



# W2100-System

## USER MANUAL

# TABLE OF CONTENTS

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<b>Important Safety Advice</b> .....	<b>5</b>
Guarantee and Liability.....	6
<b>Welcome to the W2100-System</b> .....	<b>7</b>
<b>Hardware Components</b> .....	<b>8</b>
Wireless Headstages.....	8
Battery Options .....	9
Wireless2100 Receiver .....	10
Interface Board IFB-C Multiboot.....	11
Digital Signal Processor.....	13
Accessories .....	13
<b>System Setup</b> .....	<b>15</b>
Connecting the Hardware Components.....	15
Software Installation.....	15
<b>Software MC_Rack</b> .....	<b>16</b>
<b>Software Multi Channel Suite</b> .....	<b>21</b>
Data Source W2100-System .....	21
Single Headstage Mode .....	22
Wireless System Setup .....	24
Multi Headstage Mode .....	27
Wireless System Setup .....	29
Operating the Multi Channel Experimenter Software .....	30
Video Synchronization .....	30
Gyroscope and Accelerometer Data .....	32
Stimulation .....	33
Optostimulation .....	36
Stimulation Current Display .....	37
<b>Video Control</b> .....	<b>39</b>
Operation of the Video Camera .....	40
Camera Settings via uEye Software .....	44
<b>Experimental Setup</b> .....	<b>46</b>
<b>W2100 Configuration</b> .....	<b>48</b>
<b>Troubleshooting</b> .....	<b>52</b>
<b>Video Camera Setup</b> .....	<b>53</b>
Technical Specifications.....	55
<b>Technical Specifications</b> .....	<b>56</b>

# TABLE OF CONTENTS

---

<b>Service and Maintenance</b> .....	<b>59</b>
Cleaning of the System .....	59
<b>Technical Support</b> .....	<b>60</b>
<b>Pin Layout</b> .....	<b>61</b>
IFB-C Multiboot Interface Board.....	61
Pin Layout of the Receiver W2100-RE-AO .....	62
Power Consumption .....	63
<b>Contact Information</b> .....	<b>68</b>

# IMPRINT

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## IMPRINT

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# IMPORTANT SAFETY ADVICE

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## IMPORTANT SAFETY ADVICE



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



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

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

- its intended purpose;
- be used when in a perfect condition.

Improper use could lead to serious, even fatal injuries to the user or third parties and damage to the device itself or other material damage.



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

Malfunctions which could impair safety should be rectified immediately.

## Grounding

This product is grounded through the grounding conductor on the power cord. To avoid electric shock, the grounding conductor must be connected to earth.

## Orient the Equipment Properly

Do not orient the equipment so that it is difficult to manage the disconnection device.

## Explanation of the Symbol used



Caution / Warning



DC, direct current

## 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.

# IMPORTANT SAFETY ADVICE

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## **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.

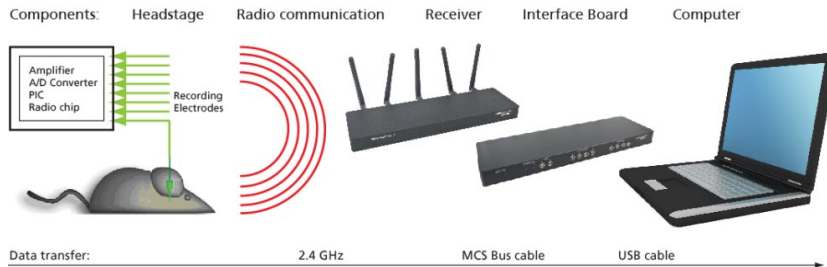
Guarantee and liability claims in the event of injury or material damage are excluded when they are the result of one of the following.

- 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.

# HARDWARE COMPONENTS

## WELCOME TO THE W2100-SYSTEM

The Wireless2100 *in vivo* recording system is the all-in one solution for amplifying, recording, and analyzing *in vivo* data from four, eight, sixteen or thirty-two channels. The system consists of small sized headstages with integrated A/D converter, a receiver, and an interface board with connectors for additional analog and digital data in- and outputs. For data acquisition and analysis, the easy to use software package Multi Channel Suite or MC\_Rack is included.



Headstages are available with four, eight, sixteen or thirty-two channels. Each Wireless2100-System can operate with any type of headstage. With its excellent signal-to-noise ratio, adjustable sampling rate and wide frequency range, the Wireless2100-Systems are a versatile solution for spikes, LFP, EEG, ECG, and ECoG. The headstage records analog signals from the electrodes. The signals are amplified and digitized directly on the headstage and transmitted to the receiver via radio communication in the 2.4 GHz frequency band. Digital data transmission guarantees a long effective range without loss in data quality. Additional in- and outputs on the interface board allow the synchronization of the data with external devices, and the simultaneous recording of additional analog data, for example from a microphone.

As advanced option, the Wireless2100-System allows the possibility to record from up to four headstages with one receiver simultaneously (at a reduced sampling rate). You can connect two receivers to one interface board, thereby building a system for up to eight headstages. It is possible to position four receivers in one room, thereby having a four-fold system with a total of sixteen headstages, from which you can record in parallel.

Furthermore, the modular design of the Wireless2100 headstages allows the customization with additional functions based on customer requests. At the moment, the basic recording option as well as modules for electrical and optical stimulation are available, video control is under development and will be available soon.

# HARDWARE COMPONENTS

## HARDWARE COMPONENTS

### Wireless Headstages

The Wireless 2100-System consists of three main components: The headstage with battery, the receiver, and the interface board, which is connected to the computer. Accessories are the signal generator, the remote control to reactivate the headstage, and the USB-charger for the battery. The components are in detail presented in the following chapters.



The headstage is the first of the three elements of the Wireless2100-System. The headstages are small and lightweight to allow recordings in freely moving animals. Headstages are available with four, eight, sixteen or thirty-two channels. Each Wireless2100 receiver and interface board is able to operate with any type of headstage. Headstages are equipped with Omnetics or single row connectors. Please see table below for an overview of available headstage types and the respective functionality. Other connector types and adaptors are available on request. Please contact the MCS support team for detailed information. Please see the respective datasheets for the technical specifications of the headstages.



Each headstage has a battery connector and two LEDs, blue and red. The headstages are coated with transparent blue material as protection against water and dirt. The standard gain of the headstages is 100 and the frequency range is 1 Hz to 5 kHz. A lower cut off frequency of 0.1 Hz is available on request.

### Available Headstages

The W2100-HS4, W2100-HS8 and W2100-HS8-SR with single row connector, the W2100-HS16 and the W2100-HS32 have 4, 8, 16 or 32 recording electrodes.

The W2100-HS-opto headstages have recording electrodes and an interface for two optical stimulation channels. The W2100 headstages with additional electrical stimulation are grouped in "internal" and "external" stimulation sites. The headstages with internal electrical stimulation have two dedicated stimulation channels, available on the connector together with the recording channels. The headstages with external electrical stimulation have an interface with two channels for access from outside.

All headstages with electrical stimulation sites are available with an output current of 0.5 mA or 2.0 mA.

W2100 Headstage	Recording	Recording and optical stimulation	Recording and electrical stimulation (internal)	Recording and electrical stimulation (external)
W2100-HS4	x			
W2100-HS8	x			
W2100-HS8-SR	x			
W2100-HS16	x			
W2100-HS32	x			
W2100-HS4-opto	x	x		
W2100-HS8-opto	x	x		
W2100-HS8-SR-opto	x	x		
W2100-HS16-opto	x	x		
W2100-HS32-opto	x	x		
W2100-HS8-ES2-0.5mA (-2.0mA)	x		x	
W2100-HS14-ES2-0.5mA (-2.0mA)	x		x	
W2100-HS8-ES2-EXT-0.5mA (-2.0mA)	x			x
W2100-HS8-SR-ES2-EXT-0.5mA (-2.0mA)	x			x
W2100-HS16-ES2-EXT-0.5mA (-2.0mA)	x			x
W2100-HS32-ES2-EXT-0.5mA (-2.0mA)	x			x



## Gyroscope and Accelerometer Data

Headstages of the latest generation are equipped with sensors for rotation and acceleration, each in x-y-z-direction. Currently, this data can only be recorded and exported by the Multi Channel DataManager.

## Sampling Rate

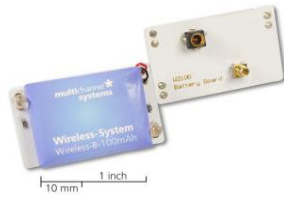
The Wireless2100-System can sample the maximum of 32 channels with 20 kHz per channel. Depending on the number of selected channels, the sampling rate can be increased even more. If multiple headstages are operated simultaneously with a single receiver, the sampling rate is limited to 2 kHz per channel. For details please see chapter "Technical Specifications" in the Appendix.

## Battery Options

Batteries of the Wireless2100 are always external, not built in the headstage. Standard batteries are available with different capacities, 30, 100, 200 and 300 mAh. Custom batteries are available on request.



They can either be connected directly on the headstage with a double plug or with a cable connection, for example, with a backpack on the back of the animal. Backpacks for rat and mice are available as accessories. The battery board for the direct connection is equipped with two LEDs for video tracking.

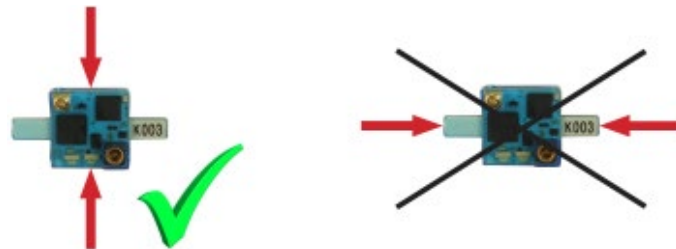


The standard battery (100 mAh) of a headstage permits continuous recording of all channels for more than 2 hours. Empty batteries can be replaced without removing the headstage, and recharged while the experiment can be continued with a second battery.

## Longterm Storage of the Lithium Polymer Batteries

Important: Ideally store the batteries 70 % charged in a low humidity environment at 5 to 7 °C, for example in the fridge, but not in the freezer. Please check the charging state quarterly to prevent totally self-discharge, which can destroy the batteries.

## Handling of the Headstage



Note: Please handle the headstage with great care! Do not touch the antennae, but the body of the headstage!

## Jacket for Rat or Mouse with Pouch to carry the Battery



## Wireless2100 Receiver



The receiver is the second element of the Wireless2100-System.

One receiver of the Wireless2100-System can receive the digitized signals sent from up to four headstages. Four antennas are used for data transmission, one antenna submits control signals to and from the headstage. The position of the antennas can have an influence on the transmission efficiency.

With a clear line of sight between sender and receiver, an effective transmission range of 5 m is guaranteed under normal circumstances. Under good conditions, the actual range can be much further.

The receiver does not need an own power supply. The device is connected to the interface board via iX-industrial cable for data transfer and power supply.



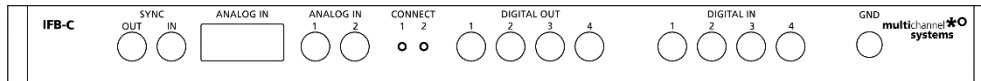
For recording analog signals additionally, please use the receiver W2100-RE-AO with analog output. The 68-pin MCS standard connector provides access to analog data for streaming into third party data acquisition, for example the USB-ME64-System. In double systems it is possible to use optionally one receiver with and one without analog output or both receivers with analog out.

## Interface Board IFB-C Multiboot



The Multiboot Interface Board IFB-C facilitates operation of all MCS *in vitro* and *in vivo* headstages within the entire 2100 amplifier solution suite. This suite includes: MEA2100-HS, Multiwell-MEA-HS, CMOS-MEA-HS, MEA2100-Beta-Screen-HS, W2100-HS and ME2100-HS. The modular 2100 amplifier solution suite design makes it easy to modify your lab equipment generally with modest hardware upgrade investments.

### Front Panel



From left to the right:

### Sync Out / In

Two or more interface boards IFB-C can be daisy-chained by use of the SYNC Out / SYNC In connectors. All daisy-chained interface boards run on the same clock – to allow perfectly synchronized recordings in large settings.

### Analog Channels

Up to eight Analog In channels are available via 10-pin connector. Please read chapter “10-Pin Connector for Analog IN” in the Appendix for more information about the pin layout. The additional analog inputs are intended for recording additional information from external devices, for example, for recording patch clamp in parallel to the MEA recording.

### Analog Channels 1 and 2

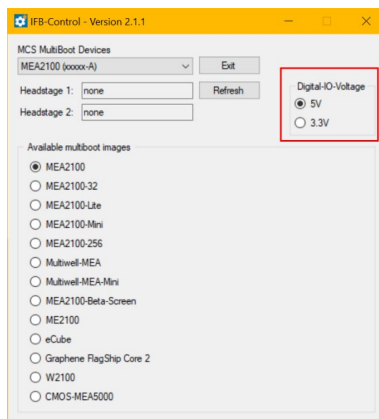
Two of these eight analog channels (Analog In No 1 and No 2) are separately available via Lemo connectors on the front panel of the interface board IFB-C.

### Two Status LEDs

The status LEDs indicate the link status of the headstages HS 1 and / or HS 2. They light up when one or both headstage is connected to the IFB-C interface board via iX-industrial cable, type B.

### Digital In / Out

A Digital IN / OUT for 16 digital in- and output bits is available (Honda-PCS-XE68LFD) on the rear panel of the interface board. On the front panel four Digital IN and four Digital OUT bits are also accessible via Lemo connector (DIG IN bit 0 to bit 3 and DIG OUT bit 0 to bit 3). The Digital OUT delivers TTL pulses with 3.3 V or 5 V. The voltage can be switched between these two levels with the software IFB-Control, please read chapter “IFB-Control” in the Appendix.



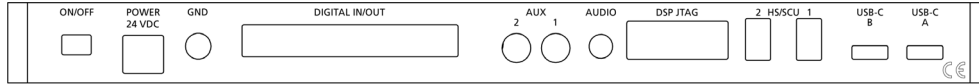
# HARDWARE COMPONENTS

If access to more bits of the DIG IN / OUT channel is required, it is necessary to connect a Digital IN / OUT extension [Di/o board](#) with a 68-pin standard cable. This Di/o board is available as an optional accessory.

## Ground

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

## Rear Panel



From left to the right:

## Toggle Switch On / Off

Toggle switch for turning the device on and off. The MEA2100-System is switched to status "ON" when the toggle switch is switched to the left. The device is switched "OFF" when the toggle switch is switched to the right. If the MEA2100-System is "ON", and the device is connected to the power line, the Power LED on the front panel of the interface board should light up. If not, please check the power source and cabling.

## Power 24 VDC

Connect the power supply unit here. This power supply powers both, the interface board IFB-C and the headstage of the MEA2100-System. The device needs 24 V and 2.5 A / 60 W.

## Ground

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

## Digital IN / OUT

A Digital IN / OUT for 16 digital in- and output bits is available via 68-pin Honda-PCS-XE68LFD connector. Please read chapter [Digital IN / OUT Connector](#) in the Appendix for more information about the pin layout of the connector. The Digital IN / OUT connection accepts or generates standard TTL signals. The Digital OUT delivers TTL pulses with 3.3 V or 5 V. The voltage can be switched between these two levels with the software IFB-Control, please read chapter "IFB-Control" in the Appendix.

TTL stands for Transistor-Transistor Logic. A TTL pulse is defined as a digital signal for communication between two devices. A voltage between 0 V and 0.8 V is considered as a logical state of 0 (LOW), and a voltage between 2 V and 5 V means 1 (HIGH). The Digital OUT allows generating a digital signal with up to 16 bits and read it out, for example, by using a Digital IN / OUT extension Di/o board. You can utilize this digital signal to control and synchronize other devices with the MEA2100-System.

Bit 0 to 3 of the Digital OUT are separated and available as Lemo connector DIG OUT 0 to 3 on the front panel of the interface board. So, the [Di/o extension](#) is only necessary if more than four trigger inputs or outputs are needed. 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. The 16 bit digital input channels is a stream of 16 bit values. The state of each bit (0 to 15) can be controlled separately. Standard TTL signals are accepted as input signals on the digital inputs.



**Warning:** A voltage that is higher than +3.3 Volts or +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 3.3 V or 5 V) to the digital inputs.

## Auxiliary Channels

Two reserve auxiliary channels are available for future use. They have no function at the moment. It is possible to use them in conjunction with the Digital Signal Processor DSP for real-time feedback, please read chapter "Digital Signal Processor" below.

## Audio OUT

To the Audio Out (3.5 mm phone jack) you can connect an audio system to make one or two of the electrode channels audible. This audio output is real-time. Headphones or speakers can be connected directly to the AUDIO OUT. Select the audible channels via software. Only two channels at a time can be converted into sound (Stereo).

## JTAG Connector

The JTAG connector has access to the digital signal processor DSP for real-time feedback. Please read chapter "Digital Signal Processor" below.

## HS / SCU

Sockets for connecting up to two signal collector units SCU via iX-industrial cable(s), type B.

## USB-C Connectors B and A

Both USB-C connectors are used to transfer the amplified and digitized data from all data channels and the additional digital and analog channels to any connected data acquisition computer via USB-C cable. Connector A corresponds with connector iX input 1, and connector B with iX input 2. If both iX inputs are used, also both USB-C connections must be used. Both USB cables must be connected to different USB-C ports of the computer, do not use an USB hub! Only use high grade USB-C cables, as provided with the MEA2100-System.

## Digital Signal Processor

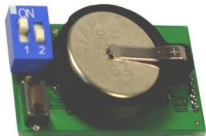
The IFB-C Multiboot interface board of the W2100-System is equipped with a high-capacity digital signal processor DSP. The DSP allows online access to the data in real-time. Filtering, spike detection, and generation of feedback stimulation can be controlled by the data acquisition software.

Additionally, the processor is freely programmable to offer the advanced user more complex online analysis features. It can be programmed in C using the Code Composer Studio Development Environment from Texas Instruments. Simlink from Mathworks can also be used to create the model which will run on the DSP. The DSP has full access to the data stream from all electrodes in real-time and can analyze the data. It also can access the stimulation unit together with the blanking switches inside the stimulation unit of the W2100-System. This allows creating closed loop experiments with sub millisecond delays. The processed data from the DSP can be streamed to the PC using a dedicated USB-C connection.

## Accessories

Default accessories of the Wireless2100-System are the signal generator, the remote control to reactivate the headstage, and the USB charger for the battery.

