中国南方电网
CHINA SOUTHERN POWER GRID

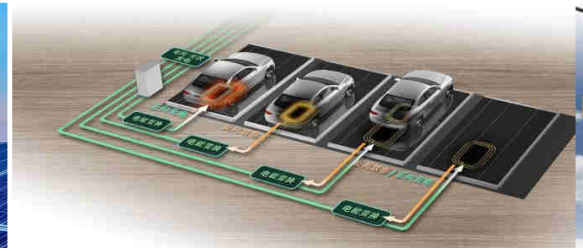
Explore the application of wireless power transfer technology in the power grid systems

Company： Electric Power Research Institute of Guangxi Power Grid Corporation

Speaker ： Shaonan CHEN

Date ： 2022/09/20





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Outline

中国南方电网 CHINA SOUTHERN POWER GRID

Outline

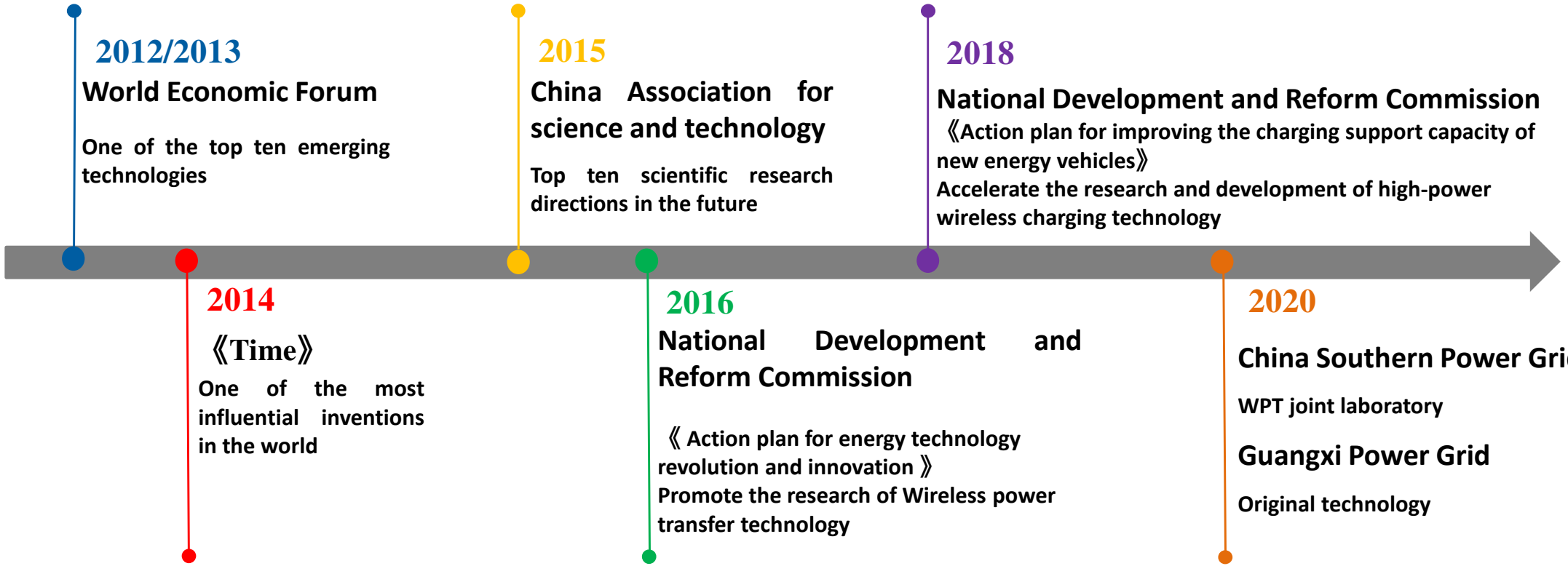
1 Introduction

2 Application Scenarios

3 Practical Explorations

1. Introduction-Technical background

Wireless power transfer technology is able to deliver non-contact electric power. This can effectively improve the safety, flexibility, convenience, and reliability, which is a new research direction in electrical technologies. WPT has received extensive attention especially in the past 10 years



1. Introduction-Technical background

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Strat from：2020/8/4

Organization： “1+2+1” Led by Guangxi power grid, Chongqing University, Guangxi University, Shenzhen Digital Research Institute

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广西电网有限责任公司

重庆大学 CHONGQING UNIVERSITY

廣西大學 GUANGXI UNIVERSITY

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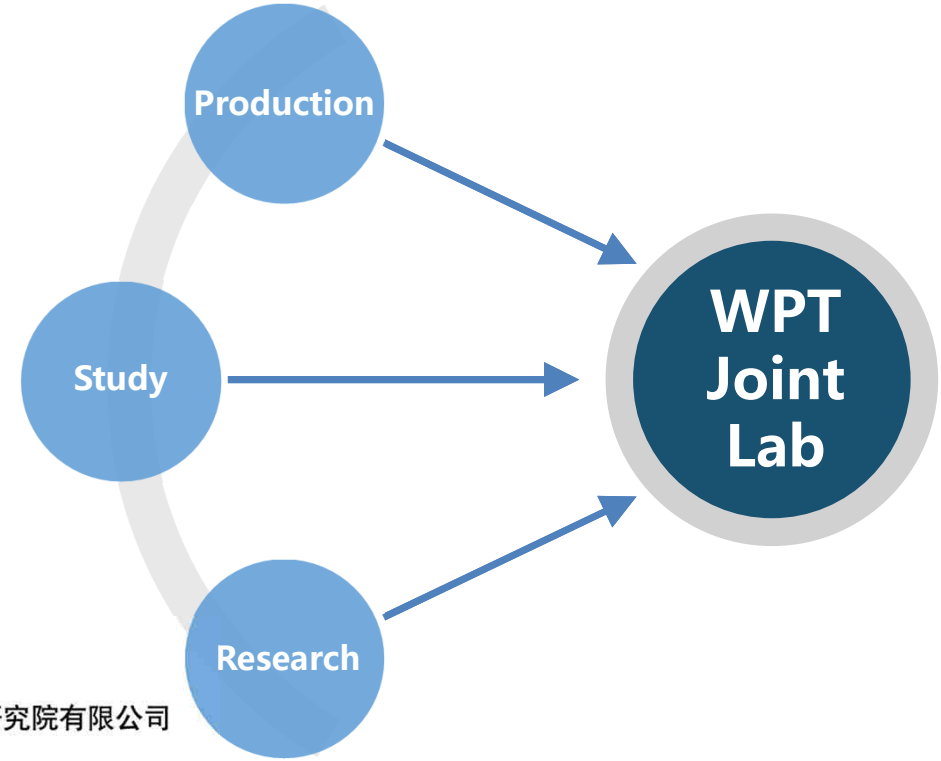

