



USB-MEA256-System Manual



Imprint

Information in this document is subject to change without notice.

No part of this document may be reproduced or transmitted without the express written permission of Multi Channel Systems MCS GmbH.

While every precaution has been taken in the preparation of this document, the publisher and the author assume no responsibility for errors or omissions, or for damages resulting from the use of information contained in this document or from the use of programs and source code that may accompany it.

In no event shall the publisher and the author be liable for any loss of profit or any other commercial damage caused or alleged to have been caused directly or indirectly by this document.

© 2020 Multi Channel Systems MCS GmbH. All rights reserved.

Printed: 30. 11. 2018

Multi Channel Systems MCS GmbH

Aspenhaustraße 21

72770 Reutlingen

Germany

Phone +49-71 21-909 25 - 0

Fax +49-71 21-909 25 -11

sales@multichannelsystems.com

www.multichannelsystems.com

Microsoft and Windows are registered trademarks of Microsoft Corporation. Products that are referred to in this document may be either trademarks and / or registered trademarks of their respective holders and should be noted as such. The publisher and the author make no claim to these trademark.

Table of Contents

1	Introduction	1
1.1	About this Manual	1
1.2	Welcome to the USB-MEA256-System	2
2	Important Safety Advice	3
2.1	Operator's Obligations	3
2.2	Guarantee and Liability	3
2.3	Important Safety Advice	4
3	Software Installation	5
3.1	Software Installation	5
3.1.1	System Requirements	5
3.1.2	Recommended BIOS settings	5
3.1.3	Driver Installation	6
3.2	Multi Channel Experimenter	6
3.2	MC_Rack	9
4	USB-MEA256-System	11
4.1	The USB-MEA256 Data Acquisition	11
4.2	The USB-MEA256 Filter Amplification	11
4.3	256MEA	12
4.4	256 Thin MEA	13
4.5	256-9well MEA	13
4.6	The USB-MEA256-System	14
4.7	Connecting the USB-MEA256-System	14
4.8	Setting Up the Amplifier	15
4.9	The USB-MEA256 Device	21
5	Troubleshooting	25
5.1	Troubleshooting	25
5.2	No Computer Connection / No Recording Possible	25
5.3	Triggering / Digital Input does not Work	26
5.4	Noise on Single Electrodes	26
5.5	MEA is defective	27
5.6	Overall Noise / Unsteady Baseline	27
5.7	Missing Spikes or Strange Signal Behavior	28
6	Appendix	29
6.1	Technical Support	29
6.2	Technical Specifications	30
6.3	Pin Layout	32
6.4	Test Model Probe	34
6.5	Digital IN / OUT Extension	34
6.6	Scope of Delivery	35
6.7	Contact Information	36
7	Index	37

1 Introduction

1.1 About this Manual

It is assumed that you already have a basic understanding of technical and software terms. No special skills are required to read this manual.

If you are using the device for the first time, please read the **Important Safety Advice** before **installing the hardware** and **software**, where you will find important information about the installation and first steps.

The device and the software are part of an ongoing developmental process. Please understand that the provided documentation is not always up to date. The **latest information** can be found in the **Help**. Check also the MCS web site (www.multichannelsystems.com) for downloading up-to-date manuals and help files.

1.2 Welcome to the USB-MEA256-System



The **USB-MEA256-System** is a compact and portable stand-alone solution for MEA recordings with integrated amplification, data acquisition, and analog / digital conversion.

It is a highly flexible system: **The system acquires data** from up to 252 electrode channels, four additional analog channels, and 16 digital IN / OUT channels. The digitized electrode data is transmitted to the connected computer via universal serial bus (High Speed USB 2.0). Thus, it is possible to use any computer as a data acquisition computer, also a laptop.

Recorded data are graphed, analyzed and reviewed with the powerful and easy-to-use **Multi Channel Suite**, the newest software package from Multi Channel Systems MCS GmbH or the well-proved **MC_Rack** program. You can export the data in standard formats.

The integrated **filter amplifier** supports 252 electrode channels. The amplification factor of 1100 is fixed. The bandwidth of 1 Hz to 5 kHz is suitable for a broad range of applications, such as spike and field potential recording from neurons or recording of cardiac signals.

Electrode raw data are acquired from the 256MEA and digitized by the **analog / digital converter board** that is integrated into the main unit. Recorded signals are converted in real time into digital data streams at sampling rates of up to 40 kHz per channel. You will not miss even fast biological signals. Data is transferred to the computer via **High Speed USB 2.0** port.

The **USB-MEA256-System** features a **heating element** with a PT100 temperature sensor. If you connect a **temperature controller TCX** to the heating element via D-Sub 9 connector, the heating element guarantees constant temperature conditions for the biological sample, placed on the 256MEA (Microelectrode Array with 252 recording electrodes and four reference electrodes) or on the 256ThinMEA or the 256-9wellMEA respectively.

To control the biological sample on the 256MEA inside the amplifier optically, you can use either an upright microscope or an inverted microscope.

A **16-bit digital input / output** (TTL) is available. You can use the digital TTL inputs, for example, for synchronizing stimulation and recording, or for synchronizing the **USB-MEA256-System** with other systems. The digital TTL outputs can be used for triggering other devices, for example, an imaging setup.

The 16 bit Digital IN / OUT channel can be contacted with a 68-pin MCS standard connector. The bits 0 from the D IN and the D OUT, respectively, are also accessible independently by the D0 IN and D0 OUT Lemo connectors.

The additional **analog inputs 1 to 4** are intended for recording additional information from external devices, for example, for recording patch clamp in parallel to the MEA recording, for monitoring the temperature, or for recording voice.

To the **Audio Out** (3.5 mm phone jack) you can connect an audio system to make the electrical activity audible. This audio output is real time. Headphones or a speaker can be connected directly to the AUDIO OUT. Only one channel at a time can be converted into sound.

2 Important Safety Advice

2.1 Operator's Obligations

The operator is obliged to allow only persons to work on the device, who

- are familiar with the safety at work and accident prevention regulations and have been instructed how to use the device;
- are professionally qualified or have specialist knowledge and training and have received instruction in the use of the device;
- have read and understood the chapter on safety and the warning instructions in this manual and confirmed this with their signature.

It must be monitored at regular intervals that the operating personnel are working safely.

Personnel still undergoing training may only work on the device under the supervision of an experienced person.

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.

2.3 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.

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.



Warning: The device must not get in contact with fluids! Spilled liquid can damage or even completely destroy the electronics of the amplifier! This is eminently important when using a perfusion system. Take care that the flow rates of the inlet and outlet flow match so that flooding of the amplifier is efficiently prevented.

3 Software Installation

3.1 Software Installation

Please check the system requirements before you install the **MC_Rack** software. MCS cannot guarantee that the software works properly if these requirements are not fulfilled. Please see the MC_Rack Help or Manual for more information. It is recommended that you check the MCS web site for software updates on a regular basis.

The **USB-MEA256-System** is a plug and play device. The driver is automatically installed together with the **Multi Channel Experimenter** or the **MC_Rack** program. It is easier to connect the **USB-MEA256-System** first to the data acquisition computer and then install the software.

Important: Please make sure that you have full control over your computer as an administrator. Otherwise, it is possible that the installed hardware does not work properly.

3.1.1 System Requirements

Software: One of the following Windows ® operating systems is required: Windows 7, VISTA or XP (English and German versions supported) with the NT file system (NTFS). Other language versions may lead to software errors. Windows 8 is essential for the Multi Channel Suite software.

Hardware (Not required for offline analysis or demo mode): The data acquisition board **USB-MEA256-System**. If no **USB-MEA256-System** is present, **MC_Rack** opens in a simulation mode. 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 **USB-MEA256-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 **USB-MEA256-System** driver to operate the **USB-MEA256-System**, which is automatically installed with **MC_Rack**. The installation may be invalid if the **USB-MEA256-System** does not respond. Please contact Multi Channel Systems or your local retailer in this case.

3.1.2 Recommended BIOS settings

Recommended operating system settings

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

1. Turned off Windows System Restore.
2. Windows Indexing Service deselected for all local disks.
3. Optimize hard disk when idle (automatic disk fragmentation) turned off.
4. It is not recommended to run any applications in the background when using MC_Rack. Remove all applications from Autostart folder.
5. Be careful when using a Virus Scanner. These programs are known to disturb data acquisition software and even data loss may occur.

