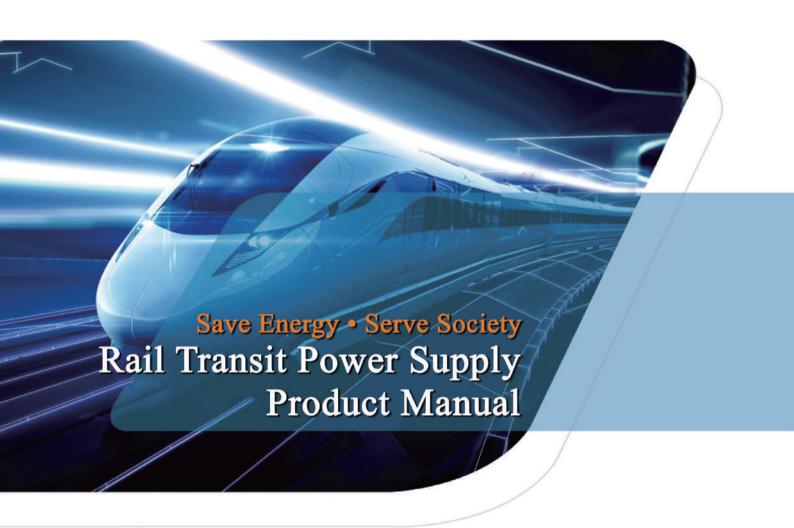
FGI WindSun







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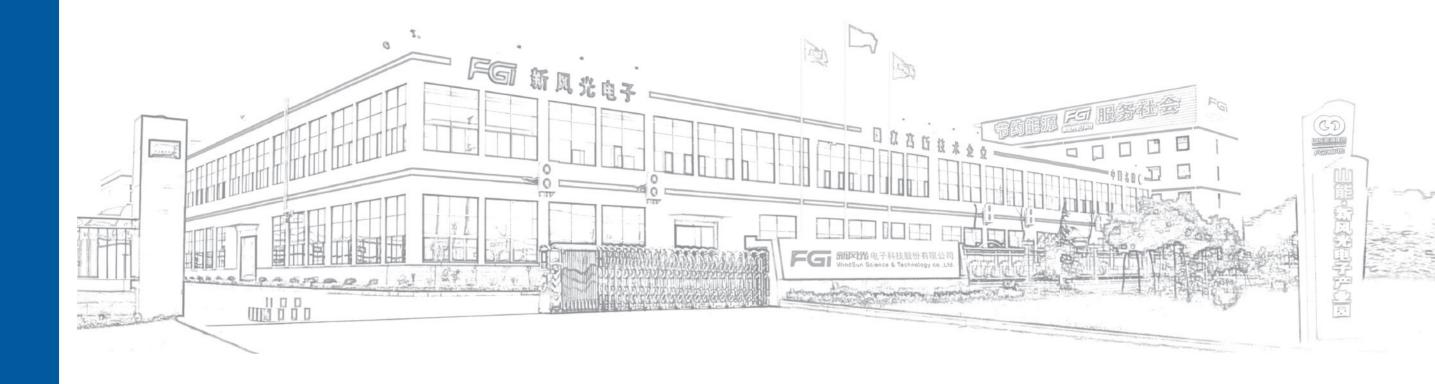
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About Us

WindSun Science & Technology Co., Ltd. (FGI) (Stock code: 688663) is a national high-tech enterprise specializing in the research and development, production, sales and service of power & electronic energy-saving control technology and related products under Shandong Energy Group, one of the world's top 500 companies. In addition, FGI went public on The Science and Technology Innovation Board.

FGI has led the development of national standards for rail transit braking energy absorption devices, and participated in the development of technical specifications for system safety evaluation of lithium-ion battery for energy storage and industry standards for static var generators for power quality (SVG), national standards for frequency convertible governors (high, medium and low voltage), and the IEEE international standards for energy feed-back devices for DC traction power supply systems. FGI is the vice president of Frequency Converter Branch of China Electrical Equipment Industry Association, and has built a number of scientific and technological innovation platforms, such as the Joint National-Local



Over 400 national pate

400 +

500 +

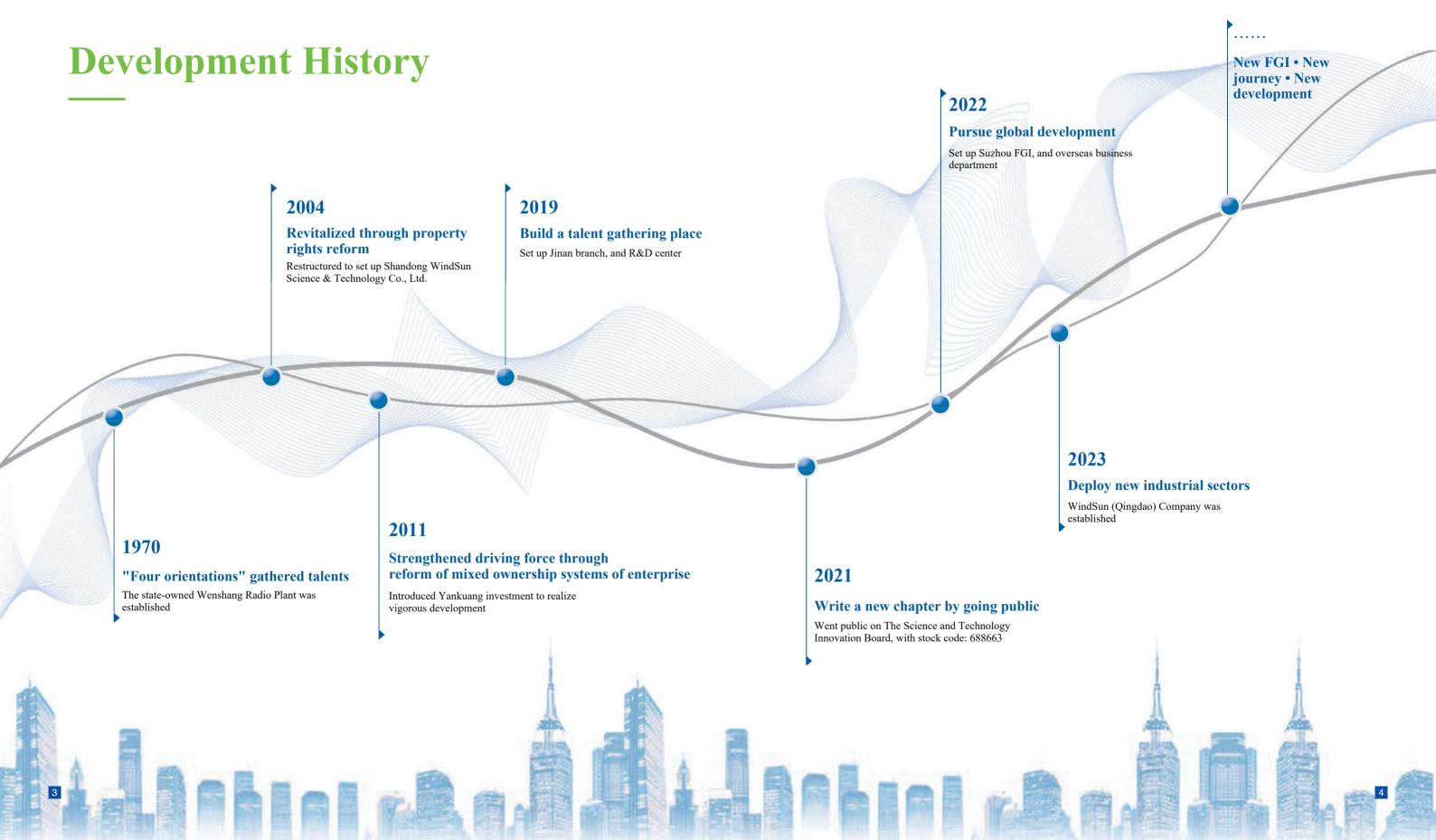
More than 500 sets of produc applied on site 300000 +

Over 300,000 KWH of electricity saved by every unit per year

Engineering Research Center for New Energy and High-Efficiency Energy Saving, Shandong Province Academician Workstation, Postdoctoral Innovation Practice Base, Shandong Frequency Conversion Technology Research and Promotion Center, Shandong Power Electronics and Frequency Engineering Technology Research Center, Shandong Enterprise Technology Center, Shandong Software Engineering Technology Center, etc..

