Kinco 步科

FD5P AC servo drive

User manual

Product Confirmation

Thank you for using Kinco FD5P series of servo products.

FD5P series AC servo is an economical product launched by Kinco for the general servo market, with a power range between 50W to 7.5 KW. The new generation servo products support CANopen, EtherCat, Modbus, Profinet and other communication protocols. The servo products can be widely used in logistics, 3C electronics, printing and packaging, textile machinery, woodworking machinery, lithium batteries and new energy automobile industry.

Please read the manual carefully and follow the operating instructions, it can help you set up the drive correctly and make the drive perform optimally.

The accessories of different models of Kinco FD5P series drives are different. We recommend that you confirm the product carefully before use.

Confirmation

- Please confirm whether the product is damaged during transportation
- Please confirm the motor model, drive model, and motor wiring model are consistent with the model you ordered according to the nameplate information on the drive and motor.
- Please confirm whether the terminal accessories of the drive is complete, and the motor oil seal and keys are complete.

If there is any problem with any of the above, please contact Kinco or your supplier to solve it.

Parts list

Model	Accessories and quantity
FD415P-□A-000 FD425P-□A/□F-000	Main power terminal (including auxiliary wiring tools)*1, D-sub36P plug*1, certificate*1, service guide*1, desiccant*1
FD435P-□A-000 FD445P-□A-000 FD615P-□A-000 FD625P-□A-000	Main power terminal 9P(including short wiring and auxiliary wiring tools)*1, power output terminal 4P*1, Dsub36P plug *1, certificate *1, service guide *1, desiccant *1
FD635P-□A-000 FD645P-□A-000	Short splice (factory assembly to main loop terminal)*1, Dsub36P plug *1, certificate *1, service Guide *1, desiccant *1

Safety attentions

Danger

Wrong operation could lead death or serious injury.

Warning

Risk of minor injury or serious property damage.

Note

Information marked for attention helps ensure proper product operation.

Remind

Suggestion, reminding, or reference linking

Security Claims

- **Operating qualifications**

This product must be operated by trained professionals. In addition, the operator must go through professional skills training, familiar with the installation, wiring, operation and maintenance of the equipment, and correctly respond to various emergency situations in use.

- **Unpacking and Acceptance**

Note

- Before unpacking, first check whether the appearance of the package is normal and intact, without obvious scratches, extrusion deformation, damage, or be affected with damp. For safety reasons, do not use products with damaged packaging or parts.
- Please verify that the model number and quantity match the order information as per the order list inside the box and the nameplate information on the product.
- Please confirm whether all terminal accessories are complete and there are no defects or rust on the surface of the product.

- **Storage and Transportation**

Warning

- When handling, please handle with care. Do not stack the products too high to prevent product damage and personal injury caused by product fall.
- If the drive is not used for a long time, it should be confirmed whether there is water or dew inside the product before use, otherwise there is the risk of burning the drive. Please carry out closer protection and necessary inspection.
- If the driver is placed in a low temperature environment for a long time, place it at a temperature higher than 0 ℃ for a period of time before use to avoid damage to the driver.
- Please store the product in accordance with the specifications and avoid shock and vibration of the driver during transportation and storage, otherwise it will cause the risk of product damage.

Remind

- If the drive is not intended to be used for a long time, it is recommended that the drive be powered on every few months to prevent damage to internal components due to moisture. At the same time, the drive should be more tightly protected storage and pre-use inspection.
- When the product needs to be transported over long distances, it is necessary to pack the product into a closed box before it can be transported.

- **Installation and operation**

Warning

- Install in a place that can support the weight of the drive, otherwise there is a risk of injury or damage to property when dropped.
- Ensure that the driver is securely installed and screws are tightened. Pay attention to sharp edges and corners of the driver to avoid injuries or cuts caused by falling.
- The product should be installed in a place that is not easy to burn, to prevent the invasion of dust, corrosive gases, conductive objects, liquids and flammable substances, and to maintain good heat dissipation conditions;
- Ensure that all protective measures are activated before powering on the product.
- Do not touch the shell, brake resistance and other parts to test the temperature during the operation of the product, otherwise there is the risk of burning.
- In the application of dust, metal debris, oil pollution serious, should use a good sealing equipment electrical cabinet.
- The static electricity on the human body may seriously damage the sensitive components inside. Before performing related operations, observe the measures and methods specified in ESD. Otherwise, the drive may be damaged.
- It is forbidden to modify the drive without permission. If the drive is damaged due to private modification, the Department will not be responsible for it!

Danger

- If the surface of the product is damaged or the parts are incomplete, do not install and operate, otherwise there is a risk of fire and injury.
- Foreign objects such as screws, metal gaskets, and metal rods falling into the drive pose a fire hazard and property damage.
- Wiring operations must be carried out by qualified personnel, otherwise there is a risk of electric shock.
- Ensure the input power is completely disconnected before wiring ,otherwise, electric shock may occur.
- The ground terminal of the driver must be grounded reliably; otherwise, electric shock may occur.
- This product controls a potentially dangerous movement. Failure to comply with the regulations or perform operations in accordance with the requirements of this manual may result in personal injury, injury, and damage to the product and associated systems.
- Before powering on the device, ensure that the power supply meets requirements. Otherwise, the device may be damaged or a fire may occur.

- When energized, do not touch the product and terminal, do not disassemble the parts of the product, otherwise there is the risk of electric shock.
- Maintenance operations should be performed 10 minutes after the power is disconnected; otherwise, there is a risk of electric shock.
- Only professional personnel can replace the parts, it is strictly prohibited to leave the wire or metal in the machine, otherwise there is the risk of fire.

Remind

- Please use the cables specified by our company whenever possible when wiring. If the cable is not specified by the kinco, please purchase the specified wiring material or equivalent after confirming the rated current or use environment of the model used.
- Do not lay or bind encoder cables and signal cables in the same casing. Too close a distance will cause signal interference and cause motor misoperation.

Manual version revision records

Chapter	Date	Edition Detail
All Chapter	2023-10-23	First edition
Chapter 3	2023-12-15	Section 3.6 Power line phase sequence modification
Chapter 10	2024-4-15	Correct the description of parameter meanings in section 10.2.2
Chapter 3~Chapter10	2024-5-14	Modified the TTL signal voltage range in section 3.4 Correct the irregular numbering of tables and pictures in Chapters 5 to 10
6.8.2、Table 9-2、10.2.1、10.3.1 AppendixII	2024-6-7	Correct manual errors
All Chapter	2025-6-13	Improve and optimize the content

Content

Product Confirmation 1
Confirmation 1
Parts list 1
Safety attentions 1
Manual version revision records 5

Chapter 1 System configuration and product description 1

1.1 Naming rule and nameplate description 1
1.1.1 Drive naming rule 1
1.1.2 Drive nameplate description 1
1.1.3 Motor model description 2
1.1.4 Motor nameplate description 2
1.1.5 Cable naming rule 3
1.2 Product parameters 5
1.2.1 Drive electrical parameter 5
1.2.2 Motor specification parameter description 7
1.3 TN curve 9

Chapter 2 System Installation requirements and announcement 11

2.1 Servo drive use requirements 11
2.1.1 Transport and storage conditions 11
2.1.2 Technical requirements 11
2.1.3 Operator requirements 11
2.2 Servo drive mounting dimensions 12
2.2.1 Mechanical dimension 12
2.2.2 Driver installation spacing 15
2.3 Servo motor installation 17
2.3.1 Installation requirements 17
2.3.2 Precaution 17
2.3.3 Motor mechanical dimension 19
2.3.4 Motor connector pin definition 21

Chapter 3 System interface and wiring 22

3.1 FD5P system interface and wiring 22
3.1.1 Part name 22

3.1.2 External wiring diagram *24*

3.1.3 Drive Interface terminal Description *26*

3.2 External installation instruction 33

3.3 EMC configuration description 35

3.3.1 Servo overload protection feature *38*

3.3.2 DC BUS *39*

Chapter 4 Digital panel operation 41

4.1Panel operation 41

4.2 Panel operation instruction 42

4.3 Easy Use Function 42

4.3.1 Easy use operation step *42*

4.3.2 EASY operation flowchart *44*

4.3.3 tunE operation flow chart *47*

4.3.4 Reasons for the failure of tunning *49*

4.3.5 Tuning case *50*

4.4 Jog mode（Test run） 51

4.5 Error history（F007） 51

Chapter 5 KincoServo + user guide 52

5.1 Getting started 52

5.1.1 Language *52*

5.1.2 Open and saving project files *52*

5.1.3 Starting communication *53*

5.1.4 Node ID and baud rate *53*

5.1.5 Objects (add， delete， help) *53*

5.2 Init save reboot 54

5.3 Firmware update 54

5.4 Read/write controller configuration 55

5.4.1 Read setting from Driver *55*

5.4.2 Write setting to Driver *55*

5.5 Digital IO function 56

5.5.1 Digital input *56*

5.5.2 Digital output *58*

5.5.3 Fast capture *59*

5.6 Scope 59

5.7 Error display and error history 61

Chapter 6 Operation mode introduction 64

6.1 General steps for starting a control mode 64

6.2 Speed mode (-3, 3) 67

6.2.1 DIN Speed mode 68

6.3 Torque mode(4) 69

6.4 Position mode(1) 69

6.4.1 DIN position mode introduction 70

6.4.2 Position table mode 71

6.5 Pulse mode (-4) 74

6.5.1 Pulse mode setting steps 75

6.5.2 Other function 76

6.5.3 Electronic gear ratio switching (expert mode) 77

6.5.4 Master-slave mode 78

6.6 Full closed loop mode 78

6.6.1Full closed loop control operation step 80

6.7 Homing mode(6) 82

6.8 Other functions 89

6.8.1 Limit function 89

6.8.2 Motor brake control 89

6.8.3 Stop Mode Control 91

6.8.4 Multi-tune encoder Setting 92

Chapter 7 Performance regulation 97

7.1 Auto-tuning 97

7.2Auto-tuning test operation method 98

7.2.1 Auto-tuning function related object parameters 98

7.2.2 Digital tube key and PC software self-tuning method 98

7.2.3Problems and adjustments with auto-tuning 98

7.2.4Adjustment after auto-tuning 99

7.3 Online self-tuning 100

7.4 Manual tuning 100

7.4.1Tuning of the velocity loop 100

7.4.2 Position loop tuning method 105

7.5 Gain switch (Pro mode) 107

7.5.1 Gain switching method *108*

7.6 Other factors affecting performance 109

Chapter 8 Alarm elimination 110

Chapter 9 FD5P panel parameter list 115

Chapter 10 Communication 125

10.1 RS232 communication 125

10.1.1 RS232 hardware interface 125

10.1.2 RS232 communication cable 125

10.1.3 RS232 transport protocol 125

10.1.4 RS232 Data protocol 126

10.2 RS485 Communication 129

10.2.1 RS485 hardware wiring 129

10.2.2 RS485 communication parameters 129

10.2.3 MODBUS RTU communication protocol 130

10.2.4 Communication troubleshooting measures 131

10.3 CANopen Bus communication 132

10.3.1 CANopen bus communication hardware description 132

10.3.2 CANopen bus communication software description 133

10.3.3 CANopen Bus communication settings 142

10.3.4 Interpolation mode based on CANopen 143

Appendix I: Braking Resistor Selection 145

Appendix II: List of Common Object Parameters 146

Mode and control（0x6040） 146

Measurement data 147

Target（0x607A） 147

Multi-segment position/multi-segment velocity（0x2020） 148

Performance object（0x6065） 149

Homing control（0x6098） 149

Velocity loop parameters（0x60F9） 150

Position loop parameters（0x60FB） 150

Input/output port parameter（0x2010） 150

Pulse input parameters（0x2508） 153

Parameters for storage（0x2FF0） 153

Error code (0x2601) 154

Stop mode 154

Other parameter 155

Chapter 1 System configuration and product description

1.1 Naming rule and nameplate description

1.1.1 Drive naming rule

FD 4 1 5P – LA- 000

Identification	Series
FD	FD series

Identification	Input voltage
4	AC220V
6	AC380V

Identification	Rated output current	
	AC220V	AC380V
1	3.2A	5.4A
2	4A/5A	12A
3	7.6A	21A
4	12.5A	26A

Identification	Software version
000	Version number

Identification	Control method
EA	RS232,EtherCAT,Have pulse
CA	RS232,CANopen,Have pulse
LA	RS232,RS485,Have pulse
PA	RS232,Profinet,Have pulse

Identification	Drive version
5P	5th generation drive enhancement

Note：FD425P-□F-000 with fan

1.1.2 Drive nameplate description

1.1.3 Motor model description

SMK 60 S – 0040 – 30 M A K – 5 L S A

Identification	Series
SMK	SMK common body series servo motor

Identification	Flange size
60	60X60mm
80	80X80mm
130	130X130mm

Identification	Inertia
S	Small inertia
G	Large inertia

Identification	Rated power
0040	40×10 (W)
0075	75×10 (W)
...	...
0240	240×10 (W)

Identification	Rated speed
15	15×100 (rpm)
30	30×100 (rpm)

Identification	Motor outlet mode
A	Special socket for common motor
R	General aviation socket

Identification	Motor version
S	S version

Identification	Voltage level
L	AC220V
H	AC380V

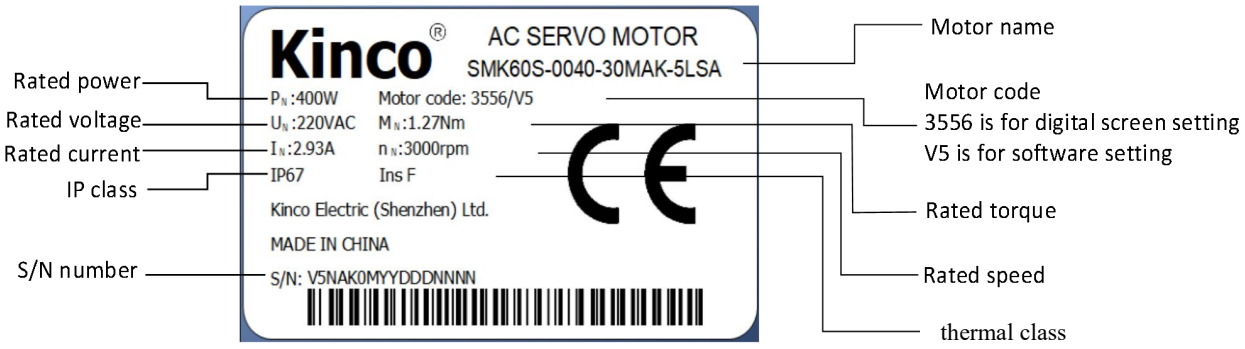
Identification	Pole pairs number
5	5 pole pair

Identification	Outlet type
K	With key

Identification	Brake
A	Without brake
B	With brake

Identification	Encoder type
V	Single turn communication type photoelectric encoder
M	Single turn communication type magnetoelectric encoder
Y	Multi turn communication type photoelectric encoder
Q	Multi turn communication type magnetoelectric encoder

1.1.4 Motor nameplate description



1.1.5 Cable naming rule

1.1.5.1 FD415P/FD425P drive adapter cable naming rule

MOT F - 005 - LL - KA - B

Identification	Cable function type
MOT	Motor power cable

Identification	Cable type
F	F: Flexible cable
	Empty: Common cable

Identification	Rated current
005	005: 5A

Identification	Cable property
B	B: Power cable with brake,highly shielded cable
	NS: Power cable without brake,common cable
	Null: Power cable without brake,highly shielded cable

Identification	Motor outlet type
KA	KA: Pluggable motor connector

Identification	Cable length
LL	03: 3m
	05: 5m
	10: 10m
	15: 15m

ENC D G F - LL - G A- DC

Identification	Cable function type
ENC	Motor encoder cable

Identification	Drive end encoder connector type
D	1394 connector

Identification	Driver connector definition
G	Communication type connector

Identification	Cable type
F	F: Flexible cable
	Empty: Common cable

Identification	Cable accessories
DC	Empty: Without battery box outlet cable
	DC: With battery box outlet cable

Identification	Motor end encoder connector type
A	Pluggable encoder connector

Identification	Core cable type
G	6-core cable

Identification	Cable length
LL	03: 3m
	05: 5m
	10: 10m
	15: 15m

BRA - LL - 2PIN

Identification	Cable function type
BRA	Motor brake extension cable

Identification	Connector type
2Pin	2PIN connector

Identification	Cable length
LL	(5): 0.5m
	01: 1m
	1(5): 1.5m

1.1.5.2 FD435P/FD445P/FD615P/FD625P/FD635P/FD645P drive adapter cable naming rule

M - A - 12A - K R0 - LL - F

Identification	Cable function type
M	Motor power cable

Identification	Drive end connector
A	Needle type cold press terminal

Identification	Current
12A	Rated current 12A

Identification	Motor platform
K	SMK

Identification	Motor end connector
R0	130 military specification

Identification	Cable
F	F: High flexibility cable
	S: Shielded cable
	FS: High flexibility shielded cable
	B: Cable with brake
	BF: High flexibility cable with brake
	BS: Shielded cable with brake
	BFS: High flexibility shielded cable with brake
	Empty: Common cable

Identification	Cable length
LL	3: 3m
	5: 5m
	10: 10m

E - D - QY - K R - LL - F

Identification	Cable function type
E	Motor encoder cable

Identification	Drive end encoder connector type
D	1394 6-core connector

Identification	Encoder type
QY	Multiturn communication encoder

Identification	Motor platform
K	SMK

Identification	Cable accessories
F	Empty: Common cable
	F: High flexibility cable

Identification	Cable length
LL	3: 3m
	5: 5m
	10: 10m

Identification	Motor end connector
R	Military specification plug

BRA - EXT - LL

Identification	Cable function type
BRA	Motor brake extension cable

Identification	Cable length
LL	0.5:0.5m
	3: 3m
	5: 5m

Identification	Drive end connector
EXT	Extension connector inside the cabinet

1.2 Product parameters

1.2.1 Drive electrical parameter

Model		FD415P	FD425P	FD425P-F (With fan)	FD435P	FD445P	FD615P	FD625P	FD635P	FD645P
Power（KW）		0.4	0.75	1	1.5	2	1.5	3	5.5	7.5
Power supply	Power Supply	1PH 200-240VAC±10% 50/60Hz±3HZ			1PH/3PH 200V-240VAC±10% 50/60Hz±3Hz		3PH 380V-415VAC±10% 50/60Hz±3Hz			
	Logic power supply	Null			1PH 200V-240VAC±10% 50/60Hz±3Hz		1PH 380V-415VAC±10% 50/60Hz±3Hz			
Current	Max continuous output current (rms)	3.2	4	5	7.6	12.5	5.4	12	21	26
	Peak current (PEAK)	15Ap	18Ap	18Ap	32.5Ap	54Ap	23Ap	45.5Ap	75Ap	92Ap
Feedback signal		Communication type encoder								
Energy consumption brake		No built-in brake resistance, limited power 20W			Built-in brake resistance / Limited power FD435P: 50Ω 60W FD445P: 50Ω 80W FD615P: 100Ω 60W FD625P: 50Ω 80W FD635P/FD645P: 25Ω 100W					
		Note: the actual power more than limit power, need external brake resistor (according to operation, mainly used in the rapid start /stop occasion)								
Energy consumption braking voltage absorption point		DC380V±5V					DC680V±5V			
Overvoltage alarm voltage		DC400V±5V					DC710V±5V			
Undervoltage alarm voltage		DC200V±5V					DC400V±5V			
Cooling method		Natural cooling		Forced air cooling						
Weight（Kg）		0.881	1.5	1.5	1.4	2.1	1.4	2.1	4	4
Encoder signal output function		Output 5V motor A, B, Z signals, frequency division output range 0 ~ 65536; used for multi-axis synchronization, maximum output frequency 5MHz								
Protection function		Over-voltage protection, under-voltage protection, motor overheating (I2T) protection, short-circuit protection, drive overheating protection, etc.								
RS232		RS232 (connection with PC: RS-232 serial port to Mini_USB)								
RS485		Maximum support 115.2KHz baud rate, can use Modbus RTU protocol to communicate with the controller								
CANopen		Maximum support 1MHz baud rate, can use CANopen protocol to communicate with the controller								
Ethercat		Support CoE (CiA402 protocol) and CSP/CSV/PP/PV/PT/HM mode, communication rate 100M								
Profinet		Support message 1, message 3, and message 111, process object, aperiodic data read and write								
Location control mode	Command control mode	External pulse input control Control of 8-segment position using DIN signal Communication setting internal object parameter control								
	Command smoothing mode	Low-pass filtering (set by internal parameters), S-curve smoothing filtering (set by internal parameters in 1 mode)								
	Pulse command mode	Pulse+direction, CCW+CW, A-phase+B-phase								
	Maximum input pulse frequency	Differential transmission mode: up to 4MHz, open collector transmission mode: 500KHz								
	Electronic gear ratios	Setting range Gear factor：-32768～32767，Gear divider：1～32767， 1/50≤|Gear factor/Gear divider|≤50								
	Torque limit	Internal parameter setting								
	Feedforward gain	0~100.0%（Internal parameter setting）								
	Position loop sampling frequency	4KHz								
Speed control mode	Command control mode	8-segment speed control using DIN signals Communication settings internal object parameter control								
	Command smoothing mode	Low-pass filtering（Internal parameter setting）								
	Speed limit	Internal parameter setting								

	Torque limit	Internal parameter setting
	Speed loop sampling frequency	8KHz
Torque control mode	Command control mode	Communication setting internal object parameter control
	Command smoothing mode	Low-pass filtering（Internal parameter setting）
	Speed limit	Internal parameter setting
	Current loop sampling frequency	16KHz
Digital Input	Input specification	7 digital inputs, through the connection of COM1 terminal, it can be valid at high level (12.5~30V) or valid at low level (0~5V).
	Input function	The following functions can be defined according to your needs: drive enable, drive error reset, drive working mode control, speed loop proportional control, positive limit, negative limit, origin signal, command reverse, internal speed segment control, internal position segment control, emergency stop, pause, start to find the origin, command activation, wheel ratio switching, gain switching, position table function, clear pulse function, etc
Digital Output	Output specification	5-channel digital output, maximum voltage DC30V, OUT1 and OUT2 differential output, maximum output current 100mA, OUT3~OUT5 single-ended output, maximum output current 20mA, control motor OUT2 brake output through relay.
	Output function	The following functions can be defined according to your needs:drive ready, drive error, motor position arrives, motor zero speed, motor holding brake, motor speed arrives, index Z signal appears, speed reaches limit, torque reaches setting, motor lock Axis, motor limit, origin found, multi-segment position, etc.
Operation Environment	Operation temperature	0～40℃
	Storage temperature	-10℃～70℃
	Humidity (no condensation)	5～95%RH
	Protection level	IP20 **Note: Exculding terminals(IP00)**
	Installation site	Dust-free, dry, lockable (e.g. electrical cabinets)
	Installation method	Vertical installation
	Installation altitude	The rated working altitude is less than 1000 meters above sea level. When the working altitude is higher than 1000 meters, it is necessary to reduce the rated value by 1.5% for every 100 meters of elevation. The maximum working altitude is 2000 meters above sea level.
	Atmosphere pressure	86kpa～106kpa

Note 1：FD415P, FD425P no PA series

Note 2：The FD5P-PA series drives have only 3 digital output (OUT1,OUT2,OUT3)

1.2.2 Motor specification parameter description

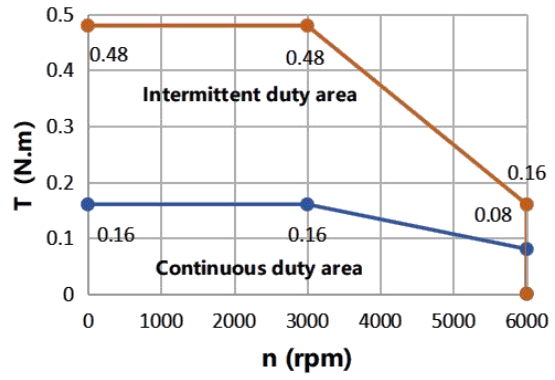
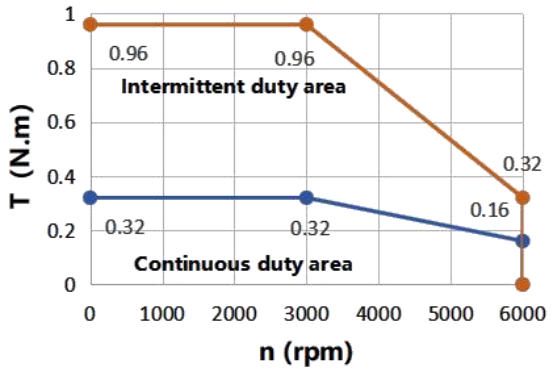
□:Encoder type ; ■:With brake/Without brake

Model		SMK40S-0005-30□■K-5LSA	SMK40S-0010-30□■K-5LSA	SMK60S-0020-30□■K-5LSA	SMK60S-0040-30□■K-5LSA
Rated voltage（VAC）		220	220	220	220
Rated power Pn(W)		50	100	200	400
Rated torque Tn(Nm)		0.16	0.32	0.64	1.27
Rated speed nN(rpm)		3000	3000	3000	3000
Rated current In(A)		0.88	1.2	1.55	2.93
Max torque Tm(Nm)		0.56	1.11	1.92	3.81
Max current Im(A)		3.3	4.4	5	9.4
Max speed（rpm）		6000	6000	6000	6000
Standstill torque Ts(Nm)		0.176	0.352	0.71	1.4
Standstill current Is(A)		0.98	1.32	1.7	3.2
Torque constant Kt(Nm/A)		0.2	0.3	0.5	0.51
Rotary inertia Jm(Kg*cm²)		0.023 (Without brake)	0.044 (Without brake)	0.17 (Without brake)	0.274 (Without brake)
		0.025 (With brake)	0.046 (With brake)	0.174 (With brake)	0.29 (With brake)
Insulation class		F	F	F	F
Protection level		IP67，IP54 at the shaft end	IP67，IP54 at the shaft end	IP67，IP54 at the shaft end	IP67，IP54 at the shaft end
Max radial force Fr(N)		78	78	180	180
Max axial force Fa(N)		54	54	90	90
Weight（Kg）		0.31	0.382	0.85	1.3
		0.5 (With brake)	0.571 (With brake)	1.2 (With brake)	1.65 (With brake)
Brake parameter	Brake holding torque T(Nm)	0.32		2	
	Rated voltage (VDC)	24		24	
	Rated power (W)	6.1		7.6	

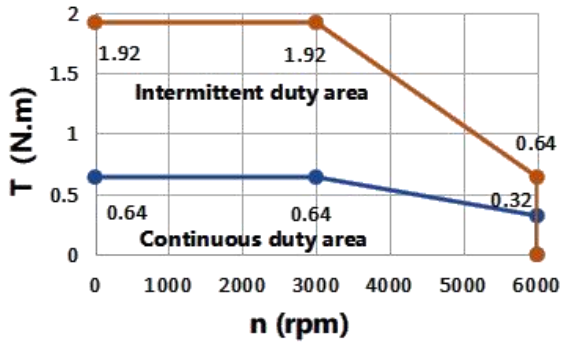
Model		SMK80S-0075-30□■K-5LSA	SMK80S-0100-30□■K-5LSA	SMK130G-0085-15□■K-5LSR	SMK130G-0130-15□■K-5LSR
Rated voltage（VAC）		220	220	220	220
Rated power Pn(W)		750	1000	850	1300
Rated torque Tn(Nm)		2.39	3.18	5.39	8.34
Rated speed nN(rpm)		3000	3000	1500	1500
Rated current In(A)		3.9	5.3	6.6	10.5
Max torque Tm(Nm)		7.17	9.54	16.17	25.02
Max current Im(A)		12.4	16	21.45	34.125
Max speed（rpm）		6000	6000	4500	4500
Standstill torque Ts(Nm)		2.63	3.5	5.929	9.174
Standstill current Is(A)		4.3	5.83	7.26	11.55
Torque constant Kt(Nm/A)		0.7	0.66	0.93	0.89
Rotary inertia Jm(Kg*cm²)		0.9 (Without brake)	1.027 (Without brake)	11.56 (Without brake)	17.17 (Without brake)
		0.95 (With brake)	1.19 (With brake)	12.86 (With brake)	18.47 (With brake)
Insulation class		F	F	F	F
Protection level		IP67，IP54 at the shaft end	IP67，IP54 at the shaft end	IP65，IP54 at the shaft end	IP65，IP54 at the shaft end
Max radial force Fr(N)		335	335	686	686
Max axial force Fa(N)		167.5	167.5	196	196
Weight（Kg）		2	2.3	6.03	7.35
		2.6 (With brake)	2.9 (With brake)	7.38 (With brake)	8.6 (With brake)
Brake parameter	Brake holding torque T(Nm)	3.2		20	
	Rated voltage (VDC)	24		24	
	Rated power (W)	11.5		23	

Model		SMK130G-0085-15□■ K-5HSR	SMK130G-0130-15□■ K-5HSR	SMK130G-0180-15□■ K-5HSR	SMK130G-0240-15□■ K-5HSR
Rated voltage（VAC）		380	380	380	380
Rated power Pn(W)		850	1300	1800	2400
Rated torque Tn(Nm)		5.39	8.34	11.5	15.2
Rated speed nN(rpm)		1500	1500	1500	1500
Rated current In(A)		3.5	5	6.9	9.1
Max torque Tm(Nm)		16.17	25.02	34.5	45.6
Max current Im(A)		11.375	16	22.425	29.575
Max speed（rpm）		4500	4500	4500	4500
Standstill torque Ts(Nm)		5.929	9.174	12.65	16.72
Standstill current Is(A)		3.85	5.5	7.59	10.01
Torque constant Kt(Nm/A)		1.85	1.85	1.85	1.85
Rotary inertia Jm(Kg*cm²)		11.56 (Without brake)	17.17 (Without brake)	22.85 (Without brake)	30.37 (Without brake)
		12.86 (With brake)	18.47 (With brake)	24.15 (With brake)	31.67 (With brake)
Insulation class		F	F	F	F
Protection level		IP65，IP54 at the shaft end	IP65，IP54 at the shaft end	IP65，IP54 at the shaft end	IP65，IP54 at the shaft end
Max radial force Fr(N)		686	686	686	686
Max axial force Fa(N)		196	196	196	196
Weight（Kg）		6.03	7.35	8.7	10.6
		7.38 (With brake)	8.6 (With brake)	9.95 (With brake)	11.85 (With brake)
Brake parameter	Brake holding torque T(Nm)	20			
	Rated voltage (VDC)	24			
	Rated power (W)	23			

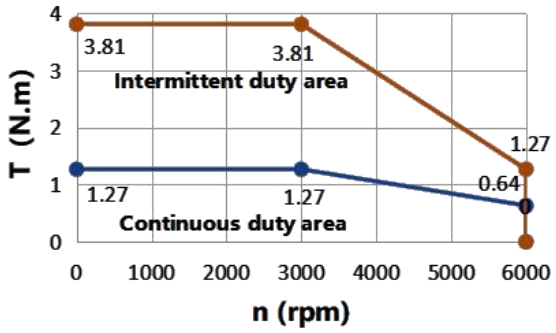
1.3 TN curve

SMK40S-0005-30□■K-5LSA	SMK40S-0010-30□■K-5LSA
	

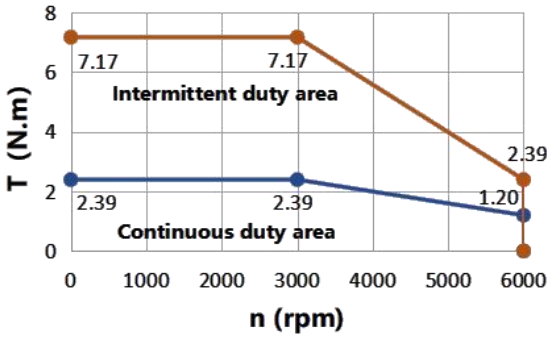
SMK60S-0020-30□■K-5LSA



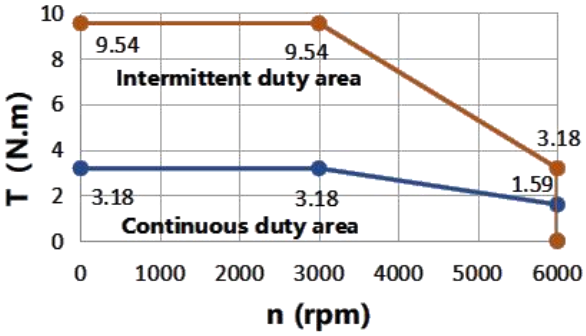
SMK60S-0040-30□■K-5LSA



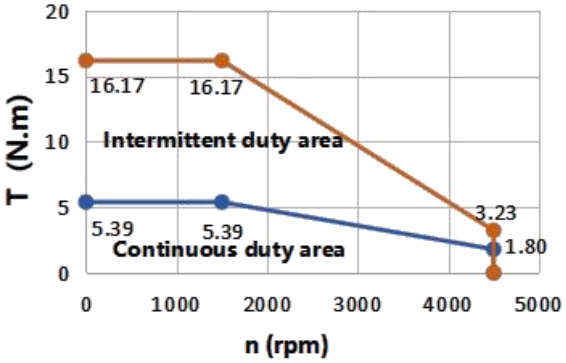
SMK80S-0075-30□■K-5LSA



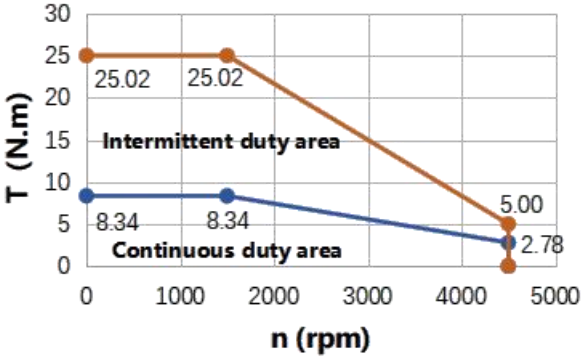
SMK80S-0100-30□■K-5LSA



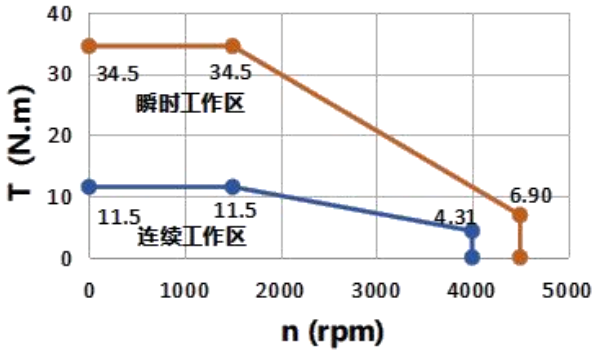
SMK130G-0085-15□■K-5LSR/5HSR



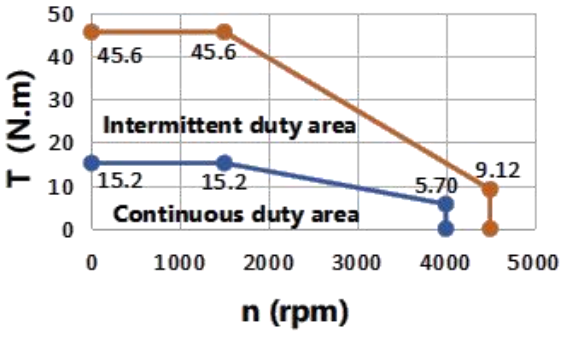
SMK130G-0130-15□■K-5LSR/5HSR



SMK130G-0180-15□■ K-5HSR



SMK130G-0240-15□■ K-5HSR



Chapter 2 System Installation requirements and announcement

2.1 Servo drive use requirements

- Ensure that this document is available to design engineers, installers, and personnel responsible for commissioning machines or systems that use the product.
- Please ensure that you always follow the requirements of this document and also consider the documentation for other components and modules.
- Please consider the legal requirements applicable to your destination and:
  - Regulations and standards
  - Test organization and insurance company regulations
  - National specifications

2.1.1 Transport and storage conditions

- Please ensure that the product is not subjected to more than permitted burdens during transportation and storage, including:
  - Mechanical load
  - The temperature is not allowed
  - Moisture
  - Corrosive gas
- Please store and transport in original packaging, which provides adequate protection against routine problems.

2.1.2 Technical requirements

The general conditions for the correct and safe use of the product must always be observed:

- The connection and environmental conditions specified in the product technical data and the technical requirements of all other connected components. Products are only allowed to operatein accordance with relevant safety procedures if they meet product specifications.
- Follow the instructions and warnings in this document.

2.1.3 Operator requirements

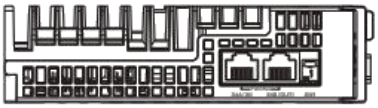
This product should only be operated by an electrical engineer who is familiar with the following provisions:

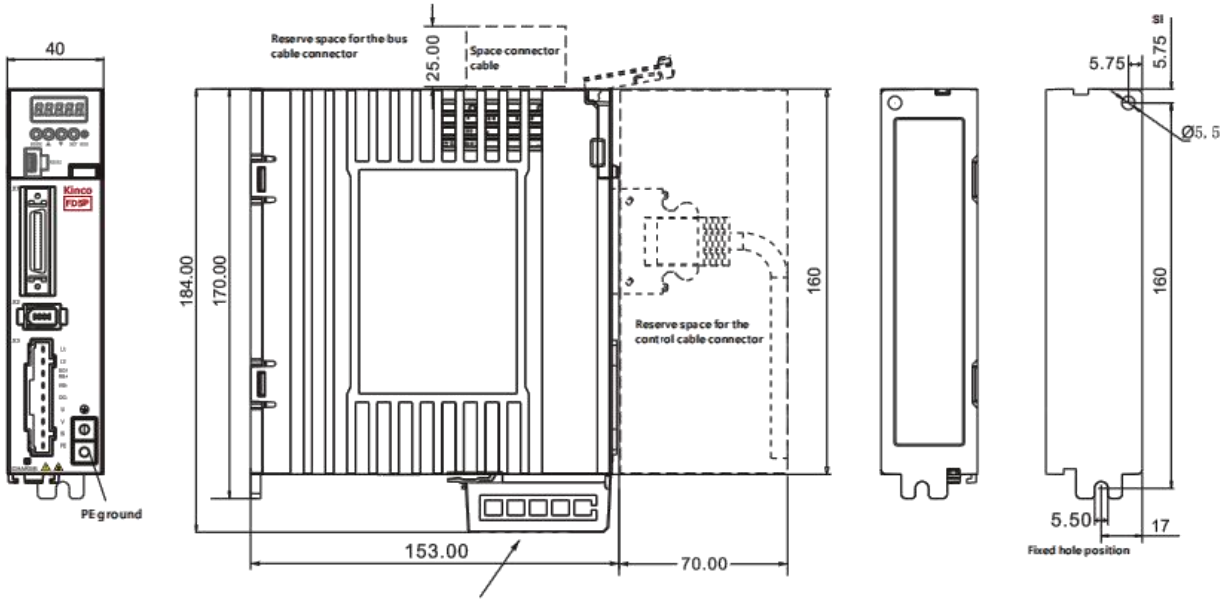
- Installation and operation of electrical control systems
- Applicable regulations for the operation of safe engineering systems
- Applicable provisions for accident protection and occupational safety
- Familiarize yourself with the documentation of the product

2.2 Servo drive mounting dimensions

2.2.1 Mechanical dimension

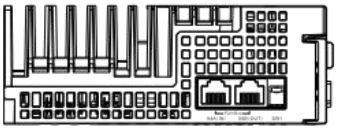
FD415P-□A-000

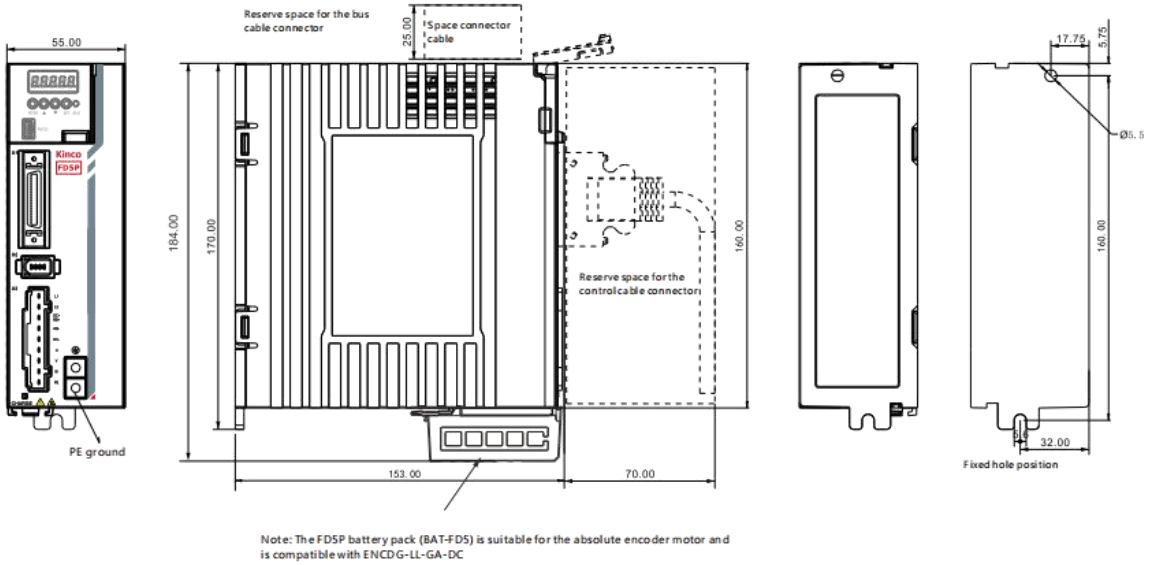




Note: The FD5P battery pack (BAT-FD fault) is suitable for the absolute encoder motor and is compatible with ENCDG-LL-GA-DC

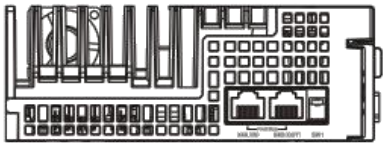
FD425P-□A-000

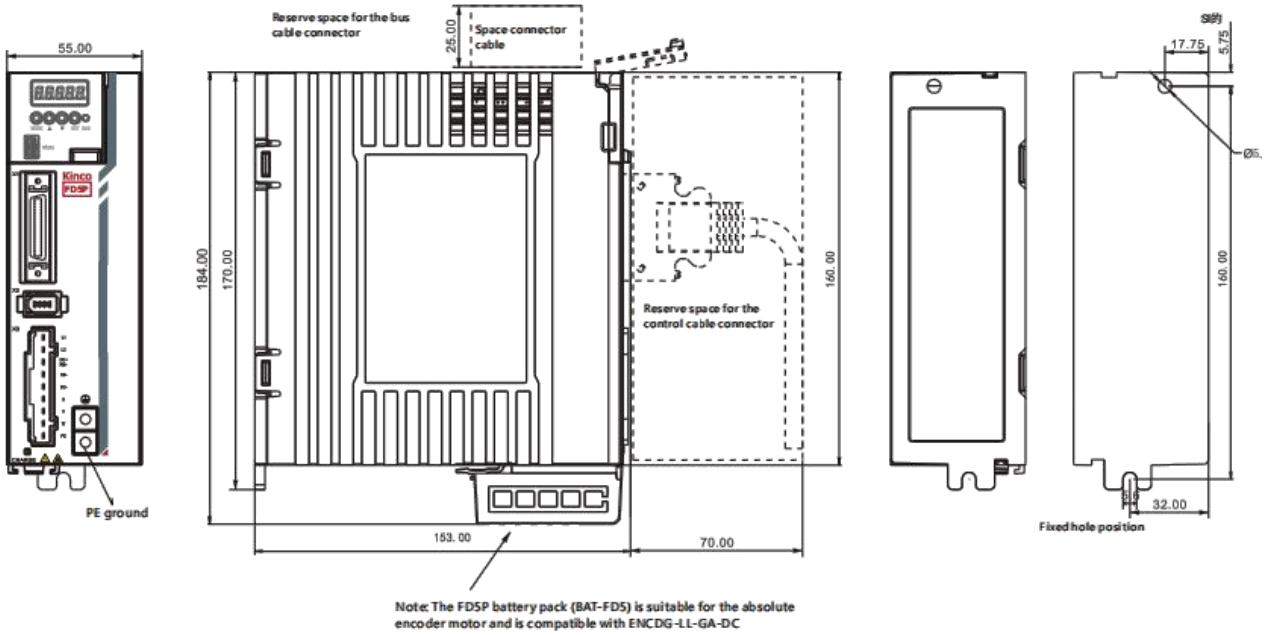




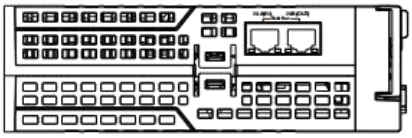
Note: The FD5P battery pack (BAT-FD5) is suitable for the absolute encoder motor and is compatible with ENCDG-LL-GA-DC

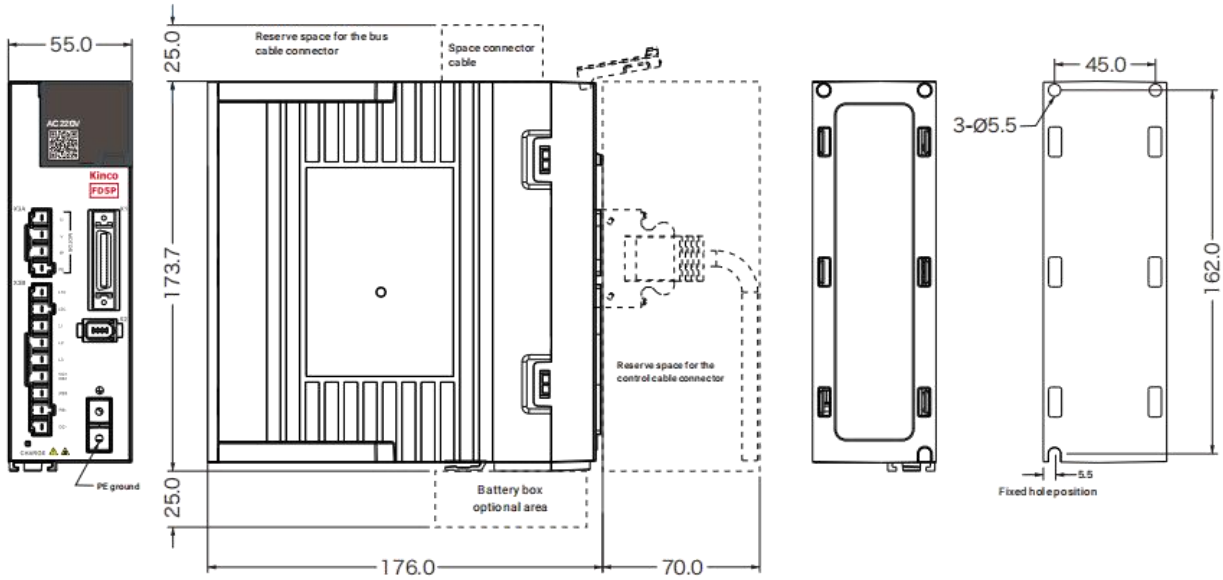
FD425P-□F-000



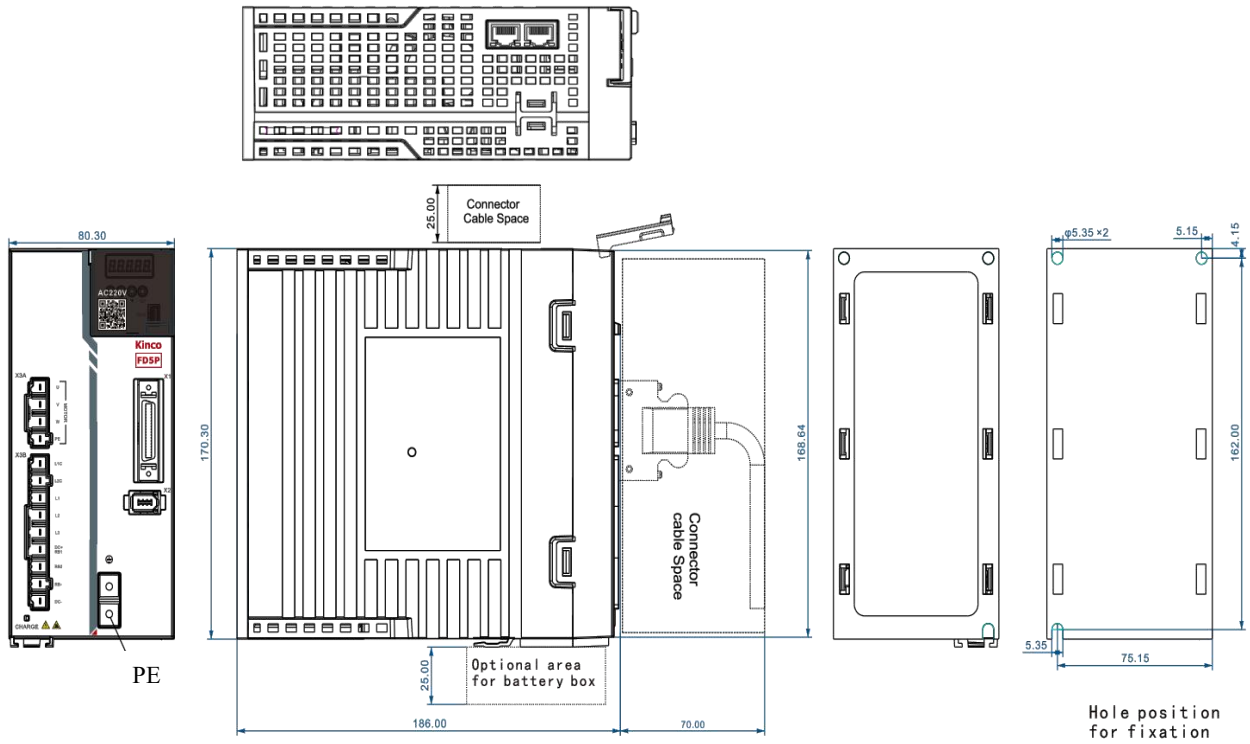


FD435P/FD615P-□A-000

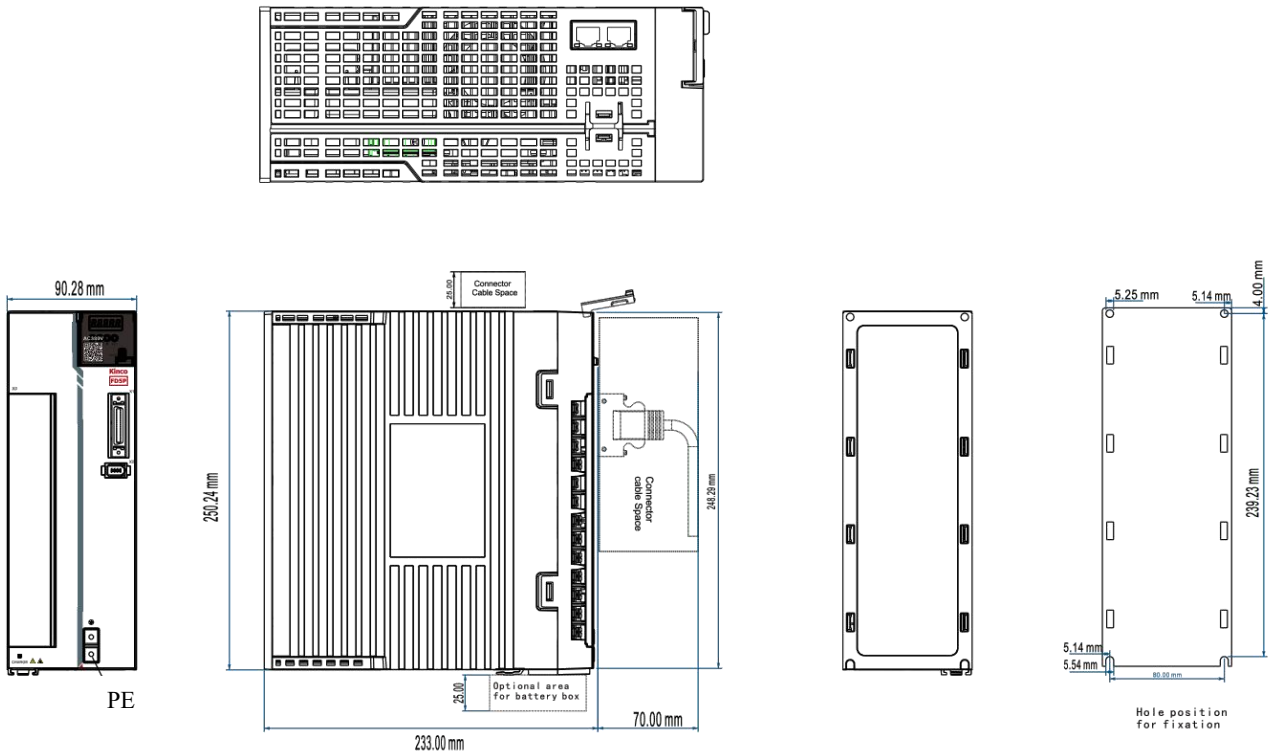




FD445P/FD625P-□A-000



FD635P/FD645P-□A-000



2.2.2 Driver installation spacing

Please install the servo drive vertically and drill holes according to the Hole Position for Fixation， There should be an installation gap of more than 20mm between two drives. There should be a gap of more than 20mm between the first and last two drives and the wall or cabinet.

