Manual for

VEDA-IN MVD

Medium-voltage frequency converters

vedaindrives.com

About This Manual

First of all, thank you for choosing the VEDA-IN MVD variable frequnce drive (VFD) by VEDA-IN DRIVES!

VEDA-IN MVD VFD are the latest-generation medium-voltage variable frequency drives developed by our company. These products are classified into two categories: VEDA-IN MVD general-purpose cascade-type drives and VEDA-IN MVD cascade-type single- side maintenance VFD. Their features include high performance, high reliability, and easy maintenance.

This manual is only applicable for VEDA-IN MVD general-purpose cascade-type drives. It covers this product's features, technical parameters, hardware configuration, function applications, installation, maintenance, etc. If you need product selection and technical guidance, don't hesitate to get in touch with our company.

Available Information

This manual is shipped together with the machine. If you need more information, please visit our official website www.VEDAINDRIVES.com or contact our technical support personnel.

For more information on the product, visit our official website or scan the following QR code!

Versions

Revision Date	Release Version	Content changes
March 19, 2024	V1.2	1. Add some information on the single-side maintenance cabinet type (VEDA-IN MVD) 2. Correct some errors
May 25, 2024	V2.0	1. Adjust the order of chapters 2. Update the introduction to VEDA-IN MVD water-cooled VFDs 3. Update the technical parameters 4. Update the nameplate style 5. Update the packaging, shipping, and installation processes 6. Update the topological diagram of the main control board 7. Update the logo on the HMI 8. Improve the function descriptions and test diagrams 9. Update the parameter descriptions and correct some errors

Other Information

In order to ensure that the manual provides accurate information, we have carefully checked all the contents of the manual. However, users are welcome to tell us about errors found in the manual so that we can correct them. If any information in this manual is found to be inconsistent with the latest product, please refer to the notes provided with the product or machine.

VEDA-IN DRIVES reserves its product improvement right and its manual interpretation right. Both the product and the manual are subject to change without notice. The related technical agreement shall take precedence.

Table of Contents

Chapter 1 Safety Information and Precautions

1.1 Overview

The VEDA-IN MVD VFD is a medium-voltage electrical apparatus designed to take into full consideration personal safety issues. However, like other medium-voltage apparatuses, it contains dangerous voltages, which may cause personal injury or asset loss if it is improperly used.

In order to prevent it from causing a personal injury or an asset loss, please read this manual carefully before using it! For the safe use of the VEDA-IN MVD VFD, pay special attention to the contents marked with "Danger" or "Caution" in this manual.

Personal and asset safety can be ensured if the instructions in this manual are strictly followed during its installation, commissioning, running, and maintenance.

1.2 Manual Conventions

In this manual, safety precautions are divided into the following two categories:

Danger: Indicates that failure to comply with the requirement may result in serious injury or even death;

Caution: Indicates that failure to comply with the requirement may result in moderate or minor injury or machine damage.

The user shall read this manual carefully and follow the safety precautions stated herein before installing, commissioning, or repairing the VFD. Our company assumes no legal responsibility for any injury or loss incurred because this section is neglected or a violative operation is performed!

1.3 Safety Precautions

We provide technical training for on-site workers involved in the operation and maintenance of the machine. The on-site workers must strictly abide by the relevant power industry procedures and specifications in addition to the safety instructions given in this manual.

1.4 Safe Operations

1.4.1 Arrival Inspection

DANGER
● Do not install the machine if you find any water ingress, missing part, or damaged part in the control system upon unpacking! ● Do not install the machine if you find any discrepancy between the actual articles and the packing list! ● Do not use any VFD that is damaged or has one or more missing parts. Otherwise, there is a risk of personal injury!

1.4.2 Shipping, Storage, and Installation

Caution
● Before the product is lifted, make sure that the external parts of the product are securely fixed; otherwise, they may come off or the product may be damaged! ● A professional lifting apparatus and qualified professionals shall be employed to handle the machine. Otherwise, personal injury or product damage may be incurred! ● During shipping, nobody is allowed to stand or stay under the product! ● During shipping, no inversion, bumping, or vibration shall happen to the product! ● Please store and transport the product strictly under the storage and transportation conditions specified in the user manual; otherwise, the product may be damaged! ● Only qualified professionals who have received electrical equipment training and have electrical knowledge are allowed to install the product! ● Do not touch any component in the VFD cabinet by hand. Otherwise, there is a risk of electrostatic damage! ● Install the machine on a metal or other flame-retardant object and keep it away from any inflammable material! ● Do not unscrew any fixing bolt of any component at will; otherwise, the machine may be damaged! ● Do not make the boring debris, conductor ends, or screws fall into the VFD; otherwise, the machine may be damaged! ● When a circuit board is installed or removed, it is necessary to wear anti-static gloves and avoid touching any electronic component!

1.4.3 Wiring

DANGER
● The wiring instructions given in the manual must be complied with. VFD wiring operations must be performed by professional electrical workers. Otherwise, one or more unexpected dangers may be posed! ● The wiring operations must be carried out under the guidance of our professionals and in accordance with the relevant electrical operation safety standards. Non-professionals are not allowed to carry out operations such as installation, wiring, maintenance, and inspection! ● Please make sure that all the power supplies are disconnected before wiring operations, so as to avoid electric shock or fire! ● The top of the product shall be covered with a piece of cloth or paper during wiring. The covering shall be removed after the wiring job is completed. This is meant to protect the inside of the product from being affected by foreign bodies, such as moisture and metal chips, during wiring! ● The PE terminal shall be reliably grounded; otherwise, the VFD housing may be electrified! ● Never connect the input power supply to an output terminal (U, V, or W) of the VFD. Pay attention to the marks of its output terminals! ● The input and output cables shall meet the insulation and capacity requirements of the relevant national or industry standard! ● The encoder (if any) must use a shielded cable, whose shielding layer shall be reliably grounded at one end! ● When the wiring job is complete, confirm again that all the cables are correctly connected to prevent the product from being damaged! ● Before power-up, ensure that all the cables are correctly connected and no screws, washers, or bare cables are left inside the machine! ● When the wiring job is complete, perform other operations after commissioning; otherwise, personal injury or product damage may be incurred!

1.4.4 Running

DANGER
● Non-professionals are not allowed to operate the machine; otherwise, personal injury or death may be incurred!
● Before power-up, further confirm whether the voltage level of the power supply is consistent with the rated voltage of the VFD and whether the terminals of the main circuit are firmly connected!
● The VFD can be powered up only after the VFD wirings are completed and the cabinet door is closed. It is strictly forbidden to open the cabinet door when it is live; Otherwise, there is a danger of electric shock!
● When self-start or a related function is enabled, a safety isolation measure shall be taken for the VFD. Otherwise, it may cause personal injury!
● After the VFD is connected to the power supply, its terminals are still in the electrified state even if it is in a shutdown state. In this case, do not touch them. Otherwise, it may cause electric shock!
● Do not disconnect the fan power supply when the VFD is running. Otherwise, the system may be damaged due to overheat!
● For the water-cooled VFD, the cooling water supply should be cut off immediately after its operation stops in order to prevent any condensation from damaging it. It is strictly prohibited to supply cooling water when its variable frequency speed regulator is in the shutdown state!
● The fault or alarm signal can be reset after confirming that the run command is cut off. Otherwise, a personal injury may be caused!

Caution
● Do not start or stop the VFD by connecting or disconnecting the power supply. Otherwise, the VFD may be damaged! ● Do not arbitrarily change the menu parameters in the manufacturer's parameter settings in the function group menus. Most of the factory parameter settings of the VFD can meet its operating requirements. It is sufficient to set some necessary parameters. Arbitrary modifying the parameters may damage the VFD. ● When it is used for a lifting machine, it shall be fitted with a mechanical brake. ● In case of power-variable frequency switching, the two contactors for controlling power-variable frequency switching should be interlocked.

1.4.5 Maintenance and Inspection

DANGER
● In the power-up state, do not touch any part in the VFD cabinet. Otherwise, there is a danger of electric shock! ● Do not maintain the VFD when it is in the power-up state. If you want to open or close a cabinet door, be sure to power down the VFD first! ● Wait at least 10 minutes after power-down or confirm that the unit power indicator is off before maintaining or checking the VFD, so as to prevent the residual voltage of the main circuit's capacitor from causing any personal injury! ● Please designate a qualified electrical worker for part maintenance, check, or replacement.

1.4.6 Others

DANGER
● It is forbidden for the user to reconstruct the VFD. Otherwise, a personal injury may be incurred!

Caution
● The discarded components shall be disposed of as industrial waste according to the related national regulations and standards.

Chapter 2 Product Introduction

2.1 Product Information

2.1. Product Nameplate

MODEL NO.:		SERIAL NO.:	
RATED CAPACITY:	kVA	ADAPTABLE MOTOR:	kW
RATED INPUT VOLTAGE:	kV	RATED OUTPUT VOLTAGE:	kV
RATED INPUT FREQUENCY:	Hz	OUTPUT FREQUENCY RANGE:	Hz
RATED INPUT POWER FACTOR:	≥0.96	PROTECTION CLASS:	IP
WEIGHT:	kg	MANUFACTURING DATE:	Year Month

Fig. 2.1 Information on Product Nameplate ※

※ The actual product nameplate style may appear different from that shown here.

2.2 Product Features

The VEDA-IN MVD VFDs are developed by VEDA-IN DRIVES. This product series is applicable for regulating the speeds of and driving medium-voltage three-phase AC motors, with the following functions and features (see Chapter 7 Function Applications):

- Motor control strategies: V/F control, open loop vector control, closed loop vector control
- Applicable motor types: asynchronous motor, synchronous motor, and permanent magnet synchronous motor
- Output voltage self-regulation: when the input voltage fluctuates (-10%~+10%), the VFD has the rated voltage output capability
- Torque boost: increase the motor's load carrying capacity during its start-up or low-frequency operation
- Speed tracking (runaway start-up): when the motor rotates, the VFD drives the motor to start up smoothly, thus reducing the impact on the grid

- Instantaneous non-stop: upon a power failure, the VFD can continue to run continuously and stably
- Automatic restart upon power failure: the VFD restarts automatically upon power supply restoration after grid power supply switching or short-time grid power failure
- Communication with host computer: the host computer can control the VFD or query the status information
- Dual-power switching: the function can ensure that the system runs stably
- Synchronous switching (system bypass): the system bypass can be smoothly connected to the grid
- High/low voltage ride through: higher grid adaptability
- Unit bypass function: multiple bypass modes are provided to ensure that the system runs continuously without shutdown
- Master-slave control: two or more motors are simultaneously controlled
- Frequency hopping: avoid resonance points
- Temperature/humidity detection: ensure the reliability of the system
- Status monitoring and warning: unit status monitoring and minor/major fault warning functions are provided

The power input of the VEDA-IN MVD VFD complies with IEEE STD 519-2014 and GB/T 14549-1993. There is no need to install an input filter, thus saving the harmonic control cost for the user. It has a high power factor and requires no power factor compensation device. Thus, both the reactive input and the input capacity can be effectively reduced. After the VFD input is converted to the secondary side and phase-shifted by the phase-shifting transformer, multi-pulse diode rectifiers are used to provide isolated power supplies for its power units, eliminating most of the harmonic currents caused by the individual power units (see Figure 2.2).

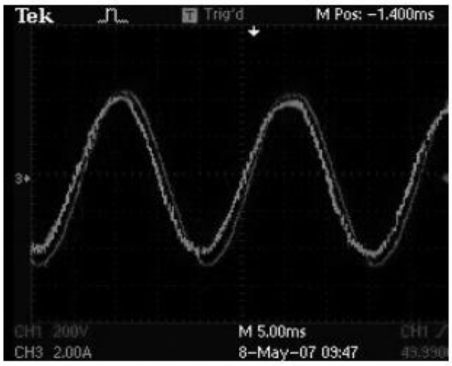


Fig. 2.2 30-pulse Input Waveform (CH1 - voltage; CH3 - current)

The VEDA-IN MVD VFD adopts the unit series H-bridge multilevel superposition technology to allow its output to have low harmonic content and be almost perfect sinusoidal waveforms (see Fig. 2.3 and Fig. 2.4). Compared to other forms of medium-voltage high-capacity VFDs, they have the following advantages:

- No need to add an output filtering device
- Directly drive the medium-voltage AC motor
- Insulate the main circuit motor and cables from the dv/dt stress
- Low pulsating torques extend the service life of the motor and mechanical equipment
- Within the allowable cable voltage drop range, there is no length limit for motor cables

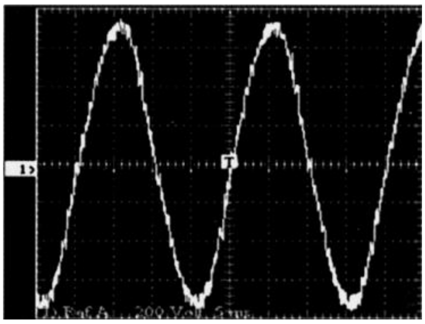


Fig. 2.3 Output Line Voltage Waveform

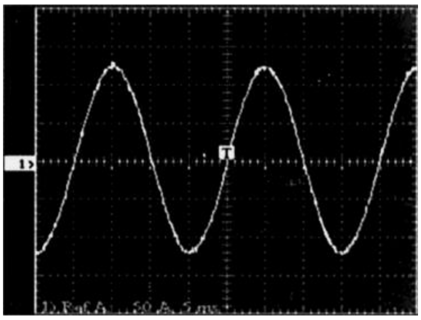


Fig. 2.4 Output Current Waveform

2.3 Technical Parameters

The VEDA-IN MVD VFDs are classified into two voltage grades: 10kV and 6kV. A product at some other voltage grade can be also customized according to the user's requirements.

Table 2-1 Technical Parameters of VEDA-IN MVD VFDs

Item	Parameter
Rated capacity	315~34640 kVA ※
Rated voltage	10kV/6kV (-10%~+10%) ※
Rated frequency	50Hz/60Hz (-10%~+10%) ※
Control power supply	380VAC/30kVA
Rated input power factor	> 0.96
Inversion efficiency	≥ 98.5%
Output frequency range	0~120Hz ※

Instantaneous over-current protection	150% (customizable)
Overload capacity	120% load/60s
Torque limiting	10%~150%
Analog quantity inputs	Four ways/4~20mA
Analog outputs	Four ways/4~20mA
Upper computer communication protocols	Isolated RS485 interface/Modbus RTU (customizable)
Acceleration/deceleration time	5s to 6000s (load dependent)
Switching value inputs and outputs	24 inputs and 16 outputs (8 outputs can be defined)
Operating environment temperature	-5~+40°C ※
Storage/transport temperatures	-25~+55°C ※
Cooling method	Forced air cooling or water cooling
Ambient humidity	< 95%, with no condensation ※
Installation elevation	≤ 1000m ※
Dust	Neither conductive nor corrosive, < 6.5mg/dm^3 ※
Protection rating	IP30/IP41 ※
Cabinet color	RAL7035+RAL7042/RAL7032 (customizable)
Maintenance mode	Dual-side maintenance (front and rear)/single-side maintenance (front) (the single-side maintenance mode is adopted for VEDA-IN MVD VFDs)

※ If there is any parameter beyond its due range, consult with VEDA-IN DRIVES

※ The dimensions of the VFD may be different from those shown here without notice. The technical agreement shall take precedence

2.4 Cooling Modes

During running, the medium-voltage VFD has a certain power consumption, generally 3% to 5% of its capacity. Among the power consumption, that by the phase-shifting transformer accounts for about 45%, that by the rectification and inversion assemblies account for about 40%, and that by the control system and the cables and copper bars of the main circuit accounts for about 15%.

There are two main cooling modes available to medium-voltage VFDs: forced air cooling and water cooling. The forced air cooling mode prevails for domestic medium-voltage VFDs. With the continuous development of domestic VFD technologies in recent years and the continuous increase in VFD capacity, the forced air cooling mode has failed to meet the cooling requirements of high-power VFDs due to multiple reasons such as radiator area, ambient temperature, working environment, fan volume, and noise.

Among multiple factors that affect the VFD reliability, heat dissipation is crucial. The heat generated by high-power semiconductor devices and the phase-shifting transformer will lead to increases in device temperatures. If there is no appropriate heat dissipation measure to take away the heat in time, the device temperatures may exceed their allowed maximum temperatures, thus resulting in their performance deterioration or even its damage. Therefore, selecting an appropriate cooling mode to provide a reasonable VFD design can effectively extend the service life of each of its devices. This is one of the indispensable processes to improve the reliability of the VFD.

Considering the service life of the medium-voltage inverter, our company has designed two cooling methods of forced air cooling and water cooling for different power levels. The operation information not specifically indicated in this manual defaults the cooling method to forced air cooling.

- A water-cooled VFD has the following features:

Monitoring instruments are installed along the cold water flow pipeline to accurately display the circulating water's temperature, flow rate, etc.;

An air bleeding valve is installed at the top of the heat exchanger and a water drain valve is installed at its bottom. Thus, the circulating water can be completely drained to prevent frost cracks;

Two temperature transmitters are respectively installed at the air inlets of the fan and heat exchanger to monitor the temperature of the transformer's working environment on a real-time basis;

Two PT100 temperature sensors are respectively installed in the air ducts of the phase-shifting transformer's primary and secondary windings to monitor the temperatures in the two air ducts.

2.5 Model Selection Instructions

Which VEDA-IN MVD VFD model should be selected depends on the motor's type, load characteristics, rated voltage, and rated current. For a special load, a special motor, or a special application environment, VEDA-IN MVD VFD selection should also follow the following recommendations:

1. If the load is a compressor or vibrator that has considerable torque fluctuations, the actual process and its working condition should be understood. The rated current of the selected VEDA-IN MVD medium-

voltage VFD must be greater than the maximum current required for power frequency operation.

2. If the load is a submersible water or oil pump, the rated current of the selected VEDA-IN MVD medium-voltage VFD should be greater than the rated current of the motor.

3. In some special applications such as high temperature and high altitude, the VEDA-IN MVD medium-voltage VFD needs to be derated and the rated current of the selected VFD model should be increased accordingly.

- The above model selection suggestions cannot cover all special loads and motors! In regard to VFD model selection, please consult with the technical support department of VEDA-IN DRIVES
- VEDA-IN MVD general-purpose VFDs are not applicable for scenarios with explosion-proof requirements.

2.6 Application Fields

Medium-voltage VFDs by our company have been widely used in various industries in Europe, Middle East, Southeast Asia, and other regions around the world. Our company can provide users with perfect medium-voltage (asynchronous and synchronous) AC motor soft start, speed regulation, and intelligent control solutions, which have been well received by users. Their typical applications in various industries are as follows:

- Power generation

Powder exhaust fan, booster fan, supply fan, induced draft fan, condensate pump, mortar pump, pumped storage pump, circulating pump, boiler feed pump, and compressor

- Petrochemical

Booster fan, induced draft fan, pipeline transport pump, water injection pump, water feed pump, oil-submersible pump, oil delivery pump, brine pump, circulating water pump, and compressor

- Mining

Counter-rotating fan, dust removal fan, main ventilator, axial flow fan, descaling pump, mud pump, slurry pump, clear water pump, feed pump, agitator pump, dewatering pump, medium pump, and belt conveyor

- Metallurgy

Induced draft fan, supply fan, secondary dust removal fan, compression fan, blast furnace blower, blast furnace dust removal fan, converter dust removal fan, electric furnace dust removal fan, sulfur dioxide fan, slag pump, water feed pump, water delivery pump, descaling pump, mud pump, mixing machine, oxygen compressor, and gas compressor

- Cement

Kiln induced draft fan, kiln air supply fan, separator fan, kiln head fan, high temperature fan, cement mill fan, dust removal fan, circulating fan, grate cooling fan, kiln tail fan, raw material mill fan, pressure blower, raw material grinding fan, rotary kiln drive, coal mill, and kiln drive

- Public works

Aeration fan, induced draft fan, air supply fan, booster pump, hot water circulating pump, reclaimed water pump, sewage pump, clear water pump, lift pump, and water supply pump

- Light industry

Gas blower, booster pump, washing pump, axial flow pump, soft water pump, water feed pump, compressor, beater, and pulverizer

- Others

Rubber and plastic industries, variable frequency power supply test bench, motor test bench, and wind tunnel test device

2.7 Applied Standards

Number of standard	Name of standard
GB/T 156-2017	Standard Voltages
GB/T 1980-2005	Standard Frequencies
GB/T 3797-2016	Electrical Control Equipment
GB/T 4208-2017/ IEC 60529:2013	Ingress Protection Levels (IP Codes)
GB4588.1-1996	Sectional Specification: Single- and double-sided Printed Boards without Plated Holes

GB4588.2-1996	Sectional Specification: Single- and double-sided Printed Boards with Plated Holes
GB/T 12668.2-2002	Speed-regulating Electrical Drive Trains Part 2: General requirements - Ratings of Low-voltage AC Speed-regulating Electrical Drive Trains
GB 12668.3-2012/ IEC 61800-3:1996	Speed-regulating Electrical Drive Trains Part 3: Requirements and Special Testing Methods for EMC
GB/T 12668.4-2006 IEC 61800-4:2002	Speed-regulating Electrical Drive Trains Part 4: General Requirements - Ratings of 1kV~35kV AC Speed-regulating Electrical Drive Trains
GB 12668.501-2013/ IEC 61800-5-1:2007	Speed-regulating Electrical Drive Trains Part 5-1: Safety Requirements - Electrical, Thermal, and Energy
GB 12668.502-2013/ IEC 61800-5-2:2007	Speed-regulating Electrical Drive Trains Part 5-2: Safety Requirements - Functions
GB/T 14549-1993	Quality of Electric Energy Harmonics in Pulic Grids
GB/T 10228-2023	Technical Parameters and Requirements for Dry-type Power Transformers
DL/T 994-2006	High Voltage VFDs for Water Pumps for Thermal Power Plant Fans
GB/T 1094.3-2017	Power Transformers Part 3: Insulation Level, Dielectric Tests, and Air Gaps of External Insulations
GB/T 16935.1-2008/ IEC 60664-1:2007	Insulation Coordination for Devices within Low-voltage Systems Part 1: Principle, Requirements, and Tests
GB 5226.3-2005/ IEC 60204-11:2000	Mechanical Safety - Mechanical and Electrical Apparatuses Part 11: Technical Specifications for 1000Vac/1500Vdc~36kV Medium-voltage Apparatuses
GB/T 4025-2019/ IEC 60073-2002	Basic and Safety Rules for Human-machine Interface Marks and Identifiers Coding Rules for Indicators and Actuators
GB/T 30843.1-2017	1kV~35kV General-purpose VVVF Drives Part 1: Technical Specifications
GB/T 30843.2-2017	1kV~35kV General-purpose VVVF Drives Part 2: Test Methods
GB/T 12668.701-2012	Speed-regulating Electrical Drive Trains Part 701: Universal Interfaces of Electrical Drive Trains and Their Application Specifications Definitions of Interfaces
GB/T 12668.8-2017	Speed-regulating Electrical Drive Trains Part 8: Voltage Specifications for Power Supply Interfaces

Chapter 3 Transport, Storage, and Installation

3.1 Transport and Storage Requirements

The VEDA-IN MVD general-purpose VFD can be transported by truck, train, ship, or another means of transport. In addition, the VFD should be stored in a room with ventilation, -25°C~55°C temperatures, and ≤95% relative humidity values; during storage, it should be prevented from being exposed to sunshine, water ingress, rain, corrosion, etc.

⚠Caution

- During transport, the VEDA-IN MVD general-purpose VFD shall not be subjected to exposure to rain or blazing sunshine, strong vibration, impact, or upside-downness.
- During means of transport and route selections, multiple factors during transport, such as height limit, etc. shall be considered.
- The load-bearing capacity of the selected vehicle (such as a truck) should be greater than the actual weight of the VEDA-IN MVD general-purpose VFD.

3.2 Acceptance Check

The complete acceptance check procedure for the VEDA-IN MVD general-purpose VFD is as follows:

- Confirm whether the outer package of the VFD is intact;
- After the package is unwrapped, check visually whether the VFD is damaged;
- Against the shipping list, check that the equipment is complete and the specifications and models are correct.

The medium-voltage VFD is packaged in a wooden box for its shipping. The distance between the VFD and its wooden packaging box is not shorter than 20mm. If you have any special packaging requirements, don't hesitate to contact our company for negotiation before placing an order. Its actual packaging dimensions may vary. The product package and its exploded view are shown in the following two figures respectively.

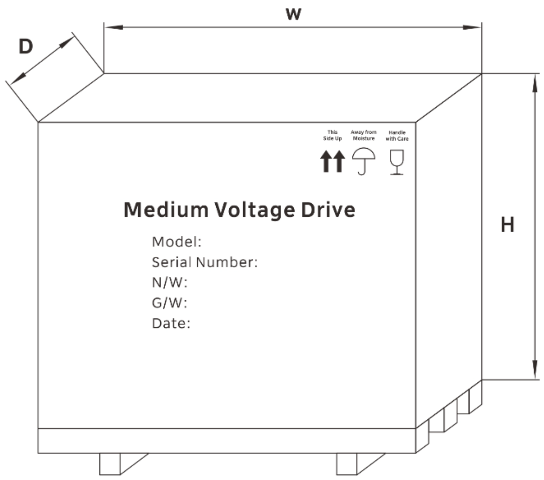


Fig. 3.1 Product Package ※

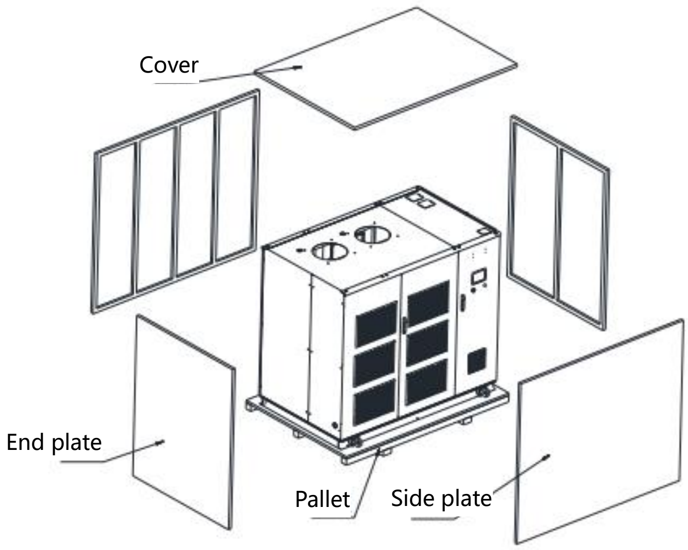


Fig. 3.2 Exploded Product Package View ※

⚠Caution

- If the VFD is damaged, refuse to sign for it and immediately contact VEDA-IN DRIVES for confirmation!

3.3 Handling and Lifting

There are 3 possible handling modes during unloading and installation of the VEDA-IN MVD general-purpose

VFD, including:

- Crane
- Chain hoist
- Rollers

Before a crane or chain hoist is used, confirm:

- The weight of the VFD is within the bearing capacity of the crane or chain hoist;
- The slings must be long enough and strong enough to support the weight of the VFD;
- It is forbidden to pass the wire rope directly through the hoisting rod. A wire rope with a safety hook must be used.

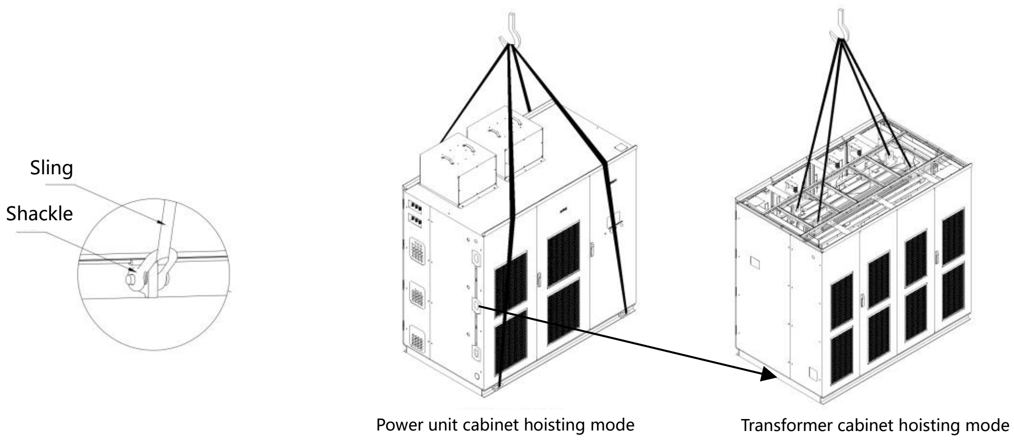


Fig. 3.3 Cabinet Hoisting Diagram

The roller-based hoisting mode is suitable for occasions where the space is small and no above apparatuses are available. When this hoisting mode is used, rollers are placed side by side on the floor and the cabinet is put on them. The VFD can be moved into place on rollers with a crowbar, as shown in the following figure.

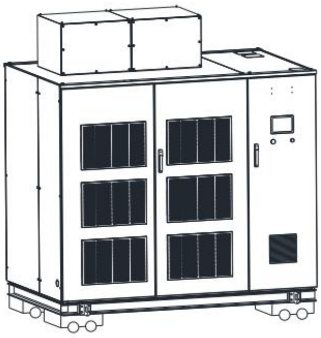


Fig. 3.4 Roller-base Transport ※

When using roller bars to transport the VFD, lay the roller bars side by side on the floor, place the cabinet on the roller bars, and use a crowbar to move the cabinet forward, as shown in Fig. 3.5. When a rolling bar is exposed, it will be placed in front of all the other rolling bars.

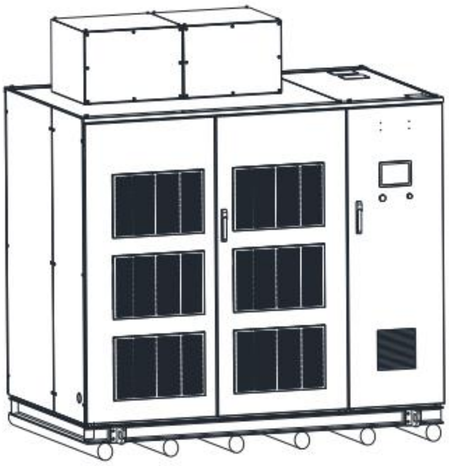


Fig. 3.5 Rolling Bar-based Transport ※

⚠Caution

- When a crane, a chain hoist, or rollers is used to hoist the VFD, avoid damaging the surfaces of the cabinet; no sling is allowed to touch any fan.
- When any cabinet is hoisted, all the four lifting rings must be used at the same time.
- When the unit cabinet is hoisted, the angle between any sling and the cabinet must not be less than 60° in order to prevent the cabinet from being deformed.
- When the transformer cabinet is hoisted, the flat steel part of the transformer shall be held and the

transformer cabinet body shall not be held unless there are special instructions on the package label or drawing. If multiple fans are installed on the top of the transformer cabinet, they shall be removed before transformer hoisting and reinstalled after transformer hoisting.

- Be careful when operating in the transformer cabinet. It is strictly forbidden to touch the transformer coils with any hard object. Prevent any foreign object from falling into the transformer. In addition, before the transformer is hoisted, the positions of the cabinet's top cover plate and the fan shall be considered to determine such a hoisting angle that the fan or cover plate will not be deformed under stress.
- The cabinets shall be placed on a flat ground. Otherwise, the metal housing of the VFD may be deformed, so that the door is out of position and cannot be normally opened or closed.
- During cabinet hoisting and unloading, nobody is allowed to stand under the lifting equipment; when the cabinet is tilted during lifting, nobody is allowed to try to correct its position.

3.4 Installation

In order to enable the VEDA-IN MVD general-purpose VFD to operate stably and reliably for a long period, the following requirements are imposed for its installation environment:

- The VFD shall be installed in a room where there are not any corrosive gas, flammable gas, conductive dust, water drips, salt, soot, etc.
- The ambient temperatures should range from -5°C to 40°C. Otherwise, a safe and reliable temperature control device should be installed.
- On the site, a measure shall be taken to prevent small animals such as snakes and rats from entering. Such VFD damages must be strictly prevented.

If the ambient temperature is too high or there is poor ventilation, circulating fans or industrial air conditioners with sufficient cooling capacity must be installed. In order to further reduce the ambient temperature, the user can install a centralized ventilation duct so that the hot air flows through the centrifugal fans and the ventilation duct into the outside. The central air duct outside the cabinet is directly connected to the cooling fans on the top of the cabinet, as shown in Fig. 3.6.

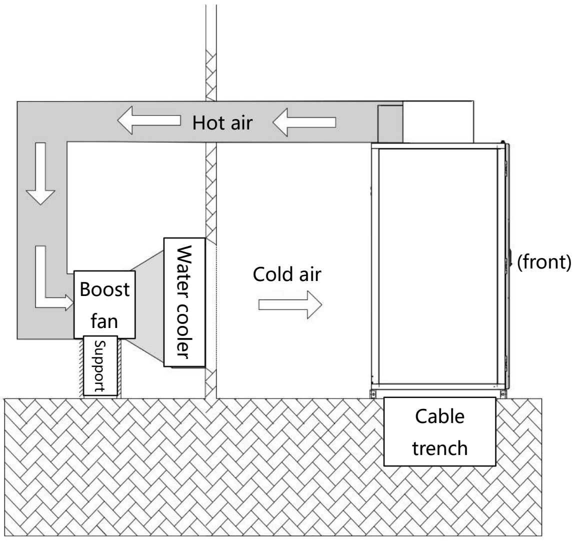


Fig. 3.6 Air/water Cooling Diagram

3.5 Environmental Requirements

In order to enable the VEDA-IN MVD general-purpose VFD to operate stably and reliably for a long period, the following requirements are imposed for its working environment:

Table 3-1 Working Environment Requirements

Item	Requirements
Ambient temperature	Within the -5~40°C range, preheating may be required when the temperature is below 0°C. The VFD needs to be derated when the temperature is higher than 40°C. The mean value within 24 hours should be in the range of 5-35°C.
Relative humidity	The relative humidity should be lower than 50% at the maximum temperature (40°C).
	The relative humidity should not be higher than 95% at low temperatures.
	Condensation should not occur due to temperature changes.
Elevation	The product should be used below 1,000 m. When the elevation is higher than 1,000 m, it shall be derated. If it is meant to be used at an elevation higher than 1,000 m, notify the factory in advance.
Atmospheric pressure	The air pressure should range from 860 kPa to 1,060 kPa.
Air quality	The dust concentration in the electric room should be roughly equal to that in the atmosphere. In particular, the dust in the electric room should not contain iron powder, organosilicon particles,

	etc.	
Corrosion factors	Corrosive gas	Concentration
	Hydrogen sulfide (H_2S)	≤ 0.001 PPM
	Sulfur dioxide (SO_2)	≤ 0.05 PPM
	Chlorine (Cl_2)	≤ 0.1 PPM
	Ammonia (NH_3)	≤ 0.1 PPM
	Nitrogen oxide (NO_x)	≤ 0.02 PPM
	Ozone (O_3)	≤ 0.002 PPM
	Hydrogen chloride (HCl)	≤ 0.01 mg/ m^3

Description:

- The above are standard specifications. For the exact specifications, refer to the technical agreement.
- The VFD's vibrations during its working should be within the normal limit of grade 3M1 specified in GB/T 4798.3-2007.
- Do not use any silicon paraffin on the floor of the electrical room. Otherwise, the VFD's electrical contacts will be adversely affected.
- After all the external cables (ground cable, main circuit cable, and control cable) are run into the cabinet and connected into place, the incoming cable hole shall be completely sealed with fireproof mud. If the cable entry hole is open, allowing animals such as mice to enter the interior of the home may cause serious damage to the equipment.

In order to enable the VEDA-IN MVD general-purpose VFD to operate stably and reliably for a long period, the following requirements are imposed for its storage environment:

Table 3-2 Storage Environment Requirements

Item	Requirements	
Storage temperature	Its storage temperature range shall be -25°C to +55°C, and the air temperature change rate shall be lower than 1°C/min.	Do not store the VFD in a place where there are condensation and/or freezing due to sharp temperature changes
Relative humidity	5% ~ 95%	
Storage environment	In its storage environment, there shall not be any direct sunlight, dust, corrosive gas, inflammable gas, oil mist, water vapor, dripping water, etc.	

Description:

- Improper storage of power and electronic equipment may shorten their service life or even cause them to fail to work normally.
- For the specific ambient conditions required for its storage, refer to grade 1K22 in IEC 60721-3-1:2017 and grades 3K22 and 3S7 (solid particles) in IEC 60721-3-3:2019.

Other Requirements:

- Do not place the VFD directly on the floor. Instead, it shall be placed on one or more appropriate supports.
- If there is moisture in the air, an appropriate amount of desiccant should be added.
- Wrap the VFD with a polyethylene or aluminum film to prevent any moisture from entering its housing.
- Regular inspection: Check the storage and package of the VFD, esp. for any mechanical damage or any damage incurred due to the humidity or temperature or a fire, at intervals of one month throughout the storage period. If the VFD and/or its package are found to have been damaged, immediately check whether and how badly the VFD is damaged. If the VFD has been damaged indeed, repair the damaged VFD and store it according to the above requirements.

Spare Part Storage:

In order to ensure that its spare parts are not damaged, take the following precautions:

⚠Caution

- There shall not be vibrations or shocks in their storage place. Its spare parts shall be protected from any moisture, frost, temperature change, dust, gravel, etc.
- The spare part storage environment must meet the temperature and humidity requirements. The spare parts must be stored in a dry, insect-free original packing box and kept away from any corrosive gas.
- Relative humidity: 5% to 95%. If the air humidity exceeds the maximum allowable humidity, it is necessary to take one or more environmental protection measures, such as cooling, heating, and dehumidification, so as to ensure that there are appropriate ambient conditions for spare part storage.
- The spare part storage temperatures should range from -25°C to 55°C.
- Each of the circuit boards must be stored in an antistatic packaging bag without moisture-proof agent leakage. Keep them away from any disruptive corrosive gas or any gas containing any salt, alkali, or other

impurities. Prevent them from being frozen.

- There is a film capacitor in each power unit. Failure to electrify them for a long time may cause their electrical characteristics to deteriorate. Thus, they shall be electrified at intervals of six months.

3.6 Space Requirements for VFD Installation

For the VFD's cabinet dimensions and bottom plate installation drawing, refer to the engineering drawings provided by the manufacturer. All the cabinet bodies shall be installed according to the drawings. Sufficient space shall be reserved around them (the single-sided cabinet can be placed against a wall) to ensure sufficient air flows, maximum door swings, and sufficient maintenance space. The specific installation requirements are shown in the figures below. (unit: mm)

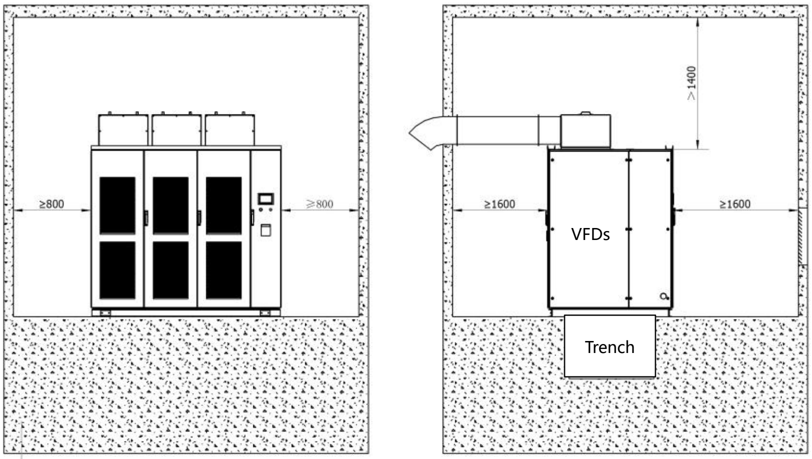


Fig. 3.7 Installation Dimension Requirements of Integrated Cabinet

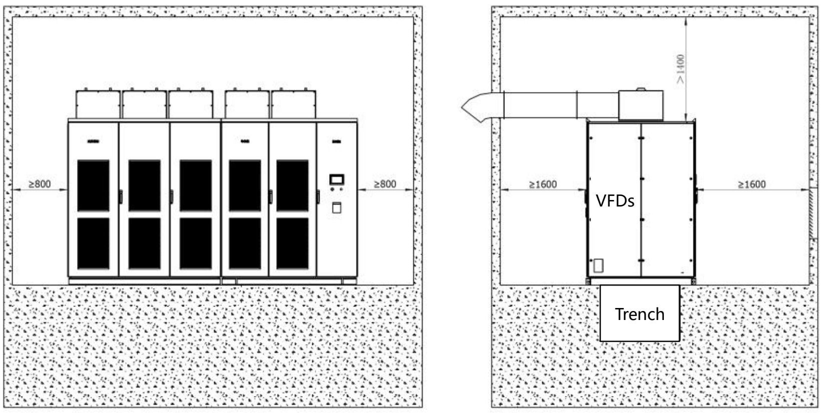


Fig. 3.8 Installation Dimension Requirements of Split Cabinet

Description:

- All the cabinets shall be firmly installed on the channel steel base and reliably connected to the factory ground.
- The protective armors of the medium-voltage incoming and outgoing cables shall be reliably grounded and reliably fixed with the cabinet, have sufficient mechanical strength, and be kept at to-ground insulation distances specified in the medium-voltage technical specifications.
- The single-side VEDA-IN MVDS VFD cabinet can be placed against a wall. An operating space of at least 1,000 mm should be reserved in front of the cabinet.