WindSun (Qingdao) Transportation Science & Technology Co., Ltd. is a high-tech joint-venture enterprise established by Qingdao Metro Group and WindSun Science & Technology Co., Ltd. under Shandong Energy Group, which specializes in the research and development, production, sales and service of energy-saving control technology and related products in the rail transit industry. Its main business involves the products like brake energy absorption device, bidirectional converter, energy storage device, active filter, high and low voltage dynamic reactive power compensation device (SVG), high and low voltage series switchgear, frequency inverter and so on, and can also tailor rail transit equipment for customers, and provide products and solutions in the aspects of intelligent power supply system integration, power supply system intelligent O&M services, etc..





Development History of Rail Transit Products

2004

In January, the company was invited by the Institute of Nuclear and New Energy Technology, Tsinghua University to participate in "863" key high-tech research project in the energy field of the national "Tenth Five-Year Plan" - The development of electromagnetic bearing system of 10 MW high-temperature gas-cooled reactor helium-direct-to-turbine cycle power generation system

In April, "regenerative energy feed grid-connected circuit and its control device" obtained the national invention patent certificate:

In May, the company established Shandong Province Power & Electronics Technology and Energy Equipment Academician Workstation;

In September, the company's regenerative braking energy absorption inverter passed the verification for Shandong Province Scientific and Technological

In December, the company's key high-efficiency operation and control technology and application project of motor system under complex working conditions won the second prize of National Technological Invention Award;

2016

In July, the company's three series of products including rail transit braking energy absorption inverter, high voltage inverter and high voltage dynamic reactive power compensation device were listed in the national "Guiding Catalogue of Key Products and Services for Strategic Emerging Industries":

On July 10, "Braking energy absorption inverter" won the title of "Electrical Innovation Product" in China: In December, the key technology development and application of regenerative braking energy absorption inverter was included in the key research and development plan (Major key technology) project of Shandong Province;

In January, Qingdao Metro Group and WindSun Science & Technology Co., Ltd. established a joint venture - WindSun (Qingdao) Transportation Science & Technology Co., Ltd.

"Train intelligent driving optimization decision control and regenerative braking key technology" won the second prize of Chongqing Science and Technology Advancement Award;

In April, the company provided supporting equipment for the national "863" project" -"National Major Scientific Research Project -EAST Nuclear Fusion Test Device" undertaken by the Institute of Plasma Physics of the Chinese Academy of Sciences: Plasma vertical displacement fast-control power supply equipment was put into operation; In July, the "regenerative energy feed device" independently designed and manufactured by the company was put into use in the subway earlier in China;

2006

In November, the company provided "Inverter and the inverter-power grid switching system" for 500kW superconducting energy storage system of the Institute of Electrical Engineering, Chinese Academy of Sciences;

2014

In October, the company's "regenerative braking energy absorption inverter" was included in the National Torch Program Project;

2015

In July, the company's rail transit regenerative braking energy absorption inverter passed the EU safety access certification (CE certification);

2017

Led the drafting of the national standard "Urban rail transit - Inverter for regenerative braking energy absorption";

2019

In January, the company's energy storage regenerative braking energy absorption

In March, the company's first set of 4500kW

two-way inverter with continuous operation

power passed acceptance in the National

Inspection Center, and was put into use;

was developed under the leading of the

company was officially implemented;

Railway Product Quality Supervision and

In December, the national standard "Urban

Rail Transit - Regenerative Braking Energy

Absorption Inverter" (GB/T37423-2019) that

device was applied to the subway site;

2018

In April, the company's three projects including rail transit and power quality products were included in the Shandong Provincial Technological Innovation Plan;

In December, the company's energy storage regenerative braking energy absorption device obtained the type test report of the National Railway Product Quality Supervision and Inspection Center;

2021

The company's bidirectional converter obtained the type test report of the National Railway Product Quality Supervision and Inspection Center;

2022

The company's bidirectional converter is applied to Lijiang urban comprehensive rail transit project, the first one in China to cancel the power supply of the rectifier unit.

1999

FGI

In July, the company successfully developed the three-level medium-voltage frequency inverter in China earlier and successfully operated it in Shengli Oilfield, and then promoted it in a wide range of oil fields:

2000

In March, the earliest low-pressure elevator (four-quadrant)-dedicated inverter in China was successfully operated in Bao'an Coal Mine of Shandong Huaning Mining Group



HONOR AND QUALIFICATION





























EU CE certification

Explosion-proof certificate

National type test report

In 2023, it was successfully selected as the "World-class Professional & Leading Demonstration Enterprise List Created by the State".



PCCC certification

Patent for invention

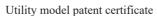


National standards



Software copyright certificate







Certificate of design patent



QUALITY ASSURANCE

The company has passed the certification of three ISO systems involving quality, environment and safety, and has been rated as AAAA-level Enterprise with Standardized Good Behavior, Shandong Province Advanced Enterprise with Excellent Quality and Management Performance, Qualified Enterprise with Metrological Assurance, and Shandong Province Quality Benchmark Enterprise.

There is a strict quality control plan for production management, which necessitates the strict implementation of ISO9001 standards, focus on PDCA management of the production process, strict process control and production process control, and the implementation of quality control in the whole process and after coupled with the on-site use of "6S" management tools, the percent of products passing factory inspection reaches 100%.

The company's production and test system covers an area of 80000 m². The company has a product test centralized control center with complete automatic functions and high integration for machine detection. It introduces automatic SMT machine, reflow soldering, automatic paint spraying line, R&D and testing tooling equipment, and environmental test equipment imported from Germany and South Korea. With 5 sets of unit assembly lines, it owns an annual production capacity of 3000-5000 sets of high-voltage products.



