multichannel systems

Portable ME-System Manual

Portable ME16-System
Portable ME32-System

ME

Printed: 26. 01. 2017

Table of Contents

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.

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 ME-System

3.1 ME Product Line

With the ME (microelectrode) and STG (stimulus generator) product lines, Multi Channel Systems provides complete solutions for stimulation, recording, and data acquisition from up to 256 channels, data analysis and export.

All ME products are 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 recordings from animals, for example NeuroNexus probes recordings. ME-Systems with separate data acquisition amplifiers are available for maximum flexibility in combining different components, while the USB-ME-FAI-Systems and the Portable ME-Systems are the most compact options available.

The **USB-ME-FAI-Systems** are the first of a new generation of universal recording systems that do not need an external data acquisition. The USB-ME16 / 32-FAI-Systems are very compact and portable stand-alone solutions. Filter amplifiers and data acquisition are integrated in one small device. The digitally converted electrode signals are transmitted to any computer via universal serial bus (High Speed USB 2.0). The miniature preamplifier headstages are available with 8 or 32 channels.

The **Portable-ME Systems** of the second generation are functionally identical to the USB-ME-FAI-Systems. However, they feature smaller improved headstage amplifiers with the widely used Omnetics connectors to further minimize size and weight.

This manual will describe the **Portable-ME Systems** only. Separate manuals are available for the USB-ME-FAI-Systems. Please make sure that you have carefully studied the documentation on the single components before setting up your system. Hardcopies of all manuals are shipped with the system. Updated versions can also be downloaded from the MCS web site.

Components of the ME-Systems

Product:	Preamplifier
USB-ME16-FAI-System	2 x 8-channel miniature preamplifiers (MPA8I)
USB-ME32-FAI-System	4 x 8-channel miniature preamplifiers (MPA8I) – or – 1 x 32-channel miniature preamplifier (MPA32I)
Portable ME16-System	2 x 8-channel miniature preamplifiers (MPA8I) – or – 1 x 16-channel micro preamplifier (µPA16)
Portable ME32-System	2 x 16-channel micro preamplifier (µPA16) – or – 1 x 32-channel micro preamplifier (µPA32)

3.2 Portable ME-System

The Portable ME-Systems are compact and lightweight. They feature an integrated 16- or 32-channel filter amplifier and data acquisition. The digitally converted electrode signals are transmitted to the connected computer via USB 2.0 High Speed. The micro preamplifiers are available with 16 or 32 channels.

Two miniature preamplifiers MPA8I – **OR** – one micro preamplifier µPA16 are part of the Portable ME16-System. Two micro preamplifiers µPA16 – **OR** – one micro preamplifier µPA32 are part of the Portable ME32-System.

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. 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.

4   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 helps or manuals of the software for more information. It is recommended that you check the MCS web site for software updates on a regular basis.

4.1   System requirements

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

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

- Turn off Screensaver.
- Turn off Windows Indexing Service. Only important for data hard drive.
- Manual management of automatic Windows Update.
- Power Options: Power scheme: Never turn off monitor, hard disk and system standby.
- It is also not recommended to run any applications in the background when using the software. 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   Multi Channel Experimenter

