

MEAXpress

USER MANUAL

TABLE OF CONTENTS

TABLE OF CONTENTS

GENERAL INFORMATION.....	4
Important Safety Advice.....	4
Guarantee and Liability	5
Operator's Obligations	5
PRODUCT OVERVIEW	6
Welcome to the MEA <i>Xpress</i>	6
Liquid Handling and Recording in one System.....	6
MEA XPRESS HARDWARE AND SOFTWARE	7
The MEA <i>Xpress</i> Robot and Accessories.....	7
CONSUMABLES	9
96 Deep Well Plate.....	9
Opentrons OT-2 Software	12
MULTIWELL-SCREEN SOFTWARE.....	13
MEA <i>Xpress</i> Workflow in Multiwell-Screen	13
Multiwell-Screen Startup.....	14
Multiwell-Screen Startup for MEA <i>Xpress</i>	14
Using the MEA <i>Xpress</i> Wizard	16
Controlling the MEA <i>Xpress</i> Robot during the Experiment.....	18
MEA <i>XPRESS</i> WIZARD.....	19
Wizard Page "Settings".....	20
Wizard Page "Compounds"	22
Wizard Page "Wells".....	24
Wizard Page "Labware Prep"	25
Wizard Page "Calibrate Prep".....	27
Wizard Page "Run Prep".....	32
Wizard Page "Labware App"	33
Wizard Page "Calibrate App".....	33
Wizard Page "Finish"	36
Advanced Mode	37
INSTALLATION GUIDES	39
Unbox MEA <i>Xpress</i> System.....	39
Calibrating the MEA <i>Xpress</i> Base Plate.....	42
Technical Specifications of the MEA <i>Xpress</i> Robot	45
MAINTENANCE.....	45
Cleaning of the System.....	45
CONTACT INFORMATION	46

Imprint

Information in this document is subject to change without notice. No part of this document may be reproduced or transmitted without the express written permission of Multi Channel Systems MCS GmbH.

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

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

© 2022 Multi Channel Systems MCS GmbH. All rights reserved.

Printed: 04.04.2022

Multi Channel Systems MCS GmbH

Aspenhastraße 21
72770 Reutlingen

Germany

Phone +49-7121-909 25 - 0
Fax +49-7121-909 25 -11

sales@multichannelsystems.com
www.multichannelsystems.com

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

GENERAL INFORMATION

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.



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.

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.

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.

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.

Explanation of the Symbols used



Caution / Warning



DC, direct current

Guarantee and Liability

The general conditions of sale and delivery of Multi Channel Systems MCS GmbH always apply. They can be found online at <https://www.multichannelsystems.com/sites/multichannelsystems.com/files/documents/Terms%20and%20Conditions.pdf>

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.

Operator's Obligations

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

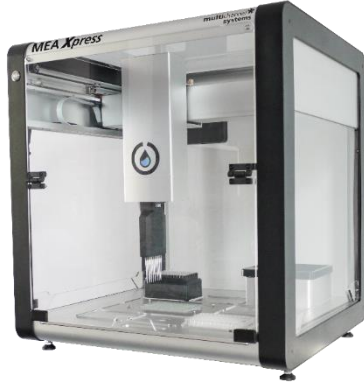
- are familiar with the safety at work and accident prevention regulations and have been instructed how to use the device;
- are professionally qualified or have specialist knowledge and training and have received instruction in the use of the device;
- have read and understood the chapter on safety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

It must be monitored at regular intervals that the operating personnel are working safely. Personnel still undergoing training may only work on the device under the supervision of an experienced person.

PRODUCT OVERVIEW

Welcome to the MEA *Xpress*

The liquid handler MEA *Xpress* is a standalone device or can be used together with the Multiwell-MEA-System and the Multiwell-Screen software.



Liquid Handling and Recording in one System

The MEA *Xpress* is the complete solution for multiwell microelectrode array (MEA) recordings and automated liquid handling.

What does the MEA *Xpress* do?

- Automates dilution series preparation.
- Records electrophysiological data from 288 channels: for cardiac and neuronal samples and compound screening.
- Automates compound application.
- Generates data files with electrophysiological data and meta information ready for analysis in the Multiwell-Analyzer.

The MEA *Xpress* is combined from two devices: the [Opentrons OT-2](#) pipetting robot and the Multiwell- MEA-System to generate an automated platform for substance screening. One software is used to automatically generate a compound plate from medium and compound stock with the pipetting robot, control the electrophysiological recording, and apply the drugs from the compound plate to the cells during the experiment without further user interference.

The robot offers high-precision pipettes that execute the liquid transfer quickly and accurately. The robot houses the Multiwell-MEA-System. However, you can always remove the recording system for benchtop operation.

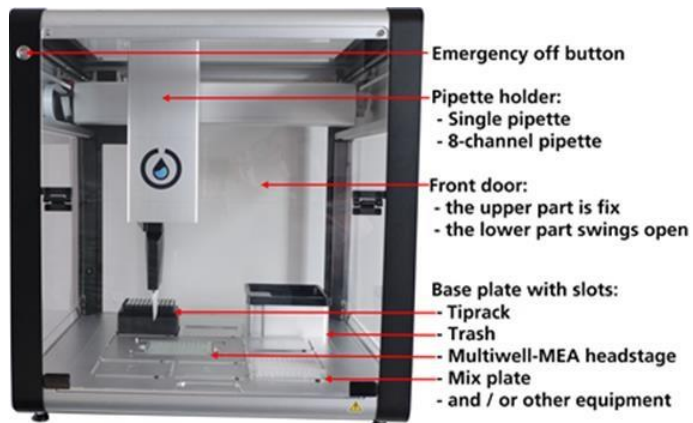
The complete experiment can be set up in advance, no user-interference needed during experiment.

HARDWARE AND SOFTWARE

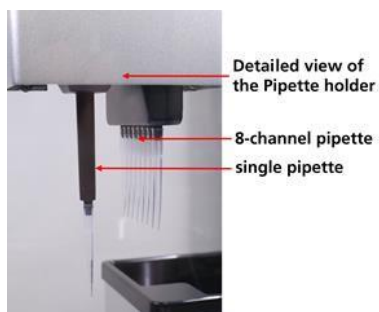
MEA XPRESS HARDWARE AND SOFTWARE

The MEA Xpress Robot and Accessories

Front of the MEA Xpress Robot



Detailed View



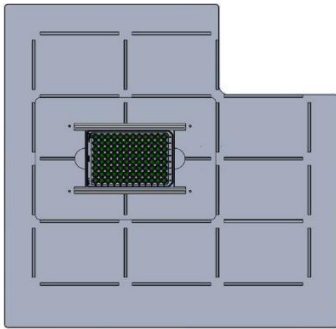
Back of the MEA Xpress Robot



Side of the MEA Xpress Robot



Base Plate of the MEA Xpress Robot



CONSUMABLES

96 Deep Well Plate



These “96 Deep Well Plates” are used as “Mix Plates” in the MEA *Xpress*. The dilution series of the compounds is prepared in these plates and transferred from them to the MEA plates during the experiment. A well volume of about 2 ml is recommended.

Reservoir



The “Reservoir” contains the cell medium used as diluent in the preparation of the dilution series. It is only needed in the preparation phase, not during the MEA experiment. Because reservoirs have a dead volume of several milliliters, please make sure to provide enough liquid in the reservoir for reliable aspiration. Otherwise, the pipette might be unable to aspirate the programmed volume and aspirate air bubbles instead.

24-well MEA Plate



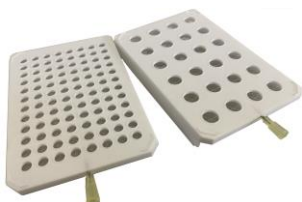
A MCS Multiwell-MEA plate in 24-well format holding the cells adherend in cell medium. The volume of the cell medium inside each well needs to be set correctly in the “MEA *Xpress Wizard*”. Per default, a volume of 500 μ l is assumed.

96-well MEA Plate



A MCS Multiwell-MEA plate in 96-well format holding the cells adherend in cell medium. The volume of the cell medium inside each well needs to be set correctly in the “MEA *Xpress Wizard*”. Per default, a volume of 200 μ l is assumed.

PAL24/96 Pipettor Atmosphere Lid for CO₂ Application



The PAL “Pipettor Atmosphere Lid” seals a 24- or 96-multiwell MEA plate during the experiment to guarantee ideal humidity, salinity and gas concentrations during the experiment. An integrated 6-channel gas superfusion outlet distributes premixed gas (like CO₂) to all wells of the plate.

A star-slitted foil is penetrated by the pipette tip during compound application into the wells, and fully reseals after the retraction of the pipette tip to maintain humidity and salinity in each well. With this helpful accessory, long term recordings are doable within the pipettor — under perfect physiological conditions.

Tip Rack



Pipette tips for the MEA Xpress robot are stored in tip racks with 96 pipette tips. Opentrons 300 µl tips are recommended for the MEA Xpress because they are needed for some calibration steps.

Tube Rack



A tube rack holds the tubes containing the compounds for dilution series preparation and is termed the “Compound Holder” in the MEA Xpress software. The default Opentrons tube rack has multiple insets for various tube sizes and fits, for example standard Eppendorf tubes.

Table: Consumables

The following consumables have been tested with the MEA *Xpress* system

Type	Vendor
96 Deep Well Plate	https://www.usascientific.com/plateone-96-deep-well-2ml/p/PlateOne-96-Deep-Well-2mL
Reservoir	https://www.integra-biosciences.com/germany-austria/en/reagent-reservoirs/automation-friendly-reagentreservoirs
24-well MEA Plate	https://www.multichannelsystems.com/products/microelectrode-arrays/multiwell-mea-plates
96-well MEA Plate	https://www.multichannelsystems.com/products/microelectrode-arrays/multiwell-mea-plates
Tip Rack	https://shop.opentrons.com/products/opentrons-300ul-tips
Tube Rack	https://shop.opentrons.com/collections/verified-labware/products/tube-rack-set-1
Lid for CO ₂ Application	https://www.multichannelsystems.com

INSTALLING THE HARDWARE

Installing the Hardware

Please read the chapter “Installation Guides”.

Connecting the Hardware to the PC

While the OT-2 robot can be connected either via USB or WiFi to the PC, the USB connection is recommended for stability. The connection to the Multiwell-MEA headstage is achieved via the MCS Interface Board on the back of the robot. Please connect the correct USB port on the Interface Board to the computer:

MCS-IFB-C: Port USB-C A
MCS-IFB 3.0: Port USB 3.0 A

Opentrons OT-2 Software

The Opentrons OT-2 software is needed for certain calibration and maintenance tasks of the OT-2 robot, like deck calibration and exchanging pipettes. Performing a deck calibration is recommended after moving the robot or removing the robot deck. Please see section 6.3 in this manual on how to perform deck calibration. For more information on the software, please consult the Opentrons Help Center (<https://support.opentrons.com/en/>).

Important: The MEA Xpress system requires Version 3.21.2 of the Opentrons Software and is not compatible with newer Opentrons versions. Please make sure that exactly this software version is installed and don't perform any software updates!

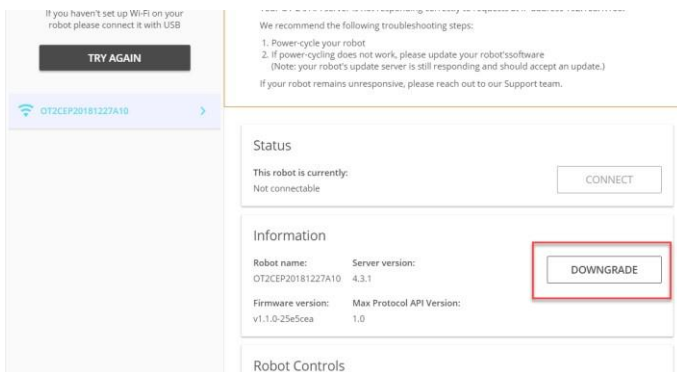
In order to install the Opentrons software V. 3.21.2, please download it from the following link <https://github.com/Opentrons/opentrons/releases/download/v3.21.2/Opentrons-v3.21.2-win-b18059.exe> and follow the installation instructions.

Robot Operating System

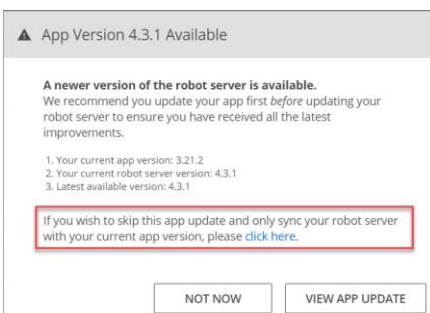
The OT-2 robot comes preinstalled with the version 3.21.2 of the Opentrons Robot Operating System.

Important: The MEA Xpress system is not compatible with newer version of the Robot Operating System. Please make sure that exactly this version of the Robot Operating System is installed and do not perform any updates!

In case the robot was accidentally updated to a different Robot Operating System, please make sure that V. 3.21.2 of the Opentrons software is installed. Start the software and press the “Downgrade” button after selecting the robot:



In the following screen, press the “click here” link to sync the robot server with the app version:



MULTIWELL-SCREEN SOFTWARE

System Requirements

Software: The following Microsoft Windows[®] operating systems is required: 64 Bit Windows 10, (English and German versions supported) with the NT file system. Other language versions may lead to software errors.

Hardware: MEA *Xpress* and a data acquisition computer.

Due to the amount of recorded data, a computer with low performance may lead to performance problems; therefore, Multi Channel Systems recommends an up-to-date computer with SSD drive for recording and an additional HDD for data storage. Please contact MCS or your local retailer for more information on recommended computer hardware specification. Please note that there are sometimes hardware incompatibilities of the data acquisition system and computer components; or that an inappropriate computer power supply may lead to artefact signals.

Important: You need to have installed the latest data acquisition driver to operate the device, which is automatically installed with Multiwell-Screen software. The installation may be invalid if the data acquisition does not respond. Please contact Multi Channel Systems MCS GmbH or your local retailer in this case.

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 Multiwell-Screen. These routines were designed for use on office computers but are not very useful for a data acquisition computer.

