



# QCM-I and QCM-I Mini eQCM-I and eQCM-I Mini

QUARTZ CRYSTAL MICROBALANCE WITH  
IMPEDANCE ANALYSIS

# Software Manual

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## 1. Safety

### ***Nomenclature***

In this document QCM-I refers to both QCM-I and QCM-I Mini instruments.

### ***Disclaimer***

In no event shall MicroVacuum ever be held responsible or liable for any direct, indirect, incidental, special or consequential damages or costs whatsoever resulting from or related to the use or misuse of the QCM-I or QCM-I Mini instrument or components thereof, even if MicroVacuum has been advised, knows of, or should be aware of the possibility of such damages. MicroVacuum emphasizes the importance of consulting experienced and qualified professionals to assure the best results when using the QCM-I instruments.

Safety warnings and information relating to the QCM-I and QCM-I Mini instrument hardware are given in the corresponding User Manual.

### ***General Safety***

WARNING!

The safety requirements listed in this manual must be followed in order to avoid personal injury and damage to the QCM-I instrument.

## 2. Introduction

This manual describes the BioSense 3 software and how it is used together with the QCM-I and QCM-I Mini family of instruments.

This Software Manual (Volume 2) focuses on the software aspects of the instrument and should be read in conjunction with the User Manual (Volume 1) which focuses on the hardware and is also provided with the equipment.

The BioSense 3 software provides a multi-user environment with the following features:

- Administrator controlled user profiles,
- Password protected user project folders,
- Experiment data file management with experiments stored in projects,
- Software can be run either with the instrument connected, or off-line for data analysis (evaluation)
- Experiment setup, instrument control and data acquisition
- Data display, analysis and export

### 3. Starting the BioSense 3 software

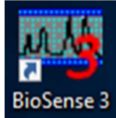
The BioSense software can be run either with the QCM-I instrument on and connected, for data acquisition and analysis, or with the instrument turned off for data review and analysis only (data evaluation mode).

To use the BioSense software to run the QCM-I, follow the procedure for starting the instrument and software:

1. **Check that the QCM-I is correctly connected to the computer** (see the “Quick Installation Guide” or “User Manual”).
2. **Turn on the computer.**

**Ensure that Windows® has finished loading before turning on the QCM-I.**

3. **Turn on the QCM-I.**
4. **Start the BioSense 3 Software.** Start the BioSense 3 software by double clicking on the icon on the Desktop or in the Start Menu. Every day you start the BioSense\_3 software, a backup copy of your database is automatically generated. (See “DATABASE TOOLS” chapter in this Manual for more information.)



## 4. Users, Projects and Data Management

### 4.1 USER LOGIN

When the BioSense software starts, it automatically creates a backup of the database. After this, the login screen is shown. The user is required to provide their login name and password.

This is assigned by the software administrator, detailed below. The Username: “user” and Password: “user” can be used as a generic login for unassigned users or for instrument training.

#### **Evaluation Mode**

The software can be started without QCM-I instrument being connected, or turned on, in which case it will run only in “evaluation mode” for data review and analysis, however the “Data evaluation only” box must be selected.

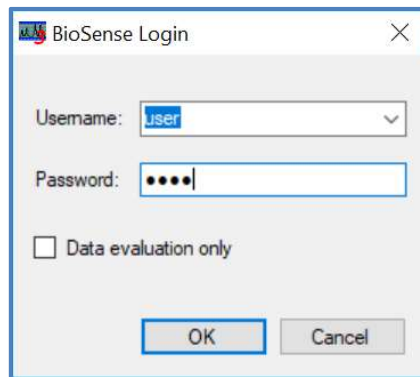


Figure 1: BioSense Login

If the QCM-I instrument is not connected or it is connected but not turned on and the evaluation mode is not selected, an error message will be displayed and the user will receive a warning about the failure (Figure 2) and the BioSense will start running in data evaluation mode.

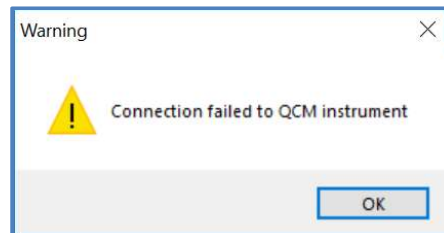


Figure 2: Connection Failed Warning Message

If the instrument was turned on, please see the troubleshooting section at the end of this manual.

### 4.2 USER MANAGEMENT

#### **User and Project**

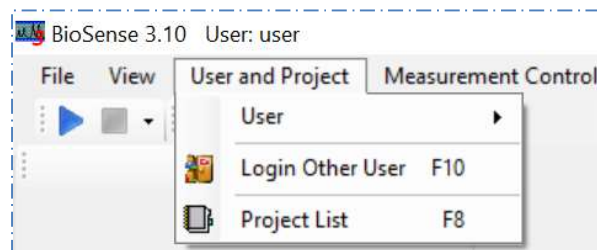


Figure 3: User and Project

The system differentiates between three types of user roles. There are any number of normal users (User), one Administrator (Administrator), and a Factory Administrator (root).

Normal users run experiments.

The Administrator is responsible for the tasks related to system administration, such as testing instruments, saving and restoring databases, and adding and deleting users. The Factory Administrator is an employee of the manufacturer, responsible for tasks related to manufacture, maintenance, and repair. The Factory Administrator's tasks are not detailed in the User Manual.

### ***View users***



*User and Project – User – Accounts (F9)*

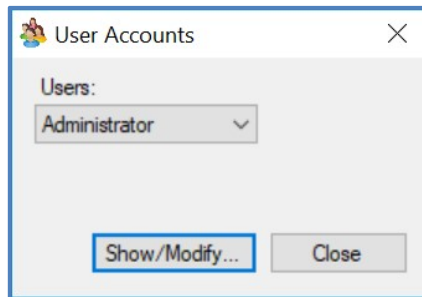


Figure 4: User Accounts

User can select the name of any other user and view the corresponding user data.

### ***Modifying data of logged in users***



*User and Project – User – Settings*

Users who are logged in can modify their own “User Settings” data but can only view the data of others (Show), naturally with the exception of the login password.

The only field that must be filled out is the Username. Giving a Password is recommended but not required. It is furthermore recommended that users provide a first and last name, organization, e-mail address, phone number, and possibly a brief description.

Figure 5: User Settings

### **Logging in other users**



#### **User and Project – Login Other User (F10)**

Other users can log in without the initial user having to log out from the software, as long as no measurements are open. Changing the software mode (measurement or evaluation) is not possible, as that requires the BioSense 3 software to be closed and restarted.

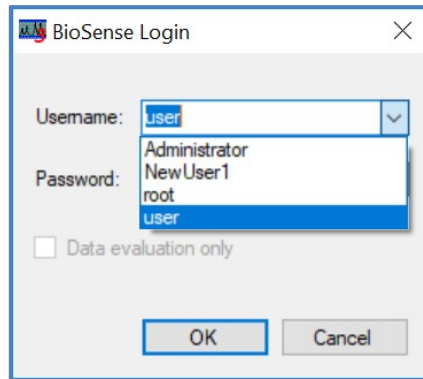


Figure 6: BioSense Login for other user

## **4.3 PROJECT MANAGEMENT**

Users can be grouped into projects. Users can belong to one or more projects.

Any user can create a project, but only regular users can own projects; administrator cannot own projects. If a project is created by a regular user, the user will automatically become the project owner. If created by the administrator, the administrator chooses who the project owner will be. When creating a new user, a project named “username project” is automatically created by the software.

Similar to user names, project names are also unique. A user can own more than one project.

Project owners can add and delete users from the project, can delete the project, and can set authorizations for users belonging to the project and for other users. The project owner or the Administrator can transfer project ownership to other users.

Any saved measurement can only belong to one project.

### **Creating, modifying, and deleting projects**



#### **User and Project – Project List (F8)**

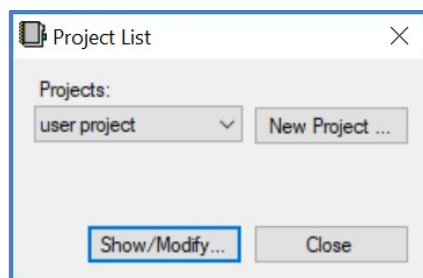


Figure 7: Project List

On the “Project List” window new projects can be added (New project) and existing projects can be viewed, modified, and deleted (Show/Modify) see Figure 7. Only the Administrator and the project owner can modify or delete the project or create new projects. However, all users can view each other’s projects.

### **Modifying Project Settings**

#### *User and Project – Project List - Show/Modify*

Figure 8: Project Setting

Project ownership can be transferred to different users with the “Delegate New Owner” command.

The “Description” field can be used to enter descriptions regarding the project.

The “Date” field is automatically filled out with the date the project was created, but it can be modified.

The “Not members” field displays all users, from whom the project owner can transfer the users to the “Members” field.

The following authorizations (Rights) can be given regarding project measurements: not visible (None), visible (Show only), Read only, and read and modify (Full). All these rights are available for both “Members” and “Not Members”; one authorization level can be selected for each group.

Only those projects can be deleted in which all measurements have been deleted. When deleting projects, deleted measurements are deleted permanently and cannot be restored.



#### 4.4 HANDLING MEASUREMENT DATA – FILES

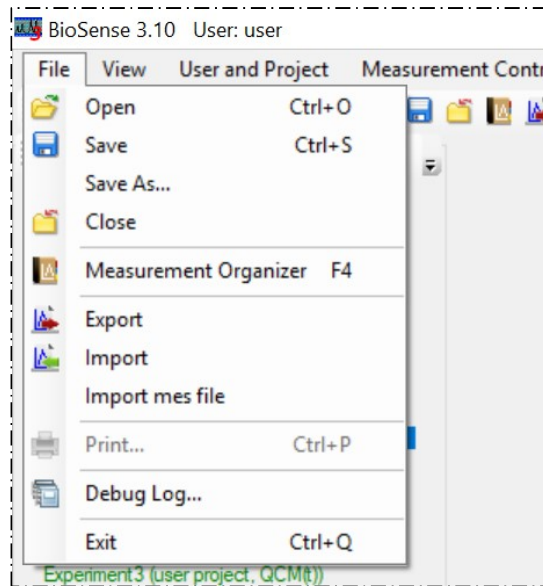


Figure 9: File Tab

#### ***Measurement Organizer***

##### *File- Measurement Organizer (F4)*

The Measurement Organizer window is very similar to Windows Explorer, see Figure 10. The tree shows those projects and corresponding folders of which the user has proper authorization. The recycle bin (Deleted Measurements) contains the deleted measurements that were owned by the user; while the Not Saved Measurements folder contains any measurements that were not saved due to external failures (power failure, the computer crashed, etc.).

The right side of the window displays the results of any searches or the contents of the selected folder, similarly to the detailed display of Windows Explorer. This side displays only measurements and not folders.

The thumbnail view of the selected measurement is displayed too.

The bottom right corner shows a brief description of the selected measurement.

By right clicking with the mouse, the Folders tab offers the following choices: creating and viewing/modifying projects, creating, deleting, renaming, moving, and copying folders.

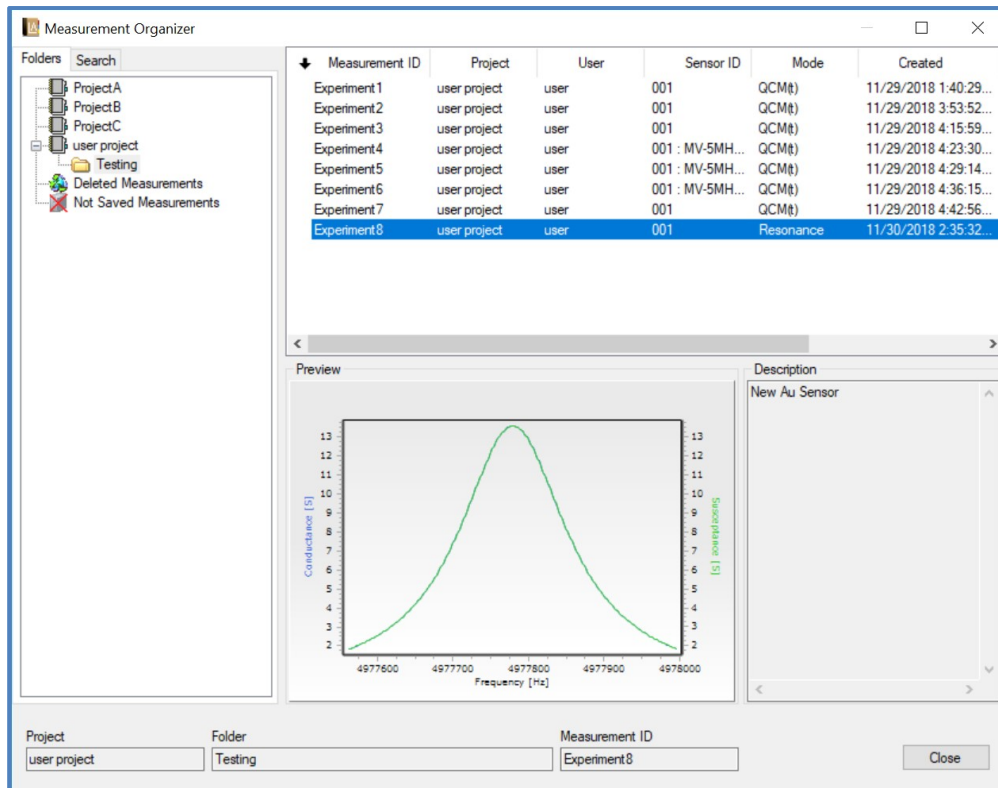


Figure 10: Measurement Organizer

### **Measurement context menu functions**

By right clicking on the selected measurement, the following functions are available from the pop-up menu: delete, rename, move, and copy measurement(s).

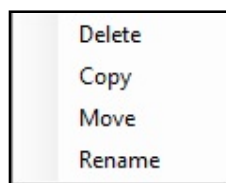


Figure 11: Measurement 'right-click' options

By right clicking on the measurements in the two special project-level folders (Deleted Measurements and Not Saved Measurements), the local pop-up menu offers the option of restoring.



Figure 12: Deleted and Not Saved Measurement 'right-click' options

**Deleting measurement(s)***Delete*

Measurements can only be deleted with the proper authorization. The software asks if the user is sure the measurement is to be deleted. The measurement will then be moved to the “Deleted Measurements” folder and can be later restored.

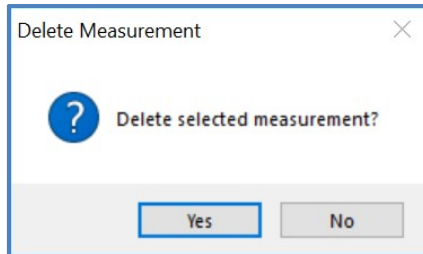


Figure 13: Delete Measurement

**Copying measurement(s)***Copy*

The destination folder where the copy is to be saved must first be chosen.

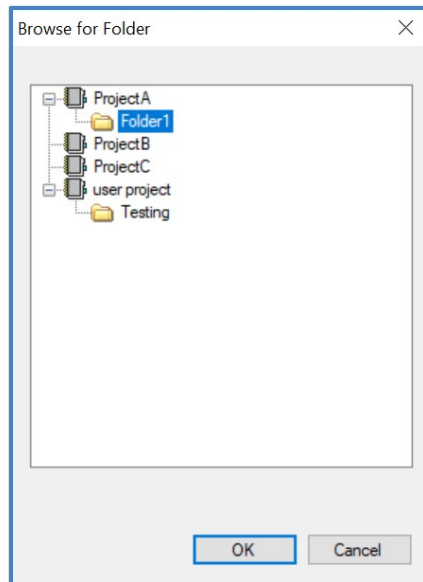


Figure 14: Browse for Folder

If this is the same as the source folder, the program copies the measurement and adds a “Copy – ” prefix, similar to Windows Explorer. If the destination folder is different than the source folder, the program will attempt to save it with the same name. If the given folder already contains a measurement with the same name, the software warns the user and offers to rename the copied measurement.

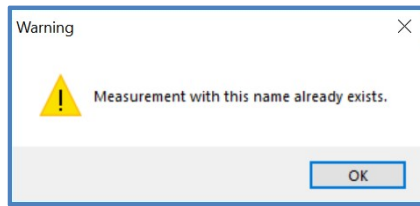


Figure 15: Duplicate measurement name warning message

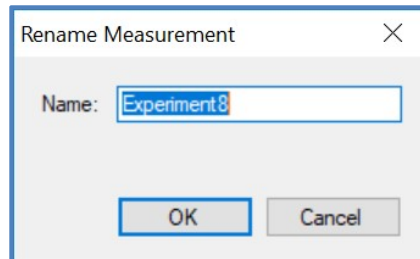


Figure 16: Rename Measurement

### ***Moving measurement(s)***

#### *Move*

This function works the same as copying. The destination folder where the measurement is to be moved must first be chosen. If this is the same as the source folder, nothing happens. If the destination folder is different than the source folder but the source folder already contains a measurement with the same name, the software warns the user and offers to rename the copied measurement.

### ***Renaming measurement(s)***

#### *Rename*

Measurements can be renamed. If the given folder already contains a measurement with the same name, the software warns the user, as folders can only contain measurements with names unique to the folder.

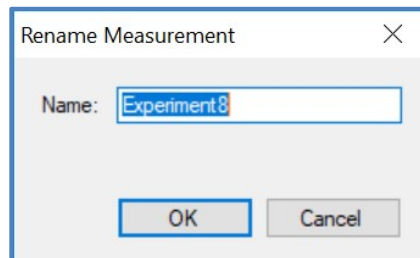


Figure 17: Rename Measurement

### ***Restoring deleted measurement(s)***

#### *Restore*

Deleted measurements are not deleted permanently but are moved to the "Deleted Measurements" folder and can be restored. Open the Deleted Measurements folder, right-click on the Measurement name and select Restore. If the path from where the measurement was deleted is still available, it is restored to the same location. If not, it is moved to the project root directory. If a measurement with the same name already exists, the software warns the user and offers to rename the measurement, similar to the method described in copying and moving measurements.

### **Restoring “Not Saved Measurements”**

#### *Restore*

Measurements that were not saved by the user for some reason (i.e. power failure, crash) can be restored from the Not Saved Measurements folder (Figure 18, left). Right click on the file name and select *Restore*. The program immediately opens the measurement after restoring it and warns the user to save it. If the user does not save the measurement restored in this way (and closes it without saving), it will be permanently deleted.

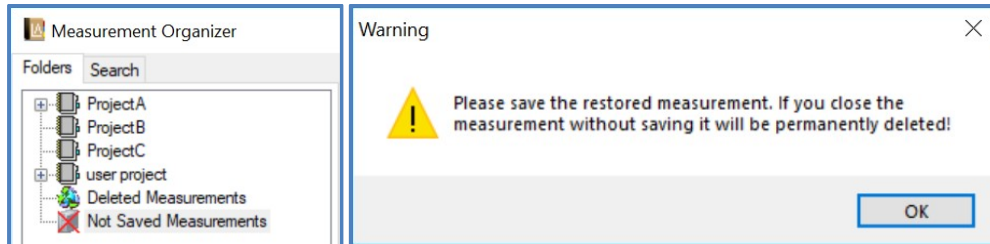


Figure 18: Not Saved Measurements Folder Icon (left) and Warning window after Restore (Right)

### **Project and folder context menu functions**

By right clicking on the Folder tree, the following functions are available from the pop-up menu: create a new project, project settings (same as described in relation to project management in section 4.3), create a new folder, and delete, rename, move, and copy folder.

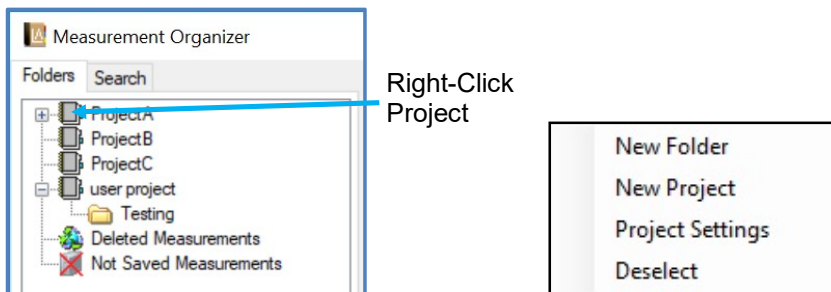


Figure 19: Project Options

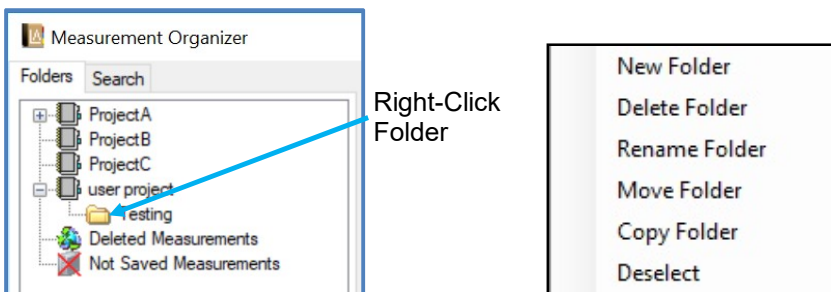


Figure 20: Folder Options

### **Creating a new project**

#### *New Project*

The same as described in point 4.3, when selected from the Project menu.

### **Project settings**

#### *Project Settings*

The same as described in point 4.3, when selected from the Project menu.

### **New folder**

#### *New Folder*

A name must be given when creating a new folder. The program warns the user if the given project or folder already contains a folder with the same name.



Figure 21: New Folder Dialogue Box (left) and Duplicate Name warning (Right)

### **Delete folder**

#### *Delete Folder*

Users having the proper authorization can delete the selected folders, together with their entire contents, subfolders, and measurements. The software asks if the user is sure it is to be deleted. Deleted measurements will be moved to the "Deleted Measurements" folder and can be later restored.

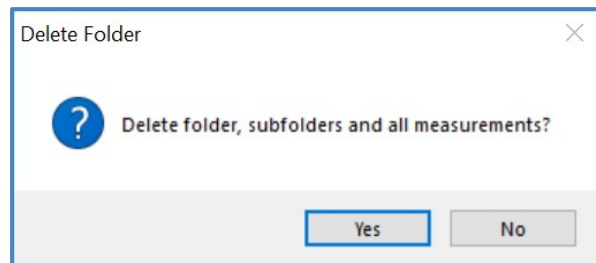


Figure 22: Delete Folder

### **Rename folder**

#### *Rename Folder*

Folders can be renamed. If the given folder or project already contains a subfolder with the same name, the software warns the user, as folders/projects can only contain subfolders with names unique to the folder/project.

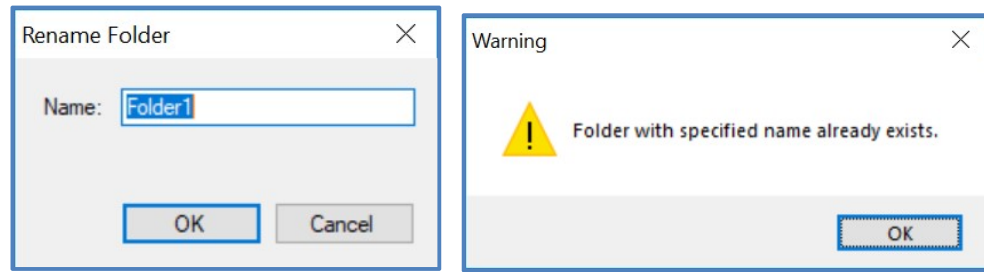


Figure 23: Rename Folder Dialogue Box (Left) and Duplicate name warning (Right)

### ***Move folder***

#### *Move Folder*

Selected folders can be moved together with their entire contents into other projects or folders.

