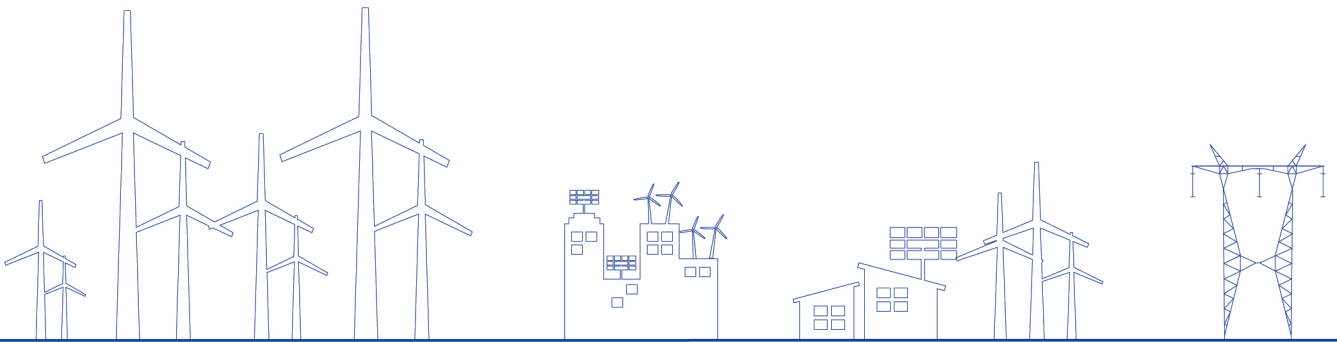




# ZG-dSVG动态无功 补偿装置产品手册

ZG-dSVG Dynamic Reactive Power  
Compensation Device Product manual

综合能源技术与服务提供商  
Integrated Energy Technology & Service Provider



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## 一、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）、港口岸电系统、低压电能治理及大型工业智慧型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), shore power system, 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.

# 总述

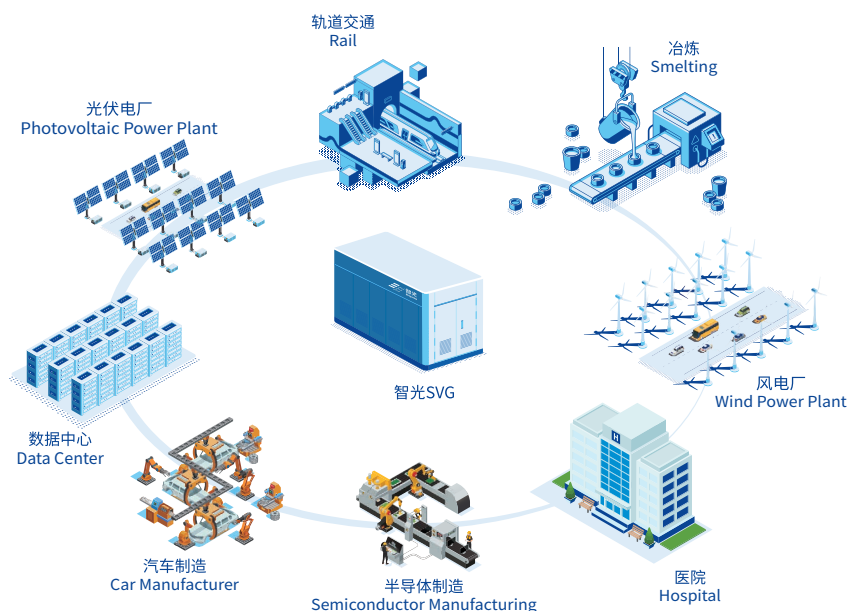
## Overview

随着国家能源产业的强势发展和各种电力新政的不断推进，以火力发电为主，各种新能源分布式发电为辅的多种电源并存的新格局已逐渐形成，并且在微网、储能等各种新应用技术发展的影响下，对电能质量比较敏感的行业，如冶金、汽车制造、风力发电、轨道交通、数据中心、半导体生产等，电能质量问题越来越受到重视。

智光电气ZG-dSVG静止无功发生装置，作为智光综合能源大服务——高低压电能质量综合治理解决方案的重要一环，以其优异的产品性能，成熟的应用解决方案，在工业及新能源等领域的无功、电压治理上发挥十分重要的作用。基于智光电气0.4kV~500kV全系列电压等级的高低压产品和技术解决方案，ZG-dSVG静止无功发生装置，可与ZG-TBB高压无功补偿装置、ZG-APF/SVG/LSC各类低压电能质量治理产品灵活搭配，结合智光工业互联网云平台，定制符合现场工况的整体解决方案，实现用户在电能质量综合治理的最大收益。

With the strong development of the national energy industry and the continuous advancement of various power new policies, a new pattern of coexistence of multiple power sources, which is dominated by thermal power generation and supplemented by various new energy distributed generations, has gradually taken shape. And under the influence of the development of various new application technologies such as microgrid and energy storage, industries that are sensitive to power quality, such as metallurgy, automobile manufacturing, wind power generation, rail transit, data center, semiconductor production, which is being paid more and more attention.

Zhiguang Electric ZG-dSVG static reactive power generation device, as an important part of Zhiguang Integrated Energy Service - high and low voltage power quality comprehensive treatment solution, with its excellent product performance, mature application solutions, in the fields of industry and new energy the reactive power and voltage management play a very important role. Based on Zhiguang Electric's high and low voltage products and technical solutions from 0.4kV to 500kV, ZG-dSVG static reactive power generation device can be combined and used flexibly with ZG-TBB high voltage reactive power compensation device and ZG-APF/SVG/LSC low voltage or other power quality management products. Combined with Zhiguang Industrial Internet Cloud Platform, we can customize the overall solution to meet the on-site working conditions, and realize the maximum benefit of users in comprehensive management of power quality.





