multichannel systems

# MEA Signal Generator Manual

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# 1 Introduction

## 1.1 About this Manual

This short manual is an **addendum** to the elaborate **MEA Manual**. It is strongly recommended to read the MEA User Manual first, if you utilize the **MEA Signal Generator** for introducing yourself to MEA-System. Being already familiar with MEA-System, the **MEA-SG** will be easy to mount and to handle.

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.

# 2 Important Information and Instructions

## 2.1 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

## 2.2 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.

## 2.3 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.

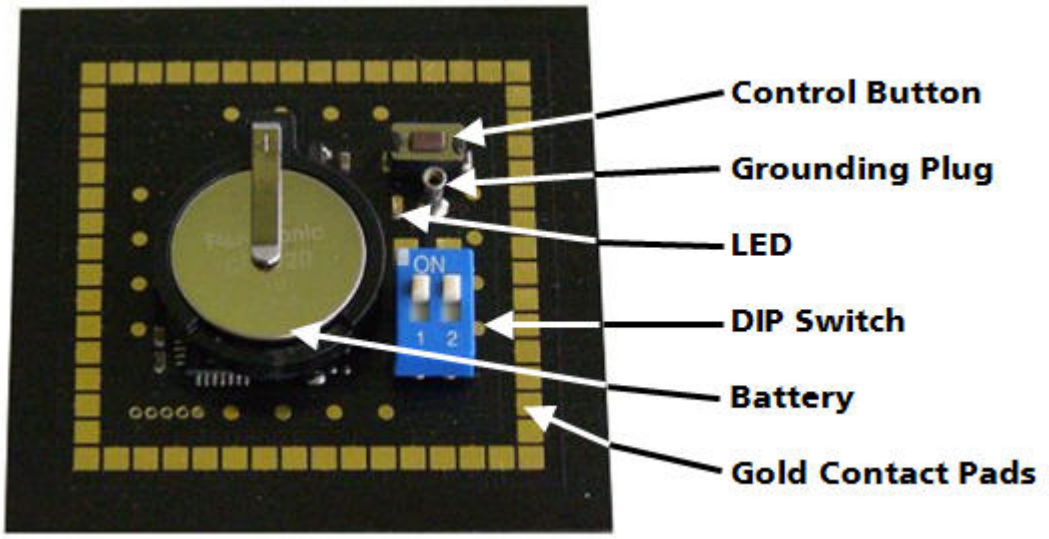
- Each time before starting up, make sure that the **power supply** agrees with the specifications of the product.
- Check the **power cord** for damage each time the site is changed. Damaged power cords should be replaced immediately and may never be reused.
- Check the **leads** for damage. Damaged 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.

# 3 MEA Signal Generator

## 3.1 Welcome to the MEA Signal Generator




The **MEA Signal Generator** is a convenient tool for **MEA-System Users**. As a variable substitute for expensive biology you can use the **MEA-SG** as you would set up a research experiment. That means you can test your own products and data acquisition settings without using valuable biological samples. It has the advantage that you do not need living material, you reduce the number of animal experiments and save laboratory equipment.

The **MEA-SG** produces sinus waves or real signals in digitized form. These signals are detected as analog signals with the **MEA-System**. Because of this data source you are able to use and to test the complete **MEA-System**.

The base of a **MEA-SG** is made of black board FR4. It shows the MEA standard design with the square recording area build from 60 **gold contact pads**. Instead of electrode arrangements in the middle, there is a battery for power supply, a blue double DIP switch, a plug socket for grounding cable, a control button, and a LED.

To **activate** the **MEA-SG** press the **control button**, to stop it manually, press the button for longer than two seconds. A flashing **LED** indicates activity. The position of the DIP switch selects different categories of signals (see table below).

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

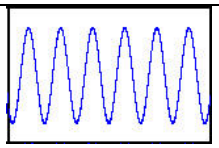
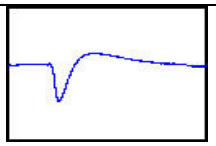
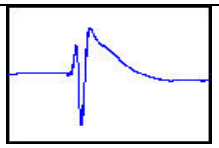
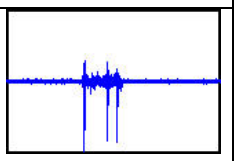
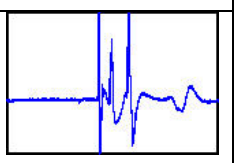
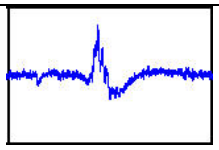
By pushing the control button it is possible to select the desired waveform **of that category**.