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 bar down under the "Recording Time" and the "DAQ Time" are registrated.
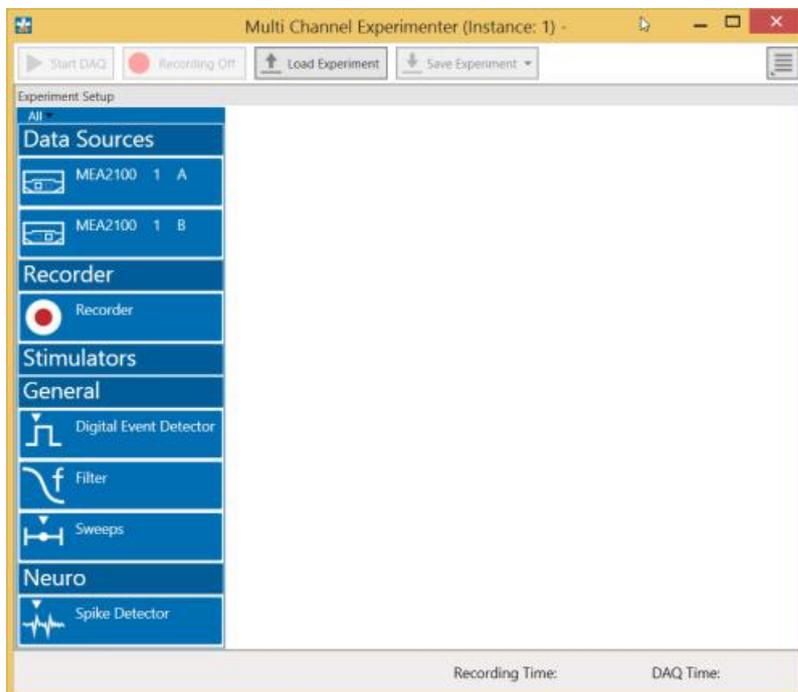
Building a Rack

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!
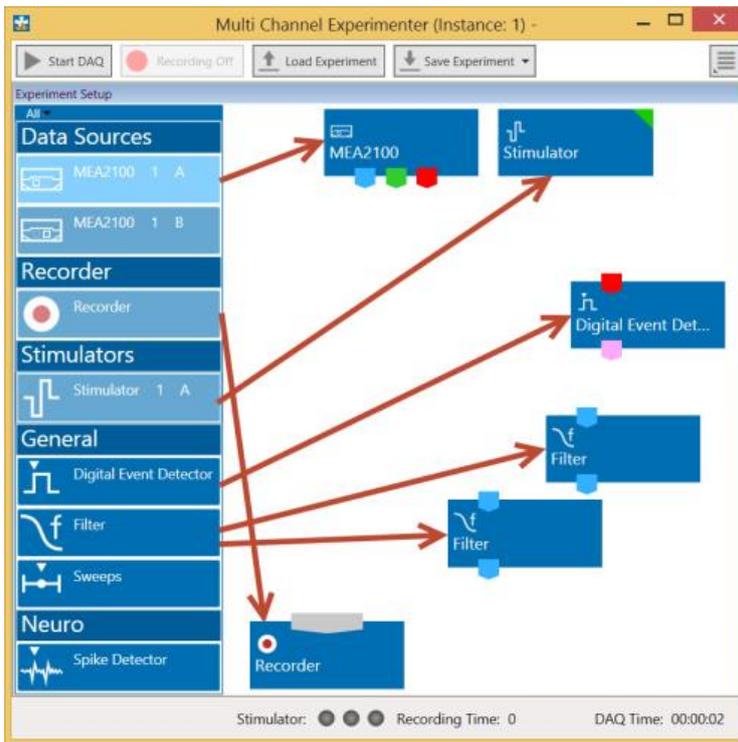
It is also easy to connect the instruments: Please click onto one of the symbols on the lower part of an instrument button to connect this output port via drag and drop with the input port (symbol on the upper side) of the target instrument. Please read the next chapter.
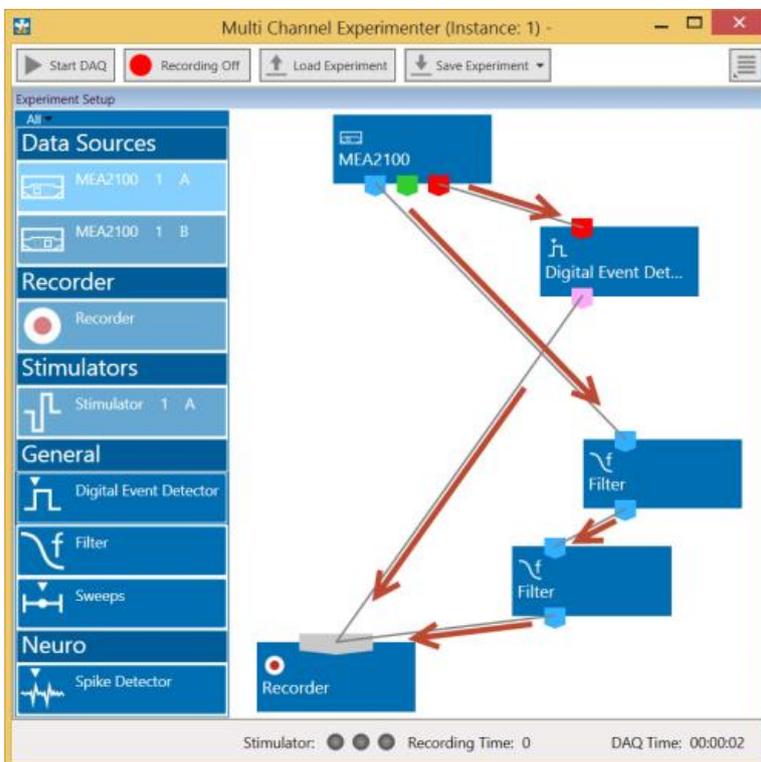
Conventions for Building a Rack