## 二、ZG-dSVG 简介

### Introduction of ZG-dSVG

### 2.1 简介

#### Introduction

智光电气多年来专注于大功率电力电子产品和自动化产品的研发和应用，具备深厚的技术积淀和经验积累，通过与清华大学、浙江大学的合作，成功研制出高性价比的新一代高压动态静止无功发生装置ZG-dSVG，并已具备多年的运行经验。

智光电气静止无功发生装置ZG-dSVG作为最新一代的无功补偿产品，得到了行业用户的高度认可。ZG-dSVG对比第一代无功补偿产品TBB，第二代无功补偿产品SVC，在补偿效果、功率密度和运行效率等技术指标上具有传统无功补偿设备无法比拟的优势，是目前电能质量综合治理的最佳解决方案。这种新型装置可用于变电站、新能源发电、电气化铁路、冶金、矿山、水泥、化工、港口等领域，并有效提高电网电压暂态稳定性、抑制母线电压闪变、补偿不平衡电流、滤除谐波及提高功率因数。

For many years, Zhiguang Electric has focused on the development and application of high-power power electronic products and automation products. It has deep technical and experiences accumulation. Through cooperation with Tsinghua University and Zhejiang University, it has successfully developed a new and cost-effective generation of high-voltage dynamic static . The power generation device ZG-dSVG has many years of operating experience.

As the latest generation of reactive power compensation products, Zhiguang Electric Static Reactive Generator ZG-dSVG has been highly recognized by users in the industry.ZG-dSVG compares the first generation reactive power compensation product TBB, and the second generation reactive power compensation product SVC has the advantages that traditional reactive power compensation equipment can't match in terms of compensation effect, power density and operating efficiency, which is the best solution for the comprehensive management of power quality.This new type of device can be used in substation, new energy power generation, electrified railway, metallurgy, mining, cement, chemical, port and other fields, and effectively improve grid voltage transient stability, suppress bus voltage flicker, compensate unbalanced current, and filter out harmonics and improve power factor.



## 2.2 原理与构成

### Principle and Composition

ZG-dSVG高压动态无功补偿装置，选用全控型器件IGBT作为核心元件，基于瞬时无功理论，集电力电子技术、微机控制技术、光电触发技术于一体，是目前最先进的高压动态无功补偿装置。

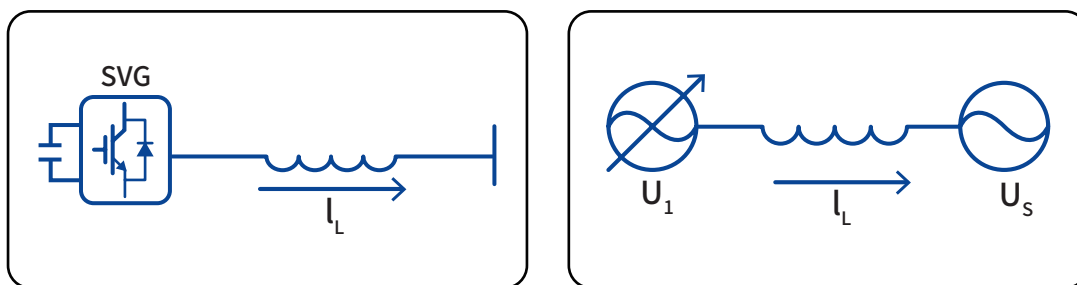
ZG-dSVG high-voltage dynamic reactive power compensation device selects full-control device IGBT as the core component. Based on instantaneous reactive power theory, it integrates power electronics technology, microcomputer control technology and photoelectric trigger technology. It is the most advanced high-voltage dynamic reactive power compensation device.

#### 2.2.1 原理

##### Principle

ZG-dSVG采用自换相桥式电路经电抗器或变压器并联在电网上，通过调节自换相桥式电路输出电压的幅值及相位，控制装置注入电网的电流，从而控制该电路吸收或发出无功功率，实现动态无功补偿。

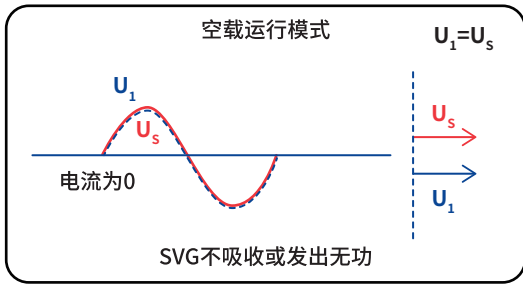
ZG-dSVG uses a self-commutated bridge circuit connected to the grid via a reactor or a transformer. By adjusting the amplitude and phase of the output voltage of the self-commutated bridge circuit, the current injected into the grid is controlled by the device. Thereby controlling the circuit to absorb or emit reactive power to achieve dynamic reactive power compensation.



