

CS3E-E Series

EtherCAT Closed Loop Stepper Drive

User Manual



For models of CS3E-D503E, CS3E-D507E

©2020 Leadshine Technology Co., Ltd.

Address: 15-20/F, Block B, Nanshan I Valley, No.3185, Shahe West Road, Nanshan District,
Shenzhen, Guangdong, 518055, China

Tel: (86)755-26409254

Fax: (86)755-26402718

Web: www.leadshine.com

Sales: sales@leadshine.com

Support: tech@leadshine.com

Notice

Read this manual carefully before any assembling and using. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information regarding installation requirements.

This manual is not for use or disclosure outside of Leadshine except under permission. All rights are reserved. No part of this manual shall be reproduced, stored in retrieval form, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise without approval from Leadshine. While every precaution has been taken in the preparation of the book, Leadshine assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained herein.

This document is proprietary information of Leadshine that is furnished for customer use ONLY. Information in this document is subject to change without notice and does not represent a commitment on the part of Leadshine. Therefore, information contained in this manual may be updated from time-to-time due to product improvements, etc., and may not conform in every respect to former issues.



EtherCAT[®] is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

- ◆ **Thank you for purchasing Leadshine CS3E-E Series Products**
- ◆ **Please read this manual carefully before operating**
- ◆ **Please keep this manual appropriately**

Record of Revisions

| Reversion | Data | Description of Release |
|-----------|------------|---------------------------------|
| V1.0 | 11/02/2017 | Initial Release |
| V1.2 | 06/01/2020 | Add debug port, change ESI file |
| | | |
| | | |

Safety Precautions

Overall Notes



- Do not remove the housing with the drive powered on. Cables, connectors and optional equipment.
- Please disconnect the power supply for at least 2 minutes and make sure the power indicator is off before wiring and checking. Even if the power is disconnected, voltage may remain inside the drive. Therefore, do not touch the power terminals while the power indicator is on.



- Please use the power supply specifications (number of phases.) that match the product. Voltage. Frequency. AC/DC).
- Be sure to connect the ground terminal of the driver (mounting surface) and motor to the ground pole.
- Do not damage or drag the cable, do not overstress the cable, do not hang heavy objects on the cable, or get caught in the cabinet door.
- Please do not disassemble the product yourself. Repair or modification.
- When the machine is connected to the machine and starts to operate, make sure that the machine is ready for emergency stop.
- Do not touch the inside of the drive.



- The heat sink of the driver may be hot when the power is on or when the power is just cut off. The motor, etc. may be in a high temperature. Take safety measures such as installing a cover to prevent accidental touching by hands and parts (cables, etc.).
- Use double-insulated or reinforced insulation for control power.
- Do not use in places where water can be splashed. Corrosive environments. Do not use the product in the vicinity of flammable gases and combustible materials.
- Do not use damaged. Drivers and motors with missing parts.
- Please set up an emergency stop circuit externally to ensure that the power can be cut off and the operation can be stopped immediately in case of an abnormality.
- If the product is used under poor power conditions, install protection equipment (AC reactor, etc.) to ensure that the input power is supplied within the specified voltage variation range.
- Please use a noise filter to reduce the influence of electromagnetic interference.
- The driver and motor should be used in the specified combination.

Precautions for Storage and Transportation



- Please follow the Commands on the packaging for storage and do not overload the product.
- Please place this product in the following environment:
 - No direct sunlight in the place.
 - Ambient temperature does not exceed the product specification.
 - Humidity does not exceed product specifications. Without condensation.
 - No corrosive gases. Place of flammable gas.
 - Dust. Dust. The place where there is less salt and metal powder.
 - No water. Oil. The place where the splash of medicine, etc. occurs.
 - Vibration or shock does not exceed product specifications.
 - No equipment generating strong magnetic fields in the vicinity.

Precautions for Installation



- Please install the drive in a cabinet that provides fire protection. Electrical protection in the control cabinet.
- Please install the driver and motor in a position with sufficient weight resistance.
- Please install this product in the following environment:
 - No direct sunlight in the place.
 - Ambient temperature does not exceed the product specification.
 - Humidity does not exceed product specifications. Without condensation.
 - No corrosive gases. Place of flammable gas.
 - Dust. Dust. The place where there is less salt and metal powder.
 - No water. Oil. The place where the splash of medicine, etc. occurs.
 - Vibration or shock does not exceed product specifications.
 - No equipment generating strong magnetic fields in the vicinity.
- Do not block the air inlet and exhaust ports, and do not allow foreign objects to enter the drive and motor.
- Do not step on the product or place heavy objects on the drive.
- Please install the driver in the specified direction.
- Make sure to keep the specified intervals between the inner surfaces of the drive control cabinet and other machines.

Precautions for Wiring



- Do not pass the magnetic contactor in the wiring between the drive and the motor.
- Please connect the power terminal and motor terminal firmly.
- Keep a minimum distance of 10mm between the drive and the control cabinet or other equipment.
- Allow at least 30mm of wiring space above and below the driver.
- Signal cable. The encoder cable should be a twisted shielded cable with the shield grounded at both ends.
- The wiring length of the encoder is up to 20m.
- Reduce the frequency of power on/off as much as possible.

Precautions during operation



- To prevent accidents, perform a test run of the servo motor at no load (without the driver connected).
- When you install the machine and start operation, please set the user parameters in advance to match the machine.
- Positive limit (POT) during JOG operation and zero return operation. The signal of negative limit (NOT) is not valid.
- When using the motor on a vertical axis, please provide a safety device to avoid dropping the work-piece in case of alarm or over travel.
- When an alarm occurs, please reset it after investigating the cause and making sure it is safe.
- Do not use the brake of the holding motor for normal braking.

Table of Contents

| | |
|--|-----------|
| 1 Introduction..... | 1 |
| 1.1 Product Introduction..... | 1 |
| 1.2 Features..... | 1 |
| 1.3 Check of Product..... | 1 |
| 1.3.1 Arrival inspection..... | 1 |
| 1.3.2 Nameplate information..... | 1 |
| 1.3.3 Part number..... | 2 |
| 1.3.4 Parts description..... | 2 |
| 1.3.5 Accessory Cables..... | 2 |
| 2 Installation..... | 3 |
| 2.1 Storage and Installation Conditions..... | 3 |
| 2.1.1 Storage condition..... | 3 |
| 2.1.2 Operating ambience conditions..... | 3 |
| 2.2 Mechanical Specification..... | 3 |
| 2.3 Installation Direction and Space..... | 3 |
| 3 Production Specifications..... | 5 |
| 3.1 Electrical and Operating Specifications..... | 5 |
| 3.1.1 EtherCAT Specifications..... | 5 |
| 3.1.2 Electrical and Operating Specifications..... | 5 |
| 3.2 Cable Specifications..... | 6 |
| 3.2.1 Power Supply Cable & Motor Cable..... | 6 |
| 3.2.2 I/O Signal Cable..... | 6 |
| 3.2.3 EtherCAT Communication Cable..... | 7 |
| 3.3 Connectors Specifications..... | 8 |
| 3.3.1 Connectors Definition..... | 8 |
| 3.3.2 CN1-Input Power Connector..... | 9 |
| 3.3.3 CN2-Motor Connector..... | 9 |
| 3.3.4 CN3-I/O Signals Connector..... | 9 |
| 3.3.5 CN4-EtherCAT Communication Connector..... | 10 |
| 3.3.6 CN5-Micro-USB Tuning Port..... | 10 |
| 3.3.7 CN6-Encoder Connector..... | 11 |
| 3.3.8 DIP Switches- SW1-SW8..... | 11 |
| 3.4 I/O Signals Wiring..... | 12 |
| 3.4.1 Digital Input Wiring..... | 12 |
| 3.4.2 Digital Output Wiring..... | 12 |
| 3.4.3 Brake Output Wiring..... | 12 |
| 4 EtherCAT Object Dictionary..... | 14 |
| 4.1 Communication Object..... | 14 |

| | |
|---|-----------|
| 4.2 Manufacture Specific Object..... | 16 |
| 4.3 I/O Configuration Object..... | 19 |
| 4.3.1 Input Ports Function Value..... | 20 |
| 4.3.2 Input Ports Filter Time & Polarity Value..... | 21 |
| 4.3.3 Output Ports Function & Polarity Value..... | 22 |
| 4.3.4 Main Control Output Function..... | 22 |
| 4.4 Motion Objects..... | 22 |
| 4.5 XML File or ESI File..... | 26 |
| 5 Error Code & Trouble Shooting..... | 27 |
| 5.1 Error Code..... | 27 |
| 5.2 Alarm LED..... | 28 |
| 5.3 Alarm Clearing..... | 29 |
| 6 Common Functions..... | 31 |
| 6.1 Saving Parameters and Resetting Drive..... | 31 |
| 6.2 Control Word and Operation Modes..... | 31 |
| 6.3 Touch Probe..... | 35 |
| Appendix A: Homing Methods..... | 37 |
| Appendix B: Object Dictionaries..... | 45 |
| Appendix C: Connectors..... | 56 |
| Appendix D: FAQ..... | 57 |



Leadshine

1 Introduction

1.1 Product Introduction

The newly released CS3E-E series drives support CANopen over EtherCAT (CoE) control and CiA 402 operating modes including Profile Position (PP), Profile Velocity (PV), Homing (HM) and Cyclic Synchronous Position (CSP). The products can be matched with many brands of EtherCAT controller/PLC such as Beckhoff, Omron, Trio, Keneyce, etc.

The CS3E-E series is highly reliable and affordable and performs excellently in many industrial applications such as solar equipment, textile, civil, robotics, power generation equipment, 3C, packaging...

1.2 Features

- CANopen over EtherCAT (CoE) with full support of CiA402,100Mbps full-duplex.
- Operation modes: Profile Position, Profile Velocity, Cyclic Synchronous Position, Homing
- 6 configurable digital inputs, 2 optically isolated digital outputs
- No loss of step, Low noise and vibration, Smooth motion
- Supply voltage: 20-50VDC. Max output current: 3.0A, or 7.0A
- Micro-USB port for parameters configuration
- Matched with NEMA11/17/23/24/ 34 CS-M series closed loop stepper motors
- Protections for over voltage, over current, limit switch error, position error etc.

1.3 Check of Product

1.3.1 Arrival inspection

- Check whether the surface of the product is damaged or not during transportation.
- Check the nameplate models of the drive and motor are what you have ordered.
- Check if it is fully equipped with accessories: power supply connector, motor connector & pins, control I/O signal connector.

CAUTION



- Neither the damaged nor missing accessories of stepper system is allowed to install.
- Contact Leadshine or local distributor if any failure was found.

1.3.2 Nameplate information

Model name → **Model: CS3E-D507E**

Input voltage → **Input: Vdc 24~48V**

Maximum output current → **Output: 7.0A PEAK**

Barcode → **S/N: 991234518082000010 MS10G**





www.leadshine.com

Leadshine Technology Co.,Ltd

↑

Version No.

↑

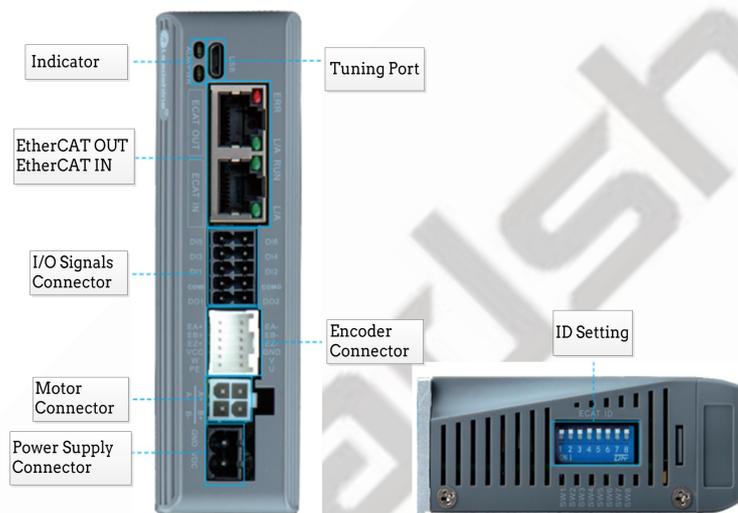
Website

1.3.3 Part number

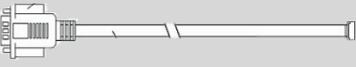
CS3E -D 50 7 E

- | | | | | | |
|--|--------------------|--------------|---------------------------|------------------------|---------------------|
| ① | ② | ③ | ④ | ⑤ | ⑥ |
| ① | ② | ③ | ④ | ⑤ | ⑥ |
| Series Name | Communication Mode | Product Type | Maximum Operating Voltage | Maximum Output Current | E: Economic Version |
| CS3: 3 rd generation stepper drives | E: EtherCAT | D: Drive | 5: 50VDC | 3: 3.0A 7: 7.0A | |

1.3.4 Parts description



1.3.5 Accessory Cables

| Name | Necessary | Picture | Description | Model |
|-------------------------|-----------|---|--|-------------------------|
| Tuning cable | No |  | Micro-USB cable | CABLE-M USB1M5 |
| Network cable | Yes |  | Optional length: 0.1m, 0.2m, 0.3m, 0.4m, 1m, 1.5m, 2m, 3m, 5m, 7m, 10m, 15m, 20m | CABLE-T X*M*-BU S |
| Motor extension cable | Yes |  | Option length: 1.5m, 2.2m, 3.0m, 4.0m, 5.0m, 6.0m, 7.0m, 8.0m, 10m | CABLEM- RZ*M* |
| Encoder extension cable | Yes |  | Optional length: 1.5m, 2.2m, 3.0m, 4.0m, 5.0m, 6.0m, 7.0m, 8.0m, 10m | CABLEM- BM*M* |

Note:

- Micro-USB cable is not necessary, it can also modify parameters by master station PC software.
- Network cable is necessary, but you can also buy shielded network cable through 3rd party.
- Encoder extension cable is also available with Z signal(or index signal) CABLEM- BM*M * Z, but then the motor encoder signal must also with Z signal(or index signal)

2 Installation

2.1 Storage and Installation Conditions

2.1.1 Storage condition

- Correctly packaged and store in a clean and dry environment where direct sunlight is avoided.
- Store within an ambient temperature ranging from -20°C to +65°C.
- Store within a relative humidity ranging from 40% to 90% and non-condensed.
- Avoid any type of exposure to corrosive gases.

