Kewell

B2000PG-EC SERIES

CELL CHARGE-DISCHARGE TEST SYSTEM

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CONTENTS

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1 Product Overview

The B2000-EC series is a cell charge-discharge test system featuring high accuracy, high dynamic performance, high efficiency, and bi-directional flow of energy. Based on the modular design, it integrates data acquisition and monitoring during the charging and discharging process, as well as current ripple injection, overcharge, negative voltage discharge, multi-channel parallel connection and other functions. The series is widely applicable to the R&D and EOL testing of cells for traction battery and energy storage battery by institutes and businesses.

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2 Product Highlights

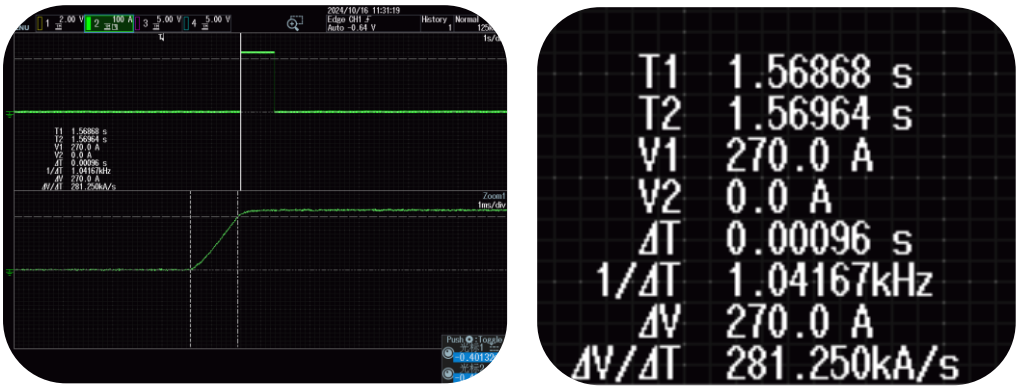
2.1 Ultra-high Accuracy

The staggered BUCK topology, the high-precision sampling chip, and the sampling algorithm together meet the high accuracy required by cell testing.

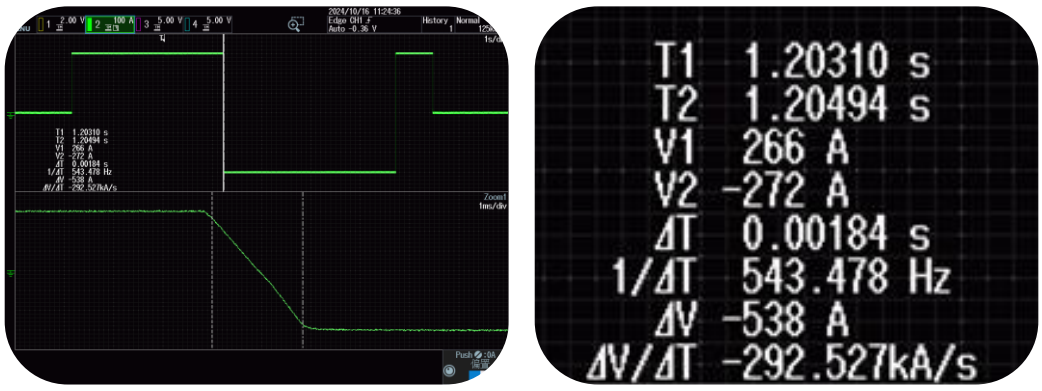
With intelligent current ranging (four ranges), if the rated current of B2000PG is 400A or below, it reaches the current accuracy of ±0.03%F.S. in the min. range of 40A, with the min. error ≤±12mA. If the rated current of B2000PG is 500A-800A, it reaches the current accuracy of ±0.03%F.S. in the min. range of 80A, with the min. error ≤±24mA.

2.2 Fast Dynamic Response

Excellent dynamic response, the time of 10-90% sudden loading of current ≤1ms, and that of -90% ~ +90% current switching ≤2ms. The output current reaches the set value in a short time without overshoot in the current curve.



Response time ≤1ms (10-90% sudden loading)



Switching time ≤2ms (-90% ~ +90% switching)

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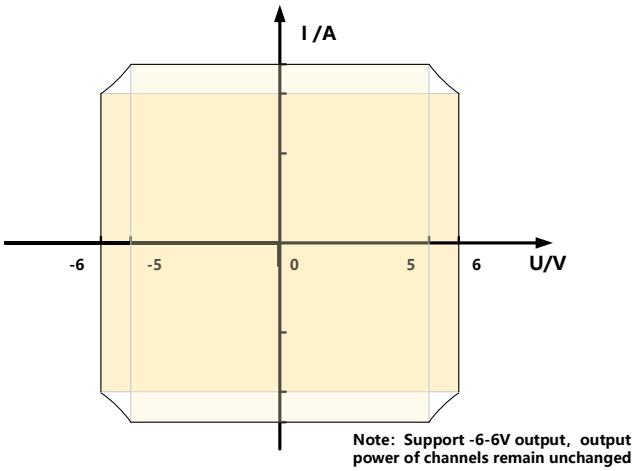
2.3 Charge and Discharge at Negative Voltage

The DC output part of the programmable power supply adopts a full bridge circuit design, which has four quadrant output capability and can output -6V-6V. It is used for cell limit testing and safety testing to understand the safety performance and electrical performance limits of the cell.



2.4 Excellent Online Data Processing

- Users may select the required data. The relevant data is plotted and analyzed.
- Online curve analysis is interactive; users may select, zoom in/out, filter or highlight certain data.
- Users can also import the results of analysis as reports or charts, for further use in R&D and certification.
- Support offline data analysis, processing, and export of large files of 30G and above.
- Support importing/exporting files in EXCEL, CSV, TXT, and MDF4 formats.
- Customizable curve color, line type, markers, etc.
- Simple and clear UI, user-friendly navigation and tags, easy to operate.

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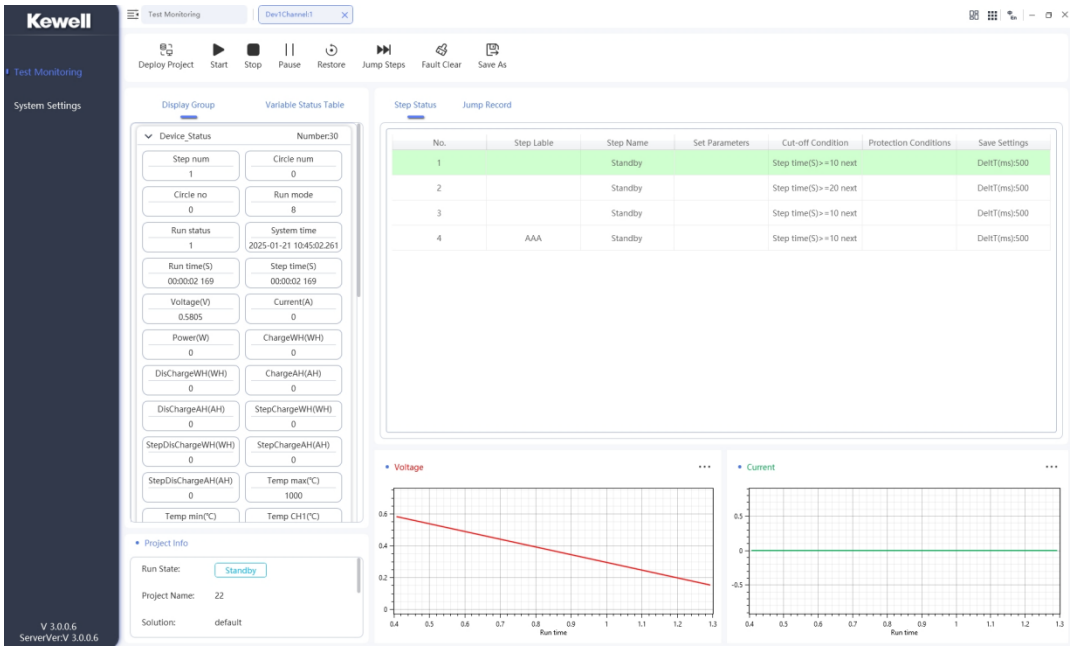
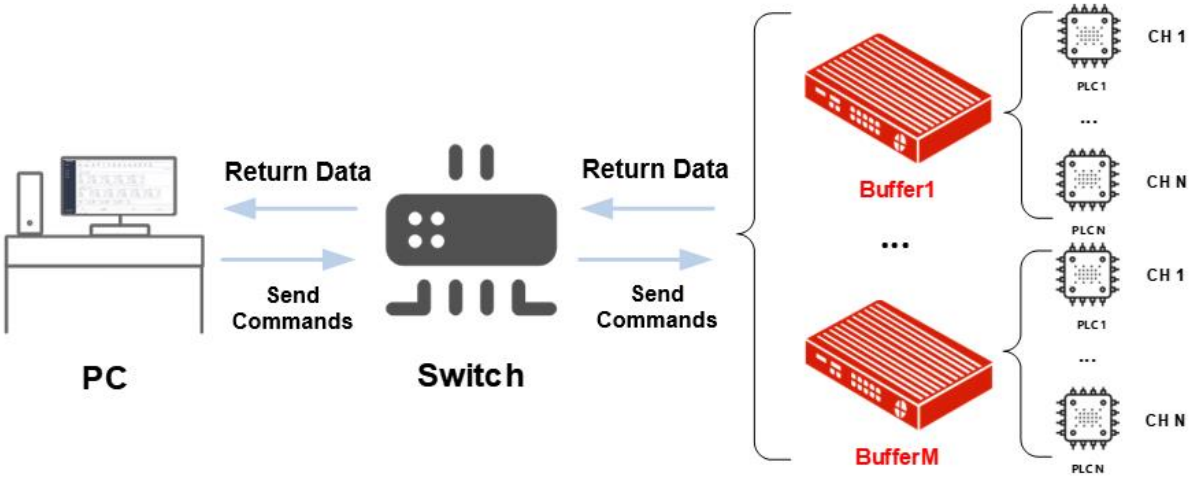


