

IviumSoft version 2.4XX

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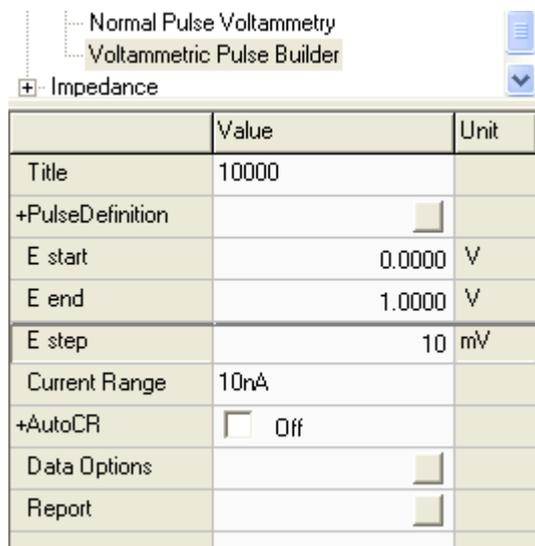
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1. Current Interrupt in ChronoPotentiometry.

The Current Interrupt Module (CIM) can be used during ChronoPotentiometry. In Advanced mode, the parameter "CI at Level[2]" was added. When checked, it will activate a Current Interrupt during the 2nd level.

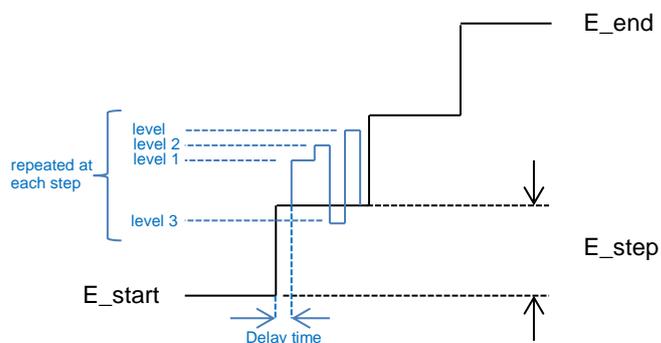
2. Voltammetric Pulse Builder

To the group of ElectroAnalysis techniques the Voltammetric Pulse Builder has been added. With this technique (new) Voltammetric Pulse Techniques can be defined to user specifications. All existing techniques, such as DPV, NPV, DNPV, SQRWV, etc, can be compiled with this tool. Moreover newly proposed pulse waveforms can be constructed and tested, in a very flexible and user-friendly manner, without the loss of performance. Pulse patterns can be defined with 0.02ms resolution, with each pulse as short as 1ms.



	Value	Unit
Title	10000	
+PulseDefinition	<input type="checkbox"/>	
E start	0.0000	V
E end	1.0000	V
E step	10	mV
Current Range	10nA	
+AutoCR	<input type="checkbox"/> Off	
Data Options	<input type="checkbox"/>	
Report	<input type="checkbox"/>	

The Voltammetric Pulse Builder implements a Voltammetric scan with the usual parameters: E_start, E_end, E_step. This will generate a staircase scan, with a pulse pattern superimposed on each staircase level:



Selecting "PulseDefinition" opens a pop-up, in which the pulse pattern can be defined, for example the pattern above can be achieved with these settings:

The dialog box 'Define MultiPulse detection' has a 'Levels' dropdown set to 4. It contains a table with columns 'E /Volt', 'Period /ms', and 'Add to Result'. The settings are as follows:

	E /Volt	Period /ms	Add to Result
Delay Time	50	50	+1
Level[1]	0.020	50	+1
Level[2]	0.030	50	+1
Level[3]	-0.010	50	+1
Level[4]	0.040	50	+1

Buttons for 'Close' and 'Verify' are at the bottom.

- Levels: the number of Levels (pulses) can be defined (min. 1, max. 4).
- Delay Time: wait-time after each staircase level application, before the first pulse is applied (min. 5ms, max. 5000ms).
- E/Volt: pulse height/amplitude (V)
- Period/ms: pulse period (ms)
- Add to Result: result multiplication-operator

Up to 4 pulse levels can be defined, each between 1ms and 200ms. The total duration of the 4 combined pulses must be below 600ms (Delay Time not included).

At the end of the "Delay Time", and at the end of each level, the current is measured. These recorded values can be used to calculate the single datapoint that is displayed and stored. The user can define how that datapoint will be calculated, using the "Add to Result" field in the definition screen. Each level measurement can be added/subtracted/ignored/etc. in the end-result with multiplication-operators "+1/-1/0/0.5/-0.5". In the example below, a DPV scan is compiled with 50mV amplitude and 10ms pulse time:

The dialog box 'Define MultiPulse detection' has a 'Levels' dropdown set to 1. It contains a table with columns 'E /Volt', 'Period /ms', and 'Add to Result'. The settings are as follows:

	E /Volt	Period /ms	Add to Result
Delay Time	90	10	-1
Level[1]	0.050	10	+1

Buttons for 'Close' and 'Verify' are at the bottom.

The "+1" operator at Level[1] will add the measured current at Level[1], and the "-1" operator at Delay Time will subtract the current measured during Delay Time, so the difference of currents from before and at the end of the pulse will be recorded.

The sampling acquisition period is set automatically equally for all levels to 25% of the shortest Level Period, maximized to 1 mains line cycle period (50Hz/60Hz option). These acquisition periods are always located at the end of the corresponding Level.

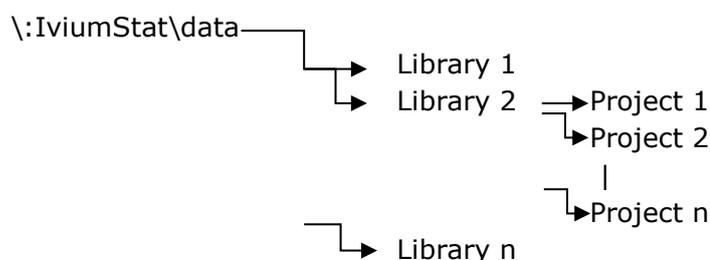
Note that the ScanRate is implicitly defined by the "E step" parameters and the sum of Delay Time and Pulse Periods. In the DPV example above, the total period is 100ms, so this scan would produce 10 datapoints/second. Suppose Estep was 10mV, the scanrate would be 100mV/sec.

3. Automatic data storage and file structure

In IviumSoft versions 2.1XX an important change has been introduced in the way data is stored and retrieved in the software. This has been done to improve on ease and accessibility. The most important changes are:

- A) All measured data is now *automatically* stored on disk upon completion of the experiment. As a result:
- The AutoSave method parameter is no longer available. When loading older methodfiles, the "Automatic save" settings are ignored.
 - In BatchMode, the automatic data saving is also implemented, which means that all parameters regarding data saving are also removed here. When running older batch files, the target data file names and folders are ignored.
- B) The new automatic data saving mechanism creates "regular" idf-files that are readable in the usual manner.
- C) The file names and folder locations for auto-saving are automatically created in a structured manner. In this way saved files are easy to locate and retrieve, and data can be stored under a project name.

In \:IviumStat a file folder named "data" is automatically created. In this "data" folder libraries are created, which in turn can contain multiple projects.



- D) Manual saving of data files and data sets remains possible in the usual way.
- E) Data files are stored under an automatically generated file name that is constructed from:
- Scan id; (=automatically incremented scan number)
 - Date stamp; (mm,dd)
 - Technique used; (for example LSV for Linear Scan Voltammetry)
 - First 8 letters (signs) of the Title of the experiment
 - Instrument serial number.

3.1 Data file management

Data will be stored to disk automatically on the following events:

- On completion of the datascan (or all datacycles in multiscan run)
- When the "timed savings" period expires before the scan finishes, default every 600 minutes:
 - The 1st occurrence of an expiry period, the data is saved in .idf format
 - At subsequent occurrences of expiry periods, the data is saved in CSV format, each time overwriting the previous CSV file.
 - After the scan finishes, the complete data is saved in .idf format, overwriting the 1st saved idf file.
- When the total number of datapoints exceeds workfile size, default 400,000 points (user definable, see paragraphs 3.3 *Data handling* and 22 *Working with large data files*):
 - When scan exceeds workfile size, an .idf will be stored with present number of datapoints. Also a CSV file is created with half the present datasize (200k), and those points are deleted from shown scan.
 - At subsequent occurrences of exceeded workfile size, the 1st data-half is saved in CSV format while deleting it from the shown data, each time appending to the previous CSV file.
 - After the scan finishes, the complete data is saved in .idf format, overwriting the 1st saved idf file. (it uses the CSV file to recover all datapoints).

Datafiles will be deleted:

- From the "tempfile" folder automatically, after the (user defined) expiry period, default 90 days (user definable, see 3.3 *Data handling*).
- Manually by the user, by selecting "delete permanently"

3.2 Data file history list

- Below the Results panel a new Listview panel is visible. This list of files will be visible in the order that these were recorded or loaded, the most recent file at the top. These files can be used for quickly switching to earlier results and back. The Listview panel keeps track of all data stored in the current session; when (re)starting IviumSoft the most recent 25 stored/called datafiles are listed (default). Files listed in **RED** are stored in the 'tempfiles' project and subject to automatic deletion after a user defined time (see 3.3: Delete temporary files).

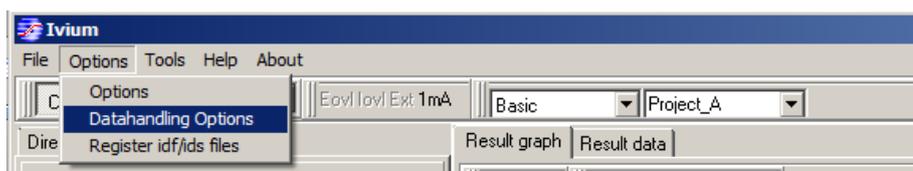
Scan id	Nscans	Date	Title	Technique	SN	Chan	Cycle	Status	File
0385	0	2012/11/07 13:25:42	Sc	V72206	1	2	100%	C:\...tempfiles\0385121107132542000v72206...	
0405	0	2012/11/07 16:19:48	Sc	V72206	1	1	100%	C:\...lib2\aqqa\0405121107161948000v72206.idf	
0398	0	2012/11/07 14:04:13	Sc	V72206	1	15	100%	C:\...moretest\0398121107140413000v72206...	
0409	0	2012/11/07 16:27:21	Sc	V72206	1	5	100%	C:\...lib2\aqqa\0409121107162721000v72206.idf	
0401	0	2012/11/07 16:06:48	Sc	V72206	1	1	100%	C:\...temp\0401121107160648000v72206.idf	
0397	0	2012/11/07 14:03:21	Sc	V72206	1	14	100%	C:\...moretest\0397121107140321000v72206...	
0396	0	2012/11/07 14:02:59	Sc	V72206	1	13	100%	C:\...moretest\0396121107140259000v72206...	
0395	0	2012/11/07 13:40:36	Sc	V72206	1	12	100%	C:\...moretest\0395121107134036000v72206...	
0394	0	2012/11/07 13:40:01	Sc	V72206	1	11	100%	C:\...moretest\0394121107134001000v72206...	