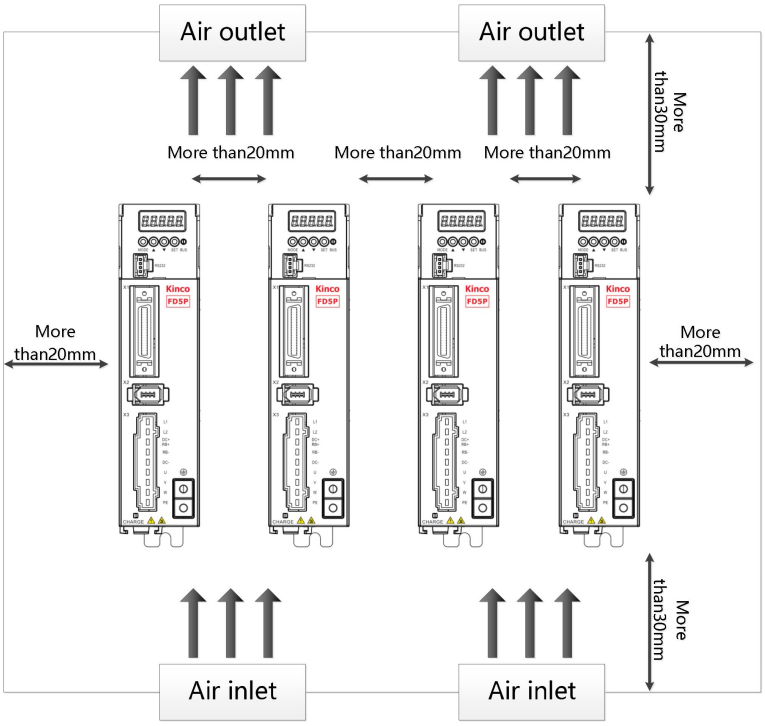


Figure 2-1 FD415P Installation direction and requirement

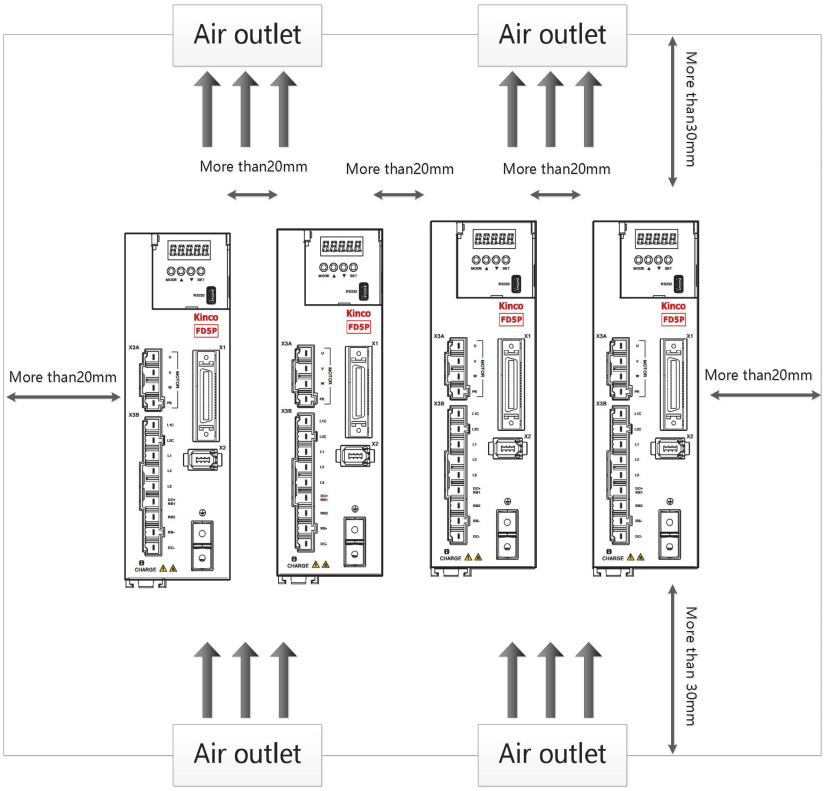


Figure 2-2 FD435P/FD445P/FD615P/FD625P installation direction and requirement

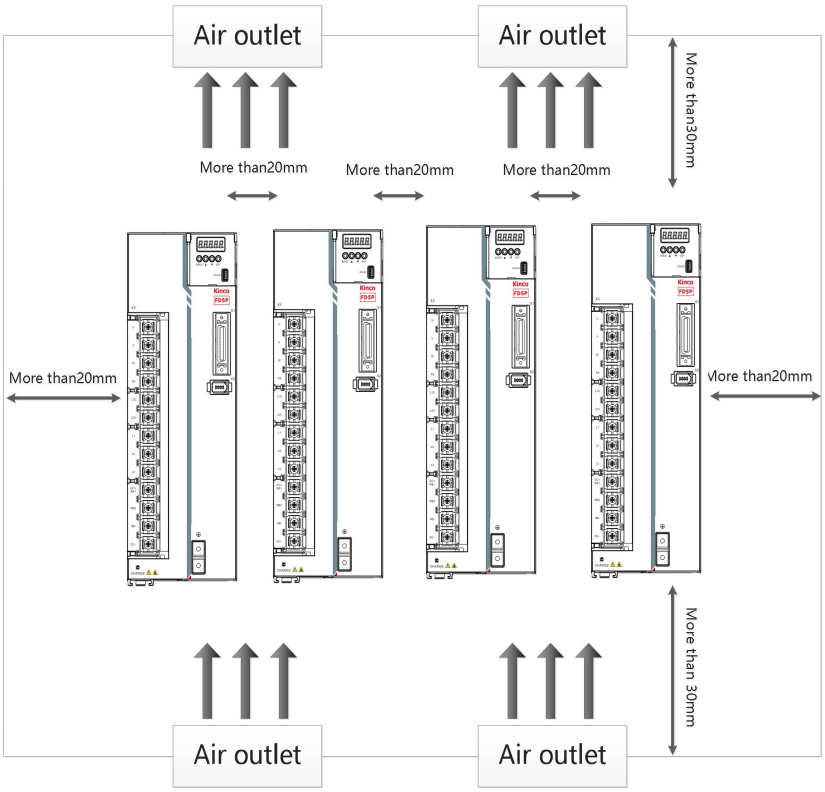


Figure 2-3 FD635P/FD645P installation direction and requirement

Warning

- Please make sure that the drive is installed securely and the screws are tightened to prevent the drive from falling and hurting people during use.
- Beware of electric shock：
  - The power cable must be connected to the X3.
  - Turn off the power when connecting cables.
  - Touching live parts can cause serious injury and possibly death.
- When using this product, it must be installed in the electric box, and all protective measures have been activated.
- In the event of maintenance, repair, cleaning work and longtime shutting down，beware before touching live parts：
  - Turn off power to electrical equipment with the power switch and prevent it from turning on again
  - After the power is turned off, check the indicators on the front panel of the unit. If the light is off, you can touch the drive.
- When installing, avoid any foreign objects entering the servo drive. Conductive or combustible foreign objects such as screws, metal chips, etc. entering the servo drive may cause fire and electric shock.
- For safety reasons, please do not use damaged servo drives and servo motors.
- Drive and motor power cables, brake cables and encoder cables must be fixed and not stretched excessively.
- The servo drive must be grounded.

2.3 Servo motor installation

2.3.1 Installation requirements

Warning

- Please install it indoor of no rain and direct sunlig
- Please do not use this product in the corrosive environment (Hydrogen sulfide, Sulfurous acid, Chlorine, Ammonia, Sulfur, Chlorinated gas, Acid, Alkaline, Salt, etc), flammable gas, combustible and etc.
- Occasion (without Grinding fluid, Oil mist, Iron powder, cutting and etc.)
- Occasion (good ventilation, no Moisture, oil and water, no heat source such as stove.)
- Occasion which is easy to be checked and cleaned.
- Occasion without vibration.
- Please do not use motor in the closed environment.
- For installation spacing, please follow the requirements of this manual. Using life of motors depend on working environment.
- Please use screws with washers when installing the motor on the flange, otherwise the paint on the surface of the motor may be scratched off.

2.3.2 Precaution

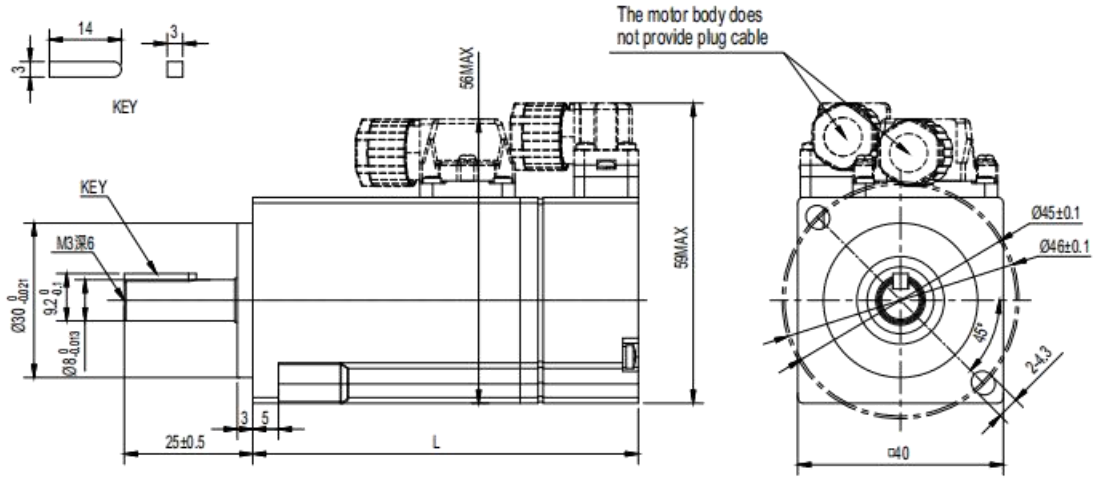
Table 2-1 Precaution

Item	Description
Anti-rust	Please wipe anti-rust agent on the motor's shaft and then make some anti-rust treatments.
Installation	Improper installation method will cause damage of motor's encoder. Please note the following during the installation process: ● When operators installation pulleys on the servo motor shaft with key, it is necessary to use screw hole. In order to install pulleys, operators need to insert double-headed nail into screw holes and use washers on the surface of coupled end. Then use nuts to fix into pulleys gradually. ● For servo motor shaft with keys, Operator need to use screw hole on the shaft to install. For motors shaft with no key, operators need to use friction coupling or other analogous methods. ● When operators need to disassemble pulleys, operators need to use pulley remover so as to make shaft avoid strong impact of load. ● In order to make it more safe, it is necessary to install protection cover or some analogous equipment in rotation area. For example, pulleys installed on the shaft.
Centering	● When it is connected with machine, please use coupling and make shaft center of servo motor and machine stay in a line. When operators install servo motors, please achieve requirements of centering accuracy. If centering is not accurate, there will be shock and sometimes it will make bearings and encoders

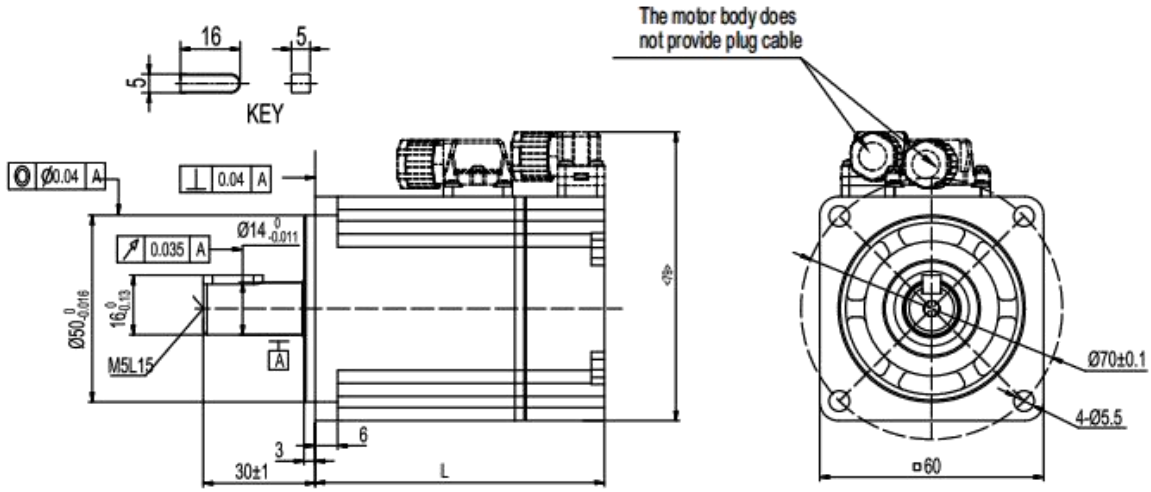
Install direction	● Servo motors can be installed in vertical or horizontal direction.
Oil and water solution	When it is used in the occasion with drops, please use after make sure protection level of servo. When oil will drop into shaft penetrating part (beside shaft penetrating part, please choose servo motors with oil seal. The using condition of servo motors with oil seal: ◆Make sure the oil level is lower than month of oil seal. ◆Please use when oil seal make sure that oil splash degree is good. ◆When servo motors are installed in vertical upward direction, please avoid oil accumulating in the month of oil seal. The motor bearing has its own double-sided dustproof effect, and the assembly of the oil seal will increase the loss of the motor, resulting in a decrease in the efficiency of the motor. If it is not a place where oil seals must be installed, it is not recommended to install oil seals. Before assembling the oil seal, please ensure that the installation holes and the oil seal are free of debris, oil, dust, etc. When assembling, please fill the oil seal sealing lip with high-temperature grease (recommended to use Great Wall's HP-R grease, with a temperature resistance of 180 degrees). Strengthen the performance of lubrication and temperature resistance and increase the sealing and waterproof effect of the oil seal. When paying attention to water and oil resistance, the side of the oil seal with the self-tightening spring (that is, the side with the groove) is installed towards the motor. Please refer to the following steps to install the oil seal correctly. 1. Evenly apply high temperature lubricating oil to the sealing ring of the oil seal lip. 2. the oil seal has a groove side facing inward, ensure that the oil seal is perpendicular to the machine shaft, use a suitable sleeve to push the oil seal into the cavity. 3.After successful installation, check whether the oil seal is tilted. The oil seal should be fitted with the motor bearing cover, and the lip of the oil seal should be completely closed to ensure the tightness of the oil seal.
Cable	Please do not make cable bending or pull the cable. When using it, please do not make it too tight.
Connector	In terms of connectors, please note the following: ◆ When connectors are connected. please make sure there is no foreign body such as trash or mental slices. ◆ When connectors are connected into servo motors, please connect to one side of servo motor's main circuit cable and make sure ground cable of main cable connecting stably. If operators first connect one side of encoder cable, then, encoder may have some faults because of voltage difference between PEs. ◆ During the process of wiring, please make sure pin arrangement is correct. ◆ Connector is made of resin. Please do not add pressure to avoid damage of connectors.

	◆ When handling operations is done (cables are connected), please hold main body of servo motors. If operators just hold cable to handle, it may cause connectors damage or make cable cut off. ◆ If operators use bend cable, please do not add pressure to connectors during the wiring operations. If pressure is added to connectors, it will cause connector damage.
Anti-rust	Please wipe anti-rust agent on the motor's shaft and then make some anti-rust treatments.

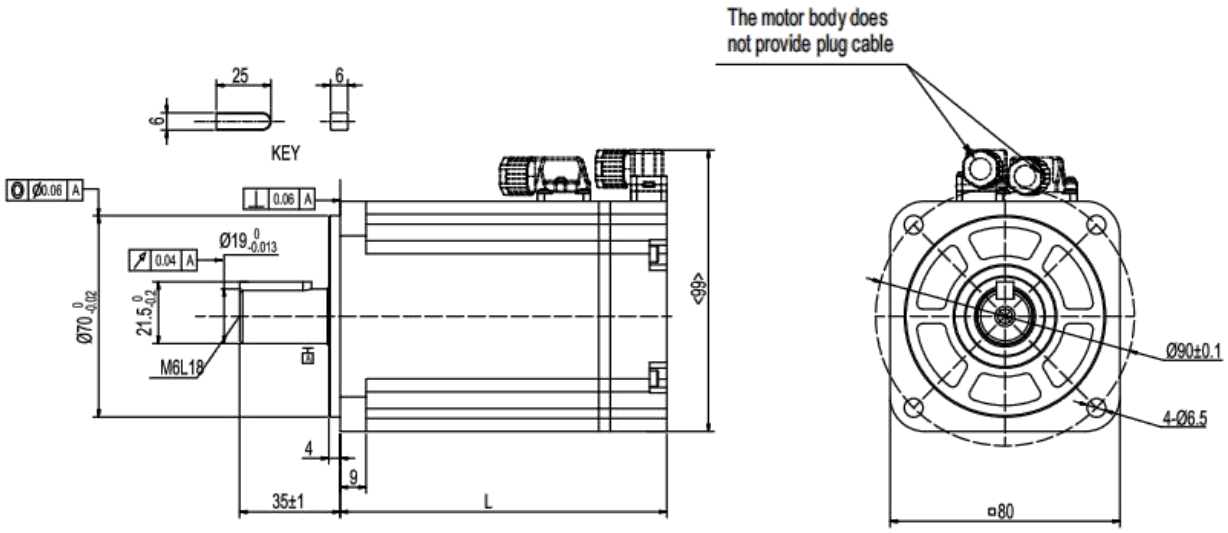
2.3.3 Motor mechanical dimension



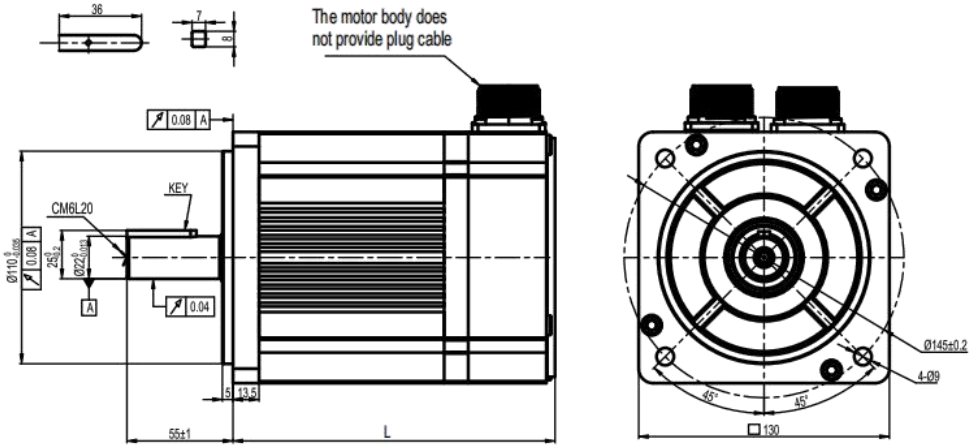
SMK40 series model	With brake	Motor body size（mm）
SMK40S-0005-30□AK-5LSA		62.5±1
SMK40S-0005-30□BK-5LSA	√	92.5±1
SMK40S-0010-30□AK-5LSA		75±1
SMK40S-0010-30□BK-5LSA	√	105±1



SMK60 series model	With brake	Motor body size（mm）
SMK60S-0020-30□AK-5LSA		77±1.5
SMK60S-0020-30□BK-5LSA	√	109.1±1.5
SMK60S-0040-30□AK-5LSA		75±1
SMK60S-0040-30□BK-5LSA	√	105±1



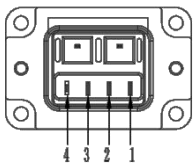
SMK80 series model	With brake	Motor body size（mm）
SMK80S-0075-30□AK-5LSA		103.7±1.5
SMK80S-0075-30□BK-5LSA	√	133.2±1.5
SMK80S-0100-30□AK-5LSA		113.7±1.5
SMK80S-0100-30□BK-5LSA	√	143.2±1.5

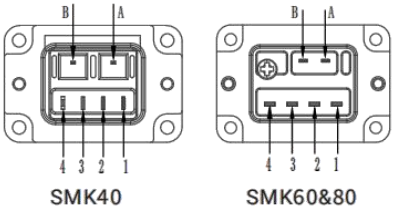


SMK130 series model	With brake	Motor body size（mm）
SMK130G-0085-15□AK-5LSR/5HSR		139±1.5
SMK130G-0085-15□BK-5LSR/5HSR	√	155±1.5
SMK130G-0130-15□AK-5LSR/5HSR		154±1.5
SMK130G-0130-15□BK-5LSR/5HSR	√	170±1.5
SMK130G-0180-15□AK-5HSR		169±1.5
SMK130G-0180-15□BK-5HSR	√	185±1.5
SMK130G-0240-15□AK-5HSR		189±1.5
SMK130G-0240-15□BK-5HSR	√	205±1.5

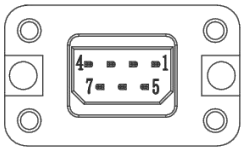
2.3.4 Motor connector pin definition

SMK40&60&80motor connector

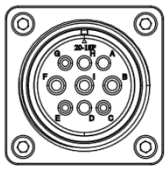
Power interface (without brake)	Pin	Name
	1	U
	2	W
	3	V
	4	PE

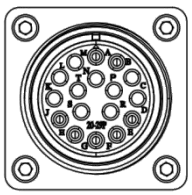
Power interface (with brake)	Pin	Name
	1	U
	2	W
	3	V
	4	PE
	A	BR+
	B	BR-

SMK40 SMK60&80

Encoder interface	Pin	Single turn encoder definition	Multi turn encoder definition
	1	+5V	+5V
	2	GND	GND
	3	/	VB+
	4	/	VB-
	5	SD+	SD+
	6	SD-	SD-

SMK130motor connector

Power interface	Pin	Name
	B	U
	I	V
	F	W
	G	PE
	C	BR+ (Suitable for motor with brake)
	E	BR- (Suitable for motor with brake)

Encoder interface	Pin	Name
	G	+5V
	H	GND
	E	VB+
	F	VB-
	A	SD+
	B	SD-
	J	PE

Chapter 3 System interface and wiring

3.1 FD5P system interface and wiring

3.1.1 Part name

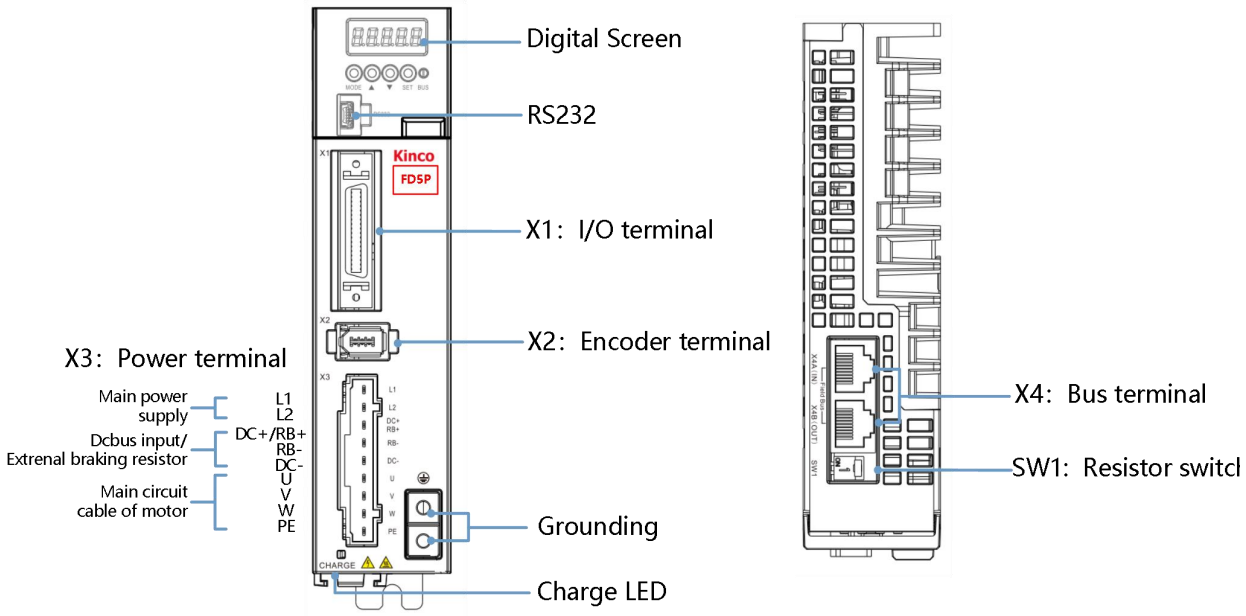


Figure 3-1 FD415P/FD425P-□A-000

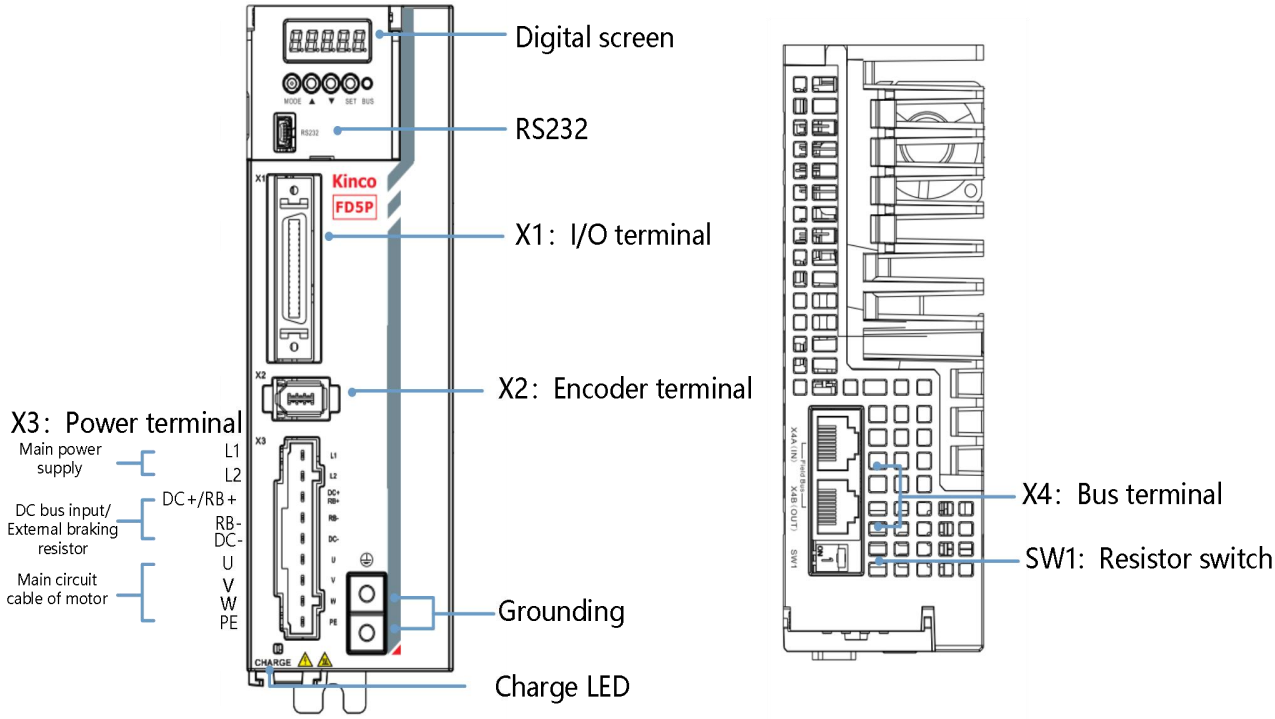


Figure 3-2 FD425P-□F-000

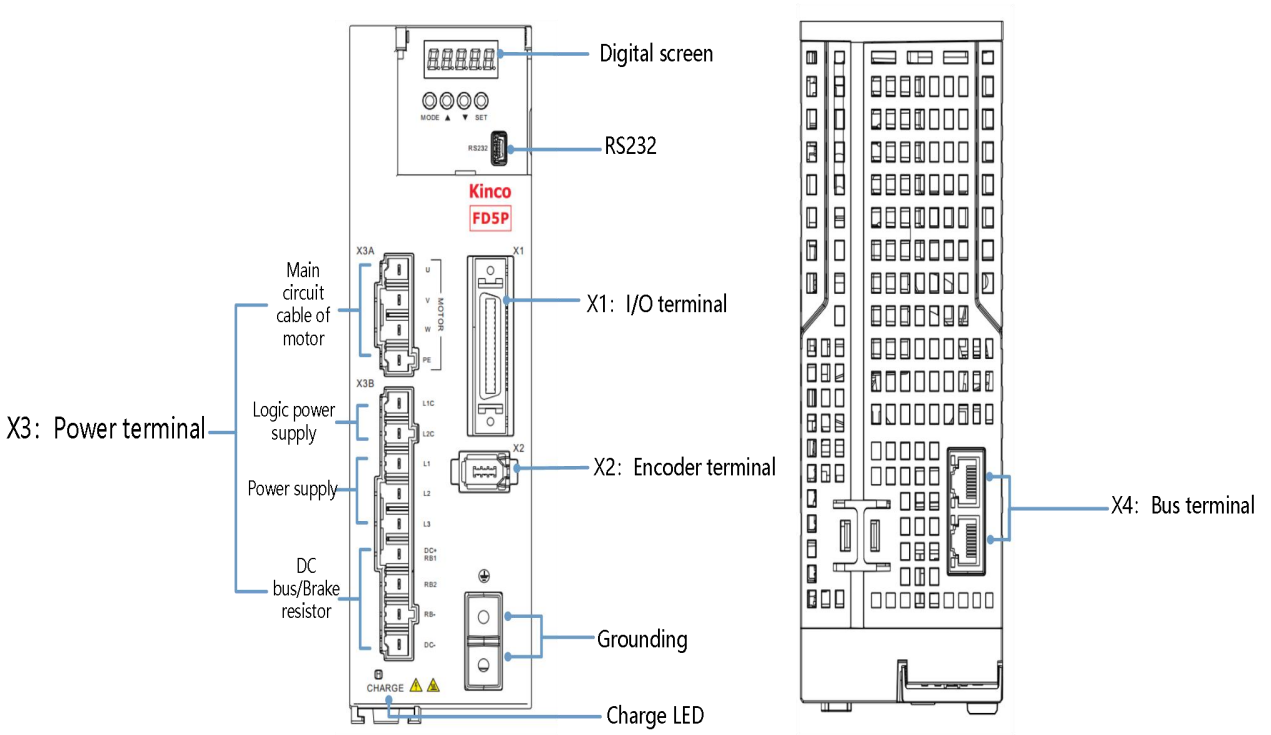


Figure 3-3 FD435P/FD445P/FD615P/FD625P-□A-000

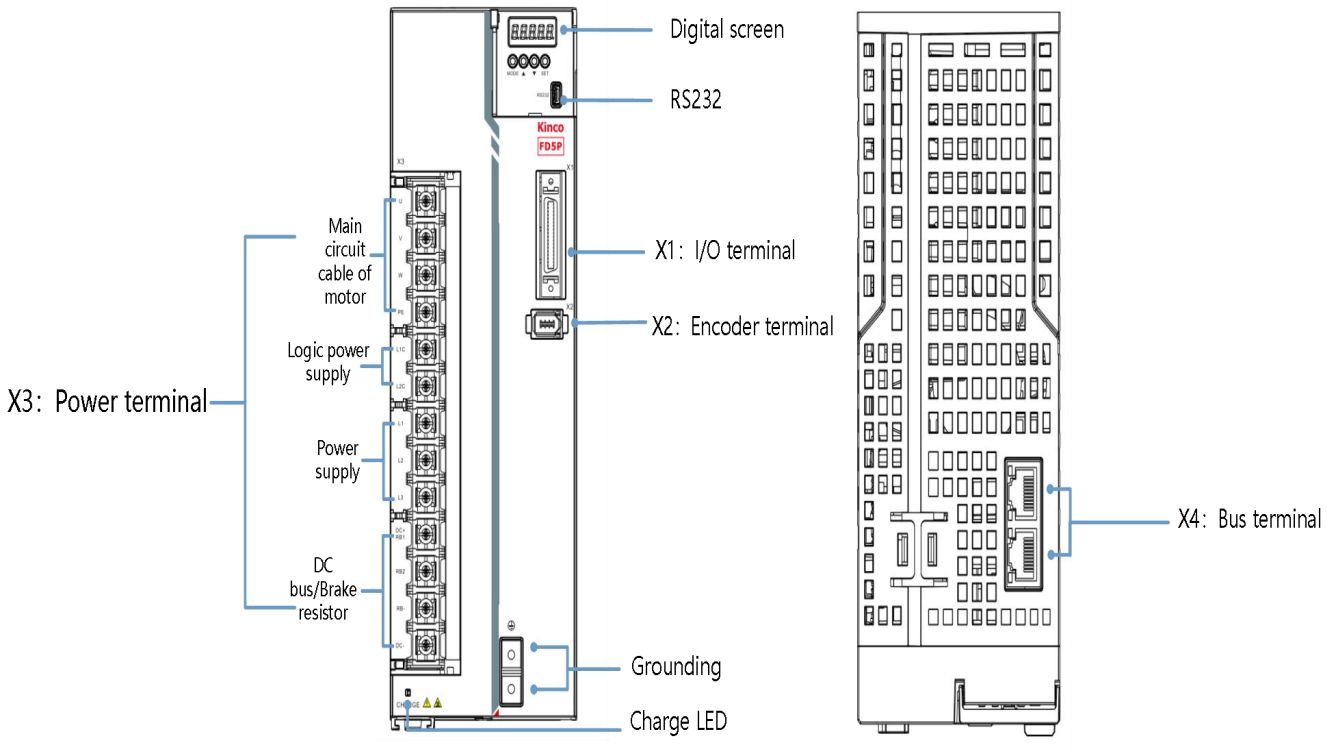


Figure 3-4 FD635P/FD645P-□A-000

3.1.2 External wiring diagram

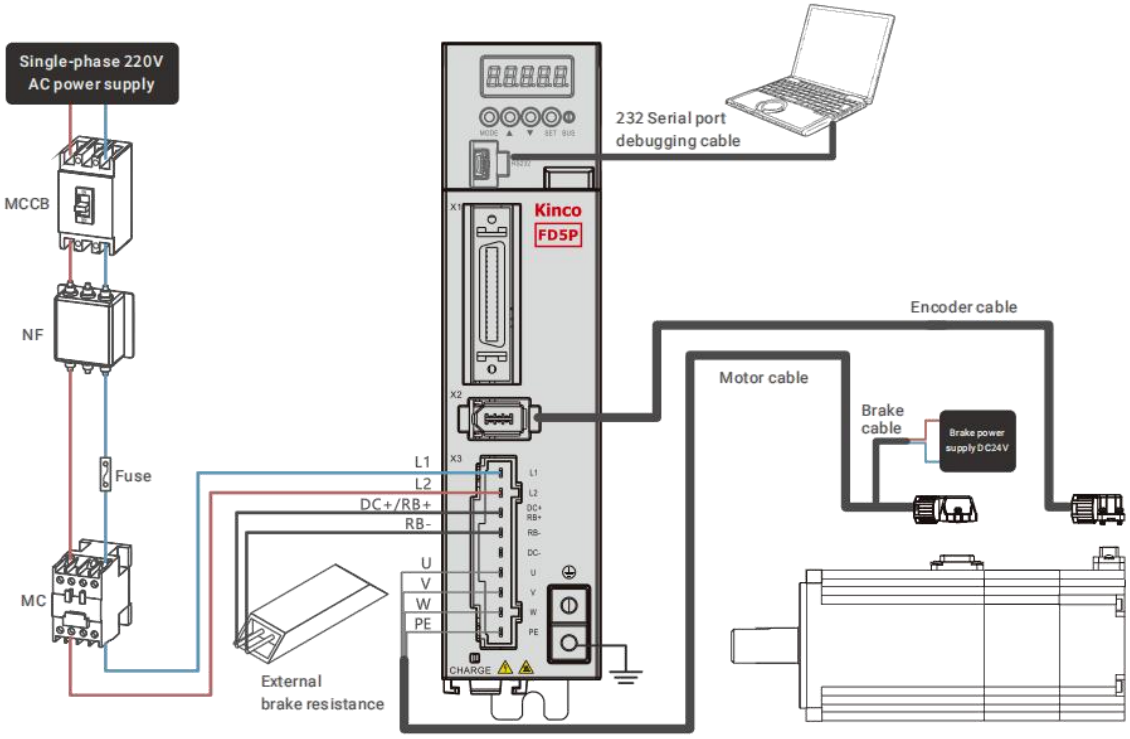


Figure 3-5 FD415P/FD425P external wiring diagram

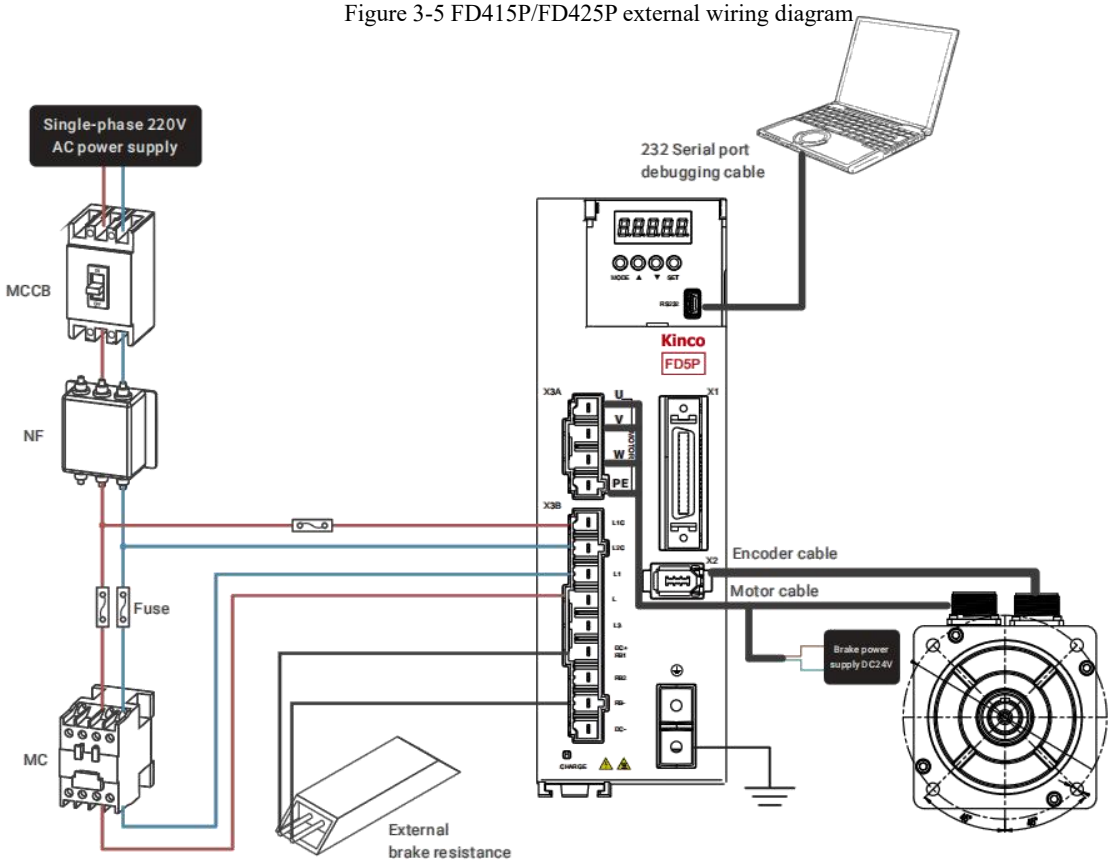


Figure 3-6 FD435P/FD445P single phase 220V AC external wiring diagram

Note: When the FD435P/FD445P is connected in single-phase mode, the input phase loss detection is enabled by default upon power-on. To use it, you need to write 0 to Input_Lack_Check (269200) in the KS+ software

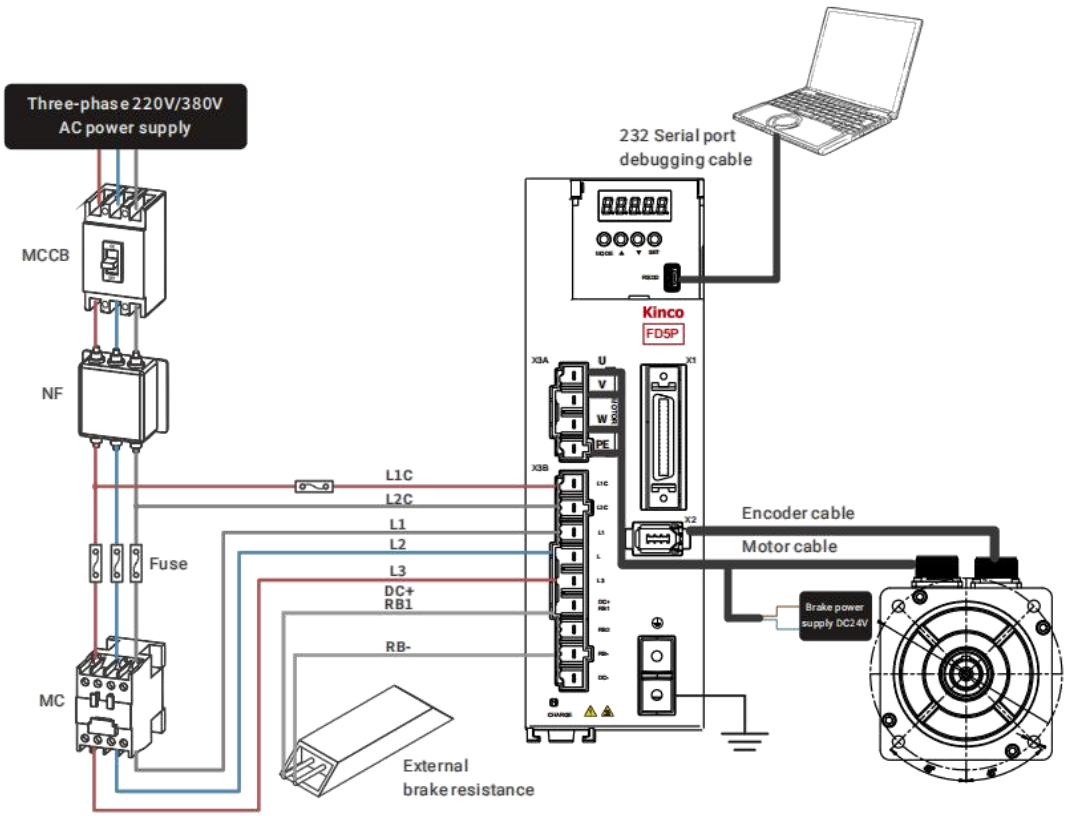


Figure 3-7 FD435P，FD445P（three phase 220V AC）/FD615P，FD625P（three phase380V AC） external wiring diagram

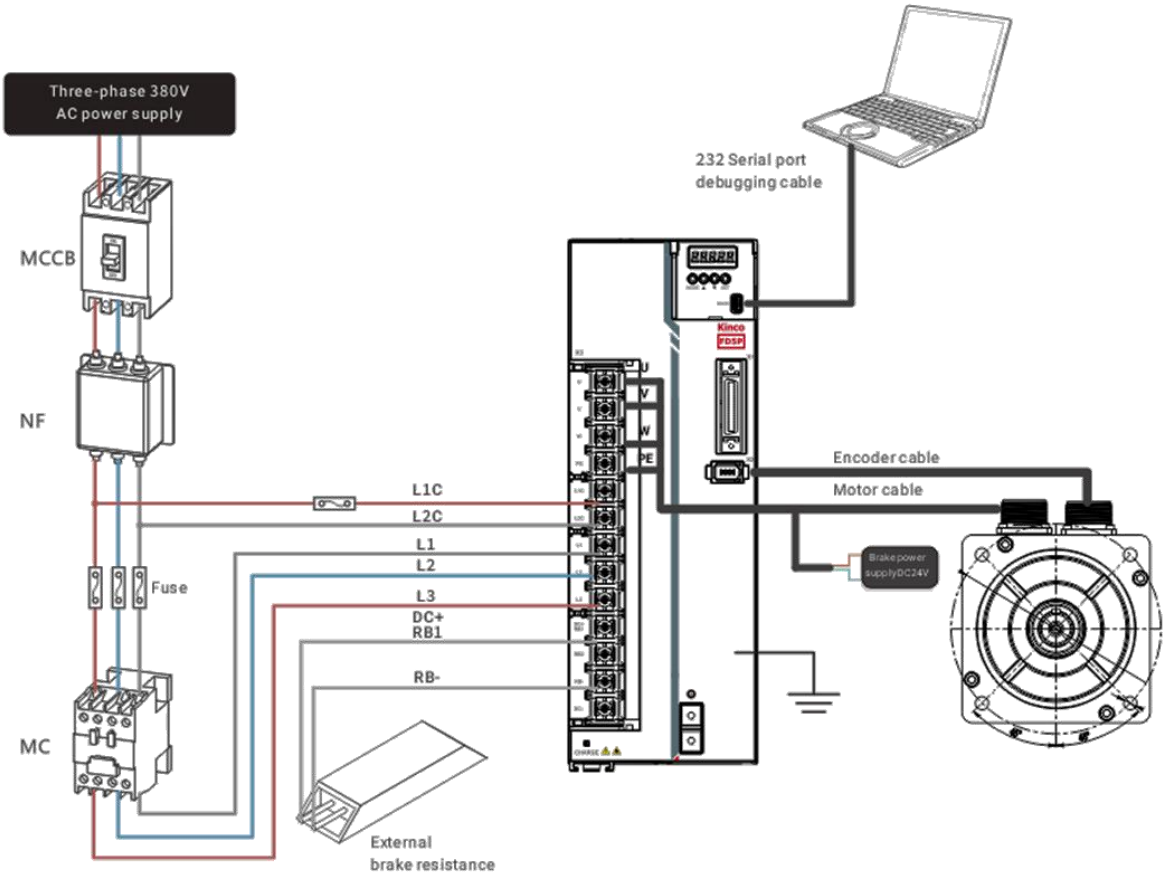


Figure 3-8 FD635P/FD645P three phase 380VAC external wiring diagram

3.1.3 Drive Interface terminal Description

3.1.3.1 External input and output connection (X1)

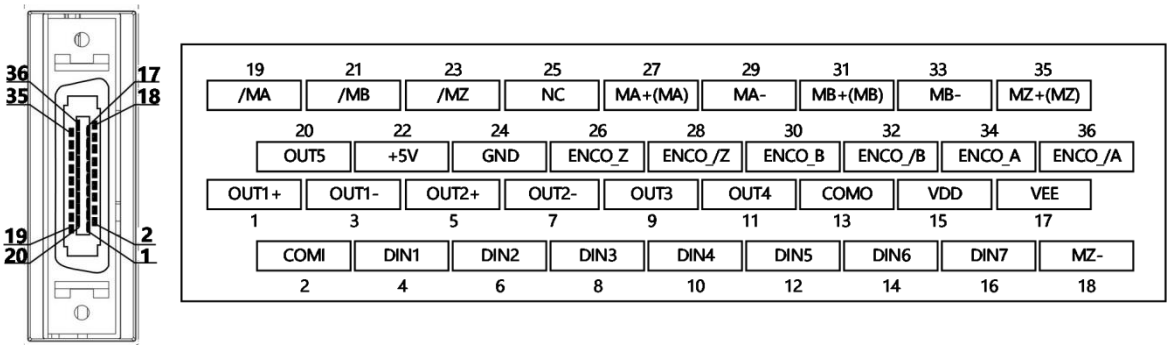


Figure 3-9 FDxx5P-LA/CA/EA drive external input and output terminal pin diagram

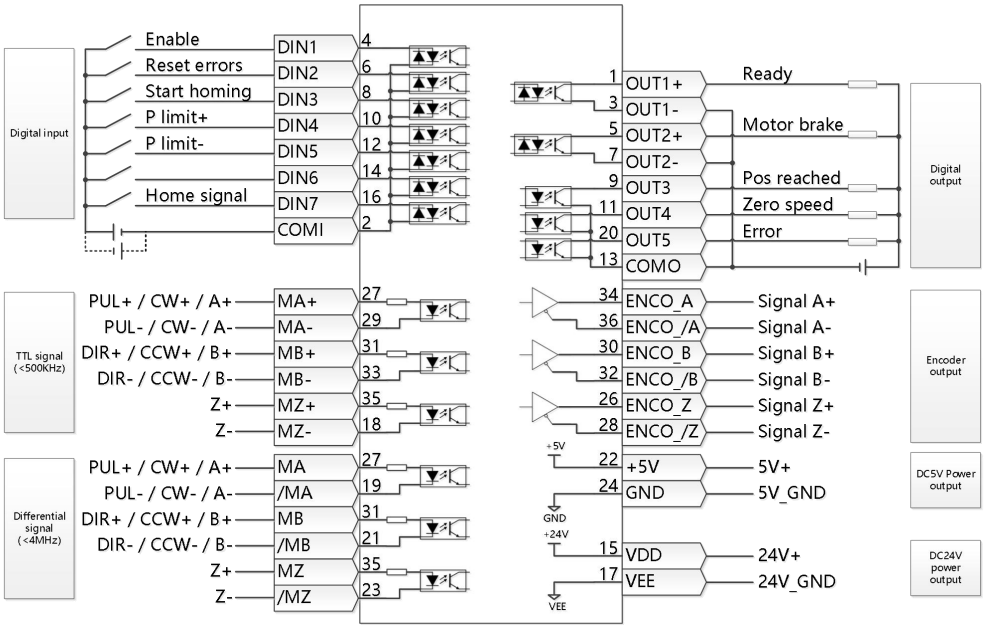


Figure 3-10 FDxx5P-LA/CA/EA drive IO port definition

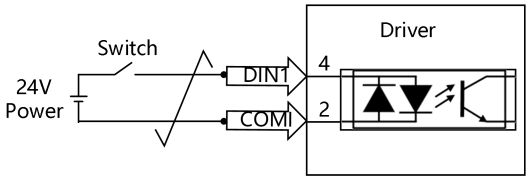
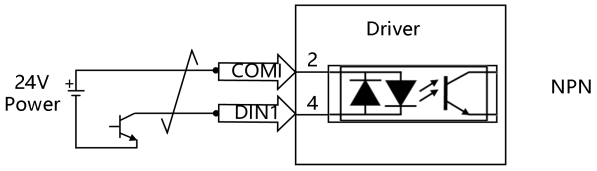
Note

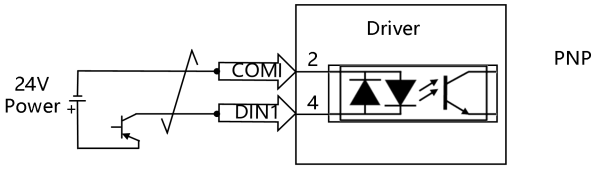
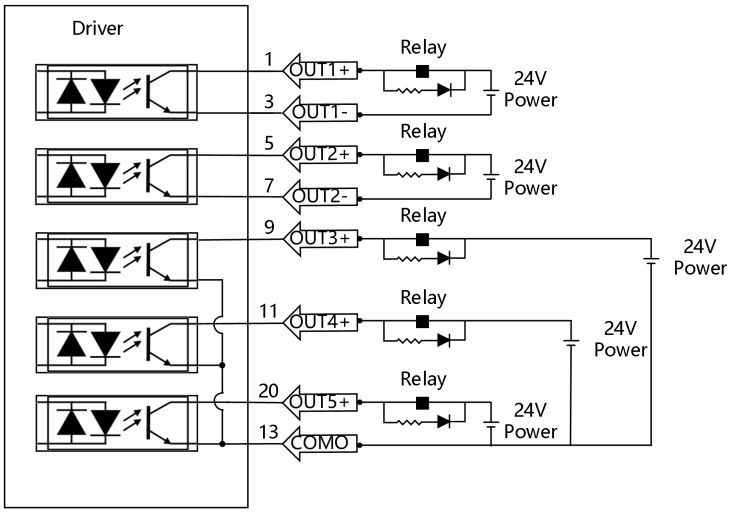
- Figure 3-10 shows the X1 wiring of the FDxx5P-LA/CA /EAdriver's default IO function. More IO functions can be defined by the digital panel or the upper computer debugging software. For more details on IO features, see Chapter 5, Section 5.5.
- FD435P/FD445P/FD615P /FD625P/FD635P/FD645P -PA without OUT4 OUT5.

