B503 SERIES

SENSORLESS VECTOR CONTROL CONTROLLER

INSTRUCTION MANUAL

GUANGZHOU BEDFORD ELECTRIC EQUIPMENT.CO.,LTD.

V1.0.0

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SAFETY PRECAUTIONS

Please read this operation manual carefully before installation, operation, maintenance or inspection.

In this manual, the safety precautions were sorted to “WARNING” or “CAUTION”.

WARNING Indicates a potentially hazardous situation which, if not, will result in death or serious injury.

CAUTION Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury and physical damage. This sign is also used for alert of any unsafe operation.

In some cases, the contents of “CAUTION” could cause serious accident. Please follow these important precautions in any situation.

★NOTE is the necessary step to ensure the proper operation.

Warning marks were shown on the front keypad of controllers.

Please follow these indications when using the controller.

WARNING
● May cause injury or electric shock. ● Please follow the instructions in the manual before installation or operation. ● Disconnect all power line before opening front cover of unit. Wait at least 5 minute until DC Bus capacitors discharge. ● Use proper grounding techniques. ● Never connect AC power to output UVW terminals

1 INTRODUCTION

1.1 Technology Features

- Input & Output
  - ◆Input Voltage Range: 380/220V ±15%
  - ◆Input Frequency Range: 47~63Hz
  - ◆Output Voltage Range: 0~rated input voltage
  - ◆Output Frequency Range: 0~600Hz
- I/O features
  - ◆Programmable Digital Input: Provide 4 terminals which can accept ON-OFF inputs
  - ◆Programmable Analog Input: AI1can accept input of 0~10V;AI2 can accept of 0~10V or 0/4~20mA.
  - ◆Programmable Open Collector Output: Provide 1 output terminal (open collector output or high-speed pulse output)
  - ◆Relay Output: Provide 1 output terminal.
  - ◆Analog Output: Provide 1 analog output terminal, whose output scope can be 0/4~20

mA or 0~10 V, as chosen.

- Main Control Function
  - ◆Control Mode: Sensorless Vector Control (SVC), V/F Control.
  - ◆Overload Capacity: 60s with 150% of rated current, 10s with 180% of rated current.
  - ◆Starting Torque: 150% of rated torque at 0.5Hz (SVC).
  - ◆Speed Adjusting Range: 1:100 (SVC)
  - ◆Speed Accuracy: ± 0.5% of maximum speed (SVC)
  - ◆Carrier Frequency: 0.5kHz ~15.0kHz.
  - ◆Reference Frequency Source: keypad, analog input, serial communication, multi-step speed, PID and so on. The combination of multi- modes and switching between different modes can be realized.
  - ◆Torque Control Function: Provide multiple torque setting source.
  - ◆PID Control Function
  - ◆Multi-Step Speed Control Function: 8 steps speed can be set.
  - ◆Traverse Control Function
  - ◆Non-Stop when power is instantaneously cut off.
  - ◆Speed trace Function: Start the running motor smoothly.
  - ◆  Key: User defined shortcut key can be realized.
  - ◆Automatic Voltage Regulation (AVR) Function:
  - ◆Automatically keep the output voltage stable when input voltage fluctuating.
  - ◆Up to 25 fault protections:
  - ◆Protect from over current, over voltage, under voltage, over heat, phase failure, over load etc.

1.2 Description of Name Plate

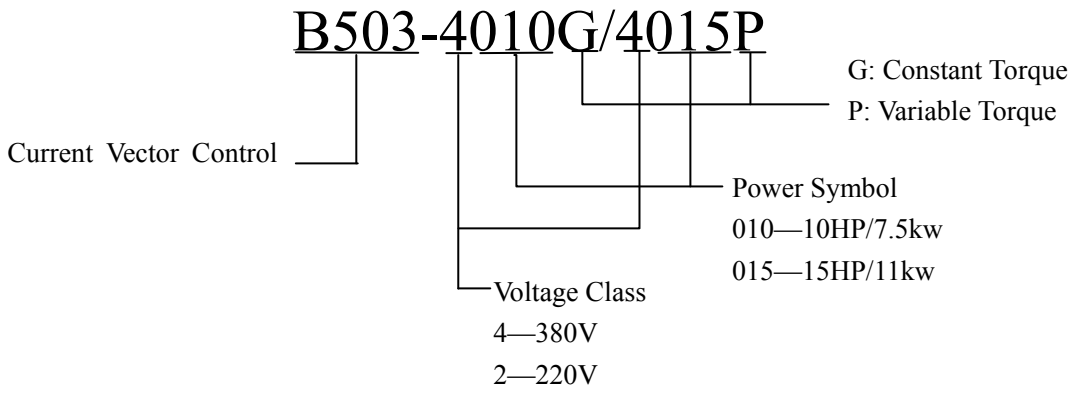


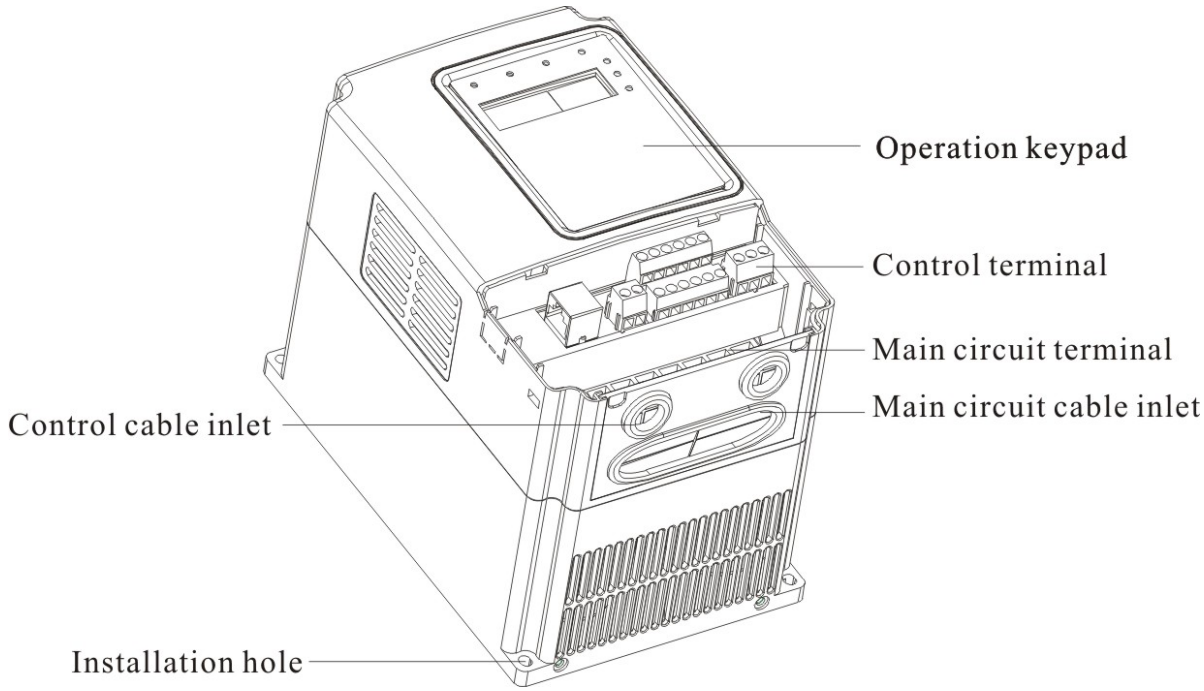
Figure1.1 Nameplate of controller

1.3 Selection Guide

Model No.	Rated Output Power	Rated Input Current	Rated Output Current	Motor Power (KW)	Size
1AC 220V ±15%					
B503-2001	0.75	8.2	4.5	0.75	A
B503-2002	1.5	14.2	7.0	1.5	B
B503-2003	2.2	23.0	10	2.2	B
3AC 220V ±15%					
B503-2001	0.75	5.0	4.5	0.75	A
B503-2002	1.5	7.7	7	1.5	B
B503-2003	2.2	11.0	10	2.2	B
B503-2005	3.7	17.0	16	3.7	C
B503-2007	5.5	21.0	20	5.5	C
B503-2010	7.5	31.0	30	7.5	D
B503-2015	11.0	43.0	42	11.0	E
B503-2020	15	56.0	55	15.0	E
B503-2025	18.5	71.0	70	18.5	E
B503-2030	22.0	81.0	80	22.0	F
B503-2040	30.0	112.0	110	30.0	F
B503-2050	37.0	132.0	130	37.0	F
B503-2060	45.0	163.0	160	45.0	G
3AC 380V±15%					
B503-4001	0.75	3.4	2.5	0.75	B
B503-4002	1.5	5.0	3.7	1.5	B
B503-4003	2.2	5.8	5	2.2	B
B503-4005G/4007P	4.0/5.5	10/15	9/13	4.0/5.5	C
B503-4007G/4010P	5.5/7.5	15/20	13/17	5.5/7.5	C
B503-4010G/4015P	7.5/11.0	20/26	17/25	7.5/11.0	D
B503-4015G/4020P	11/15	26/35	25/32	11/15	D
B503-4020G/4025P	15/18.5	35/38	32/37	15/18.5	D
B503-4025G/4030P	18.5/22	38/46	37/45	18.5/22	E
B503-4030G/4040P	22/30	46/62	45/60	22/30	E
B503-4040G/4050P	30/37	62/76	60/75	30/37	E
B503-4050G/4060P	37/45	76/90	75/90	37/45	F
B503-4060G/4075P	45/55	90/105	90/110	45/55	F
B503-4075G/4100P	55/75	105/140	110/150	55/75	F
B503-4100G/4120P	75/90	140/160	150/176	75/90	G

Model No.	Rated Output Power	Rated Input Current	Rated Output Current	Motor Power (KW)	Size
B503-4120G/4150P	90/110	160/210	176/210	90/110	G
B503-4150G/4180P	110/132	210/240	210/250	110/132	G
B503-4180G/4215P	132/160	240/290	250/300	132/160	H
B503-4215G/4250P	160/185	290/330	300/340	160/185	H
B503-4250G/4270P	185/200	330/370	340/380	185/200	I
B503-4270G/4300P	200/220	370/410	380/415	200/220	I
B503-4300G/4340P	220/250	410/460	415/470	220/250	I
B503-4340G/4380P	250/280	460/500	470/520	250/280	I
B503-4380G/4430P	280/315	500/580	520/600	280/315	I
B503-4430G/4470P	315/350	580/620	600/640	315/350	I
B503-4470	350	620	640	350	-
B503-4540	400	670	690	400	-
B503-4680	500	855	860	500	-
B503-4760	560	920	950	560	-
B503-4860	630	1050	1100	630	-

1.4 Parts Description



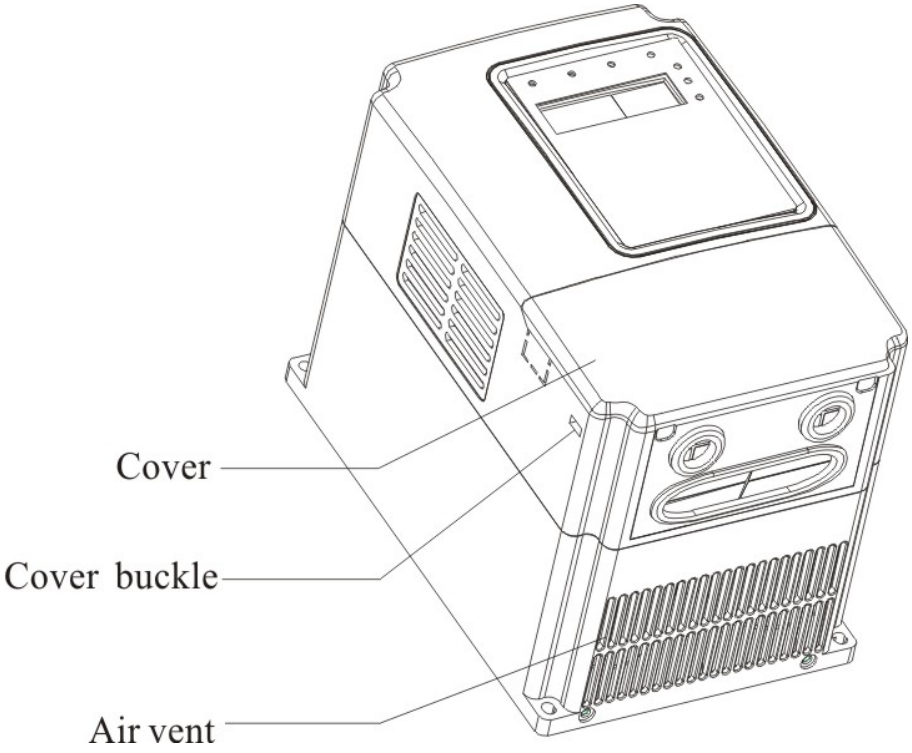
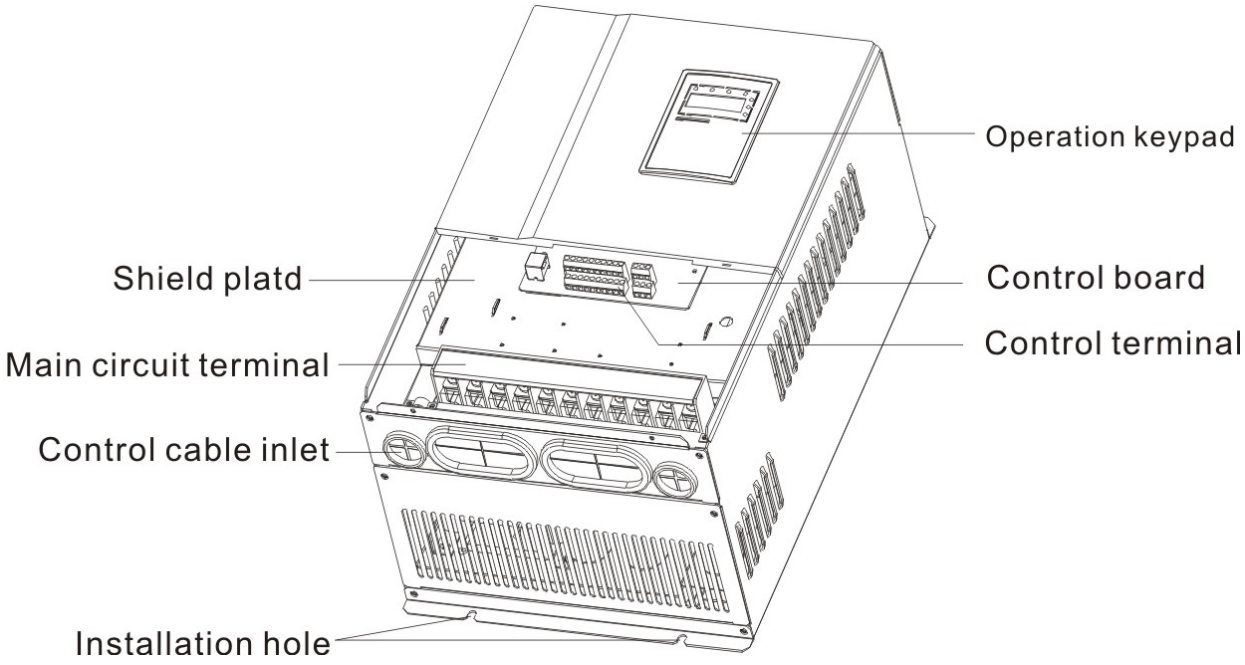


Figure 1.2 Parts of controllers(15KW and below)



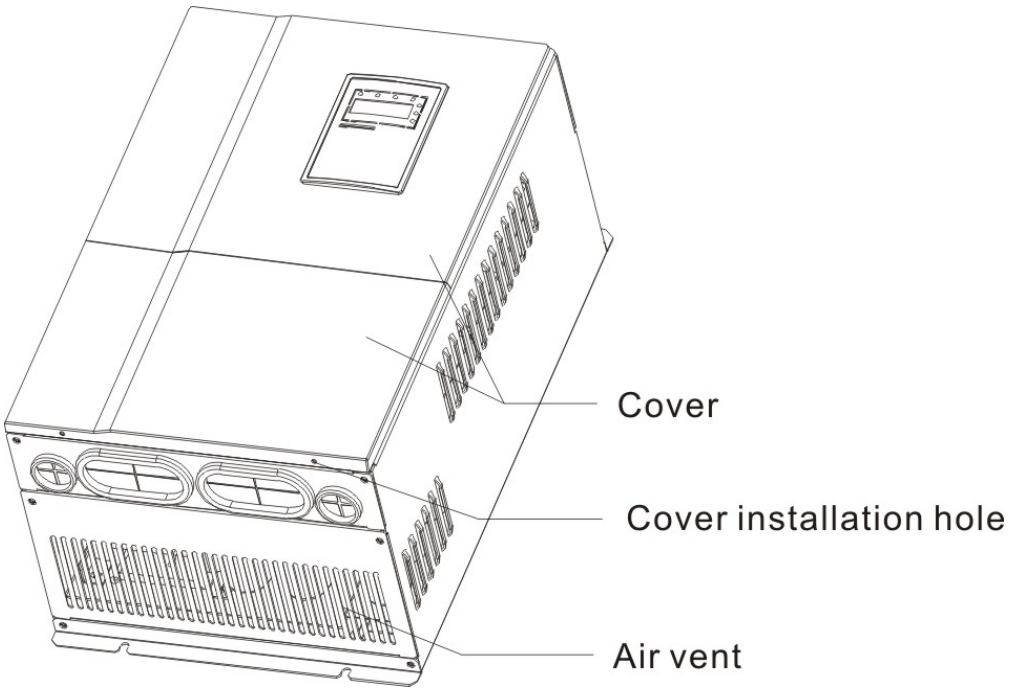


Figure 1.3 Parts of controllers (18.5KW and above)

1.5 External Dimension

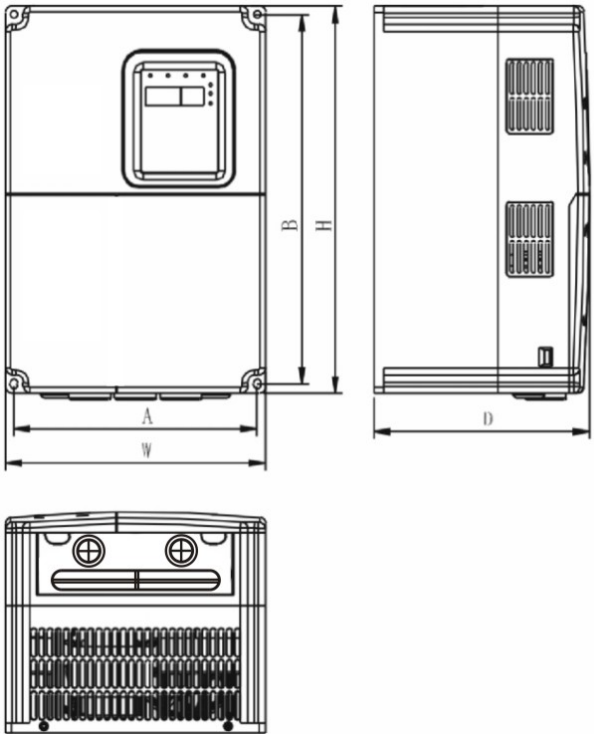


Figure 1.4 Dimension(0.75~15KW)

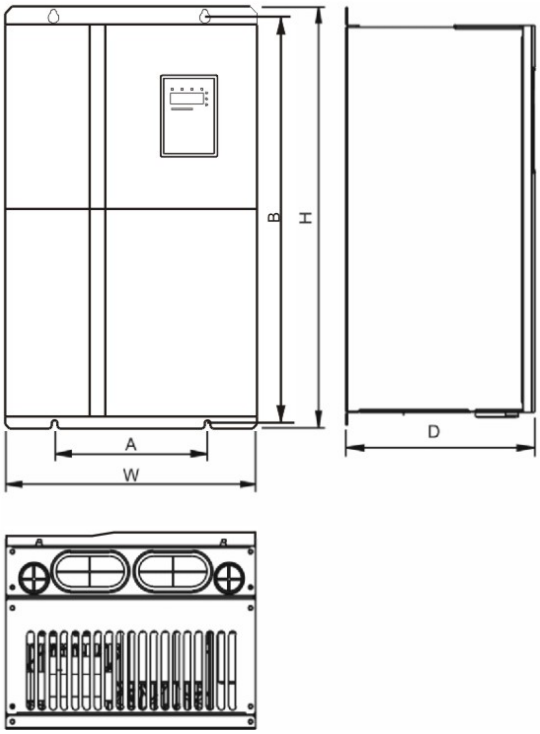


Figure 1.5 Dimension(18.5~110KW)

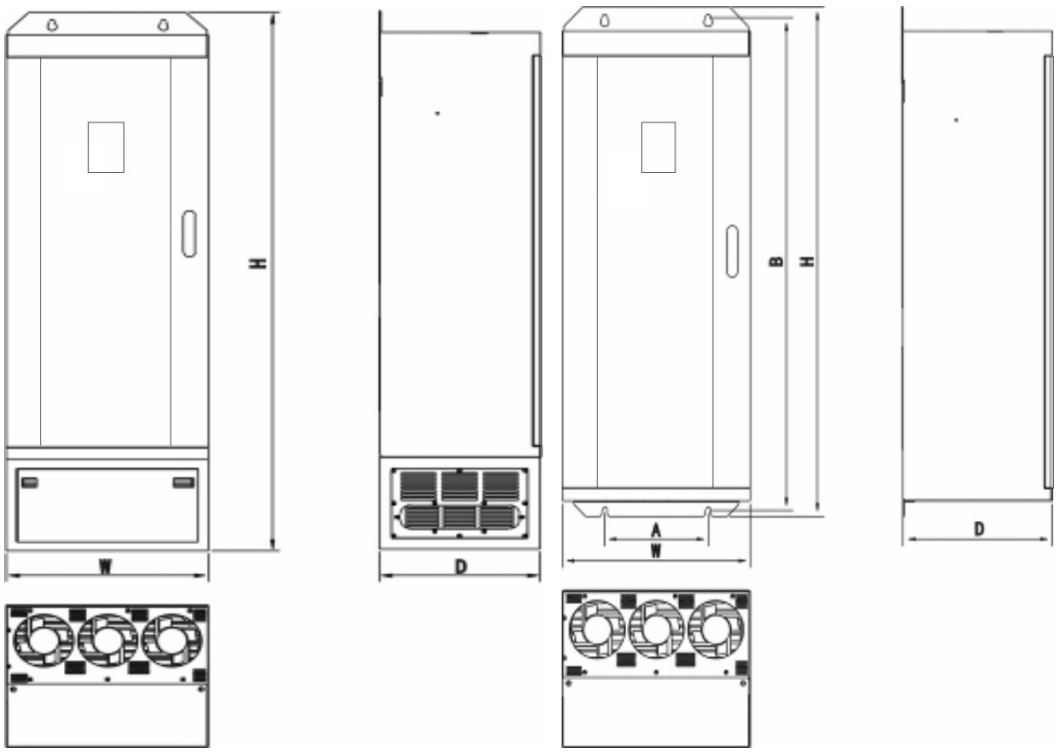


Figure 1.6 Dimension(132~315KW)

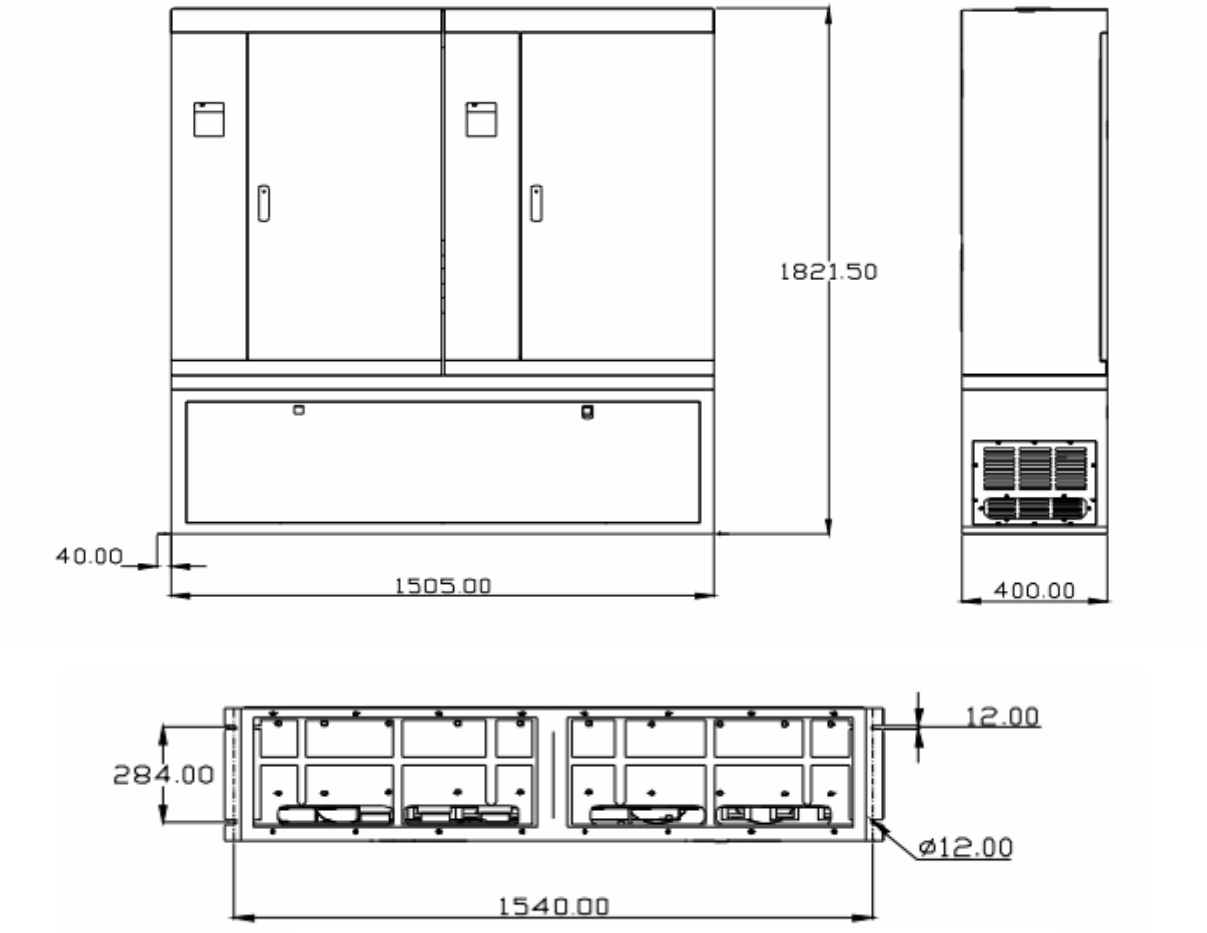


Figure 1.7 Dimension(350~630KW)

Power(KW)	Size	A(mm)	B(mm)	H(mm)	W(mm)	D(mm)	Installation Hole (mm)
		Installation Dimension		External Dimension			
0.75~2.2	B	110.4	170.5	180	120	140	5
4~5.5	C	147.5	236	250	160	183	5
7.5~15	D	206	305.5	322	220	183	6.0
18.5~30	E	175	455	472	295	222	6.5
37~55	F	230	564.5	580	380	270	7.0
75~110	G	320	738.5	755	465	330	9.0
132~185	H(without base)	270	1233	1275	490	395	13.0
	H(with base)	-	-	1490	490	395	-
200~315	I(without base)	500	1324	1358	750	402	12.5
	I(with base)	-	-	1670	750	402	-
350~630	Refer to Figure 1.7 for the specific size						

2 INSPECTION

⚠ CAUTION

- Don't install or use any controller that is damaged or have fault part, otherwise may cause injury

Check the following items when unpacking the controller.

1、Inspect the entire exterior of the Controller to ensure there are no scratches or other damage caused by the transportation.

2、Ensure there is operation manual and warranty card in the packing box.

3、Inspect the nameplate and ensure it is what you ordered.

4、Ensure the optional parts are what you need if have ordered any optional parts.

Please contact the local agent if there is any damage in the controller or optional parts.

3 INSTALLATION

⚠ WARNING

- The person who without passing the training manipulate the device or any rule in the "Warning" being violated, will cause severe injury or property loss. Only the person, who has passed the training on the design, installation, commissioning and operation of the device and gotten the certification, is permitted to operate this equipment.
- Input power cable must be connected tightly, and the equipment must be grounded securely.

- Even if the controller is not running, the following terminals still have dangerous voltage:
  —Power Terminals: R,S,T
  —Motor Connection Terminals: U,V,W.
- When power off, should not install the controller until 5 minutes after, which can ensure the device discharge completely.
- The section area of grounding conductor must be no less than that of power supply cable.