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. 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". The green symbol represents the port for the "Auxiliary Analog Data". The red symbol represents the port for the "Digital Data".

Three color coded output ports of the MEA2100 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 the black symbol input port of the recorder. The electrode raw data stream will flow from the filter to the recorder. The black 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
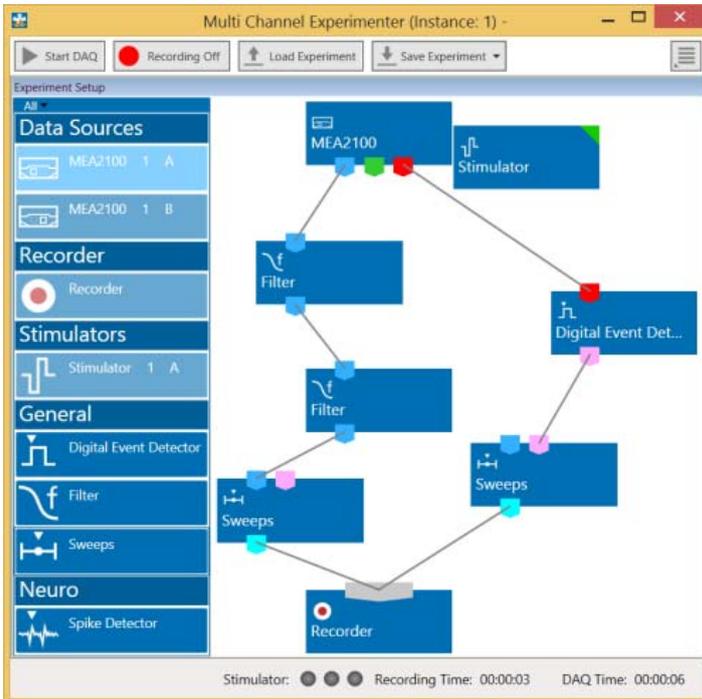
Move as many instruments as you need via drag and drop into the "Experiment Setup" window. It is possible to use the virtual tools more than one time.

4.4 MC_Rack Installation

Download the latest version of MC_Rack form the Multi Channel Systems MCS GmbH web site Click the MC_Rack_Setup.exe file and follow the instructions of the installer. It is recommended to use a different hard drive or partition for the operating system and data storage. Please check the web site on a regular basis for free upgrades.

4.5 Driver Installation

The Portable ME-System is a plug and play device. The driver is automatically installed together with the MC_Rack program. Please install MC_Rack before you connect the Portable ME-System.

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.

It is not recommended to run any applications in the background when using the software. Remove all applications from the Autostart folder.

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 Portable ME-System will be automatically recognized by the operating system.

1. Connect the Portable ME-System to the USB port of the data acquisition computer. The "Found New Hardware Wizard" is displayed.

