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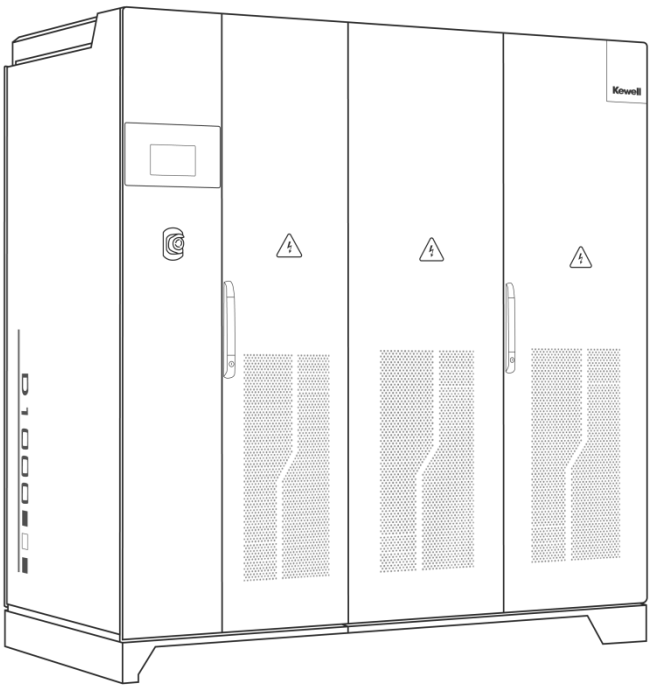


EVD SERIES HIGH PRECISION

BIDIRECTIONAL DC POWER SUPPLY

Oct. 2022 Version: A/10

KEWELL TECHNOLOGY CO,.LTD.

www.Kewelltest.com

CONTENTS

1 Summary

EVD Series High-precision Bidirectional DC power supply (hereinafter referred to as EVD) is an IGBT type high accuracy, highly reliability, programmable, automatic bidirectional DC power supply with a two-stage conversion architecture. The DC output features high accuracy and dynamic response, as well as the ability to feed energy back into the grid.

The output of the device is programmable and can be used in a variety of applications through the selection of different modes. It is mainly applied in the test of electric vehicle drive motor(or controller), electric vehicle power-train system, electric vehicle transmission system, Rail transit energy recovery unit, DC charging pile (charger), DC/DC converter, UPS/EPS, switching device, semiconductor power module, energy storage system and many other fields.

EVD can be used to simulate the input power, output current, overload capacity, withstand voltage, efficiency, locked-rotor current, maximum speed, over speed, and energy recovery performance of the electric motor and controller. It can feed back the energy of the counter electromotive force in the motor overspeed experiment to the power grid in real time, avoid the damage of the controller, and ensure the safety of the test.

2 External Conditions

To ensure that the equipment has suitable ambient conditions, the following items need to be met:

- Installation environment

For indoor installation, the installation floor must be flat and free from water, firm and able to withstand the weight of the equipment; the indoor air inlet and outlet must have a professional dustproof and rainproof design; the front, rear and top of the equipment must have sufficient distance from 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 ~ +40°C. Please ensure that the space has good ventilation conditions.

- Humidity

The equipment should be used in a humidity environment of 0~90%RH, 25°C without condensation.

- Altitude

The equipment should be used at an altitude lower than 2000m. For high altitude applications, it may cause overheating protection, which requires derating operation.

- Grid parameters

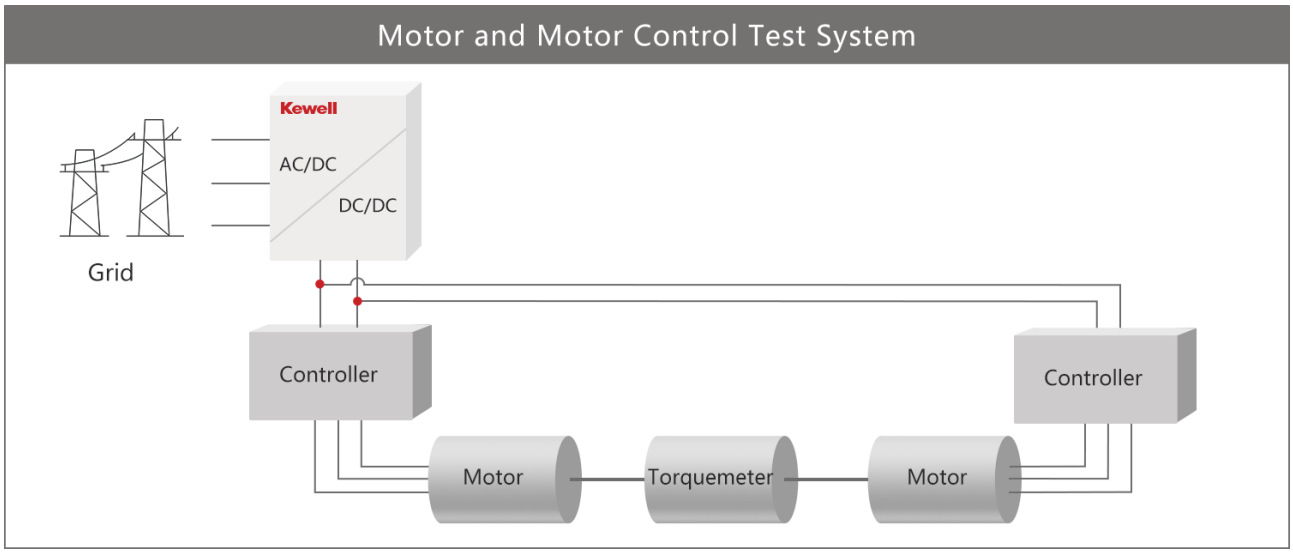
Three-phase four-wire system, rated voltage 380Vac±10%, grid frequency 50±5Hz, grid capacity needs to meet the peak power of test power supply and auxiliary equipment.

