USB-ME32-FAI-System Manual

Imprint

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Printed: 21.06.2019

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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.

2 Important Safety Advice

2.1 Important Safety Advice

Warning: Make sure to read the following advice prior to installation or use of the device and the software. If you do not fulfill all requirements stated below, this may lead to malfunctions or breakage of connected hardware, or even fatal injuries.

Warning: Always obey the rules of local regulations and laws. Only qualified personnel should be allowed to perform laboratory work. Work according to good laboratory practice to obtain best results and to minimize risks.

The product has been built to the state of the art and in accordance with recognized safety engineering rules. The device may only

- be used for its **intended purpose**;
- be used when in a **perfect condition**.
- Improper use could lead to serious, even fatal injuries to the user or third parties and damage to the device itself or other material damage.

Warning: The device and the software are **not** intended for medical uses and **must not** be used on humans. MCS assumes no responsibility in any case of contravention.

Malfunctions which could impair safety should be rectified immediately.

High Voltage

Electrical cords must be properly laid and installed. The length and quality of the cords must be in accordance with local provisions.

Only qualified technicians may work on the electrical system. It is essential that the accident prevention regulations and those of the employers' liability associations are observed.

- Each time before starting up, make sure that the **power supply** agrees with the specifications of the product.
- Check the **power cord** for damage each time the site is changed. Damaged power cords should be replaced immediately and may never be reused.
- Check the **leads** for damage. Damaged leads should be replaced immediately and may never be reused.
- Do not try to insert anything sharp or metallic into the vents or the case.
- Liquids may cause short circuits or other damage. Always keep the device and the power cords **dry**. Do **not** handle it with wet hands.

Requirements for the installation

Make sure that the device is not exposed to direct sunlight. Do not place anything on top of the device, and do not place it on top of another heat producing device, so that the air can circulate freely.

2.2   Guarantee and Liability

The *General conditions of sale and delivery* of Multi Channel Systems MCS GmbH always apply. The operator will receive these no later than on conclusion of the contract.

Multi Channel Systems MCS GmbH makes no guarantee as to the accuracy of any and all tests and data generated by the use of the device or the software. It is up to the user to use good laboratory practice to establish the validity of his / her findings.

Guarantee and liability claims in the event of injury or material damage are excluded when they are the result of one of the following:

- Improper use of the device.
- Improper installation, commissioning, operation or maintenance of the device.
- Operating the device when the safety and protective devices are defective and/or inoperable.
- Non-observance of the instructions in the manual with regard to transport, storage, installation, commissioning, operation or maintenance of the device.
- Unauthorized structural alterations to the device.
- Unauthorized modifications to the system settings.
- Inadequate monitoring of device components subject to wear.
- Improperly executed and unauthorized repairs.
- Unauthorized opening of the device or its components.
- Catastrophic events due to the effect of foreign bodies or acts of God.

2.3   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.

3 Welcome to the USB-ME32-FAI-System

3.1 ME Product Line

The standard ME product line is based on a data acquisition card, the MC_Card, that is installed in the data acquisition computer.

With the ME (microelectrode) and STG (stimulus generator) product lines, Multi Channel Systems MCS GmbH provides complete solutions for stimulation, recording, and data acquisition from up to 32 channels, data analysis and export.

All ME products are intended for extracellular electrophysiological recordings in vivo, and special in vitro applications. Typical applications include, for example simultaneous spike and local field potential recording; or multi-unit and single-unit recording from awake behaving of animals.

3.1.1 USB-ME32-FAI-System

The **USB-ME32-FAI-System** is the first of a new generation of universal recording systems that **do not need an external data acquisition card**. Data transfer to any computer is realized via USB.

The following components are part of the USB-ME32-FAI-System. Please make sure that you have carefully studied the documentation on the single components before setting up your system. All manuals can be found on the installation volume shipped with the system. Updated versions can also be downloaded from the MCS web site.

3.1.2 Single components of USB-ME32-FAI-System

Web link to the manuals download page on www.multichannelsystems.com

Product	PDF: Manual / Reference
1 x 32-channel 10x miniature preamplifier (MPA32I) **- or -**	MPA32I Manual
4 x 8-channel 10x miniature preamplifiers (MPA8I)	or MPA8I Manual
16-channel filter amplifier and data acquisition	USB-ME32-FAI-System Manual
Data acquisition and analysis software Multi Channel Suite	Multi Channel Suite Manual / Help
Data acquisition and analysis software MC_Rack and MC_DataTool	MC_Rack Manual / Help and MC_Rack Tutorial
ADPT-NN-16 **- or -** ADPT-NN-32	Adapter for connecting the NeuroNexus Probe NN-16 to two MPA8Is Datasheet **- or -** Adapter for connecting the NeuroNexus Probe NN-32 to a MPA32I. Datasheet.

3.2 Welcome to the USB-ME32-FAI-System

The USB-ME32-FAI-System is a very compact and portable stand-alone solution. It features an integrated 32-channel filter amplifier and data acquisition. The digitally converted electrode signals are 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. The size of the complete system is small enough to fit into a laptop bag together with the computer.

The system includes four 8-channel miniature preamplifiers (MPA8I) or one 32-channel miniature amplifier MPA32I. The MPA8I or MPA32I is connected to the microelectrodes to provide the initial tenfold amplification stage. Adapters to contact standard microelectrodes such as acute or chronic probes from NeuroNexus Technologies are available as accessories. Custom adapters are available on demand.

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

USB-ME32-FAI-Sytem with integrated 32-channel filter amplifier and integrated data acquisition with A / D converter, and interfaces for one 32-channel miniature preamplifier MPA32I and four 8-channel miniature preamplifiers MPA8I.

The USB-ME32-FAI-Sytem can be used either with four MPA8Is - OR - with one MPA32I. The device is preconfigured for use with four MPA8Is or with one MPA32I by Multi Channel Systems and cannot be modified by the user! If you like to change the preconfiguration, please contact MCS www.multichannelsystems.com

4 Operating the USB-ME32-FAI-System

4.1 Setting Up and Connecting the USB-ME32-FAI-System

⚠️ Warning: Please read the separate manuals of all devices before installation, especially the warnings and safety information. Make sure all devices are switched off before you connect them to the power supply. Damage to the devices and even fatal injuries may result from improper installation or use.

Note: Using a USB hub for connecting the USB-ME32-FAI-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.

⚠️ The USB-ME32-FAI-Sytem can be used either with four MPA8Is - **OR** - with one MPA32I. The device is preconfigured for use with four MPA8Is **or** with one MPA32I by Multi Channel Systems and cannot be modified by the user! If you like to change the preconfiguration, please contact MCS www.multichannelsystems.com

4.1.1 Front Panel

4 x Analog Input for MPA8I

On the front panel of the USB-ME32-FAI are four MPA8I analog inputs (Female D-SUB 15 connector) available. From the left to the right analog input No. 1 is for MC_Rack software channel 1 to 8, analog input No. 2 is for channel 9 to 16, No. 3 is for 17 to 24, and No. 4 is for channel 25 to 32.
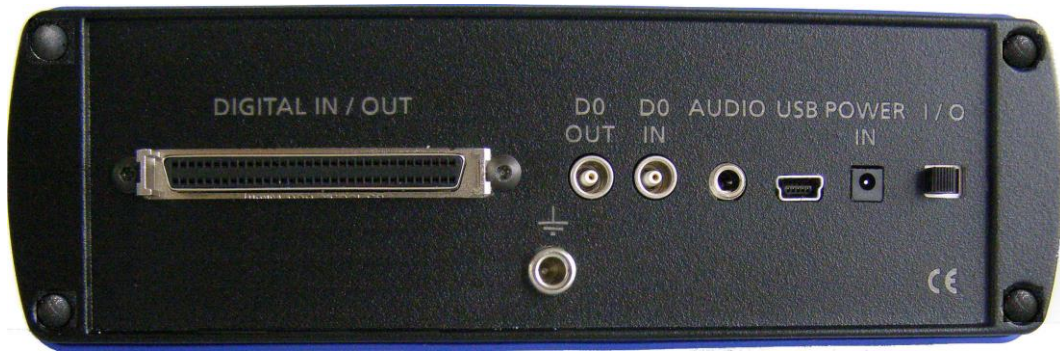
1 x Analog Input for MPA32I

The Female D-DUB 37 connector is the analog input for a MPA32I. You can connect up to four MPA8Is **or** one MPA32I.

Power LED

The power LED should light up as soon as the system is connected to the power supply and the I / O toggle switch on the rear panel is switched to status "I = On".

4.1.2   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 Signal Divider SD16 from Multi Channel Systems MCS GmbH. You can utilize this digital signal to control and synchronize other devices with the USB-ME32-FAI. 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 - 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.

DIG OUT D0

The Bit 0 of the Digital OUT D0 is also accessible independently from the 68-pin Digital IN / OUT connector. The digital output channel D0 is generally used for synchronizing the USB-ME32-FAI-System with a stimulus generator, or with another data acquisition system, for example, an imaging or a patch clamp system. The DIG OUT D0 generates standard TTL pulses.

DIG IN D0

The Bit 0 of the Digital IN D0 is parallel to Bit 0 of the DIG OUT independently available from the 68-pin Digital IN / OUT connector. The digital input channel D0 is generally used for synchronizing the USB-ME32-FAI with another device, or with another data acquisition system, for example, an imaging or a patch clamp system. The DIG IN D0 accepts standard TTL pulses.

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.

USB

The USB connector is used to transfer the digitized data from all data channels and the additional digital channels to any connected data acquisition computer via USB High Speed 2.0 cable (type A - mini B).

POWER IN

Connect here the power supply unit. This power supply powers the USB-ME32-FAI main unit only. The device needs 12 V and 1.1 A / 13.2 W.

I / O

Toggle switch for turning the device on and off. The power LED on the front panel should light up as soon as the system is connected to the power supply and the I / O toggle switch is switched to status "I = On".

GROUND

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

4.2 Setting up and Connecting the USB-ME32-FAI-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. Set up the computer (with installed software program). Set up the MPA8I (up to four MPA8Is) or the MPA32I as described in chapter "Setting Up and Connecting the MPA".

3. Set up the computer (with installed software program).

4. Set up the MPA8I (up to four MPA8Is) or the MPA32I as described in chapter "Setting Up and Connecting the MPA".

5. Connect the MPA8Is (or the MPA32I) to the main unit of the USB-ME32-FAI-System. Close all unused inputs with terminal plugs.

6. Connect the USB output connector to a free USB 2.0 port of the data acquisition computer.

7. Connect the main 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.

8. Check the power LED on the front panel. It should light up as soon as the power line is connected and the I / O toggle switch on the rear panel is "On". If not, check the power source and cabling.

9. Install the software from the installation volume if it is not already installed.

10. Start the software and select the USB-ME32-FAI-System as the data source. Please see the software help or manual for more details on how to define the data source.

