M Lab Operation Manual

Contents

What is the M Lab

M Lab is a multi channel potentiostat / galvanostat. Two potentiostat / galvanostat channels are organised on one hardware board. The boards may be housed in a small desktop box if only one board is required, or in a 19" system housing when multiples of channels are required.

Each board (with its two channels) is controlled by one microprocessor, connected to the personal computer by a RS 232 serial cable.

In multi - board arrangements, one board is designed as "master", connected to the personal computer by a RS 232 cable, while the others interconnected by RS 485 - interfaces.

M Lab has three basic operation modes for each channel:

- The potentiostatic mode
- The galvanostatic mode
- The open circuit mode

Please note that some properties which are available when only one board is engaged, will not be available when multiples of boards are engaged. For instance, in a multi - board arrangement it is not possible to use the "cell check" routine on a certain channel while a programme records data on another one.

Power Connection, Security Notes

The mains power line is expected to deliver 220 V or 230 V AC, 50 or 60 Hz.

The mains (or power line) switch is found on the rear panel of M Lab desktop housings, and on the left part of the front panel on M Lab 19" system housings.

If the fuse is blown, replace it by a 630 mA fuse.

The power cable has 3 lines, the yellow-green line must be connected to "protection earth" (PE). It is NOT allowed to remove or disconnect the PE line.

Note: If an M Lab has to be separated from the protection ground, remove the ground bridge at the rear panel. Common ground then is isolated from protection earth (PE).

Never cover the fan opening at the backside of the M Lab. Impeded cooling air stream may lead to damages by overheating.

On the rear panel is a bridge plug connecting protection earth (PE) of the power cable to the common ground of the potentiostat. Please read chapter "Some rules for Wiring and Shielding" before removing this plug.

Please keep the switch "Separated / Coupled" always in position "Separated" as long as you do not want to use the very special "coupled" mode. Note that the coupled mode requires precautions.

Interface Connections

Use a standard ("modem") type RS 232 cable. (Inverted cables of the "null - modem" type will not operate). The terminal is found on the rear panel.

The RS 485 connector requires a 1:1 connection between all RS 485 plugs of a set of M Labs.

Switches, Plugs and Signal Lamps

A set of LED's on the front page signals the instrument's state.

On the right side (when lying flat), a red LED signals power on OK when alight.

One pair of red OVL LED's signal overload condition. Overload means that the counter electrode voltage is no longer sufficient to achieve the desired potential (in potentiostatic mode) or current (in galvanostatic mode).

If both OVL LEDs of one channel are lit at same time, an excess of noise troubles your cell, or some other failure has led to instability. Please switch of the channel immediately (set it to stand-by) and check your set - up.

The LED AD-ACT blinks whenever a transfer is activated on the communication line.

The models coming in 19" housings have one green LED for each channel which is lit as long as the counter electrode is switched on.

Cell Set - up and Cell Connections for a Quick Start

(More detailed description in the last chapters of this manual)

The cells are connected to the both channels of each M Lab board by a 3 - pin XLR - type connector cable bearing the two lines (current line and potential sensing line) and the counter electrode line. The reference electrode cable is separated from the other cable from electrical reasons.

The electrochemical cell should be connected to the instrument through the cable supplied (preferably without extending it). The individual wires of the cable are colour coded as follows:

Electrode	Colour (banana plug)
Counter	yellow
Working electrode:	
WE potential	black
WE current	black
Ground	grey
Reference	green
Screen Reference electrode	no connection

Never connect the reference electrode of one channel to the cell cable of the other. The M Lab will not work then. Under such conditions, harmful oscillations might occur in addition.

The switch Coupled / Separated determines whether both channels operate independently, or are related to one another.

Separated means independent operation: You are supposed to use each set of electrodes in a separate cell.

Coupled means that the potential of working electrode of channel 1 is polarised with respect to the potential of the working electrode of channel 2 (which is expected to be kept to common ground).

To do so, the counter electrode plug and the reference electrode plug of channel 1 must be connected together, and **not to any electrode inside the cell.**

You may use this mode e.g. to control a set of sensor electrodes, or even to control a ring - disk electrode cell.

The mains connector is found on the rear panel. Please use the cable which is delivered along with the instrument.

Note: If you have to change the plug, always connect the yellow – green wire to protective ground of your plug.

M Lab Software

The M Lab software cares for control of the potentiostats, recording of data and also data processing. The M Lab software comes along as one single exe file named M Labxx.EXE, where XX is the version number. In addition, the help file system is contained on your installation CD, consisting on the MLABHLP.HLP file and the help data base file. Copy these three files to an empty directory on your hard disk. On the first start of the M Lab programme, a set of initiation files is created, which will take up the instructions for preferential appearance of graphs as well as the data for the serial communications.

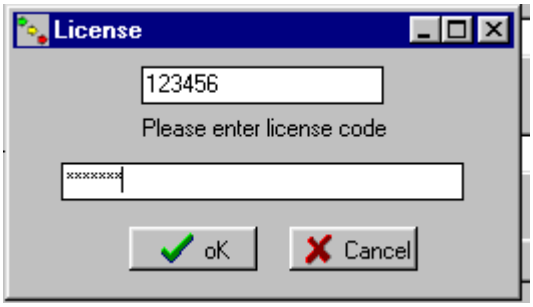
Before starting the software, the M Lab shall be properly connected to the power supply and to the personal computer. Switch on after making the connections. It turns immediately to a secure state (potentiostatic mode in each channel, and open circuit mode, i.e. counter electrode is disconnected).

We recommend to connect a "dummy load" to the M Lab while learning how to operate it. A dummy cell in the simplest mode is a 1 kOhm resistor. Connect both black banana plugs (working electrode current line and sensing line) to one end, and the yellow counter electrode plug and the green reference electrode plug to the other end of the resistor. This dummy load allows to operate potentiostatically in the current ranges 1 mA and above, and galvanostatically in the ranges 1 mA and below.

During start - up, the programme searches for a M Lab connected to the serial port. If the M Lab is disconnected or not switched on, you are asked whether you want to operate off- line (you may use the programme for data evaluation then only), or to check the connections and re - start it.

Writing: A click with the left mouse button is abbreviated as LMK , accordingly a click with the right mouse button as RMK

SCI - Activation



If you have bought the programme SCI, it can be activated from the Help – menu.

A license code is required, which is unique for each instrument. To get the license code, please send us the serial number of your instrument (the one which is connected to the pc, if more than one is linked together). We send the appropriate license code imemdiately by E – mail or fax.

If you got the license code, click to „Help“ – „License“ and the enter the License code which you get from our works.

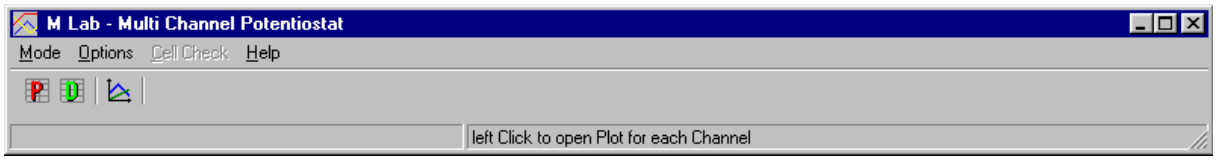
During start - up, the programme searches for a M Lab connected to the serial port. If the M Lab is disconnected or not switched on, you are asked whether you want to operate off- line (you may use the programme for data evaluation then only), or to check the connections and re - start it.

