Model 2325 Bipotentiostat

Instruction manual

BAS

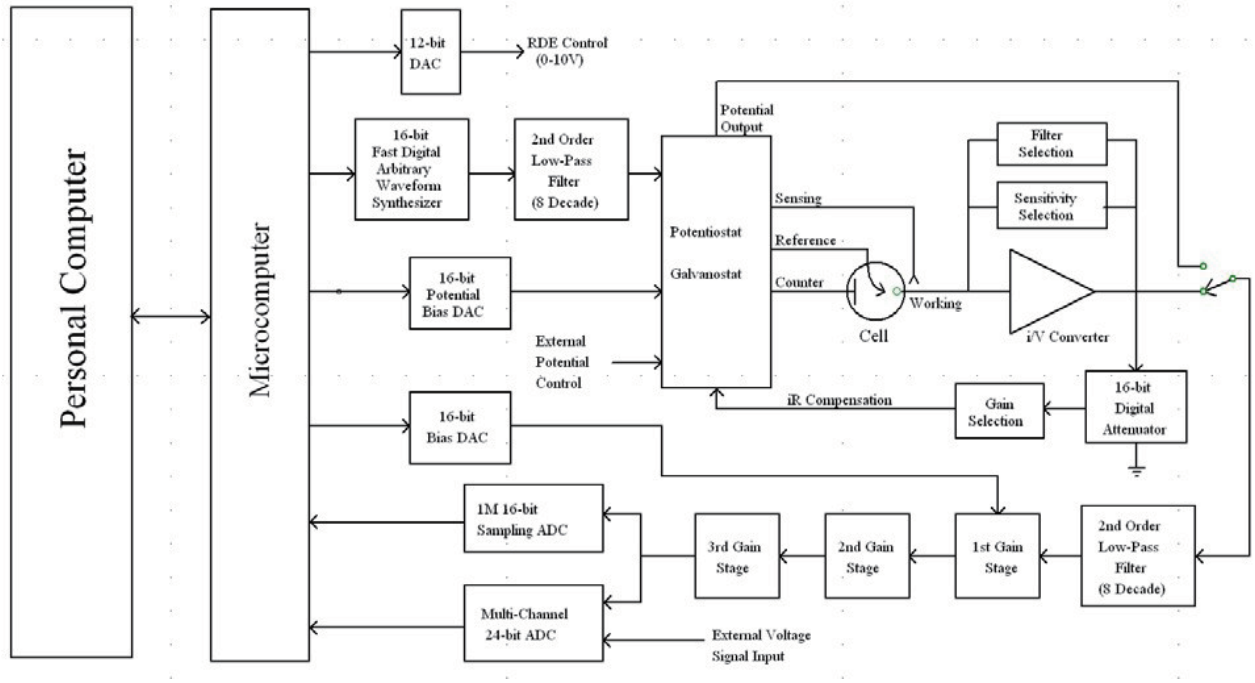
Menu

1. Overview

Model 2325 is developed to be portable, low-noise, and fast-speed both in signal generation and detection. It is achieved through the careful selection of advanced analog and digital microchips, which combine with an optimized signal pass design.

The computer interface is designed to be user–friendly, and is suitable for various applications.

Applied potential range is +/-4V, current range is +/-50mA, and compliance voltage is +/-10V. Its current senstivity



goes down nano Amp level. Therefore electrochemical measurement is done using 10um microelectrode.

Model 2325 integrates two channels into one compact design. Each channel has a low-noise analog current to voltage pre-amplifier with seven selectable gain stages, a variable analog filter, and a 16-bit bias DAC. A high impedance voltage amplifier is used for reference electrode signal condition, and a 16-bit, 200 kHz ADC is used for data acquisition.

The instrument is controlled by an external PC under Windows environment. The user interface follows Windows application design guide. If you are familiar with Windows application, you can use the software even without operation manual or help. most chemists are familiar with the commands, parameters, and options . The tool bar allows quick access to the most commonly used commands. The instrument provides many powerful functions, such as file handling, experimental control, graphics, data analyses, and digital simulation. Some of the unique features include macro command, working electrode conditioning, color, legend and font selection, visual baseline correction, signal averaging, Fourier spectrum, and equations relating to electrochemical techniques.

Model 2300 can perform many measurement tasks, such as rotating ring disk electrode (RRDE) experiments, subpicoampere current measurement, sensor conditioning, and data acquisition

2. General Information

User updates

After receiving any updated information about product, the valuable information related to current and other ALS products, please register your e-mail address at our local distributors. We would like to know about your present status and interests regarding electrochemical analysis.

Technical changes

We do reserve the right to make technical changes to improve the instrument without notice.

Damaged shipment

Breakage of any part of this instrument during shipping should be reported immediately to the freight handler and ALS Customer service.
It is necessary to keep the original packing box and contents for inspection by the freight forwarder. ALS will replace any new instrument damaged in shipping with an identical product as expediently as possible after the claim filing date. Claims not filed within 7 days after shipping may be invalid.

Do not return damaged goods to ALS. Please contact with your local distributor informing them of its damaged status.
They will contact with our service department.

Product warranty

ALS Co., Ltd warrants equipment manufactured by the company to be free from defects in material and workmanship for a period of 90 days from the date of shipment. This assumes normal usage under commonly accepted operating parameters. ALS agrees to either repair or replace, at its sole option and free of part charges to the buyer, any parts of such instrumentation which, under proper and normal conditions of use, prove to be defective within 90 days from date of shipment. Electrochemical cells and working electrodes are warranted for 30 days.

ALS neither assumes nor authorizes any person to assume for it any other liability in connection with the sale, installation, service, or use of its instrumentation.

All products manufactured by ALS are tested and inspected prior to shipment. Upon prompt notification by the buyer, ALS will correct any defects in warranted equipment of its manufacture either (by our option) by return of the item to our factory, or shipment of a repaired or replacement part. ALS will not be obliged, however, to replace or repair any piece of equipment which has been abused, improperly installed, altered, damaged or repaired by others. Defects in equipment do not include decomposition, wear, or damage by chemical action or corrosion.

This instrument is manufactured, either wholly or in part, for research purposes only. Use in medical diagnosis is not intended, implied or recommend

ed by the manufacturer. Use for this purpose and accountability for the same rests entirely with the user.

Limited obligations covered by this warranty include:
In the case of instruments not of ALS manufacture, the original manufacturers warranty applies.
Shipping charges under warranty are covered only in one direction. The buyer is responsible for shipping charges to the factory, if return of the part is required.
Expendable items including disposable items such as working electrode, reference electrodes, source lights, panel lights, fuses, etc. are excluded from the warranty

Service information

ALS provides a skilled service staff to solve your equipment oriented problems. For further details, please contact by e-mail (service@bas.co.jp). Following discussion of your specific difficulties, an appropriate course of action will be described and the problem resolved accordingly.
Please contact with local distributor and describe to them the problem you are having in full detail. They obtain a RETURN AUTHORIZATION NUMBER (RA#). The RA# identifies you as the sender. All correspondence and shipments should be sent to ALS.

3 Installation

INSPECTION OF SHIPMENT

After unpacking the instrument carefully, check the package contents and inspect for breakage. Table 1 lists the parts of the Model 2325 bipotentiostat. This list is subject to change. Please refer to the packing slip with your instrument. Assembly of these various parts will be outlined in the following chapters.

Please retain the shipping box and packing material until you have fully tested the unit to be certain that no damage was incurred during shipping.

If a shortage exists, please contact with local distributor or ALS Customer Service and describe the shortage. A replacement part will be sent immediately subject to stock availability.

Accessory list

After you receive Model 2325 appratus, please confirm whether the following items are avaible. If we do not find out one of accessories, please contact with distributor or local dealer in one week from Model 2325 arrival date. Otherwise you do not have full support.

Cat No	Description	Qty
012269	Model 2325 Bipotentiostat	1
012570	AC Adapter	1
012562	Cell leads	1
012074	Remote cable	1
	Ground cable	1
	USB cable	1
	Model 2325 control software	1

4. Quick Start

(1) Model 2325 software works under Windows XP/Vista/7. (Minimum system requirements: Windows 7/Vista/XP, iCore3, 4GB RAM, and 1024x768 screen resolution).

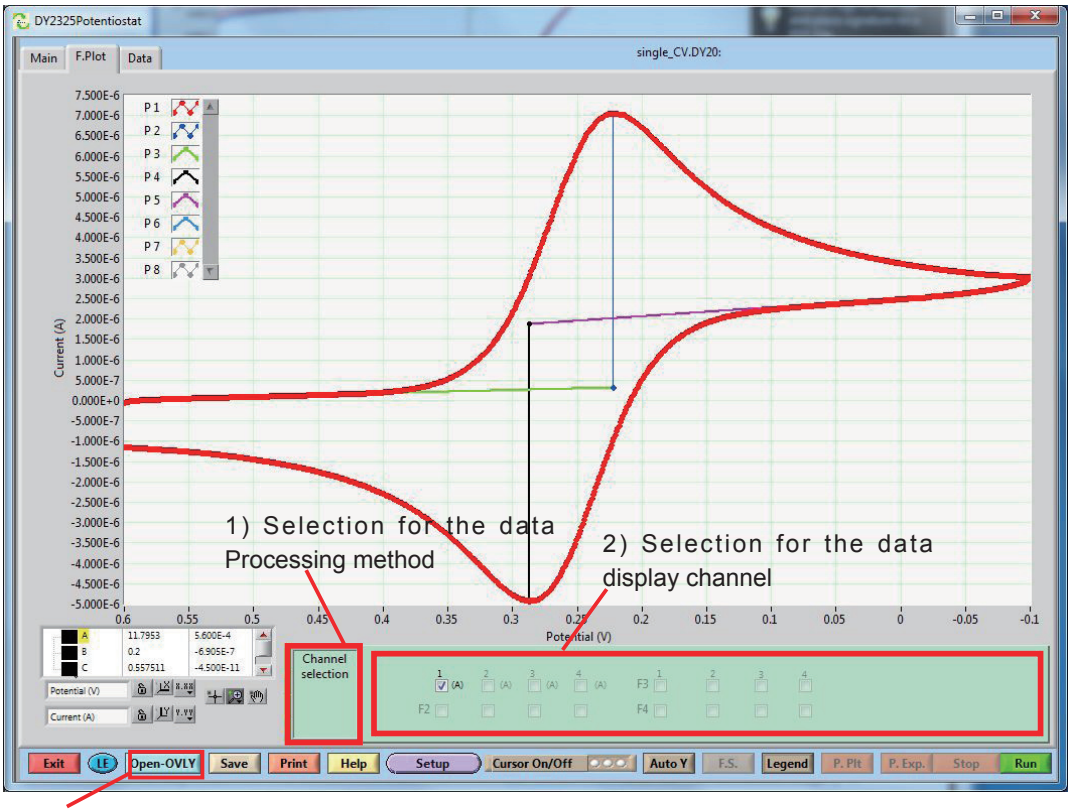
- After installing software into PC, all running software is terminated.
- Double click the file CP210x_VCP_Win_XP_S2K3_Vista_7_v6.5.exe
- PC has already connected with Model 2325 with USB cable, and Model 2325 turns on.
- Open the device manager, and then Ports (COM & LPT) is clicked. "CP210x USB to UART Bridge Controller (COMx)" [x com port #] appears. USB driver installation is successful.
- The instrument is ready to run if both blue and green LEDs on the front panel are on, and then 2325 control program is run.

(2) Main WIndow

The command on the bottom window refers to the following table.

#	Function	#	Function
(1)	Selection of electrochemical technique	(8.2)	Auto Y
(2)	Input experimental parameter	(8.3)	Print
(3)	Note	(9.1)	Legend (ON/OFF)
(4)	CH ON/OFF	(9.2)	Line style
(5)	Run	(10.1)	Cursor ON/OFF
(6)	Switch window	(10.2)	Display cursor postion
(7)	Setup Window	(10.3)	Cursor slect or move
(8.1)	FS (full scale plot)		

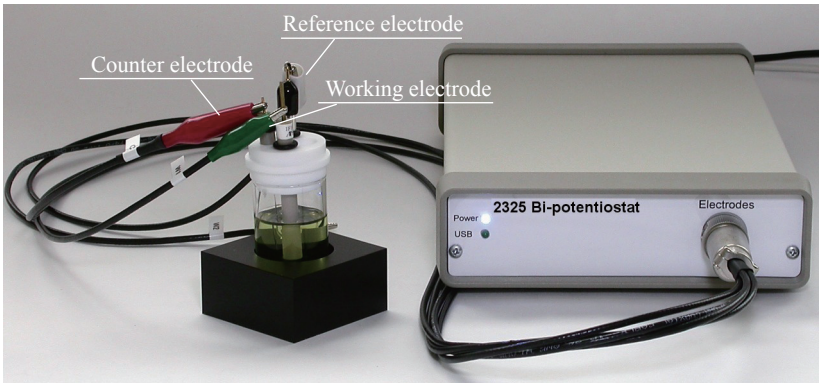
(3) F. Plot Window.



Cell leads connection

Cell cable female connector is located at right side on the front panel. Each cell leads has alligator clip, and it is easy to connect with each electrodes. The alligator clip has color code, and its specification is followed:

Green	Working electrode
White	Reference electrode
Red	Counter electrode
Yellow	2nd working electrode



Cell leads connection

Power ON

PC has already connected with Model 2325 with USB cable, and Model 2325 turns on. The instrument is ready to run if both blue and green LEDs on the front panel are on, and then 2325 control program is run.

(4) Power turn On

Model 2325 consists of
1. AC adapter
2. Cell leads, groud cable and remote cable.
3. Instruction manual
4. Model 2325
5. If you need accessories such as electrochemical cell, working electrode and reference.

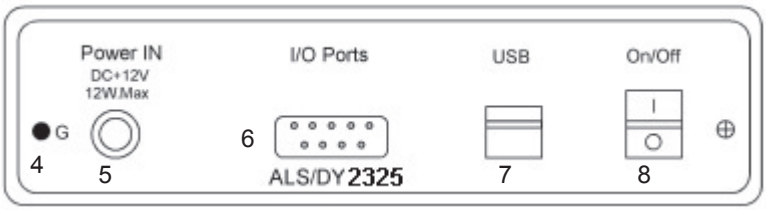
The Model 2325 can be operated by 100V to 230V (50-60 Hz) power supply. Power switching regulator is used, and then it can be used in any place without any modification. AC adapter socket is plugged directly into the power input on the rear panel (See Figure 2). After making this connection, make certain the power on/off switch is in the certain position. Make sure that all components of the system share the same ground circuit. This can best be best accomplished by plugging all components into a multi-outlet power strip. Plugging the components into independent outlets can produce ground loops, which can produce baseline noise.

After Power is ON, LED indicator on the front panel is lighting .

Front panel

1. LED for power switch
2. LED for USB
3. Cell cable connector

Rear panel



4. Ground terminal
5. Power cable socket
6. Optional terminal
7. USB terminal
8. Power switch

System requirements

Operating system:	WindowsXP/Vista/7
CPU:	iCore3
RAM:	4 GB byte
Monitor:	VGA
Mouse:	USB
Communication port:	USB 2
Output device:	any printer or plotter supported by Windows

Precautions

1. The unit described in this manual is designed to be operated by trained personnel with some reasonable background knowledge of electrochemistry. Any adjustments, maintenance or repair must be carried out as defined by this manual (please refer to appendix sections) and by a person qualified and aware of the hazards involved.

2. The instrument should be placed in a position where the likelihood of the ingress of a chemical spill is kept to an absolute minimum. Efforts should also be made to avoid contact of the instrument with for instance corrosive vapours.

3. The electrochemical cell should not be placed on top of the unit due to the risk of leakage and the possibility of the cell contents entering the instrument.If chemicals do enter the unit then it should be switched off immediately and the nearest dealer/BAS, Inc contacted.
   Routine cleaning of the chassis of the instrument is not necessary. A spill ontothe outer casing that does not enter the instrument should be wiped off with a dry cloth making sure to wide away from any instrument connections. Likewise the PC used to operate the instrument should be protected from the possible exposure to chemicals.

4. Despite the customers best efforts corrosion of the electrode leads can occur. This condition is best diagnosed by running a CV from -1 V to +1 V on a 1 M Ohm resistor; sensitivity set at 1.e-6. An Ohmic plot through the origin should be obtained with maximum currents of +/-1 uA. Working contacts (green and black) are connected to one side of the resistor and counter (aux) and reference (red and white) to the other. Noticeable divergence from this behaviour may suggest faulty leads.

5. Erroneous data/behaviour in an actual electrochemical experiment may be due to factors such a faulty cell connections, poor reference electrode contact or poor condition of the working electrode. Reference and working electrodes are consumable items and are freely available from BAS, Inc or your local dealer

6. The cover of the unit should not be removed.

7. Reference should always be made to MSDS supplied with any chemicals used. Generally accepted laboratory procedures for the safe handling of chemicals should always be employed.

8. Evidence of any fault condition should immediately be reported to BAS, Inc or the local distributor. Faults with the hardware are usually diagnosed through the instruments, and please describe which kind of error on your PC is dispalyed on the memo.

9. As the instrument operates by a data coupling to a PC we recommend that sufficient space (at least 2 m of linear bench) is set aside in order to avoid cluttering the work area and to make easy access of the cell possible. There should be some free space around the vents and fan exhaust of the instrument for effective cooling.

10. Connection of the cell by the alligator clip connections should be made in such a way as to avoid shorting of the contacts.

(5) Start

(5.1) Install

1: Model 2325 software is developed by LabVIEW(1). It works under Windows XP/Vista/7.

2: Minimum system requirements: Windows 7/Vista/XP, iCore3, 4GB RAM, and 1024x768 screen resolution.

3: After installing software into PC, all running software is terminated. Virus scan software is still running on the background, may have interference with software installation.

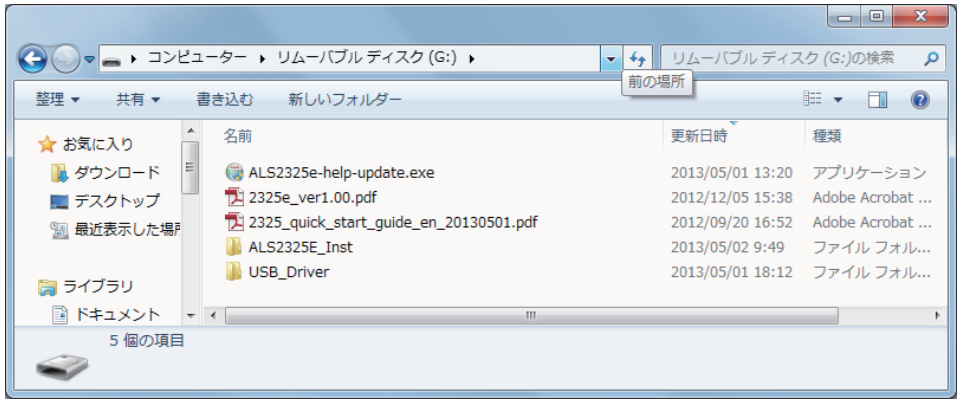
4: LabVIEW driver is not developed.

(5.2) USB memory

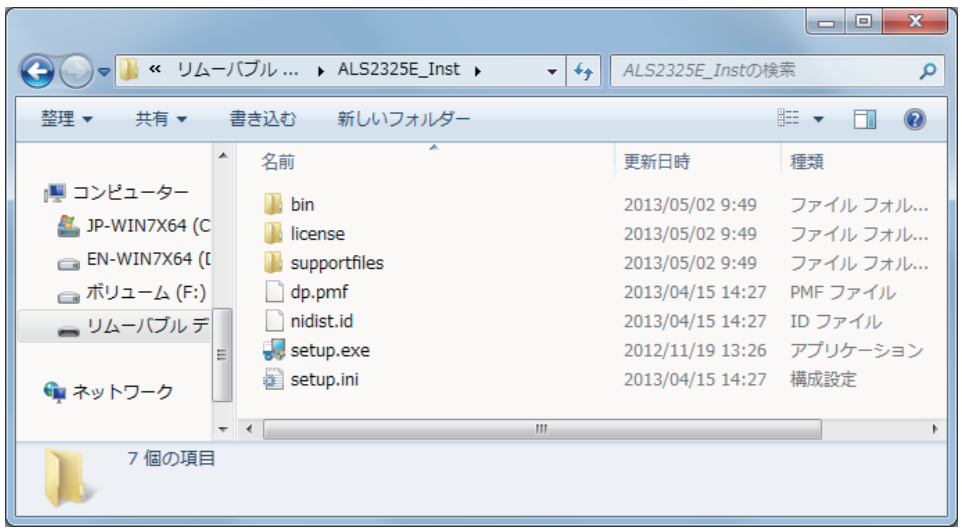
the attached USB memory is inserted into USB slot on PC.

(5.3) Install Model 2325 control software

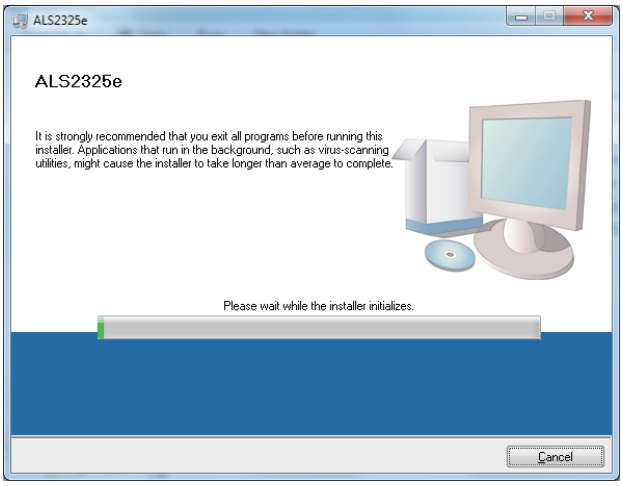
Please open "my computer", and Some of the files in USB memory are displayed. Double click ALS2325E_Inst folder.



and then setup.exe is displayed.

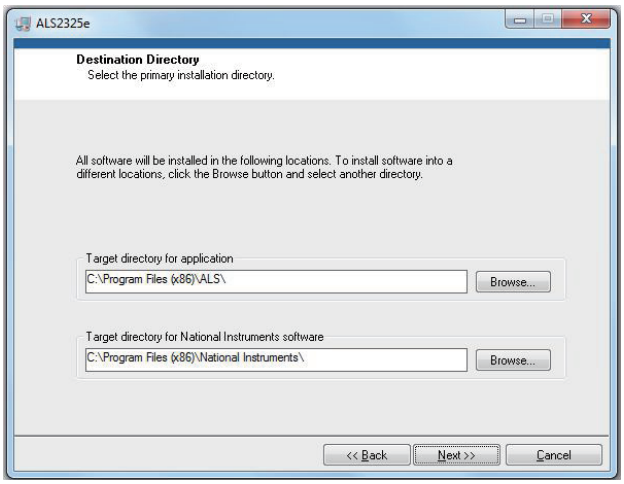


After double click setup.exe file, ALS 2325 program is started to be installed.

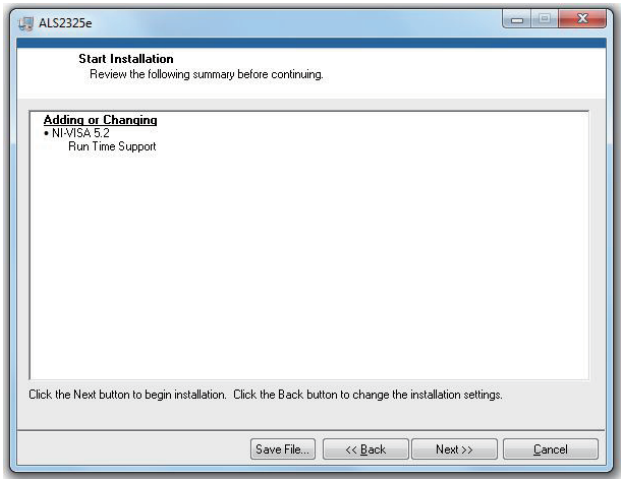


The above model 2325e display appears.

Installation is completed.

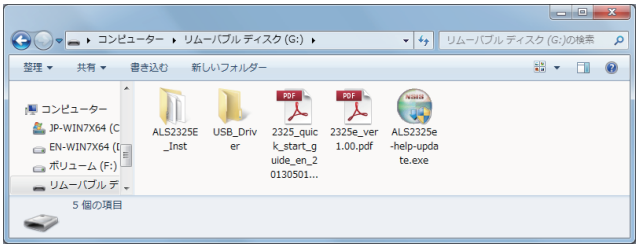


Click Next button, and installation is started.

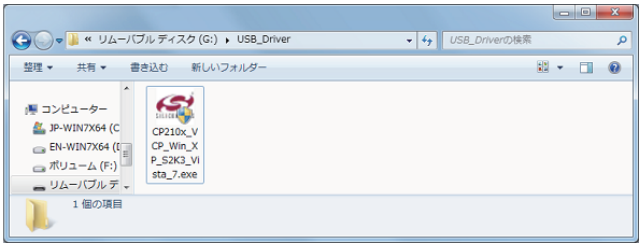


Accept above license agreement, and then click Next button. Software installation is started.

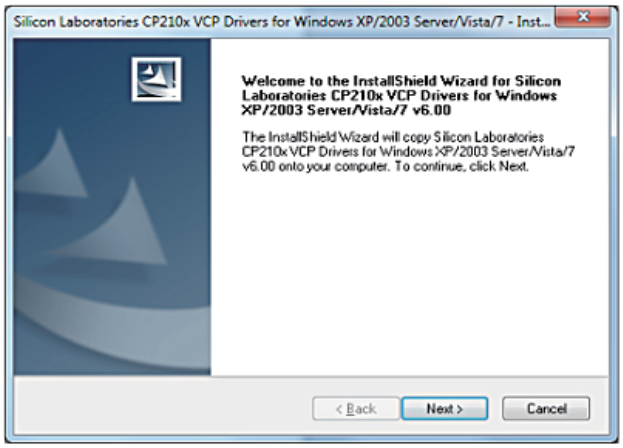
(5.4) Installation of USB driver



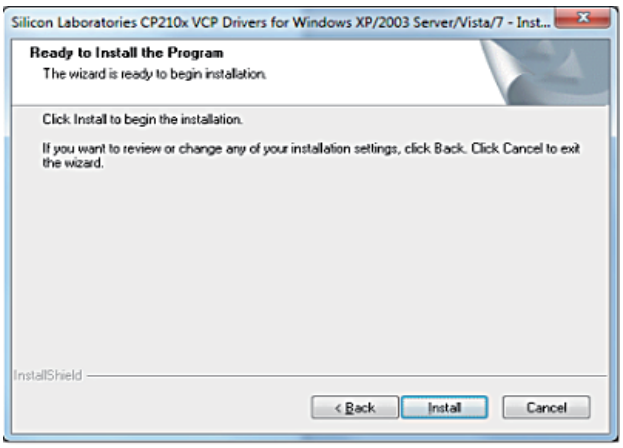
Please click USB_Driver folder and then CP210x_VCP_Win_XP_S2K3_Vista_7 is appeared.



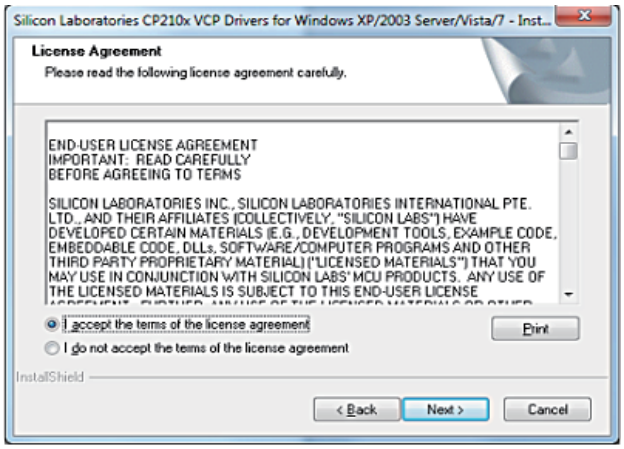
Double click the file CP210x_VCP_Win_XP_S2K3_Vista_7.exe, the following dialog box will appear. you will find a “SETUP.EXE” file. Double click this file , then the following dialog box will appear.



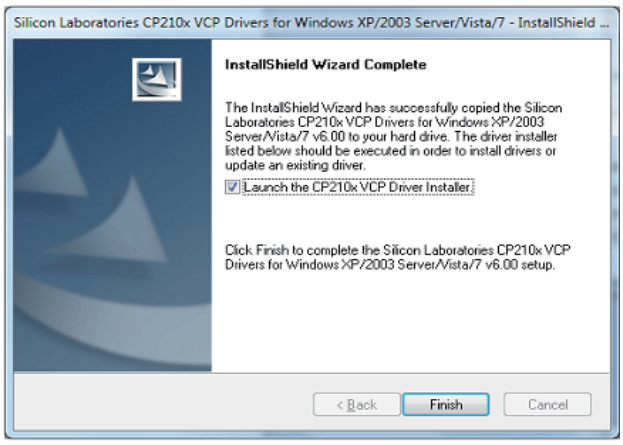
USB driver is started to be insalled. Click Next button, and then the insall is started.