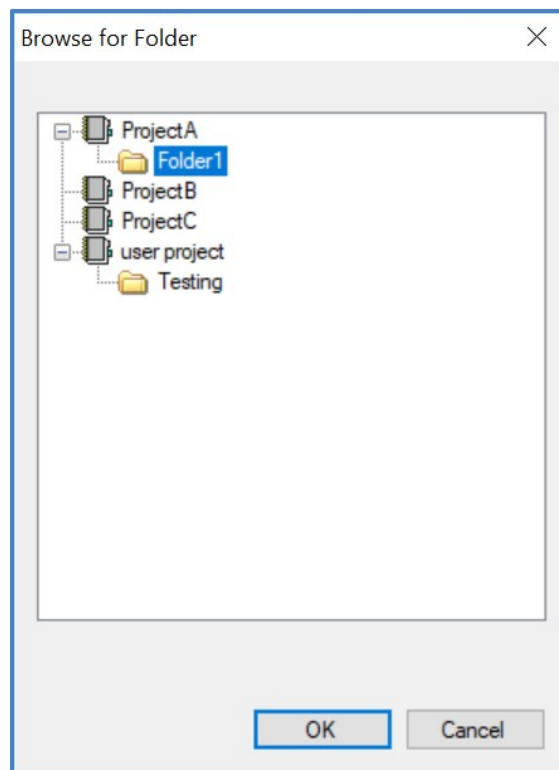


Figure 24: Browse for Folder

The destination folder must be different than the source folder and cannot be its subfolder, either. The destination folder also cannot contain a subfolder with the same name. In such cases, the software warns the user.

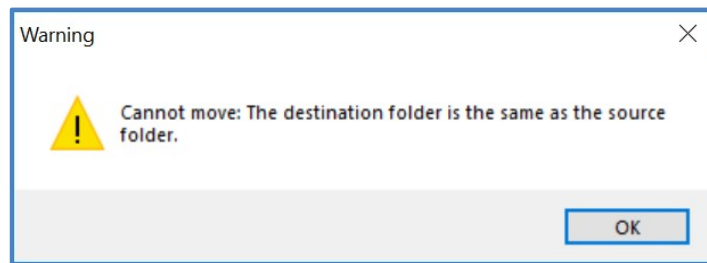


Figure 25: Destination Folder the same as the source folder warning message

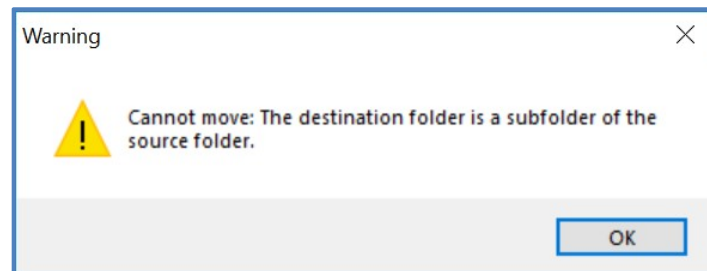


Figure 26: Destination folder a subfolder of the source folder warning message

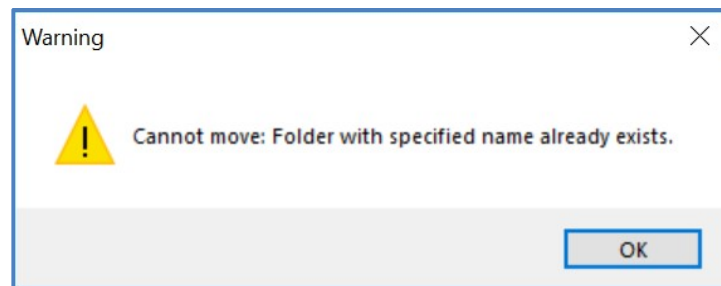


Figure 27: Destination folder name the same as the source folder name warning message

### **Copy folder**

#### *Copy Folder*

This function works the same as moving folders. The selected folder is copied together with their entire contents into the selected project or folder. The destination folder must be different than the source folder and cannot be its subfolder, either. The destination folder also cannot contain a folder with the same name. In such cases, the software warns the user.

### **Opening measurements**



*File – Open (Ctrl+O)*

The measurement to be opened can be browsed in the projects and folders on the Folders tab (Figure 28, right) or by searching for any of the substantial characteristics of the measurement in the Search tab (Figure 28, left). The program searches for any given search parameters; any empty fields are disregarded. There is a logical “and” relationship between the various search parameters.



- **Max Page Size:** The number of measurements to be displayed on a page. Navigation between pages is via the prev. and next buttons.
- **Project, Folder:** By default the search is performed in the project and folder selected on the Folders page. If no selection had been made, the search is performed in all projects and folders. When clicking on the Browse button the “Browse for folder” dialog box (Figure 28) is displayed where the search location can be changed. If the search in subfolders checkbox is selected, the search is also carried out in subfolders; otherwise, the program only searches in the given folder.
- **Measurement ID:** If the text occurs anywhere in the measurement ID (name), the measurement is included among the hits.
- **User:** Search on the basis of the username selected from the list.
- **Sensor ID:** Search on the basis of the sensor selected from the list.
- **Measurement Mode:** Search on the basis of the selected measurement mode.
- **Date From-To:** The measurement is included among the hits if the measurement date (first time the measurement was saved) or the last day on which it was modified falls into the given interval.
- **Description:** Search among the measurement descriptions.

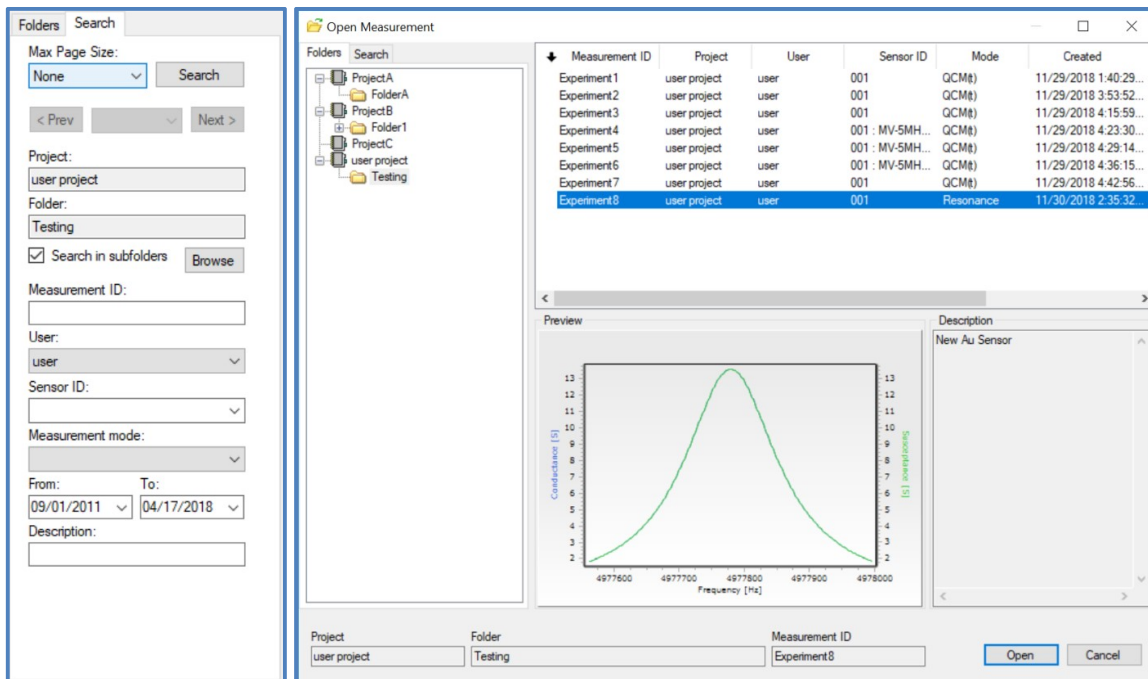


Figure 28. Open Measurement window. Left: Search tab, Right: Folders tab selected.

### ***Saving measurements***



*File – Save (Ctrl+S)*

Saving measurement can be initiated from the menu, from the toolbar or by shortcut key. If the measurement is new, the program opens the Save Measurement window.

**Save measurement as...**

*File – Save As...*

There is no search field on this page; however, the same functions as in the Measurement Organizer are available in the pop-up menu by right clicking on the Folders tab: creating and viewing/modifying projects, creating, deleting, renaming, moving, and copying folders. When saving the measurement, the user has to fill in the Measurement ID, which has to be unique within a folder. A short description can also be provided for the measurement.

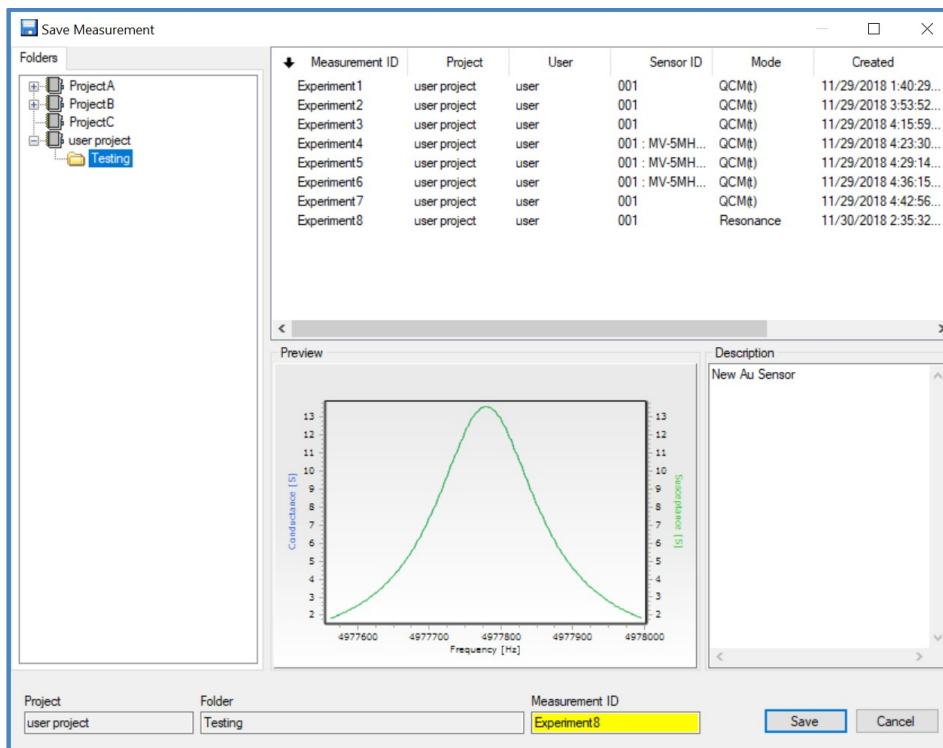


Figure 29: Save Measurement Window

**Closing measurements**

 *File – Close*

Closing the measurement can be initiated with this command. If a measurement is still running when this command is actioned, then the user is prompted to stop the measurement first. If the measurement has not been saved yet, or if it changed after the last save, the software will ask you if you want to save it or not.

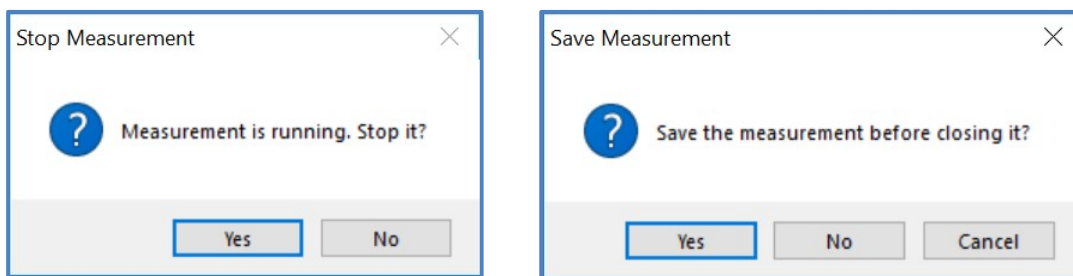
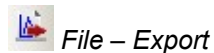


Figure 30: Closing measurement Stop and Save prompt messages

### 4.5 EXPORTING MEASUREMENT FILES

You can export a measurement data file for transferring the measurement into another BioSense 3 software (second-user licensed BioSensor software, or Biosensor software of an independent QCM measuring system). This export supports the transfer of all the data and settings parameters of the measurement, allowing the measurement to be processed and evaluated in the same way as in the original BioSense software.

#### **Export measurement file into a (second-user)BioSense 3 software**



The export window is the same as the Open measurement window, with the difference that this has an Export button instead of the Open button. Clicking on the Export button requires the user to provide a path to save the measurement to be exported.

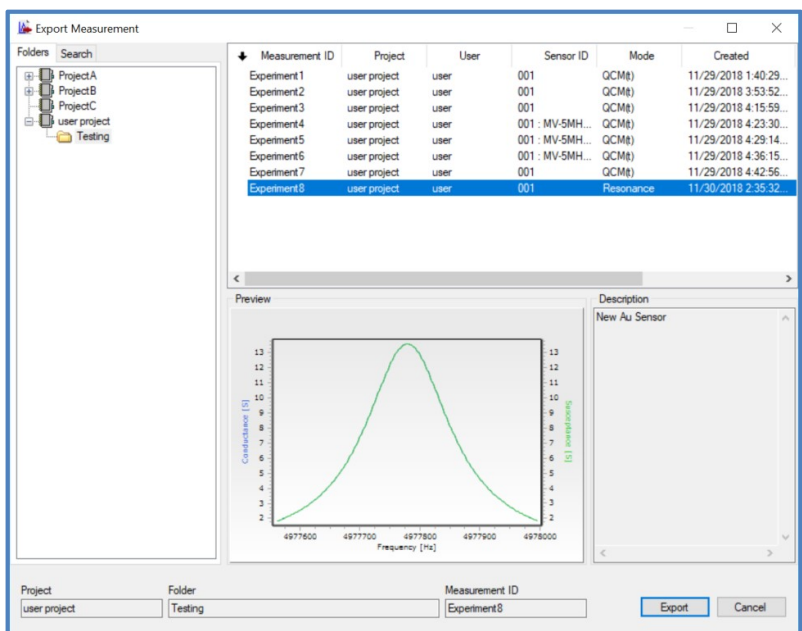


Figure 31: Export measurement selection window

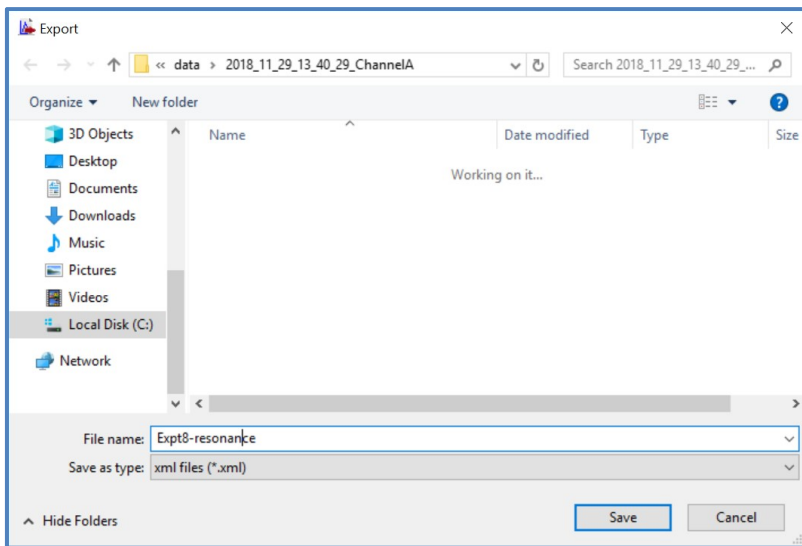


Figure 32: Export measurement save details window

### Importing measurements

#### File – Import

First you have to select the file you want to import. A window similar to the Save measurement window then appears. By checking the *Open after import* checkbox, the software also opens the measurement.

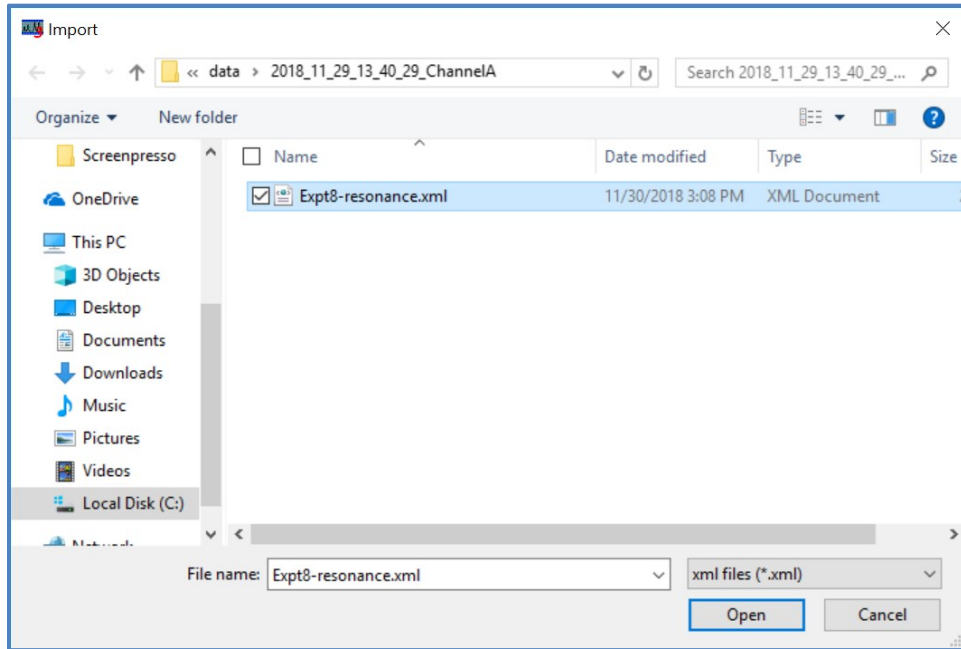


Figure 33: Import measurement select window

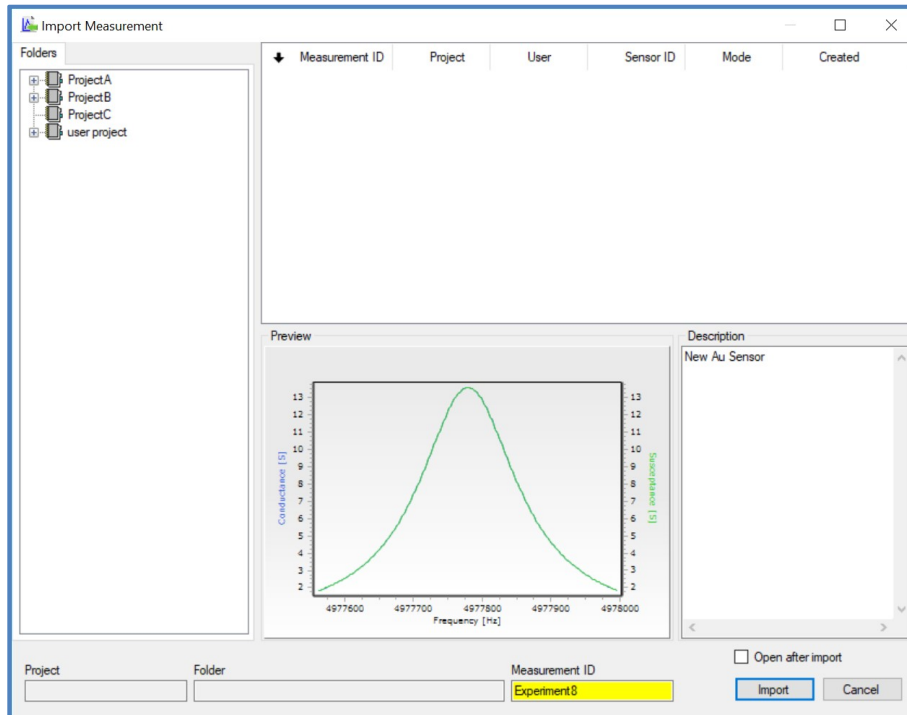


Figure 34: Import measurement save window

## 5. Measurement Control

This chapter gives an overview of how to start a measurement, control the experiment and stop the measurement at the end, and runs through the main software options involved. These are covered in more detail in the following chapters. A Frequency Scan measurement, which measures the sensor impedance over a user specified frequency range, can be run directly from the Measurement control menu. All other measurements (time dependent and/or measuring resonant frequency peaks) need to be setup first at the start.

### 5.1 SETUP AND START MEASUREMENT

#### *Measurement Control – Setup and Start Measurement (F5)*

Measurements can be started by clicking on the blue Play icon, from the Measurement Control command or from the Start command shown in Figure 35.

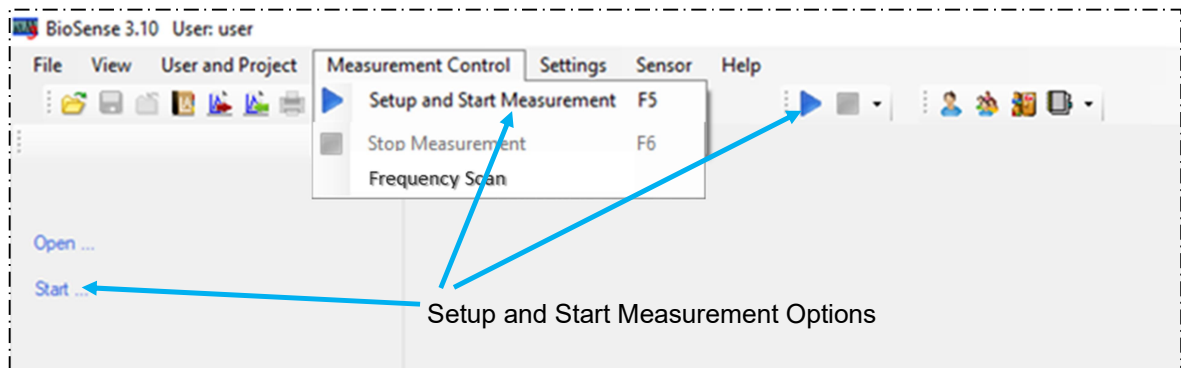


Figure 35: Setup and Start Measurement Options

A wizard will guide users through the process steps when starting a new measurement.

If a measurement has already been loaded, the software will ask whether you want to continue it or if you want to start a new measurement, Figure 36.

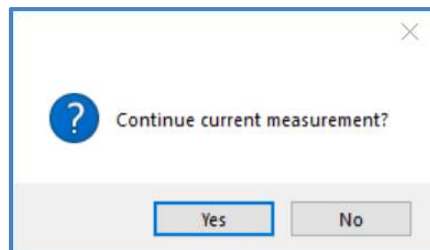


Figure 36: Continue Measurement Query

## 5.2 MEASUREMENT SETUP

The first window of the Setup process is Measurement Setup shown in Figure 37. This shows the different settings that need to be selected for a measurement.

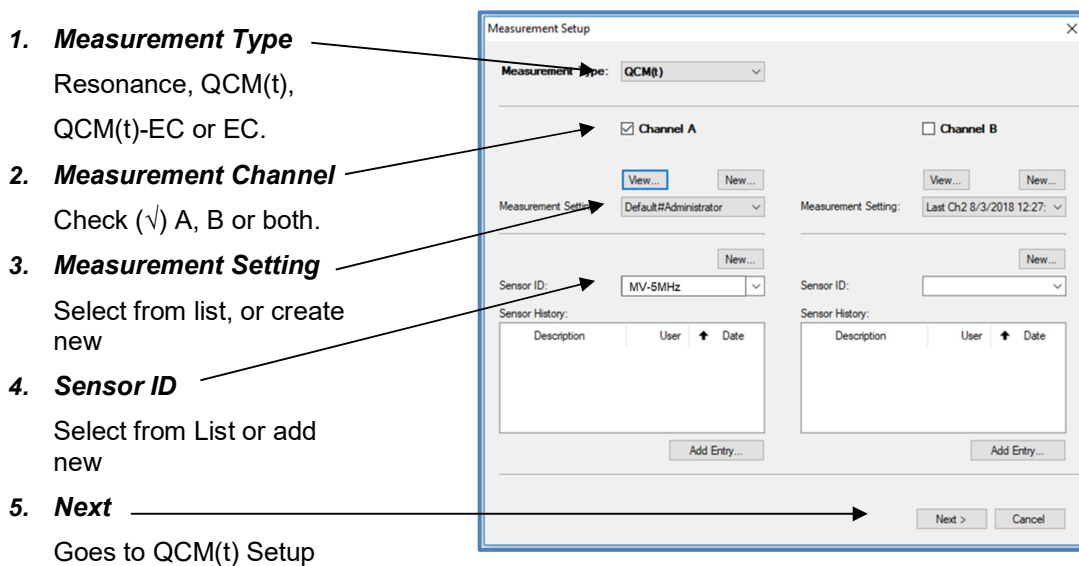


Figure 37: Measurement Setup Window

### **Measurement Type**

Select the type of measurement. The available measurement types are listed and depend on the instrument configuration, which the software will detect. The possible measurement types are: Resonance, QCM(t), EC and QCM(t)-EC.