2.1.2 Operating ambience conditions

- Temperature ranging from 0°C to 40°C. The ambient temperature of drive for long-term reliability should be under 40°C. Please install the drive in a well-ventilated area.
- Operation within a relative humidity ranging from 40% to 90% and non-condensed.
- Vibration lower than 0.15mm at a frequency of 10Hz-55Hz.

| | |
|--|--|
| <p>CAUTION</p>  | <ul style="list-style-type: none"> • DO NOT mount the drive and motor in a location subjected to corrosive or flammable gases, and combustibles. • Please mount the drive and motor in an indoor electric control cabinet without liquid where direct sunlight is avoided. • DO NOT mount the drive and motor in a location subjected to airborne dust. • Please ensure grounding wires are securely connected |
|--|--|

2.2 Mechanical Specification

Unit: mm, 1inch=25.4mm

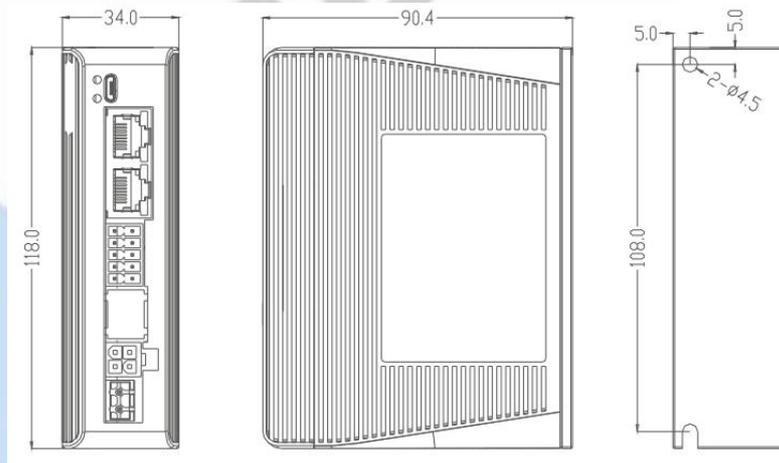


Figure 2.1: CS3E-E-522E/556E/870E Mechanical Drawing

2.3 Installation Direction and Space

- The mounting of drive, wiring and motor should be under the regulations of EN 61800-5-1.
- Incorrect installation may result in a drive malfunction or premature failure of the drive and /or motor. Please follow the guidelines in this manual when installing
- The drive should be mounted perpendicular to the wall or in the control panel.
- In order to ensure the drive is well ventilated, ensure that the all ventilation holes are not obstructed and sufficient free space is given to the drive, and a cooling fan is mounted in the control panel.

- Please ensure grounding wires are securely connected.

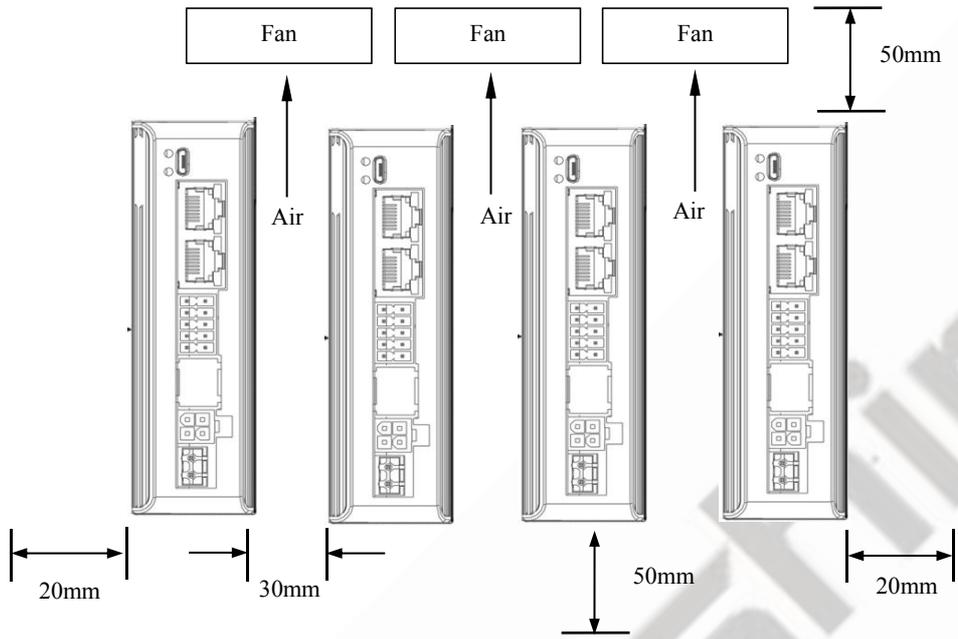


Figure 2.2: CS3E-E series installation drawing

3 Production Specifications

3.1 Electrical and Operating Specifications

3.1.1 EtherCAT Specifications

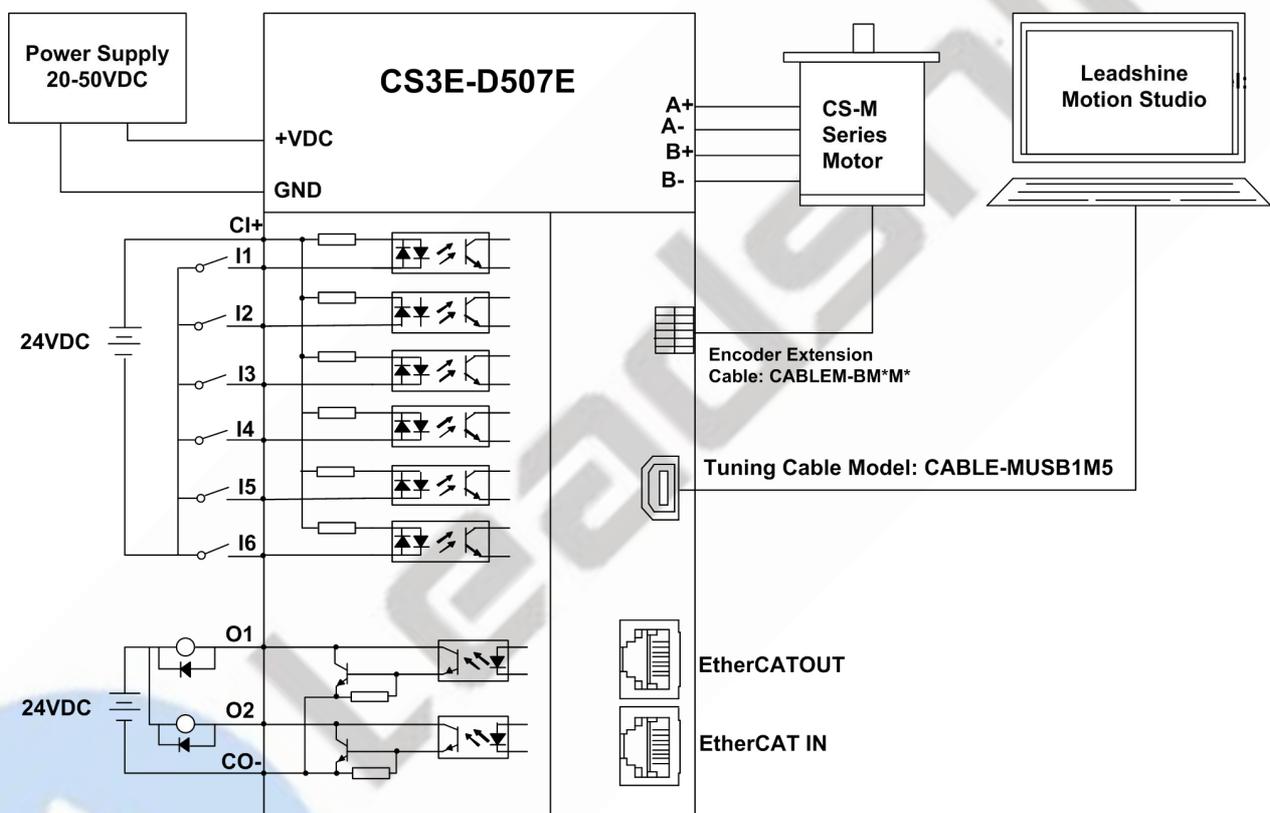
| Name | Description |
|----------------------------------|---|
| Physical Layer | Ethernet-100BASE-TX |
| Communication Connector | RJ45: EtherCAT Input and EtherCAT Output Micro-USB: Tuning port |
| Topology | Line, Tree |
| Baud Rate | 100Mbps (full-duplex-channel) |
| Frame Data Length | 1484 bytes (Max) |
| Synchronization Manager | SM0: email received (from master station to slave station)slave SM1: email sent (from slave station to master station) SM2: process data output (from master station to slave station) SM3: process data input (from slave station to master station) |
| Supported Protocol | CoE: CANopen over EtherCAT |
| Synchronization mode | DC Synchronization (SYNC0) Free Run |
| Communication Event | SDO, PDO, EMCY |
| Application Layer Specifications | IEC61800-7 CiA402 Drive Profile |
| Supported Operation Mode | Cyclic Synchronous Position Mode (CSP) Profile Position Mode (PP) Profile Velocity Mode (PV) Homing Mode (HM) |
| Cycle Time | 500us, 750us, 1ms, 2ms, 3ms, 4ms, 5ms |

3.1.2 Electrical and Operating Specifications

| Name | CS3E-D503E | CS3E-D507E |
|-----------------------|---|-----------------|
| Supply Voltage | 20-50VDC | 20-50VDC |
| Output Current (Peak) | 0.3-3.0A | 0.5-7.0A |
| Size (H*W*L mm) | 118*90.4*34 | |
| Weight (kg) | 0.57 | |
| Matched Motor | NEMA 11, 14, 17 | NEMA 17, 23, 24 |
| Input Signals | Home Input, Positive Limit, Negative Limit, Quick Stop, Touch Probe, GPIOs | |
| Output Signals | Brake, Alarm, In Position | |
| Protection Functions | Over Current, Over Voltage, Position Following Error, Encoder Cable Error, etc. | |
| PC Software | Leadshine Motion Studio | |

| | | |
|-----------------------|-----------------------|--|
| Operating Environment | Environment | Avoid dust, oil ,fog and corrosive gases |
| | Operating Temperature | 0-40°C (32 F – 104 F) |
| | Storage Temperature | -20°C -65°C (-4 F – 149 F) |
| | Humidity | 40-90%RH |
| | Vibration | 10-55Hz/0.15mm |
| | Mount | Vertical or horizontal mounting |

3.2 Cable Specifications



Note:

- There are two EtherCAT communication ports above, one of them is input port which connects with master station or previous slave, and the other is output port which connects with the following slave.
- Single-end input I1 - I6 connection types can be common-cathode and common-anode.

3.2.1 Power Supply Cable & Motor Cable

- Wire diameter: VDC, GND, A+, A-, B+, B- terminal wire diameter $\geq 0.3\text{mm}^2$ (AWG15-22)

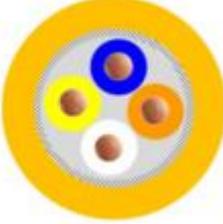
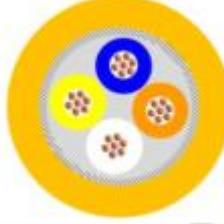
3.2.2 I/O Signal Cable

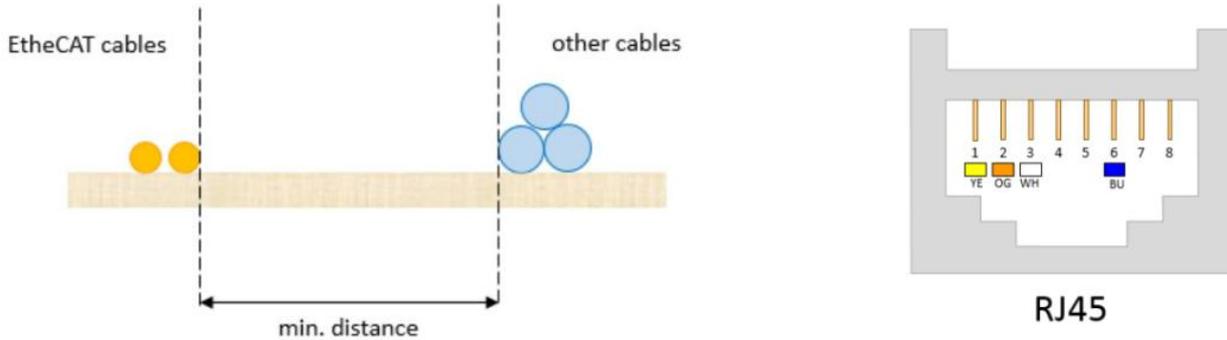
- Wire diameter: I/O signal wires diameter $\geq 0.12\text{mm}^2$ (AWG24-26)
- Recommend to adopt shielded twisted pair cable with a length of less than 3 meters (the shorter the better).
- Wiring: As far as possible away from the power line wiring, in order to prevent interference
- Please connect surge absorber to inductive device, such as anti-parallel diode for DC coil, parallel RC-snubbers circuit for AC coil.