- Turn off "Screen Saver".
- Turn off "Windows Indexing Service". Only important for data hard drive.
- Manual management of automatic Windows Update.
- Power Options: Power scheme: Never turn off monitor, hard disk, and system standby.
- It is not recommended to run any applications in the background when using Multiwell-Screen software. Remove all applications from the "Autostart" folder.
- Be careful when using a virus scanner. Exclude data files from being scanned.

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.

Software Installation

Always download the latest version of Multiwell-Screen software from Multi Channel Systems:

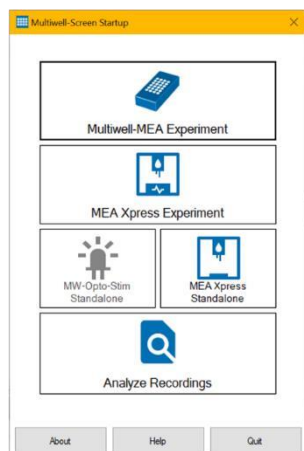
<https://www.multichannelsystems.com/software/multiwell-screen> Start the downloaded

*.exe file and follow the instructions on screen.

MEA *Xpress* Workflow in Multiwell-Screen

The Multiwell-Screen software is used to control the MEA *Xpress* system for automated dilution series preparation and Multiwell-MEA experiments with automated liquid handling. This is mainly done via the MEA *Xpress* wizard in Multiwell-Screen which is described in more detail in chapter 5. This chapter describes how to get started with the MEA *Xpress* in Multiwell-Screen and gives an introduction in the main use cases for the MEA *Xpress* wizard.

Multiwell-Screen Startup



The “Multiwell-Screen Startup” dialog only appears when using the Multiwell-Screen software for the first time after installing Version 2, or if no headstage is connected.

The dialog „Multiwell-Screen Startup” allows to select the devices necessary for the needs of the intended experiment. Do you want to run a simple “Multiwell-MEA Experiment”? Do you need the liquid handler “MEA Xpress” for the experiment? Do you want to use the MEA Xpress or the MW-OptoStim as stand-alone devices? Or are you interested to “Analyze Recordings”, which are already done? Please select the respective button!

The advantage of this initial selection is the automatic adaption of the software modules to your special experimental schedule. Parts of the software you do not need will not be available, so the software is slenderly built and more intuitive. Nevertheless, you have the possibility to change your initial settings while working later.

MEA Xpress Experiment

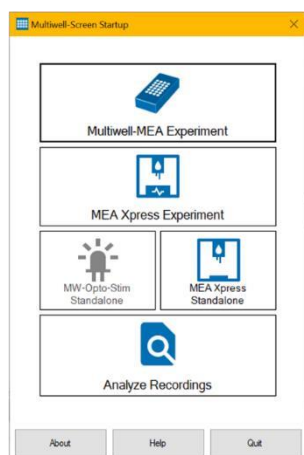
For MEA Xpress experiments, please connect the liquid handler and the MCS Interface Board to the computer. Prepare dilution series or reuse formerly prepared dilution series. Measure the cell activity in the well plate on the headstage. For detailed information about Multiwell-Screen, please see the Multiwell-MEA-System manual.

MEA Xpress Standalone

When using the MEA Xpress robot as a standalone device, please connect the liquid handler only to the computer. A Multiwell-MEA headstage is not necessary. Start the MEA Xpress wizard to prepare dilution series.

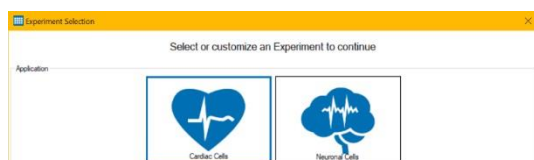
Multiwell-Screen Startup for MEA Xpress

Please select the “MEA Xpress Experiment” in the “Multiwell-Screen Startup” dialog.



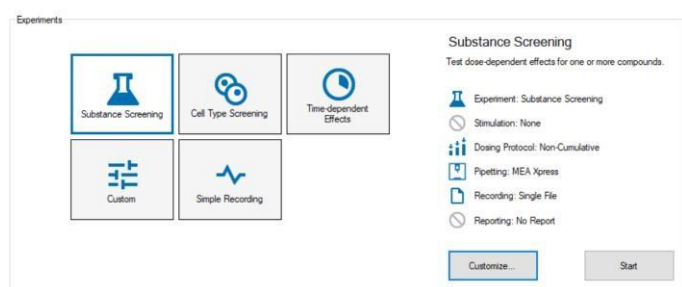
When using the Multiwell-Screen Version 2 software for the first time, define the “Application” mode “Cardiac Cells” or “Neuronal Cells” in the “Experiment Selection” dialog.

MULTIWELL-SCREEN SOFTWARE

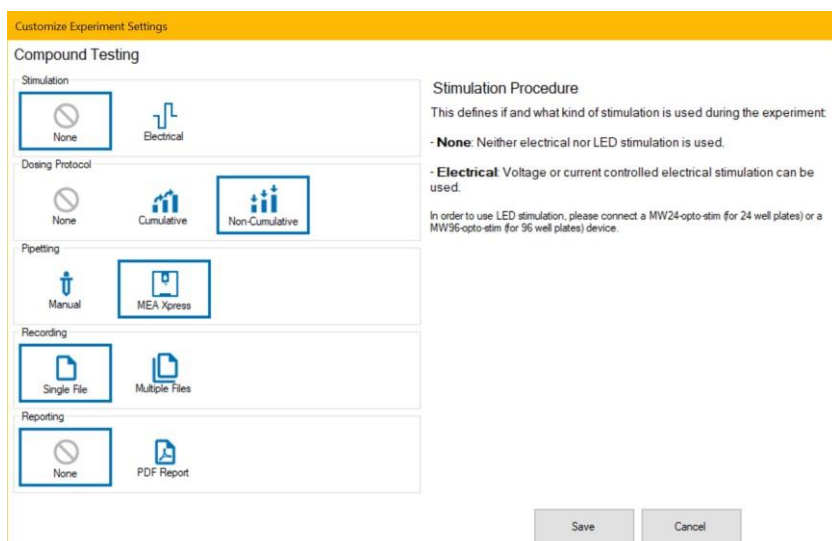


For customizing your experiment, five types are predefined in the “Experiment” window: “Substance Screening”, “Cell Type Screening”, “Time-dependent Effects”, “Custom” and “Simple Recording”.

For use with the MEA *Xpress*, please select, for example the "Substance Screening" experiment.



After selection “Substance Screening”, you can specify the experiment via five suggested modules. Click the “Customize” button to start the “Customize Experiment Settings” dialog.



For use with the MEA *Xpress*, please select only either "Cumulative" or "Non-Cumulative" for the "Dosing Protocol" and make sure that "MEA *Xpress*" is selected for "Pipetting".

Click “Save” to save your settings globally. That means, the software will start next time with all settings defined in this dialog. Nevertheless, you can change the configuration at any time.

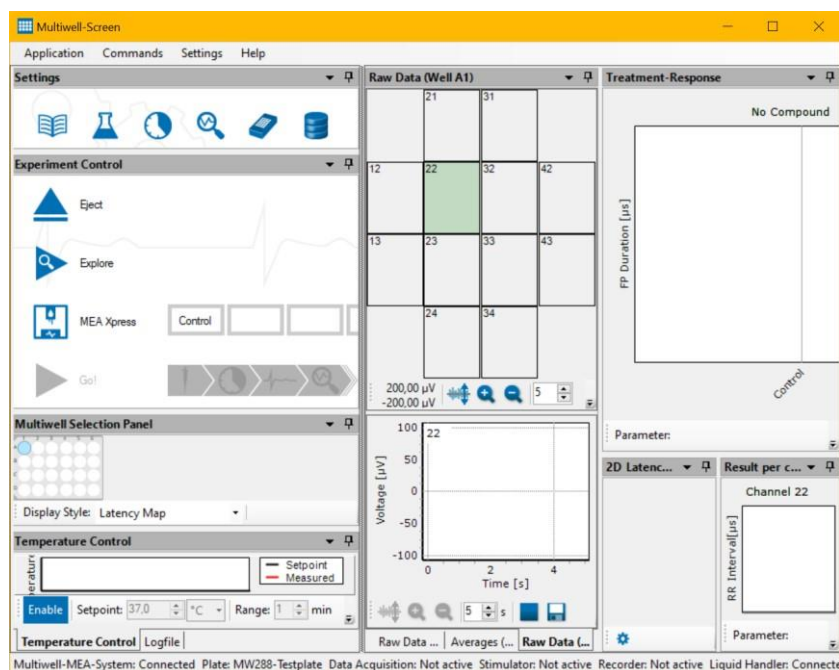
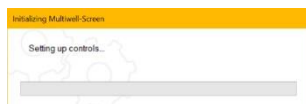


Now the “Substance Screening” experiment is customized:

- Do you want to stimulate? No.
- Which kind of dosing protocol? Non-Cumulative.
- Pipetting mode, with MEA *Xpress* or manual? MEA *Xpress*
- Recording? All data in a single file.
- Reporting: No report necessary.

MULTIWELL-SCREEN SOFTWARE

Click “Start” to run the experiment. A progress bar appears before the Multiwell-Screen software opens.



Use the buttons in the “Settings” section to configure all available tools: “Lab Book”, “Define Compounds”, “Define Experimental Flow”, “Analyzer Settings”, “Data Acquisition Setup” and “Recorder Settings”.

No “Stimulation” icon is available because no stimulation was selected.

Control the experiment via “Experiment Control” window. Insert the respective multiwell plate with “Inject”. „Explore” the experiment flow. Define the “MEA Xpress” with “MEA Xpress Wizard” or load a previously prepared script into the liquid handler device.

For detailed information about the Multiwell-Screen software, please refer to the Multiwell-MEA-System manual.

Please start the “MEA Xpress Wizard” using the “MEA Xpress” button in the “Experiment Control”.



Using the MEA Xpress Wizard

This section gives a high-level overview over the different use cases of the “MEA Xpress Wizard”.

For more detailed information about the individual pages in the wizard, please see chapter 5.

The main purpose of the MEA Xpress is to run automated substance screening experiments with the Multiwell-MEA. Typically, a dilution series of each substance is applied to the Multiwell-MEA and the preparation of these dilution series can be automated with the MEA Xpress as well. This means, we have the following main tasks when working with the MEA Xpress:

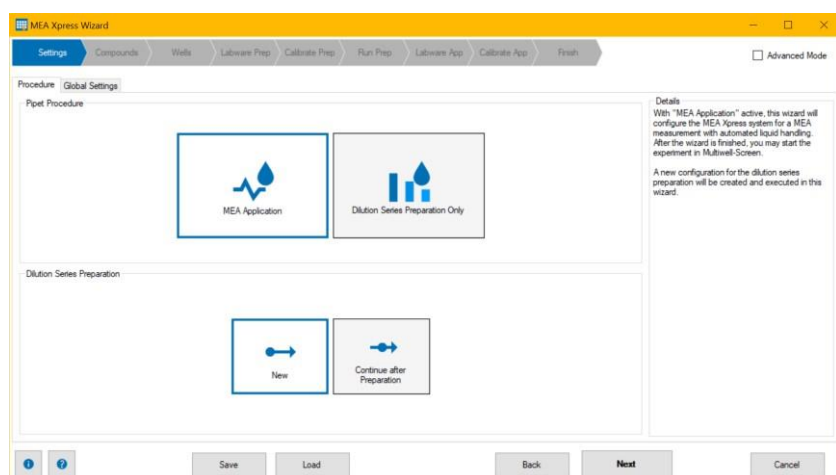
- 1) Define the tested substances, their dilution series, and the assignment to wells on the MEA plate
- 2) Prepare and calibrate the robot for mixing the dilution series
- 3) Automated preparation of the dilution series by the robot
- 4) Prepare and calibrate the robot for the MEA experiment
- 5) Run the MEA experiment. The robot automatically transfers the substance dilutions to the MEA wells

These steps have to be performed in order, but not necessarily all at once. For example, it is possible to do the dilution series preparation (steps 1-3) first, and at a later date use the prepared dilution series to do the MEA experiment (steps 4-5). Because of this, the MEA Xpress wizard can be operated in different modes (If “MEA Xpress Standalone” is used, only Dilution Series Preparation is possible):

MULTIWELL-SCREEN SOFTWARE

- Dilution Series Preparation and MEA experiment (steps 1-5)
- Dilution Series Preparation only (steps 1-3)
- MEA experiment only with previously prepared dilution series (steps 4-5)

These modes are selected on the start page of the MEA *Xpress* wizard.



The wizard will guide you through the necessary steps for the selected mode. The sequence of these steps is shown in the header of the wizard:



In short, these steps have the following functions:

- **Settings:** Set the correct procedure for the wizard and define parameters for the pipetting procedure
- **Compounds:** Define the compounds tested in the experiment and their respective dilution series
- **Wells:** Assign the compounds/dilutions to wells on the MEA plate
- **Labware Prep:** Prepare the necessary labware for the automated dilution series preparation
- **Calibrate Prep:** Calibrate the robot for the dilution series preparation
- **Run Prep:** Run the automated dilution series preparation
- **Labware App:** Prepare the necessary labware for the MEA experiment
- **Calibrate App:** Calibrate the robot for the MEA experiment
- **Finish:** Finish the MEA *Xpress* wizard

Please see chapter 5 for a detailed description of each step.

Multiwell-MEA Experiment with Automated Substance Preparation and Application

This is the default procedure for the MEA *Xpress* wizard: It guides you through dilution series preparation and directly continues with the MEA experiment. It is activated by selecting "MEA Application" and "New" in the "Procedure" tab of the "Settings" page in the MEA *Xpress* wizard. The wizard has the following steps for this procedure:



Finishing the MEA *Xpress* Wizard will return you to Multiwell-Screen, where you can start the MEA experiment.

Automated Substance Preparation as a standalone Function

This mode allows you to prepare only the dilution series for your substances without having to start a MEA experiment directly after. It is activated by selecting "Dilution Series Preparation Only" and "New" in the "Procedure" tab of the "Settings" page in the MEA *Xpress* wizard. If you are using the MEA *Xpress* as a standalone device without Multiwell-MEA headstage, this is the only allowed mode.