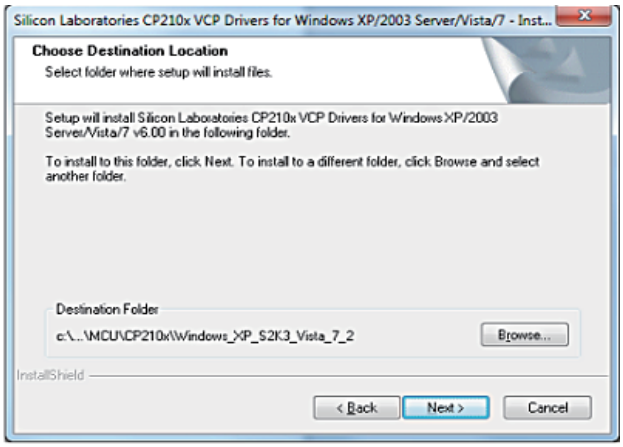
Click Install button, and then the program in the USB Driver is installed on the folder.



The above license term is appeared, and accept the license agreement. Click Next button.



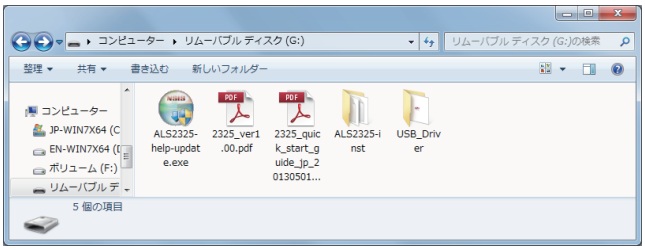
Click Finish button on the above display, and the USB driver installation is completed.



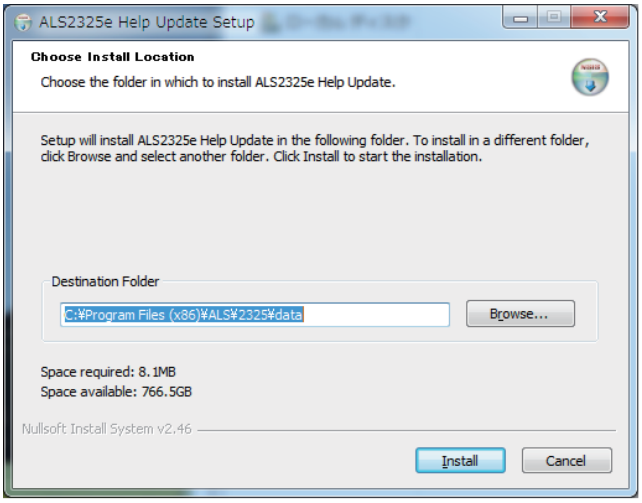
Please decide final direcotry of setup file or select default.

(5.5) Installation of Model 2325 help file

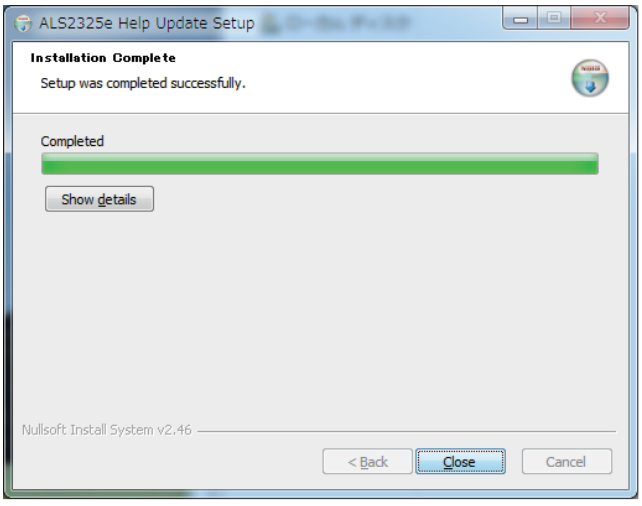
Please install help file based on the following step. Click the ALS2325-help-update.exe icon in below window



1. The model 2325 help installation window will be opened in below, and click Install button.



2. Click Close button in below window and completed.



5. Main Window

This window appears when you first open the program, and also during the experimental run. It will be used to input experimental control parameters and display the experimental data for the technique you select.

(1) Window selection tab is used to switch the working window among Main, Plot and Data. Main Window is used as measurement.

(2) Graph area is used to display recorded data for each individual channel. There are two methods to plot the data: Real time: The program will display real time experimental data. This method is used for ADC sampling rates less than or equal to 200 Hz. After run: For sampling rates higher than 200 Hz, the data will be first saved into the SRAM inside the instrument, and then be transmitted to the computer after finishing the experiment.

(3) Technique selection (Pull-down menu) is used to select the technique for the experiment.

(4) Parameter input panel is used to input user settings for the experiment. The set of available parameters changes based on which technique has been selected.

(5) Input a multi-line description of the experiment

(6) Channel on/off switch is used to turn the individual channels (except CH 1) on or off, by checking or un-checking the corresponding check box. When checked, that channel will be turned on (connected to the electrodes) during the experiment to take data, and turned off after finishing the experiment. If "Keep channel on" (in SETUP/SYSTEM) button is selected (Yes), all selected channels data will remain on after the end of the experiment.

The color of the channel number indicates the corresponding channel's states:

Red: Channel is on. Note: Do not touch the cell leads!

Green: Channel is off. You can change the electrodes.

WARNING: ESD (electrostatic discharge) as high as 4,000 V can accumulate on the human body and can cause permanent damage to the instrument. Therefore, proper ESD precautions are recommended before handling the cell leads.

Yellow: Channel is off. All channels are connected to their own internal dummy cell(1M ohm resistor), as a result of selecting "Test with internal dummy cell" in SETUP/SYSTEM.

(1) System command:

Start to run electrochemical measurement.

Stop data acquisition.

Pause data acquisition. Click again to continue data acquisition.

Pause the plotting of new data during experiment when in real-time mode, but the instrument will still acquire data. Click again to resume plotting data.

A plot legend tool appears on the upper-right corner of the graphics window, which can be used to change the plot styles (line color, line type, etc.) with right click on the legend symbol.

Displays data with full-scale range according to the sensitivity selected.

Auto-select the data display range.

Three push buttons which independently turn on/off cursors A, B, C.

Set more DY2300 controlling parameters that do not appear on the front control panel (see more details in the chapter of Set-up Windows of this manual).

You can find out your requested answer.

The printer output is identical to what is displayed on the screen.

Two text files can be saved simultaneously by using this command. The "filename. dy20" file stores both experimental data and instrument configuration parameters. The "filename.txt" file stores the experimental data only. Both files can be opened using spreadsheetprograms such as Excel. Note: Data file (filename.txt) will only be saved if you check Save data-only (*.txt) file in SETUP/General.

Use this command to read an existing data.

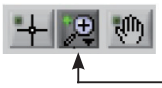
Load the Last Experiment's settings and data.

When you click Exit icon into main window, Save the instrument' s current settings, turn off cell connections, and then quit.

(2) Graphic Display and Cursor Styles Settings: These are used to change both graphic and cursor styles.

Expand graph:

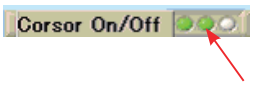
(a) Select graphic tool.



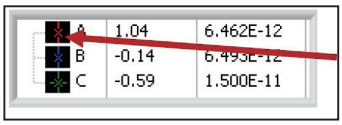
(b) Left click mouse to select the plot area, and then release the mouse button.

You can also type in the desired numbers to the both ends of X (Y) axis of the graphic display to change the plot area.

Cursor operation:



(a) Three cursors (A, B, & C) can be turned on/off individually by clicking on these three buttons.



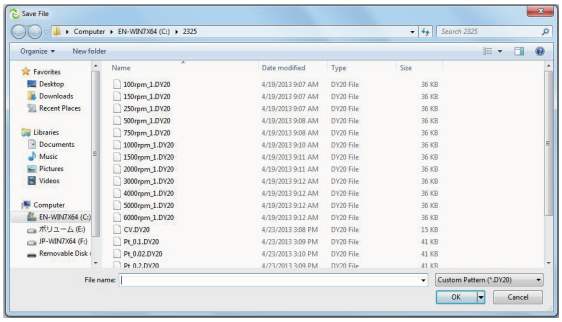
(b) After turning on the cursor, left click on the cursor property setting button (A, B, or C), and select "Bring to Center".

(c) Select the cursor tool, then use mouse to move cursor on the plot.

(d) These four buttons move the cursor left, right, up, and down.

File Format

Two text files will be saved simultaneously using the SAVE command. One is a "filename.dy20" file, a combination of experimental data and instrument configuration parameters. The other one is a "filename.txt" file, a data-only text file. Both files can be opened by other programs such as Excel.
If Save txt file is unchecked, only the "filename.dy20" file will be saved.



dy20 file

An example of stored data is shown. You can open it by note pad, and read it by Excel. It is easy for you to use it for another statics.

<< dy20 file >>

=== Cyclic Voltammetry ===
Init E(V): 0.600
High E(V): 0.600
Low E(V): -0.100
Scan Rate(V/sec):0.100
Number of Circles: 1.000

Sens1 (A/V): 1 e-5
Sens2 (A/V): Off
Diff. Scan2 (V): 0.0000

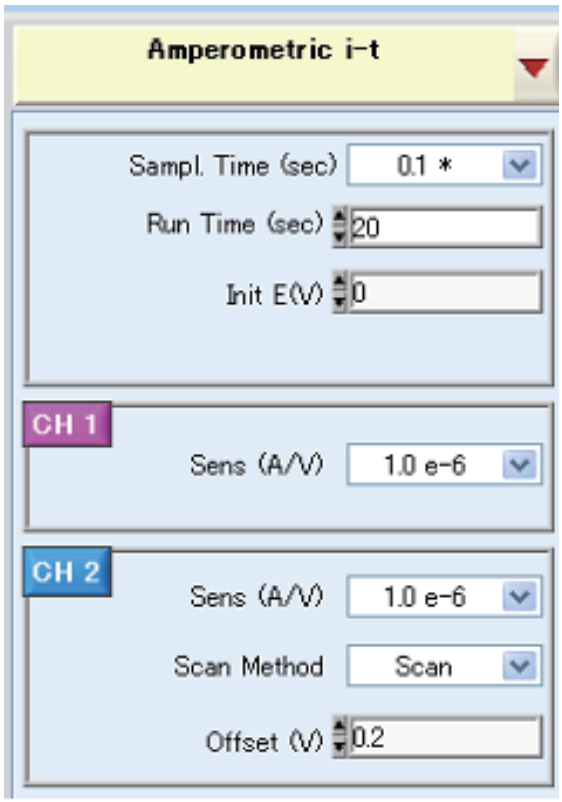
Data start from here:
Potential (V) i(A) ,CH1

6.000000E-1 -1.042080E-6
5.990000E-1 -9.007426E-7
5.980000E-1 -8.327476E-7
5.970000E-1 -7.838523E-7
5.960000E-1 -7.380130E-7
5.950000E-1 -7.028695E-7
5.940000E-1 -6.746020E-7
5.930000E-1 -6.409865E-7
5.920000E-1 -6.142469E-7
5.910000E-1 -5.913272E-7
5.900000E-1 -5.668796E-7
5.890000E-1 -5.454879E-7

5.1. Amperometric i-T (i-T)

For the Amperometric-iT (iT) measurement, the potential of the working electrode is maintained at a constant value with respect to the reference electrode. The measured current is displayed as function of time. his technique is used in the filed of current titration, amperometric sensor and flow cell. Its potential wave form is a fixed potential. Its typical current response is shown in Figs A and B. Channel 1 and 2 have independent applied potential, and please show in Fig. C.

Fig. 3.1 Amperometric i-T user interface and waveform



(A) User interface

B. CH 1 Potential waveform

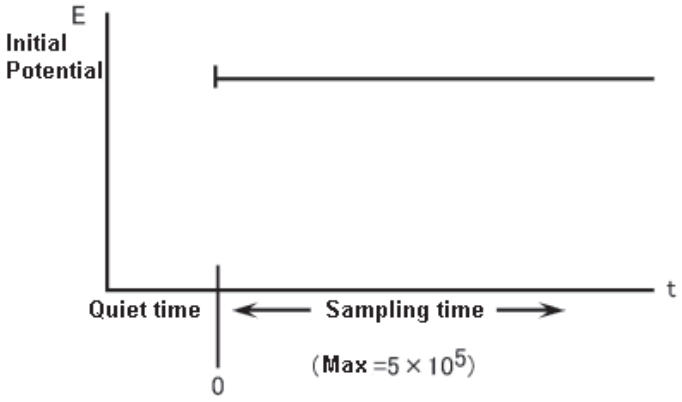
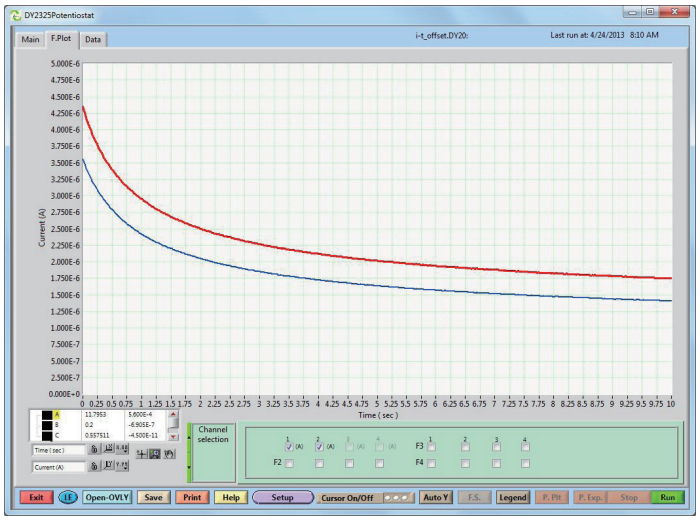
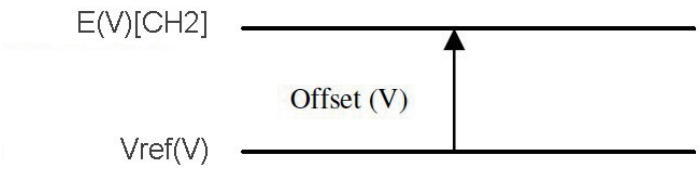


Fig. C.Typical current respons



(D) CH 2 Offset potential



Amperometric i-T Parameter

In Amperometric i-t Curve (i-t), a constant potential is applied and the current is recorded as the function of time.

- Sampling Time (sec): Sampling time range is from 0.0001 to 10 (sec). A "*" sign will appear on the Sampling Time if its value is larger than 0.02 sec. This sign means that the Sampling Time can be automatically adjusted to a multiple of the line frequency to improve the S/N ratio.
- Run Time (sec): Total data sampling time range is from 0 to 65,000 (sec). The number of data points for each channel = Run Time (sec) /Sampling Time (sec), with a maximum of 15000 data for each channel. If Run Time is set larger than 15000 * Sampling Time (sec), the program will automatically adjust this to the maximum allowed value.
- Init E (V): Initial potential on the CH1 working electrode (as well as during the Quiet time). Potential range is from -4.00 to +4.00 (V).
- G. Filter [Auto] Automatically select the cutoff frequency of a low-pass filter (Filter-B)for each data channel according to the Sampling Time.

CH 1:

Sens (A/V): Current measurement sensitivity scale (Ampere / Voltage) is selected from 1.0e-2 to 1.0e-8 (A/V).。

Filter: Automatic setting

CH 2:

Sens (A/V) : Current measurement sensitivity scale (Ampere / Voltage)is selected from 1.0e-2 to 1.0e-8 (A/V).。

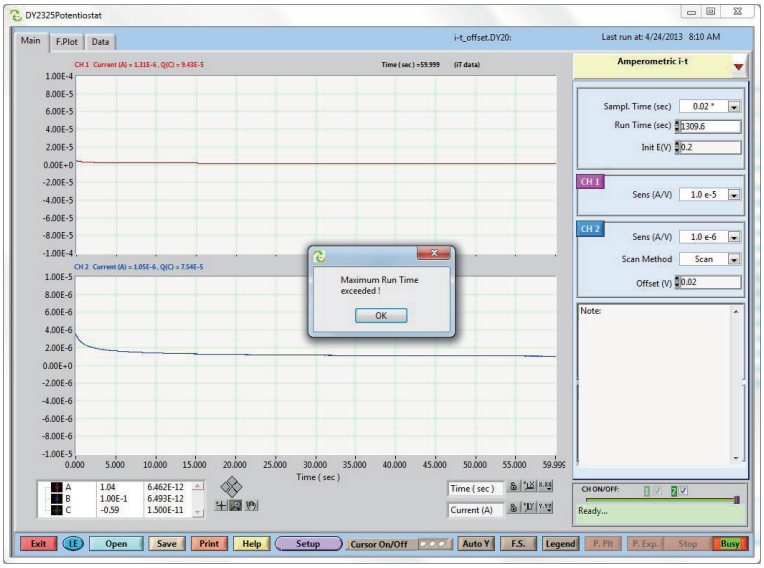
Offset (V) : The potential for each individual channel will equal CH 1' s potential plus Offset (V) (-4.00 to +4.00).

Filter: same as CH 1

Method: Scan Current measurement same as CH 1

Precaution:

When your inputted Run time is exceeded over Max data points, Run button is clicked and Maximum Run Time exceeded! as warning is displayed. Run time is corrected automatically.



5.2. Cyclic Voltammetry (CV)

In CV technique, when the final potential is reached, the scan direction is reversed and the same potential range is swept again in the opposite direction. Therefore, the product of the electrochemical reaction on the forward scan can be examined on the reverse scan.

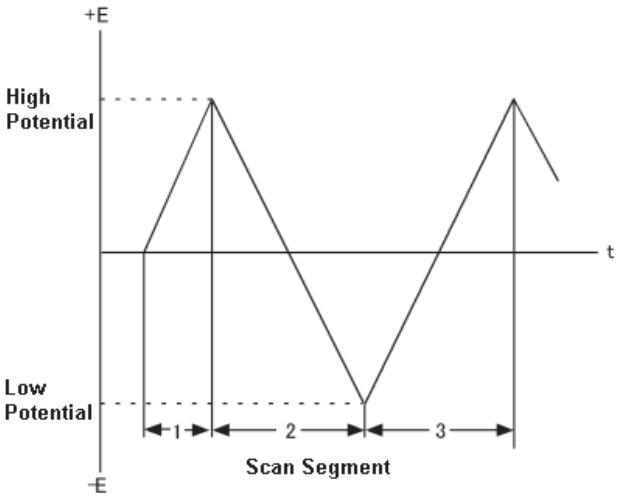
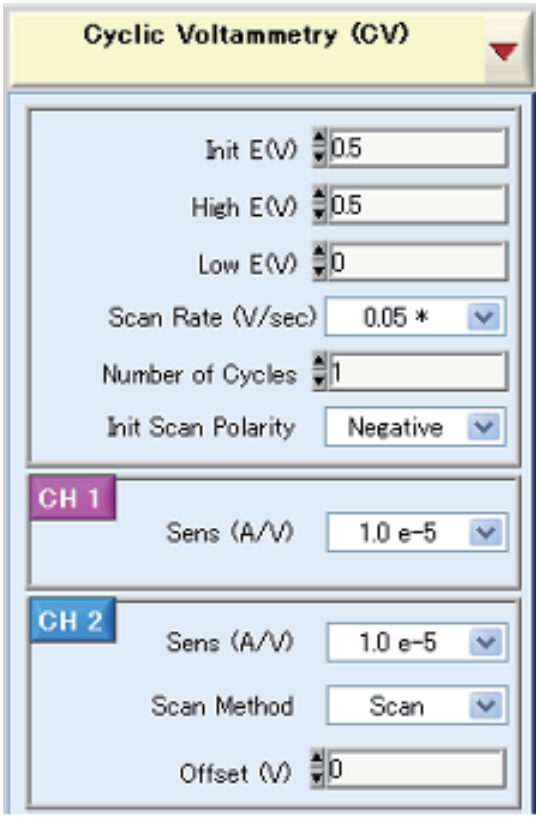


Fig A. CV potential waveform

In CV, the potential can be cycled over the same range many times. Three potential parameters are required; the initial potential (Initial E), and the two switching potentials (i.e., the potential at which the direction of the scan is reversed), High E and Low E. The potential wave form for CV is shown in Figure A.

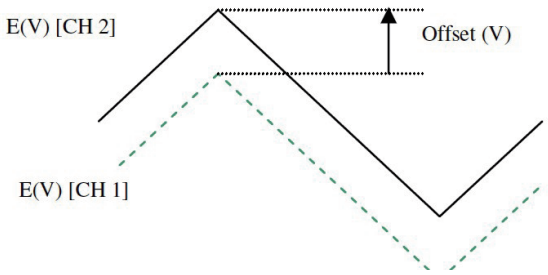
The simplest i-E curve for CV is shown in Figure A. The asymmetry of the curve is due to the diffusional mass transport. However, there are many other parameters that can affect the shape of this curve; for example, slow heterogeneous transfer kinetics, instability of the oxidized or reduced species, and adsorption. If the heterogeneous electron transfer is rapid (relative to the time scale of the experiment) and both the oxidized and reduced species are stable (again, on the time scale of the experiment), then the redox process is said to be electrochemically reversible. The standard redox potential is the mean of the two peak potentials (Epa and Epc), and the separation of the peak potentials is 57/n mV (n = number of electrons transferred per molecule).

Fig 3.2 CV user interface and waveform

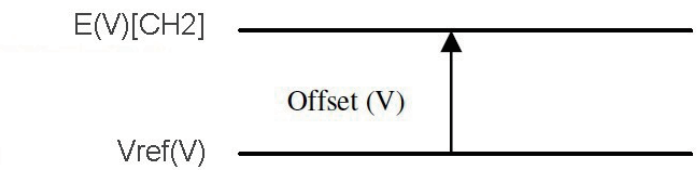


(A) User interface

(C) CH 2 wave form (differential scan)



(D) CH 2 wave form (constant potential)



(E) Typical CV respons

Cyclic Voltammetry Parameter

Init E (V): Initial potential on CH 1 working electrode (as well as during the Quiet Time) Initial potential range sets at from -4.00 to +4.00(V).

High E (V): Setting potential range from -4.00 to +4.00(V).

Low E (V): Setting potential range from -4.00 to +4.00(V).

Scan Rate (V/sec): Setting potential scan rate range from 0.001 to 10 (V/sec) A "*" sign will appear on the Scan Rate if its value is less than 0.1 V / sec. This sign means that the data sampling rate can be automatically adjusted to a multiple of the line frequency to improve the S/N ratio.

Data point: When scan rate is less than 0.1 V/s, Max data points has 15,000 for each channel,and data is real time display. When scan rate is over 0.1 V/s, data display is sometimes delayed.

Number of Cycles: Choose number of cycles from 1 to 255. This number is determined by High E and Low E. If the setting is larger than the maximum, the program will adjust it to the maximum allowed value.

G. Filter [Auto] : Automatically select the cutoff frequency of a low-pass filter (Filter-B)for each data channel according to the Sampling Time.

Initial Scan Polarity

\+ The potential will first scan from Init E to High E.

− The potential will first scan from Init E to Low E.

CH 1:

Sens (A/V) : Setting current range from 1.0e-2 to 1.0e-8 (A/V).

Filter: Automatic setting

CH 2:

Sens (A/V): Setting current range from 1.0e-2 to 1.0e-8 (A/V).

Filter: Same as CH 1

Method:

Scan: The individual channel's potential will equal CH 1's potential plus Offset (V).

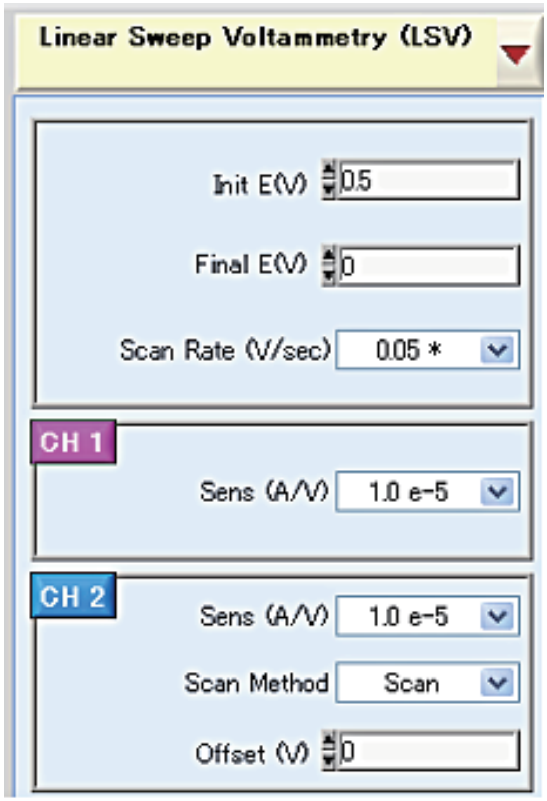
Const E: The individual channel's potential will be kept at a constant value equal to Offset(V) during the scan.

Offset: Adjust potential range from -4.00 to +4.00(V)

Scan: Setting at differential offset

Const E: Setting at constant E during scan run

5.3. Linear Sweep Voltammetry (LSV)



(A) User interface

In LSV, the potential is scanned linearly from an initial potential (Initial E) to a final potential (Final E) at a Scan Rate, and the current is measured as a function of the applied potential. The potential wave form for LSV is shown in Figure A. A offset potential for Channel 2 is added on Channel 1. Please shown in Fig B and Fig C, and D.

Fig. B. Potential wave form for LSV

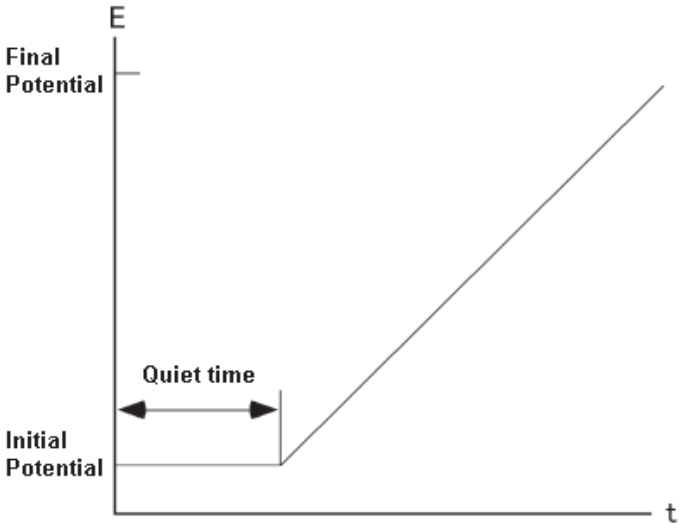


Fig. C CH 2 wave form (Differential scan)

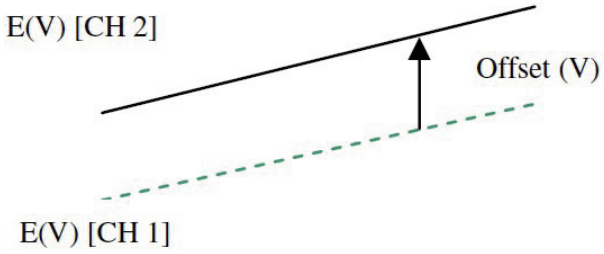
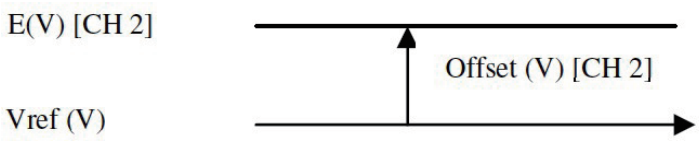
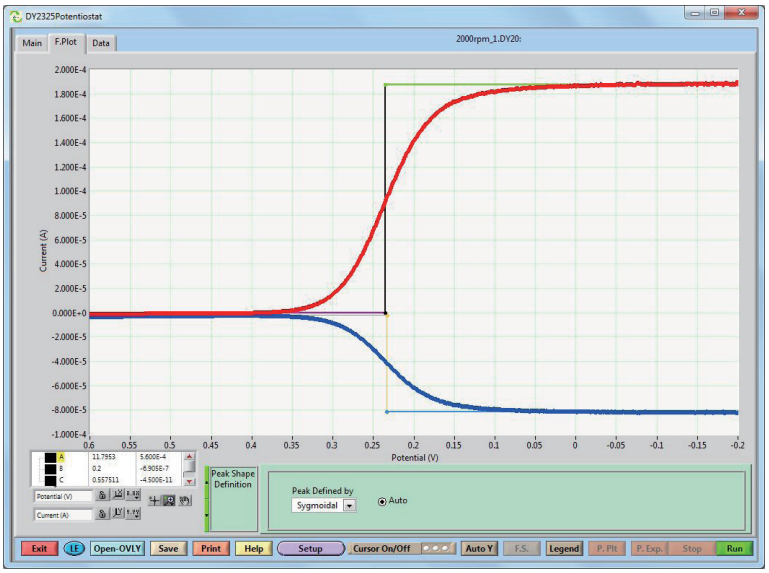


Fig. D CH 2 wave form (Constant E)



(E) Typical current-potential curve by LSV technique using RRDE-3A.



Linear Sweep Voltammetry Parameter.

Init E (V): Initial potential on CH 1 working electrode (as well as during the Quiet Time) Initial potential range sets at from -4.00 to +4.00(V).

Final E (V) : Setting final potential range from -4.00 to +4.00(V).

Scan Rate (V/sec) : Setting potential scan rate range from 0.001 to 10 (V/sec). A "*" sign will appear on the Scan Rate if its value is less than 0.05V / sec. This sign means that the data sampling rate can be automatically adjusted to a multiple of the line frequency to improve the S/N ratio.

