

Coin Cell Multisine PEIS Test

Purpose

This test is to demonstrate coin cell battery's Multisine EIS test. Single sine EIS takes long time to measure EIS especially in low frequency range. You can shorten the measurement time using Multisine techniques.

Multisine techniques can be used as Single sine + Multisine or Multisine only.

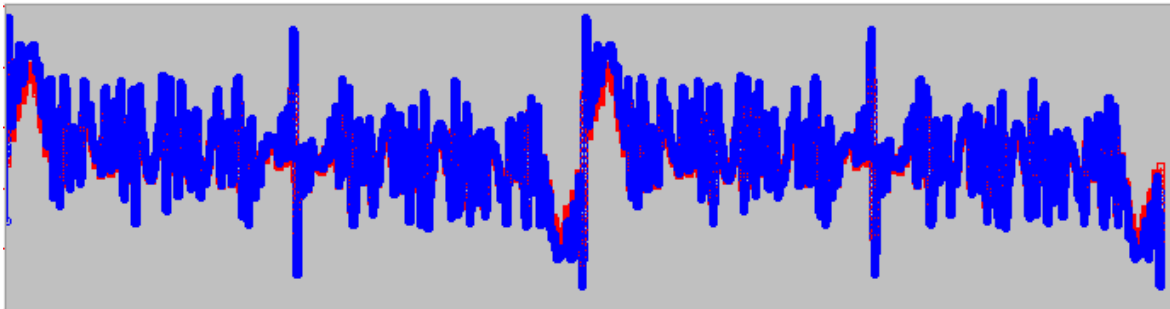
If you set same frequency value for SS start frequency and MS start frequency, only Multisine will be applied.

Data points for Multisine will be 9 points for lower frequency decade and 10 points per higher frequency decade. (This is fixed value).

Multisine will be applied for 2 decades based on lower frequency decade's base frequency. For example, if Multisine was done from 100Hz to 10mHz, they two times Multisine will be applied automatically.

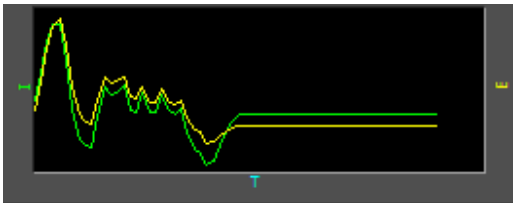
1st Multisine will be done for 100Hz to 1Hz based on 1Hz base frequency. Data points will be achieved as 10 points for 100Hz to 10Hz and 9 points for 10Hz to 1Hz. Next Multisine will be done for 1Hz to 10mHz based on 10mHz base frequency. Data points will be achieved as 10 points for 1Hz to 100mHz and 9 points for 100mHz to 10mHz.

Each Multisine needs time for two times of base frequency.



Multisine waveform.

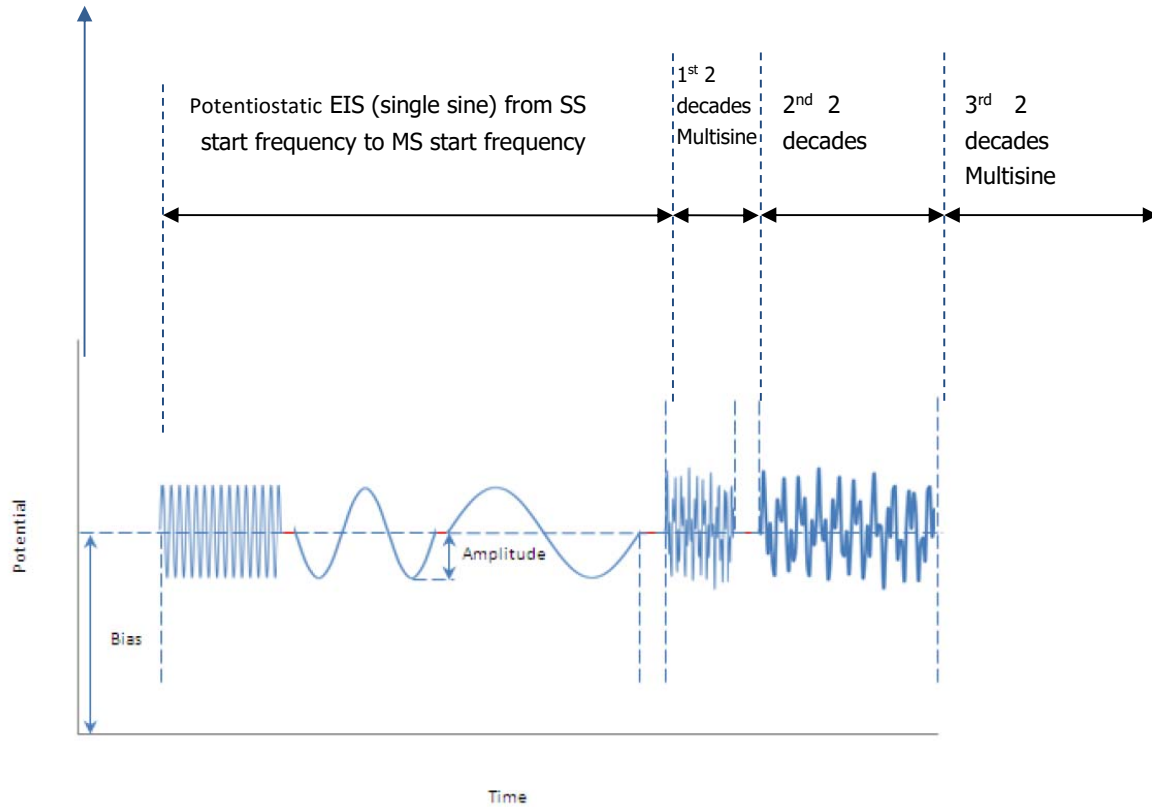
Multisine's progress can be checked from Wave scope on single channel monitor.