Multiple scans/files can be selected simultaneously by holding the [Shift] or [Ctrl] button and clicking on the desired scans/files

- The history list displays the most relevant scan (method) properties:
 - Scan id: automatically generated scan number.
 - Nscans: number of scans in the datafile/dataset; datasets are highlighted in yellow.
 - Title: scan title (= method parameter).
 - Technique: electrochemical technique used to acquire the data in the file.
 - SN: serial number of the Ivium instrument used to acquire the data.
 - Chan: Ivium-n-Stat channel number (=1 for a single channel instrument).
 - Cycle: cycle number for multi cycled experiments (=1 for single cycle).
 - Status: results status, 100% = fully completed
 - File: file path and name; the file name is automatically generated from scan id, date (mm,dd), technique and first 8 letters of the title.
- A file from the history list can be loaded by double clicking it. Right-clicking it will allow other options:
 - Load Scans: will load the selected scan, replacing the previous.
 - Add Scans: will load the selected scan while retaining the previous.
 - Copy File: will place the file on clipboard for copying; paste in MS Explorer will create a copy of this file in the active folder, paste in an email program will include the datafile as attachment, etc.
 - Move to activeproject:
 - will move the data file from its present location to the active project location. This could be used to promote temporary files to a permanent status.
 - Move to tempfiles:
 - will move the data file from its present location to the temporary data folder. This file will be deleted automatically, after the defined expiry period (see data handling options).
 - Delete permanently:
 - will delete the datafile immediately and remove it from the historylist.
- Older style datafiles (recorded with earlier IviumSoft versions) will appear in this list when loaded (data unavailable in these datafiles will be displayed arbitrarily).

3.3 Data handling options

The data handling options can be accessed from the main menu bar under Options>Options>Datahandling Options:



This will open a pop-up that allows setting how measurement data is stored:

Operator name: the users name may be entered; this will be stored in the datafile name of a group of projects.

Library: A library is a higher folder level, that can be used to group projects together. The active library is used to store new datafiles; a new one can be created, or an existing one can be called from the drop down menu.

Project: Folder that contains the datafiles. the active Project folder is used to store new datafiles; a new Project can be created, or an existing one can be called from the drop down menu. [see also 3.4].

Timed saving every: number of minutes before next automatic data saving will occur. All data will be saved automatically upon completion of the experiment. However, if a long term experiment is carried out, the data is also automatically saved at the end of every period that is specified here.

Maximum workfile size: maximum workfile size before automatic datastreaming takes place; default is 400,000 points (min. 2,000; max. 2,000,000, see paragraphs 3.1 and and 22. *Working with large data files*).

Maximum in historylist: number of datafiles listed in history list (for experiments ultimately resulting in more scans/files than specified here, *all* scans/files will be shown in the history list upon completion).

Always createdata CSV file: when checked, every time a data file (.idf) is saved, a copy of the primary data is saved as an ASCII file in the same location (this CSV file will have the same name as the .idf file). The CSV file only contains the raw data, with comma separated columns (the same as when "copy to clipboard" is selected from the "Result data" tab). Usually the .csv extension is registered by MS Excel, and double clicking will open it.

Save multiscan runs in dataset files: Multiscan experiments can produce multiple cycles after a single click on "Start". These cycles can be saved in the usual manner with each cycle in a separate .idf file. However, when this "dataset" option is activated, such scans are stored together in a single .ids file.

Maximum Nr of visible cycles: The number specified here is the maximum number of cycles (latest cycles) that will be shown in the graph during a multi-cycle experiment. When running a multi-cycle experiment with a large number of cycles

Datahandling options

Storing data

Operator name: user1

Data storage

Library: primary

Project: Project_1

Timed saving every: 600 minutes

Maximum workfile size: 400000 points

Maximum in historylist: 25 files

always create data CSV file

save multiscan runs in dataset files

Maximum Nr of visible cycles: 32

Maximum Nr of stored cycles: 1000

Copy data to external folder

Save datacopy: C:\Users\Willem ...

Redefine filename: file_0

Delete temporary files

Never After 90 days

Apply Cancel

limiting this number will prevent the graph from becoming undecipherable.

Maximum Nr of stored cycles:

The number specified here is the maximum number of cycles (latest cycles) that will be stored in the datafile during a multi-cycle experiment. When running a multi-cycle experiment with a large number of cycles limiting this number will prevent the data file from becoming too large.

Copy data to external folder:

This allows to store copies of the datafiles to other locations, such as user defined folders, network drives, dropbox, etc. The data is stored simultaneous with the automatic storage to the project location.

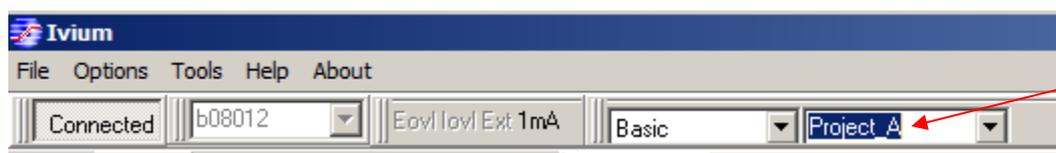
- **Save datacopy:** when checked, a copy of the data is stored to the user defined folder. If the destination location is not available, or invalid, the command is ignored without an error message.
- **Redefine filename:** normally the filename of the external copy will be the same as for the automatic generated filename of the project version. However this behavior can be overridden with this checkbox. If checked, the user defined filename is used instead. If the user defined filename already exists, an underscore and (incremented) number is added to the filename.

Delete temporaryfiles:

The folder "Tempfiles" is normally used to store files with a temporary status, such as exploratory measurements. These will automatically be deleted after the user defined time, default 90 days. Also, there is an option to "Never" delete automatically.

3.4 Project definition/selection

The Project where newly generated datafiles are stored can also be accessed and/or changed directly from the top menu bar:



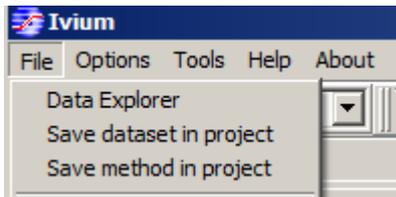
A new Project name can be entered directly, or an existing one can be selected from the drop down menu. The project name entered here is automatically copied to the Datahandling options.

For exploratory work, if measurements do not need to be saved for permanent use, you can, for example, create/select a Draft (project) folder, which can be (manually) deleted on a regular basis.

3.5 Saving Data sets and methods in Projects

Data Sets

By default data files are saved as .idf. When multiple scans are created in a single experiment, such as for example when running an number of CV cycles, it is possible to store these as a dataset in the current project. This can be done from the main menu bar: File>Save dataset in project.



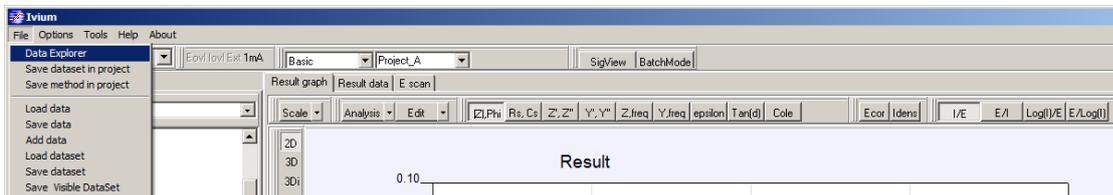
In the Data Explorer window data sets are highlighted in **yellow**.

Methods

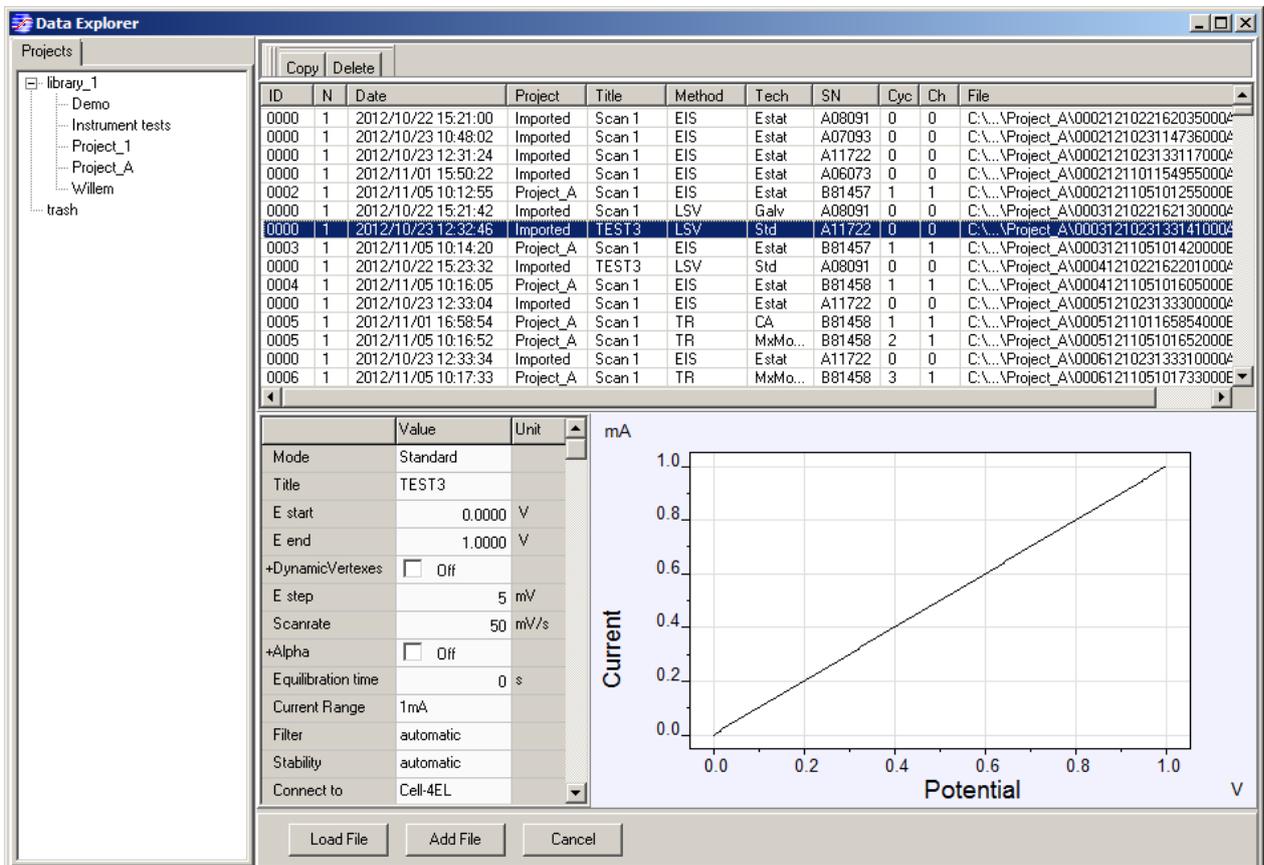
A method (technique) with all parameters can be saved as method file (.imf) in a Project. This can be done from the main menu bar: File>Save method in project. In the Data Explorer window data sets are highlighted in **green**.