3 Product Features

- Equipped with 16-bit AD sampling chip and combined with optimized software sampling algorithm to achieve the accuracy of output voltage and current to ± （0.1%FS+5dgt），to meet the requirements of high accuracy testing of DC sources;
- Designed with staggered BUCK topology for control-loop regulating frequency multiplication and high dynamic response characteristic. Voltage response time(load change from 10% to 90%) ≤ 3ms, voltage response time(load change from -90% to 90%) ≤ 6ms;
- Designed with international advanced IGBT control technology , PWM synchronous rectification and DC/DC two-stage circuit to achieve bidirectional energy flow; THD≤3%, and high quality energy recovery;
- Adopted PWM synchronous rectification and combined with the PFC corrective control in software algorithm to achieve PF≥0.99, and efficient use of energy;
- Adopted multiple filtering solution to achieve output voltage ripple ≤0.2%FS which has no impact on the load during the test;
- With DC voltage drop compensation function;
- 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;
- Humanized upper computer operator interface, modular function design based on vector diagram and complete software functions;
- With rich communication interface connection, integrates RS485, CAN and LAN communication for remote operation, and provides communication protocols for system integration control;
- Its cabinet is designed with ANSYS mechanical finite element analysis, to simplify the design and ensure the stability;
- It has a layer resistant to salt-spray corrosion. Its unique top drip-proof design combines air duct design

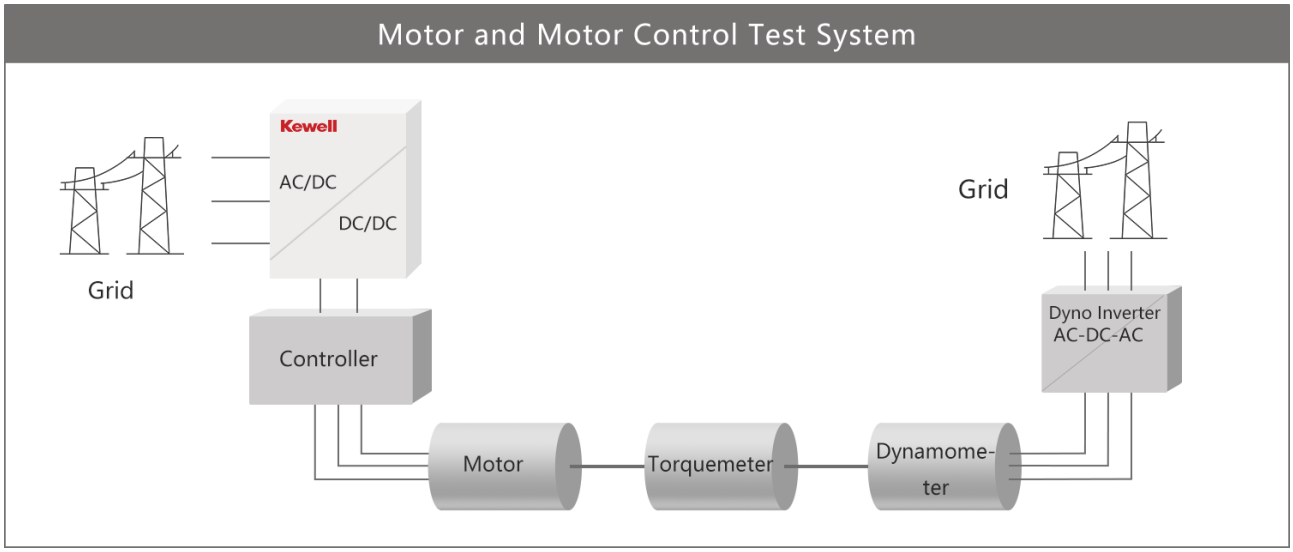
with IP protection.

4 Typical Applications

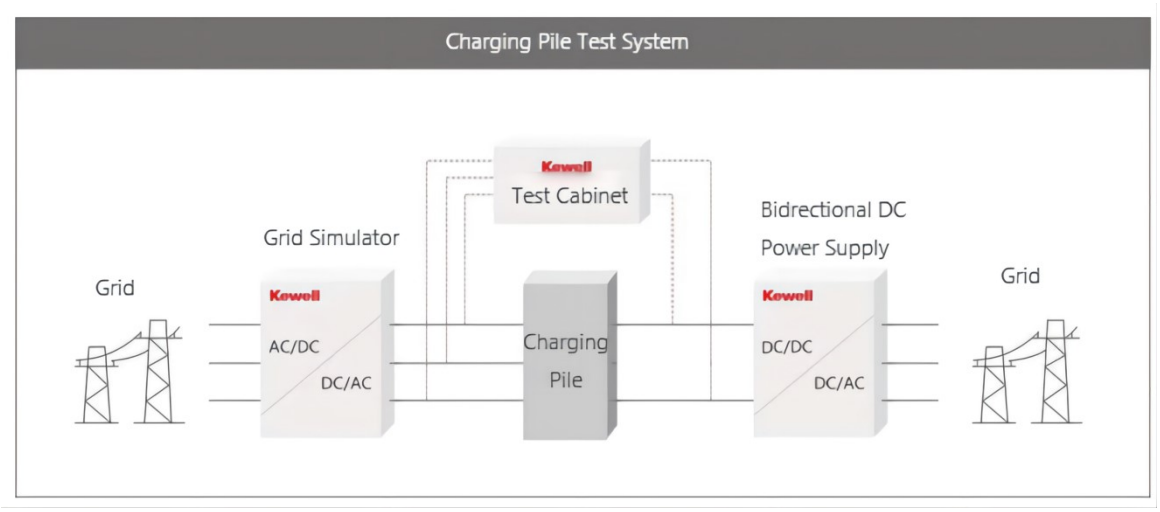


Back-to-back test bench: Mainly applied in the aging test and working condition simulation test of motor and controller.

