智光电气
Zhiguang Electric

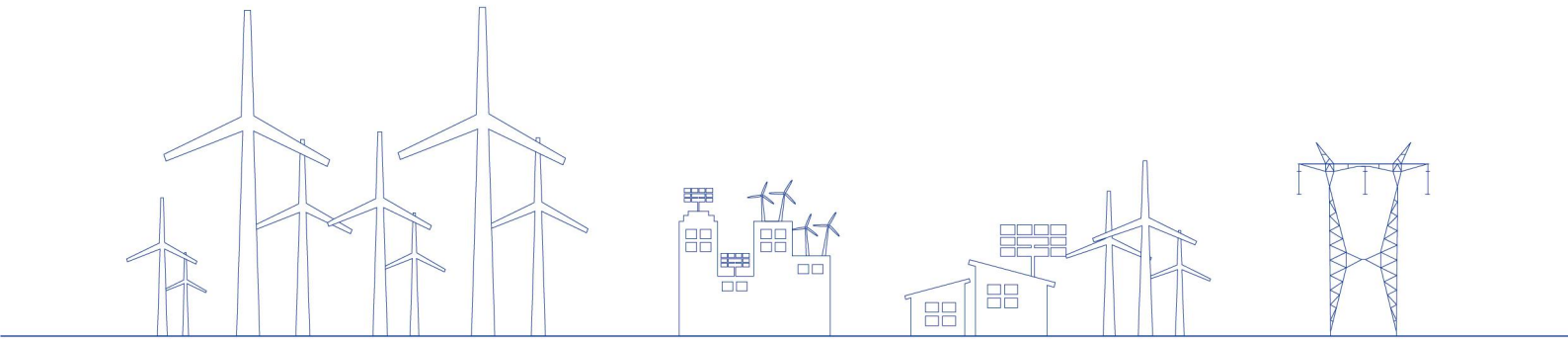

# ZG-SPS智能高压岸电系统

ZG-SPS Intelligent High-voltage Shore Power System

广州智光电气技术有限公司
Guangzhou Zhiguang Electric Technology Co., Ltd.

# 综合能源技术与服务提供商

## Integrated Energy Technology & Service Provider



# 目录
# Contents

# 公司简介
## Company Profile

广州智光电气技术有限公司成立于 2002 年，注册资金 2 亿元，是广州智光电气股份有限公司【股票代码：002169，以下简称智光】的全资子公司，是智光在综合能源技术与服务战略发展方向专业从事柔性电力技术研究的核心成员企业。

公司自成立以来一直专注于以大功率电力电子为核心技术的电气控制装备技术研究，在智能电网、分布式微网、储能、电机控制与节能、电能质量控制、先进电源技术等领域开展技术研究与产业化应用。主营产品包括配网中性点接地装置、高压变频调速装置、储能 PCS 系统、静止无功发生装置（SVG）、智能高压岸电系统、高 / 低压电能治理装置及大型工业智慧型 UPS 等。

公司产品已在全国实现地区性覆盖，并远销至数十个海外国家和地区，为全球节能减排及绿色电能事业做出了贡献。公司以私有云平台、大数据为技术手段，充分发挥“互联网 +”的优势，建立了以重点行业、重点区域、大客户为中心的营销与服务平台，为包括电力、建材、冶金、化工、煤炭、港口、市政、新能源等行业数千个客户提供产品、技术及综合技术解决方案，典型客户包括中国国家电网公司、南方电网、五大发电集团、中广核、中国建材、中石化、中石油及宝武钢铁集团等大型中央企业集团。

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 distribution network neutral point grounding device, high-voltage variable frequency converting system , energy storage PCS, static var generator(SVG), intelligent high-voltage shore power system, high\ low voltage power quality management and large 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 power, building materials, metallurgy, chemical, coal, port, municipal, and new energy industries. Typical customers include State Grid Corporation of China, China Southern Power Grid, Five Major Power Generation Groups, China General Nuclear Power Corporation, China National Building Materials Group Corporation, Sinopec, PetroChina and Baowu Iron and Steel Group.

