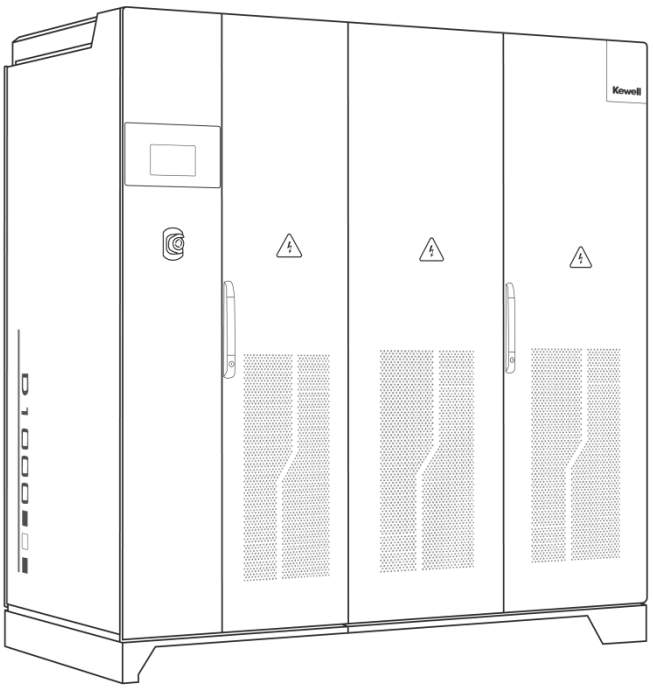
Kewell

Stock Code: 688551



D1000 SERIES

ENERGY RECYCLING DC ELECTRONIC LOAD

Mar. 2023 Version: A/11.1

KEWELL TECHNOLOGY CO,.LTD.

www.Kewelltest.com

CONTENTS

1 Summary

D1000 Series Energy Recycling DC Electronic Load (hereinafter referred to as D1000 Series) is a power electronic converter device designed with power frequency isolation IGBT device and two-stage conversion architecture which has high accuracy, high dynamic response, high reliability, programmable, energy regenerative characteristics. It can simulate various forms of DC load and it is easy to operate and energy saving.

2 External Condition

To ensure that the D1000 Series equipment is available on site for installation, commissioning and stable and reliable operation, the following conditions must be present on site.

- Installation environment

For indoor installation, the installation floor is required to be flat and free from water, the ground is flat and firm without shaking, and the ground can bear the weight of the equipment; the indoor air inlet and outlet must have a professional dustproof and rainproof design; there is sufficient distance between the front and rear of the equipment, the top and the wall to ensure normal ventilation and heat dissipation and maintenance.

- Temperature

The storage temperature of the equipment is -25°C to +50°C and the working temperature is -10°C to +40°C. The user must ensure that the space is well ventilated after the installation of the equipment to ensure that the equipment operates within the agreed ambient temperature.

- Humidity

The equipment should be used in a humidity environment of 0~90%RH and 25℃ without condensation.

- Altitude

The equipment should be used at an altitude of less than 2000m. For high altitude applications, this may result in overheating protection of the equipment and require derating.

- Grid parameters

Three-phase three-wire +PE, rated voltage: 400Vac±10%, grid frequency: 50±5Hz, grid capacity should be able to meet the Energy Recycling DC Electronic Load and other auxiliary electrical equipment operating under peak power conditions.