The wizard has the following steps for this procedure:



Finishing the MEA *Xpress* Wizard lets you save the configuration as an *.XML file. This file is necessary to use the prepared dilution series in a later MEA experiment.

Multiwell-MEA Experiment with pre-prepared Substance Plates

In this mode, you can run a Multiwell-MEA experiment with a previously prepared dilution series plate. It is activated by selecting “MEA Application” and “Continue after Preparation” in the “Procedure” tab of the “Settings” page in the MEA *Xpress* wizard and providing the *. XML file created by the wizard after preparing the dilution series.

The wizard has the following steps for this procedure:



The “Compounds” and “Wells” steps are only intended to review the configuration. Modifications are not possible because the dilution series have already been prepared. Finishing the MEA *Xpress* Wizard will return you to Multiwell-Screen, where you can start the MEA experiment.

Controlling the MEA Xpress Robot during the Experiment

Description of the performance of the liquid handler during experiment:

The robot always starts automatically after a measuring phase or after a pause phase if a “Pause” is defined.



Click the “Pause” button to stop the robot after the end of the actual movement, click the “Play” button to proceed the movement.

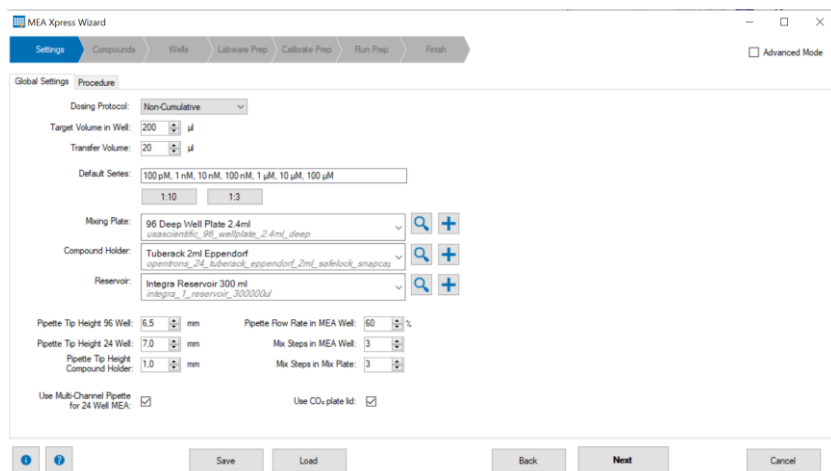
Just as well you can open the front door of the robot to stop the movement. Press “Play” after closing the door to go on.

Click the “Stop” button in the software or the “Stop” button in the front of the robot to cancel the movement of the robot in case of emergency. Additionally, the robot will move the “Home” position.

Note: When cancelling the pipetting procedure of the robot, substances available in the pipette tips may contaminate the pipettes. Please use the “Stop” command in case of emergency only!

After pipetting the actual dose starts the next “Wash-in Phase” if defined, otherwise, a measuring phase.

MEA Xpress WIZARD



MEA Xpress Wizard Header

In the header of the dialog, you see the list of Wizard pages in sequence you have to execute step by step. These steps vary depending on the desired procedure you have chosen before.


Simple Mode versus Advanced Mode


Two options are available, the "Simple Mode" and the "Advanced Mode". In the "Advanced Mode" the "MEA Xpress Wizard" holds one more tabbed page: "Script". This page gives you access to the Python scripts that will be sent to the robot. In addition, there is another tab visible on the "Settings" page: "Script Settings". The "Script Settings" allow fast access to Python templates used to generate command scripts for the robot.

The command scripts offer an overview of the pipette process for the dilution series, so you have much more possibilities for editing than in "Simple Mode". Simple mode will cover almost all applications. Advanced mode should only be used by experienced users for very specific applications.

Note: Be aware that modifying the Python scripts and templates happens at your own risk! It may lead to software errors or unpredictable behavior!"


MEA Xpress Wizard Footer


Click the "Settings" button  in the footer of the dialog to get "MEA Xpress Hardware Information" about the MEA Xpress device.

 Click this button with question mark to "Open the MEA Xpress Manual" for information.

MEA Xpress Hardware Information



Click the "Toggle Robot Lights"  button to switch the light inside the robot on or off.

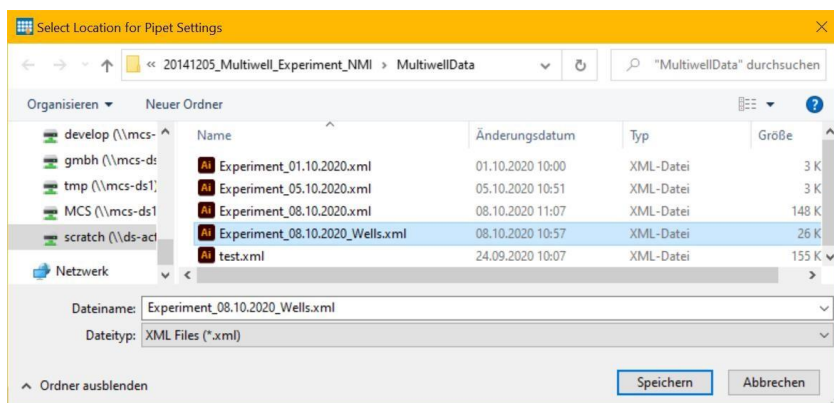
Click the "Home"  button to move the robot in "home" position in case of emergency if no other commands influence or move the robot.

If the robot has any problems and will not reply, please click the “Reset”  button to restart the protocol server of the robot. Please use only in case of trouble!

Note: Clicking the button deletes the current configuration of the robot. Restart the wizard to configure the robot again!

Save and Load

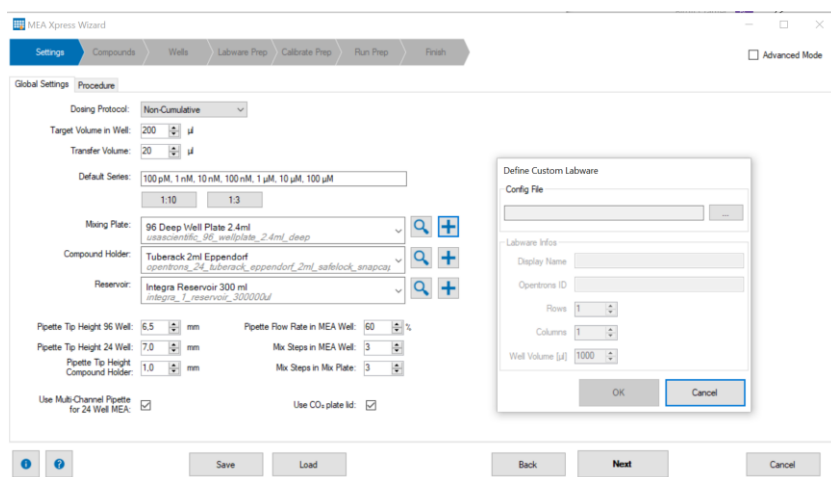
“Save” a robot configuration in a “*.xml” file to “Load” the configuration later. This option is available in each of the “Wizard Pages”.



Navigation: Next and Back

By clicking the “Next” button you will get to the next step, return to the step before with “Back”. If necessary, “Cancel” the experiment setup. The header and the footer of the “MEA Xpress Wizard” dialog are constant. Please find information about the “Wizard Pages” in “Simple Mode” in the following chapters.

Wizard Page “Settings”



Tabbed Page: Global Settings

Dosing Protocol

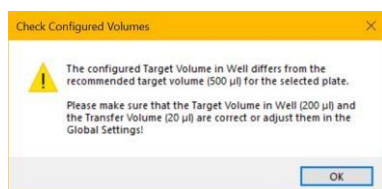
Please define first the type of the “Dosing Protocol” from the drop down menu, “Cumulative” or “Non-Cumulative”.

In cumulative dosing, every well receives all doses in the dilution series. In non-cumulative dosing, only a single dose is applied to each well. This selection can be changed only if the MEA Xpress is used as a standalone device. Otherwise, please use the “Define Experiment” function in the “Application” menu of the Multiwell-Screen main menu to change the dosing protocol.

Definition of Volume

Then you can choose the volumes which will be handled in the experiment from the up down boxes. The “Target Volume in Well” refers to the default values in the wells on the MEA plate, that means 200 µl in 96-well plates and 500 µl in 24-well plates.

The “Transfer Volume” is the volume which is substituted in the MEA well per pipetting step. Usually, 10 % of the target volume is substituted.



If later on in the wizard the error message “Check Configured Volume” comes up, please follow the instructions in the dialog.

Default Series

Define the solution series, the “Default Series” 1:10 or 1:3 are preconfigured. Other series can be manually defined by entering the concentrations in ascending order, separated by commas. Each concentration needs to be given as the value and the unit, separated by a space. For example, this is a valid manually defined dilution series: 200 nM, 3 µM, 40 µM, 500 µM, 6 mM.

Definition of Mixing Plate, Compound Holder and Reservoir



Several types of labware are available from the drop down menus. Select the types of the “Mixing Plate”, the “Compound Holder” and the “Reservoir” from the drop down menus that correspond to the exact labware used. If the correct labware type is not available, see below on how to create a custom labware configuration.



Click the button “View Labware in Opentrons Labware Library” to open the Opentrons web site and to view detailed information about the labware in the library.



Click the button “Add Custom Labware” to add custom labware that is not available via the drop down menus. In the “Define Custom Labware” dialog, you need to load a labware configuration *.json file created by the “Opentrons Labware Creator” (<https://labware.opentrons.com/create/>).

Please follow the instructions on the “Opentrons Labware Creator” page to create the labware configuration and download it. After opening the downloaded *.json file in the “Define Custom Labware” dialog, please review the labware details shown in the dialog and press “OK” to add the labware to the MEA Xpress wizard. After that, the new labware will always be available in the MEA Xpress wizard.

Definition of Pipette Position Parameter

Define the “Pipette Tip Height 96 Well” and the “Pipette Tip Height 24 Well” in mm and the “Pipette Flow Rate in MEA Well” in % from the up down boxes.

The “Pipette Tip Height” refers to the height of the pipette tip inside the well in relation to the bottom of the well. If the tip is positioned too low, the procedure of pipetting may disturb the cells inside the well. If the tip of the pipette is positioned too high, it will not reach the liquid level in the well.

Click the check box “Use Multi Channel Pipette for 24 Well MEA”, if necessary. Use the option “Multi Channel Pipette for 24 Well MEA” to allow the use of the 8-channel pipette with 24 well MEA plates. This can speed up the compound application to the MEA well considerably compared to using only the single channel pipette.

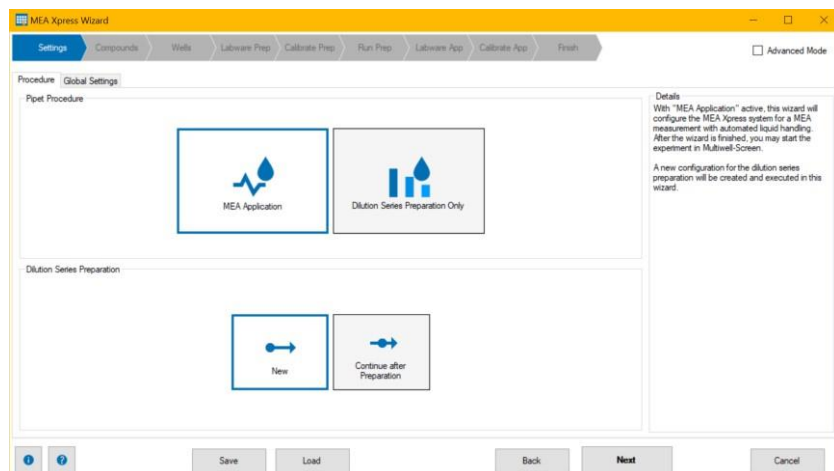
Click the check box “Use CO₂ plate lid” for experiments with the PAL24/96, the pipettor atmosphere lid for CO₂ application to the wells.

The “Pipette Flow Rate” defines the pipette aspirate and dispense speed within the MEA well as a percentage of the maximum pipette speed. The faster the pipette procedure, the higher the risk to disturb the cells in the well plate.

Define the number of “Mix Steps in MEA Well” or the number of “Mix Steps in Mix Plate” via up down boxes. This is how often the pipette will mix the liquid in one MEA well or in the wells of the mix plate.

Important: If “Use Multi Channel Pipette for 24 Well MEA” is active, it is necessary to prepare the tip racks manually in a certain way (see the section “Wizard Page “Calibrate App” in chapter 5) and a minimum well volume of 500 µl is required in the MEA wells.

Tabbed Page: Procedure



Procedure

Define the assignment of the liquid handler in the “Procedure” tab.

Pipet Procedure

Click “MEA Application” to create a dilution series and use it in the following Multiwell-MEA experiment when using the MEA Xpress together with a Multiwell-MEA-System.

The option “Dilution Series Preparation Only” is for preparing a new dilution sequence. This is the only option when using the MEA Xpress as a standalone device.

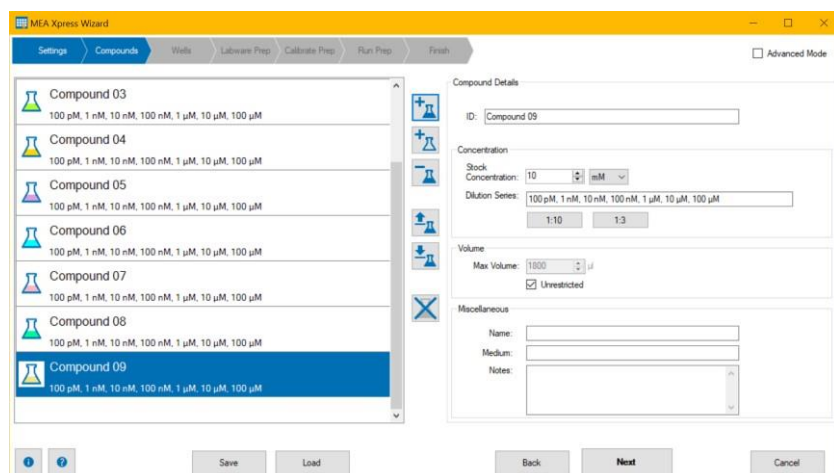
Dilution Series Preparation


Select option “New” in the “Dilution Series Preparation” section and a new dilution series will be created and executed the wizard.