2.5 High Performance Buffer

- The system is equipped with high performance buffer for the stability of fully offline operation.
- The software sends testing process, and the buffer is responsible for communication data parsing, command sending, data uploading, and data storing.
- The PC software manages multiple buffers, with up to 128 channels under control.



2.6 System-level Testing

The system software can communicate and exchange data with necessary testing equipment or

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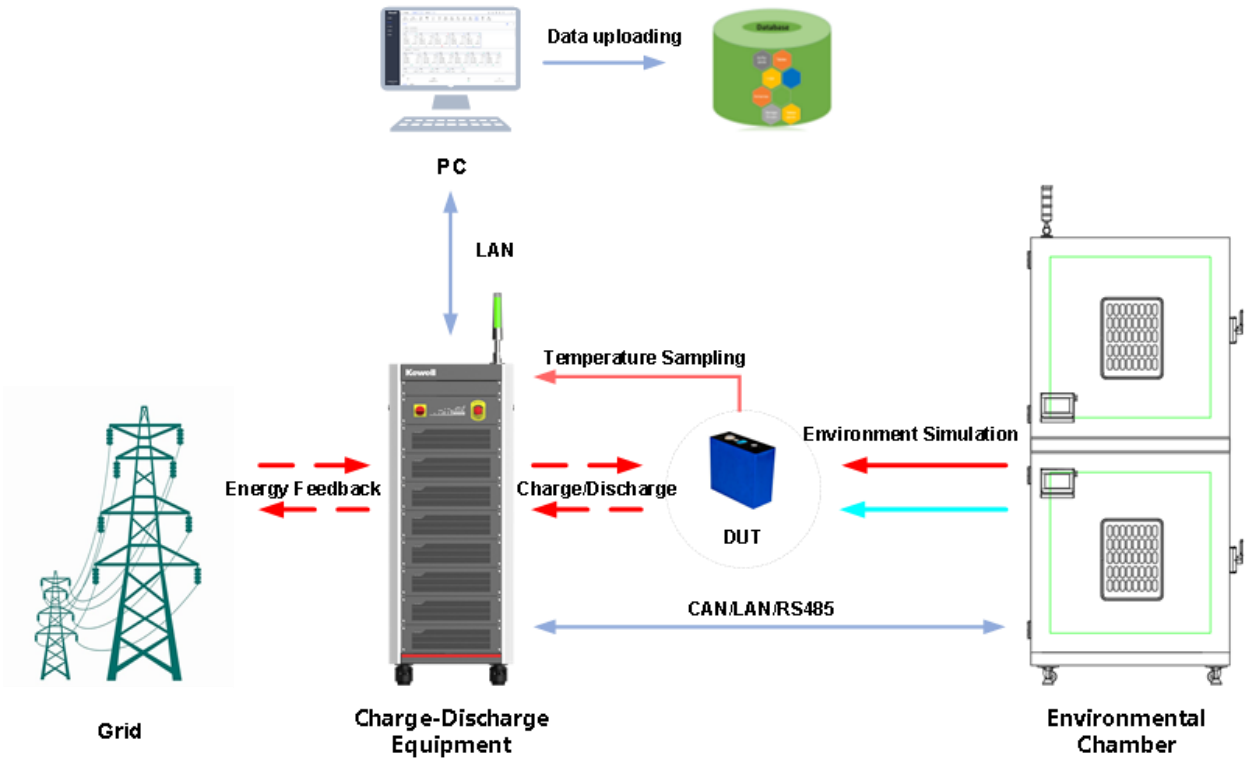
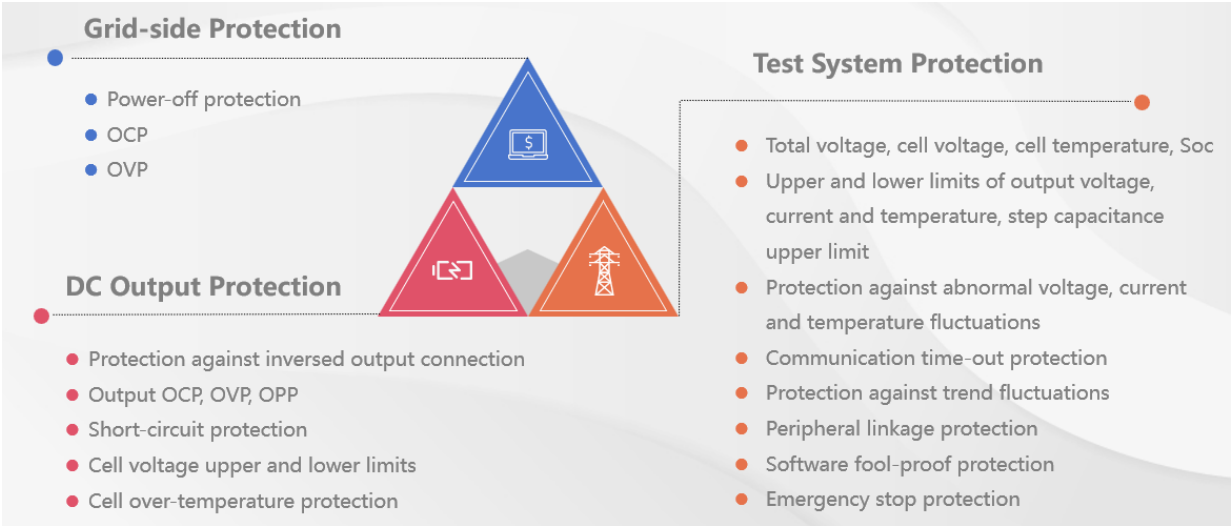
auxiliary equipment in the platform to achieve joint commissioning. This includes auxiliary channel voltage/temperature monitoring devices, high and low temperature chambers.



2.7 All-round Protections

There are all-round protections at both software and hardware levels for safety and reliability of the testing. Users can also check current and historical faults for the convenience of tracking and analysis.



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3 External Conditions

For smooth installation and stable operation of the equipment, and for a longer service life of it, there are certain restrictions on the external conditions of equipment installation, detailed as follows:

3.1 Environmental Conditions

For indoor installation, the user should provide an appropriate site for equipment placement, which should avoid dust, dripping water, and rain.