*Note: The power of the power supply should cover the power of the bench under test. If it is clear that there is a mismatched power configuration, the switching power needs to be increased. Otherwise, the DUT and the power supply may be damaged.



Dynamometer test bench: Mainly applied in the performance test and working condition simulation test of motor and controller.



Charging Pile Test System

5 Product Specification

5.1 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]
EVD-S-300-800-G	300	600	400	800	24-800	1600-1000-2000

5.2 Product Parameters

Input Requirments	
Phase	3φ3W + PE
Voltage	380V±10%
Frequency	50Hz±5Hz
Energy Recovery Characteristics	
Energy Recovery	Energy recovery is available in the full power range
THD*	≤3%
Power Factor(PF)	≥0.99
Output Characteristics	
Voltage Accuracy	± (0.1%·FS+5dgt)
Current Accuracy	± (0.1%·FS+5dgt)
Response Time	≤3ms (10%-90% Sudden loading)
Switch Time	≤6ms (+ 90%- - 90% Switching)
Voltage Ripple(rms)	≤0.2%·FS

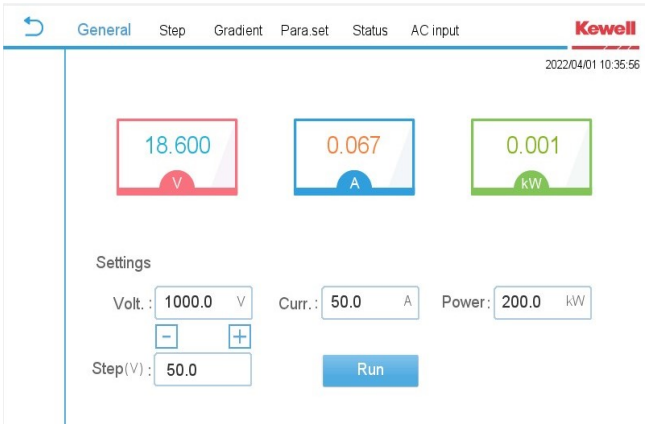
Load Regulation	0.1%·FS
Protection	Over Voltage, Over Temperature, Over Current, Phase Loss, Emergency Stop
Communication and Interfaces	
Touch Screen	LCD
Remote	RS485/LAN /CAN
Other Interfaces	External Emergency Stop, Fault Signal, Voltage Compensation
Environment Condition and Safety	
Insulation Resistance	≥20MΩ（500Vdc）
Withstand Voltage	3000Vdc(60s，No Flashover, No Breakdown Phenomenon)
Ground Resistance	≤0.1Ω
Cooling	Air Cooling
Ambient Temperature	-10 ~ 40℃
Humidity	0-90%RH （25℃Non-condensing)
Altitude	≤2000m

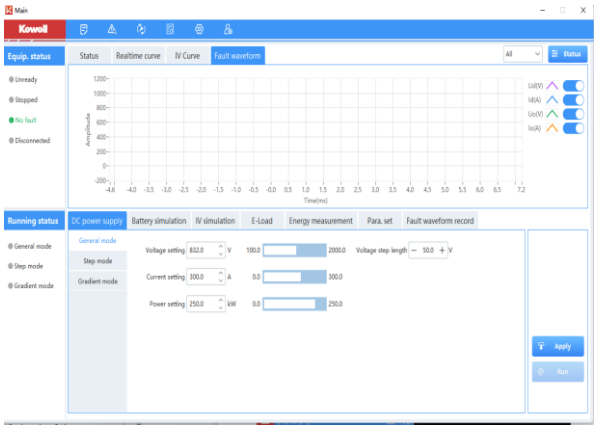
6 Product Introduction

6.1 Main Function

- General mode

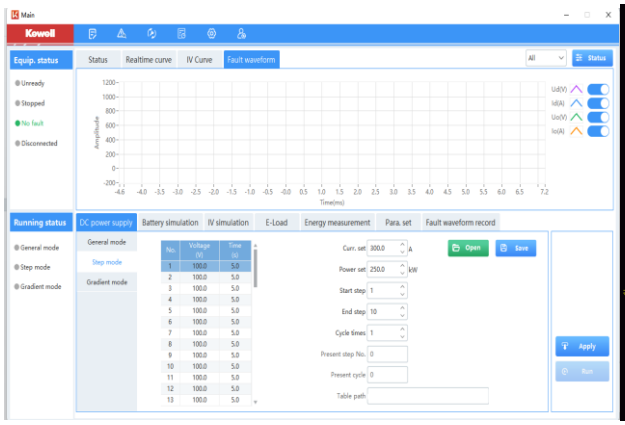
Universal mode, i.e. conventional constant voltage, current limiting and power limiting mode, allows you to customise the key parameters such as voltage, current and power in the operating interface. After the parameters have been issued, click Run to start the equipment for constant voltage output.