SVG 原理图

SVG Principle





空载运行模式

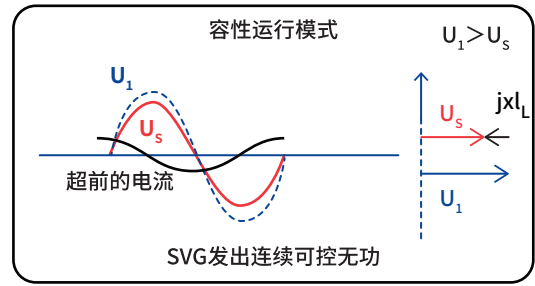
No-load operation mode

电流为0

the current is 0

SVG不吸收或发出无功

SVG not absorb or emit reactive power



容性运行模式

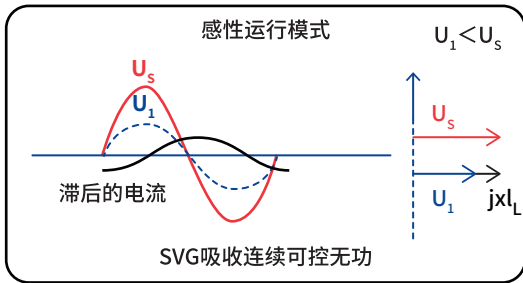
Capacitive operation mode

超前的电流

Leading current

SVG发出连续可控无功

SVG emits continuous controllable reactive power



感性运行模式

Inductive mode

滞后的电流

Lagging current

SVG吸收连续可控无功

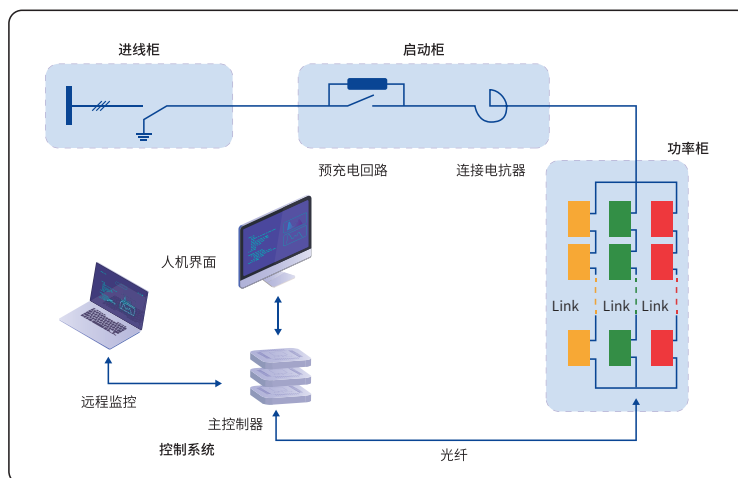
SVG absorbs continuously controllable reactive power

## 2.2.2 构成

### Composition

智光ZG-dSVG高压动态无功补偿装置的主回路采用功率单元级联链式结构。ZG-dSVG按照柜体组成分为：进线柜、启动柜、功率柜及全数字化控制柜。

The main circuit of ZG-dSVG high-voltage dynamic reactive power compensation device adopts power unit cascade chain structure. ZG-dSVG is divided into line counter, starter cabinet, power cabinet and fully digital control cabinet.



进线柜 Line Counter

启动柜 Starter Cabinet

控制系统 Control System

预充电回路 Pre-charging Circuit

人机界面 HMI

连接电抗器 Connecting reactor

远程监控 Remote Monitoring

功率柜 Power Cabinet

主控制器 Main Controller

光纤 Optical Fiber

链节 Link

### (1) 主回路

#### Main Circuit

ZG-dSVG主回路包括进线柜、启动柜和功率柜。进线柜内装有隔离开关K、真空接触器J（断路器QF）、预充电限流电阻R，启动柜内装有连接电抗器L，功率柜内装有换流链（Link），换流链（Link）通过完全相同的功率单元体（Cell）级联而成，功率单元体（Cell）内包含直流支撑电容Cd和IGBT构成的换流电路。

The ZG-dSVG main circuit includes an incoming line cabinet, a starter cabinet and a power cabinet. The inlet cabinet is equipped with an isolating switch K, a vacuum contactor J (circuit breaker QF), and a pre-charge current limiting resistor R. The starting cabinet is equipped with a connecting reactor L. The power cabinet is equipped with a converter chain (Link) and a commutation chain (Link) is formed by cascading identical power units (Cells), and the power unit body (Cell) includes a commutation circuit composed of a DC supporting capacitor Cd and an IGBT.

## A. 预充电限流电阻 R

### Precharge Current Limiting Resistor R

预充电限流电阻R能有效限制装置启动前的预充电电流，保护IGBT和直流支撑电容不会损坏。该电阻具有极大的热容量，可在短时间内反复承受冲击电流。

The pre-charge current limiting resistor R can effectively limit the pre-charging current before the device is started, and protect the IGBT and the DC supporting capacitor from damage. The resistor has an extremely large heat capacity and can withstand repeated inrush currents in a short period of time.

## B. 连接电抗器 L

### Connecting Reactor L

换流链 (Link) 通过连接电抗器L接入电网，该电抗器将换流链 (Link) 的输出电压转化为电流注入电网，同时平滑换流链 (Link) 产生的纹波。该电抗器采用优质材料和低磁密设计，具有高线性度、低损耗和抗谐波的特点。

The commutation chain (Link) is connected to the grid by connecting a reactor L, which converts the output voltage of the converter chain into a current injected into the grid, and smoothes the ripple generated by the commutation chain (Link). The reactor is made of high-quality materials and low magnetic density, featuring high linearity, low loss and harmonic immunity.

## C. 换流链 (Link)

### Converter Chain (Link)

单台功率单元体 (Cell) 将直流电压转化为交流电压，由功率单元体 (Cell) 级联而成的换流链 (Link) 输出多电平高电压。

根据装置接入电网的电压等级不同，换流链 (Link) 级联的功率单元体 (Cell) 数量不同，如10kV系统每相10~12个功率单元体 (Cell)；6kV系统每相6~8个功率单元体 (Cell)。

A single power unit (Cell) converts a DC voltage into an AC voltage, and a commutation chain (Link) that is cascaded by a power unit (Cell) outputs a multi-level high voltage.

Depending on the voltage level at which the device is connected to the grid, the number of power units (Cells) cascaded in the converter chain is different, such as 10 to 12 power units per phase for a 10 kV system; 6 to 8 power units per phase for a 6 kV system.

## (2) 控制系统

### Control System

ZG-dSVG控制系统包括主控制器、功率单元驱动板、辅助控制电路、人机界面及后台监控系统。控制系统中采用的核心元器件,如数字处理器DSP、现场可编程逻辑门阵列FPGA、光纤头、IGBT驱动模块等均为国外原装进口,可靠性已在长期应用中得到了检验。

The ZG-dSVG control system includes a main controller, a power unit driver board, an auxiliary control circuit, a human machine interface, and a background monitoring system. The core components used in the control system are all imported from abroad, such as digital processor DSP, field programmable logic gate array FPGA, fiber optic head, IGBT driver module, etc. , and the reliability has been tested in long-term applications.

#### A. 主控制器

##### Main Controller

主控制器由各个功能板卡组成,完成交流信号采集、开关量控制、PWM脉冲分配、状态检测和系统保护等工作。

The main controller is composed of various function boards, which complete AC signal acquisition, switch quantity control, PWM pulse distribution, status detection and system protection.

#### B. 功率单元驱动板

##### Power Unit Driver Board

功率单元驱动板安装在功率单元内,通过光纤与主控制器相连,将控制信号转化为IGBT的驱动信号,同时反馈功率单元的状态。

The power unit driver board is installed in the power unit, and is connected to the main controller through the optical fiber to convert the control signal into the driving signal of the IGBT, and simultaneously feed back the state of the power unit.