# 二、产品介绍

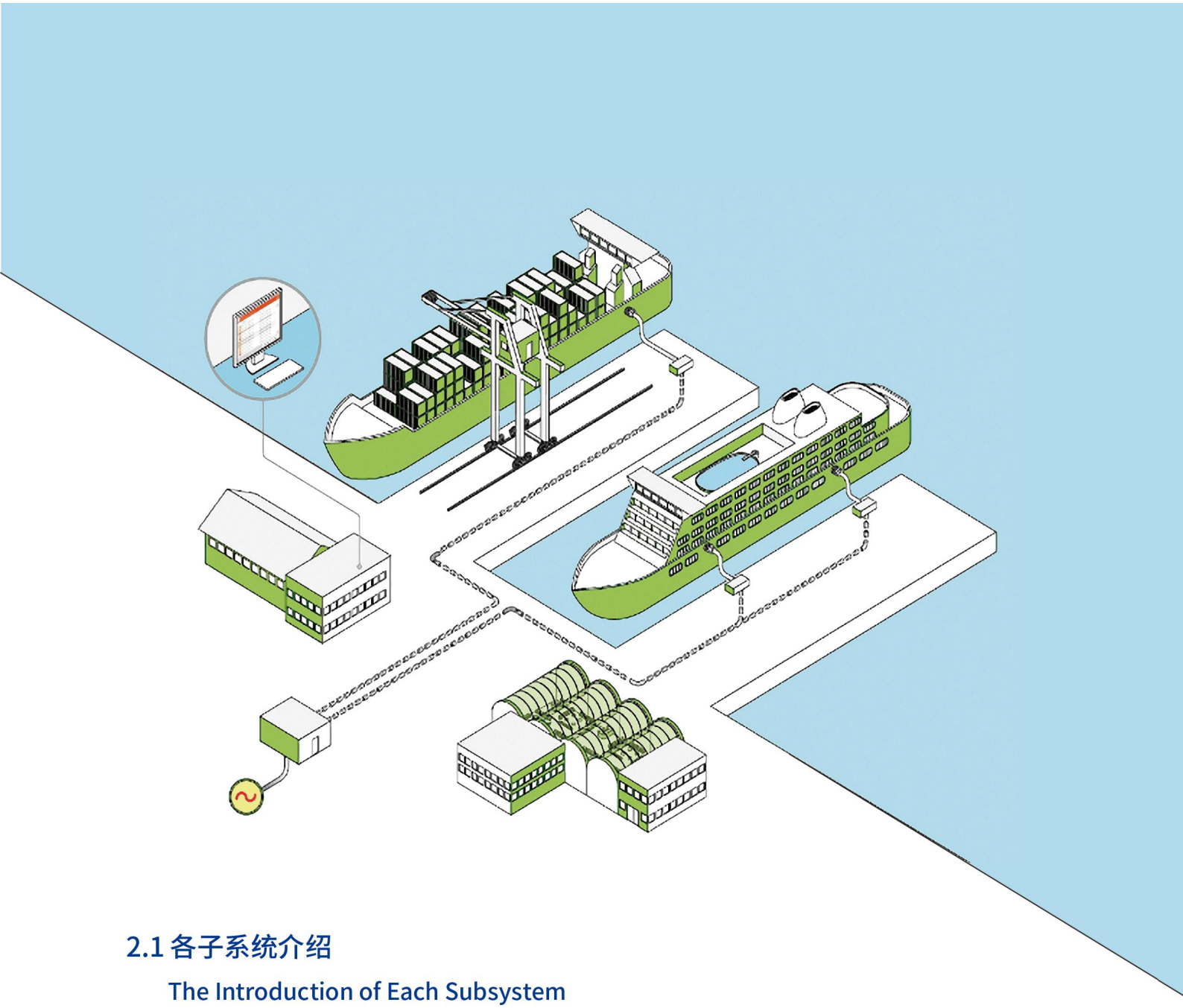
## Product Introduction

# ZG-SPS 智能高压岸电系统介绍

## Introduction of ZG-SPS Intelligent High-voltage Shore Power System

ZG-SPS智能高压岸电系统由高低压配电子系统、变频稳压子系统、变压及电网隔离子系统、中性点安全接地子系统、电能质量优化子系统、电气综合保护子系统、数据综合监控子系统、系统温度控制子系统、船岸连接子系统等9个子系统组成，集成了智光电气在高压变频领域、电气保护领域、配电网中性点接地领域、电力电子系统工程温度控制领域和自动化监控领域10多年的研究成果。系统继承了智光电气20多年来的模块化产品设计理念，通过搭配灵活多样的模块化子系统，可输出多种电压和频率制式的变频电源。

