the DIG IN / OUT channel is required, it is necessary to connect a Digital IN / OUT extension Di/o board with a 68-pin standard cable. This Di/o board is available as an optional accessory.

Ground

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

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.

Digital Signal Processor

The IFB-C Multiboot interface board of the ME2100-System is equipped with a high-capacity digital signal processor DSP. The DSP allows online access to the data in real-time. Filtering, spike detection, and generation of feedback stimulation can be controlled by the data acquisition software.

Additionally, the processor is freely programmable to offer the advanced user more complex online analysis features. It can be programmed in C using the Code Composer Studio Development Environment from Texas Instruments. Simlink from Mathworks can also be used to create the model which will run on the DSP. The DSP has full access to the data stream from all electrodes in real-time and can analyze the data. It also can access the stimulation unit together with the blanking switches inside the stimulation unit of the ME2100-System. This allows creating closed loop experiments with sub millisecond delays. The processed data from the DSP can be streamed to the PC using a dedicated USB-C connection.

SYSTEM SETUP

Connecting the Hardware Components

The setup of the ME2100-System is very simple, as all cables fit only in the designated socket. 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, please see chapter "Software Installation". The ME2100-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 Lemo cable/s to the signal collector unit SCU. The red dot on the Lemo connector must face upwards. Do not twist the cable in the connector! Do not mistake the headstage inputs (HS1 to HS4) with the Opto Stim input.

Connect the signal collector unit SCU via iX-industrial cable to the 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 3.0 micro 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 side panel, and connector B to iX input 2. If both iX-industrial inputs are used, also both USB-C connections must be used. Do not use an USB hub and also avoid USB 3.0 ports on the front panel of the computer, as they are often connected to the mainboard via an internal hub.

Connect the interface board via the 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.

If necessary, connect the system to an external ground.

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 ME2100-System on the interface board whenever connecting or disconnecting headstages.

SOFTWARE

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:

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

Software Installation

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

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.

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.
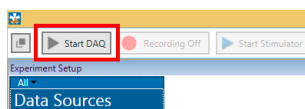
Open the Multi Channel Experimenter software.

Drag the ME2100 data source icon into the main window and doubleclick it to open the control window.
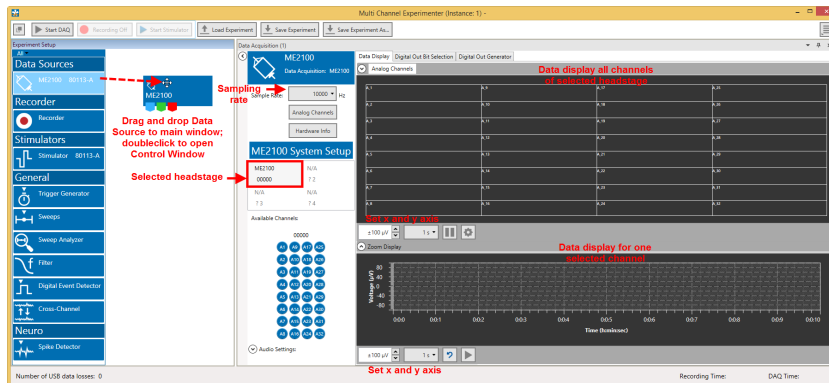
Hit the Start DAQ button in the main menu.

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.
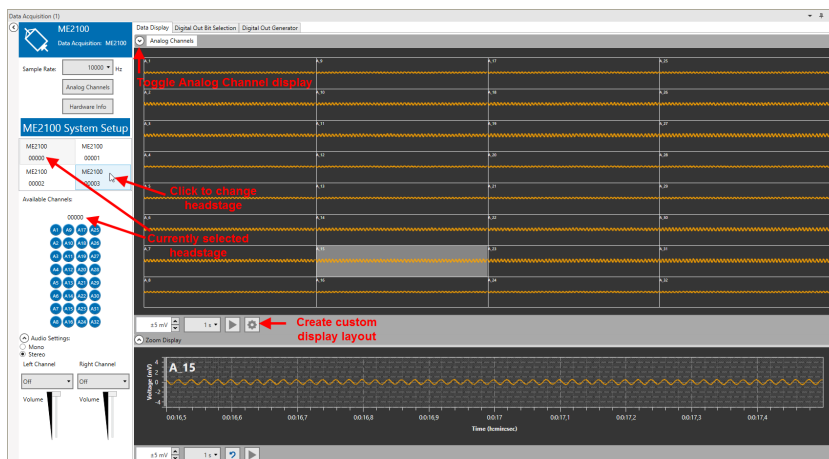
First Functional Tests