Table 3-1 FD5P-LA/CA/EA driver external input/output terminal pin definition

Pin	Signal	Signal name	Specification
1	OUT1+	Differential output	Open collector output MAX voltage DC30V MAX current 100mA
3	OUT1-		
5	OUT2+		
7	OUT2-		
9	OUT3	Single-ended output	MAX voltage DC30V MAX current 20mA
11	OUT4 **(FD5P-PAwithout OUT4)**		
20	OUT5 **(FD5P-PAwithout OUT5)**		
13	COMO	OUT3, OUT4, OUT5 output port common terminal	Digital output port common terminal
15	VDD	Internal 24V power output	Internal 24V power output Voltage range +/-20%, MAX current 200mA
17	VEE		
2	COMI	Signal input port common terminal	Digital input port common terminal
4	DIN1	Digital signal input	High level：12.5V-30V Low level：0-5V MAX input frequency：1KHz
6	DIN2		
8	DIN3		
10	DIN4		
12	DIN5		
14	DIN6		
16	DIN7		
19	/MA	Differential signal： MA,/MA,MB,/MB,MZ,/MZ MAX supported frequency 4MHz, Voltage range DC 3.3-5V	MA, MB, MZ, MA/, MB/, MZ/ RS422 differential signal input that supports 5V, the maximum pulse frequency is 4MHz, and the signal type is optional: ①Pulse+Direction（PLS+DIR） ②Forward and reverse pulses（CW/CCW） ③A+B phase
21	/MB		
23	/MZ		
27	MA+/(MA)	TTL Signal：MA+,MA- MB+,MB-,MZ+,MZ-， MAX supported frequency 500KHz, Voltage range DC12-30V	Pulse signal input terminal supports TTL/differential signal. Signal type optional: ①Pulse+Direction (PLS+DIR) ②Forward and reverse pulses (CW/CCW) ③A+B phase
29	MA-		
31	MB+/(MB)		
33	MB-		
35	MZ+/(MZ)		
18	MZ-		
22	+5V	Internal 5V power output	Output 5V A, B, Z differential signals, the frequency division output range is 0~65536; for multi-axis synchronization, the maximum output frequency is 5MHz
24	GND		
26	ENCO_Z	Encoder signal output	
28	ENCO_/Z		
30	ENCO_B		
32	ENCO_/B		
34	ENCO_A		
36	ENCO_/A		

Table 3-2 Example of digital input and output signal wiring

<table>
<tr><td colspan="2">Digital signal input wiring</td></tr>
<tr><td>Description</td><td>Digital input port high level input voltage range: 12.5-30VDC; Low input voltage range: 0-5VDC; Maximum input frequency: 1KHz</td></tr>
<tr><td>Digital input wiring example① When the host computer is relay output</td><td> 
</td></tr>
<tr><td>Digital input wiring example② When the host computer is open collector output</td><td> 


</td></tr>
<tr><td colspan="2">Digital signal output wiring</td></tr>
<tr><td>Description</td><td>OUT1/OUT2 is open collector output，MAX voltage DC30V，MAX current 100mA
OUT3-OUT5 is single-ended output，MAX voltage DC30V，MAX current 20mA
The drive’s internal 24V output can be used as a pull-up power supply
When OUT3-OUT5 use PNP wiring, only one of them can be used</td></tr>
<tr><td>Digital output wiring example① When the host computer is relay input</td><td> 
</td></tr>
</table>

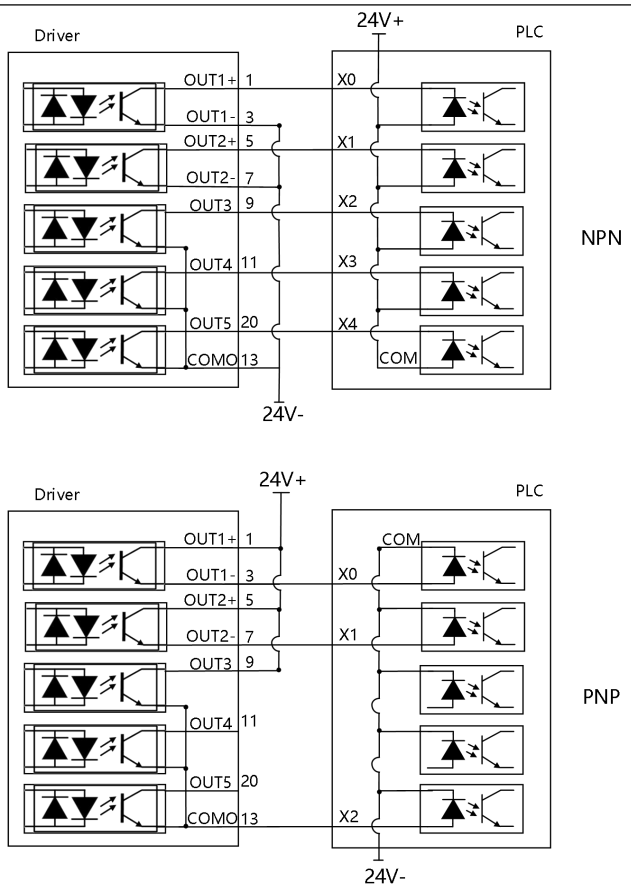
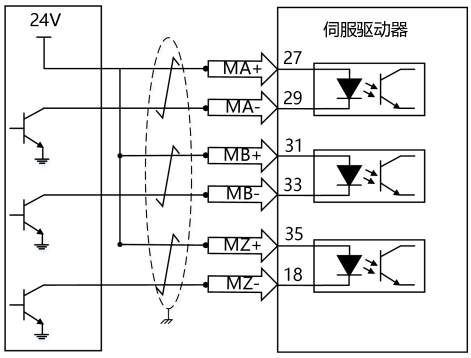
Digital output wiring example② When the host computer is optocoupler input	

Table 3-3 Pulse input wiring example

Description	Pulse input is divided into ordinary pulse input channel and high-speed pulse input channel High-speed pulse input channel supports RS422 differential signal, voltage range DC3.3-5V, MAX pulse frequency 4MHz Ordinary pulse input channel supports TTL/differential signal, voltage range DC12-30V, maximum frequency 500KHz
Ordinary pulse input wiring example① NPN Wiring method	

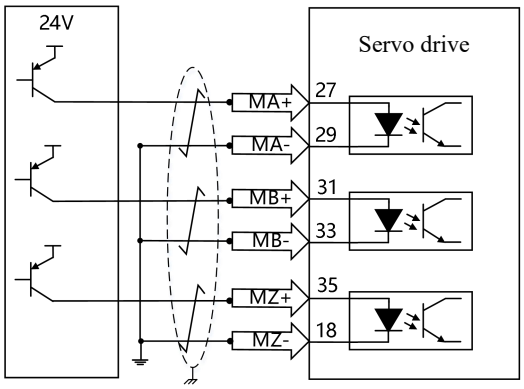
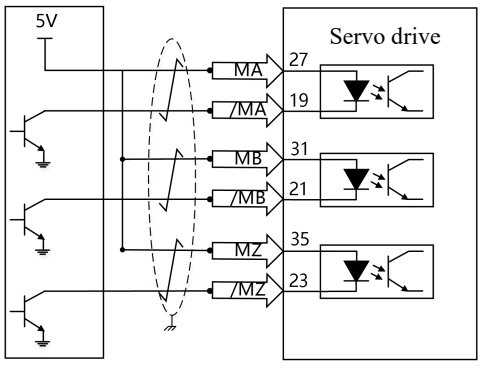
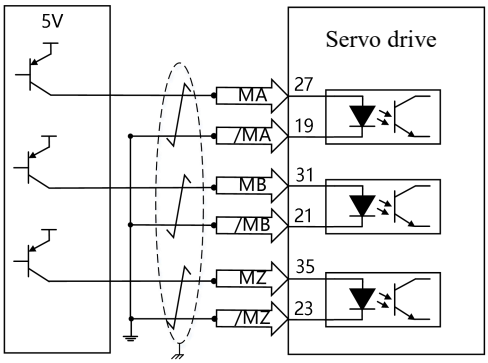
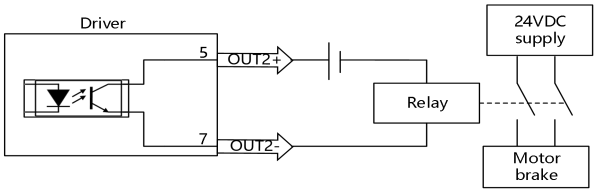
Ordinary pulse input wiring example① PNP Wiring method	
High-speed pulse input wiring example① NPN wiring method	
High-speed pulse input wiring example② PNP wiring method	

Table 3-4 Brake connection example

Instruction	By default, OUT2 of the drive is the brake control port. An external relay is required to control the motor brake. The brake coil of the motor has no polarity. The 24V output power of the drive X1 is not enough to control the brake, and an external 24V is required as the brake power supply
Brake connection example	

Note

- The use of brake can ensure that the motor shaft can remain stationary in the state of de-enable or power failure. Please ensure that the lock gate has been opened before the motor operation. Do not use brake when the drive control motor shaft is running at high speed in non-emergency cases, otherwise it will cause the lock performance degradation or damage.

3.1.3.2 RS232 serial port

Table 3-5 RS232 serial port

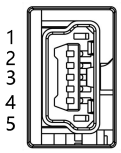
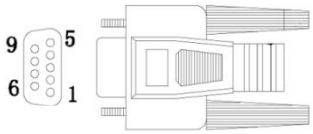
	Pin number	Pin definition	Function
	2	RX	Receive data
	3	TX	Send data
	5	GND	Signal ground

Table 3-6 RS232 Communication wiring

Drive end Pin name	Drive end Pin	PCend Signal name	PC end serial port pin	PCend pin definition
TX	3	Receive data (RXD)	2	
RX	2	Send data (TXD)	3	
GND	5	Signal ground(GND)	5	

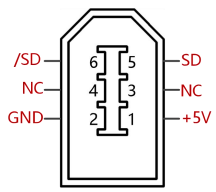
Users can purchase the FD5P drive Mini-usb 5p to DB9 female RS232 cable (Kinco order number: PDC-USB-1(5)) If your computer does not have an RS232 serial port, you will also need to use a USB to DB9 serial cable to connect.

Figure 3-11 FD5P Drive 232 debug cable

- Purchase link of Kinco official Tmall store：
https://detail.tmall.com/item.htm?spm=a212k0.12153887.0.0.4d7c687deB8shy&id=652422874770&skuId=4707119953745

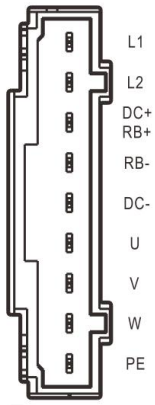
3.1.3.3 Encoder input (X2)

Table 3-7 Driver end encoder pin definition

	Pin	Name (Magnetoelectric encoder)	Name (photoelectric encoder)	Description
	1	+5V	+5V	5V power supply output positive
	2	GND	GND	5V power supply output negative
	3	CLOCK+	-	Clock signal positive
	4	CLOCK-	-	Clock signal negative
	5	SD	SD	Data signal
	6	/SD	/SD	

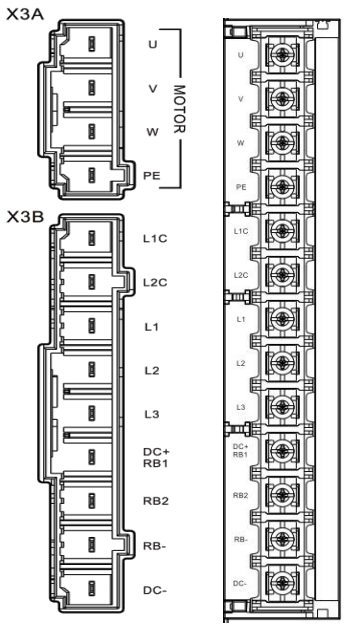
3.1.3.4 Power port (X3)

Table 3-8 FD415P/ FD425P power port instruction



Port	Name		Description
X3	L1		Drive the main power input 1 PH 200 ~ 240VAC ±10% 50 ~ 60Hz ±3Hz
	L2		
	DC+/RB+	DC+	DC bus positive
		RB+	External brake resistor positive
	RB-		External brake resistor negative
	DC-		DC bus negaitive
	U/V/W		Servo motor UVW phase cable connection
	PE		Ground terminal

Table 3-9 FD435P/ FD445P/FD615P/FD625P /FD635P/FD645P power port instruction



FD435P/ FD445P
FD615P/FD625P

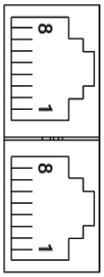
FD635P/FD645P

Port	Name		Description
X3A	U/V/W		Servo motor UVW phase cable connection
	PE		Ground terminal
X3B	L1C/L2C		Logic power input FD435P/FD445P:1PH 200V-240V AC±10% 50/60Hz±3Hz FD615P/FD625P/FD635P/FD645P:1PH 380V-415V AC±10% 50/60Hz±3Hz
	L1/L2/L3		Power supply input FD435P/FD445P:1PH/3PH 200V-240V AC±10% 50/60Hz±3Hz FD615P/FD625P/FD635P/FD645P:3PH 380V-415V AC±10% 50/60Hz±3Hz
	DC+ /RB1	DC+	DC bus positive
		RB1	When using internal brake resistor, RB1 and RB2 are short circuited
	RB2		
	RB-		When using an external brake resistor, disconnect the short cable between RB1 and RB2 , and connect the external brake resistor to RB1 and RB-
	DC-		DC bus negaitive

Note: The maximum screw tightening torque of FD635P/FD645P is 1.5N.m

3.1.3.5 Communication port input (X4)

Table 3-10 Communication port instruction



	Pin	RS485	CAN	EtherCAT / Profinet
X4A	1	-	CAN_H	TD+
	2	-	CAN_L	TD-
	3	-	GND_CAN	RD+
	4	485-	-	-
X4B	5	485+	-	-
	6	-	-	RD-
	7	-	-	-
	8	GND_RS485	-	

Note

- When the SW1 switch beside X4 port of the FD415P/FD425P drive is set to ON, it indicates that the 120 Ω terminal resistor is enabled.
- FD435P/445P/615P/625P/635P/645P drive without SW1 switch.

3.2 External installation instruction

Table 3-11 External system installation description

Electric equipment	Function
Molded case circuit breakers (MCCB)	In the event of overcurrent, short circuit, or undervoltage, the circuit breaker automatically shuts off the power supply, thus protecting the circuit and drive equipment from damage. Note that the protection parameters that match the drive parameters are set.
Noise filter (NF)	Effectively filter out external interference and improve the anti-interference ability of power supply circuit.
Magnetic contactor (MC)	Use the air ac electromagnetic contactor to turn off the power supply and install the surge suppressor recommended by the manufacturer of the electromagnetic contactor to effectively prevent reverse electromotive force.
CHARGE	Charging indicator light will not go out immediately after the power is cut off due to the charging capacitor in the internal circuit of the drive. Please make sure that the charging indicator is off or the voltage value of the dc bus voltage of the drive is below 36V before contacting the power terminal

Table 3-12 Recommended circuit breaker model

Servo driver model	Recommended circuit breaker		
	Model	Specification	Manufacture factory
FD415P-□A	NXB-63-2P-C6	230V~(1P+N、2P)，6A	CHNT
FD425P-□A/□F	NXB-63-2P-C10	230V~(1P+N、2P)，10A	
FD435P-□A	NXB-63-3P-C16	400V~(3P)，16A	
FD445P-□A	NXB-63-3P-C20	400V~(3P)，20A	
FD615P-□A	NXB-63-3P-C10	400V~(3P)，10A	
FD625P-□A	NXB-63-3P-C16	400V~(3P)，16A	
FD635P-□A	NXB-63-3P-C25	400V~(3P)，25A	
FD645P-□A	NXB-63-3P-C32	400V~(3P)，32A	

Table 3-13 Recommended noise filter model

Servo driver model	Recommended noise filter		
	Model	Specification	Manufacture factory
FD415P-□A	TY440S-16FT	Single-phase120/250VAC，16A	Tyze
FD425P-□A/□F			
FD435P-□A	ME466-20	Three-phase 380/440VAC 50/60Hz 20A	MINEN ELECTRIC
FD445P-□A	ME466-20	Three-phase 380/440VAC 50/60Hz 20A	
FD615P-□A	ME466-10	Three-phase 380/440VAC 50/60Hz 10A	
FD625P-□A	ME466-20	Three-phase 380/440VAC 50/60Hz 20A	
FD635P-□A	ME466-20	Three-phase 380/440VAC 50/60Hz 20A	
FD645P-□A	ME920-30	Three-phase 380/440VAC 50/60Hz 30A	

Table 3-14 Recommended contactor model

Servo driver model	Power supply voltage	Recommended contactor	
		Contactor model	Manufacture factory
FD415P-□A	220V	CJX2-09	CHNT
FD425P-□A/□F	220V		
FD435P-□A	220V	CJX2-18	
FD445P-□A	220V	CJX2-25	
FD615P-□A	380V	CJX2-09	
FD625P-□A	380V	CJX2-18	
FD635P-□A	380V	CJX2-25	
FD645P-□A	380V	CJX2-32	

Warning

- A surge suppressor is installed on the coil of the relay and electromagnetic contactor to prevent the damage caused by the peak voltage to the equipment.
- For details about the driver external brake resistance configuration, see **Appendix I**.
- Do not connect the power cable to the UVW end, and do not connect the external brake resistor to the DC+(RB+) and DC- ends. Before powering on the drive, check whether the cable connection are correct.
- High voltage may remain in the drive after power off. Please check that the CHARGE indicator is off ten minutes after power off before disassembling and repairing the drive.
- Please do not share power with welding machines, lasers and other equipment;
- **If the equipment is to use a residual current operated protective device (RCD), please follow the following conditions for selection:**
  - The drive device can generate direct current leakage in the protective conductor. Please be sure to use the Type B RCD
  - When the drive is in operation, it will generate a certain high-frequency leakage current. To prevent the RCD from malfunctioning, please select an RCD with an operating current of no less than 100mA for each driver
  - When multiple drives are connected in parallel to share one RCD, an RCD with an operating current of no less than 300mA should be selected

Table 3-15 Wiring Specification Table

Model	FD415P-□A FD425P-□A/□F	FD435P-□A FD445P-□A	FD615P-□A	FD625P-□A	FD635P-□A FD645P-□A
Power supply wire diameter	18~14AWG， 0.8~2mm²， stripping length 8-10mm	14AWG， 2mm²,stripping length 8-10mm	18~14AWG， 0.8~2mm²， stripping length 8-10mm	16~14AWG， 1.5~2mm²， stripping length 8-10mm	12~10AWG， 3~6mm²， stripping length 8-10mm
IO wire diameter	Wire diameter 26~22AWG，0.13-0.3mm²，stripping length 2mm				

To ensure the stable and safe use of the product, the following matters should be noted when wiring and connecting the drive:
◆During the assembly process, pay attention to the fixation of the cable. Do not apply stress to the connector part, otherwise it may cause damage to the connector
◆For the motor power cable and encoder cable, please use the cable provided by the manufacturer. Calculate the connection distance of the equipment and choose the shorter cable as much as possible.
◆The bending radius of the cable should be more than 5 ~ 10 times the wire diameter to prevent the core of the cable from breaking after long-term use. During the use of the cable, it should avoid being subjected to tension. In some drag chain cases, flexible cable should also be considered.
◆Wire is usually carried out at 8A/mm² based on the output current of the drive;When the power cable is longer than 30 meters, the wire diameter needs to be increased.
◆Keep a distance of more than 30cm between powercable and signalcable and try to avoid laying them parallel. Do not lay power cable and signal cable in the same cable tray or bundle them together.

3.3 EMC configuration description

FD5P servo drive meet the relevant requirements of EMC certification standardsEN 61000-6-2,EN61000-6-4 and so on under the set conditions, but in the course of product use, it may be affected by the actual installation method, connector and wiring status. Which result in different EMC test levels.

Warning

- In the civil environment, this product may cause interference which may degrade the reception quality of radio signals. Users shall take suppression measures if necessary to prevent interference.
- Products must be installed and certified by professionals who are familiar with safety and EMC requirements, and EMC engineers are responsible for ensuring that the products and systems produced comply with relevant laws.

Site condition

FD5P servo drive should be installed in the application site of OVCIII and PDII.

Installing environmental condition

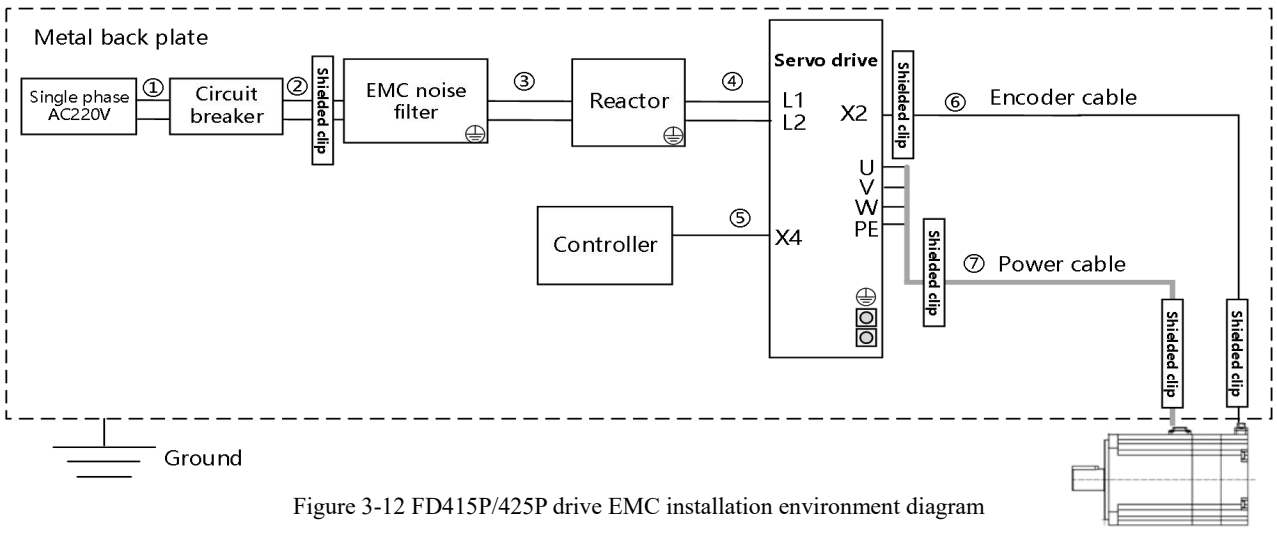


Figure 3-12 FD415P/425P drive EMC installation environment diagram

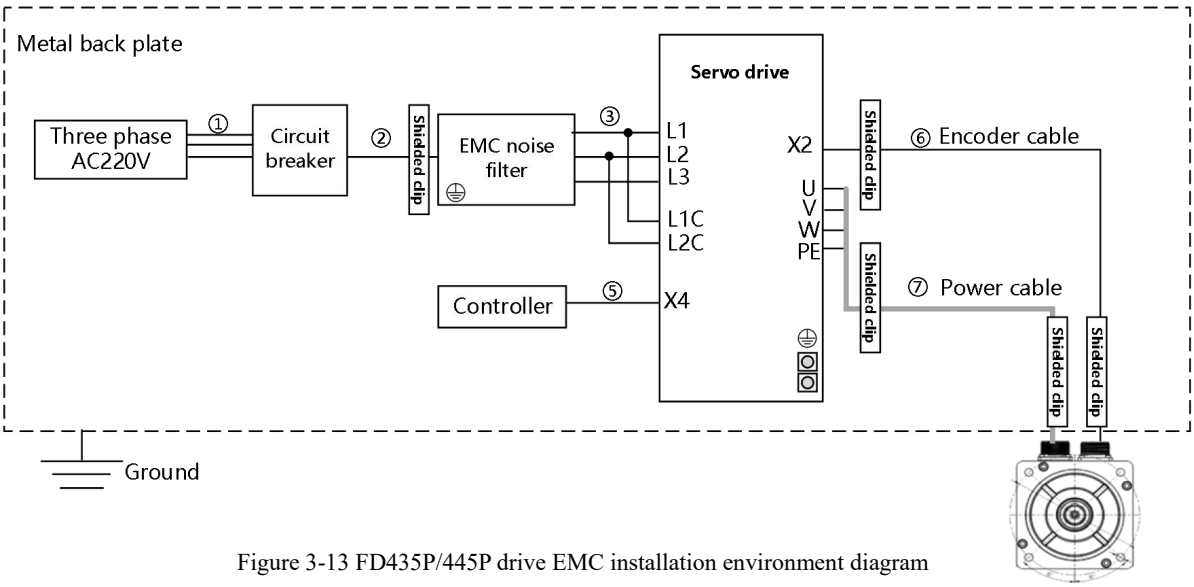


Figure 3-13 FD435P/445P drive EMC installation environment diagram

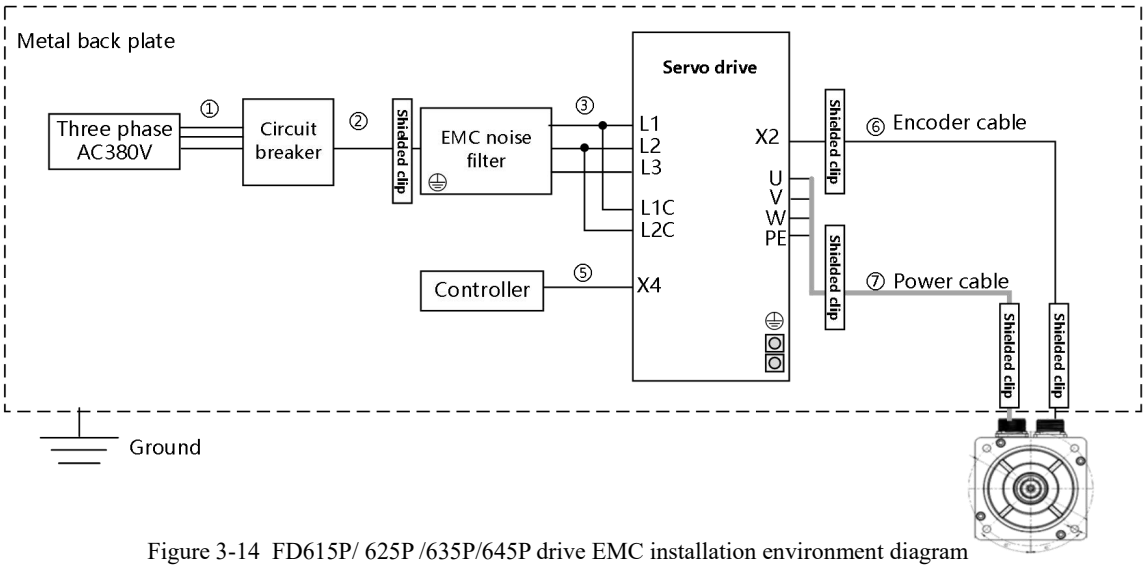


Figure 3-14 FD615P/ 625P /635P/645P drive EMC installation environment diagram

Note:

- Select the shielded cable in the diagram with a shielding coverage rate of more than 85%.

Serial number	Cable name	Specification
①②③④	Power cable	Shielded cable
⑤	Communication cable	Shielded + twisted pair cable
⑥	Encoder cable	Shielded + twisted pair cable
⑦	Motor power cable	Shielded cable

- Please install the device in the control cabinet. The device should be installed on the same metal backplane with good electrical conductivity in the cabinet.

(1) Reactor

- To suppress the higher harmonic currents at the input power side, connect a reactor to the power input end of the drive.
- The reactor and the drive must be installed in the same metal back plate (electric galvanized steel) and the metal backplane must be well grounded.

(2) EMC noise filter

- To ensure that the product meets EMC standards, install an EMC noise filter at the power input terminal near the servo drive. For details about the noise filter model, see **Section 3.2 .**
- The length of the cable between the output of the noise filter and the input power supply of the drive should be less than 30cm.
- The drive and filter are installed in the same metal backplane and the metal backplane is well grounded;
- Do not lay the input and output cables of the filter in the same slot or bind them together.
- The PE of the filter and the PE of the driver are single-point grounded. Do not connect PE in series to the ground pile.

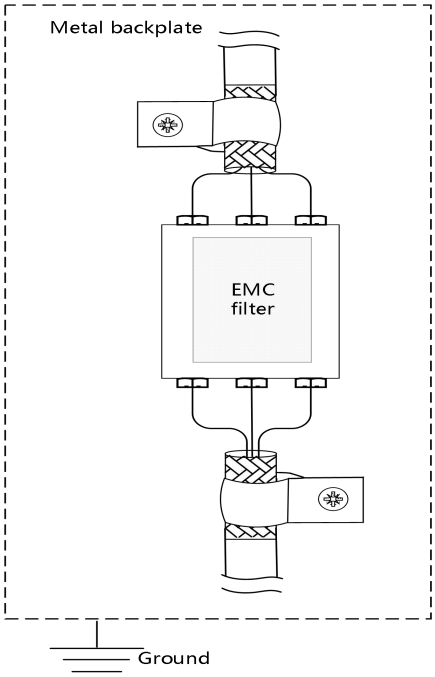


Figure 3-15 EMC noise filter installation diagram

(3) Shielded layer

- Please use shielded cable for input and output signal cable, power cable, encoder cable and communication cable.
- The shield of the encoder is clamped to the connector metal housing using metal cable clamp.
- The shielding layer near the drive side of the power cable is locked to the driver PE screw using the U-shaped metal clip delivered with the product.
- If the power cable and the encoder are not direct outlet solutions, it is necessary to peel the sheath layer at both ends of the connector and connect the shielded layer of the cable to the metal plate using a 360-degree shield clamp.

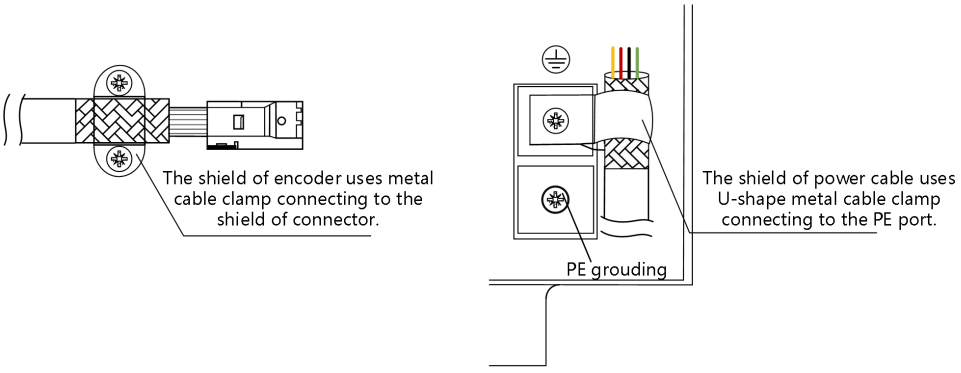


Figure 3-16 Driver side power cable/encoder cable shield layer 1* processing mode

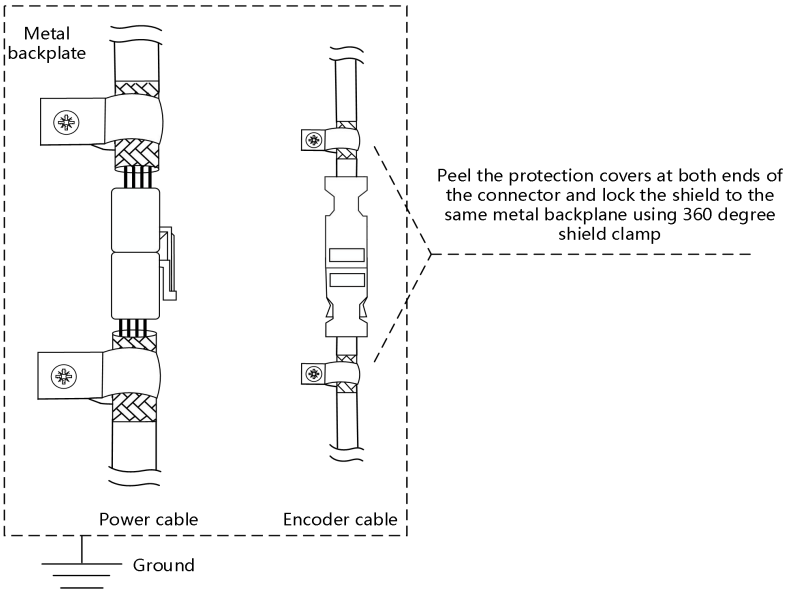


Figure 3-17 Connector side power cable/encoder cable shield layer 2* processing method

(4) Grounding

- In order to prevent electric shock, be sure to ground the reactor, noise filter and drive;
- When multiple servo drivers are used, do not connect the ground cables of multiple servo drivers in series. Instead, use the single-point grounding method.
- The driver should be grounded with the shortest possible cable (>2mm²). If the ground cable is longer, increase the diameter of the ground cable (≥4mm²).

3.3.1 Servo overload protection feature

The drive calculates the heat by the output current, and implements the overload protection function for the driver and the motor. Overload protection means that when the driver and motor exceed the rated current, continuous use cannot be guaranteed, and only overload operation can be carried out under the overload protection characteristics.

Because the drive and the motor work at the same time, if the load rate of the motor reaches 100% first, the overload alarm protects the motor; When the load rate of the driver reaches 100% before the motor, the overload alarm protects the driver.

Standard motor has no temperature sensor for overheating protection, can not real-time monitoring of the actual temperature of the motor, if there are special conditions need to detect the real-time temperature of the motor, please consult our sales staff.

Note
After the drive or motor IIT failure (fault code: 080.0), drive output short circuit (fault code: 008.0), driver bus voltage is too high (fault code: 002.0) and other alarms, stop the fault first, check the cause of the fault, and then try to run. If the root cause of the fault is not identified, a high-frequency reset may cause damage to the drive hardware.。

Panel	Name	CANopen	Modbus	Type	Data type	Detailed explanation
D1.02	Motor IIT actual utilization	2FF01010	2A00	RL	Unsigned8	The actual load rate of the motor
D1.04	Actual drive IIT utilization	2FF01110	2A01	RL	Unsigned8	The actual load rate of the drive

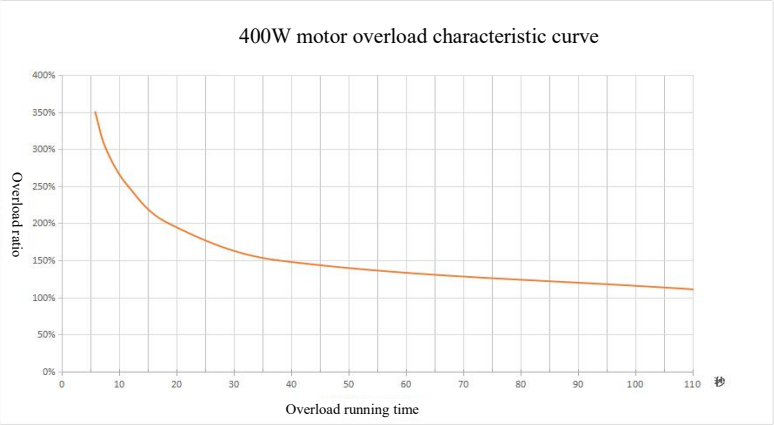


Figure 3-18 Overload characteristic curve of 400W motor

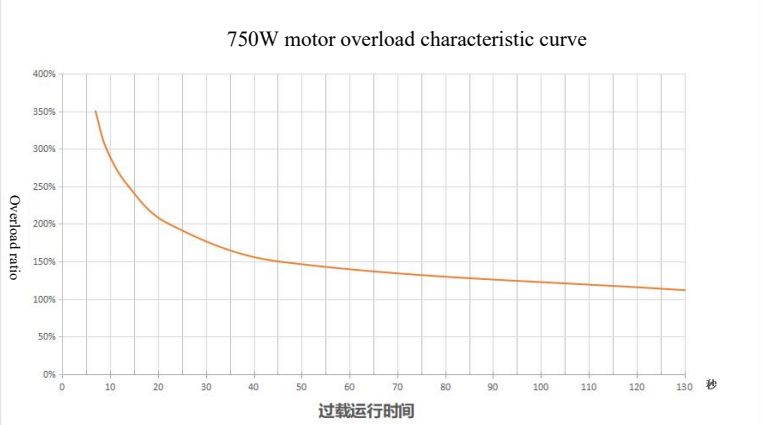


Figure 3-19 Overload characteristic curve of 750W motor

3.3.2 DC BUS

The braking energy generated during motor operation will be fed back to the drive bus capacitors, causing the drive bus voltage to rise. Under the condition that the multi-axis control is asynchronous (part of the motor is electric, part of the motor is braked), the common DC bus can keep the drive bus voltage more stable and realize the full utilization of energy.

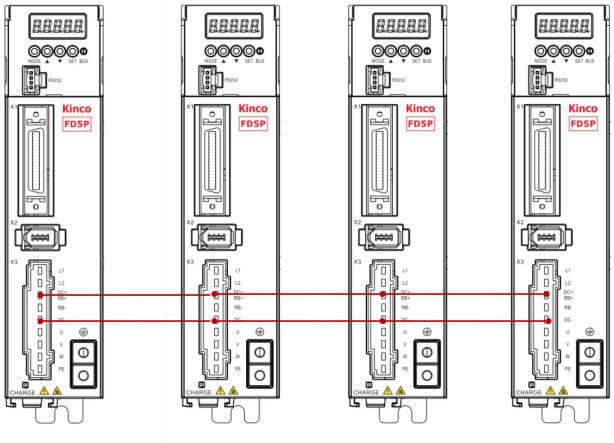


Figure 3-20 FD415P/425P common DC bus

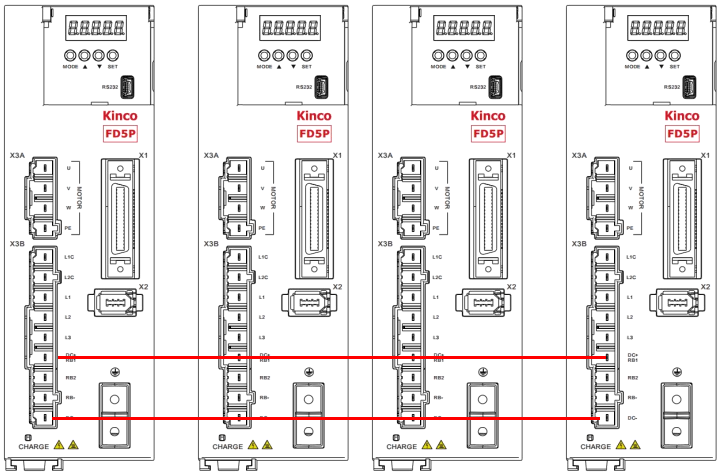


Figure 3-21 FD435P/445P /615P/ 625P common DC bus

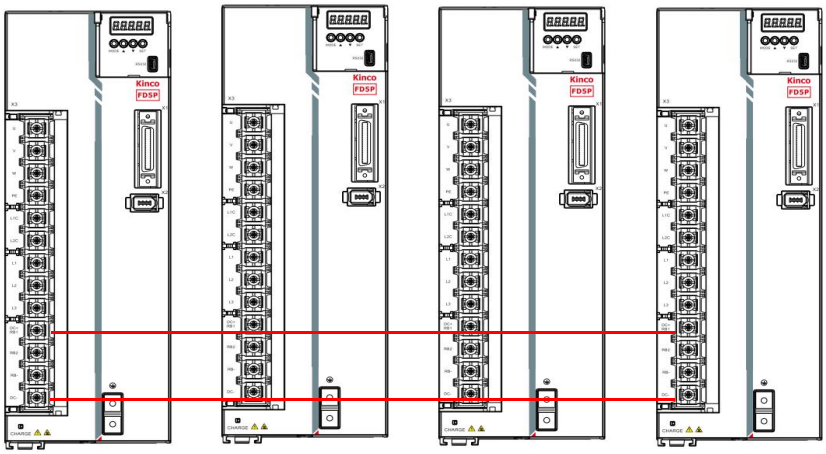


Figure 3-22 FD635P/ 645P common DC bus

Warning

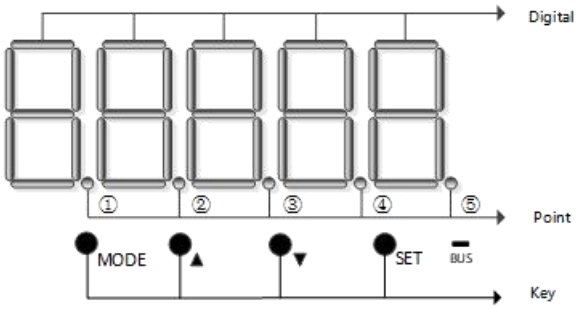
- Only drivers with the same voltage level support common DC busbars. Do not use 380V drivers and 220V drivers with common DC busbars!
- Please ensure that the driver charge light is off before connecting the cable; otherwise, electric shock may occur!
- When the DC bus is connected, DC+ and DC- must be connected between the drivers. Do not connect DC+ to DC-!
- Ensure that the cable is connected correctly before powering on the driver.

Chapter 4 Digital panel operation

4.1Panel operation

After the servo system is installed and properly wired according to the specifications and precautions, the servo drive can be set up for the specific application scenario.

Table 4-1 Panel operation instruction



Number/dot/button	Function
Dot ①	None
Dot②	Used to indicate whether the data is positive or negative. Dot2 on refers negative and off refers positive.
Dot③	When setting parameters, it is used to distinguish the current object group from the address data in the object group; When displaying the internal 32-bit data in real time, it is used to display the upper 16 bits of the current 32-bit data; Indicates that the earliest error information in the error history is being displayed when the error history record in F007 appears at the display.
Dot④	When displaying and adjusting parameters in real time, it is used to indicate the data display format: HEX data when dot 4 is on and DEC data when dot 4 is off Dot 4 indicates that the latest error information in the error history is being displayed when the error history record in F007 appears at the display.
Dot⑤	Dot 5 on indicates that the data modification is confirmed successful Dot 5 on indicates that the current displayed data is internal data Dot 5 blinking means the power section of the drive is working
MODE	Switch function menu; When setting parameters, press briefly to switch the setting bit, press and hold to return to the last menu.
SET	Enter menu; Check the values of the parameters; Confirm the setting to access the next step; When the internal 32 bit data appears at the display, press and hold to switch high/low 16 bit.
▲	Press briefly increase the value slowly, press and hold increase the value rapidly; Switch data item.
▼	Press briefly decrease the value slowly, press and hold decrease the value rapidly; Switch data item.
P..L	Positive limit signal active
n..L	Negative limit signal active
Pn.L	Positive and negative limit signal active
FFF.F	The drive is not configured with the motor model
Blinking	Error

Note

Press SET setting determining，If the panel shows PErr means failure setting. The reasons could be:

- The setting value is out of the setting range of the parameter.
- The drive is in the enabled state, the parameters cannot be changed. You need to cancel the enable state first.

4.2 Panel operation instruction

Set drive parameters and monitor real-time data as follows:

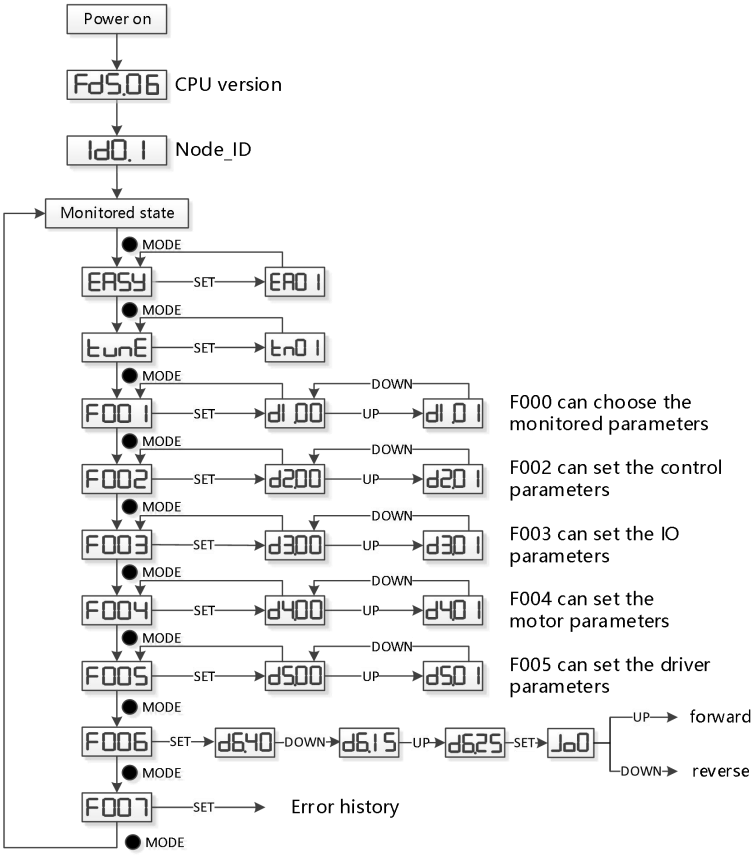


Figure 4-1 Parameters Setting

4.3 Easy Use Function

Easy Use is designed to quickly set control ring parameters for users, eliminating the tedious steps of servo debugging, and the adjusted performance can meet most applications; In addition, an independent area is created to facilitate users to set commonly used important parameters.

4.3.1 Easy use operation step

Step 1: Confirm EASY flow parameters one by one. After the EASY process is executed, run the machine, and if the performance is ideal, there is no need to perform the tunE process. Otherwise, follow the tunE process
Step 2:The tunE process is the inertia measurement process. After the inertia is measured through the tn03, the drive changes the rigidity class (tn01) according to the tuning result.
Step 3: Please run the machine, if the performance is not ideal, and then modify the rigidity level step by step through tn01, please note that while adjusting, observe the machine performance.

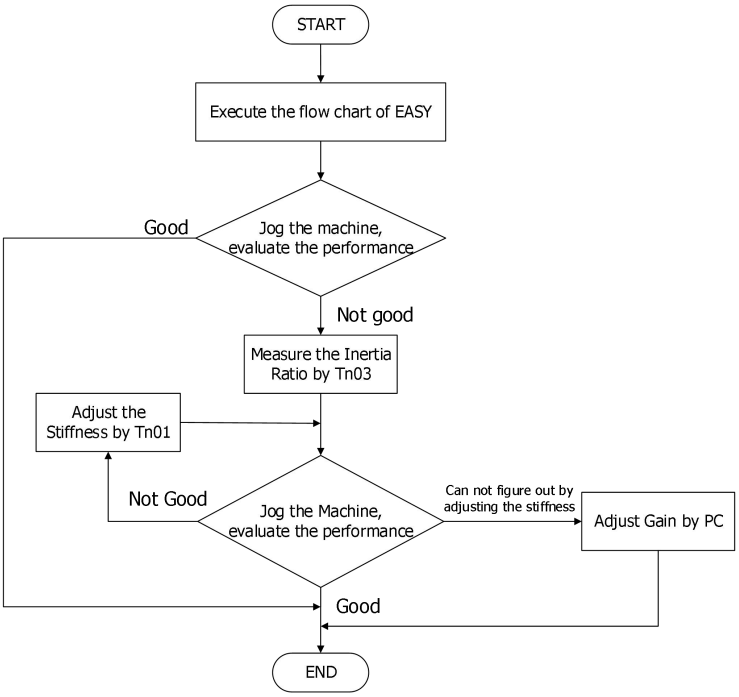


Figure 4-2 Gain self-tuning process

Note

- Inertia measurement may cause the machine to vibrate. Please turn off the power or the drive immediately.
- Turning on the inertia measurement will make the motor shaft reciprocate within a small distance, please leave a certain mechanical space.
- After executing the EASY process, it is strongly recommended to perform the tunE process to measure the inertia and adjust the rigidity level.

4.3.2 EASY operation flowchart

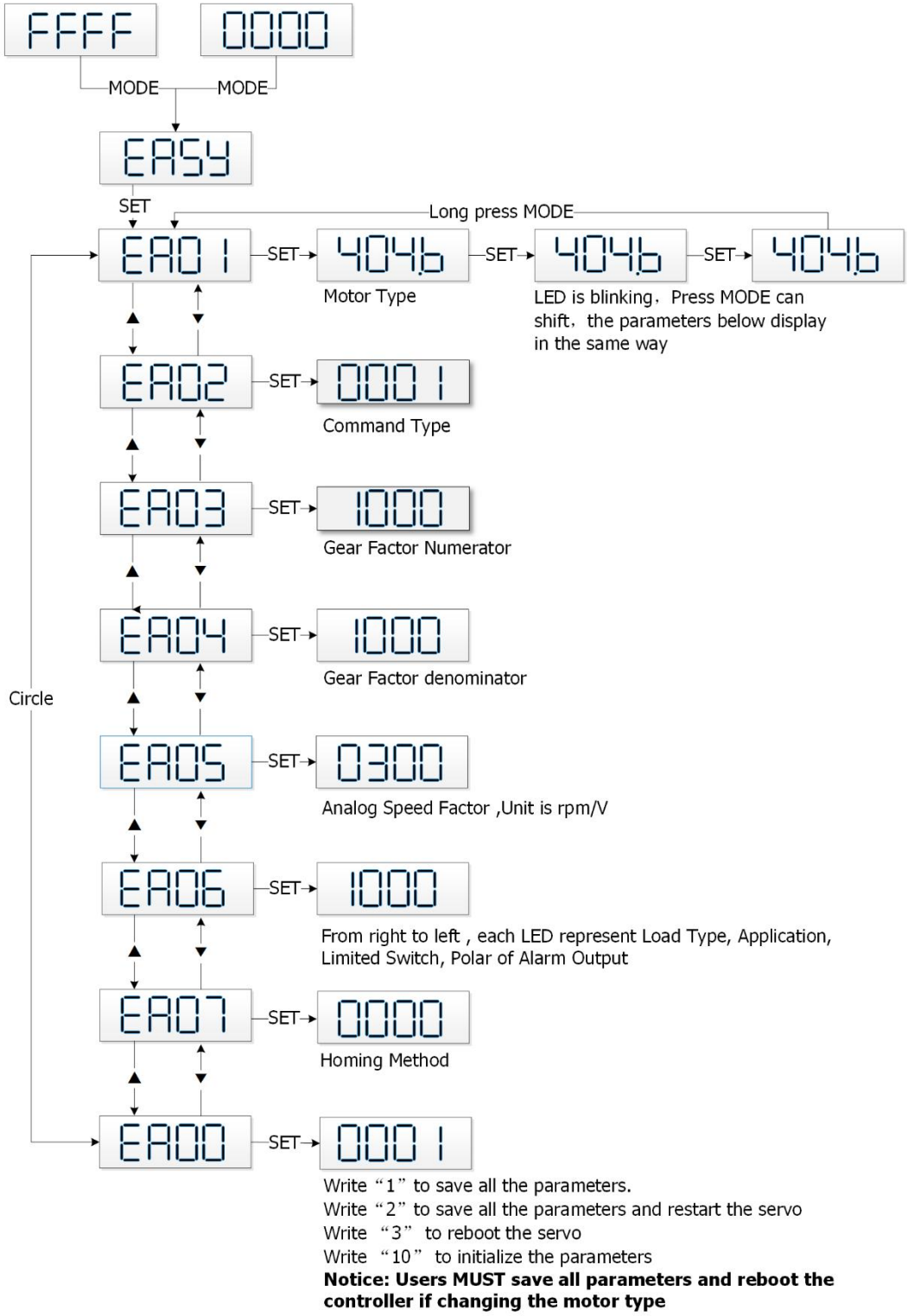


Figure 4-3 EASY operation process

Note
The menu is exited automatically if there is no operation in 30s, and users have to start again. Entered data is valid immediately but must be saved via EA00.

Table 4-2 Easy parameters

LED	Parameter	Description	Default
EA01	Motor type	For a new factory drive, the motor model is 00, and the digital panel displays 3030. If the drive is connected to the correct motor, the motor model will be automatically recognized and saved by the drive. If there is no motor model in the drive, the digital panel will flash FFFF. For the drive that has been used, the drive will judge whether the connected motor is the same as the previous one. If they are not the same, the digital panel will flash and display the FFFF/400.2 fault.	404b
EA02	Command type	Change the instruction type by modifying the first digit on the right, Note that changing the instruction type changes the working mode and the definition of the IO port. 0: Dual-pulse mode CW/CCW 1: pulse direction mode P/D 2: A/B phase control mode 8: upper computer communication control mode Instruction type 0-2, corresponding to working mode -4. Instruction type 8, the working mode is controlled by communication, and the functions defined by DIN1, DIN2, DIN3 need to be cancelled.	1
EA03	Gear Factor Numerator	Used when EA02 is set to 0-2 By default, the display shows the values in decimal format. If the number is greater than 9999, the display is in hexadecimal format	1000
EA04	Gear Factor Denominator		1000
EA06	1. load type 2.application 3. limit switch 4. alarm output polarity	The meaning of each digit of the LED display from right to left. (1) Load type, influences the control loop. 0: No load 1: Belt drive 2: Ball screw (2) Application, influences the control loop. 0: P2P 1: CNC 2: Master / slave mode (3) Limit switch. 0: Controller default 1: Delete the limit switch function (4) Polarity of OUT5 0: Normally closed contacts 1: Normally open contacts	1001
EA07	Homing method	Refer to chapter 6.7	
EA00	Save parameters	Write “1” to save control and motor parameters. Write “2” to save control and motor parameters and reboot the servo. Write “3” to reboot the servo. Write “10” to initialize the control parameters. After saving the parameters, the drive sets the control loop parameters according to the load type and application.	-

When EA02 is set to 0, 1 or 2, the default input and output functions are as follows:

Table 4-3 Default IO configuration related to EA02

	Pulse control			RS232 control
	CW/CCW	Pulse/Direction (default)	A/B phase	
EA02	0	1	2	8
DIN1	Enable	Enable	Enable	
DIN2	Reset errors	Reset errors	Reset errors	
DIN3	Start homing	Start homing	Start homing	
DIN4	P limit+	P limit+	P limit+	P limit+
DIN5	P limit-	P limit-	P limit-	P limit-

DIN6				
DIN7	Home signal	Home signal	Home signal	Home signal
OUT1	Ready	Ready	Ready	Ready
OUT2	Motor brake	Motor brake	Motor brake	Motor brake
OUT3	Pos reached	Pos reached	Pos reached	Pos reached
OUT4	Zero Speed	Zero Speed	Zero Speed	Zero Speed
OUT5	Error	Error	Error	Error
	Work model：-4			Work model：0

Note

- Changing the EA02 may cause the IO function to change, so the actual IO input may unexpectedly activate the corresponding function of the drive. Therefore, when setting the EASY menu, it is recommended to disconnect the wiring of the X4

When EA02 is set to 0,1, or 2, the default input and output functions are as follows:

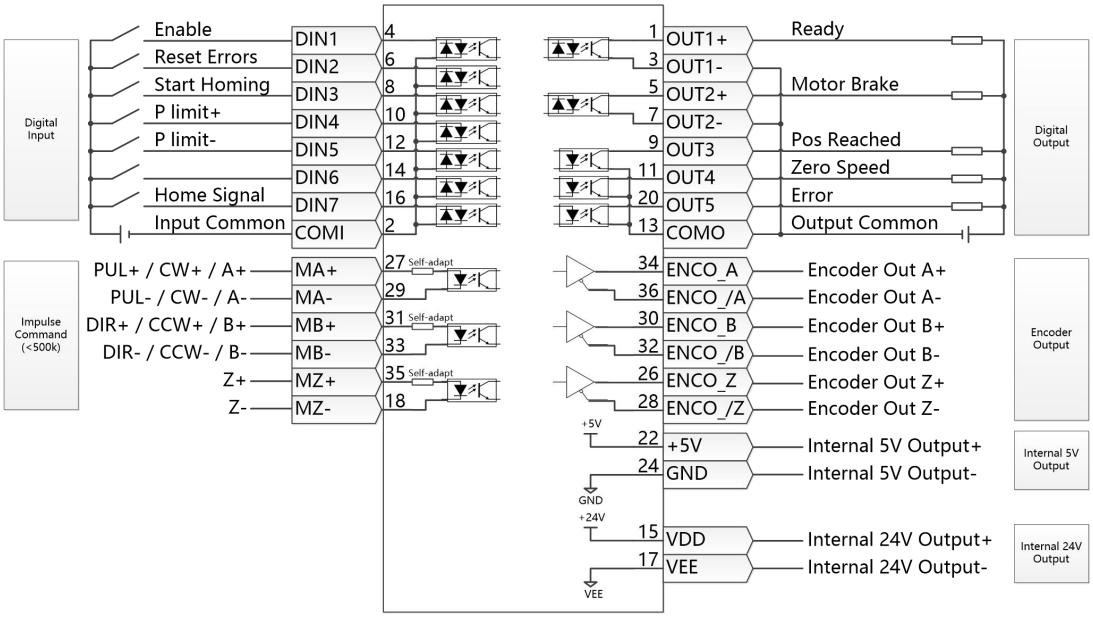


Figure 4-4 Pulse mode cable connection

When EA02 is set to8, the default input and output functions are as follows：

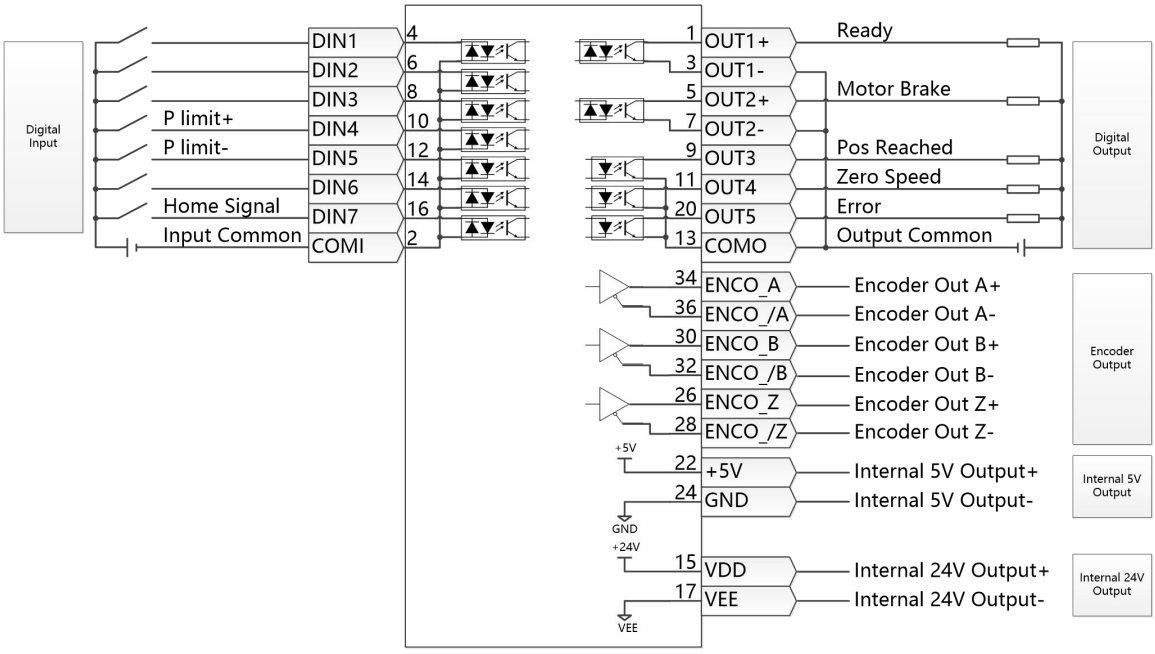


Figure 4-5 RS232 communication control mode wiring method

4.3.3 tunE operation flow chart

The tunE menu consists of self-tuning related functions and parameters based on inertia measurement. After the self-tuning is successful, the servo control loop adjustment can be simplified to adjust a single parameter (rigidity).

