

Designed by ZIVE LAB



Electrochemical Workstation ZIVE SP1

*Including Internal FRA
10Volts/1Amp*

*For
Corrosion
Material Testing
Sensor/BioElectrochemistry
Battery/Fuel Cell
Super Capacitor/Solar Cell*

Electrochemical Workstation ZIVE SP1

The **ZIVE SP1** is an outstanding potentiostat/galvanostat/FRA offered at affordable price. This powerful model is a perfect choice for the complete DC and impedance characterization of various electrochemical applications.

The **ZIVE SP1** is equipped with a frequency response analyzer(FRA) for system as standard and it provides high performance impedance measurements over the frequency range 10uHz to 1MHz. The ZRA(zero resistance ammeter) function can measure max. 1 Amp in galvanic corrosion technique. The **ZIVE SP1** can be easily upgraded with adding optional application software package without returning the system to the factory for upgrade.

Features

- Economic high quality potentiostat/galvanostat/impedance analyzer
- Compact size with full functions
- $\pm 10V@1Amp$ control range
- Wide current ranges(1A to 100nA) for various applications
- Built-in FRA : enables EIS tests by using optional software
- 12 EIS techniques capability(option) including multisine
- Capable of multitude of applications
 - corrosion, general electrochemistry, sensor, battery, fuel cell, supercapacitor, solar cell, etc.
- Bipolar pulse capability
- Voltage pulse or current pulse charge/discharge test(GSM,CDMA etc.), sine wave function for ripple simulation in battery test package(option) & pulse plating available
- High speed data sampling time
 - 50usec/sample in burst mode
 - 1msec/sample in normal mode
- 3 measurement/control voltage ranges & 8 measurement/control current ranges
- Internal 350,000 data point storage & continuing experiment regardless of PC failure.
- Optional software package
 - corrosion test software package
 - EIS test software package
 - electrochemical analysis software package
 - battery test software package
- Multichannel configuration available
- Free software upgrade

Application

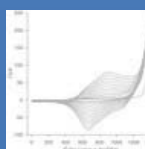
The ZIVE SP1 electrochemical workstation is ideal for fundamental research in electrochemistry, development and quality assurance of new sensors, corrosion/coatings, electrode material, membrane, conducting polymer, evaluation power device research such as battery materials, fuel cells, super capacitors and solar cells.

■ Corrosion



The system is suitable for measuring low corrosion rates(corrosion software package is needed.) and providing EIS test(EIS option) to evaluate corrosion. The ZRA function is supplied for galvanic corrosion measurement.

■ General Electrochemistry



The ZIVE SP1 is also suitable for the development of bio-research, electron transfer kinetic studies or electrochemical analysis of compounds at low trace levels, where multi-channel DC and impedance analysis is beneficial in providing high throughput of results.

■ Sensors



The ZIVE SP1 can be used for sensor research using with DNA chips or screen printed electrodes. The system's minimum current range is 100nA. Cyclic voltammetry, chronoamperometry and EIS measurement can be used for this application.

■ Batteries



The system is very well adapted for researches on cycling behavior of battery. It provides various control modes for battery cycling and can support EVS(electrochemical voltage spectroscopy) test. Fast pulse capability for GSM, CDMA test is included in battery test software package. Pulse profile measurement function to check pulse shape is available. For ripple simulation test, sine wave charging/discharging is available.

■ Fuel Cells



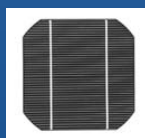
The ZIVE SP1 is ideal for characterizing the fuel cells and anodic/cathodic process mechanism at a development and research grade. This system can be directly used for PEMFC, DMFC, DEFC etc. Automatic current ranging potentiostatic/galvanostatic IV curve is available.

■ Super Capacitors



The ZIVE SP1 has a fast potentiostat circuit with high speed data acquisition(50usec/point in burst mode). This function is well applicable to super capacitor testing. Charging/discharging capability is used for this application.

■ Solar Cells



Solar cell development and production require extensive material and device testing to improve efficiency and match individual cells for panel construction. The ZIVE SP1 is the best solution for photovoltaic cell characterization.

Smart Manager(SM) Software



The Smart Manager(SM) provides user defined test sequence using sequence file, technique menu and batch file. The batch file allows the user to do a serial test by combining sequence files and/or technique files.

