

ME System User Manual



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1 Important Information and Instructions

1.1 Operator's Obligations

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

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

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

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

1.2 Guaranty 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 guaranty 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 findings.

Guaranty 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

1.3 Important Safety Advice



Warning: ME/MEA Systems include several instruments as individual components. Each instrument is shipped with a separate user manual. The information in the individual user manuals fully apply to the complete system. This manual is only to be understood as an additional information. Read all user manuals thoroughly before setting up the system.



Warning: Obey always 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 devices 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 **mains supply** agrees with the specifications of the products.
- Check the **power cords** 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 of the products.
- Liquids may cause short circuits or other damage. Keep the devices and the power cords always **dry**. Do **not** handle it with wet hands.

Electromagnetic compatibility of the MC_Card

The MC_Card data acquisition board is only intended for research work in laboratories. It belongs to product class 0 conforming to the European Product Regulations and the CE (Conformité

Européenne) marking. The MC_Card complies with all applicable directives specified in the Council Directive for Electromagnetic Compatibility (89/336/EU).

Requirements for the installation

- The MC_Card is only suitable for extra-low voltages and shall be used only as specified.
- The equipment shall be correctly earthed or connected to the ground.
- The analog inputs should be closed or connected to active signals.
- Connections to all inputs and outputs shall be made with screened cables specified by Multi Channel Systems. The screen has to be connected to a solid earth or chassis connection. ESD voltages at open lines may cause malfunction during operation.
- The products shall only be operated from approved power packs (if necessary).

2 Welcome to ME Systems

2.1 Basic Components of ME Systems

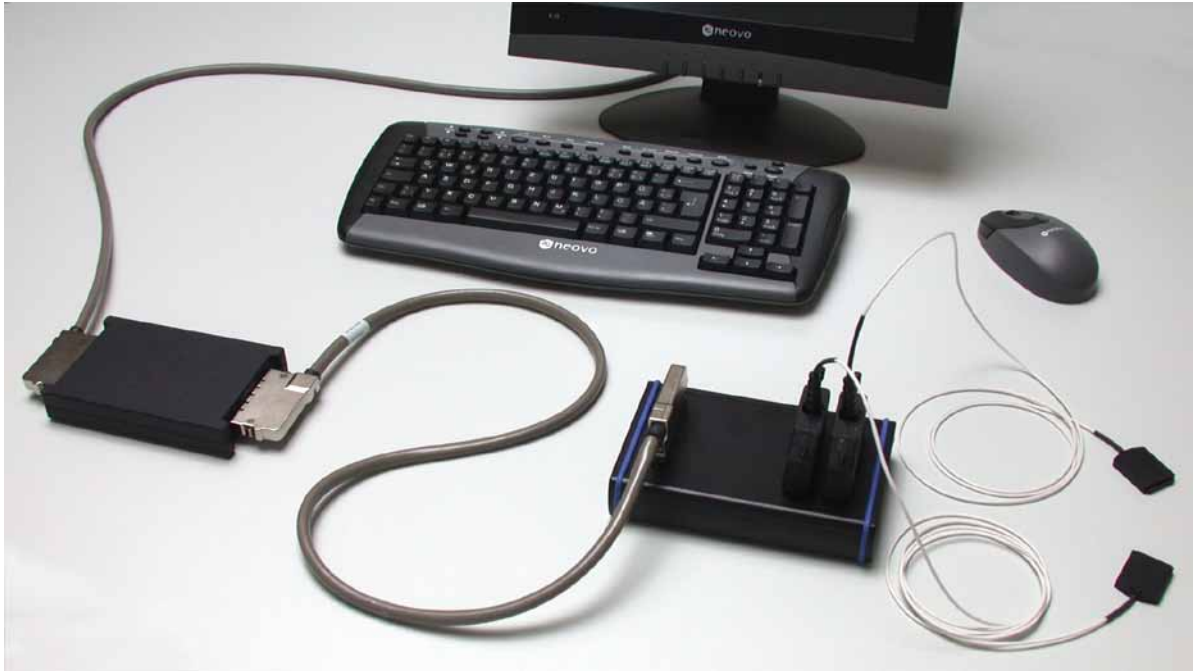


Figure 1 **ME-64-FA System**

With 64-channel data acquisition card, 64-channel filter amplifier with custom gain and bandwidth, and two 32-channel miniature preamplifiers.

