



# FD1X5 drive user manual

## Preface

Thank you for using Kinco servo products! FD1X5 servo drive are a new generation of small size, good performance and high stability products developed by Kinco after market research and according to the characteristics of the automation industry. They support CAN, Modbus, EtherCAT control methods, widely used in logistics storage equipment, mobile handling equipment, sorting cars, mobile service robots and other fields. For customers who have special requirements in communication mode, installation mode, protection level, etc., we also provide customized servo drives and motors for various application scenarios.

Please read the manual carefully and follow the operation requirements in the manual, which will help you correctly set up the drive to achieve the best performance.

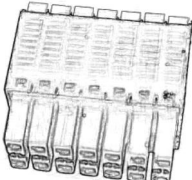
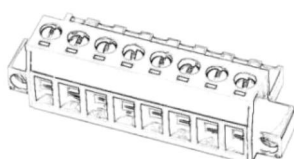
## Confirmation

- 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 on the drive.

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

## Parts list

### Driver accessories package

| Accessory package       | Name                    | External view                                                                       | Model             | Count | Note |
|-------------------------|-------------------------|-------------------------------------------------------------------------------------|-------------------|-------|------|
| FD125 accessory package | Double row 2*7 terminal |  | F7G-3.5-14P-A     | 1     |      |
|                         | Terminal head           |  | F6AM-5.08-08P-1-A | 1     |      |

|                                  |                            |                                                                                   |               |   |  |
|----------------------------------|----------------------------|-----------------------------------------------------------------------------------|---------------|---|--|
| FD135,FD145<br>accessory package | Double row<br>2*7 terminal |  | F7G-3.5-14P-A | 1 |  |
|----------------------------------|----------------------------|-----------------------------------------------------------------------------------|---------------|---|--|

### Motor accessories package

| Motor | Part size                                 |
|-------|-------------------------------------------|
| SMK60 | Framework oil seal (15*21*3)              |
|       | Plain C flat key (GB/T 1096 key C 5*5*16) |
| SMK80 | Framework oil seal (20*30*4)              |
|       | Plain C flat key (GB/T 1096 key C 6*6*25) |

### Cable accessories package

| Accessory package | Name                | Model                       | Count | Note                                                                                                                                                 |
|-------------------|---------------------|-----------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| ENCHG-GA          | Encoder connector   | SUNCHU SC-MC7S-A820-P0      | 1     | ENCHG-GA is suitable for both ENCHG-LL-GA and ENCHGF-LL-GA                                                                                           |
|                   | Encoder terminal    | SANCHU FMC19012220          | 5     |                                                                                                                                                      |
| ENCHG-GA-F        | Encoder connector   | SUNCHU SC-MC7S-A820-P0      | 1     | ENCHG-GA-F is suitable for ENCHG-LL-GA -F                                                                                                            |
|                   | Encoder terminal    | SANCHU FMC19012220          | 6     |                                                                                                                                                      |
| ENCDG/ENCDGF-GA   | Encoder connector   | SUNCHU SC-MC7S-A820-P0      | 1     | ENCDG/ENCDGF-GA is suitable for both ENCDG-LL-GA and ENCDGF-LL-GA                                                                                    |
|                   | Encoder terminal    | SANCHU FMC19012220          | 8     |                                                                                                                                                      |
|                   | 1394 Male connector | SUNCHU SC-06P               | 1     |                                                                                                                                                      |
| MOT/MOTF-005-KA   | Power connector     | SUNCHU SC-MC6S-AE20-00      | 1     | MOT/ MOTF-005-KA is suitable for both MOT-005-LL-KA-D and MOTF-005-LL-KA-D                                                                           |
|                   | Power terminal      | SANCHU FMCK6012220          | 6     |                                                                                                                                                      |
| MOT-005-KA-DF     | Power connector     | SUNCHU SC-MC6S-AE20-00      | 1     | MOT-005-KA-DF is suitable for MOT-005-LL-KA-DF                                                                                                       |
|                   | Power terminal      | SANCHU FMCK6092220(Reverse) | 5     |                                                                                                                                                      |
| MOT-005-KAB-DF    | Power connector     | SUNCHU SC-MC6S-AQ20-00      | 1     | MOT-005-KAB-DF is suitable for MOT-005-LL-KAB-DF                                                                                                     |
|                   | Power terminal      | SANCHU FMC25092220(Reverse) | 5     |                                                                                                                                                      |
|                   | Wiring terminal     | SANCHU FMC19012220          | 3     |                                                                                                                                                      |
| MOT-011-KA        | Power connector     | SUNCHU SC-MC6S-AQ20-00      | 1     | The MOT-011-KA is suitable for MOT-005-LL-KAB-D<br>MOTF-005-LL-KAB-D<br>MOT-011-LL-KA-D<br>MOTF-011-LL-KA-D<br>MOT-011-LL-KAB-D<br>MOTF-011-LL-KAB-D |
|                   | Power terminal      | SANCHU FMC25012220          | 4     |                                                                                                                                                      |
|                   | Wiring terminal     | SANCHU FMC19012220          | 2     |                                                                                                                                                      |
| MOT-011-KA-DF     | Power connector     | SUNCHU SC-MC6S-AQ20-00      | 1     | MOT-011-KA-DF is suitable for MOT-011-LL-KA-DF                                                                                                       |
|                   | Power terminal      | SANCHU FMC25092220(Reverse) | 5     |                                                                                                                                                      |

|                 |                       |                             |   |                                                                                                        |
|-----------------|-----------------------|-----------------------------|---|--------------------------------------------------------------------------------------------------------|
| MOT-011-KAB-DF  | Power connector       | SUNCHU SC-MC6S-AQ20-00      | 1 | MOT-011-KAB-DF is suitable for MOT-011-LL-KAB-DF                                                       |
|                 | Power terminal        | SANCHU FMC25092220(Reverse) | 5 |                                                                                                        |
|                 | Wiring terminal       | SANCHU FMC19012220          | 3 |                                                                                                        |
| MOT-KA(OD<11mm) | Power connector       | JinLing6353E-06S-AB-W01     | 1 | Mot-KA (OD<11mm) is suitable for MOT/ MTF-020-LL-KA-D                                                  |
|                 | Power terminal        | JinLing202.6353E0103P02     | 5 |                                                                                                        |
|                 | Brake terminal        | JinLing202.6353E0103P01     | 3 |                                                                                                        |
| MOT-KA(OD≥11mm) | Power connector shell | JinLing6353E-06S-AB-W00     | 1 | MOT-KA(OD≥11mm) is suitable for MOT/MOTF-020-LL-KAB-D<br>MOT/MOTF-030-LL-KA-D<br>MOT/MOTF-030-LL-KAB-D |
|                 | Power terminal        | JinLing202.6353E0103P02     | 5 |                                                                                                        |
|                 | Brake terminal        | JinLing202.6353E0103P01     | 3 |                                                                                                        |

## Safety attentions

### Security Definition

The following safety symbols are used in the safety-related contents of this manual. Please observe them to avoid injury.



#### **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 °C 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.
- RB+ and RB- terminals are used to connect brake resistors. Do not short circuit them, otherwise they may cause damage or fire.
- 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

| Date   | Update content                                                                           |
|--------|------------------------------------------------------------------------------------------|
| 2025-2 | First edition                                                                            |
| 2025-4 | 1.1.1 Add the UL product model<br>1.3.2 Add vibration parameter<br>8.4.1 Correct content |
| 2025-5 | 1.3.2 Supplement the description of the protection class                                 |

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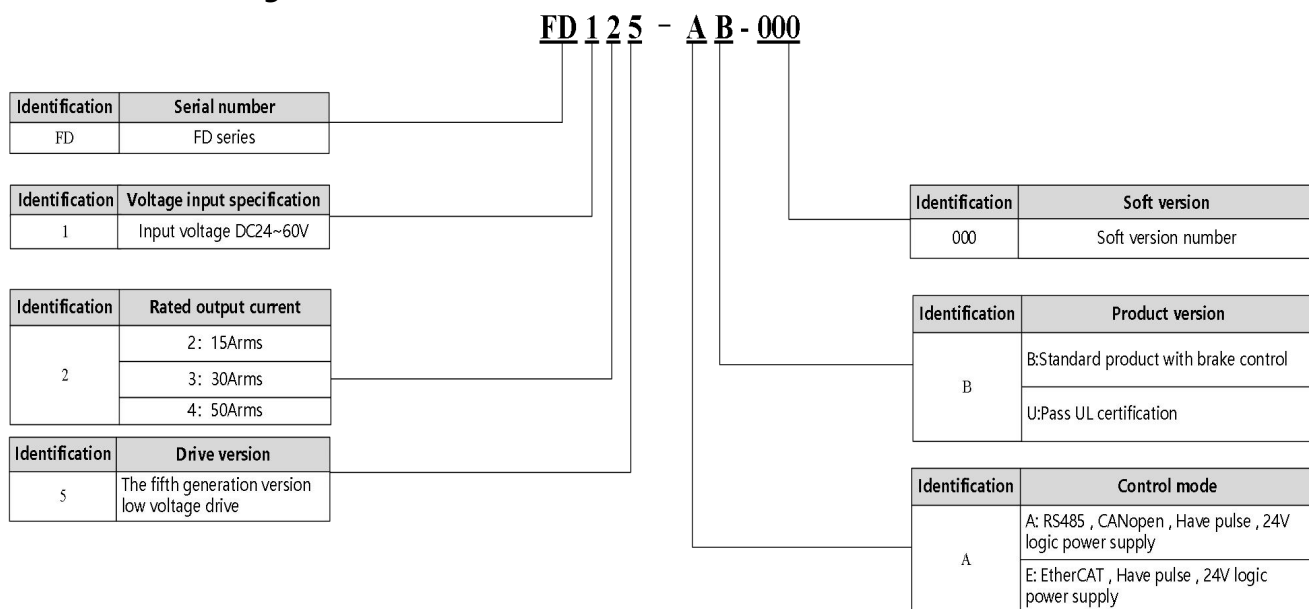
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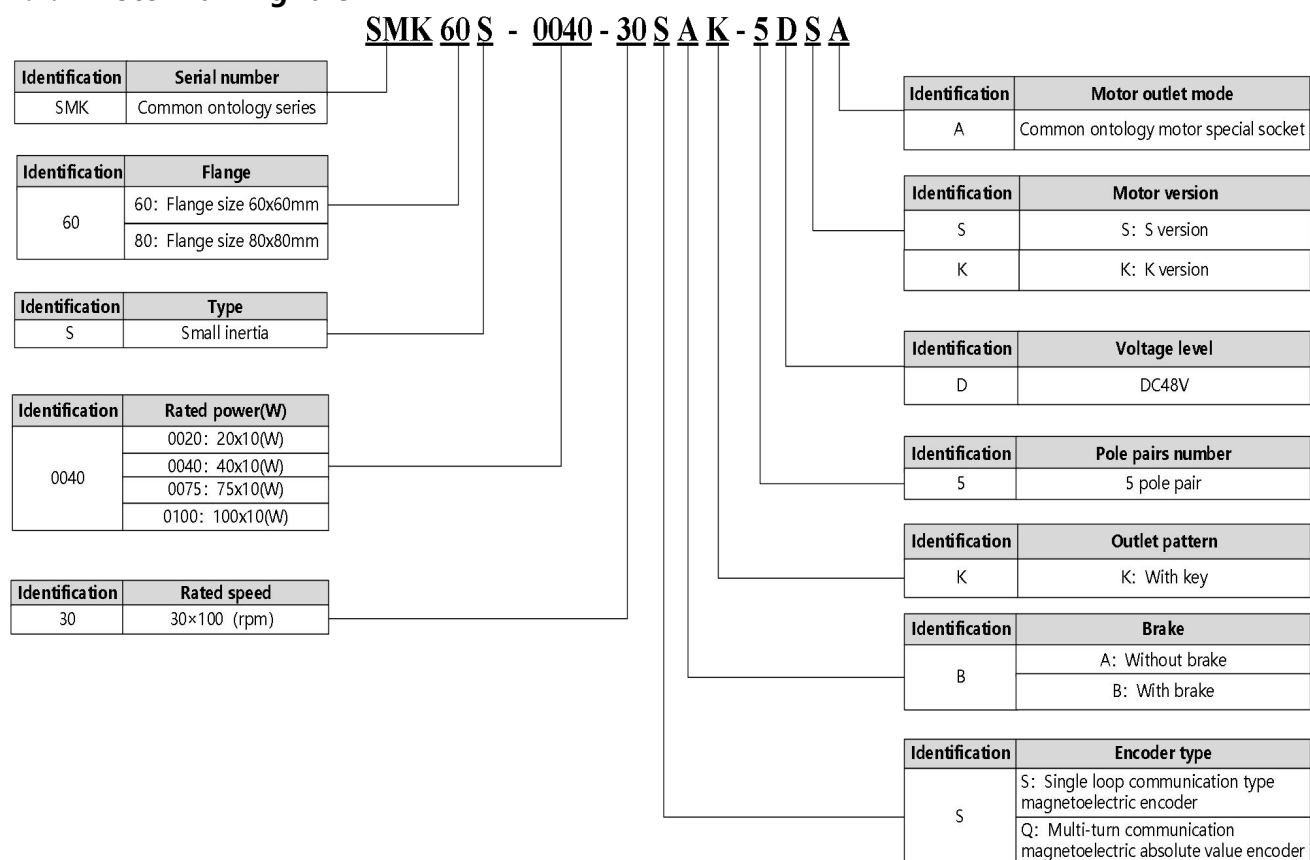
# Chapter 1 System configuration and product description

## 1.1 Product description

### 1.1.1 Drive naming rule

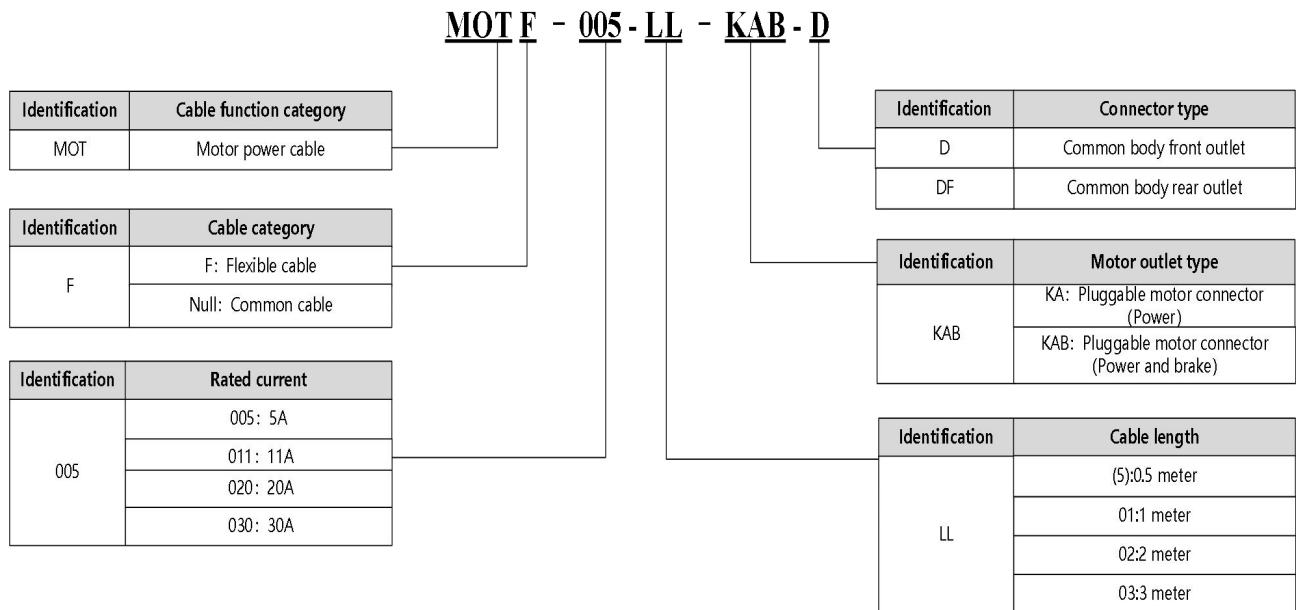


### 1.1.2 Motor naming rule



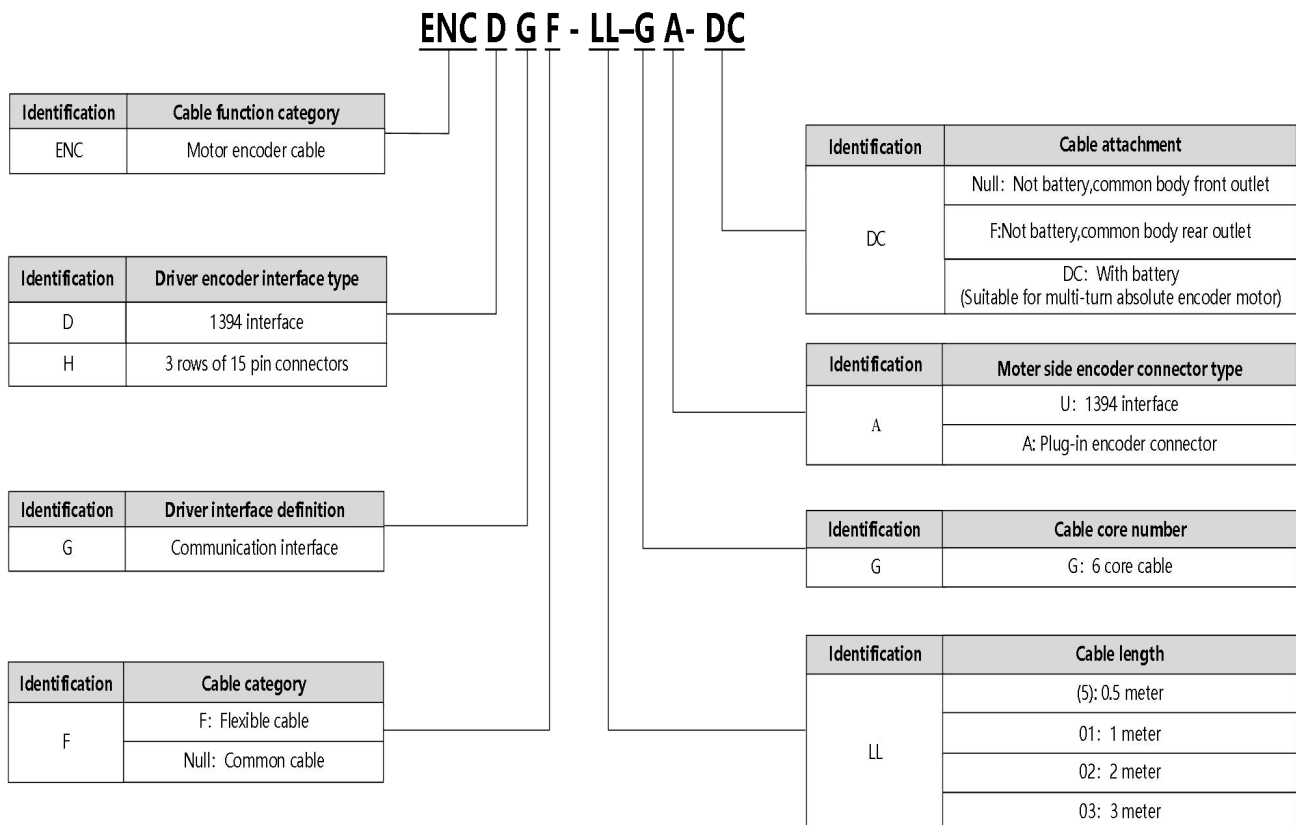
### 1.1.3 Connecting cable naming rule

#### (1) Power line



**Note:** LL indicates the cable length

#### (2) Encoder cable



**Note:** LL indicates the cable length

## 1.2 Motor configuration description

| Motor Type             | Power | Power/Brake cable                        | Encoder cable                     | Servo driver                                                 |
|------------------------|-------|------------------------------------------|-----------------------------------|--------------------------------------------------------------|
| SMK60S-0020-30SAK-5DSA | 200W  | MOT-005-LL-KA-D<br>or MOT-005-LL-KA-DF   | ENCHG-LL-GA<br>or ENCHG-LL-GA-F   | FD125-AB-000<br>FD125-AU-000<br>FD125-EB-000<br>FD125-EU-000 |
| SMK60S-0020-30SBK-5DSA |       | MOT-005-LL-KAB-D<br>or MOT-005-LL-KAB-DF |                                   |                                                              |
| SMK60S-0040-30SAK-5DSA | 400W  | MOT-011-LL-KA-D<br>or MOT-011-LL-KA-DF   |                                   |                                                              |
| SMK60S-0040-30SBK-5DSA |       | MOT-011-LL-KAB-D<br>or MOT-011-LL-KAB-DF |                                   |                                                              |
| SMK80S-0075-30SAK-5DKA | 750W  | MOT-020-LL-KA-D                          |                                   | FD135-AB-000<br>FD135-AU-000<br>FD135-EB-000<br>FD135-EU-000 |
| SMK80S-0075-30SBK-5DKA |       | MOT-020-LL-KAB-D                         |                                   |                                                              |
| SMK80S-0100-30SAK-5DKA | 1000W | MOT-030-LL-KA-D                          |                                   |                                                              |
| SMK80S-0100-30SBK-5DKA |       | MOT-030-LL-KAB-D                         |                                   |                                                              |
| SMK60S-0020-30QAK-5DSA | 200W  | MOT-005-LL-KA-D<br>or MOT-005-LL-KA-DF   | ENCDG-LL-GA/<br>ENCHG- (4) -GU-DC | FD125-AB-000<br>FD125-AU-000<br>FD125-EB-000<br>FD125-EU-000 |
| SMK60S-0020-30QBK-5DSA |       | MOT-005-LL-KAB-D<br>or MOT-005-LL-KAB-DF |                                   |                                                              |
| SMK60S-0040-30QAK-5DSA | 400W  | MOT-011-LL-KA-D<br>or MOT-011-LL-KA-DF   |                                   |                                                              |
| SMK60S-0040-30QBK-5DSA |       | MOT-011-LL-KAB-D<br>or MOT-011-LL-KAB-DF |                                   |                                                              |
| SMK80S-0075-30QAK-5DKA | 750W  | MOT-020-LL-KA-D                          |                                   | FD135-AB-000<br>FD135-AU-000<br>FD135-EB-000<br>FD135-EU-000 |
| SMK80S-0075-30QBK-5DKA |       | MOT-020-LL-KAB-D                         |                                   |                                                              |
| SMK80S-0100-30QAK-5DKA | 1000W | MOT-030-LL-KA-D                          |                                   |                                                              |
| SMK80S-0100-30QBK-5DKA |       | MOT-030-LL-KAB-D                         |                                   |                                                              |

Note:  
1. The "LL" in the list of power/brake/encoder cables indicates the cable length, see the model description;  
2.ENCHG- (4) -GU-DC is the necessary battery power cable for the multi-turn absolute encoder motor, with a wire length of 40cm  
3.SMK80S-0100-30■K-5DKA is recommended to match FD135, If 3 times overload is required, it needs to be matched with FD145

## 1.3 Product parameters

### 1.3.1 Driver electrical parameter

| Model parameter                                   |                                         | FD125-□B-000<br>FD125-□U-000                                                                                                                                                                                                                                                                                                                                                                     | FD135-□B-000<br>FD135-□U-000                             | FD145-□B-000<br>FD145-□U-000                             |
|---------------------------------------------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| Input voltage                                     | Power                                   | 24VDC ~ 60VDC                                                                                                                                                                                                                                                                                                                                                                                    |                                                          |                                                          |
|                                                   | Logic power                             | 24VDC 1A (Optional connection or not)                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                          |
| Output current                                    | Maximum continuous output current (rms) | 15Arms<br>(Up to 12Arms without auxiliary cooling plate)                                                                                                                                                                                                                                                                                                                                         | 30Arms<br>(Up to 22Arms without auxiliary cooling plate) | 50Arms<br>(Up to 35Arms without auxiliary cooling plate) |
|                                                   |                                         | For details about auxiliary heat dissipation, see <b>2.3.1.1</b>                                                                                                                                                                                                                                                                                                                                 |                                                          |                                                          |
|                                                   | Peak current (AP)                       | 48                                                                                                                                                                                                                                                                                                                                                                                               | 100                                                      | 160                                                      |
| Feedback signal                                   |                                         | Tamagawa protocol single-tur/multi-turn encoder                                                                                                                                                                                                                                                                                                                                                  |                                                          |                                                          |
| Energy consumption brake                          |                                         | Need external brake resistance (depending on the operation condition, mainly used in rapid start-stop occasions)                                                                                                                                                                                                                                                                                 |                                                          |                                                          |
| Energy consumption brake voltage absorption point |                                         | The default is 63V±2V                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                          |
| Overvoltage alarm voltage                         |                                         | The default is 70V±2V                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                          |
| Undervoltage alarm voltage                        |                                         | The default is 18V±2V                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                          |
| Cooling mode                                      |                                         | Natural cooling                                                                                                                                                                                                                                                                                                                                                                                  |                                                          |                                                          |
| Weight (KG)                                       |                                         | 0.322                                                                                                                                                                                                                                                                                                                                                                                            | 0.657                                                    | 0.861                                                    |
| Logic loss power (mW)                             |                                         | 1000                                                                                                                                                                                                                                                                                                                                                                                             | 1200                                                     | 1300                                                     |
| General function                                  | Input specification                     | 3 channels digital input, COM1 terminal; High level: 12.5-30VDC; Low level: 0-5VDC;Maximum frequency: 1KHz; Input impedance: 5KΩ.                                                                                                                                                                                                                                                                |                                                          |                                                          |
|                                                   | Input function                          | Freely defined as required, the functions are as follows: drive enable, drive error reset, drive mode control, speed loop proportional control, positive limit, negative limit, origin signal, command reverse, internal speed segment control, internal position segment control, emergency stop, start to find the origin, command activation, electronic gear ratio switching, gain switching |                                                          |                                                          |
|                                                   | Pulse control                           | Pulse + Direction, A phase + B phase (3.3V~24V)                                                                                                                                                                                                                                                                                                                                                  |                                                          |                                                          |
|                                                   | Output specification                    | 1 digital output, OUT1 is an open collector output, up to 30V, 100mA drive capability, The brake is DC 24V output, without external power supply, can directly drive the brake device. The brake output current of FD125, FD135 and FD145 are 0.5A, 0.8A and 1A respectively.                                                                                                                    |                                                          |                                                          |
|                                                   | Output function                         | Freely defined according to needs, the functions are as follows: driver ready, driver error, motor position to, motor zero speed, motor lock brake, motor speed to, index Z signal appears, maximum limit speed in torque mode, motor lock shaft, motor limit medium, origin finding                                                                                                             |                                                          |                                                          |
|                                                   | Type-C                                  | Debug special, can use Kinco PC software connection                                                                                                                                                                                                                                                                                                                                              |                                                          |                                                          |
|                                                   | Protect function                        | Overvoltage protection, undervoltage protection, motor overheat (I²T) protection, short circuit protection, drive overheat protection                                                                                                                                                                                                                                                            |                                                          |                                                          |
| Bus function                                      | Modbus/RS485                            | It supports a maximum 115.2K baud rate and can communicate with the controller using Modbus RTU                                                                                                                                                                                                                                                                                                  |                                                          |                                                          |
|                                                   | CANOpen                                 | It supports a maximum of 1 M baud rate and can communicate with the controller using the CANopen                                                                                                                                                                                                                                                                                                 |                                                          |                                                          |
|                                                   | EtherCAT                                | Support COE (CiA402 protocol) and CSP/CSV/PP/PV/PT/HM mode, communication speed 100M                                                                                                                                                                                                                                                                                                             |                                                          |                                                          |
| EMC                                               |                                         | Meet the requirements for standards EN 61800-3, EN61000-6-2, EN61000-6-4                                                                                                                                                                                                                                                                                                                         |                                                          |                                                          |
| <b>Note :</b> □ =A: RS485、CANopen<br>=E: EtherCAT |                                         |                                                                                                                                                                                                                                                                                                                                                                                                  |                                                          |                                                          |

### 1.3.2 Driver use environment parameter

|                      |                                                                                                                                                                                                                                                                              |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Working Temperature  | -20℃ ~ 40℃ (no freezing) .When the operating temperature exceeds 40℃, the driver needs to be derated                                                                                                                                                                         |
| Working Humidity     | Less than 90%RH (no condensation)                                                                                                                                                                                                                                            |
| Storage temperature  | -40℃ ~ 70℃ (no freezing)                                                                                                                                                                                                                                                     |
| Storage humidity     | 90%RH (no condensation)                                                                                                                                                                                                                                                      |
| Protection class     | IP20 (Note: The power supply terminal X5 only meets the IP00 protection level)                                                                                                                                                                                               |
| 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. |
| Atmospheric pressure | 86kpa ~ 106kpa                                                                                                                                                                                                                                                               |
| Installation site    | Dust-free, dry, lockable (e.g. electrical cabinet)                                                                                                                                                                                                                           |

|                     |                                                                                                                                                                                                                                                                                                       |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Installation method | Install vertically or horizontally                                                                                                                                                                                                                                                                    |
| Vibration           | Without packaging: Sinusoidal vibration<br>10Hz~57Hz 0.075mm<br>57Hz~150Hz 10m/s <sup>2</sup> (1g)<br>With packaging: random vibration<br>2Hz~3Hz 10 (m/s <sup>2</sup> ) <sup>2</sup> /Hz<br>10Hz~20Hz 1 (m/s <sup>2</sup> ) <sup>2</sup> /Hz<br>50Hz~2000Hz 0.5 (m/s <sup>2</sup> ) <sup>2</sup> /Hz |

### 1.3.3 Motor specification parameter description

SMK60S-0020-30S■K-5DSA (The black box indicates the motor with or without brake)

| Motor specification                                 |                        | Torque-speed characteristic curve |  |
|-----------------------------------------------------|------------------------|-----------------------------------|--|
| Pole number                                         | 10                     |                                   |  |
| DC bus voltage (V)                                  | 48                     |                                   |  |
| Rated power P <sub>n</sub> (W)                      | 200                    |                                   |  |
| Rated torque T <sub>n</sub> (Nm)                    | 0.64                   |                                   |  |
| Rated speed n <sub>N</sub> (rpm)                    | 3000                   |                                   |  |
| Rated current I <sub>n</sub> (A)                    | 5.7                    |                                   |  |
| Maximum torque T <sub>m</sub> (Nm)                  | 1.92                   |                                   |  |
| Maximum current I <sub>m</sub> (A)                  | 18.2                   |                                   |  |
| Continuous static torque T <sub>s</sub> (Nm)        | 0.7                    |                                   |  |
| Continuous static current I <sub>s</sub> (A)        | 6.27                   |                                   |  |
| Resistance line R <sub>L</sub> (Ω)                  | 0.68                   |                                   |  |
| Inductance line L <sub>L</sub> (mH)                 | 1.33                   |                                   |  |
| Electrical time constant τ <sub>e</sub> (ms)        | 1.96                   |                                   |  |
| Mechanical time constant τ <sub>m</sub> (ms)        | 1.3                    |                                   |  |
|                                                     | 1.33 (With brake)      |                                   |  |
| Voltage constant K <sub>e</sub> (V/krpm)            | 7.5                    |                                   |  |
| Torque constant K <sub>t</sub> (Nm/A)               | 0.124                  |                                   |  |
| Rotary inertia J <sub>m</sub> (Kg*cm <sup>2</sup> ) | 0.17 (Without brake)   |                                   |  |
|                                                     | 0.174 (With brake)     |                                   |  |
| Insulation grade                                    | F                      |                                   |  |
| Protection grade                                    | IP65<br>Shaft end IP54 |                                   |  |
| Maximum radial force of bearing F(N)                | 40                     |                                   |  |
| Maximum axial force of bearing F(N)                 | 30                     |                                   |  |
| Weight (Kg)                                         | 0.9                    |                                   |  |
|                                                     | 1.3(With brake)        |                                   |  |

#### Electrical specifications of the brake

|                             |                     |                 |                     |                   |                   |                        |
|-----------------------------|---------------------|-----------------|---------------------|-------------------|-------------------|------------------------|
| Static friction torque (Nm) | Rated voltage (VDC) | Rated power (W) | Coil resistance (Ω) | Operate Time (ms) | Release Time (ms) | Rotating clearance (°) |
|-----------------------------|---------------------|-----------------|---------------------|-------------------|-------------------|------------------------|

|          |               |     |                 |           |           |       |
|----------|---------------|-----|-----------------|-----------|-----------|-------|
| $\geq 2$ | $24 \pm 10\%$ | 7.6 | $75.8 \pm 10\%$ | $\leq 60$ | $\leq 40$ | $< 1$ |
|----------|---------------|-----|-----------------|-----------|-----------|-------|

SMK60S-0040-30S■K-5DSA (The black box indicates the motor with or without brake)

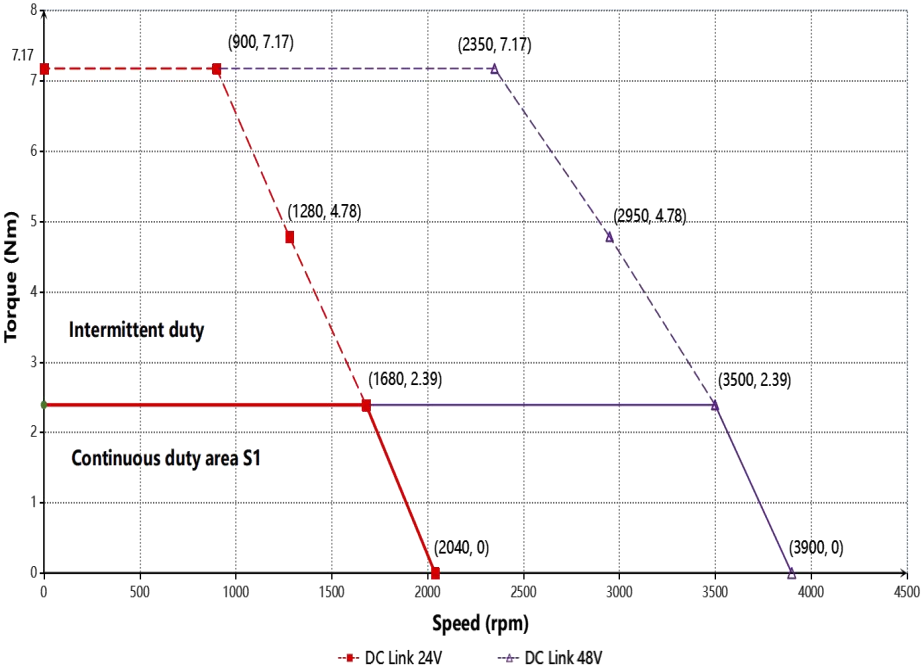
| Motor specification                                 |                            | Torque-speed characteristic curve |  |
|-----------------------------------------------------|----------------------------|-----------------------------------|--|
| Pole number                                         | 10                         |                                   |  |
| DC bus voltage (V)                                  | 48                         |                                   |  |
| Rated power P <sub>n</sub> (W)                      | 400                        |                                   |  |
| Rated torque T <sub>n</sub> (Nm)                    | 1.27                       |                                   |  |
| Rated speed n <sub>N</sub> (rpm)                    | 3000                       |                                   |  |
| Rated current I <sub>n</sub> (A)                    | 10.6                       |                                   |  |
| Maximum torque T <sub>m</sub> (Nm)                  | 3.81                       |                                   |  |
| Maximum current I <sub>m</sub> (A)                  | 33.9                       |                                   |  |
| Continuous static torque T <sub>s</sub> (Nm)        | 1.4                        |                                   |  |
| Continuous static current I <sub>s</sub> (A)        | 11.7                       |                                   |  |
| Resistance line R <sub>L</sub> (Ω)                  | 0.32                       |                                   |  |
| Inductance line L <sub>L</sub> (mH)                 | 0.65                       |                                   |  |
| Electrical time constant τ <sub>e</sub> (ms)        | 2.03                       |                                   |  |
| Mechanical time constant τ <sub>m</sub> (ms)        | 0..98<br>1<br>(With brake) |                                   |  |
| Voltage constant K <sub>e</sub> (V/krpm)            | 8                          |                                   |  |
| Torque constant K <sub>t</sub> (Nm/A)               | 0.132                      |                                   |  |
| Rotary inertia J <sub>m</sub> (Kg*cm <sup>2</sup> ) | 0.31<br>(Without brake)    |                                   |  |
|                                                     | 0.314<br>(With brake)      |                                   |  |
| Insulation grade                                    | F                          |                                   |  |
| Protection grade                                    | IP65<br>Shaft end IP54     |                                   |  |
| Maximum radial force of bearing F(N)                | 40                         |                                   |  |
| Maximum axial force of bearing F(N)                 | 30                         |                                   |  |
| Weight (Kg)                                         | 1.1                        |                                   |  |
|                                                     | 1.5(With brake)            |                                   |  |

### Electrical specifications of the brake

|                             |                     |                 |                     |                   |                   |                        |
|-----------------------------|---------------------|-----------------|---------------------|-------------------|-------------------|------------------------|
| Static friction torque (Nm) | Rated voltage (VDC) | Rated power (W) | Coil resistance (Ω) | Operate Time (ms) | Release Time (ms) | Rotating clearance (°) |
|-----------------------------|---------------------|-----------------|---------------------|-------------------|-------------------|------------------------|

|    |        |     |          |     |     |    |
|----|--------|-----|----------|-----|-----|----|
| ≥2 | 24±10% | 7.6 | 75.8±10% | ≤60 | ≤40 | <1 |
|----|--------|-----|----------|-----|-----|----|

SMK80S-0075-30S■K-5DKA (The black box indicates the motor with or without brake)

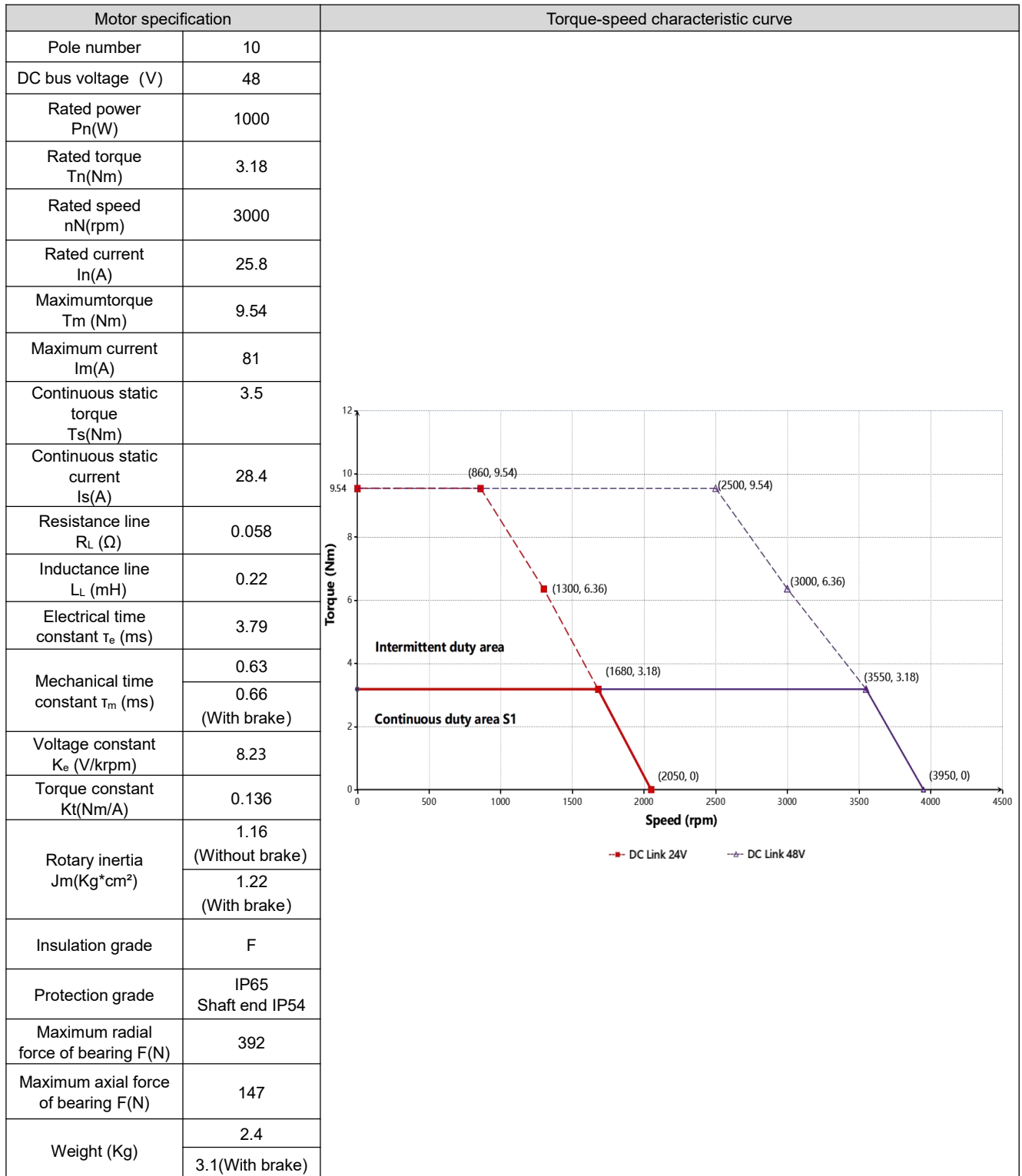
| Motor specification                                 |                                           | Torque-speed characteristic curve                                                   |  |
|-----------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------|--|
| Pole number                                         | 10                                        |  |  |
| DC bus voltage (V)                                  | 48                                        |                                                                                     |  |
| Rated power P <sub>n</sub> (W)                      | 750                                       |                                                                                     |  |
| Rated torque T <sub>n</sub> (Nm)                    | 2.39                                      |                                                                                     |  |
| Rated speed n <sub>N</sub> (rpm)                    | 3000                                      |                                                                                     |  |
| Rated current I <sub>n</sub> (A)                    | 19.2                                      |                                                                                     |  |
| Maximum torque T <sub>m</sub> (Nm)                  | 7.17                                      |                                                                                     |  |
| Maximum current I <sub>m</sub> (A)                  | 62.7                                      |                                                                                     |  |
| Continuous static torque T <sub>s</sub> (Nm)        | 2.63                                      |                                                                                     |  |
| Continuous static current I <sub>s</sub> (A)        | 21.1                                      |                                                                                     |  |
| Resistance line R <sub>L</sub> (Ω)                  | 0.088                                     |                                                                                     |  |
| Inductance line L <sub>L</sub> (mH)                 | 0.32                                      |                                                                                     |  |
| Electrical time constant τ <sub>e</sub> (ms)        | 3.64                                      |                                                                                     |  |
| Mechanical time constant τ <sub>m</sub> (ms)        | 0.687<br>0.736 (With brake)               |                                                                                     |  |
| Voltage constant K <sub>e</sub> (V/krpm)            | 8.3                                       |                                                                                     |  |
| Torque constant K <sub>t</sub> (Nm/A)               | 0.137                                     |                                                                                     |  |
| Rotary inertia J <sub>m</sub> (Kg*cm <sup>2</sup> ) | 0.85 (Without brake)<br>0.91 (With brake) |                                                                                     |  |
| Insulation grade                                    | F                                         |                                                                                     |  |
| Protection grade                                    | IP65<br>Shaft end IP54                    |                                                                                     |  |
| Maximum radial force of bearing F(N)                | 392                                       |                                                                                     |  |
| Maximum axial force of bearing F(N)                 | 147                                       |                                                                                     |  |
| Weight (Kg)                                         | 1.9<br>2.6(With brake)                    |                                                                                     |  |

#### Electrical specifications of the brake

|                             |                     |                 |                     |                   |                   |                        |
|-----------------------------|---------------------|-----------------|---------------------|-------------------|-------------------|------------------------|
| Static friction torque (Nm) | Rated voltage (VDC) | Rated power (W) | Coil resistance (Ω) | Operate Time (ms) | Release Time (ms) | Rotating clearance (°) |
|-----------------------------|---------------------|-----------------|---------------------|-------------------|-------------------|------------------------|

|          |               |      |               |           |           |       |
|----------|---------------|------|---------------|-----------|-----------|-------|
| $\geq 4$ | $24 \pm 10\%$ | 11.5 | $50 \pm 10\%$ | $\leq 80$ | $\leq 40$ | $< 1$ |
|----------|---------------|------|---------------|-----------|-----------|-------|

SMK80S-0100-30S■K-5DKA (The black box indicates the motor with or without brake)



#### Electrical specifications of the brake

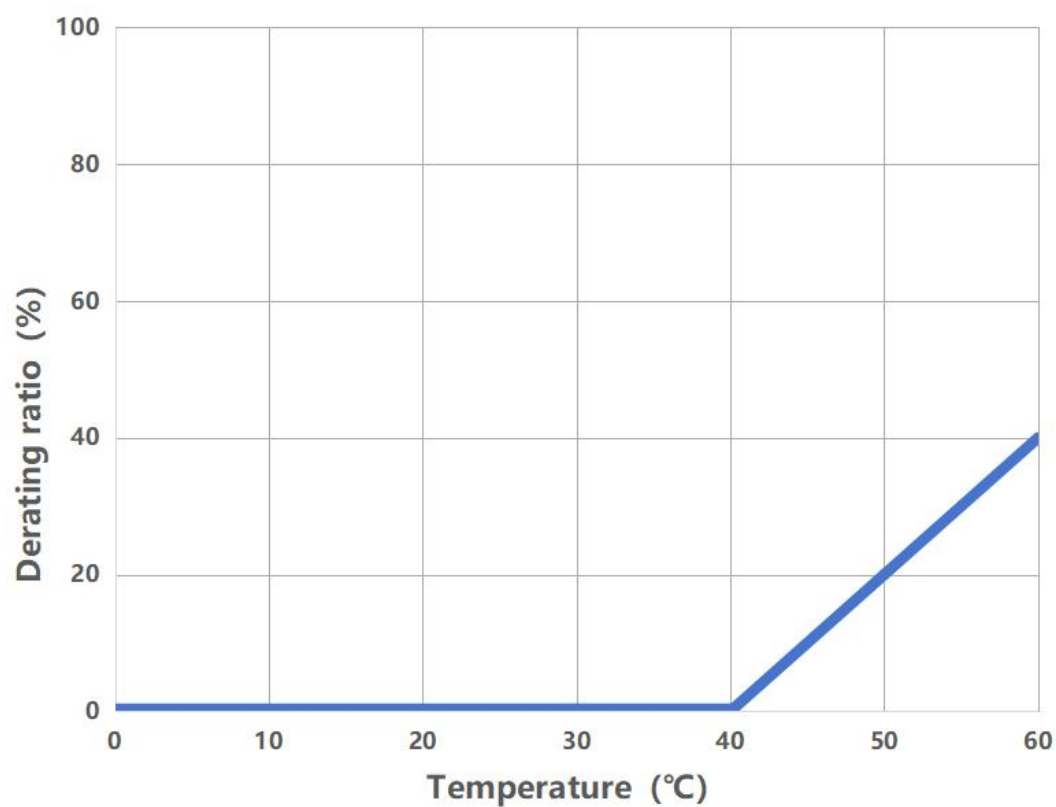
|                             |                     |                 |                              |                   |                   |                                 |
|-----------------------------|---------------------|-----------------|------------------------------|-------------------|-------------------|---------------------------------|
| Static friction torque (Nm) | Rated voltage (VDC) | Rated power (W) | Coil resistance ( $\Omega$ ) | Operate Time (ms) | Release Time (ms) | Rotating clearance ( $^\circ$ ) |
| $\geq 4$                    | $24 \pm 10\%$       | 11.5            | $50 \pm 10\%$                | $\leq 80$         | $\leq 40$         | $< 1$                           |

**Note**

- Influenced by the reverse electromotive force parameters of the motor, the floating range of the velocity inflection point in the TN curve is  $\pm 10\%$ .
- The T-N curve of the SMK motor is tested base a 1m cable.