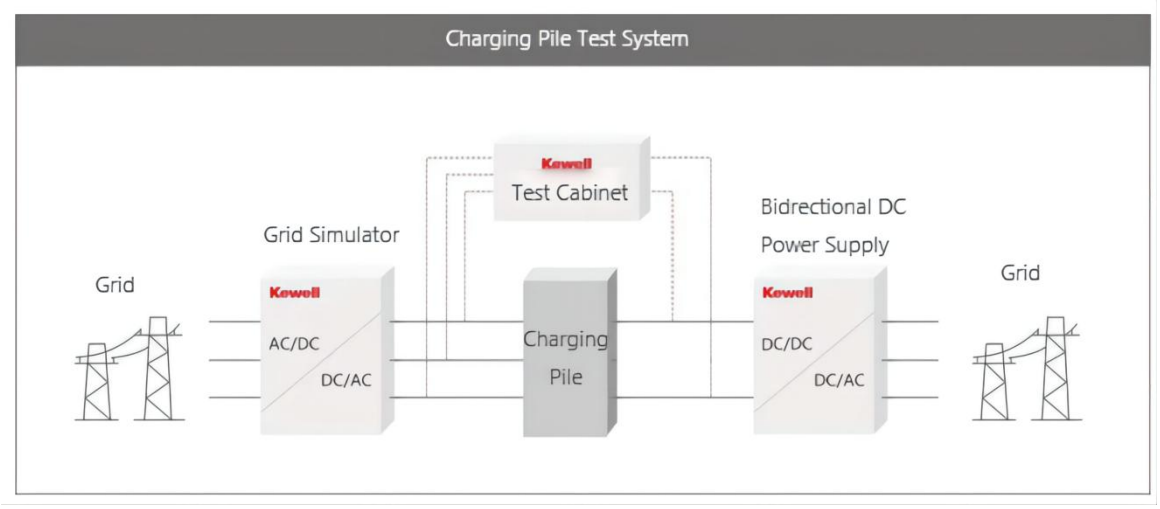
3 Product Features

- Equipped with high-performance AD sampling chip and combined digital filtering algorithm to achieve the accuracy of current to ±0.1%FS
- Designed with BUCK topology for high dynamic characteristic of load changing with response time ≤ 10ms;
- PWM synchronous rectification and DC/DC two-stage circuit to achieve high quality energy recovery with THD≤3%;
- Adopted PWM synchronous rectification and combined with the PFC corrective control in software algorithm to achieve PF≥0.99, and efficient use of energy;
- Four static output modes: constant voltage, constant resistance, constant current and constant power;
- The output has the current to power dynamic output mode to edit work-step according to the dynamic conversion instructions by setting time;
- The optional insulation detection function can realize real-time online detection of the insulation resistance of the positive and negative poles respectively to the ground to ensure the safety of the system;
- The voltage slew rate can be set;
- DC overvoltage and overcurrent protection values can be set;
- External emergency stop interface, which can be linked with the test system emergency stop function;
- With local operation and upper computer operation, the machine is equipped with a touch screen for easy offline testing.
- It has a full-featured, user-friendly interface;
- Standard communication interfaces: RS485, CAN2.0, LAN. And provide communication protocol for system integration;
- Complete internal protection mechanism and anti-misoperation protection function to improve the safety and reliability of the system;
- Its cabinet is designed with ANSYS mechanical finite element analysis, to simplify the design and ensure the stability;
- Its cabinet is designed with independent air duct to ensure that the power module unit is isolated from

magnetic devices, and combined with copper pipe to achieve small size, excellent heat dissipation

- It has a layer resistant to salt-spray corrosion. Its unique top drip-proof design combines air duct design with IP protection.

4 Typical Applications



Typical system application diagram

5 Product Specifications

5.1 200V Series Specification

Models	Rated Power [kW]	Rated Current [A]	Peak Power (60s)[kW]	Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
D1000-G-50-200-800-KDL	50	800	60	1000	10-200	890-1020-1550

5.2 800V Series Specification

Models	Rated Power [kW]	Rated Current [A]	Peak Power (60s)[kW]	Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
D1000-G-150-800-500-KDL	150	500	200	666	24-800	1000-1000-2000
D1000-G-200-800-500-KDL	200	500	250	625	24-800	1000-1000-2000

5.3 1000V Series Specification

- 1000V Single channel

Models	Rated Power [kW]	Rated Current [A]	Peak Power (60s)[kW]	Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
D1000-G-50-1000-300-KDL	50	300	60	360	24-1000	890-1020-1550
D1000-G-100-1000-350-KDL	100	350	150	525	24-1000	1000-1000-2000
D1000-G-150-1000-500-KDL	150	500	200	666	24-1000	1000-1000-2000
D1000-G-200-1000-500-KDL	200	500	250	625	24-1000	1400-1000-2000
D1000-G-250-1000-500-KDL	250	500	350	700	24-1000	1400-1000-2000
D1000-G-300-1000-600-KDL	300	600	400	800	24-1000	1800-1000-2000
D1000-G-400-1000-1000-KDL	400	1000	500	1250	24-1000	2000-1000-2000
D1000-G-500-1000-1000-KDL	500	1000	600	1200	24-1000	2000-1000-2000
D1000-G-600-1000-1000-KDL	600	1000	720	1200	24-1000	2200-1000-2000

- 1000V Dual Channel

Models	Rated Power [kW]	Single Channel Power [kW]	Rated Current [A]	Single Channel Peak Power (60s)[kW]	Single Channel Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
Free power distribution							
D1000-G-200-1000-500-2F-KDL	200	200	400	250	500	24-1000	1800-1000-2000
D1000-G-300-1000-500-2F-KDL	300	300	500	400	666	24-1000	2000-1000-2000
D1000-G-400-1000-800-2F-KDL	400	400	800	500	1000	24-1000	2600-1000-2000
D1000-G-500-1000-800-2F-KDL	500	500	800	600	1000	24-1000	2800-1000-2000

5.4 1200V Series Specification

Models	Rated Power [kW]	Rated Current [A]	Peak Power (60s)[kW]	Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
D1000-G-150-1200-500-KDL	150	500	200	666	24-1200	1000-1000-2000
D1000-G-200-1200-500-KDL	200	500	250	625	24-1200	1400-1000-2000
D1000-G-250-1200-500-KDL	250	500	350	700	24-1200	1400-1000-2000
D1000-G-300-1200-600-KDL	300	600	400	800	24-1200	1600-1000-2000
D1000-G-400-1200-1000-KDL	400	1000	500	1250	24-1200	2000-1000-2000
D1000-G-500-1200-1000-KDL	500	1000	600	1200	24-1200	2000-1000-2000

5.5 1600V Series Specification

Models	Rated Power [kW]	Rated Current [A]	Peak Power (60s)[kW]	Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
D1000-G-200-1600-350-KDL	200	350	300	525	24-1600	1800-1000-2000

D1000-G-300-1600-500-KDL	300	500	400	666	24-1600	2000-1000-2000
D1000-G-400-1600-500-KDL	400	500	500	625	24-1600	2000-1000-2000
D1000-G-500-1600-500-KDL	500	500	700	700	24-1600	2400-1000-2000

5.6 2000V Series Specification

Models	Rated Power [kW]	Rated Current [A]	Peak Power (60s)[kW]	Peak Current (60s)[A]	Voltage Range [V]	Dimensions(W*D*H) [mm]
D1000-G-300-2000-500-KDL	300	500	400	666	24-2000	2000-1000-2000
D1000-G-400-2000-500-KDL	400	500	500	625	24-2000	2400-1000-2000
D1000-G-500-2000-500-KDL	500	500	700	700	24-2000	2400-1000-2000

Note: * The voltage and current ranges in the above table can be customized.