3.6 Data exploring options

From the top menu bar, a Data explorer can be opened: File>Data explorer.



This will open a Data Explorer window (note that depending on the amount of data, this may take some seconds):



The Data Explorer window shows:

- the Library and Project tree to the left
- the list of data files in the selected Project to the right
- when a data file is selected, it will show a preview of the graph and method parameters below.

The list of data files can show different colors:

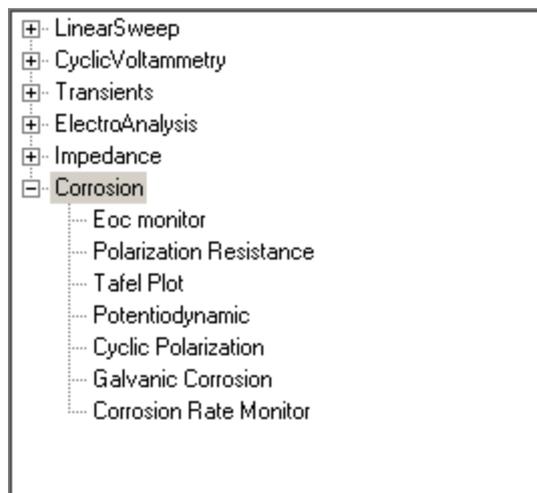
- Regular black on white: data file
- Highlighted in yellow: data set
- Highlighted in green: method file

From the Data Explorer window:

- Copy: will put the selected file(s) on the clipboard for copying (to, for example, a folder or e-mail).
- Delete: will delete the selected file(s) to the trash folder.
- Load File: will load the data file to the primary window.
- Add File: will add the data to the data already present in the primary window.
- Cancel: will close the Data Explorer window.

4. Corrosion techniques

There is a large worldwide market for electrochemical instruments to study corrosion. Corrosion Scientists can be found in industrial and academic laboratories. After many years of development, electrochemistry is now considered to be a standard tool in corrosion laboratories. A group of corrosion techniques has been added:



4.1 Eoc monitor

The Eoc monitor technique will allow the monitoring of the open circuit potential versus time.

Method parameters:

Title: scan title
Eoc interval: interval time between data points, min. 0.1s; max. 60s.
Run time: duration, min. 2s.
Stop when $dE/dt <$: experiment is automatically terminated when this criterion is met, min. 0 mV/s; max. 65 mV/s.

4.2 Polarization Resistance

The Polarization Resistance technique allows a linear potential controlled scan from E start to E end. The results can be displayed as I/E, E/I, Log(I)/E, E/log(I). The most common presentation is E (Y-axis) vs. I (X-axis) and is used to measure the corrosion rate.

Method parameters:

Title: scan title
vs Eoc: when activated, the E oc will be monitored before the scan is started and the E parameters can be entered to be relative to E oc.
E start: start potential
E end: end potential
E step: potential step increment
Scanrate: rate of the potential scan

4.3 Tafel Plot

The Tafel Plot technique will record a linear potential controlled scan from E start to E end. The results can be displayed as I/E, E/I, Log(I)/E, E/log(I). The most common presentation is E (X-axis) vs. log I (Y-axis) and is used to measure the corrosion rate. The corrosion parameters can be calculated from the Corrosion rate analysis (above the graph: Analysis>Corrosion rate)

Method parameters:

Title: scan title
vs Eoc: when activated, the E oc will be monitored before the scan is started and the E parameters can be entered to be relative to E oc.
E start: start potential
E end: end potential
E step: potential step increment
Scanrate: rate of the potential scan

4.4 Potentiodynamic

The Potentiodynamic technique will record a linear potential controlled scan from E start to E end. The results can be displayed as I/E, E/I, Log(I)/E, E/log(I). The most common presentation is E (Y-axis) vs. log I (X-axis) and is used to qualitatively evaluate the corrosion characteristics of the sample.

Method parameters:

Title: scan title
vs Eoc: when activated, the E oc will be monitored before the scan is started and the E parameters can be entered to be relative to E oc.
E start: start potential
E end: end potential
E step: potential step increment
Scanrate: rate of the potential scan

4.5 Cyclic Polarization

The Cyclic Polarization technique will record a cyclic potential controlled scan from E start to Vertex 1, and back to E start. The results can be displayed as I/E, E/I, Log(I)/E, E/log(I). The most common presentation is E (Y-axis) vs. log I (X-axis) and is used to evaluate the tendency of the sample to undergo localized corrosion. Pitting and crevice corrosion are the most common examples of localized corrosion.

Method parameters:

Title:	scan title
vs Eoc:	when activated, the E oc will be monitored before the scan is started and the E parameters can be entered to be relative to E oc.
E start:	start potential
Vertex 1:	Vertex potential (point at which the scan is reversed)
I Vertex:	Vertex current, maximum current allowed before scan direction is reversed.
E step:	potential step increment
Scanrate:	rate of the potential scan

4.6 Galvanic Corrosion

The Galvanic Corrosion technique will record the current versus time when two different metals are immersed in an electrolyte. The results can be displayed as E/time and I/time. In the Galvanic Corrosion experiment, the instrument acts as a Zero Resistance Ammeter.

The galvanic corrosion technique is implemented for low currents, smaller than and up to ca. 1mA. If the currents exceed a few mA, this electrode connection cannot be used anymore and a transient technique needs to be used, like Mixed Mode¹.

Electrode connection for Galvanic Corrosion²:

- RE to reference electrode
- WE+S to working electrode 1
- Gnd to working electrode 2

Method parameters:

Title:	scan title
Interval time:	interval time between data points, min. 0.1s; max. 60s.
Run time:	duration, min. 2s.

¹ Note that when using the transient technique, the electrode connection needs to be adjusted to the 'default' configuration. In Mixed Mode apply 0V to measure galvanic corrosion.

² Galvanic Corrosion is implemented similar to ElectroChemical Noise, the same electrode connection applies. See also p. 22/56 of the Manual.

4.7 Corrosion Rate Monitor

The Corrosion Rate Monitor technique will start with recording the E_{oc} , after this a Linear (potential controlled) Polarization Resistance measurement will be carried out. This is repeated for the duration of the experiment and the R_p and corrosion rate are displayed vs. time. This experiment is commonly used to test the performance of corrosion inhibitors.

Method parameters:

Title: scan title
Duration: experiment duration, min. 2 minutes.
Repeat interval: duration of the E_{oc} recording
E start: start potential of the LPR measurement
E end: end potential of the LPR measurement
E step: potential step increment of the LPR measurement
Scanrate: rate of the potential scan of the LPR measurement

5. Enhanced AutoCR

- *Pre ranging*

It is now possible to let the automatic current ranging start before the measurement so that the instrument will automatically look for the appropriate Current Range. This will ensure the measurement starts with an appropriate setting. The pre-ranging can be switched on/off with the checkbox in the AutoCR subparameter group.

+AutoCR	<input checked="" type="checkbox"/> On
Max range	10A
Min range	10nA
Pre ranging	<input checked="" type="checkbox"/> On

- *Pretreatment and Equilibration*

The Automatic Current Ranging option is now also activated for the Pretreatment and Equilibration stages. This will enhance the dynamic measurement range during the pre-measurement stages.

6. Continue Button to proceed to next measurement stage

Prior to a (method) measurement, there are several pre-measurement stages:

1. Purging
2. Pretreatment
3. OCP measurement
4. Equilibration

The duration of these stages is predefined. However now it is possible to manually abort such stages during its execution, by pressing the "Continue" button. This will stop the currently running pre-measurement stage, and proceed to the next. If it was the last scheduled stage, the measurement will start immediately. In case of the OCP measurement stage, it will accept the last measured value as the actual OCP, and proceed.