As the above Multisine data points will be changed. (From the above example, it shows about 50% progress)



This technique apply potential sine wave adding to bias potential and measure impedance by scanning frequency from SS start frequency to MS start frequency and apply complexed potential wave and measure impedance by FFT analysis per each two decades from MS start frequency to Final frequency. You can select potential value vs reference potential or open circuit potential and amplitude. Amplitude value is rms value.



This application note guides to understand Multisine EIS techniques using coin cell sample by comparing single sine EIS measurement and multisine EIS measurement..

This demonstration's test condition is;

➤ Single sine PEIS

- Initial frequency: 10kHz
- Final frequency: 10mHz
- Bias: 0V vs Eoc
- Amplitude: 10mV
- Points per decade: 10

➤ Multisine PEIS

- Initial frequency: 10kHz
- Final frequency: 10mHz
- Bias: 0V vs Eoc

- Amplitude: 10mV

Preparation

- ZIVE SP/MP electrochemical workstation
- 4.2V Li ion Coin cell
- Coin Cell holder

Cell Connection

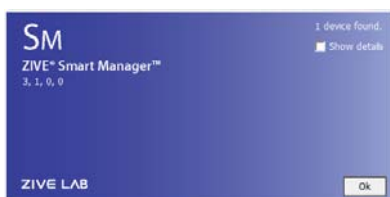
+ electrode(Green lead & Blue lead)

- electrode(White lead & Red lead)



Procedure

1. Turn the Power switch on the ZIVE SP/MP electrochemical workstation
2. Open the SM software by clicking the SM icon. The following progress box will appear, and will show the progress of checking instrument configuration and communication between ZIVE SP/MP electrochemical workstation and PC.



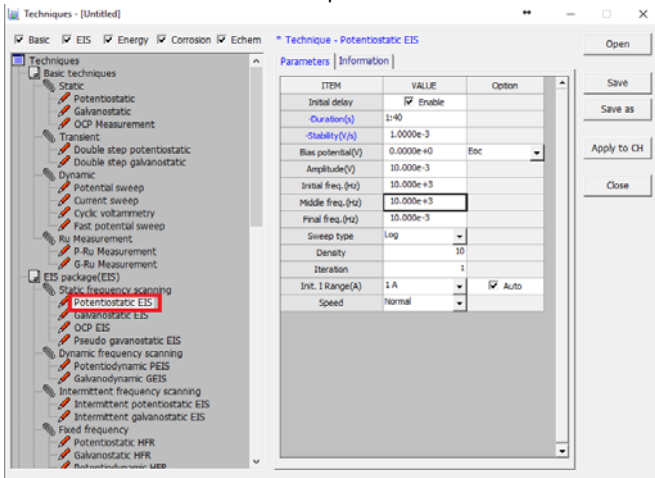
If the link is successfully connected, Click “OK” button on the box then the progress box will automatically disappear and SM software will appear. If the link failed, The following progress box will display then click the “Retry” button.



If the link failed again after clicking “Retry” button, you need to check USB cable connection.

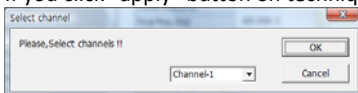
Single sine PEIS

1. Select Potentiostatic EIS in technique menu



2. Click "Save" button to save the technique file which contains the above parameter and setting file name.
3. You can assign this technique file to channel(s) which you want by click "APPLY" button or select schedule file using file selection on "Single channel control/monitor" or "multi channel control/monitor"

If you click "apply" button on technique menu, You can see the following channel selection menu.



Select channel and click OK then this technique file will be assigned on the channel.