3.7 Foundation and Cable Designs

The medium-voltage VFD must be installed on a level concrete foundation. The foundation shall be made of a kind of incombustible material and its surface shall be moisture-proof, smooth, wear-free, and able to withstand the weight of the VFD. The cable trench shall be made of a kind of incombustible material and its surface shall be wear-free, moisture-proof, dust-proof, and able to prevent animals from entering.

In the industrial site, some auxiliary switch cabinets may be selected according to the working conditions, such as a bypass cabinet for VF-PF switching in case one VFD drives one motor, a switching cabinet for VF output switching between two motors driven by one VFD, a startup cabinet for limiting the power-up current of a large-capacity VFD, etc. When these auxiliary cabinets are provided, their specific installation locations can be determined in accordance with the technical agreement.

All the cabinets shall be firmly installed on the channel steel base and reliably connected to the factory ground. The unevenness of the foundation channel steel shall be ≤ 5mm. An excessive unevenness will greatly affect closing and opening of the cabinet doors.

In order to enable safe and easy wiring, it is recommended that the VFD cabinet should be installed on a cable trench. The VFD base on the cable trench is usually made of #10 channel steel; when the VFD's rated power is greater than or equal to 1,600 kW, #16 channel steel can be used; when its rated power is 4,000 kW or above, #18 I-bar steel can be selected. After the installation is completed, the transformer and unit cabinets are arranged neatly from left to right if viewed in the front. After the cabinets are installed into place, all the cabinets shall be firmly spot-welded to the base channel steel, and the VFD's multi-core copper cable shall be reliably connected to the user's grounding point. The grounding resistance shall not be greater than 4 Ω.

The foundation design should take into account the front and rear access spaces and the heat dissipation channel, as well as the installation and routing of the medium-voltage power supply cable, medium-voltage motor-driving cable, and system control cables. It is recommended that a cable trench or cable guide trough should be designed under the VFD when the foundation is designed (high voltage cable, power cable, and signal cable must be separated from each other; otherwise, the VFD's performance will be affected). The wiring diagram and requirements are shown in Fig. 3.10. For the specific installation dimensions, see the engineering drawings delivered with the product.

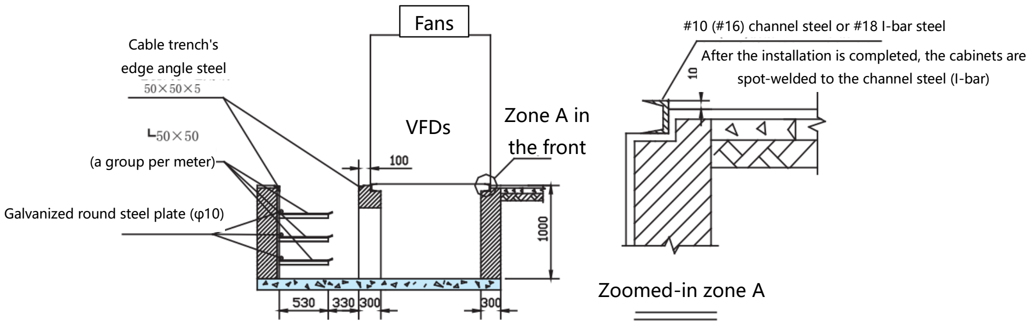


Fig. 3.10 Installation of Cabinet and Foundation

⚠Caution

- High-voltage cables must be separate from low-voltage cables.
- The cable trench must be made of a flame-retardant material and be smooth, moisture-proof, dust-proof, and able to prevent animals from entering.
- Power cables

➢ The main power supply and motor cables must be wired according to the local standards and the instructions and recommendations of the cable manufacturers.

➢ For optimal EMC characteristics, individually shielded steel armored three-phase cables are recommended. If single-phase cables are used, three-phase cables must be put together to ensure EMC characteristics.

➢ If the total cross-sectional area of the cable shielding layer is less than 50% of the cross-sectional area of some phase, it is necessary to add a ground wire along the cable to prevent the shielding layer from being overheated. For details, refer to the local regulations.

➢ The interlayer distances of the cable brackets, ladders, or trays inside the cable trench shall facilitate the laying and fixing of the cables, the placement of the connectors, and the change or addition of a cable and its connectors when multiple cables are within a layer.

- The interlayer distances of the cable brackets, ladders, or trays shall be greater than 300 mm. The brackets at the lowest layer shall be more than 100 mm away from the bottom of the trench.
- The cables are fixed on the brackets. For power and control cables that are horizontally placed and are not greater than 50 mm in outside diameter, brackets are placed at intervals of 0.6 m; for power and control cables that are horizontally placed and are greater than 50 mm in outside diameter, brackets are placed at intervals of 1.0 m. Single-core cables arranged in regular triangles should be tied with straps at intervals of 1.0 m. In case of vertical placement, cables should be fixed at intervals of 1.0 to 1.5 m.
- The power and control cables shall be installed on the brackets on both sides of the trench respectively, at intervals of more than 300 mm. If this is not possible, the power cable can be placed on the brackets above the control cable.

- Ground cable

The routing of the ground cable shall comply with the related local standard.

- Control cable

The control cable shall not be run in parallel to the power cable. If this is unavoidable, it is necessary to keep the control cable and the main cable at least 300 mm (12 in.) away from each other. The control cable shall be run at an angle of 90 degrees with the powers cable.

※ Note: The product style shown in the schematic diagrams in the chapter may vary with the up-to-date design. The actual product style may be different from the product style shown here. The schematic diagrams may be subject to change without notice.

Chapter 4 Hardwareand Structure

4.1 Working Principle

The VEDA-IN MVD series VFD is a high-high type VFD with power units in series that consists of a transformer, power units, and a control system.

The phase shift transformer output converts the power grid voltage into multiple low-voltage power supply outputs into the power units. The power units output multi-level PWM voltages. The output voltages of the power units are superimposed into different high voltage levels, depending on the number of power units.

4.1.1 Topological Structure

The topological structure of the VFD is shown in Fig. 4.1:

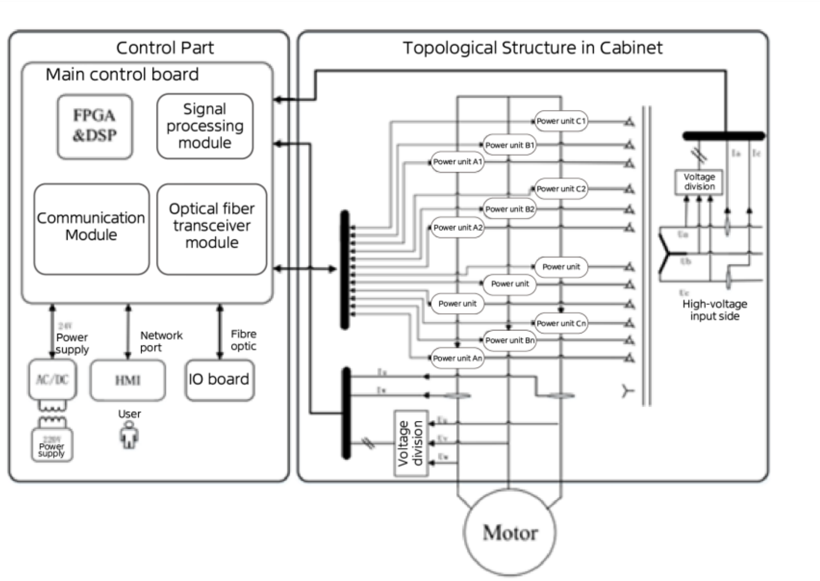


Fig. 4.1 Topological Structure of VFD

4.1.2 Main Circuit

The main circuit of the VFD is shown in Fig. 4.2:

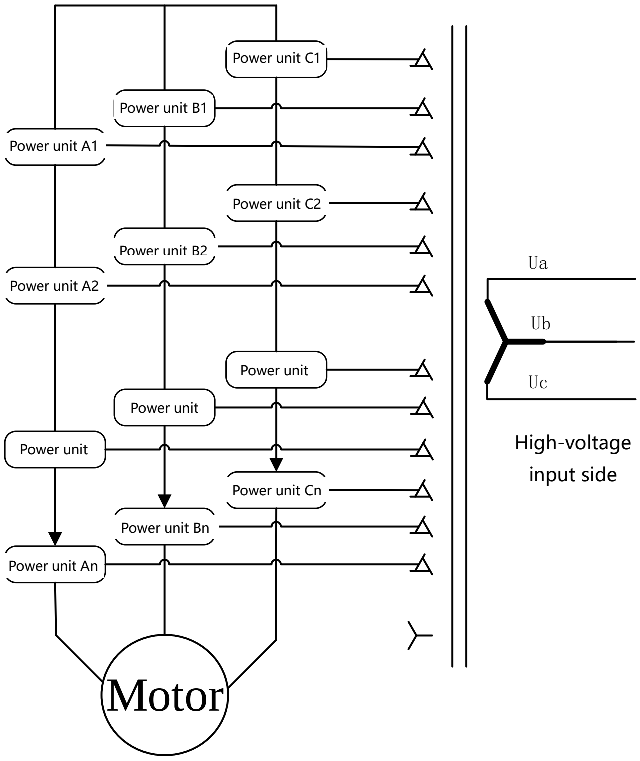


Fig. 4.2 VFD's Main Circuit Diagram

The isolation transformer is a dry-type three-phase rectifier transformer that adopts forced air cooling; the Y connection method is used to connect the primary side to the medium-voltage incoming cable; the epitaxy delta connection method is used to connect the windings on the secondary side to provide an isolated three-phase power input to each power unit. The number of power units depends on the voltage level and structure of the VFD. In order to maximize the suppression of the input side harmonic content, the secondary side windings of the same phase are phase-shifted using the epitaxy delta connection method. The phase difference between the windings is calculated using the following formula:

$$\text{Phase shift angle} = \frac{60°}{\text{Number of stages of units}}$$

The output of the frequency converter is obtained by stacking the waveforms of multiple low-voltage power units with three-phase input and one-phase output in series. For example, 5 power units with a rated voltage of 690 V are connected in series to obtain a 3,450 V phase voltage.

The Y connection method is used for three-phase outputs to obtain a medium-voltage power supply required to drive the motor. A 6 kV VEDA-IN MVD general-purpose VFD's number of power units is 15 or 18, as shown in Fig.

4.3. A 10 kV VEDA-IN MVD general-purpose VFD's number of power units is 24 or 27, as shown in Fig. 4.4.

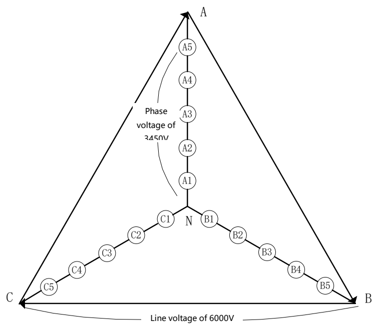


Fig. 4.3 6kV VFD's Unit Voltage Superposition

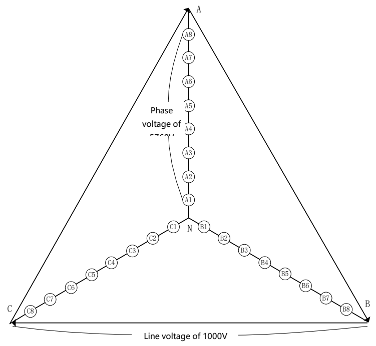


Fig. 4.4 10kV VFD's Unit Voltage Superposition

Take as an example a 6kV VFD with 5 power units connected in series. It has 11 levels (-5 ~ 0 ~ +5). When the level increases, the voltage value of each level decreases, reducing the damage of dv/dt to the motor insulation and reducing the harmonic content in the output voltage. The voltage waveform output by each power unit and the phase voltage waveform output by the unit connected in series are shown in the figure below.

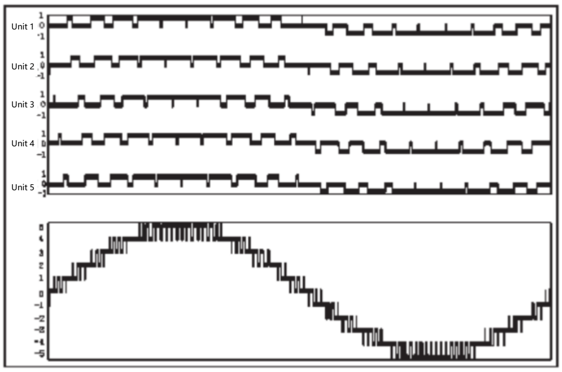


Fig. 4.5 6kV VFD's Output Phase Voltage Waveform

4.2 Control System

The control system consists of a main control board, an I/O interface board, a temperature measurement board, and a touch screen.

4.2.1 Makeup of Controller's Main Control Board

As shown in Fig. 4.6, the main control board consists of the following four subsystems:

DSP subsystem: provide functions including motor control algorithm, unit fault diagnosis, real-time protection, and communication with the I/O interface board;

FPGA subsystem: provides real-time communication with DSP, communications with units, carrier phase shift PWM output, and other logic functions.

Communication module subsystem: provides data exchanges between the data and touch screen, including parameter download, fault indication, function selection, and command issuance.

Fiber subsystem: The main control board is equipped with up to 12-level unit optical fibers. The fiber subsystem periodically sends pulse width modulation (PWM) signals and commands to the units. The power units receive its commands and status signals through the optical fibers, and send fault code signals to the fiber subsystem in the event of a fault. In addition, 6 groups of optical fibers are reserved to extend various functions, such as communication with the I/O interface board, master-slave control, encoder/rotary transformer decoding, etc.

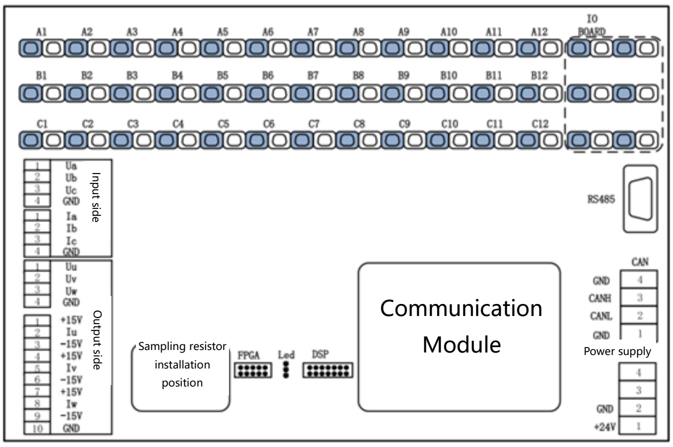


Fig. 4.6 Panel of Main Control Board

4.2.2 Descriptions of Controller's Main Control Board Interfaces

Name	Description
A1/B1/C1	Level 1 power unit's optical fiber communication interface
A2/B2/C2	Level 2 power unit's optical fiber communication interface
A3/B3/C3	Level 3 power unit's optical fiber communication interface
A4/B4/C4	Level 4 power unit's optical fiber communication interface
A5/B5/C5	Level 5 power unit's optical fiber communication interface

A6/B6/C6	Level 6 power unit's optical fiber communication interface
A7/B7/C7	Level 7 power unit's optical fiber communication interface
A8/B8/C8	Level 8 power unit's optical fiber communication interface
A9/B9/C9	Level 9 power unit's optical fiber communication interface
A10/B10/C10	Level 10 power unit's optical fiber communication interface
A11/B11/C11	Level 11 power unit's optical fiber communication interface
A12/B12/C12	Level 12 power unit's optical fiber communication interface
IO Interface Board	IO board's optical fiber communication interface
+24V	24V power supply input
GND	
LED	Status indication
CANH	CAN communication interface
CANL	
GND	
RS485	485 communication interface
Input side	Input-side voltage/current interface
Output side	Output-side voltage/current interface

4.2.3 I/O Interface Board

The I/O interface board adopts the programmable logic device CPLD as its CPU. According to the frequency converter control requirements, 24 DI inputs, 16 DO outputs, 4 AI inputs, 4 AO outputs, and 1 optical fiber communication channel are selected to ensure sufficient interfaces and fast computing and processing.

4.2.3.1 DI Module

The DI module detects the external on-off inputs and provides functions such as VFD control, fault detection, etc. It receives remote control and on-site on-off input signals. Remote control supports two kinds of signals: level and pulse. The signal type for remote control can be set through the function option "Remote start/stop mode" on the touch screen. The switching activation signal terminal is only connected when the synchronous switching function is enabled.

Note: The on-off inputs are required to come from passive nodes. When multiple on-off inputs are connected at the same point, the common line mode can be adopted for 24V+. The function of the remote reset signal of the IO board is the same as that of the reset button on the cabinet door: in case VFD has no major fault, only the touch screen is reset and no other impacts are imposed on the system (for example, resetting in the running state will not cause downtime); after a major fault happens to the VFD and is troubleshot, the control system is reset to allow the VFD to be restored into the normal state.

4.2.3.2 DO Module

The DO module provides dry contact outputs. It is used to realize functions including medium-voltage VFD status indication and alarm sounding. Some nodes have the capacity of 250VAC/8A or 250VDC/8A, and the others have the capacity of 250VAC/16A or 250VDC/16A. When the demand is exceeded, please add an intermediate relay to expand the capacity. The phase locking success signal is only connected when the synchronous switching function is enabled.

Note:

The closing allowance and opening signals are interlocked with the VFD's upper-level switch (power cabinet circuit breaker or VFD incoming cable vacuum contactor/circuit breaker in the automatic bypass cabinet). The closing allowance contact is normally open and should be connected in series to the closing circuit of the upper-level switch as a closing condition, but it does not participate in the operations of the upper-level switch. When the contact is in the closed position, the upper-level switch is allowed to power up the VFD; otherwise, the upper-level switch is not allowed to power up the VFD. The switching signal contact is normally closed and should be connected in parallel to the opening circuit of the upper-level switch. When a major fault occurs during the operation of the VFD, this contact comes into the closed position and the upper-level switch is automatically broken to protect the VFD.

4.2.3.3 AI Module

The AI module receives the external 4-20mA DC input for VFD control.

4.2.3.4 AO Module

The AO module provides the 4-20mA DC output and is used for VFD status indication (see Fig. 4.7 Schematic Diagram of I/O Interface Board for specific instructions); the impedance of the load is required to be less than 500 Ω.

4.2.3.5 Communication Module

The communication module communicates with the main control board through optical fiber. It uploads the DI and AI data to the main control board and sends the DO and AO data to the IO board.

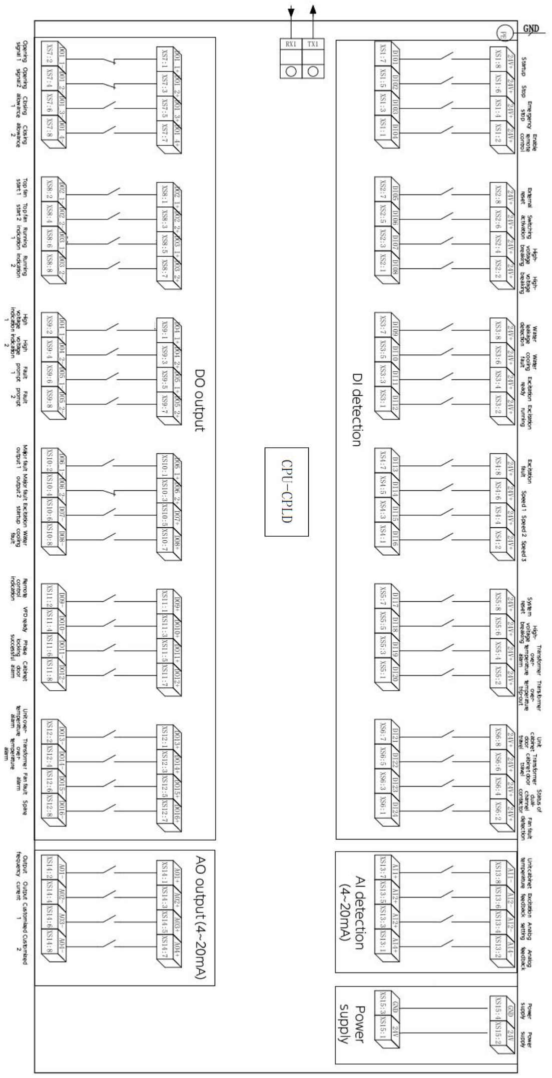


Fig. 4.7 Schematic Diagram of I/O Interface Board

4.2.4 Descriptions of I/O Board Interfaces

Terminal number	Position	Name	occurs	Type	Description
XS1	7/8	Level-based forward start/stop/ and pulse-based start	Closed/open	DI/level or pulse signal	They are enabled when the function option "Control mode" is set to "Remote control". The two input modes are set using the function option "Remote start/stop mode" on the touch screen: Level-based forward start/stop: Closingmeans forward start and opening means stop (level-based mode)

					Pulse-based start: The VFD is started in the pulse mode through closing and opening the contact (pulse width > 500ms)
	5/6	Level-based reverse start/stop and pulse-based stop	Closed/open	DI/level or pulse signal	They are enabled when the function option "Control mode" is set to "Remote control". The two input modes are set using the function option "Remote start/stop mode" on the touch screen: Level-based reverse start/stop: Closing means reverse start opening means stop (both level-based mode and VFD reverse rotation are set to "Allowed") Pulse-based stop: The VFD is shut down in the pulse mode through closing and opening the contact (pulse width > 500ms)
	3/4	Emergency stop	Enabled when in the open position	DI/normally closed Level signal	When the contact is in the open position, the output is locked and the motor can be shut down freely
	1/2	Enable remote control	Enabled when in the closed position	DI/normally open Level signal	Remote control can be enabled when the function option "Remote setting of control mode" on the touch screen is set to "Allowed". and the control method of the VFD when the contact is in the closed position.
XS2	7/8	External reset	Enabled when in the closed position	DI/normally open Pulse signal	When the contact is in the closed position, the control system is reset in the event of a major fault or the touch screen is reset during operation (equivalent to the reset button on the cabinet door)
	5/6	Switching activation	Enabled when in the closed position	DI/normally open Pulse signal	Switching activation can be enabled when the function option "Variable frequency switching" on the touch screen is set to "Allowed". When the contact is in the closed position, the output frequency of the VFD is increased to the grid frequency and phase locking is implemented.
	3/4	Medium-voltage breaking	Enabled when in the	DI/normally open	Closing the contact can break the medium-voltage input power supply

			closed position	Pulse signal	(equivalent to the medium-voltage break button on the cabinet door)
	1/2	Medium-voltage breaking	Enabled when in the closed position	DI/normally open Pulse signal	Closing the contact can break the medium-voltage input power supply (equivalent to the medium-voltage break button on the cabinet door)
XS3	7/8	Water leakage detection	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that there is water leakage (for water-cooled VFD)
	5/6	Water cooling fault	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that there is a water-cooling fault (for water-cooled VFD)
	3/4	Excitation ready	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means excitation ready (for synchronous motor)
	1/2	Excitation running	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that the VFD is in the excitation operation status (for synchronous motor)
XS4	7/8	Excitation fault	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that there is an excitation fault (for synchronous motor)
	5/6	Speed 1	Enabled when in the closed position	DI/normally open Level signal	They can be enabled when the function option "Operation mode" on the touch screen is set to "Open-loop operation" and "Setting mode" to "Switch setting". When they are in the closed position, the set frequency values are respectively the setpoints of the parameter options "Switch setting 1", "Switch setting 2" and "Switch setting 3" on the touch screen.
	3/4	Speed 2	Enabled when in the closed position		
	1/2	Speed 3	Enabled when in the closed position		
XS5	7/8	System reset	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that the control system is reset in the event of a fault.

	5/6	Medium-voltage breaking	Enabled when in the closed position	DI/normally open Pulse signal	Closing the contact can break the medium-voltage input power supply
	3/4	Transformer overtemperature alarm	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that the transformer temperature is higher than the set alarm temperature value
	1/2	Transformer overtemperature trip-out	Enabled when in the closed position	DI/normally open Pulse signal	The closed contact means that the transformer temperature is higher than the set trip-out temperature value
XS6	7/8	Unit cabinet door travel	Enabled when in the open position	DI/normally closed Pulse signal	The open contact means that the unit cabinet door is open
	5/6	Transformer cabinet door travel	Enabled when in the open position	DI/normally closed Pulse signal	The open contact means that the unit cabinet door is open
	3/4	Status of dual-channel contactor	Enabled when in the open position	DI/normally closed Pulse signal	The open contact means that there is a fan power supply fault
	1/2	Fan fault detection	Enabled when in the open position	DI/normally closed Pulse signal	The open contact means that there is a fan fault
XS7	1/2	Opening signal 1	Enabled when in the closed position	DO/normally closed	8A/250VAC; they are in the closed position when the function option "Control state" is set to "Normal state" and the VFD has no major fault output.
	3/4	Opening signal 2	Enabled when in the closed position	DO/normally closed	
	5/6	Closing allowance 1	Enabled when in the closed position	DO/normally open	8A/250VAC; they are in the closed position when the function option "Control state" is set to "Debugging state" and the VFD has no major fault output.
	7/8	Closing allowance 2	Enabled when in the closed position	DO/normally open	
XS8	1/2	Top fan start 1	Enabled when in the	DO/normally open	8A/250VAC; they are in the closed position if the fans on the top of the

			closed position		cabinet need to be started
	3/4	Top fan start 2	Enabled when in the closed position	DO/normally open	
	5/6	Running indication 1	Enabled when in the closed position	DO/normally open	8A/250VAC; they are in the closed position when the VFD is running
	7/8	Running indication 2	Enabled when in the closed position	DO/normally open	
XS9	1/2	High voltage indication 1	Enabled when in the closed position	DO/normally open	8A/250VAC; they are in the closed position in case of high votlage readiness
	3/4	High voltage indication 2	Enabled when in the closed position	DO/normally open	
	5/6	Fault prompt 1	Enabled when in the closed position	DO/normally open	8A/250VAC; they flash in case of a minor fault (1s cycle: 0.5s on + 0.5s off) and are normally on in case of a major fault
	7/8	Fault prompt 2	Enabled when in the closed position	DO/normally open	
XS10	1/2	Major fault output 1	Enabled when in the closed position	DO/normally open	8A/250VAC; the contact is in the closed position in case of a major fault
	3/4	Major fault output 2	Enabled when in the open position	DO/normally closed	8A/250VAC; the contact is in the open position Heavy Fault Disconnected
	5/6	Excitation startup	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position when excitation is enabled
	7/8	Water cooling	Enabled	DO/normally	16A/250VAC; the contact is in the

		fault	when in the closed position	open	closed position when a water-cooling fault occurs
XS11	1/2	Remote control indication	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position when the VFD's control mode is remote control
	3/4	VFD ready	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position when the VFD is ready
	5/6	Phase locking successful	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is put into the closed position when the deviation of the output voltage from the grid voltage is within the allowed phase locking range during synchronous switching (with a maximum phase deviation of ± 5 ° and a maximum amplitude deviation of ± 2%)
	7/8	Cabinet door alarm	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position when the cabinet door is open
XS12	1/2	Unit overtemperature alarm	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position when the unit cabinet is overheated
	3/4	Transformer overtemperature alarm	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position in case of transformer overtemperature
	5/6	Fan fault alarm	Enabled when in the closed position	DO/normally open	16A/250VAC; the contact is in the closed position in case of a fan fault
	7/8	Spare	Enabled when in the closed position	DO/normally open	16A/250VAC; a reserved output
XS13	7/8	Unit cabinet temperature	4~20mA	AI/current	• 4~20mA corresponds to -44.3~99.6°C
	5/6	Excitation feedback	4~20mA	AI/current	• 4~20mA corresponds to 0~maximum excitation current

	3/4	Analog setting	4~20mA	AI/current	The correspondence can be adjusted through adjusting the parameters "Minimum set current" and "maximum set current" on the touch screen, with an accuracy of 1.5% • 4~20mA corresponds to 0Hz~maximum frequency
	1/2	Analog feedback	4~20mA	AI/current	The correspondence can be adjusted through adjusting the parameters "Minimum set current" and "maximum set current" on the touch screen, with an accuracy of 1.5%. • 4~20mA corresponds to 0~100%
XS14	1/2	Output frequency	4~20mA	AO/current	The maximum load is 500Ω. 12-bit A/D sampling is implemented, with the resolution of 0.1% and the accuracy of 1.0% • 4~20mA corresponds to 0Hz~maximum frequency
	3/4	Output current	4~20mA	AO/current	The maximum load is 500Ω. 12-bit A/D sampling is implemented, with the resolution of 0.1% and the accuracy of 1.0% • 4~20mA corresponds to 0A~200% of the VFD's rated current
	5/6	Customized analog output 1	4~20mA	AO/current	The maximum load is 500Ω. 12-bit A/D sampling is implemented, with the resolution of 0.1% and the accuracy of 1.0% The functional parameter "Analog output 1" on the touch screen is set to one of the following 6 outputs: • 4~20mA corresponds to 0Hz~maximum frequency (when set to output frequency) • 4~20mA corresponds to 0A~200% of the VFD's rated current (when set to output current) • 4~20mA corresponds to 0~100°C (when set to unit cabinet temperature) • 4~20mA corresponding to 0~1 (when

					set to output power factor) • 4~20mA corresponds to 0~200% of the rated output power (when set to output power) • 4~20mA corresponding to 0~rated current of excitation cabinet (when set to excitation current setting)
	7/8	Customized analog output 2	4~20mA	AO/current	The maximum load is 500Ω. 12-bit A/D sampling is implemented, with the resolution of 0.1% and the accuracy of 1.0% The functional parameter "Analog output 2" on the touch screen is set to one of the following 6 outputs: • 4~20mA corresponds to 0Hz~maximum frequency (when set to output frequency) • 4~20mA corresponds to 0A~200% of the VFD's rated current (when set to output current) • 4~20mA corresponds to 0~100°C (when set to unit cabinet temperature) • 4~20mA corresponding to 0~1 (when set to output power factor) • 4~20mA corresponds to 0~200% of the rated output power (when set to output power) • 4~20mA corresponding to 0~rated current of excitation cabinet (when set to excitation current setting)
XS15	1/2	Power supply	Positive pole of power supply	/	External 24VDC input
	3/4	Power supply	Negative pole of power supply	/	

4.2.5 Temperature Measurement Board

The temperature measurement board has 4 platinum thermistor temperature detection circuits used to detect the temperature rises of the dry-type transformer's three-phase windings and the unit cabinet, 1 temperature and humidity detection circuit used to measure the temperature and humidity of the environment in the VFD, and 1 optical fiber communication circuit used to upload to the main control board the measured winding and unit cabinet temperature values and the measured ambient temperature and humidity values. The main control board can automatically start or stop the forced air cooling of the cooling fans for the windings and unit cabinet according to the temperature values measured by the temperature measurement board, and sound overtemperature alarms and produce overtemperature trip-out outputs according to the transformer overtemperature alarm value and overtemperature trip-out value set in the alarm setting parameters in the parameter setting interface on the touch screen, so as to ensure that the transformer is running in a safe state.

4.2.5.1 Sensors

Pt100 sensors are used for platinum thermistor-based temperature detection.

- Pt100 is a thermal resistor with good linearity in the range of -30.0°C ~ 240.0°C. It meets the Class B requirements of the standard of *Technical Specifications and R-T Table for Industrial Platinum Resistors* (GB/T 8622-97).
- Outside dimensions: Φ3mm×30mm or Φ4mm×40mm
- Pt100's resistance-temperature curve:

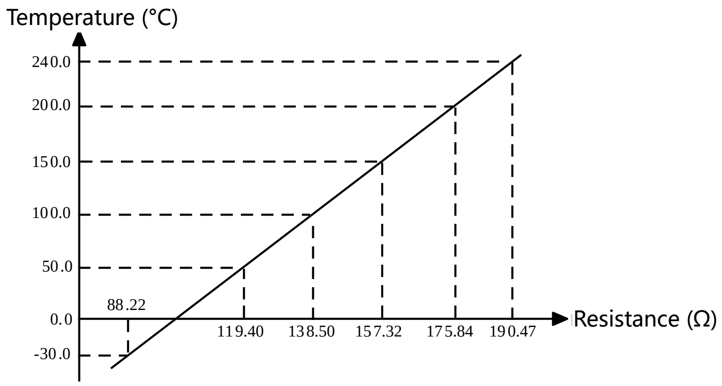


Fig. 4.8 Temperature Characteristic Curve of PT100

4.2.5.2 Descriptions of Temperature Measurement Board Interfaces

Terminal number	Position	Terminal definition	Description
P1	1	24V+	24V power supply
	2	24V-	
	3	PE	
PT1	1	PT100A	Unit cabinet temperature
	2	PT100B	
	3	PT100B	
PT2	1	PT100A	Phase A temperature of transformer
	2	PT100B	
	3	PT100B	
PT3	1	PT100A	Phase B temperature of transformer
	2	PT100B	
	3	PT100B	
PT4	1	PT100A	Phase C temperature of transformer
	2	PT100B	
	3	PT100B	
TX1	/	Fibre optic	Optical fiber communication interface

4.3 Power Units

4.3.1 Electric Principle

The electrical topology of each power unit is shown in Fig. 4.9: the input-side R, S, and T are connected to the secondary side windings of the transformer; the incoming alternating phase currents go through three-phase full-bridge rectification into a DC busbar power supply; the output side is an H-bridge inverter circuit. The power unit receives the trigger signals through the optical fiber to control the connections and disconnections between the IGBTs (Q1 ~ Q4) and outputs the single-phase pulse width modulation waveforms. Each unit has three output states: when Q1 is connected to Q4, the unit's output voltage is a DC busbar voltage; when Q2 is connected to Q3, the unit's output voltage is a negative DC busbar voltage; when Q1 is connected to Q3 or Q2 is connected to Q4, the unit's output voltage is zero.

In case power units with the bypass function are used, if one of them fails to work due to a fault, the unit will block the Q1-Q4 outputs, connect the bypass contactor K, and give a bypass alarm to ensure continuous operation of the VFD.

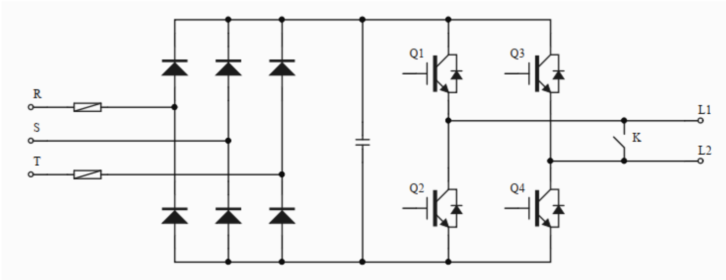


Fig. 4.9 Topological Diagram of Power Unit

The power unit consists of a monoblock board. The monoblock unit board communicates with the main control board through a set of optical fibers. Since the set of optical fibers is the only connection between the unit and the main control system of the VFD, there is a medium-voltage electric isolation between the unit and the main control system.

The power supplied to the monoblock unit board is taken from the DC busbar in the main circuit, and the required control power is obtained through switch power supply isolation and conversion. After the medium-voltage power supply is disconnected, the unit's control power supply does not immediately disappear (the power indicator on the unit's control board can only be turned off after a few minutes).

The monoblock unit board receives signals from the main control board through optical fibers and converts them into control commands through CPLD decoding, which are used to control the 4 inversion IGBT switches, bypass contactor, and unit fault state reset.

The monoblock unit board is equipped with a variety of unit fault detection and protection circuits (such as overheat detection, phase loss detection, DC busbar overvoltage, undervoltage detection, drive fault detection, control power failure detection, optical fiber fault detection, etc.). In addition, the monoblock unit board also detects voltage and temperature analog quantities. The above fault signals and analog quantity information are subjected to CPLD encoding and sent to the main control board through optical fibers to achieve unit fault protection and state storage.

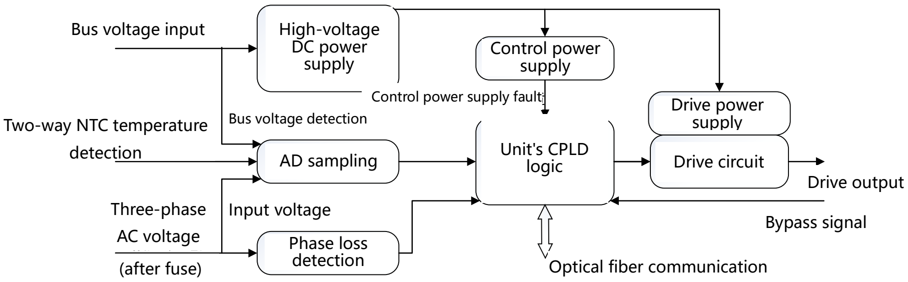


Fig. 4.10 Schematic Diagram of Unit Drive Board

4.3.2 Unit Structure

4.3.2.1 Air-cooled Power Unit

Each power unit (referred to as the unit for short) is installed in the power chamber and is fixed to a guide rail with screws. Its shape is generally as shown in Fig. 4.11. All the units in the cabinet have the same electrical and mechanical parameters and are interchangeable. The three-phase inputs of the unit are connected to the secondary side windings of the phase-shifting transformer, and fuses are provided on the incoming cable side.

After removing the fixing screws, input cables, output copper busbar, and fiber optic connector, the unit can be completely separated from the cabinet and removed from the guide rails. The unit installation procedure is the reversal of its removal procedure.

After the VFD is powered down, there is still a dangerous voltage in the unit. Open the cabinet door at least 10 minutes after power-down.

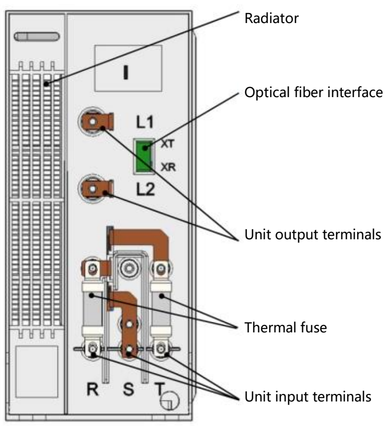


Fig. 4.11 Power Unit Outline Drawing

4.3.2.2 Water-cooled Unit

The working principle of each water-cooled power unit is the same as that of each air-cooled power unit. Vacuum-brazed water cooling radiators are used in the VFD. Such radiators can be applied to various power ranges, and are significantly effective especially for high-power VFDs with compact layout and high heat flux. All the water cooling plates have been subjected to professional heat dissipation simulation and pressure testing, with a pressure resistance of up to 1 MPa.