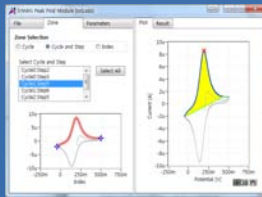
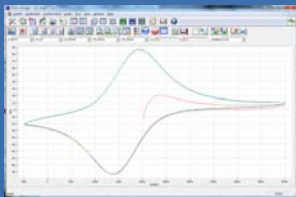
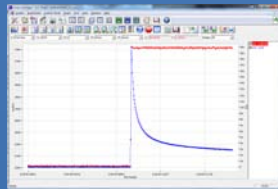
The SM software is easy to use and supports various electrochemical experiments including functions of system control, schedule file editor, real time graph, analysis graph, user calibration, and data file treatment etc.

Each software package's upgrade will be provided at free of charge.

Basic Techniques

Basic Technique with Standard Functions

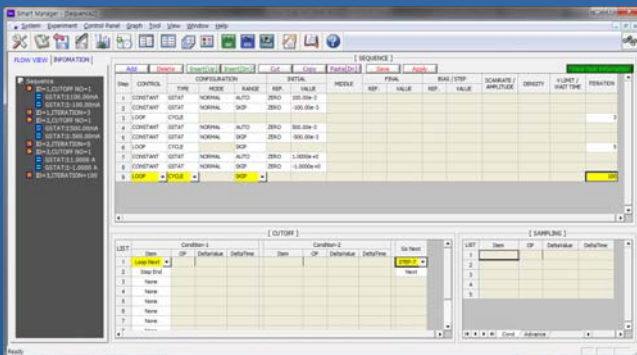
- 1) Potentiostatic
- 2) Galvanostatic
- 3) Voltage sweep
- 4) Current sweep
- 5) Cyclic voltammetry



The above functions can be used sequentially by step control function.

Sequence Editor

User can design his/her experiment procedure using TASK sequential routine editor.



1) Control task parameter

- Constant potential, current, C-rate, power, load, OCP
- Sweep potential, current
- Step potential, current
- EIS control
- ZRA control
- Pulse control
- Rest (voltage monitoring only)
- Loop(cycle) control

software package name	standard	EIS	FRA	COR	EAS	BAT
constant	GSTAT	Yes	Yes	Yes	Yes	Yes
	Crate	No	No	No	No	Yes
	PSTAT	Yes	Yes	Yes	Yes	Yes
	POWER	No	No	No	No	Yes
	LOAD	No	No	No	No	Yes
	OCP	No	No	No	Yes	No
Step	GSTAT	No	No	No	Yes	Yes
	PSTAT	No	No	No	Yes	Yes
Sweep	GSTAT	Yes	Yes	Yes	Yes	Yes
	PSTAT	Yes	Yes	Yes	Yes	Yes
EIS	GSTAT	No	Yes	No	No	No
	PSTAT	No	Yes	No	No	No
	OCP	No	Yes	No	No	No
	PSUEDO	No	Yes	No	No	No
	HER G	No	Yes	No	No	No
	HER P	No	Yes	No	No	No
	MsineG	No	Yes	No	No	No
	MsineP	No	Yes	No	No	No
Rest	Yes	Yes	Yes	Yes	Yes	Yes
ZRA	No	No	No	Yes	No	No
Pulse	Vpulse	No	No	No	No	Yes
	Ipulse	No	No	No	No	Yes
	GSINE	No	No	No	No	Yes
	PSINE	No	No	No	No	Yes

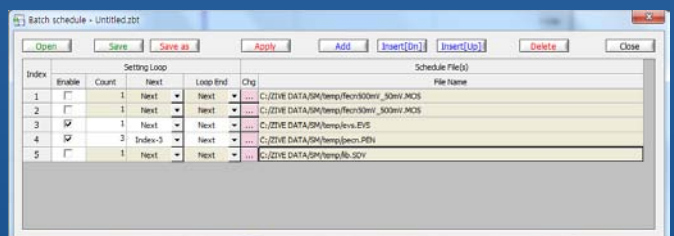
- 2) Cut-off(Vertex) condition
 - Time(step, test, loop, cycle)
 - Current, current density
 - Voltage
 - Capacity
 - .. -dV
 - |dV/dt|
 - |dI/dt|
 - Aux1
 - Eoc etc.

- 3) Sampling condition
 - time, |dI/dt|, |dV/dt|, |dA1/dt|, burst time

- 4) Flow view
 - This displays sequence flow at a glance.