5.7 Product Parameters

Load Mode	
Operation Mode	Constant voltage, constant resistance, constant current, constant power
Voltage Accuracy	±0.1%·FS
Current Accuracy	±0.1%·FS
Current Ripple(Rms)	≤0.2%·FS
Response Time	≤10ms(10-90% load variation)
Voltage Resolution	0.001V
Current Resolution	0.001A
Power Resolution	0.001kW
Operation Mode	Constant voltage, constant resistance, constant current, constant power
Energy Recovery Characteristics	
Energy Recovery	Energy recovery is available in the full power range
THD *	≤3%
Power Factor	≥0.99
Output voltage	400V±10%
Frequency	50Hz±5Hz
Communications and Interfaces	
Touch Screen	LCD
Remote	RS485/LAN /CAN
Other Interface	External emergency stop, fault signal, voltage compensation
Environment Condition and Safety	
Insulation Resistance	≥20MΩ（500Vdc）

Withstand Voltage	3000Vdc(60 s, no flashover, breakdown)
Ground Resistance	≤0.1Ω
Cooling	Forced air cooling
Ambient Temperature	-10 ~ 40℃
Humidity	0-90%RH(25℃ non-condensed)
Altitude	≤2000m

Note:

*The factory-configured upper computer software enables remote operation and communication with the test bench to complete the linkage test of the bench control system.

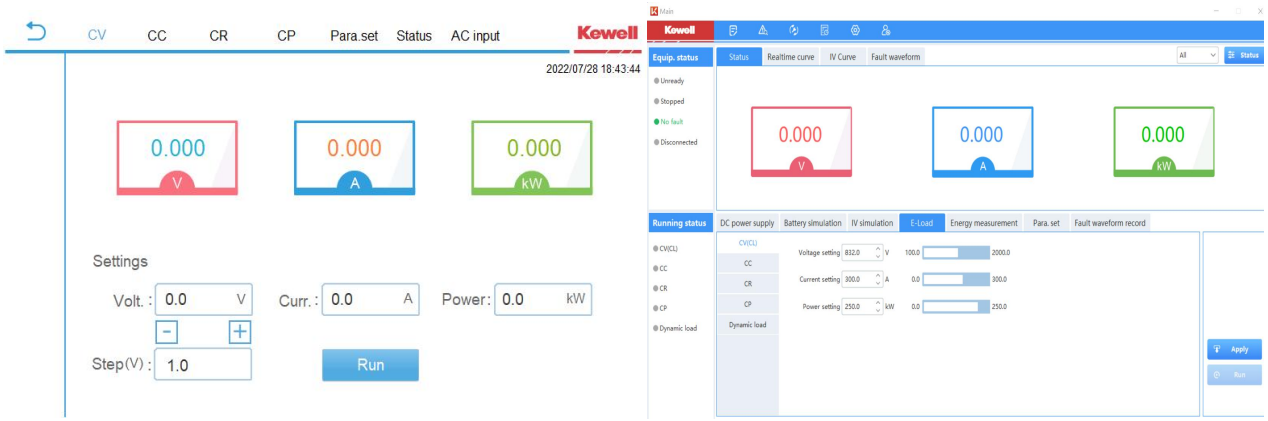
*The voltage resistance data in the above table applies to the 800V/1000V/1200V series; for the 1600V series, the voltage resistance is designed according to 3200Vdc; for the 2000V series, the voltage resistance is designed according to 3700Vdc.

6 Product Introductions

6.1 Main Functions

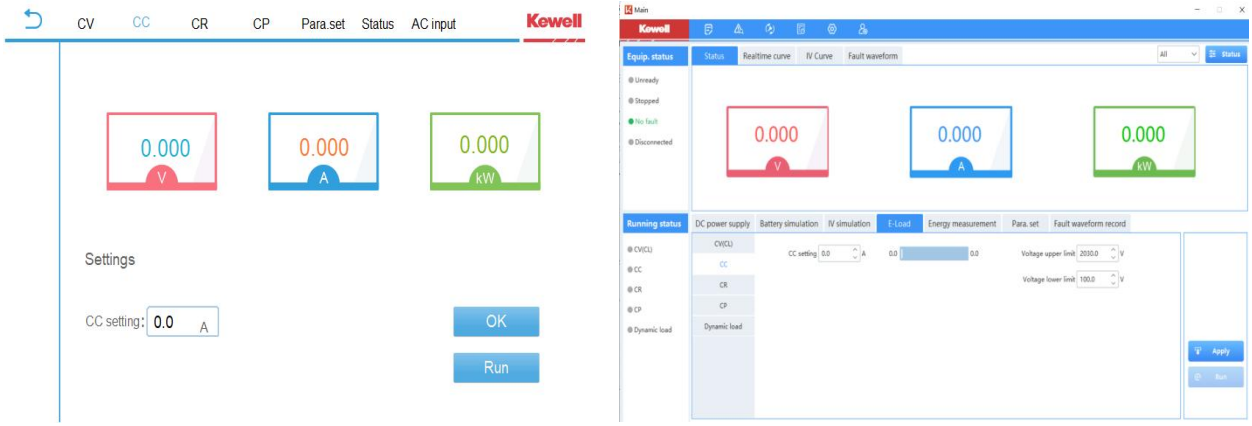
- Constant current, constant resistance, constant power and other static load functions

Select the constant voltage current limiting mode on the operation interface, and set the parameters. After the parameters are successfully sent, click Run to start the constant voltage current limiting mode of the static load.



Constant Voltage Current Limiting Mode

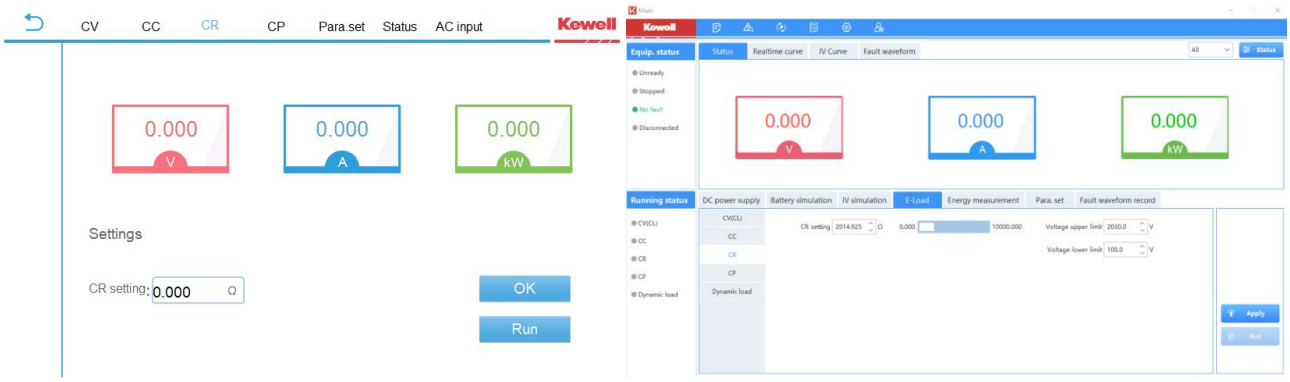
When the equipment is stopped, different operating modes can be selected via the operating interface. In constant current mode, the current value and the rise and fall times of the current can be set within the allowable current range of the equipment according to the actual required load current.