- **Resonance** records the raw QCM-I resonance curve once for the selected overtones. At the start of an experiment, a Resonance measurement can be performed on all overtones before selecting which ones to use for the measurement. For experiments in liquid do this once the crystal is in contact with the solution.
- **QCM(t)** records all the impedance parameters derived from the resonance curve as a function of time. The raw resonance curves are also automatically recorded at the start and end of an experiment and if there is a problem with the fit of a resonance curve, also during the measurement. The Resonance can also be saved manually at any point during a QCM(t) experiment by pressing “save resonance” in the resonance view tab of the Navigator Panel.
- **EC** controls a compatible potentiostat through the BioSense software, if it is connected. If this is selected only Channel A is shown as the EC measurement only occurs on one channel.
- **QCM(t)-EC** runs a combined electrochemical QCM measurement.

### **Measurement Channel**

Select which of the available measurement Channels will be used in the experiment. Any single or set of channels can be chosen. E.g. for a 2 channel instrument, Channel A, B or both can be chosen. Below each selected channel are the settings which need to be selected for that particular channel.

**In case the QCM-I instrument has 2 (or more) measuring channels in use, the Measurement Setup window allows the parameters for all the Channels (A, B etc.) to be set. In this case all the parameters for all the Channels in use must be set.**

### Measurement Setting

The program opens with the Measurement Setting that the user used in the last measurement pre-selected, however other measurement settings can also be selected from the drop-down list and new ones can be created. More details are written in the section “

Setting the measurement parameters”.

### Sensor ID

Select the Sensor ID from the drop-down list of previously used sensors in the “Sensor” textbox or add a new sensor with the “New...” command. Use the serial number printed on the sensor storage box as the Sensor ID.

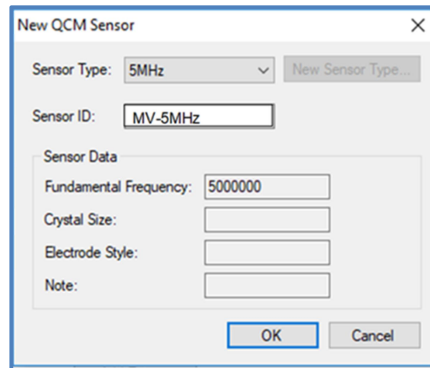


Figure 38: New Sensor Window

(Chapter 6 in this Manual includes more information about the measurement setup.)

After completing the Measurement Setup window, depending on the Measurement Type selected, Next takes you to the following Setup windows: Injection Valve Setup, QCM(t) Setup, Electrochemical Measurement (EC) Setup.

### 5.3 INJECT SETUP

If an Injection Valve is connected to the system the following window is shown, which allows injections to be setup for the measurement. The command controls the time of the start of the injection, taken from the start of the measurement and the length of time the injector valve is switched to “inject”. Multiple injections can be planned. There is no need to plan injections during the setup, as they can also be added, modified and deleted later, during the measurement. More details are given in section 7.3 below.

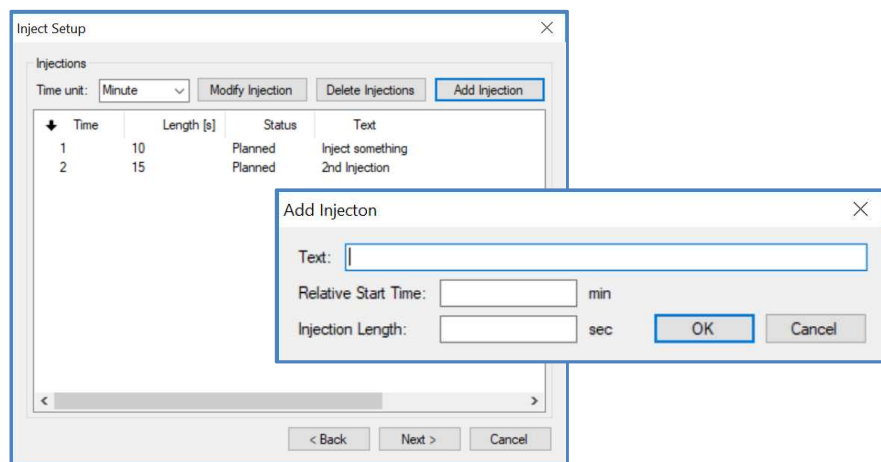


Figure 39: Inject Setup window, with sample injections planned at 1 and 2 minutes and Add Injection window

## 5.4 QCM(t) SETUP

The “QCM(t) Setup” allows you to change the selected fundamental and overtone frequencies that you want to measure in each channel. The pre-selected overtones are loaded from the “Measurement Settings” selection. During an experiment the Overtone measurements are sequential, so the maximum acquisition rate will reduce for every additional overtone selected. The acquisition speed is approximately 1s per point.

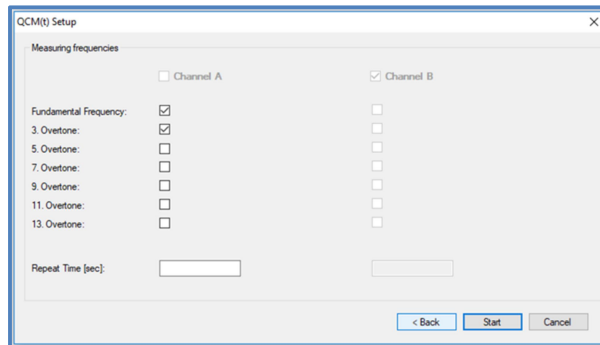


Figure 40: QCM-I Setup Window

### **Repeat Time**

The repeat time for the QCM(t) measurement this can be given in seconds and applies to all channels. If the repeat time field(s) box is left empty, or has the value 0, the resonance curve measurements are repeated without delay. The minimum repeat time depends on how many frequencies are selected. A longer time can be entered if fewer measurement points are required. If the repeat time is smaller than the time it takes to measure the frequencies selected, then the acquisition runs as fast as possible.

### **Fast Measurement**

If the Fast function is enabled in the software, the data are acquired at a higher rate. This is achieved by measuring 20 instead of 200 frequency points for the resonance spectrum. Whilst the acquisition rate is increased, the resonance curve fit is less precise and the noise level will increase. Select Fast before starting the measurement, this applies to the whole measurement, until it is stopped.

## 5.5 EC SETUP

When a compatible potentiostat is connected and Measurement type EC or QCM(t)-EC is selected the EC setup window is shown. The settings section changes according to the EC Mode selected. Figure 41 shows the Cyclic Voltammetry and Chronoamperometry versions.

The EC cell can be switched on or left at open circuit at the start of the measurement

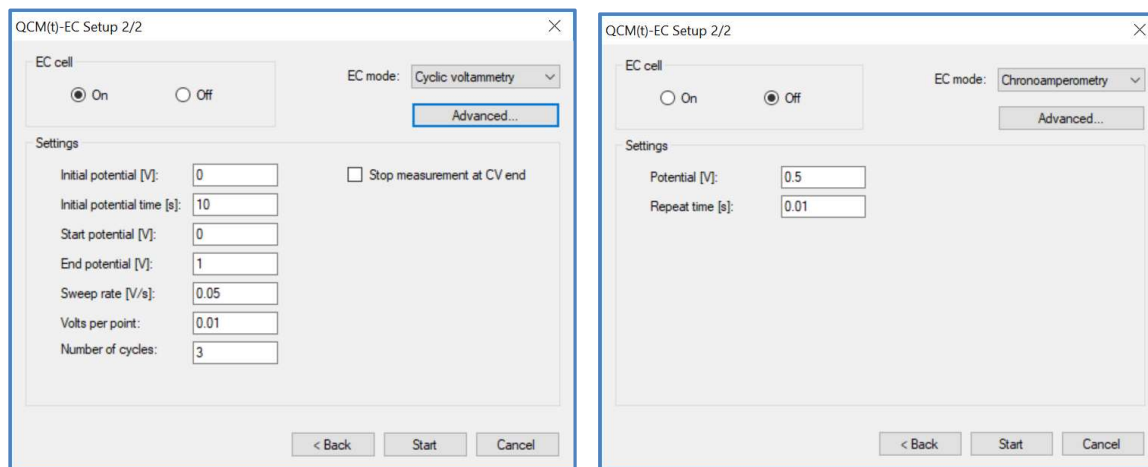


Figure 41: QCM-I Setup Window. Cyclic Voltammetry (left) and Chronoamperometry (right).




### **Electrochemical Measurement Modes**

- Cyclic Voltammetry. In the Cyclic Voltammetry setup screen the CV parameters are chosen. The QCM measurement can also be automatically stopped at the end of the CV. When the CV measurement is started the settings can no longer be modified.
- Chronoamperometry. In this setup screen the initial measurement parameters are setup, but these can also be modified during the measurement.
- Chronopotentiometry. In this setup screen the initial measurement parameters are setup, but these can also be modified during the measurement.

A range of more advanced settings can be selected with the “Advanced...” button. The electrochemical setup is detailed in the section 6.2: Electrochemical Setup.

### **5.6 STARTING THE MEASUREMENT**

Start the measurement by pressing the  button which is only shown in the final setup window (depending on the Measurement Type selected). At the start of the measurement the QCM-I starts with an initialization message as the instrument searches for the selected overtones, shown in Figure 42.

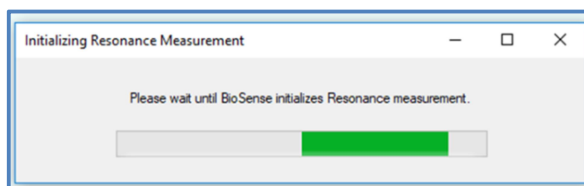


Figure 42: Initialising Resonance Measurement

For electrochemical measurements the resonance initialisation is completed first before the electrochemical measurement is initiated. During a measurement the BioSense software displays the measurement data in a graph, e.g. Figure 44 for QCM(t) measurements. (For more information on graph functions see the section “8: Graph features” in this Manual)

### **Unsaved Data**

Once the measurement has started, Resonance curves and time-dependent data (in QCM(t) or EC modes) are stored in a “Not Saved Measurement” file until the experiment is stopped and the data are saved. If an experiment is unexpectedly interrupted e.g. by a power outage, you can still recover the last-recorded data. (See “Saving Recovered Data” in DATA HANDLING section of this Manual)

### **5.7 RESONANCE MEASUREMENT TYPE**

After starting and initializing a Resonance measurement, the BioSense software will acquire a single resonance spectrum of all the selected overtones, stop acquisition and display the result in the graph. The measurement must then be saved.

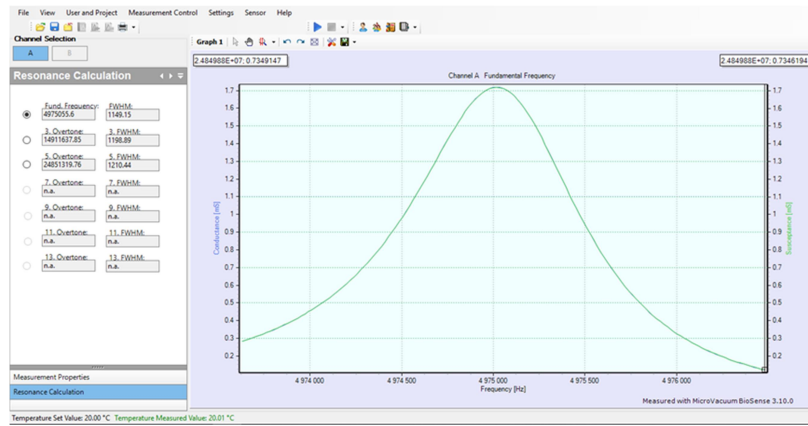


Figure 43: Resonance Calculation

### 5.8 QCM(t) MEASUREMENT TOOLS AND DISPLAYING THE DATA

After starting and initializing a Resonance measurement, the BioSense software will acquire QCM(t) measurement data, which is plotted in a graph, as shown in Figure 44. The navigator panel is located on the left side of the graph and is used to control the instrument during a measurement, to select the data that is displayed and for functions related to the measurements and calculations. (See section “7: Displaying the Measurement” in this Manual for more detailed information.)

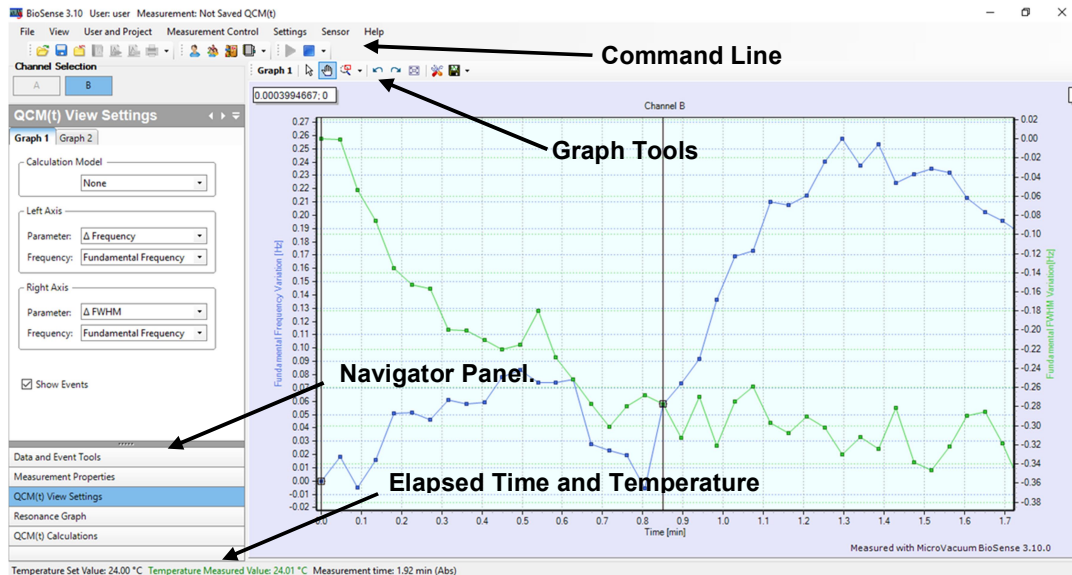


Figure 44: Measurement Display Window

The following tabs are available in the Display Navigator Panel:

#### **Data and Event Tools**

Markers: Allows event markers to be added to the trace,

Hide/Unhide Data: Portions of the data can be hidden or unhidden in the display.

Export: Select data for export

### **Measurement Properties**

This panel displays information about the measurement being displayed. A description of the measurement should be entered here.

### **QCM(t) View Settings**

This panel is used to select which data are plotted. Data can be plotted on two axes and two graphs can be displayed simultaneously.

For each frequency measured, the data calculated from the resonance curves and available to be plotted are: Frequency, FWHM,  $\Delta$ Frequency,  $\Delta$ FWHM, Gmax, Goffs, Boffs, Fi, Residual, Q, Dissipation,  $\Delta$ Dissipation, Temperature, Flow (where a fluidic pump is installed,) Resonance (the current resonance curve,) Saved Resonance (select from list of saved curves,) **Sauerbrey**.

See the QCM-I User's Manual, "Principle of Operation", for a detailed description of all the measured parameters.

### **Resonance Graph – Save Resonance**

Displays the current resonance curves in real time as the measurement progresses, shown in Figure 71: Resonance Graph. The current curve can also be saved at any point during a measurement.

### **QCM(t) Calculations**

Enables the measurement baseline value to be offset, for determining values such as change in Frequency or Sauerbrey Mass.

### **Injections**

If an injection valve is present "Injections" will appear as a tab in the Navigator Panel. This panel shows the list of injections, the time, duration and whether they are yet to be done (planned), or the set time has been reached and they have been done (completed). On injection, an Event is added automatically to the data.

## **5.9 QCM(t)-EC AND EC MEASUREMENTS**

If a potentiostat is installed and an EC experiment type is chosen, once the measurement is started, the Navigator Panel will feature an additional *EC Settings* tab. For EC type measurements the graph displays the Current and the Potential vs. time on the two Y- axes. For QCM(t)-EC measurements a *QCM(t)-EC View Settings* tab is also present to select the displayed parameters.

### **EC Settings**

For CV measurements this shows the measurement parameters set for the measurement. These cannot be changed once the measurement is running. For CA and CP measurements it allows the Potential and Current settings to be modified; these can be changed during the course of the measurement.


### **QCM(t)-EC View Settings**


This allows the different data to be selected and plotted on the graphs. In addition to the QCM parameters listed in *QCM(t) View Settings* above, there are: Current, Potential, CV and Saved CV options. CV and Saved CV plots a conventional CV graph of Current vs. Potential.

## **5.10 WARNING MESSAGES**

During a QCM(t) measurement, if sudden changes happen on the sensor surface, it may occur that the BioSense software is not able to follow the parameter changes or the resonance curve fit is of low quality. If this happens an event is added to the trace and the resonance curve is saved for future reference. The software then rescans the region to identify the resonance maximum and continues with the measurement when it has found it. If necessary, the experiment can be stopped and when it is restarted there will be the option of continuing and appending the data to the previous experiment.

### 5.11 STOPPING AND SAVING MEASUREMENTS

Measurements must be saved after they have stopped. The resonance measurements stop automatically after the resonance curves have been acquired. However, the QCM(t) and EC measurements continue until the measurement is stopped (with the  button, or the “Stop Measurement” command).

To save the measurement, click on the  icon in the toolbar or select the “Save as” option in the “File” menu, after which you will see the Save Measurement window shown in Fig. 11.

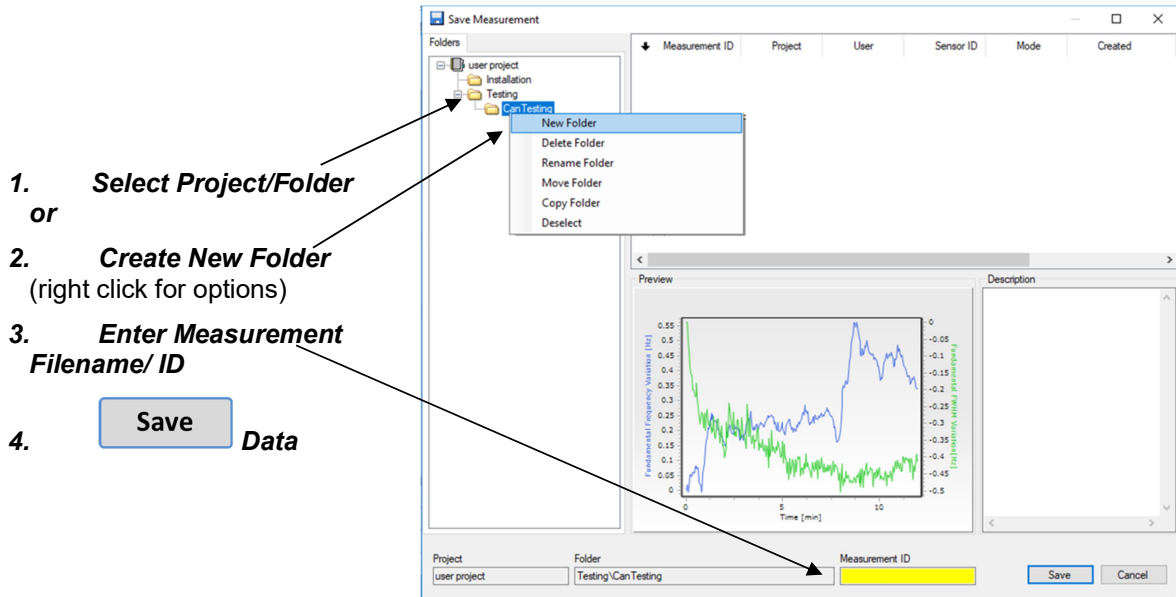


Figure 45: Save Measurement Window

Measurements are saved in Folders within Projects.

For each new User, the software automatically creates a project named “username project”. The user can save measurements in this project folder. After you select the project, enter the measurement filename in the yellow Measurement ID field. The data are saved in the BioSense database when you click the “Save” button.

Users can create new projects and/or folders within projects. Measurements can be copied, deleted, and restored. (See section “HANDLING MEASUREMENT DATA” in the QCM-I Mini Operator’s Manual for more information on managing measurement data.)

### 5.12 FREQUENCY SCAN MEASUREMENTS

#### Measurement Control – Frequency Scan

The Frequency Scan measurement window is shown in Figure 46. The channel, frequency range and number of points must be specified before starting the measurement. The frequency range can be selected between 50 kHz and 80 MHz. After the measurement is complete, the result is plotted (Conductance-real and Susceptance-imaginary, Figure 47). The data can also be saved to a text file.

When choosing a range to measure the impedance over, if you are looking for resonant peaks, make sure that there are enough points, so that the sharp resonant peaks are not missed. Calculate the frequency interval between points and compare it with the expected FWHM.