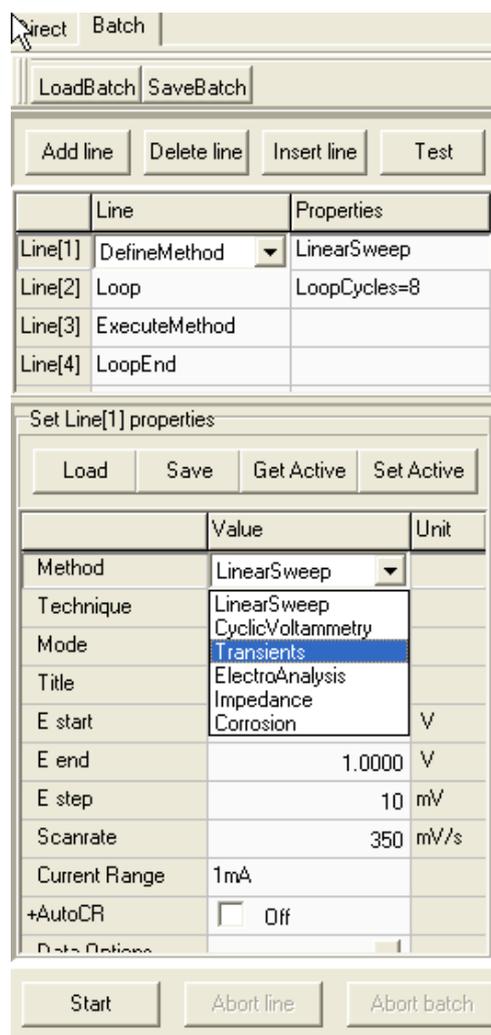
The "Continue" button only appears next to the "Abort" button at the start of a method and during the pre-measurement stages, at the bottom of the method Tab:



7. BatchMode with embedded Methods

A new function was added to the BatchMode: "DefineMethod":

- a. "DefineMethod" will allow you to define a Method procedure inside the BatchScript. You can select the Technique and edit measurement parameters directly.
- b. The "DefineMethod" variables are fully embedded in the BatchFile. You do not need to rely on external method files. When you change the file location, or move to another pc workstation, you only need to transport the ".ibf" file.
- c. The old "LoadMethod" function is retained, for compatibility reasons. But it is recommended not use this anymore.
- d. When saving BatchFiles, it is suggested to store these in the active Project folder. When you select LoadBatch/SaveBatch, the filename selection dialog will start in the active project folder.



When DefineMethod is selected, the measurement can be configured in the table below the BatchScript. Above the property grid, 4 buttons appear:

- Load: will load (import) the parameters from an existing methodfile on disk. These are loaded at the moment you press this button, and embedded in the active BatchFile. If that original sourcefile would be removed/changed afterwards, it would not affect the embedded Method definitions.
- Save: will save (export) the methodparameters to a method "*.imf" diskfile.
- Get Active: will copy the parameters from the active Method, as it is displayed on the main Method tabsheet.
- Set Active: will export the DefineMethod parameters to the active Method, and will be displayed on the main Method tabsheet, replacing the previous active Method.

It is important to note, that while a BatchScript is being edited, the DefineMethod parameters can be different from the active Method settings on the MethodSheet. Also note that a BatchScript may contain several different Method definitions. However, when a Batch is run, and a DefineMethod line is executed, the active Method setting will be set according to the embedded Method definition on the active line.

Batchfiles (.ibf) can be saved as usual. These must be saved by the user, these are not saved automatically.

8. Mixed Mode enhancement

For specific applications the Mixed Mode technique has been enhanced with additional method parameters:

Main method parameters:

- Continuous AC:** When checked this will maintain the AC amplitude throughout the Level continuously (otherwise it will be switched off during DC acquisition).
- AC mean current:** This will measure the mean AC current, instead of the DC current, and plot this in the main dataplot (black line, left axis). The mean current value is defined by averaging the quadratic current over a finite number of ac cycles, after subtraction of the dc current. Please note that the thresholds for currents, are now applicable to the AC Mean current.
- ThresholdHoldoff:** Time that threshold checking is inactive at each level. This parameter is to be used when, after a levelchange, it is undesirable that threshold switching happens too fast. It puts a minimum duration to the level. It is useful when systems need a stabilization time.
 Note 1: the time is always counted from the start of the active level, so it is "reset" at each level change.
 Note 2: the TresholdHoldoff time should not exceed the level duration.

Level parameters (stages pop-up window):

- Define ac:** When checked this will overrule the main method parameters Frequency and Amplitude. This allows you to select a dedicated frequency and amplitude for each separate level.

9. Mixed mode: Exit scan at threshold

By default, the thresholds in the Mixed mode level panel will only act within the level. If a threshold is exceeded, this Level is aborted and the scan continues to the next Level. Now, an extra option is available: "ExitScanOnThres". If checked and when a threshold is triggered, it will abort the complete scan.

10. Mixed Mode: Repeating Sequences and conditional branching

Groups of consecutive Levels can be defined as a sequence and repeated multiple times (Loops). Also, the sequence can be made conditional to definable thresholds. A sequence can be defined, by checking the "SequenceStart" and "SequenceEnd" parameters, at the desired Levels. All the enclosed Levels will be part of the sequence-block. The SequenceStart parameter has a subparameter "SeqRepeatCount" to define how many times the sequence-block will be executed.

	Mode	Properties		Value	Unit
Mode[1]	E contro	3*[E=0.100 V for 10 s	+SequenceStart	<input checked="" type="checkbox"/> On	
Mode[2]	E control	E=-1.000 V for 2 s]	SeqRepeatCount	3	

The blocks can be recognized in the Level view, by the opening and closing square brackets "[]" in the properties line, with the repeatcount before the opening bracket.

The SequenceEnd parameter has a subparameter "SeqExitOnThres" checkbox to leave the sequence-block when a Threshold value was exceeded. In this way, repeating sequences can be defined that are aborted by a boundary condition. For example: cycling charge/discharge of a battery, until the potential exceeds a critical value.



Sequences can be started and ended at each level. The SeqRepeatCount can be defined from 1-65535. Sequence-blocks can enclose other sequence-blocks (loop nesting), up to 8 levels deep.

11. Pretreatment before every frequency

For the potentiostatic Impedance technique "Constant E", the advanced method parameter "Pretreat each freq" is added. By checking this option, the pretreatment sequence is repeated before each new applied frequency.

During each pretreatment, the ac signal is removed, and the dc current is measured once every second. The (subsequent) pretreatment measurements are recorded and added to the Pretreatment data.

12. Add timestamp to exported ASCII data

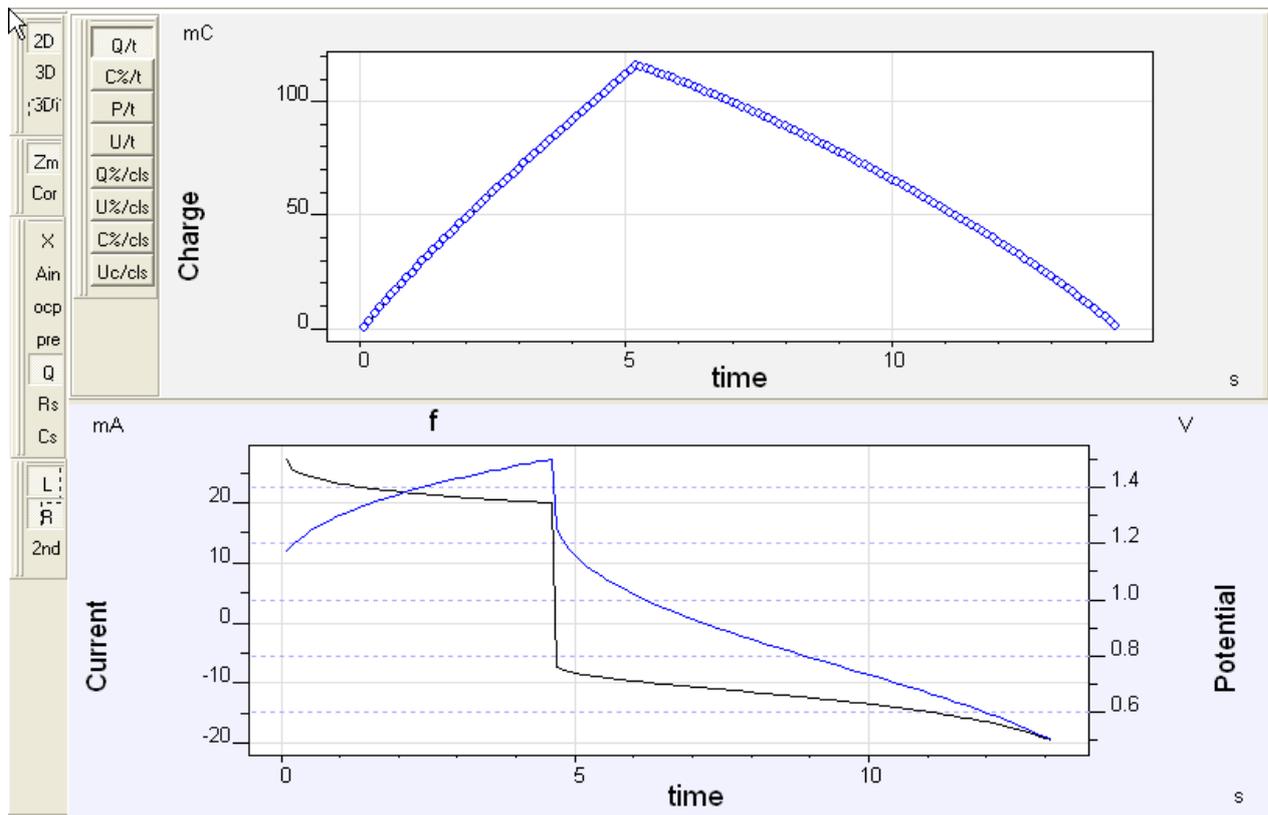
When using "Export Data as ASCII", it is possible to add the time and date of the measurement. This feature can be activated in the menu Tools>Datahandling options, on the "Content Tabsheet", by checking "Add timestamp".

When activated, the time and date will be written on the first line of the Exported ASCII file. The time corresponds with the Starting Time of the scan.

13. Monitoring Energy and Charge parameters

New features have been added to the Mixed Mode technique, that can be used for example for battery testing. During Mixed Mode experiments, the Charge and Energy state (for example of a battery) can be monitored against Time or Cycle number. To access these features click on the Q button to the left of the Result Graph. The second graph that becomes visible (as before) has now added to it a new bar with labeled buttons (only in Mixed Mode). To select the display parameter click on the relevant button:

- Q/t: Charge vs. time
- C%/t: (Capacity/Nominal Capacity) * 100% vs. time
- P/t: Power vs. time
- U/t: Energy (U) vs. time (integrated P/t plot)
- Q%/cls: (Q_discharge/Q_charge) * 100% vs. Cycle nr.
- U%/cls: (U_discharge/U_charge) * 100% vs. Cycle nr.
- C%/cls: (Capacity_discharge/Nominal Capacity) * 100% vs Cycle nr.
- Uc/cls: U_charge vs Cycle nr.



The Nominal (battery) Capacity is a user defined parameter in the method parameter Data Options/Electrode, in Coulombs. Note that 1mAh=3.6C. The numerical data vs. time, can be viewed/exported from the Result Data Tabsheet, using the Extended Data option.