- When using an USB-MEA256-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 252 channels with a sample rate of up to 40 kHz needs high memory capacity. Please remove data and defragment the hard disk regularly to ensure optimal performance.

3.1.3 Driver Installation

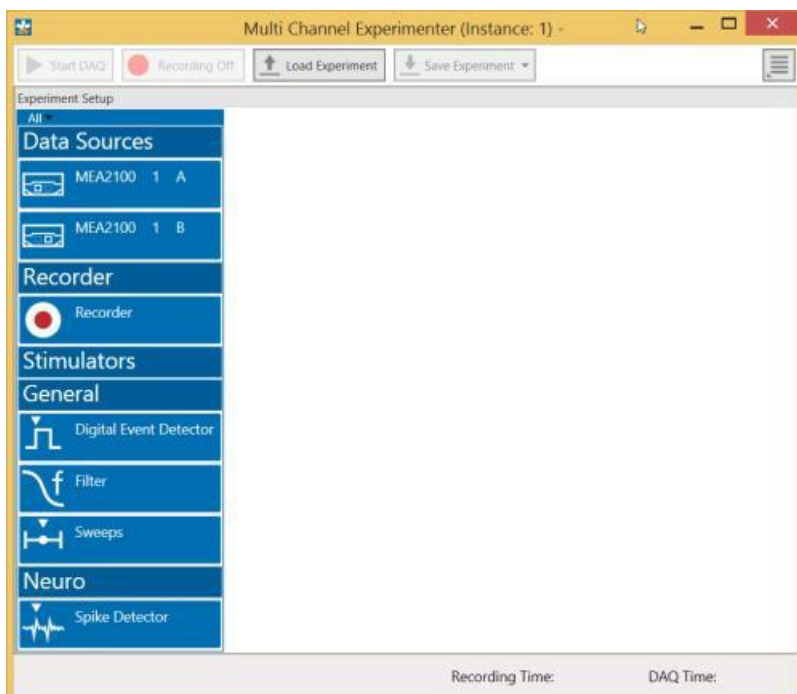
The **USB-MEA256-System** is a plug and play device. The driver is automatically installed together with the Multi Channel Suite or MC_Rack program. It is easier to connect the USB-MEA256-System first to the computer and then install the software.

3.2 Multi Channel Experimenter

Double-click the Multi Channel Experimenter icon or select Multi Channel Experimenter from the "Start" menu. The program starts. The main window opens automatically: "Multi Channel Experimenter (Instance: 1)". It is possible to open up to four instances in parallel. Operation is independent for each instance.

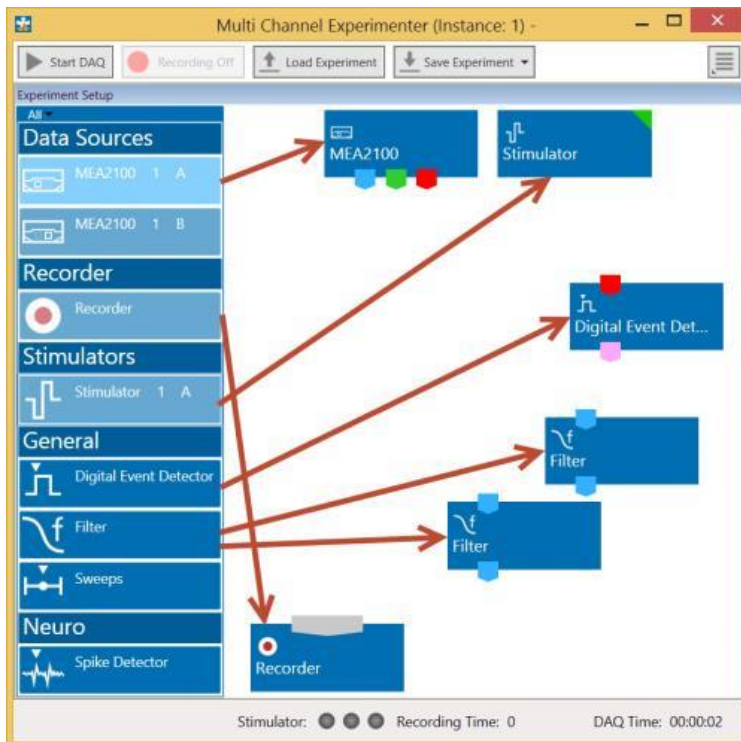
This is your virtual rack configuration in the "Experiment Setup" window, which is blank after program start. On the left side five classes of instruments are provided: "Data Sources", "Recorder" and "Stimulators" are hardware components. The virtual instruments available up to now are divided in "General" and application specific "Neuro".

The header of the dialog contains five buttons: "Start DAQ", "Start Recording", "Load Experiment" and "Save Experiment" in the main toolbar on the left and the "Menu" button on the right. In the bar down under the "Recording Time" and the "DAQ Time" are registered.

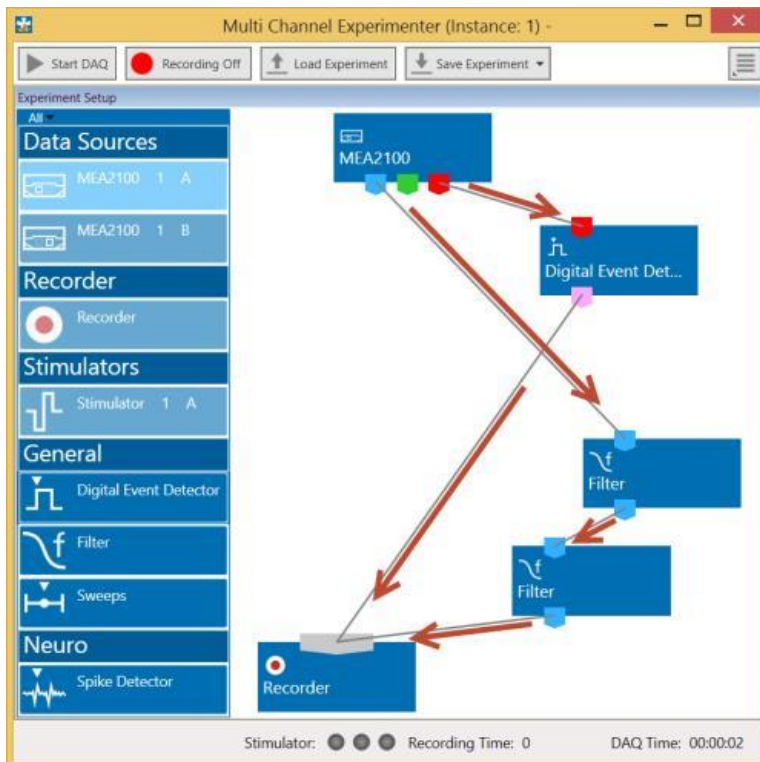


Building a Rack

It is very easy to build a rack: Please click onto the button of the desired instrument and move it via drag and drop from the left to the right side of the main window!



It is also easy to connect the instruments: Please click onto one of the symbols on the lower part of an instrument button to connect this output port via drag and drop with the input port (symbol on the upper side) of the target instrument. Please read the next chapter.



Conventions for Building a Rack

Please consider the rules for connecting the instruments. The Multi Channel Experimenter program allows only connections between output ports at the lower side of the device to the input port on the upper side of the target device. The input and output ports of the devices are color coded for a better assignment of the instruments. The blue symbol represents the port for the "Electrode Raw Data". The green symbol represents the port for the "Auxiliary Analog Data". The red symbol represents the port for the "Digital Data".