100,000-level purification parts manufacturing center



PCB board conformal coating production line



PCB board debugging -FCT and ICT function test production line



SMT-AOI production line



AGV automatic assembly line



PCS intelligent assembly line



WMS AS/RS system



Full-auto complete machine test system



Test system central control room



Simulating device for low air pressure, and high & low temperature environment



Simulating device for temperature shock environment



High-power full-load test system at the level of 10,000 kilowatts



Salt spray environment simulator

Optimize services Terminal guarantee



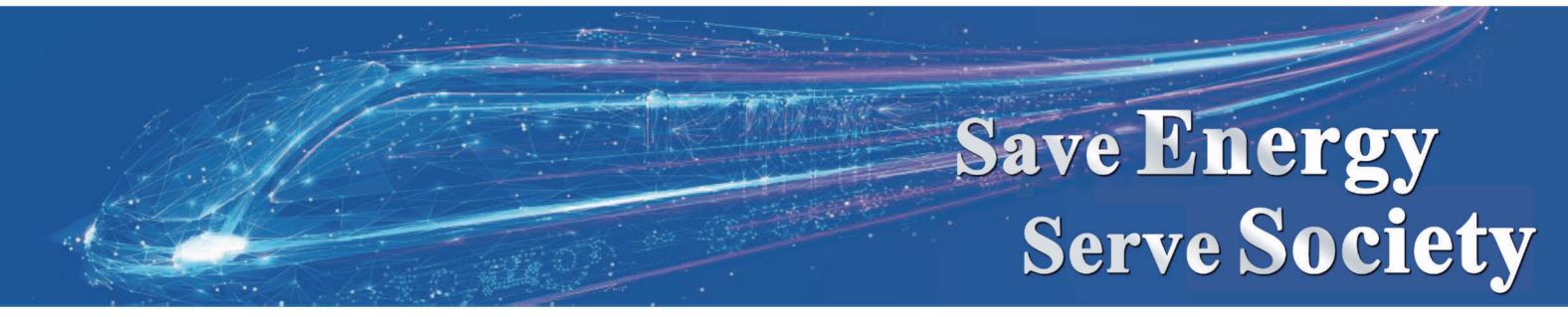














FDBL series brake energy absorption device

FDBL series brake energy absorption device is used to absorb the electric braking energy of trains in urban rail transit. The device is installed on the DC side of the traction power supply system substation. It can absorb the regenerative energy by controlling the DC voltage to ensure the full play of the regenerative braking function of trains. FDBL series brake energy absorption device includes five product categories: Bidirectional converter device, energy feed device (Regenerative brake energy absorption inverter), capacitive energy storage device, flywheel energy storage device, and resistance-type brake energy absorption device.

High-voltage dynamic reactive power compensation device

FGSVG series high-voltage dynamic reactive power compensation device can be widely used in the industries like electrified railway, petrochemical, power system, metallurgy, urban construction and so on, to provide high quality, and high reliability reactive power compensation and filtering solutions for all kinds of transformers, uncontrolled rectifier units, lighting equipment, electric locomotives, elevators, asynchronous motors, thyristor converters, frequency inverters, induction furnaces, resistance furnaces, welding machines and other equipment. FGSVG series products can enhance power transmission capabilities, reduce electric energy loss, compensate reactive power, control harmonics, suppress flickering, stabilize grid voltage, balance three-phase systems, change system damping characteristics, and improve system stability.

Active power filtering device

FGAPF series active power filtering device is a new type of power electronic device used for dynamic suppression of harmonics and compensation of reactive power. It can compensate the harmonics with changing size and frequency and the reactive power that varies. Its application can overcome the shortcomings of traditional harmonic suppression and reactive power compensation methods such as LC filter (Only fixed compensation), and realize dynamic tracking compensation. Also, it can compensate both harmonics and reactive power.

Energy management system

FGEMS series energy management system collects 35kV bus voltage, incoming line current, incoming line active power, incoming line reactive power, feeder current, feeder active power, feeder reactive power and other data of all traction substations of urban rail transit along the whole line through special data transmission channels, and processes, calculates and analyzes relevant data. It can display the collected data after various arithmetic and logic processing, and the data can be stored in the corresponding real-time database and historical database, and the active power and reactive power of the whole line can be quickly adjusted according to the analysis results, so as to achieve all-round monitoring and management functions such as electric power quality and load coordination of the whole line.

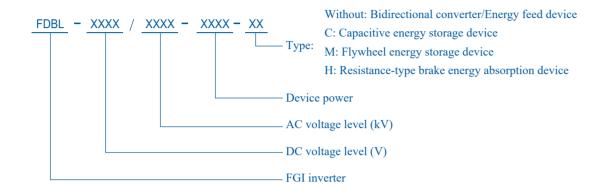
High, medium and low voltage switchgear sets

High, medium and low voltage switchgear sets are mainly used for the control and protection of the power system, which can put some power equipment or lines into or out of operation according to the operation needs of the power grid, and can quickly cut off the failed power equipment or lines from the power grid when they fails, so as to ensure the normal operation of the trouble-free part of the power grid and the safety of equipment and O&M personnel.



© FDBL series brake energy absorption device

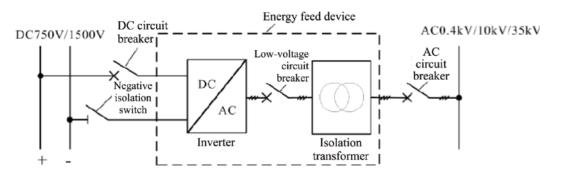
O Product specification & model



© Energy feed device (Regenerative braking energy absorption inverter)

The function of the energy feed device is that when the vehicle is subject to regenerative electric braking and the braking energy cannot be consumed by other vehicles or electrical equipment, the energy feed device will automatically adjust the output current of the power unit according to the change of the DC bus voltage, transform it into AC electricity with the same frequency and phase as those of the grid voltage, and return back to the AC grid for reuse. It does not only deals with regenerative energy effectively but also stabilizes DC traction voltage.

■ Product composition







■ Main technical parameters

Item	Parameters
Rated DC voltage	DC750V/DC1500V optional
No-load DC voltage	DC800V for 750V series, and DC1650V for 1500V series
Long-term DC operating voltage fluctuation range	DC500 - 900V for 750V series, and DC1000V - 1800V for 1500V series
Maximum voltage on the DC side	DC1000V for 750V series, and DC2000V for 1500V series
Starting voltage value	DC800V - 950V for 750V series, being continuously smooth and adjustable, and DC1600V - 1950V for 1500V series, being continuously smooth and adjustable
Rated AC voltage	AC0.4kV/1.18kV/ 10kV/35kV optional
Working modes	Intermittent working system, 30 seconds /2 minutes
Frequency	Automatically track the AC-side power grid frequency
Efficiency	98% (Excluding transformers)
Harmonics under rated working conditions	≤3%
System response time	≤ 100ms (From zero to full load)
Cooling mode	Forced air cooling, with fan start under the power unit temperature control, and fan start target value to be set
Auxiliary supply voltage	DC220V/DC110V for DC power supply; AC220V/AC380V for AC power supply

■ Technical features

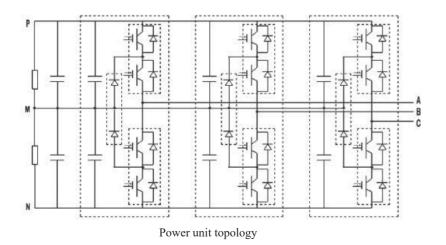
- The power unit adopts current closed-loop control, which can ensure the quality of output current waveform; The output of the power unit presents the characteristics of current source, which can be well suited to the parallel operation of the unit to achieve capacity expansion.
- The system output current waveform is sinusoidal, and the total current harmonic distortion (THD) is less than 3%; The system efficiency is high, up to 98%;



- The inverter main circuit adopts three-level circuit topology, and the voltage that each main power device withstands when it is turned off is only half of the DC-side voltage, which can not only improve the safety margin of the power device, but also improve the output waveform quality;
- Multiple power units are connected in parallel. Each unit is independently controlled, and has the characteristics of redundant operation. Even if the unit is subject to protection, the remaining power units can work normally, which can further improve the reliability of device operation;
- The control system adopts DSP digital control, which has high control precision and strong anti-interference ability;
- The control system has a self-test function, which can automatically detect the power supply state of the control circuit and various communication states:
- Part of the unit protection has a self-reset function to effectively prevent false protection actions caused by interference;
- The data transmission between the main control and the unit adopts optical fiber isolation, with high isolation performance and strong anti-interference ability;
- The complete machine adopts thin-film capacitor design, rendering long service life;
- The shape of power unit adopts mold design, and each power unit is completely consistent in structure and can be exchanged, which makes debugging and maintenance very convenient;
- The power unit is connected to the complete machine through the primary connector, which is convenient for debugging and maintenance;
- The control system uses MODBUS communication protocol to communicate with the host computer, and employs wireless network to realize remote monitoring of the system operating status, which can help users quickly understand the operation of the device, and it can also be used for remote fault diagnosis, which can help find and solve on-site problems more quickly, and thus shorten the fault downtime.