The structural drawing of the water-cooled power unit structure is as follows:

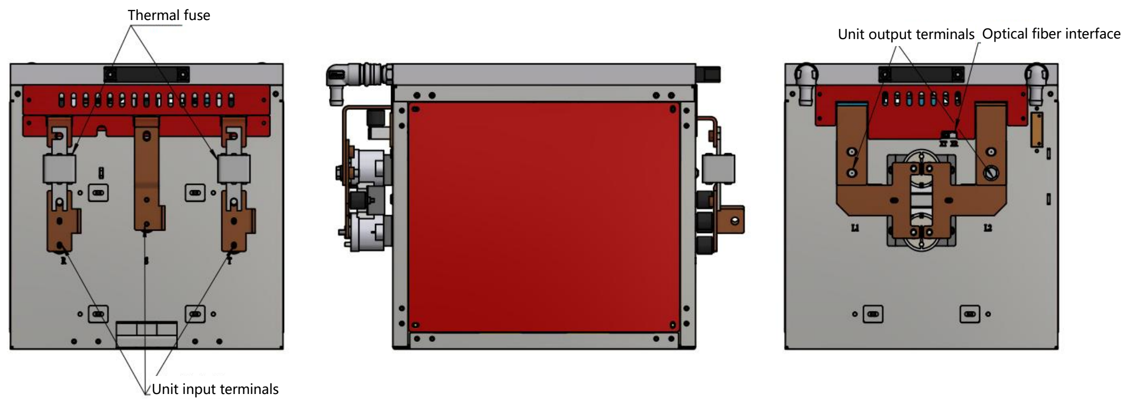


Fig. 4.12 Outline Drawing of Water-cooled Power Unit

The inlet and outlet of the flow channel on the water cooling radiator are equipped with two-way cut-off quick connectors to facilitate the replacement of the power unit. A stacked busbar design is used for minimal parasitic inductance and a compact unit structure. The water cooling radiator features lower surface temperature, stable performance, and long-life devices.

4.4 Cabinet Configuration

4.4.1 Transformer Chamber (air-cooled VFD)

4.4.1.1 Transformer of Air-cooled VFD

The transformer chamber includes a phase-shifting transformer (referred to as transformer for short) and its auxiliary components, including:

- Phase-shifting transformer
- Medium-voltage incoming copper bar

- Medium-voltage outlet copper bar
- Current transformer
- 380V auxiliary windings

The main body of the cabinet is a phase-shifting transformer, which can provide an isolated low-voltage power supply for the power units. Centrifugal fans are installed on the top of the cabinet for heat dissipation. The transformer and base are screwed together for easy transport and installation. The three-phase input cable of the VFD runs upward from the incoming cable hole at the bottom of the transformer chamber and is connected to the medium-voltage incoming cable copper bar of the transformer, and its outgoing cable runs out of the outgoing cable chamber at its bottom. It is also possible to run the incoming cable from the side bypass cabinet.

4.4.1.2 Transformer of Water-cooled VFD

A water-cooled VFD has the following two parts: transformer cabinet and water cooling air conditioning cabinet. The water cooling air conditioning cabinet is used to cool the phase-shifting transformer, that is, the heat generated by the transformer is carried into the air duct through forced air cooling. The hot air centrally collected passes through the heat exchanger to transfer its heat to the cooling water in the heat exchanger pipeline. The cooled air returns into the transformer cabinet to maintain the temperature in the transformer cabinet within a certain range. At the same time, the cooling water flowing into the heat exchanger pipe absorbs the heat and flows out of the outlet, taking the heat away. The temperature of the cooling water in the heat exchanger pipe is lower than 33°C, thus maintaining the ambient temperature in the VFD room (heat exchanger outlet temperature) below 40°C, so as to ensure that a stable operation environment is provided for the VFD.

The water-cooled VFD's water circulation system consists of two parts: internal water circulation system and external water circulation system. As shown in Fig. 4.13, the water circulation between the plate-type heat exchanger in the cabinet and the power units is called internal water circulation, also known as primary circulation, and the water circulation between the heat exchanger in the water cooling air conditioning and the plate-type heat exchanger and the outside cooling water is called external water circulation, also known as secondary circulation.

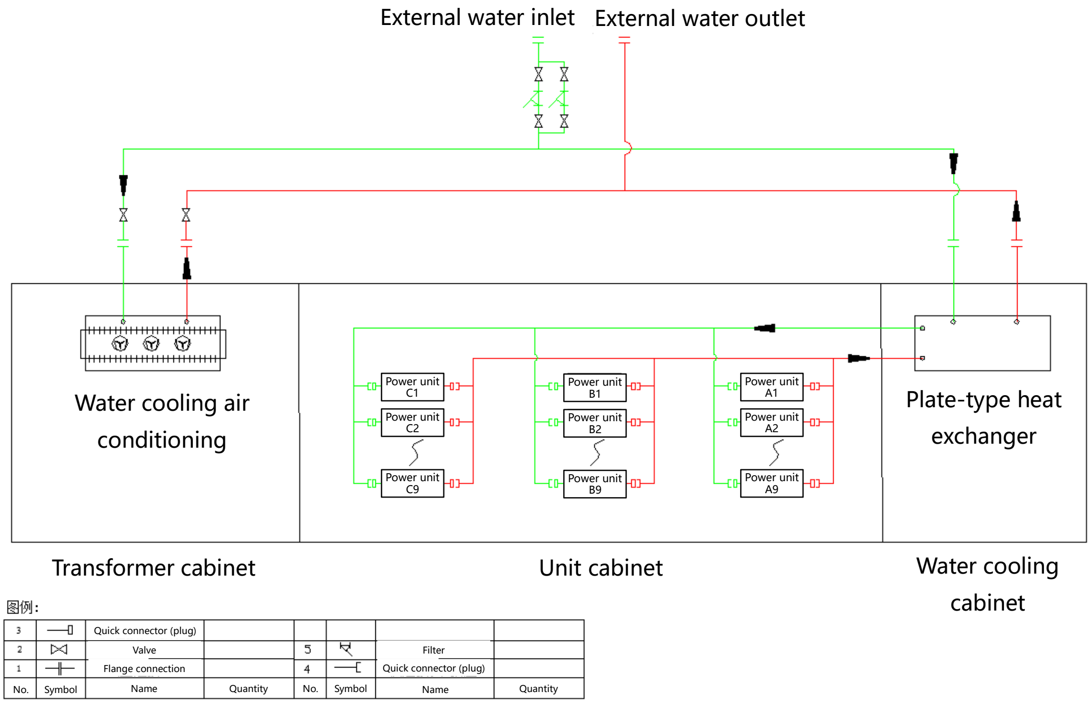


Fig. 4.13 Schematic Diagram of Water-cooled VFD's Water Circulations

4.4.2 Power, Control, and Outgoing Cable Chambers

The integrated cabinet consists mainly of a control chamber, a power chamber, a transformer chamber, and an outgoing cable chamber.

The split-type VFD is mainly composed of the following parts: control cabinet, unit cabinet, and transformer cabinet. A water cooling cabinet is provided for a water-cooled VFD model.

Split-type cabinets are only available to VEDA-IN MVDS single-side maintenance VFDs. A split-type VFD is mainly composed of the following parts: control cabinet, unit cabinet, and transformer cabinet.

- Control room

The touch screen, emergency stop button, and system reset button are located on the door panel of the control chamber. The control system is in the control chamber. From top to bottom, there are successively the main control optical fiber board, I/O interface board, and main control board. The secondary cable terminals are in the lower space or on the left side, and the standby UPS (optional) is in the lower and bottom space.

- Power chamber

There are three groups of power units inside the power chamber: phase A, phase B, and phase C (from top to bottom). Each phase has 8 units (10kV) connected in series, which are arranged from left to right. For example, the units of phase A are arranged as follows: A1, A2, A3, A4, A5, A6, A7, and A8. Below the units is the three-phase input power supply, which is connected to the secondary side output of the transformer through a fast fuse. Above the units is the single-phase output. The 8 units of each group are connected in series by a copper bar into a single phase. The left bridge arms of the L1 units of the three phases are short-circuited to form the Y-connection neutral point, and the outputs of the L8 units are connected to the output of the VFD.

Each power unit is fixed to guide rails in the cabinet with two screws at the bottom. In the rear of the unit chamber is a ventilation duct. The cooling air flows through the filter layer of the front cabinet door and the unit radiator and brings the heat generated in the power unit to the rear air outlet. A centrifugal fan on the top of the cabinet exhausts the hot air. A filter layer is installed outside the cabinet door to block dust from entering the inside of the unit. There is a travel switch on the inside of the cabinet door to sound the cabinet door interlock alarms.

- Outgoing cable chamber

The observation window is located on the door panel of the outgoing cable chamber, the resistor board assembly for input medium-voltage detection and the resistor board assembly for output medium-voltage detection are installed on the left side of the outgoing cable chamber, and the medium-voltage outgoing cable copper bar is located in the outgoing cable chamber.

The cabinet mainly contains the following parts:

- Main control optical fiber board
- I/O Interface Board
- Touch panel
- Power unit
- Resistor board assembly for input medium-voltage detection
- Resistor board assembly for output medium-voltage detection
- Main control board
- Neutral point detection Hall sensor
- Secondary wire terminal assembly
- Medium-voltage outlet copper bar
- Cooling fan
- UPS (optional)

The outline drawing of the VEDA-IN MVD series integrated VFD cabinet is as follows:

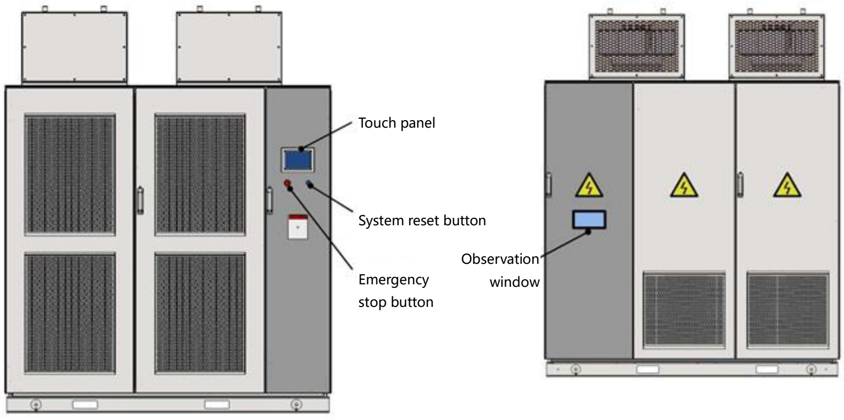
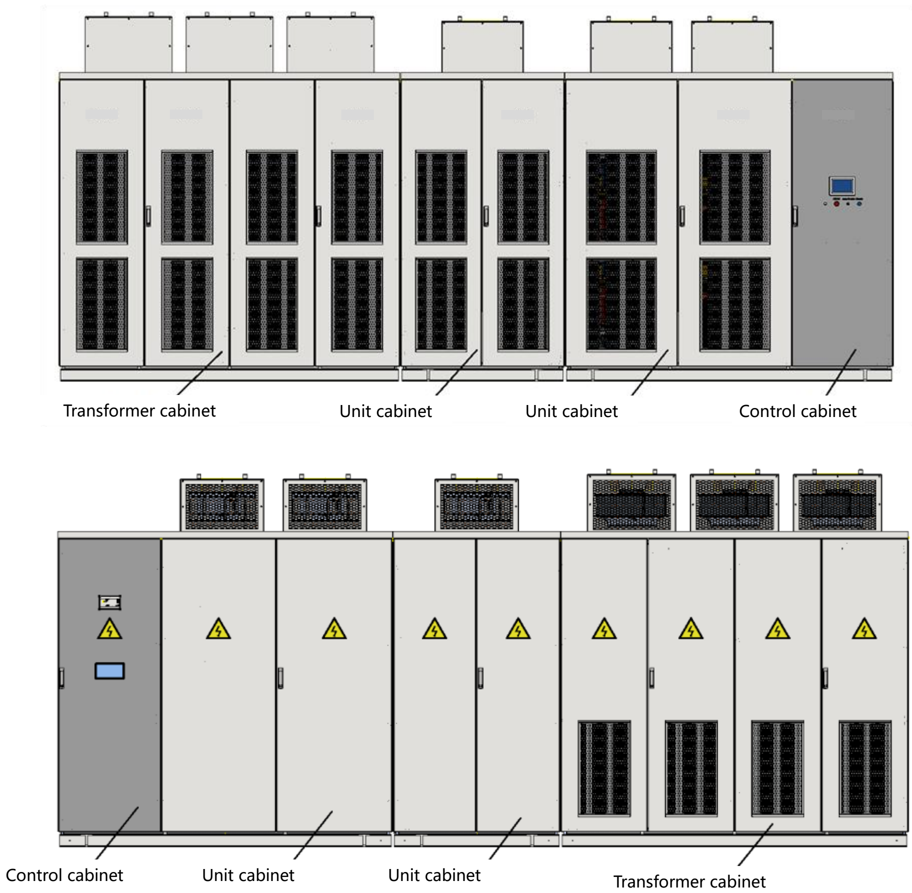


Fig. 4.14 Outline Drawing of VEDA-IN MVD Integrated VFD Cabinet

The outline drawing of the VEDA-IN MVD split-type VFD cabinet is as follows:

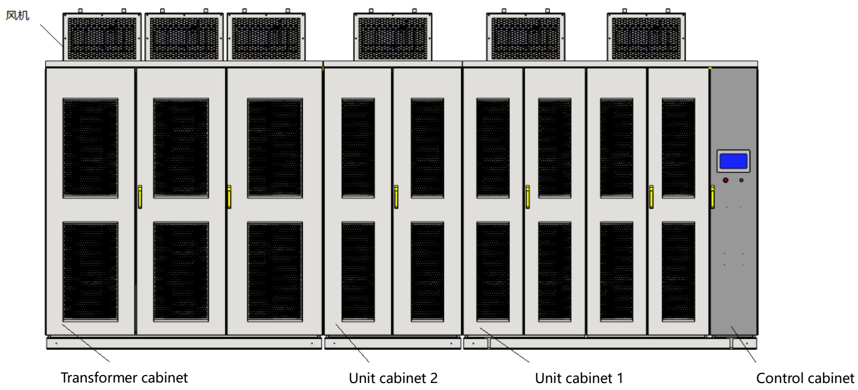


Front view

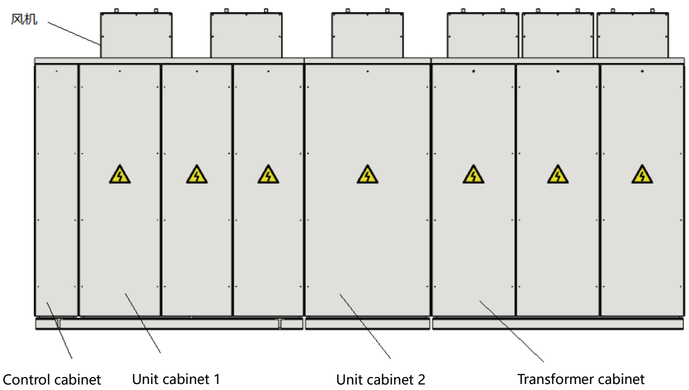
Back view

Fig. 4.15 Outline Drawing of VEDA-IN MVD Split-type VFD Cabinet (ML4.1)

The outline drawing of the VEDA-IN MVDS VFD cabinet is as follows:



Front view



Back view

Fig. 4.16 VEDA-IN MVD Cabinet (MB3.1S/ML3.1S)

The outline drawing of the VEDA-IN MVD water-cooled VFD is as follows:

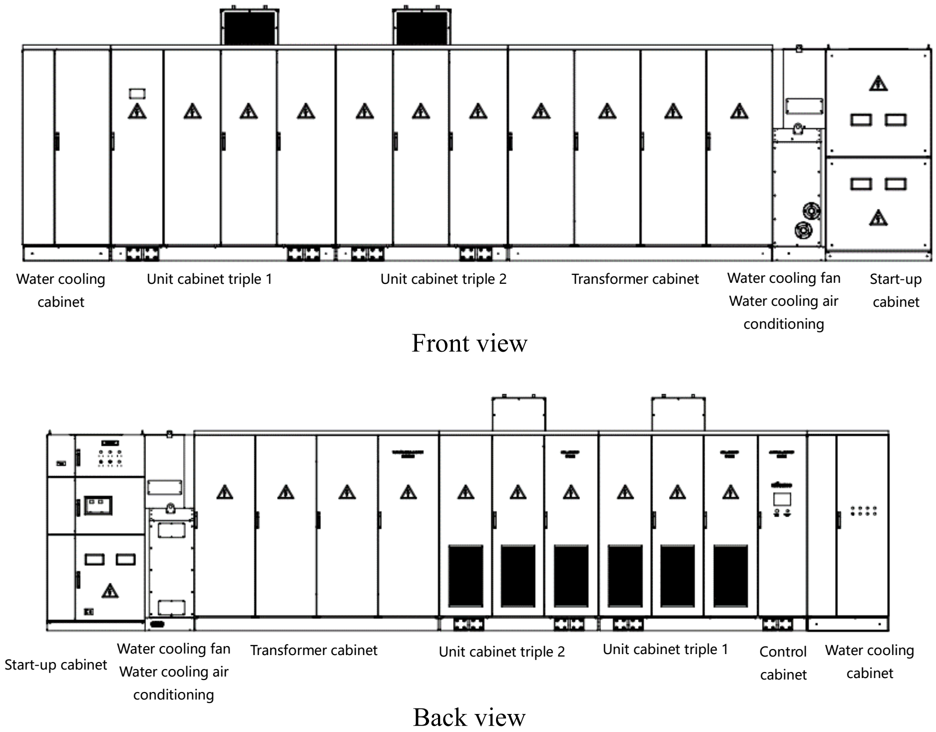


Fig. 4.17 Outline Drawing of VEDA-IN MVD Water-cooled VFD

4.4.3 Switch Cabinet (optional)

In practical applications, it is often necessary to use a switch cabinet with the VFD. The switch cabinet can be a bypass cabinet or a switching cabinet.

- Bypass cabinet

In case of a VFD fault, the bypass cabinet is able to switch the motor to the power frequency grid operation to ensure continuous system operation. The bypass cabinet can be a manual or automatic one: with the width of 0.8m, the manual bypass cabinet is interlocked with the power cabinet; the width of the automatic bypass cabinet is 1m, and the VFD is interlocked with the incoming cable contactor KM1 in the bypass cabinet.

When a bypass cabinet is provided, the user-side primary cables (incoming power cable and motor outgoing cable) usually enter it through its bottom, and the primary cables between the bypass cabinet and the VFD are arranged in the cabinet using flexible cables.

When the system allows a brief shutdown, the manual bypass cabinet can be configured as shown in Fig. 4.18. There are three knife switches in the manual bypass cabinet (QS1 and QS22 are electrically interlocked and QS21 and QS22 are double-pole and double-throw disconnect switches). Their switching operations are manually performed by the operator.

When the system does not allow any shutdown, an automatic bypass cabinet can be configured, as shown in Fig. 4.19. There are three vacuum contactors in the automatic bypass cabinet (KM1 and KM2 are interlocked and KM2 and KM3 are interlocked), and their switching operations are performed through automatic electrical circuit control. In order to facilitate the maintenance of the VFD, the automatic bypass cabinet usually has an isolation knife switch, which is used to isolate the VFD from the medium-voltage power supply.

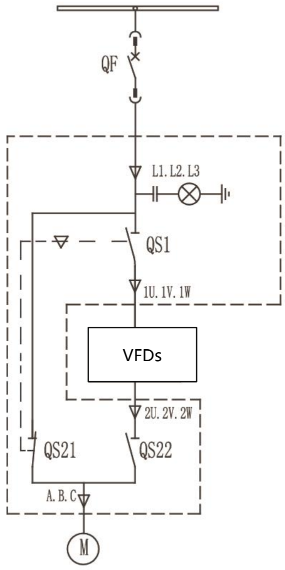


Fig. 4.18 Primary Side of Manual Bypass Cabinet

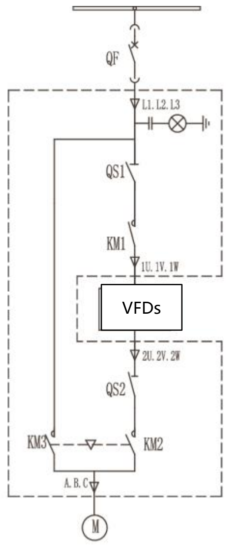


Fig. 4.19 Primary Side of Automatic Bypass Cabinet

- Switching Cabinet

The switching cabinet is applicable for scenarios where one VFD drives two motors. In case there are one motor in service and one motor on standby or there are two motors with the same condition, this scheme can be adopted to improve the utilization rate of the VFD. The switching cabinet can be a manual or automatic switching cabinet.

The principle of the manual switching cabinet is shown in Fig. 4.20: QS1 is mechanically interlocked with QS2; 1QF is electrically interlocked with QS1; and 2QF is electrically interlocked with QS2. The principle of the automatic switching cabinet is shown in Fig. 4.21: QS1 is not mechanically interlocked with QS2; KM1 is electrically interlocked with KM2; KM1 is electrically interlocked with 1QF; KM2 is electrically interlocked with 2QF.

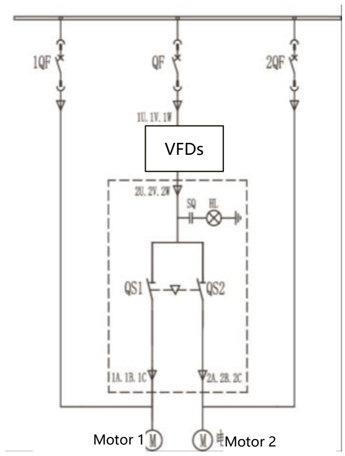


Fig. 4.20 Primary Side of Manual Switching Cabinet

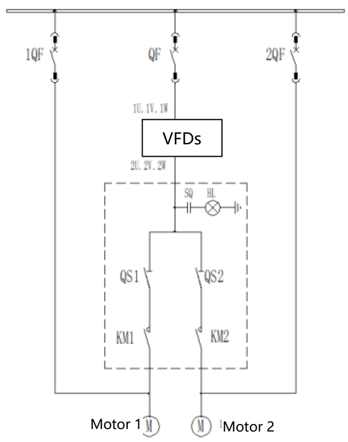


Fig. 4.21 Primary Side of Automatic Switching Cabinet

Note: During the operation of the VFD, it is strictly forbidden to open the contactor at the outgoing cable end of the VFD. Therefore, an automatic bypass cabinet and an automatic switching cabinet are used. Be sure to connect the normally closed contact for VFD running signals to the KM1 and KM2 opening circuits to prevent any misoperation from damaging any power unit.

4.4.4 Precharge Box (Optional)

If the VFD's power units have very high capacities (when their rated currents are 258A), a precharge box needs to be provided. The precharge box has two working modes: precharge and unit detection.

Precharge mode: this mode is used to precharge the capacitors of the power units. There are three charge levels available to the power units. The number of current-limiting resistors connected in series in the charge circuit determines their charge level. 3.5 seconds after the charge is complete, a closing allowance signal (valid for 4.5 seconds) is given to allow the upper-level switch cabinet to close.

Unit detection mode: this mode is used for unit self-test. Its charge process is the same as that of the precharge mode. Their only difference is that in the unit detection mode the level 3 charge continues until the user presses the medium-voltage opening button to stop this process.

The precharge box is installed in the VFD. The power levels, resistance values, and quantity of resistors are consistent with the VFD model. The primary circuit for precharge is shown in Fig. 4.22:

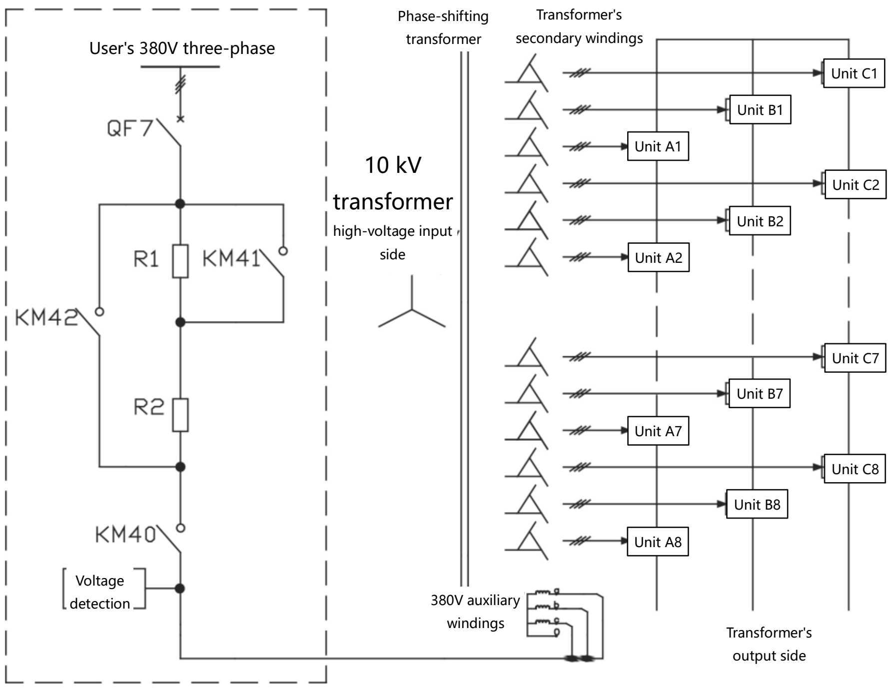


Fig. 4.22 Primary Circuit of Precharge Box

The input side of the precharge box is connected to the user's 380V power supply, and its output side is connected to the auxiliary winding of the phase-shifting transformer. The output voltage of the precharge box varies with the number of the precharge resistors connected in series. A corresponding voltage is induced in the secondary windings of the transformer to charge the DC capacitors of the power units.

4.4.5 Water Cooling Cabinet (for water-cooled VFD)

4.4.5.1 A water-cooled VFD is provided with a water cooling cabinet, in which there are mainly the following devices:

Main circulating pump: a redundant design is adopted to provide the standby power required for cooling water circulation; the pump body is mechanically sealed; the material in contact with the liquid is AISI 304 stainless steel; overcurrent and overheat protections are provided; the fault alarm function is provided so that an alarm signal is given and the other pump is automatically immediately switched to after the operating pump comes to be faulty or fail to the rated pressure or flow rate.

Plate-type heat exchanger: it provides heat exchange between cool and hot waters to transfer the heat to the cooling water.

Electric three-way valve: the cooling water temperature is adjusted through regulating the opening of the valve according to the outdoor ambient temperature and the VFD's operating load.

Deionization tank: it is connected in parallel to the main circulation loop to remove the ions that may be precipitated in the pipeline and ensure that the electrical conductivity of the water is a safe value.

Expansion tank: it is used to keep the cooling water in the pipeline of the system full and isolated from the air.

Deaeration tank: it is used to remove the air from the water.

Working principle of circulating water: the cooling water is driven by the main circulating pump to pass through the power unit radiators at a constant flow rate along the pipeline, constantly taking away heat. After the cooling water heats up, it enters the plate-type heat exchanger along the main pipeline for heat exchange. The cooled water returns to the inlet of the main circulating pump to form a closed circulating cooling system. The system control module automatically regulates the heat transfer ratio according to the preset cooling water temperature value, thus precisely controlling the water temperature. The medium-voltage VFD is meant to operate in a medium-voltage environment and its cooling water must have a very high resistivity value, so a water deionization bypass is connected in parallel to the main cooling circulation loop. A certain proportion of the cooling water flows through an ion exchanger to constantly remove the ions separated from the equipment and pipeline. In order to keep the pipeline at a constant pressure and full of cooling water and buffer the temperature-induced volume change of the cooling water, a buffer tank and a water refill device are provided in the system, as shown in Fig. 4.23.

Fig. 4.23 Circulating Pure Water Cooling Cabinet

4.4.5.2 Features and Functions of Water Cooling Cabinets:

- Our water cooling cabinets have the following features:

All the devices in the pipeline loop are made of stainless steel and have good corrosion resistance.

A redundant design is adopted to allow the main circulating pump to be replaced or repaired on-line.

An independent water deionization bypass device is provided.

An independent PLC monitoring system is provided for remote control.

A comprehensive range of alarming functions are provided. For example, water leakage monitoring and alarming, condensation monitoring and control, water temperature control and overheat alarming, water conductivity monitoring and alarming, etc.

- Our water cooling cabinets have the following functions:

Thermostatic control: PID logic control is imposed on the electric three-way valve according to the deviation between the actual and set inlet water temperature values of the valve block.

Flow regulation: the flow rate of the cooling water is regulated to ensure that the water temperature is maintained at a constant value.

Condensation control: the temperature and humidity transmitter displays the ambient humidity and temperature of the valve room and the corresponding dew point in real time. When the ambient temperature is higher than and close to the dew point, the electric heater is turned on.

Water leakage protection: water leakage detection is provided inside the water cooling cabinet; when there is any water leakage in the cabinet, the PLC will generate an alarm signal.

Ion removal: the ion exchange resin is dedicated to the removal of trace ions to prevent any leakage current in a medium-voltage environment. The electrical conductivity meter installed in the main water supply pipeline monitors the quality change of the circulating water in real time and gives an alarm in case of an anomaly.

Automatic water refill: when the outlet water pressure of the valve block is low, the water refill solenoid valve automatically opens to allow the water refill pump to refill water; when the water pressure reaches the water refill pump stop pressure, water refill will come to an end.

4.4.5.3 Internal circulating water: the internal circulating water is a mixture of deionized water and ethylene glycol. The concentration of ethylene glycol should be determined according to the lowest ambient temperature at the place where the water is used. The temperature-concentration correlation is shown in the following table:

Ambient temperature (°C)	Glycol concentration (% m/m)
0	0
-5	13
-10	22
-15	29.5
-20	36
-25	41.2
-30	45.8
-35	48.7
-40	52.9
-45	55.7
-50	58

4.4.5.4 External water circulation system of water-cooled VFD: a secondary heat exchange mode, such as water-water exchange or water-air exchange, can be adopted to release heat into the environment according to the cooling capacity and the on-site environmental conditions. There are three available external water supply methods on-site: 1) satisfactory external water is supplied on-site; 2) a closed-type cooling tower is used; 3) a precision chiller is used.

When the first method is adopted, the temperature and quality requirements for the external water are as follows:

No.	Name	Parameter	Unit	Remarks
1	Total dissolved solids	≤ 1000	mg/L	
2	pH value	6.5-8.5		
3	Hardness (equivalent concentration of $CaCO_3$)	≤ 450	mg/L	
4	Chloride	≤ 250	mg/L	
5	Sulfate	≤ 250	mg/L	
6	Suspended solids	≤ 30	mg/L	
7	Water pressure	2.5-6	Bar	
8	Solid particle size	≤ 200	μm	
9	External water flow rate of water cooling cabinet		t/h	(consult with our company)
10	External water flow rate of		t/h	(consult with our

	transformer cabinet			company)
11	External water inlet temperature (T1)	5-32	°C	
12	External water outlet temperature	T1+5	°C	

If the on-site external water is cloudy, it is necessary to add a filter with the accuracy of 200μm (80-mesh) and the bypass function in front of the external water inlet valve. The external water pipeline filter needs to be regularly cleaned, depending on the quality of the on-site external water.

Working principle of second method: the working fluid (pure water) circulates in the coil of the closed-type cooling tower and heat is dissipated from the coil into the water flowing through the coil. At the same time, the outside air flows into the unit through the side air inlet grille. It horizontally passes by the coil and a small proportion of water evaporates to absorb heat. The hot moist air is exhausted into the atmosphere by the ventilator that is located at the top of the cooling tower. The rest of the water passes through the following parts: bottom water trays, water pump, water distribution system, precooling packing, and coil.

Working principle of third method (precision water chiller): as shown in Fig. 4.24, the cooling system is mainly composed of the following devices: condenser, expansion valve, plate-type heat exchanger, cooling fan, water tank, internal water circulation pump, and external water circulation pump. On the one hand, the cold water in the water tank flows through the external water circulating pump into the external water inlet pipe of the water cooling cabinet, is subjected to heat exchange in the plate-type heat exchanger in the water cooling cabinet, and flows back into the water tank, thus achieving the purpose of reducing the temperature of the internal water of the water cooling cabinet; on the other hand, the hot water flowing back into the water tank exchanges heat with the low-temperature refrigerant through the plate-type heat exchanger in the refrigeration system to reduce its temperature, thus maintaining the temperature of the cold water in the water tank; after absorbing heat, the high-temperature refrigerant exchanges heat with the surrounding environment through the cooling fan to reduce its temperature. The precision water chiller is shown in the following figure.

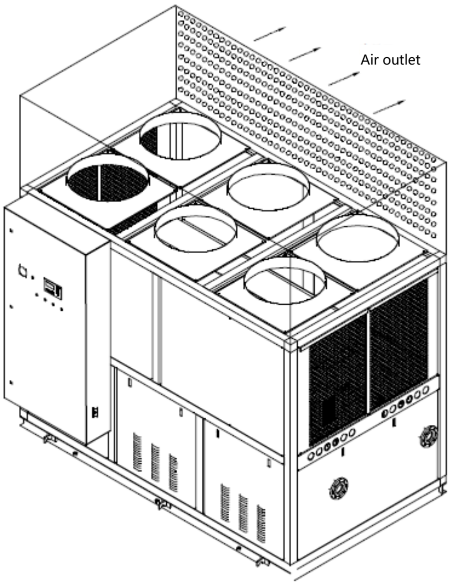


Fig. 4.24 Precision Water Chiller

4.5 Cable Selection

4.5.1 Selection of Power Cables

The selection of power cables must be in strict accordance with the following requirements:

- Current carrying capacity
- Specifications of cable manufacturer
- Cable laying mode
- Voltage drop incurred due to cable length
- Power industry specifications
- EMC specifications

⚠Caution!

- It is recommended that the high-voltage cables between the VFD and the user's apparatuses(medium-voltage power cabinet and motor) shall be shielded armored cables to prevent any rodent damage.
- If the total cross-sectional area of the cable shielding layer is less than 50% of the cross-sectional area of the single-phase conductor, it is necessary to add a ground wire along the cable to prevent the potential difference of the factory grounding network from overloading the shielding layer.
- The cross-sectional area of the ground cable must be greater than 16 mm^2.

4.5.2 Selection of Control, Signal, and Communication Cables

Recommended cross-section areas and specifications of control, signal, and communication cables:

- Analog quantity input and output cables: shielded twisted pairs with the cross-section areas of 0.5-1.5 mm^2
- Digital input and output cables: shielded twisted pairs with the cross-section areas of 0.5-1.5 mm^2
- Communication cables: professional communication cables required by relevant communication regulations or shielded twisted pairs with the cross-section areas of 0.5-1.5mm^2

⚠Caution!

- The signal cables for communication, control, etc. should be good-quality single-pair twisted pair cables or multiple-pair twisted pair cables.
- The signal cables should be laid away from the power cables using different cable trenches or trays. If this is not possible, the spacing between the two types of cables shall be greater than 30cm and they shall not be laid in parallel.
- Prevent any power supply cable from sharing a shielded cable with any signal cable.
- Each signal cable should be laid near corners at the ground potential to improve anti-interference.
- The conductors that transmit different classes of signals must cross each other vertically.
- Where there is any potential interference between different parts, a potential equalizing cable with the cross section area of 16 mm^2 must be laid in parallel to the control cable and firmly grounded.

- The shielding layer shall be grounded at one end on the VFD side; the distance between the shielding layer and the terminal should be as short as possible.

Chapter 5 Human-machine Interfaces

The VFD offers two human-machine interfaces:

Touch screen - parameter setting and information feedback;

Tools_Can - data monitoring and debugging assistance.

5.1 Touch Screen

The touch screen is on the front side of the VFD cabinet door. The user can use the touch screen to set the VFD's parameters, observe its status, read data, etc. The structure of the menu on the touch screen is shown in Fig. 5.1 (the excitation regulation function is not applicable for asynchronous motors):

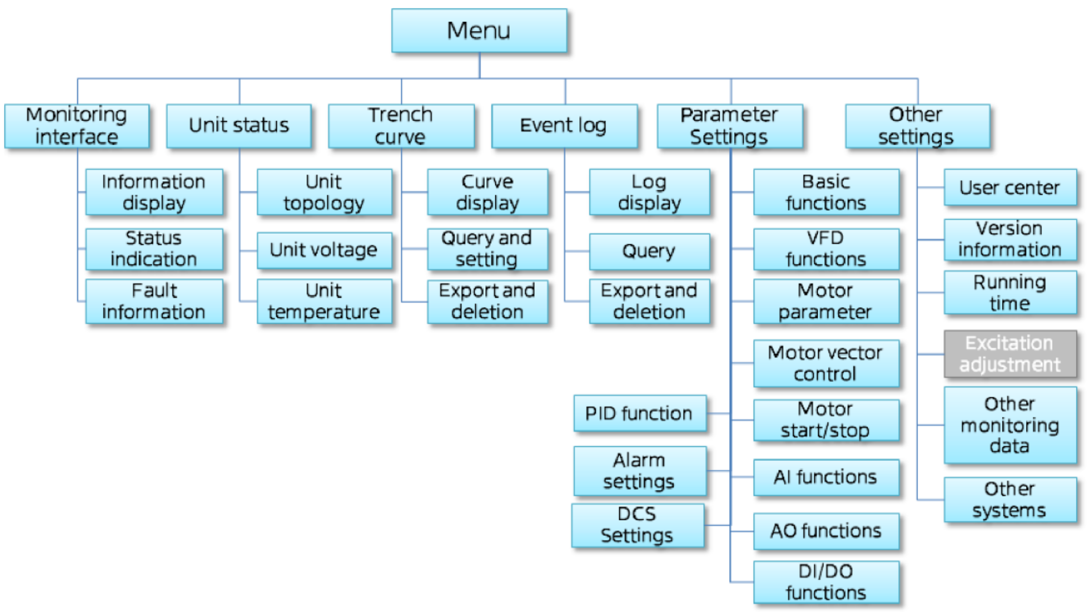


Fig. 5.1 Menu Structure

5.2 Operations and Displays on Touch Screen

5.2.1 Monitoring Interface

The default interface upon power-on is the monitoring interface, which can be divided into 4 areas: information display area, status display area, fault display area, and window/menu selection area, as shown in Fig. 5.2.

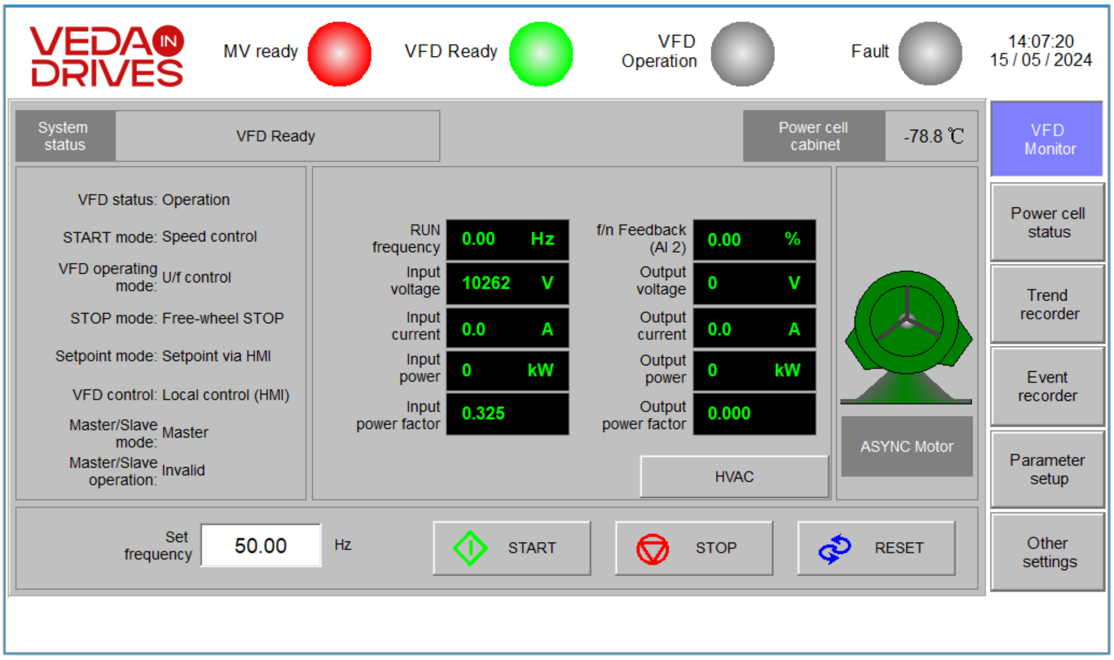


Fig 5.2 Monitoring Interface

The areas are described in the following table:

Table 5-1 Descriptions of Areas in Monitoring Interface

Area	Description
Information display area	This is the main display area showing key parameters, VFD operating status, and VFD start/stop controls, etc.
Status display area	High voltage: on when the high voltage is ready (red) Standby: on when the system is on standby (green) Running: on when the VFD is running (green) Fault: normally on when a major fault occurs (red); flashing when a minor fault occurs (red)
Fault display area	Shows the fault alarm information; in case of a major fault, the alarm bar is red; in case of a minor fault, the alarm bar is yellow
Window/menu selection area	The contents shown in the information area can be changed by clicking a menu button to show the related settings

5.2.2 Unit Status

The unit status interface is used to monitor the real-time status and operation data of the units. It mainly consists of three parts: unit topology, unit voltage, and unit temperature, as shown in figures 5.3, 5.5, and 5.6. The status indication types of the interfaces are described in the following table.