Batch Function

User can design batch file including multiple technique files and/or sequence files. With this batch file, user can do experiments at several techniques/sequence in series automatically.

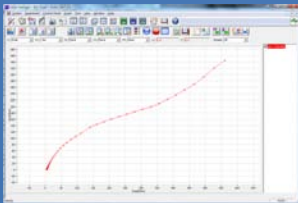


Optional Software Package

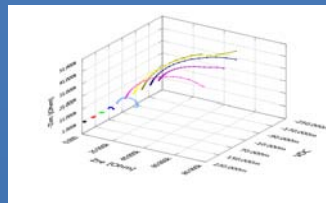
For a wide range of application, specific experimental techniques software packages are provided as option.

■ EIS Software Package (EIS)

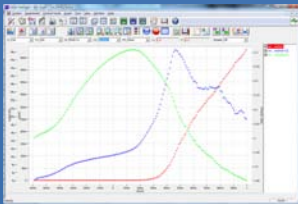
- | | |
|-----------------------------|----------------------------------|
| 1) Potentiostatic EIS | 7) Potentiodynamic HFR |
| 2) Galvanostatic EIS | 8) Galvanodynamic HFR |
| 3) Pseudo galvanostatic EIS | 9) Galvanostatic HFR monitor |
| 4) OCP(*) EIS | 10) Potentiostatic HFR monitor |
| 5) Potentiodynamic PEIS | 11) Multisine potentiostatic EIS |
| 6) Galvanodynamic GEIS | 12) Multisine galvanostatic EIS |



OCV EIS



Potentiodynamic PEIS

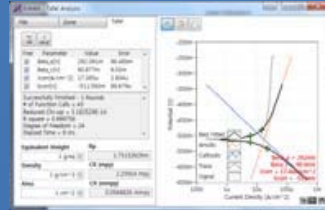


Rs, Cp & Idc vs Vdc plot

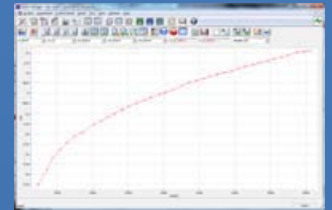
(*) The system measures open circuit potential before for each frequency change and applies AC sine wave on this potential.

■ Corrosion Software Package (COR)

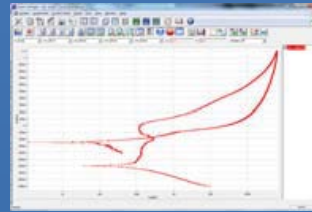
- 1) Tafel (Tafel experiment)
- 2) Rp (Polarization resistance)
- 3) RpEc trend
- 4) PDYN (Potentiodynamic)
- 5) CYPOL (Cyclic polarization resistance)
- 6) GDYN (Galvanodynamic)
- 7) Reactivation
- 8) RpEc trend
- 9) Galvanic corrosion
- 10) Potentiostatic ECN
- 11) Galvanostatic ECN
- 12) ZRA mode ECN



Tafel plot



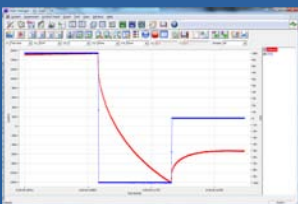
Polarization resistance



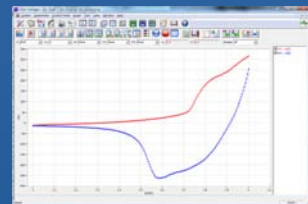
Cyclic polarization resistance

■ Electrochemical Analysis Software Package (EAS)

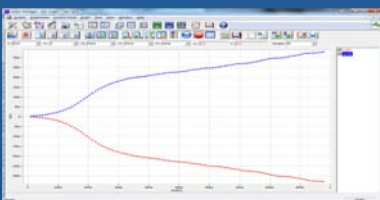
- 1) Step techniques
 - CA (Chronoamperometry)
 - CC (Chronocoulometry)
 - CP (Chronopotentiometry)
- 2) Sweep techniques
 - LSV (Linear sweep voltammetry)
 - SDV (Sampled DC voltammetry)
- 3) Pulsed techniques
 - DPV (Differential pulse voltammetry)
 - SWV (Square wave voltammetry)
 - DPA (Differential pulse amperometry)
 - NPV (Normal pulsed voltammetry)
 - RNPV (Reverse normal pulse voltammetry)
 - DNPV (Differential normal pulse voltammetry)