When the EASY process is completed, the drive selects the appropriate rigidity and inertia ratio defaults based on the load and application type in EA06.

If the ratio of inertia in the actual mechanical system is known, direct input can be made via tn02 (see Table 4-4). The inertia ratio does not need to be absolutely accurate, and the servo performance can be improved by adjusting the rigidity. However, by accurately measuring the inertia ratio, we can better adjust the control parameters to achieve multi-axis response matching. Therefore, it is of great significance to obtain an accurate ratio of inertia through the measurement of inertia.

The following flowchart and table details the tunE menu structure, setup steps, and variables.

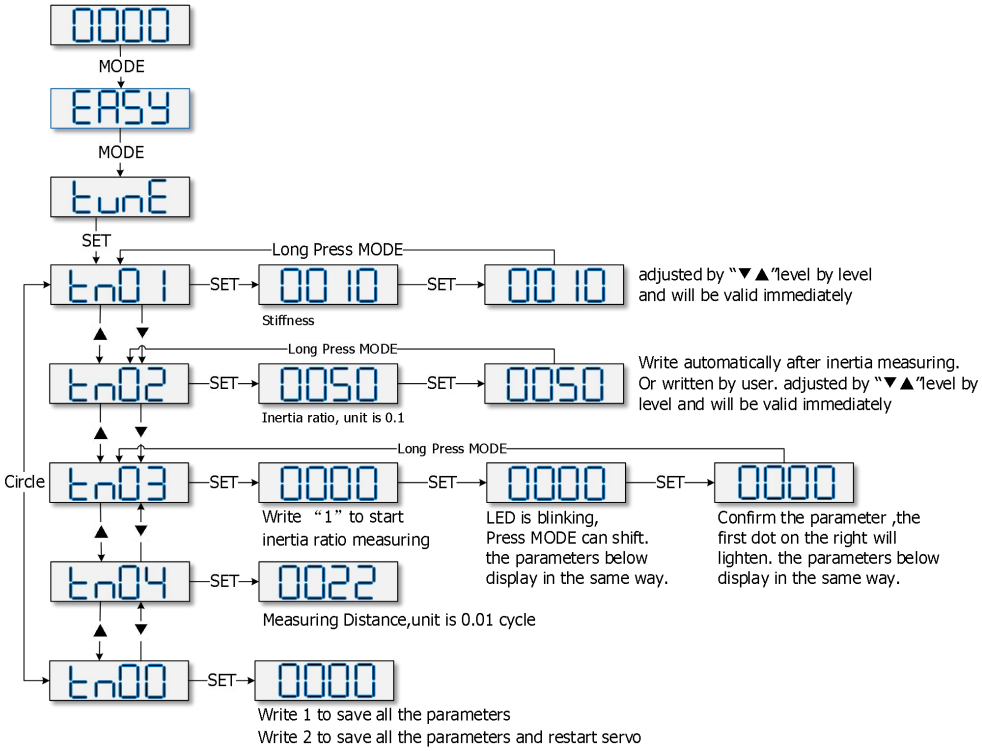


Figure 4-6 tunE operation procedure

Table 4-4 tunE parameters

tn01	Stiffness	level of control stiffness from 0 to31 determines the bandwidth (BW) of the velocity loop and the position loop (see table 4-5). The larger the value, the greater the stiffness. If this parameter is too large, the gain will change excessively and the machine will become unstable. When setting tn01 via the up and down buttons on the panel, entered values are valid immediately, in order to ensure the input of small change steps	Belt:10 Screw:13
tn02	Inertia_ratio	Ratio of total inertia and motor inertia (unit: 0.1) for example 30 represent an inertia ratio of 3. This value becomes defaulted by the EASY procedure and measured by the inertia measuring function in the tunE menu (tn03). When setting tn02 by the panel up down buttons, the data will be valid immediately, to ensure the input of small change steps.	Belt:50 Screw:30

tn03	Tuning_method	Writing 1 starts auto-tuning inertia measurement. The controller is enabled and the motor executes an oscillating motion for less than 1s. If tuning is successful, Tuning Method indicates a value of 1. The measured inertia is used to determine the Inertia Ratio. Stiffness is set to 4 to 12 depending on the inertia ratio. The control loop parameters are set according to Stiffness and Inertia Ratio. If the inertia measurement fails, Tuning Method indicates the fail-reason: 0: The controller could not be enabled by any reason. -1: Inertia cannot be measured due to too little motion or too little current. -2: The measured inertia result is outside the valid range. -3: The resulting Inertia Ratio value is greater than 250 (inertia ratio > 25). This is a possible result, but the control loop will not be tuned. -4: The resulting Inertia Ratio value is larger than 500 (inertia ratio > 50). This is an uncertain result. In the cases 0, -1, -2, -4 Inertia Ratio is set to 30, in the case -3 Inertia Ratio is set as measured, Stiffness is set to 7-10 In any fail case the control loop parameters are set to Inertia Ratio of 30 and the set Stiffness values. To make the measured Inertia Ratio of case -3 become effective, the value of tn02 must be confirmed by SET	-
tn04	Safe_Dist	Inertia measuring distance (unit: 0.01 rev), for example 22 represents 0.22 motor revolutions. The maximum is 0.4 revolutions	22
tn00	Saving parameters	Write “1” to save control and motor parameters. Write “2” to save control and motor parameters and reboot the servo. Write “3” to reboot the servo. Write “10” to initialize the control parameters	-

Table 4-5 Tuning result description

Tuning display	Tuning result description：
	1: The measurement result is correct and the inertia ratio is less than 25:1, the measurement of the inertia ratio result is valid, and the PID automatically adjusts according to the load inertia.
	-1: The speed amplitude is 1/4 of the set value or the current amplitude is less than 10DEC. The tuning result is invalid. It is recommended to increase the load detection operating range or initialize the rigidity re-detection.
	-2: Indicates that the calculated inertia coefficient is too large or too small, and the measurement result is not within the normal range. The integral needs to be adjusted, the limit parameters need to be re-tuned, and the result is invalid.
	-3: The inertia ratio exceeds 25:1. The inertia ratio result is valid but does not automatically set the loop parameters.
	-4: The measured inertia ratio is over 300 times the range. Inertia ratio result is invalid.

Table 4-6 Rigid grade table

Stiffness	Kpp0 [0.01Hz]	Kvp0 [0.1Hz]	Velocity feedback filter cut-off frequency[Hz]	Stiffness	Kpp0 [0.01Hz]	Kvp0 [0.1Hz]	Velocity feedback filter cut-off frequency[Hz]
0	70	25	18	16	1945	700	464
1	98	35	24	17	2223	800	568
2	139	50	35	18	2500	900	568
3	195	70	49	19	2778	1000	733
4	264	95	66	20	3334	1200	733
5	334	120	83	21	3889	1400	1032
6	389	140	100	22	4723	1700	1032
7	473	170	118	23	5556	2000	1765
8	556	200	146	24	6389	2300	1765
9	639	230	164	25	7500	2700	1765
10	750	270	189	26	8612	3100	1765
11	889	320	222	27	9445	3400	∞
12	1056	380	268	28	10278	3700	∞
13	1250	450	340	29	11112	4000	∞
14	1500	540	360	30	12500	4500	∞
15	1667	600	392	31	13889	5000	∞

Remind

- When the setting for the stiffness or inertia ratio results in a Kvp value of greater than 4000, it isn't useful to increase stiffness anymore。For encoders with less than 80000PPR resolution, the maximum rigidity level is 22.

Note

- Complete the EASY process before using the tunE menu feature;
- The self-tuning process may cause mechanical jitter, please be ready to cut off the driver power at any time;
- In order to prevent unnecessary mechanical damage, please ensure that the motor has sufficient range of motion before performing the self-tuning function.

4.3.4 Reasons for the failure of tunning

1. Incorrect wiring
2. The motor model is incorrectly set
3. The pre-enable function is configured for the input port, but is disabled
4. The set motor bearing is subjected to too much friction or other external forces
5. There is a large mechanical gap between the motor and the load
6. Very low mechanical rigidity
7. The load inertia ratio is too large
8. Load flexible connection
9. Acceleration and deceleration is less than the viscous friction torque

4.3.5 Tuning case

Rigid connection setting case (such as lead screw, rack and pinion, connecting rod and other rigid transmission structure) Operation instructions:

1.Enter EA01 through the panel keys, and confirm that the motor model is correct.
2.**Enter EA06 to set the tuning command type to 1002**, which means that the axis operation mode is point-to-point positioning control, the motor adopts rigid transmission structure to connect the load, the positive and negative limits use the current settings, and the OUT2 is normally open.
3.**Enter Tn04 to set the tunning distance**， The default value is 0022, which means 0.22 revolutions of the motor. If the load displacement distance allows, you can set TN04 to 0040, which means that the setting distance is extended to 0.4 revolutions of the motor.
4.**Set Tn03 to 1**， Turn on auto-tuning. After the tuning is completed the tuning result will be
Displayed on the panel
5.Perform the next adjustment according to different tuning results. For details of manual adjustment, please refer to Chapter 7.4

a. The result is 1: indicates that the tuning is successful and the inertia ratio is valid. The equipment can be run repeatedly by command, and the rigidity level Tn01 can be adjusted step by step. When the response is slow during the operation, the rigidity level Tn01 can be increased.
b. The result is -1: Indicates that the inertia is too small and the tuning fails, and the inertia ratio is invalid. You can increase the tuning distance Tn04 and then re-tune. Under this tuning result, the rigidity level Tn01 can also be adjusted to check the running effect. If the adjusted rigidity cannot meet the requirements, please use manual adjustment.
c. The result is -2: Indicates that the inertia coefficient is out of range, causing the tuning to fail and the inertia ratio to be invalid. You can modify the speed loop integral limit parameters to re-tune. Under this tuning result, the rigidity level Tn01 can be adjusted to check the running effect. If the adjusted rigidity cannot meet the requirements, please use manual adjustment.
d. The result is -3: Indicates that the inertia ratio exceeds 25 times, and the inertia ratio result is valid. After the tuning is completed, run the device, and when the motor vibrates or whistles, please use manual adjustment. The rigidity level Tn01 can be adjusted when the running equipment has no vibration/howling.
e. The result is -4: Indicates that the inertia ratio exceeds 300 times, and the inertia ratio result is invalid. After the tuning is completed, run the device, and when the motor vibrates/whistles, please use manual adjustment. The rigidity level Tn01 can be adjusted when the running equipment has no vibration/howling.

6.After the adjustment is completed, enter EA00 to set 1 to store the adjustment result.

Flexible connection setting case (such as synchronous belt, elastic coupling and other flexible transmission structure with tension) Operation instructions:

1.Enter EA01 through the panel keys, and confirm that the motor model is correct.
2.**Enter EA06 to set the tuning command type to 1001**, which means that the axis operation mode is point-to-point positioning control, the motor adopts a flexible transmission structure to connect the load, the positive and negative limits use the current settings, and the OUT2 is normally open.
3.**Enter Tn04 to set the setting distance. The default value is 0022**, which means 0.22 revolutions of the motor. If the load displacement distance allows, you can set TN04 to 0040, which means that the setting distance is extended to 0.4 revolutions of the motor.
4.**Set Tn03 to 1**， Turn on auto-tuning. After the tuning is completed, the tuning result mark will be displayed on the panel.
5.Perform the next adjustment according to different tuning results. For details of manual adjustment, please refer to Chapter 7.4.

a. The result is 1: Indicates that the tuning is successful and the inertia ratio is valid. The equipment can be run repeatedly by using the command, and the rigidity level Tn01 can be adjusted step by step. When the response is slow during the operation, the rigidity level Tn01 can be increased.
b. The result is -1: Indicates that the inertia is too small and the tuning fails, and the inertia ratio is invalid. You can increase the tuning distance Tn04 and then re-tune. Under this tuning result, the rigidity level Tn01 can also be adjusted to check the running effect. If the adjusted rigidity cannot meet the requirements, please use manual adjustment

c. The result is -2: Indicates that the inertia coefficient is out of range, causing the tuning to fail and the inertia atio to be invalid. You can modify the speed loop integral limit parameters to re-tune. Under this tuning result, the rigidity level Tn01 can be adjusted to check the running effect. If the adjusted rigidity cannot meet the requirements, please use manual adjustment.
d. The result is -3: Indicates that the inertia ratio exceeds 25 times, and the inertia ratio result is valid. After the tuning is completed, run the device, and when the motor vibrates or whistles, please use manual adjustment. The rigidity level Tn01 can be adjusted when the running equipment has no vibration/howling
e. The result is -4: Indicates that the inertia ratio exceeds 300 times, and the inertia ratio result is invalid. After the tuning is completed, run the device, and when the motor vibrates/whistles, please use manual adjustment. The rigidity level Tn01 can be adjusted when the running equipment has no vibration/howling

6. After the adjustment is completed, enter EA00 to set 1 to store the adjustment result.

4.4 Jog mode (Test run)

The jog mode can be used to test the basic operating condition of the motor. In the jog mode, the user can test whether the motor can rotate according to the set speed through the key and the digital tube display. The point mode is not affected by other operating modes or speed Settings, and the controller is in speed mode when running and runs at 30rpm.

Steps of Jog operation:

Step 1: Check all wiring is right, ESAY flow has been completed.
Step 2: Enter panel menu F006, address d6.40 appears, press ▼ several times until d6.15 appears, press ▲ several times until d6.25 appears (This step ensures that the up and down buttons work properly),then press SET again and the nixie tube will display 'Jog'.
Step 3: Press and hold ▲ for positive direction or ▼for negative direction. The controller will become enabled automatically and the motor shaft will rotate with velocity Jog_RPM. Release ▲ and ▼ , to stop the motor shaft.

If in Step 3 for more than 20 seconds none of▲ or ▼ was pressed, the Jog operation will quit and a new Jog operation needs to be started from Step 1 again.

Note

- The limit switch does not function in jog mode.
- To prevent unnecessary mechanical damage caused by excessive rotational speed, the default starting speed is 30rpm. You can change the starting speed (unit: rpm) when entering the F000 group d0.08.
- If the digital input function is configured to be pre-enabled, executing the point mode requires that the actual digital input or the simulated digital input be at the correct level, otherwise a pre-enabled alarm will be caused.

4.5 Error history (F007)

The drive can retain the last 8 historical errors. Enter F007, press SET and the error status (2601.00) will be displayed on the nixie. If 0001 is displayed, it indicates an extension error, and you can press SET again to display error status 2(2602.00). Access the entire history error by ▲ or ▼. In the nixie display area, counting from left to right, the third light indicates the earliest error, and the fourth light indicates the latest error. Some faults can be masked and written to historical errors. For details, see Section 5.7.

Table 4-7: F007 diaplay example

F007 LED display	Meaning
000.1	The current error code is the latest. And the current extension error, press SET to view the value of error status 2(2602.00)
02.00	The current error indicates that the actual trace error exceeds the allowable and is the earliest error code.
0100	The current driver brake resistance is abnormal. Neither the latest nor the earliest error.

Chapter 5 KincoServo + user guide

This chapter contains information about how to use the PC software Kincoservo+
The PC with new software function, can through the following link to download **KincoServo_HV DAT file** to replace the inside of the original software installation package . dat file, the link address:
https://www.kinco.cn/download/dsoft.html

Figure 5-1 Main window of Kincoservo+

5.1 Getting started

5.1.1 Language

Language can be switched between English and Chinese via menu item Tools->Language.

5.1.2 Open and saving project files

Create a new project file via menu item File->New, or by clicking the button.

Open an existing project via menu item File->Open, or by clicking the button and selecting a .kpjt file

Save a project via menu item File->Save, or by clicking the button and saving as a .kpjt file

Note
The saved.kpjt project file only saves the Windows in the upper computer software, and cannot save the parameters in the drive.

5.1.3 Starting communication

Click menu item Communication->Communication settings. The following window appears:

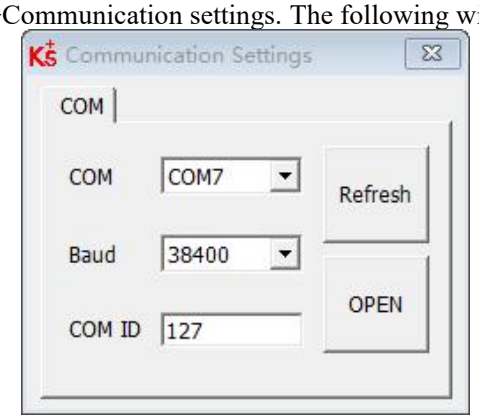


Figure 5-2 Communication setting

Select the right COM port (if it′ s not shown click the ″Refresh″ button), baud rate and COM ID (Node ID),and then click the "OPEN″ buton.

Once communication has been established with the controller, communication can be opened or closed by clicking the button .

5.1.4 Node ID and baud rate

The drive station number can be set through the menu bar "Drive" -> "Drive Property".

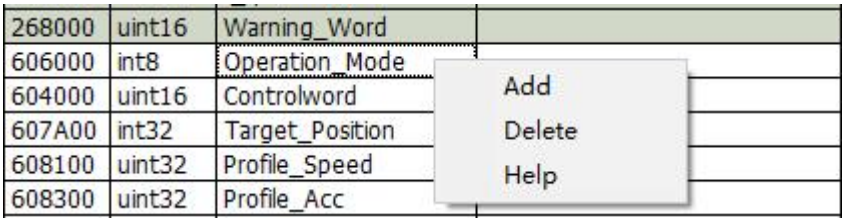
Table 5-1 note ID and baud rate

Panel address	Internal address	Type	Name	Value	Unit
D5.01	100B.00	Uint8	Node_ID	1~127	DEC
D5.02	2FE0.00	Uint16	RS232_baudrate	Panel setting Baudrate 540 19200 270 38400 90 115200	Baud

Note
The device station number and baud rate take effect only after the control parameters are stored and the drive is restarted.

5.1.5 Objects (add，delete，help)

Open any window with an object list, move the mouse pointer to the object item and right click. The following selection window appears:



Click **Add** and double click the required object from the **Object Dictionary**. The selected object is then added to the list.
Click **Delete**. The selected object is removed from the list.
Click **Help** to read a description of the selected object in the **Object Dictionary**.

5.2 Init save reboot

Click Controller->Init Save Reboot.

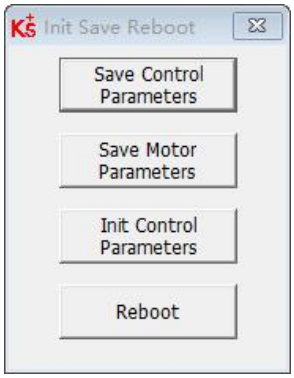


Figure 5-3 Init save reboot

Click the corresponding item to finish the necessary operation.

Note
After initializing the parameters, you need to save the control parameters to save the default parameters in the drive.

5.3 Firmware update

In general, the firmware of the drive is always the latest version, but if the drive firmware needs to be updated for some reason, please go to the menu bar "**Controller**" -> "**Load Firmware** ".

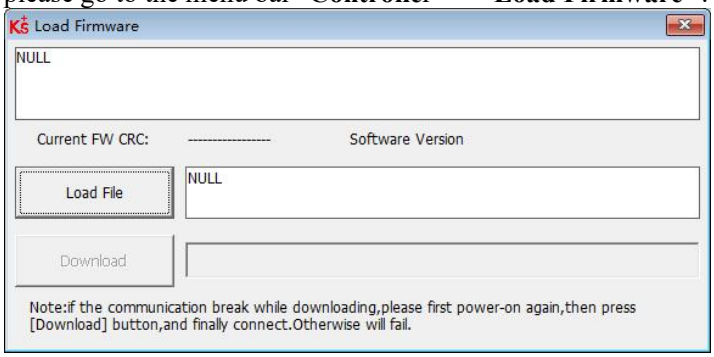


Figure 5-4 Load firmware

Click "Load File" to select the firmware file (.kinco), then click "Download" to start updating the drive firmware. After successful download, please click the menu bar "Drive" -> "Drive Properties" -> "Software Version" to determine whether the firmware download is successful.

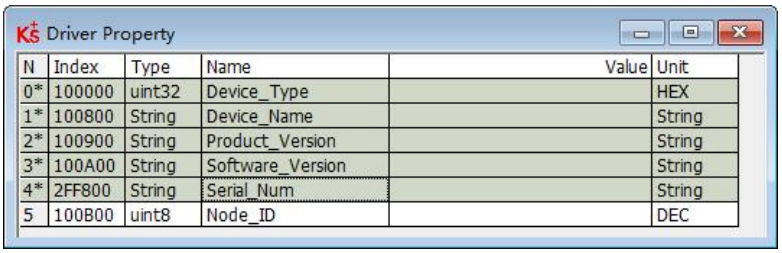


Figure 5-5 Software version

Note
If the download is stopped for some reason, first power off, then power on the drive, select the firmware version and start downloading, and finally turn on the communication and connect to the host computer.

5.4 Read/write controller configuration

For a large number of the same applications, in order to avoid setting drive parameters one by one, you can use this feature to configure drives.

5.4.1 Read setting from Driver

Click Tools->R/W Controller Configuration->Read Settings from Driver or click the button. The following window appears：

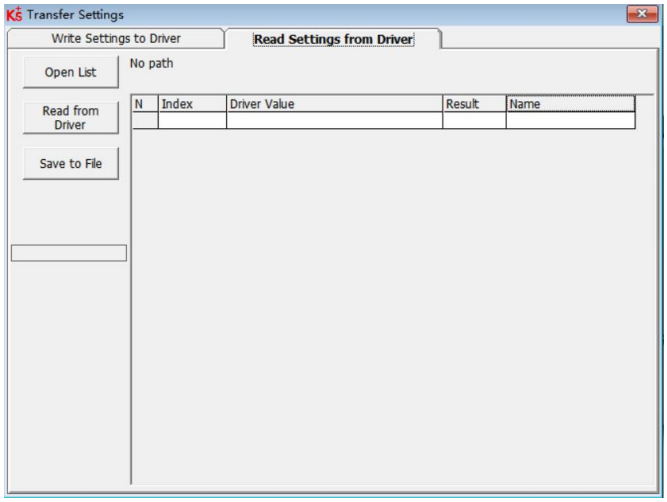


Figure 5-6 Read drive configuration

- Click Open List to select a parameter list file (.cdo). The parameter appears in the window.
- Select the cdo file, the path contains two different cdo files:
  - errlist.cdo，Only read the historical fault information in the drive.
  - Kinco_Settings_Without Postable，read drive control parameters and motor parameters
- Click Read Settings from Controller to get the Drive Value and Result, and then click Save to File to save the setting as a .cdi file

Note

- If the object does not exist in the drive, the result will be "False" and will be highlighted in red, and only read parameters with a result of "true" will be saved in the.cdi file.

5.4.2 Write setting to Driver

Click Tools->R/W Controller Configuration->Write Settings to Controller or click the button, the following window appears

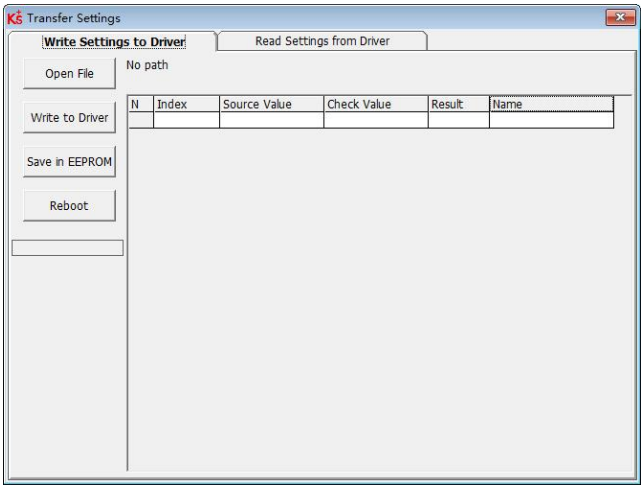


Figure 5-7 Write drive configuration

- Click Open File to select a parameter settings file (.cdi). The parameter settings appear in the window.

- Click Write to Driver to get the Check Value and Result. The "False" means the value has not been written successfully, probably the object doesn't exist in the driver.
- Click Save in EEPROM and Reboot to activate all parameters.

Note
Before writing the settings to the drive, unenable the drive, if the drive is enabled, some objects cannot be successfully written.

5.5 Digital IO function

Click menu item Driver->Digital IO Functions or click the button I-O, a pop-up window will appear. The following figure shows the default function and polarity.

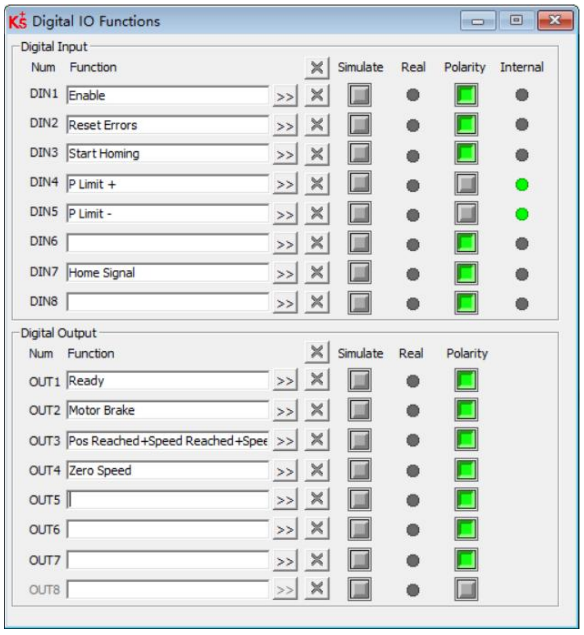


Figure 5-8 Digital IO

5.5.1 Digital input

Figure 5-9 Digital input

Function: Click >> to select Din function setting click ✕ to delete the DIN function

Real: Shows the real digital input hardware status.

Actual input: Displays the actual digit input status

Polarity: indicates a high level input, and the effective input is 1; indicates a low level input, and the effective input is 1.

Real: Shows the real digital input hardware status.

means "active", logic status of the digital input is 1; means"not inactive", logic status of the digital input is 0.

Table 5-2 Digital input function

DIN function	Description
Enable	Controller enabling 1: Enable controller = Din control word selection(2020.0F) 0: Disable controller = 0x06
Reset errors	Set the Controlword to reset errors, active edge （bit7） = 1
Operationg mode	Operation_mode selection 1:Operation_mode = EL.Din_Mode1 (2020.0E)，Defult value=-4 0:Operation_mode = EL.Din_Mode 0 (2020.0D)，Defult value =-3
Kvi off	1: Velocity control loop integrating gain off 0: Velocity control loop integrating gain has been set. Refer to chapter 7 for more information about Kvi
P limit+	Positive/Negative position limit switch input for “normally closed” limit switches 0: position limit is active, the related direction is blocked
P limit-	
Home signal	Home switch signal for homing
Invert Direction	Inverts command direction in the velocity and torque mode
DinVel Index 0	Din_Speed Index in the DIN speed mode
DinVel Index 1	
DinVel Index 2	
Din Pos Index0	Din position index in Din position mode
Din Pos Index1	
Din Pos Index 2	
Quick stop	Set control word bit2=0 to enable emergency stop. If you want to re-enable after emergency stop, you need to first set the control word to 0x06 and then to 0x0F (if the input port is configured with drive enable, you only need to trigger the enable signal again).
Start homing	Starts homing. Only makes sense if the controller is enabled. The controller returns to the previous operation mode after homing.
Activate Command	Actives the position command. Controls bit 4 of the Controlword, e.g. Controlword=0x2F—>0x3F
Motor error	If an external error occurs (for example, the motor itself is too hot), the error signal can be transmitted to the driver through the input port
Fast capture 1	Fast capture, refer to chapter 5.5.3 for more details
Fast capture 2	
Pre enable	For safety reasons, pre-enable can serve as a signal for indicating whether or not the entire system is ready， 1：Drive can be enabled；0：Drive can not be enabled
PosTable Cond 0	The operating conditions of the position table mode are detailed in Section 6.4.1
PosTable Cond 1	
Start PosTable	Start the position table mode. For details, please refer to Section 6.4.1
Position table index 0	In position table mode, the starting position index is determined by the BCD code composed of position table index 0, position table index 1, and position table index 2
Position table index 1	
Position table index 2	
Abort PosTable	Terminate the position table operation mode, see Chapter 6
Reset count	Clear the number of pulses the drive has received but not completed
Halt	1：Pause motor，code: bit8 = 1 0：Motor continues to execute unfinished instructions
Forward trim	Position fine-tuning data in positive direction in active pulse mode
Negative trimming	Position fine-tuning data in negative direction in active pulse mode

Note
DIN control word selection (2020.0F) is set to 0x2F by default. For the definition of control word, please refer to Chapter 6.1

5.5.2 Digital output

Figure 5-10 Digital output

Function：Click >> to select Din function setting click ✕ to delete the DIN output function

Real：Shows the real digital output hardware status.

Actual output: Displays the actual digital output state, which is the result of the comprehensive action of simulation, polarity and logic state, ● indicates the digital output is ON, ● indicates the digital output is OFF

Polarity：■ indicates that if the logical status is 1, the actual output is ON；■ indicates that if the logical status is 0, the actual output isON。

Effective output: the result of simulation, actual output and polarity action; ● indicates activation,the logical status of the corresponding function is 1. ● indicates not activation,the logical status of the corresponding function is 0.

Table 5-3 Digital output function

OUT function	Description
Ready	Controller is ready to be enabled
Error	Controller error
Pos reached	In position mode, when the difference between the actual position and the target position is less than the target position window (6067.00), and the duration is greater than or equal to the position window time (6068.00), the output position to the function is displayed
Zero speed	When the absolute value of the actual velocity -ms (60F9.1A) is less than or equal to the zero velocity window (2010.18), and the duration is greater than or equal to the zero velocity time (60F9.14), the zero velocity function is output
Motor Brake	The motor brake control output signal can be used to connect an external relay that controls the motor lock. If the brake motor is used, this function must be set, otherwise it will damage the motor. An effective output of green indicates that the brake is opened, and an effective output of gray indicates that the brake is closed.
Speed reached	Output speed to function when the speed error (60F9.1C) is less than the speed to window (60F9.0A)
Enc Index	Motor index signal appear
Speed limit	In torque mode ,actual speed reached Max_Speed(607F.00)
Driver enabled	Drive is enabled. Motor locks shaft
Position limit	In the positive and negative position limit
Home found	Home found
Torque reach limit	When the actual torque (60F5.08) reaches the reference (60F5.06) and the duration exceeds the filter time (60F5.07), the output torque reaches the limit, and the torque reaches the reference (60F5.06) is set to 0, indicating that the torque limit detection is not enabled .
PosTable Active	Position table mode active
Multi Dout 0	Din multi-segment position control position to output function, please refer to Chapter 6 section 6.4.1 for details
Multi Dout 1	
Multi Dout 2	

5.5.3 Fast capture

The Fast Capture function is used to capture the Position_Actual(6063.00) when the related DIN edge occurs. Response time is maximum 2ms.

Table 5-4 Fast capture

Internal address	Type	Name	Unit
2010.20	Uint8	Rising_Captured 1	Dec
2010.21	Uint8	Falling_Captured 1	Dec
2010.22	Uint8	Rising_Captured 2	Dec
2010.23	Uint8	Falling_Captured 2	Dec
2010.24	Int32	Raising_Capture_Position 1	Dec
2010.25	Int32	Falling_Capture_Position 1	Dec
2010.26	Int32	Raising_Capture_Position 2	Dec
2010.27	Int32	Falling_Capture_Position 2	Dec

When DIN function Fast_Capture1 is configured to DIN and a rising DIN edge occurs, Rising_Captured1 is changed to 1. At the same moment Pos_Actual is stored to Rising_Capture_Position1. If a falling DIN edge occurs, Falling_Captured1 is to 1. At the same moment Pos_Actual is stored to Falling_Capture_Position1.

Once Rising_Captured1 or Falling_Captured1 is changed to 1, the user needs to reset them to 0 for the next capturing operation, because any further edges after the first one will not be captured.

The usage method of Quick Capture 2 is similar to that of Fast_Capture1 .

5.6 Scope

In the operation process, if the operation effect of the equipment can not meet the requirements, or other accidents occur, you can use the oscilloscope to analyze the problem.

Click the button in the software to turn on the oscilloscope.

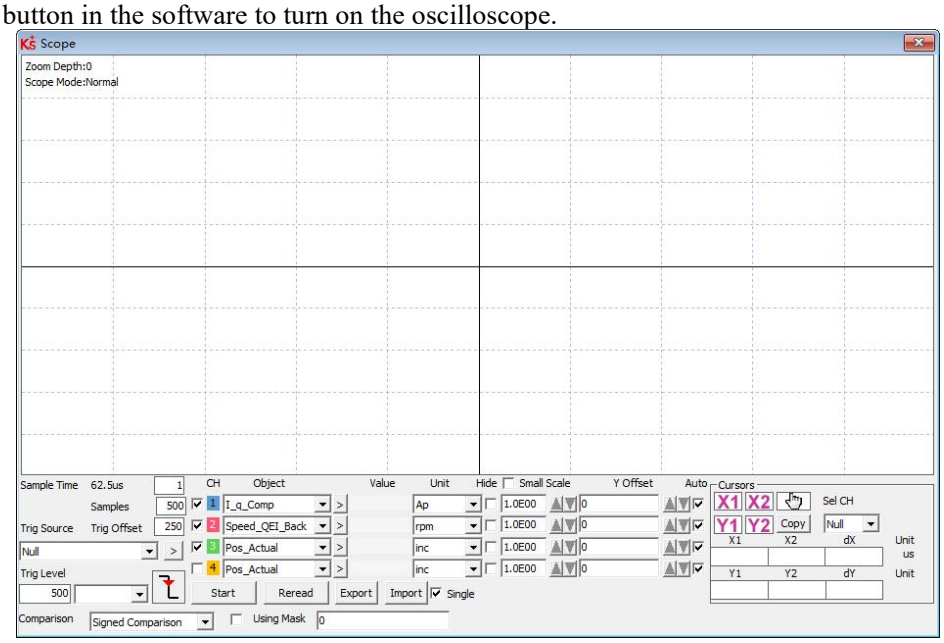


Figure 5-11 Scope window

Sample time: Data collection period. If the value is set to 1, data is collected every 62.5us.

Samples: This parameter indicates how many data are collected during the sampling. If the value is set to 500, 500 data are collected.

Trig offset: The number of samples before the trigger source is triggered.

Trig source and Trig level： The trigger condition is set in Figure 5-13 to start collecting data when the effective target current q rises to 100DEC. DEC is the internal unit and can be switched to the current unit.

Trigger edge： clicking could change it to rising edge trigger 、 falling edge trigger or rising and falling edge trigger .

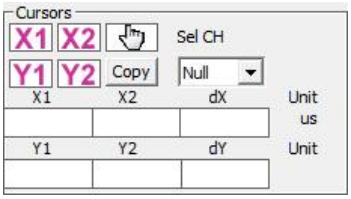
Object**: Maximum 64-bit length data can be taken in one sample, e.g.: 2 Int32 objects bit or 4 Int16 objects.**

Single： Single means sample for one trigger event only； Single means sample continuously.

Zoom in/ Zoom out the oscillogram： Hold down the right mouse button and drag the mouse down to the right to zoom in, and to the upper left to zoom out.

Cursors： Up to 4 scope cursors can be selected by clicking X1 X2 / Y1 Y2 button. The scope cursors appear in the oscillogram ,and select the channel you want to observe from the Channel Selection drop-down menu.

Moving Cursors： Hold down the left mouse button, drag the cursor to move, the sampled data, the difference between X1X2 and Y1Y2 will be displayed in the following area：



Copy： Copy the sampled data to the clipboard, you can open excel and paste the data directly.

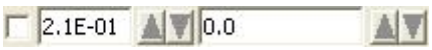
Move： The button turns to yellow means the moving works. You can drag the wave by holding down the left mouse button in the oscilloscope .

Export: Exports the sampled data as a .scope file.

Import: Imports a .scope file and shows the oscillogram in the scope window.

Reread： Rereads the last scope data out of the controller and shows the oscillogram in the scope window.

Auto： If the checkbox Auto is checked, the oscillogram is auto-scaled.If Auto is not checked, the oscillogram is scaled by scale and offset value in following



Scale and offset value can be increased by pressing the ▵ button, and can be reduced by pressing the ▿ button. If Small scale checkbox is checked, scale value changing step is changed to 10% as before.

Oscilloscope mode： On the upper left side of the oscillogram the Scope Mode "normal " or "import" is shown.

-Normal: All buttons on the oscilloscope are available

-Import: The oscillogram is imported from the.scope file. In this mode, the start and reread data buttons are disabled, and you can exit the import mode as prompted by the software.

Table 5-5 Oscilloscope group parameters

Internal address	Type	Name	Description	Unit
2300.01~2300.06	Uint32	Oscilloscope object 1-6	Oscilloscope object 2 address (Format : xxxxyyzz,xxxx:index; yy:subindex;zz:data length) Used to acquire 16-bit data; oscilloscope object 1~6 data bits total length up to 64 bits	Hex
2300.07	Uint8	Oscilloscope control	0: The oscilloscope is in an idle state, and the data captured by the oscilloscope can be read at this time 1: The oscilloscope is in the state of acquiring a certain length of data before the trigger event 2: The oscilloscope is always collecting data 3: The oscilloscope gets the trigger signal, is collecting data of a certain length, and will enter idle mode after completion	Dec

2300.08	Uint16	Sampling period	Oscilloscope sampling period	62.5us
2300.09	Int16	Trigger offset	The length of data to store before triggering the event. If you set data to -1, the oscilloscope will continuously acquire data until it is manually stopped. Used for some special occasions. At this point, the oscilloscope continuously monitors the trigger conditions, saves the data after the trigger is satisfied, and continues to monitor the trigger conditions after the acquisition ends.	Dec
2300.0A	Uint16	Number of samples	The number of samples	Dec
2300.0B	Uint8	Trigger edge	Oscilloscope trigger edge control consisting of BCD codes Bit 0： 0—Falling edge trigger； 1—Rising edge trigger Bit 1： 0-- Signed Comparison； 1-- Absolute Value Comparison bit 2：1—use mask（23000E20），AND gate Note: You can no longer use the up and down arrows on the oscilloscope page to set the trigger edge to prevent conflicts.	Dec
2300.0C	Uint32	Trigger source	Oscilloscope Trigger Object	Dec
2300.0D	Int32	Trigger level	Oscilloscope Trigger level	Dec

5.7 Error display and error history

Error： Click "Controller" -> "Error display"，or click button（which turns red if an error occurs），The Error Display window appears. It shows the last errors.

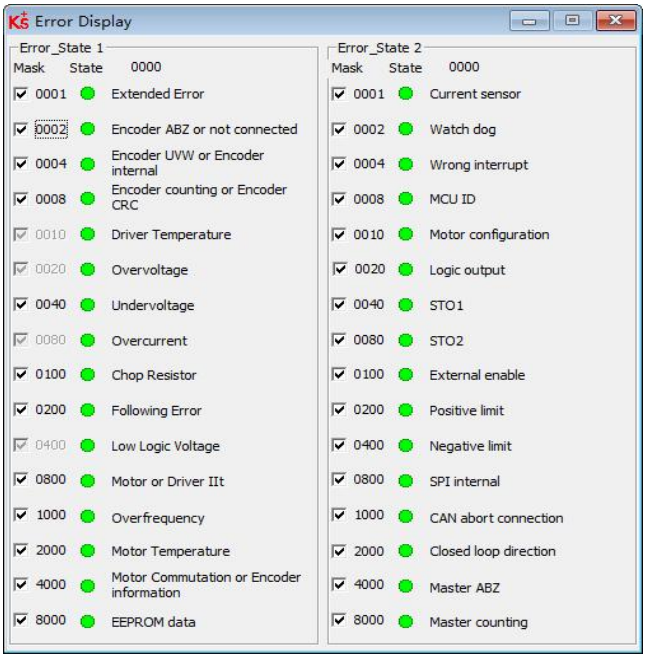


Figure 5-12 Error display window

Error history： Click "Controller" -> "Error history"， The error history window will pop up and display the last 8 error messages, including error word, bus voltage, speed, current, temperature, working mode, and power tube status. The most recent historical failure is displayed on the first line.

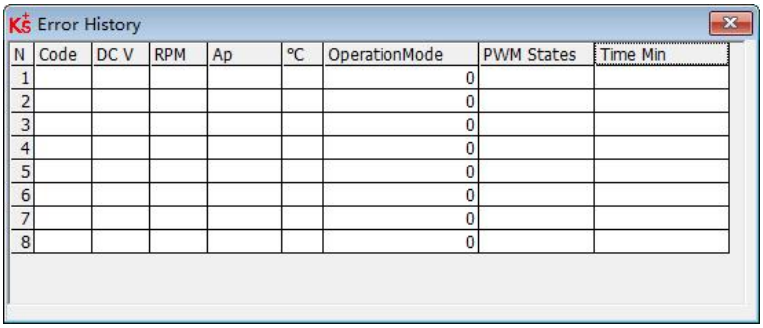


Figure 5-13 error history display window

Table 5-6 Error_state（2601.00）information

Bit	Error name	Error code	Description
0	Extended Error		Refer to object “Error_State 2”(2602.00)
1	Encoder not connected	0x7331	No communication encoder connected
2	Encoder internal	0x7320	Internal encoder error
3	Encoder CRC	0x7330	Communication with encoder disturbed
4	Controller Temperature	0x4210	Heatsink temperature too high
5	Overvoltage	0x3210	DC bus overvoltage
6	Undervoltage	0x3220	DC bus undervoltage
7	Overcurrent	0x2320	Power stage or motor short circuit
8	Chop Resistor	0x7110	Overload, brake chopper resistor
9	Following Error	0x8611	Max. following error exceeded
10	Low Logic Voltage	0x5112	Logic supply voltage too low
11	Motor or controller IIt	0x2350	Motor or power stage IIt error
12	Overfrequency	0x8A80	Pulse input frequency too high
13	Motor Temperature	0x4310	Motor temperature sensor alarm
14	Encoder information	0x7331	No encoder connected or no encoder communication reply
15	EEPROM data	0x6310	EEPROM checksum fault

Table 5-7 Error_state2（2602.00）information

Bit	Error name	Error code	Description
0	Current sensor	0x5210	Current sensor signal offset or ripple too large
1	Watchdog	0x6010	Software watchdog exception
2	Wrong interrupt	0x6011	Invalid interrupt exception
3	MCU ID	0x7400	Wrong MCU type detected
4	Motor configuration	0x6320	No motor data in EEPROM / motor never configured
5	Reserved		
6	Reserved		
7	Reserved		
8	External enable	0x5443	DIN "pre_enable" function is configured, but the DIN is inactive when the controller is enabled / going to be enabled
9	Positive limit	0x5442	Positive position limit (after homing) – position limit only causes error when Limit_Function (2010.19) is set to 0.
10	Negative limit	0x5441	Negative position limit (after homing) position limit only causes error when Limit_Function(2010.19) is set to 0.
11	SPI internal	0x6012	Internal firmware error in SPI handling
12	CAN bus interrupt	0x8100	Communication interruption mode (6007.00) is set to 1 to generate fault alarm

13	Closed loop direction	0x8A81	Different direction between motor and position encoder in closed loop operation by a second encoder.
14	Master ABZ	0x7382	Master encoder connection error
15	Master counting	0x7306	The main encoder index signal is abnormal

Remind

There's a mask checkbox beside every error item， all are defaulted to be checked , means it can be unchecked， means it can't be unchecked. mean the related error will be ignored.The error mask can also be set with the object error mask (2605.01) and Error mask 2 (2605.04) (see Table 5-9).

Table 5-8 Error extension （2605.07） information

Bit	Error name	Error code	Description
0	Origin record error	0x5210	Current sensor signal drift or ripple is too large
1	Internal braking resistor overtemperature	0x7111	The actual power of the internal braking resistor is too high
2	Internal braking resistor short circuit	0x7112	Internal braking unit damaged, braking circuit short circuit
3	Motor phase loss	0x6321	A phase in the motor power line UVW is not connected
4	ADC sampling saturation	0x2321	Current sampling ADC reaches limit, current runaway
12	Service timeout	0x81FF	Communication Bus Error Extension
13,14	Driver input missing a phase detection	0x3221	bit[13:14] : 11: power input missing two phases (power failure); 01: Power input missing a phase (single-phase input without this); 00: Power input normal
	Driver input missing two/three phase detection	0x3222	

Table 5-9 Error mask

Internal address	Type	Name	Meaning (Bit meaning please see table5-7 and table 5-8)	Default
2605.01	Uint16	Error_Mask	Mask of Error_State(2601.00). Bit = 0 means related error will be ignored.	0xFFFF
2605.02	Uint16	Store_Mask_ON	Error mask for Error_History of Error_State(2601.00) when controller is enabled. Bit = 0 means related error won't be stored in the Error_History	0xFBFF
2605.03	Uint16	Store_Mask_OFF	Error mask for Error_History of Error_State(2601.00) when controller is not enabled. Bit = 0 means related error won't be stored in the Error_History	0x0000
2605.04	Uint16	Error_Mask2	Mask of Error_State2(2602.00). bit = 0 means related error will be ignored	0xFFFF
2605.05	Uint16	Store_Mask_ON2	Error mask for Error_History of Error_State2(2602.00) when controller is enabled. Bit = 0 means related error won't be stored in the Error_History	0xF1FF
2605.06	Uint16	Store_Mask_OFF2	Error mask for Error_History of Error_State2(2602.00) when controller is not enabled. Bit = 0 means related error won't be stored in the Error_History	0x003F

Chapter 6 Operation mode introduction

The driver parameters can be set through the driver panel or RS232 interface connected to the upper computer debugging software. In the following introduction, the nixie display address and the internal address will be displayed in the object list (not all objects have corresponding panel addresses)

6.1 General steps for starting a control mode

Step1: wiring

Make sure that the necessary wiring for the application is done correctly (refer to chapter 3);

Step 2: IO function configuration

See chapter 5.5 concerning meanings of the IO function and polarity

Table 6-1 Digital input function

Panel address	Internal address	Type	Name	Value (hex): description
D3.01	2010.03	Uint16	Din1_Function	0001: Enable 0002: Reset Errors 0004:Operation Mode control 0008: Kvi Off 0010: P limit+ 0020: P limit- 0040: Homing Signal 0080: Invert Direction 0100: Din Vel Index 0200: Din Vel Index1 1000: Quick Stop 2000: Start Homing 4000: Activate Command 8001: Din Vel Index2 8004: Multifunction0 8008: Multifunction1 8010: Multifunction2 8020: Gain Switch 0 8040: Gain Switch 1 8100: Motor Error 8200: Pre Enable 8400: Fast_Capture1 8800: Fast_Capture2 9001: PosTable Cond0 9002: PosTable Cond1 9004: Start PosTable 9008: PosTable Idx0 9010: PosTable Idx1 9020: PosTable Idx2 9040: Abort PosTable A001:Clear pulse A002:Pause A040: pulse forward fine-tuning A080:Pulse negative fine-tuning
D3.02	2010.04	Uint16	Din2_Function	
D3.03	2010.05	Uint16	Din3_Function	
D3.04	2010.06	Uint16	Din4_Function	
D3.05	2010.07	Uint16	Din5_Function	
D3.06	2010.08	Uint16	Din6_Function	
D3.07	2010.09	Uint16	Din7_Function	

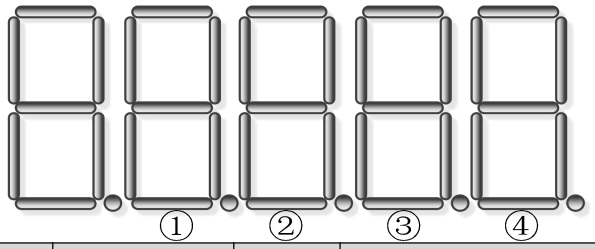
Table 6-2 Digital function output

Panel address	Internal address	Type	Name	Value (hex): description
D3.11	2010.0F	Uint16	Dout1_Function	0001: Ready 0002:Error 0004: Pos reached 0008: Zero speed 0010: Motor brake 0020: Speed reached 0040: Enc Index 0080:Speed limit 0100:Driver Enabled 0200: Position limit 0400: Home Found 0800: Torque reached limit 1000:Multi Dout 0 2000:Multi Dout 1 4000:Multi Dout 2 9001:PosTable Active
D3.12	2010.10	Uint16	Dout2_Function	
D3.13	2010.11	Uint16	Dout3_Function	
D3.14	2010.12	Uint16	Dout4_Function	
D3.15	2010.13	Uint16	Dout5_Function	

Table 6-3 Polarity setting

Panel address	Internal address	Type	Name	Description
D3.08	2FF0.0D	Uint16	Simplified IO polarity	Set IO polarity
D3.09	2FF0.08	Uint16	IO simulation	Used to simulate the input signal and force the output of a valid signal

Table 6-4 Digital input and output signal polarity and simulation setting method



	①	②	③	④
Polarity setting D3.08	Input/Output port 0：output 1：input	Channel input：1-7 output：1-5	keep	0：input and output ports are normally closed 1：input and output ports are normally closed Other than 0 or 1：check the current situation
Simulation setting D3.09	Input/output port 0：output 1：input	Channel input：1-7 output：1-5	keep	0：no simulate signals, it will not force output of valid signal 1：simulate signals, it will force output of valid signal Other than 0 or 1: check the current situation。

Example:
Setting d3.08 to "110.0" means that the DIN1 input port is a normally closed point, and setting d3.08 to "110.1" means that the DIN1 input port is a normally open point. Setting d3.09 to "110.0" means not to simulate the DIN1 input signal, and setting d3.09 to "110.1" means to simulate the DIN1 input signal.

Power-on Self-Enable (Expert Mode)

If the Enable function is not configured to DIN, the controller can be auto-enabled at power-on or reboot, with the following setting:

Table 6-5 Power-on Self-enable

Panel address	Internal address	Type	Name	Value
D3.10	2000.00	Unit8	Power-on Self-enable	1

Note
If the DIN port defines an enable signal, it cannot be powered on by the panel settings. Customers are not recommended to use the power-on self-enable operation. If you want to use it, you must fully consider the safety issues.

Step 3: Set necessary parameters

This chapter describes the setting of basic operation parameters. On the upper computer software interface, click **Driver** -> **Basic Operation** to enter the setting interface of basic operation parameters. Refer to **Chapter 7** for performance adjustment of servos. Refer to **Chapter 9** for instructions on how to operate the servo panel.

Related basic parameter Settings (Some basic parameters are not in the basic operation interface of the software, and can be added freely by referring to **section 5.1.5**)

Table 6-6 Basic parameters

Panel address	Internal address	Bit	Name	Description
D0.00	6060.00	8	Operation_mode	-3 : Immediate speed mode 3:Speed mode with acceleration and deceleration 1: position mode -4: Pulse mode 4: Torque Mode
D0.01	6040.00	16	Controlword	0x0F/0x2F: Used when operation_mode is -3, 3, -4, 4 and position flow mode 0x2F->0x3F: Activate the absolute position command, the absolute positioning command will not be executed immediately according to the change of the target position, it is used when the operation_mode is 1 0x4F->0x5F: Activate the relative position command, used when the operation_mode is 1 0x103F: Immediately execute the absolute positioning command according to the target position change, used when the operation_mode is 1 0x0F->0x1F: Used when starting to find the origin in 6 mode 0x06->0x86: Used when resetting drive faults 0x06: Loosen the shaft, turn off the drive enable
	607A.00	32	Target location	target absolute/relative position
	6081.00	32	Trapezoidal velocity	Contour velocity in position mode
	6083.00	32	Profile_Acc	Profile acceleration, profile deceleration, for Operation_Mode 1 and 3
	6084.00	32	Profile_Dec	
	60FF.00	32	Target speed	Target speed in 3 operation_mode and -3 operation_mode
	6071.00	16	Target torque %	Target torque as a percentage of rated torque
	6073.00	16	CMD_q_Max	Drive output current limit

D3.16	2020.0D	8	Din_Mode0	If Operation Mode Sel function is configured to DIN, Operation_Mode(6060.00)=Din_Mode0 when Din_Internal=0; Operation_Mode=Din_Mode1 when Din_Internal=1
D3.17	2020.0E	8	Din_Mode1	
D0.07	2690.00	8	Encoder_Data_Reset	Since the absolute value encoder data is saved by the battery, when the device runs for the first time, it is necessary to clear the multi-turn data at the origin position. After clearing the encoder status and multi-turn data, restart/reset the drive. Communication encoder command write: 1: clear encoder status 2: read fault word 3: Clear encoder status and multi-turn data 8; reset the status flag 9: Clear multi-lap data 10: Equivalent to 8 + 9 12: Clear lap data (requires factory password) Read: bit 0: 1 = Command can be entered bit 1: 1 = Last command execution completed

Note
When the value directly written in the Operation_mode through the basic operation interface cannot be saved after power off and restart, the Operation_mode can be saved by configuring the Operation_mode control function on the input port of the drive, but it should be noted that the Operation_mode is selected 0 first. Set it with the value of operation mode selection 1, and then store the control parameters.