## ME/W-Signal Generator

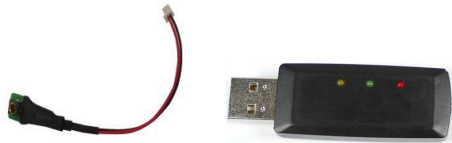


The ME/W-System Signal Generator can generate a number of pre-defined sine waves and artificial biological waveforms and feed it into all types of headstages. With those artificial signals it is possible to test the functionality of the complete system without the need to use an actual animal. Please read the ME/W-SG datasheet in the "Appendix" for connecting and operating the ME/W-Signal Generator.

# HARDWARE COMPONENTS

## Charging the Battery

The charging set for the battery works via any USB connector. To recharge the battery, please connect the charging set to an USB port of the computer and plug the battery into the back of the charger with the provided adapter cable W2100-C-B-Ch. The regular charger Wireless-C-HC is used for batteries with 100, 200 or 300 mAh. The charger Wireless-C-LC is used for the 30 mAh battery only.



W2100-Charging Set

**Important: Charging the 30 mAh battery with the wrong charger can lead to severe damage and even fire! Do not recharge batteries without supervision!**

Use the W2100-C charging device for storage batteries with low capacity (W2100-B-30mAh-CA / -BB) and high capacity (W2100-B-100mAh-CA / -BB or higher) for the W2100-System. Fix the batteries with battery board directly on the charger via connector. The W2100-C charging device provides two types of battery connectors, one for storage batteries with high capacity W2100-B-100 / -200 / -300 mAh and one for storage batteries with low capacity W2100-B-30 mAh.

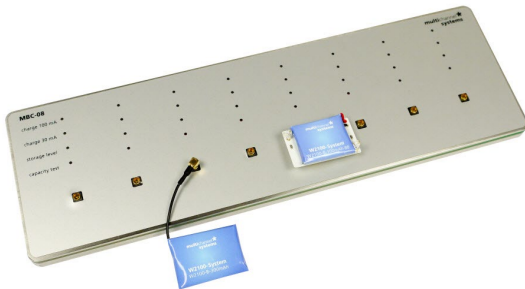


W2100-C Charging Device

**Important: Do not mistake the connectors! It will reduce the lifetime of the batteries with low capacity.**

The red LED on top indicates that the device is on. The yellow LED indicates that the battery is being recharged. After approximately one hour the green LED indicates the end of process.

## Multi Battery Charger MBC-08



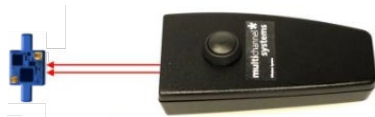
The Multi Battery Charger MBC-08 with Software Control or as stand-alone device can be used to control the charging of up to eight W2100 batteries to full charge or storage level (70 %) and to run a capacity test. The MBC-08 provides eight ports for controlling and charging batteries via LED display. It is suitable for all W2100 batteries up to 300 mAh. Operate the Multi Battery Charger connected to computer with the Multi Battery Charger software or connected to an external power unit in stand-alone mode.

## Remote Control

The headstages can be switched off with a wireless software command. To reactivate the headstage, it is either necessary to disconnect and reconnect the battery, or to turn it back on with the remote infrared remote control Wireless-F. Just point the remote control at the headstage and press the button.

You need to aim at the receiving LEDs next to the battery connector with a distance of 5 to 10 cm.

**Important: Please pay attention to the orientation of the flasher as the infrared beam has to meet the receiver LEDs on the headstage directly!**



## SYSTEM SETUP

### Connecting the Hardware Components

- Place the receiver within transmission range of your experimental setup. To get optimal results, keep the distance as short as possible.
- Place the interface board not further than 2 m away from the receiver and connect the two devices with the iX-industrial cable.
- Connect the power supply to the interface board.
- Connect the interface board with a USB 3.0 port of a computer where Multi Channel Experimenter and / or MC\_Rack is already installed. Avoid USB 2.0 ports (USB 3.0 ports are blue). Do not use USB hubs.
- Switch on the Wireless2100-System on the rear panel of the interface board. LEDs on the interface board and the receiver should light up.
- Connect a charged battery to a headstage.

### Software Installation

The following chapters describe how to set up the hardware and the data acquisition software "Multi Channel Experimenter" or "MC\_Rack" and how to test the functionality of the Wireless2100-System.

### System Requirements

Software: One of the following Microsoft Windows<sup>®</sup> operating systems is required: Windows 10, 8.1 (64 bit) with NT file system. English and German versions are supported, other language versions may lead to software errors.

### Recommended Operating System Settings

The following automatic services of the Windows operating system interfere with the data storage on the hard disk and can lead to severe performance limits in data acquisition software. These routines were designed for use on office computers, but are not very useful for a data acquisition computer.

- Turn off automatic Windows Update.
- Deselect Windows Indexing Service for all local disks.
- Turn off Optimize hard disk when idle (automatic disk fragmentation).
- It is also not recommended to run any applications in the background when using Multi Channel Experimenter or MC\_Rack. Remove all applications from the Autostart folder.
- Be careful when using a Virus Scanner. These programs are known to disturb Multi Channel Experimenter or MC\_Rack, and even data loss may occur.

When using a Wireless2100-System it is recommended to connect a high performance computer with a separate hard disc for program files and data storage. The provided possibility to make long term experiments with a sample rate of up to 40 kHz needs high memory capacity. Please remove data and defragment the hard disc regularly to ensure optimal performance.

### Installation

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.**

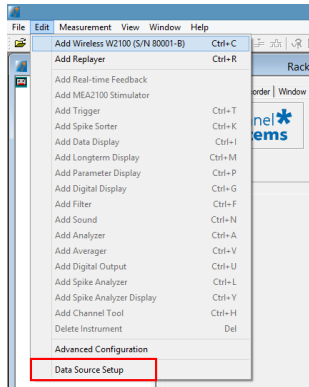
Double click Setup.exe on the installation volume. The installation assistant will show up and guide you through the installation procedure. Please follow the instructions of the installation assistant.

The Wireless2100-System driver and Multi Channel Experimenter and / or MC\_Rack are installed (or updated) automatically. Multi Channel Experimenter and / or MC\_Rack are updated on a regular basis. Please check the "Download" section of the MCS web site to get the latest version for free <http://www.multichannelsystems.com/software>.

## SOFTWARE MC\_RACK

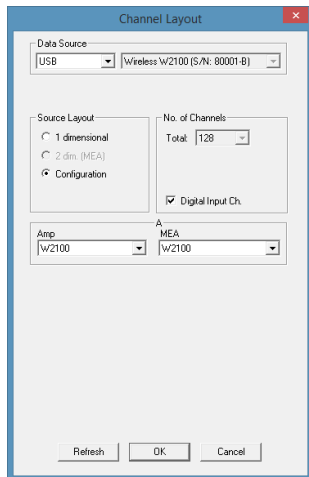


Start MC\_Rack. Please read the MC\_Rack manual for detailed information of general functions of the program. To define the Wireless2100-System as data source, please open the "Data Source Setup" in the "Edit" menu.



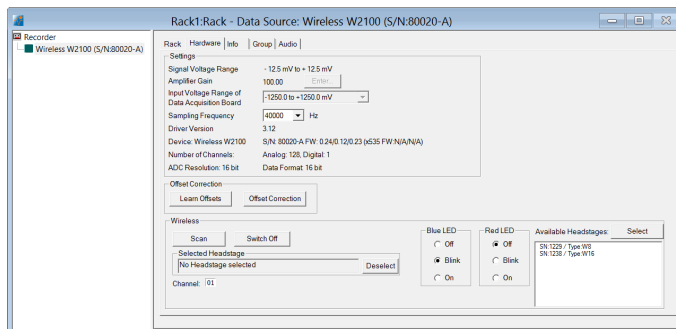
The "Channel Layout" dialog opens.

Select "USB" in the left "Data Source" drop down menu. The "Wireless W2100" is automatically selected. Click "Configuration" in "Source Layout".



Enable the check box "Digital Input Channel" if you want to display external TTL signals, fed into the W2100-System via Lemo connectors on the interface board. Deselect the check box, if you do not need additional digital channels.

Add the "Wireless W2100-System" via "Edit" menu to the virtual rack. Click "Hardware" tab.



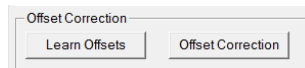


## “Settings” Window of Hardware Tab

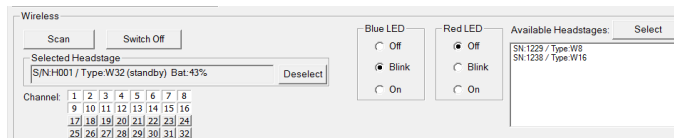
Most of the settings are predefined. Click the “Sampling Frequency” drop down menu and select the desired sampling rate. The sampling rate depends on the type of the headstage and the number of channels in use. In the example on the upper screenshot an 8-channel type headstage is selected. When recording with all eight available channels the sampling rate is limited to 25 kHz. Recording with one to four channels only is possible with a sampling frequency of up to 40 kHz.

## “Offset Correction” Window of the Hardware Tab

The “Offset Correction” can be used to correct for offsets caused by the connected electrode. The “Learn Offset” button detects the difference to 0 on all channels individually. Activating the "Offset Correction" function will subtract those differences from all incoming data to correct the offset.



## „Wireless” Window of Hardware Tab



The additional “Wireless” control panel is an extension of the hardware tab, which is only visible if a W2100-System is connected.

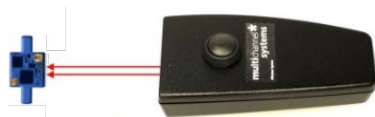
Click button "Scan" to see all available headstages. Headstages are only available for the system if the battery is connected, if they are within transmitting range, and have not been switched off previously by software command.

On the right side the "Available Headstages" are listed with type and serial number. Highlight the desired headstage and click “Select”. The headstage will now be displayed in the "Selected Headstage" window. The serial number, the type and the status of the battery charging is displayed. Deselect the headstage by clicking the button "Deselect". The LEDs on the selected headstage will blink, if they have not been switched off. In the example above the blue LED is in “Blink” mode, the red LED is off.

On the “Channel” list, any combination of channels can be selected for recording. On the screenshot above, the first 16 channels of the headstage are selected. Deactivation of channels reduces energy consumption of the headstage and might allow higher sampling rates.

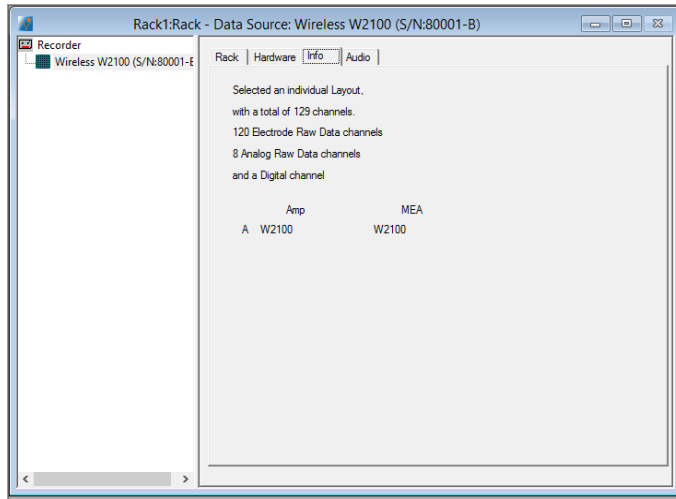
A selected headstage which is not recording is in standby mode, where it uses about 10 % energy compared to active recording. To shut it down completely, use the “Switch Off” button. A headstage which has been switched off will no longer show up in a scan. To reactivate it, you need to shortly disconnect the battery, or use the infrared “IR-Remote Control”. Aim at the headstage from 5 to 10 cm distance.

**Important: Please pay attention to the orientation of the flasher as the infrared beam has to meet the receiver LEDs on the headstage directly!**



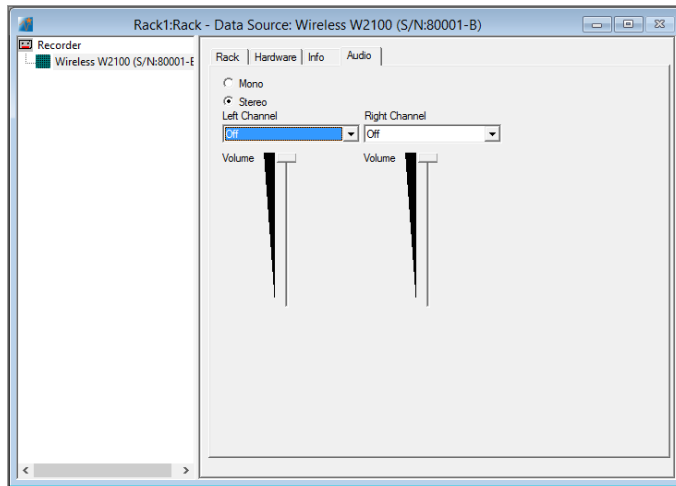
The LEDs can be used for motion tracking and / or as status indicator of the headstage. They can be set to “On”, “Off” or “Blink”. LEDs set to “On” will be on all the time on a selected headstage, regardless of the recording status. If they are set to blink, they will blink slowly in standby mode and faster while the headstage is acquiring data.

Click the "Info" tab of the dialog.



In this tab "Infos" about the connected Wireless2100-System are listed.

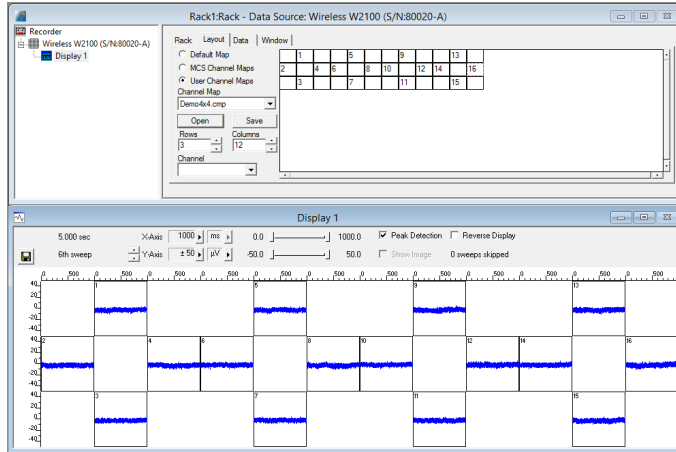
Click the "Audio" tab of the dialog.



On the interface board of the Wireless2100-System you can connect an audio system "Audio OUT" (3.5 mm phone jack) to make the electrical activity audible. This audio output is real-time. Headphones or a speaker can be connected directly to the Audio OUT. Only two channels at a time can be converted into sound. Select one "Mono" or two "Stereo" channels, switch the audio channels on and off and adjust the sound volume via the sliders.

## Data Display

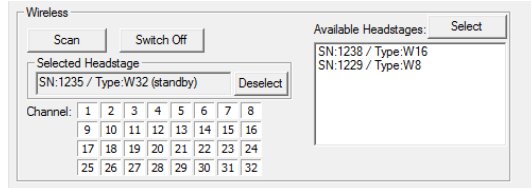
Add a data display to the rack. By default, the available channels will be displayed in numeric order. To design a display layout which resembles the layout of a specific electrode, select the "Layout" tab of the display. You can design a grid with a number of rows and columns of your choice. Each electrode channel can be assigned to any position. Once created, this configuration can be saved as user channel map ("\*.cmp" file) for future use. See below a layout for an electrode with four shanks, with four electrodes each.



## Operating multiple Headstages

It is possible to operate different headstages connected to one Wireless2100-System. The headstages are discriminated via frequency band for the radio communication. Each headstage is labeled by the type (W16) and the serial number (S/N 1230). Please see the bill of delivery for the assignment of the headstage and the frequency band.

## Sequential Recording

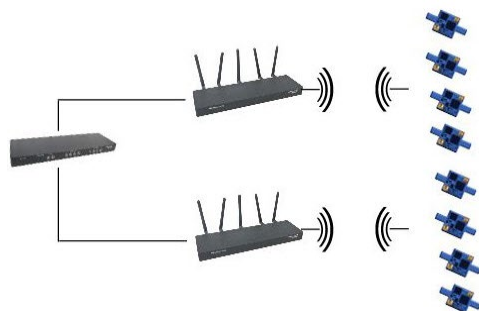


After pressing the button "Scan" the receiver scans for available headstages in range. Then the user is able to select the desired headstage. Click on one of the headstages in the "Available Headstages" window and press the button "Select".

After recording from the first headstage, deselect the headstage by clicking the button "Deselect". Now you can choose a different headstage and repeat the process. For sequential recording, the full sampling rate for the respective headstage type is available.

## Parallel Recordings

Operating multiple Wireless2100-Headstages in parallel with one computer is still under development. It will be possible to run two receivers connected to one interface board, each recording from up to four headstages in simultaneously.

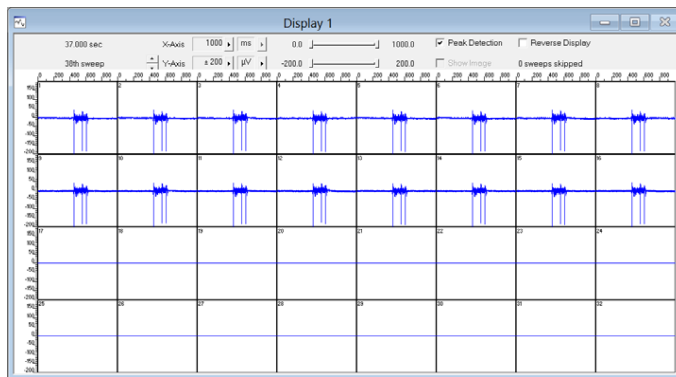


To control the different recordings independently, start one instances of MC\_Rack for each headstage. In "Data Source Setup" assign the Wireless2100 receivers via serial number to the instances of MC\_Rack. With a maximum of eight instances, it is possible to select a different headstage in each MC\_Rack instance and control the recording independently. Already selected headstages become invisible for other scanning receivers. When doing parallel recordings, the sampling rate is limited to 2 kHz.

## First functional Tests

Set up the Wireless2100 hard- and software as described above. Make sure all components are connected and the Wireless2100-System is switched on at the interface board. Connect a charged battery and the ME/W-Signal Generator to your headstage. See the ME/W-Signal generator datasheet in the Appendix for details on connector and orientation.

Open the MC\_Rack software and build a rack with a Wireless2100 data source and a data display as described above. At the signal generator, select the signal type "Spikes". You should see a noise level of about 20  $\mu\text{V}$  (peak to peak) and a signal amplitude for the largest spikes of 360  $\mu\text{V}$ .