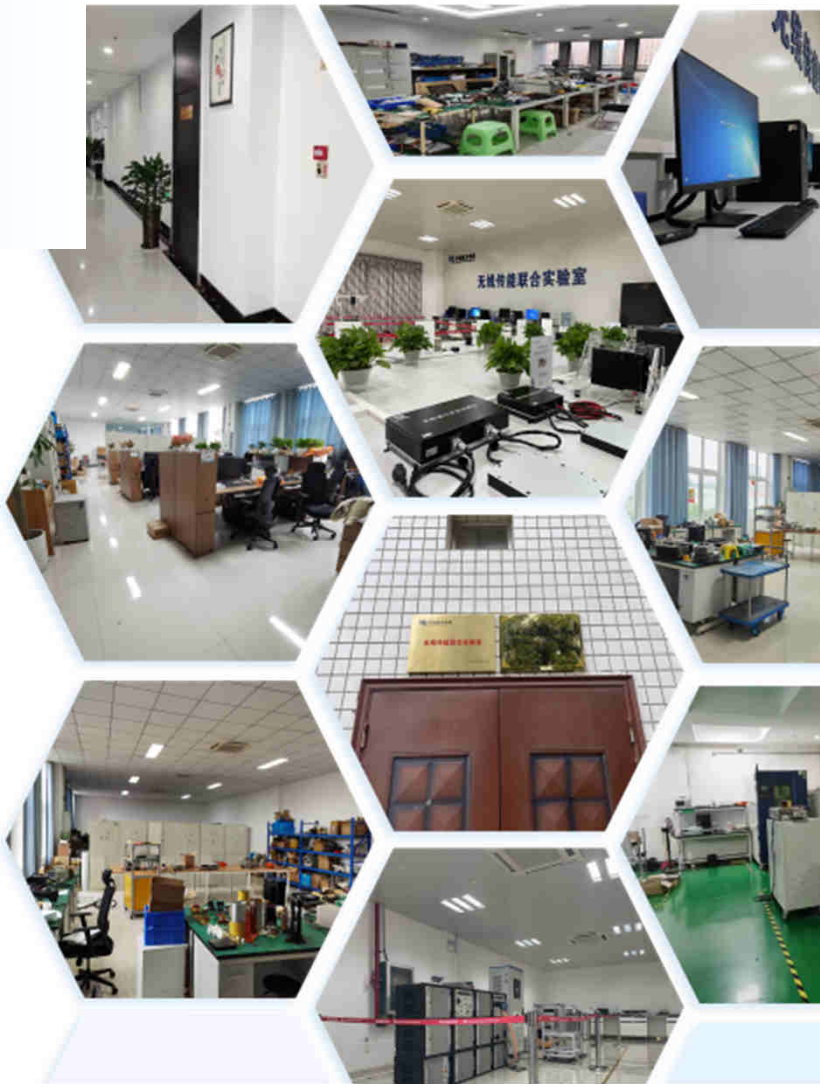

1. Introduction-Technical background

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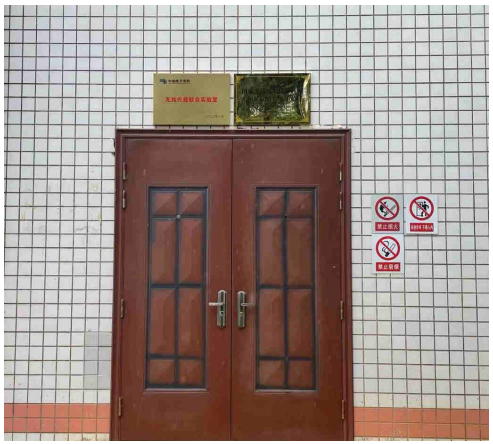
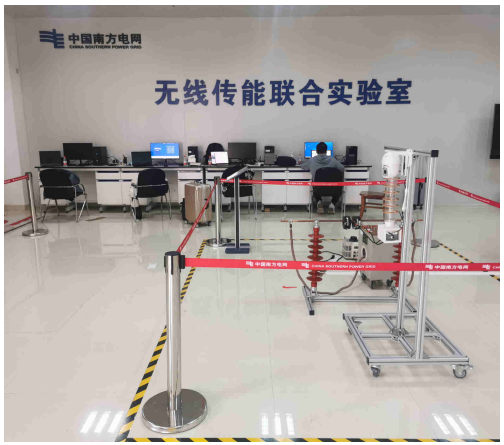
The joint laboratory headquarters and sub-centers cover an area of about 2,000 square meters and have gradually built a multi-functional integrated comprehensive laboratory with real-time testing, electromagnetic simulation, prototype development, product testing, etc.





Central Lab

Joint Lab

1. Introduction-Technical background

Provincial and ministerial science and Technology Awards

Built the first 60kW dynamic wireless charging system, and gain 6 prices from both national and province governments

☐ Provincial and ministerial science and Technology Awards

- First prize of Chongqing technological invention
- First prize of scientific and technological progress of China Southern Power Grid
- Second prize of scientific and technological progress of Guangxi Autonomous Region
- First prize of China electric power innovation
- Third prize of China Electric Power Science and Technology Progress Award
- Third prize of energy innovation award of China Energy Research Association

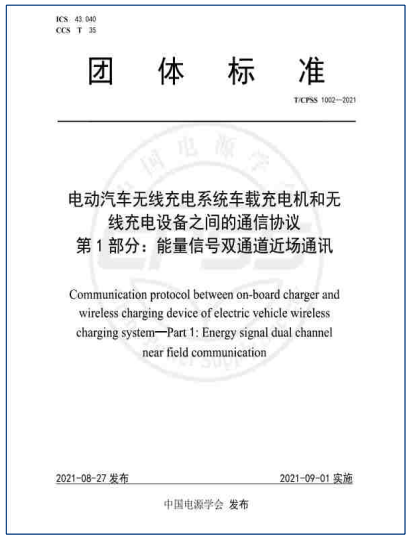
获奖证书

1. Introduction-Technical background

Lead the industry, group and local standards with enhanced influence

- **Lead 2 group standard, 1 industry standard, 3 group standards and 2 local standards**

Publish Standards



ICS 43.040
CCS T 35

团 体 标 准

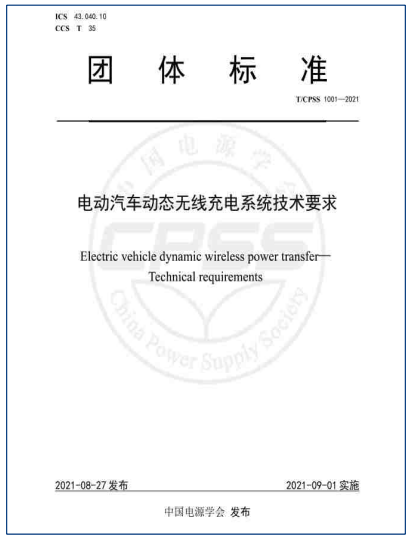
T/CPSS 1002—2021

电动汽车无线充电系统车载充电机和无线充电设备之间的通信协议
第 1 部分：能量信号双通道近场通讯

Communication protocol between on-board charger and wireless charging device of electric vehicle wireless charging system—Part 1: Energy signal dual channel near field communication

