High-voltage Frequency Inverter

SHMV - 100 - T - 06 - 1600KW - F+SS

SHMV - 100	T	06	1600KW	F+SS
Enterprise Code	Motor Type	Rated voltage of the main circuit	Rated power output	Configuration Options

Motor Type	Default: None
Asynchronous Motor	Default: None
Synchronous Motor	T

Rated voltage of the main circuit Nominal value	Permissible range
10:10KV	+10%-15%
06:6KV	+10%-15%
07:6.9KV	+10%-15%
1006:10 kV input, 6 kV output	+10%-15%
1007:10 kV input, 6 .9kV output	+10%-15%

Rated power output	Motor Power Rating (kW)
	185
	1600
	13750

Configuration Options Default: None

9: 9-level unit
F: Four-quadrant feedback
AP: Automatic bypass cabinet
MP: Manual bypass cabinet
DB: Energy consumption braking
C: Internal circulation air-water cooling
KF: Mine fan
SS: Soft start
More options, please consult...
Water-cooled

- The dimensions and weight are for reference only; the exact dimensions and weight shall be as specified in the technical agreement.
- For standard series units, the input voltage is identical to the output voltage.
- The overall height does not include the height of the cooling fan; an additional 300 mm to 600 mm should be added for the fan height.
- The above overall dimensions and weight refer to the combined total of the control cabinet, power unit cabinet, and transformer cabinet, excluding the line-frequency bypass cabinet.
- The minimum clearance requirements are as follows: at least 1500 mm from the front of the equipment to the wall, at least 1000 mm from the rear, at least 800 mm from either side, and at least 1000 mm from the top of the equipment to the ceiling.
- Standard overload capacity is 120% for 1 minute, allowed once every 10 minutes. Optional overload capacities of 125%, 150%, or 200% are available to meet different application requirements.
- The applicable motor power rating may vary depending on the motor type and construction, and is provided for reference only.

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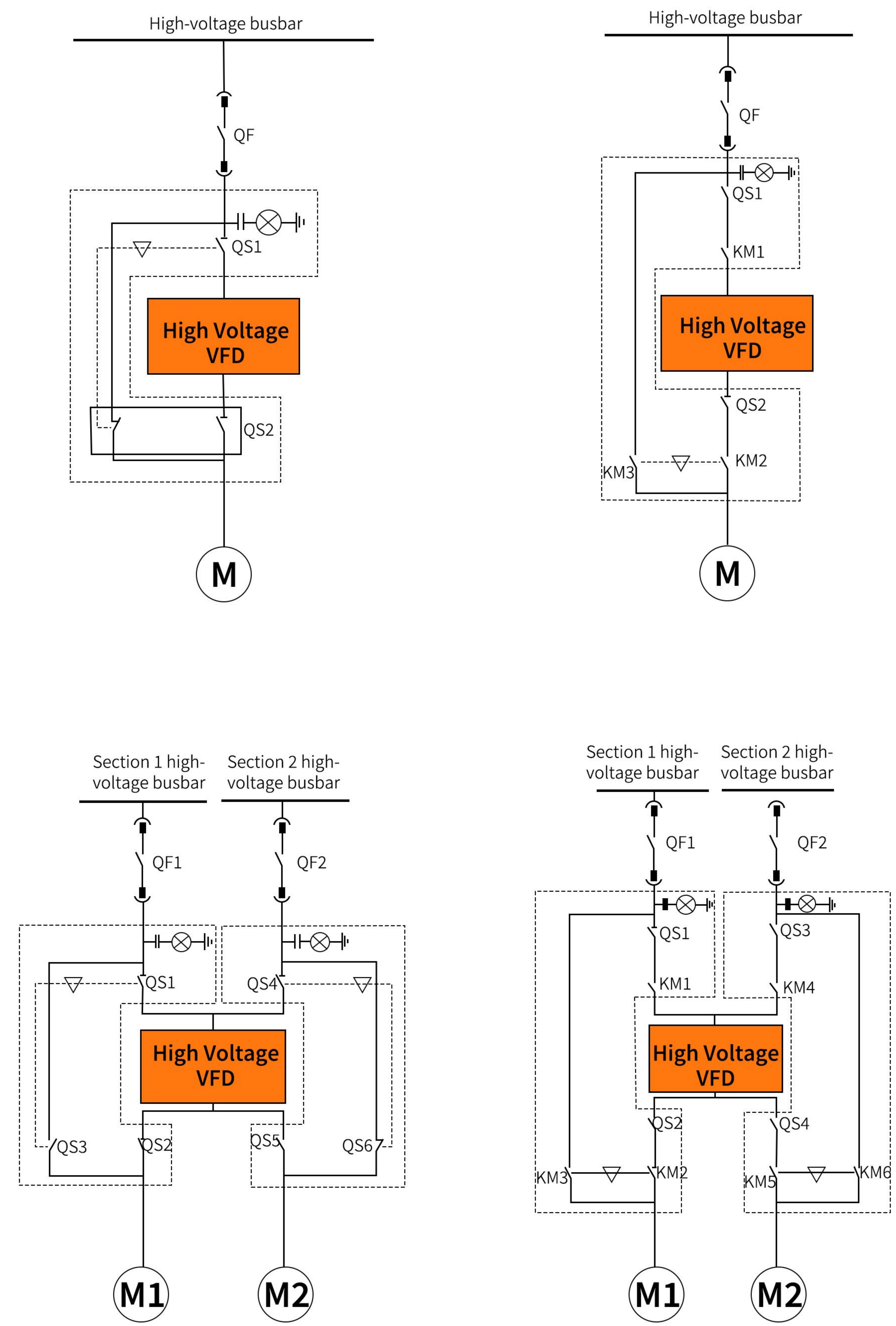
Model selection:

Model	Motor Power(Kw)	Frequency Converter Capacity(Kva)	Weight(Kg)	Cabinet Type	Cabinet Dimensions (L×W×H)
SHMV100-06-185kW	185	230	2650	Cabinet A1	1900X1500X2000
SHMV100-06-220kW	220	275			
SHMV100-06-250kW	250	320			
SHMV100-06-280kW	280	350	2760		
SHMV100-06-315kW	315	400			
SHMV100-06-355kW	355	450	2930		
SHMV100-06-400kW	400	500			
SHMV100-06-450kW	450	560	3160		
SHMV100-06-500kW	500	630	3360		
SHMV100-06-560kW	560	700	3985	Cabinet B1	2700X1500X2000
SHMV100-06-630kW	630	800	4042		
SHMV100-06-710kW	710	900	4160		
SHMV100-06-800kW	800	1000	4382		
SHMV100-06-900kW	900	1150	4590		
SHMV100-06-1000kW	1000	1250	4792		
SHMV100-06-1120kW	1120	1400	4985		
SHMV100-06-1250kW	1250	1600	5285		
SHMV100-06-1400kW	1400	1800	6120	Cabinet C1	3033X1650X2200
SHMV100-06-1600kW	1600	2000	6390		
SHMV100-06-1800kW	1800	2250	6745		
SHMV100-06-2000kW	2000	2500	7090		
SHMV100-06-2250kW	2250	2800	9220	Cabinet D1	5400X1400X2400
SHMV100-06-2500kW	2500	3200	9570		
SHMV100-06-2800kW	2800	3500	10070		
SHMV100-06-3200kW	3200	4000	10670		
SHMV100-06-3600kW	3550	4500	11240		
SHMV100-06-4000kW	4000	5000	12500	Cabinet F1	6850X1400X2400
SHMV100-06-4500kW	4500	5650	13000		
SHMV100-06-5000kW	5000	6300	14000		
SHMV100-06-5600kW	5600	7000	17755	Cabinet G1	8200X1600X2400/2600
SHMV100-06-6300kW	6300	8000	18795		
SHMV100-06-6600kW	7100	9000	19450		
SHMV100-10-185kW	185	230	2220	Cabinet A	2700X1500X2000
SHMV100-10-220kW	220	275	2240		
SHMV100-10-250kW	250	320	2260		
SHMV100-10-280kW	280	350	2286		
SHMV100-10-315kW	315	400	2316		
SHMV100-10-355kW	355	450	2346		
SHMV100-10-400kW	400	500	2383		
SHMV100-10-450kW	450	560	2433		
SHMV100-10-500kW	500	630	2483		
SHMV100-10-560kW	560	700	2593		
SHMV100-10-630kW	630	800	2719		
SHMV100-10-710kW	710	900	2875		
SHMV100-10-800kW	800	1000	3062		
SHMV100-10-900kW	900	1150	3192	Cabinet B	3033X1650X2200
SHMV100-10-1000kW	1000	1250	3258		
SHMV100-10-1120kW	1120	1400	3409		
SHMV100-10-1250kW	1250	1600	4390		
SHMV100-10-1400kW	1400	1800	4648		
SHMV100-10-1600kW	1600	2000	4948		
SHMV100-10-1800kW	1800	2250	5270		
SHMV100-10-2000kW	2000	2500	5604	Cabinet C	4000X1500X2200
SHMV100-10-2250kW	2250	2800	5916		
SHMV100-10-2500kW	2500	3150	7990		
SHMV100-10-2800kW	2800	3500	8150		
SHMV100-10-3200kW	3200	4000	8700		
SHMV100-10-3600kW	3550	4500	8820	Cabinet D	6925X1500X2455
SHMV100-10-4000kW	4000	5000	11990		
SHMV100-10-4500kW	4500	5600	12500		
SHMV100-10-5000kW	5000	6300	13300		
SHMV100-10-5500kW	5600	7000	13800		
SHMV100-10-6300kW	6300	8000	18410	Cabinet E	9100X1650X2455
SHMV100-10-7100kW	7100	9000	19700		
SHMV100-10-8000kW	8000	10000	20400	Cabinet F	9200X1700X2800
SHMV100-10-9000kW	9000	11250	22500		
SHMV100-10-10000kW	10000	12500	27120	Cabinet G	12200X1600X2455
SHMV100-10-11000kW	11000	13750	28860		

Primary circuit diagram:



Product Composition:

Power Unit

Each phase consists of 3 to 9 power units, generating a 4N+1-level PWM waveform. The three phases are connected in a Y (wye) configuration, directly outputting 3 to 11 kV.

Control System

An intelligent controller based on high-speed ARM, DSP, and FPGA; utilizing flux-closed-loop vector control and an optimized stacked-wave PWM technique to deliver high-quality sinusoidal voltage and current outputs.

Air Cooling

It employs internationally renowned, industry-leading centrifugal blowers, which offer high airflow, ample margin, long service life, and excellent stability—ensuring reliable cooling for the high-voltage variable frequency drive (HV VFD) and enhancing overall product reliability.

Human-Machine Interface (HMI)

It features a touch screen from a well-known brand, offering a modern user interface, abundant interfaces, and easy on-site expansion and integration with user systems.

Power Unit

The new power unit design is lighter and more aesthetically refined.
Its innovative semi-sealed structural design enhances environmental adaptability and reliability.
Equipped with non-lifetime-limited, self-healing film capacitors that do not short-circuit even if punctured by overvoltage.

Modular Design

The units feature a modular design, allowing for full interchangeability and easy installation and removal.

Bypass Cabinet / Wiring Cabinet

An innovative integrated design incorporates the bypass cabinet directly into the system—without altering the product's installation dimensions—allowing for either a built-in one-to-one manual bypass cabinet or a one-to-one automatic bypass cabinet.

Transformer Cabinet

The transformer cabinet and power unit cabinet are arranged in a front-to-back layout. Through advanced thermal design, this configuration ensures adequate cooling while reducing the required on-site installation footprint, thereby lowering the customer's infrastructure costs.

Multi-pulse rectification scheme

On the input side, a phase-shifting transformer is employed to implement a multi-pulse rectification scheme, significantly improving the current waveform on the grid side, enhancing input power factor, and reducing harmonic distortion injected into the power grid.

Advanced Short-Circuit Protection Technology

Phase-Shifting Transformer Secondary-Side Short-Circuit Protection Technology
This technology prevents accidents such as fires and equipment damage caused by secondary-side short circuits in the phase-shifting transformer, minimizing customer losses and preventing fault escalation.
Timely: Detects short-circuit events and initiates protective actions within the transformer's withstand time, ensuring equipment safety.
Comprehensive: Considers all possible short-circuit scenarios—including the number of affected phases and fault locations—providing effective protection under diverse operating conditions.
Flexible: Requires no additional hardware, offering a more flexible and reliable solution.