Multi Channel Systems provides complete solutions for **stimulation, recording, and data acquisition** from up to **128** channels, **data analysis** and **export**. The **ME (multielectrode)** product line is intended for **extracellular electrophysiological** recordings *in vivo*, and special *in vitro* applications. Typical applications include **simultaneous spike** and **local field potential** recording; **multi-unit** and **single-unit** recording from **awake behaving animals**, and **multitrode** (for example, Michigan probes, 8-Trode, or tetrode) recordings.

In the following, all basic components that can be part of a complete ME System are briefly described. You find more detailed information if you follow the links.

The **8- or 32-channel [miniature preamplifier](#) (MPA8I, MPA32I)** is connected to the microelectrodes for providing the initial tenfold amplification stage. Adapters for all standard microelectrodes such as example [Michigan probes from NeuroNexus Technologies](#) and the [8-Trode from ALA Scientific Instruments Inc.](#) are available as an accessory.

[Signal collectors](#) for connecting 8 x MPA8I (SC8x8) or 2 x MPA32I (SC2x32) collect the output channels of the preamplifiers and send the preamplified raw data stream to the following **filter amplifier (FAI)** with custom bandwidth and gain. Alternatively, a **programmable gain amplifier (PGA)** is available with software-selectable gain settings for all channels separately.

The amplified and filtered raw data is then acquired and digitized by the [MC_Card](#) that is preinstalled on the data acquisition computer.

68-pin MCS High Grade cables C68x3M (3 meters), **C68x1M** (1 meter), or **C68x0.5M** (0.5 meter) are used for connecting the amplifier, the MC_Card, and any additional devices.

The computer [supplies the power](#) for the miniature preamplifiers and filter amplifiers (not for the PGAs) via the **isolated power supply IPS10W**. The supply power is distributed to the amplifiers via the MCS High Grade cable as well. Please note that you need an **external power supply** if you use a programmable gain amplifier.

Recorded data is graphed, analyzed, and reviewed with the powerful and easy-to-use **MC_Rack** program. You can export the data in standard formats to other programs with the **MC_DataTool**.

ME Systems can be combined with a wide range of MCS products: Amplifiers, stimulators, and various accessories.

2.2 System Configurations and Optional Components

Multi Channel Systems provides several complete standard configurations and custom systems. This chapter will give you an overview on different system configurations. Please see also the handout **Multielectrode Array System Suggestions**, which shows detailed diagrams of several typical setups.

Please note that you have various options for setting up your personal ME System configuration. For more information about the scope of delivery of your system, please see the separate shipping documents.

Please see the separate documentation for information on installing and operating the individual components of your ME System. All warnings and safety related information of the separate documents apply and must be regarded.

Do not hesitate to contact MCS or your local retailer if you are interested in a particular setup or if you have other questions.

2.2.1 Single Components for Standard Systems

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

[Web link to the user manuals download page](http://www.multichannelsystems.com) on www.multichannelsystems.com

<i>Product</i>	<i>User Manual / Reference</i>
8- or 32-channel 10x miniature preamplifiers (MPA8I or MPA32I) with signal collectors (SC8x8 or SC2x32)	MPA8I/MPA32I User Manual, SC8x8/SC2x32 data sheet
Filter amplifiers (FA) or programmable gain amplifiers (PGA) with custom bandwidth and gain settings (PGA with flexibly adjustable gain from 10 to 5000)	FA User Manual, PGA User Manual
Data acquisition computer with MC Card and integrated isolated power supply IPS10W or External power supply PS20W	ME System User Manual
Data acquisition and analysis software MC_Rack and MC_DataTool	MC_Rack User Manual / Help, MC_Rack Tutorial
Complete ME System / Setup	ME System User Manual, Multielectrode Array Systems — Suggested Setups

2.2.2 ME Data Acquisition

The basic ME data acquisition system includes a data acquisition computer and a software package.

