Product Features

Basic Parameters

The high-voltage variable frequency drive (VFD) system is designed with high reliability, ease of operation, and high performance as its core objectives. Utilizing advanced IGBT power devices, the system incorporates fully digital control through a combination of DSP, FPGA , and ARM micro controllers. The technical requirements are as follows:

No.	Name	Guaranteed Values	Notes
1	Type	High-High Configuration	
2	Suppliers and Origins	V＆T	
3	Installation location	Interior	
4	Technical agreement	Multi-level series connection, AC-DC-AC conversion, voltage-source type, high-high configuration	
5	Requirements for Electric Motors	Asynchronous and synchronous electric motors	
6	Presence or absence of fuses on the input side of frequency converter	Two-phase fuses on the input side	
7	Permissible variation range of the rated input voltage(kV)	/+10%~-10%	
8	System input voltage(kV)	13.8kV	
9	System output voltage(kV)	6.6kV	
10	System output current(A)	240A/216A	
11	Highest output voltage on the inverter side(kV)	6.6kV	
12	Rated capacity(kVA)	2500kVA/2250kVA	
13	Rated input frequency / Allowed variation range	45-55Hz	
14	Sensitivity to grid voltage fluctuations	Meeting the specifications of "DL/T 1648-2016 Technical Specification of High and Low Voltage Ride Through for Inverter in Power Plant and Substation"	
15	Frequency converter efficiency	>96% (at rated output, including transformer)	
16	Input and Output current harmonics	<3% (at rated load)	
17	Reliability metric (Mean Time Between Failures)	40000hours	
18	Power factor on the input side	>0.96 (above 20% load)	
19	Control type	Multi-level Sinusoidal Pulse	

		Width Modulation (PWM) Control	
20	Control power / Capacity	Single-phase AC 220V ± 10%, 2kVA	Field provided
21	Rectification form	Diode full bridge rectification	
22	Inverter configuration	IGBT Single Phase Inverter	
23	Drive quadrant	1、3	
24	Whether the electrical isolation part adopts optical fiber cables.	Yes	
25	Noise level	Below 85 dB	
26	Type of cooling	Air cooling	
27	Overload capacity	130% 1 minute, 180% Immediate Protection	
28	Frequency converter losses	Power*2	
29	Total System Losses	Power*4	
30	Standard control connections	Direct hardwired switching connections	
31	Specifications and Number of Analog Signal (Input)	Industrial standard signal: 3 channels of 4 to 20mA	
32	Specifications and Number of Analog Signal (Output)	Industrial standard signal: 4 channels of 4 to 20mA	
33	Specifications and Quantity of Switching Signal (Input)	Passive contacts, 16 points	
34	Specifications and Quantity of Switching Signal (Output)	Relay Contacts, AC220V/5A or DC24V/5A，12 Points	
35	IP level	IP30	
36	Operation keyboard	Touchscreen standard operation panel	
37	Interface language	Simplified Chinese / English	
38	Dimensions of the frequency converter	Specific dimensions should accurately follow the user's drawings	mm
39	Front or Rear access for maintenance	Accessible from front or rear / Single-sided accessible	
40	After-sales service commitment	Problem Response & Resolution: We commit to acknowledging issues within 2 hours and resolving them within 24 hours.	

performance parameters

- ✧ The FV81 series of high-voltage inverters by V＆T adopts a direct "High-High" structure, featuring a direct 10kV output without the need for an output step-up transformer. The output utilizes a cascaded phase-shifted PWM method from individual units.
- ✧ The system features an integrated design encompassing all components including the input dry-type isolation transformer, the variable frequency drive, and all internal wiring. Users simply need to connect the high-voltage input, high-voltage output, low-voltage control power supply, and control signal lines. The entire system undergoes comprehensive testing prior to leaving the factory.

