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Programmable Gain Amplifier PGA Manual



Imprint

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1. Introduction

1.1 About this Manual

This manual comprises all important information about the first installation of the hardware and software, and about the daily work with the instrument. It is assumed that you have already 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 printed manual and help are basically the same, so it is up to you which one you will use. The help offers you the advantage of scrolling through the text in a non-linear fashion, picking up all information you need, especially if you use the "Index" and the "Search" function. If you are going to read larger text passages, however, you may prefer the printed manual.

The device and the software are part of an ongoing developmental process. Please understand that the provided documentation is not always up to date.

The latest information can be found in the "Help". Check also the MCS web site www.multichannelsystems.com for downloading up-to-date manuals and help files.

2. Important Information and Instructions

2.1 Operator's Obligations

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

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

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

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

2.2 Guarantee and Liability

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

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

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

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

2.3 Important Safety Advices



Warning: Make sure to read the following advice prior to install or to use 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: 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 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.

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. Keep the device and the power cords always 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.

2.4 Terms of Use for the Program

You are free to use the program for its intended purpose. You agree that you will not decompile, reverse engineer, or otherwise attempt to discover the source code of the software.

2.5 Limitation of Liability

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

To the maximum extent permitted by applicable law, in no event shall Multi Channel Systems MCS GmbH or its suppliers be liable for any special, incidental, indirect, or consequential damages whatsoever (including, without limitation, injuries, damages for data loss, loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use the program or the provision of or failure to provide Support Services, even if Multi Channel Systems MCS GmbH has been advised of the possibility of such damages.

3. First Use of the PGA

3.1 Welcome



The Programmable Gain Amplifier (PGA) is used for amplifying and filtering raw data from a miniature preamplifier, for example, a MPA32I. The PGA is a differential (I-type) filter amplifier. It operates similar to the standard I-type filter amplifiers (FA) from Multi Channel Systems MCS GmbH, but was designed for users who demand a higher flexibility. Whereas the gain in the standard FA is fixed, the gain of a PGA is software-selectable, in the range of 10 to 5000, for each individual channel. This is useful when signals from different sources with either different preamplification stages or different signal amplitudes, for example, spikes and local field potentials, are recorded.

Gain settings for each channel are selected in the user-friendly program PGA-Control. Simply pick the desired gain for each channel from the drop-down list and download the settings onto the amplifier via the USB port. You can print a report sheet and save the gain configuration for later use.

Standard versions of the PGA are available with 16, 32, and 64 inputs (PGA16, PGA32, PGA64, respectively). Standard bandwidth is 1 to 5000 Hz, which is useful for recording all signal types, such as cardiac signals, spikes, and local field potential recordings. Signals can be separated by digital filtering in MC_Rack, the data acquisition and analysis software from MCS for use with the ME- / MEA-System. Special versions feature an integrated splitter, with two different pass bands for recording signals with different frequencies, for example, for separating local field potentials from spike signals: Input signals are split and the two pass bands (1 to 300 Hz, 300 to 5000 Hz) are sent to two separate outputs. Splitter versions are available with 16 input and 32 output channels, or 32 input and 64 output channels (PGA1632 and PGA3264, respectively). Please refer to chapter "Signal Amplification and Filters" for more information.

3.2 Installing the Software

System Requirements

Software: One of the following Windows operating systems is required: Windows 10, 8.1 and 7, Vista or Windows XP (English and German versions supported). Other language versions may lead to software errors.

Hardware: USB Port 2.0 or USB Port 1.1

Installing the Software

Please check the system requirements before you install the software. MCS cannot guarantee that the software works properly if these requirements are not fulfilled.

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

Double-click Setup.exe on the installation volume. The installation assistant will show up and guide you through the installation procedure.

Follow the instructions of the installation assistant.

3.3 Setting Up and Connecting the PGA

Note: You can use an USB hub for connecting the PGA to the computer, for example, if you have no free USB port or if you need to extend the USB cable. Please note that other devices that are connected to the same USB port and that send or receive continuous data streams, for example, a web cam or USB speakers, can hinder the transmission of the gain settings from the computer.

The following instructions refer only to the operation of the PGA. For general recommendations on the grounding and shielding of the setup, please refer to the Miniature Preamplifier Manual.

Provide a power supply, for example PS40W, and a computer with USB 1.1 port in the immediate vicinity of the installation site.

The recommended value of supply voltage should be $U_S = \pm 6.0 \text{ V}$. The limits for proper operation ranges from $\pm 5.7 \text{ V}$ to $\pm 12.0 \text{ V}$. Please use the lowest possible supply voltage. The higher the supply voltage, the more heat will be internally generated by the voltage regulators!