Table 5-2 Status Indications

N	occurs	Description
1	Fault	Red and normally on
2	Alarm	Yellow and flashing
3	Normal	Green and normally on
4	Not in use	Grey

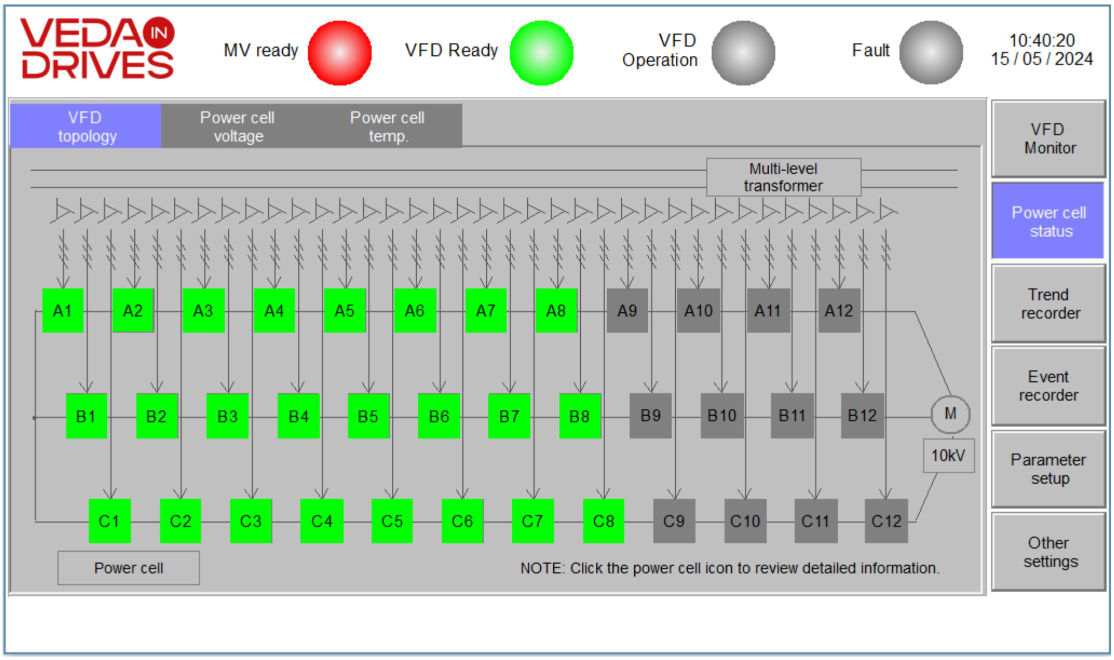


Fig. 5.3 Unit Topology

Unit topology: Through the topology diagram, you can quickly view the overall status of each unit. Click the icon of a unit, and you can view the status details of the unit. The shown information is as follows:

Table 5-3 Unit Status Details

N	Shown information
1	Code of current unit
2	Bypass status
3	Detailed fault status indication
4	Illustrated unit fault (fault indication + data monitoring)

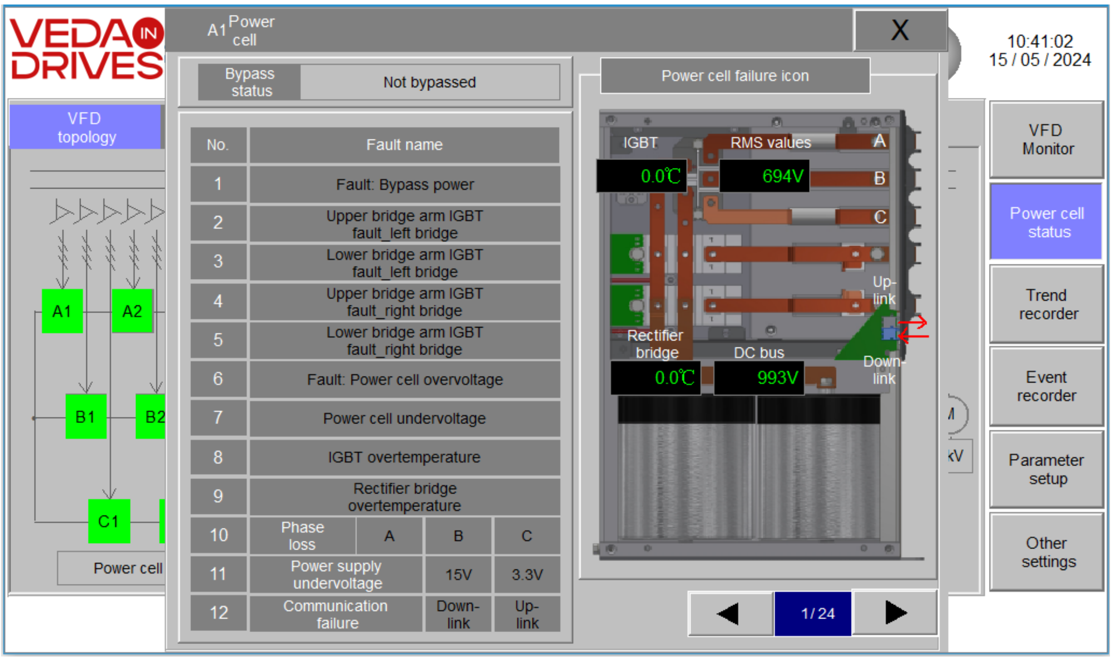
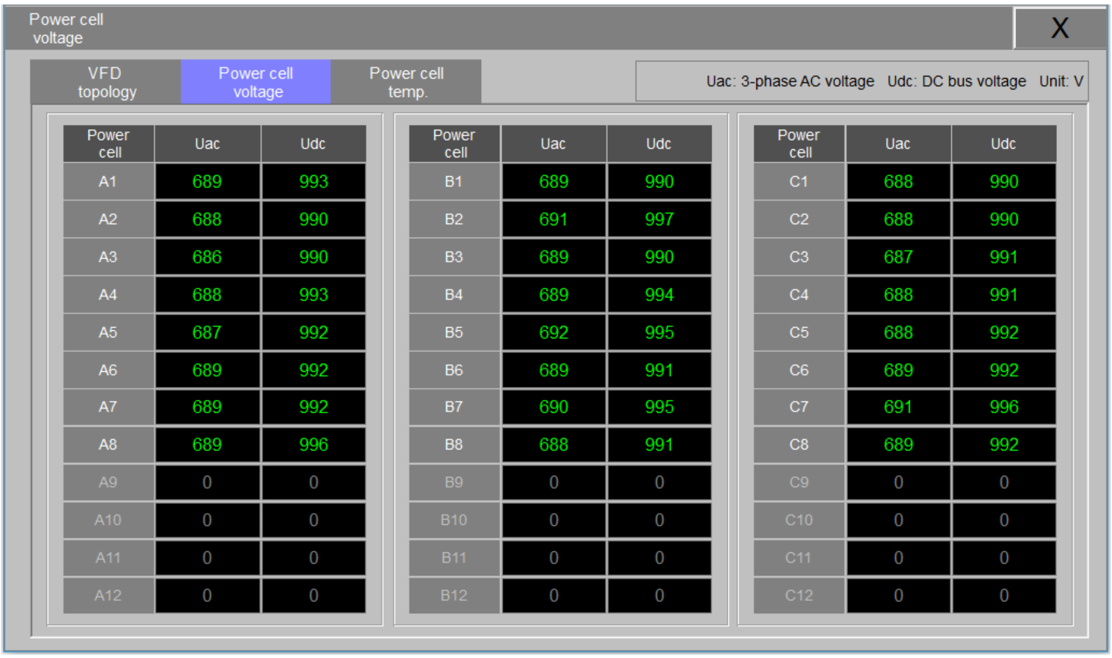
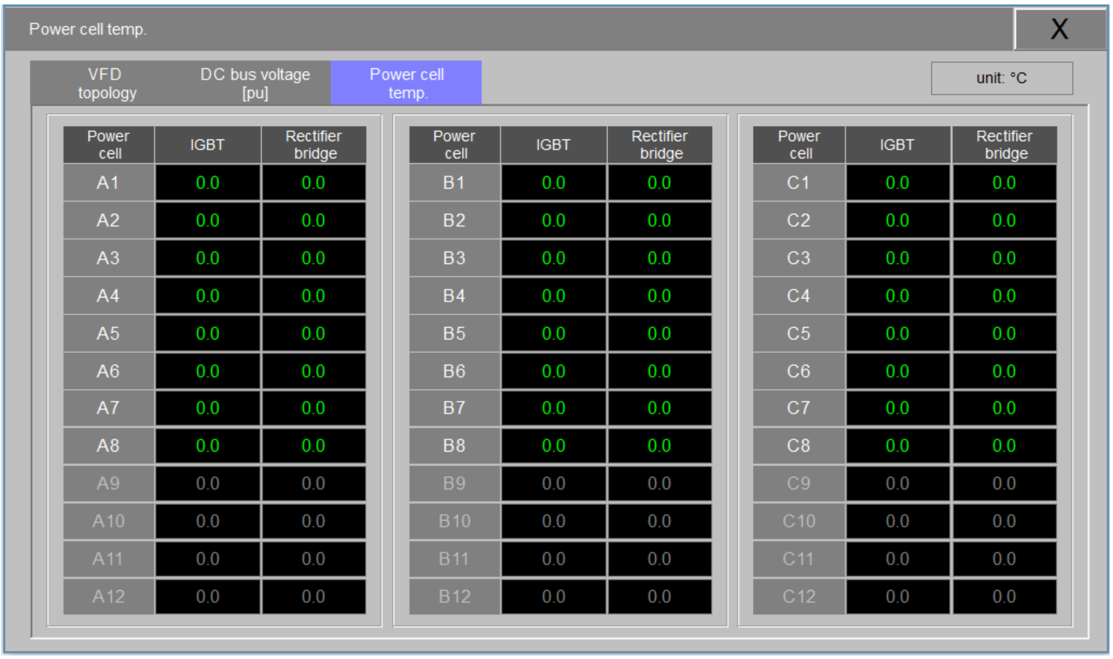


Fig. 5.4 Unit Status Details



Power cell	Uac	Udc	Power cell	Uac	Udc	Power cell	Uac	Udc
A1	689	993	B1	689	990	C1	688	990
A2	688	990	B2	691	997	C2	688	990
A3	686	990	B3	689	990	C3	687	991
A4	688	993	B4	689	994	C4	688	991
A5	687	992	B5	692	995	C5	688	992
A6	689	992	B6	689	991	C6	689	992
A7	689	992	B7	690	995	C7	691	996
A8	689	996	B8	688	991	C8	689	992
A9	0	0	B9	0	0	C9	0	0
A10	0	0	B10	0	0	C10	0	0
A11	0	0	B11	0	0	C11	0	0
A12	0	0	B12	0	0	C12	0	0

Fig. 5.5 Unit Voltage



Power cell	IGBT	Rectifier bridge	Power cell	IGBT	Rectifier bridge	Power cell	IGBT	Rectifier bridge
A1	0.0	0.0	B1	0.0	0.0	C1	0.0	0.0
A2	0.0	0.0	B2	0.0	0.0	C2	0.0	0.0
A3	0.0	0.0	B3	0.0	0.0	C3	0.0	0.0
A4	0.0	0.0	B4	0.0	0.0	C4	0.0	0.0
A5	0.0	0.0	B5	0.0	0.0	C5	0.0	0.0
A6	0.0	0.0	B6	0.0	0.0	C6	0.0	0.0
A7	0.0	0.0	B7	0.0	0.0	C7	0.0	0.0
A8	0.0	0.0	B8	0.0	0.0	C8	0.0	0.0
A9	0.0	0.0	B9	0.0	0.0	C9	0.0	0.0
A10	0.0	0.0	B10	0.0	0.0	C10	0.0	0.0
A11	0.0	0.0	B11	0.0	0.0	C11	0.0	0.0
A12	0.0	0.0	B12	0.0	0.0	C12	0.0	0.0

Fig. 5.6 Unit Temperature

5.2.3 Trend Curves

The trend curves are used to display the curves of the VFD's variables. The interface is shown in Fig. 5.7 and its basic functions are shown in Table 5-4.

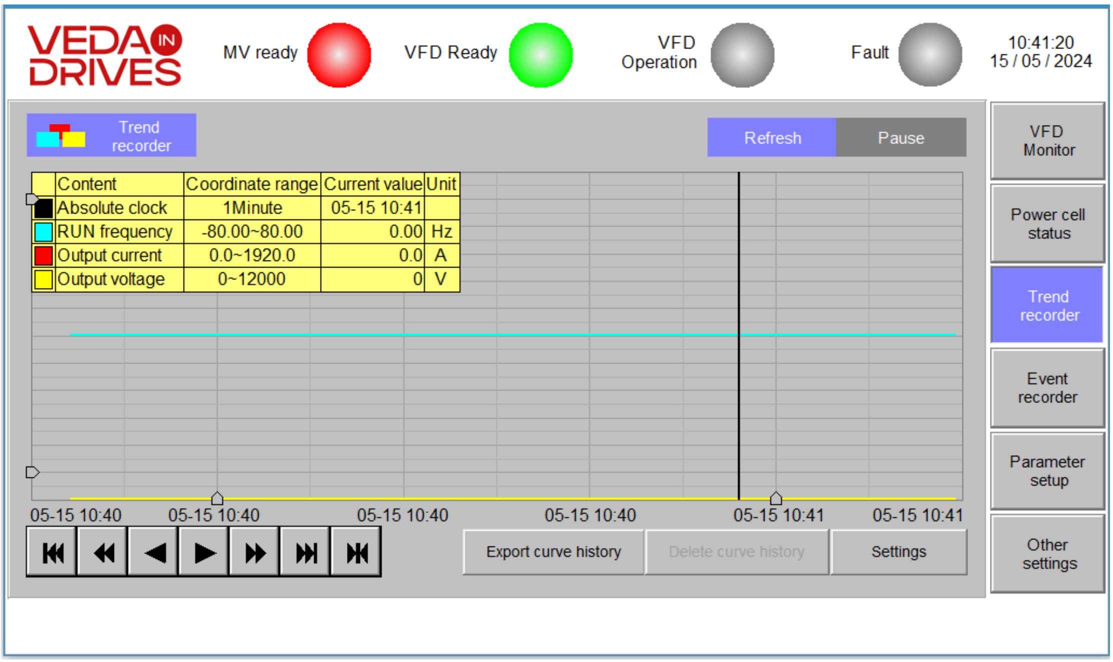


Fig. 5.7 Trend Curves

Table 5-4 Basic Functions of Trend Curves

N	Function	Description	
1	Export historical curve	USB disk's format	FAT32 (required), with no USB disk capacity requirement
		Safety Precautions	USB disk's capacity > size of data to export
			Pop-up: Historical data exported successfully! Explanation: The data export function has been successfully executed, but this does not mean that the data export is completed. The data export time is related to the size of the exported data, so you need to wait a while Note: When the amount of data is too large, please extend the waiting time appropriately after the prompt for data export success is indicated, so as to ensure that all the data is exported
2	Delete historical	Authority	Engineer and above. This function is disabled during running
		Safety	Take care! Once deleted, the historical curve cannot be restored. Important data

	curve	Precautions	should be exported for backup before deletion
3	Refresh and Pause	Refresh	Automatically refresh the curve interface into the default state
		Pause	The interface refresh stops (background data acquisition is not affected), and the history curve can be viewed now
4	Historical curve query	Method 1: Directly use the arrow buttons for positioning;	
		Method 2: Click "⏮", set the positioning time, and perform a quick query, as shown in Fig. 5.8	
5	Settings	The trend curve function setting interface is shown in Fig. 5.9, and the specific functions are described in Table 5-5.	

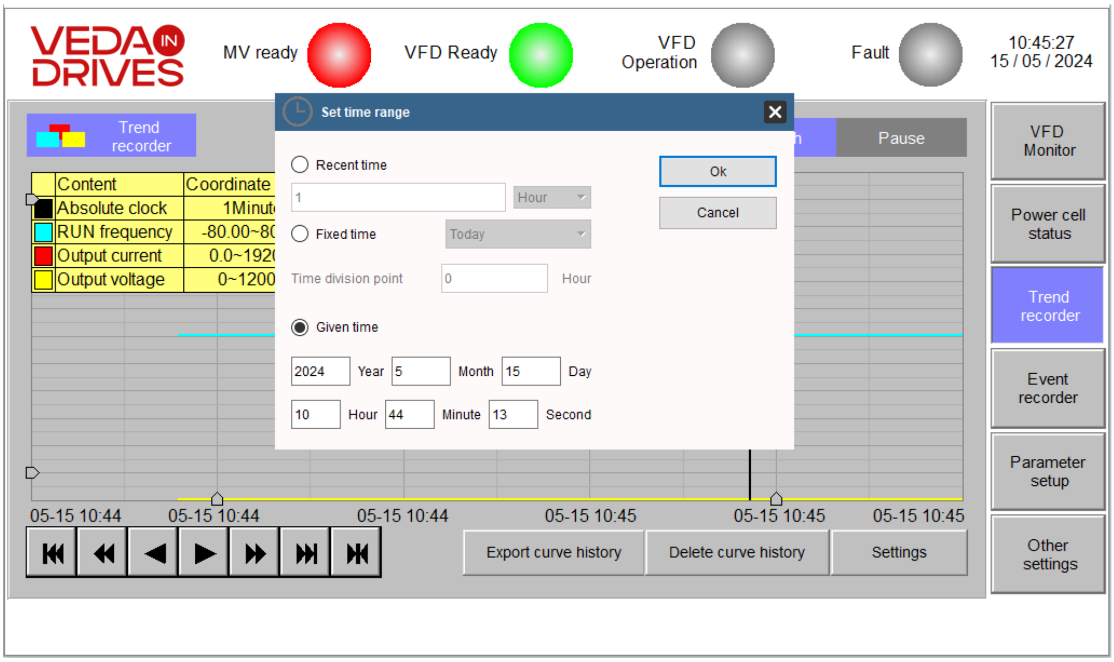


Fig. 5.8 Historical Curve Query

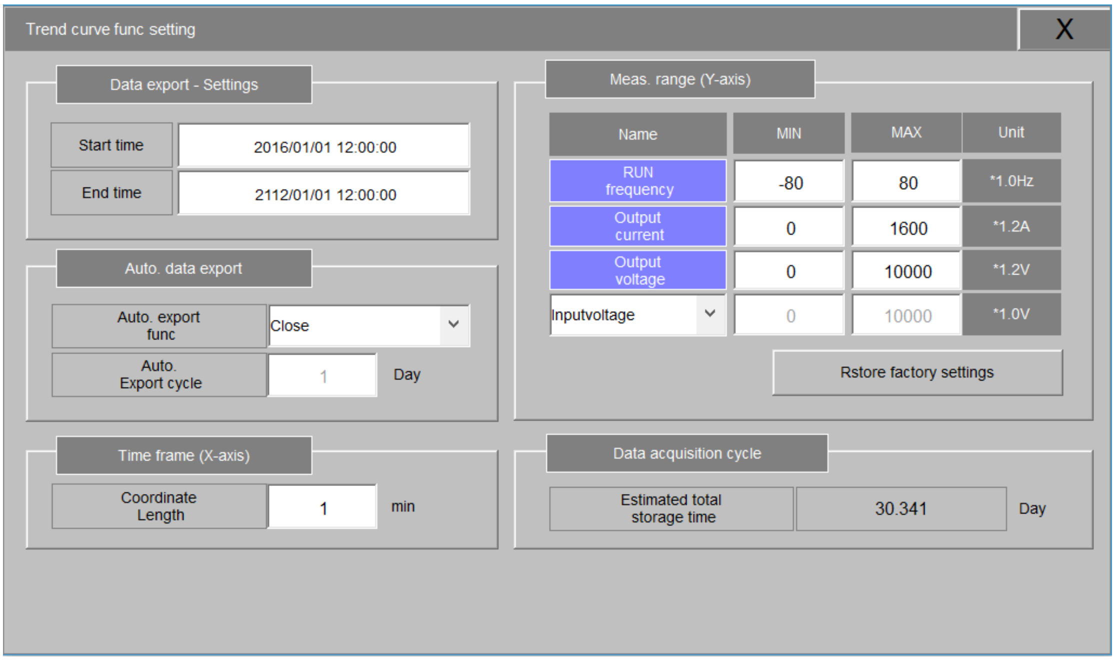


Fig. 5.9 Trend Curve Function Settings

Table 5-5 Trend Curve Function Settings

<table>
<tr><th>N</th><th>Function</th><th colspan="3">Description</th></tr>
<tr><td>1</td><td>Data export settings</td><td colspan="3">The data export time interval can be set: [Start time] - [End time]; in default, all the data are exported (ending time > current time)</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Automatic data export settings</td><td rowspan="2">Automatic export function</td><td>Disable</td><td>The function is disabled; [Automatic export interval] cannot be set</td></tr>
<tr><td>Enable</td><td>When a USB disk is available (system format: FAT32), the data can be automatically exported at intervals of [Automatic export interval]</td></tr>
<tr><td>Automatic export interval</td><td colspan="2">Minimum: 1 day (frequent export is not recommended; this parameter can be reasonably set according to [Estimated total storage time])</td></tr>
<tr><td>3</td><td>Curve X-axis Settings</td><td colspan="3">X-axis display range of trend curve (1min in default)</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Curve Y-axis Settings</td><td>Range settings</td><td colspan="2">Min. and Max. values can be set independently (in order to improve the display effect, some parameters are automatically scaled; see [Unit])</td></tr>
<tr><td>Restore default values</td><td colspan="2">Restore to the maximum, minimum, or nominal values of the parameters</td></tr>
<tr><td>Curve</td><td>Purple</td><td>Visible</td></tr>
</table>

		visibility setting	Grey	Invisible	
		Curve customization setting	Fourth parameter	Authority	Engineer and above
				Option	Parameter name	Range (default)
					Unit voltage	-20~20
					Unit temperature	-50~100
					Input current	0~10000
					Input voltage	0~12000
5	Data acquisition interval setting	Estimated total storage time	When the automatic export function is enabled, the [Automatic export interval] can be set according to this parameter; when the memory is full, cyclic overwriting is implemented			
		Interval	Description	Minimum value: 100ms; default value: 3s. It is forbidden to set too short a data acquisition interval. Otherwise, the service life of the HMI memory chip would be affected.		
			Authority	After-sales worker		

5.2.3 Parameter Settings

The parameter setting navigation diagram is shown in Fig. 5.10, and the parameters are detailed in Chapter 6.

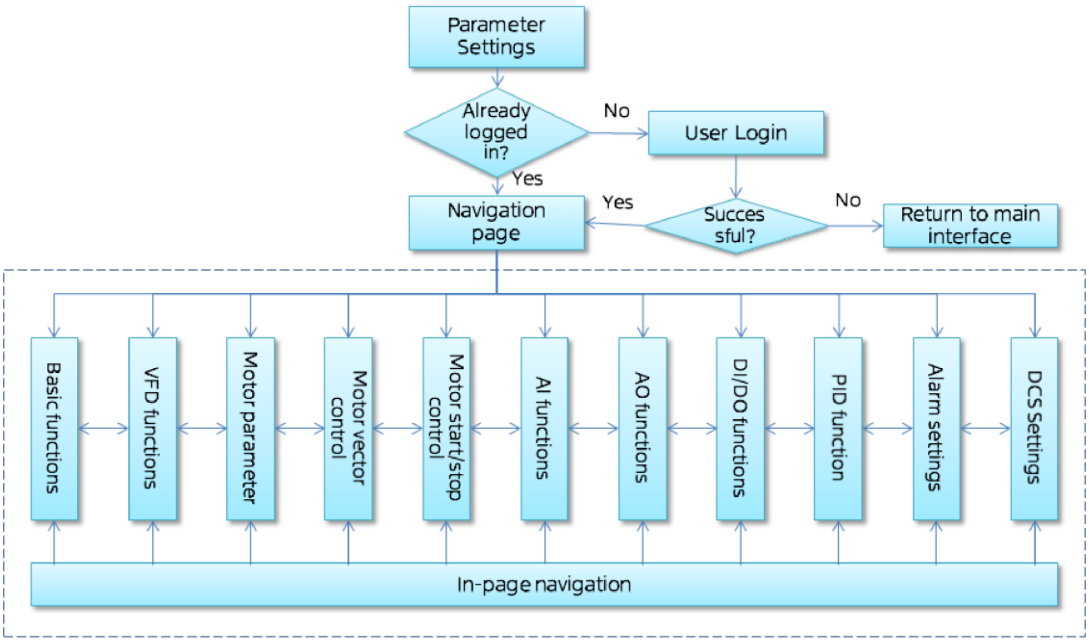


Fig. 5.10 Parameter Setting Navigation Diagram

The user needs to pass the verification to enter the parameter settings interface for the first time, as shown in Fig. 5.11.

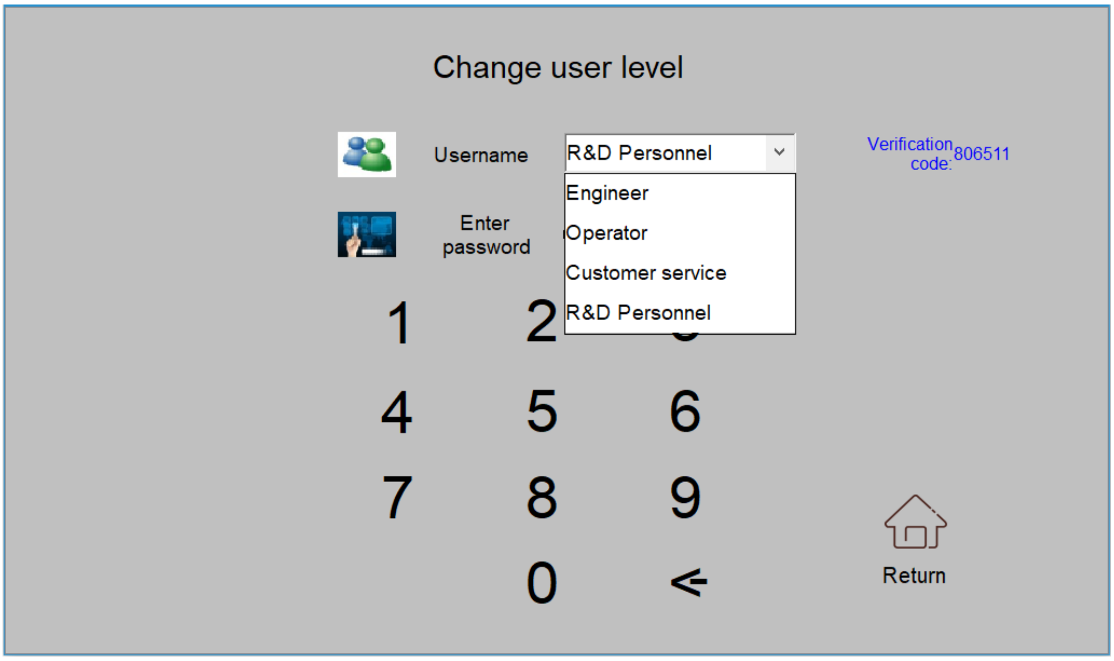


Fig. 5.11 Parameter Setting Interface Login Window

The system is open to two user types: engineer and operator. The user passwords and permissions are shown in the table below.

Table 5-6 Summary of User Passwords and Permissions

N	User name	Level	Initial password	Operation permission	Manual logout	Automatic logout
1	Engineer	2	******	All parameters	Other Settings > > Logout	No operation in five minutes
2	Operator	1	123456	Some parameters	Other Settings > > Logout	No operation in five minutes
3	After-sales worker	3	******	——	Other Settings > > Logout	No operation for one hour
4	R&D staff	4	******	——	Other Settings > > Logout	No operation for one hour

After logging into the system successfully, the user can enter the navigation page, in which parameter setting operations can be quickly performed, as shown in Fig. 5.12.

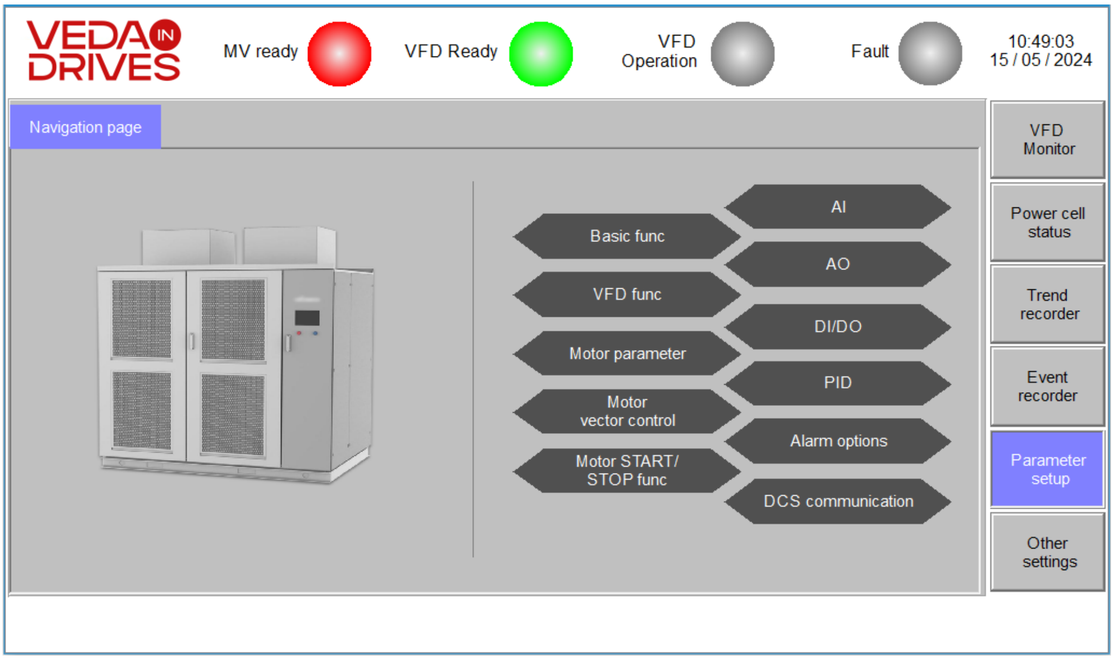


Fig. 5.12 Parameter Setting Navigation Page

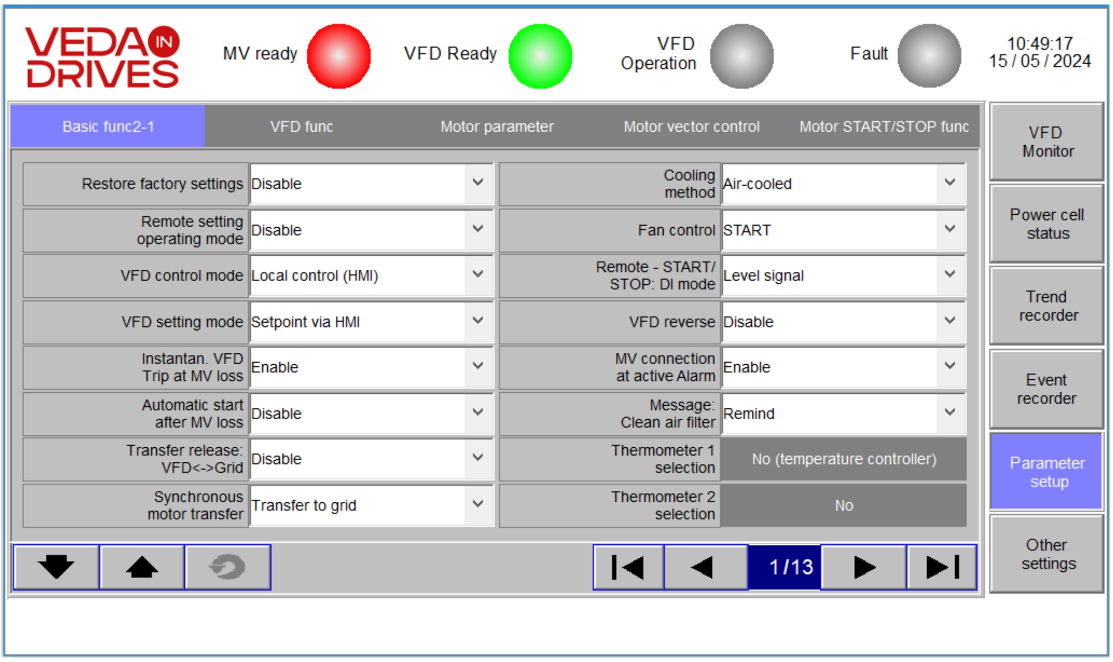


Fig. 5.13 Parameter Setting Interface

Parameter setting operations involve three operations: parameter upload, parameter download, and factory reset. All the operations are accompanied by success prompt pop-ups. The function buttons are described as follows:

Table 5-7 Descriptions of Function Buttons

N	Function button	Description
1	Restore factory setting	All the parameters are restored to the factory settings (default values)
2	Parameter upload	Upload the parameters in the memory of the main control board to the Anybus database and transmit them to the touch screen
3	Parameter download	Transmit the parameter values on the touch screen to the Anybus database and store them in the memory of the main control board

5.2.4 Event Logging

The event log interface records the fault and alarm information and other information on the VFD.

The historical data setting, export, and deletion functions are the same as those for trend curves; when the memory is full of event log data, cyclic overwriting is implemented.

Table 5-8 Descriptions of Basic Functions and Log Flags

<table>
<tr><th>N</th><th>Name</th><th colspan="2">Flag</th><th colspan="2">Description</th></tr>
<tr><td>1</td><td>Stored objects</td><td colspan="4">Serial number, time, event name, running frequency, input voltage, output voltage, input current, and output current</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">Event log naming rules</td><td rowspan="3">Format</td><td>Event name - type</td><td>Example: external fault - F</td><td rowspan="2">For details on troubleshooting and maintenance, see Chapter 8 Troubleshooting and Maintenance</td></tr>
<tr><td rowspan="2">(Status code) time log type</td><td>Example: (communication status) touch screen failing to communicate -A</td></tr>
<tr><td>Example: (unit Code) mismatching unit - E</td><td>Unit codes: 1~36, A1(1), B1(2), C1(3), A2(4), ...</td></tr>
<tr><td rowspan="2">Type</td><td>-F</td><td colspan="2">Fault</td></tr>
<tr><td>-A</td><td colspan="2">Alarm</td></tr>
</table>

			-E	Log
Note: [(0) Touch screen failing to communicate -A] Analysis: HMI's communication with DSP (Anybus) is normal; the dsp heartbeat is abnormal (dsp down), and the monitoring interval is 5s				

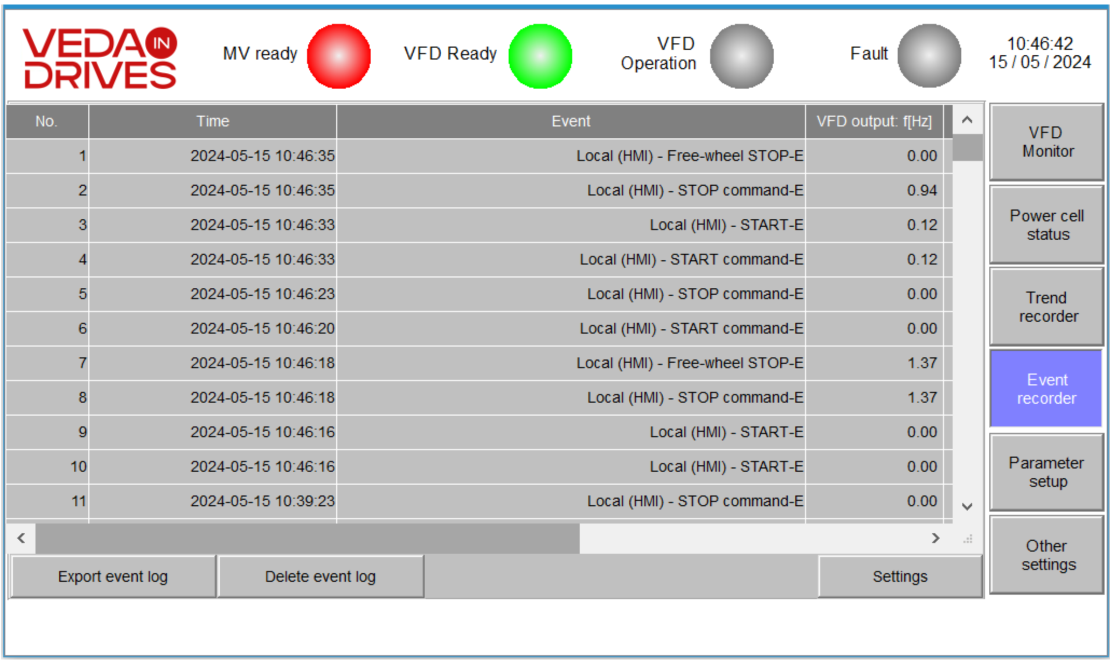


Fig. 5.14 Fault Logging Interface

5.2.5 Other Settings

The "Other Settings" interface is shown in the following figure:

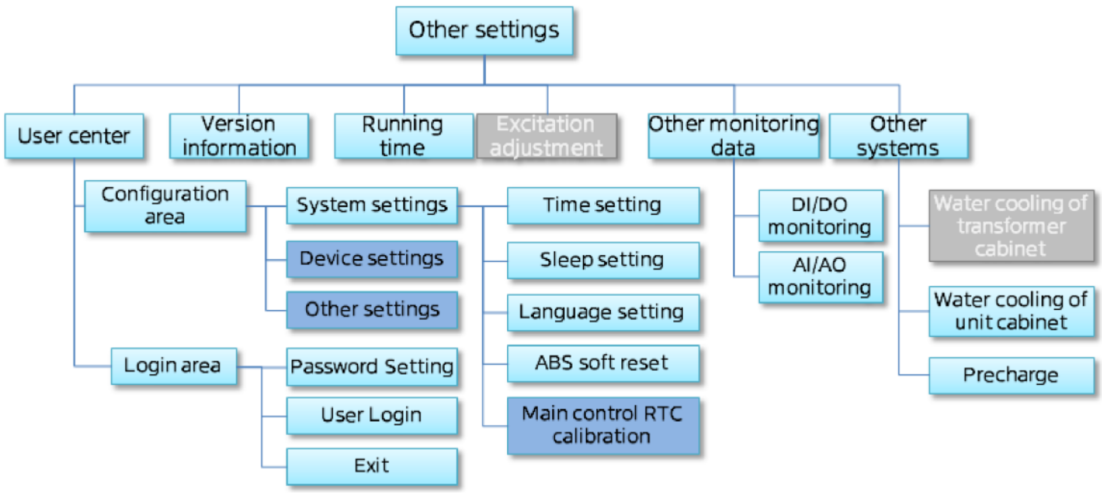


Fig. 5.15 Topological Diagram of Other Settings Interface

(1) User Center

The user center mainly includes the configuration area and the login area, as shown in Fig. 5.16, where the after-sales worker permissions are required for device settings, other settings (configuration area), and main control RTC calibration.