For example: Set the DIP switch to switch 1 ON and switch 2 OFF and activate the **MEA-SG** by pressing the button. The generator now produces EPSPs. Press the button again, and the generator switches to pop spikes, to spikes and back to EPSP and so on.

To save battery power the **MEA-SG** will run a desired signal for the duration of one hour and then switch off automatically.

The **MEA-SG** operates in a similar way to the standard MEA probe, but without a biological object. It is possible to simulate 12 different types of signals. Furthermore MCS offers the possibility to program individual signals on special request. Please contact Multi Channel Systems MCS GmbH if this is required.

Table: DIP switch position and corresponding signals

| Switch 1 | Switch 2 | press Button n times | Signal Source | Signal Type |
|---|---|---|---|---|
| OFF | OFF | 1<br>256MEA-SG ON | Artificial Sine Wave 0.005 Hz<br>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<br>256MEA-SG ON | Hippocampal Slice<br>EPSP |  |
| | | 1 | Hippocampal Slice<br>Population Spike |  |
| | | 2 | Hippocampal Neurons<br>Spikes |  |
| OFF | ON | 1<br>256MEA-SG ON | Heart<br>ECG Atrium |  |
| | | 1 | Heart<br>ECG Ventricle |  |
| | | 2 | Cardiomyocytes<br>Ventricle FP |  |
| ON | ON | 1<br>256MEA-SG ON | Retina<br>ERG with Spike |  |

Please adjust the scaling of the x- and y- axis according to the expected signals.

To change battery, please lift the clamp with a screwdriver and take out the battery. The new battery must be fixed with positive pole facing up!

# 4 Setting Up and Connecting the MEA Signal Generator

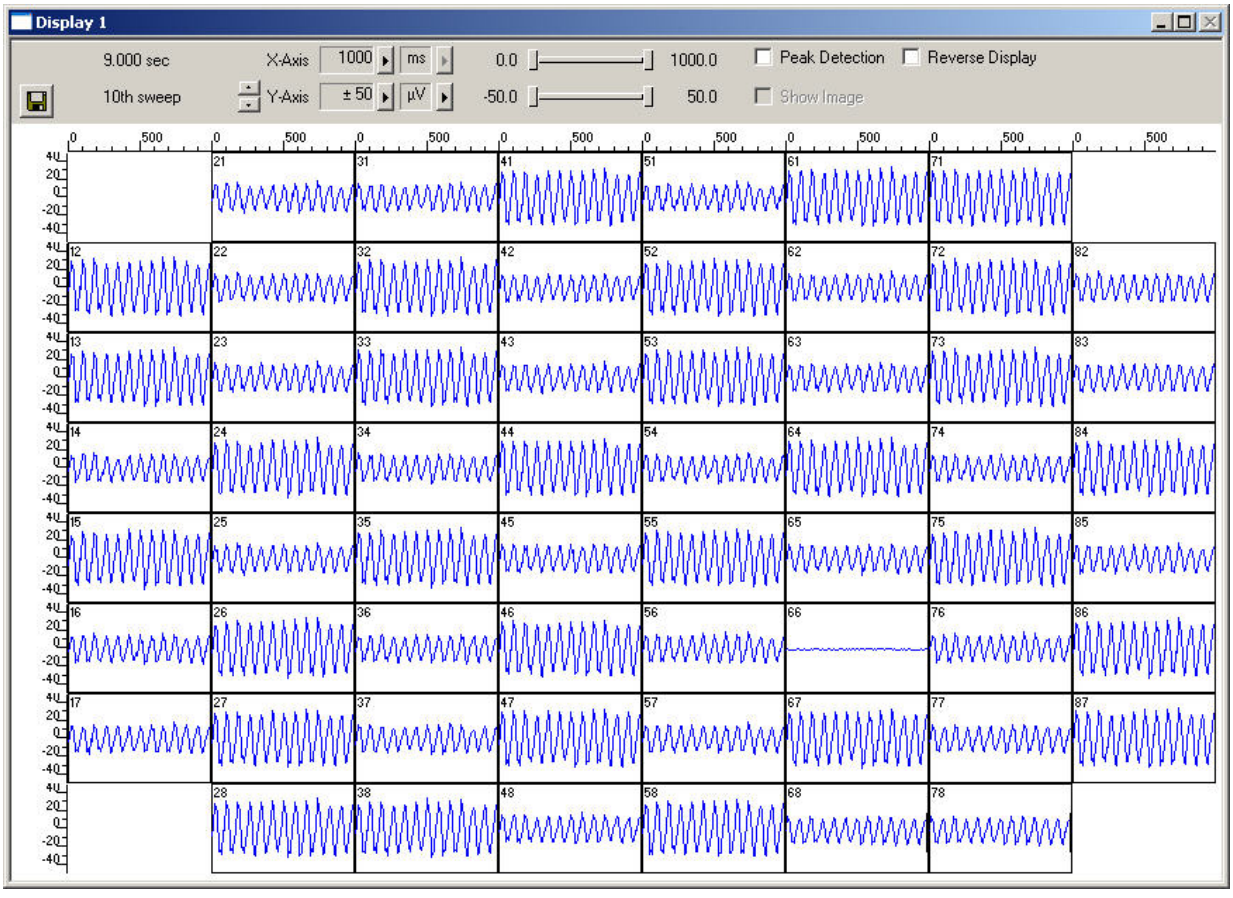
The **MEA-SG** is handled in the same manner as a **MEA probe** for experiments. For detailed information please read **MEA User Manual**.