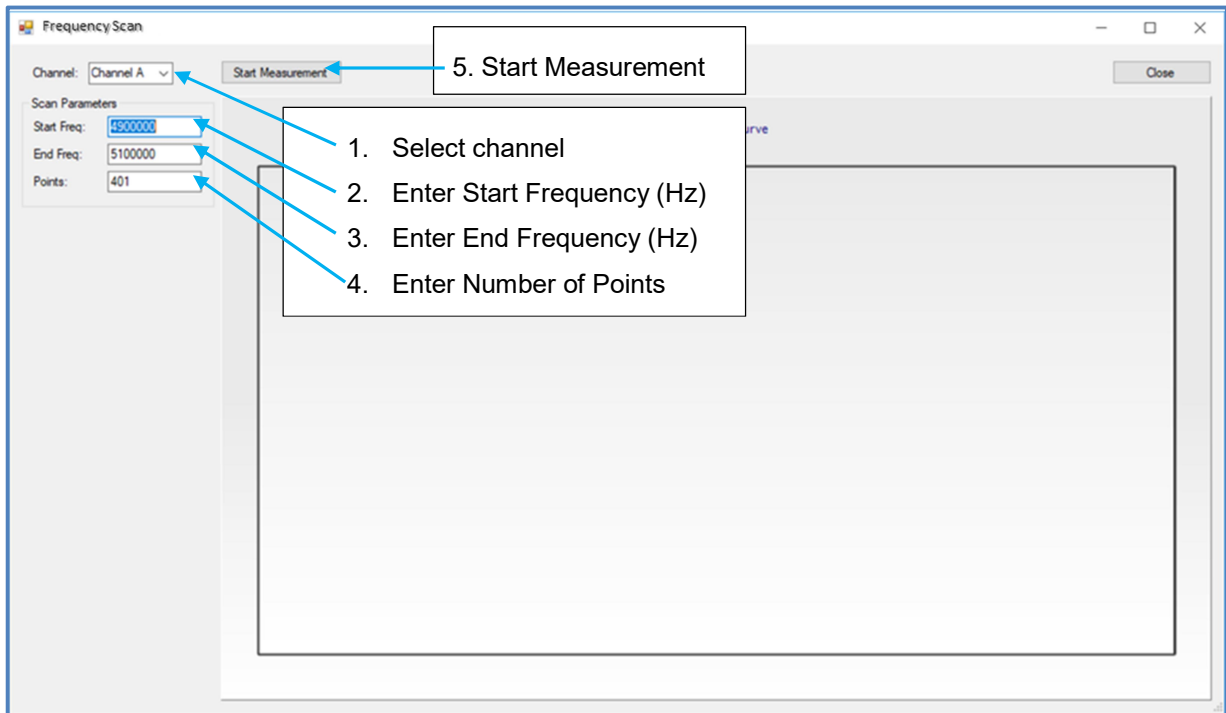


Figure 46: Frequency Scan Window

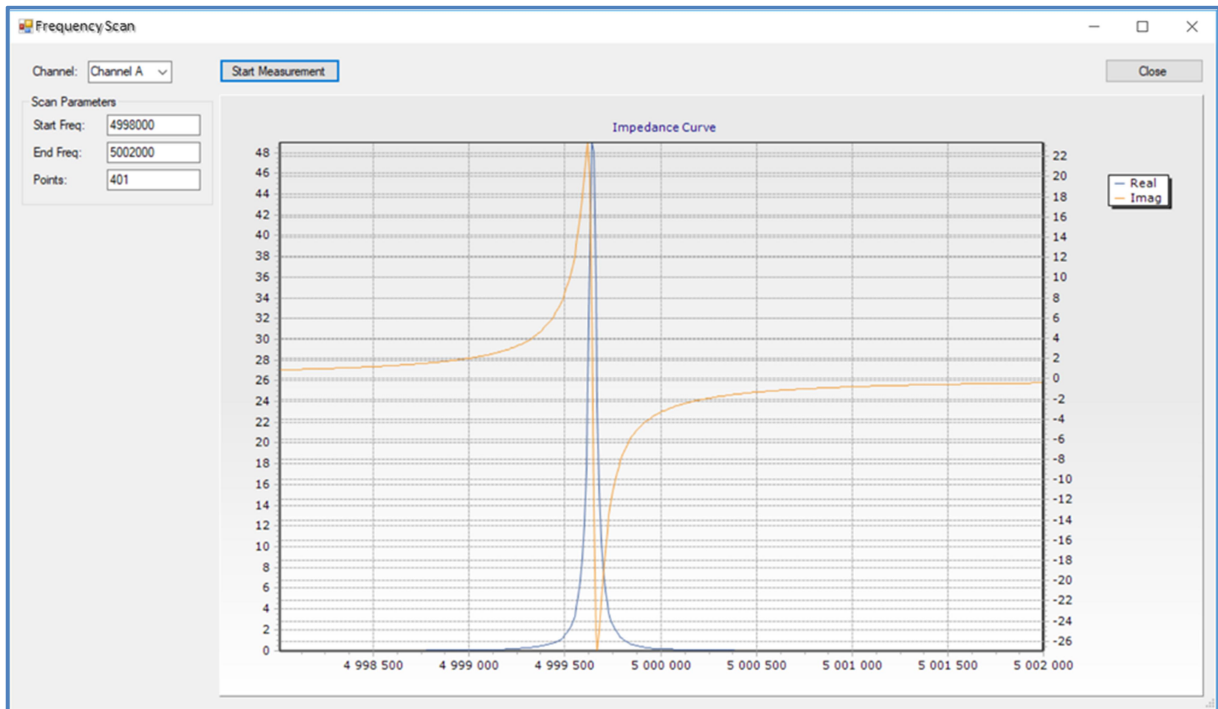


Figure 47: Frequency Scan Window after measurement

## 6. QCM-I Measurement Setup

### 6.1 SETTING THE MEASUREMENT PARAMETERS

The measurement parameters can be accessed from the *Settings* and *Sensor* commands detailed in this section, but can also be selected as part of the *Setup and Start Measurement* wizard (F5) from the BioSense main screen.

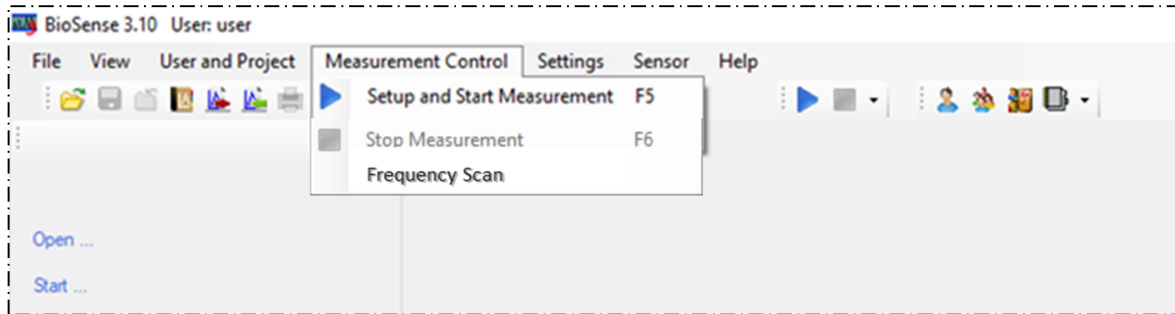


Figure 48: Setup and Start Measurement

#### **Default measurement setting template**

*Settings – Default Measurement Setting...*

The BioSense software offers a Default Measurement Setting (named "Default#Administrator"). Only the Administrator can modify the default setting.

#### **Current measurement setting template**

*Settings – Current Measurement Setting...*

The setting of the current measurement can be viewed.

#### **Creating Measurement Setting templates**

*Settings – Measurement Setting List...*

All users can create measurement setting templates based on existing templates. However, users can only modify or delete their own templates. In the list (Figure 49), the # sign separates the name given by the user from the username who created the template.

When creating a new template, a new template name must be created. The name has to be unique.

The software automatically saves the settings of the user's last measurement in the format "Last date#username."

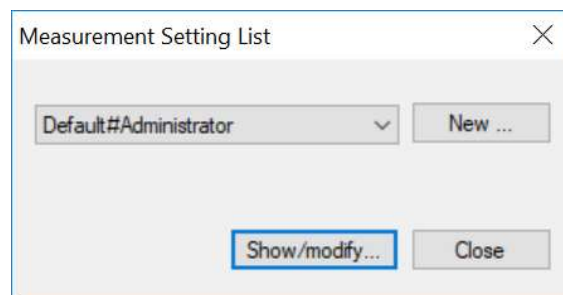


Figure 49: Measurement Setting List

**General setting page**

The Measurement settings name, a short description, and the measurement mode fields must be filled out.

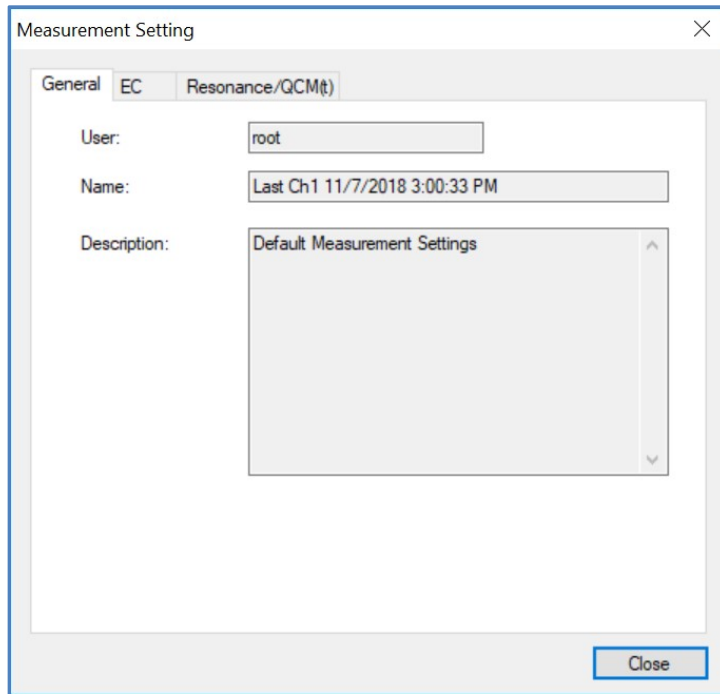


Figure 50: Measurement Setting- General

**Resonance/ QCM – QCM Measurement setting page**

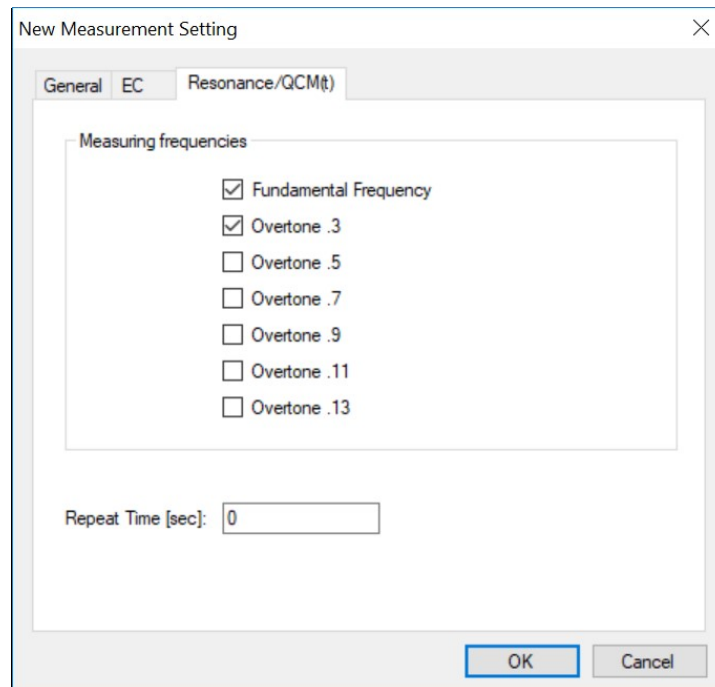


Figure 51: New Measurement Setting – Resonance/QCM(t)

In Modify Measurement Setting window, select the resonance frequencies you want to measure. The frequencies are measured sequentially and each additional frequency selected will increase the time between data points.

The repeat time can be used to reduce the number of points recorded or provide data at pre-defined intervals. If this is blank, zero, or smaller than the time required to measure all the frequency points selected, then the measurement acquisition will be as quick as possible. If the repeat time is longer, then the data will be acquired at that specified interval.

If the Fast function is enabled in the software, data can be acquired 10x faster. This is achieved by measuring 20 instead of 200 frequency points for the resonance spectrum. This increases the acquisition rate, however the resonance curve fit is less precise and the noise level will increase. Select Fast Measurement before starting the measurement. This will apply to the whole measurement, until it is stopped and saved.

### 6.2 ELECTROCHEMICAL SETUP

The EC setup window is shown below. The electrochemical method can be selected from the EC Mode drop-down list: Chronoamperometry, Chronopotentiometry or Cyclic Voltammetry,

#### **Chronoamperometry (CA)**

For Chronoamperometry measurements, the potential is set and the current is measured as a function of time. The setup window is shown below.

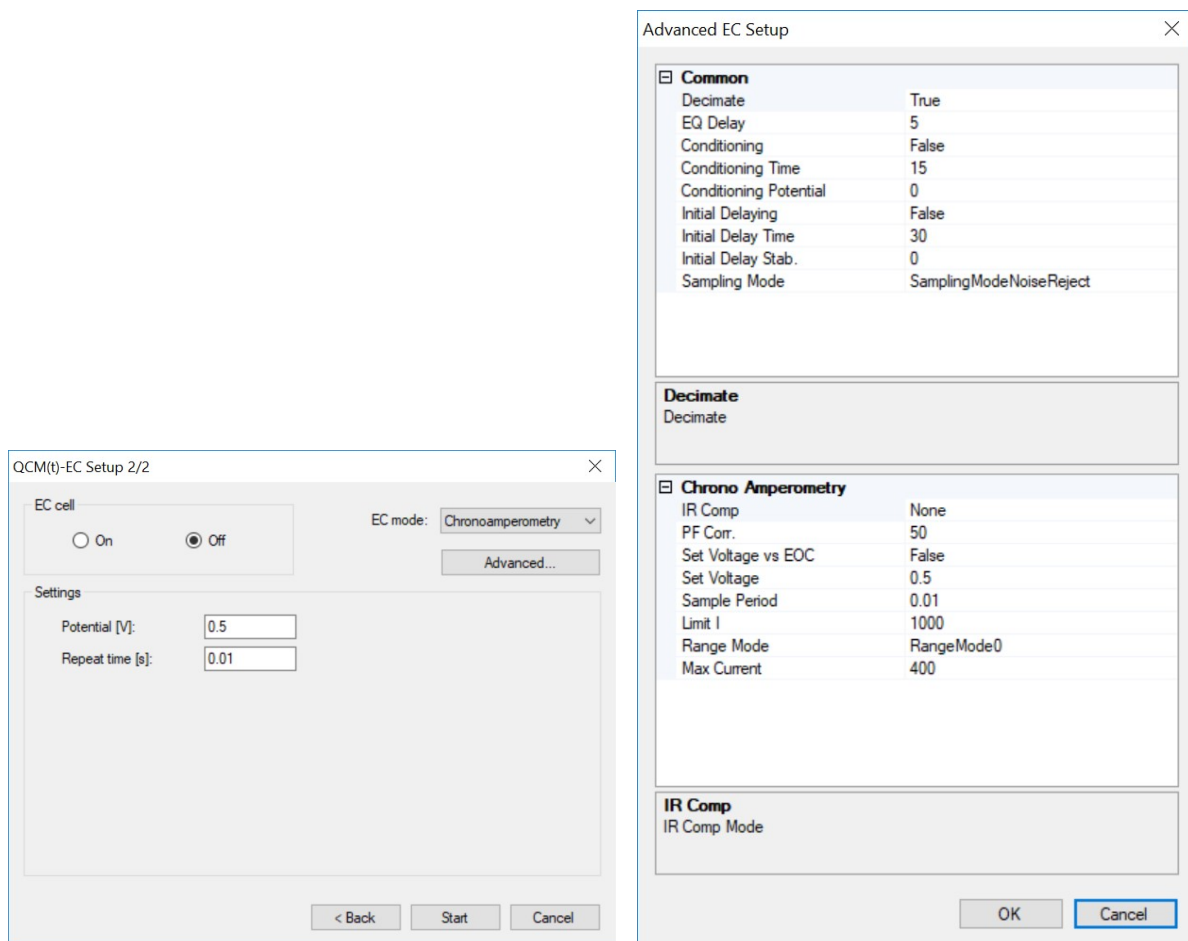


Figure 52: QCM(t)-EC Setup- Chronoamperometry



Enter the potential, the repeat time and select whether the EC cell should be on or off at the start of the measurement. If the cell is off, then an Open circuit measurement will be made until the cell is switched on. For the current at open circuit this should be zero. The setup screen can also be accessed during the measurement and the setting changed in real-time. The measurement mode is fixed however.

The Advanced Settings are commands specifically for the Gamry potentiostat and can be found in the Gamry manual.

**Chronopotentiometry (CP)**

For Chronopotentiometry measurements, the current is set and the potentiostat operates Galvanostatically to pass the fixed current. The applied potential is measured as a function of time. The setup window is shown below.

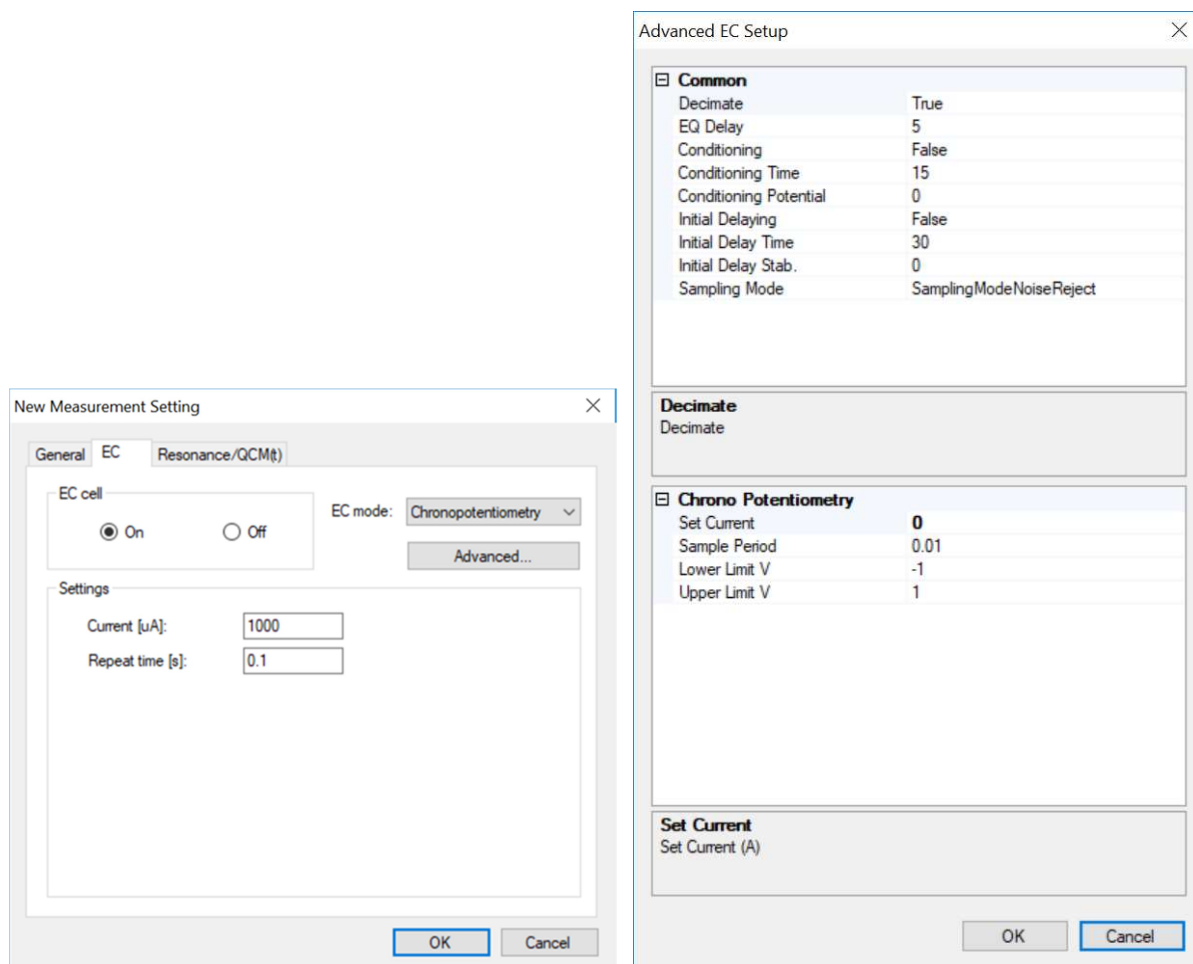


Figure 53: QCM(t)-EC Setup – Chronopotentiometry and Advanced Settings

Enter the current, the measurement repeat time and select whether the EC cell should be on or off at the start of the measurement. If the cell is off, then an Open circuit measurement will be made until the cell is switched on. The setup screen can also be accessed during the measurement and the setting changed in real-time. The measurement mode is fixed however.

The Advanced Settings are commands specifically for the Gamry potentiostat and can be found in the Gamry manual.

**Cyclic Voltammetry (CV)**

For Cyclic Voltammetry measurements, the potential is repeatedly scanned up and down between two limits while the current is measured. The basic setup window is shown below. More detailed settings can be accessed using the Advanced Settings Button.

As well as the potential limits, scan rate, number of repeat cycles and measurement repeat time, the initial time allows for an initial conditioning potential to be applied for a specified time before the measurement starts.

The settings cannot be changed in real time, so the Cell on/off is always selected as On.

If you need to change the CV settings, the scan should be stopped and the measurement restarted, at which point the settings can be changed.

If the “Stop measurement at CV end” box is checked, the QCM(t) measurements will also stop once the EC measurement has completed. If this box is not checked, the QCM(t) measurement will continue and the EC cell will remain off (at open circuit).

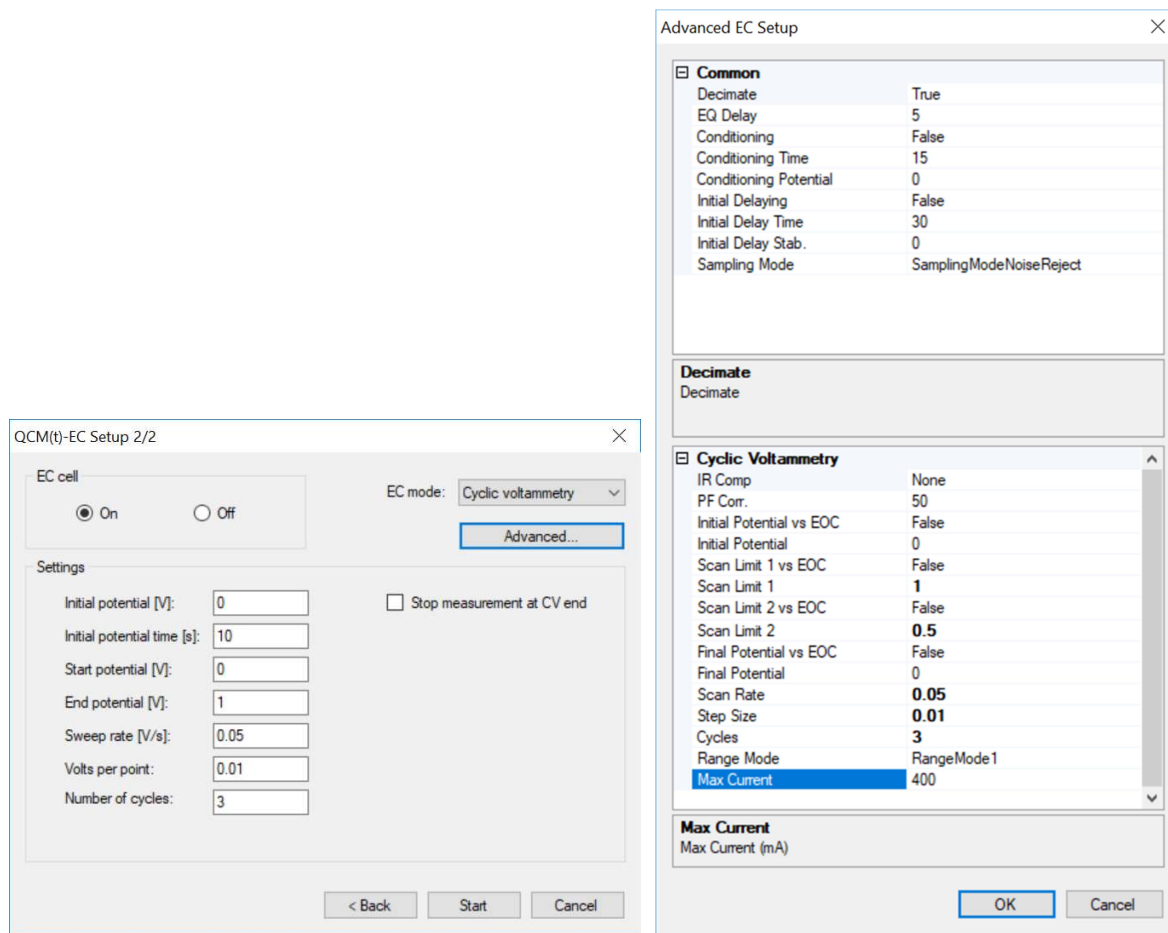


Figure 54: QCM(t)-EC Setup – Cyclic Voltammetry and Advanced Settings

The Advanced Settings are commands specifically for the Gamry potentiostat and can be found in the Gamry manual.

6.3 SENSOR MANAGEMENT

**Sensor type management**

Sensor – Sensor Types...

When selecting the Sensor Types menu item, first you have to select or confirm the Sensing Mode then you can continue with creating, modifying, deleting sensor types corresponding to Selected Sensing Mode.

The software can handle various sensor types. The “Administrator” can create a new sensor type or modify or delete sensor types. When a sensor ID is added to the measurement, the sensor type is linked to the individual sensor. Only those sensor types can be deleted to which no sensors have been added.

The user can select the proper sensor type on the pop-up window bellow.

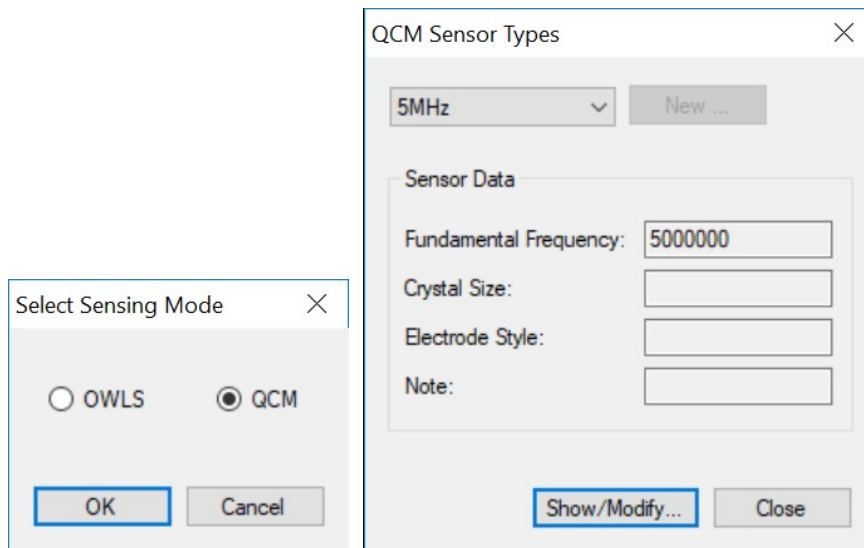


Figure 55: Select Sensing Mode and QCM Sensor Types

**Sensor properties management**

Sensor – Sensor Properties...