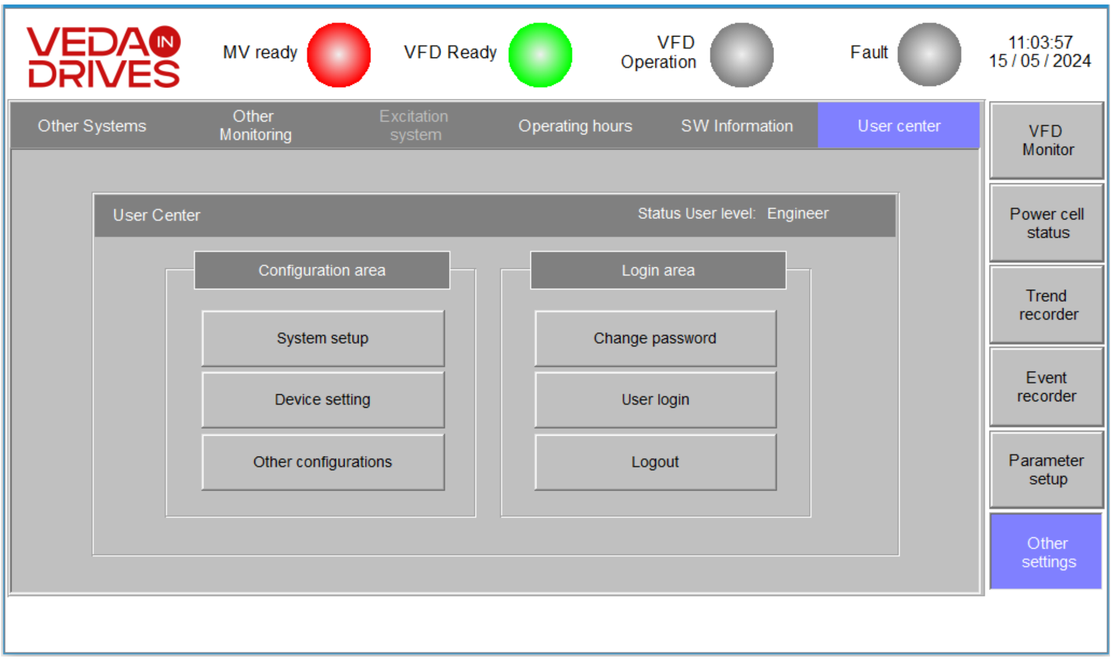


Fig. 5.16 User Center

The configuration area mainly contains system settings. The interface is shown in Fig. 5.17. The related functions are described as follows:

Table 5-9 Descriptions of System Setting Functions

N	Function	Description
1	Time setting	The "Time Settings" interface is used to set the display time of the touch screen system. When the settings are completed, the time shown in the top right corner of the touch screen is the current set time.
2	Sleep setting	Used to set whether the screensaver is turned on and the wait time after the screensaver is turned on (range: 120s-1600s)
3	Language	Another language can be selected here

	setting	
4	Main control RTC calibration	Used to initialize or calibrate the main control's internal reference time, which is the current HMI system time
5	ABS soft reset	Reset the main control's communication module Anybus

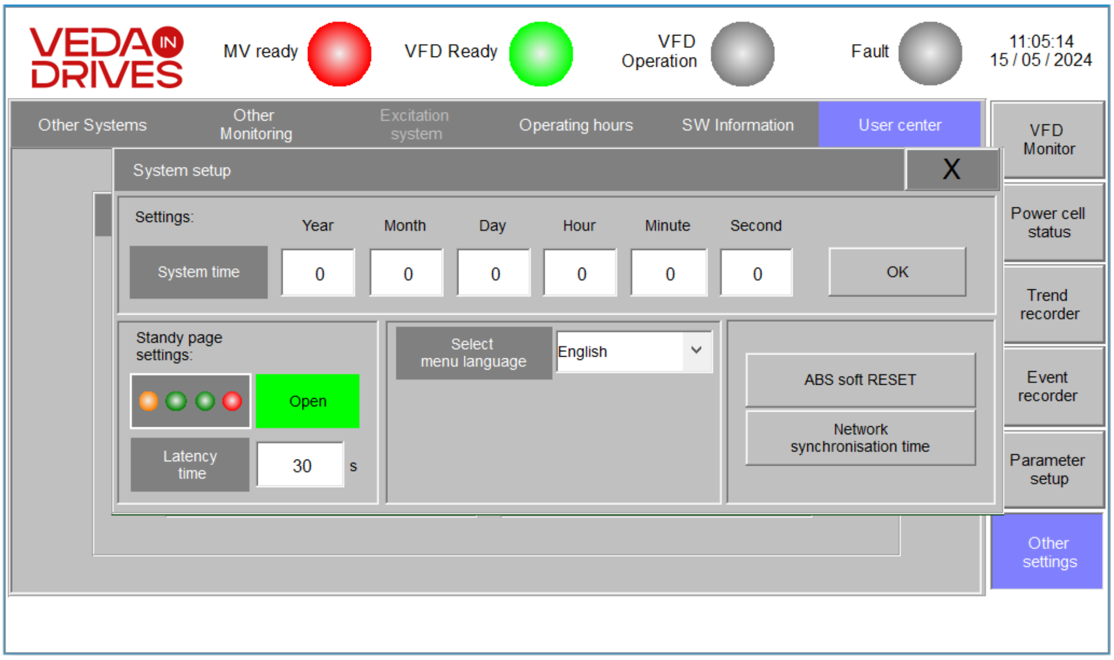


Fig. 5.17 System Settings

The login area mainly contains login-related functions, mainly including password setting, user login, and logout. Among them, password setting is used to reset the login password, as shown in Fig. 5.18; after entering the unlock password, you can set a new password.

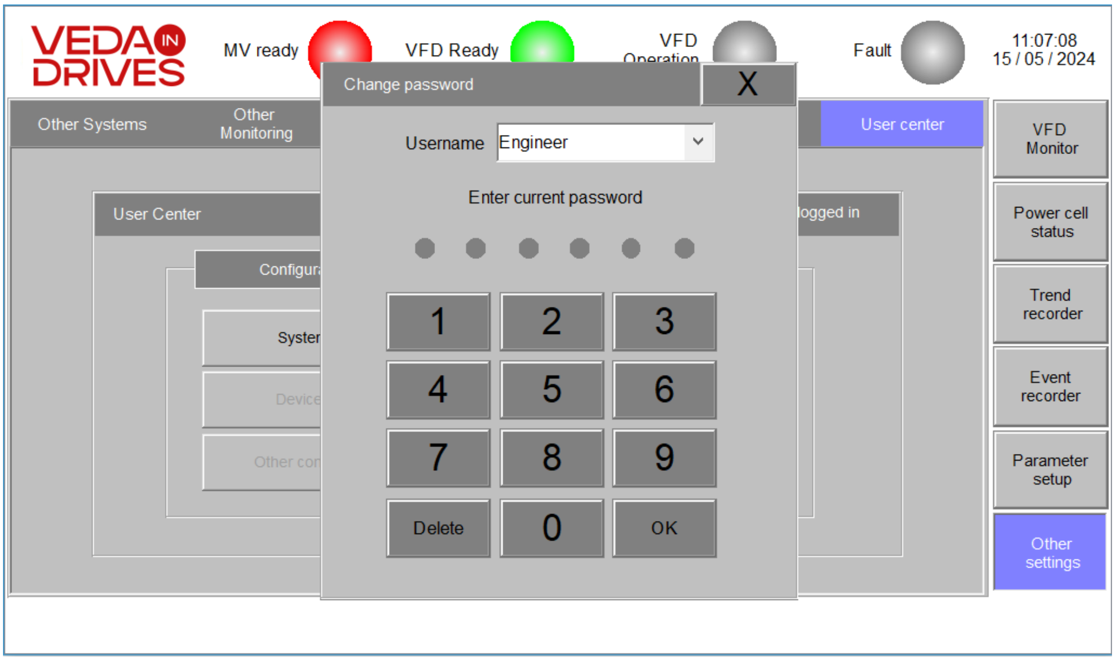


Fig. 5.18 Password Setting

(2) Version Information

The "Version Information" interface is used to show the software version information of the control system, including the main control board version, FPGA version, IO board version, and touch screen version, as shown in Fig. 5.19. It allows users and administrators to see if the software version matches.

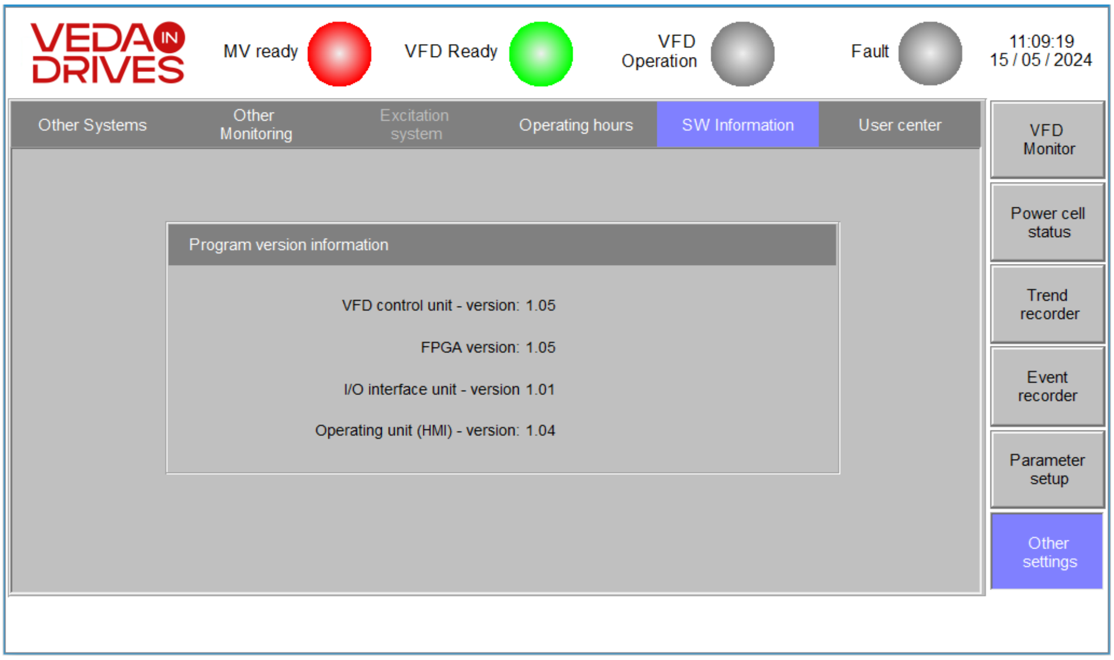


Fig. 5.19 Version Information

(3) Running Time

The interface is shown in the following figure. The related descriptions are given in the following table:

Table 5-10 Running Time Descriptions

N	Name	Description
1	Current system running time	Time for which the system has been running after power-up (the start of this run). The parameter will be automatically reset to zero when the next run starts.
2	Cumulative system running time (h)	Time for which the system has run since leaving the factory

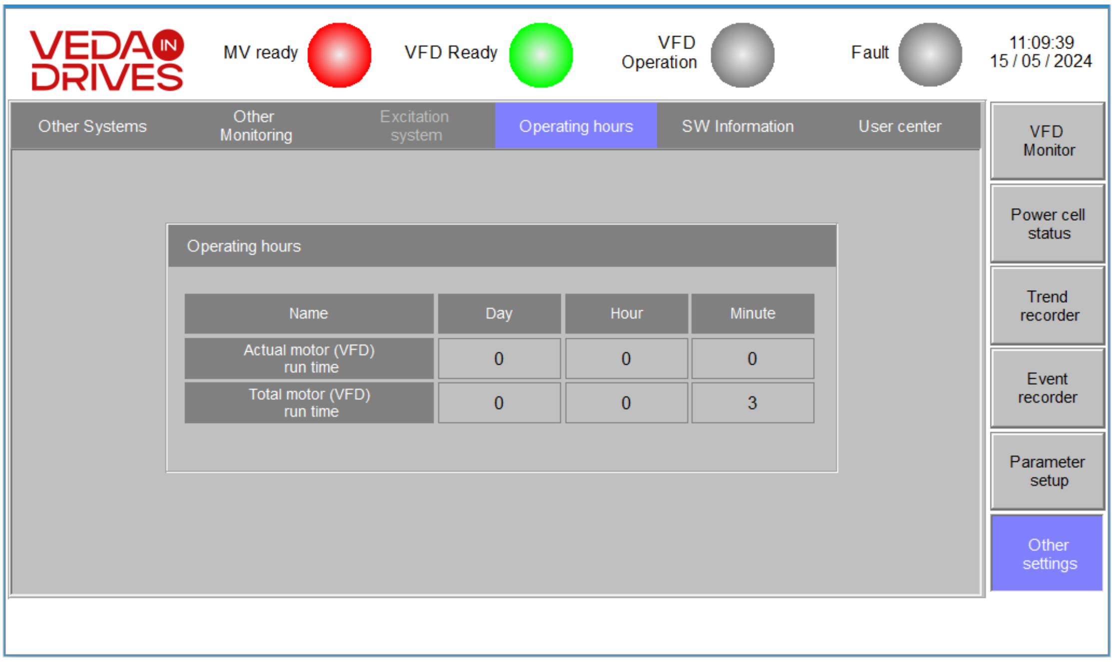


Fig. 5.20 Run Time

(4) Other Monitoring Functions

Auxiliary status monitoring functions are mainly integrated here. The interface mainly includes AI/AO signal monitoring and DI/DO signal monitoring, which can provide real-time status or data monitoring, as shown in the following figure.

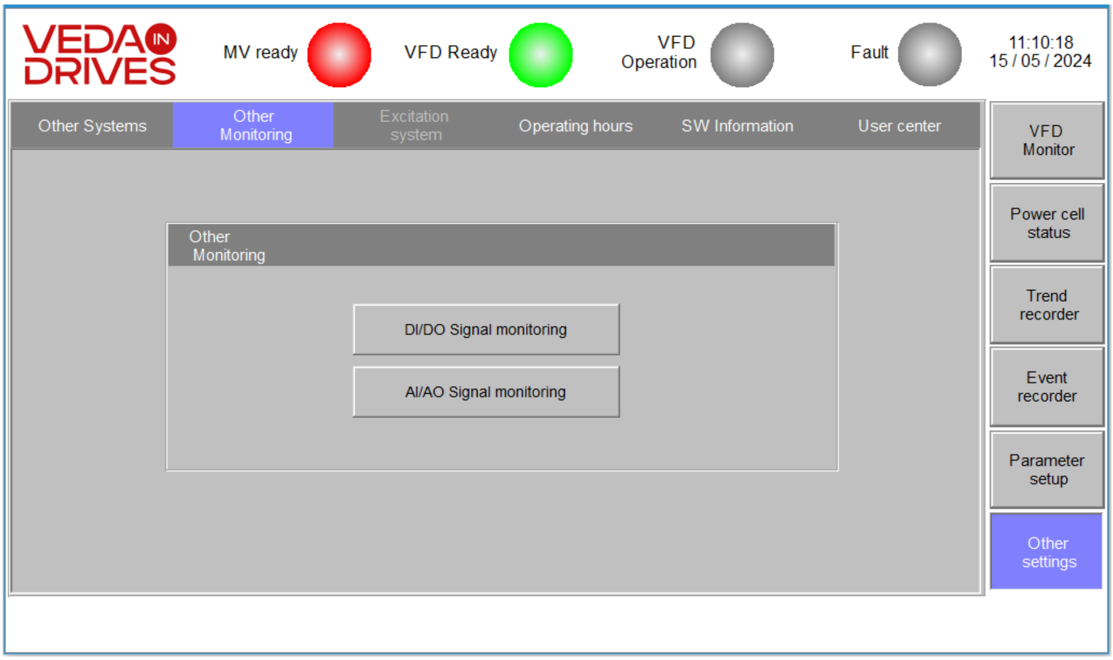


Fig. 5.21 Other Monitoring Functions

No.	Func Name	State	No.	Func Name	State
DI_01	START	0	DI_9	Transformer water leakage detection	0
DI_02	STOP	0	DI_10	Alarm: Water cooling	0
DI_03	EMERGENCY shutdown	1	DI_11	Excitation ready	0
DI_04	Release: Switch-over operating mode	1	DI_12	Excitation active	0
DI_05	External Reset	0	DI_13	Excitation fault	0
DI_06	DI: Synchronous transfer start	0	DI_14	Speed 1	0
DI_07	MV breaking	0	DI_15	Speed 2	0
DI_08	MV breaking	0	DI_16	Speed 3	0
DI_17	24-SYSTEM RESET	0	DI_21	9-Power cell cabinet door contact switch	1
DI_18	5-MV breaking	0	DI_22	10-Transf. cab. door travel switch	1
DI_19	11-Alarm: Transformer overheat	0	DI_23	8-DI: Double-circuit contactor status	1
DI_20	12-Fault: Transf. cab. temperature	0	DI_24	7-Fan failure	1

Fig. 5.22 DI/DO Signal Monitoring

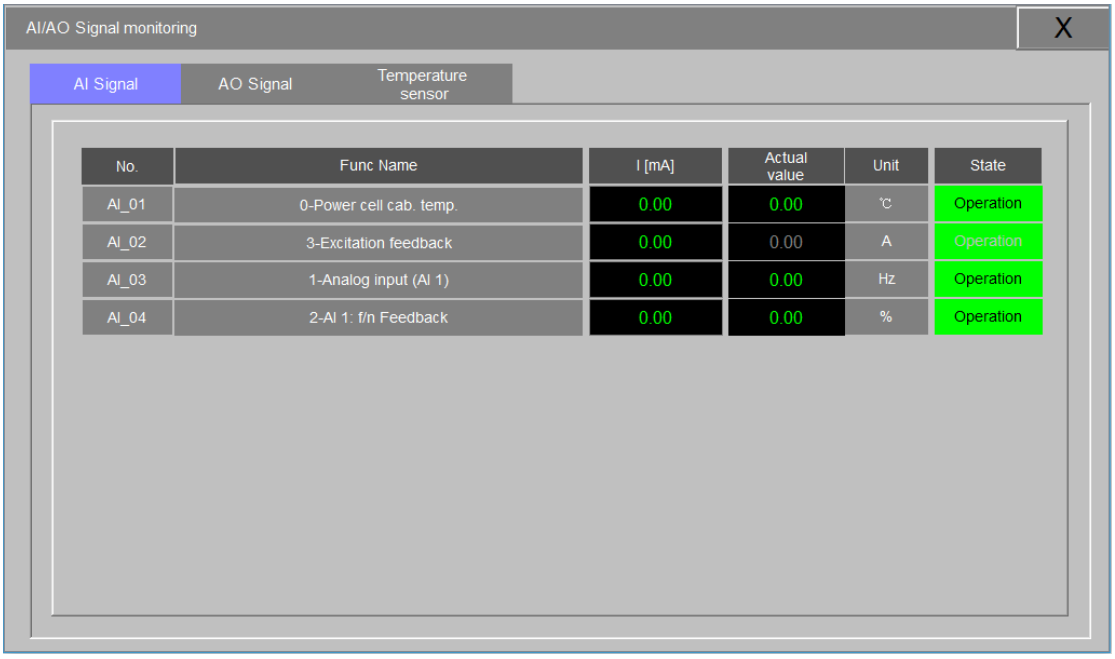


Fig. 5.23 AI/AO Signal Monitoring

(5) Other Systems

The "Other Systems" interface is mainly used to integrate the other independent monitoring systems, currently including transformer water cooling monitoring system, unit cabinet water cooling monitoring system, and precharge box.

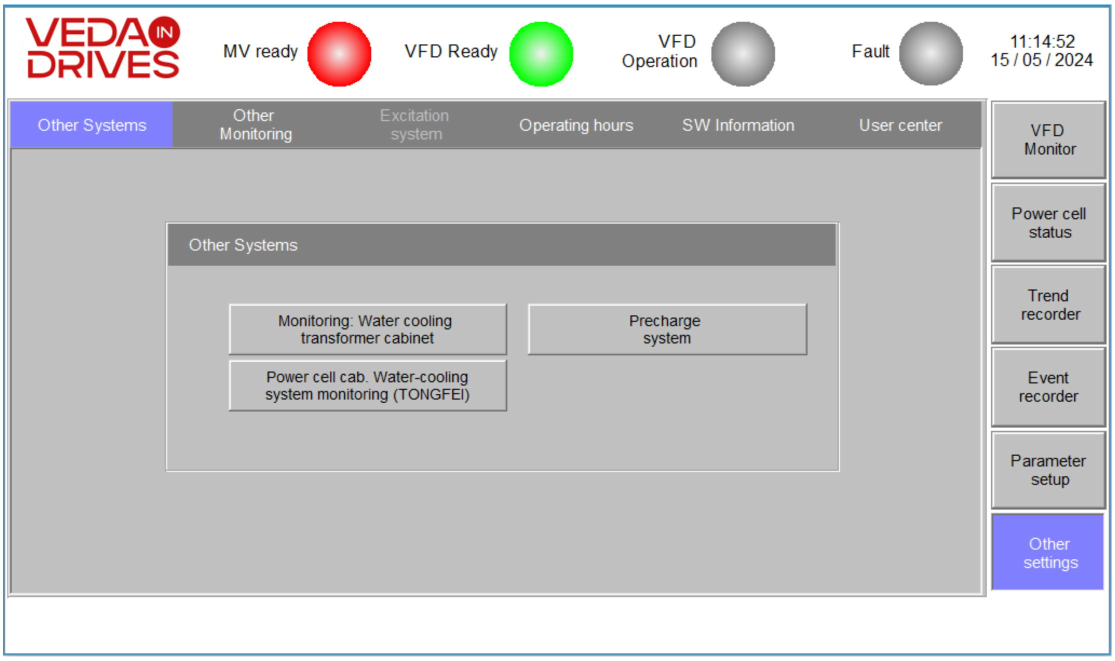


Fig. 5.24 Other Systems

Transformer water cooling monitoring system:

The system is applicable for a water-cooled VFD and can provide real-time monitoring of heat exchanger inlet and outlet air temperatures, radiator inlet and outlet water flow rates, and related parameter settings, as shown in Fig. 5.25.

N	Name	Description
1	Maximum flow rate	"Inlet/outlet water flow rate" analog data collection setting: 4 to 20ma corresponds to minimum flow rate to maximum flow rate
2	Minimum flow rate	"Inlet/outlet water flow rate" analog data collection setting: 4 to 20ma corresponds to minimum flow rate to maximum flow rate

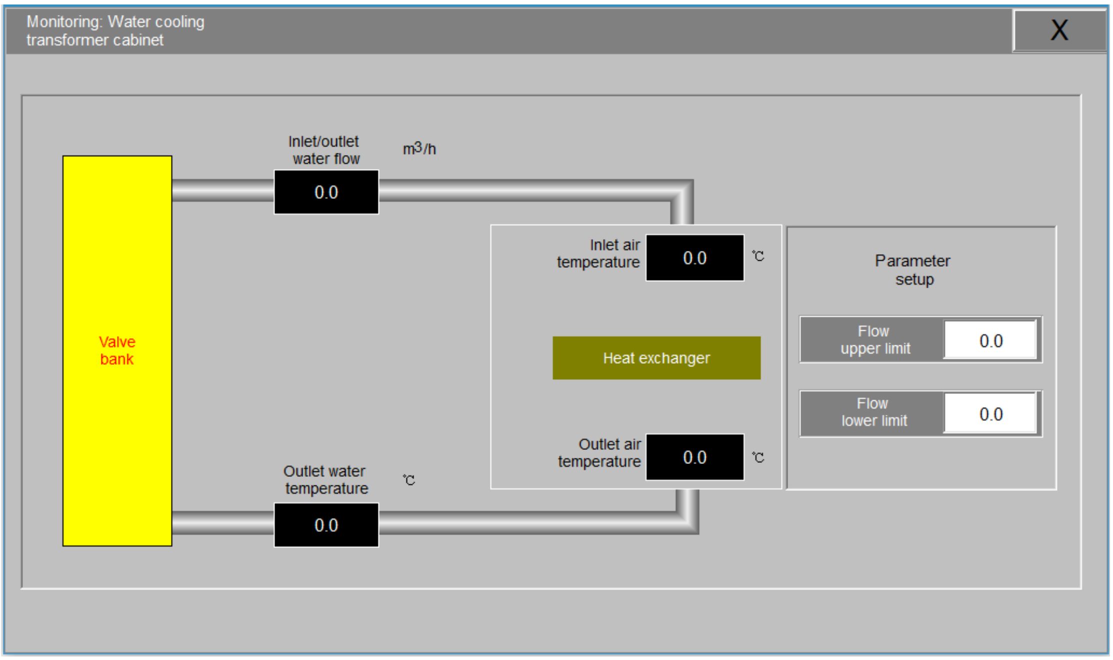


Fig. 5.25 Water Cooling System Monitoring Interface

Unit cabinet water cooling monitoring system:

The system is suitable for a water-cooled VFD and integrates the display control of the unit cabinet water cooling system. By clicking the "Unit cabinet water cooling monitoring" button, you can jump into the unit cabinet water cooling monitoring system. For the functional details about the unit cabinet water cooling system, see the *User Manual for Water-cooled VFDs*.

Pre-charging box:

When the VFD is equipped with a pre-charge box, the user can control and monitor the pre-charge process through the pre-charge interface. Click the "Precharge box" button to display the precharge interface, as shown in Fig. 5.26; click the "Return" button to return to the Other Settings interface.

For a detailed description of the pre-charge function, see Appendix User Manual for Pre-charge Box.

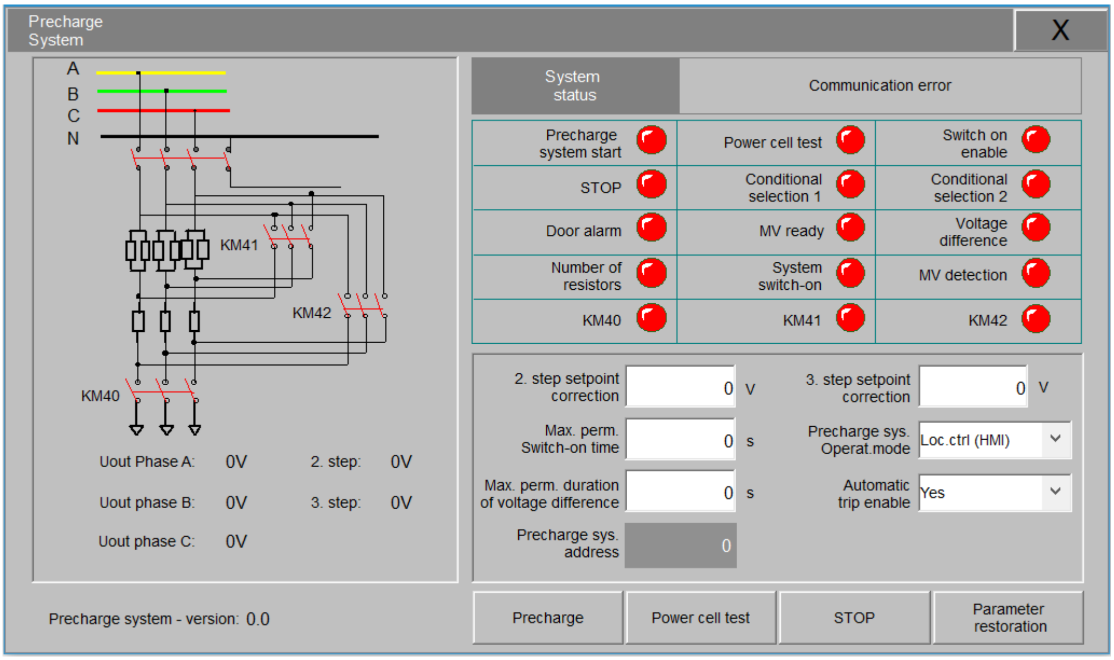


Fig. 5.26 Precharge Interface

5.3 VEDA-in Tools_Can

VEDA-IN Tools_Can is an advanced graphical human-machine interface based on LabWindows CVI, which integrates utility software providing oscilloscope and data monitoring functions. The VFD communicates with the PC running VEDA-IN Tools_Can via CAN protocol. With VEDA-IN Tools_Can, engineers can quickly debug VFDs and users can quickly and easily monitor the operation of VFDs.

5.3.1 Software Installation

The software installation involves two parts: the installation of the protocol conversion module's driver and the installation of the VEDA-IN Tools_Can software. For details on its installation process, see the *VEDA-IN Tools_Can Operation Manual*.

5.3.2 Interface Description

Double-click the desktop shortcut "VEDA-in Tool can" to launch the software. The main interface is functionally divided into several areas, as shown in the figure below:

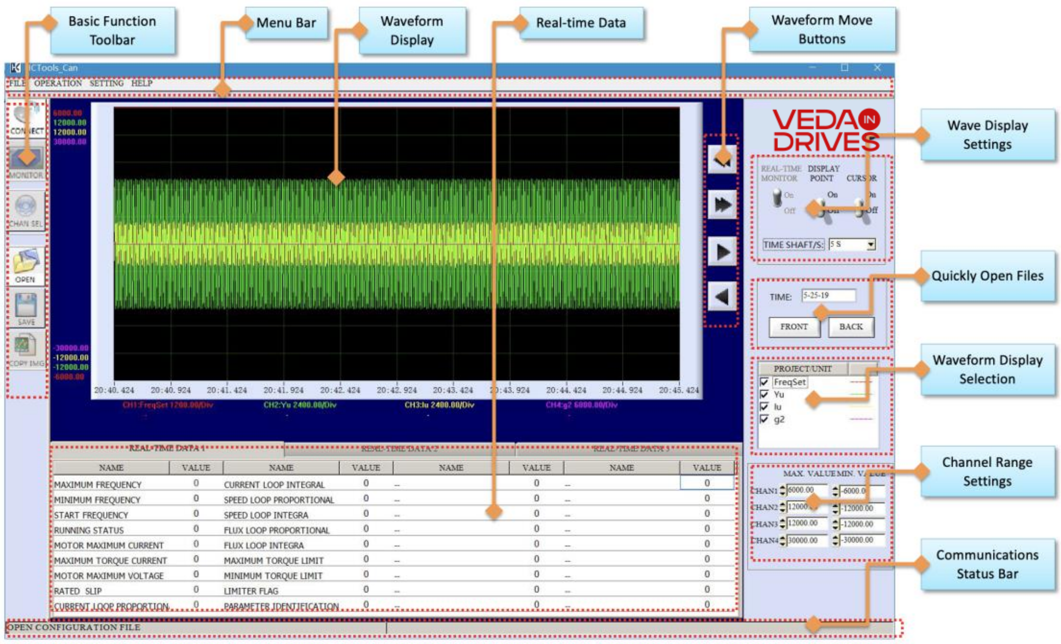


Fig. 5.27 Main Interface of VEDA-IN Tools_Can

(1) Menu Bar

Includes Save History File, Open History File, Clear History, About, Exit, and more.

(2) The functions in the basic function toolbar are described in the following table:

Table 5-11 Description of Basic Functions

Button	Function	Description
Communication connection	Used for device communication connection; the communication status is displayed at the bottom	"CAN OK" is shown. The next steps can be taken.
		"CAN device cannot be initialized". Please carefully check the device connection
Real-time monitoring	Start data monitoring	"CAN reception time out. Please check and reconnect the CAN device". Please carefully check the device connection

Channel selection	Set the waveform display channel parameters	4 parameters can be selected at most.
Open records	Open a historical waveform data file	If the version is an English or Russian version, the data file storage path must have an English name.
Save records	Save the waveform data to a file	If the version is an English or Russian version, the data file storage path must have an English name.
Copy image	Copy the waveform area into the clipboard	Used to paste it into the required file

The waveform display settings are described in the following table:

Table 5-12 Description of Waveform Display Settings

Button	occurs	Function
Real-time monitoring	ON	The waveform data acquisition begins
	OFF	The waveform data acquisition stops. If you click the "Save Records" button at this time, the current waveforms can be saved.
Display point	ON	Show the collected data points and waveforms after point connections
	OFF	Show waveforms only
Cursor	ON	Two cursors appear on the waveform interface, and the coordinate information and the relationship of the two cursor points are displayed in the top right corner.
	OFF	The two cursors disappear in the waveform interface, and the coordinates in the top right corner disappear.
Time axis		Set a time axis range in the drop-down box to indirectly change the amount of data displayed on the screen for easy waveform viewing
Waveform display selection bar	Check	Show the waveform of this channel
	Uncheck	Hide the waveform of this channel

5.3.3 Operation Steps

The steps for using VEDA-IN Tools_Can are as follows:

1) Click the "Communication connection" button for device communication connection;

2) Click the "Real-time monitoring" button to start receiving waveforms and data in real time;

3) Click the "Channel selection" button and select the variables to be shown; then, a window as shown in the figure below pops up:

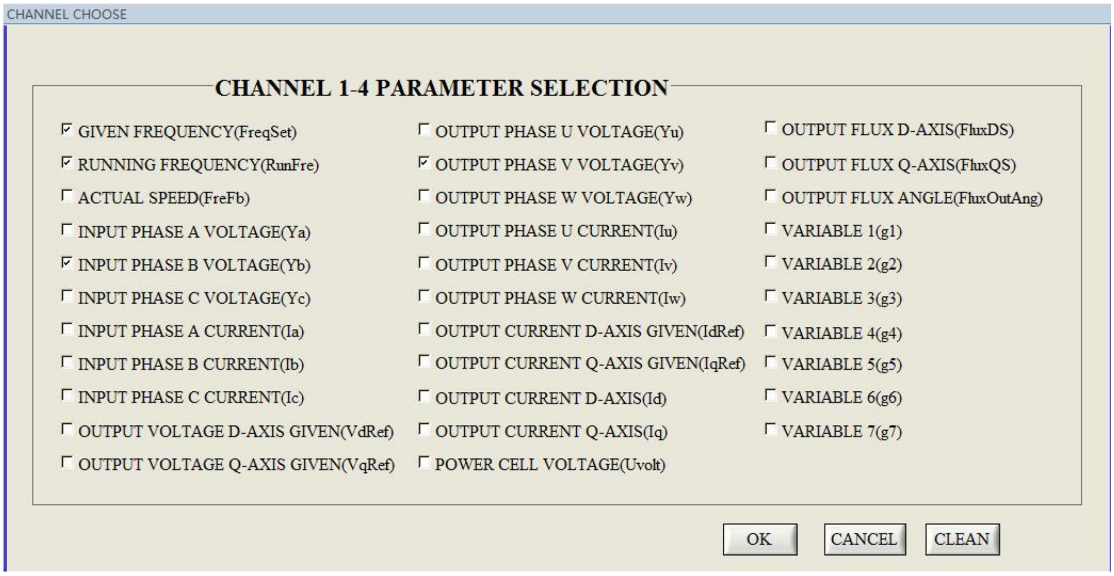


Fig. 5.28 Channel Selection Interface

4) When data monitoring is complete, if you want to save the waveform data, disable the "Real-time monitoring" function and click the "Save Records" or "Copy Image" button to enter the corresponding interface, as shown in the following figure:

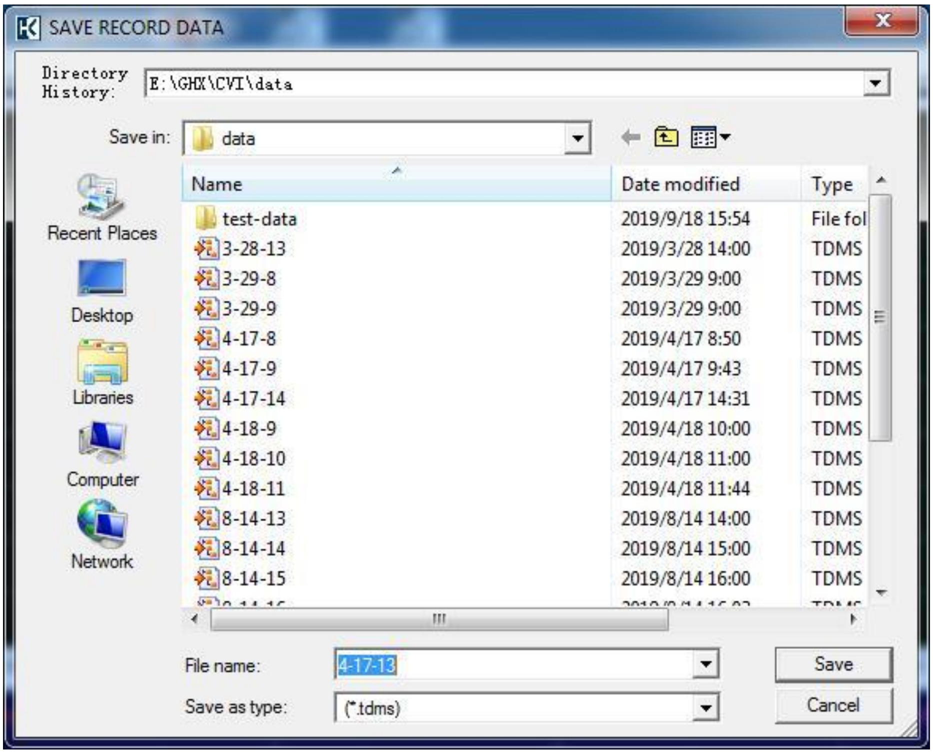


Fig. 5.29 Save Records Interface

5) To browse historical waveform data, click the "Open Records" button and select the record file to open;

6) To view the waveforms, use the waveform move buttons for positioning;

7) To automatically save waveform data for a long time, do as follows:

① Successively select "Menu bar", "Settings", and "Data Recording Settings" to open the pop-up window as shown in the following figure;

② Set the "File Save Path" and "File Open Path", and set the "Save Every Hour on the Hour" switch to "On". Click the "OK" button to complete the settings and return to the main interface. The settings will be automatically saved. Next time, the settings will be used by default.

③ After returning to the main interface, repeat the first two steps to monitor the data. Then, the waveform data will be automatically saved every hour on the hour (or when a major fault reset occurs). The file name format is month-day-hour.tdms;

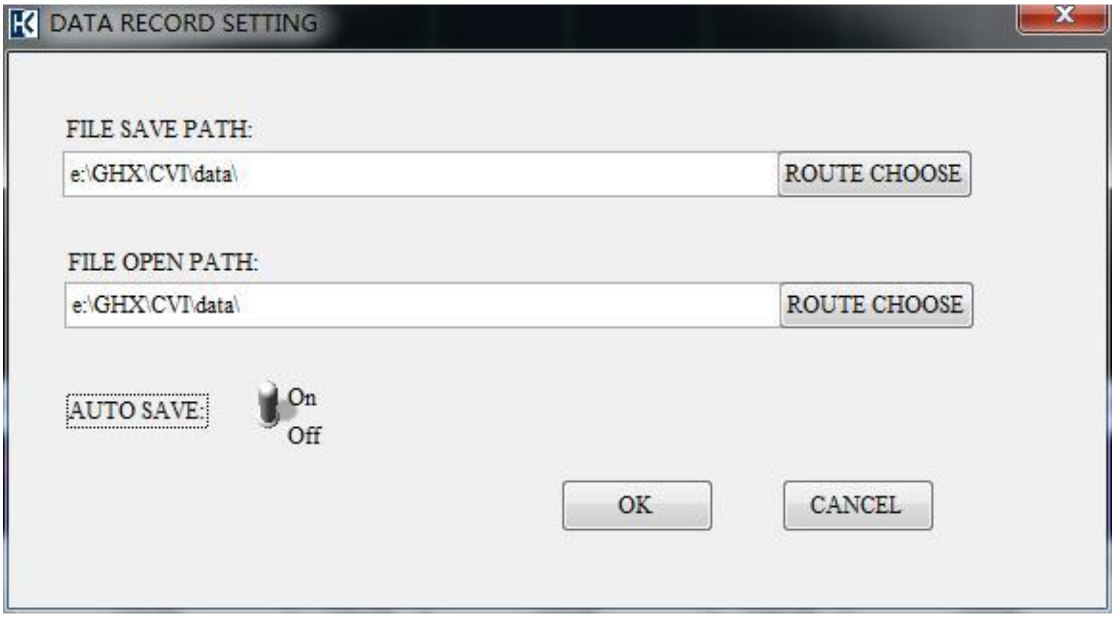


Fig. 5.30 Data Recording Settings Window

Chapter 6 Parameter Descriptions

6.1 Parameter Description

Maximum frequency: the highest frequency (absolute value) at which the VFD is allowed to operate; If the VFD runs at 10% more than the maximum frequency for up to 0.5 seconds, the VFD reports a "system overspeed" fault and stops.

Minimum frequency (absolute value): the lowest frequency at which the VFD runs continuously.

Start frequency: the initial output frequency of the VFD, that is, the frequency at which the VFD starts to run after start-up; if the set start frequency is too large, the VFD may undergo overcurrent during start-up; if the start frequency is not zero, the motor's output torque can be ensured during start-up; in order to fully establish the magnetic flux when the motor starts, it is necessary to keep the VFD at the start frequency for a certain time.