For plots against Cycle nr., it is necessary to have each cycle loaded as individual scan. Check "Cycle separate" in the method parameters. By default the plots are only updated after a button on the bar is pressed. Optionally, the plots can be updated automatically in real time while a scan is in progress, by checking "Automatic charge calc." in the menu "Options/Settings".

14. Mixed Mode at Controlled Power

In the Mixed Mode technique an extra control mode has been added. Next to controlled E/I/OpenCell/Z in Mixed Mode, also the applied Power can be controlled: P Control. The Power is defined in Watt, and is calculated from the product of the (S-RE)-voltage and the WE-Current.

Mode	Properties
Mode[1] P control	P=30.000mW for 100 s or until: E>1.500 V
Mode[2] P control	P=-10.000mW for 100 s or until: E<0.500 V

Properties for Level[2]		
	Value	Unit
P applied	-10.000	mW
Duration	100	s
+Until E>	<input type="checkbox"/> Off	
+Until E<	<input checked="" type="checkbox"/> On	
value	0.500	V
+Until I>	<input type="checkbox"/> Off	
+Until I<	<input type="checkbox"/> Off	
+Until An1>	<input type="checkbox"/> Off	
+Until An1<	<input type="checkbox"/> Off	
+Until dAn1/dt>	<input type="checkbox"/> Off	
+AnOut1	<input type="checkbox"/> Off	
+Digouts	<input type="checkbox"/> Off	

A positive applied power means that the instrument will apply a positive current, and a negative applied power will generate negative current. Note that the *potential* can be positive or negative in either of the latter cases; the sign of the "real power by the cell" depends on the object. For example for an active object, such as a battery, a positive applied power means that the battery is being charged by the Energy of the instrument, while for a negative applied power Energy will be drained from the battery, but the battery *voltage* in both these cases is "positive".

In "P control" mode, the instrument uses a fixed Current Range. AutoCR cannot be used. For the best performance, it is advisable to select the best initial Current Range and Potential Range.

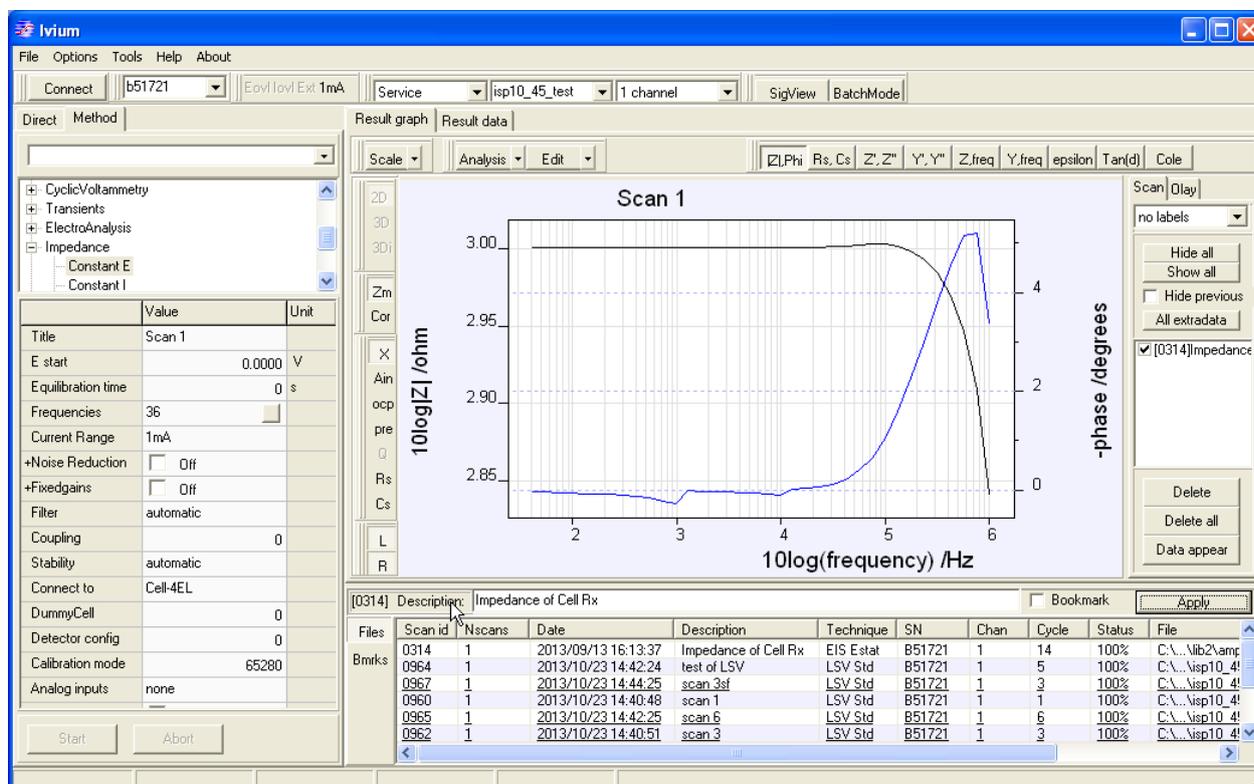
15. Remote driver .dll update and version control

The IVIUM_remdriver.dll has been updated to version 3. The version can be read by the calling program with the "IV_version" function that can be imported from the .dll. It returns an 32bit integer with the version number. The required IVIUM_remdriver version for IviumSoft can be verified in the top menu option "About". Clicking on this will open a pop-up window. At the bottom left the IviumSoft release version is given, behind it between brackets [...] the IVIUM_remdriver.dll version it corresponds with.



16. Labeling and Bookmarking Datafiles

Datafiles can be labeled with a description and/or bookmarked for convenient recognition and later retrieval. Directly above the file history list, a field is available where the "Description" of the selected scan can be entered. The new description can be stored in the datafile by pressing the Apply button.



This description will appear in the 3rd column of the filelist. The description text can be of unlimited length.

Datafiles of special importance can be bookmarked, by checking the Bookmark box and subsequently clicking "Apply" (unchecking the button and clicking "Apply" will remove the Bookmark. Bookmarked files can be recognized by the underlining in the file history list. Directly to the left of the file history list, there are 2 buttons:

- [Files] shows the usual historylist of datafiles
- [Bmrks] brings up the list of bookmarked files.

Bookmarks can also be set/removed by right-clicking on a datafile in the Historylist or Bookmarklist, and selecting the appropriate item from the popup menu. In the Data Explorer, bookmarks can also be created. A list of all bookmarks files can be shown by selecting the "Bookmarks" branch in the root of the Projects tree (on top).

ID	N	Date	Project	Description	Method	Tech	SN	Cyc	Ch	File
0964	1	2013/10/23 14:42:24	isp10_4...	test of LSV	LSV	Std	B51721	5	1	C:\...isp10_45_test\096413
0314	1	2013/09/13 14:42:24	isp10_4...	Impedance of Cell Rx	EIS	Estat	B51721	14	1	C:\...lib2\ampparis2\031409
0314	1	2013/09/13 14:42:24	isp10_4...	Scan 1	EIS	Estat	B51721	14	1	C:\...lib2\ampparis2\031409
0967	1	2013/10/23 14:42:24	isp10_4...	scan 3sf	LSV	Std	B51721	3	1	C:\...isp10_45_test\096713
0964	1	2013/10/23 14:42:24	isp10_4...	dit is een testrun 2	LSV	Std	B51721	5	1	C:\...isp10_45_test\096413
0736	1	2013/10/10 16:27:59	isp10_4...	scan 3	TR	MxMo...	A25325	3	1	C:\...isp10_45_test\073613
0737	1	2013/10/10 16:27:59	isp10_4...	scan 4	TR	MxMo...	A25325	4	1	C:\...isp10_45_test\073713
0960	1	2013/10/23 14:40:48	isp10_4...	scan 1	LSV	Std	B51721	1	1	C:\...isp10_45_test\096013
0964	1	2013/10/23 14:42:24	isp10_4...	dit is een testrun 2	LSV	Std	B51721	5	1	C:\...isp10_45_test\096413
0734	1	2013/10/10 16:01:30	isp10_4...	scan 1	TR	MxMo...	A25325	1	1	C:\...isp10_45_test\073413
0735	1	2013/10/10 16:02:03	isp10_4...	scan 2	TR	MxMo...	A25325	2	1	C:\...isp10_45_test\073513
0770	1	2013/10/11 16:30:39	isp10_4...	scan 2	LSV	Std	B51726	2	1	C:\...isp10_45_test\077013
0771	1	2013/10/11 16:31:28	isp10_4...	scan 3	LSV	Std	B51726	3	1	C:\...isp10_45_test\077113
0738	1	2013/10/10 16:28:30	isp10_4...	scan 5	TR	MxMo...	A25325	5	1	C:\...isp10_45_test\073813
0739	1	2013/10/10 16:29:09	isp10_4...	scan 6	TR	MxMo...	A25325	6	1	C:\...isp10_45_test\073913
0740	1	2013/10/10 16:31:25	isp10_4...	scan 7	TR	MxMo...	A25325	7	1	C:\...isp10_45_test\074013
0769	1	2013/10/11 16:30:27	isp10_4...	scan 1	LSV	Std	B51726	1	1	C:\...isp10_45_test\076913

Parameter	Value	Unit
Title	Scan 1	
E start	0.0000	V
Equilibration time	0	s
Frequencies	36	
Current Range	1mA	
+Noise Reduction	<input type="checkbox"/> Off	
+Fixedgains	<input type="checkbox"/> Off	
Filter	automatic	
Coupling	0	
Stability	automatic	
Connect to	Cell-4EL	
DummyCell	0	
Detector config	0	