Selecting the Sensor Properties menu item first you have to select or confirm the measurement mode, the same way as in *Sensor Type* menu item.

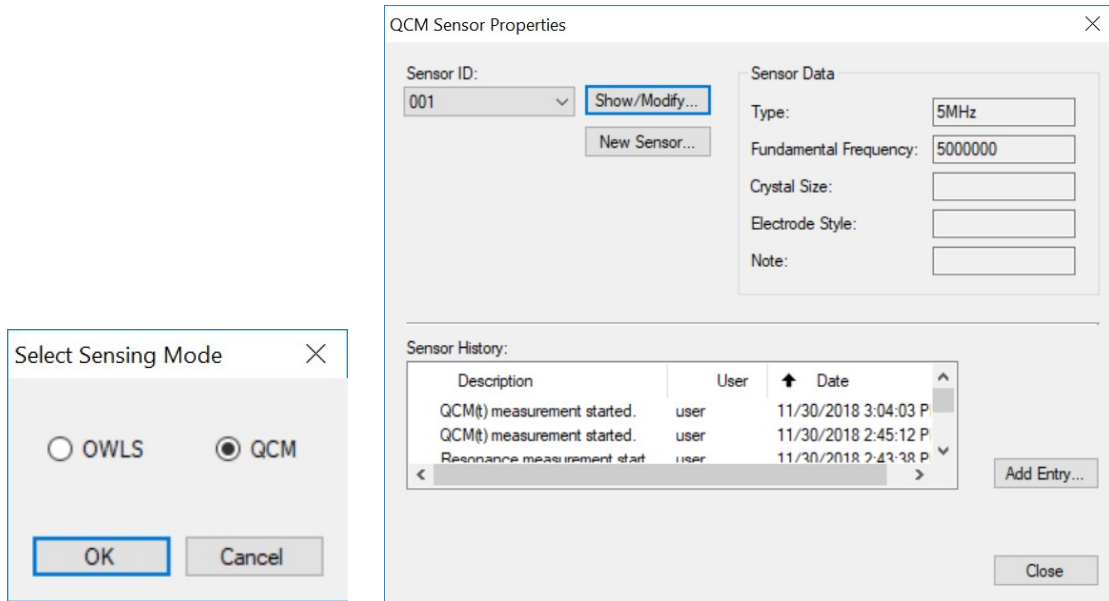


Figure 56: Select Sensing mode and QCM Sensor Properties

On the QCM Sensor properties window you can edit the properties and history of individual sensors. The sensor is identified by the Sensor ID. New sensors can be created with the “New Sensor..” command. The sensor properties can be modified, or deleted with the “Show/Modify” commands.

***Modifying sensor histories, creating new entries***

New entries can be added to the sensor history, modified or deleted.

New entries can be created in the Sensor Properties window (**Error! Reference source not found.**) by clicking on the Add Entry button. The sensor history can be modified e.g. to document sensor treatments on individual sensors outside of the experiment, prior to, during or after.

Users can access the modify and delete functions by double clicking on the line they wish to change in the Sensor Properties window, after which the following windows (Figure 57) appears. The text in the Description and Date fields can be modified and the whole entries can be deleted.

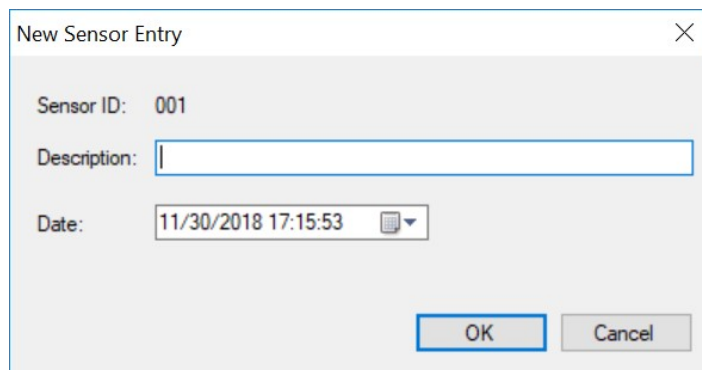


Figure 57: New Sensor Entry

## 7. Displaying the Measurement

### 7.1 VIEW MENU

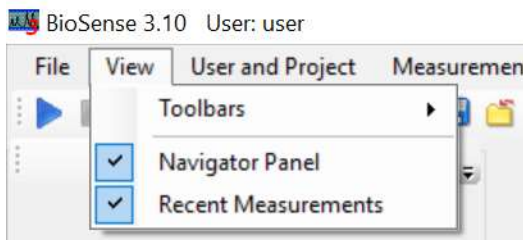


Figure 58: View Tab

#### **Viewing recent measurements**

##### *View – Recent Measurements*

If this option is selected, the left side of the screen displays the user’s last 10 saved measurements; this menu can also be used to open or run measurements.

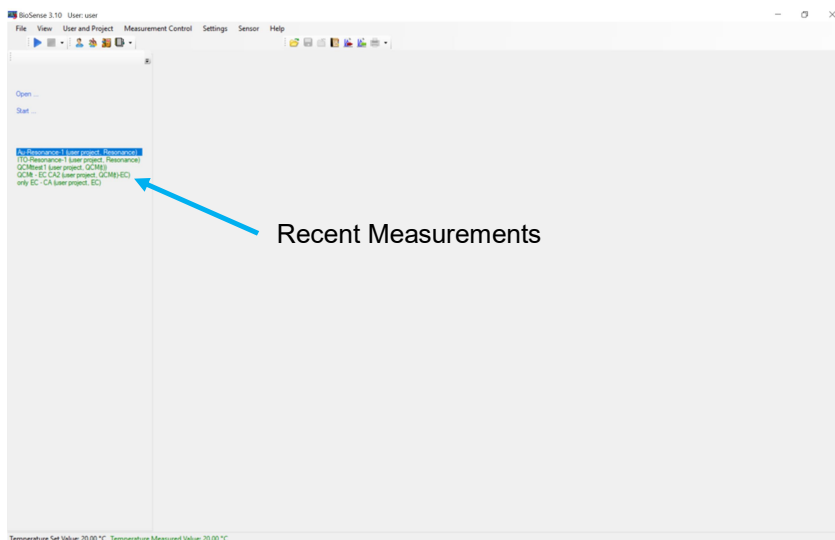


Figure 59: Recent Measurements

#### **Viewing the Navigator panel**

##### *View – Navigator Panel*

If selected, the Navigator panel is displayed on the left side of the screen (see Figure 62). The navigator panel displays the characteristics of the measurement and also serves to run certain measurement related functions. If hidden, graphs are enlarged to fill the whole screen. The contents of the Navigator Panel depend on the Measurement Type Selected.

#### **Viewing toolbars**

##### *View – Toolbars*

The user can select which toolbar panel to view (*File, User and Project, Measurement*).

After clicking on the *Add or Remove Buttons* on the toolbar panel, the buttons to be included on the given panel can be set.

Toolbar panels can be positioned at the top, bottom, or either side of the screen.

The software saves the settings per user and are loaded the next time the user logs in.

### 7.2 NAVIGATOR PANEL - RESONANCE MEASUREMENT

During a Resonance measurement the Navigator Panel shows the following tabs:

- Resonance Calculation
- Measurement Properties

#### **Resonance Calculation**

The Frequency and FWHM values are shown for the selected channel and each overtone measured. The resonance curve is plotted in the graph for the selected overtone. The Blue line is the raw data and the green line is the conductance curve fit.

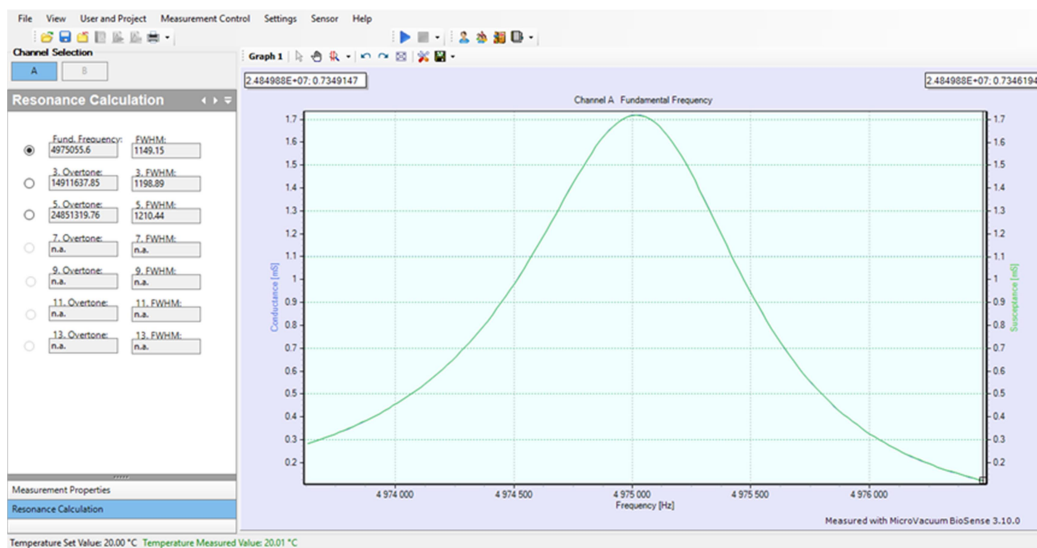


Figure 60: Resonance Measurement

#### **Measurement Properties**

This panel displays the data of the measurement, including the Measurement ID, the Date and time when the measurement was started, the User conducting the measurement, the Type of measurement, the name of the Sensor, the Project, the Folder, a brief Description of the measurement, the Serial Number of the instrument, and the Version number of the BioSense software.

The Measurement ID, the Description, and the Sensor ID can be modified during the measurement.

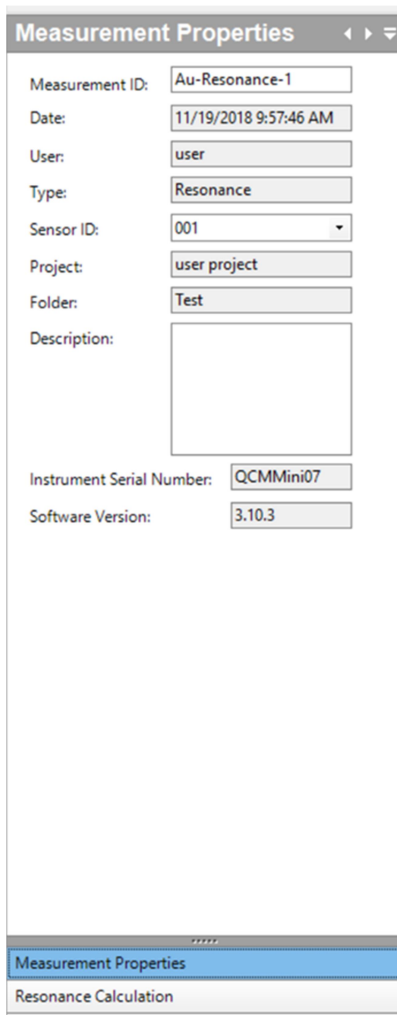


Figure 61: Measurement Properties

### 7.3 NAVIGATOR PANEL - QCM(t) MEASUREMENT

During a QCM(t) measurement the Navigator Panel shows the following tabs:

- Data and Event Tools
- Measurement Properties
- QCM View Settings
- Resonance Graph
- QCM Calculations

#### **QCM(t) View Settings**

One or two graphs can be displayed on the screen. Each graph can include two curves, one on the Left and one on the Right axis.

Choose the parameters to be displayed from the QCM(t) View Settings panel. For each curve to be plotted select the resonance *Frequency* and the measured/calculated *Parameter* to be displayed in the sections for the Right or Left axis.

If *Resonance Frequency* is selected as a parameter then this graph can only show the resonance curve and the resonance fit. Current or saved resonance curves can be selected and displayed.

The Sauerbrey-model is implemented in the BioSense software; this calculation can be selected in the *Calculation Model* field.

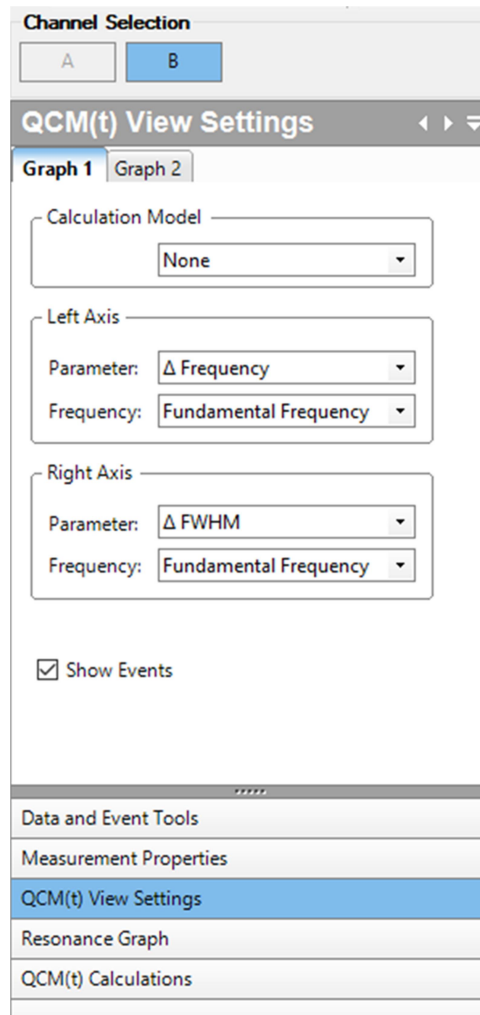


Figure 62: QCM(t) View Settings

If the *Show Events* box is checked, the event markers will be plotted on the graph too.

For each frequency measured, the data calculated from the resonance curves and available to be plotted are:

- Frequency (the resonant frequency of the selected overtone, Hz),
- FWHM (full width half maximum of the resonance peak, Hz),
- **ΔFrequency** (frequency change from start of experiment or baseline,)
- **ΔFWHM** (change in resonant peak width, Hz,)
- Gmax (parameter from Lorentz fit of the resonance curve,)
- Goffs (parameter from Lorentz fit of the resonance curve,)
- Boffs (parameter from Lorentz fit of the resonance curve,)
- Fi (parameter from Lorentz fit of the resonance curve,)



- Residual (parameter from Lorentz fit of the resonance curve,)
- Q (Q-factor),
- Dissipation,
- **ΔDissipation** (change in dissipation,)
- Temperature (measured on channel A,)
- Flow (where fluidic pump control is enabled,)
- Resonance (the current resonance curve,)
- Saved Resonance (select from list of saved curves,)
- **Sauerbrey Mass** (Mass calculated using the Sauerbrey equation from the beginning of the experiment or baseline,  $\text{ng/cm}^2$ ; if Sauerbrey is selected as the Calculation Model. )

A description of all the parameters is given in the User Manual, 3.1 Measurement Principle section.

### ***Data & event tools***

#### *Data & Event Tools*

On this panel you may handle the Measurement Data and the Events of the displayed measurement.

Selected measurement data can be hidden and unhidden on the graph.

An Event is a brief written description that is linked to a given point in time. Events can be entered and deleted on this panel.

The Export data button can be used to select data to be exported to .txt file. See section on Outputting Data on page 62.

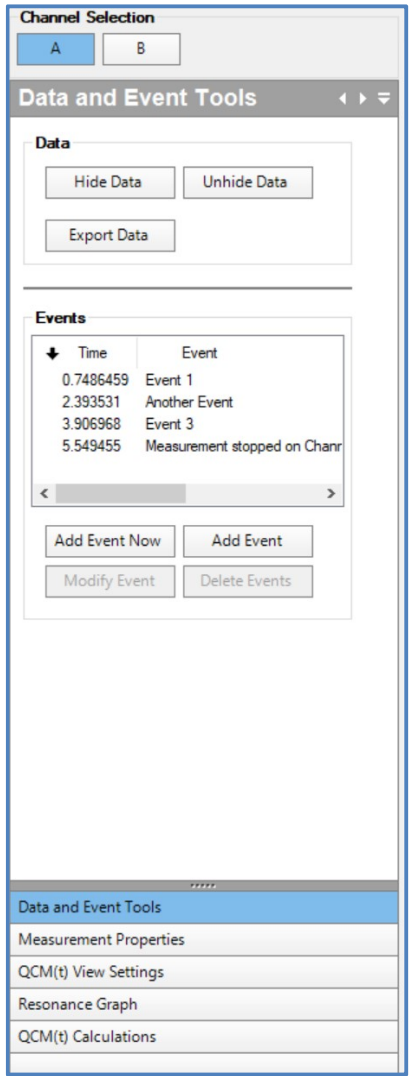



Figure 63: Data and Event Tools

**Hide and Unhide measurement data from the graph**

*Hide Data*

The top of the panel displays the type of command the user has selected and requests that the user select a time range (or point). Do this on the graph using the graph select arrow, . The command can be cancelled with the Cancel button. After the selection is made, the BioSense asks for approval. The program does not hide data permanently, only marks them as hidden. By default, hidden data are not displayed on the graph, but they can also be displayed with a different color.

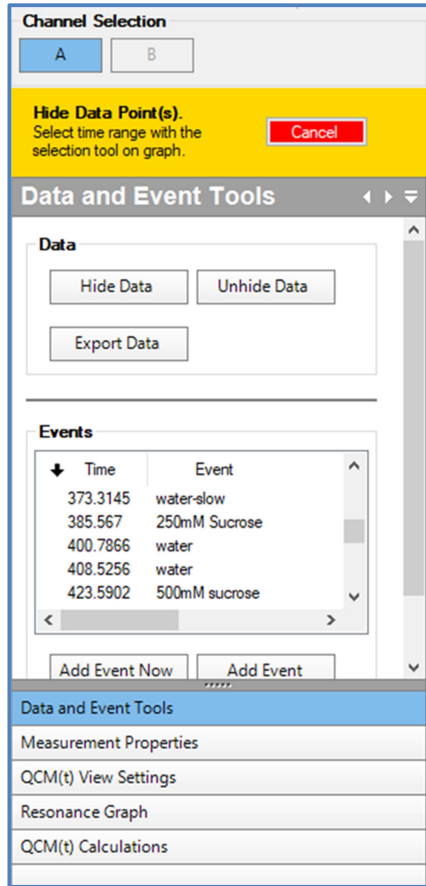


Figure 64: Hide data points

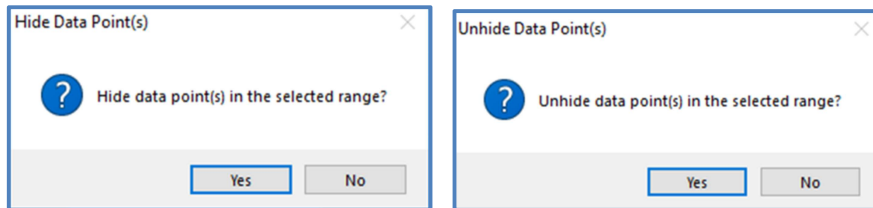


Figure 65: Hide Data Point(s) and Unhide Data Point(s)

**Adding events in real time**

*Add Event Now*

The time of the event will be the time when the “Add Event Now” button (Figure 66) is pressed.

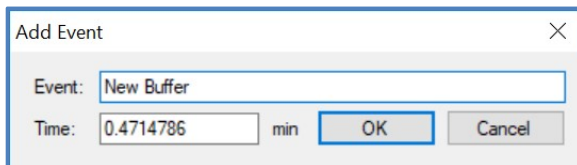


Figure 66: Add Event (in real time)

**Add Event for a selected time**

*Add Event*

Adding an event can be started by pushing the Add Event button. After selecting the time, the event description has to be filled in. The time can be changed manually as well.

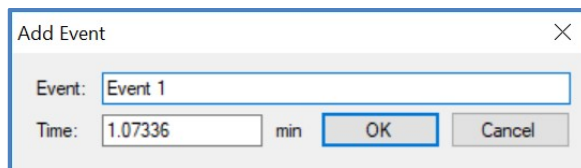


Figure 67: Add Event (at a selected time)

**Deleting event(s)**

*Delete Events*

The button “Delete Event” is only active if at least one event is selected from the list. The software asks if the user is sure to delete the selected event.

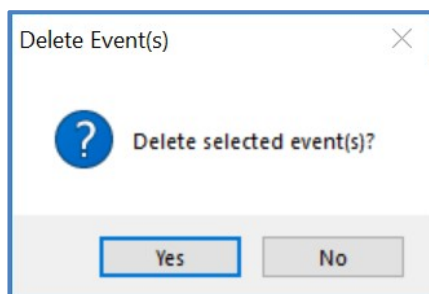


Figure 68: Delete Event(s)

**Modifying events**

*Modify Event*

The button “Modify Event” is only active if an event is selected from the list. The event description and the time of the event can be modified (Figure 69). This window also pops up by double clicking on a given event in the event list.

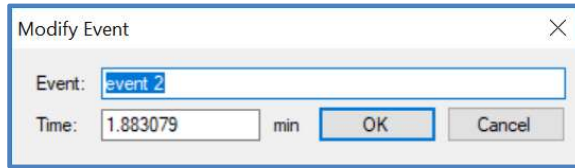


Figure 69: Modify Event

Adding, Deleting, Modifying event can also be accessed from a context menu by clicking right mouse button on a given event in the event list.



Figure 70: Event 'right-click' menu

**Resonance graph**

*Resonance Graph*

The graph on this panel displays continuously the current Resonance curve during the QCM(t) measurement for the resonance frequency selected on this panel.

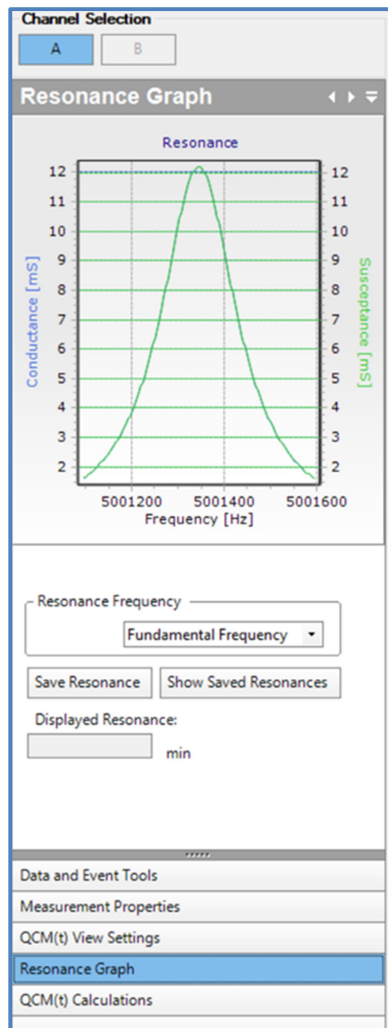


Figure 71: Resonance Graph

**Saving the actual Resonance curve**

*Save Resonance*

The current resonance peak curve be saved at any time during a QCM(t) measurement by selecting the Save Resonance button. If pressed, the following text box is displayed before the resonance is saved.

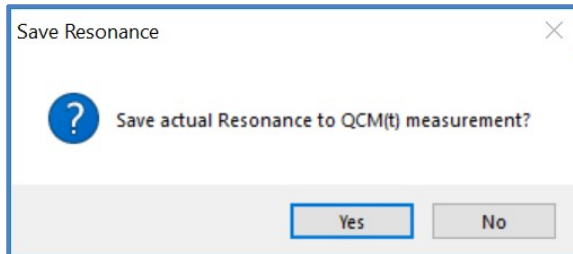


Figure 72: Save Resonance

**Displaying saved Resonance**

*Show Saved Resonances*

Displays the Resonance Peaks saved during the QCM(t) measurement. The first and the last Resonance measurements are automatically saved any time you stopped the measurement.

