CHEN TECH
ELECTRIC

BT 2000 Series

Compact Multi-range Battery Test Equipment

▪ UNPARALLELED PRECISION ▪

CE

| Worldwide Battery Testing Expert

Highlight Features

The industry's best volume optimization design
23" 25U rack can hold 128 channel 5V/10A model, 64 channel 5V/30A model, or 8 channel 5V/200A model.

4 custimizable current ranges
The system automatically switches for optimal current range according to the customer's settings, and the range of current can be designated according to customer needs.

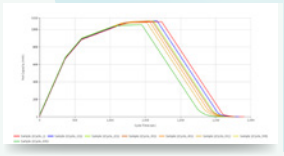
Advanced experiment grade precision
Voltage and current output/measurement precision are within 0.02% F.S.

Modularized design
Hot swapping makes replacement and repair convenient and does not affect other channels.

G Ohm and above input impedance
Current leakage can be minimized, and battery capacity calculation is extremely precise.

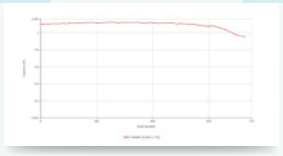
Major Test Applications

Battery Capacity Test
Battery capacity (mAh) is the product of current (mA) and time (h) and determined by discharging a fully charged battery until the voltage reaches the lower limit. Generally speaking, batteries with greater capacity can be used longer. Hence, capacity is an important indicator for measuring battery performance. However, equipment precision, output stability, and current leakage during testing will all affect capacity test results. The BT 2000 was found to have exceptional performance in the abovementioned indicators during testing, and is therefore able to minimize the margin of error in capacity.



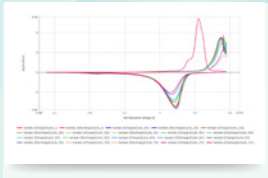
Time v.s. Capacity

Battery Cycle Life Test
Battery cycle life is generally defined as "the number of complete charge/discharge cycles in a 25°C environment and under predefined conditions that the battery is able to support before its capacity falls under 80% of it's original capacity." The battery's capacity will significantly decline after exceeding this number of cycles, and it may also affect the battery's normal use. Hence, cycle life is an important indicator of battery performance. Since the BT 2000 is very precise when calculating battery capacity, results of the battery cycle life test are highly reliable.

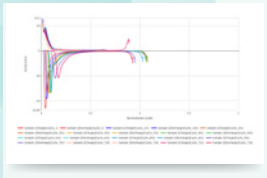


Cycle No. v.s. Capacity

dQ/dV and dV/dQ Analysis
The dQ/dV curve is plotted with capacity difference (dQ) divided by voltage difference (dV) as the Y axis, and voltage (V) as the X axis, and refers to the capacity of materials in a unit voltage. The dV/dQ curve is plotted with voltage difference (dV) divided by capacity difference (dQ) as the Y axis, and capacity (Q) as the X axis, and refers to the battery's voltage fluctuations at a certain capacity. The dQ/dV curve and dV/dQ are often used by battery researchers as indicators to observe activity changes and capacity decline in lithium batteries. The BT 2000 is able to accurately measure battery voltage and capacity and record data with an interval of voltage difference and capacity difference, allowing battery researches to easily plot the dQ/dV and dV/dQ curves.

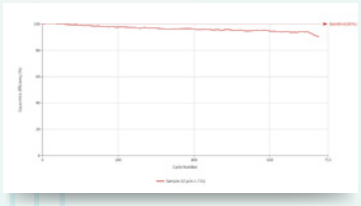


Voltage v.s. dQ/dV



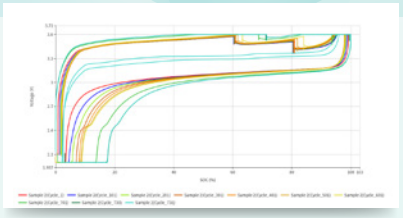
Capacity v.s. dV/dQ

Coulombic Efficiency, CE
Coulombic efficiency refers to the result of dividing discharge capacity by charge capacity of a battery in the same cycle. Higher coulombic efficiency results in better battery performance. The coulombic efficiency of present day lithium batteries is generally 99% or above, so any slight error will result in a drastic difference in calculations. The BT 2000 offers high precision and steady output along with precise capacity calculations, allowing coulombic efficiency to be accurately calculated. Hence, predictions of battery cycle life based on this data are highly reliable.