Mounting instructions:

1. Open the lid of the MEA amplifier.
2. Place the **MEA-SG** inside. The orientation of the chip is not important.
3. Replace the lid and close it carefully.
4. Ground the **MEA-SG** with a CB-GND cable.

## 4.1 Handling the MEA-SG

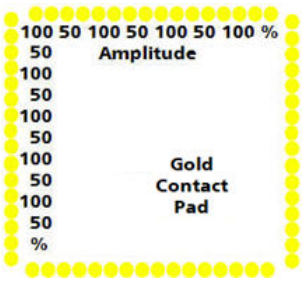
After starting **MC_Rack** and adding a data display you see your selected signal, in this case 12.5 Hz sinus waves.




**MC_Rack** data display

**Short circuit**

Please consider the different levels of amplitudes in electrode displays in direct vicinity side by side regarding to the gold contacts of **MEA-SG**, but not to the electrode displays. The **amplitude alternates** in a range of 100% and 50%. If there is a shot circuit between neighbor pads of gold contact, all electrodes will show the same averaged amplitude. You can see the changing amplitudes in **MC_Rack** data display best in data row four and five.




Gold Contact Pads

**For information**: If you ground one of the electrode pins with a small amplitude, all electrodes with small amplitudes will be set to zero. If you ground one of the electrode pins with 100% amplitude, its heights will be cut in half.

In **MC_Rack** data display channel 66 get saturated. Check whether this channels is grounded. If not, may be the electrode pin or the contact pad of your amplifier is defective. Please see chapter "Troubleshooting".

# 5 Application

**MEA-SG** is suitable for all purposes concerning **MEA-System** that is why it lends itself to **help new** users. It is possible to **learn** about the amplifier and the specific software **MC_Rack** and **MC_DataTool** just as well as other software programs. Furthermore you are able to **control** the operating mode of the amplifier and you have a tool for **troubleshooting.**

## 5.1 Training

**MEA-SG** is optimized for **training** users, because you are able to use **MC_Rack** and to work with the complete **MEA-System**. **MEA-SG** is also a good basis for demonstration.

To learn about **MC_Rack** please read the detailed **MC_Rack User Manual**. You can try out different features of the software and their influences on the signal. You can change signal types to make you familiar with specification and parameter value of the offered sinus waves and spikes. It is the best practice in software employment, you gain experience and avoid mistakes, which is beneficial for upcoming biological experiments.

