multichannel systems

USB-MEA256-System Manual

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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.

Data is recorded, graphed, analyzed, and reviewed with the powerful and easy-to-use **MC_Rack program** from Multi Channel Systems MCS GmbH. You can export the data in standard formats to other programs with the software **MC_DataTool.** Instead of MC_Rack any other common data processing program or custom software can be used.

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.

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 **MC_Rack** program. It is easier to connect the **USB-MEA256-System** first to the data acquisition computer and then install **MC_Rack**.

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.

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 MC_Rack, and even data loss may occur.
6. 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 MC_Rack program. It is easier to connect the **USB-MEA256-System** first to the computer and then install MC_Rack.

3.1.4 First Use of 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.

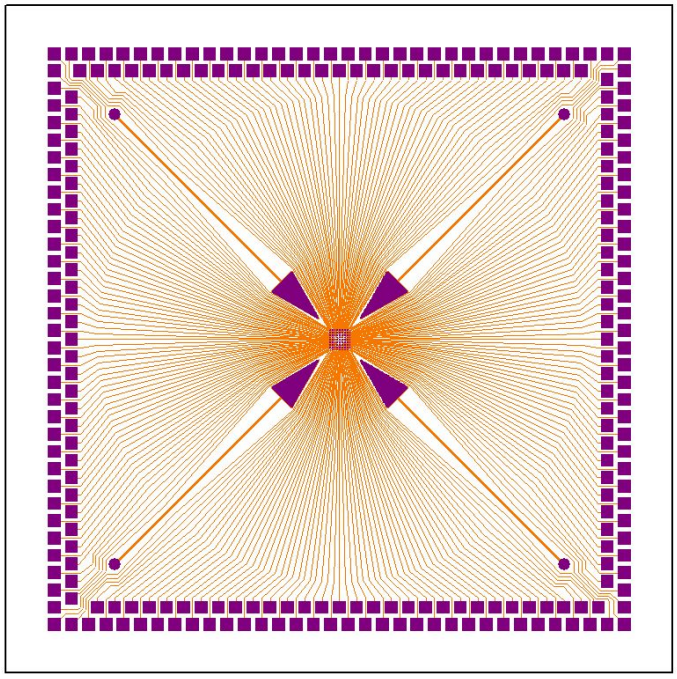
The MEA256 amplifier has an integrated heating system for controlling the MEA's temperature. The desired temperature can be easily regulated with a temperature controller TCX.

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 kΩ. Smaller electrodes have a higher impedance, so the electrode diameter of 10 or 8 µm results in an impedance of approximately 250 - 400 kΩ.

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 serial number has to be placed in the upper left edge. This way the 256-electrode layout matchs with the MC_Rack channel layout.

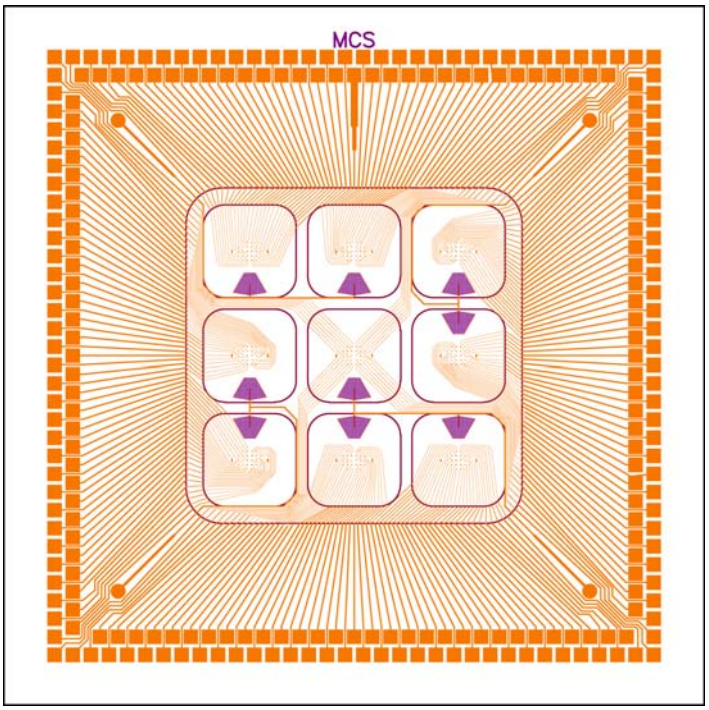
4.4 256 Thin MEA

The glass part of **256 Thin MEA**s 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



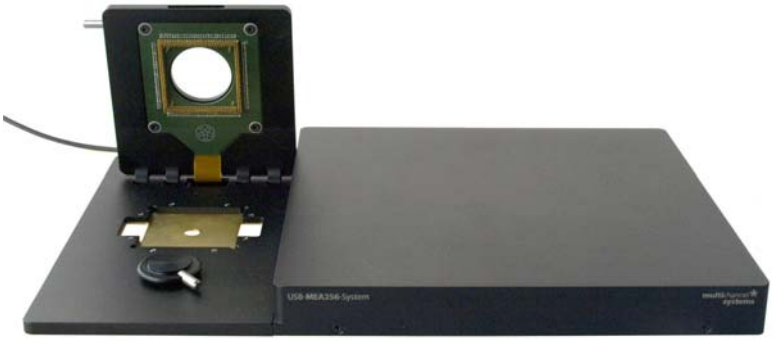
A special MEA layout for the **USB-MEA256-System** is available, the **256-9wellMEA** for using together with a 9 well macrolon quadrate. The 9 wells allow, for example drug screening experiments, with up to 9 compounds at a time. The 256-9wellMEA is in principle constructed like the 256MEA, but the 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

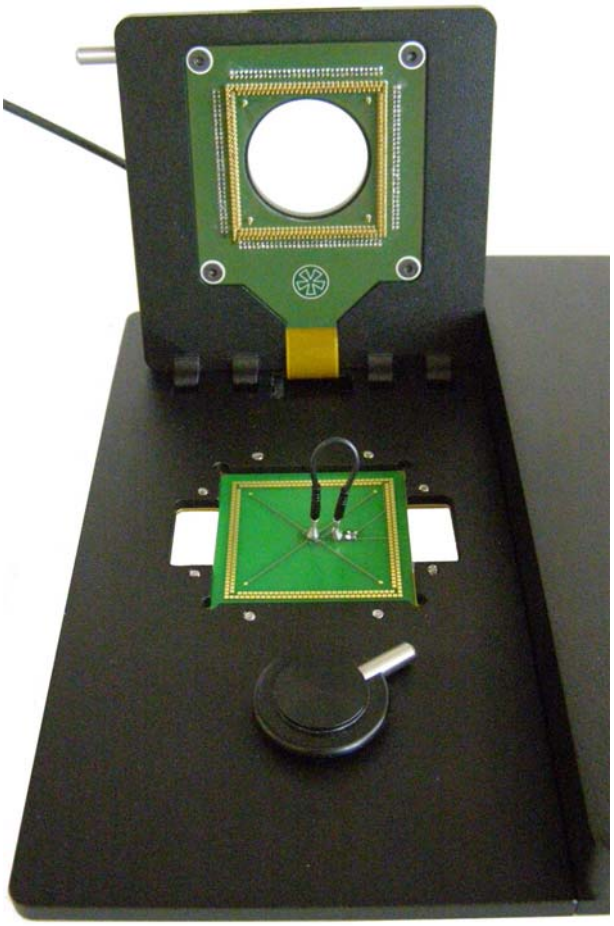


4.7 Connecting the USB-MEA256-System

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

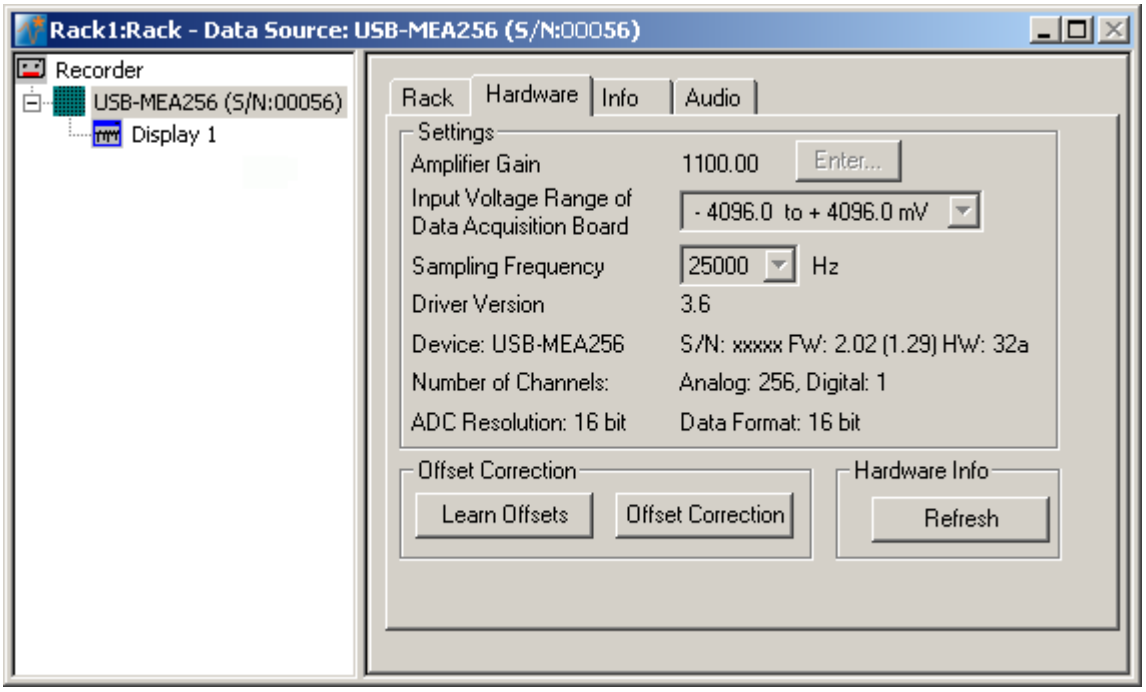
Please use the provided test model probe to test the amplifier immediately after installation. It simulates a MEA with a resistor of 220 kΩ and a 1 nF capacitor between bath and electrode. Use MC_Rack or your custom data acquisition program to record from the test model probe and to check the amplifier. 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.