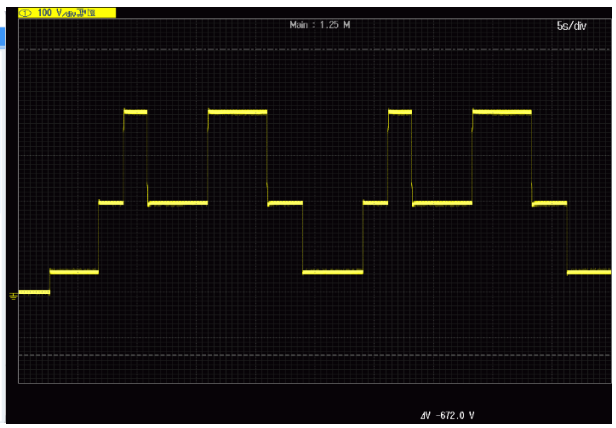




- Step mode

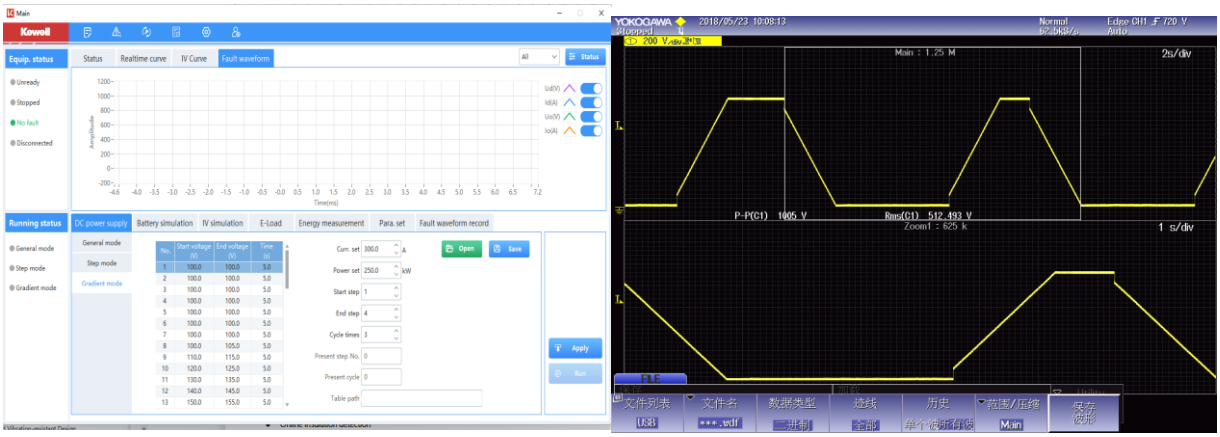
The step mode realizes the step editing function of the constant voltage working mode. In the interface. The key parameters such as voltage, current, function, step time and number of cycles can be customised in the interface, and after the step editing is completed, the equipment will transform the voltage output according to the step information by clicking Run.





- Gradient mode

Gradient mode realizes the function of outputting voltage according to a certain slope. In the mode interface, key parameters such as start voltage, cut-off voltage, fade time and number of cycles can be customised, and after the workstep has been edited, click Run and the equipment will transform the voltage and output according to the workstep information.



6.2 Optional Function

- Online insulation detection

Optional insulation detector supports real-time online impedance detection to protect the safety of the tested engine and 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, open the door to stop and alarm, and eliminate the alarm after closing the door to ensure operational safety.

- Upper-computer heartbeat

Optional heartbeat monitoring function can monitor the communication signal in real time. If the communication is interrupted, it will automatically stop quickly (the protection time can be set) to ensure the safety of the system.

- Safety relay

Optional safety relay function, emergency stop redundancy design, reduce the failure of emergency stop action, effectively ensure system safety in case of abnormality, improve the system safety level.

- Abnormal power grid switching

Optional power grid abnormal switching function, when the grid abnormality causes shutdown, the power supply still has discharge protection.

- 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.

- Electronic load function

Optional electronic load function, compatible with regenerative electronic load function, with constant current, constant resistance, constant power and other load operation modes.

- Battery pack charge-discharge test function

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

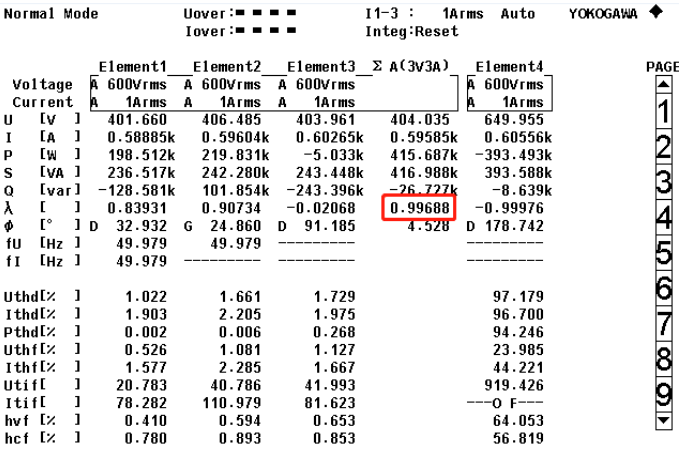
- Parallel

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)

Using PWM synchronous rectification, combined with PFC correction control in software algorithm, to achieve power factor (PF) ≥ 0.99, high-efficiency power utilization and feedback;



Normal Mode Uover:■ ■ ■ ■ I1-3 : 1Arms Auto YOKOGAWA
Iover:■ ■ ■ ■ Integ:Reset

	Element1	Element2	Element3	Σ A(3V3A)	Element4
Voltage	A 600Vrms	A 600Vrms	A 600Vrms		A 600Vrms
Current	A 1Arms	A 1Arms	A 1Arms		A 1Arms
U [V]	401.660	406.485	403.961	404.035	649.955
I [A]	0.58885k	0.59604k	0.60265k	0.59585k	0.60556k
P [W]	198.512k	219.831k	-5.033k	415.687k	-393.493k
S [VA]	236.517k	242.280k	243.448k	416.988k	393.588k
Q [var]	-128.581k	101.854k	-243.396k	-26.727k	-8.639k
λ [ ]	0.83931	0.90734	-0.02068	0.99688	-0.99976
ϕ [°]	D 32.932	G 24.860	D 91.185	4.528	D 178.742
fU [Hz]	49.979	49.979	---------		---------
fI [Hz]	49.979	---------	---------		---------
Uthd[%]	1.022	1.661	1.729		97.179
Ithd[%]	1.903	2.205	1.975		96.700
Pthd[%]	0.002	0.006	0.268		94.246
Uthf[%]	0.526	1.081	1.127		23.985
Ithf[%]	1.577	2.285	1.667		44.221
Utif[ ]	20.783	40.786	41.993		919.426
Itif[ ]	78.282	110.979	81.623		---O F---
hvf [%]	0.410	0.594	0.653		64.053
hcf [%]	0.780	0.893	0.853		56.819