Ratings: set the ratings according to the motor nameplate. The relationship between the motor's rated frequency and rated voltage is shown in Fig. 6.1:

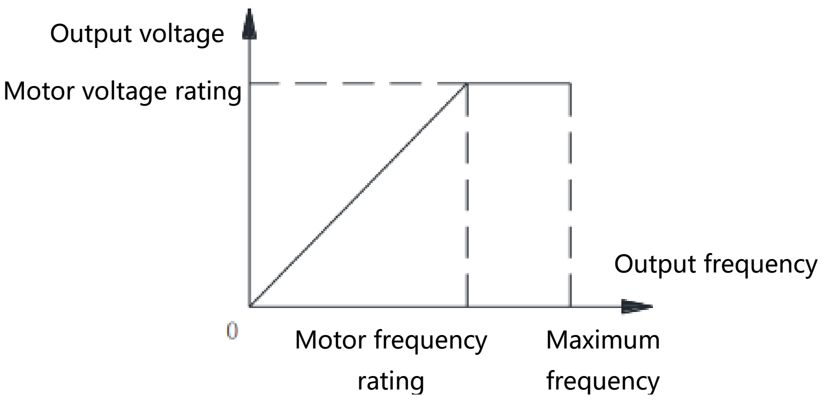


Fig. 6.1 Motor's Rated Voltage vs. Motor's Rated Frequency

Note: if the rated voltage of the motor is set to a value lower than that indicated on the motor nameplate, the VFD will run at a reduced capacity; if the rated voltage of the motor is set to a value higher than that indicated on the motor nameplate, the motor will run with overexcition, with lower efficiency and higher temperature.

Acceleration time: refers to the time required for the VFD to accelerate from zero to the motor's rated frequency. See t1 in Fig. 6.2.

Deceleration time: refers to the time required for the VFD to decelerate from the motor's rated frequency to zero. See t2 in Fig. 6.2.

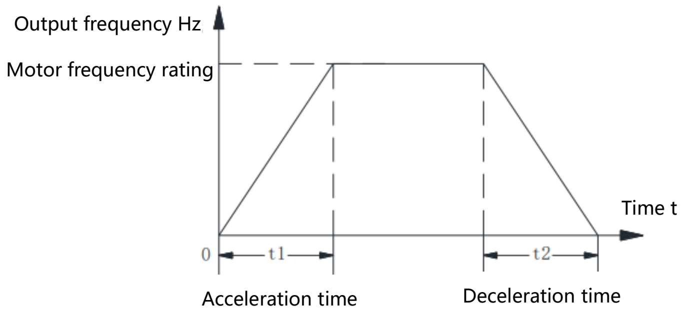


Fig. 6.2 Acceleration/deceleration Time Curve

Note: the on-site settings of the acceleration and deceleration times shall be based on the actual working condition of the load; if the set acceleration time is too short, the VFD tends to undergo overcurrent; if the set deceleration time is too short, unit overvoltage will be easily incurred.

Motor phase sequence: it is used for synchronous motor vector control, that is, the selection of the VFD's output phase sequence (U-V-W is the forward sequence and U-W-V is the reverse sequence). In general, this parameter does not need to be set by the user. It is automatically identified during the rotor positioning process of the synchronous motor. An incorrect motor phase sequence setting may cause the VFD to fail to start normally.

Phase locking angle for switching: it is used for a VFD with synchronous switching; the phase locking angle for switching can be set to adjust the synchronous switching performance. A smaller phase locking angle for switching means that the difference between the grid power angle and the VFD's output power angle after phase locking is smaller, the phase locking accuracy is higher, the phase locking is more difficult, and the impact current during switching is weaker; a larger phase locking angle for switching means that the difference between the grid power angle and the VFD's output power angle after phase locking is greater, the phase locking accuracy is lower, the phase locking is easier, and the impact current during switching is stronger.

Torque boost: the purpose of torque boost is to compensate for the voltage drop consumed by the motor's stator resistance during low-frequency operation to increase the output torque of the motor. For a high-torque load, such as a compressor, slurry pump, or belt conveyor, this parameter can be set to prevent it from being difficult to start. The torque boost degree shall be appropriately set according to the condition of the load. If it is too high, a considerable current impact will be incurred during start-up. For an asynchronous motor, the torque boost is effective below 10 Hz. One unit is equivalent to 0.5% of the motor's rated voltage. When the torque boost degree is set to 15, the corresponding VF curve is as shown in Fig. 6.3.

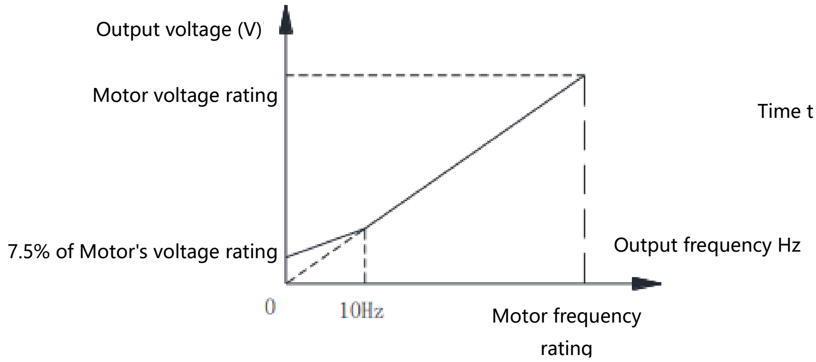


Fig. 6.3 V/F Curve

Ramp to stop: after receiving a stop command, the VFD reduces its output frequency to the minimum frequency according to the deceleration time curve, stops its output, and enters the standby mode; in order to avoid reporting an overvoltage fault during deceleration, the VFD automatically judges the unit voltages during deceleration; the VFD pauses deceleration if the unit voltages are too high, so the actual deceleration time may be longer than the set deceleration time. Free stop: after receiving a stop command, the VFD immediately stops its output and the motor coasts to stop without being controlled.

Frequency hopping: the frequency hopping setting is a VFD frequency hopping range needing to be set to evade the inherent resonance points of the mechanical system. The frequency hopping range involves two points. Unless during acceleration or deceleration, the system will automatically adjust its operating frequency to the upper limit of the frequency hopping range when the set frequency is within this range. In order to determine the frequency range of a frequency hop, two parameters need to be set, namely the upper frequency limit of U and the lower frequency limit of L. For the frequency range of a frequency hop, its upper frequency limit must be higher than its lower frequency limit; if there are two frequency hops, the setting of frequency hop 2 must be higher than that of frequency hop 1, as shown in Fig. 6.4.

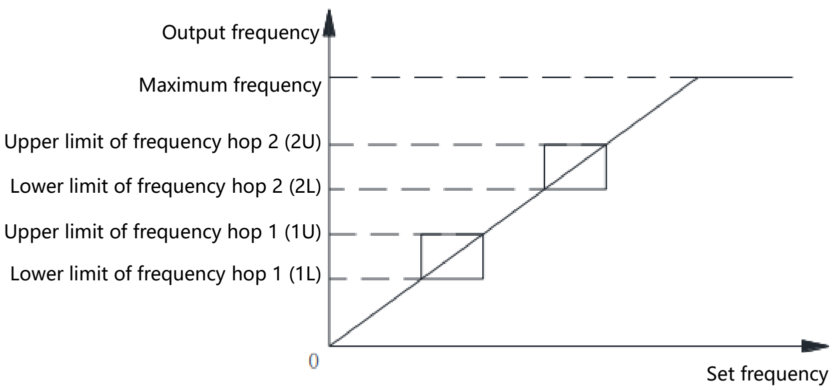


Fig. 6.4 Frequency Hopping Settings

6.2 VFD and Motor Parameters

Code	Parameter name	Parameter range	Default value	Unit
P22.00	VFD voltage rating	380~13800	10000	V
P22.01	VFD current rating	20.0~6000.0	54.0	A
P22.02	Maximum frequency	5.00~120.00Hz	50.00	0.01Hz
P22.03	Minimum frequency	0.00Hz~P22.02	0.00	0.01Hz
P22.04	Number of stages of units	2~12	8	Stage
P22.05	Allowed number of bypass units	0 ~ 3	0	Piece(s)
P22.06	Carrier frequency	100 ~ 2K	300	Hz
P22.07	VFD input current ratio	100~2000	200	
P22.08	Frequency setpoint resolution	0~1.00	0.01	0.01Hz
P22.09	Medium-voltage readiness judgment proportion	50%~100% of rated input voltage	75%	of
P22.10	VFD current limit	0.0% ~ 200.0%	110.0%	of
P22.11	VFD matching motor	0 - motor 1; 1 - motor 2; 2 - motor 3; 3 - motor 4	0	
P22.12	VFD function word 1		168	
P22.13	DSP program version	(read-only)		
P22.14	FPGA program version	(read-only)		
P22.15	IO board version	(read-only)		
P23.00	Oscillation suppression loop bandwidth	0.00~5.00Hz	0.10	0.01Hz

P23.01	Oscillation suppression coefficient	0.00~5.00	0.10	0.01
P23.02	Oscillation suppression range	0.00~P22.02	20.00	0.01Hz
P23.03	Frequency adjustment by slave	0.00~5.00Hz	0.10Hz	0.01Hz
P23.04	Proportion adjustment by slave	0.00~80.00	0.01	0.01
P23.05	Integral adjustment by slave	0.001 ~ 5.000s	1.000s	0.001s
P23.06	Phase locking angle for synchronous switching	-90.0~90.0	2.0	°
P23.07	Frequency difference upon synchronous switching	0.0 ~ 5.0	1.0	Hz
P23.08	Synchronous switching timeout	0.0 ~ 1000.0	10.0	s
P23.09	Duration of nonstop upon sudden power failure	0~1000ms	10ms	ms
P23.10	Deceleration step during nonstop upon sudden power failure	0~100.00	1	1
P23.11	Deceleration threshold during nonstop upon sudden power failure	800~1200V	950V	1V
P23.12	Overexcitation gain	0~30%	10%	1
P23.13	Overexcitation frequency	0~30Hz	30Hz	Hz
P23.14	Reserved			
P23.15	Reserved			

Note: the VFD function command word consists of 16 bits, which are defined as shown in the following table:

Bit	Definition	Remarks
D15	Spare	
D14	Spare	
D13	Spare	
D12	Spare	
D11	Spare	
D10	Spare	
D9	Spare	
D8	Spare	
D7	Unit bypass type	0 - IGBT bypass; 1 - mechanical bypass (default)
D6	Unit bypass function	0 - Disable (default); 1 - Enable
D5	Low-frequency oscillation suppression	0: Disable; 1: Enable (default)
D4	Instantaneous non-stop function	0 - Disable (default); 1 - Enable
D3	Overall state	0 - Debugging mode; 1 - Normal state (default)
D2	Stop mode	0 - Coast to stop (default); 1 - Ramp to stop
D1	Master-slave control	0 - Invalid (default); 1 - Valid
D0	Master-slave mode	0 - Host (default); 1 - Slave

Function Code	Parameter name	Parameter range	Default value	Unit
P24.00	Motor type selection	0 - Asynchronous motor; 1 - Synchronous motor; 2 - Permanent magnet motor	0	
P24.01	Motor power rating	0~60000	500	kW
P24.02	Motor voltage rating	380~13800	10000	V
P24.03	Motor current rating	0.0 ~ 6000.0	54	A
P24.04	Motor frequency rating	0.01~P22.02	50	Hz

P24.05	Motor speed rating	0~60000	1500	rpm
P24.06	No-load exciting current	0.0%~100%	25%	of
P24.07	Motor stator resistance	0.01%~100%	0.1%	of
P24.08	Motor leakage inductance	0.01%~100%	0	of
P24.09	Rotor time constant	0.01%~100%	0	of
P24.10	Moment of inertia	0 ~ 65535	30	Kgm^2
P24.11	Rated excitation current (synchronous motor)	0~1000.0	0	A
P24.12	D-axis inductance of motor (synchronous motor)	0.01%~50%	0	of
P24.13	Q-axis inductance of motor (synchronous motor)	0.01%~50%	0	of
P24.14	Back electromotive force constant (synchronous motor)	0.01%~100%	0	of
P24.15	Rotor initial position (synchronous motor)	0~P26.12	0	

Function Code	Parameter name	Parameter range	Default value	Unit
P25.00	Speed loop proportion 1	0.00 ~ 10.00	0.40	0.01
P25.01	Speed loop integral 1	0.01s ~ 10.00s	0.20	0.01s
P25.02	Switching frequency 1	0~P25.05	5	Hz
P25.03	Speed loop proportion 2	0.00 ~ 10.00	0.20	0.01
P25.04	Speed loop integral 2	0.01s ~ 10.00s	0.40	0.01s
P25.05	Switching frequency 2	P25.02~P22.02	20	Hz
P25.06	Speed loop filtering time	0.000~2.000s	0.000	0.01s

P25.07	Current loop proportion	0.00~30.00	0.65	0.01
P25.08	Current loop integral	0.01~80.00ms	0.50	0.01 ms
P25.09	Current loop derivative	0.000~2.000s	0.000	0.01 ms
P25.10	Magnetic link loop proportion	0.00~30.00	0.65	0.01
P25.11	Magnetic link loop integral	0.01~80.00ms	0.50	0.01 ms
P25.12	Magnetic link filtering time	0.000~2.000s	0.000	0.01 ms
P25.13	Electric torque limit	0.0%~150.0%	100	of
P25.14	Braking torque limit	0.0%~150.0%	100	of
P25.15	Slip compensation gain	0.0% ~ 250.0%	50.0%	0.01%

Function Code	Parameter name	Parameter range	Default value	Unit
P26.00	Startup control mode	0: speed control start; 1: speed tracking start; 2: torque control start; 3: rotor positioning start; 4: static parameter identification; 5: dynamic parameter identification	0	
P26.01	Control mode	0: V/f control; 1: asynchronous motor without PG; 2: asynchronous motor with PG; 3: synchronous motor without PG; 4: synchronous motor with PG	0	
P26.02	V/F curve	0: Straight line; 1: 2nd power curve; 3: S-curve	0	
P26.03	Motor rotation direction control	0: forward rotation; 1: reverse rotation; 2: forward and reverse rotations	0	
P26.04	Opening segment of S-curve	0.0~40.0%	30.0%	
P26.05	Closing segment of S-curve	0.0~40.0%	30.0%	

P26.06	Acceleration time	5.0~6000.0s	30.0s	0.1s
P26.07	Deceleration time	5.0~6000.0s	50.0s	0.1s
P26.08	Start frequency	0.00~10.00Hz	0.10	0.01Hz
P26.09	Start-up hold time	0.0~50.0s	2.0	0.1s
P26.10	Runaway start current	0.0~50.0% P24.03	20%	0.1%
P26.11	Runaway startup time	2s~20s	6s	1s
P26.12	PG's pulses per revolution	0 ~ 65535	8192	1
P26.13	Rotor position compensation	-100~100	0	1
P26.14	Encoder rotation direction change	0 - Forward; 1 - Reverse	0	
P26.15	Torque boost limit	0.00% ~ 100.00%	0.00%	0.01%

6.3 Function Parameters

Function Code	Name	Parameter range	Default value	Unit
P18.00	Basic function command word 1)	16bit		-
P18.01	Shielding time upon medium-voltage power loss	1.00s~100.00s	1	0.01s
P18.02	VFD control mode	0: local control 1: upper computer's control; 2: remote control	0	
P18.03	Setting mode	0: local setting 1: analog setting; 2: switch-based setting 3: upper computer-based setting	0	
P18.04	Switch setting 1	0.0~100.0% of maximum frequency	12.5	0.1%
P18.05	Switch setting 2	0.0~100.0%	25.0	0.1%
P18.06	Switch setting 3	0.0~100.0%	37.5	0.1%

P18.07	Switch setting 4	0.0~100.0%	50.0	0.1%
P18.08	Switch setting 5	0.0~100.0%	62.5	0.1%
P18.09	Switch setting 6	0.0~100.0%	75.0	0.1%
P18.10	Switch setting 7	0.0~100.0%	87.5	0.1%
P18.11	Switch setting 8	0.0~100.0%	100.0	0.1%
P18.12	1L after frequency hopping start	0.00~120.00	51.00	0.01Hz
P18.13	1U after frequency hopping end	0.00~120.00	51.00	0.01Hz
P18.14	2L after frequency hopping start	0.00~120.00	51.00	0.01Hz
P18.15	2U after frequency hopping end	0.00~120.00	51.00	0.01Hz
P19.00	Input voltage coefficient	50~200	100	
P19.01	Dust removal interval	0~30000	15	1 day
P19.02	Ventilator stop time	0~30	0	1min
P19.03	RTC_TIME1	D0-D7: minutes D8-D15: seconds		
P19.04	RTC_TIME2	D0-D7: days D8-D15: hours		
P19.05	RTC_TIME3	D13-D15: weeks D8-D12: months D0-D7: years		

Bit	Definition	Remarks
D15	Spare	0
D14	Spare	0
D13	Ventilation filter screen cleaning	0 - Fail to remind; 1- Remind (default)
D12	Power-up in case of minor fault	0 - Disable; 1 - Enable (default)
D11	Spare	

D10	Remote setting of control mode	0 - Disable (default); 1 - Enable
D9	Spare	
D8	Spare	
D7	Remote start/stop mode	0 - Pulse mode; 1 - Level mode (default)
D6	Fan control	0 - Stop; 1 - Start (default)
D5	Cooling method	0 - Air cooling (default); 1 - Water cooling
D4	Power frequency switching direction	0 - Upward switching (default); 1 - Downward switching
D3	Variable frequency switching	0 - Disable (default); 1 - Enable
D2	Automatic startup upon medium-voltage power loss	0 - Disable (default); 1 - Enable
D1	Quick break upon medium-voltage power Loss	0 - Disable; 1 - Enable (default)
D0	Factory reset	0 - Disable (default); 1 - Enable

Function Code	Name	Detailed Parameter Descriptions	Default value
P27.00	AI1 lower limit	0.00mA~20.00mA	0.00mA
P27.01	AI1 lower limit setting	0.0% ~ 100.0%	0.0%
P27.02	AI1 upper limit	0.00mA~20.00mA	20.00mA
P27.03	AI1 upper limit setting	0.0% ~ 100.0%	100.0%
P27.04	AI2 lower limit	0.00mA~20.00mA	0.00mA
P27.05	AI2 lower limit setting	0.0% ~ 100.0%	0.0%
P27.06	AI2 upper limit	0.00mA~20.00mA	20.00mA

P27.07	AI2 upper limit setting	0.0% ~ 100.0%	100.0%
P27.08	AI3 lower limit	0.00mA~20.00mA	0.00mA
P27.09	AI3 lower limit setting	0.0% ~ 100.0%	0.0%
P27.10	AI3 upper limit	0.00mA~20.00mA	20.00mA
P27.11	AI3 upper limit setting	0.0% ~ 100.0%	100.0%
P27.12	AI4 lower limit	0.00mA~20.00mA	0.00mA
P27.13	AI4 lower limit setting	0.0% ~ 100.0%	0.0%
P27.14	AI4 upper limit	0.00mA~20.00mA	20.00mA
P27.15	AI4 upper limit setting	0.0% ~ 100.0%	100.0%

Function Code	Name	Detailed Parameter Descriptions	Default value
P28.00	AI1 filtering coefficient	0.00-10.00s	0.10s
P28.01	AI2 filtering coefficient	0.00-10.00s	0.10s
P28.02	AI3 filtering coefficient	0.00-10.00s	0.10s
P28.03	AI4 filtering coefficient	0.00-10.00s	0.10s
P28.04	AI1 function	0: Unit cabinet temperature 1: Analog setting 2: Analog feedback 3: Excitation feedback	0
P28.05	AI2 function		3
P28.06	AI3 function		1
P28.07	AI4 function		2

P28.08	Analog setting dropout	0: Free stop; 1: Maintain current frequency; 2: Maintain minimum frequency	1

Function Code	Name	Detailed Parameter Descriptions	Default value
P29.00	A01 function	0: output frequency; 1: output current; 2: output cabinet temperature; 3: excitation current; 4: output power; 5: output power factor; 6: output voltage; 7: input power factor 8: input voltage; 9: input current; 10: input power	0
P29.01	A02 function		1
P29.02	A03 function		15
P29.03	A04 function		15
P29.04	AO1 zero bias coefficient	Correct output zero offset	0
P29.05	AO1 gain	Correct output amplitude deviation (0%~150%)	100%
P29.06	AO2 zero bias coefficient	Correct output zero offset	0
P29.07	AO2 gain	Correct output amplitude deviation (0%~150%)	100%
P29.08	AO3 zero offset coefficient	Correct output zero offset	0
P29.09	AO3 gain	Correct output amplitude deviation (0%~150%)	100%
P29.10	AO4 zero offset coefficient	Correct output zero offset	0
P29.11	AO4 gain	Correct output amplitude deviation (0%~150%)	100%

Function Code	Name	Detailed Parameter Descriptions	Default value
P30.00	DI20 function	0: start; 1: stop; 2: emergency stop; 3: enable remote control; 4: external reset; 5: high voltage segmentation; 6: switching activation; 7: fan fault; 8: status of dual-channel contactor; 9: unit cabinet door travel switch; 10: transformer cabinet door travel switch; 11: transformer overtemperature alarm; 12: transformer overtemperature trip-out; 13: high voltage opening; 14: high voltage ready; 15: main control board ready; 16: water cooling fault; 17: water leakage detection; 18: multi-speed terminal 1; 19: multi-speed terminal 2; 20: multi-speed terminal 3; 21: excitation ready; 22: excitation operation; 23: excitation fault	24
P30.01	DI21 function		5
P30.02	DI22 function		11
P30.03	DI23 function		12
P30.04	DI24 function		9
P30.05	DI25 function		10
P30.06	DI26 function		8
P30.07	DI27 function		7
P30.08	Spare		
P30.09	Spare		
P30.10	DO14	0: high voltage indication; 1: fault indication; 2: operation indication 3: closing allowance/opening allowance; 4: top fan start; 5: remote control indication; 6: cabinet door alarm; 7: unit cabinet overtemperature alarm; 8: fan fault alarm; 9: transformer overtemperature alarm; 10: system standby; 11: phase lock success; 12: excitation startup	7
P30.11	DO15		9
P30.12	DO16		8
P30.13	DO17		15

Function Code	Name	Parameter range	Default value	Unit
P31.00	Cabinet door alarm severity level	0: alarm; 1: fault	1	
P31.01	Fan control	0: Manual; 1: Automatic	0	

P31.02	Fan start-up temperature	0~100.0°C	50	0.1
P31.03	Fan stop temperature	0~P31.02	45	0.1
P31.04	VFD overtemperature alarm	0~100°C	80	0.1
P31.05	Transformer overtemperature trip-out	0~150°C	130	0.1
P31.06	Unit cabinet temperature alarm	0~100°C	55	0.1
P31.07	Unit cabinet temperature alarm clearing	0~P31.06	53	0.1
P31.08	Unit cabinet overtemperature alarm	0~100°C	60	0.1
P31.09	Unit cabinet overtemperature time	0~1000s	80	s
P31.10	Input phase loss protection	0: Disable; 1: Enable	0	
P31.11	Output phase loss protection	0: Disable; 1: Enable	0	
P31.12	Input current unbalance threshold	0: Disabled 5.0%~100%	0	of
P31.13	Output current unbalance threshold	0: Disabled 5.0%~100%	0	of
P31.14	Input voltage unbalance threshold	0: Disabled 5.0%~100%	0	of
P31.15	Output voltage unbalance threshold	0: Disabled 5.0%~100%	0	of

Function Code	Name	Parameter range	Default value	Unit
P21.00	Enable PID control	0: Disable; 1 - Enable	0	
P21.01	PID setting mode	0: local setting; 1: analog setting; 2: communication-based setting	0	
P21.02	PID feedback mode	1: Analog feedback; 2: upper computer feedback	1	
P21.03	PID deviation direction	0: Forward; 1: Reverse	0	
P21.04	PID proportional coefficient	0.00 to 100.00	1.00	
P21.05	PID integration time	0.01s ~ 10.00s	0.10	
P21.06	PID derivation time	0.000~2.000s	0.000	
P21.07	PID sampling period	0.01~100.00s	0.05	
P21.08	PID deviation limit	0.0~100.00%	0	
P21.09	PID output limit	0.0~100.00%	10	
P21.10	Feedback disconnection handling	0: maintain minimum frequency; 1: maintain current frequency	0	
P21.11	Feedback disconnection value	0.0~100.0%	0.0%	

P21.12	Feedback disconnection time	0.01~100.00s	0.10	
P21.13	Setpoint discontinuity handling	0: maintain minimum frequency; 1: maintain current frequency	0	
P21.14	Setpoint	0.0~100.0%	0.0%	
P21.15	Setpoint hold time	0.01~100.00s	0.10	

Function Code	Name	Detailed Parameter Descriptions	Default value
P20.00	Upper computer category	0: user host; 1: debug host	0
P20.01	Communication protocol	0: Standard Modbus-RTU; 1: Profibus-DP; 2: Profinet	0
P20.02	Local communication address	1~247 (0 is the broadcast address)	1
P20.03	Communication rate	0: 2400; 1: 4800; 2: 9600; 3: 19200; 4: 38400; 5: 115200	2
P20.04	Communication timeout time	0.1~100.0s	1
P20.05	Communication timeout handling	0: alarm and free stop; 1: alarm and running	1

Chapter 7 Function Applications

This chapter describes some relatively complex or special functions of the VEDA-IN MVD general-purpose VFD.

The following functions had been fully tested and verified before the product was delivered. For details about how to set the functions, see the parameter descriptions or ask a professional technician to do this. For other functions, consult with our company.

7.1 Synchronous Switching

The synchronous switching technology allows the VFD to be used to soft start and control multiple motors. There are two synchronous switching modes: 1) VF (variable frequency) to PF (power frequency) switching (upward switching); 2) PF to VF switching (downward switching).

VF-PF switching refers to a switching of the motor from the variable frequency running state to the grid power frequency running state, accompanied by its separation from the VFD. After the VFD receives the switching command, it detects the grid frequency on the input side and uses this frequency as the output speed command to achieve frequency matching. After the input and output frequencies match, phase matching is performed by using the grid phase information measured by the input side phase lock loop and the output phase information measured by the output side phase lock loop. When the voltage, frequency, amplitude, and phase of the VFD's output are consistent with the power grid, the touch screen shows that the phase lock is successful and a switching operation can be performed. After successful switching, the output contactor of the VFD is disconnected and the VFD stops freely. In order to adapt to different working conditions, the parameter "phase locking angle for switching" (range: 0.5°~8°) is added.

PF-VF switching refers to a switching of the motor from the grid power frequency running state to the variable frequency running state, accompanied by its separation from the grid. When the motor runs at the power frequency, the VFD first runs with no load and tracks the power grid to phase locking, and after it is connected to the grid, the motor is switched from the power frequency running state to the variable frequency running state.

Note: Before trying to perform a synchronous switching, it is necessary to check whether some system parameter settings are reasonable and meet the requirements. Commands or functions that may cause switching failure must be disabled. For example, a speed curve, a speed limit, or a setting mode, may change the output frequency of the VFD during synchronous switching, resulting in switching failure.

When the synchronous switching function is used, it is necessary to provide a synchronous switching cabinet, a reactor cabinet, and a synchronous switching sampling board. For details, consult with our professional technician.

Related parameters:

Variable frequency switching: enable;

Power frequency switching direction: upward switching;

Phase locking angle for synchronous switching: 3-8°.

Variable frequency switching: after the VFD starts up, the motor is dragged to the same frequency as that of the power grid via the switching activation DI terminal. After successful phase locking, the DO terminal sends an instruction to allow the switching cabinet to perform the switching operation.

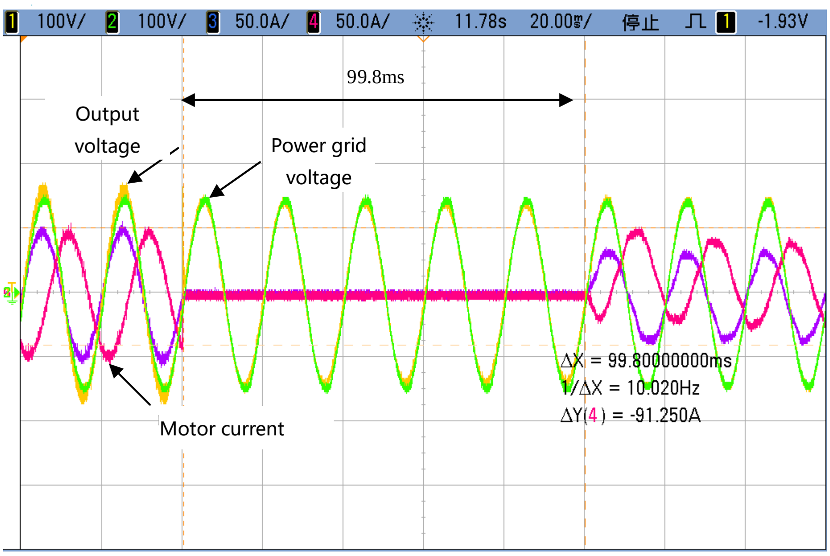


Fig. 7.1 Synchronous Switching

7.2 Speed Tracking Start

Speed tracking start is also called runaway start. When the motor is in the rotating state, the speed tracking start function allows the VFD to measure the motor speed and output the voltage with the same frequency as the motor rotation frequency, thus minimizing the impact on the motor when the VFD starts.

When the shutdown mode is set to free stop and the startup mode is set to speed tracking startup, the VFD always detects the speed of the motor before starting. Upon receiving a startup command, the VFD immediately outputs the frequency corresponding to the speed, and accordingly accelerates or decelerates the motor to allow it to run at the set frequency.

Related parameters:

Startup control mode: the speed tracking start function is able to lock the current frequency of the motor;

Runaway startup time: refers to the time required for the remaining voltage to increase to the voltage value corresponding to the current frequency in the speed tracking start mode; within the time, the frequency does not increase;

Phase lock loop disabling delay time: the motor frequency is no longer locked when this time elapses since the VFD shutdown.

Description of optimization logic:

When the control system is powered on for the first time, the phase lock loop is disabled by default.

The phase lock loop cannot be enabled in the debugging mode.

The phase lock loop is not enabled when the actual running frequency is lower than 2 Hz.

The phase lock loop is disabled when the VFD starts with the motor disconnected and it is found during shutdown that the output current is lower than 10%.

If a contactor may be used to disconnect the motor and the phase lock loop disabling delay time is used for control, this delay time can be made to be long enough (for example, 40 minutes) if you do not want this to happen.

In other cases, the phase lock loop is enabled to track the motor running frequency in real time. During shutdown, the locked motor frequency gradually decreases. If the motor frequency is lower than 2 Hz within the phase lock loop shutdown delay time, the phase lock loop is disabled.

In case of a high-speed runaway, it is not necessary to wait for the motor's back electromotive force to drop.

The test waveform is shown in the following diagram: runaway start is directly performed after shutdown.

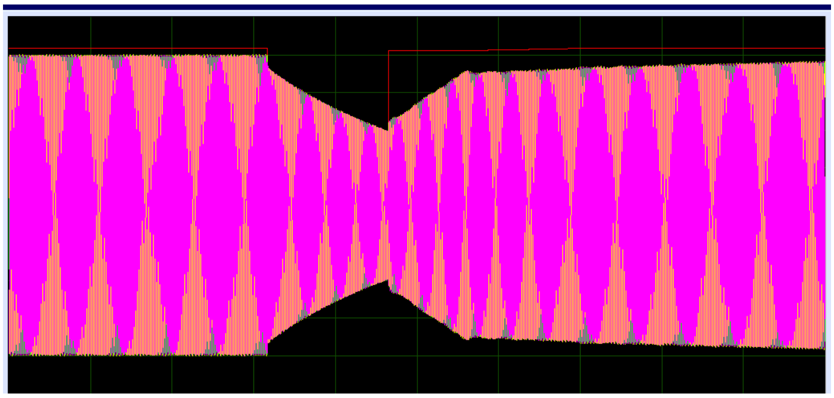


Fig. 7.2 Speed Tracking

7.3 Non-stop upon sudden power failure

Non-stop upon sudden power failure is also called instantaneous non-stop. The power grid is often unstable actually. When the VF detects a power grid voltage drop, it runs at a lower speed. This is equivalent to charging the grid side. During nonstop upon sudden power failure, the VFD drives the motor to slow down, keeps the bus capacitor voltage largely stable, and ensures the normal operation of the system. If the grid's power supply is not restored beyond the nonstop time upon sudden power failure and quick break upon medium-voltage power loss is enabled, a prompt is given to indicate that a medium-voltage power loss fault occurred.

Related parameters:

Instantaneous non-stop function: enable;

Instantaneous non-stop time: it is recommended that the instantaneous non-stop time should be 300ms or below;

Instantaneous non-stop step: it is recommended that motor running frequency parameter 1 should be adjusted to 18;

Instantaneous no-stop threshold: it is recommended that motor running frequency parameter 2 should be adjusted to 1,000.

The functional test waveforms are shown in the following figure. The green waveform represents the input voltage while the yellow waveform represents the motor current:

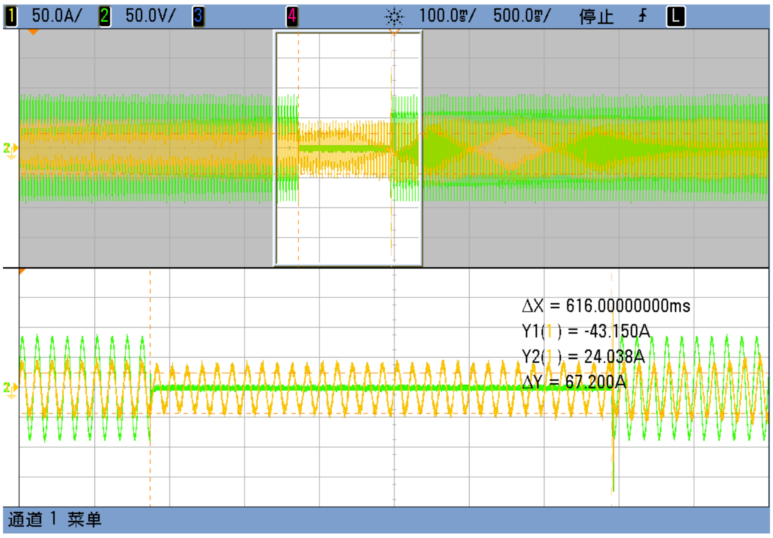


Fig. 7.3 Non-stop upon sudden power failure

7.4 Automatic Start-up upon Medium-voltage Power Loss

When the grid voltage drop lasts beyond the nonstop time upon sudden power failure, this occurrence is called medium-voltage power loss. By setting the parameters of quick break upon medium-voltage power loss, automatic start-up after medium-voltage power loss, and power loss shielding delay, the user can specify whether the VFD reports a major fault when a medium-voltage power loss occurs and whether the VFD starts up automatically when the power supply is restored.

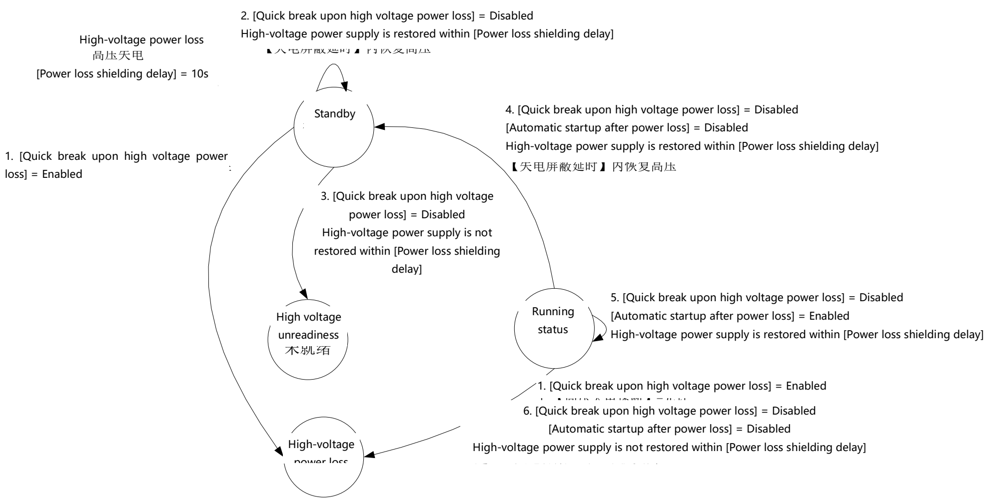


Fig. 7.4 VFD with Medium-voltage Power Loss

A VFD with medium-voltage power loss is shown in the figure above. According to different parameter settings, the possible states of the VFD are shown in the following table:

Table 7-1 State Changes Upon Medium-voltage Power Loss

No.	Status before medium-voltage power loss	Parameter	Condition	Result
1	Standby or running	[Quick break upon high voltage power loss] = Enabled		Major high voltage power loss fault
2	Standby	[Quick break upon high voltage power loss] = Disabled	High voltage restored within 10 seconds	Standby
3	Standby	[Quick break upon high voltage power loss] = Disabled	High voltage not restored within 10 seconds	High voltage unreadiness
4	Running	[Quick break upon high voltage power loss] = Disabled [Automatic startup after power loss] = Disabled	High voltage restored within 10 seconds	Standby
5	Running	[Quick break upon high voltage power loss] = Disabled [Automatic startup after power loss] = Enabled	High voltage restored within 10 seconds	Running
6	Running	[Quick break upon high voltage power loss] = Disabled [Automatic startup after power loss] = Disabled	High voltage not restored within 10 seconds	Major high voltage power loss fault

7.5 System Bypass Function (Optional)

If the VFD has a fault and cannot ensure the normal operation of the motor but the on-site working conditions do not allow it to stop, a bypass cabinet can be used to realize the system bypass function and put it into the power frequency grid for its operation.

The bypass cabinet can be a manual or automatic one. When the system can be temporarily shut down, a manual bypass cabinet can be used for manual switching by the operator; when the system is required to run all the time, it is recommended that an automatic bypass cabinet should be used if the working conditions permit, and in this case, switching operations are automatically carried out. When the motor runs at the power frequency, the VFD can be isolated from the medium-voltage power supply to facilitate its maintenance and repair.

7.6 Motor Overload Protection Function

In order to prevent the motor from being damaged due to long-time overload or overcurrent, the VEDA-IN MVD medium-voltage VFD protects the motor according to a thermal overload model for motors. The specific inverse time protection expression for motor overload is as follows:

$$\int_0^t \left[\left(\frac{I}{I_N}\right)^2 - 1 \right] dt \geq k$$

where, I_N is the rated current of the motor, I is the instantaneous current of the motor, t is the inverse time overcurrent protection time, and k is the set value of the protection constant. The expression shows that the inverse time protection function is activated when the current of the motor exceeds its rated current and that a stronger motor current means a shorter protection action duration. The schematic diagram of the inverse time protection is as follows:

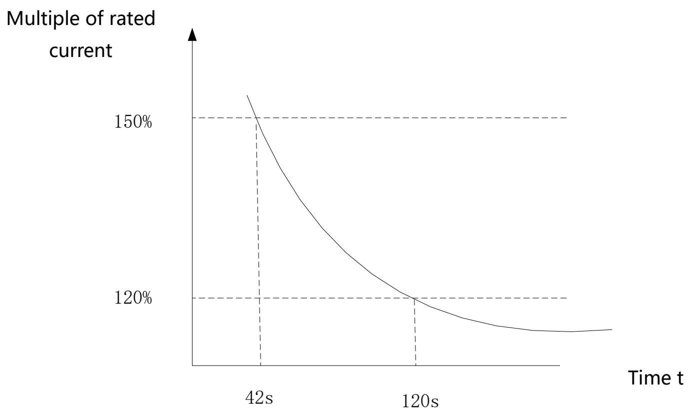


Fig. 7.5 Schematic Diagram of Inverse Time Protection

The inverse time protection is an integration process. The larger the overload multiple of rated current is, the larger the integration step is and the shorter the continuous running time of the VFD is. The following assumption is for quantitative explanation: if the output current of the VFD is constant at some overload multiple of the motor's rated current, the inverter would run continuously for a certain time until a fault is reported. The relationship between the motor overload multiple and overload duration is shown in Table 7-2:

Table 7-2 Motor Overload Multiple vs. Overload Duration

overload factor	Duration (s)
110%	251
120%	120
130%	76
140%	55
150%	42
200%	18

7.7 Stall Prevention Function

If the set acceleration or deceleration time of the VFD is too short, its output frequency change is far beyond the motor's speed change, the inverter would trip out due to overcurrent or overvoltage. This phenomenon is called stall. In order to prevent any motor stall and keep the motor running stably, it is necessary to detect the current and unit voltage values for frequency control and appropriately suppress the acceleration or deceleration.