⚠ CAUTION

- When moving the controller please lift by its base and don't lift by the panel, otherwise may cause the main unit fall off which may result in personal injury.
- Install the controller on the fireproofing material (such as metal) to prevent fire.
- When need install two or more controllers in one cabinet, cooling fan should be provided to make sure that the air temperature is lower than 45℃. Otherwise it could cause fire or damage the device.

3.1 Environmental Requirement

3.1.1 Temperature & Humidity

Environment temperature range: -10℃~+40℃，Controller will be derated if ambient temperature exceeds 40℃.

Less than 90% RH, without dewfall.

3.1.2 Altitude

Controller can output the rated power when installed with altitude of lower than 1000m. It will be derated when the altitude is higher than 1000m. For details, please refer to the following figure:

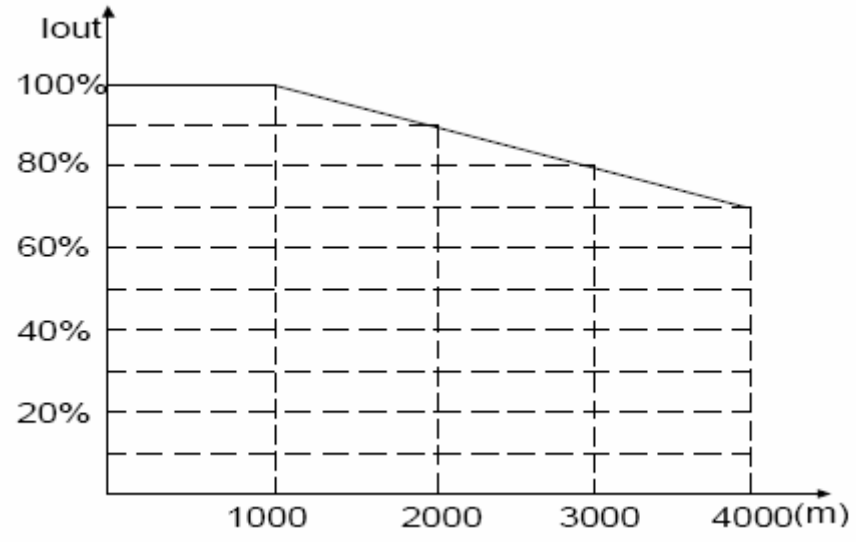


Figure 3.1 Relationship between output current and altitude

3.1.3 Others environmental requirements

It is not allowed that the controller falls down or suffers from fierce impact or the controller installed at the place that oscillation frequently. The maximum swing should less than 5.8m/Ss^2 (0.6g).

3.1.5 Electromagnetic radiation

Keep away from the electromagnetic radiation source.

3.1.6 Water

Do not install the controller at the wringing or dewfall place.

3.1.7 Air pollution

Keep away from air pollution such as dusty, corrosive gas.

3.1.8 Storage

Do not store the controller in the environment with direct sunlight, vapor, oil fog and vibration.

3.2 Installation Space

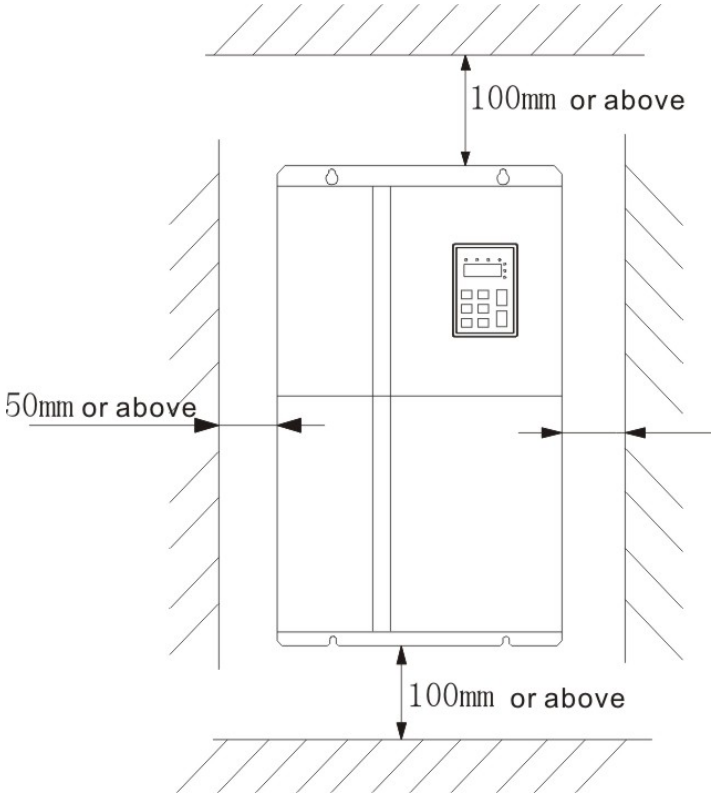


Figure 3.2 Safe space.

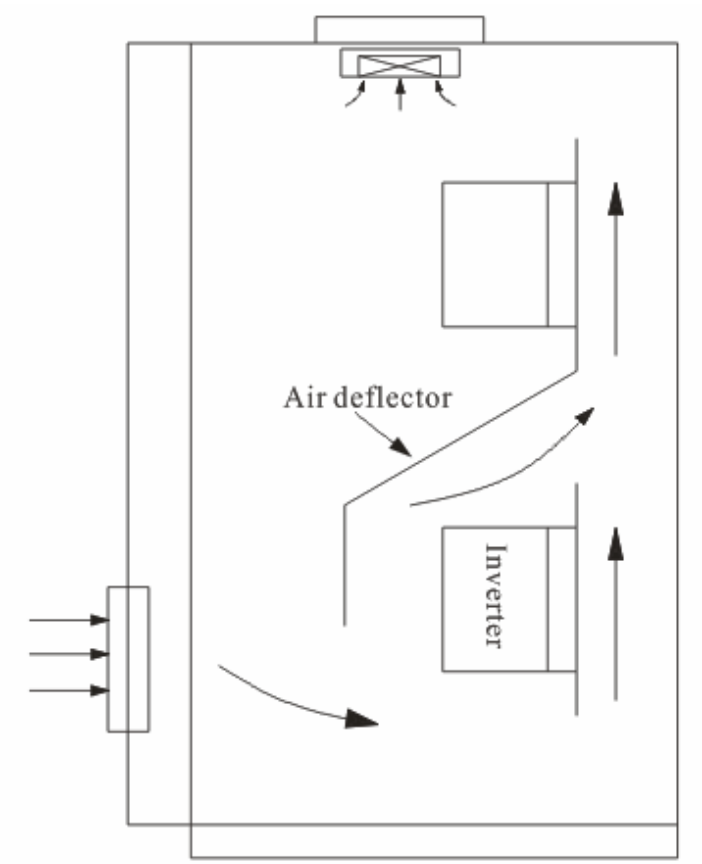


Figure 3.3 Installation of multiple controllers.

Notice: Add the air deflector when apply the up-down installation.

3.3 Dimension of External Keypad

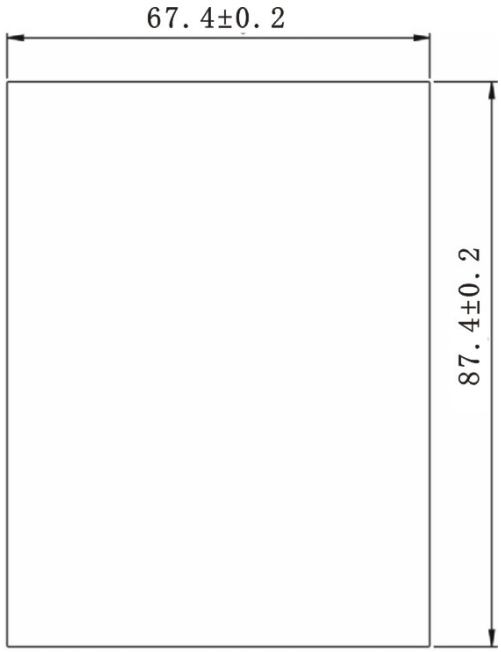


Figure 3.4 Dimension of small keypad.

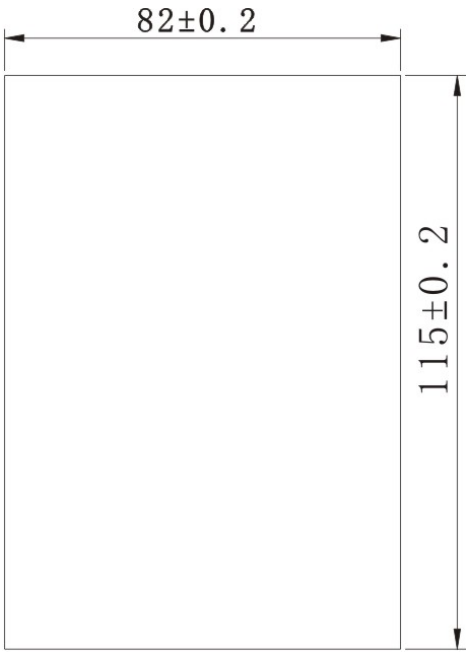


Figure 3.5 Dimension of big keypad.

3.4 Disassembly

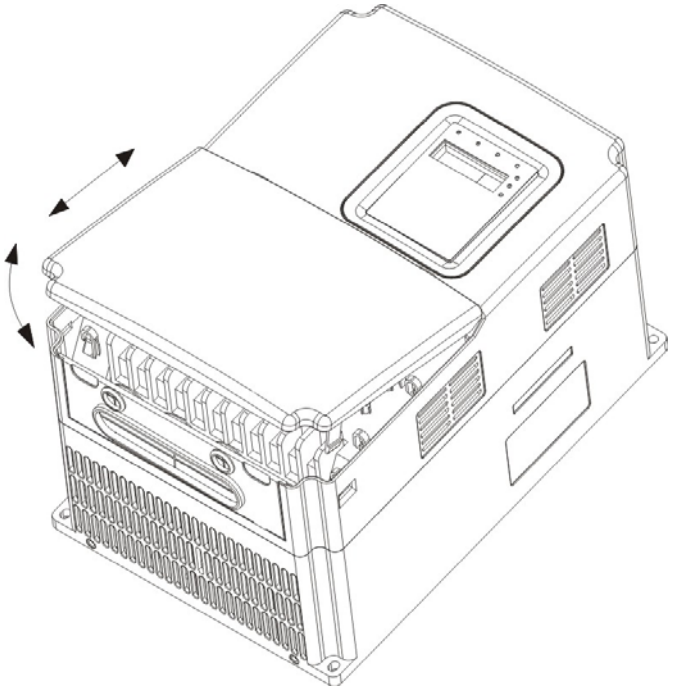


Figure 3.6 Dimension of plastic keypad.

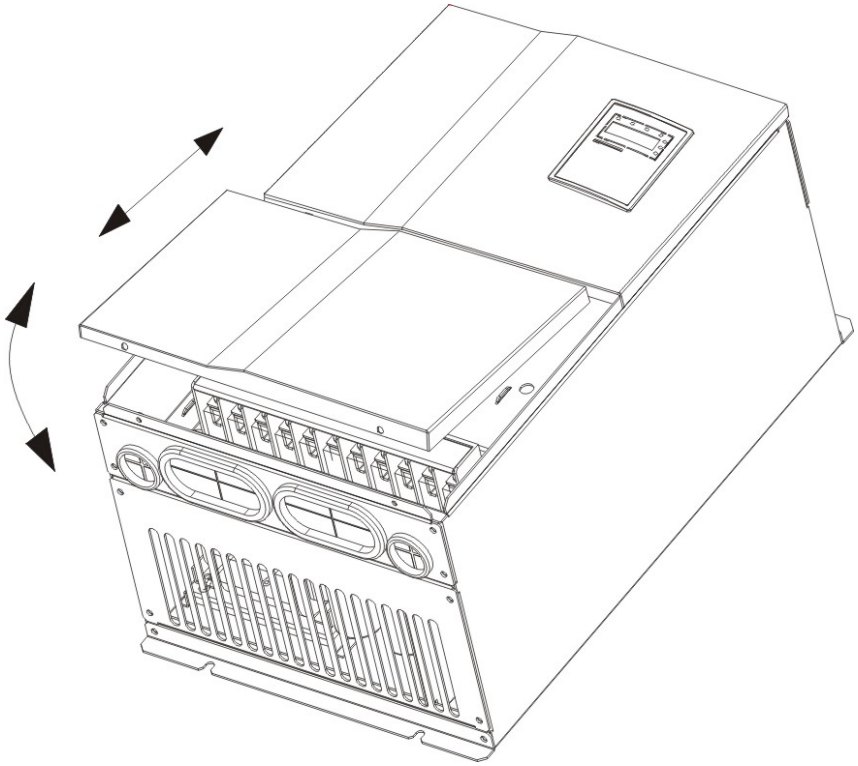


Figure 3.7 Dimension of metal plate cover.

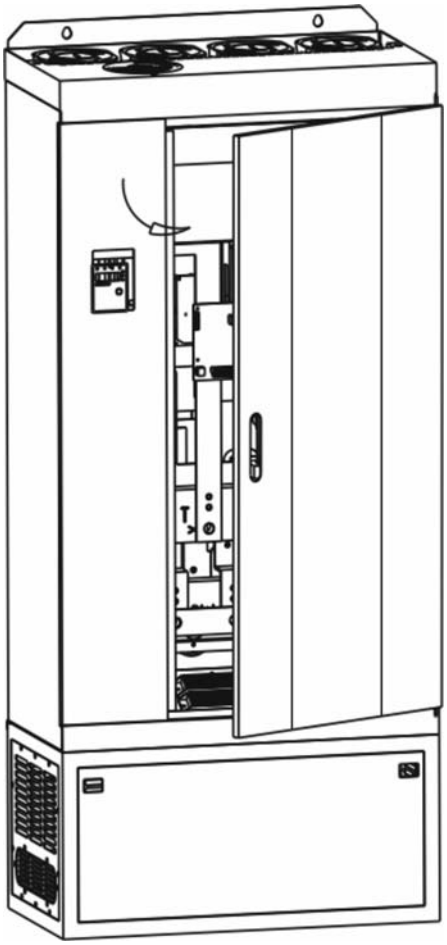


Figure 3.8 Open controller cabinet.

4 WIRING

⚠ WARNING

- Wiring must be performed by the person certified in electrical work.
- Forbid testing the insulation of cable that connects the controller with high-voltage insulation testing devices.
- Cannot install the controller until discharged completely after the power supply is switched off for 5 minutes.
- Be sure to ground the ground terminal.

(200V class: Ground resistance should be 100Ω or less, 400V class: Ground resistance should be 10Ω or less,660Vclass:Ground resistance should be 5Ω or less). Otherwise , it might cause electric shock or fire.

- Connect input terminals(R,S,T)and output terminals (U,V,W) correctly. Otherwise it will cause damage the inside part of controller.
- Do not wire and operate the controller with wet hands. Otherwise there is a risk of electric shock.

⚠ CAUTION

- Check to be sure that the voltage of the main AC power supply satisfies the rated voltage of the Controller.
- Injury or fire can occur if the voltage is not correct.
- Connect power supply cables and motor cables tightly.

4.1 Connection of Peripheral Devices

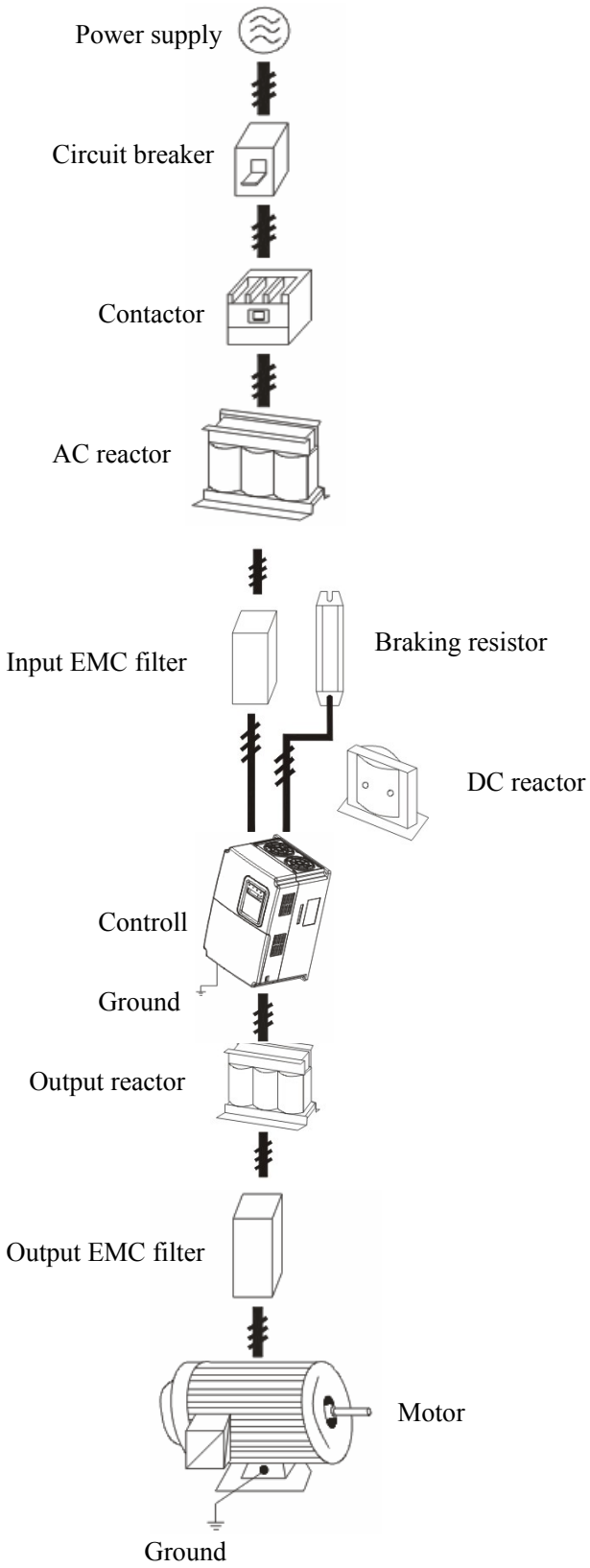


Figure 4.1 Connection of peripheral devices

4.2 Terminal Configuration

4.2.1 Main Circuit Terminals (380V AC)

（+）	PB	L	N		U	V	W	⏚

Figure 4.2 Main circuit terminals (0.75~2.2KW 1AC 220V)

(+)	PB	R	S	T	U	V	W	⏚
		POWER			MOTOR			

Figure 4.3 Main circuit terminals (1.5~2.2KW)

(+)	PB	(-)	R	S	T	U	V	W	⏚
			POWER			MOTOR			

Figure 4.4Main circuit terminals (3.7~5.5KW)

⏚	(+)	PB	(-)	R	S	T	U	V	W	⏚
				POWER			MOTOR			

Figure 4.5Main circuit terminals (7.5~15KW)

⏚	R	S	T	P1	(+)	(-)	U	V	W	⏚
	POWER						MOTOR			

Figure 4.6Main circuit terminals (18.5~110KW)

R	S	T	U	V	W
POWER			MOTOR		

⏚	P1	(+)	(-)	⏚

Figure 4.7Main circuit terminals (132~315KW)

U	V	W	
R	S	T	
PE	P1	(+)	(-)

Figure 4.8Main circuit terminals (350~500KW)

Main circuit terminal functions are summarized according to the terminal to the terminal symbols in the following table. Wire the terminal correctly for the desired purposes.

Terminal Symbol	Function Description
R、S、T	Terminals of 3 phase AC input
(+)、(-)	Spare terminals of external braking unit
(+)、PB	Spare terminals of external braking resistor
P1、(+)	Spare terminals of external DC reactor
(-)	Terminals of negative DC bus
U、V、W	Terminals of 3 phase AC output
⏚	Terminals of ground

4.2.2 Control Circuit Terminals

485+	485-	+10V	AO	COM	Y	+24V
AI1	GND	AI2	S1	S2	S3	S4

ROA	ROB	ROC

Figure 4.9 Control circuit terminals (0.75~2.2KW)

485+	485-

AO	AI1	GND	AI2	+10V	S1	S2	S3	S4	COM	Y	+24V

ROA	ROB	ROC

Figure 4.10 Control terminals (4.0KW and above)

4.3 Typical Wiring Diagram

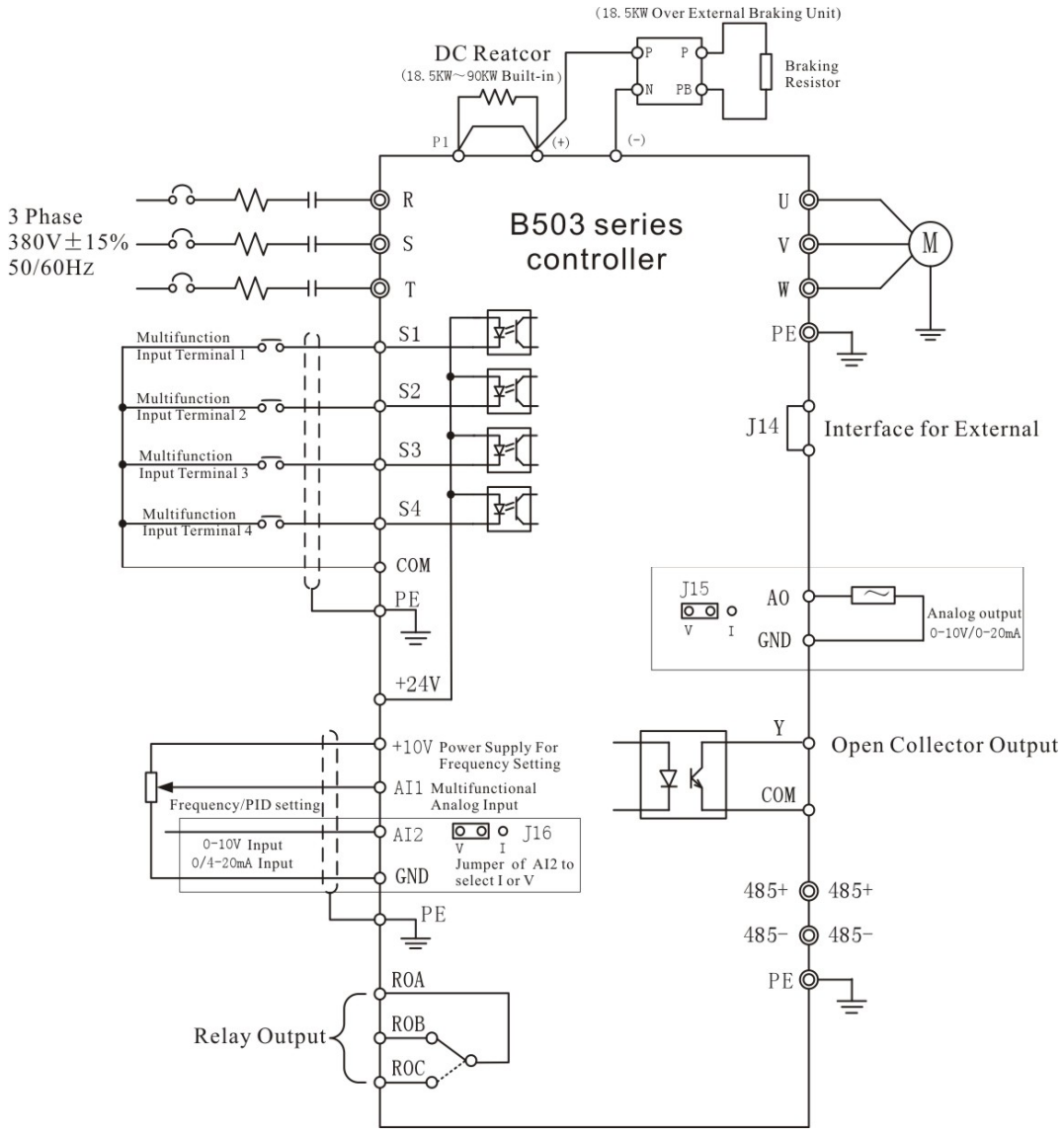


Figure4. 2 Wiring diagram

Notice:

1. **Controllers between 18.5KW and 90KW have built-in DC reactor which is used to improve power factor. For controllers above 110KW, it is recommended to install DC reactor between P1 and (+).**
2. **Controllers below 15KW have built-in braking unit. If need braking, only need to**

install braking resistor between PB and (+).

3. **For controllers above 18.5KW, If need braking, should install external braking unit between (+) and (-).**

4.4 Specifications of Breaker, Cable, Contactor and Reactor

4.4.1 Specifications of breaker, cable and contactor

Model No.	Circuit Breaker (A)	Input/ Output Cable (mm^2)	AC Contactor (A)
1AC 220V ±15%			
B503-2001	16	2.5	10
B503-2002	20	4	16
B503-2003	32	6	20
3AC 220V ±15%			
B503-2001	16	2.5	10
B503-2002	20	4	16
B503-2003	32	6	20
B503-2005	40	6	25
B503-2007	63	6	32
B503-2010	100	10	63
B503-2015	125	25	95
B503-2020	160	25	120
B503-2025	160	25	120
B503-2030	200	35	170
B503-2040	200	35	170
B503-2050	200	35	170
B503-2060	250	70	230
3AC 380V ±15%			
B503-4001	10	2.5	10
B503-4002	16	2.5	10
B503-4003	16	2.5	10
B503-4005G/4007P	25	4	16
B503-4007G/4010P	25	4	16
B503-4010G/4015P	40	6	25
B503-4015G/4020P	63	6	32
B503-4020G/4025P	63	6	50
B503-4025G/4030P	100	10	63
B503-4030G/4040P	100	16	80
B503-4040G/4050P	125	25	95
B503-4050G/4060P	160	25	120
B503-4060G/4070P	200	35	135
B503-4075G/4100P	200	35	170
B503-4100G/4120P	250	70	230
B503-4120G/4150P	315	70	280

Model No.	Circuit Breaker (A)	Input/ Output Cable (mm^2)	AC Contactor (A)
B503-4150G/4180P	400	95	315
B503-4180G/4200P	400	150	380
B503-4200G/4250P	630	185	450
B503-4250G/4280P	630	185	500
B503-4300G/4340P	800	150*2	630
B503-4340G/4380P	800	150*2	700
B503-4380G/4430P	1000	185*2	780
B503-4430G/4470P	1200	240*2	900

4.4.2 Specifications of AC input reactor, AC output reactor and DC reactor

Model No.	AC Input reactor		AC Output reactor		DC reactor	
	Current (A)	Inductance (mH)	Current (A)	Inductance (uH)	Current (A)	Inductance (mH)
3 AC 380V ±15%						
B503-4060G/4075P	120	0.13	120	0.023	95	0.54
B503-4075G/4100P	150	1.10	150	0.019	115	0.45
B503-4100G/4120P	200	0.12	200	0.014	160	0.36
B503-4120G/4150P	250	0.06	250	0.011	180	0.33
B503-4150G/4180P	250	0.06	250	0.011	250	0.26
B503-4180G/4215P	290	0.04	290	0.008	250	0.26
B503-4215G/4250P	330	0.04	330	0.008	340	0.18
B503-4250G/4270P	400	0.04	400	0.005	460	0.12
B503-4270G/4300P	490	0.03	490	0.004	460	0.12
B503-4300G/4340P	490	0.03	490	0.004	460	0.12
B503-4340G/4380P	530	0.03	530	0.003	650	0.11
B503-4380G/4430P	600	0.02	600	0.003	650	0.11
B503-4430G/4470P	660	0.02	660	0.002	800	0.06

4.5 Wiring Main Circuits

4.5.1 Wiring at input side of main circuit

4.5.1.1 Circuit breaker

It is necessary to connect a circuit breaker which is compatible with the capacity of controller between 3ph AC power supply and power input terminals (R, S, T). The capacity of breaker is 1.5~2 times to the rated current of controller. For details, see <Specifications of Breaker, Cable, and Contactor>.

4.5.1.2 Contactor

In order to cut off the input power effectively when something is wrong in the system, contactor should be installed at the input side to control the on/off of the main circuit power supply.

4.5.1.3 AC reactor

In order to prevent the rectifier damage resulted from the large current, AC reactor should be installed at the input side. It can also prevent rectifier from sudden variation of power voltage or harmonic generated by phase-control load.

4.5.1.4 Input EMC filter

The surrounding device may be disturbed by the cables when the controller is working. EMC filter can minimize the interference. Just like the following figure.