Click “Continue after Preparation” to load an earlier prepared dilution series to apply this to the MEA in the experiment after preparing the dilution series.

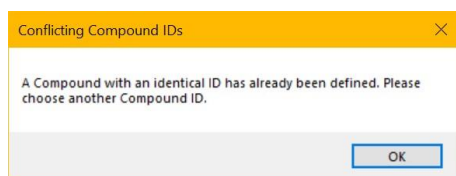
Find a short description about the available option in “Details”. Click the button “Next” to proceed to the next step.

Wizard Page “Compounds”




Click the icon  „Add Compound” as often as necessary for the experiment schedule. Define each compound separately in the “Compound Details” section.

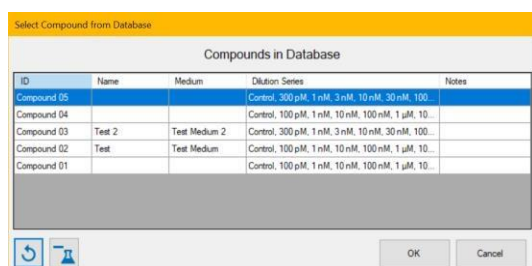
Remove one compound with the “Remove Compound”  button, remove all with the  “Remove All Compounds” button.



If compound IDs have already be defined, the software creates this warning message: “Conflicting Compound IDs”.



For saving a compound in the database, click the button “Store the selected Compound” . The following dialog appears “Select Compound from Database”.



Save the compound in the database or select one of the present compounds from the database.



Load a compound from this database. Reload the database



or remove



a compound. Click “OK” to finish the database dialog.

Compound Details

Fill in information for each compound separately: “Compound Details”, “Concentration”, “Volume”, and “Miscellaneous”.

The software labels each compound with a unique “ID” and a color code. The ID is used throughout the software to identify the compound. The “Stock Concentration” and the “Dilution Series” may be different for each compound.

Define the “Stock Concentration” for each compound. This is the concentration you have to provide in the Eppendorf tubes in the liquid handler. Define the “Max. Volume” in μl or click the check box “Unrestricted”.

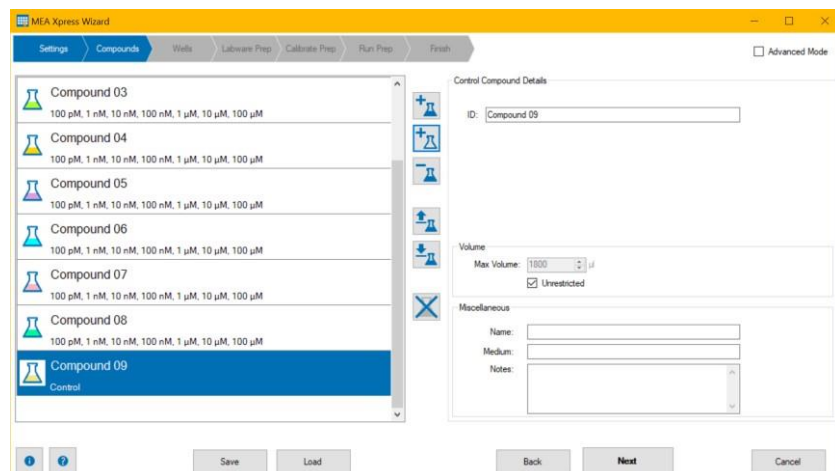
For a better overview, please identify the compounds additionally by a user defined “Name”, the “Medium” or some “Notes”. To handle major differences in stock concentration and used concentrations, the software will add intermediate steps for a dilution to the desired concentration.

Control Substances

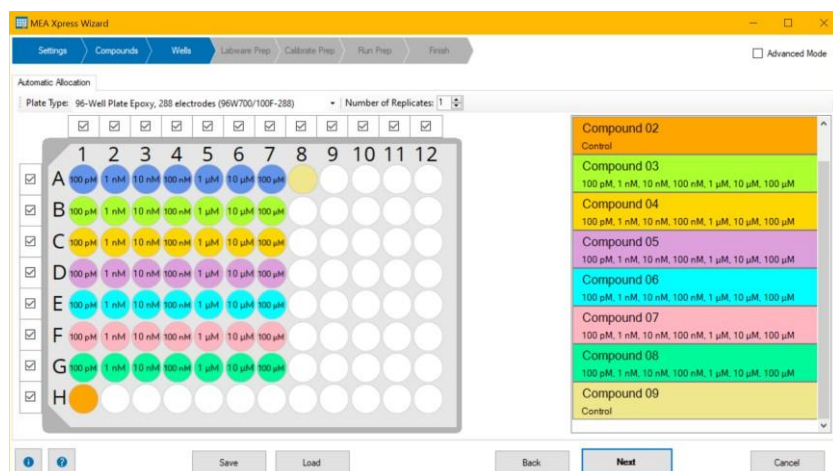


Click the “Add a new Control” button.

Click the "Add Control" button to add control substances to the experiment. Controls are not diluted, the stock solution is added directly to the MEA well in each pipetting step. This can be useful, for example when using cell medium as a negative control in the experiment. Because the stock solution is directly used for controls, neither the stock concentration nor the dilution series needs to be specified. Respectively, the “Control Compound Details” do not include the part “Concentration”.

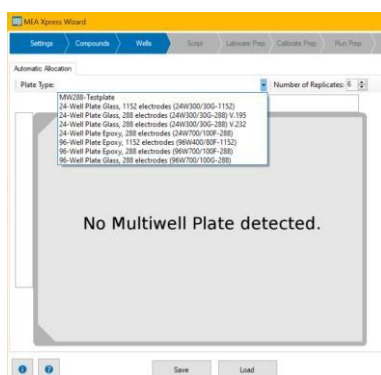


Wizard Page “Wells”



Distribution of the “Compounds” to the wells of the 96-well MEA plate. Compound 02 and 09 are control substances.

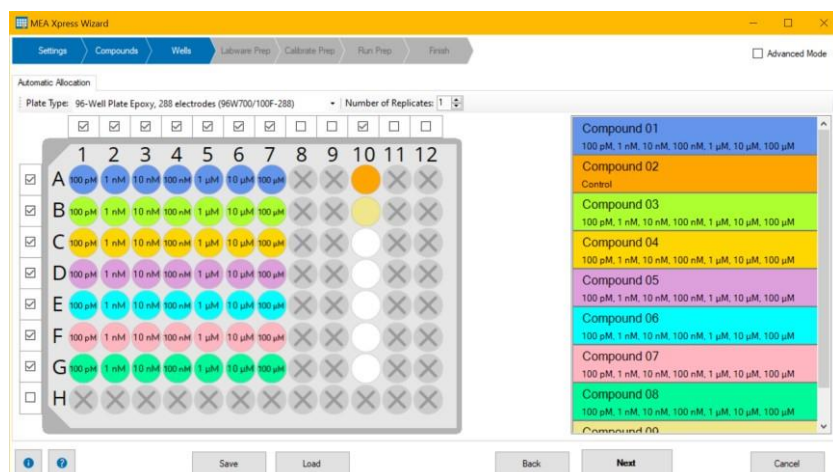
If no MEA plate is inserted in the Multiwell-MEA headstage or the wizard is running in standalone mode, the software will prompt you to select the desired MEA plate.



Automatic Allocation

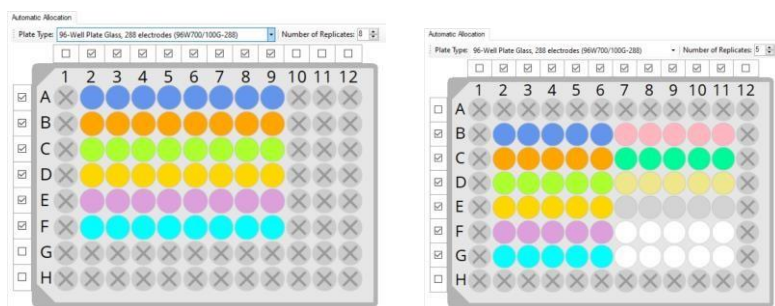
This step allows you to influence which compounds are allocated to which wells on the MEA plate.

Select the “Plate Type” from the drop down menu if no plate is inserted in the MEA headstage. Define the “Number of Replicates” which is the same number for all substances from the up down box.

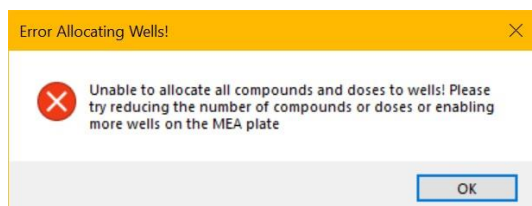


The software finds distribution patterns, which are most efficient, for example when using an 8-channel pipette for a 96-well plate. These patterns will usually distribute compounds row-wise on the MEA plate with the intention to change pipette tips as rarely as possible. Furthermore, the user may disable dedicated rows or columns by clicking the respective check boxes beside.

MULTIWELL-SCREEN SOFTWARE



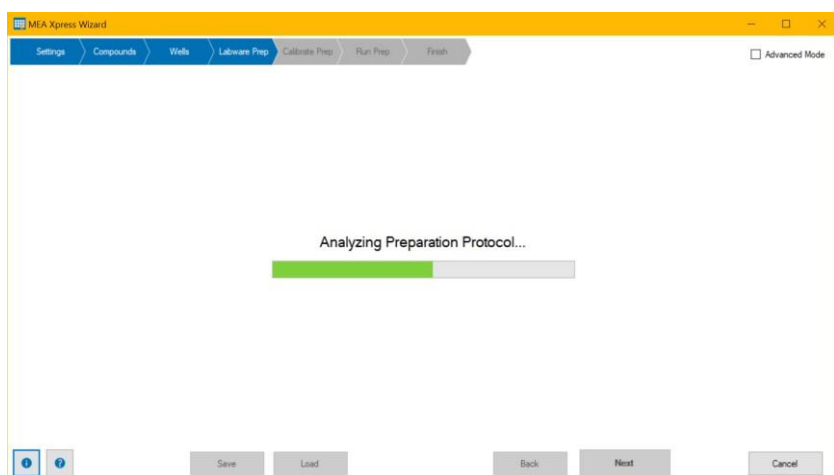
If an allocation is not possible, the Multiwell-Screen software sends this error message. Please follow the instructions in the dialog “Error Allocating Wells”.



Important: If you disable rows and the 8-channel pipette is used during the experiment, please be aware that a solution change might still happen in the wells in disabled rows. This is the case because the pipette will pick up tips on all channels, so it might access disabled wells. In order to prevent this, please remove the pipette tips in the tip rack corresponding to the disabled rows before running the MEA experiment.

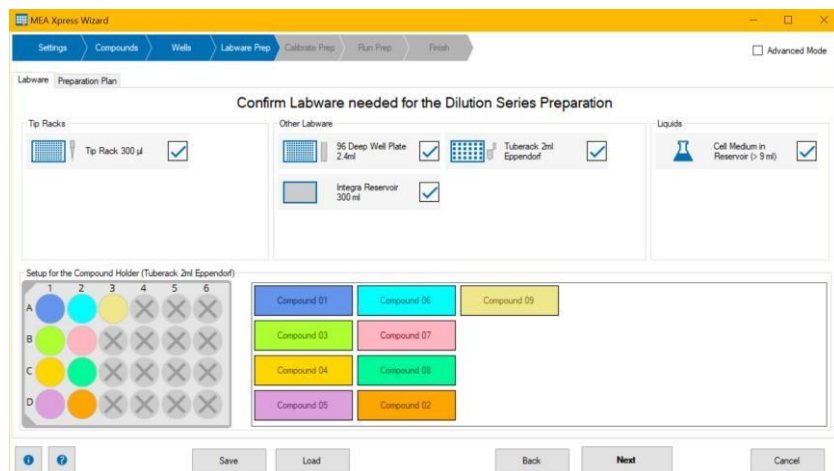
Wizard Page “Labware Prep”

After the distribution of the substances, in the next step “Labware Prep” the software analyzes the protocol “Analyzing Preparation Protocol”. The software generates a Python script and sends it to the robot. This script will be simulated on the robot to make sure, it is possible to execute the desired procedure.



The procedure takes a few seconds until the next dialog appears. Then, the robot sends back information about the labware, which is needed.

View Labware



Confirm Labware needed for the Dilution Series Preparation

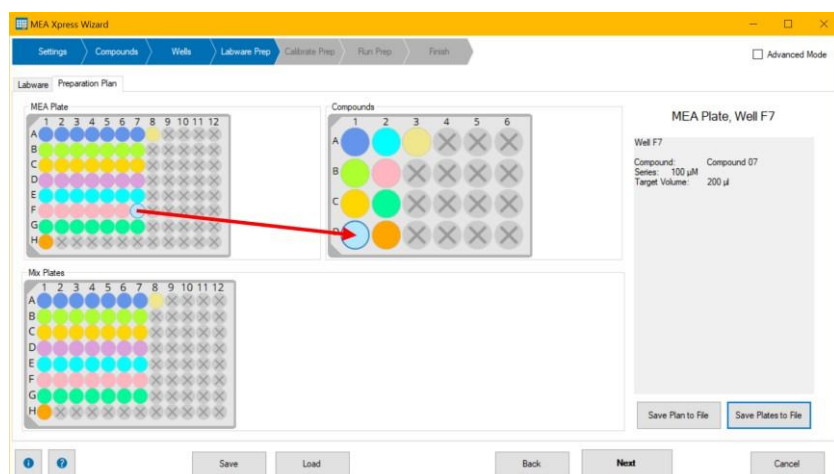
Confirm the labware via check box in three sections: “Tip Racks”, “Other Labware” and “Liquids”.