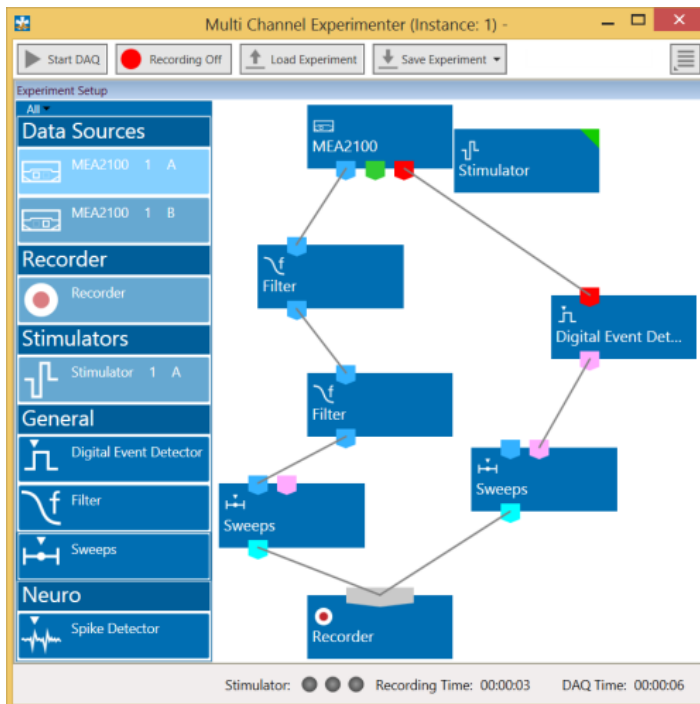


Three color coded output ports of the MEA2100 data acquisition device.

Example: Click on the blue symbol output port of the data source and connect it by drag and drop with the blue symbol input port of the filter. The electrode raw data stream will flow from the data source to the filter. Connect the blue symbol output port from the filter with the black symbol input port of the recorder. The electrode raw data stream will flow from the filter to the recorder. The black input port of the recorder accepts all types of input data streams and you can connect more than one data stream.



The Multi Channel Experimenter Rack



Move as many instruments as you need via drag and drop into the "Experiment Setup" window. It is possible to use the virtual tools more than one time.

3.2 MC_Rack

It is also not recommended to run any applications in the background when using **MC_Rack**. Remove all applications from the Autostart folder.



Warning: The operating system settings of the data acquisition computer were preconfigured by MCS and should not be changed by the user. Changing these settings can lead to program instabilities and data loss.

Installing MC_Rack with the USB-MEA256-System connected to the computer

The Windows operating system detects a new hardware when the **USB-MEA256-System** is connected to the computer, if the program has not been installed beforehand. Please make sure the device has power, that is, the power LED is lighting. Simply cancel the "Found New Hardware Wizard" and proceed with the installation of the **MC_Rack** program.

Connecting the USB-MEA256-System to a computer with installed MC_Rack

If **MC_Rack** had already been installed on the computer before the hardware was connected, the operating system needs to load the driver once. After this procedure, the **USB-MEA256-System** will be automatically recognized by the operating system.

1. Connect the **USB-MEA256-System** to the USB port of the data acquisition computer. Please make sure the device has power, that is, the power LED is lighting.
2. Switch the computer on. The "Found New hardware wizard" is displayed.
3. Choose the option "No", not this time and continue with "Next".
4. Choose the option "Install" the software automatically ("Recommended") and continue with "Next".
5. The Wizard will automatically find the appropriate **USB-MEA256-System** driver. Continue with "Next".
6. The driver installation is finished.

Please check the system requirements before you install the **MC_Rack** software. MCS cannot guarantee that the software works properly if these requirements are not fulfilled. Please see the MC_Rack help or manual for more information. It is recommended that you check the MCS web site for software updates on a regular basis.

Double-click Setup.exe on the installation volume.

The installation assistant will show up and guide you through the installation procedure.

7. Follow the instructions of the installation assistant.
8. The **USB-MEA256-System** driver and **MC_Rack** are installed (or updated) automatically.

4 USB-MEA256-System

4.1 The USB-MEA256 Data Acquisition

Analog input signals are acquired from the data source and digitized by the 256-channel analog / digital converter that is integrated into the main unit. Recorded signals are converted in real-time into digital data streams at sampling rates of up to 40 kHz per channel. You will not miss even the fastest biological signals. Data is transferred to the computer via a High Speed USB 2.0 port.

A 16 bit digital (TTL) input / output channel is available. You can use the digital TTL inputs, for example, for synchronizing stimulation and recording, or for synchronizing the **USB-MEA256-System** with other systems, video tracking, for example. The digital TTL outputs can be used for triggering other devices.

4.2 The USB-MEA256 Filter Amplification

The filter amplifier combines a band pass filter and the signal amplification in one instrument. The bandwidth of 1 to 5000 Hz is suitable for a broad range of applications, such as spike and field potential recording from neurons or recording of cardiac signals. The digital filter of the MC_Rack program can be used to adjust the pass band and filter the raw data. Please see the MC_Rack help or manual for more information. This way, you are very flexible in designing your experiments. Please note that you may need a higher sampling rate to avoid aliasing. See also the chapter [USB-MEA256 Data Acquisition](#) for more information. For slow signals like field potentials, a bandwidth of 1 to 300 Hz is appropriate. If you like to record fast signals like spikes, a pass band of 300 Hz to 5 kHz is suitable. Cardiac signals have fast and slow components; therefore, you usually need a wider bandwidth of 1 Hz to 5 kHz.

Please note that the gain factor of the filter amplifier (1100) is a fixed hardware property; and that you cannot change the gain of the amplifier by software controls. Please also note that the ratio of the output signal to the input signal, that is, the gain, is not a fixed parameter for the complete bandwidth. The gain that was specified for the amplifier, for example, 1100 is not fully reached at the borders of the amplifier's pass band. The general rule is, that at the lower and upper limit of the frequency band, the gain is approximately 70 % of the full gain. Therefore, you should use a bandwidth that is at a safe distance of the signals of interest. Outside the pass band, the gain decreases with the frequency and finally approaches zero.

For more information on gain and filters in general, please refer to standard literature or contact your local retailer.

Raw data from up to 252 electrodes of a microelectrode array MEA is amplified by 252 channels of filter amplifiers that are built very small and compact using SMD (Surface Mounted Devices) technology. The small-sized MEA amplifier combines the interface to the 256MEA probe with the signal filtering and the amplification of the signal. The compact design reduces line pick up and keeps the noise level down. The MEA sensor is placed directly into the small-sized MEA amplifier. When the amplifier is closed, the contact pins in the lid of the amplifier are pressed onto the MEA contact pads. The very close location of the amplifier to the MEA sensor is very favorable concerning a high signal-to-noise ratio.

The amplifier is intended to be used either with inverted or with upright microscopes. The MEA256 amplifier is compatible to most standard microscopes.

The MEA256 amplifier has an integrated heating system for controlling the MEA's temperature. The desired temperature can be easily regulated with a temperature controller TCX.

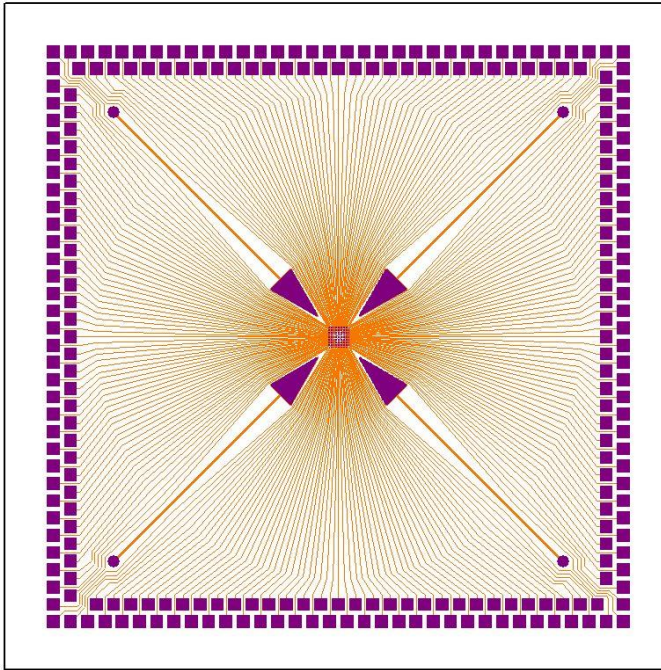
Connect the internal heating element to a temperature controller's output channel (D-Sub9 socket) with the integrated cable. Do not connect the black heating element cable to the computer!

If necessary, you can use a Faraday cage or appropriate materials, for example, aluminum foil, for shielding the amplifier. The shielding should be connected to the amplifier's ground.



Warning: Spilled liquid can damage or even completely destroy the electronics of the MEA256 amplifier. 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.