Data point: When scan rate is less than 0.1 V/s, Max data points have 65,529 for each channel,and data is real time display. When scan rate is over 0.1 V/s, data display is sometimes delayed.

G. Filter [Auto]: Automatically select the cutoff frequency of a low-pass filter (Filter-B) for each data channel according to the Sampling Time.

CH 1:

Sens (A/V): Setting current range from 1.0e-2 to 1.0e-8 (A/V).

Filter: Automatic setting

CH 2:

Sens (A/V) : Setting current range from 1.0e-2 to 1.0e-8 (A/V).

Filter: Same as CH 1.

Method: Scan: The individual channel's potential will equal CH 1's potential plus Offset (V).

Const E: The individual channel's potential will be kept at a constant value equal to Offset (V) during the scan.

Offset : Adjust potential range from -4.00 to +4.00(V).

Scan: Setting at differential offset

Const E: Setting at constant E during scan run

5.4. Open Circuit Potential (OCP)

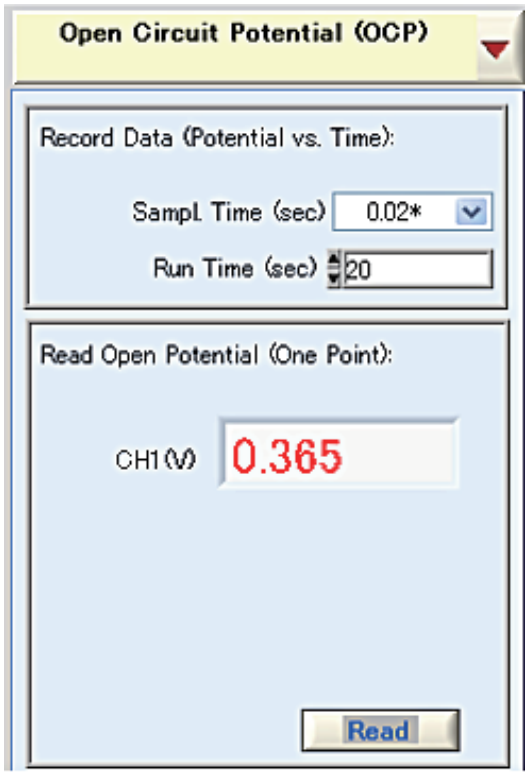
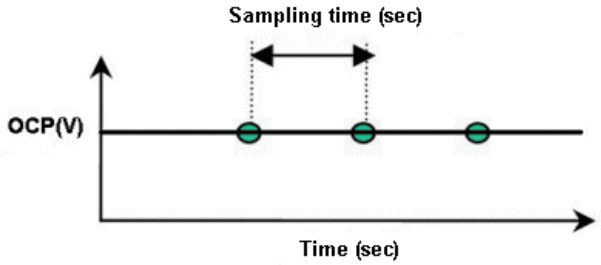


FIg. B OCP user interface

The OCP method measures the potential difference between the reference (RE) and working(WE1) electrodes with high input impedance.

For CH2, OCP measure the potential between the counter (CE) and working (WE2) electrode.

Fig .A OCP waveform.



There are two ways to measure OCP:

Record OCP vs. time. After selecting the desired Sampling Time (sec) from 0.0001 to 10 and total Run.

Time (sec), click the RUN button to start recording.

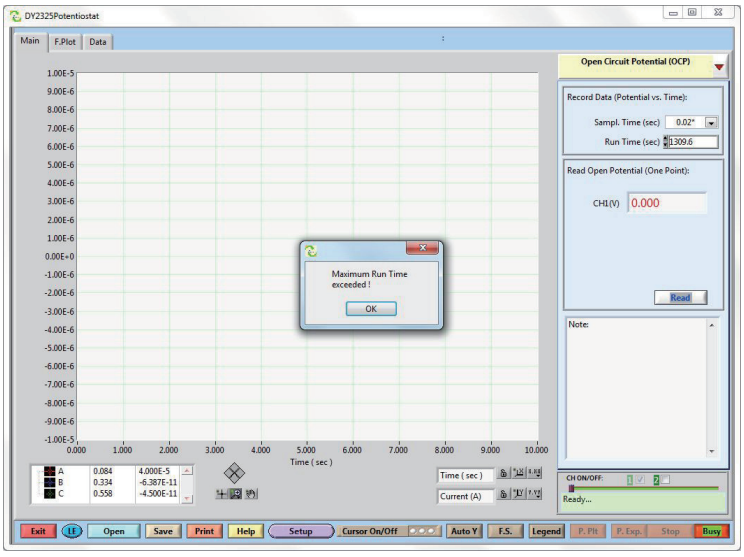
Click READ to display the current measured potential.

Fig. 3.4 . OCP user interface and waveform

Sample Time (sec):	Sampling time sets from 0.0001 to 10 (sec) , and run time is also setup. When RUN button is clicked, start to record Open circuit potential -time.
Run Time (sec) :	Run time sets from 0 to 65,000 (sec).
READ	Data points are derived from Run time divided by Sample time.
Data Point:	When scan rate is less than 0.1 V/s , Max data points are 65,529. When scan rate is over 0.1 V/S, max data points are 15,000. Data display is sometimes delayed.

Precaution

When your inputted Run time is exceeded over Max data points, Run button is clicked and Maximum Run Time exceeded! as warning is displayed. Run time is corrected automatically.



6.1 F. Plot Window.

Following the data acquisition phase, switching to this window will allow for further data analysis.

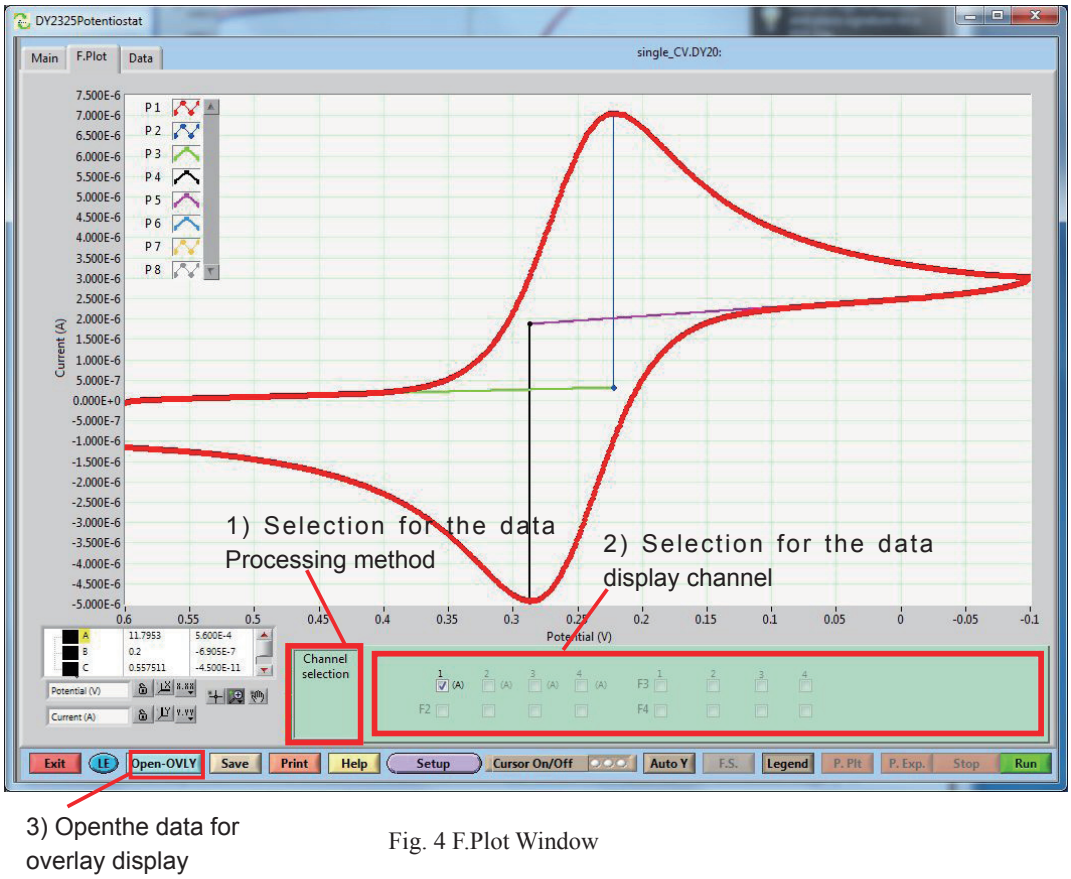


Fig. 4 F.Plot Window

The command is linked with graphic display. Each of commands function is described on the below.

(1) Legend on/off 

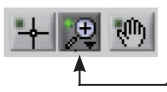
If checked, a plot legend tool will appear on the upper-right corner of the graphics window, which can be used to change the plot styles (line color, line type, etc.) with right click on the legend symbol.

(2) Open 

Input a previous saved data file and compare it with the current one.

(3) Graphics setting

The graphics setting interface are used to change some graphic display styles.



Expand graphics:

(a) Select graphic tool

(b) Left click mouse to select the plot area, and then release the mouse button

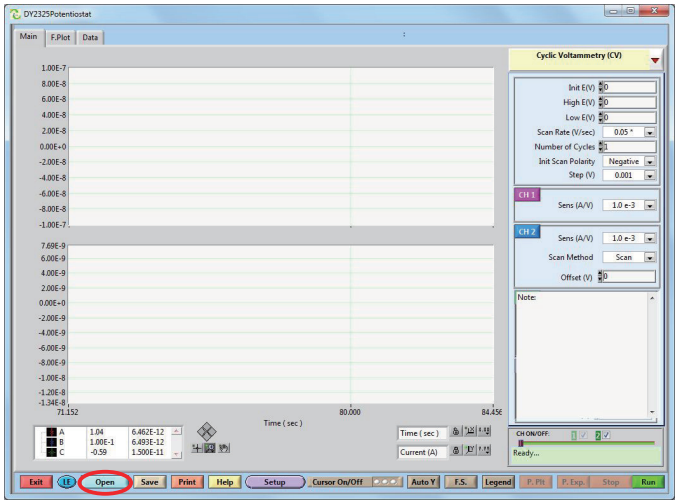
You can also type in the desired numbers to the both ends of X (Y) axis of the graphic display to change the plot area.

Various display style settings for the plot can be controlled through these buttons.

Auto-select the data display range.

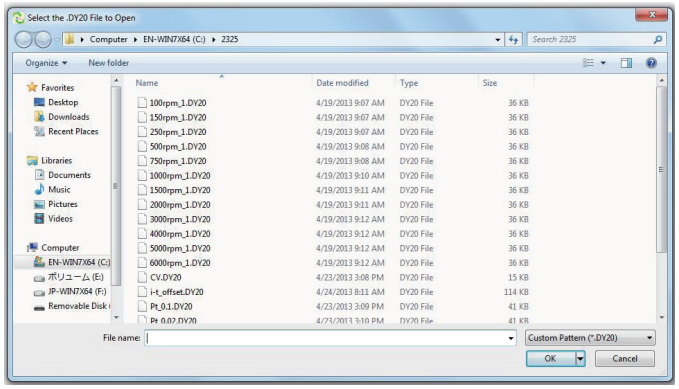
6.2.Overlay

Click Open button into Main WIndow, Open the dialogue to store data.

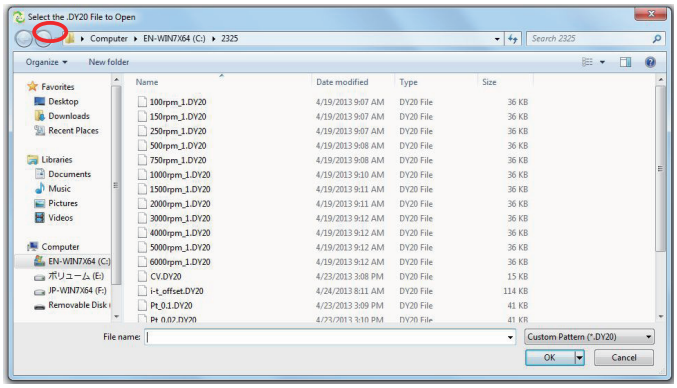


For overlay display, Click Overlay button, choose the specified data to be overlayed.

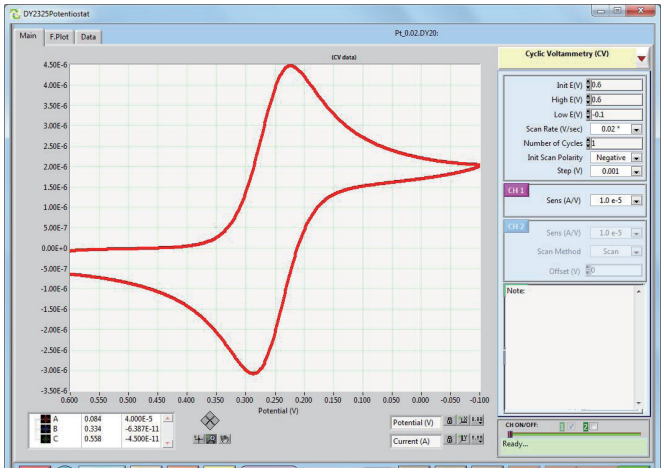
Choose the specified data stored into folder, and the click button.



Please select your inquired data.。



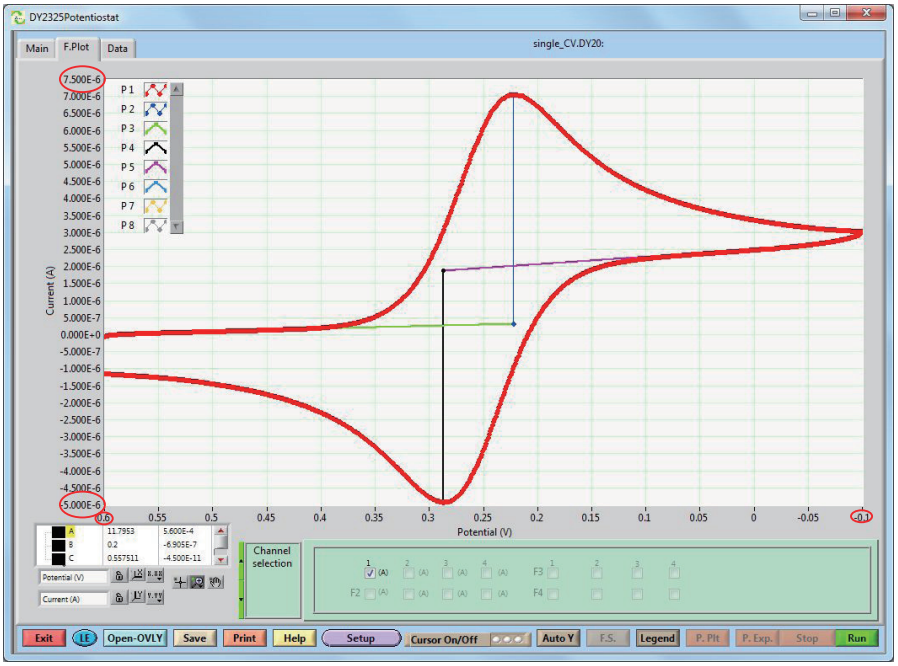
After switching to F. Plot window, the selected data is shown in the following Figure.



Overlay data is displayed.

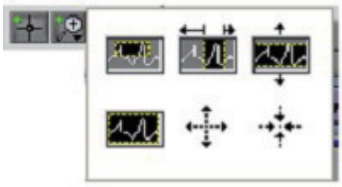
6.3.1 Graphic Display Setting

If you want to change the size of X and Y axis, These Figures on both ends of X and Y axis, X are clicked, and you can input into any numerical number, and then return enter key. X or Y axis is changed.



6.3.1.2 Change Axis Display Size

There is the low left of three buttons into F.Plot, and the center of three buttonsdis accessed by mouse, and click left button of mouse, and 6 kinds of icon appear.



When you draw the rectangle of a part of graph you want to expand with holding left button of mouse, the graph is expanded by yourself.

When you select a part of graph you want to expand with holding left button of mouse, the X-axis part of graph is expanded.

When you select a part of graph you want to expand with holding left button of mouse, the Y-axis part of graph is expanded.

Click left button of mouse, and return the original size.

Click the left button of mouse in the graph, its size is expanded gradually.

Click the left button of mouse in the graph, its size is reduced gradually.

6.3.2. Plot（X,Y axis）display setting

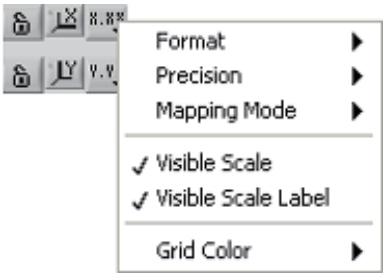
4.3.2.1 Change Plot X/Y Axis Title

When X/Y title is changed, input the appropriate numerical number into the following box, and then click 

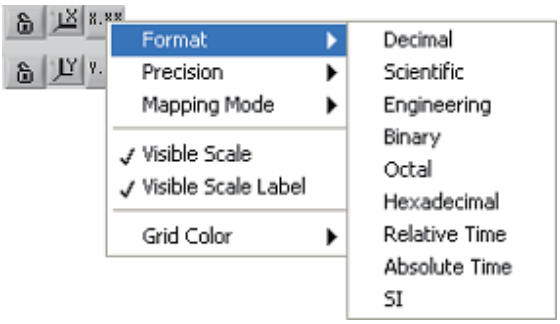
6.3.2.2 When original size of X axis is returned, click  icon.. When Y axis retunr original, click  icon.

6.3.2.3 X, Y Axis（Form, Precision, Grid color）Setting.

, Y axis display settings for each  （X axis）  （Y axis）made an icon. For example,  clicking the left mouse button can be set for each item detail.

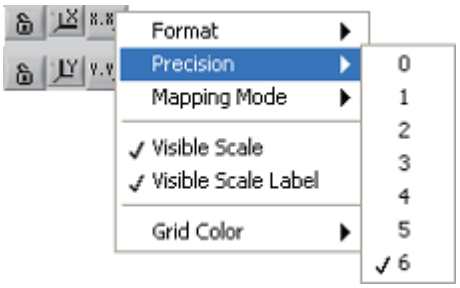


6.3.2.4 Unit Setting



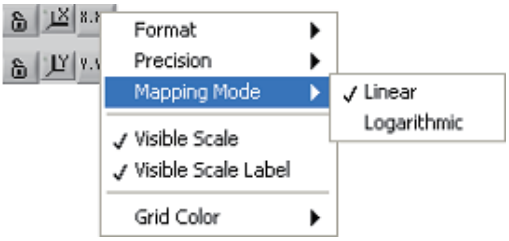
6.3.2.5Precision Setting

Precision setting of numerical number on axis display , for example, when you select 3 in the pull down menu, X axis display shows the number of digits after the decimal point three.



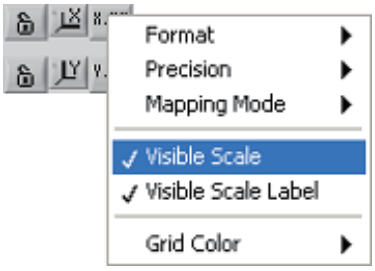
6.3.2.6 Mapping Mode

When you create a chart, you can select logarithmic or linear display.



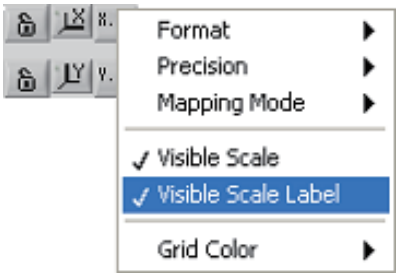
6.3.2.7 Display Scale.

The default setting is checked on the display scale. If unchecked, there is no axis display.

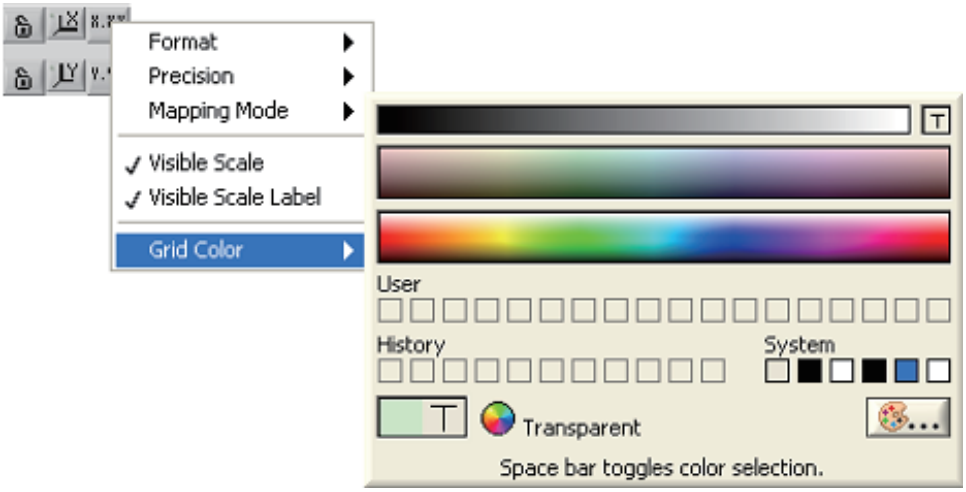


6.3.2.8 Display Scale Label.

The default setting is checked to see the scale label.



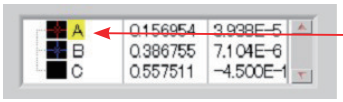
6.3.2.9 Grid Color



6.4 Cursor Operation

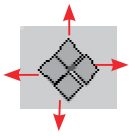
There is a button under the cursor in the center of the F. Plot screen. ○ White circle on the right will change to green with a mouse click.

(a) Three cursors (A, B, & C) can be turned on/off individually by clicking on these three buttons (green is on).

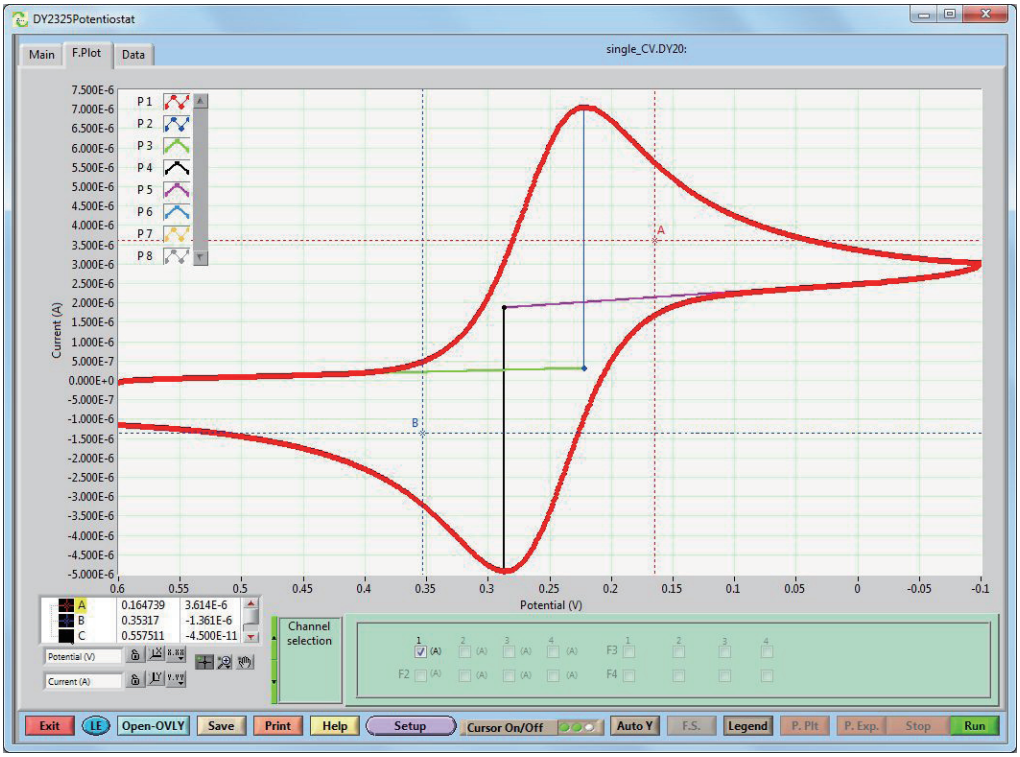


(b) If you want to move the cursor in the box, click the cursor A is yellow.

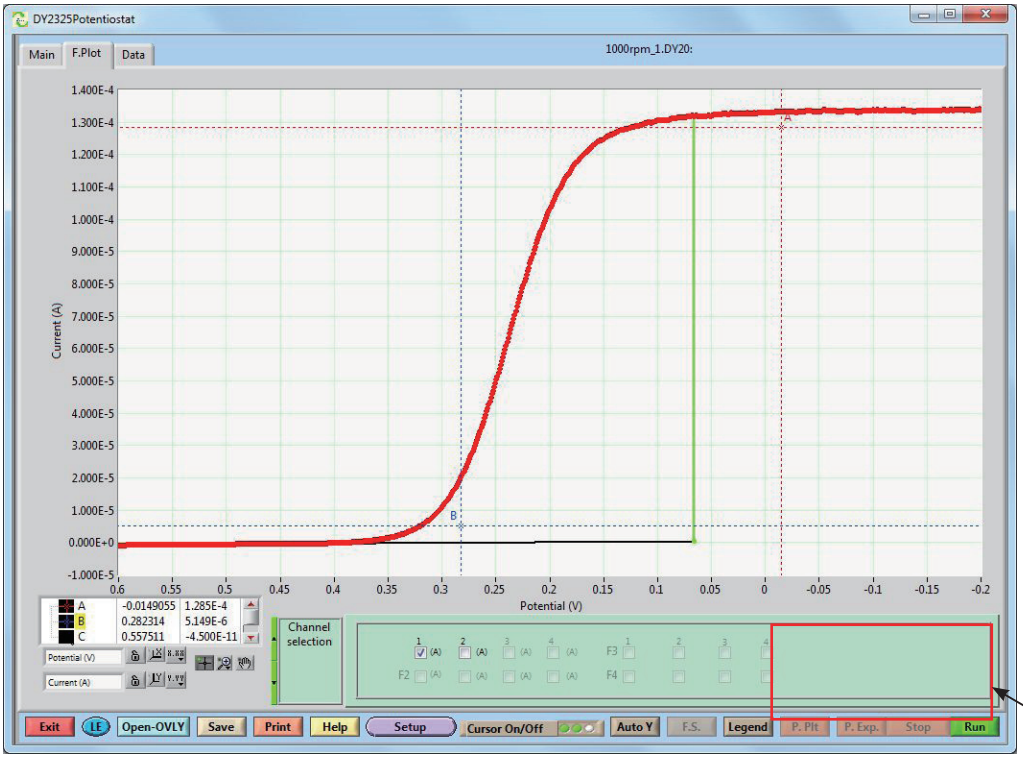
(c) Select the cursor tool, and move the cursor on the plot using the mouse.



(d) Press right button, and cursor moves to right direction. These four buttons move the cursor left, right, up, and down.



Red and blue dotted line appear on the data.



The cursor position is displayed at lower left corner.

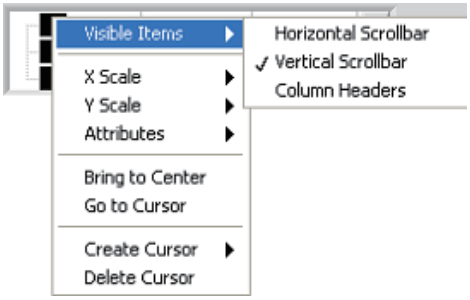
When cursor moves any place freely, the left icon of cursor tool icon  clicked, green  button is flashing. The mouse hits B cursor point, and B point changes to yellow, and its points moves on the curve. If you want to adjust cursor position slightly, click of this  four buttons, moves to the cursor left, right, up, and down is moved.

6.5.Cursor Setting

Cursor setting is to click cursor icon  with the right mouse button, and cursor setting list appears. You can set up cursor.

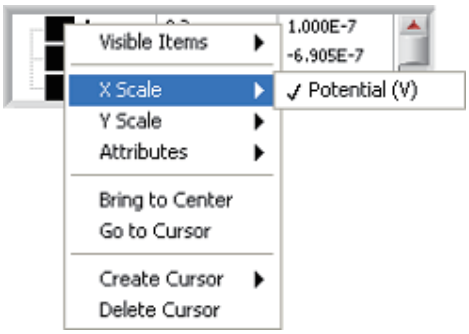
4.5. 1 . Selection of Cursor Bar Display

The display for a horizontal scroll bar cursor bar, vertical scroll bar, and select the column header.



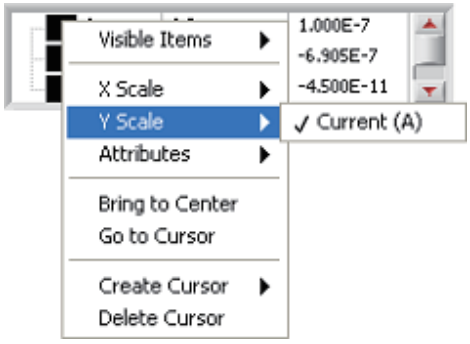
6.5.2. Check X Axis Scale

In order to confirm the X-axis scale, select from the following pull down menu.