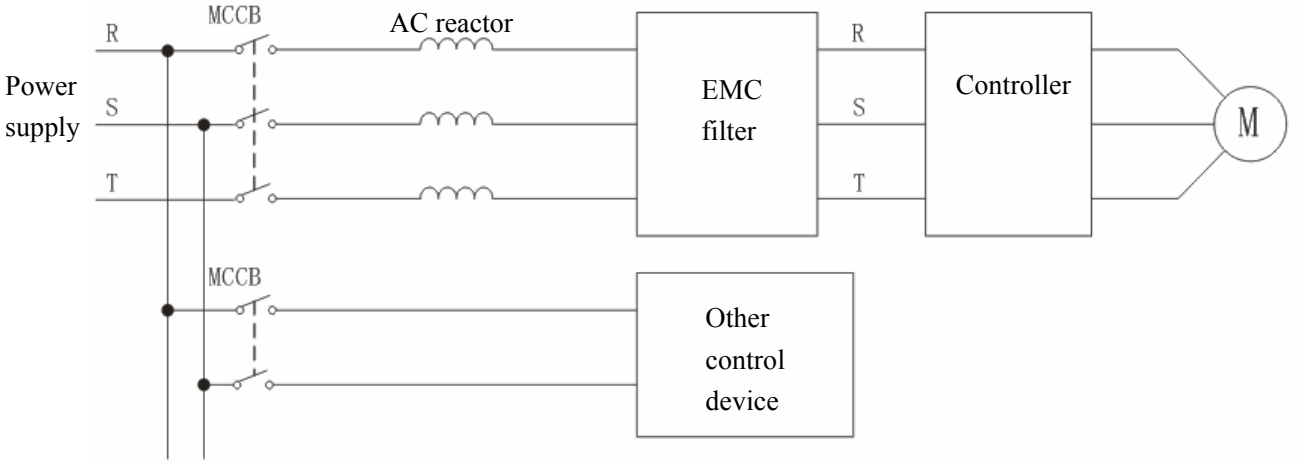


Figure 4.3 Wiring at input side of main circuit.

4.5.2 Wiring at controller side of main circuit

4.5.2.1 DC reactor

Controller from 18.5kw to 90kw have built-in DC reactor which can improve the power factor.

4.5.2.2 Braking unit and braking resistor

Controller of 15kw and below have built-in braking unit. In order to dissipate the regenerative energy generated by dynamic braking, the braking resistor should be installed at (+) and PB terminals. The wire length of the braking resistor should be less than 5m.

Controller of 18.5kw and above need connect external braking unit which should be installed at(+) and (-) terminals. The cable between controller and braking unit should be less than 5m. The cable between braking resistor should be less than 10m.

The temperature of braking resistor will increase because the regenerative energy will be transformed to heat. Safety protection and good ventilation is recommended.

Notice: Be sure that the electric polarity of (+)(-) terminals is right; it is not allowed to connect (+)(-) terminals directly, otherwise damage or fire could occur.

4.5.3 Wiring at motor side of main circuit

4.5.3.1 Output Reactor

When the distance between controller and motor is more than 50m, controller may be tripped by over-current protection frequently because of the large leakage current resulted from the parasitic capacitance with ground. And the same time to avoid the damage of motor insulation, the output reactor should be installed.

4.5.3.2 Output EMC filter

EMC filter should be installed to minimize the leak current caused by the cable and minimize the radio noise caused by the cables between the controller and cable. Just see the following figure.

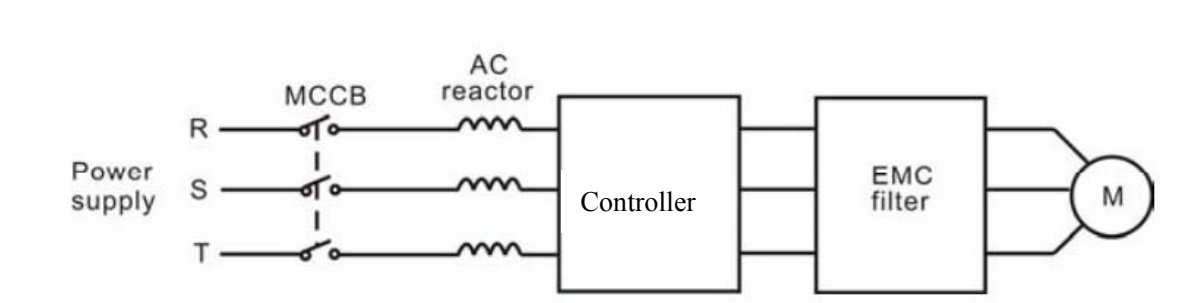


Figure 4.4 Wiring at motor side of main circuit.

4.5.4 Wiring of regenerative unit

Regenerative unit is used for putting the electricity generated by braking of motor to the grid. Compared with traditional 3 phase inverse parallel bridge type rectifier unit, regenerative unit uses IGBT so that the total harmonic distortion (THD) is less than 4%. Regenerative unit is widely used for centrifugal and hoisting equipment.

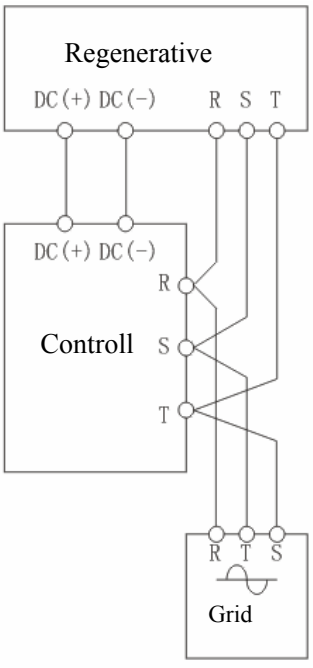


Figure 4.5 Wiring of regenerative unit.

4.5.5 Wiring of Common DC bus

Common DC bus method is widely used in the paper industry and chemical fiber industry which need multi-motor to coordinate. In these applications, some motors are in driving status while some others are in regenerative braking (generating electricity) status. The regenerated energy is automatically balanced through the common DC bus, which means it can supply to motors in driving status. Therefore the power consumption of whole system

will be less compared with the traditional method (one controller drives one motor).

When two motors are running at the same time (i.e. winding application), one is in driving status and the other is in regenerative status. In this case the DC buses of these two controllers can be connected in parallel so that the regenerated energy can be supplied to motors in driving status whenever it needs. Detailed wiring is shown in the following figure:

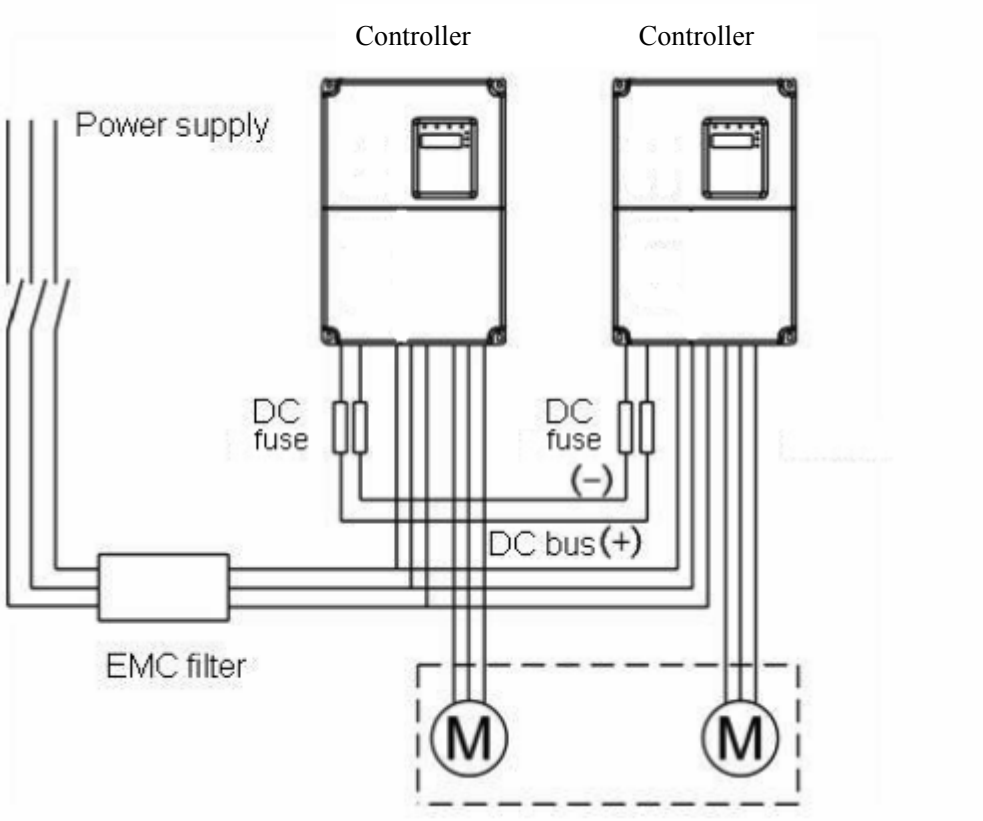


Figure 4.6 Wiring of common DC bus.

Notice: Two controllers must be the same model when connected with Common DC bus method. Be sure they are powered on at the same time.

4.5.6 Ground Wiring (PE)

In order to ensure safety and prevent electrical shock and fire, PE must be grounded with ground resistance. The ground wire should be big and short, and it is better to use copper wire (>3.5mm^2). When multiple controllers need to be grounded, do not loop the ground wire.

4.6 Wiring Control Circuits

4.6.1 Precautions

- Use shielded or twisted-pair cables to connect control terminals.
- Connect the ground terminal (PE) with shield wire.
- The cable connected to the control terminal should leave away from the main circuit and heavy current circuits (including power supply cable, motor cable, relay and contactor connecting cable) at least 20 cm and parallel wiring should be avoided. It is suggested to

apply perpendicular wiring to prevent controller malfunction caused by external interference.

4.6.2 Control circuit terminals

Terminal No.	Function
S1~S4	ON-OFF signal input, optical coupling with +24V and COM. Input voltage range: 9~30V Input impedance: 3.3kΩ
+24V	Provide output power supply of +24V. Maximum output current: 150mA
AI1	Analog input: 0~10V Input impedance: 10kΩ
AI2	Analog input: 0~10V/ 0~20mA, switched by J16. Input impedance:10kΩ (voltage input) / 250Ω (current input)
GND	Common ground terminal of analog signal and +10V. **(GND is isolated with COM.)**
+10V	Supply +10V to controller, output current; 0~10mA.
COM	Common ground terminal for digital signal and +24V(or external power supply).
AO	Provide voltage or current output which can be switched by J15. Output range: 0~10V/ 0~20mA
Y	Open collector output terminal, the corresponding common ground terminal is COM. External power range: 0～24V, Output current range: 0～50mA 24V pull-up resistor range: 2k～10kΩ
ROA、ROB、ROC	Relay output: ROA--common; ROB--NC, ROC—NO. Contact capacity: AC 250V/3A, DC 30V/1A
485+、485-	485 communication terminal. Please use twisted-pair or shielding wire

4.6.3 Jumpers on control board

Jumper	Function
J2,J4,J7	Do not change default setting otherwise it will cause communication malfunction.
J16	Switch between (0~10V) voltage input and (0~20mA) current input. V connected to GND means voltage input; I connected to GND means current input.
J15	Switch between (0~10V) voltage output and (0~20mA) current output. V connected to GND means voltage output; I connect to GND means current output.

4.7 Installation Guideline to EMC Compliance

4.7.1 General description of EMC

EMC is the abbreviation of electromagnetic compatibility, which means the device or system has the ability to work normally in the electromagnetic environment and will not generate any electromagnetic interference to other equipments.

EMC includes two subjects: electromagnetic interference and electromagnetic anti-jamming.

According to the transmission mode, Electromagnetic interference can be divided into two categories: conducted interference and radiated interference.

Conducted interference is the interference transmitted by conductor. Therefore, any conductors (such as wire, transmission line, inductor, capacitor and so on) are the transmission channels of the interference.

Radiated interference is the interference transmitted in electromagnetic wave, and the energy is inverse proportional to the square of distance.

Three necessary conditions or essentials of electromagnetic interference are: interference source, transmission channel and sensitive receiver. For customers, the solution of EMC problem is mainly in transmission channel because of the device attribute of disturbance source and receiver can not be changed

4.7.2 EMC features of controller

Like other electric or electronic devices, controller is not only an electromagnetic interference source but also an electromagnetic receiver. The operating principle of controller determines that it can produce certain electromagnetic interference noise. And the same time controller should be designed with certain anti-jamming ability to ensure the smooth working in certain electromagnetic environment. The following is its EMC features:

4.7.2.1 Input current is non-sine wave. The input current includes large amount of high-harmonic waves that can cause electromagnetic interference, decrease the grid power factor and increase the line loss.

4.7.2.2 Output voltage is high frequency PMW wave, which can increase the temperature rise and shorten the life of motor. And the leakage current will also increase, which can lead to the leakage protection device malfunction and generate strong electromagnetic interference to influence the reliability of other electric devices.

4.7.2.3 As the electromagnetic receiver, too strong interference will damage the controller and influence the normal using of customers.

4.7.2.4 In the system, EMS and EMI of controller coexist. Decrease the EMI of controller can increase its EMS ability.

4.7.3 EMC Installation Guideline

In order to ensure all electric devices in the same system to work smoothly, this section, based on EMC features of controller, introduces EMC installation process in several aspects of application (noise control, site wiring, grounding, leakage current and power supply filter). The good effective of EMC will depend on the good effective of all of these five aspects.

4.7.3.1 Noise control

All the connections to the control terminals must use shielded wire. And the shield layer of the wire must ground near the wire entrance of controller. The ground mode is 360 degree annular connection formed by cable clips. It is strictly prohibitive to connect the twisted shielding layer to the ground of controller, which greatly decreases or loses the shielding effect.

Connect controller and motor with the shielded wire or the separated cable tray. One side of shield layer of shielded wire or metal cover of separated cable tray should connect to ground, and the other side should connect to the motor cover. Installing an EMC filter can reduce the electromagnetic noise greatly.

4.7.3.2 Site wiring

Power supply wiring: the power should be separated supplied from electrical transformer. Normally it is 5 core wires, three of which are fire wires, one of which is the neutral wire, and one of which is the ground wire. It is strictly prohibitive to use the same line to be both the neutral wire and the ground wire

Device categorization: there are different electric devices contained in one control cabinet, such as controller, filter, PLC and instrument etc, which have different ability of emitting and withstanding electromagnetic noise. Therefore, it needs to categorize these devices into strong noise device and noise sensitive device. The same kinds of device should be placed in the same area, and the distance between devices of different category should be more than 20cm.

Wire Arrangement inside the control cabinet: there are signal wire (light current) and power cable (strong current) in one cabinet. For the controller, the power cables are categorized into input cable and output cable. Signal wires can be easily disturbed by power cables to make the equipment malfunction. Therefore when wirings, signal cables and power cables should be arranged in different area. It is strictly prohibitive to arrange them in parallel or interlacement at a close distance (less than 20cm) or tie them together. If the signal wires have to cross the power cables, they should be arranged in 90 angles. Power input and output cables should not either be arranged in interlacement or tied together, especially when installed the EMC filter. Otherwise the distributed capacitances of its input and output power cable can be coupling each other to make the EMC filter out of function.

4.7.3.3 Ground

Controller must be ground safely when in operation. Grounding enjoys priority in all EMC methods because it does not only ensure the safety of equipment and persons, but also is the simplest, most effective and lowest cost solution for EMC problems.

Grounding has three categories: special pole grounding, common pole grounding and series-wound grounding. Different control system should use special pole grounding, and different devices in the same control system should use common pole grounding, and different devices connected by same power cable should use series-wound grounding.

4.7.3.4 Leakage Current

Leakage current includes line-to-line leakage current and over-ground leakage current. Its value depends on distributed capacitances and carrier frequency of controller. The over-ground leakage current, which is the current passing through the common ground wire, can not only flow into controller system but also other devices. It also can make leakage current circuit breaker, relay or other devices malfunction. The value of line-to-line leakage

current, which means the leakage current passing through distributed capacitors of input output wire, depends on the carrier frequency of controller, the length and section areas of motor cables. The higher carrier frequency of controller, the longer of the motor cable and/or the bigger cable section area, the larger leakage current will occur.

Countermeasure:

Decreasing the carrier frequency can effectively decrease the leakage current. In the case of motor cable is relatively long (longer than 50m), it is necessary to install AC reactor or sinusoidal wave filter at the output side, and when it is even longer, it is necessary to install one reactor at every certain distance.

4.7.3.5 EMC Filter

EMC filter has a great effect of electromagnetic decoupling, so it is preferred for customer to install it.

For controller, noise filter has following categories:

- Noise filter installed at the input side of controller;
- Install noise isolation for other equipment by means of isolation transformer or power filter.

5 OPERATION

5.1 Keypad Description

5.1.1 Keypad schematic diagram

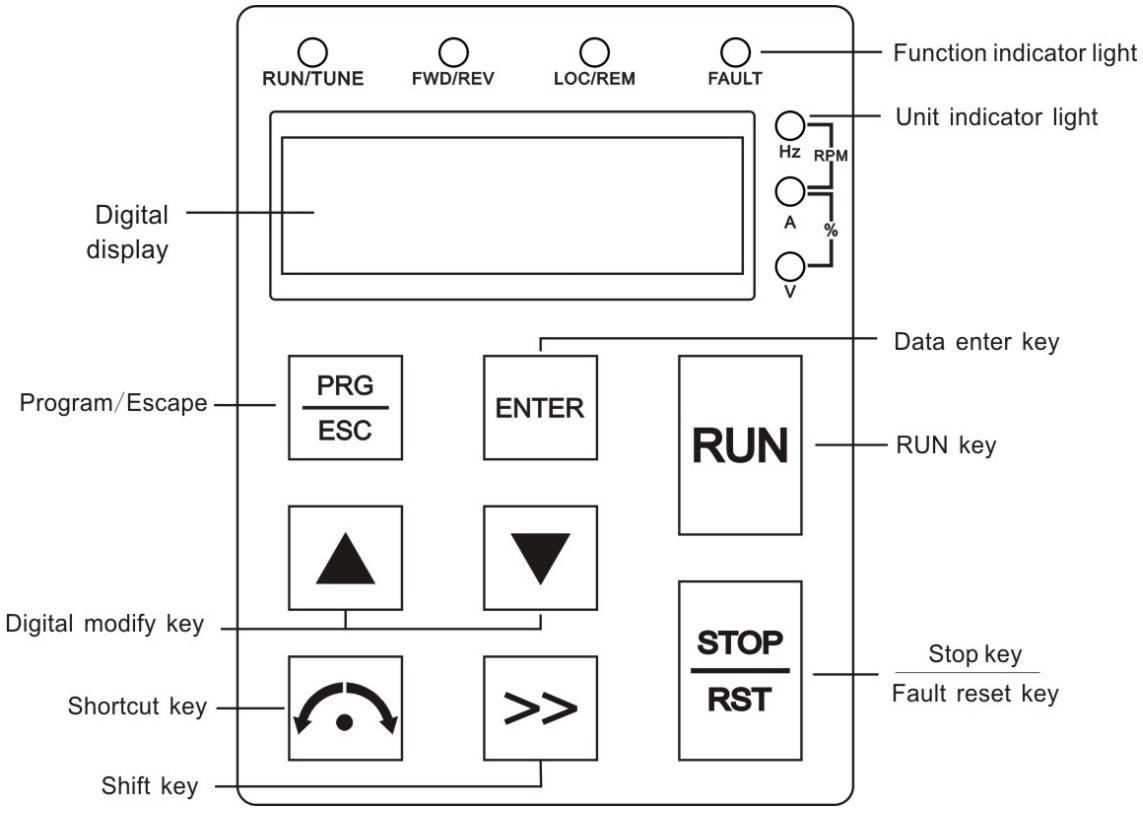


Figure 5.1 Keypad schematic diagram.

5.1.2 Key function description

Button Symbol	Name	Function Description
PRG ESC	Programming Key	Entry or escape of first-level menu.
ENTER	Enter Key	Progressively enter menu and confirm parameters.
▲	UP Increment Key	Progressively increase data or function codes.
▼	DOWN Decrement Key	Progressive decrease data or function codes.
≫	Shift Key	In parameter setting mode, press this button to select the bit to be modified. In other modes, cyclically displays parameters by right shift.
RUN	Run Key	Start to run the controller in keypad control mode.
STOP RST	STOP/RESET Key	In running status, restricted by F7.04, can be used to stop the controller. When fault alarm, can be used to reset the controller without any restriction.
	Shortcut Multifunction Key	Determined by Function Code F7.03: 0:Jog 1:FDW/REV switching 2:Cleat UP/DOWN setting
RUN + STOP RST	Combination Key	Pressing the RUN and STOP/RST at the same time can achieve controller coast to stop.

5.1.3 Indicator light description

5.1.3.1 Function Indicator Light Description

Indicator Light Name	Indicator Light Description
RUN/TUNE	Extinguished: stop status Light on: operation status Flickering: parameter auto-tuning status.
FWD/REV	Extinguished: forward operation Light on: reverse operation.

Indicator Light Name	Indicator Light Description
LOC/REM	Extinguished: keypad control Flickering: terminal control Light on: communication control
FAULT	Extinguished: normal operation status Flickering: overload pre-warning status

5.1.3.2 Unit Indicator Light Description

Symbol	Description
Hz	Frequency unit
A	Current unit
V	Voltage unit
RPM	Rotation speed unit
%	Percentage

5.1.3.3 Digital Display

Have 5 digit LED , which can display all kinds of monitoring data and alarm codes such as reference frequency, output frequency and so on.

5.2 Operation Process

5.2.1 Parameter setting

Three levels of menu are:

1、Function code group (first-level);

2、Function code (second-level);

3、Function code value (third-level).

Remarks: Press both the PRG/ESC and the ENTER can return to the second-class menu from the third-class menu. The difference is: pressing ENTER will save the set parameters into the control panel, and then return to the second-class menu with shifting to the next function code automatically; while pressing PRG/ESC will directly return to the second-class menu without saving the parameters, and keep staying at the current function code

Under the third-class menu, if the parameter has no flickering bit, it means the function code cannot be modified. The possible reasons could be:

1）This function code is not modifiable parameter, such as actual detected parameter, operation records and so on;

2）This function code is not modifiable in running status, but modifiable in stop status.

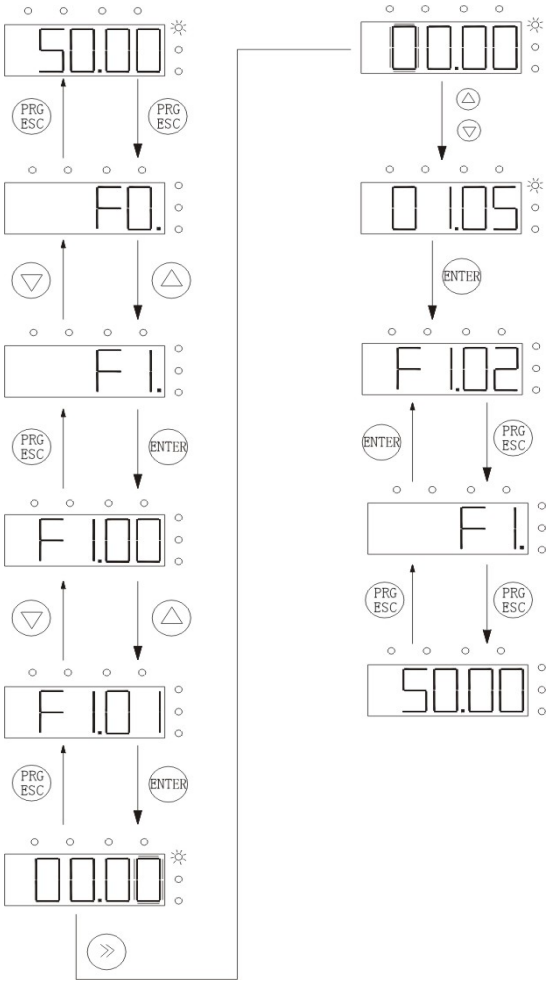


Figure 5.2 Flow chart of parameter setting.

5.2.2 Fault reset

If the controller has fault, it will prompt the related fault information. User can use STOP/RST or according terminals determined by F5 Group to reset the fault. After fault reset, the controller is at stand-by state. If user does not reset the controller when it is at fault state, the controller will be at operation protection state, and can not run.

5.2.3 Motor parameter autotuning

If "Sensorless Vector Control" mode is chosen, motor nameplate parameters must be input correctly as the autotuning is based on it. The performance of vector control depends on the parameters of motor strongly. To achieve excellent performance, firstly must obtain the parameter of motor exactly.

The procedure of motor parameter autotuning is specified as follows:

Firstly, choose the keypad command channel as the operation command channel (F0.01).

And then input following parameters according to the actual motor parameters:

F2.01: motor rated power.

F2.02: motor rated frequency;

F2.03: motor rated speed;

F2.04: motor rated voltage;

F2.05: motor rated current

Notice: the motor should be uncoupled with its load; otherwise, the motor parameters

obtained by autotuning may be not correct.

Set F0.12 to be 1, and for the detail process of motor parameter autotuning, please refer to the description of Function Code F0.12. And then press RUN on the keypad panel, the controller will automatically calculate following parameter of the motor:

F2.06: motor stator resistance;

F2.07: motor rotor resistance;

F2.08: motor stator and rotor inductance;

F2.09: motor stator and rotor mutual inductance;

F2.10: motor current without load;

then motor autotuning is finished.

5.2.4 Password setting

B503 series controller offers user's password protection function. When F7.00 is set to be nonzero, it will be the user's password, and After exiting function code edit mode, it will become effective after 1 minute. If pressing the PRG/ESC again to try to access the function code edit mode, "-b503-"will be displayed, and the operator must input correct user's password, otherwise will be unable to access it.

If it is necessary to cancel the password protection function, just set F7.00 to be zero.

5.3 Running State

5.3.1 Power-on initialization

Firstly the system initializes during the controller power-on, and LED displays "-b503-", and seven indicator lights are all on. After the initialization is completed, the controller is on stand-by status.

5.3.2 Stand-by

At stop or running status, parameters of multi-status can be displayed. Whether or not to display this parameter can be chosen through Function Code F7.06(Running status display selection) and F7.07 (Stop status display selection) according to binary bits, the detailed description of each bit please refer the function code description of F7.06 and F7.07.

In stop status, there are nine parameters which can be chosen to display or not. They are: reference frequency, DC bus voltage, ON-OFF input status, open collector output status, PID setting, PID feedback, analog input AI1 voltage, analog input AI2 voltage, step number of multi-step speed. Whether or not to display can be decided by setting the corresponding binary bit of F7.07. Press the 》 to scroll through the parameters in right order .

5.3.3 Motor parameter autotuning

For details, please refer to the description of F0.12.