On programme start, the main programme window appears on top of your screen. The main programme gives control to all other parts of software. Drop - down menus activate access to other windows, as well as the buttons (P), (D) buttons.

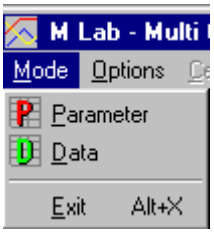
A help system is enclosed. In addition, bubble help messages appear on each topic while you move the mouse cursor slowly along the programme's windows.

The status line shows short information to each column in parameter window and data window when the mouse cursor moves over the columns.

The Main Windows of M Lab Software

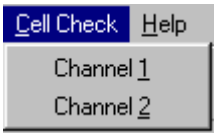


Main Menu Topic: Mode



The mode menu is another method to get access to the Parameters and the Data windows, and to close the programme (Exit).

Main Menu Topic: Cell Check



Cell Check is a mode to control any one of the M Lab channels manually. It can be used for one channel at a time, you have to select which channel to be supervised. A virtual front panel appears then allowing to operate one channel. Explicit description see chapter Cell Check.

Cell check is only enabled when both parameter window and data window are closed.

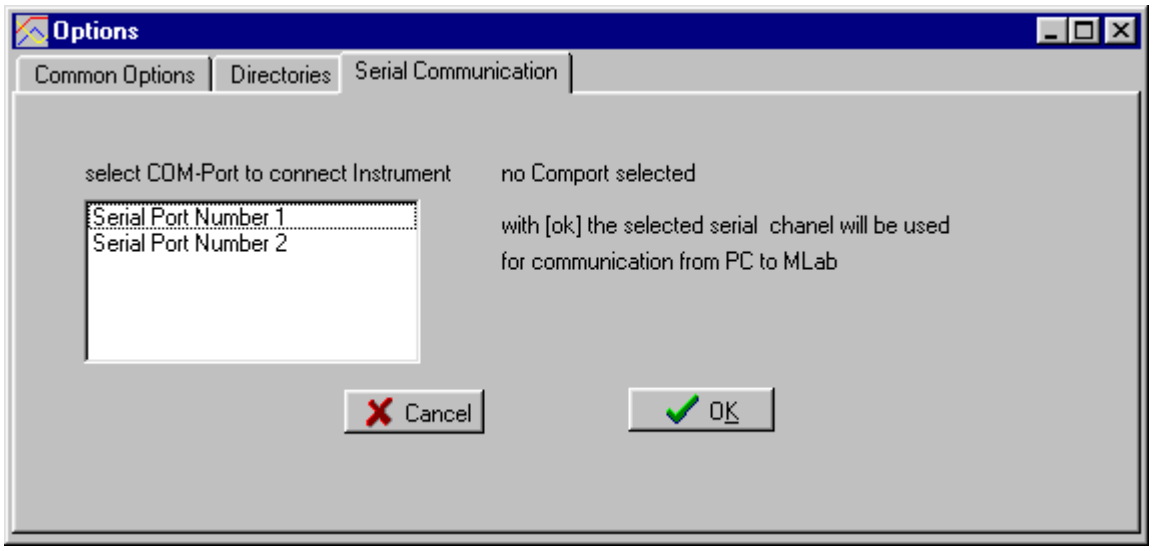
The cell check window can be active only for one channel. It is not possible to open the cell check during a running scan on any other channel in a multiple board arrangement.

Main Menu Topic: Options

Common Options

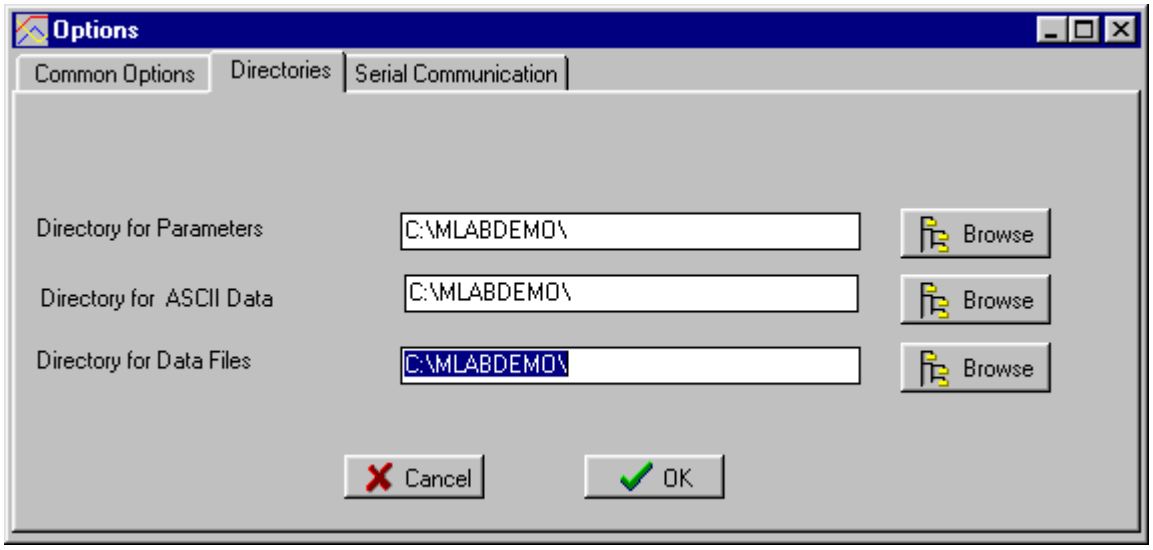
You may choose one of the sub - windows to appear automatically when the programme starts. In common options you can also set the bubble help display to "on" or "off".

Serial Communication



When clicking to the serial communication button, the programme searches for available serial ports on your computer. Click to the port the M Lab is connected to, and then to OK. Note: If the M Lab has been connected properly to a free COM – port, and no other port is available, you get an error message when trying to change the serial communication properties. Click to OK or cancel the messages (4) until the program returns to its normal state.

Directories



Clicking to directories, you may choose a directory where the data (binary and ASCII) and where the parameters are saved to.

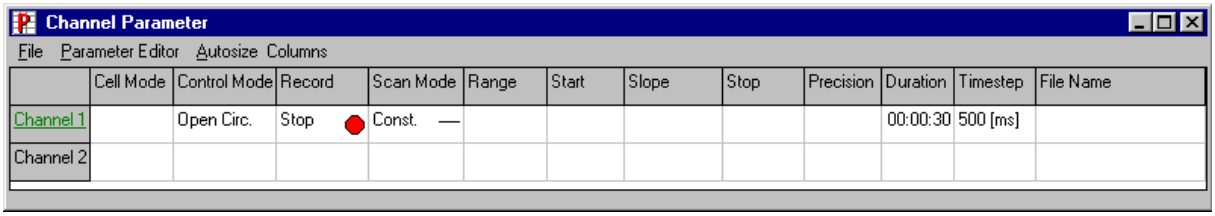
Main Menu Topic: Help

Help contains two items:

Help calls the help system.