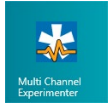
## SOFTWARE MULTI CHANNEL EXPERIMENTER

The Multi Channel Suite software, which is needed to operate the MEA2100-Mini-System, is provided on a CD with the system. However, the latest version is always available for free download from the MCS web site. Please check for updates on a regular basis to get all the latest features and bugfixes. The Multi Channel Suite consists of three individual programs:

The Multi Channel Experimenter is the online data acquisition software.

The Multi Channel Analyzer is for offline analysis of data generated with the Multi Channel Experimenter.

The Multi Channel DataManager allows to export Multi Channel Experimenter data to 3rd party file formats.



Start the Multi Channel Experimenter software. Please read the Multi Channel Experimenter manual for detailed information of general functions of the program. Please read additionally chapter "Operating the Multi Channel Experimenter Software" in this manual. Please also see the [movie](#) for illustration.

### Data Source W2100-System

Connect the W2100-System to the data acquisition computer. The "W2100" is integrated as a data source in the main window of the Multi Channel Experimenter.

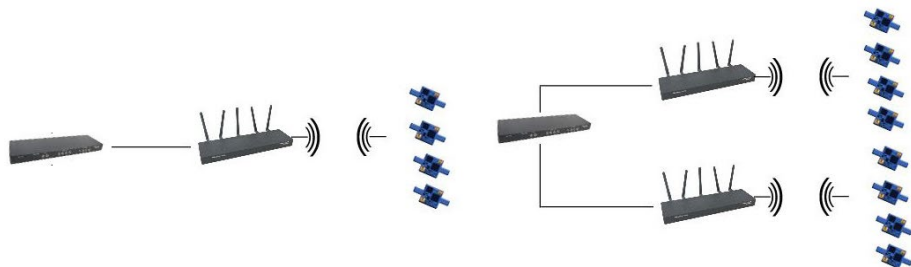
Before using the W2100 as a data source, you have to decide in which mode you start the software: Use the W2100-System in "Single Headstage Mode" or in "Multi Headstage Mode".

### Single Headstage Mode



The advantage of the "Single Headstage Mode" is the high sample rate of up to 40 kHz, when recording with one headstage only. It is possible to connect one or two receivers with one headstage each to the interface board in "Single Headstage Mode". Please open two instances of the Multi Channel Experimenter to record from two receivers connected to one headstage respectively independent from each other.

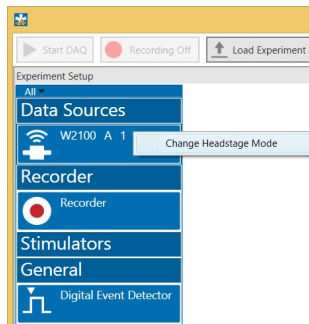
### Multi Headstage Mode



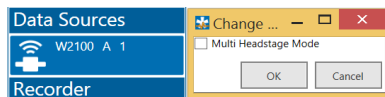
The advantage of the "Multi Headstage Mode" is the possibility of parallel recording of up to four headstages, connected to one receiver. For parallel recording from up to eight headstages connected to two receivers and one interface board of a W2100-System, you have to open two instances of the Multi Channel Experimenter to record from four headstages connected to the first receiver independent from the other four headstages connected to the second receiver. The sampling rate is reduced.

**Important:** Choose the recording mode before you start building a rack!

To select the recording mode, please click on the W2100 icon with the right mouse button. The "Change Headstage Mode" option appears.



The "Change Headstage Mode" dialog appears.



For "Multi Headstage Mode", enable the check box and confirm the selection with "OK". For "Single Headstage Mode" disable the check box.

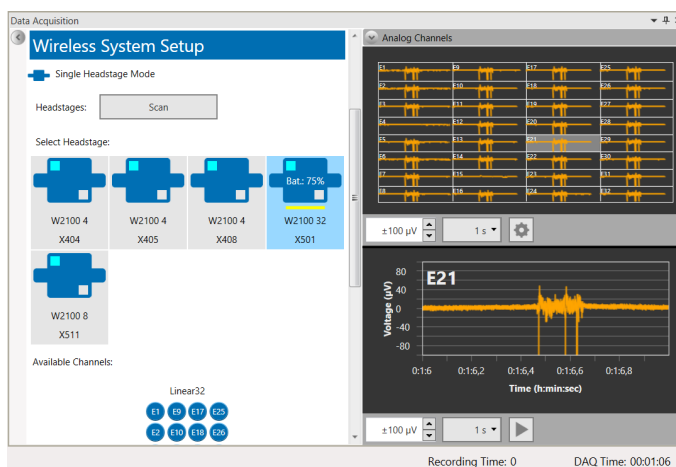
After mode selection, please go on using the Multi Channel Experimenter software as usual. Please read chapter "Operating the Multi Channel Experimenter Software" below. Move the W2100 icon via drag and drop to the right part of the main window.




The W2100-System has five output ports. Electrode Raw Data (blue), Analog Data (green), Digital Data (red) are present and active in all headstages. Headstages of the latest generation also have Gyroscope Data (light brown) and Accelerometer Data (dark brown). The brown ports are always visible, but contain no data in older headstages. As with all data sources, there are no input ports. The W2100-System can be connected directly with any number of other instruments with blue or red input ports. The green and brown ports can only be connected to the Recorder at the moment. There are no export options.

## Single Headstage Mode

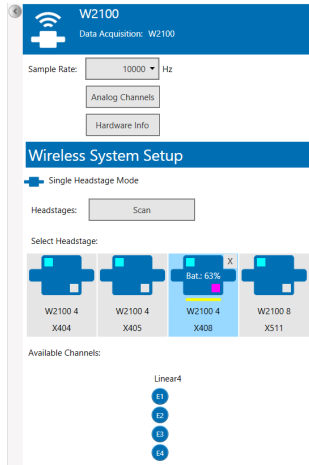
Double click the W2100 icon to open the tabbed page "Data Acquisition".



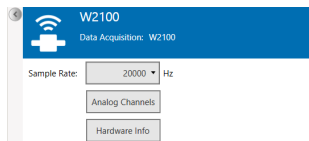
The dialog is divided in two major sections: Use the left "Control" section for the "W2100-System" hardware configuration settings. On the right "Data Display" section the available electrode data stream displays are listed: The 32 raw data channels of the W2100-HS32 headstage in overview above and the single view of one channel selected from the raw data channels below.

Additionally, you can show the auxiliary analog channels by clicking the small button  in the upper left edge of the data display section.

## Control Section



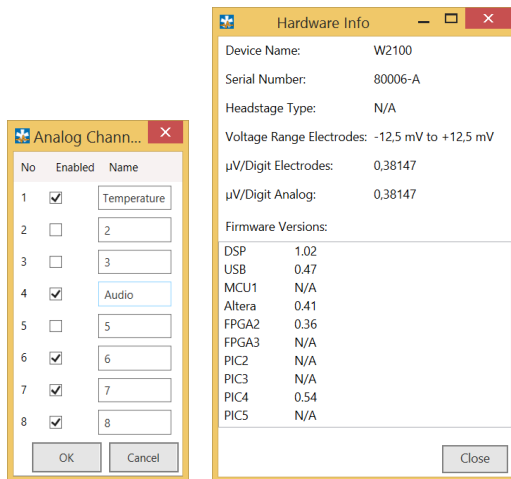
## W2100 Data Acquisition



Select the "Sampling Rate" in Hz via drop down box. Depending on the number of channels in use it is possible to sample with a rate of up to 40000 Hz.

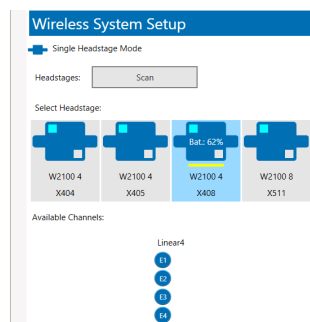
**Important: Please keep in mind that the hardware low pass filter on most of our W2100 headstages are set to 5 kHz, please refer to the datasheet of the headstage in use. If you sample at a lower frequency than 10 kHz you risk aliasing.**

Click the "Analog Channels" button. Select the needed channels "No" 1 to 8 via check box "Enable". Type in a "Name" for the analog channel, if necessary.



Click the "Hardware Info" button for information about the W2100-System.

## Wireless System Setup



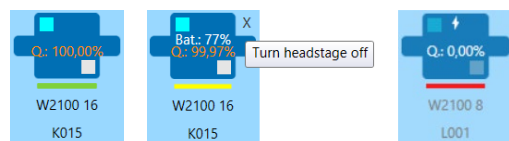
The "Single Headstage Mode" icon indicates the currently used recording mode.

### Single Headstage Mode

"Headstages:" Press "Scan" button to find the additional headstages, for example, after changing an experimental configuration or to reselect all channels of the currently used headstage after deselecting some of them.

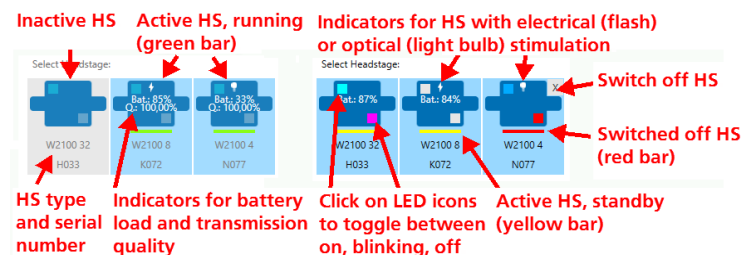
"Select Headstage:" All headstages available in the range of the receiver are displayed. The headstages must be in standby modus that means, all headstages which are not in sleep mode.

Read the type of the headstage and the serial number. Click on one of the headstages to select the device. The selected headstage is highlighted in blue and the battery status is displayed. After recording the quality of the headstage to receiver transmission in percent is displayed in red letters. In this mode it is not possible to select more than one headstage. To change your selection, please deactivate the currently used headstage first before selecting another one.



## Available Headstages

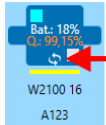
After scanning, all available headstages are displayed as icons. To select a headstage for recording, simply click on it. The headstage icons contain status information about each headstage. Grey outlined headstages are inactive (not selected), selected headstages are outlined in blue. Each icon displays type and serial number, and battery status (if active). A bar indicates whether the headstage is actively acquiring data (green), in standby (yellow) or switched off (red). Lost contact to the receiver is indicated by a purple bar.



Headstages with electrical or optical stimulation capability show a flash or light bulb icon, respectively. The two LEDs (red and blue) on the headstage have also individual indicators on the icon. Clicking on the indicator will switch each LED between on, blinking and off. The indicator colors are:

<b>Red LED</b>	<b>ON</b>	<b>OFF</b>	<b>Blinking</b>
<b>Blue LED</b>	grey	red	purple
	grey	blue	cyan





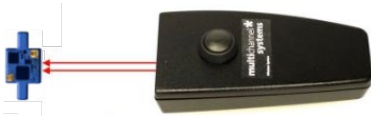
The circle arrow icon indicates a headstage of the latest generation with gyroscope and accelerometer

The LEDs can be used for motion tracking and / or as status indicator of the headstage. For video tracking, please switch on the second LED on the headstage. Click one time to switch on the LED in blinking mode, indicated in purple color, click twice for permanent mode, indicated in red color. LEDs set to permanent mode will be "On" all the time, regardless of the recording status of the headstage. If they are set to blink, they will blink slowly in standby mode and faster while the headstage is acquiring data.

The status bar of an available headstage is green. An available headstage which is not selected is in standby mode, where it uses about 10 % energy compared to active recording. This mode is indicated via yellow status bar. To shut it down completely, please click in the upper right edge of the headstage icon. A cross appears. Turn the headstage off, the status bar is red. A headstage which has been switched off is in "Sleep" mode and will no longer show up in a scan.

To reactivate it, you need to shortly disconnect the battery, or use the infrared "IR-Remote Control" flasher. Aim at the headstage from about 4 cm distance.

**Important: Please pay attention to the orientation of the flasher as the infrared beam has to meet the receiver LEDs on the headstage directly!**

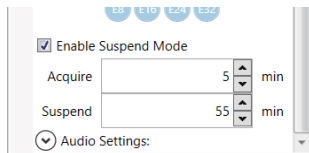


"Available Channels:" Click onto a channel to deselect it, double click to select it again. Unused channels appear in grey.



## Suspend Mode

This feature is available in "Single - or Multi Headstage Mode" and is useful to reduce the amount of data and to save battery capacity in long term experiments. "Enable Suspend Mode" via check box.

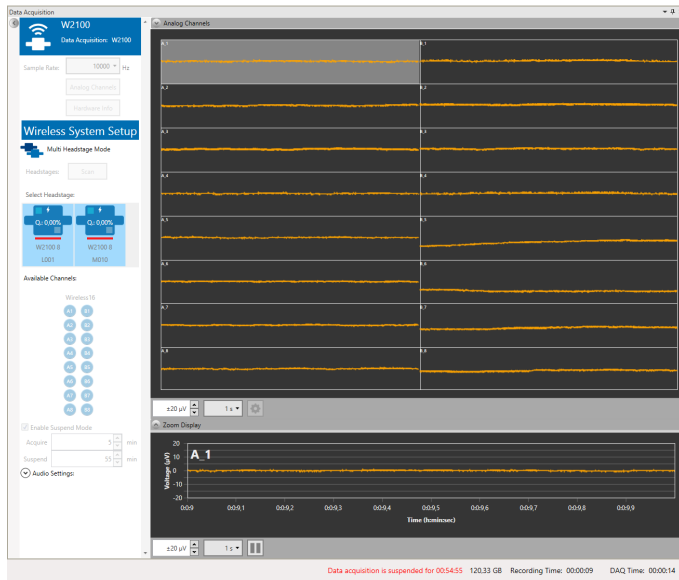


Define the time span for data recording in minutes from the "Acquire" drop-down box. Define the time span for data suspend in minutes from the "Suspend" drop-down box. Both modes alternate during the complete experiment. If more than one headstage is used in the "Multi Headstage Mode" all headstages are programmed in parallel. For each recording in the "Acquire" phase a separate raw data file will be created, well defined by the respective time stamp in the file name.

In the "Suspend" phase the headstage waits in "Sleeping Mode" until it is aroused for the recording in the "Acquire" phase. "Sleeping" means in this case: No recording is possible, of course the LEDs are not blinking, and the battery saves energy. The recorder changes to "Standby" mode



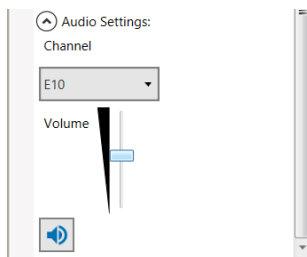
that allows starting to record data again at any time. The "sleeping" headstage is marked by a red bar.




The start of the recording in the "Acquire" phase is announced via countdown in red letters in the footer. Additionally, the LED of the headstage starts blinking and the system is warmed up for recording.

If during the "Suspend" phase the animal is moving out of the range of the receiver or the battery of the headstage is unplugged for a short time, the software will bridge the gap and the headstage "sleeps" again until it is "waked up" for recording.

## Audio Settings

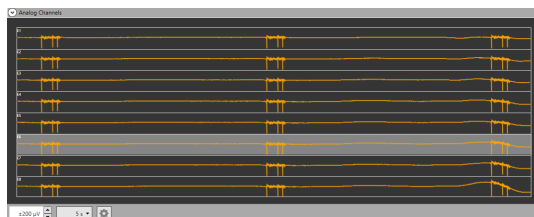


Click the "Audio Settings" button to expand the window. Select the electrode "Channel" you want to listen to from the drop-down menu and adjust the volume. Click the "Activate Audio" button  to start the audio recording.

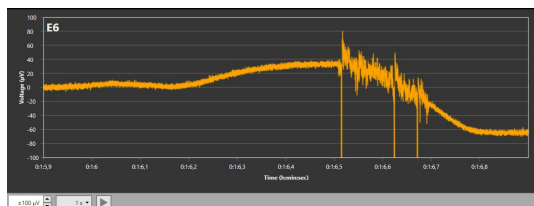
## Data Display Section

The W2100-System data source control window shows all available headstages. All channels of all active headstages can be displayed, and optionally also the additional Analog Input channels from the Interface Board. The "Scan" function will screen for available headstages in range, and display them as icons. The additional functions, "Audio", "Suspend Mode" and "Video Synchronization" can be toggled. In "Multi Headstage Mode", a drop down menu with all active headstages allows to select the active headstage to be displayed. This has no influence on recording, all active channels from all active headstages will be recorded, independently from the display.

The overview of all available channels is displayed above. In this example a W2100-HS8 headstage is recording data. Jump between the channels without stopping the experiment. Select one of the channels to have a closer look in the single channel view below the overview. The selected channel is highlighted in grey. Use the up-down and drop-down boxes for scaling the x- and y- axes.



See the selected channel in the single view. The number of the channel is displayed in the upper left edge. Use the up-down boxes for scaling the x- and y-axes.




Stopping the single view display saves computer performance, the recording of data is independent from the display and goes on continuously.

## Multi Headstage Mode

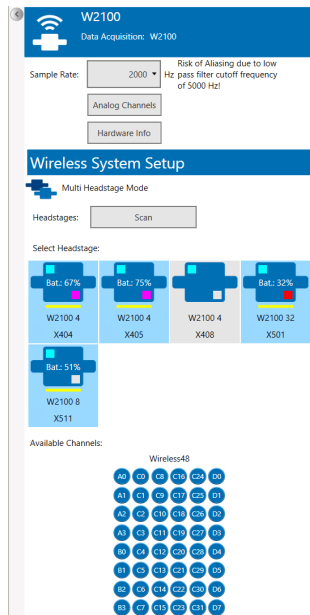
For changing the recording mode, please read the respective information above. Double click the W2100 icon to open the tabbed page "Data Acquisition".

Headstage	Channel	Channel	Channel	Channel	Channel
A.0	C.0	C.8	C.16	C.24	D.0
A.1	C.1	C.9	C.17	C.25	D.1
A.2	C.2	C.10	C.18	C.26	D.2
A.3	C.3	C.11	C.19	C.27	D.3
B.0	C.4	C.12	C.20	C.28	D.4
B.1	C.5	C.13	C.21	C.29	D.5
B.2	C.6	C.14	C.22	C.30	D.6
B.3	C.7	C.15	C.23	C.31	D.7

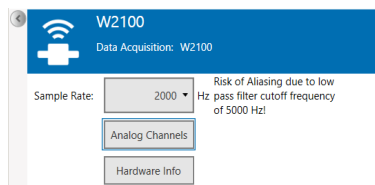
This dialog is analogous build: Use the left "Control" section for the "W2100-System" hardware configuration settings. On the right "Data Display" section the available electrode data stream displays are listed: The 32 raw data channels of the W2100-HS32 headstage in overview above and the single view of one channel selected from the raw data channels below.