5.3.4 Operation

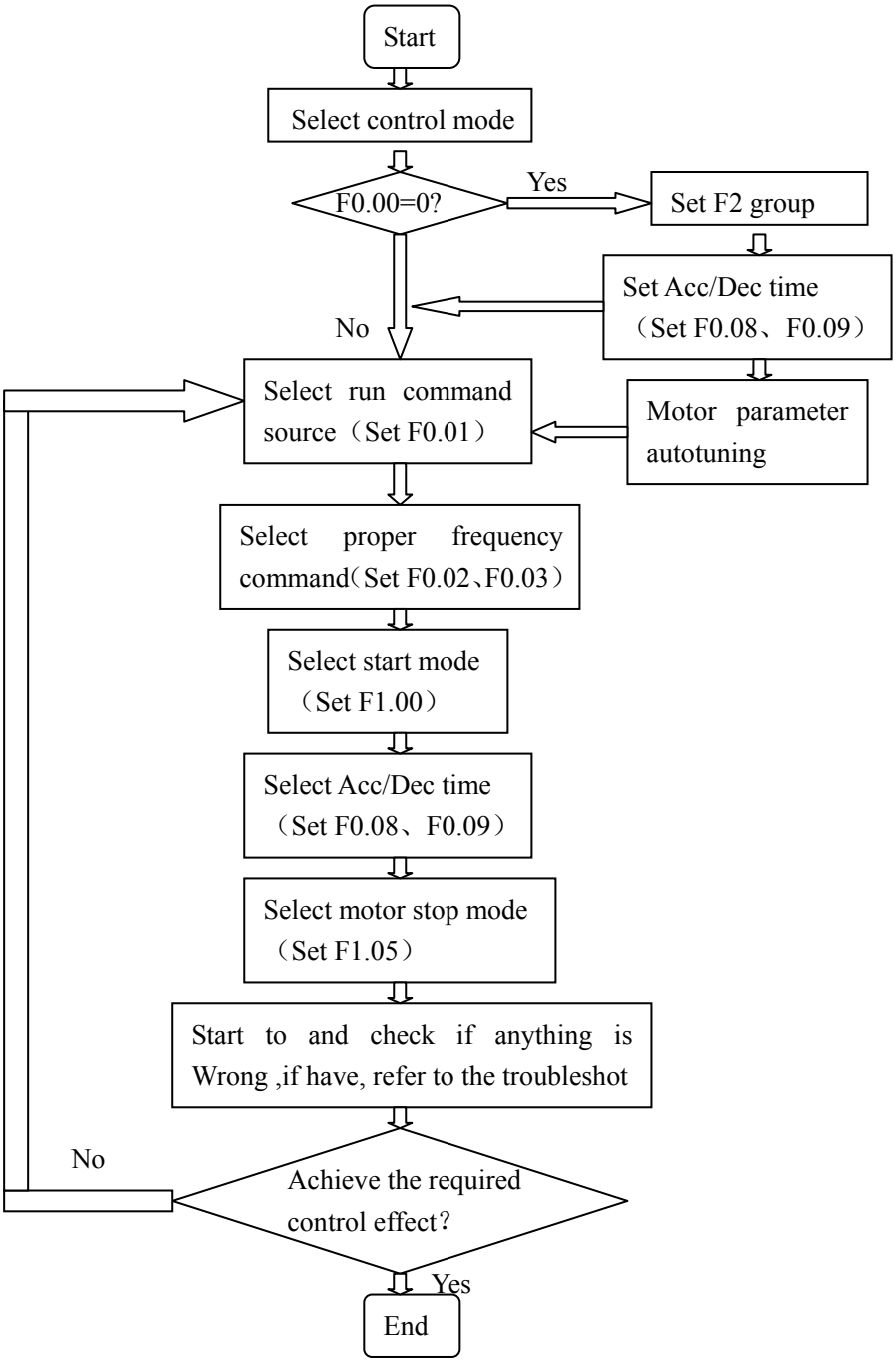
In running status, there are eighteen running parameters: output frequency, reference frequency, DC bus voltage, output voltage, output current, output power, output torque, PID setting, PID feedback, ON-OFF input status, open collector output status, length value, count value, step number of PLC and multi-step speed, voltage of AI1, voltage of AI2 and step number of multi-step speed. Whether or not to display can be decided by the bit option of

Function Code F7.06 (converted into binary system). Press the 》 to scroll through the parameters in right order .

5.3.5 Fault

B503 series controller offers a variety of fault information. For details, see controller faults and their troubleshooting.

5.4 Quick Testing



6 DETAILED FUNCTION DESCRIPTION

6.1 F0 Group--Basic Function

Function Code	Name	Description	Setting Range	Factory Setting
F0.00	Speed control mode	0：Sensorless vector control 1：V/F control 2：Torque control	0~2	0

0: Sensorless vector control

It is widely used for the application which requires high torque at low speed, higher speed accuracy, and quicker dynamic response, such as machine tool, injection molding machine, centrifugal machine and wire-drawing machine, etc.

1: V/F control

It is suitable for general purpose application such as pumps, fans etc.

2: Torque control

It is suitable for the application with low accuracy torque control, such as wired-drawing. In torque control mode, the speed of motor is determined by load, the rate of ACC/DEC has nothing to do with the value of F0.08 and F0.09 (or F8.00 and F8.01).

Notice:

- Controller can drive only one motor when F0.00 is set to be 0 or 2. When F0.00 is set to be 1, controller can drive multi motors.
- The autotuning of motor parameters must be accomplished properly when F0.00 is set to be 0 or 2.
- In order to achieve better control characteristic, the parameters of speed regulator (F3.00~F3.05) must be adjusted according to actual situation when F0.00 is set to be 0 or 2.

Function Code	Name	Description	Setting Range	Factory Setting
F0.01	Run command source	0：Keypad (LED extinguished) 1：Terminal(LED flickering) 2：Communication(LED lights on)	0~2	0

The control commands of controller include: start, stop, forward run, reverse run, jog, fault reset and so on.

0: Keypad (LED extinguished);

Both RUN and STOP/RST key are used for running command control. If Multifunction key  is set as FWD/REV switching function (F7.03 is set to be 1), it will be used to change the rotating orientation. In running status, pressing RUN and STOP/RST in the same time will cause the controller coast to stop.

1: Terminal (LED flickering)

The operation, including forward run, reverse run, forward jog, reverse jog etc. can be controlled by multifunctional input terminals.

2: Communication (LED lights on)

The operation of controller can be controlled by the host through communication.

Function Code	Name	Description	Setting Range	Factory Setting
F0.02	UP/DOWN setting	0：Valid, save UP/DOWN value when power off 1：Valid, do not save UP/DOWN value when power off 2：Invalid 3：Valid during running, clear when stop.	0~3	0

0: User can adjust the reference frequency by UP/DOWN. The value of UP/DOWN can be saved when power off.

1: User can adjust the reference frequency by UP/DOWN, but the value of UP/DOWN will not be saved when power off.

2: User can not adjust the reference frequency by UP/DOWN. The value of UP/DOWN will be cleared if F3.05 is set to 2.

3: User can only adjust the reference frequency by UP/DOWN during the controller is running. The value of UP/DOWN will be cleared when the controller stops.

Notice:

UP/DOWN function can be adjusted by keypad (∧ and ∨) and multifunctional terminals.

Reference frequency can be adjusted by UP/DOWN.

UP/DOWN has highest priority which means UP/DOWN is always active no matter which frequency command source is.

When the factory setting is restored (F1.03 is set to be 1), the value of UP/DOWN will be cleared.

Function Code	Name	Description	Setting Range	Factory Setting
F0.03	Frequency A command source	0：Keypad 1：AI1 2：AI2 3：AI1+AI2 4：Multi-Step speed 5：PID 6：Communication	0~6	0

0: Keypad: Please refer to description of F3.00

1: AI1.

2: AI2

3: AI1+AI2

The reference frequency is set by analog input. B503 series controller provides 2 analog input terminals. AI1 is 0~10V voltage input terminal, while AI2 is 0~10V voltage input or 0~20mA current input. Voltage input or current input of AI2 can be selected by Jumper J16.

Notice:

- **When AI2 is set as 0~20mA current input, the corresponding voltage range is 0~5V. For detailed relationship between analogue input voltage and frequency, please refer to description of F5.07~F5.11.**
- **100% of AI is corresponding to maximum frequency (F0.04)**

4: Multi-step speed

The reference frequency is determined by F5 group and FA group. The selection of steps is determined by combination of multi-step speed terminals.

Notice:

- **Multi-step speed mode will enjoy priority in setting reference frequency if F0.03 is not set to be 4.In this case, only step 1 to step 15 are available.**
- **If F0.03 is set to be 4,step 0 to step 15 can be realized, jog has highest priority.**

5: PID

The reference frequency is the result of PID adjustment. For details, please refer to description of F9 group

6: Communication

The reference frequency is set through RS485. For details, please refer to description of Chapter 10.

Function Code	Name	Description	Setting Range	Factory Setting
F0.04	Maximum frequency	10.0~600.00Hz	10.0~600.00	50.0Hz

Notice:

- **The frequency reference should not exceed maximum frequency.**
- **Actual acceleration time and deceleration time are determined by maximum frequency. Please refer to description of F0.08 and F0.09.**

Function Code	Name	Description	Setting Range	Factory Setting
F0.05	Upper frequency limit	F0.06~F0.04	F0.06~F0.04	50.00Hz

Notice:

- **Upper frequency limit should not be greater than the maximum frequency (F0.04).**
- **Output frequency should not exceed upper frequency limit.**

Function Code	Name	Description	Setting Range	Factory Setting
F0.06	Lower frequency limit	0.0~F0.05	0.0~F0.05	0.0Hz

Notice:

Lower frequency limit should not be greater than upper frequency limit (F0.05).

If frequency reference is lower than F0.06, the action of controller is determined by F1.12.Please refer to description of F1.12.

Function Code	Name	Description	Setting Range	Factory Setting
F0.07	Keypad reference frequency	0.00~F0.04	0.00~F0.04	50.00Hz

When F0.03 is set to be 0, this parameter is the initial value of controller reference frequency.

Function Code	Name	Description	Setting Range	Factory Setting
F0.08	Acceleration time 0	0.1~3600.0s	0.1~3600.0	Depend on model
F0.09	Deceleration time 0	0.1~3600.0s	0.1~3600.0	Depend on model

Acceleration time is the time of accelerating from 0Hz to maximum frequency (F0.04).

Deceleration time is the time of decelerating from maximum frequency (F0.04) to 0Hz.

Please refer to following figure.

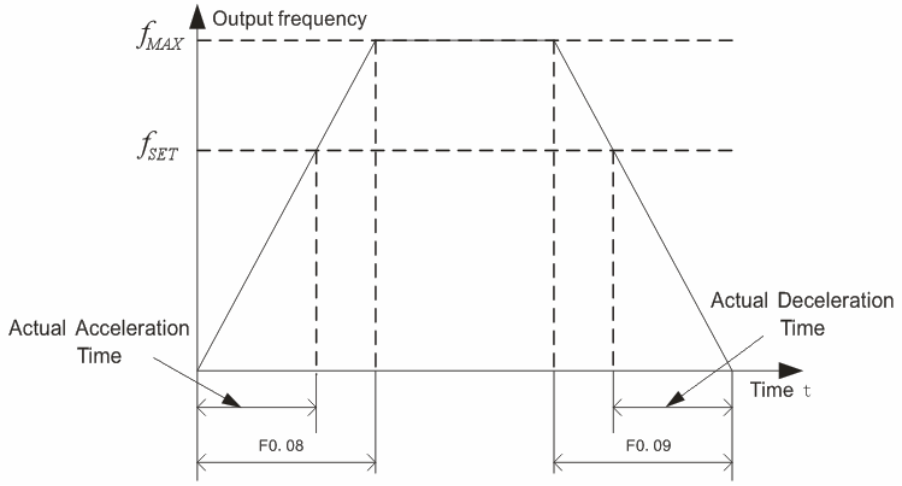


Figure 6.1 Acceleration and deceleration time

When the reference frequency is equal to the maximum frequency, the actual acceleration and deceleration time will be equal to the F0.08 and F0.09 respectively.

When the reference frequency is less than the maximum frequency, the actual acceleration and deceleration time will be less than the F0.08 and F0.09 respectively.

The actual acceleration (deceleration) time = F0.08 (F0.09) * reference frequency/F0.04.

B503 series controller has 2 groups of acceleration and deceleration time.

1st group: F0.08, F0.09

2nd group: F8.00, F8.01

The acceleration and deceleration time can be selected by combination of multifunctional ON-OFF input terminals determined by F5 Group. The factory setting of acceleration and deceleration time is as follow:

5.5kw and below: 10.0s

7.5kw~30kw: 20.0s

37kw and above: 40.0s

Function Code	Name	Description	Setting Range	Factory Setting
F0.10	Running direction selection	0：Forward 1：Reverse 2：Forbid reverse	0~2	0

Notice:

The rotation direction of motor is corresponding to the wiring of motor.

When the factory setting is restored (F0.13 is set to be 1), the rotation direction of motor may be changed. Please be cautious to use.

If F0.10 is set to 2, user can not change rotation direction of motor by ⟵ • ⟶ or terminal.

Function Code	Name	Description	Setting Range	Factory Setting
F0.11	Carrier frequency	1.0~15.0KHz	1.0~15.0	Depend on model

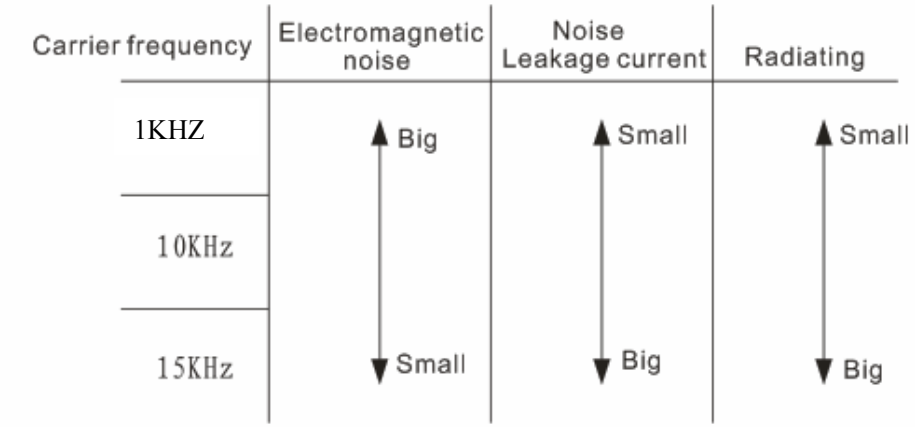


Figure 6.2 Effect of carrier frequency.

The following table is the relationship between power rating and carrier frequency.

Carrier f / Model	Highest Carrier f (kHz)	Lowest Carrier f (kHz)	Factory setting (kHz)
G Model:0.75KW~11KW P Model:0.75KW~15KW	15	1	8
G Model:15KW~55KW P Model:18.5KW~75KW	8	1	4
G Model:75KW~300KW P Model:90KW~315KW	6	1	2

Carrier frequency will affect the noise of motor and the EMI of controller.

If the carrier frequency is increased, it will cause better current wave, less harmonic current and lower noise of motor.

Notice:

- **The factory setting is optimal in most cases. Modification of this parameter is not recommended.**
- **If the carrier frequency exceeds the factory setting, the controller must be**

derated because the higher carrier frequency will cause more switching loss, higher temperature rise of controller and stronger electromagnetic interference.

If the carrier frequency is lower than the factory setting, it is possible to cause less output torque of motor and more harmonic current.

Function Code	Name	Description	Setting Range	Factory Setting
F0.12	Motor parameters autotuning	0：No action 1：Rotation autotuning 2：Static autotuning	0~2	0

0: No action: Forbidding autotuning.

1: Rotation autotuning:

- Do not connect any load to the motor when performing autotuning and ensure the motor is in static status.
- Input the nameplate parameters of motor (F2.01~F2.05) correctly before performing autotuning. Otherwise the parameters detected by autotuning will be incorrect; it may influence the performance of controller.
- Set the proper acceleration and deceleration time (F0.08 and F0.09) according to the motor inertia before performing autotuning. Otherwise it may cause over-current and over-voltage fault during autotuning.
- The operation process is as follow:

a、Set F0.12 to be 1 then press the ENTER, LED will display "-TUN-" and flickers. During "-TUN-" is flickering, if you want to exit autotuning, press the PRG/ESC to exit autotuning.

b、Press the RUN to start the autotuning. LED will display "TUN-0".

c、After a few seconds the motor will start to run. LED will display "TUN-1" and "RUN/TUNE" light will flicker.

d、After a few minutes, LED will display "-END-". That means the autotuning is finished and return to the stop status.

e、During the autotuning, pressing STOP/RST will stop autotuning.

Notice: Only keypad can control the autotuning. F0.12 will restore to 0 automatically when the autotuning is finished or cancelled.

2: Static autotuning:

- If it is difficult to disconnect the load, static autotuning is recommended.
- The operation process is the same as rotation autotuning except step c.

Notice: The Mutual inductance and current without load will not be detected by static autotuning, if needed user should input suitable value according to experience.

Function Code	Name	Description	Setting Range	Factory Setting
F0.13	Restore parameters	0：No action 1：Restore factory setting 2：Clear fault records	0~2	0

0: No action

1: Controller restores all parameters to factory setting except F2 group.

2: Controller clear all fault records.

This function code will restore to 0 automatically when complete the function operation.

Function Code	Name	Description	Setting Range	Factory Setting
F0.14	AVR function	0：Disabled 1：Enabled all the time 2：Disabled during deceleration	0~2	1

AVR (Auto Voltage Regulation) function ensure the output voltage of controller stable no matter how the DC bus voltage changes. During deceleration, if AVR function is disabled, the deceleration time will be short but the current will be big. If AVR function is enabled all the time, the deceleration time will be long but the current will be small.

6.2 F1 Group--Start and Stop Control

Function Code	Name	Description	Setting Range	Factory Setting
F1.00	Start Mode	0：Start directly 1：DC braking and start 2：Speed tracking and start	0~2	0

0: Start directly: Start the motor at the starting frequency determined by F1.01.

1: DC braking and start: Controller will output DC current firstly and then start the motor at the starting frequency. Please refer to description of F1.03 and F1.04. It is suitable for the motor which have small inertia load and may reverse rotation when start.

Function Code	Name	Description	Setting Range	Factory Setting
F1.01	Starting frequency	0.00~10.00Hz	0.00~10.00	0.50Hz
F1.02	Hold time of starting frequency	0.0~50.0s	0.0~50.0	0.0s

Set proper starting frequency can increase the starting torque.

If the reference frequency is less than starting frequency, controller will be at stand-by status. The indicator of RUN/TUNE lights on, controller has no output.

The starting frequency could be less than the lower frequency limit (F0.06).

F1.01 and F1.02 take no effect during FWD/REV switching.

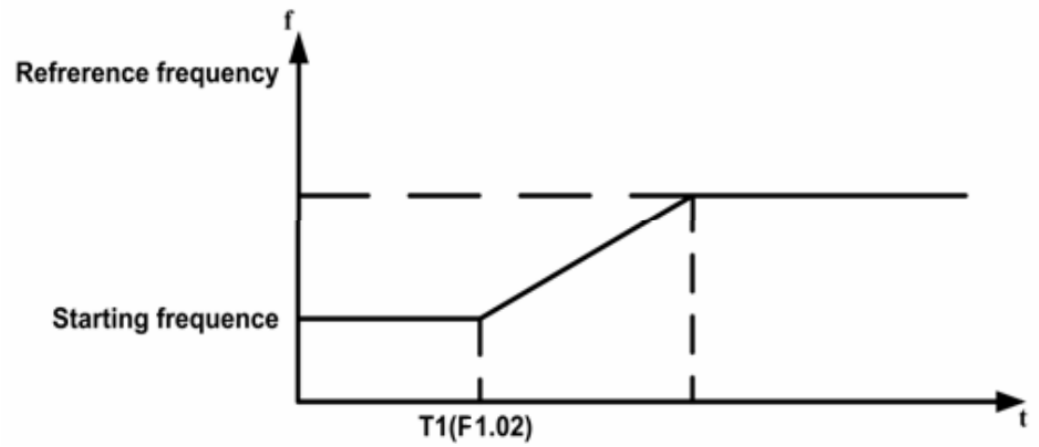


Figure 6.3 Starting diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F1.03	DC Braking current before start	0.0~150.0%	0.0~150.0	0.0%
F1.04	DC Braking time before start	0.0~50.0s	0.0~50.0	0.0s

When controller starts, it performs DC braking according to F1.03 firstly, then start to accelerate after F1.04.

Notice:

- DC braking will take effect only when F1.00 is set to be 1.
- DC braking is invalid when F1.04 is set to be 0.
- The value of F1.03 is the percentage of rated current of controller. The bigger the DC braking current, the greater the braking torque.

Function Code	Name	Description	Setting Range	Factory Setting
F1.05	Stop mode	0：Deceleration to stop 1：Coast to stop	0~1	0

0: Deceleration to stop

When the stop command takes effect, the controller decreases the output frequency according to the selected acceleration/deceleration time till stop.

1: Coast to stop

When the stop command takes effect, the controller blocks the output immediately. The motor coasts to stop by its mechanical inertia.

Function Code	Name	Description	Setting Range	Factory Setting
F1.06	Starting frequency of DC braking	0.00~10.00Hz	0.00~10.00Hz	0.00Hz
F1.07	Waiting time before DC braking	0.0~50.0s	0.0~50.0	0.0s
F1.08	DC braking current	0.0~150.0%	0.0~150.0	0.0%
F1.09	DC braking time	0.0~50.0s	0.0~50.0	0.0s

Starting frequency of DC braking: Start the DC braking when output frequency reaches starting frequency determined by F1.06.

Waiting time before DC braking: Controller blocks the output before starting the DC braking. After this waiting time, the DC braking will be started. It is used to prevent over-current fault caused by DC braking at high speed.

DC braking current: The value of F1.08 is the percentage of rated current of controller. The bigger the DC braking current, the greater the braking torque.

DC braking time: The time used to perform DC braking. If the time is 0, the DC braking will be invalid.

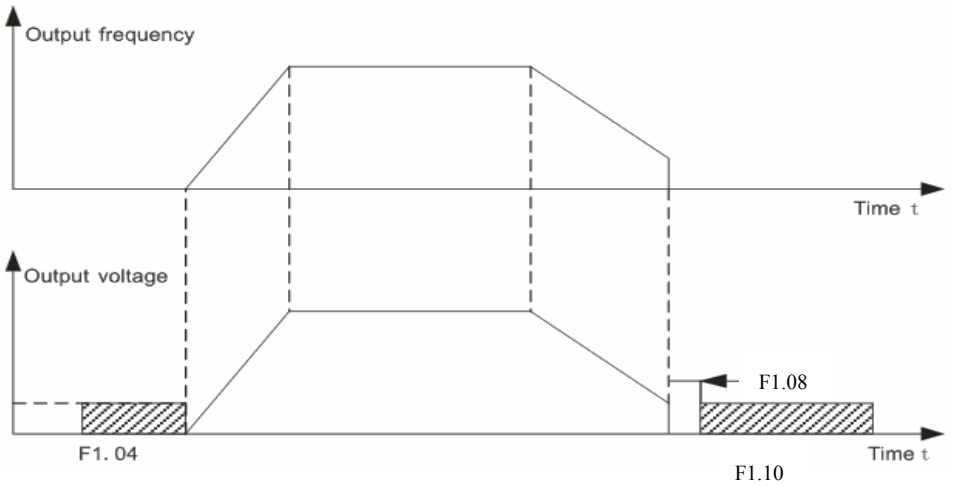


Figure 6.4 DC braking diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F1.10	Dead time of FWD/REV	0.0~3600.0s	0.0~3600.0	0.0s

Set the hold time at zero frequency in the transition between forward and reverse running.

It is shown as following figure:

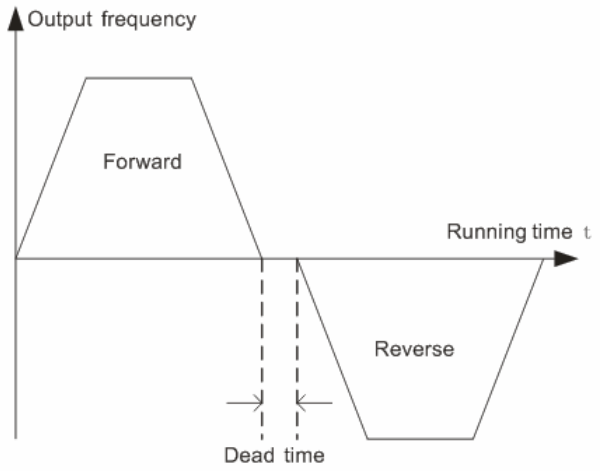


Figure 6.5 FWD/REV dead time diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F1.11	FWD/REV enable option when power on	0：Disabled 1：Enabled	0~1	0

Notice:

- **This function only takes effect if run command source is terminal control.**
- **If F1.11 is set to be 0, when power on, controller will not start even if FWD/REV terminal is active, until FWD/REV terminal disabled and enabled again.**
- **If F1.11 is set to be 1, when power on and FWD/REV terminal is active, controller will start automatically.**

- **This function may cause the controller restart automatically, please be cautious.**

Function Code	Name	Description	Setting Range	Factory Setting
F1.12	NO/NC input/output terminal selection	0x00~0x3F	0x00~0x3F	0x00

This parameter determines NO (normal open) or NC (normal close) status of each input/output terminal. It is hexadecimal value. If the corresponding bit is set to be 1, it means this terminal is normal-close(NC). The corresponding relation is specified below:

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
Reserved	Reserved	RO	Y	S4	S3	S2	S1

For example, If S1~S2 are set as "0", Y is "0", while RO is "1",
S4~S1 are corresponding to 0000. It is "0" in hex;
RO~Y are corresponding to 0010. It is"2" in hex. Therefore F1.12 should be set as "20".

6.3 F2 Group--Motor Parameters

Function Code	Name	Description	Setting Range	Factory Setting
F2.00	G/P option	0: G model 1: P model	0~1	Depend on model

0: Applicable to constant torque load
1: Applicable to variable torque load (i.e. fans, pumps)
B503 series controllers provide the G/P integration function. The adaptive motor power used for constant torque load (G model) should be one grade less than that used for variable torque load (P model). It only has G model for 220V controller.
To change from G model to P model, procedures are as follow.

- Set F2.00 to be 1;
- Input motor parameters in F2 group again.

Function Code	Name	Description	Setting Range	Factory Setting
F2.01	Motor rated power	0.75~900KW	0.75~900.0	Depend on model
F2.02	Motor rated frequency	0.01Hz~F0.04	0.01~F0.04	50.00Hz
F2.03	Motor rated speed	0~36000rpm	0~36000	Depend on model
F2.04	Motor rated voltage	0~460V	0~460	Depend on model
F2.05	Motor rated current	0.1~2000.0A	0.1~2000.0	Depend on model

Notice:

- **In order to achieve superior performance, please set these parameters according to motor nameplate, then perform autotuning.**

- **The power rating of controller should match the motor. If the bias is too big, the control performances of controller will be deteriorated distinctly.**
- **Reset F2.01 can initialize F2.02~F2.10 automatically.**

Function Code	Name	Description	Setting Range	Factory Setting
F2.06	Motor stator resistance	0.001~65.535Ω	0.001~65.535	Depend on model
F2.07	Motor rotor resistance	0.001~65.535Ω	0.001~65.535	Depend on model
F2.08	Motor leakage inductance	0.1~6553.5mH	0.1~6553.5	Depend on model
F2.09	Motor mutual inductance	0.1~6553.5mH	0.1~6553.5	Depend on model
F2.10	Current without load	0.01~655.35A	0.1~655.35	Depend on model

After autotuning, the value of F2.06~F2.10 will be automatically updated.

Notice: Do not change these parameters, otherwise it may deteriorate the control performance of controller.

6.4 F3 Group—Vector Control

Function Code	Name	Description	Setting Range	Factory Setting
F3.00	ASR proportional gain K_p1	0~100	0~100	20
F3.01	ASR integral time K_i1	0.01~10.00s	0.01~10.00	0.50s
F3.02	ASR switching point 1	0.00Hz~F3.05	0.00~F3.05	5.00Hz
F3.03	ASR proportional gain K_p2	0~100	0~100	25
F3.04	ASR integral time K_i2	0.01~10.00s	0.01~10.00	1.00s
F3.05	ASR switching point 2	F3.02~F0.04	F3.02~F0.04	10.0Hz

F3.00 and F3.01 only take effect when output frequency is less than F3.02. F3.03 and F3.04 only take effect when output frequency is greater than F3.05. When output frequency is between F3.02 and F3.05, K_P and K_I are proportional to the bias between F3.02 and F3.05. For details, please refer to following figure.

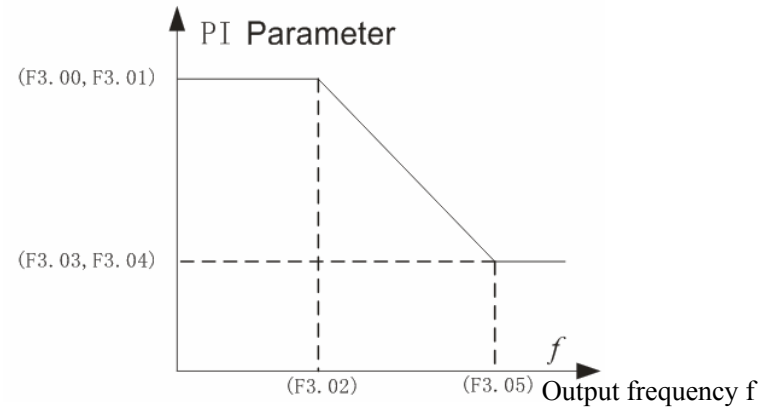


Figure 6.6 PI parameter diagram.

The system's dynamic response can be faster if the proportion gain K_p is increased; However, if K_p is too large, the system tends to oscillate.

The system dynamic response can be faster if the integral time K_i is decreased; However, if K_i is too small, the system becomes overshoot and tends to oscillate.

F3.00 and F3.01 are corresponding to K_p and K_i at low frequency, while F3.03 and F3.04 are corresponding to K_p and K_i at high frequency. Please adjust these parameters according to actual situation. The adjustment procedure is as follow:

- Increase the proportional gain (K_p) as far as possible without creating oscillation.
- Reduce the integral time (K_i) as far as possible without creating oscillation.

For more details about fine adjustment, please refer to description of F9 group.