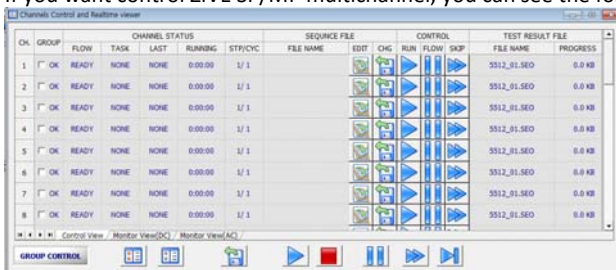
Click "Close" button or minimize technique window.

4. If you want control ZIVE SP/MP electrochemical workstation using "Single channel control/monitor", you can see following windows.



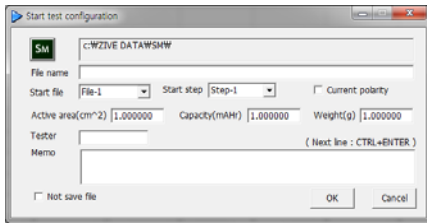
To start experiment, click Start button


If you want control ZIVE SP/MP multichannel, you can see the following window



To start experiment for specific channel, click Start button on the channel. If you want to start experiment for multiple channel, click on Group column which you want to start and click Start button at bottom side.

5. After click start button, you can see the following box.



The data file name is automatically determined as default value but if you want to change data file folder then click  icon



You can make new folder which you want to save.

- ◆ If you want use your file name, input your file name on “File name”
- ◆ If you did not make file name manually, new data folder which named as sequence file name or technique file name under data folder and it’s subfolder will be created with name as date. The data file will be saved in this folder. The data file name will be determined automatically as string with sequence file name or technique file name and hour and minute and second, finally channel number will be added.

example) If you used sequence file for test and its file name is testabc.zsc and channel number is 1 and test date is 2000 year January 1st time is 15:30: 1 then the data file will be saved as

C:\Zive data\sm\data\testabc.zsc\2000010115\3001_01.sdo (If data file have DC data only)

Or

C:\Zive data\sm\data\testabc.zsc\2000010115\3001_01.sde (If data file have DC data and EIS data)

Or

C:\Zive data\sm\data\testabc.zsc\2000010115\3001_01.seo (If data file have EIS data only)

e.g.) schedule file name with extension\yearmonthdayhour\minutesecond_channel number

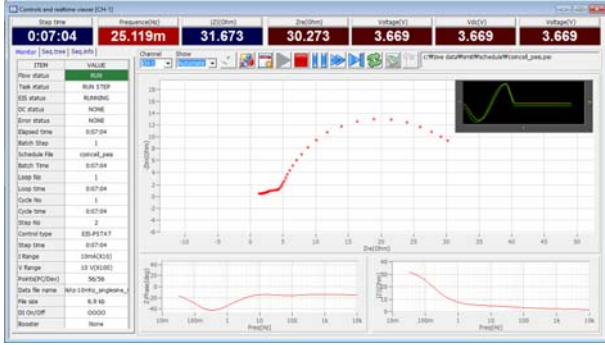
If you input file name as “tommy” then

C:\Zive data\sm\data\testabc.zsc\2000010115\tommy3001_01.sdo (sde,seo)

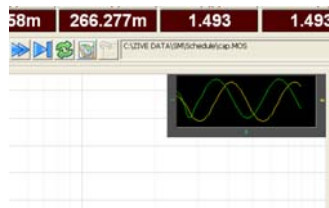
- ① Start Step: If your sequence file has several steps, you can select starting step.
 - ② Start file: If batch file is loaded, select file number
 - ③ Current polarity: If you want reverse polarity for measured current, check on this box.
 - ④ Active area: For calculation of current density
 - ⑤ Capacity: For C-rate value calculation
 - ⑥ Weight: For specific capacity calculation
 - ⑦ Tester: Operator name
 - ⑧ Memo: Text information for test (For line change, use CTRL+ENTER)
- No Save file: If you click this check box, the data will NOT be saved.

If you are ready to test, click OK button then experiment will be started.

6. You can see real time plot as the following.

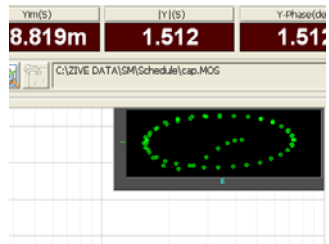


Real time EIS graph shows sub window at right upper side. This window display sine wave or E vs. I graph to check data quality. Default display is sine wave.

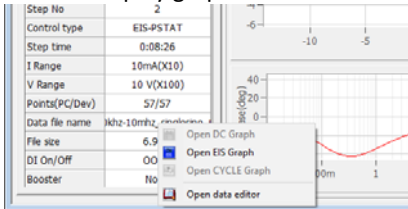


This shows two sine wave graphs. One is for current (green line) and the other is for voltage (Yellow line).

