



a division of Harvard Bioscience, Inc.

# 32-Channel Miniature Preamplifier for FlexMEAs MPA32I-Flex Manual



## Imprint

Information in this document is subject to change without notice.

No part of this document may be reproduced or transmitted without the express written permission of Multi Channel Systems MCS GmbH.

While every precaution has been taken in the preparation of this document, the publisher and the author assume no responsibility for errors or omissions, or for damages resulting from the use of information contained in this document or from the use of programs and source code that may accompany it.

In no event shall the publisher and the author be liable for any loss of profit or any other commercial damage caused or alleged to have been caused directly or indirectly by this document.

© 2019 Multi Channel Systems MCS GmbH. All rights reserved.

Printed: 11.11.2019

Multi Channel Systems MCS GmbH

Aspenhaustraße 21

72770 Reutlingen

Germany

Phone +49-71 21-909 25 - 0

Fax +49-71 21-909 25 -11

[sales@multichannelsystems.com](mailto:sales@multichannelsystems.com)

[www.multichannelsystems.com](http://www.multichannelsystems.com)

Microsoft and Windows are registered trademarks of Microsoft Corporation. Products that are referred to in this document may be either trademarks and/or registered trademarks of their respective holders and should be noted as such. The publisher and the author make no claim to these trademark.

# Table of Contents

<b>1</b>	<b>Important Information and Instruction</b>	<b>4</b>
1.1	Operator's Obligations	4
1.2	Guarantee and Liability	4
1.3	Important Safety Advice	5
<b>2</b>	<b>Welcome to the MPA32I-Flex</b>	<b>5</b>
<b>3</b>	<b>Setting Up and Connecting the MPA</b>	<b>7</b>
3.1	General Setup Recommendations	7
3.2	Connecting FlexMEAs	8
3.2.1	FlexMEAs	9
<b>4</b>	<b>Service and Maintenance</b>	<b>10</b>
4.1	Cleaning the Connectors	10
4.2	Sterilization	10
<b>5</b>	<b>Pin Layout</b>	<b>11</b>
5.1	Power Supply	11
5.2	Inputs	11
5.3	Outputs	11
<b>6</b>	<b>Contact Information</b>	<b>12</b>
<b>7</b>	<b>Technical Specifications MPA32I-Flex</b>	<b>13</b>

# 1 Important Information and Instruction

## 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 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.

## 1.3 Important Safety Advice



Warning: Make sure to read the following advices 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.

Malfunctions which could impair safety should be rectified immediately.

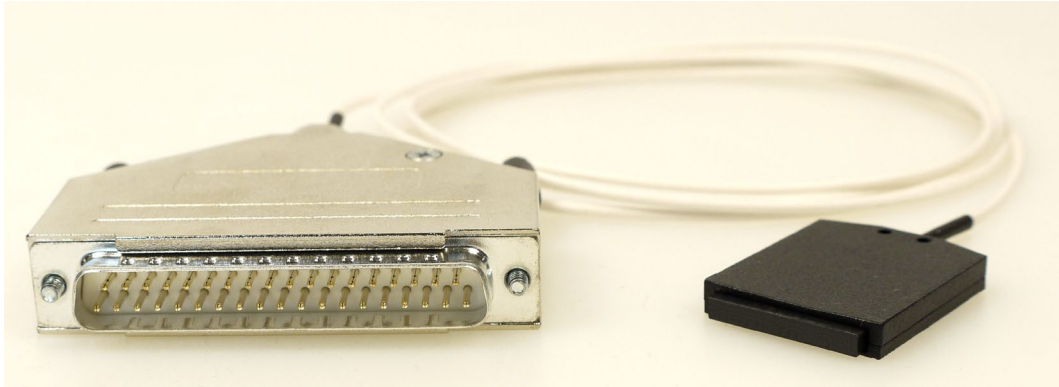
Any physical damage of the cable, such as a broken cable, causes a physical damage of the miniature preamplifier that cannot be repaired.

Protect the device from heat. Do not autoclave!

You can clean the connectors with distilled water in an ultra sonic bath, but keep the cable away from the fluid. Dry the device with compressed air.

Use and keep the device always in a dry environment. Do not expose it to fluids or vapor for a longer period of time.