2. The Wizard will automatically find the appropriate Portable ME-System driver. The driver installation is finished.

4.6 Setting up MC_Rack

Please refer to the MC_Rack manual or help for more information.

Start MC_Rack. Click "Data Source Setup" on the "Edit" menu. In "Channel Layout" dialog select USB-MEA from the left drop down menu and USB-ME from the right drop down menu. Please select 1-dimensional in "Source Layout" and define the number of channels. If you need digital input channel, enable the respective check box.
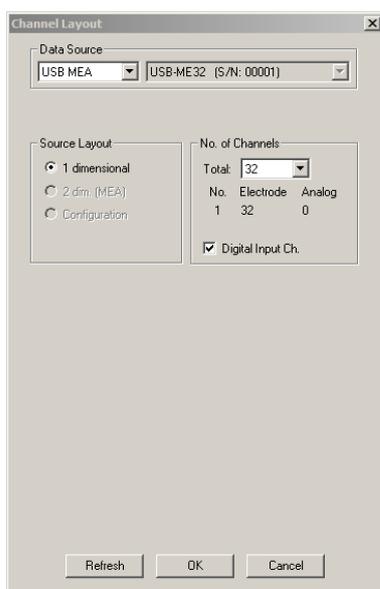
MC_Rack now recognizes the Portable-ME System as data source. For further instructions how to use he MC_Rack software please refer to the respective manual and help files available on the web site and as online help in MC_Rack.

5 The Portable ME-System

5.1 The Portable ME16-System

The Portable ME16-System with integrated 16-channel filter amplifier and integrated data acquisition with A / D converter includes two 8-channel miniature preamplifiers (MPA8I) or one 16-channel micro preamplifier (µPA16). The MPA8Is or the µPAs are connected to the microelectrode probes to provide the initial tenfold amplification stage. You can contact standard microelectrodes such as probes from NeuroNexus directly without the need of any adapter in many cases. Adapters 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.

The Portable ME16-System can be used either with two MPA8Is - **or** - with one µPA16. The device is preconfigured by Multi Channel Systems and cannot be modified by the user. If you like to change the preconfiguration, please contact MCS: www.multichannelsystems.com

5.1.1 Front Panel

2 x Analog Input for MPA8I

On the left side when looking directly on the front panel of the Portable ME16-System two analog inputs (female D-SUB 15 connector) are available for two miniature preamplifiers MPA8I. The upper one is for software channel 1 to 8, the lower one is for channel 9 to 16. Please read the MPA8I manual for setting up the MPA8I.

1 x Analog Input for µPA16. Additionally is on the right side of the front panel of the Portable ME16-System one analog input (female D-SUB 26 connector) for a micro preamplifier µPA16 available. Please read the Micro Preamplifier Manual for setting up the µPA16.

Note: Only the MPA8I inputs - or - the µPA16 input can be used at a time, as they connect to the same channels on the filter amplifier.

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 at the rear panel is switched to status "I = On".

5.1.2 Rear Panel

Note: Using a USB hub for connecting the Portable ME16-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.

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.

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. 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. You can utilize this digital signal to control and synchronize other devices with the Portable ME16-System. Bit 0 of the Digital OUT is separated and available as Lemo connector DIG OUT D0. 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.

One bit of the DIG OUT and DIG IN, respectively, are directly accessible via Lemo connectors. If you need all bits, a Di/o box is available which provides a BNC connector for each bit (http://www.multichannelsystems.com/products/dio).

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 Portable ME16-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 Portable ME16-System 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. Two channels can be converted into sound (Stereo). The real-time audio output can be configured in the software. Please refer to the manuals or helps for details.

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 (type A - mini B) cable.

POWER IN

Connect here the power supply unit. This power supply powers the Portable ME16-System main unit only. The device needs 12 V and 1.1 A / ~13 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)

5.2 The Portable ME32-System

The Portable ME32-System with integrated 32-channel filter amplifier and integrated data acquisition with A / D converter includes two 16-channel micro preamplifiers (µPA16) or one 32-channel micro preamplifier (µPA32). The µPAs are connected to the microelectrode probes to provide the initial tenfold amplification stage. You can contact standard microelectrodes such as probes from NeuroNexus directly without the need of any adapter in many cases. Adapters 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.