ZG-SPS intelligent high-voltage shore power system 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. It integrates Zhiguang for over 10 years' research achievements in the field of high-voltage variable frequency, electrical protection, distribution network neutral point earthing, power electronic system engineering temperature control and automation monitoring. By combining with flexible and diverse modular subsystems, it can output various voltage and frequency.



## 2.1 各子系统介绍

### The Introduction of Each Subsystem

#### 高低压配电子系统

#### High and Low Voltage Power Distribution Subsystem

系统输入侧配电系统根据常规配电设备规范要求设计，输出侧配电系统根据岸电设备规范要求设计。两套配电子系统均可设置监控、计量、通信相关的设备和接口，便于对供电情况和设备运行情况进行监控和计量。

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.

## 变频稳压子系统
## Variable Frequency Voltage Regulator Subsystem

变频稳压子系统的核心设备是高压变频电源，其功能特点如下:

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

### 无滤波装置谐波小
### Low Harmonics without Filter Device

采用多脉波、移相整流技术，输出电压谐波低于1%；采用多电平移相叠加变压变频技术，可直接输出接近正弦波的6.6kV和11kV电压。

Using multi-pulse, phase-shifting rectification technology, the output voltage harmonic is less than 1%. The multi-level transformer and frequency conversion technology realized by phase shift can directly output 6.6kV and 11kV voltages close to a sine wave.

### 多脉波整流技术
### Multi-pulse Rectification Technology

智能高压岸电系统采用多脉波整流技术，电网侧谐波污染小，20%负载以上工况下，输入功率因数＞0.97，无需功率因数补偿及谐波抑制装置，即可满足国家标准。

Intelligent high-voltage shore power system adopts multi-pulse rectification technology, which generates less harmonic pollution to the grid side. Under working conditions above 20% load, input power factor > 0.97. It can meet national standards without power factor compensation and harmonic suppression device.

### 频率电压一键切换
### One-click Switching of Frequency and Voltage

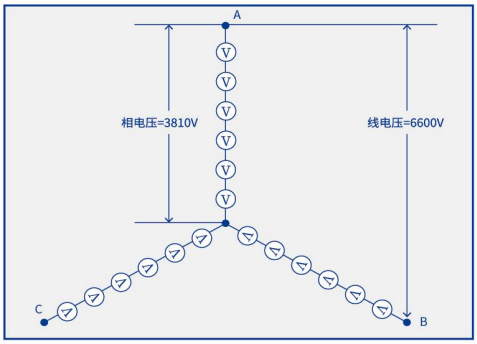
高压变频电源具备频率、输出电压微调设置功能和输出相序一键切换功能，可以大大提高系统灵活性，缩短岸电接入时间。

The high-voltage 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.

### 逆功率处理与保护
### Reverse Power Processing and Protection

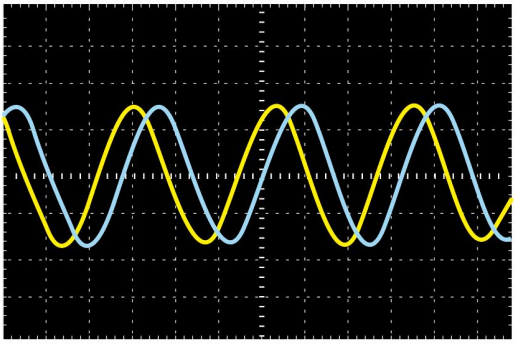
高压变频电源具备逆功率处理与保护功能，当并网和解列过程中，电源系统检测到发生逆功率时，自动调整系统输出电压，消除逆功率；如消除失败，系统发出跳闸保护。

The high-voltage 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.