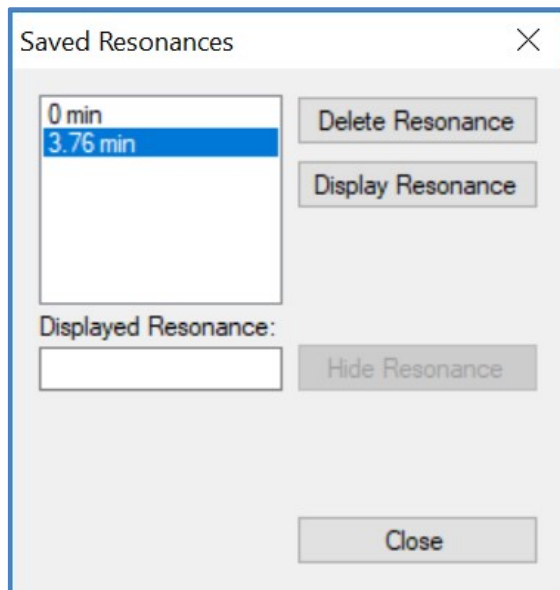


Figure 73: Saved Resonances List

The peak selected from the list can be deleted. You can display or hide the Peak curve on a graph.

**QCM Calculations**

*Calculations*

A Baseline calculation is needed when you want to make model calculations. The baseline value is the average of the data in the selected region. The change of the frequency and the change of the FWHM are calculated compared to these "zero" (baseline ) values.

Select a time period on the graph before starting baseline calculation. The time period can be selected with the *Selection* arrow on the graph tool bar.

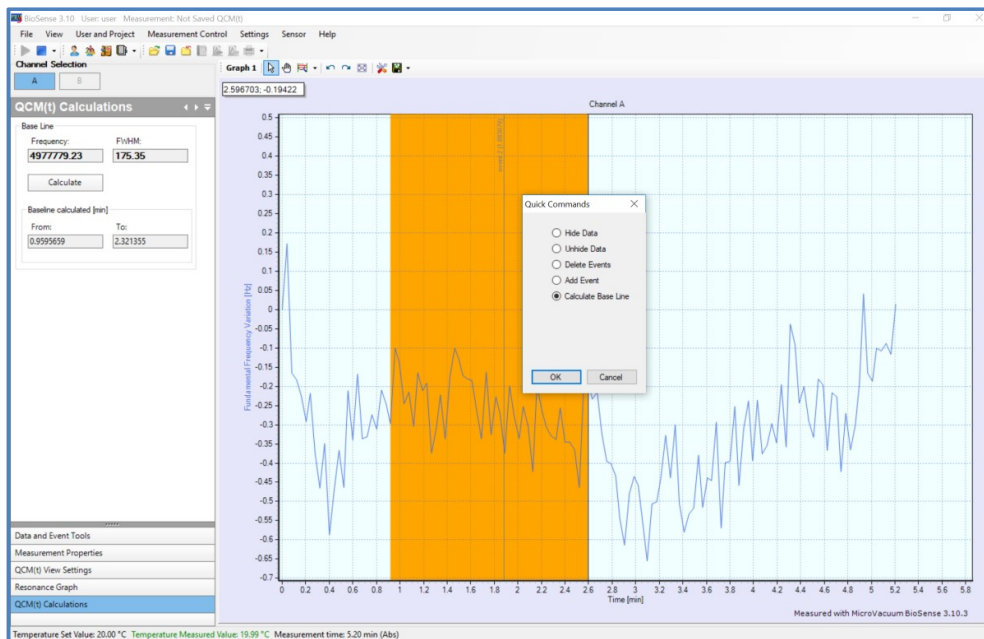


Figure 74: Calculate Base Line

The calculation can be initiated by pushing the Calculate Base Line button, and selecting OK on the Quick Command window. The Calculated values (Frequency, FWHM) are displayed on the QCM Calculations panel (Figure 75).

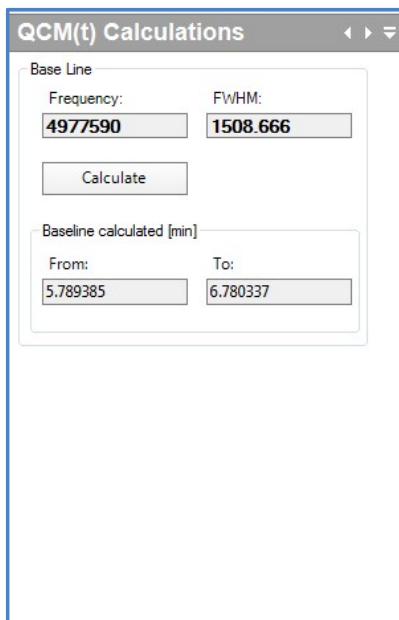


Figure 75: QCM(t) Calculations

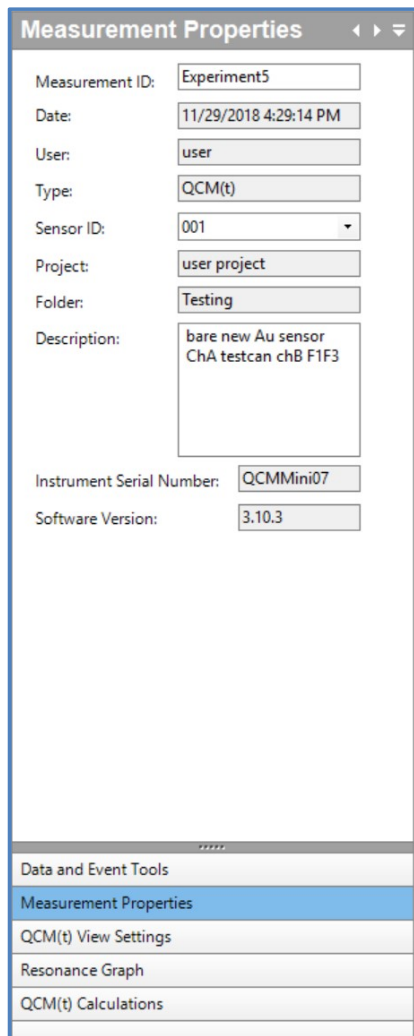
**Measurement properties**

*Measurement Properties*

This panel displays the details of the measurement.

The description should start with a brief description of the experiment, which can be used for file management. Information can be added to it during an experiment.

The Description and the Sensor ID can be modified during as well as after a measurement. The Measurement ID is the file name, which can be modified for saved files. While a new experiment is running, the ID is an automatically generated title that cannot be modified until the measurement is stopped saved.



**Measurement ID:** Measurement file name, once the measurement has been saved. (Modifiable once saved)

**Date:** Date and time at the start of the experiment

**User:** The user name

**Type:** The experiment type

**Sensor ID:** Sensor type and serial no. (Modifiable)

**Project:** The project under which the measurement is saved.

**Folder:** The project subfolder in which the measurement is saved.

**Description:** (Modifiable)

**Instrument Serial No.:**

**Software Version:**

Figure 76: Measurement Properties



## Injections

### Injections

If an automated sample injector valve is connected to the system, the *Injector* panel is shown in the Navigator Panel. This is shown in Figure 77.

The Injections panel shows the status of the injector valve: Load or Inject.

The panel also lists all the injections that have been planned in the Injections setup, or added during the measurement, together with their status. New injections can be added, or planned injections can be deleted.

For Add Injections, the Relative Start time is the time from the start of the experiment.

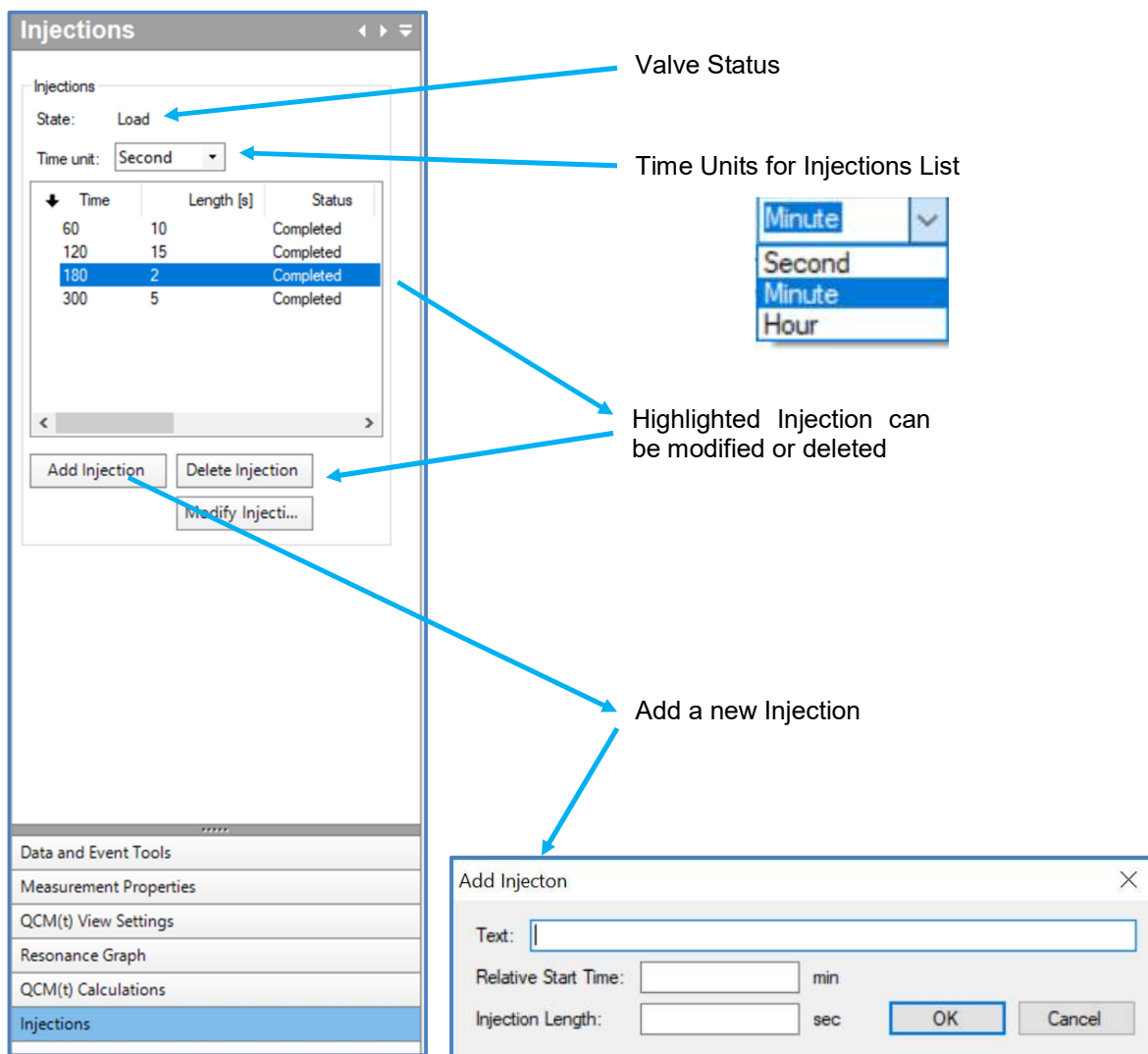


Figure 77: Injections Navigator Panel and Add Injection Window

When an injection takes place, an event marker is automatically added to the measurement.

## 7.4 NAVIGATOR PANEL - QCM(t)-EC AND EC MEASUREMENT

### **QCM(t)-EC View Settings**

The *QCM(t)-EC View Settings* panel is shown instead of the *QCM(t) View Settings* panel when EC measurements are enabled. The *QCM(t)-EC View Settings* panel is the same as the *QCM(t) View Settings* panel above with the addition of the following data to plot:

- Current,
- Potential,
- CV and
- Stored CV

By default, for EC measurements Graph 2 is selected to show the Current and Potential vs. time.

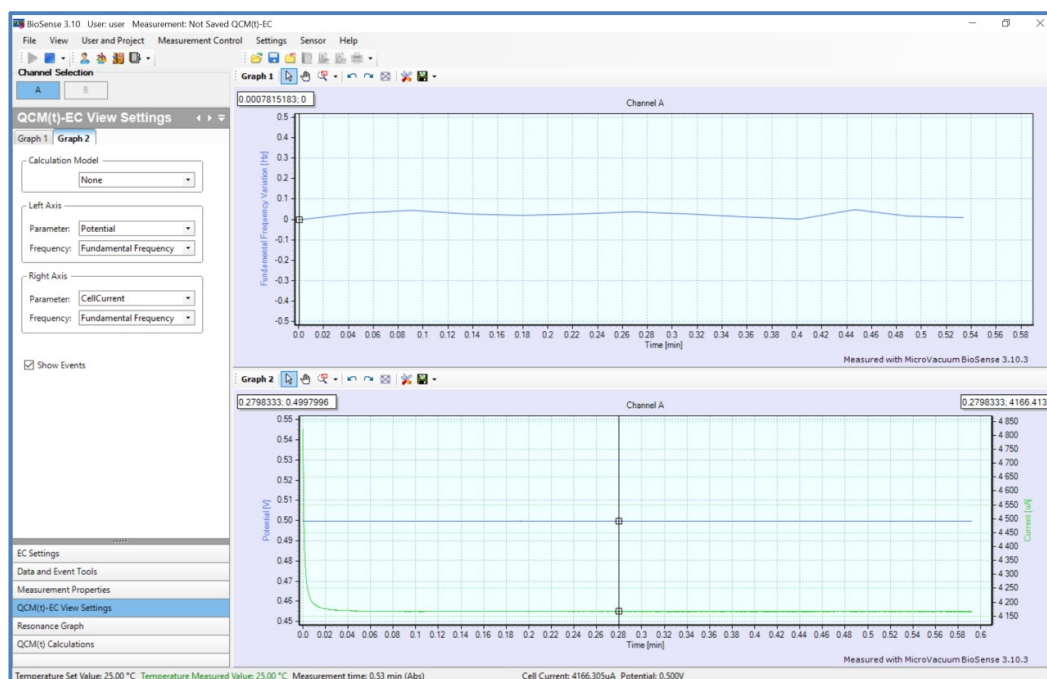


Figure 78: QCM(t)-EC View Settings

### **EC Settings**

When an EC measurement has been chosen (EC or QCM(t)-EC measurement types), the EC settings panel is visible. It shows the measurement mode. During an EC Chronopotentiometry or Chronoamperometry measurement, it also allows the Settings to be modified. So the cell can be switched on or off, and the potential and repeat time can be changed. Clicking on the Modify EC Settings.... Button opens the QCM(t)-EC Setup window.

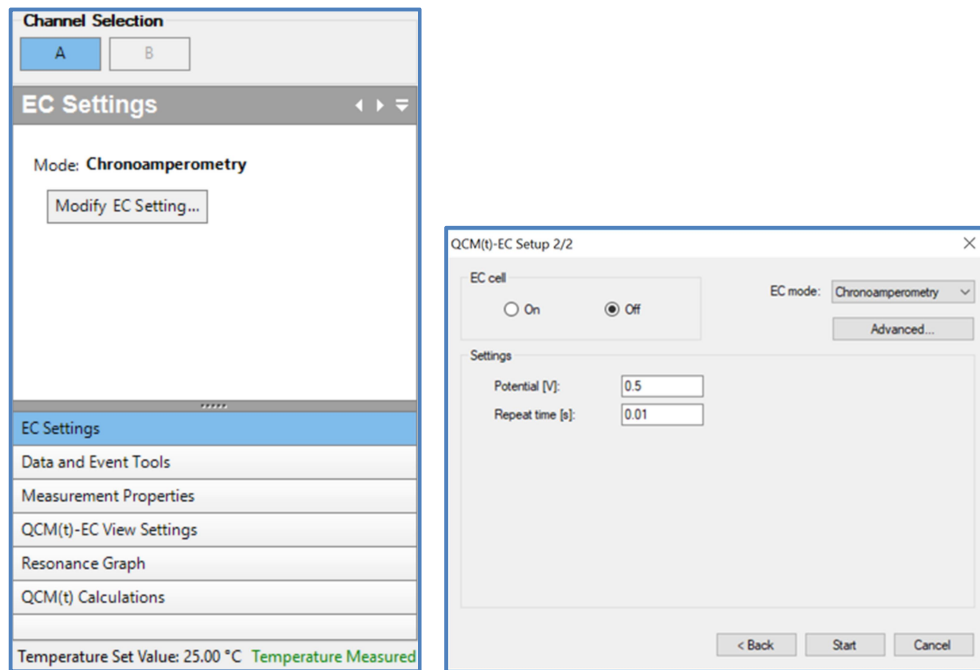


Figure 79: EC Settings

During a Cyclic Voltammetry measurement, the settings cannot be changed however.

## 8. Graph features

### 8.1 GENERAL GRAPH FEATURES

The graph's horizontal axis typically displays time. Its unit is hours, minutes or seconds.

The display can be switched from absolute to relative time. In relative time mode the time period when the measurement was stopped is not included in the graph. When you stop the measurement, an event is automatically generated.

If the horizontal axis is time, the vertical axes can include one or two measured or calculated data.

- The mouse has several functions when moving over the graph: The curve can be dragged. If the graph displays two curves, dragging moves both.
- You can select a time period (or one point) in the graph. The selected time period can then be used for various operations: Hiding, Unhiding points, selecting/calculating the baseline, adding/deleting events, etc. If a graph includes two curves, the operation applies to both.
- The selected area can be magnified either horizontally or vertically.
- The BioSense stores magnification and movement, making it easy to move back and forth by up to a maximum of 20 steps.

The cursor can also move over the graph continuously or from measurement point to measurement point, in the latter case the coordinates are displayed at the top of the graph.

Events can be included on the graph, with text entered rotated by 90 degrees.

Measurement points and the curves connecting them can be displayed. In case of two curves, these change simultaneously.

Smoothing of the curve can be turned on and off. The default setting is off. In case of two curves, these change simultaneously.

Measurement points can be hidden. There is also a view where hidden points are displayed with a different color.

A grid can be placed over the graph.

The displayed graph can be saved as a picture. For this option, select the Save image (bmp, jpg, tif, etc.) menu point from the toolbar.

The displayed data can be saved as a tab separated text, xml, html, and Excel files, by selecting the Save Data or the Save Event points from the toolbar.

The displayed graph can be printed.

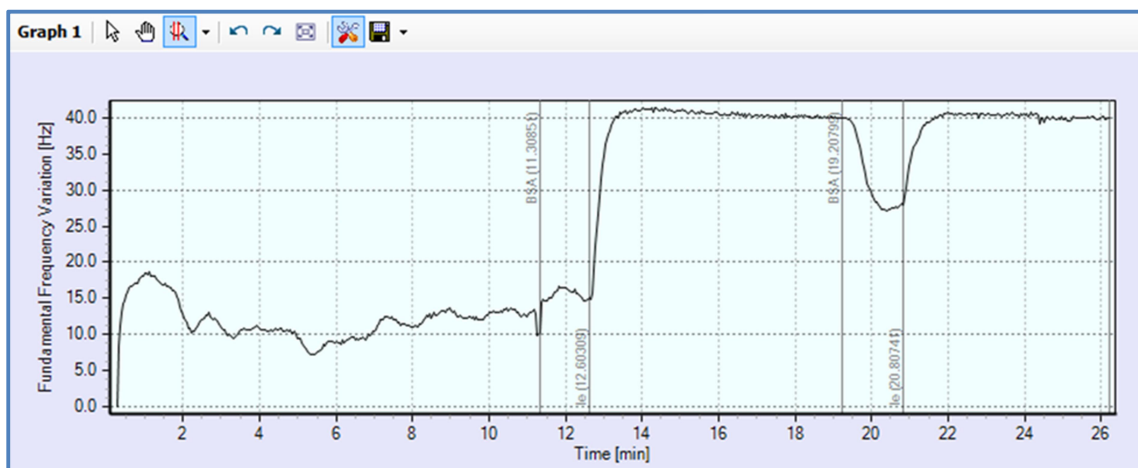


Figure 80: BioSense Graph Display

## 8.2 GRAPH TOOLS AND PROPERTIES

### **Graph Tool Bar**

The format of the graphs displayed can be changed using the graph tools in the graph tool bar above each graph. These are shown (for Graph 1 ) in Figure 81.

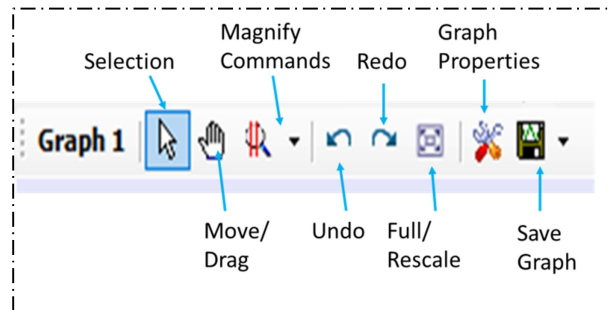


Figure 81: Graph Tool Bar

### **Selection**



Selection

Measurement points can be selected and used for various actions: Hide data (masking), Unhide data, selecting the baseline, etc.

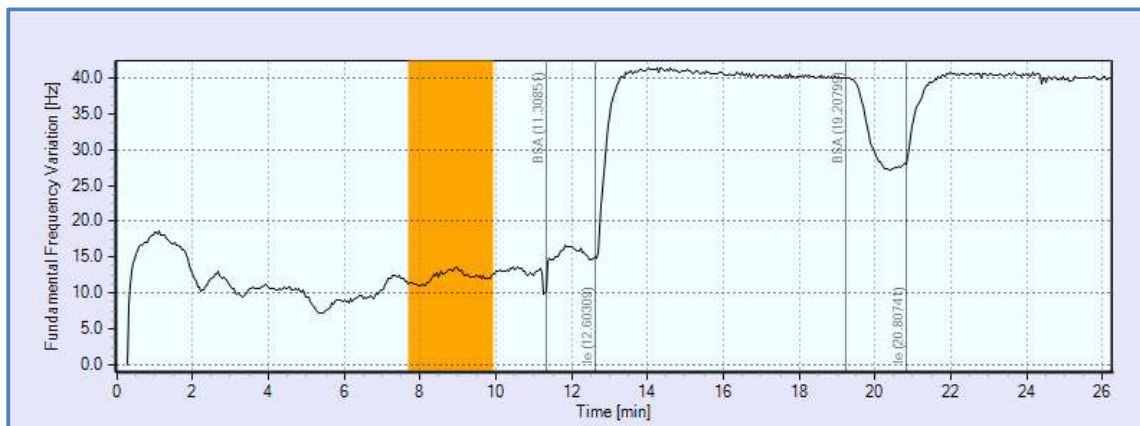


Figure 82: Selection Tool

The selected time period is colored.

In move and magnification modes, *Selection* may be activated by pressing the shift key.

When *Selection* is activated and the user selects a region or clicks on the graph, the Quick Commands Window, shown in Figure 82 is displayed to choose the action to be performed on the selected data. Hide/ Unhide Data, Add/ Delete Events and Calculate Baseline.

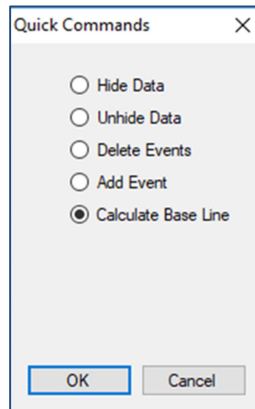


Figure 83: Quick Commands Window

### **Magnification**



The curve(s) can be magnified in the following way: selected area, only horizontally, or only vertically. When you click on the "Magnify" button on the graph's toolbar you can select the method of magnification (Figure 84.) If two curves are displayed both curves are magnified in "Vertical" mode. The "Vertical Left/Right Axis" mode allows magnification of the corresponding curve.

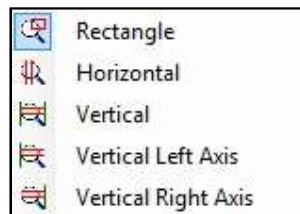


Figure 84: Magnification tool options

Moving the mouse, a dashed line indicates the area to be magnified.