Each ME2100-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 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.
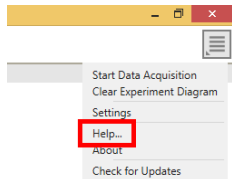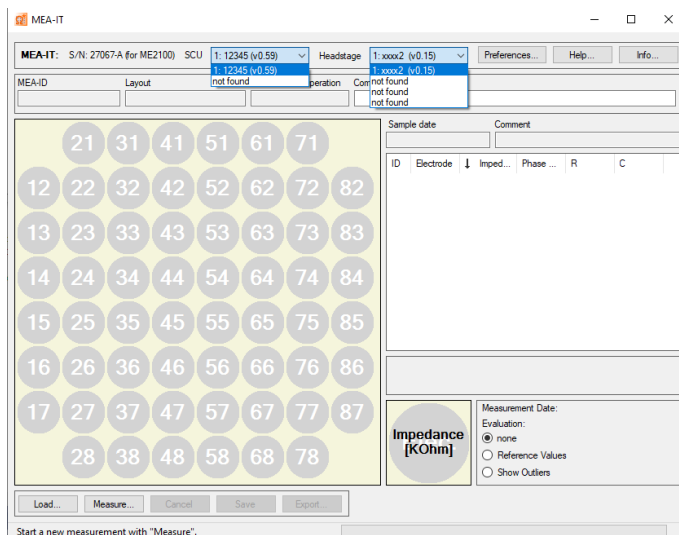

Please use the provided test model probe to test the functionality and noise level of the ME2100-System. Connect the test model probe to each headstage.


MEA-IT Software

Please read the MEA-IT manual for detailed information to the impedance measurement software.

Connect a ME2100-System with signal collector unit SCU, interface board IFB and headstage to a PC.

SOFTWARE

When opening the MEA-IT software, the header of the software includes two additional drop down boxes, "SCU" and "Headstage". Please use the drop down boxes to define which headstage should be measured.

A ME2100-System includes up to two "Signal Collector Units, SCU". Please select the SCU in use from the drop down box "SCU". It is not possible to select both SCUs at once.
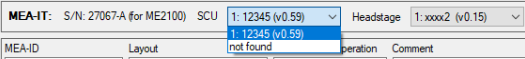
A ME2100-System includes up to eight headstages connected to up to two SCUs. First you have to select the SCU in use, then you have to select the headstage in use from the drop down box "Headstage". Up to four headstages can be connected to one SCU. Select one of them, regardless to which connector of the SCU the headstage is connected. Unplugged connectors are indicated with "not found". It is not possible to measure more than one headstage simultaneously.
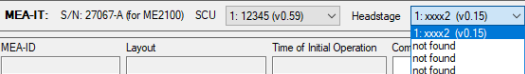
Define the type of the MEA in the "Select MEA" dialog: Select "Linear 32" in "Layout" from the drop down box.
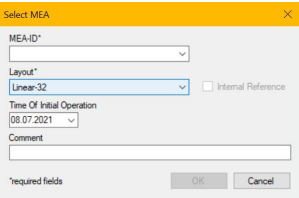
SETTING UP AN EXPERIMENT

Bandwidth Specification

The ME2100-System uses headstages with selectable hardware filter bandwidth. Default settings for the hardware filter are currently DC to 10 kHz. In a future release, it will be possible to change the hardware bandwidth with an additional software program. No hardware modification is necessary.

DC Offset Correction

The internal baseline restore routine is used to eliminate DC offsets of the electrode channels and set all baseline values to zero. This has to be a slow process. If the routines corrected too fast, slow signals would be eliminated as well.

All electrodes on an electrode array have different DC offsets at the beginning of an experiment. The DC offsets are amplified by the headstage, and the amplified output signal of the preamplifier is likely to exceed the input range of the filter amplifier. In order to eliminate this DC offset, a so-called baseline restorer is integrated in the headstage. For signals in the usual measurement range, the baseline restore routine acts like a high pass filter with a very low cut off frequency of roughly 0.01 Hz.

