智光电气
Zhiguang Electric

# 船岸电系统

ZG-SPS智能船

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# 公司简介
# Company Profile

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Guangzhou Zhiguang Electric Technology Co., Ltd., established in 2002 with a registered capital of 200 million yuan, is a wholly-owned subsidiary of Guangzhou Zhiguang Electric Co., Ltd. [stock code: 002169, hereinafter referred to as Zhiguang]. It is a core member company of Zhiguang, which is specializing in flexible power technology research in the direction of integrated energy technology and service strategy development.

Since its establishment, the company has been focusing on the research of electrical control equipment technology with high-power electronics as its core technology, and conducting technical research and industrial applications in the fields of smart grid, distributed micro-grid, energy storage, motor control and energy conservation, power quality control, advanced power technology, etc.

The main products include intelligent ship shore power system, DC power system, distribution neutral grounding device, high voltage frequency converting system, gate machine potential energy feedback products, cold box section energy storage power system, energy storage system, static var generator(SVG), automation products, power management device and large-scale industrial intelligent UPS.

The company's products have achieved regional coverage in the country and are exported to dozens of overseas countries and regions, contributing to the global energy conservation and emission reduction and green energy industry. The company uses the private cloud platform and big data as its technical means to give full play to the advantages of the“ Internet + ” and establishes a marketing and service platform centered on key industries, key regions and major customers, providing products, technologies and comprehensive technical solutions to thousands of customers in the port , power, building materials, metallurgy, chemical, coal, municipal, and new energy industries.

# ZG-SPS智能船舶岸电系统介绍

## Introduction of ZG-SPS Intelligent Ship Shore Power System

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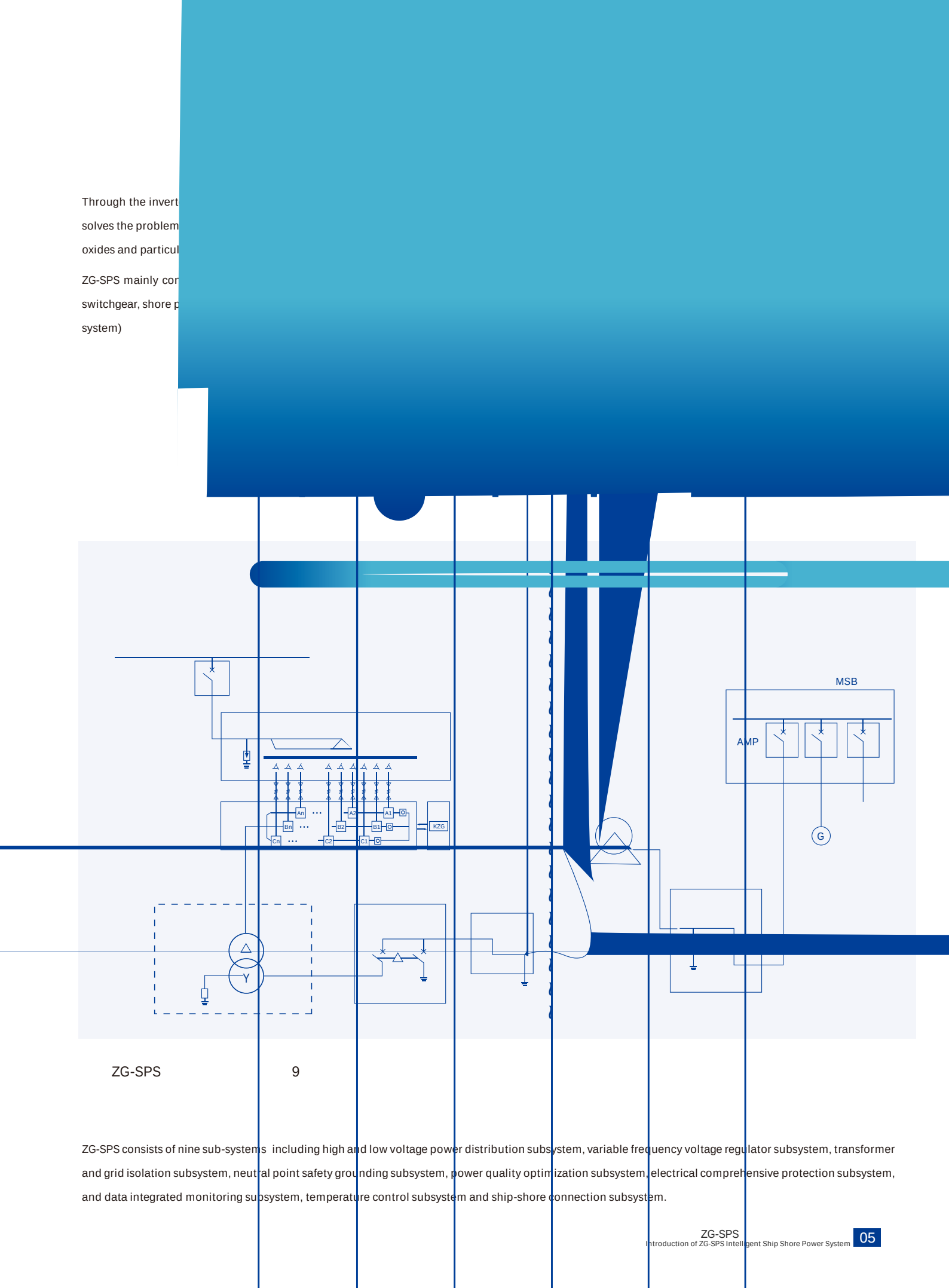