## 5.2 Demonstration

The **MEA-SG** is a great tool for demonstrating how the **MEA-System** works. In contrast to biological experiments you can be sure that the Signal Generator will produce what you want to show, there is no risk of failure, which is always a problem with living objects.

# 6 Training MC_Rack

With **MEA-SG** it is easy to train users on the software which is specially made for MEA-Systems: **MC_Rack, MEA_Select** (if you have an amplifier with blanking circuit), and **MC_DataTool**.

Together with **MC_Card** and **MC_Rack** you have a complete set for data acquisition, and **MEA-SG** generates the data for training instead of an animal experiment. This possibility increases the flexibility of the unpracticed user. Please read the **MC_Rack User Manual** for detailed information. The reasonable "Step by Step" Tutorial gives you an impression how **MC_Rack** is generally working, and you can deal with prepared racks.

If you do not wish to read the complex **MC_Rack User Manual**, **MEA-SG** gives you the chance of "Learning by Doing". Because of your "mechanical animal", you can learn the **MC_Rack** features until you feel comfortable. Do not only follow the specified way in "Step by Step" Tutorial, try to think about some features which are important for your own experimental intentions and you will realize your ideas.

## 6.1 Summarized information about MC_Rack

In **MC_Rack** (the rack you use to record and analyze data online and offline) the data files are independent from each other. You can save and reuse a rack for several experiments, and generate separate data files. You can then load the generated data file with another rack for further offline analysis later.

The main power of **MC_Rack** is its great flexibility. You can combine various virtual instruments according to your experimental setup. You can decide about the fate of each single data stream separately. It is up to you, which data streams are displayed on the screen, which are saved, which are analyzed, and so on. This concept saves disk space and computer performance and makes handling of up to 128 channels with up to 50 kHz sampling rate easy. A status bar informs you of the actual performance of your computer when you record or replay data.

Please note that the high flexibility of **MC_Rack** can make a complex configuration of the software necessary - please do not be concerned by this. It is easy when you know how.

It is very important to note, that all **virtual instruments** in your rack work independently from each other. As a consequence, they have to be configured separately. For example, you have to select the input streams for each instrument separately.

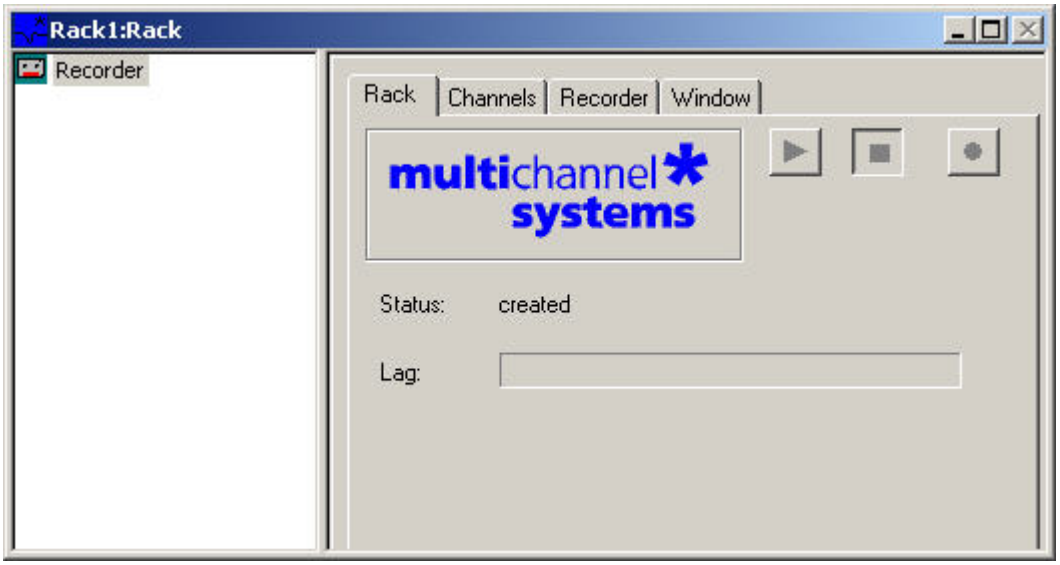
Generally, you will arrange the virtual instruments in your rack in a **hierarchical order**. The selected data streams flow from your **MC_Card** or from the **Replayer** (recorded data) into the virtual instrument highest in the hierarchy. Similar to a production line in a plant, this instrument picks up only those channels from the data streams that you have assigned to it. It processes this data and produces an output stream, that is lead to the virtual instrument(s) next in the hierarchy, and so on. When you build a rack, make yourself clear, which data streams flow to which instrument and what output you should expect. If you change the selection of channels for a virtual instrument, you may have to adjust the selection for instruments that depend on its output as well. If you have not specified an input for a tool, an error message will inform you.