50 usec sampling



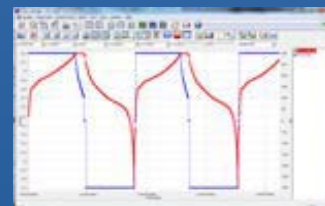
sdv_charging/sdv_discharging



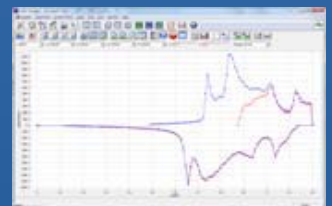
NPV & RNPV overlay

■ Battery/Energy Software Package (BAT)

- 1) Battery test technique
 - CC/CV test for lithium battery charging/discharging cycle life test
 - CC/CC test for NiCd & NiMH battery charging/discharging cycle life test
 - Discharging test
 - EVS (Electrochemical voltage spectroscopy)
 - Variable scan rate CV
 - Potentiostatic IV curve
 - Galvanostatic IV curve
 - Pulse mode is available for GSM & CDMA profile. Pulse shape profile can be measured by user's demand.



CC/CV test



EVS



Pulse shape profile monitor (micro sec order)



Current sine wave (charge ripple simulation)

- 2) Control mode
 - Charge: CC, CC-CV, pulse, sine wave
 - Discharge: CC, CP, CR, pulse, sine wave
- 3) Cutoff condition
 - time, voltage, current, power, auxV etc.
 - Various battery charge/discharge test is available including pulse discharge for GSM, CDMA application.

Control & Real Time Graph

Smart Manager program provides virtual control panel for control & data acquisition with real time graph.



Multichannel real time graph

User can control and monitor in this control panel and he/she can monitor data in VOI (value of interest) window and channel status in one window. Real time graph's X Y axis format will be automatically changed per techniques. It can be

defined by user's demand per techniques. For experiment using sequence file or batch file, user can select 3 real time graphs X, Y axis parameter.

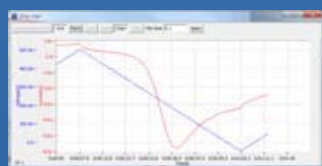
Each real time graphs format also can be selected. The real time graph and VOI will be changed depending on DC test or impedance test automatically. The Virtual control panel always display graph for recent test result. For impedance measurement, wave monitor will be displayed on real time graph to check wave quality. This monitor can be switched to Lissajous (I vs. E) plot.



Single channel control panel

Multichannel real time graph

Strip Chart



The Strip chart recorder function is provided independently of real time graph function. You can monitor 2 Y axis data such as voltage, current, auxV1, power, capacity etc. in real time.

Graph



The Smart Manager's graph function is to simplify the operation. There are 3 kinds of graphs per experiments. You can change X, Y1, Y2, Y3, Y4 axis parameter as you want. Each graph provides short buttons. When you click these buttons, graph format will be changed following short button format.

1) DC graph

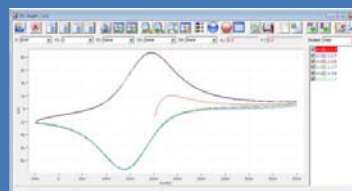
- for general data display
- 4 short buttons: I vs. V, E vs. LogI, V, I vs. time, V vs. Q
- graph parameters: Time, Eref, I, Eoc, Id, Aux1, LogI, Load, ChQ, DchQ, ChQs, DchQs, Ch P, Dch P, Ch-Wh, Dch-Wh, Sum Wh, Sum Q, Sum |Q|, |Q|, Rp, Ch Q/Q0, dQ/dV, Q-Q0

2) EIS graph

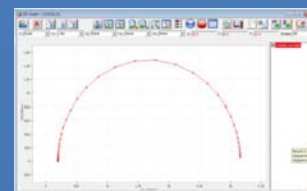
- for EIS data display
- 3 short buttons: Nyquist plot, Bode plot, Cs vs. frequency
- graph parameters: Frequency, Zre, -Zim, Zmag, Zph, Y', Yimg, Y, |Y|, Yph, LogZ, LogY, Rs(R-C), Cs(R-C), Rp(R|C), Cp(R|C), Rs(R-L), Ls(R-L), Q(R-L), time, Vdc, Idc, Aux1