Step 4: Save and reboot

For details on how to save and restart the drive, see Chapter 5.

Step 5: Start operation

The parameters related to the start mode can be started by I/O configuration or by writing parameters directly to the host computer.

Note
Because DIN has the highest priority, you cannot manually modify the value of an object parameter if the object data is controlled by DIN. For example, when the operation mode parameter is set through I/O configuration, the value of the internal object working mode cannot be directly written through the host computer. When the control word parameters are set through I/O configuration, the value of the internal object control word can no longer be written directly to the host computer.

6.2 Speed mode (-3, 3)

The speed mode has two modes: 3 and -3. The speed mode can be controlled by external I/0 control and internal instruction writing.

Table 6-7 Speed mode parameters description

Panel address	Internal address	Bit	Name	Description	Value
D0.00	6060.00	8	Operation_Mode	-3: Immediate speed mode, not involved in position loop control. The actual speed will immediately reach the target speed. 3: The speed mode with acceleration and deceleration is controlled by the position loop and the speed loop. The actual speed is planned as the target speed by trapezoidal acceleration/trapezoidal deceleration.	-3 and 3

	60FF.00	32	Target_Speed	Target velocity	User defined
	6040.00	16	Controlword	0x0F Enables the driver 0x06 Loosen the shaft and disable the driver	0x0F、0x06
D2.16	607E.00	8	Invert_Dir	Run polarity reversal 0: Counterclockwise is the positive direction (default value) 1: Clockwise is the positive direction	0,1

Note
The speed and position direction control cannot be modified in the enabled state.

6.2.1 DIN Speed mode

The Din_Speed object window in PC software can be accessed from menu item **Controller->ControlModes-> DIN Speed Mode**.

Table 6-8 DIN speed mode

Panel address	Internal address	Bit	Name	Description	Value
D3.18	2020.05	32	Din_Speed[0]	The speed command is specified via Din_Speed[x]. x is the BCD code of Bit 0: Din Vel Index0 Bit 1: Din Vel Index1 Bit 2: Din Vel Index2 As soon as one Index is configured to Din,the index which is not confifured means 0	User defined
D3.19	2020.06	32	Din_Speed[1]		
D3.20	2020.07	32	Din_Speed[2]		
D3.21	2020.08	32	Din_Speed[3]		
D3.44	2020.14	32	Din_Speed[4]		
D3.45	2020.15	32	Din_Speed[5]		
D3.46	2020.16	32	Din_Speed[6]		
D3.47	2020.17	32	Din_Speed[7]		
	6083.00	32	Profile_Acc	When the operation_mode is 3 mode, the trapezoidal acceleration and trapezoidal deceleration must be set, otherwise the response speed segment will not be executed.	
	6084.00	32	Profile_Dec		

Table 6-9 DIN speed setting

DIN speed index 0	DIN speed index 1	DIN speed index 2	Speed	Value
0	0	0	Din_Speed[0]	User defined
1	0	0	Din_Speed[1]	
0	1	0	Din_Speed[2]	
1	1	0	Din_Speed[3]	
0	0	1	Din_Speed[4]	
1	0	1	Din_Speed[5]	
0	1	1	Din_Speed[6]	
1	1	1	Din_Speed[7]	

0 means the signal is off, 1 means the signal is on.

The following points need to be noted when activating DIN speed mode：

1.DIN speed mode is only available in 3 or -3 operation_mode, invalid in other working modes.
2.Analog-speed control (250207) is 0, close the analog-speed channel.
3.At least one of DIN speed index 0, DIN speed index 1 and DIN speed index 2 is defined in the digital input DIN as the switching signal of the speed segment.

6.3 Torque mode(4)

In the torque mode, the CD3 motor controller causes the motor to rotate with a specified torque value.

Table 6-10 Torque mode parameters description

Internal address	Bit	Name	Description	Value
6060.00	8	Operation_Mode	Set operation_mode to Torque mode	4
6071.00	16	Target_Torque%	Target torque,percentage of rated torque	User defined
6040.00	16	Controlword	Enable drive	0x0F,0x06
607F.00	32	Max_Speed	Motor running maximum speed limit	User defined
60F5.06	16	Torque_Out_Ref	The limit value, the actual torque exceeds the reference data and the duration exceeds the filter time, the output torque of the Dout port reaches the setting, the unit is Ap	User defined
60F5.07	16	Torque_Out_Filter	When the actual torque reaches the reference value and the duration exceeds the filter time, Dout output torque reaches the setting, the unit is ms, the maximum is 32767	User defined
60F5.08	16	Current_Out_Real	Monitar the actual torque.unit in Ap	/

Note
The torque reach setting function of Dout can be used in any operation mode.

6.4 Position mode(1)

In the position mode, the driver control motor can carry out absolute position positioning and relative position positioning. The speed and position instructions are controlled by the target position, trapezoid speed and position table inside the driver.

Table 6-11Position mode parameter description

Panel address	Internal address	Bit	Name	Description	Value
D0.00	6060.00	8	Operation_Mode	Set the working mode to absolute/relative position mode	1
	607A.00	32	Target_Position	Target absolute / relative position	User defined
	6081.00	32	Profile_Speed	Profile speed for positioning	User defined
	6083.00	32	Profile_Acc	Profile acceleration for positioning	User defined
	6084.00	32	Profile_Dec	Profile deceleration for positioning	User defined
	6040.00	16	Control word	0x2F->0x3F: Activate the absolute position command. The absolute positioning command will not be executed immediately according to the change of the target position. It is used when the operation mode is 1. 0x4F->0x5F: Activate relative position command， used when the operation mode is 1.	0x2F->0x3F 0x4F->0x5F 0x0F 0x06 0x103F

				0x103F: Immediately execute absolute positioning instructions according to target position changes, used when the operation mode is 1. 0x0F Location table mode	

6.4.1 DIN position mode introduction

First, when using the DIN position mode, at least one of the DIN position index 0, DIN position index 1, and DIN position index 2 must be defined in the I/O configuration as a switch signal for the position segment.

DIN position section can be opened through the **Driver -> Control mode >DIN position mode** in the upper computer software menu bar.

Table 6-12 DIN position mode instruction

Panel address	Internal address	Bit	Name	Description	Value
	2020.01	32	Din_pos[0]	The speed instruction of the drive is specified by DIN speed [x], where x is a BCD code consisting of the following signals: bit 0: Din_pos[0]; bit 1: Din_pos[1] ; bit 2: Din_pos[2]; The case where the digits are all 0 cannot occur;	User defined
	2020.02	32	Din_pos[1]		
	2020.03	32	Din_pos[2]		
	2020.04	32	Din_pos[3]		
	2020.10	32	Din_pos[4]		
	2020.11	32	Din_pos[5]		
	2020.12	32	Din_pos[6]		
	2020.13	32	Din_pos[7]		
D3.40	2FF1.01	8	Din_position_selectL	Select the position segment L to be set (L range is 0-7, corresponding to the internal position segment 0-7 in turn)	
D3.41	2FF1.02	16	Din_position_M	Number of pulses set in position segment (L) =M*10000+N	
D3.42	2FF1.03	16	Din_position_n		

For example

The configuration interface of I/O is shown in the following figure:

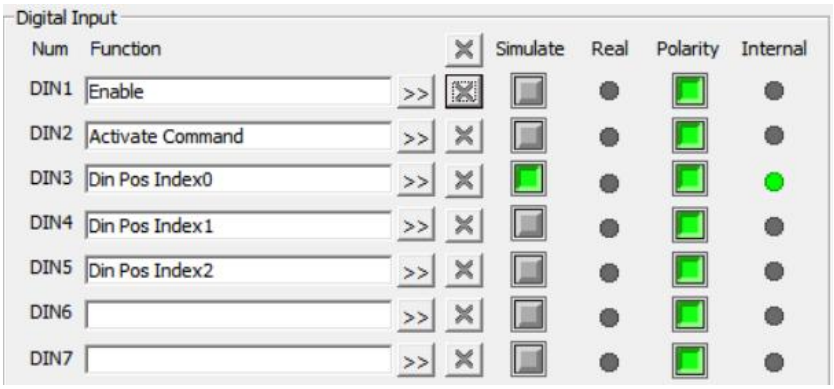


Figure 6-1 DIN configuration window

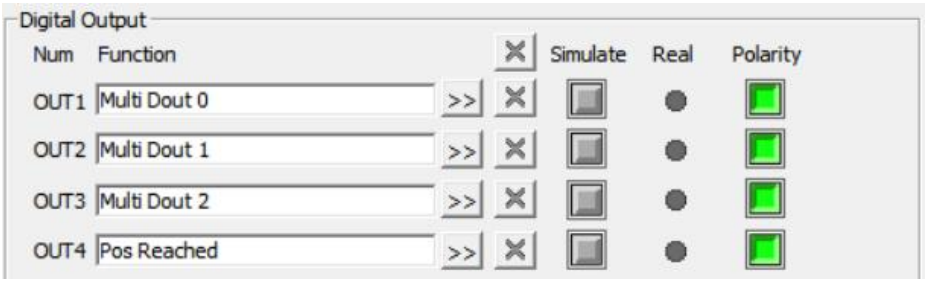


Figure 6-2 DOUT configuration window

Table 6-13 DIN position mode setting

Panel address	Internal address	Name	Value	Unit
D3.17	2020.0E	Din_Mode 1	1	
	2020.02	Din_Pos 1	User define	DEC
	2020.06	Din_Speed 1	User define	rpm
	6083.00	Profile_ Acc	User define	rps/s
	6084.00	Profile_ Dec	User define	rps/s

After enabling, select the position segment to go, the simulation command is activated, the drive executes the program of the selected position segment, and outputs the multi-function signal 0 after reaching the Din_pos[1].

Remind

- In the multi-segment position mode, the position-to-signal of the 1-7 segment of the Din position is represented by the BCD code composed of the multi-function signal 0-2.
- The command activation can set the bit4 of the control word to activate the position command. The level change of the DIN position index 0~2 can also activate the position command. However, when the first segment is positioned as DIN position 0 after enabling, there is no index signal, the level change cannot activate the DIN position 0, so the DIN input port definition command is required to activate.

6.4.2 Position table mode

Position Table mode is used to run up to 32 tasks in Position mode. Each task includes information about target position, speed, acceleration, deceleration, stopping/advancing to the next task, index to the next task, conditions for the next index, maximum number of cycles, etc.

To use the positio table function, you must configure the "Activate positio table" function in the input port, and other location table functions can be defined according to usage requirements.

Table 6-14 Input port function of PosTable mode

Name	Description
PosTable Cond0	If Cond0 ON, Condition0 = PosTable Cond0 (refer to introduction concerning Cond0 ON)
PosTable Cond1	If Cond1 ON, Condition1 = PosTable Cond1 (refer to introduction concerning Cond1 ON)
Start PosTable	Start position flow
PosTable Idx0	Entry index of position flow, bit0: PosTable Idx0; bit1: PosTable Idx1; bit2: PosTable Idx2. A bit which is not configured to DIN means 0.
PosTable Idx1	
PosTable Idx2	
Abort PosTable	Abort position flow

Table 6-15 Position table mode output function

Name	Description
PosTable Active	Position table mode running

Through the PC software, click the menu bar **Driver - > Control Modes - > Position Table Mode** to enter the position table parameter Settings.

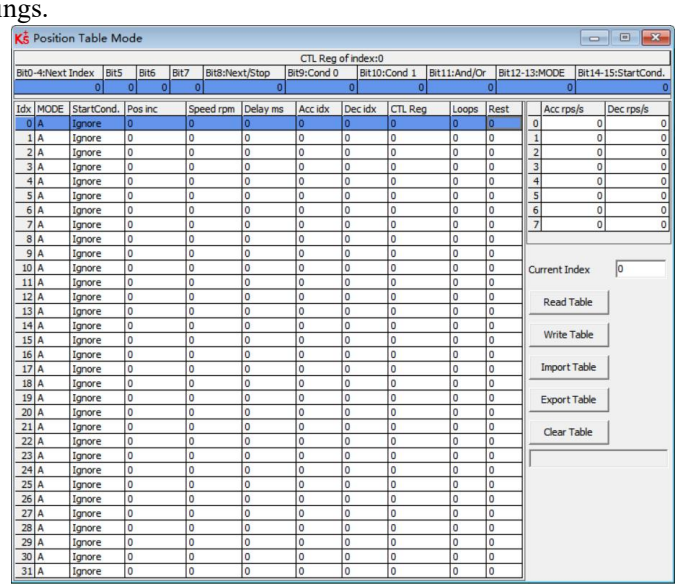


Figure 6-3 Position table mode window

The DIN Start PosTable signal (rising edge) triggers the entry index (specified via the DIN function) task, but whether or not the task is executed depends on the start condition (CTL reg bit14-15). After one task is finished, it goes to the next index (CTL reg bit0-4) or stops, depending on Next / Stop (CTL reg bit 8), Condition (CTL reg bit 9-11) and Loops. The current index box shows the index of the task which is being executed.

Up to 32 position control tasks can be set, and each task contains the following items:

Idx: Index of task, range: 0-31

Pos inc: Position command

Speed rpm: Speed command during positioning

Delay ms: Delay time before going next index(unit: ms).

Acc idx, Dec idx: Range: 0-7, index of profile acceleration, deceleration during positioning, related acc / dec value is set in following area fields:

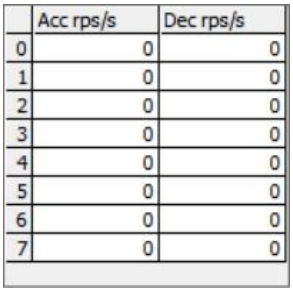


Figure 6-4 Acceleration and deceleration table

CTL Reg: Contains following bits:

- Bits 0-4: Next index, defines the index of the next position control task
- Bits 5-7: reserved

- Bit 8: Next / stop,

  1: Next; go to next task if condition (see bit9-11) = 1 and loops checking is OK (see Loops) after current positioning task is finished.

  0: Stop; stop after current positioning task is finished

- Bit9: Cond0 ON

  1: Cond0 ON; condition0 means Logic status of DIN function PosTable Cond0.

  0: Cond0 OFF

- Bit 10: Cond1 ON,

  1: Cond1 ON; condition1 = Rising edge of DIN function PosTable Cond1.

  0: Cond1 OFF

- Bit 11: and / or; only on case of both Cond0 and Cond1 is ON,

  1: AND; Condition = (Condition0&&Condition1).

  0: OR; Condition = (Condition0||Condition1).

Note

Condition = 1 if neither Cond0 nor Cond1 is ON

Condition = Condition0 if only Cond0 is ON

Condition = Condition1 if only Cond1 is ON

- Bits 12-13: MODE, mode of the position command,

  0 (A): Pos inc is the absolute position.

  1 (RN): Pos inc is the position relative to current target position.

  2 (RA): Pos inc is the position relative to the actual position.

- Bits 14-15: StartCond, start condition. If this task is triggered by the Start PosTable signal, normally the controller will execute it immediately, but if there's a positioning task still running:

  0 (ignore): ignore.

  1 (wait): execute this command after current task is finished (without delay).

  2 (interrupt): interrupt the current task, execute this command immediately.

For convenience, all CTL_Reg bits can be set in the following fields:

CTL Reg of index:0									
Bit0-4:Next Index	Bit5	Bit6	Bit7	Bit8:Next/Stop	Bit9:Cond 0	Bit10:Cond 1	Bit11:And/Or	Bit12-13:MODE	Bit14-15:StartCond.
0	0	0	0	0	0	0	0	0	0

Figure 6-5 CTL Reg edit

Loops

- Defines loop limit for the task which is running in loops;

  0: no limit,

  ≥ 1: position flow stops when loop count = loops, or if the next index loop count = next index loops.

Remaining

- The remaining number of times the task can be executed, invalid when the Loops is 0.

The data is imported from the loop when the position flow is started. Each time a task is executed, the remaining number of times is reduced by one. When the remaining number of times is reduced to 0, the corresponding task will exit the execution.

Copy and paste

- The task information of the location table can be copied to another row. Right-click on the task of any row selected, and the following window will appear. Click Copy Row, then select another row, and click Paste Row.

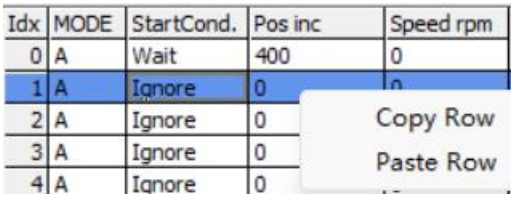


Figure 6-6 Position table copy

Activate position table

- After the setting of position flow，click

button to write it into drive.
- Start the table via DIN with the Start PosTable function. The entry index task is triggered and position flow is started (via StartCond rule).
- The DIN AbortPosTable signal (rising edge) or deleting the Start PosTable function configuration in DIN aborts a running position flow after the currently running task is finished.
- Positiontable is aborted immediately if an error occurs or if the Operation_Mode is changed.

Note

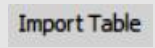
The position table in the window will not be automatically written to the drive. After modifying the position table parameters, you need to click Write Table to make the modified content take effect

Click

button can write the position table values in the window to the drive

Click

button can read the position table values stored in the drive into the window

Click 

button can import the existing .pft file into the position table window

Click

button can export the data in the location table window as.pft file

6.5 Pulse mode (-4)

In the pulse mode, the target velocity command is specified via the pulse input with gear ratio， Please refer to Figure 4-4 in Chapter 4.3.2 for the wiring method in pulse mode. It can be debugged by expanding the relevant parameters in the software.

Table 6-16 Pulse Mode

Panel address	Internal address	Bit	Name	Description	Value
	6060.00	8	Operation_Mode	Setting operation mode	-4
D3.34	2508.01	16	Gear_Factor[0]	Gear_ratio=Gear_Factor/Gear_Divider	User define
D3.35	2508.02	16	Gear_Divider[0]		
	6040.00	16	Controlword	Enable drive	0x2F:
D3.36	2508.03	8	PD_CW	Pulse train mode 0: CW / CCW 1: Pulse / direction 2: A / B (incremental encoder)	0, 1, 2
D1.21	2508.04	32	Gear_Master	The main encoder port counts before inputting pulse electronic gear	
D1.22	2508.05	32	Gear_Slave	The main encoder port counts after inputting pulse electronic gear	

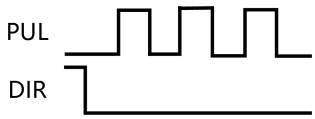
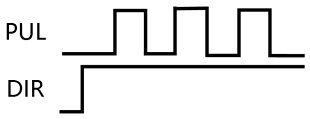
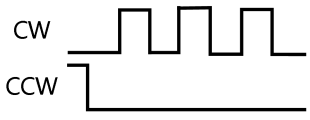
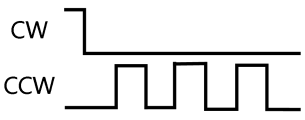
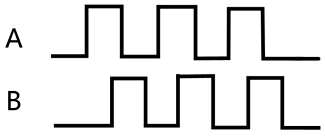
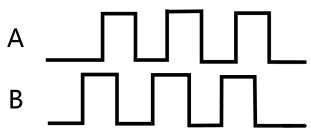
D1.23	2508.0C	16	Master_Speed	Pulse speed of spindle input(pulse/ms)	
D1.24	2508.0D	16	Slave_Speed	Speed after spindle input pulse gear ratio (pulse/ms)	
D3.37	2508.06	16	PD_Filter	Pulse filter (ms)	User define
D3.38	2508.08	16	Frequency_Check	Frequency limit (inc/ms), if pulse count (in 1 ms) is greater than Frequency_Check, over frequency error occurs.	
	2507.01	32	Position adjustment	Position adjustment is used to set the position data to be fine-tuned in pulse mode, the unit is inc, the default value is 0	
	2507.02	16	Speed adjustment	Speed adjustment is used to set the speed when performing position fine-tuning, the unit is inc/ms, the default value is 0	
	3046.00	08	CPLD_Filter	CPLD internal filter is used for pulse input port, only for pulse signal with 50% duty cycle, the filter frequency is: 0: 4MHz 1: 3.2MHz 2: 2MHz 3: 1.6MHz 4: 500KHz(Default) 5: 330KHz 6: 250KHz 7: 125KHz Note: The filter frequency must be higher than the Gear pre-pulse frequency	User define

6.5.1 Pulse mode setting steps

Step1： Confirm pulse mode

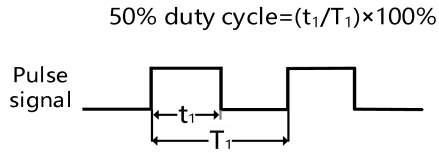
Select the pulse mode according to the type of external input pulse signal， After the pulse mode is modified, it needs to be saved and restarted to take effect.

Table 6-17 Pulse input supported by the drive

Pulse mode	Forward	Reverse
P/D		
CW/CCW		
A/B		

Step2：Confirm CPLD Pulse Filter Setting

The CPLD filter inside the drive is used to filter the high-frequency clutter at the pulse input port to prevent pulse interference. This filter is only valid for pulsed signals with a 50% duty cycle. It should be noted that the filter frequency must be greater than the pulse frequency before the gear, otherwise the effective pulse signal will be filtered.

50% Pulse duty cycle	

Step3：Confirm the electronic gear ratio

Electronic gear numerator/ Electronic gear dinomerator=65536/number of external input pulses
Example:
If the number of external input pulses is 10000 to make the motor rotate once, the electronic gear ratio should be 65536:10000, the numerator of the electronic gear should be set to 4096, and the denominator of the electronic gear should be set to 625.

Step4：Basic parameter settings before running

After setting the parameters of the first three steps, you can check whether there is data in the pre-gear pulse data, and whether the pre-gear pulse frequency is consistent with the pulse frequency sent by the host device. After confirmation, the working mode and the control word can be set to run the motor. The running direction of the motor can be adjusted by modifying the speed, position and direction control.

6.5.2 Other function

Pulse filter coefficient： Set the filter coefficient so that the externally input pulse command can be smoothly input to the drive. Adjusting this parameter can reduce the motor vibration caused by the high electronic gear ratio setting or the lack of acceleration and deceleration of the pulse command. If the coefficient is set too high, the motor response may be slowed down.。 The filter coefficient can only be adjusted when the motor is stopped.

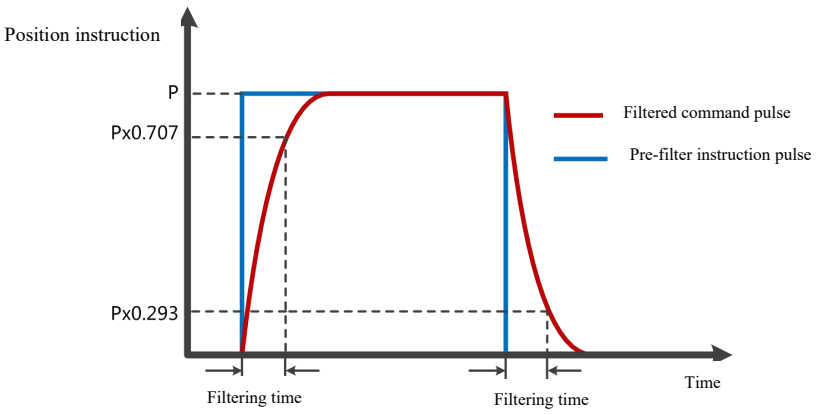


Figure 6-7 Pulse filter

Clear pulse： The clear pulse function in DIN can clear the number of pulses that the drive has received but not completed, and the deviation pulse can be adjusted during operation。 When DIN defines a clear pulse and the actual input changes from 0 to 1, use the rising edge to clear the deviation between the pre-gear pulse data and the post-gear pulse data.
Position fine-tuning: Position fine-tuning is used to set the position data to be fine-tuned in pulse mode, and speed fine-tuning is used to set the speed of fine-tuning when position fine-tuning is performed. The fine-tuning function can be used during pulse positioning operation in the following two ways:
Method 1: To achieve positive and negative direction fine-tuning by directly setting the position fine-tuning data value. When the value of position fine-tuning is greater than 0, positive fine-tuning is performed; when the value

of position fine-tuning is less than 0, negative fine-tuning is performed. When position fine-tuning and velocity fine-tuning are set to 0, the fine-tuning function is disabled. Under this control mode, DIN does not define the positive/negative fine tuning function, and position fine tuning and speed fine tuning data are not saved when power fails.
Method 2: Define positive fine-tuning and negative fine-tuning functions through DIN to control fine-tuning, position fine-tuning and speed fine-tuning data can be saved after power failure.

6.5.3 Electronic gear ratio switching (expert mode)

This function can only be used by expert!

The drive supports 8 sets of electronic gear ratio settings, these settings are only valid in pulse mode

Table 6-18 Electronic gear ratio switching

Internal address	Type	Name	Value	Unit
2508.01	Int16	Gear_Factor[0]	1000	Dec
2508.02	Uint16	Gear_Divider[0]	1000	Dec
2509.01	Int16	Gear_Factor[1]	1000	Dec
2509.02	Uint16	Gear_Divider[1]	1000	Dec
2509.03	Int16	Gear_Factor[2]	1000	Dec
2509.04	Uint16	Gear_Divider [2]	1000	Dec
2509.05	Int16	Gear_Factor[3]	1000	Dec
2509.06	Uint16	Gear_Divider[3]	1000	Dec
2509.07	Int16	Gear_Factor[4]	1000	Dec
2509.08	Uint16	Gear_Divider[4]	1000	Dec
2509.09	Int16	Gear_Factor[5]	1000	Dec
2509.0A	Uint16	Gear_Divider[5]	1000	Dec
2509.0B	Int16	Gear_Factor[6]	1000	Dec
2509.0C	Uint16	Gear_Divider[6]	1000	Dec
2509.0D	Int16	Gear_Factor[7]	1000	Dec
2509.0E	Uint16	Gear_Divider[7]	1000	Dec

The actual electronic gear ratio used is the electronic gear numerator [x]，electronic gear denominator [x]，x is a BCD code composed of multi-function input：

Bit0：muti-function input 0

Bit1：muti-function input 1

Bit2：muti-function input 2

Undefined bit is 0

For example:

Figure 6-8 Muti-function define

Muti-function input 0 = 0，Muti-function input 1 = 1，Muti-function input 2 = 2，so x = 6，The actual electronic gear ratio used is the Gear_Factor [6] and Gear_Divider [6]

Note
After the electronic gear ratio is switched, the deviation of the pulse data after the gear is a normal phenomenon. Please use this function with caution.

6.5.4 Master-slave mode

The slave drive runs synchronously with the master drive instructions. The pulse input from the driver comes from an external encoder signal or the encoder output from the main driver. The resolution of the encoder output signal of the main driver is specified by the encoder frequency division resolution.

Table 6-19 Master-slave mode

Drive	Internal address	Bit	Name	Description	Value
Master drive	2340.0F	32	Encoder_Out_Res	It can be used to set the number of encoder pulses output by the drive after the motor rotates once	User define
Slave drive	2508.03	8	PD_CW	Slave drive is set to incremental encoder mode	2

For slave driver parameter Settings, refer to the pulse mode described in the previous section.

The connection between the master and slave is shown in the following figure:

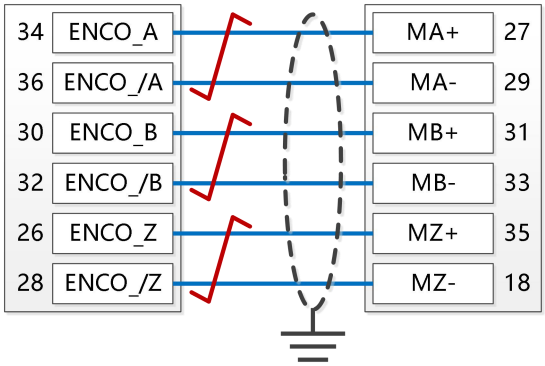


Figure 6-9 Encoder cable connection

Note
Forward rotation means positive position counting, the default is CCW direction, you can set the speed position direction control (607E.00) = 1, change the rotation direction of the motor shaft

6.6 Full closed loop mode

The servo drive is connected to the encoder/grating ruler feedback signal at the mechanical end for more accurate closed-loop control, which avoids positioning errors due to the mechanical system.

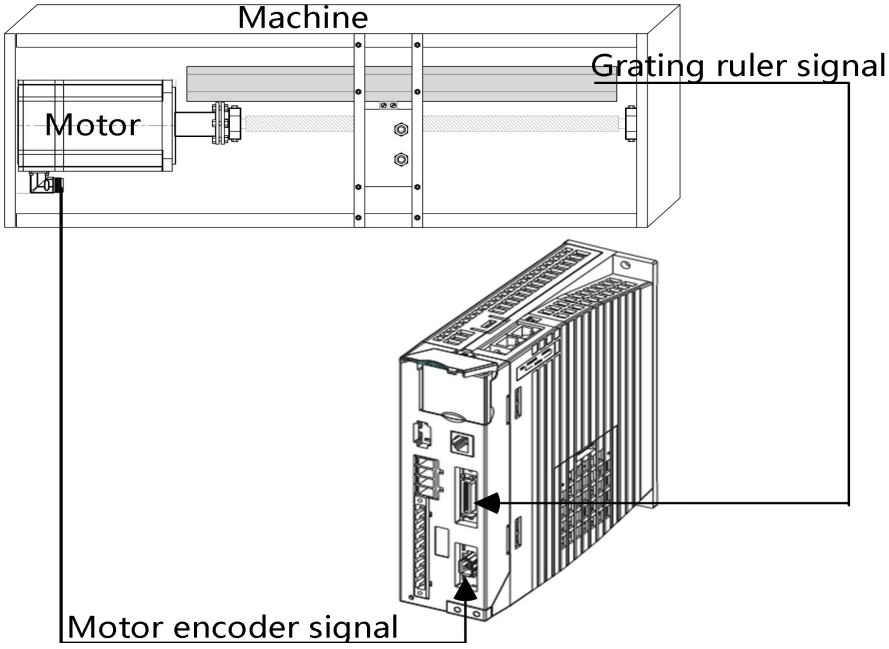


Figure 6-10 Full Closed Loop Application Case

Table 6-20 Full closed loop mode

Internal address	Bit	Attribute	Name	Description	Unit
250A01	32	RW	Master_Enc_Period	Fill in the resolution of the external encoder	inc
250A02	08	RW	Closed_Loop_Control	0: normal mode 1: closed position mode 2: closed velocity&position mode	DEC
250A03	08	RW	Master_Enc_Direction	1: direction by wiring 0: reverse direction	DEC
250A04	16	RW	Closed_Loop_Err_Filter	The corresponding relationship between the main encoder and the motor encoder detects the filtering time. If the counting direction inconsistency time reaches this threshold, the main encoder ABZ fault is reported	ms
250A05	16	RW	Check_Master	When the full closed-loop control is 1 and the proportional relationship between the main encoder and the motor encoder is not 1:1, it is necessary to set the correct full closed-loop spindle check and full closed-loop slave shaft check. The full closed-loop spindle check is used to set the ratio of the motor encoder, and the full closed-loop slave shaft check is used to set the ratio of the main encoder. When the full closed-loop control is set to 2, the master-slave shaft check can be used to prevent the main encoder from slipping during operation. When the running speed of the main encoder and the running speed of the motor are not within the ratio range of the full closed-loop spindle check/full closed-loop slave shaft check, the full closed-loop fault will be reported. When any value of the master/slave axis check is 0, the full closed-loop fault detection is not enabled.	DEC
250A06	16	RW	Check_Slave		DEC
250A07	32	R	Pos_Abs_Master	Position information from the external encoder	inc
250A08	16	R	Master_Speed_VL	Speed information from the external encoder	inc/250μs
250804	32	RW	Gear_Master	The main encoder port input pulse electronic gear front count	DEC
250803	08	RW	PD_CW	0：CW/CCW，Double pulse mode 1：P/D，Pulse direction mode (factory default) 2:A/B,Orthogonal (incremental encoder) mode	DEC
250A09	08	RW	Check_Rate	The full closed-loop main encoder and motor speed fluctuation ratio detection can appropriately increase the ratio when the inevitable flexible connection slip occurs between the main shaft and the main shaft.	%

The full closed-loop control wiring is shown in the figure below:

①Use the regular pulse interface to connect the external encoder signal, the output frequency of the external encoder is required to be below 500KHz, and the signal voltage range is 12-30VDC.

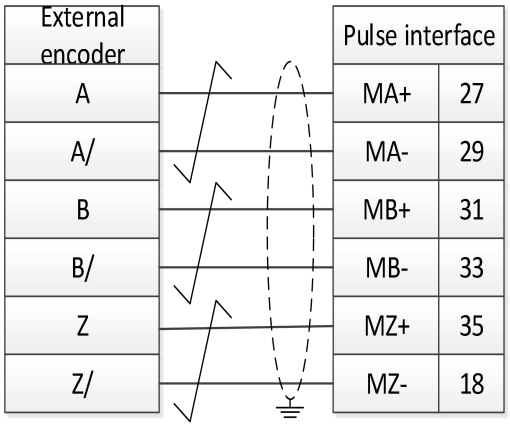


Figure 6-11 Fully closed loop control connection to regular pulse interface

②Use the high-speed pulse interface to connect the external encoder signal, the output frequency of the external encoder is required to be below 4MHz, and the signal voltage range is 3.3-5VDC.

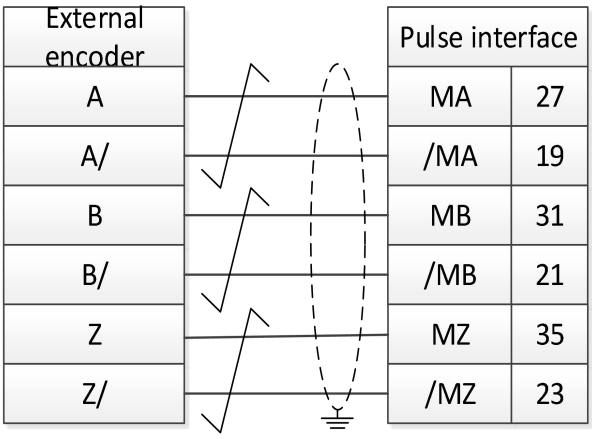


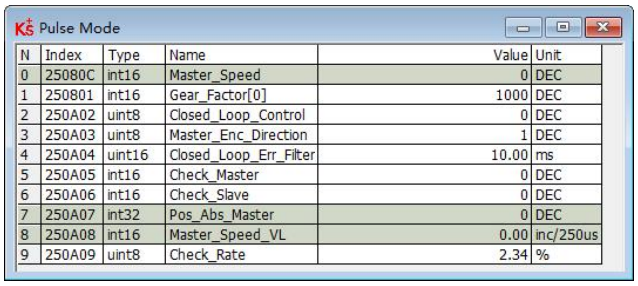
Figure 6-12 Full closed-loop control to connect high-speed pulse interface

Note
The full closed loop control function occupies the pulse input port, and the driver cannot use the pulse mode after using this mode control.

6.6.1Full closed loop control operation step

Step 1: Add the full closed loop parameters

The control parameters of the full closed loop need to be added to the window by the user. The control parameters of the full closed loop are in group 250A of the object dictionary. Right-click any window of the software and choose Add. You can add the full closed-loop parameters in the object dictionary to the window. You can save the added software window interface as a.kpjt file through **file F-> Save** in the software menu bar for subsequent debugging.



N	Index	Type	Name	Value	Unit
0	25080C	int16	Master_Speed	0	DEC
1	250801	int16	Gear_Factor[0]	1000	DEC
2	250A02	uint8	Closed_Loop_Control	0	DEC
3	250A03	uint8	Master_Enc_Direction	1	DEC
4	250A04	uint16	Closed_Loop_Err_Filter	10.00	ms
5	250A05	int16	Check_Master	0	DEC
6	250A06	int16	Check_Slave	0	DEC
7	250A07	int32	Pos_Abs_Master	0	DEC
8	250A08	int16	Master_Speed_VL	0.00	inc/250us
9	250A09	uint8	Check_Rate	2.34	%

Figure 6-13 Close loop setting window

Step 2：Confirm pulse mode

Wiring according to the out signal of the external encoder and confirm the pulse mode according to the signal type of the external encoder. Rotate the external encoder and you can see the continuous change of the front pulse data of the gear.

When the external encoder moves a fixed distance and feeds back the same gear pre-pulse data, you can enter the next step, otherwise, please check the external encoder installation, hardware wiring and pulse mode again.

Note

After the change of pulse mode （2508.03） the control parameter need to be saved and it will effect after reboot drive.

Step 3：Set the main encoder cycle

The main encoder cycle needs to fill in the number of AB-phase pulses between two adjacent Z-phase signals of the external encoder. If the rotary encoder has 1 Z-phase signal per revolution, the main encoder period is equal to the resolution of the external encoder. Setting the main encoder cycle to 0 means not to detect the number of pulses between adjacent Z signals.

Step 4：Sets the main encoder counting direction

When the counting direction of the main encoder and the motor encoder is inconsistent, the full closed-loop fault alarm will appear when the full closed-loop control is turned on, which can be adjusted by the counting direction of the main encoder (0x250A03).

Main encoder count the default value is 1, rotate the motor shaft and observe its absolute position and the main direction of the change of the absolute position encoder, if change the position of the two objects in the same direction you do not need to modify the master the direction of the encoder count number, if two position changes direction is not consistent the direction should be the main encoder count is set to 0.Note: All above operations are done with loose shafts.

Step 5: Set up full-closed-loop master check and full-closed-loop slave check

The calculation method of the master-slave axis ratio is as follows：Firstly, the full closed-loop control is set to 0 and the mechanical connection between the motor and the main encoder is intact and non-skid. Clear the gear front pulse data and remember the actual position value (such as 150231), manually rotate the motor to drive the main encoder to operate for a certain distance, then observe the gear front pulse data and the actual position, and confirm the ratio according to the difference between the two positions.As shown in the table below, according to the final results, the full closed-loop spindle check =1586 and the full closed-loop slave shaft check =1000 are calculated.

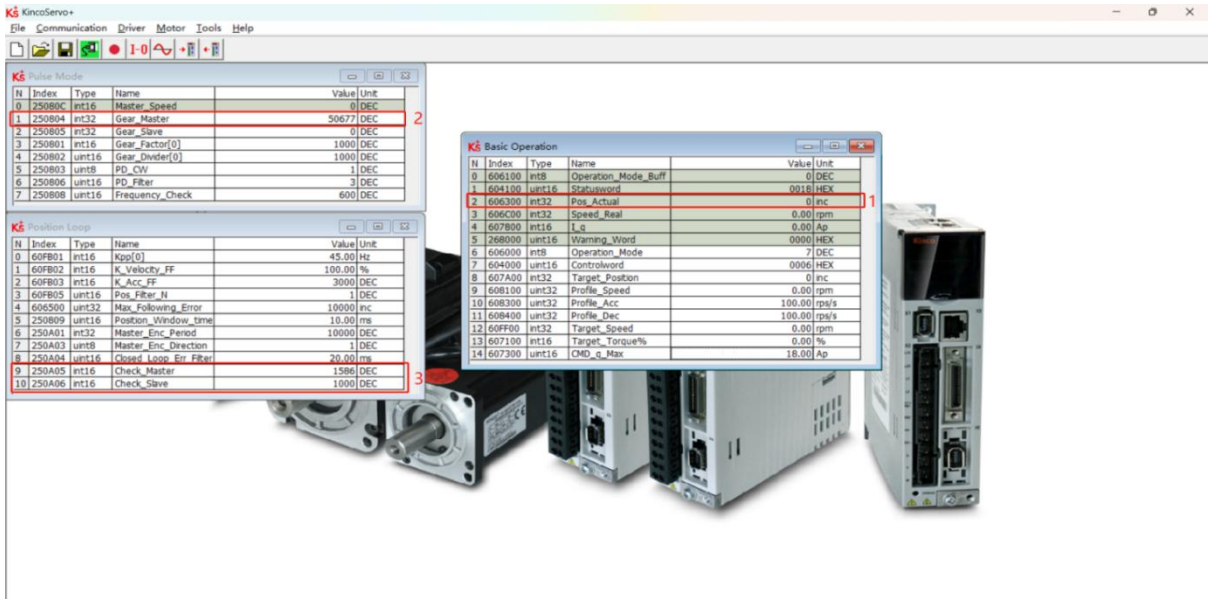


Figure 6-14 Fully closed-loop master-slave axis check settings

Table 6-21 Master and slave axis check calculation method

	Gear Pre-pulse data	The actual position of motor
Initial value	0	150231
End value	50677	182179
D-value	50677	31948
Proportion	50677/31948=1.586	

Step 6: Set up full closed-loop proportional detection and full closed-loop signal detection and filtering

The full closed-loop proportional detection is the proportional detection range of the operating speed fluctuation of the main encoder and the motor under the full closed-loop control. The default value is 2.34%, which can meet most applications. When the flexible connection of the main and slave shafts slips seriously, the ratio can be appropriately increased.
The full closed-loop signal detection filter is the detection time of the proportional relationship between the main encoder and the motor encoder, and the default value is 10ms. The detection time can be appropriately increased when the main and slave axes are flexibly connected or slip seriously.

Step 7: Set the position loop speed feedforward

When the ratio of the master and slave axes is not 1:1, adjust the position loop speed feedforward according to the ratio of the master and slave axes. In full closed-loop mode, position loop speed feedforward (%)= full closed-loop spindle check/full closed-loop slave shaft check *100%, for example: in the fifth step, the full closed-loop spindle check is 1586, and the full closed-loop slave shaft check is 1000, then the position loop speed feedforward needs to be set to 158%.

6.7 Homing mode(6)

In some applications, the system requires every movement of the mechanical load to start from the same position, so the user can meet the demand by using the homing mode. In homing mode, the user can define an origin or zero point to ensure that the mechanical load runs from the same starting point every time. The origin mode operation interface can be opened by menu bar -> Driver -> Control Modes -> Homing definition, and the operation interface after opening is shown as follows:

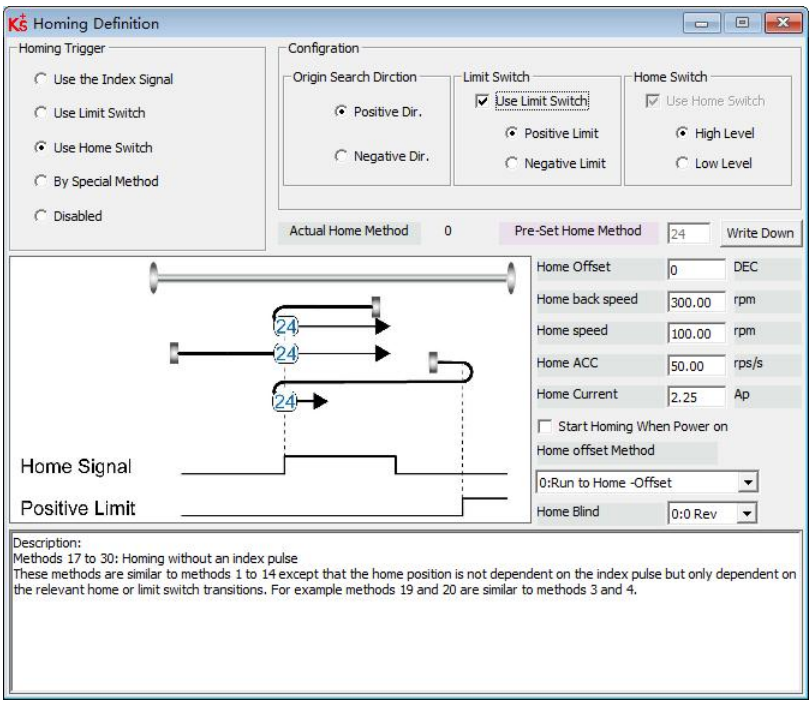


Figure 6-15 Homing setting

In the homing operation interface, an origin trigger signal mode must be selected first, and its related parameters can be set in the configuration bar, and mechanical limit and origin switch related configurations can be selected according to the user's site and hardware conditions. After the hardware configuration is selected, the preset homing mode is performed. If the preset origin mode cannot be written under the selected origin trigger signal mode, you can click Write Down on the right to directly write the preset homing mode. The graphic effect of each origin mode is displayed in real time in the display bar below the operation interface.

Table 6-22 Homing mode

Internal address	Name	Bit	Value	Description
607C.00	Home_Offset	32	User defined	Zero position offset to the home position
6098.00	Homing_Method	8	User defined	Chose the homing method
6099.02	Homing_Speed_Zero	32	User defined	Velocity for finding home position and zero position
6099.03	Homing_Power_On	8	0，1，2	0：Default, turn off the Homing_Power_On 1：Start homing after power on or reboot and first controller enable 2：Automatically save the origin position of the multi-turn absolute encoder motor
609A.00	Homing_Accelaration	32	User defined	Profile deceleration and acceleration during homing
6099.01	Homing_Speed_Switch	32	User defined	Velocity for searching position limit switch / home switch signal
6099.04	Homing_Current	16	User defined	Max. current during homing
6099.05	Home_Offset_Mode	8	0，1	0: Go to the homing offset point. The actual position will be 0. 1: Go to the home trigger point. The actual position will be -homing offset
6099.06	Home_N_Blind	8	0，1	Home blind window
6060.00	Operation_Mode	8	6	Operation mode of drive
6040.00	Controlword	16	0x0F->0x1F	Enable drive

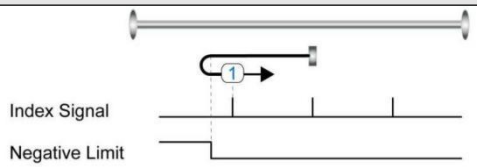
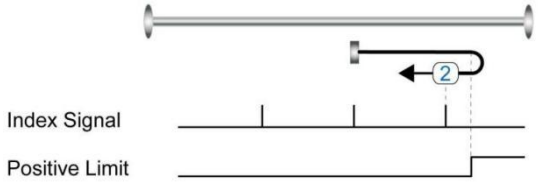
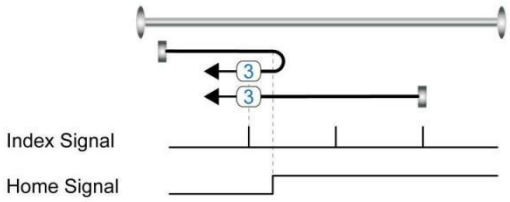
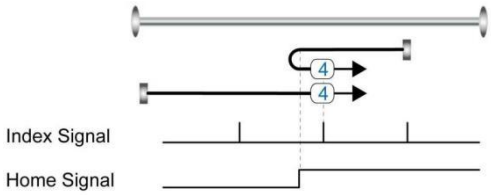
Note
When the power-on origin search parameter of the drive is set to 1, the power-on self enable function must be set to 1 at the same time. After the drive is powered on and started, the motor is enabled and the origin search starts immediately. Safety factors must be fully considered before use.

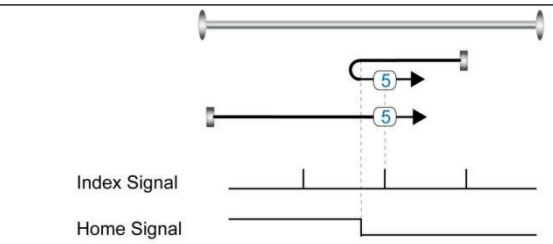
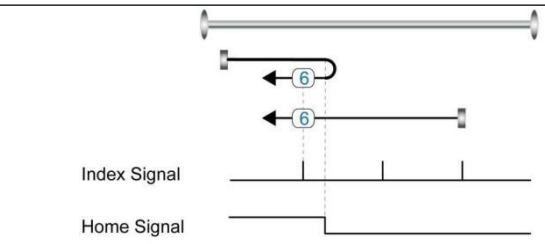
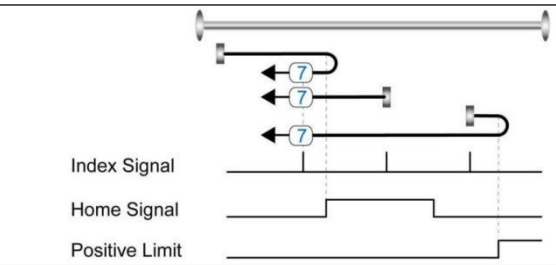
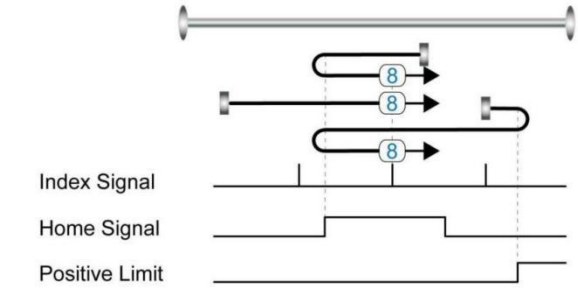
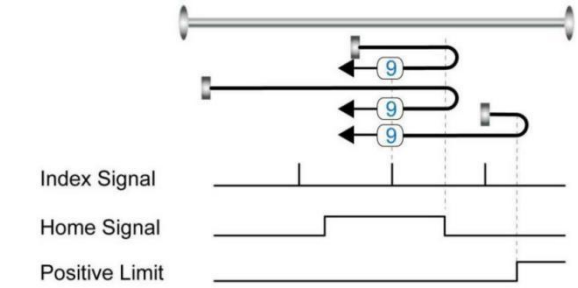
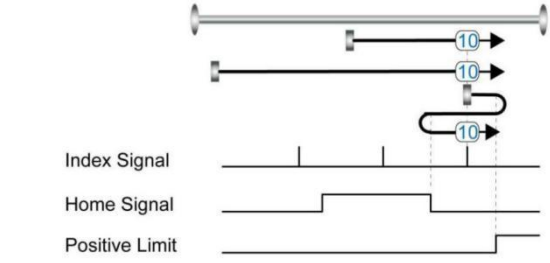
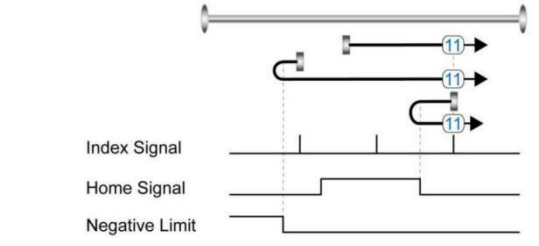
Home_N_Blind:

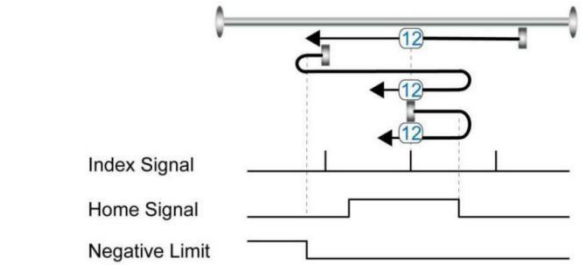
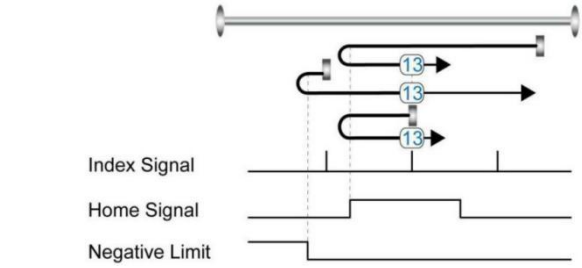
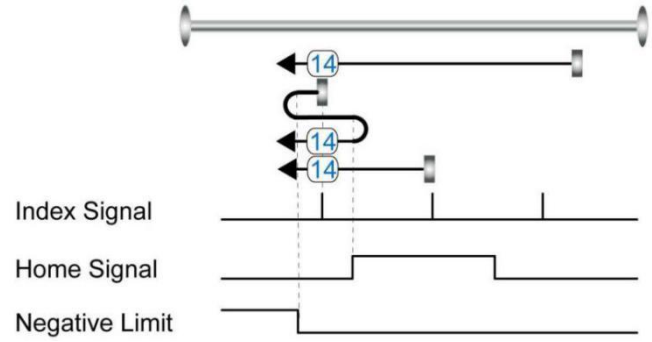
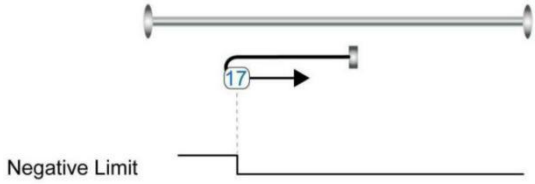
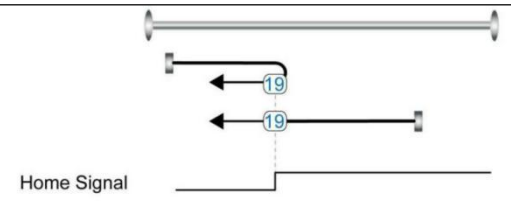
If the homing_method needs home signal (position limit / home switch) and index signal, Home_N_Blind function can avoid the homing result being different with the same mechanics, when the Index signal is very close to the home signal. By setting to 1 before homing, the controller detects a suitable blind window for homing automatically. It can be used to assure that homing results are always the same.