电压叠加形成高压输出原理结构

Voltage Superimposed to Form a High-voltage Output Principle Structure



六级串联系统输出波形

Six-stage Series System Output Waveform

## 变压及电网隔离子系统
## Transformer and Power Grid Isolation Subsystem

隔离变压器采用Dy11接法的设计，50/60Hz双频工作模式，额定电压按照60Hz电制设置，通过设置变频电源输出电压值实现不同频率下系统输出电压切换功能。

The isolation transformer adopts the Dy11 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 different frequencies is achieved by setting the output voltage value of the variable frequency power supply.

## 数据综合监控子系统
## Data Integrated Monitoring Subsystem

数据综合监控子系统不仅监控各设备，也与码头监控系统通信，便于操作人员掌握设备运行情况。监控系统应记录供电期间输出电压、电流数据（含必要波形），便于供电发生异常中断时，追溯故障发生时的状态，分析故障原因。

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.


岸电系统监测
Shore Power Monitoring System

## 中性点安全接地子系统
## Neutral Point Grounding Safely Subsystem

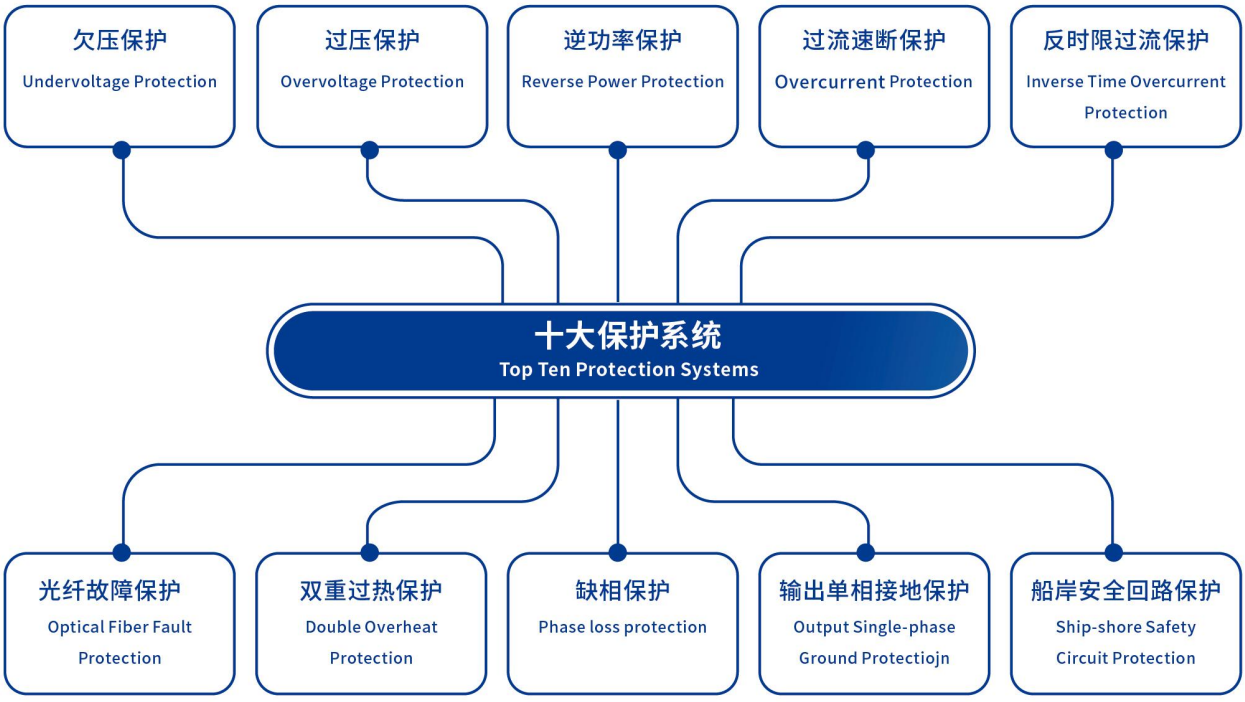
隔离变压器中性点采用电阻接地，并通过中性线与船壳连接，限制岸电供电过程中船侧接地时的故障电流，为船上设备和人员提供安全保护。

The neutral point of the isolation transformer adopts resistance grounding and is connected to the ship's hull through the neutral line to limit the fault current when the ship side is grounded during the shore power supply process and provide safety protection for the equipment and personnel on board.