The analysis in this example makes following labware necessary: One “Tip Rack” filled with 300 µl pipette tips, a “96 Deep Well Plate with 2.4 ml”, a “Tube Rack” for 2 ml Eppendorf tubes, a “Reservoir” holding 300 ml and at least a “Cell Medium in Reservoir” with more than 12 ml. Please be aware that this is the absolute minimum volume for the cell medium. In reality, more cell medium needs to be provided to ensure that the pipettes can aspirate enough liquid without aspirating air bubbles.

Please use the check boxes to confirm that the equipment is available.

The “Setup for the Compound Holder (Tube Rack 2 ml Eppendorf)” is displayed in the lower part of the dialog. Insert the compounds in Eppendorf tubes in the recommended pattern with the appropriate stock concentration.

View Preparation Plan



The tabbed page "Preparation Plan" contains an overview of the individual pipetting steps for the preparation of the dilution series. It shows the layout of the “MEA Plate”, the “Compounds” holder and the necessary “Mix Plates”.

Click on wells on the MEA plate to get information about the compound and dilution series applied to each well. Select wells in the compound holder to view the configuration of the compound. Click wells on the mix plate for details of the dilution steps.

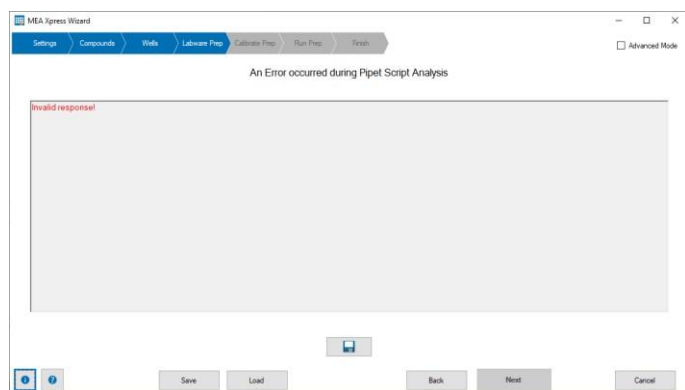
The "Save Plan to File" button allows you to save a text file containing all planned pipetting steps for dilution series preparation.

Pressing the "Save Plates to File" button creates a *.pdf file containing images of the compounds holder and the mix plates. For the mix plates, the images also show the planned concentrations within each well.

Troubleshooting

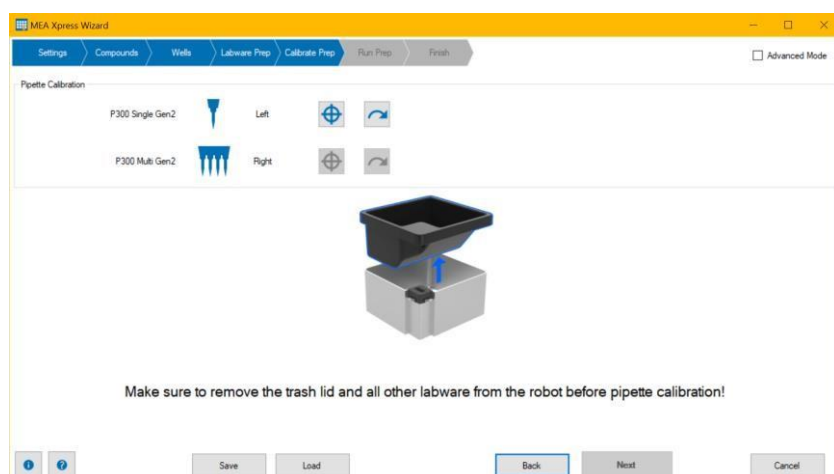
If there is an error during script simulation, the error message is shown in red in the error window.

You can use the "Save" button to save all diagnostic information to a zip file. See below for a non-exhaustive list of possible error messages and troubleshooting information:



Message	Cause of the Error	Troubleshooting
Invalid response!	Indicates a communication failure with the robot.	Make sure that the robot is switched on and connected to the PC. Use the MEA Xpress "Hardware Information" button to investigate the state of the robot and make sure it responds e.g. to toggling the robot lights. If the robot responds to the commands, restart the pipet script analysis. If the problem persists, restart the "Protocol Server" from the MEA Xpress "Hardware Information" dialog, wait a few seconds and restart the MEA Xpress wizard. If this does not fix the problem, power cycle the robot and restart the MEA Xpress wizard.
Error in Protocol:...	Indicates a syntax or logic error in the simulated Python protocol.	If you have modified the automatically generated protocols via the "Advanced Mode" of the MEA Xpress wizard, please check your modifications for errors. The error message will usually indicate the line number where the error happened. If you have not modified the protocols or are unsure of the cause of the error, please save the diagnostic to a file and contact MCS support.
Comparison with simulation failed:...	Indicates that the simulated robot actions differ from the planned actions.	After the script has been simulated on the robot, the MEA Xpress software checks whether the simulated robot actions would create the same concentrations and amounts of volume in each well as planned. This error message occurs if there is a significant discrepancy between the two. If you have modified the automatically generated protocols via the "Advanced Mode" of the MEA Xpress wizard, please check your modifications for errors. Otherwise, this may indicate a software bug. In this case, please save the diagnostic information to a file and contact MCS support.
Unable to parse and interpret simulation log	Indicates an error parsing the simulation information from the robot.	If you have modified the automatically generated protocols via the "Advanced Mode" of the MEA Xpress wizard, please check your modifications for errors. Otherwise, this may indicate a software bug. In this case, please save the diagnostic information to a file and contact MCS support.

Wizard Page "Calibrate Prep"



Pipette Calibration

Opentrons recommends calibrating the labware and pipettes each time before you start an experiment. It is possible to skip this step, but this may lead to positioning problems of the pipettes and happens at your own risk.

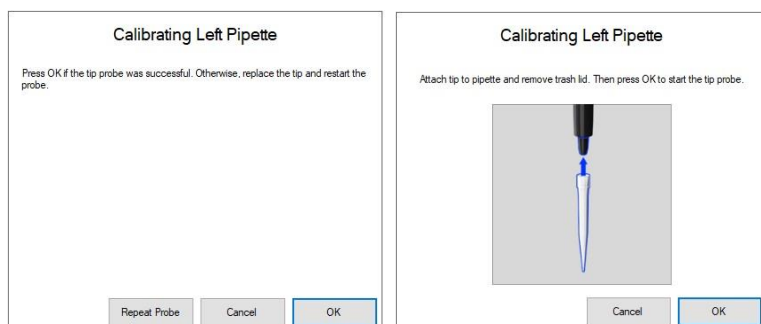
Please make sure the MEA *Xpress* robot is ready for pipette calibration and remove the trash lid and all other labware from the robot before pipette calibration!

Please make sure to closely follow the instructions of the calibration wizard. First, put an Opentrons 300 μ l pipette tip on the pipette.

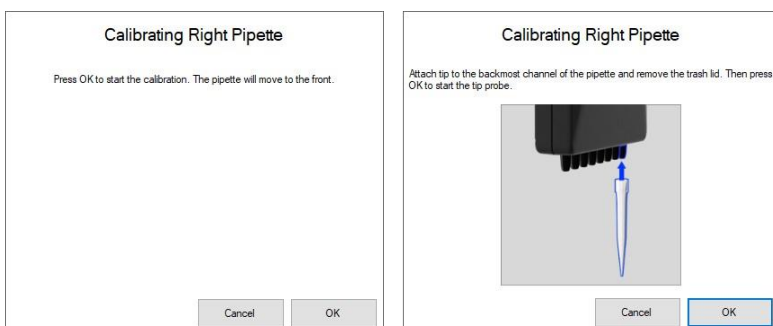
Note: Pipette tips from other manufacturers might not work properly.



Start with the calibration of the single pipette "P300 Single Gen2" on the left by clicking the "Calibrate" button.



Then calibrate the 8-channel pipette "P300 Multi Gen2" on the right. As shown on the graphic below, the tip needs to be fixed on a definite place of the multi channel pipette!



Note: In case of the multi channel pipette, the tip needs to be placed on the back most channel!

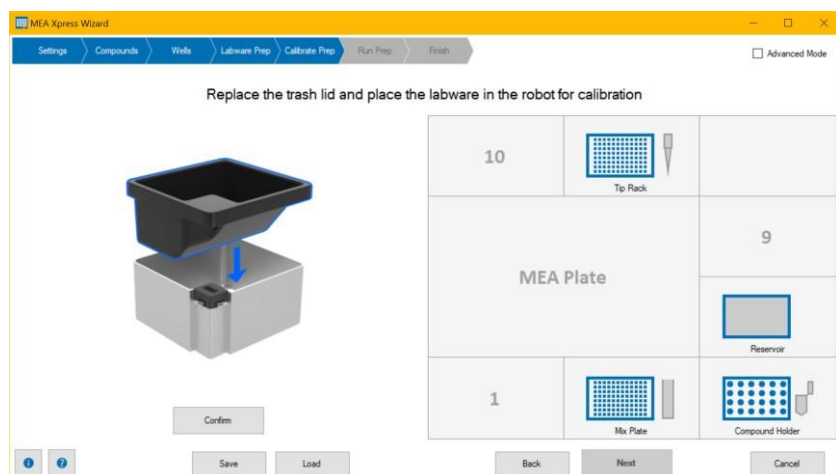


Removing the trash lid exposes five switches that are used as reference points for pipette calibration.

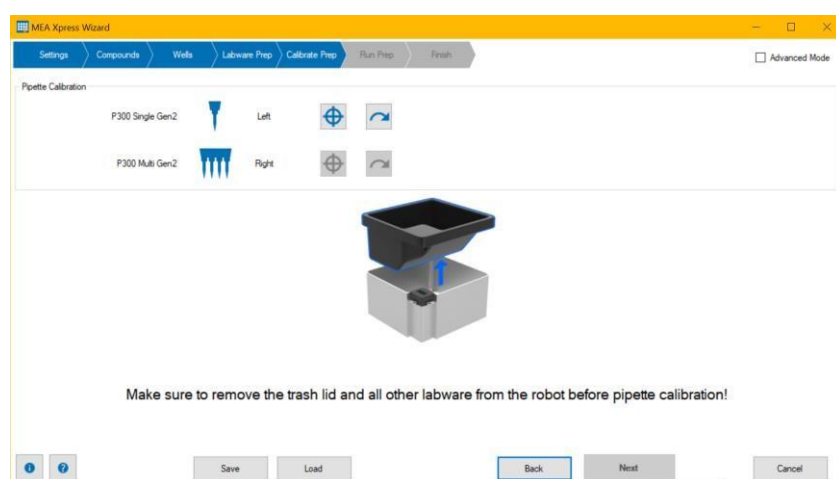
After pressing "OK" on the first dialog, the pipette will move towards these switches in a fixed pattern.

It will first hit the four switches on the side of the trash compartment and then move vertically from the top towards the switch in the center. If all switches have been hit successfully, press "OK" to finish the pipette calibration and then remove the pipette tip. If the tip probe produced an error, for example, because one or more switches have been missed or the pipette has fallen off, press "Repeat Probe" to redo the pipette calibration.

MULTIWELL-SCREEN SOFTWARE



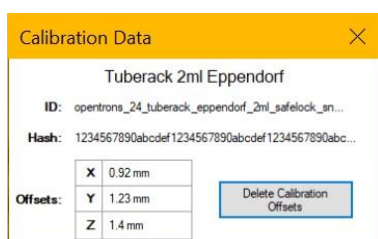
Click the button “Confirm” after “Replace the trash lid and place the labware in the robot for calibration”. The next dialog appears.



This dialog shows the distribution of the labware on the MEA Xpress robot: “Select labware for calibration”. Please calibrate the “Tip Racks” and the “Other Labware”.

Tip Racks

Press the “Labware and Calibration Info” button to view the calibration data stored on the robot. You can use the “Delete Calibration Offsets” button to reset the calibrated values of the labware. This can be helpful if the stored calibration data prevents any further calibration.

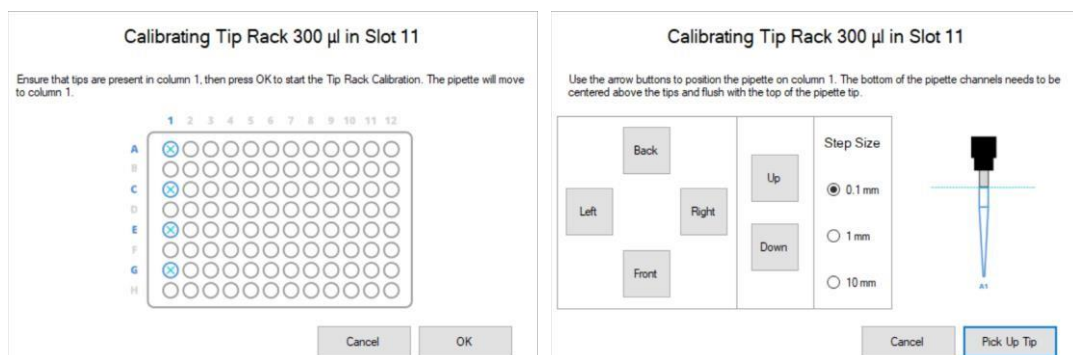


However, please make sure to perform a proper calibration of this labware after the calibration offsets have been deleted!

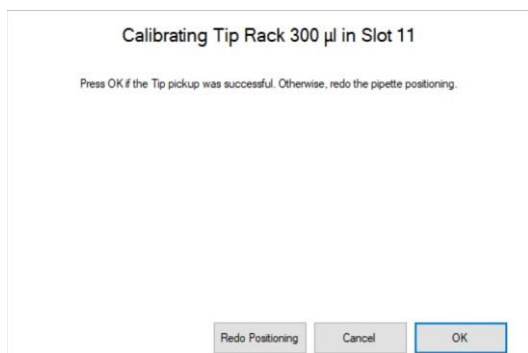
Start the calibrating process with the tip rack.

The tip racks need to be calibrated before the other labware because the calibration of the other labware needs to happen with tips on the pipettes. In this example, a tip rack needs to be placed in slot 11. From the drop down menu, you can select whether the multi or the single channel pipette will be used for calibration.