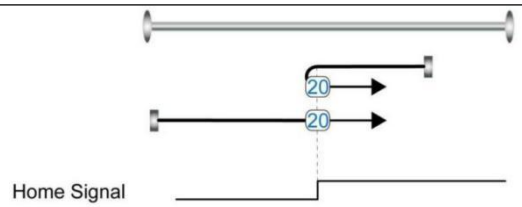
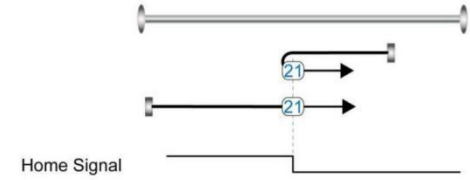
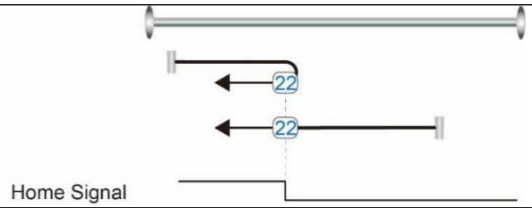
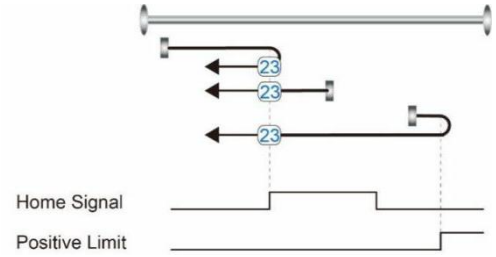
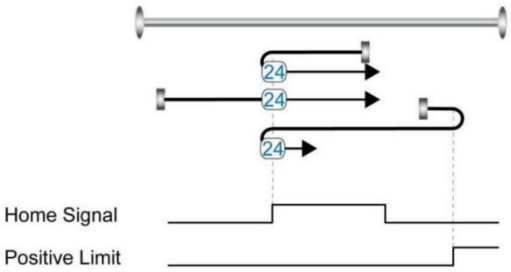
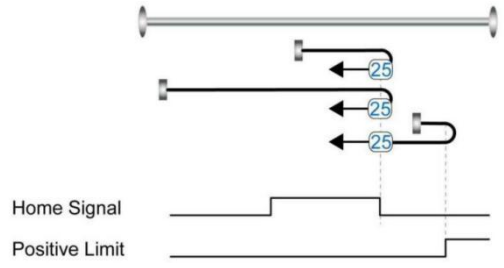
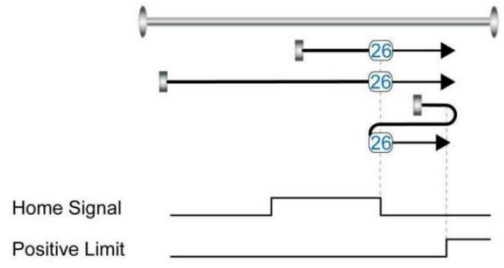
During homing, the index signal inside this blind window is ignored after the home signal is found. Home_N_Blind (0:0rev;1:0.25rev;2:0.5rev) is defaulted to 0. If it's set to 1, it′ s changed to 0 or 2 after homing depending on the index signal position relative to the homing signal.This parameter needs to be saved. If the mechanical assembly is changed or the motor has been replaced, just set it to 1 again for initial homing.

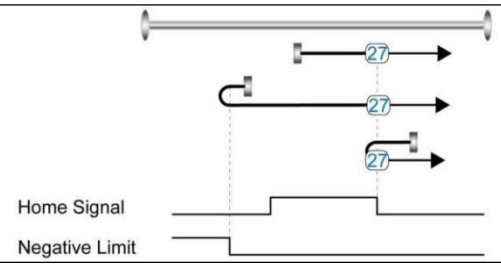
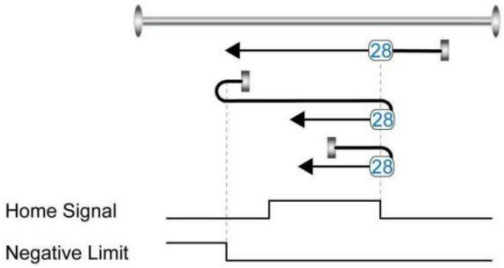
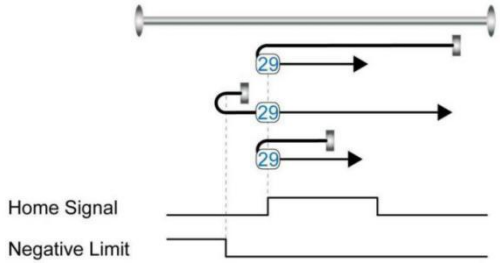
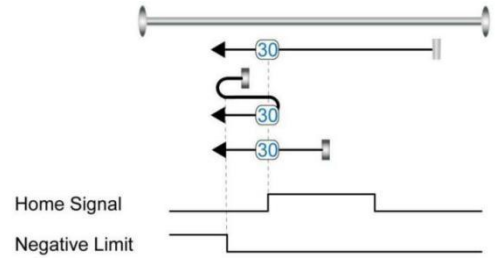
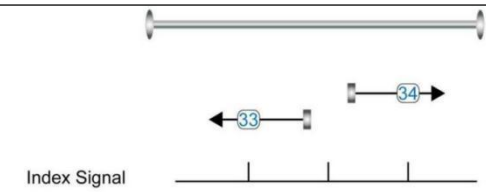
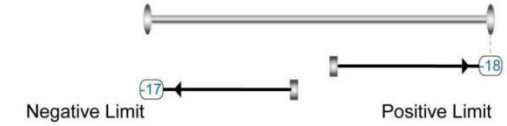
Table 6-23 Introduction to the homing method

Homing_ Method	Description	Schematic
1	Homing with negative position limit switch and index pulse	
2	Homing with positive position limit switch and index pulse	
3	Homing with home switch and index pulse	
4	Homing with home switch and index pulse	

5	Homing with home switch and index pulse	
6	Homing with home switch and index pulse	
7	Homing with positive position limit switch, home switch and index pulse	
8	Homing with positive position limit switch, home switch and index pulse	
9	Homing with positive position limit switch, home switch and index pulse	
10	Homing with positive position limit switch, home switch and index pulse	
11	Homing with negative position limit switch, home switch and index pulse	

12	Homing with negative position limit switch, home switch and index pulse	
13	Homing with negative position limit switch, home switch and index pulse	
14	Homing with negative position limit switch, home switch and index pulse	
17	Homing with negative position limit switch	
18	Homing with positive position limit switch	
19	Homing with home switch	

20	Homing with home switch	
21	Homing with home switch	
22	Homing with home switch	
23	Homing with positive position limit switch and home switch	
24	Homing with positive position limit switch and home switch	
25	Homing with positive position limit switch and home switch	
26	Homing with positive position limit switch and home switch	

27	Homing with negative position limit switch and home switch	
28	Homing with negative position limit switch and home switch	
29	Homing with negative position limit switch and home switch	
30	Homing with negative position limit switch and home switch	
33, 34	Homing with index pulse	
35	Homing to actual position	
-17, -18	Homing via mechanical limit	

6.8 Other functions

6.8.1 Limit function

In order to ensure that the motor runs within the stroke range allowed by the mechanical structure, the motor can be prevented from overtravel running by inputting the limit signal.

Table 6-24 Limit setting

Panel address	Internal address	Bit	Name	Description
D3.04	2010.06	16	Din4_Function	Define digital input DIN 4。Default value 0010，Indicates the definition of the positive limit function
D3.05	2010.07	16	Din5_Function	Define digital input DIN5。Default value 0020，Indicates the definition of the negative limit function
	2010.1B	32	Pos_L_Pos	Actual position when the digital input signal triggers the positive limit
	2010.1C	32	Pos_L_Neg	Actual position when the digital input signal triggers the negative limit
	2010.19	8	Limit_Function	The function of defining whether to alarm after the limit signal occurs 0： If the limit signal appears after homing, it will alarm 1: it will not alarm when the limit signal appears after homing
	607D.01	32	Soft_Positive_Limit	Soft limit positive polarity data setting
	607D.02	32	Soft_Negative_Limit	Soft limit negative data setting, the negative data must be less than the positive data, otherwise the soft limit will not work
	6085.00	32	Quick_Stop_Dec	Stop deceleration after the limit signal takes effect

(1)Digital input limit digital

By installing the sensor in the machine and connecting the external sensor signal to the digital input signal port of the drive, when the sensor level changes, the positive and negative limit signals take effect, and the motor stops. For safety reasons, the positive/negative limit signals are normally closed . When the valid input is 1 (the valid input is green), the limit function is invalid. When the valid input is 0 (the valid input is gray), it means that the limit is activated and the corresponding movement direction is prohibited.

(2)Soft limit position

To prevent overtravel by setting the position of the software limit, it should be noted that the position of the software limit only takes effect after homing. When the actual position reaches the set software limit position, the motor stops.

6.8.2 Motor brake control

In order to ensure that the motor will not rotate under the influence of gravity or other external forces after the power is turned off, the load equipment needs to use a brake motor。Please refer **3.1.3.1** for motor brake wiring，The default brake control port is OUT2. If you want to control the motor brake through other ports, you need to define the corresponding digital output signal function as motor brake.

Table 6-25 Brake control related objects

Panel address	Internal address	Bit	Name	Description
D4.21	6410.17	8	Addition_Device	Whether the motor has a brake accessory 0: Motor without brake 1: The motor has a holding brake, and the drive needs to wait for a period of time (holding brake delay) to fully open/close the holding brake
	6410.11	16	Brake_Duty_Cycle	The duty cycle of the brake signal
	6410.12	16	Brake_Delay	The delay time of the brake signal, the default value is 150ms
	605A.00	16	Quick_Stop_Mode	0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop 5: The curve stops, and finally stops in the rapid stop state 6: Rapid deceleration stop, and finally stop in rapid stop state 18: Use the motor's own resistance to brake, even if there is a problem with the encoder Factory default is uncontrolled stop mode
	6085.00	32	Quick_Stop_Dec	Deceleration when quick stop mode is 2

After the control word is written into the enable command, the servo motor is energized to lock the shaft, and the driver outputs 24V DC to the brake after the relay pull-in delay for a certain period of time (brake delay) to make the brake open as soon as possible. After the delay, the speed command takes effect and the motor starts to run.

When the stop enable command is written in the control word, the control of the holding brake is related to the set quick stop mode.

When the quick stop mode is 0 (uncontrolled stop), the drive will automatically switch to the immediate speed mode (-3) and set the target speed to 0 internally to make the motor stop as soon as possible, in the uncontrolled stop mode After the drive changes the target speed, it will immediately cut off the 24V power supply to the brake. After the brake power is cut off and lasts for a certain period of time (the brake delay), the drive actually enters the disabled state, and the motor is powered off and the shaft is released.

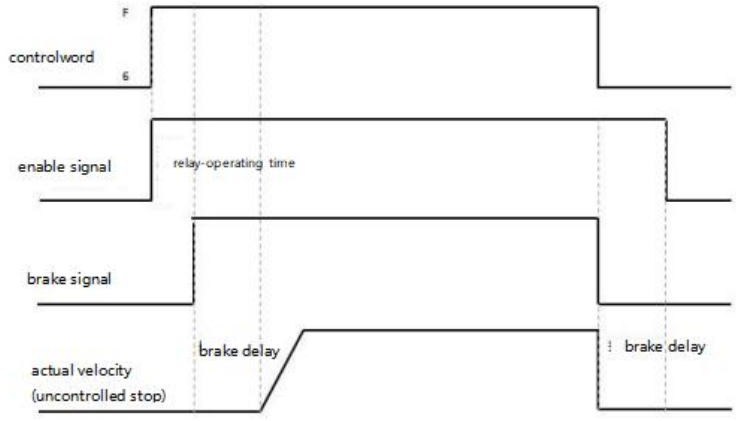


Figure 6-16 Motor holding brake sequence when the fast stop mode is 0

When the quick stop mode is 2 (quick stop deceleration stop), the drive automatically switches to speed mode (3) and decelerates to stop at quick stop deceleration (60850020) when it is disabled. Only after the drive judges that the effective target speed is zero speed , the drive will cut off the 24V brake power supply. After the brake power supply has been cut off for a certain period of time (the brake delay time), the drive will enter the disabled state, and the motor will be disconnected from the power supply.

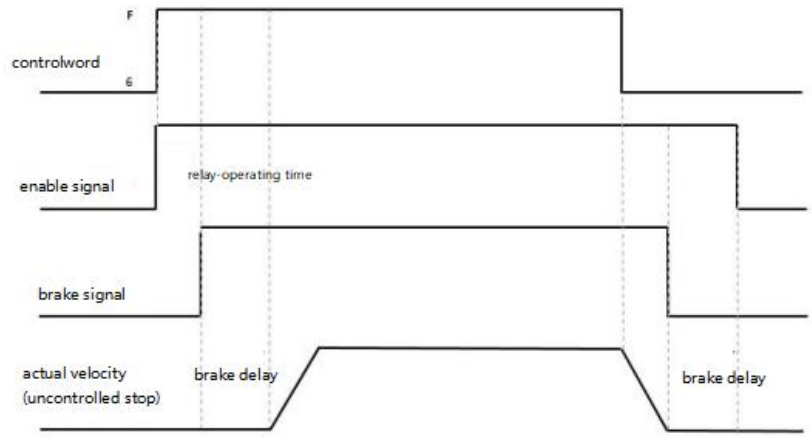


Figure 6-17 Motor holding brake sequence when the fast stop mode is 2

Note
After the motor accessory is set to 1, the load drop will be disabled, and the brake delay can be appropriately increased. If adjusting the brake delay cannot improve the problem, check whether the brake torque meets the load demand.

6.8.3 Stop Mode Control

The motor can be stopped in the following ways:

0, uncontrolled stop; the motor will directly cut off the power to loosen the shaft without any control, and stop naturally by friction. After the stop is completed, the motor loosens the shaft. The uncontrolled stop mode has a longer deceleration time, but less mechanical impact.

1. The curve stops; it stops according to the trapezoidal deceleration (60840020) curve, and the motor loosens the shaft after the stop is completed.

2. Quick stop deceleration stop; stop according to the quick stop deceleration (60850020), and the motor loosens the shaft after the stop is completed.

18， Short-circuit braking stop mode, use the motor's own resistance to stop. After the stop is completed, the motor keeps the shaft locked and stops in the fast stop state. It can be enabled after the control word sends 0x06 to exit the fast stop state. A stop mode that can quickly complete a stop even in the event of an encoder failure.。

5，Stop according to the trapezoidal deceleration (60840020). After the stop is completed, the motor keeps the axis locked and stops in the fast stop state. It can be enabled after the control word 0x06 is issued to exit the fast stop state.。

6，Stop according to the quick stop deceleration (60850020). After the stop is completed, the motor keeps the axis locked and stops in the quick stop state. It can be enabled only after the control word sends 0x06 to exit the quick stop state.

Table 6-26 Stop control objects

Panel address	Internal address	Bit	Name	Description
	605A.00	16	Quick_Stop_Mode	Quick stop mode Stop mode when bit2 in the control word is set to 0. For example: the control word is switched from 0x0F to 0x0B 0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop 5: The curve stops, and finally stops in the fast stop state 6: Rapid deceleration stop, and finally stop in rapid stop state 18: Use the motor's own resistance to brake, even if there is a problem with the encoder

	605B.00	16	Shutdown_Stop_Mode	Shutdown mode When the control word is switched to 0x06, the stop mode when the motor switches from the locked axis to the loose axis state 0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop 18: Use the motor's own resistance to brake, even if there is a problem with the encoder
	605C.00	16	Disable_Stop_Mode	Disable stop mode Stop mode when bit3 in the control word is set to 0. For example: the control word is switched from 0x0F to 0x07 0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop 18: Use the motor's own resistance to brake, even if there is a problem with the encoder
	605D.00	16	Halt_Mode	Pause mode Pause mode when bit8 in the control word is set to 1. For example: the control word is switched from 0x0F to 0x10F 1: Decelerate and stop at the current deceleration 2: Decelerate to stop at emergency stop deceleration
	605E.00	16	Fault_Stop_Mode	Error emergency stop mode Error stop mode will be activated after an alarm in the motor shaft lock state. 0: stop immediately 1: Decelerate to stop 2: Use emergency stop deceleration to stop 18: Use the motor's own resistance to brake, even if there is a problem with the encoder
	6084.00	32	Profile_Dec	Curve stop deceleration
	6085.00	32	Quick_Stop_Dec	Emergency stop deceleration
	2340.01	08	Step_Stop_Mode	Step Mode Stop Enable It only takes effect under position control. When the position reaches the signal output, the motor uses the stepping method to lock the shaft (that is, the driver applies DC power to the motor to keep the motor in the locked shaft state), and the shaft locking current is set by the step stop current (2340.02). . 0: Do not use step mode stop enable 1: Use step mode to stop enable
	2340.02	16	Step_Stop_Amp	Stop current after step stop mode is turned on

6.8.4 Multi-tune encoder Setting

When choosing an absolute value encoder motor, please select the cable ENCDG/ ENCDGF-LL-GA-DC, E-D-QY-KR-LL/(-F) and the battery box BAT-FD5 according to the selection table in the selection manual

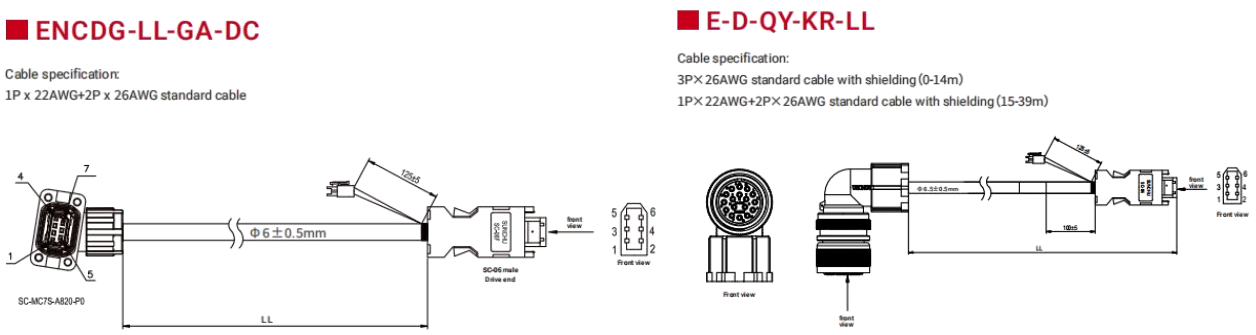


Figure 6-18 Configuration cable diagram

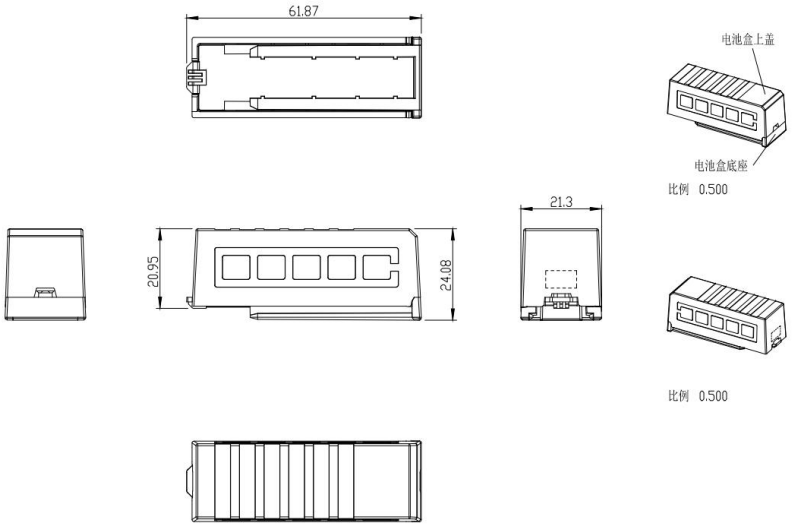
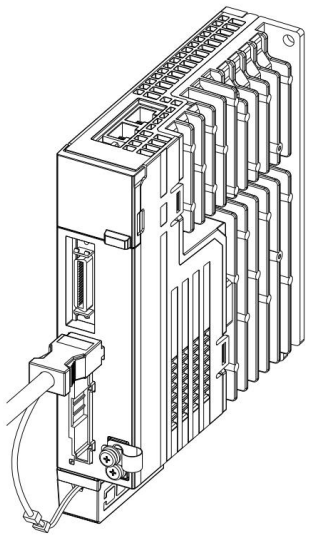
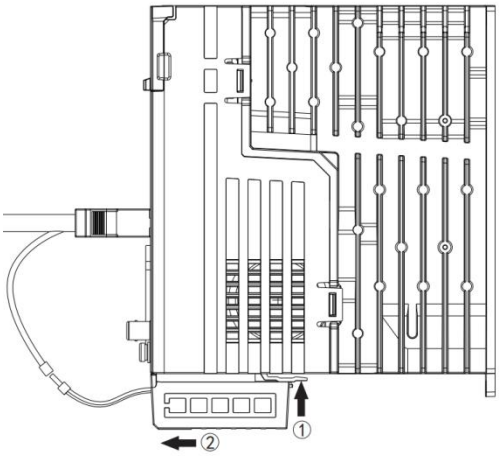


Figure 6-19 BAT-FD5 diagram

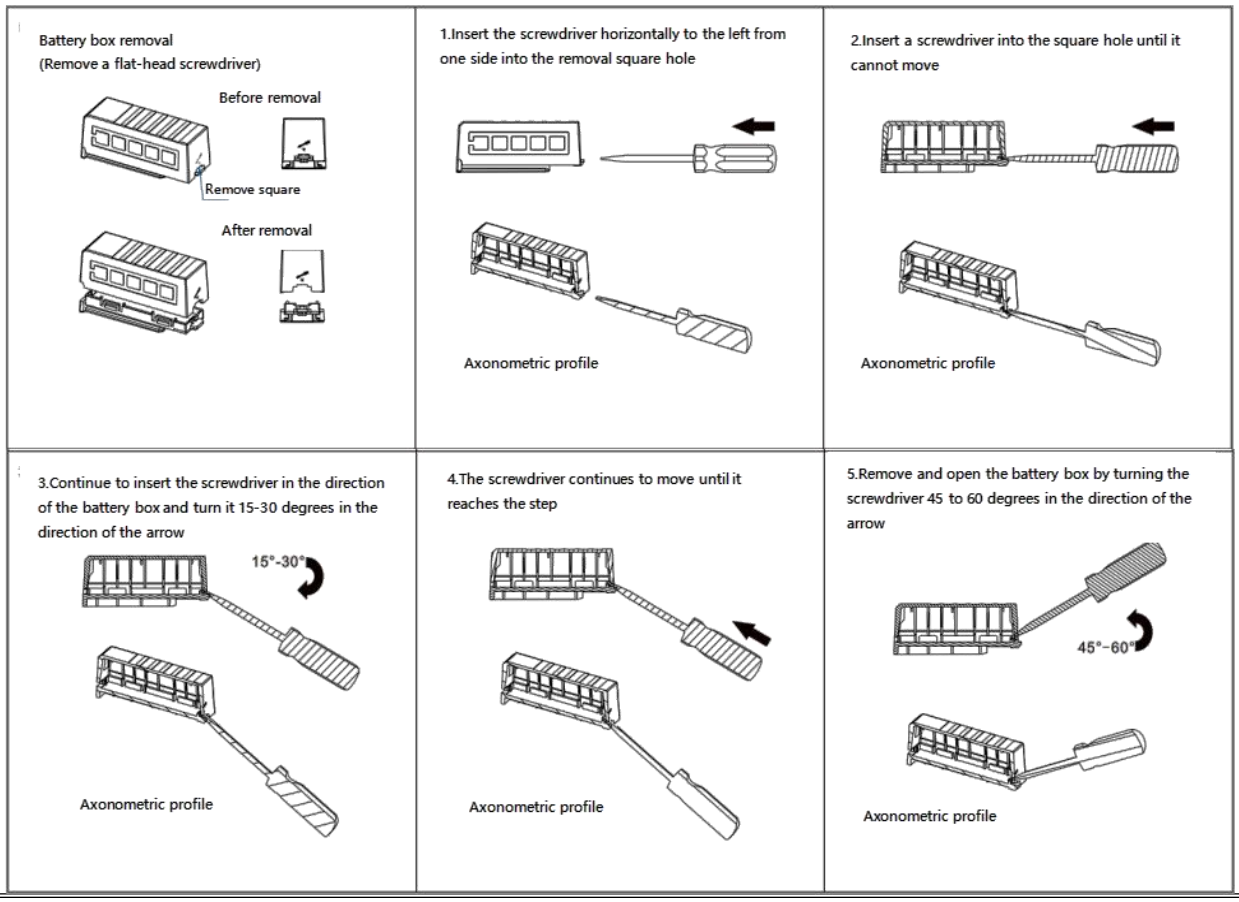
Table 6-27 Battery box installation diagram

1）Insert the battery box into the bottom of the driver, and the battery lead in the battery box is connected to the 2p terminal of the encoder cable. 

2）To remove the battery case from the bottom of the drive, first press the buckle and then remove the battery box.



3）To replace the battery, remove the cover by performing the following steps.



6.8.4.1 Multi-turn motor power-on configuration

When the absolute encoder motor is connected to the driver for the first time, the driver will appear 000.4 encoder UVW fault or communication fault alarm, which can be cleared by resetting the status marker of the encoder.

Table 6-28 Absolute encoder related parameters

Panel address	Internal address	Bit	Name	Description	Default
D0.07	2690.00	8	Encoder_Data_Reset	Communication encoder command Write: 1: clear encoder status 2: Read the fault word, the fault status can be viewed at 0x30510110 3: Clear encoder status and multi-turn data 8 Reset the status flag of the encoder 9 Clear multi-lap data 10 Reset encoder status flag and clear multi-turn data operation 12 Clear the single-turn data (requires the manufacturer's password) Read: bit 0: 1 = Command can be entered bit 1: 1 = Last command execution completed Note: Clearing the single-turn data will cause the motor phase error. It is forbidden to clear the single-turn data when the motor can run normally!	1
	2680.00	16	Warning_Word	Encoder alarm status word bit 0: battery alarm bit 1: Hybrid alarm (overspeed, overtemperature) bit 2: Encoder busy (motor speed too high at power-on) Note: When the drive has warning data, the panel will flash the warning status, and the warning status will not stop the operation of the drive.	0
	2340.0E	8	Encoder_MT_Disable	0: Default 1: Use the multi-turn encoder as a single-turn encoder	0
	3051.01	16	Group_Encoder_inf	Nikon internal error of encoder Bit0: BATT Bit1: MTERR Bit2: 0 Bit3: OVSPD Bit4: MEMERR Bit5: STERR Bit6: PSERR Bit7: BUSY Bit8: MEMBUSY Bit9: OVTEMP	0

Note

- After the communication encoder data is reset, the drive alarm will not be cleared directly. It is necessary to clear the drive alarm through the control word or restart the drive.
- After clearing the multi-turn fault, if the connection between the encoder wire and the motor end is disconnected, the drive will have fault 000.4 again, and the encoder state needs to be reset.
- After clearing the multi-turn data through the communication encoder data reset, the actual position single-turn data will not be cleared at this time. To reset the actual position, you need to use the 35 homing mode to return to the origin.

6.8.4.2 Multi-Circle Data Range

YAK/YBK absolute encoder motor single-turn resolution 8388608 (23bit), multi-turn number 65536, the actual position value after the positive multi-turn data overflow changes from 2147418112 to -2147418112, the negative multi-turn data overflow after the actual position value Changed from -2147483648 to 2147483648, the motor rotation direction remains unchanged after overflow.

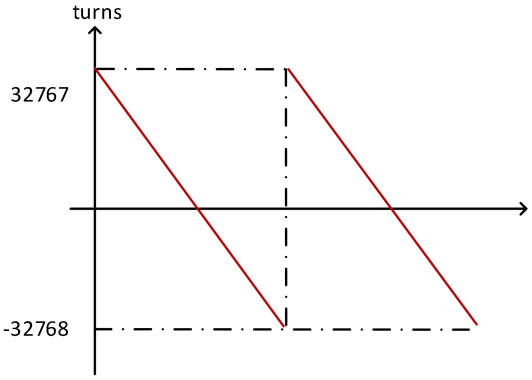


Figure 6-20 Multi-circle data range

6.8.4.3 Multi-turn prohibition

Set encoder multi-turn disable (0x23400E) to 1, absolute encoder can be used as incremental encoder without connecting battery. However, it should be noted that when the multi-turn prohibition is turned on, the position of the encoder cannot be saved after the power is turned off.

6.8.4.4 Battery usage

When the battery voltage is below 3.1V, the driver appears the warning status word 0001 and the panel will flash 000.1, but the driver will not alarm stop at this time. Under the condition that the driver remains properly powered and the encoder cable is properly connected, the battery replacement will not cause multiple data loss. When the battery voltage is lower than 2.5V, the encoder UVW fault or internal fault (fault code 000.4) occurs in the driver. At this time, the motor stops running, the data is lost in multiple turns, and the absolute encoder needs to be re-initialized after the battery is replaced.

Note

- The battery must be used within a limited temperature range, away from high temperature and humidity, and free of dust and inflammable and explosive substances.
- The battery must be used within a limited temperature range, away from high temperature and humidity, and free of dust and inflammable and explosive substances.
- Do not impact or squeeze batteries during transportation and assembly to avoid battery damage.
- If the battery cable is placed for a long time, check whether the battery has expanded shell before use.
- Do not short-circuit the positive and negative terminals of the battery; otherwise, the battery may burst.
- The battery is disposable. Do not charge the battery.
- Batteries must be discarded according to local regulations.

Table 6-29 Battery Specifications

battery name	Lithium thionyl chloride battery
Standard Voltage	3.6V
Standard capacity	2700mH
Maximum continuous discharge current	60mA
Maximum pulse capacity	150mA
Weight	19g
Operation temperature	-55℃~85℃
Storage temperature	-55℃~115℃

Chapter 7 Performance regulation

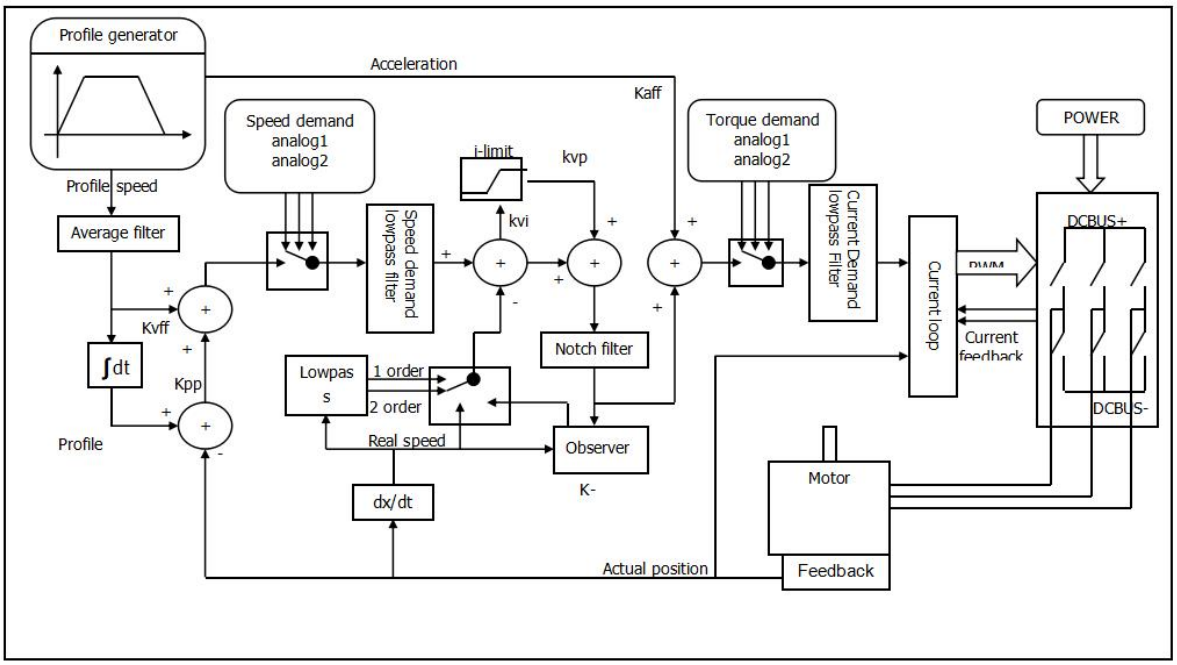


Figure 7-1 Servo system control block diagram

Figure 7-1 shows the servo system control block diagram. It can be seen from the figure that the servo system generally includes three control loops: current loop, velocity loop and position loop.

The adjustment process of a servo system is used to set loop gain and filters to match the mechanical characteristics, and finally to prevent the entire system from oscillating, to permit it to follow commands quickly and to eliminate abnormal noise.

- kaff：Position loop acceleration feedforward
- kvff：Position loop speed feedforward
- kvp：Velocity loop proportional gain
- kvi：Velocity loop integral gain
- kpp：Position loop proportional gain

7.1 Auto-tuning

The auto-tuning function of servo drive is to enable the motor and drive the load to carry out small reciprocating motion and automatically measure the inertia ratio and load rigidity class. If the inertia self-tuning is successful, the drive will automatically write the rigidity level according to the tuning result.

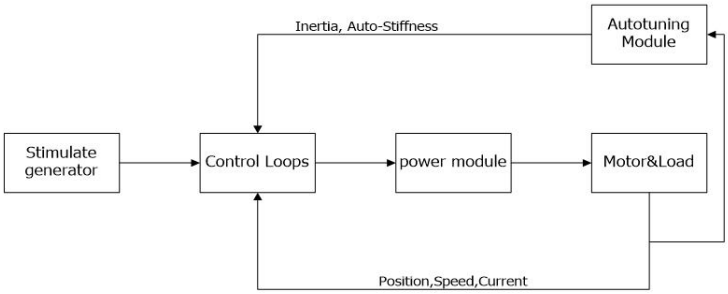


Figure 7-2 Auto-tuning

7.2Auto-tuning test operation method

When inertia auto-tuning is opened, motor shaft will reciprocate in a very short distance. So please keep some mechanical space before using.

7.2.1 Auto-tuning function related object parameters

Table 7-1 Auto-tuning function parameters

Panel address	Object index	Name	Description	Default	Range	R: read W: write S: save
tn01	0x304008	Stiffness	Stiffness of the load	12	0-31	RWS
tn02	0x30400B	Inertia_Ratio	Inertia_Ratio=(J_Load+J_Motor) *10/J_Motor	30	10-500	RWS
tn03	0x304001	Tunning-method	Start auto-tuning after write 1			RW
tn04	0x304006	Safe_Dist	Unit:0.01 Set the possible motion range during inertia measurement	22	0-40	RWS

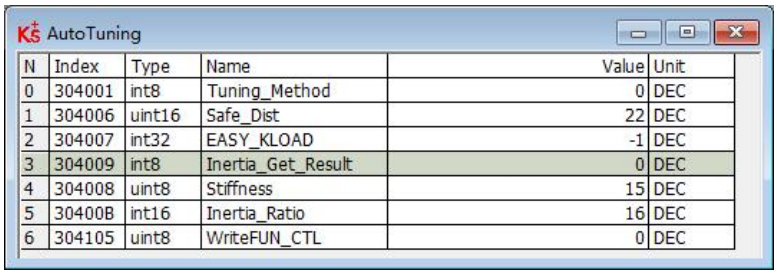
7.2.2 Digital tube key and PC software self-tuning method

1. Auto-tuning panel key operation

Open the tunE menu in the LED panel and go to tn03.
Write 1 to tn03. The motor oscillates with a small amplitude, the oscillation lasts less than 1s.
If tn03 remains at 1 after auto-tuning is done, auto-tuning has been successful. Otherwise it has failed.

2.Auto-tuning PC software operation

Click upper computer menu item**Driverler->Control Modes->Auto-tuning**.



N	Index	Type	Name	Value	Unit
0	304001	int8	Tuning_Method	0	DEC
1	304006	uint16	Safe_Dist	22	DEC
2	304007	int32	EASY_KLOAD	-1	DEC
3	304009	int8	Inertia_Get_Result	0	DEC
4	304008	uint8	Stiffness	15	DEC
5	30400B	int16	Inertia_Ratio	16	DEC
6	304105	uint8	WriteFUN_CTL	0	DEC

Figure 7-3 Auto-tuning window

First set the "write function permission control" object parameters of the address to 0x304105 to 1, and set the "setting mode" object parameters of the address to 0x304001 to 1, then the motor shaft in a very small distance began to do reciprocating motion, setting time does not exceed 1s, and get the setting result parameters.

The values in the parameters of the Inertia Test Result Flag on the last address 0x304009 reflect the final setting of the result parameters.

Users can also increase the motion range of inertia measurement by increasing the value of the object parameter of "inertia measurement operating range", so as to obtain more accurate setting result parameters. If the mechanical dither is large during the self-tuning process, the setting value of this object parameter can be appropriately reduced.

7.2.3Problems and adjustments with auto-tuning

The results of inertia measurement are marked as follows:

1：The Measure result is valid

0：The Measuring Process is not start or running

-1：User should add the distance of the measurement

-2：The measure result is out of range.You may solve this proble by set the Kvi_Limit to a small value.

-3：The inertia ratio is bigger than 25. the result is valid,but will not set the Control Loop automaticly

-4：The inertia ratio is impossible.

In the cases 0, -1, -2, -4 Inertia_Ratio is set to 30, in the case -3 Inertia_Ratio is set as measured, Stiffness is set to 7-10.

In any fail case the control loop parameters are set to Inertia_Ratio of 30 and the set Stiffness values. To make the measured Inertia_Ratio of case -3 become effective, the value of tn02 must be confirmed by SET.

Reasons for the failure of auto-tuning：

1.Incorrect wiring of the servo system；

2.DIN function Pre_Enable is configured but not active；

3.Too much friction or external force is applied to the axis to be tuned；

4.Too big backlash in the mechanical path between the motor and the load；

5.The mechanical path contains too soft components (soft belts or couplings)；

6.Inertia ratio is too large

Adjustment：

1.Try to increase the value of the "Safe_dist" parameter to perform auto-tuning again；

2.If it still fails, manually adjust the performance.

7.2.4Adjustment after auto-tuning

After auto-tuning the stiffness is set to a certain value. The greater the inertia ratio, the smaller the stiffness value will be. The range of parameter after auto-tuning is shown below.

Table 7-2 Stiffness table

Stiffness	Kpp/[0.01HZ]	Kvp/[0.1Hz]	Output filter[Hz]	Stiffness	Kpp/[0.01HZ]	Kvp/[0.1Hz]	Output filter[Hz]
0	70	25	18	16	1945	700	464
1	98	35	24	17	2223	800	568
2	139	50	35	18	2500	900	568
3	195	70	49	19	2778	1000	733
4	264	95	66	20	3334	1200	733
5	334	120	83	21	3889	1400	1032
6	389	140	100	22	4723	1700	1032
7	473	170	118	23	5556	2000	1765
8	556	200	146	24	6389	2300	1765
9	639	230	164	25	7500	2700	1765
10	750	270	189	26	8612	3100	1765
11	889	320	222	27	9445	3400	∞
12	1056	380	268	28	10278	3700	∞
13	1250	450	340	29	11112	4000	∞
14	1500	540	360	30	12500	4500	∞
15	1667	600	392	31	13889	5000	∞

Note

When the rigidity or inertia ratio is modified so that the Kvp is greater than 4000, then increasing the rigidity has no effect on the performance adjustment, and increasing the inertia ratio will reduce the bandwidth. For encoders with resolutions below 8000ppr, rigidity class is set to a maximum of 22. If the rigidity is changed through communication, set the write function permission control to 1 before changing the rigidity. After the rigidity is changed, set the write function permission control back to 0.

The adjustment of stiffness according to actual needs.

If response is too slow → increase stiffness. If oscillation or noise increases → reduce stiffness.

If the command from the controller (e.g. PLC) is unreasonable or inappropriate for the machine, some filters should be modified in order to reduce oscillation

7.3 Online self-tuning

The on-line self-tuning function of the servo drive does not need to be separated from the controller program, and it is turned on by a key during the movement of the device, which automatically calculates the load inertia and automatically adjusts the gain to the load state.

Table 7-3 Parameters related to the online self-tuning function

Panel address	Object index	Name	Description	Default	Range	R: read W: write S: save
/	0x234010	Online self-tuning control	The BCD code consists of the following bits to determine the self-tuning mode: Bit0: Enables online self-tuning Bit1: Automatically adjusts kvp after online self-tuning Bit2: The acceleration feedforward is automatically adjusted after the online self-tuning Bit4: No self-tuning when running forward Bit5: No self-tuning when running in reverse Bit7: Use friction to calculate the load	12	0-31	RWS

7.4 Manual tuning

The final setting parameters obtained through the self-tuning process cannot meet the user's field requirements or when there is mechanical clearance, inertia change or flexible connection, the requirements can be achieved by manual adjustment. The parameters of speed ring and position ring should be adjusted during debugging. The speed ring parameter is related to the load inertia of the whole mechanical system converted to the motor shaft. The position ring is the outermost control ring of the servo system and is related to the motor action mode, that is, the field application. The current ring is the innermost control ring in the servo system, and the current ring parameters are related to the motor parameters. After the motor is correctly configured, the system defaults the current ring parameters to the best parameters of the configured motor, so there is no need to adjust again.

Manual adjustment is required to work with the oscilloscope to capture the data waveform. Please refer to Section 5.6 when using the oscilloscope.

7.4.1Tuning of the velocity loop

Table 7-4 Velocity loop parameter

Panel address	Internal address	Name	Description	Default	Range
	60F901	kvp[0]	Setting reaction speed of Velocity loop	/	1-32767
d2.01	2FF00A	Velocity_BW	Changing this parameter changes kvp[0] by the inertia ratio	/	1-700
	60F902	Kvi[0]	Integral velocity loop gain	/	0-1023

d2.02	60F907	Kvi/32	It is 1/32 of Kvi，used for high resolution encoder.	/	0-32767
	2FF019	Kvi_Mix	The value of this parameter is 0x60F902 cross 32 plus 0x60F907. Writing this parameter sets 0x60F902 to 0，and the value is 0x60F907	/	0-16384
d2.05	60F905	Speed_Fb_N	Used to set Velocity feedback filter bandwidth. Filter bandwidth=100+Speed_Fb_N*20	7	0-45
d2.06	60F906	Speed_mode	Used to set the velocity feedback mode 0: 2nd order FB LPF 1: Directly feedback the original velocity 2: Velocity feedback after velocity observer 4: Velocity feedback after 1st order LPF 10: Velocity feedback after 2nd order LPF and the velocity command is filtered by a 1st order LPF. Both filters have the same bandwidth. 11: The velocity command is filtered by a 1st order LPF 12: Velocity feedback after velocity observer, the velocity command is filtered by a 1st order LPF 14: Velocity feedback after 1st order LPF and the velocity command is filtered by a 1st order LPF. Both filters have the same bandwidth Bit7： 1 ： Use 8K Velocity loop sampling frequency and 2K position loop sampling frequency (for 23-bit encoders) 0 ： Use 4K Velocity loop sampling frequency and 1K position loop sampling frequency	0	/
	60F915	Output_Filter_N	A 1st order lowpass filter in the forward path of the velocity loop	1	100-1370
	60F908	Kvi_Sum_Limit	Integral output limit of the velocity loop	/	0-2^15

The velocity loop adjustment steps are as follows:

Step 1：Adjustment for Kvp

Increasing Kvp can improve the bandwidth of the velocity loop and make the velocity response ability faster. To calculate the Kvp, please refer the following formula.

$$kvp = \frac{1.853358080 \times 10^5 \times J \times \pi^2 \times \mathrm{B}}{I_{Max} \times Kt \times Encoder}$$

Kt Motor torque constant，unit N.m/Arms*100

J Inertia，unit kg*m^2*10^6 B

B Velocity loop bandwidth unit: Hz

Imax MAX mortor current(6510.03)，unit: DEC

Encoder Resolution of the encoder

Because the -3 of Operation_mode has no acceleration and deceleration and does not participating the velocity loop control, the -3 mode and automatic flip mode can be used to run the motor when adjusting the velocity loop parameters. During the reciprocating motion, the responsiveness of the servo can be monitored by collecting the speed step curve

If the Kvp too low, the bandwidth of the velocity loop and the position loop will not match, which will lead to oscillation. If the Kvp is too high, it will cause the speed to overshoot and cause the speed loop to oscillate. In some rigid connection loads (such as ball screw, rack and pinion, etc.) The Kvp should be as high as possible. By comparing the oscillograms under different Kvp, find the optimal curve – the actuall speed curve should be tight follows the target command and does not have velocity oscillations.

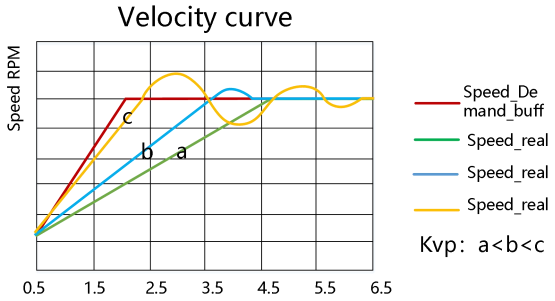


Figure 7-4 Speed step curve after Kvp adjustment

Remind

- Speed step curve：Curve that shows rise/fall changes.
- The vibration and noise of the motor can be felt by hand touch and listening

Step 2： Adjustment for Kvi

Kvi is designed to eliminate static errors. It can strengthen the low frequency gain of the velocity loop, and a large Kvi can reduce the response ability from low-frequency disturbance, thereby improving the anti-disturbance capability in low-frequency.

When Kvi is too small, The integral time will be long. The error adjustment will be slow, and it will take longer time to make the system entering steady state. When the integral gain of the speed loop is too large, the error will appear and in severe cases, the motor may oscillate. Kvi should be adjusted to the servo eliminating the error and enter a stable state efficiently.

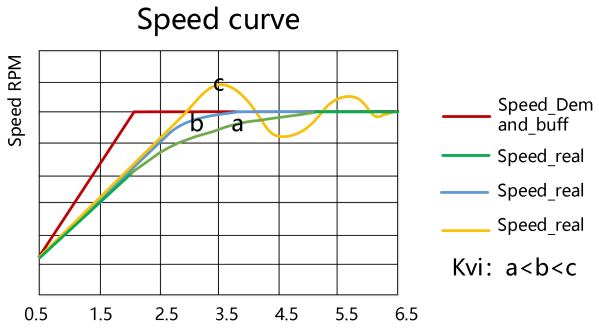


Figure 7-5 Speed step curve after Kvi adjustment

Generally, if the machine has more friction, the kvi should be set larger. If the entire system needs to respond quickly, kvi should be set as small as possible . If you need to dynamically close kvi during operation, you can use the kvi close in Din function.

Note

- Kvi32=1/32 of Kvi[0]， In high resolution encoder, directly increasing the data in the kvi[0] will lead to overshoot. At this time, you can reduce the data in kvi[0], and fine-tune it in the kvi32
- Generally,the parameters of kpp and kvi are relative. When the kpp data is adjusted to be much larger than the factory value, the kvi should also be appropriately increased on the basis of the factory value.

Step 3：Adjustment of Kvi_Sum_Limit

The Kvi_sum_Limit is the maximum current limit when performing adjustment。 Usually the default value can satisfy most applications. However, if the application system has a large resistance or the acceleration is too large, so that the actual current has reached the Kvi_sum_limit current, and at the same time, the actual speed is far less than the target speed. The value of this parameter should be increased. If the output current is prone to saturation, but the saturated output current will cause low frequency oscillations, this parameter should be reduced.
The Kvi_sum_limit should be as small as possible on the basis of satisfying the applicaition. The smaller the Kvi_sum_limit value, the shorter the adjustment time.

Step 4：Adjustment for Speed_fb_N

Feedback filter can reduce noise from the feedback path, eg, encoder resolution noise.
For different applications, the speed feedback filter can be converted to 1st and 2nd order by Speed_Mode.
1st order can reduce more noise, but produce less phase shift, allowing the higher Kvi or Kvp. 2nd order filter reduces more noise, but also provide more phase shift, which can limit the Kvi or Kvp.
Usually, if the machine and the load use soft connection, it is recommended to use a 1st order low-pass feedback filter or turn off the feedback filter. If the rigid connection is used or the load is too heavy, the 2nd order low-pass feedback filter could be used. Factory default is a 2nd order low-pass feedback filter, which is suitable for most applications.

If the motor noise is too loud when adjusting the Kvi or Kvp， you can appropriately reduce the speed feedback filter parameter(60F9.05). However, the velocity loop feedback filter bandwidth F must be greater than 2 times of the velocity loop bandwidth. Otherwise, oscillation may result. Speed feedback filter bandwidth F = speed feedback filter*20+100 [HZ]

Step 5：Adjustment of output filter

The output filter is a first order low pass torque filter. It can reduce the high-frequency torque order output by the speed control loop, so as to achieve the purpose of suppressing the resonance of the entire system.
When the output filter is set to 2546Hz (1DEC), it means to close the output filter control. When the system has resonance, the user can try to adjust the DEC value of the output filter setting from small to large to reduce noise.
The output filter frequency can be calculated by the following formula:

$$f = \frac{1}{2 \times \pi \times Ts \times Output_Filter_N}$$

Output_Filter_N (60F9.15)，Uint : DEC

Ts Constant 62.5us

Note

- The larger the DEC value set by the output filter, the stronger the filtering effect.
- Output filter settings [Hz]=2546/[DEC]
- Output filter settings [DEC]=2546/[Hz]

Step 6：Notch Filter Adjustment

A notch filter can suppress the resonance frequency by reducing the gain near the mechanical resonance.
If the resonant frequency is unknown, it can be obtained by flowing method:
Adjust the load so that the system runs in the resonance region, monitor the actual current at resonance on the oscilloscope, and then adjust the notch filter to observe whether the resonance disappears. When the current data at resonance is collected on the software oscilloscope, the period value of adjacent harmonics can be measured by the cursor to calculate the resonance frequency. After collecting multiple sets of harmonic cycles to calculate the average value of the cycles, the resonant frequency can be calculated using the average value of the cycles.

Table 7-5 Notch filter parameter

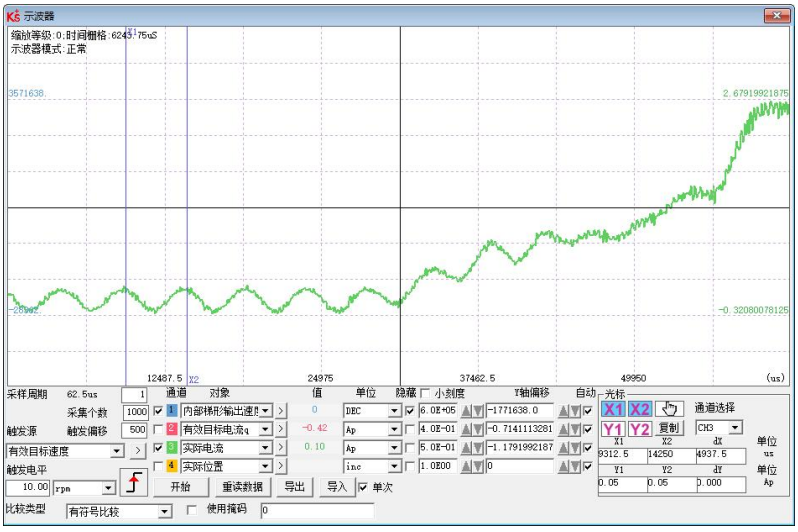
Panel address	Internal address	Name	Description	Default	Range
d2.03	60F903	Notch filter	Used to set the frequency of the internal notch filter to eliminate the mechanical resonance that occurs when the motor drives the machine	550	100-2000
/	250B01	Notch filter 1			
/	250B02	Notch filter 2			
/	250B03	Notch filter 3			

d2.04	60F904	Notch filter control	Notch filter control of Speed loop Bit0~1： The BCD code composed of two bits determines the filter to be turned on。 Bit4： 1 :Indicates FFT analysis using actual current， 0 :Indicates that the target current is used for analysis Bit5： 1: Indicates use actual speed for FFT analysis， 0: Indicates do not use actual speed for FFT analysis Bit.7： 1 Indicates that the FFT function is turned on, it will automatically become 0 after the analysis is completed, and it can only be turned on in the enabled state.	0	0-255

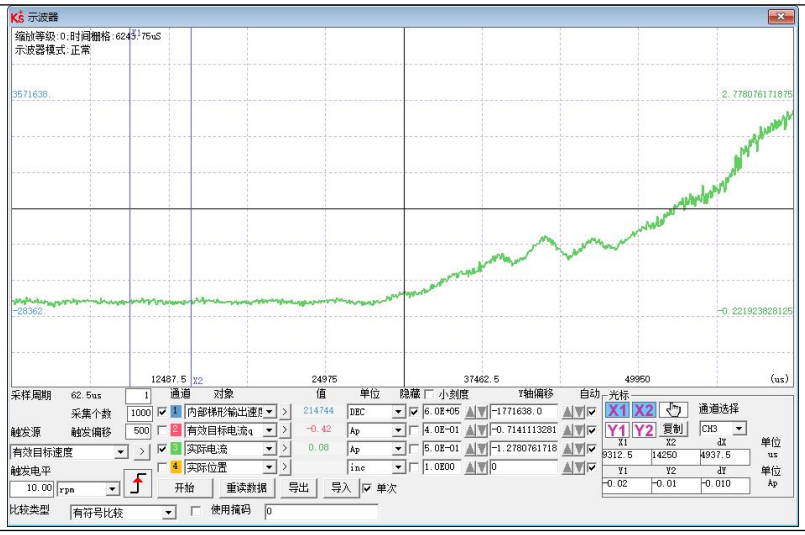
(1) Single-point notch filter

When the notch filter control (60F9.04) is set to 0, it indicates to close the notch filter control; when set to1, it indicates to open a single notch filter, and the frequency of the filter is set by the notch filter (60F9.03) .

Table 7-6 Single point notch filter debugging case

Instruction	Process
Limit output current of drive	Enter D2.14 of F002 through the panel to adjust the MAX output current RMS or adjust the target current limit through the basic operation interface of the servo software.
Use the oscilloscope to collect the current waveform in the resonance region. Note that when collecting the current with the oscilloscope, the sampling period should be set as small as possible, otherwise the resonance waveform may not be collected.	
Observe the resonant frequency with an oscilloscope and calculate the notch filter setting value based on the frequency	The resonant frequency in the figure is 200Hz, the notch filter control is set to 1, and the notch filter is set to 200Hz

After adding a notch filter, collect the actual current waveform again, and adjust it until the current waveform is smooth and free of resonance.



Note

- In order to prevent machine damage caused by large resonance amplitude during debugging, the value of target current limit can be reduced and then the notch filter can be adjusted.
- During the automatic setting of notch filter, the oscilloscope function cannot be used. After the setting is successful, the oscilloscope automatically switches the acquisition object, and click the reread data to display the FFT result amplitude.

(2)FFT Multi-point Notch Filter

Adopt high-order multi-point notch filter technology, automatically measure the mechanical resonance frequency of the load, and write the tuning result into the filter 0 and filter 1。The FD5 drive can be set with 4 notch filters, and the FFT will be adjusted according to the setting value of the notch filter control. Filter 2 and Filter 3 are manually adjusted notch filters, and the corresponding filters can be turned on/off through the notch filter control.

When the notch filter control (60F9.04) is set to 144DEC, it indicates that the actual current is used for FFT analysis.