Harmonic-Free Solution:

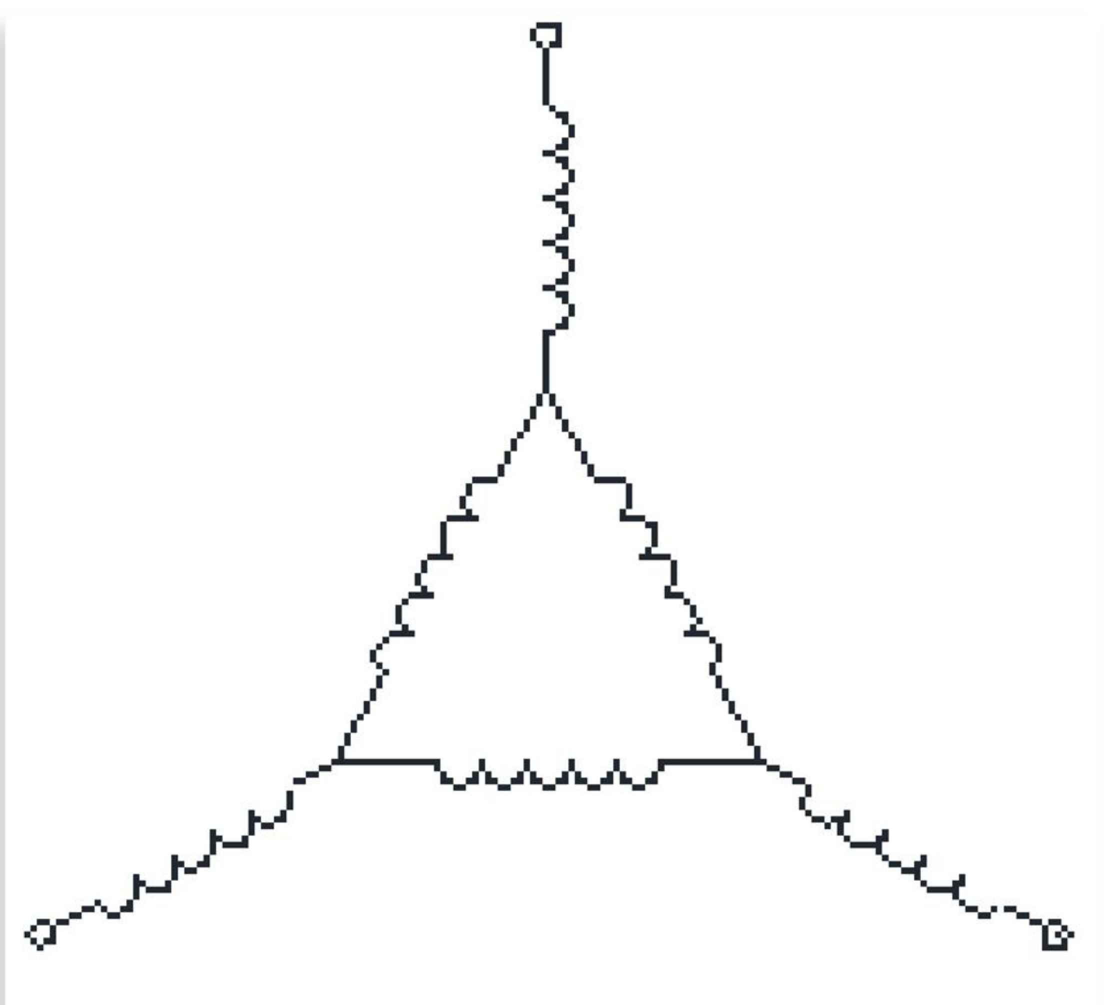
The secondary winding of the phase-shifting transformer employs an extended delta connection, altering the phase angle of each secondary winding per phase.

- This mitigates the impact of harmonics generated by the unit on the power grid.
- Taking two units connected in series as an example for analysis: the phase-shift angle $\sigma = 60°/2 = 30°$.
- The current is referred to the primary input side and expanded into a Fourier series:

$$I_a = \frac{1}{2}\left(I_1\sin(\omega t) + I_5\sin(7\omega t) + I_7\sin(7\omega t) + I_{11}\sin(11\omega t) + I_{13}\sin(13\omega t) \ldots\right)$$

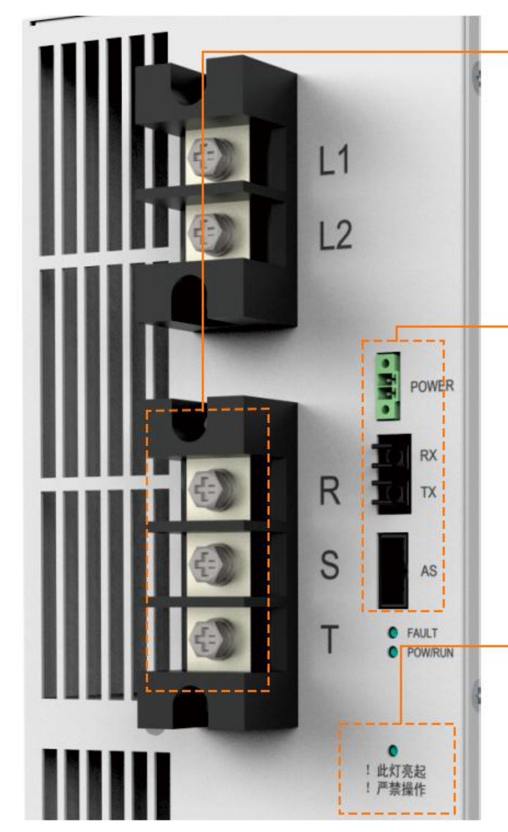
$$I_b = \frac{1}{2}\left(I_1\sin(\omega t) - I_5\sin(7\omega t) - I_7\sin(7\omega t) - I_{11}\sin(11\omega t) + I_{13}\sin(13\omega t) \ldots\right)$$

The 5th, 7th, and 11th harmonic components have phase angles differing by 180°, and through phase-shifting rectification technology, these harmonics cancel each other out.



Extended delta connection

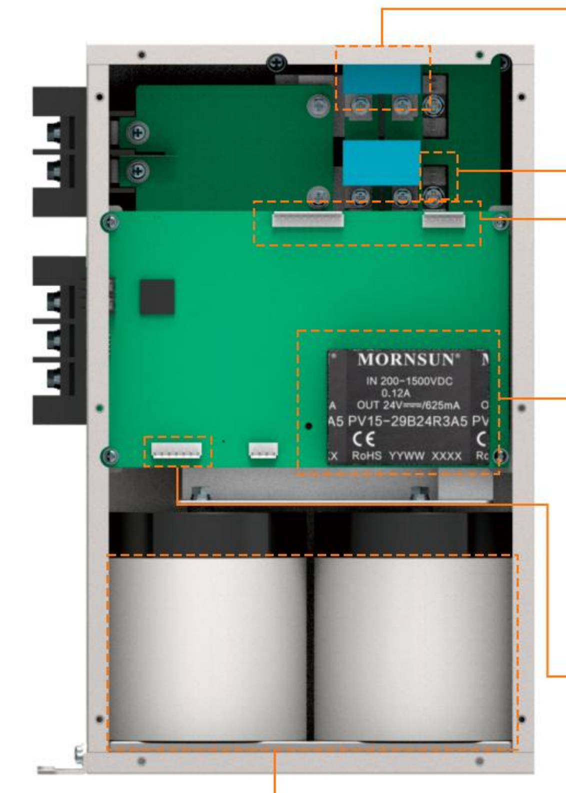
Take the input phase-shifting transformer of a 10kV variable frequency drive (VFD) as an example. Its primary winding is rated at 10kV, while the secondary side consists of 24 three-phase windings, each with an output voltage of 690V. Every winding adopts an extended delta connection and has a phase shift angle difference of 7.5°. This configuration can effectively eliminate harmonics below the 47th order, which means that 48-pulse rectification is capable of suppressing harmonics lower than the 47th order (calculated by the formula 6n-1, where n refers to the number of units per phase).