ZG-SPS 9

ZG-SPS consists of nine sub-systems including high and low voltage power distribution subsystem, variable frequency voltage regulator subsystem, transformer and grid isolation subsystem, neutral point safety grounding subsystem, power quality optimization subsystem, electrical comprehensive protection subsystem, and data integrated monitoring subsystem, temperature control subsystem and ship-shore connection subsystem.

## 2.1
## The Introduction of Each Subsystem

### 2.1.1
### High and Low Voltage Power Distribution Subsystem

The power distribution system at the input side of the system is designed according to the specifications of the conventional power distribution equipment, and the power distribution system at the output side is designed according to the specifications of the shore power equipment. Both sets of the power distribution subsystems can be equipped with monitoring, metering, and communications-related equipment and interfaces to facilitate monitoring and metering of power supply and equipment operation.

## 2.1.2
## Variable Frequency Voltage Regulator Subsystem

The core equipment is a high-voltage variable frequency power supply, and its functional characteristics are as follows:

NO.1

### Low harmonics without filter device

3%

400V/440V 6.6kV/6kV 11kV

Adopting multi-pulse wave and phase-shift rectification technology, the output voltage harmonic is lower than 3% (when there is no filtering device); adopting multi-level phase-shift superimposed transformer frequency conversion technology, through the isolation transformer can directly output close to sinusoidal 400V/440V, 6.6kV/6kV and 11kV voltage.

NO.2

### One-click Switching of Frequency and Voltage

The variable frequency power supply has the function of fine-tuning the setting of frequency and output voltage and the one-key switching function of output phase sequence, which can greatly improve the flexibility of the system and shorten the access time of shore power.

NO.3

### Reverse Power Processing and Protection

The variable-frequency power supply has reverse power processing and protection functions. When reverse power is detected in the power system during grid-connection and de-linking, the system output voltage is automatically adjusted to eliminate the reverse power; if the power fails, the system issues trip protection.