4.3 256MEA



The microelectrode array **256MEA** to be used with the **USB-MEA256-System** contain 252 recording and four ground electrodes on a glass carrier. Contact to the amplifier is provided by a double ring of contact pads around the rim of the MEA. The electrodes are from Titanium Nitride (TiN) with a Silicon Nitride (SiN) isolator, and contact pads and tracks are made of transparent Indium Tin Oxide (ITO). The electrode grid is 16 x16 with a spacing of 30, 60, 100 or 200 μm between the electrodes with a diameter of 8, 10 and 30 μm . The electrode diameter of 30 μm results in an impedance of approximately 30 - 50 k Ω . Smaller electrodes have a higher impedance, so the electrode diameter of 10 or 8 μm results in an impedance of approximately 250 - 400 k Ω .

The dimension of the glass carrier is 49 x 49 x 1 mm. MEAs are stable in a temperature range from 0° - 125° C. For information about handling and cleaning, please refer to the MEA manual and / or to the MEA Cleaning Quick Guide. The Pin Layout is described in chapter "[Data Sheet 256MEA](#)" in the Appendix. The 256MEA is rotationally symmetrical, so in principle the orientation in the amplifier doesn't matter. If the orientation is important for your experiments, you can use the engraved serial number as marker. The serial number is on the backside of the MEA in the upper right edge. In the amplifier the mirrored number has to be placed in the left upper edge. This way the 256-electrode layout will match the MC_Rack channel layout.

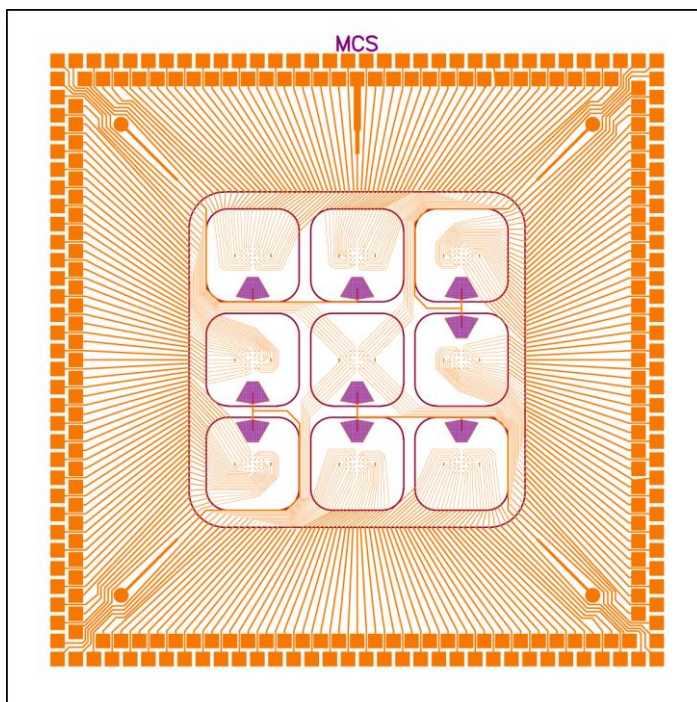
4.4 256 Thin MEA

The glass part of **256 Thin MEAs** are only 180 μm "thick", ideally suited for high-resolution imaging. 256ThinMEAs are like standard MEAs, but the electrodes are embedded in a very thin and delicate glass substrate on a robust ceramic carrier. The thin glass allows the use of oil immersion objectives with a high numerical aperture.

Like 256MEAs, 252 electrodes are arranged in a 16 x 16 layout grid with electrode diameter of 30 μm , and interelectrode distance of 200 μm (256ThinMEA200/30-ITO).

256ThinMEAs are heat-stabilized and can be autoclaved. They can also be coated with different procedures for cell and tissue cultures. They should be handled with great care because of the thin and delicate recording area. Please see chapter "[Data Sheet 256ThinMEA](#)" in the Appendix.

4.5 256-9well MEA



A special MEA layout for the **USB-MEA256-System** is available, the **256-9wellMEA** for using together with a 9 well macrolon quadrate. The 9 wells allow, for example drug screening experiments, with up to 9 compounds at a time. The 256-9wellMEA is in principle constructed like the 256MEA, but the electrodes are clustered. There are 23 recording electrodes with a diameter of 30 μm , two bigger recording or stimulation electrodes (2 x 50 μm), and one big reference electrode per each well. Please see chapter "[Data Sheet 256-9wellMEA](#)" in the Appendix.

4.6 The USB-MEA256-System

USB-MEA256-System is a high flexible system with integrated amplification, data acquisition, and analog / digital conversion. Via USB High Speed 2.0 it is possible to transfer a digitally converted and amplified data stream of up to 252 electrode channels to any data acquisition computer.

Note: Using a USB hub for connecting the **USB-MEA256-System** to the computer is not recommended. The system needs a broad bandwidth for the data transmission. Recording might not be possible, especially if 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.

Top View

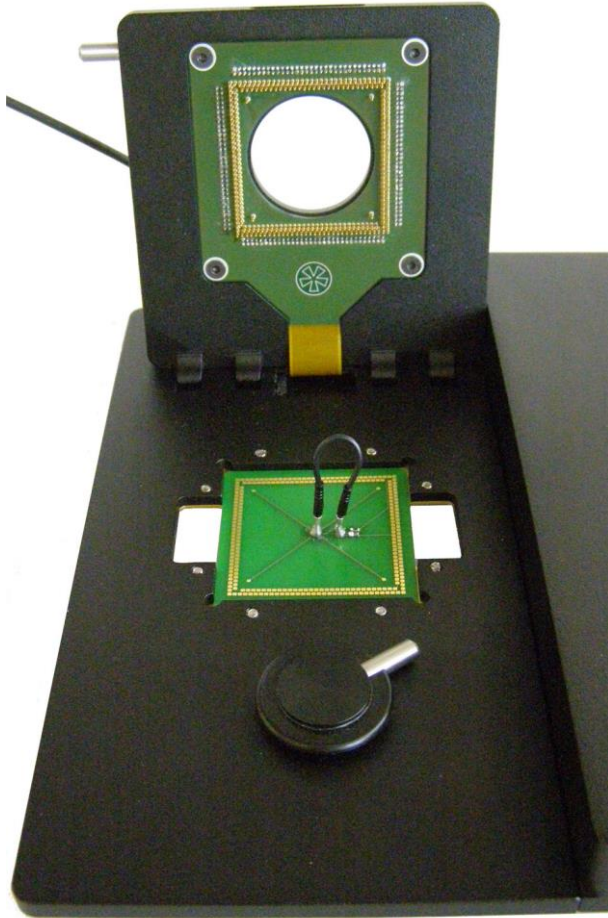


4.7 Connecting the USB-MEA256-System

1. Provide a power supply in the immediate vicinity of the installation site.
2. Place all devices on a stable and dry surface, where the air can circulate freely and the devices are not exposed to direct sunlight.
3. Set up the computer (with installed **MC_Rack** program).
4. Set up the MEA256 amplifier as described in chapter "**Setting up the Amplifier**".
5. Connect the USB output connector to a free USB 2.0 port of the data proceeding computer. It is not recommended to use an USB hub.
6. Connect the **USB-MEA256** via power supply unit to a power outlet of the same electrical system (connected to the same ground / earth wire) as all other components of the setup, for example, the computer or shielding.
7. If necessary, connect the system to an external ground.
8. Connect the internal heating element to the temperature controller's output channel (D-Sub9 socket) with the integrated cable. Do not connect the heating element cable to the computer!
9. Turn the toggle switch at the rear panel on.
10. 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.
11. Install the **MC_Rack** program from the installation volume if it is not already installed. The **USB-MEA256-System** is a plug and play device. The driver is automatically installed together with the MC_Rack program.
12. Start the **MC_Rack** program and select the **USB-MEA256-System** as the data source. Please see the **MC_Rack** help or manual for more details on how to define the data source.

4.8 Setting Up the Amplifier

Open the lid of the amplifier.



Place the 256MEA **test model probe** inside. Replace the lid and close it carefully.

First Functional Tests

Each MEA amplifier 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, or to fulfill your own guidelines, for instance. Some of the tests will also help you to get to know the basic functions of the hard- and software, like a short tutorial. It will take only a few minutes time and can save you time and trouble in the long run. Multi Channel Systems recommends running these tests after the setup of your system before you start your real experiments.

