Instruction of this manual

This manual is shipped with inverter, and direct inverter's installation, working and maintenance. Without permission, users can not let contents of this manual out. Company will update the product and manual, there will be no future notice. The inverter is made by FGI Science And Technology Co., Ltd. If there is any technical and engineering problem, please contact FGI Science And Technology Co., Ltd.

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Chapter 1 Safety instruction

FD5000 series of intelligent high voltage inverter with dangerous high voltage and some of the parts will be in high temperature due to long running, directly touching is forbidden.

When you do the operation, maintenance and viewing, please obey this manual. Any incorrect operations may stop the inverter, do damage to it or professionals.

Do the installation, operation, maintenance and connection as the manual introduced, it will be safe.

1.1 The signs

	Danger: pay attention to it, it is dangerous.
	Caution: pay attention to it, incorrect operation may do damage to the inverter or yourself.

1.2 The safety rules

1.2.1 The requirements

 **Danger**
◆ Obey the rules. ◆ Only the person who has been trained is allowed to do the installation, operation, maintenance to the inverter.

1.2.2 The installation

 **Danger**
◆ The high voltage inverter should be installation on the retardant, such as metal bracket, cement floor. ◆ Any flammable materials are not allowed to lay in or near the inverter, such as the drawings and instructions, etc.

Cautions

- When removing, transporting or setting, it must be in the horizontal.
- The lifting machine must have the enough power and acts wildly. When lifting, please catch the transformer rings, the transformer cabinet rings are forbidden. If forklift is used, it must have the enough power, act wildly and set slowly.
- Any waste is not allowed to lay in the inverter.
- When the parts of inverter are damaged, please don't run again.
- Lay the fences with the danger signs, it can't be moved when it is running.

1.2.3 The wiring

Danger

- Connect the ground wires according to the rules of manual and national standards.
- wiring must be carried out by professional electricians.
- Do the connection by the professionals when the power is off.
- Do the connection according to the instruction, or it will damage the equipment.
- Assure the input power supply is in the demand of the index.
- The input and output wires are in the demand of the insulation and capacity

1.2.4 The operation

Danger

- Using optic fiber isolation technology, there is no high voltage among the cabinets, but only the trained and authorized person can operate.
- Obey the rules of high voltage operation procedures, such as holding with one hand, wearing insulated boots and insulated gloves, and with no less than one person care, when doing the operation for the switching cabinet /connection cabinet, phase-shifting transformer cabinet, power cabinet.
- Any operation for the switching cabinet/connection cabinet, phase-shifting transformer cabinet, power cabinet is forbidden when it is running.
- Don't touch the parts when the input voltage is on.

Caution

- Don't turn off the power of fan, or it will damage the inverter.
- Don't run or stop the inverter by way of turning on or off the input power supply.
- The rules of power on or off: firstly, connect the control power supply then the high voltage when starting; firstly, disconnect the high voltage then the control power supply when stopping.
- Users should monitor the state of the load at any times, stop the inverter when it is abnormal.
- Be ensure the system with good ventilation, keep the temperature is within the range of 0 ~ +40℃.

1.2.5 Maintenance and replacing

Danger

- Please do not touch any parts of the cabinet, if it is not sure the voltage and temperature is within the safe range.
- Wait for 10 minutes then do the maintenance, check or replace by the professionals.
- Check whether the ground resistance meets the equipment operation requirements and national standards all the time, if not may cause the danger.
- Keep the isolation knife brakes open, when doing the operation for the motors and fans. Do the safe measure when doing maintenance for the spare motor and load.

Caution
◆ Clean the dirty waste in the cabinet regularly if the wind cooling is used. ◆ Do the maintenance regularly, the vibration may cause the loose of electrical parts, it may cause the damage to the inverter. ◆ Do the maintenance regularly and write down the details.

1.2.6 The waste

Caution
◆ Deal with the waste according to the rules of industrial waste standard.

1.2.7 Others

Danger
◆ The inverter has the influence to the heart, set the caution sign before the entering doors.

The details of installation, commissioning, operation and maintenance of FD5000 series inverter will be trained for each relevant person. All the persons must obey the rules when do the work for the inverter.

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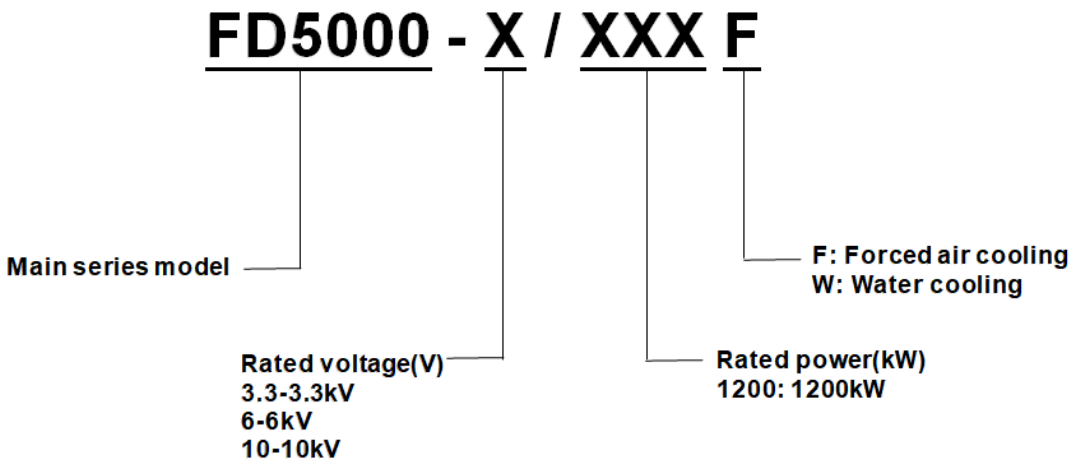
Chapter 2 Product description

2.1 Product model



For example: FD5000-6/2200F, the inverter rated votage is 6kV, and rated output power is 2000kW, forced air cooling.

2.2 The components and configuration

The structure of FD5000 series inverter is shown in below:

The overview of high voltage inverter

The configuration of FD5000 inverter is shown below:

Item	Number	Note
Transformer cabinet	1 set	Main body of MVD
Control cabinet	1 set	
Power cells cabinet	1 set	
Switch cabinet / Bypass cabinet (Manual or auto, optional)	1 set	
Connection wires	1 set	The internal wires
Technology files	1 set	User manual and drawings

Transformer cabinet:

Provide three-phase power supply for power cells, mainly includes phase-shift rectification transformer and its cabinet. Input power line enters inverter from this cabinet and output power line to motor also is led from here. Input and output power line applies both up and down incoming line.

Power cells cabinet:

Each phase with the series cells provides the voltage for the motor. As the critical part of system rectification and inverter, power unit is composed of rectifier bridge, energy storage capacitor and IGBT. Power unit at each level provides a level grade of output voltage. Change from low voltage to high voltage is realized by series connection output of multiple units.

Control cabinet:

The control master can deal with all kinds of data and has the DCS ports. System control parts are included in the control cabinet whose doors can be opened during operation. This part mainly includes: master control system formed by microprocessor (ARM) and site programmable logic gate array (FPGA), acquisition system of inverter status signal as well as low voltage power supply system composed of UPS and switch power supply.

Switch cabinet / bypass cabinet: This cabinet can achieve the function to switch the power supply of motor from MVD to grid power.

2.3 The functions of inverter

The FD5000 series high voltage inverter is high-high voltage device, which is controlled by DSP, with the SVPWM and cell in series multi-level technology to guarantee the inverter suits different industrial fields. The product was awarded as national key new products in 2003, high voltage hoister inverter was awarded as National Torch Project in 2005 and funded by Ministry of Science and Technology Innovation Fund for SMEs project. The FD5000 series high voltage inverter includes the phase shifting transformer, power cell and controller, the characteristics are:

- Easy to install, set and test
- SVPWM control technology
- Fast restart technology
- Carrier phase-shifting technology
- Flying start technology
- Star drifting technology
- Internal PID regulator
- Good performance and low price
- Keep running when the control power is off
- The good parameters setting function
- Module design, easy to maintain and replace
- The English interface, color LCD touch-screen
- Built in PLC interface board, easy to change the control logic relationship to suit the different fields
- Communications by fiber-optic between power circuit and the controller, strong, safe and reliable
- Perfect fault monitoring, accurate fault protection, accurate position display and alarm function
- High power factor and good output wave quality without input filters, power factor compensation device and output filter
- The high-high voltage device, the input is 6kV, 10kV, and the output are 6kV, 10kV, the

transformer and filter are not used

- Receive and output 4 ~ 20mA industrial standard signal to suit the users' DCS system interface
- Communicate with the host computer by MODBUS, PROFIBUS and other communication agreements
- The output is multi-level voltage without the filter device, and the current harmonics are small and with little damage to cables and motors so the vibration is low
- National key new products, National Torch Project, the technology is leading

2.4 Application fields

Power generation fields	Water given pump, Condensate pump, Circulating pump, Booster fan, Compressor, Induced draft fan, Vacuum fan
Petroleum fields	Air compressor, Induced draft fan, Injection pump, Submersible pump, Water circulating pump, Brine pump, Oil pump
Coal and Mine fields	Hoister, Axial fans, Cleaning pumps, Mixing pumps, Dust fan, Mud pump, Water pump, Feed pumps, drain pump
Metallurgy fields	Dust fan, Blast furnace blowers, Compressor fan, Oxygen Compressor, Feed pumps, SO2 fans, Cleaning pumps, Gas compressors
Cement, and building materials fields	Raw mill fan, Cement mill fans exhaust fan, Heat fan mill, Dust fan, Circulating fan, Pressure fan
Municipal areas	Pressure pump, Hot water circulation pumps, Sewage pumps, The water supply pump, Fan
Chemical industry	Pressure pump, Compressor, Pump, Soft water pump, Blower, Fan
Other fields	Air pump test stand, Wind tunnel test device

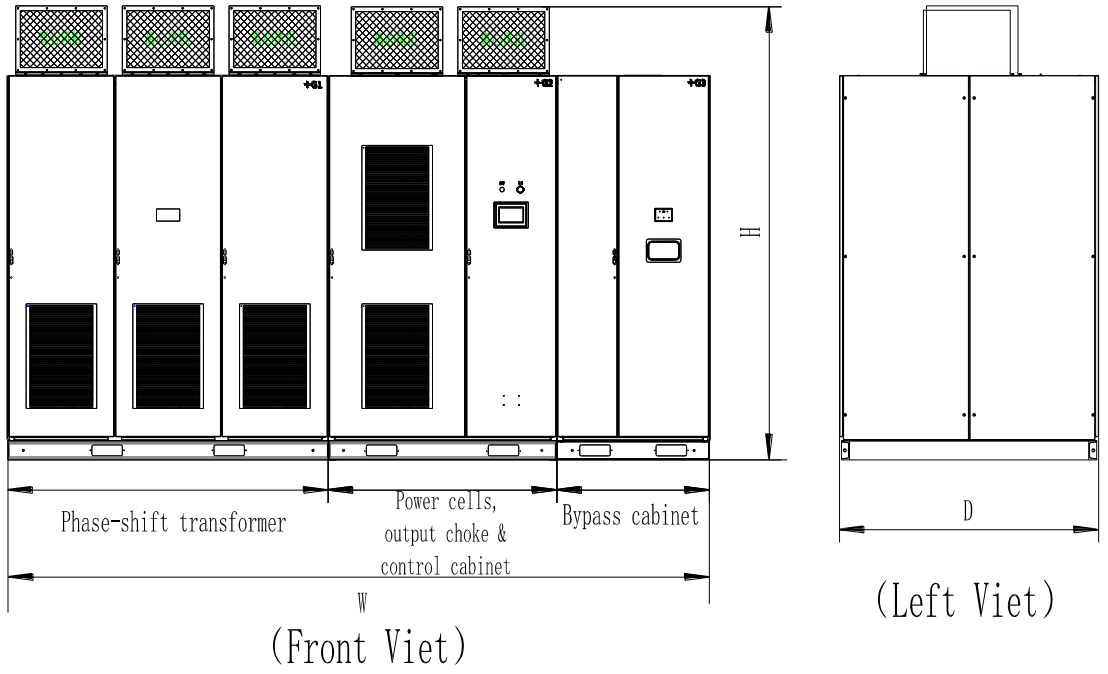
2.5 The standards

FD5000 series inverters meet the following standards.

Standard No.	Standard Name
Q/0830SFD001-2016	FD5000 Series AC Motor Variable Speed System Enterprise Standard
GB/T 1980-2005	Standard frequency
GB/T 156-2007	Standard voltage
GB/T 3797-2005	Electrical control devices
GB 4208-2013	Classification of protection level (IP level)
GB/T 4588.1-1996	Standard of without metal hole and Double-sided PCB
GB/T 4588.2-1996	Standard of with metal hole and Double-sided PCB
GB/T 9969-2008	Request for industrial products user manual
GB/T 10233-2005	Basic test methods for electrical drives control
GB/T 30843.1-2014	General-purpose inverter equipment of 1kV or more and not exceeding 35kV - Part 1: Technical conditions
GB/T 30843.2-2014	General-purpose inverter equipment of 1kV or more and not exceeding 35kV - Part 1: Testing method
GB/T 2900.1-2008	Electrical terms, basic terms
GB/T 2900.33-2004	Electrical terminology, power electrical technology
GB 3797-2005	Electrical controls equipment Part 2: Electrical devices equipped with electric control components.
GB/T 3859.1-2013	Semiconductor power converters Basic requirements
GB/T 3859.2-2013	Semiconductor power converters Application guidelines
GB/T 3859.3-2013	Semiconductor power converters Transformer and reactors

GB/T 13422-2013	Semiconductor power converters Electrical test method
GB 10233-2005	Basic test methods for electrical drives control
GB/T 15139-94	General technical requirements for electrical equipment
GB/T 14549-93	Power quality Public harmonic
IEEE Std 519-2014	Power system harmonic control
GB 3859.1-2013	Semiconductor power converters Basic requirements
GB/T 12668.3-2003	Adjustable electric drive systems - Part 3: Electromagnetic compatibility standards and specific test methods
GB/T 12668.4-2006	Speed electric drive systems The forth Part: General Standards AC variable speed electrical drive systems - Rating specifications from 1kV to 35kV

2.6 Product types and sizes



The outlook diagram and dimensions of FD5000 series inverters:

The models and sizes of FD5000 series device (switch cabinet or wiring cabinet omitted)

Model	Power level	Size and Weight			
		(W) Width (mm)	(D) Depth	(H) Height	(W) Width (mm)
FD5000-6/250F	250kW/6kV	1700	1500	1900	1900
FD5000-6/280F	280kW/6kV				2000
FD5000-6/315F	315kW/6kV				2070
FD5000-6/355F	355kW/6kV				2150
FD5000-6/400F	400kW/6kV				2210
FD5000-6/450F	450kW/6kV				2320
FD5000-6/500F	500kW/6kV				2410
FD5000-6/560F	560kW/6kV				2480
FD5000-6/630F	630kW/6kV	2100	1700	2120	3120
FD5000-6/710F	710kW/6kV				3250
FD5000-6/800F	800kW/6kV				3400
FD5000-6/1000F	1000kW/6kV				3560
FD5000-6/1120F	1120kW/6kV				3700
FD5000-6/1250F	1250kW/6kV	3300	1700	2420	4900
FD5000-6/1400F	1400kW/6kV				5500
FD5000-6/1600F	1600kW/6kV	3600	1700	2420	6800
FD5000-6/1800F	1800kW/6kV				7200
FD5000-6/2000F	2000kW/6kV				8100
FD5000-6/2250F	2250kW/6kV				9000
FD5000-6/2500F	2500kW/6kV				9400
FD5000-6/2800F	2800kW/6kV				9900
FD5000-6/3250F	3250kW/6kV	4600	1700	2420	11500
FD5000-6/4000F	4000kW/6kV	5900	1700	2420	12800
FD5000-6/4500F	4500kW/6kV	6500	1700	2420	14000

FD5000-6/5000F	5000kW/6kV	6500	1700	2620	15500
FD5000-6/5600F	5600kW/6kV				16000
FD5000-6/6300F	6300kW/6kV	7100	1700	2620	17200
FD5000-6/7100F	7100kW/6kV				17800
…	…	…	…	…	…

Model	Power level	Size and Weight			
		(W) Width (mm)	(D) Depth (mm)	(H) Height (mm)	Weight (kg)
FD5000-10/250F	250kW/10kV	2000	1500	1900	2160
FD5000-10/280F	280kW/10kV				2200
FD5000-10/315F	315kW/10kV				2240
FD5000-10/355F	355kW/10kV				2350
FD5000-10/400F	400kW/10kV				2390
FD5000-10/450F	450kW/10kV				2490
FD5000-10/500F	500kW/10kV				2560
FD5000-10/560F	560kW/10kV				2610
FD5000-10/630F	630kW/10kV				2720
FD5000-10/710F	710kW/10kV				2790
FD5000-10/800F	800kW/10kV				2860
FD5000-10/900F	900kW/10kV				2910
FD5000-10/1000F	1000kW/10kV				3100
FD5000-10/1120F	1120kW/10kV				4350
FD5000-10/1250F	1250kW/10kV				4430
FD5000-10/1400F	1400kW/10kV				4570

FD5000-10/1600F	1600kW/10kV	2800	1700	2120	4700
FD5000-10/1800F	1800kW/10kV				4880
FD5000-10/2000F	2000kW/10kV				4950
FD5000-10/2250F	2250kW/10kV	4100	1700	2420	7900
FD5000-10/2500F	2500kW/10kV				11000
FD5000-10/3250F	3250kW/10kV	4400	1700	2420	17300
FD5000-10/4000F	4000kW/10kV	4400	1700	2420	17300
FD5000-10/4500F	4500kW/10kV				22500
FD5000-10/5000F	5000kW/10kV	6200	1700	2620	25000
FD5000-10/5600F	5600kW/10kV				27300
FD5000-10/5900F	5900kW/10kV	8100	1700	2620	28400
FD5000-10/6800F	6800kW/10kV				29800
FD5000-10/8000F	8000kW/10kV	8300	1700	2820	31200
FD5000-10/9000F	9000kW/10kV				33300
FD5000-10/10000F	10000kW/10kV	9000	1700	2820	34500
FD5000-10/11000F	11000kW/10kV				36700
FD5000-10/12000F	12000kW/10kV				38300
…	…	…	…	…	…

Notes: We keep the rights to update the product. The size and weight of the product will be different according the demand of the users.

The size and feature of the product will be different after updated, there will be no future notice.

2.7 Technical specifications

Comprehensive technology parameters of FD5000 series MVD

Product series		Two quadrants	Four quadrants
power range		200kW-12000kW	200kW-2000kW
Rated output	Rated Power	The rated power when running at the rated voltage is 200kW-12000kW	The rated power when running at the rated voltage is 200kW-12000kW
	Rated current	The rated current when running at the rated voltage	The rated current when running at the rated voltage
	Overload	105% / continuing， 130% / 60s， 150% / 3s， 180% / turning off	150% / continuing， 180% / 60s, 250% / turning off
	Output voltage	0~3/3.3kV, 0-6/6.6kV, 0-10/11kV	0~3.3kV, 0-6/6.6kV, 0-10/11kV
	Output wave		A group of SPWM waves
Input voltage	Phase, Frequency, Voltage		3AC, 50/60Hz, 3/3.3kV, 6/6.6kV, 10/11kV
	Fluctuation range		Voltage: -10%~+10%； Frequency: ±5%； Continuous running at the low power of -15% ~ -35%
Basic features	Start frequency		The value can be set from 0 to 10Hz
	Precision		Analog setting: 0.3% of the highest frequency setting value (25 ±10^{0}C) Digital setting: 0.1% of the highest frequency setting value (-10~+50^{0}C)
	Resolution		Analog setting: 0.05% of the highest frequency setting value Digital setting: 0.01 Hz (less than 99.99Hz) , 0.1Hz (larger than100Hz)
	Efficiency		>98%，in rated condition
	Power factor		>0.95

Control features	The time of acceleration and deceleration	0.1~6000.0s, acceleration and deceleration time can be set separately
	The feature of voltage and frequency	Set by the V/F curve
	PID	Build-in standard PID function
	The other functions	V/F curve, Compensation for the low frequency, Rated current, The value of the protection current
	Isolation of high voltage	electromagnetic coupling and more optical fiber channels
	Control circuit power supply	1AC 220V 2kVA
Running	Operation modes	The local control, Remote control, and host computer control
	Frequency setting modes	Setting on touch screen, Multi-step speed setting, Analog signal setting (0-20mA)
	The running state	Instructions of relays, Fault, Alarm, Running or stop
	Touch screen display	Input/output voltage, Input/output current, setting value, Cells states, Running states, Transformer states, Cell bus
	Protection function	Over-current of the motor, Over-voltage of the inverter, Under-voltage of the inverter, Over-current of the cell, Over-voltage of the cell, Over-heat of the cell, Lack phase of cell, Communication failure.
Environment	Application fields	Indoor, Non-corrosive and conductive gas, dust, direct sunlight, the altitude below 1,000 meters (high altitude can be customized design)
	Temperature and humidity	-10℃~+40℃ /20~90%RH no condensation
	Vibration	5m/ s^2 (below 0.6g)
	Storage temperature	-20~+65℃ short time transportation allowed
Cooling method and protection level		forced air cooling /IP31

2.8 The transportation

The product can be transported by the truck, train, ship, etc. The product should be carefully handled, no rain, no strong sunlight, no severe vibration, no hit and upside down in the transportation. The temperature should be within the range of – 25℃ ~+65℃.

The maximum height of the inverter is 2900 mm, the total height is 2500 mm, so the height limit of transportation tools must be considered.

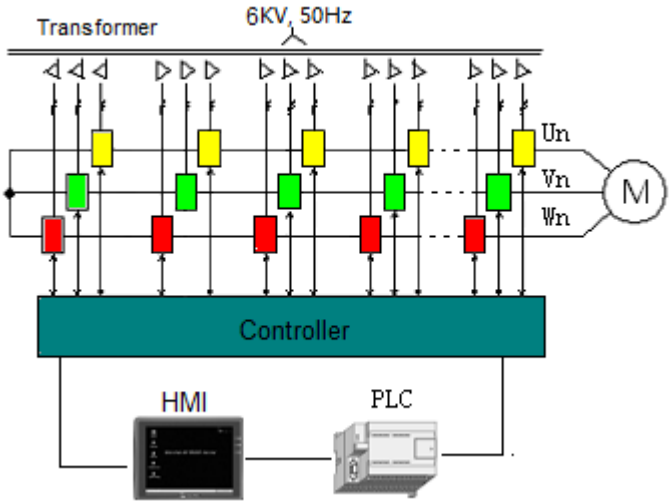
2.9 The storage

Products should be stored in the condition that air circulation, -20℃ to + 65℃, air relative humidity does not exceed 90% (equal to air temperature 20±5℃) and non corrosive gases in the storehouse, no rain and strong sunlight.

Chapter 3 System Principle

3.1 System structure

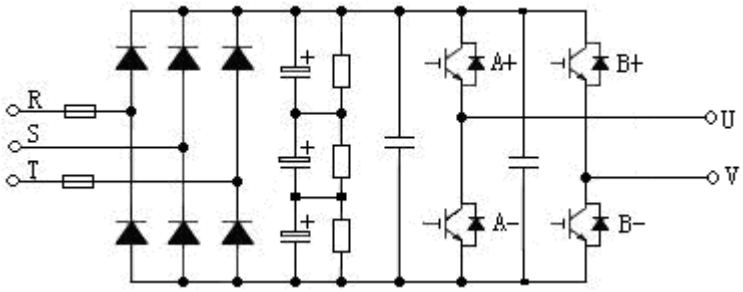
The structure of FD5000 series high voltage inverter is shown below, includes phase shifting transformer, power cells and controller. 3.3kV series inverter contains 3 cells each phase, 9 cells in total. 6/6.6kV series inverter contains 5/6 cells each phase, 15/18 cells in total. 10/11kV series inverter contains 8/9 cells each phase, 24/27 cells in total.



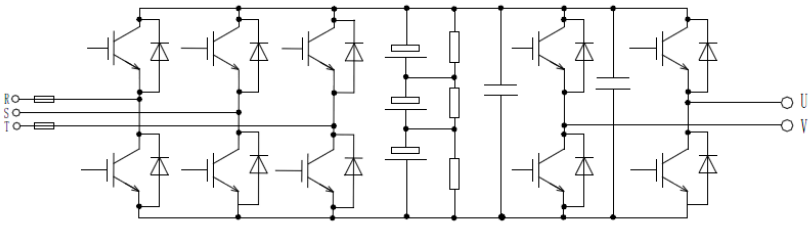
The structure of high voltage inverter

3.2 Power cell circuit

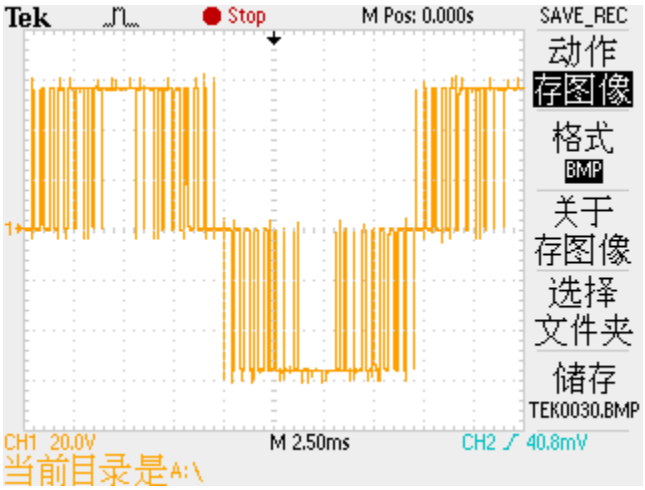
The structures of power cell are common, it is the AC - DC - AC single phase inverter circuit, rectifier diodes are for the three-phase full-wave, IGBT inverter bridge controlled by sinusoidal PWM technology. Each power cell is same, it is easy to commission, maintain and do the spare, if a failure occurs, the up bridges are on to achieve the bypass and the output of the inverter is decelerating.



The power cell structure of two-quadrant high voltage inverter



The power cell structure of four-quadrant high voltage inverter



The output PWM waves of the cell

3.3 The input side structure

The secondary winding of phase-shifting transformer (H-class insulation) is the input of power cell, each power cell is under full current, 1/3 (1/5) (1/8) of the phase voltage, 1/9 (1/15) (1/24) of the output power. 6 (15) (24) cells have their own input winding, so it is insulating. The extended triangular connection of secondary windings is to achieve the

multiplex and decelerate the harmonic of the input current. The 15 (24) secondary windings are divided into three phase groups.

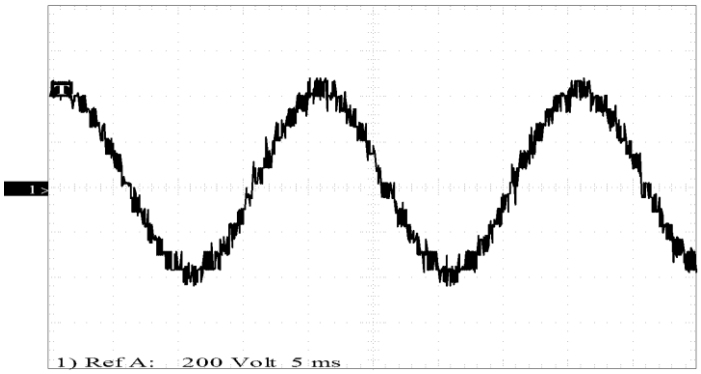
The number of power cells will vary according to power and voltage levels, and the larger level of power and voltage, the larger number of cells will be.

Secondary windings of phase shifting transformer are divided into three groups, 18 (30) (48) pulses rectifier is achieved, the harmonic of input current wave is decelerating and the value of load power factor is close to 1. The total harmonics value of input current is less than 5% by measurement.

The secondary windings of the transformer are insulating, so the main circuit of power cell is relatively independent, the structure is similar to the low-voltage inverter, mature technologies are adopted.

3.4 The output side structure

The output structure is shown in below figures, the output of the cell in series as the star mode connection to supply for the motor. The output wave of the inverter is shown in figure 3-5, it has low dv/dt, good sinusoidal quality, low damage to the wires and motor, so the output reactor is omitted and the motor can run at full load. The harmonic loss of the motor is small, the mechanical vibration is avoided, the mechanical stress of bearings and blade is decelerating.