17. ECN direct transient analysis

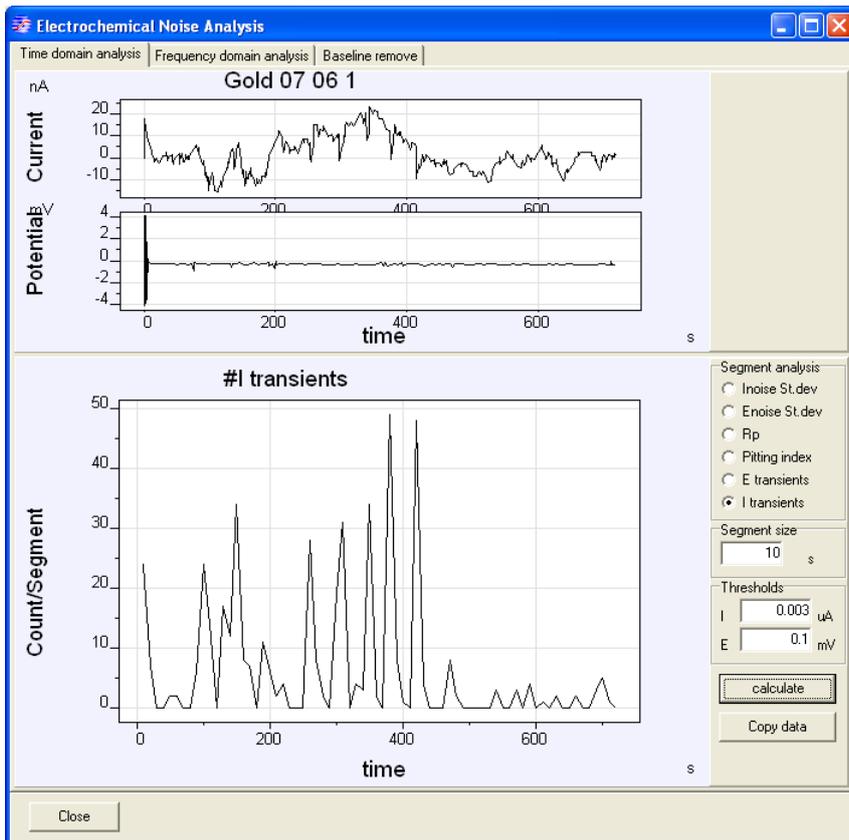
In addition to the possibility to analyze ElectroChemical Noise (ECN) data in the frequency domain (Fourier, MEMS, etc.), now the time domain transients can be evaluated directly.

On the "Time domain analysis" tabsheet of the Electrochemical Noise Analysis tool, both the E and I data can be analyzed, in segments over time: the full length of the ECN E or I data is divided into segments of user defined duration, to which the selected analysis is applied. The segment-results are plotted vs. time.

Several analysis are available:

- Inoise Std.dev: standard deviation of the current signal
- Enoise Std.dev: standard deviation of the potential signal
- Rp: Enoise Std.dev / Inoise Std.dev
- Pitting index: Inoise Std.dev / mean current
- E transients: number of E transients* in each segment.
- I transients: number of I transients* in each segment.

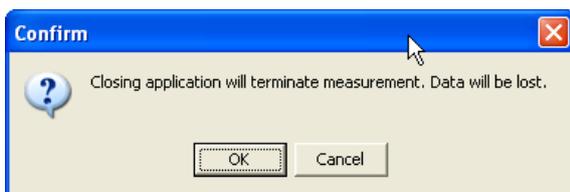
*A transient (or peak) is counted when its absolute difference from the "average segment value" exceeds the defined threshold. Note that consecutive points that exceed the threshold do not increase the transient (or peak)-count. These are assumed to belong to the same transient.



The selected time analysis is performed by clicking the "calculate" button. The results are shown in the graph, which can be copied by right-clicking on the plot and selecting "Copy". The numerical results can be copied with the "Copy data" button, and can be pasted into other applications (Excel, etc.) in the usual manner.

18. Prevent IviumSoft from closing while measurement in progress

If the IviumSoft application is closed, active/running measurements are aborted and the data is lost. When the user attempts to close the application while a measurement is in progress, a message will popup:



Responding with "OK" will close IviumSoft and the data is lost. Selecting "Cancel" will ignore the attempt to close Iviumsoft and continue the measurement. Note that the popup will wait for a response while the measurement continues. A response is needed before IviumSoft can accept new commands or settings.

19. New help file

IviumSoft is equipped with a 'help' function that is content sensitive: this means that placing your cursor or making a selection and pressing [F1] will automatically open the help file on the subject that is selected.

Starting at IviumSoft version 2.301 the help file is based on and compiled in .html. This means that if you have an existing IviumSoft installation the old help file does not work anymore and the new .html help file needs to be installed (instructions, see below).

The new .html help is expanded to include the complete manual. Next to the content sensitive help, of course the help file can also be opened from the top menu bar. In this case the complete contents of the help/manual are displayed by subject in logical order. The help/manual can be searched for example by subject or keyword.

Future releases of IviumSoft, when relevant, will also include a new help file. New features of the new IviumSoft release are included in that new help file.

Installing the new help file

New installation: The newest help file will be automatically installed when first installing IviumSoft from the installation CD on a PC.

IviumSoft update: When IviumSoft is updated from our webpage at www.ivium.com/support, a new helpfile (IviumSoft.chm) is included in the zipfile and should be copied together with the IviumSoft.exe to your IviumStat file directory.

20. Hiding noncompliant data in ResultGraph

Previously all loaded and/or generated data would be visible in the ResultGraph, i.e. when an LSV was executed after an impedance (EIS) experiment without deleting the EIS data, the LSV data would be plotted in the EIS graph. This would cause the data/graph to look erratic.

Now, only data will be displayed that is compliant with the active plot. So in the previous example, the EIS data would be hidden from view after the LSV started. Note that the EIS data is still there. If thereafter another EIS experiment would be run, the older EIS data would become visible again (and the LSV data will become hidden).

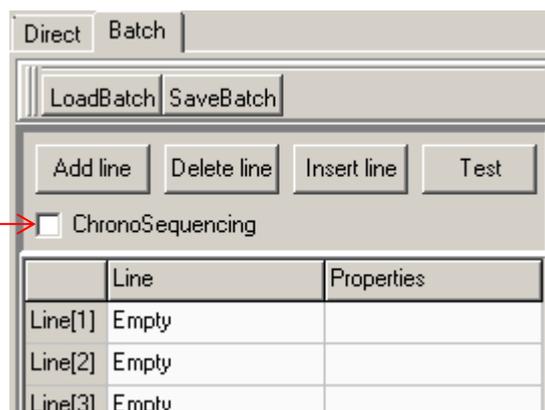
The display mode always follows the active scan. Previous recorded/loaded scans will only be visible when these are compliant with the current display mode. Note that this will make it now possible to meaningfully combine results from different techniques in 1 dataset.

When multiple scans are loaded, containing data recorded with different techniques, the hidden ones can be viewed by mouseclick, while keeping CTRL pressed. This will make the clicked scan active, thus redefining the plot "mode".

21. ChronoSequencing in BatchMode

In BatchMode, it is possible to display the time scale of the ChronoTechnique methods relative to the starting time of the Batch. When multiple techniques are executed in sequence, their time variable accumulates. This mode is activated by checking the "ChronoSequencing" checkmark, on the Batch tabsheet.

Note that if the "cleargraph" option is not used in batchmode, one can view all the Chrono results in one plot, in a chronological manner.



22. Working with large datafiles

When experiments produce a large number of datapoints ($>10^6$), the Windows PC system can become unstable due to performance issues. In order to ensure reliable operation with such experiments, IviumSoft employs several strategies. The main feature is to limit the maximum number of points in memory and visible on screen. Note that the excess data is not lost, but will be stored on disk. The maximum can be defined in the "Datahandling options" (see also paragraph 3.3 on p.6):

MWS: The Maximum Workfile Size; default 400,000 points

When an ongoing experiment exceeds MWS, the first half of the datapoints are saved to disk in a CSV file, and these are removed from the pc memory (and graph). The visual plot continues with the most recent datapoints. When the scan continues to produce data, and the MWS is again exceeded, the first half of the visible data is appended to the previously created CSV file, and removed from the visual scan. And so on, until the scan ends.

When such a scan ends, it adds all the remaining data to the CSV file, which will be saved. Thereafter it will load the complete CSV file, which contains all data points, and create a reduced datafile, which will be shown and saved in the usual .idf format. The reduced datafile is designed to contain all important results, while maintaining a manageable datasize. The reduced datafile characteristics:

- Reduced datafiles are always between 15,000 and 200,000 datapoints
- For scans that have produced more than 15,000 points, data reduction is accomplished by omitting datapoints that differ less than 1% from the previous included point.

Normally a reduced datafile will display all relevant features. However, in case this is in doubt, the CSV file can be used. This contains the complete datapoint collection. The full data length can be restored in .idf format by rightclicking the selected scan in the Legend panel, and pressing "Restore full datasize".

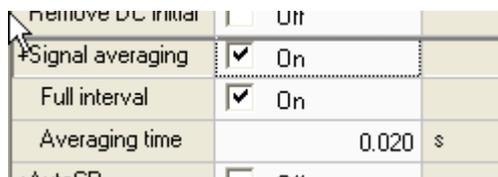
23. Realtime Impedance

The 'Mixed Mode' technique allows the recording of Impedance data simultaneous with DC results, in real time. The minimum interval time to allow real time impedance measurement has been greatly reduced from 0.2 sec to 0.002 sec. But note that at interval times shorter than 0.2sec, the AC signal is always continuously applied (regardless of Continuous AC option). At interval times longer than 0.2 sec the AC signal is only applied at the last portion of the interval.

To make use of real time impedance the the condition must be observed that: the Signal Frequency must be higher than (2/interval time).