General Performance / Noise Level

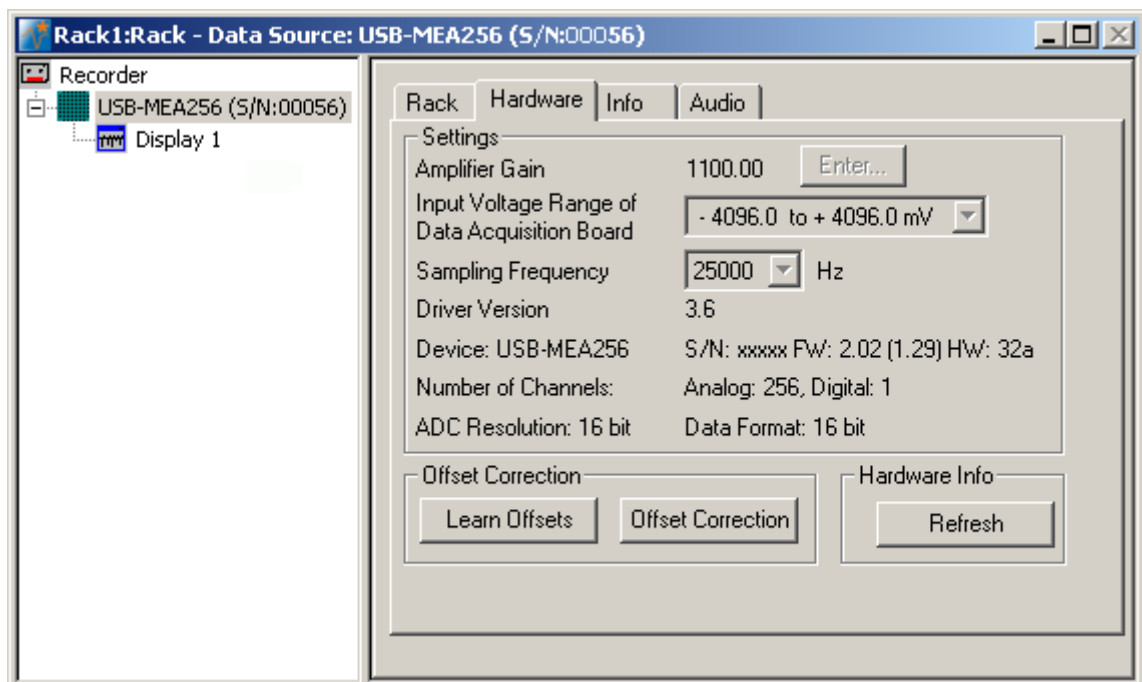
Please use the provided test model probe to test the amplifier immediately after installation. It simulates a MEA with a resistor of 220 k Ω and a 1 nF capacitor between bath and electrode. Use MC_Rack or your custom data acquisition program to record from the test model probe and to check the amplifier. Please see "[Test Model Probe](#)" in the Appendix.

Alternative to the test model probe you can use n 256MEA Signal Generator. 256MEA Signal Generator is a convenient tool for USB-MEA256 System users. Use the 256MEA-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 see the data sheet "[256MEA-SG](#)" in the Appendix

Setting up MC_Rack

Please refer to the MC_Rack manual for more information.

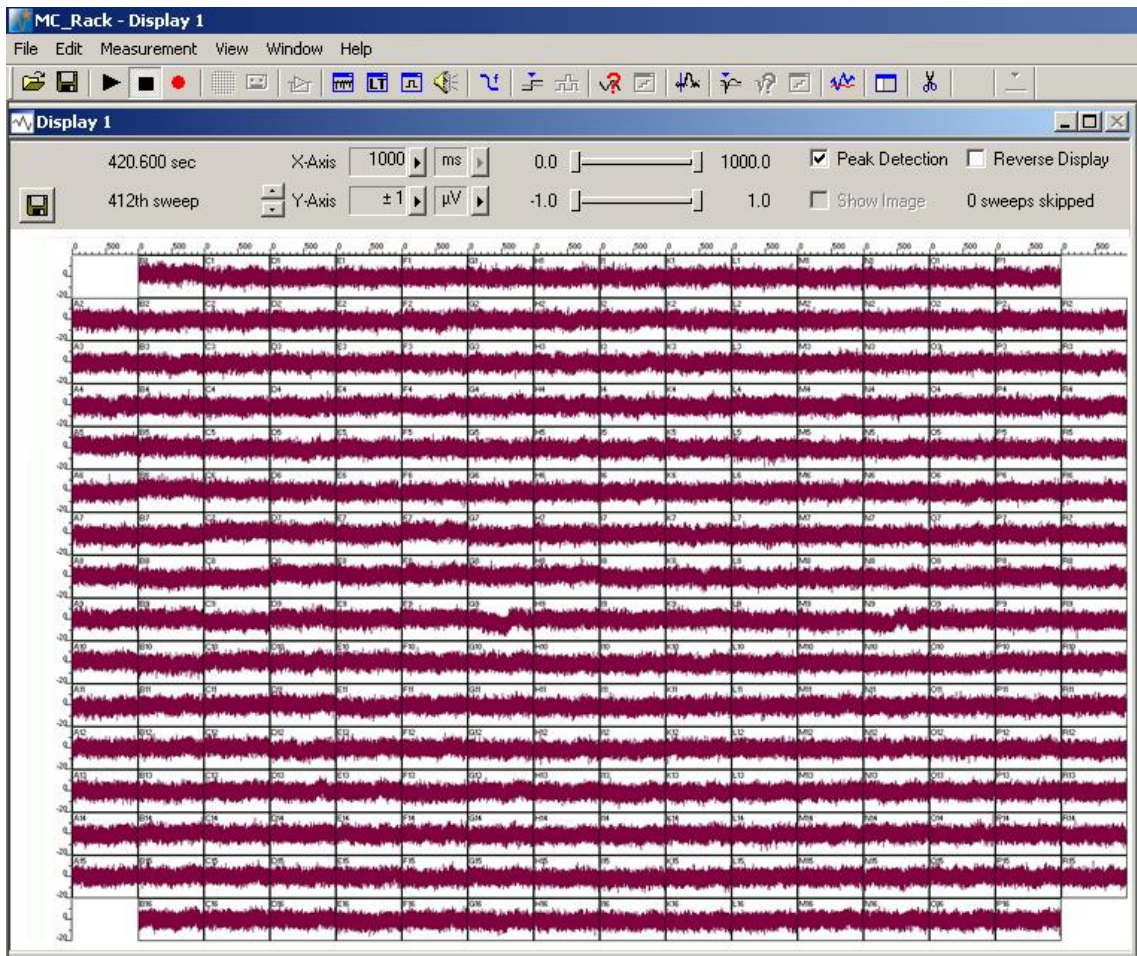
1. Start MC_Rack.
2. Click "Data Source Setup" on the "Edit" menu. Select USB-MEA256.
3. Add USB-MEA256 as a data source to your virtual rack.
4. On the "Edit" menu, click "Add Data Display" to add a raw data display to your virtual rack.
5. Click the "Hardware" tab of the USB-MEA256 and enter the sampling frequency in Hz.



Start the data acquisition

1. Click the "Start" button to start the data acquisition. No data is recorded. You see the raw data streams of all 252 channels in the 16 x 16 MEA layout.
2. You may have to adjust the position and span of the axes until you can clearly see the noise level. You should see the baseline with a maximum noise level of +/- 8 μ V.