## 6.2 Getting Started

Here you will find a short description of basic tasks and tools that are needed. Go through this chapter before you start building a rack.

### 6.2.1 Starting MC_Rack

Double-click the **MC_Rack** icon or select **MC_Rack** from the Start menu.




The program starts. One dialog box opens automatically. This is your **rack**. You will now configure your rack and implement the features you need to accomplish the task. Your rack is almost empty, it holds only a Recorder. In the Recorder dialog box, you define the path and the file in which the acquired data is going to be saved.

### 6.2.2 Creating a Data File

1. Click the Recorder tab.

2. Browse your folders and select a path.

3. Type a file name into the text box.

4. Confirm by clicking Save.

The file extension for the data files is ".mcd".

The generated files can have a maximum size of 2047 MB. This is a limit of Microsoft Windows. When this size has been reached, a new file is generated automatically. The file name is extended by four digits, counting up, for example LTP-Parameters0001.mcd, LTP-Parameters0002.mcd, and so on. This allows you to create very large data files. You can also choose that the recording is stopped automatically when a file has reached the maximum size (option Auto Stop).

As has been said before, the fate of each single channel is independent from other channels. You can pick specific channels you wish to save from all generated data streams. For example, you can decide to save only one channel of raw data, but the peak-to-peak amplitude results of all, or of a specific selection of channels.

### 6.2.3 Replaying Data

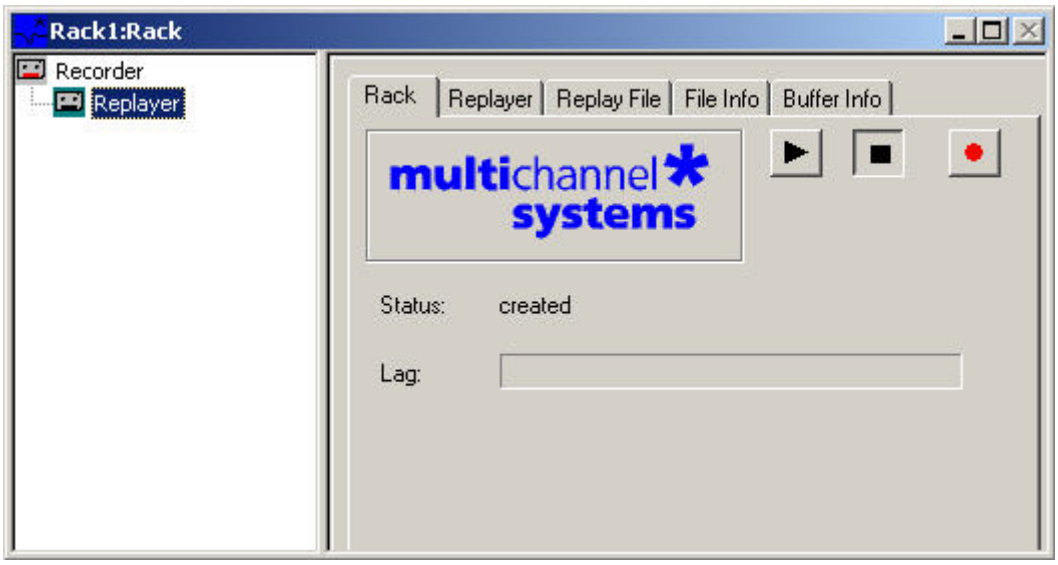
In **MC_Rack** you can then load the generated data file with another rack later for further offline analysis. The general design of a rack is basically the same for online or for offline analysis. The only difference is that you use the Replayer instead of the **MC_Card** to generate data streams, which can be processed by other virtual instruments in the rack.