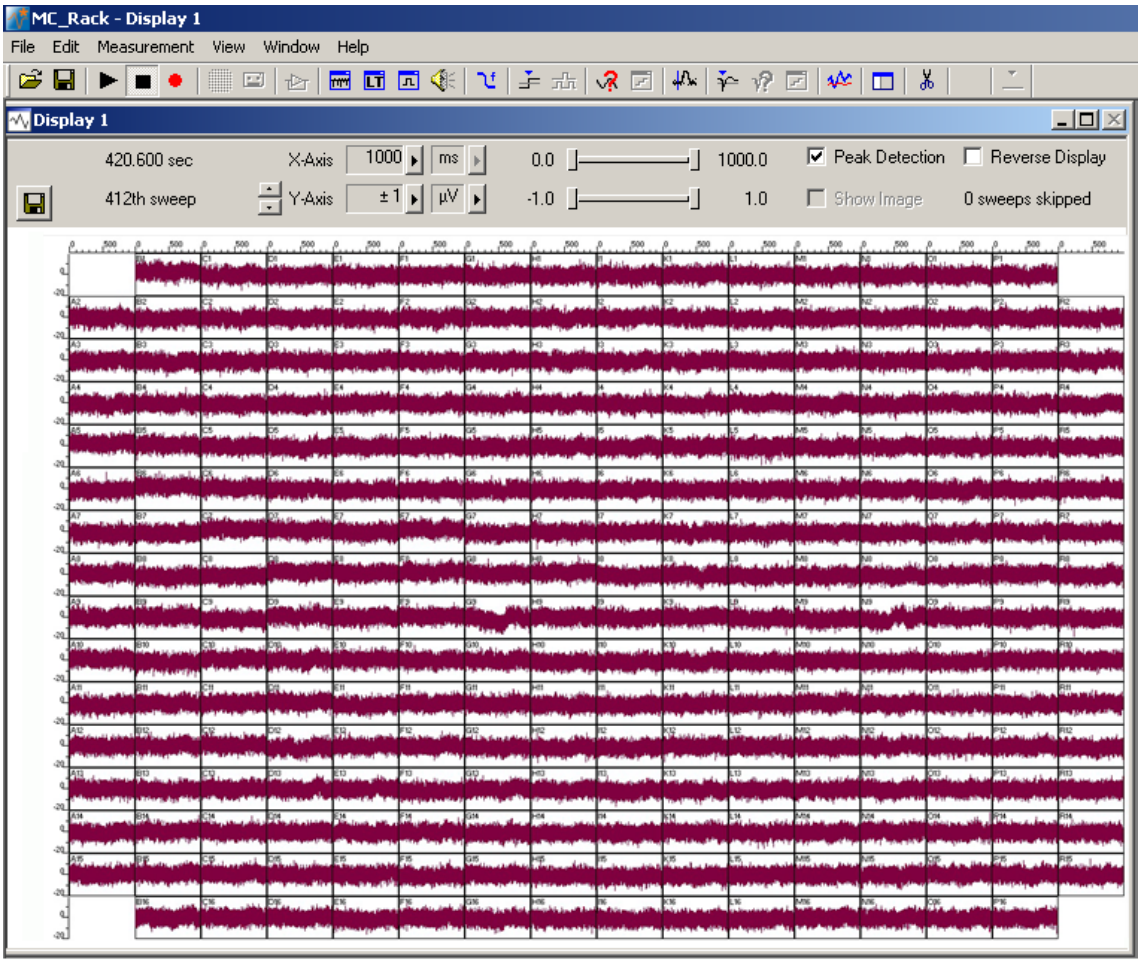
1. Start MC_Rack.
2. Click “Data Source Setup” on the “Edit” menu. Select USB-MEA256.
3. Add USB-MEA256 as a data source to your virtual rack.
4. On the “Edit” menu, click “Add Data Display” to add a raw data display to your virtual rack.
5. Click the “Hardware” tab of the USB-MEA256 and enter the sampling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

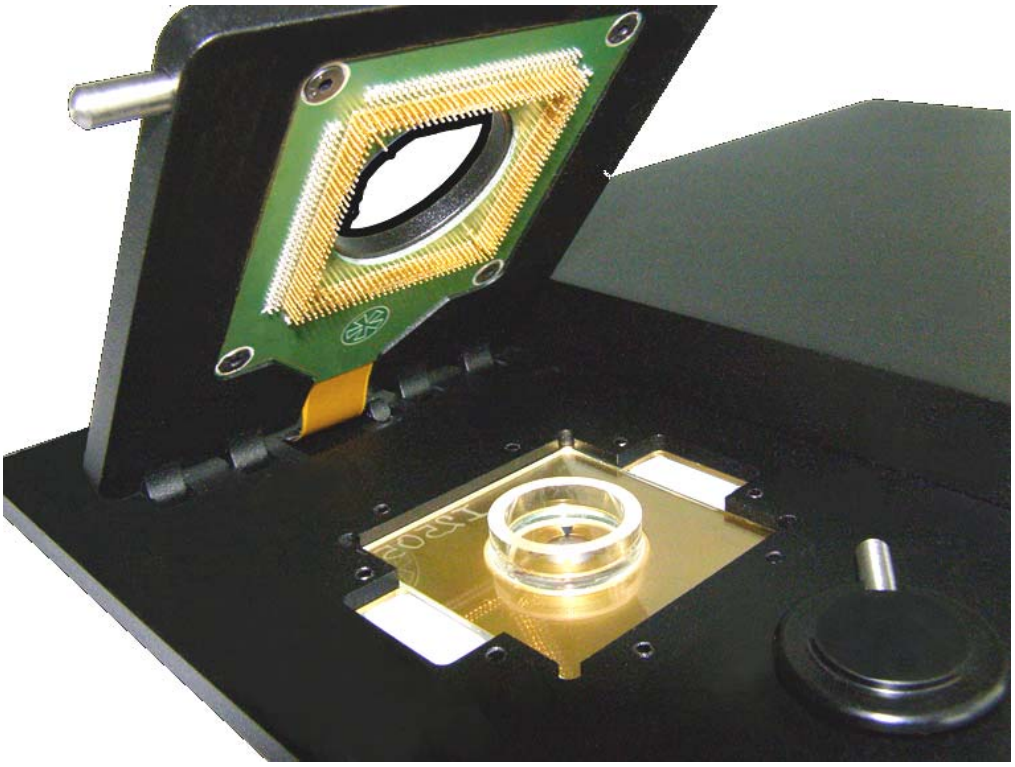
The following screen shot shows a recording from a USB-MEA256-System with a test model probe and a sampling rate of 40 kHz.



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

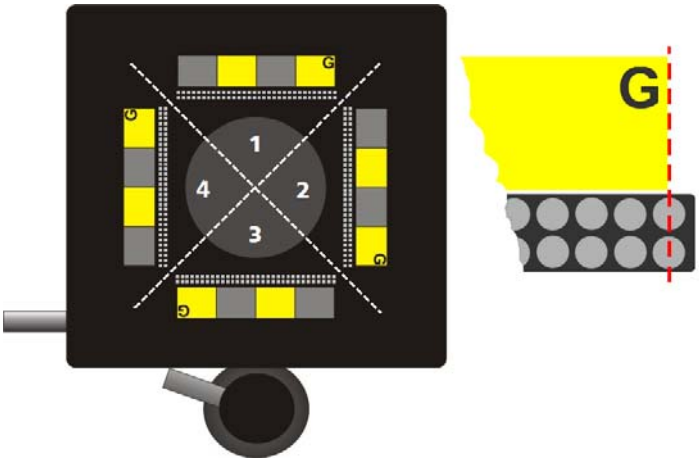
You should clean the contact pins of the amplifier carefully with a soft tissue and alcohol or isopropanol from time to time, especially if you have problems with the noise level. For handling and cleaning of the MEA, please refer to the MEA manual or to MEA Cleaning Quick Guide on the MCS web site www.multichannelsystems.com.

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.

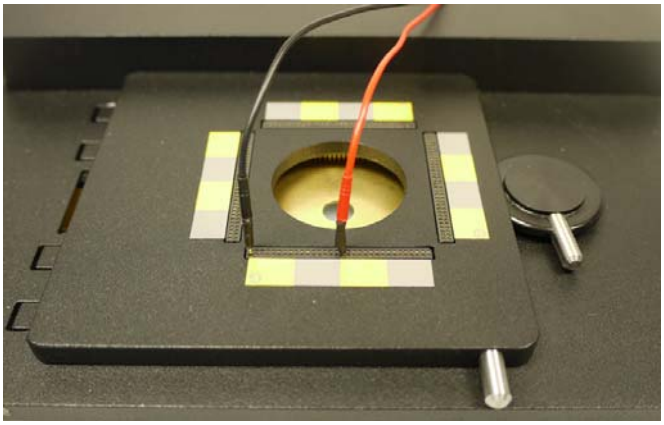
To make it easier to find the correct socket for each electrode, stickers are included to color code the electrode sockets in four blocks of 2 x 8 sockets, corresponding to the color code used in the layout map in chapter "Pin Layout" in the Appendix. If you want to do electrical stimulation, please 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

4.9.1 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 MΩ || 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 kΩ
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

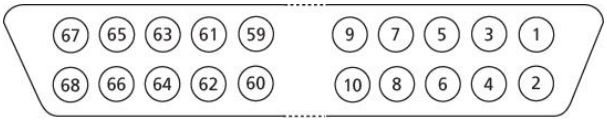
Analog IN A1 to A4

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

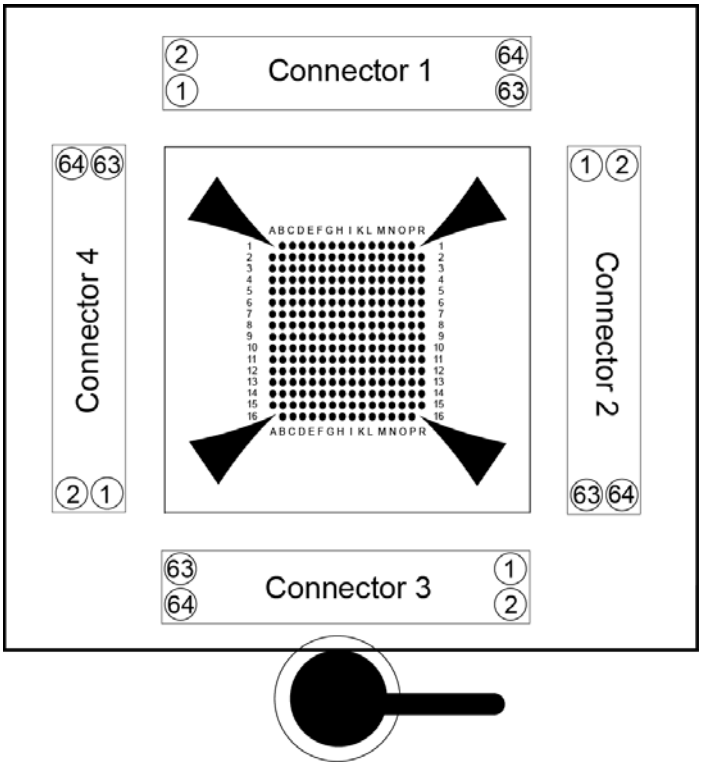


Pin 1	GNDP (power ground)
Pin 2	GNDS (signal ground)
Pin 3 - 10	Digital output channels bit 0 - 7
Pin 11 - 14	GNDS (signal ground)
Pin 15 - 22	Digital output channels bit 8 - 15
Pin 23 - 26	GNDS (signal ground)
Pin 27 - 34	Digital input channels bit 0 - 7
Pin 35 - 38	GNDS (signal ground)
Pin 39 - 46	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)

USB-MEA256-System Amplifier: Stimulation Connector Sockets 1 to 4



USB-MEA256-System Amplifier: Spring Contacts

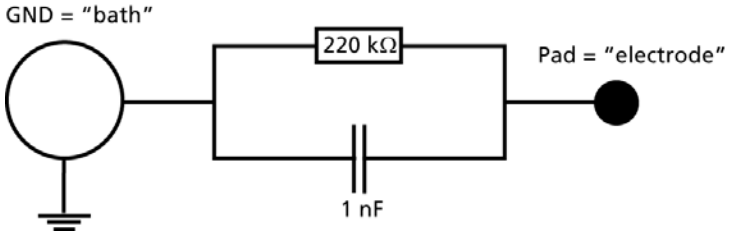
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
132																																	35
131																																	36
130	252																															163	37
129	251																															164	38
128	250																															165	39
127	249																															166	40
126	248																															167	41
125	247																															168	42
124	246																															169	43
123	245																															170	44
122	244																															171	45
121	243																															172	46
120	242																															173	47
119	241																															174	48
118	240																															175	49
117	239																															176	50
116	238																															177	51
115	237																															178	52
114	236																															179	53
113	235																															180	54
112	234																															181	55
111	233																															182	56
110	232																															183	57
109	231																															184	58
108	230																															185	59
107	229																															186	60
106	228																															187	61
105	227																															188	62
104	226																															189	63
103	225																															190	64
102	224																															191	65
101	223																															192	66
100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67

GND GND GND GND

Number of the spring contact in the lid of the amplifier which connect to the contact pads of the 256MEA. The spring contacts are counted clockwise, starting in the upper left edge.