MULTIWELL-SCREEN SOFTWARE



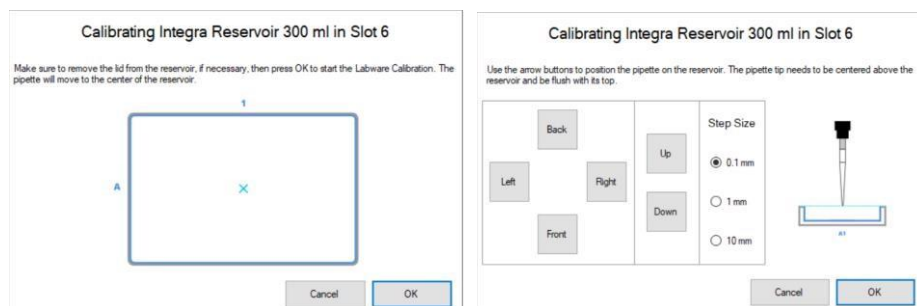
Please calibrate “Tip Rack 300 µl in Slot 11”. Use the buttons “Back”, “Front”, “Left” and “Right” to navigate the tip exactly into its position. Vary the “Step Size” when moving closer. The bottom of the pipette tip needs to be centered above the tip and flush with the top of the pipette tip. Click “Pick Up Tip” to finish this calibration.



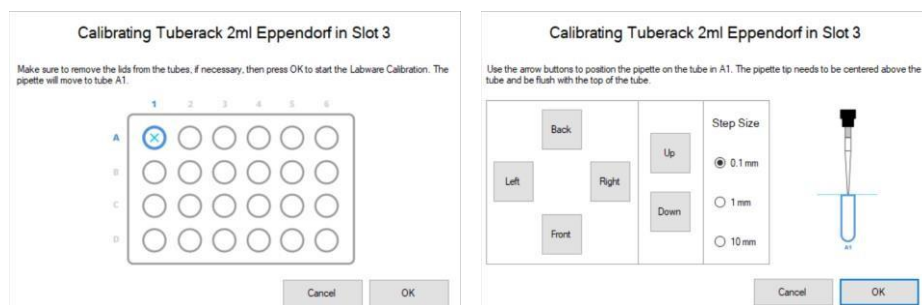
Press “OK” when calibration was successful and a pipette tip was picked up.

Other Labware

Reservoir from Integra

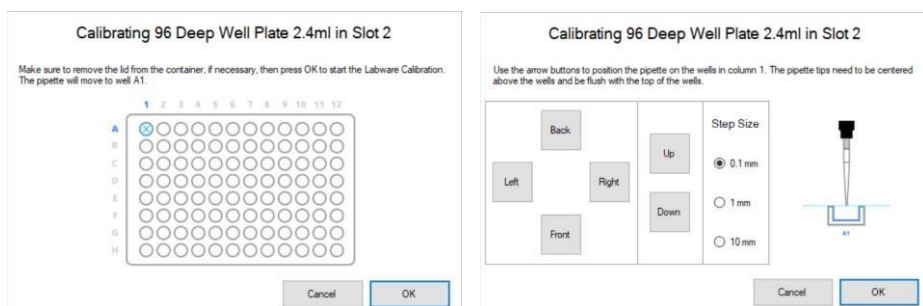


Calibrate the “Integra Reservoir 300 ml in Slot 6” in the same manner as before.

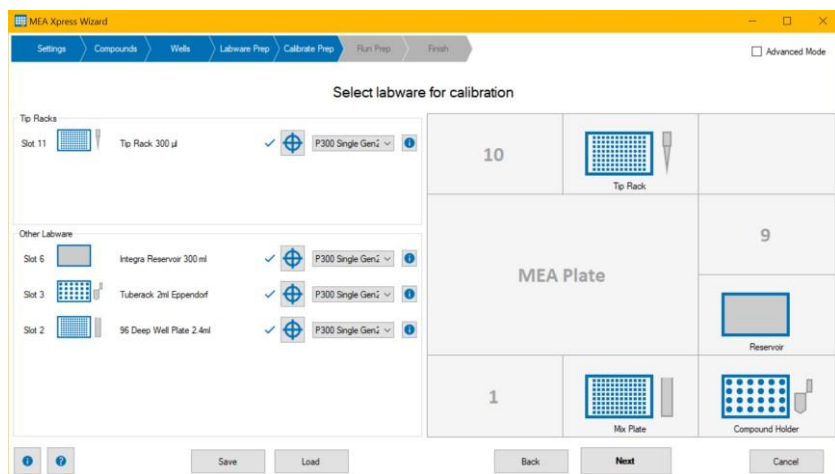


Calibrate “Tube Rack 2 ml Eppendorf in Slot 3”.

MULTIWELL-SCREEN SOFTWARE

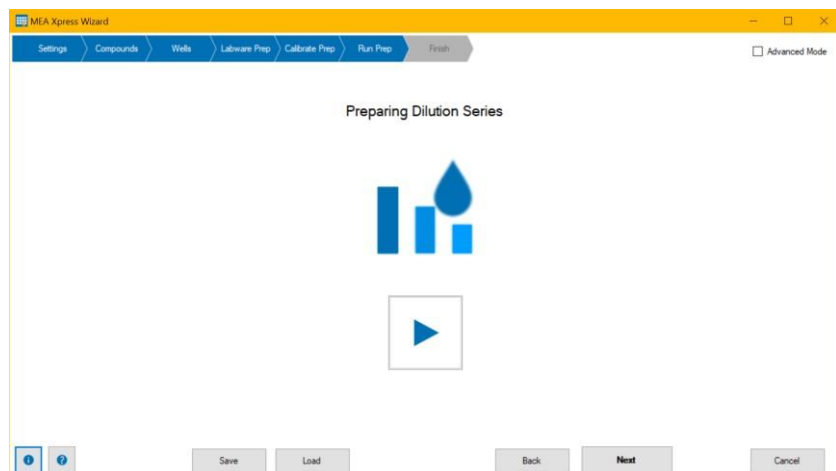


Calibrate "96 Deep Well Plate 2.4 ml in Slot 2".



After finishing the labware calibration, you can go on, please click button "Next".

Wizard Page “Run Prep”



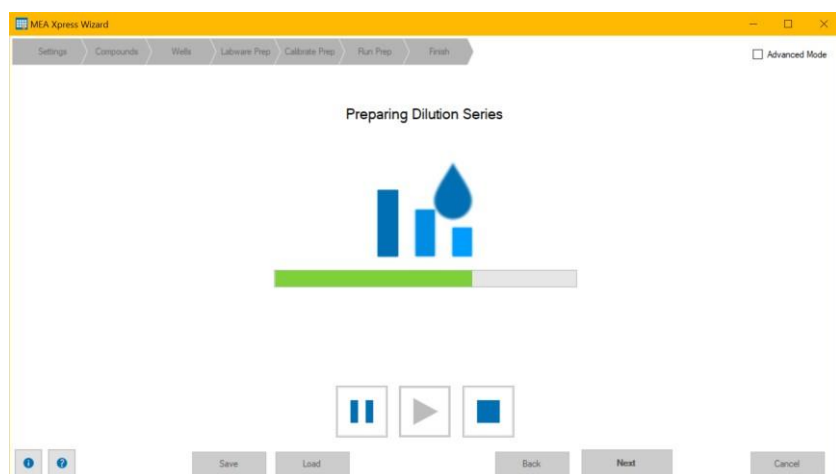
Please click the “Start” button. Preparing a dilution series takes a little bit time.

The first step of “Preparing Dilution Series” is the transfer of cell medium to the mix plate(s) with the multi channel pipette. The robot may aspirate a bit more cell medium than needed before dispensing it to the mix plate and blow out the rest to the trash. This increases the precision of the volume delivery. Depending on the configuration of the compounds and dilution series, the single channel pipette may also transfer cell medium to some wells in the mix plate.

After that, the single channel pipette starts with the transfer of the compounds from the tubes in the compound holder to the mix plate(s). Depending on the configured compounds either the single channel or the multi channel pipettes will then perform a serial dilution of the compounds to achieve the desired dilution series.

The lowest concentration will be placed in the first column of the mix plate, next concentration in the second row, and so on. If the step size in the dilution series is too large to perform the dilution in a single step, the pipettes will add intermediate steps. When performing the dilution, substances in the mix plate will be mixed three times in each step.

If a lot of substances have to be worked on, a second mix plate may be necessary.



Click the “Pause” button to stop the robot after the end of the actual movement, click the “Play” button to proceed the movement.

Just as well you can open the front door of the robot to stop the movement. Press “Play” after closing the door to go on.

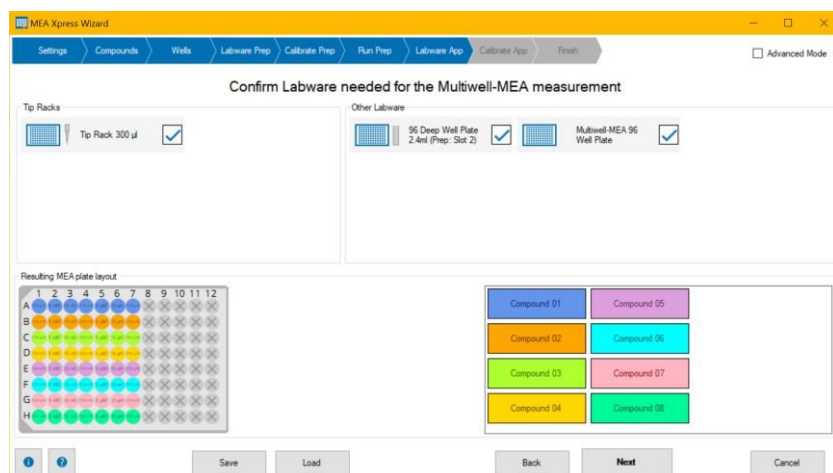
Click the “Stop” button in the software or the “Stop” button in the front of the robot to cancel the movement of the robot in case of emergency. Additionally, the robot will move the “Home” position.

Note: When cancelling the pipetting procedure of the robot, substances available in the pipette tips may contaminate the pipettes. Please use the “Stop” command in case of emergency only!

Wizard Page "Labware App"

In this step, the software generates a Python script that controls the application of the compounds to the MEA plate during the experiment. This script is simulated by the robot to make sure that it is valid and can be executed.

After the script simulation has finished, which can take several seconds, the robot sends back information about the necessary labware.



Confirm Labware needed for the Multiwell-MEA Measurement

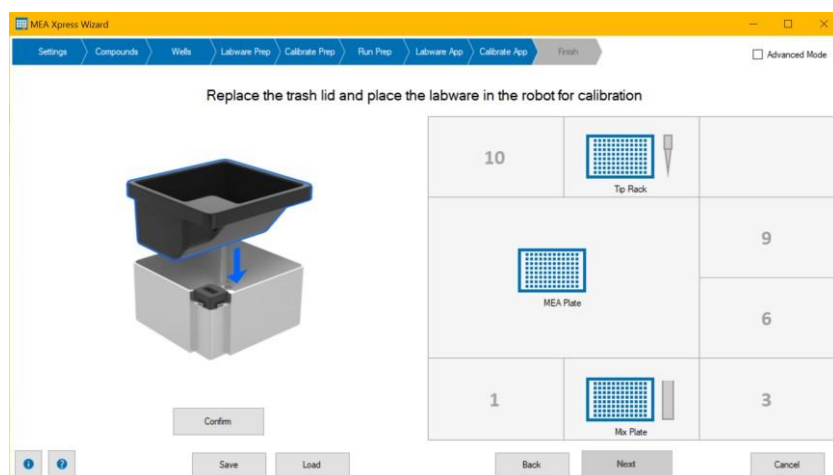
Confirm the labware via check box in the sections "Tip Racks" and "Other Labware". The analysis in this example makes the following labware necessary: One "Tip Rack 300 µl", a "96 Deep Well Plate" which is located in slot 2 during dilution series preparation, and a "Multiwell-MEA 96 Well Plate".

Please use the check boxes to confirm that the equipment is available.

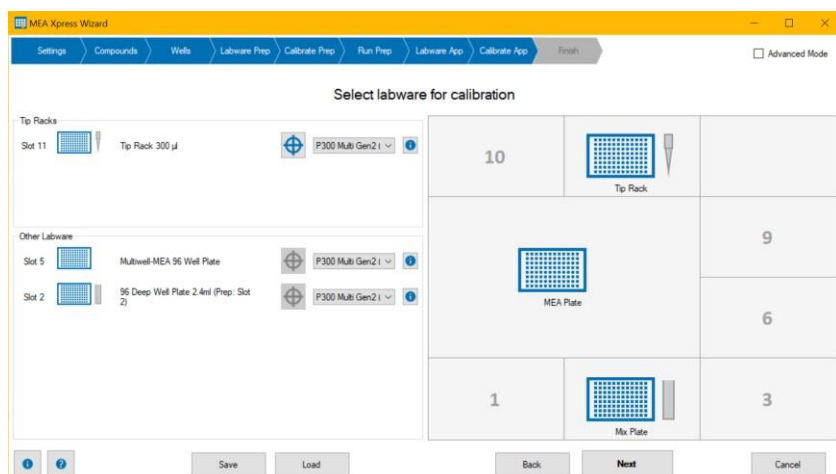
The "Resulting MEA plate layout" is displayed in the lower part of the dialog as a reminder.

Wizard Page "Calibrate App"

This wizard page controls the calibration procedures for the pipettes and labware necessary for the application to the Multiwell-MEA plate. It behaves almost identical to the "Calibrate Prep" page.



Press "Confirm" after replacing the trash lid and placing the labware.