Constant Current Mode

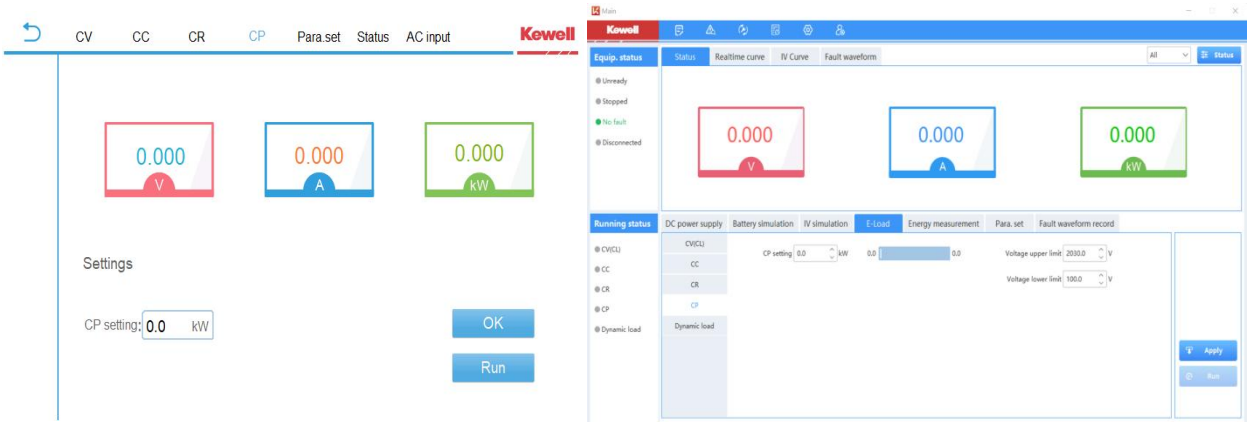
When the equipment is stopped, it is possible to jump to the constant resistance mode interface by clicking on the constant resistance mode on the screen. In constant resistance mode the resistance value can be calculated and set according to the actual required load requirements and the voltage value under the current operating

conditions.



Constant Resistance Mode

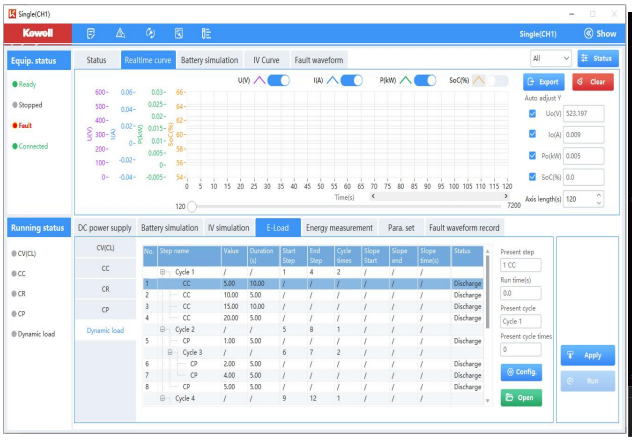
When the equipment is stopped, you can jump to the constant power mode interface by clicking on the constant power mode on the screen. The constant power mode allows you to set the power value directly according to the actual required load power requirements.

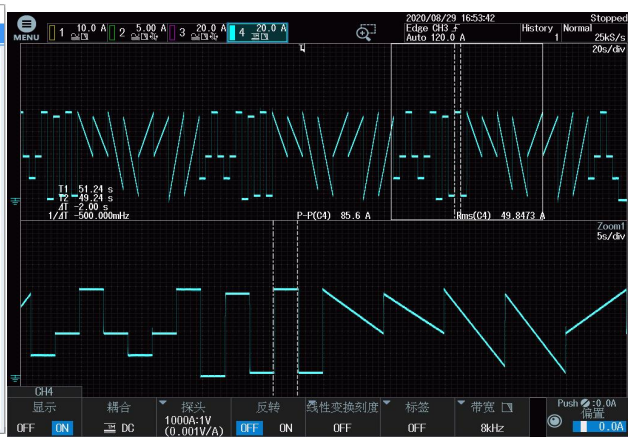


Constant Power Mode

- Dynamic load mode

Multiple sets of constant current, constant power and other combined load steps can be preset in advance. After operation, the load will be pulled according to the preset steps.





6.2 Optional Functions

- On-line insulation detection

Optional insulation detector to support real-time online impedance detection to protect the engine under test and the testers. Insulation resistance protection thresholds are open to set, and can optionally disable the online insulation monitoring function.

- Door limit switch

Optional door limit switch function stops and alarms when the door is opened and removes the alarm when it is closed, ensuring safe operation.

- The heartbeat of the upper computer

Optional heartbeat monitoring function, real-time monitoring of communication signals, automatic rapid shutdown (protection time can be set) when communication is interrupted to ensure system safety.

- Safety relay

The optional safety relay function and the redundant design of the emergency stop reduce the failure of the emergency stop action, effectively ensuring system safety in case of abnormality and increasing the system safety level.