4.3   Software Installation

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

4.3.1   System Requirements

Software: One of the following Windows operating systems is required: Windows 10, Windows 8.1, 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-ME32-FAI-System. If no USB-ME32-FAI-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-ME32-FAI-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-ME32-FAI-System driver to operate the USB-ME32-FAI-System, which is automatically installed with the software. The installation may be invalid if the USB-ME32-FAI-System does not respond. Please contact Multi Channel Systems MCS GmbH or your local retailer in this case.

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

- Turned off **Screensaver**.

- Turned off **Windows Indexing Service**. Only important for data hard drive.

- Manual management of automatic **Windows Update.**

- **Power Options**: Power scheme: **Never** turned off monitor, hard disk and system standby.

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

- Be careful when using a **Virus Scanner.** These programs are known to disturb the software, and even data loss may occur.

4.3.3   Driver Installation

The USB-ME32-FAI-System is a plug and play device. The driver is automatically installed together with the software. It is easier to connect the USB-ME32-FAI-System first to the data acquisition computer and then install the software.

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

4.4 Multi Channel Experimenter

Please read the Multi Channel Experimenter manual!

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

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

The header of the dialog contains five buttons: "Start DAQ", "Start Recording", "Load Experiment" and "Save Experiment" in the main toolbar on the left and the "Menu" button on the right. In the footer the "Recording Time" and the "DAQ Time" are registrated.
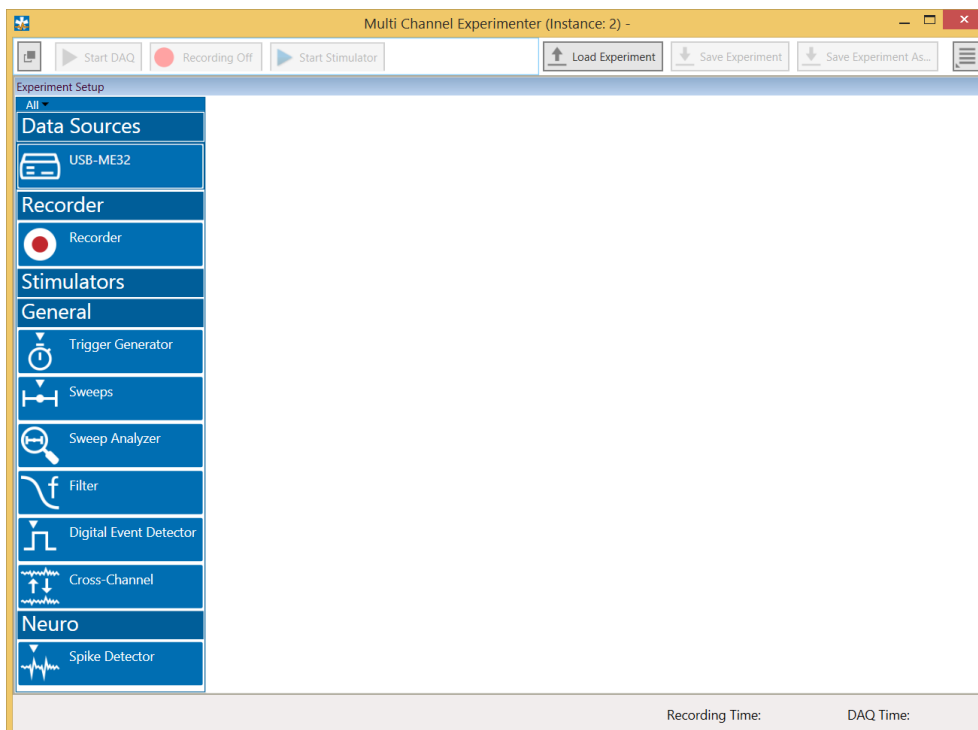
Building a Rack

It is very easy to build a rack: Please click onto the button of the desired instrument and move it via drag and drop from the left to the right side of the main window!
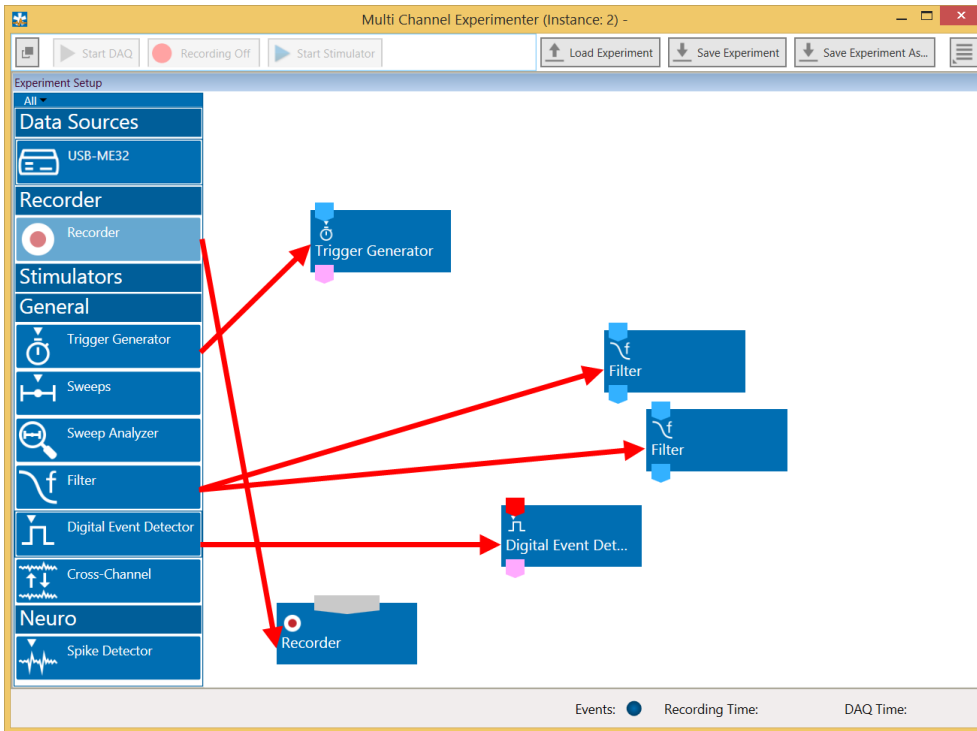
It is also easy to connect the instruments: Please click onto one of the output ports on the lower part of an instrument to connect this output port via drag and drop with the input port (symbol on the upper side) of the target instrument. Please read the next chapter.
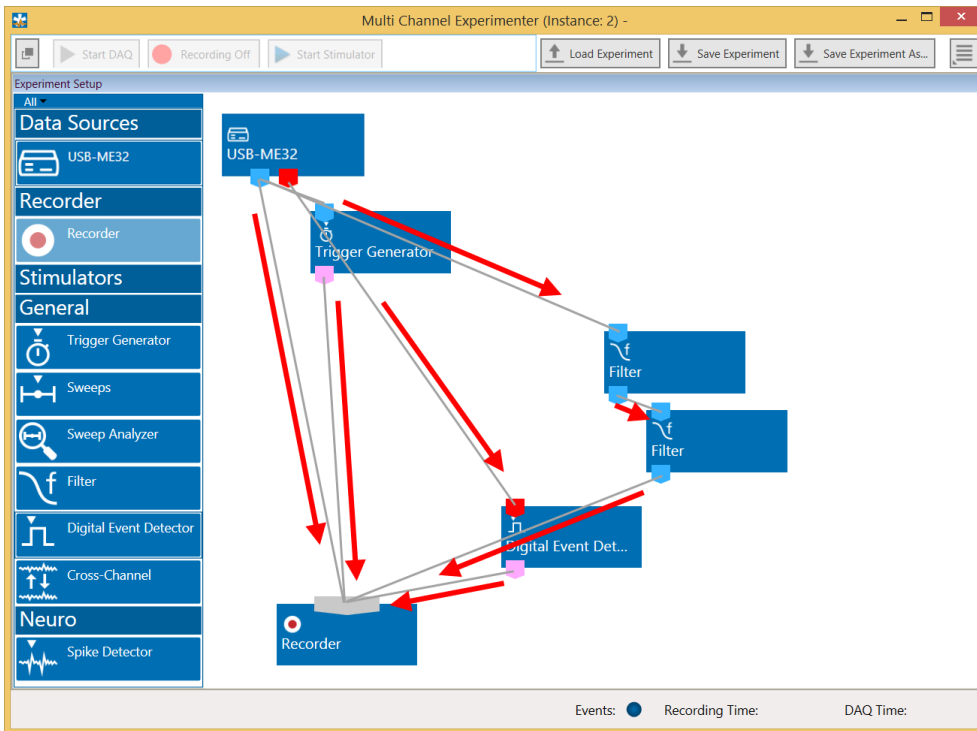
Conventions for Building a Rack

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

Two color coded output ports of the USB-ME32-FAI data acquisition device.

Example: Click on the blue symbol output port of the data source and connect it by drag and drop with the blue symbol input port of the filter. The electrode raw data stream will flow from the data source to the filter. Connect the blue symbol output port from the filter with "Sweeps" instrument and then to the recorder. Connect the red digital output port of the data source with the red input port of the "Digital Event Detector" device and to the recorder. The grey input port of the recorder accepts all types of input data streams and you can connect more than one data stream.
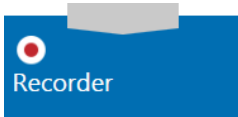
The Multi Channel Experimenter Rack
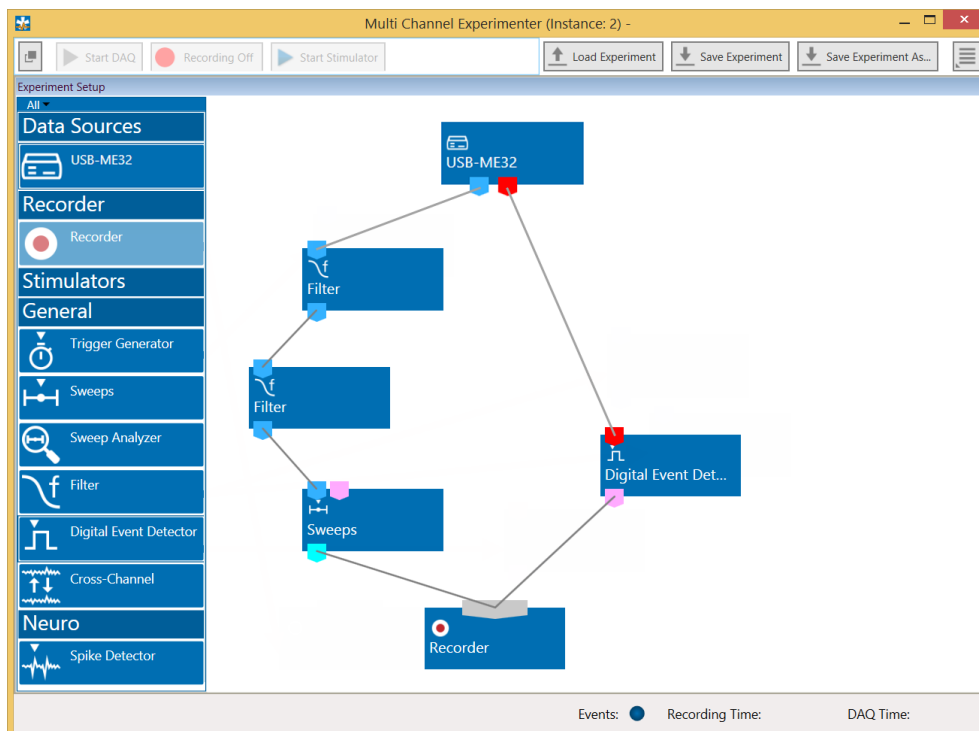
Move as many instruments as you need via drag and drop into the "Experiment Setup" window. It is possible to use the virtual tools more than one time.