Due to the low cut off frequency, the baseline restorer takes some time to stabilize after switching on the amplifier or after replacing the electrode. One to two minutes are quite normal. During this time, the filter amplifier input will be overloaded, and you will see only a straight line with very low noise. This is considered a normal behavior and should not trouble you. Please wait until the baseline restore routine has been completed. After about one minute, the baseline restorer of the headstage has corrected the DC offset, and the output signals are now in the operating range of the filter amplifier.

Connecting the Electrode

In the following, you find general recommendations for the installation.
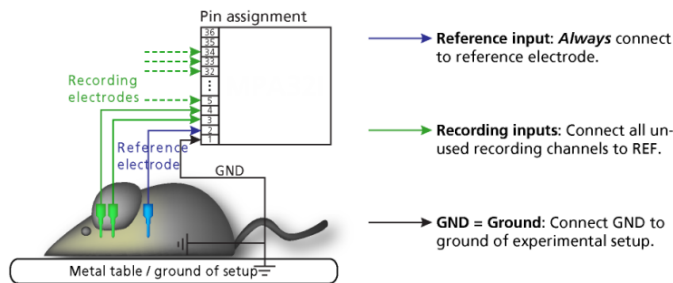
Important: It is important that the complete setup refers to a single common ground. The reference input always has to be connected. It is recommended to use a reference electrode. However, if you are not using a reference electrode, connect the reference input to ground (GND). Otherwise, noise picked up by the reference input will be subtracted from the recording signals. This will either lead to signal loss or to a very high noise level.

Ground the animal with a ground electrode of large surface area, for example, a liquid gel adhesive electrode, that is connected to the ground of the setup, for example a large metal table or a Faraday cage, to avoid pickup of noise from the environment. The ground electrode is best positioned in an electrically inactive region (not near muscle, nor heart), for example, at the belly.

Connect the GND input or the metal case of the ME2100 headstage to the common ground of the setup. The GND input is internally connected to the metal case.

Connect the reference electrode to the reference input of the ME2100 headstage. Generally, a reference electrode is inserted into non-active tissue of the experimental model. The reference electrode should be identical to the recording electrode so that both electrodes see the same background noise. This is necessary because despite the grounding, the animal's body often has not exactly a potential of zero, due to the electrode impedance, for example. The background noise is then subtracted from the recording signal, increasing the signal-to-noise ratio. Please note that this may not work if the complete setup is not properly grounded.

(Optional) If two reference electrodes are used, connect the second electrode to the free reference input. Otherwise, leave it free. It is generally not necessary to use a second reference electrode. It can be used to enlarge the surface area of the reference, though.

Connect the recording electrodes to the recording channels of the ME2100 headstage. You can either use single electrodes or multitrodes. MCS provides adapters for standard probes.

Connect all unused recording channels to the GND input or to the reference electrode if the reference and ground electrode of the amplifier are short circuited, to avoid noise pickup.

If you are not using a Faraday cage, it might be necessary to shield the complete setup with aluminum foil or similar to prevent electrical interference from the outside. Connect the aluminum foil to the ground of the setup, for example the metal table.

Troubleshooting

If you observe problems with noise, check that the ground of the setup is connected to the same ground as the data acquisition computer. For example, connect the metal table to the ground / earth wire of a free power outlet of the same electrical system, as the computer is generally connected to ground via the power plug, too. Also, connect the data acquisition computer's metal case with a thick ground wire to the ground of the setup for example the metal table, preferably with a 4 mm plug.

Stimulation

Each headstage of the ME2100-System is equipped with an integrated two channel stimulus generator, which delivers rectangular pulses, sine waves, ramps, or random waveforms. You can choose between current or voltage driven stimulation and you can select each electrode for stimulation within the software. Alternatively, external stimulation electrodes can be used. The stimulation electrodes can be connected at the side of each headstage. Please see below the connector, pin assignment, and internal connection scheme of the stimulation outputs. The 6-pin socket is protected against polarity reversal, as the connector can be plugged in either way. The pins for stimulus generator No 1 (STG 1) and No 2 and ground (GND) are physically connected internally. Control of stimulation patterns and selection of stimulation electrodes is done within the data acquisition software. Please see the Multi Channel Experimenter manual for details.
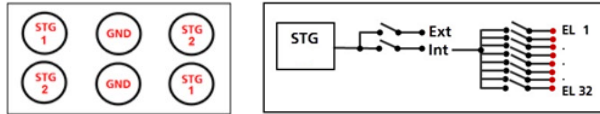
ME2100-HS32-System Headstage: Side Panel

Pin Layout of the Connector and Scheme

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.