6.5.3.Check Y Axis Scale

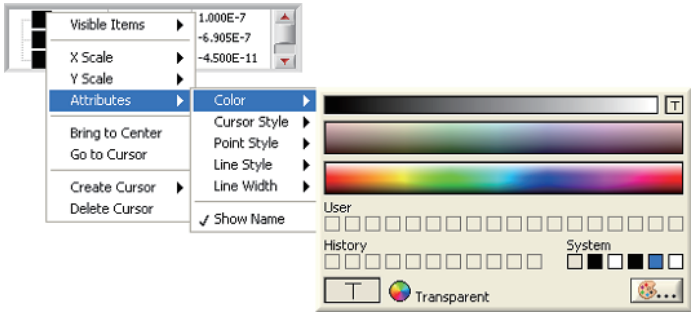
In order to confirm the Y-axis scale, select from the following pull down menu



6.5.4 Set cursor attributes（Color、Style、Point、Line syle、width setting）

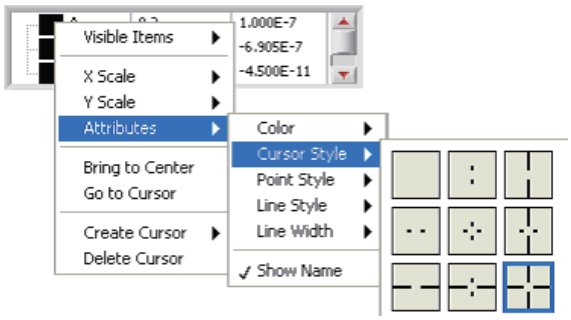
(4.5.4.1) Cursor Color Setting

In order to confirm the color settings of the cursor and select color.



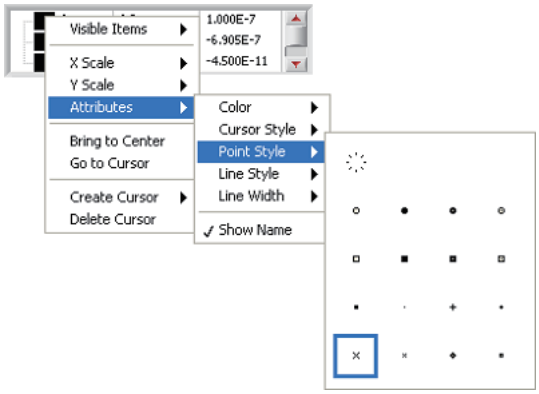
6.5.4.2. Cursor Style Setting

In order to confirm the cursor style, choose the line type.



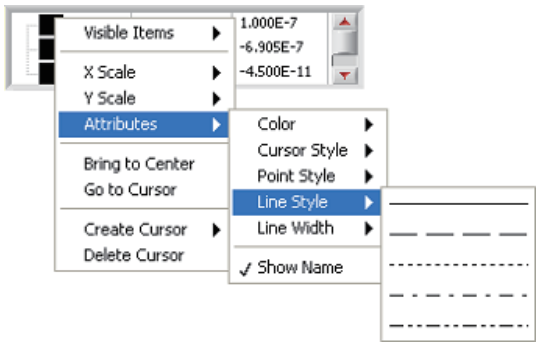
6.5.4.3. Point Setting

In order to confirm the point settings, select a point.



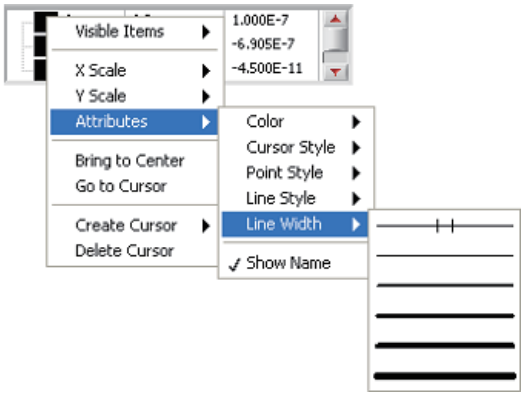
6.5.4.4. Line Style Setting

In order to confirm the line style settings, select the line type.



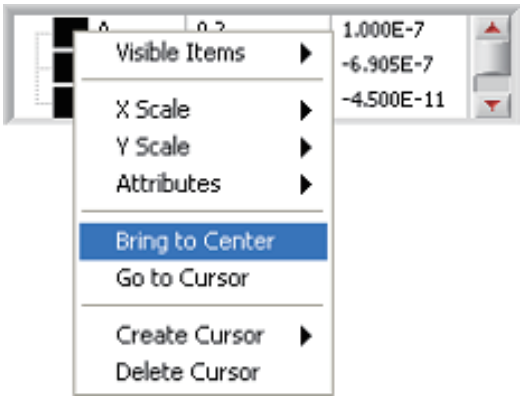
6.5.4.5.Set Line Width

Confirm the configuration of the thickness of the line.



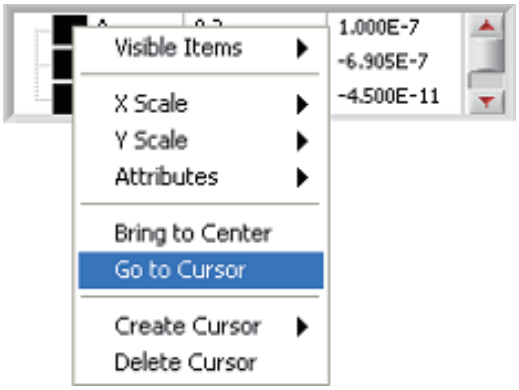
6.5.4.6. Cursor located at Center Position

We use to make sure the cursor is located in the center of the graph.



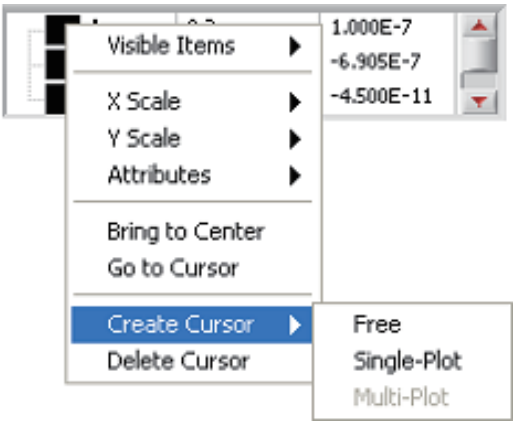
6.5.4.7. Move Cursor

After selecting Move the cursor, the cursor can move with mouse freely. Cursor  button on the bottom right corner of the bar is having the same function.

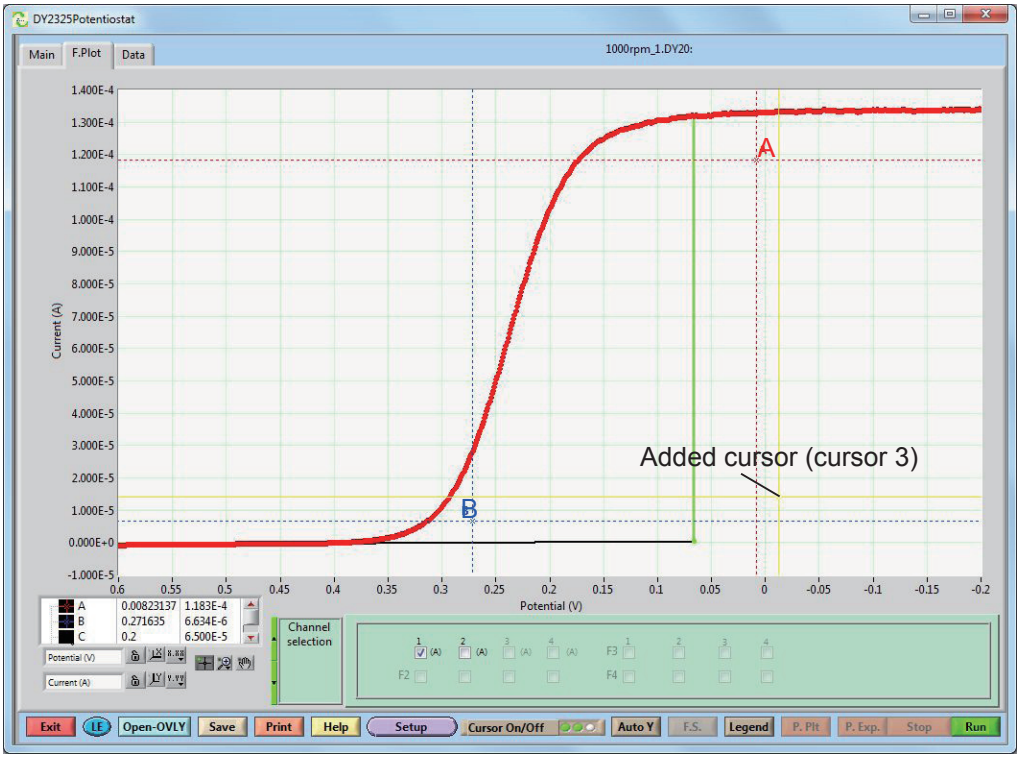


6.5.4.8. New Cursor

Create the cursor in the dialog box below the default When you click to release A, B, C you can create a new cursor outside the cursor. To create the cursor> with a single click on the plot, the cursor can only move on to create a new plot.

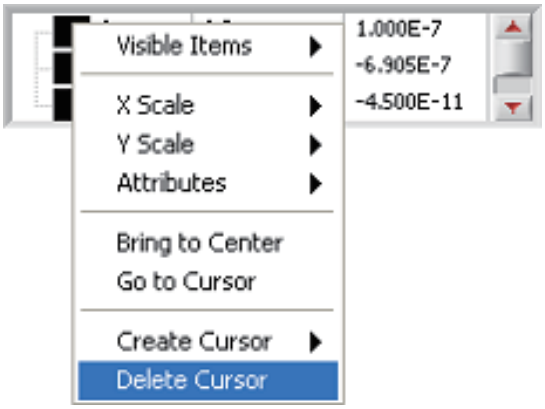


Below D and E cursor is added except A, B and C cursor. E can only move on the plot since it was added in a single plot.



6.5.4.9. Delete Cursor

If you want to delete cursor,. select Delete.

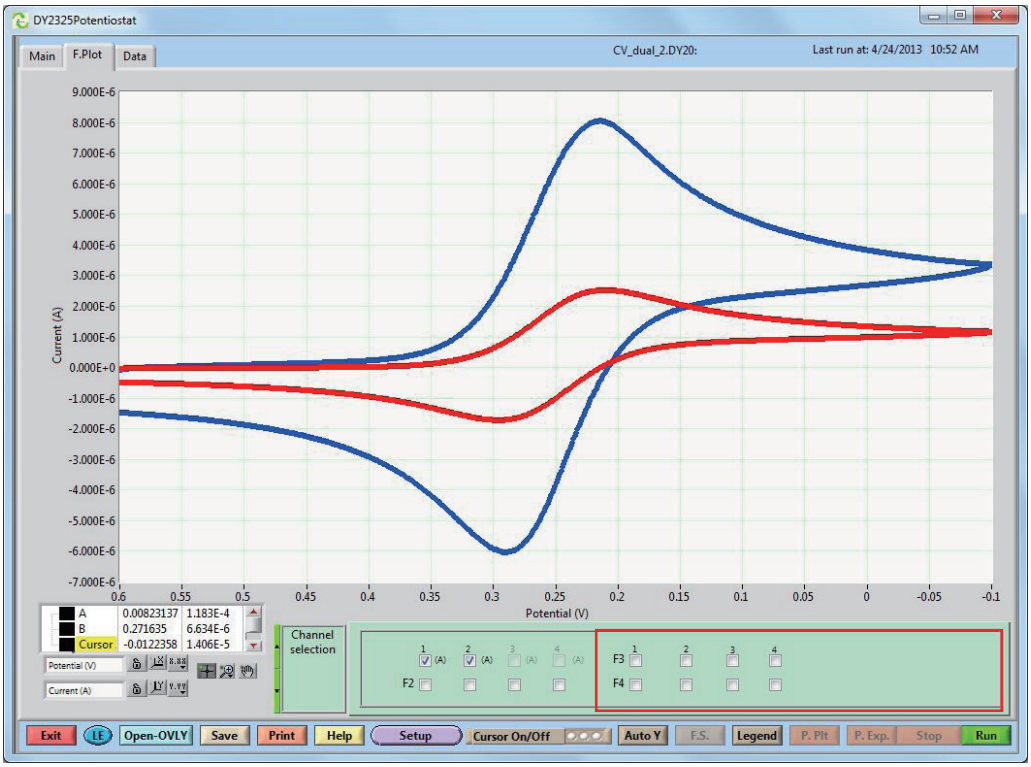


6.6. Data Processing

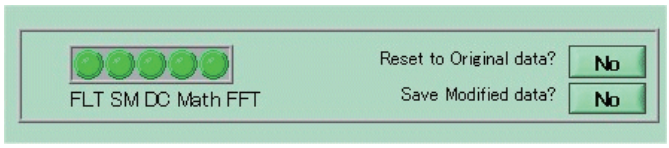
F.Plot Window, which provides some data processing methods can be applied to experimental data.

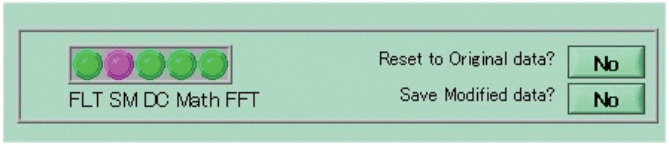
6.6.1. Channel Selection

Click the data channel in the window, then show/hide can be performed.



Selection of data processing "Reset?" and select channel selection dialog box will change to the next dialog box





There are five green buttons on the screen corresponds to the following data processing capabilities.

FLT：Low Pass Filter

SM：Smoothing

DC：Remove DC

Math：Math

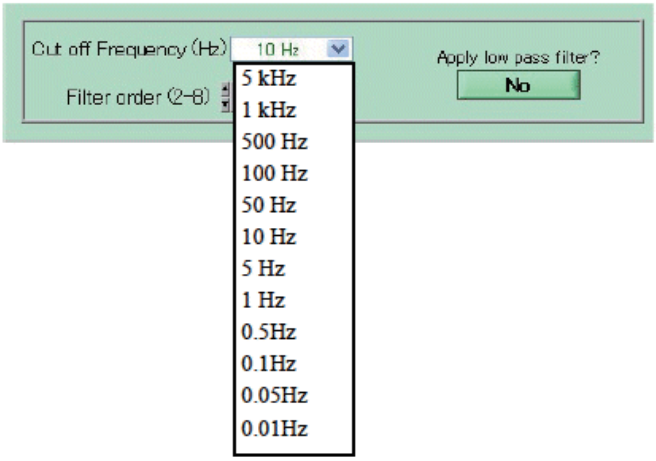
FFT：FFT

When any data are processed, green button is changes to pink color. For example,after smoothing (SM) the data and returning to CH selection, SM button switches to pink color. If you press No button of Reset to Original data, thenthe button switches to Reset and return No button. The previous processed data are deleted, and original data are kept. If the Smoothing processed data is stored, press No of Save Modified data, then the data file store screen appears. You can save it after newly naming.

6.6.2. Low Pass Filter

If you set to "Yes" , a Bessel type low-pass filter with selectable cutoff frequency and filter order will be applied on all of the data channels. Click cut off Frequency (Hz) button, and a list of frequencies is shown. Low pass filter is used to select the frequency.

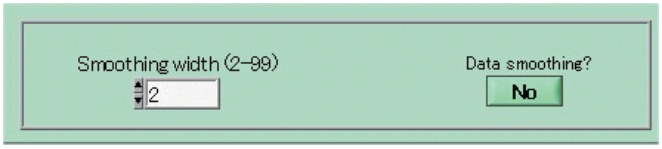
Select from the list box to cut the frequency. Click NO button in the Apply low pass filter. Low pass filter is applied, and the below table is shown. Select the frequency, then the data are processed.



In case of Low pass filter processing is cancelled, press YES button and return the original data.

6.6.3. Smoothing

If the noise is noticeable in the data, you can make use of smoothing processing. 2 to 99 as smoothing width, and press No button in the Data smoothing. No button switches to Yes, then smoothing processing for data is done. The following figure appears.

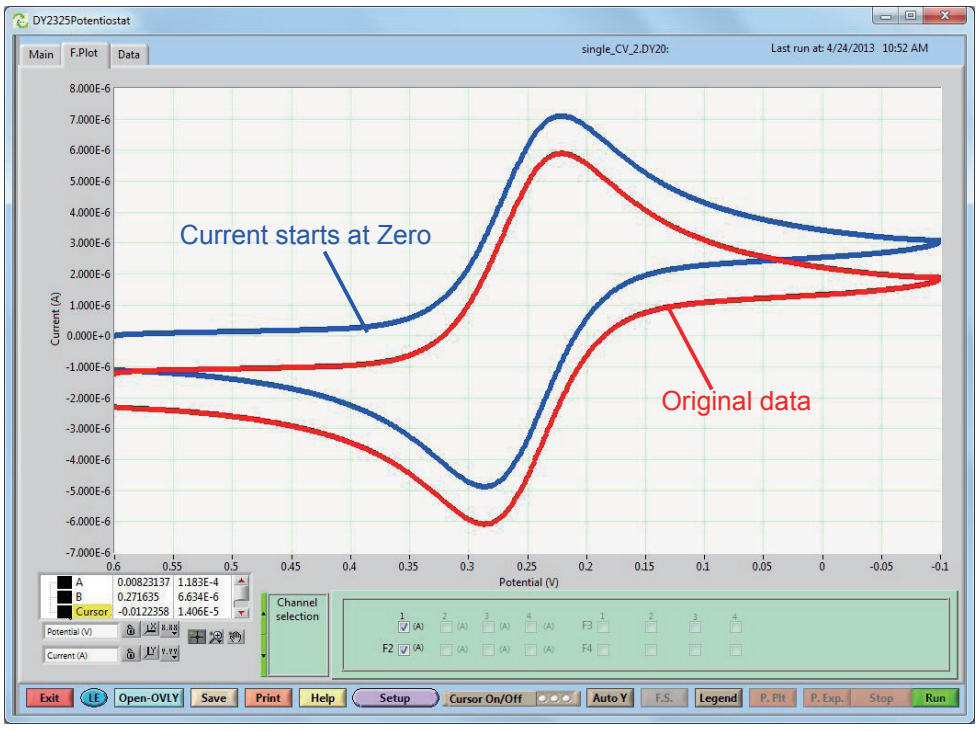


In case of cancelling smoothing processing, press Yes button and return original data.

4.6.4. Remove DC Offset

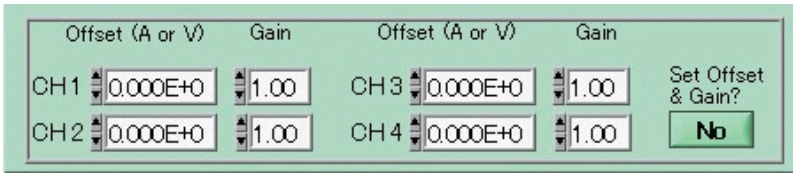
In case of the starting current under CV run is 0.918 uA, If set to "Yes", each data channel's DC value is removed by subtracting its first data point and the value changes to zero.

The data process by Remove Data DC offset is saved, and are overlayed.. It is shown in the following Figure.

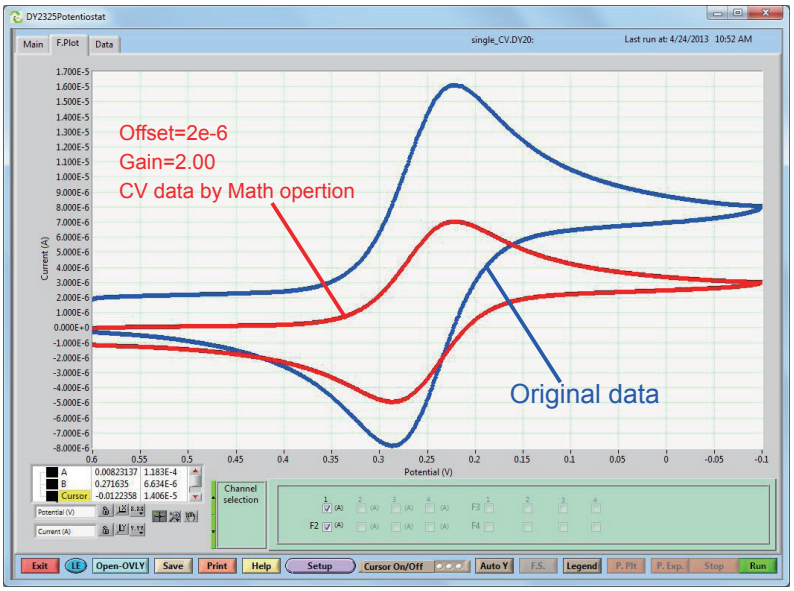


6.6.5. Math

The mathematical calculation capabilities. The 2325 model is available to calculate a CH1 and CH2. Offset (A or V) and enter a numeric field. This number is added to the vertical axis data.

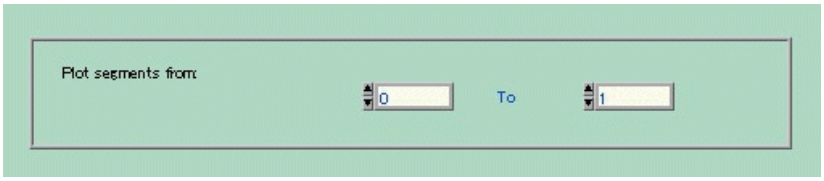


When you enter a number in the Gain column, this number is multiplied by the vertical axis. CV treated with Offset = 2e-6 and Gain = 2.00 is shown below. The data are overwritten on the original data.



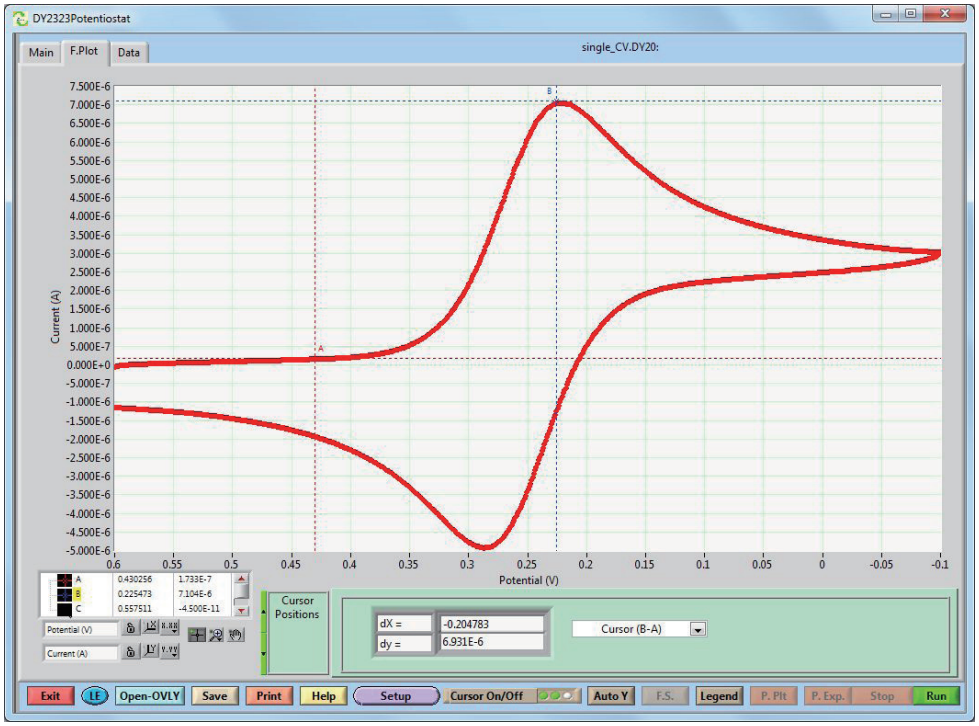
6.6.6. Plot Segments

Under running CV, you can set segment you want to display in the graph, Setting Plot segment for example, from 0 to 1, one segment appears.



6.6.7. Cursor Positions

If you want to display the cursors at least two, between the values of the difference between the two cursors of the dX and values of the difference between X axis and dY value of the Y axis are automatically displayed in the dialogue.

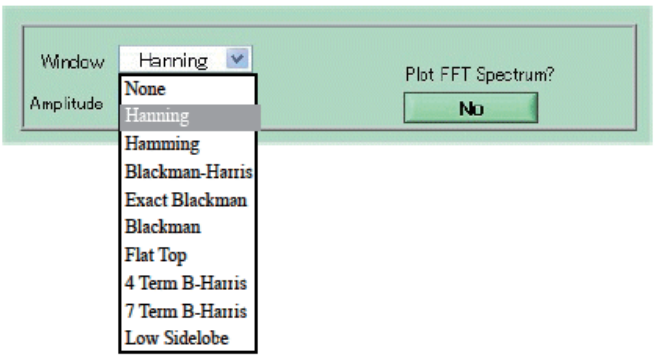


When cursor is selected,
white circle switch to green

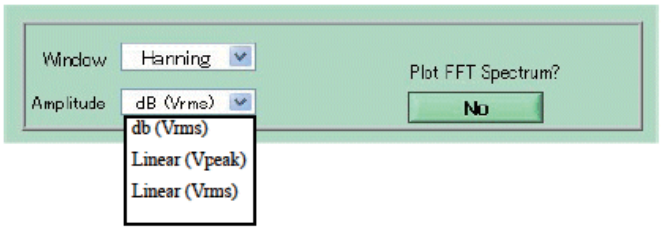
6.6.8. FFT (Fourier Spectrum)

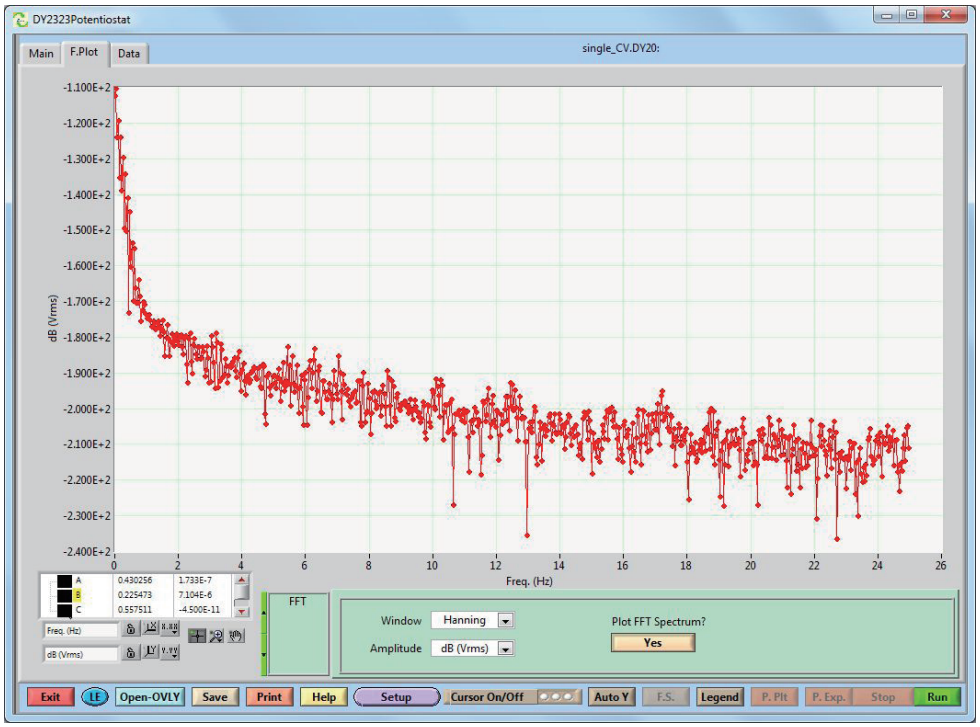
FFFT (Fast Fourier Transform) is the Fourier transform. When Fourier transform of each window is selected and clicked, Window displays a list box.

Select the techniques required,



When you click the Amplitude, Amplitude appears in the list box, Select the unit.

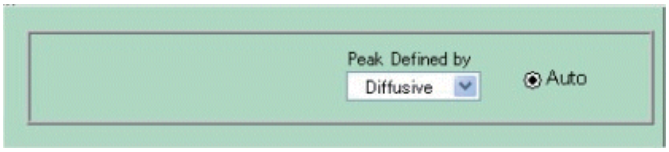




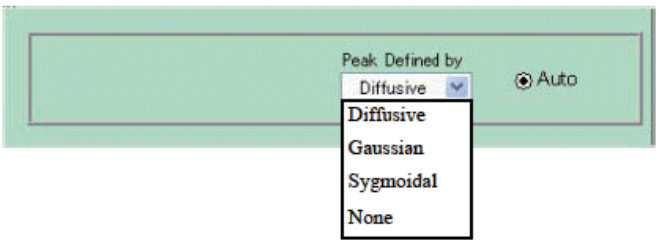
After setting Amplitude and Window, press the NO button of Plot FFT Spectrum to display the Fourier transform data. To cancel the Fourier transform, pressing YES button to returns to the original data.