2021-08-27 发布　　2021-09-01 实施

中国电源学会 发布



ICS 43.040.10
CCS T 35

团 体 标 准

T/CPSS 1001—2021

电动汽车动态无线充电系统技术要求

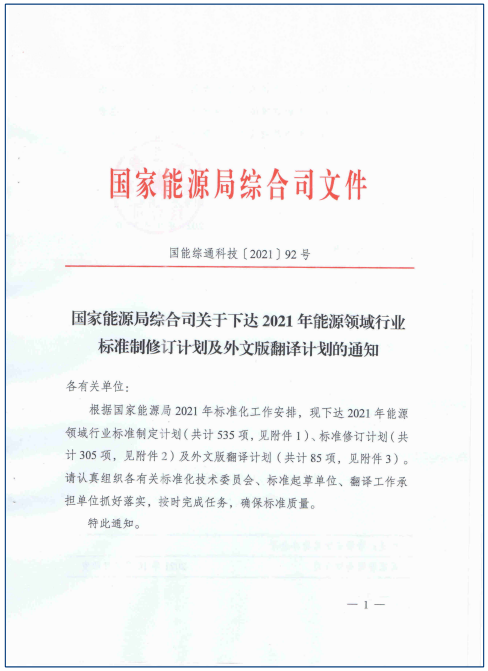
Electric vehicle dynamic wireless power transfer—Technical requirements

2021-08-27 发布　　2021-09-01 实施

中国电源学会 发布

- T/CPSS 1001-2021 Technical requirements for dynamic wireless charging system of electric vehicle
- T/CPSS 1002-2021 Communication protocol between on-board charger and wireless charging equipment of electric vehicle wireless charging system

Apply standards



国家能源局综合司文件

国能综通科技〔2021〕92 号

国家能源局综合司关于下达 2021 年能源领域行业标准制修订计划及外文版翻译计划的通知

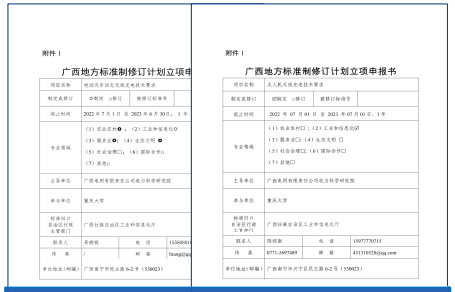
各有关单位：

根据国家能源局 2021 年标准化工作安排，现下达 2021 年能源领域行业标准制定计划（共计 535 项，见附件 1）、标准修订计划（共计 305 项，见附件 2）及外文版翻译计划（共计 85 项，见附件 3）。请认真组织各有关标准化技术委员会、标准起草单位、翻译工作承担单位抓好落实，按时完成任务，确保标准质量。

特此通知。

— 1 —

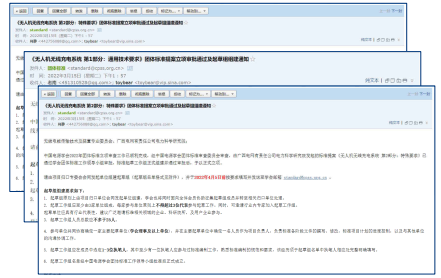
1 Industry standard



附件 1

广西地方标准制修订计划立项申报书

2 local standards



3 group standards

1. Introduction-Technical background

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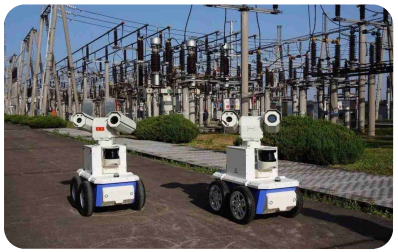
Four key technologies in the Lab: High power WPT; High power density; Long Distance WPT, Special environments

High power and efficient WPT	Lightweight WPT equipment	Small power remote WPT	Special environments WPT
● Electrical vehicle ● Railways ● Harbor ● …	● Drones ● Drones Bases ● Robots ● …	● Sensors ● Online monitoring ● …	● Underwater lights/robots ● Super clear workshop ● High salt/humidity environments ● …



Outline

中国南方电网 CHINA SOUTHERN POWER GRID

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1 Introduction

2 **Application Scenarios**

3 Practical Explorations

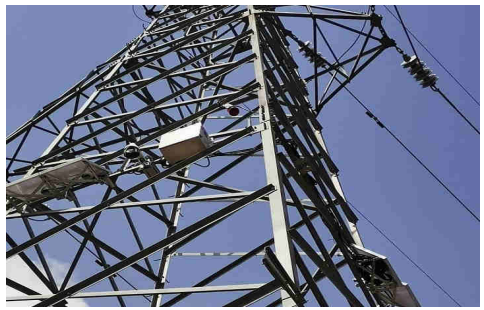
2、Application Scenarios

中国南方电网 CHINA SOUTHERN POWER GRID

①The power line online monitoring equipment provides wireless power supply

1 Background of apply

- With the acceleration of the construction of new power systems, online monitoring equipment has been widely used in the field of transmission line monitoring, and the normal operation of monitoring equipment requires stable and reliable power supply.



On-line monitoring of icing | Online monitoring of contamination | Online monitoring of tower displacement

Online identification of wildfires, breakouts | Micrometeorological online monitoring | Online monitoring of line dance

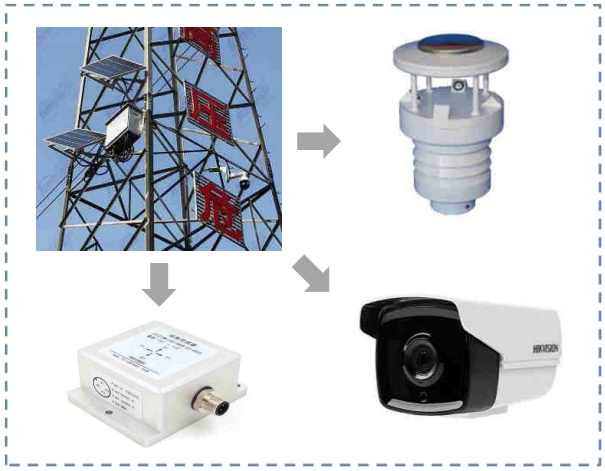
2、Application Scenarios

①The power line online monitoring equipment provides wireless power supply

2 Industry pain points

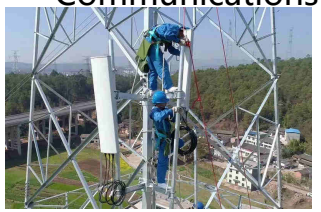
- The traditional "photovoltaic + battery" power supply mode is greatly affected by the weather and has high maintenance costs
- The increasing number of online monitoring devices makes it difficult to obtain convenient power supplies
- Non-monitoring equipment, such as unmanned aerial vehicle nests, communication base stations, etc., have large power requirements and are difficult to meet by traditional power supply methods

- It is greatly affected by the weather: night, rain, ice and snow
- Long-term maintenance problems: dust accumulation of photovoltaic panels, battery failure
- Photovoltaic panels are large in size and battery weight



Drone nest

Power + Communications



Traditional power supply methods such as photovoltaic + batteries are facing drawbacks → The number of power line online monitoring equipment is increasing → Higher electricity demand for non-on-line monitoring equipment