#### C. 人机界面

##### HMI

ZG-dSVG采用液晶触摸屏,具有完备的数据显示(表格、曲线、棒图)、信息存储和历史数据查询功能;友好的界面设计保证运行人员可以安全、便捷地操作设备。

ZG-dSVG adopts LCD touch screen, with complete data display (table, curve, bar graph), information storage and historical data query function; friendly interface design ensures that operators can operate the device safely and conveniently.



## 2.3 技术特点

Technical Characteristics



### 五大技术特点

Five Technical Characteristics

## 1 功能强大 Powerful Functions

### A. 控制目标多样 Diverse Control Objectives

ZG-dSVG具备多种工作模式: 恒定无功电流、恒定无功功率、恒定母线电压、恒定功率因数, 每一种模式均可以按照用户要求进行设置和整定。

ZG-dSVG has a variety of operating modes: constant reactive current, constant reactive power, constant bus voltage, constant power factor, and each mode can be set according to user's requirements.

### B. 综合治理能力强 Strong Comprehensive Management Ability

ZG-dSVG不仅能补偿基波无功, 同时兼有抑制低次谐波和补偿不平衡功能。

ZG-dSVG not only compensates for fundamental reactive power, but also suppresses low-order harmonics and compensates for imbalance.

## 2 技术领先 Leading Technology

### A. 自动重启功能 (专利技术)

#### Automatic Restart Function (Patented Technology)

ZG-dSVG能够实时监测电网状态, 避免电网短时故障或外部干扰停机后导致装置永久停机, 大大加快装置的恢复速度, 提高装置长期运行的稳定性。(需定制)

ZG-dSVG can monitor the status of the grid in real time, avoiding short-term failure of the power grid or external interference, causing permanent shutdown of the device, greatly speeding up the recovery of the device and improving the stability of the long-term operation of the device. (customized)

### B. 多台并列运行技术 (专利技术)

#### Multiple Parallel Operation Technologies (Patented Technology)

针对超大容量应用和分段母线补偿而开发的专利技术, 能有效提高系统运行的可靠性, 完美解决母线运行方式变化时并列运行的协调问题。

The patented technology developed for ultra-large capacity applications and segmented bus compensation can effectively improve the reliability of system operation and perfectly solve the coordination problem of parallel operation when the bus operation mode changes.

### C. 单元直流电压与电容老化检测技术 (专利技术)

#### Unit DC Voltage and Capacitance Aging Detection Technology(Patented Technology)

单元直流电压检测技术使得各单元体直流母线电压均可查询, 可实时了解每个功率单元的工作状态, 精确定位故障单元。

电容老化检测技术使得用户可通过电容器的充放电功能来检验电容器的使用老化情况, 预计电容器寿命。

The unit DC voltage detection technology enables the DC bus voltage of each unit to be queried, and the working status of each power unit can be known in real time, and the fault unit can be accurately located.

Capacitance aging detection technology allows the user to verify the aging of the capacitor through the charge and discharge function of the capacitor, and predict the life of the capacitor.

## 3 性能优异 Excellent Performance

### A. 动态响应速度快 Dynamic Response Speed

ZG-dSVG具有4ms以内的动态响应速度, 因而对快速的冲击负荷具有更好的补偿效果, 对闪变也有更好的抑制效果。

ZG-dSVG has a dynamic response speed of less than 4ms, so it has better compensation effect for fast impact load and better suppression of flicker.

### B. 谐波特性优异 Excellent Harmonic Characteristics

ZG-dSVG是有源型设备, 输出电流完全可控, 在补偿无功时输出电流畸变率 $<2\%$ 。

ZG-dSVG is an active device with fully controllable output current and output current distortion rate  $<2\%$  when compensating for reactive power.

### C. 运行效率高 High Operating Efficiency

ZG-dSVG采用低损耗全控型功率器件, 优化的CPS-SPWM控制算法, 在保证性能的同时将装置的损耗控制在最小, 装置效率 $\geq 99\%$ 。

ZG-dSVG adopts low-loss full-control power device and optimized CPS-SPWM control algorithm to minimize the loss of the device while ensuring performance, and the device efficiency is  $\geq 99\%$ .

#### D. 散热设计独特 Unique Heat Dissipation Design

ZG-dSVG风冷散热系统采用具有专利技术的中间风道设计, 柜顶风机采用长寿命、免维护外转子电机、低噪音设计的离心风机, 保证了散热系统的安全性和可靠性。

The ZG-dSVG air-cooled system adopts the patented intermediate air duct design. The cabinet top fan adopts long-life, maintenance-free outer rotor motor and low-noise design centrifugal fan to ensure the safety and reliability of the heat dissipation system.

#### E. 暂态适应性强 Strong Transient Adaptability

ZG-dSVG呈现电流源特性, 在系统电压深度跌落到时仍可以输出额定无功电流。

ZG-dSVG暂态无功强补功能, 在系统发生电压骤升骤降, 2s过载1.5倍额定电流设计, 提供有力的无功支撑。

ZG-dSVG has current source characteristics, and it can still output rated reactive current when the system voltage drops deeply.

ZG-dSVG transient reactive power compensation function, when the system voltage swells or sags, the design of 2s overload 1.5 times the rated current can provide strong reactive power support.

## 4 使用方便 Use Easily

ZG-dSVG具备户内柜式、户外箱式两种安装方式, 具有结构紧凑, 接线简单, 便于维护等优点, 满足用户灵活多变的安装需求。

ZG-dSVG has two kinds of installation methods: indoor cabinet type and outdoor box type. It has the advantages of compact structure, simple wiring and easy maintenance, which can meet the flexible and variable installation requirements of users.



## 5 多样化的解决方案 Diversified Solutions

### A. 提高功率因数 Improve power factor

快速动态进行无功补偿，使工业用户功率因数达标，避免力调电费。尤其对于动态的负载，多电源供电系统的功率因数控制有很好的效果。保证接口点的实时功率因数满足设定值要求。

Reactive power compensation is performed quickly and dynamically, so that the power factor of industrial users is up to standard, and power adjustment is avoided. Especially for dynamic loads, the power factor control of multi-supply systems has a good effect. Ensure that the real-time power factor of the interface point meets the set value requirements.