- Ambient temperature: -10℃ ~ +40℃
- Ambient humidity: 0~90%RH, 25℃ non-condensing
- Altitude: <2000m

3.2 Site Requirements

The site requirements are as follows:

- Check the dimensions and load bearing capacity of the doors, elevators, etc. of the passageway and make sure they are ready for transport of the equipment.
- In the equipment area, also reserve space for maintenance, testing and cable layout.
- The setup of the test stations should take into account the placement and wiring of the equipment and the DUT, as well as safety and neatness.
- A distance of 80cm should be reserved behind the equipment for the convenience of wiring and maintenance.
- Avoid direct sunlight or direct radiation from other heat sources.

Check the diagram and table below:

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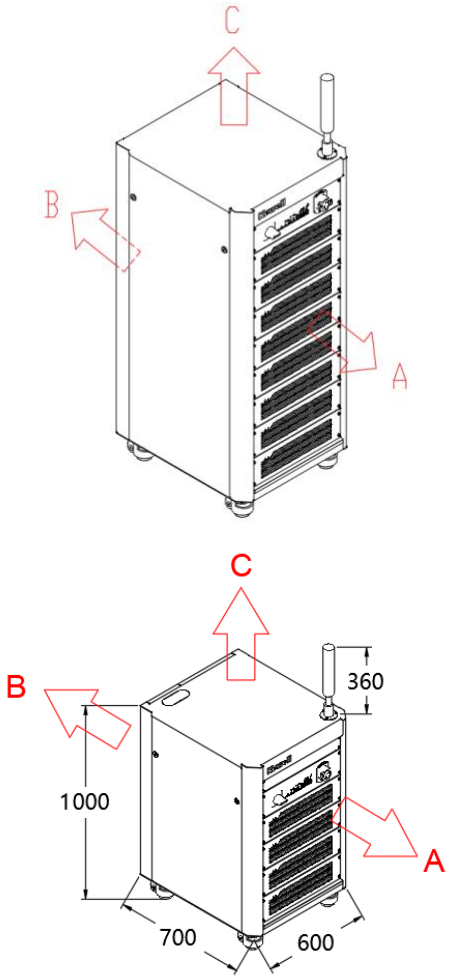

Table 3-1 Space requirements on site

No.	Model	Space A	Space B	Space C
1	B2000PG-24K-6-300-16-EC	100cm	80cm	60cm
2	B2000NG-12K-6-300-8-EC	≥100cm	≥80cm	≥60cm

3.3 Requirements for Power Distribution

To make sure that the equipment runs normally, the power grid distribution capacity should meet the following requirements:

- Three-phase five-wire input cable.
- Voltage range: 380Vac±10%, grid frequency: 50/60Hz±5Hz.
- Always make sure the switch at the front end of the wiring is disconnected and not charged before AC wiring, for fear of safety incidents.
- After grounding, measure that the ground resistance is no higher than 0.1Ω.

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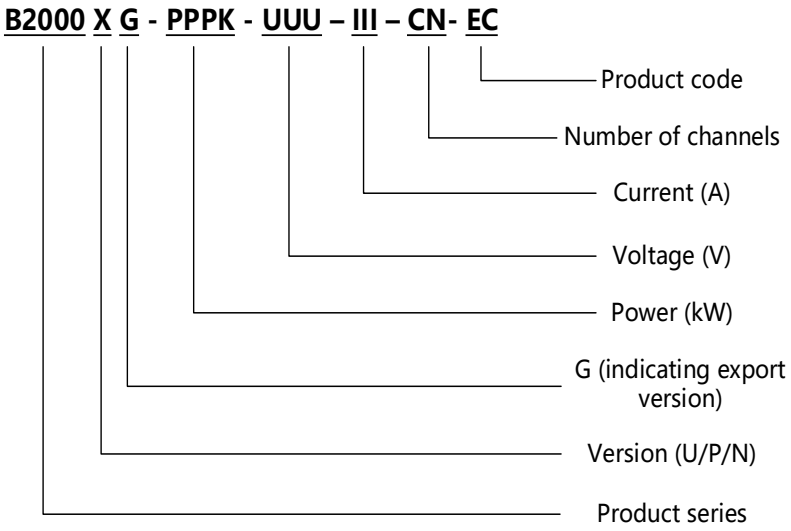
4 Technical Parameters

4.1 Model Description



4.2 Product Portfolio

Model	Single Channel Rated Power[kW]	Voltage Range[V]	Single Channel Rated Current[A]	Channel	Dimension (W*D*H) [mm]
B2000PG-2K-6-100-4-EC	0.5	-6-6	100	4	600-700-1000
B2000PG-4K-6-100-8-EC	0.5	-6-6	100	8	600-700-1000
B2000PG-6K-6-100-12-EC	0.5	-6-6	100	12	600-700-1550
B2000PG-8K-6-100-16-EC	0.5	-6-6	100	16	600-700-1550
B2000PG-4K-6-200-4-EC	1	-6-6	200	4	600-700-1000
B2000PG-8K-6-200-8-EC	1	-6-6	200	8	600-700-1000
B2000PG-12K-6-200-12-EC	1	-6-6	200	12	600-700-1550
B2000PG-16K-6-200-16-EC	1	-6-6	200	16	600-700-1550
B2000PG-6K-6-300-4-EC	1.5	-6-6	300	4	600-700-1000
B2000PG-12K-6-300-8-EC	1.5	-6-6	300	8	600-700-1000
B2000PG-18K-6-300-12-EC	1.5	-6-6	300	12	600-700-1550
B2000PG-24K-6-300-16-EC	1.5	-6-6	300	16	600-700-1550
B2000PG-8K-6-400-4-EC	2	-6-6	400	4	600-700-1000
B2000PG-16K-6-400-8-EC	2	-6-6	400	8	600-700-1000
B2000PG-24K-6-400-12-EC	2	-6-6	400	12	600-700-1550
B2000PG-32K-6-400-16-EC	2	-6-6	400	16	600-700-1550
B2000PG-10K-6-500-4-EC	2.5	-6-6	500	4	600-700-1000

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B2000PG-15K-6-500-6-EC	2.5	-6-6	500	6	600-700-1550
B2000PG-20K-6-500-8-EC	2.5	-6-6	500	8	600-700-1550
B2000PG-12K-6-600-4-EC	3	-6-6	600	4	600-700-1000
B2000PG-18K-6-600-6-EC	3	-6-6	600	6	600-700-1550
B2000PG-24K-6-600-8-EC	3	-6-6	600	8	600-700-1550
B2000PG-14K-6-700-4-EC	3.5	-6-6	700	4	600-700-1000
B2000PG-21K-6-700-6-EC	3.5	-6-6	700	6	600-700-1550
B2000PG-28K-6-700-8-EC	3.5	-6-6	700	8	600-700-1550
B2000PG-16K-6-800-4-EC	4	-6-6	800	4	600-700-1000
B2000PG-24K-6-800-6-EC	4	-6-6	800	6	600-700-1550
B2000PG-32K-6-800-8-EC	4	-6-6	800	8	600-700-1550

4.3 Technical Specifications

4.3.1 Pro Version Technical Specifications

Version		Pro
Output parameter	Voltage range	-6-6V
	Current ranging	Yes
	Voltage accuracy	±0.02%F.S. @ 15-35℃ ambient temperature
	Current accuracy	±0.02%F.S. @ 15-35℃ ambient temperature
	Power accuracy	±0.05%F.S. @ 15-35℃ ambient temperature
	Temperature coefficient	±25ppm/℃
	Current response time	≤1ms (10% ~ 90%)@3.5m cable
	Current switching time	≤2ms (-90% ~+90%)@3.5m cable
	Min operating time	10ms
	Data record time	1ms One cabinet supports a maximum of 2 channels to perform data logging at the interval of 1ms, whil e the other channels can record data at an interval ≥10ms
	Peak efficiency	80%
	Displayed resolution	0.1mV/0.1mA
	Setting resolution	1mV/1mA
	Channel parallel	Yes
Input Parameter	Grid voltage	380Vac±15%
	Grid frequency	50/60Hz±5Hz
Temperature sampling	Sensor type	K/T
	Sampling range	-50~200℃
	Sampling accuracy	±2℃ (This accuracy is the sampling accuracy provided by the module itself. If higher accuracy is needed, there are also optional built-in data acquisition systems)
General parameter	Noise	≤70dB
	Work temperature	-10 ~ 40℃
	Communication interface	LAN, RS485, CANFD *
	Other interface	Voltage sensing, EMG

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Standard accessory	Ethernet cable (PC LAN)	5m
	CAN cable	5m
	Packing list	1 copy
	Inspection report	1 copy
	USB flash drive	With software and user manual in it

Note: * the communication interfaces are used for integrating peripherals such as environmental chamber and temperature acquisition instruments.