■ Power unit topology

- · Rated DC voltage: DC750V/DC1500V optional;
- No-load DC voltage: DC800V for 750V series, and DC1650V for 1500V series;
- · Long-term DC operating voltage fluctuation range: DC500 900V for 750V series, and DC1000V 1800V for 1500V series;
- Maximum voltage on the DC side: DC1000V for 750V series, and DC2000V for 1500V series;
- Starting voltage value: DC800V 950V for 750V series, being continuously smooth and adjustable, and DC1600V 1950V for 1500V series, being continuously smooth and adjustable
- Rated AC voltage: AC 0.4kV/1.18kV/ 10kV/35kV optional;
- Working mode: Intermittent working system, 30 seconds /2 minutes;
- Frequency: Automatically tracking the frequency of the AC-side power grid;
- Efficiency: 98% (Excluding transformer);
- Harmonic under rated working conditions: $\leq 3\%$;
- System response time: $\leq 100 \text{ms}$ (From zero to full load);
- · Cooling mode: Forced air cooling, with fan start under the power unit temperature control, and fan start target value to be set;
- Auxiliary power supply voltage: DC220V/DC110V for DC power supply; AC220V/AC380V for AC power supply.

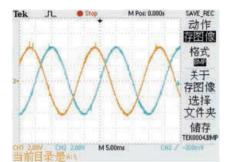


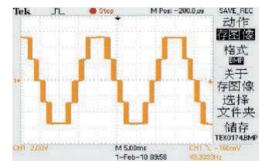
O Power unit

- . Convert the DC electric energy into AC electric energy with the same amplitude and phase as those of AC power grid;
- · Receive the main control signal;
- Upload the detected signals and internal status signals to the main control;
- · Conduct individual current closed-loop detection for each unit;
- Each power unit is subject to full bus voltage, 1/N current, and 1/N output power.



Power unit appearance





Power unit no-load voltage waveform

Power unit no-load voltage waveform





Transformer part

Inverter part

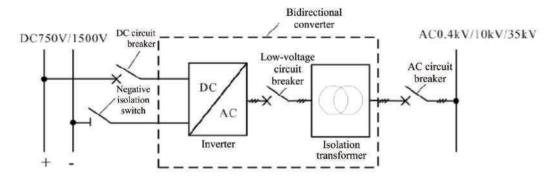


Bidirectional converter

The bidirectional converter is a converter composed of fully-controlled power electronic devices. The AC side is connected to the medium-voltage AC power grid through the isolation transformer, and the DC side is connected to the DC traction power grid. After it is put into operation, the control system determines the running state of the train on the DC-side power grid according to the voltage and current parameters in the system, and automatically enters the controllable rectification mode or the inverter feed mode. The bidirectional converter can not only provide the driving electric energy for the train, but also absorb the regenerative braking energy of the train, realizing the bidirectional electric energy flow directly and quickly.



■ Product composition



■ Field application



Indoor installation

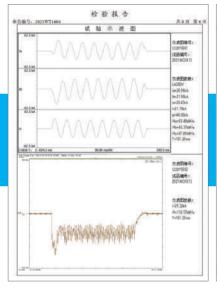
Outdoor prefabricated compartment installation

 Overload capacity requirements: The bidirectional converter needs to meet the VI-level load, and the energy feed device has no corresponding requirements. There is difference existing in the actual corresponding capacity;



 Short-circuit withstand capacity: The bidirectional converter needs to provide short-circuit withstand current, and the energy feed device has no such demand;

Short-circuit withstand capacity report

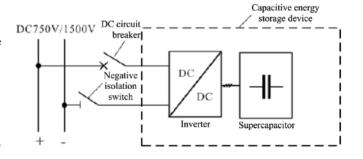


产品名称	双向变流装置			直接	2
型号规格	FDBL-1500/35-2	1640		检验类别	委托试验
主要技术数据	杨林电压。1500	标称电报: 1500V: 横定电流: 1412A: 纂			W.
委托人	新风光电子科技	股份有限公司			
委托人地址	山东汶上经济开	发区全成胜中	ž.		
生产单位	新风光电子科技	股份有限公司			
生产单位地址	山东双上经济开	山东汉上经济开发区金成器中设			
抽样地点		3.		始样日期	386
並祥者	X	抽件基施	(E	独样数量	1021
送符書	吳建學	科品数量	1.62	剥拌日期	2021年12月17日
样巫狐号	2021W01813	样品状态	1	生产日期	1
检验检查	天津市本田开加	民信道路の号	5	8	
物验收据	3859.1-2013 €1	9.体变液整通	旧要求科也	网络纽安波器 篇	分、点则》。GB/T 61-1 部分。基本要求 也力电子完深器》
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Capacitive energy storage device

The capacitive energy storage device mainly includes two parts: Bidirectional DC/DC converter (or DC/AC) and energy storage medium (Supercapacitor, battery, etc.). Its main function is to absorb energy from the traction grid and store it in the storage medium when the train is braking, and release the energy in the storage medium to the traction grid when the train is starting or accelerating. For different occasions, different control strategies are adopted to meet the demands of various application scenarios. The capacitive energy storage device has the characteristics of green, environmental protection and energy saving. The system is simple, safe and reliable, and can be widely used in braking energy absorption, power grid load balancing, standby power supply and other occasions.

■ Product composition





Main advantages

Absorb and store the braking energy of the train, and release it when the train starts, so as to save energy. This can increase the capacity of the DC traction power supply grid in the disguised form, and alleviate the impact on the DC traction power grid when the train starts and brakes.

Replace or reduce the use capacity of the on-board resistance, thereby reducing the weight of the locomotive and improving the carrying capacity of the locomotive.

Reduce energy consumption-type resistance capacity, reduce energy loss, decrease demands on heat dissipation capability of tunnel, and save energy and investment costs.

Reduce braking frequency of brake shoe, decrease dust pollution caused by brake shoe friction, and lower brake shoe maintenance costs.

Realize energy recycling and reusing, saving energy in response to the national policy of energy conservation and emission reduction.

■ Main performance indicators (Take 2MW as an example)

Rated Power	2000KW	Operating voltage range of the supercapacitor	DC490V - 810V
Rated voltage	DC1500V	Rated charging and discharging current of the supercapacitor	4000A
Operating voltage fluctuation range	DC1500V - 2000V	Total capacity of the supercapacitor	183F
Working mode	20S/120S	Available store electric energy for supercapacitor	17KW·h
DC-side current	1212A	Response time	Less than 100ms

■ Use effect

CH1: Voltage waveform on the grid side

CH2: Current waveform on the grid side

CH3: Supercapacitor voltage waveform

CH4: Supercapacitor charge and discharge current waveform





Single charge and discharge test waveform

Cyclic charge and discharge test waveform

■ Main technical features

1 Control Method

There are two charge and discharge control modes of supercapacitor to be selected by users: Constant current charge and discharge, and constant power charge and discharge.