### B. 提高变压器的利用率 Improve Transformer Utilization

进行无功补偿后，可减少用户对变压器容量的投资，或提高变压器的带载能力。

After reactive power compensation, the user's investment in transformer capacity can be reduced, or the load capacity of the transformer can be improved.

### C. 保持系统电压稳定 Keep the System Voltage Stable

动态维持系统电压稳定，减少电压波动的影响，防止发生暂态电压崩溃。

Dynamically maintain system voltage stability, reduce the effects of voltage fluctuations, and prevent transient voltage collapse.

### D. 提高电网传输能力 Improve Grid Transmission Capacity

减少无功功率在线路上传输，降低线损。

Reduce reactive power transmission on the line and reduce line loss.

### E. 可协调多种或多套无功补偿设备并联运行

Coordinate multiple sets of reactive power compensation equipment in parallel operation.

### F. 实现负序补偿 Negative Sequence Compensation

角接SVG可实现负序补偿，降低由于负荷引起的系统电压不平衡。

Corner-to-SVG enables negative sequence compensation and reduces system voltage imbalance due to load.

## 三、规格和技术参数

### Specifications and Technical Parameters

#### 3.1 型号说明

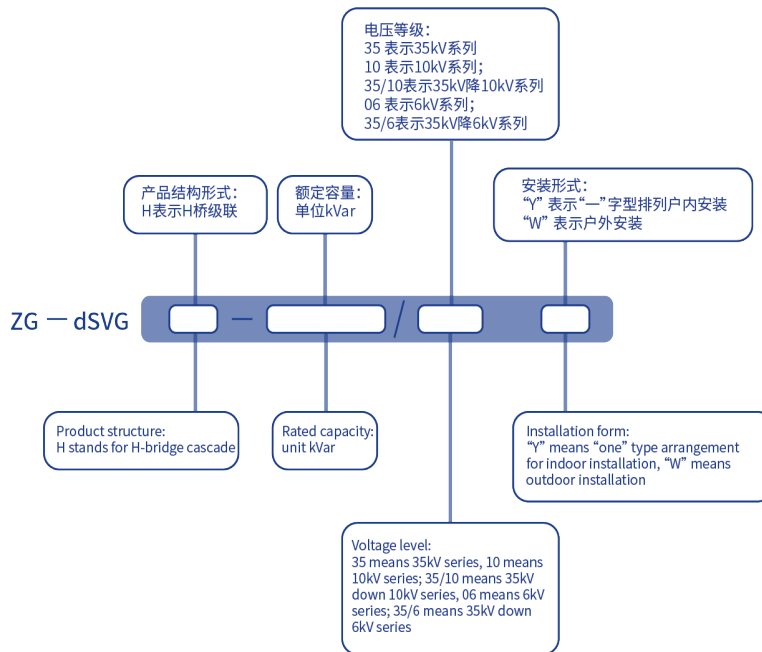
##### Model Description

ZG-dSVG系列高压动态无功补偿装置的产品分类如下:

The product classification of ZG-dSVG series high voltage dynamic reactive power compensation device is as follows:

示例: 额定电压为10kV, 额定补偿容量为±10000kVar的系统, H桥级联拓扑方式, 采用“一”字型排列户内安装, 其型号可表示为ZG-dSVG-H 10000/10Y。

Example: A system with a rated voltage of 10kV and a rated compensation capacity of ±10000kVar. The H-bridge cascaded topology adopts a "one" type arrangement for indoor installation, and its model can be expressed as ZG-dSVG-H 10000/10Y.

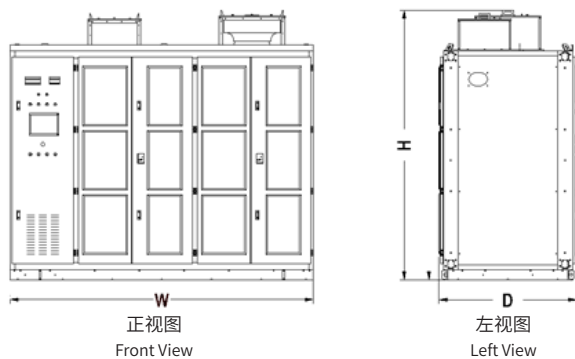


高压动态无功补偿装置命名方式  
High-voltage Dynamic Reactive Power Compensation Device

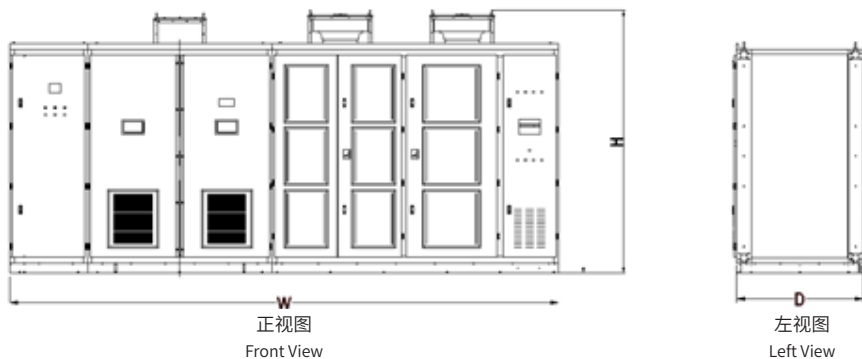
## 3.2 图例

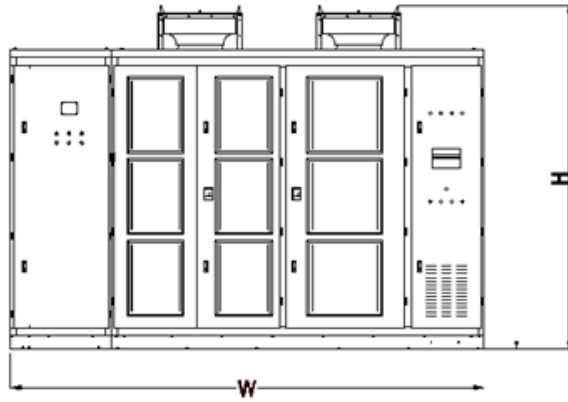
### Legend

容量 Capacity	电压等级 Voltage Level	连接方式 Connection Method	冷却方式 Cooling Method	连接电抗器 Connecting Reactor
0.3~2Mvar	6kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor
0.5~4.5Mvar	10kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor

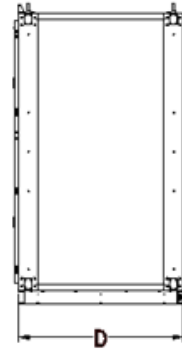


容量 Capacity	电压等级 Voltage Level	连接方式 Connection Method	冷却方式 Cooling Method	连接电抗器 Connecting Reactor
3~6Mvar	6kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor
5~8Mvar	10kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor





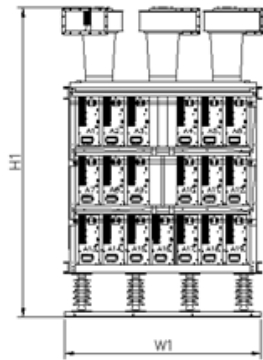
正视图  
Front View



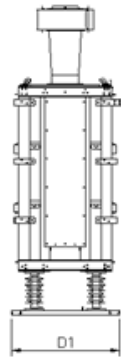
左视图  
Left View

容量 Capacity	电压等级 Voltage Level	连接方式 Connection Method	冷却方式 Cooling Method	连接电抗器 Connecting Reactor
7~10Mvar	6kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor
9~18Mvar	10kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor

功率柜  
Power Cabinet



正视图  
Front View

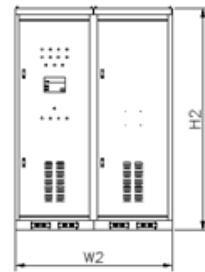


左视图  
Left View

控制柜  
Control Cabinet



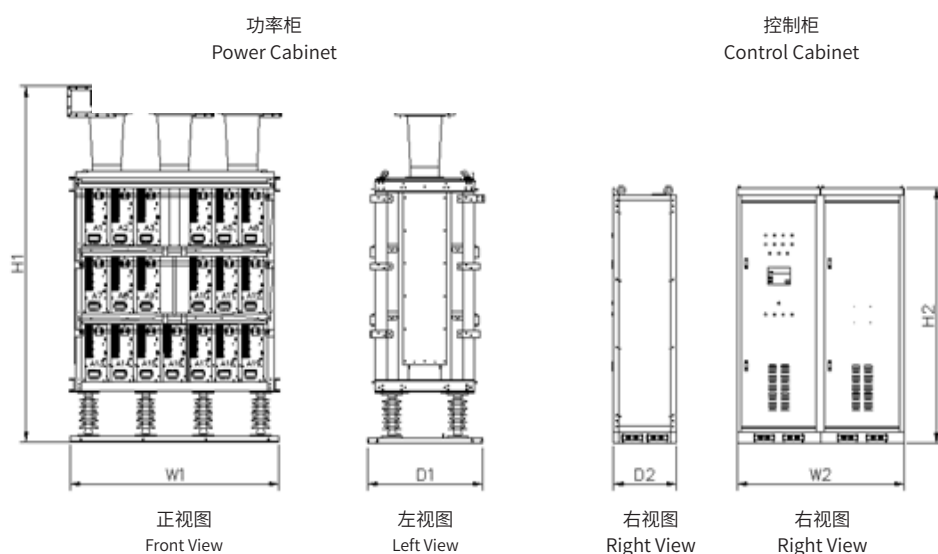
右视图  
Right View



右视图  
Right View

容量 Capacity	电压等级 Voltage Level	连接方式 Connection Method	冷却方式 cooling method	连接电抗器 Connecting Reactor
8~50Mvar	35kV	星接 Star Connection	风冷 Air Cooled	空芯电抗器 Air Core Reactor





容量 Capacity	电压等级 Voltage Level	连接方式 Connection Method	冷却方式 cooling method	连接电抗器 Connecting Reactor
8~50Mvar	35kV	星接 Star Connection	水冷 Water Cooling	空芯电抗器 Air Core Reactor

注:

- 1.SVG产品配套的空芯电抗器、水冷装置、户外隔离刀、户外断路器等为柜外安装，不在图例中显示。
- 2.上述图例均为户内安装的柜体结构，如需将柜体户外布置，需要采用集装箱结构。
- 3.各容量的SVG产品详细尺寸，请与我司技术人员了解。
- 4.对于需要角接的应用场合，可以定制。

Note:

1. The hollow reactor, water cooling device, outdoor isolation knife and outdoor circuit breaker for SVG products are installed outside the cabinet, not shown in the legend.
2. The above illustrations are all cabinet structures installed indoors. If the cabinets need to be arranged outdoors, a container structure is required.
3. For detailed dimensions of SVG products of various capacities, please contact our technical staff.
4. For applications requiring corner joints, it can be customized.

## 3.3 技术参数

### Technical Parameters

技术指标 Technical Indicators	技术参数 Technical Parameters
额定电压 Rated Voltage	6~35kV
补偿容量 Compensation Capacity	0.3~50Mvar
调节范围 Adjustment Range	额定感性无功到额定容性无功连续无极调节 Rated inductive reactive to rated capacitive reactive continuous stepless adjustment
额定频率 Rated Frequency	50Hz
响应时间 Response Time	<4ms
过载能力 Overload Capability	1.05倍长期过载 1.05 times long-term overload
谐波特性 Harmonic Characteristics	输出谐波电流总畸变率小于2% Output harmonic current total distortion rate is less than 2%
冷却方式 Cooling Method	风冷/水冷/空水冷 Air-cooled/Water-cooled/Air-water-cooled
运行模式 Operating Mode	恒功率因数/恒无功/恒电压/恒电流/电压无功综合/负荷补偿 Constant power factor / Constant reactive / Constant voltage / Constant current / Voltage reactive power / Load compensation
安装方式 Installation Method	户内柜式、户外集装箱式 Indoor cabinet type, outdoor container type
环境温度 Ambient Temperature	-40°C ~45°C
海拔高度 Altitude	<3500m