## 2 Welcome to the Miniature Preamplifier MPA32I



The 32-channel Miniature Preamplifier MPA32I is connected to the microelectrodes for providing the initial tenfold amplification stage.

It has additional common ground and **reference electrode inputs**. The reference electrode is ideally identical to the recording electrodes and placed into a comparable but inactive area or tissue. Background or noise signals that are picked up by both the reference electrode and the recording electrodes are removed.

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

The MPA32I-Flex is optimized for the use with flexible microelectrode arrays (FlexMEAs) from Multi Channel Systems. **FlexMEAs** are two-dimensional microelectrode arrays with two microelectrodes for recording or stimulation, two indifferent reference electrodes, and two large ground electrodes. They are intended for recordings from several species, in both acute and long-term chronic experiments.

Please see the MEA manual and chapter "FlexMEAs" for more details.

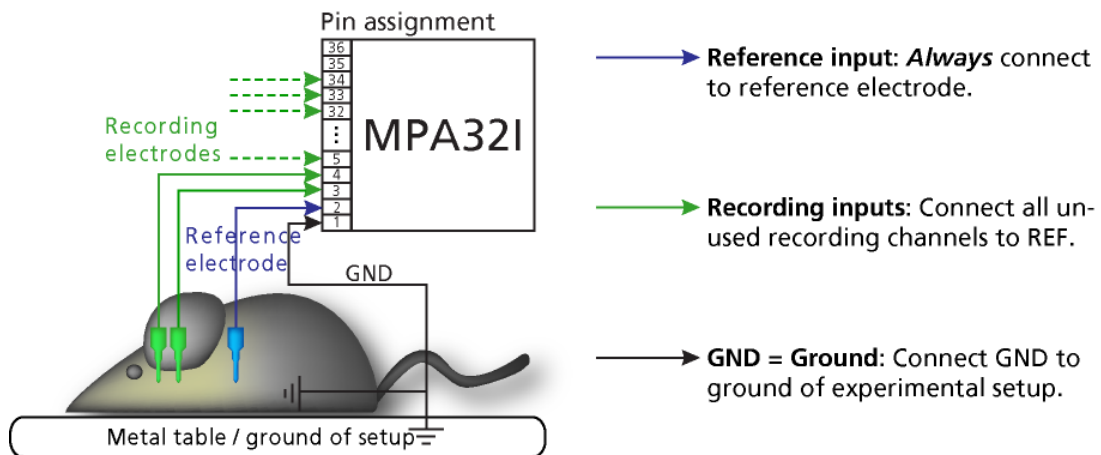
**FlexMEA electrodes** are planar with a diameter of only 30  $\mu\text{m}$  resulting in an impedance of about 50 kilo Ohms, arranged in a square 6 x 6 grid, with an interelectrode distance of 300  $\mu\text{m}$ . FlexMEAs are made of flexible and biocompatible polyimide as the base material supporting the titanium nitride (TiN) electrodes and the gold thin-film conductors. TiN allows the formation of electrodes as small as possible with an excellent signal to noise ratio and a long lifetime. Only 12  $\mu\text{m}$  "thick" and weighing less than 1 g, the FlexMEA biosensor is very thin and lightweight. The flexible base is perforated for a better contact with the surrounding tissue.

### 3 Setting Up and Connecting the MPA32I

#### 1.4 General Setup Recommendations

In the following, you find general recommendations for the installation.

##### Miniature preamplifier setup



Steps 3 to 6 are not applicable if you are using a FlexMEA, because all channels are automatically connected to the appropriate electrodes as long as the orientation of the FlexMEA in the amplifier is correct. See Connecting FlexMEAs for details.

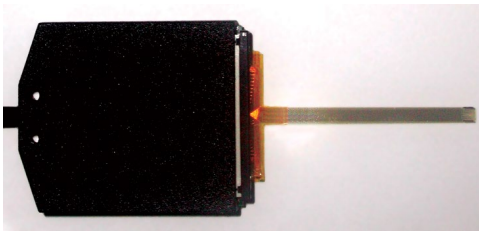
**Important:** It is important that the complete setup refers to a single common ground. The reference input has always to be connected. It is recommended to use a reference electrode. However, if you are not using a reference electrode, connect the reference input to ground (GND). Otherwise, noise picked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