Additionally you can show the auxiliary analog channels by clicking the small button  in the upper left edge of the data display section.

## Control Section



## W2100 Data Acquisition



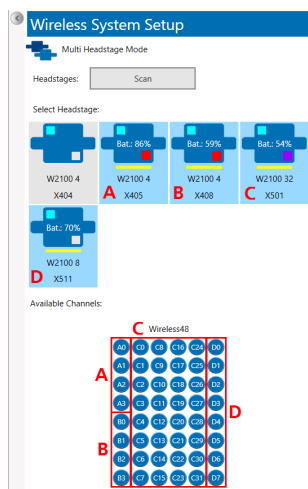
Select the "Sampling Rate" in Hz via drop-down box. Depending on the number of headstages in use it is possible to sample with a rate of up to 10000 Hz. The standard sampling frequency is 2000 Hz.

**Important: Please keep in mind that most of the sample rates are set to 2000 Hz when using more W2100 headstages in parallel. If you sample at a lower frequency than 10 kHz you risk aliasing.**

Click the "Analog Channels" button. Select the needed channels "No" 1 to 8 via check box "Enable". Type in a "Name" for the analog channel, if necessary. Please see the picture of the "Analog Channels" dialog above.

Click the "Hardware Info" button for information about the W2100-System. Please see the picture of the "Hardware Info" dialog above.

## Wireless System Setup



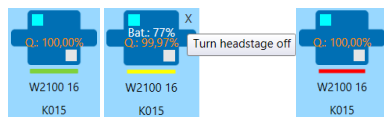
The "Multi Headstage Mode" icon indicates the currently used recording mode.



Press "Scan" button to find the additionally headstages, for example after changing an experimental configuration or to reselect all channels of the currently used headstage after deselecting some of them.

"Select Headstage:" All headstages available in the range of the receiver are displayed. Read the type of the headstage and the serial number. Click on one of the headstages to select the device. The selected headstage is highlighted in blue and the battery status is displayed. After recording the quality of the headstage-receiver transmission is displayed in red letters. In this mode it is possible to select up to four headstages. Multi Channel Experimenter will not accept to select a fifth headstage. To change your selection, please deactivate one of the currently used headstages first.

Independent from the position in the "Wireless System Setup" window, the selected headstages are labeled in sequence with "A", "B", "C", and "D". The letters are not written on the headstage icons, but you find the letters in the channel IDs, displayed in the "Available Channels" window under the headstages.

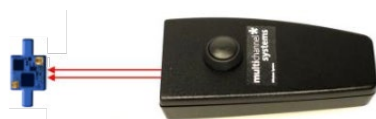


The LEDs can be used for motion tracking and / or as status indicator of the headstage. For video tracking, please switch on the second LED on the headstage. Click one time to switch on the LED in blinking mode, indicated in purple, click twice for permanent mode, indicated in red color. LEDs set to permanent mode will be "On" all the time, regardless of the recording status of the headstage. If they are set to blink, they will blink slowly in standby mode and faster while the headstage is acquiring data. The status bar of an available headstage is green. An available headstage which is not selected is in standby mode, where it uses about 10 % energy compared to active recording. This mode is indicated via yellow status bar.

To shut it down completely, please click in the upper right edge of the headstage icon. A cross appears. Turn the headstage off, the status bar is red. A headstage which has been switched off is in "Sleep" mode and will no longer show up in a scan.

To reactivate it, you need to shortly disconnect the battery, or use the infrared "IR-Remote Control" flasher. Aim at the headstage from about 4 cm distance.

**Important: Please pay attention to the orientation of the flasher as the infrared beam has to meet the receiver LEDs on the headstage directly!**



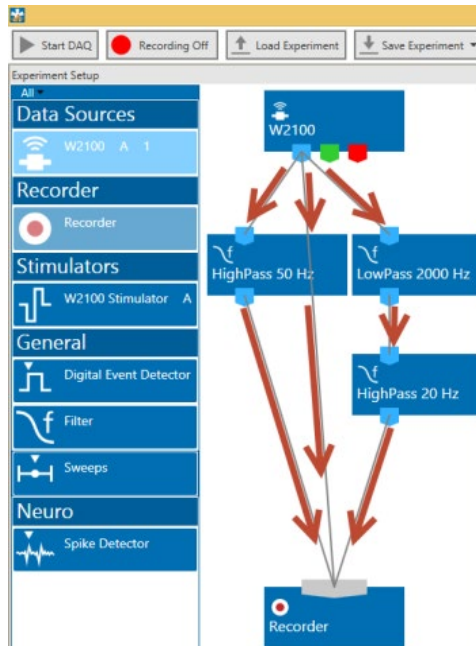
"Available Channels:" Click onto a channel to deselect it, double click to select it again. Unused channels appear in grey.

## Operating the Multi Channel Experimenter Software

### Building a Rack

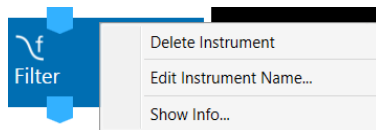
It is very easy to build a rack: Please click onto the button of the desired instrument and move it via drag and drop from the left to the right side of the main window!

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 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.

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 grey symbol input port of the recorder. The electrode raw data stream will flow from the filter to the recorder. The grey input port of the recorder accepts all types of input data streams and you can connect more than one data stream.



Clicking the button of any instrument with the right mouse provides three options: "Delete Instrument" for deleting the tool, "Edit Instrument Name" for changing the name and "Show Info" for information about the instrument. It is not possible to loop instruments.

Delete a connection between instruments by clicking with the right mouse on the connection path. The command "Delete Connection" appears.

Please read the Multi Channel Experimenter manual for detailed information about general functions of the different instruments. At the moment seven "General" features are available and one in "Neuro" mode: Stimulation, Filter, Digital Event Detector, Sweeps, Sweep Analyzer, Trigger Generator, Cross Channel Instrument and the Spike Detector. Use all features adapted to the Wireless2100-System.

### Video Synchronization

Please read also the manual "[Multi Channel VideoControl](#)".

Activate the Video Synchronization if you want to record a video together with the electrophysiological data with the Multi Channel VideoControl software. The selected frame rate must be identical to the frame rate of the video acquisition, which is selected in the VideoControl software.

This needs to be done manually, if Multi Channel Experimenter and VideoControl software are not connected. If "Enable Remote" function is active, the Experimenter and the VideoControl software communicate via a pipe connection. In that case, the "Frame Rate" control in the Experimenter is inactive and the "Frame Rate" selected in the VideoControl software will automatically be adjusted. Please see manual of Multi Channel VideoControl for details.

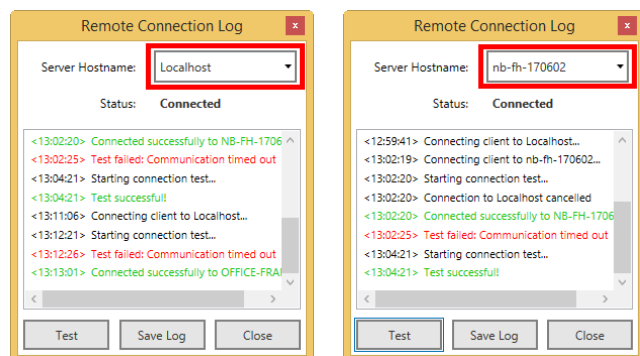
This works if both programs run on the same PC, but also if they run on different PCs which are in the same network. To enable a connection, both programs must be running on the respective PC(s).

By default, the Multi Channel Experimenter software will attempt to connect to a VideoControl instance running on the same PC (Localhost).

To connect to a different PC in the network, press the "Log" button in the Video Settings of the W2100 Data Source of the Experimenter and select a different Hostname from the drop down list or enter a new one.

The hostname of a PC is the computer name shown in the Windows Settings / System.

If the connection is established, press "Test" for a quick check. The hostnames with successful connections are stored by the Experimenter software in its "\*.ini" file and the last connected one will be used in the next session automatically.



If the connection is established, VideoControl remotely controls the "Video Frame Rate" setting, the base file name in the "Recorder" and whether "Video Sync" is enabled in the Multi Channel Experimenter. The Experimenter software sends the ID stored in the W2100 data file via this connection to VideoControl, so that the same ID can be stored in the VideoControl movie file. This ID identifies video files and recordings belonging together. Make sure the appropriate bits of the "Digital Out" channel are assigned to the "Video Sync" function.

### Known problems with pipe connections in Windows:

The windows firewall might interfere with the pipe connection. The connection uses UDP ports 137 and 139 and TCP port 445 for communication, so if these are blocked a connection to a remote PC might not work. More detailed info about pipe connections can be found [here](#).

### Analog Output DAC Range

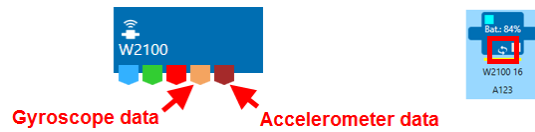
Receivers with the AO (Analog Out) option have the Analog Output DAC Range as additional setting. The  $\pm 12.4$  mV input range of the W2100 headstage can be converted to different output ranges on the digital output, depending on the input range of the connected 3rd party data acquisition:

The signal on the "AO output times" the "conversion factor", or divided by the "Gain setting", is the actual signal size.

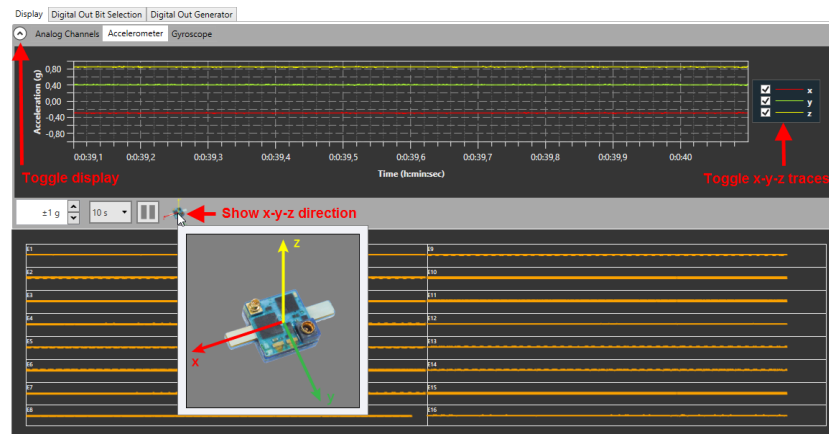
AO DAC Range	Conversion factor	Gain setting
$\pm 2.5$ V	0.00496	201
$\pm 5$ V	0.00248	403
$\pm 10$ V	0.00124	806

## Gyroscope and Accelerometer Data

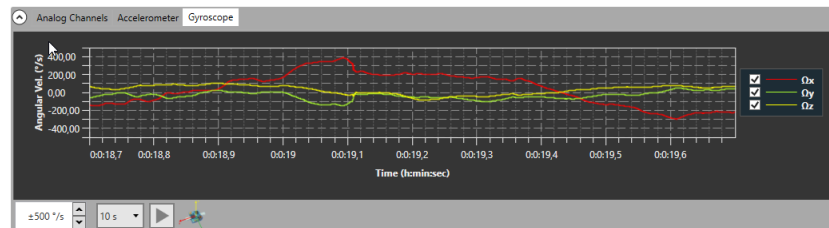
Headstages of the latest generation are equipped with sensors for rotation and acceleration, each in x-y-z-direction. Currently, this data can only be recorded and exported by the Multi Channel DataManager. These headstages show a circle arrow icon, and the W2100 data source ports in light brown and dark brown are usable.



If such a headstage is selected, toggle the display for auxiliary analog channels, which now contains also tabs for the "Accelerometer" and "Gyroscope" data. All three special directions are shown as individual traces, and can also be toggled individually. Acceleration is shown in g (gravity acceleration, 9.81 m/s<sup>2</sup>), rotation in degree per second (°/s).



Be aware that due to gravity, there is a constant acceleration of 1 g in downward direction. That means, if the headstage is held still and perfectly horizontal, the acceleration z value is 1, and x and y are 0. In all other positions, earth gravity is distributed between all three special directions. Any kind of movement causes fluctuations in acceleration and rotation.



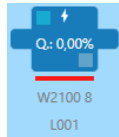


## Stimulation

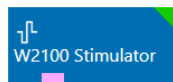
Please read the following chapter "Stimulation". The user has the possibility to work with optical stimulation beside electrical stimulation. This is exclusive for the W2100-System: The Optostimulation via LED.

### Electrical Stimulation

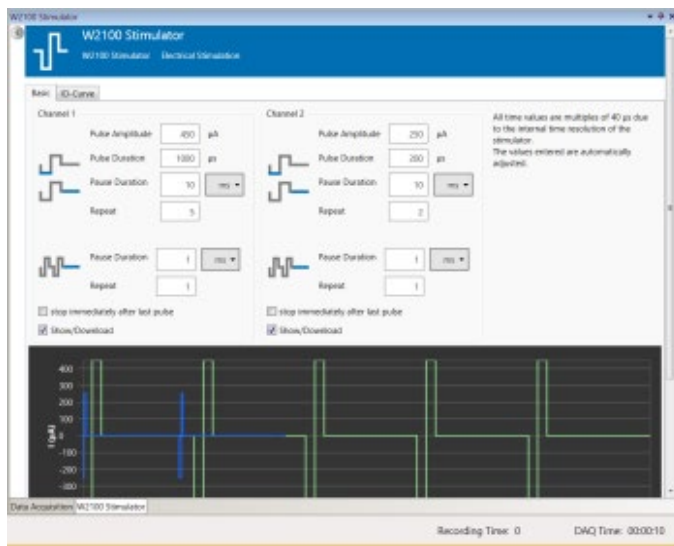
The W2100-System "Stimulator" instrument controls the optical or electrical stimulation outputs of W2100-System headstages with stimulation capabilities. Headstages equipped with the configuration for electrical stimulation are marked with a flash icon.



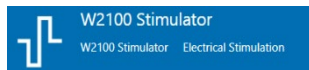
The Stimulator has a "Trigger" data port which produces trigger events marking start and stop of the stimulator and individual pulses. There are no export options.



Move the "W2100 Stimulator" from the left to the right side of the "Control" section. The stimulator is integrated in the data acquisition device and need not to be connected. Double click the icon to open the "W2100 Stimulator" window, consisting of two tabbed pages "Basic" and "IO-Curve".

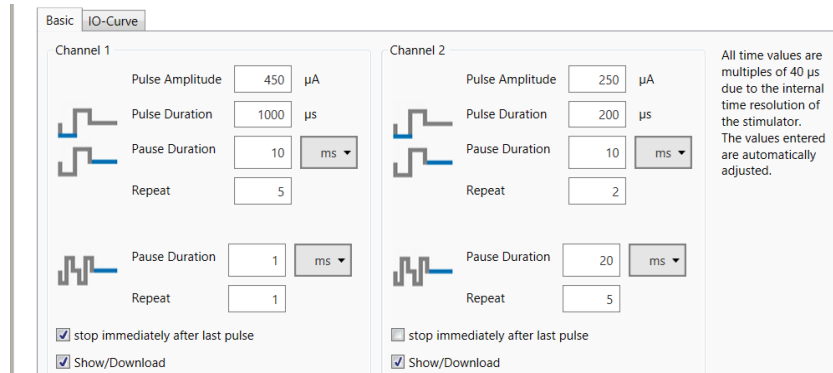


The header of the tabbed page informs about the kind of stimulation: Electrical or optical LED stimulation.



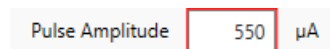
## Basic

Select the "Basic" tab to configure the stimulation pattern. Set up channel 1 independent from channel 2. Only rectangular current pulses are available. The default is negative phase first. With the "Invert Pulse" check box, this can be changed to positive or negative respectively. If identical but inverted pulses without time offset are programmed for both stimulation channels, this results in a bipolar stimulation.



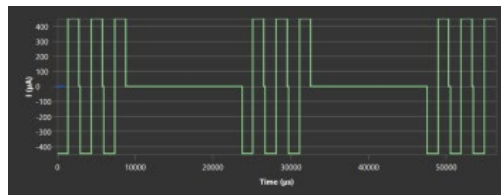
**Important:** All time values are multiple of 40 µs due to the internal time resolution of the stimulus generator. The values entered are automatically adjusted.

Define the "Pulse Amplitude" first. In headstages limited to 500 µA it is not possible to increase the current more than 500 µA. The red frame around the "Pulse Amplitude" window warns the user.

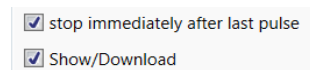


**Important:** Each rectangle stimulation pattern has to start with the negative part of the pulse (cathode). After the plateau the positive part follows (Anode).

Define the "Pulse Duration" in µs and the "Pause Duration". Use the drop-down box to define the unit for the time frame of the inter pulse interval. Give the number of repeats in the "Repeat" window, if necessary.



To schedule a complex pulse train, use the second window "Pause Duration" and "Repeat" the complete pulse pattern as often as necessary.



In the picture above the check box "stop immediately after last pulse" is active. The stimulus generator stops stimulation automatically after the last pulse was sent.

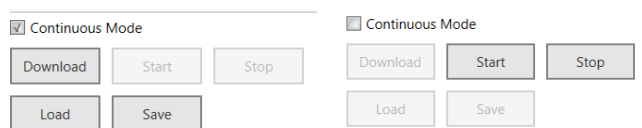
Click the "Show/Download" check box to download the stimulation pattern to the stimulus generator of the headstage. The pattern is shown in the display at once.

## Continuous Mode

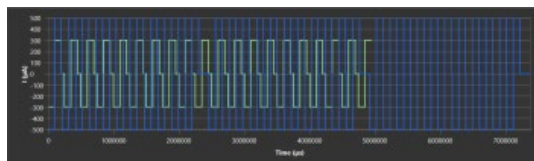
Below the display there is an additional toolbar. Select the check box "Continuous Mode" and "Download" the stimulus to the headstage. The stimulus generator will permanent sent the defined stimulation pattern to the headstage. If the pattern on channel 1, for example, is shorter than the pattern on channel 2, the repetition of the fist stimulus pattern starts earlier than the repetition of the second one, the stimulus generation will not wait until both patterns are processed.