## 1.4 Product characteristic

### SMK temperature derating curve



## Chapter 2 System Installation requirements and announcement

### 2.1 Servo system 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 operate in 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

## 2.1.4 Announcement



### Note

- Please use the servo system in a well-ventilated, dry and dust-free place, free of vibration, grinding fluid, oil mist, iron powder, chips, and immersion of moisture, oil, and water, away from the furnace and other heat sources.
- When the servo system parts are found to be incomplete or damaged, safety and use shall not be carried out.
- Do not use the servo motor in a closed environment, and the servo system must be installed in a control box in a room without rain and direct sunlight, and the surrounding must be non-flammable.
- When making mechanical connections, use a coupling or expansion sleeve and keep the shaft of the motor in line with the shaft of the machine. When installed, it meets the centering accuracy requirements. If the centering is not sufficient, it will cause vibration, which may sometimes damage bearings and encoders.
- When fixing the drive and motor, ensure that each fixing point is locked.
- Do not block the driver vent when installing the servo driver. Reserve heat dissipation space around the driver to ensure that the servo driver is not affected when installing the brake resistance.
- Avoid any foreign matter entering the servo system, screws, metal chips and other conductive foreign matter or flammable foreign matter entering the servo drive may cause fire and electric shock, for safety reasons, please do not use damaged or damaged parts of the servo drive and servo motor.
- The shaft of the motor and the shaft of the equipment must be installed in good alignment. Please use the shaft connector or the expansion sleeve.
- Do not "bend" the cable or apply "tension" to it, and do not make it too tight when wiring (in use).
- Do not use gasoline, thinner, alcohol, acid or alkaline detergent to avoid discoloration or damage to the shell.
- Improper installation may cause damage to the motor encoder. Please note the following during installation:
- When installing pulleys on motor shafts with keyways, screw holes are used at shaft ends. In order to install the pulley, first insert the double-headed nail into the screw hole of the shaft, use a washer on the surface of the coupling end, and gradually lock the pulley with a nut.
  - ◆ For motor shafts with keyways, install them using screw holes at shaft ends. For shafts without keyways, frictional coupling or similar methods are used.
  - ◆ When the pulley is removed, the pulley removal device is used to prevent the bearing from being strongly impacted by the load.
  - ◆ To ensure safety, install a protective cover or similar device in the rotating area, such as a pulley mounted on the shaft.
- When used in places with water drops, please use it on the basis of confirming the protection level of the servo motor. (except shaft through) Specify servo-products with oil seals for use in areas where oil droplets may drip onto shaft through parts. Conditions of use of oil seal:
  - ◆ Make sure the oil level is lower than the lip of the oil seal when using.
  - ◆ Use in a condition where the oil seal can keep the oil spray level good.
  - ◆ When the servo motor is installed vertically, please be careful not to make the oil seal lip oil.

2.1.5 Oil seal installation instructions

The bearing of the motor has a double-sided dust proof 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 necessary to install the oil seal, it is not recommended to install the oil seal. Before assembling the oil seal, please ensure that the installation hole and the oil seal are free of debris, oil, dust, etc. Incorrect installation of the oil seal may cause abnormal operation of the motor (such as the no-load running current increases, and the temperature rise of the motor shaft increases). Please install the oil seal correctly according to the following steps:

- 1.Before the oil seal installation, grease is evenly applied in the oil seal lip and the outer circle of the seal (recommended to use HP-R of the Great Wall, temperature resistance of 180 degrees of grease) to strengthen the performance of lubrication and temperature resistance, increase the sealing and waterproof effect of the oil seal, and at the same time, appropriate amount of grease is also applied to the motor shaft oil seal location, front end cover and oil seal chamber.
- 2.When installing the oil seal, the side of the oil seal with the spring should be oriented towards the motor, select the appropriate sleeve specification, and put the oil seal on the sleeve to ensure that the seal lip will not be damaged.
- 3.After the sleeve with the oil seal is put into the motor shaft, the oil seal is slowly pressed into the oil seal chamber with the press assembly tool. Pay attention to ensure that the oil seal is perpendicular to the machine shaft. The purpose of using the framework oil seal press assembly tool is to ensure that the oil seal is pushed into the chamber with uniform force.
- 4.After successful installation, check whether the oil seal will tilt, 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.

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Shaft Seal Installation

油封安装示意图

CAUTION

VORSICHT

ATTENTION

ATTENDRE

Flange Size

ID

OD

L

60mm

16mm

32mm

50mm

80mm

21mm

42mm

50mm

Flange Size

ID

OD

L

60mm

16mm

32mm

50mm

80mm

21mm

42mm

50mm

Oil seal installation instructions

油封安装说明

1、 Seal must be fitted with gaiter spring visible from inside of motor.  
油封安装时，使油封有弹簧的一面朝向电机。

2、 Ensure that seal is lubricated sufficiently for installation and initial start-up. (HP-R lubricants of Sinopec is recommended)  
确保油封安装前充分润滑。(推荐使用长城HP-R润滑油)

3、 Sealing lip must be protected from damage during installation by use of suitable sleeve over shaft. Specifications of sleeve refer to shaft seal installation flow chart printed on opposite page.  
在安装过程中必须用合适的套筒，确保密封唇不被损坏，套筒规格见反面《油封安装示意图》中所示。

4、 Firmly support rear of motor on suitable press, taking care to avoid damage to connectors.  
在电机后端用合适的压力支撑，同时避免损坏电机插头。

WARNING:

Under no circumstances attempt to hammer seal into position.

警告:

任何情况下，严禁敲击油封至油封室内。

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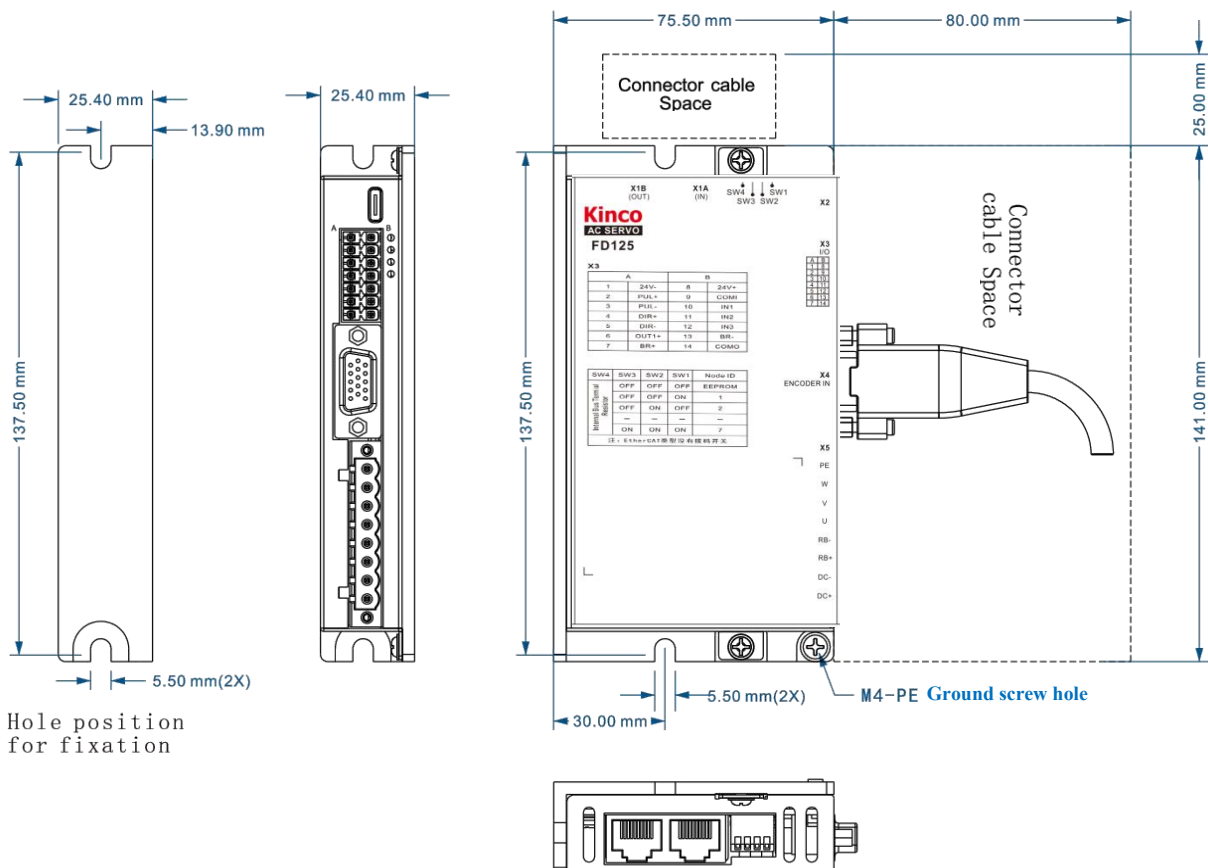
### Note

- Before installing the oil seal, ensure that experienced personnel install the oil seal according to correct steps to prevent damage to the motor or the oil seal.
- Do not use a hammer to directly hit the oil seal for assembly. Direct tapping will cause deformation of the oil seal, scratches on the outer diameter of the oil seal and the seal lip, and the spring of the oil seal.
- When installing the oil seal, the oil seal must be placed horizontally and then installed under uniform pressure. If the oil seal is forcibly installed in the skewed state, it will cause the deformation of the oil seal and thus fail.
- If no professional tools can be installed, use a stop plate on the oil seal, and evenly apply force to knock the oil seal into the oil seal chamber.

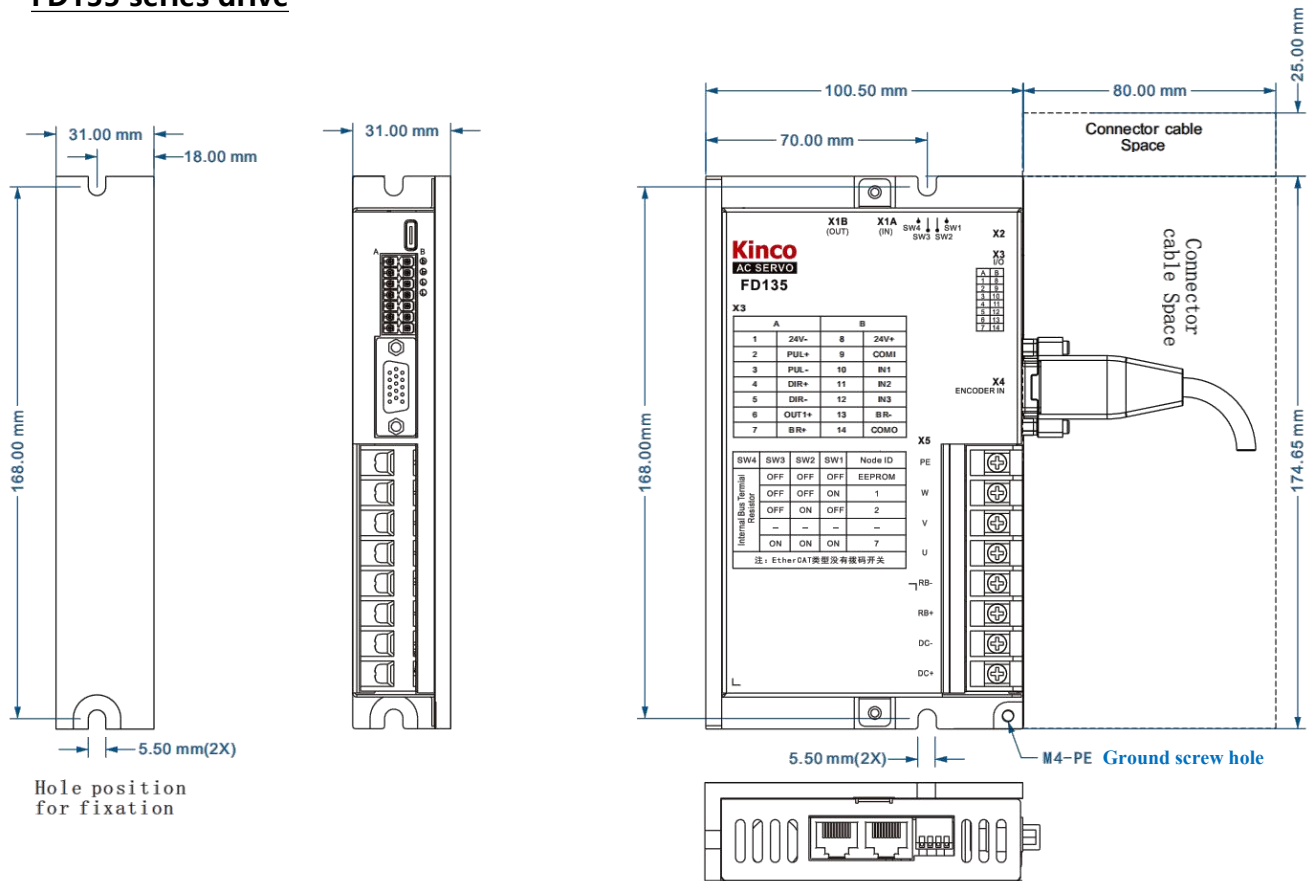
## 2.2 Servo system mounting dimensions

### 2.2.1 FD1X5 series mechanical dimension

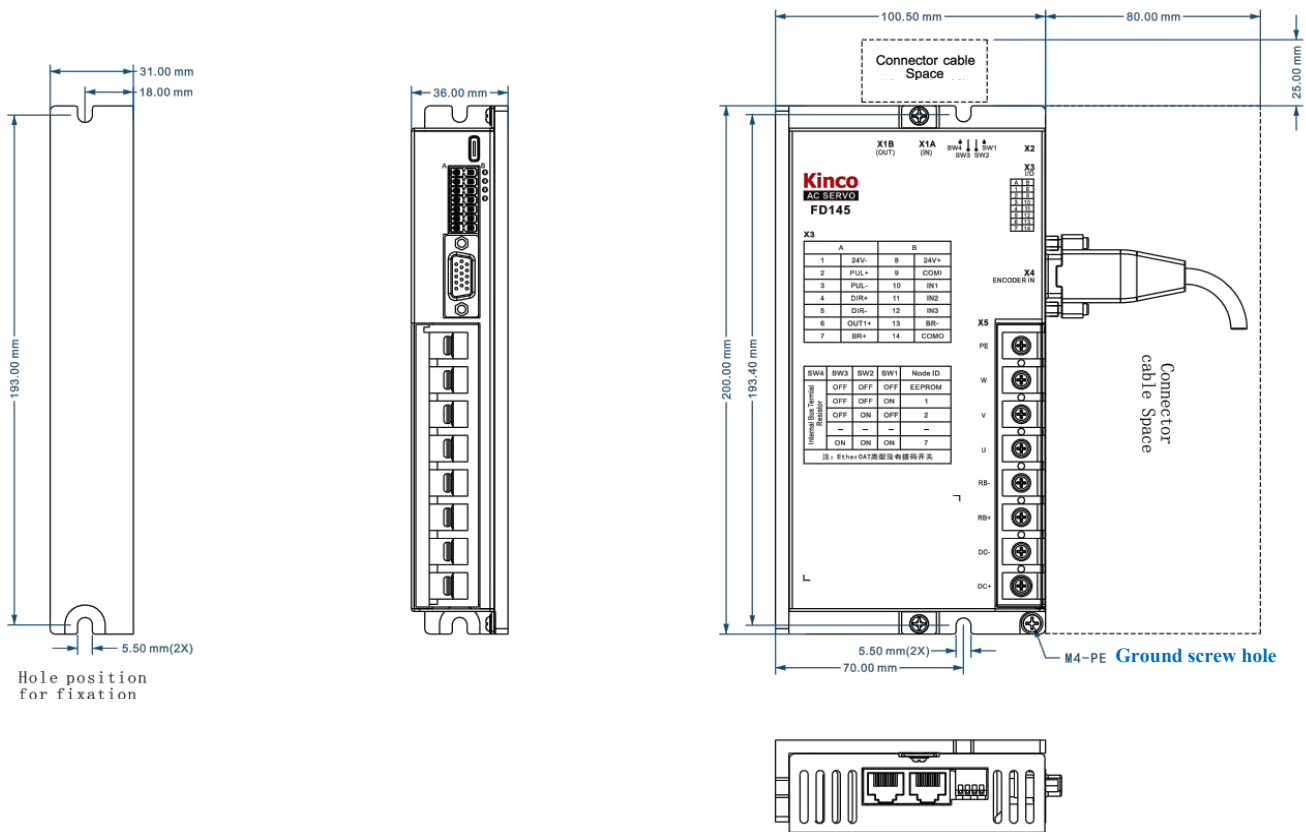
## FD125 series drive



## FD135 series drive



## FD145 series drive

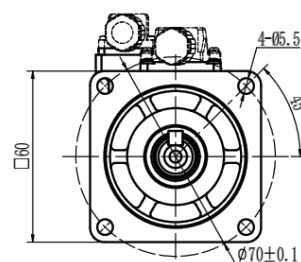
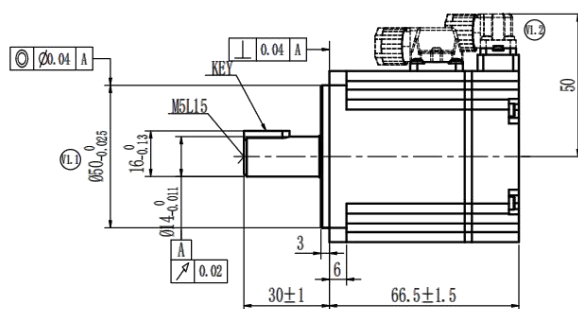
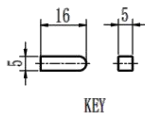


**Note**

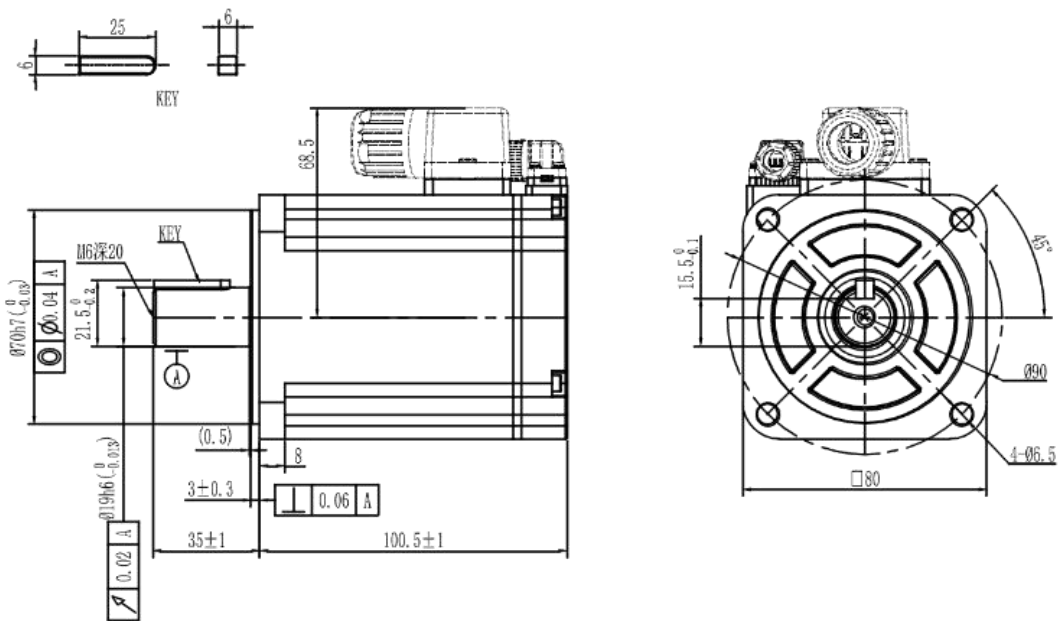
- When the driver is installed on the wall, it must be placed vertically, and the upper and lower spacing must be reserved.
- If you use thermal devices such as brake resistors, the heat dissipation situation should be fully taken into account to ensure the heat dissipation space of the driver and ensure that the driver is not affected. (Unit: mm)
- FD1X5-EB-000 drive has no dip switch

**Warning**

- Ensure that the driver is securely installed and screwed. Otherwise, the driver may fall and be hurt.
- Pay attention to the danger of electric shock. Disconnect the power supply when connecting the cable. Contact with live parts can cause serious injury and may result in death.
- The product must be installed in the electric box when used, and all protective measures have been activated.
- In the event of maintenance, repair and cleaning work and prolonged service interruption, the power supply of electrical equipment should be turned off by the power switch before contact with live parts and prevent it from being turned on again.
- During installation, avoid any foreign matter entering the servo drive. Electrically conductive foreign matter such as screws, metal chips or combustible foreign matter entering the servo drive may cause fire and electric shock.
- Please do not use damaged or damaged servo drives and servo motors.
- The motor power cord and encoder cable of the driver should be fixed and not overextended.
- The servo driver must be well grounded.

**2.2.2 Motor mechanical dimensions**

| SMK60 series model     | With brake | Overall dimension (mm) |
|------------------------|------------|------------------------|
| SMK60S-0020-30SAK-5DSA |            | 66.5±1.5               |
| SMK60S-0020-30SBK-5DSA | √          | 98±1.5                 |
| SMK60S-0040-30SAK-5DSA |            | 89±1.5                 |
| SMK60S-0040-30SBK-5DSA | √          | 116±1.5                |



| SMK80 series model     | With brake | Overall dimension<br>(mm) |
|------------------------|------------|---------------------------|
| SMK80S-0075-30SAK-5DKA |            | 100.5±1                   |
| SMK80S-0075-30SBK-5DKA | √          | 134.5±1                   |
| SMK80S-0100-30SAK-5DKA |            | 112.5±1                   |
| SMK80S-0100-30SBK-5DKA | √          | 146.5±1                   |

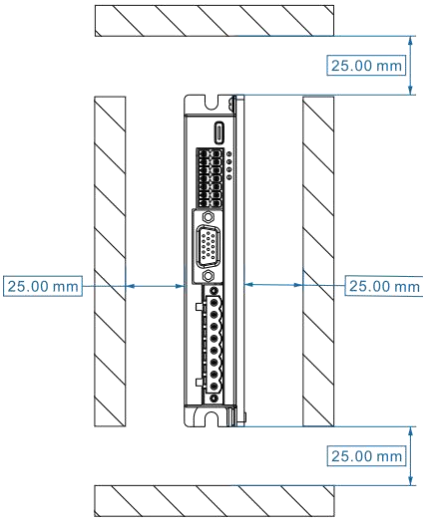
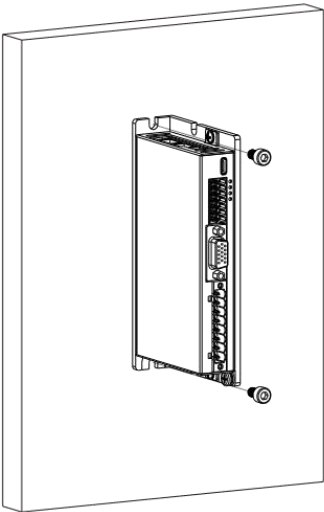
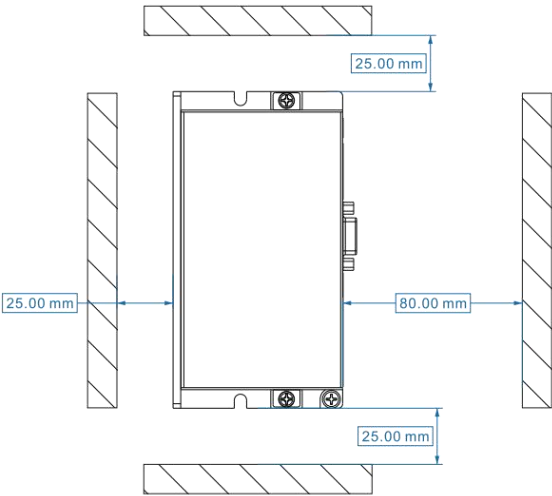
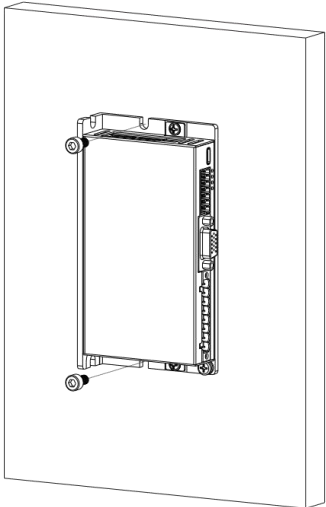
### 2.3 Driver installation spacing and auxiliary heat dissipation

### 2.3.1 FD1X5 series driver installation spacing

There are two ways to install the servo drive of the FD1X5 series: vertical installation or horizontal installation, and the hole should be drilled according to the hole position for fixation in the product size drawing.

When the driver is installed vertically, a gap of 25mm should be reserved between the driver and the wall/cabinet. When the driver is horizontally installed, leave a gap of 25mm between the sides without network ports and the wall/cabinet surfaces, and 80mm between the side with network ports and the wall/cabinet surfaces. The spacing and installation methods are as follows

Table 2-1 FD1X5 drive installation spacing and method

| Installation spacing                                                                | Installation method                                                                  |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Vertical installation                                                               |                                                                                      |
|    |    |
| Horizontal installation                                                             |                                                                                      |
|  |  |

2.3.2 Auxiliary heat dissipation description

The output currents for the FD125, FD135 and FD145 are 15Arms, 30Arms and 50Arms respectively. These values were measured with the driver mounted on a 300mm\*300mm\*10mm (L\*W\*H) black oxide 6063 aluminum plate auxiliary heatsink.

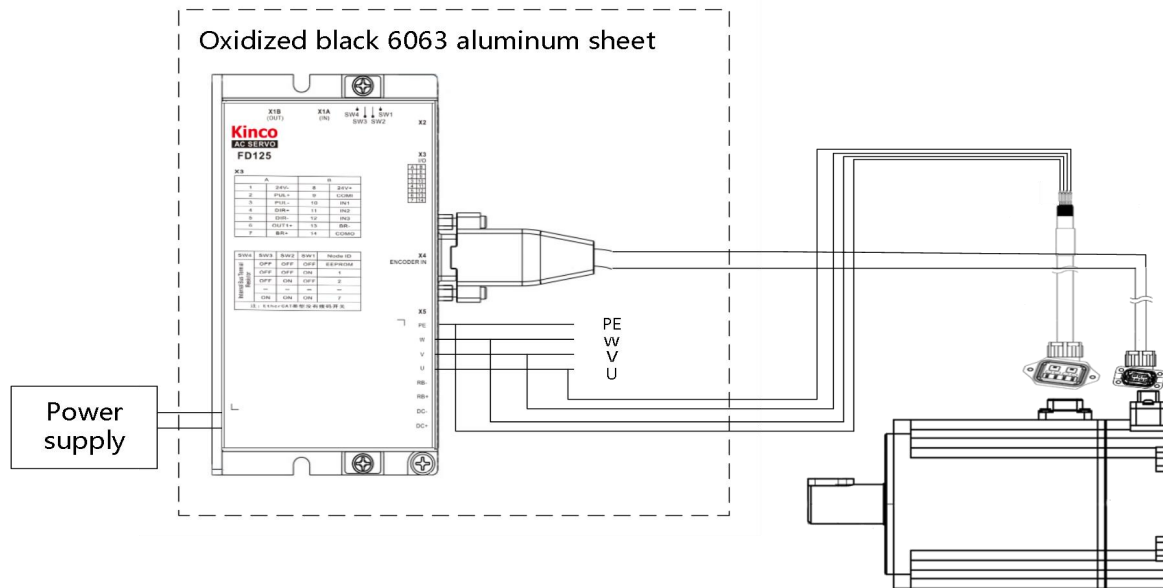


Figure 2-1 Auxiliary heat dissipation installation diagram

## Chapter 3 System interface and wiring

### 3.1 FD1X5 series system interface and wiring

#### 3.1.1 Part name

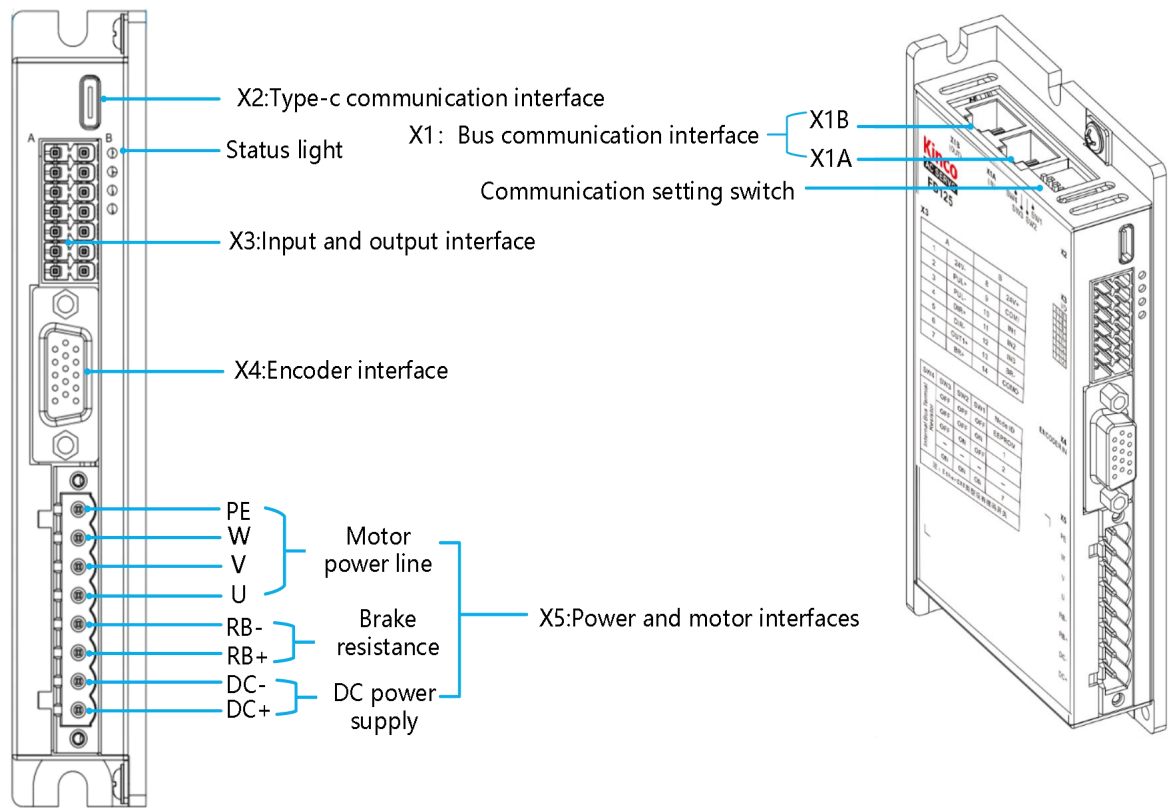


Figure 3-1 FD1X5 series part name

Table 3-1 status light Description

|                    |             |                                                                                                                 |
|--------------------|-------------|-----------------------------------------------------------------------------------------------------------------|
| From top to bottom | ERR (Red)   | When the driver reports an error, it is in the steady state and is associated with the OUT4 port                |
|                    | RUN (Green) | When the drive is ready, it is in the steady state and associated with the OUT3 port                            |
|                    | PWR (Green) | The drive is powered on and the POWER indicator is steady on                                                    |
|                    | BUS (Green) | When packets are transmitted on the CAN bus, the blinking frequency is related to the packet transmission speed |

Table 3-2 DIP switch description (Only applicable to FD1X5-AB/AU-000)

|         |                                                                                                  |
|---------|--------------------------------------------------------------------------------------------------|
| SW1~SW3 | They are used to set the drive ID. When SW1 to SW3 are OFF, the drive reads the ID in the EEPROM |
| SW4     | Turn on or off the driver built-in terminal resistor                                             |

3.1.2 External wiring diagram

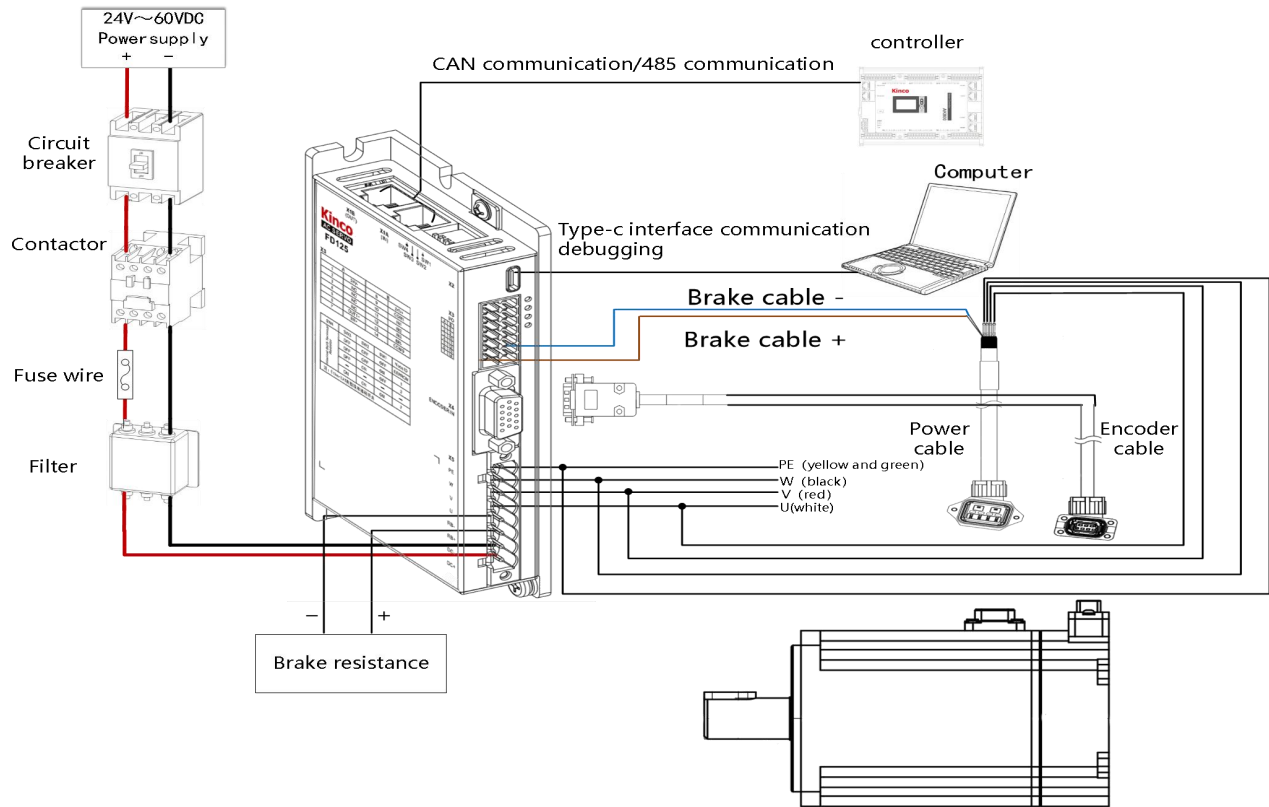


Figure 3-2 FD1X5 series external wiring diagram

3.1.2.1 Brake resistance selection

The energy generated by the servo motor in the braking state will be fed back to the DC bus of the driver. When the voltage of the DC bus exceeds the protection range, the driver will report that the bus voltage is too high and the excess energy needs to be absorbed by an external brake resistor. When the external brake resistance is used, the brake resistance resistance value and brake resistance power can be set at the driver end, and the driver will turn on the brake resistance overtemperature protection function according to the set resistance value and power. It should be noted that the resistance value of the optional external brake resistor cannot be lower than the recommended resistance value.

Table 3-3 Recommended specifications for braking resistor

| Driver type | Minimum resistance of brake resistance [Ω] | Brake resistance power [W] | Brake resistance voltage [VDC] (minimum value) |
|-------------|--------------------------------------------|----------------------------|------------------------------------------------|
| FD125       | 10                                         | 100                        | 500                                            |
| FD135       | 5                                          | 100                        | 500                                            |
| FD145       | 3.5                                        | 200                        | 500                                            |

Table 3-4 Brake resistance parameters

| Address  | Name                              | Bits       | Modbus address | Command Type | Unit | Description                                                                                                                                                                                       |
|----------|-----------------------------------|------------|----------------|--------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 60F70110 | Brake resistance resistance value | Unsigned16 | 0x6010         | RW           | Ω    | You can enter the resistance value and power of the external brake resistance. The default value is 0, indicating that the external brake resistance power and temperature detection are disabled |
| 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**  
●The chopper voltage setting must be greater than the actual input voltage of the driver, otherwise it will cause brake resistance or drive damage.

3.1.3 Cable Description

The FD1X5 series driver comes with two cables: power cable and encoder cable. For a motor with a brake, the power cable also contains two brake cables. For ordinary or standard cables, the bending radius must be greater than 5 x OD mm (OD indicates the outer diameter of the cable). For flexible cable, the bending radius can be fixed or moved. The bending radius must be greater than 5 x OD mm for fixed installation and greater than 10 x OD mm for mobile installation. Power cable and encoder cable specifications are as follows.

1. Encoder cable

Table 3-5 Encoder cable type

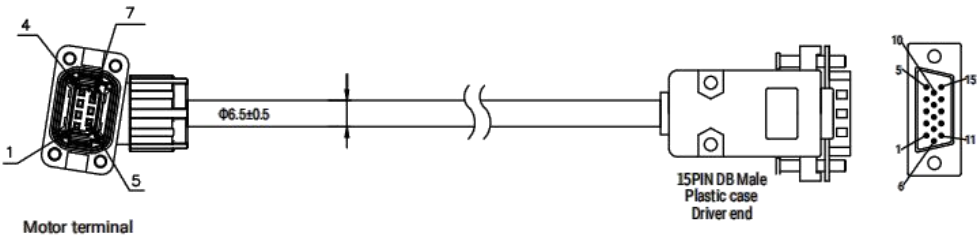
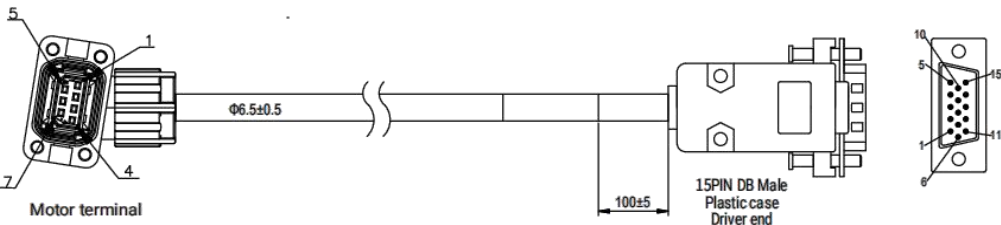
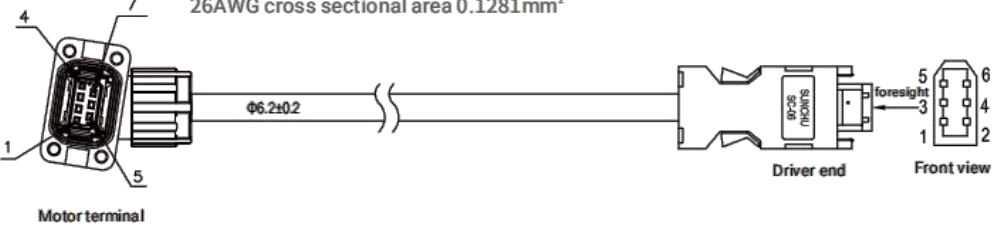
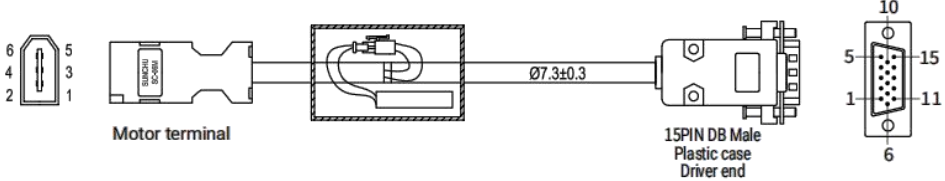
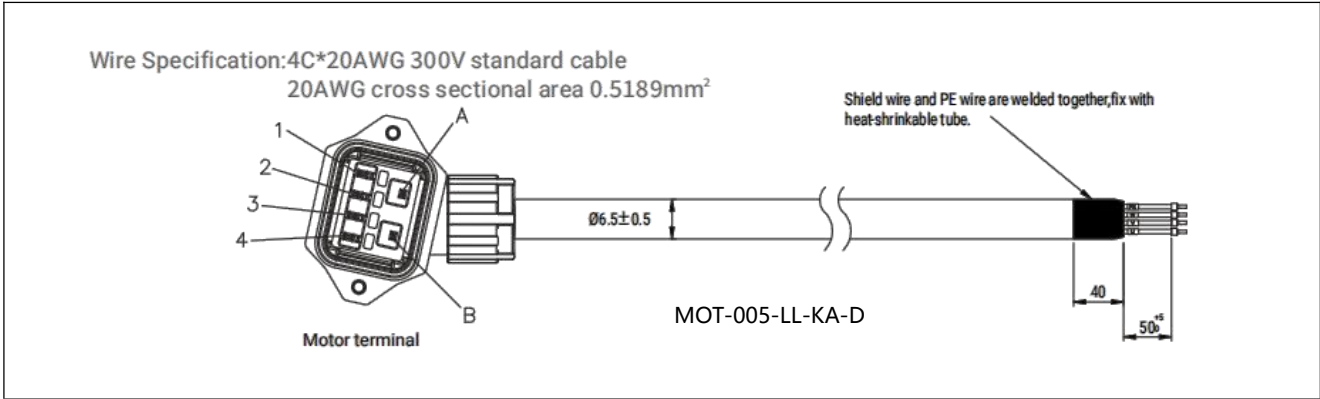
| Encoder cable (ENCHG-LL-GA,ENCHG-LL-GA-F,ENCDG-LL-GA,ENCHG-(4)-GU-DC)                                                                                                                                                                                                   |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <div>Wire Specification: 1P*22AWG+2P*26AWG standard cable<br/>22AWG cross sectional area 0.3247mm<sup>2</sup><br/>26AWG cross sectional area 0.1281mm<sup>2</sup></div> <div></div>  |  |
| <div>Wire Specification: 1P*22AWG+2P*26AWG standard cable<br/>22AWG cross sectional area 0.3247mm<sup>2</sup><br/>26AWG cross sectional area 0.1281mm<sup>2</sup></div> <div></div> |  |
| <div>Wire Specification: 1P22AWG+2P26AWG standard cable<br/>22AWG cross sectional area 0.3247mm<sup>2</sup><br/>26AWG cross sectional area 0.1281mm<sup>2</sup></div> <div></div>   |  |
| <div>Wire Specification: 3×2×0.2mm<sup>2</sup></div> <div></div>                                                                                                                    |  |

Table 3-6 Encoder cable port connection description

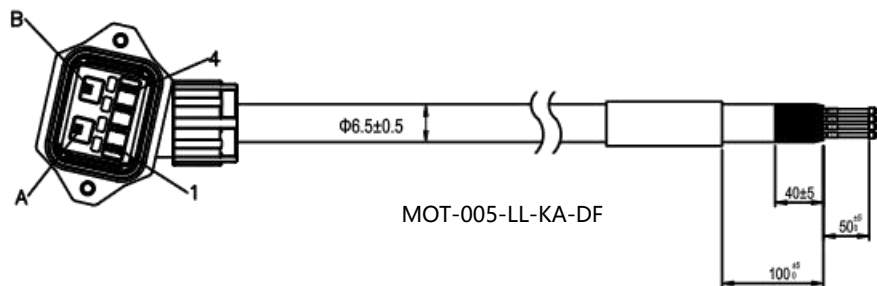
| ENCHG/ENCHGF-LL-GA , ENCHG-LL-GA-F |                |           |                      |            |            |
|------------------------------------|----------------|-----------|----------------------|------------|------------|
| Motor end                          | Cable color    | Signal    |                      | Driver end |            |
| PIN1                               | Red            | +5V       |                      | PIN1       |            |
| PIN2                               | Orange         | GND       |                      | PIN2       |            |
| PIN3                               | /              | /         |                      | /          |            |
| PIN4                               | /              | /         |                      | /          |            |
| PIN5                               | Blue           | SD+       |                      | PIN9       |            |
| PIN6                               | Purple         | SD-       |                      | PIN14      |            |
| PIN7                               | Shielded cable | Shielded  |                      | Shell      |            |
| ENCDBG/ENCDBGF-LL-GA               |                |           |                      |            |            |
| Motor end                          | Cable color    | Signal 1  | Signal 2             | Driver end |            |
| PIN1                               | Red            | +5V       | +5V                  | PIN1       |            |
| PIN2                               | Orange         | GND       | GND                  | PIN2       |            |
| PIN3                               | Brown          | MA_P+     | /                    | PIN3       |            |
| PIN4                               | Black          | MA_N      | /                    | PIN4       |            |
| PIN5                               | Blue           | SLO_P+    | SD+                  | PIN5       |            |
| PIN6                               | Purple         | SLO_N-    | SD-                  | PIN6       |            |
| PIN7                               | Shielded cable | Shielded  | Shielded             | Shell      |            |
| ENCHG-(4)-GU-DC                    |                |           |                      |            |            |
| Motor end                          | Color          | Black HSG | External single line | Signal     | Driver end |
| PIN1                               | Red            | /         | /                    | +5V        | PIN1       |
| PIN2                               | Black          | /         | /                    | GND        | PIN2       |
| PIN3                               | Brown          | PIN1      | Red                  | VB+        | /          |
| PIN4                               | Blue           | PIN2      | Black                | VB-        | /          |
| PIN5                               | Yellow         | /         | /                    | SD+        | PIN9       |
| PIN6                               | Green          | /         | /                    | SD-        | PIN14      |
| Outer shell                        | Shielded cable | /         | /                    | Shielded   | Shell      |