### **Move**



The curve can be moved. In selection and magnification modes, move mode may be activated by right mouse button.

### **Undo**



The last magnification or movement is cancelled.

### **Redo**



You can return to the last magnification or movement that was cancelled.

### **Full screen**



Resets magnification and movement to the default setting to display all measurement points.

## **Graph properties**

### *Graph Properties*

The Graph properties panel that appears on the right side of the screen allows the graph properties detailed below to be set. The various settings can be applied separately for each of the two graphs.

The graph properties are saved for each user, thus personalized graph displays will be automatically loaded at the time of the next login.

The BioSense default setting can be reloaded when clicking on “Set Default” button.

### **List of graph properties:**

- *AxisColor*: the color of axes and labels.
- *AxisFont*: the font type and properties of labels.
- *BackgroundColor*: the color of the background
- *ChartColor*: the background color of the graph’s useful area.
- *EventFont*: the font type and properties of events.
- *EventColor*: the color of event marker and description.
- *ncListColor*: the color of nc marker and description.
- *ncListFont*: the font type and properties of nc’s.
- *NearestPointFont*: the font type and properties of the nearest measurement point.
- *SelectionColor*: the color of the selected area.
- *ImageHeight*: the height of the graph to be exported as a picture, in pixels (200-4000).
- *ImageWidth*: the width of the graph to be exported as a picture, in pixels (200-4000).
- *JPEGQuality*: the quality of the graph to be exported as a JPEG picture (10-100).
- *DeletedColor*: the color of deleted points, if those are displayed.
- *LeftColor*: the color of the data on the left vertical axis.
- *LeftLineWidth*: the width of the line connecting the data of the left vertical axis (1-8).
- *LeftPointSize*: the size of the points of the left vertical axis (1-8).
- *LeftPointStyle*: the style of the points of the left vertical axis (circle, square, etc.).
- *RightColor*: the color of the data on the right vertical axis.
- *RightLineWidth*: the width of the line connecting the data of the right vertical axis (1-8).
- *RightPointSize*: the size of the points of the right vertical axis (1-8).
- *RightPointStyle*: the style of the points of the right vertical axis (circle, square, etc.).
- *Coupled*: True or False. If two graphs are plotted, True couples the magnification of both graphs together. So a selection you make on either graph is made automatically on the other graph.
- *TimeMode*: absolute or relative mode.
- *TimeUnit*: the unit of time measurement: seconds, minutes, or hours.
- *AllowSmooth*: allow smoothing. See description below.
- *Series*: Curve view: line, connecting line, both, none.
- *ShowDeleted*: Show deleted points: display=true, hide=false.
- *ShowEvents*: Show events: display=true, hide=false.
- *ShowGrid*: display grid: horizontal, vertical, both, none.

- *ShowncList*: Show nc: display=true, hide=false.
- *ShowNearestPoint*: have the cursor jump to the nearest point and display the coordinates.

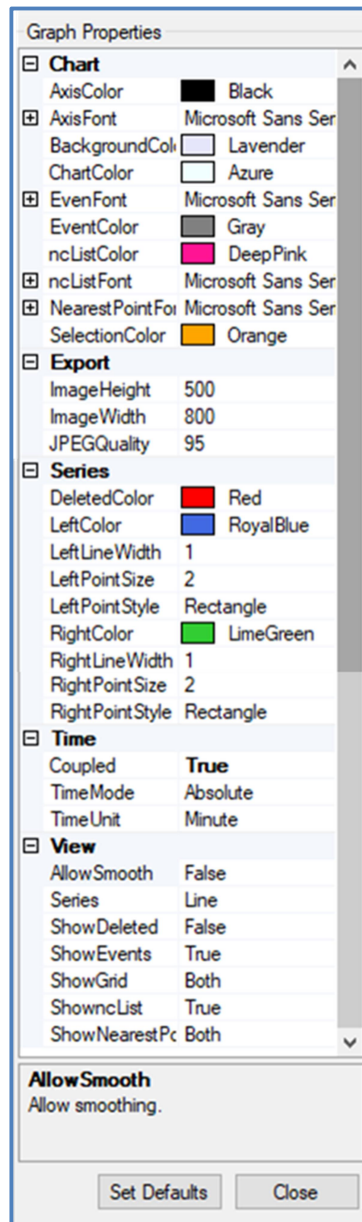


Figure 85: Graph Properties

### ***Allow Smooth***

If *Allow Smooth* is enabled, the data is smoothed using a Savitzky-Golay filter over a window width of 11 data points, and a 3<sup>rd</sup> degree smoothing polynomial. This is reversibly applied to the data displayed on the screen, which can be returned to the original raw data at any stage.

### ***Save Graphs***





This command saves the measured data that are displayed in the graph. If the graph displays two curves, both are saved.

This tool consists of three submenus: Image, Data, Event.

Data and events are saved as a tab separated text file.

The graph image can be saved in following image formats: bitmap, jpeg, tiff, gif, png, emf. The size of the image will be given in the properties of the graph: ImageHeight and ImageWidth; in case of JPEG files, quality can also be set in JPEG Quality property.

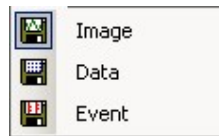


Figure 86: Graph Save Options

## 9. Data Output

There are four ways that you can output the measured data from the BioSense environment, detailed in the pages below and shown in Figure 87:

- Save Graph applies just to the data that is displayed on-screen in the graph. – This exports the Graph data as an image file and/or Data & Events in text files. (see Figure 86). This uses the Save icon on the Graph panel
- Export data outputs data from the whole of a measurement file into a .txt file for further data analysis or graphing - e.g. in Excel®. Whilst the User can select the data types to be exported, the experiment settings and events are not exported. This uses the Export button on the Data and Tools Navigator Panel.
- Printing Measurements. – This prints the displayed graph and other data.
- Export EC and QCM(t)-EC measurements in the Gamry compatible file format for opening in Gamry's Echem Analyst™ software.

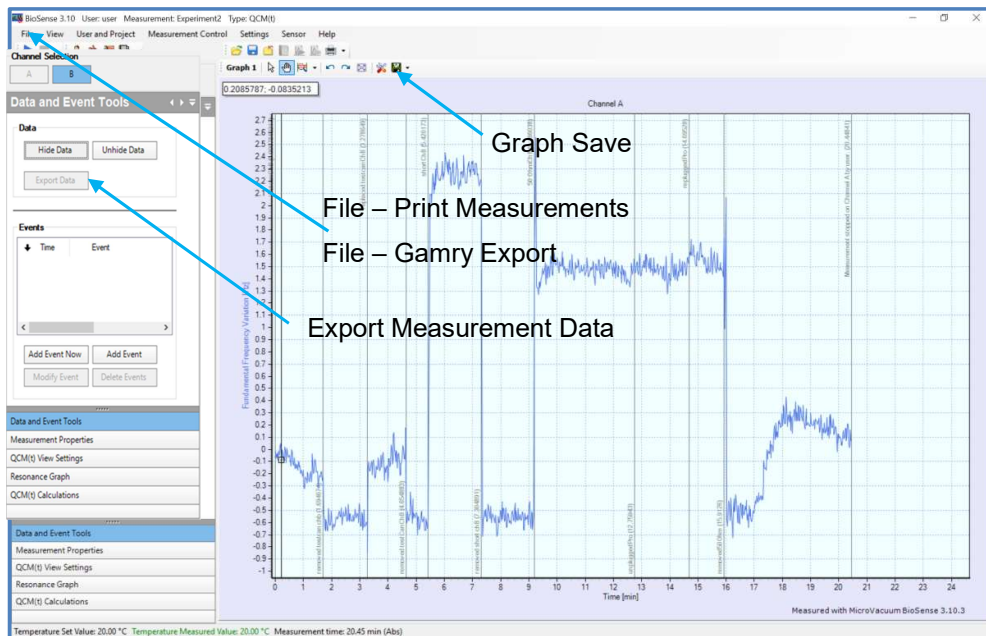


Figure 87: Data Output Options

### 9.1 EXPORT SELECTED PARAMETERS TO THIRD PARTY SOFTWARE (E.G. EXCEL)

#### Export Data

You can export a customized selection of the measured data in the following way.

Select the Data and Event Tools in the Navigator Panel. On the Data and Event Tools panel select Export Data, as in Figure 88.

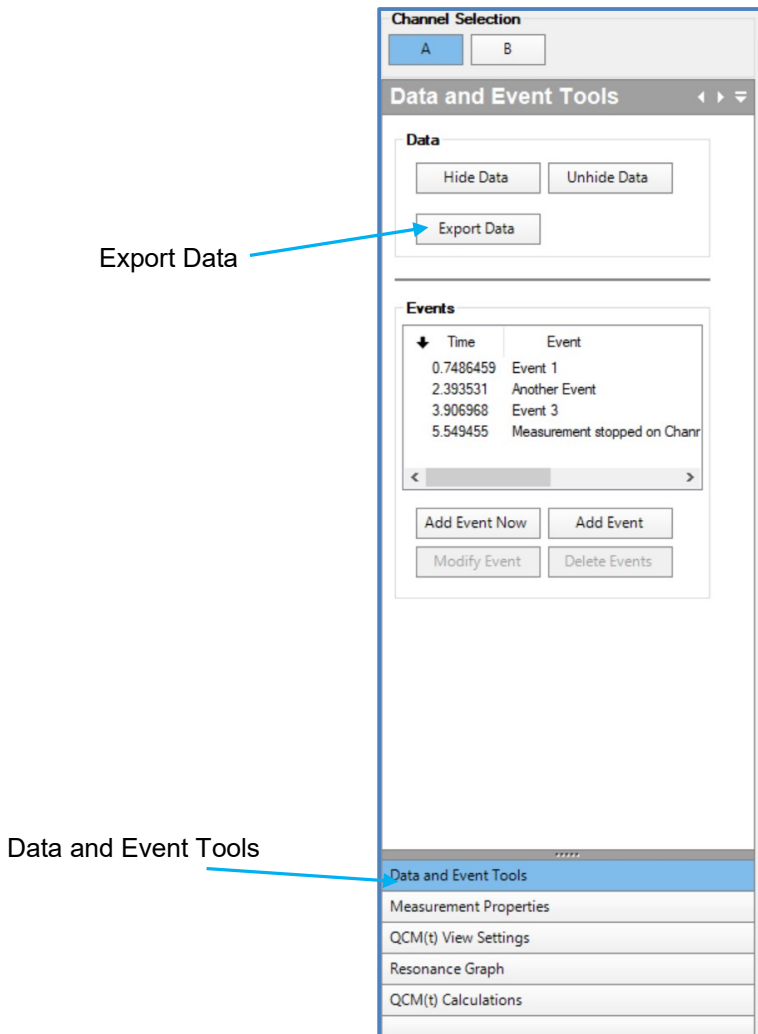


Figure 88: Data and Event Tools – Export Data

The following pop-up window allows you to select the channel, the resonance frequency, and the parameters for each frequency that you want to export. You can select any parameters for any frequency. The selected parameters are inserted into the export data list by clicking the *Add* button.

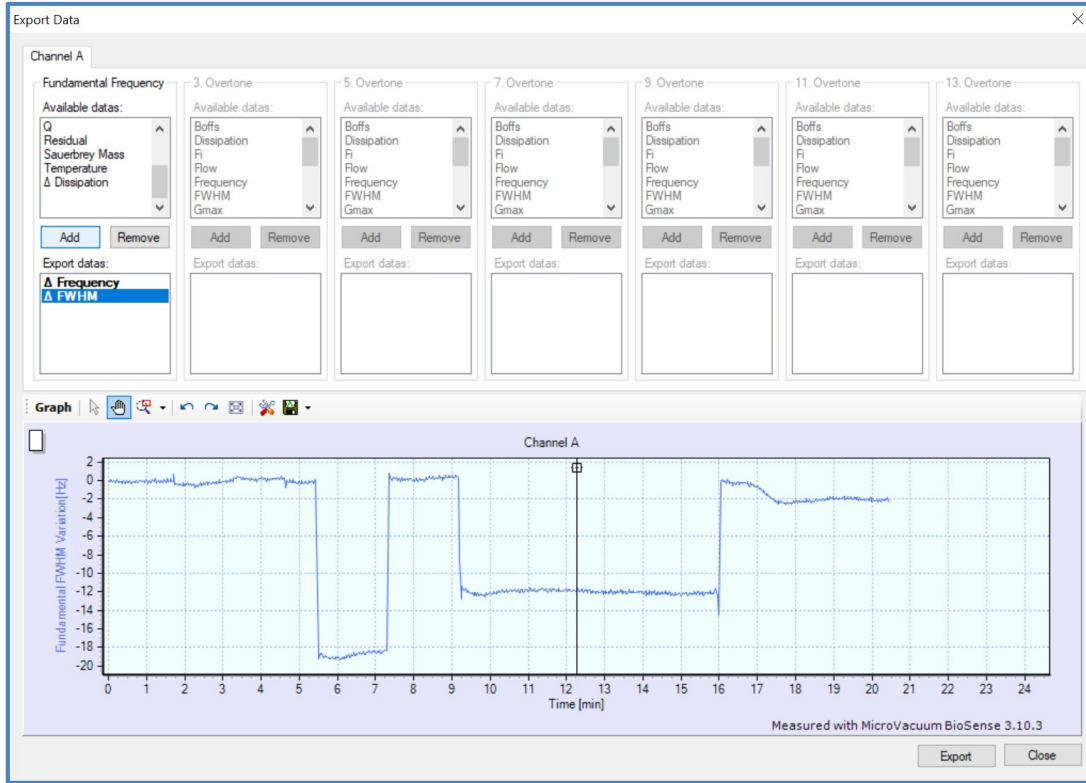


Figure 89: Export Data

Use the Export button to complete the procedure. The exported data are saved in a text file using Tab separated values. Each row in the table corresponds to one measurement point at a certain time, the data from the A channel is followed by the data from the B channel. The data can be imported into an external graphing or analysis software package such as Excel®.

	A	B	C	D	E	F	G	H	I	J
	Channel A Time [sec]	Channel A Fundamental Dissipation Variation [ ]	Channel A Fundamental Frequency Variation [Hz]	Channel A 3. Overtone Dissipation Variation [ ]	Channel A 3. Overtone Frequency Variation [Hz]	Channel B Time [sec]	Channel B Fundamental Dissipation Variation [ ]	Channel B Fundamental Frequency Variation [Hz]	Channel B 3. Overtone Dissipation Variation [ ]	Channel B 3. Overtone Frequency Variation [Hz]
1	29.5608295	0	0	0	0	29.5764296	0	0	0	0
3	696.1032003	-7.49435910587766E-	-1.70168284513056	7.30566922050389E-	3.527762075888613	696.1188003	3.98944866509922E-	-0.281150589697063	-1.60527184613741E	0.360957751050591
4	700.2684076	-5.41592035522136E-	-1.70800016820431	7.385497667015-09	3.53008218668401	700.2840076	4.44352860662738E-	-0.28222272451967	-1.31063509581072E	0.360836567357183
5	704.4648149	-7.54065066992858E-	-1.66285529080778	7.73684635589979E-	3.54447035118937	704.480415	5.55821428692343E-	-0.301135706715286	-1.42427198495907E	0.323738567531109
6	708.6612223	-7.34089341860919E-	-1.66683518700302	7.45144477972853E-	3.568890153326094	708.6768223	4.8621544955183E-0	-0.25501192081719E	-2.049773984355589E	0.335730766877532
7	712.8264296	-7.13607326818507E-	-1.67588731832802	7.49193707916133E-	3.58985340595245	712.8420297	4.87496371673199E-	-0.266395043581724	-2.19316568791391E	0.337826976552606
8	717.022837	-7.75231781147828E-	-1.68522153515369	6.33533377876959E-0	3.61359641238454	717.038437	4.85007439900793E-	-0.266295551321401	-1.87678696480759E	0.32622803747654
9	721.2192444	-7.35389899416043E-	-1.69215742684901	6.26966033669168E-	3.61767560982665	721.2348444	4.9001587924466E-0	-0.254651208255887	-2.06857651631347E	0.3306323237717509
10	725.3688517	-7.56638492662432E-	-1.69109822344035	5.42220819309267E-	3.63721679898116	725.3844517	4.94561881651638E-	-0.261131727136672	-1.92437170700571E	0.326591588556767
11	729.534059	-7.64013511225946E-	-1.70113982073963	5.44831074838336E-	3.65410207707065	729.549659	5.07720564565413E-	-0.264190936461091	-1.99412902174478E	0.338251542299986
12	733.6992663	-7.66483952795968E-	-1.70807620603591	6.09090005497737E-	3.67260712943971	733.7148663	5.04397519135888E-	-0.264735016971827	-1.86292035074154E	0.336443271487951
13	737.8800736	-7.46131144703329E-	-1.70887991879135	5.49352102928774E-	3.69006486423314	737.8956737	4.84962776139375E-	-0.267563922330737	-1.82880874557012E	0.309343731030822
14	742.060881	-7.6441934602368E-	-1.71821733657271	5.67298052874383E-	3.70358579419553	742.076481	5.03002997860429E-	-0.262657050043345	-1.98729466314033E	0.321892760694027
15	746.2260883	-7.91922922808029E-	-1.72388604647666	5.47914693687746E-	3.71853839419782	746.2416883	4.76524893867276E-	-0.261984335885055	-1.88119286845829E	0.314197856932878
16	750.4224957	-7.85153019613744E-	-1.7289605634287	6.54063840363812E-	3.7322537931174	750.4380957	4.60405833480217E-	-0.249175187200308	-2.01109196965638E	0.341083327308297
17	754.587703	-8.04143164183919E-	-1.73683705646545	5.48289422301296E-	3.75957155972719	754.603503	4.80057937056271E-	-0.25814511999487E	-1.95651672184217E	0.337127108126879
18	758.7685103	-8.05483838698073E-	-1.73633266147226	6.18031867197284E-	3.77737884968519	758.7841103	4.44463745704596E-	-0.249668310396373	-1.02437991238994E	0.32704340107739
19	762.9337176	-8.21965102604805E-	-1.73949474934489	6.16430491852903E-	3.80573073215783	762.9493177	4.74456670510688E-	-0.245396258309484	-2.07268896026005E	0.320477541536093
20	767.114525	-8.08007140088227E-	-1.737459685658477	5.60257839407258E-	3.83218063227832	767.130125	4.62283167271814E-	-0.24030696041882	-1.96002210596629E	0.314371155574918

Figure 90: Exported Data in Excel®.

## 9.2 PRINTING MEASUREMENTS



*File – Print (Ctrl + P)*

The content of the printed document can be selected. Only the Graph is selected in the default setting. It is also possible to print the description, the sensor history, the list of calculated parameters. The program saves the user's last print selection and page setup, which is loaded the next time the user logs on.

When it is a Resonance measurement, you can print the calculated data as well.

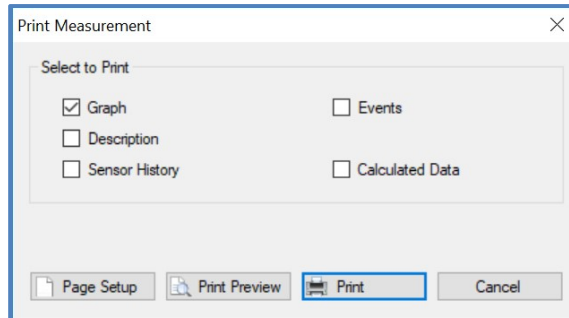


Figure 91: Print Measurement

### **Page setup**

#### *Page Setup*

Page settings can be defined, including the page size, the type of feeder, the orientation of the page, and margin settings. The printer's special settings are also accessible.

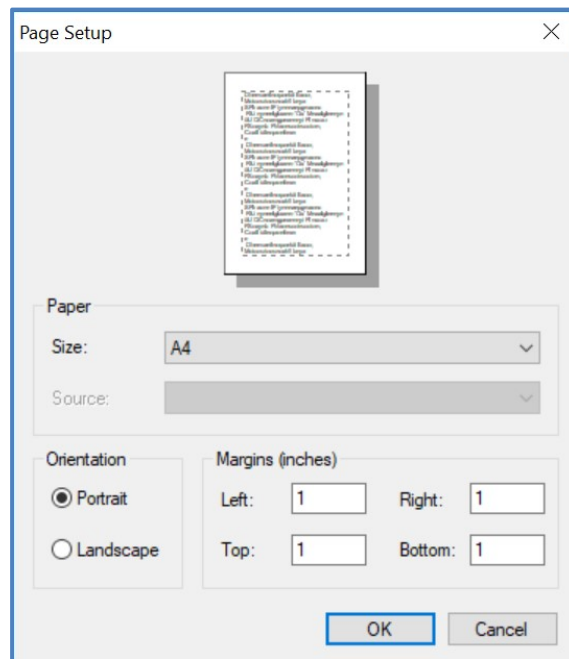


Figure 92: Page Setup

### **Printing**

#### *Print*

Printing is available to the selected printer or to a file. The user can define the number of copies, and, if printing multiple copies, sorting is also an available option. The selected printer's special settings are also accessible.

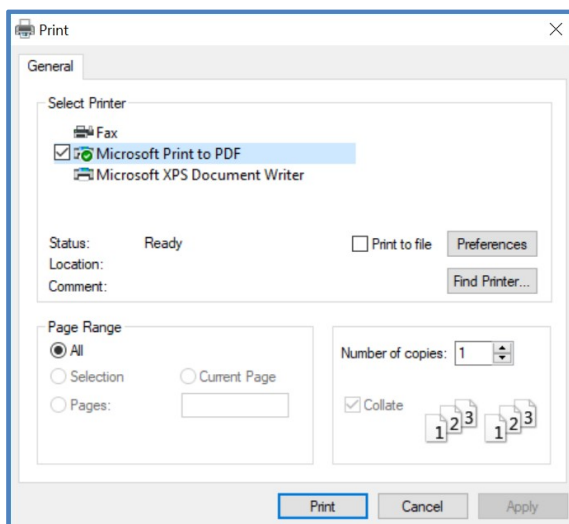


Figure 93: Print

### **Print preview**

#### *Print Preview*

The print preview can be viewed. The settings of the preview can be modified (e.g. the number of pages shown simultaneously) and the page to be viewed can be selected. The page can be magnified and it can also be printed from this view.

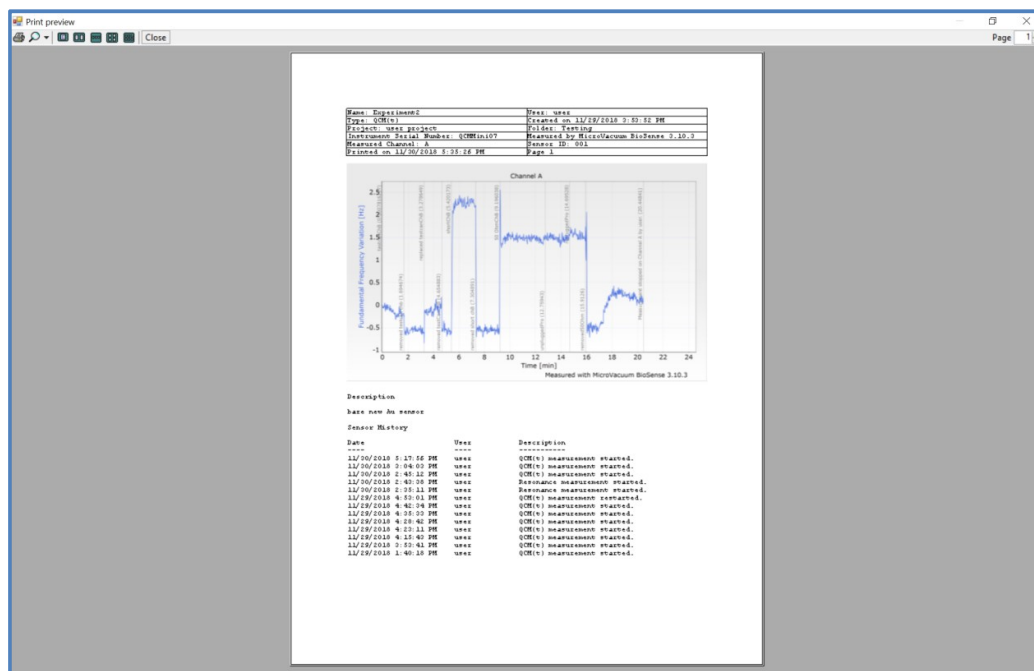


Figure 94: Print Preview

## 9.3 GAMRY EXPORT

### *File - Gamry export*

The open EC and QCM(t)-EC data is exported in the \*.DTA format for analysis with Gamry Echem Analyst™ software.