Core Technical Characteristics

- ✧ Vector Control Technology: Through the measurement and control of the stator current vector of an AC motor, vector control technology utilizes the principle of flux orientation to separately regulate the magnetizing current and torque current of the AC motor, thereby achieving the purpose of controlling the motor's torque. Its characteristics include high starting torque, rapid torque dynamic response, high speed regulation accuracy, and strong load carrying capacity. It is capable of driving both AC induction motors and synchronous motors. Under vector control mode, the inverter controls the excitation and torque currents, automatically compensates for stator resistance voltage drop and slip frequency, avoiding low-frequency oscillations, and adapts automatically to load conditions.
- ✧ Oscillation Suppression Technology: When the motor is lightly loaded or unloaded, there may appear local instability phenomena, during which the amplitude of the current can fluctuate significantly. Oscillations in the current could potentially trigger system protections due to over-current or over-voltage. Our company employs a superior current oscillation suppression algorithm that effectively mitigates these oscillations, ensuring that the system operates stably and reliably.
- ✧ Neutral Point Drift Function: Upon detection of a unit failure, the system is capable of bypassing the faulty unit within 100 microseconds. It then executes the neutral point drift technique, maintaining balanced line voltages on the output, thus maximizing the utilization of voltage to the greatest extent possible.
- ✧ Faulty Unit Hot Reset Technology: If a unit fails during operation and the inverter has already bypassed it to continue running, the faulty unit can now be reset while the inverter is still in operation, without needing to wait for the inverter to shut down.
- ✧ Multi-unit Master-Slave Control Technology: The inverter is equipped with master-slave control functionality, enabling multiple inverters to form a master-slave control network via a data bus. One inverter is designated as the master unit while the others are set as slave units. The master unit continuously collects status information from each slave unit and simultaneously sends frequency and torque commands to them, achieving power balance and integrated control across all inverters. This technology is suitable for applications requiring power balancing control, such as conveyor belts, hoists, and other systems where coordinated operation is essential.
- ✧ Rapid Flywheel Start Technology: Through real-time acquisition of the stator voltage's frequency, amplitude, and phase information, when a flywheel start is required, the initial voltage of the inverter is adjusted to match the stator voltage. Following this, the output voltage is quickly adjusted to normal levels. Utilizing this technology, after the inverter is protected from load impact, it can automatically reset itself and then restart automatically, thereby avoiding losses caused by inverter protection shutdowns in critical situations, such as high-temperature fans in cement plants. The rapid flywheel start technology enables the inverter to reset from a protection state and resume load operation within one second.
- ✧ Efficient Fiber Optic Communication Technology: The communication cycle between the main controller and the units is 1.5 microseconds, demonstrating extremely high communication efficiency and excellent real-time performance.
- ✧ Possesses Low Voltage Ride Through (LVRT) and High Voltage Ride Through (HVRT) capabilities. When transient, dynamic, or prolonged voltage sags at the supply line, caused by external faults or disturbances, drop into the specified

LVRT zone, the system is able to provide reliable power supply, ensuring the safe operation of the connected equipment.

✧ Various Control Modes: Options include local control, remote box control, and DCS (Distributed Control System) control. Supports communication protocols such as MODBUS and PROFIBUS. Frequency setting can be done locally, remotely via analog input, or through communication interfaces. Supports preset frequencies and acceleration/deceleration functions.

✧ Direct Current (DC) Braking Technology: When the motor is in a rotating state (below 10 Hz), a DC braking current is applied, which can forcibly transition the motor from a rotating state to a stopped state.

✧ Automatic Output Voltage Stabilization Technology: The inverter continuously monitors the bus voltage of each unit and adjusts the output voltage factor based on the bus voltage readings, thereby implementing an automatic voltage stabilization function. This prevents fluctuations in the grid from affecting the output voltage.

✧ Built-in UPS Power Module: In the event of a power failure to the peripheral control power supply, the system immediately switches to the backup power supply provided by the transformer within the inverter.

✧ Grid Instantaneous Power Loss Restart Function: The system is capable of restarting automatically after a brief power loss, with the duration of the power outage being configurable. The default setting is typically 3 seconds, but it can provide a maximum waiting time of up to 60 seconds before attempting to restart.