4.3.2 Pro Version Current Ranges

Current accuracy	100A	200A	300A	400A
0.02%FS	0-40A@0.03%FS 40-100A@0.02%FS	0-40A@0.03%FS 40-100A@0.02%FS 100-200A@0.02%FS	0-40A@0.03%FS 40-100A@0.02%FS 100-200A@0.02%FS 200-300A@0.02%FS	0-40A@0.03%FS 40-100A@0.02%FS 100-200A@0.02%FS 200-400A@0.02%FS
Current accuracy	**500A**	**600A**	**700A**	**800A**
0.02%FS	0-80A@0.03%FS 80-200A@0.02%FS 200-400A@0.02%FS 400-500A@0.02%FS	0-80A@0.03%FS 80-200A@0.02%FS 200-400A@0.02%FS 400-600A@0.02%FS	0-80A@0.03%FS 80-200A@0.02%FS 200-400A@0.02%FS 400-700A@0.02%FS	0-80A@0.03%FS 80-200A@0.02%FS 200-400A@0.02%FS 400-800A@0.02%FS

4.4 Optional Configuration

No.	Name	Description
1	Output voltage range	-10-10V, channel power remains unchanged, voltage range increases
2	Controllable I/O port	Additional 1 * DI + 1 * DO signals
3	Temperature monitoring device	Support integration of temperature monitoring device and temperature sampling wire
4	Computer and accessories	i5-12400,16G,1T SSD, /,180W, Win10 and above, black, serial port *1, with a 23.8" monitor + mouse and keyboard set
5	Main power cable	1* positive + 1* negative /channel (including voltage sensing cable, for cable length, you may refer to section 4.5)
6	Lightning protection	Optional at input terminal
7	Test fixture	Customizable based on cell specifications (customer to provide cell dimensions)

Note: If you need to configure the Ethernet switch, the communication speed should be higher than 100Mbps.

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4.5 Optional Test Cables

4.5.1 Power Cables

No.	Model	Model Description
1	PA1080-WC-T1.1	T1.1: 3m 3AWG (current capacity 100A) power cable, 3.2m voltage sensing cable
2	PA1080-WC-T1.2	T1.2: 3.5m 3AWG (current capacity 100A) power cable, 3.7m voltage sensing cable
3	PA1080-WC-T1.3	T1.3: 4m 3AWG (current capacity 100A) power cable, 4.2m voltage sensing cable
4	PA1080-WC-T1.4	T1.4: 5m 3AWG (current capacity 100A) power cable, 5.2m voltage sensing cable
5	PA1080-WC-T2.1	T2.1: 3m 1/0AWG (current capacity 200A) power cable, 3.2m voltage sensing cable
6	PA1080-WC-T2.2	T2.2: 3.5m 1/0AWG (current capacity 200A) power cable, 3.7m voltage sensing cable
7	PA1080-WC-T2.3	T2.3: 4m 1/0AWG (current capacity 200A) power cable, 4.2m voltage sensing cable
8	PA1080-WC-T2.4	T2.4: 5m 1/0AWG (current capacity 200A) power cable, 5.2m voltage sensing cable
9	PA1080-WC-T2.5	T2.5: 10m 1/0AWG (current capacity 200A) power cable, 10.2m voltage sensing cable
10	PA1080-WC-T2.6	T2.6: 15m 1/0AWG (current capacity 200A) power cable, 15.2m voltage sensing cable
11	PA1080-WC-T3.1	T3.1: 3m 3/0AWG (current capacity 300A) power cable, 3.2m voltage sensing cable
12	PA1080-WC-T3.2	T3.2: 3.5m 3/0AWG (current capacity 300A) power cable, 3.7m voltage sensing cable
13	PA1080-WC-T3.3	T3.3: 4m 3/0AWG (current capacity 300A) power cable, 4.2m voltage sensing cable
14	PA1080-WC-T3.4	T3.4: 5m 3/0AWG (current capacity 300A) power cable, 5.2m voltage sensing cable
15	PA1080-WC-T4.1	T4.1: 3m 4/0AWG (current capacity 400A) power cable, 3.2m voltage sensing cable
16	PA1080-WC-T4.2	T4.2: 3.5m 4/0AWG (current capacity 400A) power cable, 3.7m voltage sensing cable
17	PA1080-WC-T4.3	T4.3: 4m 4/0AWG (current capacity 400A) power cable, 4.2m voltage sensing cable
18	PA1080-WC-T4.4	T4.4: 5m 4/0AWG (current capacity 400A) power cable, 5.2m voltage sensing cable
19	PA1080-WC-T5.1	T5.1: 3m 185mm^2 (current capacity 500A-600A) power cable, 3.2m voltage sensing cable
20	PA1080-WC-T5.2	T5.2: 3.5m 185mm^2 (current capacity 500A-600A) power cable, 3.7m voltage sensing cable
21	PA1080-WC-T5.3	T5.3: 4m 185mm^2 (current capacity 500A-600A) power cable, 4.2m voltage sensing cable
22	PA1080-WC-T5.4	T5.4: 5m 185mm^2 (current capacity 500A-600A) power cable, 5.2m voltage sensing cable

4.5.2 Temperature Sampling Cables

No.	Model	Model Description
1	PA1080-TS-T1-3.2-1	1* thermocouple sampling cable (3.2m) per channel，error: ±1℃
2	PA1080-TS-T1-3.2-2	2* thermocouple sampling cable (3.2m) per channel，error: ±1℃
3	PA1080-TS-T1-3.2-3	3* thermocouple sampling cable (3.2m) per channel，error: ±1℃
4	PA1080-TS-T1-3.2-4	4* thermocouple sampling cable (3.2m) per channel，error: ±1℃
5	PA1080-TS-T1-3.7-1	1* thermocouple sampling cable (3.7m) per channel，error: ±1℃
6	PA1080-TS-T1-3.7-2	2* thermocouple sampling cable (3.7m) per channel，error: ±1℃
7	PA1080-TS-T1-3.7-3	3* thermocouple sampling cable (3.7m) per channel，error: ±1℃
8	PA1080-TS-T1-3.7-4	4* thermocouple sampling cable (3.7m) per channel，error: ±1℃

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9	PA1080-TS-T1-4.2-1	1* thermocouple sampling cable (4.2m) per channel，error: ±1℃
10	PA1080-TS-T1-4.2-2	2* thermocouple sampling cable (4.2m) per channel，error: ±1℃
11	PA1080-TS-T1-4.2-3	3* thermocouple sampling cable (4.2m) per channel，error: ±1℃
12	PA1080-TS-T1-4.2-4	4* thermocouple sampling cable (4.2m) per channel，error: ±1℃
13	PA1080-TS-T1-5.2-1	1* thermocouple sampling cable (5.2m) per channel，error: ±1℃
14	PA1080-TS-T1-5.2-2	2* thermocouple sampling cable (5.2m) per channel，error: ±1℃
15	PA1080-TS-T1-5.2-3	3* thermocouple sampling cable (5.2m) per channel，error: ±1℃
16	PA1080-TS-T1-5.2-4	4* thermocouple sampling cable (5.2m) per channel，error: ±1℃
17	PA1080-TS-T1-10.2-1	1* thermocouple sampling cable (10.2m) per channel，error: ±1℃
18	PA1080-TS-T1-10.2-2	2* thermocouple sampling cable (10.2m) per channel，error: ±1℃
19	PA1080-TS-T1-10.2-3	3* thermocouple sampling cable (10.2m) per channel，error: ±1℃
20	PA1080-TS-T1-10.2-4	4* thermocouple sampling cable (10.2m) per channel，error: ±1℃
21	PA1080-TS-T1-15.2-1	1* thermocouple sampling cable (15.2m) per channel，error: ±1℃
22	PA1080-TS-T1-15.2-2	2* thermocouple sampling cable (15.2m) per channel，error: ±1℃
23	PA1080-TS-T1-15.2-3	3* thermocouple sampling cable (15.2m) per channel，error: ±1℃
24	PA1080-TS-T1-15.2-4	4* thermocouple sampling cable (15.2m) per channel，error: ±1℃

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5 Product Features

5.1 Operating Modes

The system supports constant voltage (CV), constant current (CC), constant resistance (CR), CC+CV, pulse current, pulse power, ramp current, operating condition simulation and other steps of charge and discharge.