The Portable ME32-Sytem can be used either with two µPA16s - **or** - with one µPA32. The device is preconfigured by Multi Channel Systems and cannot be modified by the user! If you like to change the preconfiguration, please contact MCS **www.multichannelsystems.com**

5.2.1 Front Panel

2 x Analog Input for µPA16

On the left side when looking directly on the front panel of the Portable ME32-System two analog inputs for two micro preamplifiers µPA16 (female D-SUB 26 connector) are available. The upper one is for software channel 1 to 16, the lower one is for channel 17 to 32. Please read the Micro Preamplifier Manual for setting up the µPA16.

1 x Analog Input for µPA32

Additionally is on the right side of the front panel of the Portable ME32-System one analog input (female D-SUB 44 connector) for a micro preamplifier µPA16 available. Please read the Micro Preamplifier Manual for setting up the µPA16.

Note: Only the MPA8I inputs - or - the µPA16 input can be used at a time, as they connect to the same channels on the filter amplifier.

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".

5.2.2 Rear Panel

Note: Using a USB hub for connecting the Portable ME16-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.

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.

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. 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. You can utilize this digital signal to control and synchronize other devices with the Portable ME16-System. Bit 0 of the Digital OUT is separated and available as Lemo connector DIG OUT D0. 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.

One bit of the DIG OUT and DIG IN, respectively, are directly accessible via Lemo connectors. If you need all bits, a Di/o box is available which provides a BNC connector for each bit.

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 Portable ME32-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 Portable ME32-System 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. Two channels can be converted into sound (Stereo). The real-time audio output can be configured in the data source tool of the software Please refer to the manuals or helps for details.

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 (type A - mini B) cable.

POWER IN

Connect here the power supply unit. This power supply powers the Portable ME32-System main unit only. The device needs 12 V and 1.1 A / ~13 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).

5.3   Setting Up and Connecting the Portable ME-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.

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 (one or two MPA8Is or one µPA16 as described in the "MPA8I Manual" and in "Micro Preamplifier Manual").

3. Set up the computer with installed software program.

4. Connect the MPA8Is or the µPA16 one or two µPAs16 or one µPA32 to the main unit of the Portable ME-System. Close all unused inputs with terminal plugs.

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

6. 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.

7. 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.

8. Connect adapters and electrodes. See preamplifier manual on how to connect the electrodes.

9. Start the software and select the ME-System as the data source. Please see the helps or manuals for more details on how to define the data source.

6   System Components

6.1   Integrated Filter Amplifiers (FA)

Raw data from the preamplifiers is amplified by a 16- or 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 (MPA8I) output and the filter amplifier (FA) input that results from the supply voltage drop in the line from the MPA8I to the FA. If two or more MPA8Is 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.

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, 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 more information on gain and filters in general, please refer to standard literature or contact your local retailer.

6.2   Integrated Data Acquisition

Analog input signals are acquired from the data source and digitized by the 16- or 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 High Speed USB 2.0 port.

A 16-bit digital (TTL) input / output channel is available. You can use the digital TTL inputs, for example, for synchronizing stimulation and recording, or for synchronizing the Portable 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 voltage input range of the DAQ is +/- 4 V. with the standard gain of 1000, this means that the signals can be up to +/- 4 mV in size before getting clipped. Please refer to the MC_Rack help or manual for more information.

DC Offset Correction

An offset correction is generally not necessary, because the intrinsic DC offsets of the Portable ME-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.

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.

6.3 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).

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.

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 a 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.