✧ With a wealth of practical design experience, we are capable of designing specialized main circuits for special operating conditions to meet a variety of main circuit requirements for our customers.

Additional Technical Features

✧ Possesses industry-leading high power density: The units are small in volume, employing a modular design, which results in a compact overall structure for the machine, occupying minimal space.

✧ Control Power Supply: Features dual-loop power supply functionality with both external control power and a phase-shift transformer auxiliary winding. In the event of an external control power failure, it can instantly switch to internal power supply, preventing shutdowns caused by instability in the external control power.

✧ A variable frequency drive (VFD) that outputs sine wave current and voltage waveforms without the need for a filter is typically designed with advanced Pulse Width Modulation (PWM) technology. This type of VFD generates a high-frequency switching pattern that approximates a clean sine wave, which is much less harsh on motors than the square waves produced by some older VFD technologies.

✧ Achieves or exceeds a power factor of 0.96 within a load variation range of 20% to 100%, and features minimal current harmonics, eliminating the need for power factor correction or harmonic suppression devices.

✧ Features a soft-start function, which eliminates the voltage sag on the power grid that would otherwise be caused by the inrush current during motor startup. This ensures the safety and longevity of the motor operation.

✧ The waveform output by the variable frequency drive does not induce resonance in the motor, with torque pulsation kept below 0.1%. The inverter is equipped with three sets of resonant frequency jump functions, which help to avoid surge phenomena in the equipment.

✧ The variable frequency drive imposes no special requirements on the output cables. Motors are not affected by common-mode voltage or dv/dt, allowing output cable lengths to extend up to 1000 meters.

✧ The frequency conversion system is equipped with fault location and logging functions. For general faults, the variable frequency drive (VFD) issues real-time alarm information on the main interface. When there are critical system failures or power unit malfunctions, the system automatically displays a pop-up showing the type of failure and its location. This facilitates the user's ability to pinpoint, investigate, and address the faulty points.

✧ The frequency conversion system supports both local and remote monitoring methods. Under the local monitoring mode, through the touch screen display on the inverter, one can manually start and stop the inverter on-site, as well as adjust the speed and frequency. The local control interface uses a Chinese operation interface, with function settings and parameter configurations all in Chinese. Under the remote monitoring mode, the inverter can be manually started and stopped remotely via the peripheral terminals of the inverter, allowing for the adjustment of speed and frequency, as well as monitoring of the operating frequency and output current. The support software for the frequency conversion device provided by the seller is the latest, officially licensed software that has been localized into Chinese.

- ✧ Torque Characteristics: From 0 to 50Hz, the system exhibits constant torque characteristics, delivering rated torque output. The torque step response is less than 200 milliseconds. Above 50Hz, it demonstrates constant power characteristics, with the maximum torque decreasing inversely proportional to the speed.
- ✧ Output Frequency: 0~300Hz (adjustable according to the motor specifications).
- ✧ The inverter is capable of withstanding a seismic intensity of up to 7 on the Richter scale and vibrations of up to 0.5g.
- ✧ Installation, configuration, and commissioning are simple and straightforward.
- ✧ Power circuit modular design, making maintenance simple and straightforward.
- ✧ The system comes equipped with its own cooling fan, with the fan's power supply separated from the control power supply, both drawing power from the transformer on the input side.
- ✧ The system features an in-house designed Programmable Logic Controller (PLC), which facilitates easy modification of control logic relationships. This capability allows the system to adapt swiftly to the diverse and changing requirements encountered in field applications.
- ✧ The system allows for flexible selection between on-site remote control and local control.
- ✧ The system is capable of accepting and outputting industrial standard signals ranging from 4 to 20 milliamps (mA) and from 0 to 5 volts (V).
- ✧ The system incorporates an internal Proportional-Integral-Derivative (PID) controller, enabling both open-loop and closed-loop operation.
- ✧ The transformer employs an independent air duct for cooling, enhancing the transformer's heat dissipation efficiency.
- ✧ The variable frequency drive (VFD) is equipped with a fault waveform recording function, capable of capturing the waveforms of current, voltage, and frequency before and after a fault occurs. This feature greatly assists on-site personnel in analyzing the root cause of the fault, thereby enhancing the efficiency of troubleshooting and resolution.
- ✧ The system features a comprehensive Input/Output (I/O) point status display, which facilitates a clear understanding of the PLC board's state.
- ✧ The system incorporates a frequency reduction self-adaptation feature, which effectively prevents overvoltage protection in the units.
- ✧ Current limiting functionality is incorporated to effectively prevent system overcurrent protection from being triggered.
- ✧ Comprehensive parameter setting functions for general-purpose inverters.
- ✧ Excellent price-to-performance ratio.
- ✧ The power unit housing adopts a modular design, which facilitates fast installation. The units are designed in a sealable format to accommodate environments with high humidity, abundant dust, and corrosive gases.
- ✧ The system has a high level of integration, enabling whole-unit transportation, which results in simple on-site installation. It is capable of being operational with a motor in as little as 45 minutes.
- ✧ The control system exhibits strong resistance to interference and dust. Circuit boards within the control cabinet are housed in metallic enclosures, effectively suppressing EMC (Electromagnetic Compatibility) interference and preventing dust ingress.