Info shows a version info and checks the serial communication between PC and M Lab.

Parameters



The Parameter editor opens an alternative spreadsheet – shaped window to define parameters for programming each channel. To copy data from one channel to another one, click to the grey field named "channel" of any channel to be programmed. A menu opens asking you whether you want to use the same data.

Note: As M Lab is a multi – channel system, and each channel may be operated at appreciable data transfer rate, you will understand that in multi – channel operation the number of channels in use limit the maximum achievable transfer rate. During programming, a bar graph appears on top of the parameters menu named "Used Transfer Capacity".

The transfer capacity is "filled up" during programming the channels.

The bar grows to the right margin of the bar graph with increasing number of programmed channels. When reaching the right limit (100% used), no more channels can be used.

Note that the number of channels and the transfer rate in the fastest channel determine the use of the transfer capacity. If you want to have all channels running, you are bound to lower down the used transfer capacity by reducing the transfer rate of the fasted channel hitherto programmed. The means to do so is to reduce the "precision" of the reading, that means reading the data at wider intervals (increase the number in the column "precision")..

How to Operate the Parameter Spreadsheet

File

New : clears all parameters for all channels

Open : opens the dialog to read parameters for all channels

Save : opens the dialog to write parameters for all channels

Save as : opens the dialog to write parameters for all channels with new name.

Save Single Channel : opens the dialog to write parameters for one channel

Open Single Channel : opens the dialog to read parameters for one channel

Columns

Click on this point to optimise column width.

Channel Name

This column shows the channel names.

Left click on it opens the "Same as" window for each channel, to duplicate the parameters.

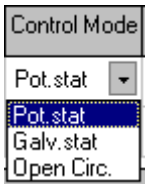
Right click marks this channel to save parameters with File|Save single channel.
The channel name appears green and underlined.

Right click with depressed Ctrl-key marks this channel to load parameters with File|Open single Channel. The channel name appears red and underlined.

Cell Mode

Switch on or off the load by switching the counter electrode.

Control Mode



Select control mode in this column.

Open Circuit : Counter electrode is off, the open circuit potential is measured.

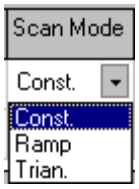
Potentiostat : Potentiostatic control to the set potential, counter electrode is switched on.

Galvanostat : Galvanostatic control to the set current, counter electrode is on.

Record

Start or stop scan in this column

Scan Mode



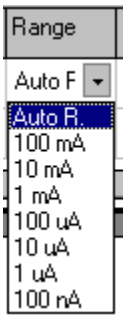
Select the scan mode in this column

Const : scan on constant voltage/current

Ramp : scan from a start voltage/current to a stop voltage/current

Triangle : scan from a start voltage/current to a stop voltage/current and back to the start voltage/current

Current Range



Select the current range in this column.

The autorange mode is only accessible in the potentiostatic mode. Galvanostatic mode requires a fixed range even when you programme a scan. This implies that galvanostatic scans do not cover more than 3 decades of current at best.

Use the autorange mode preferentially unless heavy noise (which occurs sometimes when heavy gas evolution is caused at one electrode) causes permanent up- and down ranging.

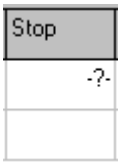
Precautions:

Using a fixed range, it is wise to set it properly. Currents exceeding the range limit in the potentiostatic mode will lead to clipped current results.

Currents which cannot be imposed to the cell when using the galvanostatic mode result in an overload condition.

Note: Avoid overload conditions. It may happen that even the working electrode is not longer kept at ground potential, resulting in electrode damage caused by wrong potential.

Start, Stop

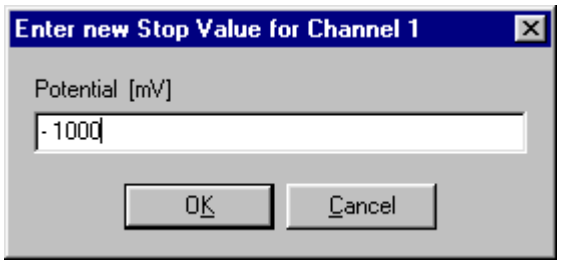


Define the voltage or current limits for a scan, respectively.
The columns into which voltage or current data are to be entered, behave slightly different.

Freshly opened, a question mark appears in the respective cells.

When clicking into the cell, a dot – marked square appears.
You could now directly type a number into this cell, or click onto the grey dotted square.

Doing so, a new window opens which forces you to enter the data in the required format. It is recommended to use this way of data input as long if you are not quite familiar with the data formats.



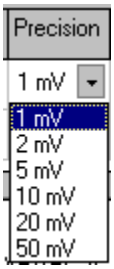
Start is the start voltage / current of scan

Stop
In ramp mode the stop means the voltage / current at which the scan actually stops.

In triangle mode, stop marks the reverse point of the scan.

Slope

Slope is the scan rate for a (potentiostatic) voltage scan, or a (galvanostatic) current scan.



Precision

Select the precision in this column. This means not the resolution of A/D - converter. It means the density of points on a curve.

Duration

This column shows the total duration of scan. It is calculated when you are programming a ramp or triangle, and it must be edited when you are programming a constant function ("chrono - amperometry" or "chrono - potentiometry"). It cannot be edited, correspondingly, if you have chosen ramp or triangle as base function.

Time Step

This column shows the calculated time step for recording data. It depends on slope and precision. Smallest step is 100 ms.

File Name

Enter the desired file name for the data record here.

Left click to this field opens the dialog to define the filename.

If no filename is defined on start of scan, a default filename is used. Existing files having the same name will be overwritten.

Data are stored as binary files (extension .MPD) when a measurement is done. If you want to save them as ASCII files for later use in other environments, you have to open the respective .MPD file from the data spreadsheet window and save them from there using the "save as" command.

How to Run a Programmed Task

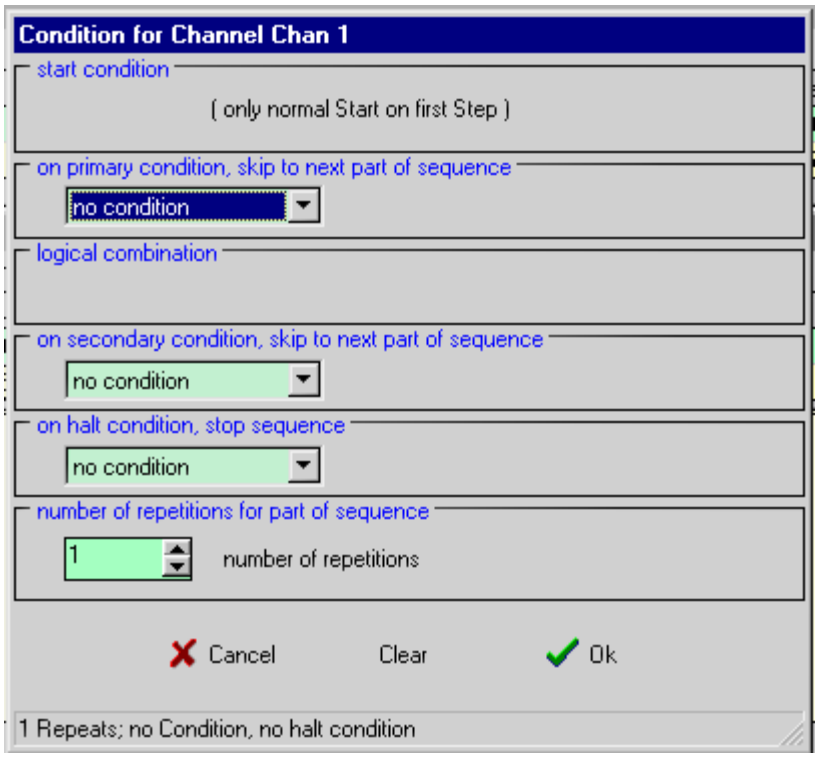
Having programmed a task on any of the channels appearing in the spread sheet, you can immediately start this task, or do it whenever it is desired. If you want to look at the data as soon as the task is started, simply click to the Data button. The data spreadsheet appears, where the incoming data are displayed numerically.