6.6.9. Peak Shape Definition

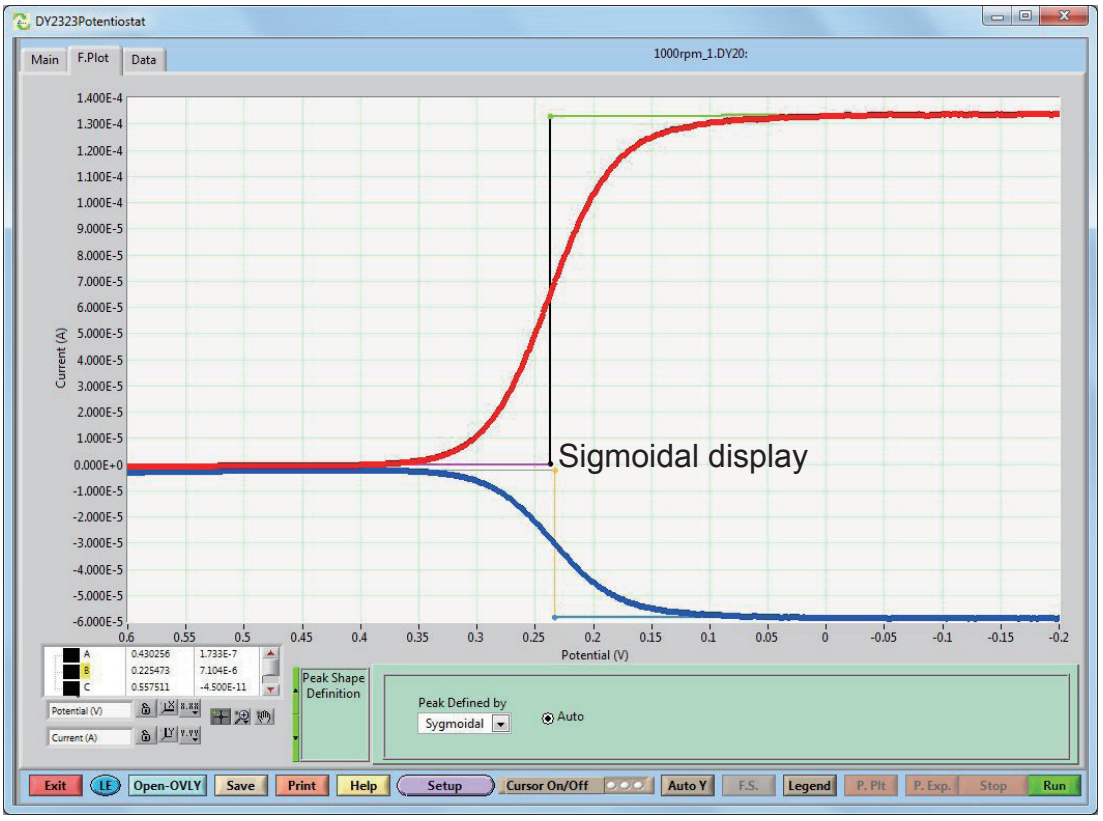
This command is peak definition and analyzes the shape of the current-potential curve with the appropriate function curve. Click the dialogue, then peak definition list（Diffusive, Gaussian, Sigmoidal, None) appears.



The peak definition corresponds to electrochemical techniques, and Diffusive is selected as CV peak definition The symmetrical peak such as adsorption selects Gaussian The steady state current by RDE and RRDE selects Sigmoidal If you do not need to display data, select None.



When sigmoidal peak definiation is selected, the following result is shown.

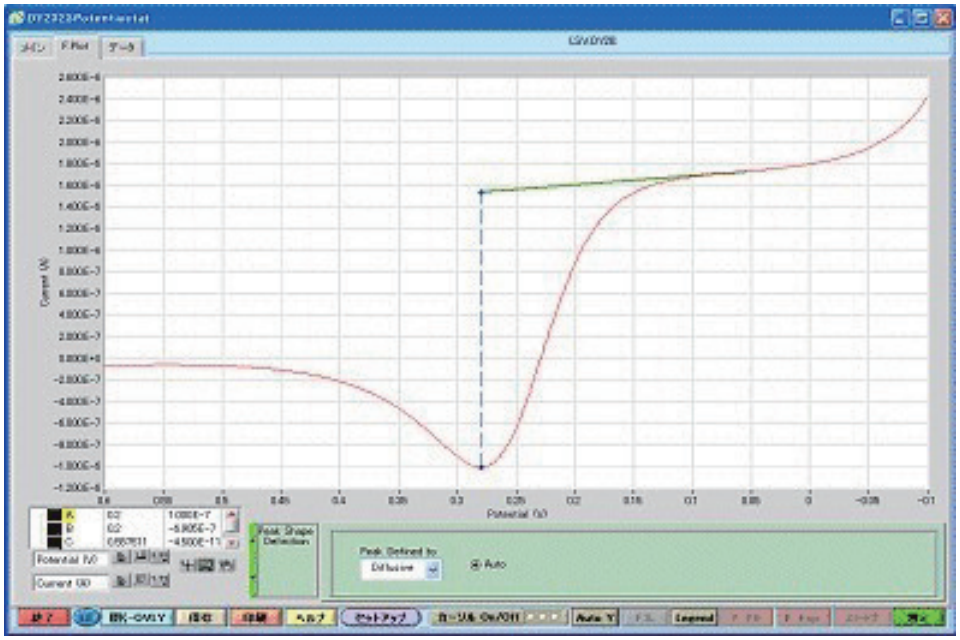


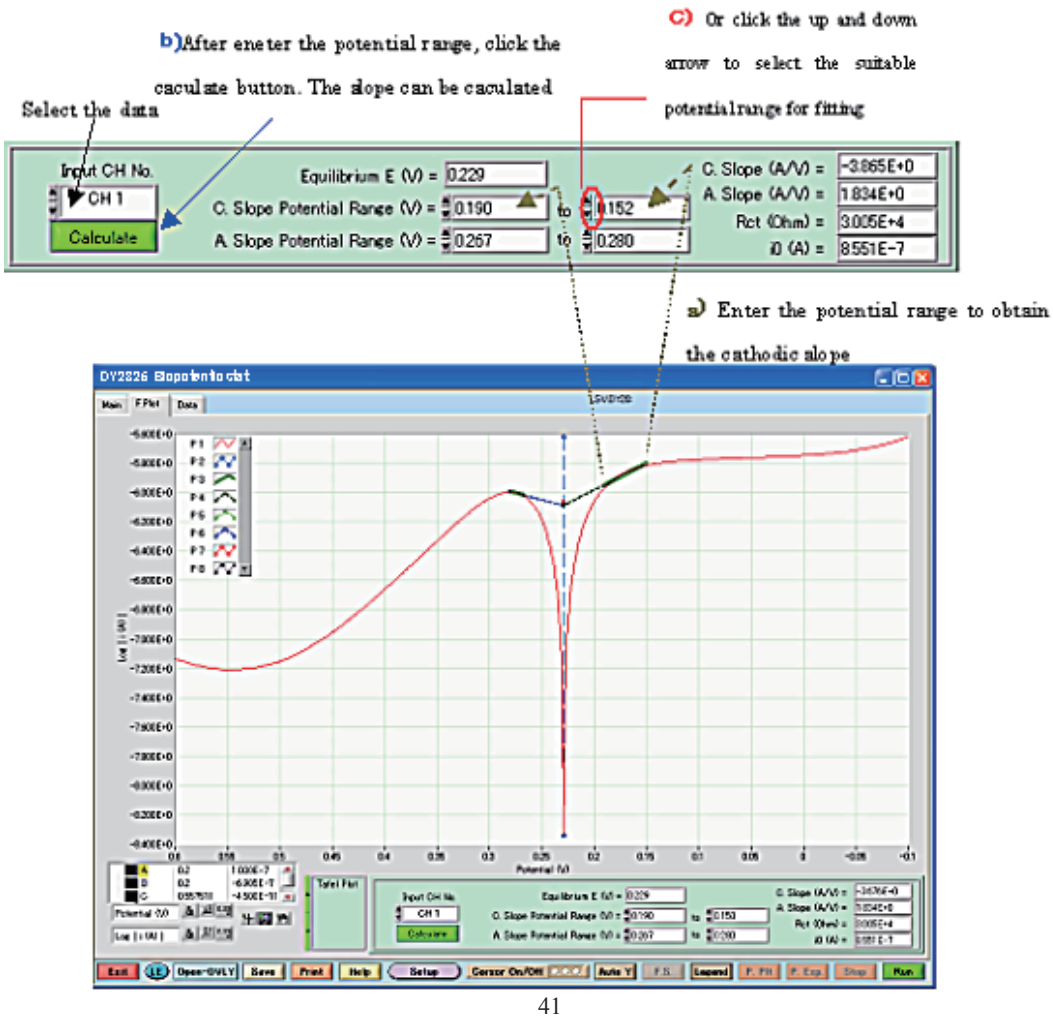
6.6.10.Tafel Plot

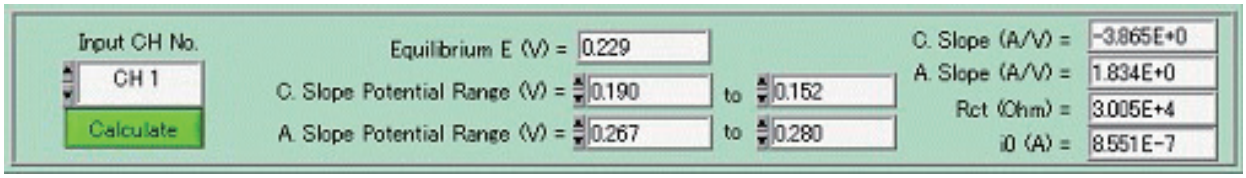
The negative peak current by ＬＳＶ (setup current polarity in the System) is used. The current-potential curve is converted into semi-logarithmic plot by Tafel.

The program automatically calculates the polarization curves of the cathode and the anode. Tafel data processing capabilities of the LSV (current polarity: cathode, voltage polarity: the only positive data set measured at the left side) are applied.

The data obtained by other techniques (CV, i-T) is not proceeded by Tafel plot properly.。







Equilibrium E (V): Equilibrium potential (corrosion potential)

C. Slope Potential Range (V): Cathode slope obtains from fitting setup of the potential range. Input numerical number and click calculate button.

A. Slope Potential Range (V): Anode slope obtains from fitting setup of the potential range. Input numerical number and click calculate button.

Calculate： Determine to do the fitting potential range, and then press the slope is calculated.

C. Slope (A/V): Cathode slope value.

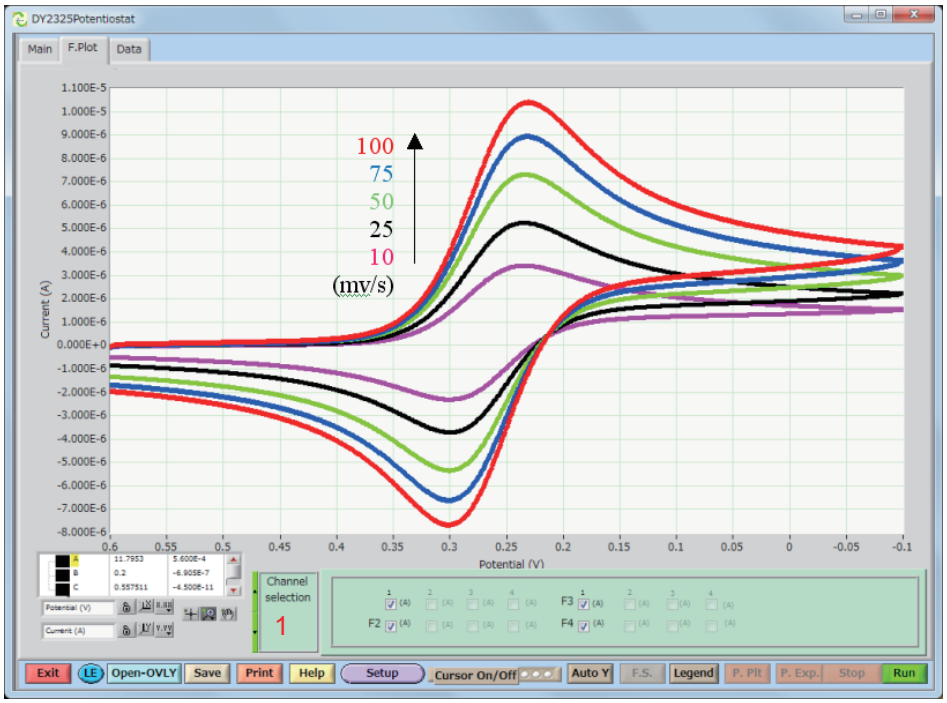
A. Slope (A/V): Anode slope value.

Rct (Ohm): Polarization resistance value

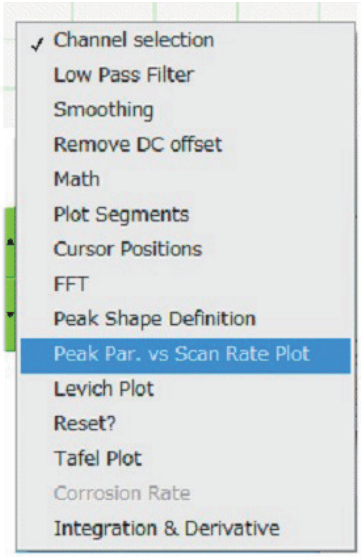
i_0 (A): Polarization resistance (Rct) values obtained from the exchange current density

6.6.11.Peak Par. Vs Scan Rate Plot (This method is used for CV experiments only.)

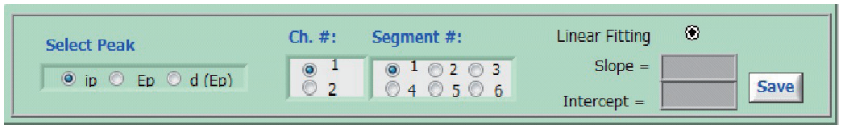
Peak Par. Vs Scan Rate Plot has a function to display Scan rate as X axis Vs peak current (Ip) or peak potential (Ep) as Y axis.
Do CV experiments with different scan rate, and save data file (Peak Sharpe Definition=Diffusive). First Open a saved files in Main window, then switch to Plot window and using Open-OVLY command to open the rest files (<=15)



Click Data processing window 1 and then the following menu is appeared.



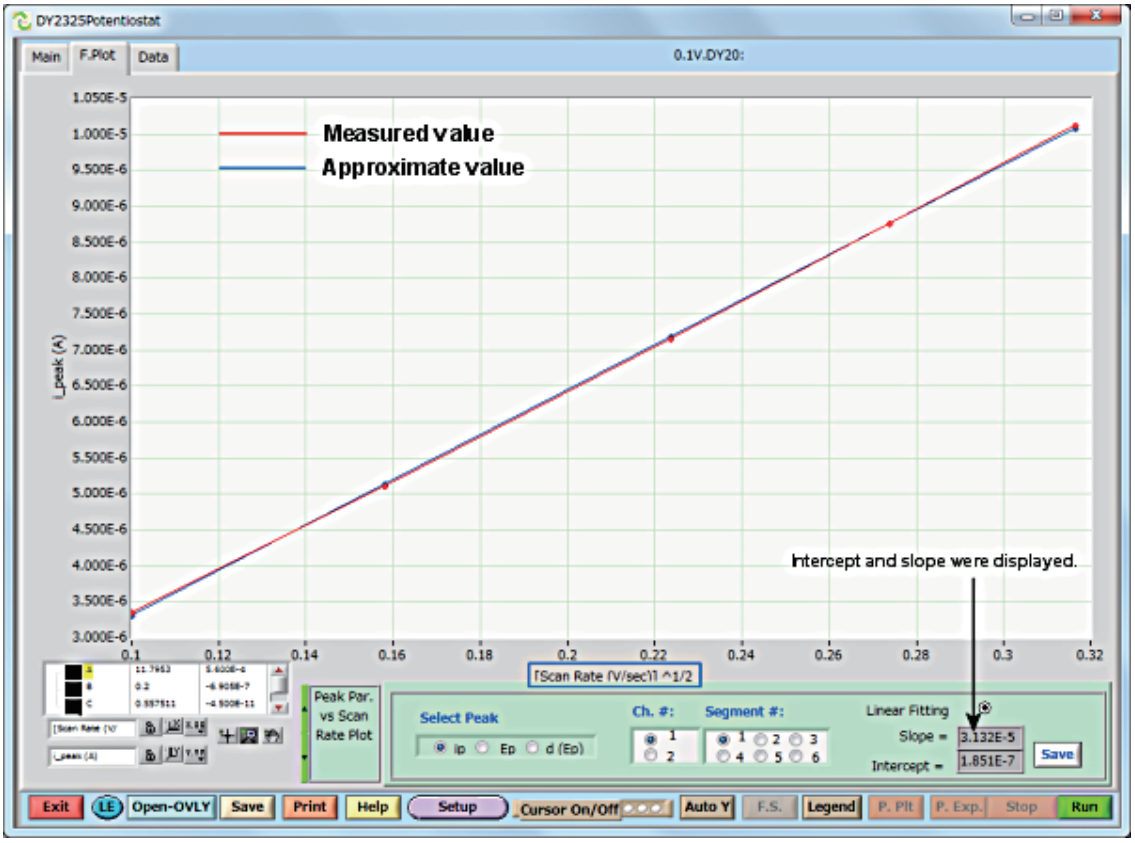
Peak select, channel, segment, linear fitting and slope and intercept are selected from【Peak Par. vs ScanRate Plot】.
{ip, Ep, or d(Ep) = Ep [Seg(n+1)] - Ep [Seg(n)]} for CH1 or CH2 at Seg(n), n=1 to 6.



Select peak : Select peak difinition to be plotted. vs scan rate.
Ch.#, Segment : Select peak channel and segment to be plotted
Linear Fitting : Measured line and approximte line are displayed after click Linear
Slope, Intercept : Scan rate Vs intercept and slope are displayed

Click SAVE button, save (x,y) are sved as text file.

Peak current ip、Ch.1、Segment 1、Linear Fitting are selected, and the following figure was obtained. X axis is set at the square root of the scan rate. If you want to change its dimension, please use excel software.



6.6.12.Koutecky-Levich (K-Levich) Plot

In case of data obtained by hydrodynamic voltammetry using Ring Disk electrode was analyzed, Koutecky-Levich (K-Levich) lot is used frequently. This function shows Koutecky-Levich (K-Levich) display automatically. Electron number (n) is calculated.

The experimental run of oxygen reduction reaction in 1 M NaOH aq (saturated with oxygen) is done under the following condition.

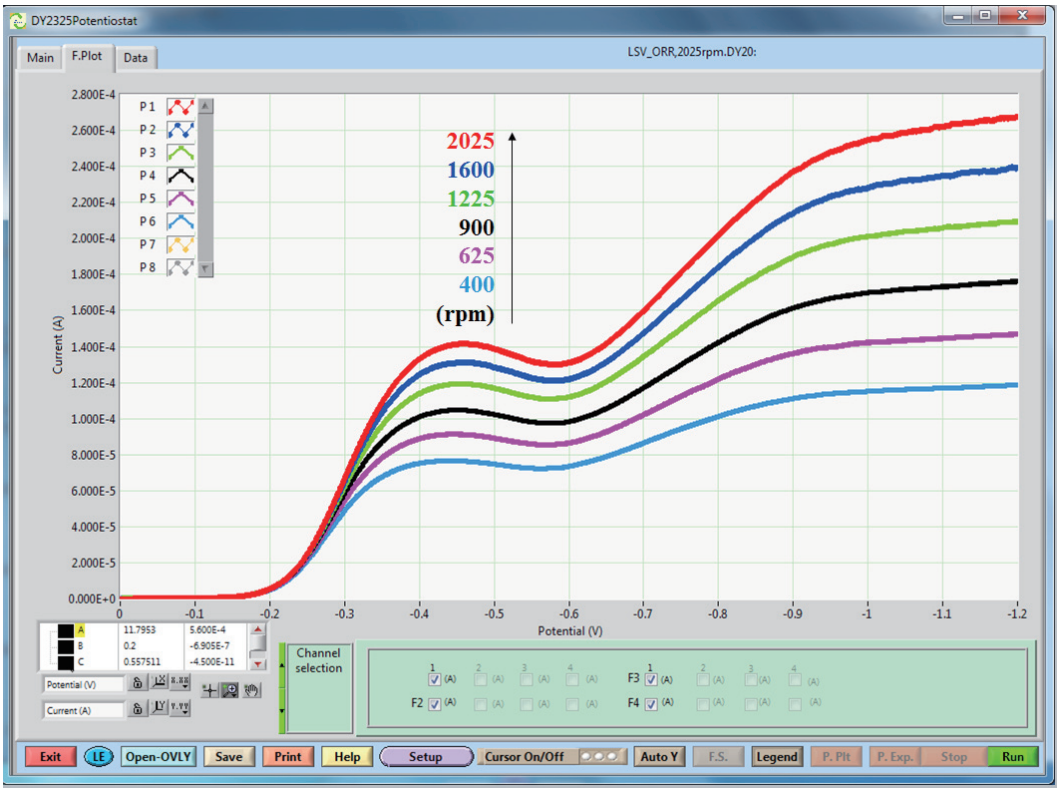
WE：DRE（Disk：GC ϕ 4、Ring：Pt Cat. No.013336）

RE：RE-6A (Reference electrode for alkaline solution Cat. No.012974)

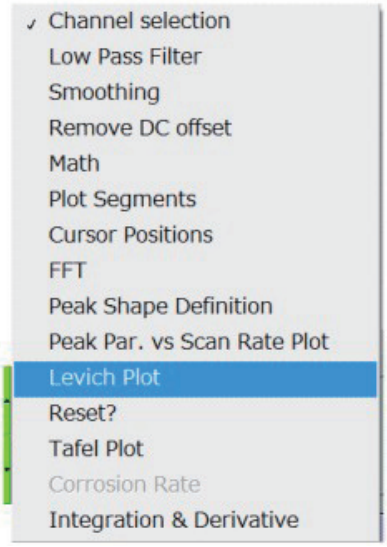
CE：Pt coil (Cat. No.012961)

Rotating speed (rpm) : 400, 625, 900, 1225, 1600, 2025

First, overlay the measurement data of each rotating speed on "F.plot" screen. (See 6.2.Overlay）

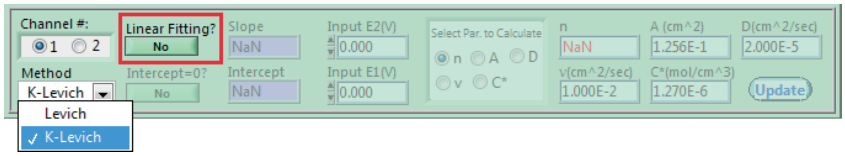


Click Data processing window 1 and then the following menu is appeared.

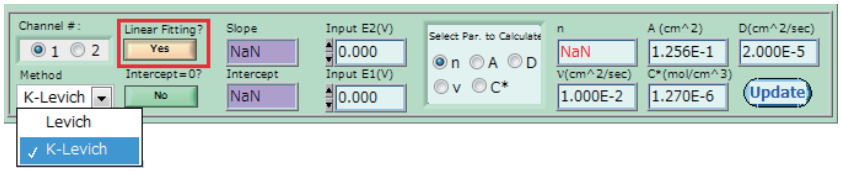


When K-Levich Plot was selected, the following dialogue was appeared, and click Linear Fitting, and set at Yes. You can input specified value into each parameters box In cse of No, You can not input any value into parameters box

For No,



For Yes, You can input specified value into each parameters box.



The detail of Input parameters are shown.

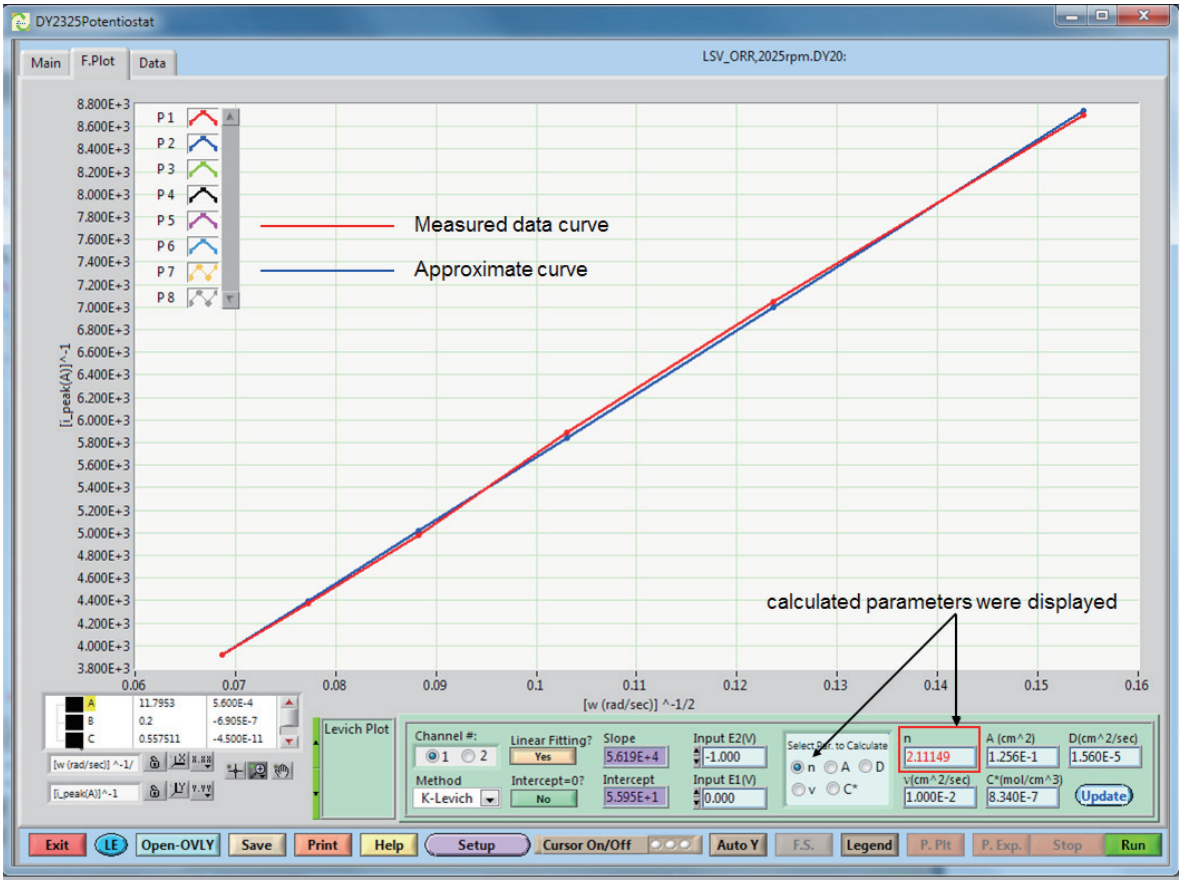
Channel # :	Select run channel
Method :	Select K-Levich from pull down menu (K means shortcut name of Koutechy)
Linear Fitting ? :	Select whether approximate linear line is show or not
Intercept = 0? :	Select whether intercept set at 0 or not.
Slope, Intercept :	Display intercept and slope calculated by approximate plotted line.
Input E2(V) :	Input potential at diffusion limited current.(For K-Levich is selected)
Input E1(V):	Input potential at background current. (For K-Levich is selected)
Select Par. to Calculate :	Select one paramater to be calculated.
n, A, D, v, C :	For reaction electron # and electrode area (cm2), diffusion coefficient (cm2/sec), kinematic viscosity (cm2/sec), concentration of reactant (mol/cm3) and can be inputted except parameter of Select Par. to Calculat. The calculated values are displayed at red figure.

Update button is clicked, and calculated result is updated at the time of corrected parameters.

The result by K-Levich plot using hydrodynamic voltammogram was shown below figure.

【K-Levich Plot】: calculate electron number as parameter.

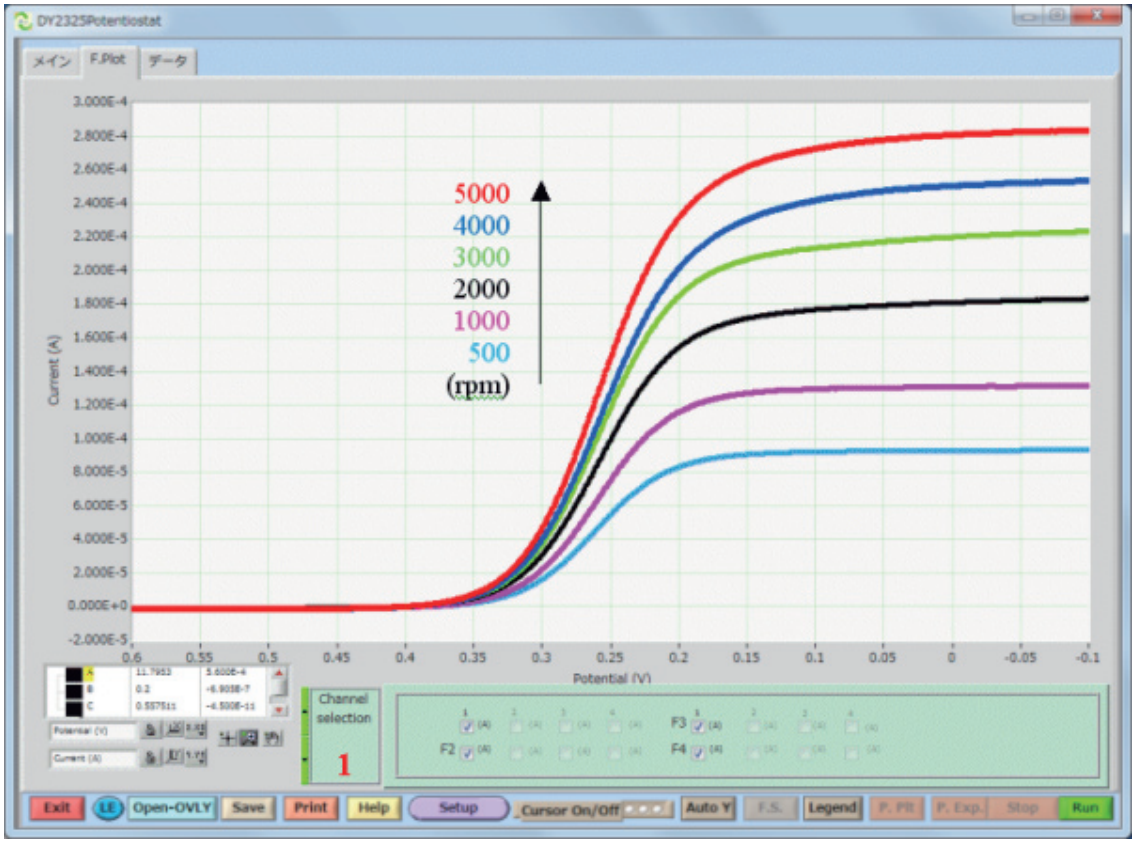
For run experiment, reactant concentration (dissolved oxygen) is 8.34E-7 mol/cm3, and diffusion coefficient is 1.56E-5 cm2/sec. Kinematic viscosity is 1E-2 cm2/sec. Diffusion limited current at 1.0 V and background current at 0 V was plotted under each rotation.