Analog input signals are acquired from the data source and digitized by the [MC Card](#) that is preinstalled on the data acquisition computer. The ME data acquisition system is available in different channel configurations: **ME16**, **ME32**, **ME64**, and **ME128** with 16, 32, 64, and 128 analog channels, respectively.

The MC_Card provides the option to use a [16-bit digital \(TTL\) channel](#) instead of one of the analog data acquisition channels. 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. The standard scope of delivery includes a **3 BNC input slot** for connecting 3 input bits of the digital channel. If you need more input bits or output bits for more advanced setups, MCS provides a digital in/out extension as an [accessory](#), with 32 BNC connectors for connecting all 16 input and output bits to separate TTL sources/inputs.

2.2.3 Miniature Preamplifiers (MPA)

The miniature head stage preamplifiers **MPA** can be connected directly to the microelectrodes in the test model to provide the first amplification stage of 10. Adaptors for standard multi-electrodes such as Michigan probes or the 8-Trode are available. The signal channels can then be collected and sent to a signal collector, which connects to the amplifier. The miniature preamplifiers small size allows easy placement. The metal housing prevents the amplifier from picking up external noise.

Miniature preamplifiers are available for 8 and 32 electrodes (**MPA8I**, **MPA32I**). Both versions are type I amplifiers, that is, they include a common ground and one reference electrode input. Please see [Filter Amplifiers with Fixed Gain](#) for more information on I type amplifiers.

2.2.4 Filter Amplifiers with Fixed Gain (FA)

Raw data from electrodes or from the preamplifier can be amplified by filter amplifiers with fixed gain. Amplifiers with 4, 8, 16, 32, 48, and 64 input channels are available with 2 different input types (S or I).

Amplifiers can be ordered with any gain and bandwidth configurations by the user's choice. For example, typical pass bands would be 1–300 Hz for recording field potentials and 300–3000 Hz for recording action potentials. It is also possible to use a broadband amplifier and filter the data with the digital filter of the MC_Rack program.

Input type S / Single ended inputs

Amplifiers with input type S have **single** ended inputs. All signals are measured with respect to the amplifier's ground. The signal source's ground and the amplifier's ground should have the same value for obtaining good results.

Input type I / Subtracts reference from input voltage

An amplifier with input type I includes a common ground and a common **indifferent** 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.

2.2.5 Programmable Gain Amplifiers

Raw data from the preamplifier is amplified by the programmable gain amplifier, which is basically an S type filter amplifier, but in addition, the gain can be flexibly adjusted from 10 to 5000 with the user-friendly program **FiltAmp**.

Standard versions with 16, 32, and 64 input and output channels are available. Also, special versions are available that feature two different pass bands. Signals are split and the two pass bands are sent to two separate output channels. For 16 input and 32 output channels, or 32 input and 64 output channels, respectively. These amplifiers are perfect for recording signals with different frequencies.

Programmable gain amplifiers can be ordered with any bandwidth configuration by the user's choice.

2.3 Accessories

MCS provides a wide range of accessories that will make your ME system setup even more efficient and convenient to use. All accessories are perfect for use with MCS products, but are easily adaptable to custom systems as well. Some accessories are included in complete systems, other have to be ordered separately.

- **Signal Collectors** for collecting the channels from the miniature preamplifiers and leading them to the amplifier via a 68-pin MCS standard cable. Versions for connecting 8x MPA8I or 2x MPA32I are available (**SC8x8** and **SC2x32**, respectively). The **SC8x8** is also available as a special version with **blanking circuit (SC8x8BC)**: A blanking signal transiently grounds the recording electrodes during the stimulus, thus **preventing stimulus artifacts**.
- **Signal Dividers (SD16, SD32, SD64)** allow you to connect any channel via BNC connector to an external device, for example, an oscilloscope, without interfering with the data acquisition.
- **Digital in/out extension (Di/o)** for connecting other devices to single digital input and output channels of the MC_Card via BNC connectors (up to 16 inputs and 16 outputs), for example for synchronizing stimulation and recording, or for applying feedback
- **Signal Grounding Unit (GND64)** for silencing defective electrodes. Single channels can be turned off with small toggle switches. Inputs not in use are grounded.
- **Power Supply (PS20W)** for supplying 20 W power (+/- 7 V output voltage) to programmable gain amplifiers, for custom setups that lack an internal power supply, or for other custom applications