4.5   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-ME32-FAI-System connected to the computer

The Windows operating system detects a new hardware when the USB-ME32-FAI-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-ME32-FAI-System to a computer with installed Software

If the software 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-ME32-FAI-System will be automatically recognized by the operating system.

1. Connect the USB-ME32-FAI-System to the USB port of the data acquisition computer.

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-ME32-FAI-System driver.
    Continue with "Next".

6. The driver installation is finished.

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

7. Double-click Setup.exe on the installation volume.

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

8. Follow the instructions of the installation assistant.

    The USB-ME32-FAI-System driver and the software are installed (or updated) automatically.

4.6 Setting up MC_Rack

Please refer to the MC_Rack Manual for more information.

- Start MC_Rack.

- Open the file MPA8I_NoiseTest.rck and / or MPA32I_NoiseTest.rck on the installation volume (see folder Tutorial). This rack contains the virtual MC_Card instrument with a continuous raw data display and an Analyzer to measure the peak-to-peak amplitude.

- Click Start to start the recording.

- — OR — Set up the rack on your own:

  Click Set Channel Layout on the Edit menu. In Data Source, select USB-MEA from the left drop down menu and USB-ME32 from the right drop down menu.
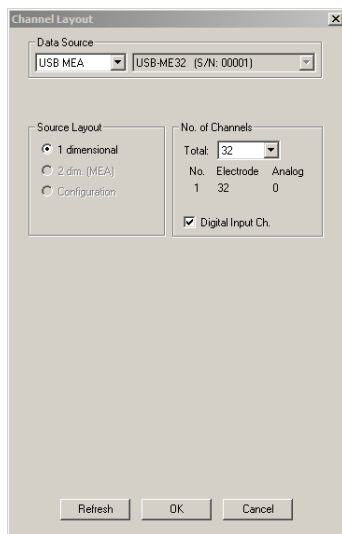
- Add the USB-ME32-FAI to your virtual rack.

- In the tree view pane of the virtual rack, select the USB-ME32-FAI-System and click the Hardware tab. Enter the total amplifier gain according to the specifications of the instruments. For example, for a miniature preamplifier with a gain of 10 and a following filter amplifier with a gain of 100, the total gain is 1000.

- Select an input voltage range of –819.2 to 818.8 mV and a sampling rate of 10000 Hz.

- On the Edit menu, click Add Data Display to add a raw data display to your virtual rack.

- In the virtual rack tree view pane, select the Display 1 and click the Layout tabbed page. Set up a channel map with channels 1 to 32.

- Adjust the display ranges to 500 ms and +/–50 µV.

- On the Edit menu, click Add Analyzer to add an Analyzer to the virtual rack. Select all or two typical channels on the Channels tabbed page. Select the Peak-Peak Amplitude parameter on the Analyzer tabbed page.

- On the Edit menu, click Add Parameter Display to add a Parameter Display to the virtual rack.

- In the virtual rack tree view, select the Display 2 and click the Layout tabbed page. Set up a channel map with all channels that were assigned to the Analyzer.

- Click the Ranges tabbed page and enter 0 to 10 s for the x range and 0 to 100 µV for the y-range.

5 System Components

5.1 Miniature Preamplifier (MPA8I)

The 8-channel miniature head stage preamplifiers MPA8I is connected directly to the microelectrodes in the test model to provide the first amplification stage of 10. Adaptors for standard microelectrodes such as NeuroNexus probes are available. The miniature preamplifiers small size allows easy placement. The metal housing prevents the amplifier from picking up external noise.

The MPA8I is a differential (type I) amplifier, that is, it includes additional common ground and reference electrode inputs. The reference electrode is ideally identical to the recording electrodes and placed into a comparable but inactive area or tissue. Background or noise signals that are picked up by both the reference electrode and the recording electrodes are removed.

The metal case provides electrical shielding. Electrode damage is prevented by the very low bias current. The high input impedance ensures stable long-term recordings: Ideally, the input impedance would be infinite. As low voltages are generally recorded, a high current would flow if the input impedance were low. As a result, the amplifier would not be able to deliver the current, and the voltage would break down. The miniature preamplifier has a high input impedance to avoid this problem.

5.2 Setting up and Connecting the MPA8I

General Setup Recommendations

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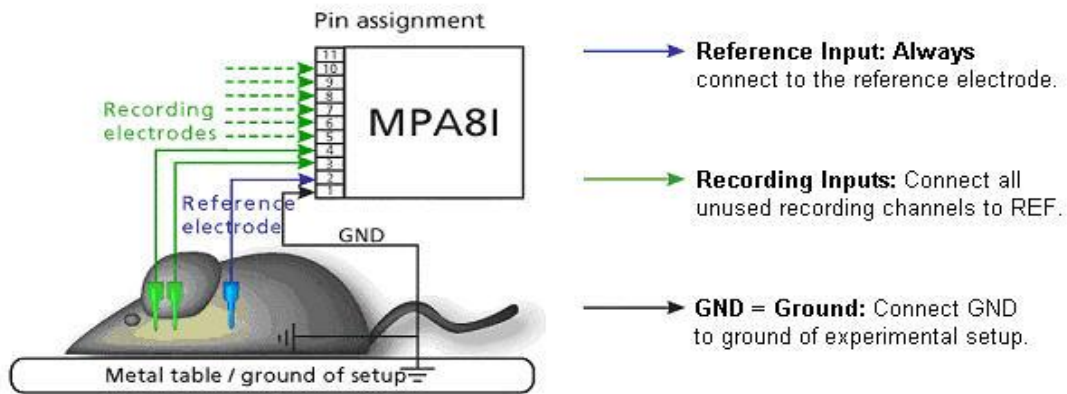
Important: It is important that the complete setup refers to a single common ground. The reference input has always to be connected. It is recommended to use a reference electrode. However, if you are not using a reference electrode, connect the reference input to ground (GND). Otherwise, noise picked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

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

- Connect the GND input or the metal case of the miniature preamplifier to the common ground of the setup. (The GND input is internally connected to the metal case.)

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

- Connect the recording electrodes to the recording channels of the miniature preamplifier. You can either use single electrodes or multitrodes with the miniature preamplifier. MCS provides adapters for standard probes.

- Connect all unused recording channels to the GND input or to the reference electrode, if ground and reference are short circuited to avoid noise pickup. As the total amplifier gain generally lies in the range of 1000, even very small noise signals may generate high noise signals.signals.

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

5.3   Testing the Noise Level of the MPA8I

A **terminal plug** that connects all inputs to ground, and a **test model probe** that mimics the electrode impedance are available for testing the noise level of the setup.

Please note that the test model probe has to be ordered separately.

All instruments were thoroughly tested at the factory site before delivery. The tests suggested below are mainly intended for optimizing and troubleshooting your setup, to exclude any damage that might have occurred during transportation, or to fulfill your own guidelines, for instance. It will take only a few minutes time and can save you time and trouble in the long run. Multi Channel Systems MCS GmbH recommends running these tests before you start your real experiments.

1. Shorten the inputs of one MPA8I with the terminal plug, and connect the test model probe to the other MPA8I as shown in the picture (do not mismatch the polarity).

2. Connect the MPA8I with the test model probe to channels 1 to 8.

3. Connect the MPA8I with the terminal plug to channels 9 to 16.

4. Make sure that all other connections are appropriate, and that your setup has an appropriate grounding and shielding as recommended in the chapter "General Setup Recommendations".

Typical Results of Noise Level Test

Typical results of this test are shown in the following screen shot.
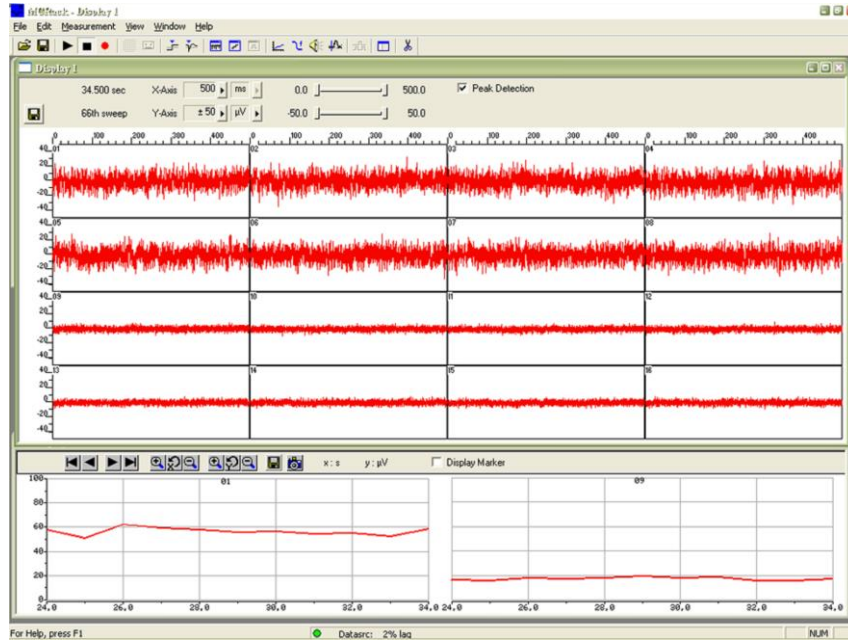
The noise level is 60 µV peak to peak with the provided test model probe (channels 1 to 8) and 20 µV peak to peak with grounded inputs (channels 9 –16). The top window shows raw data; the bottom window shows the extracted peak-to-peak amplitudes of channels 1 and 9. (The miniature preamplifier was shielded by a metal case connected to the ground / earth of the test laboratory).

5.4   Miniature Preamplifier MPA32I

The 32-channel miniature preamplifier MPA32I is connected to the microelectrodes for providing the initial tenfold amplification stage. It has additional common ground and reference electrode inputs. The reference electrode is ideally identical to the recording electrodes and placed into a comparable but inactive area or tissue. Background or noise signals that are picked up by both the reference electrode and the recording electrodes are removed.

The metal case provides electrical shielding. Electrode damage is prevented by the very low bias current. The high input impedance ensures stable long-term recordings: Ideally, the input impedance would be infinite. As low voltages are generally recorded, a high current would flow if the input impedance were low. As a result, the amplifier would not be able to deliver the current, and the voltage would break down. The miniature preamplifier has a high input impedance to avoid this problem.