## 2.1.3
## Transformer and Power Grid Isolation Subsystem

D,yn11 50/60Hz 60Hz

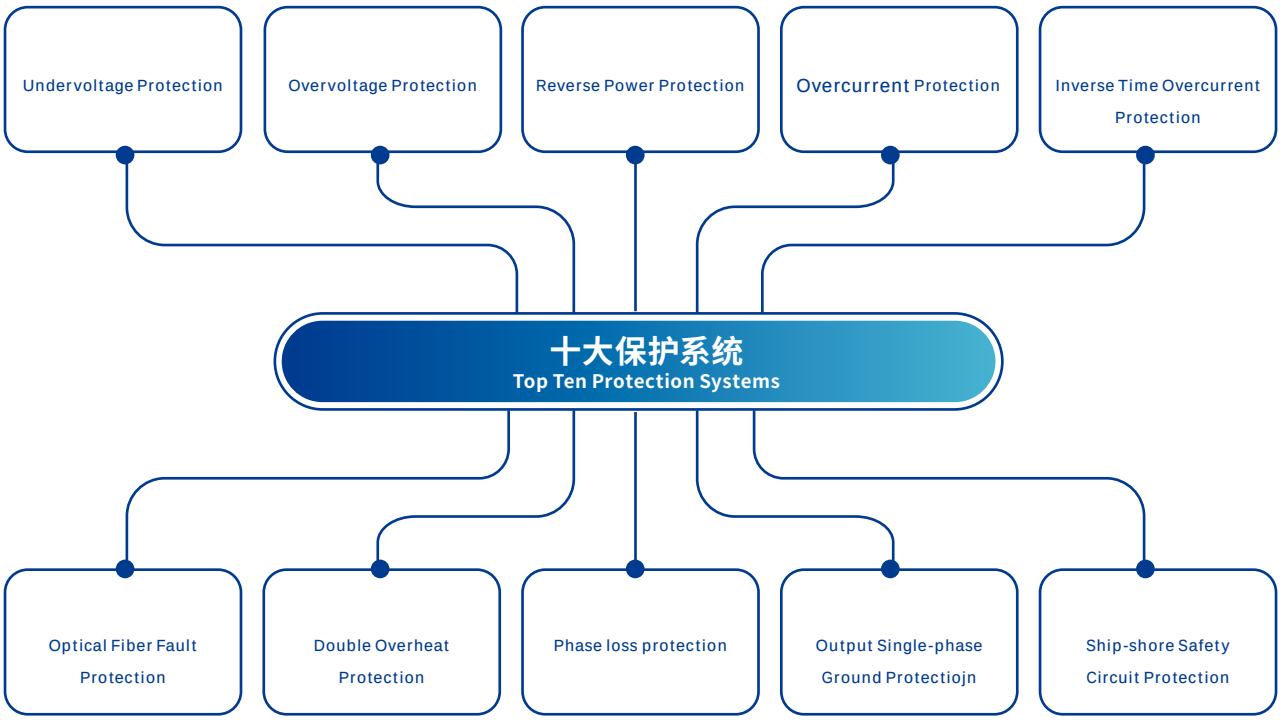
The isolation transformer adopts the D,yn11 connection design, 50/ 60Hz dual-frequency working mode, the rated voltage is set according to the 60Hz electrical system, and the system output voltage switching function at di erent frequencies is achieved by setting the output voltage value of the variable frequency power supply.

## 2.1.4
## Neutral Point Grounding Safely Subsystem

Zhiguang Electric is the drafting unit of domestic neutral grounding equipment industry standard, and is also the main manufacturer of neutral grounding equipment for domestic medium voltage grid. The neutral point of isolation transformer adopts resistance grounding and zero sequence protection in the output switchgear, limiting the fault current when the ship side is grounded during the shore power supply process and providing safety protection for the equipment and personnel on board.

## 2.1.5
## Electrical Integrated Protection Subsystem

The electrical comprehensive protection subsystem is provided with a mechanical lock key for the grounding switch and a key exchange box for the dock socket box socket key to ensure that the dock socket cable plug can only be plugged and unplugged when there is no voltage at the socket and the grounding switch of the output switch cabinet is closed.



## 2.1.6
## Power Quality Optimization Subsystem

3% IEC80005-1

The power quality optimization subsystem uses multi-pulse, phase-shift rectification technology, and the output voltage harmonics are less than 3% when no filtering device is configured, which meets the requirements of the IEC80005-1 standard for shore power system harmonics. For occasions requiring a purer power quality, a filter cabinet can be selected to further reduce system output harmonics.

## 2.1.7
## Data Integrated Monitoring Subsystem

The data comprehensive monitoring subsystem not only monitors each device, but also communicates with the terminal monitoring system, which is convenient for the operator to grasp the operation status of the device. The monitoring system should record the output voltage and current data (including the necessary waveforms) during power supply, so that when the power supply is abnormally interrupted, the state of the fault can be traced back and the cause of the fault can be analyzed.

Shore Power Monitoring System

## 2.1.8

## Temperature Control Subsystem unCasbinb t 5 p Å Ü ;

A large number of power electronic components inside the system are sensitive to the operating temperature, so the ambient temperature of the system operation must be monitored and controlled in real time.Unique and e cient heat dissipation schemes are adopted in multiple design links.