2.4 Add-ons for Stimulation

MCS provides general-purpose stimulators like the basic **1000 series** with **1, 2, 4, or 8** output channels or the advanced **2000 series** with **4 or 8** channels.

The flexible **MC Stimulus software** enables complex stimulus waveforms (both **current** and **voltage**). Waveforms designed in the program or imported from an external file are converted by the STG into pulses, which are sent to stimulating electrodes.

Stimulus isolation units are integrated in the STG for **each** channel. Thus, no additional stimulus isolations units are required.

Trigger in- and outputs are available for an exact timing of stimulation and for controlling other instruments by TTL pulses. For example, stimulation and recording can be synchronized with a digital trigger signal (TTL) sent from the **Sync Out** output of the stimulus generator to the MC_Card via digital inputs.

With the **SC8x8BC** with **blanking circuit**, stimulus artifacts and amplifier saturation are effectively **prevented**.

2.5 Setting up the ME System



Warning: Please read the separate user 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.

See also the documentation **ME System Setups** detailed diagrams and various setup suggestions. Provide a power supply in the immediate vicinity of the installation site.

1. Place all devices on a stable and dry surface, where the air can circulate freely and the devices are not exposed to direct sunlight.
2. Set up the computer.
3. Set up all system components as described in the separate user manuals.
4. Connect the MPA8Is to the SC8x8, or the MPA32Is to the SC2x32. Close all unused sockets with ground connectors.
5. Connect the SC8x8 or the SC2x32 to the FA or PGA.
6. Connect the FA or PGA amplifier to the MC_Card (input labeled **MC_Card Ch. 01–64**) with the 68-pin MCS standard cable C68x3M.
7. If you have an ME128 System, connect a second amplifier with the 68-pin MCS standard cable C68x3M to the input for channels 65–128 labeled **MC_CX64 Ch. 65–128**.

2.6 Supply Power and Recommended Setups

In the standard ME-FA systems, the isolated power supply IPS10W that is preinstalled on the data acquisition computer delivers the power for the amplifiers (MPA and FA), distributed via the 68-pin MCS High Grade cable. One of the limiting factors when using the IPS10W is the voltage drop of the 3 m MCS High Grade cable. The characteristic resistance of the cable is 0.3 Ohms per meter. This results in a 1 Ohm resistance for a 3 m cable, leading to a voltage drop of 500 mV for a 500 mA current ($U = R * I = 1 \Omega * 500 \text{ mA} = 500 \text{ mV}$). As the voltage drop limit is 500 mV, the limit for each cable is $\pm 500 \text{ mA}$.



Warning: Follow the manufacturer's setup recommendations. Do not use longer cables than recommended. Do not connect other amplifiers or more amplifiers than recommended. A voltage drop exceeding the limit of $\pm 500 \text{ mA}$ can lead to improper behavior of the amplifier, or can even melt the wire!

The following tables show you how much power the amplifiers need, and how much power the MCS power supplies will provide.