1. Ground the animal with a **ground electrode** of large surface area, for example, a liquid gel adhesive electrode, that is connected to the **ground** of the setup, for example, a large metal table or a Faraday cage, to avoid pickup of noise from the environment. The ground electrode is best positioned in an electrically inactive region (not near muscle, nor heart), for example, at the belly.
2. Connect the **GND input** or the metal case of the miniature preamplifier to the common ground of the setup. (The GND input is internally connected to the metal case.)
3. Connect the **reference electrode to the reference input** of the miniature preamplifier. Generally, a reference electrode is inserted into non-active tissue of the experimental model. The reference electrode should be identical to the recording electrode so that both electrodes see the same background noise. This is necessary because despite the grounding, the animal's body often has not exactly a potential of zero, due to the electrode impedance, for example. The background noise is then subtracted from the recording signal, increasing the signal to noise ratio. Please note that this may not work if the complete setup is not properly grounded.
4. (Optional) If two reference electrodes are used, connect the second electrode to the free reference input. Otherwise, leave it free. It is generally not necessary to use a second reference electrode. It can be used to enlarge the surface area of the reference, though.
5. Connect the **recording electrodes** to the **recording channels** of the miniature preamplifier. You can either use single electrodes or multielectrodes with the miniature preamplifier. MCS provides adapters for standard probes.

6. Connect all unused recording channels to the GND input or to the reference electrode if the reference and ground electrode of the amplifier are short circuited, to avoid noise pickup. As the total amplifier gain generally lies in the range of 1000, even very small noise signals may generate high noise signals.
7. If you are not using a Faraday cage, it might be necessary to shield the complete setup with aluminum foil or similar to prevent electrical interference from the outside. Connect the aluminum foil to the ground of the setup (for example, the metal table).

**Troubleshooting:** If you observe problems with noise, check that the ground of the setup is connected to exactly the same ground as the data acquisition computer. For example, connect the metal table to the ground/earth wire of a free power outlet (of the same electrical system), as the computer is generally connected to ground/earth via the power plug, too. Also, connect the data acquisition computer's metal case with a thick ground wire to the ground of the setup (for example, the metal table), preferably with a 4 mm plug.

## 1.5 Connecting FlexMEAs



**FlexMEA36 connected to MPA321-Flex.**

The side with no screws is considered the top side of the MPA321. If the MPA321 is oriented as shown in the figure, the FlexMEA36 is inserted with the contact pads facing downward.

The MPA321-FLEX has a slot for inserting FlexMEAs. For a tight and reliable connection, the FlexMEA36 contacts are pressed down onto the amplifier contacts by the slot lid. To insert the FlexMEA36, you have to pull open the slot lid.

**Important:** Please use a thin plastic spacer between the FlexMEA36 and the connector so that the contact pads make a tight contact to the connector pins. Otherwise, the FlexMEA36 will sit too loose and will have a bad contact resulting in a higher noise level.

### Inserting the Flex-MEA into the MPA321-FLEX slot



Grip the sides of the black slot cover with your fingers and carefully pull open the slot cover only a little bit (about 1 or 2 mm). Do not demount the cover as the plastic supports might break easily.

Insert the FlexMEA36 with the contact pads upside down, and the plastic spacer into the slot. The plastic spacer should be placed on the opposite side of the contact pads of the FlexMEA36 in the slot, otherwise the connection will be interrupted.

Carefully push back the slot cover until it locks.



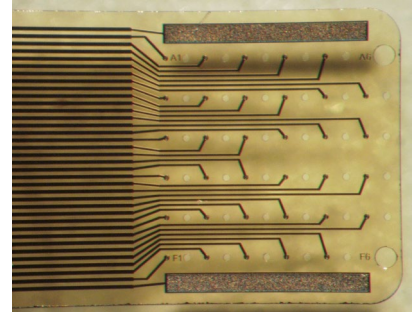
### 1.5.1 FlexMEAs

FlexMEAs are made of flexible polyimide material (Polyimide 2611 foil), perfect for *in vivo* and special *in vitro* applications. Only 12  $\mu\text{m}$  "thick" and weighing less than 1 g, the FlexMEA biosensor is very thin and lightweight.

FlexMEA36 has 32 titanium nitride (TiN) electrodes plus two internal reference electrodes and two ground electrodes. The flexible base is perforated for a better contact with the surrounding tissue.