Adapters for all standard microelectrodes such as NeuroNexus probes (from NeuroNexus Technology) for acute and chronic implantations ensure a close proximity to the probe to minimize signal loss and cross talk. Adapters are not included in the standard scope of delivery and have to be ordered separately. For custom adapters, please ask your local retailer or contact Multi Channel Systems MCS GmbH.

5.4.1 Setting up and Connecting the MPA32I

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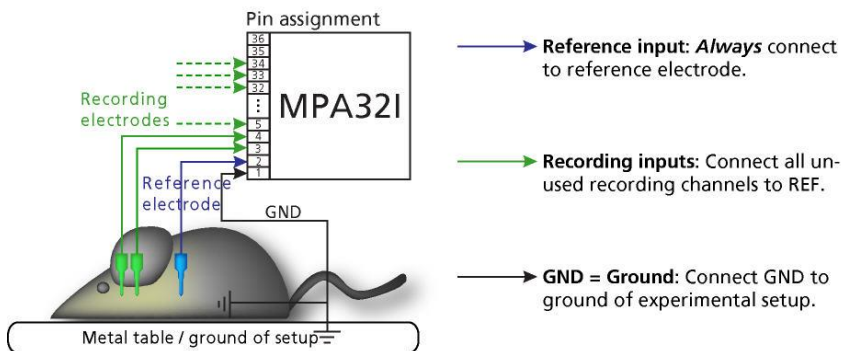
Important: It is important that the complete setup refers to a single common ground. The reference input has always to be connected. It is recommended to use a reference electrode. However, if you are not using a reference electrode, connect the reference input to ground GND). Otherwise, noise picked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

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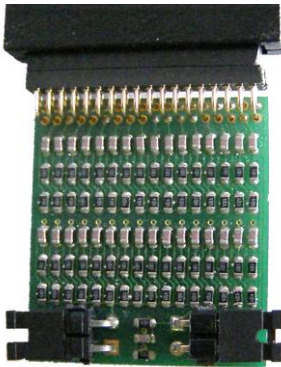t. The ground electrode is best positioned in an electrically inactive region (not near muscle, nor heart), for example, at the belly.

2. Connect the GND input of the miniature preamplifier or the ground input of the probe adapter to the common ground of the setup. (The GND input is internally connected to the metal case.)

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

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

5. Connect the recording electrodes to the recording channels of the miniature preamplifier. You can either use single electrodes or multitrodes with the miniature preamplifier. MCS provides adapters for standard probes.

6. Connect all unused recording channels to the GND input or to the reference electrode, if ground and reference are short circuited to avoid noise pickup. As the total amplifier gain generally lies in the range of 1000, even very small noise signals may generate high noise signals.

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

5.4.2 Testing the Noise Level of the MPA32I

A terminal plug that connects all inputs to ground, and a test model probe that mimics the electrode impedance are available for testing the noise level of the setup.

Please note that the test model probe has to be ordered separately.

All instruments were thoroughly tested at the factory site before delivery. The suggested tests are mainly intended for optimizing and troubleshooting your setup, to exclude any damage that might have occurred during transportation, or to fulfill your own guidelines, for instance. It will take only a few minutes time and can save you time and trouble in the long run. Multi Channel Systems MCS GmbH recommends running these tests before you start your real experiments.

1. Connect the terminal plug to one miniature preamplifier and the test model probe to the other as shown in the picture (do not mismatch the polarity). If you have only one MPA32I, you can perform the two tests consecutively.

2. Connect the MPA32I with the test model probe to channels 1 to 32 of the signal collector.

3. Connect the MPA32I with terminal plug to channels 33 to 64 of the signal collector.

4. Make sure that all other connections are appropriate, and that your setup has an appropriate grounding and shielding as recommended in the chapter above "General Setup Recommendations".

5.5   Connecting 16-Electrode NeuroNexus Probe

Connecting the 16-electrode probe from NeuroNexus Technologies via adapter ADPT-NN-16 to two MPA8Is.

Complete Setup with 'NeuroNexus Probe and two MPA8Is

NeuroNexus
Probe

ADPT-NN-16
MPA8I No.1
MPA8I No.2
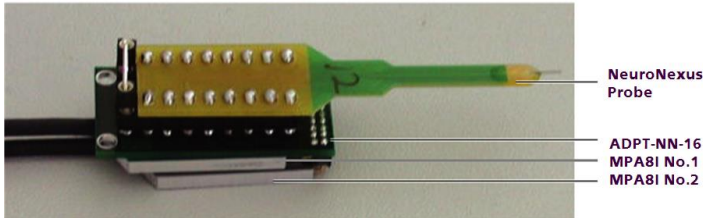
Insert one pin array of the adapter into one MPA8I, and the other into the second MPA8I. Make sure that the orientation of the MPA8I is correct (see illustration).

Important: Connect the **MPA**8I with the black side down. Otherwise, the device does not work.

Connect **MPA**8I No. 1 here
Connect **MPA**8I No. 2 here

NeuroNexus Probe

NN-Adapter

MPA8I No. 1   G R 1 2 3 4 5 6 7 8 G

MPA8I No. 2   G R 1 2 3 4 5 6 7 8 G
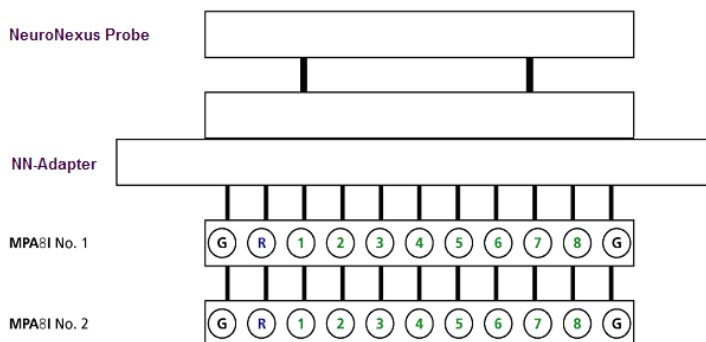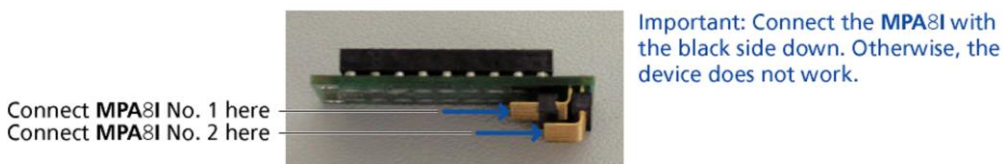
Channel assignment, output pins.

Shown are the output pins of the adapter that are connected to the miniature preamplifiers MPAI when looking directly at the pins. The numbered channels are the ground channels (G), the reference channel (R), and the 8 recording channels (1 to 8) of the MPA8I.

MPA8I No. 2	MPA8I No. 1
1	8
2	7
3	6
4	5
5	4
6	3
7	2
8	1
R	G
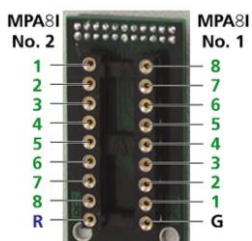
Channel assignment, input pins, connected to the probe.

Shown are the input pins of the adapter that are connected to the probe. The labelled channels are the ground channel (G), the reference channel (R), and the 8 recording channels (1 to 8) of the MPA8I. Please see the MPA8I Manual for details.

G and R have been connected together as factory-default settings. You can change this connection to meet your requirements.

Important: Operation of the MPA8I is differential. The reference channel R has to be used for obtaining a proper signal.

5.6   Connecting 32-Electrode NeuroNexus Probe

Connecting the 32-electrode probe from NeuroNexus Technologies via adapter ADPT-NN-32 to MPA32I.
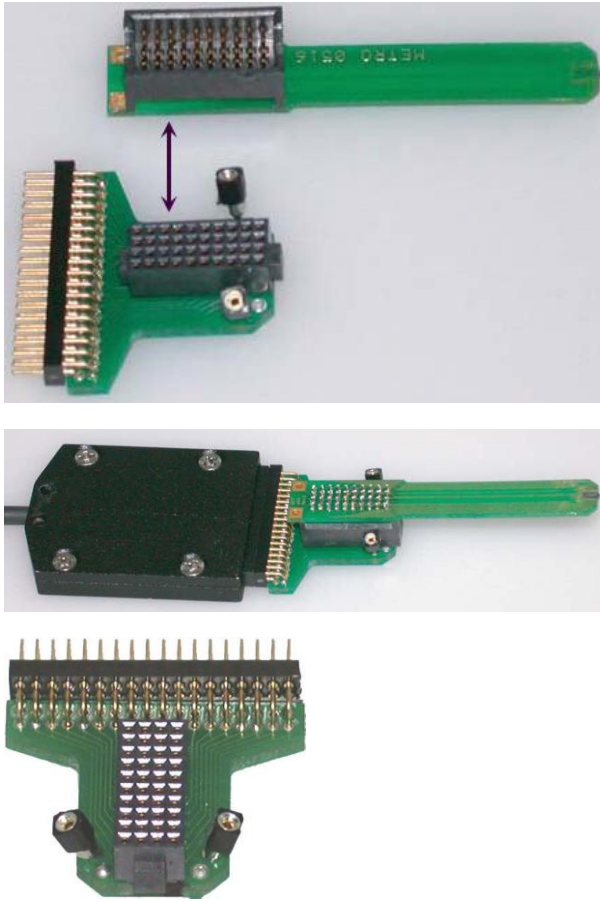
The indicated numbers are the ME System channel numbers that will show up in the MC_Rack program. The list on the second page shows you the assignment to the electrode numbers as given by NeuroNexus Technologies. GND is the ground, REF is the reference input of the miniature preamplifier. Please see the MPA32I manual for details. Optionally, it is possible to connect G1 / G2 and GND together.

MPA32I	MC_Rack	Probe Rev. A	Probe Ref. B
Pin 1:	GND		
Pin 2:	REF	REF	REF
Pin 3:	Channel 1	EL 16	EL 16
Pin 4:	Channel 2	EL 12	EL 12
Pin 5:	Channel 3	EL 15	EL 15
Pin 6:	Channel 4	EL 10	EL 11
Pin 7:	Channel 5	EL 14	EL 14
Pin 8:	Channel 6	EL 8	EL 10
Pin 9:	Channel 7	EL 13	EL 13
Pin 10:	Channel 8	EL 6	EL 9
Pin 11:	Channel 9	EL 4	EL 8
Pin 12:	Channel 10	EL 3	EL 7
Pin 13:	Channel 11	EL 1	EL 6
Pin 14:	Channel 12	EL 3	EL 5
Pin 15:	Channel 13	EL 5	EL 4
Pin 16:	Channel 14	EL 7	EL 3
Pin 17:	Channel 15	EL 9	EL 2
Pin 18:	Channel 16	EL 11	EL 1
Pin 19:	Channel 17	EL 32	EL 32
Pin 20:	Channel 18	EL 30	EL 31
Pin 21:	Channel 19	EL 31	EL 30
Pin 22:	Channel 20	EL 28	EL 29
Pin 23:	Channel 21	EL 29	EL 28
Pin 24:	Channel 22	EL 26	EL 27
Pin 25:	Channel 23	EL 27	EL 26
Pin 26:	Channel 24	EL 24	EL 25
Pin 27:	Channel 25	EL 25	EL 24
Pin 28:	Channel 26	EL 20	EL 20
Pin 29:	Channel 27	EL 22	EL 23
Pin 30:	Channel 28	EL 19	EL 19
Pin 31:	Channel 29	EL 23	EL 22
Pin 32:	Channel 30	EL 18	EL 18
Pin 33:	Channel 31	EL 21	EL 21
Pin 34:	Channel 32	EL 17	EL 17
Pin 35:	REF		
Pin 36:	GND		

5.7   Connecting Chronic Probe from NeuroNexus

Connecting two MPA8Is to the Chronic Probe from NeuroNexus Technologies.
Adapter ADPT-NNCP-16 from Multi Channel Systems MCS GmbH.