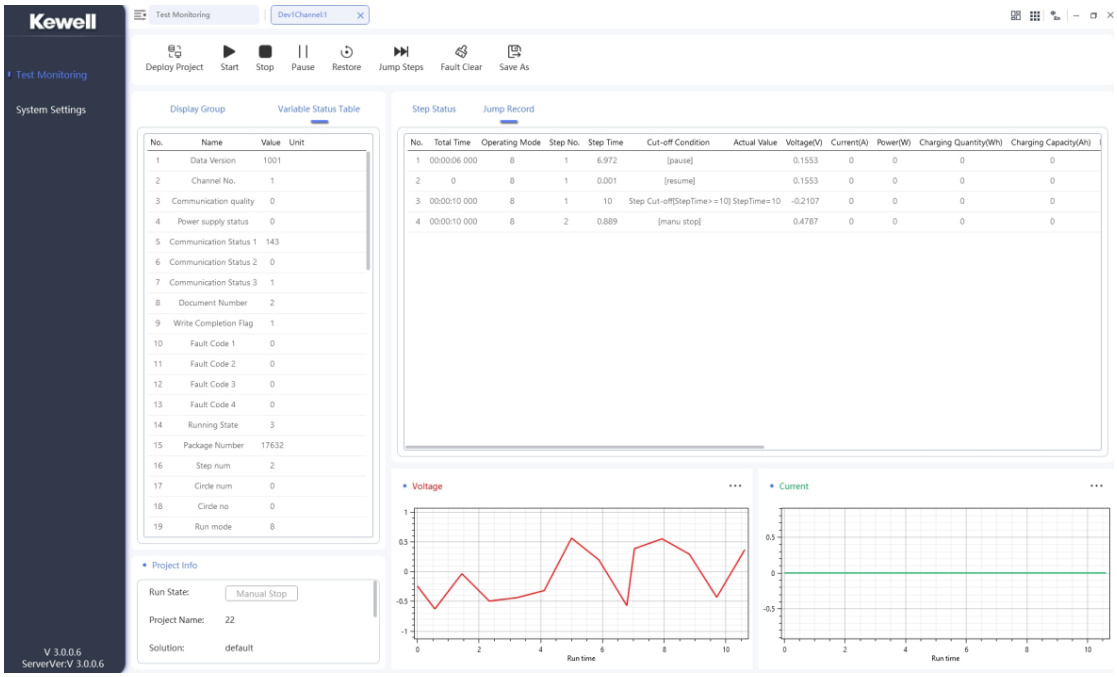

Figure 5-1 Operating mode selection

5.2 Variables Management

The system has a set of predefined abstract variables for users to call. Users may also create custom variables in the variables management system. Abstract variables are intrinsically mapped to actual device status. The user's test logic based on abstract variables will no longer be coupled to specific devices, allowing a device to be replaced without requiring modification of the test logic.

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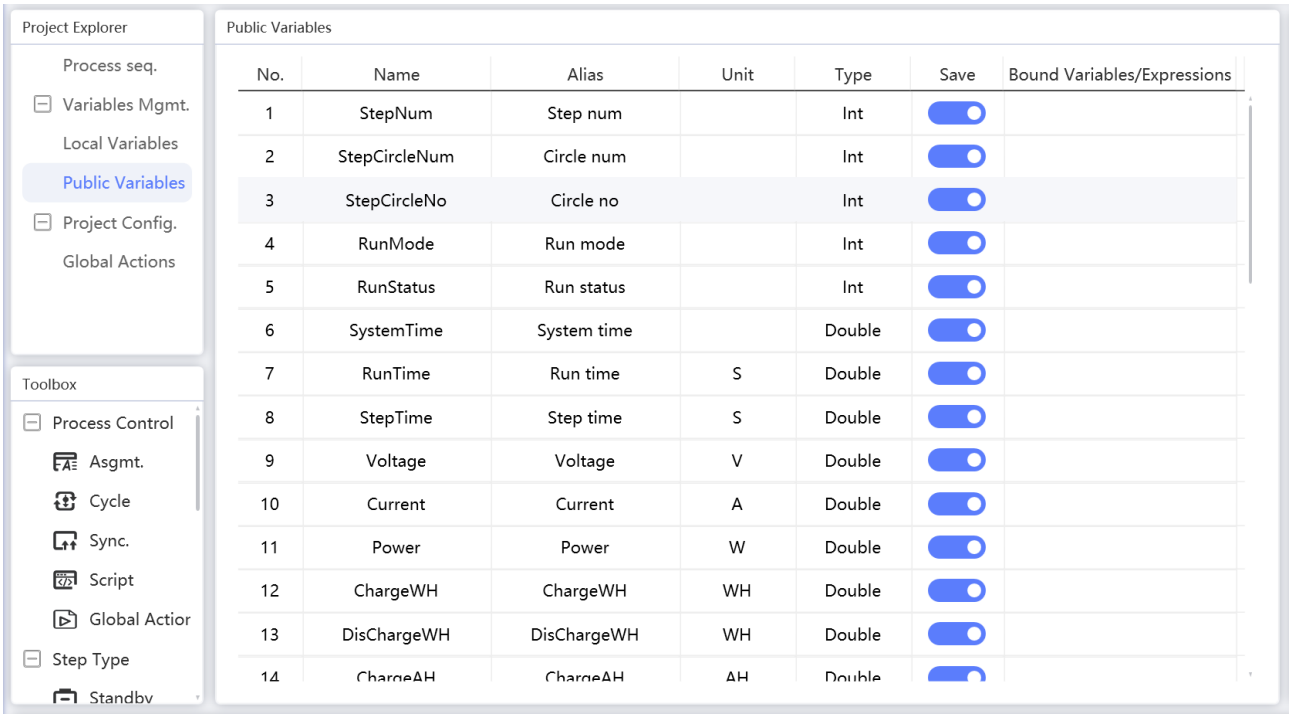

Figure 5-2 Variables management interface

5.3 Management of Test Sequences

This function supports definition of step execution logic, test protection logic, and test data logging logic in specific formats. Users can customize the test logic by scripting, or edit the process file through the defined, visualized test logic system.