When the notch filter control (60F9.04) is set to 160DEC, it indecates that the actual speed is used for FFT analysis.

When the FFT is successfully tuned, the notch filter control bit7 to reset, and the BCD code combined with bit0 and bit1 determines the filter to be turned on.

7.4.2 Position loop tuning method

Table 7-7 Position loop parameters

Panel address	Internal address	Name	Description	Default	Range
d2.07	60FB01	Kpp[0]	Set the response bandwidth of the position loop, unit: 0.01Hz	10	0～327
d2.08	2FF01A	K_Velocity_FF‰	0 means no feedforward，1000 means 100% feed forward	1000	0～4000
d2.09	2FF01B	K_Acc_FF‰	The unit only is right if the inertia ratio is correctly set. If the inertia ratio is unknown, set K_Acc_FF(60FB.03)instead	/	0-4000
d2.26	60FB05	Pos_Filter_N	The time constant of the position demand LPF. Unit:ms	1	1~255
d2.25	2FF00E	Max_Followin_error_16	Maximum allowable error(6065.00)=100* Max_Following_error_16.	10000	/

	60FB04	Position loop filter order	Setting value: 1：Use trapezoidal curve mode 3：Use S-shape mode	1	1or 3

Position loop tuning steps:

Step 1：Kpp adjustment

Increasing the Kpp can increase the position loop bandwidth to reduce the positioning time and the following error, but if the setting is too large, it will cause noise or even oscillation, and it must be set according to the load conditions. Kpp = 103 * position loop bandwidth。 The bandwidth of the position loop cannot exceed the bandwidth of velocity loop. It is recommended that the setting value of the position loop bandwidth be less than one quarter of the bandwidth of the velocity loop.

Step 2：Kvff adjustment

Increasing the Kvff can reduce the position following error and improve the dynamic response characteristics of the entire system, but it may lead greater overshoot during acceleration and deceleration. When the position command signal is not smooth, reducing the Kvff can reduce the motor oscillation. When the feedforward is set to 0, if only the Kvp is used to position the servo, the in-position time will be longer.

Kvff function can be regarded as the upper controller, such as PLC, has the opportunity to directly control the velocity in position operating mode. In fact, the function will consume part of the speed loop responsiveness, so the setting value needs to match the position loop and velocity loop bandwidth.

The elastic factor of the flexible load, such as pulley, will cause the speed feedforward command loaded to the speed loop to be unsmooth and cause the load to oscillate. In this type of load, the position loop speed feedforward can be appropriately reduced. In a rigid load, if adjusting the Kpp cannot eliminate the vibration generated by the motor during acceleration and deceleration, you can also try to gradually decrease the default 100% feedforward.

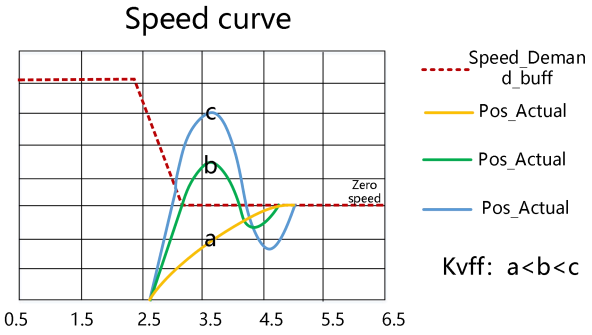


Figure 7-6 Speed step curve after Kvff adjustment

Step 3：Kaff adjustment

Users are not advised to adjust this parameter. When the practical application requires very high position loop response, the acceleration feedforward can be adjusted to improve the response performance.

The acceleration feedforward function can be seen as the upper controller has the opportunity to directly control the torque in the position operating mode. This function actually consumes some of the current loop responsiveness, so if the settings do not match the Kvp and velocity loop bandwidth, overshoot and oscillation will occur.

Also, the velocity feed forward to the velocity loop may not be smooth and has some noise signal inside, so a large velocity feed forward value will also amplify the noise.

Kaff can be calculated by following function:

ACC_%= 6746518 / K_Acc_FF / Easy_Kload * 100

ACC_% This means what percentage will be used for acceleration feedforward.
K_Acc_FF Kaff(60FB.03), calculates the final internal factor of the feedforward.
Easy_Kload Inertia Coefficient in Easy Mode (3040.07) Load coefficient calculated from auto-tuning or direct user input inertia ratio.

Note
The smaller the value of the K_Acc_FF parameter, the greater the position loop acceleration feedforward.

Step 4：Smooth filter adjustment

The smoothing filter is a moving average filter. It filters the velocity commands from the velocity generator to make the velocity and position commands smoother. Using this filtering causes velocity and position commands to be delayed in the drive. So for some applications, like CNC, it is better not to use this filter, but to do the smoothing in the CNC.

Smoothing filters reduce machine influence by smoothing commands. Smoothing Filter (60FB.05) defines the time constant of this filter in ms. Under normal circumstances, if the machine system vibrates when starting and stopping, it is recommended to increase the smoothing filter setting.

Step 5：other adjustment

In position mode (operation mode 1), the position loop commend filter control(60FB.04) can be set to 3 to enable the S-curve control. This curve has no command delay and is suitable for long-distance positioning control. When the speed step of the trapezoidal speed curve is large, it will cause a certain impact on the mechanical equipment. The S-shaped curve has better flexibility and smooth acceleration and deceleration, which can effectively overcome the mechanical vibration caused by the sudden change of speed.

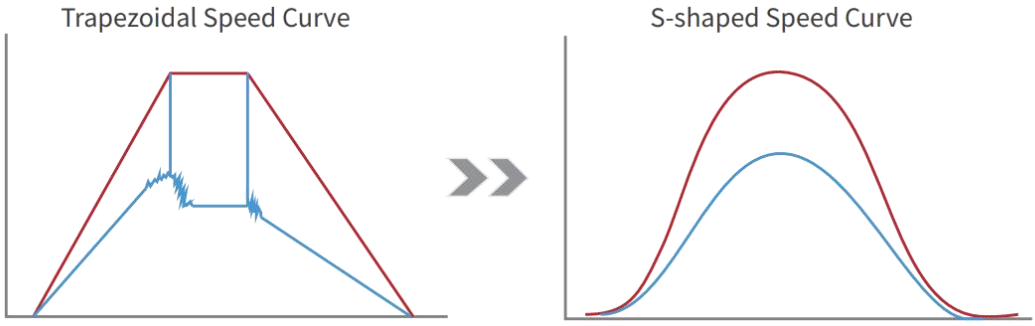


Figure 7-7 S-shaped speed step curve

Note

- S-curve is only valid in position mode (operation mode 1)

7.5 Gain switch (Pro mode)

This function is only used for professional！

the drive support 4 sets of PI gain settings. Each set includes Kvp, Kvi, Kpp. The actual PI parameters used are Kvp (x), Kvi (x), and Kpp (x). x=data of PI pointer.

Table 7-8 Gain switch parameters

Internal address	Type	Name	Description	unit
64F9.01	Uint16	Kvp[0]	Gain parameter called when PI pointer is 0	Dec, Hz
60F9.02	Uint16	Kvi[0]		Dec
60FB.01	Int16	Kpp[0]		Dec. Hz
2340.04	Uint16	Kvp[1]	Gain parameter called when PI pointer is 1	Dec, Hz
2340.05	Uint16	Kvi[1]		Dec
2340.06	Int16	Kpp[1]		Dec. Hz
2340.07	Uint16	Kvp[2]	Gain parameter called when PI pointer is 2	Dec, Hz
2340.08	Uint16	Kvi[2]		Dec
2340.09	Int16	Kpp[2]		Dec. Hz
2340.0A	Uint16	Kvp[3]	Gain parameter called when PI pointer is 3	Dec, Hz
2340.0B	Uint16	Kvi[3]		Dec
2340.0C	Int16	Kpp[3]		Dec. Hz
60F9.28	Uint8	PI point	Indicates the PI parameter being called	Dec

60F9.09	Uint8	Auto PI switch	When the target position/target speed is reached, that is, when bits.Target_reached=1, select the PI parameter, which is suitable for the occasions where different PI parameters need to be used during the motion process and the static state: 0: PI pointer (60F9.28)=0; 1: PI pointer (60F9.28)=1;	Dec

7.5.1 Gain switching method

The drive provide three method for dynamically selecting PI control parameters.

Method 1: Switch PI by digital input:
Configure the function gain switch 0 or/and gain switch 1 at the digital input port, and the value of the PI pointer is the BCD code composed of the input:
Bit0: Gain switch 0
Bit1: Gain switch 1

Table 7-9 Correspondence between gain switching and PI pointer

Gain switch 0 Effective input level	Gain switch 1 Effective input level	Value of PI pointer
1	0	1
0	1	2
1	1	3

For example:

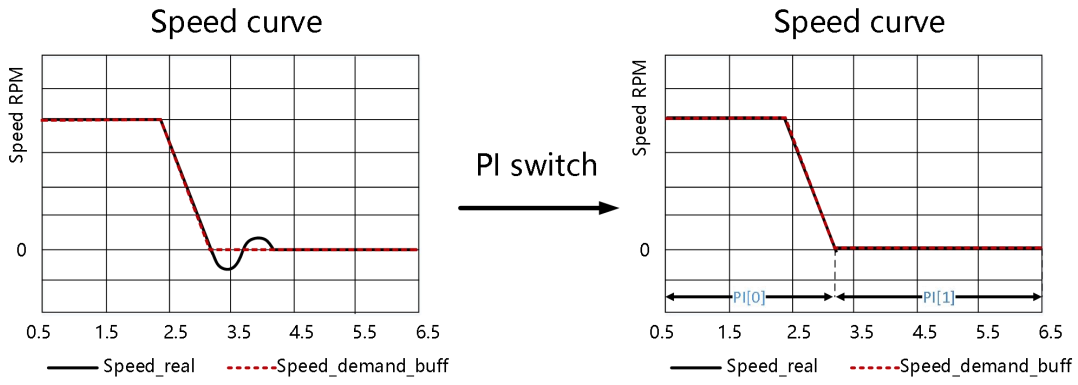
Figure 7-8 S-shaped speed step curve

Gain switch 0 = 1, Gain switch 1 = 0, so PI pointer =1, Valid PI parameter is Kvp[1], Kvi[1], Kpp[1]

Method 2: Drive auto switch PI

Set auto switch PI (6069.09) = 1: When the motor is running, the PI pointer is 0; when the motor is in the position to or the motor zero speed state, the PI pointer is 1.

Some equipment with large inertia may be affected by inertia or elastic force and vibrate when it decelerates to stop. At this time, switching flexible PI parameters helps to achieve efficient shutdown. Automatic PI switching is suitable for applications where different PI parameters are required for these motors in running and stopped states. If the gain switching function is defined on the digital input port, the automatic gain switching will be invalid.



Method 3: Set PI pointer value directly through communication

7.6 Other factors affecting performance

Control commands created by a controller (e.g. PLC).

Control commands should be as smooth as possible and must be correct and reasonable. For example, the acceleration in the control command cannot exceed the maximum acceleration that can be produced by the motor torque. By collecting the speed and current step waveforms, during the acceleration process, when the current is saturated and clipped, the acceleration and deceleration can be appropriately reduced or the smoothing filter can be increased.

The control command should obey the bandwidth limit of the control loop.

Mechanical design

In applications, performance is often limited by the machine. Various factors can affect the final control performance.

Control performance will affect the final performance of the machine such as accuracy, responsiveness and stability.

Chapter 8 Alarm elimination

When the drive alarms, the drive panel flashes an alarm code.
For more detailed error messages and error history, connect the drive to your PC using an RS232 serial cable.

Table 8-1 Alarm codes of Error_State (2601.00)

Alarm	Name	Reason	Troubleshooting
FFF.F	Wrong motormodel	1. The driver is not equipped with a motor. 2, the current motor model is different from the motor model saved by the driver	1.The driver factory parameters do not include motor configuration, connect the motor encoder line can automatically identify the motor parameters. 2. Connect the PC software to check whether the current motor model matches the motor code on the nameplate; Check that the current motor model matches the motor code with panel address EA01. If the current motor model is different from the actual motor, please self-identify the motor parameters
000.1	Extended Error	Error status word 2 alarm	Press the SET key to enter the error status word 2 (D1.16), and check the error meaning according to the alarm code in Table 8-2.
000.2	Encoder not connected	Encoder cable error or not connected; The presence of a 400.0 alarm indicates that the communication encoder is not responding	1.Make sure that the encoder between the driver and the motor is properly connected and the cable is firmly connected. 2. Use the EA01 or the host software to check whether the motor model 0x641001 is correctly set. When the motor model is abnormal, use the internal motor library (0x304106) to change to 1 and re-enter the motor model
000.4	Encoder internal	Multi-turn absolute encoder multi-turn data is invalid, need to reset	1: Press the button to enter d0.07 and set the data to 10, or modify the communication encoder data reset (0x269000) to 10 through the host software. 2: Reset the faulty or restart the drive. If the error persists, check whether the battery cable is securely connected, and try to replace the battery cable or compare the motor.
000.8	Encoder CRC	Motor model setting error; Encoder wiring error or external interference caused;	1.Check whether the motor code set is consistent with the connected motor through EA01 or the upper computer software 2. Check whether the encoder is properly wired and securely connected.
001.0	Controller Temperature	The temperature of controller's power module has reached the alarm value.	1.Check whether the motor and drive power meet the requirements; 2.Check whether the driver cooling fan can be opened normally, whether the heat dissipation port is blocked 3.Take heat dissipation measures in the electrical cabinet. 4. The power circuit inside the driver is damaged. Replace the driver.

002.0	Overvoltage	The DC bus voltage exceeds the overvoltage alarm point	1. Check whether the power supply voltage is within the driver input voltage range and whether the power supply voltage is stable. 2. When the feedback energy is too high in high-speed braking situations, the brake resistance is not connected and the control actions of multiple axes are not synchronized, the common DC bus scheme in section 3.2.4 can be considered. 3. If the resistance value of the brake resistor is too large, the energy leakage of the bus is not timely. You can reduce the resistance value of the brake resistor by referring to the recommended range in Appendix 1.
004.0	Undervoltage	The input power supply of the three-phase driver is missing a phase	Support the drive of the three-phase 220V, when using the single-phase 220V power supply needs to be 0x269200 configured to 0,When three-phase 220V/380V driver experiences a phase loss in the input power supply during operation, it is necessary to check if the input power cable is securely connected
		The power voltage input is lower than the low voltage protection alarm value.	1. Check whether the power supply voltage is within the driver input voltage range and whether the power supply voltage is stable. 2. Power on the power supply and then the logic power supply, and ensure that the drive is connected to the power supply before enabling the power supply. Note: FD415P/425P logic and power are not separated. When the power is cut off in the enabled state, the driver panel will blink 004.0. When the capacitor is discharged, the panel LED will be extinguished.
008.0	Overcurrent	Instantaneous current exceeds the overcurrent protection value.	1.Check whether the motor configuration parameters are consistent with the motor drawing. 2. Check whether there is a short circuit between the power line UVW, and try to replace the power cable/motor/driver for comparison. 3. Interference causes an overcurrent alarm. For details, see 3.3 Setting EMC Conditions.
010.0	Chop Resistor	External brake resistance is overloaded	1.Check whether the external brake resistance value and brake resistance power are set correctly on the panel or PC. 2. The brake resistor power is insufficient, replace the brake resistor with a higher power.
		Internal brake resistance overtemperature	The power of the brake resistance inside the driver is insufficient. Please disconnect the short cable between DC+/RB1 and RB-end, and connect the appropriate external brake resistance between DC+/RB1 and RB-end.
		Internal brake unit damaged, brake circuit short circuit	After the driver is powered off, use a multimeter to measure the DC- and RB-ends. If the driver works properly, replace the driver.

020.0	Following Error	The actual following error exceeds the set maximum following error value. The possible reasons are: 1. The motor cable is improperly connected 2. The control ring is too rigid 3. The maximum following error is set too small 4. Target speed exceeds maximum speed limit 5. The target torque limit is too small 6. Brake is not enabled 7.Mechanical device jamming/friction	1. Make sure the power cable UVW is connected correctly 2.Readjust the gain and increase the rigidity. Refer to Chapter 7 for the rigidity adjustment method 3.Readjust the maximum follow error (0x606500) 4. Readjust the maximum speed limit (0x607f00) 5. Readjust the target current limit (0x607300), the default value of the target current limit is equal to the maximum motor current (0x64100B) 6.Measure whether the brake cable connection is normal, measure the lock voltage, replace the motor and compare the test 7.Remove mechanical jams and apply lubricant
040.0	Low Logic Voltage	The logic voltage is lower than the lower alarm limit	Check whether the logical voltage is within the driver input voltage range and whether the power supply voltage is stable
080.0	Motor or controller IIt	The motor or drive is overloaded for a long time, the possible reasons are: 1. Motor power cable and encoder cable error 2. When the motor shaft is rotating, the lock is not loosened 3. The drive control ring parameters are incorrectly set 4. The mechanical device is stuck or the friction is too large 5. Driver/motor selection error can not meet the application requirements	1. Check that the encoder/power line is properly connected 2.Measure whether the lock line connection is normal, measure the lock voltage, replace the motor and compare the test 3. Adjust the parameters of the control ring 4.Eliminate mechanical jams and apply lubricant 5. Run with reduced load or replace with more powerful products
100.0	Over frequency	External input pulse frequency is too high.	1. Reduce the pulse frequency 2. When using more than 600KHz pulse, need to increase the pulse frequency control 0x250808(panel address D3.38) value.
200.0	Motor temperature	Input port defines and triggers motor failure	User-defined alarm
400.0	Encoder information	Encoder cable error or not connected; The presence of a 000.2 alarm indicates that the communication encoder is not responding	1. Make sure that the encoder between the driver and the motor is properly connected and the cable is firmly connected. 2.Check whether the current motor model matches the motor code in the nameplate through EA01 or the upper computer software. When the motor model is abnormal, use the internal motor library (0x304106) to change to 1 and re-enter the motor model
800.0	EEPROM data	Data is damaged when the power is turned on and data is read from the EEPROM.	1.Initialize the control ring parameters, save the control parameters, and restart the drive. Step 2.Import the cdi file through the host software

Table 8-2: Alarm codes of Error_State2 (extended)

Alarm	Name	Reason	Trouble shooting
000.1	Current sensor	Current sensor signal offset or ripple too big	1. The current sensor generates an alarm due to external interference. For details, see 3.3 Setting EMC Conditions. 2. Current sensor circuit is damaged, replace the driver and compare.
000.2	Watchdog	Software watchdog exception	After initializing the control ring parameters, save the control parameters and restart the drive.
000.4	Wrong interrupt	Invalid interrupt exception	After initializing the control ring parameters, save the control parameters and restart the drive.
000.8	MCU ID	1. The software program does not match the hardware 2. An MCU error is detected	1.Check the software version in the drive properties and update the correct software 2.Replace the drive and compare.
001.0	Motor configuration	1. Motor model cannot be automatically identified EEPROM No motor data or the motor is not configured correctly 2. The motor cable is missing, and a phase of the power cable UVW is not connected	1.Check whether the current motor model matches the motor code in the nameplate through EA01 or the upper computer software. When the motor model is abnormal, use the internal motor library (0x304106) to change to 1 and re-enter the motor model 2.Make sure the motor power line UVW is connected correctly and reliably 3.Replace the power cable or driver comparison test.
010.0	External enable	DIN is equipped with a pre-enable function. It is necessary to confirm that the pre-enable signal is effectively input before enabling the driver	User-defined alarm
020.0	Positive limit	Positive position limit (after homing), position limit only causes error when Limit_Function (2010.19) is set to 0.	User-defined alarm
040.0	Negative limit	Negative position limit (after homing), position limit only causes error when Limit_Function (2010.19) is set to 0.	User-defined alarm
080.0	SPI internal	Internal firmware error in SPI handling	Please contact the supplier
100.0	CAN bus fault	This function is enabled only when the Communication interruption mode (0x600700) is set to 1	User-defined alarm
200.0	Closed loop direction	In full closed loop mode, the counting direction of the main encoder is opposite to that of the motor encoder	1. Check the count direction of the main encoder and the count direction of the motor encoder, the count direction is inconsistent, please change the count direction of the main encoder (0x250A03) 2.The master encoder speed is not proportional to the motor encoder speed. Check the mechanical installation, exclude mechanical slippage or jammed, check the full closed spindle check (0x250A05) and full closed slave shaft check (0x250A06) and full closed loop ratio check (0x250A09) Settings.

400.0	The main encoder ABZ fault	Master encoder connection error	Check that the main encoder signal line is connected correctly
800.0	Master counting	Master encoder counting error	Step 1: Correctly fill in the main encoder period (0x250A01) and set it to 0 to disable check. Step 2: Check for interference

Table 8-3 Performance anomalies and solution

Anomalies	Alarm reason	Solutions
Abnormal noise or vibration occurs when the motor runs without load	● Wiring error ● Improper handling of control loop parameters ● Improper installation of motor oil seal or motor failure	● Use standard power cables, encoder cables and control cables to ensure that the cables are correctly wired and not loose or damaged. ● Initialize the control parameters—store the control parameters and restart and try to run ● Twist the motor bearing by hand to check whether the motor is abnormal, and try to reinstall the motor oil seal
Inaccurate positioning	● Improper control loop parameters ● The pulse data before the gear is inconsistent with the number of pulses sent by the controller ● The electronic gear ratio is set too large ● Accumulated error of reciprocating motion ● Mechanical system factors	● Adjust the drive control loop parameters according to chapter 7.1 ● Use shielded twisted pair cables for pulse lines. When the cables are long, the diameter of the control lines should be appropriately increased. The pulse line should be kept away from the power line as far as possible, and the drive and the motor should be well grounded. ● Restore factory gear ratio operation. ● Restore the machine to the original under the conditions allowed by the process, and search for the origin before the accumulated error exceeds the allowable. ● Check whether the coupling equipment is firmly installed, the pulleys or gears are well engaged, whether the load inertia is too large, try to reduce the load or replace the motor with higher power, etc.

Chapter 9 FD5P panel parameter list

The EASY group allows users to quickly set commonly used control parameters.

Table 9-1 EASY parameters

Panel address	Internal address	Name	Description	Default	Range	R/W/S
EA00	2FF00108	Store_Data	Store control loop parameters (excluding motor parameters) 1:Store all parameters of control loop 10: Initiative all parameters of control loop	0	0-255	RW
EA01	30410110	EASY_MT_TYPE	Configuration motor model	404b	/	RWS
EA02	30410208	Command_Type	Control instructions can be configured quickly by setting the instruction type. Note: Changing the instruction type will change the working mode and the definition of the IO port. 0: Dual-pulse mode CW/CCW 1: pulse direction mode P/D 2: A/B phase pulse control mode 8: Communication control mode When the instruction type is set to 0-2, corresponding to working mode -4, DIN will be configured to factory Settings. When the instruction type is set to 8, DIN4 and DIN5 are defined as positive limit and negative limit respectively, DIN7 is defined as origin mode, working mode and control word are controlled by communication.	1	0~8	RWS
EA03	25080110	Gear_Factor[0]	This parameter is valid when EA02 is written to 0-2. The value is displayed in decimal by default. Values over 10000 are displayed in hexadecimal. Note: See Table 4 for the decimal and hexadecimal display methods.	1000	32767~ -32768	RWS
EA04	25080210	Gear_Divider[0]		1000	1~32767	RWS
EA05	30410410	EASY_Analog_ Speed	Set the analog speed factor	11	/	RWS
EA06	30410310	EASY_App_SET	Digit tube from units to thousands (digit tube from right to left) represents: Bits: Load type, which affects control ring parameters 0: no load 1: Flexible load (such as belt, etc.) 2: Rigid load (such as ball screw) Tens: applications that affect control ring parameters	1020	/	RWS

			0: point-to-point mode (positioning control) 1: CNC mode (interpolation control) 2: master/slave mode Hundred position: Set the limit switch 0: Use the current limit switch setting 1: Block all limit switches Thousands: OUT5's drive fault polarity 0: The output is normally closed 1: The output is normally open			
EA07	60980008	Homing_Method	Look for patterns at the origin	0	/	RWS

The Tune group is the driver inertia measurement related parameters.

Table 9-2 Tune parameter

Panel address	Internal address	Name	Description	Default	Range	R/W/S
Tn00	2FF00108	Store_Data	Store control loop parameters (excluding motor parameters) 1:Store all parameters of control loop 10: Initiative all parameters of control loop	0	0-255	RW
Tn01	30400808	Stiffness	Rigidity class	15	0-31	RWS
Tn02	30400B10	Inertia_Ratio	Inertia ratio = total load inertia/motor inertia *10	16	/	RWS
Tn03	30400108	Tuning_Method	Write 1 Enable the inertia measurement function. Do not write values other than 1. Note that writing 1 causes the external IO control signal to briefly lose control for 2 seconds. The working mode will be changed to 11	0	0、1	RW
Tn04	30400610	Safe_Dist	Set the possible range of motion when measuring inertia in 0.01 turns	22	0-40	RW

F000 is drive instruction groupr , the parameters could not be saved.

Table 9-3 F000 parameters

Panel address	Internal address	Name	Description	Default	Range	R/W/S
D0.00	60600008	Operation_Mode	Drive operation mode |-4:Pulse train Control |-3:Speed Control |4:Torque Control |1:Position Control |3:Speed Control |6:Homing mode |7:Interpolation mode	-4	/	RW
D0.01	2FF00508	Control_Word_Easy	000.0: Release motor，controlword write 6 000.1: Lock motor，default controlword write 2F, could be selected by 0x20200F.	0	/	RW

			001.0: Clean error, controlword write 86 Note: To use the simplified control word, the digital input port cannot define the enable and reset fault functions.			
D0.02	2FF00910	SpeedDemand_RPM	3/-3 RPM in speed mode, unit: rpm	0	0~5000	RW
D0.03	60F60810	CMD_q	It is used to set the input torque command (current command) when the drive works in 4 mode and d3.30 is set to 0 (no external analog control), the unit is DEC.	0	-2047~2047	RW
D0.04	2FF00A10	Vc_Loop_BW	Velocity loop bandwidth setting, unit Hz	59	0-600	RW
D0.05	2FF00B10	Pc_Loop_BW	Position loop bandwidth setting, unit Hz	9	/	RW
D0.06	2FF00C10	Tuning_Start		0	/	RW
D0.07	26900008	Encoder_Data_Reset	Write: 1: clear encoder status 2: read fault word 3: Clear encoder status and multi-turn data 8: Reset status flag 9: Clear multi-lap data 10: write 8 and 9 Read: bit 0: 1 = Commands can be entered bit 1: 1 = The last command is executed	0	/	RW
D0.08	2FF02310	Jog_RPM	Speed in jog mode, unit rpm	0	0~5000	RW
D0.09	23400D08	Keba	0:default 1:turn on remote node 40:Compatible with 2S panel parameter flags	0	0、1、40	RW

The F001 panel menu contains real-time data for panel monitoring when the drive has no fault alarms. After entering the F001 group by pressing the key, select the data address that needs to be displayed and hold down the SET key until the last decimal point at the bottom right of the panel lights up, indicating that the setting is successful. Hold down the MODE key to return to the monitoring screen. The selected data will be displayed on the monitoring panel.

Table 9-4 F001 parameter

Panel address	Internal address	Name	Description	Default	Range	R/W/S
D1.00	2FF00F20	Soft_Version_LED	Firmware version, display at the LED.	/	/	R
D1.02	2FF01008	Motor_IIt_Rate	Displays the rate of real iit and max iitof the motor.	0	0-100%	R

D1.04	2FF01108	Driver_IIt_Rate	Display the rate of real iit and max iit of the controller.	0	0-100%	R
D1.06	2FF01208	Chop_Power_Rate	Display the rate of real power and rated power of the chopper.	0	0-100%	R
D1.08	60F70B10	Temp_Device	temperature of controller, unit: ℃	/	/	R
D1.09	60790020	Real_DCBUS_mV	DC bus voltage	/	/	R
D1.10	60F70C10	Ripple_DCBUS	Ripple voltage of DC bus	/	/	R
D1.11	20100A10	Din_Real	The actual status of the digital input port bit0: Din1 bit1: Din2 bit2: Din3 ... bit7: Din8	/	/	R
D1.12	20101410	Dout_Real	The actual effective output state of the digital output outlet is the result calculated by Dout state, Dout polarity and Dout simulation. Dout effective =(Dout state OR Dout simulation)XOR(NOT Dout polarity) bit0:Dout1 bit1:Dout2 bit2:Dout3 … bit6:Dout7	/	/	R
D1.15	26010010	Error_State	Real-time alarm error status bit0: Extension error, read Error status 2(D1.16) bit 1: encoder not connected bit 2: encoder internal fault bit 3: encoder CRC error bit 4: driver temperature alarm bit 5: High voltage alarm bit 6: Low voltage alarm bit 7: overcurrent alarm bit 8: brake resistance alarm bit 9: excessive position error alarm bit 10: logic low voltage alarm bit 11: motor or driver iit alarm bit 12: Pulse frequency is too high alarm bit 13: Motor temperature alarm bit 14: encoder information error bit 15: EEPROM alarm	0	0-65535	R
D1.16	26020010	Error_State2	bit 0: Current sensor error bit 1: watchdog error bit 2: interrupt error bit 3:	0	0-65535	R

			MCU ID error bit 4: motor configuration error bit 5: logic output error bit 8: preenable error bit 9: Positive limit error bit10: Negative limit error bit11: SPI error bit12: CAN communication error bit13: full closed loop direction error bit14: master encoder ABZ error bit15: master encoder count error			
D1.17	60410010	Status word	Status word of controller	/	/	R
D1.18	60610008	Operation_Mode_Buff	Operation mode in buffer	0	/	R
D1.19	60630020	Pos_Actual	Actual position of motor	0	-2^31-2^31-1	R
D1.20	60FB0820	Pos_Error	Following error of position	0	-2^31-2^31-1	R
D1.21	25080420	Gear_Master	Input pulse amount before electronic gear	0	-2^31-2^31-1	RW
D1.22	25080520	Gear_Slave	Execute pulse amount after electronic gear	0	-2^31-2^31-1	RW
D1.23	25080C10	Gear front pulse frequency	Spindle input pulse speed rate (pulse/ms)	0	-32768-32767	R
D1.24	25080D10	Gear front pulse frequency	Spindle input pulse gear ratio pulse speed (pulse/ms)	0	-32768-32767	R
D1.25	2FF01410	Real_Speed_RPM	Real speed, unit: rpm	0	0-15000	R
D1.26	60F91910	Real_Speed_RPM2	Real speed, unit: 0.01rpm	0	-10-10	R
D1.28	60F60C10	CMD_q_Buff	q current command buffer	0	-2048-2047	R
D1.29	2FF01800	I_q_Arms	Real current in q axis, unit 0.1Arms	0	/	R
D1.48	26800010	Warning_Word	warning status word of the encoder Bit 0: Battery Warning Bit 1: Mixed Warning Bit 2: Encoder Busy	0	0-7	R
D1.49	30440008	Cur_Index of Table	Range: 0-31, current index in the position table	0	0-31	R
D1.50	30101420	Encoder_Err_Report	Incremental encoder ABZ signal loss count	0	0-2^32	RW

The F002 Group panel menu contains the parameters that the control ring needs to set.

Table 9-5 F002 parameter

Panel address	Internal address	Name	Description	Default	Range	R/W/S
D2.00	2FF00108	Store_Data	Save or init parameters 1: save control parameters 10: init control parameters	0	0-255	RW
D2.01	2FF00A10	Vc_Loop_BW	Bandwidth of the velocity loop, unit: Hz.	/	1-700	RWS

D2.02	2FF01910	Kvi_Mix	Integral gain of the velocity loop, as a combination of 32*Kvi(60F9.02) + Kvi/32(60F9.07). When written, it sets Kvi(60F9.02)=0 and the value goes to Kvi/32(60F9.07).	/	0-65535	RWS
D2.03	60F90308	Notch_N	Notch filter frequency BW=Notch_N*10+100[Hz]	45	0-127	RWS
D2.04	60F90408	Notch_On	Notch filter enable	0	0-1	RWS
D2.05	60F90508	Speed_Fb_N	Bandwidth of velocity feedback filter BW=Speed_Fb_N*20+100[Hz]	7	0-45	RWS
D2.06	60F90608	Speed_Mode	0: 2nd order FB LPF 1: No FB LPF 2: Observer FB 4: 1st order FB LPF 10: 2nd LPF+SPD_CMD FT 11: SPD_CMD FT 12: SPD_CMD FT+Observer 14: 1st LPF+Observer	1	0-255	RWS
D2.07	60FB0110	Kpp[0]	Kp of position loop.unit:0.01Hz	1000	0-32767	RWS
D2.08	2FF01A10	K_Velocity_FF‰	Feedforward of position loop, unit: 0.1%	0	0-1500	RWS
D2.09	2FF01B10	K_Acc_FF‰	Acceleration forward of position loop, unit: 0.1%	0	0-1500	RWS
D2.10	2FF00610	Profile_Acc_16	Trapezoidal acceleration. Unit rps/s	100	/	RWS
D2.11	2FF00710	Simplified deceleration	Trapezoidal deceleration. Unit rps/s	100	/	RWS
D2.12	60F60110	Kcp	Kp of current loop	/	1-32767	RWS
D2.13	60F60210	Kci	Ki of current loop	/	0-1000	RWS
D2.14	2FF01C10	CMD_q_Max_Arms	Maximum current command in q axis unit: 0.1Arms	/	0-32767	RWS
D2.15	60F60310	Speed_Limit_Factor	A factor for limiting max velocity in the torque mode	10	0-1000	RWS
D2.16	607E0008	Invert_Dir	Invert motion 0: CCW is positive direction 1: CW is positive direction	0	0-1	RWS
D2.24	60800010	Max_Speed_RPM	Motor's max speed unit: rpm	5000	0-15000	RWS
D2.25	2FF00E10	Max_Following_Error_16	Max_Following_Error= 100*Max_Following_Error_16	100	1-32767	RWS
D2.26	60FB0510	Pos_Filter_N	Average filter parameter	1	1-255	RWS
D2.27	20101810	Zero_Speed_Window	Zero speed window, inc/ms	3	0-65535	RWS

The F003 Group panel menu includes the parameters needed to configure the multi-speed multi-bit control and the digital input/output function.

Table 9-6 F003 parameter

Panel address	Internal address	Name	Description	Default	Range	R/W/S
D3.00	2FF00108	Store_Data	Save or init parameters 1: save control parameters 10: init control parameters	0	0-255	RW
D3.01	20100310	Din1_Function	See chapter 6.1, table 6-1	0x01	0-65535	RWS
D3.02	20100410	Din2_Function		0x02	0-65535	RWS
D3.03	20100510	Din3_Function		0x04	0-65535	RWS
D3.04	20100610	Din4_Function		0x08	0-65535	RWS
D3.05	20100710	Din5_Function		0x10	0-65535	RWS
D3.06	20100810	Din6_Function		0x20	0-65535	RWS
D3.07	20100910	Din7_Function		0x40	0-65535	RWS
D3.08	2FF00D10	Dio_Polarity	Sets IO polarity	65535	0-65535	RWS
D3.09	2FF00810	Dio_Simulate	Simulates input signals, and enforce output signals for outputting	0	0-65535	RWS
D3.10	20000008	Switch_On_Auto	0: no operation 1: auto-enable when logic power-up. Can be set only if the DIN function enable is not defined.	0	0-255	RWS
D3.11	20100F10	Dout1_Function	See chapter 6.1, table 6-2	0x01	0-65535	RWS
D3.12	20101010	Dout2_Function		0x02	0-65535	RWS
D3.13	20101110	Dout3_Function		0xA4	0-65535	RWS
D3.14	20101210	Dout4_Function		0x08	0-65535	RWS
D3.15	20101310	Dout5_Function		0x10	0-65535	RWS
D3.16	20200D08	Din_Mode0	Operation mode channel 0: select via input port	-4	-128-127	RWS
D3.17	20200E08	Din_Mode1	Operation mode channel 1: select via input port	-3	-128-127	RWS
D3.18	20200910	Din_Speed0_RPM	See chapter 6.2.1, table 6-8 unit: rpm	0	-32768-32767	RWS
D3.19	20200A10	Din_Speed1_RPM		0	-32768-32767	RWS
D3.20	20200B10	Din_Speed2_RPM		0	-32768-32767	RWS
D3.21	20200C10	Din_Speed3_RPM		0	-32768-32767	RWS
D3.34	25080110	Gear_Factor0	Numerator of electronic gear	1000	-32768-32767	RWS
D3.35	25080210	Gear_Divider0	Denominator of electronic Gear	1000	1-32767	RWS
D3.36	25080308	PD_CW	Pulse control mode 0: CW / CCW mode 1: pulse direction mode 2: incremental encoder mode	1	0-255	RWS
D3.37	25080610	PD_Filter	Filter parameter of pulse input	3	0-255	RWS

D3.38	25080810	Frequency_Check	Maximum frequency of input pulse unit: pulse/ms	600	0-3000	RWS
D3.39	25080910	Target_Reach_Time _Window	Target (position velocity) reached time window. unit: ms	10	0-32767	RWS
D3.40	2FF10108	Multi-stage_pos_control_L	Target (position velocity) reached time window. unit: ms	0	0-8	RWS
D3.41	2FF10210	Pos_M	Select the internal position segment, When the data is 0~7, it means to select and set the DIN position 0~7 in turn. When the data is 8, it means homing offsets in sequence.	0	-32768-32767	RWS
D3.42	2FF10310	Pos_N	D3.40 Selected position L Number of pulses=M*10000+N	0	-32768-32767	RWS
D3.43	20200F10	Din_Controlword		0x2F	0-65535	RWS
D3.44	20201820	Din_Speed4_RPM	Multi-stage speed control 4[rpm]	0	-32768-32767	RWS
D3.45	20201920	Din_Speed5_RPM	Multi-stage speed control 5[rpm]	0	-32768-32767	RWS
D3.46	20201A20	Din_Speed6_RPM	Multi-stage speed control 6[rpm]	0	-32768-32767	RWS
D3.47	20201B20	Din_Speed7_RPM	Multi-stage speed control 7[rpm]	0	-32768-32767	RWS

The Group F004 panel menu includes the parameters related to the motor.

Table 9-7 F004 parameters

Panel address	Internal address	Name	Description	Default	Range	R/W/S
D4.00	2FF00308	Store_Motor_Data	1: Store the set motor parameters	0	0-255	RW
D4.01	64100110	Motor_Num	Configuration motor model	0	/	RWS
D4.02	64100208	Feedback_Type	Encoder Type bit0: UVW signal check bit1: Nikon multi-turn absolute value bit2: Nikon single-turn absolute value bit4: ABZ signal check bit5: snip encoder	/	0-255	RWS
D4.03	64100508	Motor_Poles	Motor pole pairs[2p]	/	0-255	RWS
D4.04	64100608	Commu_Mode	Commutation mode	/	0-255	RWS
D4.05	64100710	Commu_Curr	Current for commutation	/	-2048-2047	RWS
D4.06	64100810	Commu_Delay	Time for commutation	/	0-32767	RWS
D4.07	64100910	Motor_IIt_I	Current setting of motor overtemperature protection	/	1-1500	RWS
D4.08	64100A10	Motor_IIt_Filter	Time setting of motor overtemperature protection	100	2-32767	RWS
D4.09	64100B10	Imax_Motor	Maximum peak current of the motor	/	0-32767	RWS
D4.10	64100C10	L_Motor	Motor phase inductance	/	1-32767	RWS

D4.11	64100D08	R_Motor	Motor phase resistance	/	0-32767	RWS
D4.12	64100E10	Ke_Motor	Reverse electromotive force of the motor	/	0-32767	RWS
D4.13	64100F10	Kt_Motor	Motor torque coefficient	/	1-32767	RWS
D4.14	64101010	Jr_Motor	Motor rotor inertia	/	2-32767	RWS
D4.16	64101210	Brake_Delay	Delay time for motor brake Default value: 150ms	150	0-32767	RWS
D4.17	64101308	Invert_Dir_Motor	Motor running dirction	0	0-1	RWS
D4.18	64101610	Motor_Using	Current using motor type	/	0-65535	R
D4.21	64101710	Addition_Device	Bit0=0: Motor without brake Bit0=1: Motor with brake if motor with brake,before the brake close totally,drive will keep working for some time(controlled by 6410.12).	0	0-65535	RWS
D4.22	64101810	Temp_Motor_Ref	Motor temperature reference	/		RWS
D4.24	64101C10	Index_Width	Index signal width	8		RWS
D4.25	64101D08	Encoder_Power_Delay	Power delay on encoder	5		RWS

The F005 Group panel menu contains common controller parameter Settings.

Table 9-8 F005 parameters

Panel address	Internal address	Name	Description	Default	Range	R/W/S
D5.00	2FF00108	Store_Data	Save or init parameters 1: save control parameters 10: init control parameters	0	0-255	RW
D5.01	100B0008	Node_ID	Controller ID	1	0-255	RWS
D5.02	2FE00010	RS232_Baudrate	Serial port baudrate540: 19200 270: 38400 90: 115200 Effective after reboot	270	0-65535	RWS
D5.03	2FE10010	U2BRG	Serial port baudrate540: 19200 270: 38400 90: 115200 Effective immediately, can't be saved	270	0-65535	RWS
D5.04	60F70110	Chop_Resistor	Resistance value of brake resistor unit: ohm	0	0-32767	RWS
D5.05	60F70210	Chop_Power_Rated	Nominal power of brake resistor unit: W	0	0-32767	RWS
D5.06	60F70310	Chop_Filter	For chop power calculation.	60	1-32767	RWS
D5.15	65100B08	RS232_Loop_Enable	RS232 communication control 0: 1 to 1 1: 1 to N	0	0-255	RWS
D5.16	2FFD0010	User_Secret	User secret, 16 bit	0	0-65535	RW

D5.17	2F810008	CAN_Baudrate	CAN baudrate setting 100: 1M 50: 500k 25: 250k 12: 125k 5: 50k	50	0-65535	RWS
D5.18	2FE20010	RS485_Baudrate	RS485_Baudrate of RS485 1080 9600 540: 19200 270: 38400 90: 115200 need reboot	540	0-65535	RWS
D5.19	65100C08	RS485_Protocol	RS485 communication protocol select 0: MODBUS 1: Same protocol as RS232	0	0-255	RWS

Chapter 10 Communication

10.1 RS232 communication

10.1.1 RS232 hardware interface

The mini-usb port under the panel cover of the FD5P series servo drive is the 232 debugging port, which can be connected to the Kinco servo+ to directly control the work of the servo drive.

10.1.2 RS232 communication cable

The MINIUSB5p to DB9 configuration cable is the adapter cable between the drive and the computer. One end is connected to the RS232 (DB9 pin header interface) of the computer, and the other end is connected to the Mini-usb interface of the drive. If your computer does not have an RS232 DB9 interface, you need to use a USB-to-serial cable to connect.

Figure 10-1 miniusb-5p to DB9

10.1.3 RS232 transport protocol

FD5P series drives RS-232C communication strictly follows the master-slave protocol, Kinco servo+ can send any data to drive. The drive sets the address to calculate these data and respond with a return value. The default communication parameters of FD5P series servo are as follows:
Baud rate = 38400 bps
Data bit = 8
Stop bit = 1
No verificaiton
The communication ID can be set through the device station number d5.01, and the baud rate can be set through d5.02. After setting, the baud rate must be saved by setting d5.00. The changed baud rate and ID will be restarted in the drive. effective later.

Note

- When the host computer is connected through a baud rate of 115200, due to the high frequency of transmission signals, there are certain requirements for the communication environment. If there is a disconnection or frame loss, it is recommended to reduce the communication baud rate to connect to the host computer software.

The transport protocol used by RS232 uses a fixed ten-byte packet format:

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7	Byte8	Byte 9
Drive ID	Data								CHKS

CHKS = -SUM(byte0……byte8)，CHKS are the last two digits of the calculation result

Master send：

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7	Byte8	Byte 9
Drive ID	Master sends data								CHKS

Servo send/master receive:

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7	Byte8	Byte 9
Drive ID	Master receive								CHKS

Note

- There is an independent CHKS for every ten bytes.
- If the master sends an address that does not exist in the network to the servo drive, the servo drive will not respond.
- When the master sends a correct data, the slave will look for the slave data of the corresponding address and check the check value. If the check value does not match, the slave will not respond

10.1.4 RS232 Data protocol

The data protocol is different from the transmission protocol, and its content refers to 8 data bytes out of the 10 bytes above. The internal data definition of FD5 series servo drives conforms to the CANopen international standard. Values and functions are expressed by indices and sub-indexes.

A：Downloading（From master to slave）

Download means that the master sends a command to write a value to the slave object. If downloaded to a non-existent object, the master will generate an error.

Master send data format

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7
Function code	Indexes		Subindexes	Data			

- Function data Specifies the direction and size of the data transfer
- 23(0x16) Sending 4 bytes of data(bytes 4...7 include 32 bits)
- 2B(0x16) Sending 2 bytes of data(bytes 4...5 include 16 bits)
- 2F(0x16) sending 1bytes of data(bytes 4 include 8 bits)
- Indexes The address of the sending object, 16 bits
- Subindexes Subaddress of the sending object, 8 bits
- Data Sending data The order of the four bits in the data is that the high bit is in the back and the low bit is in the front.

For example：

Write 600rpm to the "target speed" of the slave station, the internal unit of 2FF0.09 is rpm, 600 is decimal, and hexadecimal is 258. Since the length of the object to be written is 4 bytes, but the calculation result is only two bytes, should be filled with 0 in the high order, so the final result = 00 00 02 58

Slave response data format

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7
Function code	Indexes		Subindexes	Reserve			

- Function code： Display slave response
  60(0x16) Data sending successed
  80(0x16) Error from Byte 4...7
- Indexes The address of the sending object, 16bits, same as master′ s

- Subindexes Subaddress of the sending object, 8bits, same as master′ s
- Reserve Reverse

B：upload(from slave to master)

Upload means that the master sends a command to read the slave object address. Uploading a non-existent address will cause an error to the master.

Master send data

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7
Function code	Indexes		Subindexes	Reserve			

- Function code Define the direction of data transfer
- 40(0x16) Read data
- Indexes The address of the sending object，18 bits
- Subindexes Subaddress of the sending object, 8 bits
- Reverse Bit 4...7 are not used

Slave receive data

Byte0	Byte1	Byte2	Byte3	Byte4	Byte 5	Byte6	Byte7
Function code	Indexes		Subindexes	Data			

- Function code Display Slave response
  - 43(0x16) Byte 4...7 include 32 bits data
  - 4B(0x16) Byte 4...5 include 16 bits data
  - 4F(0x16) Byte 4 include 8 bits data
  - 80(0x16) Error frombyte 4...7
- Indexes The address of the sending object, 16bits, same as master′ s.
- Subindexes Subaddress of the sending object, 8bits, same as master′ s
- Data Data from slave

If there is no error in the data,byte 4…7 hold the value of the slave object, with the low order first and the high order last.

If there is an error in the data, the data of these four bits is not equal to the value of the slave object

For example:
The master sends an "upload" command to the slave:

01 40 F0 2F 09 00 00 00 00 3D（This command is to read the target speed of the slave 2FF00910）

Slave response：

01 4B F0 2F 09 58 02 00 00 32

Direction：

01 Slave number is 1
4B Received 2 bytes, saved by byte4 and byte5 in the 10 bytes of the response
F0 2F The object index address is 2FF0
09 The object subindex address is 09
58 02 00 00 Data is 00 00 02 58(hex)= 600 rpm

Table 10-1 Set homing mode/position mode/speed mode via RS232 communication

Homing mode				
Address	Name	Value	Message(ID=1)	Remark
60400010	Control word	F	Send→01 2B 40 60 00 0F 00 00 00 25	Origin turning signal speed and origin The signal speed is expressed in decimal DEC by default, DEC=[(RPM*512*[641003])/1875]
60600008	Operation mode	6	Receive←01 60 40 60 00 0F 00 00 00 F0	
60980008	Homing mode	33	Send→01 2F 60 60 00 06 00 00 00 0A Receive←01 60 60 60 00 06 00 00 00 D9	

60990120	Origin turning signal speed	200RPM	Send→01 2F 98 60 00 21 00 00 00 B7 Receive←01 60 98 60 00 21 00 00 00 86	
60990220	Origin signal speed	100RPM	Send→01 23 99 60 01 03 9D 36 00 0C Receive←01 60 99 60 01 03 9D 36 00 CF	
60400010	Control word	1F	Send→01 2B 40 60 00 1F 00 00 00 15 Receive←01 60 40 60 00 1F 00 00 00 E0	
Send 01 40 41 60 00 00 00 00 00 1E Read control bits，Drive response 01 4B 41 60 00 31 C0 FF FF 24，bit15=1 indicates home is found				
Position mode				
Address	Name	Value	Message(ID=1)	Remark
60400010	Control word	2F	Send→01 2B 40 60 00 2F 00 00 00 05 Receive←01 60 40 60 00 2F 00 00 00 D0	The trapezoidal speed is expressed in decimal DEC by default DEC=[(RPM*512*[641003])/1875]
		4F	Send→01 2B 40 60 00 4F 00 00 00 E5 Receive←01 60 40 60 00 4F 00 00 00 B0	
60600008	Operation mode	1	Send→01 2F 60 60 00 01 00 00 00 0F Receive←01 60 60 60 00 01 00 00 00 DE	
607A0020	Target position	50000inc	Send→01 23 7A 60 00 50 C3 00 00 EF Receive←01 60 7A 60 00 50 C3 00 00 B2	
60810020	trapezoidal speed	200RPM	Send→01 23 81 60 00 03 9D 36 00 25 Receive←01 60 81 60 00 03 9D 36 00 E8	
60830020	trapezoidal acceleration	100rps/s	Send→01 23 83 60 00 6E A3 01 00 E7 Receive←01 60 83 60 00 6E A3 01 00 AA	Trapezoidal acceleration and trapezoidal acceleration are expressed in decimal DEC by default. DEC=[(RPS/S*65536*[641003])/4000000] 2F→3F:absolute positioning 4F→5F:relative positioning
60840020	trapezoidal acceleration	100rps/s	Send→01 23 84 60 00 6E A3 01 00 E6 Receive←01 60 84 60 00 6E A3 01 00 A9	
60400010	Control word	3F	Send→01 2B 40 60 00 3F 00 00 00 F5 Receive←01 60 40 60 00 3F 00 00 00 C0	
		5F	Send→01 2B 40 60 00 5F 00 00 00 D5 Receive←01 60 40 60 00 5F 00 00 00 A0	
Send 01 40 41 60 00 00 00 00 00 1E read status word，Drive return 01 4B 41 60 00 37 C4 FF FF 1A,bit10 for target position reach				
Velocity mode				
Address	Name	Value	Message(ID=1)	Remark
60600008	Operation mode	3	Send→01 2F 60 60 00 03 00 00 00 0D Receive←01 60 60 60 00 03 00 00 00 DC	The target speed is expressed in decimal DEC by default DEC=[(RPM*512*[641003])/1875] Trapezoidal acceleration and trapezoidal acceleration are expressed in decimal DEC by default: DEC=[(RPS/S*65536*[641003])/4000000]
60FF0020	Target speed	-100RPM	Send→01 23 FF 60 00 7E B1 E4 FF 6B Receive←01 60 FF 60 00 7E B1 E4 FF 2E	
60400010	Control word	2F	Send→01 2B 40 60 00 2F 00 00 00 05 Receive←01 60 40 60 00 2F 00 00 00 D0	
60830020	Trapezoidal acceleration	100rps/s	Send→01 23 83 60 00 6E A3 01 00 E7 Receive←01 60 83 60 00 6E A3 01 00 AA	
60840020	Trapezoidal deceleration	100rps/s	Send→01 23 84 60 00 6E A3 01 00 E6 Receive←01 60 84 60 00 6E A3 01 00 A9	

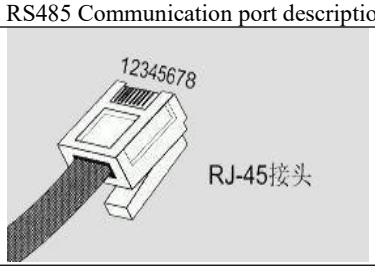
Note: The message is expressed in hexadecimal, and the motor resolution used in this case is 65536

10.2 RS485 Communication

10.2.1 RS485 hardware wiring

The RS485 port of the FD5P series servo drive supports the MODBUS communication function, which can be used to modify the internal parameters of the servo and monitor the servo status. The communication line of the master station is connected to X4A (IN), and X14B (OUT) is connected to the next slave device。 Wiring is shown in Figure 10-2.

Table 10-2 RS485 Communication port description



Pin	Signal mark	Signal name
4	TX-	Negative of data sending
5	TX+	Positive of data sending
8	GND	Ground

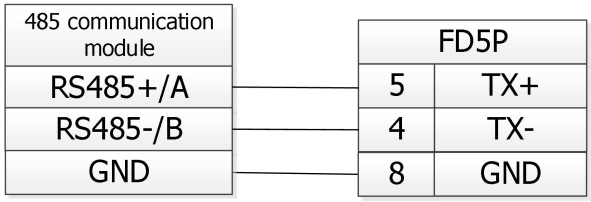


Figure 10-2 RS485 signal wiring

10.2.2 RS485 communication parameters

Table 10-3 RS485 communication parameters setting

LED display	Internal address	Name	Meaning	Default
d5.01	100B0010	ID_Com Station No.	Drive station ID. To change this parameter, save it with d5.00 and restart it.	1
d5.18	2FE20010	RS485 baud rate	Used to set the baud rate of RS485 value baud rate 1080————9600 540————19200 270————38400 90————115200 Note: need to save and restart.	540
d5.19	65100C08	RS485 protocol selection	0：use Modbus communication protocol 1：use RS232 communication protocol Note: need to save and restart。	0
	65100E10	RS485 Mod	0008：data bit=8, stop bit=1，No parity check 0009：data bit=8, stop bit=2，No parity check	0008

10.2.3 MODBUS RTU communication protocol

FD5P servo driver supports MODBUS RTU communication protocol, and its internal object is a discontinuous 16-bit data register (mapped to 4X when it is read and written by the upper computer).

Table 10-4 Modbus RTU communication protocol basic format

Target station	Function code	data	CRC check code
1 Byte	1 Byte	N Byte	2 Byte

Note: The starting message interval should be no less than 3.5 characters.