Function Code	Name	Description	Setting Range	Factory Setting
F3.06	Slip compensation rate of VC	50%~200.0%	50.0~200.0	100%

The parameter is used to adjust the slip frequency of vector control and improve the precision of speed control. Properly adjusting this parameter can effectively restrain the static speed bias.

Function Code	Name	Description	Setting Range	Factory Setting
F3.07	Torque limit	0.0~200.0%	0.0~200.0	150.0%

This parameter is used to limit the torque current output by speed regulator. Torque limit value 0.0-200% is the controller's rated current percentage.

6.5 F4 Group-- V/F Control

Function Code	Name	Description	Setting Range	Factory Setting
F4.00	V/F curve selection	0：Linear curve 1：Torque step down curve (2.0 order)	0~1	0

0: Linear curve. It is applicable for normal constant torque load.

1: Torque_ step down curve. It is applicable for variable torque load, such as blower, pump and so on. Please refer to following figure.

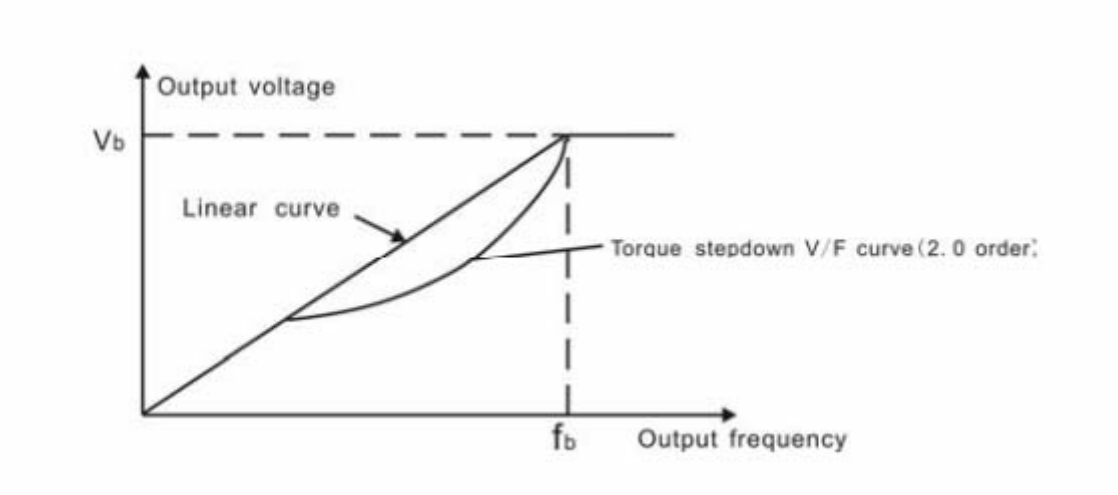


Figure6.7 V/F curve diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F4.01	Torque boost	0.0%：（auto）0.1%~30.0%	0.0~30.0	0.0%
F4.02	Torque boost cut-off	0.0%~50.0%（motor rated frequency）	0.0~50.0	20.0%

Torque boost will take effect when output frequency is less than cut-off frequency of torque boost (F4.02). Torque boost can improve the torque performance of V/F control at low speed.

The value of torque boost should be determined by the load. The heavier the load, the larger the value.

Notice: F4.01 should not be too large, otherwise the motor would be over-heat or the controller would be tripped by over-current or over-load.

If F4.01 is set to be 0, the controller will boost the output torque according to the load automatically.

Please refer to following diagram.

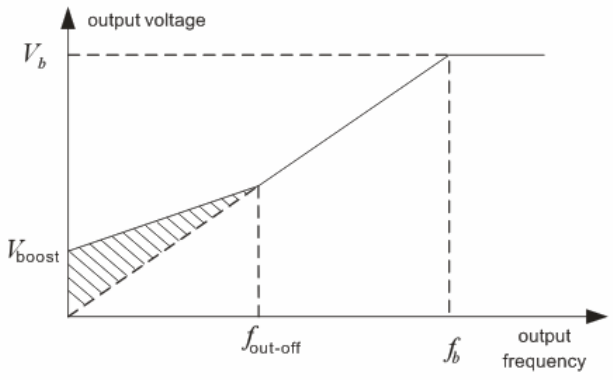


Figure 6.8 Manual torque boost diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F4.03	V/F Slip compensation limit	0.00~200.0%	0.00~200.00	0.0%

The slip compensation function calculates the torque of motor according to the output

current and compensates for output frequency. This function is used to improve speed accuracy when operating with a load. F4.03 sets the slip compensation limit as a percentage of motor rated slip, with the motor rated slip taken as 100%.

Function Code	Name	Description	Setting Range	Factory Setting
F4.04	Auto energy saving selection	0：Disabled 1：Enabled	0~1	0

When F4.04 is set to be 1, while there is a light load, it will reduce the controller output voltage and saves energy.

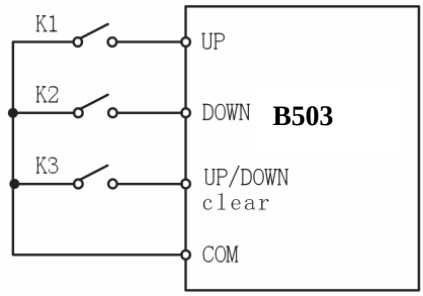
Function Code	Name	Description	Setting Range	Factory Setting
F4.05	Reserves			

6.6 F5 Group--Input Terminals

Function Code	Name	Description	Setting Range	Factory Setting
F5.00	S1 Terminal function	Programmable multifunctional terminal	0~25	1
F5.01	S2 Terminal function	Programmable multifunctional terminal	0~25	2
F5.02	S3 Terminal function	Programmable multifunctional terminal	0~25	4
F5.03	S4 Terminal function	Programmable multifunctional terminal	0~25	7

The meaning of each setting is shown in following table.

Setting value	Function	Description
0	Invalid	Please set unused terminals to be invalid to avoid malfunction.
1	Forward	Please refer to description of F5.05.
2	Reverse	
3	3-wire control	
4	Jog forward	Please refer to description of F8.02~F8.04.
5	Jog reverse	
6	Coast to stop	The controller blocks the output immediately. The motor coasts to stop by its mechanical inertia.
7	Reset fault	Resets faults that have occurred. It has the same function as STOP/RST.
8	External fault input	Stop the controller and output a alarm when a fault occurs in a peripheral device.

<table>
<tr><th>Setting value</th><th>Function</th><th>Description</th></tr>
<tr><td>9</td><td>Up command</td><td rowspan="3">The reference frequency of controller can be adjusted by UP command and DOWN command.
 

Use this terminal to clear UP/DOWN setting. Please refer to description of F0.02.</td></tr>
<tr><td>10</td><td>DOWN command</td></tr>
<tr><td>11</td><td>Clear UP/DOWN</td></tr>
<tr><td>12</td><td>Multi-step speed reference1</td><td rowspan="3">8 steps speed control can be realized by the combination of these four terminals. For details, please refer to: Multi-step speed reference terminal status and according step value table:
<table>
<tr><td>Multi-step speed reference3</td><td>Multi-step speed reference2</td><td>Multi-step speed reference1</td></tr>
<tr><td>BIT2</td><td>BIT1</td><td>BIT0</td></tr>
</table></td></tr>
<tr><td>13</td><td>Multi-step speed reference 2</td></tr>
<tr><td>14</td><td>Multi-step speed reference 3</td></tr>
<tr><td>15</td><td>ACC/DEC time selection</td><td>2 groups of ACC/DEC time can be selected by the combination of these two terminals.
<table>
<tr><td>Terminal</td><td>ACC/DEC time</td><td>Corresponding Parameter</td></tr>
<tr><td>OFF</td><td>Acceleration Time 0</td><td>F0.08、F0.09</td></tr>
<tr><td>ON</td><td>Acceleration Time 1</td><td>F8.00、F8.01</td></tr>
</table></td></tr>
<tr><td>16</td><td>Pause PID</td><td>PID adjustment will be paused and controller keeps output frequency unchanged.</td></tr>
<tr><td>17</td><td>Pause traverse operation</td><td>Controller keeps output frequency unchanged. If this terminal is disabled, controller will continue traverse operation from current frequency.</td></tr>
<tr><td>18</td><td>Reset traverse operation</td><td>Reference frequency of controller will be forced as center frequency of traverse operation.</td></tr>
<tr><td>19</td><td>ACC/DEC ramp hold</td><td>Pauses acceleration or deceleration and maintains output frequency. When this terminal is disabled, acceleration/deceleration is restarted.</td></tr>
<tr><td>20</td><td>Disable torque control</td><td>Torque control is disabled. Controller will work in speed control mode.</td></tr>
<tr><td>21</td><td>UP/DOWN invalid temporarily</td><td>UP/DOWN setting is invalid and will not be cleared. When this terminal is disabled, UP/DOWN setting before will be valid again.</td></tr>
</table>

Setting value	Function	Description
22	DC brake when stopping	During the process of decelerating to stop, when this terminal is on, the controller will be in the status of DC braking promptly. Braking status is determined by F1.07~F1.09
23~25	Reserved	Reserved

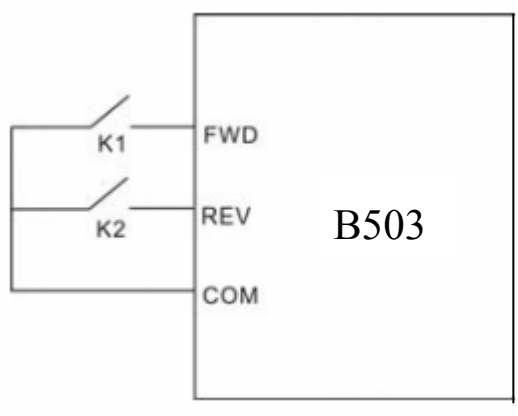
Function Code	Name	Description	Setting Range	Factory Setting
F5.04	ON/OFF filter times	1~10	1~10	5

This parameter is used to set filter strength of terminals (S1~S4), When interference is heavy, user should increase this value to prevent malfunction.

Function Code	Name	Description	Setting Range	Factory Setting
F5.05	FWD/REV control mode	0：2-wire control mode 1 1：2-wire control mode 2 2：3-wire control mode 1 3：3-wire control mode 2	0~3	0

This parameter defines four different control modes that control the controller operation through external terminals.

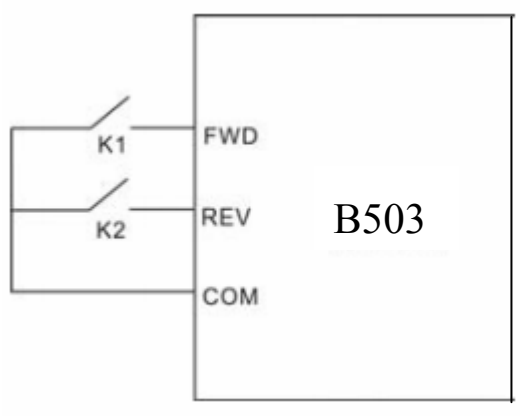
0:2-wire control mode 1: Integrate START/STOP command with run direction.



K1	K2	Run command
OFF	OFF	Stop
ON	OFF	FWD
OFF	ON	REV
ON	ON	Stop

Figure 6.9 2-wire control mode 1.

1:2-wire control mode 2: START/STOP command is determined by FWD terminal. Run direction is determined by REV terminal.



K1	K2	Run command
OFF	OFF	Stop
ON	OFF	Stop
OFF	ON	FWD
ON	ON	REV

Figure 6.10 2-wire control mode 2.

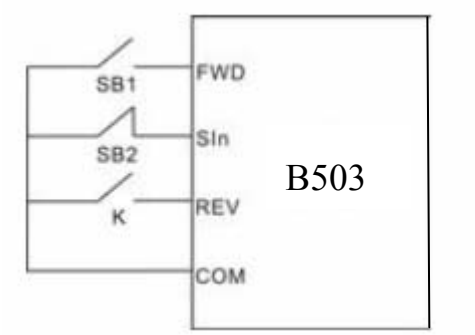
2:3-wire control mode 1:

SB1: Start button

SB2: Stop button (NC)

K: Run direction button

Terminal Sin is the multifunctional input terminal of S1~S4. The terminal function should be set to be 3(3-wire control).



K	Run command
OFF	FWD
ON	REV

Figure 6.11 3-wire control mode 1.

3:3-wire control mode 2.

SB1: Forward run button

SB2: Stop button (NC)

SB3: Reverse run button

Terminal Sin is the multifunctional input terminal of S1~S4. The terminal function should be set to be 3 (3-wire control)

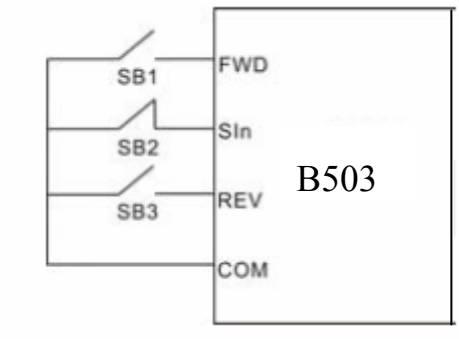


Figure 6.12 3-wire control mode 2.

Notice:

- **When 2-wire control mode is active, the controller will not run in following situation even if FWD/REV terminal is enabled;**
- **Coast to stop (press RUN and STOP/RES at the same time).**
- **Stop command from serial communication.**
- **FWD/REV terminal is enabled before power on. Please refer to description of F1.11.**

Function Code	Name	Description	Setting Range	Factory Setting
F5.06	UP/DOWN setting change rate	0.01~50.00Hz/s	0.01~50.00	0.50Hz/s

Terminal UP/DOWN regulates the incremental rate of setting frequency.

Function Code	Name	Description	Setting Range	Factory Setting
F5.07	AI1 lower limit	0.00V~10.00V	0.00~10.00	0.00V
F5.08	AI1 lower limit corresponding setting	-100.0%~100%	-100.0~100	0.0%
F5.09	AI1 upper limit	0.00V~10.00V	0.00~10.00	10.00V
F5.10	AI1 upper limit corresponding setting	-100.0%~100%	-100.0~100	100%
F5.11	AI1 filter time constant	0.00s~10.00s	0.00~10.00	0.10s

These parameters determine the relationship between analog input voltage and the corresponding setting value. When the analog input voltage exceeds the range between lower limit and upper limit, it will be regarded as the upper limit or lower limit.

The analog input AI1 can only provide voltage input, and the range is 0V~10V.

For different applications, the corresponding value of 100.0% analog setting is different. For details, please refer to description of each application.

Notice: AI1 lower limit must be less or equal to AI1 upper limit.

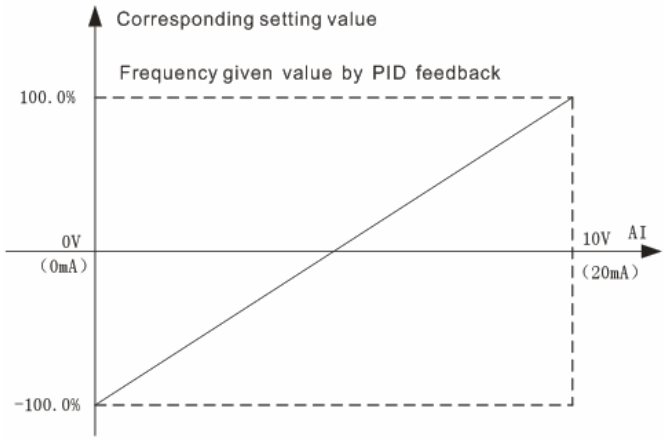


Figure 6.13 Relationship between AI and corresponding setting.

AI1 filter time constant is effective when there are sudden changes or noise in the analog input signal. Responsiveness decreases as the setting increases.

Function Code	Name	Description	Setting Range	Factory Setting
F5.12	AI2 lower limit	0.00V~10.00V	0.00~10.00	0.00V
F5.13	AI2 lower limit corresponding setting	-100.0%~100%	-100.0~100	0.0%
F5.14	AI2 upper limit	0.00V~10.00V	0.00~10.00	10.00V
F5.15	AI2 upper limit corresponding setting	-100.0%~100%	-100.0~100	100%
F5.16	AI2 filter time constant	0.00s~10.00s	0.00~10.00	0.10s

AI2 is similar with AI1. AI2 can be set as 0～10V/0～20mA. When AI2 is set as 0~20mA current input, the corresponding voltage range is 0~5V.

6.7 F6 Group--Output Terminals

Function Code	Name	Description	Setting Range	Factory Setting
F6.00	Y output selection	Open-collector output	0~11	1
F6.01	Relay output selection 1	Relay output	0~11	3

OC/Relay output functions are indicated in the following table.

Setting Value	Function	Description
0	No output	Output terminal has no function
1	Run forward	ON: During forward run.。
2	Run reverse	ON: During reverse run.
3	Fault output	ON: Controller is in fault status.
4	FDT reached	Please refer to description of F8.13 and F8.14.
5	Frequency reached	Please refer to description of F8.15.
6	Zero speed running	ON: The running frequency of controller is zero.
7	Upper frequency limit reached	ON: Running frequency reaches the value of F0.05.
8	Lower frequency limit reached	ON: Running frequency reaches the value of F0.06.
9~10	Reserved	Reserved
11	Over-torque Checkout	In the process of Checkout, Output :On Signal

Function Code	Name	Description	Setting Range	Factory Setting
F6.02	AO selection	Multifunctional analog output	0~10	0

Current (0~20mA) or voltage (0~10V) output can be selected by Jumper J15.

AO functions are indicated in the following table:

Setting Value	Function	Range
0	Running frequency	0~ maximum frequency(F0.04)
1	Reference frequency	0~ maximum frequency(F0.04)
2	Motor speed	0~ 2* rated synchronous speed of motor
3	Output current	0~ 2* controller rated current
4	Output voltage	0~1.5* controller rated voltage
5	Output power	0~2* rated power
6	Output torque	0~2*rated current
7	AI1 voltage	0~10V
8	AI2 voltage/current	0~10V/0~20mA
9~10	Reserved	Reserved

Function Code	Name	Description	Setting Range	Factory Setting
F6.03	AO lower limit	0.0%~100.0%	0.0~100.0	0.0%
F6.04	AO lower limit corresponding output	0.00V~10.00V	0.00~10.00	0.00V
F6.05	AO upper limit	0.0%~100.0%	0.0~100.0	100.0%
F6.06	AO upper limit corresponding output	0.00V~10.00V	0.00~10.00	10.00V

These parameters determine the relationship between analog output voltage/current and the corresponding output value. When the analog output value exceeds the range between lower limit and upper limit, it will output the upper limit or lower limit.

When AO is current output, 1mA is corresponding to 0.5V.

For different applications, the corresponding value of 100.0% analog output is different. For details, please refer to description of each application.

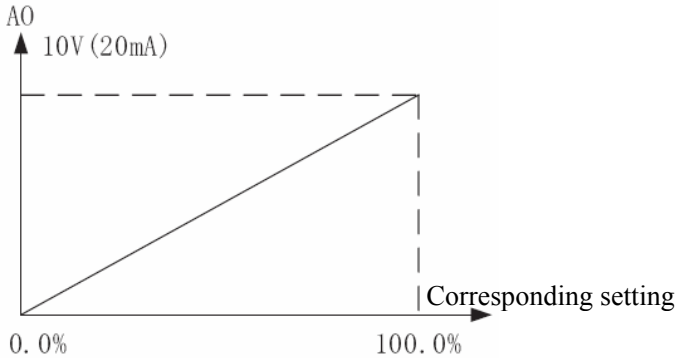


Figure 6.14 Relationship between AO and corresponding setting.

6.8 F7 Group--Display Interface

Function Code	Name	Description	Setting Range	Factory Setting
F7.00	User password	0~65535	0~65535	0

The password protection function will be valid when set to be any nonzero data. When F7.00 is set to be 00000, user's password set before will be cleared and the password protection function will be disabled.

After the password has been set and becomes valid, the user can not access menu if the user's password is not correct. Only when a correct user's password is input, the user can see and modify the parameters. Please keep user's password in mind.

Function Code	Name	Description	Setting Range	Factory Setting
F7.01	LCD language selection	0: Chinese 1: English	0~1	0
F7.02	Parameter copy	0: Invalid 1:Upload from controller 2:Download to controller	0~2	0

F7.02 will take effect when LCD keypad is used.

1: All value of parameters will be upload from controller to LCD.

2: All value of parameters will be downloaded from LCD to controller.

Notice: When upload or downloaded operation completes, F7.02 will be set to 0 automatically.

Function Code	Name	Description	Setting Range	Factory Setting
F7.03	function selection	0：Jog 1：FDW/REV switching 2：Clear UP/DOWN setting	0~2	0

is a multifunctional key, whose function can be defined by the value of F7.03.

0: Jog: Press, the controller will jog.

1: FWD/REV switching: Press, the running direction of controller will reverse. It is only valid if F0.03 is set to be 0.

2: Clear UP/DOWN setting: Press, the UP/DOWN setting will be cleared.

Function Code	Name	Description	Setting Range	Factory Setting
F7.04	STOP/RST function option	0：Valid when keypad control (F0.01=0) 1：Valid when keypad or terminal control (F0.01=0 or 1) 2：Valid when keypad or communication control (F0.01=0 or 2) 3：Always valid	0~3	0

Notice:

- **The value of F7.04 only determines the STOP function of STOP/RST.**
- **The RESET function of STOP/RST is always valid.**

Function Code	Name	Description	Setting Range	Factory Setting
F7.05	Keypad display selection	0: Preferential to external keypad 1: Both display, only external key valid. 2: Both display, only local key valid. 3: Both display and key valid	0~3	0

0: When external keypad exists, local keypad will be invalid.

1: Local and external keypad display simultaneously, only the key of external keypad is valid.

2: Local and external keypad display simultaneously, only the key of local keypad is valid.

3: Local and external keypad display simultaneously, both keys of local and external keypad are valid.

Notice: This function should be used cautiously, otherwise it may cause malfunction.

Notice:

- **When F7.05 is set to be 1, local keypad is valid if external keypad is not connected.**
- **When LCD keypad is connected, F7.05 must be set to be 0.**

Function Code	Name	Description	Setting Range	Factory Setting
F7.06	Running status display selection	0~0x7FFF	0~0x7FFF	0xFF

F7.06 defines the parameters that can be displayed by LED in running status. If Bit is 0, the parameter will not be displayed; If Bit is 1, the parameter will be displayed. Press》 to scroll through these parameters in right order .

The display content corresponding to each bit of F7.06 is described in the following table:

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
Output torque	Output power	Rotation speed	Output current	Output voltage	DC bus voltage	Reference frequency	Output frequency
BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8
Reserved	Step No. of multi-step	AI2	AI1	Output terminal status	Input terminal status	PID feedback	PID preset

For example, if user wants to display output voltage, DC bus voltage, Reference frequency, output frequency, output terminal status, the value of each bit is as the following table:

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
0	0	0	0	1	1	1	1
BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8
0	0	0	1	0	0	0	0

The value of F7.06 is 100Fh.

Notice: I/O terminal status is displayed in decimal.

For details, please refer to description of F7.18 and F7.19.

Function Code	Name	Description	Setting Range	Factory Setting
F7.07	Stop status display selection	0~0x1FF	0~0x1FF	0xFF

F7.07 determines the display parameters in stop status. The setting method is similar with F7.06.

The display content corresponding to each bit of F7.07 is described in the following table:

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
AI2	AI1	PID feedback	PID preset	Output terminal status	Input terminal status	DC bus voltage	Reference frequency
BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Step No. of multi-step

Function Code	Name	Description	Setting Range	Factory Setting
F7.08	Rectifier module temperature	0~100.0℃		
F7.09	IGBT module temperature	0~100.0℃		
F7.10	Software version			
F7.11	Accumulated running time	0~65535h		

Rectify module temperature: Indicates the temperature of rectify module. Overheat protection point of different controller may be different.

IGBT module temperature: Indicates the temperature of IGBT module. Overheat protection point of different controller may be different.

Software version: Indicates current software version of DSP.

Accumulated running time: Displays accumulated running time of controller.

Notice: Above parameters are read only.

Function Code	Name	Description	Setting Range	Factory Setting
F7.12	Third latest fault type	0~25		
F7.13	Second latest fault type	0~25		
F7.14	Latest fault type	0~25		

These parameters record three recent fault types. For details, please refer to description of chapter 7.

Function Code	Name	Description	Setting Range	Factory Setting
F7.15	Output frequency at current fault	Output frequency at current fault.		
F7.16	Output current at current fault	Output current at current fault.		
F7.17	DC bus voltage at current fault	DC bus voltage at current fault.		
F7.18	Input terminal status at current fault	This value records ON-OFF input terminal status at current fault. The meaning of each bit is as below: BIT3 BIT2 BIT1 BIT0 S4 S3 S2 S1 1 indicates corresponding input terminal is ON, while 0 indicates OFF. **Notice: This value is displayed as decimal.**		
F7.19	Output terminal status at current fault	This value records output terminal status at current fault. The meaning of each bit is as below: BIT3 BIT2 BIT1 BIT0 R0 Y 1 indicates corresponding output terminal is ON, while 0 indicates OFF. **Notice: This value is displayed as decimal.**		

6.9 F8 Group--Enhanced Function

Function Code	Name	Description	Setting Range	Factory Setting
F8.00	Acceleration time 1	0.1~3600.0s	0.1~3600.0	Depend on model
F8.01	Deceleration time 1	0.1~3600.0s	0.1~3600.0	Depend on model

For details, please refer to description of F0.08 and F0.09.

Function Code	Name	Description	Setting Range	Factory Setting
F8.02	Jog reference	0.00~F0.04	0.00~F0.04	5.00Hz
F8.03	Jog acceleration time	0.10~3600.0s	0.10~3600.0	Depend on model
F8.04	Jog deceleration time	0.10~3600.0s	0.10~3600.0	Depend on model

The meaning and factory setting of F8.03 and F8.04 is the same as F0.08 and F0.09. No matter what the value of F1.00 and F1.05 are, jog will start as start directly mode and stop as deceleration to stop mode.

Function Code	Name	Description	Setting Range	Factory Setting
F8.05	Skip frequency	0.00~F0.04	0.00~F0.04	0.00Hz
F8.06	Skip frequency bandwidth	0.00~F0.04	0.00~F0.04	0.00Hz

By means of setting skip frequency, the controller can keep away from the mechanical resonance with the load. F8.05 is centre value of frequency to be skipped.

Notice:

- **If F8.06 is 0, the skip function is invalid.**
- **If F8.05 is 0, the skip function is invalid no matter what F8.06 is.**
- **Operation is prohibited within the skip frequency bandwidth, but changes during acceleration and deceleration are smooth without skip.**

The relation between output frequency and reference frequency is shown as follow:

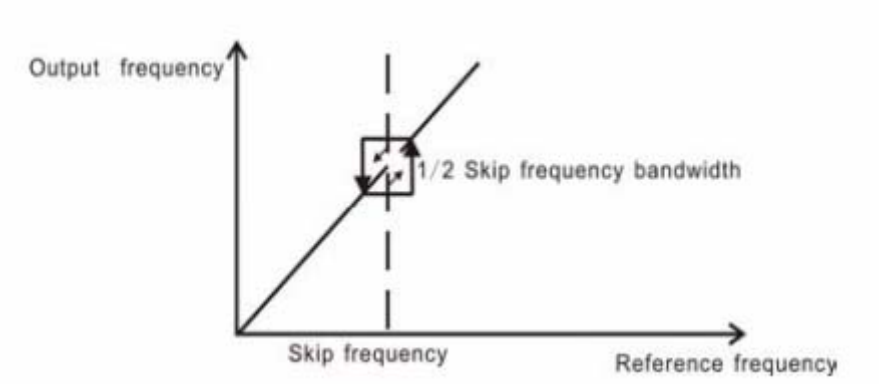


Figure 6.15 Skip frequency diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F8.07	Traverse amplitude	0.0~100.0%	0.0~100.0	0.0%
F8.08	Jitter frequency	0.0~50.0%	0.0~50.0	0.0%
F8.09	Rise time of traverse	0.1~3600.0s	0.1~3600.0	5.0s
F8.10	Fall time of traverse	0.1~3600.0s	0.1~3600.0	5.0s

Traverse operation is widely used in textile and chemical fiber industry. The typical application is shown in following figure.

