

# Product Catalog

## WBR200 5V20A Battery Test System



# Battery Test System WBR200

The **WBR200** is a Max. 20Ampere@-1V to +5V single cell test system in 1800mm height rack (64 channels per rack). This can be configured up to 40 channels with battery interface software.

The **WBR200** provides independent control over each channel, user can test multiple samples simultaneously and independently. The powerful battery interface software can give various plots for users to analyze test results easily.

The **WBR200** is designed with 4 probe type true potentiostat/galvanostat circuit and various switching conditions and multiple condition parameters can be input. Pre-defined techniques for battery test allow user to test their battery so easily even if he/she is a novice for battery testing. And it also can easily create test conditions using the schedule editor.

The **WBR200** is suitable for battery testing and analysis and provides techniques such as EVS and variable scanning speed CV as well as charging and discharging test.

## Features

### ● Potentiostat/Galvanostat Circuit

- No switching time (charging to discharging, discharging to charging)
- Analog feedback control to keep constant voltage & current
- Capable of testing anode materials, cathode materials, and complete cells, including half-cell experiments

### ● High Precision

- 16bit ADC, DAC: High resolution of 0.0015% f.s. (control and data storage)
- Voltage accuracy :  $\pm 0.02\%$  f.s.
- Current accuracy :  $\pm 0.03\%$  f.s.
- 4 current ranges
- MOSFET type linear power supply circuit
- Digital coulometer is included: capability to calculate real-time capacity at hardware sampling rate and store it in memory

### ● Safety

- Unique "Fail check" function  
: To protect the system and cell itself, the experiment will stop automatically when the measured value is different from control value due to battery failure or wrong cell connection, etc.  
e.g. Control value: 10A, Measured value: 5A  
The experiment will stop automatically.
- System safety parameter  
: If the measured value is over system specification or user defined safety limit condition, the experiment stops automatically.  
: User defined safety condition setting  
User can input safety level depending on chemical properties of reactants in test cell.
- Automatic cell connection check  
: Before experiment, if the cell voltage value is over than standby voltage range, program gives the warning message for the operator to check the cell connection.
- If operator presses stop button by mistake, a confirmation message box will appear.
- To prevent over current, a poly-switch is located in each channel.
- Watchdog function:  
Experiments stop of the channel connected to the board when error occurs in the CPU operation of the SIF board.

- Even if a PC failure/communication failure happens, the system will work without data loss and will store the data by max. 290,000 data points per control board.
- If the main program is down by unstable operating system, the independent server program keeps the experiment (control & data acquisition) without dead time.

### ● Maintenance & System Expansion

- Channel expansion: Max. 64 channels in one WBR200 rack is available.
- Automatic data backup function
- Hard disk space check function
- While one or more channels is working, the calibration for the other channels in rest mode is available.
- Software specialized for battery testing (Battery Interface Software)
- Easy calibration software
- Stable TCP/IP communication
- Automatic firmware upgrade

## Options

### ● Auxiliary voltage & temperature measurement

- Auxiliary voltage monitoring
- Temperature measurement monitoring

### ● Mixed model configuration available

eg) 32-channel WBR100 + 16-channel WBR200 in one rack

### ● Various Battery jig

- Prismatic battery jig
- Cylindrical Battery jig
- Pouch cell jig

## Specifications

|                                    |                                     |
|------------------------------------|-------------------------------------|
| Control voltage range              | -1V ~ +5V                           |
| Control current range              | 4 ranges<br>20A, 2A, 200mA, 20mA    |
| Input impedance                    | 1Tohm                               |
| Cell connection                    | 4 probe type, alligator clip cables |
| Max. channel No.                   | 64 (40 channels for PC rack)        |
| Min. channel No.                   | 8                                   |
| Voltage accuracy                   | $\pm 0.02\%$ f.s.                   |
| Current accuracy                   | $\pm 0.03\%$ f.s.                   |
| <b>Voltage Control/Measurement</b> |                                     |
| Full scale ranges                  | -1V ~ +5V                           |
| Resolution (16 bits)               | 0.15mV                              |
| <b>Current Control/Measurement</b> |                                     |
| Full scale ranges                  | Max. 20A@-1V to +5V                 |
| Resolution                         | 16 bit (0.0015% f.s.)               |
| Communication                      | TCP/IP                              |
| Sampling time                      | 50msec                              |
| Safety                             | Emergency button integrated         |
| Size                               | W724xH1015xD1800mm                  |

All specifications are subject to change without notice.