In the constant current charge and discharge mode, the charging and discharging current of the supercapacitor is proportional to the braking energy of the train, and the device current increases proportionally with the increase of the braking energy.

In the constant power charge and discharge mode, the charging and discharging power of the supercapacitor is proportional to the braking energy of the train, and the device power increases proportionally with the increase of the braking energy.

Both control modes are finally realized through the current closed-loop control of the unit, which aims at controlling the current and makes the power unit present the current source characteristics to the outside.

2 Three-level topology

The capacitive energy storage device uses the three-level topology of FGI regenerative braking energy absorption device, which has the following advantages:

(1) Can effectively raise the carrier frequency of the device, and the carrier frequency of the device is up to 5kHz.

(2) Can reduce the filtering pressure on the output electric reactor due to the increase of the carrier frequency, reduce the volume of the reactor, and further minimize the volume of the DC/DC inverter.

(3) Ensure that the voltage that each main power device withstands when it is turned off is only half of the DC-side voltage, which can improve the safety margin of the power device and improve the reliability of the device.

3 Multi-unit parallel control

The DC/DC power unit of the capacitive energy storage device corresponds to single cabinet of the super capacitor, that is, each DC/DC power unit corresponds to a supercapacitor cabinet, there is no direct electrical connection with other supercapacitors, and they are relatively independent from each other.

The advantage of this method is that each power unit has no influence on each other, and when one power unit or supercapacitor cabinet is abnormal, it does not affect the work of other parts, and perfect redundancy can be achieved.

A Drawer-type unit design

Whether it is DC/DC power unit or supercapacitor storage unit, it is designed with drawer-type unit, which can facilitate on-site installation, inspection and maintenance

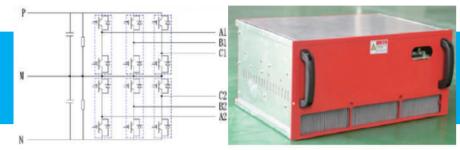
The two types of units are connected by a primary connector, and there is no need to remove and mount screws when disassembling and assembling the unit, which is convenient for debugging and maintenance.

Carrier phase-shift

The machine adopts multi-unit parallel operation. There are 3 branches per each unit. The total number of branches is 3*N per machine, and the phase-shifting angle is 360*/(3*N), which greatly reduces the charge and discharge current ripple and improves the service life of the supercapacitor. When a unit fails and quits the operation, the device automatically redistributes the phase-shifting angle according to the number of remaining units, and always ensures the minimum ripple of charging and discharging current.



■ DC/DC unit topology and outline



The topology and outline of the DC/DC power unit are shown in the figure. The DC/DC power unit is connected to the machine by a primary connector. There is no need to remove and mour screws when disassembling and assembling the unit, which is convenient for debugging and maintenance.

DC/DC unit topology

DC/DC unit appearance

■ Application site







Energy storage inverter

Supercapacitor energy storage cabinet

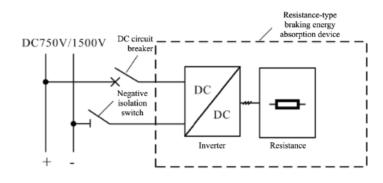
Inverter + Energy storage cabinet

○ Flywheel energy storage device

The flywheel energy storage device is mainly composed of two parts: Bidirectional DC/AC converter and flywheel. Its main function is to convert the energy absorbed from the traction grid to the kinetic energy of the flywheel under the condition of train braking, and release the energy in the flywheel to the traction grid under the condition of train starting or accelerating. When the flywheel energy storage device is charging, the flywheel is in the motor mode, so that the flywheel rotor accelerates to rotate, and the electric energy is converted into the flywheel kinetic energy to achieve energy storage. When it is discharging, the flywheel is in generator mode, which makes the flywheel rotor slow down, and the flywheel dynamic energy is converted into electric energy to realize energy output.

$$E_k = \frac{1}{2}mv^2 = \frac{1}{2}J\omega^2$$

■ Product composition



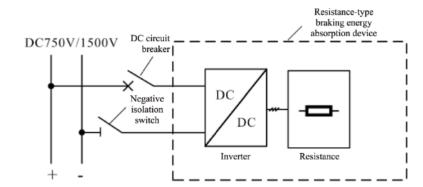


■ Main technical parameters

Item	Parameters
Nominal voltage on the DC side	DC1500V
Maximum voltage on the DC side	DC2000V
Charge and discharge starting voltage	DC1100V - 1950V, adjustable
The flywheel stores energy	40MJ (11.1kWh)
Flywheel cycle charge and discharge energy	30MJ (8.3kWh)
Inverter charging and discharging efficiency	≥0.95
Charge and discharge peak power	1MV
Inverter main loop topology	Three-level
Inverter output dV/dt	<800V/us
Machine-side current harmonic THDi	<5%
Response time	≤100ms
DC-side ripple coefficient	≤3%
Noise	Full-load noise $\leq 80 dB$
Operating temperature	-20.5°C to +45°C (Derated operation above 45°C)
Relative temperature range	0-95%
Altitude	<1500m
Cooling mode	Water-cooling
Control power supply	DC220V, AC380V (Three-phase 4-wire)
Communication interface	RS485, Ethernet



Resistance-type braking energy absorption inverter

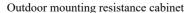














Wall mounted resistance cabinet

■ Technical parameters

Item	Parameters
Rated DC voltage	DC750V/DC1500V optional
No-load DC voltage	DC800V for 750V series, and UDC1650V for 1500V series
Long-term DC operating voltage fluctuation range	DC500 - 900V for 750V series, and DC1000V - 1800V for 1500V series
Maximum voltage on the DC side	DC1000V for 750V series, and DC2000V for 1500V series
Starting voltage value	DC800V - 950V for 750V series, being continuously smooth and adjustable, and DC1600V - 1950V for 1500V series, being continuously smooth and adjustable
Working modes	Intermittent working system, 30 seconds /2 minutes
Inverter efficiency	98%
System response time	≤ 100ms (From zero to full load)
Chopped wave control mode	PWM (Conducting ratio adjustment range: 5% - 95%)
Cooling mode	Forced air cooling, with fan start under the power unit temperature control, and fan start target value to be set
Auxiliary supply voltage	DC220V/DC110V for DC power supply; AC220WAC380V for AC power supply

■ Technical features

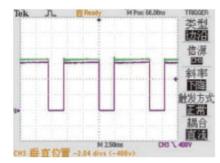
- If at the same switching frequency, the switching loss is smaller than that of the two-level circuit, which improves the system efficiency and can extend the service life of the power semiconductor device;
- Adopt the constant voltage absorption mode of phase-shifting multiplex IGBT chopper coupled with absorption resistance ®, adjust the conducting ratio of the chopper according to the change of DC bus voltage during regenerative braking, and control the power-on time of the absorption resistance, thus changing the absorbed power, keeping the DC voltage of the grid constant within a certain set value through constant voltage closed-loop control of the grid voltage, and consuming the regenerative braking energy on the absorption resistance;
- The main circuit adopts a three-level circuit topology. The voltage that each main power device withstands when it is turned off is only half of the DC-side voltage, which improves the safety margin of the power device.
- The use of multiple power units in parallel, each unit under independent control = featuring redundancy work, even if the unit is subject to protection, the remaining power units can work normally, which further improves the reliability of device operation;
- The control system adopts DSP digital control, which has high control precision and strong anti-interference ability;
- The control system has a self-test function, which can automatically detect the power supply state of the control circuit and various communication states;
- Part of the unit protection has a self-reset function to effectively prevent false protection actions caused by interference;
- The data transmission between the main control and the unit adopts optical fiber isolation, with high isolation performance and strong anti-interference ability;
- The complete machine adopts thin-film capacitor design, rendering long service life;
- The shape of power unit adopts mold design, and each power unit is completely consistent in structure and can be exchanged, which makes debugging and maintenance very convenient;
- The power unit is connected to the complete machine through the primary connector, which is convenient for debugging and maintenance:
- The control system uses MODBUS communication protocol to communicate with the host computer, and employs wireless network to realize remote monitoring of the system operating status, which can help users quickly understand the operation of the device, and it can also be used for remote fault diagnosis, which can help find and solve on-site problems more quickly, and thus shorten the fault downtime.