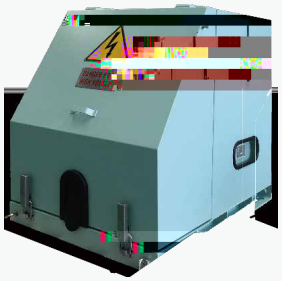
The system adopts a unique double-sided layout design of the power unit body to shorten the air flow, reduce the air resistance, and improve the system's heat dissipation e ect.

Power electronic devices are arranged in parallel and evenly on the surface of the radiator to avoid the problem of short heat dissipation in the series arrangement. According to the di erence in the power conversion, air-cooled or pure water-cooled heat dissipation schemes can be used.

Zhiguang ' s many years of experience in the design and engineering of high-power device cooling can provide heat dissipation design and operation and maintenance programs adapted to the actual needs of di erent on-site working conditions.

## 2.1.9
## Ship-shore Connection Subsystem

Special Dock Socket Box for Cruise

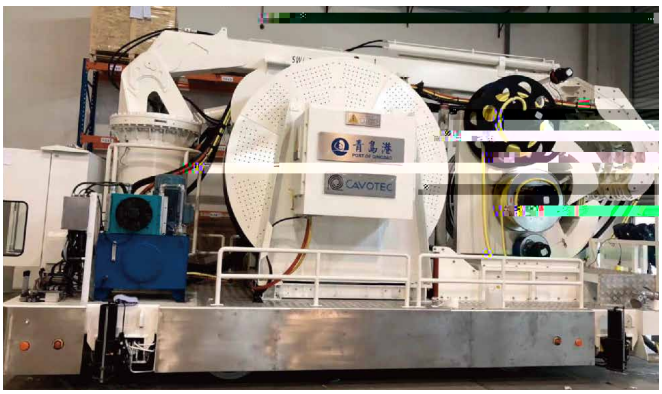


Special Dock Socket Box for Container Ship

-

The ship-shore connection subsystem mainly includes two parts: dock socket box and cable management system (required for some types of ship). The dock socket box is installed at the front of the dock, and the ship-shore electrical circuit is established by plugging in cables to shorten the connection time. The dock socket box maintenance door is provided with a travel switch and an interlock corresponding output switch to provide interlock protection for the maintenance work.

The cable management system that integrates power transmission, intelligent control, safety and reliability and other functions. The hydraulically coupled drive unit drives the cable turntable to realize intelligent cable retraction and ensure that the retraction tension is always lower than the cable's maximum bearing capacity and the safe use of shore power cables. In addition, the cable turntable has a limit action, which outputs an emergency cut-o shore power signal to avoid the live cable being pulled o .




Special Cable Management System for Cruise

## 2.2
## Technical Parameters

| | | |
|---|---|---|
| 输出 output | overload capacity | 110% 60 200<br>Normal operation is possible for 60 minutes at 110% of rated output current based on the rated output current; inverse time limit protection at 200% and above output current. |
| | / Rated voltage/frequency | 6kV/50Hz 6.6kV/60Hz 400V/50Hz 440V/60Hz<br>Switchable with one click |
| | Three-phase voltage unbalance | ≤ 2% |
| | Three-phase current unbalance | ≤ 30% customizable |
| | Load stabilization rate | 6.6kV 0-100% -1 ≤ ≤ 1 -3 ≤ ≤ 3<br>Output voltage 6.6kV, when 0-100% load change<br>Output voltage stabilization rate: -1% ≤ static ≤ 1%, -3% ≤ dynamic ≤ 3%; |
| | Output voltage harmonics (no load) | ≤ 1% filter state |
| | output frequency | 0.01Hz<br>60Hz/50Hz 0-100%<br>≤ 0.1%<br>Accuracy 0.01Hz<br>Output frequency 60Hz/50Hz, when 0-100% load change<br>Output frequency change rate ≤ 0.1% |
| 输入 Input | Phase, Frequency | three-phase 50/60Hz |
| | Allowable frequency fluctuations | -5 +5% |
| | Input Voltage | 10kV -15 +15%<br>Normal operation within -15 to +15% |
| | Input power factor | >0.96 20% overloaded |
| | rectifier circuit | 36 6<br>36 pulse wave (6 levels in series) |
| | Input current harmonics | <3% rated load |
| 控制 Control | System controller | TI DSP<br>TI's motor control special high-speed DSP chip |
| | Control power | AC380V 10kVA<br>AC380V AC power supply is a three-phase power supply with a power of 10kVA |
| | / Input/Output Interface | 16 /16 2<br>2 4 20mA 0 10V<br>16 digital inputs/16 digital outputs<br>2 analog inputs/2 analog outputs (4 20mA or 0 10V signal)<br>The above is the basic configuration, more optional, subject to the technical agreement of the order. |
| | communication interface | RS232 RS485 CAN, Profibus |