- ACDC start-stop

The optional ACDC start-stop function can control whether the ACDC part is automatically started and stopped.

- IVS function

Optional IVS function, compatible with basic I-V simulation function, to meet the needs of multi-scenario use.

- DC source function

Optional DC source function with universal, step and gradual modes.

- Battery Simulation Function

Compatible with the battery simulation function with 6 common battery models, custom battery models and DC source function.

- Battery pack charge-discharge test function

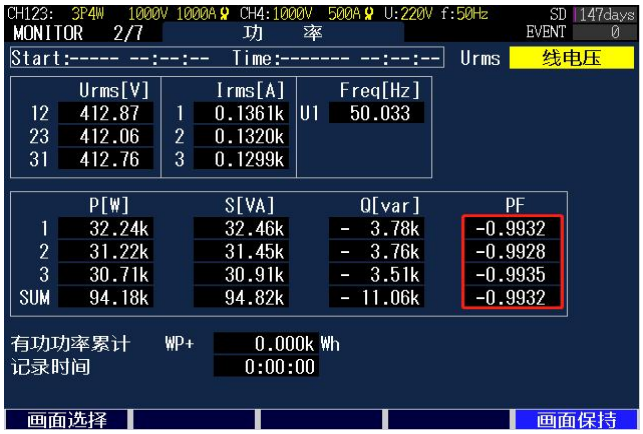
Optional battery pack charge-discharge test function, compatible with the basic functions of EBD software and hardware, to meet the battery charge and discharge test requirements.

- Parallel

The power supply is equipped with parallel function as standard, with optional parallel capability; when only parallel function is supported, no parallel test is done without a communication line; only when parallel capability is required, a parallel test is performed and a parallel line is provided.

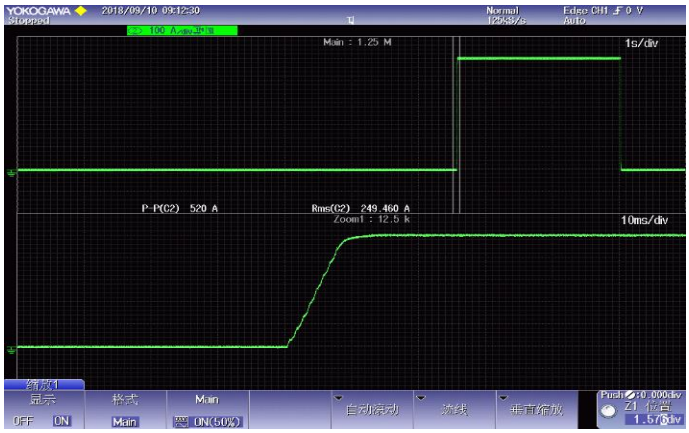
6.3 Key Performance

- Power factor≥0.99（@Rated power）



- iTHD≤3% (@Rated power)

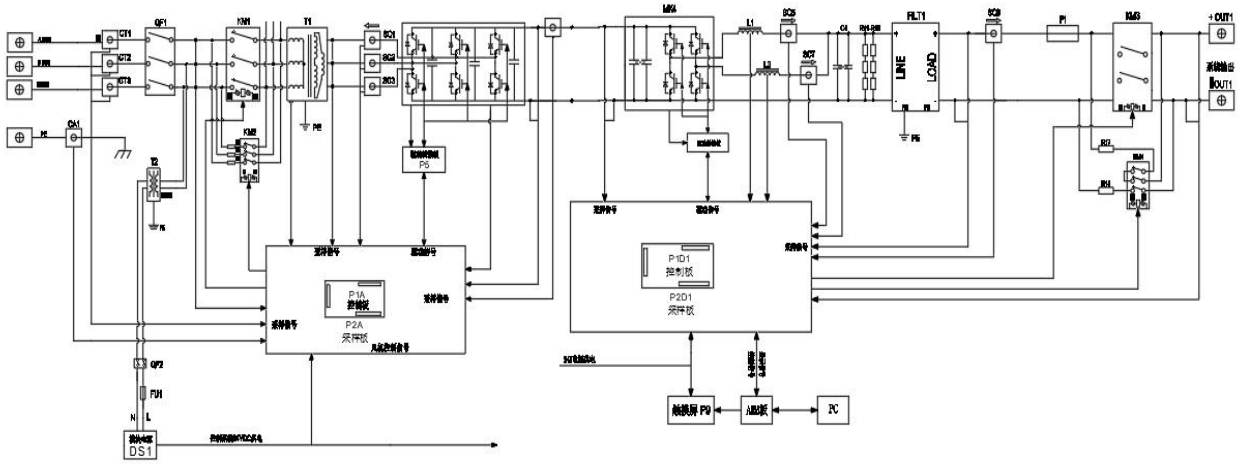
- Voltage response time ≤ 10ms (10%-90% sudden load)



7 Product Design

7.1 Main Electrical Units

The D1000 Series design is divided into a pre-stage rectifier unit and a post-stage DC chopper unit. The pre-stage rectifier design is available in two forms, PWM rectifier and diode rectifier, with different electrical design configurations according to actual requirements. The main electrical topology of the two forms is shown below(For reference only and subject to actuality).



From left to right, they are AC soft start unit, rectifier unit, chopper unit, DC filter unit and DC soft start units etc.

7.1.1 Input Unit

The design takes into account that the capacitive devices on the DC side of the electronic load have a transient high current impact at the moment of equipment contactor closure, so a soft-start circuit is set up at the DC side to realize the energy pre-charge of the system filter capacitor through the soft-start circuit before the main contactor closes, thus reducing the transient high current impact and improving the safety of the system.