FGi

■ Power unit

- Transfer the energy generated by the system to the resistance for consumption;
- · Receive the main control signal;
- Upload the detected signals and internal status signals to the main control;
- Each unit is controlled independently, and the phase shifting between units is multiplexed;
- Each power unit is subject to full DC voltage, 1/N current, and 1/N output power.





Oscillogram

O Hybrid type

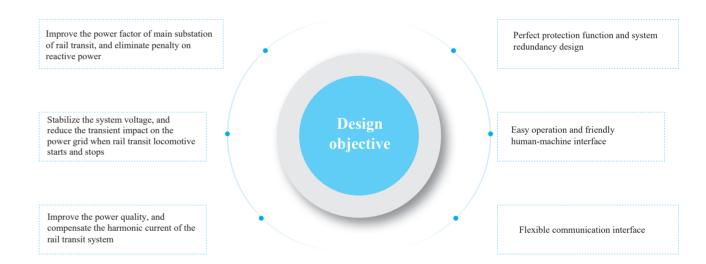
Hybrid brake energy absorption device is a combination of two or more brake energy absorption devices, which can play their respective advantages and features, to achieve the best effect on site.



High-voltage dynamic reactive power compensation device (FGSVG)

■ Application effect

The power supply system of urban rail transit generally adopts the mode of DC traction and AC centralized power supply, with many transformers, the high-voltage power supply circuit dominated by power cables, and a larger overall length of cable. Power and traction transformers, traction locomotives, cables, and rectifier units produce obvious reactive power shocks and harmonics at the transmission system side, which not only worsens the power quality of the grid power supply, resulting in low power factor, but also reduces the reliability of the grid power supply. Therefore, it is required to study the power quality characteristics of the rail transit power supply system. It is of great significance to improve the reliability of power supply by taking corresponding treatment measures to solve the problem of reactive power compensation and comprehensive harmonic suppression of electrified railway in rail transit system.



■ Application effect

It can be known from the description of the principle of SVG that SVG can automatically adjust the size and quality of its output reactive power (Capacitive or inductive) according to the load characteristics and working conditions. Thus, in essence, SVG can be equivalent to a capacitor or reactor whose size can be continuously adjusted.

SVG is the most advanced reactive power compensation technology at present, and its compensation device based on electric voltage source converter realizes a qualitative leap in reactive power compensation. It no longer uses large-capacity capacitors and inductors, but realizes the transformation of reactive power energy through high-frequency switches of high-power power & electronic devices. Technically speaking, SVG has the following advantages over traditional reactive power compensation devices:





Faster response

SVG response time: <5ms; Response time of traditional dynamic compensation device: ≥50ms. As the FGSVG type test report, it takes 3.8ms from rated inductive load (+5M) to rated capacitive load (-5M). SVG can complete the conversion from rated capacitive reactive power to rated inductive reactive power in a very short

time, and this unparalleled response speed is

fully capable of compensating impact loads.

Stronger ability to suppress voltage flickering

Traditional dynamic compensation can suppress voltage flickering up to 2:1, and SVG can suppress voltage flickering up to 5:1 or even higher. In addition, increasing the capacity of the device can continue to improve the ability of suppressing voltage flickering due to the extremely fast response of the SVG.

Wider operating range

SVG can operate in the range of rated inductive load to rated capacitive load, so the operating range is much wider than that of other types of dynamic compensation. More importantly, when the system voltage is low, SVG can also output reactive current close to the rated working condition. All of the other types of dynamic compensation rely on capacitors to provide capacitive reactive power. The output reactive current is proportional to the power grid voltage, and the lower the power grid voltage, the lower the output reactive current, so the compensation ability towards the power grid is correspondingly weak. This is an essential shortcoming of the other types of dynamic compensation techniques.

Diversification of compensation functions

Use the same set of SVG device, to achieve different compensation functions: Individual compensation of load reactive power, individual compensation of load harmonics, and simultaneous compensation of load reactive power and harmonics imbalance, so SVG has a powerful compensation function.

The FGSVG products of FGI have the following working modes: Constant device reactive power mode, constant-check point power factor mode, constant-check point voltage mode, and constant-check point reactive power mode.

Active power filtering function

SVG uses PWM technology, which can not only minimize the harmonic component generated by itself, but also compensate the harmonic and reactive power of the load, realizing the function of active filter, and truly achieving multi-function. For the filtering function, FGSVG has the suppression function for harmonic 21st below, and can set the compensation enabling and the compensation current number for harmonics 2nd - 21st on the human-machine interaction interface to complete the harmonic suppression.

Small active power loss

The active power loss of the complete machine is less than 1.2% of the rated power.

Small footprint

Since large-capacity capacitors and reactors are not required as energy storage components, the footprint of SVG is usually only 50% of that of other types of dynamic compensation device with the same capacity, or even smaller.

For the equipment with FGSVG—C4.0/35T (35T indicates 35kV step-down type) specifications, the indoor SVG body part can be of width * depth * height = 3000mm*1400mm*2400mm per set (The cooling fan at the top of the cabinet is 450mm high, and such size does not include the reactor cabinet).

■ Technical parameters

Item	Parameters
Rated operating voltage	400kV> 6kV> 10kV, 27.5kV> 35kV;
Rated capacity	± 0.1 - ± 100 Mvar;
Output reactive power range	Continuous change from inductive rated reactive power to capacitive rated reactive power;
Response time	≤5ms
Overload Capacity	1.2 times overload for 1min;
Total harmonic distortion of output voltage (Before grid connection)	≤5%;
Total harmonic distortion of output current THD	≤3%
System voltage imbalance protection, setting range	4% - 10%
Operating temperature	-10°C - +40°C;
Storage temperature	-30°C - +70°C;
Human-machine interface	Color touch screen display in Chinese
Relative Humidity:	The monthly average is not more than 90% (25°C), without condensation
Altitude	< 1000 m (Customized if higher than 1000m)
Seismic intensity	≤ 8

Active power filtering device (FGAPF)

■ Generation of harmonics in subway system

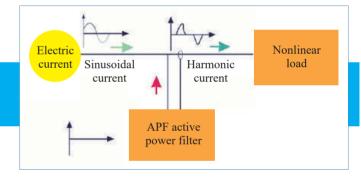
① The locomotive needs DC power supply, which is a typical nonlinear load, and the harmonic voltage and harmonic current are sent back to the power grid through the catenary when the locomotive is running. The air-conditioning, ventilation, lighting, battery and other electrical equipment of the locomotive are all supplied by the auxiliary inverter on the locomotive, and the locomotive traction DC electricity is nonlinear load, generating the harmonics in the same case.