High-voltage barrier-type power terminal blocks are used, making wiring more convenient and safer.

The power unit panel features a well-organized layout;
communication between the unit and the control section is implemented via optical fiber;
and a rich set of interfaces facilitates on-site maintenance and commissioning.

Power unit live-voltage indicators enhance safety and provide peace of mind during on-site maintenance.



High-voltage-rated IGBT snubber capacitors absorb voltage spikes, ensuring smoother IGBT voltage waveforms.

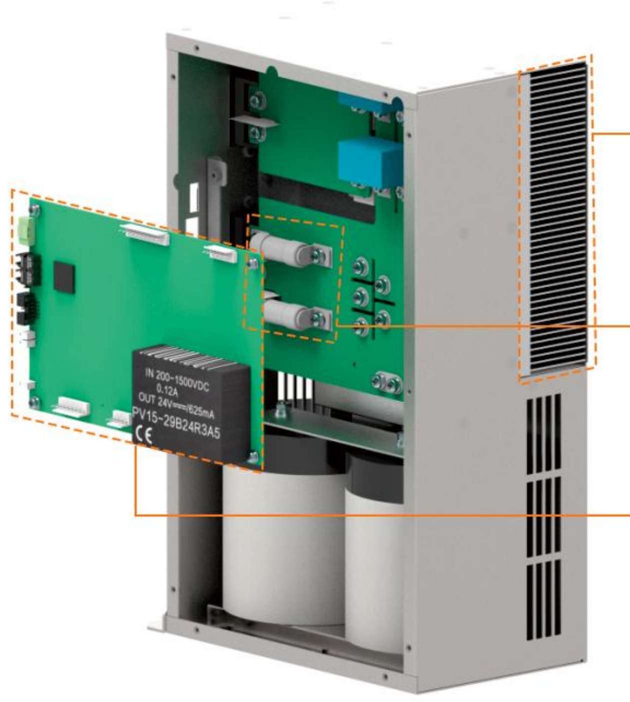
Advanced insulated-gate bipolar transistors (IGBTs) are employed, offering low power loss and high efficiency.

Dedicated IGBT high-side and low-side gate drive connectors.

Domestically sourced, top-tier modular power supplies are used, providing higher reliability and more stable output voltage.

RST (Reset/Test) detection connector.

Filter capacitors stabilize and maintain the DC bus voltage. Specially designed long-life metallized film capacitors, optimized for power electronics applications, are utilized.



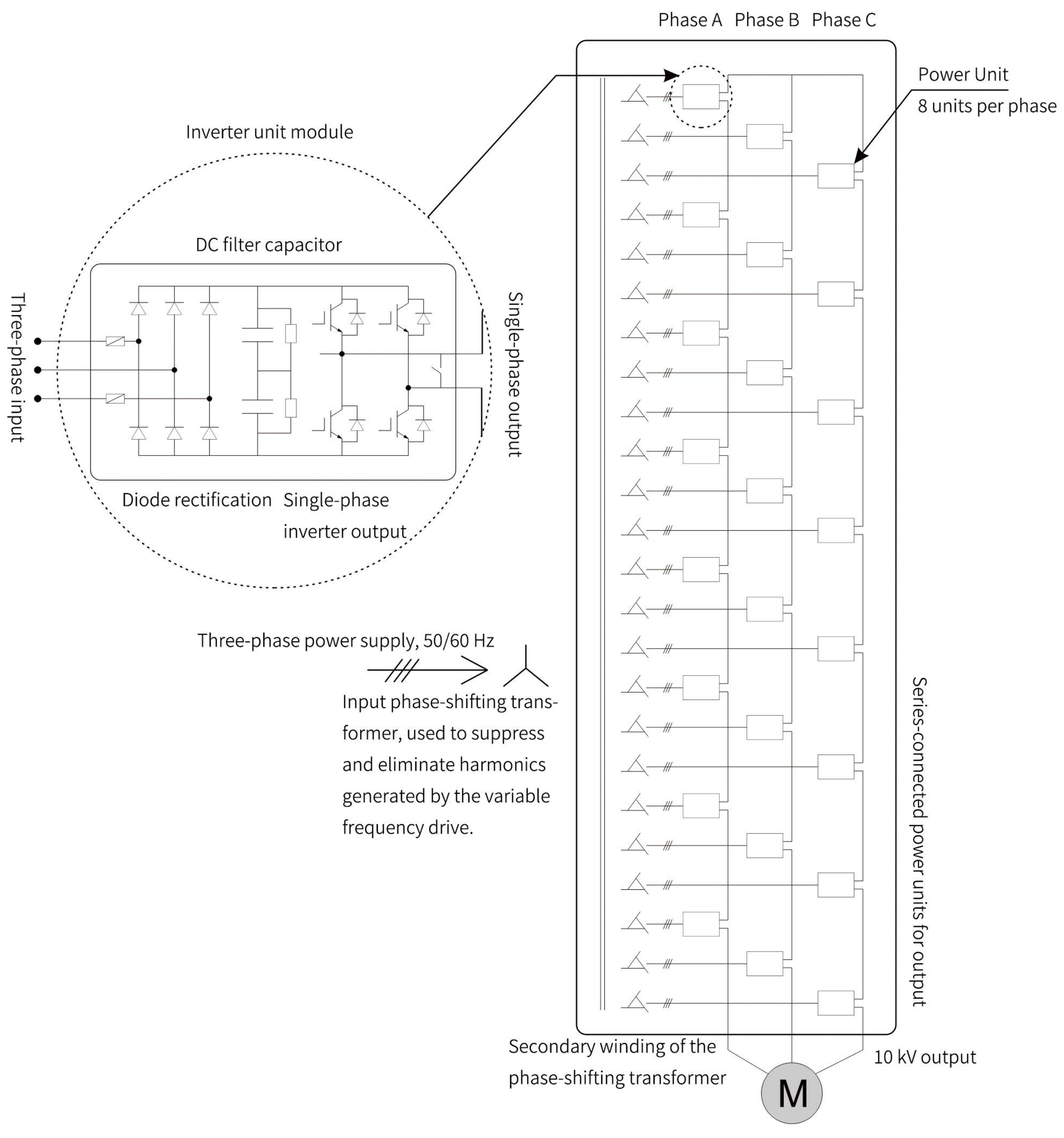
A unique thermal design efficiently transfers heat from the heatsink to the cooling air.