7.1.2 DC Filter Unit

Electronic loads are current-controlled devices and their current ripple characteristics have an important impact on practical applications. It mainly includes high-frequency switching sub ripple and low-frequency control loop ripple, in addition to the ripple caused by common-mode interference. When designing, considering the hardware design and software control, according to the calculation formula of the current ripple of the BUCK

chopper circuit, under the condition of a certain output voltage drop, reducing the ripple can be achieved in the following two ways. One is to increase the switching frequency of the power unit. , and the second is to increase the inductance. Under the same conditions, due to the reduced output current stress of the multi-interleaved buck, the volume and cost of the inductor are effectively controlled, and the inductance can be increased. The power supply is designed for a ripple current of 0.2% of the rated current value. Electronic load from the above aspects focus on consideration, so that the electronic load current ripple is effectively controlled.

When the electronic load is switched under different operating conditions, it mainly involves a rapid change in current response. The design of this part uses negative current feedback to adjust the DC input current in real time, together with an optimised PID regulator circuit to make the DC input current control on a stable basis.

7.1.3 DC Chopper Unit

The DC chopper unit of the equipment adopts IGBT modular design, and uses the interleaved parallel wave generation method. In this way, energy complementation is realized, and the current stress of the IGBT single tube is reduced.

The DCDC conversion unit adopts a complementary multi-channel interleaved BUCK circuit, which is a topology optimization and upgrade based on the traditional BUCK circuit. The advantages of the design are mainly in following aspects:

Complementary PWM wave generation mode. The cut-off diode in the traditional BUCK circuit is replaced by an IGBT. Two channels of IGBT module in DCDC are used for complementary wave generation. Realize the characteristics of small size, low energy loss, and bidirectional operation.

The interleaved voltage dropping chopper topology structure can realize multiple gears based on the bus voltage, and reduce the output current ripple.

Staggered parallel BUCK circuit topology, combined with high-accuracy shunt control algorithm, effectively distributes the output current equally. In electrical design and selection, the rated current of IGBT module can be reduced, effectively reducing the current stress of the IGBT module.

7.1.4 Rectifier Unit

The D1000 Series uses an IGBT-type two-stage conversion architecture and synchronous PWM rectification technology to achieve bi-directional energy flow.The PWM synchronous rectification is realized by a controllable three-terminal semiconductor switch device, so there must be a gate drive signal that conforms to a certain timing relationship to control, so that it can be turned on and off like a diode. The system adopts IGBT modules specially designed for high-voltage and high-power power supplies, with special drive circuits to achieve high stability and safety.

PWM rectification adopts typical control technology based on dq model, through feedforward decoupling control, and uses two independent PI regulators to control the active and reactive components respectively. Regarding the dynamic coupling between active and reactive components and the constraints of PWM voltage utilization, the time optimal control algorithm is adopted to reduce the response speed of reactive components in the dynamic process, thereby effectively improving the dynamic response speed of active components.

7.1.5 AC Soft-start Unit

After the AC side is powered up, due to the role of the filter capacitor and its capacitive load characteristics, there is a large current impact instantaneously through the capacitor, at the same time, the isolation transformer on the power excitation process will also generate a large current, the impact current affects system safety and service life. Therefore, the soft-start control is added at the AC side. The capacitors are charged by the soft-start resistor path and when the capacitor voltage reaches a stable value close to the grid voltage, the main circuit is put into operation to ensure the safety and reliability of the system operation.

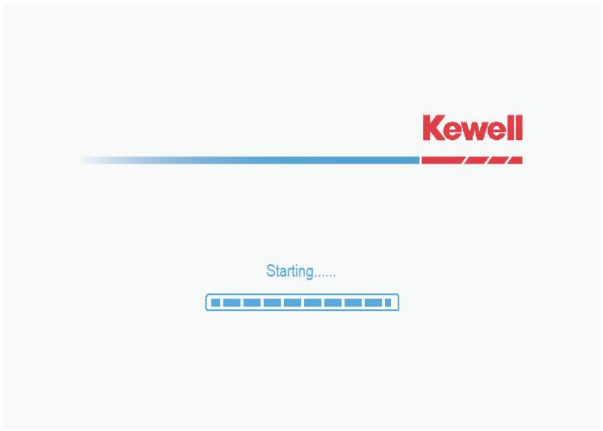
A 3-phase isolation transformer is used at the AC side to electrically isolate the grid from the inverter section to improve system safety, reduce the impact on the grid when the system feeds back energy and ensure the power quality when feeding back. In the control process, the phase difference judgment method is used to determine whether the system power supply is normal by taking the voltage value on the grid side of the transformer, and the phase and amplitude of the inverter voltage and the grid voltage are judged by means of pre-generated waves. The energy is transferred to the grid under optimal grid connection conditions.

7.2 Software Introduction

The D1000 Series has a variety of operation modes including local operation, remote operation and remote integrated control by the client (communication protocol provided, secondary development by the client).

7.2.1 Local Operation

The D1000 Series is equipped with a local operation function, and adopts a 7-inch touch LCD screen, which can realize the operation of the basic functions of the power supply and the display of the corresponding state parameters. The operation modes mainly include constant current, constant resistance, constant power mode, etc.