6.4 Test Model Probe

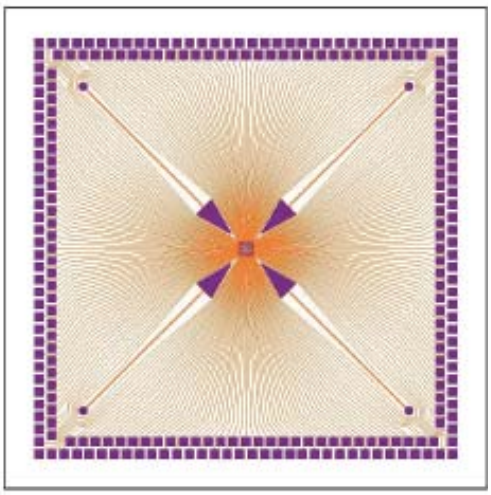
The provided model test probe simulates a 256MEA with a resistor of 220 kΩ and a 1 nF capacitor between bath and electrode, for all 256 electrodes, and can be used for testing USB-MEA256-Systems.



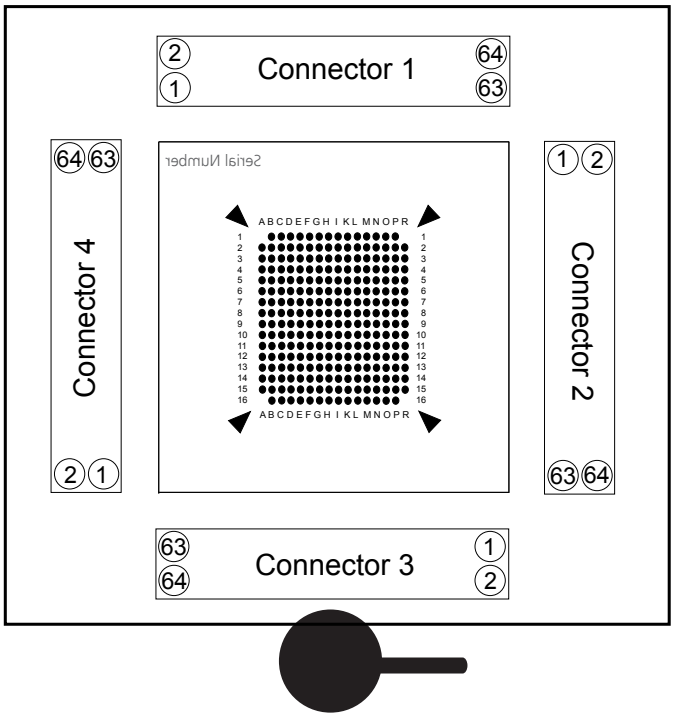
6.5 Data Sheet 256MEA

256MEA

256MEA30/8iR-ITO
256MEA60/10iR-ITO
256MEA100/30iR-ITO
256MEA200/30iR-ITO



256 Microelectrode Array for
use with USB-MEA256-System.



Technical Specifications 256MEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	8, 10 or 30 µm
Interelectrode distance (centre to centre)	30, 60, 100 or 200 µm
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride (SiN)
Electrode impedance	30 - 50 kΩ for 30 µm, or 250 - 400 kΩ for 10 µm
Electrode layout grid	16 x 16
Number of recording electrodes	252
Number of reference electrodes	4 internal reference electrodes (iR)
Contact pads for reference electrodes (connected to ground)	4
MC_Rack	
Source layout in "Data Source Setup"	Configuration
Channel map	16 x 16.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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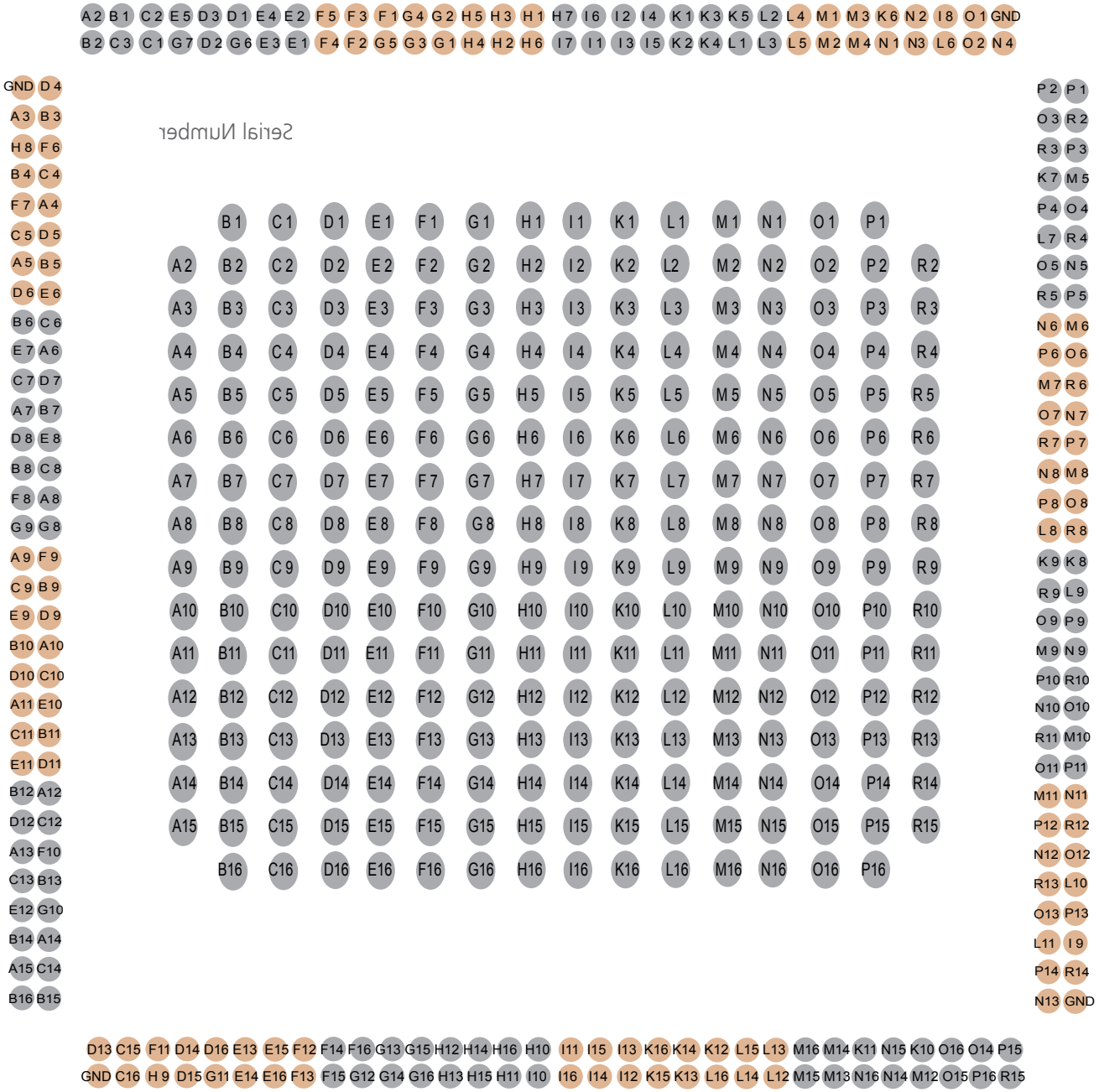
256MEA

multichannel systems



The letter digit code is the electrode identifier, and refers to the position of the electrode in the 16 x 16 layout grid. The layout of the letter digit code for the four connectors of the USB-MEA256 amplifier is shown. To correlate the pin layout of the connectors, please see the table on the next page.
The MEA is rotationally symmetrical, so the orientation does not 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.

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256MEA

multichannel systems

Stimulation Connector Socket 1			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
A2	2	1	196
B1	4	133	130
B2	1	2	226
C1	5	4	223
C2	6	134	193
C3	3	3	158
D1	12	137	254
D2	9	6	224
D3	10	136	194
E1	15	9	55
E2	16	139	25
E3	13	8	123
E4	14	138	93
E5	8	135	253
F1	22	142	91
F2	19	11	56
F3	20	141	26
F4	17	10	124
F5	18	140	94
G1	25	14	122
G2	26	144	92
G3	23	13	53
G4	24	143	23
G5	21	12	121
G6	11	7	156
G7	7	5	155
H1	32	147	21
H2	29	16	119
H3	30	146	89
H4	27	15	54
H5	28	145	24
H6	31	17	51
H7	34	148	90
I 1	35	19	52
I 2	38	150	87
I 3	37	20	117
I 4	40	151	19
I 5	39	21	49
I 6	36	149	22
I 7	33	18	120
I 8	60	161	16
K1	42	152	88
K2	41	22	118
K3	44	153	20
K4	43	23	50
K5	46	154	85
K6	56	159	15
L1	45	24	115
L2	48	155	17
L3	47	25	47
L4	50	156	86
L5	49	26	116
L6	59	31	46
M1	52	157	18
M2	51	27	48
M3	54	158	83
M4	53	28	113
N1	55	29	45
N2	58	160	84
N3	57	30	114
N4	63	33	43
O1	62	162	81
O2	61	32	111
GND	64	253	

Stimulation Connector Socket 2			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
I 9	60	191	125
K7	7	38	41
K8	34	178	74
K9	33	51	104
L10	56	189	2
L11	59	64	30
L7	11	40	42
L8	31	50	35
L9	36	179	5
M10	46	184	69
M11	49	59	100
M5	8	165	14
M6	18	170	78
M7	21	45	105
M8	28	175	7
M9	39	54	33
N10	43	56	34
N11	50	186	70
N12	53	61	97
N13	63	66	27
N5	14	168	77
N6	17	43	108
N7	24	173	10
N8	27	48	38
N9	40	181	6
O10	44	183	3
O11	47	58	31
O12	54	188	67
O13	57	63	98
O3	3	36	44
O4	10	166	80
O5	13	41	107
O6	20	171	9
O7	23	46	37
O8	30	176	73
O9	37	53	101
P1	2	34	82
P10	41	55	102
P11	48	185	4
P12	51	60	32
P13	58	190	68
P14	61	65	95
P2	1	35	112
P3	6	164	79
P4	9	39	110
P5	16	169	12
P6	19	44	40
P7	26	174	76
P8	29	49	103
P9	38	180	71
R10	42	182	72
R11	45	57	99
R12	52	187	1
R13	55	62	29
R14	62	192	65
R2	4	163	13
R3	5	37	109
R4	12	167	11
R5	15	42	39
R6	22	172	75
R7	25	47	106
R8	32	177	8
R9	35	52	36
GND	64	254	

Stimulation Connector Socket 3			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
C15	61	98	239
C16	62	222	209
D13	63	99	171
D14	57	96	184
D15	58	220	213
D16	55	95	181
E13	53	94	182
E14	54	218	243
E15	51	93	179
E16	52	217	147
F11	59	97	183
F12	49	92	180
F13	50	216	145
F14	47	91	177
F15	48	215	191
F16	45	90	178
G11	56	219	245
G12	46	214	192
G13	43	89	175
G14	44	213	189
G15	41	88	176
G16	42	212	190
H10	33	84	150
H11	36	209	185
H12	39	87	153
H13	40	211	187
H14	37	86	152
H15	38	210	188
H16	35	85	154
H9	60	221	215
I 10	34	208	186
I 11	31	83	151
I 12	28	205	59
I 13	27	81	149
I 14	30	206	62
I 15	29	82	148
I 16	32	207	61
K10	7	71	63
K11	11	73	247
K12	21	78	250
K13	24	203	57
K14	23	79	251
K15	26	204	60
K16	25	80	146
L12	18	200	220
L13	17	76	248
L14	20	201	221
L15	19	77	252
L16	22	202	58
M12	8	195	217
M13	14	198	218
M14	13	74	246
M15	16	199	222
M16	15	75	249
N14	10	196	216
N15	9	72	244
N16	12	197	219
O14	3	69	28
O15	6	194	214
O16	5	70	64
P15	1	68	96
P16	4	193	126
R15	2	67	66
GND	64	255	