If you want to have the data displayed graphically, click to the grey Channel box at the left margin of the spread sheet. Immediately the graph window opens, showing the incoming data as a curve. For changing the graph properties or arranging a couple of graphs from different channels, see section graph.

Programme SCI: Programmed Conditions

SCI offers additional possibilities, e.g. to end programmes when a certain limit is exceeded, to start a programme step with the last potential of the previous step and others more.

The conditions are selected by clicking into the field "condition" right. A sub – menu appears as follows:

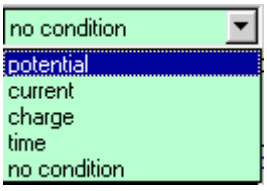


The upper field is used to enter a start condition. This is only possibly for programme steps 2 and all further steps, since step 1 cannot get a start condition.

If the first programme step is e.g. measurement of open circuit potential, and the polarisation curve shall start at open circuit potential, then just enter "start with OCP" here.

The entry field below is used to enter a primary break condition. If this condition is met, the actual programme step is stopped and the next step will be started.

Selectable conditions are: No condition (default) / potential / current / charge / time. Clicking to one of these parameters, an entry opens where you are asked to enter a numeric value, and one of the operators "<" or ">=". Please note that ">=" means always a value ***more positive*** than the limit. That implies, when using negative values, e.g. -2 is ">=" –5 .

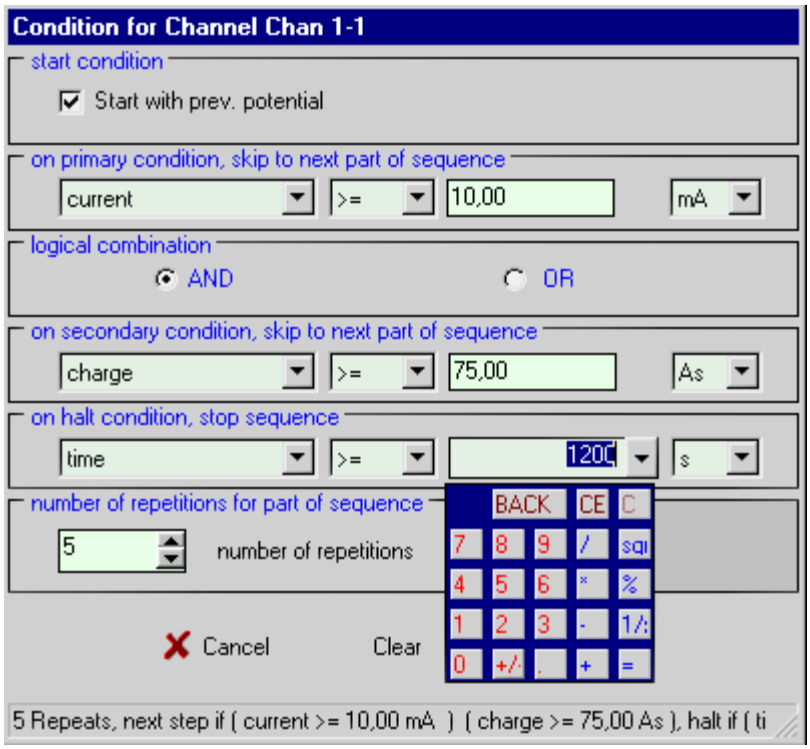


In addition to the first condition, another one can be entered in the entry field below.
Both conditions can be connected by either AND or OR.

"On Halt Condition" is the condition which may be used to cut any operation of this channel, and switch off the counter electrode.

Number of Repetitions:

This entry defines the number of repetitions of the actual step.



A calculator field opens when select time as limiting condition. Using it, you can easily calculate the time in terms of seconds..

Example:

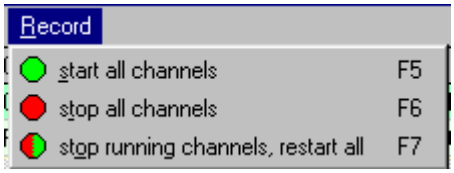
Step 1: Measurement of rest potential
Step 2: Record a triangle function, repeating five times, starting at OCP
Stop the polarisation if current exceeds 4 mA.

Starting a Programmed Function

As soon as a step is programmed, it can be started immediately or at any time later. Click into the entry start, and then to the pop-up – "start" – field there.

To read the data during a measurement, click to the "D" – symbol (Data) of the main menu task bar. Graphics display starts when you click to the desired channel of the Data display.

Start / Stop Options

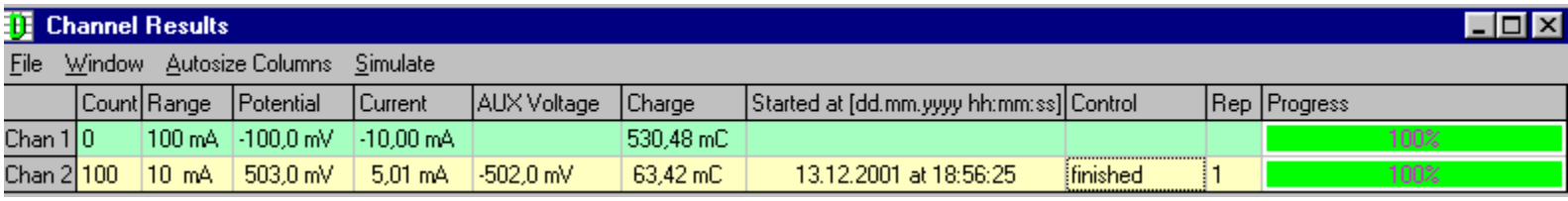


Clicking to "Record" with the right mouse button, you are allowed to select one the start / stop

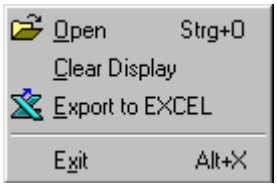
options shown above. Using this option, the channels can be started (nearly) simultaneously, or stopped at same time. Or, you can stop running channels and re-start all simultaneously.

Data Spreadsheet (Channel Results)

The spreadsheet Data is called by clicking to "D" or "Data". Results are displayed there and updated continuously during a record.