Input fuses are installed at the three-phase voltage input terminals, providing excellent protection.

The control board transmits PWM control signals to the gate driver, and the gate driver circuit board directly drives the IGBTs.

Harmonic-Free Solution:

The main circuit of the high-voltage variable frequency drive (VFD) consists of an input transformer and multiple single-phase PWM inverter units. For a 6 kV system, five inverter units per phase can generate an output voltage with 11 levels. For a 10 kV system, eight inverter units per phase can produce an output voltage with 17 levels. A pre-charge circuit is employed to reduce the capacitor inrush current and transformer magnetizing inrush current during high-voltage startup, thereby minimizing stress on the power grid, protecting the VFD, and extending its service life.



Performance Advantages:

High reliability is achieved by using 1700V high-voltage IGBTs (Insulated Gate Bipolar Transistors) from reputable manufacturers, ensuring an average fault-free operation period of 20 years.

The main circuit employs long-life self-healing metal film capacitors instead of traditional electrolytic capacitors that require periodic replacement, resulting in low maintenance and operational costs with no need for servicing or replacements throughout the entire lifecycle of the variable frequency drive.

The system efficiency is as high as 97.5% (design value), which is particularly energy-saving in flow control applications.

Diode rectification ensures a power factor exceeding 95% across the speed regulation range, eliminating the need for power factor compensation capacitors.

The multi-level PWM control method produces output waveforms very similar to sine waves (11 levels for 6kV VFDs and 17 levels for 10kV VFDs). This near-perfect sine waveform allows motors to operate without capacity reduction and prevents additional harmonic heating.

Using multi-pulse rectification and phase-shifting transformers: for the 3.3kV class - 18 pulses; 6.0kV class - 30 pulses; 10kV class - 48 pulses. Harmonic filters are unnecessary as it meets the limits on harmonic current outputs specified by IEEE-519 (1992) and GB14549-1993 standards.

In the event of a momentary voltage drop or power interruption within 300ms, the VFD can maintain output and continue operation, providing safety assurance for critical loads.

Synchronous switching functions allow smooth transitions to bypass at line frequency without disturbance. One VFD can control multiple motors, and when switching from VFD power supply to bypass at line frequency, there is no impact on the grid or motor, allowing for soft starting of extremely high-power motors without disturbances.

Precise control ensures short acceleration times and excellent dynamic response, meeting requirements for high-precision control. For variable torque loads, it offers protection against overcurrent during acceleration and overvoltage during deceleration.

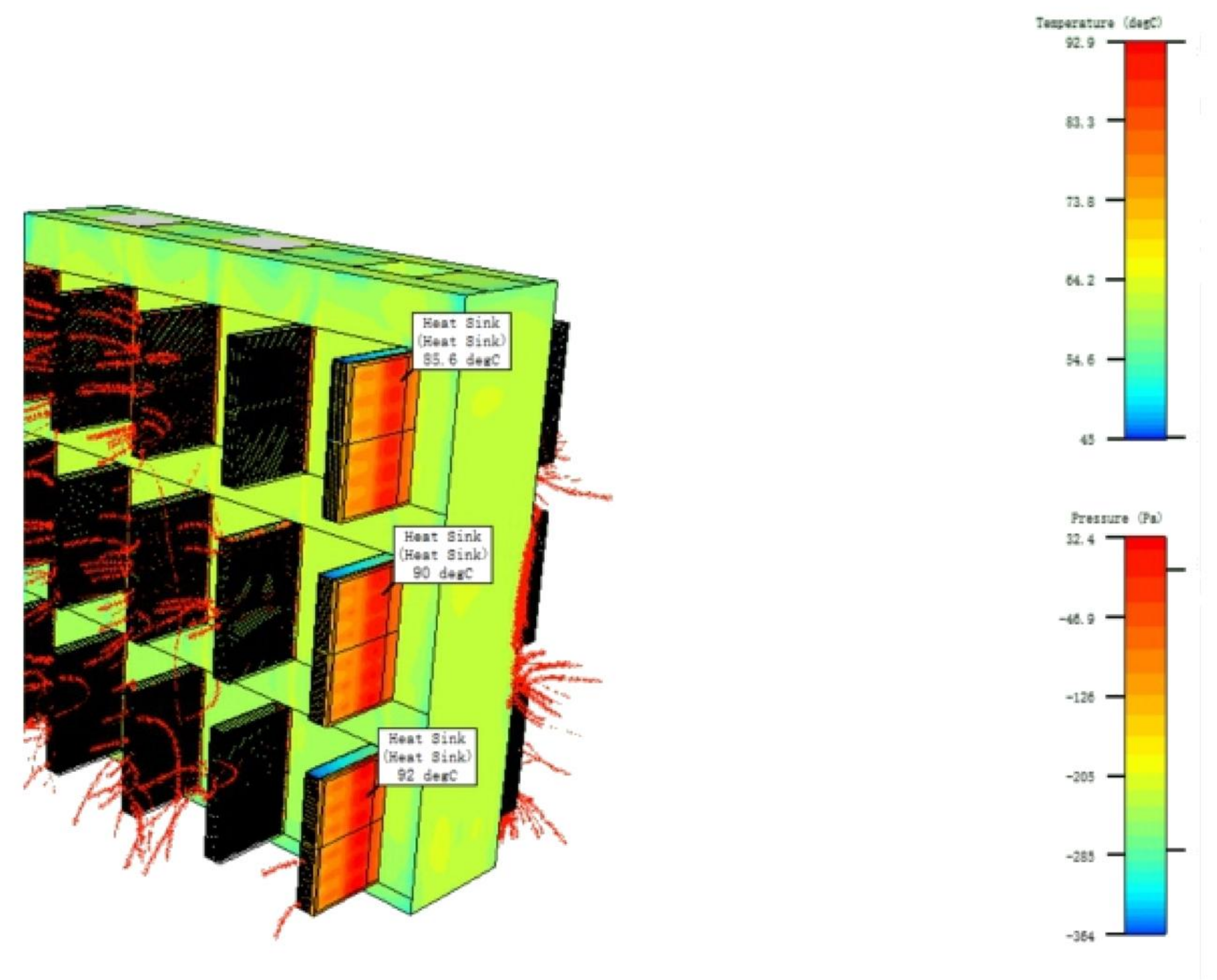
Built-in input dry-type isolation transformers in the VFD feature an integrated design that provides better protection for motors, simplifies installation, and reduces installation costs.