Cycle No. v.s. Coulombic Efficiency

SOC Research
Generally speaking, the SOC (%) v.s. OCV (V) curve slightly changes along with the number of battery charge/discharge cycles. Battery researchers can evaluate battery performance and predict battery life based on these changes, and can also estimate the battery's current SOC state based on its open circuit voltage. The BT 2000 is able to accurately measure voltage and supports SOC calculation functions, allowing the SOC curve to be rapidly plotted.



Voltage v.s. SOC

Applications

- Academic Research
- Mobile Phone
- Laptop
- Electric Motorcycle
- Materials
- Tablet
- Electric Bike
- Electric Vehicles

Technical Features

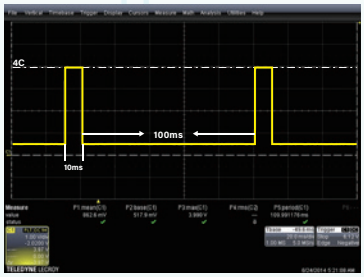
Advanced Specifications

In order to meet various testing requirements for performing advanced research on battery materials, auto current range change can be achieved according to user's current settings to maintain a consistent level of precision. Furthermore, a number of custom-made current configuration mechanisms have been created exclusively for material research to elevate the efficiency and flexibility during the execution of the test.

Unlimited Pulse Charge/ Discharge

The precision pulse-width control within 10ms and high-speed current climbing rates can be used freely under any charging/ discharging conditions for consumer electronics and power batteries to help clients perform advanced battery research and testing.

100Hz Pulse

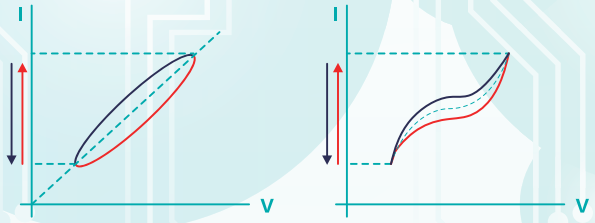


Current Rise Time (10% → 90%)

Current Ramping

Automatic scanning function within a given current range, which is extremely convenient during linear system identification; can be combined with the Lissajous Plot to confirm the system's linearity under specific operating conditions. As the track of the Lissajous Plot comes closer to the ellipse, it means that the system is closer to becoming a linear system.

Lissajous Plot



DCIR

Equipped with ISO12405 and IEC61960 DC resistance measurement standards. Customized measurement methods set up by the user is also supported. The internal resistance experienced by the battery during charge/ discharge process can be measured to significantly enhance the efficiency of the battery's quality screening process.

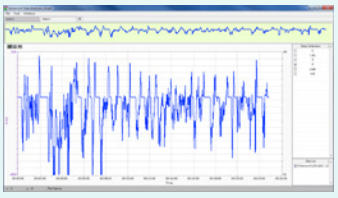
Gas Gauge/ BMS Communication

Supports a wide range of popular battery pack Gas Gauge/ BMS interfaces including SMBus, I^2C, HDQ, CAN, ModBus, and RS485. Importing CAN Bus DBC files is also supported. The user is free to configure battery test equipment behavior and BMS parameters to be recorded during the test. Confidential BMS parameter data will not be leaked and the client do not have to wait for software development. The overall user experience is safe and unrestricted.

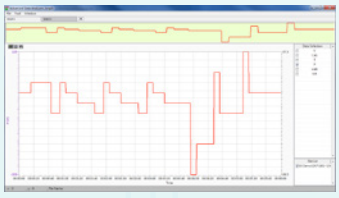
Dynamic waveform simulation

With a current rise time of 1ms (10% to 90%) and a charging/discharging switch time of 5ms (-90% to 90%), international drive simulation standards such as FUDS and DST can be fully realized with the BT 2000. Supports customized drive simulation test modes, and the import of Excel files to create customized testing processes. Each simulation is the reproduction of a real scenario. Under customized drive simulation mode, the minimum step time supported is 100ms. Constant current and constant power operating modes are also supported.