File



To save data or to open a file, to export data or to reset the display click to FILE.
During the measurement, all data are saved using a binary data format. This allows compressed saving, which reduces HD – space consumption and saves time. When opening this binary file, and saving them again, the data then are converted into ASCII – format. Such data can be read using any text editor, spreadsheet etc. Export to Excel uses Excel 4 format. .

Window

The command Window displays graphics frames for more than one curve. Different options are available to display the graphics on the screen in different manners.

Autosize Columns

Columns can be narrowed or widened. To reset the original column width, just click to "Autosize".

The Data Spreadsheet Window

The Data spreadsheet shows data running in during a record simultaneously on all channels.

Window

The windows can be arranged in different modes, as single windows at full size, or arranged cascaded (cascade) or in tiles (arrange | show channels n to m), where n and m are channel numbers of available channels.

Autosize

Click on this point to optimise column width

Channel Name

This column shows the channel names. Left click on it opens the graphic display for each channel.

Count

This column shows the number of data sets which have already passed.

Range

This column shows the used range. It is always the real used range reported back from the microprocessor.

Voltage

This column shows the measured voltage.

Current

This column shows the measured current.

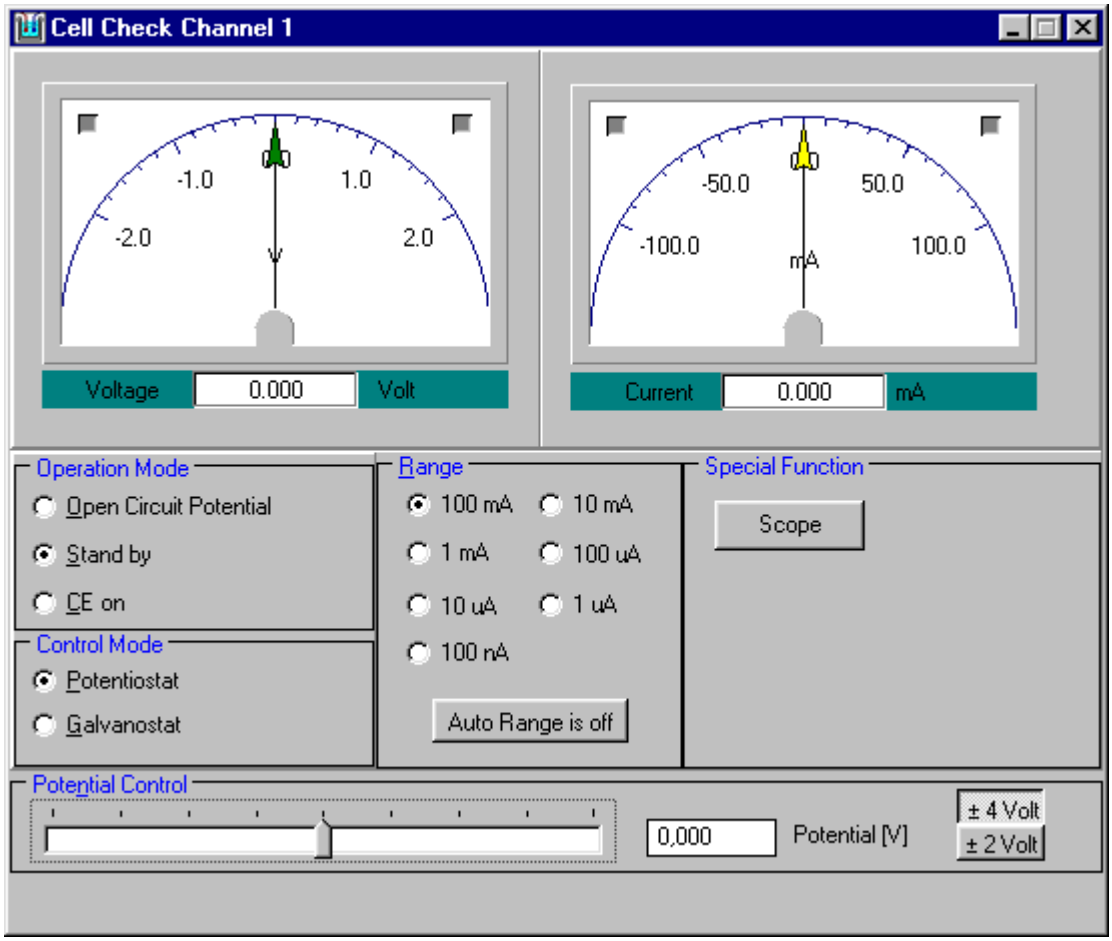
Started

This column shows the date and time of scan start.

Rest Duration

This column shows the remaining time of scan.

Cell Check



Voltage and current are displayed by two virtual instruments. Under the instruments, a numeric display shows the precise values of potential and current.

To perform a cell check, please do it in following order:

Select the control mode (Potentiostat / Galvanostat) in box Control Mode. The control mode is selected, but the counter electrode is still off.
Note: After changing the control mode the operation mode is always switched to stand by.

Next set the potential to the desired value, or to a region where no harmful reaction will damage working electrode or spoil the electrolyte.

The you may set the operation mode selector to CE on.

Select the current range to use. Auto Range enables automatic range finding by the microprocessor. Auto Range is enabled only in potentiostatic mode.

Auto Range is switched off by selecting a fixed range.

Potential or current setting:

Use the slider in box Potential Control / Current Control to adjust voltage/current or use direct numeric input.

For potential range setting two buttons switch between the +/- 4 V or +/-2 Volt range. The 4 V option is only operating to its limits if you have got a M Lab being equipped with this option.

Graphics

The graphics windows can be opened during a running record, or after a record has been performed and the data having been saved. For this purpose, click to the graph icon in the main menu's action bar.

After opening the graphics menu, you may directly view data which are running in during a record, or open an existing data file. Clicking to File at the task bar of a graph, the file manager opens to choose a file from a directory.

Note: From the graph file, you have only access to data stored in the ASCII format (extension .VPO).

To open files which are stored in binary format (extension .MPD), use the "open file" command in the data spreadsheet window.

Changing Plot Properties

From the View menu, you have access to different plot types:

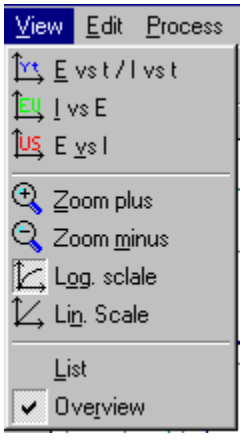
 - potential and current vs. time,

- potential vs. current (European E-I - plots) - linear or semi - log

Polarisation Curves & Analysis

This graphics menu can only be opened for one channel at a time. It allows more types of graphics (e.g. plotting current – potential curves according to US – conventions), zooming, panning and much more. In the E-t / I – t record, two separate graphs are shown for E vs. t and I vs. t. By clicking to the separating line between the two graphs, you can now increase one of them, by decreasing the other one.

In addition, from this menu you have access to the mathematics processes: Filtering, Tafel line calculation, and reference electrode re – scaling.