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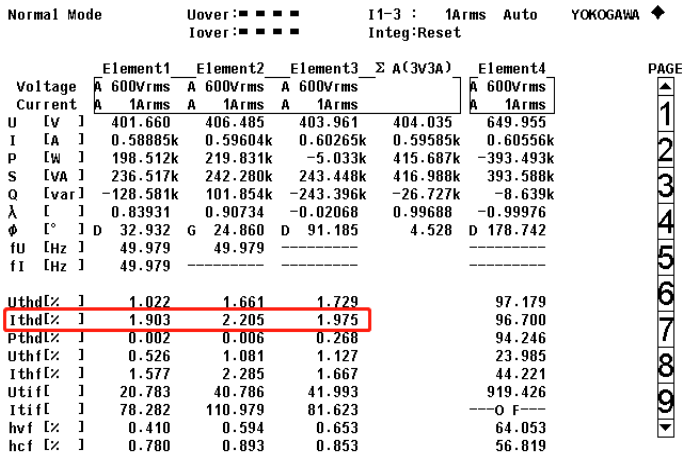
Power factor ≥ 0.99

- THD ≤ 3% (rated power)

The host power supply in the system adopts international advanced IGBT control technology, and adopts PWM synchronous rectification combined with interleaved DC/DC two-stage circuit to achieve total harmonic distortion (THD) ≤ 3%.



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hvf [%]	0.410	0.594	0.653		64.053
hcf [%]	0.780	0.893	0.853		56.819

PAGE 1 2 3 4 5 6 7 8 9

THD ≤3%

- Voltage response time≤3ms (10%-90% sudden load)

The DCDC unit is designed with an interleaved BUCK topology and the control loop regulates frequency multiplication to achieve the high dynamic response characteristics of the DC voltage output.

Voltage response time≤3ms

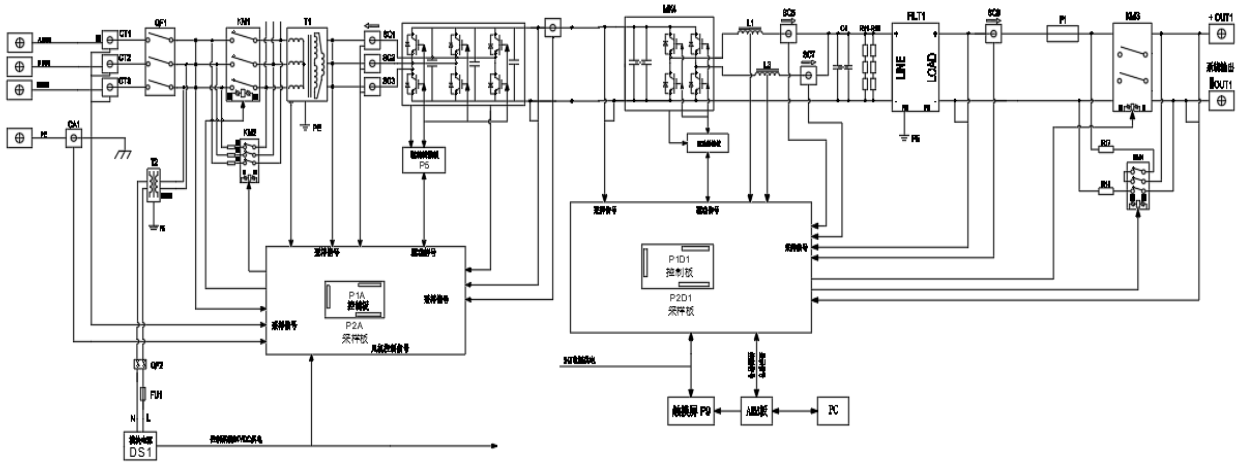
- Switching voltage response time ≤ 6ms ("90% - 90% switching")

Switching voltage response time≤6ms

7 Product Design

7.1 Main Electrical Units

The DC power supply design is divided into a pre-stage synchronous rectifier unit and the post-stage DC chopper unit. The pre-stage rectifier is designed to be bidirectional, so that energy can be fed back to the power grid. The main electrical topology diagram of the equipment is shown below (for reference only, subject to actuality).



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

7.1.1 Input Unit

After the AC input terminal is powered up, due to the role of the filter capacitor and its capacitive load characteristics, there will be a large current impact instantaneously through the capacitor. At the same time, a large current will also be generated during the power-on excitation process of the isolation transformer, and the inrush current affects system safety and service lifeservice life. Therefore, a soft-start control is added at the input. The capacitor is charged by the soft-start resistor path. When the capacitor voltage is close to the grid voltage value, the main circuit is put into operation to ensure the safe and reliable operation of the system.

The input side uses a three-phase isolation transformer 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 to judge the phase and amplitude conditions of the inverter voltage and the grid voltage by

means of pre-generation, so that the energy can be fed back to the grid under optimal grid connection conditions.

7.1.2 Rectifying Unit

The DC power supply system uses an IGBT type two-stage converter architecture with synchronous PWM rectification in the pre-stage to achieve bi-directional energy flow. PWM synchronous rectification is realized by a controllable three-terminal semiconductor switching device, which must be controlled by a gate drive signal that conforms to a certain timing relationship to make it turn on and off like a diode. The driving method has a significant impact on the overall performance, so the gate drive signal is often the primary issue that must be addressed when designing synchronous rectifier circuits. The system adopts IGBT modules specially designed for high-voltage and high-power power supplies of internationally renowned brands, together with special drive circuits to achieve high stability and safety.