Stimulation Connector Socket 4			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
A10	25	113	236
A11	22	232	205
A12	15	108	169
A13	12	227	143
A14	5	103	241
A15	4	223	141
A3	62	252	195
A4	55	128	159
A5	52	247	131
A6	45	123	229
A7	42	242	202
A8	35	118	166
A9	32	237	138
B10	26	234	206
B11	19	110	170
B12	16	229	144
B13	9	105	242
B14	6	224	211
B15	1	101	240
B16	2	100	210
B3	61	131	225
B4	58	250	198
B5	51	126	162
B6	48	245	134
B7	41	121	232
B8	38	240	201
B9	29	115	233
C10	23	112	167
C11	20	231	139
C12	13	107	237
C13	10	226	212
C14	3	102	172
C4	57	129	228
C5	54	248	197
C6	47	124	161
C7	44	243	133
C8	37	119	231
C9	30	236	203
D10	24	233	140
D11	17	109	238
D12	14	228	207
D4	63	132	157
D5	53	127	227
D6	50	246	200
D7	43	122	164
D8	40	241	136
D9	27	114	168
E10	21	111	235
E11	18	230	208
E12	8	225	142
E6	49	125	230
E7	46	244	199
E8	39	120	163
E9	28	235	137
F10	11	106	174
F6	59	130	160
F7	56	249	132
F8	36	239	135
F9	31	116	165
G10	7	104	173
G8	33	117	234
G9	34	238	204
H8	60	251	129
GND	64	256	

Stim. Socket = Stimulation socket number in the connectors 1 to 4
Spring Contact = Spring contacts in the lid of the amplifier
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout
Electrode ID = Electrode ID of the MEA electrode in the 16 x 16 layout grid

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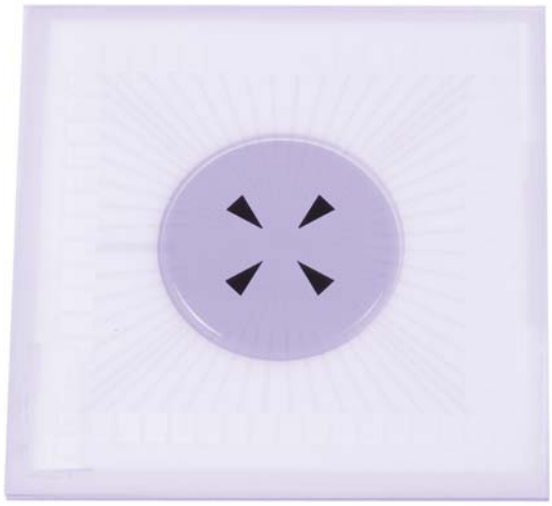
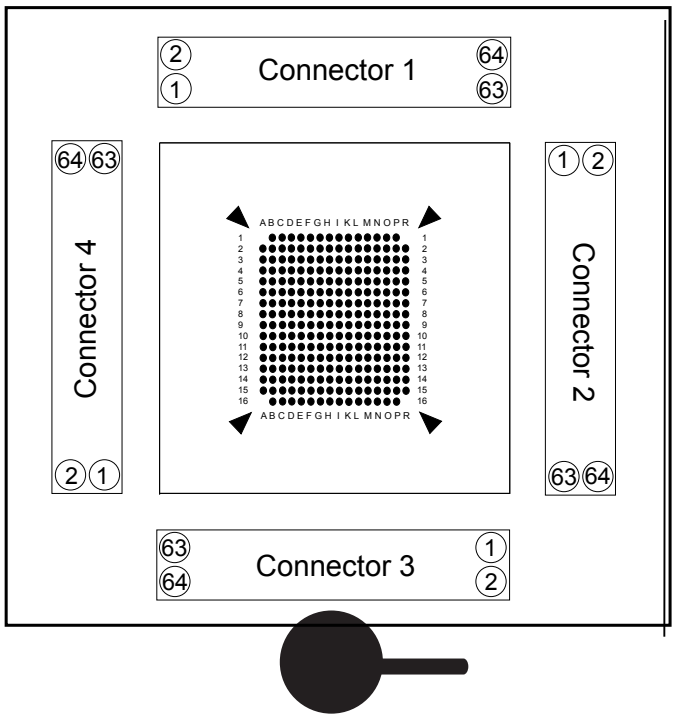
6.6 Data Sheet 256ThinMEA

256ThinMEA

256ThinMEA200/30iR-ITO



Thin microelectrode array with 16 x 16 layout. The electrodes are embedded in a very thin glass substrate on a robust ceramic carrier. Contact pads and tracks are made from transparent ITO for high resolution imaging.



Technical Specifications 256ThinMEA200/30iR-ITO

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Thickness of the glass part	180 µm
Base material	Glass on ceramic carrier
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	200 µm
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride (SiN)
Electrode impedance	30 - 50 kΩ
Electrode layout grid	16 x 16
Number of recording electrodes	252
Number of reference electrodes	4 internal reference electrodes (iR)
Contact pads for reference electrodes (connected to ground)	4
MC_Rack	
Source layout in "Data Source Setup"	Configuration
Channel map	16 x 16.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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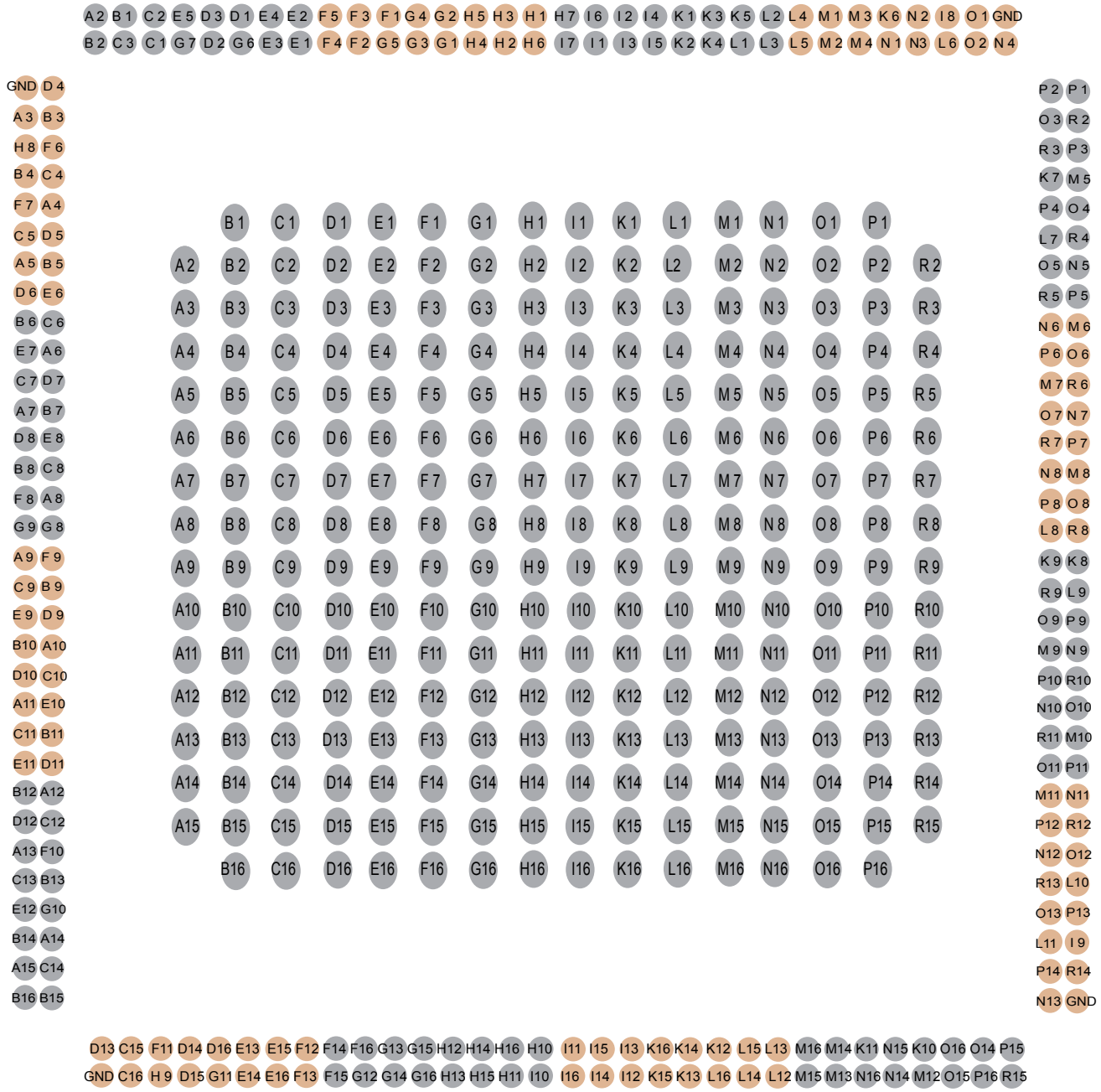
256ThinMEA



The letter digit code is the electrode identifier, and refers to the position of the electrode in the 16 x 16 layout grid. The layout of the letter digit code for the four connectors of the USB-MEA256 amplifier is shown.

To correlate the pin layout of the connectors, please see the table on the next page.