2. Power cable

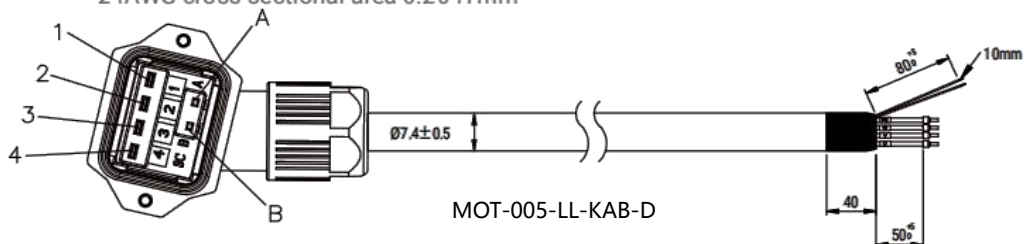
Table 3-7 Power cable types



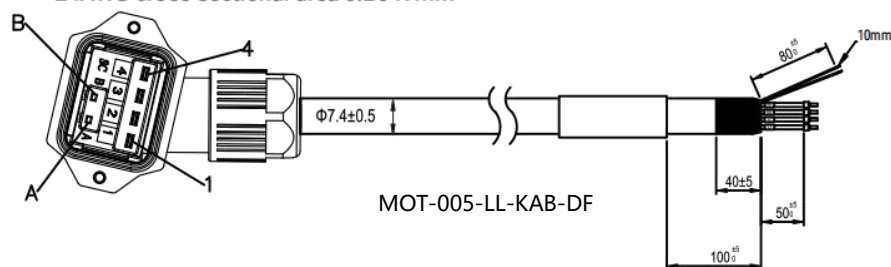
Wire Specification: 4C\*20AWG 300V standard cable  
20AWG cross sectional area 0.5189mm<sup>2</sup>



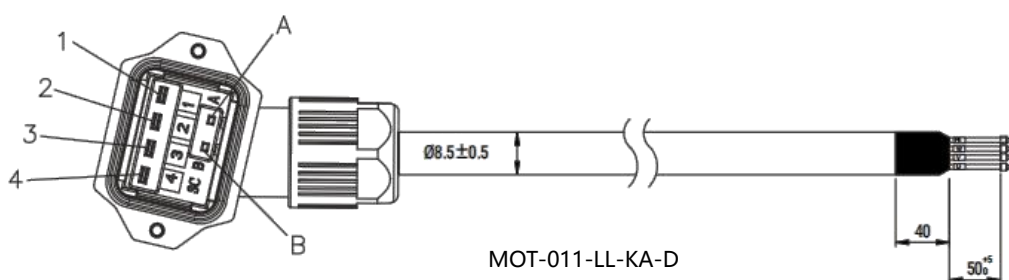
Wire Specification: 4C\*18AWG+1P\*24AWG standard cable  
18AWG cross sectional area 0.8107mm<sup>2</sup>  
24AWG cross sectional area 0.2047mm<sup>2</sup>



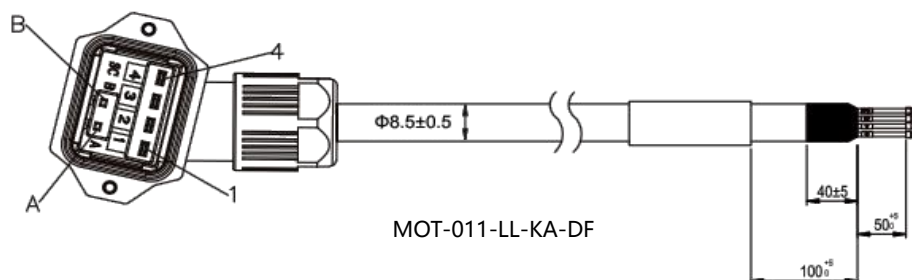
Wire Specification: 4C\*18AWG+1P\*24AWG standard cable  
18AWG cross sectional area 0.8107mm<sup>2</sup>  
24AWG cross sectional area 0.2047mm<sup>2</sup>



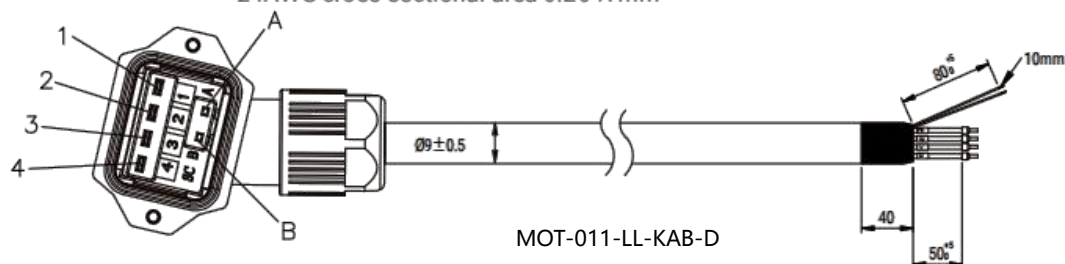
Wire Specification: 4C\*16AWG 300V standard cable  
16AWG cross sectional area 1.318mm<sup>2</sup>



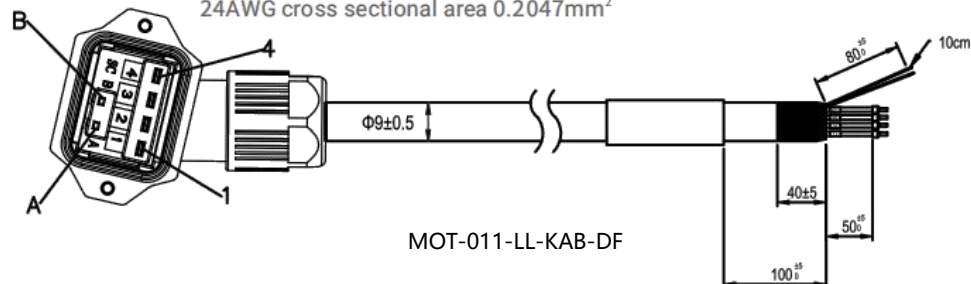
Wire Specification: 4C\*16AWG 300V standard cable  
16AWG cross sectional area 1.318mm<sup>2</sup>



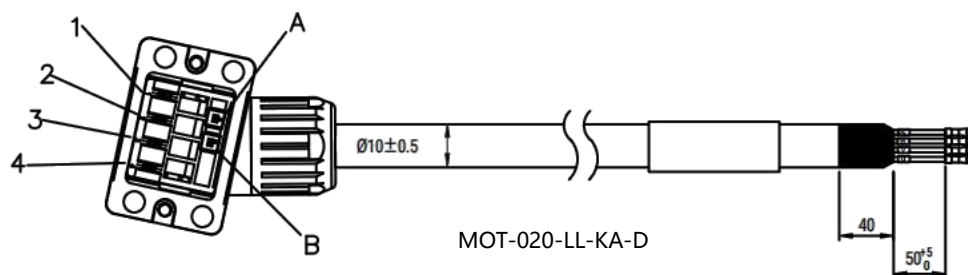
Wire Specification: 4C\*16AWG+1P\*24AWG standard cable  
 16AWG cross sectional area  $1.318\text{mm}^2$   
 24AWG cross sectional area  $0.2047\text{mm}^2$



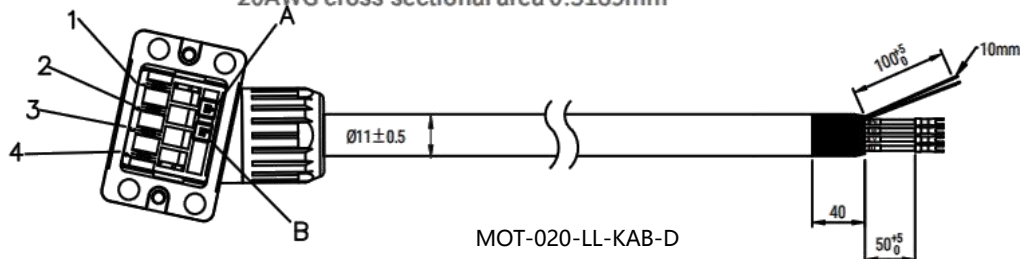
Wire Specification: 4C\*16AWG+1P\*24AWG standard cable  
 16AWG cross sectional area  $1.318\text{mm}^2$   
 24AWG cross sectional area  $0.2047\text{mm}^2$



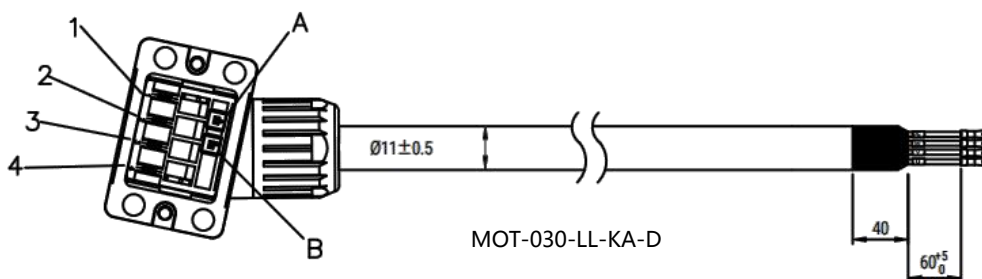
Wire Specification: 4\*13AWG standard cable  
 13AWG cross sectional area  $2.627\text{mm}^2$



Wire Specification: 4C\*13AWG+1P\*20AWG standard cable  
 13AWG cross sectional area  $2.627\text{mm}^2$   
 20AWG cross sectional area  $0.5189\text{mm}^2$



Wire Specification: 4\*12AWG standard cable  
 12AWG cross sectional area  $3.332\text{mm}^2$



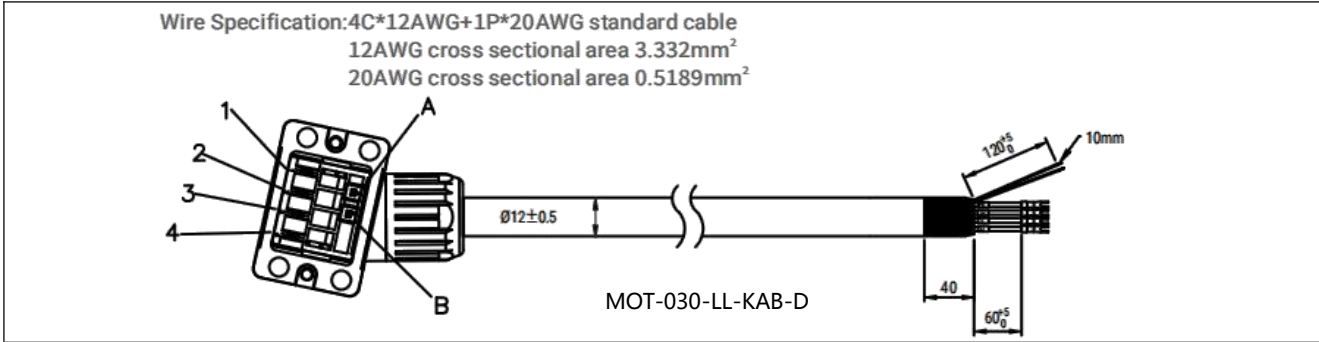
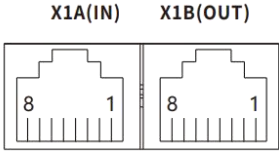


Table 3-8 Power cable port wiring description

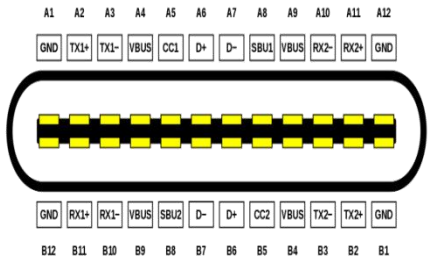
| Pin  | Cable color               | Signal           |
|------|---------------------------|------------------|
| PIN1 | White                     | U                |
| PIN2 | Black                     | W                |
| PIN3 | Red                       | V                |
| PIN4 | Yellow and green+shielded | PE               |
| PINA | Brown                     | BR+ (with brake) |
| PINB | Blue                      | BR- (with brake) |

3.1.4 Driver Interface Terminal Description

3.1.4.1 Bus Communication Interface (X1)

| <br>5JA-1X2-8P8C-S | Pin | RS485/Modbus | CAN     | EtherCAT |
|-------------------------------------------------------------------------------------------------------|-----|--------------|---------|----------|
|                                                                                                       | 1   | -            | CAN_H   | TD+      |
|                                                                                                       | 2   | -            | CAN_L   | TD-      |
|                                                                                                       | 3   | -            | GND_CAN | RD+      |
|                                                                                                       | 4   | 485B         | -       | -        |
|                                                                                                       | 5   | 485A         | -       | -        |
|                                                                                                       | 6   | -            | -       | RD-      |
|                                                                                                       | 7   | -            | -       | -        |

3.1.4.2 Communication Debugging Interface (X2)

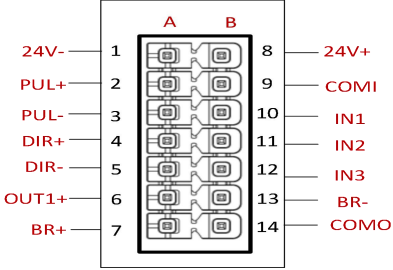
|  | Pin    | Signal |
|-------------------------------------------------------------------------------------|--------|--------|
|                                                                                     | A1&B12 | GND    |
|                                                                                     | A6&B6  | USBDP  |
|                                                                                     | A7&B7  | USBDN  |
|                                                                                     | A4&B9  | +5V    |



Note

- FD1X5 series driver use the Type-C communication interface to connect and debug the PC end. Users can buy the charging cable of the fast charging Type-C connector online. It should be noted that some cables may have GND and PE short connection, which will affect the communication stability. You need to use the usb isolator cable to connect the two ends. The isolator cable purchase link is as follows:  
[https://m.tb.cn/h.gcovkrNnIaapcxJ?sm=244100?tk=QSa3WGq8vF3\\_CZ3458](https://m.tb.cn/h.gcovkrNnIaapcxJ?sm=244100?tk=QSa3WGq8vF3_CZ3458)

### 3.1.4.3 Digital Signal Input/Output Interface (X3)

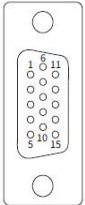
|  <p>F8CR-THR-3.5-14P-A-L28</p> | Pin | Pin name | Pin specification                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------|-----|----------|-------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                 | 8   | 24V+     | The logical power input is positive<br>Input voltage: 24V, rated input current: 1A                                      |
|                                                                                                                 | 1   | 24V-     | The logical power input is negative<br>Input voltage: 24V, rated input current: 1A                                      |
|                                                                                                                 | 2   | PUL+     | Input voltage: 3.3V~24V<br>Maximum input frequency: 500KHz                                                              |
|                                                                                                                 | 3   | PUL -    |                                                                                                                         |
|                                                                                                                 | 4   | DIR+     |                                                                                                                         |
|                                                                                                                 | 5   | DIR-     | Digital signal output<br>OUT1 is an open-collector output with a maximum voltage of 30V and a driving capacity of 100mA |
|                                                                                                                 | 6   | OUT1+    |                                                                                                                         |
|                                                                                                                 | 14  | COMO     | Output common terminal                                                                                                  |
|                                                                                                                 | 7   | BR+      | Brake output terminal                                                                                                   |
|                                                                                                                 | 13  | BR-      | The brake output current of FD125, FD135 and FD145 are 0.5A, 0.8A and 1A respectively.                                  |
|                                                                                                                 | 9   | COMI     | Input common terminal                                                                                                   |
|                                                                                                                 | 10  | IN1      | Digital signal input<br>High level: 12.5-30VDC; Low level: 0-5VDC;<br>Maximum frequency: 1KHz; Input impedance: 5KΩ.    |
|                                                                                                                 | 11  | IN2      |                                                                                                                         |
|                                                                                                                 | 12  | IN3      |                                                                                                                         |



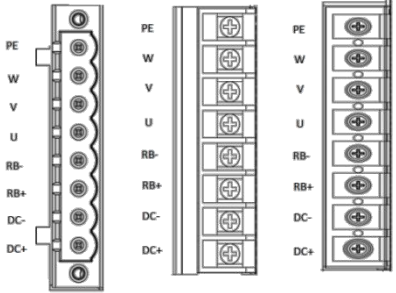
#### Note

- FD1X5 series drives do not support dual pulse mode!

### 3.1.4.4 Encoder Interface (X4)

|  <p>15PIN DB Female</p> | Pin | Magnetoelectric photoelectric encoder signal<br>(Supporting the Tamagawa Agreement) | Pin specification              |
|------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------|--------------------------------|
|                                                                                                            | 1   | +5V                                                                                 | 5V supply voltage              |
|                                                                                                            | 2   | GND                                                                                 | Encoder signal ground terminal |
|                                                                                                            | 3   | PTC_IN                                                                              | Motor temperature detection    |
|                                                                                                            | 9   | ENC_A                                                                               | Encoder signal input           |
|                                                                                                            | 14  | ENC_B                                                                               |                                |

### 3.1.4.5 Power and Motor Ports (X5)

|  <p>FD125      FD135      FD145</p> | Pin | Pin specification                                           |
|------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------|
|                                                                                                                        | PE  | Servo motor power supply output end and motor grounding end |
|                                                                                                                        | W   |                                                             |
|                                                                                                                        | V   |                                                             |
|                                                                                                                        | U   |                                                             |
|                                                                                                                        | RB- | External brake resistance input                             |
|                                                                                                                        | RB+ |                                                             |
|                                                                                                                        | DC- | Drive power input                                           |
|                                                                                                                        | DC+ |                                                             |

X5 Interface terminal model:

FD125: F8A-8-5.0-08P-A    FD135: BRTB950-02-08-R3    FD145: BRTB130-00-08-50A

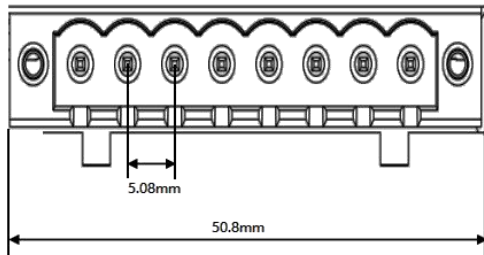
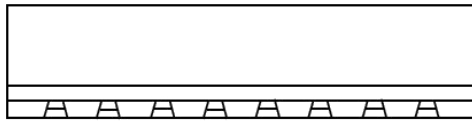
X5 Interface terminal size

Figure 3-3 FD125 driver X5 interface dimension

Screw: M3.5 nickel-plated

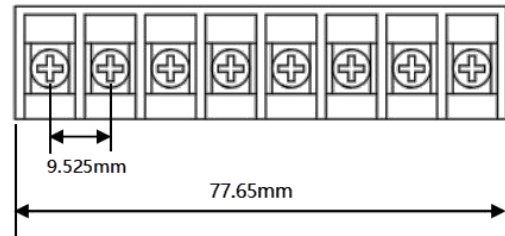
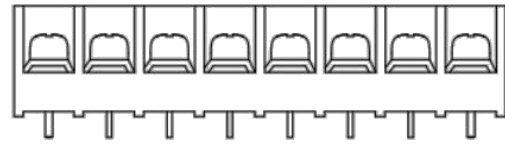


Figure 3-4 FD135 driver X5 interface dimension

Screw: M4 nickel-plated

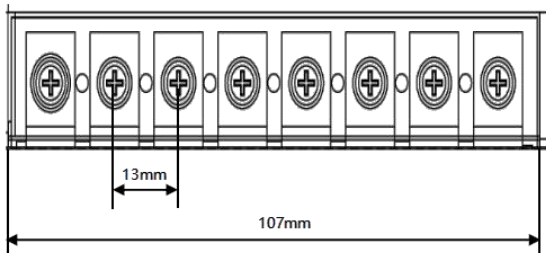


Figure 3-5 FD145 driver X5 interface dimension

**Note**

- The X5 interface of the FD125 drive needs to be connected to a terminal block before it can be used. The terminal model is F6AM-5.08-08P-1-A, and the screw tightening torque is 0.5 N.m ~ 0.6 N.m
- The maximum screw tightening torque for the X5 interface terminal of FD135 drive is 10 N.m; The maximum screw tightening torque for the X5 interface terminal of FD145 drive is 13 N.m

3.1.5 Driver electrical wiring

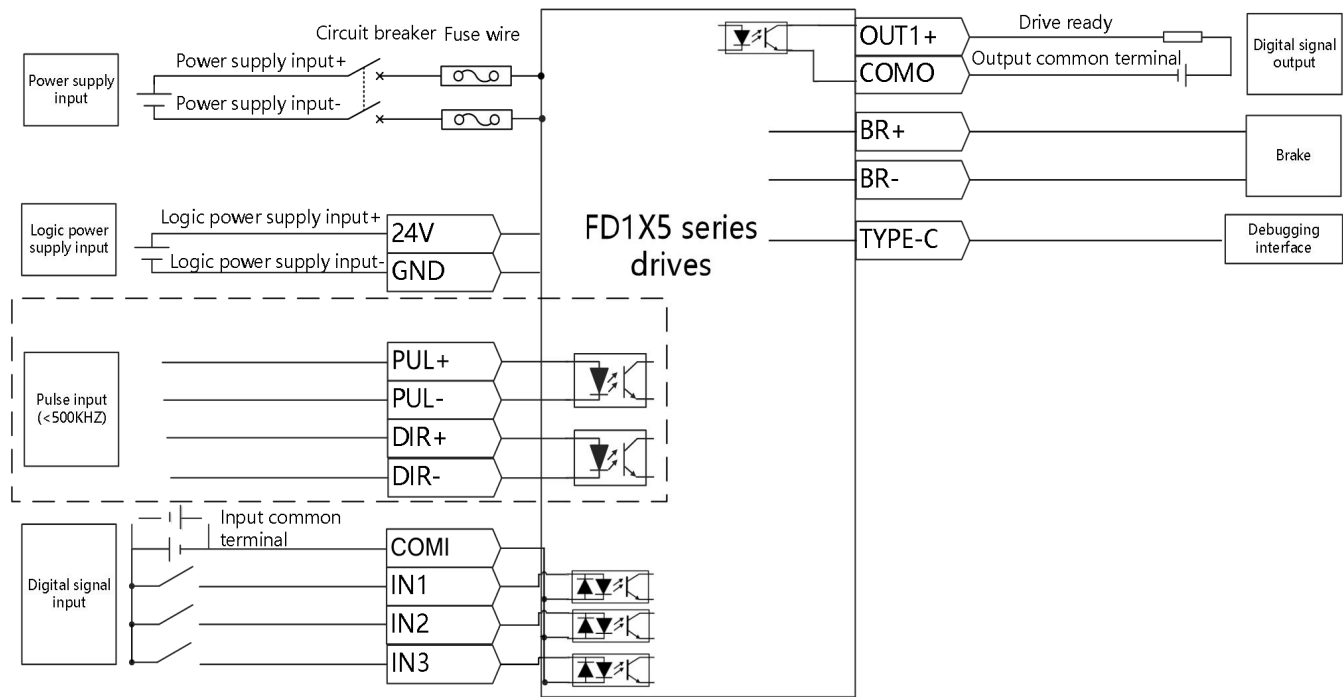


Figure 3-6 FD1X5 series drivers electrical wiring diagram



- Note**
- Figure 3-6 shows the wiring of the FD1X5 series driver with the default IO function. More IO functions can be defined by the upper computer software.
  - For the digital input and output signals, the wiring mode with the host computer is shown in the following table.

Table 3-9 Example of digital input and output signal wiring

| Digital signal input wiring                 |                                                                                                                               |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Description                                 | Digital input port high level input voltage range: 12.5-30VDC; Low input voltage range: 0-5VDC; Maximum input frequency: 1KHz |
| The upper computer is relay output          |                                                                                                                               |
| The upper computer is open collector output | <br>NPN                                                                                                                       |
|                                             | <br>PNP                                                                                                                       |

| Digital signal output wiring            |                                                                                            |
|-----------------------------------------|--------------------------------------------------------------------------------------------|
| Description                             | OUT1 is an open collector output, maximum voltage is 30V and the driving capacity is 100mA |
| The upper computer is relay input       |                                                                                            |
| The upper computer is optocoupler input |                                                                                            |
|                                         |                                                                                            |

3.1.6 Brake connection

3.1.6.1 Internal brake connection

Table 3-10 Example of brake wiring

|                             |                                                                                                                                                                                                                                                                |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description                 | 1.By default, pin 7 and pin 13 of the driver IO terminal are the output signals of the motor brake, which can be directly driven by OUT5 through the upper computer simulation<br>2.Thebrake coil of the motor has no polarity and is not positive or negative |
| Example of brake connection |                                                                                                                                                                                                                                                                |

➔

**Note**

- The motor brake does not need external 24V power supply. You can simulate the OUT5 drive lock device by connecting to the host computer. For details, see **section 5.7.2**.
- When the connected brake motor is a magnetoelectric encoder, the connection of the brake needs to distinguish positive and negative polarity to avoid the impact of wrong polarity on the accuracy of the motor encoder (brown positive electrode, blue negative electrode).

## 3.2 External installation instructions

Table 3-11 External system installation description

| Electrical equipment | Effect                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MCCB                 | When there is overcurrent, short circuit or undervoltage, the circuit breaker automatically cuts off the power supply, thereby protecting the line and driver equipment from damage. Note that the circuit breaker matching the driver should be selected to effectively protect the drive device.<br>To prevent accidental electric shock, please use circuit breakers with overload protection, short circuit protection and leakage protection. |
| NF                   | Effectively filter out the external interference, improve the anti-interference ability of the power supply circuit.                                                                                                                                                                                                                                                                                                                               |
| MC                   | The use of air type AC electromagnetic contactor is used to switch off the power supply, while installing the electromagnetic contactor manufacturer recommended surge suppressor can effectively prevent reverse electromotive force.                                                                                                                                                                                                             |
| CHARGE               | Charging indicator light, due to the charging capacitor in the internal circuit of the driver, the charging indicator light will not be extinguished immediately after the power is cut off. Make sure that the charging indicator is off or the measured DC bus voltage of the driver is lower than 36V before touching the power terminal.                                                                                                       |

Table 3-12 Recommended circuit breaker model

| Servo driver model | Recommended circuit breaker |               |                     |
|--------------------|-----------------------------|---------------|---------------------|
|                    | Model                       | Specification | Manufacture factory |
| FD1X5 series       | NB1G-63                     | AC230V,63A    | CHNT                |

Table 3-13 Recommended noise filter model

| Servo driver model |       | Recommended noise filter |                                        |                     |
|--------------------|-------|--------------------------|----------------------------------------|---------------------|
|                    |       | Model                    | Specification                          | Manufacture factory |
| FD1X5 series       | FD125 | TY440S-16FT              | Single phase direct/AC 120/250VAC, 16A | Tyze                |
|                    | FD135 | QMN30M4-S                | Single phase DC/AC 120/250VAC, 30A     | QIMAI               |
|                    | FD145 | QMN50M4-S                | Single phase DC/AC 120/250VAC, 50A     | QIMAI               |

Table 3-14 Recommended contactor model

| Servo driver model | Recommended contactor |               |                     | Note                                                                                  |
|--------------------|-----------------------|---------------|---------------------|---------------------------------------------------------------------------------------|
|                    | Contactor model       | Specification | Manufacture factory |                                                                                       |
| FD1X5 series       | TGC1-6511             | AC220V,65A    | TENGEN              | The user chooses the working voltage of the contactor coil according to the field use |

Table 3-15 Recommended fuse

| Servo driver model |       | Recommended fuse |                   |                     |
|--------------------|-------|------------------|-------------------|---------------------|
|                    |       | Specification    | Rated current (A) | Manufacture factory |
| FD1X5 series       | FD125 | ANL35A80VDCM8    | 35                | Vicfuse             |
|                    | FD135 | ANL60A80VDCM8    | 60                |                     |
|                    | FD145 | ANL150A80VDCM8   | 150               |                     |



### 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 **3.1.2.1**.
- Do not connect the power cable to the UVW end, and do not connect the external brake resistor to the DC+ and DC- ends. Before powering on the driver, check whether the cable connections 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;

### 3.3 EMC Configuration Description

FD1X5 servo drive meet the relevant requirements of EMC certification standards EN 61800-3, EN61000-6-2, 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. Results 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

FD1X5 devices are not directly connected to the mains and meet the requirements of OVC II and PD II use sites.

#### Installing environmental condition

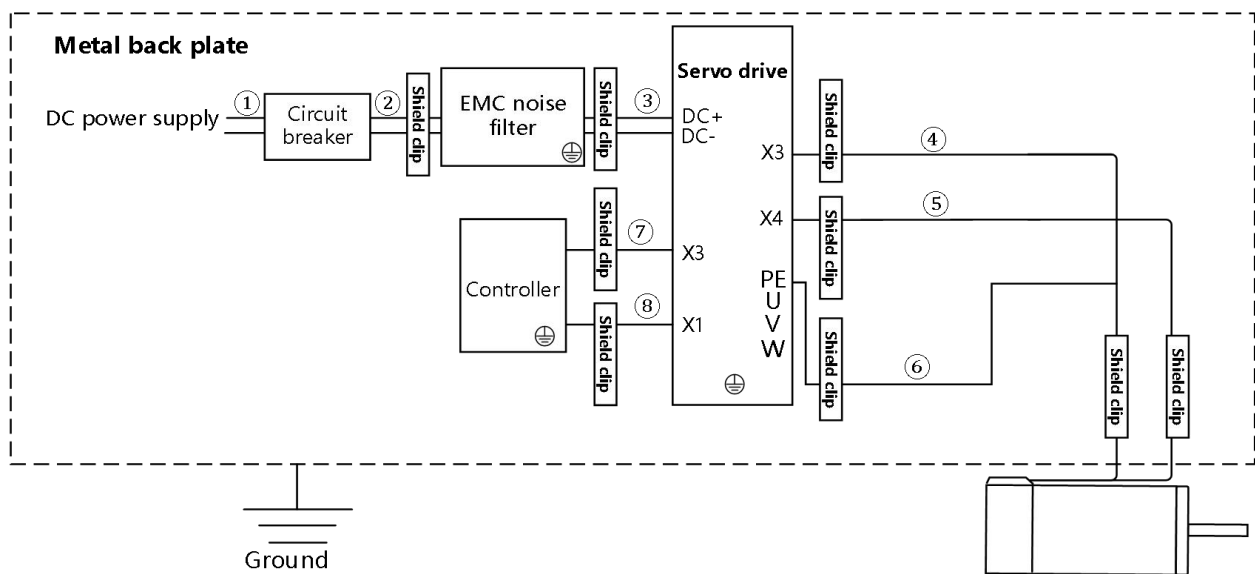


Figure 3-7 FD1X5 series driver installation environment diagram



#### Note :

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

| Serial number | Cable name                | Specification                 |
|---------------|---------------------------|-------------------------------|
| ①②③           | Power cable               | Shielded cable                |
| ④             | Brake cable               | Shielded cable                |
| ⑤             | Encoder cable             | Shielded cable                |
| ⑥             | Power cable               | Shielded cable                |
| ⑦             | Input/Output signal cable | Shielded cable                |
| ⑧             | Communication cable       | Shielded + twisted pair cable |

2. 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) EMC noise filter

- To ensure compliance with EMC standards, install an EMC noise filter at the power input close to the servo drive. For 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 driver should be less than 30cm;
- The driver 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, and it is forbidden to connect PE in series to the ground pile.

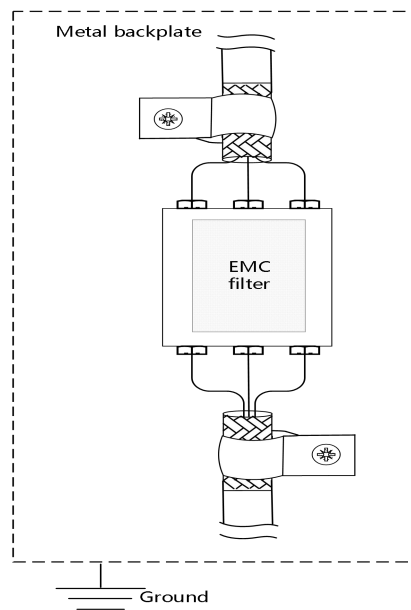


Figure 3-8 EMC noise filter installation diagram

(2) Shielded layer

- Input and output signal cables, power cables, encoder cables and communication cables please use shielded cables.
- The shield of the encoder is clamped to the connector metal housing using metal cables.
- The shielding layer near the driver 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 line 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.

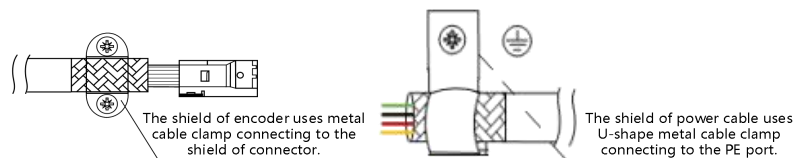


Figure 3-9 FD1X5 driver side power line/encoder line shield layer 1\* processing mode

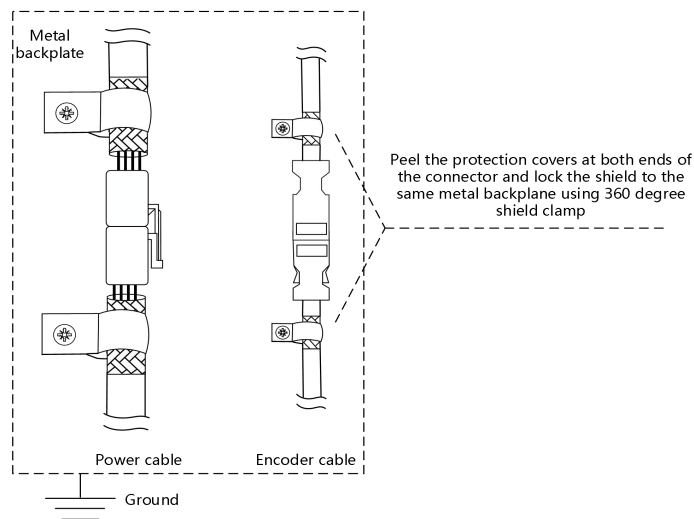


Figure 3-10 FD1X5 connector side power line/encoder line shield layer 2\* processing method

### (3) Grounding

- In order to prevent electric shock, be sure to ground the reactor, noise filter, driver;
- 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 ( $>2\text{mm}^2$ ). If the ground cable is longer, increase the diameter of the ground cable ( $\geq 4\text{mm}^2$ ).

### (4) Magnetic ring

- When the driver and motor are used for wiring and grounding problems, mutual interference with other devices may still occur. In this case, a magnetic ring can be placed on the cable to effectively inhibit interference.
- The preferred choice of ferrite magnetic ring, can suppress higher frequency interference above 1M, the power line is recommended to add RFC-13 magnetic ring (around 2-3 turns), the encoder line and other I/O signal line is recommended to add RFC-10 magnetic ring (around 2-3 turns), the magnetic ring installation position as close as possible to the driver side, the magnetic ring installation distance on the cable should be less than 300mm. The installation diagram is as follows:

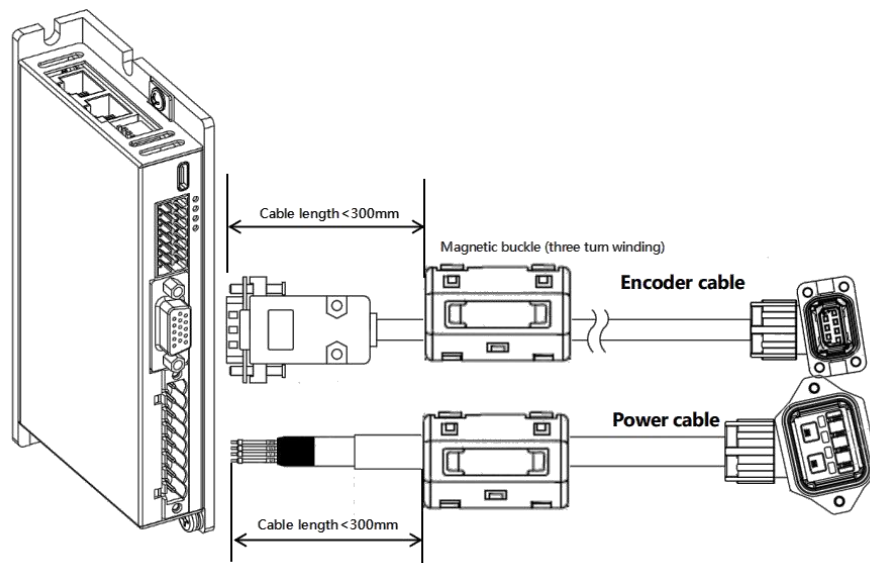


Figure 3-11 Magnetic ring installation diagram

### 3.4 Servo overload protection feature

The driver 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 driver 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.

FD1X5 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 driver or motor IIT failure (fault code: 080.0), driver 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.

| Name                          | CANopen  | Modbus | Type | Data type | Explanation                                           |
|-------------------------------|----------|--------|------|-----------|-------------------------------------------------------|
| Motor IIT actual utilization  | 2FF01010 | 2A00   | RL   | Unsigned8 | The actual load rate of the motor                     |
| Actual drive IIT utilization  | 2FF01110 | 2A01   | RL   | Unsigned8 | The actual load rate of the drive                     |
| Motor temperature alarm point | 64101810 | 7180   | RWSL | Integer16 | The default alarm point for the temperature is 100 °C |

➔

**Note**

When the motor is not connected to the temperature sensor or the temperature sensor is abnormal, the motor temperature will be displayed at -40°C.

### 3.5 Power Supply Description

FD1X5 series drive must use the monotonic power supply shown in Figure 3-12 when powering on. If the non-monotonic power supply shown in Figure 3-13 is used, when the deviation is close to any threshold voltage, the non-monotonic slope may cause problems such as abnormal start of the driver, resulting in an error failure.

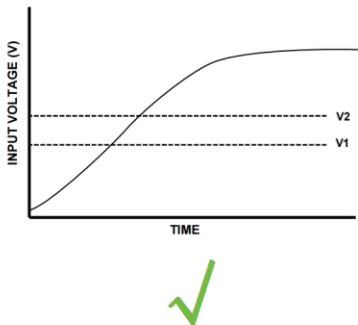


Figure 3-12 Monotonic power supply

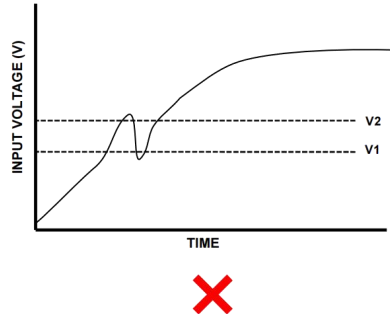


Figure 3-13 Non-monotonic power supply

➔

**Note**

- In figure 3-12 and figure 3-13, V1 indicates 10V voltage, and V2 indicates 17V voltage.
- The driver has an electrolytic capacitor. Ensure that the input power is working properly before powering on the driver.

## Chapter 4 Trial operation

### 4.1 KS3 debugging software description

#### 4.1.1 Overview

The KincoServo3 software installation package can be obtained from kinco official website..

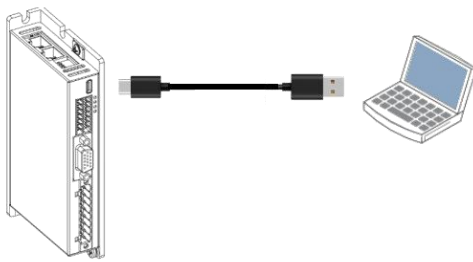
FD1X5 series drivers use KincoServo3 software to connect the computer to the servo drive through 485 port or USB.

#### 4.1.2 Connection

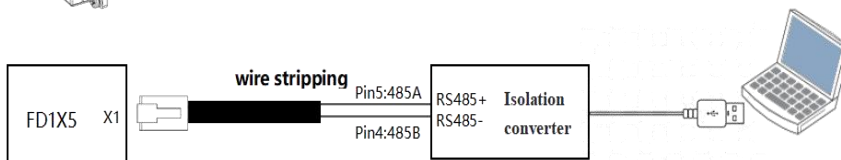
##### 4.1.2.1 Description of the connection between the PC and the drive

###### 485 communication connection

- FD1X5 driver communicates with the PC : Communicate using a USB-type C cable via the X2 port of the drive or via the X1 port with a 232/485 to USB isolation converter.



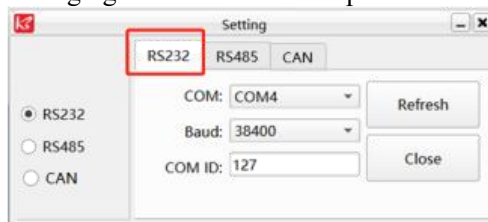
**X2 interface communication**



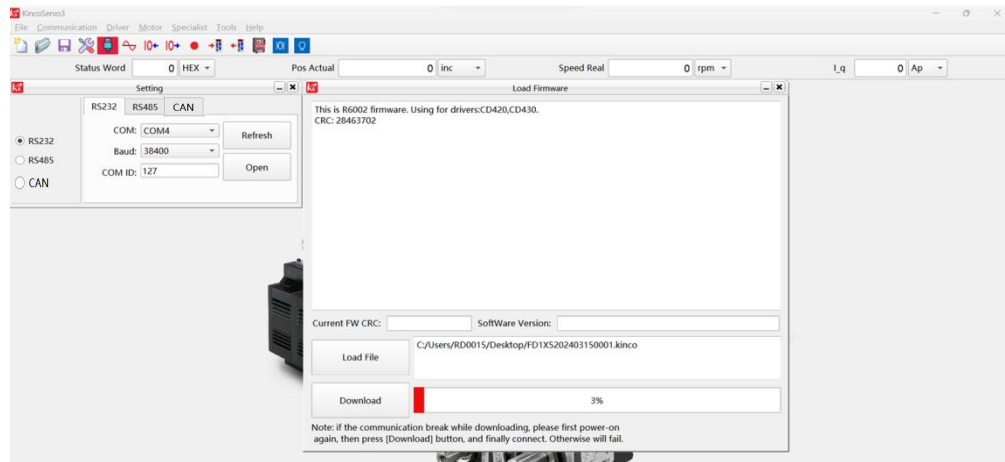
**X1 interface communication**

(1) When using the USB cable to connect to the host computer, note that:

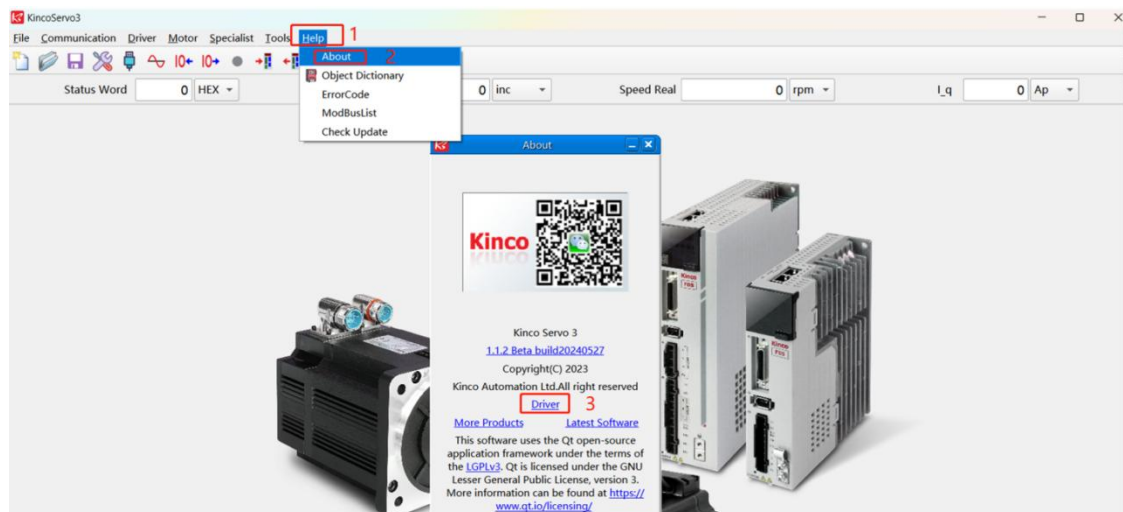
- The RS232 interface is required on the communication settings page. Since the USB interface of the FD1X5 drive uses the 232 communication protocol by default, it can be successfully connected to the host computer without changing the communication protocol through the internal address.



- If only the USB cable is used to communicate with the host computer and there is no power supply outside the drive, the debugging cable suddenly drops during data storage. In this case, the drive will report to EEPROM.
- When using the Type-C interface in the process of updating the firmware, the power suddenly fails, resulting in communication interruption, the phenomenon displayed on the software is as follows, You need to power on the drive, click the download button to enable the serial port communication before updating the firmware again.



- For most users who use XP/Win7/Win10/Win11, the Type-C interface does not require the user to install the driver. If the drive cannot connect to the upper computer after accessing the Type-C interface, the serial port driver used by the Type-C interface may be wrong. Here provides tested and verified Type-C serial port driver, users can download from Baidu Netdisk. The operation is as follows: click "Help" → "About", click "Driver" button in the pop-up interface will jump to the corresponding Baidu Netdisk interface, select FD1X5 special serial port driver folder to download.



(2) When using X1 interface connect to the host computer, note that:

- The default communication protocol of the X1 interface of the FD1X5 driver is MODBUS. You need to change the RS485 communication protocol (modbus address mapping is 0X86C0) to 232 by modbus. Perform the following steps to restart the driver after the operation is complete.

| Step | MODBUS message          | Message specification (ID=1)                                                                 |
|------|-------------------------|----------------------------------------------------------------------------------------------|
| 1    | 01 06 86 C0 00 01 61 7E | 65100C Write 1 , switch to the 232 protocol immediately                                      |
|      | 01 06 86 C0 00 03 E0 BF | 65100C Write 3, switch to the 232 protocol, save the Settings, and take effect after restart |
| 2    | 01 06 29 10 00 01 41 93 | Storage control parameter                                                                    |

Relevant parameter:

| Internal address | Parameter Name                         | Meaning                                                                                                                                                                                 | Default     |
|------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 100B0010         | Equipment station number               | Driver station number                                                                                                                                                                   | 1           |
| 2FE20010         | RS485 baud rate                        | Set the baud rate of the RS485 port (Modbus address: 0X2600)<br>Set value      Baud rate<br>1080———9600<br>540———19200<br>270———38400<br>90———115200<br>Note: Need to save and restart. | 270         |
| 65100C08         | RS485 Communication protocol selection | bit0: 0: Using MODBUS protocol 1: using RS232 communication protocol<br>bit1: 0: Changing bit0 takes effect immediately 1: Changing bit0 takes effect when the storage restarts         | 0           |
| 65100E10         | RS485 mode                             | Data bit =8, stop bit =1, no parity check                                                                                                                                               | Fixed value |

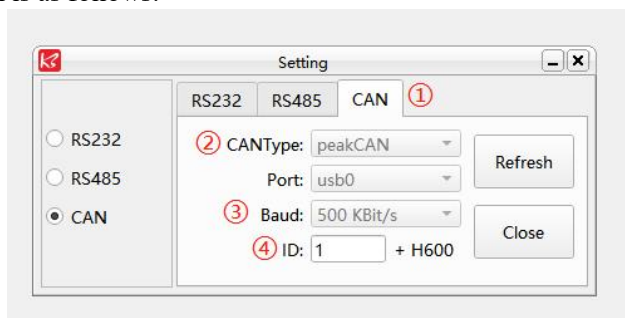


#### Note

Do not move the PC interface when downloading the firmware. Otherwise, the download will fail.