FUDS Cycle Test

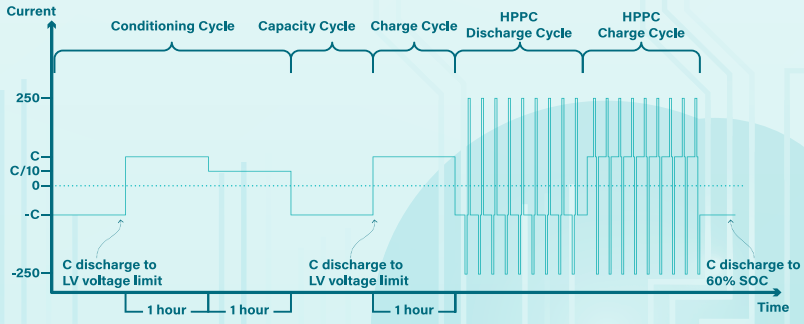


DST Cycle Test

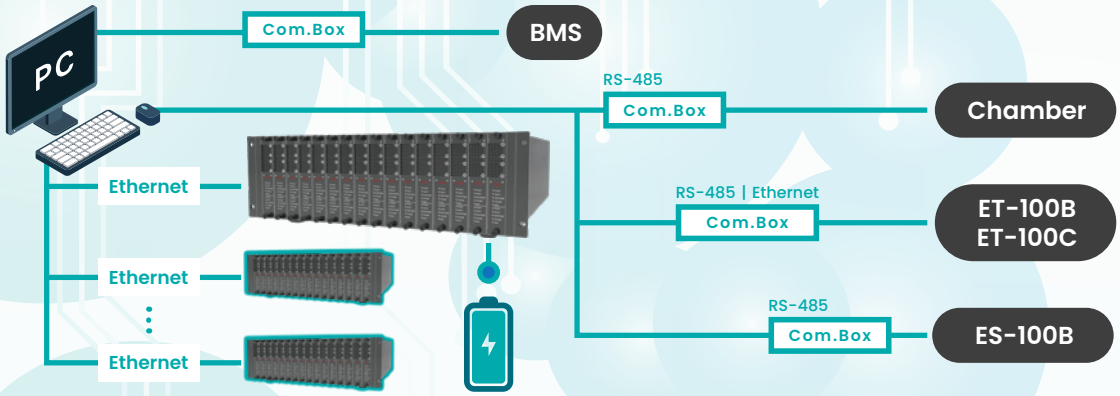


The Hybrid Pulse Power Characteristic (HPPC)

The Hybrid Pulse Power Characteristic (HPPC) is mainly used for testing characteristics of power batteries such as the power during charging and discharging cycles, open circuit voltage, and DC resistance. In addition to ensuring that all assembled batteries meet specifications, these parameters can also be used as battery BoL (Beginning of Life) test benchmarks to guarantee product quality. Chen Tech Electric provides appropriate equipment, combined with software functions to perform automatic calculations and record of key test parameters, to produce reports/tables that meet customer requirements as well as save configuration time for customers.



System Architecture



Safety Is Our 1st Priority

Prevention (Detection)

1. Automatically detects battery contact resistance when the battery is connected, verifies if battery leads are correctly placed and tightly joined with the fixture.

2. During tests, it detects whether the battery voltage, temperature, and equipment output current are normal. *1

3. Additional monitoring mechanisms include battery voltage and temperature detected by an independent program or plug-in hardware. *2

4. Channel abnormality detection, continuously compares the process and channel states to determine if they are consistent.

Elimination (Action)

1. When the system detects any abnormalities, it will immediately suspend ovperations and issue a warning.

2. When the system is suspended due to abnormalities, separate the battery and fixture. *2

3. Send a message on the abnormality to the control center to take corresponding action, such as extinguish a fire or throw a battery into the tank. *2

Investigation (Correction)

External monitoring of power values, the external smart meter records various power related values, which are used as reference after an abnormality occurs. *2

*1 Temperature measurement is an optional function *2 Option

Optional Accessories

Auxiliary Voltage ES-100B

During serial/parallel battery pack testing, the voltage of each cell/module is measured and recorded. The safety of the battery can be monitored, and the data obtained can be used as the condition for program step change or providing protection.