## Continued

安全防护 safety protection

外壳防护等级 Enclosure protection class

| | |
|---|---|
| Signal isolation | opto-isolation |
| Control signal transmission | Fiber Optic Transmission, Code Conversion |
| Display, Metering | |
| Running Operations | Panel keys, remote switch command control |
| | Panel setting, remote current analog control |

# 2.3
# Key Technologies for Ship-to-shore Grid Connection

## Reliable Phase Sequence Detection and Rectification Technology

ZG-SPS (STT )

ZG-SPS Intelligent Shore Power System adopts the phase tracking technology of power supply at output end (STT proprietary technology), which can track the status of power supply at output end at any time, and the function of automatic adjustment of phase sequence, which can accept the phase adjustment instruction from the ship to adjust the output phase sequence automatically;
Or analyze the voltage of the ship's power grid by detecting the output end, calculate the phase sequence of the ship's power system, adjust the phase sequence of the shore power according to the phase sequence of the ship's power, and automatically adjust the output phase sequence. One of the phase sequence detection and adjustment programs is selected for implementation during on-site construction.

## Excellent High and Low Voltage Ride-through Technology

85% 115%Un

65% 85%Un

65%Un “ ”

Through the independent redundancy technology of multiple control power supplies and output voltage compensation stabilization technology, the system has excellent high and low voltage ride-through performance.
85% 115%Un: supplying power to ships at full capacity and keeping voltage and frequency stable;
65% 85%Un: automatically derate the power supply to the ship and keep the voltage and frequency stable;
<65%Un: selecting the mode of "maintaining hot operation" or protection trip mode through parameter setting to ensure the safety of the whole system.

## High-precision Control Technology for Voltage and Frequency Regulation

ZG-SPS

0.01Hz

The ZG-SPS detects the output voltage and DC voltage of the unit in real time for closed-loop control of the split-phase voltage to achieve stable control of the output voltage; the power supply frequency is precisely controlled by a high-precision digital quantity with an output frequency accuracy of 0.01Hz.

### Seamless Ship-to-shore Switching Technology

ZG-SPS

ZG-SPS can adapt to the automatic synchronization function in ship-side operating mode and shore-side operating mode to achieve rapid synchronization and seamless power switching between ship-side generators and shore-side power supply.

## 2.4
## System Installation Form

ZG-SPS

The ZG-SPS intelligent high-voltage shore power system is available for both indoor installation and outdoor container installation.

### 2.4.1
### ndoor Installation

The indoor installation is suitable for sites with large spaces. The system is installed in the onshore power supply room or terminal front substation, and there is plenty of space for on-site maintenance and operation, but the equipment can ' t be moved.

### 2.4.2
### Outdoor Container Installation

The outdoor container installation method is suitable for occasions where the site is limited and is not suitable for the construction of permanent power distribution rooms. The system covers a relatively small area.

# 三、典型应用案例
# Typical Application Case

300

Up to now, Zhiguang's self-developed inteligent ship shore power system covers nearly 300 berths in major ports across China  which have been widely used in major domestic ports such as Shandong Port Group, Hebei Port Group, Tianjin Port,, Yingkou Port, Qinhuangdao Port, Xiamen Port, Guangzhou Port, Shenzhen Shekou Port, and Zhanjiang Port. In addition, the normalized supply of electricity by ships is carried out in several ports such as Yingkou Port, Qingdao Port, Qinhuangdao Port, Xiamen Port and Shenzhen Shekou Port.

## 3.1

### Qingdao Cruise Terminal Intelligent High-voltage Shore Power System

3000 3.6

Project highlights Large stand-alone capacity without parallel connections. The shore power project is expected to replace 30 million kilowatt-hours of electricity a year, reduce CO2 emissions by 36,000 tons, and achieve zero emissions for cruise ships docking in Qingdao.