<i>Amplifier</i>	<i>Supply voltage</i>	<i>Supply current</i>
MPA2I	$\pm 3 \text{ V}$ to $\pm 8 \text{ V}$ DC	$< \pm 2 \text{ mA}$, typically $\pm 1 \text{ mA}$
MPA8I		$< \pm 6 \text{ mA}$, typically $\pm 4 \text{ mA}$
MPA32I(FLEX)		$< \pm 14 \text{ mA}$, typically $\pm 9 \text{ mA}$
FA8	$\pm 6 \text{ V}$ to $\pm 9 \text{ V}$ DC	$< \pm 40 \text{ mA}$, typically $\pm 25 \text{ mA}$
FA16		$< \pm 75 \text{ mA}$, typically $\pm 50 \text{ mA}$
FA32		$< \pm 150 \text{ mA}$, typically $\pm 100 \text{ mA}$
FA48		$< \pm 225 \text{ mA}$, typically $\pm 150 \text{ mA}$
FA64		$< \pm 300 \text{ mA}$, typically $\pm 200 \text{ mA}$
PGA16		$\pm 5.7 \text{ V}$ to $\pm 12 \text{ V}$ DC
PGA32	550 mA (positive rail), 225 mA (negative rail)	
PGA64	725 mA (positive rail), 450 mA (negative rail)	
PGA1632	550 mA (positive rail), 225 mA (negative rail)	
PGA3264	725 mA (positive rail), 450 mA (negative rail)	

<i>Power supply</i>	<i>Supply voltage</i>	<i>Supply current</i>
IPS10W (internal power supply)	$\pm 6.3 \text{ V} \pm 10 \%$	max. 1.2 A @ + 6.3 V or - 6.3 V
PS20W (external power supply)	$\pm 7 \text{ V} \pm 10 \%$	max. 1.5 A @ $\pm 7 \text{ V}$

2.7 Signal Amplification and Filters

FA and PGA amplifiers combine a band pass filter and the signal amplification in one instrument.

Different filter settings are used to enhance the signal-to-noise ratio. The pass band of the filter amplifier depends on the signal type. It is generally useful to filter the data with a cutoff at the highest signal frequency.

For slow signals like field potentials, a bandwidth of 1–300 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.

Multi Channel Systems provides custom amplifiers with a bandwidth of your choice, from 0.1 Hz to 10 kHz. Please note that it is often wise to acquire the data with a **broadband** amplifier and use the **digital filter** of the free MC_Rack program to change the pass band and filter the raw data. This way, you are much more flexible in designing your experiments. As a further advantage, you can see the original (not filtered) data as well. This is especially important because **all** filters are known to distort signals. On the other hand, you may need a higher sampling rate to avoid **aliasing**, and the **signal-to-noise ratio** is **lower**. See also the chapter [Data Acquisition](#) for more information.

Multi Channel Systems also provides amplifiers with a gain of your choice (from 100 to 5000). For large signals (for example from heart preparations), you need a lower gain to prevent a saturation of the amplifier. Please note that the gain of FAs is a **fixed** hardware property; and that you **cannot** change the gain of the amplifier by software controls. The gain of PGAs can be flexibly adjusted for each channel from 10 to 5000.

Please 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, 1200, 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 $\sqrt{2}/2$, that 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.

The low-pass filter properties of the MC_Card will affect the bandwidth of the complete system only slightly.

For information on the gain and filters of the amplifiers, please see the appropriate user manual. For more information on gain and filters in general, please refer to standard literature or contact your local retailer.

2.8 Data Acquisition

Recording from up to 128 channels is easy with the **MC_Card hardware** and the **MC_Rack software**.

MC_Card hardware

Important: You need to have installed the latest MC_Card driver to operate the MC_Card, which is usually preinstalled on the data acquisition computer. The installation may be invalid if the MC_Card does not respond. Please contact Multi Channel Systems if you need the MC_Card Driver and a description of the installation.

The MC_Card is an A/D board that converts analog signals in real time into digital data streams at **sampling rates of up to 50 kHz** for **all** channels. You will not miss even the fastest signals.

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 User Manual for more information.

Please see the MC_Card data sheet for additional information on the pin layouts and the technical specifications.

DC Offset correction

An offset correction is generally not necessary, because the intrinsic DC offsets of the MEA amplifier outputs and the MC_Card are very low in comparison to the signals of interest. The maximum total DC offset is ± 3 mV (± 2 mV for the MC_Card, ± 1 mV for the MEA amplifier outputs). For a standard MEA amplifier with a standard gain of 1200, this results in a maximum offset of only $2.5 \mu\text{V}$ (± 3 mV divided by 1200) with respect to the input signals.