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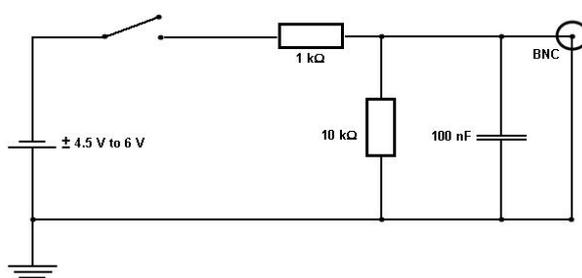
You can connect any device that produces TTL outputs, for example a switch, to one of the digital input bits. This means you can use a trigger for remote controlling the recording with MC_Rack, or for synchronizing systems, if the data acquisition computer is not within reach during an experiment.

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.

Triggering other Instruments

The digital output of the Portable ME-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 Portable 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 manual for more details.

7 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.

7.1 No Computer Connection / No Recording Possible

You cannot establish a connection to the computer. The Portable ME-System channel layout is not available in MC_Rack. When loading a previously saved virtual rack file, you will get an error message and the simulator will be started automatically.

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 Portable ME-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 Portable ME-System directly to a USB port, not via a hub.

7.2 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 Portable ME-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 Portable ME-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.

8 Appendix

8.1 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. Or you can see the serial number when starting MC_Rack. Click Edit > Data Source Setup > Data Source. The serial number will be displayed in the right drop down menu.

- 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.

8.2 Technical Specifications

8.3 Pin Layout Portable ME16-System
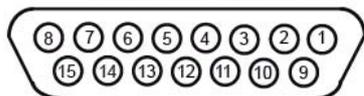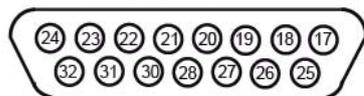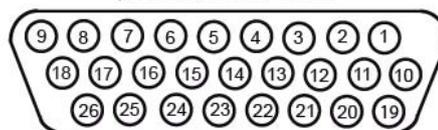
MPA8I Input to Portable ME16-System

MPA8I Input (15-Pin D-SUB 15 Connector, female)

Pin	MPA8I Input 1	MPA8I Input 2
Pin 1	GNDP (power ground)	GNDP (power ground)
Pin 9	GNDS (signal ground	GNDS (signal ground)
Pin 2	Channel 1	Channel 9
Pin 10	Channel 2	Channel 10
Pin 3	Channel 3	Channel 11
Pin 11	Channel 4	Channel 12
Pin 4	Channel 5	Channel 13
Pin 12	Channel 6	Channel 14
Pin 5	Channel 7	Channel 15
Pin 13	Channel 8	Channel 16
Pin 6	GNDP (power ground)	GNDP (power ground)
Pin 14	GNDP (power ground)	GNDP (power ground)
Pin 7	GNDP (power ground)	GNDP (power ground)
Pin 15	Positive supply voltage	Positive supply voltage
Pin 8	Negative supply voltage	Negative supply voltage

The channel numbers refer to the recording channel numbers in the software program. Please make sure that you have selected the Portable ME16-Layout in the software. See the manuals or helps for details.

µPA16 Input to Portable ME16-System

µPA8I Input (26-Pin D-SUB Connector, female)

Pin	**µPA16**	**Pin**	
Pin 2	Channel 1	1, 10, 19, 23	GNDP (power ground)
Pin 3	Channel 3	20, 21, 22	Positive supply voltage
Pin 4	Channel 5	24, 25, 26	Negative supply voltage
Pin 5	Channel 7		
Pin 6	Channel 9		
Pin 7	Channel 11		
Pin 8	Channel 13		
Pin 9	Channel 15		
Pin 11	Channel 2		
Pin 12	Channel 4		
Pin 13	Channel 6		
Pin 14	Channel 8		
Pin 15	Channel 10		
Pin 16	Channel 12		
Pin 17	Channel 14		
Pin 18	Channel 16		

The channel numbers refer to the recording channel numbers in the software program. Please make sure that you have selected the Portable ME16-Layout in the software. See the manuals or helps for details.