## 10. Administrator functions

The Administrator is responsible for adding or removing Users from the system and can transfer ownership of projects between users.

The Administrator can also create new sensor types, maintain the database and calibrate the instrument.

### 10.1 ADMINISTRATOR LOGIN

When the instrument is supplied the Administrator Username is “Administrator” and the password is “Admin”. The Password should be changed immediately after installation by the Administrator. If the password is forgotten, the factory administrator can reset the password remotely. See chapter “Support” for information.

- **Warning.** It is strongly recommended that the Administrator Password is reset by the person responsible for the instrument, so that the calibration status of the instrument and the database integrity and user data is well controlled.

### 10.2 ADDING AND DELETING USERS



*User and Project – User – Accounts (F9)*

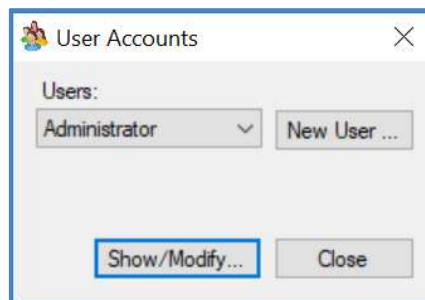


Figure 95: User Accounts

The administrator can create a new user by pressing the New User button, or modify by pressing the Show/Modify button. Only those users can be deleted who do not own any projects. If the user is owner of one or more projects, the project first has to be transferred to a different user. The project can be transferred by the project’s owner or the Administrator.

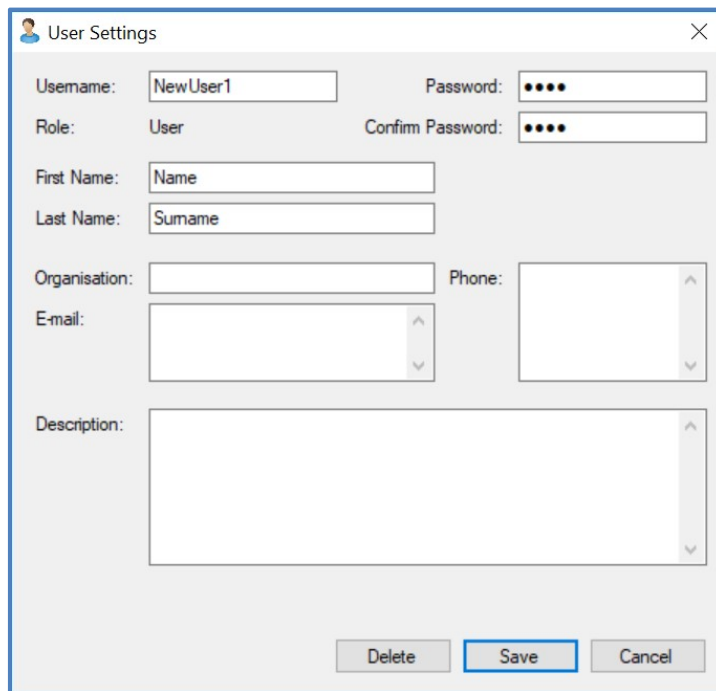


Figure 96: User Settings

10.3 SENSOR MANAGEMENT

**Sensor type management**

Sensor – Sensor Types...

**Creating new sensor type**

The Administrator is authorized to create new sensor type or delete existing sensor type or modify its specification.

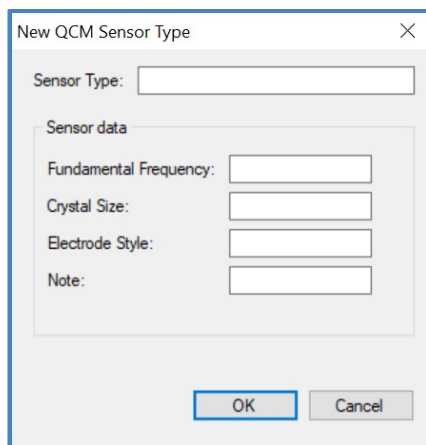


Figure 97: New QCM Sensor Type

**Deleting and modifying sensors**

The following window allows users to modify the sensor ID and type. Only those sensors can be deleted that do not belong to any measurements.



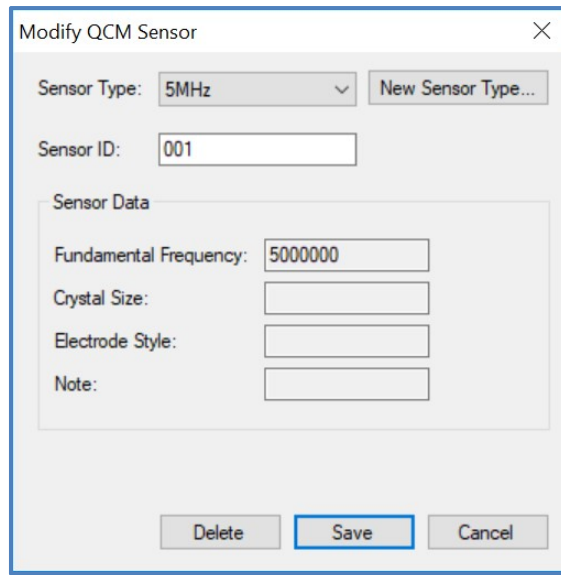


Figure 98: Modify QCM Sensor

## 10.4 DATABASE TOOLS

### ***Database archiving***



#### *Database – Archive*

A file name and path is required for archiving. A status bar provides information on the state of the archiving process. The archived Database includes data that has been added since the last Automatic backup.

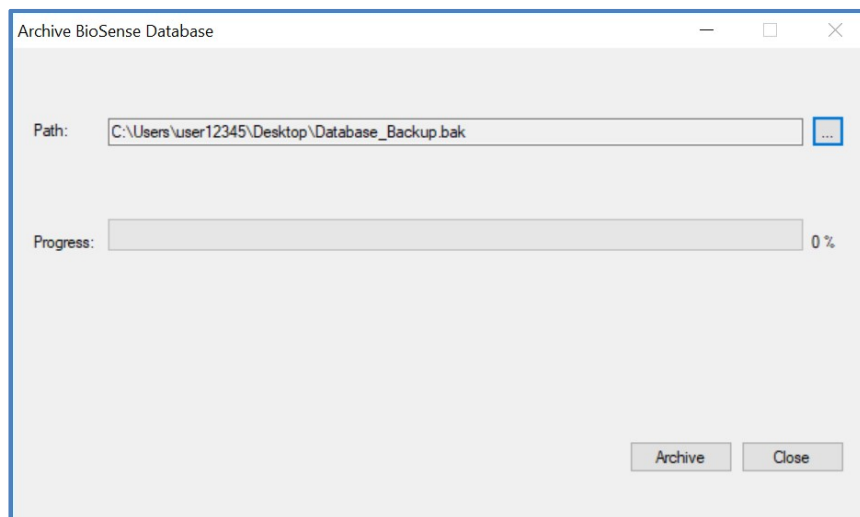


Figure 99: Archive BioSense Database

## Database restoring



### Database – Restore

If you start the restoring process, the BioSense software is automatically closed. When the restoring is completed the BioSense is automatically restarted.

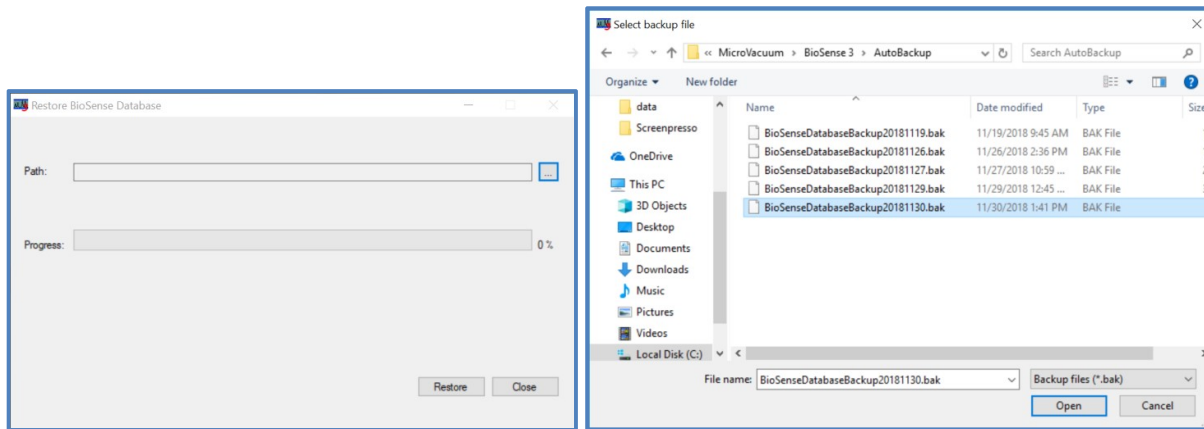


Figure 100: Restore BioSense Database (left) and Select Backup File (right) Windows

## Automatic backup

The database is automatically saved each day when the BioSense is loaded for the first time. The saved file is called BioSenseDatabaseBackupyyyyymmdd.bak. It is saved in the AutoBackup folder in the BioSense installation folder (default: “C:\Program Files\MicroVacuum\BioSense 3\AutoBackup”). The software keeps the last 5 AutoBackup files and deletes the rest.

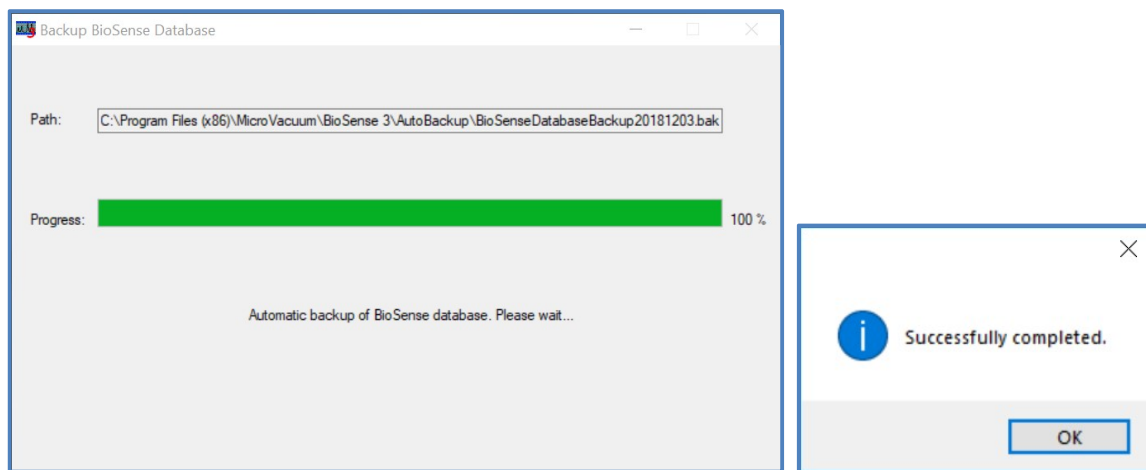


Figure 101: Backup BioSense Database Window and Completed Message

The BioSense informs the user that the automatic backup has been successfully completed.

**It is recommended that a copy of the most recent Backup file is made to an external drive before the software is updated, or the computer is serviced.**

## 10.5 VNA CALIBRATION

The Vector Network Analyser in the QCM-I instrument needs to be calibrated to account for the line impedance between the analyser input and the sensor crystal (in practice this is done to the sensor holder). The calibration step has already been done during the initial instrument configuration, however very occasionally the instrument may need to be recalibrated. This could be required after a software update (you will be informed if this is the case and it was not possible to calibrate as part of the update), or if an external sensor holder is used which significantly increases the distance between the instrument and the sensor. In this latter case it may be necessary to recalibrate the instrument for use with this accessory. Afterwards the instrument will need to be recalibrated to return it to its original state.

The calibration kit contains the following components: SMA adaptor for thermal chamber, SMA Short fitting, SMA 50 Ohm Load fitting, shown in Figure 102.

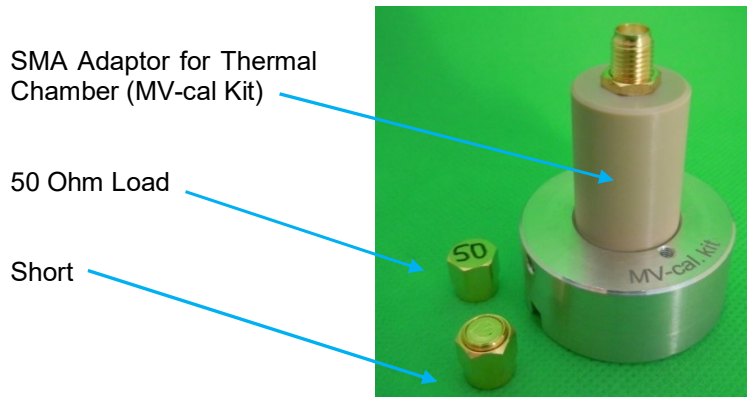


Figure 102: VNA Calibration Kit

### Hardware – VNA Calibration

The VNA Calibration window, shown in Figure 103, is accessed from the Hardware Menu.

The following sequence is used for the VNA Calibration:

1. Select Channel to Calibrate (Channel A in figure)
2. Press Start Calibration (this starts the calibration wizard)
3. The text box “Please apply open for Reflection Bridge Port 1” will appear. If the Channel being calibrated is a thermal chamber, put the SMA Adaptor (MV-cal Kit) into the chamber and fix into position – make sure nothing is attached to it as in Figure 102. If the channel being calibrated is just an SMA bulk-head connector on the instrument make sure nothing is connected to it. If the channel to be calibrated will be used with an extension cable, attach the cable, but leave the SMA connector at the end open/ unconnected to the sensor holder. Then press OK.
4. After a short time the text box “Please apply Short for Reflection Bridge Port 1” will appear. Connect the SMA Short part to the connector for the channel. I.e. on top of the MV-cal Kit, or the SMA Bulk-head connector or the SMA Connector at the end of the extension piece. Press OK.
5. After a short time the text box “Please apply Load for Reflection Bridge Port 1” will appear. Remove the “Short” and connect the SMA 50 Ohm Load part to the connector. Press OK.
6. The calibration will now be completed and the three calibration curves will be plotted in the VNA Calibration window, shown in Figure 104.
7. Press “Save to File” to save the calibration
8. Repeat the process for any other Channels that need to be calibrated.
9. Close the Biosense software and restart it. This is required to load the new calibration file.

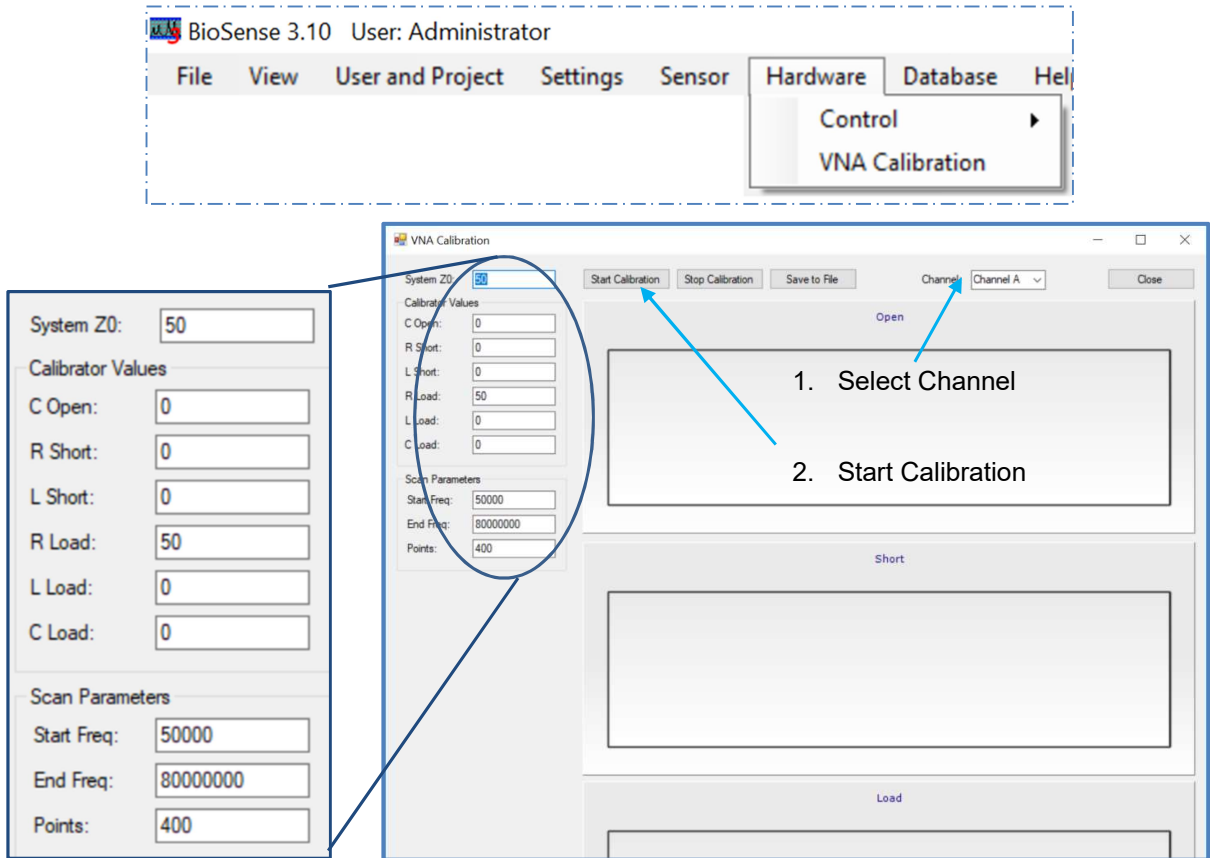


Figure 103: Hardware Menu in BioSense (Top), VNA Calibration Window and settings (Bottom)

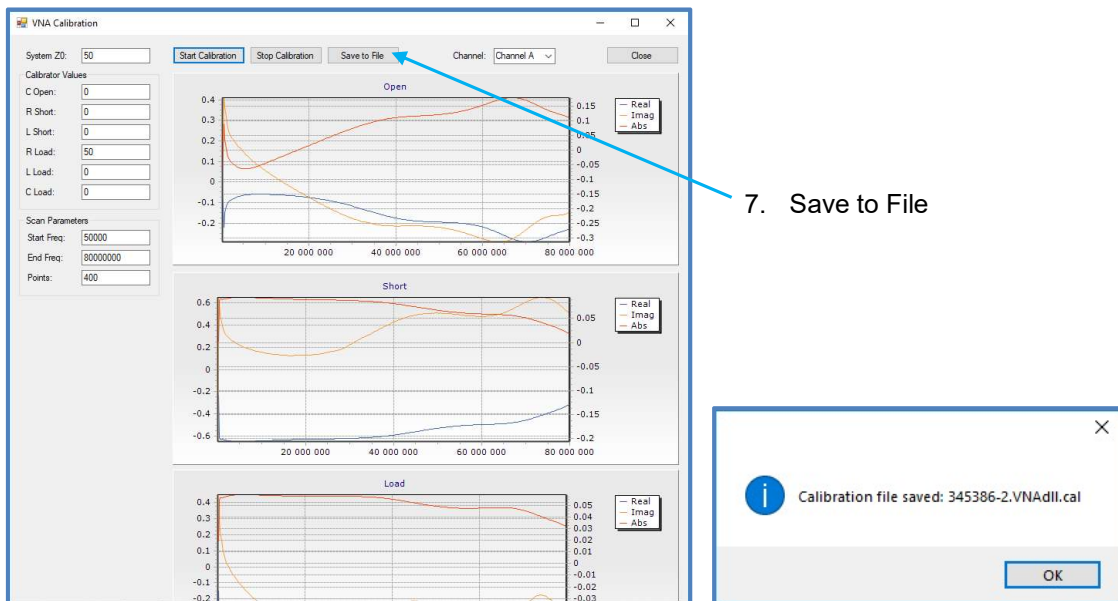


Figure 104: VNA Calibration window after calibration (left) and text box after saving calibration (right).

## 10.6 HELP

### **About BioSense**



*Help – About*

About BioSense includes the software version number, which can be required when asking for customer support.



Figure 105: BioSense Version Information Box

## 11. Troubleshooting

### 11.1 ERROR MESSAGES

#### “Connection failed to QCM instrument”

If QCM instrument is not connected or it is connected but not turned on and the evaluation mode is not selected, an error message will be displayed and the user will receive a warning about the failure (Figure 106) and the BioSense starts running in data evaluation mode.

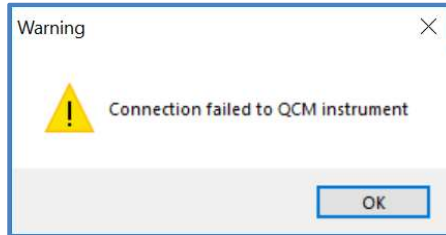


Figure 106: Connection Failed Error Message

If the QCM-I is on and this error is still generated, please check the USB cable between the QCM-I and the computer.

## 12. Support

MicroVacuum offers remote customer support via preinstalled TeamViewer software. This support requires that the computer of QCM system is connected to the internet, and the QCM measurement system is switched on.

### 12.1 HOW TO ESTABLISH REMOTE CONTACT?

The date and time of the remote contact should be decided via e-mail. At the prefixed time please follow the steps bellow:

1. Please start the software (TeamViewerQS.exe) on your PC
2. On the pop up window you will see an ID and a Password. Please send us the ID and the Password by e-mail (we will provide the e-mail of the service/support engineer when we arrange the support).

**Attention!!! Do not close this window!**

3. After receiving the ID and the Password we can make the remote connection from our computer.

for customer service CONTACT:

MicroVacuum Ltd.

Kerékgyártó u. 10.

Budapest, H-1147, Hungary

Phone: +36 1 252 1991

Fax: +36 1 221 7996

E-mail: [support@microvacuum.com](mailto:support@microvacuum.com)

Web site: <http://www.microvacuum.com/>

### 13. Warranty

MicroVacuum Ltd. warrants this product to be free from defects in material and workmanship for a period of one year from date of shipment. MicroVacuum Ltd. warrants the following expendable items for 30 days from the date of shipment: fuses, lamps and batteries. During the warranty period MicroVacuum will, at its option, either repair or replace any product that proves to be defective.

To exercise this warranty, contact MicroVacuum for RMA # at the address below. Returns will not be accepted without RMA #. The owner will send the product, transportation prepaid, to MicroVacuum Ltd. Repairs will be made and the product will be returned to the owner with transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period. For products not covered by warranty, the repair has a warranty of 90 days.

When a product is returned for examination and inspection, or for any other reason, Customer shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or non-conformity in the Product, in all cases, Seller has the sole responsibility for determining the cause and nature of failure, and Seller's determination with regard thereto shall be final.

#### Limitation of warranty

This warranty does not apply to defects resulting from product modification without MicroVacuum's express written consent, or misuse of any product or part. This warranty also does not apply to software, damage from battery leakage, or problems arising from normal wear or failure to follow instructions

this warranty is in lieu of all other warranties, expressed or implied including any implied warranty of merchantability of fitness for a particular use. the remedies provided herein are buyer's sole and exclusive remedies.

neither microvacuum ltd. nor any of its employees shall be liable for any direct, indirect, special, incidental or consequential damages arising out of the use of its instruments or software even if microvacuum ltd. has been advised in advance of the possibility of such damages. such excluded damages shall include, but are not limited to: any lost profits or lost savings, costs of removal and installation, losses sustained as the result of injury to any person, or damage to property. MicroVacuum Ltd. does not and CANNOT warrant the performance or results obtained by using its equipment and software.

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