16000kVA/11kV/6.6kV | Project size 16000kVA/11kV/6.6kV

## 3.2

### Liaoning Yingkou Port Intelligent High-voltage Shore Power System

19 2000KVA 3000KVA 4000KVA

50Hz 60Hz

Project highlights Yingkou Port currently has 19 sets of Zhiguang shore power installations with capacities of 2,000KVA, 3,000KVA and 4,000KVA respectively, and all berths can be connected to high voltage shore power. The shore power system can provide two types of power supply, 50Hz and 60Hz, to meet the needs of various ships' power consumption.

2000kVA&3000kVA/6kV | Project size 2000kVA&3000kVA/6kV

## 3.3

### Intelligent High-voltage Shore Power System of Songyu Container Terminal in Xiamen Port

5000kVA 3 20

60Hz/50Hz

Project highlights Installation of one set each of 2000kVA and 3000kVA.The operating vessels connected to this shore power system use a 6kV high-voltage embarkation mode. The ship is equipped with a step-down transformer, the ship's grid voltage is low voltage 400V, and the output power of the ship-side generator is 360kW when connected to the grid.

5000kVA /6.6kV | Project size 5000kVA /6.6kV

## 3.4

### Shenzhen Shekou Container Terminal Intelligent High-voltage Shore Power System

3 5MVA 4MVA 4MVA

\+ +

3#-9#

Project highlights Shenzhen Shekou Container Terminal has three sets of intelligent high-voltage shore power systems, respectively, the first phase of 5MVA intelligent high-voltage shore power system, the second phase of 4MVA, the third phase of 4MVA, all of which are Zhiguang Electric general contracting project. Functionally, the intelligent shore power systems of Phase I, II and III projects realize interconnection and mutual backup mode. These three sets of shore power supply (Phase I+Phase II+Phase III) are capable of supplying power to any one of the shore power socket boxes at berths 3#-9#.

4000kVA/6.6kV | Project size 4000kVA/6.6kV

## 3.5

### Xiamen Haitong Terminal Intelligent High-voltage Shore Power System

2.5MVA+2.5MVA 10kV/50Hz 6kV/50Hz

6.6kV/60Hz 2 2.5MVA 1 5MVA

Project highlights In Haitong terminal configuration and installation of 2.5MVA + 2.5MVA high-voltage inverter shore power system device, 10kV/50Hz industrial power supply into 6kV/50Hz and 6.6kV/60Hz marine power, that is, two sets of 2.5MVA shore power system can be operated separately and independently, or when necessary, parallel operation of the grid into a set of 5MVA shore power system.

5000kVA/6.6kV | Project size 5000kVA/6.6kV

## 3.6

### Hebei Port Group Intelligent Ship Shore Power System

1250kVA 6 10kV/50Hz 6kV/50Hz

6.6kV/60Hz

Project highlights: 6 sets of 1250 kVA intelligent ship-to-shore power systems were installed in Qinhuangdao Port's 2nd, 6th, 7th and 9th companies to convert 10kV/50Hz industrial power supply into 6kV/50Hz and 6.6kV/60Hz marine power supply, which helped Qinhuangdao Port to be awarded as a five-star green port.

1250kVA&1600kVA&2000kVA &3000kVA /6kV
Project Scale: 1250kVA&1600kVA&2000kVA &3000kVA /6kV

# Extensive Practical Experience in Power Supply with Connected Ships

200 10000TEU

According to incomplete statistics, there are currently more than 200 Chinese and foreign ships connected to our shore power supply system. Among them, there are many large container ships above 10000TEU, as well as bulk cargo and ro-ro passenger ships, cruises, details are as follows:

## ZG-SPS

### Various types of ships (parts) successfully connected to ZG-SPS

| 型号 Model | | 型号 Model | |
|---|---|---|---|
| COSCO Shipping France | 13386TEU | COSCO Shenhua Round 801 | |
| COSCO Shipping Netherlands | 13386TEU | | 8000TEU |
| COSCO Constellation Sagittarius | 20000TEU | | 4600TEU |
| COSCO Constellation Grand Virgo | 20000TEU | | 8452TEU |
| Maersk Edinburgh | 13000TEU | | 4636TEU |
| Maersk Ensenada | 13000TEU | 98 | 1868TEU |
| Maersk Gudi | 13000TEU | | 5000TEU |
| Maersk Essen | 13000TEU | | 3300TEU |
| MSC DANIELA | 14000TEU | | 19000TEU |
| Yingkou Port Lilac Passenger Ship | normal power supply with ship | | 3300TEU |

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