3.2.3 EtherCAT Communication Cable

Single-core cables can be used for fixed applications, while multi-core cables are recommended for flexible applications

- Specifications**

| Item |  Type A (Cable-fixed) |  Type B (Cable Flexible) |
|--|--|---|
| Cross-sectional area | AWG 22/1(Single solid root) | AWG 22/7 (7x0.254mm) |
| Nominal/characteristic impedance (tolerance) | 100Ω (15Ω)(IEC61156-5) | |
| Balanced or Unbalanced | Balanced | |
| Loop resistance | $\cong 115\Omega/\text{Km}$ | |
| Insulation resistance | $\cong 500\text{M}\Omega/\text{Km}$ | |
| Transmission impedance | $\cong 50\text{m}\Omega/\text{m}(10\text{MHZ})$ | |
| Maximum time delay | $\cong 550\text{ns}/100\text{m}$ | |
| Time delay deviation | $\cong 20\text{ns}/100\text{m}$ | |
| Shielding | S/FTQ (Outer stranded shield/inner layer) | |
| Temperature | $\cong 60^\circ$ | |



- Requirements:**

- (1) It is recommended to use a Category 5 Fast Ethernet cable with double shielding or better,
- (2) The length between two nodes is recommended to not exceed 100 meters.

3.3 Connectors Specifications

3.3.1 Connectors Definition

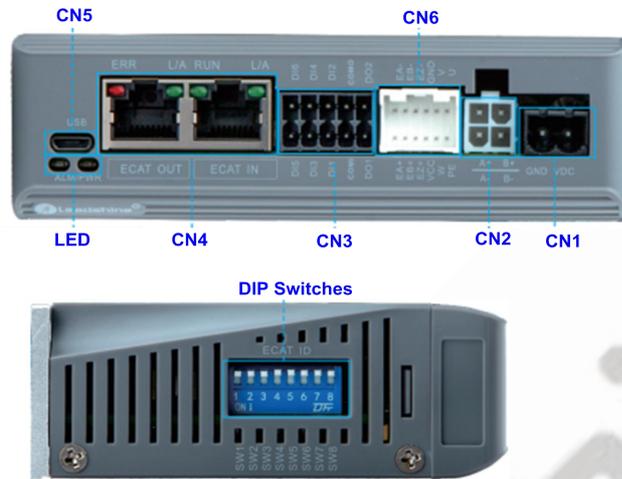


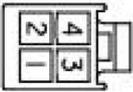
Figure 3.2: CS3E-E series connectors

| Name | Description |
|--------------|--|
| CN1 | Input power connector |
| CN2 | Motor connector |
| CN3 | I/O signals connector |
| CN4 | EtherCAT communication connector |
| CN5 | Micro-USB tuning connector |
| CN6 | Encoder connector |
| LED | The LED for the drive's running status |
| DIP Switches | 8-bits switches: SW1 - SW7 to set 0-127 Node ID, SW8 for self test |

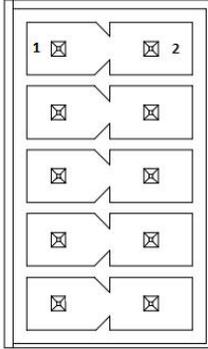
3.3.2 CN1-Input Power Connector

| Name | Pic | PIN | Signal | Description |
|------|---|-----|--------|-------------|
| CN1 |  | 1 | VDC | 20- 50V |
| | | 2 | GND | GND |

3.3.3 CN2-Motor Connector

| Name | Pic | PIN | Signal | Description |
|------|---|-----|--------|----------------|
| CN2 |  | 4 | A+ | Motor phase A+ |
| | | 2 | A- | Motor phase A- |
| | | 3 | B+ | Motor phase B+ |
| | | 1 | B- | Motor phase B- |

3.3.4 CN3-I/O Signals Connector

| Name | Pic | PIN | Signal | I/O | Description |
|------|---|-----|--------|-----|--|
| CN3 |  | 1 | DI5 | I | Configurable Single-ended Digital Input 5, 12V - 24V, 10KHz, Negative Limit (default) |
| | | 2 | DI6 | I | Configurable Single-ended Digital Input 6, 12V - 24V, 10KHz, GPIO |
| | | 3 | DI3 | I | Configurable Single-ended Digital Input 3, 12V - 24V, 10KHz, Home switch (default) |
| | | 4 | DI4 | I | Configurable Single-ended Digital Input 4, 12V - 24V, 10KHz, Positive Limit (default) |
| | | 5 | DI1 | I | Configurable Single-ended Digital Input 1, 12V - 24V, 10KHz, Touch Probe 1 (default) |
| | | 6 | DI2 | I | Configurable Single-ended Digital Input 2, 12V - 24V, 10KHz, Touch Probe 2 (default) |
| | | 7 | COMI | I | Common anode of external input signals |
| | | 8 | COMO | O | Common ground of digital output signals |
| | | 9 | DO1 | O | Configurable Single-ended Digital Outputs 1, OC output, Max. 30V/100mA. Alarm output (default) |
| | | 10 | DO2 | O | Configurable Single-ended Digital Outputs 2, OC output, Max. 30V/100mA. Brake output (default) |

Remark:

(1) I/O interface and corresponding parameter setting refer to chapter 4.3

(2) In Leadshine MotionStudio, digital input(DI) and digital output(DO) are displayed as SI and SO.

3.3.5 CN4-EtherCAT Communication Connector

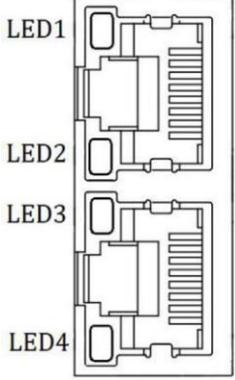
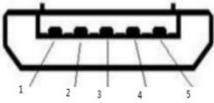
| Name | Pic | PIN | Signal | Description |
|------|---|-------|--------|-----------------|
| CN4 |  | 1, 9 | E_TX+ | EtherCAT TxD+ |
| | | 2, 10 | E_TX- | EtherCAT TxD- |
| | | 3, 11 | E_RX+ | EtherCAT RxD+ |
| | | 4, 12 | / | / |
| | | 5, 13 | / | / |
| | | 6, 14 | E_RX- | EtherCAT RxD- |
| | | 7, 15 | / | / |
| | | 8, 16 | / | / |
| | | Cover | PE | Shield earthing |
| Note | (1) LED1 as 'Link/Activity IN' indicator, green (2) LED3 as 'Link/Activity OUT' indicator, green (3) LED2 as 'RUN' indicator, green (4) LED4 as 'ERR' indicator, red | | | |

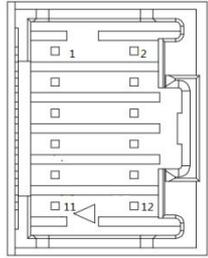
Table 3.3 Link/Activity LED status

| Name | Color | Status | Description |
|---------|-------|----------------------|---|
| RUN | Green | off | Initialization Status |
| | | Blinking | Pre-operation status |
| | | Single Flash | Safe operating status |
| | | on | Operation Status |
| ERR | Red | Refer to Chapter 5.2 | |
| L/A IN | Green | off | Physical layer link cannot be established |
| | | on | Physical layer link establishment |
| | | Blinking | Interaction data |
| L/A OUT | Green | off | Physical layer link cannot be established |
| | | on | Physical layer link establishment |
| | | Blinking | Interaction data |

3.3.6 CN5-Micro-USB Tuning Port

| Name | Pic | PIN | Signal |
|------|---|-----|----------|
| CN5 |  | 1 | GND |
| | | 2 | Reserved |
| | | 3 | Data+ |
| | | 4 | Data- |
| | | 5 | V_Bus |

3.3.7 CN6-Encoder Connector

| Name | Pic | PIN | Signal | Description |
|------|---|-----|--------|------------------------------|
| CN3 |  | 1 | EA+ | Encoder signal of phase A+ |
| | | 2 | EA- | Encoder signal of phase A- |
| | | 3 | EB+ | Encoder signal of phase B+ |
| | | 4 | EB- | Encoder signal of phase B- |
| | | 5 | EZ+ | Encoder Z+ signal (optional) |
| | | 6 | EZ- | Encoder Z- signal (optional) |
| | | 7 | VCC | Encoder +5V voltage |
| | | 8 | GND | Encoder ground |
| | | 9 | - | Reserved |
| | | 10 | - | Reserved |
| | | 11 | - | Reserved |
| | | 12 | - | Reserved |

3.3.8 DIP Switches- SW1-SW8

There are 8-bit DIP switches in CS3E-E series drives, SW1-SW7 are used to set slave ID, SW8 is used for self-test.

(1) SW1-SW7 for Slave ID

The slave ID (also called Site Alias) of CS3E-E series can be set by the following 3 methods:

| 2151h | 2150h | DIP Switches | Slave ID |
|-------|----------|--------------|---|
| 0 | Read ID | 0~127 | Setting by DIP Switches SW1-SW7 |
| 1 | Write ID | - | Setting by writing a value to 2050h |
| 2 | - | 0 | Configure to EEPROM 0004h of ESC automatically. |

- When 2151h=0, setting via DIP Switches SW1-SW7

| SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 |
|-----|-----|-----|-----|-----|-----|-----|
|-----|-----|-----|-----|-----|-----|-----|

Slave ID can be set a value non-zero via the SW1-SW7, activated after restarting the power supply. The specific definition is as below:

| ID | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | ON |
| 1 | OFF | ON | ON | ON | ON | ON | ON |
| 2 | ON | OFF | ON | ON | ON | ON | ON |
| 3 | OFF | OFF | ON | ON | ON | ON | ON |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 126 | | OFF | OFF | OFF | OFF | OFF | OFF |
| 127 | OFF |

OFF=1, ON=0

ID = SW1*(1)+ SW2*(2)+SW3*(4)+SW4*(8)+SW5*(16)+SW6*(32)+SW7*(64)

- **When 2151h=1, setting via Object (2150h)**

The value written in Object (2150h) is as the slave ID, activated after saving parameter and restarting the power supply.

- **When 2151h=2, master configure ID to ESC(EtherCAT slave Controller)**

Setting all SW1-SW7 to ON, the EtherCAT master will configure slave ID to the address of EEPROM 0004h of ESC automatically.

(2) SW8 for Self Test

SW8 is used for self-test, when SW8=OFF, self-test is disabled, when SW8=ON, self-test is activated, the motor will run at a speed of 0.2r/s, back and forth 5 circles.

3.4 I/O Signals Wiring

3.4.1 Digital Input Wiring

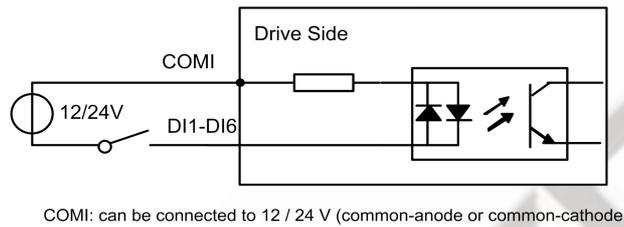


Figure 3.4: Input Interface Connection

Note:

(1) Controller/PLC/Control card should provide input DC power 12-24V, current $\geq 100\text{mA}$.

(2) If the polarity of input DC power is reversed, the EtherCAT Closed Loop stepper drive won't work; you need to turn the wiring.

3.4.2 Digital Output Wiring

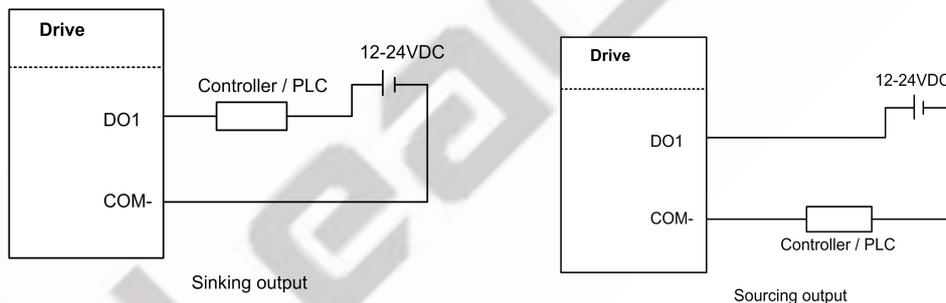


Figure 3.5: Output Interface Wiring

Note:

(1) The power supply (12-24VDC) above is provided by user, and if the polarity of power supply is reversed, it will damage the drive.

(2) Digital output is OC output with the maximum capacity of 100mA/30V (recommended 50mA/25V), the provided power supply should be under 30V (recommended 24V), otherwise it will cause damage to the drive.

3.4.3 Brake Output Wiring

This driver has a special brake output, built-in a fly-wheel diode, driving current up to 500 mA, can directly drive the motor brake without relays. The connection is below:

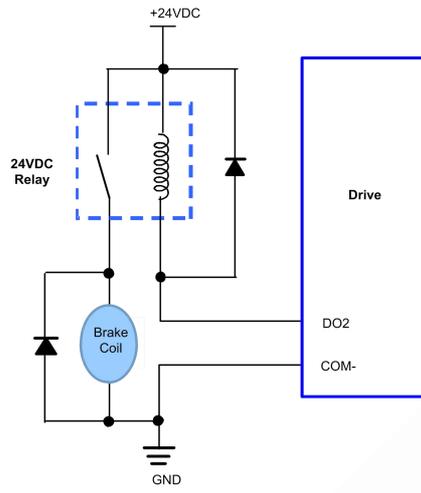


Figure 3.6: Brake output connection

4 EtherCAT Object Dictionary

4.1 Communication Object

The CS3E-E Series drives follows the EtherCAT standard protocol, can communicate with the master stations which also supports the EtherCAT standard protocol.