First, you define the input data. Because you are going to perform an offline analysis with previously saved data, you need the Replayer. The Replayer works like a tape deck; you load a file and you can then start and stop replaying the data streams by mouse-click.

You can select an instrument in your rack to open the corresponding property sheet. A selected instrument is highlighted in blue.

1. On the toolbar, click  to add a Replayer to your rack.

The Replayer property sheet is opened.




2. Click the Replay File tab. Here, you load the file you like to review or to analyze offline.

3. Click Browse and browse your folders. choose the desired file and click Open.

Later on, you can choose recently used files from the Recent Files drop-down list. Load a file by clicking Open.

### 6.2.4 File Information

Click File Info.

You see the date and time when the file has been recorded and all important information about the conditions which was used.

Click Buffer Info.

On the left pane, you see the single data stream or several streams which were recorded, the number of channels, the sampling frequency, the gain factor and the data format.

### 6.2.5 Saving a Rack

Save the rack if you would like to keep it for future use.

1. On the File menu, click Save As.

2. The Save As dialog box opens.

3. Browse your folders and select a path.

4. Enter a file name and confirm by clicking Save.

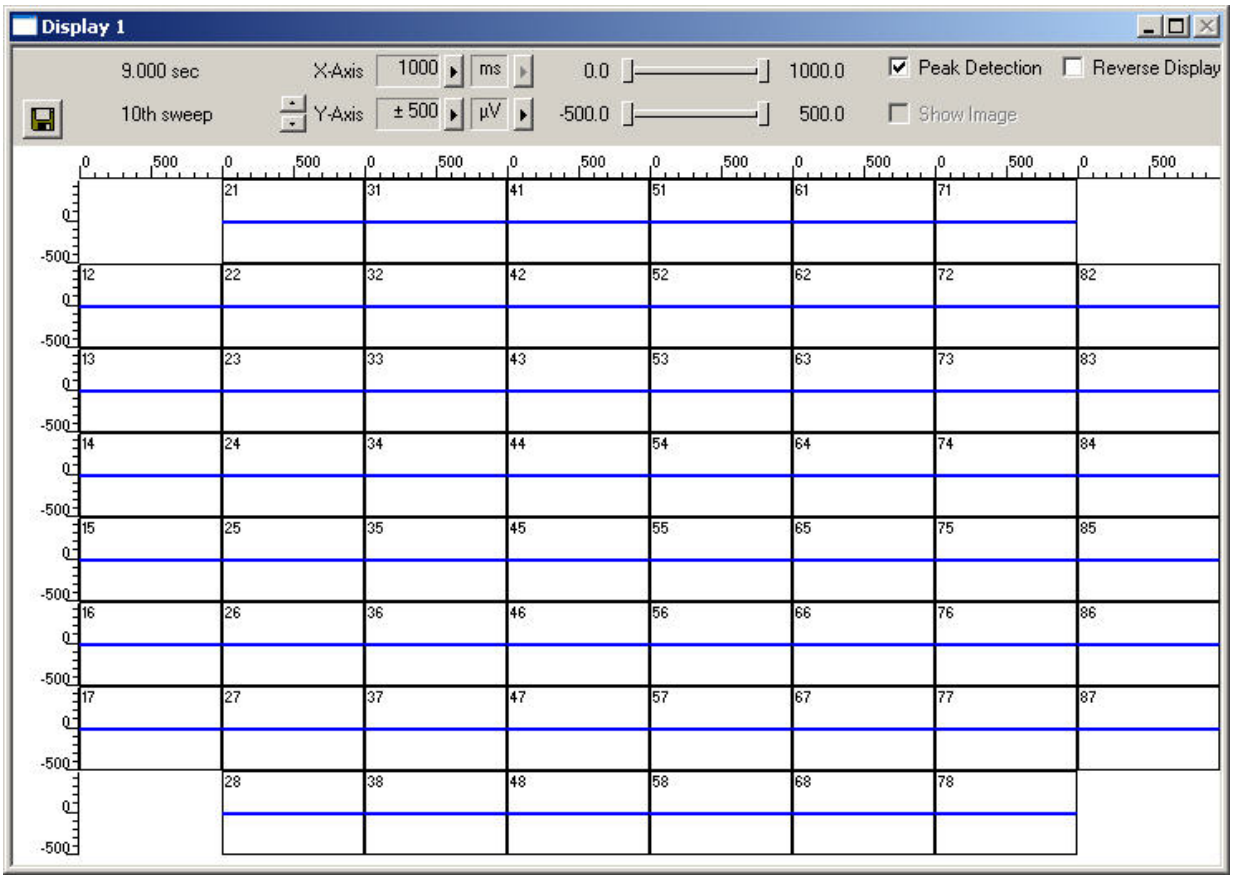
# 7 Troubleshooting MEA Amplifier

It is possible to **control** some functions of the **MEA amplifier** with **MEA-SG**. Please read also chapter "Troubleshooting" in **MEA Manua**l. Most of the problems with MEA-System are rare, and most are minor problems which can be easily avoided and solved. If a problem persists, please contact your retailer. With **MEA-SG** you are able to check the electrode pins of your amplifier and the general behavior due to grounding and shielding the system.