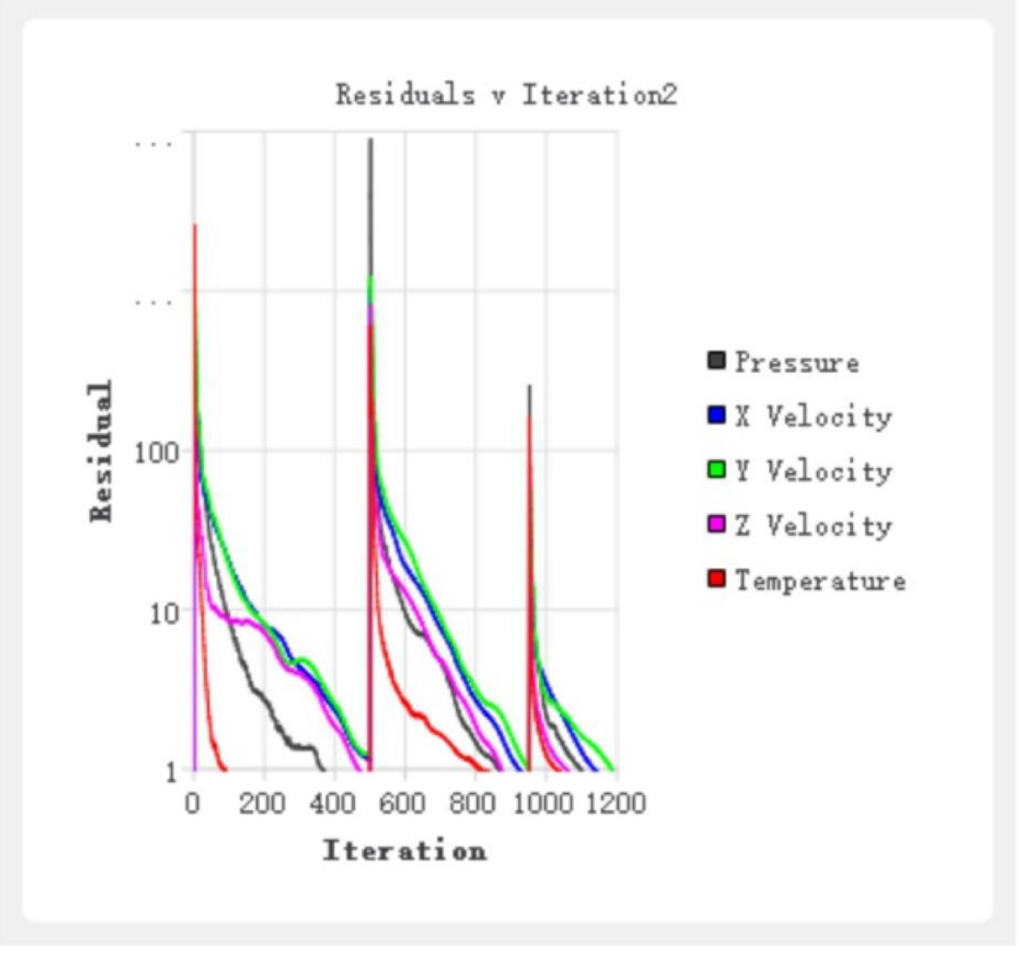
Capable of directly driving standard high-voltage motors, it can be matched with conventional synchronous/asynchronous motors and other special motors. There's no need for an output transformer, saving costs and energy while also reducing space requirements for installation sites.

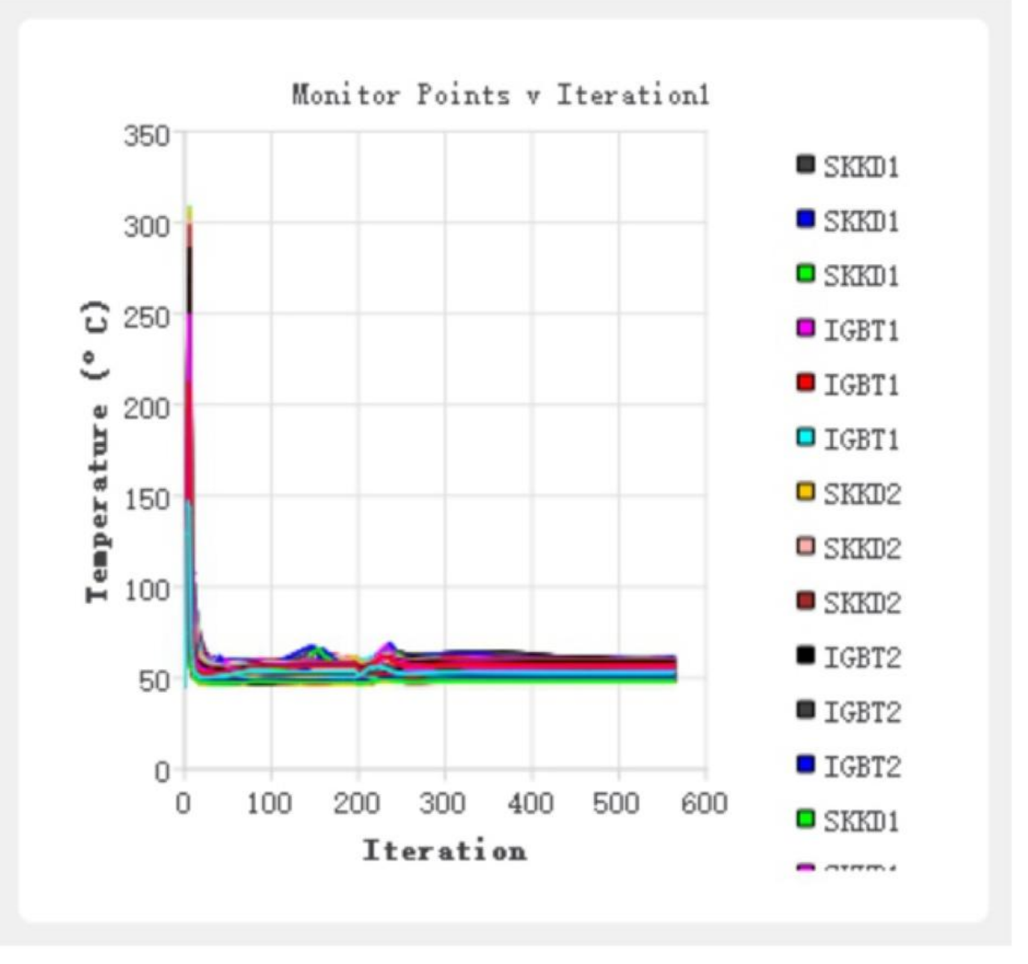
Product Advantages:

Thermal Simulation Analysis

Mainstream simulation software is used to perform thermal analysis, calculating the heatsink temperature and airflow distribution within the cooling ducts.