The line voltage wave of 5cells in series

3.5 The controller

The controller is high-speed 32-bit DSP, the algorithm can guarantee the motor performance well. Provide friendly English monitoring and operation interface, and the

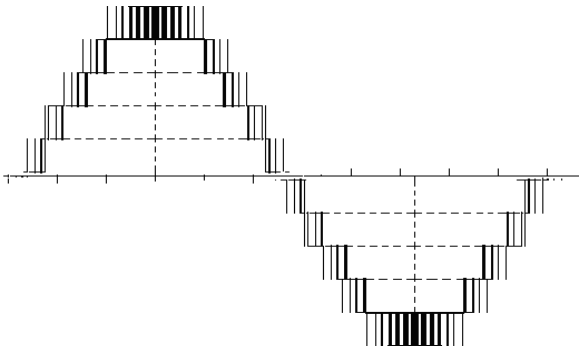
network control is realized. PLC controller is used for the signals processing of the cabinet, deals with all kinds of field signals and operation state signals, so the flexibility of the system is enhanced.

The high-speed 32-bit DSP, large scale integrated circuit and the surface welding technology are adopted, the system has the extremely high reliability.

Using multi channel optical fiber communication technology between the controller and power cells, the isolation is achieved, the system has high security and good anti-interference performance.

The third harmonic compensation technology is used to improve the DC bus voltage utilization and the modulation signal pre-distortion technology is used, so the voltage utilization rate is close to 1.

Using carrier phase shifting technology whose feature is the harmonic of output is decreasing when the fundamental wave of each cell is added. So, the total output waveform distortion in series is very small. The theoretical output waveform is shown in Figure 3-6 (which is the total output of 5cells).



The output PWM waveform of the inverter

Notes:

(1) The input current harmonics and the output current harmonics are the key indexes to the high voltage inverter.

These two indexes have been tested by the national authorities and reached the national standard GB / T 14549-93 and IEEE Std519-1992 international standards.

(2) A total of 17 detection by national authoritative departments are all qualifying in November 2002.

A total of 23 detection by national authoritative departments are all qualifying in November 2005.

(3) The national authorities: Tianjin power distribution and electronic control equipment inspection institute and the national quality supervision and Inspection Center for electric power distribution equipment.

Chapter 4 Settings of the parameters

4.1 Control modes

There are two kinds of control mode, one is the touch screen, the other is host computer.

4.2 HMI

Introduction of Home page related buttons:

Name of button	Functions
Control settings	The basic parameters，frequency and more advanced functions of inverter can be set here.
Parameters	The basic parameters of the inverter can be set here.
Real-time data	The curves and values of input voltage, input current, output voltage, output current, running frequency, given frequency, active power, feedback pressure can be seen here.
Historical data	The input current and voltage, frequency and feedback pressure can be seen here.
Fault records	The state of cell, fault code of the cell, the fault contents and time of the system can be seen here.
Running states	The page of monitoring inverter running parameters, inverter status and related cabinet status etc.

4.3 Featured functions of the high voltage inverter

4.3.1 PID regulator

PID regulator is used to adjust the parameters of the inverter. The proportional coefficient, integration time constant and differential time constant couldn’t be changed while the inverter is running. The parameters of PID regulator can be set in the specified position.

- Proportional coefficient

  The proportional coefficient is larger, the regulation speed of the system is faster. If it is too large, the system will overshoot and shock.

- Integration time constant

  The integration time constant is larger than zero, its unit is second. When the integration regulator is used as the reverse, it must be set as the reverse. The absolute value of coefficient is larger, the regulation speed of the system is slower.

- Derivation time constant

  Differential time constant can be positive or zero, it is always set positive. When the differential regulator is only used as the reverse, it must be set as the reverse. The coefficient absolute value is larger, the regulation speed of the system is faster. More details are shown in 4.4.3.

4.3.2 Function of speed tracking

The function of speed track is used in many industrial occasions to the start the rotating motor, such as:

(1) Motor whose rotational inertia is small. For example the fans whose rotational inertia is big, the slight wind may drive it. The inverter that has no this function may over current when it connects to the motor, until motor stops the link may be carried out, so it takes a lot of time.

(2) The occasion that two air fans are adopted to introduce air in one channel, the air fan which is switched off will be driven to rotate continuously by another rotating one and couldn't stop until both of the two fans stop.

(3) When the inverter driving many motors. The speed of motor will be detected, when from MVD to grid power or from grid power to variable frequency, so the function speed track will be used.

The key point of speed track is that the frequency of inverter must be same to the motor's. Firstly, the inverter detects the frequency of the motor; secondly, the output frequency of inverter is same to the motor, so over current and over voltage will be avoided.

4.3.3 Netural point shifting

When one cell of the inverter is in fault, the value of the voltage is low that may leads to the unbalance of the current. The function that netural point shifting will solve the problem.

The star drifting is to make the line voltage balance when one or more cells are in fault so the reliability of inverter increases.

The functions that speed track and star drifting are meaningful to improve the performance of the inverter. More details are shown in 4.4.3.

4.3.4 Function of bypass cabinet

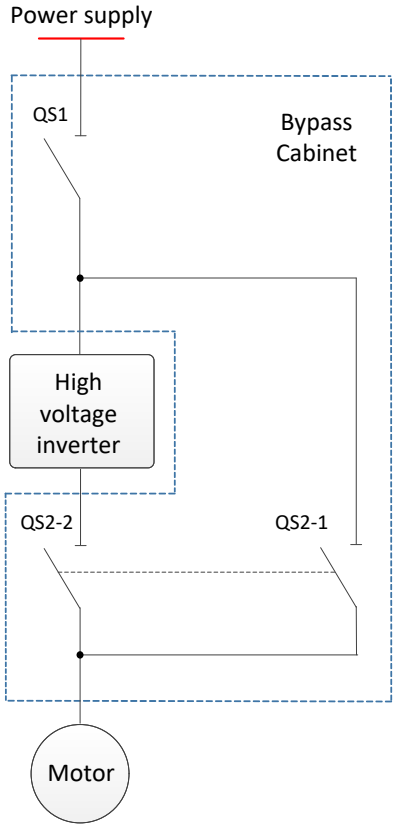
Switch(bypass) cabinet

- Manual bypass electrical diagram

  There are three isolated knife switchs of QS1, QS2-2, QS2-1 in the bypass cabinet. QS2-1 and QS2-2 are inter-locked.

  When QS1, QS2- 2 are closed, QS2-1 is open, the motor is powered by inverter.

  When QS1, QS2-1 are closeed, QS2-2 is open, the motor is running at grid power, under this condition, the inverter is disconnected with the grid power, it is easy to maintain when it is in fault.

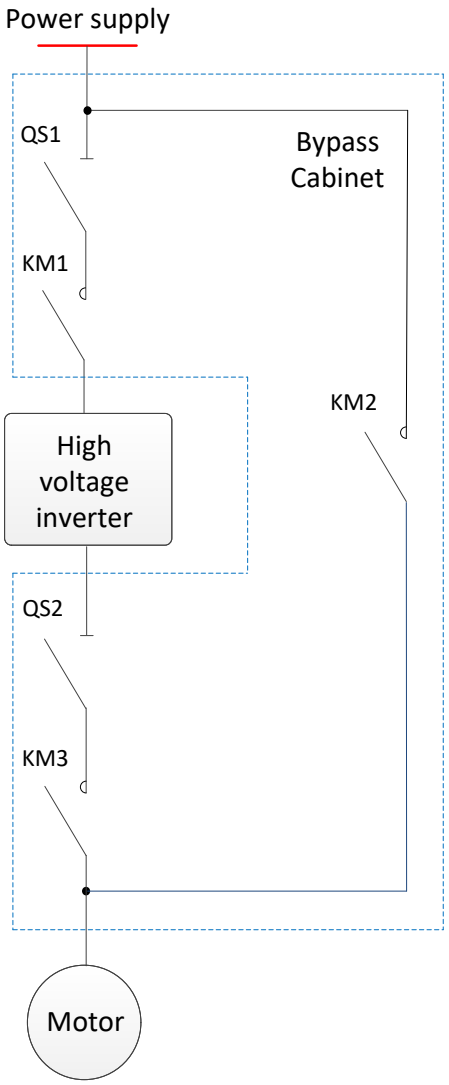


◆ Auto bypass (shown below)

KM1, KM2 and KM3 are contactor, and KM2 and KM3 are inter-locked.

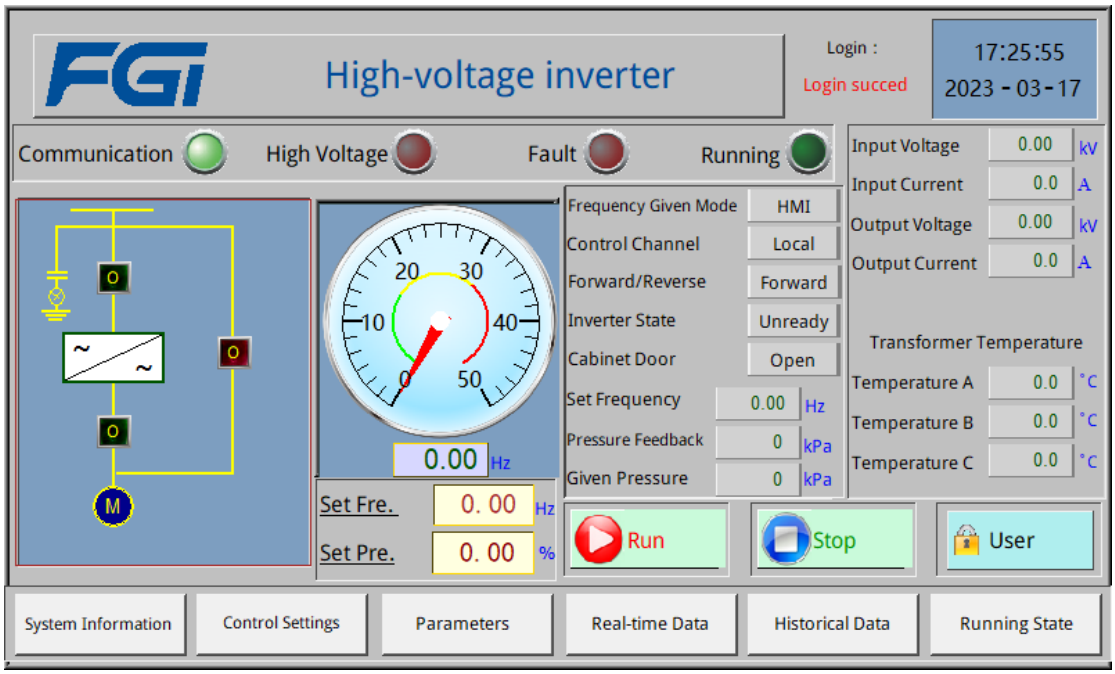
When the motor is required to be soft started by the inveter, and after starting, it need to be switched to the grid power supply, the automatic bypass cabinet can realize it.

The cabinet also has two isolated knife switches of QS1 and QS2, they are used to isolate the inverter from high-voltage power supply when the motor runs at grid power (KM3 close), it is convenient for system maintenance and inspection.


Power supply
QS1
Bypass
Cabinet
KM1
KM2
High
voltage
inverter
QS2
KM3
Motor

4.4 Operating on HMI

4.4.1 Home page of HMI



Running screen

Note: The main circuit at the left side may be different according to the system requirement, this figure is only for reference.

Status light

Items	State
Running indicator	While the inverter is running, the indicator light-on, While the inverter is stop, the indicator light-off.
Fault indicator	When the inverter is in fault, the indicator light-o, otherwise it is off.
High voltage indicator	When the high voltage is on, the indicator light-on, otherwise it is off.
Communication indicator	When the Main Control Box communicates with HMI, the light will flash, otherwise it will not flash.

Operation button

Item	Function
Run	After selecting the start/stop channel as “HMI”, when the high voltage is on, press the ‘Run’ button, the inverter will start.
Stop	After selecting the start/stop channel as “HMI”, when the inverter is running, press the ‘Stop’ button, the inverter will stop.

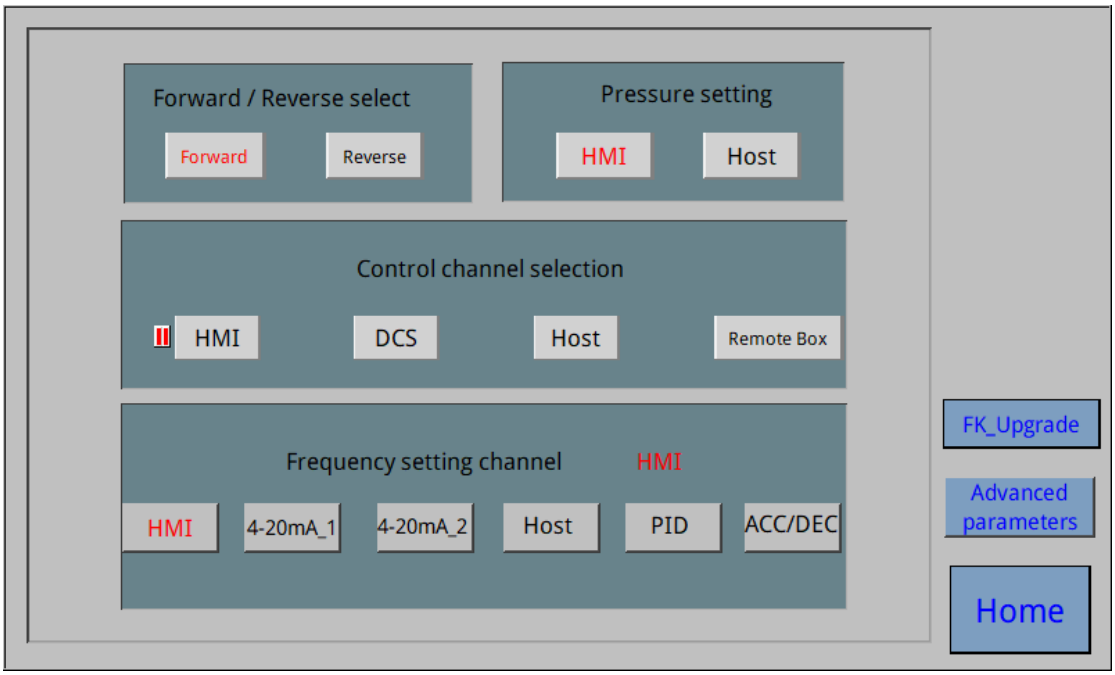
User	Control operator’s rights, for different operation grades.
System information	Display inverter information, touch screen information etc.
Control setting	Setting parameters, it is related inverter control function.
Parameter	Setting parameters, it is related inverter function.
Real-time data	Records running dates which include the inverter current, voltage, power and frequency.
Historical data	Records fault dates of inverter.
Running states	Display dates related inverter running states, which include cells, logic, specials dates etc.
Set frequency	After selecting the frequency setting channel as “HMI”, press the button of “set frequency”, to set the inverter’s running frequency.
Set Pre.	The setting of pressure is chosen by PID and setting of PID parameters is chosen on the HMI, click the ‘button’ set pressure, the inverter will work for it.

The display of inverter state

Item	**State**
Control modes	Three modes: internal control, external control (DCS and remote control box), host computer.
Frequency channels	Six modes: touch screen, acceleration and deceleration button, remote analog signal，Multi-step speed, host computer, close loop.
State of doors	Display doors open and close.
High voltage ready	Display high voltage is ready or not.
State of forward and reverse	Display inverter forward and reverse running

4.4.2 Control mode screen

Click the "control settings" button to enter the control parameter setting interface.

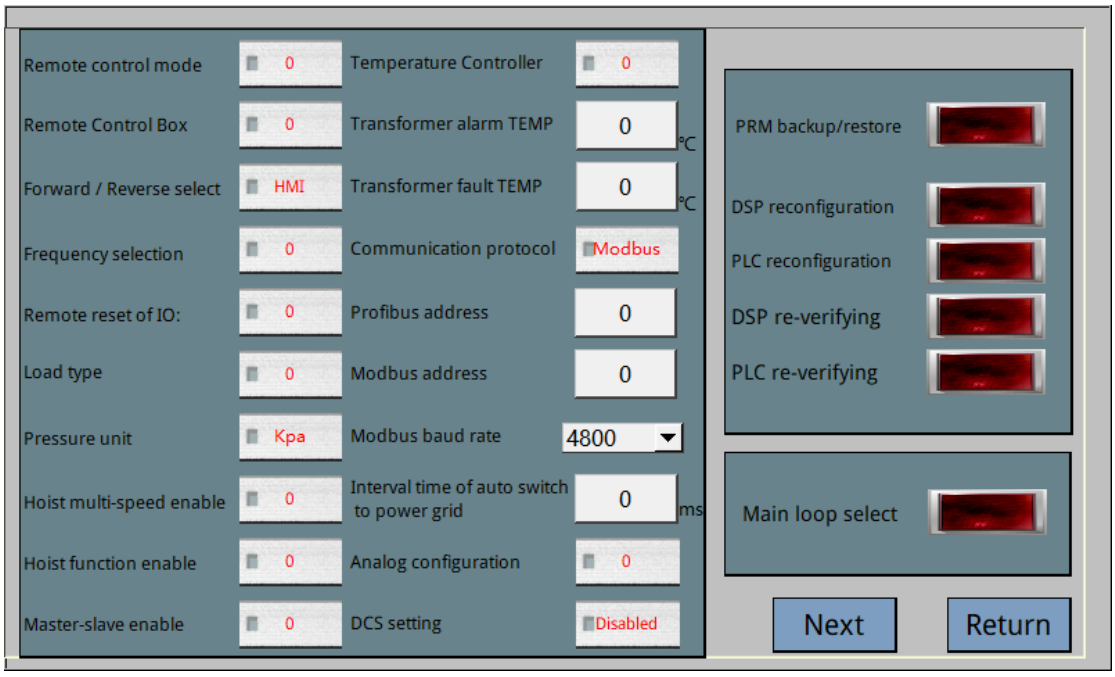


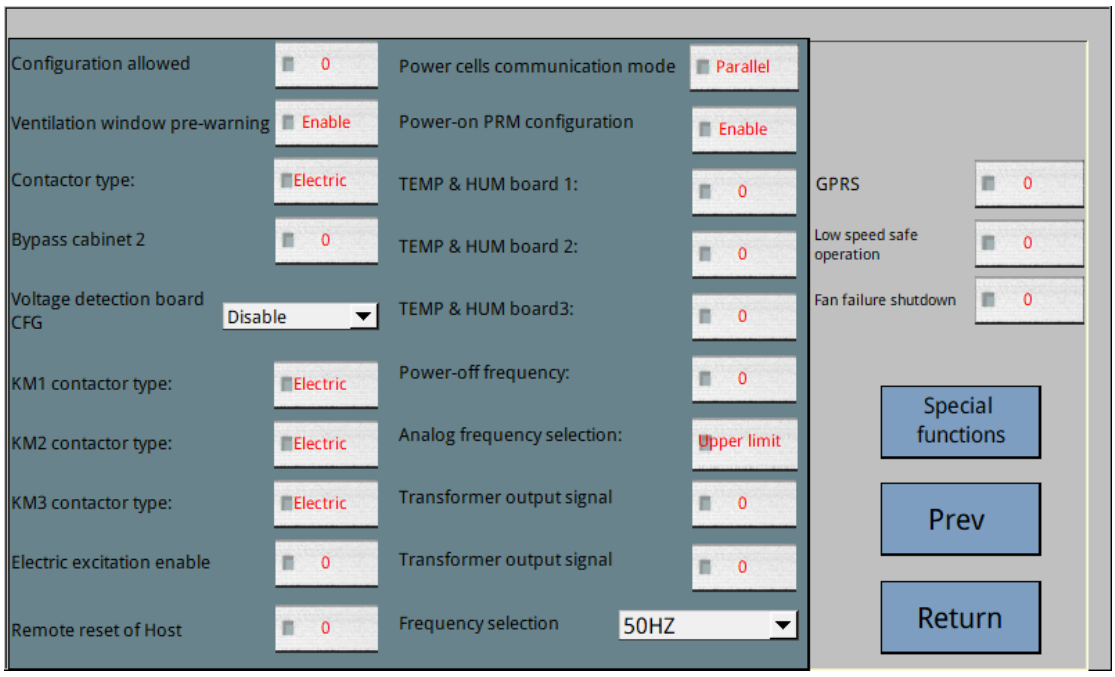
Control setting screen

The name and function of the button

Control channel selection	HMI	Start and stop the inverter by the touch screen, and is controlled by the button “run” or “stop”
	DCS	Start and stop the inverter by the DCS system.
	Host	Start and stop the inverter by the host computer.
	Remote control box	Start and stop the inverter by the remote-control box.
Frequency setting channel	HMI	Set the frequency from HMI
	4-20mA-1	Set the frequency by analog input one of 4-20mA.
	4-20mA-2	Set the frequency by analog input two of 4-20mA.
	Host	Set the frequency by host computer, and is set by the digital signal.
	PID	Set the frequency by the PID function, and it can be given by analog signal of 4-20mA.
	ACC/DEC	The setting of frequency is by the acceleration and deceleration button. Click the acceleration button, the frequency will increase, click the deceleration button, the frequency will decrease.
Pressure setting		Pressure setting channel selection.
Forward / reverse select		Forward and reverse select.

Press the “Advance parameters” button, it will enter into below pages, some of parameters can be set accordingly.

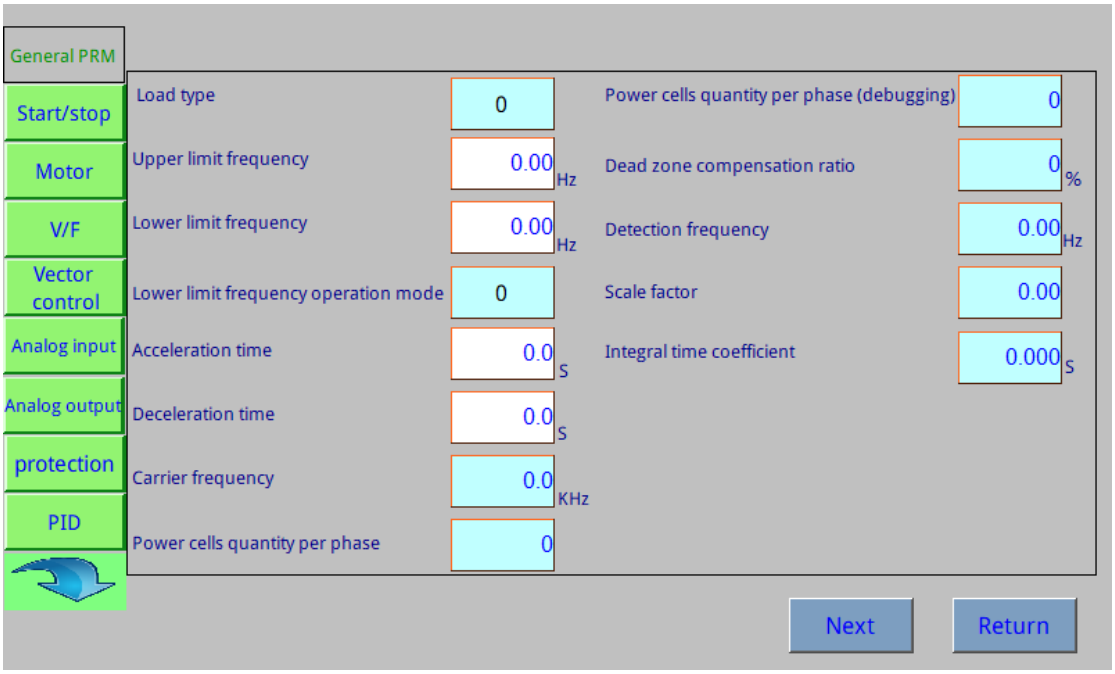


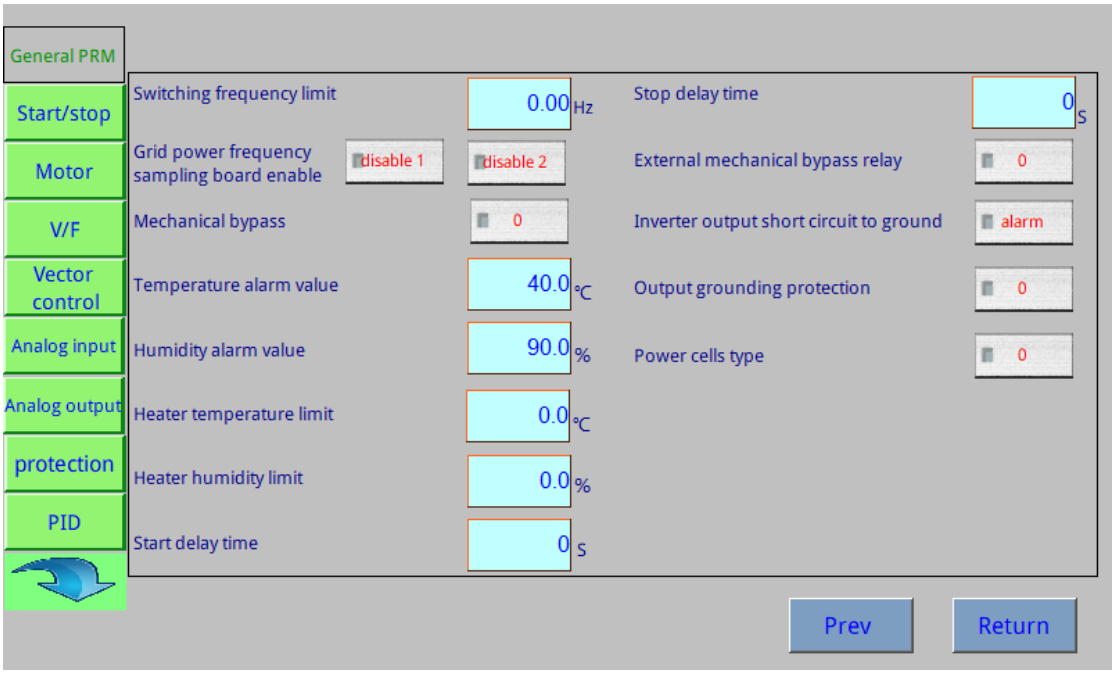


4.4.3 The parameters setting screen

(1) General parameters

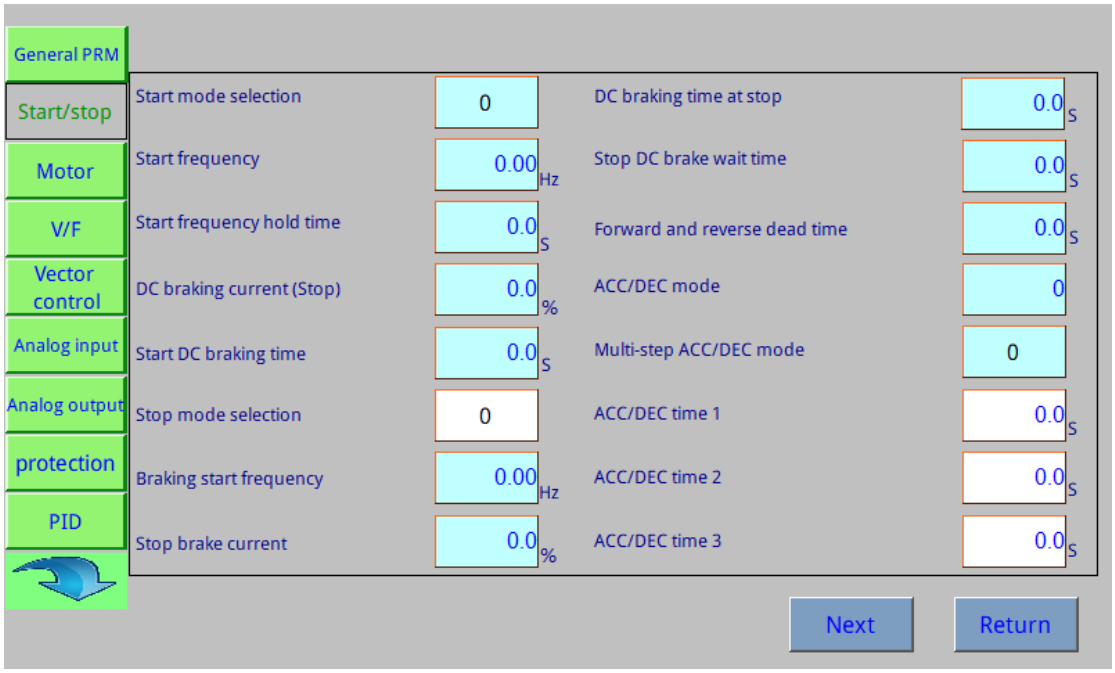
These two pages are used to set general parameters:

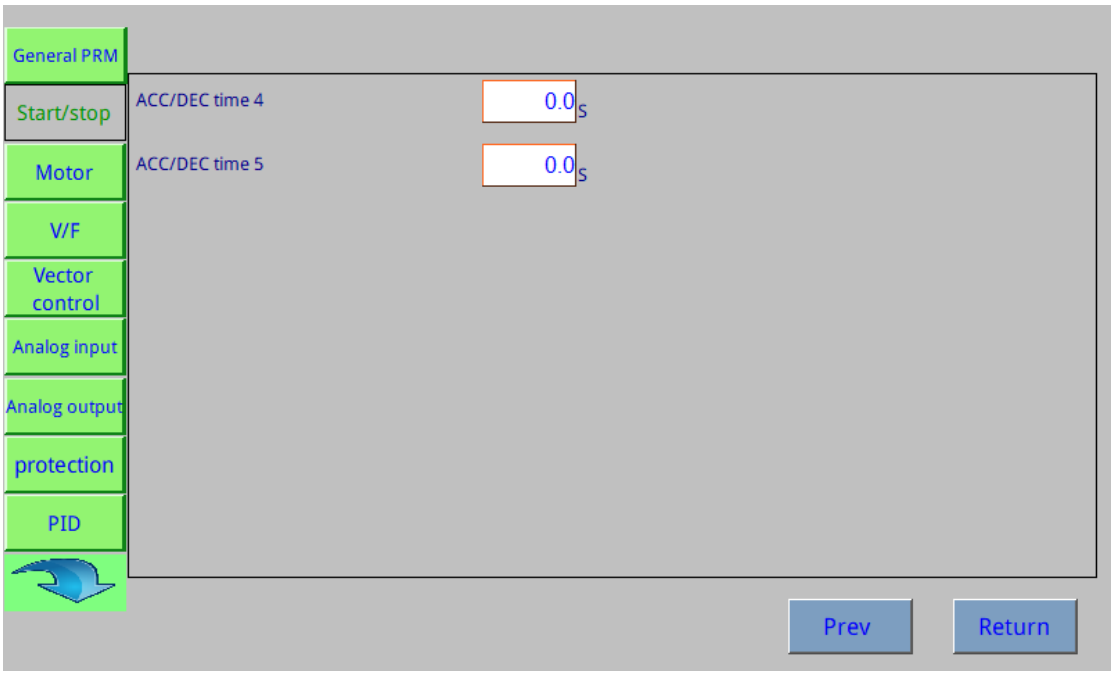

General PRM
Start/stop
Motor
V/F
Vector control
Analog input
Analog output
protection
PID
Load type
0
Upper limit frequency
0.00
Hz
Lower limit frequency
0.00
Hz
Lower limit frequency operation mode
0
Acceleration time
0.0
S
Deceleration time
0.0
S
Carrier frequency
0.0
KHz
Power cells quantity per phase
0
Power cells quantity per phase (debugging)
0
Dead zone compensation ratio
0
%
Detection frequency
0.00
Hz
Scale factor
0.00
Integral time coefficient
0.000
S
Next
Return



(2) Start / stop parameters

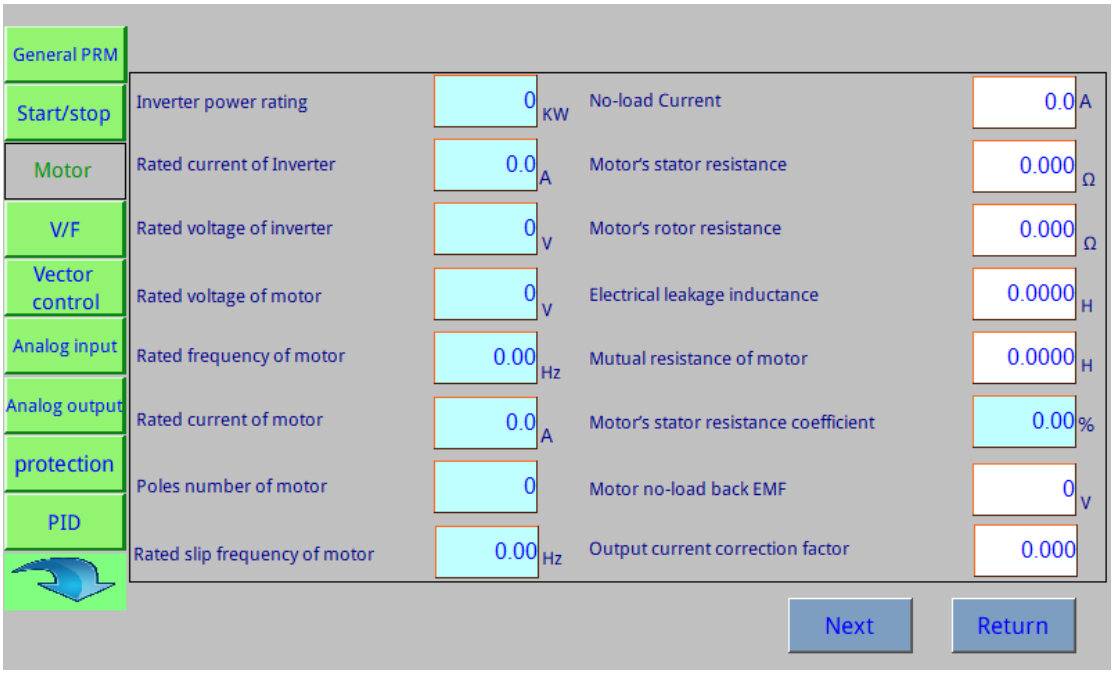
These two pages are used to set the start/stop related parameters:

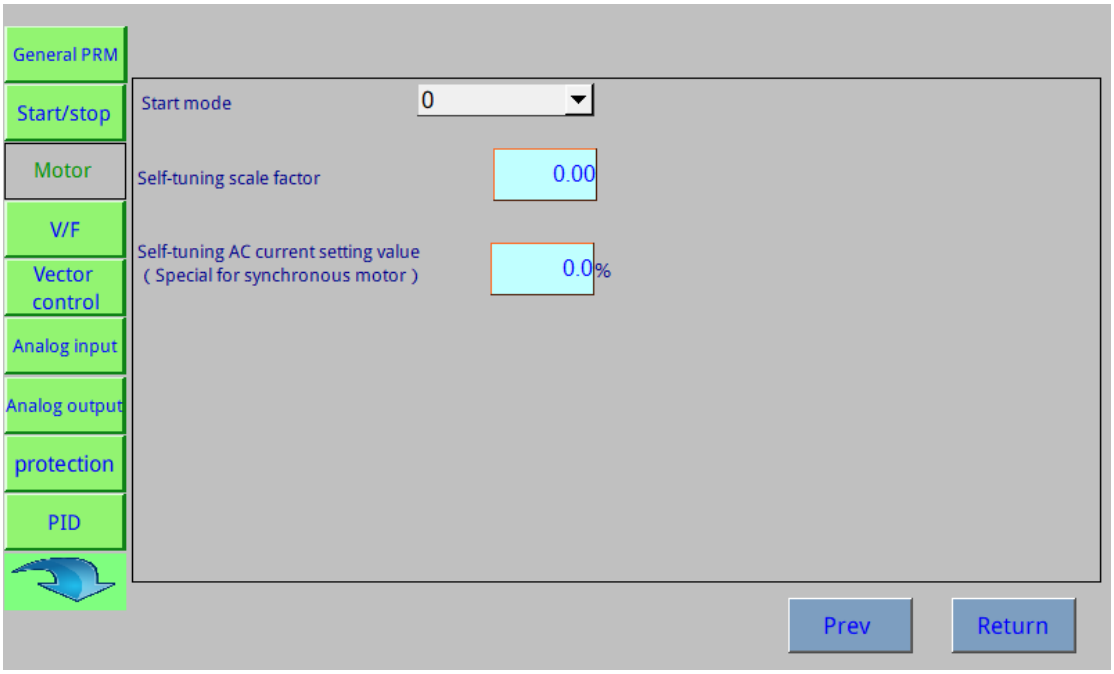




(3) Motor parameters

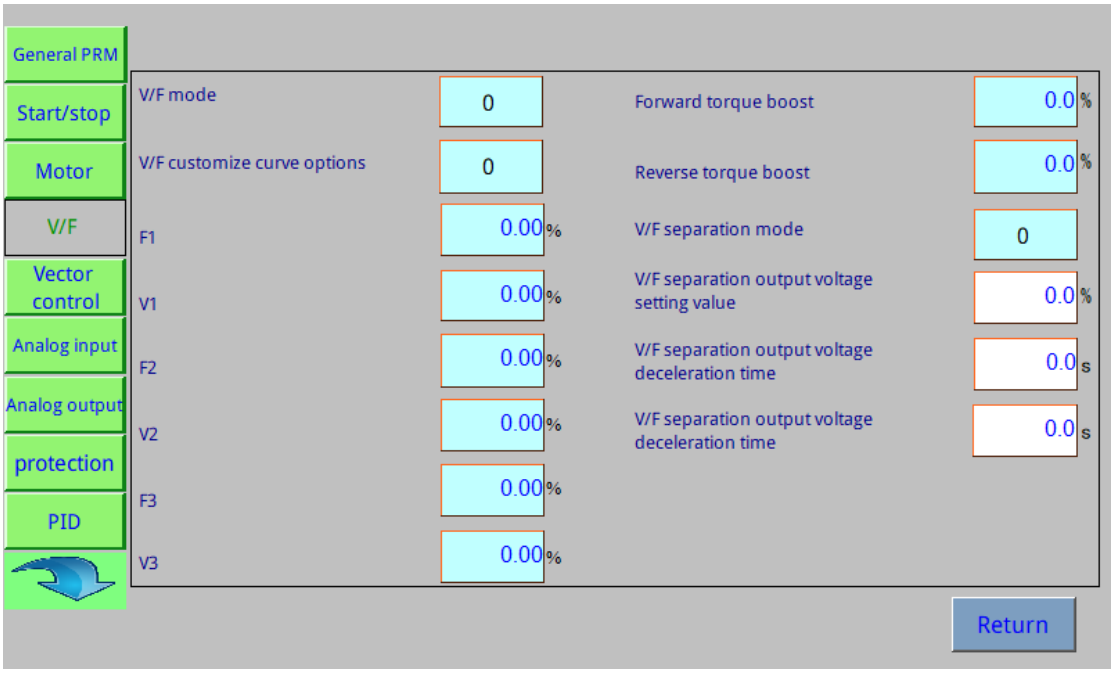
These two pages are used to set the motor related parameters, user must set them according to the motor nameplate correctly.





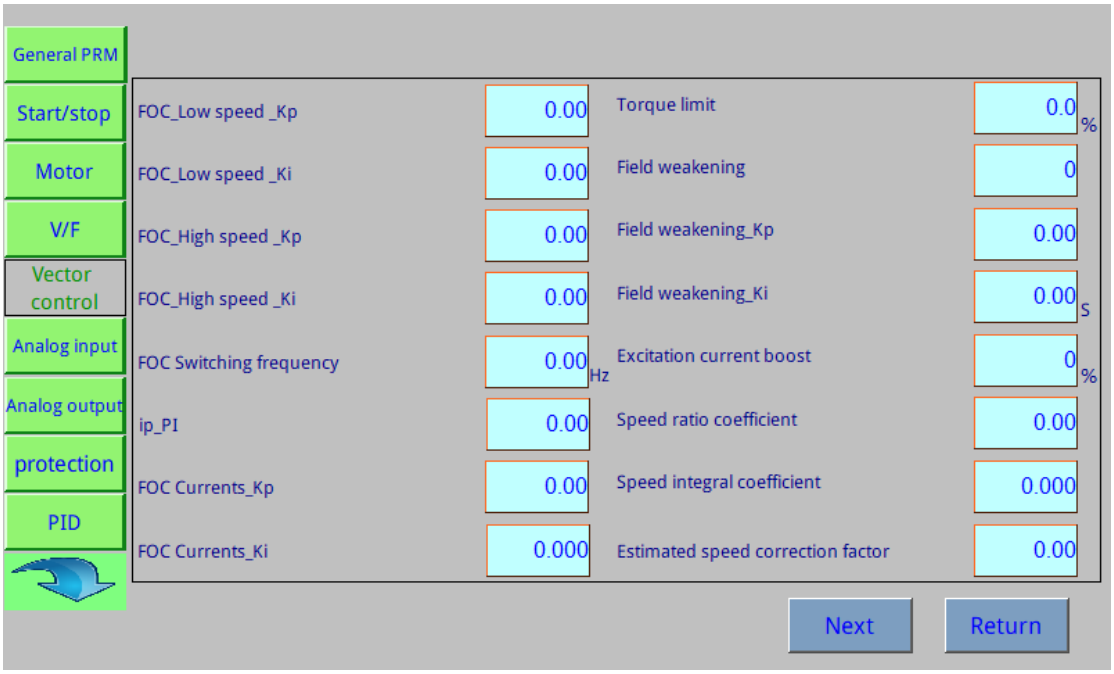
(4) V/F

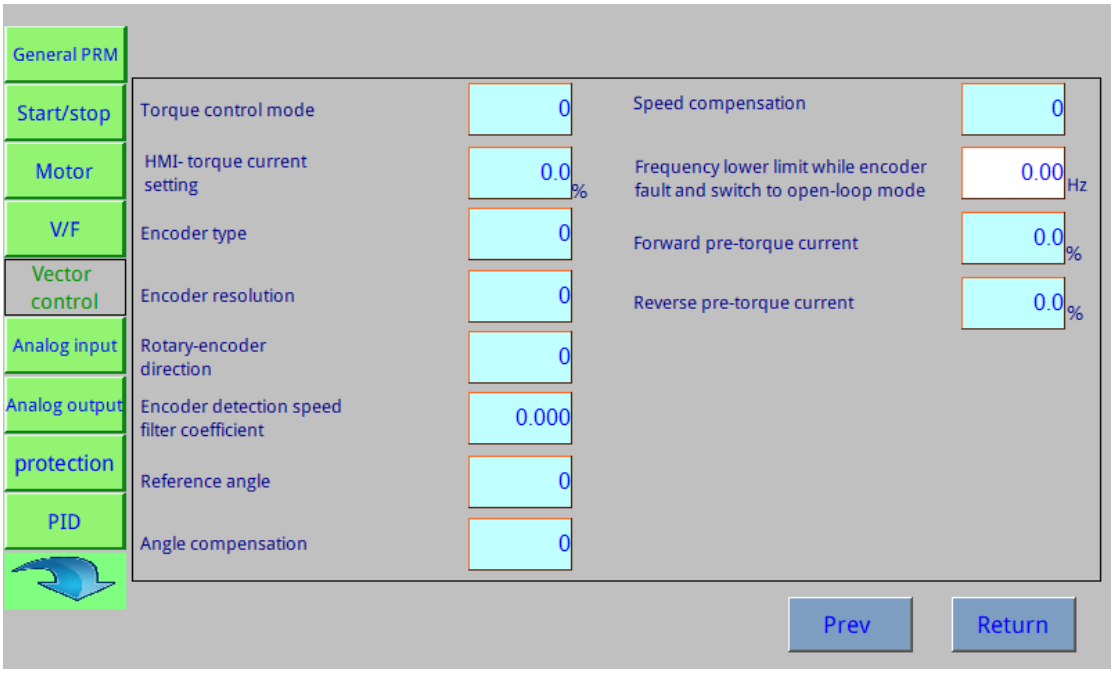
This page is used to set V/f control mode related parameters.



(5) Vector control

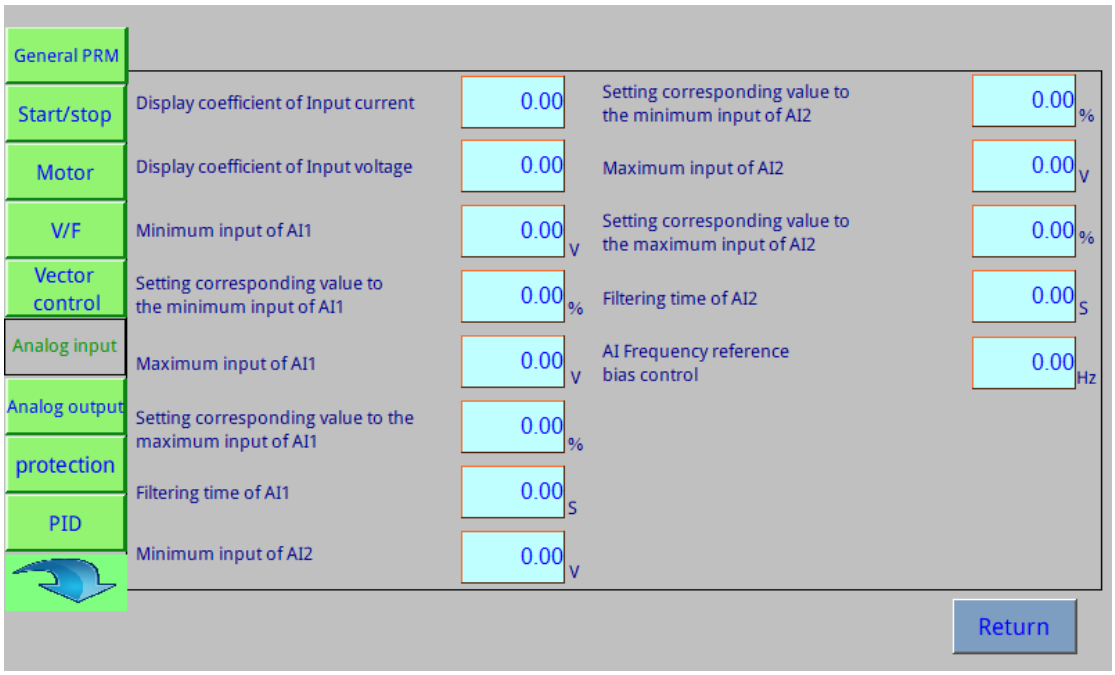
These two pages are used to set vector control mode related parameters.





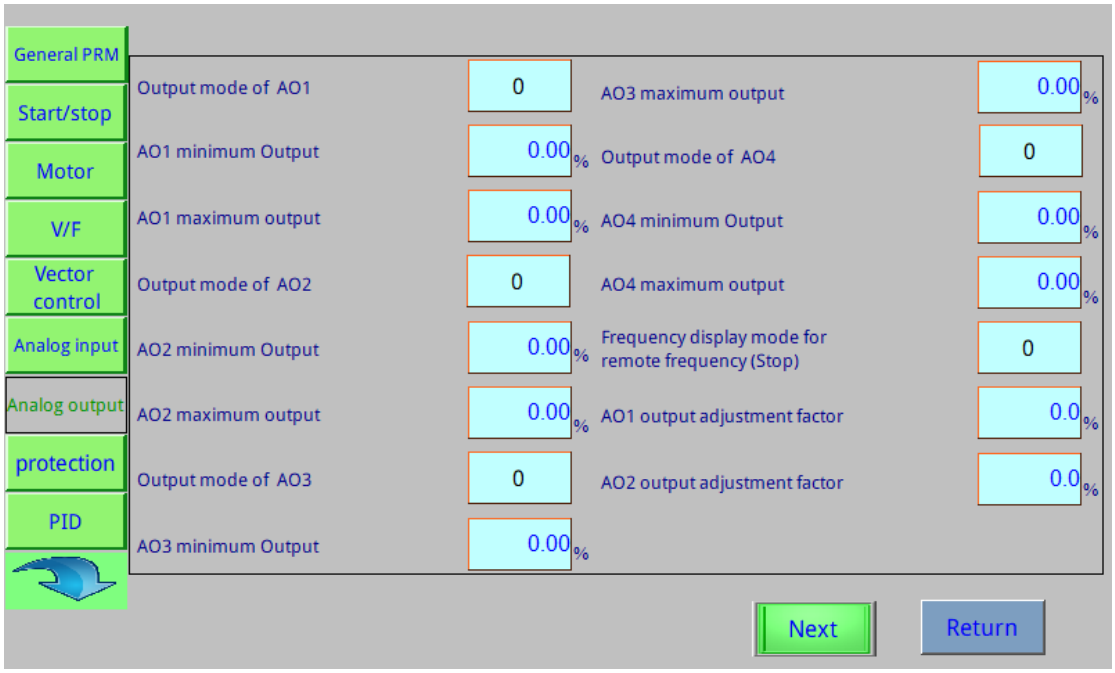
(6) Analog input

This page is used to set the input analog parameters:



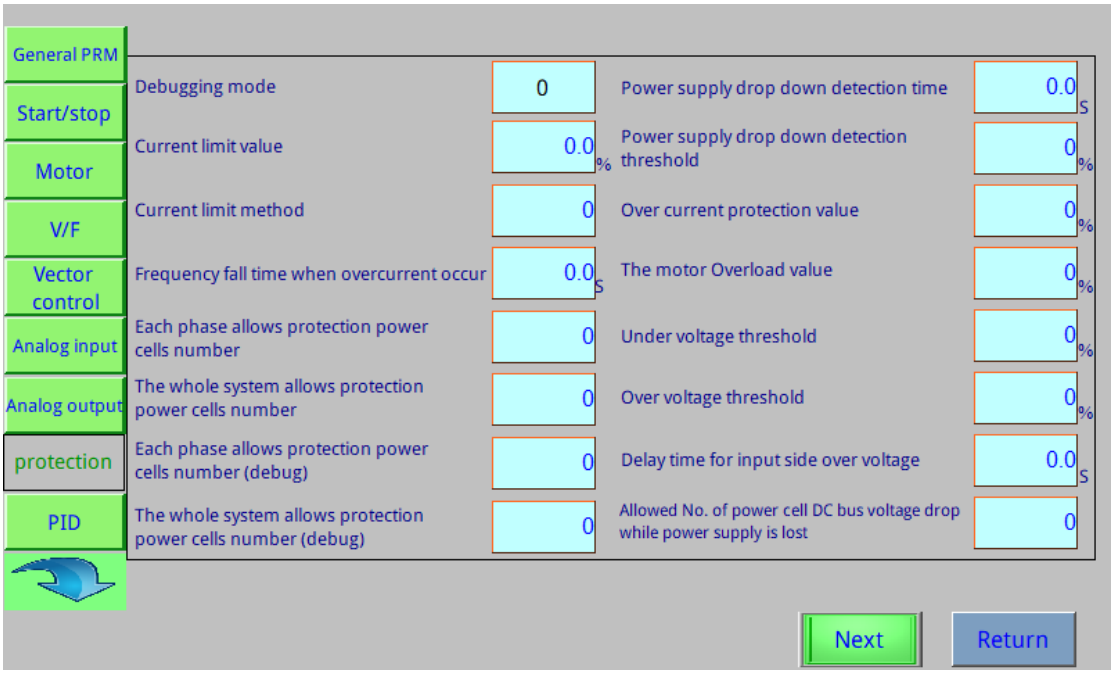
(7) Analog output

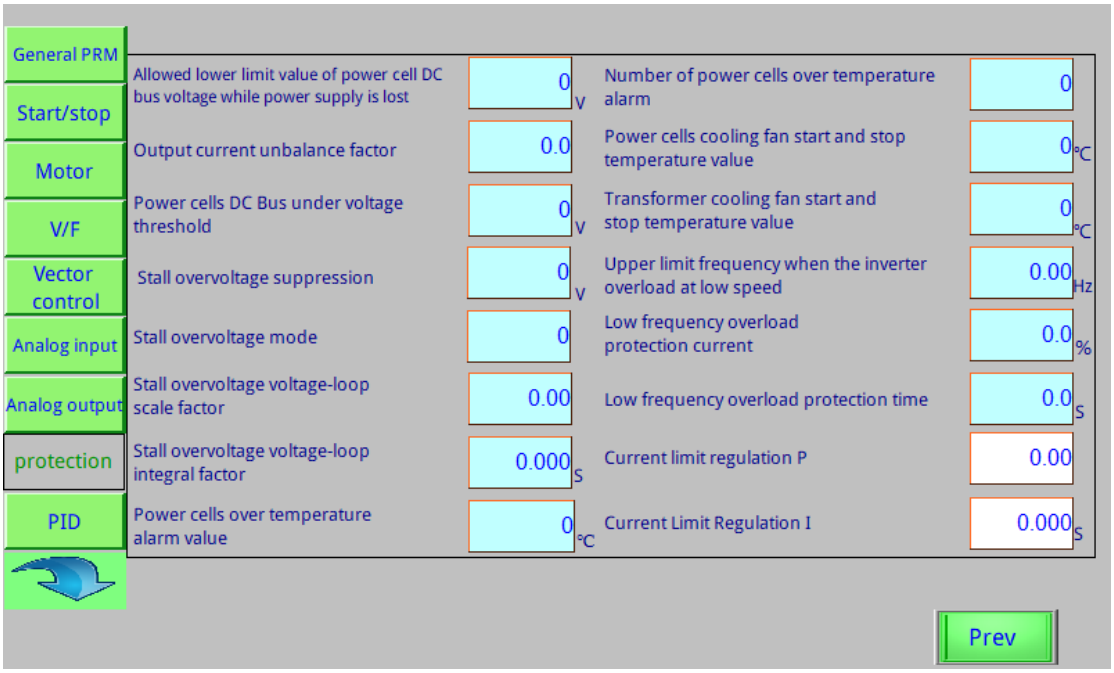
This page is used to set the output analog parameters:



(8) Protection

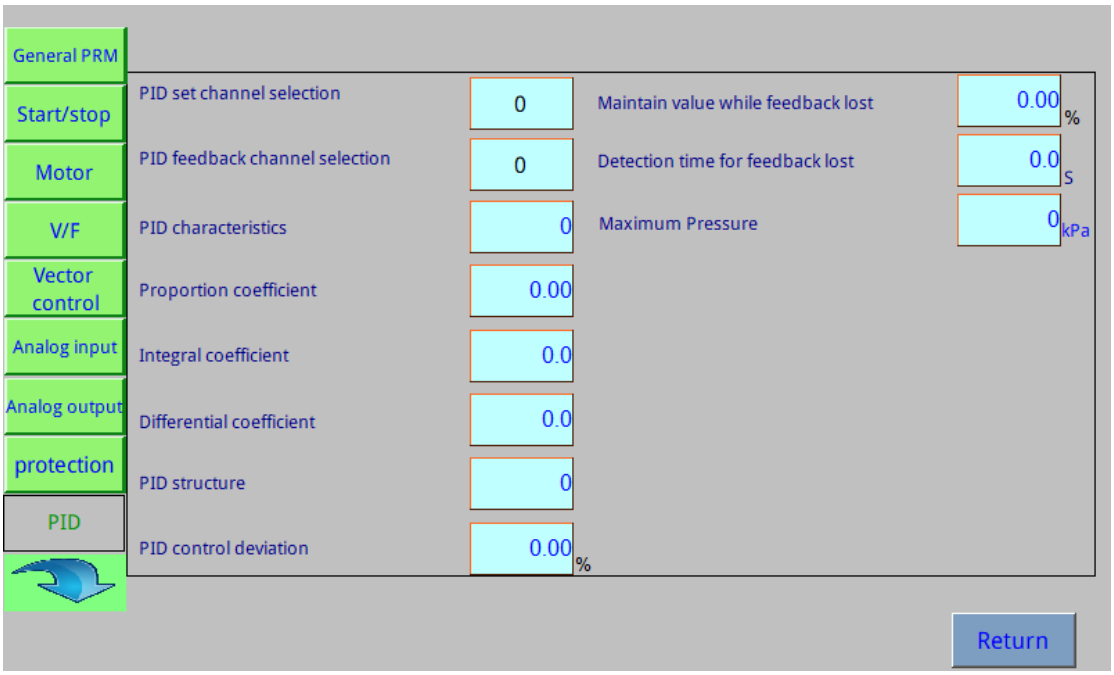
These two pages are used to set the protection related parameters:





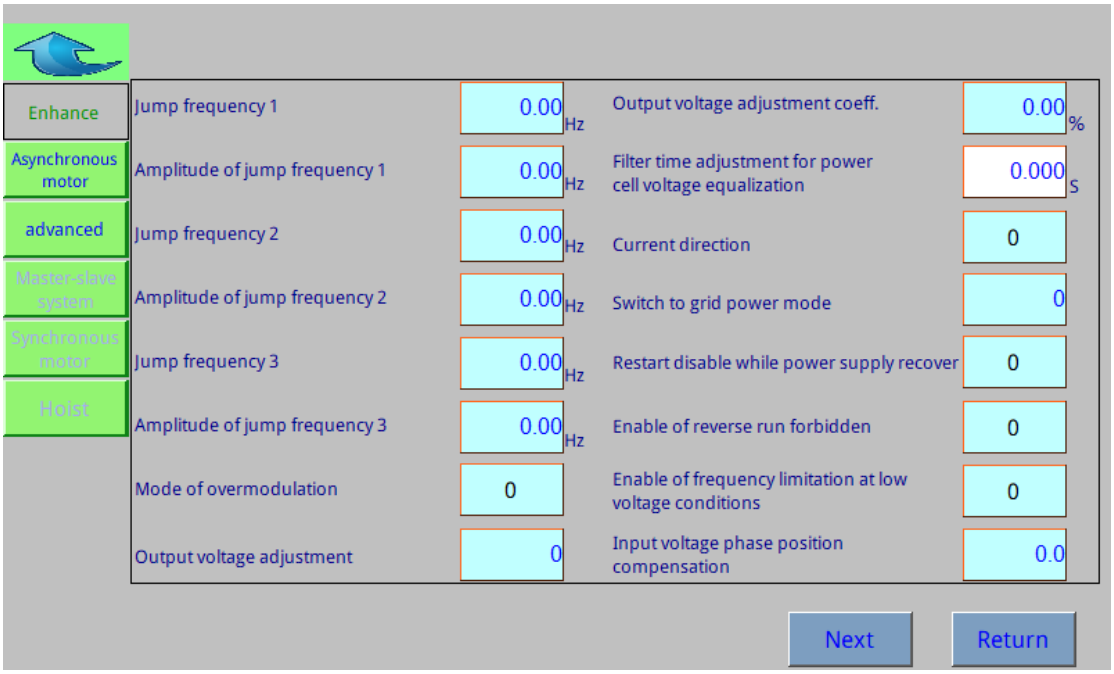
(9) PID

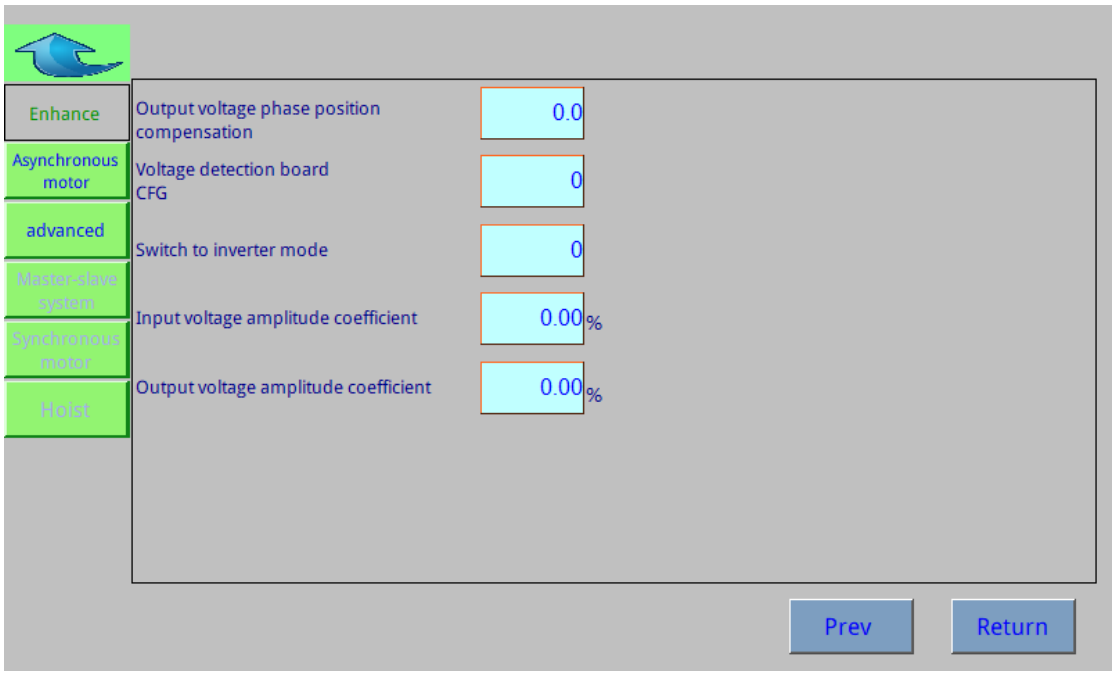
This page is used to set the PID function related parameters:



(10) Enhance

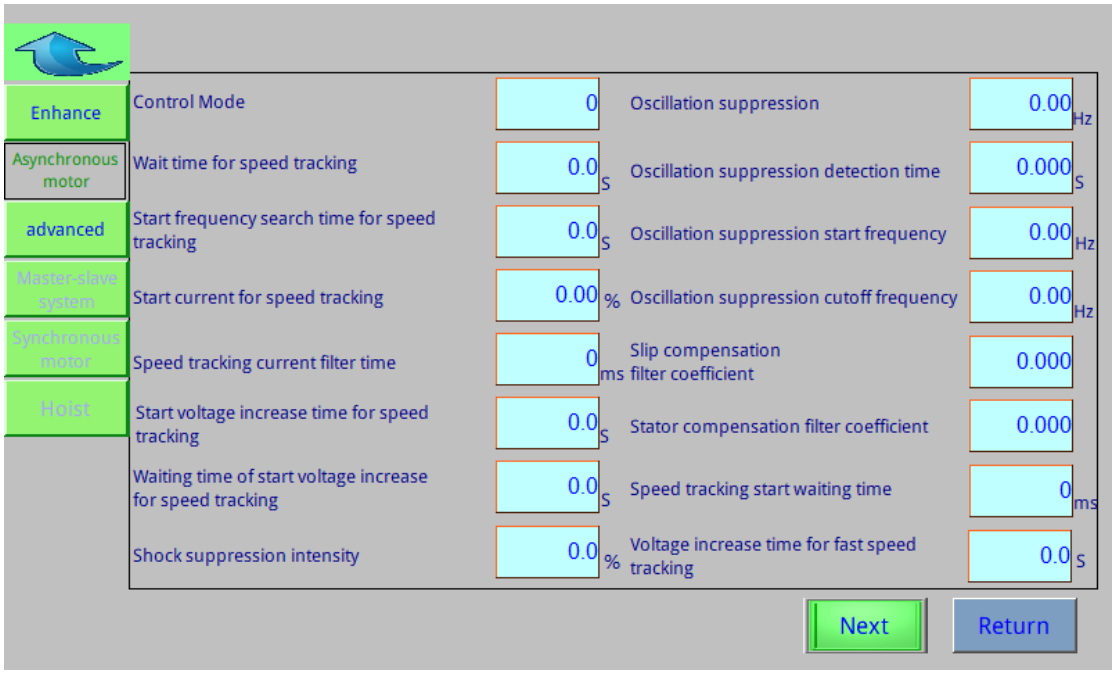
These two pages are used to set some parameters which can enhance the inverter peformance:

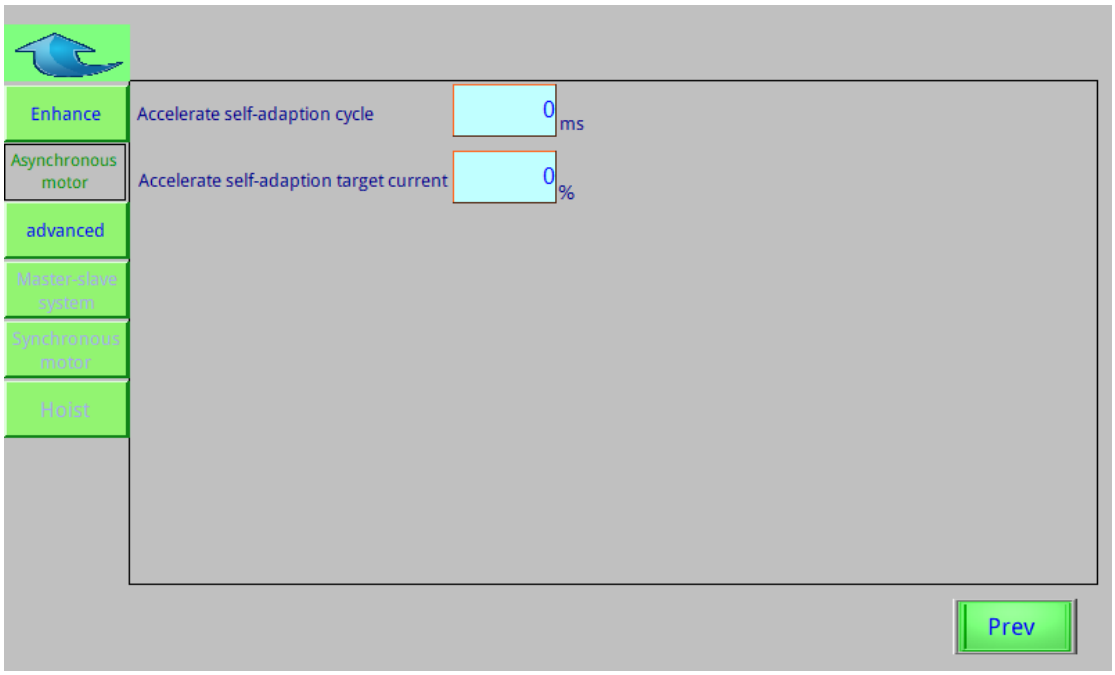




(11) Asynchronous motor

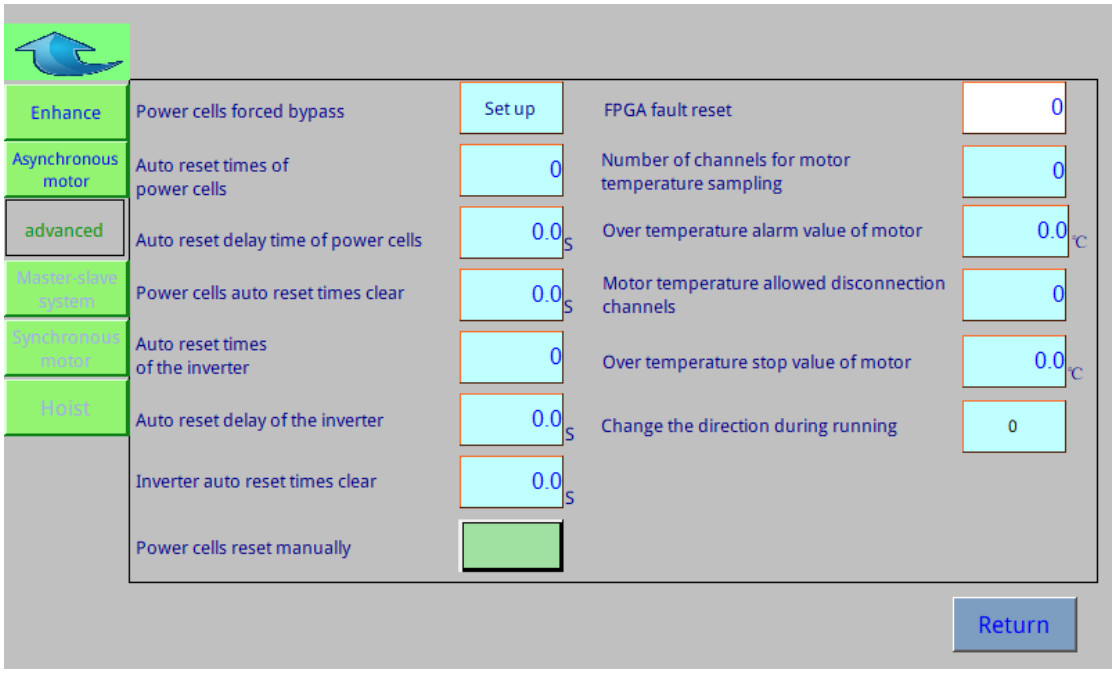
These two pages are used to set the asynchronous motor related parameters, to optimize the motor control performance





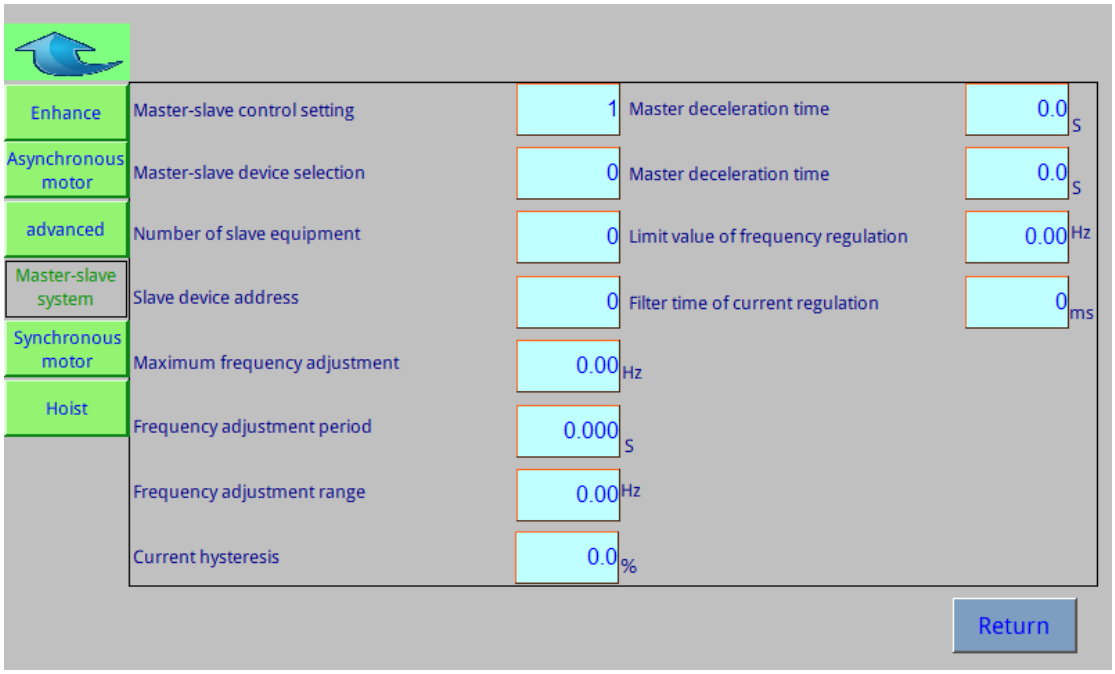
(12) advanced

This page is used to set some advanced parameters:



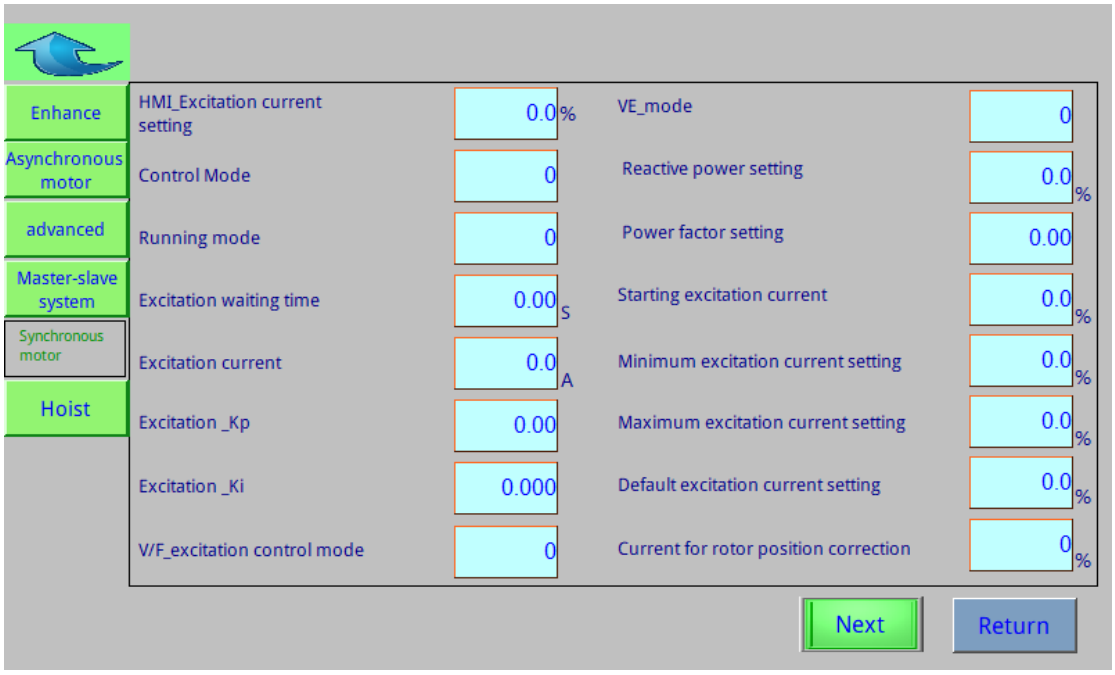
(13) Master-slave system

This page is used to set master-slave control parameters if necessary.



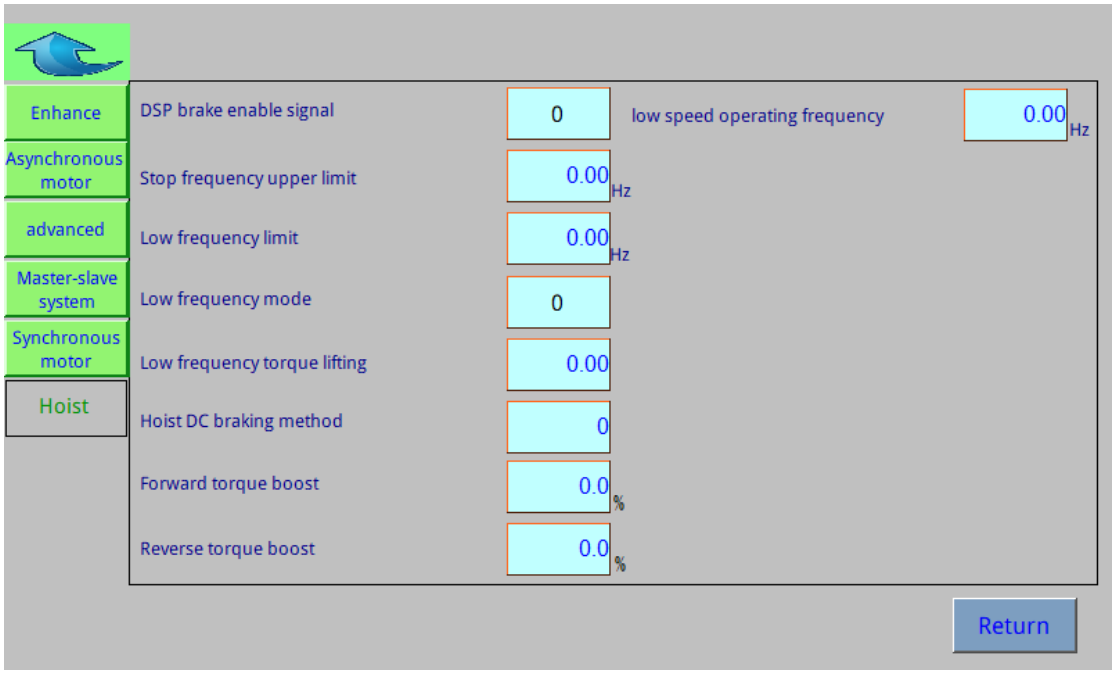
(14) Synchronous motor

This page is used to set synchronous motor parmaters if the motor typ is selected as synchronous motor.



(15) Hoist

This page is used to set hoist application related parameters if the hoist function is enabled.



Firstly, enter the “User Manager” by the “Running Screen” to log in, and the name of logged-on user is "Admin" and the password is "6000". Secondly, click the “Parameters”. Thirdly, click the “Advanced Parameters”, which includes the basic parameters of the inverter. The parameters can be set when the inverter is stop and can’t be changed when it is running.

The following table lists the functions of the basic parameters.

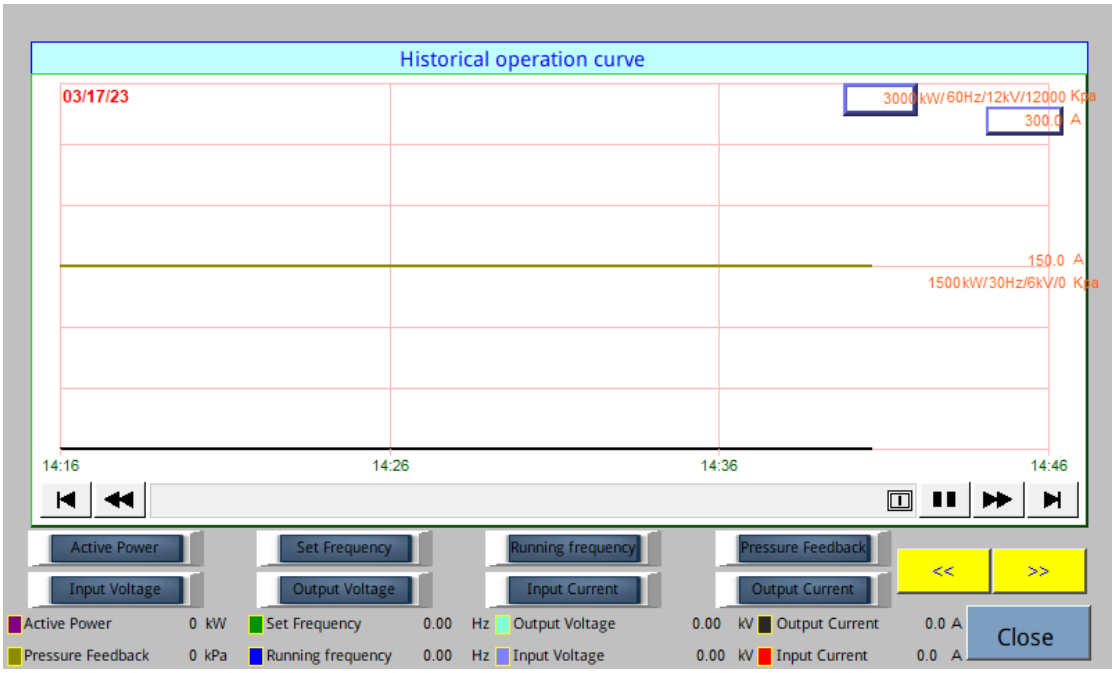
The meaning of the parameters

The name of parameter	Functions
Acceleration time	It is the time of inverter accelerate from 0 Hz to maximum frequency.
Deceleration time	It is the time of inverter decelerate from the maximum frequency to 0Hz.
Upper limit frequency	The maximum frequency of the inverter allowed to run.
Lower limit frequency	The minimum frequency that the inverter allowed to run, the default is 0Hz.
Rated frequency	The rated frequency is the minimum frequency when the output voltage of the inverter is the highest, and it is usually the rated frequency of the motor.
Rated voltage	The rated voltage is the output voltage of the inverter at rated frequency, it is usually the rated frequency of the motor.
Rated current	Rated current is the coefficient of output current and it is used to adjust the output current displayed on touch screen.

Start frequency	The frequency that the inverter starts.
The settings of start	0: starting from the setting frequency The inverter starts at the starting frequency and the time starting frequency continues. 1: Brake first and then start from the starting frequency Firstly, brake with DC current and the time it continues, then start from the starting frequency. 2: Speed tracking start when the motor is running, it is the function called as speed tracking.
The time of speed tracking	The delay time that from power off to start or speed tracking is enabled.
Settings of stop	0: Deceleration to stop the inverter receives the stop command, the output frequency reduces gradually to zero according to the setting deceleration time. 1: Coast to stop the inverter receives the stop command and blocks the output immediately. The motor stops slowly according to the inertia.
VF curve modes	Only the control mode is 0, the function is enabled. 0: VF standard curve, V / F = const The feature of V / F curve is constant torque. 1: VF square relationship curve (larger than 10Hz is quadratic) The characteristic of V / F curve is 2.0 times decelerating power torque. 2. Custom curve Set the required curve by setting the voltage Vx at the frequency Fx.
Fx	The value is the percentage of the maximum frequency, it is used to set the frequency Fx of a custom curve.
Vx	The value is the percentage of rated voltage, it is used to set the voltage Vx of a custom curve.
Proportional coefficient	When proportional coefficient is larger, the regulation speed of the system is faster. If it is too large, the system will overshoot and shock. If the proportional coefficient is positive, the loop is positive feedback loop; if the proportional coefficient is negative, the loop is negative feedback loop.
Integration time constant	The integral time constant is larger than zero, its unit is second.
The gain of derivation	The gain coefficient of PID regulator derivation
PID structure	0: Only proportion of the PID regulator works. 1: Only integration of the PID regulator works. 2: Both Proportion and integration of the PID regulator work. 3: Proportion, integration and derivation of the PID regulator all work.
Setting of pressure	Set the expectation pressure in PID parameter
The maximum pressure	Set the max value of pressure according to the maximum range of pressure transmitter. For example, the maximum range of the pressure transmitter is 700kPa, the output signal of the transmitter is 20mA at 700KPa, and the maximum pressure is set of 700kPa.

PID setting channel selection	0: Set by the digital signal operating on touch screen 1: AI1 set by the analog signal through port of AI1 2: AI2 set by the analog signal through port of AI2
PID feedback channel selection	0: AI1 feedback by the analog signal through port of AI1 1: AI2 feedback by the analog signal through port of AI2

4.4.4 Historical operation curve / data page



Running curve screen

Firstly, click “Real-time data” button. Secondly, click “Running Curve” button, the setting frequency, running frequency, output current, input current, input voltage, output voltage and the feedback pressure are recorded as shown above.

The function of each curve is shown in the following table:

Item	Color of curve	Function
Set frequency	Green line	Record the value of the inverter frequency set over a period of time
Running frequency	Blue line	Record the value of the inverter running frequency over a period of time
Output current	Deep brown line	Record the value of the output current over a period of time
Input current	Red line	Record the value of the input current over a period of time
Output voltage	Light blue line	Record the value of the output voltage over a period of time

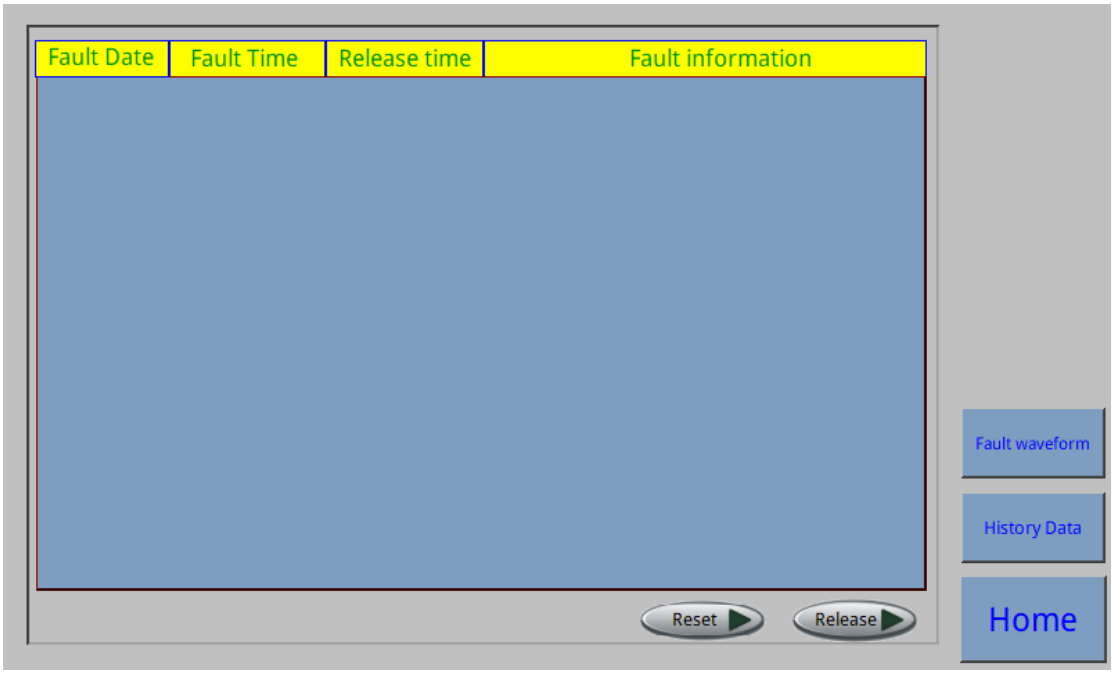
Input voltage	Purple line	Record the value of the input voltage over a period of time
Feedback pressure	Deep yellow line	Record the value of the feedback pressure over a period of time
Active Power	Deep red line	Record the value of the active power over a period of time.