Operational Advantages

- ✧ Colorful full-Chinese Human-Machine Interface (HMI)
- ✧ The Human-Machine Interface (HMI) utilizes a full-color, 7-inch touch screen in Simplified Chinese, enabling a wide array of operations including status display, parameter adjustment, fault record retrieval, historical operation data query, and control of startup/shutdown procedures.

- ✧ The variable frequency drive (VFD) features a unique on-site debugging mode that allows for commissioning without the need for high voltage power. Simply applying control voltage enables functions such as start-up operation and logic debugging.
- ✧ Accurate fault location and recording functions.
- ✧ All faults can be accurately located and recorded, reducing the time required for fault diagnosis and repair.
- ✧ Each power unit is equipped with the capability to detect and display bus voltage and temperature. This data is transmitted via an upstream communication fiber to the main controller, which then relays it to the human-machine interface (HMI). Through the HMI, operators can monitor the bus voltage and heatsink temperature of all units.

Protection Features

The input terminal connectors of the variable frequency drive (VFD) are sufficiently large, facilitating easy connection with the incoming cables. The high-voltage lead conductors within the VFD cabinet are designed to meet allowable temperature rise values (less than 65°C).

The transformer is designed to withstand the dynamic and thermal stresses caused by sudden short-circuits at its tap positions without suffering any damage, deformation, or loosening of its fasteners.

Each power unit is equipped with two-phase input fuse protection.

The variable frequency drive (VFD) system also comes equipped with the following fundamental protection features:

a、Over-voltage Protection: The system monitors the DC bus voltage of each power module. If the bus voltage exceeds 1200V, the variable frequency drive (VFD) initiates protective measures. This protection inherently includes safeguarding against positive fluctuations in the grid voltage.

b、Under-voltage Protection: The system monitors the DC bus voltage of each power module. If the voltage falls below a predetermined level, the variable frequency drive (VFD) initiates protective measures. This protection effectively safeguards against negative fluctuations in the grid voltage.

c、Phase Loss Protection: Phase loss protection is implemented on each power module. When a phase dropout occurs on the input side or if the fuse cores in the power modules are damaged, an alarm signal is triggered and protective measures are initiated.

d、Over-current Protection: The system is designed to provide protection when the current exceeds 180% of the motor's rated current, initiating immediate protective measures.

e、Overload Protection: The system provides protection when the current exceeds 130% of the motor's rated current for more than one minute within a ten-minute period.

f、Overheat Protection: Temperature sensors are placed on the primary heat-generating components, specifically the rectifier transformer and power electronic devices. If the temperature exceeds the critical limits (130°C for the transformer and 80°C for the power devices), protective measures are initiated.

g、Fiber Optic Failure Protection: When a fault occurs in the fiber optic link between the controller and the power modules, an alarm signal is generated and protective measures are taken.