3) BAT graph

- for battery cycle data display
- 3 short buttons: cycle capacity, cycle average, Log(cycle No) vs. depth of discharge plot.
- graph parameters: cycle number, Ch Q, Dch Q, Sum Q, Coulomb Eff, Ch-Wh, Dch-Wh, Sum Wh, Energy Eff, MinV, MaxV, ChQs, DchQ, ChVavg, DchVavg, Vavg



DC graph



Nyquist plot

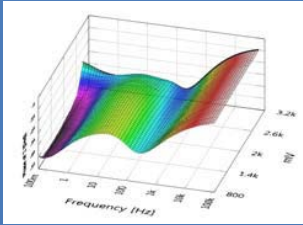
Data Analysis Software

The ZIVE data file can be used for analysis using external IVMAN™ software for DC analysis, IVMANDA™ software for battery data analysis and ZMAN™ software for EIS data analysis without license.

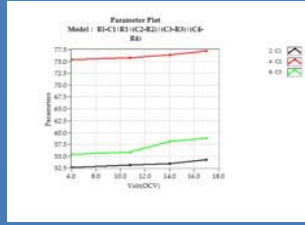
ZMAN™ EIS Data Analysis Software

- Model simulation and fitting
- 2D- and 3D-Bode- and Nyquist plots
- Automatic equivalent circuit model search function
- Project concept to handle multiple EIS data analysis
- Parameter plot from fitted elements value
- Compatible with data format from Zahner, Gamry, Ametek etc. (License code is needed.)
- Various weighting algorithm
- Model library and user model
- KK plot
- Batch fitting for project data
- Impedance parameter simulation
- Interpolate bad data
- Black-Nichols plot
- 3D graph setting option
- Improved model editor
- Application model library for automatic searching
- Parameter simulation of model
- Genetic algorithm option for initial guessing
- Automatic initial guessing
- Trace movie function on fitting
- Free for ZIVE's data format (*.seo, *.wis) analysis (No license code required.)
- Circle fitting
- Data editing available (insert, delete, edit)
- Add/subtract element parameters
- Add/subtract model parameters
- Impedance, Z in polar, admittance, Y in Polar, modulus, M in polar, dielectric constant, E in polar. data display
- Empty cell capacitance calculation
- Find file function
- Data replacement by formula function
- Cursor data display
- Model finding result automatic sorting by Chi square value
- R, C, R/L, R, Q preview & graphic
- ZHIT function
- Mott-Schottky analysis
- Donor density vs. Vfb graph
- C vs. voltage graph