At the same time, the setting frequency, running frequency, input current, output current, input voltage are all shown in the right side of the screen.

Operation button: The operation button contains some basic operations for the history curve, such as:

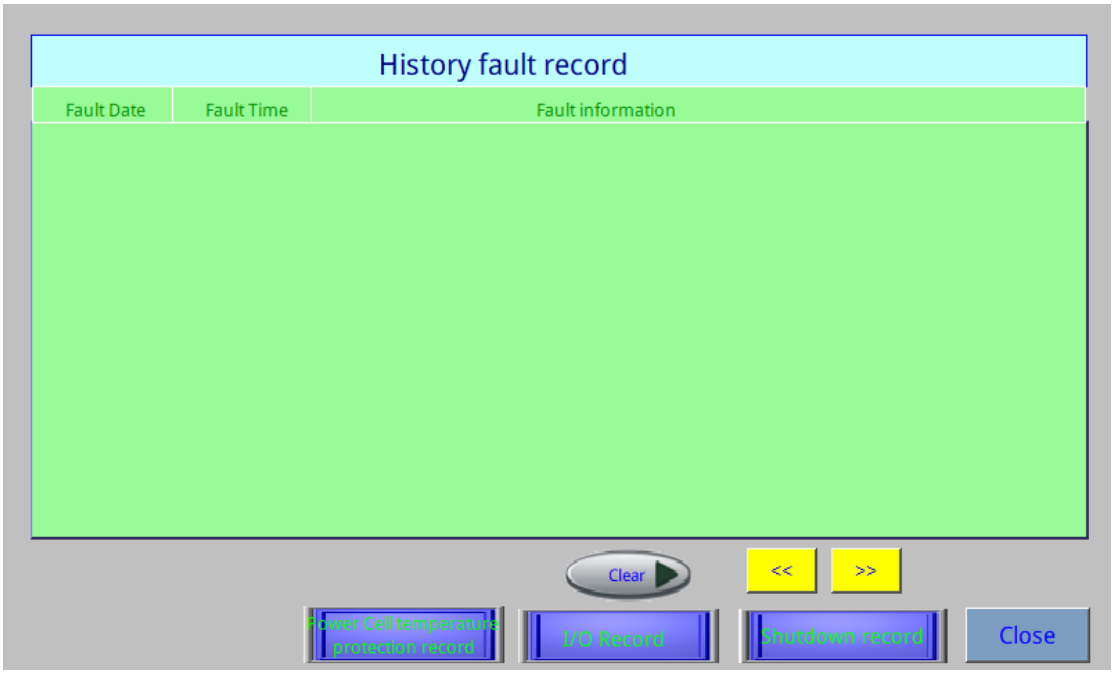
- ◆ >>: Page forward, view the data curve after the time
- ◆ <<: Back page, view the data curve before the time

4.4.5 Fault records screen



Fault record screen

Click the "faulty record" button, the fault waves, fault content are all shown below When the system is faulty or power cell is faulty, this page will appear.



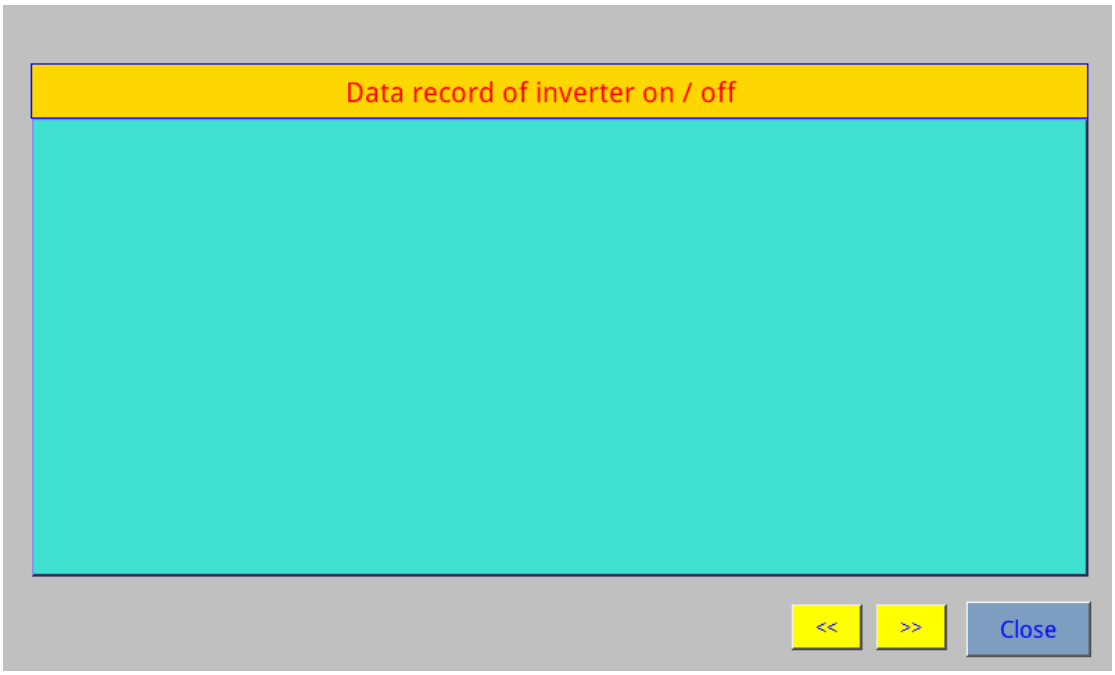
History fault record screen

The screen shows the alarm records, so it is easy to find the reasons for the fault of inverter.

Click the button of "View Stop Record" to open the "inverter stop record screen", view the time and the reasons for the inverter stop, as shown in Figure 4-15.

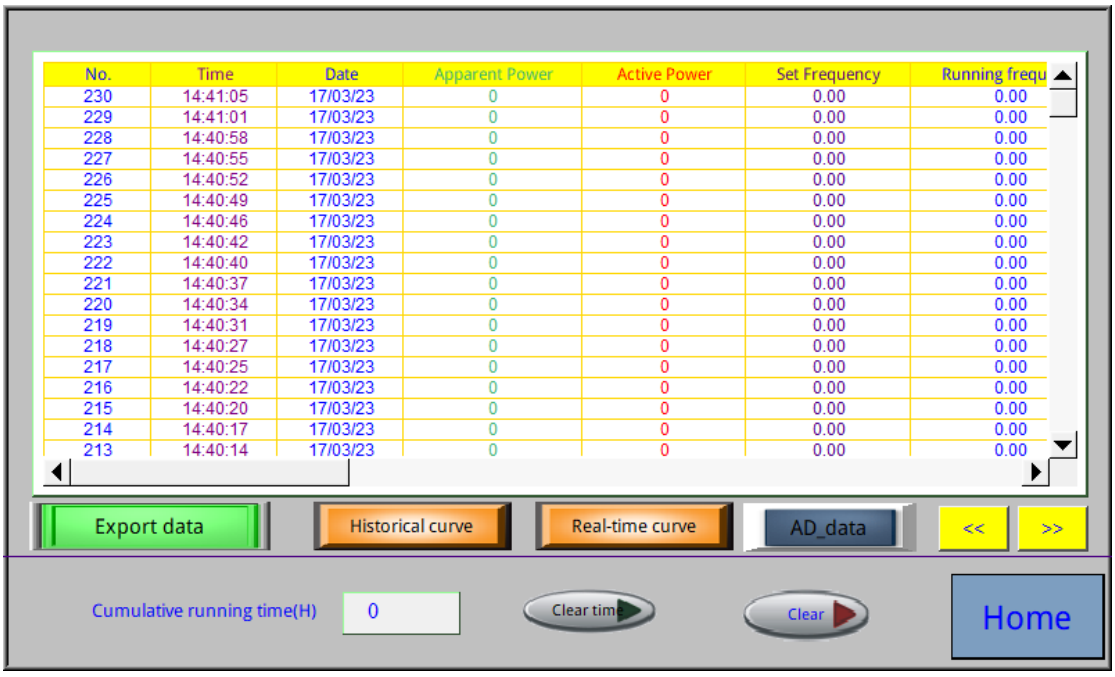
Operation button

- ◆ ＞＞: Page forward, view the next page of alarm records
- ◆ ＜＜: Back page, view the last page of alarm records.



Inverter stop record screen

4.4.6 Real-time data record page



Click the menu button on the left bottom of the screen, click the "running record" button, running frequency, given frequency, output current, input current, input voltage, and running time of the inverter are shown as below.

Operation button: The operation button contains some basic operations for the running record, such as:

Clear record: the alarm records of the inverter are cleared.

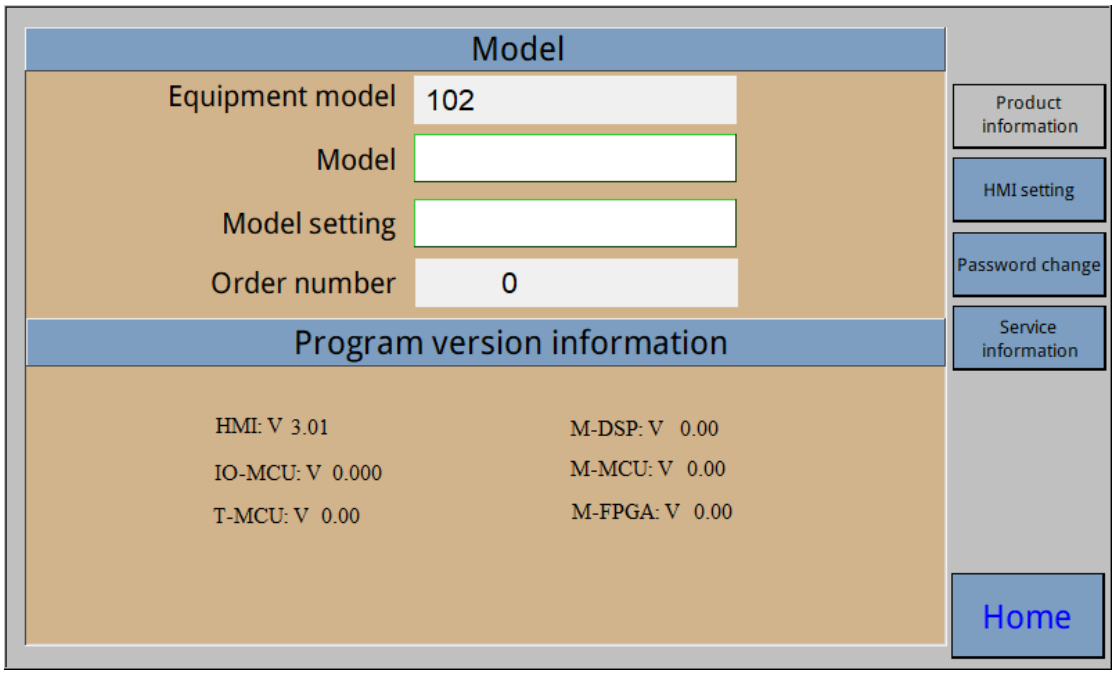
Time reset: running time of the inverter is cleared.

- ＞＞: Page forward, view the next page of alarm records
- ＜＜: Back page, view the last page of alarm records

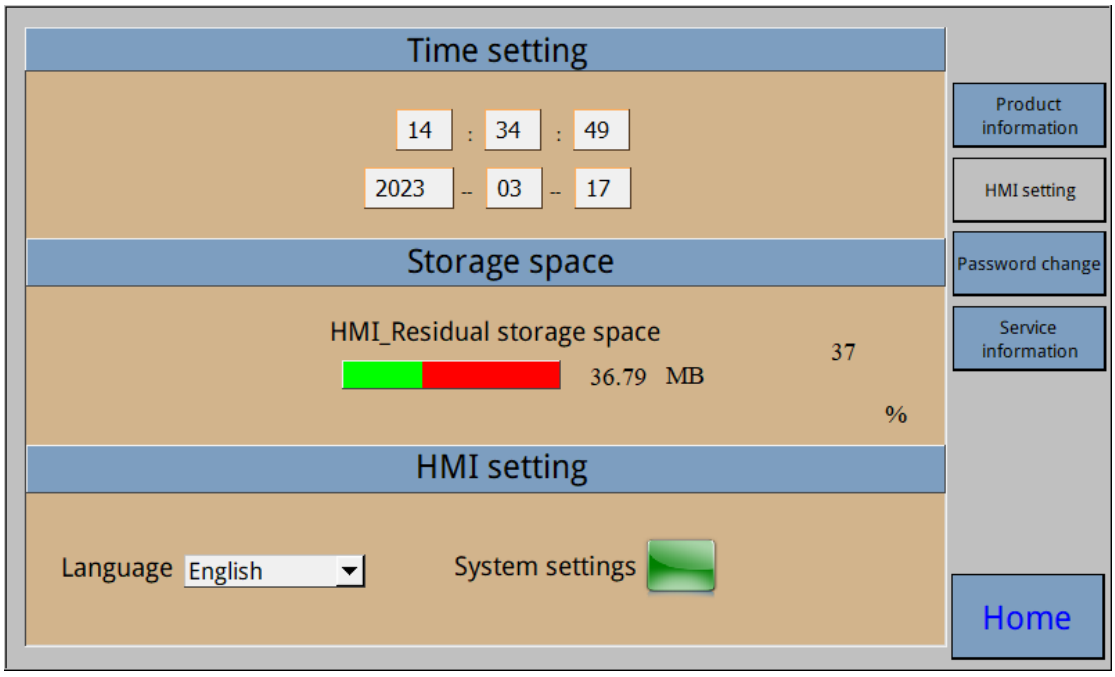
Insert U disk at USB port at the bottom of the touch screen, click "Export operating data" button, you can get the running data of excel format.

4.4.7 System information screen

Click “System information” button, the screen includes product information, HMI system information, etc.

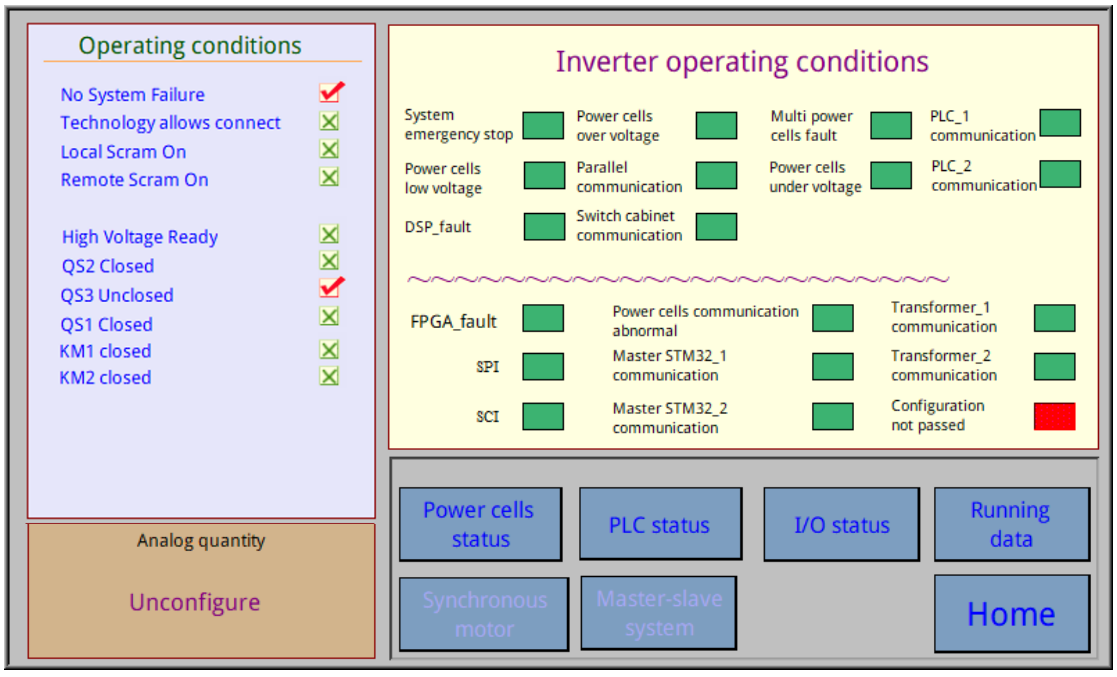


Press “HMI setting”, it will enter into HMI setting page:



System information screen

4.4.8 Running states screen



Running states screen

Click “Running States” button, enter into this page, it includes the operation conditions, the key signal related with power condition, power cells states, running status etc.

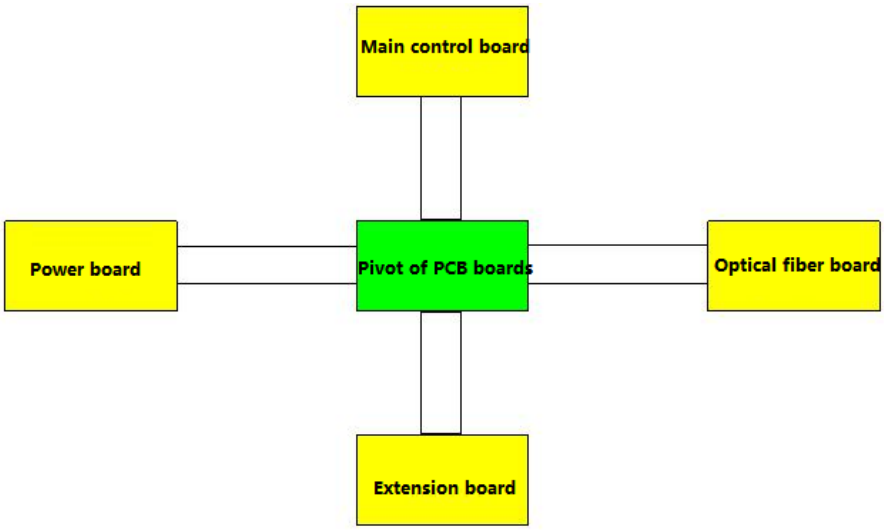
The conditions of start display on the left side of the screen, when all the conditions are ready, it is gonging to start.

Note: The different models of inverters, the start conditions are different.

4.5 Control box

Standard push-pull structure is adopted and connectors are used so that installation efficiency is greatly improved and the virtual connection is avoided. The control box is shown below:

There are four types basic circuit board: motherboard, main control board, signal conversion board, fiber board.



The control box frame diagram

4.6 Local control and external control

The inverter has two control modes which are Local control and external control, that can be selected by the “Internal/External Control” button on the touch screen or the ports. The local control and external control not only influence the selection of orders, but also turn the frequency setting mode of the inverter, and the frequency setting mode can be reset on the touch screen.

- **Local control**

If the software control button on the main interface of the inverter is enabled, users can do the operation on the touch screen. The users or professional can press the “start” button to start the inverter. When the control mode is local control, users can also press the “stop” button to stop the inverter.

In any case, the "stop" button of external control, the "stop" button of local control and the "stop" button of remote box are all effective, no matter what the control mode is.

- **The external control**

The external control modes for start and stop can be divided into DCS control and remote control box, the remote control box is an optional device.

4.7 Operation modes of inverter

The inverter has several operation modes such as open loop and close loop and so on. Whatever operation mode, the start must be carried out when the system is ready,the controller is reset, the "stop" buttons of external control and local control are open and there is no fault.

◆ **Open loop operation**

When the system is ready, the external control is selected, if there is a “start” order, the inverter will start as the rising time, and runs at the setting frequency set by users. When the local control is selected, the “Start” button of external control is invalid, and the inverter will start by the “Start” button on the touch screen.

◆ **Close loop operation**

In close loop mode, the expected values can be set, and the speed of motor will be adjusted according to the actual values by the PID controller to make the actual values follow the expected values.

4.8 The steps of fast and safe start

The motor parameters and inverter parameters must be set in the “Control Setting” and “Parameters Setting” windows on the main interface before the first start of the inverter, The settings of control modes, frequency, open loop and close loop are shown as follows.

4.8.1 Control modes

There are 3 control modes of start and stop:

◆ **Local control**

Set by the “Start” or “Stop” buttons in the “running Status” window of the touch screen.

◆ **External control**

That is the DCS control, which can be operated by the “Start”/“Stop”/ “Emergence Stop” buttons.

◆ **Host computer control**

When it is the host computer control, press the “Start”, “Stop” buttons to operate. The settings of parameters are shown in 4.4.2 control screen.

4.8.2 Settings of frequency

There are 5 setting modes of frequency, please select one of them:

- Set on touch screen

Set the frequency on the touch screen.

- By external control

When the setting of frequency is chosen by the analog signal, the remote analog signal is the current of 4-20mA or the voltage 0-5V, chose one of them according to the application fields. Please refer to 4.4.2 control screen for details.

- By host computer

The setting of the frequency is chosen by host computer, the expecting frequency can be set by digital signal.

- By function of Multi-step speed

When the setting of frequency is chosen by function of the Multi-step speed,the frequency can be set by the digital signals in DCS control room.

- By function of Acceleration and deceleration

The expecting frequency can be set by the button of the acceleration and deceleration. Please refer to 4.4.2 Control screen for details.

4.8.3 Running modes of inverter

The running modes of the system include manual open loop and automatic operation close loop, which can be set by frequency setting source. For details, please refer to 4.4.3 basic parameters setting screen for details.

4.8.4 Setting instruction

After the control power supply is on and control wires are connected, please close the switch input and output switches of the switch cabinet:

step1: Close the small breaker QF1 in the control cabinet

step2: Select the control mode according to the application fields

step3: Select the settings of the frequency.

Step4: Close the power input switch;

Step5: Look at the red records on the “Operation Record” screen, find out corresponding

reasons and solve the problem;

Step6: The inverter gives the signal when it is ready;

Step7: Press start button to start the inverter according to the control mode.

Step8: Regulate or set the frequency according to the selected mode

Step9: The inverter will get the frequency according to the acceleration and deceleration time

Step10: Press the “stop” or “Emergency Stop” button to stop the inverter according to control mode.

4.9 Operation notes

	◆ The inverter is a high-voltage dangerous device, and any operator must obey the operation procedure. ◆ Firstly, give the power to the control part, while each part is ready, then give the high voltage. ◆ When using the touch screen, just a finger touch is ok, hard hitting or click with hard things are forbidden. ◆ Non professional staff click on the touch screen is forbidden, in case of wrong operation. ◆ Do not open the door when the inverter is running, otherwise the system will alarm. ◆ The ACC and DEC time is forbidden to set to 0, the setting time is not too short, and should be set according to load type. ◆ After the inverter is stopped, the interval time should not be less than 5 minutes to start. ◆ The signals of the inverter are not allowed to detect by the instrument when it is running. ◆ The motor can not connect to the capacitor which is used to improve the power factor with no output AC reactor.

Chapter 5 Operation

	◆ Obey the rules of the first chapter of the safety information, or it will be dangerous. ◆ Only the person who has been trained can operate the inverter. ◆ This chapter only describes standard switch cabinet, different application requirements will cause the change of switch cabinet wiring principle. Please develop your own operation rules according to the actual switching

This chapter describes the operation rules in detail for FD5000 series product after installation and test, all the rules are numbered and the operator must obey that.

5.1 Preparation before operation

step1: Complete the installation and test according to the information in chapter 7 .

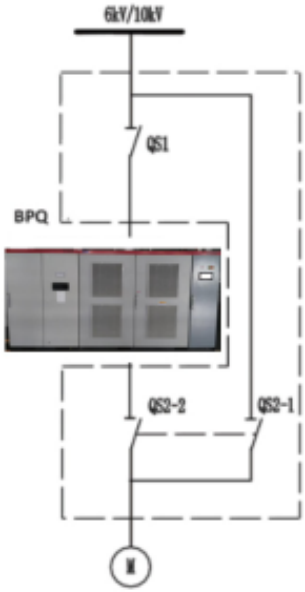
Step2: Turn on the control power supply. Close QF1 in control cabinet, at the same time, the touch screen starts and automatically enters the monitoring program.

Step3: Set and check the special start parameters, including acceleration time, deceleration time, the curve of acceleration, the start frequency, control modes, the protection parameters of motor and so on.

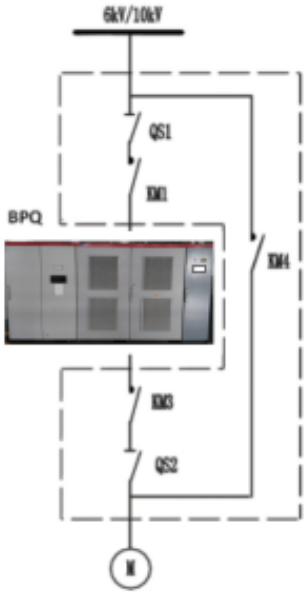
	◆ Check the special parameters that have effect on startup to ensure the safety and normal start.

Step4: Open the input wire switch and the ground wire or ground switch form the vacuum contactors (if it is connecting).

Step5: Choose the mode that runs at the grid power or MVDaccording the occasions. If it is the one drags one manual switch cabinet, such as shown in Figure 5-1, open the grid power bypass switch QS2-1; if it is the one drags one automatic switch cabinet, such as shown in Figure 5-2, open bypass vacuum contactor KM4.



Manual switch cabinet



Automatic switch cabinet

Step6: If it is the one drags one manual switch cabinet, check the input and output switch of the inverter.

Check and ensure the input switch QS1 is closed.

Check and ensure the output switch QS2-2 is closed.

If it is the one drags one automatic switch cabinet, check the input and output vacuum contactor of the inverter.

Check and ensure the input switch QS1is closed.

Check and ensure the output switch QS2 is closed.

Check and ensure all the switches are closed. (When the switch is open, the high voltage is disconnecting it is to ensure the safety of the inverter and maintenance staff. In order to change between MVDand grid power automatic, they must be closed.)

The rules of isolating switch operating: press the red button until it shocks and the red light is lighting, pull the lock out, operate the isolation switch. If the lock dose not shock and the light is off, the isolation switch could not be operated. Using the key to change the state of it is not allowed.

Step7: Close all the doors.

Step8: Choose the control modes on the touch screen.

Step9: Choose the setting of the frequency on the touch screen.

Step10: If the DCS control, check the preparation for the DCS.

Step11: Switch on the high voltage power.

Step12: Check the preparation state of the inverter

5.2 Start

Step1: Check the FD5000 series inverter is ready or not, the light "running" on the touch screen should be gray, fault status should be normal, and no warning and fault information. If there is a fault or alarm no remove, refer to the information that “Fault detection and removal” in Chapter 9.

Step2: Change the frequency.

Step3: If it is the control on touch screen, click the button “run” in the state of running screen. If it is the DCS control, give the digital signal to start the inverter.

5.3 Change the frequency

Operation on the touch screen: enter the running state screen, click the button “set frequency”, enter the value is OK

The DCS control: give the analog signal such as the current 4-20mA or the voltage 0-5V to set the frequency.

The host computer control: set the value in the window “set frequency” to change the frequency.

“Multi-step speed” control: change the state of switch to change the frequency.

5.4 Deceleration to stop

If operate on the touch screen, click the button “stop” in the “running” state screen.

If the remote control, give the digital signal to stop the inverter.

Notes: Click the button “run” in the touch screen, the button “run” in the control cabinet or give the digital signal to start, the inverter will run to the setting frequency again when it doesn’t decelerate to the stop frequency.