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 User 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.

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. Considering the preceding statements about filtering data, you would for example use a **5 kHz sampling rate** when using a MEA amplifier with a **cutoff frequency** of **1 kHz**.

Please note that if you use a **broadband amplifier** and a **digital filter**, you may have to use an even **higher** sampling rate.

This is the case because the whole amplifier bandwidth is recorded and then high frequency noise is removed with a 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**. This low frequency noise passes the digital Low Pass filter and increases your noise level.

According to the Nyquist-Shannon sampling theorem, the sampling rate should equal **twice** the **bandwidth** of the **analog (hardware) Low Pass filter**. The 1/2 bandwidth frequency is also called Nyquist frequency. You may ignore this 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 0.1 Hz to **10 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 **20 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 enough.

MC_Rack software

With the high-performance data acquisition and analysis program MC_Rack, you can **flexibly** manage all data streams. For example, you can display the raw data of **all** channels while recording **only** the raw data of the **channels of interest** and the extracted parameters of **all** channels. This saves computer performance and hard disk space.

MC_Rack is not limited to special applications, but can be flexibly adapted to a wide range of applications.

Unlimited software licenses and support come free with the system, and free software updates lower the costs as well.

2.9 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 a 1 (HIGH).



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 MC_Card. Make sure that you apply **only** TTL pulses (0–5 V) to the digital inputs.

Important: 3 BNC connectors for the **digital input bits 0–2** are included in the standard configurations of the ME System. If you want to use more bits of the 16-bit input channel or the 16-bit output channel (as described in 2.9.2), you have to order a [digital in/out extension](#) (see 5.3) separately. You can also upgrade your system with the extension later. Please contact your local retailer for details.

2.9.1 Triggering the MC_Card and MC_Rack

The digital input accepts TTL pulses. This feature can be used for triggering the MC_Card and 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. 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 User Manual for more details.

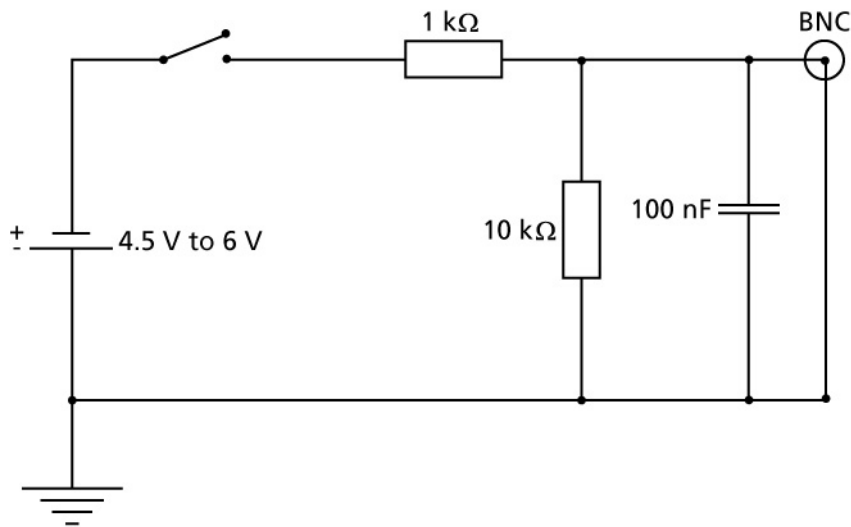
Important: It is recommended to set the **duration** of a TTL pulse to at least **200 μ s**. Shorter pulses may be ignored by the MC_Card. Please **mask unused** (not connected) digital input channels in the MC_Rack program to ignore undefined states of the open inputs that can cause unwanted trigger events. Please see the MC_Rack User Manual for more details.

2.9.2 Custom Switch for "Remote-Controlling" of the MC_Card

You can connect any device that produces TTL outputs, for example a switch, to one of the digital input bits of the MC_Card. 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 (select the **Recorder** option **Create New File On Trigger**).