2、Application Scenarios

①The power line online monitoring equipment provides wireless power supply

3 Power supply requirements

Transmission line online monitoring device

Non-video classes

Peak power consumption：≤25W

Acquire power consumption：≤3.5W

Static power consumption ：≤1.0W

video classes

Peak power consumption：≤30W

Acquire power consumption：≤12W

Static power consumption ：≤3W

□ **Power greater than 30W can meet all scenarios**

Non-online monitoring devices

Drone nest

Power class 100 watts

Communication base stations

Power class kilowatt class

□ **Traditional power supply methods are difficult to meet power demand**

2、Application Scenarios

中国南方电网 CHINA SOUTHERN POWER GRID

②Patrol the drone wireless charging

1 Background of apply

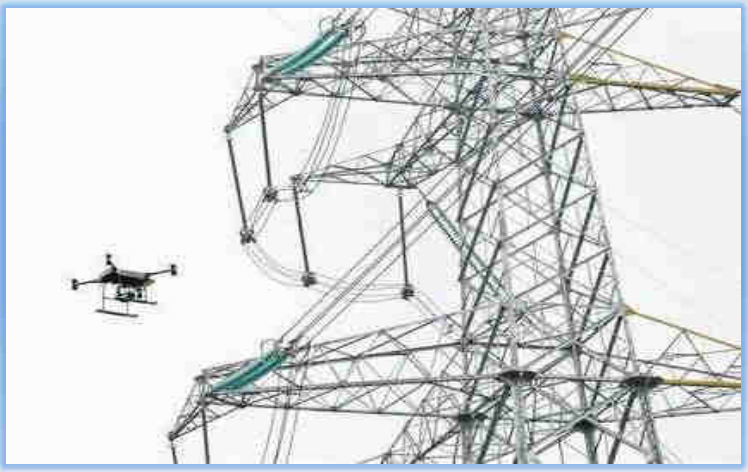
- Southern Power Grid Corporation issued the "2021-2023 Distribution UAV Autonomous Inspection Promotion Work Plan", which clarified the work goal of full coverage of power line UAV inspection
- Remote mountainous areas have long overhead lines, complex geographical environment, low manual inspection efficiency, and serious lack of intelligent and efficient line inspection methods

2、Application Scenarios

②Patrol the drone wireless charging

2 Industry pain points

- Limited by the battery capacity, the UAV has a short mileage and a small operating radius
- Manually replacing the battery or returning to the "airport" for charging has the problems of large manpower workload, low work efficiency and low level of intelligence
- Although the contact type can solve the problem of autonomous charging of unmanned aerial vehicles, there is a problem of poor environmental adaptability



2、Application Scenarios

中国南方电网 CHINA SOUTHERN POWER GRID

②Patrol the drone wireless charging

3 Power supply requirements

- Depending on the model, the charging power ranges from tens of watts to hundreds of watts, and the 100-watt charging device can meet most application scenarios

DJI latitude and longitude M300 RTK

Charging power： 124W

DJI MAVIC 3

Charging power： 65W

DJI Air 2s

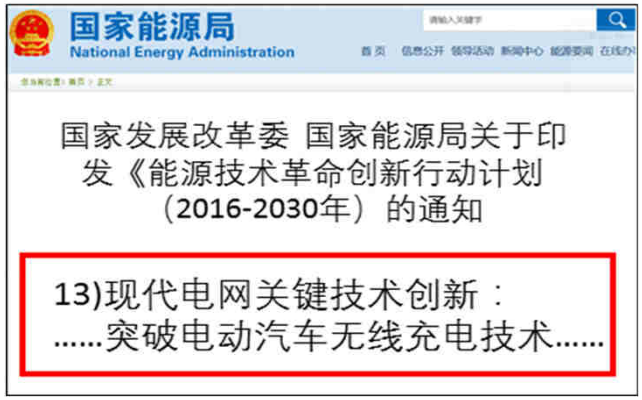
Charging power： 38W

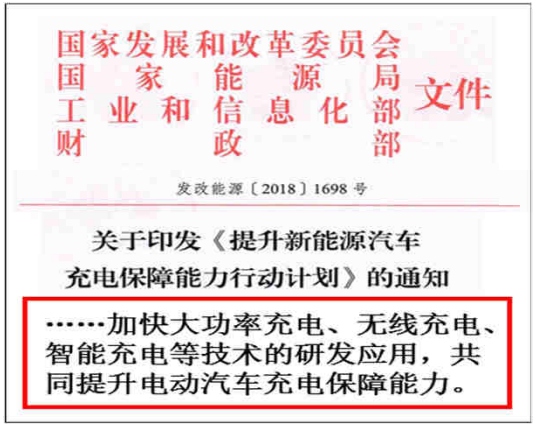
2、Application Scenarios

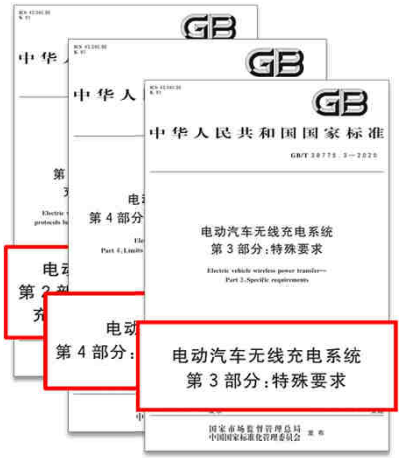
③Wireless charging of electric vehicles

1 Background of apply

- The state vigorously promotes the development of new energy vehicles, and electric passenger cars and buses are being promoted and applied in a large area
- The "Energy Technology Revolution Innovation Action Plan (2016-2030)" and the "Action Plan for Improving the Charging Guarantee Capacity of New Energy Vehicles" mention that we should vigorously develop wireless charging technology and even charge during driving
- The national standard for wireless charging of electric vehicles has been released 4 times, and it will be officially implemented from November 2020, and wireless charging is the development trend of future car charging