1. Each module contains 24 measurement points. A data recording frequency of 100ms.
2. Measurement range: ±8V, ±32V or ±64V; accuracy ±0.02% F.S.

Auxiliary Temperature ET-100B/ ET-100C

During battery testing, the temperature of each battery is measured and recorded. The safety of batteries can be monitored, and the data obtained can be used as the condition for program step change or providing protection.

ET-100B

1. Each module contains 24 measurement points. A data recording frequency of 100ms.
2. Supports Thermoistor as temperature sensors. Measurement range: -50°C~150°C; accuracy ±1°C (-40°C~90°C).

ET-100C

1. Each module contains up to 8~16 measurement points. A data recording frequency of 4s.
2. Supports various mainstream temperature sensors available on the market, such as: Thermocouple, Thermistor, RTD, and Diode (can be selected according to customer specifications). Measurement range is vast, and accuracy can reach ±0.1°C.

ACIR Measurement Module

ACIR measurement, frequency of 1kHz, supports sequential measurement of up to 128 channels, updates every 3 minutes.

Chamber/ Third-party Chamber Control

The synchronous control of chambers can be achieved during the testing processes. Temperature and humidity levels can be adjusted to simulate different environments for measuring the battery's performance.

Auto-Calibrator ACP2

Uses fully-automated methods to perform voltage and current calibration for the equipment channels to maintain accurate measurements and output, as well as to reduce the human resource costs, time costs, and errors caused by performing manual calibration.

1. Customizable reports.
2. The flexible and scalable design is capable of calibrating mutiple channels simultaneously.

BMS Data Collector GDA-300/ iBox-G

During battery modules/ packs testing, the Gas Gauge/ BMS data is retrieved and recorded. The data obtained can be used as the condition for program step change or providing protection.

1. Supports communication protocols such as SMBus, I^2C, HDQ etc. for IT batteries, and Modbus, CANBus etc. for power batteries.
2. Supports CAN .dbc file editing and import.

EIS Measurement Module

Battery impedance measurement, supports multiple measurement ranges, as well as frequency and current options that can be selected based on customers' testing requirements.

iBest Software

UPGRADED USER EXPERIENCE

Configuration — Execution — Analysis — Within One Click

iBEST SOFTWARE + DATA ANALYZER

Program Configuration

Simple Provides different test program configuration interfaces for beginners and experts to satisfy different needs. Easy to configure, intuitive operation, and no need for an instruction manual.

Comprehensive Provide a variety of test program options to meet different kinds of testing needs.

Test modes	Constant current (CC), Constant current-Constant voltage (CC-CV), Constant power (CP), Constant power-Constant voltage (CP-CV)*, Constant resistance (CR)*, Pulse*, Waveform*, ACIR*, DCIR*, Current Ramp*, Voltage Ramp*
Step Cutoff Conditions	Time, EV, EC, ET*, mAh, Wh, END mAh, SoC*, END SoC*, Ni-MH conditions, BMS conditions*, CHamber conditions*, ΔI*
Protection Mechanism	OC, LC, OV, LV, OT*, Verr, Cerr, CC Time*, CV Time,* ΔI, Cell Voltage Unbalance*, Temperature Unbalance*
Data Recording Interval	Δt, Δ V, ΔI, ΔT

Support a variety of international standardized test patterns. No need to be edited manually.

Pulse*	Intel Turbo Boost, GSM, PWM
Dynamic waveform*	FUDS, DST, HPPC
DCIR measurement*	ISO 12405, IEC 61960
Battery performance testing*	UL, IEC, SAE International and GB Standards

Customization Introduce variable setting functions; supports diverse charging/discharging test patterns and data recording. Test programs can be configured freely.

Integration* Control a variety of plug-in modules such as chamber, BMS data collector, auxiliary voltage, and auxiliary temperature, eliminating the tedious operation of separate control.