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.

SERVICE AND MAINTENANCE

Cleaning the Connector

⚠️ Warning: It is recommended to avoid the use of cleaning solutions to avoid corrosion. If a wet cleaning is required, use distilled water. Make sure that only the connector touches the liquid, do not submerge the ME2100 headstage or the cable. Otherwise, you can fatally damage the electronics.

If this does not provide satisfying results, insert only the connectors into a small beaker with acetone or alcohol and treat them in an ultrasonic bath for 10 to 20 s. Air-dry the miniature preamplifier for about 5 minutes before use.

You can also clean the connectors with distilled water in an ultra sonic bath. Dry the connectors with compressed air immediately after sonication and let the amplifier air dry for at least 6 h before use.

Cleaning of the System

Always unplug the ME2100-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 ME2100 headstage by high heat (above 70 °C) or vapor. The resin is not heat-stable and may deform under heat. Vapor can lead to a corrosion of the electronics.

ME2100-System headstages can be sterilized with standard methods that are not based on high heat or vapor, for example, with 70 % ethanol, ultraviolet light, or by thermal sterilization in an oven at 56 °C with an incubation time of 8 hours.
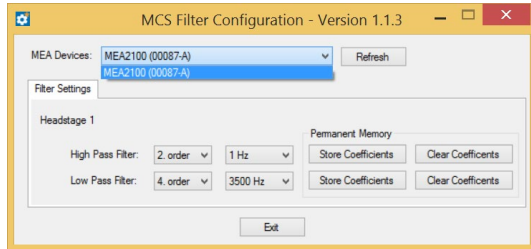
MCS FILTER CONFIGURATION

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.

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.
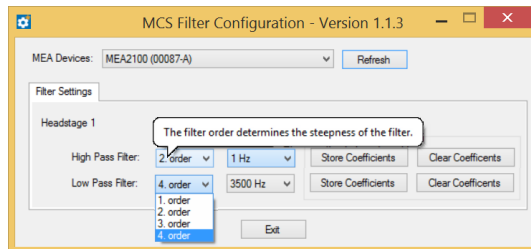
Select the cut off frequency of the filter from the second drop-down box. The message "The cut off frequency of the filter. The amplitude is reduced by 3 db at this frequency. A filter with Bessel characteristic is used." is shown.
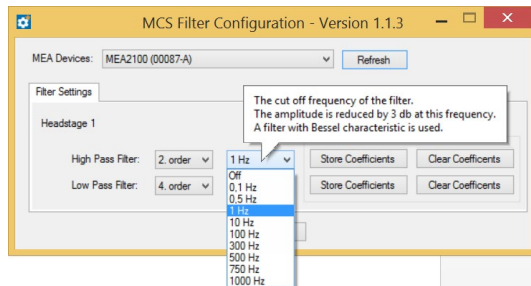
If you need a frequency which is not available on the list, please contact the MCS support team. support@multichannelsystems.com. The selected settings are automatically downloaded to the ME2100 / MEA2100 device as soon as you select them. If the "Store Coefficients" button is not used, the device will 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).
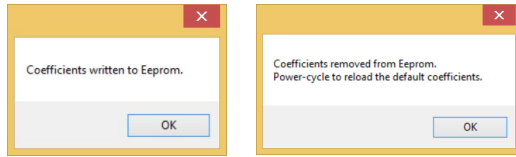
Click the button "Clear Coefficients" to remove the coefficients from Eeprom and to refresh the factory default settings via power-cycle.

IFB-Control Software
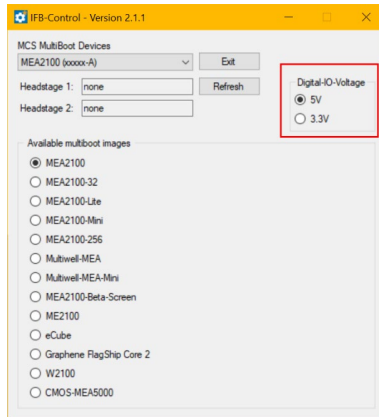
Software to control the MCS multiboot devices: Select the connected device and the headstages in the "MCS Multiboot Devices" window from the drop down menu.