Technical Specifications Table:

Voltage	6 kV Series	10 kV Series
Input Rated Voltage	3-phase 50/60Hz, 6kV	3-phase 50/60Hz, 10kV
Input Voltage Tolerance	Full-load operation at 6kV/10kV±10%; long-term derated operation allowed at -10%~-35% voltage deviation	
Frequency Variation Range	50Hz±10%	
Unit Input Voltage	690V	
Input Power Factor	0.95 (above 20% load)	
Input Current Harmonics	<2% (complies with IEEE 519-1992 and GB/T 14549-93)	
Output Voltage Range	0~6kV	0~10kV
Output Power Range	230~7000kVA	250~12500kVA
Unit Output Voltage	690V	
Output Frequency Range	0~50Hz (max. 330Hz; above 120Hz available on factory customization)	
Speed Control Ratio	40:1 (general vector control) ; 100:1 (SVC) ; 200:1 (FVC)	
Speed Accuracy	±0.5% (SVC) ; ±0.2% (FVC)	
Torque Response	750rad/s	
Starting Torque	0.5Hz/150% (SVC) ; 0Hz/180% (FVC)	
Technical Solution		
Control Mode	General vector control, sensorless/sensor-based vector control (SVC/FVC)	
Rectifier Topology	3-phase full-bridge diode rectifier	
Inverter Topology	IGBT inverter bridge	
Acceleration/Deceleration Time	0.1–6500 seconds; above 6500 seconds available on factory customization	
Start/Stop Control	Local or remote	
Control System	ARM, DSP, CPLD, HMI, PLC	
Panel Display	Touch screen, Simplified Chinese (other languages customizable)	
Overload Capacity	120% of rated current for 1 minute	
Overall efficiency	>97.5%	
Does the inverter unit have a fuse	The input side of the power unit is equipped with a fuse.	
Fiber Optic Isolation for Electrical Isolation Section	Yes	
Input Filter Required	No	
Output Filter Required	No	
Power Factor Compensation Required	No	
Power Unit Protection		
System Protection:	Motor overload, output overload, output short circuit, output ground fault, input overcurrent,input overvoltage, input phase imbalance, input ground fault, cooling fan failure alarm, door interlock protection, transformer overtemperature alarm, transformer overtemperature trip, etc.	
Mean Time Between Failures (MTBF):	50,000 hours	

Technical Specifications Table:

Communication Interface

Digital Inputs	8 channels, dry contact relay (other options customizable)
Digital Outputs	4 channels, dry contact relay (other options customizable)
Analog Inputs	4 channels, 4–20 mA or 0–10 V (other options customizable)
Analog Outputs	4 channels, 4–20 mA or 0–10 V (other options customizable)

Operating Environment — Indoor

Ambient temperature:	–10°C to +40°C.Derated operation required at +40°C to +50°C.Preheating is required before startup if the ambient temperature is below –10°C.
Relative humidity:	5% to 95%, non-condensing.
Altitude:	< 1,000 m above sea level.Derated operation is required at altitudes above 1,000 m—please specify this when placing your order.

Equipment Noise — <75dB

Cooling Method:	Forced air cooling or water cooling
Protection Rating:	IP30, IP33, IP42, IP55 (customizable)
Cable Entry/Exit Configuration:	Bottom entry/bottom exit or top entry/top exit (other configurations available upon customer request)
Control Power Supply:	380 V ±10% AC, three-phase four-wire

Energy-Saving Principle:

Fans and pumps are mechanical devices used to transport fluids (gases and liquids). Their function is to transfer mechanical energy from a prime mover or other energy sources to the fluid, thereby enabling fluid transport. Once the fluid receives this mechanical energy, it not only overcomes flow resistance during transportation but can also be moved from a low-pressure area to a high-pressure area, or from a lower elevation to a higher elevation. Generally, mechanical equipment designed for transporting gases is referred to as a fan (or compressor), while equipment for transporting liquids is called a pump.

Performance Parameters of Fans and Pumps

The basic performance of fans and pumps is characterized by six fundamental parameters: flow rate, total pressure, shaft power, efficiency, rotational speed, and specific speed.

Flow Rate:
Denoted by the letter Q (or q), with units such as liters per second (L/s), cubic meters per second (m^3/s), or cubic meters per hour (m^3/h).

Total Pressure:
Total pressure, denoted by p, represents the mechanical energy gained by a gas or liquid after passing through a fan or pump. Specifically, it refers to the mechanical energy acquired per unit volume of fluid as it moves from the inlet cross-section (1) to the outlet cross-section (2). The formula for total pressure is: $P=(P_2+\frac{1}{2}PV_2^2)-(P_1+\frac{1}{2}PV_1^2)$ N/m²

Shaft Power:
The power transmitted from the prime mover or drive system to the shaft of the fan or pump is called shaft power, denoted by P, and measured in kilowatts (kW). $P=\frac{Q\times p\times g}{1000\,\eta_r\eta_f}=\frac{Q\times p}{102\,\eta_r\eta_f}$

Q — air or water flow rate (m^3/s, Nm^3/s);
p — total pressure (kg/m^2);
η_f— efficiency;
"1/102" = g/1000 — unit conversion factor for converting from kg・m/s to kW.
η_f— drive system efficiency;

If the units for airflow or water flow rate are expressed in m^3/h and pressure is in kg/m^2, then the result must also be divided by 3600:

$$P=\frac{Q\times p\times g}{3{,}600{,}000\eta_r\eta_f}$$

If the units for airflow or water flow rate are expressed in m^3/s and pressure is in MPa, then:

$$P=\frac{Q\times p\times 1000000}{1000\cdot\eta_r\eta_f}=1000\cdot\frac{Q\times p}{\eta_r\eta_f}$$

If the units for airflow or water flow rate are expressed in m^3/h and pressure is in MPa, then the result must also be divided by 3600:

$$P=\frac{1000\times Q\times p}{3600\eta_r\eta_f}=\frac{Q\times p}{3.6\eta_r\eta_f}$$

If the units for airflow or water flow rate are expressed in m^3/s and pressure is in kPa, then:

$$P=\frac{Q\times p\times 1000}{1000\eta_r\eta_f}=\frac{Q\times p}{\eta_r\eta_f}$$

Electric Motor Sizing: $P_d=\frac{P}{\eta_d}$ (η_d-----Motor Efficiency) $P=\frac{Q\times p}{\eta_r\eta_f\eta_d}$

Efficiency:
The ratio of the fluid output power (effective power) P_u to the input power (shaft power) P is referred to as the fan or pump efficiency, or total pressure efficiency, denoted by η: $\eta_f=\frac{P_u}{P}=\frac{Q.p}{P}$

Rotational Speed:
The rotational speed of a fan or pump refers to the angular velocity of its shaft—i.e., the number of revolutions the fan shaft makes per unit time. It is denoted by n and expressed in units of rpm (revolutions per minute) or S-1(radians per second).

