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LIYUANHAINA

RECTIFIER SYSTEM FOR HYDROGEN ENERGY INDUSTRY

ZHENGZHOU LIYUANHAINA RECTIFIER CO., LTD

LIYUANHAINA PERFORMANCE COMPARISON TABLE OF HYDROGEN PRODUCTION POWER SUPPLY BY ELECTROLYSIS

No.	Comparison items	1.SCR Rectifier (Rectifier transformer + thyristor rectifier)	2.Diode Rectifier (Rectifier transformer + diode rectifier + IGBT chopper)	3.PWM Rectifier (Power transformer + PWM rectifier + IGBT chopper)	4.SST Power Supply
1.1	Technical Background	Traditional AC power products	High	Very High	Highest
1.2	Transformer Type	Rectifier Transformer	Rectifier Transformer	Power Transformer	Power Electronic Transformer
1.3	Power Factor	Low with 6-pulse rectification, but can reach 0.92 with multi-pulse rectification	High (⩾0.95)	High (⩾0.99)	High (⩾0.99)
1.4	Rated Efficiency	High	Medium	Low	Highest
1.5	Actual comprehensive efficiency (including transmission lines and distribution equipment)	May have large harmonic current, low power factor, increased transformer and line losses	Stable overall efficiency	High power factor, low harmonic content, low apparent current, reduced losses	Highest efficiency, reduced energy usage, minimum harmonic content
1.6	Adjustment of Response Speed	Low	High	High	High
1.7	Stability Precision	⩽0.5%	⩽0.2%	⩽0.2%	⩽0.2%
1.8	Rated harmonic control effect	6-pulse rectifier THDi>20% but can be improved by adding harmonic control devices and power factor compensation devices Multi-pulse or 24-pulse rectifier + OLTC THDi⩽8%	THDi⩽6% with 24-pulse rectification	THDi⩽3%	THDi⩽3%
1.9	Ripple Factor	6-pulse>10%, 24-pulse+OLTC>5%	⩽3%(can be adjusted according to needs)	⩽3%(can be adjusted according to needs)	⩽3%(can be adjusted according to needs)
2.0	Cost	Low	High	Higher	Highest
2.1	Advantages	Mature technology, cost-effective, suitable for high voltage and large current outputs	Low harmonic, low ripple, high power factor, fast adjustment	High power factor, low harmonic and ripple, fast adjustment	High power factor, low harmonics and ripple, high efficiency, no need for additional SVG/SVC or OLTC, etc., small size, more convenient to move
2.2	Disadvantages	High harmonic, large ripple, low power factor, bulky	High cost, complex	High cost, complex	High cost, complex, requires skilled support

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Liyuan Haina Rectifier Group

Rectifier System For Hydrogen Electrolysis Industry

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A Group Profile

Overview of the Company

- Liyuan Haina Group was founded in 1997. It is a national high-tech enterprise and a national green manufacturing factory. The company committed to the research and development and manufacturing of IGBT based rectifiers, SCR rectifiers, Pulse Power Supplies, networked intelligent control systems and harmonic control devices. It is the earliest established professional rectifier manufacturer in China. Electrolytic copper foil rectifiers and PCB electroplating rectifiers have a large domestic market share.

- The company continues to absorb cutting-edge technologies from related industries in the world (Italy, Germany, the USA and Japan), and has a number of independent and forward-looking core technologies with domestic and foreign influence, more than 200 patented technologies, and also pays great attention to energy-saving and intelligent breakthroughs and innovations in power supplies in various application fields.

- On the basis of introducing Schneider's lean digital management model, Liyuan Haina has established the Liyuan Intelligent Manufacturing Platform (MIS) including digital systems such as ERP, PLM, and MES, and fully implemented the IS09001:2015 quality management system. Series of products have passed CE and CSA certification.

Overview of the Company

- Liyuan Haina currently has two major production bases in Jiangxi, China with an area of about 80,000㎡ and Chonburi, Thailand with an area of about 40,000㎡(which is expected to be put into use in September,2024), and three wholly-owned subsidiaries in Hong Kong, Singapore, and the United States. Branches in the UAE and Turkey are under planning. Liyuan Haina also has two exclusive agents in Japanese and Korean markets.