The parameters can be configured by master station's PC software or Leadshine Motion Studio.

| Index | Sub-index | Name | Access | Type | Range | Default Value | Unit | Remark |
|-------|-----------|---|--------|-------|--------------|---------------|------|--|
| 1000 | 0 | Device type | R | UINT | 0-32767 | 0x40912 | - | Refer to CIA 402 profile |
| 1001 | 0 | Error register | R | USINT | 0-255 | 0 | -- | Refer to Chapter 5.1 |
| 1008 | 0 | Device name | R | UINT | 0-32767 | CL3C-X | - | - |
| 1010 | 00 | Number of sub-index | R | UINT | 0-32767 | 4 | - | - |
| | 01 | Save all parameters | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully |
| | 02 | Save communication parameters | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | |
| | 03 | Save motion parameters | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | |
| | 04 | Save factory parameters | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | |
| 1011 | 00 | Number of sub-index | R | UINT | 0-32767 | 4 | - | |
| 1011 | 01 | Restore all parameters to default setting | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully |
| | 02 | Reset communication parameters to factory setting | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | |
| | 03 | Reset motion parameters to factory setting | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | |
| | 04 | Reset user parameters to factory setting | R/W | UDINT | 0-0xFFFFFFFF | 0 | - | |
| 1018 | 00 | Number of sub-index | R | UINT | 0-32767 | 4 | - | - |
| | 01 | Vendor ID | R | UINT | 0-32767 | 4321 | - | Leadshine code |
| | 02 | Product code | R | UINT | 0-32767 | 8X00 | - | - |
| | 03 | Revision number | R | UINT | 0-32767 | 1 | - | - |
| | 04 | Series number | R | UINT | 0-32767 | 1 | - | - |
| 1600 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 3 | - | Default number of 1 st mapping object |
| | 01-08 | 1 st RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF | - | - | Default number of 1 st RXPDO-Map object |
| 1601 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 6 | - | Default number of 2 nd mapping object |

| | | | | | | | | |
|------|-------|----------------------------------|-----|-------|----------------|------|---|--|
| | 01-08 | 2 nd RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF F | - | - | Default number of 2 nd RXPDO-Map object |
| 1602 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 5 | - | Default number of 3 rd mapping object |
| | 01-08 | 2 nd RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF F | - | - | Default number of 3 rd RXPDO-Map object |
| 1603 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 7 | - | Default number of 4 th mapping object |
| | 01-08 | 3 rd RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF F | - | - | Default number of 4 th RXPDO-Map object |
| 1A00 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 7 | - | Default number of 1 st mapping object |
| | 01-08 | 1 st TXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF F | - | - | Default number of 1 st TXPDO-Map object |
| 1A01 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 0 | - | Default number of 2 nd mapping object |
| | 01-08 | 2 nd TXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF F | - | - | Default number of 2 nd TXPDO-Map object |
| 1C00 | 0 | Number of sub-index | R | UINT | 0-32767 | 4 | - | - |
| | 01 | Output type of email | R | UINT | 0-32767 | 1 | - | - |
| | 02 | Input type of email | R | UINT | 0-32767 | 2 | - | - |
| | 03 | Output type of process data | R | UINT | 0-32767 | 3 | - | - |
| | 04 | Input type of process data | R | UINT | 0-32767 | 4 | - | - |
| 1C12 | 0-04 | RXPDO assign | R/W | UINT | 0-32767 | 1600 | - | - |
| 1C13 | 0-02 | TXPDO assign | R/W | UINT | 0-32767 | 1A00 | - | - |
| 1C32 | 0-0A | RXPDO administrative parameters | R | UINT | 0-32767 | - | - | - |
| 1C33 | 0-0A | TXPDO administrative parameters | R | UINT | 0-32767 | - | - | - |

4.2 Manufacture Specific Object

| Index | Sub-index | Name | Access | Type | Range | Default value | Unit | Remark |
|-------|-----------|--|--------|------|-----------|---------------|--------|--|
| 2000 | 00 | Peak current | R/W/S | DINT | 1-100 | 60 | 0.1A | Drive's max output current. CS3E-D503E is 25 by default; CS3E-D507E is 60 by default. |
| 2001 | 00 | Microstep resolution | R/W/S | DINT | 200-51200 | 10000 | Pulse | Required number of pulse to rotate 1 revolution of motor. But it is recommended to modify via 6092+01 |
| 2007 | 00 | Action when disabled | R/W/S | UINT | 0-1 | 0 | - | 0: Don't respond to commands, and the motor shaft is not locked; 1: Don't respond to commands, but the motor shaft is locked; |
| 2010 | 01 | Internal filtering time | R/W/S | UINT | 0-32767 | 100 | 0.1ms | Internal smoothing time for control command. |
| 2012 | 00 | Soft-starting time | R/W/S | UINT | 10-3000 | 1 | ms | Internal smoothing time for starting current. |
| 2013 | 00 | Auto-tuning at power on | R/W/S | UINT | 0-2 | 1 | -- | 1: Yes. 0: No |
| 2019 | 01 | In-position pulse compensation | R/W/S | UINT | 0-1 | 1 | -- | 0: With compensation, the value of 6064 = 607A in position; 1: Without compensation |
| 2019 | 02 | In-position mode at disabled state | R/W/S | UINT | 0-1 | 0 | -- | 0: Not allowed in-position signal output when disabled; 1: Allowed in-position signal output when disabled; |
| 201A | 01 | Locking current percentage of power on | R/W/S | UINT | 0-100 | 100 | % | Usually keep the default value. |
| 201A | 02 | Closed loop holding current percentage | R/W/S | UINT | 0-100 | 50 | % | Multiply by the value of object 0x2000, the drive output current will change between these according to the load. |
| 201B | 00 | Locking duration time | R/W/S | UINT | 0-1500 | 200 | ms | Appropriately reduce this value if you want to shorten the time of locking shaft. |
| 201C | 00 | Max time to close brake | R/W/S | UINT | 100-10000 | 1000 | ms | Usually keep the default value |
| 201D | 00 | Zero speed point | R/W/S | UINT | 0-500 | 10 | 0.1r/s | - |
| 2024 | 00 | Control Mode | R/W/S | UINT | 0~10 | 2 | -- | 0: Open Loop Control; 2: Closed Loop Control |
| 2025 | 01 | Speed point for open loop switching closed loop | R/W/S | UINT | 0~200 | 18 | 0.1r/s | - |
| 2025 | 02 | Delay for open loop switching closed loop | R/W/S | UINT | 0~32767 | 12 | ms | - |
| 2025 | 03 | Speed point for closed loop switching open loop | R/W/S | UINT | 0~200 | 5 | 0.1r/s | - |
| 2025 | 04 | Delay for closed loop switching open loop | R/W/S | UINT | 0~32767 | 250 | ms | - |
| 2025 | 05 | Feedback speed point for closed loop switching open loop | R/W/S | UINT | 0~200 | 50 | 0.1r/s | - |

| | | | | | | | | |
|------|----|--|-------|------|------------|-------|-------|---|
| 2029 | 00 | Encoder resolution | R/W/S | UINT | 4000-20000 | 4000 | Count | 4 times the encoder resolution. But it is recommended to modify by 0x608F+01 |
| 2030 | 00 | Allowed max position following error pulses | R/W/S | UINT | 0~32767 | 4000 | Count | 4000 indicates the error of one turn |
| 2032 | 00 | Distance to send "In Position" output signal | R/W/S | UINT | 0-1000 | 4 | Pulse | - |
| 2033 | 00 | Delay of in-position error de-jitter | R/W/S | UINT | 0-1000 | 3 | ms | - |
| 2047 | 00 | Over voltage point | R | UINT | 0-1000 | 75 | V | - |
| 2048 | 00 | Bus-voltage | R | UINT | 0-65535 | - | V | - |
| 2051 | 00 | Motor running direction | R/W | DINT | 0-1 | 0 | -- | 0: CCW direction 1: CW direction But it is recommended to modify by 0x607E |
| 2056 | 00 | Alarm detection selection | R/W/S | DINT | 0~65535 | 65535 | -- | Bit setting: =1: Yes; =0: No Bit0: over-current (invalid) Bit1: over-voltage Bit2: Position following error Bit3: Encoder wiring error Bit4: over speed alarm |
| 2057 | 00 | Reset alarm | R/W/S | UINT | 0~65535 | 0 | -- | Write value 1 to clear the alarm. But it is recommended to write value 128(Decimal) to 0x6040 |
| 2090 | 01 | Current loop Kp | R/W | DINT | 0~32767 | 1500 | -- | -- |
| | 02 | Current loop Ki | R/W | DINT | 0~32767 | 300 | -- | -- |
| | 03 | Current loop Kc | R/W | DINT | 0~32767 | 300 | -- | -- |
| 2091 | 01 | Speed Loop Kp | R/W | UINT | 0~10000 | 25 | - | |
| | 02 | Speed Loop Ki | R/W | UINT | 0~10000 | 3 | - | |
| 2092 | 01 | Position Loop Kp | R/W | UINT | 0~100 | 25 | - | |
| 2150 | 00 | Slave ID | R/W/S | UINT | 0-256 | 1 | -- | Valid when 0x2151= 1; |
| 2151 | 00 | Slave ID resource | R/W/S | UINT | 0-10 | 0 | -- | 0: DIP switches 1: Setting by 0x2150 2: ESC |
| 2232 | 00 | Synchronous compensation1 | R/W | DINT | 0—65535 | 2 | -- | -- |
| 2233 | 00 | Synchronous compensation2 | R/W | DINT | 0—65535 | 100 | -- | -- |
| 225C | 00 | Special function register | R/W | DINT | 0~32767 | 0 | -- | Bit1=1: Set motor running direction by 0x607E Bit2=1: Set virtual input by 0x5012-03 |
| 22A9 | 00 | Limit Mode | R/W | DINT | 0-10 | 0 | -- | 0: Stop normally 1: Invalid 2: Alarm, error code 260 |
| 22B4 | 00 | Quick stop selection | R/W | DINT | 0~32767 | 0 | -- | 0: Alarm, error code 570, 1: Refer to 0x605A |
| 22C2 | 01 | JOG acceleration | R/W | UINT | 0~32767 | 200 | | |
| | 02 | JOG speed | R/W | UINT | 0~32767 | 60 | | |
| | 03 | JOG distance | R/W | UINT | 0~32767 | 0 | | |

| | | | | | | | | |
|------|-------|--|-------|-------|---------|-----|--------|--|
| | 04 | JOG cycles | R/W | UINT | 0~32767 | 1 | | |
| | 05 | JOG direction | R/W | UINT | 0~32767 | 0 | | |
| | 06 | JOG preparation time | R/W | UINT | 0~32767 | 100 | ms | |
| 3100 | 01 | Control software version | R | UINT | | | -- | |
| | 02 | Firmware version | R | UINT | | | -- | |
| | 03 | EtherCAT protocol version | R | UINT | | | -- | |
| 3FFE | 01-0E | Alarm record | R | USINT | 0~32767 | -- | -- | 0x3FFE+01 is the current error code (current alarm) or the most recent error code (currently no alarm); 0x3FFE+02-0E are followed by the historical error code. |
| 4003 | 01 | Delay of closing brake | R/W/S | UINT | 0-1500 | 250 | ms | |
| 4003 | 02 | Delay of loosening brake | R/W/S | UINT | 0-1500 | 250 | ms | |
| 4003 | 03 | Max speed to close brake | R/W/S | UINT | 0-500 | 10 | 0.1r/s | |
| 5000 | 01 | Trajectory generator | R | UINT | 0~32767 | 1 | -- | Internal protocol stack parameters |
| | 02 | Motion state machine | R | UINT | 0~32767 | 0 | -- | 0: Disabled 0x9A9A: Enabled |
| | 03 | Internal enable state | R | UINT | 0~32767 | 0 | -- | 0: Disabled 1: Enabled |
| | 04 | Reach the target state | R | UINT | 0~32767 | -- | -- | Bit0=0: Not reach Bit0=1: Reach Bit1=0: No stall Bit1=1: Stalled |
| 5002 | 01 | ESC ID | R/W | UINT | 0~32767 | 0 | -- | Write 0, return the ID data in ESC to 0x5002-02 ; Write 0x12, return the current ID setting by DIP switches |
| | 02 | ESC data | R | UINT | 0~32767 | 408 | -- | Return Node ID data |
| 5004 | 01-0E | Sync0 Synchronization interface parameters | R | UINT | 0~32767 | -- | -- | -- |
| | 0F | Sync0 Synchronization interface parameters | R/W | UINT | 0~32767 | -- | -- | Bit0 =1: RPDO mapping can't be written by SDO; Bit0 =0: RPDO mapping can be written by SDO; Bit1=1: Detect the number of PDO mapping; Bit1=1: Don't detect the number of PDO mapping; Bit2=1: Send 0xF directly to enable; Bit2=0: Send 0xF can't be enabled. |
| 5005 | 00 | DC compensation base value | R/W | UINT | 0~32767 | 500 | -- | -- |
| 5006 | 00 | Synchronization error detection | R/W | UINT | 0~32767 | 0 | -- | -- |
| 5010 | 00 | Effective input and output watchdog time | R/W | UINT | 0~32767 | 0 | -- | -- |
| 5011 | 00 | Internal actual location | R | UDINT | 0~32767 | -- | -- | -- |
| 5012 | 01 | Homing arrival position | R/W | DINT | 0~32767 | 0 | -- | -- |