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256ThinMEA

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Stimulation Connector Socket 1				Stimulation Connector Socket 2				Stimulation Connector Socket 3				Stimulation Connector Socket 4			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID	Electrode ID	Stim. Socket	Spring Contact	Hardware ID	Electrode ID	Stim. Socket	Spring Contact	Hardware ID	Electrode ID	Stim. Socket	Spring Contact	Hardware ID
A2	2	1	196	I 9	60	191	125	C15	61	98	239	A10	25	113	236
B1	4	133	130	K7	7	38	41	C16	62	222	209	A11	22	232	205
B2	1	2	226	K8	34	178	74	D13	63	99	171	A12	15	108	169
C1	5	4	223	K9	33	51	104	D14	57	96	184	A13	12	227	143
C2	6	134	193	L10	56	189	2	D15	58	220	213	A14	5	103	241
C3	3	3	158	L11	59	64	30	D16	55	95	181	A15	4	223	141
D1	12	137	254	L7	11	40	42	E13	53	94	182	A3	62	252	195
D2	9	6	224	L8	31	50	35	E14	54	218	243	A4	55	128	159
D3	10	136	194	L9	36	179	5	E15	51	93	179	A5	52	247	131
E1	15	9	55	M10	46	184	69	E16	52	217	147	A6	45	123	229
E2	16	139	25	M11	49	59	100	F11	59	97	183	A7	42	242	202
E3	13	8	123	M5	8	165	14	F12	49	92	180	A8	35	118	166
E4	14	138	93	M6	18	170	78	F13	50	216	145	A9	32	237	138
E5	8	135	253	M7	21	45	105	F14	47	91	177	B10	26	234	206
F1	22	142	91	M8	28	175	7	F15	48	215	191	B11	19	110	170
F2	19	11	56	M9	39	54	33	F16	45	90	178	B12	16	229	144
F3	20	141	26	N10	43	56	34	G11	56	219	245	B13	9	105	242
F4	17	10	124	N11	50	186	70	G12	46	214	192	B14	6	224	211
F5	18	140	94	N12	53	61	97	G13	43	89	175	B15	1	101	240
G1	25	14	122	N13	63	66	27	G14	44	213	189	B16	2	100	210
G2	26	144	92	N5	14	168	77	G15	41	88	176	B3	61	131	225
G3	23	13	53	N6	17	43	108	G16	42	212	190	B4	58	250	198
G4	24	143	23	N7	24	173	10	H10	33	84	150	B5	51	126	162
G5	21	12	121	N8	27	48	38	H11	36	209	185	B6	48	245	134
G6	11	7	156	N9	40	181	6	H12	39	87	153	B7	41	121	232
G7	7	5	155	O10	44	183	3	H13	40	211	187	B8	38	240	201
H1	32	147	21	O11	47	58	31	H14	37	86	152	B9	29	115	233
H2	29	16	119	O12	54	188	67	H15	38	210	188	C10	23	112	167
H3	30	146	89	O13	57	63	98	H16	35	85	154	C11	20	231	139
H4	27	15	54	O3	3	36	44	H9	60	221	215	C12	13	107	237
H5	28	145	24	O4	10	166	80	I 10	34	208	186	C13	10	226	212
H6	31	17	51	O5	13	41	107	I 11	31	83	151	C14	3	102	172
H7	34	148	90	O6	20	171	9	I 12	28	205	59	C4	57	129	228
I 1	35	19	52	O7	23	46	37	I 13	27	81	149	C5	54	248	197
I 2	38	150	87	O8	30	176	73	I 14	30	206	62	C6	47	124	161
I 3	37	20	117	O9	37	53	101	I 15	29	82	148	C7	44	243	133
I 4	40	151	19	P1	2	34	82	I 16	32	207	61	C8	37	119	231
I 5	39	21	49	P10	41	55	102	K10	7	71	63	C9	30	236	203
I 6	36	149	22	P11	48	185	4	K11	11	73	247	D10	24	233	140
I 7	33	18	120	P12	51	60	32	K12	21	78	250	D11	17	109	238
I 8	60	161	16	P13	58	190	68	K13	24	203	57	D12	14	228	207
K1	42	152	88	P14	61	65	95	K14	23	79	251	D4	63	132	157
K2	41	22	118	P2	1	35	112	K15	26	204	60	D5	53	127	227
K3	44	153	20	P3	6	164	79	K16	25	80	146	D6	50	246	200
K4	43	23	50	P4	9	39	110	L12	18	200	220	D7	43	122	164
K5	46	154	85	P5	16	169	12	L13	17	76	248	D8	40	241	136
K6	56	159	15	P6	19	44	40	L14	20	201	221	D9	27	114	168
L1	45	24	115	P7	26	174	76	L15	19	77	252	E10	21	111	235
L2	48	155	17	P8	29	49	103	L16	22	202	58	E11	18	230	208
L3	47	25	47	P9	38	180	71	M12	8	195	217	E12	8	225	142
L4	50	156	86	R10	42	182	72	M13	14	198	218	E6	49	125	230
L5	49	26	116	R11	45	57	99	M14	13	74	246	E7	46	244	199
L6	59	31	46	R12	52	187	1	M15	16	199	222	E8	39	120	163
M1	52	157	18	R13	55	62	29	M16	15	75	249	E9	28	235	137
M2	51	27	48	R14	62	192	65	N14	10	196	216	F10	11	106	174
M3	54	158	83	R2	4	163	13	N15	9	72	244	F6	59	130	160
M4	53	28	113	R3	5	37	109	N16	12	197	219	F7	56	249	132
N1	55	29	45	R4	12	167	11	O14	3	69	28	F8	36	239	135
N2	58	160	84	R5	15	42	39	O15	6	194	214	F9	31	116	165
N3	57	30	114	R6	22	172	75	O16	5	70	64	G10	7	104	173
N4	63	33	43	R7	25	47	106	P15	1	68	96	G8	33	117	234
O1	62	162	81	R8	32	177	8	P16	4	193	126	G9	34	238	204
O2	61	32	111	R9	35	52	36	R15	2	67	66	H8	60	251	129
GND	64	253		GND	64	254		GND	64	255		GND	64	256	

Stim. Socket = Stimulation socket number in the connectors 1 to 4
Spring Contact = Spring contacts in the lid of the amplifier
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout
Electrode ID = Electrode ID of the MEA electrode in the 16 x 16 layout grid

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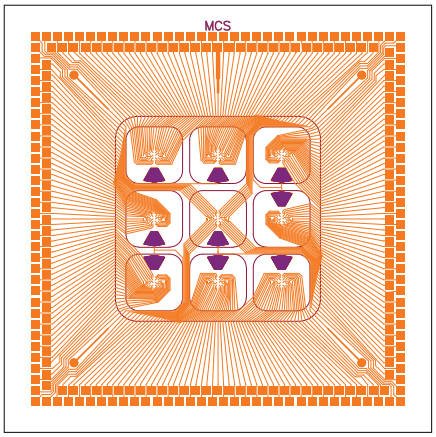
6.7 Data Sheet 256-9wellMEA

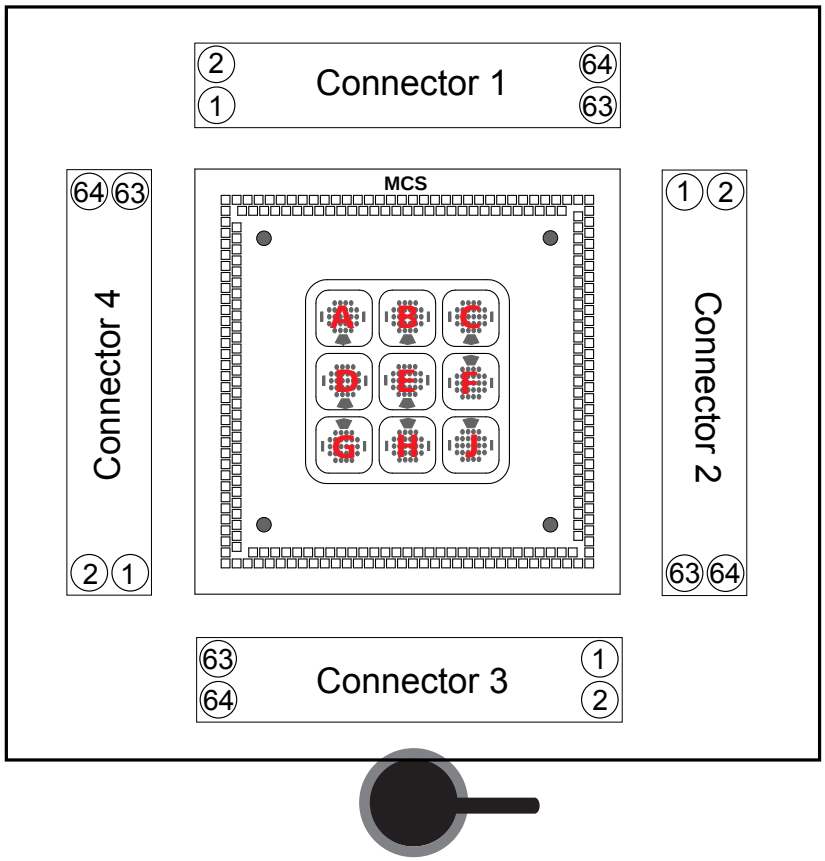
256-9wellMEA

256-9wellMEA300/30iR-ITO-w/o
256-9wellMEA300/30iR-ITO-mq

9-well Microelectrode Array for use with USB-MEA256-System.



The MEA is not symmetrical and has to be inserted into the amplifier with the writing MCS on top as shown in the picture beside.



Technical Specifications 9-Well MEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	30 µm (recording), 50 x 200 µm (stimulation)
Interelectrode distance (centre to centre)	300 µm (recording), 500 µm (stimulation)
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride (SiN)
Electrode impedance	30 - 50 kΩ
Electrode layout grid	6 x 5 recording + 2 stimulation electrodes in each well
Number of recording electrodes	252 (26 recording electrodes in each well)
Number of reference electrodes	9 (1 internal reference electrode (iR) in each well)
Contact pads for reference electrodes (connected to ground)	4
Source layout in “Data Source Setup”	Configuration
Channel map	9-well-256MEA.cmp

MEA perfusion chamber	(w/o)	Without Macrolon quadrat
	(mq)	Macrolon quadrat with 9 wells: ID 6.5 x 6.5 mm of each well, OD 24 x 24 mm of all wells, height 9 mm, Volumetric capacity of each well: minimum 250 µl.

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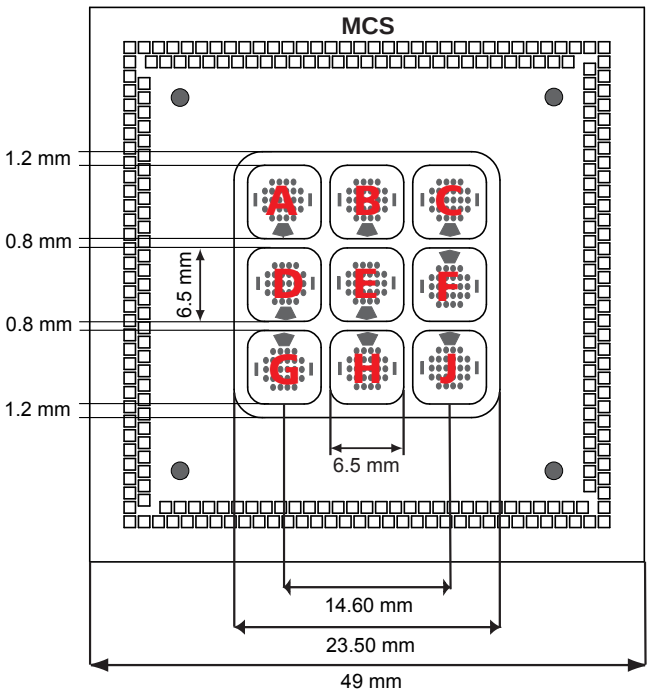
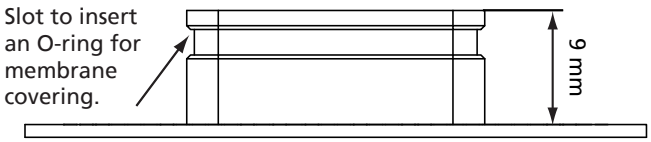
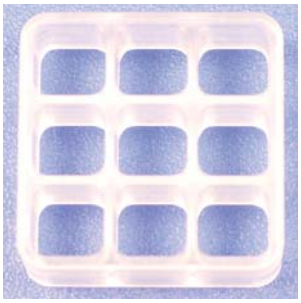
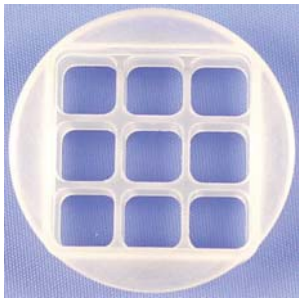