Smart Provides multiple convenient ways to configure test program, such as custom variables, C-rate, and current ramp*, are provided to speed up program editing.

Safety Test curves can be previewed after completing the test program setting. Set protection criteria for the batteries to avoid any human error that might cause accident. (Fig. 1)

Confidential Supports .dbc file import for CANBus communication protocols used for power battery BMS. BMS data can be collected easily during testing without revealing the confidential information to CTE.

Control Includes account management mechanisms, supports multi-role access restrictions.

Program Execution

Personalization Multiple displays of channel status as well as color choices, parameters displayed can be customized, and can be adjusted based on personal preferences and the execution status of the test program. (Fig. 2, 3, 4)

Easy to understand The main display provides clear information about each testing channel's current status. Additional data can be shown on other display panels based on the personal preference of the operator, no crucial data will be missed.

Immediate Test data can be viewed in real time. The program can be adjusted dynamically during the test to rectify any unexpected issue. (Fig.5)

Flexible Supports prescheduled pause functionality; test program can be halted during specific points in time for personnel inspection and analysis, no more waiting around.

Assurance

- Dual OV and OT detection mechanism; an independent program monitors the voltage and temperature of batteries being tested, and suspends equipment operations when the system is abnormal*.
- Abnormal channel status detection; continuously matches the process and channel status, and issues a warning or suspends equipment if it is inconsistent.
- Extra and independent monitoring mechanism; uses third party hardware attached to the equipment to monitor battery voltage and temperature at all times, and directly cuts off equipment power when there are any abnormalities*.
- External monitoring of power values; the external smart meter records various power related values, and the data is used for abnormalities tracking and comparison*.

Data Analysis*

Time-saving A variety of test data presentations that can be adjusted according to the needs of researchers, saving data processing time.

Text and graphical reports

Graphs zoom-in and zoom-out

Self-defined X and Y-axis parameters on graphs

Convenient

- Users will be able to choose from a selection of templates for data tables and curve charts available in the system, or create a brand new template based on their requirements.
- Testing graphics and raw data can be displayed simultaneously, cross-reference data mechanisms are also provided. (Fig. 6)
- Data retrieval tools allow users to quickly browse important test data.

Professional Multiple advanced analytics tools are introduced to assist battery researchers learn battery characteristics in an efficient way.

Report: Step Report — Charts: Cycle life

Compatible Test data can be exported in .csv format and manipulated in the third-party software that clients are familiar with, improving the data usability.

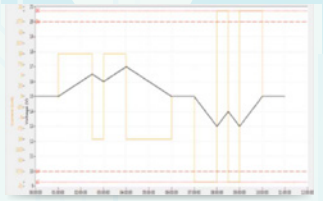


Fig. 1 Pre-test Simulation

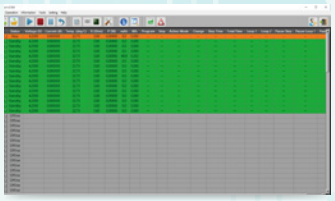


Fig. 2 Default status display panel

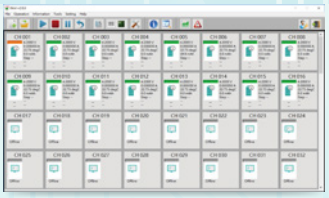


Fig. 3 32 Channels status display panel

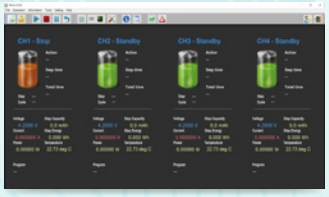


Fig. 4 4 Channels status display panel

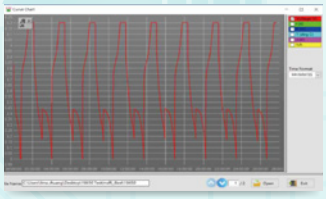


Fig. 5 Real time test curve

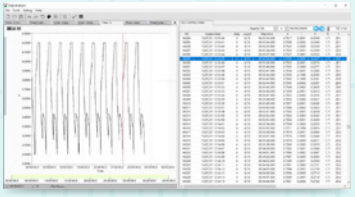


Fig. 6 Test curve and report

*Option

DMAP

Cloud Battery Test Data Analysis Platform

*Option

Compatibility Supports file formats of mainstream battery testing equipment brands, making it more convenient for analysis and comparison.