② The air conditioning, elevator and lighting systems in the electromechanical systems of subway stations are subject to the increasingly demand on energy saving. The use of a large number of nonlinear power electronic devices, such as VFD air conditioning, VFD speed-control elevator, energy-saving lights, UPS, etc., will produce more harmonics, making the power quality problem of subway stations more serious; According to the analysis of subway station, the main power quality problems are: Harmonics, reactive power, and unbalance. Among them, the harmonic problem is the most serious one.

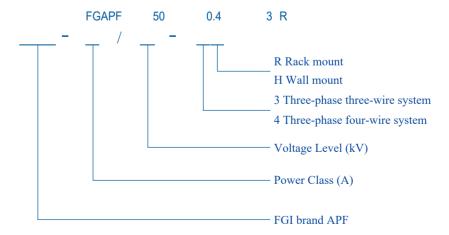


FGAPF front view

Generation of harmonics in subway system



■ Specification & type





FGAPF active power filter is a new generation of harmonic control solution for dynamic filtering of harmonics, and adopts the advanced dynamic real-time tracking compensation mode to eliminate harmonics in the power grid. FGAPF is a high-power power electronic device based on current detection and current injection technology. By monitoring the current waveform generated by the nonlinear load in real time, the harmonic part is separated, and by controlling the triggering of IGBT, the harmonic current with the opposite size and direction is injected into the power grid to filter (offset) the harmonic, so as to improve the safety and reliability of the electrical system and realize the purpose of energy saving and efficiency improvement.

■ Technical parameters

FGAPF	Three-phase three-wire system	Three-phase four-wire system
Rated compensation current	100A-600A	50A-600A
Operating voltage	400V(-20% - +15%) 690V(-20% - +15%)	400V(-20% - +15%)
Operating frequency (Hz)	50/60	50/60
Filtering capability	THDi < 3%	% (Rated)
Filter range	2nd - 50th harmonics, elimina	ating all specified harmonics
Adjust the compensation rate of individual harmonics	Limit the compensation curre	ent value for each harmonic
Instantaneous response time	<100)us
Full response time	<101	ms
Active power loss	<3% (F	Rated)
Correct three-phase unbalance	Ye	S
Reactive power compensation function	Yes, and the power	r factor can be set
Overload Protection	Automatic current limiting	ng at 100% rated output
Display interface	Color touch scro	een in Chinese
Display parameters	Grid parameters such a	as current and voltage
Communication	Modbus, RS485,	TCP/IP Ethernet
Stand-alone operation	Allov	wed
Parallel operation	Allow the parallel operation	on of multiple machines
Environment temperature	-10°C -	45°C
Relative Humidity:	Up to	90%
Installation condition	Indoor ins	stallation
Altitude	Below 1000 meters (Contact the n	nanufacturer for higher altitudes)

© Energy management system (FGEMS)

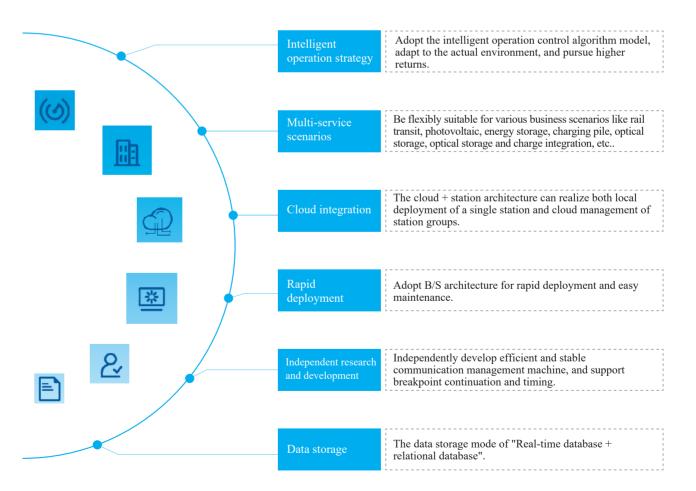




Application cases of rail transit products

Application cases of energy storage products

■ Product features





Switchgear series

High, medium and low voltage switchgear sets are mainly used for the control and protection of the power system, which can put some power equipment or lines into or out of operation according to the operation needs of the power grid, and can quickly cut off the failed power equipment or lines from the power grid when they fails, so as to ensure the normal operation of the trouble-free part of the power grid and the safety of equipment and O&M personnel.

○ High-voltage switchgear

■ Technical parameters

Rated voltage	40.5kV
Rated current of main bus	630 - 1600A
Rated short-circuit switching current	25/31.5kA
Rated short-circuit standing current	63/80kA
Outline dimensions	1400mm*2800mm*2600mm



© GCD116 (MNS) low-voltage pull-out switchgear set



■ Product features

- Drawer unit features small size, strong function, easy replacement, and strong versatility:
- Adopt standard module design, with more than 200 kinds of assembly parts that can constitute different schemes of cabinet structure and drawer unit;
- Safe and reliable operation and maintenance, and the cabinet is divided into three areas:

 Electrical apparatus area, cable area, and bus

■ Technical parameters

Rated voltage	380/660V
Rated current of main bus	400 - 6300A
Rated short-time withstand current (kA/1s)	Horizontal bus 30/50/80/100kA, and vertical bus 15/20/30kA
Outline dimensions	2200mm*600 (800, 1000) m*600 (800, 1000) mm

○ ZBW19 series outdoor box-type combination substation

■ Product features

- *Beautiful appearance, low noise, and harmony with the surrounding environment;
- Adopt three cooling measures: Upper and lower natural wind convection, lateral natural wind convection and forced air cooling by special fan at the bottom;
- Strong adaptability, being able to meet different design schemes, and different customer requirements.





■ Technical parameters

Rated voltage	10 (6) / 0.4kV
Rated capacity	50 - 1250kVA*2

○ Intelligent substation



■ Product overview

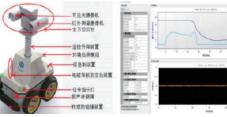
The intelligent substation adopts advanced, reliable and integrated intelligent equipment, and automatically completes the basic functions of information collection, measurement, control, protection, metering and detection on the basis of the whole station information digitization, communication platform networking and information sharing standardization. It realizes the full life cycle management of related equipment from the aspects of "Equipment monitoring and control, maintenance services, and optimized operation", so as to provide guarantee for the safe and efficient operation of the power supply system.

■ Main functional features

- The intelligent substation is composed of intelligent switchgear, communication equipment, intelligent substation management system, intelligent patrol robot, and intelligent fire protection equipment. It is divided into field equipment layer, communication management layer and cloud management layer, which can be viewed at anytime and anywhere through networked terminals like computers, tablets, smart phones and so on.
- The intelligent switchgear is equipped with electric chassis truck and electric grounding switch, with the assistance of the video monitoring system in cabinet, to realize remote visual electric operation, and achieve unattended substation as no personnel is needed for operating on site;
- The substation has functions such as wireless temperature measurement, on-line monitoring of partial discharge, circuit breaker mechanical
 characteristics monitoring and action curve monitoring, and provides expert-level fault pre-diagnosis and O&M suggestions for switchgear with
 perfect background database, changing the post-fault maintenance into pre-fault maintenance, and changing periodic maintenance into directed
 maintenance.
- The intelligent substation management system (Cloud platform) can help upload the operation information, protection information, health

information, environmental information, etc. of various substation equipment such as intelligent switchgear, transformer, reactive power compensation device, patrol robot,





access control and so on to the cloud for data fusion and centralized analysis and management, and for improving power supply reliability and management efficiency of the substation and reducing operating costs.