2、Application Scenarios

中国南方电网 CHINA SOUTHERN POWER GRID

③Wireless charging of electric vehicles

Plugging in and out of cables is time-consuming and laborious

More convenient

No need to use the hand to stop and charge

Metal parts are easily worn and exposed

safer

Fully enclosed equipment protection

Dense yards are difficult to build piles

More compact

Space-free installation

Electric piles and cross-lines affect the living environment

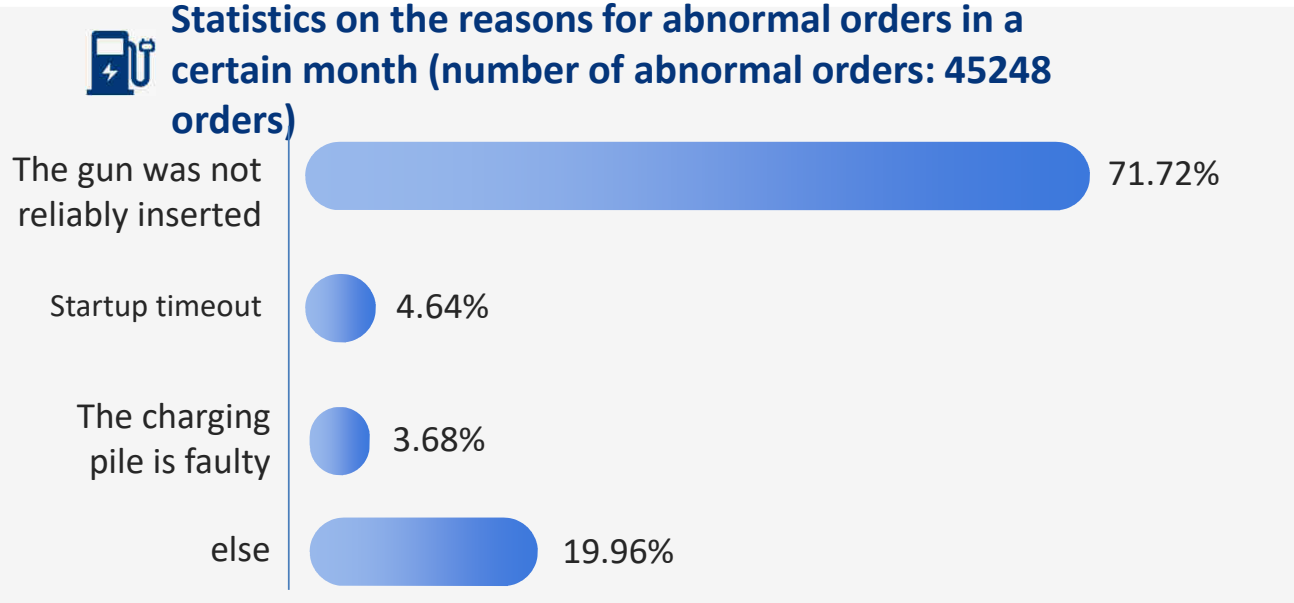
More aesthetically pleasing

Environmentally friendly

2、Application Scenarios

③Wireless charging of electric vehicles

- **Charging operator: The success rate of a single charge is about 85%.**



- The low success rate of a charge seriously reduces the user's charging experience, of which the gun insertion link is the main reason for charging failure

2、Application Scenarios

③Wireless charging of electric vehicles

2 Industry pain points

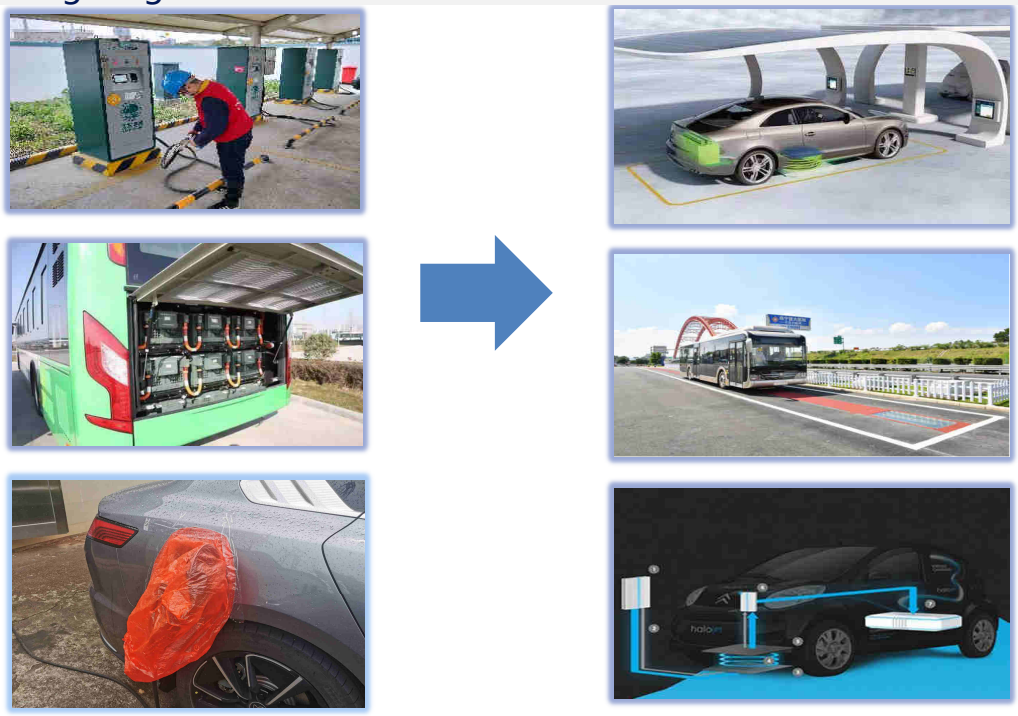
- Develop a static wireless charging system for electric vehicles, realize fully autonomous wireless charging of electric vehicles, and improve charging safety and reliability
- Develop a dynamic wireless power supply system for electric vehicles, realize mobile wireless power supply for electric vehicles, reduce the capacity of on-board batteries, and improve cruising range

Static wireless charging

Wirelessly charge the vehicle while it is stationary. When the vehicle is parked in a designated location in the garage with wireless charging, it can be charged autonomously.

Dynamic wireless charging

Wireless charging for the vehicle in the driving state of the vehicle to achieve the "running while charging" of the vehicle can greatly improve the vehicle mileage.



2、Application Scenarios

③Wireless charging of electric vehicles

3 Power supply requirements

- The wireless charging power of electric vehicles designed by different car companies is between a few kilowatts and tens of kilowatts

BMW530Le	SAIC Zhiji L7	Volvo XC40
Charging power： 3.2kW	Charging power： 11kW	Charging power： 40kW

Outline

中国南方电网 CHINA SOUTHERN POWER GRID

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1 Introduction

2 Application Scenarios

3 **Practical Explorations**

3、Practical Explorations

① Completed the first 60kW dynamic wireless charging demonstration project for electric vehicles in China

- In view of the three major problems faced by dynamic charging applications of electric vehicles, such as "low power efficiency", "difficult switching control" and "poor adaptability of vehicles", we carried out technical research and built the first 60kW mobile wireless charging demonstration project for electric vehicles in China. The dynamic charging lane is 53 meters long and the optimal efficiency of the system is 82.7%

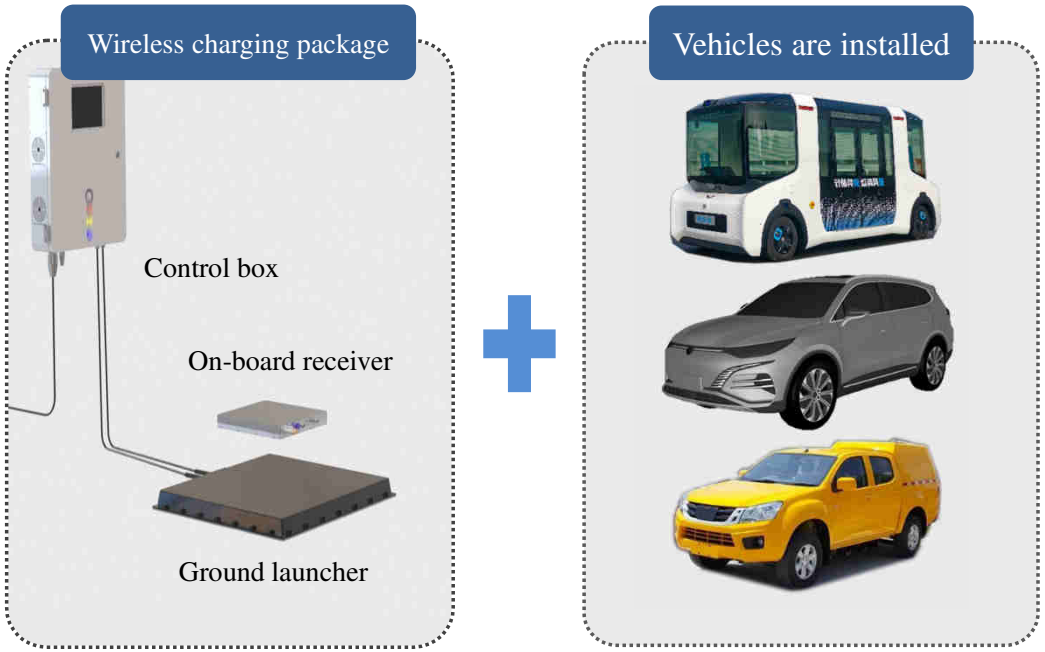
Demonstration project site and mainstream media reports