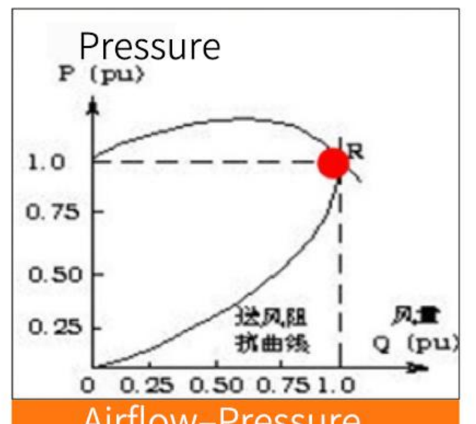
Specific Speed:
The specific speed of a fan or pump is denoted by n_y and is defined by the following formula: $n_y=\frac{5.54n\sqrt{q}}{(\frac{1.2}{\rho}p)^{3/4}}$

As a performance parameter, specific speed is calculated using the basic performance parameters corresponding to the point of maximum efficiency for a given fan or pump. For geometrically similar fans or pumps, the specific speed remains constant regardless of their physical size or rotational speed. Therefore, specific speed also serves as a criterion for classifying fans and pumps.

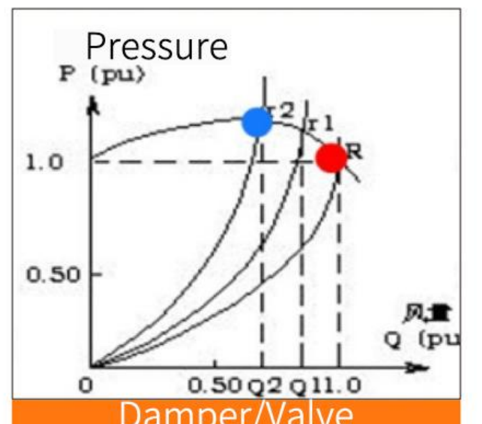
Main Characteristics of Fan and Pump Drive Systems:

The load characteristics of centrifugal fans and pumps belong to the quadratic torque type—meaning the torque required at the shaft is proportional to the square of the rotational speed.

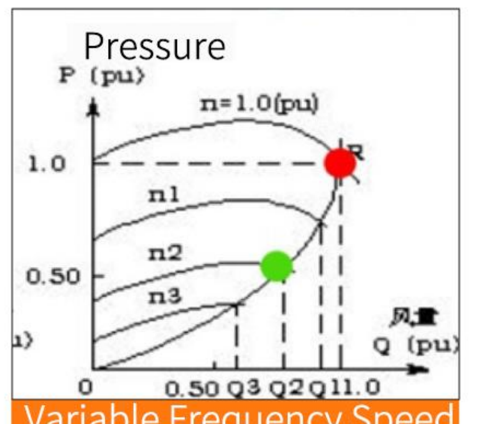
When three similarity conditions are satisfied—geometric similarity, kinematic similarity, and dynamic similarity—fans and pumps follow the affinity laws. For a given fan (or pump) handling fluid of constant density ρ, if only the rotational speed changes, its performance parameters vary according to the following proportional relationships:
Flow rate is directly proportional to the first power of speed;
Head (pressure) is proportional to the square of the speed;
Shaft power is proportional to the cube of the speed. $\frac{Q'}{Q}=\frac{n'}{n}$; $\frac{H'}{H}=(\frac{n'}{n})^2$ $\frac{p'}{p}=(\frac{n'}{n})^2$; $\frac{P'}{P}=(\frac{n'}{n})^3$



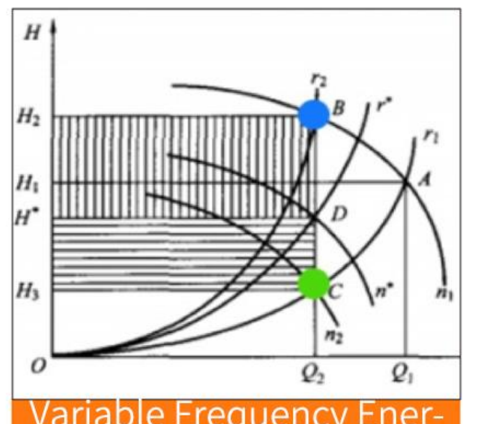
Airflow–Pressure Characteristic Curve



Damper/Valve Control Characteristics



Variable Frequency Speed Control Characteristics



Variable Frequency Energy-Saving Potential

Industry Applications:

Power Generation:
Induced draft fans, primary/secondary air fans, circulating water pumps, boiler feed pumps, condensate pumps, slurry circulation pumps, vertical coal mills

Oil, Gas & Chemicals:
Electric submersible pumps (ESPs), injection pumps, crude oil transfer pumps, pipeline compressors, LNG compressors, air separation compressors, syngas compressors, ammonia refrigeration compressors ("ice machines"), product gas compressors, propylene compressors, carbon dioxide compressors

Mining:
Conveyor belts, main mine ventilation fans, methane drainage pumps, slurry pumps, crushers, semi-autogenous grinding (SAG) mills, ball mills, high-pressure roller mills

Cement:
Raw mill circulating fans, coal mill exhaust fans, cement mill exhaust fans, kiln inlet exhaust fans, kiln outlet high-temperature fans, kiln tail exhaust fans, clinker cooler fans, coal mills, roller presses

Metallurgy:
Dust collection fans, sintering main induced draft fans, blast furnace blowers, circulating water pumps, descaling pumps, slag granulation pumps, air separation compressors, grinding mills, stamping presses, bidirectional energy recovery compressors

Municipal/Water Treatment:
Raw water intake pumps, water supply pumps, primary lift pumps, secondary clear water pumps, seawater desalination pumps, booster pumps, irrigation pumps

Waste-to-Energy:
Various standard fans and pumps

Main Features

- Low-voltage ride-through (LVRT)
- Auto-restart after power loss (within 20 seconds)
- Power cell bypass function
- Flying-start (spin-start) capability
- Synchronous switching function
- Redundant control power supply (optional)
- Redundant power unit design (N+1, optional)
- Redundant cooling fans (optional)
- Other functions customizable per customer requirements
- Dedicated control function module for mills

Main Features

- Magnetizing inrush current suppression cabinet
- One-drive-one manual bypass cabinet
- One-drive-two manual bypass cabinet
- One-drive-one automatic bypass cabinet
- One-drive-two automatic bypass cabinet
- One-drive-one synchronous switching cabinet
- Output reactor cabinet
- Isolation cabinet