Deselect the "Continuous Mode" and the defined pattern will be applied only one time. Or you can "Start" and "Stop" the stimulation manually by clicking the button. Each time you start the stimulus pattern, it will be applied one time. "Save" a stimulation pattern to "Load" it later again.

Note: The download of a stimulus is only possible if the data acquisition is stopped and the stimulation can only be started when the data acquisition is running.



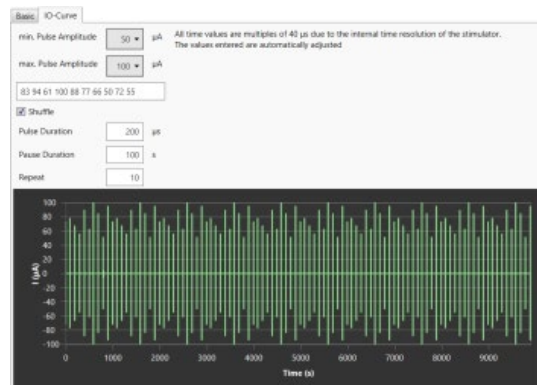
After scheduling the second stimulation pattern, the pattern are displayed color coded, channel 1 in green, channel 2 in blue color.



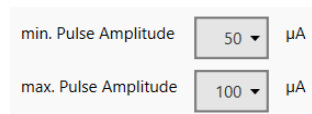
## IO-Curve

Select the "IO-Curve" tab. The aim of an "IO-Curve" analysis is to analyze the input / output (I/O) relationship of the biological response to the electrical stimulation.

The IO-Curve is displayed only once, but applied to all enabled channels with the user defined "Start Delay". For the IO-Curve, the highest and lowest value can be selected, and the software automatically calculates ten steps in between. These ten steps can be applied once, or repeatedly. Different stimulation amplitudes will be applied either linear, from lowest to highest value, or shuffled.



The upper part of the "IO-Curve" tab gives the option to run an IO-curve with 10 stimuli of increasing strength.



Define the "min. Pulse Amplitude" and the "max. Pulse Amplitude" in µA as corner points from the drop-down menus. In between 10 stimuli of increasing strength will be generated. The values are displayed in the window below.

Click the check box "Shuffle".

Shuffle

Pulse Duration   $\mu$ s

Pause Duration  s

Repeat

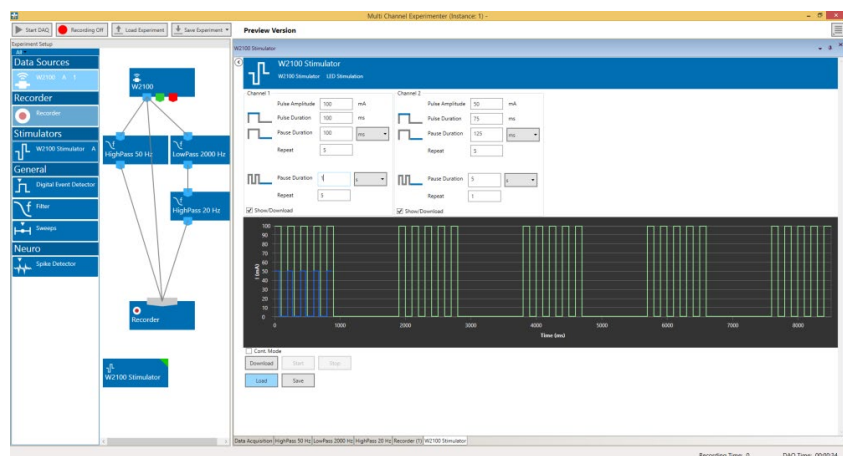
In this mode the stimuli are not ordered by size, but mixed and applied at random. Please define the "Pulse Duration" in  $\mu$ s and the "Pause Duration" in seconds. "Repeat" the pulses, if necessary. The values are displayed in the window above.

83 94 61 100 88 77 66 50 72 55

When using the "IO-Curve" feature the defined stimulus will be loaded to the stimulus generators as selected with the "Show / Download" check boxes on the "Base" tabbed page.

## Optostimulation

Beside the electrical stimulation one instrument is exclusive for the W2100-System: The Optostimulation via LED.



Move the "W2100 Stimulator" from the left to the right side of the "Control" section. The stimulator is integrated in the data acquisition device and need not to be connected. Double click the icon to open the "W2100 Stimulator" in a tabbed page. "LED Stimulation" is possible on two channels.

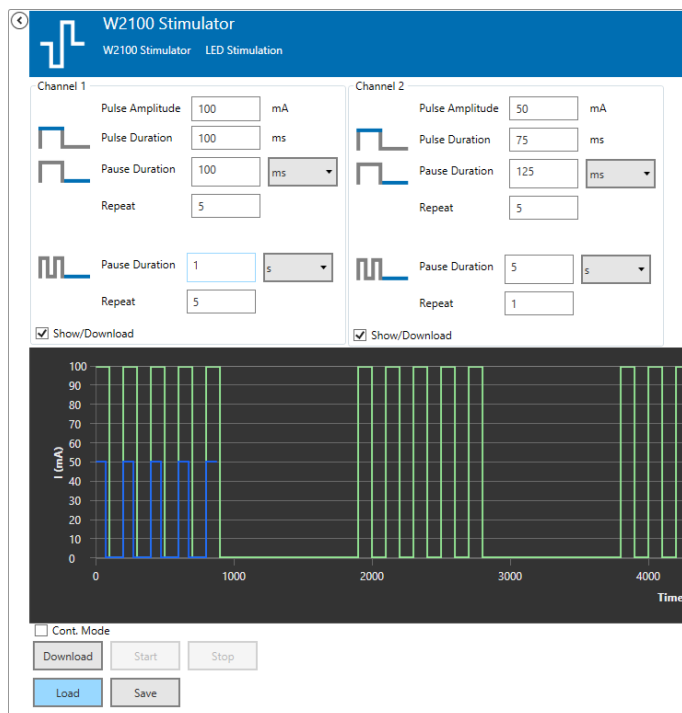
The header of the tabbed page informs about the kind of stimulation: Electrical or optical LED stimulation.



The stimulation paradigm for the two available optical stimulation channels can be programmed. Only rectangular positive current pulses are available. If more than one headstage with stimulation capabilities is selected in "Multi Headstage Mode", it is possible to select a headstage by serial number. Amplitude, duration and inter pulse interval can be selected individually for each channel. Furthermore, a pulse train can be repeated a number of times, with a pause in between. Once programmed, a pulse paradigm can be "Saved / Loaded" as \*.osf file.

The programmed stimulation paradigm for both channels is shown in overlay in the stimulation display, green for Channel 1 and blue for Channel 2. It is possible to skip the inter pulse interval and pause between trains at the end of the stimulus paradigm and stop immediately by activating the "Stop" immediately after last pulse check box. Each stimulation channel can be selected to be enabled or disabled with a second check box. In "Continuous Mode", the programmed pulse is repeated until manually stopped. A start delay can be set individually for both channels. This allows a time offset between the two channels, but also in relation to the start command.

A stimulation paradigm needs to be downloaded before it can be used. "Start" and "Stop" is only available while the data acquisition is running, while "Download" is only available while it is stopped. The green or blue virtual LEDs in the "Stimulator" window and in the lower "Main Menu" indicate ongoing stimulation on stimulation channels one and two, respectively.



Define the parameter of the LED pulse in the upper part of the window to build your own stimulus pulse. Select the "Pulse Amplitude" in mA, the "Pulse Duration" in ms and the "Pause Duration" in ms or a bigger unit, selectable from the drop-down menu. Type in the number of "Repeat" if necessary.

To repeat a series of pulses, please define the "Pause Duration" and the number of "Repeat" again. Click the check box "Show Download" for displaying the shape of the pulses in the black window below. Changes in pulse parameters will immediately be shown.

Define the parameters of the second LED pulse independent from the first one.

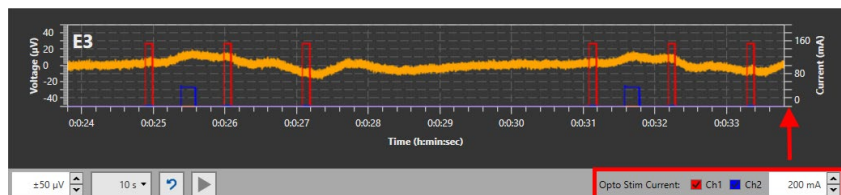
Enable the check box "Continuous Mode" and the created pulses will run in a loop until the stimulation is stopped.

Press the "Download" button to send the stimulation pattern to the headstage. "Start" and "Stop" the stimulation manually with the buttons beside.

"Save" the created LED stimulus pattern for later use via "Load".

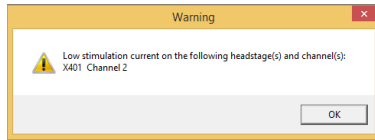
## Stimulation Current Display

The maximum current which can be set to drive the connected LED is 1000 mA. However, due to a limited capacity of the attached battery, or a decreasing battery charge, it is possible that the actual current is lower than the set current. This usually is only a problem for high currents. The W2100-Opto-Headstages measure the actual current used during optical stimulation. It can be displayed independently for both optical stimulation channels in the Zoom Display of the W2100 Data Source.



The selected data channel and the current for both stimulation channels are displayed in the same graph, with individual y-axis. Display for both channels can be toggled.

If the actual current is more than 10 % lower the set current, a popup window with a warning is shown.



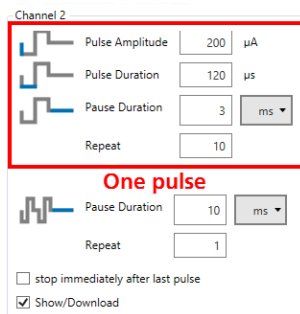
The same warning will not be shown again till the W2100 Data Source has been stopped and restarted. The actual stimulation current is also recorded in the data file.

## Trigger Output

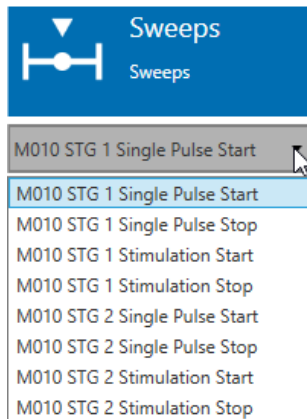
The stimulator of the W2100-System has a pink data port for trigger events. These events will be generated automatically, for each enabled stimulation channel of each active headstage there are four events:

- Stimulation "Start"
- Stimulation "Stop"
- Single Pulse "Start"
- Single Pulse "Stop"

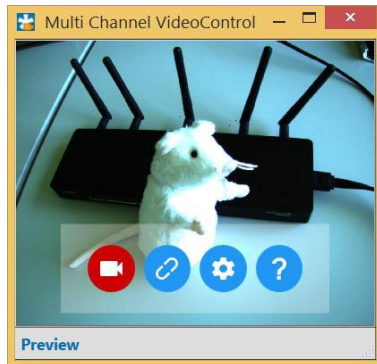
Stimulation in this case is the whole stimulation paradigm, including all repeats, also in continuous mode. There will be on trigger at the very beginning, and one at the end of a stimulation. "Single Pulse" in this case means a pulse train, with all repeats.



There will be on trigger at the beginning, and one at the end of each pulse. The "Trigger" events can be recorded and used to control other instruments, like the "Sweeps" tool.



## VIDEO CONTROL



### Multi Channel VideoControl

For detailed information, please read also manual "[Multi Channel VideoControl](#)".

Together with the software Multi Channel VideoControl it is possible to record video data, which can be synchronized via time stamps to the recording data of the W2100 headstage, generated with Multi Channel Experimenter software.

### Hardware

Recommended camera: USB3\_CP from IDS "IDS Imaging Development Systems GmbH".

### Hardware Setup

Please read also chapter "Video Camera Setup" in the Appendix. Connect the USB 3.0 port of the IDS camera to the computer with the provided USB 3.0 cable. It is not essential to use the data acquisition computer.

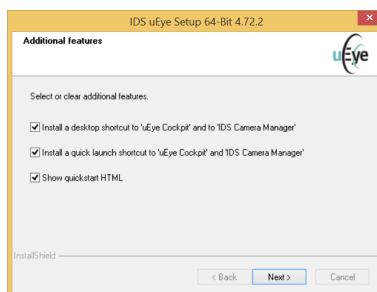
Connect the 8-pin circular connector of the camera control cable to the camera and the lemo connectors to one of the Digital In 1- 4 and Digital Out 1- 4 connectors on the front panel of the IFB-C Multiboot interface board of the W2100-System. Please use the provided camera control cable with 8-pin circular connector for the camera on one side and two Lemo connectors for the interface board on the other side.

### Software

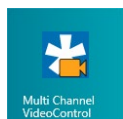
Additionally, to the Multi Channel Experimenter software you need two external software types for operating and synchronizing the recording from the W2100 headstage and the video control with the camera: "Multi Channel VideoControl" and "USB 3 uEye Cockpit".

Please install the "USB 3 uEye Cockpit" software from IDS "IDS Imaging Development Systems GmbH" first. The software with drivers is available on the provided installation CD. If not, please download the software from the web site of IDS (<https://de.ids-imaging.com>).

You just need the uEye Cockpit software for additional camera settings, which are not available via Multi Channel VideoControl software. If you do not use any additional settings, you need the drivers of the software only.



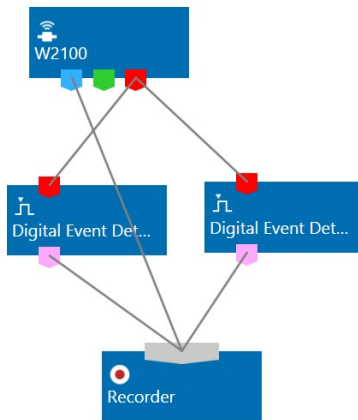
The second step is to install the Multi Channel VideoControl Software from Multi Channel Systems MCS GmbH from the provided CD.



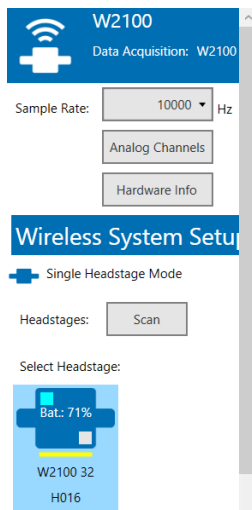
# VIDEO CONTROL

## Operation of the Video Camera

Please open the "Multi Channel Experimenter" software first.

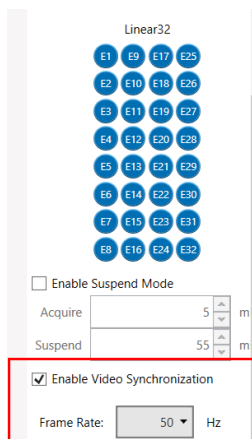


Build a rack, for example, with two "Digital Event Detector" tools. Double click the "Data Source W2100" and select and connect the headstage of the animal, you want to observe in the "Settings" part of the window.



## Synchronization

Next step is to enable the synchronization of recording from the headstage and camera by clicking the check box "Enable Video Synchronization".





# VIDEO CONTROL

## Frame Rate

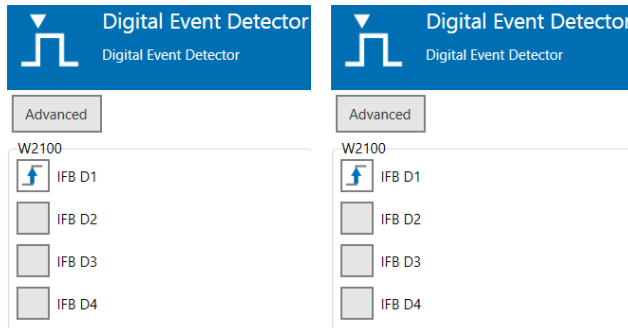
Select the "Frame Rate" in Hz from the drop down menu. The frame rate is the frequency of the pictures per second. A high frame rate results in larger file sizes but smoother videos, a low frame rate saves disk space.

**Warning: The frame rate settings in Multi Channel Experimenter and in Multi Channel VideoControl have to match, otherwise the synchronization fails.**

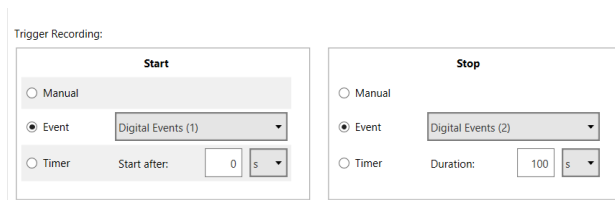
A frame rate of 50 Hz is recommended. Please adjust the frame rate in the "Video Settings" dialog in the "Multi Channel VideoControl" software as well.

## Synchronization of "Start" and "Stop"

Double click the "Digital Event Detector" buttons to open both tabbed pages.



Please set the first "Digital Event Detector" to the rising edge on "IFB D1" provided that this is the connector where the camera cable labeled "Dig In" is plugged in. Set the second "Digital Event Detector" to the falling edge on "IFB D1" provided that this is the connector where the camera cable labeled "Dig Out" is plugged in. Please open the "Recorder" tabbed page.



Please set the "Event" radio button in "Trigger Recording" and select "Digital Event (1)" for "Start" and "Digital Event (2)" for "Stop" from the drop down menu.

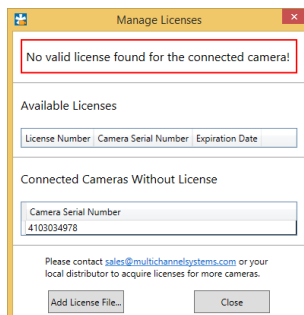
Last step in Multi Channel Experimenter program is to arm the data acquisition.



Switch the "Recording" to "Standby" and start the data acquisition "Start DAQ" after preparing the Multi Channel VideoControl software.

## 7.3 Operation of the Multi Channel VideoControl Software

Make sure to have a valid license for the camera! If no license is available, please contact [Multi Channel Systems](http://www.multichannelsystems.com).




# VIDEO CONTROL

Click the button "Add License File" and select the license file from the folder on the provided CD. You need one license per camera, defined by the serial number of the camera, otherwise you will not be able to record videos. After adding the license file, the "Multi Channel VideoControl" software will open. The toolbar appears when moving the mouse over the window.

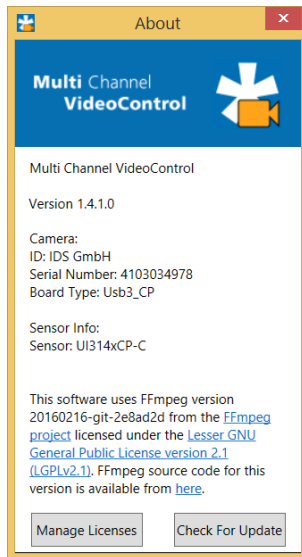


On the left "Camera" button, you can start and stop the camera manually without connection to the Multi Channel Experimenter.