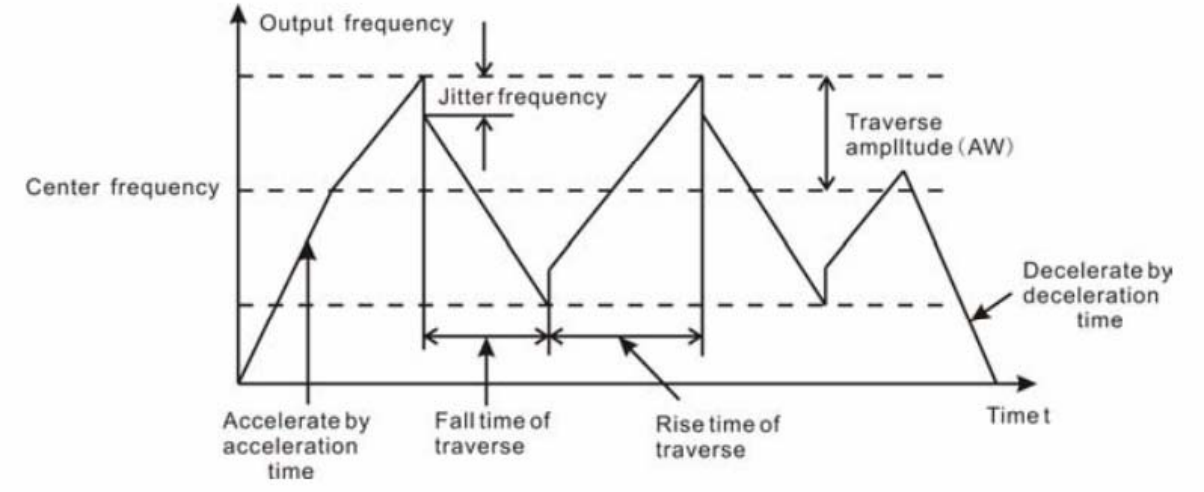


Figure 6.16 Traverse operation diagram.

Center frequency (CF) is reference frequency.

Traverse amplitude (AW) =center frequency (CF) * F8.08%.

Jitter frequency = traverse amplitude (AW) * F8.08%.

Rise time of traverse: Indicates the time rising from the lowest traverse frequency to the highest traverse frequency.

Fall time of traverse: Indicates the time falling from the highest traverse frequency to the lowest traverse frequency.

Notice:

- F8.07 determines the output frequency range which is as below:
- (1-F8.07%) * reference frequency ≤ output frequency ≤ (1+F8.07%) * reference frequency
- The output frequency of traverse is limited by upper frequency limit (F0.05) and lower frequency limit (F0.06).

Function Code	Name	Description	Setting Range	Factory Setting
F8.11	Auto reset times	0~3	0~3	0
F8.12	Reset interval	0.1~100.0s	0.1~100.0	1.0s

Auto reset function can reset the fault in preset times and interval. When F8.11 is set to be 0, it means “auto reset” is disabled and the protective device will be activated in case of fault.

Notice: The fault such as OUT1, OUT2, OUT3,OH1 and OH2 cannot be reset automatically.

Function Code	Name	Description	Setting Range	Factory Setting
F8.13	FDT level	0.00~F0.04	0.00~F0.04	50.0Hz
F8.14	FDT lag	0.0~100.0%	0.0~100.0	5.0%

when the output frequency reaches a certain preset frequency (FDT level), output terminal will output an ON-OFF signal until output frequency drops below a certain frequency of FDT level (FDT level - FDT lag), as shown in following figure.

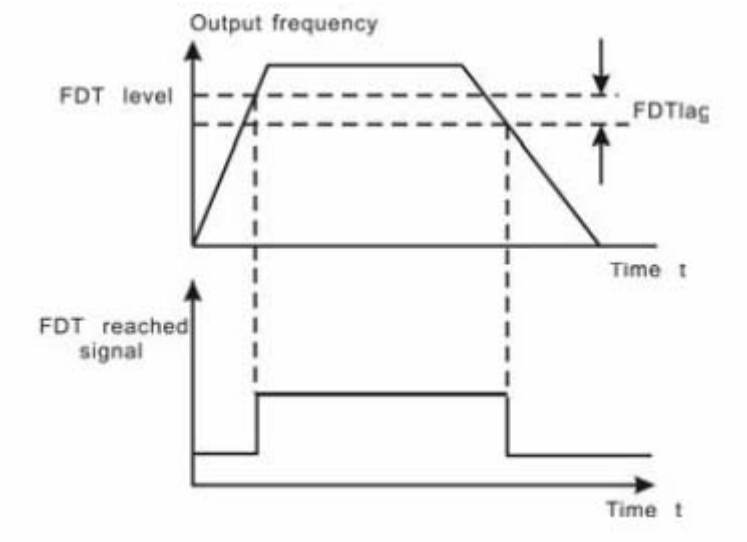


Figure 6.17 FDT level and lag diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F8.15	Frequency arrive detecting range	0.0~100.0% (maximum frequency)	0.0~100.0	0.0%

When output frequency is within the detecting range of reference frequency, an ON-OFF signal will be output.

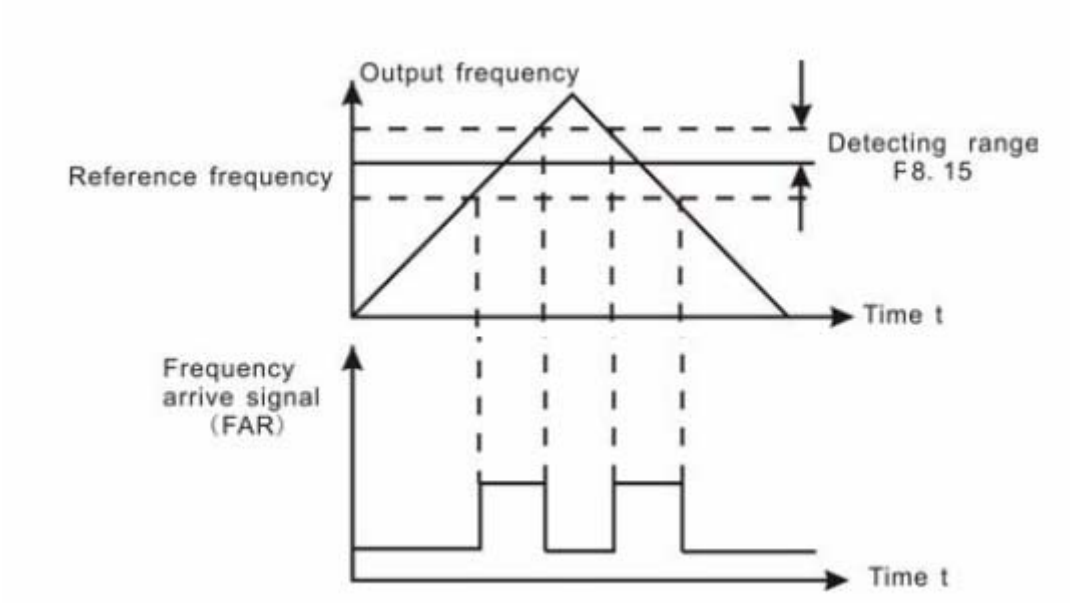


Figure 6.18 Frequency arriving signal diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F8.16	Brake threshold voltage	115.0~140.0% （380V series 130%）	115.0~140.0	Depend on model
		115.0~140.0% （220V series 120%）	115.0~140.0	

When the DC bus voltage is greater than the value of F8.16, the controller will start dynamic braking.

Notice:

- **Factory setting is 120% if rated voltage of controller is 220V.**
- **Factory setting is 130% if rated voltage of controller is 380V.**
- **The value of F8.16 is corresponding to the DC bus voltage at rated input voltage.**

Function Code	Name	Description	Setting Range	Factory Setting
F8.17	Coefficient of rotation speed	0.1~999.9%	0.1~999.9%	100.0%

This parameter is used to calibrate the bias between actual mechanical speed and rotation speed. The formula is as below:

Actual mechanical speed = 120 * output frequency *F8.17 / Number of poles of motor

6.10 F9 Group--PID Control

PID control is a common used method in process control, such as flow, pressure and temperature control. The principle is firstly detect the bias between preset value and feedback value, then calculate output frequency of controller according to proportional gain, integral and differential time. Please refer to following figure.

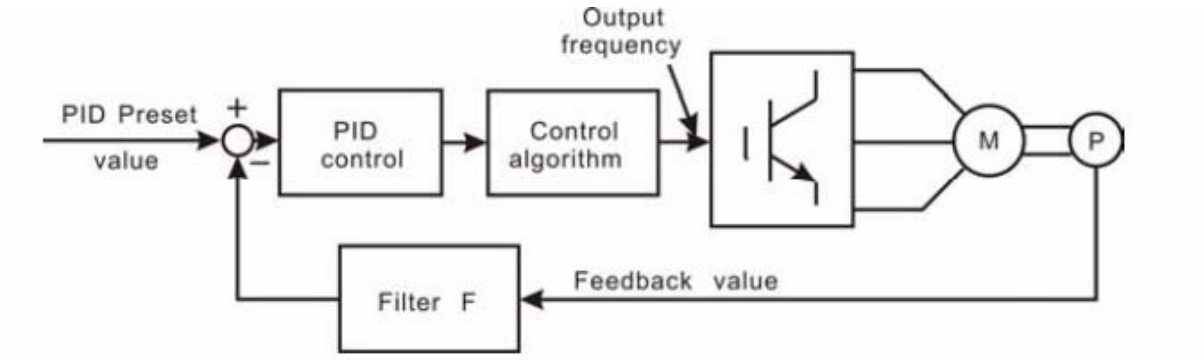


Figure 6.19 PID control diagram.

Function Code	Name	Description	Setting Range	Factory Setting
F9.00	PID preset source selection	0：Keypad 1：AI1 2：AI2 3：Communication 4：Multi-step	0~4	0
F9.01	Keypad PID preset	0.0%~100.0%	0.0~100.0	0.0%
F9.02	PID feedback source selection	0: AI1 1: AI2 2: AI1+AI2 3:Communication	0~3	0

These parameters are used to select PID preset and feedback source.

Notice:

- **Preset value and feedback value of PID are percentage value.**
- **100% of preset value is corresponding to 100% of feedback value.**

- **Preset source and feedback source must not be same, otherwise PID will be malfunction.**

Function Code	Name	Description	Setting Range	Factory Setting
F9.03	PID output characteristics	0：Positive 1：Negative	0~1	0

0：Positive. When the feedback value is greater than the preset value, output frequency will be decreased, such as tension control in winding application.

1: Negative. When the feedback value is greater than the preset value, output frequency will be increased, such as tension control in unwinding application.

Function Code	Name	Description	Setting Range	Factory Setting
F9.04	Proportional gain（Kp）	0.00~100.00	0.00~100.00	0.10
F9.05	Integral time (Ti)	0.01~10.00s	0.01~10.00	0.10s
F9.06	Differential time (Td)	0.00~10.00s	0.00~10.00	0.00s

Optimize the responsiveness by adjusting these parameters while driving an actual load. Use the following procedure to activate PID control and then adjust it while monitoring the response.

1. Enabled PID control (F0.03=5)
2. Increase the proportional gain (Kp) as far as possible without creating oscillation.
3. Reduce the integral time (Ti) as far as possible without creating oscillation.
4. Increase the differential time (Td) as far as possible without creating oscillation.

Making fine adjustments:

First set the individual PID control constants, and then make fine adjustments.

- Reducing overshooting

If overshooting occurs, shorten the differential time and lengthen the integral time.

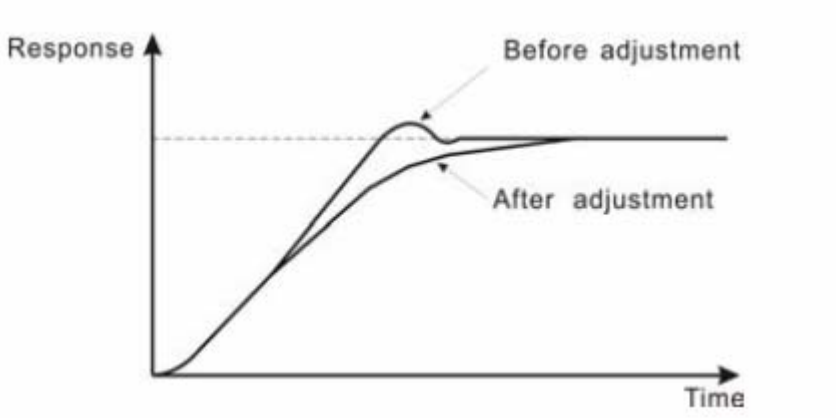


Figure 6.20 Reducing overshooting diagram.

- Rapidly stabilizing control status

To rapidly stabilize the control conditions even when overshooting occurs, shorten the integral time and lengthen the differential time.

- Reducing long-cycle oscillation

If oscillation occurs with a longer cycle than the integral time setting, it means that integral operation is strong. The oscillation will be reduced as the integral time is lengthened.

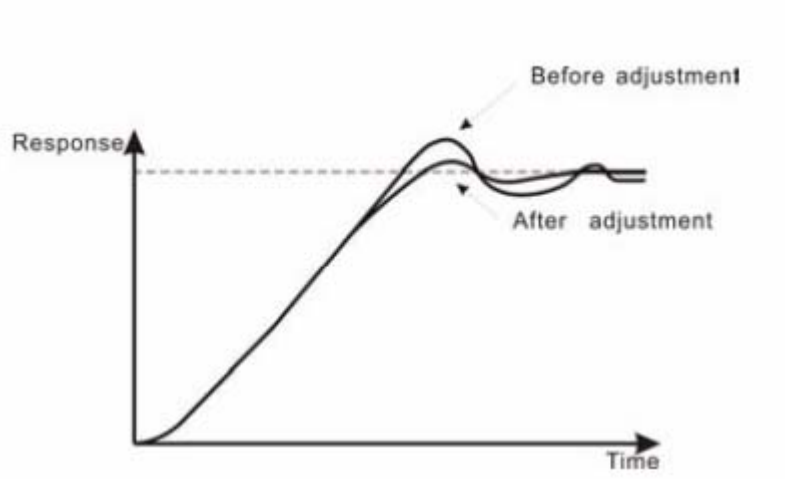


Figure 6.21 Reducing long-cycle oscillation diagram.

- Reducing short-cycle oscillation

If the oscillation cycle is short and oscillation occurs with a cycle approximately the same as the differential time setting, it means that the differential operation is strong. The oscillation will be reduced as the differential time is shortened.

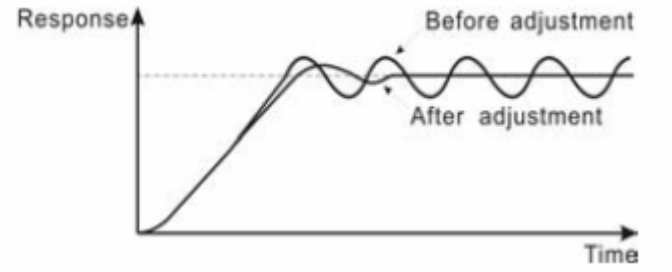


Figure 6.22 Reducing short-cycle oscillation diagram.

If oscillation cannot be reduced even by setting the differential time to 0, then either lower the proportional gain or raise the PID primary delay time constant.

Function Code	Name	Description	Setting Range	Factory Setting
F9.07	Sampling cycle (T)	0.01~100.00s	0.01~100.00	0.10s
F9.08	Bias limit	0.0~100.0%	0.0~100.0	0.0%

Sampling cycle T refers to the sampling cycle of feedback value. The PI regulator calculates once in each sampling cycle. The bigger the sampling cycle, the slower the response is.

Bias limit defines the maximum bias between the feedback and the preset. PID stops operation when the bias is within this range. Setting this parameter correctly is helpful to improve the system output accuracy and stability.

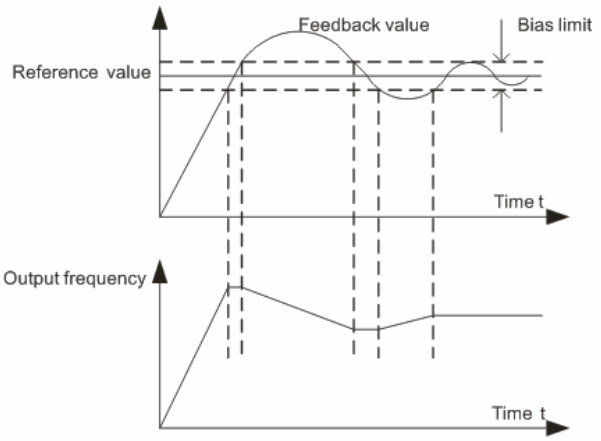


Figure 6.23 Relationship between bias limit and output frequency.

Function Code	Name	Description	Setting Range	Factory Setting
F9.09	Feedback lost detecting value	0.0~100.0%	0.0~100.0	0.0%
F9.10	Feedback lost detecting time	0.0~3600.0s	0.0~3600.0	1.0s

When feedback value is less than F9.09 continuously for the period determined by F9.10, the controller will alarm feedback lost failure (PIDE).

Notice: 100% of F9.09 is the same as 100% of F9.01.

Function Code	Name	Description	Setting Range	Factory Setting
F9.11	Sleep delayed Time	0.0~3600.0s	0.0~3600.0	0.0s
F9.12	Sleep Threshold Value Frequency	0.0~F0.04	0.0~ F0.04	0.0Hz
F9.13	Sleep Awaken Threshold Value Deviation	0.0~100%	0.0~100.0	0.0%
F9.14	Sleep Awaken Delayed Time	0.0~300.0s	0.0~300.0	0.0s

Notice: F9.13 Sleep Awaken Threshold Value Deviation: the reference value of parameters comes from the feedback volume of PID which is less than the setting value of F9.01.

F9.11~F9.14 is mainly use for setting up the sleep and awaken function of controller:

Sleep: When the PID feedback volume is more than the setting value of F9.01, the controller will decrease the frequency to the threshold value and keep running. If the feedback volume is still more than the setting value of F9.01 through the time delayed of F9.11, the motor speed will drop brake and inter into sleep mode.

Awaken: If the controller is in sleep mode and the feedback volume is less than the difference value between the setting value of F9.01 and sleep awaken threshold value deviation, the controller will start to work automatically after the sleep awaken time delayed setting of F9.14.

For example:

If the PID feedback resource Analog Channel AI2 is 1~5V, parameter settings are as

follows:

Function Codes	F0.03	F5.12	F5.14	F9.01	F9.02	F9.11	F9.12	F9.13	F9.14
Setting Parameters	5	1.00V	5.00V	50%	1	10s	20Hz	15%	5s

When PID feedback volume is more than the value of 3V[1V+(5-1)V×50%],the controller will decrease the frequency to the threshold value and keep running in 20HZ.If the feedback volume is still more than 3V through 10s delayed, the motor speed will drop to brake and enter into sleep mode.

If the controller is in sleep mode and the PID feedback volume is less than the value of 2.4V[(5-1)V×(50%-15%)+1V],the controller will start to work automatically in 5 seconds later.

6.11 FA Group-- Multi-step Speed Control

Function Code	Name	Description	Setting Range	Factory Setting
FA.00	Multi-step speed 0	-100.0~100.0%	-100.0~100.0	0.0%
FA.01	Multi-step speed 1	-100.0~100.0%	-100.0~100.0	0.0%
FA.02	Multi-step speed 2	-100.0~100.0%	-100.0~100.0	0.0%
FA.03	Multi-step speed 3	-100.0~100.0%	-100.0~100.0	0.0%
FA.04	Multi-step speed 4	-100.0~100.0%	-100.0~100.0	0.0%
FA.05	Multi-step speed 5	-100.0~100.0%	-100.0~100.0	0.0%
FA.06	Multi-step speed 6	-100.0~100.0%	-100.0~100.0	0.0%
FA.07	Multi-step speed 7	-100.0~100.0%	-100.0~100.0	0.0%

Notice:

- 100% of multi-step speed x corresponds to the maximum frequency (F0.04).
- If the value of multi-step speed x is negative, the direction of this step will be reverse, otherwise it will be forward.
- Multi-step speed function has highest priority

Selection of step is determined by combination of multi-step terminals. Please refer to following figure and table.

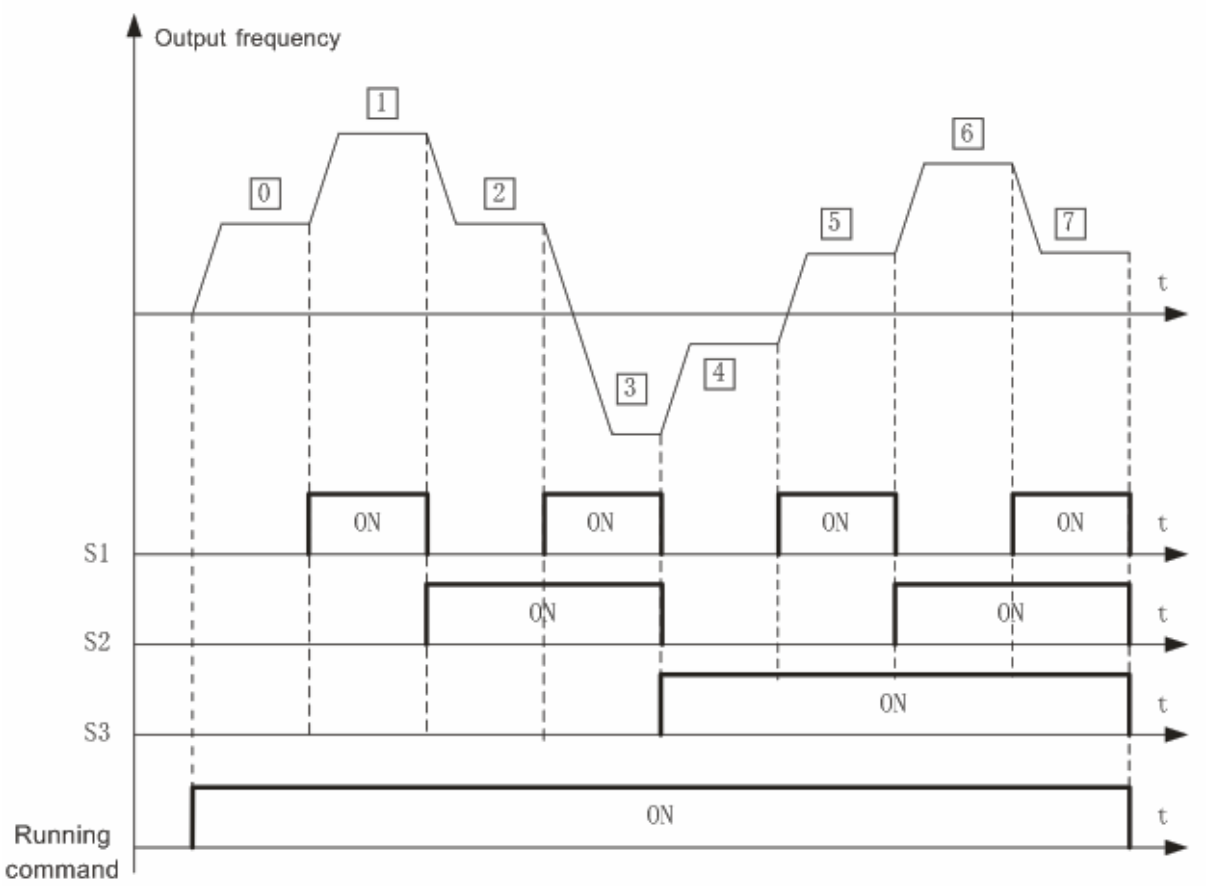


Figure 6.24 Multi-steps speed operating diagram.

Terminal / Step	Multi-step speed reference1	Multi-step speed reference2	Multi-step speed reference3
0	OFF	OFF	OFF
1	ON	OFF	OFF
2	OFF	ON	OFF
3	ON	ON	OFF
4	OFF	OFF	ON
5	ON	OFF	ON
6	OFF	ON	ON
7	ON	ON	ON

6.12 FB Group-- Protection Function

Function Code	Name	Description	Setting Range	Factory Setting
FB.00	Motor overload protection	0：Disabled 1：Normal motor 2：Variable frequency motor	0~2	2

1: For normal motor, the lower the speed, the poorer the cooling effect. Based on this reason, if output frequency is lower than 30Hz, controller will reduce the motor overload

protection threshold to prevent normal motor from overheat.

2: As the cooling effect of variable frequency motor has nothing to do with running speed, it is not required to adjust the motor overload protection threshold.

Function Code	Name	Description	Setting Range	Factory Setting
FB.01	Motor overload protection current	20.0%~120.0%	20.0~120.0	100.0%

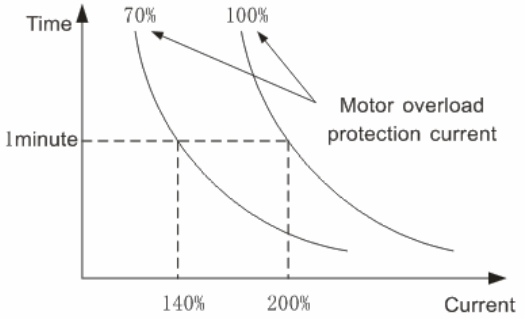


Figure 6.25 Motor overload protection curve.

The value can be determined by the following formula:

Motor overload protection current = (motor rated current / controller rated current) * 100%

Notice:

- **This parameter is normally used when rated power of controller is greater than rated power of motor.**
- **Motor overload protection time: 60s with 200% of rated current. For details, please refer to above figure.**

Function Code	Name	Description	Setting Range	Factory Setting
FB.02	Threshold of trip-free	70.0~110.0%	70~110.0	80.0%
FB.03	Decrease rate of trip-free	0.00Hz~F0.04	0.00Hz~F0.04	0.00Hz

If FB.03 is set to be 0, the trip-free function is invalid.

Trip-free function enables the controller to perform low-voltage compensation when DC bus voltage drops below FB.02. The controller can continue to run without tripping by reducing its output frequency and feedback energy via motor.

Notice: If FB.03 is too big, the feedback energy of motor will be too large and may cause over-voltage fault. If FB.03 is too small, the feedback energy of motor will be too small to achieve voltage compensation effect. So please set FB.03 according to load inertia and the actual load.

Function Code	Name	Description	Setting Range	Factory Setting
FB.04	Over-voltage stall protection	0：Disabled 1：Enabled	0~1	1
FB.05	Over-voltage stall protection point	110~150%	110~150	130%(380V) 115%(220V)

During deceleration, the motor's decelerating rate may be lower than that of controller's output frequency due to the load inertia. At this time, the motor will feed the energy back to

the controller, resulting in DC bus voltage rise. If no measures taken, the controller will trip due to over voltage.

During deceleration, the controller detects DC bus voltage and compares it with over-voltage stall protection point. If DC bus voltage exceeds Fb.05, the controller will stop reducing its output frequency. When DC bus voltage become lower than Fb.05, the deceleration continues, as shown in following figure.

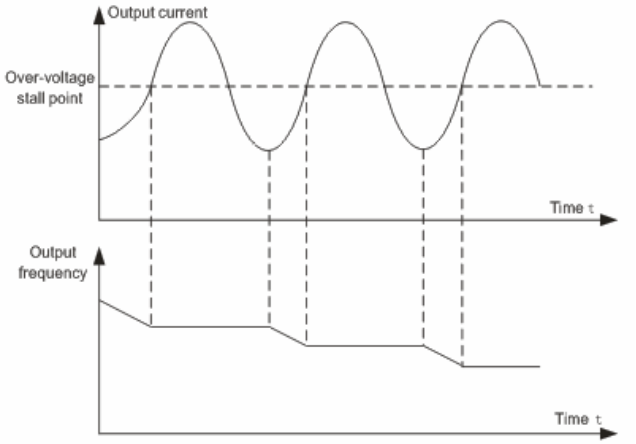


Figure 6.26 Over-voltage stall function.

Function Code	Name	Description	Setting Range	Factory Setting
FB.06	Auto current limiting threshold	100~200%	100~200	160%
FB.07	Frequency decrease rate when current limiting	0.00~100.00Hz/s	0.00~100.00	10.0Hz/s

Auto current limiting is used to limit the current of controller smaller than the value determined by FB.06 in real time. Therefore the controller will not trip due to surge over-current. This function is especially useful for the applications with big load inertia or step change of load.

FB.06 is a percentage of the controller's rated current.

FB.07 defines the decrease rate of output frequency when this function is active. If FB.06 is too small, overload fault may occur. If it is too big, the frequency will change too sharply and therefore, the feedback energy of motor will be too large and may cause over-voltage fault. This function is always enabled during acceleration or deceleration.

Notice:

- During auto current limiting process, the controller's output frequency may change; therefore, it is recommended not to enable the function when requires the controller's output frequency stable.
- During auto current limiting process, if FB.06 is too low, the overload capacity will be impacted.

Please refer to following figure.