Saves effort Multiple advanced data analysis charts are a click away, including dQ/dV and SOC analysis, saving time on data pre-processing.

High performance By maximizing cloud computing performance, analysis results for big data can be immediately obtained.

Benchmark The innovative benchmarking function allows the performance of different batteries to be quickly compared. (Fig. 2)

Fast Provides user friendly data screening and simplification functionality to help battery researchers quickly verify preliminary testing results.

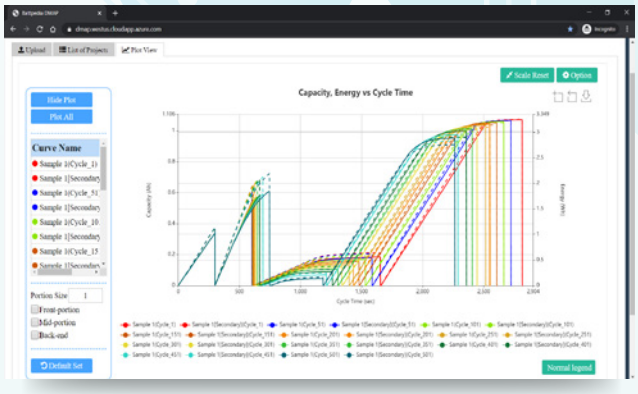


Fig. 1 DMAP Visualized presentation of battery test results

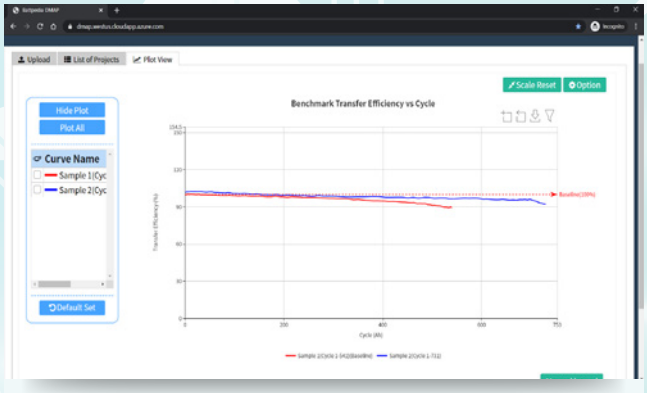
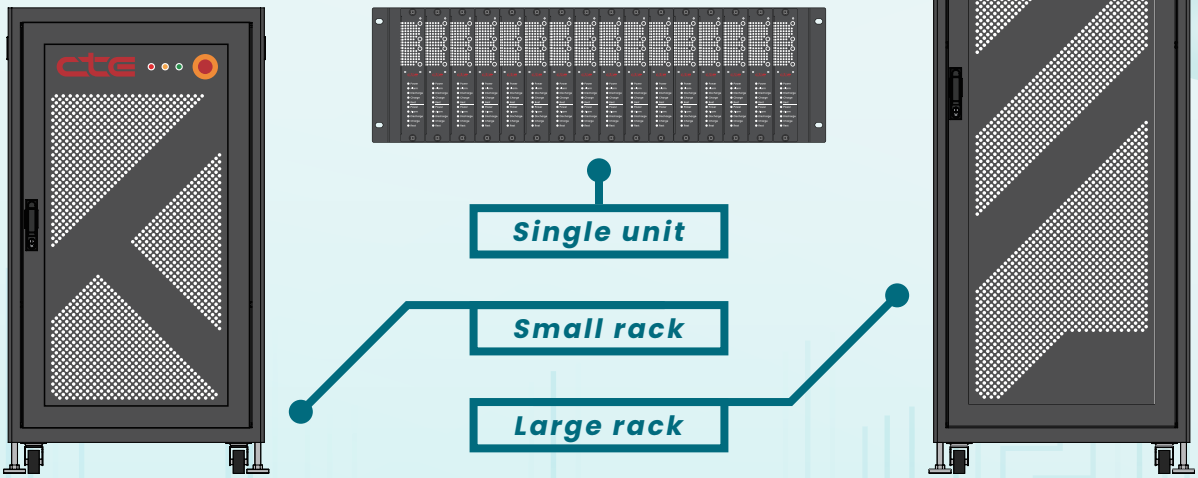