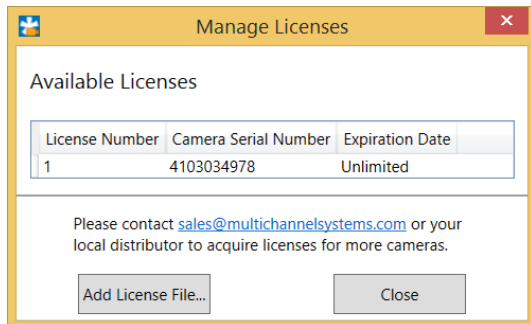
Connect the "Multi Channel VideoControl" software with "Multi Channel Experimenter" by clicking the button with the chain link .

## About

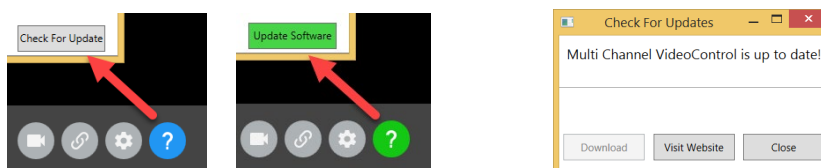
Click the question mark button for the "About" dialog.



Find information about the software version, the camera and additional programs. Click the button "Manage License" to open the "Manage Licenses" dialog. If necessary, click the "Add License File" button to insert the license file.



The button "Check For Update" in the "About" dialog is grey and the "About" question mark button is blue, if the software is up to date. The "About" question mark button is green and the grey button "Check For Update" has turned in a green button "Update Software", if a new version of the Multi Channel VideoControl software is available.



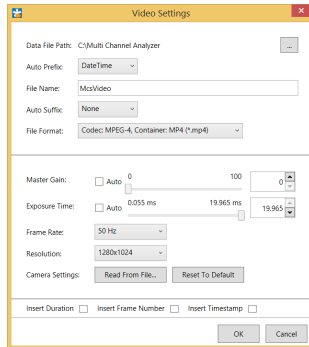
"Download" the update, if necessary. Via the "Visit Website" button you have fast access to our MCS web site [Multi Channel Systems](http://www.multichannelsystems.com).

# VIDEO CONTROL

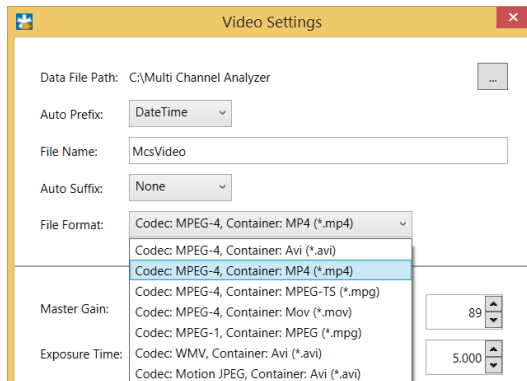
## Settings



Click the settings button  for the "Video Settings" dialog.



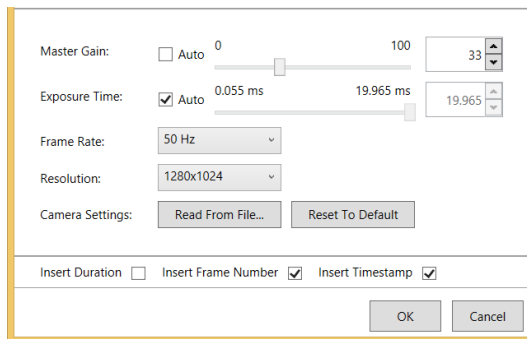
The upper part of the "Settings" dialog deals with file path, file name and file format.



Please define the "Data File Path" and adjust the individual file name: "Auto Prefix" and "Auto Suffix". The complete file name is displayed in the "File Name" window.

Select the "File Format" of the video from the drop down box. Different "Codec" and "Container" formats are available, which have effects on the file size and the quality of the video.

The lower part of the "Settings" dialog allows additional external settings.



Click the check box "Auto" for automatic settings of the "Master Gain" (sensor gain) and the "Exposure Time" or select the settings via slider or updown box. These parameters have mainly an effect on the brightness of the video.

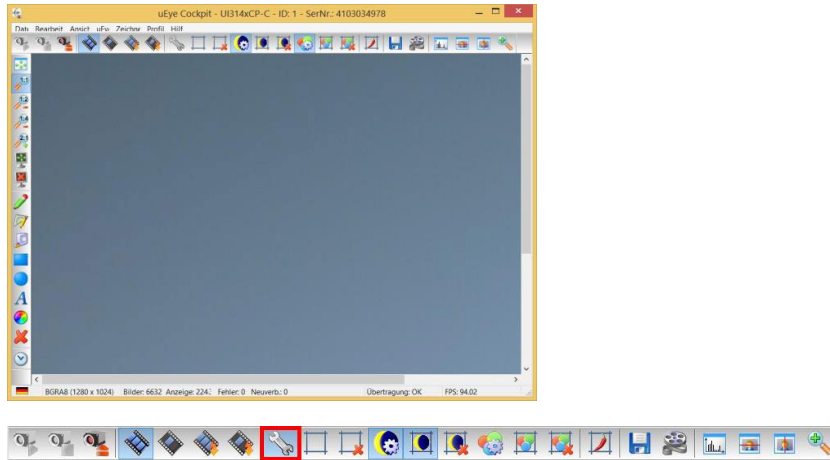
Select the "Frame Rate" from the drop down menu. Low frame rates allow high exposure times, which is relevant for example, when experiments are designed for dark environment.

**Warning: The frame rate settings in Multi Channel Experimenter and in Multi Channel VideoControl have to match, otherwise the synchronization fails!**

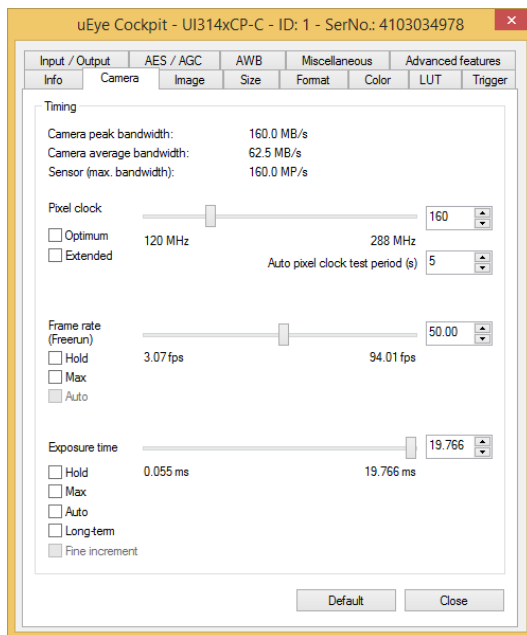
Define the "Resolution" depending on the camera and the requirements.

## Camera Settings via uEye Software

If you need to adjust additional camera settings that are not accessible via the Multi Channel VideoControl settings, such as for example the white balance of the image, you can do so with the uEye Cockpit software.



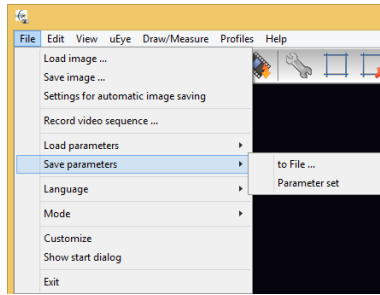
Click the "Screw Wrench" in the toolbar to open the camera setting tabs.



# VIDEO CONTROL

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After adjusting the parameters as desired, you can transfer the parameters from the uEye Cockpit software to the Multi Channel VideoControl software by selecting the option “Save parameters” in the “File” menu.



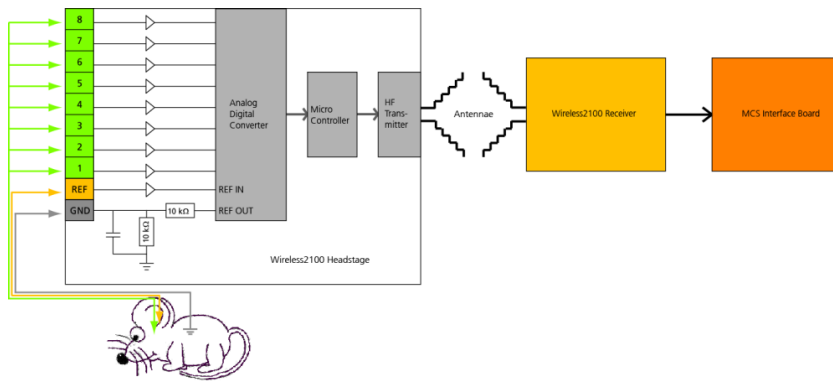
Select option “Parameter set” to store the settings in the camera EEPROM. Select “to File...” to store the settings as an “\*.ini” file, then load the \*.ini file in the Multi Channel VideoControl software via the “Read From File...” button in the “Camera Settings” menu.

In both cases will these settings be applied to the camera at each start of the Multi Channel VideoControl software. Please be aware that some settings such as the frame rate might get overwritten if they do not match the constraints of the Multi Channel VideoControl software.

All settings made in uEye program and in Multi Channel VideoControl are stored and available when starting the program again. To return to default settings, please click the button “Reset to Default” in the “Settings” dialog.

# EXPERIMENTAL SETUP

## EXPERIMENTAL SETUP



First step to set up an experiment with the Wireless2100-System is to implant an electrode into the laboratory animal. The electrode has to be fixed to the skull, for example with dental cement, to guarantee a stable positioning of the electrode in the desired area of the brain. The electrode connector must be available on the skin surface of the animal. A ground electrode is essential, a reference electrode is recommended.

### Battery Options

Make sure that the battery of the headstage is charged and plugged in properly. The battery can be fixed on top of the headstage, or it can be stored in a special backpack on the back of the animal. Batteries are available either with a cable or fixed on a circuit board with a double connector to be plugged in directly on the headstage, please see the images below.



### Ground and Reference Electrode

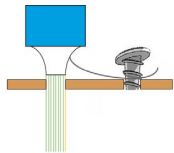
For optimal signal quality in in vivo experiments, it is necessary to provide a good grounding (GND) and a well placed reference (REF) electrode. Therefore, all headstages of the Wireless2100-System are equipped with dedicated pins for a ground and a reference electrode.

**Important: For good signal quality you should use dedicated reference and ground electrodes!**

The reference electrode is used to measure the relative potential differences in relation to the recording electrodes. The reference electrode should be out of a similar or the same material as the recording electrodes and it should be of comparable size. The reference is ideally placed near the recording electrodes, but not in active tissue. The signals from all electrodes are amplified and then each signal from the recording electrodes is compared to the signal from the reference electrode. The difference is measured by the analog to digital converter (ADC) and digitized.

When external interferences, for example heartbeats, muscle potentials, breathing, disturb the measurements, both, the recording and the reference electrodes measure the same disturbance and the noise signal is removed because only the difference between recording and reference electrode is digitized and transmitted (Common Mode Rejection).

To make sure that the animal and the headstage are set to the same electrical potential, a ground connection is also necessary. A good ground option is usually a large conductor, such as a skull screw or a silver wire implanted under the skin of the animal.



**Important: Please connect all unused inputs of the headstage to ground (GND) to prevent floating!**

If you do not use all inputs of a headstage, for example, when using a headstage with eight channels and a probe with four electrodes, the open channels are floating and disturb the recording of the connected channels.

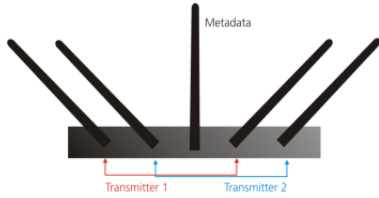
It is necessary to ground the open channels physically. Deselecting the channels in the hardware tab of the software has no effect.

# EXPERIMENTAL SETUP

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## Positioning of the System Components

If possible, always provide a clear line of sight between the headstage and the receiver and keep the distance as short as possible. In a larger cage, ideally position the receiver in the center on top of the cage. The position of the antennas does have an influence on the quality of the connection, so in case of connection issues, it might help to play around with the antenna positions. Two out of five antennas receive data from one transmitter on the headstage. One antenna is for metadata only. In theory, the ideal position is if the two antennas of one receiver are orthogonal to each other, like in the image below.



However, as the signal is reflected by surrounding objects, the ideal position can be quite different in each setup.

## Optimizing Energy Consumption

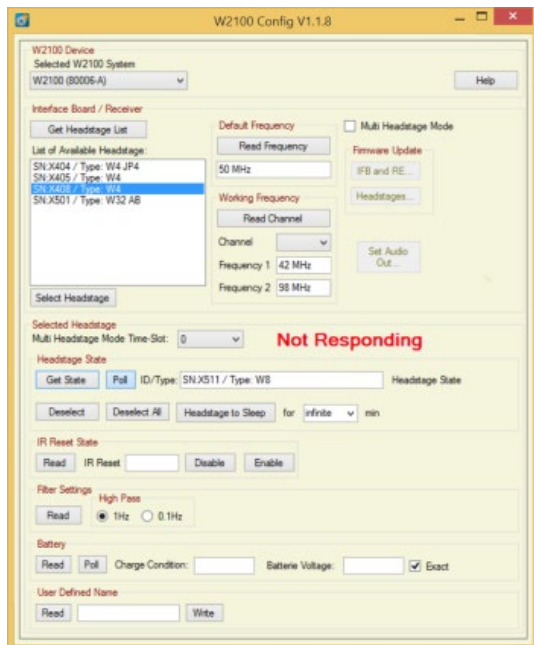
The power consumption of the Wireless2100 headstage mainly depends on two parameters: The number of channels and the sampling rate. To save power, the headstage automatically goes to stand by mode while not acquiring data. To decrease the power consumption while recording the most effective measures are to decrease the sampling rate as far as possible and switch off channels with irrelevant data. While experiment breaks, it is recommended to disconnect the battery or switch the headstage off via software command. It is also possible to decrease the sending power of the transmitters, if the distance between headstage and receiver is small.

# W2100 CONFIGURATION

## W2100 CONFIGURATION

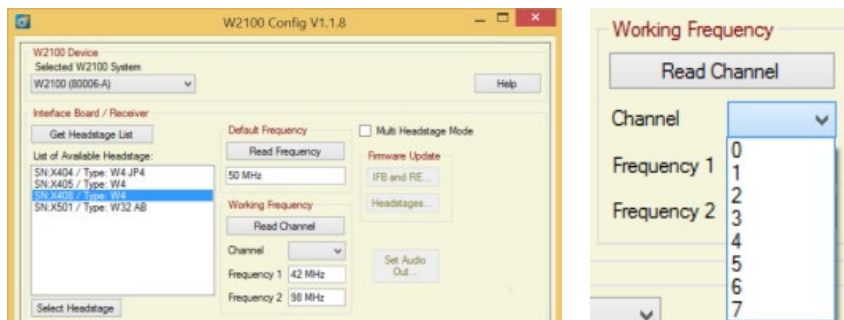
The tool "W2100 Config" helps to configure new Wireless2100 receivers and headstages to a present setup. Use the W2100 Config program for firmware updates before you start recording to experience best performance with newest firmware.

Some of the functions are described via tool tip, when moving the mouse over the respective button.



## W2100 Device

"Select one of the "W2100-Systems that is connected to this computer" from the drop down menu in the "W2100 Device" section in the upper part of this dialog. Each Wireless2100-System is characterized by its serial number. The letter "A" or "B" indicates to which of the USB ports the W2100-System is connected.



## Interface / Receiver

The "Receiver" section shows the available headstages and the radio frequencies in use. Click the "Get Device List" button to "Update the list of the available headstages below". The headstages are characterized by their serial number and type.

The available headstages appear in the window. Click onto the desired headstage which is highlighted in blue. Confirm the headstage with the "Select Headstage" button: "Selects a headstage that is selected in the list of available headstages to be connected with the current receiver".

Error messages in red letters will inform the user, if there is a problem, for example: If no headstage is available the error message "No Headstage" in the device list informs the user. If a headstage was found and selected, but this headstage is currently not available, for example because the battery voltage is down, the warning "Not Responding" is displayed.



# W2100 CONFIGURATION

## Default Frequency

See the window "Default Frequency". Analog signals are amplified and digitized directly on the headstage, and transmitted to the receiver via radio communication in the 2.4 GHz frequency band. Click the button "Read Frequency". It "Reads the default radio frequency that is used during the selection of headstages. This value is fix for all devices and shown only for your information".

Additionally, there is the radio frequency transmitted from all headstages which are switched on. The default is 50 MHz, which means 2450 MHz. The antennae in the middle of the receiver is due for receiving this frequency, it is responsible for checking all the contactable headstages in the spatial range. The other four antennae of the receivers are programed to receive the data from the left and the right antennae of the headstages in recording mode.

## Working Frequency

See the window "Working Frequency". If you are going to record with more than one Wireless2100-System nearby at the same time you have to assign the systems to one of the eight channels from the "Channel" drop down menu in the "Working Frequency" window. Otherwise, the radio frequencies of the receivers overlap and disturb each other. You can operate up to eight systems simultaneously in one room, but each system on a different frequency. Choose different "Channels" for the different receivers of the systems. Optionally confirm the selected channel with the "Read Channel" button. "Reads the radio frequencies that are used by this receiver. Please make sure that each receiver gets its unique channel".

The small window "Frequency 1" and "Frequency 2" displays both actual used frequencies of the selected receiver for the "left" and for the "right" antennae. In this example is "Frequency 1" 2400 MHz and "Frequency 2" 2456 MHz, in sum with the radio communication frequency band 2.4 GHz.

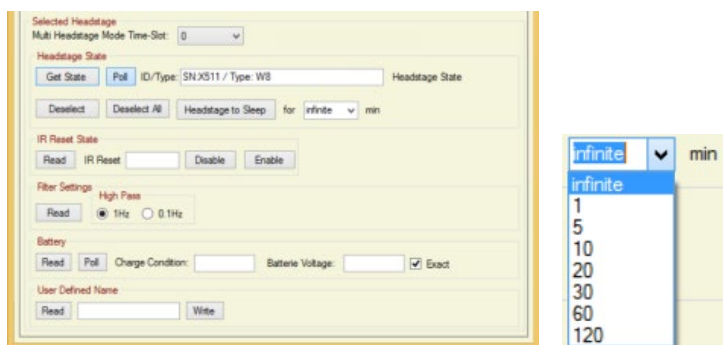
## Multi Headstage Mode

You can connect one headstage to one receiver of a W2100-System in "Single Headstage Mode" and up to four headstages connected to one receiver in "Multi Headstage Mode".