Side view
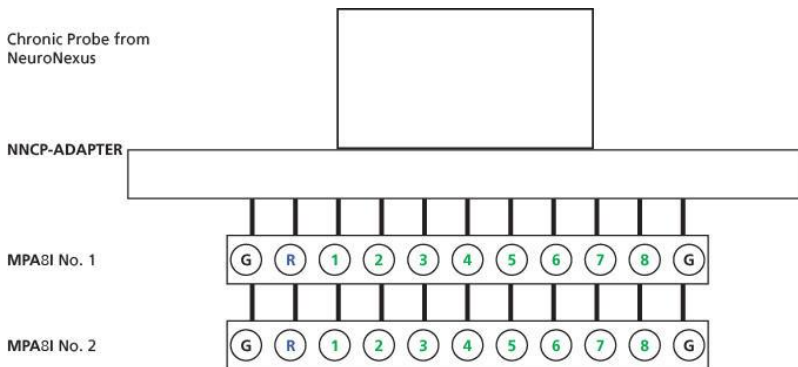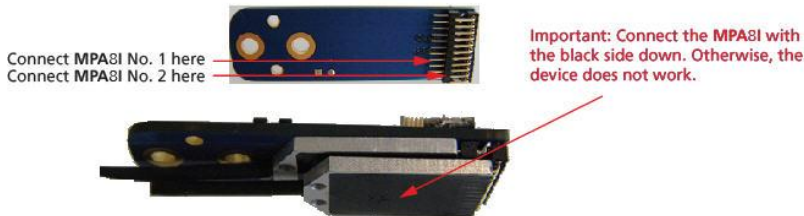
Connect **MPA8I** No. 1 here
Connect **MPA8I** No. 2 here

Important: Connect the MPA8I with the black side down. Otherwise, the device does not work.

Chronic Probe from NeuroNexus

NNCP-ADAPTER

MPA8I No. 1   G R 1 2 3 4 5 6 7 8 G

MPA8I No. 2   G R 1 2 3 4 5 6 7 8 G

Shown are the output pins of the adapter that are connected to the miniature preamplifiers MPAI when looking directly at the pins. The labelled channels are the ground channels (G), the reference channel (R), and the 8 recording channels (1 to 8) of the MPA8I. Please see the MPA8I Manual for details.

Top view

GND   REF

ADPT_NNC16_A_080611   GND

Important:
Black side of MPA8I faced down !

male connector fixed on the adapter

○●●●●●●●●●○
●●●●●●●●●●●

The red arrow shows the direction of the probe. Because of the blind pins it is just possible to plug the male connector of the adapter into the female connector of the probe in one required position!
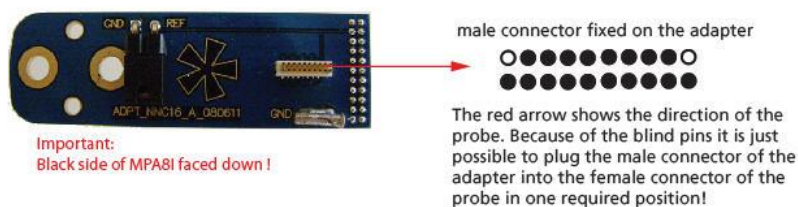
Pin Layout of MPA8I No.1 and No.2 and NeuroNexus Chronic Probe CP16

MPA8I No. 1	NeuroNexus CP16		MPA8I No. 2	NeuroNexus CP16
CH 01	SITE 8		CH 01	SITE 9
CH 02	SITE 7		CH 02	SITE 10
CH 03	SITE 6		CH 03	SITE 11
CH 04	SITE 5		CH 04	SITE 12
CH 05	SITE 4		CH 05	SITE 13
CH 06	SITE 3		CH 06	SITE 14
CH 07	SITE 2		CH 07	SITE 15
CH 08	SITE 1		Ch 08	SITE 16

The photo shows the top of the adapter NNCP from Multi Channel Systems MCS GmbH.

To insert the chronic probe from NeuroNexus Technologies C16 into the adapter you have to turn the chronic probe upside down. It is only one way possible to plug in the probe.

5.8   Connecting Cactus Needle

Connecting the adapter ADPT-CN-32 from Multi Channel System MCS GmbH to a MPA32I
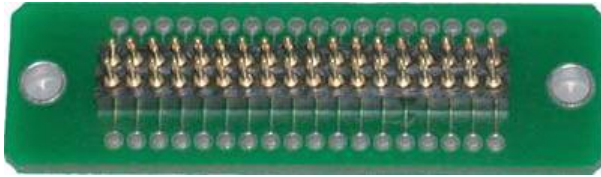
The ADPT-CN-32 is used for connecting electrodes with cactus needles to a miniature preamplifier MPA32I from Multi Channel Systems MCS GmbH. The contact pins are inserted into the 32-pin input sockets of the MPA32I. The pins are connected directly to the contact holes of the adapter board. The electrodes can be connected to the contact holes. Below you find the pin layout of the MPA32I. The pin layout of the adapter board is accordingly (depending on the direction, in which it is plugged into the MPA32I). The layout of the adapter board is symmetrical, it does not matter in which direction it is plugged into the MPA32I.
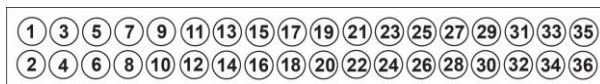
Pin 1   GND (ground)

Pin 2   Reference

Pin 3-34   Channel 1-32

Pin 35   Reference

Pin 36   GND (ground)

5.9   Connecting FlexMEA36 via ADPT-FM-32

Connecting the FlexMEA36 via adapter ADPT-FM-32 to the MPA32I.
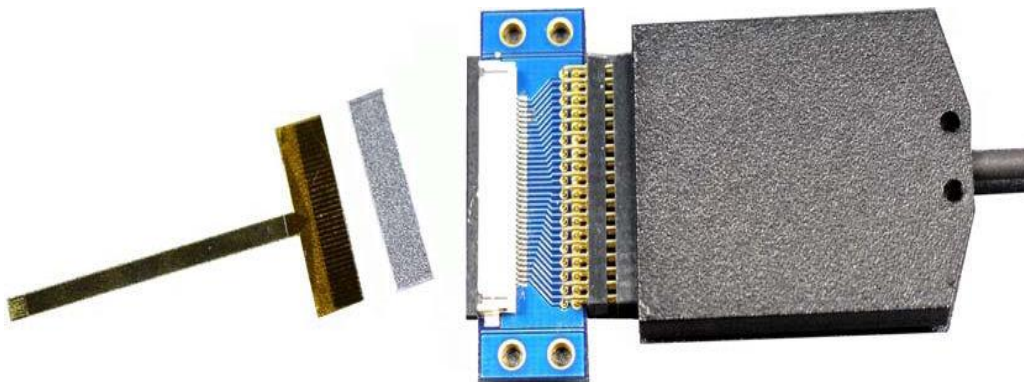
The side with no screws is considered the top side of the MPA32I. If the adapter is oriented as shown in the figure, the FlexMEA36 is inserted with the contact pads facing downward. Please insert the spacer on the opposite side of the contact pads and electrodes.

5.10 MPA8I Pin Layout

Power Supply

Supply voltage is applied to the output connector pins 8 and 15. The voltage source should supply a stable noise-free voltage. Do not exceed the maximum voltage.

Pin   8:   −3 V to −8 V

Pin 15:   +3 V to +8 V

Warning: Do not mismatch the polarity of the power supply. A false connection may damage the unit.

MPA8I Input Connector

8-Channel Miniature Preamplifier inputs

Please note that the black side is considered the bottom side.

1	Ground (GND)
2	Reference input
3 ... 10	Recording channels 1 - 8
11	Ground (GND)

MPA8I Output (Male D-SUB 15 Connector)
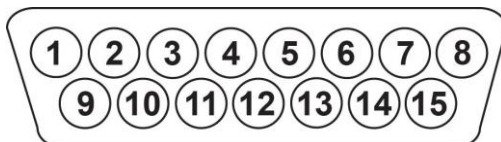
1	Ground (GND)
9	Signal ground*
2, 10, 3, 11, 4, 12, 5, 13	Recording channels 1 - 8
6, 14, 7	Ground (GND)
15	Positive supply voltage
8	Negative supply voltage

* = Connected to the ground of the amplifier. The signal ground is used as the reference for the following filter amplifier.

Test Model Probe

Test model probe for MPA8I pin layout

Ground

Reference IN

Ground

Optional signal IN

1 MPA8I pin #
2
3
4
5
6
7
8
9
10
11

Model test probe for MPA - circuit

Test signal input jumper

Signal ground | Signal IN

Jumper

GND

4.7 MΩ

330 kΩ

150 pF

MPA8I el. inputs 1-8

Reference input jumper

4.7 MΩ

330 kΩ

150 pF

MPA8I ref. input 2

GND

Jumper

GND

Test signal IN: You can use the jumper to connect the signal input pin (Signal IN) to ground (standard situation for a noise level test), or you can connect a data source, for example, a sine wave generator to the input (and the ground of the test signal to the signal ground input) to test the signal distribution. The input signal is distributed across all recording channels.

REF IN: The standard situation in an experiment should be that the reference electrode has properties identical or close to the recording electrodes. You can remove the jumper to connect the reference output of the test model probe to the same resistors as the recording channels to mimic the experimental situation, or you can use the jumper to connect the reference output to ground.

DC resistance	4.7 mega ohm
Dynamic resistance	330 kilo ohm
Capacitance	150 picofarads

5.11 MPA32I Pin Layout

Power Supply

Supply voltage is applied to the output connector pins 19 and 37. The voltage source should supply a stable noise-free voltage. Do not exceed the maximum voltage.

Pin 19:   –3 V to –8 V

Pin 37:   +3 V to +8 V

Warning: Do not mismatch the polarity of the power supply. A false connection may damage the unit.