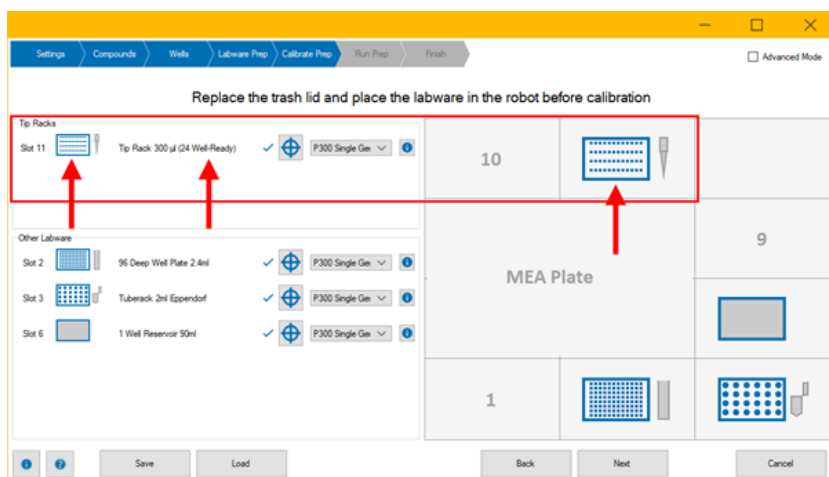


“Select Labware for Calibration” as shown in the step before “Labware App”.

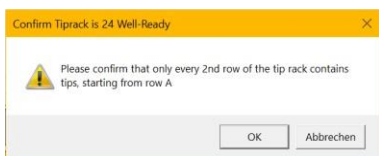
Special cases on the Wizard Page "Calibrate App"

Tip Racks for 24 Well MEA plates

If the 8-channel pipettes is used for 24 well MEA plates, it is very important that the tip racks has to be prepared in a specific way: Only every second channel on the pipette can have a tip, otherwise the pipette would collide with the MEA plate. This is referred to in the software as "24-well ready" tip racks.



Use of the Tip Rack with 24 Well MEA Plate

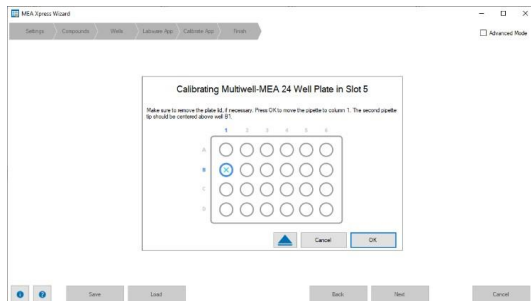


Please take care when calibrating a tip rack for use with a 24 well MEA plate. The upcoming dialog “Confirm Tip Rack is 24 Well-Ready” points out to the different configuration of the tip rack. Fill the tip rack with tips in each second row, starting at slot A1, as shown on the photo below.



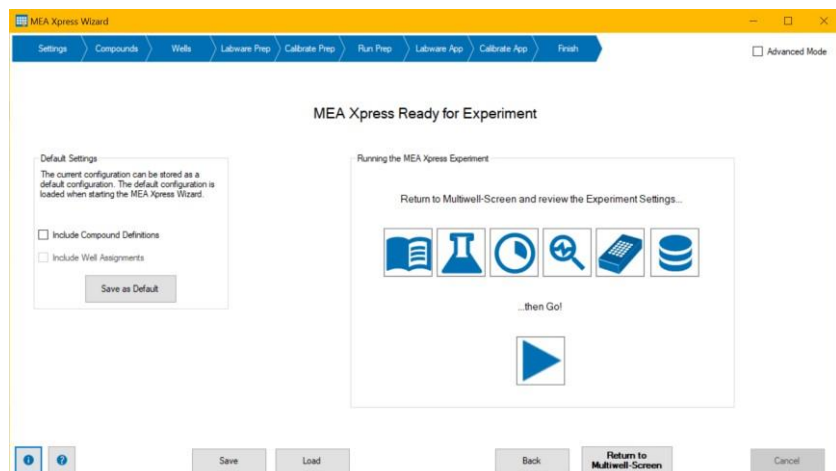
Calibrating the 24 or 96 Well MEA Plate

When calibrating the MEA plates, they need to be inserted into the headstage before calibration. If necessary, please use the “Insert/Eject” button in the wizard to insert the MEA plate.



Please also make sure to remove the lid from the MEA plate before calibration. Because the position of the pipette tip inside the MEA well is critical to avoid mechanical stress for the cells during pipetting (pipette tip is too deep in the well) and aspirating air because the tip is above the fluid level (pipette tip too high), please ensure that the pipette tip is perfectly level with the top of the well. As seen in the image above, for 24 well MEA plates it is necessary to align the second tip on the pipette with the center of well B1. This makes sure that the other 3 pipette tips are close enough to the center of their respective wells.

Wizard Page "Finish"

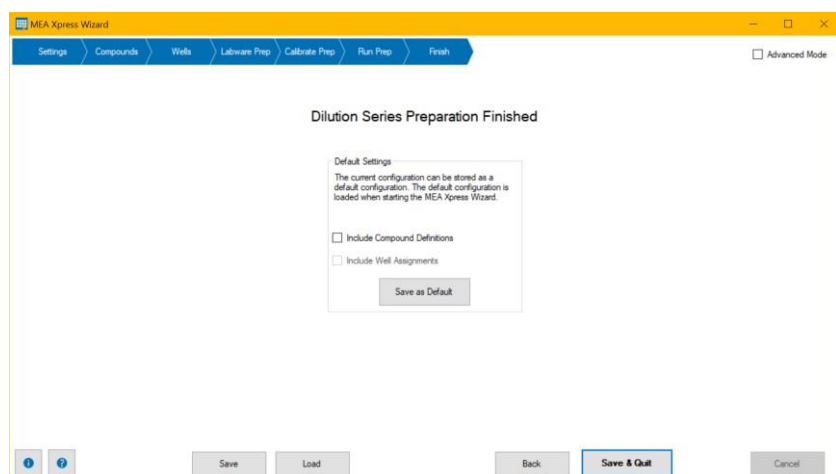


"The "Finish" page behaves almost identical to the "Finish" page when creating dilution series only.

However, after pressing "Return to Multiwell-Screen" button, the wizard closes and the information about the prepared dilution series is transferred to Multiwell-Screen, which is now ready to start the measurement. Please review the other settings such as the timing of the experiment before actually starting the experiment.

It is also recommended to run the "Explore" phase at least for 10 seconds to get an overview of the data. After that, please press the "Go!" button to start the experiment.

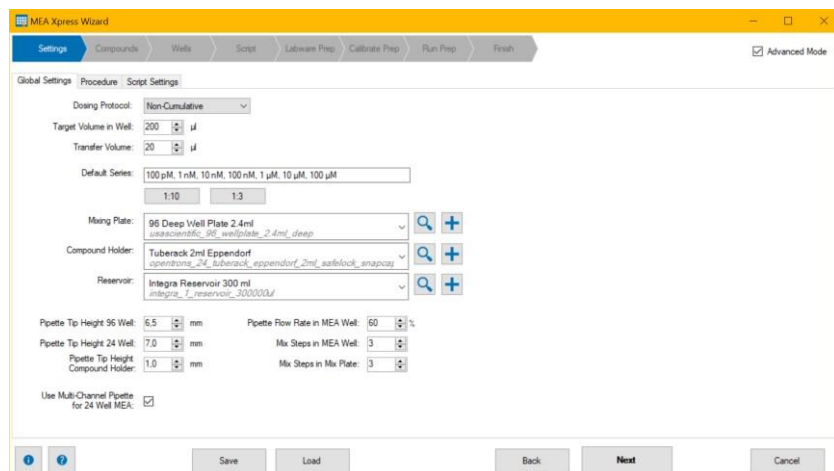
Wizard Page „Finish“ in standalone Mode



Click button "Save as Default" in "Default Settings" to store the current configuration as default. It will be reloaded each time you start the MEA Xpress wizard.

When using the liquid handler as standalone device, the "MEA Xpress Wizard" will now be closed. If you have selected the "MEA Application" procedure, please see section "MEA Xpress Wizard for Multiwell-MEA Experiments" for more information on the steps the wizards takes to prepare the application of the substances to the MEA.

Advanced Mode



Advanced users may work in the “Advanced Mode” by activating the check box in the header. The “MEA Xpress Wizard” holds one more tabbed page: “Script”.

In “Advanced Mode” you have access to the Python scripts available for the different software parts. This allows much more possibilities for editing than in “Simple Mode”.

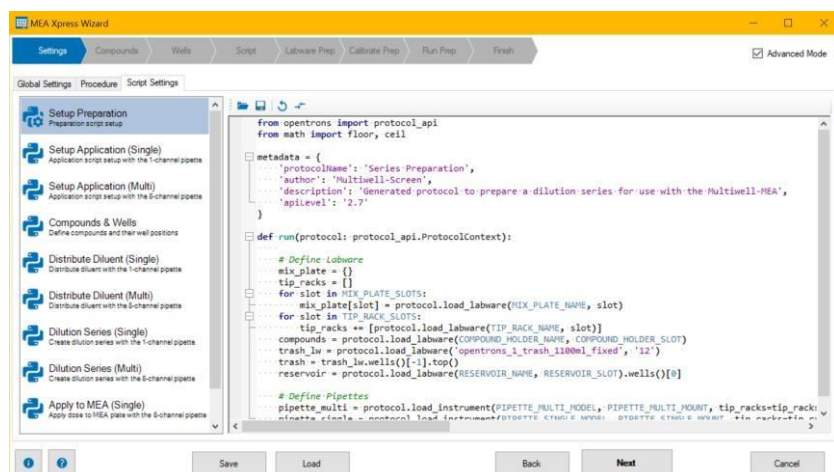
Note: Be aware to modify the Python scripts on your own risk!

Wizard Page “Settings” in advanced Mode

The “Settings” page shows a list of the single modules of the command scripts as Python code. Each module can be edited, loaded, saved, replaced, or compared to default modules. Doing so requires experience with the system and Python programming skills.

Be careful, changes may provoke bugs!

For example: Indentations are important! Or blue keywords written in uppercase letters are keywords which are replaced internal with corresponding values during script file generation.



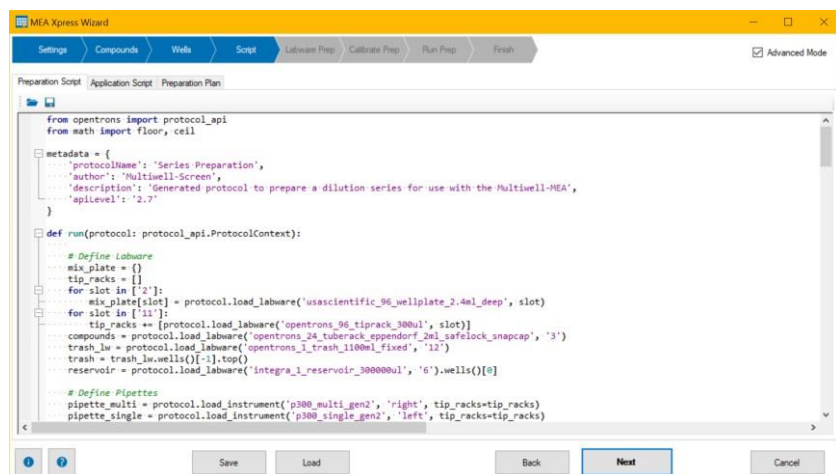
Wizard Page “Script” in advanced Mode

The “Script” page allows access to the command scripts for the dilution series preparation and for the distribution of the substances during the experiment. Each module can be edited, loaded, saved, replaced or compared to default modules. Doing so assumes experience on the system and Python skills.

Be careful, changes may provoke bugs!

Three tabs are available in the “Script” page: “Preparation Script”, “Application Script” and “Preparation Overview”.

See an overview about each single step of pipetting while mixing the dilution series and the organization of the mixing plates.



```
from opentrons import protocol_api
from math import floor, ceil

metadata = {
    'protocolName': 'Series Preparation',
    'author': 'Multiwell-Screen',
    'description': 'Generated protocol to prepare a dilution series for use with the Multiwell-MEA',
    'apiLevel': '2.7'
}

def run(protocol: protocol_api.ProtocolContext):
    # Define Labware
    mix_plate = {}
    tip_racks = []
    for slot in ['2']:
        mix_plate[slot] = protocol.load_labware('usascientific_96_wellplate_2.4ml_deep', slot)
    for slot in ['11']:
        tip_racks += [protocol.load_labware('opentrons_96_tiprack_300ul', slot)]
    compounds = protocol.load_labware('opentrons_24_tuberack_ependorf_2ml_safelock_snapcap', '3')
    trash_lw = protocol.load_labware('opentrons_1_trash_1100ml_fixed', '12')
    trash = trash_lw.wells()[0].top()
    reservoir = protocol.load_labware('integra_1_reservoir_300000ul', '6').wells()[0]

    # Define Pipettes
    pipette_multi = protocol.load_instrument('p300_multi_gen2', 'right', tip_racks=tip_racks)
    pipette_single = protocol.load_instrument('p300_single_gen2', 'left', tip_racks=tip_racks)
```

INSTALLATION GUIDES

Unbox MEA Xpress System

Remove the MEA Xpress Robot from Package

- 1) Remove the lid of the box and the top layer of foam.
- 2) Remove the acrylic top window located under this foam and put it aside for now.
- 3) Remove the next layer of foam and packaging and lift the robot out from the box by grabbing its frame.

Note: Add least two people are needed for this step!

Please see also videos from Opentrons for more information.

<https://support.opentrons.com/en/articles/2687501-get-started-unbox-the-ot-2>

Remove Transport Locks

The movable parts of the robot are secured with 3 transport locks. These need to be removed before progressing further. Please collect the transport locks and screws and keep them with the robot.

They are needed in case the robot needs to be shipped, for example for maintenance.

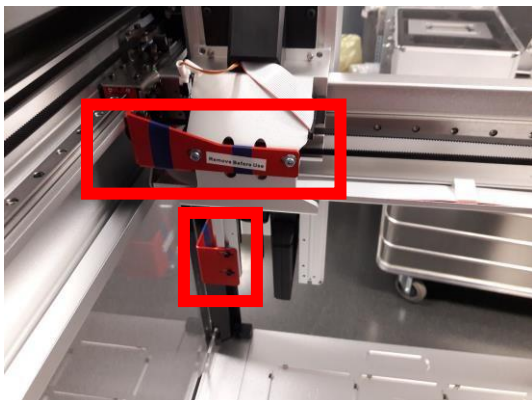
See also videos from Opentrons for more information.