Click the check box "Multi Headstage Mode". "Select here if the system works in single or multi headstage mode. Please make sure that you are not measuring and that no headstage is selected in both receivers, if you want to change the settings".

The headstages for parallel recording need not to have the same channel numbers. When using two receivers, you have to open two instances of Multi Channel Experimenter for operating the receivers independent from each other. Connect two USB-C cable to USB-C A and USB-C B. The USB-C A controls the first receiver RE1, which is via iX-industrial cable connected to the socket labeled HS / SCU 1 on the back panel of the interface board IFB-C. The USB-C B controls the second receiver RE2, connected to HS / SCU 2 socket.

Enable the check box "Multi Headstage Mode", to record from more than one headstage. Disable the check box, to record one headstage only in "Single Headstage Mode". Please read chapter "Firmware Update" for information about this subject.



## Selected Headstage

### Headstage State

Press the "Get Selected Headstage State" button to display the actual selected headstage. The selected headstage will appear in the window "Selected Headstage ID".

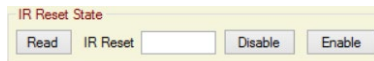
If the button "Poll" is checked, the "Selected Headstage State" is polled regularly, and the result is shown in the text box beside.

Change the state of the one or all headstages by clicking the buttons "Deselect Headstage", "Deselect All Headstages".

The button "Headstage to Sleep" turns a headstage to "Sleeping Mode", if the select time span for this headstage is set to "infinite" time. The button "Headstage to Sleep" turns a headstage to "Suspend Mode", if the select time span for this headstage is set to "1 to 120" minutes.

### IR Reset State

Click the button "Read" to see the IR state. "Disable" or "Enable" the settings.



### Filter Settings

Change the filter characteristic of the "High Pass" of the selected headstage from 1 Hz to 0.1 Hz and vice versa with the respective radio button. Click the button "Read" to see the current settings.

### Battery

Check the battery charge conditions with the "Read Battery" button. If it is necessary to control the battery charge continuously, check "Poll". When "Polling" is enabled the battery status is checked once every 20 seconds. Enable the check box "Exact" to get exact information, otherwise a range is displayed in "Charge Condition" and "Battery Voltage".


### User defined Names

Determine specific names for a better identification of a headstage. "Read User Defined Name" of a headstage by clicking the button, type a name in the window and confirm the name with the "Write User Defined Name" button.

### Firmware Update

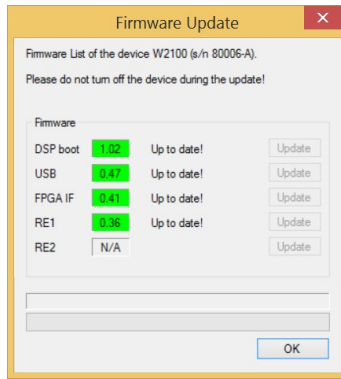
**Important: Make sure all components of the Wireless2100-System are updated to the latest firmware version!**

The latest firmware update is automatically installed with the latest software version. The installation may be invalid if the Wireless2100-System or single components of the system do not respond. Please update the firmware for each component via W2100Config software.

Click the button "Firmware Update for IF and RE..."  for updating the firmware of the interface board and the receiver. The "Firmware Update" dialog opens.

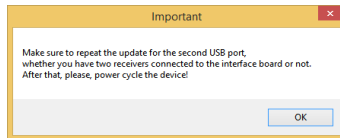
Please update one device after the other, the "DSP boot", the "USB", the interface board "FPGA IF", and the receiver "RE1" and optionally "RE2", until all of the devices are "Up to date!".

# W2100 CONFIGURATION



**Important: It is essential to update both USB ports!**

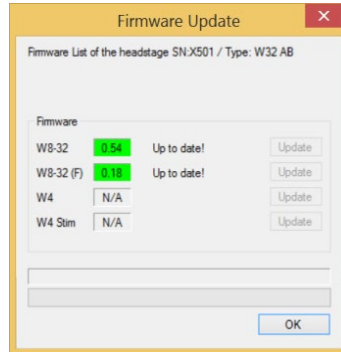
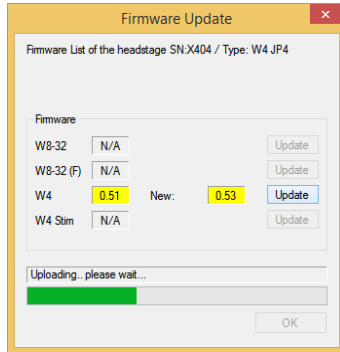
It is necessary to update both USB-C ports on the rear panel of the interface board, whether you are going to use two receivers connected to one interface board or not. Connect the USB cable to the port "A" and the receiver to the connector labeled "1". Make sure to repeat the update for the second USB port "B" and connector "2". After that, please power cycle the system by switching the power unit on the rear panel of the interface board off and on again.



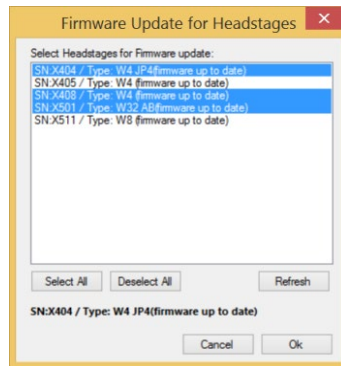
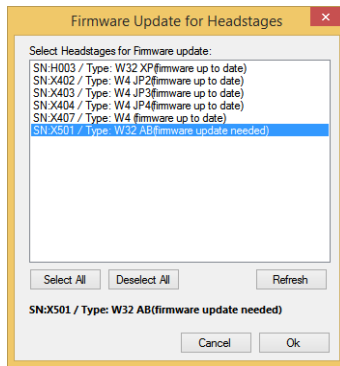
Please update the firmware of the headstages, respectively. Click the "Firmware Update for Headstages..." button to open the "Firmware



Update" dialog



Update one headstage after the other until all available headstages are "Up to date!".



Check whether the firmware is up to date for each single headstage.

## TROUBLESHOOTING

Most problems occur seldom and only under specific circumstances. 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 of chapter "Important Safety Advice". 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.

### Potential problems

The headstage sends signals to the receiver in 2.4 GHz frequency band. That is why devices working in the same frequency band may disturb the data communication between headstage and receiver. Please do not use, for example, a mobile phone equipped with blue tooth or a WLAN connection or a microwave in the vicinity of headstage and receiver otherwise it may cause trouble in data transfer.

**Important:** For bandwidth reasons it is not recommended to use an USB hub to connect the W2100-System to your computer.

### 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 the 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 question or if any problem occurs that is not mentioned in this documentation, 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. 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 bottom side of the main unit.
- The software of Multi Channel Experimenter / MC\_Rack version you are currently using. On the "Help" menu, click "About Multi Channel Experimenter / MC\_Rack". The displayed dialog box shows the version number.
- The hardware version of the Wireless2100-System you are currently using is displayed in the "Hardware" tab of the starting dialog.
- 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.

### Storage Batteries



Batteries and accumulators do not belong in normal household waste and, thus, must always be disposed of within the framework of existing legislation.

### Longterm Storage of the Lithium Polymer Batteries

**Important:** Ideally store the batteries 70 % charged in a low humidity environment at 5 to 7 °C, for example in the fridge, but not in the freezer. Please check the charging state quarterly to prevent totally self-discharge, which can destroy the batteries.

## VIDEO CAMERA SETUP

### Installation of the Video Camera for Use with the W2100-System

Video Camera UI-3140CP-C-HQ Rev.2 from IDS (Imaging Development Systems GmbH, <http://en.ids-imaging.com>)



Objective H2Z0414C-MP from Computar ([www:/computar.com](http://www.computar.com))



### Video Camera Cable Assembly

Camera control cable with 8-pin circular connector for the camera on one side and two Lemo connectors for the interface board on the other side.

(KRY-2100-50, 5 m, BK, PIN 3200044)



USB 3.0 cable with USB 3.0 connector for the computer and connector for the camera.

(A-male/microB-male, screwable, 5 m, BK, PIN 4900033)



Hint: Make sure that no mechanical forces act on the cable plugs. Do not break off the cable directly after the plugs. This may damage the plugs.  
Optional: If it is necessary to fix the cable, please use a strain relief with a minimum distance of 50 mm on each plug when installing the cable.

## Video Camera Setup

Please connect the microB connector of the USB 3.0 cable to the camera and fix the screws to lock the connection. Please connect the 8-pin circular connector of the camera control cable to the camera and lock the connection with the coupling nut.



Please connect the Lemo connectors of the camera control cable with the Interface board of the W2100-System. The cable with the label „DIG IN“ connects to the „DIGITAL IN 1“ port and the cable with the label „DIG OUT“ to the „DIGITAL OUT 1“ port of the IFB-C Multiboot interface board.



Finally connect the USB 3.0 to the computer. It is recommended to use an USB 3.0 port on the back side of the computer.



Optional: Screw the camera via tripod adapter to the camera mount. Now it is possible to fix the camera with the mount to the wall or the ceiling. With the help of the ball shaped head, you can move the camera in any direction. Please open the big screw near to the head for installation and fix it again.



## Technical Specifications of the Camera

### Camera

Type / Manufacturer	UI-3140CP-C-HQ Rev.2 from IDS ( <a href="http://en.ids-imaging.com">http://en.ids-imaging.com</a> )
Sensor type	CMOS Color
Frame rate (freerun mode)	224.0 fps
Resolution (h x v)	1280 x 1024 Pixel
Shutter	Global-Shutter
Optical class	1/2"
Resolution	1.31 MPixel
Pixel size	4.8 $\mu\text{m}$
USB interface	USB 3.0, Micro-B, screwable
I / O connector	8-pin circular connector (HR25-7TR-8PA(73))
Camera mount	C-Mount

### Objective

Type / Manufacturer	H2Z0414C-MP from Computar ( <a href="http://www.computar.com">www:/computar.com</a> )
Focal length	4 mm - 8 mm
Max. image format	6.4 mm x 4.8 mm (diameter 8 mm)
Operation range: Focus	0.5 m - inf.
Objective mount	C-Mount

## TECHNICAL SPECIFICATIONS

The Wireless2100-System is a 4-, 8-, 16- or 32-channel wireless in vivo system with headstage, receiver and interface board. Analog signals are converted in digital data streams in real-time.



**Warning:** The devices may only be used together with Wireless-Systems from Multi Channel Systems MCS GmbH, and only for the specified purpose. Damage of the devices and even fatal injuries can result from improper use. Do not open the receiver or the interface box and do not change hardware configuration as it could lead to improper behavior of the system.

<b>General characteristics</b>	
Operating temperature	10 °C to 50 °C
Storage temperature	0 °C to 50 °C
Relative humidity	10 % to 85 %, non-condensing
<b>Headstages: Please read the respective datasheets for detailed information!</b>	
Recording only	W2100-HS4 W2100-HS8 W2100-HS8-SR-opto W2100-HS16 W2100-HS32
Recording and Optical Stimulation	W2100-HS4-opto W2100-HS8-opto W2100-HS8-SR-opto W2100-HS16-opto W2100-HS32-opto
Recording and Electrical Stimulation (internal)	W2100-HS8-ES2-0.5mA W2100-HS8-ES2-2.0mA W2100-HS14-ES2-0.5mA W2100-HS14-ES2-2.0mA
Recording and Electrical Stimulation (external)	W2100-HS8-ES2-EXT-0.5mA W2100-HS8-ES2-EXT-2.0mA W2100-HS8-SR-ES2-EXT-0.5mA (with single row connector) W2100-HS8-SR-ES2-EXT-2.0mA (with single row connector) W2100-HS16-ES2-EXT-0.5mA W2100-HS16-ES2-EXT-2.0mA W2100-HS32-ES2-EXT-0.5mA W2100-HS32-ES2-EXT-2.0mA
<b>Amplifier integrated in the headstage</b>	
Bandwidth	Selectable via software: off, 0.1 Hz or 1 Hz
Resolution	16 bit
Input voltage range	± 12.4 mV

Sampling rate in kHz per channel in <b>Single Headstage Mode</b>	Sampling rate	Number of simultaneously selected channels				
		2	4	8	16	32
	W2100-HS4	40	25			
	W2100-HS8	40	40	25		
	W2100-HS8-SR	40	40	25		
	W2100-HS16	40	40	25	25	
	W2100-HS32	40	40	25	25	20
	W2100-HS8-ES2-0.5mA	40	40	25		
	W2100-HS8-ES2-2.0mA	40	40	25		
	W2100-HS14-ES2-0.5mA	40	40	25	25	
	W2100-HS14-ES2-2.0mA	40	40	25	25	
	W2100-HS8-ES2-EXT-0.5mA	40	40	25		
	W2100-HS8-ES2-EXT-2.0mA	40	40	25		
	W2100-HS8-SR-ES2-EXT-0.5mA	40	40	25		
	W2100-HS8-SR-ES2-EXT-2.0mA	40	40	25		
	W2100-HS16-ES2-EXT-0.5mA	40	40	25	25	
	W2100-HS16-ES2-EXT-2.0mA	40	40	25	25	
	W2100-HS32-ES2-EXT-0.5mA	40	40	25	25	20
	W2100-HS32-ES2-EXT-2.0mA	40	40	25	25	20



# APPENDIX

	W2100-HS4-opto W2100-HS8-opto W2100-HS8-SR-opto W2100-HS16-opro W2100-HS32-opto	10	10			
Sampling rate in kHz per channel in <b>Multi Headstage Mode</b>	Sampling rate	Number of simultaneously selected channels				
		2	4	8	16	32
	W2100-HS4	10	10			
	W2100-HS8	10	10	10		
	W2100-HS8-SR	10	10	10		
	W2100-HS16	10	10	10	5	
	W2100-HS32	10	10	10	5	2
	W2100-HS8-ES2-0.5mA	10	10	10		
	W2100-HS8-ES2-2.0mA	10	10	10		
	W2100-HS14-ES2-0.5mA	10	10	10	5	
	W2100-HS14-ES2-2.0mA	10	10	10	5	
	W2100-HS8-ES2-EXT-0.5mA	10	10	10		
	W2100-HS8-ES2-EXT-2.0mA	10	10	10		
	W2100-HS8-SR-ES2-EXT-0.5mA	10	10	10		
	W2100-HS8-SR-ES2-EXT-0.5mA	10	10	10		
	W2100-HS16-ES2-EXT-0.5mA	10	10	10	5	
	W2100-HS16-ES2-EXT-2.0mA	10	10	10	5	
	W2100-HS32-ES2-EXT-0.5mA	10	10	10	5	2
	W2100-HS32-ES2-EXT-2.0mA	10	10	10	5	2
	W2100-HS4-opto	10	10			
W2100-HS8-opto						
W2100-HS8-SR-opto						
W2100-HS16-opto						
W2100-HS32-opto						
<b>Max. distance for wireless link</b>	Under normal circumstances 5 m guaranteed					
<b>Electrical Stimulation</b>						
Output current (W2100-HS8-ES2-0.5mA) (W2100-HS8-ES2-2.0mA)	- 0.5 mA to + 0.5 mA @ ± 10 V compliance voltage - 2.0 mA to + 2.0 mA @ ± 10 V compliance voltage					
Rise time (10 - 66 % current, 0 - 100 µA)	1.5 µs @ RL = 10 kΩ (W2100.....0.5mA) 2.8 µs @ RL = 10 kΩ (W2100.....2.0mA)					
<b>Storage battery:</b> Please read the respective datasheets for detailed information!						
Storage battery	Lithium polymer, rechargeable					
Dimensions (W x D x H) of battery	30 mAh	17 x 11 x 3 mm				
	100 mAh	26 x 19.5 x 2.3 mm				
	200 mAh	26 x 20 x 4.5 mm				
	300 mAh	27.5 x 19.5 x 5 mm				
Weight of battery	30 mAh	W2100-B-CA approx. 1.6 g		W2100-B-BB approx. 1.4 g		
	100 mAh	approx. 3.9 g		approx. 5.0 g		
	200 mAh	approx. 5.0 g		approx. 6.7 g		
	300 mAh	approx. 8.1 g		approx. 8.7 g		
Recording time of batteries in hours at maximal sampling rate on all available channels		W2100-HS4	W2100-HS8	W2100-HS16	W2100-HS32	
	30 mAh	0.8	0.6	0.4	0.4	
	100 mAh	2.5	2	1.3	1.2	
	200 mAh	5	4	2.5	2.3	
	300 mAh	7.5	6.1	3.8	3.5	
	For all channels: 80 days (in stand-by mode)					
<b>Recharging Device</b>						
Dimensions (W x D x H)	55 mm x 20 mm x 10 mm					
Period of charging	1 hour					
Power	USB powered					

# APPENDIX

<b>Receiver</b>	
Dimensions (W x D x H)	110 mm x 78 mm x 29 mm
Frequency band	2.4 GHz
Impedance of antennae	50 Ohm
Analog Out	68-pin MCS standard connector, MCS high grade cable
<b>Interface Board "IFB-C Multiboot"</b>	
Dimensions (W x D x H)	250 mm x 83 mm x 25 mm
Weight	300 g
<b>Front panel</b>	
2 Sync In and Sync Out	Lemo connector, EPL.00.250 NTN
1 8-Channel Analog In	10-pin connector, DIL10Header-100mil
2 Analog Inputs, Channel 1 and 2	Lemo connector, EPL.00.250 NTN
Signal input range for analog channels	± 2500 mV
Gain for analog channels	2 *
2 LEDs	LED light is on, while link to receiver is working
4 Digital inputs	Lemo connector, EPL.00.250 NTN
4 Digital outputs	Lemo connector, EPL.00.250 NTN
1 Ground	Common jack 4 mm, banana plug
<b>Rear panel</b>	
I / O	Switch On / Off
Power supply	MPU 30, PWR DC 0.65 x 2.75 mm
1 Ground	Common jack 4 mm, banana plug
1 16 bit Digital In / Out	68-pin MCS standard connector, Honda-PCS-XE68LFD
2 Auxiliary channels (Not in use!)	Lemo connector, EPL.00.250 NTN
1 Audio output	Stereo Jack 3.5 mm
1 JTAG DSP port	14-pin JTAG connector, DIL14Header-100mil-anged
2 interface board to receiver connectors	External power over iX-industrial cable, type B
2 USB-C ports	USB-C A and USB-C B
<b>Power supply unit (MPU 30)</b>	
Input voltage	110 - 240 V
Output voltage	24 V max.
Power	65 W
Mark of conformity	CE, TÜV, cUL European standards EN60601
<b>Software</b>	
Software Digital Signal Processor DSP for real-time feedback	TMS320C6454™ (Texas Instruments)
Operating system	Microsoft Windows® 10, 8.1 with NTFS, English and German version supported
Multi Channel Experimenter	Version 2.17.6 and higher
Multi Channel Analyzer	Version 2.17.6 and higher
Multi Channel DataManager	Version 1.13.3 and higher
MC_Rack	Version 4.6.2 and higher
MC_DataTool program	Version 2.6.15 and higher
Data export software	Axon binary file (*.abf), ASCII file (*.txt), binary file (*.raw)
W2100 Configuration software	Version 1.4.9 and higher

\* Important: In MC\_Rack software the scaling of the analog channels is not correct for a factor of 2, because the gain of the analog input channels is not considered.