Input Connector

32-Channel Miniature Preamplifier inputs
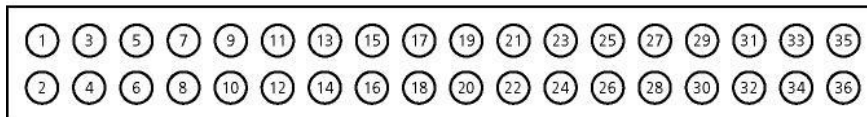
Pin 1:   GND (ground)
Pin 2:   Reference
Pin 3-34: Channel 1-32
Pin 35:   Reference
Pin 36:   GND (ground)

This illustration shows the pin layout viewed from the front, with the case screws upside down. The two reference inputs are used for connecting a reference electrode. Both inputs are equal, so it does not matter which of the two inputs is used. If both are used, the mean of both reference signals is used as reference.

Output Connector

MPA32I Output (Male D-SUB 37 Connector)
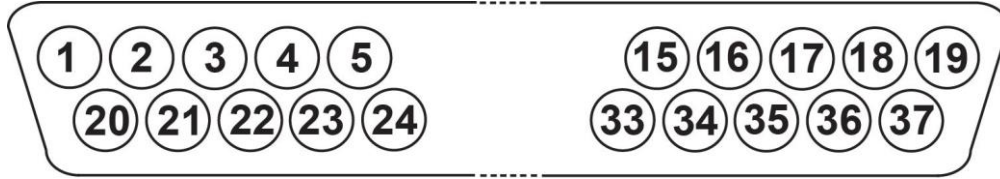
Pin 1	GNPD (power ground)	Pin 29	Channel 18
Pin 20	GNPS (signal ground)	Pin 11	Channel 19
Pin 2	Channel 1	Pin 30	Channel 20
Pin 21	Channel 2	Pin 12	Channel 21
Pin 3	Channel 3	Pin 31	Channel 22
Pin 23	Channel 4	Pin 13	Channel 23
Pin 4	Channel 5	Pin 32	Channel 24
Pin 24	Channel 6	Pin 14	Channel 25
Pin 5	Channel 7	Pin 33	Channel 26
Pin 25	Channel 8	Pin 15	Channel 27
Pin 6	Channel 9	Pin 34	Channel 28
Pin 26	Channel 10	Pin 16	Channel 29
Pin 7	Channel 11	Pin 35	Channel 30
Pin 27	Channel 12	Pin 17	Channel 31
Pin 8	Channel 13	Pin 36	Channel 32
Pin 28	Channel 14	Pin 18	GNPD (power ground)
Pin 9	Channel 15	Pin 37	Positive supply voltage
Pin 29	Channel 16	Pin 19	Negative supply voltage
Pin 10	Channel 17		

The signal ground is connected to the ground of the amplifier. The signal ground is used as the reference for the following filter amplifier.

Test Model Probe

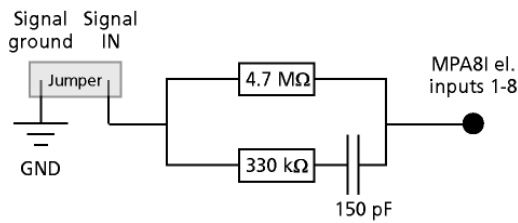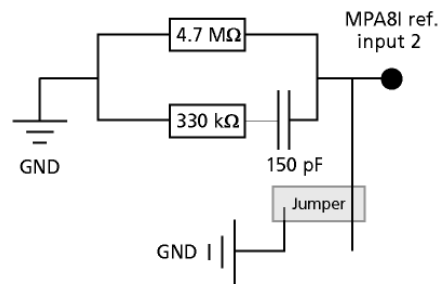**Test model probe for MPA32I - pin layout**
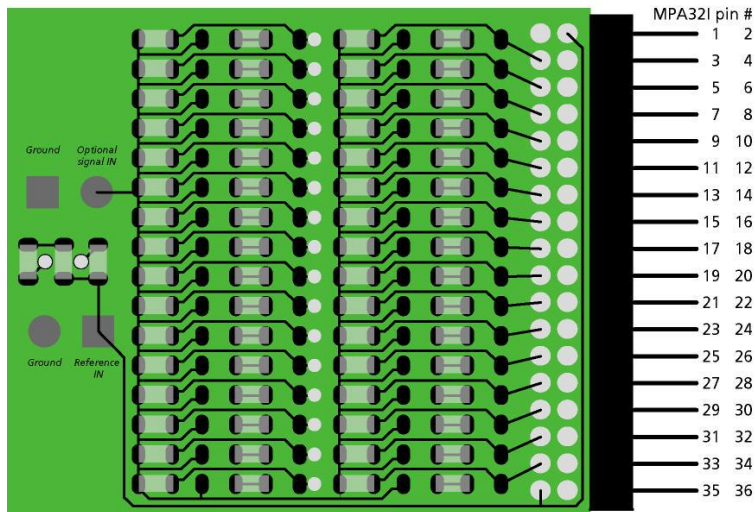
Model test probe for MPA - circuit

Test signal input jumper
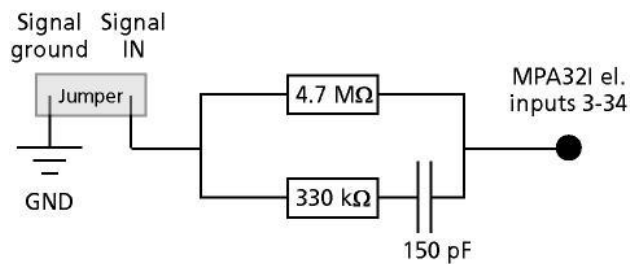
Reference input jumper

Test signal IN: You can use the jumper to connect the signal input pin (Signal IN) to ground (standard situation for a noise level test), or you can connect a data source, for example, a sine wave generator to the input (and the ground of the test signal to the signal ground input) to test the signal distribution. The input signal is distributed across all recording channels.

REF IN: The standard situation in an experiment should be that the reference electrode has properties identical or close to the recording electrodes. You can remove the jumper to connect the reference output of the test model probe to the same resistors as the recording channels to mimic the experimental situation, or you can use the jumper to connect the reference output to ground.

DC resistance	4.7 mega ohm
Dynamic resistance	330 kilo ohm
Capacitance	150 picofarads

5.12 Service and Maintenance

Cleaning the Connectors

Warning: It is recommended to avoid the use of cleaning solutions to avoid corrosion. If a wet cleaning is required, use distilled water. Make sure that only the connectors touch the liquid; do not submerge the miniature preamplifier or the cable. Otherwise, you can fatally damage the electronics.

Clean the connectors with 70 % alcohol and cotton swabs from time to time.

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

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

Sterilization

Warning: Do not autoclave or sterilize miniature preamplifiers by high heat (above 70 °C) or vapor. The resin is not heat-stable and may deform under heat. Vapor can lead to a corrosion of the electronics.

Miniature preamplifiers can be sterilized with standard methods that are not based on high heat or vapor, for example, with 70 % ethanol, UV-light, or by thermal sterilization in an oven at 56 °C with an incubation time of 8 hours.

5.13 Integrated Filter Amplifiers (FA)

Raw data from the preamplifiers is amplified by a 32-channel filter amplifier with fixed gain and bandwidth.

A differential amplifier with input type I includes a common ground and a common reference electrode input. The reference electrode is ideally identical to the recording electrodes and placed into a comparable but inactive area or tissue. Background or noise signals that are picked up by both the reference electrode and the recording electrodes are removed.

The reference electrode input also compensates the potential difference between the miniature preamplifier (MPA) output and the filter amplifier (FA) input that results from the supply voltage drop in the line from the MPA to the FA. If two or more MPAs are connected to the FA, the amplifier offsets are averaged for compensation.

Important: It is very important that the reference electrode inputs are always connected. Connect it to ground when you are not using a reference electrode.

5.14 Signal Amplification and Filters

The filter amplifier combines a band pass filter and the signal amplification in one instrument.

The broad 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 "Integrated 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 3 kHz is suitable. Cardiac signals have fast and slow components; therefore, you usually need a wider bandwidth of 1 Hz to 3 kHz.

Please note that the gain of the filter amplifier 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, 100 (1000 in total with the preamplifier), 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.

5.15 Integrated Data Acquisition

Analog input signals are acquired from the data source and digitized by the 32-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 50 kHz per channel. You will not miss even the fastest biological signals. Data is transferred to the computer via a Full 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 ME System with other systems, video tracking, for example. The digital TTL outputs can be used for triggering other systems and instruments, for example for applying a feedback.

You configure the input voltage range from +/- 400 mV to +/- 4V and the sampling rate with the software controls in the MC_Rack program. Please refer to the MC_Rack Help or Manual for more information.

5.15.1 DC Offset Correction

An offset correction is generally not necessary, because the intrinsic DC offsets of the USB-ME32-FAI System is very low in comparison to the signals of interest. You can use the MC_Rack offset correction feature to remove even this low offset and reset all channels to zero. Please refer to the MC_Rack Help or Manual for more information.

Note: If you observe a large offset on any channel(s), you should contact your local retailer for troubleshooting. The offset correction is not intended for removing large offsets, because the offset correction will decrease the input voltage range.

5.15.2 Sampling Rate

It is recommended to adjust the sampling rate according to your signals, because the higher the sampling rate, the bigger the file size will be.

As a rule of thumb, the sampling rate should equal five times the highest signal frequency for a good digitized representation of the continuous analog signals. If the sampling rate is too low, you will miss signals and/or see artifacts. For example, this means approximately 15 kHz for spike recording, or 10 kHz for cardiac signals (which have fast and slow waveform components).

Please note that the sampling rate also depends on the amplifier's bandwidth. According to the Nyquist-Shannon sampling theorem, the sampling rate should be at least twice the bandwidth of the analog (hardware) low pass filter, that is 10 kHz sampling rate when using a filter amplifier with a cutoff frequency of 5 kHz. The 1/2 bandwidth frequency is also called Nyquist frequency. You should not lower the sampling rate when using a low-pass digital filter. This is the case because the whole amplifier bandwidth is recorded and then high frequency noise is removed with the digital low pass filter after recording. Frequencies (noise) that are above half the sampling rate (for example above 2.5 kHz at a 5 kHz sampling rate) will be transformed into lower frequencies. This is called aliasing. The resulting low-frequency noise passes the digital low pass filter and increases your noise level. You may ignore these recommendations if saving hard disk space is more important for your application than the noise level.

Note: The sampling frequency should be at least five times the highest signal frequency and at least twice the bandwidth of the filter amplifier.

Example:

You have a broadband filter amplifier with a bandwidth of 1 Hz to 5 kHz. The expected signals have a maximum frequency of 1 kHz. Therefore, you want to filter the data with a digital low pass filter and a cutoff frequency of 1 kHz. A sampling rate of 5 kHz (five times the highest signal frequency) would be required for faithfully reproducing the signals, but you should use a sampling rate of at least 10 kHz because the sampling rate should equal twice the bandwidth of the analog filter, regardless of the digital filter properties. If you had an amplifier with a cutoff frequency of 1 kHz instead, no digital filter would be required, and a sampling rate of 5 kHz would be sufficient.

5.16 Digital Input / Output, System Synchronization

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).

See "Digital IN/OUT Connector" in the **Appendix** for information on the pin layout.