Digital IN / OUT Connector

68-Pin MCS Standard Connector
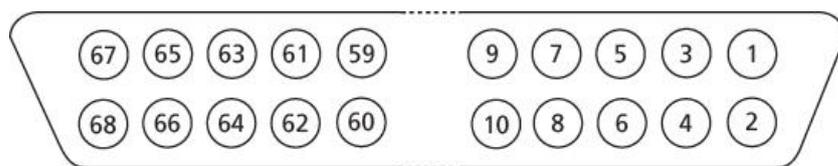
Pin 1	GND Channels bit 0 - 7
Pin 2	GND
Pin 3 - 10	Digital output
Pin 11 - 14	GND
Pin 15 - 22	Digital output Channels bit 8 - 15
Pin 23 - 26	GND
Pin 27 - 34	Digital input Channels bit 0 - 7
Pin 35 - 38	GND
Pin 39 - 46	Digital input Channels bit 8 - 15
Pin 47 - 48	GND
Pin 49 - 63	Not connected
Pin 64 - 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)

8.4 Pin Layout Portable ME32-System

μPA16 No 1, Channel 1 to 16
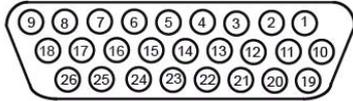
μPA16 No 2, Channel 17 to 32
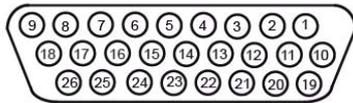
μPA32, Channel 1 to 32
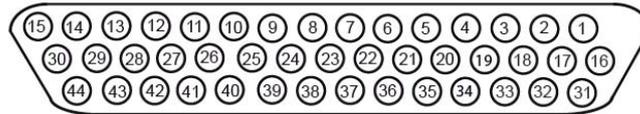
μPA16 Input to Portable ME32-System

μPA16, Input (26-Pin D-SUB Connector, female)

Pin	μPA16, No 1	μPA16, No 2
Pin 2	Channel 1	Channel 17
Pin 3	Channel 3	Channel 19
Pin 4	Channel 5	Channel 21
Pin 5	Channel 7	Channel 23
Pin 6	Channel 9	Channel 25
Pin 7	Channel 11	Channel 27
Pin 8	Channel 13	Channel 29
Pin 9	Channel 15	Channel 31
Pin 11	Channel 2	Channel 18
Pin 12	Channel 4	Channel 20
Pin 13	Channel 6	Channel 22
Pin 14	Channel 8	Channel 24
Pin 15	Channel 10	Channel 26
Pin 16	Channel 12	Channel 28
Pin 17	Channel 14	Channel 30
Pin 18	Channel 16	Channel 32
Pin 1, 10, 19, 23	GNDP (power ground)	
Pin 20, 21, 22	Positive supply voltage	
Pin 24, 25, 26	Negative supply voltage	

The channel numbers refer to the recording channel numbers in the software program. Please make sure that you have selected the Portable ME32-Layout in the software. See the manuals or helps for details.

µPA32 Input to Portable ME32-System

µPA32 Input (44-Pin D-SUB Connector, female)

Pin	Channel	Pin	Channel	Pin	Channel
Pin 1	Channel 1	Pin 17	Channel 2	Pin 32	Channel 3
Pin 2	Channel 4	Pin 18	Channel 5	Pin 33	Channel 6
Pin 3	Channel 7	Pin 19	Channel 8	Pin 34	Channel 9
Pin 4	Channel 10	Pin 20	Channel 11	Pin 35	Channel 12
Pin 5	Channel 13	Pin 21	Channel 14	Pin 36	Channel 15
Pin 6	Channel 16	Pin 22	Channel 17	Pin 37	Channel 18
Pin 7	Channel 19	Pin 23	Channel 20	Pin 38	Channel 21
Pin 8	Channel 22	Pin 24	Channel 23	Pin 39	Channel 24
Pin 9	Channel 25	Pin 25	Channel 26	Pin 40	Channel 27
Pin 10	Channel 28	Pin 26	Channel 29	Pin 41	Channel 30
Pin 11	Channel 31	Pin 27	Channel 32		
Pin 12, 13, 16, 28, 31, 42	GNDP (power ground)				
Pin 14, 15, 30	Positive supply voltage				
Pin 29, 43, 44	Negative supply voltage				