h、Over-frequency Protection: The variable frequency drive (VFD) incorporates maximum and minimum frequency limit functions, ensuring that the output frequency remains within a prescribed range. This feature effectively implements over-frequency protection.

i、Stall Protection: This is typically a protection feature under vector control mode, which is activated when there is a significant discrepancy between the commanded speed and the actual speed of the motor, indicating a potential stall condition.

j、Short Circuit Protection

System Structure

High-voltage frequency converter utilize a direct "high-to-high" conversion method, adopting a topology of cascaded multilevel cells. The main structure is composed of multiple power modules connected in series, which together generate the required high-voltage output through the superposition of lower voltage levels. This topology contributes to minimal harmonic pollution to the grid, with input harmonic distortion kept below 3%, directly conforming to the harmonic suppression standards stipulated in GB/T 30843.1-2014. The high input power factor negates the need for input harmonic filters and power factor correction devices.The output waveform quality is exceptional, with output voltage harmonic distortion less than 2%. This ensures there are no issues arising from harmonics such as additional motor heating, torque pulsations, noise, high output dv/dt (rate of change of voltage), and common-mode voltage. Thus, there is no requirement for output filters, allowing for the direct use of standard asynchronous motors. The VFD outputs at 6.6kV, and each system comprises a total of 18 power units, with every six power units connected in series to form one phase.

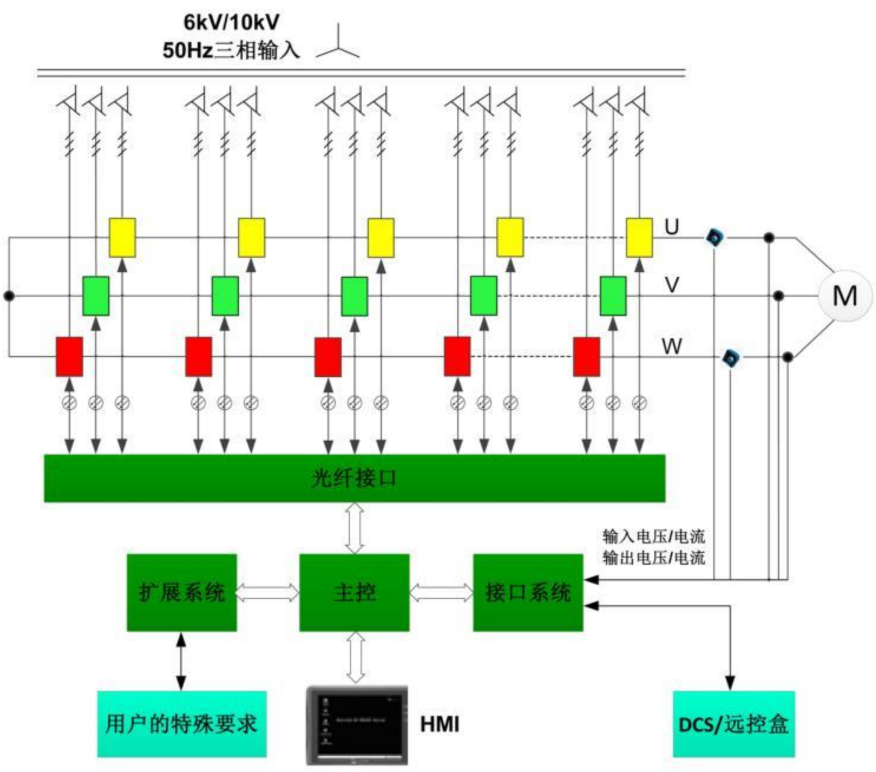
Power Unit

Each power unit is supplied by an individual secondary winding of the input transformer, and all power units along with the secondary windings of the transformer are electrically insulated from each other. The secondary windings are connected in a zigzag delta configuration, with the secondary windings of the phase-shifted transformer phased shifted to reduce the input harmonic currents. Each power unit has an identical structure, making them interchangeable.