Fig. 2 DMAP benchmarking function

Layout

Type	Dimension (W*D*H)	Applicability
Single unit	584*700-850*173 mm	5V/200A and under
Small rack	702*700-1200*1301 mm	Full series specifications
Large rack	702*700-1200*2012 mm	Full series specifications



*It varies regarding to the optional specification. Please contact CTE to get more information.

Specifications

Model		BT 2000 5V/1A	BT 2000 5V/5A	BT 2000 5V/10A	BT 2000 5V/20A	BT 2000 5V/30A	BT 2000 5V/60A	BT 2000 5V/100A
Maximum Charge/Discharge Current		5V/1A	5V/5A	5V/10A	5V/20A	5V/30A	5V/60A	5V/100A
Current Range		±0.001A/±0.01A/ ±0.1A/±1A	±0.005A/±0.05A/ ±0.5A/±5A	±0.01A/±0.1A/ ±1A/±10A	±0.02A/±0.2A/ ±2A/±20A	±0.03A/±0.3A/ ±3A/±30A	±0.06A/±0.6A/ ±6A/±60A	±0.1A/±1A/ ±10A/±100A
Maximum Power		5W	25W	50W	100W	150W	300W	500W
Number of Channels Per Unit	41U Chassis (W702*D700-1200*H2012 mm)	512	256		128		64	24
	25U Chassis (W702*D700-1200*H1301 mm)	256	128		64		32	12
	4U Unit (W584*D700-850*H173 mm)	32(2U)	32		8		4	2
Voltage	Range	0~5V						
	Resolution Setting	0.1mV						
	Resolution Measurement	10μV						
	Accuracy (0.02% F.S.)	±1mV						
	Input Resistance	MΩ (option: GΩ)						
Current	Range	1μ~0.001A/ ~0.01A/~0.1A/~1A	5μ~0.005A/ ~0.05A/~0.5A/~5A	10μ~0.01A/ ~0.1A/~1A/~10A	20μ~0.02A/ ~0.2A/~2A/~20A	30μ~0.03A/ ~0.3A/~3A/~30A	60μ~0.06A/ ~0.6A/~6A/~60A	100μ~0.1A/ ~1A/~10A/~100A
	Resolution Setting	1μA/10μA/0.1mA/1mA						10μA/100μA/1mA/10mA
	Resolution Measurement	0.1μA/1μA/10μA/0.1mA						1μA/10μA/100μA/1mA
	Accuracy (0.02% F.S.)	±0.2μA/±2μA/ ±20μA/±0.2mA	±1μA/±10μA/ ±100μA/±1mA	±2μA/±20μA/ ±200μA/±2mA	±4μA/±40μA/ ±400μA/±4mA	±6μA/±60μA/ ±600μA/±6mA	±12μA/±120μA/ ±1.2mA/±12mA	±20μA/±200μA/ ±2mA/±20mA
	Rise Time (10%→90%)	<1ms						
Operation Protocol		CC, CC-CV, CP (Option: CR, Waveform, Pulse, DCIR, ACIR, Current Ramping, Voltage Ramping)						
Data Recording Time		100ms (Option: 10ms, 1ms)*						
Communication Protocol		Ethernet						
Ambient Conditions	Temperature	23°C±2°C						
	Humidity	20~90 HR						
Optional Feature		Constant Resistance、Dynamic Waveform Simulation、Pulse Charge/Discharge、DCIR Measurement、ACIR Measurement、Voltage Ramp、Current Ramp、Parallel Connections among Channels、BMS & Gas Gauge Data Collection、Chamber Integration、Data Analyzer						
Optional Feature		BMS & Gas Gauge Data Collector、Auxiliary Voltage、Auxiliary Temperature、Chamber、Customized Fixture、Auto-Calibrator、Alarm Buzzer						