7.1.3 DC Chopper Unit

The DC chopper unit of the power supply adopts the IGBT modular design and utilises a staggered parallel wave generation method. The energy complementation is realized, which greatly reduces the current stress on the IGBT single tube during high current operation. Due to the IGBT modular design, the upper and lower bridge arms also use complementary wave generation method, thus realizing a bi-directional energy conversion.

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

Complementary PWM wave generation method, the cut-off diode in the traditional BUCK circuit is replaced by an IGBT module, the upper and lower tubes of the DCDC are complementary to generate waves, and the integrated diode inside the IGBT is used for the current reverse cut-off, which realizes the small size and low loss of the mold box design, as well as the system characteristics of bi-directional flow of energy.

The staggered parallel BUCK circuit topology, combined with the high-accuracy shunt control algorithm, can effectively distribute the output current evenly, and reduces the selection of IGBT module rated current during electrical design and selection, effectively reduces the current stress of the IGBT module, and achieves effective cost control.

7.1.4 DC Filter Unit

The DC power supply is voltage-controlled. To ensure the voltage response characteristics and good voltage ripple characteristics, the LC filter design is strictly enforced in accordance with the requirement that the voltage

ripple rate is controlled to within 0.2% of the full-scale voltage. The cut-off frequency calculation method is also used to effectively reduce the output voltage control loop ripple to a minimum. The filter capacitors selected for the circuit are low internal resistance film capacitors, and multiple capacitors are connected in parallel.

When the equipment is switched under different working conditions, it mainly involves the dynamic characteristics of the voltage. The design of this part adopts the voltage negative feedback method to feedback and adjust the output voltage in real time, together with the optimized PID regulator circuit, this results in a fast dynamic response for output voltage control on the basis of output stability.

7.1.5 DC Soft Start Units

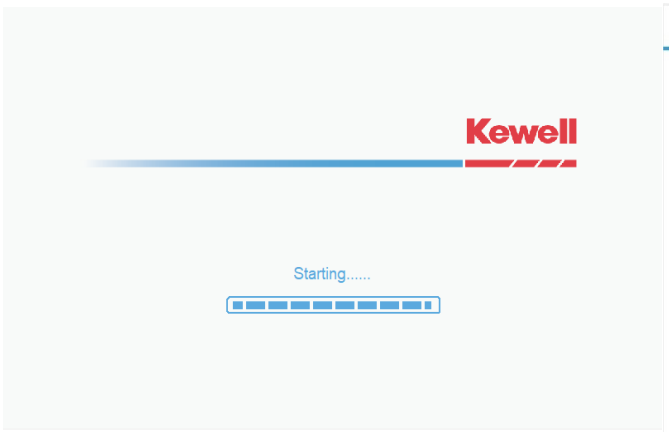
The design takes into account the fact that the load input may have capacitive devices and that there is an instantaneous high current shock at the moment of closing the output contactor of the device. Therefore, a soft start circuit is set up at the output to realize the energy pre-charge of the system filter capacitor through the soft start circuit before the main contactor closes, thus reducing the shock to the filter capacitor and improving the safety of the system.

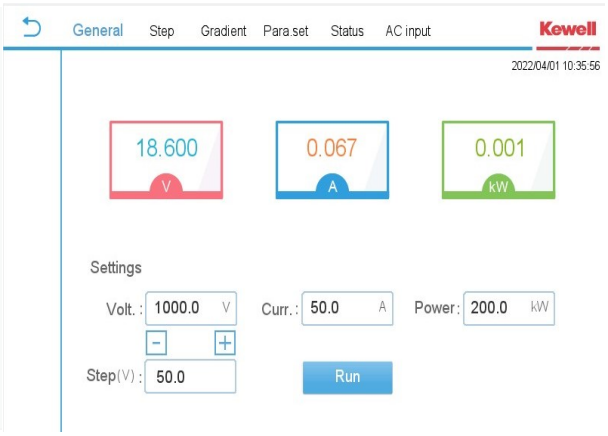
7.2 Software Description

The power supply has multiple operation modes of local operation, remote operation and remote integrated control of the client (providing communication protocol, secondary development by customers).

7.2.1 Local Operation

The power supply is equipped with local operation functions, using a 7" touch screen LCD, which enables the operation of the basic functions of the power supply and the display of the corresponding status parameters, the operation modes mainly include general, gradient and step mode, etc.





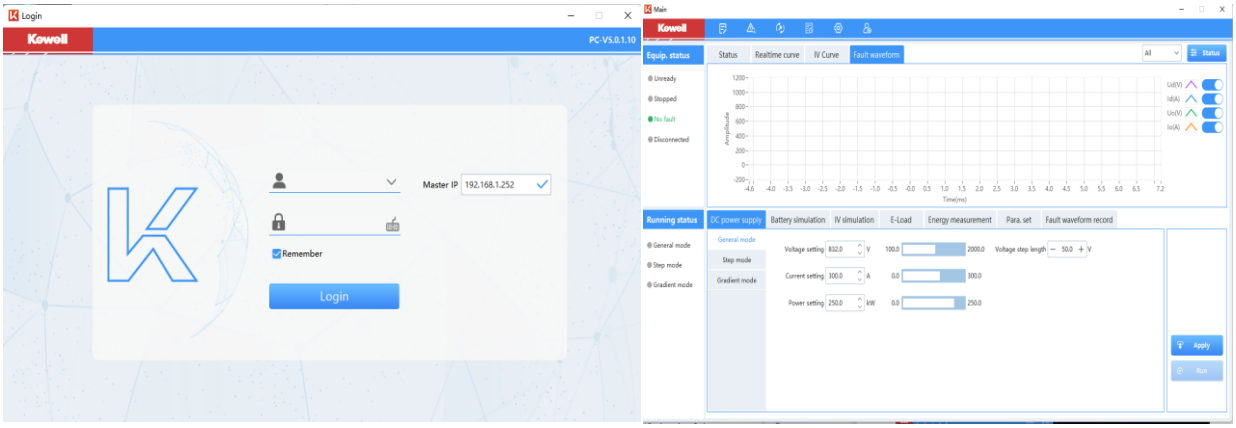
7.2.2 Remote Operation

The power supply has an Ethernet interface, and the software adopts the Modbus TCP/IP communication protocol. It can be seamlessly connected with software based on the standard Modbus communication protocol.