The following 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.



2.9.3 Triggering Other Instruments by the MC_Card

The digital output of the MC_Card 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 via the digital in/out extension. You can also use the digital output for a synchronization of the ME 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 User Manual for more details.

3 Troubleshooting

3.1 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 user manuals of the related products and in the software help. Multi Channel Systems has put all effort into making the product fully stable and reliable, but like all high-performance products, it has to be handled with care.

3.2 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 MC_Card, 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 is shorter than **200 µs**.
- The MC_Card can only accept [TTL signals](#) as a digital input stream. A minimum TTL pulse of 200 µs is recommended. Otherwise, a detection of the trigger by the MC_Card is not guaranteed.
- ? The settings of 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**. 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 MC_Rack Help or User Manual for more details.

4 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 an excellent opportunity for you to exchange your experience or thoughts with other users worldwide.

[Web link to the User Forum](#)

Mailing list

If you have subscribed to the [ME-System 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 MCS web site.

www.multichannelsystems.com

5 Ordering Information

Please contact your local retailer for pricing and ordering information.

5.1 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	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

5.2 Amplifiers

Product	Product Number	Description
Miniature preamplifier with 2 electrode inputs	MPA2I	Small sized and light weight headstage 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 use with FlexMEAs	MPA32IFLEX	
Filter amplifiers with 4, 8, 16, 32, 48, or 64 channels and input type S or I	FANNX	<i>NN</i> is the total number of channels, <i>X</i> 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, with custom bandwidth
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 custom pass bands
Amplifier with programmable gain, 32 input and 64 output channels	PGA3264	

5.3 Accessories

Product	Product Number	Description
Michigan Probe adapters	MP-ADAPTER	Allow a direct connection of Michigan probes to two miniature preamplifiers MPA8I. Available for 16, 32, and 64 channels.
8-Trode adapter	8-Trode adapter	Allows a direct connection of the 8-Trode from ALA Scientific Instruments Inc. to the MPA8I.
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.
Power supply with 20 W power and +/- 7 V output voltage	PS20W	For supplying power to programmable gain amplifiers, for custom setups that lack an internal power supply, or for other custom applications
Digital in/out extension	Di/o	For connecting other devices to single digital input and output channels of the MC_Card via BNC connectors (up to 16 inputs and 16 outputs), for example for synchronizing stimulation and recording, or for applying feedback.

5.4 Add-ons for stimulation

Product	Product Number	Description
1-Channel stimulus generator	STG1001	General purpose stimulators for a very wide variety of applications. Flexible and easy-to-use MC_Stimulus software enables complex stimulus waveforms (both current and voltage). Stimulus isolation units are integrated in the STG for each channel. With additional digital trigger in- and output.
2-Channel stimulus generator	STG1002	
4-Channel stimulus generator	STG1004	
8-Channel stimulus generator	STG1008	
4-Channel stimulus generator	STG2004	Advanced version with 4 additional digital trigger in- and outputs. About 100 x faster download via USB. 16 times more memory for long-time stimulation.
8-Channel stimulus generator	STG2008	

5.5 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	
3 m 68-pin MCS Standard cable	C68x3M	
Isolated power supply	IPS10W	

5.6 Multielectrode Arrays

Multielectrode arrays are not available from Multi Channel Systems, but from several other 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 or your local retailer for compatibility.

Product	Description	Supplier
Michigan probes	16-, 32-, 64-channel silicon probes	NeuroNexus Technologies www.neuronexustech.com
8-Trode	Electrodes with eight pads, for <i>in vivo</i> acute or chronic implantation	ALA Scientific Instruments, Inc. www.alascience.com

Use and Operation

The MC_Card is an A/D board converting analog signals into digital data streams in real time. It is generally delivered preinstalled on the data acquisition computer. All inputs and outputs are labeled on the computer's rear panel. Please see the MEA System or ME System User Manual for details.

Please refer to the MC_Rack Help and/or User Manual for more information on the data acquisition.