<https://support.opentrons.com/en/articles/2687521-get-started-unlock-the-ot-2>

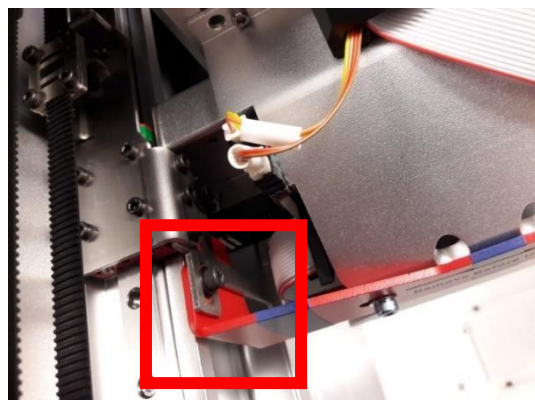
Tools needed:

- 3 mm hex screwdriver (provided in the Accessories box)

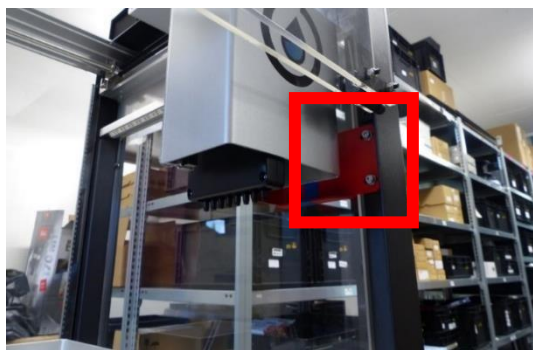
- 1) Use the screwdriver to remove the 4 screws behind the pipette carriage.



- 2) Move the pipette carriage to the side to remove the last screw of the transport lock at the top.



- 3) Remove the remaining screws for the transport lock at the bottom.



- 4) The third and final transport lock is located at the top of the robot as well, on the other side across from the other locks. Remove this small L-shaped lock as well.



Install Top Window

After removing the transport locks, the top acrylic window has to be installed.

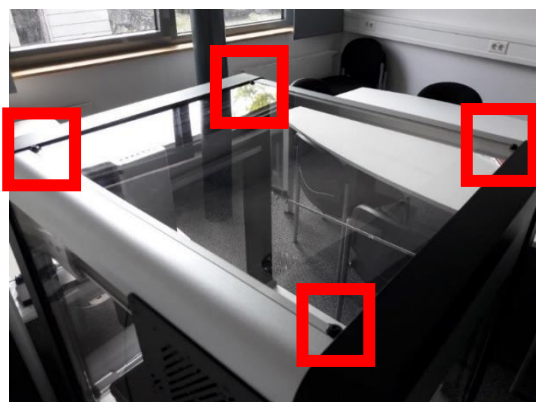
See also videos from Opentrons for more information:

<https://support.opentrons.com/en/articles/4234955-get-started-install-the-top-window-and-the-window-covers>

Tools needed:

- Top acrylic window (removed from the robot box)
- 4 screws (from the bag labelled "Top window screws")
- 2.5 mm hex screwdriver

- 1) Slide the acrylic window onto the top of the robot.
- 2) Fasten the window with the 4 screws.



Insert Multiwell-MEA Headstage

The Multiwell-MEA headstage can now be placed inside the MEA *Xpress* System.

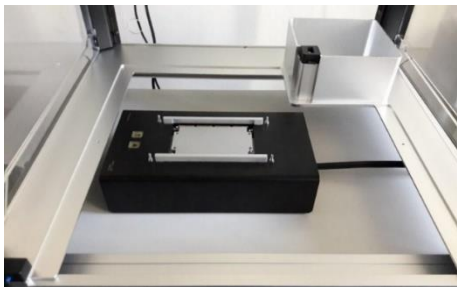
Tools needed:

- Multiwell-MEA headstage
- 2.5 mm hex screwdriver

- 1) Remove the base plate, if necessary, by removing the two screws to either side of the base plate.



- 2) Place the Multiwell-MEA headstage inside the robot and connect the cable. The buttons on the headstage need to point to the left, the cable port to the right.



- 3) Carefully place the base plate inside the robot and try to match the four holes in the base plate to the four rods on top of the headstage. Adjust the position of the headstage inside the robot until the base plate sits well inside the robot and the four rods fit through the holes.
- 4) Fasten the base plate to the robot with the two screws.

Calibrate Deck

Please see chapter "Calibrate Deck Z Position" for more information.

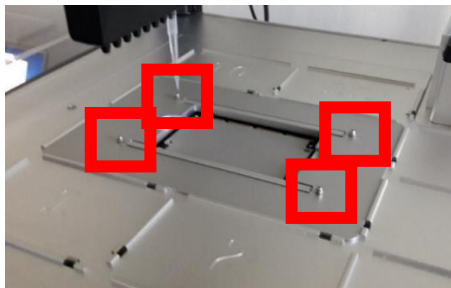
Fasten Cover Sheet

After deck calibration, place the cover sheet on the base plate to fasten the headstage to it.

Tools needed:

- MEA *Xpress* cover sheet
- 4 x 5.5 mm hat nuts
- 5.5 mm hex socket screwdriver

- 1) Place the cover sheet on top of the baseplate.
- 2) Use the screwdriver to fasten the cover plate with the 4 nuts to the base plate and headstage.



Calibrating the MEA Xpress Base Plate

The base plate calibration is performed with the Opentrons software. Please make sure that the software V. 3.21.2 is installed, all transport locks are removed and at least 1 pipette is installed.

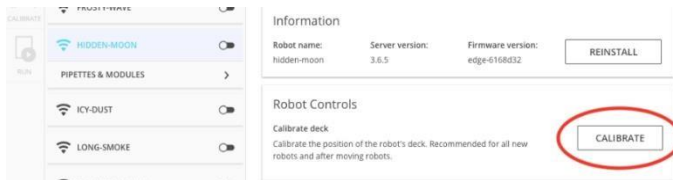
Tools needed:

- Opentrons 300 µl pipette tip
- PC/Laptop with Opentrons software V. 3.21.2

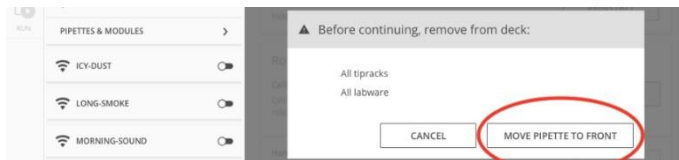
- 1) Make sure that the MEA Xpress cover plate is removed. See above (Removing the MEA Xpress base plate, steps 1 and 2) for how to remove the cover plate.
- 2) Switch the robot on.
- 3) Start the Opentrons software and ignore any available software updates. Neither a software update nor a firmware update for the robot should be performed!



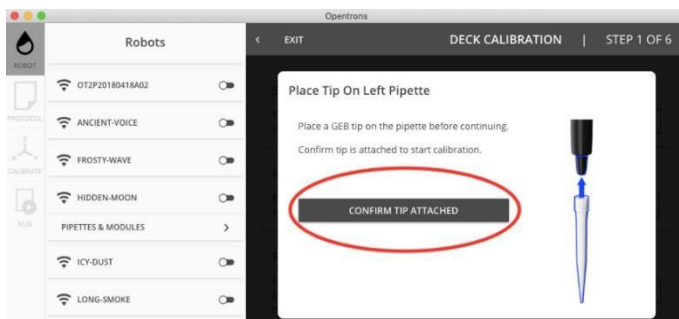
- 4) Wait for the software to find the robot, then click on the robot name.
- 5) Select the "Calibrate" button.



- 6) Select "Move Pipette to the Front" to initiate deck calibration - the single channel pipette will now move to the front and lower itself.

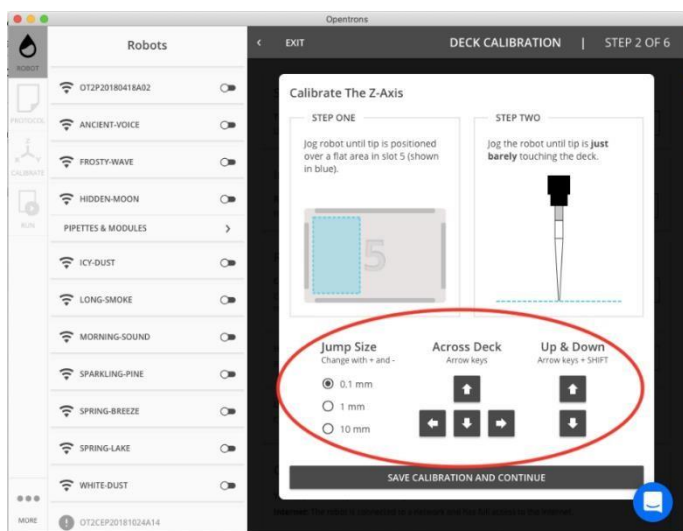


- 7) Attach a 300 µl Opentrons tip to the descended pipette. Make sure that the tip sits tightly and centered on the pipette.
- 8) Before pressing "Confirm Tip Attached", make sure that everything has been removed from the deck plate, because the pipette will now move to a spot close to the surface above deck slot 5.
- 9) Press "Confirm Tip Attached".

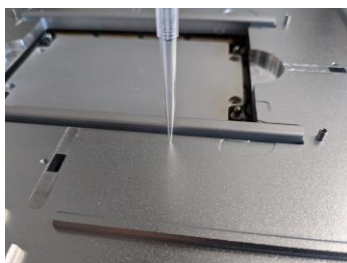


Calibrate Deck Z Position

The first calibration step is to acquire the Z position of the deck. The pipette will automatically move to a point close to the deck surface. Then, it needs to be moved with the keyboard until the pipette tip is flush with the surface.



Slot 5 is partially covered by the Multiwell-MEA headstage, so the pipette needs to be moved slightly in X and Y direction until it is above a flat part of the baseplate. Then, move the pipette down until its tip is flush with the deck. Press "Save Calibration and Continue" to save the Z position to the robot.

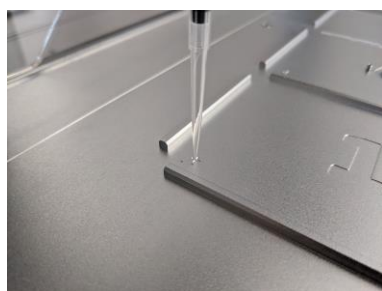
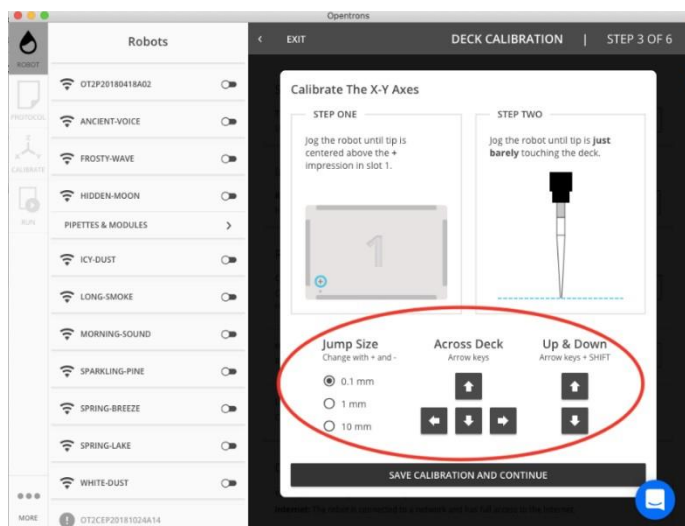


Calibrate X/Y Positions

The X-Y axes calibration works by moving the pipette tip to 3 defined positions on the robot deck.

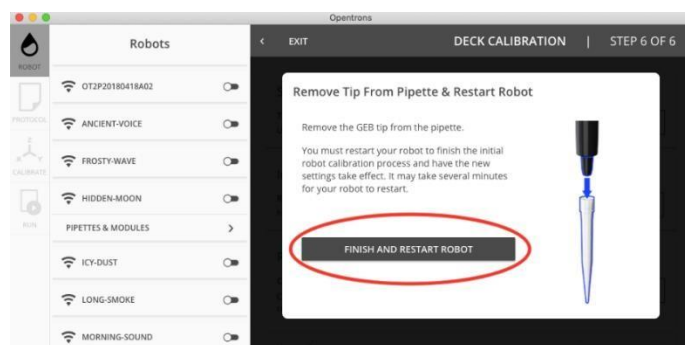
They are in slots 1, 3 and 7 and marked on the deck with engraved crosses. The cross in deck slot 7 is only accessible if the cover plate has been removed.

The deck calibration procedure requires you to navigate the pipette to the center of each cross with the tip just barely touching the deck. Whenever one of these positions has been reached, press "Save Calibration and Continue".



Finishing Up

After this has been done for slots 1, 3 and 7, the deck calibration is finished. Remove the pipette tip from the pipette and press “Finish and Restart Robot” to save the calibration to the robot.



The robot restart may take 1-2 minutes and the software will lose the connection to it. Only if the robot has not reappeared in the list of available robots after more than 5 minutes, you may consider power cycling the robot!

Technical Specifications of the MEA Xpress Robot

Operating temperature	20 °C to 24 °C
Relative humidity	40 - 60 %
Dimensions (W x D x H)	63 cm x 57 cm x 66 cm
Weight	40 kg
Volume	1 - 1000 µl (1 channel) 1 - 300 µl (8 channel)
Number of pipette mounts	2 (for any combination of 1- and 8-channel pipettes)
Labware	7 slots available
Speed	Fills a 96-well plate in min. 30 seconds, depends on pipette and protocol
Accuracy (systematic error) Precision (random error) for default pipettes	1-Channel (20 – 300 µl): < 5 % / < 2.5 % 8-Channel (20 – 300 µl): < 10 % / < 4 %
Protocols	Predefined or customizable
Warranty	One year warranty against manufacturer defects. Stress tested to last a minimum of 3 years of full time use.

MAINTENANCE

Cleaning of the System

Always unplug the MEA Xpress robot and Multiwell-MEA-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.

For cleaning the well plates, please read the respective datasheets.

CONTACT INFORMATION

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 contact form of the MCS web site.

multichannelsystems.com