### CAN open communication connection

FD1X5 drive can also communicate with the host computer through the CANopen protocol. Since one CAN bus can mount multiple devices, this function realizes the cascaded debugging of multiple drives. The communication operation is as follows:



(1) Switch to the CAN interface on the Setting page

(2) Select the type of CAN device to be used. Currently, two kinds of CAN devices are supported to connect with the host software:

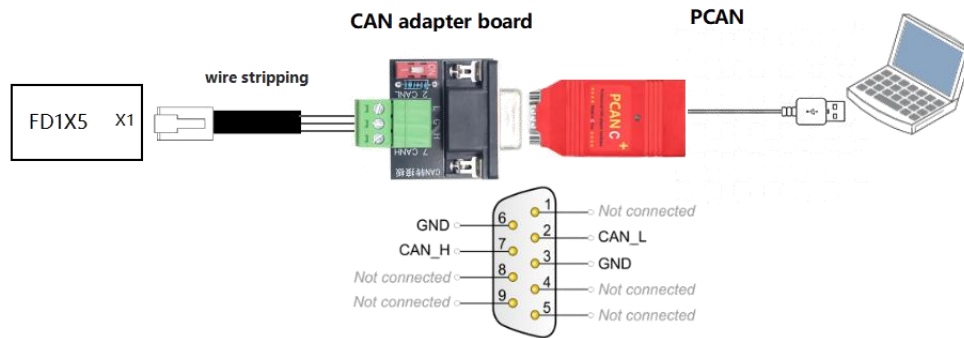
- Peak CAN device** Recommended purchase link is as follows:

a. **【Amazon】**

[https://www.amazon.com/CAN-Adapter-PCAN-USB-Isolation-GC-CAN-USB-ISO/dp/B078VQDR3G/ref=sr\\_1\\_1?crd=P0P8ZG4LDOON&dib=eyJ2IjojMSJ9.cnsyJZ7VFjmrXpKz0K3pvKcQeaNNduR0GI3wMWP0uy8\\_IHbeGgFXk73ql-yfhIZl6j92rVCgMlCm1I7n-IDLb82DHgcDiTg8w0I2-w\\_-5hxs2pi7y1yyoOm\\_f6NJ6\\_](https://www.amazon.com/CAN-Adapter-PCAN-USB-Isolation-GC-CAN-USB-ISO/dp/B078VQDR3G/ref=sr_1_1?crd=P0P8ZG4LDOON&dib=eyJ2IjojMSJ9.cnsyJZ7VFjmrXpKz0K3pvKcQeaNNduR0GI3wMWP0uy8_IHbeGgFXk73ql-yfhIZl6j92rVCgMlCm1I7n-IDLb82DHgcDiTg8w0I2-w_-5hxs2pi7y1yyoOm_f6NJ6_)

### ● ChuangxinCAN

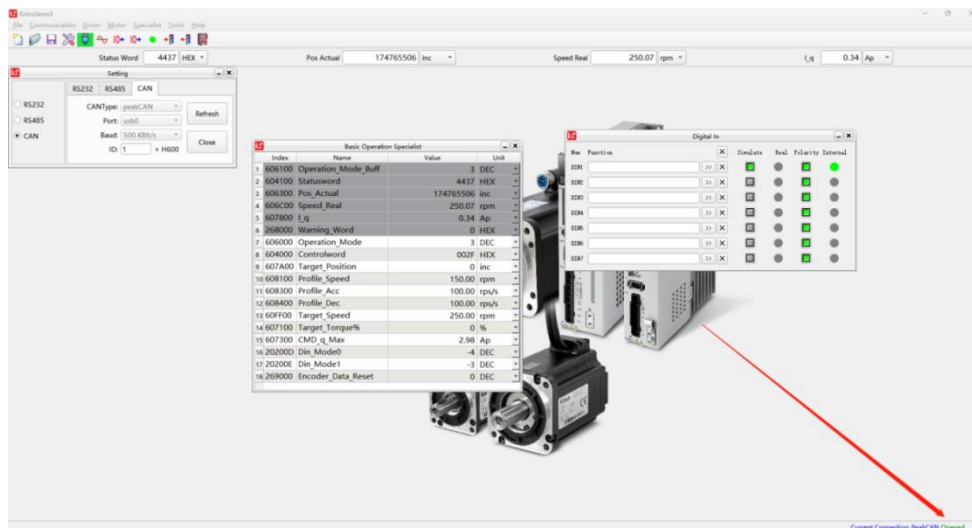
The connection between FD1X5 driver and host computer to realize CAN communication are as follow:



(3) Select the baud rate of CAN communication, the default is 500 KBit/s, and the object dictionary address is 【2F81 00】

(4) Select the device station number, the default is 1, the object dictionary address is 【100B 00】

After following the above steps, click the open button to connect the upper computer. Take the PeakCAN device as an example, the sign after successful connection of CAN communication is shown as follows:



### Note

The following are several situations that may cause the communication failure of the upper computer:

- CAN Type is not set correctly. Currently, only Peak CAN and Chuangxin CAN can be connected to the upper computer
- The baud rate and device station number are not set correctly
- The driver of CAN device is not compatible, here provide tested and verified PeakCAN and Chuangxin drivers, users can download from Baidu Netdisk. The operation is as follows: click **"Help"** → **"About"**, click **"Driver"** button in the pop-up interface will jump to the corresponding Baidu Netdisk interface
- The communication between KS3 and driver adopts CANopen protocol. Therefore, during the communication of the upper computer, do not use other devices (such as PLC or Linux devices) to send CAN messages (such as SDO/PDO messages) to the drive, otherwise the communication of the upper computer will be abnormal or even unable to communicate

### 4.1.2.2 Start KincoServo3

#### 1. Start kincoservo3

- Double click to launch the software



#### 2. Click Communication to open the Setting



- Click Refresh, and select the serial port from the drop-down list.
- Select the baud rate set inside the drive. The default is 38400 for FD1X5.
- Set the device station number of the drive. The default is usually 1 (127 is the universal ID).



#### Note

When the host computer and the driver are not connected, the following points should be noted:

- Determine the quality of the communication cable and check whether the communication connection is correct.
- Check whether the debugging cable is consistent with the serial port connected to the PC.
- Verify that the baud rate selected for communication is the value set internally by the drive.
- Determine whether the station number set for communication is the station number set inside the drive, you can use the universal ID=127 for connection.

### 4.1.3 Debugging Software Function Description

KincoServo3 has the following functions:

- **System monitoring:** monitor the running status of the servo drive, alarm, and detect and save the instantaneous data of the servo operation

Specific functional modules include:

- Oscilloscope function
- Alarm display function
- Status monitoring function

- **Parameter management:**

- Read and download all parameters in the servo drive object dictionary
- Read the previously saved parameter file
- Modify the parameter
- Send the parameter to the drive
- Save the drive parameter to EEPROM
- Restores factory parameter

- **Inertia recognition:** After a series of actions to identify the load inertia can be written to the driver through parameter management
- **Gain adjustment:**
  - The rigidity level and adjustment method of the servo can be adjusted. When adjusting to manual mode, each parameter can be modified
  - The rigidity level can be set. Its main function is to call the rigidity table. Different rigidity levels correspond to the corresponding PID parameters in the rigidity table, and no parameter can be modified

## 4.2 Pre-operation preparation

The following table items need to be checked before running the drive and servo motor.

### 4.2.1 Cable Connection and environment Check

Table 4-1 Check list

| Serial number | Wiring check items                                                                                                                                                  |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1             | The power input terminals (DC+, DC-) of the servo driver must be properly connected                                                                                 |
| 2             | The servo driver output terminals (U, V, and W) and the servo motor power cables (U, V, and W) must be in the same phase and connected correctly.                   |
| 3             | The power input terminals (DC+, DC-) and main loop output terminals (U, V, W) of the servo driver cannot be short-circuited                                         |
| 4             | The control signal cables of the servo driver are correctly connected, and the external signal cables such as lock and over-range protection are reliably connected |
| 5             | The servo drive and servo motor must be reliably grounded                                                                                                           |
| 6             | The stress on all cables is within the specified range                                                                                                              |
| 7             | The distribution terminals have been insulated                                                                                                                      |
| Serial number | Environmental inspection items                                                                                                                                      |
| 1             | There are no foreign objects such as wire heads and metal shavings inside and outside the servo drive that will cause short circuit of signal lines and power lines |
| 2             | The servo drive and external brake resistors are not placed on combustible objects                                                                                  |
| 3             | The installation, shaft and mechanical connection of the servo motor must be reliable                                                                               |
| 4             | The servo motor and the connected machinery must be in operational condition                                                                                        |

### 4.2.2 Motor parameter check

FD1X5 series currently only supports the encoder motor of the Tamagawa protocol, and the relevant parameters can be modified according to the motor parameter table when configuring the motor parameters.

Relevant parameter:

| Internal Address | Bits      | Parameter name                 | Meaning description                                                                                                                                                                     |
|------------------|-----------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3041.06          | Unsigned8 | Use the internal motor library | 1: The user enters the motor model manually and uses the motor parameters corresponding to the motor library in the driver<br>2: Read and use the motor parameters saved in the encoder |

|         |            |             |                                                                                                                                                              |                                 |
|---------|------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 6410.01 | Unsigned16 | Motor model | Motor model                                                                                                                                                  | Corresponding code (Motor code) |
|         |            |             | SMK60S-0020-30SAK/SBK-5DSA                                                                                                                                   | R2                              |
|         |            |             | SMK60S-0040-30SAK/SBK-5DSA                                                                                                                                   | R4                              |
|         |            |             | SMK80S-0075-30SAK/SBK-5DKA                                                                                                                                   | R7                              |
|         |            |             | SMK80S-0100-30SAK/SBK-5DKA                                                                                                                                   | R8                              |
|         |            |             | <b>Note:The above models are SMK single-turn motors, which can be set up using internal motor library 1/ internal motor library 2</b>                        |                                 |
|         |            |             | Motor model                                                                                                                                                  | Corresponding code (Motor code) |
|         |            |             | SMK60S-0020-30QAK/QBK-5DSA                                                                                                                                   | R2                              |
|         |            |             | SMK60S-0040-30QAK/QBK-5DSA                                                                                                                                   | R4                              |
|         |            |             | SMK80S-0075-30QAK/QBK-5DKA                                                                                                                                   | R7                              |
|         |            |             | SMK80S-0100-30QAK/QBK-5DKA                                                                                                                                   | R8                              |
|         |            |             | <b>Note:The above models are SMK multi-turn motors which corresponding motor code remains unchanged,and it must be set up using internal motor library 2</b> |                                 |

→

Note

Please refer to **Section 5.7.5** for more details on motor parameter configuration steps

### 4.3 Trial operation

In order to verify whether the servo drive and motor can be used normally, the -3 mode can be used to confirm whether the servo motor can rotate normally, and observe whether there is abnormal vibration and abnormal sound during rotation. It can be connected to the upper computer software for operation. Its operation steps are as follows:

- Wiring check:
  - Power input and motor output are correctly connected
  - 485 debugging cable (or USB debugging cable) is used to communicate with the servo drive and the upper computer software KS3
- Check whether the POWER supply voltage is within the rated range. Power on the driver and observe whether the power indicator is steady on
- Configure the enable signal and set the working mode to -3. During the initial operation, it is recommended to rotate the motor at a low speed to confirm whether the motor is rotating correctly
- Observe the motor rotation direction is correct, if the motor steering is found to be opposite to the expected, please check the input command signal, command direction setting signal
- The running state can be monitored in the upper computer software, such as actual speed, actual current and other parameters
- After the above motor condition check is completed, the PID related parameters can be adjusted to make the motor work in the expected condition

→

Note

If a drive alarm occurs during the trial operation , refer to **Chapter 10** for error troubleshooting

## Chapter 5 Working mode introduction

The servo system consists of three main parts: servo drive, servo motor and encoder.

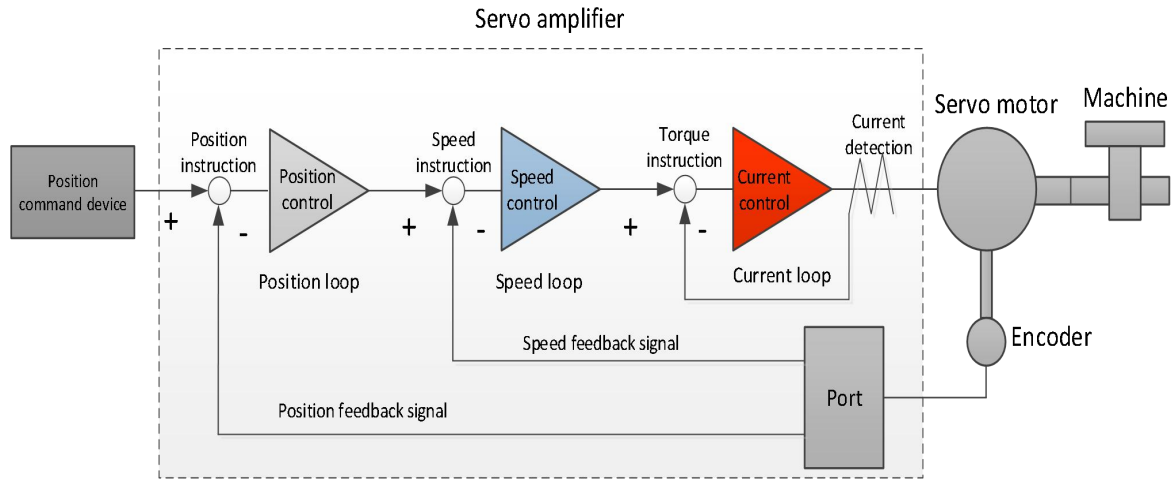


Figure 5 - 1 Servo system control diagram

The servo drive is the control core of the servo system. By processing the input signal and feedback signal, the servo drive can accurately control the position, speed and torque of the servo motor, that is, the position, speed, torque and mixed control mode. Among them, position control is the most important and commonly used control mode of servo system.

According to the command mode and operation control characteristics of the servo drive, it can be divided into three control modes, namely, position mode, speed mode and torque mode.

Position control is to control the position of the motor through the position command. The target position of the motor is determined by the total number of position instructions, and the rotation speed of the motor is determined by the position instruction frequency. By means of an internal encoder (the servo motor has its own encoder) or an external encoder (full closed-loop control), the servo drive can achieve fast and precise control of the position and speed of the machine. Therefore, the position control mode is mainly used in situations where positioning control is required.

Speed control is to control the speed of the machine through the speed command. By communicating the given speed instructions, the servo drive can achieve fast and accurate control of the mechanical speed. Therefore, the speed control mode is mainly used for the occasion of controlling the speed, or the occasion of using the upper computer to achieve position control, and the upper computer output as the speed command input to the servo drive.

The current and torque of the servo motor are linear, so the control of the current can realize the control of the torque. Torque control is to control the output torque of the motor through the torque command. Torque instructions can be given by communication.

## 5.1 Server Status

### 5.1.1 Server Status

The use of FD1X5 servo drive must follow the DS402 protocol to guide the servo drive in order to operate in the specified state.

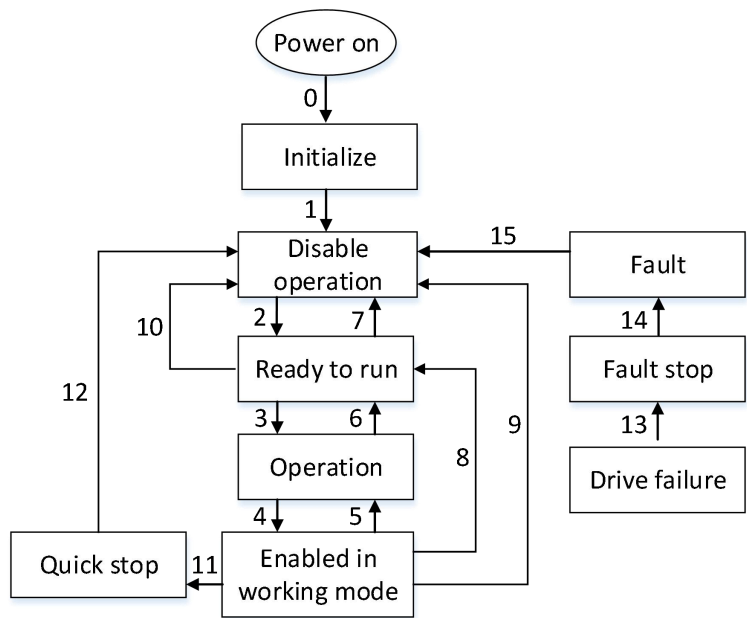


Figure 5 - 2 DS402 state machine

Each state is explained in the following table:

Table 5 - 1 State description

| State                   | Explanation                                                                                                                                                                |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Initialize              | The drive is in the initializer state and cannot set parameters.                                                                                                           |
| Disable operation       | The drive is in the initializer state and cannot set parameters.                                                                                                           |
| Ready to run            | The drive is ready to run, you can set parameters to allow the drive to be enabled.                                                                                        |
| Operation               | The driver main power circuit is ready but not powered, parameters can be set and allow the driver to be enabled.                                                          |
| Enabled in working mode | The driver is in the enable state, the main power circuit is energized to start the drive function, and the motor is running. Some parameters cannot be set in this state. |
| Quick stop              | Execute the quick stop command and the motor stops according to the quick stop mode.                                                                                       |
| Fault stop              | The driver fails and the motor stops according to the error stop mode.                                                                                                     |
| Fault                   | The drive is in the faulty state and the fault shutdown has been completed. Enable the drive after troubleshooting and resetting the fault.                                |

Table 5 - 2 Control commands and status switching description

| Serial number | Status switching                      | Trigger event (bit3~bit0)                                                                             | Drive state (bit7~bit0)          |
|---------------|---------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------|
| 0             | Power-on state → Initialization state | After the driver is powered on, it automatically switches the status without sending the control word | The drive initializes itself     |
| 1             | Initialize state → Disable state      | Automatically switches the status without delivering the control key                                  | The drive communicates normally  |
| 2             | Forbidden State → Ready State         | Control word Enter 6                                                                                  | The status word is changed to 31 |
| 3             | Ready State → Running state           | Control word enter 7                                                                                  | The status word is changed to 33 |

|    |                                              |                                                                                                                                                                  |                                                                                                                                  |
|----|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 4  | Running State → Working Mode Enable state    | Control word enter F                                                                                                                                             | The status word is changed to 0037                                                                                               |
| 5  | Working Mode Enable state → Running state    | Control word enter 7                                                                                                                                             | The status word is changed to 0033                                                                                               |
| 6  | Running State → Ready state                  | Control word Enter 6                                                                                                                                             | The status word is changed to 0031                                                                                               |
| 7  | Ready State → Disable State                  | Control word Enter 0                                                                                                                                             | The status word is changed to 0070                                                                                               |
| 8  | Working Mode Enable status → Ready state     | Control word Enter 6                                                                                                                                             | The status word is changed to 0031                                                                                               |
| 9  | Working Mode Enable state → Disable State    | Control word Enter 0                                                                                                                                             | The status word is changed to 0070                                                                                               |
| 10 | Ready State → Disable State                  | Control word Enter 0                                                                                                                                             | The status word is changed to 0070                                                                                               |
| 11 | Working Mode Enable state → Fast Stop state  | Control word Enter 2                                                                                                                                             | The status word is changed to 0050                                                                                               |
| 12 | Fast Stop state → Disable state              | When the quick stop function is complete and the quick stop mode is 0, 1, 2, or 18, the drive automatically switches to the disabled state                       | Disable the driver and turn off the main power supply                                                                            |
| 13 | → Fault shutdown state                       | In the initialization, disable running, running ready, running, working mode enabled, fast stop state automatically switched when the fault condition is reached | Stop according to the error stop mode                                                                                            |
| 14 | Fault Stop state → Fault state               | Automatic switchover                                                                                                                                             | The status word is changed to 0038<br>The driver function needs to be disabled and the main power supply needs to be turned off  |
| 15 | Fault state → Disable state                  | Control word Enter 86 Switch status<br>Error reset command from I/O or remote control                                                                            | The status word is changed to 0031<br>If the drive exception has been cleared, use the control word bit to clear the fault state |
| 16 | Quick Stop State → Working Mode Enable state | When the quick stop mode is 5 or 6, the control word input F switches the status                                                                                 | The drive function needs to be enabled                                                                                           |

### 5.1.2 Control word and status word description

The following table describes the control words and status words:

Table 5-3 Control word and status word

| Name         | Index address | Property | Type   | Unit | Explanation                                                                                                                                                                                                                                                                                                                                      | Factory default |
|--------------|---------------|----------|--------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Control word | 60400010      | RWLTM    | Uint16 | HEX  | bit0: Switch_on<br>bit1: Enable_voltage<br>bit2: Quick_stop<br>bit3: Enable_operation<br>bit4: Set_Point<br>bit5: Immed_Change<br>bit6: Related_Abs<br>bit7: Fault_reset<br>bit8: Halt<br>bit9: Reserved0<br>bit10: Reserved1<br>bit11: Manufacture0<br>bit12: Manufacture1<br>bit13: Manufacture2<br>bit14: Manufacture3<br>bit15: Manufacture4 | 6               |

|             |          |      |        |     |                                                                                                                                                                                                                                                                                                                                                                   |   |
|-------------|----------|------|--------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| Status word | 60410010 | RLTM | Uint16 | HEX | bit0: Ready_on<br>bit1: Switched_on<br>bit2: Operation_enable<br>bit3: Fault<br>bit4: Voltage_enable<br>bit5: Quick_stop<br>bit6: Switchon_disabled<br>bit7: Warning<br>bit8: Maunufacture0<br>bit9: Remote<br>bit10: Target_reached<br>bit11: Intlim_active<br>bit12: Setpoint_Ack<br>bit13: Flowing_Error<br>bit14: Commutation_Found<br>bit15: Reference_Found | - |
|-------------|----------|------|--------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

### 5.1.2.1 Control word description 604000

Table 5-4 Control word declaration

| Control word | State | Meaning                                                                                                                         | Note                                                          |
|--------------|-------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| bit0         | 0     | Drive running - invalid                                                                                                         | For details, see Table 5-2                                    |
|              | 1     | Drive running - valid                                                                                                           |                                                               |
| bit1         | 0     | Main power circuit ready - invalid                                                                                              |                                                               |
|              | 1     | Main power circuit ready - valid                                                                                                |                                                               |
| bit2         | 0     | Quick stop - valid                                                                                                              |                                                               |
|              | 1     | Quick stop - invalid                                                                                                            |                                                               |
| bit3         | 0     | Servo running - invalid                                                                                                         | Position mode                                                 |
|              | 1     | Servo running - valid                                                                                                           |                                                               |
| bit4         | 0→1   | Indicate that a new displacement command is pre-enabled. Whether the command is successfully enabled depends on the servo state |                                                               |
|              | 1→0   | Indicates that bit12 of control word 6041h is pre-cleared. Whether it is successfully cleared depends on the servo status       |                                                               |
|              | 0     | Origin mode is not activated                                                                                                    |                                                               |
|              | 0→1   | Active origin mode                                                                                                              | Origin mode                                                   |
|              | 1     | The origin return to zero is in progress                                                                                        |                                                               |
|              | 1→0   | Interrupt origin return to zero                                                                                                 |                                                               |
|              | 0     | Interrupt interpolation                                                                                                         | Interpolation mode                                            |
|              | 1     | Enable interpolation                                                                                                            |                                                               |
| bit5         | 0     | Acceleration and deceleration, trapezoidal speed, target position is not updated                                                | F→2F                                                          |
|              | 1     | Acceleration and deceleration, trapezoidal speed, target position update immediately                                            |                                                               |
| bit6         | 0     | Target position 607Ah is a position instruction for absolute positioning                                                        | Position mode                                                 |
|              | 1     | Target position 607Ah is a position instruction for relative positioning                                                        |                                                               |
| bit7         | 0→1   | Fault reset - Rising edge effective                                                                                             | Fault reset                                                   |
|              | 1     | Fault reset complete                                                                                                            |                                                               |
| bit8         | 1     | The servo motor is suspended                                                                                                    | Applicable to operating modes other than torque mode (4 mode) |
|              | 0     | Servo motor continues to run (continue to perform the previous task)                                                            |                                                               |

|                                                                                                                                                                                                                                                                    |         |                                                                                                                                                                        |               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| bit9                                                                                                                                                                                                                                                               | Reserve |                                                                                                                                                                        |               |
| bit10                                                                                                                                                                                                                                                              |         |                                                                                                                                                                        |               |
| bit11                                                                                                                                                                                                                                                              |         |                                                                                                                                                                        |               |
| bit12                                                                                                                                                                                                                                                              | 0       | The target position 607Ah is a position instruction for absolute positioning and does not update the contour trajectory according to the change of the target position | Position mode |
|                                                                                                                                                                                                                                                                    | 1       | Target position 607Ah is a position instruction for absolute positioning, which updates the contour trajectory in real time according to the change of target position |               |
| bit13                                                                                                                                                                                                                                                              | Reserve |                                                                                                                                                                        |               |
| bit14                                                                                                                                                                                                                                                              |         |                                                                                                                                                                        |               |
| bit15                                                                                                                                                                                                                                                              |         |                                                                                                                                                                        |               |
| Motor lock shaft: 0x2F/0x0F<br>Motor loose shaft: 0x06<br>Error reset: 0x86<br>Absolute position mode: 0x2F→0x3F<br>Absolute positioning mode immediately as target position changes: 0x103F<br>Relative position mode: 0x4F-->0x5F<br>Find the origin: 0x0F->0x1F |         |                                                                                                                                                                        |               |

### 5.1.2.2 Status Word Description 604100

Table 5 - 5 Status word description

| Control word | State               | Meaning                                               | Note                       |
|--------------|---------------------|-------------------------------------------------------|----------------------------|
| bit0         | 0                   | Servo no fault - invalid                              | For details, see Table 5-2 |
|              | 1                   | Servo fault-free - valid                              |                            |
| bit1         | 0                   | Waiting to turn on the servo enable - invalid         |                            |
|              | 1                   | Wait to turn on the servo enable - Valid              |                            |
| bit2         | 0                   | Servo ready to run - invalid                          |                            |
|              | 1                   | Servo ready to run -valid                             |                            |
| bit3         | 0                   | Fault-invalid                                         |                            |
|              | 1                   | Fault-valid                                           |                            |
| bit4         | 0                   | Power on the main circuit-invalid                     |                            |
|              | 1                   | Power on the main circuit-valid                       |                            |
| bit5         | 0                   | Quick stop - valid*                                   |                            |
|              | 1                   | Quick stop - invalid*                                 |                            |
| bit6         | 0                   | Servo ready- invalid                                  |                            |
|              | 1                   | Servo ready- valid                                    |                            |
| bit7         | 0                   | The servo has no warning status word                  |                            |
|              | 1                   | Servo in warning status word                          |                            |
| bit8         | Reserved, undefined |                                                       |                            |
| bit9         | 0                   | DIN defines enable/reset faults, IO controls          |                            |
|              | 1                   | Telecommunication control                             |                            |
| bit10        | 0                   | Target position, zero speed, target speed not reached | Target arrival             |
|              | 1                   | Position, speed , zero speed reached                  |                            |

|       |   |                                                                                                                                                                            |                          |
|-------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| bit11 | 0 | The actual position does not reach the soft limit or hard limit                                                                                                            | Positive/negative limit  |
|       | 1 | The actual position reaches the soft limit/hard limit position, and input the reverse shift instruction can make the motor exit the position limit state and clear the bit |                          |
| bit12 | 0 | The servo can receive new displacement commands                                                                                                                            | position mode            |
|       | 1 | The servo cannot receive new shift instructions                                                                                                                            |                          |
|       |   | Origin return to zero error                                                                                                                                                | Origin mode              |
|       | 0 | User speed is not zero                                                                                                                                                     | Speed mode               |
|       | 1 | User speed is zero                                                                                                                                                         |                          |
| bit13 | 0 | The position following error does not exceed the maximum following error                                                                                                   | Position following error |
|       | 1 | The position following error exceeds the maximum following error                                                                                                           |                          |
| bit14 | 0 | No motor excitation found or motor excitation missing                                                                                                                      | Excitation state         |
|       | 1 | Motor excitation found                                                                                                                                                     |                          |
| bit15 | 0 | The origin return to zero has not been performed or completed                                                                                                              | Origin state             |
|       | 1 | The origin has been returned to zero. The reference point has been found                                                                                                   |                          |

## 5.2 Speed Mode (-3, 3) description

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

Table 5 - 6 Speed mode parameters description

| Internal address | Type       | Name           | Description                                                                                                                                                                                                   | Value                    |
|------------------|------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 6060.00          | Integer8   | Operation_Mode | -3: In immediate speed mode, the actual speed will immediately reach the target speed;<br>3: For the speed mode with acceleration and deceleration, the actual speed will be accelerated to the target speed; | -3 and 3                 |
| 6040.00          | Unsigned16 | Controlword    | 0x0F Motor lock shaft<br>0x06 Motor loose shaft                                                                                                                                                               | 0x0F.0x06                |
| 60FF.00          | Integer32  | Target_Speed   | The target speed cannot exceed the rated motor speed                                                                                                                                                          | According to user demand |
| 6083.00          | Unsigned32 | Profile_Acc    | It takes effect in mode 1 and mode 3                                                                                                                                                                          | The default is 100rps/s  |
| 6084.00          | Unsigned32 | Profile_Dec    | It takes effect in mode 1 and mode 3                                                                                                                                                                          | The default is 100rps/s  |
| 607E.00          | Unsigned 8 | Invert_Dir     | invert motion<br>0: CCW is positive dirction (default value)<br>1: CW is positive direction                                                                                                                   | 0.1                      |



### Note

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

## 5.2.1 Related Function Settings

### 5.2.1.1 DIN Speed mode introduction

The setting interface of DIN speed segment opens in the upper computer software.

Table 5-7 DIN Speed mode introduction

| Internal Address | Bits       | Name         | Description                                                                                                                                                                                                                                                                      | Value        |
|------------------|------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 2020.05          | Integer32  | Din_Speed[0] | The speed instruction for the drive is specified by the DIN speed [x], where the x is the BCD code from the following signals:<br>Bit 0: Din speed index 0;<br>Bit 1: Din speed index 1;<br>Bit 2: Din Speed index 2;<br>The situation where all the medians are 0 cannot occur; | User defined |
| 2020.06          | Integer32  | Din_Speed[1] |                                                                                                                                                                                                                                                                                  |              |
| 2020.07          | Integer32  | Din_Speed[2] |                                                                                                                                                                                                                                                                                  |              |
| 2020.08          | Integer32  | Din_Speed[3] |                                                                                                                                                                                                                                                                                  |              |
| 2020.14          | Integer32  | Din_Speed[4] |                                                                                                                                                                                                                                                                                  |              |
| 2020.15          | Integer32  | Din_Speed[5] |                                                                                                                                                                                                                                                                                  |              |
| 2020.16          | Integer32  | Din_Speed[6] |                                                                                                                                                                                                                                                                                  |              |
| 2020.17          | Integer32  | Din_Speed[7] |                                                                                                                                                                                                                                                                                  |              |
| 6083.00          | Unsigned32 | Profile_Acc  | When the operating mode is 3 mode, the trapezoidal acceleration and trapezoidal deceleration must be set, otherwise the response speed segment will not be performed                                                                                                             |              |
| 6084.00          | Unsigned32 | Profile_Dec  |                                                                                                                                                                                                                                                                                  |              |

Table 5-8 DIN speed segment settings

| DIN speed index 0 | DIN speed index 1 | DIN speed index 2 | Corresponding velocity segment | 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.

### 5.2.1.2 Speed to function

The Speed to window can be used to monitor whether the actual speed feedback is consistent with the target speed instruction. When the speed error window monitored in speed mode is less than the speed to window set value, the output speed is to, and the BIT10 of the status word is set to 1.

Relevant parameter:

| Internal Address | Bits      | Name                | Description                                                                                                                                         | Value          |
|------------------|-----------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 60F9.1C          | Integer32 | Speed_Error         | Speed error window                                                                                                                                  | \              |
| 60F9.0A          | Integer32 | Target_Speed_Window | Target_Speed_Window,Under velocity mode,if $ \text{Speed\_Error} (60F9.1C) < \text{Target\_Speed\_Window}$ means target reached,Statusword Bit10=1; | Default 100rpm |

### 5.2.1.3 Zero speed function

Zero speed monitoring can be used to verify that the absolute value of the motor's speed feedback is less than the zero speed window set value. If so, the current motor is considered to be close to the zero speed stationary state, and the bit12 of the status word is set to 1.

Relevant parameter:

| Internal Address | Bits       | Name              | Description                                                                                                                                                                                                                                   | Value           |
|------------------|------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 2010.18          | Unsigned16 | Zero_Speed_Window | 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 | Default 3inc/ms |
| 60F9.14          | Unsigned16 | Zero_Speed_Time   |                                                                                                                                                                                                                                               | Default 10ms    |

### 5.2.1.4 Maximum speed limit function

In speed mode, the maximum forward and reverse speed can be limited by setting the maximum speed limit 607F.00. However, it always does not exceed the maximum operating speed allowed by the motor.

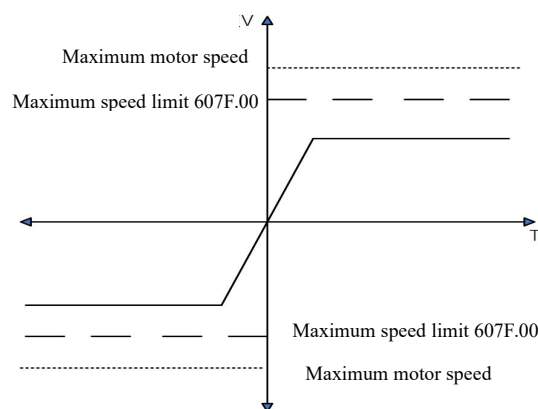


Figure 5-3 Maximum speed limit diagram

Relevant parameter:

| Internal Address | Bits       | Name      | Description               | Value           |
|------------------|------------|-----------|---------------------------|-----------------|
| 607F.00          | Unsigned32 | Max_Speed | Maximum motor speed limit | Default 5000rpm |

### 5.3 Torque mode (4)

In torque mode, the drive will control the output torque of the motor set by the user during operation.

Table 5 - 9 Description of related parameters of torque mode

| Internal Address | Bits       | Name              | Description                                                                                                                                                                    | Value        |
|------------------|------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 6060.00          | Integer8   | Operation_Mode    | Select the working mode according to the actual control mode. 4 is the torque mode                                                                                             | 4            |
| 6071.00          | Integer16  | Target_Torque%    | Percentage of the target torque to the rated torque                                                                                                                            | User defined |
| 6040.00          | Unsigned16 | Controlword       | Enable drive                                                                                                                                                                   | 0006→000f    |
| 607F.00          | Unsigned32 | Max_Speed         | Motor operating maximum speed limit                                                                                                                                            | User defined |
| 60F5.06          | Integer16  | 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          | Integer16  | 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          | Integer16  | Current_OUT_Real  | Monitors the actual torque, the unit in Ap                                                                                                                                     | /            |



**Note**

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

#### 5.3.1 Related function Settings

##### 5.3.1.1 Maximum speed limit function in torque mode

In torque mode, the maximum forward and reverse running speed can be limited by setting the maximum speed limit of 607F.00. However, it always does not exceed the maximum operating speed allowed by the motor.

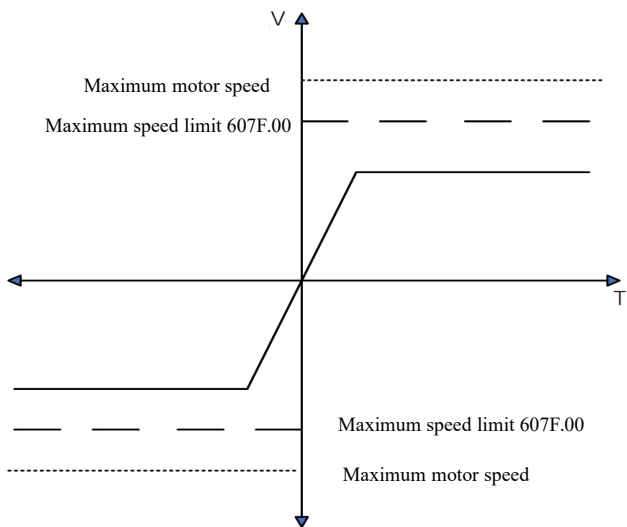


Figure 5-4 Maximum speed limit diagram

Relevant parameter:

| Internal Address | Bits       | Name                | Description               | Value           |
|------------------|------------|---------------------|---------------------------|-----------------|
| 607F.00          | Unsigned32 | Maximum speed limit | Maximum motor speed limit | Default 5000rpm |

### 5.3.1.2 Torque reaches the preset function

The torque reach function is to judge whether the target torque command value reaches the set torque reference value and output the corresponding torque reach signal for the host computer. When the actual torque reaches the set torque reaches the benchmark and the duration is the set torque reaches the filtering time, the corresponding signal is output.

Relevant parameter:

| Internal Address | Bits      | Name              | Description                                                                                                                                                                                               | Value         |
|------------------|-----------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 60F5.06          | Integer16 | Torque_OUT_Ref    | The limit value, when the reference data is exceeded, the output torque reaches the setting, the unit is Ap, and the setting is 0, which means that the torque reaches the limit detection is not enabled | Default 0Ap   |
| 60F5.07          | Integer16 | Torque_OUT_Filter | Torque reaches filtering time                                                                                                                                                                             | Default 100ms |
| 60F5.08          | Integer16 | Current_OUT_Real  | Monitor actual torque parameters, unit : Ap                                                                                                                                                               | \             |

## 5.4 Position mode (1)

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

Table 5 - 10 Position mode parameter description

| Internal Address | Bits       | Name            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Value                                            |
|------------------|------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| 6060.00          | Integer8   | Operation_Mode  | The way to control the servo motor                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1                                                |
| 607A.00          | Integer32  | Target_Position | Target absolute/relative position                                                                                                                                                                                                                                                                                                                                                                                                                                                  | User defined                                     |
| 6081.00          | Unsigned32 | Profile_Speed   | Speed command in position mode                                                                                                                                                                                                                                                                                                                                                                                                                                                     | User defined                                     |
| 6083.00          | Unsigned32 | Profile_Acc     | Acceleration of trapezoidal curve                                                                                                                                                                                                                                                                                                                                                                                                                                                  | User defined                                     |
| 6084.00          | Unsigned32 | Profile_Dec     | Trapezoidal curve deceleration                                                                                                                                                                                                                                                                                                                                                                                                                                                     | User defined                                     |
| 6040.00          | Unsigned16 | Controlword     | 0x2F->0x3F: activates the absolute position instruction, does not execute the absolute position instruction immediately according to the change of the target position, used when the working mode is 1<br>0x4F->0x5F: Activates the relative position instruction, used when the working mode is 1<br>0x103F: Absolute position command is executed immediately when the target position changes. This command is used when the working mode is 1<br>0x06->0x0F Enables the drive | 0x2F->0x3F<br>0x4F->0x5F<br>0x06->0x0F<br>0x103F |

## 5.4.1 Related function Settings

### 5.4.1.1 DIN Position mode introduction

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

The setting interface of DIN position segment can be opened through the menu bar of the upper computer software.

Table 5-11 DIN position mode introduction

| Internal address | Bits      | Name                  | Description                                                                                                                                                                                                                                          | Value        |
|------------------|-----------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 2020.01          | Integer32 | 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:<br>bit 0: Din_pos[0];<br>bit 1: Din_pos[1] ;<br>bit 2: Din_pos[2];<br>The case where the digits are all 0 cannot occur; | User defined |
| 2020.02          | Integer32 | Din_pos[1]            |                                                                                                                                                                                                                                                      |              |
| 2020.03          | Integer32 | Din_pos[2]            |                                                                                                                                                                                                                                                      |              |
| 2020.04          | Integer32 | Din_pos[3]            |                                                                                                                                                                                                                                                      |              |
| 2020.10          | Integer32 | Din_pos[4]            |                                                                                                                                                                                                                                                      |              |
| 2020.11          | Integer32 | Din_pos[5]            |                                                                                                                                                                                                                                                      |              |
| 2020.12          | Integer32 | Din_pos[6]            |                                                                                                                                                                                                                                                      |              |
| 2020.13          | Integer32 | Din_pos[7]            |                                                                                                                                                                                                                                                      |              |
| 2FF1.01          | Unsigned8 | Din_position_select_L | Select the position segment L to be set (L range is 0-7, corresponding to the internal position segment 0-7 in turn)                                                                                                                                 | User defined |
| 2FF1.02          | Integer16 | Din_position_M        | Number of pulses set in position segment (L)                                                                                                                                                                                                         |              |
| 2FF1.03          | Integer16 | Din_position_n        | =M*10000+N                                                                                                                                                                                                                                           |              |

Table 5-12 DIN position mode related IO Settings

| DIN                     | Function introduction                                                                                                                                                                                                                                                                                   |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable                  | Drive enable                                                                                                                                                                                                                                                                                            |
| Command activation      | activate position instructions, such as the control word from 0x2F to 0x3F                                                                                                                                                                                                                              |
| DIN position Index 0    | DIN position index [x] is specified, where the x is a BCD code composed of the following signals:<br>Bit 0: Din position index 0;<br>Bit 1: Din location index 1;<br>Bit 2: Din location index 2;                                                                                                       |
| DIN position Index1     |                                                                                                                                                                                                                                                                                                         |
| DIN position Index2     |                                                                                                                                                                                                                                                                                                         |
| DOUT                    | Function introduction                                                                                                                                                                                                                                                                                   |
| Multi-function signal 0 | The driver executes the selected position segment program and outputs a multifunction signal after reaching the Din position [x], where the x is a BCD code composed of the following signals:<br>Bit 0: multi-function signal 0;<br>Bit 1: multi-function signal 1;<br>Bit 2: multi-function signal 2; |
| Multi-function signal 1 |                                                                                                                                                                                                                                                                                                         |
| Multi-function signal 2 |                                                                                                                                                                                                                                                                                                         |

Table 5-13 DIN position mode related Settings

| Internal address | Name        | Value        | Unit  |
|------------------|-------------|--------------|-------|
| 2020.0E          | Din_Mode1   | 1            | DEC   |
| 2020.02          | Din_Pos1    | User defined | DEC   |
| 2020.06          | Din_Speed 1 | User defined | rpm   |
| 6083.00          | Profile_Acc | User defined | rps/s |
| 6084.00          | Profile_Dec | User defined | rps/s |

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



#### Remind

- In the multi-segment position mode, the position to signal of Din positions 1-7 segments is represented by the BCD code composed of the multi-function signal 0-2.
- Command activation can set the bit4 of the control word to activate the position command, and the level change of DIN position index 0~2 can also activate the position command, but when the first segment is positioned as DIN position 0 after enablement, DIN position 0 cannot be activated due to no level change of the non-index signal, so the DIN input port is required to define the command activation.

#### 5.4.1.2 Position-to-function

The Position to window can be used to monitor whether the actual position feedback is consistent with the target position instructions. When the speed error window monitored in speed mode is less than the speed to window set value, the output speed to, BIT 10 of the status word is set to 1.

Relevant parameter:

| Internal address | Bits      | Name                | Description                                                                                                                    | Value          |
|------------------|-----------|---------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------|
| 60F9.1C          | Integer32 | Speed_Error         | Speed error window                                                                                                             | \              |
| 60F9.0A          | Integer32 | Target_Speed_Window | Target_Speed_Window,Under velocity mode,if  Speed_Error (60F9.1C)<Target_Speed_Window means target reached,Statusword Bit10=1; | Default 100rpm |

#### 5.4.1.3 Position following error monitoring function

The position following error (60F4.00) function is to calculate the difference between the given instruction of the effective target position (60FC.00) and the feedback instruction of the actual position (6063.00). When the difference accumulates to the set maximum following error (6065.00) threshold, the alarm position following error is allowed to be too large.

Relevant parameter:

| Internal address | Bits       | Name                | Description                                                                  | Value         |
|------------------|------------|---------------------|------------------------------------------------------------------------------|---------------|
| 6063.00          | Integer32  | Pos_Actual          | The actual position of the motor                                             | \             |
| 6065.00          | Unsigned32 | Max_Following_Error | Follow the error alarm limit value                                           | Default 10rpm |
| 60F4.00          | Integer32  | Pos_Error           | The difference between the actual position and the effective target position | \             |
| 60FC.00          | Integer32  | Pos_Demand          | Target position instruction after PID adjustment                             | \             |

## 5.5 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 operation interface of origin mode can be opened by menu bar ->**Specialist** -> **Control Modes** -> **Homing mode**. The operation interface after opening is shown as follows:

| Index    | Name                | Value | Unit  |
|----------|---------------------|-------|-------|
| 1 607C00 | Home_Offset         |       | inc   |
| 2 609800 | Homing_Method       |       | DEC   |
| 3 609901 | Homing_Speed_Switch |       | rpm   |
| 4 609902 | Homing_Speed_Zero   |       | rpm   |
| 5 609903 | Homing_Power_On     |       | DEC   |
| 6 609A00 | Homing_Accelaration |       | rps/s |
| 7 609904 | Homing_Current      |       | Ap    |
| 8 609905 | Home_Offset_Mode    |       | DEC   |
| 9 609906 | Home_N_Blind        |       | DEC   |

Figure 5 - 5 Homing mode interface

Table 5 - 14 Homing mode parameter description

| Internal address | Name                | Bits       | Value        | Meaning                                                                                                                                                               |
|------------------|---------------------|------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 607C0020         | Home_Offset         | Integer32  | User defined | The offset position setting of the final positioning from the origin position                                                                                         |
| 60980008         | Homing_Method       | Integer 8  | User defined | Find the origin of the way to choose                                                                                                                                  |
| 60990220         | Homing_Speed_Zero   | Unsigned32 | User defined | Find the origin signal velocity                                                                                                                                       |
| 60990308         | Homing_Power_On     | Unsigned 8 | 0, 1         | The origin search function is performed once after each power-on                                                                                                      |
| 609A0020         | Homing_Accelaration | Unsigned32 | User defined | Find the acceleration at the origin                                                                                                                                   |
| 60990120         | Homing_Speed_Switch | Unsigned32 | User defined | Look for the speed of the origin switch, limit switch signal                                                                                                          |
| 60990410         | Homing_Current      | Integer16  | User defined | The maximum current setting when finding the origin                                                                                                                   |
| 60990508         | Home_Offset_Mode    | Unsigned 8 | 0, 1         | Origin offset mode control<br>0: Run to the origin offset<br>1: Run to the origin event trigger point, after the end of the actual position will be "- origin offset" |
| 60990608         | Home_N_Blind        | Unsigned 8 | 0, 1         | Origin index signal blind area                                                                                                                                        |
| 60600008         | Operation_Mode      | Integer8   | 6            | Homing mode                                                                                                                                                           |
| 60400010         | Controlword         | Unsigned16 | 0x0F->0x1F   | Trigger back to origin                                                                                                                                                |

**Note**

Homing\_Power\_On=1 causes the motor to start rotating as soon as the controller is enabled after power on or reboot. Consider all safety issues before using.