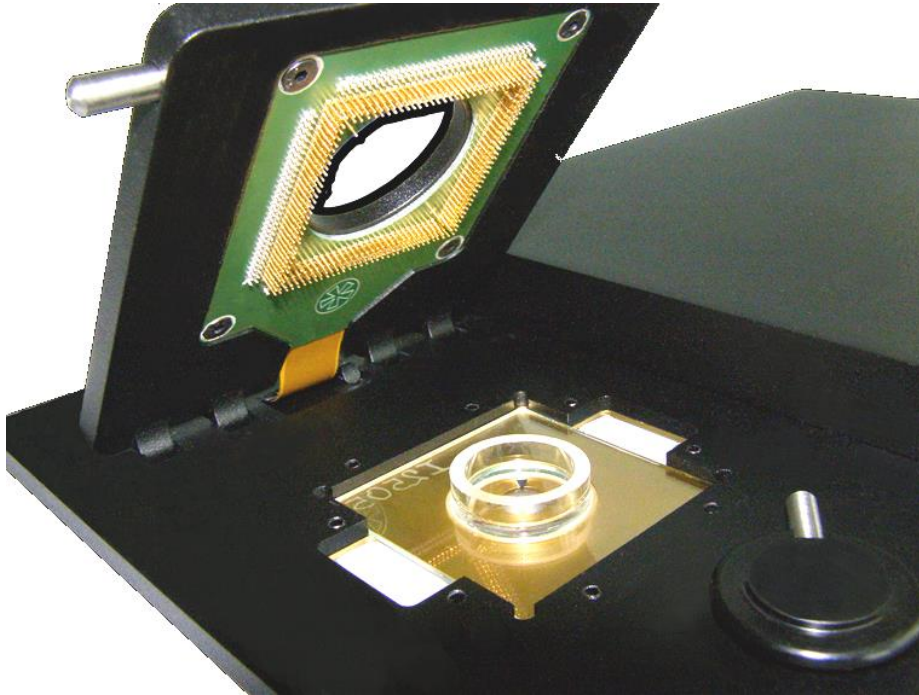
The following screen shot shows a recording from a USB-MEA256-System with a test model probe and a sampling rate of 40 kHz.



Setting up an Experiment

Open the lid of the amplifier. Place the 256MEA chip inside the USB-MEA256 amplifier. The pin layout is described in chapter "Pin Layout" in the Appendix. The MEA256 is rotationally symmetrical, so in principle the orientation in the amplifier doesn't matter. If the orientation is important for your experiments, you can use the engraved serial number as marker.

Replace the lid and close it carefully.



Warning: Spilled liquid can damage or even completely destroy the electronics of the MEA256 amplifier. 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.

Grounding the bath

256MEAs are equipped with 4 internal reference electrodes, which will be automatically connected to the systems ground when the amplifier is closed. This has the advantage that you can keep the culture chamber closed and sterile (for example, with MEA-MEM semipermeable membranes).

Service and Maintenance

You should clean the contact pins of the amplifier 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.

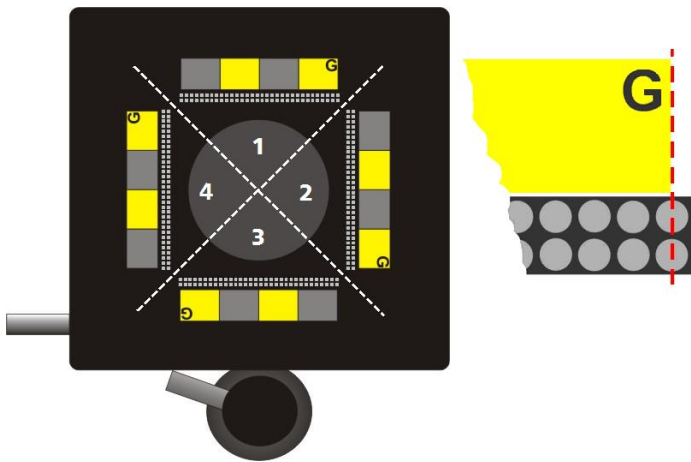


Warning: Please be very careful when handling the amplifier, or cleaning the device! The pins can be damaged easily.

Using 256MEA Electrodes for Stimulation

The electrodes of the 256MEAs can also be used for electrical stimulation. Around the open area for the 256MEA, there are two rows of connection sockets on each side in the lid of the amplifier. There is one socket for each electrode and four ground sockets. These sockets can be used to connect each electrode to a stimulus generator, for example, a STG4000 from Multi Channel Systems MCS GmbH. The ground sockets can be used to connect other devices, like the stimulator, or the perfusion to the systems ground. You will find the layout map of the sockets in chapter "Pin Layout" in the Appendix.

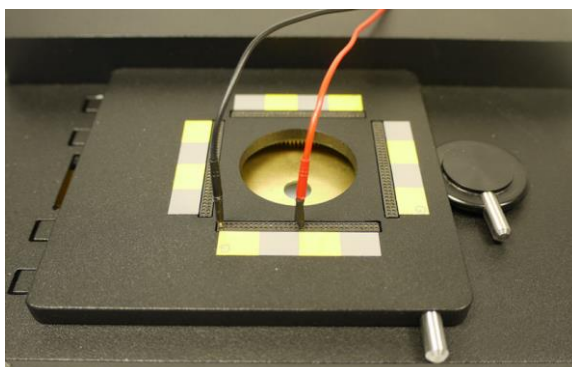
To make it easier to find the correct socket for each electrode, stickers are included to color code the electrode sockets in four blocks of 2 x 8 sockets, corresponding to the color code used in the layout map in chapter "Pin Layout" in the Appendix. If you want to do electrical stimulation, please attach the stickers as shown in the image below. The edge of the sticker has to be aligned with the first pair of sockets.



The position of the four ground sockets is labeled with a G. The connection sockets are arranged in quadrants. The electrodes in quadrant 1 have their sockets in the upper row, electrodes in quadrant 2 in the right row and so on.

To find the connection socket for a specific electrode, please do following:

- Determine the quadrant the electrode is in.
- Look up the exact position of the socket in the layout map.
- Determine the label (yellow/grey) the socket belongs to.
- Count the sockets from the edge of the label.
- Plug in the stimulation adapter ADPT-STIM-MEA256 in the correct connector socket.
- Connect the ADPT-STIM-MEA256 via laboratory cable with the stimulus generator STG.



Using 256-9wellMEA Electrodes for Stimulation

Each well of the nine wells of the 256-9wellMEA is equipped with 26 round recording electrodes in a 6 x 5 grid, two square electrodes S1 and S2 for recording or stimulation and one big reference electrode. For detailed information, please read chapter “256-9wellMEA” and the data sheet.

If stimulation electrodes S1 and S2 in all wells are to be stimulated simultaneously, it is recommended to use the adapter 256MEA-9well-STIM-ADPT. See also the data sheet “256MEA-9well-STIM-ADPT” in the Appendix.



Please fix the adapter 256MEA-9well-STIM-ADPT on the connector sockets on the lid of the USB-MEA256 amplifier as shown on the picture above. The red connectors (2 mm) connect to the stimulation electrodes S1 or S2 in each well, respectively. The black connectors connect to the ground electrodes in each well.

Three modes of stimulation are possible:

- Monopolar S1 versus ground: Connect the stimulator output to the red connector S1, and the stimulator ground to the black connector S1.
- Monopolar S2 versus ground: Connect the stimulator output to the red connector S2, and the stimulator ground to the black connector S2.
- Bipolar S1 versus S2: Connect the positive stimulator output to the red connector S1, the negative stimulator output to the red connector S2, and the stimulator ground to the black connector S1 or S2.

Please see STG manual for details on stimulation modes.

4.9 The USB-MEA256 Device

Rear Panel



DIGITAL IN / OUT

A **Digital IN / OUT** for 16 digital in- and output bits is available (68-pin MCS standard connector). The Digital IN / OUT connection accepts or generates standard TTL signals. 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** from Multi Channel Systems MCS GmbH. You can utilize this digital signal to control and synchronize other devices with the **USB-MEA256-System**. Bit 0 of the Digital OUT is separated and available as Lemo connector DIG OUT D0. So if you need only one bit of the digital signal, you don't need the additional signal divider SD16. Please read chapter "Pin Layout" (Digital IN / OUT Connector) in the Appendix for more information.

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 from a stimulator.

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, the state can be HIGH (1) or LOW (0). Standard TTL signals are accepted as input signals on the digital inputs. Unused input bits, which have an undefined state, should be masked in the Trigger Detector of MC_Rack.



Warning: A voltage that is higher than +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 – 5 V) to the digital inputs.

Power LED

The **Power LED** lights up when the **USB-MEA256** is connected via power supply unit to the power supply system, and the toggle switch on the rear panel is switched on.

Digital Output D0 OUT

The Bit 0 of the Digital OUT is also accessible independently from the 68-pin Digital IN / OUT connector with a Lemo connector. The digital output channel D0 is generally used for synchronizing the **USB-MEA256-System** with a stimulus generator, or with another data acquisition system, for example, an imaging or a patch clamp system. The **D0 OUT** generates standard TTL pulses.