	◆ Wait for 10 minutes to touch the main circuit or the motor, the high voltage in the cell is dangerous. ◆ Set the frequency to zero by the frequency knob is forbidden.

5.5 Power off

Step1: Stop the inverter.

Step2: Disconnect the AC input breaker.

	◆ Don’t touch the main circuit or the motor until the ground switch is connected. ◆ If the input switch is open, the DC voltage will fall to the safe value after 10min. ◆ The ground switch of control cabinet can be connected when the DC voltage of the cell falls to the safe value. ◆ The power to the control cabinet can not be disconnected when the high voltage is on.

Step3: Disconnect the input and output switch QS1, QS2-2.

5.6 Running state monitoring

Signals of running state: running and fault signals.

Running signal: view the running information at the main screen or at the “running state” screen.

5.7 Switch from MVD to grid power

5.7.1 The manual switch cabinet operation

Step1: Stop the inverter.

Step2: Disconnect the input AC breaker

Step3: Disconnect the input switch QS1

Step4: Disconnect the output switch QS2-2.

Step5: Close the bypass switch QS2-1.

Step6: Close all the doors except control cabinet.

	◆ If not all the door are closed, it will alarm.

Step7: Close the input breaker.

5.7.2 Automatic switch cabinet operation

If the user chooses the automatic terminal cabinet and the manual mode, the switch process is as follows:

Step1: Stop the inverter.

Step2: Disconnect the input AC breaker

Step3: Disconnect the input switch QS1.

Step4: Disconnect the output switch QS2.

Step5: Close the bypass switch KM4.

Step6: Close all the doors except control cabinet.

Step7: Close the input breaker.

	◆ If all doors are not closed, it will alarm.

If the user chooses the "auto" mode, the inverter automatically completes the conversion from MVDto grid power when it is in fault .The process is as follows:

When FD5000 series inverter is in fault, the controller sends the signals to open the input vacuum contactor KM1 and the output vacuum contactor KM3, after a moment, the bypass contactor KM4 automatically closes.

When the inverter is asked to turn to the grid power , press the button “grid power ”, KM1 and KM3 automatically open, then KM4 closes, the inverter will automatically run at grid power .

5.8 Switch from grid power to MVD

5.8.1 The manual switch cabinet operation

Step1: Disconnect the input AC breaker

Step2: Disconnect the bypass switch QS2-1.

Step3: Close the input switch QS2-2

Step4: Close the output switch QS1.

Step5: Close all the doors.

	◆ If not all the door are closed, it will alarm.

Step6: Do the start process as before.

5.8.2 Automatic switch cabinet operation

Step1: Disconnect the input AC breaker

Step2: Disconnect the bypass switch KM4.

Step3: Do the preparation before start which is shown in 5.1.

5.9 The stop modes of inverter

5.9.1 Normal stop

“Operation on touch screen/DCS/host computer” run and stop modes

- DCS control，press the “stop”button to stop the inverter.
- Host computer control, click the “stop” button on the main running screen to stop the inverter.
- Operation on the screen, click the “stop” button on the running screen to stop the inverter.

5.9.2 Emergency Stop

In any case, the "stop" button on operation station and the "stop" button on inverter door are both effective. When the inverter receives an emergency stop command or a serious fault occurs, it will immediately blocks the pulse of the cell, the motor and machine will stop freely.

When the inverter is in serious fault, press the "stop" button on operation station and the "stop" button on inverter door, it not only blocks the pulse of the cell, but also disconnects the high voltage.

5.10 Inverter maintenance

Step1: Disconnect the high voltage doing as the 5.5.

Step2: Open the door of the control cabinet, the ground wire must be connected.

Step3: If the motor is asked to run and the inverter has a spare wire cabinet, do the processes from MVD to grid power which is shown in 5.7.

	◆ Don’t open the door of the wire cabinet when doing the maintenance, because the high voltage is on .

Step4: The maintenance for transformer cabinet and power cabinet , which is shown in chapter 9 “Fault Detection and Elimination”.

Step5: When the maintenance is end, please disconnect the input ground wires.

Step6: If the inverter is not running at the grid power, now is asked to turn to the MVD side, do the star process which is shown in 5.2. If the inverter is running at the grid power, now is asked to turn to the MVD side, do the processes of switch from grid power to MVD which is shown in 5.8.

Chapter 6 Installation Instruction

This chapter introduces the electrical installation and mechanical installation of FD5000 series of intelligent high voltage inverter, including the cabinet installation and the connection of ground wires, main circuit, motor and control parts.

6.1 Safety rules for installation

Please read the safety instructions in chapter 1 carefully and obey the rules as follows:

	◆ It is a high voltage equipment; any wrong operation may cause personal injury or property losses. It should be located, installed and connected according to the guidance of the manual. ◆ All electrical installation must be completed by experienced electrical engineers according to the national power utilization standards. ◆ The installation room shall have enough lighting for the maintenance and operation. ◆ Only the trained engineers of our company are authorized to commission. ◆ All the work must be carried out when the main power supply and auxiliary power supply are off. The input and output isolation switches must be open, the earthing switch must be closed. The input main power supply wires must be grounded. ◆ When main power supply is off, wait for more than 10 minutes after the capacitor of the power cells is discharging, the operation to inverter, the motor and the wires can be done. Before the operation, the equipment connected with the system must be completely grounded and the auxiliary power supply is closed.

6.2 Requirements of foundation, space and surrounding environment

◆ Requirements of environment: please refer to the technical requirements as follows. For the environment conditions, air temperature and elevation etc, that may exceed the indexes, it may need to reduce the rating of the inverter with sufficient air flow. Other

factors (such as relative humidity, air pollution degree, attack and violation) should be within the maximum allowable ranges.

In order to guarantee the long-term, stable and reliable operation, there are some requirements of the installation environment for the converter as follows:

The minimum environment temperature is -10℃, while the maximum temperature is 40℃, and the temperature variation of the working temperature should be no more than 5℃/h. If the temperature exceeds the allowable value, the air conditioning equipment should be added.

The installation height should be less than 1000m. If it exceeds the 1000m, special design should be considered.

The environment humidity is required to be less than 90% (20℃) and the relative humidity variation rate should not exceed 5% per hour, so as to avoid condensation.

Do not install the inverter in the polluted environment with large dirt, corrosive or explosive gases and conductive dust.

Vibration conditions of installation: vibration frequency is from 10Hz to 150Hz and the vibration acceleration is not more than 5m/s^2. When the inverter begins to resonance as the installation stablemate vibrates, vibration attenuation measures for the inverter should be taken.

◆ Basic size and space: the cabinet size and bottom board installation diagram of the inverter shown in installation drawing. All cabinets should be installed based on the drawing and reserved with enough space to guarantee air flow and maximum door swing as well as maintenance space. Besides, the channels to enter the installation should be provided to ensure the space for auxiliary equipment to transport the system.

◆ Basic level and cable duct: the FD5000 series of cabinets must be installed vertically, the foundation must be made of nonflammable materials, it should have smooth surface, must be damp-proof and can bear the weight of the system. The cable pipes must be made of nonflammable materials, it should have non-wear surface, must be damp-proof and dust-proof, and prevent small animals entering.

6.3 Installation of the high voltage parts

6.3.1 Requirements of AC input power supply

- The voltage fluctuation should not exceed ±10%.
- The frequency fluctuation should not exceed ±5% and the frequency variation per second should not exceed ±1%.
- Unbalance degree of three-phase voltage: the negative sequential quantity should not exceed the positive sequential quantity by 5%.
- Power supply harmonic composition, the root-mean-square value of the voltage relative harmonic content should not exceed 10%.

6.3.2 Considerations

The FD5000 series of high voltage inverter is the dangerous equipment, and the correct installation can guarantee safety of users, especially the installation of high pressure part must obey the relevant high voltage electrical installation standands, such as:

◆ High voltage installation personnel must be subject to professional skill training and obtain corresponding qualification certificate.

◆ All input and output wires must meet the electrical insulation requirements, and connecting wires that do not meet the technical requirements should not be used, so as to prevent the harm to the personal and equipment.

◆ All high voltage connectors must be subject to insulation treatment to guarantee the good insulation.

◆ The high voltage connection parts must be clean and meet the requirements

◆ The electrical insulation distance of the high voltage parts must comply with the requirements of electrical safety distance, so as to avoid the short-circuit.

◆ Non-professional personnel cannot open the cabinet door for application or detection.

◆ The inverter has been subject to breakdown voltage test before leaving the factory, so it is not necessary to do it again.

◆ The input and output wires must be separate to prevent insulation being damaged and danger.

◆ There should not be capacitor which is used to improve the power factors on the motor.

◆ Consider the lubricating effects of the fan equipped with the motor when it runs at low frequency, and capability of the bearing when it runs at high frequency.

◆ The change from three-phase to two-phase is forbidden, or it will cause lacking phase.

◆ Guarantee reliable connection of the inverter cabinet and the ground wires to ensure personnel safety.

◆ Before measuring the transformer insulation resistance and doing the test of breakdown voltage, disconnect the connection wires between the transformer and the power cells.

◆ After the circuits are connected, careful check should be done ,the motor wire and the power supply wires are connected inversely is forbidden.

◆ Check whether the inverter capacity, motor power and the connector specification are matching or not and the conductors are no damage.

◆ After all connections are completed, electrical insulation detection should be done,the voltage values are referred to the following values: the voltage is 25kV for the 6kV system, the voltage is 35kV for the 10kV system.The actual insulation test voltage should be 75% of the mentioned values.

	When carrying out electrical insulation detection test to the system, the test should be carried out after the transformer cores and all secondaries are short circuited to the ground, or it will damage the system.

◆ The identifications of high voltage parts must be clear, so as not to cause errors.

6.3.3 Installation of large current locations

In order to make the system meet the application requirements and reach the technical performance better, pay more attention to the installation of parts with large current (more than 10A should be taken as large current terminals). The rules are as follows:

◆ The material of ports should be with perfect conductivity.

◆ The ports should be carefully washed by alcohol before connecting.

◆ The connection should be very reliable, important connecting points shall be reliably wrenching by torque wrench, so as to ensure the contacting resistance is less than 2 milliohms.

◆ The fastening pieces for all connection parts with large current should include the spring washer,

and the spring washer shall be flat after fastening,

◆ The current density of connecting wires with large current should be suitable, so as not to cause heat and influence the equipment application.

6.3.4 Requirement of the device and wires

◆ Breaker of main circuit

The breaker of the main circuit can be vacuum breaker or gas insulation breaker. It should not only meet the requirements of power supply voltage and current, but also meet the requirement of rated voltage and current at the primary of the transformer. In addition, its basic electrical characteristics must bear the switch on impulse current of the transformer, and it should disconnect the secondary cause by short circuit in100ms.

◆ Protection equipment

The switch of FD5000 series high voltage inverter must be set with the protection, and the values should be set refer to the follows:

When the primary winding or the input wires of the transformer are subject to short circuit, the input switch should open immediately. The value of the protection current should bear the no-load switch on inrush exciting current of the transformer and will not act (which can be set at eight to ten times of the rated current of the rectifier transformer).

The delay tripping mode for protection of the secondary is used, when the secondary winding of the transformer, wires connecting to the secondary and the cells ,the input rectifier bridge of the cells are subject to short circuit, the input switch will open. The delay time is short and the setting time can be adjusted to long enough to guarantee the transformer normal running during the inrush exciting current period of transformer. The value can be set two times of the rated current, so as to trip within 500ms in case of failure of the secondary.

Overload protection is the inverse time limit characteristic, and it can gurantee the long-time overload of the transformer and the wires.

◆ Wires of the transformer primary

There is no special requirement of the wires between the breaker and the primary of transformer. Its rated voltage should be identical with the voltage of the primary. The rated current of wires should meet the setting values of the transformer and the protection. The wires decelerating value should refer to the maximum temperature, cooling conditions and other factors required by local electrical rules and regulations, and the installation should comply with the standards for high voltage devices.

◆ The output wires to motor

There are no special requirements for the output wires and the length should not be more than 1000m. The rated voltage should be identical with the type of motor and the rated current of wires should meet the requirement of allowing overload current. The wires decelerating value should refer to the maximum temperature, cooling conditions and other factors required by local electrical rules and regulations, and the installation should comply with the standards for high voltage devices.

6.4 The grounding of MVD

The users should guarantee the grounding resistance of the wire used is less than 4Ω, and the wires between the ground point of FD5000 series system and that of power grid should be not less than 50mm$^{2.}$

When the equipment is being installed, special grounding electrode should be embedded for the system. The grounding resistance should be not more than 0.5Ω.

6.5 Auxiliary power supply and wires

The single phase 220VAC power supply should be provided, and the capacity of power supply for FD5000 series system should be not less than 2kVA.If the power supply can not be provided or the quality of power supply can not be guaranteed, please contact us for help.

Pay attention to the phase sequence of power supply when connecting. The wires of auxiliary power supply should be in accordance with the industrial standards.

6.6 Wires for control signals

Control wires should be selected in accordance with below table. The shielding wires should be single side grounded. One or more pairs of twisted wires can be used.

Requirements of control wires

Types of signals	Types of wire	Sectional area (I/O ports)
Analog input	shielding wires	0.5～2.5 mm^2
Analog output	shielding wires	0.5～2.5 mm^2
Digital input	shielding wires	0.5～2.5 mm^2
Digital output	shielding wires	0.5～2.5 mm^2

6.7 The wiring

6.7.1 Power wires

The arrangement of main power supply and motor wires should be in accordance with national standards, and the instructions and advice of the wire's producers are as follows.

◆ The single shielding steel armored three-phase wires are recommended. If single-phase wire is used, the three-phase wires must be combined to ensure the EMC characteristic.

◆ If the sectional area of the shielding wires is less than 50% that of single-phase, an additional wire must be added to avoid overheating of the shielding wires

◆ In accordance with the requirements of wire producer, the wire connector must be installed at the cable socket.

◆ The output voltage and the current waveform are close to sine, the voltage drop caused by the length of the wire should be considered, but the length of the wire should not exceed 1000m.

◆ The ground wire connection should be in accordance with national standards on electric installation.

6.7.2 **Control** wires

In order to guarantee the normal operation of the system, various signal wires must be normal to avoid EMI. When installing, the wires between external signal circuit and DCS system, the input/output wires of various sensors, various signal detection wires must be correctly installed.

◆ The signal wires and power supply wires, especially large current and high voltage wires must be separately arranged to avoid electromagnetic interference. The control wires and power wires should not be parallelly arranged. If the cases can not be avoided, the distance between the control wires and main wires should not exceed 30cm. The control wires and power wires should be arranged in the angle of 90°

◆ The digital signal wire and analog signal wire shall be arranged separately to avoid the interference.

◆ If the signal wire and power supply wire must be arranged in the same place, shielding measures must be taken for the signal wire to eliminate the interference to the signal wire caused by the power supply wire.

◆ The signal wire and power supply wire should not be parallelly arranged to avoid interference.

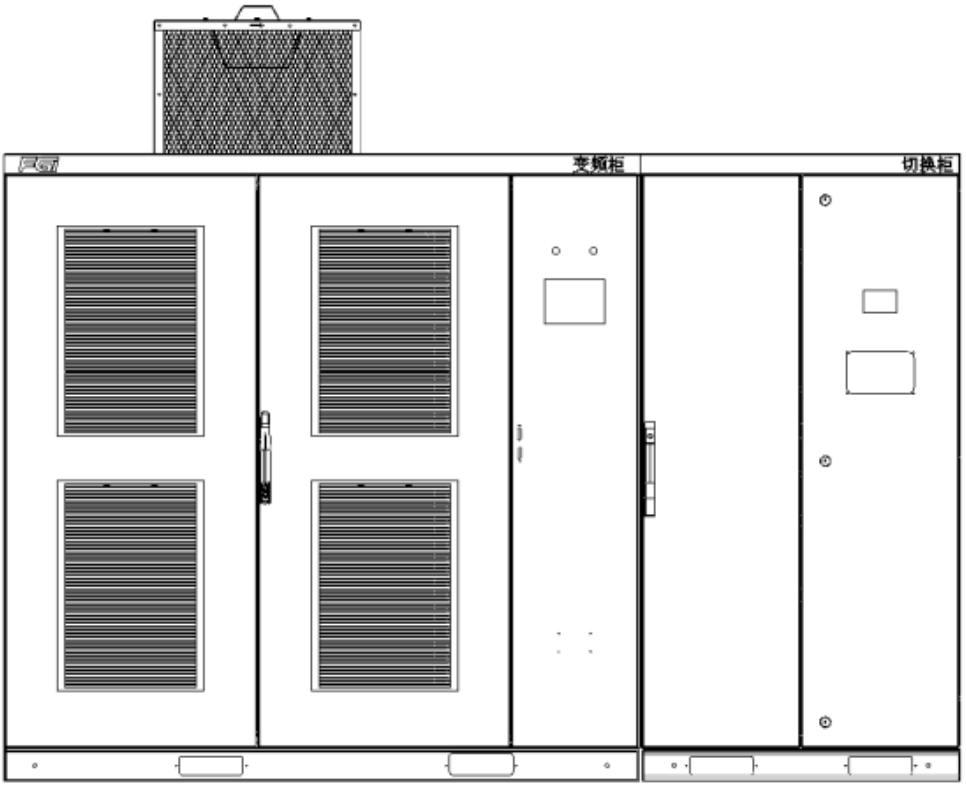
◆ The signal ground must be connected to shielding wire reliably, and the shielding wires must be connected to ground reliably.

◆ The signal wire can adopt the conductive metal pipes and be connected. In this way, interference signals can be separated to ensure the normal operation of the system.

6.8 Mechanical installation

6.8.1 The mechanical structure

The FD5000 series inverter includes transformer cabinet, power inverter cabinet and control cabinet. Input and output wire cabinet, bypass cabinet are needed in some conditions.The equipment should be arranged according to the occasions.



The cabinet structure of FD5000 series inverter

The system is made up of two cabinets, installed on the steel foundation frame based on concrete, its surface irregularity is less than 5mm. The input transformer should be transported alone, when it is landed, it should be installed on the steel foundation.

If the power cells separately packed and transported, it should be installed to the slide-way of the power cabinet when it reaches the destination. If the power cells packed and transported with power cabinet, it should be removes the beams when packed.

After assembling, connection, location, they should be welded on the foundation channel steel. The wire connections of the cabinet should be conducted and completed under the guidance of our company.

6.8.2 Installation of cabinets

The following installation guidance applies to general installation conditions in the industrial environment. If they are applied to special environment or conditions, please contact us for detail installation procedures.

◆ Before installing, all the conditions in the 6.2 requirements for the foundation, space and surrounding environment should be meted.

◆ Use the equipment to check the basic level. The acceptable maximum overall irregularity is less than 5mm.

◆ Move the equipment to the installation places. If cranes are needed to move the FD5000 series equipment, the cabinet equipment must be protected from paint damage.

◆ Open all the cabinet doors, examine whether there is any transport damage to the system and the spare equipment carefully. If there is any component damage or missing, please contact us for replace. Please pay attention to the way of opening the cabinet door.

◆ Close all the doors

◆ Move the cabinet to the installation place by the forklift truck and crane carefully. When installing the equipment, the need of ventilation and heat dissipation must be considered. The distance between the equipment and the wall should not be less than 1500mm. The distance between the top of the equipment and the roof should not be less than 1500mm. The distance between the front side of the equipment and the wall should not be less than 1500mm.

◆ Check whether the door can be fully opened or closed. If not, the level of the cabinet should be adjusted. Check the mechanical mutual interlocking on the gate: before or during the operation, all the doors can't be opened except the door of the control cabinet. The electromagnetic lock can be opened only when the high voltage is powered off or with a key. If the cabinet door opens during operation, the system will alarm.

Note: please pay attention to the opening way of the cabinet gate. Open the cabinet door by force is forbidden, or the equipment may be damaged.

6.8.3 Installation of power cells

The dismantlement and assembling of the cell must be conducted by the guidance of the processional in our company.

◆ Open the package of the cell module of the system to check whether there is any damage. If there is any damage, please contact us for replace.

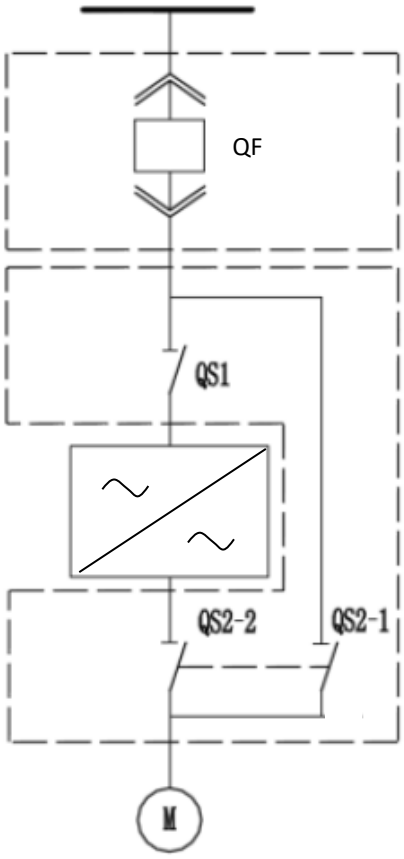
◆ Place the power cell on the rail and push it to the right place. Then tight the bolt.

◆ If the inverter is transported as the whole, the item will be omitted.

6.9 The electrical installation

The electrical installation includes connections of input and output power wires, wires among the cabinet, the signal wires between the cabinet and control platform.

6.9.1 The connection of input and output wires



The power circuit of inverter

It is the reference structure of the inverter, please do the process as the real.

The input power wires must be connected to the input terminals of MVD, and the phase must be correct.

The input power wires of the motor must be connected to the output terminals of MVD

Assure the value of input voltage, the diameter of the wire and breakdown voltage are right.

Assure the lightning protection is done.

6.9.2 The wires among the power cells

Note: please do the connection with the professionals of our company

◆ Connect the input wires of the cell to the transformer

◆ Link the cells in series as the star connection, the star point is near the control cabinet and the outputs are connected to the switch cabinet or wire cabinet.

◆ Connect the fibers of main control box to the cells.

6.9.3 The connection of power wires

Please connect the power wires among the power supply, inverter and motor refer to the drawings, the shielding wires for motor must be connected by the motor side.

	◆ The connections must be done by the professionals. ◆ Open the switch of 220V AC when connecting. ◆ Open the input and output switch of the inverter, the ground wires must be grounded. ◆ The hit and vibration are forbidden when connecting. ◆ Put the fence to prevent the little animals for protection. ◆ Only the professionals can give the high voltage after the inverter is right.

Do the connections among the motor, inverter and other equipments as the manual introduced:

◆ Make sure the input switches of high voltage and auxiliary power are open.

• Open the input switch of high voltage and close the ground switch.

• Open the switch between the motor and high voltage, close the ground switch.

• Any equipment connected to the inverter must be disconnected.

◆ Open the door of the power cabinet then do the connection of the power wires.

◆ Connect the power wires between the primary of transformer and high voltage. If the wires cabinet is chosen, please connect the wires to the input ports.

◆ Connect the wires between the motor and the output ports.

◆ Test the wires before the connection.

◆ Connect the shielding wires to the ground copper row.

◆ Close all the doors and tight all the bolts.

	◆ Don’t cut the wires in the cabinet. The dirt and waste is not allowed in or it may cause the damage to the inverter. ◆ The wrong connection of input and output wires is forbidden or it will cause the damage to the inverter. ◆ Connect the output wires to the motor according to the rotation.

6.9.4 The power supply wires in control cabinet

The wires come from the bottom of the control cabinet, please do as follows:

Open the front door of the control cabinet, connect the wires to the ports. If the shielded wires are used, please connect the shielded wires to the ground.

6.9.5 Connections of control cabinet

Open the input switches and auxiliary power switch, link the signal wires according to the wire drawings.

	◆ Connect the shielded wires to the ground. ◆ If the inverter is not tested , don’t close the input switch .

Chapter 7 The commissioning

FD5000 series high voltage inverter can only be commissioned by professionals in our company. The functions test, commissioning, and original parameters adjusting should be done by professionals in our company. The final function test and original parameters adjusting should be done by professionals and the users. The contents which users should know are as follows:

7.1 Preparation for commissioning

◆ Do the installation of FD5000 series inverter according to the guidance in chapter 6.

◆ The high voltage switch has been connected and can be operated.

◆ The rectifier transformer has been installed, connected and is ready to run.

◆ The motor has been installed, connected and is ready to run.

◆ All the wires are connected.

◆ All the shielding wires are connected.

◆ The insulation of the wires, transformer and motor must be tested and should comply with the manual. A formal test report should be afforded.

◆ Provide the main power supply.

◆ The load (pump, fan etc) is ready to run.

◆ All the auxiliary control wires are connected.

◆ The switch of the auxiliary power supply is connected and is ready.

◆ The control wires are connected.

◆ Provide auxiliary power supply.

◆ All the cabinet doors are closed.

◆ Get all the guidance documents, graphs and materials from our company.

7.2 With help of professionals

During the commissioning, the users should do the operation with the help of no less than two professionals. The conditions are as follows:

◆ Be familiar with the low voltage electrical equipments and relevant safety rules.

- Be familiar with the users' loads.
- Do the operation to medium and low voltage equipment (the breaker, the medium and low voltage switches)
- Do the operation to the drive equipment

7.3 Test and acceptance

When the commissioning is finished, the result data draft should be accepted and signed by the users and professionals of our company. The professionals of our company should write two commissioning reports as the same, one is for the user and the other is for our company to keep a record.

Chapter 8 Maintenance

This chapter introduces the maintenance of the FD5000 series of inverter. List all maintenance and spare parts replacement work done by the users of the company. In addition, the maintenance for users is described in detail.

8.1 Safety instruction

	◆ If you do not follow the guidance of the safety instructions in Chapter 1, the operation is very dangerous。 ◆ Only the trained and qualified persons can do the maintenance operations for the inverter.

◆ Obey the manual when doing the operation, the damage and danger will be avoided.

◆ Read the information of safety instructions carefully, any damage to the inverter that users didn't do the operation as the manual, the company takes no responsibility for it.

◆ All electrical work for the FD5000 series must be completed by the qualified electrical engineers according to the national electrical standards.

◆ Maintenance must be carried out in the condition that high voltage power and auxiliary power supply are off for 10 minutes. The input and output switches must be open, and the input high voltage power switch must be grounded. Don't touch the high voltage circuit and the motor without switch grounding. When the input high voltage power supply is off, any operation to the inverter, motor and power wires must wait for the DC capacitor of the cell is discharging.

◆ Some loads may provide a mechanical torque to the motor. If the load can drive the motor to rotate, the motor must be separated from the load or mechanical blockage is used.

◆ Even FD5000 series high voltage power and external auxiliary power supply is off, there may be a high voltage from an external control circuit (for example the faulty wiring or other reasons). Before beginning any work on all external devices, do the proper

measurement to the equipment such as the auxiliary power supply, heaters, coolers, I / O interfaces, PT, and so on.

◆ Turn on the power after all the follows are done.

(1) Connect the inverter to the motor.

(2) Connect the control power supply to the control circuit

(3) Remove all the tools and waste out.

(4) Close all the doors.

8.2 The process of the maintenance

The process of stop for maintenance

Do the operation as below table to stop the inverter to ensure the safty

◆ Obey the safety guidelines in the first chapter and the safety instructions of this chapter.

◆ Turn off all the power supply

	◆ Any operation to the power circuit and motor is not allowed when the high voltage is on and input switch is not grounded. Wait for 10 minutes after the DC capacitor of the cell is discharging before doing the operation to inverter, motor and wires after the input switch is grounded. ◆ All the equipment and inverter must be grounded and turn off the auxiliary power supplies.

◆ Turn off the auxiliary power supplies and all the equipment that may do harm to the inverter

◆ Do the maintenance according to the maintenance process.

	◆ Any operation that not mentioned at this chapter is not allowed to do.

◆ When the maintenance finishes, please check the follows:

(1) Connect the inverter to the motor

(2) Connect the control power supply to the control circuit

(3) Remove all the tools and waste out.

(4) Close all the doors.

◆ Restart the inverter, please do the operation according to the fifth chapter.

◆ Write down all the information on the maintenance book

(1) The time and date

(2) The operations for the inverter

(3) The special replaces or conditions.