Note: The PGA should only be operated if the brightness of the power LEDs is stable (without flickering), otherwise the DC shows instabilities.

PGA Front Panel



+6.0 V	4 mm red plug connector	positive supply voltage
GND	4 mm black plug connector	Ground
-6.0 V	4 mm blue plug connector	negative supply voltage



Warning: Do not mismatch the polarity of the power supply. False connection may damage the device.

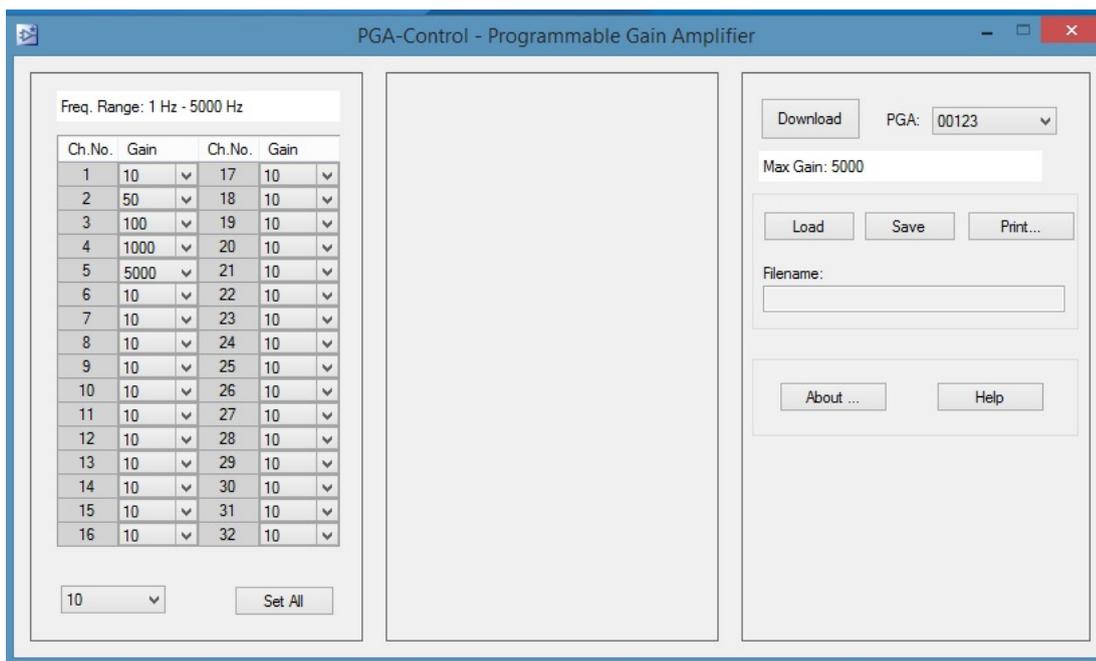
Important: Make sure that the reference input is always connected, because signals applied to the reference input are subtracted from the recording signal input channels. If the reference input is unconnected or connected to an electrode in an active area (for example, it sees signals of interest), this will either lead to signal loss or to a very high noise level. Connect the reference input to the ground of the setup when you are not using a reference. For more information, please see [Differential Amplifier and Noise Reduction](#).

1. Place the PGA on a stable surface, where the air can circulate freely and the PGA is not exposed to direct sunlight.
2. Connect the input signal source, for example, a SC8x8 or SC2x32 signal collector connected to miniature preamplifiers, to the **68-pin MCS standard** input connector of the PGA.
3. Connect the **68-pin MCS standard** output connector to the MC_Card input of the data acquisition computer by a 68-pin MCS standard cable. Make sure the IPS10W as a power supply source is properly installed to the data acquisition computer. Check the output power if you are in doubt. For more information, please see the ME-Systems Manual.
4. If the data acquisition computer has no IPS10W, connect a suitable power supply, for example a PS40W, to the 4 mm power input sockets. An internal power supply transforms the supply voltage into the internal supply voltage.
5. Connect the USB connector to a free USB 1.1 port of the computer with a USB cable Type A - B. The connector on the PGA side is type B; the connector on the computer side is type A. The computer connection is necessary for programming the PGA, but not for operating it.
6. Switch on the PGA. The LEDs on the rear panel must light up, otherwise the power is insufficient.
7. Install the PGA-Control program provided together with the PGA to the connected computer. The PGA driver is installed automatically as well.