Digital Input D0 IN

The Bit 0 of the Digital IN is also accessible independently from the 68-pin Digital IN / OUT connector with a Lemo connector. The digital output channel D0 is generally used for synchronizing the **USB-MEA256-System** with a stimulus generator, or with another data acquisition system, for example, an imaging or a patch clamp system. The **D0 IN** accepts standard TTL pulses.

Audio Output AUDIO

To the **AUDIO OUT** (3.5 mm phone jack) you can connect an audio system to make the electrical activity audible. In contrast to the sound tool of MC_Rack, this audio output is real time. There is almost no time delay between the detection of a signal by the recording electrode and the corresponding sound. Headphones or a speaker can be connected directly to the AUDIO OUT. Only one channel can be converted into sound. This channel can still be selected by using the sound instrument of MC_Rack. You can listen only to Electrode Raw Data in real time. The quality of the sound is mono.

Note: You can add only one sound instrument to your rack, and you can convert only one channel into sound.

Analog Input A1 to A4

Four additional analog inputs are available (Lemo connectors).

The amplifier delivers analog data streams from 252 channels to the integrated data acquisition and A / D converter of the **USB-MEA256**. The remaining four channels 127, 128, 255 and 256 are used for the additional analog inputs **Analog IN A1 to A4**.

The additional analog inputs one to four are intended for recording additional information from external devices, for example, for recording patch clamp in parallel to the MEA recording, for monitoring the temperature, or for recording voice. You could also use the analog inputs for triggering, but please note that the digital inputs, especially D0 IN are intended for accepting TTL pulses. Signals on the analog channels are not amplified. They are only digitized and recorded as they are, with no respect to the gain specified in MC_Rack.

USB

The USB connector is 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 High Speed USB 2.0 (type A - mini B) cable.

GROUND

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

POWER IN

Connect the power supply unit here. This power supply powers the **USB-MEA256** main unit only. The device needs 12 V and 1.3 A / 16 W.

Toggle Switch I / O

Toggle switch for turning the device on and off. The **USB-MEA256** is switched to status "ON" when the toggle switch is switched to the left to "I". The device is switched "OFF" when the toggle switch is switched to the right "O". If the **USB-MEA256** is "ON", and the device is connected to the power line, the LED should light up. If not, please check the power source and cabling.

Cabling

For D0 IN and D0 OUT, and Analog Input A1 to A4 on the rear panel of the device you need coaxial cable: Lemo cable with one head BNC connector, the other head "Lemo" connector. Please see the picture below.



Temperature Controller TC01 / 02

The **USB-MEA256-System** features a **heating element** with a PT100 temperature sensor. If you connect a **temperature controller TCX** to the heating element via D-Sub 9 connector, the heating element guarantees constant temperature conditions for the biological sample, placed on the 256MEA.



5 Troubleshooting

5.1 Troubleshooting

The following hints are provided to solve special 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 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.

5.2 No Computer Connection / No Recording Possible

You cannot establish a connection to the computer. The **USB-MEA256-System** channel layout is not available in MC_Rack. When loading a previously saved virtual rack file, you will get an error message and the simulator will be started automatically. You get an error message when starting the recording in MC_Rack 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 2.0 or might not be working.

Check the USB port. Only full speed USB 2.0 ports can be used. Try another USB 2.0 port.

? You can establish a connection, but get an error message when starting the recording in MC_Rack. The bandwidth of the USB port is not sufficient for recording. This can be the case if the **USB-MEA256-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 **USB-MEA256-System** directly to a USB port, not via hub.

5.3 Triggering / Digital Input does not Work

You have connected a TTL source (for example, the Sync Out of a stimulus generator) to the digital input D0 of the **USB-MEA256-System**, and configured the virtual rack in MC_Rack 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 (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 **USB-MEA256-System** can only accept TTL signals (5 V TTL level) 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 Trigger Detector do not match with the hardware configuration.

In MC_Rack, add a Trigger Detector to your virtual rack, and select the Digital Data D1 input stream as the Trigger. Check the pin layout of the Digital IN/OUT connector and make sure that the same bit input that is connected is selected in the software. (The standard settings of the Trigger Detector are for using bit 0.) Mask all unused bits. Select the appropriate logical state (generally HIGH) for triggering. Please see the MC_Rack help or manual for more details.

5.4 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 amplifier may be defective. To test this, do the following.

Open the amplifier and turn the 256MEA by 90 degrees. Close the amplifier 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 okay now, the 256MEA electrode is not okay, but the amplifier is fine.

— OR —

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

5.5 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. See the MEA amplifier's manual for more information on grounding channels. 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.

5.6 Overall Noise / Unsteady Baseline

The baseline is unstable, signals are jumping or drifting.

Possible causes:

? Bath electrode is not connected to ground.

Connect the internal or external bath electrode to one of the ground inputs of the amplifier.

? 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 the amplifier that is connected to any metal part of the MEA amplifier. You can also use special shielding equipment like a Faraday cage.

5.7 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 electrode/tracks and the bath. You will still see signals, but as an unspecific smear over the complete array.

Use a fresh MEA.

6 Appendix

6.1 Technical Support

Please read the chapter "Troubleshooting" of the user manual first. Most problems are caused by minor handling errors. Contact your local retailer immediately if the cause of trouble remains unclear. 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 in MC_Rack Hardware tab.
- 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. On the "Help menu", click "About" to display the software version.

6.2 Technical Specifications

The USB-MEA256-System is a 252 + 4 channels amplifier with integrated analog / digital board converting analog signals to digital data streams in real time. It is intended to directly contact to a 252 electrode Microelectrode Array (MEA).

General characteristics

Operating temperature	10 °C to 50 °C
Storage temperature	0 °C to 70 °C
Relative humidity	10 % to 85 %, non-condensing
Dimensions (L x D x H)	325.4 mm x 207.7 mm x 25.2 mm
Weight	2005 g

Amplifier

Number of electrode channels	252
Input voltage range	+/- 3.7 mV
Data resolution	16 Bit
Bandwidth	1 Hz – 5 kHz
Gain of analog signal path	1100
Cross talk (channel to channel)	typical 0.01 %, max. 0.1 %

Additional analog inputs

Number of additional inputs	4
Input voltage range	+/- 4.096 V
Bandwidth	DC to 15 kHz
Input impedance	1 M Ω 1 nF
DC offset	max. +/- 2 mV

Digital inputs & outputs

Number of digital input channels	16
Digital input signal levels	CMOS (3.3 V input)
Digital input impedance	100 k Ω
Number of digital output channels	16
Digital output signal levels	CMOS (3.3 V output)

Data converter and USB interface

Sampling frequency	up to 40 kHz
--------------------	--------------

Maximal data rate	20.5 MB/s
Data resolution	16 Bit
USB Version	USB 2.0 High Speed

Heating element and temperature sensor

Heating element impedance	20 Ω
Temperature sensor type	PT 100 with 4 wire connection

Rear Panel interface and connectors

1 16 bit digital in / out	68-pin MCS standard connectors, MCS high grade cable
1 Digital out D0 OUT	Lemo connector (EPL.00.250 NTN)
1 Digital in D0 IN	Lemo connector (EPL.00.250 NTN)
1 Audio output	Stereo jack 3.5 mm
4 Additional analog inputs	Lemo connector (EPL.00.250 NTN)
USB	USB 2.0 High Speed cable (type A – Mini B)
Ground	Common jack 4 mm, banana plug
Power supply	Barrel connector 0.7 x 2.35 mm

Power supply unit (MPU 30)

Input voltage	90 – 264 VAC @ 47 - 63 Hz
Output voltage	11 – 13 V
Max. Power	30 W

Software

MC_Rack program	Version 3.7.0 and higher
Operating system	Windows 7, XP or Vista with NTFS English and German versions are supported
MC_DataTool program	Version 2.4.5 and higher
Data export	ASCII (*.txt), binary file (*.raw) format



Warning: The device may only be used together with Microelectrode Arrays 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 data acquisition box and do not change hardware configuration as it could lead to improper behavior of the system.

6.3 Pin Layout

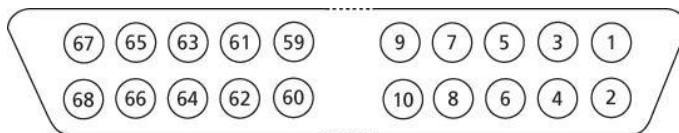
Analog IN A1 to A4

Please note that the channels 127, 128, 255 and 256 are not used for recording analog raw data from 256MEA in the USB-MEA256-System. A1 to A4 are for additional analog data.