Demonstration project monitoring screen

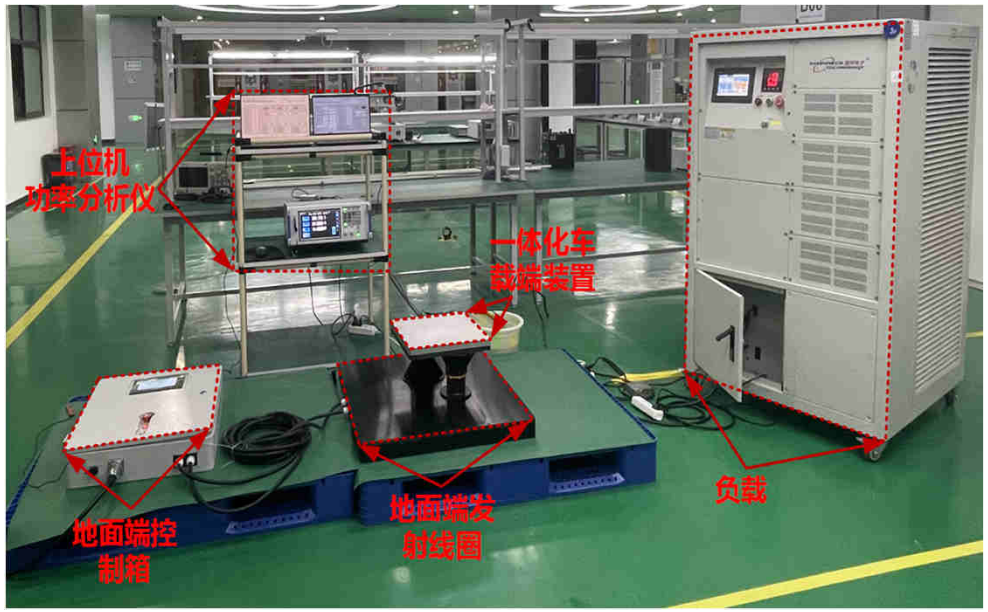
3、Practical Explorations

② Developed a complete set of 11kW wireless charging devices for electric vehicles

- Developed a 11kW wireless charging package for electric vehicles, with a system efficiency of 92%



11kW wireless charging package and planned vehicle

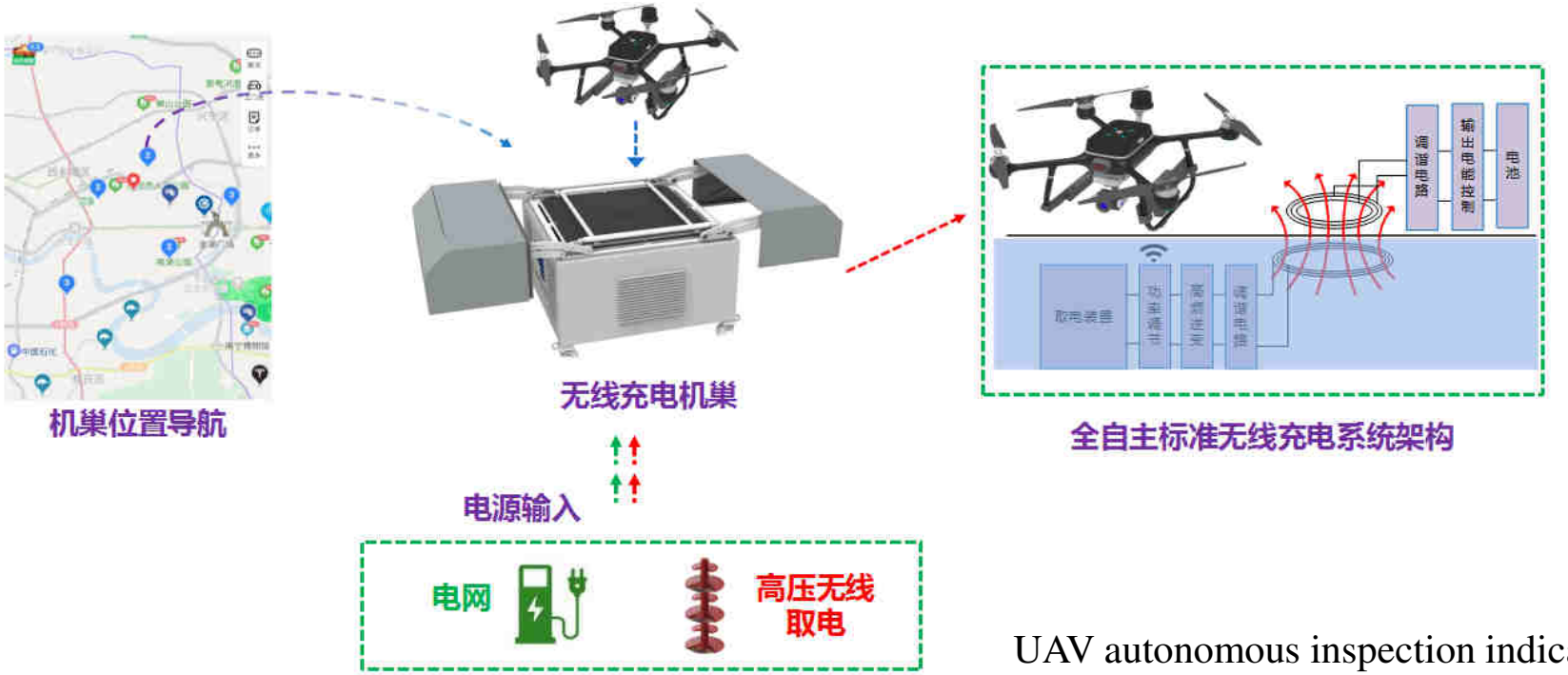


11kW electric vehicle wireless charging system test experiment

3、 Practical Explorations

③ Chinese first distribution line wireless charging UAV autonomous inspection demonstration project

- The magnetic coupling spiral tube wireless charging technology is used to avoid the oxidation problem of the UAV charging interface, and comprehensively solve the technical problems such as poor interoperability of the UAV charging interface, inability to communicate control over a long distance, and flight control logic judgment that it is not suitable for power grid scenarios