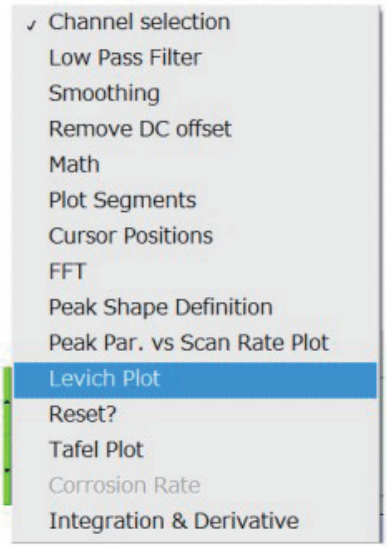
Intercept and slope of approximate linear line was displayed

6.6.13.Levich Plot

In case of data obtained by hydrodynamic voltammetry using Ring Disk electrode was analyzed, Levich Plot is used frequently. This function shows Levich and K-Levich display automatically. Diffusion coefficient and electron number (n) are calculated.



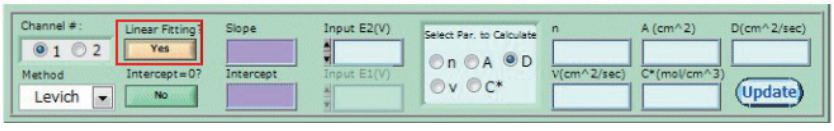
Click Data processing window 1 and then the following menu is appeared.



When Levich Plot was selected, the following dialogue was appeared, and click Linear Fitting, and set at Yes.
You can input specified value into each parameters box. In case of No, You can not input any value into parameters box.

For No,

For Yes, You can input specified value into each parameters box



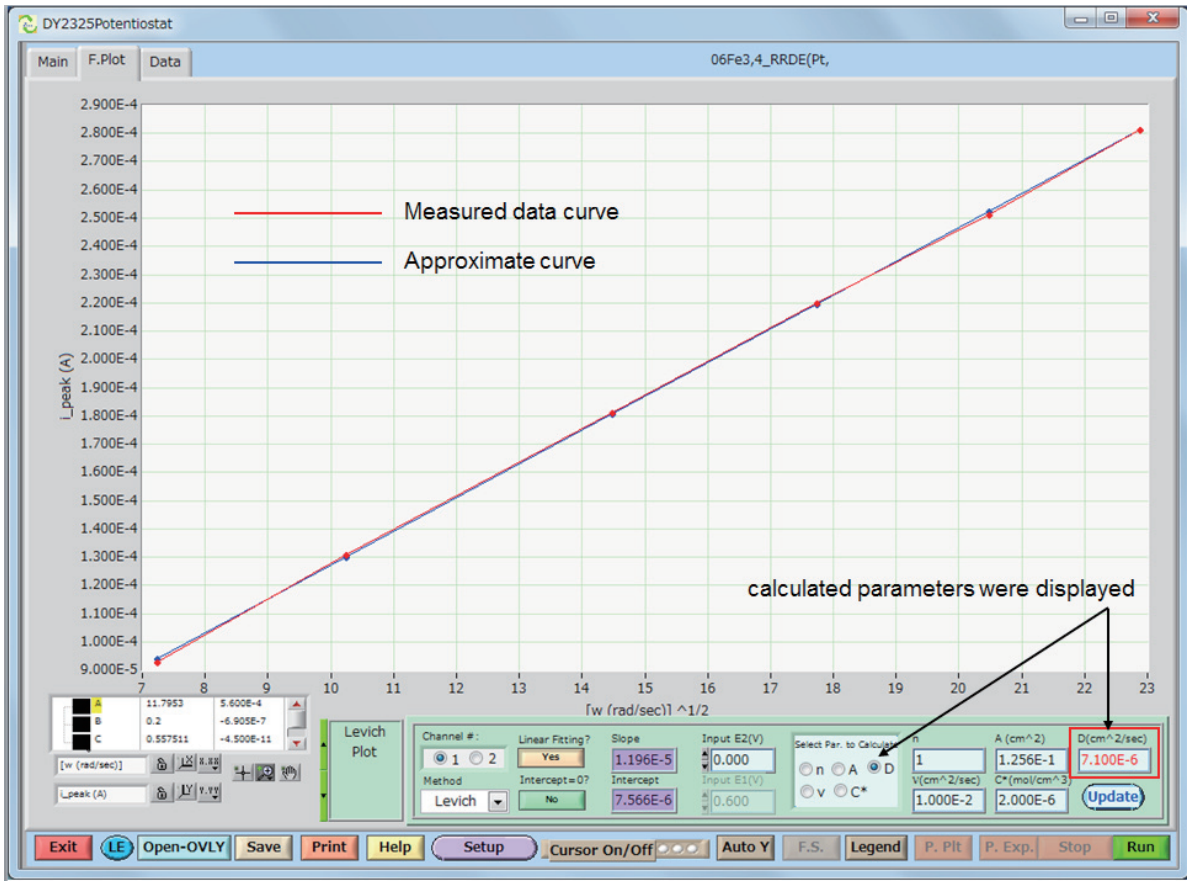
The detail of Input parameters are shown.

Channel # :	Select run channel
Method :	Select Levich from pull down menu.
Linear Fitting ? :	Select whether approximate linear line is show or not
Intercept = 0? :	Select whether intercept set at 0 or not.
Slope, Intercept :	Display intercept and slope calculated by approximate plotted line.
Input E2(V) :	Input potential at diffusion limited current.
Input E1(V):	Input potential at background current.
Select Par. to Calculate :	Select one paramater to be calculated.
n, A, D, v, C :	For reaction electron # and electrode area (cm2), diffusion coefficient (cm2/sec), kinematic viscosity (cm2/sec), concentration of reactant (mol/cm3) and can be inputted except parameter of Select Par. to Calculat. The calculated values are displayed at red figure.

Update button is clicked, and calculated result is updated at the time of parameteris corrected. The result by K-Levich plot using convection voltamogram was shown below figure.

【Levich Plot】…calculate diffusion coefficient (D) as parameter.

For run experiment, reactant concentration is 2mM. Disk electrode diameter is 4mm, and kinematic viscosity is 1E-2 cm2/sec. Diffusion limited current at 0 volt was plotted under each rotation



Intercept and slope of approximate linear line was displayed

6.6.14.Integration & Derivative

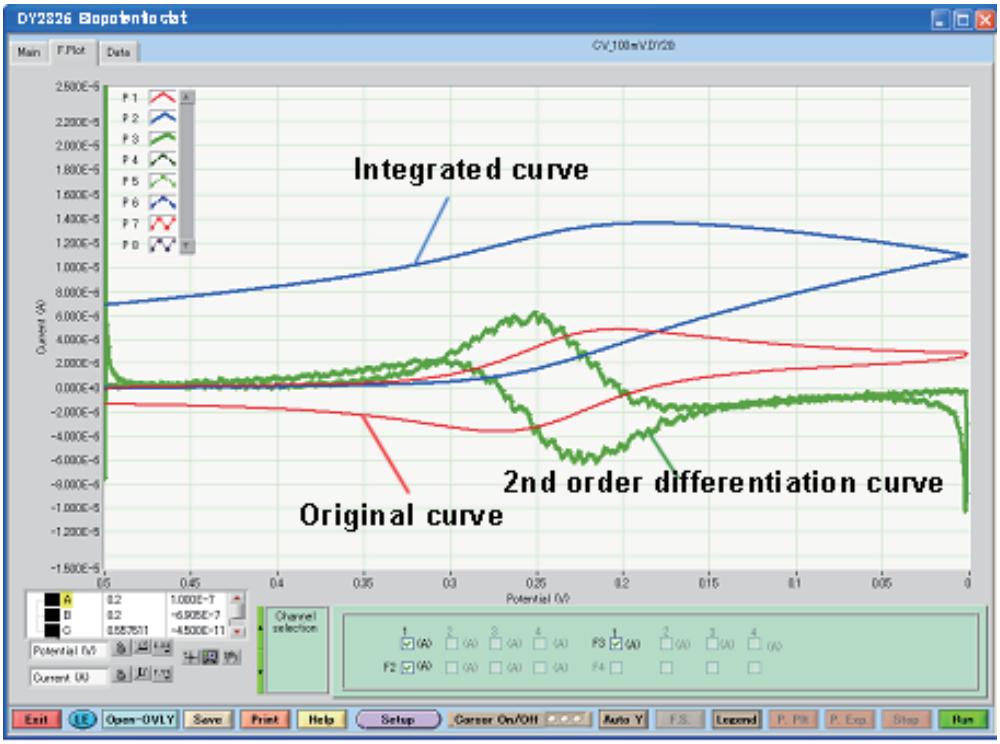
Use this command to integrate/derivative displayed experimental data.

Integration:

Represents the integral curve.

2nd Order derivative:

Represent the second derivative curve.



7. Data Window

Following the data acquisition phase, this window views the experimental run time and collects data in table form, as well as writing down experimental notes and the title of the experiment.

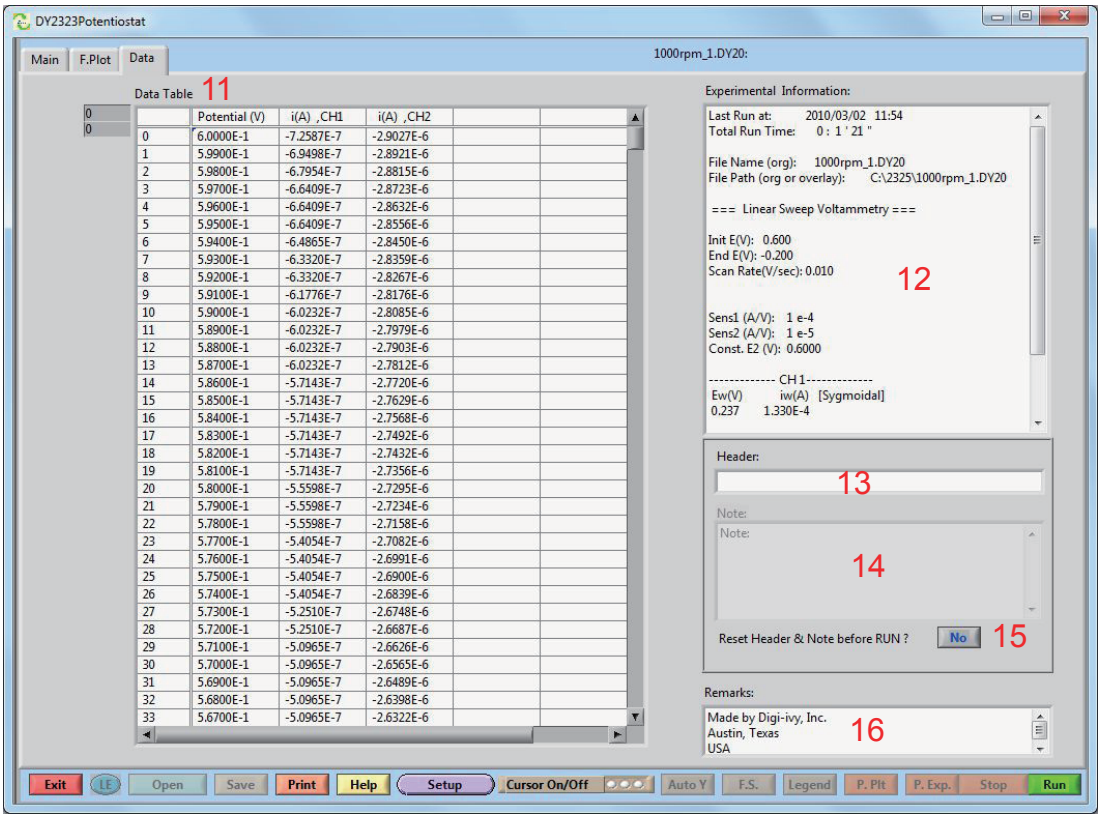


Fig. 7 Data Window

Data Table (11): Display of the experimental data.

Experimental Information (12): Displays the start time and total time for the experiment, with some other information. If the data have been saved, the data filename and the directory will also be displayed.

Header (13): Space for a single-line description of the experiment. This will appear on the top of the program and can be cleared for each RUN.

Note (14): Display a multi-line description of the experiment as inputted from the main Window.

Reset Header and Note for Each RUN (Yes/No) (15): If set to Yes, the Header and Note will be cleared at the beginning of each RUN. Otherwise, the Header and Note will not be changed.

Remarks (16): Space for a multi-line description of the experiment, and will not be cleared for each RUN.

8. Setup Window

The system setup for Model 2325 is described. Software interface of Model 2325 is graphical user interface. Therefore it is easy to operate its function, and measure electrochemical sample. When Model 2325 software is executed, the following figure appears

Fig. 8.1 Setup Window from Main menu

When the SETUP button is clicked, setup window appear, allowing for the configuration of certain system settings for the experiment.

8.1. General

When you click SETUP button, General screen appears.

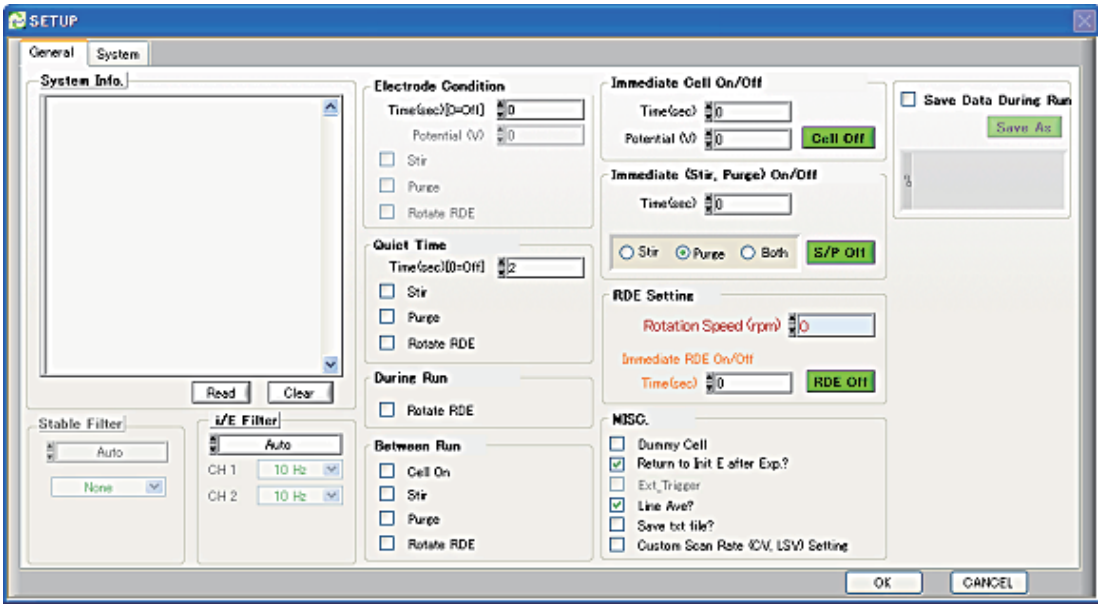


Fig. 8.2 General Screen

i/E Filter: This filter is placed in parallel with the current to voltage converter of each channel to reduce the measured current noise level.

Auto: Automatic adjustment of the filter setting according to the experimental parameters.

Manual: Filter becomes user-adjustable.

Electrode condition [0 to ～ 3600]: If you set to "On" from 0 to 3600 (sec), the defined Potential (V) between - 4.0V and + 4.0 V can be applied on the all electrodes for the condition (deposition) Time (sec) prior to the Quiet Time. Stir, Purge & RRDE can also be turned on/off individually during this time.

Quiet Time (sec) [0 to 3600]: Time delay from applying the initial potential on the electrode to the actual [0, 3600] time of data sampling.. Increasing the Quiet Time could reduce the initial current transient on the data. Stir, Purge & RRDE can also be turned on/off individually during this time

During Run [RDE on/off]: If selected, the RDE output pin in the 9-pin sub-D connector will be active [RDE on/off] during the experiment with an output voltage corresponding to the RDE rotation speed setting [10V = 10000 rpm].

Between RUN: Cell, Stir, Purge & RRDE can also be turned on/off individually during this time. Do not touch the cell leads if the cell is on between runs.

Immediate Cell On/Off: This function can be used to turn cells on/off without running an experiment. To use this function, set the time (sec) [0, 3600] and potential (V) [-4.0, +4.0], then click the Cell Off button. The cell will be on for the selected time and off afterwards. If cell on between run is selected, and time (sec) is set to 0, click the Cell Off button to turn off the cell immediately.

Immediate (Stir, Purge) On/Off: First set the time (sec) [0, 3600] and the output control line(s) (stir, purge or both) on the 9-pin sub-D connector, then click the S/P Off button to turn the output line(s) on/off for a selected time.

RDE Setting: RDE rotation speed setting [10V = 10000 rpm]. Click the RDE Off button to turn the RDE output on/off for a selected time.

Test with Internal Dummy Cell: If checked, the instrument will connect a 1 MW internal resistor between the working and counter electrodes of each channel. At this time, the instrument is disconnected from the cell leads. The dummy cell can be used to test the functionality of the instrument. This option must be unchecked prior to running experiments on an external cell.

Return to Init E after Exp: If checked, Model 2325 will reset its control voltage to the initial value (CV or LSV).

Sampling: If checked, the program will automatically adjust the sampling time to an integer multiple of the line frequency when the sampling frequency is lower than the line frequency. This will help to reduce the line frequency interference on the measured signals. The available Sampling Rates are marked with "*" sign from the selection menu.

Custom Scan Rate (CV, LSV) Setting: User can input CV (LSV) scan rate instead of the pull down selection for scan rate setting. Scan rate range: 0.001 V/sec ～ 10 V/sec.

Save data during run: Data file are saved as your specified name during run

8.2. System

You can update flash memory, setup com port, current polarity, potential axis, line frequency and check link test.

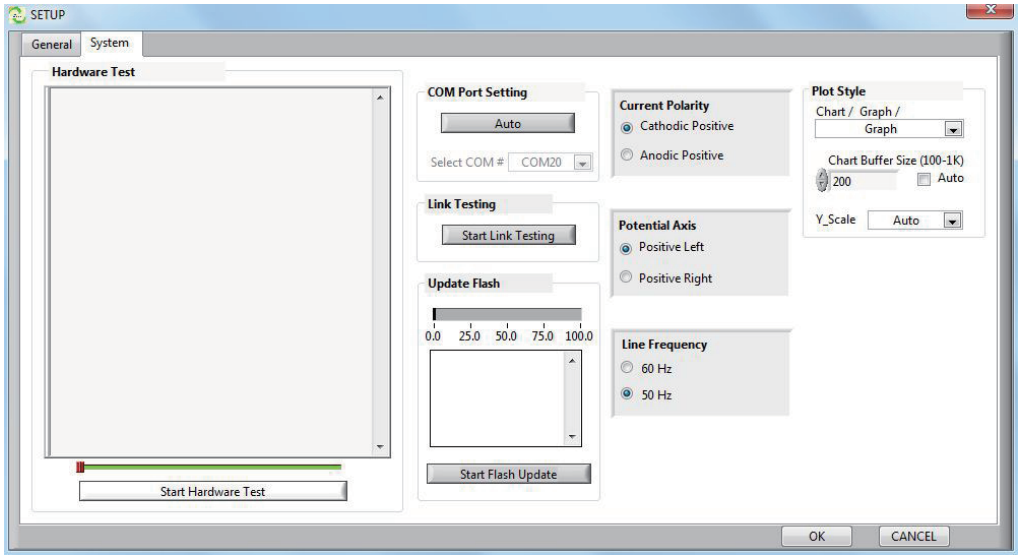


Fig . 8.3 Setup window

Hardware Test:

Start: This checks the hardware and gets a new set of calibration coefficients for the instrument. This can take a few minutes to finish, and will report the test results in the window below. The new calibration data can also be saved for future use. If errors appear on the test results, a few things may be tried firs

(1) Run the Hardware Test several more times to see if the same errors repeat every time.

(2) Turn off the instrument and computer, reboot both, and then try again. If errors still exist, contact the manufacturer for service.

COM Port Setting: (CP210x_VCP_Win_XP_S2K3_Vista_7_v6.5.exe) installed on the PC will convert the USB data communication to a serial data communication protocol. Please refer to Confirmation of device driver.

Auto The instrument automatically sets the comports.

Manual Manually set at 0 to 9 comports.。

Update Flash memory: There is a program placed in the flash memory inside the Model 2325 instrument for its proper operation. Due to our constant efforts to improve the instrument’ s performance and functionality, Here are the steps to update flash memory

1) Save the new version of the flash program (such as“Model 2325x.hex”) onto your computer

2) Quit all other programs running on your computer except Model 2325.exe.

3) Go to the SETUP panel and click Update Flash.

4) Find the flash program (“Model 2325x.hex”) and click OK to start the update process.

5) Wait for the update to finish (this could take a few minutes). When the update has finished, a window will appear and say “Update finished successfully” . Click OK and and close the SETUP window.

6) EXIT the Model 2325.exe program and turn the instrument off and then on. Restart Model 2325. exe to resume normal operation. Note: Please do not disturb the computer or the instrument during a flash update, as this may cause damage to the instrument!

Current Polarity: Select the displayed current direction as either Cathodic Positive or Anodic Positive.

Potential Axis: Select the displayed potential direction as either Positive Left or Positive Right

Line Frequency: The program will use this parameter to reduce the line frequency noise on the measured signal for certain ADC sampling rates. A CS-3A Faraday cage may also be used to reduce the line frequency (and other electromagnetic) interference on the signal, especially for the low current measurements.

8.3. Execution (Automatic run)

Click Execution button, the following Execution menu is displayed.

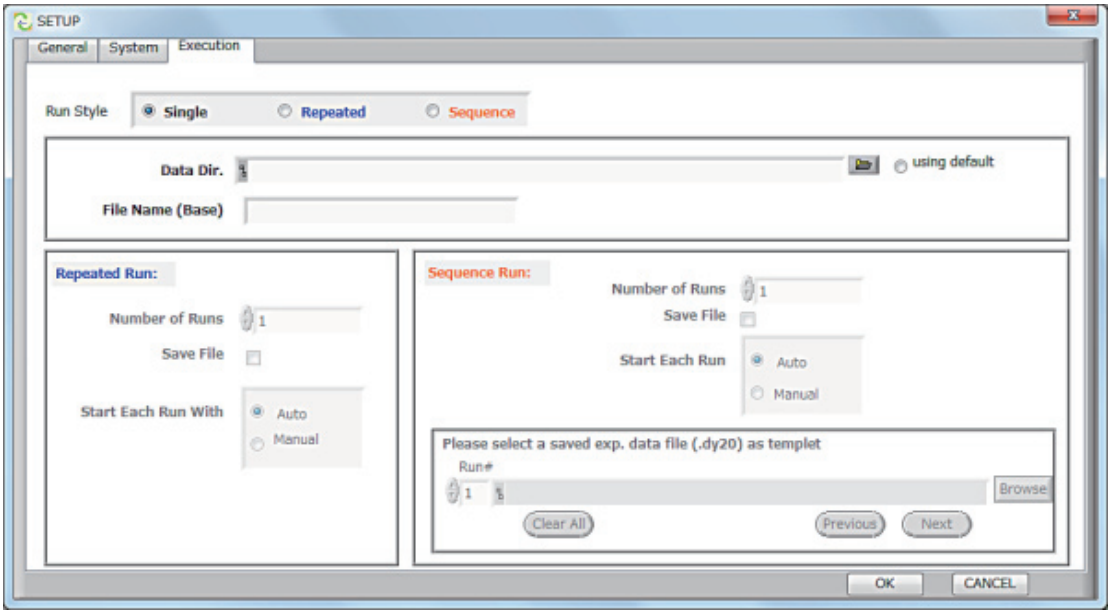


Fig . 8.3 Execution window

Type of run

Single : Default setting for standard experiment.。

Repeat : Select repeat run under same experimental condition.

Sequence : Select sequential run under different experimental condition

Data Directory : Select data directory to be save file. Data file can not be save at C:\ program directory after Win 7. Please confirm where you can save your date file

File name : Input file name for measured data For repeat run or sequence run, XXXX_1 (file name), XXXX_2, XXXX_3, XXXX_4 are saved automatically.

Please refer to Remote Mode Measurement.

8.4. Repeat run

Repaet run is selected from Execution dialogue. Execution from Model 2325 software is clicked, and select repeat run, and clicked. The following window is appeared.

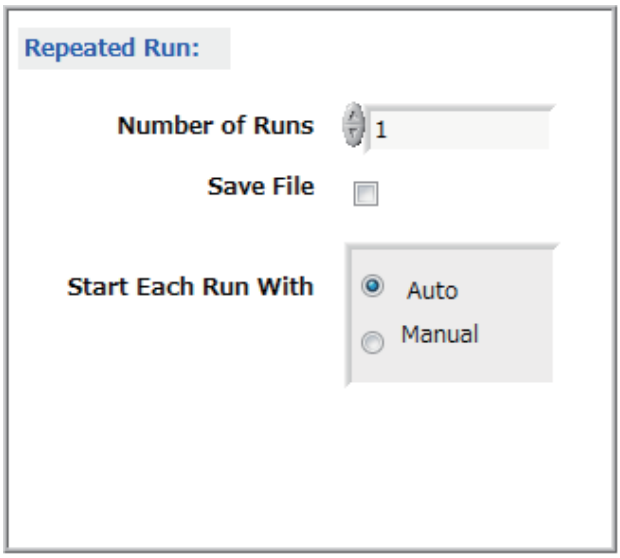


Fig . 8.4 Repeat run window

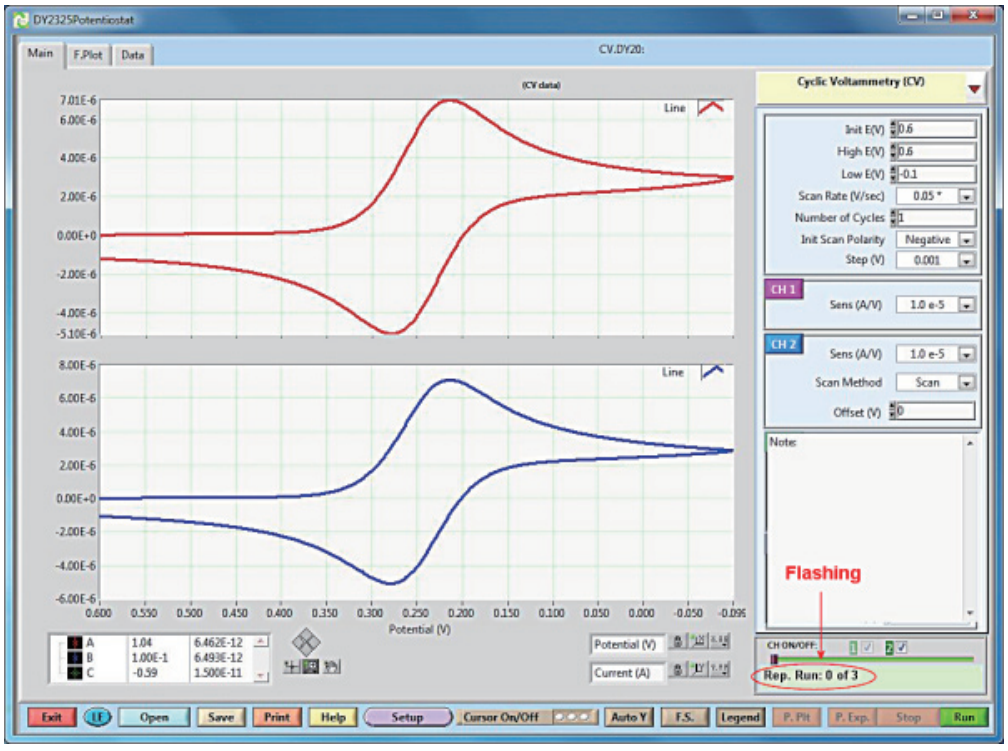
Type of run

Number of runs : Number of repeat run is inputted.