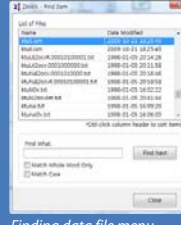
Electrochemical Workstation ZIVE SP1



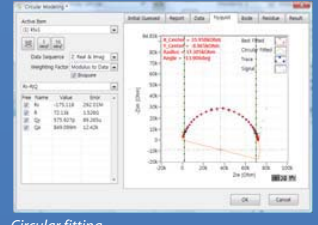
3D Bode plot for series measurement



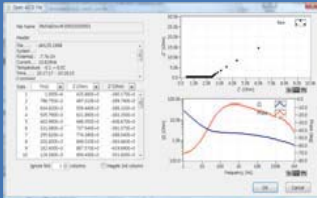
Parameter plot



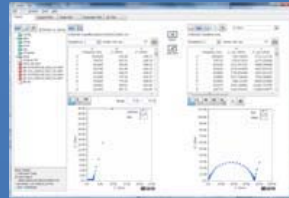
Finding data file menu



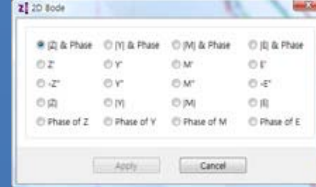
Circular fitting



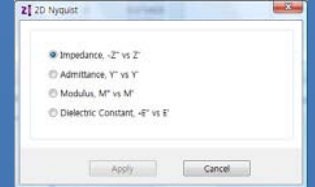
Importing 3rd parties ASCII data file



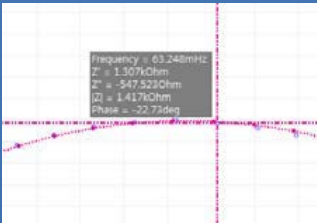
Project manager with data preview



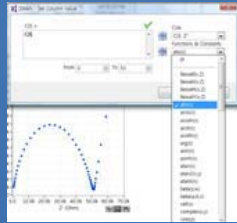
2D Nyquist plot



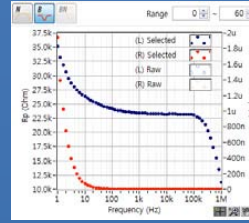
2D Bode plot



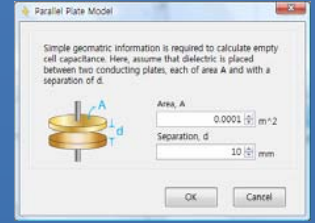
Cursor data display



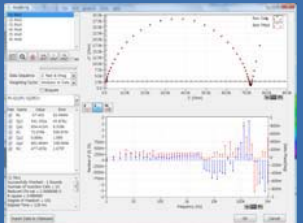
Data replacement by formula function



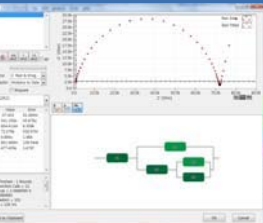
Rp, Cp vs frequency (R/C)



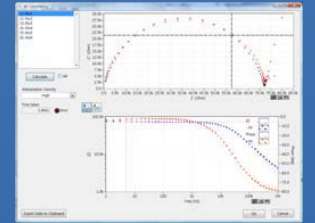
Empty cell capacitance



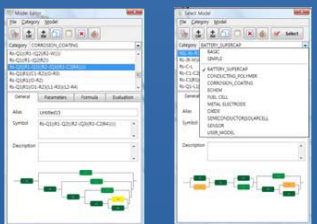
Fitting display



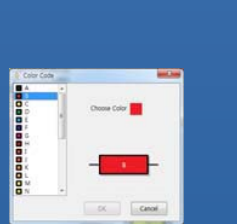
Donor density vs. Vfb graph and analysis



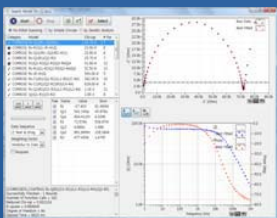
KK consistency



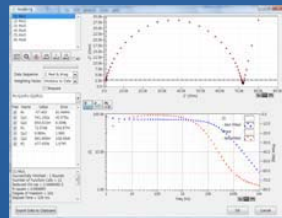
Model editor & model library



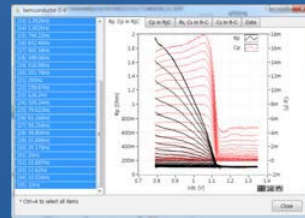
Mott-Schottky analysis window



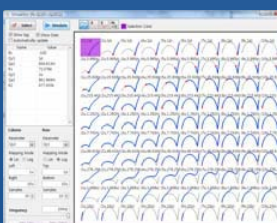
Automatic model searching



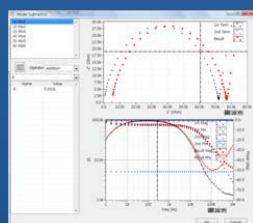
LEVM fitting



C/R-V graph



Parameter simulation



Element add/subtraction

WonAtech
ZMAN™ 2.2
 Impedance Spectroscopy Analysis & Presentation

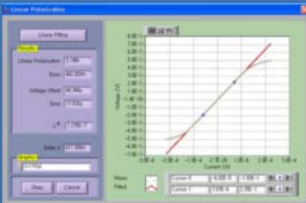
IVMAN™ DC Data & Battery Test Data Analysis Software

IVMAN™ software package consists of

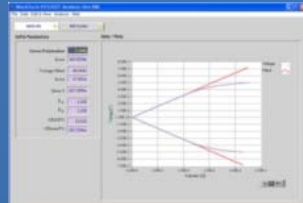
- IVMAN software
- IVMAN utilities
 - differential analysis (battery analysis)
 - Extractor
 - peak find module
 - Harmonic analysis
 - Tafel analysis

■ IVMAN™ Software

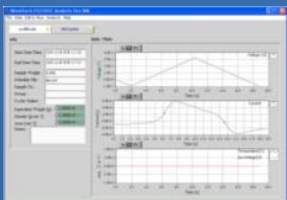
- Electrochemical analysis software
- Ideal for DC corrosion data analysis and electro-analytical data analysis
- Initial guessing function on Tafel analysis
- Automatic Tafel fitting
- Polarization resistance fitting
- 3D graph
- Find peak function
- Interpolation, differentiation, integration etc.
- Reporting function