# Battery Test System WBR200

The **WBR200** is a Max 20Ampere@-1V to +5V single cell test system in 1800mm height rack ( 32 channels per rack). This can be configured upto 128 channels with Battery Interface software.

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- Voltage accuracy :  $\pm 0.02\%$  f.s.
- Current accuracy :  $\pm 0.05\%$  f.s.
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: To protect the system and cell itself, the experiment will stop automatically when the measured value is different from control value due to battery failure or wrong cell connection, etc.  
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Experiments stop of the channel connected to the board when error occurs in the CPU operation of the SIF board.

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- If the main program is down by unstable operating system, the independent server program keeps the experiment (control & data acquisition) without dead time.

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- Cylindrical Battery jig
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| Current accuracy                   | $\pm 0.05\%$ f.s.                   |
| <b>Voltage Control/Measurement</b> |                                     |
| Full scale ranges                  | -1V ~ +5V                           |
| Resolution (16 bits)               | 0.15mV                              |
| <b>Current Control/Measurement</b> |                                     |
| Full scale ranges                  | Max. 20A@-1V to +5V                 |
| Resolution                         | 16 bit(0.0015% f.s)                 |
| Communication                      | TCP/IP                              |
| Sampling time                      | 50msec                              |
| Size                               | W724xD1015xH1800mm                  |

All specifications are subject to change without notice.

# Battery Test System WBR200

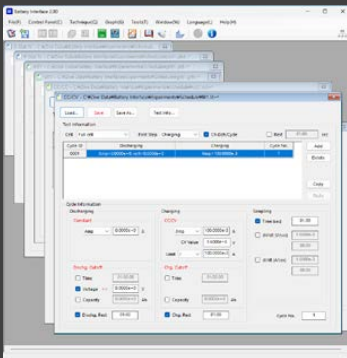
Cut off Condition List

| No. | Change Step | Type     | Cond.      | Value             | dt                     |
|-----|-------------|----------|------------|-------------------|------------------------|
| 1   | Next Step   | Step End |            |                   |                        |
|     | Step List   | Step No. | Step Name  | Value (Scan Rate) |                        |
|     |             | 1        | 1ST Step   | Auxiliary Voltage | 40.0000e-3 (0.0000e+0) |
|     |             | 2        | 2ST Step   | Temperature       |                        |
|     |             | 3        | 3ST Step   | Loop Time         | -40.0000e-3            |
|     |             | 4        | 4ST Step   | Eoc Voltage       |                        |
|     |             |          | Step End   |                   |                        |
|     |             |          | C Rate     |                   |                        |
|     |             |          | AB5(i)     |                   |                        |
|     |             |          | Cycle/Loop |                   |                        |
|     |             |          | FCC        |                   |                        |
|     |             |          | FCD        |                   |                        |
|     |             |          | LCC        |                   |                        |
|     |             |          | LCD        |                   |                        |
|     |             |          | Specific I |                   |                        |

Cut-off condition

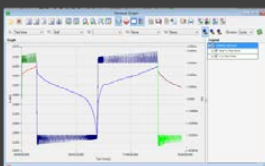
- Data sampling condition by each step
  - time, dV/dt, dI/dt, dT/dt, dV2/dt
- And/Or logic for cut-off condition settings

## Menu Selection (Pre-defined techniques)

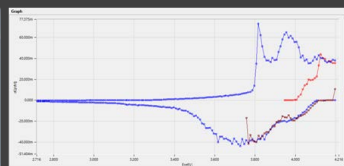


## Techniques

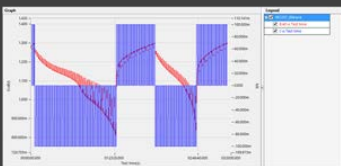
- CC/CV (Lithium battery) test
- CC/CC (NiCd(NiMH) battery) test
- Steady state CV
- Pstat IV curve
- Gstat IV curve
- EVS (Electrochemical voltage spectroscopy) test
- GITT (Galvanostatic intermittent titration technique) test
- PITT (Potentiostatic intermittent titration technique) test
- Discharge test
- Variable scan rate CV test



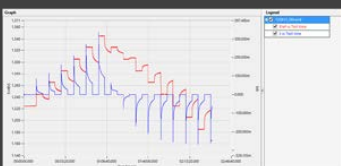
EVS test raw data



EVS graph format (dQ/dV vs. V)



GITT test



PITT test raw data

## Real time data monitor



- Real time display: time, voltage, current, channel status
- Channel status displayed by color: charging, discharging, standby, idle, calibration