Common Modbus function codes are described as follows:

- Function code 0x03: read data register

Request format:

Target station	Function code	Start address High Byte	Start address Low Byte	Read number High Byte	Read number Low Byte	CRC
1 Byte	03	1 Byte	1 Byte	1 Byte	1 Byte	2 Byte

Correct response：

Target station	Function code	Return data Byte number	Register 1 High Byte	Register 1 Low Byte	……	CRC
1 Byte	03	1 Byte	1 Byte	1 Byte	……	2 Byte

If a response error such as the address does not exist, the returned function code is 0x81

Example：Sending message 01 03 32 00 00 02 CA B3

Message meaning：01——ID No.；

03——Function code，read data register;

32 00——The modbus address of the servo read-only object "status word" 60410010;

00 02——Read the number of word data;

CA B3——Check code

- Function code 0x06: write single data register

Request format

Target station	Function code	Register address High Byte	Register address Low Byte	Forcing value High Byte	Forcing value Low Byte	CRC
1 Byte	06	1 Byte	1 Byte	1 Byte	1 Byte	2 Byte

Response format: If the setting is successful, the original text will be returned.
If the written data is out of range, the address does not exist, and the response to read-only data operations is wrong, the returned function code is 0x86.

Example：Sending message 01 06 31 00 00 0F C7 32

Message meaning：01——ID No.

06——Function code to write a single WORD；

3100——The modbus address of the servo writable object "control word" 60400010, the data length is a single WORD；

00 0F——Write data Hexadecimal 000F

C7 32——Check code

- Function code 0x10: write multi-holding register

Request format:

Target station	Function code	Start address High Byte	Start address Low Byte	Quantity high byte	Quantity low byte	Force value byte number	Force value 1 High byte	Force value 1 Low byte	CRC	Target station
1 Byte	10	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	2 Byte	1 Byte

Correct response format:

Target station	Function code	Start address High Byte	Start address Low Byte	Quantity high byte	Quantity low byte	CRC
1 Byte	10	1 Byte	1 Byte	1 Byte	1 Byte	2 Byte

If the written data is out of range, the address does not exist, and the response to read-only data operations is wrong, the returned function code is 0x90。

Example: Sending message: 01 10 6F 00 00 02 04 4E 82 00 1B ED 56

Message meaning:

01——ID No.

10——Function code to write multiple WORD;

6F 00——The modbus address of the servo writable object "control word" 60400010, the data length is two WORD

00 02——write 2 WORD;

04——Data length is 4 Byte (2 WORD);

4E 82 00 1B——write data hexadecimal 001B4E82, decimal 1789570, convert to 100RPM;

ED 56——Check code;

10.2.4 Communication troubleshooting measures

When the communication connection between the driver and the Kinco Servo+ cannot be performed, please refer to Chapter 10.2 to check the communication parameters and wiring of the driver. When the communication of the drive is easy to drop, read only but not write or only write but not read, etc., you can troubleshoot through the following aspects:

1. Terminating resistor. When the 485 communication rate is high and the communication distance is long, the signal will be reflected at the end of the transmission line. Therefore, it is necessary to connect a 120Ω terminal resistor in parallel at the beginning and end of the communication network. Since the FD servo drive has its own terminal resistance, it is only necessary to dial the dial code of the first and last drives to the ON position.
2. Cable size. The recommended wire diameter of the 485 signal cable is 24AWG, and shielded twisted pair cables should be used. The shielding layers of the cables should be grounded together and the grounding resistance should not be greater than 1Ω. The use of twisted pairs can effectively eliminate antagonistic interference, and cables with good shielding can effectively reduce the impact of external interference sources。
3. Reasonable wiring. The communication cables should be routed in separate troughs from the power cables, and the distance should be ≥ 20cm. If the cables can be tucked into a metal tube, the anti-interference ability will be better. During the wiring process, the signal line and the power supply line intersect vertically, and parallel laying should be avoided as much as possible.
4. Good grounding. The motor power cable must use a cable with a shielded net, the motor PE is connected to the ground terminal of the driver, and the driver shell must be well grounded. For the grounding diagram, please refer to Chapter 3.
5. Power disturbance. The unstable power supply of the grid will also directly affect the normal use of the servo. For the external circuit of the driver, please refer to Chapter 3.1.2 for connection.

10.3 CANopen Bus communication

CANopen is the most famous and successful of the open fieldbus standards, which has been widely recognized and widely used in Europe and the United States. In 1992, the Association of Automation CAN Users and Manufacturers (CiA) was established in Germany and began to develop CANopen, an application layer protocol for automation CAN. Since then, the members of the Association have developed a series of CANopen products, which are widely used in machinery manufacturing, pharmaceuticals, food processing and other fields.

The FD5P series servo is a standard CAN slave device, which strictly follows the CANOpen 2.0A/B protocol, and any host computer that supports the protocol can communicate with it. The servo uses a strictly defined list of objects, we call it the object dictionary, this object dictionary is designed based on the CANopen international standard, all objects have a clear function definition. The Objects mentioned here are similar to the memory address we often say, some objects such as speed and position can be modified by the external controller, and some objects can only be modified by the drive itself, such as status and error messages. Table 10-5 lists these objects.

Table 10-5 Object dictionary example list

Index	Sub	Bits	Character	Meaning
6040	00	16(=0x10)	RW	Device status control word
6060	00	8(=0x08)	RW	Operating mode
607A	00	32(=0x20)	W	Target location
6041	00	16(=0x10)	MW	Device status word

The properties of an object are as follows:

1. RW(Read and write) : Objects can be read or written;

2. RO(read-only) : The object can only be read;

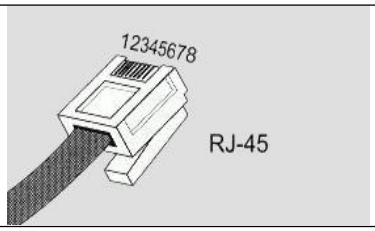
3. WO(Write only) : Write only;

4. M(Mappable) : Objects can be mapped, similar to indirect addressing;

5. S(Storable) : Objects can be stored in the Flash-ROM area and are not lost when powered off.

10.3.1 CANopen bus communication hardware description

Table 10-6 Pin name and function



Pin No.	Signal mark	Signal description
1	CAN_H	CAN_H bus （high dominant)
2	CAN_L	CAN_L bus (low dominant)
3	CAN_GNDB	Signal ground

The CAN communication protocol mainly describes the information transfer method between devices. The definition of the CAN layer is consistent with the open system interconnection model (OSI). Each layer communicates with the same layer on another device, the actual communication takes place on two adjacent layers on each device and the devices are interconnected only through the physical medium of the model physical layer, The specification of CAN defines the bottom two layers of the model, the data link layer and the physical layer. The physical layer of the CAN bus is not strictly regulated, and can use a variety of physical media such as twisted pair optical fibers, etc. The most commonly used is twisted pair signals, using differential voltage transmission (commonly used bus transceivers). The two signal lines are called CAN_H and CAN_L, and they are both about 2.5V in static state. At this time, the state is expressed as logic 1, which can also be called recessive bit. CAN_H is higher than CAN_L to represent logic 0, which is called display bit. At this time, the usual voltage value is CAN_H=3.5V and CAN_L=1.5V， Epiphany first in conflict. The names and functions of the CAN communication interface pins are shown in Table 10-6.

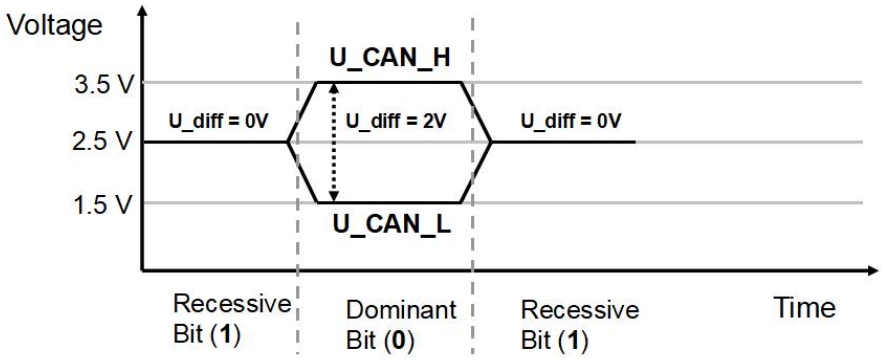


Figure 10-3 CAN Signal Identification

Note:

1.All CAN_L and CAN_H pins of the slave station can be directly connected and connected in series.
2.The master station and the last slave station need to be connected to 120 ohms of terminal resistance,FD415P/FD425P drive with terminal resistance dip SW1, set to ON to turn on terminal resistance. Restart the drive after changing the terminal resistance dip status.
3.Use shielded twisted pair cables for communication, and ground them properly. (The 3-pin ground cable can be disconnected for short-distance communication, but it is recommended to ground the 3-pin for long-distance, high-baud communication.)
4.Table 10-7 lists the theoretical maximum communication distances of various baud rates.
5.The FD5P series servo drive does not require an external 24V power supply to power the CAN.

Table10-7 The longest distance table that can theoretically communicate with each baud rate

Communication speed (bit/s)	Communication distance (M)
1M	25
800K	50
500K	100
250K	250
125K	500
50K	600
25K	800
10K	1000

10.3.2 CANopen bus communication software description

EDS files

The EDS (electronic data sheet) file is the identification file or similar code of the slave station connected to the PLC. Through this file, the type of the slave station is identified (what kind of 401, 402, 403 is similar, or which one of 402 belongs to) equipment). This file contains all the information of the slave station, such as manufacturer, serial number, software version, supported baud rate type, OD that can be mapped and the attributes of each OD and other parameters, similar to the GSD file of Profibus. Therefore, before the hardware configuration, we first need to import the EDS file of the slave station into the host configuration software.

SDO

SDO (Service data object) is mainly used to transmit low-priority objects between devices, and is typically used to configure and manage slave devices. For example, it is used to modify PID parameters of current loop, speed loop and position loop, PDO configuration parameters, etc. This data transmission method is the same as that of MODBUS, that is, after the master station sends out, the slave station needs to return data response. This communication method is only suitable for parameter setting, not suitable for data transmission with high real-time requirements.

The communication mode of SDO is divided into upload and download. The host computer can read and write the OD inside the servo according to the dedicated SDO read and write instructions. In the CANopen protocol, the content of the object dictionary can be modified through SDO (Service Data Object). The structure of the SDO command and the guidelines to follow are described below.

The basic structure of SDO is as follows:

Client→Server/Server→Client

Byte0	Byte1-2	Byte3	Byte4-7
SDO Command specifier	Object index	Object subindex	Maximum 4 Bit data

The SDO command word contains the following information:

- Download/upload
- Request/response
- Segmented/expedited transfer
- CAN frame data bit length, used for alternately clearing and setting toggle bits for each subsequent segment.

5 request/response protocols are implemented in SDO:

- Initiate Domain Download;
- Download Domain Segment;
- Initiate Domain Upload;
- Upload Domain Segment;
- Abort Domain Transfe

Among them, Download refers to the write operation of the object dictionary, and Upload refers to the read operation of the object dictionary; when reading parameters, use the Initiate Domain Upload protocol; when setting parameters, use the Initiate Domain Download protocol; the SDO command word of the protocol (SDO CAN The first Bit) syntax of the message is described in Table 10-8 and Table 10-9, where "-" means irrelevant and should be 0).

Table 10-8 Initiate Domain Download

Bit	7	6	5	4	3	2	1	0
Client→	0	0	1	-	n		e	s
←Server	0	0	1	-	-	-	-	-

Table 10-9 Initiate Domain Upload

Bit	7	6	5	4	3	2	1	0
Client→	0	0	1	-	-	-	-	-
←Server	0	0	1	-	n		e	s

Description：

n——Indicates the number of bits of meaningless data in the message data [from (8-n) Bit to the 7th Bit data is meaningless] (n is valid when e=1 and s=1, otherwise n is 0)

e——Normal transmission when e=0, accelerated transmission when e=1；

s——Indicates whether the data length is specified, 0 means the data length is not specified, 1 means the data length is specified

e=0，s=0——Keep by CiA ；

e=0，s=1——Data Bit is the Bit counter, byte4 is LSB，byte7 is MSB

e=1——Data Bit is the data to be downloaded.

Table 10-10 and 10-11 show the format of sending and receiving SDO message when reading parameters.

Table 10-10 Send SDO message when reading parameters

Identifier	DLC	Daten							
		0	1	2	3	4	5	6	7
0x600+Node_ID	8	Send command word	Object index		Object subindex	00			

Table 10-11Receive SDO message when reading parameters

Identifier	DLC	Daten							
		0	1	2	3	4	5	6	7
0x580+Node_ID	8	receive command word	Object index		Object subindex	Maximum 4 byte data			

Note： When the SDO message is sent, the command word is 0x40;
If the received data is 1 byte, the received command word is 0x4F;
if the received data is 2 byte, the received command word is 0x4B;
if the received data is 4 byte, the received command word is 0x43;
if there is an error in the received data , the received command word is 0x80.

Table 10-12 and 10-13 show the format of sending and receiving SDO message when modifying parameters.

Table 10-12 Send SDO message when edit parameters

Identifier	DLC	Daten							
		0	1	2	3	4	5	6	7
0x600+Node_ID	8	Send command word	Object index		Object subindex	Maximum 4 byte data			

Table 10-13 Receive SDO message when edit parameters

Identifier	DLC	Daten							
		0	1	2	3	4	5	6	7
0x580+Node_ID	8	Receive command word	Object index		Object subindex	Maximum 4 Bit data			

Note： If the SDO message is sent successfully, the received command word is 0x60; if the SDO message fails to be sent, the received command word is 0x80.
If the data to be sent is 1 byte, the command word to send is 0x2F;
If the data to be sent is 2byte, the command word to send is 0x2B;
If the data to be sent is 4 byte, the sending command word is 0x23.

When the SDO message fails to be sent, you can troubleshoot the problem according to the error code returned.

Table 10-14 SDO message error code

Error code	Description
0x05040001	Invalid command, unknown or illegal Client/Server command word
0x06010001	Attempt to read write-only object parameter
0x06010002	Attempt to write read-only object parameter
0x06020000	Invalid index, the object does not exist in the object dictionary
0x06040041	Unable to map, object parameter does not support mapping to PDO
0x06060000	The drive is in an error failure state and the object parameter access fails
0x06070010	Data type mismatch, service parameter length mismatch
0x06070012	Data type mismatch, service parameter length is too large
0x06070013	Data type mismatch, service parameter length is too short
0x06090011	invalid subindex
0x06090030	Invalid data, beyond the object parameter setting range
0x06090031	The write data value is too large
0x06090032	Write data value is too small
0x08000022	Data cannot be transferred or saved to the app due to the current device state

Table 10-15 Set the origin mode by SDO message

Parameters address	Name	Value	Message(ID=1)
60400010	Control word	F	Send→601 2B 40 60 00 0F 00 00 00 Receive←581 60 40 60 00 0F 00 00 00
60600008	Operation mode	6	Send→601 2F 60 60 00 06 00 00 00 Receive←581 60 60 60 00 06 00 00 00
60980008	Origin mode	33	Send→601 2F 98 60 00 21 00 00 00 Receive←581 60 98 60 00 21 00 00 00
60990120	Origin turning signal speed	200RPM	Send→601 23 99 60 01 03 9D 36 00 Receive←581 60 99 60 01 03 9D 36 00
60990220	Origin signal speed	100RPM	Send→601 23 99 60 02 82 4E 1B 00 Receive←581 60 99 60 02 82 4E 1B 00
60400010	Control word	1F	Send→601 2B 40 60 00 1F 00 00 00 Receive←581 60 40 60 00 1F 00 00 00
Send 601 40 41 60 00 00 00 00 00 read status word，Drive response 581 4B 41 60 00 31 C0 FF FF，bit15=1 indicate origin found			

Table 10-16 Setting location mode through SDO messages

Parameters address	Name	Value	Message(ID=1)
60400010	Control word	2F	Send→601 2B 40 60 00 2F 00 00 00 Receive←581 60 40 60 00 2F 00 00 00
		4F	Send→601 2B 40 60 00 4F 00 00 00 Receive←581 60 40 60 00 4F 00 00 00
60600008	Operation mode	1	Send→601 2F 60 60 00 01 00 00 00 Receive←581 60 60 60 00 01 00 00 00
607A0020	Target position	50000inc	Send→601 23 7A 60 00 50 C3 00 00 Receive←581 60 7A 60 00 50 C3 00 00
60810020	trapezoidal speed	200RPM	Send→601 23 81 60 00 03 9D 36 00 Receive←581 60 81 60 00 03 9D 36 00
60830020	trapezoidal acceleration	100rps/s	Send→601 23 83 60 00 6E A3 01 00 Receive←581 60 83 60 00 6E A3 01 00
60840020	trapezoidal acceleration	100rps/s	Send→601 23 84 60 00 6E A3 01 00 Receive←581 60 84 60 00 6E A3 01 00
60400010	Control word	3F	Send→601 2B 40 60 00 3F 00 00 00 Receive←581 60 40 60 00 3F 00 00 00
		5F	Send→601 2B 40 60 00 5F 00 00 00 Receive←581 60 40 60 00 5F 00 00 00
Send 601 40 41 60 00 00 00 00 00 read status word，Drive response 581 4B 41 60 00 37 C4 FF FF,bit10 indicates target position reached			

Table 10-17 Setting Velocity mode through SDO message

Parameter address	Name	value	Message(ID=1)
60600008	Operation mode	3	Send→601 2F 60 60 00 03 00 00 00 Receive←581 60 60 60 00 03 00 00 00
60FF0020	Target speed	-100RPM	Send→601 23 FF 60 00 7E B1 E4 FF Receive←581 60 FF 60 00 7E B1 E4 FF
60400010	Control word	2F	Send→601 2B 40 60 00 2F 00 00 00 Receive←581 60 40 60 00 2F 00 00 00
60830020	Trapezoidal acceleration	100rps/s	Send→601 23 83 60 00 6E A3 01 00 Receive←581 60 83 60 00 6E A3 01 00

60840020	Trapezoidal deceleration	100rps/s	Send→601 23 84 60 00 6E A3 01 00 Receive←581 60 84 60 00 6E A3 01 00

Note: The message is expressed in hexadecimal, and the resolution of the motor used in this case is 65536

PDO description

PDO can transmit 8 bytes of data at a time, with no other protocol presetting (meaning that the data content is predefined), and is mainly used to transmit data requiring high frequency exchange. The transmission mode of PDO breaks the existing data question-and-answer transmission concept and adopts a new data exchange mode. The two sides of the device define the data receiving and sending area in each device before transmission, and directly send the relevant data to the data receiving area of the other side during data exchange, which reduces the question-and-answer inquiry time and greatly improves the efficiency of bus communication. As a result, high bus utilization is achieved.

PDO's COB-ID description

COB-ID is a unique method of CANopen communication protocol, its full name is Communication Object Identifier-communication object-ID, These COB-IDs define the corresponding transmission levels for the PDO. With these transmission levels, the controller and the servo can define the same transmission level and the transmission content in their respective software configurations. In this way, after both the controller and the servo use the same transmission level and transmission content, the data transmission is transparent, that is, both parties know the content of the data to be transmitted, and there is no need for the other party to reply data when transmitting data.

The default ID allocation table is based on the 11-bit CAN-ID defined by CANopen 2.0A (CANopen 2.0B protocol COB-ID is 27 bits), including a 4-bit function code part and a 7-bit node ID (Node-ID) section, as shown in Figure 10-4.

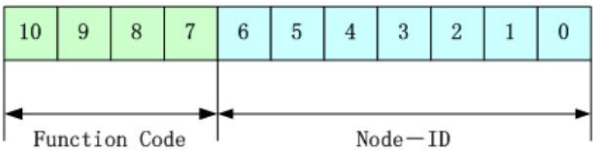


Figure 10-4 Default ID explanation diagram

Node-ID ——Defined by the system integrator, for example, set by the DIP switch on the device (that is, the station number of the servo), the Node-ID range is 1~127 (0 is not allowed to be used);

Function Code ——The function code of data transmission defines the transmission level of various PDOs, SDOs, and management messages. The smaller the function code, the higher the priority.

Table 10-18 CANopen predefined master/slave connection set CAN identifier assignment table

Broadcast object for CANopen predefined master/slave connection set			
Object	Function code (ID-bits 9-7)	COB-ID	Index of communication parameters in OD
NMT Module Control	0000	000H	-
SYNC	0001	080H	1005H, 1006H, 1007H
TIME SSTAMP	0010	100H	1012H, 1013H
Peer object for CANopen master/slave connection set			
Object	Function code (ID-bits 9-7)	COB-ID	Index of communication parameters in OD
Emergency	0001	081H-0FFH	1024H, 1015H
PDO1 (Send)	0011	181H-1FFH	1800H
PDO1 (Receive)	0100	201H-27FH	1400H

PDO2（Send）	0101	281H-2FFH	1801H
PDO2（Receive）	0110	301H-37FH	1401H
PDO3（Send）	0111	381H-3FFH	1802H
PDO3（Receive）	1000	401H-47FH	1402H
PDO4（Send）	1001	481H-4FFH	1803H
PDO4（Receive）	1010	501H-57FH	1403H
SDO（Send/Server）	1011	581H-5FFH	1200H
SDO（Receive/Client）	1100	601H-67FH	1200H
NMT Error Control	1110	701H-77FH	1016H-1017H

Note：

1.The smaller the COB-ID, the higher the priority;

2.The function code in front of each level of COB-ID is in a fixed format；

3.COB-IDs are 00H, 80H, 100H, 701H-77FH, and 081H-0FFH, which are all system management formats.

FD5P series servo drive supports COB-ID

- Send PDO（TXPDO）

TXPDO refers to the data sent by the servo relative to the servo, and these data are received by the PLC. The function code (COB-ID) for sending PDO is:

1.0x180+Servo station NO.
2.0x280+ Servo station NO.
3.0x380+ Servo station NO.
4.0x480+ Servo station NO.

- Receive PDO（RXPDO）

Compared with the servo, the receiving PDO refers to the data received by the servo. These data are sent by the PLC. The function code (COB-ID) of the sending PDO is:

1.0x200+ Servo station NO.
2.0x300+ Servo station NO.
3.0x400+ Servo station NO.
4.0x500+ Servo station NO.

- PDO transmission type

PDO has two different transmission type：

Synchronize (SYNC)——Transmission triggered by synchronization messages（Transmission type：0-240）

In this transmission mode, the controller must have the ability to send synchronization messages (messages sent periodically with a frequency of up to 1KHZ), and the servo will send the synchronization message after receiving the message.

Period - The transfer type is 1-240. Delivery is triggered after every 1 to 240 SYNC messages. In this mode, the data in the PDO is sent once every time the servo drive receives n synchronization messages.

Asynchronous (Transmission Type: 254/255)

The message is sent after the slave message data has changed, regardless of whether the master asks it or not. And can define the time interval between two transmissions of the same message to avoid high priority messages occupying the bus all the time (the lower the PDO value, the higher the priority).

The transmission PDO(TPDO) of the FD5P series servo drive supports synchronous and asynchronous transmission modes, and the corresponding transmission type can be selected according to the transmission mode. For receiving PDO(RPDO), when the driver node is enabled in non-interpolation mode, the object data will be received in real time as long as the RPDO packets from the bus are detected, regardless of the transmission type setting. In interpolation mode, the driver receives data after detecting the RPDO signal, but only updates the object data at a specific point in time. Detailed interpolation mode controls are described in section 10.3.4.

- PDO inhibit time

A PDO can specify a prohibition time, that is to define the minimum interval between two consecutive PDO transmissions, to avoid the problem that the data volume of high-priority information will always occupy the bus and make other data with lower priority unable to compete for the bus. The disable time is defined by a 16-bit unsigned integer, the unit is 1ms.

- PDO event time

The interval (unit ms) for the driver to send PDO packets to the controller in asynchronous transmission mode. Notice When using event time, disable time should be set to 0.

Protection mode/Monitoring Type Description

Supervision type refers to which inspection method the master station chooses to check the slave station during the running process, judge whether the slave station is faulty or not by these two methods, and make corresponding treatment according to these faults.

1. Master heartbeat message

The slave station periodically uploads messages to the master station with the "supervision time". If the master station has not received the next heartbeat message from the slave station after the "heartbeat client time", the master station judges that the communication is wrong and generates an alarm!

Table 10-19 Format of heartbeat message uploaded by slave station

COB-ID	Byte 0
0x700+Node_ID	Status
Case message (Slave ID=1)：701 05	

2. Slave heartbeat message

The master station periodically sends packets to the slave station according to the "monitor time". If the slave station does not receive the next heartbeat packet from the master station after the "Heartbeat Producer time", the slave station determines that the communication is wrong! When the communication interrupt mode (0x600700 set) is 1, the driver will alarm and stop when the CAN communication fails.

Table 10-20 Format of the heartbeat message sent by the master station

COB-ID	Byte 0
0x700+Node ID	Master station status
Case message (Slave ID=127)：77F 05	

Table 10-21 Status value

Status value	Meaning
0x00	Boot-up
0x04	Stopped
0x05	Operational
0x7f	Pre-operational

When a Heartbeat node starts up, its Boot-up message is its first Heartbeat message.

Note

- The generation time of the heartbeat message and the heartbeat message of the slave station are configured by the power-on of the master station, and are not saved by default.

3. Node guard

The master station periodically sends a remote request message to the slave station with the "supervision time", and the slave station responds after receiving it. If the master station has not received the response message from the slave station after the time of "supervision time * life factor", the master station judges that the slave station has an error. At the same time, the slave station can also monitor the remote request status of the master station, and start communication protection from the first remote frame received. If the remote frame of the master station is not received after the time of "node protection time * node protection coefficient", the slave station will judge the communication error. You need to set the communication interruption mode (0x600700) to 1, the drive will alarm and stop when there is an error in CAN communication.

Master request message format——— (0x700+node number) (this message has no data)

Station response message format———(0x700+node number)+status

Table 10-22 Slave station response message

COB-ID	Byte 0
0x700+Node_ID	Bit7:trigger bit Bit6-Bit0:status

Table 10-23 The meaning of the status value of the response message from the slave station

Status value	Meaning
0	Initializing
1	Disconnnected
2	Connecting
3	Preparing
4	Stopped
5	Operational
127	Pre-operational

Status - The data section includes a trigger bit (bit7), which must be alternately set to "0" or "1" in each node protection response. The trigger bit is set to 0 for the first node protection request. Bits 0 and 6 (bit0 to 6) indicate the node status. Table 10-18 describes the values.

The standard CAN slave station generally supports only one type of node protection, and the FD5 series servo drive supports both types of protection. However, a node cannot support both node protection and heartbeat packets at the same time. Only one of them can be used for protection.

Bootup process description

During network initialization, CANopen supports extended boot-up as well as minimized boot-up. This initialization process can be represented by a node state transition diagram, as shown in Figure 10-5.

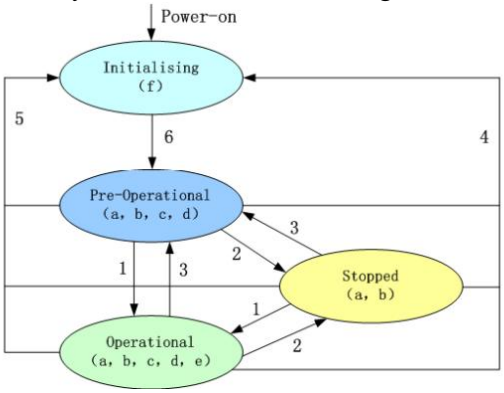


Figure 10-5 Node state transition diagram

Note: The letters in parentheses in the figure indicate communication objects that can be used in different states.

a———NMT d———Emergency b———Node Guard

e———PDO c———SDO f———Boot-up

Switching between modes can be achieved through NMT management messages, only the NMT-Master node can send NMT Module Control messages, all slave devices must support the NMT Module Control service, and NMT Module control messages do not need to be answered. After the initialization is complete, the device automatically enters the Pre_Operational state and sends Boot-up messages. NMT message format is as follows:

Nmt-master →NMT Slave(s)

Table 10-24 Format of NMT managing message

COB-ID	Byte0	Byte1
0x000	CS	Node-ID

When Node-ID=0, all NMT slaves are addressed.CS is the command word, and its value is shown in Table 10-25.

Table 10-25 CS value table

Command word	NMT service
0x01	Start the remote node
0x02	Shut down the remote node
0x80	Enter pre-operational state
0x81	Enter pre-operational state
0x82	Reset communication

Emergency message description

When a fatal error occurs inside the device, the application device sends an emergency packet with the highest priority to other devices. An emergency message consists of eight bytes.

Table 10-26 Emergency message format

COB-ID	Byte 0-1	Byte2	Byte4-5	Byte6-7
Emergency message station number 0x101400	Emergency Error code 0x603F00	Error register (0x100100)	Error state 0x260100	Error state 0x260200

Table 10-27 Emergency error code 0x603F00

Alarm content	Emergency error code (Hex)	Alarm content	Emergency error code (Hex)
Communication encoder is not connected	0x7331	Current sensor failure	0x5210
Communication encoder multi-turn error	0x7320	Software watchdog reset	0x6010
Communication encoder check error	0x7330	abort	0x6011
Drive temperature is too high	0x4210	MCU failure	0x7400
Drive bus voltage too high	0x3210	Motor model configuration error	0x6320
Drive bus voltage too low	0x3220	Phase loss of motor power line	0x6321
Power input is missing one phase	0x3221	Power input is missing three phase	0x3222
Drive power section short circuit or motor short circuit	0x2320	Pre-enable alarm	0x5443
Current sampling saturation	0x2321	Positive limit error	0x5442
Abnormal extrnal braking resistor of drive	0x7110	Negative limit error	0x5441
Abnormal inner braking resistor of drive	0x7111	SPI failure	0x6012
The actual following error exceeds the allowable	0x8611	bus communication error	0x8100
low logic voltage	0x5112	Bus communication timeout	0x81FF
Motor or drive overloaded	0x2350	Full closed loop check error	0x8A81
Input pulse frequency is too high	0x8A80	Main encoder ABZ fault	0x7382
Motor temperature is too high	0x4310	Main encoder count error	0x7306
Communication encoder does not respond	0x7331	EEPROM data error	0x6310

Table 10-28 Error registor

Bit	Error type
0	General error
1	Current
2	Voltage

3	Temperature
4	Communication error
5	Device Profile Specific
6	Encoder
7	Reserve

10.3.3 CANopen Bus communication settings

This chapter will introduce the settings of CAN bus communication parameters. In the host computer software interface, click Drive->ECAN Configuration->Other to enter the parameter setting interface. When the master station with network management function is powered on, it will initialize the parameters of the slave station by sending SDO. In general, parameters such as synchronization ID, node protection time, node protection time coefficient, node protection station number, emergency message station number, and heartbeat message generation time do not need to be set by the user.

Table 10-29 CANopen communication parameters

LED panel display	Internal address	Parameter's name	Description	Default value
d5.00	2FF00108	Store control loop parameters	1:Stores all set parameters except the motor 10:Initialize all saveable parameters except motor	0
d5.01	100B0008	Device Station No.	Drive station No. Note： To change this parameter, you need to use d5.00 to save and restart.	1
d5.17	2F810008	CAN baud rate	CAN baud rate setting Value Baud rate 100 1M 50 500k 25 250k 12 125k 5 50k 1 10k Note: need to save and restart	50
	60070010	Communication interruption mode	CAN Communication interruption mode 0：do not handle 1：report an error	0
	10050020	Sync ID	Synchronous message COB-ID, the transmission type is 1-240. It is valid in synchronous mode and does not need to be set in asynchronous mode.	80
	100C0010	Node guard time	Through node guarding, the master station can monitor the current status of each node. The master station sends a remote frame to inquire about the node status with the node guard time as a period. The node needs to respond within the node guard time * node guard time coefficient, otherwise the master station Judging that the slave station is offline, when the communication interruption mode is 1, the drive alarms.	1000
	100D0008	Node guard time factor		3
	100E0020	Node guard ID	700+Divice station No.(0x100B00)	701
	10140020	Emergency message station number	80+ Divice station No.(0x100B00)	81

LED panel display	Internal address	Parameter's name	Description	Default value
	10170010	Heartbeat message generation time	The slave station periodically sends a message to the master station based on the "heartbeat message generation time". If the master station does not receive the message within a certain period of time, it judges that the slave station is offline and the master station alarms. The heartbeat message generation time data will not be saved when power off. It is configured by the master station when it is powered on (unit: ms). It should be noted that the data format is DEC.	0
	10160120	Slave heartbeat message	Bit24~31: Invalid data Bit16~23:Used to set the host ID Bit0~15:Used to set the interval time for heartbeat message detection, unit: ms If the value is 7F03E8, it means that the ID of the master station is 127, and the heartbeat message interval is 1000ms. The heartbeat message data of the slave station will not be saved when power off. It is configured by the master station when it is powered on. Note that the data format is HEX	7F0000

➔ EDS file download:
https://www.kinco.cn/download/sfqdqdj36.html

10.3.4 Interpolation mode based on CANopen

The interpolation mode is suitable for single-axis operation control and multi-axis synchronous control. The master station performs the motion contour planning, and the target position is periodically updated in the synchronous mode. In the host computer software interface, click **Drive->ECAN Configuration->Other** to enter the interpolation mode parameter setting interface

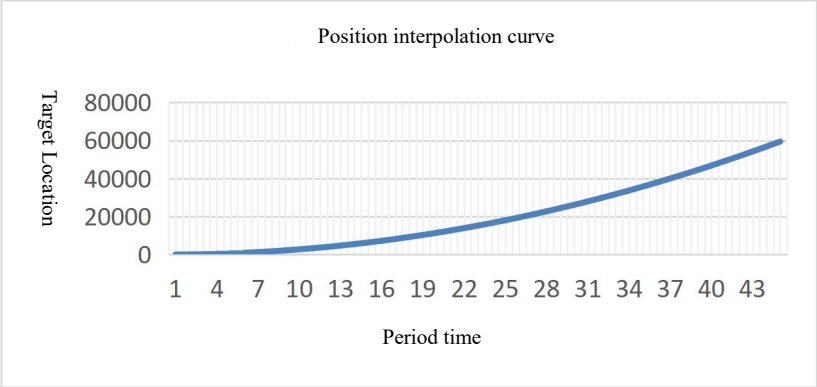


Figure 10-6 Position interpolation curve

Table 10-30 Interpolation control related parameters

LED panel display	Internal address	Parameter name	Description	Value
	60600008	Operation mode	Set the operation mode to interpolation mode	7
	60400010		0x1F Enable drive, run interpolation mode 0x06 Loose axis, close drive enable 0x86 Reset drive failure	1F 6 86
	607A0020	target location	target absolute/relative position	User define
	30110108	ECAN sync period	In interpolation mode, it is set according to the synchronization message cycle of the master station value synchronization period 0 1ms 1 2ms 2 4ms 3 8ms	User define
	30110208	ECAN Synchronous Clock Mode	Set to 1 in interpolation mode to enable clock synchronization, and set to 0 in non-interpolation mode to disable clock synchronization.	0
	30110410	ECAN Sync Loss Count	Monitor the synchronous communication status in interpolation mode, if the value keeps changing, it means that there is communication interference or the synchronization period is inconsistent with the master station setting	/

Appendix I: Braking Resistor Selection

The energy generated by the servo motor in the braking state will be fed back to the DC bus of the drive. When the voltage of the DC bus exceeds the protection range, the drive will report a bus voltage high fault, and the excess energy needs to be absorbed by an external braking resistor. When using an external braking resistor, please set the braking resistor resistance value and braking resistor power correctly. The resistance value of the optional external braking resistor cannot be lower than the recommended resistance value.

Table 11-1 Recommended specification of braking resistor

Model	Power [W]	Brake resistance resistance value[Ω]			Braking resistor power [W] (Ref)	Braking resistor VDC (Min)	Energy consumption braking voltage absorption point (V)
		Min	Max	Ref			
FD415P-□A FD425P-□A	400W 750W	39	100	75	100	500	380V±5V
FD425P-□F	1KW	27	51	39	200	500	380V±5V
FD435P-□A	1.5KW	27	51	39	200	500	380V±5V
FD445P-□A	2KW	27	51	39	300	500	380V±5V
FD615P-□A	1.5KW	47	150	75	200	800	680V±5V
FD625P-□A	3KW	39	100	47	300	800	680V±5V
FD635P-□A	5.5KW	39	100	47	500	800	680V±5V
FD645P-□A	7.5KW	20	47	27	1000	800	680V±5V

Table 11-2 Parameters related to braking resistor

Address	Name	Unit	Modbus address	Command type	Unit	Description
60F71308	Chop_Resistor_Set	Unsigned8	0x6130	RW	DEC	Chop_Resistor_Set default value: 0 **Brake resistor switching:** When using an internal braking resistor: Short circuit RB1 and RB2 to the external wiring port. The Chop_Resistor_Set should be set to 1, and the resistance value and power do not need to be written; When using an external braking resistor: first disconnect the short circuit between RB1 and RB2, connect the external braking resistor to RB1 and RB-,set Chop_Resistor_Set to 2, and write the value and power of the external braking resistor used
60F70110	Brake resistance value	Unsigned16	0x6010	RW	Ω	
60F70210	Brake resistance power	Unsigned16	0x6020	RW	W	
60F70310	Brake resistance time constant	Unsigned16	0x6030	RW	S	External brake resistance time constant S=DEC*256/1000

Note

- When the braking resistor malfunctions and alarms, the driver alarms 010.0. The internal brake resistor alarm error code is 7111, and the external brake resistor alarm error code is 7110.

Appendix II: List of Common Object Parameters

Note

- CANopen address and 232 communication address are the same
- Express register addressing in the form of Index (16-bit address) and Subindex (8-bit sub-address)
- The digit 0x08 indicates that the length of the data stored in this register is 1 Byte, the digit 0x10 indicates that the length of the data stored is 2 Bytes, and the digit 0x20 indicates that the length of the data stored is 4 Bytes
- R: readable，W: writable，S: savable，M: mappable；
- The complete CANopen address format is main index + sub index + data length, such as 60400010 (control word)
- The complete Modbus address format is a 4-digit hexadecimal number, such as 3100 (control word)

Mode and control (0x6040)

Name	CANopen	Modbus	Commend properties	Type of data	Description
Control word	60400010	3100	RWM	Unsigned16	0x06：Motor power off 0x0F：Motor power on 0x0B：Quick stop, load stop - voltage disconnect 0x2F→3F：absolute positioning mode 0x4F→5F：relative positioning mode 0x103F：absolute positioning based on target position changes 0x0F→1F：Origin positioning 0X86：clear internal fault
Status word	60410010	3200	RM	Unsigned16	Status Bit shows the status of the drive bit0: ready to power on bit1: powered on bit2: enable bit3: fault bit4: Disable output voltage bit5: Quick stop bit6: Power-on prohibition bit7: warning bit8: reserved internally bit9: remote control bit10: target position to bit11: Internal limit activation bit12: Impulse response bit13: Following error/Origin error bit14: Find motor excitation bit15: Origin found
，Operation mode	60600008	3500	RWM	Integer8	Operating mode: 1: Positioning mode with position loop 3: Speed mode with position loop 4: Torque Mode -3: Speed loop (immediate speed mode) -4: Pulse mode 6: Homing mode 7: Motion interpolation based on CANopen

Absolute /relative position control selection	20200F10	0CF0	RWS	Unsigned16	When the "drive enable" function is configured to Din, and the corresponding Din valid input is 1, the "control word" (6040.00) will be set to this value; 0x2F: Absolute position control 0x4F: Relative position control

Measurement data

Name	CANopen	Modbus	Commend type	Data type	Description
Actual position	60630020	3700	RM	Integer32	
Actual current	60780010	3E00	RM	Integer16	
Input port status	60FD0020	6D00	RM	Unsigned32	bit0: Negative limit signal status bit1: Positive limit signal status bit2: Origin signal status bit3: Hardware lock signal status
Actual velocity	606C0020	3B00	RM	Integer32	

Note

0x606C0020，The unit conversion method is DEC=[(RPM*512* Encoder resolution)/1875]

Target（0x607A)

Name	CANopen	Modbus	Commend type	Data type	Description
Velocity position direction control	607E0008	4700	RWS	Unsigned8	Run polarity reversal 0: Counterclockwise is the positive direction 1: Clockwise is the positive direction
Target position	607A0020	4000	RWM	Integer32	The target position in position mode 1, if the control word is set to start motion, transitions to the valid command position inc
Trapezoidal velocity	60810020	4A00	RWM	Unsigned32	Trapezoidal velocity (rpm) in operating mode 1
Target speed	60FF0020	6F00	RWM	Integer32	Target speed in mode 3 and -3,
Max velocity limit	60800010	4900	RW	Unsigned16	Default 5000rpm
Trapezoidal acceleration	60830020	4B00	RWSM	Unsigned32	Default：610.352rps/s
Trapezoidal deceleration	60840020	4C00	RWSM	Unsigned32	Default：610.352rps/s
Target torque	60710010	3C00	RW	Integer16	Torque command in torque mode, the percentage of target torque to rated torque
Target current	60F60810	5880	RWM	Integer16	Current command in torque mode
Target current limit	60730010	3D00	RWSM	Unsigned16	The maximum value of the current command, the unit is Arms

Note:

Velocity address：0x60810020，0x60800020，0x60FF0020

The unit conversion method is 为 DEC=[(rpm*512*encoder resolution)/1875]

Acceleration and deceleration address：0x60830020，0x60840020，

The unit conversion method is DEC=[(rps/s*65536*encoder resolution)/4000000]

Current address：0x60710010，0x60730010

The unit conversion method is 1Arms=[2048/(Ipeak/1.414)]DEC , Ipeak is Max current (6510.03)

Multi-segment position/multi-segment velocity（0x2020）

Name	CANopen	Modbus	Commend type	Data type	Description
Multi-stage position control 0	20200120	0C10	RWS	Integer32	
Multi-stage position control 1	20200220	0C20	RWS	Integer32	
Multi-stage position control 2	20200320	0C30	RWS	Integer32	
Multi-stage position control 3	20200420	0C40	RWS	Integer32	
Multi-stage Position Control 4	20201020	0D00	RWS	Integer32	
Multi-stage Position Control 5	20201120	0D10	RWS	Integer32	
Multi-stage position control 6	20201220	0D20	RWS	Integer32	
Multi-stage position control 7	20201320	0D30	RWS	Integer32	
Multi-stage speed control 0	20200520	0C50	RWS	Integer32	
Multi-stage speed control 1	20200620	0C60	RWS	Integer32	
Multi-stage speed control 2	20200720	0C70	RWS	Integer32	
Multi-stage speed control 3	20200820	0C80	RWS	Integer32	
Multi-stage speed control 4	20201420	0D40	RWS	Integer32	
Multi-stage speed control 5	20201520	0D50	RWS	Integer32	
Multi-stage speed control 6	20201620	0D60	RWS	Integer32	
Multi-stage speed control 7	20201720	0D70	RWS	Integer32	

Performance object (0x6065)

Name	Subindex	Modbus	Commend type	Data type	Description
Max. following error	60650020	3800	RWSM	Unsigned32	Following error value alarm value Default 524288inc
Target location window	60670020	3900	RWS	Unsigned32	"Target location reached" target range, Default 10inc
reach position time window	25080916	1990	RW	Unsigned16	Target (location、velocity) reach time window, Determine the reach position signal together with 0x60670020
Reach speed window	60F90A20	63A0	RWS	Integer32	The error window when the actual speed reaches the target speed or trapezoidal speed, and determines the reach speed signal together with 0x60F91C20
Zero speed output speed window	20101810	0980	RWS	Unsigned16	Error window when actual speed is 0
Zero speed output time	60F91410	6440	RWS	Unsigned16	Zero-speed output speed window 0x20101810 After reaching the set range, it takes a period of time to output the zero-speed signal, and the time is determined by the zero-speed output time
Positive setting of soft limit	607D0120	4410	RWS	Integer32	Positive comparison point for setting software limit, unit in inc
Soft limit negative setting	607D0220	4420	RWS	Integer20	Negative comparison point for setting software limit, unit in inc
Limit function definition	20101908	0990	RWS	Unsigned8	Used to set the action after the limit is reached 0: If there is a limit after finding the origin, it will alarm 1: do nothing

Homing control (0x6098)

Name	CANopen	Modbus	Commend type	Data type	Description
Homing mode	60980008	4D00	RWSM	Integer8	Homing function Refer origin control chapter
Origin turning signal speed	60990120	5010	RWSM	Unsigned32	After touching the trigger event, the speed of homing process (rpm)
Origin signal speed	60990220	5020	RWSM		Speed when starting to find the origin
Homing acceleration	609A0020	5200	RWS	Unsigned32	Acceleration when homing process unit: rps/s
Origin offset	607C0020	4100	RWSM	Integer32	Offset value after homing unit: inc

Origin Offset Mode	60990508	5050	RWS	Unsigned8	Origin Offset Mode Control 0: run to the origin offset position, the actual position is displayed as 0 1: Run to the event trigger point, after the end the actual position will become: - Origin offset

Velocity loop parameters (0x60F9)

Name	CANopen	Modbus	Commend type	Data type	Description
Kvp	60F90110	6310	RW	Unsigned16	The larger the value, the stronger the gain, but it may cause the motor howling
Kvi	60F90210	6320	RW	Unsigned16	The larger the value, the stronger the gain, but it may cause the motor howling
Kvi/32	60F90710	6370	RW SL	Unsigned16	Kvi's 1/32
Output filter	60F90508	6350	RW	Unsigned8	velocity output filter of velocity loop BW=Speed_Fb_N*20+100[Hz]

Position loop parameters (0x60FB)

Name	CANopen	Modbus	Commend type	Data type	Description
kpp 0	60FB0110	6810	RWS	Unsigned16	Scale value of the position loop
kvff	60FB0210	6820	RWS	Unsigned16	Position loop speed feedforward
kaff	60FB0310	6830	RWS	Unsigned16	Acceleration feedforward for position loop
Smoothing filter	60FB0510	6850	RWS	Unsigned16	Modify in the disabled state
Actual position save enable	60FB0608		RWS	Unsigned8	Used to control whether to save the actual position when the logic power is lost 0: Not save 1: The actual position is saved after power-off 2: When the communication type single-turn absolute encoder motor is used, the actual position will display the single-turn absolute position when the drive is powered on.

Input/output port parameter (0x2010)

Name	CANopen	Modbus	Commend type	Data type	Description
Digital input 1	20100310	0830	RWS	Unsigned16	Refer to the function definition below
Digital input 2	20100410	0840	RWS	Unsigned16	
Digital input 3	20100510	0850	RWS	Unsigned16	
Digital input 4	20100610	0860	RWS	Unsigned16	
Digital output 1	20100F10	08F0	RWS	Unsigned16	
Digital output 2	20101010	0900	RWS	Unsigned16	

Input port status	20100A10	08A0	RM	Unsigned16	bit0：Din1 bit1：Din2 bit2：Din3 bit3：Din4
Output port status	20101410	0940	RM	Unsigned16	bit0：Dout1 bit1：Dout2
Change the input signal polarity definition	20100110	0810	RWS	Unsigned16	0：Turn off; 1：Turn on bit0：Din1 bit1：Din2 bit2：Din3 bit3：Din4 bit4：Din5 bit5：Din6 bit6：Din7 bit7：Din8 默认值 0xFF
Polarity definition of output port	20100D10	08D0	RWSM	Unsigned16	输出口极性定义
Input port signal simulation	20100210	0820	RW	Unsigned16	bit0：Din1 bit1：Din2 bit2：Din3 bit3：Din4 bit4：Din5 bit5：Din6 bit6：Din7 bit7：Din8
Output port signal simulation	20100E10	08E0	RWM	Unsigned16	bit0：Dout1 bit1：Dout2 bit2：Dout3 bit3：Dout4 bit4：Dout5

Note

Digital input function definition（HEX）	Digital output function definition（HEX）
0001：Enable	0001：Ready
0002：Reset Errors	0002：Error
0004：Drive working mode control	0004：Pos reached
0008：Kvi off	0008：Zero speed
0010：P Llimit+	0010：Motor brake
0020：P Llimit-	0020：Speed reached
0040：Home signal	0040：Index signal occurrence
0080：Invert direction	0080：Speed limit
0100：Din vel index 0	0100：Driver enabled
0200：Din vel index 1	0200：Position limit
0400：Din pos index0	0400：Home found
0800：Din pos index 1	0800：Torque reach limit
1000：Quick stop	1000：Multi Dout 0
2000：Start homing	2000：Multi Dout 1
4000：Activate command	4000：Multi Dout 2
8001：Din vel index 2	9001：Postable Active
8002：Din pos index 2	
8004：Multi-function input signal 0 (for setting multi-stage electronic gear ratio)	
8008：Multi-function input signal 1	
8010：Multi-function input signal 2	
8020：Gain switch 0	
8040：Gain switch 1	
8080：MaxCue Switch	
8100：Motor error	
8200：Pre-enable (the IO port must have an enable signal, otherwise it will alarm, for some occasions that need to determine the safety before running the machine)8400：Fast capture 1	
8800：Fast capture 2	
9001：PosTable Cond 0	
9002：PosTable Cond1	
9004：Start Postable	
9008：Postable idx 0	
9010：Postable idx 1	
9020：Postable idx 2	
9040：Abort Postable	

Pulse input parameters (0x2508)

Name	CANopen	Modbus	Commend type	Data type	Description
Electronic gear molecule 0	25080110	0x1910	RWSM	Integer16	Electronic gear molecule 0
Electronic gear denominator 0	25080210	0x1920	RWSM	Unsigned16	Electronic gear denominator 0
Pulse mode control	25080310	0x1930	RWSB	Integer16	0: Double pulse mode 1: Pulse direction mode 2: Incremental encoder mode 10:422 Double pulse mode 11: 422 pulse direction mode 12: 422 Incremental encoder mode
Number of input pulses before electronic gear	25080410	0x1940	RWM	Integer16	Number of input pulses before electronic gear
Number of input pulses after electronic gear	25080510	0x1950	RW	Integer16	Number of input pulses after electronic gear
Pulse filter parameters	25080610	0x1960	RWS	Unsigned16	Pulse filter parameters
Pulse frequency before gear	25080C10	0x19C0	RM	Integer16	Pulse frequency before gear (pulse/mS)
Pulse frequency after gear	25080D10	0x19D0	RW	Integer16	Pulse frequency after gear (pulse/mS)

Parameters for storage (0x2FF0)

Name	CANopen	Modbus	Commend type	Data type	Description
Storage control parameters	2FF00108	2910	RW	Unsigned8	1: Store all configuration parameters set 10: Initialize all configuration parameters Note: The control loop parameters are stored, excluding motor parameters.
Store motor parameters set	2FF00308	2930	RW	Unsigned8	1：Store all motor parameters set

Error code (0x2601)

Name	CANopen	Modbus	Commend type	Data type	Description
Error word	26010010	1F00	RM	Unsigned16	Real-time alarm error status bit0: Internal error alarm bit 1: Encoder ABZ connection alarm bit 2: Encoder UVW connection alarm bit 3: Encoder count alarm bit 4: Driver high temperature alarm bit 5: Driver high voltage alarm bit 6: Driver low voltage alarm bit 7: Driver overcurrent alarm bit 8: Absorption resistance alarm bit 9: Alarm for excessive position error bit 10: Logic Low Voltage Alarm bit 11: Motor or drive iit alarmb it 12: Pulse frequency too high alarm bit 13: Motor high temperature alarm bit 14: Motor excitation alarm bit 15: Memory Alarm
Error_More	260507	2270	R	Unsigned16	bit0: homing eeprom wrong bit1: inner brake resistor actual power is too big bit2: inner brake resistor is ON always. Out of control. bit3: motor phase get lost bit4: current ADC data touch the limit bit12: service time out bit[13:14] : 11: power input missing two phases (power failure); 01: Power input missing a phase (single-phase input without this); 00: Power input normal

Note:

- When the drive is not enabled, the phase loss status can be checked through Error_More (260507). If one phase is missing, Error_More will show 4000; if two or more phases are missing, Error_More will show 6000.
- When the drive is enabled in phase loss state, an alarm 0040 will be triggered. When the drive experiences phase loss in the enabled operating state, an alarm will be triggered immediately. Error_More will also display the phase loss state. When one phase is missing, the error code is 3221, and when two or more phases are missing, the error code is 3222.

Stop mode

Name	CANopen	Modbus	Commend type	Data type	Description
Quick stop mode	605A0010	3400	RWS	Integer16	Encountered limit switch, emergency stop switch, or control word is 0x000B 0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop 5: The curve stops, and finally stops in the fast stop state 6: Quick stop decelerates to stop, and finally stops in quick stop state

Shutdown mode	605B0010	3410	RWS	Integer16	Shutdown mode (drive enable canceled) 0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop
Disable stop mode	605C0010	3420	RWS	Integer16	0: Uncontrolled stop 1: Curve stop 2: Quick stop deceleration stop
Pause mode	605D0010	3430	RWS	Integer16	Control word bit8 is set to 1 Pause the motor and keep it enable 1: Decelerate and stop at the current deceleration 2: Quick stop deceleration stop
Error stop mode	605E0010	3440	RWS	Integer16	When the drive alarms 0: stop immediately 1: Decelerate to stop 2: Stop with quick stop deceleration
Trapezoidal deceleration	60840020	4C00	RWSM	Unsigned32	Deceleration in operating modes 1 and 3
Quick stop deceleration	60850020	3300	RWS	Unsigned32	Emergency stop deceleration

Other parameter

Name	CANopen	Modbus	Commend type	Data type	Description
Use internal motor library	30410608	-	RWS	Unsigned8	0: Automatically read the motor model from the encoder and use the corresponding motor parameters in the drive motor library (factory default) 1: Support the user to manually input the motor model and use the motor parameters corresponding to the motor library in the driver
Device restart	2FFF0010	2F00	RW	Unsigned16	Starting the bootloader 55AA: starts the bootloader AA55: Restarts the driver
Analog Increment	64101F10	-	RW	Integer16	Used to set the resolution of the communication magnetoelectric encoder to the incremental encoder resolution, which can be set to 4000,8000, and 10000 =0: Do not simulate incremental encoders, use the resolution of the default motor >0: Analog incremental encoder resolution Note: Multi-turn motors do not support analog increments.
Input_Lack_Check	26920008	1D20	RWS	Unsigned8	Power input phase loss detection control 0: Turn off input phase loss detection 1: Turn on input phase loss detection

Note:
Input_Lack_Check is turn on by default, so it will persist during the power-on period of the driver.