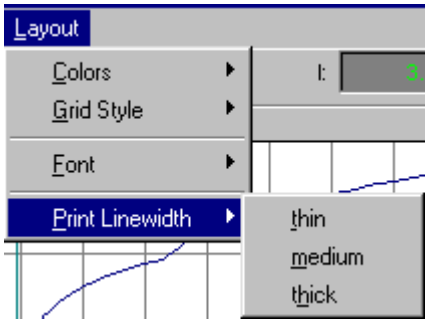


View

The menu View allows to change the plot types in various manners: Strip – chart type (E vs. t / I vs. t), I vs. E both in European style (X – axis for potential) and US – style (Y – axis for potential), and linear and semi – log scaling. List produces the data listing (you are not allowed to edit it, however). Checking the box "Overview", you get information on then

number of data points, minimum and maximum of the curve.

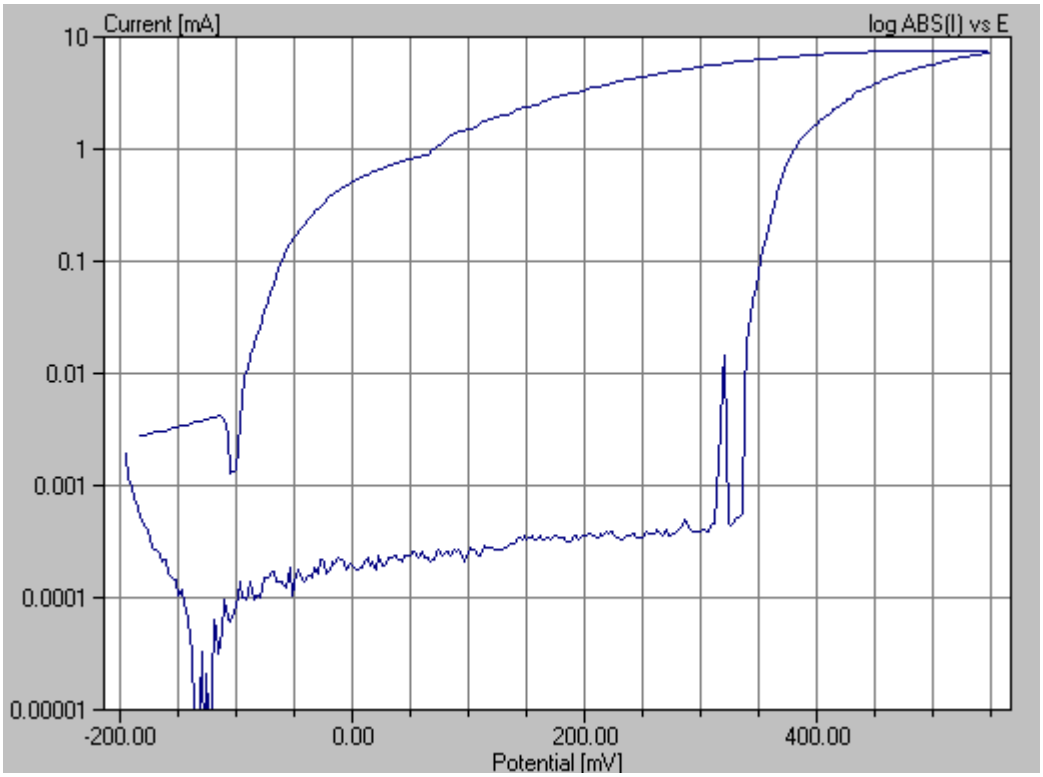
Layout



The menu colours allows to select colours for different elements of plots. These selections are saved for use at next start. Further you can change the grid style (none, dots, dashed, or solid), the font and the line width of the plot.

Edit

The Edit – button allows you to copy any type of plot to the clipboard in order to insert it in any other Windows – programme.

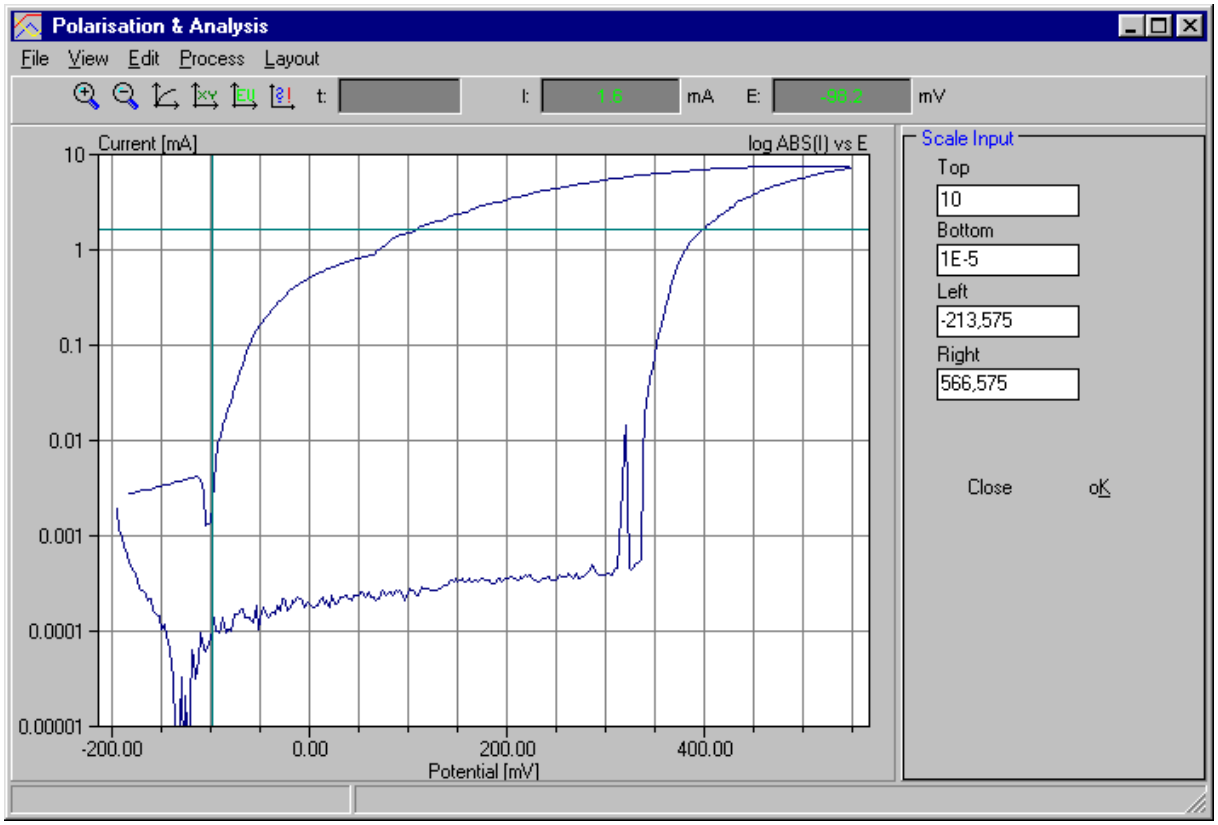


This is just a plot copied from the M Lab - clipboard

To get access to other plot actions, do a right - click of your mouse into the plot area. A menu opens allowing different methods for zooming and panning.

Note: If you want to return to the full – scale plot after zooming, just right – click the mouse in the graph, and click to Scale | Auto – Scale.