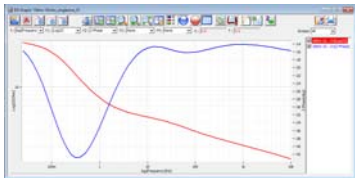
If you switch this graph to I vs E, double click on the graph then graph format will be changed.



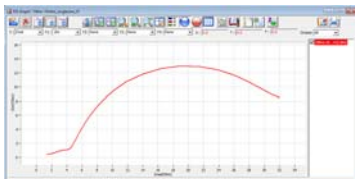
7. You can display graphic or data editor by clicking right mouse on data file name



8. You can select Bode plot by clicking icon or Nyquist plot by clicking icon.

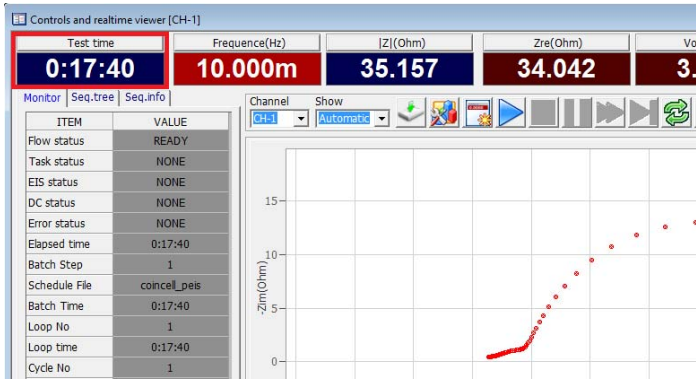


Bode plot



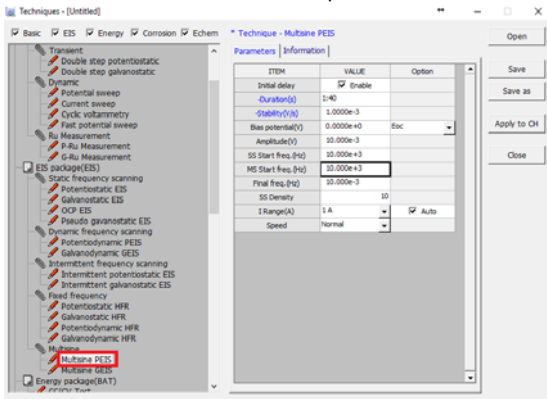
Nyquist plot

9. It took 17 minutes 40 seconds to finish single sine PEIS test.



Multisine PEIS

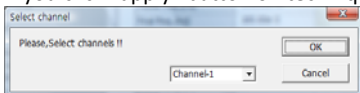
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Select channel and click OK then this technique file will be assigned on the channel.

Click "Close" button or minimize technique window.

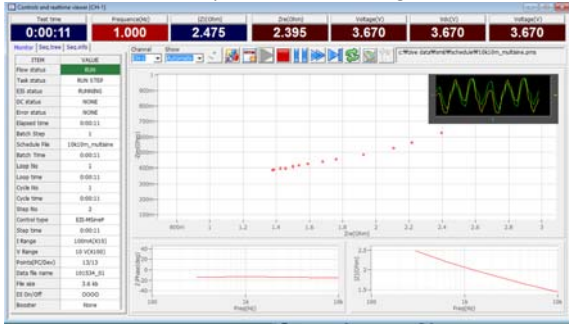
4. If you want control ZIVE SP/MP electrochemical workstation using "Single channel control/monitor", you can see following windows.



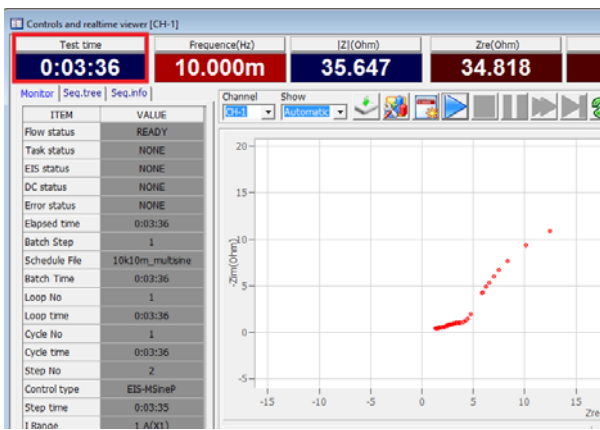
To start experiment, click Start button



5. You can see real time plot as the following.



6. It took 3 minutes 36 seconds to finish Multisine PEIS test.



Comparison between single sine PEIS and Multisine PEIS

1. Measurement time
 - Single sine PEIS: 17min 40sec
 - Multisine PEIS: 3min 36sec
2. Spectrum