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 to 5 V) to the digital inputs.

5.16.1 Triggering MC_Rack

The digital input accepts TTL pulses. This feature can be used for triggering MC_Rack, for example for synchronizing stimulation and data acquisition.

For example, you can connect the Sync Out of an STG (stimulus generator) to one of the digital input bits. If you use only one instrument for triggering, connect it to bit 0, for example. In MC_Rack, add a Trigger Detector to your virtual rack, and select the "Digital Data D1" input stream as the Trigger. Select the appropriate logical state (generally HIGH) for triggering. Mask all unused bits. The standard settings of the Trigger Detector are for using bit 0.

Please see the documentation on the Trigger Detector instrument and on triggered data in the MC_Rack Help or Manual for more details.

Important: It is recommended to set the duration of a TTL pulse according to the sampling rate. The TTL pulse must be long enough to cover at least one data point. For example, if you have a sampling rate of 10 kHz, a data point is recorded each 100 µs. Therefore, TTL input pulses must be at least 100 µs long to make sure that it is detected by the system. MC_Rack will miss some or all pulses if the pulse duration is shorter.

Please mask unused (not connected) digital input channels in the MC_Rack program to ignore undefined states of the open inputs that can cause unwanted trigger events. Please see the MC_Rack Manual for more details.

5.16.2 Custom Switch for "Remote-Controlling"
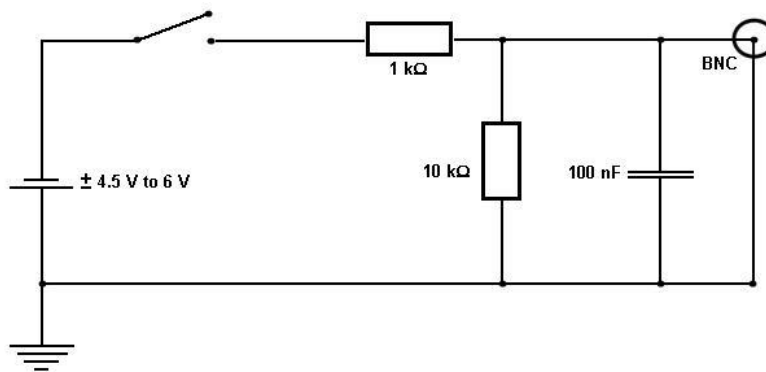
You can connect any device that produces TTL outputs, for example a switch, to one of the digital input bits. This means you can use a trigger for remote controlling the recording with MC_Rack, or for synchronizing systems, if the data acquisition computer is not within reach during an experiment.

You can define the time length of the cutouts that are recorded around the trigger event in MC_Rack. Please note that it is not possible to start the recording of a continuous data file with MC_Rack on a trigger, but you can start a new data file on the trigger event. Please select the Recorder option "Create New File On Trigger".

The picture shows a suggested circuit diagram for a switch used for remote controlling. The resistor and capacitor work as a low-pass filter on the TTL signal and are necessary to reduce ringing of the signal.

5.16.3 Triggering other Instruments

The digital output of the USB-ME32-FAI-System sends 20 ms TTL pulses (0 V = LOW and 5 V = HIGH). This feature can be used to apply a feedback triggered by a signal or a parameter stream.

For example, you can connect the Trigger In of an STG (stimulus generator) to the digital output. You can also use the digital output for a synchronization of the USB-ME32-FAI-System with other systems, for example, for video tracking (provided that the other system of choice is able to receive TTL pulses). Please see the documentation on the Digital Output instrument in the MC_Rack Help or Manual for more details.

6   Troubleshooting

6.1   About 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.

6.1.1   No Computer Connection / No Recording Possible

You cannot establish a connection to the computer. The USB-ME32-FAI 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.

Or you get an error message when starting the recording in MC_Rack after a successful computer connection.

Possible causes:

? The power LED is not lighting. 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-ME32-FAI-System is connected via a 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-ME32-FAI-System directly to a USB port, not via a hub.

6.1.2 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 of the USB-ME32-FAI-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), 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-ME32-FAI System can only accept TTL signals (CMOS 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.

7   Appendix

7.1   Technical Support

Please read the chapter "Troubleshooting" of the 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.

- The amplifier type and serial numbers of the connected amplifiers. You will find them on the devices.

- The operating system and service pack number of the connected computer.

- The hardware configuration (microprocessor, frequency, main memory, hard disk) of the connected computer. This information is especially important if you have modified the computer or installed new hard- or software recently.

- The version of the recording software. On the "Help menu", click "About" to display the software version.

7.2 Pin Layout USB-ME32-FAI-System

MPA8I Input to USB-ME32-FAI

MPA8I Input (Female D-SUB 15 Connector)
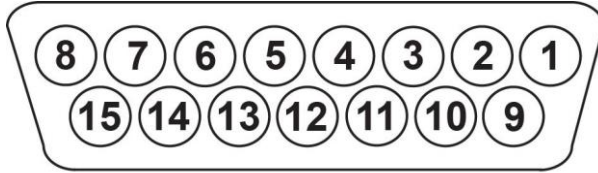
Pin Number	MPA8I Input No 1	MPA8I Input No 2	MPA8I Input No 3	MPA8I Input No 4
Pin 1	GNDP	GNDP	GNDP	GNDP (power ground)
Pin 9	GNDS	GNDS	GNDS	GNDS (signal ground)
Pin 2	Channel 1	Channel 9	Channel 17	Channel 25
Pin 10	Channel 2	Channel 10	Channel 18	Channel 26
Pin 3	Channel 3	Channel 11	Channel 19	Channel 27
Pin 11	Channel 4	Channel 12	Channel 20	Channel 28
Pin 4	Channel 5	Channel 13	Channel 21	Channel 29
Pin 12	Channel 6	Channel 14	Channel 22	Channel 30
Pin 5	Channel 7	Channel 15	Channel 23	Channel 31
Pin 13	Channel 8	Channel 16	Channel 24	Channel 32
Pin 6	GNDP	GNDP	GNDP	GNDP
Pin 14	GNDP	GNDP	GNDP	GNDP
Pin 7	GNDP	GNDP	GNDP	GNDP
Pin 15	Positive supply voltage	Positive supply voltage	Positive supply voltage	Positive supply voltage
Pin 8	Negative supply voltage	Negative supply voltage	Negative supply voltage	Negative supply voltage

The recording channel numbers refer to the channel numbers in the MC_Rack program.
Please make sure that you have selected the USB-ME16-Layout in the MC_Rack program.
See the MC_Rack Manual or Help for details.

MPA32I Input to USB-ME32-FAI

MPA32I Input (Female D-SUB 37 Connector)

Pin	1	GNPD (power ground)	Pin 29	Channel 18
Pin 20		GNPS (signal ground)	Pin 11	Channel 19
Pin	2	Channel 1	Pin 30	Channel 20
Pin 21		Channel 2	Pin 12	Channel 21
Pin	3	Channel 3	Pin 31	Channel 22
Pin 22		Channel 4	Pin 13	Channel 23
Pin	4	Channel 5	Pin 32	Channel 24
Pin 23		Channel 6	Pin 14	Channel 25
Pin	5	Channel 7	Pin 33	Channel 26
Pin 24		Channel 8	Pin 15	Channel 27
Pin	6	Channel 9	Pin 34	Channel 28
Pin 25		Channel 10	Pin 16	Channel 29
Pin	7	Channel 11	Pin 35	Channel 30
Pin 26		Channel 12	Pin 17	Channel 31
Pin	8	Channel 13	Pin 36	Channel 32
Pin 27		Channel 14	Pin 18	GNPD (power ground)
Pin	9	Channel 15	Pin 37	Positive supply voltage
Pin 28		Channel 16	Pin 19	Negative supply voltage
Pin 10		Channel 17		

The recording channel numbers refer to the channel numbers in the MC_Rack program. Please make sure that you have selected the USB-ME32-Layout in the MC_Rack program. See the MC_Rack Manual or Help for details.

Digital IN / OUT Connector

68-Pin MCS Standard Connector
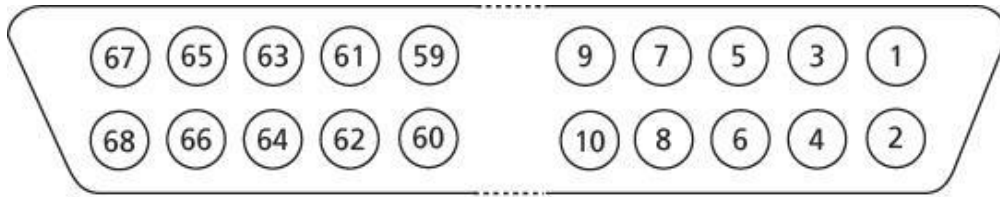
Pin 1	GND
Pin 2	GND
Pin 3 – 10	Digital output channels bit 0-7
Pin 11 – 14	GND
Pin 15 – 22	Digital output channels bit 8-15
Pin 23 – 26	GND
Pin 27 – 34	Digital input channels bit 0-7
Pin 35 – 38	GND
Pin 39 – 46	Digital input channels bit 8-15
Pin 47 – 48	GND
Pin 49 – 63	Not connected
Pin 64 – 66	GND
Pin 67	Positive supply voltage output
Pin 68	Negative voltage supply output

D0 OUT

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

D0 IN

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

7.3 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 newsletter, you will be automatically informed about new software releases, upcoming events, and other news on the product line. You can subscribe to the list on the contact form of the MCS web site.

www.multichannelsystems.com

7.4 Technical Specifications

USB-ME32-FAI System

USB-ME32-FAI System

The USB-ME32-FAI-Sytem can be used either with four MPA8Is - **OR** - with one MPA32I. The device is preconfigured for use with four MPA8Is or with one MPA32I by Multi Channel Systems and cannot be modified by the user. If you like to change the preconfiguration, please contact MCS www.multichannelsystems.com

Technical Specifications

Operating temperature	10 °C to 50 °C
Storage temperature	0 °C to 50 °C
Relative humidity	10 % to 85 %, non-condensing
Dimensions (W x D x H)	227 x 166 x 60 mm

4 x 8-Channel Miniature Preamplifier (MPA8I):

Dimensions (W x D x H)	17 mm x 25 mm x 2 mm
Weight	1.3 g w/o cable and plug, 21 g with cable and plug
Maximum tensile strength of cable	2 kg
Input connector type	Single-row precision sockets, 50 mil (1.27 mm) grid pattern, for 0.35-0.45 mm round pins
Number of input channels	8
Input voltage	± 500 mV (with respect to a supply voltage of 5 V)
Input impedance	10^{12} Ω ‖ 10 pF
Input noise	< 1.5 µV $_{RMS}$ (1 Hz to 5 kHz, inputs short-circuited)
Noise density	e_n = 15 nV / $\sqrt{Hz}$
Number of output channels	8
Output voltage	within supply voltage range
Output current	max. ± 10 mA
Output impedance	0 Ω
Bandwidth	DC to 50 kHz
Gain	10

1 x 32-Channel Miniature Preamplifier (MPA32I):