## 四、应用案例

Applications



## 4.1 电力配电网的应用

### Application of Power Distribution Network



### 1、广东电网某变电站

#### Guangdong Power Grid Substation

**变电站概况:** 主变2台240MVA, 6回220kV出线, 10回110kV出线, 24回10kV出线。其中一条110kV出线引向广珠城轨变电站。

**电能质量问题:** 城轨直流供电产生谐波电流、电压闪变和电压波动较大、启动无功冲击大。

**解决方案:** 在10kV母线侧加装一套智光SVG装置ZG-dSVG-H8000/10Y, 10kV, 容量为 $\pm 8$ Mvar。

**Substation overview:** The main transformer is 2 sets of 240MVA, 6 sets of 220kV outlets, 10 times of 110kV outlets, and 24 times of 10kV outlets. One of the 110kV outlets was led to the Guangzhu Urban Rail Substation.

**Power quality problem:** The urban rail DC power supply generates harmonic current, voltage flicker and voltage fluctuation, and the starting reactive power impact is large.

**Solution:** Install a set of ZG-dSVG-H8000/10Y, 10kV, with a capacity of  $\pm 8$ Mvar on the 10kV busbar side.



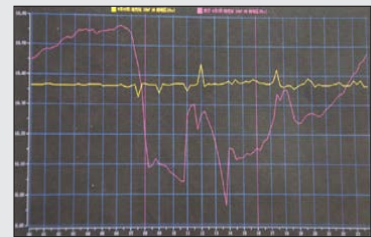


**治理效果:**

SVG投入有效抑制了电压波动, 系统电压的稳定性提高到一个新水平。

红色波形即波动大的波形为SVG停运后电压监控波形图。

黄色波形即波动小的波形为SVG投运后电压监控波形图。



**Governance effect:**

The SVG input effectively suppresses voltage fluctuations and increases the stability of the system voltage to a new level.

The red waveform with large fluctuations is the voltage monitoring waveform after SVG is stopped.

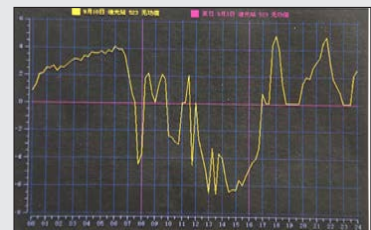
The yellow, small fluctuation waveform is the voltage monitoring waveform after the SVG is put into operation.

SVG投入使得变电站获得有效的无功补偿。

黄色波形为SVG投运后, SVG的无功输出状况。

The SVG investment enables the substation to obtain effective reactive power compensation.

The yellow waveform is the reactive output of the SVG after the SVG is put into operation.





## 4.2 新能源发电的应用

### Application of New Energy Power Generation



#### 1、华电集团某风电场 (高海拔)

Huadian Group's Wind Farm (high altitude)

**风电场概况:** 风电场建设规模为49.5MW, 单机容量为1500kW的风电机组33台。风电场海拔3500米。

**电能质量问题:** 风电发电项目受天气影响, 电压幅值波动较大, 功率因数低。

**解决方案:** 加装35kV降压式 $\pm 8\text{Mvar}$  SVG+7Mvar FC滤波支路, 实现-1~15Mvar的动态无功出力。

**补偿效果:** 提高风电场的功率因数, 稳定系统电压。

**Wind farm overview:** The wind farm construction scale is 49.5MW, and 33 wind turbines with a single unit capacity of 1500kW. The wind farm is 3,500 meters above sea level.

**Power quality problems:** Wind power generation projects are affected by the weather, the voltage amplitude fluctuates greatly, and the power factor is low.

**Solution:** Add 35kV step-down  $\pm 8\text{Mvar}$  SVG + 7Mvar FC filter branch to achieve dynamic reactive power output of -1 ~ 15Mvar.

**Compensation effect:** Improve the power factor of the wind farm and stabilize the system voltage.





## 2、华能集团某风电场（单套大容量水冷系统）

Huaneng Group's Wind Farm (single set of large capacity water cooling system)

**风电场概况:** 风电场建设规模为100MW，单机容量为2500kW的风电机组40台。风电场海拔2000米。

**电能质量问题:** 风电发电项目受天气影响，电压幅值波动较大，功率因数低。

**解决方案:** 在35kV母线加装1套35kV直挂式40Mvar水冷SVG，实现-40~+40Mvar的动态无功出力。

**补偿效果:** 提高风电场的功率因数，稳定系统电压。

**Wind farm overview:** The wind farm construction scale is 100MW, and 40 wind turbines with a stand-alone capacity of 2500kW. The wind farm is 2,000 meters above sea level.

**Power quality problems:** Wind power generation projects are affected by the weather, the voltage amplitude fluctuates greatly, and the power factor is low.

**Solution:** Install a 35kV direct-mounted 40Mvar water-cooled SVG on the 35kV busbar to achieve a dynamic reactive output of -40 ~ +40Mvar.

**Compensation effect:** Improve the power factor of the wind farm and stabilize the system voltage.





### 3、宁夏某光伏电站（多套系统并联运行）

#### A Photovoltaic Power Station in Ningxia (multiple sets of systems running in parallel)

**光伏电站概况:** 此220kV光伏升压站安装有2台360MVA的主变压器，主变压器35kV侧无功补偿容量 $3 \times 24\text{Mvar}$ ，采用动态无功补偿装置SVG，接于35kV I、II段母线上。

**电能质量问题:** 光伏发电项目受天气影响，电压幅值波动较大，功率因数低。

**解决方案:** 在两段35kV母线上分别加装3套，共6套并联运行实现 $-144 \sim +144\text{Mvar}$ 无功动态输出。

**补偿效果:** 提高光伏电站的功率因数，稳定系统电压。


**Overview of photovoltaic power station:** This 220kV photovoltaic booster station is equipped with two 360MVA main transformers with a reactive power compensation capacity of  $3 \times 24\text{Mvar}$  on the 35kV side of the main transformer. It uses a dynamic reactive power compensation device SVG and is connected to the 35kV buses I and II.