## 电气综合保护子系统
## Electrical Integrated Protection Subsystem

电气综合保护子系统设置接地开关机械锁钥匙与码头插座箱插座钥匙交换盒，确保在插座无电压，输出开关柜接地刀闸合闸状态下才能插拔码头插座电缆插头。

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.



## 系统温度控制子系统
## Temperature Control Subsystem

系统内部大量的电力电子元件对工作温度比较敏感，因此必须对系统运行的环境温度进行实时监测和控制。在多重设计环节均采用独特高效的散热方案。

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 efficient heat dissipation schemes are adopted in multiple design links.

### 变频电源柜体冷却设计
### Cooling Design of Variable Frequency Power Cabinet

系统采用独特的功率单元体双侧布置设计方案，缩短空气流程、降低空气阻力，提升系统散热效果。

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 effect.

### 功率单元冷却设计
### Cooling Design of Power Unit

电力电子器件并列均匀布置在散热器表面，避免串联布置方案存在的散热短板问题，根据变换功率大小的差异，可以采用空冷型、纯水冷却型散热方案。

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 difference in the power conversion, air-cooled or pure water-cooled heat dissipation schemes can be used.

### 设备外部环境制冷系统设计
### Cooling Design of the Equipment External Environment

智光多年的变频器室制冷设计工程经验，可为不同的现场工况提供适应实际需求的散热设计和运行维护方案。

Zhiguang has many years of experience in the refrigeration design engineering of the inverter room, which can provide heat dissipation design and operation and maintenance solutions that meet the actual needs for different field conditions.

## 船岸连接子系统
## Ship-shore Connection Subsystem

船岸连接子系统主要包括码头插座箱和电缆管理系统（部分船型需要）两部分。码头插座箱安装在码头前沿，通过插接电缆方式建立船-岸电气回路，缩短接驳时间。码头插座箱检修门设置行程开关，联锁对应输出开关，为检修工作提供联锁保护。

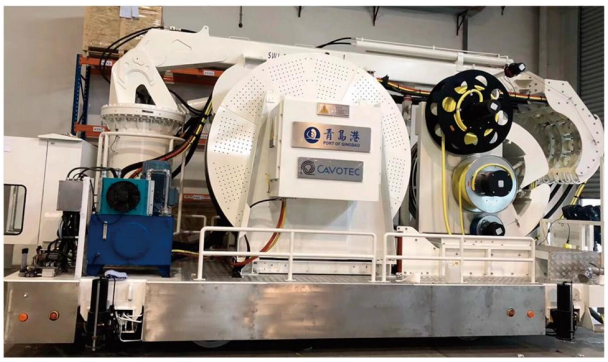
集电力传输、智能控制、安全可靠于一体，由液力耦合驱动单元驱动电缆转盘，实现电缆智能收放，保证收放拉力始终低于电缆最大承受力，保证岸电电缆使用安全；另外电缆转盘带限位动作，输出紧急切断岸电信号，避免电缆带电被拉断。

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-off shore power signal to avoid the live cable being pulled off.

邮轮专用码头插座箱
Special Dock Socket Box for Cruise

集装箱船专用码头插座箱
Special Dock Socket Box for Container Ship



邮轮专用电缆管理系统
Special Cable Management System for Cruise

# 2.2 功能特点
# Features

## 电能质量优异
## Excellent Power Quality

| | |
|---|---|
| 输出电压谐波 < 1%<br>Output voltage harmonics < 1% | 负载稳压率 < 1%<br>Load regulation < 1% |
| 三相输出电压不平衡度 < 2%<br>Three-phase output voltage imbalance < 2% | 输出频率分辨率 0.01Hz<br>Output frequency resolution 0.01Hz |
| 输入电流谐波 < 3%<br>Input current harmonics < 3% | 输入功率因数 > 97%<br>Input power factor > 97% |