The system is essentially a single-phase inverter circuit. On the rectification side, a diode-based three-phase full-bridge rectifier is used. The IGBT inverter bridge is controlled via Pulse Width Modulation (PWM). Additionally, the system features an automatic bypass function for individual units, which allows for continued operation even if one of the power modules fails.

Bypass Function for Units: When a power module fails, the system automatically routes around the faulty module without shutting down the entire variable frequency drive (VFD). This allows the VFD to continue operating at a reduced capacity. Additionally, a hot-reset function can be activated, permitting the reset of the faulty unit while the system remains online. This ensures that production requirements are met and significantly enhances the reliability of system operation.

Control system



Power Cabinet

The cabinet primarily combines power modules, connecting them in a star configuration through the mutual series connection of each module's U and V output terminals. This arrangement supplies power to the motor, and by reconfiguring the PWM waveform of each unit, an excellent PWM waveform is achieved with a low dv/dt, which can significantly reduce damage to the insulation of cables and motors. The output does not require the addition of an output filter to meet the requirements for long-distance output of motor cables, and as a result, the motor does not need to be derated for use.

Transformer cabinets

The main components typically include phase-shifting transformers that supply power to the power modules, voltage and current detection devices on the input side, as well as temperature detection devices.

Cooling fan

The cooling fans installed on the tops of the inverter power cabinets and transformer cabinets automatically start running after the inverter is operational. The size and number of fans are configured according to the power rating of the system. High-quality centrifugal fans are used, and they come equipped with fan guards for safety. If the customer requires the hot air to be exhausted externally, they will need to process and install an exhaust system themselves.

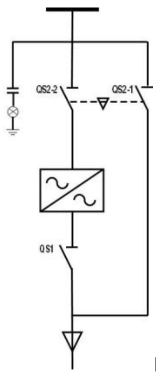
Control cabinets

The controller uses a combination of DSP, FPGA, and ARM chips, with algorithms designed to optimize motor performance. A color, embedded Human-Machine Interface (HMI) provides a user-friendly, fully Chinese interface for monitoring and operation, supporting remote supervision and networked control. The controller includes an integrated I/O board for handling switch signal logic and coordinating with field operation signals and status signals, including DCS/RS485 communications, with expandable control switch capacity. Fiber optic communication between the controller and power units ensures reliable isolation between low and high voltage sections, offering high safety and excellent immunity to electromagnetic interference.

Switching cabinet

one-to-one manual switch-over control scheme

In the switching cabinets, three high-voltage disconnect switches are present. Mechanical interlocking between switches QS2-1 and QS2-2 prevents back feeding to the inverter output. When QS1 and QS2-2 are closed and QS2-1 is open, the motor operates in VFD mode. When QS1 and QS2-2 are open and QS2-1 is closed, the motor runs at line frequency, with the inverter isolated for maintenance.



Manual Transfer Primary Switching Cabinet

The switching cabinet must be interlocked with the upstream high-voltage circuit breaker. When the high-voltage circuit breaker is closed, it is absolutely prohibited to operate the switching isolators and the inverter output isolator to prevent arcing, ensuring the safety of the operators and the equipment.

Circuit Closure Lockout: The "Circuit Closure Permit" signal from the inverter is serially connected to the circuit closure loop of the user's high-voltage switching cabinet. When the inverter is faulty or not ready, it does not allow the user to close the high-voltage circuit on-site. This signal is closed when switched to line frequency operation (when QS2-1 is engaged).

Fault Disconnection: The inverter's "High Voltage Disconnection" signal is connected in series with the switching cabinet's "Inverter Engagement" signal, then paralleled onto the high voltage switch disconnection circuit. In the inverter engagement state, when the inverter encounters a fault, it disconnects the high voltage input to the inverter; in the line frequency engagement state, the inverter fault disconnection is ineffective.

High Voltage Ready Signal: Once the high voltage switching is closed, a set of normally open contacts feedback to the inverter, indicating that high voltage has been applied. This signal is used to lock out the inverter's isolator switches and other energized equipment, prohibiting any operation once the system is energized.

Protection: Maintain the existing protections for the motor and their setting values unchanged.