## Grouping

- Classification/grouping channels by user's purpose
- Each group can be named based on user name, chemistries, etc
- Group monitoring available
- Group control



## Detailed Data Monitor

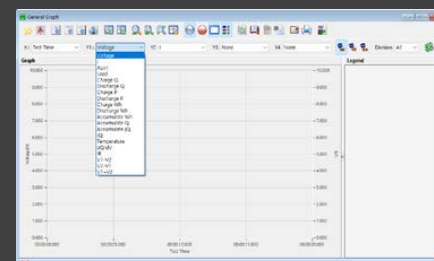
- Display test data: status, running time, step number, cycle number, step time, current range, current, voltage, capacity, power, energy, Aux V, Calc V, temp, cycle file name, data file name, and file size.
- Monitor type selection: All channels, running channels only, and grouped channels.
- Display active status only for running channels

Channel Monitoring

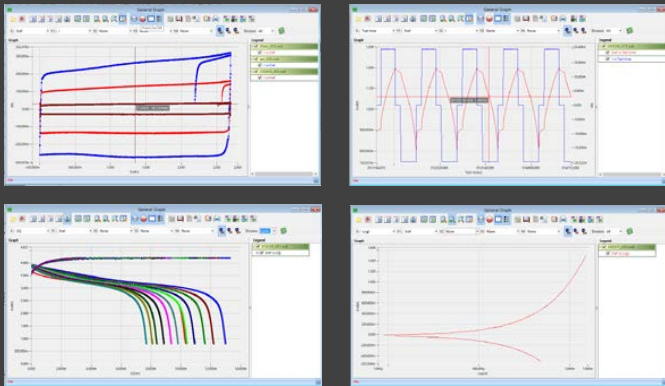
| Item / Ch.     | 1         | 2         | 3         | 4         | 5           | 6           | 7           | 8           |
|----------------|-----------|-----------|-----------|-----------|-------------|-------------|-------------|-------------|
| Status         | 00:00:00  | 00:00:00  | 00:00:00  | 00:00:00  | 00:00:00    | 00:00:00    | 00:00:00    | 00:00:00    |
| Step / Cycle   | 1 / 1     | 1 / 1     | 1 / 1     | 1 / 1     | 1 / 1       | 1 / 1       | 1 / 1       | 1 / 1       |
| Step Time      | 00:00:00  | 00:00:00  | 00:00:00  | 00:00:00  | 00:00:00    | 00:00:00    | 00:00:00    | 00:00:00    |
| Current Range  | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   |
| Current (A)    | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   |
| Voltage (V)    | 3.8188e+0 | 3.7895e+0 | 3.7895e+0 | 3.7895e+0 | 3.7895e+0   | 3.7895e+0   | 3.7895e+0   | 3.7895e+0   |
| Capacity (Ah)  | 1.9433e+0 | 1.9433e+0 | 1.9433e+0 | 1.9433e+0 | 1.9433e+0   | 1.9433e+0   | 1.9433e+0   | 1.9433e+0   |
| Power (Watt)   | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   |
| Energy (Whatt) | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   |
| Scan (V)       | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   |
| Calc V         | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0 | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   | 0.0000e+0   |
| Temp (C)       | 0.0       | 0.0       | 0.0       | 0.0       | 0.0         | 0.0         | 0.0         | 0.0         |
| File Name      | 00000001  | 00000002  | 00000003  | 00000004  | 00000005    | 00000006    | 00000007    | 00000008    |
| File Size      | 822 bytes | 771 bytes | 810 bytes | 4 bytes   | 10405 bytes | 10405 bytes | 10405 bytes | 10405 bytes |

## Graphics

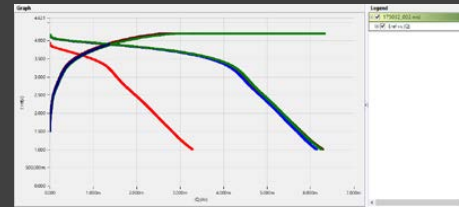
- Multiple graph format
  - General graph
  - Cycle graph
- General graph format



# Battery Test System WBRS200

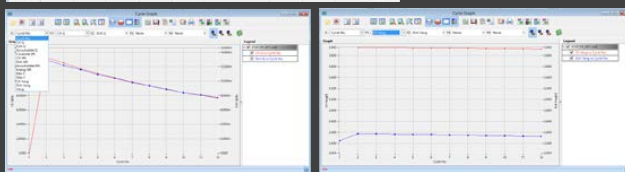
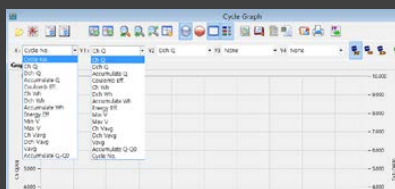