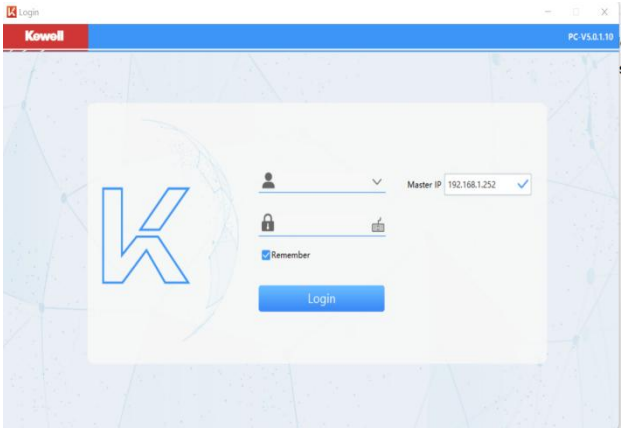
7.2.2 Remote Operation

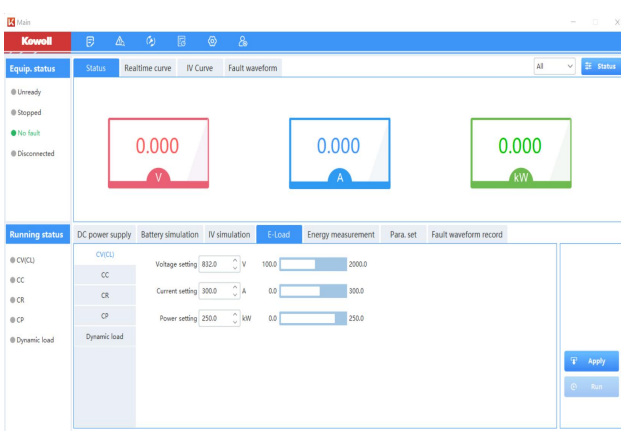
The D1000 Series has an Ethernet interface, adopts the Modbus TCPIP communication protocol.

The D1000 Series has an RS-485 interface, and adopts the Modbus RTU communication protocol.

Controller Area Network (CAN) is a serial communication protocol bus used for real-time applications. It can use twisted-pair wires to transmit signals and is one of the most widely used field buses in the world. The user can configure the functional parameters of the power supply through the standard CAN communication interface to realize remote control function. The power supply supports the standard CAN2.0 communication protocol and uses the extended frame type (CAN data frame with 29-bit identifier). The data communication format is Intel format (the low byte is in front, and the high byte is in the end). The protocol is mainly divided into two types of data forms: the communication board periodically uploads the status information of the equipment and the upper computer remotely controls and sets the parameters of the equipment.

The upper computer software of the operating system is suitable for running on platforms such as Microsoft Windows versions, including Windows 7, Windows 10, etc. The standard upper computer is network port communication, and users can use CAN, RS485, and LAN for third-party integration.





7.3 Structure Introduction

7.3.1 Exterior Design

7.3.1.1 Design Principles

- Cabinet color: Traffic white (optional industrial grey), colour code RAL9016 (optional 7035).
- Uniform painting and spraying on the surface of the product, colour code RAL9016(optional 7035), no oxidation and rust on the surface of the assembled parts.
- Smooth, flat, non-deformed and non-broken outlet terminals with complete and clear identification.
- Internal mounting brackets with rounded corners all around, solid welds, clean welds, good flatness, no grit, and obvious grounding markings on the shell.

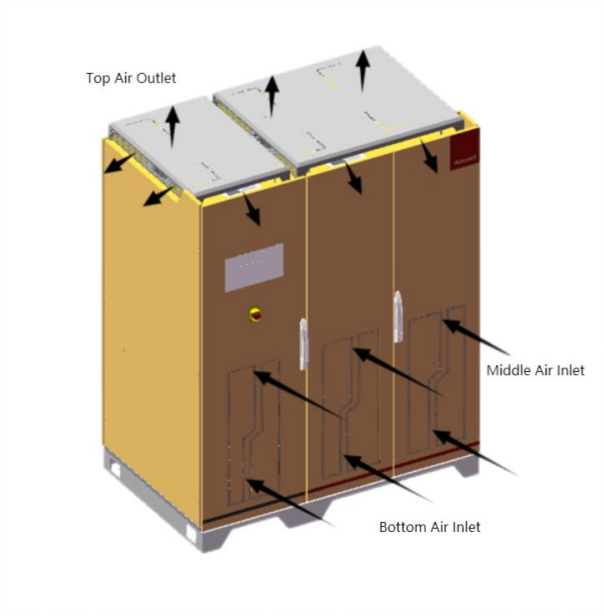
7.3.1.2 Appearance

7.3.2 Product Thermal Design

- Air inlet and outlet: bottom and front of the equipment, rear air inlet, top air outlet.
- Cooling method: forced air cooling, using imported centrifugal fans to dissipate heat from key components, the top axial fan to pump air outward for system cooling.
- Independent air duct: independent air duct design for the two internal heat sources of the power supply to dissipate heat independently and avoid heat crossover.

- Heat sink fins are placed vertically up and down, with downstream air flow, so that natural convection is conducive to forced convection.

Thermal simulations of the key heat sink components and the system as a whole were carried out at a maximum operating temperature of 40 degrees and at full load, showing that the working components are within the safe operating temperature range. The results of the simulations further validate the reliability of the system thermal design.



7.3.3 Mechanical Load-bearing and Anti-vibration Design

- Mounting of heavier components such as transformers and inductors at the bottom of the cabinet.
- Component fixation avoids cantilever beam structure;
- Split and strengthen large plane in the shape of "#";

7.3.4 Maintainability Design

- Adopt the front/back maintenance method to install all components, reducing the difficulty of repairing and replacing components;
- Modular design.
- Maintainability design

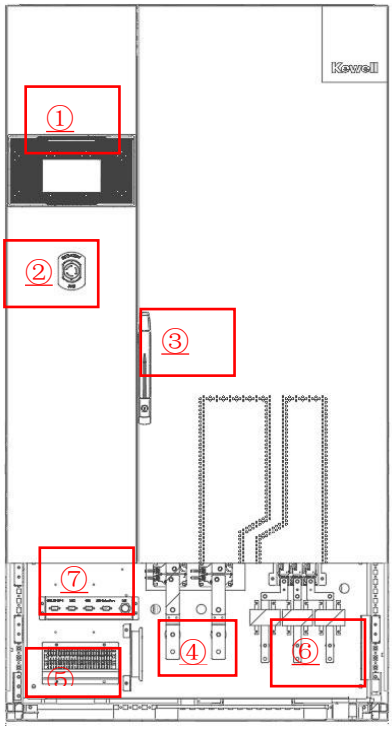
- Process description

1) The internal wiring connected by copper bar as much as possible;

2) Separate the signal wire from the power cable, and use shielded cables to avoid interference;

7.4 Interface Introduction

7.4.1 Diagram of The Interface



①: Touch screen and status indicators: you can operate or view the equipment through the touch screen; status indicators, respectively "POWER", "RUN", "ALARM "; "POWER" is the power indicator, which is lit when the equipment is powered on; "RUN" is the operation indicator, which is lit when the equipment is running normally; "ALARM " is the fault indicator, which lights up when the equipment is faulty.