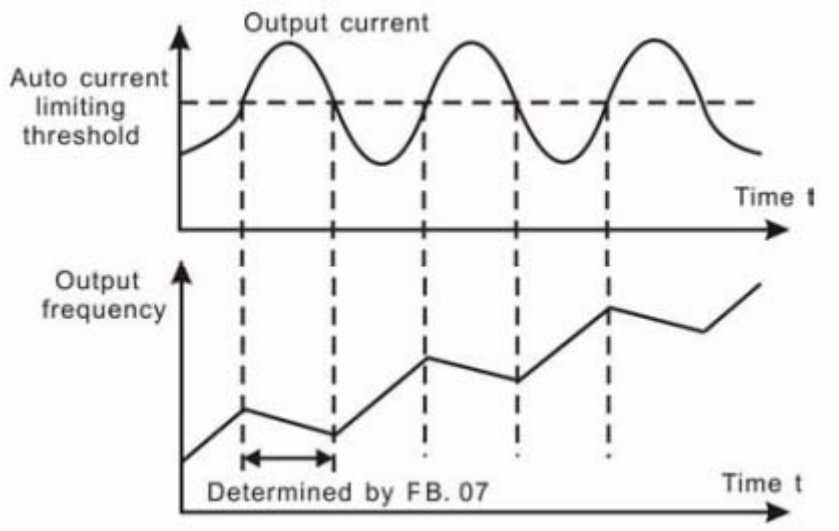


Figure 6.27 Current limiting protection function.

Function Code	Name	Description	Setting Range	Factory Setting
FB.08	Over-torque Checkout Options	0~4	0~4	0
FB.09	Over-torque Checkout Criterion	30~200%	30~200%	160%
FB.10	Over-torque Checkout Time	0.0~25.5s	0.0~25.5s	0.1s

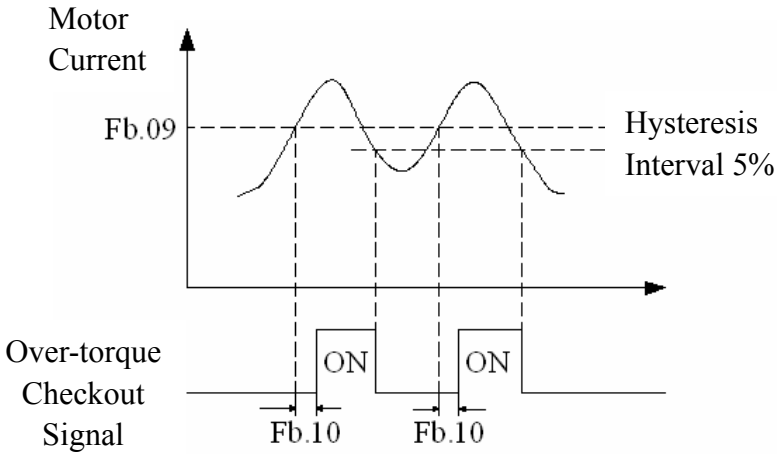
Over-torque Checkout Options (Fb.08)

- When the setting of Over-torque is available as well as the Controller Current exceeds Over-torque Checkout Criterion (Fb.09), even the time exceeds Over-torque Checkout Time (Fb.10), that is, check out over-torque.

Fb.08 Options

0	Over-torque Checkout invalid
1	Only when frequency is in conformity, check out Over-torque valid; after checkout, keep on running
2	Only when frequency is in conformity, check out Over-torque valid; after checkout, suspend output
3	In the process of running (including acceleration/deceleration), Over-torque can be checked out; after checkout, keep on running.
4	In the process of running (including acceleration/deceleration), Over-torque can be checked out; after check out, suspend output.

Over-torque Checkout Function: When the setting of over-torque is available (Fb0.8=1~4) as well as Mechanical Load is oversize, Controller will check out Motor Current, If Output Current of Controller ≥ Over-torque Checkout Criterion(Fb.09), even Continuous time exceeds Over-torque Checkout Time (Fb.10), Multi-Function Output Terminals (External Terminal RO1A-RO1B-RO1C) will output Over-torque Checkout Signal



- Utilizing Parameter of Fb.08, can set that check out Over-torque only when frequency is in conformity, or in the process of running; proceed with running or suspend output after check out can also be set.

6.13 FC Group--Serial Communication

Function Code	Name	Description	Setting Range	Factory Setting
FC.00	Local address	1~247 ,0 broadcast address	1~247	1

This parameter determines the slave address used for communication with master. The value "0" is the broadcast address.

Function Code	Name	Description	Setting Range	Factory Setting
FC.01	Baud rate selection	0：1200BPS 1：2400BPS 2：4800BPS 3：9600BPS 4：19200BPS 5：38400BPS	0~5	4

This parameter can set the data transmission rate during serial communication.

Notice: The baud rate of master and slave must to be the same.

Function Code	Name	Description	Setting Range	Factory Setting
FC.02	Data format	0~17	0~17	1

This parameter defines the data format used in serial communication protocol.

0: RTU, 1 start bit, 8 data bits, no parity check, 1 stop bit.

1: RTU, 1 start bit, 8 data bits, even parity check, 1 stop bit.

2: RTU, 1 start bit, 8 data bits, odd parity check, 1 stop bit.

3: RTU, 1 start bit, 8 data bits, no parity check, 2 stop bit.

4: RTU, 1 start bit, 8 data bits, even parity check, 2 stop bit.

5: RTU, 1 start bit, 8 data bits, odd parity check, 2 stop bit.

6: ASCII, 1 start bit, 7 data bits, no parity check, 1 stop bit.

7: ASCII, 1 start bit, 7 data bits, even parity check, 1 stop bit.
8: ASCII, 1 start bit, 7 data bits, odd parity check, 1 stop bit.
9: ASCII, 1 start bit, 7 data bits, no parity check, 2 stop bit.
10: ASCII, 1 start bit, 7 data bits, even parity check, 2 stop bit.
11: ASCII, 1 start bit, 7 data bits, odd parity check, 2 stop bit.
12: ASCII, 1 start bit, 8 data bits, no parity check, 1 stop bit.
13: ASCII, 1 start bit, 8 data bits, even parity check, 1 stop bit.
14: ASCII, 1 start bit, 8 data bits, odd parity check, 1 stop bit.
15: ASCII, 1 start bit, 8 data bits, no parity check, 2 stop bit.
16: ASCII, 1 start bit, 8 data bits, even parity check, 2 stop bit.
17: ASCII, 1 start bit, 8 data bits, odd parity check, 2 stop bit.

Function Code	Name	Description	Setting Range	Factory Setting
FC.03	Communication delay time	0~200ms	0~200	5ms

This parameter can be used to set the response delay in communication in order to adapt to the MODBUS master. In RTU mode, the actual communication delay should be no less than 3.5 characters' interval; in ASCII mode, 1ms.

Function Code	Name	Description	Setting Range	Factory Setting
FC.04	Communication timeout delay	0.0: Disabled 0.1~100.0s	0~100.0	0.0s

When the value is zero, this function will be disabled. When communication interruption is longer than the non-zero value of FC.04, the controller will alarm communication error (CE).

Function Code	Name	Description	Setting Range	Factory Setting
FC.05	Communication error action	0：Alarm and coast to stop 1：No alarm and continue to run 2：No alarm but stop according to F1.05 (if F0.01=2) 3：No alarm but stop according to F1.05	0~3	1

0: When communication error occurs, controller will alarm (CE) and coast to stop.

1: When communication error occurs, controller will omit the error and continue to run.

2: When communication error occurs, if F0.01=2, controller will not alarm but stop according to stop mode determined by F1.05. Otherwise it will omit the error.

3: When communication error occurs, controller will not alarm but stop according to stop mode determined by F1.05.

Function Code	Name	Description	Setting Range	Factory Setting
FC.06	Response action	Unit's place of LED 0：Response to writing 1：No response to writing Ten's place of LED 0：Response not saved when power off 1：Response saved when power off	0~1	0

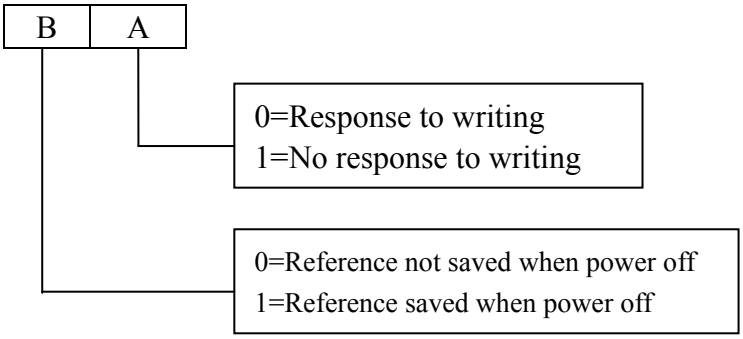


Figure 6.28 Meaning of FC.06

A stands for: Unit's place of LED

B stands for: Ten's place of LED

6.14 FD Group--Supplementary Function

Function Code	Name	Description	Setting Range	Factory Setting
FD.00	Low-frequency threshold of restraining oscillation	0~500	0~500	5
FD.01	High-frequency threshold of restraining oscillation	0~500	0~500	100

This function is valid only when FD.04 is set to be 0. The smaller the value of FD.00 and FD.01, the stronger the restraining effect.

Notice: Most motor may have current oscillation at some frequency point. Please be cautious to adjust these parameters to weaken oscillation.

Function Code	Name	Description	Setting Range	Factory Setting
FD.02	Amplitude of restraining oscillation	0~10000	0~10000	5000

This parameter is used to limit the strength of restraining oscillation. If the value of FD.02 is too big, it may cause controller over current. It should be set a little bit smaller for large power motor, vice versa.

Function Code	Name	Description	Setting Range	Factory Setting
FD.03	Boundary of restraining oscillation	0.00~F0.04	0.00Hz~F0.04	12.5Hz

If output frequency is greater than FD.03, FD.00 takes effect, otherwise FD.01 takes effect.

Function Code	Name	Description	Setting Range	Factory Setting
FD.04	Restrain oscillation	0：Enabled； 1：Disabled.	0~1	1

Motor always has current oscillation when its load is light. This will cause abnormal operation even over-current. For details, please refer to description of FD.00~FD.03.

Function Code	Name	Description	Setting Range	Factory Setting
FD.05	PWM mode	0：PWM mode 1 1：PWM mode 2 2：PWM mode 3	0~2	0

The features of each mode, please refer the following table:

Mode	Noise in lower frequency	Noise in higher frequency	Others
PWM mode 1	Low	high	
PWM mode 2	low		Need to be derated, because of higher temperature rise.
PWM mode 3	high		Can more effectively restrain the oscillation

Function Code	Name	Description	Setting Range	Factory Setting
FD.06	Torque setting source	0：Keypad 1：AI1 2：AI2 3：AI1 +AI2 4：Multi-step setting 5：Communication	0~5	0
FD.07	Keypad torque setting	-100.0%~100.0%	-100.0~100.0%	0

- When torque control takes effect

If $T_{set} > T_{load,}$ output frequency will increase continuously until it reaches upper frequency limit.

If $T_{set} < T_{load,}$ output frequency will decrease continuously until it reaches lower frequency limit.

Controller can run at any frequency between upper and lower frequency limit only when $T_{set} = T_{load}$

- Torque control can be switched to speed control, vice versa.

■Switching by multifunctional terminal: For example, if torque control is enabled (F0.00=2), torque setting source is AI1, the value of multifunction terminal S5 is set to 20 (Disable torque control). When S5 is valid, control mode will switch from torque control, vice versa.

■When running at torque control mode, press STOP/RST, it will switch to speed control automatically.

- If torque setting is positive, controller will run forward; otherwise it will run reverse.

Notice:

- **When running at torque control mode, the acceleration time has nothing to do with F0.08.**
- **The 100% of torque setting is corresponding to 100% of F3.07 (Torque limit). For example, if torque setting source is keypad (FD.06=0), FD.07=80% and F3.07=90%, then**
- **Actual torque setting=80% (FD.07)*90%(F3.07)=72%.**

Function Code	Name	Description	Setting Range	Factory Setting
FD.08	Upper frequency limit selection	0：Keypad 1：AI1 2：AI2 3：Multi-step setting 4：Communication	0~4	0

The 100% of this parameter is corresponding to 100% of F0.04 (maximum frequency). When running at torque control mode, output frequency can be adjusted by changing upper frequency limit.

Function Code	Name	Description	Setting Range	Factory Setting
FD.09	Auto current limiting selection	0：Enabled 1:Disabled when constant speed	0~1	0

Auto current limiting function is used to prevent controller trip over-current from surge current. It is especially useful for the applications with big load inertia or step change of load. This function is always enabled during acceleration or deceleration period.

Notice: During auto current limiting process, the controller's output frequency may change; therefore, it is recommended not to enable the function when output frequency need to be stable.

6.15 FE Group--Factory Setting

This group is the factory-set parameter group. The user DO NOT try to open these group parameters, otherwise it will cause the controller abnormal operation or damage.

7 TROUBLE SHOOTING

7.1 Fault and Trouble shooting

Fault Code	Fault Type	Reason	Solution
E001	IGBT Ph-U fault	1、Acc/Dec time is too short 2、IGBT module fault 3、Malfunction caused by interference 4、Grounding is not properly	1、Increase Acc/Dec time 2、Ask for support 3、Inspect external equipment and eliminate interference
E002	IGBT Ph-V fault		
E003	IGBT Ph-W fault		
E004	Over-current when acceleration	1、Short-circuit or ground fault occurred at controller output 2、Load is too heavy or Acc/Dec time is too short 3、V/F curve is not suitable 4、Sudden change of load	1、Inspect whether motor damaged, insulation worn or cable damaged 2、Increase Acc/Dec time or select bigger capacity controller 3、Check and adjust V/F curve. Check the load.
E005	Over-current when deceleration		
E006	Over-current when constant speed running		
E007	Over-voltage when acceleration	1、Dec time is too short and regenerative energy from the motor is too large 2、Input voltage is too high	1、Increase Dec time or connect braking resistor 2、Decrease input voltage within specification
E008	Over-voltage when deceleration		
E009	Over-voltage when constant speed running		
E010	DC bus Under-voltage	1、Open phase occurred with power supply 2、Momentary power loss occurred 3、Wiring terminals for input power supply are loose 4、Voltage fluctuations in power supply are too large	Inspect the input power supply or wiring
E011	Motor overload	1、Motor drive heavy load at low speed for a long time 2、Improper V/F curve	1、Select variable frequency motor 2、Check and adjust V/F curve

Fault Code	Fault Type	Reason	Solution
		3、Improper motor's overload protection threshold 4、Sudden change of load	3、Check and adjust FB.01 4、Check the load
E012	Controller overload	1、Load is too heavy or Acc/Dec time is too short 2、Improper V/F curve 3、Capacity of controller is too small	1、Increase Acc/Dec time or select bigger capacity controller 2、Check and adjust V/F curve 3、Select bigger capacity controller
E013	Input phase failure	1、Open-phase occurred in power supply 2、Momentary power loss occurred 3、Wiring terminals for input power supply are loose 4、Voltage fluctuations in power supply are too large 5、Voltage balance between phase is bad	Check the wiring installation and power supply
E014	Output phase failure	1、There is a broken wire in the output cable 2、There is a broken wire in the motor winding 3、Output terminals are loose	Check the wiring and installation
E015	Rectify overheat	1、Ambient temperature is too high 2、Near heat source 3、Cooling fans of controller stop or damaged 4、Obstruction of ventilation channel 5、Carrier frequency is too high	1、Install cooling unit 2、Remove heat source 3、Replace cooling fan 4、Clear the ventilation channel 5、Decrease carrier frequency
E016	IGBT overheat		

Fault Code	Fault Type	Reason	Solution
E017	External fault	Sx: External fault input terminal take effect	Inspect external equipment
E018	Communication fault	1、Improper baud rate setting 2、Receive wrong data 3、Communication is interrupted for Long time	1、Set proper baud rate 2、Check communication devices and signals
E019	Current detection fault	1、Wires or connectors of control board are loose 2、Hall sensor is damaged 3、Amplifying circuit is abnormal	1、Check the wiring 2、Ask for support
E020	Autotuning fault	1、Improper setting of motor rated parameters 2、Overtime of autotuning	1、Set rated parameters according to motor nameplate 2、Check motor's wiring
E021	EEPROM fault	1、R/W fault of control parameters	1、Press STOP/RST to reset 2、Ask for support
E022	PID feedback fault	1、PID feedback disconnected 2、PID feedback source disappears	1、Inspect PID feedback signal wire 2、Inspect PID feedback source
E023	Brake unit fault	1、Braking circuit failure or brake tube damaged 2、Too low resistance of externally connected braking resistor	1、Inspect braking unit, replace baking tube 2、Increase braking resistance
E024	Factory Reserved		
E025	Over-torque Detection		

7.2 Common Faults and Solutions

Controller may have following faults or malfunctions during operation, please refer to the following solutions.

7.2.1 No display after power on:

- Inspect whether the voltage of power supply is the same as the controller rated voltage or not with multi-meter. If the power supply has problem, inspect and solve it.
- Inspect whether the three-phase rectify bridge is in good condition or not. If the rectification bridge is burst out, ask for support.
- Check the CHARGE light. If the light is off, the fault is mainly in the rectify bridge or the buffer resistor. If the light is on, the fault may be lies in the switching power supply. Please ask for support.

7.2.2 Power supply air switch trips off when power on:

- Inspect whether the input power supply is grounded or short circuit. Please solve the problem.
- Inspect whether the rectify bridge has been burnt or not. If it is damaged, ask for support.

7.2.3 Motor doesn't move after controller running:

- Inspect if there is balanced three-phase output among U, V, W. If yes, then motor could be damaged, or mechanically locked. Please solve it.
- If the output is unbalanced or lost, the controller drive board or the output module may be damaged, ask for support.

7.2.4 Controller displays normally when power on, but switch at the input side trips when running:

- Inspect whether the output side of controller is short circuit. If yes, ask for support.
- Inspect whether ground fault exists. If yes, solve it.
- If trip happens occasionally and the distance between motor and controller is too far, it is recommended to install output AC reactor.

8 MAINTENANCE

WARNING
- Maintenance must be performed according to designated maintenance methods. - Maintenance, inspection and replacement of parts must be performed only by authorized personnel. - After turning off the main circuit power supply, waiting for 10 minutes before performance maintenance or inspection - DO NOT directly touch components or devices of PCB board. Otherwise controller can be damaged by electrostatic. - After maintenance, all screws must be tightened.

8.1 Daily Maintenance

In order to prevent the fault of controller to make it operate smoothly in high-performance for a long time, user must inspect the controller periodically (within half year).The following table indicates the inspection content.

Items to be checked	Main inspections		Criteria
	Inspection content	Frequency	Means/methods
Operation environment	1、temperature 2、humidity 3、dust 4、vapor 5、gases	1、point thermometer hygrometer 2、observation 3、visual examination and smelling	1.ambient temperature shall be lower than 40℃, otherwise, the rated values should be decreased. Humidity shall meet the requirement 2、no dust accumulation, no traces of water leakage and no condensate. 3、no abnormal color and smell.
Controller	1、vibration 2、cooling and heating 3、noise	1.point thermometer 2.comprehensive observation 3.listening	1.smooth operation without vibration. 2.fan is working in good condition. Speed and air flow are normal. No abnormal heat. 3.No abnormal noise
Motor	1.vibration 2、heat 3、noise	1、comprehensive observation 2、point thermometer 3、listening	1. No abnormal vibration and no abnormal noise. 2. No abnormal heat. 3. No abnormal noise.
Operation status parameters	1.power input voltage 2. controller output voltage 3.controller output current 4.internal temperature	1. voltmeter 2.rectifying voltmeter 3. ammeter 4. point thermometer	1.satisfying the specification 2.satisfying the specification 3.satisfying the specification 4.temperature rise is lower than 40 ℃

8.2 Periodic Maintenance

Customer should check the drive every 3 months or 6 months according to the actual environment

8.2.1 Check whether the screws of control terminals are loose. If so, tighten them with a screwdriver;

8.2.2 Check whether the main circuit terminals are properly connected; whether the mains cables are over heated;

8.2.3 Check whether the power cables and control cables are damaged, check especially for any wear on the cable tube;

8.2.4 Check whether the insulating tapes around the cable lugs are stripped;

8.2.5 Clean the dust on PCBs and air ducts with a vacuum cleaner;

8.2.6 For drives that have been stored for a long time, it must be powered on every 2 years. When supplying AC power to the drive, use a voltage regulator to raise the input voltage to rated input voltage gradually. The drive should be powered for 5 hours without load.

8.2.7 Before performing insulation tests, all main circuit input/output terminals should be short-circuited with conductors. Then proceed insulation test to the ground. Insulation test of single main circuit terminal to ground is forbidden; otherwise the drive might be damaged. Please use a 500V Mega-Ohm-Meter.

8.2.8 Before the insulation test of the motor, disconnect the motor from the drive to avoid damaging it.

8.3 Replacement of wearing parts

Fans and electrolytic capacitors are wearing part, please make periodic replacement to ensure long term, safety and failure-free operation. The replacement periods are as follows:

◆Fan: Must be replaced when using up to 20,000 hours;

◆Electrolytic Capacitor: Must be replaced when using up to 30,000~40, 000 hours.

9 LIST OF FUNCTION PARAMETERS

Notice:

■FE group is factory reserved, users are forbidden to access these parameters.

■The column “Modify” determines the parameter can be modified or not.

“○” indicates that this parameter can be modified all the time.

“◎” indicates that this parameter cannot be modified during the controller is running.

“●” indicates that this parameter is read only.

■ “Factory Setting” indicates the value of each parameter while restoring the factory parameters, but those detected parameters or record values cannot be restored.

9.1 Function Parameters of B503

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F0 Group: Basic Function					
F0.00	Control mode selection	0：Sensorless vector control 1：V/F control 2：Torque control	0	◎	0.
F0.01	Run command source	0：Keypad(LED extinguishes) 1：Terminal(LED flickers) 2：Communication(LED lights up)	0	◎	1
F0.02	UP/DOWN setting	0：Valid, save UP/DOWN value when power off 1：Valid, do not save UP/DOWN value when power off 2：Invalid 3：Valid during running, clear when stop.	0	○	2
F0.03	Frequency A command source	0：Keypad 1：AI1 2：AI2 3：AI1 +AI2 4：Multi-Step speed 5：PID 6：Communication	0	○	3.
F0.04	Maximum output frequency	10.0~600.00Hz	50.0Hz	◎	4.
F0.05	Upper frequency limit	F0.06~F0.04	50.0Hz	○	5.
F0.06	Lower frequency limit	0.0Hz~F0.05	0.00Hz	○	6.
F0.07	Keypad reference frequency	0.00Hz~F0.04	50.00Hz	○	7.
F0.08	Acceleration time 1	0.1~3600.0s	Depend on model	○	8.
F0.09	Deceleration time 1	0.1~3600.0s	Depend on model	○	9.
F0.10	Running direction selection	0：Forward 1：Reverse 2：Forbid reverse	0	◎	10.

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F0.11	Carrier frequency	1.0~15.0KHz	Depend on model	○	11.
F0.12	Motor parameters autotuning	0：No action 1：Rotation autotuning 2：Static autotuning	0	◎	12.
F0.13	Restore parameters	0：No action 1：Restore factory setting 2：Clear fault records	0	◎	13.
F0.14	AVR function	0：Disabled 1：Enabled all the time 2：Disabled during deceleration	1	○	14.
F1 Group: Start and Stop Control					
F1.00	Start Mode	0：Start directly 1：DC braking and start 2：Speed tracking and start	0	◎	15.
F1.01	Starting frequency	0.00~10.00Hz	0.50Hz	○	16.
F1.02	Hold time of starting frequency	0.0~50.0s	0.0s	○	17.
F1.03	DC Braking current before start	0.0~150.0%	0.0%	○	18.
F1.04	DC Braking time before start	0.0~50.0s	0.0s	○	19.
F1.05	Stop mode	0：Deceleration to stop 1：Coast to stop	0	○	20.
F1.06	Starting frequency of DC braking	0.00~10.00Hz	0.00Hz	○	21.
F1.07	Waiting time before DC braking	0.0~50.0s	0.0s	○	22.
F1.08	DC braking current	0.0~150.0%	0.0%	○	23.
F1.09	DC braking time	0.0~50.0s	0.0s	○	24.
F1.10	Dead time of FWD/REV	0.0~3600.0s	0.0s	○	25.

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F1.11	FWD/REV enable when power on	0：Disabled 1：Enabled	0	○	26.
F1.12	NO/NC input/output terminal selection	0x00~0x3F	0x00	●	27.
F2 Group: Motor Parameters					
F2.00	G/P option	0: G model 1: P model	Depend on model	◎	28.
F2.01	Motor rated power	0.75~900KW	Depend on model	◎	29.
F2.02	Motor rated frequency	0.01Hz~F0.04	50.0Hz	◎	30.
F2.03	Motor rated speed	0~36000rpm	Depend on model	◎	31.
F2.04	Motor rated voltage	0~460V	Depend on model	◎	32.
F2.05	Motor rated current	0.1~2000.0A	Depend on model	◎	33.
F2.06	Motor stator resistance	0.001~65.635 Ω	Depend on model	○	34.
F2.07	Motor rotor resistance	0.001~65.535 Ω	Depend on model	○	35.
F2.08	Motor leakage inductance	0.1~6553.5mH	Depend on model	○	36.
F2.09	Motor mutual inductance	0.1~6553.5mH	Depend on model	○	37.
F2.10	Current without load	0.01~655.35A	Depend on model	○	38.
F3 Group: Vector Control					
F3.00	ASR proportional gain Kp1	0~100	20	○	39.
F3.01	ASR integral time Ki1	0.01~10.00s	0.50s	○	40.

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F3.02	ASR switching point 1	0.00Hz~F3.05	5.00Hz	○	41.
F3.03	ASR proportional gain Kp2	0~100	25	○	42.
F3.04	ASR integral time Ki2	0.01~10.00s	1.00	○	43.
F3.05	ASR switching point 2	F3.02~F0.04	10.00Hz	○	44.
F3.06	Slip compensation rate of VC	50.0%~200.0%	100%	○	45.
F3.07	Torque limit	0.0~200.0%	150.0%	○	46.
F4 Group: V/F Control					
F4.00	V/F curve selection	0：Linear curve 1：Torque step down curve (2.0 order)	0	◎	47.
F4.01	Torque boost	0.0%：(auto) 0.1%~30.0%	0.0%	○	48.
F4.02	Torque boost cut-off	0.0%~50.0%(motor rated frequency)	20.0%	◎	49.
F4.03	V/F Slip compensation limit	0.00~200.0%	0.0%	○	50.
F4.04	Auto energy saving selection	0：Disabled 1：Enabled	0	◎	51.
F4.05	Reserves			●	52
F5 Group: Input Terminals					
F5.00	S1 terminal function	0：Invalid 1：Forward 2：Reverse 3：3-wire control 4：JOG forward 5：JOG reverse	1	◎	53
F5.01	S2 terminal function		2	◎	54

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F5.02	S3 terminal function	6：Coast to stop 7：Reset fault 8：External fault input 9：UP command 10：DOWN command 11：Clear UP/DOWN 12：Multi-step speed reference 1 13：Multi-step speed reference 2 14：Multi-step speed reference 3 15：ACC/DEC time selection 16：Pause PID 17：Pause traverse operation 18：Reset traverse operation 19：ACC/DEC ramp hold 20：Disable torque control 21：UP/DOWN invalid temporarily 22：DC braking when stop 23~25：reserved	4	◎	55
F5.03	S4 terminal function		7	◎	56
F5.04	ON/OFF filter times	1~10	5	○	57
F5.05	FWD/REV control mode	0: 2-wire control mode 1 1: 2-wire control mode 2 2:3-wire control mode 1 3:3-wire control mode 2	0	◎	58
F5.06	UP/DOWN setting change rate	0.01~50.00Hz/s	0.50Hz/s	○	59
F5.07	AI1 lower limit	0.00V~10.00V	0.00V	○	60.
F5.08	AI1 lower limit corresponding setting	-100.0%~100.0%	0.0%	○	61
F5.09	AI1 upper limit	0.00V~10.00V	10.00V	○	62.
F5.10	AI1 upper limit corresponding setting	-100.0%~100.0%	100.0%	○	63.