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

Digital IN / OUT Connector

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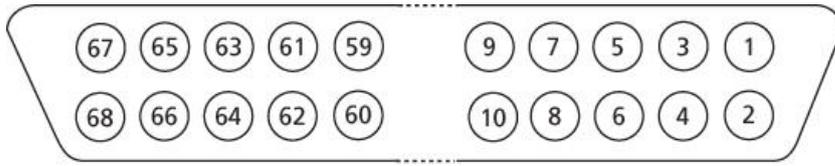
Pin 1	GND
Pin 2	GND
Pin 3 - 10	Digital output channels bit 0 - 7
Pin 11 - 14	GND
Pin 15 - 22	Digital output channels bit 8 - 15
Pin 23 - 26	GND
Pin 27 - 34	Digital input channels bit 0 - 7
Pin 35 - 38	GND
Pin 39 - 46	Digital input channels bit 8 - 15
Pin 47 - 48	GND
Pin 49 - 63	Not connected
Pin 64 -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

8.5   Additional Analog Input

Portable ME-System with additional ANALOG OUTPUT for amplified analog data via 68-pin MCS standard connector.

Rear Panel
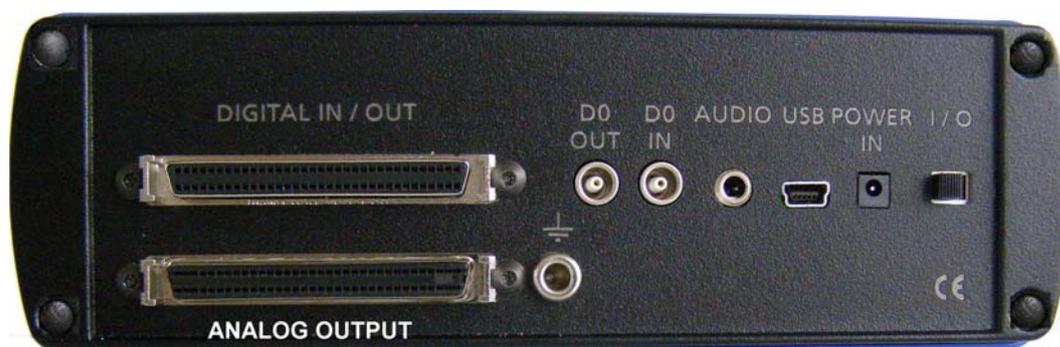
Analog signals are splitted between the filter amplifier and the A / D converter. The additional analog output on the rear panel of the Portable ME-System has the same pin layout as the output of a FA32 (32-channel filter amplifier). Please see pin layout below.

Pin Layout ANALOG OUTPUT

68-Pin MCS Standard Connector
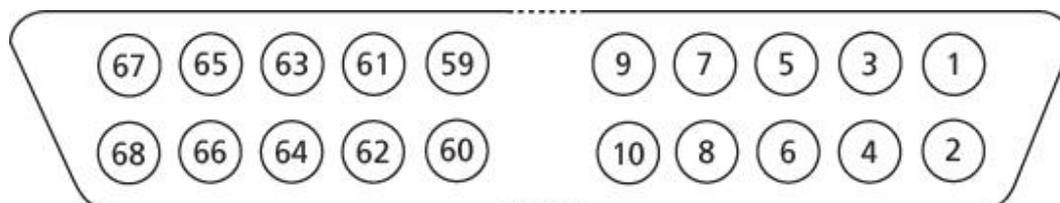
Pin 1	GNDP (power ground)
Pin 2	GNDI (connected to GNDP)
Pin 3 –18	Analog output channels 1 - 16
Pin 19 – 34	Analog output channels 17 - 32
Pin 35 – 66	Not connected
Pin 67	Positive supply voltage output (+5.5 V to +9 V)
Pin 68	Negative voltage supply output (-5.5 V to -9 V)

8.6   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