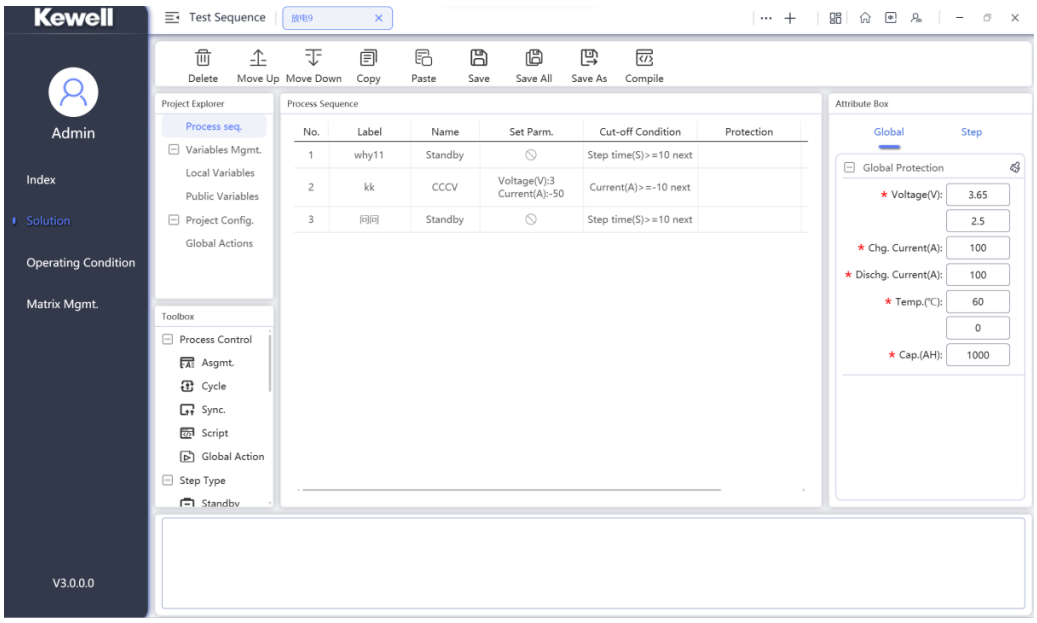

Figure 5-3 Table of test sequences

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5.4 Simulation of Operating Conditions

1) Operating condition file

Simulation of operating conditions supports cycling test of EV driving as per industry standards such as NEDC, WLTC and WLTP. Users can also import real-time data of operating conditions in excel, .csv and other formats.

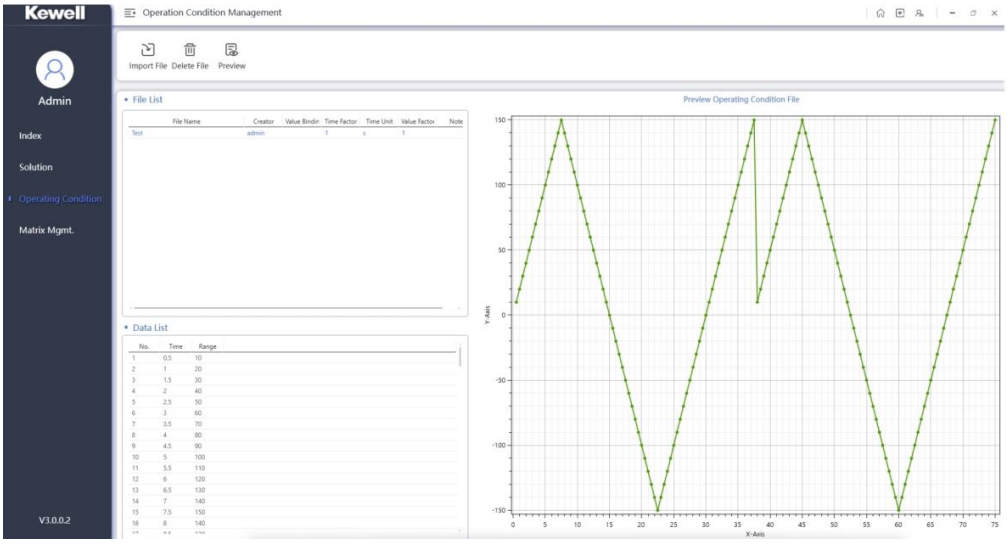

Figure 5-4 Operating condition simulation

2) Matrix file

Users can import the operation data of two 2D matrices in advance. When the equipment is running, the external variables are read in real time, based on which it will run real-time table look-up. Here, the table look-up values from the matrices can be used directly as the operating parameters of the equipment, or they can be first compared and then used as the operating parameters.

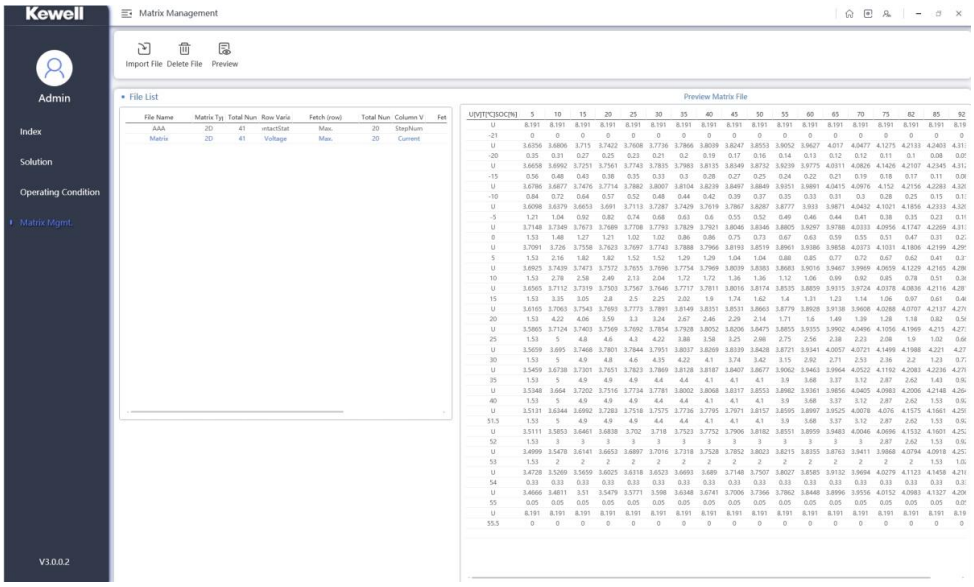

Figure 5-5 Matrix file

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5.5 Data Processing

- Real-time data display, dynamic analysis of test waveforms.
- Real-time recording to test process and data, full process tracking.
- Test data export in Excel and CSV formats, the same project can be split into multiple data sheets for the convenience of users.

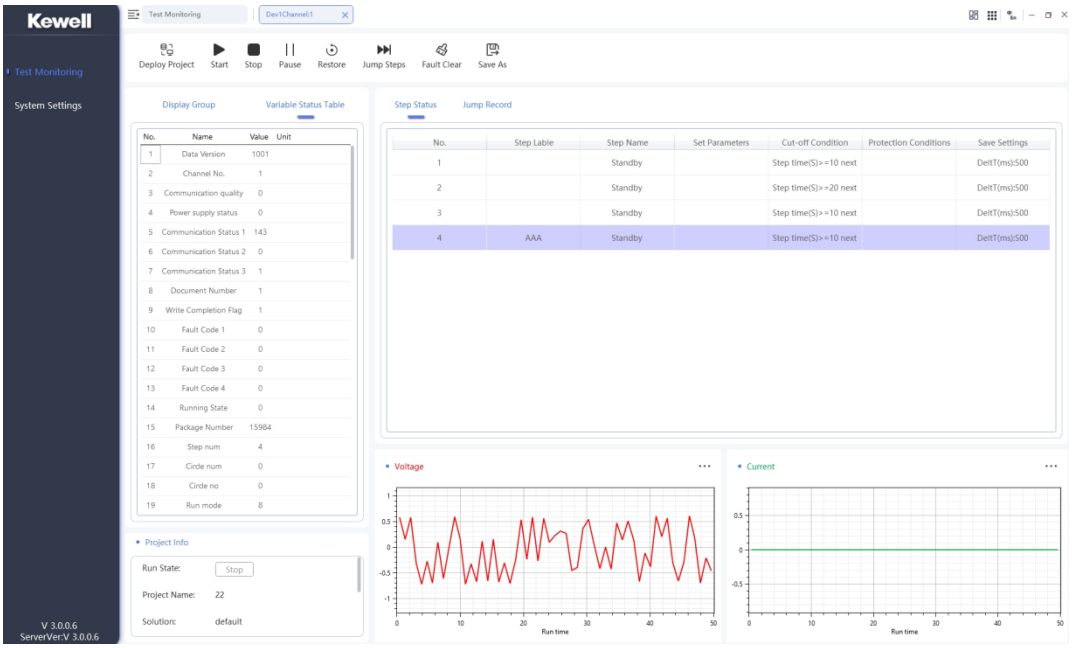

Figure 5-6 Data processing

5.6 Script Editing

Users can write the test using Lua scripting language. Users may define the execution logic of each step, the test protection logic, data logging logic, control of system peripherals, and test-related custom algorithms.