- Parameter change without reloading the data file
- Data On/Off settings: Data can be shown or hidden by selecting or deselecting it.
- Rest step data hidden function
- Advanced graph settings



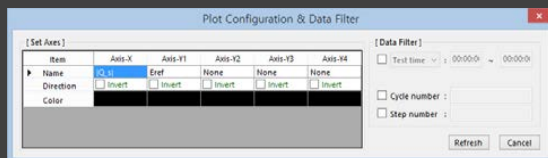
Voltage vs. |capacity| graph

## • Cycle graph format

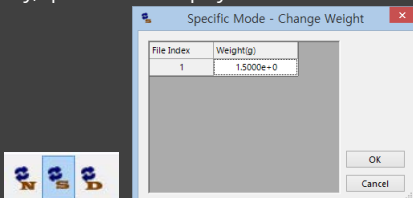


## • General graph functions

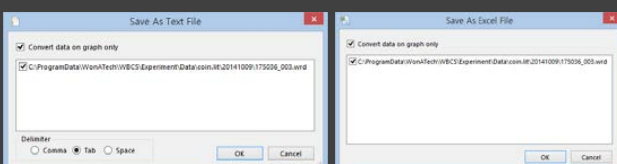
- Various axis variable settings
- Graph overlay: max. 20 data
- Universal graph: Combinations of X, Y1, Y2, Y3, Y4 axis parameters
- Automatically update the plot of running channels by pressing the 'reload' button
- Automatic/manual scale and polarity selection for each axis



- Cross-hair pointer by mouse click/arrow key displays coordinate values on graph
- Mouse zooming
- Density, specific value display

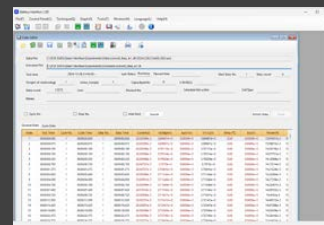


- Graphic data can be copied to the clipboard for use in other application software
- Grid on/off and dot/line selection
- Only the data on the graph can be converted to an ASCII file or an Excel file.



## • Tools

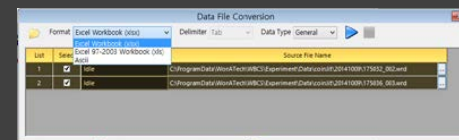
- Data Editor
  - General data report
  - Cycle data report



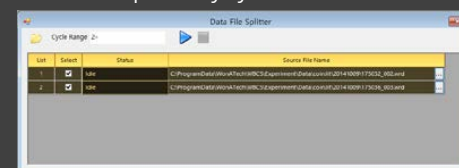
- \* Data editing
- \* Data filtering

## • Data Conversion

- Convert data to ASCII or Excel file format

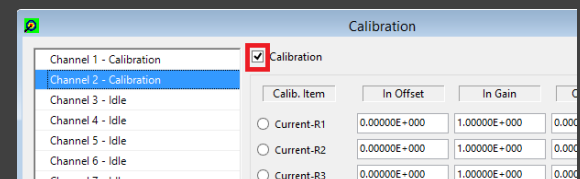


## - Data file splitter by cycle number

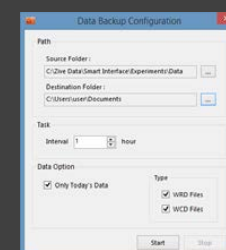


## • Calibration

- User can calibrate channel(s) while other channels are running.



## • Data backup



## Independent Data Analysis Software



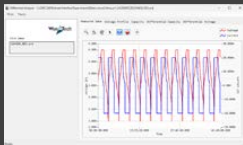
The data format obtained using BI and SI can be analyzed with independent data analysis software, and the following analysis tools are available for free.