Note that the "crosshair" cursor is not fixed to the curve: It can be moved freely within the plot area, and the I and E – values are shown for the actual position as well.



Data Processing

Data processing includes filtering and smoothing, in addition re-scaling of potential data to other reference electrodes and last not least Tafel line calculation.

Smoothing

Smoothing is done by calculation of the average of a sub - set of data points, running along the curve.

Smoothing is the best adapted method to remove noise or periodical signals like power line hum.

Filter

For removal of single spikes please use the filter process.

The filter applied here is a so - called "median" filter, calculating the median (or middlemost point) of each sub - set of data.

This filter process is best adapted to remove single spikes from your curve, which may arise from switching spikes in the power line, or similar singular actions.

New Reference

The "New Reference" process allows to rescale the potential axis from the used reference electrode base to another reference electrode, e.g. to NHE standard.

You can save the re - scaled data using the "save as" option in the file menu.

Tafel Line Calculations

The original "Tafel" line is the slope of the current – potential curve where hydrogen is evolved. It follows the law

$$i = i^\circ * \exp(\alpha * F * \Delta E / RT)$$

as long as the electron transfer is the rate determining step of the reaction.

The terms in the formula are:
i° is the exchange current density, α the transfer number, n the number of electrons per transfer step, ΔE is the distance from equilibrium potential, R is the gas constant, and T the temperature in °K.

The term "Tafel line" has since extended to all reactions showing similar behaviour.

Prior to Tafel line calculation, the data should be filtered or smoothed in order to ensure a single zero crossing (unfiltered data might expose more than one zero crossing due to noise)

Note: Tafel lines are calculated as linear fits on parts of the logarithmically scaled curve. You are expected to switch the graph to semi - log prior to starting the Tafel calculation procedure.

The method of Tafel line calculation is as follows:

The inner limits next to the zero crossing is done automatically, while the outer limits are set manually by moving a cursor along the curve. We choose to use this method because fully - automated Tafel calculation fails when the curve does not expose very fine and long Tafel regions.

By clicking to "Tafel line", the inner limitation of the Tafel region (the closest possible point next to the **first** zero crossing) is calculated from the zero crossings.

It is not possible to move the start points beyond the calculated start point in direction to the zero crossing, because in that case you would get necessarily wrong results. However, you may move it further away from the zero crossing, if that is opportune.

Click to "Tafel line 1", or "Tafel line 2", respectively. The limit points for the line calculation now can be moved manually using the arrow (or cursor) keys on your keyboard. Left arrow moves the point to left and right cursor moves to the right. To speed up the cursor movement, hold the Ctrl key depressed.

The Tafel slopes are calculated by a linear fit procedure.

The results of the Tafel line calculation is shown while you move the limiting points along the curve. Intercept I gives the calculated exchange current (or corrosion current), below the Tafel slopes are shown.

You might want to calculate "Tafel" slopes in other parts of the curve, wherever it seems suitable. In that case, start the Tafel line calculation as usual, but move the start point to the desired point where the curve starts to show again "Tafel" behaviour, and then move the outer limit accordingly using the arrow keys.

Note: Tafel regions positive to the zero crossing can only be reached by moving the right start point, and vice versa.

Invert

When using data from old records, it may happen that the current data appear with inverted sign. To correct that, click to invert in the Process menu.

Hardware Handling

Connecting the Cell

Use the original cell cable for best results. If possible, do not use any longer cables. If you want to make a cable by yourselves, follow the notation given below. The cell connector is an "XLR" – type 3 – pole male plug, available in shops selling professional audio electronics.

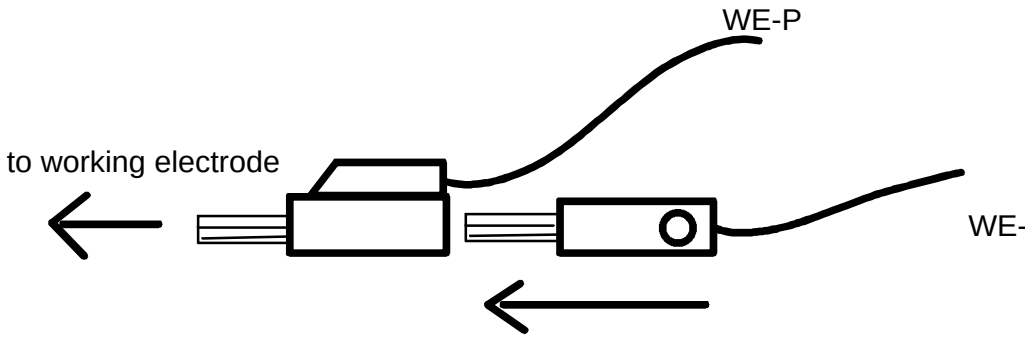
Colour Markings:

Electrode	Banana plug colour	XLR Pin No.
Working el.(current)	black	1
Working el.(potential)	black	3
Counter el.	yellow	2
Common ground	light grey	cell plug socket's screen

Reference electrode cable

Reference screen		BNC - shield
Reference el.	green	BNC - core

Connect the banana plugs to the electrodes of the cell. Make sure that both black bananas are connected to the working electrode. The black potential line should be as near to the electrode itself as possible.



Connect the two black banana plugs in this manner:

insert the WE-C banana plug into the back hole of the WE-P banana plug

One black line is connected to WE-C, the current carrying line to the working electrode. The other black line is the potential - sensing line WE-P. Both must be connected to one another as near to the working electrode as possible. Although the working electrode is kept on virtual ground (it shows 0 V when measured against ground), it is NOT connected to ground. If you connect the WE to ground, the potentiostat itself will work, but the current measurement is cut off.

Do not interchange the cables of different cells or channels. This will unavoidably produce malfunction of both channels.

Never connect the shield of a reference electrode to ground. This shield is an active guard, kept on ref. Electrode potential. The grey banana plug at the cell cable is the connector used to make ground connections e.g. to metal parts in the vicinity of the cell.

Some Rules for Wiring and Shielding

Something you don't learn at any school is to make correct ground connections. Where 1 V is a very low voltage, and 1 mA is a small current, there are no big problems about ground lines. Electrochemical measurements deal with millivolts and microamperes (or much smaller currents), and with amplifiers having extreme high amplification (about 1 million or much more), so you are bound to follow some strict rules. Many people think that their noise problems arise from bad shielding. That may occur, but in most cases the noise comes from elsewhere.

Rule 1: Never form spider - webs of current lines! Instead of, connect them star - like: One single point shall be the ground - star - point.

Rule 2: (is a consequence of rule 1) Never form a loop by connecting ground wires!

Rule 3: Use a Faraday's cage shielding your cell, if either

- very low currents shall be measured
- the electrolyte is badly conductive
- the reference electrode system has high impedance

Shielding of the cell is **absolutely necessary when measuring very low currents** or when using high - impedance reference electrodes. It is important to locate the cell away from power control panels and power cables. Electrical equipment producing powerful magnetic stray fields, such as magnetic stabilisers or regulating transformers should never be placed near the cell. Iron parts adjacent to the cell may have the effect of concentrating magnetic stray fields within the laboratory on to the cell. Screening the cell against electric fields is relatively simple; hum induced by magnetic fields can in practice be avoided only by correct location of the equipment. When using high - impedance reference electrodes (appreciably above 10 kΩ) it is important to screen the cell. A bent sheet of aluminium, left open at the front, is usually quite sufficient. This sheet is then grounded to the grey plug on the cell cable together with the supporting stand.