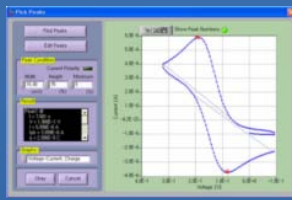
Polarization resistance fitting



Polarization analysis result



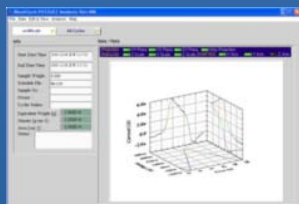
Time graph



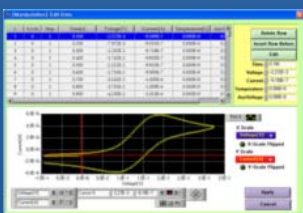
Find peak menu



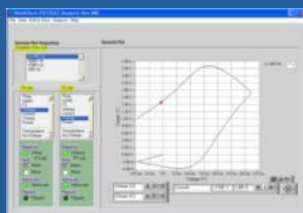
CV graph



3D graph



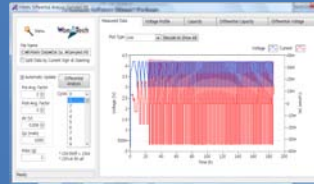
Edit data menu



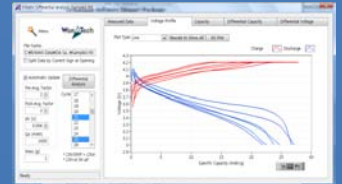
Universal graph

■ IVMAN™ Diff. Software

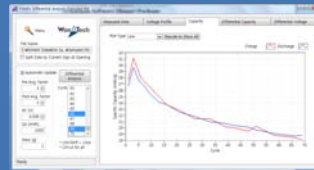
- Battery test data analysis
- Electrochemical voltage spectroscopy (dQ/dV vs. V)
- Voltage vs. capacity analysis (V vs. Q)
- Cycle graph (Q vs. cycle)
- Differential voltage graph(dV/dQ vs. Q)



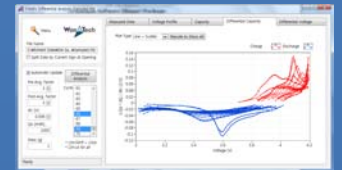
Measured data



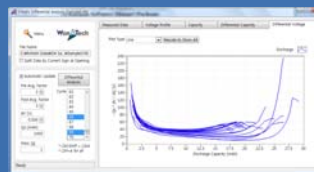
V vs. Q



Cycle graph



dQ/dV vs. V



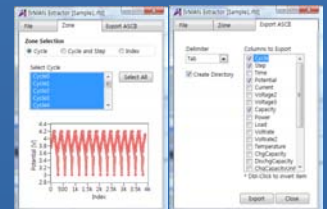
dV/dQ vs. Q

Time (h)	Current (A)	Voltage (V)	Capacity (Ah)	Differential analysis (dQ/dV)	Differential analysis (dV/dQ)
0	0	0	0	0	0
1	0.00000	0.00000	0.00000	0.00000	0.00000
2	0.00000	0.00000	0.00000	0.00000	0.00000
3	0.00000	0.00000	0.00000	0.00000	0.00000
4	0.00000	0.00000	0.00000	0.00000	0.00000
5	0.00000	0.00000	0.00000	0.00000	0.00000
6	0.00000	0.00000	0.00000	0.00000	0.00000
7	0.00000	0.00000	0.00000	0.00000	0.00000
8	0.00000	0.00000	0.00000	0.00000	0.00000
9	0.00000	0.00000	0.00000	0.00000	0.00000
10	0.00000	0.00000	0.00000	0.00000	0.00000
11	0.00000	0.00000	0.00000	0.00000	0.00000
12	0.00000	0.00000	0.00000	0.00000	0.00000
13	0.00000	0.00000	0.00000	0.00000	0.00000
14	0.00000	0.00000	0.00000	0.00000	0.00000
15	0.00000	0.00000	0.00000	0.00000	0.00000
16	0.00000	0.00000	0.00000	0.00000	0.00000
17	0.00000	0.00000	0.00000	0.00000	0.00000
18	0.00000	0.00000	0.00000	0.00000	0.00000
19	0.00000	0.00000	0.00000	0.00000	0.00000
20	0.00000	0.00000	0.00000	0.00000	0.00000