8.3 Maintenance plan

The correct maintenance is the necessary condition for the long term and stable running of the inverter. In addition to system emergency maintenance, preventive maintenance should be planned, includes the weekly maintenance, monthly maintenance, quarterly maintenance and annual check.

8.3.1 First running of the inverter

◆ Check and clean all the connecting parts of the invterter, the connecting parts of the transformer, the connecting parts of the power cabinet.

◆ Please stop to tight the screws when the inverter is running for a week.

◆ Check all the ground wires.

◆ Check the cooling condition of the equipment and clean the air channels carefully and regularly.

8.3.2 Daily Check

◆ Check the temperature and humidity of the environment, vibration and so on, there should be no dust, gas and condensation

◆ It should be no abnormal vibration, noise or odor.

◆ Check the interface of the human machine and there are no warning information and the latest incidents to be processed.

8.3.3 Monthly Check

◆ Check the air filter in doors, the obvious dirt should be removed when cleaning. The tools can not be deep inside to prevent the electric shock. After the cleaning the air filter should be installed in time.

◆ If there is obvious dirt in the fin of the cell, please remove it in time. Pay attention to the high voltage on the pins, do the processes according to the rules of maintance.

◆ Check the cooling system: The paper of A4 should be attached to the ventilation window when it is normal running.

8.3.4 Quarterly Check

◆ Check all the contents of the month, and then tight the connections.

◆ Clean all the waste in the cabinet, pay attention to the high voltage.

8.3.5 Change the components

◆ Replace some consumable components periodically for example fuses.

◆ It is a good to change the big part of the inverter, when it is in fault, the type must be the same with the original component. Ask for help for the company when it is in fault.

8.4 The maintenance items

Maintain items	Maintain people	Maintain cycle	Safety requirement	Instructions
The outside cleaning	user	No longer than a year	No stop	If there is dirty, then clean it
The inside cleaning	User or professional	Once a year	Stop	If there is dirty, clean it
Check the wires such as the control power wires and the control wires	User	In a year when it first running After that every four years	Stop	Tight the screws when checking
Check the inside wires	Professional	In a year when it first running	Stop	

		After that every four years		
Clean the air filters in doors	User	Monthly or when it is overheat	No stop	Pay attention to the high voltage
Change the fan	User or professional	When it is running more than 30000 hours or according to the reality	Stop	Check the parameters
The spare of the parameter	User	When the parameter changes	No stop	
Insulation test	User	Every two years	Stop	Do as the sixth chapter 6

The details for maintenance item are as follows:

8.4.1 Outside cleaning

Check the air filter when it is dirty using the cloth or vacuum cleaner. If it is too dirty the water can be used, it should be completely dry before the reloading, so as not to affect the insulation performance of the cabinet.

8.4.2 Internal floor cleaning

- ◆ Turn off the power supply as the process in chapter 8.2.
- ◆ Do all the safety measures.
- ◆ Clean the internal floor by the vacuum cleaner.

	◆ Be careful, don’t damage the equipment when cleaning the internal floor.

- ◆ Do the process according to the maintenance in chapter 8.2.

8.4.3 Check the connection

- ◆ Turn off the power supply as the process in chapter 8.2.
- ◆ Do all the safety measures.
- ◆ Tight the power supply wires and control wires.

	◆ The wires in cells are not allowed to check.

- ◆ Do the process according to the maintenance in charpter 8.2.

8.4.4 Replace the air filter

◆ Unscrew the bolt and take the cover and air filter out from the door.

◆ If the cover is dirty, clean it then installed when it is dry and tight the bolt. At last, write down the date.

8.4.5 Change the fan

◆ Turn off the power supply.

◆ Open the doors of power and transformer cabinet when the wires are grounded.

◆ If it has the air duct, take it and fan fixing plate out.

◆ Take the wires out.

◆ Unscrew the bolts and take the fan bracket out.

◆ Install the new fan and screw the bolt. If it has the air duct, tight it.

◆ Check the fan is right or not, do the process as the process in charpter 8.2. The fan should drive the wind out.

8.4.6 Check the motor and fuse

Do the process according to the instruction.

8.5 Maintenance log

Every maintenance log should include:

- Date and time
- The work done for maintenance
- The special replaces or conditions.

Chapter 9 Fault detection and elimination

This chapter is the information for the electrical engineer who is responsible for the maintenance for the FD5000 series inverter when it is in fault. The electrical engineer must read this chapter carefully.

⚠	◆ Any operations that this manual not mentioned such as measurement, devices change and maintenance are not allowed. ◆ The operations for example the maintenance and installation only can be done by the professional in the company, the user can be trained to do these when the inverter is out of the warranty.

9.1 Fault classification

When the inverter is in fault according to the influence it can be classified: light fault and serious fault.

◆ The light fault: the light overheats of the transformer, the fault of the cabinet door, fan fault of the power cabinet, the fault of Industrial Personal Computer.

The controller DSP doesn't remember the light fault, when it occurs, the inverter doesn't stop and it can start again.

◆ Serious fault: such as the serious fault of cell (second over voltage, under voltage, upload communication fault, download communication fault), the fault of system or the fault of the contactor and so on when it occurs, the controller DSP will remember it and alarm and the input connector opens. When the fault is removed, the inverter will start again. When the serious fault occurs, the input connector will open, if it doesn't open, please press the button "stop"to open the connector.

◆ Alarm: when the light fault occurs, the inverter doesn't need to stop, it will alarm, some operation can be done. If the alarm is not removed, it will lead to the serious fault. Please view the information of alarm and fault in table 9-1 to see the type of the fault, causes and solutions.

9.2 Fault instruction

When the system is in fault to stops or keeps alarming, the power of the controller is normal, the "fault record" on touch screen will display alarm information or fault instruction will be shown.

When the fault is removed, click the button “reset” on touch screen to reset the system. The fault information will not be shown again and stored in the fault records.

9.3 Fault record

More than 1000 of the recent fault information records can be stored in the controller of FD5000 series inverter. The information includes the date, time, content of a fault or alarm, the input and output state of the system and the state of the control when the fault occurs.

9.4 The fault detection process

If the inverter is in fault, do as the follows:

◆ The instruction: Be familiar with fault information of this chapter and the safety instruction of the first chapter.

◆ View the information of the fault record, write it down and don’t clear it.

◆ Analyze the reason of the fault and make the log records.

◆ If it is asked to turn to the grid power, do as the process from the MVDto grid power in 5.8.

	◆ Any operation is not allowed when the high voltage is on. Open the breaker, input switch and the ground wire must be connected, then the do the repair to the main circuit and motor. ◆ After the high voltage is off, any operation to inverter, motor and wire within 10 min is not allowed when the voltage of the capacitor is high. ◆ The ground wire between the inverter and other devices must be connected and the auxiliary power supply is off before the operation.

The information about the fault is list in table 9-1, including:

()1 The data and time

(2) The state of load (the rated load, overload or light load, rising frequency or reducing frequency and so on);

(3) The parameters of the controller

(4) The environment and running conditions (the temperature of the environment and cooling condition and so on)

The information of the fault must be afforded when communicate with the professionals in our company, it is meaningful to remove the fault:

◆ Do as the instruction in 9.1 to remove the fault.

	◆ Any operation to the inverter that not mentioned in the manual is not allowed. Do as the manual introduced to remove the fault.

Do as the manual introduced, if the fault is not removed, please communicate with the professionals in our company.

◆ Detection:

(1) Check the wire from the inverter to the motor.

(2) Check the wire from the auxiliary power to the control circuit.

(3) No tools and other material are left in the cabinet.

(4) Close all the doors.

◆ Turn on the auxiliary power.

◆ Start the inverter do as the process in chapter 5 operation instruction.

9.5 The information of alarm, fault, causes and solutions

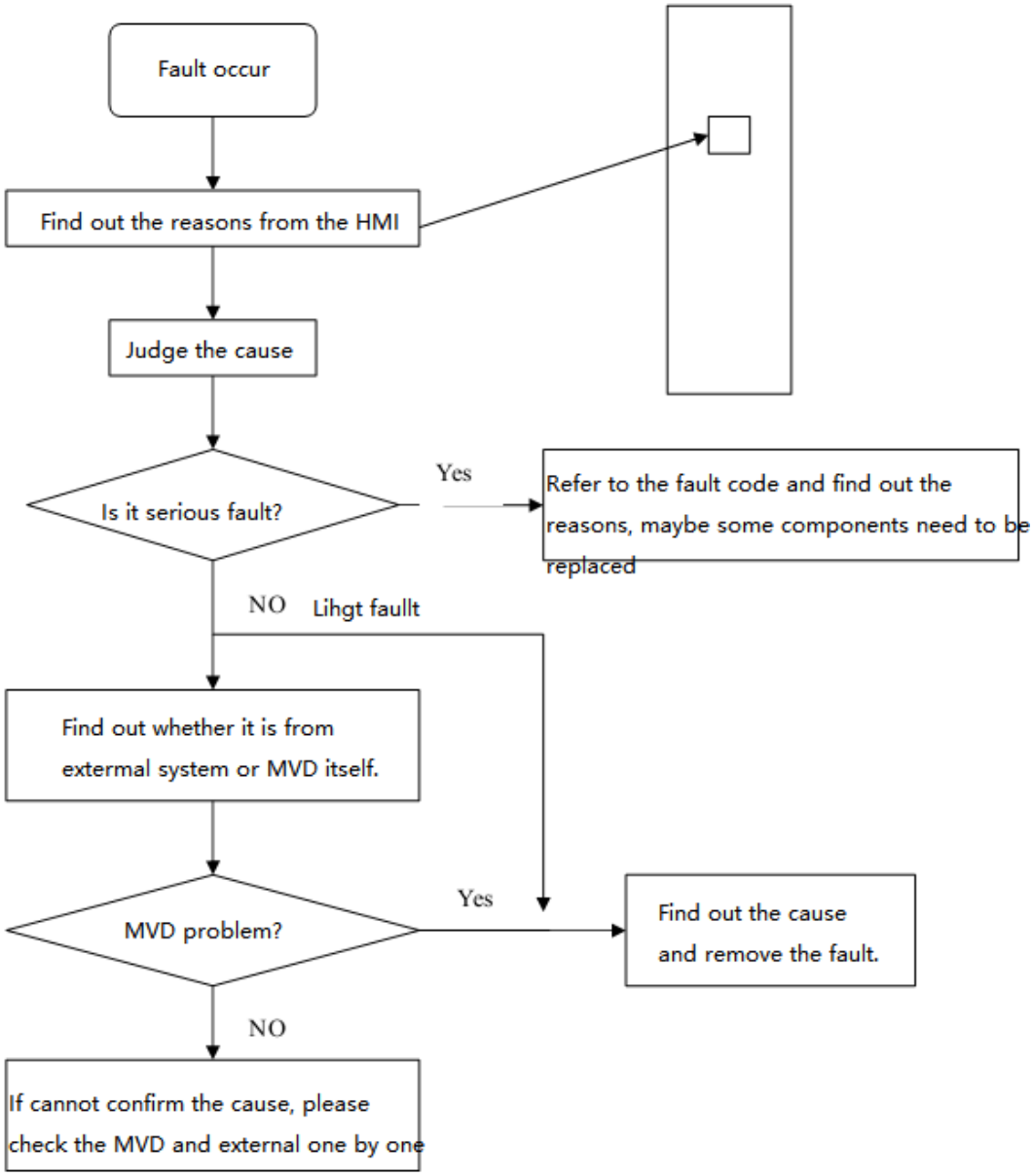
9.5.1 The detection of fault

Look for the cause of the fault:

1, It is the serious fault，change the parts if necessary.

2, Do as the operation in chapter 5 the inverter will start again, in order to find out the reason, the instrument is needed.

3, The cause is clear, reset the fault the inverter will start again. The solutions are different according the causes, the process is shown in figure 9-1.



Flow chart of fault process

Fault occurs

Look for the causes on the touch screen

Assure the causes

Whether the serious fault or not --- Yes--- Assure the causes according to the fault codes, the replacing may be needed ---NO---Assure the running state, remove the causes

Assure the cause is from host computer system or the inverter

It is from the inverter

Check the parts as the manual introduced

9.5.2 The classification of light fault

The inverter can also run when the light fault occurs and it only provides sound and light alarm, the user can view the cause of the fault on the touch screen.

When the light fault occurs, the inverter doesn't stop and only provides sound and light alarm, click the button "reset", the alarm will be removed. When the light fault occurs, the inverter can start from stop and the solutions must be taken or it will lead to the stop .For example, when the transformer is over temperature, the sound alarm occurs, if the inverter run to the limit temperature, then light fault will turn to the serious fault.

The light fault includes:

- The analog signal disappears
- The power of the control circuit is off
- The light overheat of the transformer (adjustable)
- The door of cabinet is open during running

9.5.3The classification of serious fault

When the serious fault occurs, the inverter will block the pulse of the cell and give the signal to open the input switch, then the motor stops freely.

When the serious fault occurs, the inverter provides sound, light alarm and the information will be stored, click the button "reset" will remove the alarm.

When the serious fault occurs, the cause must be found to avoid the serious damage to the inverter.

The serious fault includes:

- The over current of the systerm
- The motor is 130% overload for 60s
- The high voltage is off
- the fault of the power cell
- The overheat of transformer
- The 150% over current of motor

9.5.4 The solutions to the common fault

The inverter is highly intelligent and has perfect fault detection circuit, can provide accurate position of all faults and give the information on the touch screen. Users can find the solution to the fault according to the information on the touch screen.

The solutions to the common fault

Types of faults	The causes	The solutions
The short circuit protection of the cell	The related cell is short circuit.	Check the condition of the cell or replace the cell
Over current when it accelerates	1) The time of acceleration is short 2) The curve of V/F is not fit 3) The restart for the motor at the moment stop occurs	1) Increase the time of acceleration 2) Check and adjust the curve of V/F and enhance the torque 3) Start the motor when it stops.
Over current when it decelerates	The deceleration time is short	Increase the time of deceleration
Over current when it runs at the constant speed	1) Sudden change of the load 2) The load is not Normal	1)Reduce the sudden change of the load 2)Check the load
The over voltage when it accelerates	1) The input voltage is not normal 2) The restart for the motor at the moment stop occurs	1) Check the input voltage 2) Start the motor when it stops.
The over voltage when it decelerates	1) The deceleration time is short when it is generating 2) The brake components are not fit 3) The input voltage is not normal	1) Increase the time of deceleration. 2) Choose the right brake components. 3) Check the input voltage
Over voltage when it runs at the constant speed	1) The change of input voltage 2) Renewable energy which is produced by load inertia.	1) Install the input reactor 2) Choose the right brake components
The fault of IGBT	1) Short circuit between the phases and the short circuit to ground 2) Air channel blocks or the fan is broken 3) The short circuit of IGBT	1) Replace the wires 2) Clear the air channel and replace the fan 3) Replace the fault power cell
The overheat of the cell	1) The fan is broken 2) The air channel is blocking. 3) The IGBT or IPM is in fault. 4) The fan is reversing.	1) Replace the fan 2) Clear the air channel 3) Replace the fault cell 4) Change the input power of the fan
Overload of the inverter	1) The sudden acceleration 2) The DC brake is too large 3) The set curve of V/F is not suitable 4) The restart for the motor at the moment stop occurs 5) The load is large	1) Increase the time of deceleration 2) Decrease the DC brake voltage and increase the brake time 3) Adjust the curve of V/F 4) Start the motor when it stops. 5) Check the load is normal or not.

	6) The power voltage is low	6) Check the power voltage
Overload of the motor	1) The set curve of V/F is not suitable 2) The motor stalls or load changes suddenly 3) The motor runs in low speed with large load 4) The power voltage is low	1) Adjust the curve of V/F 2) Check the load. 3) Choose the special motor, if the motor always runs at low speed. 4) Check the power voltage
The contactor doesn't connect.	1) The contactor is broken. 2) The control circuit is in fault. 3) The power voltage is low	1) Replace the contactor. 2) Contact the supplier 3) Check the power voltage
The power for the control cabinet is in fault	1) The power of 220VAC is off 2) The little breaker QF1 is broken or doesn't connect. 3) Control power supply detection relay ZJ0 is broken.	1) Check the power supply of 220VAC 2) Check the sate of QF1 or ZJ0.
The analog signal disappears	The frequency given signal disappears	Check the analog signal is normal or not.
The fault of the door	The door isn't close or the switch is broken.	1) Close the door of the cabinet 2) Replace the door of the cabinet
The phase failure of output voltage	The output voltage (U, V, W) is lacking.	1) Check the output wire 2) Check the motor and wire
The phase failure of input voltage	The input voltage (R, S, T) is lacking.	Check the input voltage
The Current detection circuit is in fault	1) Hall current sensor is broken 2) The auxiliary power supply is in fault 3) The amplification circuit is not normal.	Contact the supplier for support

9.6 Power cell bypass

9.6.1 Instruction of power cell bypass

The FD5000 series inverter can run with the fault cell using the function of cell bypass, it greatly increases the reliability of the system especially for the occasion of power plant.

When the cell is in fault，the inverter alarms and runs at low output voltage using the function of cell bypass. The fault cell should be replaced in the right condition.

9.6.2 The mode of power cell bypass

- ◆ When one cell is in fault, the fault cell will be bypassed
- ◆ When one cell is bypassed, the inverter can run with the balance output.
- ◆ The inverter runs at full load, when one cell is bypassed, the inverter must run at less load; if it runs at little load, when one cell is bypassed, the inverter will run the same. The series of system is different, allowing the amount of the bypass cells is different. The amount of cell is more than 6 of each phase, the inverter can run at full load with the control algorithm when one cell is in fault.
- ◆ When one cell is in fault，the inverter will alarm and the operator can view the information in the fault record.

9.7 Grid power bypass

The FD5000 series inverter is in fault, if it is the manual switch cabinet, please open the QS1，QS2-2， and close the QS2-1 which is shown in figure5-1；if it is the automatic switch cabinet，open the KM1, KM3and close the KM4. The motor can run at the grid power, the load control system will turn to the control mode of traditional wind door and valve. The bypass function will increase the adaptability of the inverter to ensure the continuous running, more details is shown in 5.8.

The operation of series FD5000 that from grid power to MVDwhich is shown 5.9 when the inverter is right from fault.

9.8 How to replace the fault cell

All cell module is same, if one cell is in fault, it can be replaced by the spare cell. The cell module replace steps are as follows:

step1: Click the “stop” button on the touch screen or press the stop button.

step2: Open the input switch

step3: Wait for 10 minutes for the next step

step4: Turn off the control power

step5: Pull the fibers in the fault cell off

step6: Take off the three input lines and two output copper Copper row

step7: Take off the fixed bolt between the fault cell and track

step8: Pull out the fault cell slowly

step9: Install the spare cell in reverse process as before

step10: Close the input switch

step11: Contact the supplier to repair the fault cell.

Chapter 10 Transportation, storage, processing and recycling

This chapter introduces the transportation, storage of FD5000 series high voltage inverter and the processing, recycling of the spare parts. In order to improve the reliability of system, the requirements of transportation and storage are presented. This chapter describes the requirements of transportation and storage in details.

10.1 Requirements of transportation and storage

The product can be transported by cars, trains, planes, ships and so on. Products must be handled carefully during transport, rain and stong sunlight are forbidden. There should be no strong vibration, impact, and upside down.

- ◆ Transportation and storage temperature (within 4weeks): -20 to +65℃
- ◆ Relative humidity: less than 95%, no condensation;
- ◆ Vibration (storage): the maximum is 0.3mm (2 - 9 Hz), the maximum is 0.1g
- ◆ Vibration (earthquake): the maximum is 9mm (5 - 35Hz), the maximum is 2g
- ◆ Impact (storage and transportation): the maximum is 10g

10.2 The Package

The good package design is needed to prevent pollution, such as water and dust. In addition, maritime and air transport should be concerned, the design should also prevent mechanical damage and serious weather conditions. So the system can bear the effects of sea, air and land transportation.

All the relevant cautions and instruction labels should be marked on the boxes for the proper handling, moving and storage.

10.3 Loading and unloading

A lifting device should be available when loading and unloading the system. Pay attention to the followings:

- ◆ Keep the system upright when handling.

◆ By the holes at the bottom of the cabinet

When unloading do as follows:

◆ Check the packaging: the damage caused by mechanical, impacts, water, humidity, heat and fire to the equipment.

◆ If the package is broken, do the operation that damage note described in the latter.

◆ Remove the packing materials carefully, do not use sharp or hard tools to open the box to prevent damaging to the shell of the system.

◆ Check the condition of system, pay attention to the notes:

(1) The Door and side panel deformed or not

(2) Control wires are loosing or not

(3) Unassembled spare parts

(4) The broken parts

(5) The dust layer

(6) Water or humidity

(7) Damage caucused by insects

◆ Open the rear door of the inverter, check the internal condition.

◆ Compare with the orders to prevent the missing spare parts. If any spare parts are missing please immediately contact us for help.

10.4 The Storage requirement

The requirement for the storage:

The range of ambient temperature: -5 ℃ - + 65 ℃

Relative air humidity: 5 - 85%, no-condensing

Keep the environment conditions are suitable for transportation and storage in the storage period.

Note: Do the follows if the system is stored for a year. If you want to store it longer, please contact us for help.

◆ Place the system on the wooden platforms.

◆ Block the wires entrance and ventilation slots with the wood. Put a layer of plastic or aluminum metal membrane in between the wood and the ventilation slots.

◆ Put a proper amount of desiccant: per unit desiccant (30g) can absorb 6g moisture. According to the packaging materials, the desiccant you need is followed:

(1) Polyethylene metal membrane: 10 units per square meter

(2) Aluminum metal membrane: 8 units per square meter

◆ Close and lock all the doors.

◆ Use the polyethylene material or aluminum metal membrane as protection package to prevent water entering:

(1) Polyethylene metal membrane: 0.3 grams per square meter for 24 hours

(2) Aluminum metal membrane: 0.01 grams per square meter for 24 hours

◆ Attach a humidity indicator inside the protection membrane (for example mechanical hygrometer). The hygrometer should be put on the front door of the system.

◆ Check the system regularly within the storage period. Check the storage and packaging conditions of system monthly. Pay attention to mechanical damage or damages caused by moisture, humidity, temperature or fire. If the package is broken or the system is subject to the damage caused by moisture, humidity, temperature or fire, open the packaging immediately and check the internal and external conditions of the system. Repair the broken parts then store the system as the above listed steps.

10.5 The spare parts

10.5.1 **Storage** instruction of spare parts

Check the spare parts carefully when receiving them. Once the damage is found, contact us for a record. The company is not responsible for it if the damage caused by external environment factors.

Pay attention to the follows within the warranty period in order to prevent the spare parts from damaging.

There should be no vibration and shock around the storage location, or damage of moisture, frost, temperature, dust and grit.

The environment condition should meet the requirements of temperature and humidity. Spare parts should be stored in a dry box, without insects and away from corrosive gases. Relative air humidity is from 5% to 85%, storage temperature is from -5℃ to +65 ℃.
The circuit board should be stored in the anti-static package and away from corrosive gases and gases with salinity or other impurities and freezing is forbidden. If the air humidity is above the maximum allowed value, do the operation to reduce it, for example heating to protect the spare parts.

10.5.2 **Operation** instruction of spare parts

When taking the spare parts out of original package, be aware of the electrostatic discharge. Wrong operations may cause damage to the sensitive components. The instructions below should be followed:

- ◆ Even the short distance transmission, spare parts should be packed to prevent static electricity.
- ◆ Hold the edge of the board and do not touch the ports and components.
- ◆ The circuit board and components should be put on a grounded operation table to avoid static electricity.
- ◆ Transport and deliver the faulty clamp as the new one to prevent static electricity.

10.6 Stop for a moment

When it is asked to stop for a moment, please open the input switch, the output switch of system should be grounded according to the instructions in chapter one. Pay attention to safety instructions and safety precautions. The system should be stored according to the requirements listed.

10.7 Deal with the package materials and waste

10.7.1 The package materials

Some of the packing materials can be recycled, the package design of FD5000 series inverter is to minimize the environment impact. Deal with the packing material according to the environment protection regulations.

10.7.2 Deal with the devices of system

Please open the input switch, the output switch of system should be grounded according to the instructions in chapter one before disassembling. Pay attention to safety instructions and safety precautions.

Correct action should be taken to deal with the electrolytic capacitors, printed circuit boards, electricity components and other parts according to national environment protection rules, make sure that no harm to the environment.

Chapter 11 Delivery and acceptance

11.1 Installation acceptance

Pay attention to the equipment installation inclination, the cabinet space, flatness and bearing, wires laying and grounding wires, whether they meet the requirements or not. Check whether the screws are tightening, the channel designed meets the requirements and is provided with a door, the duct meets the requirements or not.

11.2 Insulation acceptance

The insulation must be test when it is sunny and dry. If the equipment is wet, it must be dried or it will be damaged.

Obey the rules introduced in this chapter.

Open the lightning arrester device connection, the connection to voltage display device, the connection between output wires and cells, and the connection between the input wires and the transformer before the voltage test so as not to damage the equipment. In principle, our company has done the voltage test, it is not necessary for the users to do it again.

	◆ Obey the rules of the standard requirements for testing semiconductor devices, if not any operation that damages the inverter, our company will not be responsible for it.

11.2.1 The test method for high voltage phase shifting transformer

High voltage phase shifting transformer test is carried out in accordance with the national standards, the test contents include insulation and breakdown voltage, DC resistance test, the insulation that iron core to the ground. Before the test, please open the input switch and disconnect all the secondary windings. The tests of the breakdown voltages from high voltage side to the core or to the secondary windings, all the secondary windings must connect to the ground.

View the value of test voltage referring to the data before leaving factory, it should be 80% of the test value.

	◆ Open the connection between the sensor and the display device, or it will be damaged when doing the breakdown voltage test. ◆ Open the connection between the secondary windings to the cells and keep the safe distance, or it will be damaged.

11.2.2 The test method for vacuum contactor and switch in the switch cabinet

Please open the wires connection, and do the safety measures when these devices are tested and refer to the national standards. The tests for the switch, vacuum contactors include the breakdown voltage among the contacts and the DC resistance when it is turning on.

11.2.3 The breakdown voltage of voltage display device and insulation pillar

Connect the output wires to the ground when these devices are tested, please refer to the national standards.

11.2.4 The test method for wires between the switch cabinet and power cabinet

Disconnect the output wires from inverter to motor and do the insulation work for the wires when doing the test.

After the test, please connect the wires and tight it.

	◆ When doing the voltage test, open the connection between the test equipment and power cells, ensure the insulation distance is enough. ◆ Please contact the supplier for help when having a problem during the breakdown voltage test. ◆ Before doing any test that is not mentioned in this paper, please ask the company for help.