- IVMAN differential analysis (battery analysis) software
- IVMAN photovoltaic cell analysis
- IVMAN peak find module

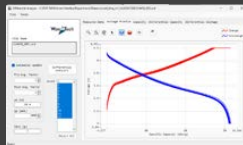


### IVMAN DA™ Battery Test Data Analysis Software

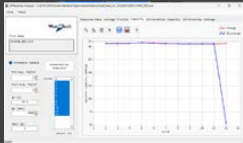
- Battery test data analysis
- Electrochemical voltage spectroscopy (dQ/dV vs. V)
- Voltage vs. capacity analysis (V vs. Q)
- Cycle graph (Q vs. cycle)
- Differential voltage graph (dV/dQ vs. Q)



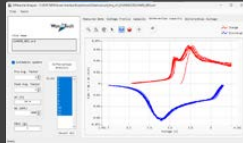
Measured data



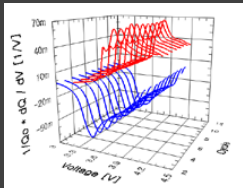
V vs. Q



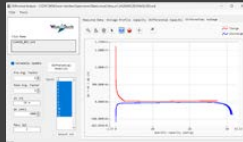
Cycle graph



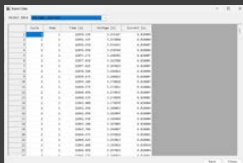
dQ/dV vs. V



3D graph



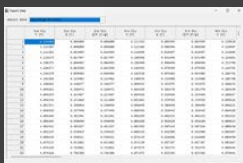
dV/dQ vs. Q



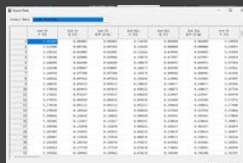
V/I vs. T



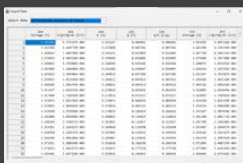
Charging profile



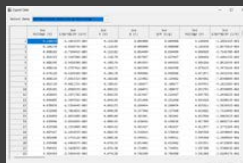
Discharging profile



Cycle profile



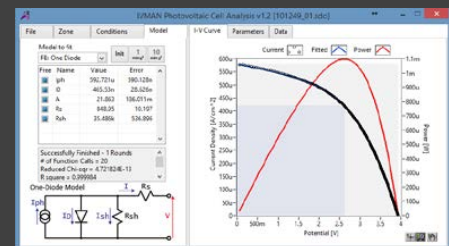
Charging EVS



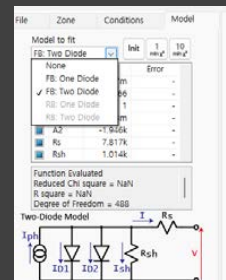
Discharging EVS



### IVMAN™ photovoltaic cell analysis



• V vs. I graph



• Model selection and fitting

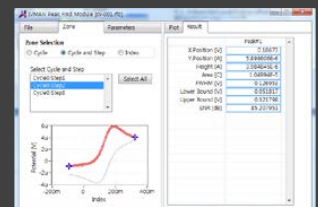
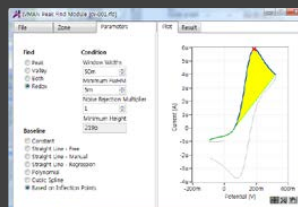
| Parameter                                       | Value     | Unit |
|-------------------------------------------------|-----------|------|
| Area (cm <sup>2</sup> )                         | 100       |      |
| Temperature (K)                                 | 300       |      |
| Open-circuit voltage (V)                        | 0.60000   |      |
| Short-circuit current (A/cm <sup>2</sup> )      | -0.02000  |      |
| Voltage @ max power (V)                         | 0.40000   |      |
| Current @ max power (A/cm <sup>2</sup> )        | -0.01500  |      |
| Max power (W/cm <sup>2</sup> )                  | -0.00600  |      |
| Efficiency (%)                                  | 2.00000   |      |
| Photo-induced current (A/cm <sup>2</sup> )      | 0.02000   |      |
| Series resistance (ohm)                         | 0.00000   |      |
| Shunt resistance (ohm)                          | 100.00000 |      |
| Diode quality factor                            | 1.00000   |      |
| Reverse saturation current (A/cm <sup>2</sup> ) | 1.00000   |      |

- Automatic analysis of parameters
  - open circuit voltage, open circuit current, max. power, efficiency
  - photo induced current, diode quality factor, series resistance, etc.



### Peak Find Module

- Independent peak finding software



## Jigs

### ● Prismatic Battery Jig

- 4 pin knob type

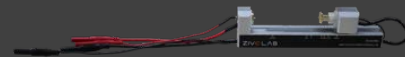


### ● Pouch Cell Jig

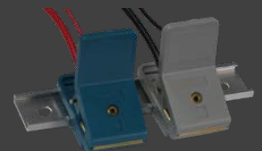
- 4 pin lever type



### ● Cylindrical Battery Jig

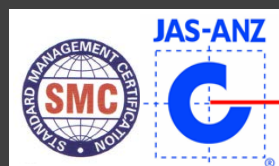


### ● Clamp cable





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