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.

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.

APPENDIX

TECHNICAL SPECIFICATIONS

ME2100-System

⚠️ Warning: The device may only be used together with FlexMEAs from Multi Channel Systems MCS GmbH or designated probes and only for the specified purpose. Damage of the device and even fatal injuries can result from improper use. Do not open the headstage or the interface box 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
Relative humidity	10 % to 85 %, non-condensing

Headstage: ME2100-HS32 (-M/-S)

Dimensions (W x D x H)	ME2100-HS32-M: 50 mm x 72.5 mm x 8 mm, ME2100-HS32-S: 35 mm x 72.5 mm x 8 mm
Weight (without cable)	50 g
Length of the cable	Optional: 3 m, 5 m or 10 m
Input connector type	Dual-row precision socket, 50 mil (1.27 mm) grid pattern, for 0.35 to 0.45 mm round pin

Integrated Amplifier

Number of analog recording channels	32
Data resolution	24 bit
Signal input voltage range	± 250 mV
Bandwidth	DC to 10 kHz
Sampling frequency per channel	up to 50 kHz, software controlled
Input impedance	470 MΩ || 10 pF
Input noise	ME2100-HS32-M: < 0.7 µV $_{RMS}$ (1 Hz to 3.5 kHz, inputs short-circuited)
	ME2100-HS32-S: < 2.4 µV $_{RMS}$ (1 Hz to 3.5 kHz, inputs short-circuited)

Integrated Stimulus Generators

Output current	± 1.5 mA @ ± 16 V compliance voltage
Output voltage	± 10 V ± 20 mA max. compliance current
Stimulation pattern	Multi Channel Experimenter: Almost arbitrary patterns,
	MC_Rack: Rectangle (biphasic, monophasic, pulse trains)
Number of stimulation channels	2 independent stimulation patterns per 32 channels
Resolution	16 bit

External Stimulation

1 Digital Output Connector	6-pin connector for 2 independent stimulation patterns per 32 channels

Headstage: ME2100-µPA32

Dimensions (W x D x H)	24 mm x 25 mm x 3 mm without cable
Weight	± 2 g without cable
Length of the cable	Optional: 3 m, 5 m or 10 m
Input connector type	Omnetics NSD series, female with 4 guide posts: A79023-001, NSD-36-DD-GS
Output connector type to SCU	Lemo with integrated A/D converter

Integrated Amplifier

Number of analog recording channels	32
Data resolution	24 bit
Bandwidth	Software controlled
Sampling frequency per channel	up to 50 Hz
Input voltage range	± 250 mV
Input impedance	1 GΩ @ 1 kHz
Input capacitance	13 pF
Input noise	typical 0.7 µV$_{RMS}$ (1 Hz to 5 kHz, inputs shortened)

Headstage: ME2100-µPA16

Dimensions (W x D x H)	21 mm x 17 mm x 1.5 mm
Weight	1.5 g
Length of the cable	Optional: 3 m, 5 m and 10 m
Input connector type	Omnetics NSD series, female with 2 guide posts: A79039-001, NSD-18-DD-GS
Output connector type to SCU	Lemo connector with additional A/D converter

Integrated Amplifier

|	
Number of analog recording channels	16
Data resolution	24 bit
Bandwidth	Software controlled
Sampling frequency per channel	up to 50 Hz

Input voltage range	± 250 mV
Input impedance	1 GΩ @ 1 kHz
Input capacitance	13 pF
Input noise	typical 0.7 µV$_{RMS}$ (1 Hz to 5 kHz, inputs shortened)

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
Back Panel	
1 64-Channel Analog Out connector	68-pin MCS standard connector, Honda-PCS-XE68LFD
1 Ground	Common jack 4 mm, banana plug
Side Panel	
Collector unit to interface board connector	External power over iX-industrial cable, 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	14-pin JTAG connector, DIL14Header-100mil-angeled
Not in use in MEA2100-Mini-Systems!	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	Version 2.13.5 and higher
Multi Channel Analyzer	Version 2.13.5 and higher
Multi Channel DataManager	Version 1.9.7 and higher HDF5 (Matlab, Python), NEX (NeuroExplorer), CED (Spike2), ASCI