| | 02 | Homing trigger position | R/W | DINT | 0~32767 | 0 | -- | -- | | | | | | | | | | | | |
|-------------------------|-------------|--------------------------------|-----|-------|-----------|-------|----|--|--------|-------------|----------------|----------|-------------|---------|----------------|---------|----------------|---------|-------------------------|----------|
| | 03 | Homing virtual input | R/W | UDINT | 0~32767 | 0 | -- | <p>When 0x225C=4, activate the virtual input function; 60FD different bits, corresponding to different virtual inputs;</p> <table border="1"> <thead> <tr> <th>Inputs</th> <th>Bit of 60FD</th> </tr> </thead> <tbody> <tr> <td>Probe signal 1</td> <td>Bit 26=1</td> </tr> <tr> <td>Home switch</td> <td>Bit 2=1</td> </tr> <tr> <td>Positive limit</td> <td>Bit 1=1</td> </tr> <tr> <td>Negative limit</td> <td>Bit 0=1</td> </tr> <tr> <td>Z signal (index signal)</td> <td>Bit 31=1</td> </tr> </tbody> </table> <p>For example: 0x225C=4 and start homing, set 0x5012-03=4, Home switch input; set 0x5012-03=2, Positive limit input; set 0x5012-03=2, Negative limit input</p> | Inputs | Bit of 60FD | Probe signal 1 | Bit 26=1 | Home switch | Bit 2=1 | Positive limit | Bit 1=1 | Negative limit | Bit 0=1 | Z signal (index signal) | Bit 31=1 |
| Inputs | Bit of 60FD | | | | | | | | | | | | | | | | | | | |
| Probe signal 1 | Bit 26=1 | | | | | | | | | | | | | | | | | | | |
| Home switch | Bit 2=1 | | | | | | | | | | | | | | | | | | | |
| Positive limit | Bit 1=1 | | | | | | | | | | | | | | | | | | | |
| Negative limit | Bit 0=1 | | | | | | | | | | | | | | | | | | | |
| Z signal (index signal) | Bit 31=1 | | | | | | | | | | | | | | | | | | | |
| | 04 | Homing setting | R/W | UINT | 0~32767 | 5 | -- | <p>Bit0=0: Homing protection is not turned on; Bit0=1: Homing protection is turned on; (Homing protection: when start homing, If the limit signal takes effect, bit0=0 means homing normally, bit0=1 means stop homing as limit protection)</p> <p>Bit2=0: The value of current position after in position = 0x607C; Bit2=1: The value of 0x607C is used as the motion offset, and finally 0x6064 = 0; Bit3=0: 0x6064= 0x607C after in position; Bit3=1: 0x6064 = 0x607C after in position;</p> | | | | | | | | | | | | |
| 5015 | 05 | Protocol setting | R/W | UINT | 0~32767 | 255 | -- | Bit8 is used to select whether the speed arrival in PV mode comes from bit0 of 0x5000-04 or bit8 of 0x5000-04. | | | | | | | | | | | | |
| 5400 | 01 | Minimum synchronization period | R/W | UINT | 250~2000 | 250 | us | -- | | | | | | | | | | | | |
| | 02 | Maximum synchronization period | R/W | UINT | 250~20000 | 10000 | us | -- | | | | | | | | | | | | |
| 5503 | 04 | Special register function | R/W | UINT | 0~65535 | 2 | -- | <p>Bit0 = 0: Asynchronous mode, the host will track 0x607A-00 in real time; Bit0=1: Asynchronous mode, the host does not track 0x607A-00in real time.</p> | | | | | | | | | | | | |

4.3 I/O Configuration Object

The configuration of input ports includes three parts: function setting, filter time and polarity setting. Therefore, **the relevant object dictionary value (Decimal) = Input port function setting value + Filter time setting value + Input port polarity setting value.**

The configuration of output ports includes two parts: function setting and polarity setting. Therefore, **the relevant object dictionary value (Decimal) = Output port function setting value + Output port polarity setting value.**

It is recommended to use Leadshine free tuning software MotionStudio for parameter settings, which will be very simple. In Leadshine MotionStudio, digital input(DI) and digital output(DO) are displayed as SI and SO.

| Index | Sub-index | Name | Access | Type | Range | Default value | Unit | Remark |
|-------|-----------|-----------------|--------|------|---------|-------------------|------|---|
| 2152 | 01 | Input1 function | R/W/S | DINT | 0-65535 | 0x17 (Decimal 23) | -- | Default is touch probe1, take effect changes need restart power |
| | 02 | Input2 function | R/W/S | DINT | 0-65535 | 0x18 (Decimal 24) | -- | Default is touch probe2, take effect changes need restart power |
| | 03 | Input3 function | R/W/S | DINT | 0-65535 | 0x16 (Decimal 22) | -- | Default is Home switch, take effect changes need restart power |
| | 04 | Input4 function | R/W/S | DINT | 0-65535 | 0x01 (Decimal 1) | -- | Default is positive limit, take effect changes need restart power |
| | 05 | Input5 function | R/W/S | DINT | 0-65535 | 0x02 (Decimal 2) | -- | Default is negative limit, take effect changes need restart power |
| | 06 | Input6 function | R/W/S | DINT | 0-65535 | 0x19 (Decimal 25) | -- | Default is user defined, take effect changes need restart power |

4.3.1 Input Ports Function Value

Note:

- (1) After configuring the input and output functions through the master station software or MotionStudio, it needs to save and restart the power to take effect.
- (2) If the function configuration of the two input ports is repeated, the input port with the smaller number is valid, and the other input port will be set to GPIO automatically. For example: SI3 and SI4 are configured as positive limit, after saving and restarting, SI3 function as positive limit, SI4 function as GPIO.

There are two object dictionaries that can be used to monitor input ports:
 0x2155 is used to monitor whether the input port is connected to a valid signal;
 0x60FD is used to monitor whether the input port is configured with a function

● **0x2155 Corresponding Input Port Table:**

| Input port | Index +Sub index | Default Function Value | Default Function | Physical State Read State1 (3) |
|------------|------------------|------------------------|----------------------|--------------------------------|
| IN1 | 0x2152+01 (1) | 0x17 | Probe1 | 0x2155.00=1 (2) |
| IN2 | 0x2152+02 | 0x18 | Probe2 | 0x2155.01=1 |
| IN3 | 0x2152+03 | 0x16 | Home switch (ORG) | 0x2155.02=1 |
| IN4 | 0x2152+04 | 0x01 | Positive limit (POT) | 0x2155.03=1 |
| IN5 | 0x2152+05 | 0x02 | Negative limit (NOT) | 0x2155.04=1 |
| IN6 | 0x2152+06 | 0x19 | GPIO (SI-MON) | 0x2155.05=1 |

Note:

- (1) 0x2152+01 indicates that the index is 0x2152, and sub-index is 01.
- (2) 0x2155.01 indicates that the index is 0x2155, and bit is bit1.
- (3) Read State1: when IN1~IN6 inputs are valid, at this time, it has nothing to do with whether the function is configured, bit0~bit5 of 0x2155 will change to value 1. For example, when only IN5 input port is valid, bit 4 of 0x2155 will be value 1, then 0x2155=F (Decimal 16).

● **0x60FD Corresponding Function Table:**

| Input Function | Setting Value | Logic state Read state2 (1) |
|----------------|-------------------|-----------------------------|
| Invalid | 0x00 | - |
| Probe1 | 0x17 (Decimal 23) | 0x60FD.26=1 |

| | | |
|-------------------------|-------------------|--|
| Probe2 | 0x18 (Decimal 24) | 0x60FD.27=1 |
| Home switch (ORG) | 0x16 (Decimal 22) | 0x60FD.02=1 |
| Positive limit (POT) | 0x01 (Decimal 1) | 0x60FD.01=1 |
| Negative limit (NOT) | 0x02 (Decimal 2) | 0x60FD.00=1 |
| Quick Stop (EMG) | 0x14 (Decimal 20) | 0x60FD.23=1 |
| Z signal (Index signal) | - | 0x60FD.31=1 |
| GPIO (SI-MON) | 0x19 (Decimal 25) | When IN1 is set to GPIO → 60FD.04=1 When IN2 is set to GPIO → 60FD.05=1 When IN3 is set to GPIO → 60FD.06=1 When IN4 is set to GPIO → 60FD.07=1 When IN5 is set to GPIO → 60FD.08=1 When IN6 is set to GPIO → 60FD.09=1 |

Note:

- (1) Read State2: when inputs function are valid, at this time, it has nothing to do with which input port, bit0-bit26 of 0x60FD will change to value 1. For example: when IN5 input port is set to POT and input signal is valid, then bit0 of 0x60FD will be value 1.
- (2) When input function is set to GPIO, at this time, different input ports correspond to different bit of 0x60FD.

4.3.2 Input Ports Filter Time & Polarity Value

| Filter Time | Setting (Decimal) | Value | Polarity | Setting Value |
|-------------|-------------------|-------|----------------------|---------------|
| 1ms | 0 | | Normally open (NO) | 0 |
| 2ms | 256 | | Normally closed (NC) | 128 |
| 3ms | 512 | | | |
| 4ms | 768 | | | |
| 5ms | 1024 | | | |
| 6ms | 1280 | | | |
| 8ms | 1536 | | | |
| 10ms | 1792 | | | |
| 15ms | 2048 | | | |
| 20ms | 2304 | | | |
| 30ms | 2560 | | | |
| 40ms | 2816 | | | |
| 50ms | 3072 | | | |
| 100ms | 3328 | | | |
| 200ms | 3584 | | | |
| 500ms | 3840 | | | |

Therefore, Value of 0x2152 (Decimal) = Input port function value + Filter time value + Polarity value.

For Example:

1. IN1 needs to be set as quick stop function, filtering time is 20ms and polarity is NC:
 $0x2152+01 = 20+128+2304=2452(0x994)$
2. Need to set the polarity of IN3, IN4, IN5 to NC:
 $0x2152+03 = 128+22 = 150(0x96)$
 $0x2152+04 = 128+1 = 129(0x81)$
 $0x2152+05 = 128+2 = 130(0x82)$

4.3.3 Output Ports Function & Polarity Value

| Index | Sub-index | Name | Access | Type | Range | Default value | Unit | Remark |
|-------|-----------|--------------------|--------|------|---------|---------------|------|---|
| 2155 | 00 | Digital I/O status | R | DINT | 0-65535 | 0 | -- | Upper 8 bits indicate the status of digital outputs |
| 2156 | 01 | Output1 function | R/W/S | DINT | 0-65535 | 0x01 | -- | Default is alarm output, take effect changes need restart power |
| | 02 | Output2 function | R/W/S | DINT | 0-65535 | 0x03 | -- | Default is brake output, take effect changes need restart power |

More detail:

| Output Port Function | Setting Value | Polarity | Setting Value |
|----------------------|---------------|----------------------|---------------|
| Reserved | 0 | Normally open (NO) | 0 |
| Alarm (ALM) | 1 | Normally closed (NC) | 128 |
| Servo-on (Ready) | 2 (invalid) | | |
| Brake (BRK) | 3 | | |
| In-position (INP) | 4 (invalid) | | |
| Main control output | 5 | | |

Therefore, Value of 0x2156 (Decimal) = Output port function value + Polarity value.

For Example:

OUT1 needs to be set as alarm function and polarity is NC:

$0x2156+01=1+128=129(0x81)$

4.3.4 Main Control Output Function

Main control output is also called general output and User-defined output, and its usage is as follows:

| Name | Index+Sub-index | Polarity | | Open main control output (60FE+01) | Enable main control output (60FE+02) |
|------|-----------------|----------|------|------------------------------------|--------------------------------------|
| | | NO | NC | | |
| OUT1 | 2156+01 | 0x05 | 0x85 | bit16 (0x10000) | bit16 (0x10000) |
| OUT2 | 2156+02 | 0x05 | 0x85 | bit17 (0x20000) | bit17 (0x20000) |

For example, when OUT2 is set to main control output function and polarity is NC, the operation steps are as below:

- Set Object (2156+02h) to value 0x05 to main control output function;
- Set both 60FE+01 and 60FE+02 to value 0x20000, then it is available.

4.4 Motion Objects

| Index | Name | Access | Type | Range | Default value | Unit | Remark |
|-------|---------------------------|--------|------|---------|---------------|------|--|
| 603F | Error code | R | UINT | 0-65535 | 0 | -- | Refer to chapter 5.2 |
| 6040 | Control word | R/W | UINT | 0-65535 | 0 | -- | Refer to chapter 6.1 |
| 6041 | Status word | R | UINT | 0-65535 | 0 | -- | Refer to chapter 6.1 |
| 605A | Quick stop type selection | R/W | UINT | 0-65535 | 6 | -- | 0: After stopping immediately, switch on disable state; 1: After decelerating to stops at a speed value of 0x6084, switch on disable state; |

| | | | | | | | |
|------|--|-------|-------|----------------------------|---|-------|--|
| | | | | | | | 2: After decelerating to stops at a speed value of 0x6085, switch on disable state; 3: After decelerating to stops at a speed value of 0x60C6, switch on disable stat; 4: After stopping immediately, switch on quick stop state; 5: After decelerating to stops at a speed value of 0x6084, switch on quick stop state; 6: After decelerating to stops at a speed value of 0x6085, switch on quick stop state; 7: After decelerating to stops at a speed value of 0x60C6, switch on quick stop stat; |
| 605D | Asynchronous mode halt selection | R/W | INT | 0~65535 | 1 | -- | 1: After decelerating to stops at a speed value of 0x6084, keep operation enable state; 2: After decelerating to stops at a speed value of 0x6085, keep operation enable state; 3: After decelerating to stops at a speed value of 0x60C6, keep operation enable state; 4: After stopping immediately, keep operation enable state. |
| 6060 | Operation mode | R/W | USINT | 0-255 | 8 | -- | 1: PP mode, 3: PV mode, 6: Home mode, 8: CSP mode |
| 6061 | Operation mode display | R | USINT | 0-255 | 8 | -- | - |
| 6062 | Position command | R | DINT | -2147483648 ~2147483647 | 0 | Pulse | - |
| 6064 | Position actual value | R | DINT | -2147483648 ~2147483647 | 0 | Pulse | - |
| 6067 | Distance to send "In Position" output signal | R/W/S | UINT | 0-1000 | 4 | Pulse | It is recommended to use this object in preference, Can also set by 0x2032, |
| 606B | Velocity command | R | DINT | -2147483648 ~2147483647 | 0 | P/s | - |
| 606C | Velocity actual value | R | DINT | -2147483648 ~2147483647 | 0 | P/S | - |
| 607A | Target position | R/W | DINT | -2147483648 ~2147483647 | 0 | P | Target position under PP mode |