Macrolon Quadrat



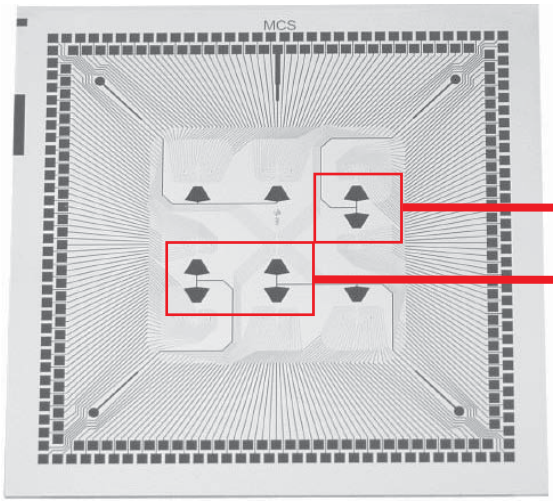


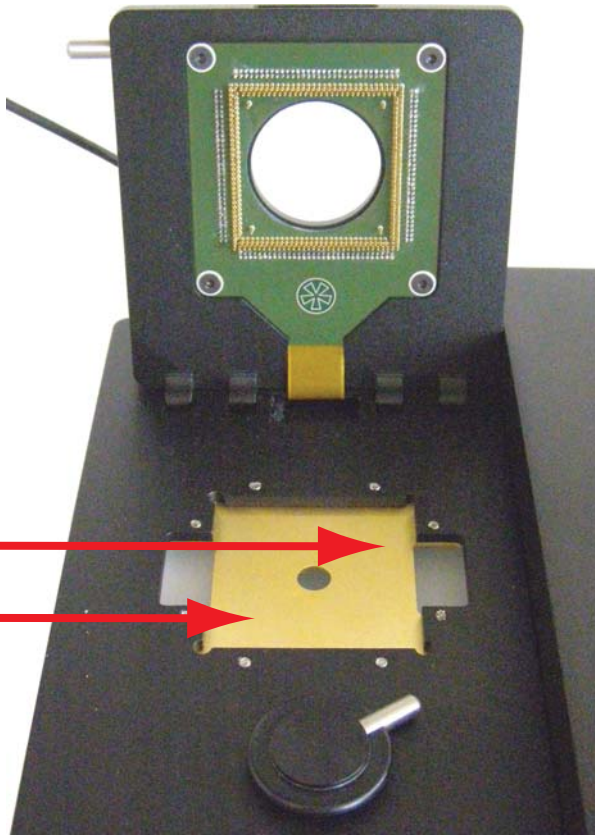
9-Well macrolon quadrat for 256-9wellMEA.



256-9wellMEA with macrolon quadrat and 9well-CC ring to use it as a culture chamber. Please insert a foil between quadrat and ring.

Please insert the 256-9wellMEA in correct orientation into the amplifier: If you can not read the “MCS”, use the black reference electrodes as marker.





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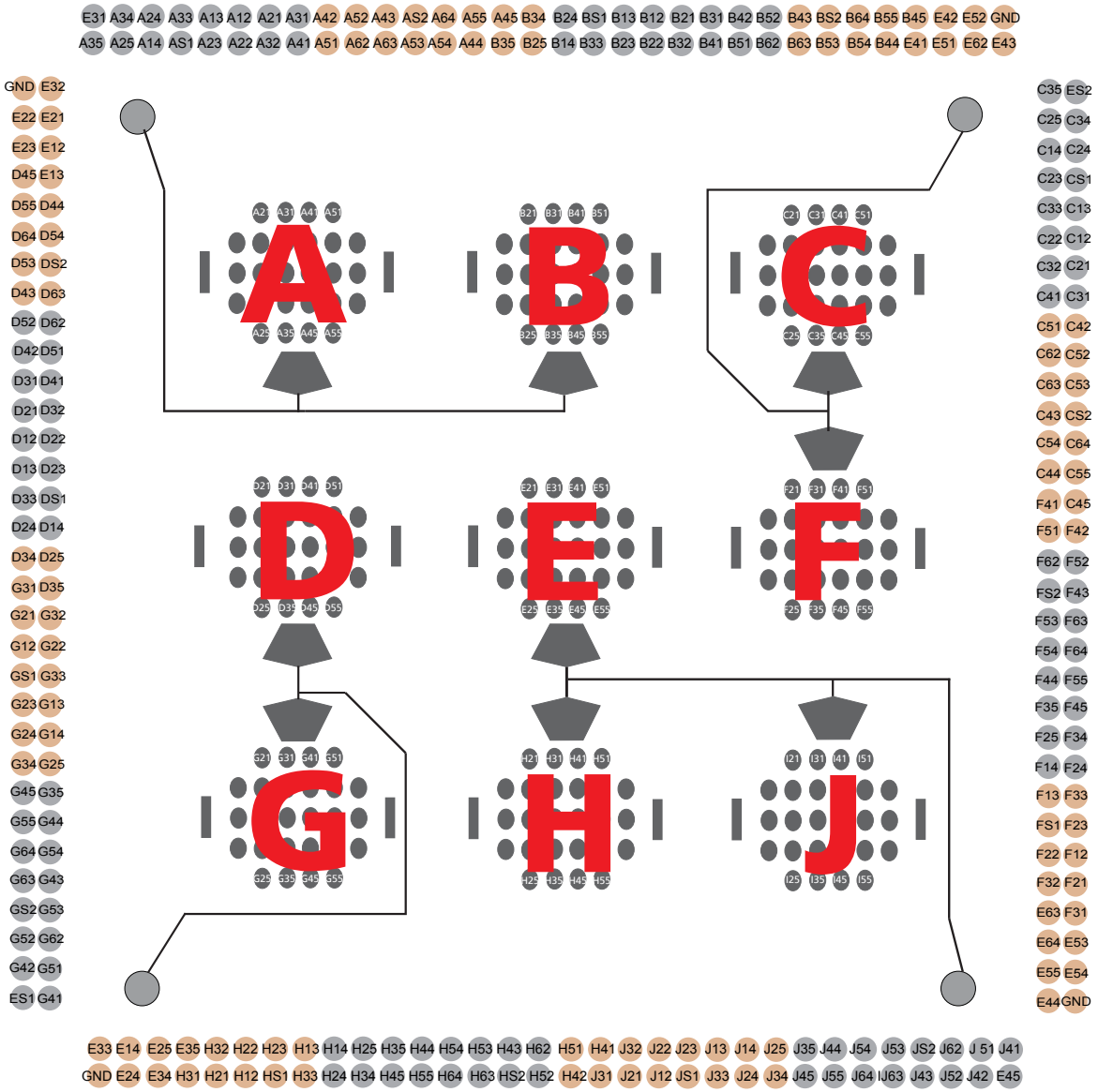

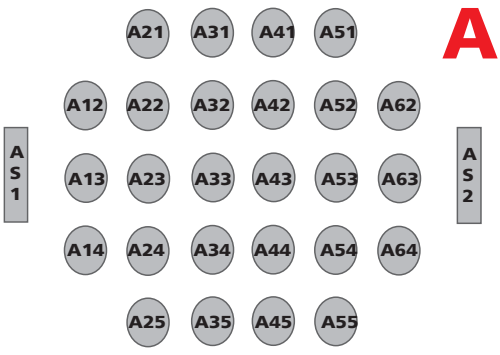

A

Example Well A : The numbering of MEA electrodes in the 6 x 5 grid per each well follows the standard numbering scheme for square grids:
The first digit is the column number and the second digit is the row number. For example, electrode 23 is positioned in the second column of the third row.
Two square electrodes (S1 and S2) per well are available for stimulation or recording.
There is one big internal reference electrode in each well. The nine reference electrodes are connected to four contact pads for grounding them.

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Tables:
Electrode ID and number of stimulation connector socket in well A, B, and C.

Well A		Well B		Well C	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
AS1	Conn. 1 No. 7	BS1	Conn. 1 No. 36	CS1	Conn. 2 No. 8
A12	Conn. 1 No. 12	B12	Conn. 1 No. 40	C12	Conn. 2 No. 12
A13	Conn. 1 No. 10	B13	Conn. 1 No. 38	C13	Conn. 2 No. 10
A14	Conn. 1 No. 5	B14	Conn. 1 No. 33	C14	Conn. 2 No. 5
A21	Conn. 1 No. 14	B21	Conn. 1 No. 42	C21	Conn. 2 No. 14
A22	Conn. 1 No. 11	B22	Conn. 1 No. 39	C22	Conn. 2 No. 11
A23	Conn. 1 No. 9	B23	Conn. 1 No. 37	C23	Conn. 2 No. 7
A24	Conn. 1 No. 6	B24	Conn. 1 No. 34	C24	Conn. 2 No. 6
A25	Conn. 1 No. 3	B25	Conn. 1 No. 31	C25	Conn. 2 No. 3
A31	Conn. 1 No. 16	B31	Conn. 1 No. 44	C31	Conn. 2 No. 16
A32	Conn. 1 No. 13	B32	Conn. 1 No. 41	C32	Conn. 2 No. 13
A33	Conn. 1 No. 8	B33	Conn. 1 No. 35	CS1	Conn. 2 No. 9
A34	Conn. 1 No. 4	B34	Conn. 1 No. 32	C34	Conn. 2 No. 4
A35	Conn. 1 No. 1	B35	Conn. 1 No. 29	C35	Conn. 2 No. 1
A41	Conn. 1 No. 15	B41	Conn. 1 No. 43	C41	Conn. 2 No. 15
A42	Conn. 1 No. 18	B42	Conn. 1 No. 46	C42	Conn. 2 No. 18
A43	Conn. 1 No. 22	B43	Conn. 1 No. 50	C43	Conn. 2 No. 23
A44	Conn. 1 No. 27	B44	Conn. 1 No. 55	C44	Conn. 2 No. 27
A45	Conn. 1 No. 30	B45	Conn. 1 No. 58	C45	Conn. 2 No. 30
A51	Conn. 1 No. 17	B51	Conn. 1 No. 45	C51	Conn. 2 No. 17
A52	Conn. 1 No. 20	B52	Conn. 1 No. 48	C52	Conn. 2 No. 20
A53	Conn. 1 No. 23	B53	Conn. 1 No. 51	C53	Conn. 2 No. 22
A54	Conn. 1 No. 25	B54	Conn. 1 No. 53	C54	Conn. 2 No. 25
A55	Conn. 1 No. 28	B55	Conn. 1 No. 56	C55	Conn. 2 No. 28
A62	Conn. 1 No. 19	B62	Conn. 1 No. 47	C62	Conn. 2 No. 19
A63	Conn. 1 No. 21	B63	Conn. 1 No. 49	C63	Conn. 2 No. 21
A64	Conn. 1 No. 26	B64	Conn. 1 No. 54	C64	Conn. 2 No. 26
AS2	Conn. 1 No. 24	BS2	Conn. 1 No. 52	CS2	Conn. 2 No. 24

Electrode ID and number of stimulation connector socket in well D, E, and F.