PIN LAYOUT

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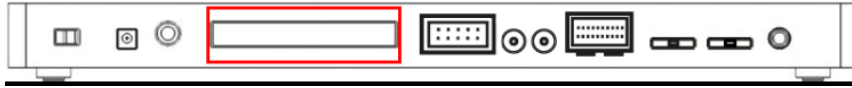
IFB-C Multiboot Interface Board: Digital IN / OUT Connector

68-Pin MCS Standard Connector
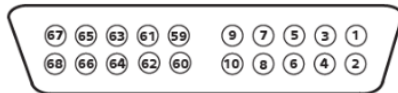
Pin	1	GND
Pin	2	GND
Pin	3 - 10	Digital output channels bit 0 - 7
Pin	11 - 14	GND
Pin	15 - 22	Digital output channels bit 8 - 15
Pin	23 - 26	GND
Pin	27 - 34	Digital input channels bit 0 - 7
Pin	35 - 38	GND
Pin	39 - 46	Digital input channels bit 8 - 15
Pin	47 - 48	GND
Pin	49 - 63	Internal use (do not connect)
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)

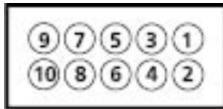**IFB-C Multiboot Interface Board: 10-Pin Connector for Analog IN**

10-Pin Connector for Analog IN and Ground

10-Pin Analog Connector

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

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

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.

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.

APPENDIX

ME2100 Headstage Input Connector

Pin 1	Ground
Pin 2	Reference
Pin 3 to Pin 34	Channel 1 to Channel 32
Pin 35	Reference
Pin 36	Ground

This illustration shows the pin layout of the ME2100 headstage viewed from the front, with the case screws upside down.

The two reference inputs are used for connecting a reference electrode. Both inputs are equal, so it does not matter which of the two inputs is used. If both are used, the mean of both reference signals is used as reference.
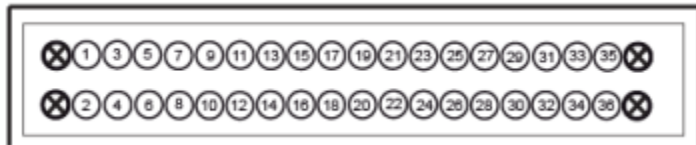
ME2100-HS32 Headstage: Connector for External Stimulation

Top

Bottom
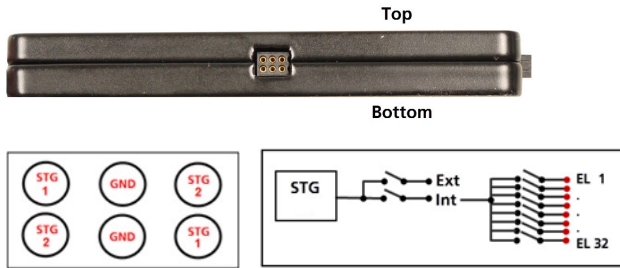
For detailed information, please read the respective datasheets: ME2100-HS32-M and ME2100-HS32-S.

ME2100-µPA32 Headstage

ME2100-µPA32 Input Connector

Please note that the side with no screws is considered to be the top side of the ME2100-µPA32.

The figure shows the pin layout viewed from the front, with the case screws down.

ME2100-µPA32: Pin Layout Input Connector

Pin 1, 35, 36	GND /Ground)
Pin 2	Reference input
Pin 3 to Pin 34	Recording channels 1 to 32

4 Guide posts

For detailed information, please read the respective datasheets: ME2100-µPA16 and ME2100-µPA32.

ME2100-µPA16 Input Connector
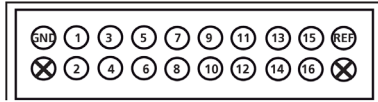
Please note that the side with no screws is considered to be the top side of the ME2100-µPA16.
The figure shows the pin layout viewed from the front, with the housing up.

ME2100-µPA16: Pin Layout Input Connector

Ground (GND)	Guide post
Pin 1	Pin 2
Pin 3	Pin 4
Pin 5	Pin 6
Pin 7	Pin 8
Pin 9	Pin 10
Pin 11	Pin 12
Pin 13	Pin 14
Pin 15	Pin 16
Reference input (REF)	Guide post

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