| | | | | | | | |
|---------|-------------------------|-------|-------|----------------------------|----------|-------|--|
| 607C | Home offset | R/W | DINT | -2147483648 ~2147483647 | 0 | P | The value of difference between zero position and mechanical zero point under Homing mode . If the value is set to10000, it means that at homing mode 19, the motor reaches the Home switch and stops immediately, then reverses at low speed until it leaves the Home switch, at last stops at a distance of 10000P. |
| 607D+01 | Software negative limit | R/W | DINT | -2147483648 ~2147483647 | 0 | P | New target positions are checked against these limits. The limits are relative to the machine home position, which is the result of homing. As default the software position limits are switched off. Changed values must be saved and the drive must be restarted to take enable the new the software limits. |
| 607D+02 | Software positive limit | R/W | DINT | -2147483648 ~2147483647 | 0 | P | |
| 607E | Motor direction | R/W | USINT | 0~255 | 0 | -- | Need to set 0x225C first |
| 60FF | Target velocity | R/W | DINT | -2147483648 ~2147483647 | 0 | P/S | Profile velocity under PV mode |
| 6080 | Max velocity limit | R/W/S | UDINT | -2147483648 ~2147483647 | 3000 | rpm | - |
| 6081 | Max profile velocity | R/W/S | DINT | -2147483648 ~2147483647 | 50000 | -- | Max. Allowable velocity under PP mode |
| 6082 | Start velocity | R/W/S | DINT | -2147483648 ~2147483647 | 0 | -- | Start velocity under PP mode |
| 6083 | Profile acceleration | R/W/S | DINT | -2147483648 ~2147483647 | 4000 | P/S^2 | Acceleration under PP and PV mode |
| 6084 | Profile deceleration | R/W/S | DINT | -2147483648 ~2147483647 | 4000 | P/S^2 | Deceleration under PP and PV mode |
| 6085 | Quick stop deceleration | R/W/S | DINT | -2147483648 ~2147483647 | 40000000 | P/S^2 | Deceleration of quick stop under PP, PV and Home mode |
| 608F+01 | Encoder resolution | R/W/S | UINT | 4000-20000 | 4000 | Count | It is recommended to use this object in preference, can also set by 0x2029, |
| 6092+01 | Microstep resolution | R/W/S | DINT | 200-51200 | 10000 | Pulse | It is recommended to use this object in preference,can also be modified via 0x2001, |
| 6098 | Homing method | R/W/S | USINT | 1-100 | 19 | - | Methods of searching zero position under homing mode, refer to Appendix A |

| | | | | | | | |
|---------|-----------------------------------|-------|-------|----------------------------|-------|-------|---|
| 6099+01 | Fast homing velocity | R/W/S | DINT | -2147483648 ~2147483647 | 50000 | P/S | Speed during search for limit switch signal |
| 6099+02 | Slow homing velocity | R/W/S | DINT | -2147483648 ~2147483647 | 25000 | P/S | Speed during search for Home switch |
| 607C | Home offset | R/W/S | DINT | -2147483648 ~2147483647 | 0 | P | The value of difference between zero position and mechanical zero point under Homing mode |
| 609A | Homing acceleration | R/W/S | USINT | -2147483648 ~2147483647 | 25000 | P/S^2 | Acc / Dec velocity under Home mode |
| 60B0 | Position offset | R/W | DINT | -2147483648 ~2147483647 | 0 | P | Position offset under PP mode |
| 60B8 | Touch probe control word | R/W | UINT | 0-65535 | 0 | - | Set touch probe function, refer to chapter 6.3 |
| 60B9 | Touch probe statue word | R | UINT | 0-65535 | 0 | - | Status of touch probe 1/2, refer to chapter 6.3 |
| 60BA | Touch probe 1 positive value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 1 at rising edge |
| 60BB | Touch probe 1 negative value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 1 at falling edge |
| 60BC | Touch probe 2 positive value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 2 at rising edge |
| 60BD | Touch probe 2 negative value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 2 at falling edge |
| 60C2+01 | Interpolation time period value | R/W | USINT | 0-255 | 2 | -- | Only for internal tuning. |
| 60C2+02 | Interpolation time unit | R/W | SINT | -128-127 | 0 | -- | |
| 60D5 | Touch probe 1 rising edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 1 rising edge |

| | | | | | | | |
|---------|------------------------------------|-------|-------|--------------|-----|----|---|
| 60D6 | Touch probe 1 falling edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 1 falling edge |
| 60D7 | Touch probe2 rising edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 2 rising edge |
| 60D8 | Touch probe 2 falling edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 2 falling edge |
| 60FD | Digital input statue | R | UDINT | 0-4294967296 | 0 | -- | Statue of digital input signals, refer to chapter 4.3.1 |
| 60FE+01 | Open physical output | R/W/S | UDINT | 0-4294967296 | 0 | -- | Able to control user output through this object, refer to chapter 4.3.4 |
| 60FE+02 | Enable physical output | R/W/S | UDINT | 0-4294967296 | 0 | -- | |
| 6502 | Supported operation mode | R | UDINT | 0-4294967296 | 165 | -- | Operation modes the drive supported |

4.5 XML File or ESI File

EtherCAT Slave Information file (XML File or ESI file) is needed to connect controller with EtherCAT Master.

This file is provided by Leadshine, described slave device information as XML format based on EtherCAT specifications. Please follow the EtherCAT Master software manual for importing method.

Some master stations require files in a specific format and do not recognize XML format, please contact the master technical engineer of master station.

5 Error Code & Trouble Shooting

When an alarm is occurred, the drive turns on the protection function and the motor stops running. CS3E-E has three object dictionaries that can read alarm code, and two red LED lights flash to display some of the alarm information.

5.1 Error Code

- (1) Object **0x3FFE+01** indicates the current failure alarm, and other sub-index indications are historical alarms.
- (2) Object **0x1001** and **0x603F** indicate the current failure alarm, The error code read by 0x603F is IEC 61800 specification; the error code read by 0x1001 is CIA specification.
- (3) Error code read by some master station is displayed in decimal. At this time, please convert it to hexadecimal and then refer to the error code table as below. For example, the master station reports error code of 8721, the corresponding hexadecimal number is 0x2211, so the alarm information in the reference table is over-current alarm.

Error code table

| 0x3FFE Value | 0x603F Value | Description | Trouble Shooting |
|---------------------|---------------------|--|---|
| 0x0e0 | 0x2211 | Over-current | <ol style="list-style-type: none"> 1. Check whether the wiring is short-circuited, or the motor is short-circuited. 2. Switch power supply alarm caused, replace other power supply for a try. |
| 0x0c0 | 0x3211 | Over-voltage | <ol style="list-style-type: none"> 1. Check the voltage of power supply; 2. If over-voltage occurs in motion, the acceleration and deceleration time can be increased |
| 0x0a0 | 0x3150 | EEPROM error in phase A | <ol style="list-style-type: none"> 1. Reset parameters to the factory and restart power supply 2. If it still exists, the hardware failure |
| 0x0a1 | 0x3151 | EEPROM error in phase B | |
| 0x1a0 | 0x8402 | Over-speed | <ol style="list-style-type: none"> 1. Reduce command speed value; 2. Write 0x10 to the object 0x2056 to clear the alarm. |
| 0x240 | 0x5530 | Save error | <ol style="list-style-type: none"> 1. Reset parameters to the factory and restart power supply 2. If it still exists, the hardware failure |
| 0x260 | 0x7329 | Limit switched alarm | Refer to 0x22A9+00 |
| 0x570 | 0x5441 | Quick stop alarm | Refer to 0x22B4+00 |
| 0x5f0 | 0x7122 | Auto-tuning error | <ol style="list-style-type: none"> 1. Restart the drive; 2. If it still exists, disable auto-tuning by 0x2013 |
| - | 0x7321 | Encoder wiring error | <ol style="list-style-type: none"> 1. The drive is not connected to a motor; 2. If alarm is occurred when connect a motor, please check the encoder wiring or a cable break. |
| 0x816 | 0x8216 | Invalid mailbox configuration in pre-operation state | Check the network cable |
| 0x81b | 0x821B | Watchdog timeout | Check the network cable |
| - | 0x8611 | Position following error | <ol style="list-style-type: none"> 1. Set the value of Object 2024h to "0" to make motor run in open loop mode, If alarm disappears, it means encoder wiring error; 2. Motor torque is not enough or motor speed is too high; |
| 0x836 | 0x8736 | Invalid DC synchronization period | Decrease the value of the synchronization period or increase the value of 0x5400+02 |
| 0x870 | 0x5201 | Unsupported operation mode | Check the value of 0x6061 and correct it to the supported operation mode; |
| 0x801 | 0x8201 | ESM state machine transition failed | Alarms related to the master station, without accurate solution. |
| 0x802 | 0x5510 | Memory overflow | |
| 0x807 | 0x8207 | The mapping object does not | |
| | | | |

| | | |
|-------|--------|--|
| | | exist |
| 0x808 | 0x8208 | PDO mapping object length error |
| 0x809 | 0x8209 | PDO mapping object has no mapping attribute |
| 0x811 | 0xA001 | Invalid ESM conversion request |
| 0x812 | 0xA002 | Unknown ESM conversion request |
| 0x813 | 0x8213 | Boot state request protection |
| 0x815 | 0x8215 | Email configuration with invalid boot status |
| 0x818 | 0x8211 | No valid input data |
| 0x819 | 0x8212 | No valid output data |
| 0x81c | 0x821C | Invalid sync manager type |
| 0x81d | 0x821D | Invalid output configuration |
| 0x81e | 0x821E | Invalid input configuration |
| 0x821 | 0xA003 | Waiting for the initial state of ESM |
| 0x822 | 0xA004 | Waiting for ESM pre-operation state |
| 0x823 | 0xA005 | Waiting for ESM safe operation status |
| 0x824 | 0x8224 | Invalid process data input mapping |
| 0x825 | 0x8225 | Invalid process data output mapping |
| 0x827 | 0x8727 | Free running mode is not supported |
| 0x828 | 0x8728 | Does not support synchronous mode |
| 0x82b | 0x8210 | Invalid input and output |
| 0x82c | 0x872C | Fatal sync error |
| 0x82d | 0x872D | No synchronization errors |
| 0x82e | 0x872E | Synchronization period is too small |
| 0x830 | 0x8730 | Invalid DC synchronization configuration |
| 0x832 | 0x8732 | DC phase locked loop failure |
| 0x833 | 0x8733 | DC sync IO error |
| 0x834 | 0x8734 | DC synchronization timeout |
| 0x835 | 0x8735 | Invalid DC cycle |
| 0x850 | 0x5550 | EEPROM inaccessible |
| 0x851 | 0x5551 | EEPROM error |
| 0x852 | 0x5552 | The hardware is not ready |

5.2 Alarm LED

As shown in the figure below, there are two red alarm indicator lights. ALM usually shows the drive motion alarms, and ERR shows the drive communication alarms.



ALM red light alarm indication table:

| ALM flicker number | Description | Error code in 0x603F | Trouble Shooting |
|--------------------|--------------------------|----------------------|---|
| 1 | Over-current | 0x2211 | 1. Check whether the wiring is short-circuited, or the motor is short-circuited. 2. Switch power supply alarm caused, replace other power supply for a try. |
| 2 | Over-voltage | 0x3211 | 1. Check the voltage of power supply; 2. If over-voltage occurs in motion, the acceleration and deceleration time can be increased |
| 4 | Shaft locking error | 0x7323 | 1. Check whether the motor wire is not connected 2. Check whether motor wiring is incorrect |
| 5 | Save parameter error | 0x5530 | 1. Reset parameters to the factory and restart power supply 2. If it still exists, the hardware failure |
| 6 | Auto-tuning error | 0x7122 | 1. Restart the drive; 2. If it still exists, disable auto-tuning by 0x2013 |
| 7 | Position following error | 0x8611 | 1. Set the value of Object 2024h to "0" to make motor run in open loop mode, If alarm disappears, it means encoder wiring error; 2. Motor torque is not enough or motor speed is too high; |
| 8 | Encoder wiring error | 0x7321 | 1. The drive is not connected to a motor; 2. If alarm is occurred when connect a motor, please check the encoder wiring or a cable break. |
| 10 | Quick stop error | 0x5441 | Refer to 0x22B4+00 |
| 11 | Limit switches error | 0x7329 | Refer to 0x22A9+00 |
| Always on | Hardware error | - | 1. Restart power supply, 2. If it still exists, the hardware failure. |

When the CS3E-E has a network communication failure, the Alarm LED2 flicker status and the error code in object 0x603F are listed in the following table. The part of the network communication failure can be saved and all can be cleared.

Alarm LED2 alarm indication table:

| ERR flicker | Description | Error code in 0x603F | Savable | Trouble Shooting |
|-----------------------|--|----------------------|---------|-------------------------|
| Low frequency flicker | Invalid configuration in pre-operation state | 0x8216 | No | Check the network cable |
| | Others | - | No | - |
| Double flicker | Watchdog timeout | 0x821B | Yes | Check the network cable |
| Single flicker | Sync mode error | 0x871A | Yes | |
| | Others | - | No | |

5.3 Alarm Clearing

After the CS3E-E drive alarms, the power should be cut off first to check the fault, especially the over-current and

over-voltage faults. Some alarms (except over-voltage and over-current) can be cleared when the drive is holding on, the step is as follows:

- Write 0x80 (decimal 128) to the object 0x6040 to clear the current alarm (except over-voltage and over-current). [This method is recommended as a priority](#);
- Or write 1 to the object 0x2093 to clear the historical alarm records. At this time, all sub-indexes of 0x3FFE are cleared;

Leadshine



6 Common Functions

6.1 Saving Parameters and Resetting Drive

To save all storable parameters into EEPROM through Object 0x1010, need to write “0x65766173” into sub-index 01h. To reset the drive to default parameters through Object 0x1011, need to write “0x64616F6C” into sub-index 01h. **After writing the save command, do not turn off the power immediately, wait around 10s to ensure that all parameters have been saved successfully.** The below table is the description of Object (1010h) and Object (1011h).