Rule 4: Do not use the reference electrode cable shield for grounding the Faraday's cage! (that is the reason why the reference cable shield is clipped). This shield lies on virtual ground only. A connection of this shield to the earth ground might produce rare results!

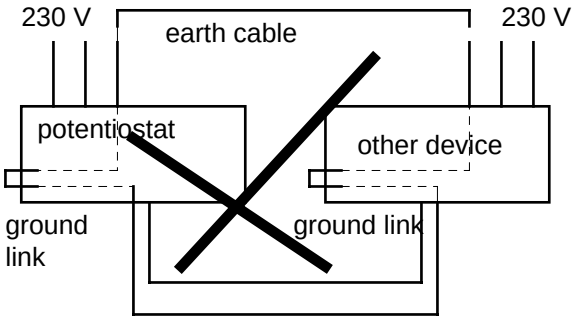
The reference electrode is kept at virtual ground. Do not try to connect it to its shield or the ground plugs of the potentiostat, otherwise the potentiostat will not operate!

Rule 5: If a computer is interfaced to the potentiostat, please let it have a distance of at least 1 meter to the potentiostat, the cell and the other analogue instrumentation and cables. Especially its monitor (the screen) may cause RF radiation.

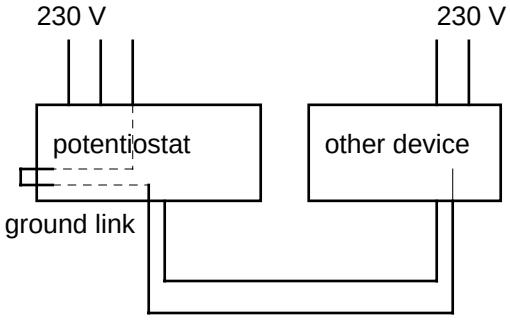
Rule 6: Avoid power cables in parallel to the cell cable or any other cable feeding control voltages into the potentiostat. (Power cables near the analogue output lines also induce some noise, but this noise acts on a rather low - resistive line and - moreover - it will never pass the cell, so it may be regarded as less harmful)

Rule 7: Avoid power cables in vicinity of the cell.

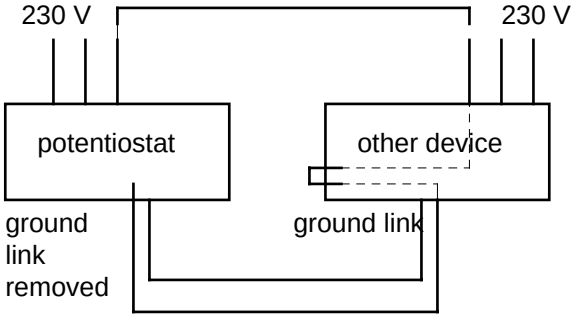
Rule 8: Any metal parts in the neighbourhood of the cell which are not already grounded should be grounded to the potentiostat. Any metal stand in particular should be grounded through the grey earth plug of the cell cable, taking care to ensure a reliable electrical contact. (Here, the formation of ground loops is very easy: be careful!)



Bad circuit: an earth ring is produced along the dashed line



Good circuit:
other device has plastic housing



Good circuit: one ground link is removed, earth connected to other device

Who informs you about which instrument is grounded internally and which is not?
There are several hints. Instruments which have isolated "Low" inputs and separate protection earth sockets usually allow a separation between protection earth (PE) and GND. On the other hand, many oscilloscopes have, for reasons of shock prevention, always GND internally connected to PE. The same applies to A/D - D/A - boards mounted in personal computers: In computers, also PE is connected to their internal ground. A/D - D/A converter boards have to use this ground, so it is connected to measurement ground (GND). However, the analogue

inputs of these boards usually can be switched to "differential input" to avoid such grounding problems. More problems arise when the D/A outputs are connected to two different instruments. In that case it may be necessary to use the computer's ground as star point (alas, it is not the best one) and disconnect PE from GND at all other instruments.

On all our instruments made by Bank Elektronik you will find a removable ground bridge. So you are free to decide where the ground - to earth connection shall be established.

Further reading for people who try to do their best in measuring small signals in noisy environments:
Keithley Instruments, "*Low Level Measurements*"

Make sure that no ring earth is produced. Ground all metal parts in the vicinity of the cell, but do it "star" –like, connecting all objects to one single star – point, from there to common ground (e.g. the grey banana plug of one of the cell cables).

If the potentiostat has to be disconnected from ground, pull out the ground bridge at the rear panel.

If a computer is interfaced to the potentiostat, please let it have a distance of at least 1 meter to the potentiostat, the cell and the other analogue instrumentation and cables. The screen (If cathode ray tube) usually produces pretty high noise to disturb your measurement. Keep it as far as possible from the potentiostat.

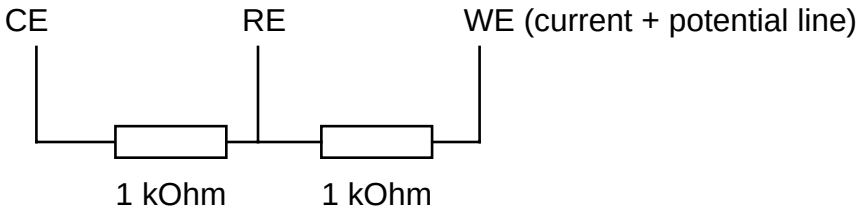
Avoid line cables in parallel and in vicinity of the cell cable or any other cable feeding control voltages into the potentiostat.

IF SOMETHING GOES WRONG: TROUBLESHOOTING

These rules may be familiar to you, but recall them when things go wrong:

Usually, a potentiostat is not defect. The common error sources are gas bubbles within the Haber-Luggin-capillary, the salt-bridge, or general bad cables connecting the potentiostat to the cell.

To check this, plug in a dummy cell into the potentiostat and check its performance.



Turn the control voltage to 1 V, set the current range to 1 mA.
Turn the Operating Selector to position "I".

The meter shall show full scale deflection. Turning the potential to lower values, the meter shall follow the setting.

If this works, but the cell does not work, replace the reference electrode by a copper wire dipping directly into the cell (without Haber-Luggin-capillary and other bridges). You should be able to control the potential when setting the Operating Selector to "I" - what-ever the potential meter means now. If not, the bug lies within the cell cable. Check the connections according to the list given above, bending the cables violently during testing to find possibly broken lines (2 persons may be necessary to perform this test).

If the cables are in good order, but the dummy cell test does not work, consider the potentiostat to be wrong.

Change to another current range and repeat the testing. If things are working properly (keep in mind the dummy cell will show other values depended of the set current range), a range resistor may have burnt out in the range tried previously.

If all these tests show bad results, take into consideration that the potentiostat might be wrong.

At this point we recommend to ring up to:

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Phone (+49)-6403-609860 Fax -6098622 E-mail info@bank-ic.de
INTELLIGENT CONTROLS