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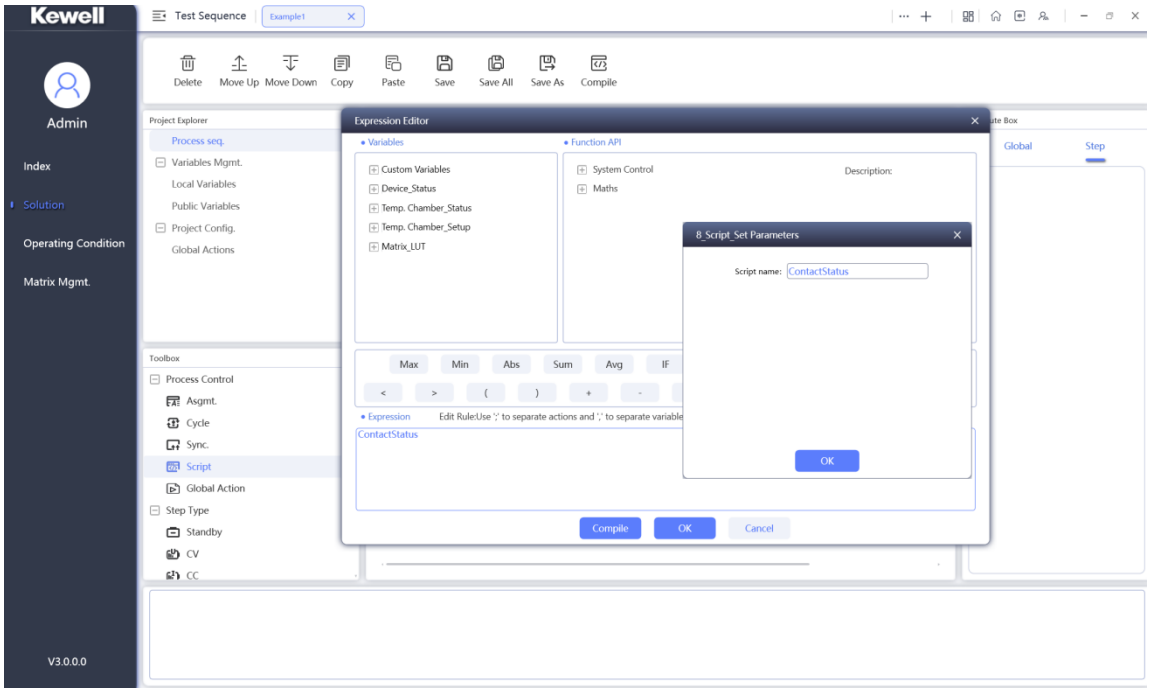

Figure 5-7 Script editing

5.7 Detailed Description of Functions

Table 5-1 Function description

Control program	
Number of steps in step file	≥9999
Cycle times	≥9999
Cycle nesting	Up to 10 layers
Programming features	1. Each step has one or more exits, and supports “goto” statement 2. Users can select to jump to the next step, jump to step N, jump to the last unfinished task, or end
Operating modes/ Cut-off conditions	
Charge mode	CV, CC, CP, CR, CC to CV, pulse current, pulse power, ramp current, ramp power
Discharge mode	CV, CC, CP, CR, CV to CC, pulse current, pulse power, ramp current, ramp power
Standby	Yes
Simulation of operating conditions	Users can import operating condition file in EXCEL and CSV formats; minimum operating condition interval: 10ms, up to 1 million pieces of operating condition data, support comparison of operating condition file with external variables, and the smaller value will be adopted
Matrix mode	1. Users can import two 2D matrices of operation data in advance. When the equipment is running, the external variables are read in real time, based on which it will run real-time table look-up. Here, the table look-up values from the matrices can be used directly as the operating parameters of the equipment, or they can be first compared and then used as the operating parameters

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	2. Select both current and power limit in matrix mode 3. Two matrix look-up modes: constant value interpolation and linear interpolation	
Command limits	Current limit Power limit	Current or power output can be limited in real time according to a custom variable, with formula editing function
Cut-off conditions	Voltage, current, time, capacity, power, DC internal resistance, quantity of electric charge, temperature, and derived values of extended transformations	
Process editing/ Functions		
New process	Operations such as create new test step, open/add/delete/modify test step, load operating condition file, and scan battery barcode	
Open process	Open the process file at a specified location	
Save process	Save new or modified process file	
Add to process	Add steps of other process file to the current step	
New step	Master mode	Charge/Discharge, standby, matrix, operating condition, etc.
	Operating modes	CP, CC, CV, CR, CC+CV, pulse current, pulse power, ramp current, ramp power
	Parameters	Set operating current, select follow the BMS instructions, current command limit, and power command limit; users can enter values in the box, or double-click the box to enter formula editing mode.
Step editing separated from sending	First, edit the step and save it as step file, then select the very step in the interface and send it; the pause, stop, continue buttons are also required.	
Interface partition	The step editing interface is divided into three parts: detailed settings, battery safety protection and limit parameter settings, and step name management, easy to operate and identify run-time error	
Online step change	Support online modification of step parameters, and seamless connection with currently running steps after modification; moreover, only one file will be generated, and the file path remains unchanged	
Conditional jump	Support logic AND, OR, NOT ① AND (jump to a specified step when multiple conditions are met) ② OR (jump to a specified step when one of multiple conditions is met) ③ NOT (jump to a specified step when multiple conditions are not met)	
Selective jump	Select to jump to a specified step based on different conditions	
Custom functions	The software supports custom variables (variables and functional operations x+z. x-z, x*z, x/z, ax+b, Asin(ωx+φ)+b, max, min, sum, avg.), and function calling in subsequent step file	
Process import	Test process can be programmed offline. The edited process can be saved as a separate file for further use. The saved process file can be recognized by and imported to other devices of the same brand and model.	
Assignment of value to variables	Take the data of step operation as parameters, and save the calculated results as variables for subsequent steps to call as execution parameters or cut-off conditions	
Preset pause	Preset the test process to pause at the end of a step or at the end of a cycle	

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Continuation	Support seamless process continuation in situations like pause, equipment restart, software upgrading, and equipment fault, also support cross-device continuation
Channel migration	Support migration of unfinished test data of a channel to other channels for further operation
Temperature-limited current	In fast charging test, based on the given temperature range, the charge/discharge equipment regulates the current and power in real time to make sure that the cell temperature falls within the set range, preventing battery overheating
User privilege management	Super admin, admin, tester; users can assign different privileges to different operators Super admin and admin will be downgraded to tester if no operation is run for more than 5min (can be adjusted) after logging in
Integration of peripherals	Integrate the environmental chamber, data acquisition unit, BMS simulator and other peripherals, and record key parameters
Continuation after power failure	Upon power failure, users may select to continue from the equipment status before the power failure when powering up the equipment again
Barcode scanning	Easy to enter the battery barcodes
Zero clearing	Clear charge/discharge time, charge/discharge energy, charge/discharge capacity, total run time, standby time, and other operating statistics
Real-time monitoring	Display equipment current, voltage dynamics in real time, current channel status, and also time, current, voltage, capacity, quantity of electric charge, test step and other information
Split screen	Split screen control of operation interface and engineering interface, and with password protection
Interlock	1. The charge-discharge device interlocks with the direct cooling platform of the environmental chamber and the temperature monitoring device, and the software opens communication protocol editing for users to customize based on their needs. 2. Signals and data from the interlocked environmental chamber and temperature monitoring device can be used as the basis for judgment and jumping, or as protection parameters. 3. Users may control the interlock with the environmental chamber based on charge/discharge jump/ cut-off conditions or any logical combination of several conditions. 4. The uploaded data from environmental chamber and temperature/voltage monitoring device can be saved in raw test data. 5. Based on the feedback information of the environmental chamber/temperature monitoring device, upon communication anomaly with the chamber, there will be the alarm of ‘charge-discharge device stops’. 6. When setting third-party information in the equipment, make sure specific values are entered; the tester enters values to assign, starts operation directly, and calls third-party commands in an explicit manner. The interface must show specifically is there interlocked third-party equipment, with specific set values and execution conditions.
LIMS joint debugging	The equipment acquisition system supports general mode of data forwarding, or open communication protocols and general communication port configuration, or the acquisition system software outputs data in general formats.
Data processing/ Display	