The power supply has an RS-485 interface, and the software adopts the Modbus RTU communication protocol. It can be seamlessly connected with software based on the standard Modbus communication protocol.

Controller Area Network (CAN, Controller Area Network) is a serial communication protocol bus for real-time applications. It can use twisted pair to transmit signals and is one of the most widely used field buses in the world. The standard CAN communication interface allows the user to configure the functional parameters of the power supply and to control it remotely. The power supply supports the standard CAN 2.0 communication protocol. The protocol is mainly divided into two data forms: the communication board uploads the status information of the device at regular intervals and the parameters of the device are controlled remotely by the upper computer.

The operating system's upper computer software is suitable for running on platforms such as Microsoft Windows versions, including Windows 7, Windows 10, etc. The standard upper computer is a network port communication, user third party integration can use CAN, RS485, LAN method.



7.3 Structure Description

7.3.1 Exterior Design

7.3.1.1 Design Principles

- Cabinet color: traffic white (optional industrial gray), color code RAL9016 (optional 7035);
- The surface of the product is painted and sprayed evenly, the color code is RAL9016 (optional 7035), and the surface of the assembly is free from oxidation and rust;

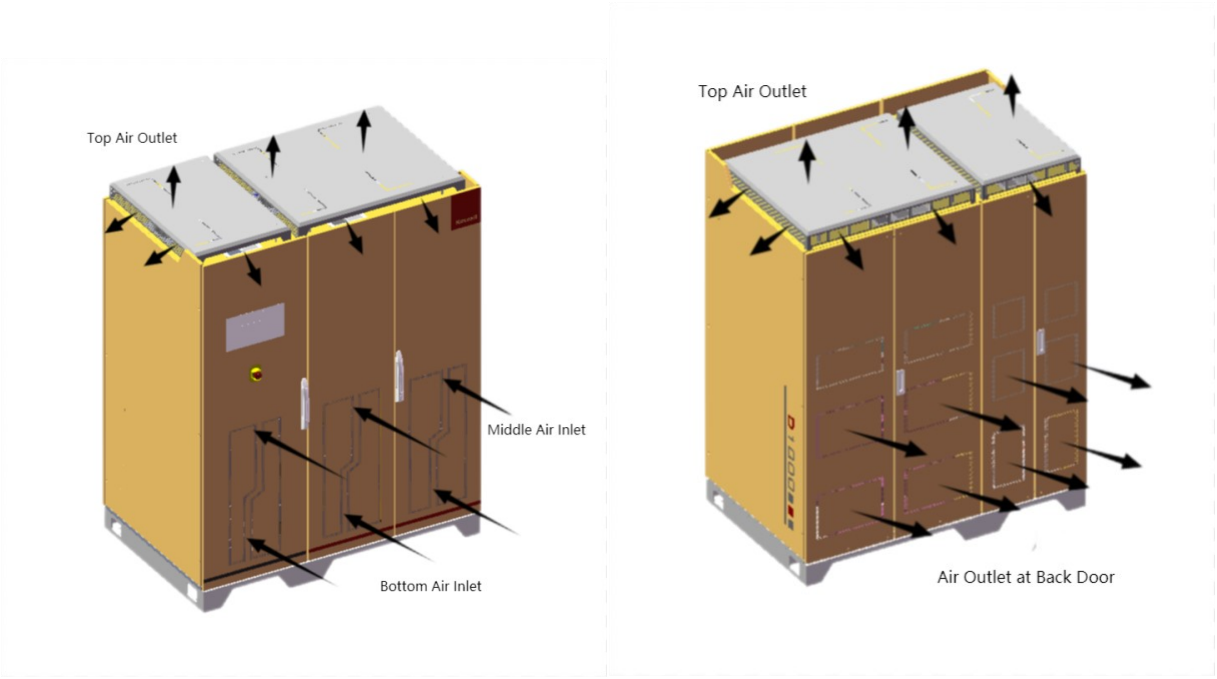
- Smooth, flat, non-deformed and non-broken outlet terminals with complete and clear identification.
- Internal mounting brackets firmly welded, clean welds, good flatness and no grit, with obvious grounding markings on the housing.

7.3.1.2 Appearance

7.3.2 Product Thermal Design

- Air inlet and outlet: air inlet at the bottom and the front of the equipment, air outlet at the top and the rear.
- Cooling method: forced air cooling, using imported centrifugal fans to dissipate heat from key components, with the top axial fan pumping air outwards for system cooling.
- Independent air duct: Independent air duct design is adopted for multiple heat sources inside the power supply to conduct independent heat dissipation and avoid heat crossover.
- The fins of the heat sink are placed in the direction of the airflow, so that natural convection helps forced convection.

The results of the thermal simulation of the key cooling components and the system as a whole at a maximum operating ambient temperature of 40 degrees and at full load show that the working components are within the safe operating temperature range. The results of the simulation further validate the reliability of the thermal design of the system.