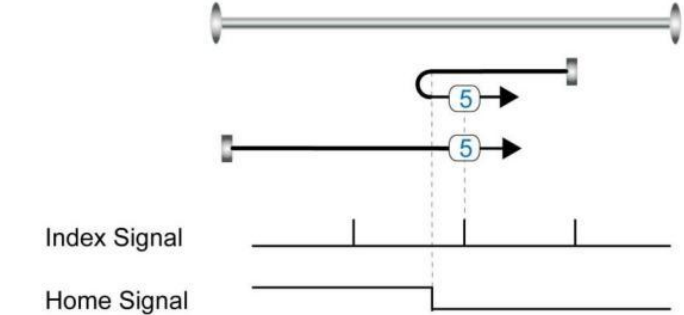
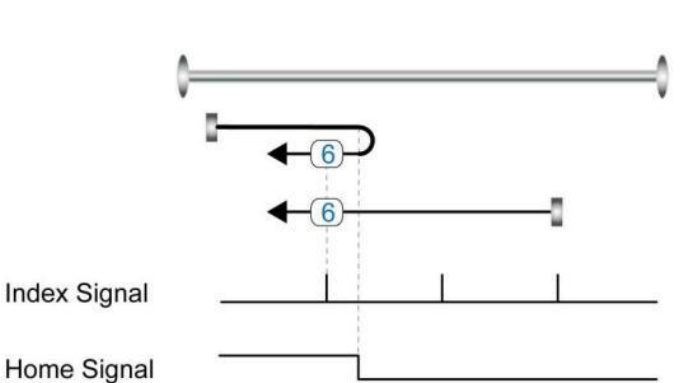
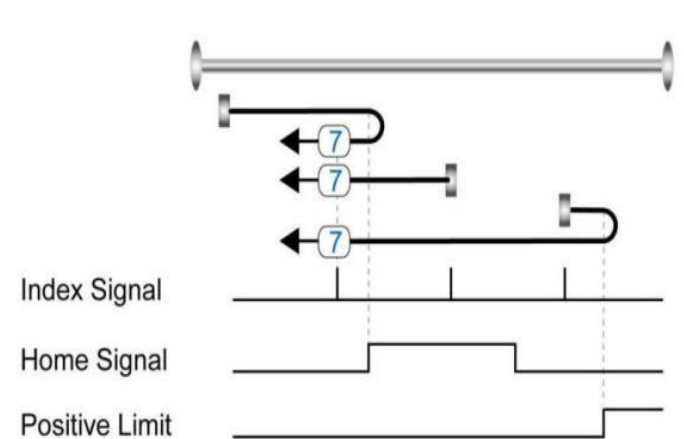
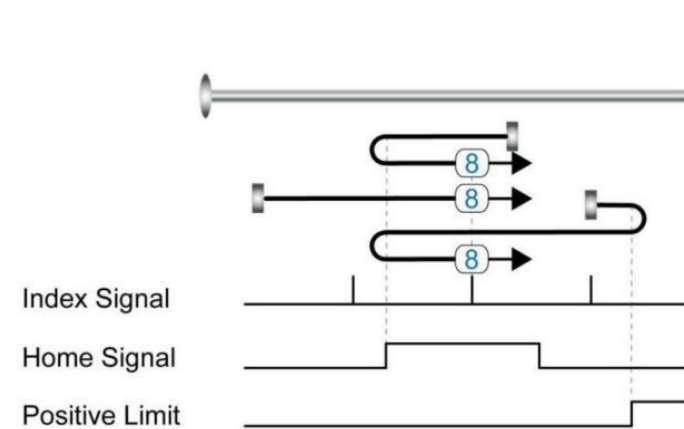
**Home\_N\_Blind:**

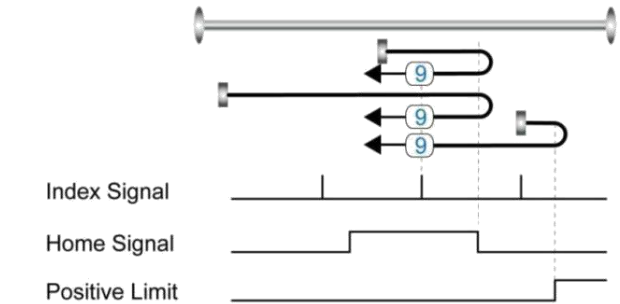
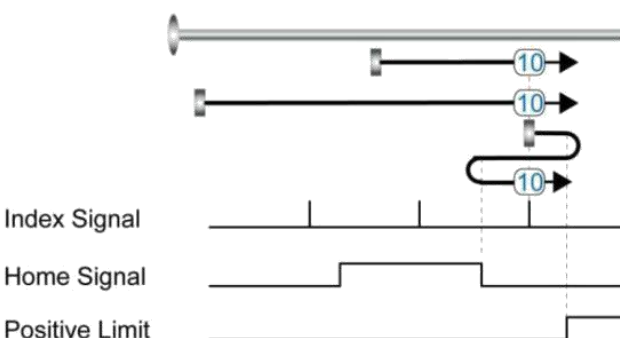
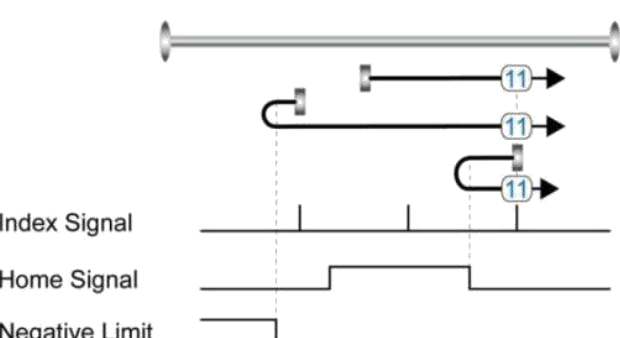
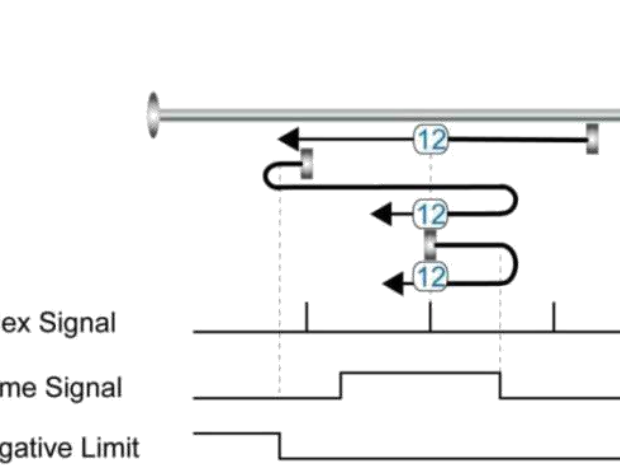
If the homing mode needs home signal (position limit / home switch) and index signal, Home\_N\_Blind function can avoid the homing result being different with the same mechanics, when the Index signal is very close to the home signal. By setting to 1 before homing, the controller detects a suitable blind 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.

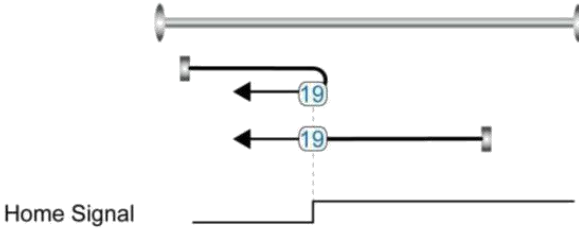
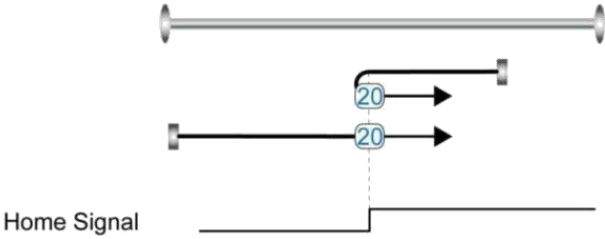
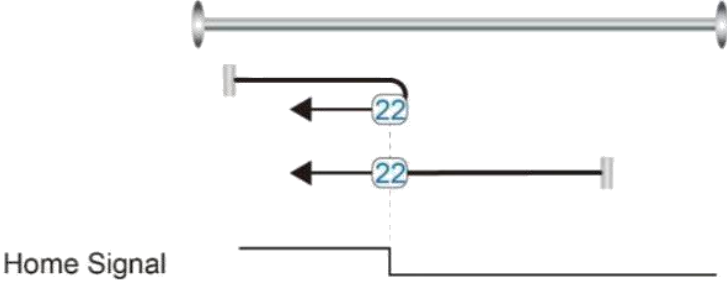
Table 5 - 15 Homing mode introduction

| Homing mode | Description                                                                                                | Schematic |
|-------------|------------------------------------------------------------------------------------------------------------|-----------|
| 1           | Z phase pulse trigger signal with negative limit as origin                                                 |           |
| 2           | Z-phase pulse trigger signal with positive limit as origin                                                 |           |
| 3           | The origin switch signal is the Z-phase pulse trigger signal, and the initial motion direction is positive |           |
| 4           | The origin switch signal is the Z-phase pulse trigger signal, and the initial motion direction is positive |           |

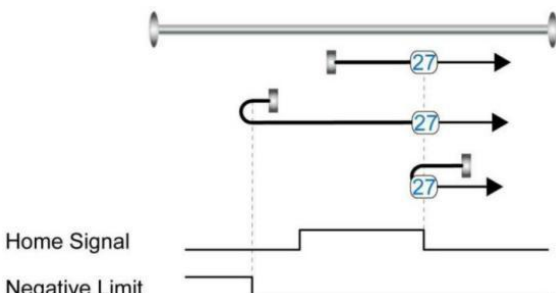
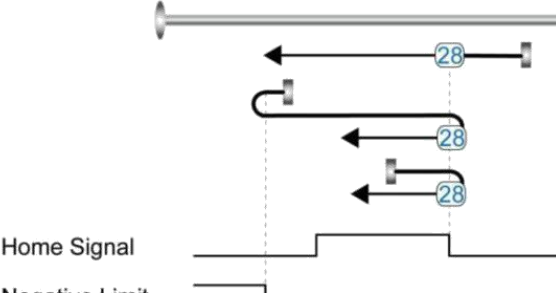
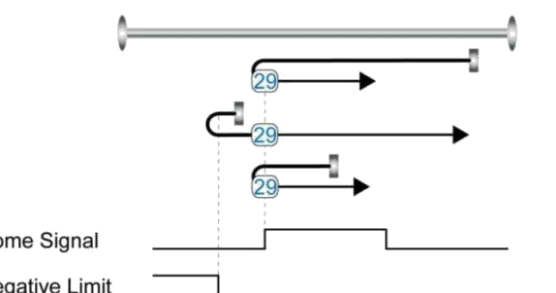
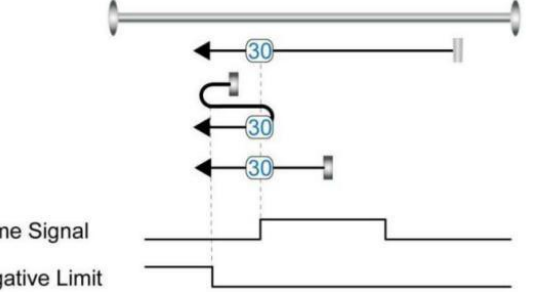
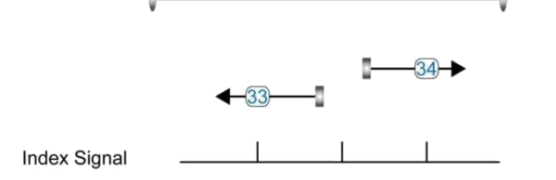
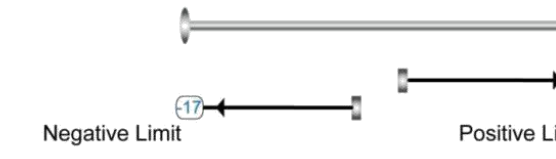
|   |                                                                                                                                    |                                                                                                                                                   |
|---|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | The origin switch signal is the Z-phase pulse trigger signal, and the initial motion direction is negative                         |  <p>Index Signal</p> <p>Home Signal</p>                         |
| 6 | The origin switch signal is the Z-phase pulse trigger signal, and the initial motion direction is negative                         |  <p>Index Signal</p> <p>Home Signal</p>                         |
| 7 | With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial direction of movement is positive |  <p>Index Signal</p> <p>Home Signal</p> <p>Positive Limit</p>  |
| 8 | With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial direction of movement is positive |  <p>Index Signal</p> <p>Home Signal</p> <p>Positive Limit</p> |

|    |                                                                                                                                           |                                                                                                                                                   |
|----|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 9  | <p>With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial direction of movement is positive</p> |  <p>Index Signal</p> <p>Home Signal</p> <p>Positive Limit</p>   |
| 10 | <p>With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial direction of movement is positive</p> |  <p>Index Signal</p> <p>Home Signal</p> <p>Positive Limit</p>   |
| 11 | <p>With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial movement direction is negative</p>    |  <p>Index Signal</p> <p>Home Signal</p> <p>Negative Limit</p>  |
| 12 | <p>With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial movement direction is negative</p>    |  <p>Index Signal</p> <p>Home Signal</p> <p>Negative Limit</p> |

|    |                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13 | With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial movement direction is negative | <p>The diagram shows a motor moving to the left (negative direction) to find the origin. Three pulses, labeled 13, are shown as the motor passes the origin point. Below the motor diagram are three signal waveforms: 'Index Signal' (a series of pulses), 'Home Signal' (a pulse that goes high when the motor reaches the origin and returns to low), and 'Negative Limit' (a signal that is high when the motor is in the negative range and goes low at the origin).</p> |
| 14 | With double limit, the origin switch signal is the Z-phase pulse trigger signal, and the initial movement direction is negative | <p>The diagram shows a motor moving to the left (negative direction) to find the origin. Three pulses, labeled 14, are shown as the motor passes the origin point. Below the motor diagram are three signal waveforms: 'Index Signal' (a series of pulses), 'Home Signal' (a pulse that goes high when the motor reaches the origin and returns to low), and 'Negative Limit' (a signal that is high when the motor is in the negative range and goes low at the origin).</p> |
| 17 | Take the negative limit as the origin signal                                                                                    | <p>The diagram shows a motor moving to the right (positive direction) until it reaches the negative limit. A single pulse, labeled 17, is shown at the moment the motor reaches the limit. Below the motor diagram is a 'Negative Limit' signal waveform that goes high when the motor reaches the limit.</p>                                                                                                                                                                 |
| 18 | Take the positive limit as the origin signal                                                                                    | <p>The diagram shows a motor moving to the left (negative direction) until it reaches the positive limit. A single pulse, labeled 18, is shown at the moment the motor reaches the limit. Below the motor diagram is a 'Positive Limit' signal waveform that goes high when the motor reaches the limit.</p>                                                                                                                                                                  |

|    |                                                                                                       |                                                                                      |
|----|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 19 | The external origin switch is the origin trigger signal, and the initial motion direction is positive |    |
| 20 | The external origin switch is the origin trigger signal, and the initial motion direction is positive |    |
| 21 | The external origin switch is the origin trigger signal, and the initial motion direction is negative |  |
| 22 | The external origin switch is the origin trigger signal, and the initial motion direction is negative |  |

|    |                                                                                                                               |                                          |
|----|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 23 | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is positive | <p>Home Signal</p> <p>Positive Limit</p> |
| 24 | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is positive | <p>Home Signal</p> <p>Positive Limit</p> |
| 25 | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is positive | <p>Home Signal</p> <p>Positive Limit</p> |
| 26 | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is positive | <p>Home Signal</p> <p>Positive Limit</p> |

|          |                                                                                                                               |                                                                                                                                  |
|----------|-------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 27       | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is negative |  <p>Home Signal</p> <p>Negative Limit</p>      |
| 28       | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is negative |  <p>Home Signal</p> <p>Negative Limit</p>      |
| 29       | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is negative |  <p>Home Signal</p> <p>Negative Limit</p>     |
| 30       | With double limit, the external origin switch is the origin trigger signal, and the initial direction of movement is negative |  <p>Home Signal</p> <p>Negative Limit</p>    |
| 33, 34   | Take the next Z phase pulse signal of the motor as the origin                                                                 |  <p>Index Signal</p>                         |
| 35       | Take the current position of the motor as the reference origin                                                                |                                                                                                                                  |
| -17, -18 | Refer to the origin mode where the mechanical end position is the origin                                                      |  <p>Negative Limit</p> <p>Positive Limit</p> |

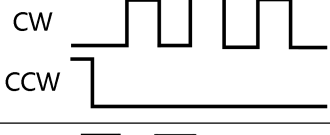
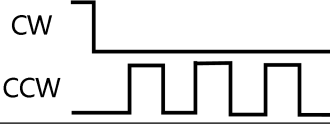
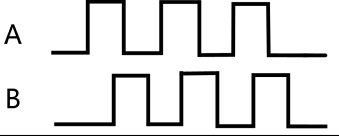
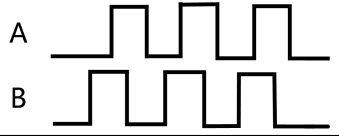
## 5.6 Pulse mode (-4)

FD1X5 driver supports a pulse mode in which the target speed command is determined by the external pulse frequency and the electronic gear ratio.

Table 5-16 Pulse mode parameter description

| Internal address | Bits       | Name            | Description                                                                               | Value       |
|------------------|------------|-----------------|-------------------------------------------------------------------------------------------|-------------|
| 6060.00          | Integer8   | Operation_Mode  | Setting operation mode                                                                    | -4          |
| 2508.01          | Integer16  | Gear_Factor[0]  | Gear_ratio=Gear_Factor/Gear_Divider                                                       | User define |
| 2508.02          | Unsigned16 | Gear_Divider[0] |                                                                                           |             |
| 6040.00          | Unsigned16 | Controlword     | Enable drive                                                                              | 0x2F        |
| 2508.03          | Unsigned8  | PD_CW           | Pulse train mode<br>0: CW / CCW<br>1: Pulse / direction<br>2: A / B (incremental encoder) | 0,1,2       |
| 2508.06          | Unsigned16 | PD_Filter       | Master_encoder pulse input filter                                                         | User define |
| 2508.08          | Unsigned16 | Frequency_Check | Main encoder port pulse input pulse frequency alarm point set                             |             |

Table 5-17 Pulse input supported by the drive

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



- Note**
- Forward indicates positive position count, default direction is CCW;
  - The speed position direction control (607E.00) = 1 to reverse the direction of the motor shaft.

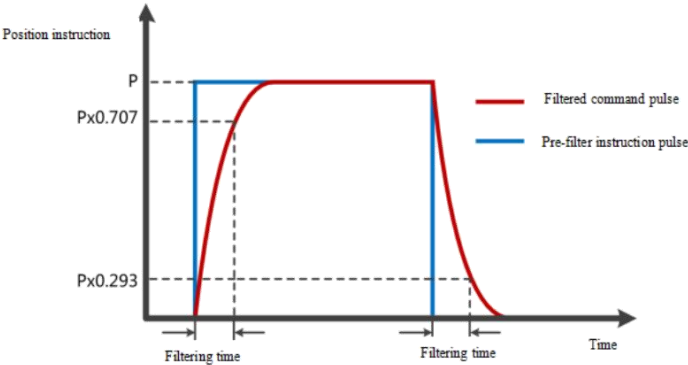


Figure 5 - 6 Pulse filter

## 5.7 Other application control functions

### 5.7.1 Limit function

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

Table 5-18 Limit setting instruction

| Internal address | Bits       | Name                           | Description                                                                                                                                                                                              |
|------------------|------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2010.06          | Unsigned16 | DIN4 Function                  | Define digital input DIN 4. Default value 0010, Indicates the definition of the positive limit function                                                                                                  |
| 2010.07          | Unsigned16 | DIN5 Function                  | Define digital input DIN5. Default value 0020, Indicates the definition of the negative limit function                                                                                                   |
| 2010.1B          | Integer32  | Positive limit position        | Actual position when the digital input signal triggers the positive limit                                                                                                                                |
| 2010.1C          | Integer32  | Negative limit position        | Actual position when the digital input signal triggers the negative limit                                                                                                                                |
| 2010.19          | Unsigned8  | Limit function define          | The function of defining whether to alarm after the limit signal occurs<br>0: If the limit signal appears after homing, it will alarm<br>1: it will not alarm when the limit signal appears after homing |
| 607D.01          | Integer32  | Positive setting of soft limit | Soft limit positive polarity data setting                                                                                                                                                                |
| 607D.02          | Integer32  | Soft limit negative setting    | Soft limit negative data setting, the negative data must be less than the positive data, otherwise the soft limit will not work                                                                          |
| 6085.00          | Unsigned32 | Quick stop deceleration        | 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.

### 5.7.2 Motor brake control

FD1X5 do not need an external 24V power supply when using the internal brake!

In order to ensure that the motor will not be affected by gravity or other external forces after power off and rotation, load equipment such as vertical shaft need to choose brake motor, driver factory default OUT5 for brake control interface, please see 5.7.2.1 for details.

Table 5-19 Brake control related objects

| Internal address | Bits       | Name                    | Description                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------|------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6410.17          | Unsigned8  | Additional device       | whether the motor has any addition device<br>0: Motor without brake<br>1: Motor with brake,before the brake close totally,driver will keep working for some time                                                                                                                                                                                                                                              |
| 6410.11          | Unsigned16 | Brake duty cycle        | Duty cycle of the lock signal. By changing the on-time (pulse width) and switching frequency of the switching device, the output voltage or current is controlled to reduce the temperature rise. The duty cycle of the lock is adjustable from 0 to 100%, corresponding to the average chopper voltage from 0 to 24V. The default value is 70%, that is, the lock supply voltage is $24 \times 70\% = 16.8V$ |
| 6410.12          | Unsigned16 | Brake delay             | Brake signal delay time. The default value is 150ms                                                                                                                                                                                                                                                                                                                                                           |
| 605A.00          | Integer16  | Quick stop mode         | 0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>5: stop with profile deceleration, stay in quick stop active<br>6: stop with quick stop deceleration, stay in quick stop active<br>18: using motor winding for brake even encoder is wrong<br>The factory default is stop without control mode                              |
| 6085.00          | Unsigned32 | Quick stop deceleration | Deceleration when the quick stop mode is 2                                                                                                                                                                                                                                                                                                                                                                    |

**Note**

It is not recommended that the duty cycle of the brake be less than 40% or higher than 90%. Otherwise, the brake cannot be opened or the lock heats up.

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.

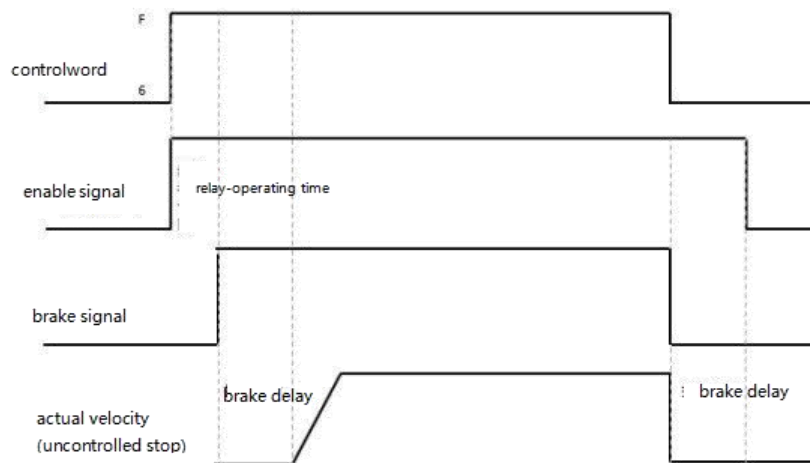


Figure 5-7 Motor holding brake sequence when quick stop mode is 0

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.

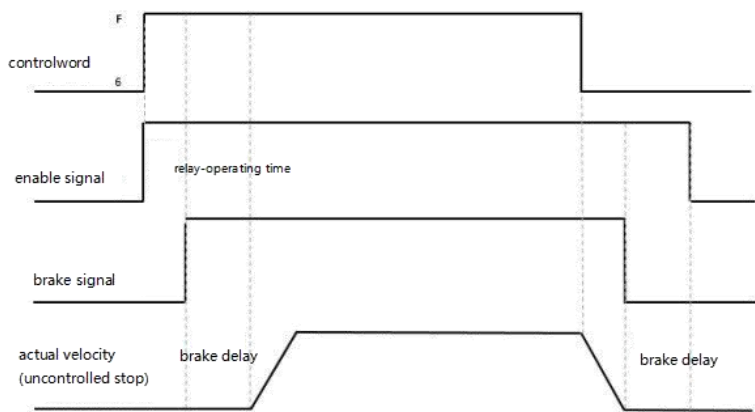


Figure 5-8 Motor brake sequence when quick stop mode is 2

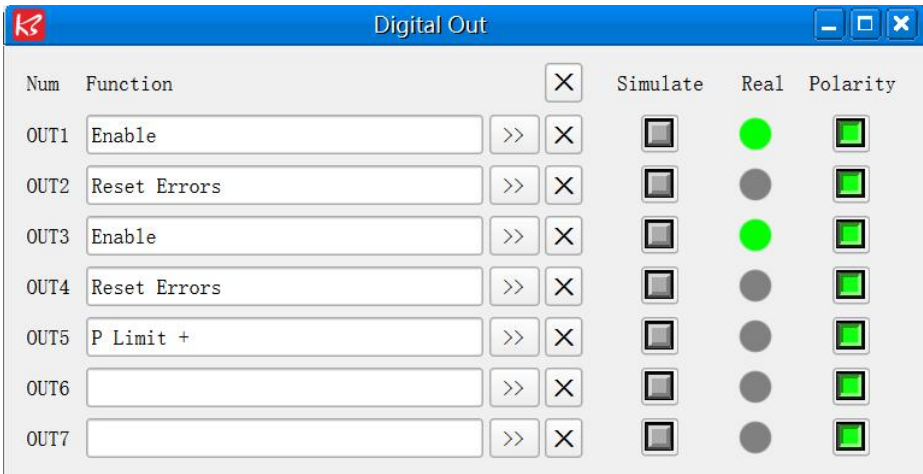


**Note**  
After the motor accessory is set to 1, the load drop will be disabled, and the brake delay can be appropriately increased. If adjusting the brake delay cannot improve the problem, check whether the brake torque meets the load demand.

5.7.2.1 Motor brake signal function introduction

OUT5 is the motor brake control output signal, which can be used to control the internal brake. 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.

Brake can also be manually controlled, after the "motor brake" of OUT5 is removed, click the simulation button, the effective output becomes green, indicating that the brake is opened, and then click the simulation button, the effective output becomes gray, indicating that the brake is closed. This feature is for debugging only!



### 5.7.3 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 5-20 Stop controlling related objects

| Internal address | Bits      | Name               | Description                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------|-----------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 605A.00          | Integer16 | Quick_Stop_Mode    | quick stop mode<br>(Controlword.bits.2=0, eg:Controlword=0x0F->0x0B)<br>0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>5: stop with profile deceleration, stay in quick stop active<br>6: stop with quick stop deceleration, stay in quick stop active<br>18: using motor winding for brake even encoder is wrong |
| 605B.00          | Integer16 | Shutdown_Stop_Mode | Shutdown stop mode<br>The control word is switched to 0x06, and the motor switches from the lock shaft to the loose shaft state<br>0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>18: using motor winding for brake even encoder is wrong                                                                         |
| 605C.00          | Integer16 | Disable_Stop_Mode  | Disable stop mode<br>Stop mode when bit3 in the control word is set to 0<br>For example, the control word is changed from 0x0F to 0x07<br>0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>18: using motor winding for brake even encoder is wrong                                                                  |

|         |            |                 |                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------|------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 605D.00 | Integer16  | Halt_Mode       | <p>Halt mode</p> <p>Pause mode when bit8 in the control word is set to 1</p> <p>For example, the control word is changed from 0x0F to 0x10F</p> <p>1: stop by current ramp</p> <p>2: stop by quick stop deceleration</p>                                                                                                                                                                                               |
| 605E.00 | Integer16  | Fault_Stop_Mode | <p>Fault stop mode</p> <p>The false stop mode will be activated after the motor is alerted in the locked shaft state.</p> <p>0: stop without control</p> <p>1: stop by using ramp, then switch off</p> <p>2: stop by using quick stop deceleration, then switch off</p> <p>18: using motor winding for brake even encoder is wrong</p>                                                                                 |
| 6084.00 | Unsigned32 | Profile_Dec     | Deceleration of trapezoidal curve                                                                                                                                                                                                                                                                                                                                                                                      |
| 6085.00 | Unsigned32 | Quick_Stop_Dec  | Deceleration for quick stop                                                                                                                                                                                                                                                                                                                                                                                            |
| 2340.01 | Unsigned8  | Step_Stop_Mode  | <p>The step mode stop enable is only effective under position control.</p> <p>When the position reaches the signal output, the motor locks the shaft by step (that is, the driver passes direct current to the motor to keep the motor locked shaft), and the lock shaft current is set by step stop current (2340.02).</p> <p>0: disables the function in step mode.</p> <p>1: disables the function in step mode</p> |
| 2340.02 | Integer16  | Step_Stop_Amp   | The stop current after the step stop mode is enabled                                                                                                                                                                                                                                                                                                                                                                   |

## 5.7.4 Absolute value system instruction

### 5.7.4.1 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 5-21 Absolute value encoder parameters

| Internal address | Bits      | Name                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Default |
|------------------|-----------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 2690.00          | Unsigned8 | Communication encoder data reset | <p>Communication encoder command</p> <p>Write:</p> <p>1: clear encoder status</p> <p>2: Read the fault word, the fault status can be viewed at 0x30510110</p> <p>3: Clear encoder status and multi-turn data</p> <p>8 Reset the status flag of the encoder</p> <p>9 Clear multi-lap data</p> <p>10 Reset encoder status flag and clear multi-turn data operation</p> <p>12 Clear the single-turn data (requires the manufacturer's password)</p> <p>Read:</p> <p>bit 0: 1 = Command can be entered</p> <p>bit 1: 1 = Last command execution completed</p> <p>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!</p> | 1       |

|         |            |                               |                                                                                                                                                                                                                                                                                                                  |   |
|---------|------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 2680.00 | Unsigned16 | Warning status word           | Encoder alarm status word bit 0: battery alarm<br>bit 1: Hybrid alarm (overspeed, overtemperature)<br>bit 2: Encoder busy (motor speed too high at power-on)<br>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 | Unsigned8  | Encoder multi-turn prohibited | 0: default<br>1: Use the multi-turn encoder as a single-turn encoder                                                                                                                                                                                                                                             | 0 |
| 3051.01 | Unsigned16 | Encoder warning message       | Help:encoder warning messages<br>Nikon internal error of encoder<br>Bit0: BATT<br>Bit1: MTERR<br>Bit2: 0<br>Bit3: OVSPD<br>Bit4: MEMERR<br>Bit5: STERR<br>Bit6: PSERR<br>Bit7: BUSY<br>Bit8: MEMBUSY<br>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.

**5.7.4.2 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.

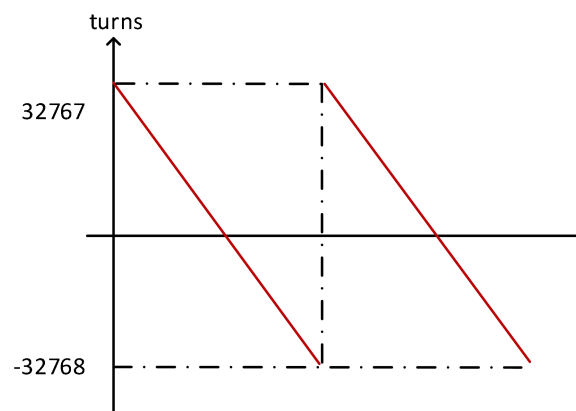


Figure 5-9 Multi-turn data range

### 5.7.4.3 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.

### 5.7.4.4 Battery instruction

When the battery voltage is below 3.1V, the driver appears the warning status word 0001, but the driver does not alarm for shutdown 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 high humidity environments, and without dust or inflammable and explosive substances.
- During transportation and assembly, be careful not to impact and squeeze the battery, so as not to damage the battery.
- Before using a battery that has been placed for a long time, check whether the battery is swollen or not.
- Do not short-circuit the positive and negative poles of the battery, otherwise the battery may burst.
- The battery is a one-time item, do not charge the battery.
- Please dispose of batteries according to local regulations.

Table 5-22 Battery specification

|                                      |                                  |
|--------------------------------------|----------------------------------|
| 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℃                        |

### 5.7.5 Motor configuration instructions

FD1X5 uses the Tonomagawa encoder by default. When the motor needs to be configured, the motor parameters can be configured in the following ways

Relevant parameter:

| Internal address | Bits       | Name                          | Description                                                                                                                                                                             |
|------------------|------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3041.06          | Unsigned8  | Use an in-house motor library | 1: The user enters the motor model manually and uses the motor parameters corresponding to the motor library in the driver<br>2: Read and use the motor parameters saved in the encoder |
| 6410.01          | Unsigned16 | Motor model                   | Motor code (generally the first two digits of S/N code on the motor nameplate)                                                                                                          |

If you need to use FD1X5 to adapt to the SMC-Q series motor of FD1X4-005 (Tamagawa protocol) :

- I. Use the internal motor parameters of the driver: use the internal motor library to set 1 + input Q series motor model (such as Q7). After saving the motor parameters and restarting, initialize the control parameters. (Currently FD1X5 supports setting 'Q0/Q1/Q2/Q4/Q6/Q7/Q8', and SMC-Y series motor code is not added in the bottom layer)
- II. Automatically read the internal data of the encoder: use the internal motor library set to 2 + motor model (such as Q4), save the motor parameters and restart.

To use FD1X5 compatible SMK multi turn motor (Such as multi-turn R4 motor :SMK60S-0040-30QAK-5DSA):

I. Automatically read the internal data of the encoder: use the internal motor library set to 2 + motor model (such as R4), save the motor parameters and restart.

#### Method 1:

Manually input the motor model and configure the motor parameters.

Step 1. Correctly connect the encoder wire of the motor according to the encoder definition

Step 2. Set internal motor library to 1

Step 3. Set "Motor Model" to the corresponding "Motor code" on the motor nameplate or open the corresponding motor drawing to find the corresponding "Motor code"

Step 4. Save the motor parameters and restart

Step 5. After the restart, initialize the control parameters, store the control parameters, and restart again

#### Method 2:

Set up the internal motor library to read the motor parameter configuration, Multi-turn motor must use this setting.

Step 1. Correctly connect the encoder wire of the motor according to the encoder definition

Step 2. Set internal motor library to 2

Step 3. There are two configuration methods:

① Set "Motor Model" to 00, After restart, the corresponding control parameters are automatically generated according to the read motor parameters, namely, current/speed/position loop parameters, no need to manually initialize the control parameters

② Set "Motor Model" to the Motor code on the motor nameplate (e.g. R4), then the motor data inside the encoder will be automatically read after restart, but the control ring parameters will not be initialized.

Step 4. Save the motor parameters and restart

#### Method 3:

According to the motor drawing, manual configuration of motor parameters, FD1X5 driver currently only supports Tama Agawa communication encoder

Step 1. Correctly connect the encoder wire of the motor according to the encoder definition

Step 2. Set internal motor library to 1

Step 3. Set "Motor Model" to VX (Tamagawa Encoder)

Step 4. Set Feedback Type to 04

Step 5. Set the "feedback accuracy" to the motor encoder feedback accuracy:

- Incremental: Number of encoder lines x 4
- Communication type: the resolution of a single turn is less than 16 bits set to the actual encoder resolution; Single-turn resolution higher than 16 bits is generally set to 65536 to prevent position overflow.

Step 6. Set Feedback Cycle as follows:

- Incremental: the number of pulses per turn of the motor
- Communication type: Define the encoder type, for example, multi-turn 16-bit, single turn 17-bit, and feedback period set to 0x1617 for the Tameragawa encode

Step 7. Set Excitation Mode as follows:

- Excitation mode 0: Use current to search for excitation
- Excitation mode 1: Use the data defined by the manufacturer to find excitation
- Excitation mode 10: micro-jitter excitation, determine the direction of operation
- Excitation Mode 9: Use custom excitation to find excitation

"Excitation current" setting is smaller than the rated current, generally 0.75 times the rated current of the motor

Step 8. Set Motor Ilt Current to the rated current of the motor

Step 9. Configure other motor parameters according to the drawing

Step 10. Save the motor parameters and control parameters and restart

Step 11. After the restart, initialize the control parameters, save the control parameters, and restart

#### Common problems in configuration:

| Common problem                                                                    | Solution                                                                                                                                        |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| The motor model cannot be entered or entered incorrectly                          | This drive does not support manual input of this motor model, please try to use method 3 for manual configuration                               |
| When using internal motor library 2, the motor model cannot be read after restart | Try to use mode 1, manually enter the motor model to configure or use mode 3 to manually configure the motor parameters                         |
| After configuring the motor parameters, the encoder is still warned of failure    | Please check whether the motor configuration parameters are incorrect and connect the encoder cable of the motor correctly                      |
| After configuring the motor parameters, restart and alarm 0004 separately         | When the multi-turn motor is powered on for the first time, the alarm of the encoder can be cleared by resetting the status mark of the encoder |

## Chapter 6 Performance adjustment

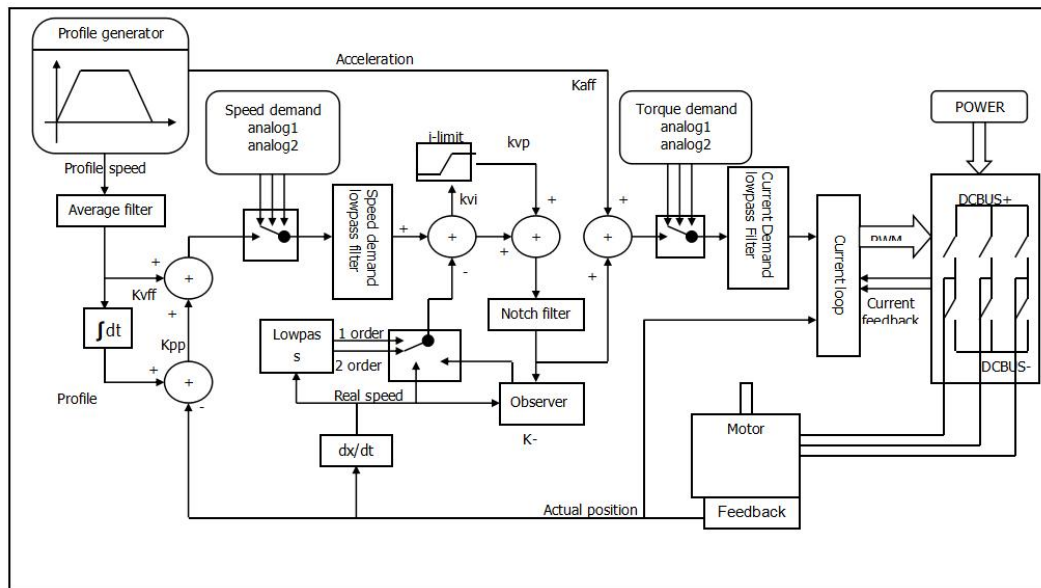


Figure 6 - 1 Servo system control block diagram

Figure 6-1 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. For the servo system, good control loop parameters can improve the performance of the servo and better meet the field process requirements. Therefore, it is necessary to adjust good control loop parameters.

The parameters of speed loop and position loop should be adjusted during debugging. The speed loop parameter is related to the load inertia of the whole mechanical system converted to the motor shaft. The position loop is the outermost control loop of the servo system and is related to the motor action mode, that is, the field application. The current loop is the innermost control loop in the servo system, and the current loop 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.



### Remind

- 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

## 6.1 Online auto-tuning

The online auto-tuning function of the servo drive does not need to be separated from the controller program, and can be turned on at the touch of a button during the movement of the machine, by automatically calculating the load inertia and automatically adjusting the gain to the load state.

Table 6-1 Online auto-tuning function related parameters

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

## 6.2 Manual tuning

### 6.2.1 Speed loop setting method

Table 6-2 Speed loop parameter

| Internal address | Name            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Default | Range    |
|------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|
| 60F901           | kvp[0]          | Setting reaction speed of speed loop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | /       | 1-32767  |
| 2FF00A           | Velocity_BW     | Changing this parameter changes kvp[0] by the inertia ratio                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | /       | 1-700    |
| 60F902           | Kvi[0]          | Integral velocity loop gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | /       | 0-1023   |
| 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.<br>Writing this parameter sets 0x60F902 to 0, and the value is 0x60F907                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | /       | 0-16384  |
| 60F905           | Speed_Fb_N      | Used to set speed feedback filter bandwidth.<br>Filter bandwidth=100+Speed_Fb_N*20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 7       | 0-45     |
| 60F906           | Speed_mode      | Used to set the speed feedback mode<br>0: 2nd order FB LPF<br>1: Directly feedback the original velocity<br>2: Speed feedback after velocity observer<br>4: Speed feedback after 1st order LPF<br>10: Speed feedback after 2nd order LPF and the speed command is filtered by a 1st order LPF. Both filters have the same bandwidth. 11: The speed command is filtered by a 1st order LPF<br>12: Speed feedback after speed observer, the speed command is filtered by a 1st order LPF<br>14: Speed feedback after 1st order LPF and the speed command is filtered by a 1st order LPF. Both filters have the same bandwidth<br>Bit7:<br>1: Use 8K Velocity loop sampling frequency and 2K position loop sampling frequency (for 23-bit encoders)<br>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   |

### Speed 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:

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

|                  |                                                                   |
|------------------|-------------------------------------------------------------------|
| Kt               | Motor torque constant, unit N.m/Arms*100                          |
| J                | System moment of inertia, unit kg*m <sup>2</sup> *10 <sup>6</sup> |
| B                | Speed loop bandwidth, unit Hz                                     |
| I <sub>Max</sub> | Maximum current (6510.03) in DEC                                  |
| Encoder          | Encoder resolution                                                |

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 actual speed curve should be tight follows the target command and does not have velocity oscillations.

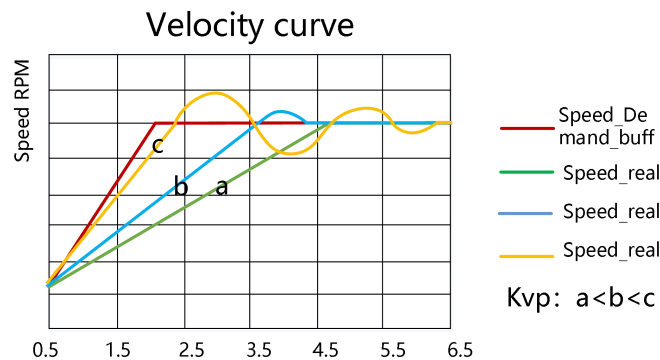


Figure 6-2 Speed step curve after Kvp adjustment



#### 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.

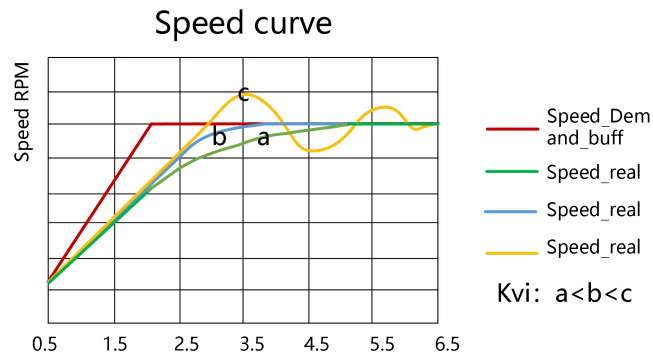


Figure 6-3 Speed step curve after Kvi adjustment

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.



#### Remind

- $Kvi32 = 1/32$  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 application. 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  $F = \text{speed feedback filter} * 20 + 100$  [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:

$$f = \frac{1}{2 \times \pi \times T_s \times \text{Output\_Filter\_N}}$$

Output\_Filter\_N      Output filter setting(60F9.15), Unit DEC

Ts                      Constant 62.5us

**Remind**

- 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.

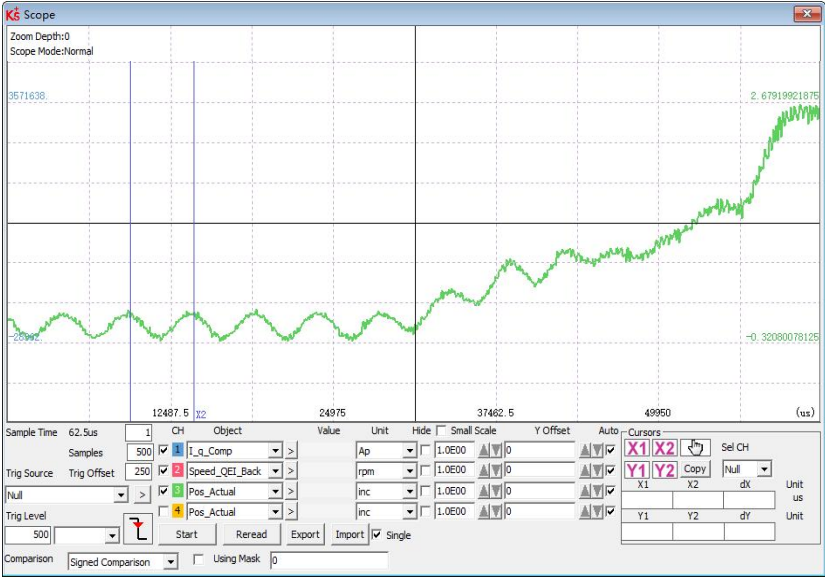
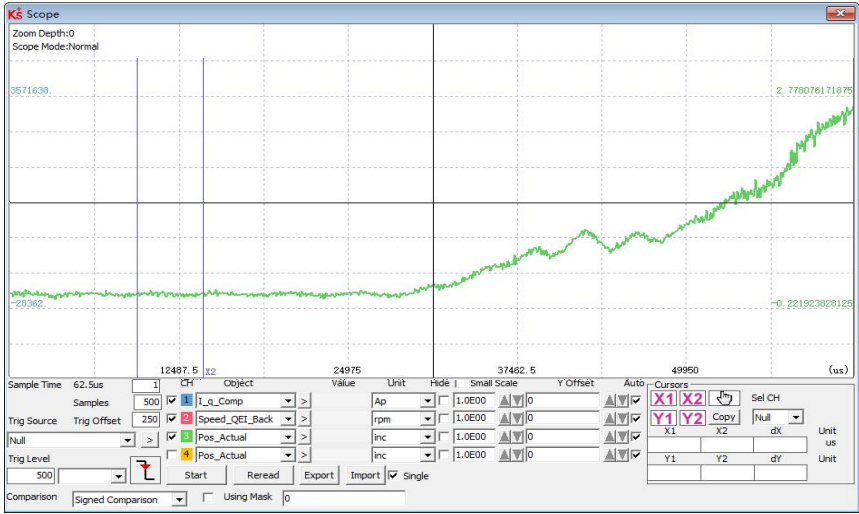
Table 6-3 Notch filter parameter

| Internal address | Name                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Default | Range    |
|------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|
| 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       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |          |
| 60F904           | Notch filter control | Notch filter control of Speed loop<br>Bit0~1: The BCD code composed of two bits determines the filter to be turned on.<br>Bit4: 1 :Indicates FFT analysis using actual current, 0 :Indicates that the target current is used for analysis<br>Bit5: 1: Indicates use actual speed for FFT analysis, 0: Indicates do not use actual speed for FFT analysis<br>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 to 1, it indicates to open a single notch filter, and the frequency of the filter is set by the notch filter (60F9.03) .