Table 6.1: Object (1010h) and Object (1011h)

| Action | Index Sub-index | Write Command (hex) | Return Value | Description |
|-------------------------------|-----------------|---------------------|--------------|------------------------------------|
| Save Objects (2000h-5000h) | 1010+04 | 0x65766173 | Return 1 | Save Manufacture Specific Objects |
| Save Objects (6000h) | 1010+03 | 0x65766173 | Return 1 | Save Motion Objects |
| Save Objects (1000h) | 1010+02 | 0x65766173 | Return 1 | Save Communication Objects |
| Save all Objects | 1010+01 | 0x65766173 | Return 1 | Save all Objects |
| Restore Objects (2000h-5000h) | 1011+04 | 0x64616F6C | Return 1 | Reset Manufacture Specific Objects |
| Restore Objects (6000h) | 1011+03 | 0x64616F6C | Return 1 | Save Motion Objects |
| Restore Objects (1000h) | 1011+02 | 0x64616F6C | Return 1 | Reset Communication Objects |
| Restore all Objects | 1011+01 | 0x64616F6C | Return 1 | Reset all Objects |

6.2 Control Word and Operation Modes

CS3E-E supports both synchronous mode and asynchronous mode. In the synchronous mode, master station processes trajectory planning and outputs cyclical instructions. Drives follow the planning instructions given by master station in synchronous cycle, making it suitable for synchronous motion of multiple axes. CS3E-E synchronous motion mode supports CSP mode. In CSP mode, master station completes trajectory planning and sends it to CS3E-E. The drive will execution the synchronous cyclic position instructions immediately once they has arrived. The **CS3E-E supports following synchronous cycles:250 us, 500 us, 750us, 1000 us, 2000 us, 4000 us, 8000 us.**

In asynchronous motion mode, master station is only responsible for sending motion parameters and control commands. CS3E-E drives will process trajectory planning according to the motion parameters after receives control command from master station and the movements between each axis are asynchronous. CS3E-E asynchronous mode includes Profile Position mode(PP), Profile Velocity mode(PV)and Homing mode(HM).

In both control modes, EtherCAT data transmission between master and slave station is achieved through object dictionary. The transmission types contain PDO and SDO and only one can be chosen in general cases. According to control needs, it is classified in three levels by data transmission real time capability and importance:

Must> Recommend > Can.

- “Must” indicates under this mode, the object dictionary has to be PDO mode;
- “Recommend” indicates under the set mode, the object dictionary is suggested to be configured as PDO mode to achieve real-time capability but SDO transmission can be allowed if the controlling is not quite demanding;
- ”Can” indicates under this mode, object dictionary data transmission is generally through SDO mode and PDO communication mode won’t be necessary.

The object dictionary of each control mode are shown as below:

Table 6.2: Objects Dictionary related to each operation mode

| Operation Modes | Index + Sub-index | Name | Data Type | Access | Unit | PDO Configuration | SDO Configuration |
|-----------------|-------------------|--------------|-----------|--------|------|-------------------|-------------------|
| CSP Mode (8) | 6040+00 | Control Word | U16 | RW | — | Must | - |

| | | | | | | | |
|---|---------|------------------------------|-----|----|------------------|-----------|-----|
| | 607A+00 | Target Position | I32 | RW | P | Must | - |
| | 6041+00 | Status Word | U16 | RO | — | Must | - |
| | 6064+00 | Actual Position | I32 | RO | P | Must | - |
| | 606C+00 | Actual Velocity | I32 | RO | P/S | Can | Can |
| PP Mode (1) | 607A+00 | Target Position | I32 | RW | P | Recommend | Can |
| | 6081+00 | Max Profile Velocity | U32 | RW | P | Can | Can |
| PV Mode (3) | 60FF+00 | Target Velocity | I32 | RW | P | Recommend | Can |
| PP Mode (1) And PV Mode (3) General | 6040+00 | Control Word | U16 | RW | — | Recommend | Can |
| | 6083+00 | Profile Acceleration | I32 | RW | P/S ² | Can | Can |
| | 6084+00 | Profile Deceleration | U32 | RW | P/S ² | Can | Can |
| Homing Mode (6) | 6040+00 | Control Word | U16 | RW | — | Recommend | Can |
| | 6098+00 | Homing Method | I8 | RW | — | Can | Can |
| | 6099+01 | Fast Homing Velocity | U32 | RW | P/S | Can | Can |
| | 6099+02 | Slow Homing Velocity | U32 | RW | P/S | Can | Can |
| | 609A+00 | Homing Acceleration | U32 | RW | P/S ² | Can | Can |
| | 607C+00 | Homing Offset | U32 | RW | P | Can | Can |
| PP, PV and HOME Mode General | 6041+00 | Status Word | U16 | RO | — | Recommend | Can |
| | 6064+00 | Actual Position | I32 | RO | P | Recommend | Can |
| | 606C+00 | Actual Velocity | I32 | RO | P/S | Can | Can |
| All operation modes General | 60B8+00 | Touch Probe Control Word | U16 | RW | — | Recommend | Can |
| | 60B9+00 | Touch Probe Status Word | U16 | RO | — | Recommend | Can |
| | 60BA+00 | Touch Probe 1 Positive Value | I32 | RO | P | Can | Can |
| | 60FD+00 | Digital Input Status | U32 | RO | — | Recommend | Can |
| | 603F+00 | Latest Error Code | U16 | RO | P | Recommend | Can |
| Other Related | 6060+00 | Operation Mode | I8 | RW | — | Can | Can |
| | 60B0+00 | Position Offset | I32 | RW | — | Can | Can |
| | 6082+00 | Start Velocity | U32 | RW | P/S | Can | Can |
| | 6085+00 | Quick Stop Deceleration | U32 | RW | P/S ² | Can | Can |
| | 6061+00 | Displayed Operation Mode | I8 | RO | — | Can | Can |

No matter using which operation mode, it can not be separated from the reading and writing of Control Word (6040h) and Status Word (6041h). Master and slave stations use these two object dictionaries as a medium to send instructions and monitor status. Following contents will highlight the definitions of each bit of the two object dictionaries.

The bit definition of Control Word (6040 h) is as shown in Table 6.3. The table A is about bit4, bit5, bit6 and bit8, whose definition depend on the operation mode, and mainly cover the execution, stop, etc. of each operation mode. The table B is about bit0-3 and bit7, which manages the state transition of the 402 state machine. The definition of.

Status Word (6041h) is as shown in Table 6.4. The bit0 -7 mainly show the state machine transition state, while the bit8-15 mainly shows the status of execution or stop in each operation mode. The typical state transition of enable is as follows:

Initiation (00h) -> power-on (06h) -> start (07h) -> enable (0fh) -> execute or pause (depending on operation mode to send related control instructions of bit4-6 and bit8). The state transition that triggers the running control in each control mode is shown in Table 6.5.

Table 6.3A: Control Word (6040h) Bit Definition

| Bit Mode | 15-9 | 8 | 6 | 5 | 4 |
|--------------|------|-------------------|---------------------------------|-------------------|--------------------|
| General | - | Pause | Depending on the operation mode | | |
| CSP mode (8) | - | Invalid | Invalid | Invalid | Invalid |
| PP mode (1) | - | Deceleration stop | Absolute / Relative | Immediate trigger | New position point |
| PV mode (3) | - | Deceleration stop | Invalid | Invalid | Invalid |
| HM mode (6) | - | Deceleration stop | Invalid | Invalid | Starting motion |

Table 6.3B: Control Word (6040h) Bit Definition

| Bit Mode | 7 | 3 | 2 | 1 | 0 | Type value | Action |
|--------------|-------------|---------------------|------------|----------------|-------|------------|-------------|
| General | Wrong reset | Permitted operation | Quick stop | Voltage output | Start | | |
| CSP mode (8) | 0 | 0(x) | 1 | 1 | 0 | 06h | Get power |
| PP mode (1) | 0 | 0 | 1 | 1 | 1 | 07h | Start |
| PV mode (3) | 0 | 0(x) | 0 | 1 | 0(x) | 02h | Quick |
| HM mode (6) | 0 | 1 | 1 | 1 | 1 | 0fh | Enable |
| - | 1 | 0(x) | 0(x) | 0(x) | 0(x) | 80h | Clear error |
| - | 0 | 0 | 0 | 0 | 0 | 0 | Initiation |

Additional information on other bits:

- Bit 2 is quick stop, trigger logic is 0 effective, notice to separate from other trigger logic.
- Bit 7 is error reset, trigger logic is rising edge effective.
- Bit 5 is immediate trigger, trigger logic is rising edge effective.

Table 6.4 Status Word(6041h) Bit Definition

| Mode | Low 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|---------------------------------|----------|-------------|------------|----------|-------|---------------------|-------|----------------|
| Shared | Reserved | Reserved | Not started | Quick stop | Power on | Error | Permitted operation | Start | Ready to start |
| Mode / high 8 bits | 15 | 14 | 13 | 12 | 10 | 8 | 11 | 9 | |
| Shared | Depending on the operation mode | | | | | | | Limit | Distance |

| | | | | | | | validity | |
|--------------|------------------|-----------------|--------------|-----------------------------|------------------|----------------|--|----------------------|
| CSP mode (8) | Invalid | Invalid | Invalid | Following effective | Invalid | Emergency stop | It will be set when the hardware limit effective | 0 below PreOP status |
| PP mode (1) | Trigger response | Parameter has 0 | Invalid | New position point response | Position arrival | Emergency stop | | |
| PV mode (3) | Invalid | Parameter has 0 | Invalid | Speed is 0 | Velocity arrival | Quick stop | | |
| HM mode (6) | Trigger response | Parameter has 0 | Homing error | Homing find | Position arrival | Emergency stop | | |

Additional information on other bits:

- When the drive is put into power, the bit 4 will be set.
- Bit 5 quickly stops activation, which is valid under logic 0, contrary to the logic of other bits.
- Bit 9 remote, showing the state of the communication state, 0 below ProOP, at this time the control word (6040 h) command will not be executed.
- Bit 11 limit is set only, when the hardware limit is valid.
- Bit 8 abnormal stop is generally valid in hardware limit, deceleration stop and fast stop trigger state.
- Bit 12 follows the master station, if the driver does not enable or no longer follow instructions from the master station under CSP, this position is 0.

Table 6.5: State transition of each mode control operation

| Action | | PreOP | Initializati on | Get power | Start | Enabl e | Start operation | Change position | Stop | Alarm |
|--------------|------|--|-----------------|-----------|-------|---------|------------------------------------|------------------------|--|--------------|
| CSP mode (8) | 6040 | Create a communication OP state and activate the NC axis | -- | 06h | 07h | 1fh | Master station send instruction | Master station control | Master station stop position instruction | Over-voltage |
| | 6041 | | -- | 631h | 633h | 1637h | 1237h | 1237h | 1637h | 638h |
| PP mode (1) | 6040 | Create a communication OP state, setting motion parameters | 00h | 06h | 07h | 0fh | 2fh | 3fh | 13fh | Over-voltage |
| | 6041 | | 650h | 631h | 633h | 8637h | 8637h | 1237h | 737h | 638h |
| PV mode (3) | 6040 | Create a communication OP state, setting motion parameters | 00h | 06h | 07h | 0fh | Immediate operation after enabling | Change the speed | 10fh | Over-voltage |
| | 6041 | | 650h | 631h | 633h | 637h | 637h | 237h->637h | 737h | 638h |
| HM mode (6) | 6040 | Create a communication OP state, setting motion parameters | 00h | 06h | 07h | 0fh | 1fh | Error / Completion | 11fh | Over-voltage |
| | 6041 | | 650h | 631h | 633h | 8737h | 237h | 2637h / 1637h | 737h | 638h |

Additional information on other bits:

- When the PP mode changes the position, it needs to give the bit5 rising edge of the control word to start the new position motion.

6.3 Touch Probe

Touch probe function is to capture and record the actual position of the motor by using the input signal with the touch probe function. The CS3E-E driver has two input I/O signals to support the probe function and can be enabled at the same time. The probe function related object dictionaries are shown in Table 6.6.