If the VFD has a strong current during acceleration or deceleration and the current exceeds the preset overcurrent regulation point (that is, the maximum allowable value of the acceleration current), the output frequency of the VFD will not change any longer, the acceleration or deceleration will be delayed, and the acceleration or deceleration will resume after the current drops below the overcurrent recovery point. See the figure below:

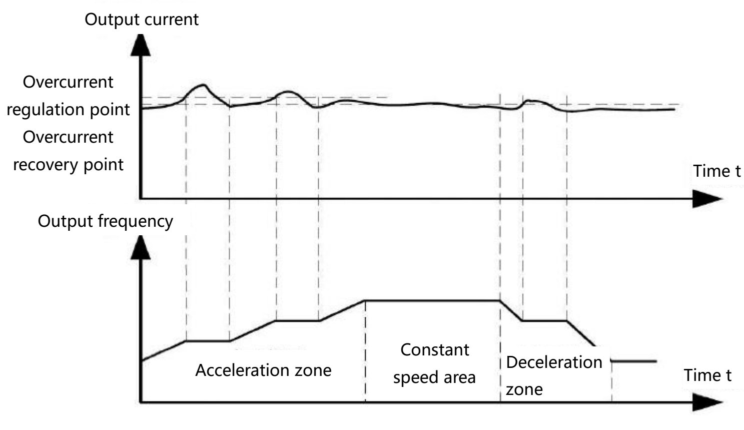


Fig. 7.6 Schematic Diagram of Overcurrent Regulation

When the VFD decelerates the motor, excessive load inertia or too short deceleration time might cause the DC busbar voltage to rise, thus probably causing unit overvoltage protection. In order to avoid this occurrence, the inverter detects the unit bus voltage on a real-time basis. When it exceeds the unit overvoltage regulation point, deceleration is stopped. When the unit bus voltage is lower than the overvoltage regulation point, deceleration resumes, as shown in the following figure:

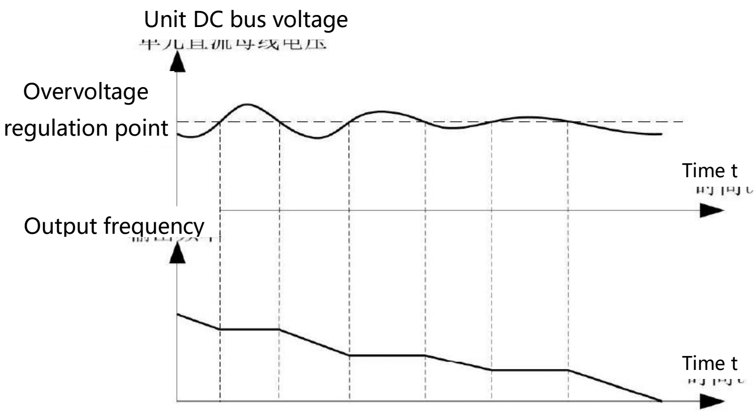


Fig. 7.7 Schematic Diagram of Overvoltage Regulation

7.8 Mechanical Bypass for Unit Bypass Function and Fault-tolerant Modulation for Neutral Drift

7.8.1 Mechanical bypass for Unit bypass function

The units of each phase unit of the medium-voltage VFD are connected in series. When one or more units of the VFD are faulty, the unit bypass operation mode is usually adopted to maintain on-site production in order not to cause a shutdown on the customer's site.

A unit for the VEDA-IN MVD VFD can be mechanically bypassed through adding a contactor at the output end. When the VFD detects a faulty unit, it immediately blocks the outputs of all its IGBTs and issues a bypass command to close the corresponding contactors, thus separating the unit from its output loop. Then, the VFD restarts and runs at lower ratings.

The mechanical bypass function can solve nearly all the faults. Its function is not limited to the protection of the VFD when a power semiconductor device is faulty.

7.8.2 Fault-tolerant Modulation for Neutral Drift

When a faulty unit is bypassed, the current output capacity of the VFD is not affected but its voltage output capacity is reduced. In the traditional same-stage bypassing mode, one bypass unit is put into use for each phase in order to maintain the three-phase output balance when a unit is faulty, so the voltage output capacity is greatly reduced.

When the fault-tolerant modulation technology is used, only the faulty unit is bypassed and the other units work normally so that the voltage output capacity can be maximized.

The following figure is a schematic diagram of an 8-stage medium-voltage VFD with no unit bypass. Each phase is composed of 8 power units connected in series. At this time, all units are normal without any fault. Therefore, all the voltage angles between the A, B, and C phases are 120°. In the figure, taking phase A as an example, A1 refers to the L1 unit of phase A, A2 refers to the L2 unit of phase A, and so on.

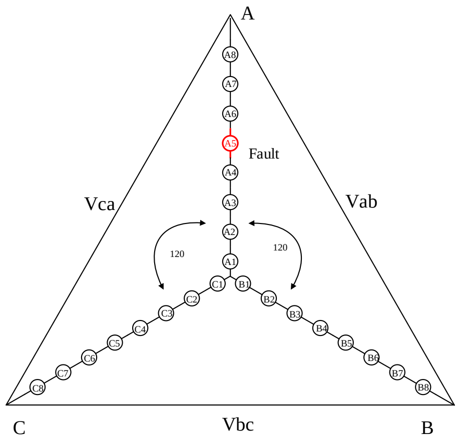


Fig. 7.8 Schematic Diagram of 8-stage VFD with No Unit Bypass

When one unit of the VFD's phase A is faulty and bypassed, only 7 units remain in normal operation and the output voltage becomes unbalanced, as shown in Fig. 7.9. At this time, the output voltage of phase A is dramatically lower and the output line voltages are not in balance. The precondition of this method is that the neutral point of the units floats and is not connected to the neutral point of the motor, so the neutral point of the output voltage of the VFD and the neutral point of the motor can have different potentials and a balance between the output line voltages can be ensured by adjusting the phase angles of the output phase voltages. As can be seen in the figure, the phase angles of the output phase voltages are appropriately adjusted. The phase differences between A and B/C are 124° rather than the usual phase difference of 120°. Therefore, although the A phase's number of working units is different from those of B and C and the output phase voltages are unbalanced, it is the phase differences between the phase voltages that produce balanced line voltage outputs and make the motor operate normally. In order to maximize the voltage utilization rate, an unbalanced zero sequence component is injected into the modulated waveform to further improve the output voltage. In the figure, there are 23 units still in normal operation, which can provide an output voltage equivalent to 94% of the maximum output voltage. The 8-stage VFD can still output the voltage of 10000V in the event that a unit is faulty.

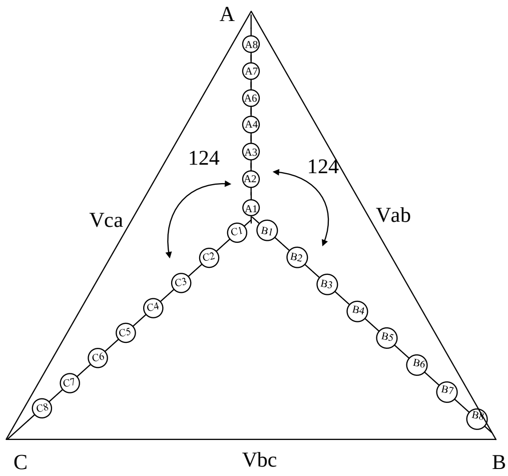


Fig. 7.9 Output Diagram of Asymmetric Units with Bypass Function

7.9 Master-slave Control

The master-slave control technology is designed for multi-drive applications, where the system is jointly driven by two or more medium-voltage VFDs. In addition, the motor shafts are coupled together through couplings, chains, gears or belts, etc. Through the master-slave control function, the load can be evenly distributed among the motors.

When the technology is applied, the master-slave setting of the system should be set to Enabled, the master to Master Mode, and the slaves to Slave Mode. The master communicates with the slaves through optical fibers. The host transmits information on operations, speed, torque, etc. to the slaves on the real time basis, and the slaves respond to the data instructions from the host according to their measurement data.

Related parameters:

The master and slave shall have the same acceleration and deceleration times, start mode (speed control), start frequency, and start-up hold time;

Master settings: master and master-slave control enabling;

Slave settings: slave and master-slave control enabling, frequency adjustment by slave, active control mode, slave PI setting, and limit setting.

Setting References:

Table 7-3 Master-slave Control Parameter Setting References

	Master	Slave
Master-slave mode	Master	Slave
Master-slave control	Enable	Enable
Master-slave control mode	Power balance	Power balance
Start frequency	0	0
Start-up hold time	0	0
Startup control mode	Speed control	Speed control
Frequency adjustment by slave		0.2
Proportion adjustment by slave		2
Integral adjustment by slave		4

Note: before a master/slave control fault is handled, the slave makes a judgment about optical fiber communication; if the host is not powered on, the slave reports a communication fault; the host needs to be powered on before the slave is reset.

Chapter 8 Troubleshooting

The VEDA-IN MVD medium-voltage VFD has perfect fault monitoring and protection functions. Faults are divided into two classes: minor and major faults. Minor faults: only an alarm is issued, and the system can be powered up, started, and operated normally. Major faults: the system immediately cuts off the medium-voltage power supply, saves the fault information, and latches the system status.

Before seeking a technical service, the user can try to fix the fault alone according to its name. To seek a technical service, contact the retailer you purchased the VFD from or directly contact VEDA-IN DRIVES.

8.1 Minor Faults and Their Alarms

In the event of a minor fault, the system sends out an alarm signal, the fault indicator flashes, and the minor fault indication is memorized. After the fault disappears, the alarm is automatically canceled. When there occurs a minor fault alarm during the operation of the VFD, the system does not stop. When there occurs a minor fault before the medium-voltage power-up of the VFD, the power-up option on the touch screen can be used for setting. When power-up is enabled, the power cabinet at the upper end of the VFD can be switched on; when power-up is disabled, the power cabinet cannot be switched on.

Minor faults include:

- Fan fault alarm
- Fan power loss
- Unit cabinet overtemperature alarm
- Transformer overtemperature alarm
- Analog setting dropout
- Analog feedback dropout
- Unit cabinet door alarm
- Transformer cabinet door alarm
- Unit undervoltage alarm
- Phase A fuse fault
- Phase B fuse fault
- Phase C fuse fault
- Left bridge overtemperature alarm
- Right bridge overtemperature alarm
- Unit overvoltage alarm
- Touch screen failing to communicate
- Unit bypass fault
- Motor overload
- Prompt for ventilation filter screen cleaning
- D1 emergency stop breaking
- Bypass power supply fault

8.2 Major Faults and Their Alarms

Major fault alarms are divided into major system faults and major unit faults. In the event of a major fault alarm, the system sends out an alarm signal and a fault indication and issues a medium-voltage breaking command (the medium-voltage power supply of the VFD will be automatically cut off). Moreover, the fault indication and medium-voltage breaking instruction are memorized - even if the fault disappears, the fault indication and medium-voltage breaking instruction are still held in place. After troubleshooting and system reset, the VFD returns to the medium-voltage unreadiness state.

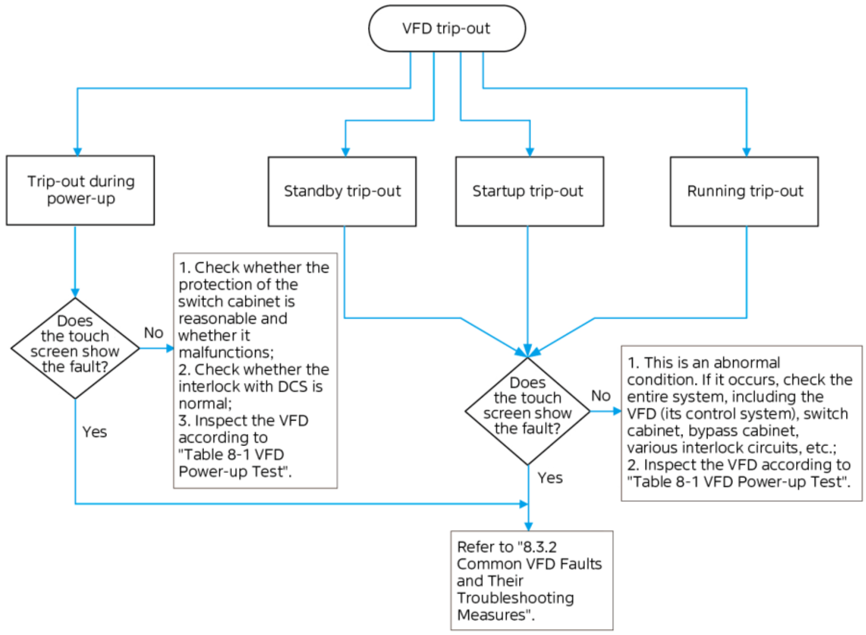
Major faults include:

- VFD overcurrent fault
- Motor overload
- Transformer overtemperature trip-out
- Unit cabinet overheat fault
- External faults
- Major unit cabinet door fault
- Major transformer cabinet door fault
- IO board's downlink communication fault
- IO board power supply fault
- IO board's uplink communication fault
- Parameter setting error
- Left bridge overtemperature fault
- Right bridge overtemperature fault
- Unit undervoltage
- Unit overvoltage fault
- Left bridge upper tube fault
- Left bridge lower pipe fault
- Right bridge upper tube fault
- Right bridge lower tube fault
- 3.3V power supply undervoltage fault
- 15V power supply undervoltage fault
- Downlink optical fiber communication fault
- Uplink optical fiber communication fault
- Excitation fault
- Medium-voltage power loss

8.3 Troubleshooting of Common Faults

After a fault happens to the VFD, the information about the fault is explicitly shown on the touch screen. The user can take corresponding measures according to the fault information displayed on the touch screen.

8.3.1 VFD Trip-out Analysis



Refer to Fig. 8.1 to identify the cause of the trip-out.

Fig. 8.1 VFD Trip-out Detection Flowchart

No.	Check point		Check item
1	VFD and Its Accessories	Switch cabinet	Check whether the L1, L2, and L3 voltages of the switch cabinet's incoming primary power cable are normal and whether the circuit breaker is closed.
		Bypass cabinet	Check whether the electrified display instrument gives an indication and whether the medium-voltage vacuum contactor is closed.
		Incoming primary power cable	Check whether the switch cabinet is properly connected to the bypass cabinet and whether the bypass cabinet is properly connected to the VFD.
		Power supply controlled by interlock wiring machine	Check whether the bypass cabinet's control circuit is normally supplied with power and whether the interlock connections for closing allowance and medium-voltage breaking are correct.

		VFDs	Check whether the primary connection between the VFD cabinet and the unit cabinet is correct, whether the parameters of the VFD are set correctly, whether the VFD is in the medium-voltage unreadiness state, whether the fault indicator is normally on, and whether there is any major fault signal output.
2	Loads	Primary wiring	Check whether the VFD is properly connected to the motor.
		Motor	Check whether the motor is jammed. Check whether the power frequency operation is normal.
		Load	Check whether the fans are normal.
3	Documentation	On-site installation and debugging files	Check if the check procedures are followed.

8.3.2 Summary of Minor Faults

No.	Fault name	Protection value	Possible fault causes	Countermeasures
1	Fan fault alarm		1. There is a wiring error at the fan fault point. 2. The auxiliary contact inside the fan is disconnected.	1. Check whether the fan fault signal line is connected correctly. 2. Determine through measurement whether the auxiliary contact of the fan is connected or disconnected.
2	Fan power loss		1. The fan's power circuit breaker, contactor, or thermal relay is not closed. 2. The fan's thermal relay trips out due to protection. 3. The fan's auxiliary contact is disconnected.	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether the protection value set for the thermal relay is too low; if so, adjust the protection value. 3. Seek technical support.
3	Unit cabinet overtemperature alarm	55°C	1. The unit cabinet's fan is not running. 2. The filter screen is clogged. 3. The VFD runs with overload for long.	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether a sheet of A4 can be adsorbed to the air inlet.

			4. The ambient temperature is too high.	3. Observe the touch screen temperature after load reduction. 4. Control the ambient temperature and improve the air conditioner's cooling effect.
4	Transformer overtemperature alarm	100°C	1. The set temperature protection value is incorrect. 2. The resistance value of the platinum thermistor is abnormal. 3. The fans at the top and bottom of the cabinet are not running. 4. The VFD runs with overload for long. 5. The ambient temperature is too high.	1. Check whether the set temperature protection value is correct. 2. Check whether the platinum thermistor is damaged. 3. Check whether the circuit breaker, contactor, and thermal relay work normally. 4. Observe the transformer temperature after load reduction. 5. Control the ambient temperature and improve the air conditioner's cooling effect.
5	Analog setting dropout		Disconnected analog setting signal line 2. The current source does not supply power.	1. Check whether the analog setting signal line is correctly connected and determine through measurement whether there is a disconnection along it. 2. Check whether the current source works properly.
6	Analog feedback dropout		1. The analog feedback signal line is disconnected. 2. The current source does not supply power.	1. Check whether the analog feedback signal line is correctly connected and determine through measurement whether there is a disconnection along it. 2. Check whether the current source works properly.
7	Transformer cabinet door alarm		1. The travel switch is not pushed firmly against the top bumper of the cabinet door. 2. The secondary line of the travel switch is disconnected. 3. The IO port relay of the interface board is damaged.	1. Check whether the travel switch is in good contact. 2. Check whether the secondary line is correctly connected and determine through measurement whether there is a disconnection along it. 3. Seek technical support.
8	Unit cabinet door		1. The travel switch is not	1. Check whether the travel switch is in good

	alarm		pushed firmly against the top bumper of the cabinet door. 2. The secondary line of the travel switch is disconnected. 3. The IO port relay of the interface board is damaged.	contact. 2. Check whether the secondary line is correctly connected and determine through measurement whether there is a disconnection along it. 3. Seek technical support.
9	Phase A fuse fault		1. Input power supply's phase loss 2. Abnormal power failure of power grid 3. The unit module's incoming cables are not connected. 4. The unit module's fuse is damaged. 5. The electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are not up to standard. 6. VFD cabinet grounding is not up to standard. 7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	1. Check whether the higher-level power cabinet is correctly connected; 2. Identify the cause of the power grid's abnormal power failure and eliminate the fault source. 3. Check whether the three incoming phase wires of the unit module are connected correctly. 4. Seek technical support. 5. Check whether the electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are within the allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
10	Phase B fuse fault		1. Input power supply's phase loss 2. Abnormal power failure of power grid 3. The unit module's incoming cables are not connected. 4. The unit module's fuse is damaged. 5. The electrical distances between the terminals on the	1. Check whether the higher-level power cabinet is correctly connected; 2. Identify the cause of the power grid's abnormal power failure and eliminate the fault source. 3. Check whether the three incoming phase wires of the unit module are connected correctly. 4. Seek technical support. 5. Check whether the electrical distances

			secondary side of the transformer and the adjacent terminals are not up to standard. 6. VFD cabinet grounding is not up to standard. 7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	between the terminals on the secondary side of the transformer and the adjacent terminals are within the allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
11	Phase C fuse fault		1. Input power supply's phase loss 2. Abnormal power failure of power grid 3. The unit module's incoming cables are not connected. 4. The unit module's fuse is damaged. 5. The electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are not up to standard. 6. VFD cabinet grounding is not up to standard. 7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	1. Check whether the higher-level power cabinet is correctly connected; 2. Identify the cause of the power grid's abnormal power failure and eliminate the fault source. 3. Check whether the three incoming phase wires of the unit module are connected correctly. 4. Seek technical support. 5. Check whether the electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are within the allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
12	Left bridge overtemperature alarm	105°C	1. The fan at the top of the cabinet is not working. 2. The filter screen is clogged. 3. The overtemperature sensor is damaged. 4. Long-time overload	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether the filter screen is clogged. 3. Seek technical support. 4. Check whether the motor runs with

			5. The ambient temperature is too high.	overload; if so, reduce its load and observe its running. 5. Control the ambient temperature and improve the air conditioner's cooling effect.
13	Right bridge overtemperature alarm	105°C	1. The fan at the top of the cabinet is not working. 2. The filter screen is clogged. 3. The overtemperature sensor is damaged. 4. Long-time overload 5. The ambient temperature is too high.	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether the filter screen is clogged. 3. Seek technical support. 4. Check whether the motor runs with overload; if so, reduce its load and observe its running. 5. Control the ambient temperature and improve the air conditioner's cooling effect.
14	Unit undervoltage alarm	680V	1. The input power supply's actual voltage is lower than its rated voltage.	1. Check whether the grid voltage is within the allowed range. 2. Seek technical support.
15	Unit overvoltage alarm	1100V	1. Too quick deceleration 2. The input power supply's actual voltage exceeds its rated voltage. 3: Output current oscillation 4. The Hall sensor works abnormally. 5. The motor's reactive power is too high. 6. Unbalanced load outputs in case of dual-machine linkage	1. Extend the deceleration time and adjust the overexcitation gain coefficient. 2. Check whether the grid voltage is within the allowed range. 3. Adjust the speed ratio coefficient. 4. Check whether the Hall device is intact and is correctly connected. 5. Seek technical support.
16	Touch screen's failure to communicate		1. The communication network cable is disconnected. 2. Poor contact 3. The touch screen's port is damaged.	1. Check whether the network cable is connected. 2. Check whether the network cable is plugged in place. 3. Seek technical support.
17	Unit bypass fault		Damaged bypass module	Check the unit.

			The bypass function has been enabled on the touch screen. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	Check whether the bypass function has been enabled on the touch screen. Remove the dust on the circuit board and the dust within the unit. Seek technical support
18	Motor overload		The motor's running current exceeds its rated current by 1.1-2.0 times. The load is too heavy. Too short acceleration time	The rated power of the VFD is too low. Extend the acceleration time. Seek technical support
19	Prompt for ventilation filter screen cleaning		Set dust removal time reached The ventilation filter screen cleaning reminder function is enabled.	Disable the dust removal time setting. Disable the ventilation filter screen cleaning reminder function. Replace the ventilation filter screen in case of such a fault.
20	D1 emergency stop breaking		1. Emergency stop breaking	1. Check the emergency stop signal. 2. Seek technical support.
21	Water cooling fault		Insufficient water flow outside water cooler cabinet The temperature, pressure, or flow rate of the water in the water cooler cabinet is too high or too low. The internal water has too high electrical conductivity. Internal water pipe leakage The cooling mode setting is incorrect.	Check the temperature, flow rate, and pressure of the water cooler cabinet. Check whether there is any water leakage from any water pipe. Replace the internal water or filter screen. Seek technical support
22	Water leakage from transformer's heat exchanger		1. Water leakage from heat exchanger piping	1. Check the transformer's heat exchanger. 2. Seek technical support.
23	Bypass power		1. The power cord is in poor	1. Check whether the power cord is in good

	supply fault		contact. 2. The power cord is damaged. 3. The bypass module is damaged. 4. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	contact. 2. Replace the power cord. 3. Seek technical support. 4. Remove the dust on the circuit board and the dust within the unit.

8.3.3 Summary of Major Faults

No.	Fault name	Protection value	Possible fault causes	Countermeasures
1	VFD overcurrent fault	150%	1. Sudden load change 2. Parameter setting error 3. Incorrect main circuit wiring 4. The control mode is asynchronous-motor open-loop vector control without parameter identification. 5. The control mode is asynchronous-motor vector control with incorrect encoder wiring. 6. The control mode is synchronous-motor vector control with incorrect encoder wiring. 7. The main circuit is not well connected. 8. There are damaged diodes on the output voltage detection board. 9. Output current oscillation 10. Damaged motor insulation 11. Incorrect Hall sensor wiring 12. Too short acceleration/deceleration time 13. Abnormal unit fixture 14. Jammed motor or auxiliary machine 15. Too high starting frequency setting	1. Identify the cause of the sudden load change and eliminate the fault. 2. Make the current module of the signal board consistent with the parameter setting. 3. Check whether the output loop wiring is correct. 4. Perform motor parameter identification in the correct parameter identification sequence. 5. Check whether the encoder's signal lines are properly connected. 6. Check whether the encoder's signal lines are properly connected. 7. Check whether there is any peripheral cable or copper bar in poor contact. 8. Seek technical support. 9. Adjust the speed ratio parameter to optimize the waveform of the output current. 10. Check through measurement whether the insulations of the connecting cables and motor windings are within the allowed range. 11. Check whether the Hall sensor wiring is correct and whether the measured Hall sensor voltage is within the allowed range. 12. Extend the acceleration and

<table>
<tr><td></td><td></td><td colspan="2"></td><td>16: Too high torque boost setting
17. The power factor correction capacitor or surge absorption device is incorrectly connected.
18. The rated power of the VFD is too low.
19. Output short circuit</td><td>deceleration times.
13. Seek technical support.
14. Replace the motor or eliminate the mechanical fault.
15. Check whether the starting frequency setting is appropriate.
16. Check whether the torque boost setting is appropriate.
17. Check whether the wirings of the peripheral electrical devices at the output end of the VFD are correct.
18. Select a matching VFD according to the load characteristics.
19. Check whether the insulation of the output cable is damaged.</td></tr>
<tr><td rowspan="11">2</td><td rowspan="11">Motor overload</td><td>overload factor</td><td>Duration</td><td rowspan="11">1. The motor current reaches the protection value.
2: Too short acceleration/deceleration time
3. Incorrect parameter setting
4. The motor is mechanically jammed.
5. The input power supply's voltage is too low.
6. The rated power of the VFD is too low.</td><td rowspan="11">1. Check whether the VFD runs with overload; if so, reduce its load and observe its output current.
2. Extend the acceleration and deceleration times.
3. Check whether the motor's rated current is set correctly.
4. Replace the motor or eliminate the mechanical fault.
5. Check whether the grid voltage is within the allowed range.
6. Select a matching VFD according to the load characteristic.</td></tr>
<tr><td>110%</td><td>201</td></tr>
<tr><td>120%</td><td>118</td></tr>
<tr><td>130%</td><td>74</td></tr>
<tr><td>140%</td><td>54</td></tr>
<tr><td>150%</td><td>41</td></tr>
<tr><td>160%</td><td>33</td></tr>
<tr><td>170%</td><td>28</td></tr>
<tr><td>180%</td><td>23</td></tr>
<tr><td>190%</td><td>18</td></tr>
<tr><td>200%</td><td>15</td></tr>
<tr><td>3</td><td>Transformer overtemperature trip-out</td><td colspan="2">130°C</td><td>1. Incorrect temperature protection setting
2. The filter screen is clogged.
3. The fans at the top and bottom of the cabinet are not</td><td>1. Check whether the temperature protection value is set correctly.
2. Check whether a sheet of A4 can be adsorbed to the air inlet.
3. Check whether the circuit breaker,</td></tr>
</table>

			working. 4. The VFD runs with overload for long. 5. The ambient temperature is too high.	contactor, and thermal relay work normally. 3. Observe the touch screen temperature after load reduction. 4. Control the ambient temperature and improve the air conditioner's cooling effect.
4	Unit cabinet overheat fault	60°C	1. The unit cabinet's fan is not running. 2. The filter screen is clogged. 3. The VFD runs with overload for long. 4. The ambient temperature is too high.	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether a sheet of A4 can be adsorbed to the air inlet. 3. Observe the touch screen temperature after load reduction. 4. Control the ambient temperature and improve the air conditioner's cooling effect.
5	External faults		1. The medium-voltage breaking button on the cabinet door is in the closed position. 2. The remote medium-voltage breaking point is in the closed position. 3. The medium-voltage breaking input point of the interface board is short-circuited. 4. The internal relay of the interface board is damaged.	1. Check whether the medium-voltage breaking button is in the closed position. 2. Check if the remote medium-voltage breaking button is in the closed position. 3. Check whether the interface board's input point port is correctly connected. 4. Seek technical support.
6	Major unit cabinet door fault		1. The travel switch is not pushed firmly against the top bumper of the cabinet door. 2. The secondary line of the	1. Check whether the travel switch is in good contact. 2. Check whether the secondary line is correctly connected and determine

			travel switch is disconnected. 3. The IO port relay of the interface board is damaged.	through measurement whether there is a disconnection along it. 3. Seek technical support.
7	Major transformer cabinet door fault		1. The travel switch is not pushed firmly against the top bumper of the cabinet door. 2. The secondary line of the travel switch is disconnected. 3. The IO port relay of the interface board is damaged.	1. Check whether the travel switch is in good contact. 2. Check whether the secondary line is correctly connected and determine through measurement whether there is a disconnection along it. 3. Seek technical support.
8	Unit's uplink communication fault		1. Abnormal main control board 2. The optical fiber signal transmission and reception locations are incorrectly connected. 3. There is dust inside the optical fiber connector socket. 4. The optical fiber core is in poor contact with the external plug. 5. Optical fiber signal interruption 6. Detached optical fiber connector 7. Damaged optical fiber panel 8. Too much dust on the circuit board causes the unit module to have a false alarm fault. 9. Damaged unit module	1. Seek technical support. 2. Check whether the optical fiber connections are correct. 3. Use a dust-free cloth to remove dust. 4. Check whether the optical fiber connectors are in good contact. 5. Replace the entire optical fiber. 6. Check whether the optical fiber's peripheral press-fit pieces are secure. 7. Seek technical support. 8. Remove the dust on the circuit board and the dust within the unit. 9. Seek technical support.
9	Unit's downlink communication fault		1. Abnormal main control board 2. The optical fiber signal	1. Seek technical support. 2. Check whether the optical fiber connections are correct.

			transmission and reception locations are incorrectly connected. 3. There is dust inside the optical fiber connector socket. 4. The optical fiber core is in poor contact with the external plug. 5. Optical fiber signal interruption 6. Detached optical fiber connector 7. Damaged optical fiber panel 8. Too much dust on the circuit board causes the unit module to have a false alarm fault. 9. Damaged unit module	3. Use a dust-free cloth to remove dust. 4. Check whether the optical fiber connectors are in good contact. 5. Replace the entire optical fiber. 6. Check whether the optical fiber's peripheral press-fit pieces are secure. 7. Seek technical support. 8. Remove the dust on the circuit board and the dust within the unit. 9. Seek technical support.
10	IO board's uplink communication fault		1. Abnormal main control board 2. The optical fiber signal transmission and reception locations are incorrectly connected. 3. There is dust inside the optical fiber connector socket. 4. The optical fiber core is in poor contact with the external plug. 5. Optical fiber signal interruption 6. Detached optical fiber connector 7. Damaged optical fiber panel	1. Seek technical support. 2. Check whether the optical fiber connections are correct. 3. Use a dust-free cloth to remove dust. 4. Check whether the optical fiber connectors are in good contact. 5. Replace the entire optical fiber. 6. Check whether the optical fiber's peripheral press-fit pieces are secure. 7. Seek technical support. 8. Remove the dust on the circuit board and the dust within the unit.

			8. Too much dust on the circuit board causes the unit module to have a false alarm fault.	
11	IO board's downlink communication fault		1. Abnormal main control board 2. The optical fiber signal transmission and reception locations are incorrectly connected. 3. There is dust inside the optical fiber connector socket. 4. The optical fiber core is in poor contact with the external plug. 5. Optical fiber signal interruption 6. Detached optical fiber connector 7. Damaged optical fiber panel 8. Too much dust on the circuit board causes the unit module to have a false alarm fault.	1. Seek technical support. 2. Check whether the optical fiber connections are correct. 3. Use a dust-free cloth to remove dust. 4. Check whether the optical fiber connectors are in good contact. 5. Replace the entire optical fiber. 6. Check whether the optical fiber's peripheral press-fit pieces are secure. 7. Seek technical support. 8. Remove the dust on the circuit board and the dust within the unit.
12	Parameter setting error		The upper and lower limits of the parameters are incorrectly set Inconsistent system parameter readings	1. Check whether the parameter settings are correct. 2. Resupply the control electricity.
13	Left bridge overtemperature fault	115°C	1. The fan at the top of the cabinet is not working. 2. The filter screen is clogged. 3. Damaged thermistor 4. Long-time overload 5. The ambient temperature is	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether the filter screen is clogged. 3. Seek technical support.

			too high.	4. Check whether the motor runs with overload; if so, reduce its load and observe its running. 5. Control the ambient temperature and improve the air conditioner's cooling effect.
14	Right bridge overtemperature fault	115°C	1. The fan at the top of the cabinet is not working. 2. The filter screen is clogged. 3. Damaged thermistor 4. Long-time overload 5. The ambient temperature is too high.	1. Check whether the fan's power circuit breaker, contactor, and thermal relay work normally. 2. Check whether the filter screen is clogged. 3. Seek technical support. 4. Check whether the motor runs with overload; if so, reduce its load and observe its running. 5. Control the ambient temperature and improve the air conditioner's cooling effect.
15	Unit undervoltage fault	520V	1. The input power supply's actual voltage is lower than its rated voltage. 2. The secondary winding of the transformer is damaged.	1. Check whether the grid voltage is within the allowed range. 2. Check whether the secondary winding of the transformer is well connected.
16	Unit overvoltage fault	1230V	1. Too quick deceleration 2. The input power supply's actual voltage exceeds its rated voltage. 3: Output current oscillation 4. The Hall sensor works abnormally. 5. The motor's reactive power is too high. 6. Unbalanced load outputs in	1. Extend the deceleration time and adjust the overexcitation gain coefficient. 2. Check whether the grid voltage is within the allowed range. 3. Adjust the speed ratio coefficient. 4. Check whether the Hall device is intact and is correctly connected. 5. Seek technical support.

			case of dual-machine linkage	
17	Left bridge upper tube fault		1. Sudden load change 2. The VFD output ground wire is not removed. 3. Damaged motor insulation 4. Load-incurred motor stall 5. The electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are not up to standard. 6. The VFD cabinet is not grounded as required. 7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	1. Identify the cause of the sudden load change and eliminate the fault. 2. Check whether the VFD's output wires are properly connected. 3. Determine through measurement whether the motor insulation is within the allowed range. 4. Replace the motor or eliminate the mechanical fault. 5. Check whether the electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are within the allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
18	Left bridge lower pipe fault		1. Sudden load change 2. The VFD output ground wire is not removed. 3. Damaged motor insulation 4. Load-incurred motor stall 5. The electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are not up to standard. 6. The VFD cabinet is not grounded as required.	1. Identify the cause of the sudden load change and eliminate the fault. 2. Check whether the VFD's output wires are properly connected. 3. Determine through measurement whether the motor insulation is within the allowed range. 4. Replace the motor or eliminate the mechanical fault. 5. Check whether the electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are within the

			7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
19	Right bridge upper tube fault		1. Sudden load change 2. The VFD output ground wire is not removed. 3. Damaged motor insulation 4. Load-incurred motor stall 5. The electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are not up to standard. 6. The VFD cabinet is not grounded as required. 7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	1. Identify the cause of the sudden load change and eliminate the fault. 2. Check whether the VFD's output wires are properly connected. 3. Determine through measurement whether the motor insulation is within the allowed range. 4. Replace the motor or eliminate the mechanical fault. 5. Check whether the electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are within the allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
20	Right bridge lower tube fault		1. Sudden load change 2. The VFD output ground wire is not removed. 3. Damaged motor insulation 4. Load-incurred motor stall 5. The electrical distances between the terminals on the secondary side of the	1. Identify the cause of the sudden load change and eliminate the fault. 2. Check whether the VFD's output wires are properly connected. 3. Determine through measurement whether the motor insulation is within the allowed range. 4. Replace the motor or eliminate the

			transformer and the adjacent terminals are not up to standard. 6. The VFD cabinet is not grounded as required. 7. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	mechanical fault. 5. Check whether the electrical distances between the terminals on the secondary side of the transformer and the adjacent terminals are within the allowable range. 6. Check whether the ground resistance of the VFD cabinet is not greater than 0.1Ω. 7. Remove the dust on the circuit board and the dust within the unit.
21	3.3V power supply undervoltage fault	2.7V	1. Damaged unit control board 2. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	1. Seek technical support. 2. Remove the dust on the circuit board and the dust within the unit.
22	15V power supply undervoltage fault	12.8V	1. Damaged unit control board 2. Too much dust accumulation on the circuit board causes the unit module to have a false alarm fault.	1. Seek technical support. 2. Remove the dust on the circuit board and the dust within the unit.
23	IO board power supply fault		1. Power supply terminals in poor contact 2. The power cord is damaged. 3. Damaged IO board	1. Check whether the power cord is in good contact. 2. Replace the power cord. 3. Seek technical support.
24	Medium-voltage power loss fault		1. The function of quick break upon medium-voltage power loss is enabled. 2. The medium-voltage power-down time is longer than the shielding delay time upon power loss.	1. Identify the cause of the medium-voltage trip-out, eliminate the fault, and reset the system. 2. Seek technical support.
25	Excitation fault		1. The power supply for	1. Check the power supply for

			excitation is faulty.	excitation.

8.4 Power Unit Replacement

The power unit modules in the unit cabinet have the same model number and outside dimensions. It is confirmed that, in case of the VFD's failure to work normally due to some unit's fault, a spare unit can be substituted when the faulty unit can be taken out of service. In case of a unit replacement, contact VEDA-IN DRIVES to have the faulty unit module repaired. The power unit module replacement shall follow the following procedure:

- Shut down the system and make the VFD quit running.
- Cut off the medium-voltage power supply, isolate the VFD from the medium-voltage cabinet trolley (when there is a bypass cabinet, the VFD can be isolated using the isolating knife switch of the bypass cabinet), lock the local or remote medium-voltage break switch, and ground the medium-voltage cabinet's grounding knife switch;
- Open the unit cabinet door and wait for the lights of all the units to go out;
- Unplug the TX and RX optical fiber connectors of the faulty unit;
- Remove the R, S, and T input power wires and L1 and L2 output connection copper bars of the faulty unit;
- Remove the fixing screws holding the faulty unit and the track together;
- Pull out the faulty unit along the track (handle with care);
- Place the optical fiber socket plug of the new unit onto the replaced unit;
- Install and wire the spare unit in the order opposite to the above removal order;
- Power up the system again to get it up and running.

Chapter 9 Routine Maintenance

9.1 Routine Inspection

Item	Inspection contents	Means of inspection	Criteria
Operating environment	Temperature	Thermometer	-10~+40°C Derate the VFD between 40~50°C. Its rated output current is reduced by 1% per 1°C temperature rise.
	Humidity	Hygrometer	5%~95%, w/o condensation
	Dust, oil stains, water, and drips	Visual inspection	There are no dirt, oil stains, or water leakage marks.
	Vibration	Dedicated tester	0.15 mm/9-58 Hz; 03m/s2
	Gas	Dedicated tester, sniff, and visual check	Neither odor nor abnormal smoke
VFDs	Temperature	Dedicated tester	Normal outlet temperature
	Sound	Dedicated tester and hearing	No abnormal sound
	Gas	Sniff and visual check	Neither odor nor abnormal smoke
	Appearance	Visual check	Intact appearance
	Cooling air duct	Visual check	There are no obstructions (dirt, lint, etc.) in the air duct.
	Input current	Ammeter	The input current is within the normal working current range (refer to the nameplate)
	Input voltage	Voltmeter	The input current is within the normal working current range (refer to the nameplate)
	Output current	Ammeter	The output current is within the rated current range; short-time overloads are allowed.
	Output voltage	Voltmeter	The output voltage is within the rated voltage range.
Motor	Temperature	Dedicated tester and sniff	Neither abnormal high temperature

			nor smell of burning
	Sound	Hearing	No abnormal sound
	Vibration	Dedicated tester	No abnormal vibrations

9.2 Regular Maintenance

Please regularly maintain the VFD according to the following table at intervals of 3~6 months, depending on its usage.

Item	Inspection contents	Testing means	Criteria
VFDs	Terminals of main circuit	Screwdriver/socket wrench	Tightened screws and intact cables
	PE terminal	Screwdriver/socket wrench	Tightened screws and intact cables
	Terminals of control circuit	Screwdriver	Tightened screws and intact cables
	Internal cables and connectors	Screwdriver/hand	Securely connected
	Fixing screws	Screwdriver/socket wrench	Tightened screws
	Dust removal	Vacuum cleaner	There are no dust, lint, etc.
	Internal foreign matter	Visual check	No foreign matter
Motor	Insulation test	2500 V megohmmeter	No anomaly

Caution!