Table 6-4 Single notch filter debugging case

| Description                                                                                                                                                                                                                                               | Process                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Limit output current of drive                                                                                                                                                                                                                             | The target current limit is adjusted through the basic operating 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

The high order notch filter technology is acquired, the mechanical resonance frequency of the load is measured automatically, and the tuning results are written into filter 0 and filter 1. The FD1X5 open a total of 4 notch filters,

filter 0 and filter 1 are automatically adjusted notch filters, filter 2 and filter 3 are manually adjusted notch filters, and the corresponding filters can be turned on/off by the notch filter control.

When the notch filter control (60F9.04) is set to 128DEC, it indicates that the actual current 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.

## 6.2.2 Position loop setting method

Table 6-5 Position loop parameter list

| Internal address | Name                       | Description                                                                                                                                                                            | Default | Range    |
|------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|
| 60FB01           | Kpp[0]                     | Set the response bandwidth of the position loop, unit: 0.01Hz                                                                                                                          | 10      | 0 ~ 327  |
| 2FF01A           | K_Velocity_FF%             | 0 means no feedforward, 1000 means 100% feed forward                                                                                                                                   | 1000    | 0 ~ 4000 |
| 2FF01B           | K_Acc_FF%                  | This parameter can only be set if the inertia ratio is set correctly. If you do not know the inertia ratio, please directly set the position loop acceleration feedforward (0x60FB03). | /       | 0-4000   |
| 60FB05           | Pos_Filter_N               | The average of N effective target velocities                                                                                                                                           | 1       | 1~255    |
| 2FF00E           | Max_Followin_error_16      | Maximum following error (6065.00)=100* Maximum following error 16                                                                                                                      | 10000   | /        |
| 60FB04           | Position loop filter order | Set value<br>1: Use trapezoidal curve mode<br>3: Use S curve 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.  $Kpp = 103 * \text{position loop bandwidth}$ . The bandwidth of the position loop cannot exceed the bandwidth of speed loop. It is recommended that the setting value of the position loop bandwidth be less than one quarter of the bandwidth of the speed 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.

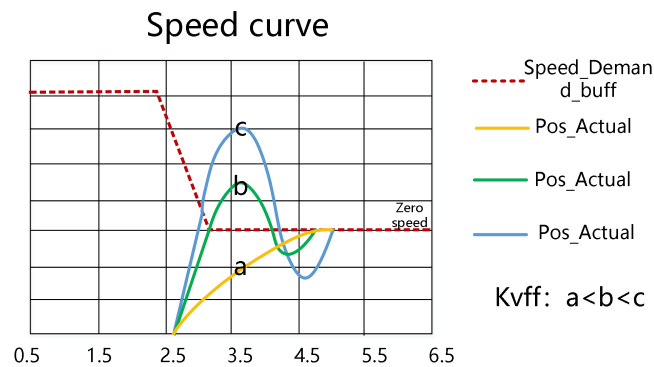


Figure 6-4 Speed step curve after Kvff adjustment

**Step 3: Position loop acceleration feedforward 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:

$$\text{ACC}_{\%} = 6746518 / K_{\text{Acc\_FF}} / \text{Easy\_Kload} * 100$$

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.

**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 command 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.

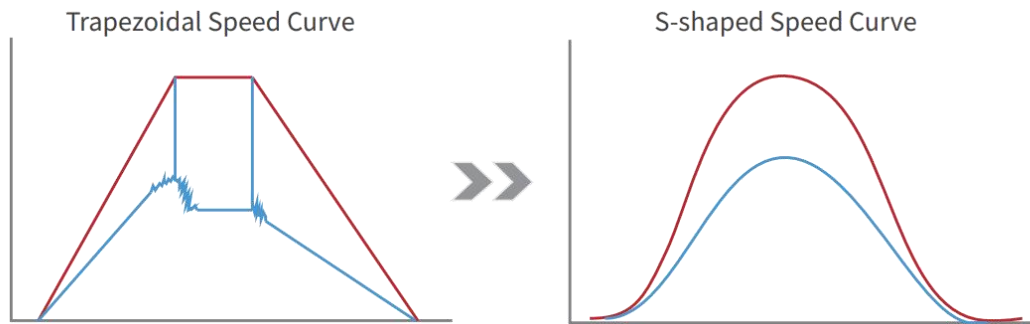


Figure 6-5 S-shaped speed step curve

**Note**

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

## 6.3 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 6-6 Gain switching parameter

| Internal address | Type       | Name           | Description                                                                                                                                                                                                                                                                                                   | Unit    |
|------------------|------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 60F9.01          | Unsigned16 | Kvp[0]         | Gain parameter called when PI pointer is 0                                                                                                                                                                                                                                                                    | Dec, Hz |
| 60F9.02          | Unsigned16 | Kvi[0]         |                                                                                                                                                                                                                                                                                                               | Dec     |
| 60FB.01          | Integer16  | Kpp[0]         |                                                                                                                                                                                                                                                                                                               | Dec. Hz |
| 2340.04          | Unsigned16 | Kvp[1]         | Gain parameter called when PI pointer is 1                                                                                                                                                                                                                                                                    | Dec, Hz |
| 2340.05          | Unsigned16 | Kvi[1]         |                                                                                                                                                                                                                                                                                                               | Dec     |
| 2340.06          | Unsigned16 | Kpp[1]         |                                                                                                                                                                                                                                                                                                               | Dec. Hz |
| 2340.07          | Unsigned16 | Kvp[2]         | Gain parameter called when PI pointer is 2                                                                                                                                                                                                                                                                    | Dec, Hz |
| 2340.08          | Unsigned16 | Kvi[2]         |                                                                                                                                                                                                                                                                                                               | Dec     |
| 2340.09          | Unsigned16 | Kpp[2]         |                                                                                                                                                                                                                                                                                                               | Dec. Hz |
| 2340.0A          | Unsigned16 | Kvp[3]         | Gain parameter called when PI pointer is 3                                                                                                                                                                                                                                                                    | Dec, Hz |
| 2340.0B          | Unsigned16 | Kvi[3]         |                                                                                                                                                                                                                                                                                                               | Dec     |
| 2340.0C          | Unsigned16 | Kpp[3]         |                                                                                                                                                                                                                                                                                                               | Dec. Hz |
| 60F9.28          | Unsigned8  | PI point       | Indicates the PI parameter being called                                                                                                                                                                                                                                                                       | Dec     |
| 60F9.09          | Unsigned8  | 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:<br>0: PI pointer (60F9.28)=0;<br>1: PI pointer (60F9.28)=1; | Dec     |

6.3.1 Gain switching method

The driver provides three ways to dynamically select PI control parameters:

Method 1: Switch PI through a digital input port

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 6-7 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                   |

Example:



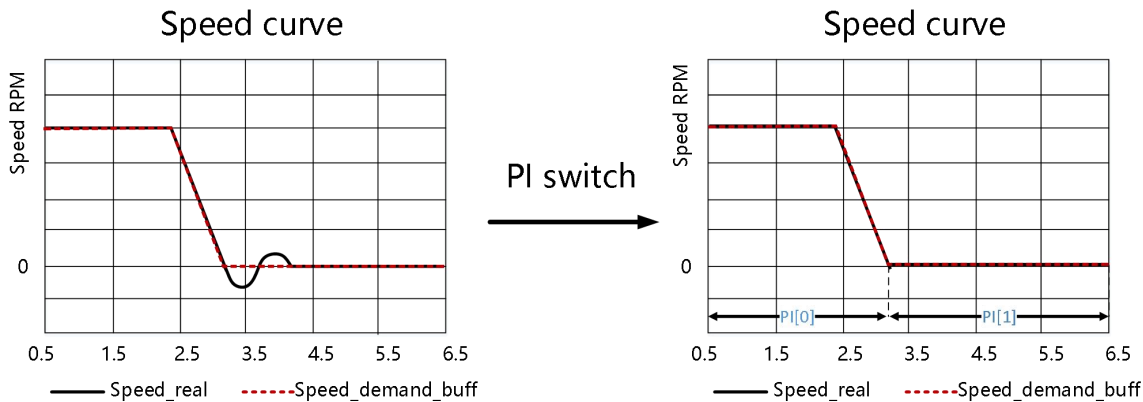
Figure 6-6 Gain switch definition

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.

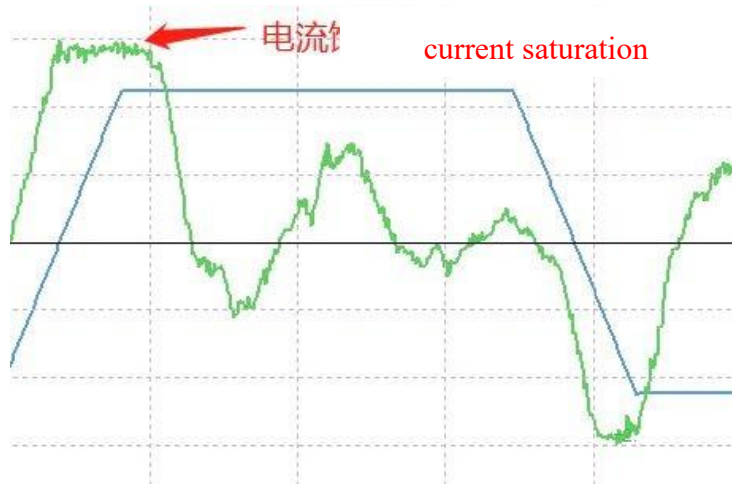


Method 3: Set PI pointer value directly through communication

## 6.4 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 follow the bandwidth limits 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 7 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; T: traceable, L: read in the control ring, B: need to save and restart
- A complete CANopen address is in the format of: 60400010 (control word)
- Modbus address is a 4-digit hexadecimal number
- A complete Modbus address format is: 3100 (control word)

## Object list

| Category                               | Index | Sub-index | Modbus address | Data type  | Name              |
|----------------------------------------|-------|-----------|----------------|------------|-------------------|
| Category 1<br>[Input/Output Settings]  | 2010  | 01        | 0810           | Unsigned16 | Din_Polarity      |
|                                        |       | 02        | 0820           | Unsigned16 | Din_Simulate      |
|                                        |       | 03        | 0830           | Unsigned16 | Din1_Function     |
|                                        |       | 04        | 0840           | Unsigned16 | Din2_Function     |
|                                        |       | 05        | 0850           | Unsigned16 | Din3_Function     |
|                                        |       | 06        | 0860           | Unsigned16 | Din4_Function     |
|                                        |       | 0A        | 08A0           | Unsigned16 | Din_Real          |
|                                        |       | 0D        | 08D0           | Unsigned16 | Dout_Polarity     |
|                                        |       | 0E        | 08E0           | Unsigned16 | Dout_Simulate     |
|                                        |       | 0F        | 08F0           | Unsigned16 | Dout1_Function    |
|                                        |       | 10        | 0900           | Unsigned16 | Dout2_Function    |
|                                        |       | 14        | 0940           | Unsigned16 | Dout_Real         |
|                                        |       | 18        | 0980           | Unsigned16 | Zero_Speed_Window |
|                                        |       | 19        | 0990           | Unsigned8  | Limit_Function    |
| Category 2<br>[Speed/position setting] | 2020  | 01        | 0C10           | Integer32  | Din_Pos0          |
|                                        |       | 02        | 0C20           | Integer32  | Din_Pos1          |
|                                        |       | 03        | 0C30           | Integer32  | Din_Pos2          |
|                                        |       | 04        | 0C40           | Integer32  | Din_Pos3          |
|                                        |       | 05        | 0C50           | Integer32  | Din_Speed0        |
|                                        |       | 06        | 0C60           | Integer32  | Din_Speed1        |
|                                        |       | 07        | 0C70           | Integer32  | Din_Speed2        |
|                                        |       | 08        | 0C80           | Integer32  | Din_Speed3        |
|                                        |       | 10        | 0D00           | Integer32  | Din_Pos4          |
|                                        |       | 11        | 0D10           | Integer32  | Din_Pos5          |
|                                        |       | 12        | 0D20           | Integer32  | Din_Pos6          |
|                                        |       | 13        | 0D30           | Integer32  | Din_Pos7          |
|                                        |       | 14        | 0D40           | Integer32  | Din_Speed4        |
|                                        |       | 15        | 0D50           | Integer32  | Din_Speed5        |
|                                        |       | 16        | 0D60           | Integer32  | Din_Speed6        |
|                                        |       | 17        | 0D70           | Integer32  | Din_Speed7        |
|                                        |       | 0F        | 0CF0           | Unsigned16 | Din_Control_Word  |

| Category                                        | Index | Sub-index | Modbus address | Data type  | Name                 |
|-------------------------------------------------|-------|-----------|----------------|------------|----------------------|
| Category 3<br>[Pulse input Settings]            | 2508  | 01        | 1910           | Integer16  | Gear_Factor[0]       |
|                                                 |       | 02        | 1920           | Unsigned16 | Gear_Divider[0]      |
|                                                 |       | 03        | 1930           | Unsigned8  | PD_CW                |
|                                                 |       | 04        | 1940           | Integer32  | Gear_Master          |
|                                                 |       | 05        | 1950           | Integer32  | Gear_Slave           |
|                                                 |       | 06        | 1960           | Unsigned16 | PD_Filter            |
|                                                 |       | 09        | 1990           | Unsigned16 | Position_Window_time |
|                                                 |       | 0C        | 19C0           | Integer16  | Master_Speed         |
|                                                 |       | 0D        | 19D0           | Integer16  | Slave_Speed          |
| Category 4<br>[Error code]                      | 2601  | 00        | 1F00           | Unsigned16 | Erroe_State          |
|                                                 | 2602  | 00        | 2000           | Unsigned16 | Erroe_State 2        |
| Category 5<br>[Storage parameter setting]       | 2FF0  | 01        | 2910           | Unsigned8  | Store_Data           |
|                                                 |       | 03        | 2930           | Unsigned8  | Store_Motor_Data     |
| Category 6<br>[Control and status of equipment] | 6040  | 00        | 3100           | Unsigned16 | Controlword          |
|                                                 | 6041  | 00        | 3200           | Unsigned16 | Statusword           |
| Category 7<br>[Stop mode setting]               | 605A  | 00        | 3400           | Integer16  | Quick_Stop_Mode      |
|                                                 | 605B  | 00        | 3410           | Integer16  | Shutdown_Stop_Mode   |
|                                                 | 605C  | 00        | 3420           | Integer16  | Disable_Stop_Mode    |
|                                                 | 605D  | 00        | 3430           | Integer16  | Halt_Mode            |
|                                                 | 605E  | 00        | 3440           | Integer16  | Fault_Stop_Mode      |
| Category 8<br>[Working mode setting]            | 6060  | 00        | 3500           | Integer8   | Operation_Mode       |
| Category 9<br>[Basic parameter setting]         | 6063  | 00        | 3700           | Integer32  | Pos_Actual           |
|                                                 | 6065  | 00        | 3800           | Unsigned32 | Max_Following_Error  |
|                                                 | 6067  | 00        | 3900           | Unsigned32 | Target_Pos_Window    |
|                                                 | 606C  | 00        | 3B00           | Integer32  | Speed_Real           |
|                                                 | 6071  | 00        | 3C00           | Integer16  | Target_Torque%       |
|                                                 | 6073  | 00        | 3D00           | Unsigned16 | CMD_q_Max            |
|                                                 | 6078  | 00        | 3E00           | Integer16  | I_q                  |
|                                                 | 607A  | 00        | 4000           | Integer32  | Target_Position      |
|                                                 | 607C  | 00        | 4100           | Integer32  | Home_Offset          |
|                                                 | 607D  | 01        | 4410           | Integer32  | Soft_Positive_Limit  |
|                                                 |       | 02        | 4420           | Integer32  | Soft_Negative_Limit  |
|                                                 | 607E  | 00        | 4700           | Unsigned8  | Invert_Dir           |
|                                                 | 6080  | 00        | 4900           | Unsigned16 | Max_Speed_RPM        |
|                                                 | 6081  | 00        | 4A00           | Unsigned32 | Profile_Speed        |
|                                                 | 6083  | 00        | 4B00           | Unsigned32 | Profile_Acc          |
|                                                 | 6084  | 00        | 4C00           | Unsigned32 | Profile_Dec          |
|                                                 | 6085  | 00        | 3300           | Unsigned32 | Quick_Stop_Dec       |
|                                                 | 60F6  | 08        | 5880           | Integer16  | CMD_q                |
|                                                 | 60FD  | 00        | 6D00           | Unsigned32 | Digital_Inputs       |
|                                                 | 60FF  | 00        | 6F00           | Integer32  | Target_Speed         |
| Category 10<br>[Origin mode setting]            | 6098  | 00        | 4D00           | Integer8   | Homing_Method        |
|                                                 | 6099  | 01        | 5010           | Unsigned32 | Homing_Speed_Switch  |
|                                                 |       | 02        | 5020           | Unsigned32 | Homing_Speed_Zero    |
|                                                 |       | 05        | 5050           | Unsigned8  | Home_Offset_Mode     |
|                                                 | 609A  | 00        | 5200           | Unsigned32 | Homing_Accelaration  |
| Category 11<br>[Speed loop parameters]          | 60F9  | 01        | 6310           | Unsigned16 | Kvp[0]               |
|                                                 |       | 02        | 6320           | Unsigned16 | Kvi[0]               |
|                                                 |       | 05        | 6350           | Unsigned8  | Speed_Fb_N           |
|                                                 |       | 07        | 6370           | Unsigned16 | Kvi/32               |
|                                                 |       | 0A        | 63A0           | Integer32  | Target_Speed_Window  |
|                                                 |       | 14        | 6440           | Unsigned16 | Zero_Speed_Time      |

| Category                                 | Index | Sub-index | Modbus address | Data type  | Name           |
|------------------------------------------|-------|-----------|----------------|------------|----------------|
| Category 12<br>[Position loop parameter] | 60FB  | 01        | 6810           | Integer16  | Kpp[0]         |
|                                          |       | 02        | 6820           | Integer16  | K_Velocity_FF  |
|                                          |       | 03        | 6830           | Integer16  | K_Acc_FF       |
|                                          |       | 05        | 6850           | Unsigned16 | Pos_Filter_N   |
| Category 13<br>[Alarm parameters]        | 6410  | 18        | 7180           | Integer16  | Temp_Motor_Ref |
|                                          |       | 19        | 7190           | Integer16  | Temp_Motor     |
|                                          | 6510  | 07        | 8670           | Unsigned16 | Voltage_Under  |
|                                          |       | 08        | 8680           | Unsigned16 | Chop_Voltage   |
|                                          |       | 09        | 8690           | Unsigned16 | Voltage_Over   |

## 7.1 Mode and Control (0x6040)

| Name         | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------|----------|--------|--------------------|------------|------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Control word | 60400010 | 3100   | RWLTM              | Unsigned16 | HEX  | 0006          | 0x06: Loose shaft<br>0x0F: Lock shaft<br>0x0B: Quick stop, load stop - voltage disconnect<br>0x2F→3F: Enter the absolute positioning mode<br>0x4F→5F: Enter relative positioning mode<br>0x103F: Immediate absolute positioning as target position changes<br>0x0F-1F: homing<br>0X86: Error reset                                                                                                                                      |
| Status word  | 60410010 | 3200   | RLTM               | Unsigned16 | HEX  | 0218          | The status byte shows the status of the drive<br>bit0: Ready_on<br>bit1: Switched_on<br>bit2: Operation_enable<br>bit3: Fault<br>bit4: Voltage_enable<br>bit5: Quick_stop<br>bit6: Switchon_disabled<br>bit7: Warning<br>bit8: Internal retention<br>bit9: Remote<br>bit10: Target_reached<br>bit11: Internal limit activation<br>bit12: Pulse response<br>bit13: Following_Error<br>bit14: Commutation_Found<br>bit15: Reference_Found |

|                                                           |          |      |      |            |     |      |                                                                                                                                                                                                                            |
|-----------------------------------------------------------|----------|------|------|------------|-----|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operating mode                                            | 60600008 | 3500 | RWLM | Integer8   | DEC | -4   | 1: Positioning mode with position ring<br>3: Speed mode with position loop<br>4: Torque mode<br>-3: Speed loop(Immediate velocity mode)<br>-4: Pulse mode<br>6: Homing mode<br>7 : Motion interpolation based on CANopen   |
| Absolute/<br>relative<br>position<br>control<br>selection | 20200F10 | 0CF0 | RWSL | Unsigned16 | HEX | 002F | When the "Drive Enable" function is configured to Din and the corresponding Din valid input is 1, the "Control word" (6040.00) is set to this value;<br>0x2F: Absolute position control<br>0x4F: Relative position control |

## 7.2 Metrical data

| Name                 | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                        |
|----------------------|----------|--------|--------------------|------------|------|---------------|----------------------------------------------------------------------------------------------------|
| Actual position      | 60630020 | 3700   | RLTM               | Integer32  | inc  | 0             | Actual motor position                                                                              |
| Actual current value | 60780010 | 3E00   | RLTM               | Integer16  | Ap   | 0.00          | Rated current                                                                                      |
| Input port status    | 60FD0020 | 6D00   | RLTM               | Unsigned32 | HEX  | 0             | bit0: negative limit switch<br>bit1: positive limit switch<br>bit2: home switch<br>bit4: interlock |
| Actual speed         | 606C0020 | 3B00   | RLTM               | Integer32  | rpm  | 0.00          | rpm                                                                                                |



### Note

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

## 7.3 Target object (0x607A)

| Name                                | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                                                       |
|-------------------------------------|----------|--------|--------------------|------------|------|---------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Velocity position direction control | 607E0008 | 4700   | RWSL               | Unsigned8  | DEC  | 0             | Run polarity reversal<br>0: Counterclockwise is the positive direction<br>1: Clockwise is the positive direction                  |
| Target position                     | 607A0020 | 4000   | RWLTM              | Integer32  | inc  | 0             | 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   | RWLTM              | Unsigned32 | rpm  | 0.00          | Trapezoidal velocity (rpm) in operating mode 1                                                                                    |
| Target speed                        | 60FF0020 | 6F00   | RWLTM              | Integer32  | rpm  | 0.00          | Target speed in mode 3 and -3,                                                                                                    |
| Max velocity limit                  | 60800010 | 4900   | RWL                | Unsigned16 | rpm  | 5000          | Default:5000rpm                                                                                                                   |

|                          |          |      |        |            |       |        |                                                                                |
|--------------------------|----------|------|--------|------------|-------|--------|--------------------------------------------------------------------------------|
| Trapezoidal acceleration | 60830020 | 4B00 | RWSLTM | Unsigned32 | rps/s | 100.00 | Default: 100rps/s                                                              |
| Trapezoidal deceleration | 60840020 | 4C00 | RWSLTM | Unsigned32 | rps/s | 100.00 | Default: 100rps/s                                                              |
| Target torque            | 60710010 | 3C00 | RWL    | Integer16  | %     | 0.00   | Torque command in torque mode, the percentage of target torque to rated torque |
| Target current           | 60F60810 | 5880 | RWLTM  | Integer16  | Ap    | 0.00   | Current command in torque mode                                                 |
| Target current limit     | 60730010 | 3D00 | RWSLTM | Unsigned16 | Ap    | 48.00  | Current instruction maximum                                                    |

**Note**

- Velocity address: 0x60810020, 0x60800020, 0x60FF0020
- The unit conversion method is  $DEC = [(rpm * 512 * \text{encoder resolution}) / 1875]$
- Acceleration and deceleration address: 0x60830020, 0x60840020,
- The unit conversion method is  $DEC = [(rps/s * 65536 * \text{encoder resolution}) / 4000000]$
- Current address: 0x60710010, 0x60730010
- The unit conversion method is  $1Arms = [2048 / (I_{peak} / 1.414)]$  DEC Note:  $I_{peak}$  is peak current (6510.03)

## 7.4 Multi-segment position/Multi-segment speed (0x2020)

| Name                           | CANopen  | Modbus | Command Properties | Data type | Unit | Initial value | Explanation                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------|----------|--------|--------------------|-----------|------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Multi-stage position control 0 | 20200120 | 0C10   | RWSL               | Integer32 | DEC  | 0             | Din position [x] is meaningful only if at least one of Din Position Index 0, Din Position Index 1, or Din Position Index 2 is configured to Din; x=0~7, is the BCD code composed of the three indexes; bit0: Din Location index 0<br>bit1: Din Location index 1<br>bit2: Din Location index 2<br>When one of the bits is configured to Din, the unconfigured bits are equal to 0 |
| Multi-stage position control 1 | 20200220 | 0C20   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |
| Multi-stage position control 2 | 20200320 | 0C30   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |
| Multi-stage position control 3 | 20200420 | 0C40   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |
| Multi-stage Position Control 4 | 20201020 | 0D00   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |
| Multi-stage Position Control 5 | 20201120 | 0D10   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |
| Multi-stage position control 6 | 20201220 | 0D20   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |
| Multi-stage position control 7 | 20201320 | 0D30   | RWSL               | Integer32 | DEC  | 0             |                                                                                                                                                                                                                                                                                                                                                                                  |

| Name                        | CANopen  | Modbus | Command Properties | Data type | Unit | Initial value | Explanation                                                                                                                                                                                                                                                                           |
|-----------------------------|----------|--------|--------------------|-----------|------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Multi-stage speed control 0 | 20200520 | 0C50   | RWSL               | Integer32 | rpm  | 0.00          | The speed instruction of the driver is specified by the DIN speed [x], where the x is a BCD code composed of the following signals:<br>bit 0: Din speed index 0;<br>bit 1: Din speed index 1;<br>bit 2: Din Speed index 2;<br>The situation where all the medians are 0 cannot occur; |
| Multi-stage speed control 1 | 20200620 | 0C60   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |
| Multi-stage speed control 2 | 20200720 | 0C70   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |
| Multi-stage speed control 3 | 20200820 | 0C80   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |
| Multi-stage speed control 4 | 20201420 | 0D40   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |
| Multi-stage speed control 5 | 20201520 | 0D50   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |
| Multi-stage speed control 6 | 20201620 | 0D60   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |
| Multi-stage speed control 7 | 20201720 | 0D70   | RWSL               | Integer32 | rpm  | 0.00          |                                                                                                                                                                                                                                                                                       |

## 7.5 Performance object (0x6065)

| Name                           | CANopen  | Modbus | Command Properties | Data type  | Unit    | Initial value | Explanation                                                                                                                                                                                 |
|--------------------------------|----------|--------|--------------------|------------|---------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Max following error            | 60650020 | 3800   | RWSLM              | Unsigned32 | inc     | 524288        | Following error value alarm value<br>Default 524288inc                                                                                                                                      |
| target location window         | 60670020 | 3900   | RWSL               | Unsigned32 | inc     | 327           | "Target location reached " target range, Default 10inc                                                                                                                                      |
| reach position time window     | 25080910 | 1990   | RWSLTM             | Unsigned16 | ms      | 10            | Target ( location.velocity ) reach time window , Determine the reach position signal together with 0x60670020                                                                               |
| Reach speed window             | 60F90A20 | 63A0   | RWSL               | Integer32  | inc/16s | 178956        | 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   | RWSL               | Unsigned16 | inc/ms  | 3.00          | Error window when actual speed is 0                                                                                                                                                         |
| Zero speed output time         | 60F91410 | 6440   | RWSL               | Unsigned16 | ms      | 10.00         | 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   | RWSL               | Integer32  | DEC     | 0             | Soft limit positive setting                                                                                                                                                                 |

|                             |          |      |      |           |     |   |                                                                                                                                      |
|-----------------------------|----------|------|------|-----------|-----|---|--------------------------------------------------------------------------------------------------------------------------------------|
| Soft limit negative setting | 607D0220 | 4420 | RWSL | Integer32 | DEC | 0 | Soft limit negative setting                                                                                                          |
| Limit function definition   | 20101908 | 0990 | RWSL | Unsigned8 | DEC | 1 | Used to set the action after the limit is reached<br>0: If there is a limit after finding the origin, it will alarm<br>1: do nothing |

## 7.6 Homing control (0x6098)

| Name                        | CANopen  | Modbus | Command Properties | Data type  | Unit  | Initial value | Explanation                                                                                                                                                                                                    |
|-----------------------------|----------|--------|--------------------|------------|-------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Homing mode                 | 60980008 | 4D00   | RWSLM              | Integer8   | DEC   | 0             | Homing function<br>Refer origin control chapter                                                                                                                                                                |
| Origin turning signal speed | 60990120 | 5010   | RWSLTM             | Unsigned32 | rpm   | 300.00        | After touching the trigger event, the speed of homing process (rpm)                                                                                                                                            |
| Origin signal speed         | 60990220 | 5020   | RWSLTM             | Unsigned32 | rpm   | 100.00        | Speed when starting to find the origin                                                                                                                                                                         |
| Homing acceleration         | 609A0020 | 5200   | RWSL               | Unsigned32 | rps/s | 50.00         | Acceleration when homing process unit: rps/s                                                                                                                                                                   |
| Origin offset               | 607C0020 | 4100   | RWSLTM             | Integer32  | inc   | 0             | Offset value after homing unit: inc                                                                                                                                                                            |
| Origin Offset Mode          | 60990508 | 5050   | RWSL               | Unsigned8  | DEC   | 0             | Origin Offset Mode Control<br>0: run to the origin offset position, the actual position is displayed as 0<br>1: Run to the event trigger point, after the end the actual position will become: - Origin offset |

## 7.7 Speed loop parameter (0x60F9)

| Name          | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                     |
|---------------|----------|--------|--------------------|------------|------|---------------|---------------------------------------------------------------------------------|
| Kvp           | 60F90110 | 6310   | RWSL               | Unsigned16 | DEC  | 4             | The larger the value, the stronger the gain, but it may cause the motor howling |
| Kvi           | 60F90210 | 6320   | RWSL               | Unsigned16 | DEC  | 0             | The larger the value, the stronger the gain, but it may cause the motor howling |
| Kvi/32        | 60F90710 | 6370   | RWSL               | Unsigned16 | DEC  | 2             | Kvi's 1/32                                                                      |
| Output filter | 60F90508 | 6350   | RWSL               | Unsigned8  | Hz   | 240           | velocity output filter of velocity loop<br>BW=Speed_Fb_N*20+100[ Hz]            |

## 7.8 Position loop parameter (0x60FB)

| Name             | CANopen   | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                |
|------------------|-----------|--------|--------------------|------------|------|---------------|--------------------------------------------|
| kpp 0            | 60FB 0110 | 6810   | RWSL               | Integer16  | Hz   | 10.00         | Scale value of the position loop           |
| kvff             | 60FB0210  | 6820   | RWSL               | Integer16  | %    | 100.00        | Position loop speed feedforward            |
| kaff             | 60FB0310  | 6830   | RWSL               | Integer16  | DEC  | 32767         | Acceleration feedforward for position loop |
| Smoothing filter | 60FB0510  | 6850   | RWSL               | Unsigned16 | DEC  | 1             | Modify in the disabled state               |

## 7.9 Input/output port parameter (0x2010)

| Name                                        | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                                                                 |
|---------------------------------------------|----------|--------|--------------------|------------|------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Digital input 1                             | 20100310 | 0830   | RWSL               | Unsigned16 | HEX  | 0000          | Refer to the function definition below                                                                                                      |
| Digital input 2                             | 20100410 | 0840   | RWSL               | Unsigned16 | HEX  | 0000          |                                                                                                                                             |
| Digital input 3                             | 20100510 | 0850   | RWSL               | Unsigned16 | HEX  | 0000          |                                                                                                                                             |
| Digital input 4                             | 20100610 | 0860   | RWSL               | Unsigned16 | HEX  | 0000          |                                                                                                                                             |
| Digital output 1                            | 20100F10 | 08F0   | RWSL               | Unsigned16 | HEX  | 0001          |                                                                                                                                             |
| Digital output 2                            | 20101010 | 0900   | RWSL               | Unsigned16 | HEX  | 0002          |                                                                                                                                             |
| Input port status                           | 20100A10 | 08A0   | RLTM               | Unsigned16 | HEX  | 0000          | bit0: Din1<br>bit1: Din2<br>bit2: Din3<br>bit3: Din4                                                                                        |
| Output port status                          | 20101410 | 0940   | RLTM               | Unsigned16 | HEX  | 000A          | bit0: Dout1<br>bit1: Dout2                                                                                                                  |
| Change the input signal polarity definition | 20100110 | 0810   | RWSL               | Unsigned16 | HEX  | FFFF          | 0: Turn off; 1: Turn on<br>bit0: Din1 bit1: Din2<br>bit2: Din3 bit3: Din4<br>bit4: Din5 bit5: Din6<br>bit6: Din7 bit7: Din8<br>Default 0xFF |
| Polarity definition of output port          | 20100D10 | 08D0   | RWSLTM             | Unsigned16 | HEX  | FFFF          | Polarity definition of output port                                                                                                          |
| Input port signal simulation                | 20100210 | 0820   | RWL                | Unsigned16 | HEX  | 0000          | bit0: Din1 bit1: Din2<br>bit2: Din3 bit3: Din4<br>bit4: Din5 bit5: Din6<br>bit6: Din7<br>bit7: Din8                                         |
| Output port signal simulation               | 20100E10 | 08E0   | RWLM               | Unsigned16 | HEX  | 0000          | bit0: Dout1 bit1: Dout2<br>bit2: Dout3 bit3: Dout4<br>bit4: Dout5                                                                           |

**Note**

| Definition of digital input function (hexadecimal)                                                                                                                                      | Output port definition (hexadecimal) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| 0001: Enable                                                                                                                                                                            | 0001: Ready                          |
| 0002: Reset errors                                                                                                                                                                      | 0002: Error                          |
| 0004: Operate mode control                                                                                                                                                              | 0004: Motor position reached         |
| 0008: Kvi off                                                                                                                                                                           | 0008: Motor zero speed               |
| 0010: Positive limit                                                                                                                                                                    | 0010: Motor brake                    |
| 0020: Negative limit                                                                                                                                                                    | 0020: Motor speed reached            |
| 0040: Home signal                                                                                                                                                                       | 0040: Index signal appears           |
| 0080: Invert direction                                                                                                                                                                  | 0080: Speed limit                    |
| 0100: Din speed index 0                                                                                                                                                                 | 0100: Driver enabled                 |
| 0200: Din speed index 1                                                                                                                                                                 | 0200: Position limit                 |
| 0400: Din position index 0                                                                                                                                                              | 0400: Home found                     |
| 0800: Din position index 1                                                                                                                                                              | 0800: Torque reached limit           |
| 1000: Quick stop                                                                                                                                                                        | 1000: Multi-function signal 0        |
| 2000: Start homing                                                                                                                                                                      | 2000: Multifunction Signal 1         |
| 4000: Activate command                                                                                                                                                                  | 4000: Multifunction Signal 2         |
| 8001: Din speed index 2                                                                                                                                                                 | 8001: STO active                     |
| 8002: Din position 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 switching 0                                                                                                                                                                  |                                      |
| 8040: Gain switching 1                                                                                                                                                                  |                                      |
| 8080: Maximum current toggle input switch                                                                                                                                               |                                      |
| 8100: Motor error                                                                                                                                                                       |                                      |
| 8200: Pre-enable (The IO port must have an enable signal, otherwise it will alarm, which is used in some occasions where the machine needs to be determined before running the machine) |                                      |
| 8400: Fast capture 1                                                                                                                                                                    |                                      |
| 8800: Fast capture 2                                                                                                                                                                    |                                      |

The digital input function is described in the following table:

| Input function         | Description                                                                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable                 | Drive enable<br>1: Control word = Din Control word selection (2020.0F)<br>0: Control word = 0x06                                                                                    |
| Reset error            | The reset error bit (bit7) in the control word = 1                                                                                                                                  |
| Operating mode control | Working mode selection<br>1: Work mode = Work mode Select 1 (2020.0E). The default value is -4<br>0: Working mode = The working mode is set to 0 (2020.0D). The default value is -3 |
| Kvi off                | 1: Turn off the speed loop integral gain<br>0: The set value of the speed loop integral gain is valid<br>See Chapter 6 for more information                                         |
| Positive limit         | Normally closed positive/negative limit switch signal input<br>0: In the limit, the limit is activated and the corresponding direction of movement is prohibited                    |
| Negative limit         |                                                                                                                                                                                     |
| Home signal            | Origin switch signal can be used when finding the origin                                                                                                                            |
| Invert direction       | In speed and torque mode, the speed command can be reversed                                                                                                                         |
| Din speed index 0      | Din speed index in Din speed mode                                                                                                                                                   |
| Din speed index 1      |                                                                                                                                                                                     |
| Din speed index 2      |                                                                                                                                                                                     |
| Din position index 0   | Din position index in Din location mode                                                                                                                                             |

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Din position index1           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Din position index2           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Quick stop                    | Set control word bit bit2=0 to enable emergency stop. 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                  | Start to find the origin signal, must be used with the driver enabled. When the origin is found, the working mode switches back to the working mode before the origin is found                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Activate command              | Activate position instructions, such as the control word from 0x2F to 0x3F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Multi-function input signal 0 | Used to select the electronic gear ratio, the electronic gear molecule and the electronic gear denominator are determined by a BCD code composed of multifunctional inputs.<br>The actual electronic gear ratio used is the electronic gear molecule [x], the electronic gear denominator [x], and x is the BCD code composed of multi-function input:<br>Bit0: Multi-function input 0<br>Bit1: Multifunction input 1<br>Bit2: Multi-function input 2                                                                                                                                                                                                                                                                                                                                                                           |
| Multi-function input signal1  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Multi-function input signal 2 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Gain switching input signal 0 | The PI pointer (60F9.28) is determined by the BCD code consisting of gain switch 0 and gain switch 1, which also determines the index of Kvp, Kvi, and Kpp, as detailed in Section 6.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Gain switching input signal1  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 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                | The fast capture function is used to capture the actual position (6063.00) data when the corresponding input signal edge arrives, with the fastest response time not exceeding 2ms.<br>When the input function is configured as fast capture 1, if the rising edge of the input port comes, the rising edge capture state 1 will change to 1, and the actual position will be stored in the rising edge position 1. If the input falling edge arrives, the falling edge capture state 1 changes to 1, and the actual position is stored in falling edge position 1.<br>Once rising edge capture state 1 or falling edge capture state 1 changes to 1, the user needs to reset them to 0 for the next capture, otherwise the next position will not be captured.<br>Quick Capture 2 is used in a similar way to Quick Capture 1. |
| Fast Capture 2                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Pre-enable                    | For security reasons, a pre-enable signal can be used to represent whether the drive is ready, 1: indicates that the drive is ready and can be enabled. 0: indicates that the drive is not ready and cannot be enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Cear pulse                    | Clear gear front pulse data that has been received but not executed by the drive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Pause                         | 1: The motor is suspended, bit8 = 1 in the control word<br>0: The motor continues to execute unfinished instructions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Positive trim                 | Position fine-tuning data in positive direction in active pulse mode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Negative trim                 | Position fine-tuning data in negative direction in active pulse mode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

The digital output function is described in the following table:

| Output function         | Description                                                                                                                                                                                                                                                                                                                                |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ready                   | The drive is ready and can be enabled                                                                                                                                                                                                                                                                                                      |
| Error                   | Driver failure alarm                                                                                                                                                                                                                                                                                                                       |
| Motor position 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                                                             |
| Motor 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 lock is opened, and an effective output of gray indicates that the lock is closed. |
| Motor speed reached     | Output speed to function when the speed error (60F9.1C) is less than the speed to window (60F9.0A)                                                                                                                                                                                                                                         |
| Index signal occurrence | Motor index signal appears                                                                                                                                                                                                                                                                                                                 |

|                         |                                                                                                                                                                                                                                                                              |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Speed limit reached     | In torque mode, the actual speed reaches the maximum speed limit (607F.00)                                                                                                                                                                                                   |
| Driver enabled          | Drive is enabled. Motor locks shaft                                                                                                                                                                                                                                          |
| Position limited        | Positive-negative position limit medium                                                                                                                                                                                                                                      |
| Home found              | Home found                                                                                                                                                                                                                                                                   |
| Torque reached limit    | When the actual torque (60F5.08) reaches the baseline (60F5.06) and the duration exceeds the filtering time (60F5.07), the output torque reaches the limit. If the torque reaches the baseline (60F5.06) is set to 0, the torque reaches the limit detection is not enabled. |
| Multi-function signal 0 | Din multi-segment position control for position-to-output functions is described in Chapter 5, Section 5.4.1.1                                                                                                                                                               |
| Multifunction signal 1  |                                                                                                                                                                                                                                                                              |
| Multifunction signal 2  |                                                                                                                                                                                                                                                                              |

## 7.10 Pulse input parameters (0x2508)

| Name                                          | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                                                                                                                                                                                           |
|-----------------------------------------------|----------|--------|--------------------|------------|------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Electronic gear molecule 0                    | 25080110 | 0x1910 | RWSLTM             | Integer16  | DEC  | 1000          | Electronic gear molecule 0                                                                                                                                                                                                                                            |
| Electronic gear denominator 0                 | 25080210 | 0x1920 | RWSLTM             | Unsigned16 | DEC  | 1000          | Electronic gear denominator 0                                                                                                                                                                                                                                         |
| Pulse mode control                            | 25080308 | 0x1930 | RWSLB              | Unsigned8  | DEC  | 1             | 0: Double pulse mode<br>1: Pulse direction mode<br>2: Incremental encoder mode<br>10:422 Double pulse mode<br>11: 422 pulse direction mode<br>12: 422 Incremental encoder mode(After the data change takes effect, the storage control parameters must be restarted.) |
| Number of input pulses before electronic gear | 25080420 | 0x1940 | RWLTM              | Integer32  | DEC  | 0             | Number of input pulses before electronic gear                                                                                                                                                                                                                         |
| Number of input pulses after electronic gear  | 25080520 | 0x1950 | RWL                | Integer32  | DEC  | 0             | Number of input pulses after electronic gear                                                                                                                                                                                                                          |
| Pulse filter parameters                       | 25080610 | 0x1960 | RWSL               | Unsigned16 | DEC  | 3             | Pulse filter parameters                                                                                                                                                                                                                                               |
| Pulse frequency before gear                   | 25080C10 | 0x19C0 | RLTM               | Integer16  | DEC  | 0             | Pulse frequency before gear (pulse/mS)                                                                                                                                                                                                                                |
| Pulse frequency after gear                    | 25080D10 | 0x19D0 | RLT                | Integer16  | DEC  | 0             | Pulse frequency after gear (pulse/mS)                                                                                                                                                                                                                                 |

## 7.11 Parameter for storage (0x2FF0)

| Name                       | CANopen  | Modbus | Command Properties | Data type | Unit | Initial value | Explanation                                                                                                                                                           |
|----------------------------|----------|--------|--------------------|-----------|------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Storage control parameters | 2FF00108 | 2910   | RWL                | Unsigned8 | DEC  | 0             | 1: Store all configuration parameters set<br>10: Initialize all configuration parameters<br>Note: The control loop parameters are stored, excluding motor parameters. |
| Store motor parameters set | 2FF00308 | 2930   | RWL                | Unsigned8 | DEC  | 0             | 1: Store all motor parameters set                                                                                                                                     |

## 7.12 Error code (0x2601)

| Name          | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------|----------|--------|--------------------|------------|------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error state   | 26010010 | 1F00   | RLTM               | Unsigned16 | HEX  | 0408          | Real-time alarm error status<br>bit 0: Extended Error<br>bit 1: Encoder ABZ/not connected<br>bit 2: Encoder UVW/ Encoder internal<br>bit 3: Encoder Counting/Encoder CRC<br>bit 4: Driver temperature<br>bit 5: Over voltage<br>bit 6: Under voltage<br>bit 7: Over current<br>bit 8: Chop Resistor<br>bit 9: Position Following<br>bit 10: Low logic voltage<br>bit 11: Motor or Driver Ilt<br>bit 12: Over frequency<br>bit 13: Motor temperature<br>bit 14: Motor commutation<br>bit 15: EEPROM data |
| Error state 2 | 260200   | 2000   | RLTM               | Unsigned16 | HEX  | 0000          | Error state 2<br>bit 0: Current Sensor<br>bit 1: Watch dog<br>bit 2: Wrong interrupt<br>bit 3: MCU ID<br>bit 4: Motor configuration<br>Bits 5 to 7: reserved<br>bit 8: External enable<br>bit 9: Positive limit<br>bit 10: Negative limit<br>bit 11: SPI internal<br>bit 12: Abort connection<br>bit 13: Closed loop direction<br>bit 14: Master ABZ<br>bit 15: Master counting                                                                                                                         |

## 7.13 Stop mode

| Name            | CANopen  | Modbus | Command Properties | Data type | Unit | Initial value | Explanation                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------|----------|--------|--------------------|-----------|------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quick stop mode | 605A0010 | 3400   | RWSL               | Integer16 | DEC  | 0             | Encountered limit switch, emergency stop switch, or control word is 0x000B<br>0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>5: stop with profile deceleration, stay in quick stop active<br>6: stop with quick stop deceleration, stay in quick stop active<br>18: using motor winding for brake even encoder is wrong |

|                          |          |      |        |            |       |        |                                                                                                                                                                                                                                       |
|--------------------------|----------|------|--------|------------|-------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Shutdown mode            | 605B0010 | 3410 | RWSL   | Integer16  | DEC   | 0      | Shutdown stop mode (Drive enable cancel)<br>0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>18: using motor winding for brake even encoder is wrong |
| Disable stop mode        | 605C0010 | 3420 | RWSL   | Integer16  | DEC   | 0      | 0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>18: using motor winding for brake even encoder is wrong                                             |
| Pause mode               | 605D0010 | 3430 | RWSL   | Integer16  | DEC   | 1      | Control word bit8 is set to 1<br>The motor is paused and enabled<br>1: stop by current ramp<br>2: stop by quick stop deceleration                                                                                                     |
| Error stop mode          | 605E0010 | 3440 | RWSL   | Integer16  | DEC   | 0      | 0: stop without control<br>1: stop by using ramp, then switch off<br>2: stop by using quick stop deceleration, then switch off<br>18: using motor winding for brake even encoder is wrong                                             |
| Trapezoidal deceleration | 60840020 | 4C00 | RWSLTM | Unsigned32 | rps/s | 100.00 | Working Mode<br>Deceleration in modes 1 and 3                                                                                                                                                                                         |
| Quick stop deceleration  | 60850020 | 3300 | RWSL   | Unsigned32 | rps/s | 610.00 | Deceleration for quick stop                                                                                                                                                                                                           |

## 7.14 Alarm parameter

| Name           | CANopen  | Modbus | Command Properties | Data type   | Unit | Initial value | Explanation                                                                                                                                      |
|----------------|----------|--------|--------------------|-------------|------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Temp_Motor_Ref | 64101810 | 7180   | RWSL               | Integer16   | ℃    | 100           | The default alarm point for the temperature is 100 ° C                                                                                           |
| Temp_Motor     | 64101910 | 7190   | RLT                | Integer16   | ℃    | -             | When the motor is not connected to the temperature sensor or the temperature sensor is abnormal, the motor temperature will be displayed at -40℃ |
| Voltage_Under  | 65100710 | 8670   | RWHP               | Unsigned16  | V    | 18            | Drive low voltage alarm point                                                                                                                    |
| Chop_Voltage   | 65100810 | 8680   | RWHP               | Unsigned 16 | V    | 63            | Driver chopper voltage point                                                                                                                     |
| Voltage_Over   | 65100910 | 8690   | RWHP               | Unsigned 16 | V    | 70            | Drive overvoltage alarm point                                                                                                                    |

## 7.15 Other Parameter

| Name                           | CANopen  | Modbus | Command Properties | Data type  | Unit | Initial value | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------|----------|--------|--------------------|------------|------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use the internal motor library | 30410608 | -      | RWSL               | Unsigned8  | DEC  | 2             | 0: The driver automatically reads the motor model from the encoder, using the corresponding motor parameters in the driver's motor library<br>1: The user enters the motor model manually and uses the motor parameters corresponding to the motor library in the drive<br>2: Read and use the saved motor parameters in the encoder (factory default)                                                                                                                                                                                         |
| Device restart                 | 2FFF0010 | 2F00   | RW                 | Unsigned16 | HEX  | -             | Start bootloader<br>55AA: start bootloader<br>AA55: restart drive                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Analog increment               | 64101F10 | -      | RWSL               | Integer16  | DEC  |               | >0: when the encoder is communication type, the simulated resolution of incremental encoder supports 4000, 8000, 10000 incremental encoder data.<br>0: Disable the simulated incremental encoder, and the feedback resolution refer to motor' default.<br><br><b>Note:</b><br><b>After setting the analog increment, click "Save motor parameters" to save, and it will take effect after restarting. Because the resolution has changed, you must re-initialize the control parameters and save them again for the restart to take effect</b> |

## Chapter 8 RS485 Communication

### 8.1 RS485 cable connection

FD1X5 series servo drive RS485 port supports the 232 protocol and Modbus protocol, which can be used to modify the internal parameters of the servo and monitor the servo state. The default baud rate of FD1X5 is 38400 and Modbus is used by default. Figure 8-1 shows the connection diagram.