24. ECN: Signal averaging

Normally the signals for each time interval are recorded at the last portion of that interval: i.e. the signals are sampled at high speed and averaged during a sufficiently narrow period, that is automatically chosen by the instrument. The option has been added (in the ECN technique only) to allow the user to override this and redefine the period by using the "Signal averaging" parameter:

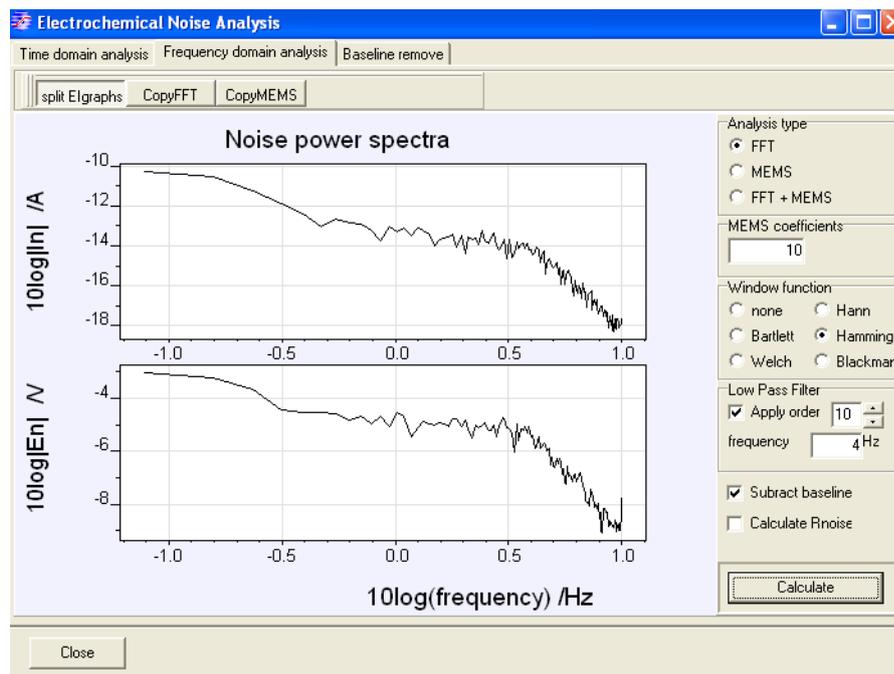


Remove DC initial	<input type="checkbox"/>	Off	
Signal averaging	<input checked="" type="checkbox"/>	On	
Full interval	<input checked="" type="checkbox"/>	On	
Averaging time		0.020	s
AutoFB	<input type="checkbox"/>	Off	

By checking the "Full interval" option, the data is measured and averaged during the whole interval period (note the similarity with the current integration techniques). If the "Full interval" option is left unchecked, the user can define the "Averaging time" to any other value between 0.0003 and 10 seconds. Normally the Averaging time would be a fraction of the interval time, but it is also possible to use larger time periods. In that case, the averaging also uses the previous datapoints, and in fact will become a digital lowpass filter.

25. ECN analysis: digital low pass filtering

In ECN analysis, an option for digital lowpass filtering has been added:



In the frequency domain a filter function can be applied by checking "Apply". The frequency and the order can be set by the user. The frequency will correspond with the cut-off frequency: at which half the signal magnitude is attenuated. The order gives the "slope" of the filter: 1st order = 20dB/decade, 2nd order=40dB/decade, etc.

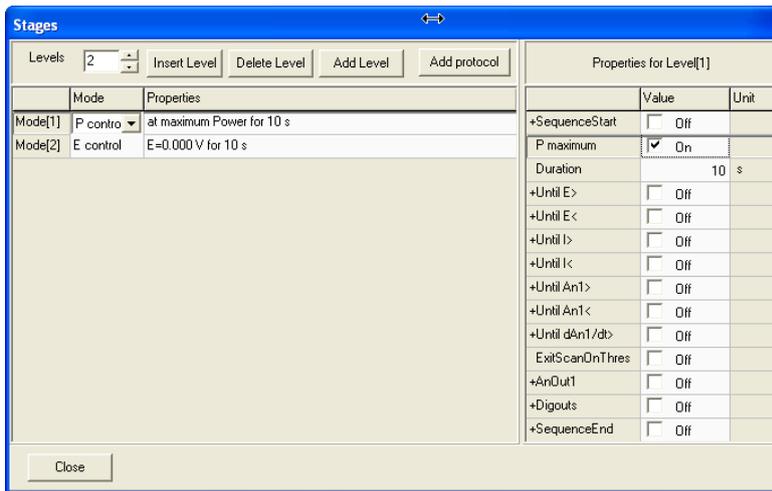
26. Power optimization for active Cells.

A new mode has been introduced in the "P-control" of the Mixed Mode technique. This "P-maximum" -setting facilitates the further investigation and operation of active cells, such as Batteries, Fuel Cells, SolarCells, and other power generating devices.

The power that a device (Cell) generates is dependent on its Potential/Current settings. Often there is a certain E/I setpoint that yields maximum Power. That point is not known in advance and/or is constantly changing, i.e. consider a Solar Cell for which the incoming light is variable. When the "P maximum" option is checked, IviumSoft will automatically select the E/I settings that yield maximum power. The Potential/Current settings are continuously adjusted, so the device is always operated at its maximum power output.

Note 1: The P-maximum is software controlled, based on real-time measured values.

Note 2: The P-maximum point is re-calculated at each 'interval time', so the shorter the interval, the faster the 'control loop'.

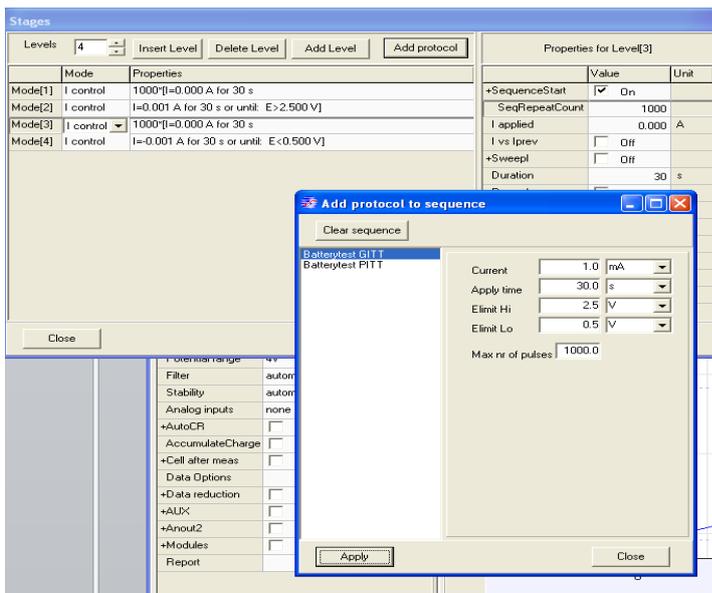


To operate a cell at maximum power, in Mixed mode technique, Levels, select P control. In the Properties check "P maximum". This mode can be used like any other Mixed Mode regime, and can be sequenced at will.

27. Importing Protocol Templates in Mixed Mode (PITT, GITT)

To facilitate the compiling of complex sets of method parameters, it is possible to add standard protocols. At this time, there are 2 protocols available for Battery testing: GITT and PITT. Over time, more will be added.

To add a protocol to a Mixed Mode sequence, select the Mixed Mode technique. From the method parameters, open the Levels window. In the menu bar at the top of this window, click on 'Add protocol'. This will open an additional pop-up window for selecting and changing a predefined, protocol. The protocol parameters can be edited before adding the protocol to the Mixed Mode. But, after adding the protocol, the lines can also be edited; they appear as "normal" lines. In this way the protocols can be used as templates, that are flexible and can be adjusted to any specific requirements.

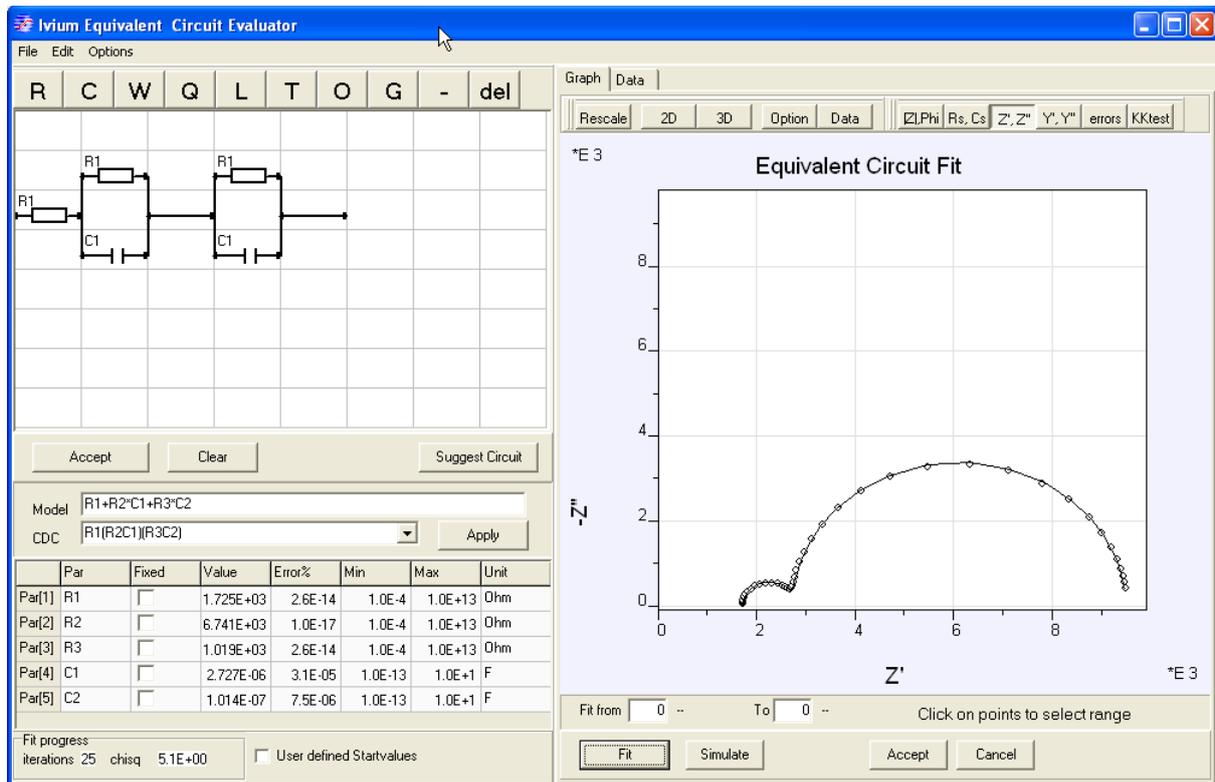


28. IviFit - IviumSoft Equivalent Circuit Fitting

The Equivalent Circuit fitting tool, that comes included with IviumSoft, has been greatly enhanced.

28.1 Increased visual grid

The visual grid has been increased from 5x5 to 8x8 component positions (25→64). This allows for easier building of complex circuits, and it allows even more complex circuits.



28.2 Improved modelling algorithms

The modeling has been optimized in several ways:

- The fitting is mathematically more robust, avoiding numerical error messages.
- A higher success rate is obtained due to better coping with "local minima".
- Better algorithms are applied to deal with difficult components, such as CPE (Q).