②: Emergency stop button switch: When the equipment is found to be abnormal and needs to be stopped urgently, press this button switch, the equipment will be stopped urgently.

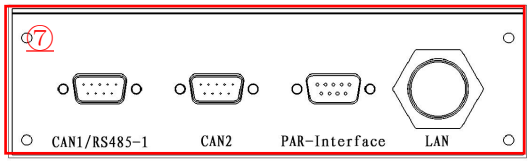
③: Front door lock and handle: open the door lock with the key, gently turn the handle and pull it outwards to open the front door of the equipment.

④: DC side wiring copper row of the equipment.

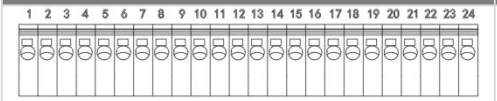
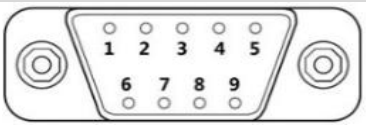
⑤: External interface terminal block.

⑥: AC side wiring copper strip and earth wire copper strip of the equipment.

⑦: Communication interface at the bottom left of the device.

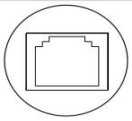


7.4.2 Auxiliary Interface Description

Auxiliary interface schematic diagram and wiring instructions (for reference only, subject to the actual equipment)	
Picture	Description
	"External interface terminal block", instructions for use are as follows. 1)1, 2, 3 and 4 are external emergency stop interfaces: when users need to use external emergency stop switches to control this equipment, they need to remove the short wiring under 1, 2 or 3 and 4, and access the normally closed emergency stop push button switch; when not using this function, they need to restore the short wiring; this interface is an active interface (24Vdc). (2)5, 6, 7 and 8 are voltage compensation interfaces: when users need to use the voltage compensation function, they need to remove the short wires under 5, 6 and 7 and 8; then connect the positive terminal of the external voltage compensation sampling line to pin 5 and the negative terminal to pin 7 (do not connect the wrong positive and negative); when this function is not used, you need to restore the short wires. (3)9, 10 for the fault signal interface: when the user needs to monitor the fault status of the equipment, the monitoring equipment can be connected to pin 9, 10 for fault status monitoring; this interface is a passive normally closed interface, disconnected on behalf of the fault exists. (4)11, 12 is the DC side positive contactor status signal interface: this interface is a passive normally open interface; this interface is closed to represent the contactor suction. (5)13, 14 for the DC side negative contactor status signal interface: this interface is a passive normally open interface; this interface is closed to represent the contactor suction. (6)15, 16 is the AC side main contactor status signal interface: this interface is a passive normally open interface; this interface is closed to represent the contactor suction.
 CAN1/RS485-1 interface pins: Pin 6 — Description: 485B	JX16 is one of the "External interface terminals" of the equipment. The usage instructions are as follows: 1) 1 and 2 are the status signal interfaces of the DC side positive pole contactor: The interface is a passive normally open interface, when this interface is closed, it means that the contactor is closed. 2) 3 and 4 are the status signal interfaces of the DC side negative contactor: The interface is a passive normally open interface when this interface is closed, it means that the contactor is closed. 3) 5 and 6 are main contactor status signal interfaces on AC side: The interface is a

Pin 9	485A
Pin 7	CANH
Pin 2	CANL

CAN1/RS485-1 Communication Interfaces



LAN Communication Interface

passive normally open interface, when this interface is closed, it means that the contactor is closed.

1)External communication interface and interface definition;

2)This device provides external LAN and RS485 communication for users and the upper computer of the device. The interface is on the lower left inner side of the equipment.

7.5 Reference Standards

No.	Standard / file number	Standard/file name
1	GB 50055-2011	Code for Design of Electric Distribution of General-purpose Utilization Equipment
2	GB 50054-2011	Code for Design of Low Voltage Electrical Installations
3	GB/T 4798	Environmental Conditions Existing in the Application of Electrical and Electronic Products
4	GB/T 3859.1-2013	Semiconductor Converters-Specification of Basic Requirements
5	GB/T 3859.2-2013	Semiconductor Converters-Application Guide
6	GB/T3859.3-2013	Semiconductor Converters-Specification of Basic Requirements
7	GB/T 24343-2009	Electrical Equipment of Industrial Machines-Insulation Resistance Test Specifications
8	GB/T 29843-2013	General Specification for DC Electric Load
9	GB 4208-2017	Degree of Protection Provided by Enclosure
10	GB/T 20850-2014	Safety of Machinery-Guidelines for the Understanding and Use of Safety of Machinery Standards
11	BSEN 61800-3-2004+A1-2012	Adjustable Speed Electrical Power Drive Systems - EMC Requirements and Specific Test Methods
12	BSEN 62477-1-2012+A11-2014	Power Electronic Converter Systems and Equipment-General Safety Requirements
13	EN ISO 13849-1-2015	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
14	IEC 61000-6-4-2011	Electromagnetic Compatibility (EMC) Part 6-4 General Standards- Emission Standard for Industrial Environments
15	IEC 61010-1-2010	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
16	IEC 60204-1-2016	Electrical Safety of Machinery- Electrical Equipment of Machines- Part 1: General Requirements