## 7.1 Grounding and Shielding

### Noise level

After mounting the **MEA-SG**, connecting it to ground, but before switching it on, you first see the noise level 50 Hz hum. The level should be comparable on each channel, not too big and without additional interference. If the overall noise is too strong, shielding and grounding of the set up is not sufficient. Check the grounding cable and improve the  shielding. The easiest way is to cover the USB-MEA amplifier with aluminium foil and connect the foil to any metal part of the amplifier. Another possibility is shielding with a Faraday cage.

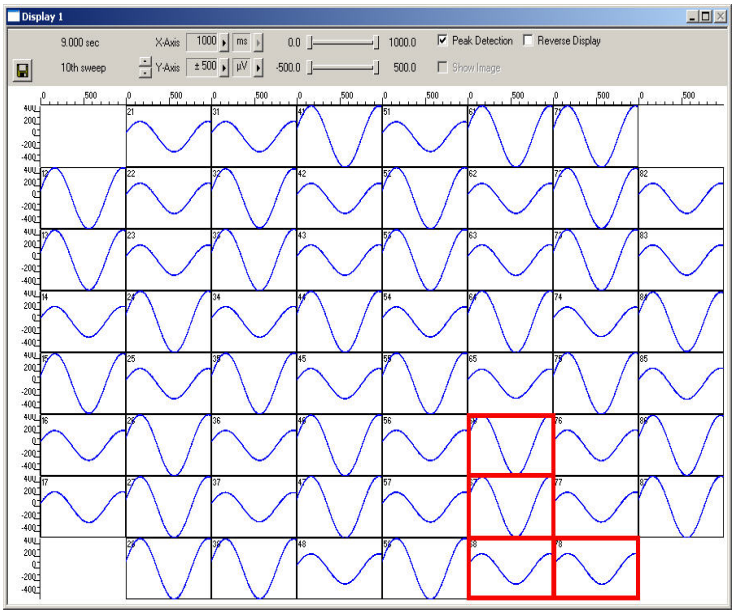


## 7.2 Checking the Electrode Pins of the Amplifier

### Noise in single Electrodes

Starting **MEA-SG** with 12.5 Hz sinus waves you may see the following display:


Channel 66, 67, 68 show an significant higher level of noise, channel 78 is completely in saturation. That means, there is a problem with the contact pad of **MEA-SG** and / or the electrode pins of the amplifier. To test this, turn **MEA-SG** by 90 degrees. If the same electrodes in the MEA layout are affected, the contact of the amplifiers electrode pins are bad, may be the gold contacts of **MEA-SG** too. In most cases this is a problem of contamination. To repair, clean the gold contacts of **MEA-SG** and electrode pins of the amplifier with a soft tissue or a cotton swab and 100% pure alcohol. The channels should now display flawless signals (see data display below). If contamination was not the cause, it may be that the electrode pins are defective. Ground the channels if you do not need them, or change electrode pins in amplifier. Please read MEA User Manual for detailed instructions.




**MC_Rack** data display with flawless signals.

# 8 Appendix

## 8.1 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

## 8.2 Scope of Delivery

| | |
|---|---|
| 1 | MEA Signal Generator |
| 1 | Lithium Battery CR 1620 (durability maximal 2 years) |
| 1 | Grounding Cable CB-GND |