Well D		Well E		Well F	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
DS1	Conn. 4 No. 35	ES1	Conn. 4 No. 2	FS1	Conn. 2 No. 51
D12	Conn. 4 No. 40	E12	Conn. 4 No. 59	F12	Conn. 2 No. 54
D13	Conn. 4 No. 38	E13	Conn. 4 No. 57	F13	Conn. 2 No. 49
D14	Conn. 4 No. 33	E14	Conn. 3 No. 61	F14	Conn. 2 No. 47
D21	Conn. 4 No. 42	E21	Conn. 4 No. 61	F21	Conn. 2 No. 56
D22	Conn. 4 No. 39	E22	Conn. 4 No. 62	F22	Conn. 2 No. 53
D23	Conn. 4 No. 37	E23	Conn. 4 No. 60	F23	Conn. 2 No. 52
D24	Conn. 4 No. 34	E24	Conn. 3 No. 62	F24	Conn. 2 No. 48
D25	Conn. 4 No. 31	E25	Conn. 3 No. 59	F25	Conn. 2 No. 45
D31	Conn. 4 No. 44	E31	Conn. 1 No. 2	F31	Conn. 2 No. 58
D32	Conn. 4 No. 41	E32	Conn. 4 No. 63	F32	Conn. 2 No. 55
D33	Conn. 4 No. 36	E33	Conn. 3 No. 63	F33	Conn. 2 No. 50
D34	Conn. 4 No. 32	E34	Conn. 3 No. 60	F34	Conn. 2 No. 46
D35	Conn. 4 No. 29	E35	Conn. 3 No. 57	F35	Conn. 2 No. 43
D41	Conn. 4 No. 43	E41	Conn. 1 No. 57	F41	Conn. 2 No. 29
D42	Conn. 4 No. 46	E42	Conn. 1 No. 60	F42	Conn. 2 No. 32
D43	Conn. 4 No. 50	E43	Conn. 1 No. 63	F43	Conn. 2 No. 36
D44	Conn. 4 No. 55	E44	Conn. 2 No. 63	F44	Conn. 2 No. 41
D45	Conn. 4 No. 58	E45	Conn. 3 No. 2	F45	Conn. 2 No. 44
D51	Conn. 4 No. 45	E51	Conn. 1 No. 59	F51	Conn. 2 No. 31
D52	Conn. 4 No. 48	E52	Conn. 1 No. 62	F52	Conn. 2 No. 34
D53	Conn. 4 No. 52	E53	Conn. 2 No. 60	F53	Conn. 2 No. 37
D54	Conn. 4 No. 53	E54	Conn. 2 No. 62	F54	Conn. 2 No. 39
D55	Conn. 4 No. 56	E55	Conn. 2 No. 61	F55	Conn. 2 No. 42
D62	Conn. 4 No. 47	E62	Conn. 1 No. 61	F62	Conn. 2 No. 33
D63	Conn. 4 No. 49	E63	Conn. 2 No. 57	F63	Conn. 2 No. 38
D64	Conn. 4 No. 54	E64	Conn. 2 No. 59	F64	Conn. 2 No. 40
DS2	Conn. 4 No. 51	ES2	Conn. 2 No. 2	FS2	Conn. 2 No. 35

Electrode ID and number of stimulation connector socket in well G, H, and J.

Well G		Well H		Well J	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
GS1	Conn. 4 No. 24	HS1	Conn. 3 No. 52	JS1	Conn. 3 No. 24
G12	Conn. 4 No. 26	H12	Conn. 3 No. 54	J12	Conn. 3 No. 26
G13	Conn. 4 No. 21	H13	Conn. 3 No. 49	J13	Conn. 3 No. 21
G14	Conn. 4 No. 19	H14	Conn. 3 No. 47	J14	Conn. 3 No. 19
G21	Conn. 4 No. 28	H21	Conn. 3 No. 56	J21	Conn. 3 No. 28
G22	Conn. 4 No. 25	H22	Conn. 3 No. 53	J22	Conn. 3 No. 25
G23	Conn. 4 No. 22	H23	Conn. 3 No. 51	J23	Conn. 3 No. 23
G24	Conn. 4 No. 20	H24	Conn. 3 No. 48	J24	Conn. 3 No. 20
G25	Conn. 4 No. 17	H25	Conn. 3 No. 45	J25	Conn. 3 No. 17
G31	Conn. 4 No. 30	H31	Conn. 3 No. 58	J31	Conn. 3 No. 30
G32	Conn. 4 No. 27	H32	Conn. 3 No. 55	J32	Conn. 3 No. 27
G33	Conn. 4 No. 23	H33	Conn. 3 No. 50	J33	Conn. 3 No. 22
G34	Conn. 4 No. 18	H34	Conn. 3 No. 46	J34	Conn. 3 No. 18
G35	Conn. 4 No. 15	H35	Conn. 3 No. 43	J35	Conn. 3 No. 15
G41	Conn. 4 No. 1	H41	Conn. 3 No. 29	J41	Conn. 3 No. 1
G42	Conn. 4 No. 4	H42	Conn. 3 No. 32	J42	Conn. 3 No. 4
G43	Conn. 4 No. 9	H43	Conn. 3 No. 35	J43	Conn. 3 No. 8
G44	Conn. 4 No. 13	H44	Conn. 3 No. 41	J44	Conn. 3 No. 13
G45	Conn. 4 No. 16	H45	Conn. 3 No. 44	J45	Conn. 3 No. 16
G51	Conn. 4 No. 3	H51	Conn. 3 No. 31	J51	Conn. 3 No. 3
G52	Conn. 4 No. 6	H52	Conn. 3 No. 34	J52	Conn. 3 No. 6
G53	Conn. 4 No. 7	H53	Conn. 3 No. 37	J53	Conn. 3 No. 9
G54	Conn. 4 No. 11	H54	Conn. 3 No. 39	J54	Conn. 3 No. 11
G55	Conn. 4 No. 14	H55	Conn. 3 No. 42	J55	Conn. 3 No. 14
G62	Conn. 4 No. 5	H62	Conn. 3 No. 33	J62	Conn. 3 No. 5
G63	Conn. 4 No. 10	H63	Conn. 3 No. 38	J63	Conn. 3 No. 10
G64	Conn. 4 No. 12	H64	Conn. 3 No. 40	J64	Conn. 3 No. 12
GS2	Conn. 4 No. 8	HS2	Conn. 3 No. 36	JS2	Conn. 3 No. 7

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256-9wellMEA

multichannel systems

Connector 1			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	A35	2	226
2	E31	1	196
3	A25	3	158
4	A34	133	130
5	A14	4	223
6	A24	134	193
7	AS1	5	155
8	A33	135	253
9	A23	6	224
10	A13	136	194
11	A22	7	156
12	A12	137	254
13	A32	8	123
14	A21	138	93
15	A41	9	55
16	A31	139	25
17	A51	10	124
18	A42	140	94
19	A62	11	56
20	A52	141	26
21	A63	12	121
22	A43	142	91
23	A53	13	53
24	AS2	143	23
25	A54	14	122
26	A64	144	92
27	A44	15	54
28	A55	145	24
29	B35	16	119
30	A45	146	89
31	B25	17	51
32	B34	147	21
33	B14	18	120
34	B24	148	90
35	B33	19	52
36	BS1	149	22
37	B23	20	117
38	B13	150	87
39	B22	21	49
40	B12	151	19
41	B32	22	118
42	B21	152	88
43	B41	23	50
44	B31	153	20
45	B51	24	115
46	B42	154	85
47	B62	25	47
48	B52	155	17
49	B63	26	116
50	B43	156	86
51	B53	27	48
52	BS2	157	18
53	B54	28	113
54	B64	158	83
55	B44	29	45
56	B55	159	15
57	E41	30	114
58	B45	160	84
59	E51	31	46
60	E42	161	16
61	E62	32	111
62	E52	162	81
63	E43	33	43
GND			

Connector 2			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	C35	35	112
2	ES2	34	82
3	C25	36	44
4	C34	163	13
5	C14	37	109
6	C24	164	79
7	C23	38	41
8	CS1	165	14
9	C33	39	110
10	C13	166	80
11	C22	40	42
12	C12	167	11
13	C32	41	107
14	C21	168	77
15	C41	42	39
16	C31	169	12
17	C51	43	108
18	C42	170	78
19	C62	44	40
20	C52	171	9
21	C63	45	105
22	C53	172	75
23	C43	46	37
24	CS2	173	10
25	C54	47	106
26	C64	174	76
27	C44	48	38
28	C55	175	7
29	F41	49	103
30	C45	176	73
31	F51	50	35
32	F42	177	8
33	F62	51	104
34	F52	178	74
35	FS2	52	36
36	F43	179	5
37	F53	53	101
38	F63	180	71
39	F54	54	33
40	F64	181	6
41	F44	55	102
42	F55	182	72
43	F35	56	34
44	F45	183	3
45	F25	57	99
46	F34	184	69
47	F14	58	31
48	F24	185	4
49	F13	59	100
50	F33	186	70
51	FS1	60	32
52	F23	187	1
53	F22	61	97
54	F12	188	67
55	F32	62	29
56	F21	189	2
57	E63	63	98
58	F31	190	68
59	E64	64	30
60	E53	191	125
61	E55	65	95
62	E54	192	65
63	E44	66	27
GND			

Connector 3			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	J41	68	96
2	E45	67	66
3	J51	69	28
4	J42	193	126
5	J62	70	64
6	J52	194	214
7	JS2	71	63
8	J43	195	217
9	J53	72	244
10	J63	196	216
11	J54	73	247
12	J64	197	219
13	J44	74	246
14	J55	198	218
15	J35	75	249
16	J45	199	222
17	J25	76	248
18	J34	200	220
19	J14	77	252
20	J24	201	221
21	J13	78	250
22	J33	202	58
23	J23	79	251
24	JS1	203	57
25	J22	80	146
26	J12	204	60
27	J32	81	149
28	J21	205	59
29	H41	82	148
30	J31	206	62
31	H51	83	151
32	H42	207	61
33	H62	84	150
34	H52	208	186
35	H43	85	154
36	HS2	209	185
37	H53	86	152
38	H63	210	188
39	H54	87	153
40	H64	211	187
41	H44	88	176
42	H55	212	190
43	H35	89	175
44	H45	213	189
45	H25	90	178
46	H34	214	192
47	H14	91	177
48	H24	215	191
49	H13	92	180
50	H33	216	145
51	H23	93	179
52	HS1	217	147
53	H22	94	182
54	H12	218	243
55	H32	95	181
56	H21	219	245
57	E35	96	184
58	H31	220	213
59	E25	97	183
60	E34	221	215
61	E14	98	239
62	E24	222	209
63	E33	99	171
GND			

Connector 4			
Stim Socket	Electrode ID	Spring Con.	hardware D
1	G41	101	240
2	ES1	100	210
3	G51	102	172
4	G42	223	141
5	G62	103	241
6	G52	224	211
7	G53	104	173
8	GS2	225	142
9	G43	105	242
10	G63	226	212
11	G54	106	174
12	G64	227	143
13	G44	107	237
14	G55	228	207
15	G35	108	169
16	G45	229	144
17	G25	109	238
18	G34	230	208
19	G14	110	170
20	G24	231	139
21	G13	111	235
22	G23	232	205
23	G33	112	167
24	GS1	233	140
25	G22	113	236
26	G12	234	206
27	G32	114	168
28	G21	235	137
29	D35	115	233
30	G31	236	203
31	D25	116	165
32	D34	237	138
33	D14	117	234
34	D24	238	204
35	DS1	118	166
36	D33	239	135
37	D23	119	231
38	D13	240	201
39	D22	120	163
40	D12	241	136
41	D32	121	232
42	D21	242	202
43	D41	122	164
44	D31	243	133
45	D51	123	229
46	D42	244	199
47	D62	124	161
48	D52	245	134
49	D63	125	230
50	D43	246	200
51	DS2	126	162
52	D53	247	131
53	D54	127	227
54	D64	248	197
55	D44	128	159
56	D55	249	132
57	E13	129	228
58	D45	250	198
59	E12	130	160
60	E23	251	129
61	E21	131	225
62	E22	252	195
63	E32	132	157
GND			

256-9wellMEA for use with USB-MEA256-System

Stim. Socket = Stimulation socket number in the connectors 1 to 4.
Spring Contact = Spring contacts in the lid of the amplifier, connecting to the contact pads of the 256-9wellMEA.
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout.
Electrode ID = Electrode ID of the MEA electrode in the 6 x 5 + 2 layout grid.