- Liyuan Haina's rectifiers are widely used in various industrial fields such as electrolysis, PCB electroplating, metallurgy, anodizing and coloring, electrophoresis, electrochemistry, electrolytic gas, electrolytic copper foil, electrolytic nuclear raw materials, water treatment electrolysis, rare earth electrolysis, water treatment and surface treatment industries. As dedicated power supplies, they can provide direct power with green and efficient performance in the production or processing of the above fields!

Business Philosophy

01

Expertise

02

Innovation

03

Brand

04

Service

- **Enterprise mission**

  Become a leader in the design, development and manufacturing of efficient intelligent industrial power supplies

- **Enterprise Vision**

  A hundred rivers into the sea industry

- **Core value**

  Honesty, pragmatic, pioneering and innovative people-oriented return to society

Development History

1997–2007

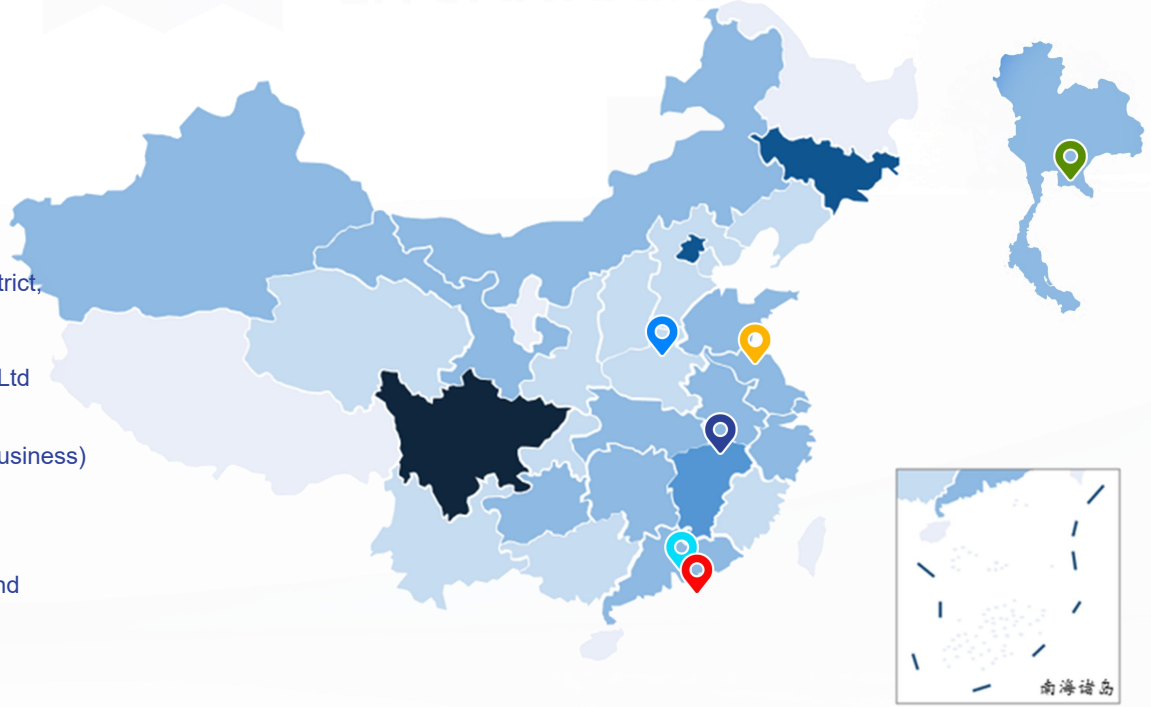
- 1997-Established Guangzhou Panyu Liaoyuan Electrical Appliance Factory (predecessor of Liyuan)
- 2000-Renamed Guangzhou Panyu Liyuan Electrical Equipment Factory
- 2004-Guangzhou Liyuan Electrical Equipment Co., Ltd
- 2005-Hong Kong Liyuan Electrical Appliances International Limited
- 2006-Jiujiang Liyuan Rectifier Equipment Co., Ltd
- 2006-Dongguan Li Yu Yuan Electrical Equipment Co., Ltd
- 2007-Passed ISO9001 quality system certification