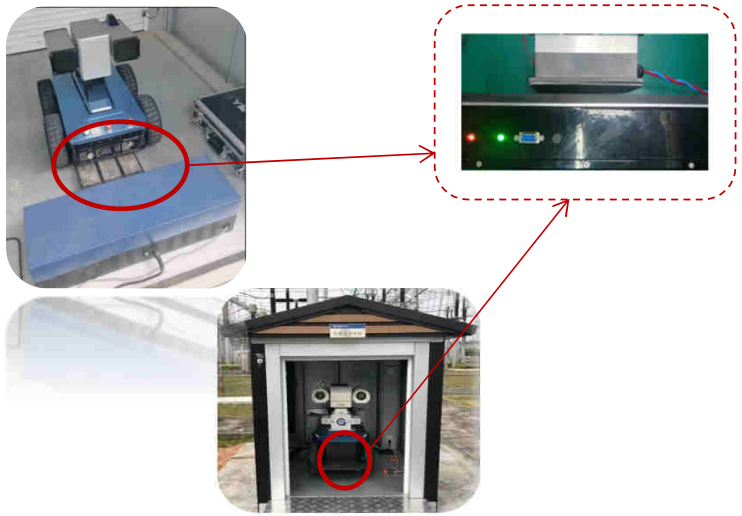


UAV autonomous inspection indication

3、Practical Explorations

④Complete set of inspection robot wireless charging device

- A complete set of wireless charging devices for inspection robots has been developed, with a rated power greater than 1kW and a transmission efficiency of 91.2%. It can realize autonomous wireless charging of substation inspection robots, and can meet the charging adaptation needs of various robots.

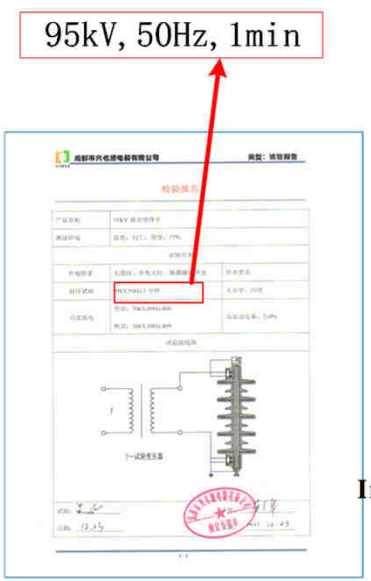


- **Jinglan Station Wireless Charging Demonstration Project**

3、Practical Explorations

⑤35kV high-voltage line online monitoring terminal wireless power supply device

- In order to provide stable and reliable low-voltage power supply for online monitoring equipment on high-voltage transmission lines, the laboratory team proposed the technical solution of "CT power acquisition + wireless power supply"

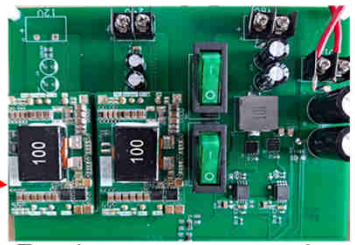


Third Party Test Report

Integrated insulator

Multi-relay wireless power supply system

Transmitter power conversion device



Receiver power conversion device

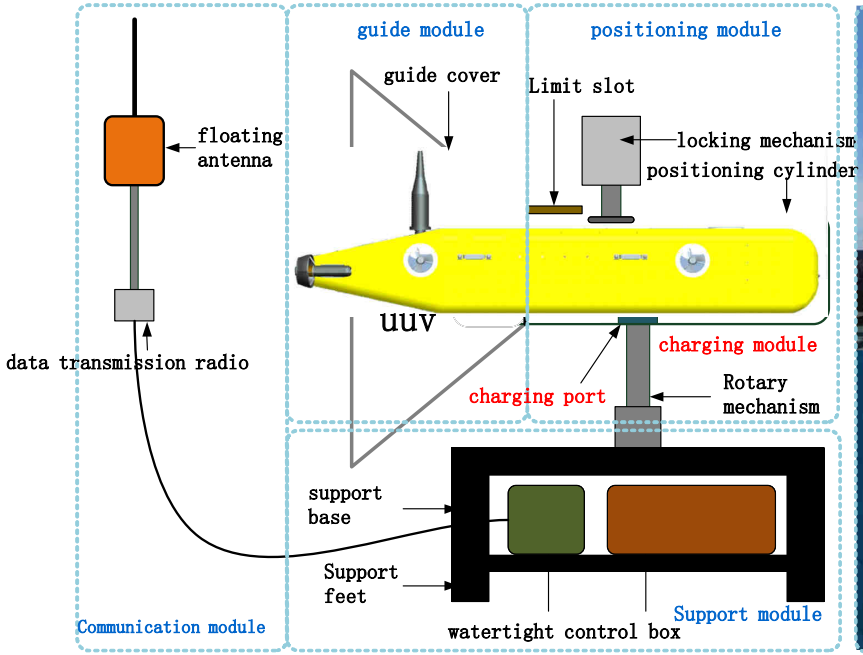
- rated power:50W
- system efficiency:82%
- Withstand voltage:95kV

3、Practical Explorations

⑥Complete set of wireless charging device for underwater submersible

- In response to the energy supply and replenishment needs of underwater vehicles and robots, the laboratory has developed wireless charging system modules and devices suitable for underwater electrical equipment. It realizes intelligent power supply of underwater submersibles.

- rated power:1kW
- system efficiency:87%
- offset distance range:±8cm



The structure of wireless charging platform

Underwater application test of charging platform

3、Practical Explorations

⑦ AGV wireless charging/power supply device

- The laboratory has developed AGV wireless charging supply prototype of 1/2/3kW series power level based on the AGV wireless charging supply requirements in different scenarios, and has carried out installation and application on the site of Haikang and Ningde Times.

Power:1kW
Voltage:57V
Current:20A

Power:2kW
Voltage:57V(24V)
Current:40A(90A)