**Power quality problems:** Photovoltaic power generation projects are affected by the weather, the voltage amplitude fluctuates greatly, and the power factor is low.

**Solution:** Three sets are added to each of the two 35kV busbars, with a total of six sets operating in parallel to achieve  $-144 \sim +144\text{Mvar}$  reactive power dynamic output.

**Compensation effect:** Improve the power factor of photovoltaic power stations and stabilize the system voltage.





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A photograph of a hot steel rolling mill. The scene is filled with complex machinery, including large rollers and structural frames. A bright orange glow from a furnace or heat source is visible on the right side, illuminating the scene. A blue semi-transparent banner is overlaid on the top left of the image, containing the section title.

## 4.3 工业负荷的应用

### Application of Industrial Load

#### 1、河北某钢铁热轧系统

##### Hebei Hot Steel Rolling System

**现场概况:** 该公司的600mm热轧带钢线项目10kV生产线的主传动系统电机大多数为直流电机, 6脉波整流供电; 另外还有部分低压变频调速电机。

**电能质量问题:** 荷冲击较大、谐波含量超标、电压跌落幅值较大、功率因数低。

**解决方案:** 10kV母线加装一套额定补偿容量为 $\pm 6\text{Mvar}$ 的SVG和一套容量为6Mvar的FC滤波支路, 其中FC分5、7、11次滤波支路。

**Site Overview:** The main drive system motor of the company's 600mm hot-rolled strip line project 10kV production line is mostly DC motor, 6-pulse rectification power supply; in addition, there are some low-voltage variable frequency speed control motors.

**Power quality problems:** Large load impact, excessive harmonic content, large voltage drop amplitude, and low power factor.

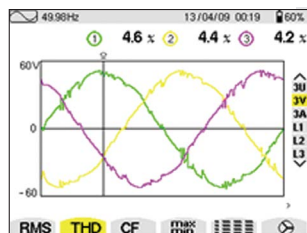
**Solution:** The 10kV busbar is equipped with a set of SVG with a rated compensation capacity of  $\pm 6\text{Mvar}$  and a set of FC filter branches with a capacity of 6Mvar, of which FC is divided into 5, 7 and 11 filter branches.



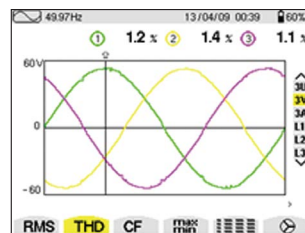


### 补偿效果 Compensation Effect:

1) 母线电压畸变率降低 Bus voltage distortion rate is reduced;



改造前电压畸变波形  
Voltage distortion waveform  
before transformation

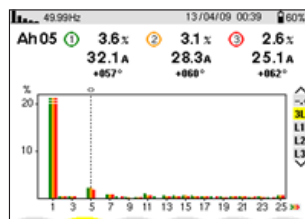


改造后电压畸变波形  
Voltage distortion waveform  
after modification

2) 谐波含量降低 Harmonic content reduction;



改造前电流谐波频谱  
Current harmonic spectrum  
before modification



改造后电流谐波频谱  
Current harmonic spectrum  
after modification

3) 提高功率因数, 稳定系统电压 Improve power factor and stabilize system voltage.



## 2、宁夏宝丰集团某煤矿

Ningxia Baofeng Group Coal Mine

主要负载概况: 矿井提升机

电能质量问题: 矿井提升机工作时冲击较大, 电压跌落幅值较大, 功率因数低。

解决方案: 在10kV两段母线各加装一套额定补偿容量为±8Mvar的SVG。

补偿效果: 提高功率因数, 稳定系统电压, 电压畸变率降低。

Main load profile: Mine hoist

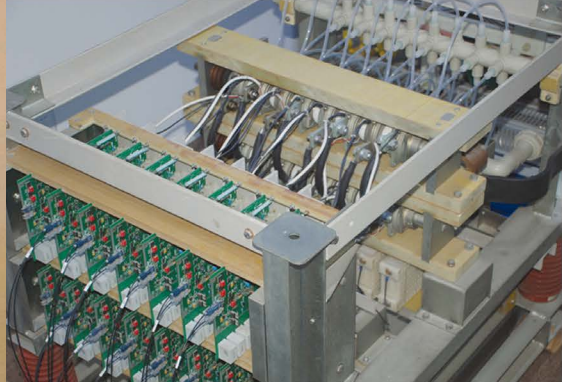
Power quality problem: The mine hoist has a large impact when working, the voltage drop amplitude is large, and the power factor is low.

Solution: Install a set of SVG with a rated compensation capacity of ±8Mvar on each of the 10kV two-segment busbars.

Compensation effect: Improve power factor, stabilize system voltage, and reduce voltage distortion rate.







## 五、试验与服务

### Test and Service

#### 十大研发试验室

#### Ten R&D Labs

- |                     |                                                                         |
|---------------------|-------------------------------------------------------------------------|
| ▶ 电气控制与电力节能工程研究开发中心 | Electrical Control and Power Energy Conservation Engineering R&D Center |
| ▶ 超大容量高压负载重点实验室     | Super Large Capacity High-voltage Load Key Lab                          |
| ▶ 大功率电力电子低压负载实验室    | High-power Electronics Low-voltage Load Lab                             |
| ▶ 高压动态无功补偿技术研究实验室   | High-voltage Dynamic Reactive Compensation Technology Research Lab      |
| ▶ 电网中性点接地技术研究实验室    | Grid Neutral Grounding Technology Research Lab                          |
| ▶ 电气控制与电磁兼容实验室      | Electrical Control and Electromagnetic Compatibility Lab                |
| ▶ 电力电子应用技术研究实验室     | Power Electronics Application Technology Research Lab                   |
| ▶ 特种变压器和电抗器研究实验室    | Special Transformer and Reactor Research Lab                            |
| ▶ 软件系统仿真实验室         | Software System Simulation Lab                                          |
| ▶ 分布式能源与微网技术研究实验室   | Distributed Energy and Microgrid Technology Research Lab                |





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