2010–2024

- 2015-National High-tech Enterprise
- 2016-Jiujiang Liyuan Electromechanical Equipment Co., Ltd
- 2017-Shenzhen Liyuan Haina Energy Co., Ltd
- 2019-Schneider Fine Digital System Management; Liyuan Haina Jiangxi Jiujiang Industrial Park was put into operation
- 2020-Estabilshed Zhengzhou Liyuan Rectifier Co.,Ltd
- 2022-Changed company name to Liyuan Haina Rectifier Group
- 2023-Construction of Thailand Factory started
- 2024-Estabilshed USA company Liyuan Haina Energy Co., Ltd

Group Composition

- Jiujiang headquarters, Jiangxi
- Shenzhen (R&D center) Nanshan District, Longgang District
- HongKong Liyuan Haina Energy Co., Ltd
- Zhengzhou subsidiary (international business)
- Kunshan subsidiary
- Thailand production base (planning and preparation)
- USA Liyuan Haina Energy Co., Ltd



Overseas Factory In Thailand

Phase 4, Pintong Industrial Park, Chonburi Province, Thailand (area 52 mu, under planning and preparation)

- Thailand production base area: 52 acre
- Base address: Phase 4, Pintong Industrial Park, Chonburi Province, Thailan

Overseas Company In USA

- Base address: Studio by Tishman Speyer, 8th floor, Office #08-112, 28-07 Jackson Avenue, Long Island City, NY 11101

Quality Management System

- Three system certification of quality, environment and safety
- Some products are CE certified, some products are UL certified
- 2012 Kingdee K3 system useage
- 2015 Yuanda Management Company settled in
- 2018 Kingdee K3 CLOUD Usage
- 2019 Schneider Digital Refined Management Model Introduced
- SMT electronic material intelligent warehouse, fully put into trial in May 2020
- Integrated automatic intelligent machining center for aluminum profiles

Efficient Production Process

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Smart Silo

PCBA-SMT Workshop

PCBA-DIP Workshop

PCBA-Automatic Coating Line

Assembly Line A

Assembly Line B

Assembly Line C

Assembly Line D

Automated Workshop

Transformer Workshop

Product Test Area

Product Warehouse

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B Application Field

Green Hydrogen, Powering a Clean Energy Future

Hydrogen is the most abundant element on the planet and is widely lauded as a clean, flexible energy carrier capable of decarbonizing our planet through multiple uses. The production of green hydrogen through electrolysis as a clean energy source has great potential to power manufacturing, transportation, steel production, and other key industries worldwide.

Application

- Photovoltaic, wind power, wave power, biomass power(green power) are connected to the power source rectifier and the electrolyzer to electrolyze hydrogen production
- Electrolytic hydrogen production by power source rectifier connected to conventional power grid and integrated with electrolyzer
- Inverter system between hydrogen energy storage and power grid

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C Production Introduction

SST Power Supply For Electrolytic Hydrogen

- SST solid-state transformer (power electronic transformer), which integrates electrical isolation, voltage conversion, and reactive power compensation;
- The integration and innovation of circuits and magnetic circuits, from medium voltage 10KV AC to 750V DC
- Small harmonics and high power factor. Harmonic<5%, power factor ≥0.99
- It can quickly match the power fluctuation characteristics of renewable energy, ensure the realization of 100% green hydrogen, and reduce hydrogen production costs;
- Stronger adaptability to grid voltage and frequency fluctuations
- Small in size. The amount of equipment and engineering construction can be saved by 40%, and the floor space can be reduced by 30%;
- The efficiency of the power module is as high as 98%, and the architecture is simple and reliable.