4. Operating the PGA

4.1 Adjusting the Gain Settings

1. Switch the power supply on. The PGA's power LED should be lighting.
2. Start the PGA-Control program.
3. Specify the gain settings for all channels by selecting the appropriate gain factor from the drop-down menu, or load a previously saved gain configuration ("*.amp" file). A different gain level can be selected individually for each channel. The option "Set All" can be used to define a general gain level for all channels.
4. Always click the "Download" button to apply the settings to the PGA.
5. It is recommended to print out the gain settings for later reference by clicking the "Print" button.
6. If you want to keep the pattern for future use, save the file as an "*.amp" file.
7. Switch off the power supply after use. If the PGA is switched off, the last gain settings are stored. When starting the PGA later, the stored settings will automatically be restored.



PGA Gain Settings Example

In the screenshot above, the gain of the PGA channel 1 is set to 10, channel 2 to 50, 3 to 100, 4 to 1000, channel 5 to 5000, and the rest of the available channels to a gain factor of 10. The pass band of the amplifier is displayed on top of the channel numbers.

4.2 Signal Amplification and Filters

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

Different filter settings are used for different applications to enhance the signal-to-noise ratio. The pass band of the filter amplifier should be chosen according to the signal type. It is generally useful to set the upper limit of the amplifier near the highest expected signal frequency, but also at a safe distance to make sure that the full gain is used for signal amplification. The PGA is available with a standard bandwidth of 1 to 5000 Hz, which is suitable for most applications.

A bandwidth of 10 to 5000 Hz is optional, which has the advantage that the amplifier is more stable towards low-frequency noise and oscillations, but has the disadvantage that slow signal components such as plateaus are removed from the input signal. Other bandwidth configurations are available on request. The PGA1632 and the PGA3264 are special versions 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: You can record slow signals like field potentials with a bandwidth of 1 to 300 Hz on one half of the channels, and fast signals like spikes with a pass band of 300 Hz to 5 kHz on the other half. Please refer to the label on the amplifier to check the bandwidth of the amplifier version that you have in use.

If you have a complete ME-System with MC_Card, you can use the digital filter of the 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 you will have a lower signal to noise ratio.

The gain of a PGA can be adjusted from 10 to 5000. Usually, a total gain (of preamplifier and PGA) of about 1000 to 2000 is used for extracellular recording of biological signals. For large signals, for example, from whole-heart preparations, you need a lower gain to prevent a saturation of the amplifier.

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 "Root of 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.

For information on the gain and filters of the MC_Card data acquisition system, please see the ME-System Manual. For more information on gain and filters in general, please refer to standard literature or contact your local retailer.

4.3 Differential Amplifier and Noise Reduction

If the reference electrode is properly placed into an inactive region near the recording site, the noise voltage is usually a common component of the input voltages from the reference electrode and the recording electrodes. Thus, the noise will be canceled out when the difference of the amplifier inputs is taken as the recording signal.

As a differential amplifier, the PGA has a reference input in addition to the ground input. The power ground and the reference input are connected to the power ground and reference output of the connected miniature preamplifier.

The reference input of the miniature preamplifier (in case that a differential preamplifier is used) should be connected to a reference electrode that is ideally identical to the recording electrodes and placed into a comparable but inactive area or tissue. This way, background or noise signals that are picked up by both the reference electrode and the recording electrodes are removed from the recording signal already in the miniature preamplifier. (For more details on this issue, please see the MPA8I or MPA32I Manual.)

So what is the benefit of the differential operation of the PGA, if the noise is already canceled out in the preamplifier? The differential operation of the PGA compensates the potential difference between the miniature preamplifier output and the PGA input that results from the supply voltage drop in the line from the preamplifier to the PGA. If multiple preamplifiers are connected to a PGA, the amplifier offsets are averaged. Also, it is possible to connect a non-differential preamplifier or the electrodes themselves directly to the PGA and cancel out the noise in the PGA. However, connecting the electrodes directly to the PGA is not recommended, as the distance from the electrodes to the first amplification stage should be kept as short as possible to optimize the signal-to-noise ratio.

5. Troubleshooting

5.1 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 (chapter "Important Safety Advice" in the manual or help). Multi Channel Systems has put all effort into making the product fully stable and reliable, but like all high-performance products, it has to be handled with care.

5.2 Technical Support

Please read the Troubleshooting part of the manual or help 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. If you have any questions or if any problem occurs that is not mentioned in this document, please contact your local retailer. The highly qualified staff will be glad to help you.

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 device.
- The software and hardware version you are currently using. In the PGA-Control window, click "About". The displayed dialog box shows the version numbers.
- The operating system and service pack number on 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.