Export ASCII file

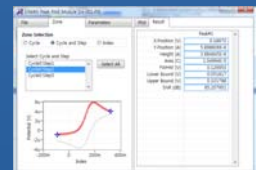
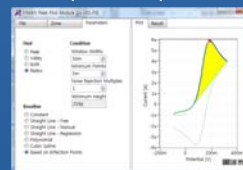
■ Extractor

- Extracting data by cycle number or step
- Exporting ASCII file



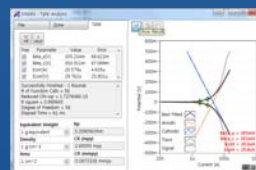
■ Peak Find Module

- Independent peak finding software

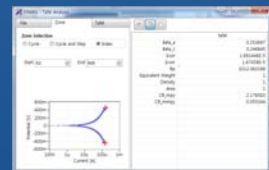


■ Tafel Analysis

- Independent peak finding software



Tafel analysis



Tafel analysis result

Specification

Main System	
PC communication	USB2.0 high speed
Line voltage	100~240VAC, 50/60Hz, 1Amp
Power adapter	24V
Size/weight	160*324*76mm(W*D*H) / 2Kg
Max. output power	15Watt

System	
Cell cable	1 meter shielded type(standard) working, reference, counter, working sense, auxV1
Control	DSP with FPGA
Calibration	automatic
Data acquisition	
ADC	2x16bit ADCs(500kHz)for voltage, current
DAC	2x16bit DAC(50MHz) for bias & scan
Filter	4ea(5Hz,1kHz,500kHz, 5MHz)
Scan rate	0~200V/sec (10mV step@200V/sec)
Max. channel No.	32 channels via USB connection
Internal data memory	350,000 points
LCD Display	DC & EIS mode automatically

Power Amplifier(CE)	
Power	15Watt (15V@1A)
Compliance voltage	±15V
Max. current	±1A
Control speed selection	5ea
Bandwidth	5MHz
Slew rate	10V/usec

Potentiostat Mode (voltage control)	
Voltage control	
Control voltage range	±10V, ±1V, ±100mV
Voltage resolution	16 bit per each range
Voltage accuracy	<0.02% f.s.
Max. scan range	±10V vs. ref. E
Current measurement	
Current range	8 ranges(auto/manual setting) 100nA~1A
Current resolution	16 bit 30uA,3uA,300nA,30nA,3nA,300pA,30pA,3pA
Current accuracy	0.02% f.s

Galvanostat Mode (current control)	
Current control	
Control current range	max. ±1A ± full scale depending on selected range
Current resolution	16 bit 30uA,3uA,300nA,30nA,3nA,300pA,30pA,3pA
Current accuracy	0.02% f.s
Voltage measurement	
Voltage range	10V, 1V, 100mV
Voltage resolution	16 bit 0.3mV, 30uV, 3uV
Voltage accuracy	<0.02% f.s. @10V range

Electrometer	
Max. input voltage	±10V
Input impedance	$2 \times 10^{13} \Omega$ 4pF
Bandwidth	>16MHz
CMRR	>110db(1Hz) >60db(1MHz)

EIS(Internal FRA) for System	
Frequency range	10uHz~1MHz
Frequency accuracy	0.01%
Frequency resolution	5000/decade
Amplitude	0.1mV~5V rms (Potentiostatic) 0.1~70% f.s. (Galvanostatic)
Mode	Static EIS: potentiostatic, galvanostatic, pseudogalvanostatic, OCP Dynamic EIS: potentiodynamic, galvanodynamic Fixed frequency impedance: potentiostatic, galvanostatic, potentiodynamic, galvanodynamic Multisine EIS: potentiostatic, galvanostatic

Interfaces for System	
Auxiliary port	10uHz~1MHz
Auxiliary voltage input	1 analog input ±10V
Zero Resistance Ammeter	100nA~1A ranges

Software	
Max. step per experiment	1000
Shutdown safety limits	voltage, current, temperature etc.
Max. sampling rate	20kHz(50usec), burst mode
Max. sampling time	unlimited
Sampling condition	time, dv/dt, di/dt etc.

PC Requirement	
Operating system	WindowsXP/2000/Vista/7
PC specification	Pentium4, RAM 1GB or better
Display	1280x800 high color
USB	high speed 2.0

General	
Dummy cell	one external dummy cell included

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