IGBT Electrolytic Hydrogen Production Rectifier Series

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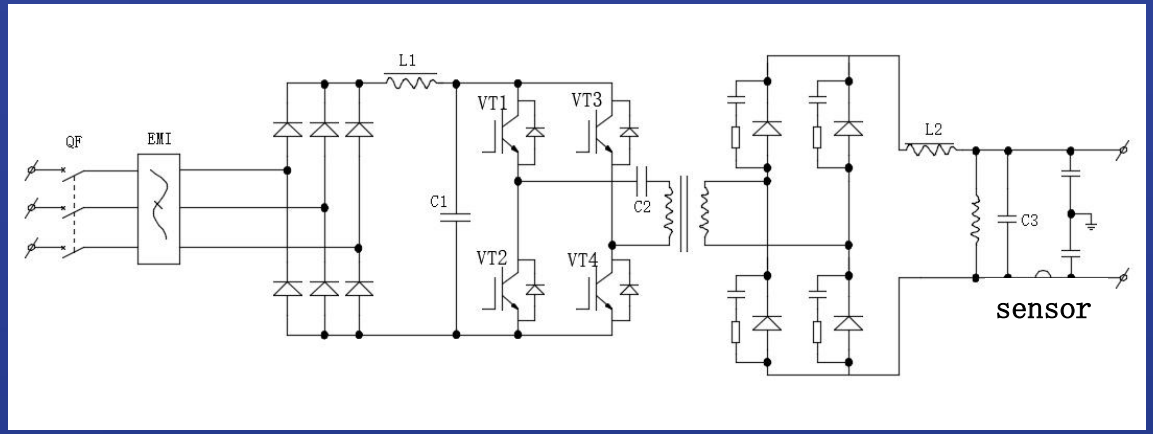
Capacity ≤ 1000kW

- The rectifier adopts a high-frequency rectifier circuit, with high inverter frequency, fast control speed and high power factor of the equipment;
- The incoming line of the unit is equipped with an EMI filter reactance device
- The rectifier adopts multiple modules in parallel, with a small single module, low requirements for electronic components and low failure rate;
- Full-bridge phase-shifted soft switching control mode
- Adopt advanced logic interlock control circuit
- The problem of magnetic bias is well eliminated
- Adapt to wind off-grid direct hydrogen production, maximum power point tracking (MPPT), improve energy utilization

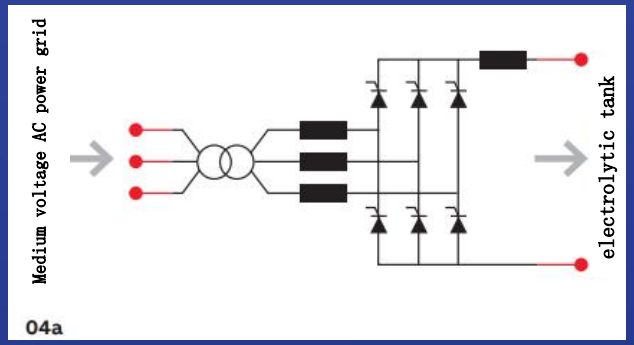
Schematic Of IGBT Electrolysis Hydrogen Rectifier



- **Rectification principle:** rectifier + inverter + transformer + rectifier
- Multi-module parallel mode
- With isolation transformer, good isolation
- The input voltage is three-phase AC220V, AC380V, AC415V, AC480V, etc.
- Input frequency: 50HZ/60HZ

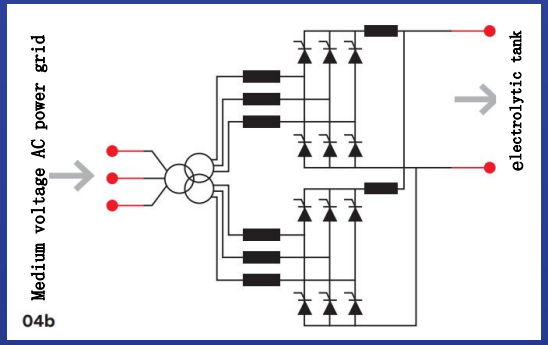
High-power Electrolytic Hydrogen Production Rectifier

6 pulse rectifier



- Structure is simple
- Low cost
- Large harmonic content
- The transformer is a rectifier transformer