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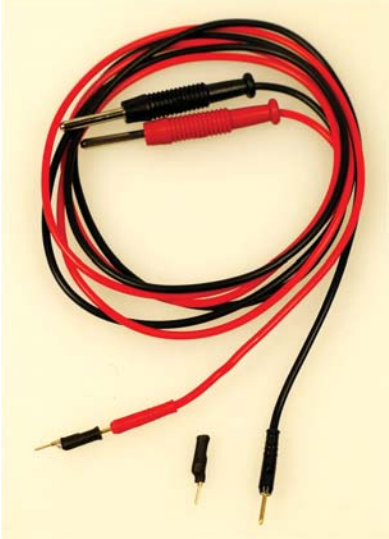
6.8 Data Sheet 256MEA-STIM-C-Con

256MEA-STIM-C-Con

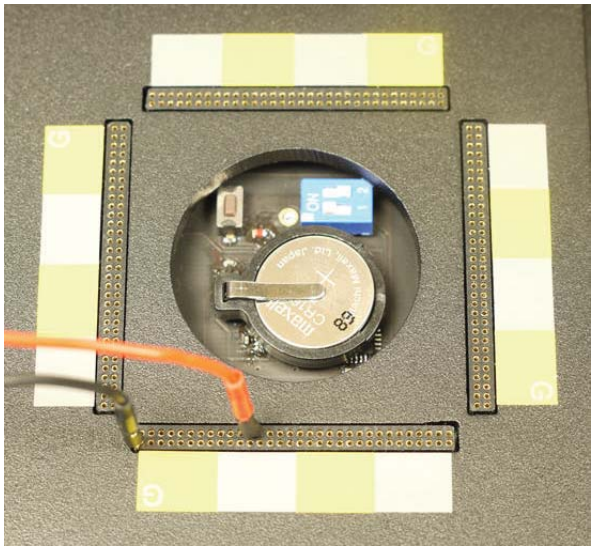
Connector for Electrode Stimulation of 256MEAs in USB-MEA256-Systems

Connector for inserting the stimulation cable CB and / or CR from the STG into the provided stimulation sockets of the USB-MEA256-System.



Stimulation cable CB (black) and CR (red) with connected adapter.

The stimulation cables have a 0.76 mm connector on the head for the adapter, and a 1.0 mm connector on the head for the stimulus generator.



USB-MEA256-System (top view) with signal generator 256MEA-SG and stimulation cable CR (red) for stimulation of a electrode, and cable CB (black) for grounding the system.

The electrodes of the 256MEA can also be used for electrical stimulation. Around the 256MEA, there are two rows of connection sockets on each side. There is one socket for each electrode and four ground sockets. These sockets can be used to connect each electrode to a STG, for example, a stimulus generator of STG4000 series 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 of the USB-MEA256-System manual.

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". If you want to do electrical stimulation, please attach the stickers as shown in the image above. The edge of the sticker has to be aligned with the first pair of sockets.

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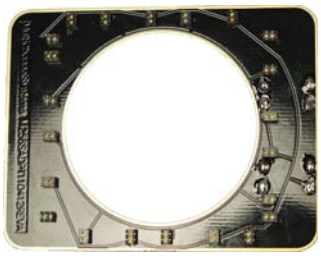
6.9 Data Sheet 256MEA-9well-STIM-ADPT

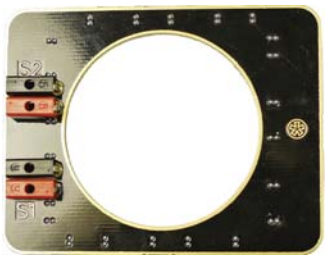
256MEA-9well-STIM-ADPT

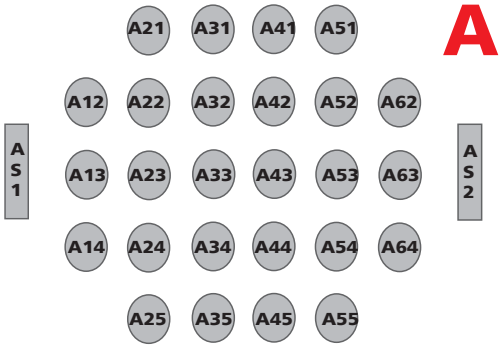
Adapter for Electrode Stimulation of 9-Well MEAs in USB-MEA256-Systems



Rear panel of the adapter

Front panel of the adapter 256MEA-9well-STIM-ADPT. The red connectors are for stimulation of the electrodes S1 and / or S2 in each well. The black connectors are for grounding the system.





Pin layout 9-Well MEAs

Example Well A : The numbering of MEA electrodes in the 6 x 5 grid per each well follows the standard numbering scheme for square grids: The first digit is the column number and the second digit is the row number. For example, electrode 23 is positioned in the second column of the third row. Two square electrodes (S1 and S2) per well are available for stimulation or recording and additionally one big internal reference electrode.

Please fix the adapter 256MEA-9well-STIM-ADPT on the USB-MEA256 amplifier as shown on the foto. Connect the red connectors (2 mm) with the provided cables to the STG for stimulation of S1 and S2. The black connectors (2 mm) are for grounding the system.

Stimulation of S1 means, that the S1 electrodes in each of the nine wells are stimulated altogether.

Stimulation of S2 means, that the S2 electrodes in each of the nine wells are stimulated altogether.

It is not possible to stimulate only one of the nine stimulation electrodes S1 or S2, for example.

Warning: The 256MEA-9well-STIM-ADPT may only be used together with the USB-MEA256-System from Multi Channel Systems MCS GmbH, and only for the specified purpose. Damage of the device and even injuries can result from improper use.

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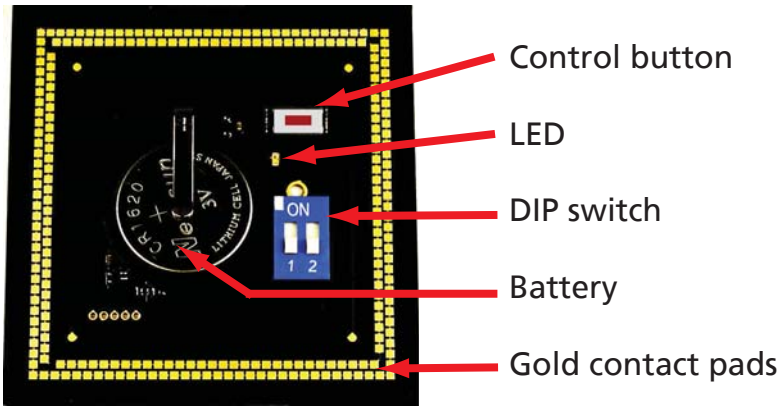
6.10 256MEA-Signal Generator

256MEA-SG

256MEA Signal Generator for use with USB-MEA256-System



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.

Switch on : Press control button. Switch off : Press control button longer than two seconds.

Important : To change DIP switch position, please switch off the device!

Table : DIP switch positions, number of control button presses, and corresponding signals

Switch 1	Switch 2	Control button presses n times	Signal	
OFF	OFF	MEA-SG ON	Sinus	0.005 Hz
		1	Sinus	0.01 Hz
		2	Sinus	0.03 Hz
		3	Sinus	1.25 Hz
		4	Sinus	12.5 Hz
ON	OFF	MEA-SG ON	EPSP	
		1	Population Spike	
		2	Spikes	
OFF	ON	MEA-SG ON	ECG Atrium	
		1	ECG Ventricle	
		2	Ventricle FP	
ON	ON	MEA-SG ON	ERG with Spikes	

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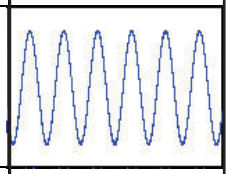
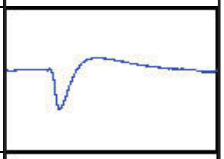
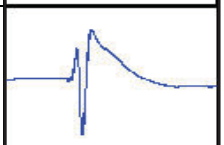
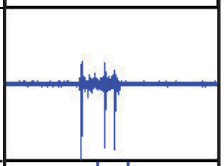
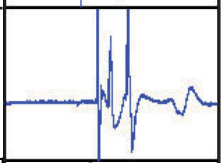
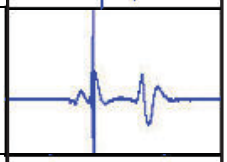
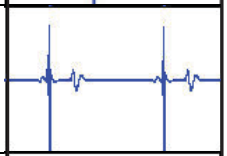
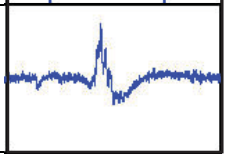
256MEA-SG

256MEA Signal Generator

Switch 1	Switch 2	press Button n times	Signal Source	Signal Type
OFF	OFF	1 256MEA-SG ON	Artificial Sine Wave (1.75 mV) 0.005 Hz Note: sine waves < 1Hz might not be visible because of the hardware filter bandwidth.	
		2	Sine Wave 0.01 Hz	
		3	Sine Wave 0.03 Hz	
		4	Sine Wave 1.25 Hz	
		5	Sine Wave 12.5 Hz	
ON	OFF	1 256MEA-SG ON	Hippocampal Slice EPSP	
		1	Hippocampal Slice Population Spike	
		2	Hippocampal Neurons Spikes	
OFF	ON	1 256MEA-SG ON	Heart ECG Atrium	
		1	Heart ECG Ventricle	
		2	Cardiomyocytes Ventricle FP	
ON	ON	1 256MEA-SG ON	Retina ERG with Spike	

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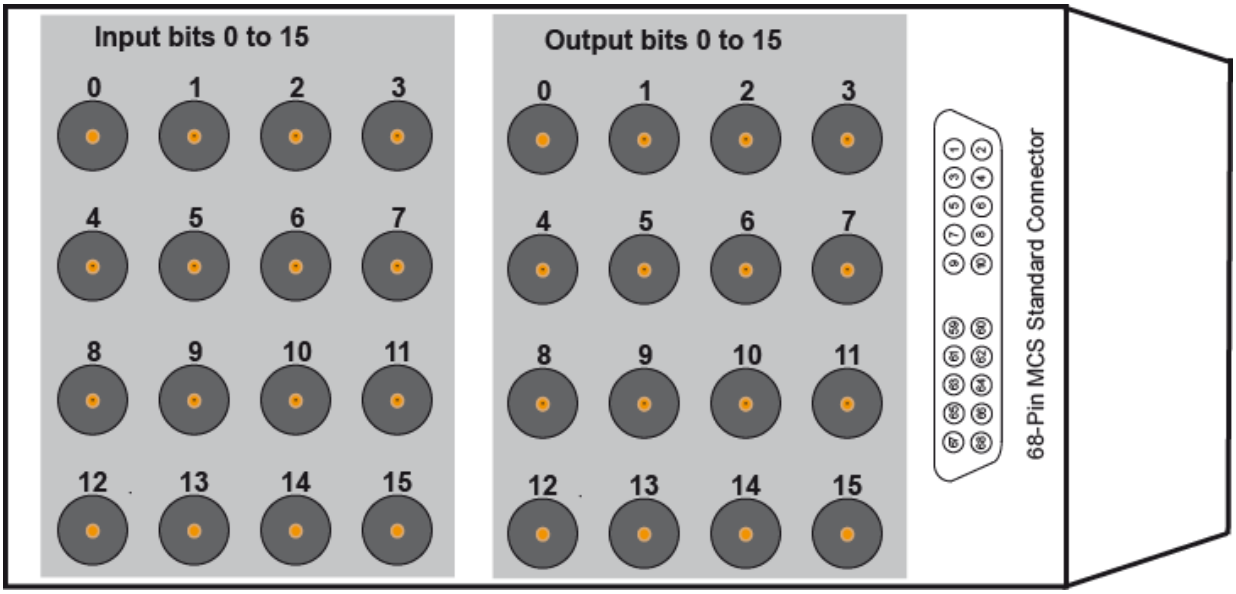
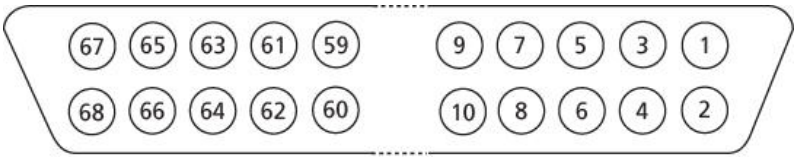
6.11 Digital IN / OUT Extension



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

6.12 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

6.13 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

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