5.3 Insufficient Power

You see no signals or strange artifacts on all channels. This behavior can be caused by an insufficient supply power, indicated by a flickering or dark power LED. Please see the PGA data sheet for more information on the supply power requirements. If the voltage drops beyond a critical level, the amplifier cannot operate properly, resulting in artifacts or in a saturation of the amplifier. MCS standard cables with a total length of up to 3 m and the isolated power supply IPS10W are recommended for operating the PGA.

Possible causes:

? Loose cable or bad contact. The power distribution from the IPS10W in the connected computer is obstructed.

Unplug and reconnect the 68-pin MCS standard cable connecting the PGA with the data acquisition computer. Make sure the connectors are properly plugged in and not tilted.

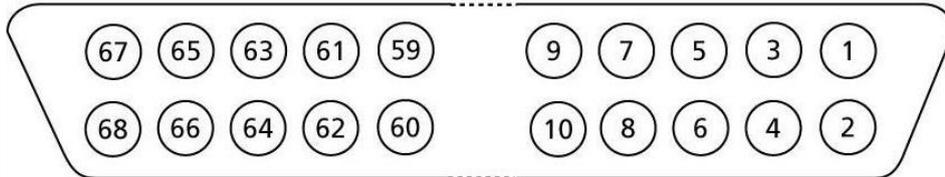
? The output power of the power supply is too low for operating the amplifier. This is especially likely if you use a custom power supply, or the power supply has a technical defect.

— Please check the output power of the power supply and compare it with the PGA data sheet. Contact your local retailer, describe the problem and your hardware configuration, and ask for a power supply that is suitable for your amplifier.

6. Appendix

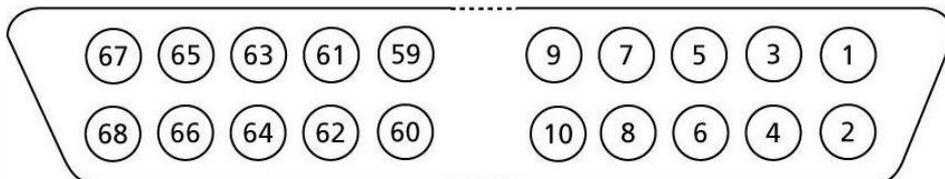
6.1 Pin Layout

PGA Input: 68-Pin MCS Standard Connector



Pin 1	GNDP Power Ground
Pin 2	Reference IN
Pin 3 - 18	Channel 1 - 16
Pin 19 - 34	Channel 17 - 32 (only used in PGA32, PGA64, PGA1632)
Pin 35 - 50	Channel 33 - 48 (only used in PGA64, PGA3264)
Pin 51 - 66	Channel 49 - 64 (only used in PGA64, PGA3264)
Pin 67	Positive supply voltage
Pin 68	Negative supply voltage

PGA Output: 68-Pin MCS Standard Connector



Pin 1	GNDP Power Ground
Pin 2	GNDI (connected to GNDP)
Pin 3 - 18	Channel 1 - 16
Pin 19 - 34	Channel 17 - 32 (only used in PGA32, PGA64, PGA1632)
Pin 35 - 50	Channel 33 - 48 (only used in PGA64, PGA3264)
Pin 51 - 66	Channel 49 - 64 (only used in PGA64, PGA3264)
Pin 67	Positive supply voltage
Pin 68	Negative supply voltage

6.2 Contact Information

Local retailer

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

User forum

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

Mailing list

If you have subscribed to the [Mailing List](#), you will be automatically informed about new software releases, upcoming events, and other news on the product line. You can subscribe to the list on the contact form of the MCS web site.

www.multichannelsystems.com

6.3 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 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	
Filter amplifiers with 4, 8, 16, 32, 48, or 64 channels and input type S or I	FANNX	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	PGA16/32	Gain programmable from 10 to 5000, with two different pass bands
Amplifier with programmable gain, 32 input and 64 output channels	PGA32/64	

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	

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-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 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 NeuroNexus Probe Adapter allows a direct connection of 16-Electrode acute probes from NeuroNexus Technologies to two 8-channel miniature preamplifiers MPA8I. The 32-Electrode NeuroNexus Probe Adapter allows a direct connection of 32-Electrode acute probes from NeuroNexus Technologies to a 32-channel miniature preamplifier MPA32I. The 54-Electrode NeuroNexus 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.

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 MCS GmbH. 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
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.	Multi Channel Systems MCS GmbH www.multichannel-systems.com
Flexible microelectrode array (FlexMEA72)	With 72 electrodes in total 72 electrodes arranged in an 8 x 9 grid + 4 reference electrodes + 4 ground electrodes. 100 µm electrode diameter, 625 to 750 µm interelectrode distance. TiN electrodes and gold tracks embedded in flexible polyimide.	
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 10 x 2 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.neuronexus-tech.com