- It is recommended that the VFD should be maintained and cleaned at intervals of 3 to 6 months. If there is a lot of dust, the filter screen should be cleaned regularly and replaced at intervals of one week.
- It is recommended that all the incoming and outgoing cables of the VFD, all the incoming and outgoing cables of all the power units, and all the control cables should be tightened once within the first month after putting the VFD into operation and tightened at intervals of 3 to 6 months later and that the dust inside the cabinet should be removed with a vacuum cleaner.
- Record the running status of the VFD (see Table 8-2). When a fault trip-out occurs, record the information about the fault, identify its cause, eliminate the fault, and power up the VFD again.

Time of recording	Indoor temperature	Transformer temperature	Unit cabinet temperature	Running frequency	Output current	Output voltage	Fault records and overview

9.3 Maintenance of Standby VFD and Unit Modules

- Ensure that the TX and RX optical fiber socket plugs of each spare unit are inserted in place to prevent dust pollution.
- Regularly (generally 6 months) power up the standby unit modules.
- The spare VFD, which needs to be stored for a long time, should be subjected to a power-up test (at least one hour) at intervals of 6 months. During each power-up test, a voltage regulator should be used to slowly boost the voltage to the rated value.

9.4 Precautions for Use of UPS Battery (Optional)

This VFD employs a sealed maintenance-free lead-acid battery. Normally, the battery can be used for three years. However, the service life of the battery varies with its storage and working environments and how often it is discharged. The following precautions should be taken.

1. Even if the battery is not used, its performance will gradually degrade. If the battery is not used for a long time, it is recommended that the battery should be charged at intervals of four to six months; during normal use, the battery should be discharged and charged at intervals of four to six months. The discharge and charge procedure is as follows: Disconnect the battery at the mains, discharge it completely, power down the VFD, connect it at the mains, and charge it for 16 hours or more.

2. If the temperature is too high or too low, the service life or performance of the battery will be affected. The normal working temperature range of the UPS is 0~40°. If the temperature is too low, the discharge of the battery will be affected; if the temperature is too high, the service life of the battery will be reduced.

3. If the battery is discharged too often, its service life will be affected; this product is designed to ensure

that the load can continue to work for a short period of time in the event of a sudden power failure. In case of frequent discharging, its service life may be reduced to 0.5 to 1 year.

4. If this product is used to ensure that electricity is available to an important machine, it is recommended that the effectiveness of the battery should be regularly checked to prevent any accident.

Chapter 10 Instructions for Use of Dry-type Transformer

Overview:

The contents of this chapter cover the installation, use, and maintenance of the Class H dry-type transformer. Be sure to read the complete instruction manual before installing, commissioning, and using the transformer.

10.1 Instructions for Installation and Use of Class H Dry-type Transformer

10.1.1 Purpose

The supporting Class H dry-type VVVF rectifier transformers currently provided by VEDA-IN DRIVES are ZTSFG (H) transformers, which feature an open-type (VPI) structure, the heat-resistant class of H, and the voltage level of 35kV or below, and are widely used in VVVF drives in waterworks, power plants, metallurgical plants, and petrochemical plants.

10.1.2 Normal Operation Conditions

- Installed in a cabinet for indoor use;
- The elevation shall not be higher than 1000m;
- Ambient temperatures:

Maximum temperature	+40°C
Maximum daily average temperature	+30°C
Maximum yearly average temperature	+20°C
Minimum air temperature	-5°C (for indoor transformers)

- In its working environment, there shall not be any harmful gas or dust that corrodes and destroys its insulation. Do not expose it to water, rain, or snow;
- The power supply voltage waveform is similar to a sinusoidal wave, and the voltage of the power supply connected to the multi-phase transformer should be approximately symmetrical;
- The surface of the ventilation window on the protective housing shall be kept more than 1m away from the occluding object to ensure good ventilation;

10.1.3 Transport and Storage

- The Class H dry-type VVVF rectifier transformer should have rainproof and moisture-proof measures during transportation. The documentation (product certificate, etc.) shall be properly packaged to be protected against moisture;
- The transformer should not be subjected to any strong shock or vibration during loading, unloading, and transportation;
- After the transformer arrives at the site, it is necessary to timely conduct appearance inspection: whether there is any mechanical damage, whether there are complete accessories, whether the documentation are moist, and whether the rainproof and moisture-proof measures are intact.
- After the transformer arrives at the site, it should be timely installed in place. Otherwise, it should be stored in the room, and effective rainproof and moisture-proof measures should be taken.

10.1.4 General Inspection before Installation

- After its long-distance transportation and storage, the user must conduct a comprehensive visual inspection. Check whether there is any foreign body in all parts of the transformer (in the air channel between the iron core and the coil and in the air channel between the coil and the air duct), and if so, remove them. Check whether there is any loose fastener. After the inspection, remove the accumulated dust with dry compressed air and tighten the loose fasteners.
- Iron core inspection

The iron core should not be deformed and the insulation between the iron yoke and the clamp should be in good condition;

The iron core should not be grounded at multiple points;

If necessary, further open the clamp and the iron yoke grounding plate, use a 2500V megohmmeter to measure the insulation resistance of the iron core to the ground (≥ 5MΩ) and the insulation resistances between the core screw and the iron core/clamp (≥ 100MΩ);

- Winding inspection

The winding insulation layers should be intact, free from breakage, dislocation, and deformation;

The windings should be arranged neatly with even spacings;

The upper and lower yoke cushion blocks of the windings should be in the tightened state, and the clamp nuts should be in the tightened state;

- The outgoing wire insulations should be firmly wrapped and free of any damage, displacement, breakage, or bending; the outgoing wires should be firmly fixed, their fixing brackets should be in the tightened state, and the outgoing wire insulation supports should be intact;
- The connections between the taps of the non-excitation voltage-regulating terminal board or device and the coil should be correct and firm. The connection points or rotating connection points should stay in place as indicated by the sign or indicator;
- Before the transformer is connected to any external apparatus, a 2500V megohmmeter should be used to measure the insulation resistance of the coil to ground. If the insulation resistance is lower than the minimum allowable insulation resistance value on site listed in the following table, a corresponding measure listed in the appendix can be taken to dry the coil.

<table>
<tr><td colspan="2">Coil voltage level (kV)</td><td colspan="4">0.4</td><td colspan="2">3.0</td><td colspan="3">6.0</td><td colspan="3">10</td><td colspan="3">20</td></tr>
<tr><td rowspan="2">Predelivery test</td><td>Test conditions</td><td colspan="15">Temperature: room temperatures (10-40°C); relative humidity: < 85%</td></tr>
<tr><td>Insulation resistance (MΩ)</td><td colspan="4">≥ 50</td><td colspan="2">≥ 100</td><td colspan="3">≥ 200</td><td colspan="3">≥ 300</td><td colspan="3">≥ 500</td></tr>
<tr><td rowspan="3">Field test</td><td>Relative humidity (%)</td><td colspan="15">≤ 85</td></tr>
<tr><td>Temperature (°C)</td><td>15</td><td>15</td><td>25</td><td>55</td><td>15</td><td>25</td><td>5</td><td>15</td><td>25</td><td>5</td><td>15</td><td>25</td><td>5</td><td>15</td><td>25</td></tr>
<tr><td>Insulation resistance (MΩ)</td><td>11.5</td><td>7.5</td><td>5.0</td><td>45</td><td>30</td><td>20</td><td>68</td><td>45</td><td>30</td><td>90</td><td>60</td><td>40</td><td>225</td><td>75</td><td>50</td></tr>
</table>

10.1.5 Installation of Class H Dry-type VVVF Rectifier Transformer and Its Accessories

10.1.5.1 The transformer is installed smoothly and the base foot bolts are tightened; if it has rollers, its rollers should fit with the track gauge, and after it is put in place, it should be fixed with the brake device.

10.1.5.2 Installation of fans (optional): install the fans according to the requirements given in the fan manual; the side-blown fans shall be distinguished from the top-blown fans. The fans are generally installed on the lower side of the transformer body (sometimes the fans are installed on the top of the housing so as to draw out the hot air through the top). They should be installed according to the best position drawing of the side-blowing or top-blowing fans. Their rotation directions should allow the hot air to flow smoothly through the core cooling duct, low-voltage coil duct, high-low-voltage coil duct, and medium-voltage coil duct. The connected power supply's voltage and number of phases should be consistent with the rated voltage and number of phases of the fans. The fans on the same transformer are connected to each other in parallel and then connected to the temperature controller. If the fans are high-capacity, an intermediate relay should be installed. After the initial installation of the fans, it is necessary to check whether the wirings are correct, whether their rotation directions are as indicated on the fan signs, whether the air passes through the corresponding cooling ducts, and whether the three phases are uniform. The insulation resistances of the fans shall not be less than 0.5MΩ. In order to prevent foreign bodies from falling into the spaces between the fan blades during installation, VEDA-IN DRIVES covered them with protective paper before the VFD left the factory. Please remove the protective paper after installation and commissioning and before being put into operation.

10.1.5.3 Temperature controller installation (if any): (note: when the transformer is running, it is necessary to ensure that the temperature controller power supply is normal; otherwise, the transformer may burn out!)

Install and debug the temperature controller strictly according to its operation manual. For the Class H transformer, three Φ11 heat shrinkable sleeves are fixed to the upper end of the high-low voltage coil duct. The sensor cable is installed in the wiring epoxy tube of the upper clamp, and the three pt100 platinum thermistors are inserted into the tube. The three-phase insertion depths should be the same (the insertion depth is customized according to the customer's requirements). Before installation and operation, it is necessary to confirm that the temperature probe is inserted to the stopper in the temperature control tube. The external wirings of the temperature controller need to correspond to the wiring identifications on the rear cover: control the fan start/stop, overtemperature alarm, overtemperature trip-out, and fault alarm. After the wirings are completed, the corresponding contact points need to be checked for action correctness when in the electrified state.

10.1.5.4 The wirings of the temperature controller and cooling fans (if any) should be in accordance with the installation requirements for low-voltage electrical devices.

10.1.5.5 Grounding: the transformer, its housing, fans, and temperature controller (if any) must be reliably grounded. The grounding resistance shall not be higher than 2Ω.

10.1.5.6 When the transformer operates with no load, it is recommended that the power supply input should be on the primary side. To use the 380V windings on the secondary side to supply power is not recommended; this may cause overheat damage to the 380V windings.

10.1.6 Acceptance Test and Trial Run of Class H Dry-type VVVF Rectifier Transformer

10.1.6.1 The acceptance test items and their requirements are given in the table below:

<table>
<tr><th colspan="2">Test item</th><th colspan="2">Scope of application</th><th colspan="6">Quality characteristic requirements and allowable deviations</th><th>Remarks</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">Winding DC resistance</td><td colspan="2" rowspan="2">Capacity (kVA)</td><td colspan="6">Unbalance rate</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Phase</td><td colspan="4">Line</td></tr>
<tr><td colspan="2">Distribution transformer ≤ 2500
Power transformer ≥ 630</td><td colspan="2">≤ 4%
≤ 2%
(lead from neutral point)</td><td colspan="4">≤ 2%
≤ 2%
(no lead from neutral point)</td></tr>
<tr><td colspan="2">Rectifier transformer, convertor transformer</td><td colspan="7">Not specified; factory-measured values and test temperatures are provided</td></tr>
<tr><td>2</td><td>Connection symbol</td><td colspan="2">All transformers</td><td colspan="7">Consistent with the information on the nameplate</td></tr>
<tr><td rowspan="2">3</td><td>Iron core grounding</td><td colspan="2">All transformers</td><td colspan="6">Must be grounded only at one point</td><td rowspan="2">10-40°C
Humidity ≤ 85%</td></tr>
<tr><td>Insulation resistance of iron core</td><td colspan="2">All transformers</td><td colspan="6">A 2500V megohmmeter shall last for at least 1 minute without any flashover or breakdown</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Insulation resistance (not lower than)</td><td colspan="2" rowspan="3">All transformers (Broken external connections)</td><td>kV</td><td>1</td><td>3</td><td>6</td><td>10</td><td>20</td><td rowspan="3">25°C
Humidity ≤ 85%</td></tr>
<tr><td rowspan="2">MΩ/ 2500V</td><td>5</td><td>20</td><td>30</td><td>40</td><td>50</td></tr>
<tr><td colspan="5">R2=R1×1.5(t1-t2)/10</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Transformation ratio</td><td colspan="2">Distribution transformer, power transformer</td><td colspan="6">Rated tapping ≤ ± 0.5% or ≤ measured impedance ± 10%</td><td></td></tr>
<tr><td rowspan="2">Rectifier transformer, convertor transformer</td><td>DC voltage < 250V</td><td colspan="6">Technical agreement</td><td rowspan="2">Or technical agreement</td></tr>
<tr><td>DC voltage > 250V</td><td colspan="6">Rated tapping ≤ ±1%</td></tr>
<tr><td>6</td><td>Inspection and test of voltage regulation switching device</td><td>Non-excitation voltage regulating</td><td>Terminal board type</td><td colspan="6">The settings are consistent with the information on the nameplate and the connections are reliable.</td><td></td></tr>
</table>

		transformer	Tap switch	Flexible rotation and settings consistent with the information on the sign						
7	AC withstand voltage (broken external connections and pulled-out temperature probe)	Distribution transformer, power transformer		Voltage level (kV)	≤ 1	3	6	10	15	No breakdown or flashover
				Withstand voltage (kV/1min)	2.6	8.5	17	24	32	
8	Phase check	All transformers		The primary side is consistent with the phase of the grid						
				The secondary side is consistent with the user's design requirements						

10.1.6.2 Checks before Trial Run

A comprehensive inspection should be carried out to confirm that the transformer meets the following commissioning conditions:

The transformer body, cooling devices, and all its accessories should have been installed without any defect;

There shall not be any metal or nonmetal foreign body left on the transformer body;

The tapping positions should meet the on-site grid voltage and operating requirements, and each tapping nut should be tightened and fastened with a locknut;

The transformer phase and wiring group type shall meet the operating requirements, and the wiring sequence shall be consistent with the phase sequence identification;

The connection of the grounding lead and its ground grid shall meet the design requirements, and its grounding shall be reliable;

The temperature measuring device shall have correct indication, and the settings shall meet the requirements (see 10.1.8.3);

The fans shall be correctly connected (see 10.1.6.2) and the trial run shall normal;

the transformer shall be accepted in terms of all the handover test items, the protection settings shall be in accordance with the requirements, and the operation and linkage test shall be correctly carried out.

10.1.6.3 Impact Closings under No-load Rated Voltage of Transformer

The magnitude of the excitation inrush current depends on the phase of the line voltage and the state of the core residual flux when the transformer is connected. It can be
10-12 times the rated current value, and its value decays after a few cycles or a few seconds, so the inrush current does not cause much harm to the transformer. However, if no measure is taken, it may cause the transformer to perform an overcurrent or differential protection misoperation. Therefore, attention should be paid to this when operating the transformer;

Disconnect the secondary side wiring and perform 5 impact closings at the rated voltage. Wait at least 10 minutes after the first electrification, and wait at intervals of 5 minutes later. The transformer should be free of abnormalities, and the excitation inrush current should not cause malfunctions of the protection devices.

10.1.6.4 Transformer Trial Run

When the five impact closings of the rectifier transformer are acceptable, make it operate with no load for 30 minutes. If its no-load operation is normal, gradually increase its load to the rating. Then, make it operate continuously for 24 hours. If its 24-hour continuous operation is normal, its trial run comes to an end; the transformer can be put into operation after acceptance check and handover in accordance with the relevant requirements.

10.1.7 Operation of Class H Dry-type VVVF Rectifier Transformer and Related Precautions

10.1.7.1 Regarding the operation of the transformer, please follow DL/T 572 *Operation Regulations for Power Transformers* and GB/T 17211 *Load Guidelines for Dry-type Power Transformers*;

10.1.7.2 Excitation Inrush Current at No-load Closing

The peak current ip should be converted to an effective value of the phase excitation inrush current

$I\Phi = \frac{0.6}{\sqrt{2}} ip(A)$.

10.1.7.3 The winding temperature rise limits for classes B, F, and H are as follows:

Temperature level	Class B	Class F	Class H
Maximum allowable temperature of insulation material (°C)	130	155	180
Winding temperature rise limit (K)	80	100	125

The coil temperature rises of the operating transformer under normal operating conditions should not exceed the corresponding limits in the table (resistance method). Since the pt thermistors of the transformer's temperature controller are inserted into the protective tube of the upper part of the air duct, the temperature shown is the temperature of the air duct. In general, it is lower than the actual temperature of the coil (about 40°C). The user should select appropriate set values for alarm and trip-out according to the specific environmental conditions and operating specifications. In addition, the user can also refer to the following table:

Temperature (°C) (air duct temperature)	Overtemperature alarm (°C)	Overtemperature trip (°C)
Class H	95	115

10.1.7.4 The transformer should be often checked during operation

- Check its sound and temperature during operation;
- Check whether there is any damaged or discolored coil, iron core, and seal and whether there is any dust accumulation or dirt;
- Check whether its components such as air-cooling devices, tapping switches, and temperature measuring device are working properly;
- Be sure to prevent water droplets from falling on the transformer and prevent the coils from being exposed to direct sunshine;
- Shift records on its operation shall be kept.

10.1.8 Regular Maintenance of Class H Dry-type VVVF Rectifier Transformer

10.1.8.1 For its regular maintenance, see DL/T 596 *Preventive Testing Procedure for Electric Power Equipment*;

10.1.8.2 The power supply to the transformer should be interrupted for the maintenance of the following items at intervals of half a year (severe operating conditions) or a year (normal operating conditions):

- Check that the coils, iron core, star sealing line, tapping terminals, and the fasteners of all parts are free of any damage, deformation, discoloration, looseness, overheating trace, or corrosion; if there is an abnormality, find out the cause and take necessary measures;
- Turn on the top fans, remove the dust on the transformer and inside the housing with dry compressed air, and

extract it out of the housing. The dust can also be wiped off with a dry cotton cloth. Do not use any volatile detergent;

- Remove the dust on the fans and their blades and check the grease on the bearings and replenish or replace the bearing grease if necessary;
- The no-load or on-load tapping switches can be checked and maintained in accordance with the provisions in the user manual;

10.1.8.3 After each check and maintenance work, the insulation resistances of the transformer must be tested, and the measured insulation resistances must not be lower than the values specified in section 5.6 of this manual. When the insulation resistance values meet the requirements, the transformer can be put into operation again;

10.1.8.4 There is a dust screen in the air inlet window of the transformer. The dust screen should be checked and cleaned regularly according to its operating environment. A sheet of A3 or a piece of newspaper is placed on the air inlet window at the air inlet. If the paper is strongly adsorbed on the air inlet window, it is acceptable. If it cannot be adsorbed or if its adsorption is weak, the dust screen is blocked. The cleaned dust screen should be installed after being dried. Each time the air inlet is checked, the air outlet of the fan on the top of the cabinet should also be checked to prevent its air outlet from being blocked. Otherwise, the hot air in the cabinet cannot be circulated, resulting in the transformer being unable to dissipate heat.

For the removal of the air inlet window, see the figure below:

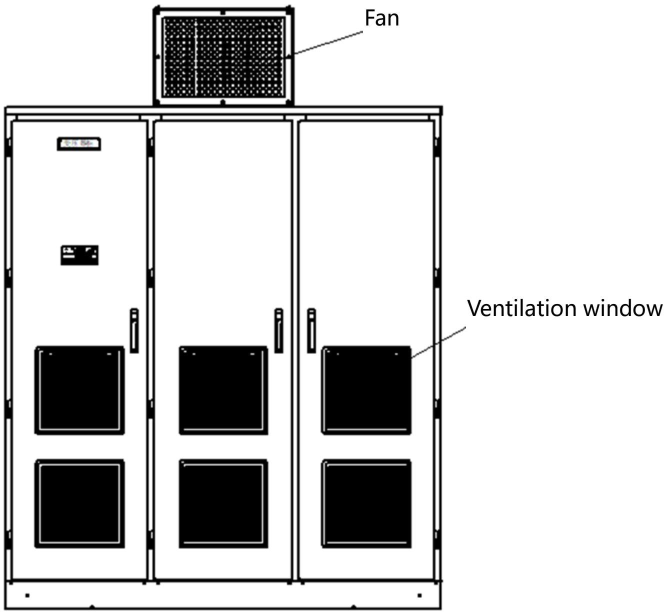


Fig. 10.1 Ventilation Window

10.1.9 Appendix

The appendix describes how to dry the moist Class H dry-type VVVF rectifier transformer.

10.1.9.1 Drying method selection: According to the insulation moisture situation and the on-site conditions, possible drying methods include infrared lamps, oven, hot air, and short circuiting. Their application procedures are respectively described as follows:

- Infrared lamps: high-power infrared lamps are used around and on the top of the transformer;
- Oven: if the transformer is a small-capacity Class H dry-type VVVF rectifier transformer, it is possible to hoist the transformer into an oven with the inside temperature not higher than 100°C; it is dried in the oven for 3~4 hours (the air is exhausted for 10 minutes at intervals of 50 minutes or so), and when the drying process is complete, the insulation resistance is measured after the transformer is naturally cooled;

- Hot air: According to the size of the rectifier transformer, a drying chamber is built with wallboards, the inside surfaces of which are covered with asbestos board or linen or asbestos cloth impregnated with a fireproof solution; The transformer is hoisted into it. Its distance from the periphery is not less than 200mm. It can be heated by an electric furnace or a serpentine steam tube. The hot air flow passing through the drying chamber is the volume of the drying chamber multiplied by 1.5 (m^3/min). The hot air with a temperature of no more than 100°C is blown upward from the bottom of the transformer body, and the moisture is discharged through the upper ventilation hole.

- Low-voltage winding short circuit: The low-voltage winding is short-circuited, and the medium-voltage winding is powered with voltage regulation starting with zero by a generator set or a coil-moving voltage regulator to keep the current of the medium-voltage winding equal to the rated current until the drying process is completed;

10.1.9.2 Temperature control during drying: during drying, platinum resistance thermometers must be installed at different parts of the transformer for monitoring. Ensure uniform heating (heating rate: 10-15°C/h). Especially for the windings, their temperatures shall not exceed the maximum allowable temperatures of their insulation levels. For a Class B transformer, the air duct temperature should not exceed 80°C; for a Class H transformer, the air duct temperature should not exceed 100°C. Measure the temperatures of the high- and low-voltage coils at different points at intervals of 30 minutes;

10.1.9.3 Judgment on drying termination: after the transformer drying process is completed and the transformer is naturally cooled to the normal temperature, the insulation resistance test is performed. The insulation resistance is measured every 1 hour. When there is no significant difference between three consecutive measured insulation resistance values, the insulation resistance value is regarded as in accordance with the factory test report and acceptable;

10.1.9.4 When the transformer is dried, fire safety measures should be taken in advance to prevent the heating system from failing or the windings from overheating and burning out the transformer;

10.1.9.5 After being dried, the transformer should be subjected to body inspection. All the electrical connection bolts and fasteners should be free of looseness, and the insulating surfaces should be free of abnormal conditions such as overheat.

10.2 Temperature Sensor Cable Assembly

10.2.1 D25 Sensor Cable (three-wire system)

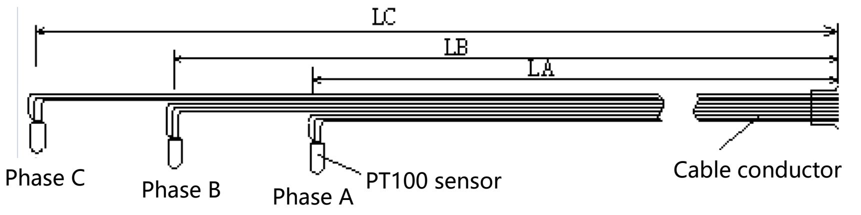


Fig. 10.2 Schematic Diagram for Three-way Cable Connection

10.2.2 Technical Parameters of Temperature Sensors

- Pt100 is a thermal resistor with good linearity in the range of -30.0°C ~ 240.0°C. It meets the Class B requirements of the standard of *Technical Specifications and R-T Table for Industrial Platinum Resistors* (GB/T 8622-97).
- Outside dimensions: Φ3mm×30mm or Φ4mm×40mm
- The resistance vs. temperature curve of the Pt100 platinum resistor is as follows:

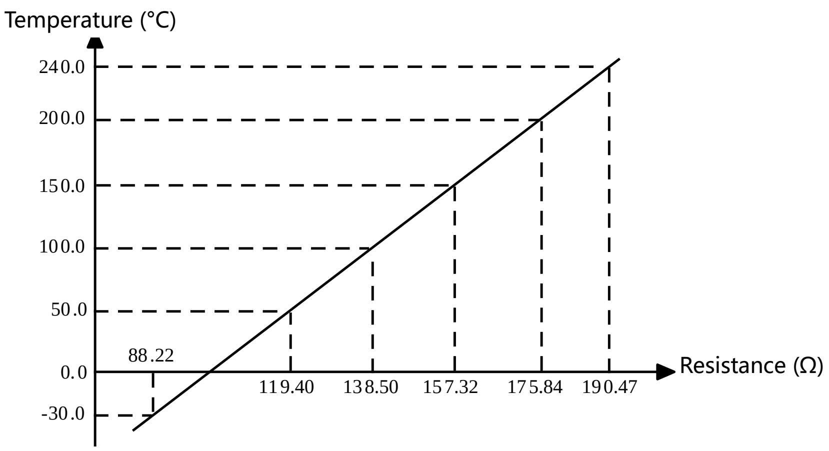


Fig. 10.3 Resistance vs. Temperature

Chapter 11 Modbus Communication Protocol

11.1 Basic Principles

The VEDA-IN MVD VFD has an RS485 communication interface and supports the Modbus communication protocol. With this protocol interface, the user can use the host computer to read or change the parameters of the VFD, view its working status and fault information, etc.; the centralized control of the industrial site can be achieved through controlling the VFD startup, shutdown, etc. with the VFD start, stop, etc. commands from the host computer.

Topographical structure: this is a system with one host and multiple slaves; the address of each slave is unique; the slave address range is 1-247; 0 is the broadcast communication address. Here, the master is a personal computer, a programmable logic controller (PLC), etc., and the slaves are VFDs. The master can communicate with a single slave or broadcast messages to all the slaves.

Interface mode: RS485 hardware interface.

Transmission mode: asynchronous serial half-duplex transmission mode; when the master or slave sends data, the other can only receive data at the same time.

Data and frame format: The VFD adopts the RTU mode, with the number of data bits of 8; parity check - even; stop bit - 1; possible baud rates (bps): 2400, 4800, 9600, 19200, and 38400. The RTU data frames adopt the CRC check mode. Each frame begins with a pause of at least 3.5 character time and ends with a pause of at least 3.5 character time behind the last transmitted character (CRC check bit). The information of a frame must be transmitted in the form of a continuous data stream. If there is a time interval of more than 1.5 characters before the end of the transmission of the entire frame, the receiving device considers the message frame incomplete and discards this message frame.

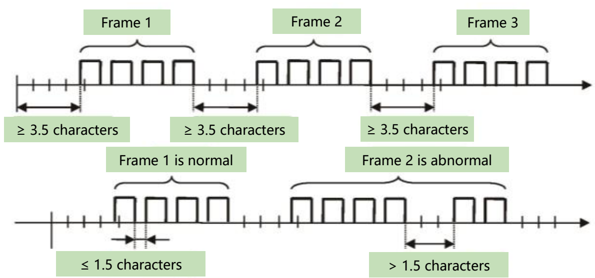


Fig. 11.1 Data and Frame Format

Standard structure of RTU frame:

Name	Description
Frame header (START)	T1-T2-T3-T4 (3.5-byte transfer time)
Address of slave (ADR)	Communication address: 0~247 (decimal; 0 is the broadcast address)
Functional domain (CMD)	03H: read slave parameters; 06H: issue slave commands; 10H: write slave parameters
Data domain DATA (N-1) Data (0)	2*N-byte data, which is the main content of the communication and the core of the data exchange in communication.
CRC low	Check value: CRC check value (16BIT)
CRC high	
Frame end (END)	T1-T2-T3-T4 (3.5-byte transfer time)

11.2 Structure of Data Packet

No.	Name	Number of bytes	Scope of Application	Remarks
1	Address code	1	1 ~ 247	Address of slave
2	Function Code	1	0x03, 0x06, 0x10, 0x04	03H, 06H, 10H, 04H
3	Data area	2*N	0x00~0xFF	Core elements of data exchange
4	Check code	2	0x00~0xFF	CRC check
Total		≤ 256		

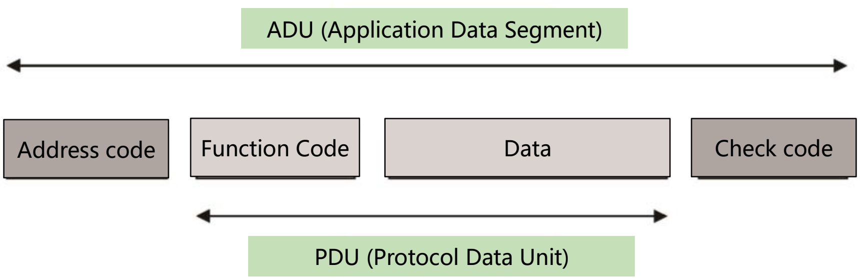


Fig. 11.2 Structure of Data Packet

11.3 Definitions of Function Codes

N	Data area	Function Code	Name	Description
1	Area 4	03H	Read from multiple holding registers	Read multiple register values of the slave
2		06H	Write into a single hold register	Set one register value of the slave
3		10h	Write into multiple holding registers	Set multiple register values for the slave
4	Area 3	04h	Read from multiple input registers	Read multiple register values of the slave

11.4 Common Function Codes and Answers

11.4.1 0x03 (read from multiple hold registers)

Host request packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x03
Start address high	1	0x00~0xFF
Start address low	1	0x00~0xFF
Number of registers high	1	N registers
Number of registers low	1	
CRC check low	1	Cyclic redundancy check
CRC check high	1	

Slave response packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x03
Number of bytes	1	2*N bytes

The start address corresponds to a high bit in the register data	1	First register
The start address corresponds to a low bit in the register data	1	
…	…	…
Register N corresponds to a high bit in the data	1	Register N
Register N corresponds to a low bit in the data	1	
CRC check low	1	Cyclic redundancy check
CRC check high	1	

* N = number of registers

Error response

Data contents	Number of bytes	Description
Function Code	1	0x83
Error code	1	01, 02, 03, or 04

Note to error codes:

01: Function code error

02: Start address or (start address + number of registers) error

03: Number of registers error

04: Read from multiple registers error

11.4.2 0x06 (write into a single hold register)

Host request packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x06
Register address high	1	0x00~0xFF

Register address low	1	0x00~0xFF
Register value high	1	0x00~0xFF
Register value low	1	0x00~0xFF
CRC check low	1	Cyclic redundancy check
CRC check high	1	

Slave response packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x06
Register address high	1	0x00~0xFF
Register address low	1	0x00~0xFF
Register value high	1	0x00~0xFF
Register value low	1	0x00~0xFF
CRC check low	1	Cyclic redundancy check
CRC check high	1	

Error response

Data contents	Number of bytes	Description
Function Code	1	0x86
Error code	1	01, 02, 03, or 04

Note to error codes:

01: Function code error

02: Register address error

03: Register value error

04: Write into single register error

11.4.3 0x10 (writing into multiple hold registers)

Slave response packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x10
Start address high	1	0x00~0xFF
Start address low	1	0x00~0xFF
Number of registers high	1	0x00
Number of registers low	1	0x01-0x7B (1~123)
Number of bytes	1	2×N
First register value high	1	0x00~0xFF
First register value low	1	0x00~0xFF
…	…	…
Rregister N value high	1	0x00~0xFF
Register N value low	1	0x00~0xFF
CRC check low	1	Cyclic redundancy check
CRC check high	1	

* N = number of registers

Slave response packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x10
Start address high	1	0x00 ~ 0x81
Start address low	1	0x00~0xFF
Number of registers high	1	0x00
Number of registers low	1	0x01-0x7B (1~123)
CRC check low	1	Cyclic redundancy check
CRC check high	1	

Error response

Data contents	Number of bytes	Description
Function Code	1	0x90
Error code	1	01, 02, 03, or 04

Note to error codes:

01: Function code error

02: Start address or (start address + number of registers) error

03: Number of registers or number of bytes error

04: Write into multiple registers error

11.4.4 0x04 (read from multiple input registers)

Host request packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x04
Start address high	1	0x00~0xFF
Start address low	1	0x00~0xFF
Number of registers high	1	N registers
Number of registers low	1	
CRC check low	1	Cyclic redundancy check
CRC check high	1	

Slave response packet

Data contents	Number of bytes	Description
Address of slave	1	1 ~ 247
Function Code	1	0x04
Number of bytes	1	2*N bytes
The start address corresponds to a high bit in the register data	1	First register
The start address corresponds to a low bit in the register data	1	
…	…	…
Register N corresponds to a high bit in the data	1	Register N
Register N corresponds to data low	1	
CRC check low	1	Cyclic redundancy check
CRC check high	1	

* N = number of registers

Error response

Data contents	Number of bytes	Description
Function Code	1	0x84
Error code	1	01, 02, 03, or 04

Note to error codes:

01: Function code error

02: Start address or (start address + number of registers) error

03: Number of registers error

04: Read from multiple registers error

11.5 CRC Check (16-bit)

CRC: Cyclic redundancy check

The CRC calculation steps are as follows:

XOR polynomial U = 0xA001

CRC register initial value V = 0xFFFF

V or the first byte (B0, an address code) is stored in V: V = V XOR B0

V shifted to right by one bit

5a) If the shift distance is 1, then V = V XOR U and return to step 6

5b) If the shifting distance is 0, return to step 6

6) Repeat steps 4 and 5 and complete 8 shifts

7) V or the next byte (B1, function code) is stored in V: V = V XOR B1

8) Repeat steps 4-7 until all the bytes in the packet are subjected to xor operation and 8 shifts are completed.

9) The register's V is the CRC check code appended to the end of the packet, with the low byte in the front and

the high byte in the back.

11.6 Definitions and Assignment of Address Codes

In order to facilitate the user's control and management of the VFD, its relevant parameters and operating status variables are open to the user. Through the host's control system, the user can view all parameters and operating status of the VFD. Through employing the host computer to send various function and address code messages, the user can control the operation of the VFD, obtain its status information, and set its related function parameters.

Address Code Allocation Table for VFD Control Parameters

ID	Name	Property	Holding register	DSP Address	Parameter Descriptions
1	Command word	R\W	00H	40001	0xbf - start; 0x79 - stop; 0xf0 - reset
2	Set frequency	R\W	01H	40002	Minimum frequency ~ maximum frequency (accuracy: 0.01Hz)
3	Reserved	R\W	02H	40003	-
4	Reserved	R\W	03H	40004	-
5	Reserved	R\W	04h	40005	-
6	Reserved	R\W	05H	40006	-
7	Reserved	R\W	06H	40007	-
8	Reserved	R\W	07H	40008	-
9	Reserved	R\W	08H	40009	-
10	Reserved	R\W	09H	40010	-
11	Reserved	R\W	0AH	40011	-
12	Reserved	R\W	0BH	40012	-
13	Reserved	R\W	0CH	40013	-
14	Reserved	R\W	0DH	40014	-
15	Reserved	R\W	0EH	40015	-
16	Reserved	R\W	0FH	40016	-
1	System status	R	00H	30001	Bit3-0 System status word: 0: System initialization 1. Main control board

						readiness 2: High voltage indication 3: Standby indication 4: Running indication 5: Fault indication
					Bit7-4	Startup control mode: 0: Speed control start 1: Speed tracking start 2: Torque control start 3: Rotor positioning test 4: Static parameter identification 5: Dynamic parameter identification
					Bit11-8	Running status: 0: Accelerated running 1: Constant speed running 2: Decelerated running 3: Forward frequency search 4: To be determined 5: Rotor positioning 6: Phase locking success 7: Simultaneous switching: upward switching 8: Simultaneous switching: downward switching 9: Static parameter identification 10: Dynamic parameter identification
					Bit13-12	Spare
					Bit14	Spare

					Bit15	High voltage ready
2	Running status	R	01H	30002	Bit0	Major system fault indication
					Bit1	Minor fault indication
					Bit15-2	Spare
3	Event log	R	02H	30003	Bit0	Execution of local start command
					Bit1	Execution of remote start command
					Bit2	Execution of start command from host
					Bit3	Execution of local stop command
					Bit4	Execution of remote stop command
					Bit5	Execution of stop command from host
					Bot6	Execution of start command
					Bit7	Execution of free stop command
					Bit8	Execution of deceleration stop
					Bit9	Emergency stop command
					Bit10	Major fault stop command
					Bit11	Execution of reset command
					Bit12	Local control mode
					Bit13	Host control mode
					Bit14	Remote control mode
					Bit15	High voltage ready state
4	Main control	R	03H	30004	Bit0	VFD overcurrent

	board fault words 1				Bit1	Motor overload
					Bit2	Unit fault
					Bit3	Medium-voltage power loss
					Bit4	System overspeed
					Bit5	Input phase loss
					Bot6	Output-to-ground short-circuiting
					Bit7	PG card fault
					Bit8	Master-slave communication fault
					Bit9	Bypass power supply fault
					Bit10	Bypass contactor fault
					Bit11	FPGA system anomaly
					Bit12	DSP system anomaly
					Bit15-13	Spare
5	Main control board fault words 2	R	04h	30005	Bit0	Major unit cabinet door fault
					Bit1	Major transformer cabinet door fault
					Bit2	Excitation fault
					Bit3	IO board's downlink communication fault
					Bit4	IO board power supply fault
					Bit5	Parameter setting error
					Bot6	Unit cabinet overtemperature trip-out
					Bit7	Transformer overtemperature trip-out
					Bit8	High voltage disabled in debugging

					Bit9	High voltage breaking (external fault)
					Bit10	IO board's uplink communication fault
					Bit11	Temperature measurement board communication fault
					Bit15-12	Spare
6	Main control board alarm words 1	R	05H	30006	Bit0	Motor overload
					Bit1	Load shedding alarm
					Bit2	Unit alarm
					Bit3	Unit bypass
					Bit4	Unbalanced three-phase output
					Bit5	Unbalanced three-phase input
					Bot6	Disconnected three-phase output
					Bit15-7	Spare
7	Main control board alarm words 2	R	06H	30007	Bit0	Analog feedback dropout
					Bit1	Analog setting dropout
					Bit2	Prompt for ventilation filter screen cleaning
					Bit3	Excessive excitation difference
					Bit4	Main control board failing to communicate
					Bit5	Fan power loss
					Bot6	Fan fault alarm
					Bit7	Unit cabinet temperature analog acquisition dropout
					Bit8	Minor unit cabinet door fault

					Bit9	Unit cabinet overtemperature alarm
					Bit10	Spare
					Bit11	Water leakage from transformer's heat exchanger
					Bit12	Transformer overtemperature alarm
					Bit13	Transformer cabinet open alarm
					Bit14	Water cooling fault
					Bit15	External emergency stop alarm
8	Input effective voltage value	R	07H	30008	1V	
9	Input effective current value	R	08H	30009	0.1A	
10	Input power	R	09H	30010	1kW	
11	Input power factor	R	0AH	30011	0.01	
12	Reserved	R	0BH	30012	-	
13	Reserved	R	0CH	30013	-	
14	Reserved	R	0DH	30014	-	
15	Reserved	R	0EH	30015	-	
16	Reserved	R	0FH	30016		
17	Running frequency	R	10h	30017	0.01Hz	
18	Output effective voltage value	R	11h	30018	1V	

19	Output effective voltage value	R	12H	30019	0.1A
20	Output power	R	13H	30020	1kW
21	Output power factor	R	14H	30021	0.01
22	Reserved	R	15H	30022	-
23	Reserved	R	16H	30023	-
24	Reserved	R	17H	30024	-
25	Reserved	R	18H	30025	-
26	Reserved	R	19H	30026	-
27	Reserved	R	1AH	30027	-
28	Reserved	R	1BH	30028	-
29	Reserved	R	1CH	30029	-
30	Reserved	R	1DH	30030	-
31	Reserved	R	1EH	30031	-
32	Reserved	R	1FH	30032	-