Important: The latest MC_Card driver is required, which is usually preinstalled on the data acquisition computer. The driver can be installed or updated by installing the latest MC_Rack version (3.3.3.0 or later).

Warning: The device may only be used together with ME Systems and MEA 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 computer and do not change the hardware configuration as this could lead to improper behavior of the system.



Technical Specifications

Number of analog input channels	64 or 128 (depending on the version of the system)
Input voltage	± 400 mV to ± 4 V (software controlled)
Input impedance	33 k Ω serial by 470 pF
Bandwidth	DC to 9 kHz
Number of digital input channels	16 (Use of digital input reduces number of analog channels by 1)
Input signals	TTL (CMOS 5 V TTL level)
Number of digital output channels	16
Output signals	TTL (CMOS 5 V output)
Sampling frequency	Up to 50 kHz on each channel (software controlled)
Total conversion rate	12.8 MB/s
Data resolution	14 bit
Crosstalk (channel to channel)	max 0.1 %, typically 0.01 %
DC Offset	max ± 2 mV

Interface and connectors

3 Digital Inputs*	BNC connector
Analog inputs	68-Pin MCS standard connector
3 Analog inputs (MEA System only)	BNC connectors

* For using all 16 digital input and output bits, a digital IN/OUT extension can be ordered separately.

MC_Rack program

(Data Acquisition and analysis software)

Operating system

Windows 2000 or XP with NTFS; English and German versions supported

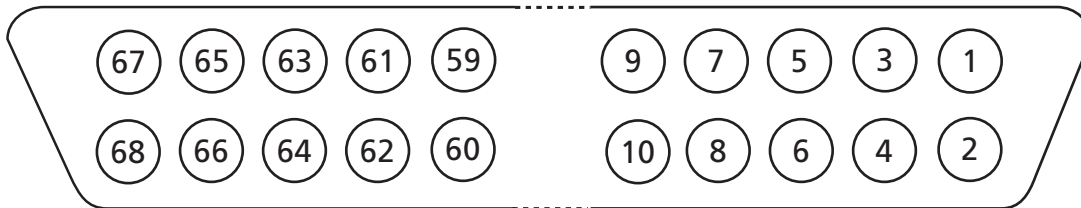
Export features via MC_DataTool

Data Export

Axon Binary File (*.abf), ASCII file (*.txt), and binary file (*.raw) format

Pin layout

Electrode/analog input 68-Pin MCS standard connector



64 channel version

128 channel expansion

Pin 1: GNDP (power ground)
 Pin 2: GNDS (signal ground)
 Pin 3-66: Channels 1-64
 Pin 67: Positive voltage supply
 Pin 68: Negative voltage supply

GNDP (power ground)
 GNDS (signal ground)
 Channels 65-128
 Positive voltage supply
 Negative voltage supply

Galvanically isolated voltage supply and ground. Supplies voltage to connected amplifiers.
 Power is supplied to the MC_Card by the computer's power supply.

Note: The analog channel 64 is available **only** if the digital input channel is **not** selected in the **Channel Layout** dialog box of the MC_Rack program.

Please note that channels 61 to 64 and 125 to 128 are **not** used for the **MEA** System. Channels 61 to 63 can be used as additional analog input channels A1 to A3 via the additional BNC connectors.

Digital IN

BNC connectors



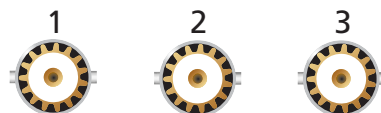
BNC 0: Bit 0 of the 16-bit digital input channel
 BNC 1: Bit 1 of the 16-bit digital input channel
 BNC 2: Bit 2 of the 16-bit digital input channel

Note: The additional digital inputs are available **only** if the digital input channel is selected in the **Channel Layout** dialog box of the MC_Rack program.

A digital in/out extension with 16 BNC inputs and 16 BNC outputs that can be connected to the MC_Card via a 68-pin digital in/out connector is available as an accessory.

Analog IN (MEA System only)

BNC connectors



BNC 1: Channel 61
 BNC 2: Channel 62
 BNC 3: Channel 63