Model		BT 2000 5V/180A	BT 2000 5V/200A	BT 2000 5V/250A	BT 2000 5V/300A	BT 2000 5V/350A	BT 2000 5V/400A	BT 2000 5V/450A	BT 2000 5V/500A
Maximum Charge/Discharge Current		5V/180A	5V/200A	5V/250A	5V/300A	5V/350A	5V/400A	5V/450A	5V/500A
Current Range		±0.18A/±1.8A/ ±18A/±180A	±0.2A/±2A/ ±20A/±200A	±0.25A/±2.5A/ ±25A/±250A	±0.3A/±3A/ ±30A/±300A	±0.35A/±3.5A/ ±35A/±350A	±0.4A/±4A/ ±40A/±400A	±0.45A/±4.5A/ ±45A/±450A	±0.5A/±5A/ ±50A/±500A
Maximum Power		900W	1000W	1250W	1500W	1750W	2000W	2250W	2500W
Number of Channels Per Unit	41U Chassis (W702*D700-1200*H2012 mm)	16	12	8	7		5		4
	25U Chassis (W702*D700-1200*H1301 mm)	8	6	4			3		2
	4U Unit (W584*D700-850*H173 mm)	2	1	N/A					
Voltage	Range	0~5V							
	Resolution Setting	0.1mV							
	Resolution Measurement	10μV							
	Accuracy (0.02% F.S.)	±1mV							
	Input Resistance	MΩ (option: GΩ)							
Current	Range	180μ~0.18A/ ~1.8A/~18A/~180A	200μ~0.2A/ ~2A/~20A/~200A	250μ~0.25A/ ~2.5A/~25A/~250A	300μ~0.3A/ ~3A/~30A/~300A	350μ~0.35A/ ~3.5A/~35A/~350A	400μ~0.4A/ ~4A/~40A/~400A	450μ~0.45A/ ~4.5A/~45A/~450A	500μ~0.5A/ ~5A/~50A/~500A
	Resolution Setting	10μA/100μA/1mA/10mA							
	Resolution Measurement	1μA/10μA/100μA/1mA							
	Accuracy (0.02% F.S.)	±36μA/±360μA/ ±3.6mA/±36mA	±40μA/±400μA/ ±4mA/±40mA	±50μA/±500μA/ ±5mA/±50mA	±60μA/±600μA/ ±6mA/±60mA	±70μA/±700μA/ ±7mA/±70mA	±80μA/±800μA/ ±8mA/±80mA	±90μA/±900μA/ ±9mA/±90mA	±100μA/±1mA/ ±10mA/±100mA
	Rise Time (10%→90%)	<1ms							
Operation Protocol		CC, CC-CV, CP (Option: CR, Waveform, Pulse, DCIR, ACIR, Current Ramping, Voltage Ramping)							
Data Recording Time		100ms (Option: 10ms, 1ms)*							
Communication Protocol		Ethernet							
Ambient Conditions	Temperature	23°C±2°C							
	Humidity	20~90 HR							
Optional Feature		Constant Resistance、Dynamic Waveform Simulation、Pulse Charge/Discharge、DCIR Measurement、ACIR Measurement、Voltage Ramp、Current Ramp、Parallel Connections among Channels、BMS & Gas Gauge Data Collection、Chamber Integration、Data Analyzer							
Optional Feature		BMS & Gas Gauge Data Collector、Auxiliary Voltage、Auxiliary Temperature、Chamber、Customized Fixture、Auto-Calibrator、Alarm Buzzer							

*Channel qty will be adjusted regarding to the requirement of data recording time.

SERVICE GUARANTEE

COST EFFICIENT
TIMELY EFFECTIVE

Multiple Issue Report Channels

Telephone, e-mail, and instant messaging apps all have dedicated personnel to immediately respond to customer inquiries

- IMMEDIATE REMOTE TROUBLESHOOTING
- MODULARIZED DESIGN, SPARE PARTS RAPIDLY PROVIDED FOR REPLACEMENT BY CUSTOMERS
- GLOBALIZED CUSTOMER SERVICE TEAM EFFECTIVELY AND SATISFACTORILY RESPONDS TO CUSTOMERS

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PRODUCT INFORMATION

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