Save File : Run data is saved every run automatically.

Start each Run With : For Auto, experimental run is repeated automatically. For Manual, Every run experiment, Click Run button, and then next run is started.

After parameter is inputted, and then Click OK button into Execution menu. Main menu is returned. For repeat run, electrochemical technique and parameter is inputted from main menu and then, click Run button. run is started.



For repeat run, the following red circle is flashed.

8.5. Sequence run

Sequence run is selected from Execution dialogue. Execution from Model 2325 software is clicked, and select repeat run, and clicked. The following window is appeared

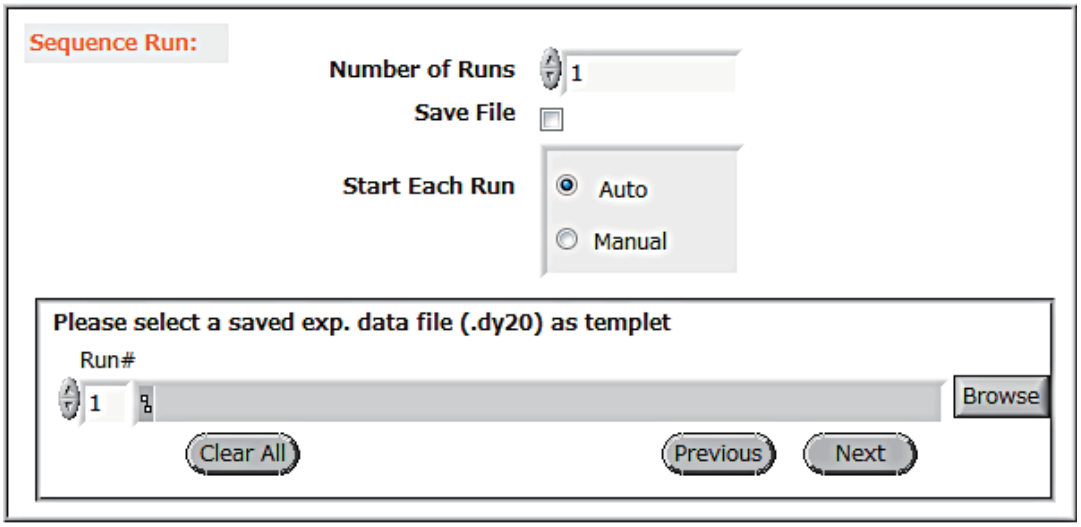


Fig . 8.5 Sequencet run window

Type of run

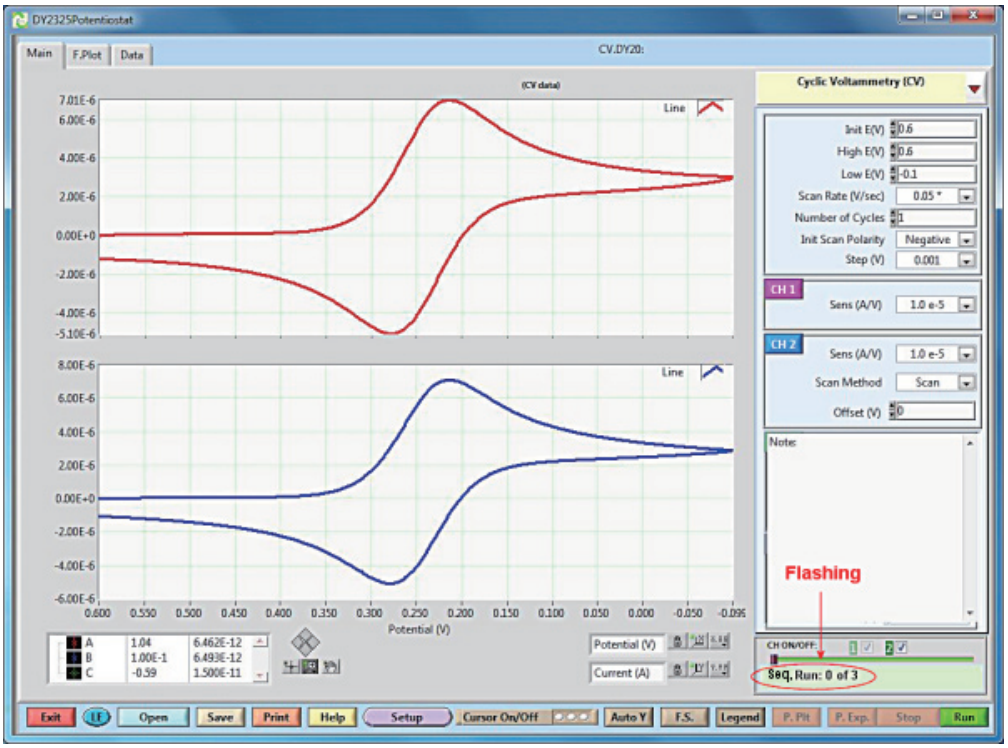
Number of runs : Number of repeat run is inputted.

Save File : Run data is saved every run automatically.

Start each Run With : For Manual, Every run experiment, Click Run button, and then next run is started,

Select saved experimental data file (.dy20) as templet : Click Browse button every Run#, and please load previous data with experimental condition under sequence run. After load Run1 data is completed, and click Next button. repeat same operation based on your inquiry.

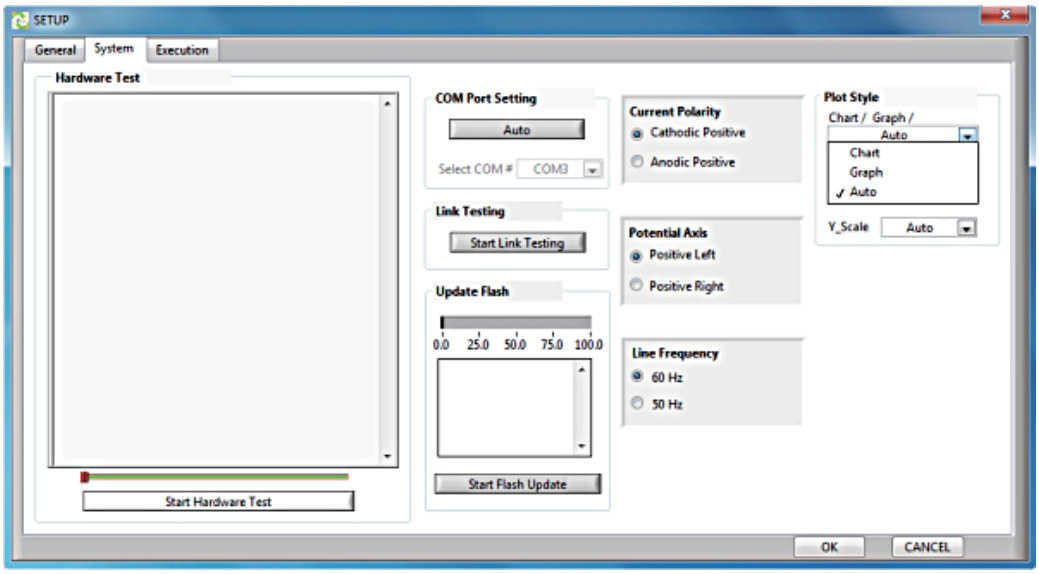
After parameter is inputted, and then Click OK button into Execution menu. Main menu is returned. For sequence run, electrochemical technique and parameter is inputted from main menu and then, click button. run is started.



For Sequence run, the following red circle is flashed.

8.6. Plot style

You can select data display on Amperometric i-T and OCP technique.

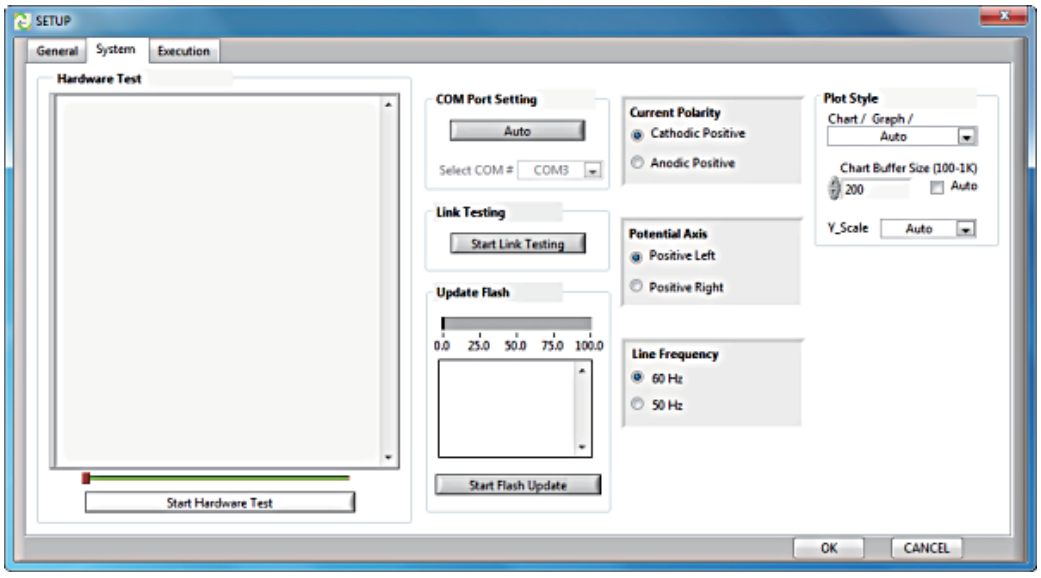


（1）Chart/Graph/Auto

Chart:

The recent data point inputted into Chart Buffer Size box is displayed. When the addition of specified data points overflow, new data points are added into right side chart, but old data points are removed from left side chart.

if Auto box is checked instead of input of point number, Chart buffer size is decided automatically.



Graph:

Display all data points from the start to run to present data.

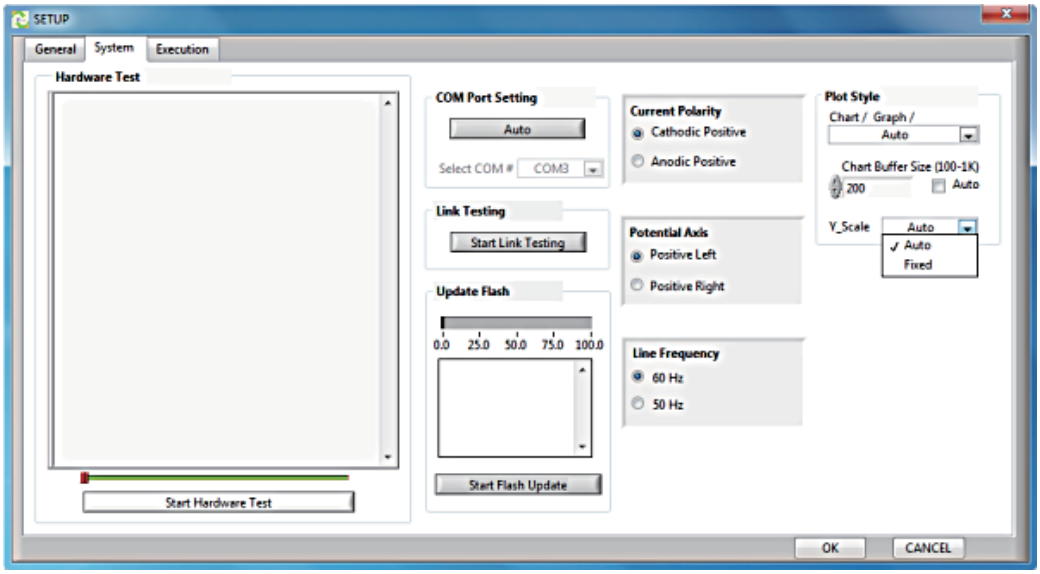
Auto:

The above plot style is decided based on experimental condition automatically.

(2) Chart Buffer Size (100 - 1,000)

If plot style is Chart, display max data points.

If "AUTO" box is checked, Chart Buffer Size is decided automatically.



(3) Y_Scale:

Auto:

Y axis unit is changed during run automatically.

（If variable volume onto Y axis is slight small, expand Y axis unit.）

Fixed:

Y axis unit is fixed at sensitivity (A/V)

8.7. Hardware Test

When hardware test is done at the bottom of System screen, each command refers to the following table.

Hardware Test	This checks the hardware and gets a new set of calibration coefficients for the instrument This can take a few minutes to finish, and will report the test results in the window.below. The new calibration data can also be saved for future use. If errors appear on the test results, a few things may be tried first:
	Run the Hardware Test several more times to see if the same errors repeat every time
	Turn off the instrument and computer, reboot both, and then try again. If errors still exist, contact the manufacturer for service.
COM Port Setting	(CP210x_VCP_Win_XP_S2K3_Vista_7_v6.5.exe) installed on the PC will convert the USB data communication to a serial data communication protocol. Please refer to Confirmation of device driver
Auto	The instrument automatically sets the comports
Manual	Manually set at 0 to 9 com ports.
Update Flash memory	There is a program placed in the flash memory inside the Model 2323 instrument for its proper operation. Due to our constant efforts to improve the instrument’ s performance and functionality, Here are the steps to update flash memory
	Save the new version of the flash program (such as“Model 2323x.hex”) onto your computer
	Quit all other programs running on your computer except Model 2323.exe.
	Go to the SETUP panel and click Update Flash.
	Find the flash program (“Model 2323x.hex”) and click OK to start the update process.
	Wait for the update to finish (this could take a few minutes). When the update has finished, a window will appear and say“Update finished successfully”. Click OK and close the SETUP window.
	EXIT: the Model 2323.exe program and turn the instrument off and then on. Restart Model 2323.exe to resume normal operation. Note: Please do not disturb the computer or the instrument during a flash update, as this may cause damage to the instrument!
Current Polarity	Select the displayed current direction as either Cathodic Positive or Anodic Positive.
Potential Axis	Select the displayed potential direction as either Positive Left or Positive Right
Line Frequency	The program will use this parameter to reduce the line frequency noise on the measuredsignal for certain ADC sampling rates. A CS-3A Faraday cage may also be used to reduce the line frequency (and other electromagnetic) interference on the signal, especially for the low current measurements.

9.RRDE-3A Rotating Ring Disk Electrode Apparatus Ver.1.2

9.1. Set the rotating speed of the RRDE-3A manually. During rotating the electrode select LSV from Technique Selection at the Model 2325 software. Connect the Model 2325 cell cable with WE1 disk electrode and WE2 Ring electrode, and connect a white aligator clip connects with reference electrode, and a red aligator clip with counter electrode.

Please refer to the following table of the cell cable connection.

Reference Electrode	: 1
Counter Electrode	: 2
Disk Electrode	: 3
Ring Electrode	: 3

9.2. Rotating Speed Setting

For measurement in a manual mode, the rotating speed setting is performed before starting the measurement.

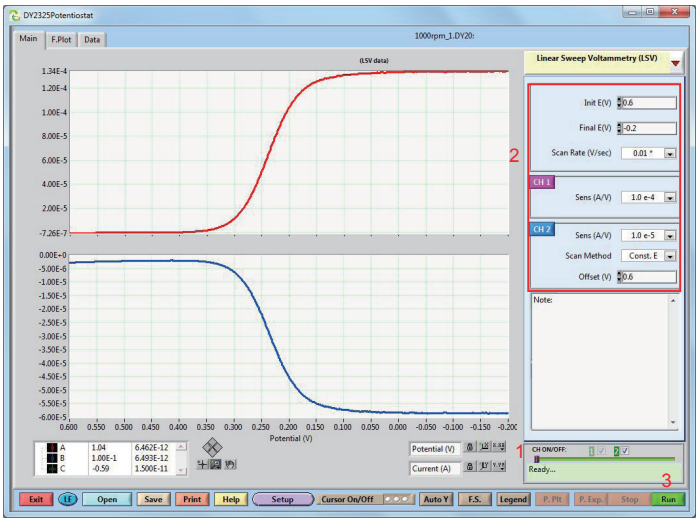
Example:

1.Turn the rotation switch to a "SET" position.

2.Set the rotation speed by digital switch knob (1).

3.Turn the rotation switch (2) to a "LOCAL" position. The shaft assembly will rotate and the rotating speed will be displayed on a digital display.

9.3. Model 2325 Setting



Select LSV measurement technique from the main menu of the Model 2325. For RRDE measurement,select bi-potentiostat technique.

Example:

1 Select the 1 and 2 on the channel 1 ON/OFF box, which works as a bi-potentiostat.

2 Set the following parameters.

initial potential

final potential

scan rate

Filter

sensibility

3 Press the start icon and then the measurement will start.

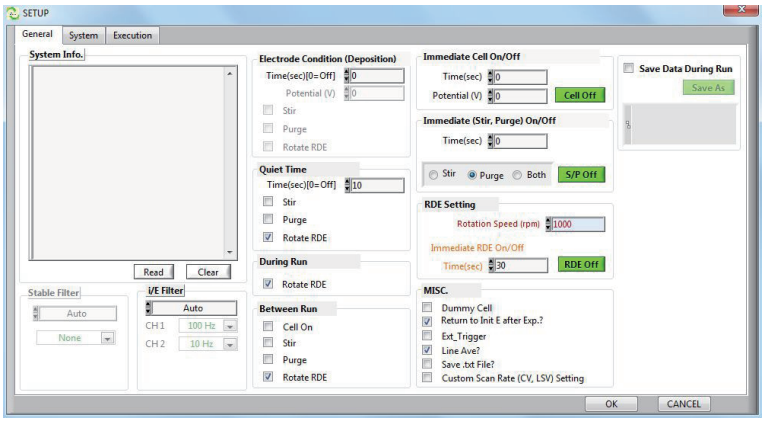
9.4. Remote Mode Measurement

For the RRDE measurement using the remote mode of the Model 2325, connect the remote terminal, in the rear panel of the RRDE, to the I/O port of the Model 2325 with an appropriate cable.

Connect the Model 2325 and RRDE-3A as indicated below:

2325	RRDE-3/A
IN	IN
A GND	GND
Purge	PURGE
D GND	GND

9.5. Remote Setting



Turn the rotation switch to a "REMOTE" position. Select the set-up from the Model 2325 software. Open the general window at the left top.

Set the four parameters below and press OK.

Quiet time

RDE Rotation

RDE rotation during Run

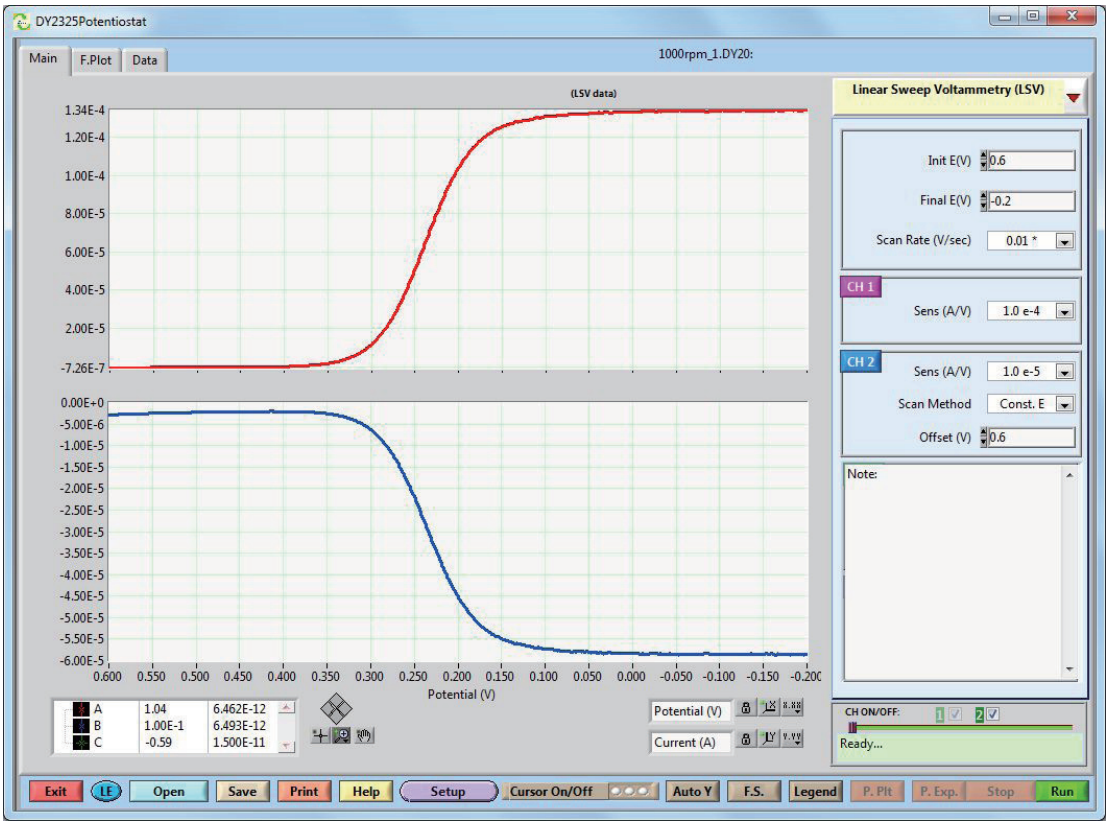
RDE rotation speed setting (rpm)

9.6. Measurement

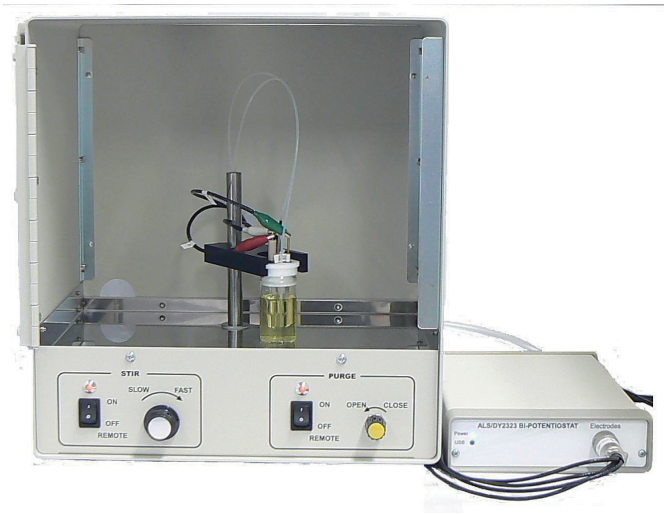
When press OK in the SETUP window, it will automatically return to the main window.

Measurement technique, as a manual setting for RRDE measurement, sets the parameter for RRDE measurement in a LSV mode.

Press the measurement icon at the right bottom of the main window, then RRDE measurement of the remote control start.



10.CS-3A Cell Stand Ver 1.1.



10.1. CS-3A Cell Stand Setting.

When press OK in the SETUP window, it will automatically return to the main window.Measurement technique, as a manual setting for RRDE measurement, sets the parameter for RRDE measurement in a LSV mode. Press the measurement icon at the right bottom of the main window, then RRDE measurement of the remote control will start.

Setting of the gas purge and stirrer.

Turn on the stirrer switch, and set the rotation by the front stirrer switch.

Turn on the purge switch, and control the flow by the front purge switch.

10.2. Remote Control Setting.

After pass electrode leads are passed, communication cable is connected with PC,

electrode leads and control line cable are connected between the model 2325 and CS-3A cell stand. CS-3A is controlled by Model 2325,

Please refer to the following cell cable connection:

2325 CS-3A	(25 pin terminal)
Purge PURGE	(21)
Stir STIR	(8)
D GND GND	(7)

If remote control is used, CS-3A is preset.

1. Set stirer switch ON.
2. Set Purge switch OFF.

10.3. Remote Setting.

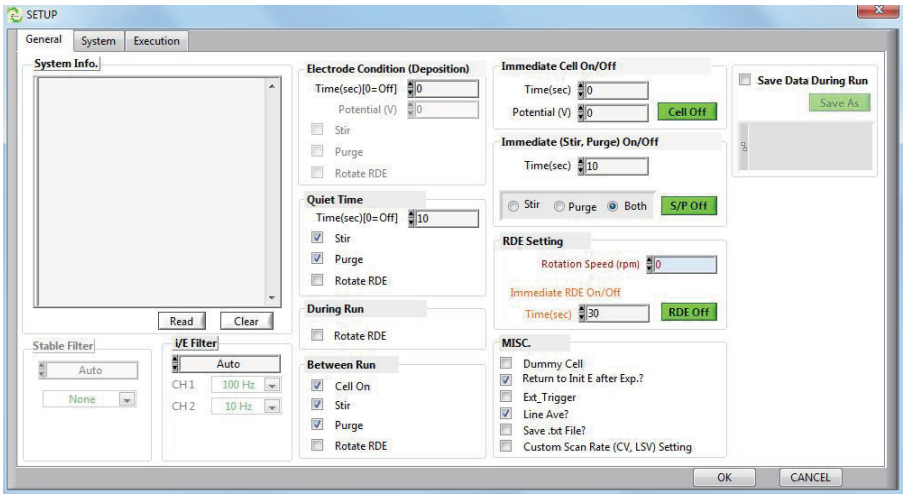
Click Setup button from the Model 2325 software. Open General window at the left top.

Set the parameter described in red line.

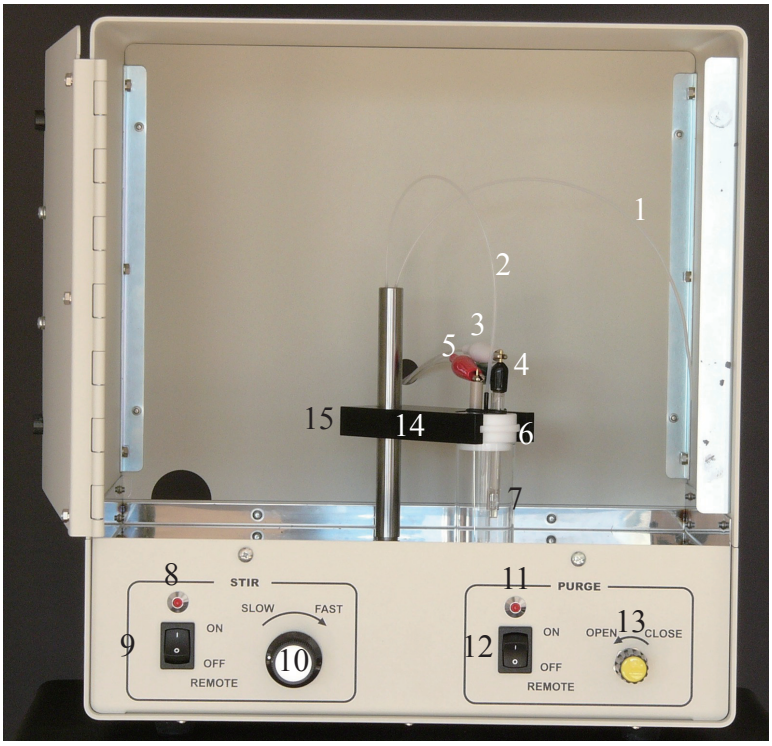
1.Purge in the Quiet time, if stirrer is needed, stir, and select purge.

2.Purging during Run, if stirrer is needed, stir, and select purge.

3.Immediate purge, if stirrer is needed, time (sec), purge, stir the same time,and choose either use alone.



10.4.Introduction of CS-3A cell stand.



CS-3A front panel.

CS-3A Cell stand application will be introduced. CS-3A provides the sample purging and stirrer function. Furthermore reduction of external electrical interference and high-speed scan rate can be performed.

Front panel components of CS-3A are listed below:

#	Description
1	Gas blanket line.
2	Gas purge line for Test sample.
3	Reference electrode (white clip)
4	Counter electrode (red clip).
5	Working electrode (green clip).
6	Teflon cell vial cap.
7	Test sample glass cell vial.
8	Stir LED: LED is flashing when stir is turned on, either manually or remotely.
9	Stir control switch: Manually control stirrer or select remote control option.
10	Knob to manually control stirring rate.
11	Gas purge LED: LED is flashing when gas purge is turned on for Test sample cell, either manually or remotely.
12	Test sample gas purge control switch: Manually control gas purge in Test sample cell or select for remote control.
13	Test sample purge rate controller: Needle valve controlling gas flow rate to test sample gas dispersion tube.
14	Cell top positioner.
15	Thumb screw to control height adjustment.

11. Trigger signal acquisition for SEC2000 Ver1.2

The data acquisition of SEC2000 spectrometer system Ver1.2 can be started by an external trigger signal. Fig.1 shows the schematic of external trigger signal on "High Level" mode. When the external signal changes from 0 V to 5 V, the spectrometer is active, and measurement starts.

The data acquisition of SEC2000 can be also started on "Low level" mode, the opposite schematic of "High Level" mode. The following example describes the method how to control the SEC2000 by external trigger signal on "High Level" mode.

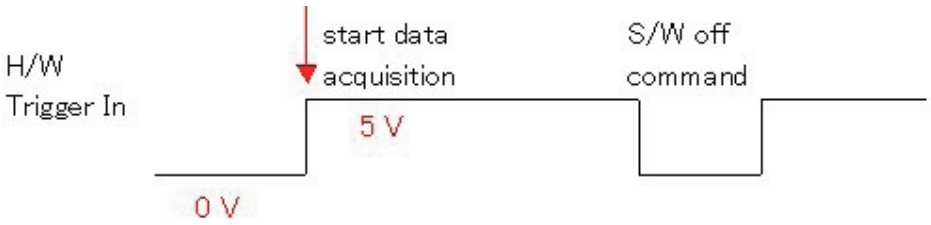


Fig 1.External Trigger Signal: High level

11.1. SEC2000 Trigger In cable

Connect the Trigger cable to the Spectrometer of SEC2000 as shown in Fig. 2. And connect the Ground and Trigger In wires with the cable of electrochemical analyzer.