Power:3kW
Voltage:57V
Current:60A

Device diagram

(a)AGV Application in Haikang

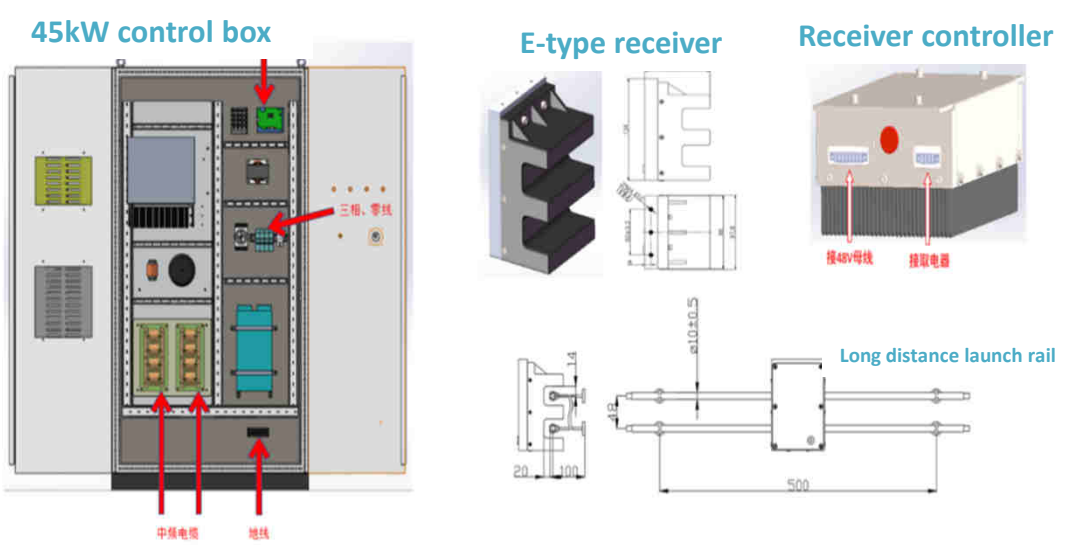
(b)AGV Application in Ningde Times

System application

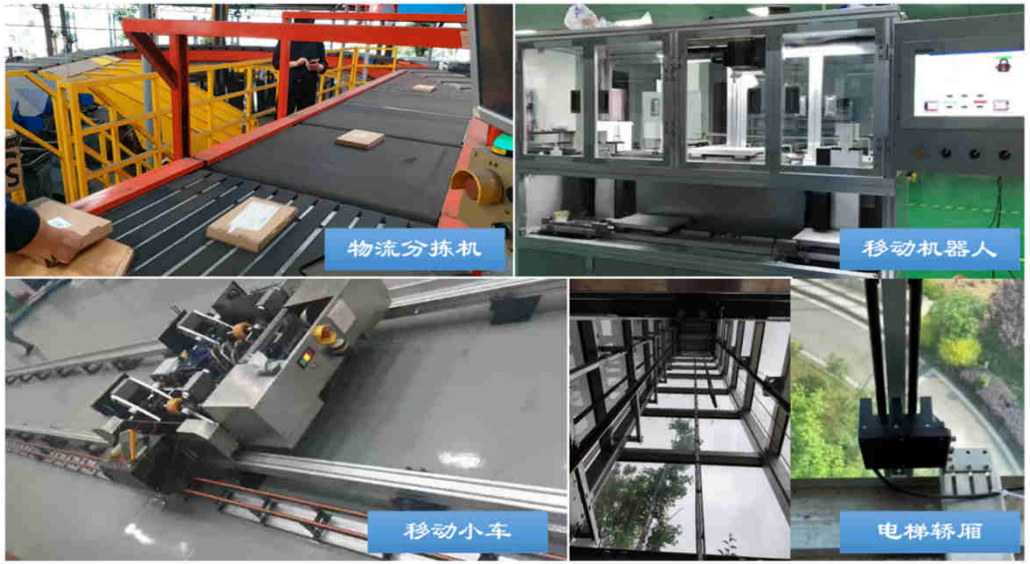
3、Practical Explorations

⑧ Wireless power supply device for industrial assembly line

- Aiming at the problems such as contact wear, unreliable power supply and sparking in sliding contact line power supply mode, a wireless power supply solution for industrial assembly line based on E-type tap+long guide rail mode is proposed.



Device diagram

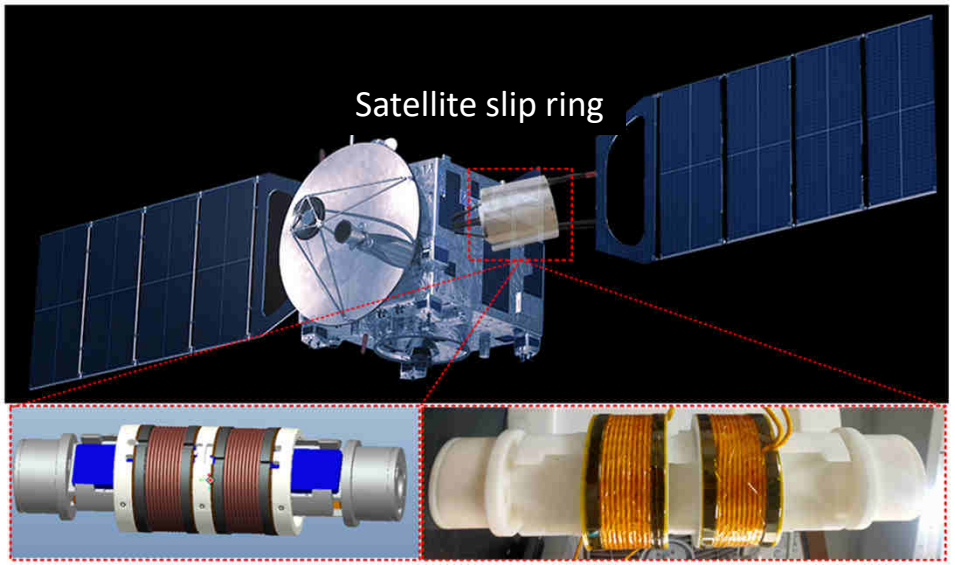


System application

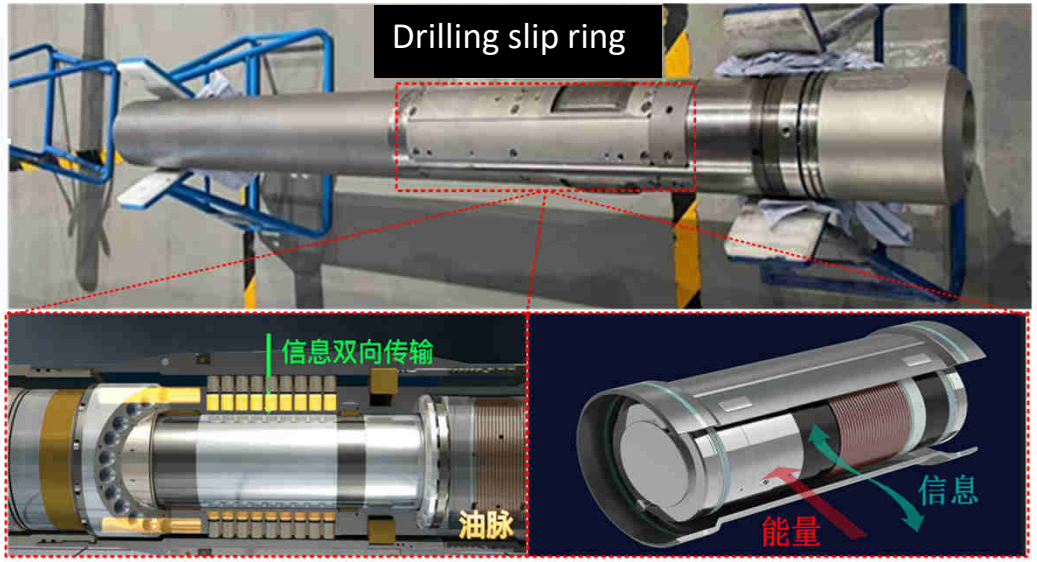
3、 Practical Explorations

⑨ Wireless power supply device for rotating mechanism

- Aiming at the problems of electric spark, short life and high replacement cost of conductive slip ring of rotating mechanism, the technical scheme of "shared channel radio energy and signal parallel transmission system" is proposed. For example



Principle prototype of solar panel slip ring



Physical drawing of oil drilling slip ring device

Thank you!

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