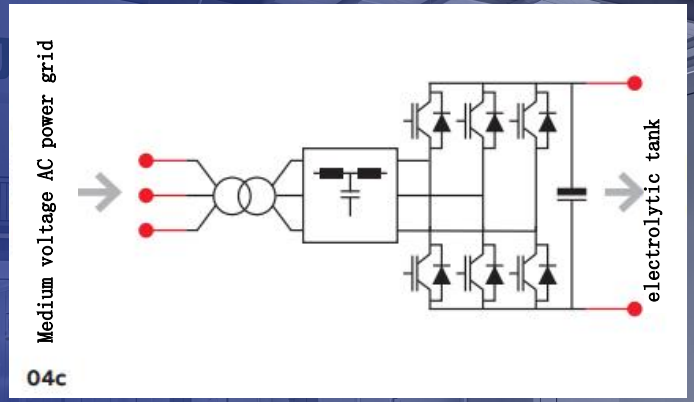
12 pulse rectifier



18, 24, 36 pulse, etc

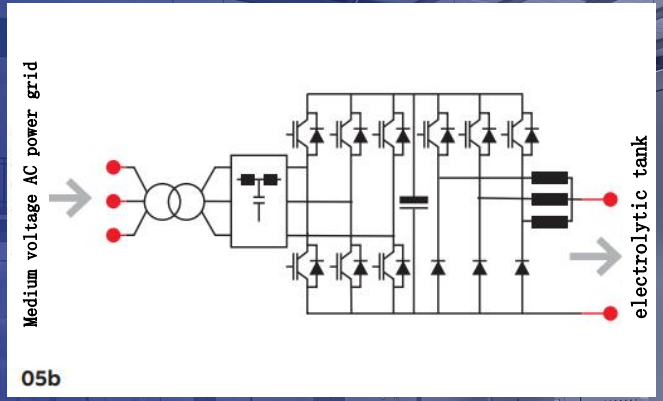
- Complex structure of multi-pulse rectifier
- The more pulse number, the more complex the structure and the higher the cost
- The higher the number of pulses, the lower the harmonic content
- The transformer is a rectifier transformer

PWM Electrolytic Hydrogen Production Rectifier



- Basic composition: transformer + PWM rectifier
- High power factor, up to 0.99;
- Low harmonic, the harmonic current is less than or equal to 3%;
- The ripple coefficient is less than or equal to 3%;

PWM + IGBT Chopper Electrolysis Hydrogen Production Power Supply

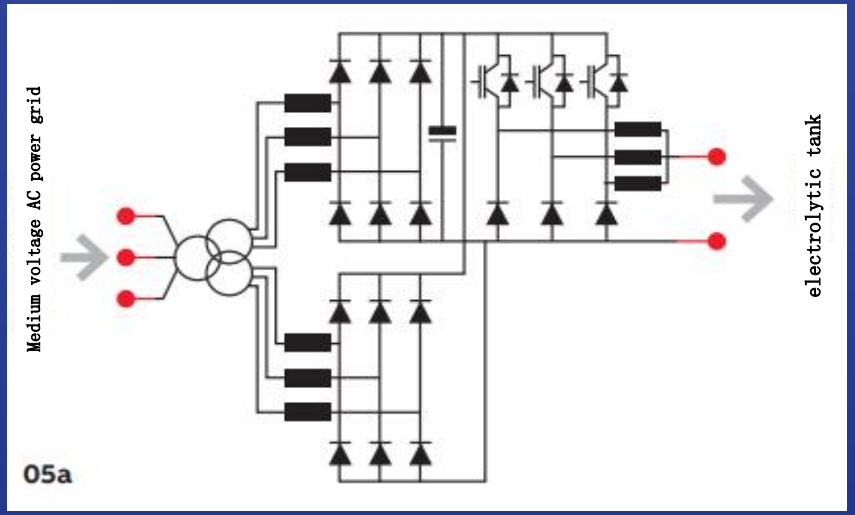


- Basic composition: transformer + PWM rectifier + IGBT chopper
- High power factor, up to 0.99;
- High control accuracy, up to 0.2%
- Low harmonic, the harmonic current is less than or equal to 3%;
- The ripple coefficient is less than or equal to 3%;

Diode Rectification + IGBT Chopper Electrolysis Hydrogen Production Power Supply

- **Basic composition:** rectifier transformer + diode rectification + IGBT chopper;
- High power factor and low harmonics;
- IGBT chopper with redundant backup of independent units;
- The touch control system is convenient to track module faults and replace them in time;
- High efficiency, high adjustment accuracy and stable output.

Diode Rectification + IGBT Chopper Schematic:



- Multi-pulse rectification has good harmonic control effect
- IGBT chopper output current accuracy is high and ripple coefficient is good

Pre-stage rectification can use 6, 12, 18, 24, 36 pulse waves, etc.