Chapter 11 Function Parameters List

Function code	Name	Setting range/ Parameter Description	Default value
Group 1: Basic functions			
001	Motor type	0: Asynchronous motor 1: Synchronous motor	0
002	Maximum frequency	15.00~300.00Hz	50
003	Minimum frequency	0~300.00Hz	0.5
004	Minimum frequency's run mode	0: Stop when the frequency is lower than the minimum frequency 1: Keep running at minimum frequency when the frequency is lower than the minimum frequency	1
005	Acceleration time	0.1~6000.0s	300
006	Deceleration time	0.1~6000.0s	300
007	Carrier frequency	0.2~2.0K	0.8
008	The number of power cells in each phase	1~9 It could be set by actual situation.	8
009	The number of power cells in each phase unde test mode	1~9	8
010	The ratio of dead time compensation	0~100%	50
011	The detection frequency	1.00~120.00Hz When the output frequency reaches the detection frequency, the inverter will output a signal.	49.00Hz
012	Current regulator proportional coefficient	0.01~10.00	0.2
013	Current regulator integral constant time	0.000~1.000s	0.050
Group 2: Start and stop function			

001	Start mode	0: Start from the setting frequency 1: Brake firstly, then start from the setting frequency 2: Speed tracking and start	0
002	The start frequency	0.00~10.00Hz	0.50
003	The holding time of start frequency	0.0~20.0s	0.50
004	DC braking current	0.0~150.0% It is the percentage of rated current	50.0
005	The duration of DC braking current	0.0~30.0s	0.0
006	The start frequency of DC braking current for stopping	0.00~15.00Hz The stop for the motor with DC braking current is to get the emergency stop and precise position of the motor.	3.00
007	The stop DC braking current	0.0~150.0% It is the percentage of rated current, set the value according to the load inertia, if the load inertia is large, the number must be increased.	50.00
008	The duration of DC braking current for stopping	0.0~60.0s The percentage of rated current, When the time is 0.0, that is no the DC braking process.	0.00
009	Acceleration and deceleration mode	0: straight line of acceleration and deceleration, the output frequency increases or decreases in constant value 1: S curve of acceleration and deceleration. The output frequency increases or decreases as the setting S curve	0
010	Multi-step acceleration and deceleration mode selection	0: Ineffective 1: Effective during deceleration	0

		2: Effective during acceleration 3: Effective during acceleration and deceleration	
011	Multi-step ACC/DEC time 1	0.1~6000.0s Coorespongding ACC/DEC time of 0%~20% segment	100.0
012	Multi-step ACC/DEC time 2	0.1~6000.0s Coorespongding ACC/DEC time of 20%~40% segment	100.0
013	Multi-step ACC/DEC time 3	0.1~6000.0s Coorespongding ACC/DEC time of 40%~60% segment	100.0
014	Multi-step ACC/DEC time 4	0.1~6000.0s Coorespongding ACC/DEC time of 60%~80% segment	100.0
015	Multi-step ACC/DEC time 5	0.1~6000.0s Coorespongding ACC/DEC time of 80%~100% segment	100.0
016	Stop mode	0: Deceleration to stop, the inverter receives the stop command, the output frequency reduces gradually to zero according to the setting deceleration time. 1: Coast to stop, the inverter receives the stop command and blocks the output immediately, and the motor stops slowly according to the inertia.	0
017	The deadtime of forward to reverse	Set the duration when it is from forward to reverse or from reverse to forward.	0.1
3. The parameters of the motor			
001	The rated power of inverter	1~20000kW	800
002	Rated current	0.1~1500.0A The rated current is the coefficient of output current, and	50

		it is for adjusting the display of output current.	
003	The motor rated input voltage	1~11000V	10000
004	The motor rated voltage	1~11000V	10000
005	The rated frequency of motor	15.00~120.00Hz	50.00
006	The rated current of motor	0.1~1500.0A	57.00
007	Motor poles	2~1001	4
008	The rated slip frequency	0.00~5.00Hz	0.80
009	The no-load current of the motor	0.1~ 1000.0A	16.0
010	The stator resistance of motor	0.001~60.000	5.0
011	The rotor resistance of motor	0.001~60.000	5.000
012	The stator and rotor leakage reactance of motor	0.001~6.0000H	0.1000H
013	The mutual reactance between stator and rotor	0.0001~6.0000H	2.0000H
014	The stator resistance of motor coefficient	0.00~50.00%	1.00%
015	The encode digits	8~24	12.
016	The encode resolution	10~10000	2000.
4.The parameters of VF control			
001	The curve of VF	0: VF standard curve, V / F = const 1: The feature of V / F curve is constant torque 2: VF square relationship curve (10Hz or more is quadratic) The characteristics of V / F curve is 2.0 times lower power torque. 3. Custom curve Set the required curve by setting the voltage Vx at the frequency Fx.	0

002	The custom curve mode	0: Two sections 1: Four sections	0.0
003	F1. xx	1.00~100.00% of rated frequency The value is the percentage of rated frequency	25.0
004	V1. xx	1.00~100.00% of rated voltage The value is the percentage of rated voltage	25.0
005	F2. xx	1.00~100.00% of rated frequency The value is the percentage of rated frequency.	50.0
006	V2. xx	1.00~100.00% of rated voltage The value is the percentage of rated voltage	50.00
007	F3. xx	1.00~100.00% of rated frequency The value is the percentage of rated frequency	75.0
008	V3. xx	1.00~100.00% of rated voltage The value is the percentage of rated voltage	75.00
009	Torque boost	0.0~20.0% In order to compensate for the low frequency torque characteristic of V/F, some compensation for the output voltage is made, and it increases the output current and torque. When the load is large, please increase the value of the parameter, if the load is little, please decrease the value of the parameter.	1.0
5. The input analog signals			
001	Input current coefficient	0.50~600.00%	100.00

		It is to adjust the value of input current display on the touch screen.	
002	Input voltage coefficient	0.50~300.00% It is to adjust the value of input voltage display on the touch screen.	100.00
6．The group of protection parameters			
001	Debug mode	1: Debug mode 0: Non debug mode	0
002	The value of the limit current	100.0~200.0% The limit current is the maximum value of the output current; it is the percentage of the rated current.	120.0%
003	The fall time of the frequency when the over current occurs	1.0~1000.0s When over current occurs, the inverter limits the value of the output current, the deceleration time is for the frequency drop to zero	20.0
004	The number of allowed protection cell each phase	0~5	1
005	The number of allowed protection cell of the inverter	0~9	3
006	The number of allowed protection cell each phase when testing	0~5	1
007	The number of allowed protection cell of the inverter when testing	0~9	3
008	The test time of high voltage is off	0~100.0s If it doesn’t test the high voltage is on within the test time when it is running, it considers the high voltage is off	3.0
009	The minimum voltage of high voltage is off	40%~80% The minimum voltage when it considers the high voltage is off,	60

		it is the percentage of the rated voltage	
010	The value of over current	100~250% It is the percentage of the rated current, when it reaches, it will immediately stop.	180,
011	The overload value of the motor	40~130% When it reaches, it will decease the output as the inverse proportion for 1minutes.	130
012	The value of low voltage, it is the percentage of the rated voltage	70%~90% When it starts, the input voltage is less than the value, it will alarm.	80
013	The value of over voltage, it is the percentage of the rated voltage	100%~130% When input voltage is larger than the value,it will alarm or stop after the delay time	120.
014	The delay time of over voltage	0.1~100.0s When it is set of 100, it will alarm when the over voltage occurs or stop	100.
015	The number of allowed low voltage cells when the bus voltage is low.	1~9	5
016	The allowed value of the bus voltage when the high voltage is off	100~1000V	650.
017	The allowed minimum DC bus voltage of power cell	100~1000V	500
018	The unbalance coefficient of the output current	0.1~100.00 When it is set of 100, the unbalance of output current is not tested	2.0
019	The value of temperature alarm	30~80℃ Both the value of temperature alarm and number of cell temperature alarm causes alarm signal. When multiple cells is	60℃

		high temperature, it will be pre-alarm.	
020	The number of alarm power cells	0~9 When the number of alarms is 0, there will no alarm	5.
021	The input voltage frequency drop time	0.1~100.0s If the input voltage decreases, the inverter frequency decreases	5.0
022	Stall over voltage restrain	500~1200V	1050
7.The group of enhanced parameters			
001	The jump frequency 1	0.00~ 50.00Hz	0.00
002	The amplitude of jump frequency 1	0.00~ 5.00Hz	0.00
003	The jump frequency 2	0.00~ 50.00Hz	0.00
004	The amplitude of jump frequency 2	0.00~ 5.00Hz	0.00
005	The jump frequency 3	0.00~ 50.0Hz	0.00
006	The amplitude of jump frequency 3	0.00~ 5.00Hz	0.00
007	The over modulation mode	0: Not enable 1: Enable	0
008	The output voltage self adjustment	0: No adjustment 1: Adjust the voltage to ensure the balance of the output	0
009	The output voltage self adjustment coefficient	80.00%~120.00%	100.00%
010	Positive and negative installation of the system	0: positive 1: negative	0
011	The mode of turning to the grid power	0: The frequency only reaches 50Hz, no adjustment for the phase 1: The frequency reaches 50Hz and adjust for the phase with the help of input voltage detection board	3

		2: The frequency reaches 50Hz and adjust for the phase with the help of input voltage detection board and reactor 3: Do not turning to the grid power	
012	Restart selection for power supply recover	0: allowed 1: prohibited	0
013	Revere run selection	0: allowed 1: prohibited	0
014	Enable of frequency limitation at low voltage situation	0: prohibited 1: allowed When the DC bus voltage is low, to limit output maximum frequency	0
015	Input voltage phase compensation	0.0~20.0	15
016	Output voltage phase compensation	0.0~20.0	15
017	Open the output voltage detection	1: Open 0: Close	1
018	The mode of turning to the grid power	0: Common mode 1: Common mode 2: Bump-less mode (supported by reactor) 3: Not allowed	3
8.The parameters of asynchronous motor inverter			
001	The control modes	0: V/f 1: Simple Vector control 2: Sensorless Vector control 1 3: Sensorless Vector control 2 4: Inductive Vector control	0
002	Start mode	0: start normal 1: start by determined motor parameter completely 2: start-up by determined motor parameter incompletely	0
003	Time of speed tracking	0.0~60.0s	6.0

		The time that from stop to start or speed track is enabled from the power is off	
004	The tracking time for the function of speed tracking start	10.0~1000.0s	30.0
005	The minimum current that the function of speed track allows, it is the percentage of the rated current	1.00~50.00%	12.0
006	Filter time of current of speed track	1~1000ms	20
007	Time of start-up voltage of speed track	1.0~5.0s	1.0
008	Time of voltage rise of speed track	1.0~5.0s	1.0
009	Oscillation suppression coefficient	0.0~100.0% When the shock occurs, increase the coefficient it can be suppressed	20.0
010	Limit the output of the shock suppression	0.10~3.00Hz It will affect the feature of VF control.	0.3
011	The time of oscillation suppression	0.002~0.050s	0.01
012	The maximum frequency of oscillation suppression	1.50Hz~50.00Hz When it is larger than that, this function is forbidden.	15.00.
013	Proportional coefficient of vector control in low-speed adjustment	0.00~20.00	5.00
014	Integration coefficient of vector control in low-speed adjustment	0.00~20.00s	0.50
015	Proportional coefficient of vector control in high-speed adjustment	0.00~20.00	5.00

016	Integration coefficient of vector control in high-speed adjustment	0.00~20.00s	0.50
017	The adjustment for speed of vector control	1.00~50.00Hz	5.00
018	Proportional coefficient of vector control in current adjustment	0.00~2.00	0.2
019	Integration coefficient of vector control in current adjustment	0.000~1.000s	0.050
020	Filter coefficient of vector control in speed adjustment	0.001~1.000s	1.000
021	Filter coefficient of vector control in current adjustment	0.001~1.000s	1.000
022	Compensation coefficient for torque in vector control	1~300%	100
023	Compensation coefficient for slip in vector control	50~200%	100
024	Limited for torque in vector control	20.0~200%	100%
025	Filter coefficient in compensation for slip	0.001~1.000	0.003
026	Filter coefficient in compensation for stator	0.001~1.000	0.003
027	Coefficient of proportionality of speed	0.00~50.00	0.80
028	Integral coefficient of speed	0.000~20.000s	0.050
029	Correction coefficient of speed	0.00~1.00	0.60
030	Coefficient of proportionality of weak magnetic	0.00~50.00	5.00
031	Integral coefficient of weak magnetic	0.00~20.00s	2.00
032	Current rising of magnetization	0~100%	60

033	Efficient of proportionality of determined parameter	0.01-5.00	0.50
034	Waiting time of speed track	0~2000ms	0.50
9.The belt inverter parameters of master-slave control			
001	Enable the function of belt inverter	0: Not enable 1: Enable	1
002	The selection of master-slave inverter	0: Slave inverter 1: Master inverter	1
003	The number of slave inverters	1~6	2
004	Address	Set master to 1, set slave to 2 or 3	1
005	The maximum frequency for adjustment	0.00~10.00Hz	1.00
006	The cycle of frequency adjustment	0.001~5.000s	0.012
007	The amplitude of frequency adjustment	0.00~1.00Hz	0.01
008	The allowed deviation of current, it is the percentage of the rated current	0.1~10.0%	5.0%
009	Acceleration time of the master inverter	10.0~1000.0s	200.0
010	Deceleration time of the master inverter	10.0~1000.0s	200.0
011	The minimum frequency for adjustment	1.00~10.00Hz	3.0
012	The filter time of given current	10~5000ms	50
10. The parameters of hoister inverter			
001	Enable the functions of hoister inverter	0-1	0
002	Enable the function of braking	0-1	0
003	The maximum frequency when the MVD stops	1.00-100.00Hz	10.00
004	Limited to low frequency	0.00~10.00Hz	3.00

005	Process mode of low frequency (0~4)	0: ineffective 1: Lift effective 2: Down effective 3: Both lift and down effective 4: Automatic processing	1
006	Torque boost gain of low frequency	1.00~10.00	1.20
11. The parameters of synchronous motor			
001	Magnetizing current given by HMI	0.0~120.0%	
002	Torque current given by HMI	0.0~100.0% Stand for positive 1000.0~1100.0% Stand for negative	
003	The control modes	0: VF 1: Inductive vector control 2: Sensorless vector control	0
004	Torque mode	0: Controlled by speed 1: Controlled by torque mode	0
005	The running modes	0: the normal running 1: assure the direction of the encoder and initial angle of the rotor	0
006	The value o f the Magnetizing voltage	10~12000V	100
007	The value o f the Magnetizing current	1.0~1000A	100
008	Proportional coefficient of PID magnetizing control	0.00~20.00	0.50
009	Integration integral coefficient of PID magnetizing control	0.000~10.000	5.000
010	Proportional coefficient of PID speed control	0.00~20.00	5.00
011	Integration time constant of speed control	0.00~20.00	0.50
012	Proportional coefficient of PID current control	0.00~2.00	0.20

013	Integration time constant of current control	0.000~1.000	0.050
014	The filter coefficient of the magnetizing loop	0.001~1.000	1.000
015	The filter coefficient of the speed loop	0.001~1.000	1.000
016	The filter coefficient of the current loop	0.001~1.000	1.000
017	The current for correct the position of rotor	0~120%	100%
018	The time for correct the position of rotor	0.5~10.0s	1.0
019	The setting of the magnetizing current to start	0.0~120.0%	100.0%
020	The setting of the D axis current	0.0~100.0%: Positive 1000.0~1100.0%: Negative	0
021	The position of rotor	0.0~360.0: Forward 1000.0~1360.0: Reverse	0
022	The direction that the encoder goes	0: Forward 1: Reverse	0
023	The initial angle of the rotor	0~360.0	0
024	The modes of VF control	0: constant magnetizing 1: constant reactive power 2: constant power factor	0
025	The modes of VE control	0: constant magnetizing 1: adjust according to the load 2: adjust power factor close to 1	0
026	The setting of reactive power	0.0%~50.0% Output 0.0%~50.0% of the reactive power 1000.0%~1050.0% Input 0.0%~50.0% of the reactive power	0.0
027	The setting of power factor	0.00~1.00 Input the reactive power 10.00~11.00 Output the reactive power	1.00
028	The minimum setting of the magnetizing current	0.0%~100.0%	

029	The maximum setting of the magnetizing current	15.0%~120.0%	120.0%
030	The setting of the magnetizing current	0.0%~100.0%	50.0%
031	Reference angle	0~255	0
032	Angle compensation coefficient	0~1000	0
033	Speed compensation coefficient	0~1000	0
12. Advanced permission parameter			
001	Forced bypass cells of A phase		
002	Forced bypass cells of B phase		
003	Forced bypass cells of C phase		
004	The power cells automatic reset times	0~10	0
005	The delay times of cells automatic reset	0.1~100.0s	1
006	To clear cells automatic reset	60.0~6000.0s	200
007	The whole machine automatic reset times	0~10	0
008	The delay times of whole machine automatic reset	0.1~100.0s	1
009	To clear whole machine automatic reset	60.0~6000.0s	200
010	Cells manual reset	1: It can be reset in operation	0
011	Wave recording channel 1	0~8	0
012	Wave recording channel 2	0~8	1
013	Wave recording channel 3	0: Output current of A phase 1: Output current of B phase 2: Output current of C phase 3: Output voltage of A phase 4: Output voltage of B phase 5: Output voltage of C phase 6: Output voltage of AB phase 7: Output voltage of BC phase 8: Output voltage of CA phase	2
13. The group of PID parameters			

001	Setting channels of PID control group	0: HMI Set by HMI 1: AI1 Set by AI1 2: AI2 Set by AI2	0
002	Feedback channels of PID control group	0: AI1 The feedback from AI1 1: AI2 The feedback from AI2	0
003	The features of PID close loop	0: positive feature 1: negative feature	0
004	Proportional coefficient	0.00~5.00 When proportional coefficient is larger, the adjust speed of the system is faster. If it is too large, the system will shock	0.50
005	Integral coefficient	0.1~100.0 The error can not be eliminated, only the integration is used. Both the proportion and integration are used, the error will be eliminated and the integration time constant is less, the adjust speed of the system is faster. If it is too little, the system will shock.	10.0
006	Differential coefficient	0.0~5.0 The rate of error multiplies this parameter as the output of the differential part of the PID control. It can predict the error trends, and improve the system dynamics, but it is too large, the system will shock	0.1
007	The structure of PID	0: Proportion 1: Integration 2: Proportion and integration 3: Proportion, integration and derivation	2
008	The maximum deviation value of PID	0.00~100.00%	0
009	The detection value of the feedback disconnection	0.00~100.00%	0

010	The detection time of the feedback disconnection	0.0~3600.0s	1.0
011	The maximum value of setting pressure	1~30000 It is to set the value of the maximum pressure.	10000
14. The group of external analog signals			
001	The minimum inputof AI1	0.00~5.00V Set the value according to the minimum input analog voltage	0.00
002	The minimum input of AI1 corresponds to the setting value	0~100.00% The minimum input of AI1 corresponds to the percentage of maximum frequency	0.00
003	The maximum input of AI1	0.00~5.00V Set the value according to the maximum input analog voltage.	5.00
004	The maximum input of AI1 corresponds to the setting value	0~100.00%	100.00
005	Filter time constant of AI1	0.01~50.00s	0.10
006	The minimum input of AI2 corresponds to the setting value	0.00~5.00V The minimum input of AI2 corresponds to the percentage of maximum frequency	0.00
007	The minimum input of AI2 corresponds to the setting value	0~100.00% The minimum input of AI2 corresponds to the percentage of maximum frequency.	0.00
008	The maximum input of AI2	0.00~5.00V Set the value according to the maximum input analog voltage	5.00
009	The maximum input of AI2 corresponds to the setting value	0~100.00% The maximum input of AI2 corresponds to the percentage of maximum frequency	100.00
010	Filter time constant of AI2	0.01~50.00s	0.10
011	AI frequency setting deviation control	0.00~5.00Hz	0.10
012	The modes of output signal AO1	0: output frequency 1: output current 2: output voltage	0
013	The minimum output of AO1	0.00~40.00%	0.00

		It is used to adjust the minimum analog output of AO1	
014	The maximum output of AO1	50.00~100.00% It is used to adjust the maximum analog output of AO1	100.00
015	The modes of output signal AO2	0: output frequency 1: output current 2: output voltage	0
016	The minimum output of AO2	0.00~40.00% It is used to adjust the minimum analog output of AO2	0.00
017	The maximum output of AO2	50.00~100.00% It is used to adjust the maximum analog output of AO2	100.00
018	The modes of output signal AO3	0: output frequency 1: output current 2: output voltage 3: the value of magnetizing current	0
019	The minimum output of AO3	0.00~40.00% It is used to adjust the minimum analog output of AO3	0.00
020	The maximum output of AO3	50.00~100.00% It is used to adjust the maximum analog output of AO3	100.00
021	The modes of output signal AO4	0: Output frequency 1: Output current 2: Output voltage 3: The value of magnetizing current	0
022	The minimum output of AO4	0.00~40.00% It is used to adjust the minimum analog output of AO4	0.00
023	The maximum output of AO4	50.00~100.00% It is used to adjust the maximum analog output of AO4	100.00
024	The display modes of frequency	0: display the setting frequency when stop 1: display the running frequency when stop	0

025	The adjusting coefficient of AO1	10.0%~1000.0%	100.0%
026	The adjusting coefficient of AO2	10.0%~1000.0%	100.0%

Chapter 12 Communication protocol

1. Description

This description is used to description the external Modbus/Profibus communication protocol and communication content of FD5000 series high-voltage inverter of FGI Science And Technology Co., Ltd.

2. Communication protocol

Communication method	Modbus RTU/Profibus
Transmission form	RS485 (half duplex)
Station address	1~255 (adjustable)
Baud rate	Modbus: 4800, 9600, 14400, 19200 (adjustable) Profibus: Self-following
Parity check	No parity
Stop bit	1 bit

3. Modbus communication

Modbus address	Address name	Description	Remarks
Operation status and operation data (read-only)			
Address 1~5	Reserved		
Address 6	PLC version number		
Address 7	Running time(hour) low bit		Running time is 32-bit variable quantity.
Address 8	Running time(hour) high bit		
Address 9	Switch status of main circuit		
Bit 0	K1 normal open	=1 closed =0 open	
Bit 1	K2 normal open	=1 closed =0 open	
Bit 2	K3 normal open	=1 closed =0 open	
Bit 3	K4 normal open	=1 closed =0 open	
Bit 4	K5 normal open	=1 closed =0 open	
Bit 5	K6 normal open	=1 closed =0 open	
Bit 6	KM1 normal open	=1 closed =0 open	
Bit 7	KM2 Normal open	=1 closed =0 open	The status display is valid only when the system is under automatic control status at one MVD drives one motor or one MVD drives two motors.
Bit 8	KM3 normal open	=1 closed =0 open	
Bit 9	KM4 normal open	=1 closed =0 open	
Bit10	KM5 normal open	=1 closed =0 open	
Bit11	KM6 normal open	=1 closed =0 open	
Bit12~ Bit15	Reserved		
Address 10	Reserved		
Address 11	Reserved		
Address 12	Inverter status 1		
Bit 0	MVD starts command	=1 starts =0 stops	
Bit 1	Forward and reverse setting	=1 forward	

Bit 2	Forward and reverse setting	=1 reverse	
Bit 3	Mark of switched to grid power supply		
Bit 4	Mark of switched to MVD power supply		
Bit 5	Inverter ready	=1 ready =0 not ready.	
Bit 6	MVD alarm		
Bit 7	MVD fault emergency stop	=1 emergency stop =0 normal	
Bit 8	Braking state	=1 not holding brake =0 holding brake	Used for hoist application
Bit 9 ~Bit15	Reserved		
Address 13	Reserved		
Address 14	Inverter status 2		
Bit 0	High voltage ready	=1 ready =0 not ready.	
Bit 1	Local emergency stop	=1 emergency stop =0 normal	
Bit 2	Remote emergency stop	=1 emergency stop =0 normal	
Bit 3	DCS emergency stop	=1 emergency stop =0 normal	
Bit 4	Emergency stop status	=1 emergency stop =0 normal	
Bit 5	Manual automatic control selection	=1 automatic =0 manual	
Bit 6	The main circuit is configured.	=1 configured =0 unconfigured	
Bit 7	Operation box configuration	=1 Yes =0 No	
Bit 8	High voltage indication of cabinet door	=1 high pressure =0 no high pressure	
Bit 9~ Bit 15	Reserved		
Address 15	Reserved		
Address 16	Active power	5000 corresponds to 5000kW	

Address 17	Given frequency	5000 corresponds to 50.00Hz	
Address 18	Running frequency	5000 corresponds to 50.00Hz	
Address 19	Setting pressure	5000 corresponds to 5000.	The unit is Pa or kPa
Address 20	Feedback pressure	5000 corresponds to 5000.	The unit is Pa or kPa
Address 21	Input voltage	5000 corresponds to 5000V.	
Address 22	Output voltage	5000 corresponds to 5000V.	
Address 23	Incoming current	5000 corresponds to 500.0A	
Address 24	Output current	5000 corresponds to 500.0A	
Address 24- Address 40	Reserved		
Operation status and operation data (read and write)			
Address 201	MVD control		
Bit0	Reserved		
Bit1	Alarm reset	=1 reset	pulse signal
Bit2	Upper computer starts MVD	=1 start	pulse signal
Bit3	Upper computer shops MVD	=1 stops	pulse signal
Bit4- Bit15	Reserved		
Address 202	MVD starts and stops control channel	0: Local (HMI) starts and stops MVD. 1: DCS starts and stops MVD. 2. The upper computer starts and stops MVD. 3: Remote control box starts and stops MVD.	

Address 203	Frequency set channel	0: HMI sets frequency 1. Analog channel 1 2. Analog channel 2 3. The frequency is set by the upper computer 4: Frequency is set by external increase and decrease signal 5: Multi-step speed mode sets the frequency 6: Closed-loop (PID) sets the frequency	
Address 204	Upper computer given frequency	50.00Hz corresponds to 5000	
Address 205	The upper computer gives a certain speed	50.00Hz corresponds to 5000	
Address 206	The upper computer gives the second speed.	50.00Hz corresponds to 5000	
Address 207	Upper computer given pressure	5000 corresponds to 5000.	The unit is Pa or kPa

4. Profibus communication content

Profibus address	Address name	Description	Remarks
Operation status and operation data (read-only)			
Address 1	MVD status		
Bit 0~ Bit 1	MVD starts and stops control channel	0: Local (HMI) starts and stops MVD. 1: DCS starts and stops MVD. 2. The upper computer starts and stops MVD. 3: Remote control box starts and stops.	
Bit 2	MVD ready	=1 ready =0 not ready.	
Bit 3	MVD is started	=1 start =0 stop	

Bit 3	MVD failure	=1 fault =0 normal	
Bit 4~ Bit 15	Reserved		
Address 2	Switch status of main circuit		
Bit 0	K1 normal open	=1 closed =0 open	
Bit 1	K2 normal open	=1 closed =0 open	
Bit 2	K3 normal open	=1 closed =0 open	
Bit 3	K4 normal open	=1 closed =0 open	
Bit 4	K5 normal open	=1 closed =0 open	
Bit 5	K6 normal open	=1 closed =0 open	
Bit 6	KM1 normal open	=1 closed =0 open	
Bit 7	KM2 Normal open	=1 closed =0 open	The status display is valid only when the system is under automatic control status at one MVD drives one motor or one MVD drives two motors.
Bit 8	KM3 normal open	=1 closed =0 open	
Bit 9	KM4 normal open	=1 closed =0 open	
Bit10	KM5 normal open	=1 closed =0 open	
Bit11	KM6 normal open	=1 closed =0 open	
Bit12~ Bit15	Reserved		
Address 3	MVD status		
Bit 0	High voltage ready	=1 ready =0 not ready.	
Bit 1	Local emergency stop	=1 emergency stop =0 normal	
Bit 2	Remote emergency stop	=1 emergency stop =0 normal	
Bit 3	DCS emergency stop	=1 emergency stop =0 normal	
Bit 4	Emergency stop status	=1 emergency stop =0 normal	
Bit 5	Manual automatic control selection	=1 automatic =0 manual	
Bit 6	The main circuit is configured.	=1 configured =0 unconfigured	
Bit 7	Operation box configuration	=1 Yes =0 No	

Bit 8	High voltage indication of cabinet door	=1 high voltage =0 no high voltage	
Bit 9~ Bit 15	Reserved		
Address 4	Reserved		
Address 5	Output current	5000 corresponds to 500.0A	
Address 6	Running frequency	5000 corresponds to 50.00Hz	
Address 7	Active power	5000 corresponds to 5000kW	
Address 8	Feedback pressure	5000 corresponds to 5000.	The unit is Pa or kPa
Address 9	Output voltage	5000 corresponds to 5000V.	
Address 10	Input voltage	5000 corresponds to 5000V.	
Operation status and operation data (read and write)			
Address 1	MVD control		
Bit0	Starts the MVD	=1 starts	pulse signal
Bit1	Stops the MVD	=1 stops	pulse signal
Bit2- Bit15	Reserved		
Address 2	Upper computer given frequency	50.00Hz corresponds to 5000	
Address 3	Upper computer given pressure	5000 corresponds to 5000	The unit is Pa or kPa
Address 4	Reserved		
Address 5	MVD starts / stops control channel	0: Local (HMI) starts and stops MVD. 1: DCS starts and stops MVD. 2. The upper computer starts and stops MVD. 3: Remote control box starts and stops.	
Address 6	Frequency set channel	0: HMI sets frequency 1. Analog channel 1 2. Analog channel 2 3. The frequency is set by the upper computer	

		4: Frequency is set by external increase and decrease signal 5: Multi-step speed mode sets the frequency 6: Closed-loop (PID) sets the frequency	