## 系统稳定
## System Stability

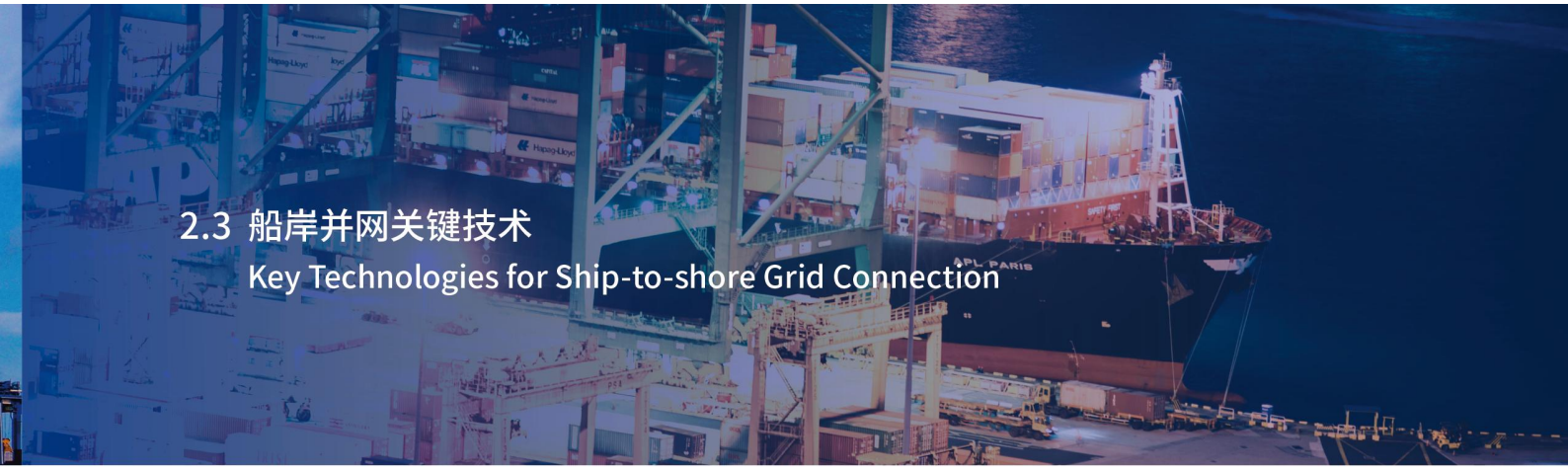
智光多年在岸基电源研究和技术积累，已为全国多个港口提供优质的岸电产品与服务。每套产品出厂须进行严格的性能试验，保证设备在各种环境的稳定性和一致性。

After years of research and technical accumulation in shore-based power supply, Zhiguang has provided high-quality shore power products and services for many ports in China. Each set of products must undergo strict performance tests to ensure its stability and consistency in various environments.

## 维护便利性
## Maintenance Convenience

主设备采用先进的模块化结构设计，若模块出现故障，会自动显示故障模块的名称并切除故障单元，检修时便于快速更换，减少维修时间，从而把电源故障对客户产生的影响程度降低到最小。

The main equipment adopts advanced modular structure design, if the module is faulty, it will automatically display the name of the faulty module and cut out it, which is easy to replace and reduces maintenance time, thus reducing the impact of power failure on customers to a minimum.



# 2.3 船岸并网关键技术
# Key Technologies for Ship-to-shore Grid Connection

## 可靠的相序检测与整定技术
## Reliable Phase Sequence Detection and Rectification Technology

ZG-SPS智能高压岸电系统默认输出为正序，具备手动调整和自动检测调整输出电压相序的功能。

The default output of ZG-SPS is positive sequence. The system is capable of manually adjusting or automatically detecting and adjusting the output voltage phase sequence.

## 低电压穿越技术
## Low-voltage Ride-through Technology

ZG-SPS智能高压岸电系统在岸上电网电压突降时具备低电压穿越能力，保证供电期间船上设备不受岸侧电网电压暂降的威胁，最大限度地兼顾供电连续性和设备安全性。

The ZG-SPS is capable of low-voltage ride-through capability in case of sudden voltage drop in the on-shore power grid, ensuring that the ship' s equipment is not affected by the transient voltage drop in the shore-side power grid during the power supply period and maximizing both power supply continuity and equipment safety.

## 高精度稳压稳频控制技术
## High-precision Control Technology for Voltage and Frequency Regulation

ZG-SPS智能高压岸电系统实时检测输出电压和单元直流电压进行分相电压闭环控制，实现输出电压的稳定控制；电源频率由高精度数字量精确控制，输出频率精度达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.