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F5.11	AI1 filter tine constant	0.00s~10.00s	0.10s	○	64
F5.12	AI2 lower limit	0.00V~10.00V	0.00V	○	65
F5.13	AI2 lower limit corresponding setting	-100.0%~100.0%	0.0%	○	66
F5.14	AI2 upper limit	0.00V~10.00V	10.0V	○	67
F5.15	AI2 upper limit corresponding setting	-100.0%~100.0%	100.0%	○	68
F5.16	AI2 filter time constant	0.00s~10.00	0.10s	○	69
F6 Group: Output Terminals					
F6.00	Y output selection	0：No output 1：Run forward 2：Run reverse 3：Fault output 4：FDT reached 5：Frequency reached 6：Zero speed running 7：Upper frequency limit reached 8：Lower frequency limit reached 9~10：reserved 11：Over-torque Checkout	1	○	70.
F6.01	Relay output selection		3	○	71
F6.02	AO selection	0：Running frequency 1：Reference frequency 2：Motor speed 3：Output current 4：Output voltage 5：Output power 6：Output torque 7：AI1 voltage 8：AI2 voltage/current 9~10：reserved	0	○	72
F6.03	AO lower limit	0.0%~100.0%	0.0%	○	73

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F6.04	AO lower limit corresponding output	0.00V~10.00V	0.00V	○	74
F6.05	AO upper limit	0.0%~100.0%	100.0%	○	75
F6.06	AO upper limit corresponding output	0.00V~10.00V	10.00V	○	76
F7 Group: Display Interface					
F7.00	User password	0~65535	0	○	77
F7.01	LCD language selection	0: Chinese 1: English	0	○	78
F7.02	Parameter copy	0: Invalid 1: Upload to LCD from controller 2:Download to controller from LCD	0	◎	79
F7.03	 function selection	0：Jog 1：FDW/REV switching 2：Clear UP/DOWN setting	0	◎	80
F7.04	STOP/RST function option	0：Valid when keypad control (F0.01=0) 1：Valid when keypad or terminal control(F0.01=0 or 1) 2: Valid when keypad or communication control(F0.01=0 or 2) 3：Always valid	0	○	81
F7.05	Keypad display selection	0: Preferential to external keypad 1: Both display, only external key valid. 2: Both display, only local key valid. 3: Both display and key valid	0	○	82
F7.06	Running status display selection	0~0x7FFF BIT0：Output frequency BIT1：Reference frequency BIT2：DC bus voltage BIT3：Output voltage BIT4：Output current BIT5：Rotation speed	0xFF	○	83

Function Code	Name	Description	Factory Setting	Modify	Serial No.
		BIT6：Output power BIT7：Output torque BIT8：PID preset BIT9：PID feedback BIT10：Input terminal status BIT11：Output terminal status BIT12：AI1 BIT13：AI2 BIT14：Step No. of multi-step BIT15：Reserved			
F7.07	Stop status display selection	0~0x1FF BIT0：Reference frequency BIT1：DC bus voltage BIT2：Input terminal status BIT3：Output terminal status BIT4：PID preset BIT5：PID feedback BIT6：AI1 BIT7：AI2 BIT8：Step No. of multi-step BIT9~BIT15：Reserved	0xFF	○	84
F7.08	Rectifier module temperature	0~100.0℃		●	85
F7.09	IGBT module temperature	0~100.0℃		●	86
F7.10	Software version			●	87
F7.11	Accumulated running time	0~65535h		●	88
F7.12	Third latest fault type	E000：Not fault E001：IGBT Ph-U fault(（OUT1） E002：IGBT Ph-V fault（OUT2） E003：IGBT Ph-W fault（OUT3） E004 ： Over-current when acceleration（OC1） E005 ： Over-current when deceleration（OC2） E006：Over-current when constant speed running（OC3）		●	89

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F7.13	Second latest fault type	E007 ： Over-voltage when acceleration（OV1） E008 ： Over-voltage when deceleration（OV2） E009：Over-voltage when constant speed running（OV3） E010：DC bus Under-voltage（UV） E011：Motor overload（OL1） E012：Controller overload（OL2） E013：Input phase failure（SPI） E014：Output phase failure（SPO） E015：Rectify overheat（OH1） E016：IGBT overheat（OH2） E017：External fault（EF） E018：Communication fault（CE） E019：Current detection fault（ITE） E020：Autotuning fault（TE） EO21：EEPROM fault（EEP） E022：PID feedback fault（PIDE） E023：Brake unit fault（BCE） E024：Reserved E025：Over-torque Detection（OL3）		●	90
F7.14	Latest fault type			●	91
F7.15	Output frequency at current fault	Output frequency at current fault		●	92
F7.16	Output current at current fault	Output current at current fault		●	93
F7.17	DC bus voltage at current fault	DC bus voltage at current fault		●	94
F7.18	Input terminal status at current fault			●	95
F7.19	Output terminal status at current fault		0	●	96
F8 Group: Enhanced Function					
F8.00	Acceleration time2	0.1~3600.0s	Depend on model	○	97

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F8.01	Deceleration time 2	0.1~3600.0s	Depend on model	○	98
F8.02	Jog reference	0.00~F0.04	5.00Hz	○	99
F8.03	Jog acceleration time	0.1~3600.0s	Depend on model	○	100
F8.04	Jog deceleration time	0.1~3600.0s	Depend on model	○	101
F8.05	Skip frequency	0.00~F0.04	0.00Hz	○	102
F8.06	Skip frequency bandwidth	0.00~F0.04	0.00Hz	○	103
F8.07	Traverse amplitude	0.0~100.0%	0.0%	○	104
F8.08	Jitter frequency	0.0~50.0%	0.0%	○	105
F8.09	Rise time of traverse	0.1~3600.0s	5.0s	○	106
F8.10	Fall time of traverse	0.1~3600.0s	5.0s	○	107
F8.11	Auto reset times	0~3	0	○	108
F8.12	Reset interval	0.1~100.0s	1.0s	○	109
F8.13	FDT level	0.00~F0.04	50.00Hz	○	110
F8.14	FDT lag	0.0~100.0%	5.0%	○	111
F8.15	Frequency arrive detecting range	0.0~100.0%（maximum frequency）	0.0%	○	112
F8.16	Brake threshold voltage	115.0~140.0%（380V series 130.0%） 115.0~140.0%（220Vseries 120.0%）	Depend on model	○	113
F8.17	Coefficient of rotation speed	0.1~999.9%	100.0%	○	114

Function Code	Name	Description	Factory Setting	Modify	Serial No.
F9 Group: PID Control					
F9.00	PID preset source selection	0：Keypad 1：AI1 2：AI2 3：Communication 4：Multi-step	0	○	115
F9.01	Keypad PID preset	0.0%~100.0%	0.0%	○	116
F9.02	PID feedback source selection	0：AI1 1：AI2 2：AI1 +AI2 3：Communication	0	○	117
F9.03	PID output characteristic	0：Positive 1：Negative	0	○	118
F9.04	Proportional gain（Kp）	0.00~100.00	0.10	○	119
F9.05	Integral time（Ti）	0.01~10.00s	0.10s	○	120
F9.06	Differential time（Td）	0.00~10.00s	0.00s	○	121
F9.07	Sampling cycle (T)	0.01~100.00s	0.10s	○	122
F9.08	Bias limit	0.0~100.0%	0.0%	○	123
F9.09	Feedback lost detecting value	0.0~100.0%	0.0%	○	124
F9.10	Feedback lost detecting time	0.0~3600.0s	1.0s	○	125
F9.11	Sleep delayed Time	0~3600.0s	0.0s	◎	
F9.12	Sleep Threshold Value Frequency	0~ F0.04	0.0Hz	◎	
F9.13	Sleep Awaken Threshold Value Deviation	0~100.0%	0.0%	◎	
F9.14	Sleep Awaken Delayed Time	0.0~300.0s	0.0s	◎	

Function Code	Name	Description	Factory Setting	Modify	Serial No.
FA Group: Multi-step Speed Control					
FA.00	Multi-step speed 0	-100.0~100.0%	0.0%	○	126
FA.01	Multi-step speed 1	-100.0~100.0%	0.0%	○	127
FA.02	Multi-step speed 2	-100.0~100.0%	0.0%	○	128
FA.03	Multi-step speed 3	-100.0~100.0%	0.0%	○	129
FA.04	Multi-step speed 4	-100.0~100.0%	0.0%	○	130
FA.05	Multi-step speed 5	-100.0~100.0%	0.0%	○	131
FA.06	Multi-step speed 6	-100.0~100.0%	0.0%	○	132
FA.07	Multi-step speed 7	-100.0~100.0%	0.0%	○	133
FB Group: Protection Function					
FB.00	Motor overload protection	0：Disabled 1：Normal motor 2：Variable frequency motor	2	◎	134
FB.01	Motor overload protection current	20.0%~120.0%	100.0%	○	135
FB.02	Threshold of trip-free	70.0~110.0%	80.0%	○	136
FB.03	Decrease rate of trip-free	0.00Hz~F0.04	0.00Hz	○	137
FB.04	Over-voltage stall protection	0：Disabled 1：Enabled	1	○	138
FB.05	Over-voltage stall protection point	110~150%	130%（380V） 115%(220V)	○	139
FB.06	Auto current limiting threshold	100~200%	G: 160% P: 120%	○	140
FB.07	Frequency decrease rate when current limiting	0.00~100.00Hz/s	10.0Hz/s	○	141

Function Code	Name	Description	Factory Setting	Modify	Serial No.
FB.08	Over-torque Checkout Options	0~4	0		
FB.09	Over-torque Checkout Criterion	30~200%	160%		
FB.10	Over-torque Checkout Time	0.0~25.5s	0.1s		
FC Group: Serial Communication					
FC.00	Local address	1~247，0 broadcast address	1	○	142
FC.01	Baud rate selection	0：1200BPS 1：2400BPS 2：4800BPS 3：9600BPS 4：19200BPS 5：38400BPS	4	○	143
FC.02	Data format	0：RTU, 1 start bit, 8 data bits, no parity check, 1 stop bit. 1: RTU, 1 start bit, 8 data bits, even parity check, 1 stop bit. 2：RTU, 1 start bit, 8 data bits, odd parity check, 1 stop bit. 3：RTU, 1 start bit, 8 data bits, no parity check, 2 stop bit. 4：RTU, 1 start bit, 8 data bits, even parity check, 2 stop bit. 5：RTU, 1 start bit, 8 data bits, odd parity check, 2 stop bit. 6：ASCII, 1 start bit, 7 data bits, no parity check, 1 stop bit. 7：ASCII, 1 start bit, 7 data bits, even parity check, 1 stop bit. 8：ASCII, 1 start bit, 7 data bits, odd parity check, 1 stop bit. 9：ASCII, 1 start bit, 7 data bits, no parity check, 2 stop bit. 10：ASCII, 1 start bit, 7 data bits, even parity check, 2stop bit.	1	○	144

Function Code	Name	Description	Factory Setting	Modify	Serial No.
		11：ASCII, 1 start bit, 7 data bits, odd parity check, 2 stop bit. 12：ASCII, 1 start bit, 8 data bits, no parity check, 1stop bit. 13：ASCII, 1 start bit, 8 data bits, even parity check, 1 stop bit. 14：ASCII, 1 start bit, 8 data bits, odd parity check, 1 stop bit. 15：ASCII, 1 start bit, 8 data bits, no parity check, 2 stop bit. 16：ASCII, 1 start bit, 8 data bits, even parity check, 2 stop bit. 17：ASCII, 1 start bit, 8 data bits, odd parity check, 2 stop bit.			
FC.03	Communication delay time	0~200ms	5ms	○	145
FC.04	Communication timeout delay	0.0（Disabled），0.1~100.0s	0.0s	○	146
FC.05	Communication error action	0：Alarm and coast to stop 1：No alarm and continue to run 2：No alarm but stop according to F1.05 (if F0.01=2) 3：No alarm but stop according to F1.05	1	○	147
FC0.6	Response action	Unit’s place of LED 0：Response to writing 1：No response to writing Ten’s place of LED 0: Reference not saved when power off 1: Reference saved when power off	0	○	148
FD Group: Supplementary Function					
FD.00	Low-frequency threshold of restraining oscillation	0~500	5	○	149

Function Code	Name	Description	Factory Setting	Modify	Serial No.
FD.01	High-frequency threshold of restraining oscillation	0~500	100	○	150
FD.02	Amplitude of restraining oscillation	0~10000	5000	○	151
FD.03	Boundary of restraining oscillation	0.00Hz~F0.04	12.5Hz	○	152
FD.04	Restrain oscillation	0：Enabled 1：Disabled	1	○	153
FD.05	PWM mode	0：PWM mode 1 1：PWM mode 2 2：PWM mode 3	0	◎	154
FD.06	Torque setting source	0：Keypad 1：AI1 2：AI2 3：AI1+AI2 4：Multi-step setting 5：Communication	0	○	155
FD.07	Keypad torque setting	-100.0%~100.0%	0	○	156
FD.08	Upper frequency limit selection	0：Keypad（F0.05） 1：AI1 2：AI2 3：Multi-step setting 4：Communication	0	○	157
FD.09	Auto current limiting selection	0：Enabled 1：Disabled when constant speed	0	○	158
FE Group: Factory Setting					
FE.00	Factory password	0~65535	*****	●	159

10 SPECIFICATION OF BRAKING UNIT AND BRAKING RESISTOR

Model No.	Braking unit		Braking resistor (100% braking torque)	
	Order No.	Quantity	Specification	Quantity
220V±15%				
B503-20005	Built-in	1	200Ω/80W	1
B503-2001		1	200Ω/80W	1
B503-2002		1	100Ω/260W	1
B503-2003		1	70Ω/260W	1
B503-2005		1	40Ω/390W	1
B503-2007		1	30Ω/520W	1
B503-2010		1	20Ω/780W	1
B503-2015		1	13.6Ω/2400W	1
B503-2020		1	10Ω/3000W	1
B503-2025	B5-054	1	8Ω/4000W	1
B503-2030		1	6.8Ω/4800W	1
B503-2040		1	5Ω/6000W	1
B503-2050		1	4Ω/9600W	1
B503-2060		1	3.4Ω/9600W	1
3AC 380V ±15%				
B503-4001	Built-in	1	750Ω/80W	1
B503-4002			400Ω/260W	1
B503-4003			250Ω/260W	1
B503-4005G/4007P			150Ω/390W	1
B503-4007G/4010P			100Ω/520W	1
B503-4010G/4015P			75Ω/780W	1
B503-4015G/4020P			50Ω/1040W	1
B503-4020G/4025P			40Ω/1560W	1
B503-4025G/4030P	B5-054	1	32/4800W	1
B503-4030G/4040P			27.2/4800W	1
B503-4040G/4050P			20/6000W	1
B503-4050G/4060P			16/9600W	1
B503-4060G/4075P			13.6/9600W	1
B503-4075G/4100P	B5-064	1	10/12000W	1
B503-4100G/4120P		1	6.8/12000W	1
B503-4120G/4150P		1	6.8/12000W	1
B503-4150G/4180P		1	6/20000W	1
B503-4180G/4215P		1	6/20000W	1
B503-4215G/4270P		2	5/25000W	2

Model No.	Braking unit		Braking resistor (100% braking torque)	
	Order No.	Quantity	Specification	Quantity
B503-4270G/4300P		3	4/30000W	3
B503-4300G/4340P		3	4/30000W	3
B503-4340G/4380P		3	4/30000W	3
B503-4380G/4430P		4	3/40000W	4
B503-4430G/4470P		5	3/30000W	5
B503-4470		5	2/40000W	5
B503-4540		6	2/40000W	6
B503-4680		6	2/40000W	6
B503-4760		7	2/40000W	7

Notice:

1. Above selection is based on following condition: 700V DC braking voltage threshold, 100% braking torque and 10% usage rate.
2. Parallel connection of braking unit is helpful to improve braking capability.
3. Wire between controller and braking unit should be less than 5m.
4. Wire between braking unit and braking resistor should be less than 10m.
5. Braking unit can be used for braking continuously for 5 minutes. When braking unit is working, temperature of cabinet will be high, user is not allowed to touch to prevent from injure.

For more details, please refer to DBU and RBU user manual.

11 COMMUNICATION PROTOCOL

11.1 Interfaces

RS485: asynchronous, half-duplex.

Default: 8-E-1, 19200bps. See Group PC parameter settings.

11.2 Communication Modes

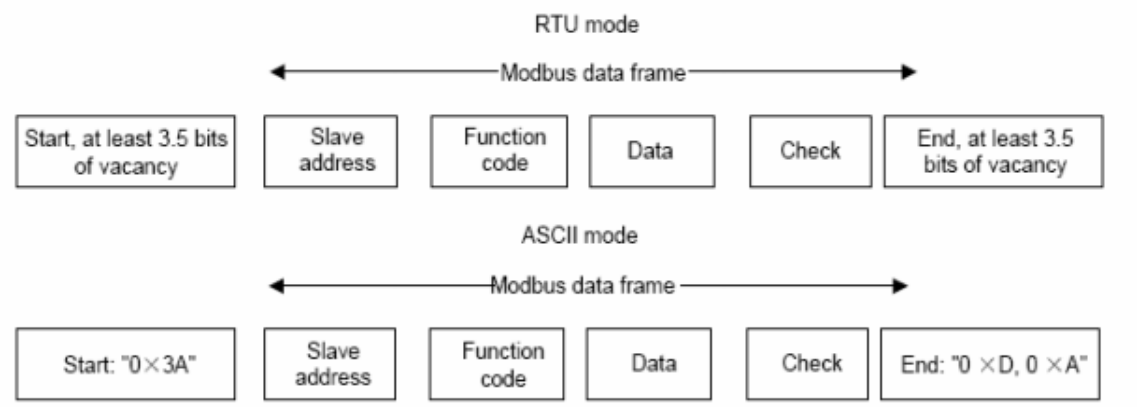
11.2.1 the protocol is Modbus protocol. Besides the common register Read/Write operation, it is supplemented with commands of parameters management.

11.2.2 The drive is a slave in the network. It communicates in 'point to point' master-salve mode. It will not respond to the command sent by the master via broadcast address.

11.2.3 In the case of multi-drive communication or long-distance transmission, connecting a 100~120Ω resistor in parallel with the master signal line will help to enhance the immunity to interference.

11.3 Protocol Format

Modbus protocol supports both RTU and ASCII mode. The frame format is illustrated as follows:



Modbus adopts “Big Endian” representation for data frame. This means that when a numerical quantity larger than a byte is transmitted, the most significant byte is sent first.

RTU mode

In RTU mode, the Modbus minimum idle time between frames should be no less than 3.5 bytes. The checksum adopts CRC-16 method. All data except checksum itself sent will be counted into the calculation. Please refer to section: CRC Check for more information. Note that at least 3.5 bytes of Modbus idle time should be kept and the start and end idle time need not be summed up to it.

The table below shows the data frame of reading parameter 002 from slave node address 1.

Node addr.	Command	Data addr.		Read No.		CRC	
0x01	0x03	0x00	0x02	0x00	0x01	0x25	0xCA

The table below shows the reply frame from slave node address 1.

Node addr.	Command	Bytes No.	Data		CRC	
0x01	0x03	0x02	0x00	0x00	0xB8	0x44

ASCII mode

In ASCII mode, the frame head is “0x3A”, and default frame tail is “0x0D” or “0x0A”. The frame tail can also be configured by users. Except frame head and tail, other bytes will be sent as two ASCII characters, first sending higher nibble and then lower nibble. The data have 7/8 bits. “A”~ “F”corresponds to the ASRCII code of respective capital letter. LRC check is used. LRC is calculated by adding all the successive bytes of the message except the head and tail, discarding any carriers, and then two’s complementing the result.

Example of Modbus data frame in ASCII mode:

The command frame of writing 0x0003 into address “0x1000” of slave node address 1 is shown in the table below:

LRC checksum= the complement of(01+06+10+00+0x00+0x03)=0xE5

	Frame head	Node addr.		Command		Data addr.			
Code		0	1	0	6	1	0	0	0
ASCLL	3A	30	31	30	36	31	30	30	30
Data to write				LRC		Frame tail			
0	0	0	3	E	5	CR		LF	
30	30	30	33	45	35	0D		0A	

11.4 Protocol function

Different respond delay can be set through drive's parameters to adapt to different needs. For RTU mode, the respond delay should be no less than 3.5 bytes interval, and for ASCII mode, no less than 1ms.

The main function of Modbus is to read and write parameters. The Modbus protocol supports the following commands:

0x03	Read controller's function parameter and status parameters
0x06	Write single function parameter or command parameter to controller

All drive's function parameters, control and status parameters are mapped to Modbus R/W data address.

The data address of control and status parameters please refer to the following table.

Parameter Description	Address	Meaning of value	R/W Feature
Control command	1000H	0001H：Forward	W/R
		0002H：Reverse	
		0003H：JOG forward	
		0004H：JOG reverse	
		0005H：Stop	
		0006H：Coast to stop	
		0007H：Reset fault	
		0008H：JOG stop	
Controller status	1001H	0001H：Forward running	R
		0002H：Reverse running	
		0003H：Standby	
		0004H：Fault	
Communication setting	2000H	Communication Setting Range (-10000~10000) Note: the communication setting is the percentage of the relative value (-100.00%~100.00%). If it is set as frequency source, the value is the percentage of the maximum frequency (F0.04). If it is set as PID (preset value or feedback value), the value is the percentage of the PID.	W/R

Parameter Description	Address	Meaning of value	R/W Feature
Status parameters	3000H	Output frequency	R
	3001H	Reference frequency	R
	3002H	DC Bus voltage	R
	3003H	Output voltage	R
	3004H	Output current	R
	3005H	Rotation speed	R
	3006H	Output power	R
	3007H	Output torque	R
	3008H	PID preset value	R
	3009H	PID feedback value	R
	300AH	Input terminal status	R
	300BH	Output terminal status.	R
	300CH	Input of AI1	R
	300DH	Input of AI2	R
	300EH	Reserved	R
	300FH	Reserved	R
	3010H	HDI frequency	R
	3011H	Reserved	R
	3012H	Step No. of PLC or multi-step	R
	3013H	Length value	R
	3014H	External counter input	R
	3015H	Reserved	R
	3016H	Device code	R
Fault info address	5000H	This address stores the fault type of controller. The meaning of each value is same as F7.15.	R
Modbus communication fault info address	5001H	0000H：No fault 0001H：Wrong password 0002H：Command code error 0003H：CRC error 0004H：Invalid address 0005H：Invalid data 0006H：Parameter change invalid 0007H：System locked 0008H: Busy (EEPROM is storing)	R

The above shows the format of the frame. Now we will introduce the Modbus command and data structure in details, which is called protocol data unit for simplicity. Also MSB stands for the most significant byte and LSB stands for the least significant byte for the same reason. The description below is data format in RTU mode. The length of data unit in ASCII

mode should be doubled.

Protocol data unit format of reading parameters:

Request format:

Protocol data unit	Data length(bytes)	Range
Command	1	0x03
Data Address	2	0~0xFFFF
Read number	2	0x0001~0x0010

Reply format (success):

Protocol data unit	Data length(bytes)	Range
Command	1	0x03
Returned byte number	2	2*Read number
Content	2*Read number	

If the operation fails, the controller will reply a message formed by failure command and error code. The failure command is (Command+0x80). The error code indicates the reason of the error; see the table below.

Value	Name	Mean
01H	Illegal command	The command from master can not be executed. The reason maybe: 1. This command is only for new version and this version can not realize. 2. Slave is in fault status and can not execute it.
02H	Illegal data address	Some of the operation addresses are invalid or not allowed to access.
03H	Illegal value	When there are invalid data in the message framed received by slave. Note: This error code does not indicate the data value to write exceed the range, but indicate the message frame is an illegal frame.
06H	Slave busy	Controller is busy (EEPROM is storing)
10H	Password error	The password written to the password check address is not same as the password set by F7.00.
11H	Check error	The CRC(RTU mode) or LRC (ASCII mode) check not passed.
12H	Written not allowed	It only happen in write command, the reason maybe: 1. The data to write exceed the range of according parameter 2. The parameter should not be modified now 3. The terminal has already been used.
13H	System locked	When password protection take effect and user does not unlock it, write/read the function parameter will return this error.

Protocol data unit format of writing single parameter:

Request format:

Protocol data unit	Data length(bytes)	Range
Command	1	0x06
Data Address	2	0~0xFFFF
Write Content	2	0~0xFFFF

Reply format (success):

Protocol data unit	Data length(bytes)	Range
Command	1	0x06
Data Address	2	0~0xFFFF
Write Content	2	0~0xFFFF

If the operation fails, the controller will reply a message formed by failure command and error code. The failure command is(Command+0x80). The error code indicates the reason of the error; see table 1.

11.5 Note

11.5.1 Between frames, the span should not less than 3.5 bytes interval, otherwise, the message will be discarded.

11.5.2 Be cautious to modify the parameters of PC group through communication, otherwise may cause the communication interrupted.

11.5.3 In the same frame, if the span between two. Near bytes more than 1.5 bytes interval, the behind bytes will be assumed as the start of next message so that communication will failure.

11.6 CRC Check

For higher speed, CRC-16 uses tables. The following are C language source code for CRC-16.

```
Unsigned int crc-cal=value(unsigned char*data-value, unsigned char data-length)
{
    int i;
    unsigned int crc_value=0xffff;
    while(data_length--)
        {
            crc_value^=*data_value++;
            for(i=0;i<8;i++)
            {
            if(crc_value&0x0001)crc_value=(crc_value>>1)^0xa001;
            else crc_value=crc_value>>1;
              }
        }
     return(crc_value);
    }
```

11.7 Example

11.7.1 RTU mode, read 2 data from 0004H

The request command is:

START	T1-T2-T3-T4(transmission time of 3.5 bytes)
Node address	01H
Command	03H
High byte of start address	00H
Low byte of start address	04H
High byte of data number	00H
Low byte of data number	02H
Low byte of CRC	85H
High byte of CRC	CAH
END	T1-T2-T3-T4（transmission time of 3.5 bytes）

The reply is:

START	T1-T2-T3-T4(transmission time of 3.5 bytes)
Node address	01H
Command	03H
Returned byte number	04H
Higher byte of 0004H	00H
Low byte of 0004H	00H
High byte of 0005H	00H
Low byte of 0005H	00H
Low byte of CRC	43H
High byte of CRC	07H
END	T1-T2-T3-T4（transmission time of 3.5 bytes）

11.7.2 ASCII mode, read 2 data from 0004H:

The request command is:

START	‘:’
Node address	‘0’
	‘1’
Command	‘0’
	‘3’
High byte of start address	‘0’
	‘0’
Low byte of start address	‘0’
	‘4’
High byte of data number	‘0’
	‘0’
Low byte of data number	‘0’
	‘2’
LRC CHK Hi	‘F’
LRC CHK Lo	‘6’

END Lo	CR
END Hi	LF

The reply is

START	‘:’
Node address	‘0’
	‘1’
Command	‘0’
	‘3’
Returned byte number	‘0’
	‘4’
Higher byte of 0004H	‘0’
	‘0’
Low byte of 0004H	‘0’
	‘0’
High byte of 0005H	‘0’
	‘0’
Low byte of 0005H	‘0’
	‘0’
LRC CHK Lo	‘F’
LRC CHK Hi	‘8’
END Lo	CR
END Hi	LF

11.7.3 RTU mode, write 5000(1388H) into address 0008H, slave node address 02

The request command is:

START	T1-T2-T3-T4(transmission time of 3.5 bytes)
Node address	02H
Command	06H
Higher byte of data address	00H
Lower byte of data address	08H
Higher byte of write content	13H
Lower byte of write content	88H
Lower byte of CRC	05H
Higher byte of CRC	6DH
END	T1-T2-T3-T4（transmission time of 3.5 bytes）

The reply command is:

START	T1-T2-T3-T4(transmission time of 3.5 bytes)
Node address	02H
Command	06H
Higher byte of data address	00H
Lower byte of data address	08H
Higher byte of write content	13H

Lower byte of write content	88H
Lower byte of CRC	05H
Higher byte of CRC	6DH
END	T1-T2-T3-T4（transmission time of 3.5 bytes）

11.7.4 ASCII mode, write 5000(1388H) into address 0008H, slave node address 02

The request command is:

START	‘:’
Node address	‘0’
	‘2’
Command	‘0’
	‘6’
Higher byte of data address	‘0’
	‘0’
Lower byte of data address	‘0’
	‘8’
Higher byte of write content	‘1’
	‘3’
Lower byte of write content	‘8’
	‘8’
LRC CHK Hi	‘5’
LRC CHK Lo	‘5’
END Lo	CR
END Hi	LF

The reply command is:

START	‘:’
Node address	‘0’
	‘2’
Command	‘0’
	‘6’
Higher byte of data address	‘0’
	‘0’
Lower byte of data address	‘0’
	‘8’
Higher byte of write content	‘1’
	‘3’
Lower byte of write content	‘8’
	‘8’
LRC CHK Hi	‘5’
LRC CHK Lo	‘5’
END Lo	CR
END Hi	LF

Agent：