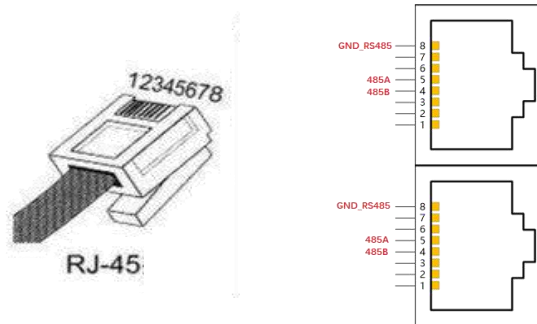


Figure 8-1 RS485 interface and definition of FD1X5



#### Note

1. The device station ID and baud rate take effect only after the drive is restarted.
2. When the communication is unstable when connecting the host computer with the baud rate, reduce the communication baud rate and reconnect the software for debugging.
3. The driver has added the function of switching the 232 protocol through modbus, the internal address is 6510 0C, and the corresponding modbus address is mapped to 0X86C0, when the 485 interface uses the Modbus protocol, it can be immediately switched to the 232 protocol by sending the command (Take ID = 1 as an example): 01 06 86 C0 00 01 61 7E can be switched to the host computer immediately, or you can send 01 06 86 C0 00 03 E0 BF (232 protocol, effective after saving and restarting) 01 06 29 10 00 01 41 93 (store control parameters), and then restart the machine to connect with the host computer.
4. If FD1X5 fail to connect to the host computer using the RS485 communication protocol, it may be caused by MODBUS being selected as the communication protocol. You can send MODBUS instructions according to the third point above to replace the MODBUS protocol with 232 protocol and then reconnect to the host computer.

### 8.2 RS485 communication parameters list

| Internal address | Name                  | Meaning               | Default |
|------------------|-----------------------|-----------------------|---------|
| 100B0010         | Device station number | Driver station number | 1       |

|          |                                        |                                                                                                                                                                                         |             |
|----------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 2FE20010 | RS485 baud rate                        | Set the baud rate of the RS485 port (Modbus address: 0X2600)<br>Set value      Baud rate<br>1080———9600<br>540———19200<br>270———38400<br>90———115200<br>Note: Need to save and restart. | 270         |
| 65100C08 | RS485 Communication protocol selection | bit0:0: Using MODBUS protocol 1: using RS232 communication protocol<br>bit1:0: Changes to bit0 take effect immediately. 1: Changes to bit0 take effect after the storage restarts       | 0           |
| 65100E10 | RS485 mode                             | Data bit =8, stop bit =1, no parity check                                                                                                                                               | Fixed value |
| 65100B08 | RS232 class communication              | RS232 level communication control (Modbus address: 0X86B0)<br>0:1 to 1 communication<br>1: Cascade communication                                                                        | 0           |

## 8.3 MODBUS RTU protocol

FD1X5 support the MODBUS RTU communication protocol, and their internal objects are discontinuous 16-bit data registers (mapped to 4X when read and written by the upper computer). The format of the message is as follows:

| Target station | Function code | Data   | CRC check code |
|----------------|---------------|--------|----------------|
| 1 Byte         | 1 Byte        | N Byte | 2 Byte         |

### 8.3.1 Modbus common function codes introduction

#### Function code 0x03: Read data register

Request format:

| Target station | Function code | Modbus address |          | Read byte |          | CRC    |
|----------------|---------------|----------------|----------|-----------|----------|--------|
|                |               | High Byte      | Low byte | High Byte | Low byte |        |
| 1 Byte         | 03            | 1 Byte         | 1 Byte   | 1 Byte    | 1 Byte   | 2 Byte |

Correct response:

| Target station | Function code | Return bytes | Register data |          | ..... | CRC    |
|----------------|---------------|--------------|---------------|----------|-------|--------|
|                |               |              | High Byte     | Low byte |       |        |
| 1 Byte         | 03            | 1 Byte       | 1 Byte        | 1 Byte   | ..... | 2 Byte |



#### Note

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

#### Function code 0x06: Write single data register

Request format:

| Target station | Function code | Modbus address |          | Revise content |          | CRC    |
|----------------|---------------|----------------|----------|----------------|----------|--------|
|                |               | High Byte      | Low byte | High Byte      | Low byte |        |
| 1 Byte         | 06            | 1 Byte         | 1 Byte   | 1 Byte         | 1 Byte   | 2 Byte |



#### Note

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.

Response format: If the setting is successful, the original text will be returned.

### Function code 0x10: Write multi-holding register

Request format:

| Target station | Function code | Modbus address | Data length (word) |          | Number of bytes of data written (byte) | Low level data |          | High level data |          | CRC   |
|----------------|---------------|----------------|--------------------|----------|----------------------------------------|----------------|----------|-----------------|----------|-------|
|                |               |                | High Byte          | Low byte |                                        | High Byte      | Low byte | High Byte       | Low byte |       |
| 1 Byte         | 10            | 2Byte          | 1Byte              | 1Byte    | 1Byte                                  | 1Byte          | 1Byte    | 1Byte           | 1Byte    | 2Byte |

Correct response:

| Target station | Function code | Modbus address | Data length (word) |          | CRC   |
|----------------|---------------|----------------|--------------------|----------|-------|
|                |               |                | High Byte          | Low byte |       |
| 1 Byte         | 10            | 2Byte          | 1Byte              | 1Byte    | 2Byte |



#### Note

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

Example: Send packet 01 10 6F 00 00 02 04 55 55 00 08 1A 47

Message meaning:

01——ID number

10——Function code, write multiple WORD

6F 00——The modbus address of the servo writable object "target speed" 60FF0020, the data length is 2 WORD;

00 02——write 2 WORD

04——Data length is 4 Byte (2 WORD);

55 55 00 08——Write data in hexadecimal 00085555, decimal 546133, converted to 30RPM;

1A 47——Check code

### 8.3.2 Modbus packet Example

When using Kincoservo 3 software, there are two ways to obtain Modbus address information:

1. Click **Help** → **Object Dictionary** on the menu bar. The current Modbus address will be displayed in the help box to the right of the corresponding variable name.

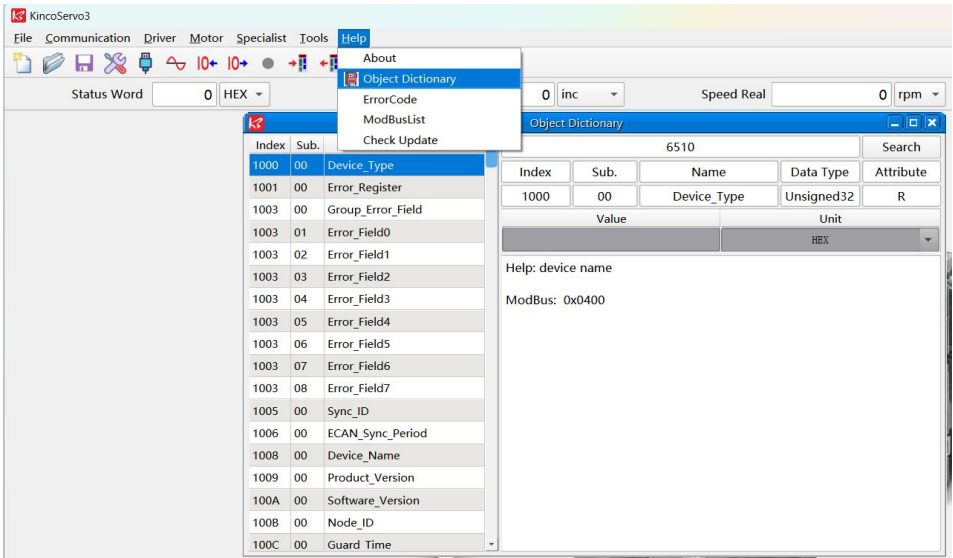


Figure 8-2 Object dictionary interface

2. Click **Help** → **Modbus List** on the menu bar. the complete Modbus address information of all parameters will be displayed.

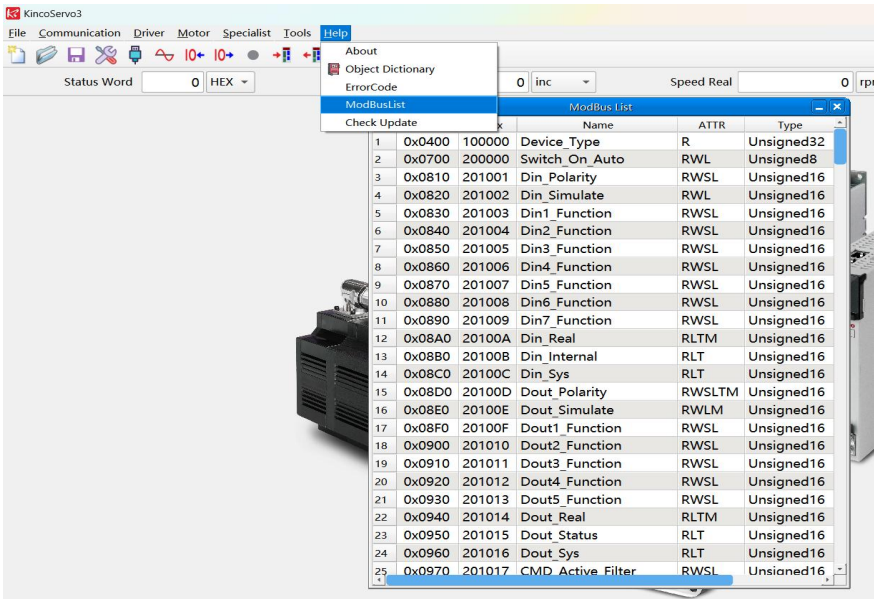


Figure 8-3 ModbusList interface

The following is an example of sending packets in different modes. The station number is 1.

Table 8-1 Message format

| Internal address                                   | Modbus address | Name         | Note              | Message (ID=1)                         |
|----------------------------------------------------|----------------|--------------|-------------------|----------------------------------------|
| 60600008                                           | 3500           | Operate mode | Operate mode is 3 | 01 06 35 00 00 03 C6 07                |
| 60FF0020                                           | 6F00           | Target speed | Speed 150RPM      | 01 10 6F 00 00 02 04 F5 C3 00 28 D9 B3 |
| 60400010                                           | 3100           | Control word | Enable to write F | 01 06 31 00 00 0F C7 32                |
| 60410010                                           | 3200           | Statu word   | Read drive status | 01 03 32 00 00 02 CA B3                |
| Homing control mode (control word first F then 1F) |                |              |                   |                                        |
| Internal address                                   | Modbus address | Name         | Value             | Message (ID=1)                         |
| 60400010                                           | 3100           | Control word | F                 | 01 06 31 00 00 0F C7 32                |
| 60600008                                           | 3500           | Operate mode | 6                 | 01 06 35 00 00 06 06 04                |
| 60980008                                           | 4D00           | Homing mode  | 33                | 01 06 4D 00 00 21 5E BE                |

| 60990120                                                                                                                                  | 5010           | Homing transition signal speed | 200RPM                   | 01 10 50 10 00 02 04 9D 03 00 36 57 98 |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------------------------|--------------------------|----------------------------------------|
| 60990220                                                                                                                                  | 5020           | Homing signal speed            | 150RPM                   | 01 10 50 20 00 02 04 F5 C3 00 28 CE 5A |
| 60400010                                                                                                                                  | 3100           | Control word                   | 1F                       | 01 06 31 00 00 1F C6 FE                |
| 01 03 32 00 00 02 CA B3 Read the status word. C037 indicates that the origin is found (bit15 set to 1)                                    |                |                                |                          |                                        |
| Position control mode (control word absolute positioning first 2F then 3F relative positioning first 4F then 5F, 103F update immediately) |                |                                |                          |                                        |
| Internal address                                                                                                                          | Modbus address | Name                           | Value                    | Message (ID=1)                         |
| 60400010                                                                                                                                  | 3100           | Control word                   | F                        | 01 06 31 00 00 0F C7 32                |
| 60600008                                                                                                                                  | 3500           | Operate mode                   | 1                        | 01 06 35 00 00 01 47 C6                |
| 607A0020                                                                                                                                  | 4000           | Target position                | 50000inc                 | 01 10 40 00 00 02 04 C3 50 00 00 FE 39 |
| 60810020                                                                                                                                  | 4A00           | Trapezoid speed                | 30RPM                    | 01 10 4A 00 00 02 04 55 55 00 08 BC D6 |
| 60830020                                                                                                                                  | 4B00           | Trapezoidal acceleration       | 610.352rps/s             | Use default value                      |
| 60840020                                                                                                                                  | 4C00           | Trapezoidal deceleration       | 610.352rps/s             | Use default value                      |
| 60400010                                                                                                                                  | 3100           | Control word                   | 2F                       | 01 06 31 00 00 2F C6 EA                |
|                                                                                                                                           |                | Variable name                  | 3F(Absolute positioning) | 01 06 31 00 00 3F C7 26                |
|                                                                                                                                           |                | Control word                   | 4F                       | 01 06 31 00 00 4F C6 C2                |
|                                                                                                                                           |                | Operate mode                   | 5F(Relative positioning) | 01 06 31 00 00 5F C7 0E                |
| 01 03 32 00 00 02 CA B3 Reads the status word. D437 indicates the location recal(bit10 set to 1)                                          |                |                                |                          |                                        |
| Speed control mode                                                                                                                        |                |                                |                          |                                        |
| Internal address                                                                                                                          | Modbus address | Name                           | Value                    | Message (ID=1)                         |
| 60600008                                                                                                                                  | 3500           | Operate mode                   | 3                        | 01 06 35 00 00 03 C6 07                |
| 60FF0020                                                                                                                                  | 6F00           | Target position                | 30RPM                    | 01 10 6F 00 00 02 04 55 55 00 08 1A 47 |
| 60400010                                                                                                                                  | 3100           | Control word                   | F                        | 01 06 31 00 00 0F C7 32                |
| 60830020                                                                                                                                  | 4B00           | Trapezoidal acceleration       | 610.352rps/s             | Use default value                      |
| 60840020                                                                                                                                  | 4C00           | Trapezoidal deceleration       | 610.352rps/s             | Use default value                      |

**Note**

In communication mode, data is transmitted in hexadecimal format.

Table 8-2 Unit conversion relation

| Name                                                                                                   | Engineering unit | Internal unit | Conversion relation                                             |
|--------------------------------------------------------------------------------------------------------|------------------|---------------|-----------------------------------------------------------------|
| Speed                                                                                                  | rpm              | DEC           | $DEC = [(RPM * 512 * \text{Encoder resolution}) / 1875]$        |
| Acceleration                                                                                           | r/s <sup>2</sup> | DEC           | $DEC = [(R/S^2 * 65536 * \text{Encoder resolution}) / 4000000]$ |
| Current                                                                                                | A                | DEC           | $1 Arms = [2048 / (I_{peak} / 1.414)] DEC$                      |
| Note: The encoder resolution is 65536, and the driver I <sub>peak</sub> is shown in <b>section 1.3</b> |                  |               |                                                                 |

## 8.4 RS232 communication protocol

### 8.4.1 RS232 transport protocol

FD1X5 series driver RS-232C communication strictly follow the master/slave station protocol, the host computer can send any data to the driver. The drive is set to an address that calculates this data and replies with a return value.

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

| Byte 0    | Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 | Byte 8 | Byte 9 |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Driver ID | Data   |        |        |        |        |        |        |        | CHKS   |

Host send:

| Byte 0    | Byte 1         | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 | Byte 8 | Byte 9 |
|-----------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Driver ID | Host send data |        |        |        |        |        |        |        | CHKS   |

Servo send/host receive:

| Byte 0    | Byte 1             | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 | Byte 8 | Byte 9 |
|-----------|--------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Driver ID | Host received data |        |        |        |        |        |        |        | CHKS   |

#### Key points:

The calculation process of the check code CHKS takes 01 40 F0 2F 09 00 00 00 00 97 (this command is to read the target speed of the slave station 2FF00910) as an example, the last 0x97 is the check code, which is calculated by LRC check (vertical redundancy check).

Here recommend a check code online computing website: <http://www.ip33.com/lrc.html>

**LRC Check (Longitudinal Redundancy Check) Online Calculation**

☒ Hex    ☐ Ascii

Data to be verified: 01 40 F0 2F 09 00 00 00 00

The input data is hexadecimal, for example: 31 32 33 34

Generated check code
9 Bytes

|                                  |                      |                                     |
|----------------------------------|----------------------|-------------------------------------|
| Check calculation result (Hex) : | <div>97</div>        | <input type="button" value="Copy"/> |
| Check calculation result (Dec) : | <div>151</div>       | <input type="button" value="Copy"/> |
| Check calculation result (Oct) : | <div>227</div>       | <input type="button" value="Copy"/> |
| Check calculation result (Bin) : | <div>1001 0111</div> | <input type="button" value="Copy"/> |



#### Note

- There is a separate CHKS for every ten bytes
- If the host sends the server drive an address that does not exist on the network, the server drive will not respond.
- When the host sends a correct data, the slave station will look for the corresponding address of the slave station data and check the parity value, if the parity value does not match, the slave station will not respond.

## 8.4.2 RS232 data protocol

The data protocol is different from the transmission protocol, and its content refers to the 8 data bytes of the above 10 bytes above. FD1X5 series servo drive internal data definition is compliant with Canopen international standards. Numerical and functions are expressed through indexes 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 station sends data format

| Byte 0        | Byte 1 | Byte 2 | Byte 3   | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
|---------------|--------|--------|----------|--------|--------|--------|--------|
| Function code | Index  |        | Subindex | Data   |        |        |        |

**Function code :** Specifies the direction and size of the data transfer

**23(0x16):** Send 4 bytes of data (bytes 4... 7 Contains 32 bits)

**2B(0x16):** Send 2 bytes of data (bytes 4... 5 Contains 16 bits)

**2F(0x16):** Send 1 byte of data (bytes 4 contains 8 bits)

**Index:** The address of the sending object, 16 bits

**Subindex:** Subaddress of the sending object, 8 bits

**Data :** The data to be sent (the order of the four bytes in the data is high byte after, low byte before)

#### For example:

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

#### Slave response data format

| Byte 0        | Byte 1 | Byte 2 | Byte 3   | Byte 4  | Byte 5 | Byte 6 | Byte 7 |
|---------------|--------|--------|----------|---------|--------|--------|--------|
| Function code | Index  |        | Subindex | Reserve |        |        |        |

**Function code :** Specifies the direction and size of the data transfer

**60(0x16):** Data sent successfully

**80(0x16):** Error, by byte 4... 7 generation

**Index:** The address of the sending object, 16 bits, Same as the main station

**Subindex:** Subaddress of the sending object, 8 bits, Same as the main station

**Reserve:** Reserved

### B: Upload (From slave to master)

Upload means that the master sends a command to read the address of the slave object. Uploading an address that does not exist will result in an error for the master.

**Function code:** Define the direction of the data transfer

**40(0x16) :** Read data

**Index:** The address of the sending object, 16 bits

**Subindex:** Subaddress of the sending object, 8 bits

**Reserve:** Byte 4... 7 no use

#### Slave receive data

| Byte 0        | Byte 1 | Byte 2 | Byte 3   | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
|---------------|--------|--------|----------|--------|--------|--------|--------|
| Function code | Index  |        | Subindex | Data   |        |        |        |

**Function code:** Display slave response

**43(0x16):** Bytes 4... 7 contains 32 bits

**4B(0x16):** Bytes 4... 5 contains 16 bits

**4F(0x16):** Bytes 4 contains 8 bits

**80(0x16):** Error, by byte 4... 7 generation

**Index:** The address of the sending object, 16 bits, Same as the main station

**Subindex:** Subaddress of the sending object, 8 bits, Same as the main station

**Data:** Data returned from the slave station

If there is no error in the data, byte 4... 7 saves the value of the slave object, low byte in front, high byte in back.

If there is an error in the data, the four bytes of data are 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 97 (This command is to read the target speed of the slave station 2FF00910)

Slave station response:

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

Description:

01: The slave station number is 1

4B: 2 bytes are received, saved by byte4 and byte5 in the 10 bytes of the response

F0 2F: The object index address is 2FF0

09: The address of the object subindex is 09

58 02 00 00: The value is 00 00 02 58(hex)= 600 rpm

Table 8-3 Setting homing mode, position mode, and speed mode through RS232 communication

| Homing mode       |                |       |                                                                             |                                                                                                                               |
|-------------------|----------------|-------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Parameter address | Name           | Value | Message(ID=1)                                                               | Note                                                                                                                          |
| 60400010          | Control word   | F     | Send→01 2B 40 60 00 0F 00 00 00 25<br>Receive←01 60 40 60 00 0F 00 00 00 F0 | Home turning signal speed and Homing signal velocity are expressed in decimal DEC by default<br>DEC=[(RPM*512*[641003])/1875] |
| 60600008          | Operating mode | 6     | Send→01 2F 60 60 00 06 00 00 00 0A<br>Receive←01 60 60 60 00 06 00 00 00 D9 |                                                                                                                               |
| 60980008          | Homing mode    | 33    | Send→01 2F 98 60 00 21 00 00 00 B7<br>Receive←01 60 98 60 00 21 00 00 00 86 |                                                                                                                               |

|                                                                                                                                        |                              |          |                                                                             |                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 60990120                                                                                                                               | Home turning<br>signal speed | 200RPM   | Send→01 23 99 60 01 03 9D 36 00 0C<br>Receive←01 60 99 60 01 03 9D 36 00 CF |                                                                                                                                                                                                                                                 |
| 60990220                                                                                                                               | Homing signal<br>velocity    | 100RPM   | Send→01 23 99 60 02 82 4E 1B 00 F6<br>Receive←01 60 99 60 02 82 4E 1B 00 B9 |                                                                                                                                                                                                                                                 |
| 60400010                                                                                                                               | Controlword                  | 1F       | Send→01 2B 40 60 00 1F 00 00 00 15<br>Receive←01 60 40 60 00 1F 00 00 00 E0 |                                                                                                                                                                                                                                                 |
| Send 01 40 41 60 00 00 00 00 00 1E read status word, Drive response 01 4B 41 60 00 31 C0<br>FF FF 24, bit15=1 indicates homing found   |                              |          |                                                                             |                                                                                                                                                                                                                                                 |
| Position mode                                                                                                                          |                              |          |                                                                             |                                                                                                                                                                                                                                                 |
| Parameter<br>address                                                                                                                   | Name                         | Value    | Message(ID=1)                                                               | Note                                                                                                                                                                                                                                            |
| 60400010                                                                                                                               | Control word                 | 2F       | Send→01 2B 40 60 00 2F 00 00 00 05<br>Receive←01 60 40 60 00 2F 00 00 00 D0 | The trapezoidal speed is expressed in<br>decimal DEC by default<br>DEC=[(RPM*512*[641003])/1875]                                                                                                                                                |
|                                                                                                                                        |                              | 4F       | Send→01 2B 40 60 00 4F 00 00 00 E5<br>Receive←01 60 40 60 00 4F 00 00 00 B0 |                                                                                                                                                                                                                                                 |
| 60600008                                                                                                                               | Operating mode               | 1        | Send→01 2F 60 60 00 01 00 00 00 0F<br>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<br>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<br>Receive←01 60 81 60 00 03 9D 36 00 E8 | Trapezoidal acceleration and<br>trapezoidal deceleration are expressed<br>in decimal DEC by default.<br>DEC=[(RPS/S*65536*[641003])/<br>4000000]<br>2F→3F: absolute location<br>4F→5F: relative location                                        |
| 60830020                                                                                                                               | Trapezoidal<br>acceleration  | 100rps/s | Send→01 23 83 60 00 6E A3 01 00 E7<br>Receive←01 60 83 60 00 6E A3 01 00 AA |                                                                                                                                                                                                                                                 |
| 60840020                                                                                                                               | Trapezoidal<br>deceleration  | 100rps/s | Send→01 23 84 60 00 6E A3 01 00 E6<br>Receive←01 60 84 60 00 6E A3 01 00 A9 |                                                                                                                                                                                                                                                 |
| 60400010                                                                                                                               | Controlword                  | 3F       | Send→01 2B 40 60 00 3F 00 00 00 F5<br>Receive←01 60 40 60 00 3F 00 00 00 C0 |                                                                                                                                                                                                                                                 |
|                                                                                                                                        |                              | 5F       | Send→01 2B 40 60 00 5F 00 00 00 D5<br>Receive←01 60 40 60 00 5F 00 00 00 A0 |                                                                                                                                                                                                                                                 |
| Send 01 40 41 60 00 00 00 00 00 1E read the status word,Drive response 01 4B 41 60 00 37<br>C4 FF FF 1A,bit10 representsTarget_reached |                              |          |                                                                             |                                                                                                                                                                                                                                                 |
| Speed mode                                                                                                                             |                              |          |                                                                             |                                                                                                                                                                                                                                                 |
| Parameter<br>address                                                                                                                   | Name                         | Value    | Message(ID=1)                                                               | Note                                                                                                                                                                                                                                            |
| 60600008                                                                                                                               | Operation mode               | 3        | Send→01 2F 60 60 00 03 00 00 00 0D<br>Receive←01 60 60 60 00 03 00 00 00 DC | The target speed is expressed in<br>decimal DEC by default<br>DEC=[(RPM*512*[641003])/1875]<br>Trapezoidal acceleration and<br>trapezoidal deceleration are expressed<br>in decimal DEC by default:<br>DEC=[(RPS/S*65536*[641003])/<br>4000000] |
| 60FF0020                                                                                                                               | Target speed                 | -100RPM  | Send→01 23 FF 60 00 7E B1 E4 FF 6B<br>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<br>Receive←01 60 40 60 00 2F 00 00 00 D0 |                                                                                                                                                                                                                                                 |
| 60830020                                                                                                                               | Trapezoidal<br>acceleration  | 100rps/s | Send→01 23 83 60 00 6E A3 01 00 E7<br>Receive←01 60 83 60 00 6E A3 01 00 AA |                                                                                                                                                                                                                                                 |
| 60840020                                                                                                                               | Trapezoidal<br>deceleration  | 100rps/s | Send→01 23 84 60 00 6E A3 01 00 E6<br>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<br>case is 65536                                  |                              |          |                                                                             |                                                                                                                                                                                                                                                 |

## 8.5 Troubleshooting Measures for Communication Faults

When the driver cannot communicate with the host computer, please check the driver communication parameters and wiring; When the drive is prone to disconnection, read-only no write or only write no read and other problems, you can check through the following aspects:

| Serial number | Check item          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1             | Terminal resistance | 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, so it is necessary to parallel a 120Ω terminal resistor 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 dip switch of the first and last drive to the ON position.                        |
| 2             | Cable specification | The recommended wire diameter of 485 signal cable is 24AWG, and the shielded twisted pair cable should be used, and the shielding layer of the cable should be grounded together and the grounding resistance should not be greater than 1Ω. The use of twisted pair cables can effectively eliminate adversarial interference, and the cable with a good shielding layer can effectively reduce the impact of external interference sources. |
| 3             | Reasonable wiring   | The distance between communication cables and strong-current cables should be at least 20cm. If the cables can be folded into metal pipes, the anti-interference capability is better. During the wiring process, the signal line and the power line intersect vertically, and parallel laying should be avoided as far as possible.                                                                                                          |
| 4             | Good grounding      | The motor power line must be a cable with a shielded network, the motor PE must be connected to the driver ground terminal, and the driver shell must be well grounded.                                                                                                                                                                                                                                                                       |
| 5             | Power interference  | Power interference. The instability of the power supply of the grid will also directly affect the normal use of the servo, and the external circuit of the driver can be connected by referring to Chapter 3.                                                                                                                                                                                                                                 |

## Chapter 9 CANopen Communication

### 9.1 CANopen communication protocol introduction

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.

FD1X5 servo is standard CAN slave devices that strictly follow the CANopen 2.0A/B protocol and can communicate with any host computer that supports the protocol. The FD1X5 use a strictly defined list of objects, which we call the Object Dictionary. This object dictionary is designed based on the CANopen international standard, and all objects have clear functional definitions. 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. These objects are hexadecimal numbers. For example, the CANopen address in working mode is 0x60400010, as shown in Table 9-1.

Table 9-1 The example object dictionaries lists

| Complete CANopen address composition |          |                   | property | Meaning                    |
|--------------------------------------|----------|-------------------|----------|----------------------------|
| Index                                | Subindex | Bits(Data length) |          |                            |
| 0x6040                               | 00       | 0x10              | RW       | Device status control word |
| 0x6060                               | 00       | 0x08              | RW       | operate mode               |
| 0x607A                               | 00       | 0x20              | W        | Target position            |
| 0x6041                               | 00       | 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.

### 9.2 Hardware Description

FD1X5 series servo driver CANopen port hardware definition is as follows:

Table 9-2 Pin name and function description table

|  | Pin | Signal identification | Signal name                |
|-------------------------------------------------------------------------------------|-----|-----------------------|----------------------------|
|                                                                                     | 1   | CAN_H                 | CAN_H bus (high dominant ) |
|                                                                                     | 2   | CAN_L                 | CAN_L bus (low dominant )  |
|                                                                                     | 3   | CAN_GNDB              | Signal ground              |

CAN communication protocol mainly describes the mode of information transmission between devices. The definition of CAN layer is consistent with the open system interconnection model (OSI). Each layer communicates with the same layer on another device. The actual communication occurs in the two adjacent layers of each device, and the devices are only interconnected through the physical medium of the physical layer of the model. The specification of CAN defines the bottom two layers of the model, the data link layer and the physical layer. CAN bus physical layer is not strictly stipulated, can use a variety of physical media such as twisted pair optical fiber, etc., the most commonly used is twisted pair signal, the use of differential voltage transmission (commonly used bus transceiver), two signal lines are called CAN\_H and CAN\_L, static time is about 2.5V, at this time the state is expressed as logic 1, can also be called hidden bit, CAN\_H is higher than CAN\_L to represent logical 0, which is called display, and the usual voltage value at this time is CAN\_H=3.5V and CAN\_L=1.5V, and display is preferred in competition. Table 9-2 show the names and functions of CAN communication port pins.

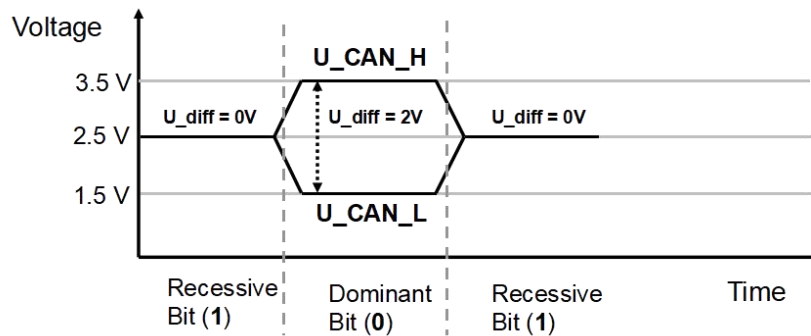


Figure 9-1 CAN Signal Identification

**Note:**

1. All CAN\_L and CAN\_H pins of the slave station can be directly connected and connected by series connection.
2. Connect the master terminal and the last slave terminal to a terminal resistor of 120  $\Omega$ . The FD1X5 drive comes with a terminal resistance dip switch SW4, which is set to ON to enable the terminal resistance. Restart the drive after changing the terminal resistance dip status;
3. Use shielded twisted pair cables for communication cables 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 9-3 lists the theoretical maximum communication distances of different baud rates.
5. The FD1X5 do not require an external 24V power supply to power the CAN.

Table 9-3 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                       |

## 9.3 Software Description

### 9.3.1 EDS description

EDS (electronic data form) file is the identification file or similar code of the slave station connected to the PLC, through which to identify the type of slave station (which is similar in 401, 402, 403, or which device belongs to 402). 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 so on, similar to the GSD file of Profibus. Therefore, before hardware configuration, we first need to import the EDS file from the station to the upper configuration software.

### 9.3.2 SDO Description

SDO is mainly used to transmit low-priority objects between devices. Typically, it is used to configure and manage slave devices, such as modifying PID parameters and PDO configuration parameters of current ring, speed ring, position ring, etc. This kind of data transmission is the same as MODBUS, that is, after the master station sends out, the slave station needs to return data response. This communication mode is only suitable for parameter setting, and is not suitable for data transmission with high real-time requirements.

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

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 bytes of data |

SDO command word contains the following information:

- Download/upload
- Request/response
- Segmented/expedited transfer
- CAN the frame data byte length, which is used to alternately clear and set the toggle bit for each subsequent segment

There are five request/reply protocols implemented in SDO:

- Initiate domain Download
- Download Domain Segment
- Initiate Domain Upload;
- Upload Domain Segment
- Abort Domain Transfer

Among them, Download refers to write operation of the object dictionary, Upload refers to read operation of the object dictionary; Use the Initiate Domain Upload protocol when reading parameters; When setting parameters, use the Initiate Domain Download protocol; The syntax of the protocol's SDO command word (the first byte of an SDO CAN message) is described in Table 8-4 and Table 8-5, where "-" indicates that it is irrelevant and should be 0.

Table 9-4 Start domain download

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

Table 9-5 Start 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 bytes of meaningless data in the packet data [from (8-n) bytes to the seventh byte of meaningless data] (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 indicates that the data length is not specified, and 1 indicates that the data length is specified.

e=0, s=0——Retained by the CiA;

e=0, s=1——The data byte is the byte counter, byte4 is the low data part (LSB), byte7 is the high data part (MSB);

e=1——ata bytes are the data to be downloaded.

### SDO message format description

The transmission of SDO is an object data transmission of no more than 4 bytes, and the message consists of a COB-ID and a data segment. The following table shows that the COB-ids of the sending SDO(RSD) and the receiving SDO do not agree.

Data segments are arranged in the "low position in front, high position in back" mode. All SDO message data segments must be eight bytes. The format of the SDO transmission message is shown in the following table.

Table 9-6 SDO transmit message format table

|          | COB-ID        | DLC | Data                 |              |   |                 |                         |   |   |   |
|----------|---------------|-----|----------------------|--------------|---|-----------------|-------------------------|---|---|---|
|          |               |     | 0                    | 1            | 2 | 3               | 4                       | 5 | 6 | 7 |
| Master → | 0x600+Node_ID | 8   | Send command word    | Object Index |   | Object subindex | 00                      |   |   |   |
| ← Slave  | 0x580+Node_ID | 8   | Receive command word | Object Index |   | Object subindex | Maximum 4 bytes of data |   |   |   |

The command code specifies the transmission type and data length of the SDO, the index and subindex are the objects to be transmitted, and the data is the numerical value of the object.

### SDO read message

Depending on the length of the received data, the received SDO command word changes, and the message format is as follows:

Table 9-7 SDO reads message description

|          |        | COB-ID        | DLC | Data |              |                 |      |   |   |   |
|----------|--------|---------------|-----|------|--------------|-----------------|------|---|---|---|
|          |        |               |     | 0    | 1            | 2               | 3    | 4 | 5 | 6 |
| ➡ Master |        | 0x600+Node_ID | 8   | 40   | Object index | Object subindex | -    | - | - | - |
| ⬅ Slave  | Normal | 0x580+Node_ID | 8   | 4F   | Object index | Object subindex | Data | - | - | - |
|          | Normal | 0x580+Node_ID | 8   | 4B   | Object index | Object subindex | Data | - | - | - |

|  |        |               |   |    |              |                 |            |
|--|--------|---------------|---|----|--------------|-----------------|------------|
|  | Normal | 0x580+Node_ID | 8 | 43 | Object index | Object subindex | Data       |
|  | Error  | 0x580+Node_ID | 8 | 80 | Object index | Object subindex | Error code |

The command word sent by the SDO message is 0x40 when the parameter is read. The command word received will be different depending on the length of the message data returned by the driver.



### Note

"-" indicates that data exists but is not considered. You are advised to write 0 when writing data.

## SDO write message

Using SDO to modify parameters for objects no larger than 4 bytes, the transmission message varies according to the read and write mode and the inconsistency of the content data length. SDO write messages as shown in the following table:

Table 9-8 SDO write message description

|          | COB-ID | DLC           | Data |    |              |                 |            |   |   |   |
|----------|--------|---------------|------|----|--------------|-----------------|------------|---|---|---|
|          |        |               | 0    | 1  | 2            | 3               | 4          | 5 | 6 | 7 |
| → Master |        | 0x600+Node_ID | 8    | 2F | Object index | Object subindex | Data       | - | - | - |
|          |        | 0x600+Node_ID | 8    | 2B | Object index | Object subindex | Data       | - | - | - |
|          |        | 0x600+Node_ID | 8    | 23 | Object index | Object subindex | Data       |   |   |   |
| ← Slave  | Normal | 0x580+Node_ID | 8    | 60 | Object index | Object subindex | -          | - | - | - |
|          | Error  | 0x580+Node_ID | 8    | 80 | Object index | Object subindex | Error code |   |   |   |

When writing parameters, the command word is related to the data length of the object when the SDO message is sent. If the data to be sent is 1 byte, the command word is 0x2F. If the data to be sent is 2 bytes, the command word is 0x2B. If the data to be sent is 4 bytes, the command word is 0x23. The SDO message is successfully sent, and the received command word is 0x60. The SDO message failed to be sent with the received command word 0x80.

### Example:

The slave station number is 1, the SDO is used to write the object to the target position 607A.00, and the write value is 100000, that is, 0x186A0. The master station sends a message as shown in the following table. (All in hexadecimal)

Master send SDO message

| COB-ID | DLC | Data |    |    |    |    |    |    |    |
|--------|-----|------|----|----|----|----|----|----|----|
|        |     | 0    | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
| 0x601  | 8   | 23   | 7A | 60 | 00 | A0 | 86 | 01 | 00 |

Write normal drive receives SDO message

| COB-ID | DLC | Data |    |    |    |    |    |    |    |
|--------|-----|------|----|----|----|----|----|----|----|
|        |     | 0    | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
| 0x601  | 8   | 60   | 7A | 60 | 00 | A0 | 86 | 01 | 00 |

If the write is abnormal, the error command word 0x80 is returned

| COB-ID | DLC | Data |    |    |    |    |    |    |    |
|--------|-----|------|----|----|----|----|----|----|----|
|        |     | 0    | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
| 0x601  | 8   | 80   | 7A | 60 | 00 | 01 | 00 | 01 | 06 |

Table 9-9 SDO message error code

| Error code | Code function description                                      |
|------------|----------------------------------------------------------------|
| 0x05040001 | Invalid command, unknown or illegal Client/Server command word |

|            |                                                                                        |
|------------|----------------------------------------------------------------------------------------|
| 0x06010001 | Attempts to read only write object parameters                                          |
| 0x06010002 | An attempt was made to write read-only object parameters                               |
| 0x06020000 | Invalid index. The object does not exist in the object dictionary                      |
| 0x06040041 | Cannot be mapped, object parameters do not support mapping to PDO                      |
| 0x06060000 | The drive is in an error state, causing the object parameter access failure            |
| 0x06070010 | The data type and length of the service parameter do not match                         |
| 0x06070012 | The data type does not match, and the length of the service parameter is too large     |
| 0x06070013 | The data type does not match, and the length of the service parameter is too short     |
| 0x06090011 | Invalid subindex                                                                       |
| 0x06090030 | Invalid data, out of range of object parameters                                        |
| 0x06090031 | The value of the written data is too large                                             |
| 0x06090032 | Write data value is too small                                                          |
| 0x08000022 | Data cannot be transferred or saved to the application due to the current device state |

Table 9-10 Set the origin mode via SDO messages

| Parameter address                                                                                                                 | Name                           | Value  | message(ID=1)                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------|-------------------------------------------------------------------------|
| 60400010                                                                                                                          | Control word                   | F      | Send→601 2B 40 60 00 0F 00 00 00<br>Receive←581 60 40 60 00 0F 00 00 00 |
| 60600008                                                                                                                          | Operate mode                   | 6      | Send→601 2F 60 60 00 06 00 00 00<br>Receive←581 60 60 60 00 06 00 00 00 |
| 60980008                                                                                                                          | Homing mode                    | 33     | Send→601 2F 98 60 00 21 00 00 00<br>Receive←581 60 98 60 00 21 00 00 00 |
| 60990120                                                                                                                          | Homing transition signal speed | 200RPM | Send→601 23 99 60 01 03 9D 36 00<br>Receive←581 60 99 60 01 03 9D 36 00 |
| 60990220                                                                                                                          | Homing signal speed            | 100RPM | Send→601 23 99 60 02 82 4E 1B 00<br>Receive←581 60 99 60 02 82 4E 1B 00 |
| 60400010                                                                                                                          | Control word                   | 1F     | Send→601 2B 40 60 00 1F 00 00 00<br>Receive←581 60 40 60 00 1F 00 00 00 |
| Send 601 40 41 60 00 00 00 00 00 Read the status word and the drive replies 581 4B 41 60 00 31 C0 FF FF, bit15=1 for origin found |                                |        |                                                                         |

Table 9-11 Setting the position mode via SDO message

| Parameter address                                                                                                                                    | Name                     | Value    | message(ID=1)                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|----------|-------------------------------------------------------------------------|
| 60400010                                                                                                                                             | Control word             | 2F       | Send→601 2B 40 60 00 2F 00 00 00<br>Receive←581 60 40 60 00 2F 00 00 00 |
|                                                                                                                                                      |                          | 4F       | Send→601 2B 40 60 00 4F 00 00 00<br>Receive←581 60 40 60 00 4F 00 00 00 |
| 60600008                                                                                                                                             | Operate mode             | 1        | Send→601 2F 60 60 00 01 00 00 00<br>Receive←581 60 60 60 00 01 00 00 00 |
| 607A0020                                                                                                                                             | Target position          | 50000inc | Send→601 23 7A 60 00 50 C3 00 00<br>Receive←581 60 7A 60 00 50 C3 00 00 |
| 60810020                                                                                                                                             | Trapezoidal speed        | 200RPM   | Send→601 23 81 60 00 03 9D 36 00<br>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<br>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<br>Receive←581 60 84 60 00 6E A3 01 00 |
| 60400010                                                                                                                                             | Control word             | 3F       | Send→601 2B 40 60 00 3F 00 00 00<br>Receive←581 60 40 60 00 3F 00 00 00 |
|                                                                                                                                                      |                          | 5F       | Send→601 2B 40 60 00 5F 00 00 00<br>Receive←581 60 40 60 00 5F 00 00 00 |
| Send 601 40 41 60 00 00 00 00 00 Read the status word and the drive replies 581 4B 41 60 00 37 C4 FF FF,bit10 representing the target location reach |                          |          |                                                                         |

Table 9-12 Speed mode is set through SDO message

| Parameter address | Name                     | Value    | message(ID=1)                                                           |
|-------------------|--------------------------|----------|-------------------------------------------------------------------------|
| 60600008          | Operate mode             | 3        | Send→601 2F 60 60 00 03 00 00 00<br>Receive←581 60 60 60 00 03 00 00 00 |
| 60FF0020          | Target position          | -100RPM  | Send→601 23 FF 60 00 7E B1 E4 FF<br>Receive←581 60 FF 60 00 7E B1 E4 FF |
| 60400010          | Control word             | 2F       | Send→601 2B 40 60 00 2F 00 00 00<br>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<br>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<br>Receive←581 60 84 60 00 6E A3 01 00 |

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

9.3.3 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.

9.3.3.1 PDO 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 transport levels for PDO. The controller and the servo can define the same transmission level and the transmission content in their respective software configurations, so that after the controller and the servo use the same transmission level and transmission content, the data transmission is transparent, that is, both sides know the data content to be transmitted. It is not necessary to reply whether the data is transmitted successfully when the data is transmitted.

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 29 bits), which contains a 4-bit function code part and a 7-bit Node-ID part, as shown in Figure 9-2.

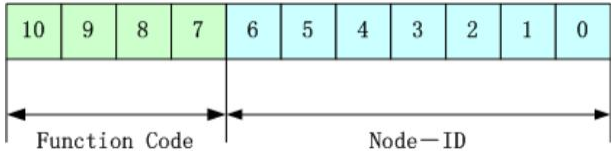


Figure 9-2 Default ID description diagram

➔

**Note**

Node-ID — The station number of the servo. The Node-ID ranges from 1 to 127.

Function Code —Function codes for data transmission, which define the transmission levels of various PDO, SDO, and management packets. The smaller the function codes, the higher the priority.

Table 9-13 CANopen predefined master/slave connection set CAN identifier assignment table

| Object                 | COB-ID    |
|------------------------|-----------|
| NMT Module Control     | 000H      |
| SYNC                   | 080H      |
| TIME SSTAMP            | 100H      |
| Object                 | COB-ID    |
| Emergency              | 081H-0FFH |
| PDO1 (Send)            | 181H-1FFH |
| PDO1 (Receive)         | 201H-27FH |
| PDO2 (Send)            | 281H-2FFH |
| PDO2 (Receive)         | 301H-37FH |
| PDO3 (Send)            | 381H-3FFH |
| PDO3 (Receive)         | 401H-47FH |
| PDO4 (Send)            | 481H-4FFH |
| PDO4 (Receive)         | 501H-57FH |
| SDO (Send/server)      | 581H-5FFH |
| SDO (Receive/customer) | 601H-67FH |
| NMT Error Control      | 701H-77FH |

**Note**

1. The smaller the COB-ID, the higher the priority.
2. The function code before the COB-ID of each level is in a fixed format.
3. The COB-ID 00H, 80H, 100H, 701H-77FH, and 081H-0FFH are all system management formats.