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DC-DC Converter

- Directly connected to photovoltaic power generation or photovoltaic power storage system, reducing a large number of intermediate equipment
- The overall cost of this part of the electrolytic hydrogen production power system is reduced
- Converter modular design for easy replacement and maintenance
- Harmonic ≤ 5%
- Strong adaptability to power grid fluctuations
- Volume and space advantages
- Can be used with photovoltaic energy storage systems to produce hydrogen

SCR Controlled Electrolysis Hydrogen Rectifier

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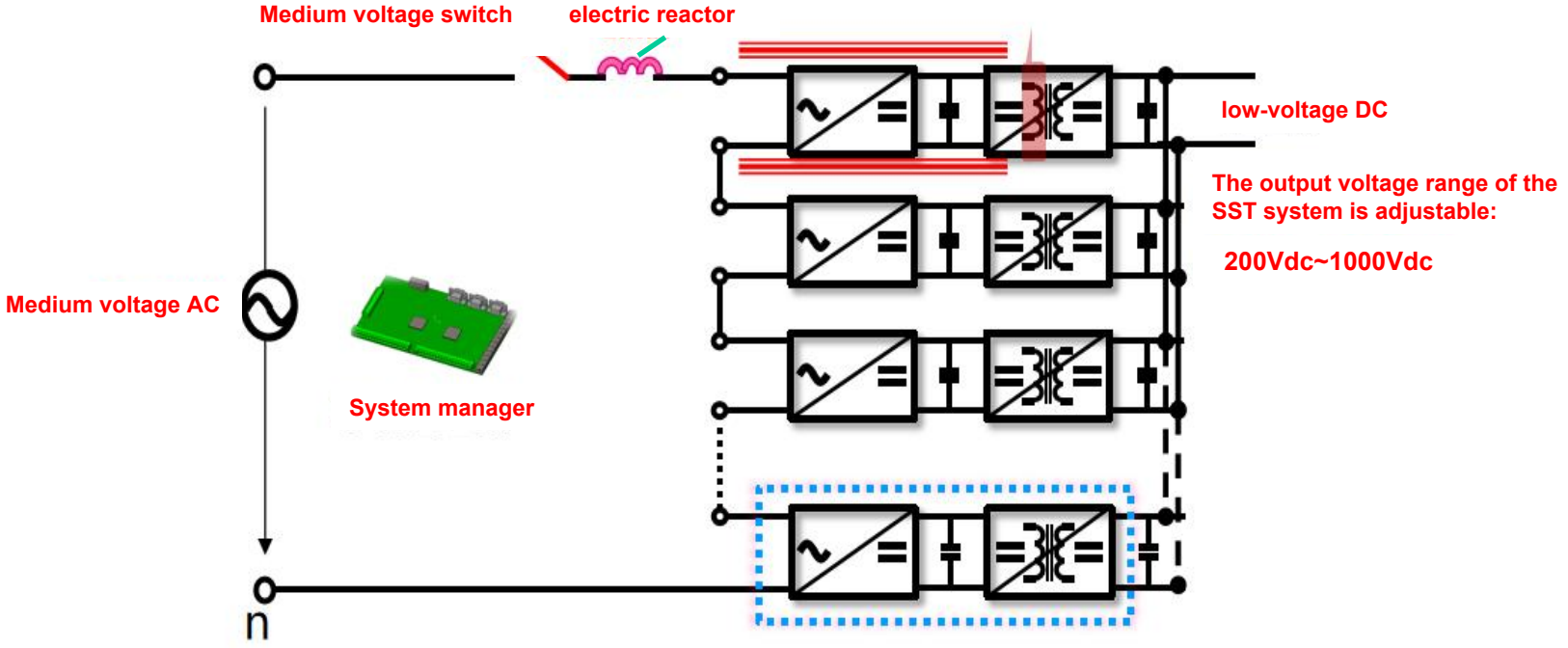
- Select the core device thyristor with low on-state threshold voltage to reduce losses, improve efficiency and achieve stable overall performance;
- The number of parallel components of the bridge arm is controlled within a reasonable range,improve the current sharing coefficient of the rectifier bridge arm;
- Self-developed low-power current-sharing reactor to improve the efficiency
- Stable, safe, decades of technology, output voltage up to 1500V, current 100kA(or special customization);
- Multi-pulse modes such as 12, 24, and 36 can be used to reduce the impact of power supply system on power grid.



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D Industry Performance

Partners of Electrolysis Hydrogen Industry

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Create value for customers

Focus on customers

* Display for some brands only

Cases of Electrolysis Hydrogen

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* Partial live display only

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