The electrodes have a diameter of about 30  $\mu\text{m}$  with an interelectrode distance of 300  $\mu\text{m}$ .

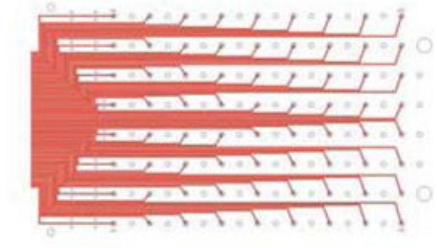
Contact pads and conducting material is pure gold.



FlexMEA72 has 72 titanium nitride (TiN) electrodes plus four internal reference electrodes and four ground electrodes. The flexible base is perforated for a better contact with the surrounding tissue.

The electrodes have a diameter of about 100  $\mu\text{m}$  with an interelectrode distance from 625 to 750  $\mu\text{m}$ .

Contact pads and conducting material is pure gold.



#### Using FlexMEAs

FlexMEAs are usually connected to a headstage preamplifier that is connected to a filter amplifier or programmable gain amplifier (see also the ME-System product line of Multi Channel Systems). FlexMEAs can be via adapter connected to a 32-channel miniature preamplifier from Multi Channel Systems for *in vivo* experiments. FlexMEAs are stable at a temperature range from 10  $^{\circ}\text{C}$  to 40  $^{\circ}\text{C}$ .



**Warning: Do not autoclave or sterilize FlexMEAs by heat. These MEA types are not heatstable and will be irreversibly damaged if the temperature is too high.**

**Do not use ultrasonic bath for cleaning the FlexMEA!**

## 4 Service and Maintenance

### 1.6 Cleaning the Connectors



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

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

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

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

### 1.7 Sterilization



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

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

## 5 Pin Layout

### 1.8 Power Supply

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

Pin 19: -3 V to -8 V

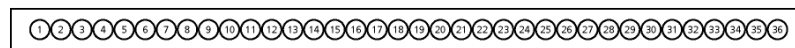
Pin 37: +3 V to +8 V



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

### 1.9 Inputs

#### 32-Channel Miniature Preamplifier for Flex-MEAs inputs



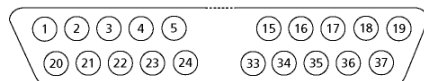
Pin 1: GND (ground)  
Pin 2: Reference  
Pin 3-34: Channel 1-32  
Pin 35: Reference  
Pin 36: GND (ground)

This illustration shows the pin layout viewed from the front, with the case screws upside down.

The two reference inputs are used for connecting a reference electrode. Both inputs are equal, so it does not matter which of the two inputs is used. If both are used, the mean of both reference signals is used as reference.

### 1.10 Outputs

#### 32-Channel Miniature Preamplifier outputs



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

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

## 6 Contact Information

### **Local retailer**

Please see the list of official MCS distributors on the MCS web site.

### **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 contact form of the MCS web site.

**[www.multichannelsystems.com](http://www.multichannelsystems.com)**

## 7 Technical Specifications MPA32I-Flex

Operating temperature	0° C to 50° C
Storage temperature	0° C to 50° C
Relative humidity	10 % to 85 % non-condensing
Dimensions (W x D x H)	27 x 36 x 5 mm
Weight	7 g w/o cable and plug, 56 g with cable and plug
Length of the cable	1.5 m
Maximum tensile strength of cable	20 N
Input connector type	Special input for use with FlexMEAs
Supply voltage	$\pm 3 \text{ V}$ to $\pm 8 \text{ V}$ DC
Supply current	$< \pm 14 \text{ mA}$ , typically $\pm 9 \text{ mA}$
Number of input channels	32
Input voltage	$\pm 500 \text{ mV}$ (with respect to a supply voltage of 5 V)
Input impedance	$10^{12} \Omega$ parallel to 10 pF
Input noise	$< 1.5 \mu\text{V}_{\text{RMS}}$ (1 Hz to 5 kHz, inputs short-circuited)
Noise density	$e_n = 15 \text{ nV} / \sqrt{\text{Hz}}$
Number of output channels	32
Output voltage	= supply voltage
Output current	max. = 10 mA
Output impedance	0 $\Omega$
Bandwidth	DC to 50 kHz
Gain	10