## SERVICE AND MAINTENANCE

### Cleaning the Connector



**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 connector touches the liquid, do not submerge the W2100 headstage or the cable. Otherwise, you can fatally damage the electronics.

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 minutes 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.

### Cleaning of the System

Always unplug the W2100-System prior to cleaning. To clean the exterior surfaces, use a lint-free cloth to remove loose dust. For more efficient cleaning, use a soft cloth dampened (not soaked) with an aqueous solution of 75 % isopropyl alcohol, or a mild detergent.

### Sterilization



**Warning:** Do not autoclave or sterilize The W2100 headstage 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.

W2100-System headstages can be sterilized with standard methods that are not based on high heat or vapor, for example, with 70 % ethanol, ultraviolet light, or by thermal sterilization in an oven at 56 °C with an incubation time of 8 hours.

# TECHNICAL SUPPORT

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## TECHNICAL SUPPORT

In case of technical problems, please contact MCS support. 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:

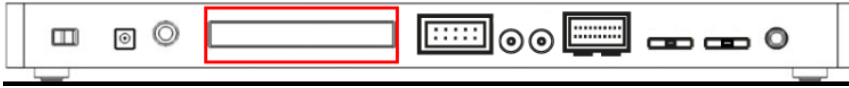
- Description of the error (the error message text or any other useful information) and of the context in which the error occurred. Try to remember all steps you had performed immediately before the error occurred. The more information on the actual situation you can provide, the easier it is to track the problem. The serial number of the device. You will find it on the backside of the housing or click option "About" in "Help" in the main menu of the data acquisition software.
- The type and serial numbers of the connected headstages. 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. Click option "About" in "Help" in the main menu to display the software version.

# PIN LAYOUT

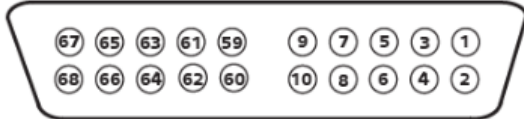
## PIN LAYOUT

### IFB-C Multiboot Interface Board



### IFB-C Multiboot Interface Board: 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	Internal use (do not connect)
Pin 64 - 66	GND
Pin 67	Positive supply voltage output +3.3 V
Pin 68	GND

### Digital IN / OUT, separate available via Lemo Connectors

#### Separate Digital IN Lemo Connectors

Digital In 1	Bit 0 of the 16 bit digital input channels (Pin 27)
Digital IN 2	Bit 1 of the 16 bit digital input channels (Pin 28)
Digital IN 3	Bit 2 of the 16 bit digital input channels (Pin 29)
Digital IN 4	Bit 3 of the 16 bit digital input channels (Pin 30)

#### Separate Digital OUT Lemo Connectors

Digital OUT 1	Bit 0 of the 16 bit digital output channels (Pin 3)
Digital OUT 2	Bit 1 of the 16 bit digital output channels (Pin 4)
Digital OUT 3	Bit 2 of the 16 bit digital output channels (Pin 5)
Digital OUT 4	Bit 3 of the 16 bit digital output channels (Pin 6)

# POWER CONSUMPTION

## IFB-C Multiboot Interface Board: 10-Pin Connector for Analog IN

10-Pin Connector for Analog IN and Ground



10-Pin Analog Connector



Analog IN

Pin 1	GND
Pin 2	GND
Pin 3	Analog channel 1
Pin 4	Analog channel 2
Pin 5	Analog channel 3
Pin 6	Analog channel 4
Pin 7	Analog channel 5
Pin 8	Analog channel 6
Pin 9	Analog channel 7
Pin 10	Analog channel 8

## IFB-C Multiboot Interface Board: Lemo Connectors for Analog IN

Two of the eight analog channels are additionally separate available via Lemo Connectors

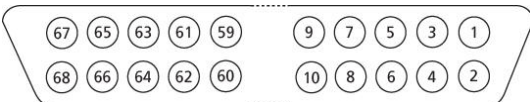
Analog IN 1, Channel 1, Pin 3

Analog IN 2, Channel 2, Pin 4

The gain factor for amplification of all analog channels is 2.

## Pin Layout of the Receiver W2100-RE-AO

**W2100-RE-AO: 68-Pin MCS Standard Connector (Analog OUT)** 68-Pin MCS Standard Connector for Analog Out, Honda-PCS-XE68LFD



### Pin Layout

Pin Number	Pin Assignment
Pin 1	Ground (GND)
Pin 2	Ground (GND)
Pin 3 to 66	Channel 1 to 64
Pin 67	not connected
Pin 68	not connected

Please use a 68-Pin MCS high grade cable for connection to third party device.



# POWER CONSUMPTION

## Power Consumption

Power Consumption of the W2100 Wireless Headstages with Stimulation in different Operation Modes [mA]  $V_{\text{supply}} = 3.75 \text{ V}$

To determine the battery lifetime, divide the capacity of the battery in use by the current drawn by the headstage. Please see the following tables for the power consumption.

Example: Using a 100 mAh battery with a W8-System, sampling at 25 kHz with all eight channels, recording only without stimulation, the power consumption is 50.5 mA, so the battery life is approximately  $100 \text{ mAh} / 50.5 \text{ mA} = 1 \text{ h}$  and 58 min.

For electrical or optical stimulation additional power is needed, that means, battery life is shortened.

### W2100-HS4

Number of Channels	1	2	3	4
RF Output Power [dB]	5	5	5	5
Sampling frequency [kHz]				
1	20,7	22,8	25,9	26,5
2	20,8	23,2	26,3	27,3
5	22,2	24,7	27,0	28,0
10	23,8	26,2	28,9	30,5
20	26,2	30,5	35,2	38,4
25	23,9	29,0	35,2	39,2
40	30,5	38,4	x	x
Standby	5.8 mA			
Switch Off	13.66 $\mu\text{A}$			

### W2100-HS8

Number of Channels	1	2	3	4	5	6	7	8
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	27,7	27,9	28,0	28,1	28,8	29,0	29,3	29,4
2	27,9	28,2	28,5	28,8	29,7	30,1	30,5	30,8
5	29,5	30,2	30,9	32,2	33,0	34,0	35,0	34,4
10	31,4	32,8	34,2	35,3	36,9	38,2	39,5	40,2
20	33,2	35,8	38,4	40,5	43,2	45,7	47,9	50,0
25	29,5	32,4	35,5	38,0	42,1	44,7	47,9	50,5
40	36,1	40,8	45,5	49,7	x	x	x	x
Standby	6,6 mA							
Switch Off	10,3 $\mu\text{A}$							

### W2100-HS16

Number of Channels	1	2	3	4	5	6	7	8
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	34,0	34,2	34,3	34,5	35,6	35,8	35,9	36,1
2	34,2	34,5	34,8	35,2	36,5	36,8	37,1	37,4
5	35,5	36,5	37,5	38,0	39,1	40,2	41,2	40,9
10	37,6	38,9	40,0	41,4	43,2	44,5	45,9	46,5
20	39,8	42,3	44,8	47,0	50,4	52,9	54,9	56,9
25	36,2	39,0	41,5	44,4	49,1	52,0	55,0	57,4
40	42,9	47,6	52,2	56,4	x	x	x	x

# POWER CONSUMPTION

## W2100-HS16

Number of Channels	9	10	11	12	13	14	15	16
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	36,5	36,5	36,7	37,0	37,1	37,2	37,5	37,5
2	37,9	38,2	38,7	39,0	39,3	39,7	39,8	39,4
5	41,4	41,9	42,8	43,4	44,5	44,4	44,9	45,2
10	47,7	48,6	50,2	51,4	52,6	53,5	54,5	55,5
20	59,8	61,7	64,2	66,9	68,9	71,2	73,8	75,6
25	60,5	63,4	66,6	69,5	71,8	75,2	78,2	80,5
40	x	x	x	x	x	x	x	x
Standby	6.6 mA							
Switch-Off	10.3 µA							

## W2100-HS32

Number of Channels	1	2	3	4	5	6	7	8
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	49,1	49,4	49,6	49,7	51,6	52,0	52,3	52,4
2	49,1	49,7	50,2	50,3	52,5	53,0	53,4	53,7
5	50,1	51,2	52,1	52,7	54,7	55,9	56,8	56,5
10	52,2	53,7	54,9	56,0	58,5	59,9	61,4	62,0
20	55,3	58,0	60,5	62,4	67,0	69,6	71,8	74,0
25	51,2	54,2	57,1	59,5	65,5	68,5	71,9	74,5
40	59,1	63,8	68,5	72,5	x	x	x	x

## W2100-HS32

Number of Channels	9	10	11	12	13	14	15	16
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	52,6	52,7	52,9	53,1	53,2	53,3	53,4	53,8
2	54,2	54,5	54,8	55,2	55,4	55,7	55,8	55,6
5	57,0	57,2	58,3	59,2	59,9	59,9	60,3	60,5
10	63,2	64,3	65,5	66,7	68,1	68,8	69,9	71,0
20	76,7	78,9	81,0	83,7	85,6	87,8	90,7	92,6
25	77,6	80,1	83,0	86,0	89,1	91,6	95,0	97,5
40	x	x	x	x	x	x	x	x

## W2100-HS32

Number of Channels	17	18	19	20	21	22	23	24
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	53,9	54,0	54,4	54,6	54,4	54,7	54,9	55,0
2	55,8	55,9	56,0	56,2	56,6	56,9	57,3	57,5
5	61,6	62,6	63,5	63,5	63,4	64,2	65,0	65,9
10	72,5	73,6	75,0	75,9	77,0	78,0	79,4	80,4
20	75,6	76,7	78,2	79,0	80,0	81,1	82,4	83,6
25	x	x	x	x	x	x	x	x
40	x	x	x	x	x	x	x	x



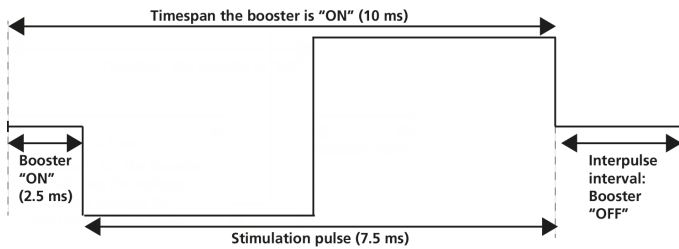
# POWER CONSUMPTION

## W2100-HS32

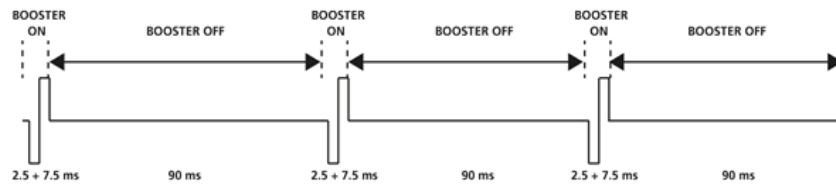
Number of Channels	25	26	27	28	29	30	31	32
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency								
1	55,3	55,4	55,2	56,0	56,0	56,0	55,6	55,6
2	58,0	58,2	58,3	58,5	58,5	58,6	58,6	59,0
5	66,6	66,9	67,0	67,8	68,0	69,3	70,6	70,2
10	81,9	82,7	83,6	85,3	86,6	87,8	89,0	89,8
20	85,0	85,7	86,8	88,3	89,6	91,0	92,2	92,7
25	x	x	x	x	x	x	x	x
40	x	x	x	x	x	x	x	x
Standby	6.6 mA							
Switch Off	10.3 $\mu$ A							

### Power Consumption of Headstages while using Electrical Stimulation

Headstages with electrical stimulation need additional power of 90 mA to boost the voltage before each single stimulation pulse. The booster will run 2.5 ms before stimulation to build up the voltage needed and during stimulation to avoid voltage drop before the stimulation pulse is finished. Please see the exemplified diagram below. Using pulse trains with interpulse intervals shorter than 2.5 ms, the booster is running continuously. The booster serves for one or two stimulation channels with a negligible difference of power consumption.



Define the stimulation pulse via Multi Channel Experimenter protocol and calculate the additional power consumption for stimulation from the ratio booster "ON" to booster "OFF" per second.



Example: Define an electrical stimulation pulse of 7.5 ms. The booster starts running 2.5 ms before the stimulation pulse starts. That means the booster is running for 10 ms. Define an interpulse interval of 90 ms and repeat these settings periodical 10 times in a second (@ 10 Hz). Use a W8-System with 100 mAh battery, sampling at 25 kHz on all eight channels (power consumption 53.1 mA, please see the table).

For 10 % of a second the booster is running and for 90 % of the time the booster is off:  $53.1 \text{ mA} + 90 \text{ mA} / 10 = 53.1 \text{ mA} + 9 \text{ mA} = 62.1 \text{ mA}$

Battery lifetime (approximately):  $100 \text{ mAh} / 62.1 \text{ mA} = 1 \text{ h and } 37 \text{ min}$

# POWER CONSUMPTION

Table:

## W2100-HS8-ES2-0.5mA

(Blue LED flashing, red LED off, no stimulation)

Number of Channels	1	2	3	4	5	6	7	8
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency [kHz]								
1	29.1	29.3	29.4	29.5	30.3	30.6	30.5	30.7
2	29.4	29.8	30.1	30.3	31.3	31.7	31.8	32.2
5	31.3	32.0	33.4	33.9	35.5	36.0	35.5	35.7
10	34.1	35.2	36.6	34.3	39.3	40.6	41.0	41.9
20	37.0	39.5	41.6	37.6	46.6	49.0	50.6	53.0
25	33.7	36.2	39.5	41.6	45.5	48.7	50.9	53.1
40	41.6	46.3	50.5	54.8	x	x	x	x
Additional power consumption for the booster	90 mA							
Rise time before stimulation	2.5 ms							
Standby	6.6 mA							
Switch Off	10.98 µA							

## W2100-HS14-ES2-0.5mA

(Blue LED flashing, red LED off, no stimulation)

Number of Channels	1	2	3	4	5	6	7	8
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency [kHz]								
1	34.9	35.0	35.1	35.4	36.3	36.5	36.8	37.0
2	35.3	35.5	35.8	36.2	37.3	37.7	38.2	38.6
5	37.0	38.0	39.1	40.1	41.1	42.2	42.2	42.2
10	39.6	40.9	42.1	43.3	45.0	46.6	47.4	48.5
20	43.1	45.7	47.8	49.8	53.3	55.9	58.2	60.8
25	39.5	42.4	45.1	48.1	52.4	55.4	58.8	61.8
40	48.3	53.1	57.5	62.1	x	x	x	x
Number of Channels	9	10	11	12	13	14	15	6
RF Output Power [dB]	5	5	5	5	5	5	5	5
Sampling frequency [kHz]								
1	37.0	37.2	37.6	37.5	37.8	37.9	x	x
2	38.8	39.1	39.6	39.8	40.2	40.2	x	x
5	42.2	43.2	44.4	45.1	45.3	45.2	x	x
10	49.6	51.0	52.2	53.5	54.3	55.2	x	x
20	62.9	65.3	67.9	70.1	72.3	74.7	x	x
25	64.0	67.6	70.3	73.2	76.3	79.0	x	x
40	x	x	x	x	x	x	x	x
Additional power consumption for the booster	90 mA							
Rise time before stimulation	2.5 ms							
Standby	6.6 mA							
Switch Off	12.7 µA							

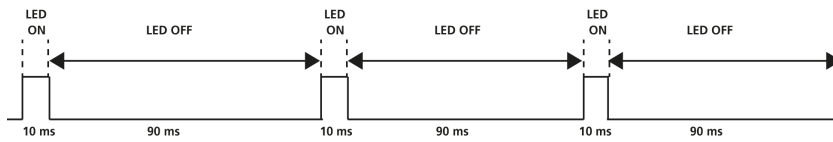
### Power Consumption of Headstages while using Optical Stimulation

To determine the battery life-time divide the capacity of the battery in use by the current drawn by the headstage. Please see the following table for the power consumption.

Example: Using a 100 mAh battery with a W8-System, sampling at 25 kHz with all eight channels, recording only without stimulation, the battery life is approximately  $100 \text{ mAh} / 50.5 \text{ mA} = 1 \text{ h}$  and 58 min.

# POWER CONSUMPTION

For optical stimulation the additionally needed power correlates directly with the value defined in the Multi Channel Experimenter software, for example 150 mA. Please calculate the ratio LED "ON" and LED "OFF" per second.



Example: Define an optical stimulation pulse of 150 mA for 10 ms. Define an interpulse interval of 90 ms and repeat these settings periodical 10 times in a second (@ 10 Hz). Use a W4-System with 100 mAh battery, sampling at 10 kHz on all four channels (power consumption 37.0 mA, please see the table).

For 10 % of a second the LED is on and for 90 % of the time the LED is off:  $37.0 \text{ mA} + 150 \text{ mA} / 10 = 37.0 \text{ mA} + 15 \text{ mA} = 52 \text{ mA}$

Battery lifetime (approximately):  $100 \text{ mAh} / 52 \text{ mA} = 1 \text{ h and } 55 \text{ min}$

Table:

### W2100-HS4-opto

(Blue LED flashing, red LED off, no stimulation)

Number of Channels	1	2	3	4
RF Output Power [dB]	5	5	5	5
Sampling frequency [kHz]				
1	23.2	23.5	23.8	24.0
2	23.9	24.5	25.3	25.7
5	27.5	28.9	29.9	29.8
10	30.8	33.2	35.7	37.0
20	x	x	x	x
25	x	x	x	x
40	x	x	x	x
Standby	5.8 mA			
Switch Off	13.7 $\mu$ A			

# CONTACT INFORMATION

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## 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 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 MCS web site.