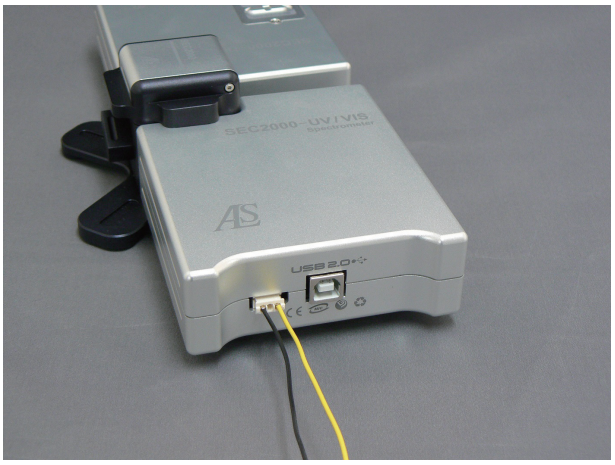


Fig. 2 The external trigger cable. The black wire is for Ground, and the yellow wire is for Trigger In.

11.2. Connect with the electrochemical analyzer

Using a Model 2325 Bi-potentiostat, connect the AGND pin to SEC2000 Ground wire and the V_RDE pin to SEC2000 Trigger In wire as shown in Fig. 3.

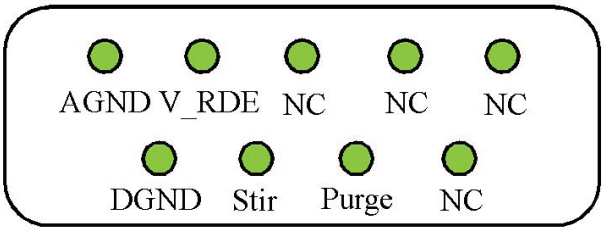


Fig. 3 9-pin sub-D connector at the back panel of Model 2325.

11.3. Setting Trigger Out of Model 2325 Bi-potentiostat

To trigger SEC2000 on "High Level" mode, set the trigger out of Model 2325 first. In the "SETUP" window, configure "RED Setting" / "Rotation Speed (rpm)" to "5000 " . Then, the signal output from the V_RDE pin is 0 V between the measurements and 5 V during the measurement. A 0 V signal is applied to SEC2000 before starting the measurement.

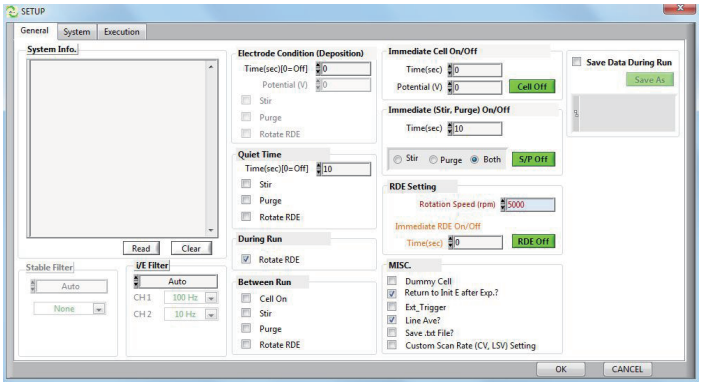


Fig. 4 Set trigger out by configure RED.

11.4. Setting of SEC2000 software

To use the trigger function, please choose the trigger mode from the menu of "Time" / "Trigger Setting" to "Active High" (Fig. 5).

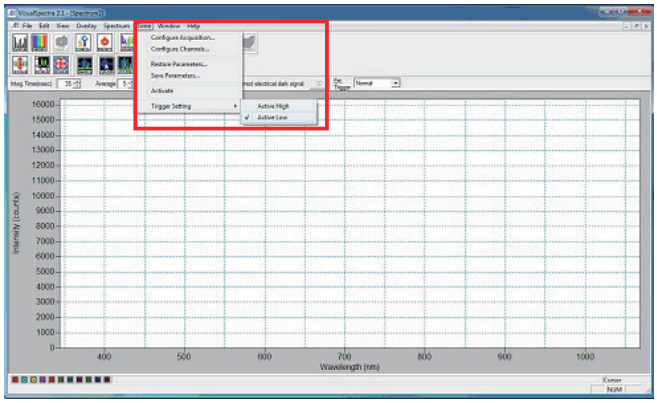


Fig. 5 Choose the trigger mode on software

11.5. Setting of Time acquisition

Choose "Trigger Enable" in the lower spectrum screen, and click "START" icon in the top of the monitor screen as shown in Fig. 6. Then, the SEC2000 will wait for the change of the external signal. In this time, Trigger In wire receives a 0 V signal.

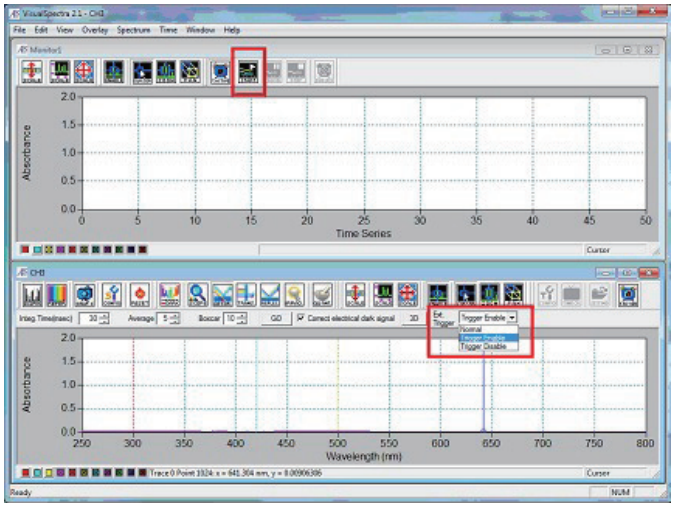


Fig. 6 Set trigger enable and wait for external signal by click of the start icon on software.

11.6. Start Measurement

When click the "START" icon of Model 2325 Bi-potentiostat (Fig. 7), Trigger In pin of SEC2000 receives the signal changing from 0 V to 5 V, the spectrometer becomes active, and the spectrum measurement starts at the same time (Fig. 8).

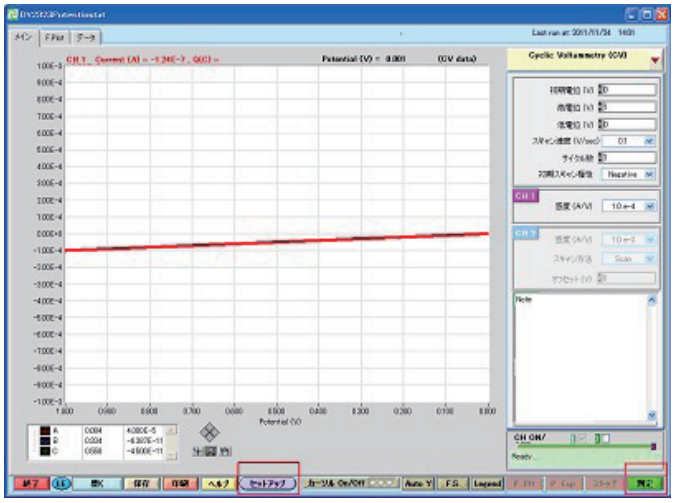


Fig. 7 Start measurement from Model 2325.

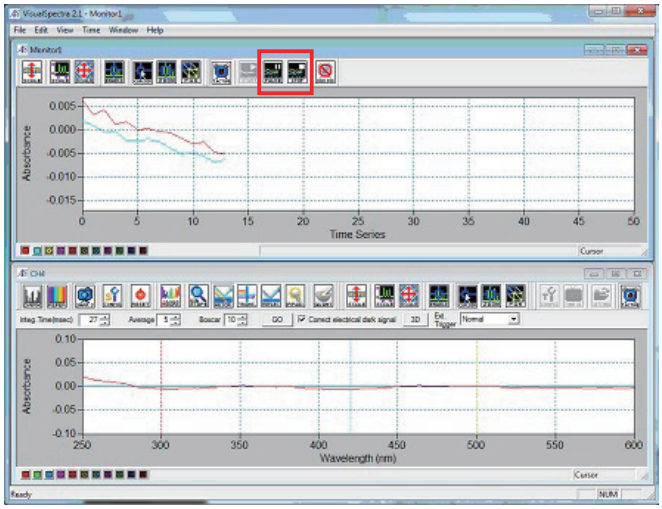


Fig. 8 Spectrum measurement and time course acquisition.

11.7. Stop measurement

To stop the spectrum measurement, you may click the "STOP" icon in Fig.8 or set the "Duration" from the "Configure Time Acquisition" of SEC2000 in Fig. 9.

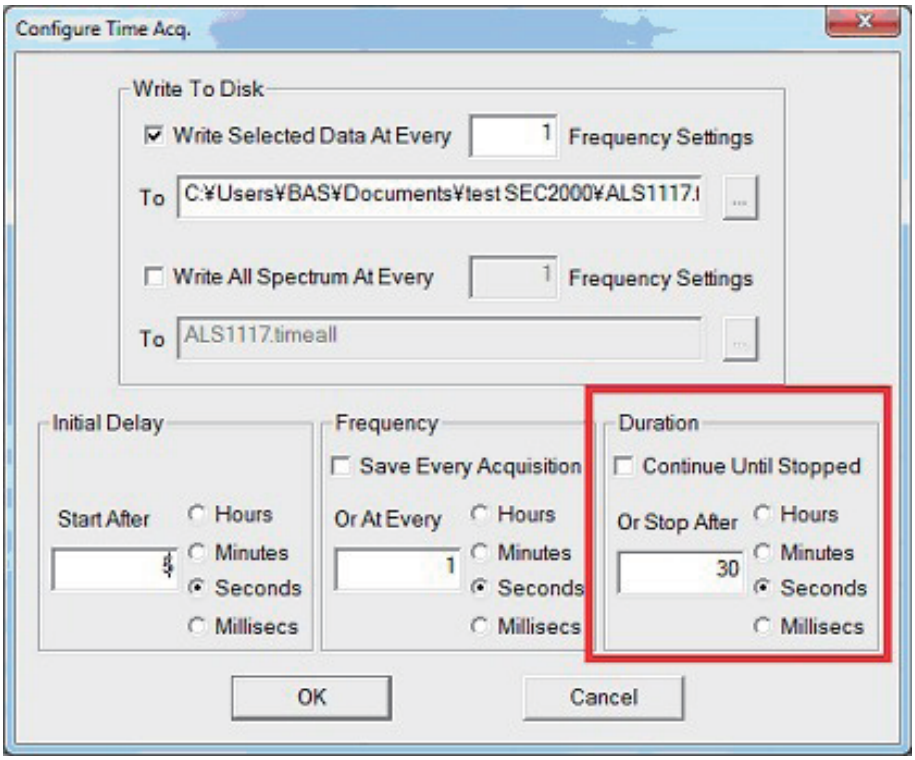
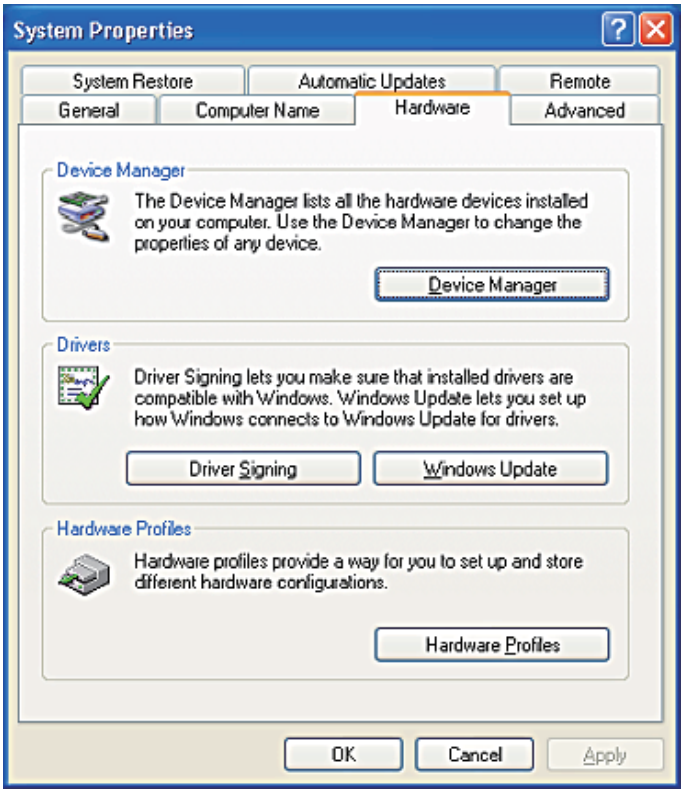


Fig. 9 Configure Time Acquisition.

About the detailed Time Acquisition, please read the document of SEC2000 Manual.

Appendix I: USB device driver (CP210xVCPInstaller.exe).

When Model2325 control program is installed. USB driver (CP210xVCPInstaller.exe) is installed, after Please confirm whether USB device driver is assigned. Please click "my computer" on the PC, and click right button on the mouse. "property" appears and select it. The following system property is shown, and then "hardware"is selected by mouse.

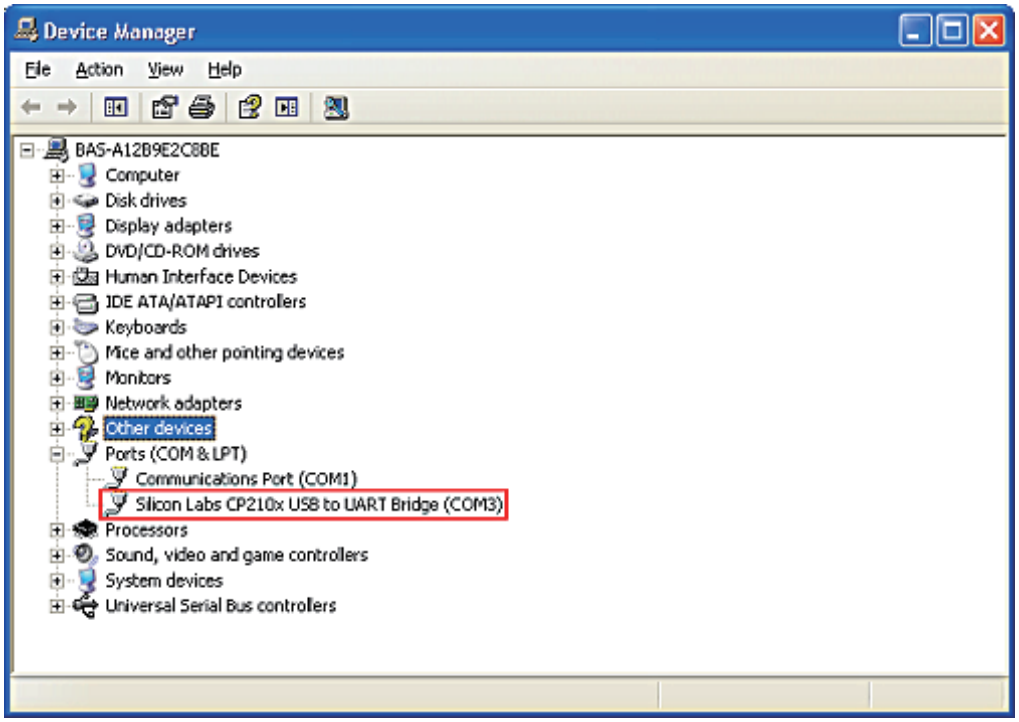


Confirmation of device driver.

Click device manager.

1.Select hardware of my computer property. Device manager is clicked .

2.Open the device manager, and then Ports (COM &LPT) is clicked. "CP210x USB to UART Bridge Controller (COMx)" [x com port #] appears. USB driver installation is successful.



Appendix II: Hardware specification.

Max output current:	± 50 mA
Potential range:	± 4.095 V
Bias Potential range:	± 4.095 V
Compliance voltage:	± 10.0 V
Current range:	± 100 nA ～ ± 50 mA (7 range)
Current resolution:	0.0019 %、3 pA/100 nA range
Current accuracy:	< 1.0 %
Input bias current@ 25 centi dgree:	< 0.2 nA
Min potential step:	1.0 mV
Input impedance:	> 10^{12} Ω
ADC converter:	16-bit, 100 kHz
DAC converter:	16-bit
Potential bandwidth:	> 20 kHz
Rise time:	< 5.0 μsec / V
Min time base:	0.1 msec
Max data point/CH	15,000
RRDE rotation control (V):	0 ～ 10 V
RRDE control signal (stirrer, purge):	TTL
Cell connection:	WE1, WE2, RE, CE
communication interface:	USB (Windows XP/Vista/7/)
Size (W x D x H) / weight:	15 x 26 x 5 cm, 1 kg
Power:	90 ～ 240 VAC, 10 W

Electrochemical technique

1Amperometric i-t

Sampling time (sec) = [0.0001 ～ 10].

2) linear sweep voltammetry (LSV)

Scan rate (V/sec) = [0.001 ～ 10].

3) Cyclic voltammetry (CV)

Scan rate (V/sec) = [0.001 ～ 10].

4) Open circuit potential vs. time (OCP)

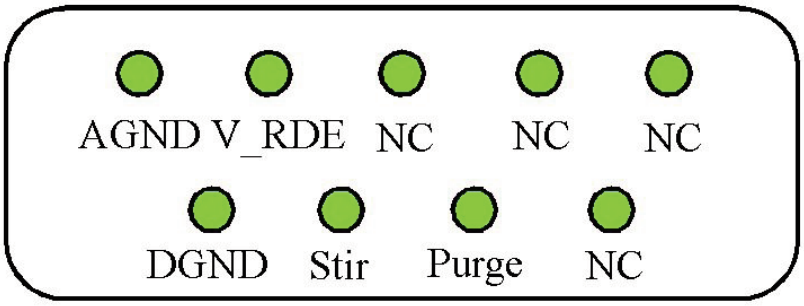
Samoling time (sec) = [0.0001 ～ 10].

Appendix III: I/O Port

A 9-pin sub-D connector at the back panel provides several additional inputs and outputs which can be used to monitor and control several functions of the instrument:

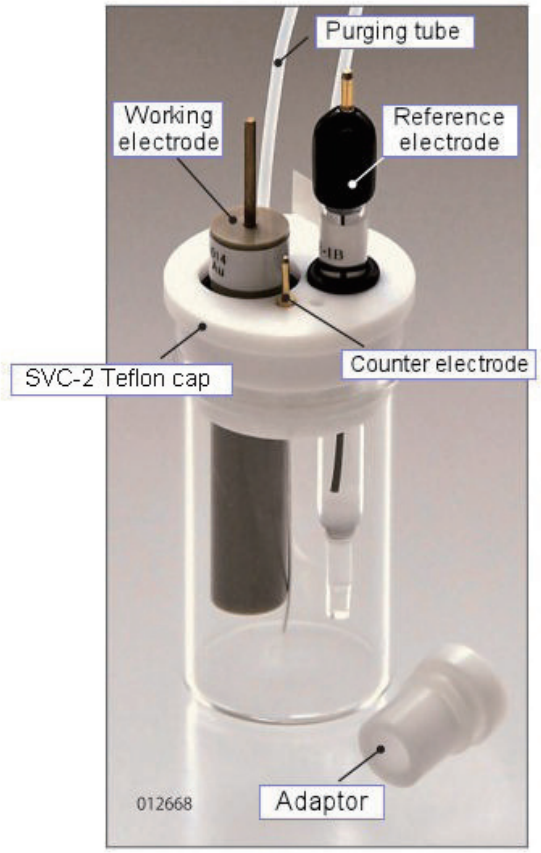
V_RDE:	Voltage output (0-10 V) that is proportional to RDE rotation speed of 0-10000 rpm. 50 ohm output impedance。
Stir & Purge:	Digital output (TTL signal), active low
AGND:	Analog ground of the instrumen
DGND:	Digital ground of the instrument

The other pins are reserved for future expansion purposes and should not be connectedby the user.



Voltammetry Cells

SVC-2 Voltammetry cell



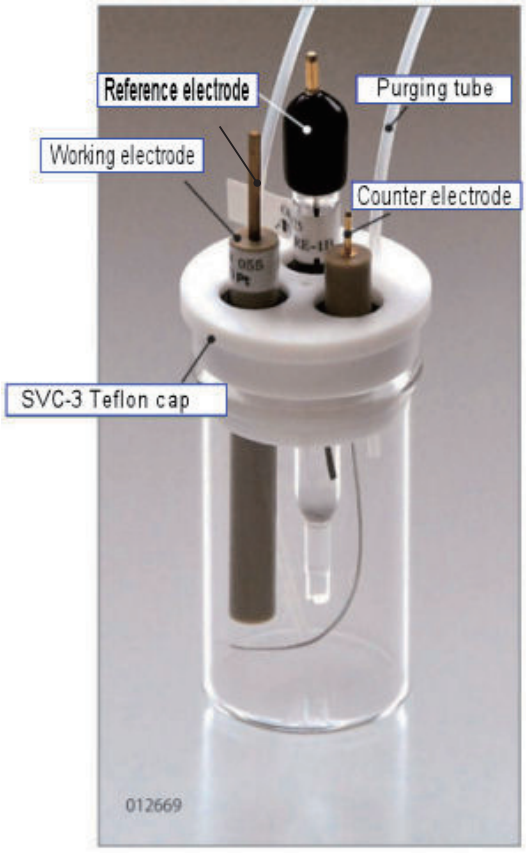
4 ways application

SVC-2 Voltammetry cell can also be used as previous VC-2, VC-5, MCA and SVC-2C Voltammetry cells. Each Voltammetry cell has its specific feature. However, SVC-2 can be used in 4 ways, and you also can apply as an oxygen-free voltammetry cell.

1. For various types of electrodes.
2. Sample volume from 5 to 20 mL
3. Easy removal of the dissolved oxygen

Cat No.	Description	
012668	SVC-2 Voltammetry cell	
Contents		Qty
001056	Sample vial (20 mL)	7
002222	Pt counter electrode	1
012670	Teflon cap for SVC-2	1
010537	Purge tube (ETFE), 1 m	1
Option		
012177	Sample holder 9 mm $^{\phi}$	2

SVC-3 Voltammetry cell



This cell can be utilized with CS-3A Cell stand. This feature is well suited for measurements of ultra weak current.

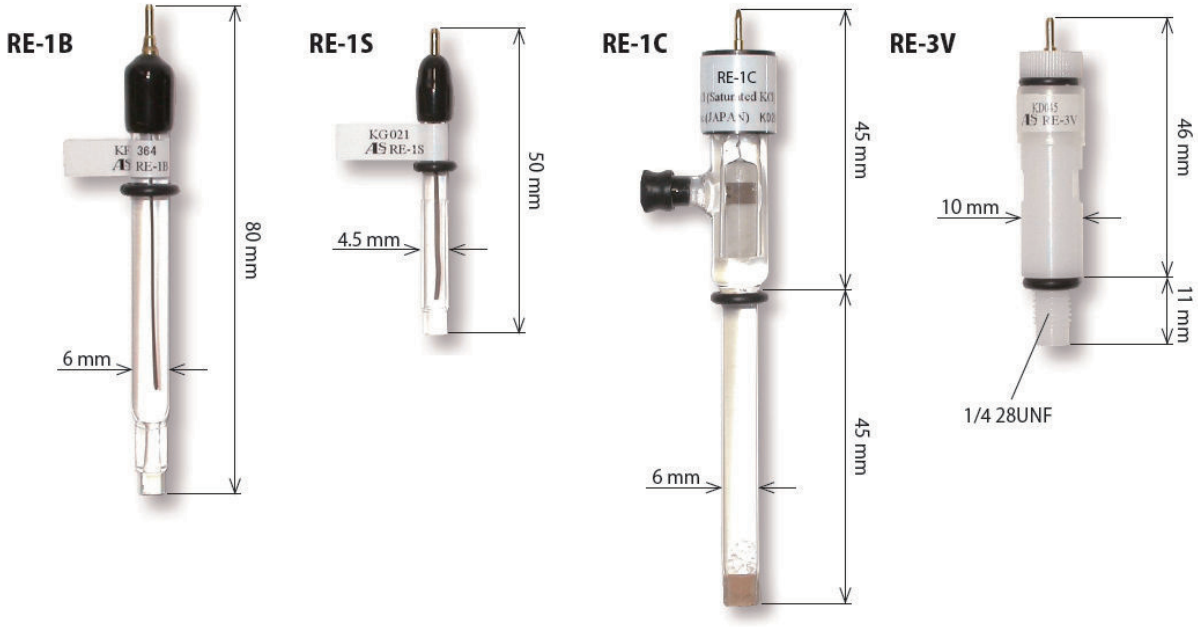
1. Sample volume: 5-10 mL.
2. For various types of electrode.
3. Easy removal of the dissolved oxygen.

Cat No.	Description	
012669	SVC-3 Voltammetry cell	
Contents		Qty
001056	Sample vial (20 mL)	7
002233	Pt counter electrode	1
012671	Teflon cap for SVC-3	1
010537	Purge tube (ETFE), 1 m	1
Option		
012961	Pt counter electrode 23 cm	1
012963	Ni counter electrode 23 cm	1

Reference Electrode

Reference electrodes are widely used as for electrochemical measurements (CV, LSV, DPV, etc.) and electrochemical devices (electrochemical detectors for HPLC, electrochemical biosensor, etc.). Various kinds of them such as aqueous, non-aqueous, calomel and own-constructing types are available.

Ag/AgCl type (Aqueous electrode)



Feature

1. For application in an aqueous solution
2. Relatively long life

$$AgCl + e = Ag^{+} + Cl^{-}$$
$$E_0 = 199 \text{ mV vs NHE (25 centi dgree)}$$

Cat No.	Description	Liquid junction	Internal solution
012167	RE-1B Silver - silver chloride reference electrode	Vycor glass	3 M NaCl
012168	RE-1S Silver - silver chloride reference electrode	Vycor glass	3 M NaCl
002058	RE-1C Silver - silver chloride reference electrode	Ceramic	Saturated KCl
012169	RE-3V Silver - silver chloride reference electrode	Vycor glass	3 M NaCl
012170	RE-3VP Silver - silver chloride reference electrode	Vycor glass	3 M NaCl

Technical note

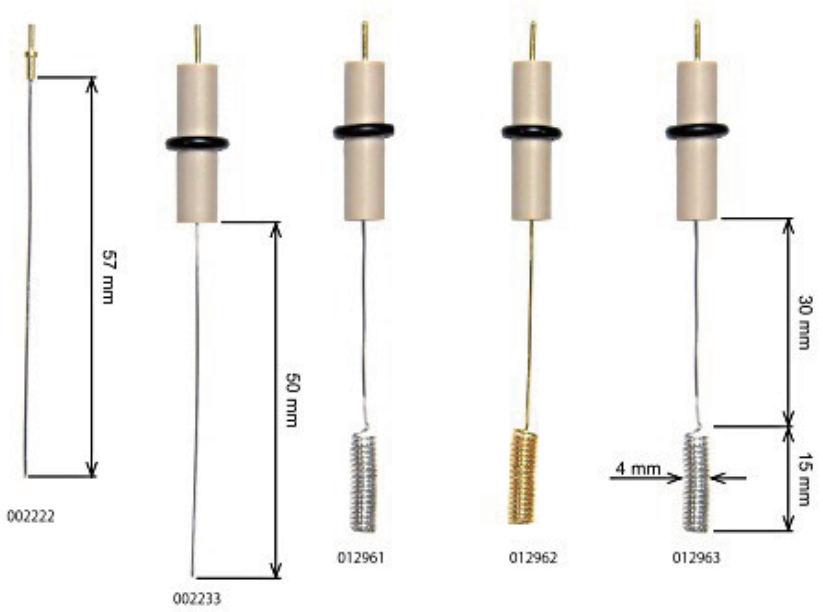
Reference Electrode potentials at 25 ° C

NHE (Normal Hydrogen Electrode) ---------- 0 mV
SCE (Saturated Calomel Electrode) ---------- 241 mV
SSCE (Sodium Saturated Calomel Electrode) ---------- 236 mV
Ag/AgCl (Saturated KCl) ---------- 198 mV
Hg/Hg_2SO_4 (0.5 M H_2SO_4) ---------- 682 mV

(Encyclopedia of Electrochemistry 5th Ed. (The Electrochemical Society of Japan)

Counter Electrode

Three different shapes of the counter electrode are available. Select the counter electrodes suitable for the experimental condition. Custom-made counter electrode is also available.



Cat No.	Description	Length	Pt wire diameter	Purpose
002222	Pt Counter electrode	5 cm	ϕ 0.5	SVC-2, VC-4, Plate Material Evaluating cell
002233	Pt Counter electrode	5 cm	ϕ 0.5	SVC-3
012961	Pt Counter electrode (coil type)	23 cm	ϕ 0.5	RRDE-3A, Bulk Electrolysis, SVC-3
012962	Au Counter electrode (coil type)	23 cm	ϕ 0.5	RRDE-3A, Bulk Electrolysis, SVC-3
012963	Ni Counter electrode coil type)	23 cm	ϕ 0.5	RRDE-3A, Bulk Electrolysis, SVC-3

※ 002234 Pt counter electrode 23 cm as Pt coiled type is available.