Analog 1	Channel 127
Analog 2	Channel 128
Analog 3	Channel 255
Analog 4	Channel 256

Digital IN / OUT Connector

68-Pin MCS Standard Connector



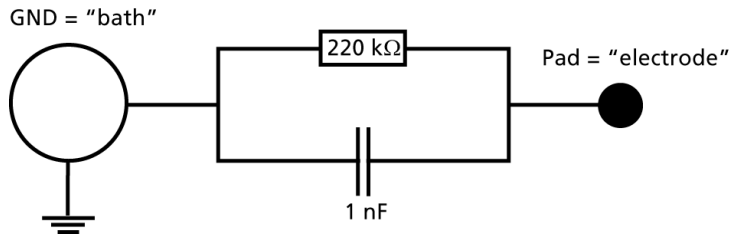
Pin 1	GNDP (power ground)
Pin 2	GNDS (signal ground)
Pin 3 - 10	Digital output channels bit 0 - 7
Pin 11 - 14	GNDS (signal ground)
Pin 15 - 22	Digital output channels bit 8 - 15
Pin 23 - 26	GNDS (signal ground)
Pin 27 - 34	Digital input channels bit 0 - 7
Pin 35 - 38	GNDS (signal ground)
Pin 39 - 46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

Digital Out D0 OUT Bit 0 of the 16 bit digital output channels (Pin 3)

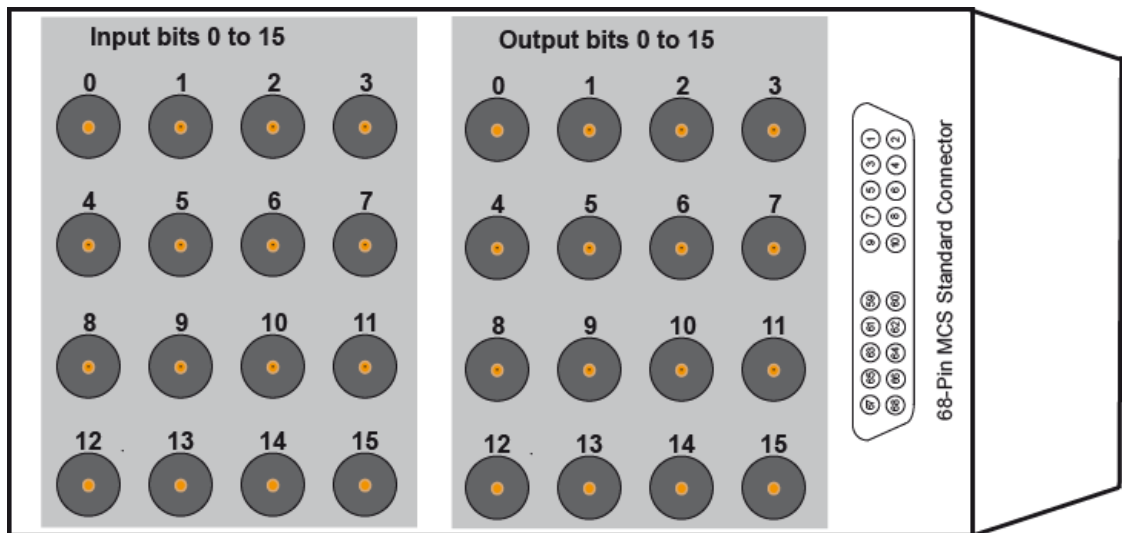
Digital In D0 IN Bit 0 of the 16 bit digital input channels (Pin 27)

6.4 Test Model Probe

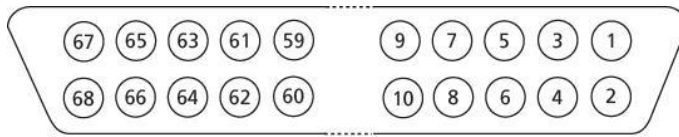
The provided model test probe simulates a 256MEA with a resistor of 220 k Ω and a 1 nF capacitor between bath and electrode, for all 256 electrodes, and can be used for testing USB-MEA256-Systems.



6.5 Digital IN / OUT Extension



16 bit Digital IN / OUT Connector (68-Pin MCS Standard Connector)



Pin	1	GNDP (power ground)
Pin	2	GND5 (signal ground)
Pin	3 - 10	Digital Output channels bit 0 to 7
Pin	11 - 14	GND5 (signals ground)
Pin	15 - 22	Digital output channels bit 8 to 15
Pin	23 - 26	GND5 (signals ground)
Pin	27 - 34	Digital input channels bit 0 to 7
Pin	35 - 38	GND5 (signals ground)
Pin	39 - 46	Digital output channels bit 8 to 15
Pin	47 - 48	GND5 (signals ground)
Pin	49 - 63	Internal use, please do not connect
Pin	64 - 66	GND5 (signals ground)
Pin	67	Positive supply voltage
Pin	68	Negative supply voltage

6.6 Scope of Delivery

1	USB-MEA256-System
1	Data acquisition computer
1	USB 2.0 high speed cable (type A - mini B)
4	Lemo coaxial cable with BNC and Lemo connectors (1 m)
1	Power supply unit with country specific power cord
1	Data acquisition and analysis software MC_Rack (Version 3.6.7 and higher)
1	Data export software MC_DataTool (Version 2.4.3 and higher)
1	USB-MEA256-System Manual
1	Data Sheet

6.7 Contact Information

Local retailer

Please see the list of official MCS distributors on the [MCS web site](#).

User forum

The [Multi Channel Systems User Forum](#) provides the opportunity for you to exchange your experience or thoughts with other users worldwide.

Mailing list

If you have subscribed to the [mailing list](#) 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 contact form of the MCS web site.

www.multichannelsystems.com

7 Index

1		
16-bit digital IN / OUT	1, 9	
2		
256MEA	9, 10, 23, 30	
16x16 grid.....	10	
Electrode diameter	10	
Electrode impedance	10	
Glass carrier.....	10	
Ground electrodes.....	10	
ITO.....	10	
Pin Layout.....	10, 30	
Recording electrodes	10	
SiN isolator	10	
Spacing between electrodes	10	
Temperature range.....	10	
Tin electrodes.....	10	
256MEA-9well-STIM-ADPT	34	
256MEA-STIM-C-Con	33	
25MEA Signal Generator	12, 34	
9		
9 Wells	10, 34	
256-9wellMEA	10, 12, 34	
256ThinMEA	10, 35	
A		
A / D converter	1, 9	
Amplifier	1, 9, 11	
Filter	9	
Signal Amplifikation	9	
Analog Input A1 to A4	11	
Analog input signals	9	
AUDIO	11	
C		
Cardiac signals	9	
D		
D0 IN	11	
D0 OUT	11	
Data acquisition	1, 9, 11	
DIGITAL IN / OUT	11	
Digital IN / OUT Extension	20	
E		
Electrode Stimulation	20	
F		
Faraday cage	9	
Field potential	9	
Filter amplifier	9	
bandwidth.....	9	
frequency band	9	
gain	9	
First functional test	12	
G		
General Performance / Noise Level	12	
Ground	11	
Grounding	12	
Grounding the bath	12	
H		
Hub	11	
L		
Lemo connector	11	
M		
Macrolon Quadrate	10, 34	
MC_Rack software	5, 11	
MEA Cleaning	10	
Microscope	1, 9, 12	
N		
Noise Level	12	
P		
Pin Layout	30	
Power In	11	
POWER LED	11	
R		
Rear Panel	20	
S		
Sampling rate	1, 9, 12, 27	
Service and Maintenance	12	
Stimulation	20	
T		
TCX	9	
Technical Specifications	27	
Technical Support	27	
Temperature Control	1, 12	
Test model probe	12, 30	
Toggle Switch I / O	11	
Triggering other devices	1, 9	
Troubleshooting	23, 27	
MEA is defective	23	
Missing Spikes	23	
No Computer Connection	23	
Noise on Single Electrodes	23	
Triggering does not work.....	23	
TTL	1, 12, 27	

U

USB 1, 11, 27
USB hub 11

USB-MEA256-System 1, 11
Using Electrodes for Stimulation 12
 Pin Layout..... 12
 Sticker 12