**9.3.3.2 COB-ID**

- Send PDO relative to the servo refers to the data sent by the servo, which is received by the PLC. The function code (COB-ID) for sending the PDO is:
  1. 0x180+ Servo station NO.
  2. 0x280+ Servo station NO.
  3. 0x380+ Servo station NO.
  4. 0x480+ Servo station NO.
- Receiving PDO relative to the servo refers to the data received by the servo, which is sent by the PLC, and the function code (COB-ID) for sending PDO is:
  1. 0x200+ Servo station NO.
  2. 0x300+ Servo station NO.
  3. 0x400+ Servo station NO.
  4. 0x500+ Servo station NO.

**Note**

Since the FD1X5 series servo drives are designed according to the standard CANopen 2.0A protocol, but also support CANopen 2.0B protocol, which means that if the above eight Pdos are not enough, you can also define a new PDO. For example, 0x43FH is used as the communication PDO of station 1, as long as the controller and the servo are defined in accordance with this.

**9.3.3.3 PDO transmission type**

- SYNC - Transmission triggered by a synchronization message (transmission type: 0-240)

In this transmission mode, the controller must have the ability to send synchronous messages (periodic messages with a frequency of up to 1KHZ), which the servo sends after receiving the synchronous message.

Aperiodic - pre-triggered transfer by a remote frame, or by an object-specific event specified in the device subprotocol. In this mode, the data in the PDO is sent once every time the servo drive receives a synchronization message.

Periodic - 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 packets.

When CANopen communication is configured in synchronous transmission mode, the driver uploads the mapped data in TPDO only after receiving the synchronization message.



TPDOSetting Specialist





| TPDO1 | TPDO2  | TPDO3            | TPDO4 | TPDO5 | TPDO6    | TPDO7 | TPDO8 |                                                                                     |
|-------|--------|------------------|-------|-------|----------|-------|-------|-------------------------------------------------------------------------------------|
| Index |        | Name             |       |       | Value    |       | Unit  |                                                                                     |
| 1     | 1A0000 | Group_TX1_PDO    |       |       | 2        |       | DEC   |  |
| 2     | 1A0001 | TX1_PDO1         |       |       | 60630020 |       | HEX   |  |
| 3     | 1A0002 | TX1_PDO2         |       |       | 60410010 |       | HEX   |  |
| 4     | 1A0003 | TX1_PDO3         |       |       |          |       | HEX   |  |
| 5     | 1A0004 | TX1_PDO4         |       |       |          |       | HEX   |  |
| 6     | 1A0005 | TX1_PDO5         |       |       |          |       | HEX   |  |
| 7     | 1A0006 | TX1_PDO6         |       |       |          |       | HEX   |  |
| 8     | 1A0007 | TX1_PDO7         |       |       |          |       | HEX   |  |
| 9     | 1A0008 | TX1_PDO8         |       |       |          |       | HEX   |  |
| 10    | 180001 | TX1_ID           |       |       | 00000181 |       | HEX   |  |
| 11    | 180002 | TX1_Transmission |       |       | 1        |       | DEC   |  |
| 12    | 180003 | TX1_Inhibit_Time |       |       | 0        |       | DEC   |  |
| 13    | 180005 | TX1_Event timer  |       |       |          |       | DEC   |  |

Figure 9-3 TPDO configuration in synchronous mode

Table 9-14 TPDO configuration in synchronous mode

| Name                                                                                                       | Meaning                                                                                                                |
|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| TPDO1 Mapping group                                                                                        | 2, the number of objects configured in this PDO, TPDO1 is configured with two objects: actual location and status word |
| Mapping 1-8                                                                                                | Configure the servo-CANOPEN control object                                                                             |
| TPDO1 station number                                                                                       | 180+ Drive ID (TPDO2 station number should be set to: 280+ drive ID)                                                   |
| TPDO1 Transport type                                                                                       | Synchronous transmission mode: The driver sends TPDO to the controller after receiving synchronization packets         |
| TPDO1 Disable time                                                                                         | It must be set to 0                                                                                                    |
| Note: The sum of the actual position and status word length of the assigned object in TPDO1 is 4+2=6 bytes |                                                                                                                        |

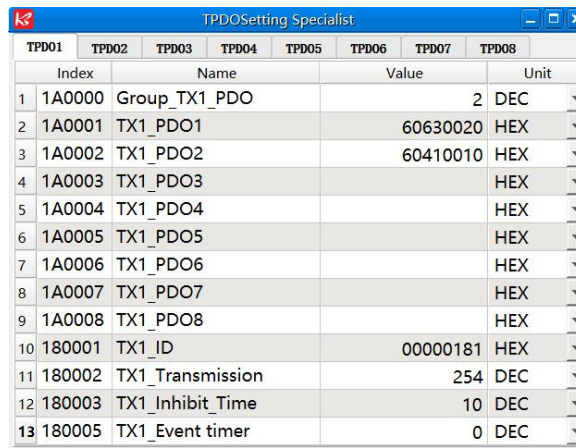
→

**Note**

- The sum of the actual position of the object and the length of the status word in TPDO1 is 4+2=6 bytes. The default RPDO transmission mode is 254. You do not need to set the transmission mode. The transmission mode takes effect immediately after data is received.
- The default value of synchronizing packets is

|        |     |
|--------|-----|
| COB-ID | DLC |
| 0x80   | 0   |

- Asynchronous (Transfer type: 254/255)  
  
The slave station sends the packet after the change regardless of whether the master station asks for it. In addition, you can define the interval between sending the same packet twice to prevent the packets with higher priorities from occupying the bus all the time (the lower the value of PDO, the higher the priority).  
  
For FD1X5 servo drive, it supports all 256 transmission modes, and the user only needs to select the transmission mode of the drive according to the transmission mode supported by the controller.  
  
In asynchronous transfer mode, the mapped object data in PDO is transmitted as soon as it changes.



| TPDO1 | TPDO2                   | TPDO3    | TPDO4 | TPDO5 | TPDO6 | TPDO7 | TPDO8 |
|-------|-------------------------|----------|-------|-------|-------|-------|-------|
| Index | Name                    | Value    | Unit  |       |       |       |       |
| 1     | 1A0000 Group_TX1_PDO    | 2        | DEC   |       |       |       |       |
| 2     | 1A0001 TX1_PDO1         | 60630020 | HEX   |       |       |       |       |
| 3     | 1A0002 TX1_PDO2         | 60410010 | HEX   |       |       |       |       |
| 4     | 1A0003 TX1_PDO3         |          | HEX   |       |       |       |       |
| 5     | 1A0004 TX1_PDO4         |          | HEX   |       |       |       |       |
| 6     | 1A0005 TX1_PDO5         |          | HEX   |       |       |       |       |
| 7     | 1A0006 TX1_PDO6         |          | HEX   |       |       |       |       |
| 8     | 1A0007 TX1_PDO7         |          | HEX   |       |       |       |       |
| 9     | 1A0008 TX1_PDO8         |          | HEX   |       |       |       |       |
| 10    | 180001 TX1_ID           | 00000181 | HEX   |       |       |       |       |
| 11    | 180002 TX1_Transmission | 254      | DEC   |       |       |       |       |
| 12    | 180003 TX1_Inhibit_Time | 10       | DEC   |       |       |       |       |
| 13    | 180005 TX1_Event timer  | 0        | DEC   |       |       |       |       |

Figure 9-4 TPDO configuration in asynchronous transport mode

Table 9-15 TPDO configuration in asynchronous transport mode

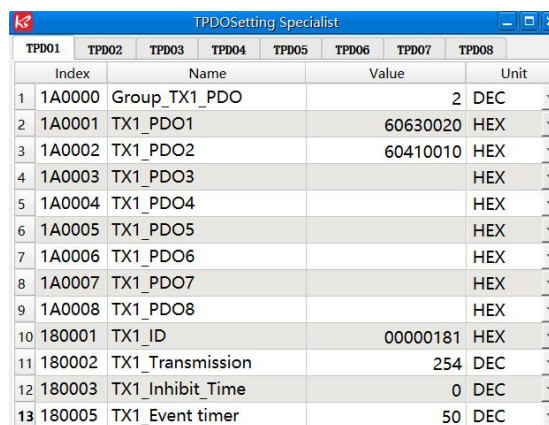
| Name                 | Meaning                                                                                                                                                                                                    |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TPDO1 Mapping group  | Indicates the number of objects configured in the PDO. TPDO1 is configured with two objects: actual location and status word                                                                               |
| Mapping 1-8          | Configure the servo-CANOPEN control object                                                                                                                                                                 |
| TPDO1 station number | 180+ Drive ID (TPDO2 station number should be set to: 280+ drive ID)                                                                                                                                       |
| TPDO1 Transport type | 254 or 255, asynchronous transmission modev                                                                                                                                                                |
| TPDO1 Disable time   | The unit is ms. This parameter prevents the network from being blocked by frequent packets sent by the server. In multi-axis asynchronous transmission mode, set this parameter based on site requirements |

**Note**

- The sum of the actual position of the object and the length of the status word in TPDO1 is 4+2=6 bytes.
- The default RPDO transfer mode is 254. This parameter takes effect immediately after data is received.
- A PDO can specify a forbidden time, that is, define the minimum interval between two consecutive PDO transmissions, to avoid the problem that the data of high priority information always occupies the bus because the amount of data is too large, and other low priority data cannot compete with the bus. The forbidden time is defined by a 16-bit unsigned integer, in 1ms.

- Event time reporting function

In asynchronous transfer mode, in addition to the instantaneous, the event time can be set if the driver needs to periodically upload data to the controller.



| TPDO1 | TPDO2                   | TPDO3    | TPDO4 | TPDO5 | TPDO6 | TPDO7 | TPDO8 |
|-------|-------------------------|----------|-------|-------|-------|-------|-------|
| Index | Name                    | Value    | Unit  |       |       |       |       |
| 1     | 1A0000 Group_TX1_PDO    | 2        | DEC   |       |       |       |       |
| 2     | 1A0001 TX1_PDO1         | 60630020 | HEX   |       |       |       |       |
| 3     | 1A0002 TX1_PDO2         | 60410010 | HEX   |       |       |       |       |
| 4     | 1A0003 TX1_PDO3         |          | HEX   |       |       |       |       |
| 5     | 1A0004 TX1_PDO4         |          | HEX   |       |       |       |       |
| 6     | 1A0005 TX1_PDO5         |          | HEX   |       |       |       |       |
| 7     | 1A0006 TX1_PDO6         |          | HEX   |       |       |       |       |
| 8     | 1A0007 TX1_PDO7         |          | HEX   |       |       |       |       |
| 9     | 1A0008 TX1_PDO8         |          | HEX   |       |       |       |       |
| 10    | 180001 TX1_ID           | 00000181 | HEX   |       |       |       |       |
| 11    | 180002 TX1_Transmission | 254      | DEC   |       |       |       |       |
| 12    | 180003 TX1_Inhibit_Time | 0        | DEC   |       |       |       |       |
| 13    | 180005 TX1_Event timer  | 50       | DEC   |       |       |       |       |

Figure 9-5 Event time is used to schedule the upload in asynchronous mode

Table 9-16 Event time is used to schedule the upload in asynchronous mode

| Name                                                                                                       | Meaning                                                                                                                       |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| TPDO1 Mapping group                                                                                        | Represents the number of objects configured in the PDO. TPDO1 is configured with two objects: actual location and status word |
| Mapping 1-8                                                                                                | Configure the servo-CANOPEN control object                                                                                    |
| TPDO1 station number                                                                                       | 180+ Drive ID (TPDO2 station number should be set to: 280+ drive ID)                                                          |
| TPDO1 Transport type                                                                                       | 254 or 255, asynchronous transmission mode                                                                                    |
| TPDO1 Disable time                                                                                         | When uploading using event time, this object is set to 0                                                                      |
| TPDO1 Event time                                                                                           | Cycle time (in ms) for the driver to send PDO to the controller                                                               |
| Note: The sum of the actual position and status word length of the assigned object in TPDO1 is 4+2=6 bytes |                                                                                                                               |

### 9.3.3.4 Protection Mode/Monitoring Type Description

Monitoring type refers to the check method selected by the master station to check the slave station during operation. Through these two ways, the slave station can be judged whether there is a fault, and the corresponding treatment is made according to these faults!

#### 1. Master heartbeat message

The slave station periodically uploads the message to the master station at the "monitoring time". If the master station does not receive the next heartbeat message from the slave station after the "heartbeat consumer time", the master station determines that the communication is wrong and the master station generates an alarm!

Table 9-17 The format of the heartbeat packet was uploaded from the slave station

| COB-ID                             | Byte 0 |
|------------------------------------|--------|
| 0x700+Node_ID                      | State  |
| 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 9-18 The format of heartbeat packets sent by the master station

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

Table 9-19 Status value meaning

| State value | Meaning         |
|-------------|-----------------|
| 0x00        | boot-up         |
| 0x04        | Stopped         |
| 0x05        | Operational     |
| 0x7f        | Pre-operational |

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



**Note**  
The generation time of heartbeat message and the heartbeat packets of the slave station are configured by the master station when the power is turned on, and they are not saved by default when the power is off.

3. Node protection

The master station periodically sends the remote request packet to the slave station in the monitoring time. The slave station responds immediately after receiving the request packet. If the master station does not receive the response packet from the slave station after the Monitoring time x Life Factor time expires, the master station determines that the slave station is wrong. 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 beyond the time of "Node protection time \* node protection factor", the slave station will also judge the communication error. The communication interrupt mode (0x600700) needs to be set to 1, and the drive will alarm and stop when CAN communication fails.

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

Slave response message format—— (0x700+node number) +state

Table 9-20 Slave station reply message

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

Table 9-21 Slave station reply packet status value meaning

| State value | Meaning         |
|-------------|-----------------|
| 0           | Initializing    |
| 1           | Disconnected    |
| 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 9-21 describes the values.

The standard CAN slave station generally supports only one node protection mode, FD1X5 both support protection mode. However, a node cannot support both node protection and heartbeat message at the same time. Only one of them can be used for protection.

9.3.3.5 Startup process description

CANopen supports both extended boot-up and minimal boot-up procedures during network initialization. The initialization process can be represented by a node state transition diagram, as shown in Figure 9-6.

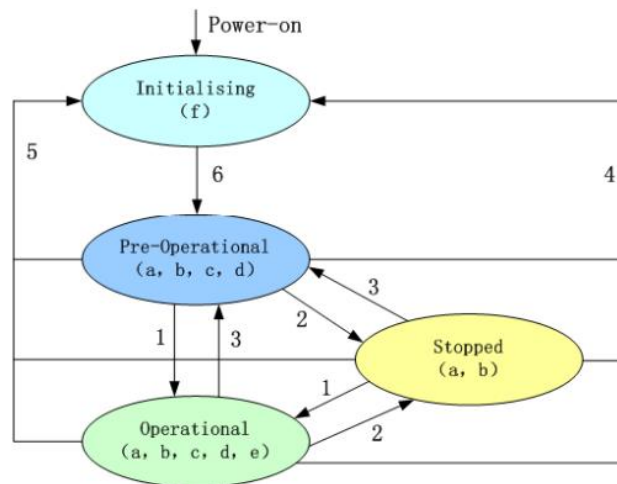


Figure 9-6 Node state transition diagram

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

Including : 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 9-22 NMT manages the packet format

| COB-ID | Byte0 | Byte1   |
|--------|-------|---------|
| 0x000  | CS    | Node-ID |

Node-ID=0 indicates that all NMT slave devices are addressed. CS is the command word. Table 9-23 lists the values of CS.

Table 9-23 CS value table

| Command word | NMT service                   |
|--------------|-------------------------------|
| 0x01         | Enable remote node            |
| 0x02         | Close remote node             |
| 0x80         | Enter the pre-operation state |
| 0x81         | Reset node                    |
| 0x82         | Reset communication           |

### 9.3.3.6 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 9-24 Emergency message format

| COB-ID                                       | Byte 0-1                         | Byte2                      | Byte4-5                 | Byte6-7                 |
|----------------------------------------------|----------------------------------|----------------------------|-------------------------|-------------------------|
| Emergency message station number<br>0x101400 | Emergency error code<br>0x603F00 | Error register<br>0x100100 | error state<br>0x260100 | error state<br>0x260200 |

Table 9-25 Emergency error code 0x603F00

| Alarm content                                          | Emergency Error Code (Hex) | Alarm content                 | Emergency Error Code (Hex) |
|--------------------------------------------------------|----------------------------|-------------------------------|----------------------------|
| Communication encoder is not connected                 | 0x7331                     | Current sensor fault          | 0x5210                     |
| Communication encoder multi-turn error                 | 0x7320                     | Software watchdog reset       | 0x6010                     |
| Communication encoder check error                      | 0x7330                     | Abnormal interrupt            | 0x6011                     |
| Driver temperature is too high                         | 0x4210                     | MCU fault                     | 0x7400                     |
| The driver bus voltage is too high                     | 0x3210                     | Motor model configure error   | 0x6320                     |
| The driver bus voltage is too low                      | 0x3220                     | Motor power line out of phase | 0x6321                     |
| Driver power part short circuit or motor short circuit | 0x2320                     | Pre-enable alarm              | 0x5443                     |
| Current sampling saturation                            | 0x2321                     | Positive limit error          | 0x5442                     |
| Driver brake resistance is abnormal                    | 0x7110                     | Negative limit error          | 0x5441                     |
| Actual following error exceeds allowable               | 0x8611                     | SPI fault                     | 0x6012                     |
| Logic low voltage                                      | 0x5112                     | Bus communication error       | 0x8100                     |
| Motor or drive is overloaded                           | 0x2350                     | Bus communication timeout     | 0x81FF                     |
| Input pulse frequency is too high                      | 0x8A80                     | Full closed loop check error  | 0x8A81                     |
| Excessive motor temperature                            | 0x4310                     | Main encoder ABZ error        | 0x7382                     |
| Communication encoder is not response                  | 0x7331                     | Main encoder count error      | 0x7306                     |
| EEPROM data error                                      | 0x6310                     |                               |                            |

Table 9-26 Error register

| Bit | Error type              |
|-----|-------------------------|
| 0   | Common fault            |
| 1   | Current                 |
| 2   | Voltage                 |
| 3   | Temperature             |
| 4   | Communication error     |
| 5   | Device profile specific |
| 6   | Encoder                 |
| 7   | Reserve                 |

## 9.4 CANopen Bus Communication Setting

This chapter will introduce the setting of CAN bus communication parameters. In the upper computer software interface, click **Specialist ->ECAN Configuration -> ECAN Settings** to enter the parameter setting interface. When the master station with the network management function is powered on, the parameters of the slave station are initialized by sending SDO. Generally, 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 9 - 27 CANopen relate parameter

| CANopen address | Name               | Meaning                                                                    | Default |
|-----------------|--------------------|----------------------------------------------------------------------------|---------|
| 10050020        | Synchronization ID | The transmission type ranges from 1 to 240. This parameter is available in | 80      |

| CANopen address | Name                                      | Meaning                                                                                                                                                                                                                                                                                                                                                                                                                                             | Default |
|-----------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
|                 |                                           | synchronous mode but does not need to be set in asynchronous mode.                                                                                                                                                                                                                                                                                                                                                                                  |         |
| 100C0010        | Node protection time                      | Through node protection, the master station can monitor the current status of each node. The master station sends a remote frame (the default COBID is 0x700+ station number and contains no message) to query the status of the slave node according to the node protection period. The slave node needs to respond within a certain time range, otherwise the master node considers the slave node offline and the driver enters the alarm state. | 1000    |
| 100D0008        | Node protection time coefficient          |                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3       |
| 100E0020        | Node protection ID                        | 700+ drive ID                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |
| 10140020        | Emergency message station number          | 80+ drive station number                                                                                                                                                                                                                                                                                                                                                                                                                            |         |
| 10170010        | Timestamp of heartbeat message generation | The slave node periodically sends message to the master node. If the master node does not receive the message within a certain period of time, the slave node is considered to be disconnected                                                                                                                                                                                                                                                      |         |
| 2F810008        | CAN baud rate                             | CAN baud rate Setting<br>100: 1M<br>50: 500k<br>25: 250k<br>12: 125k<br>5: 50k<br>1: 10k                                                                                                                                                                                                                                                                                                                                                            | 50      |
| 30110108        | ECAN synchronization period               | In interpolation mode, this parameter is set based on the synchronization packet interval of the master station. In asynchronous mode, this parameter is not required.<br>0:1ms<br>1:2ms<br>2:4ms<br>3:8ms                                                                                                                                                                                                                                          | 2       |
| 30110208        | ECAN Synchronous clock mode               | Set to 1 in interpolation mode to enable the synchronization clock, and set 0 to turn off the synchronization clock in non-interpolation mode                                                                                                                                                                                                                                                                                                       | 0       |
| 30110410        | ECAN synchronization Lost count           | In synchronization mode, the communication status is monitored. If the value does not change, the communication status is good. If the value keeps changing, interference occurs or the synchronization period is incorrectly set.                                                                                                                                                                                                                  |         |
| 60070010        | Communication interrupt mode              | CAN communication interruption mode: determines the action logic that the driver still does not receive the node protection packet after the node protection time x node protection coefficient is exceeded<br>0: No processing<br>1: An error is reported                                                                                                                                                                                          | 0       |

- Use the PLC to initialize PDO parameter

For the CANopen master station that can import EDS files, PDO Settings in the server are not required, and PDO information can be directly configured in the master station. After power-on, PLC initialization will send SDO messages to configure the PDO of the server. After the configuration is completed, the master station will send startup messages to start the slave station, and then PDO communication can be carried out. Most PLCs can be used in this way, such as: Schneider PLC, Siemens S7-1200+CM CANOPEN module, Buke F1 and so on.



#### Note

EDS file download address: [http://download.kinco.cn/D\\_Software/Servo/EDS.zip](http://download.kinco.cn/D_Software/Servo/EDS.zip)

## 9.5 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 **Specialist ->ECAN Configuration -> ECAN Settings** to enter the interpolation mode parameter setting interface.

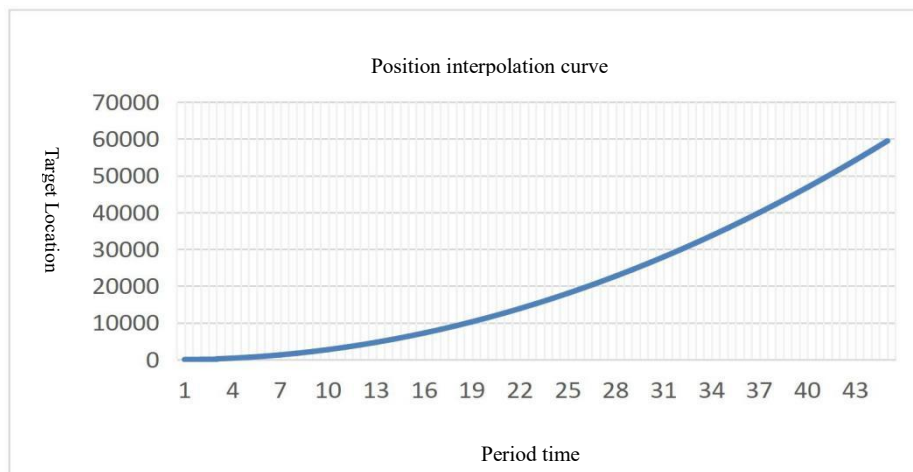


Figure 9-8 Position interpolation curve

Table 9-28 Interpolation control relate parameter

| Internal address | Parameter name              | Description                                                                                                                                                                                                                      | Default value |
|------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 60600008         | Operation mode              | Set the operation mode to interpolation mode                                                                                                                                                                                     | 7             |
| 60400010         | Controlword                 | 0x1F Enable drive, run interpolation mode<br>0x06 Loose axis, close drive enable<br>0x86 Reset drive failure                                                                                                                     | 1F<br>6<br>86 |
| 607A0020         | Target position             | target absolute/relative position                                                                                                                                                                                                | User Defined  |
| 30110108         | ECAN sync period            | In interpolation mode, it is set according to the synchronization message cycle of the master station value      synchronization period<br>0      1ms<br>1      2ms<br>2      4ms<br>3      8ms                                  | User Defined  |
| 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 | /             |

- CAN communication interruption alarm function

For the communication interruption alarm function, the following parameters need to be set

Table 9 - 29 Communication interrupt alarm function setting

| CANopen address | Name                             | Meaning                                                                                                                                                                                                                                                                                                                                                                                                                                             | Default value |
|-----------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 100C0010        | Node protection time             | Through node protection, the master station can monitor the current status of each node. The master station sends a remote frame (the default COBID is 0x700+ station number and contains no message) to query the status of the slave node according to the node protection period. The slave node needs to respond within a certain time range, otherwise the master node considers the slave node offline and the driver enters the alarm state. | 1000          |
| 100D0008        | Node protection time coefficient |                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3             |
| 100E0020        | Node protection ID               | 700+ drive ID                                                                                                                                                                                                                                                                                                                                                                                                                                       |               |
| 10140020        | Emergency message station number | 80+ drive station number                                                                                                                                                                                                                                                                                                                                                                                                                            |               |
| 60070010        | Communication interrupt mode     | CAN communication interruption mode: determines the action logic that the driver still does not receive the node protection packet after the node protection time x node protection coefficient is exceeded<br>0: No processing<br>1: An error is reported                                                                                                                                                                                          | 0             |

## Chapter 10 Alarm exclusion

### 10.1 Mistakes and historical errors

**Error:** Click "Driver" -> "Error Display", or click the  button (becomes  when an error occurs), the error window will pop up and display the most recent error message. Troubleshoot the fault according to Chapter 10, section 10.2.

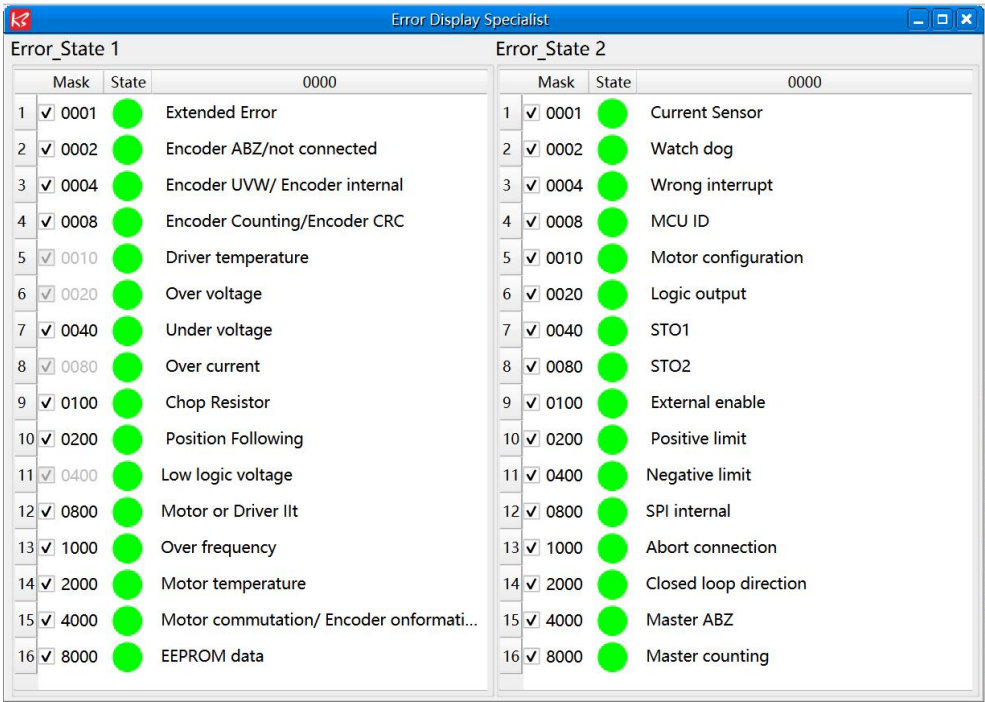


Figure 10-1 Error display interface

**Historical error:** Click the menu bar "Driver" -> "Error History", the error history window will pop up, and display the latest 8 error information, including error word, bus voltage, speed, current, temperature, working mode, power tube status. The most recent historical fault is displayed on the first line.

| Error History |      |      |     |    |    |               |           |          |
|---------------|------|------|-----|----|----|---------------|-----------|----------|
|               | Code | DC V | RPM | Ap | °C | OperationMode | PWM State | Time Min |
| 1             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 2             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 3             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 4             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 5             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 6             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 7             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |
| 8             | 0    | 0    | 0   | 0  | 0  | 0             | 0         | 0        |

Figure 10-2 History error display screen

Table 10-1 Error status (2601.00) information

| Bit | Error Name                  | Error code | Description                                                        |
|-----|-----------------------------|------------|--------------------------------------------------------------------|
| 0   | Extended error              |            | Refer to Error Status 2 definition (2602.00)                       |
| 1   | Encoder communication error | 0x7331     | Communication encoder not connected                                |
| 2   | Encoder internal fault      | 0x7320     | Encoder internal fault                                             |
| 3   | Encoder CRC error           | 0x7330     | Encoder communication is being interfered with                     |
| 4   | Driver temperature          | 0x4210     | Heat sink temperature is too high                                  |
| 5   | Overvoltage                 | 0x3210     | Bus overvoltage                                                    |
| 6   | Undervoltage                | 0x3220     | Bus undervoltage                                                   |
| 7   | Overcurrent                 | 0x2320     | Driver power tube or motor short circuit                           |
| 8   | Chop resistor               | 0x7110     | Brake resistance overload                                          |
| 9   | Following error             | 0x8611     | The actual following error exceeds the maximum set following error |
| 10  | Low logic voltage           | 0x5112     | The logical power supply voltage is too low.                       |
| 11  | Motor or driver Ilt         | 0x2350     | The motor or drive power tube Ilt is faulty                        |
| 12  | Overfrequency               | 0x8A80     | The pulse input frequency is too high                              |
| 13  | Motor temperature           | 0x4310     | Motor temperature sensor alarm                                     |
| 14  | Encoder information error   | 0x7331     | Encoder is not connected or encoder communication times out        |
| 15  | EEPROM data error           | 0x6310     | EEPROM data verification error                                     |

Table 10-2 Error status 2 (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                                                                           |
| 5~7 | 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 abort connection  | 0x8100     | The fault alarm will be generated only when the communication interruption mode (6007.00) is set to 1                      |
| 13  | Closed loop direction | 0x8A81     | In the full closed-loop working state, the counting direction of the main encoder is opposite to that of the motor 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. An unchecked ☐ means 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 10-4).

Table 10-3 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                             |

Table10-4 Error mask

| Internal address | Type   | Name            | Description                                                                                                                                            | 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  |

## 10.2 Alarm cause and treatment measures

When the drive alarms, the red ERR light of the drive will be steady on.

If you want to query more detailed error information and error history, please use the RS485 serial port communication cable (or usb debugging cable) to connect the drive to the upper computer to view.

Table 10 - 5 Error status word 1 alarm code

| Alarm code | Alarm information                                                  | Reason                                                                                                                          | Troubleshooting                                                                                                                                                                                                                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FFF.F      | The motor is not configured or the motor is incorrectly configured | 1. The driver is not equipped with a motor.<br>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.<br>2. Connect the upper computer software to check whether the current motor model matches the motor code on the nameplate; When the current motor model is different from the actual connected motor, please re-identify the motor parameters. |
| 000.1      | Extended Error                                                     | Error status word 2 alarm                                                                                                       | Look at the error status word 2 and check the meaning of the error against the alarm code.                                                                                                                                                                                                                                                                                                           |
| 000.2      | Encoder communication failure                                      | Encoder cable error or not connected; The presence of a 400.0 alarm indicates that the communication encoder is not responding  | Step 1: Make sure that the encoder between the driver and the motor is properly connected and the cable is firmly connected.<br>Step 2: Check whether the current motor model matches the motor code in the nameplate through the upper computer software. If the current motor model is different from the actual motor, please refer to <b>4.2</b> Chapter to self-identify the motor parameters.  |

|       |                        |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 000.4 | Encoder internal fault | Multi-turn absolute encoder multi-turn data is invalid, need to reset               | Step 1: Use the host software to modify the communication encoder data reset (0x269000) to 10.<br>Step 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 error      | Motor model setting error;<br>Encoder wiring error or external interference caused; | 1, Whether the motor configuration is correct<br>Step 1: Check whether the current motor code is consistent with the motor code in the connected motor nameplate through the upper computer software.<br>Step 2: Make sure that the encoder between the driver and the motor is properly connected and the cable is firmly connected.<br>2, check whether the driver grounding wire is well connected (different from the motor PE wire)<br>3. Check whether the grounding cable of the entire device is well connected.<br>4. Use an independent power supply to power the drive.                                        |
| 001.0 | Driver overtemperature | The temperature of the drive power module reaches the alarm value                   | Step 1: Check whether the motor and drive power meet the requirements.<br>Step 2: Restart the drive and check whether the cooling fan can be started during the power-on process. Check that the heat dissipation hole in the driver housing is blocked.<br>Step 3: When the ambient temperature exceeds 40°, take heat dissipation measures or derate the power cabinet.<br>Step 4: Increase the drive installation distance appropriately<br>Step 5: The internal power circuit of the driver is damaged. Replace the driver.                                                                                           |
| 002.0 | Overvoltage            | The DC bus voltage exceeds the overvoltage alarm point                              | Step 1: Check whether the power supply voltage is within the driver input voltage range and whether the power supply voltage is stable.<br>Step 2: The energy generated in high-speed braking occasions will be fed back to the driver bus capacitor, and it can be considered to connect a suitable brake resistance to absorb and consume excess energy through the brake resistance.<br>Step 3: If the brake resistance value is too large, the bus energy leakage is not timely, and the brake resistance value should be reduced.<br>Note: FD1X5 series brake resistors recommended range please see section 3.1.2.1 |
| 004.0 | Undervoltage           | The DC bus voltage is lower than the low voltage alarm point                        | Step 1: Check whether the power supply voltage is within the driver input voltage range and whether the power supply voltage is stable.<br>Step 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.                                                                                                                                                                                                                                                                                                                |
| 008.0 | Overcurrent            | Instantaneous current exceeds the overcurrent protection value.                     | Step 1: Check whether the motor configuration parameters are consistent with the motor drawing.<br>Step 2: Check whether there is a short circuit between the power line UVW, and try to replace the power cable/motor/driver for comparison.<br>Step 3: Interference causes an overcurrent alarm. For details, see 3.3 Setting EMC Conditions.                                                                                                                                                                                                                                                                           |
| 010.0 | Chop Resistor          | External brake resistance is overloaded                                             | Step 1: Check whether the external brake resistance value and brake resistance power are set correctly on the upper computer.<br>Step 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:<br>1. The motor cable is improperly connected<br>2. The control ring is too rigid<br>3. The maximum following error is set too small<br>4. Target speed exceeds maximum speed limit<br>5. The target torque limit is too small<br>6. The lock is not opened<br>7. Mechanical plug/friction          | Step 1: Make sure the power cable UVW is connected correctly<br>Step 2: Readjust the gain and increase the rigidity. Refer to Chapter 5 for the rigidity adjustment method<br>Step 3: Readjust the maximum follow error (0x606500)<br>Step 4: Readjust the maximum speed limit (0x607f00)<br>Step 5: Readjust the target current limit (0x607300), the default value of the target current limit is equal to the maximum motor current (0x64100B)<br>Step 6: Measure whether the lock line connection is normal, measure the lock voltage, replace the motor and compare the test<br>Step 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 logic voltage is within the driver input voltage range and the power supply voltage is stable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 080.0 | Motor or drive IIT error  | The motor or drive is overloaded for a long time, the possible reasons are:<br>1. Motor power line and encoder wiring error<br>2. When the motor shaft is rotating, the lock is not loosened<br>3. The drive control ring parameters are incorrectly set<br>4. The mechanical device is stuck or the friction is too large<br>5. Driver/motor selection error can not meet the application requirements | Step 1: Check that the encoder/power line is properly connected<br>Step 2: Measure whether the brake line connection is normal, measure the lock voltage, replace the motor and compare the test<br>Step 3: Adjust the parameters of the control ring<br>Step 4: Eliminate mechanical jams and apply lubricant<br>Step 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<br>2, when using more than 600KHz pulse, need to increase the pulse frequency control 0x250808 value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 200.0 | Motor temperature         | The motor temperature exceeds the specified value.                                                                                                                                                                                                                                                                                                                                                      | User-defined alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 400.0 | Encoder information error | Encoder cable error or not connected; The presence of a 000.2 alarm indicates that the communication encoder is not responding                                                                                                                                                                                                                                                                          | Step 1: Make sure that the encoder between the driver and the motor is properly connected and the cable is firmly connected.<br>Step 2: Check whether the current motor model matches the motor code in the nameplate through the upper computer software. If the current motor model is different from the actual connected motor, please set the correct motor parameters.                                                                                                                                                                                                                                                            |
| 800.0 | EEPROM error              | Data is damaged when the power is turned on and data is read from the EEPROM.                                                                                                                                                                                                                                                                                                                           | Step 1: After initializing the control ring parameters, save the control parameters and restart the drive<br>Step 2: Import the cdi file through the host software                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

Table 10-6 Error status word 2 Alarm code

| Alarm code | Alarm information      | Reason                                                                                                                                                                                                     | Troubleshooting                                                                                                                                                                                                                                                                                                                                                                           |
|------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 000.1      | Current sensor         | Current sensor signal offset or ripple too big                                                                                                                                                             | Step 1: The current sensor generates an alarm due to external interference. For details, see 3.3 Setting EMC Conditions.<br>Step 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 fault              | 1. The software program does not match the hardware<br>2. An MCU error is detected                                                                                                                         | Step 1: Check the software version in the drive properties and update the correct software<br>Step 2: Replace the drive and compare.                                                                                                                                                                                                                                                      |
| 001.0      | Motor misconfiguration | 1. Motor model cannot be automatically identified<br>EEPROM has no motor data or the motor is not configured correctly<br>2. The motor line is missing, and a phase of the power line UVW is not connected | Step 1: Connect the host computer software to check whether the current motor model matches the motor code on the nameplate; If the current motor model is different from the actual connected motor, reset the correct motor parameters.<br>Step 2: Make sure the motor power line UVW is connected correctly and reliably<br>Step 3: Replace the power cable or driver comparison test. |
| 010.0      | External enable        | DIN function "pre_enable" is configured, but the input is inactive when the controller is enabled or should become enabled                                                                                 | User-defined alarm                                                                                                                                                                                                                                                                                                                                                                        |

|       |                            |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|----------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 020.0 | Positive limit             | Positive position limit (after homing), position limit only causes error when Limit_Function (0x201019) is set to 0. | User-defined alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 040.0 | Negative limit             | Negative position limit (after homing), position limit only causes error when Limit_Function (0x201019) is set to 0. | User-defined alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 080.0 | SPI fault                  | 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        | Step 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)<br>Step 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 error      | Master encoder index signal is abnormal                                                                              | Step 1: Correctly fill in the main encoder period (0x250A01) and set it to 0 to disable check.<br>Step 2: Check for interference                                                                                                                                                                                                                                                                                                                                                                                          |

Table 10-7 Performance anomalies and solutions

| Anomalies                                              | Alarm reason                                                                                                                                                                                                                                                                        | Solutions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motor no load operation<br>abnormal sound or vibration | 1. Wiring error<br>2. Improper setting of control loop parameters<br>3. Improper installation of motor oil seal or motor failure                                                                                                                                                    | Use standard power cables, encoder cables, and control cables to ensure that the cables are properly connected and are not loose or damaged. Initialize Control parameters - The storage control parameters restart before trying to run.<br>Hand twist the motor bearing to check whether the motor is abnormal and try to reinstall the motor oil seal.                                                                                                                                                                                                                                                                                                                                                    |
| Incorrect positioning                                  | 1. Improper control loop parameters<br>2. The pulse data in front of the gear is inconsistent with the number of pulses delivered by the controller<br>3. The electronic gear ratio is set too large<br>4. Cumulative error of reciprocating motion<br>5. Mechanical system factors | Adjust drive control ring parameters according to Section 5<br>Use shielded twisted pair cables for pulse cables. If the cables are long, increase the diameter of the control cables appropriately. The pulse line is as far away from the power cord as possible, and the driver is well grounded to the motor.<br>Resume factory gear ratio operation.<br>The machine is returned to the original where the process permits, and the origin is searched before the accumulated error exceeds the allowable.<br>Check whether the coupling equipment is firmly installed, the pulley or gear is well fastened, the load inertia is too large, and try to reduce the load or replace a more powerful motor. |

## Appendix I Method of configuring a third-party motor

| Name                           | Parameter         | Note                                                                                                                                                                                                                                                                                             |
|--------------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of motor poles          | Must be filled in | Please refer to the motor drawing                                                                                                                                                                                                                                                                |
| Maximum motor current          | Must be filled in | Please refer to the motor drawing                                                                                                                                                                                                                                                                |
| Phase inductance               | Must be filled in | The parameter on the motor drawing $\times 100$ gets configuration parameters                                                                                                                                                                                                                    |
| Phase resistance               | Must be filled in | The parameter on the motor drawing $\times 100$ gets configuration parameters                                                                                                                                                                                                                    |
| Reverse electromotive force    | Must be filled in | Please refer to the motor drawing                                                                                                                                                                                                                                                                |
| Torque coefficient             | Must be filled in | Please refer to the motor drawing                                                                                                                                                                                                                                                                |
| Rotor inertia                  | Must be filled in | Please refer to the motor drawing                                                                                                                                                                                                                                                                |
| Brake duty cycle               | Reference remarks | 90%                                                                                                                                                                                                                                                                                              |
| Brake delay                    | Reference remarks | 150ms                                                                                                                                                                                                                                                                                            |
| Motor model                    | Reference remarks | The FD1x5 driver currently supports only the Tonomagawa encoder protocol, with the following Settings:<br>Tama River: VX                                                                                                                                                                         |
| Use the internal motor library | Reference remarks | Set it to either 1 or 2                                                                                                                                                                                                                                                                          |
| Feedback type                  | Reference remarks | Set the corresponding value according to the encoder feedback type.<br>Bit0: UVW cable check<br>Bit2: Communication type wiring check<br>Bit4: ABZ connection check<br>Bit5: Provincial encoder<br>Tonomagawa encoder set to: 04                                                                 |
| Feedback accuracy              | Reference remarks | Encoder feedback accuracy<br>Incremental: Number of encoder lines $\times 4$<br>Communication type: the resolution of a single turn is less than 16 bits set to the actual encoder resolution; Single-turn resolution higher than 16 bits is generally set to 65536 to prevent position overflow |
| Feedback cycle                 | Reference remarks | Incremental: The number of pulses per turn of the motor<br>Communication type: Define the encoder type, for example, multi-turn 16-bit, single-turn 17-bit, and feedback period set to 0x1617 for the Tama Agawa encoder                                                                         |
| Excitation mode                | Reference remarks | Mode 0 or mode 10                                                                                                                                                                                                                                                                                |
| Excitation current             | Reference remarks | Smaller than the rated current, generally 0.75 times the rated current of the motor                                                                                                                                                                                                              |
| Excitation time                | Reference remarks | The default value is 2000ms                                                                                                                                                                                                                                                                      |
| Motor iit current              | Reference remarks | Generally set to rated current                                                                                                                                                                                                                                                                   |
| Motor iit time                 | Reference remarks | Usually 60 s                                                                                                                                                                                                                                                                                     |
| Motor current loop bandwidth   | Reference remarks | The default value is 2000Hz                                                                                                                                                                                                                                                                      |



### Note

- After filling in the above forms, enter our upper computer software, find the motor configuration and selection, fill in the information in turn, and finally save the motor parameters, initialize the control ring parameters, and restart the drive.
- Power on and find that the motor does not have any alarm, you can start to try to run other control modes.
- If there is an alarm, check the corresponding drive manual step by step.
- Before trial operation of the motor, limit the target current to prevent excessive output current of the driver.
- If it is found that the motor does not have any alarm and the motor does not turn, first check whether the resolution is set correctly, then check whether the UVW line is connected inversely, sometimes due to the different specifications of various manufacturers, it may be necessary to adjust the UV line, and finally check whether the excitation mode is set correctly.
- The two parameters of phase inductance and phase resistance need to be multiplied by 100 to get the correct configuration value.

## Appendix II Commonly used formulas

The selection method of the trolley motor is suitable for the mechanism of the motor + reducer + wheel

| Formula: $T \cdot n = \mu \cdot m \cdot g \cdot d / 2$ |                               |
|--------------------------------------------------------|-------------------------------|
| Diameter of wheel $d$                                  | m                             |
| The reduction ratio of the reducer $n$                 | 1: $n$                        |
| Torque of motor $T$                                    | Nm, $\text{kgm}^2/\text{s}^2$ |
| Full load capacity $m$                                 | kg                            |
| friction coefficient $\mu$                             | unitless                      |
| gravitational acceleration $g$                         | $\text{m/s}^2$                |

The relationship between the number of pulses and mechanical displacement in pulse mode

| Formula: $N \cdot A / B = s \cdot n \cdot r / P$ |          |
|--------------------------------------------------|----------|
| Gear ratio molecule $A$                          | unitless |
| Gear score $B$                                   | unitless |
| Ball screw lead $P$                              | mm       |
| The number of pulses per turn of the motor $r$   | unitless |
| Reduction ratio 1: $n$                           | unitless |
| Mechanical displacement $s$                      | mm       |
| Pulse count $N$                                  | unitless |

The relationship between speed and linear velocity

| Formula: $n = v \div r \div \pi$ |      |
|----------------------------------|------|
| Speed $n$                        | rpm  |
| linear velocity $v$              | mm/s |
| Radius $r$                       | mm   |

| Parameter Name | Engineering unit | Internal unit | Conversion relation                                                                                        |
|----------------|------------------|---------------|------------------------------------------------------------------------------------------------------------|
| Speed          | rpm              | DEC           | $\text{DEC} = \lceil (\text{RPM} \cdot 512 \cdot \text{encoder resolution}) / 1875 \rceil$                 |
| Acceleration   |                  | DEC           | $\text{DEC} = \lceil (\text{RPS} / \text{S} \cdot 65536 \cdot \text{encoder resolution}) / 4000000 \rceil$ |
| Current        | A                | DEC           | $1\text{Arms} = \lceil 2048 / (\text{drive peak current} \cdot \text{lpeak} / 1.414) \rceil \text{dec}$    |

For example:

The speed engineering unit is rpm, the internal unit is dec, and the relationship between the two is that 1RPM is equal to 2730dec (encoder resolution 10000)! Assuming that the required speed is 10rpm, then the write speed is 27300dec when using the communication control and 6AA4 in hexadecimal.

The current engineering unit is Arms, the internal unit is dec, 1Arms is equal to about 60dec, if the current needs to be 10Arms, then the current needs to be written to 600d when using communication control.