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Real-time data display	1. The operation interface displays equipment information, time, project and step data, operating status, and peripherals information (environmental chamber, data acquisition system) in real time 2. At the start of the current project, the time 0 status of the first step cannot be recorded (if it is set to 1ms logging, the time of the first line of data is 00.00.0001); the initial status, i.e., time 0 status, of each step should be recorded	
Data logging conditions	△T(ms)/△V/△I/△Ah/ /△Wh/△T(℃)	
Data presentation	Cycle list	Cycle No., cycle time, output voltage, output current, charge capacity, discharge capacity, quantity of charge, quantity of discharge, charge time, discharge time, etc.
	Procedure list	Step No., cycle group No., current cycle count, operating mode, operating status, procedure time, step charge capacity, step discharge capacity, DC internal resistance, cut-off voltage, etc.
	Detailed list	Record No., cumulative time, voltage, current, quantity, power, cell temperature, cell voltage, environmental chamber data, etc.
	Process list	Step No., operating mode, step parameters, cut-off conditions, cycling conditions
	Log list	Step No., operating mode, step parameters, step time, cut-off conditions, actual trigger conditions, cut-off action, output voltage, output current, etc.
Data export	Data export in EXCEL and CSV formats	
Report splitting	Split the same project into multiple data reports for the convenience of users	
Real-time data curves	Select curves to display in real time during test Support data screening based on user needs Translate, zoom in/out, or fit the curve to screen Display charge and discharge status in different colors Export and print test curves	
Historical curves	Display historical data curves, users can select required ones Support data screening based on user needs Translate, zoom in/out, or fit the curve to screen Support oscilloscope simulation based on user needs Display charge and discharge status in different colors Export and print test curves	
Types of historical curves	X-axis	Total time, charge time, discharge time, capacity, quantity, water chiller data, environmental chamber data, etc.
	Y-axis	Total voltage, total current, capacity, quantity, power, cell voltage, cell temperature and other external parameters
Data look-up	Look up historical data by project name, battery type, operator, time, battery No., path, etc.	
Custom data report	Support custom reports, the test data can be exported according to the rules given by the user and summarized in an Excel file.	
MES connection	Upload test data to MES	
Protections		
Input protections	Overvoltage, overcurrent, power failure	
Output protections	Overvoltage, overcurrent, reversed polarity, short-circuit, cell over-temperature	

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Power failure protection	Upon external power failure, the battery is automatically disconnected from the equipment, effectively preventing accidents from re-power up; also, the data at the point of disconnection is saved for continuation after the power resumes
Cell protection	Cell voltage, cell temperature
Global conditions	Users can set power supply voltage upper/lower limit, power supply charge/discharge current upper limit, cell voltage upper/lower limit, and cell current upper/lower limit, and set custom variables as global protection conditions
Step protection	Set special protection conditions for a single step or several specified steps
Emergency stop	Stop the equipment in cases of emergency
Communication monitoring	Protection against interruption of communication with the software
Software protections	In the case of abnormal close of the software, the buffer continues operation until exceeds offline time; if there is no offline time, it will execute process in sequence without the software or remain in standby
	Support data protection in cases of power-down. Upon power failure, the equipment stops the current step, and continues from that after power supply is resumed.
	Test continuation upon communication anomaly or power supply abnormality, support off-line running after interruption, and the computer will automatically continue the process after it resumes normal state.
	With protection against data loss (due to mis-operation or accidents)
	The emergency stop button stops the equipment in cases of emergency
	Users can set overvoltage, undervoltage, capacity, overcurrent, undercurrent, and temperature protections
	Protection against reversed polarity and communication anomaly, and communication protection for auxiliary modules
Protection against reverse polarity or incorrect connection of voltage sensing	When reverse polarity or incorrect connection of the voltage sensing line of any channel is detected, the system will trigger an alarm protection, and you won't be able to start the testing process
Running offline	Offline time >24h (dependent on data logging time)
Buffer	1. The equipment buffer is the center of equipment control; after the software sends the test process, the buffer controls the equipment and collects data and then uploads data to the software. 2. Support offline running, upon software communication breakdown or equipment stop, the buffer can continue to support normal operation of the equipment and safety protection conditions, and can save test data for uploading to the software after it resumes normal state.

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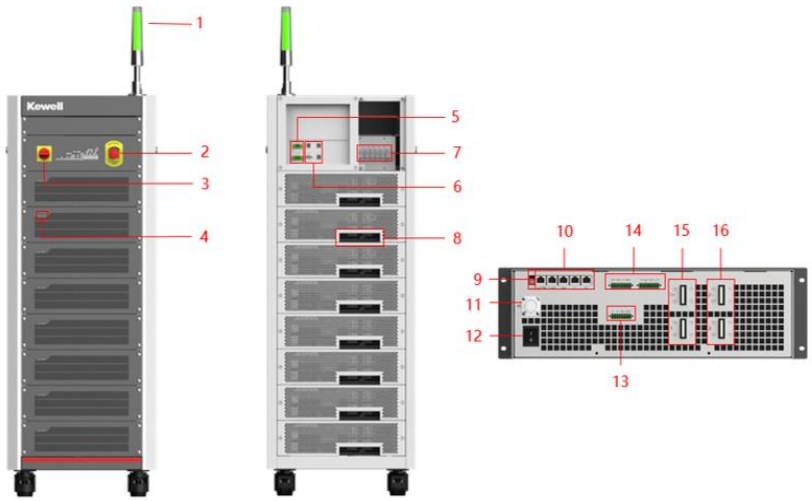
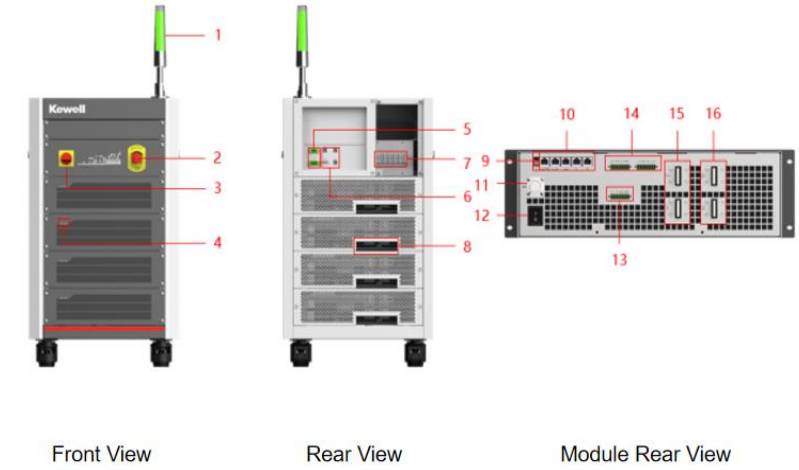
6 Interfaces



Front View Rear View Module Rear View

Serial No.	Name
1	Three color light
2	Emergency stop
3	AC power switch (padlocked available)
4	LED light
5	1 DI,1 DO,1 RS485,1 EMG
6	2 CANFD,3 LAN(1 PC, 2 Peripheral integration)
7	380VAC input interface(OT plug)
8	DC output terminal bolck
9	DIP swtich
10	Internal communication and parallel interface
11	Module AC input interface
12	Power switch
13	Voltage sampling and Can communication interface
14	Temperature sampling interface
15	CH1 positive,negative output
16	CH2 positive,negative output



Front View Rear View Module Rear View

Serial No.	Name
1	Three color light
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11	Module AC input interface
12	Power switch
13	Voltage sampling and Can communication interface
14	Temperature sampling interface
15	CH1 positive,negative output
16	CH2 positive,negative output

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