## 船岸无缝切换技术
## Seamless Ship-to-shore Switching Technology

ZG-SPS智能高压岸电系统可适应船侧工作模式和岸侧工作模式下自动同步功能，实现船侧发电机和岸电供电的快速同步和电源无缝切换。

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 系统安装方式
## System Installation Form

ZG-SPS智能高压岸电系统有室内安装和室外集装箱安装两种方式可供用户选择。

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

### 室内安装
### Indoor Installation

室内安装方式适合空间较大的现场，系统装在专用岸电电源室或者码头前沿变电所内，室内有充足的空间，现场维护操作空间大，散热条件较好。

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.

### 室外集装箱安装
### Outdoor Container Installation

室外集装箱安装方式，适用于场地有限、不适合建设永久配电房的场合，系统占地面积相对较小。

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

截止至2019年12月，智光共累计生产智能高压岸电系统70余套，已广泛应用于天津港、青岛港、营口港、厦门港、广州港、深圳蛇口港、湛江港等国内主要大型港口，并在营口港、青岛港、厦门港、深圳蛇口港等多个港口进行常态化连船供电。

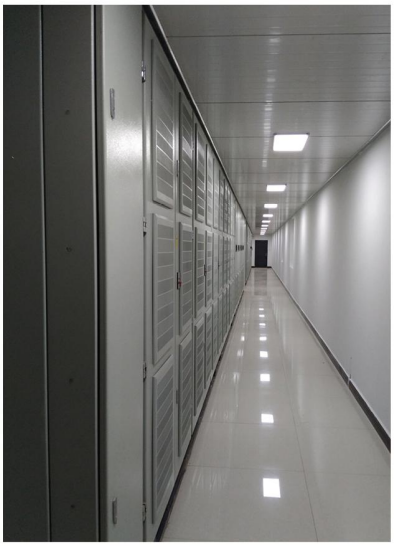
As of Dec. 2019, Zhiguang has produced a total of more than 70 sets of intelligent high-voltage shore power system，which have been widely used in major domestic ports such as Tianjin Port, Qingdao Port, Yingkou Port, Xiamen Port, Guangzhou Port, Shenzhen Shekou Port, and Zhanjiang Port. In addition, the normalized supply of electricity by ships is carried out in several ports such as Yingkou Port, Qingdao Port, Xiamen Port and Shenzhen Shekou Port.

# 3.1 青岛邮轮母港 16000kVA/11kV 智能高压岸电系统

## Qingdao Cruise Terminal 16000kVA/11kV Intelligent High-voltage Shore Power System

2015年,青岛邮轮母港项目使用一套16000kVA/11kV智能高压岸电系统，该岸电项目单机容量大、无需并联。该岸电项目预计一年可实现替代电量3000万千瓦时，减排二氧化碳3.6万吨，在青岛停靠邮轮可实现在港零排放。

In 2015, the Qingdao Cruise Terminal project used a 16,000kVA/11kV intelligent high-voltage shore power system, which has a large stand-alone capacity without parallel connections. The shore power project is expected to replace 30 million kilowatt-hours of electricity a year, reduce $CO_2$ emissions by 36,000 tons, and achieve zero emissions for cruise ships docking in Qingdao.



# 3.2 辽宁营口港 2000kVA /3000kVA 智能高压岸电系统

## Liaoning Yingkou Port 2000kVA / 3000kVA Intelligent High-voltage Shore Power System

2016年，辽宁营口港分别安装了一套2000kVA和一套3000kVA容量的智能高压岸电系统，连接该岸电系统的运营船舶采用6kV高压上船模式，在船上配有降压变压器，船上电网电压为低压400V，并网时船侧发电机输出功率360kW。

In 2016, a 2,000 kVA and a 3,000 kVA capacity intelligent high-voltage shore power system were installed at Liaoning Yingkou Port. 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.