Product performance

S/N	Product type	Project name	Quantity
1		Beijing Metro Line 6 Phase II	7
2		Beijing Metro Line 7	11
3		Beijing Metro Line 9	8
4		Beijing Metro Line 10	14
5	Low-voltage	Beijing Metro Line 14	5
6	energy feed	Chongqing Metro Line 1	15
7		Chongqing Metro Line 3	15
8		Chongqing Metro Line 6	16
9		Chengdu Metro Line 7	6
10		Nanjing Metro Line 1, Line S1, and Line S8	5
1		Beijing Rail Transit Line 12 Project	17
2		Qingdao Metro Line 3	1
3		Qingdao Metro Line 6	11
4		Qingdao Metro Line 8 Project - Regenerative Braking Energy Absorption Device Procurement Project	21
5		Qingdao Metro Line 11	12
6		Qingdao Hongdao - Jiaonan Intercity Rail Transit Project Medium-voltage Energy Feed Device Procurement Project	12
7		Chengdu Rail Transit Line 27 Phase I Project	12
8		Chengdu Metro Line 5	25
9		Fuzhou Rail Transit Line 6 Project Section 4 Project Department	13
10	Medium-	Luoyang Rail Transit Line 1 Project - Power Supply System Equipment Procurement Project Package 05	10
11	voltage energy feed	Shanghai Baoye Group Guiyang Rail Transit Line 2 Phase II Project	6
12	chergy feed	Jinan Rail Transit Line R3 Phase I Project Regenerative Energy Feed Project	10
13		Zhengzhou Rail Transit Line 2 Phase II Project	3
14		Zhengzhou Rail Transit Line 4 Project Power Supply System Installation Construction Project	15
15		General Contracting Project for the Installation and Construction of the Western Section of Zhengzhou Rail Transit Line 6 Phase I Project	10
16		Zhengzhou Metro Line 6 Northeast Section	13
17		Zhengzhou Metro Line 7	18
18		Zhengzhou Metro Line 8	25
19		Zhengzhou Metro Line 12	10
20		Tianjin Metro Line B1	4
21		Tianjin Metro Line 7	12
22		Changsha-Zhuzhou-Xiangtan Intercity Railway - West Ring Line Phase I Project	2
23		Luoyang Metro Line 2 - Power Supply System Installation Section 01	4
24		Luoyang Metro Line 2 - Power Supply System Installation Section 02	5
25		Xi'an Metro Line 16 Phase I Project	7

26		Shaoxing Rail Transit Line 1	8
27	Medium-	Dalian Metro Line 5	10
28	voltage energy feed	Shenzhen Metro Line 13	9
29		Xuzhou Metro Line 3 phase II	3
1	Bidirectional converter	Lijiang Urban Rail Transit Line 1	11
1		Chengdu Metro Line 7	1
2		Chengdu Metro Line 5	1
3		Chengdu Metro Line 9	1
4		Chengdu Metro Line 27	1
5	Resistance-type	Qingdao Metro Line 6	1
6	brake energy absorption	Xi'an Metro Line 16 Phase I	1
7	device	Qingdao Metro Line 8	1
8		Test Line Substation Project of Changchun Railway Vehicle - Bombardier Railway Vehicles Co., Ltd.	1
9	1	Changsha CRSC Industrial Park	1
10		Luoyang Metro Line 1	1
11		Xi'an Metro Maintenance and Manufacturing Project of CRRC Changchun Railway Vehicles Co., Ltd.	1
12		Kaifeng Air Rail Transit	1
1	Capacitive	Qingdao Metro Line 2 Taishan Road Station Supercapacitor Contract - Energy Management Project	2
2	energy storage	Qingdao Metro Line 8 project - Regenerative Braking Energy Absorption Device Procurement Project	3
1	Flywheel	Qingdao Metro Line 6	4
2	energy storage	Qingdao Metro Line 11	6
1		Tianjin Metro Line 7 Phase I Project Main Substation Equipment Procurement and Installation Project	4
2		Guiyang Rail Transit Line 3 Phase I	6
3		Qingdao Metro Line 4 Power Supply System Engineering Materials Procurement	4
4		Shenzhen Metro Line 12	4
5		Chongqing River Jumper	4
6		Electromechanical Project Department of Foshan Nanhai District New Public Transport (Sanshan to Guicheng) Hub Section System	5
7		Qingdao Metro Line 8	8
8	SVG	Dayangzhuang Main Substation of Jinan Metro Line R1 External Power Supply and its Supporting Project	2
9		Jinan Metro Line R3 Phase I Project External Power Supply and Supporting Projects (Olympic Sports Center Main Substation)	2
10	1	Qingdao Metro Line 1 Project 35kV SVG Device Procurement Project	10
11		Liuzhou City Public Transport Supporting Project (Phase 1) Yuanbao Main Substation Project	2
12		Qingdao Metro Line 1 Lingshanwei Substation and External Power Supply Project	2
13		Qingdao Hongdao - Jiaonan Intercity Railway Project 0.4kV Switchgear Procurement Project	1
14	1	Qingdao Metro Line 2 Phase I Project Power	4
15		Supply System Installation Construction Project Qingdao Metro Line 3 SVG Dynamic Reactive Power Companyation Page Proposition Project	4
	+	Power Compensation Device Renovation Project	



Typical site

Regenerative braking energy
 Absorption inverter (400V feed)
 Beijing Metro Line 10



 Regenerative braking energy absorption inverter (35kV feed)

Xi'an Metro Line 16



Bidirectional converterLijiang urban rail transit Line 1



 Capacitive energy storage
 Qingdao
 Metro Line 8



Resistance-type absorption deviceChengdu Metro Line 9



 Hybrid brake energy absorption device of energy feed and energy consumption

Chengdu Metro Line 7



SVGQingdaoMetro Line 1



U Full-life cycle service for worry-free use

Serve at anytime and anywhere • Customer always comes first

Pre-sale, in-sale and after-sale services

- Full-life cycle management mechanism
- Professional technicians diagnose electricity consumption conditions, and select more reasonable equipment
- On-site installation, debugging, training, and Q&A

Remote monitoring

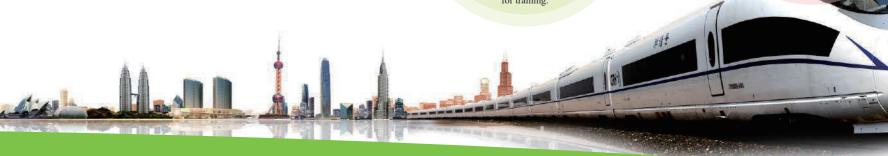
- Have remote data
- monitoring center
 Grasp the running status of the device in real time
- Timely prompt for repair
 and maintenance
- and maintenanceAnticipate failure

Sunshine service

- Regularly launch the campaign of "With passions for customers, provide sunshine services", and take the initiative to the user site to provide one-stop free services.
- Users can come to the company at any time to visit and learn for free. The company headquarters organizes trainings four times a year (At the end of each quarter) training, and invites customers to the company

Service agency

- 5 service centers
- 21 offices
- 2-hour response time, and arrive at the site within 24 hours
- Service radius less than 200 km
- An experienced and skilled service team



Save Energy & Serve Society



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