28.3 Automatic generation of startvalues

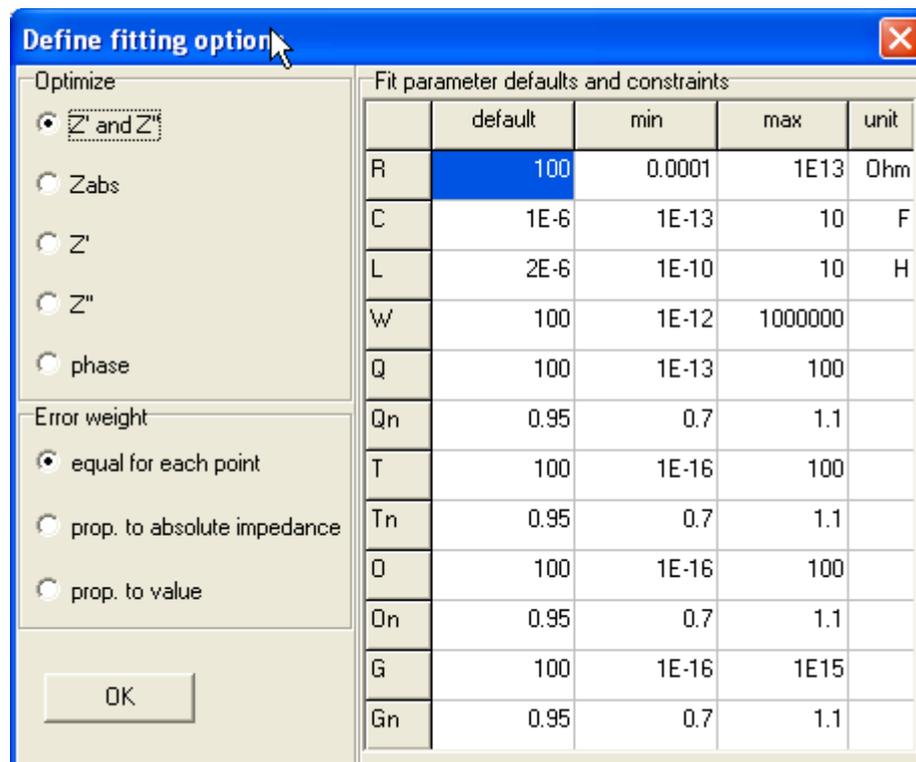
The modeling tool is now capable of generating its own starting values. This is convenient for the user, and it obtains better endresults. Therefore by default the starting values are automatically generated. Optionally, the user can still apply their own starting values by checking "user defined startvalues".

28.4 Automatic circuit suggestion

When the equivalent circuit is not known, the Ivium Software can suggest a circuit that would fit the data the best. This is done by internally evaluating several standard circuits, and comparing fit quality. At this time only combinations of R,L and C are included.

28.5 User definable fit boundaries

The user can set boundaries for the fit-able parameters. In the circuit evaluator window select Options/Fitting Options; here the default values for the parameter types, and their allowable limits, can be set. These will be applied as starting values for newly created circuit parameters. The boundaries can also be individually edited after circuit creation in the actual parameter grid.



28.6 Graphic selection of fitting range

The range of data points to be included in (or left out of) the fit can be selected graphically: simply mouse-click on the outer data points to be included in the fit range. The fit range is shown in highlight. Only the included (high lighted) datapoints will be used in the numerical modeling and simulation.

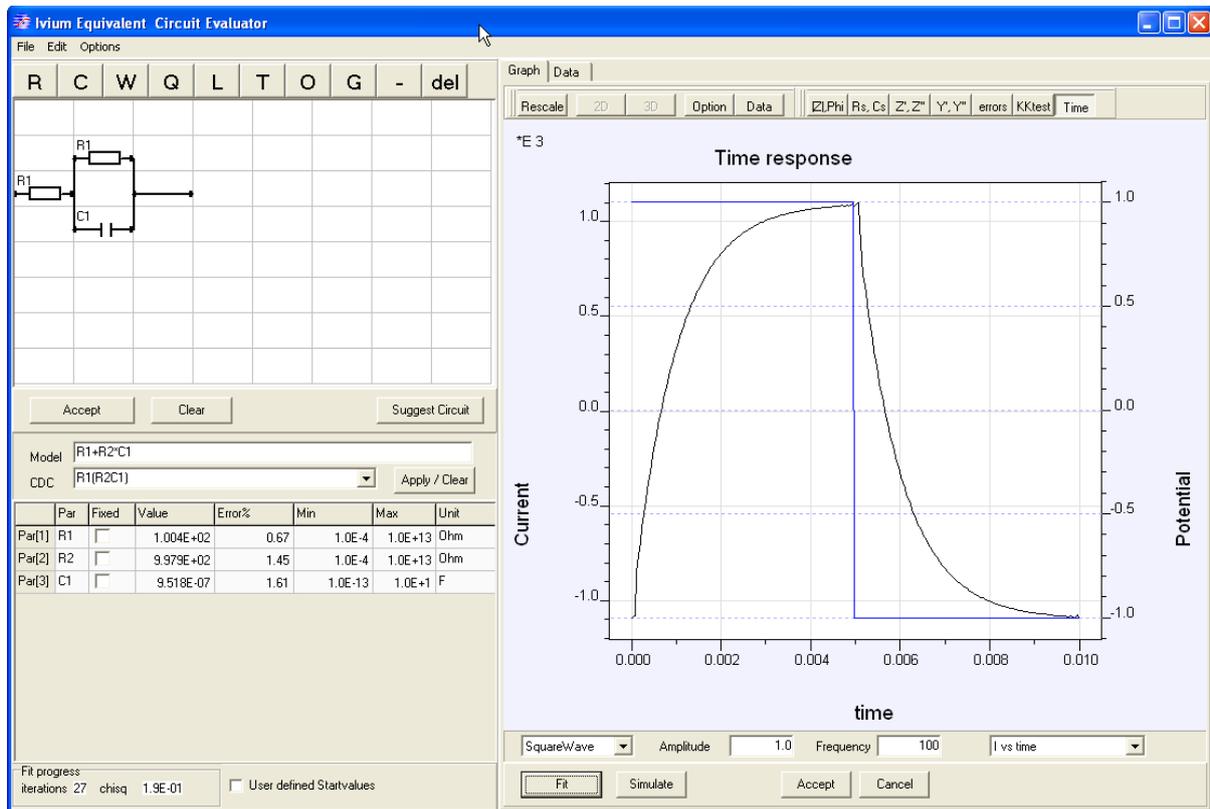
Graphic selection of the fitting range is available in the plots: Bode, Nyquist, RSCs, Y1Y2.

28.7 Kramers Kronig test

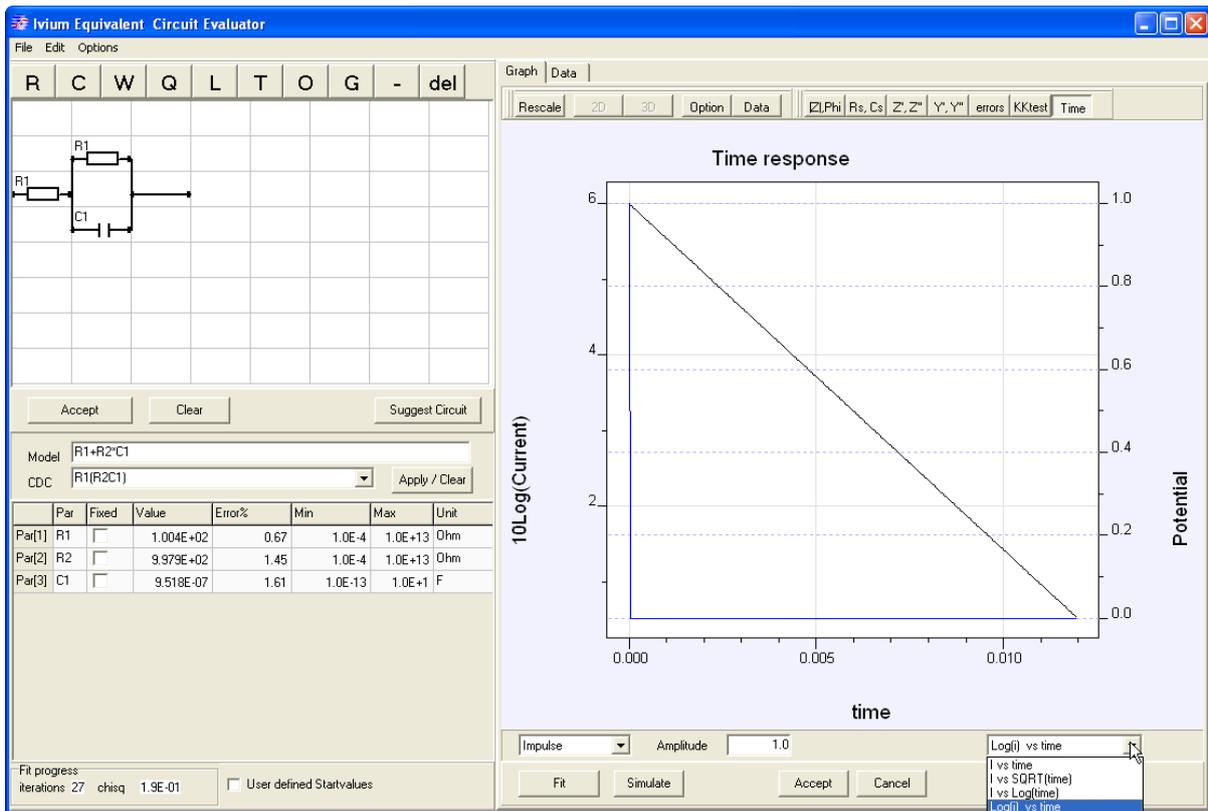
Data can be validated by means of the Kramers Kronig test. When you press the "KKtest" button, the KK plot will be generated.

28.8 Time response reconstruction from the equivalent circuit

Time responses can be calculated from the equivalent circuit. Equivalent circuits are normally modeled from the Z vs. frequency relation. However from any equivalent circuit, the E&I vs. time relation can be reconstructed also. This might be useful for educational purposes, or verification of particular measurements in the time domain. It can be selected by clicking the "Time" button. There is a choice between various potential perturbations: SquareWave, Cosine, Impulse, Sweep, Sine, Step, Triangle. These perturbations can be applied either in potentiostatic mode (: apply E and measure I), or in galvanostatic mode (: apply I and measure E).



For SquareWave, Cosine, Sine and Triangle, also the frequency can be chosen.



It is possible to transform the axis, evaluate the time dependence of the signals: see the indicated example above for the linear relation of the Logarithmic decay of the impulse response on an RC network.