7.3.3 Mechanical Load-bearing and Vibration-resistant Design

- Mounting of heavier components such as transformers and inductors at the bottom of the cabinet.
- Avoidance of cantilevered beam construction for component fixing.
- Split and strengthen large plane in the shape of "#";

7.3.4 Maintainable Design

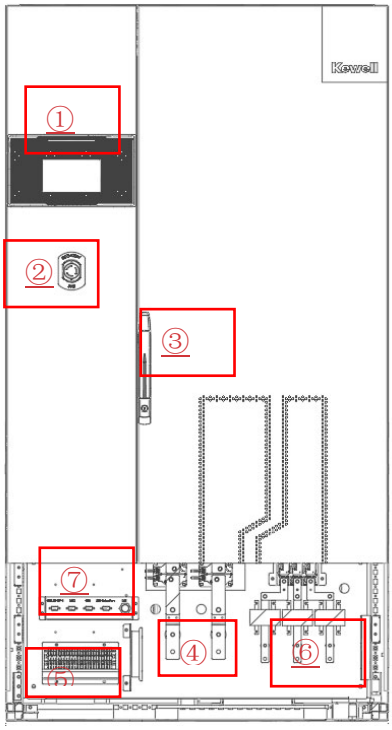
- The front/back maintenance method is adopted, and all components are installed at the reach, which reduces the difficulty of maintenance and replacement of components;
- Modular design by dividing the internal components according to functionality.
- Process description

1) Internal power lines are connected mainly by copper rows, with aesthetically pleasing alignments.

2) The signal line is separated from the power line, and if necessary, shielded cable is used to avoid interference.

7.4 Interface Description

7.4.1 Diagram Of The Interface



(For reference only, the actual equipment shall prevail)

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.

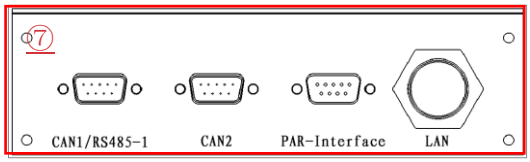
③: Front door lock and handle: open the door lock with the key, gently turn the handle and pull it outwards to open the front door of the equipment.

④: DC side wiring copper row of the equipment.

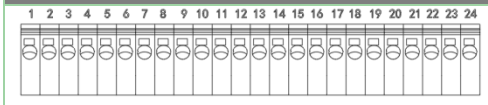
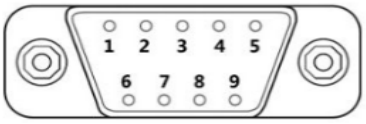
⑤: External interface terminal block.

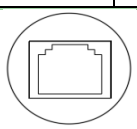
⑥: AC side wiring copper strip and earth wire copper strip of the equipment.

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



7.4.2 Auxiliary Interfaces

<table>
<tr><th colspan="2">Auxiliary interface schematic diagram and wiring instructions (for reference only, subject to the actual equipment)</th></tr>
<tr><th>Picture</th><th>Description</th></tr>
<tr><td> 
</td><td>"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.</td></tr>
<tr><td> 

CAN1/RS485-1 Communication Interfaces
<table>
<tr><th>CAN1/RS485-1 interface pins</th><th>Description</th></tr>
<tr><td>Pin 6</td><td>485B</td></tr>
<tr><td>Pin 9</td><td>485A</td></tr>
<tr><td>Pin 7</td><td>CANH</td></tr>
<tr><td>Pin 2</td><td>CANL</td></tr>
</table>
 </td><td>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 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.</td></tr>
</table>

LAN Communication Interface	

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 electric and electronic products-Storage
4	GB/T 3859.1-2013	Semiconductor convertors-Specification of basic requirements
5	GB/T 3859.2-2013	Semiconductor convertors-Application guide
6	GB/T 3859.3-2013	Semiconductor convertors-Transformers and reactors
7	NB/T 32004-2018	Technical specification of grid-connected PV inverter
8	GB/T 24343-2009	Electrical equipment of industrial machines-International resistance test specifications
9	GB/T 18488-1 2015	The electrical machines and controllers for electrical vehicles Part 1; General specification
10	GB/T 18384.2-2015	Electrically propelled road machines-Safety specifications-Part 2: Vehicle operation safety means and protection against failures
11	GB/T 18384.3-2015	Electrically propelled road machines-Safety specifications-Part 3: Protection of persons against electric shock
12	GB 4208-2017	Degrees of protection provided by enclosure
13	GB/T 20850-2014	Safety of machinery-Guidelines for the understanding and use of safety of machinery standards
14	BSEN 61800-3-2004+A1-2012	Adjustable speed electrical power drive systems. EMC requirements and specific test methods
15	BSEN 62477-1-2012+A11-2014	Safety requirements for power electronic converter systems and equipment. General
16	EN ISO 13849-1-2015	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
17	IEC 61000-6-2:2005	Electromagnetic compatibility (EMC) –Part 6-2: Generic standards –Immunity for industrial environments
18	IEC 61000-6-4:2006+A1:2010	Electromagnetic compatibility (EMC). Part 6-4: General standards. Emission standard for industrial environments
19	IEC 61000-2-4:2002	Electromagnetic compatibility(EMC)-Part 2-4: Environment-Compatibility levels in industrial plants for low-frequency conducted disturbances
20	EN 61800-3:2004+A1:2012	Adjustable speed electrical power drive systems —Part 3: EMC requirements and specific test methods
21	IEC 61010-1-2010	Safety requirements for electrical equipment for measurement, control, and laboratory use-Part 1: General requirements
22	EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use-Part 1 : General requirements
23	EN 62040-1:2008+A1:2013	Safety of machinery-Electrical requirement of machines-Part 1: General requirements
24	EN 62477-1	Safety requirements for power electronic converter systems and equipment-Part 1:General