# 3.3 青岛港前湾港区 103 泊位 5000kVA 智能高压岸电系统

## Qingdao Qianwan Port Area 103 Berth 5000kVA Intelligent High-voltage Shore Power System

2017年，由智光研发的国内容量最大的智能高压岸电系统在青岛港口一次性连船成功。该项目的岸电系统输出容量5000kVA，频率60Hz，采用模块化产品设计理念。该项目是国内第一套完整地融合电源变换技术、中性点接地及保护技术、电缆实时监控及控制技术等技术的智能高压岸电系统。

In 2017, the intelligent high-voltage shore power system with the largest capacity in China, developed by Zhiguang, was successfully connected to a ship at Qingdao port at one time. This shore power system has an output capacity of 5000 kVA at 60Hz and adopts a modular product design concept.This is the first intelligent high-voltage shore power system in China that integrates power conversion technology, neutral grounding and protection technology, real-time cable monitoring and control technology.

# 3.4 厦门港嵩屿集装箱码头 5000kVA 智能高压岸电系统

## 5000kVA Intelligent High-voltage Shore Power System of Songyu Container Terminal in Xiamen Port

2017 年，厦门嵩屿项目使用一套 5000kWA 智能高压岸电系统，使用 6.6kV 高压变频方案。码头两套船舶岸电额定容量均为 5000KVA，供 3 个泊位使用，满足两艘 20 万吨级的船舶同时靠泊时使用岸电。岸电系统输出可工作在 60Hz 和 50Hz 两种模式，满足各种船舶用电要求，同时具备完善的保护功能，可限制船侧发生接地时的故障电流，保护船上人员和设备安全。

In 2017, the design capacity of the intelligent high-voltage shore power system of the Xiamen Songyu Project was 5000kW, using a 6.6kV high-voltage voltage conversion scheme. The rated capacity of the shore power of the two sets of ships at the terminal is 5000KVA, which is used by three berths. It can meet the requirement of two 200,000-ton ships to berth and use shore power at the same time. The system output can work in two modes, 60Hz and 50Hz, to meet various ship power requirements, and has complete protection functions, which can limit the fault current when the ship side is grounded and protect the safety of personnel and equipment on board.



# 3.5 深圳蛇口集装箱码头 4000kVA 智能高压岸电系统

## Shenzhen Shekou Container Terminal 4000kVA Intelligent High-voltage Shore Power System

2019年，深圳蛇口集装箱码头使用一套4000kVA智能高压岸电系统，采用6.6kV级高压船舶港口岸电系统，可根据船舶电网参数，调整供电频率和供电电压，设置系统输出电压和频率，使岸基电源与船舶发电机实现无冲击并网和负荷转移。

In 2019, a set of 4,000kVA intelligent high-voltage shore power system adopted by Shenzhen Shekou Container Terminal uses a 6.6kV high-voltage ship port shore power system, which can adjust the power supply frequency and supply voltage and set the system output voltage and frequency according to the ship's power grid parameters, so that the shore-based power supply and the ship's generator can achieve non-impact grid connection and load transfer.


# 四、丰富的连船供电实践经验

# Extensive Practical Experience in Power Supply with Connected Ships

据不完全统计，目前与我司岸电电源系统成功连接的中外船舶超过40余艘，其中有多艘10000TEU以上的大型集装箱船，还有散货、客滚船等，具体信息如下:

According to incomplete statistics, there are currently more than 40 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, details are as follows:

## 成功连接智光高压变频岸电的各型轮船（部分）

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

| | |
|---|---|
| 中远海运法国号（13386TEU） | COSCO Shipping France (13386TEU) |
| 中远海运荷兰号（13386TEU） | COSCO Shipping Netherlands (13386TEU) |
| 中远星座级人马座号（20000TEU） | COSCO Constellation Sagittarius (20000TEU) |
| 中远星座级室女座号（20000TEU） | COSCO Constellation Grand Virgo (20000TEU) |
| 马士基爱丁堡号（13000TEU） | Maersk Edinburgh (13000TEU) |
| 马士基恩塞纳达号（13000TEU） | Maersk Ensenada (13000TEU) |
| 古帝马士基号（13000TEU） | Maersk Gudi (13000TEU) |
| 马士基埃森号（13000TEU） | Maersk Essen (13000TEU) |
| 地中海MSC DANIELA（14000TEU） | Mediterranean MSC DANIELA (14000TEU) |
| 营口港紫丁香号客箱船 （常态连船供电） | Yingkou Port Lilac Passenger Ship (normal power supply with ship) |
| 中远神华801轮 | COSCO Shenhua Round 801 |

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24h Service：**400-8800-233**

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