Dimensions (W x D x H)	27 mm x 36 mm x 5 mm
Weight	7 g w/o cable and plug, 56 g with cable and plug
Maximum tensile strength of cable	2 kg
Input connector type	Dual-row precision sockets, 50 mil (1.27 mm) grid pattern, for 0.35-0.45 mm round pins
Number of input channels	32
Input voltage	± 500 mV (with respect to a supply voltage of 5 V)
Input impedance	10^{12} Ω ‖ 10 pF
Input noise	< 1.5 µV $_{RMS}$ (1 Hz to 5 kHz, inputs short circuited)
Noise density	e_n = 15 nV / $\sqrt{Hz}$
Number of output channels	32
Output voltage	within supply voltage range
Output current	max. ± 10 mA
Output impedance	0 Ω
Bandwidth	DC to 50 kHz
Gain	10

32-Channel filter amplifier:

Number of input channels	32
Input voltage	AC coupled
Input impedance	300 Ω
Input noise	< 1 µV $_{RMS}$ (full bandwidth, inputs short-circuited)
Noise density	@ 1 kHz e_n = 9 nV / Hz
Bandwidth	1 - 5000 Hz
Filter slope	80 db / decade
Gain	100
(other gain / filter settings available on request)	

32-Channel data acquisition:

Sampling frequency	Up to 50 kHz (software controlled)
Data resolution	16 bit
Crosstalk (channel to channel)	typical 0.01 %, max. 0.1 %
Number of analog input channels	32
Number of digital input channels	16
Input signals	TTL (CMOS 3.3 V TTL level)
Number of digital output channels	16
Output signals	TTL (CMOS 3.3 V output)

Interface and connectors:

Analog inputs	4 x 15 Pin Sub D for MPA8I and 1 x 37 Pin Sub D for MPA32I
16 Digital input and output bits	68-Pin MCS Standard connector
USB	USB 2.0 High Speed cable (type A – mini B)
D0 OUT (Digital OUT)	Lemo connector, EPL 00 250 NTN
D0 IN (Digital IN)	Lemo connector, EPL 00 250 NTN
Audio OUT	Stereo jack 3.5 mm
Ground	Common jack 4 mm, banana plug
Power supply	Barrel connector 0.7 x 2.35 mm
Data transfer	USB 2.0 High Speed (true USB 2.0 transfer rate)

Power supply unit (MPU 30):

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

Software:

Operating system	Microsoft Windows ® **8 or** 7, Vista or XP with NTFS English and German versions are supported
Multi Channel Suite	Version 1.2.2 and higher
MC_Rack	Version 3.7.0 and higher
MC_DataTool	Version 2.4.5 and higher

Warning: The device may only be used together with MEA-Systems or ME-Systems 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 behaviour of the system.

7.5 Ordering Information

Please contact your local retailer for pricing and ordering information.

Amplifiers

Product	*Product Number*	*Description*
Miniature preamplifier with 2 electrode inputs	MPA2I	Small sized and light weight head stage with common ground and additional indifferent reference electrode input, input type I, gain = 10
Miniature preamplifier with 8 electrode inputs	MPA8I	
Miniature preamplifier with 32 electrode inputs	MPA32I	
Miniature preamplifier with 32 electrode inputs for FlexMEAs only	MPA32IFlex	Small sized and light weight headstage with common ground and additional indifferent reference electrode input, input type I, gain = 10. With special connector for FlexMEAs. For use with FlexMEAs only
Filter amplifiers with 4, 8, 16, 32, 48, or 64 channels and input type S or I	FA*NNX*	*NN* is the total number of channels, *X* is the input type (S or I), with custom gain and bandwidth
Amplifier with programmable gain, 16 channels	PGA16	Gain programmable from 10 to 5000
Amplifier with programmable gain, 32 channels	PGA32	
Amplifier with programmable gain, 64 channels	PGA64	
Amplifier with programmable gain, 16 input and 32 output channels	PGA1632	Gain programmable from 10 to 5000, with two different pass bands
Amplifier with programmable gain, 32 input and 64 output channels	PGA3264	

ME-Systems

Product	Product Number	Description
Data acquisition system with 16 analog channels	ME16 System	Complete with data acquisition computer with MC_Card and IPS10W, and software package
Data acquisition system with 32 analog channels	ME32 System	
Data acquisition system with 64 analog channels	ME64 System	
Data acquisition system with 128 analog channels	ME128 System	
ME recording system with 16 analog channels and filter amplifier with fixed gain	USB-ME16-FAI System	Stand-alone system for extracellular recordings, complete with 2 x MPA8I, integrated FA16I, integrated 16-channel data acquisition, USB 2.0 data transfer to computer, and software package
ME recording system with 32 analog channels and filter amplifier with fixed gain	USB-ME32-FAI System	Stand-alone system for extracellular recordings, complete with 4 x MPA8I **or** 1 x MPA32I, integrated FA32I, integrated 32-channel data acquisition, USB 2.0 data transfer to computer, and software package
ME recording system with 16 analog channels and filter amplifier with fixed gain	ME16-FA System	Complete with 2 x MPA8I, SC8x8, FA16I, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 32 analog channels and filter amplifier with fixed gain	ME32-FA System	Complete with 2 x MPA32I, SC2x32, FA32I, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 64 analog channels and filter amplifier with fixed gain	ME64-FA-System	Complete with 2 x MPA32I, SC2x32, FA64I, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 128 analog channels and filter amplifier with fixed gain	ME128-FA-System	Complete with 4 x MPA32I, 2 x SC2x32, 2 x FA64I, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 16 analog channels and filter amplifier with programmable gain	ME16-PGA-System	Complete with 2 x MPA8I, SC8x8, PGA16, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 32 analog channels and filter amplifier with programmable gain	ME32-PGA-System	Complete with 2 x MPA32I, SC2x32, PGA32, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 64 analog channels and filter amplifier with programmable gain	ME64-PGA-System	Complete with 2 x MPA32I, SC2x32, PGA64, data acquisition computer with MC_Card and IPS10W, and software package
ME recording system with 128 analog channels and filter amplifier with programmable gain	ME128-PGA-System	Complete with 4 x MPA32I, 2 x SC2x32, 2 x PGA64, data acquisition computer with MC_Card and IPS10W, and software package

Accessories

Product	Product Number	Description
Power supply with 40 W power and ± 7 V output voltage	PS40W	For supplying power to programmable gain amplifiers, for custom setups that lack an internal power supply, or for other custom applications.
32-Channel Cactus Needle Adapter	ADPT-CN-32	Allows a direct connection of electrodes with cactus needles to a 32-channel miniature preamplifier MPA32I.
NeuroNexus Probe adapters for 16, 32, or 54 channels	ADPT-NN-16 ADPT-NN-32 ADPT-NN-54	The 16-Electrode Probe Adapter allows a direct connection of 16-Electrode acute probes from NeuroNexus Technologies to two 8-channel miniature preamplifiers MPA8I. The 32-Electrode Probe Adapter allows a direct connection of 32-Electrode acute probes from NeuroNexus Technologies to a 32-channel miniature preamplifier MPA32I. The 54-Electrode Probe Adapter allows a direct connection of 54-Electrode acute probes from NeuroNexus Technologies to two 32-channel miniature preamplifiers MPA32I.
Signal collector for 8 x MPA8I	SC8x8	Collects the 8 channels from each of the up to 8 miniature preamplifiers MPA8I and leads them to the amplifier via a 68-pin MCS standard cable.
Signal collector for 2 x MPA32I	SC2x32	Collects the 32 channels from each of the up to 2 miniature preamplifiers MPA32I and leads them to the amplifier via a 68-pin MCS standard cable.
Signal collector with blanking circuit for 8 x MPA8I	SC8x8BC	Collects the 8 channels from each of the up to 8 miniature preamplifiers MPA8I and leads them to the amplifier via a 68-pin MCS standard cable, the voltage outputs are held constant during the TTL blanking signal, stimulus artifacts are avoided.
Signal dividers with 16, 32, or 64 channels	SD16, SD32, SD64	Placed between amplifier and MC_Card, permits to select any channel, does not interfere with the data acquisition.
Signal grounding unit	GND64	For silencing defective electrodes. Single channels can be switched off with small toggle switches. Inputs not in use are grounded.

Spare parts

Product	Product Number	Description
0.5 m 68-pin MCS Standard cable	C68x0.5M	For MEA- or ME-Systems
1 m 68-pin MCS Standard cable	C68x1M	
2 m 68-pin MCS Standard cable	C68x2M	
3 m 68-pin MCS Standard cable	C68x3M	

Microelectrode Arrays

A broad range of microelectrode probes are available from several providers. The following are compatible with the miniature preamplifiers from Multi Channel Systems. If you are interested in a particular probe that is not mentioned here, please ask Multi Channel Systems MCS GmbH or your local retailer for compatibility.

Product	*Description*	*Supplier*
Flexible microelectrode array (FlexMEA36)	With 36 electrodes in total: 32 electrodes arranged in a 6 x 6 grid + 2 reference electrodes + 2 ground electrodes. 30 µm electrode diameter, 300 µm interelectrode distance. TiN electrodes and gold tracks embedded in flexible polyimide foil.	Multi Channel Systems MCS GmbH www. multichannelsystems. com
Flexible microelectrode array (FlexMEA72)	With 72 electrodes in total: 32 electrodes arranged in a 9 x 8 grid + 4 reference electrodes + 4 ground electrodes. 30 µm electrode diameter, 625 to 750 µm interelectrode distance. TiN electrodes and gold tracks embedded in flexible polyimide foil.	
Flexible microelectrode array (EcoFlexMEA36)	With 36 electrodes in total: 32 electrodes arranged in a 6 x 6 grid + 2 reference electrodes + 2 ground electrodes. 50 µm electrode diameter, 300 µm interelectrode distance. Gold electrodes and gold tracks embedded in flexible polyimide (Kapton).	
Flexible microelectrode array (EcoFlexMEA24)	With 24 electrodes in total: 24 electrodes arranged in a 2 x 10 grid + 2 reference electrodes + 2 ground electrodes. 80 µm electrode diameter, 300 µm interelectrode distance. Gold electrodes and gold tracks embedded in flexible polyimide (Kapton).	
NeuroNexus acute or chronic probes	16-, 32-, 64-channel silicon probes	NeuroNexus Technologies www. neuronexustech.com

7.6 Scope of Delivery

1	USB-ME32-FAI-System
1	32-chanel miniature preamplifier MPA32I - OR -
4	8-channel miniature preamplifier MPA8I
1	ADPT-NN-16 (with MPA8I)
1	ADPT-NN-16 datasheet - OR -
1	ADPT-NN-32 (with MPA32I)
1	ADPT-NN-32 datasheet
1	USB 2.0 High Speed cable (type A - B)
1	Power supply unit with country specific power cord
1	Data acquisition and analysis software Multi Channel Suite
1	Data acquisition and analysis software MC_Rack
1	Data export software MC_DataTool
1	USB-ME32-FAI manual
1	USB-ME32-FAI datasheet