Table 6.6: Related Object Dictionaries of Touch Probe

| Index | Bit Definition | | | | | |
|-------|---|------------------------------------|-----------------------------------|---|--|----------------------|
| | 7-6 | 5 | 4 | 3-2 | 1 | 0 |
| 60B8h | - | Touch Probe 1 falling edge trigger | Touch Probe 1 rising edge trigger | - | Touch Probe 1 mode | Touch Probe 1 enable |
| | 15-14 | 13 | 12 | 11-10 | 9 | 8 |
| | - | Touch Probe 2 falling edge trigger | Touch Probe 2 rising edge trigger | - | Touch Probe 2 mode | Touch Probe 2 enable |
| | | | | | | |
| 60B9h | 7 | 6 | 5-3 | 2 | 1 | 0 |
| | Actual level of touch probe 2 | Actual level of Touch Probe 1 | | Touch Probe 1 falling edge trigger complete | Touch Probe 1 rising edge trigger complete | Touch Probe 1 action |
| | 15-11 | | | 10 | 9 | 8 |
| | - | | | Touch Probe 2 falling edge trigger complete | Touch Probe 2 rising edge trigger complete | Touch Probe 2 action |
| 60BAh | Touch Probe 1 rising edge capture data value register | | | | | |
| 60BBh | Touch Probe 1 falling edge capture data value register | | | | | |
| 60BCh | Touch Probe 2 rising edge capture data value register | | | | | |
| 60BDh | Touch Probe 2 falling edge capture data value register | | | | | |
| 60FDh | The state of bit26 is bit 1 and bit 2 AND logic of Object (60B9h); The state of bit27 is bit 9 and bit 10 AND logic of Object (60B9h) | | | | | |
| 2152h | It can be configured as probe 1 or probe 2 by writing its sub-indexes 01h and 02h to 17 or 18. | | | | | |

Additional information on other bits:

- The bit0 and bit8 of Object (60B8h): start/stop control bit of Touch Probe 1 and Touch Probe 2 respectively, and the rising edge is effective.
- The bit1 and bit9 of Object (60Bh): Touch Probe modes are divided into single mode and continuous mode.
 - Single mode: After a Touch Probe is activated, it is captured only under the first trigger signal. In order to capture the new position value again, the bit0 /bit8 of the Object (60B8h) must be given a rising edge signal to restart the probe action.
 - Continuous mode: After a Touch Probe is activated, the capture action is carried out under each trigger signal.

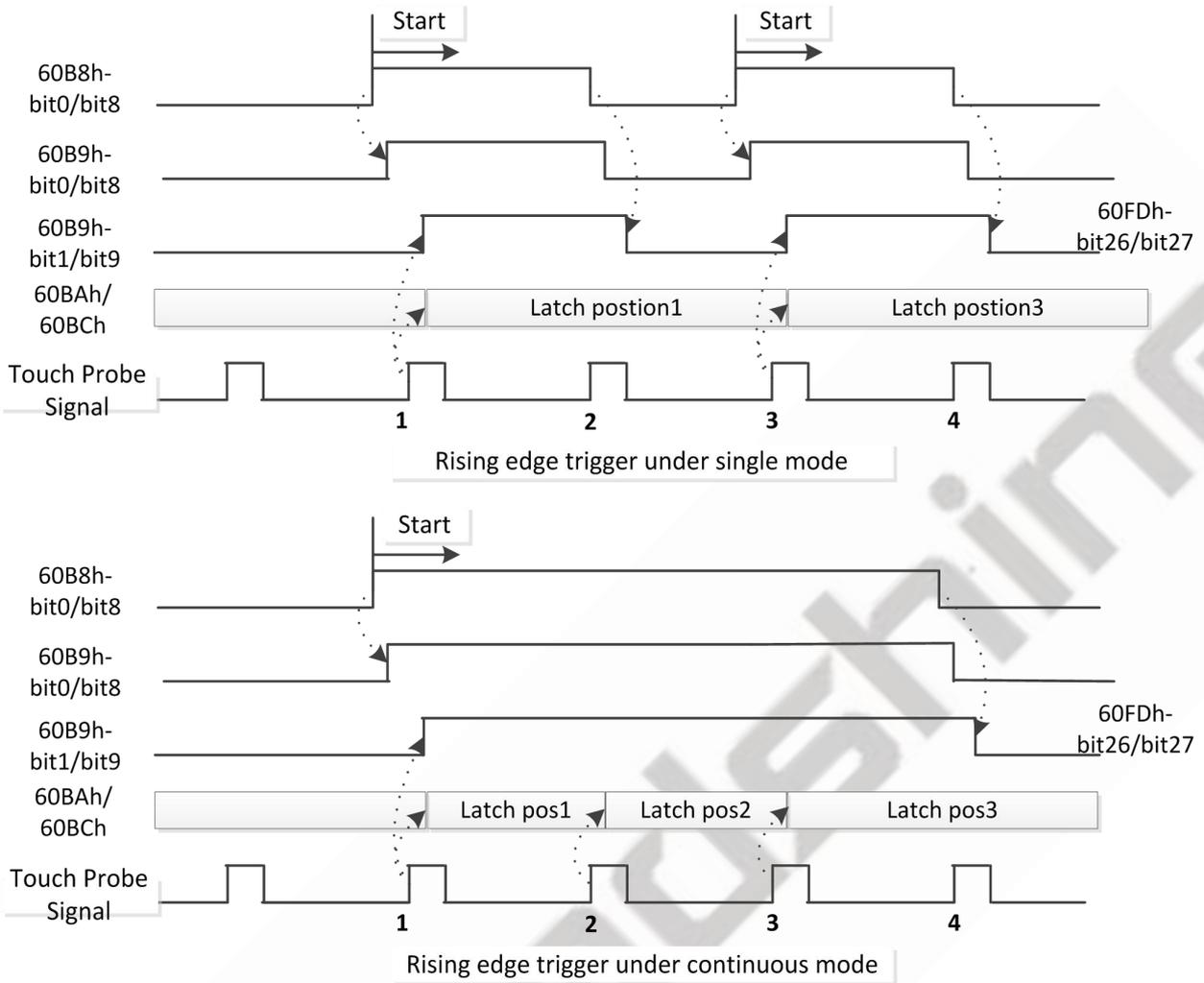


Figure 6.1: Touch Probe Mode

Appendix A: Homing Methods

The CS3E-E series drives support homing method -1, -2, 1 - 14, 17 - 34, and method 35 & 37. Specific definition and the process of homing methods described below.

Z Signal: Index signal, Bit31 of Object 60FDh set to 1;

Stalling Signal: After the motor is stalled, if the position error is greater than the value of Object 22EFh (default = 2000), the stalling signal is triggered (bit1 of Object 5000+04h set to 1);

Zero Position: a fixed position on the machine can correspond to a definite digital input signal, or to a Z signal

Zero Point of Machine: mechanical absolute zero position

Home offset: difference between zero position and zero point of machine, the value of Object 607Ch (default = 0) , Zero position= zero point + home offset

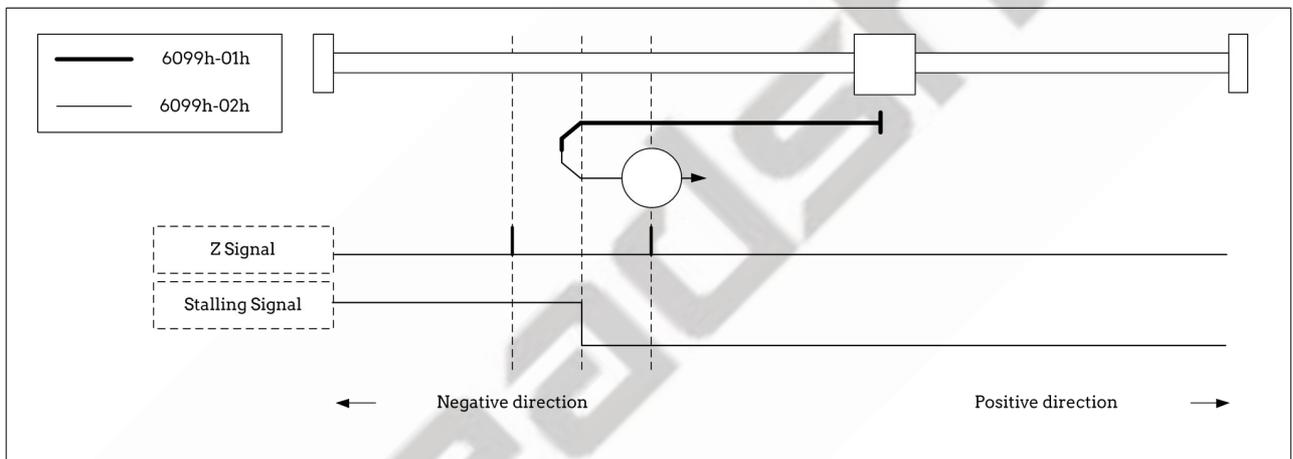
Home Switch: homing switch input signal

Negative Limit: negative limit switch input signal

Positive Limit: positive limit switch input signal

- **Method -1 requires Z signal and Stalling Signal.**

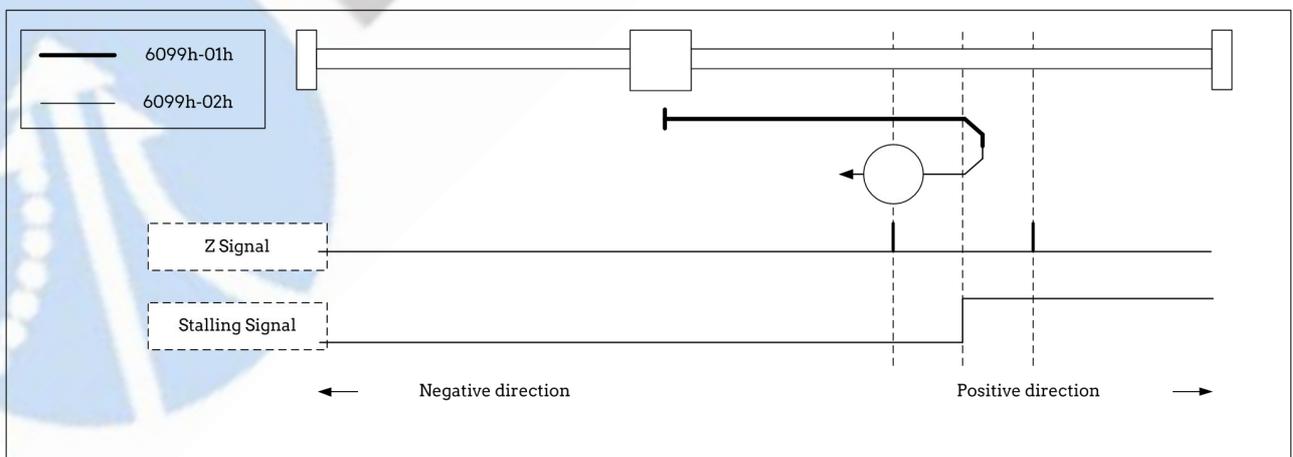
During the motor running in negative direction, when reaching the stalling signal, it will slow down and stop, then run in reverse, at last stops immediately when reaching the first Z signal. (Z signal as the zero position)



Method -1

- **Method -2 requires Z signal and Stalling Signal.**

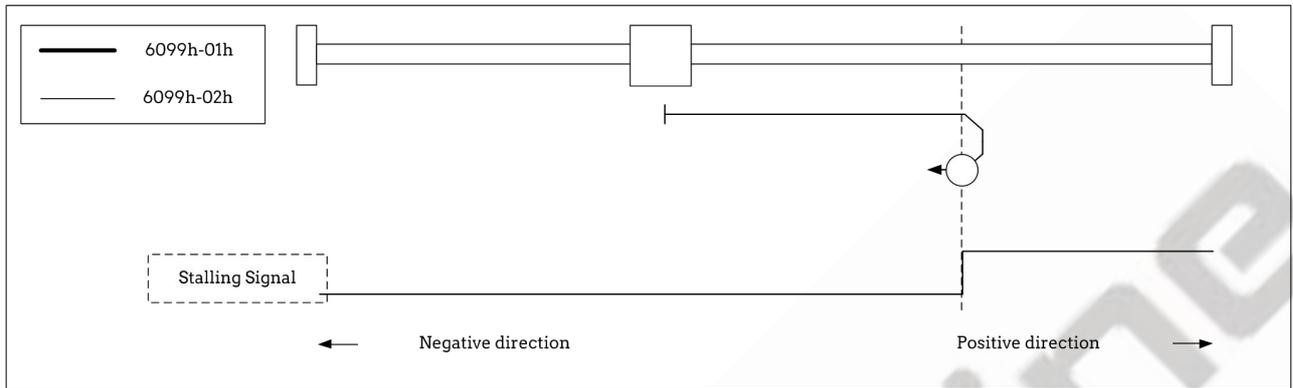
During the motor running in positive direction, when reaching the stalling signal, it will slow down and stop, then run in reverse, at last stops immediately when reaching the first Z signal. (Z signal as the zero position)



Method -2

- **Method -3 requires Stalling Signal.**

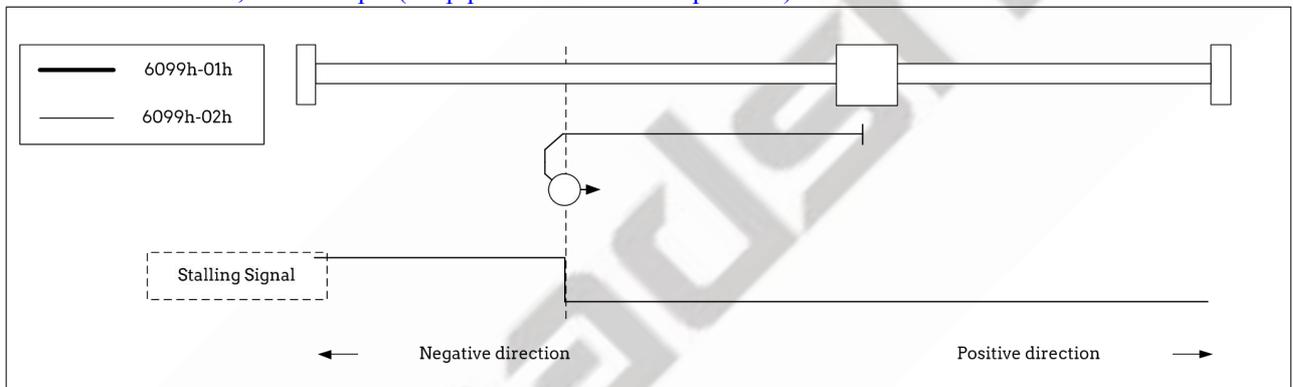
During the motor running in positive direction, when reaching the stalling signal, it will slow down and stop, then run in reverse, at last stops. (stop position as the zero position)



Method -3

- **Method -4 requires Stalling Signal.**

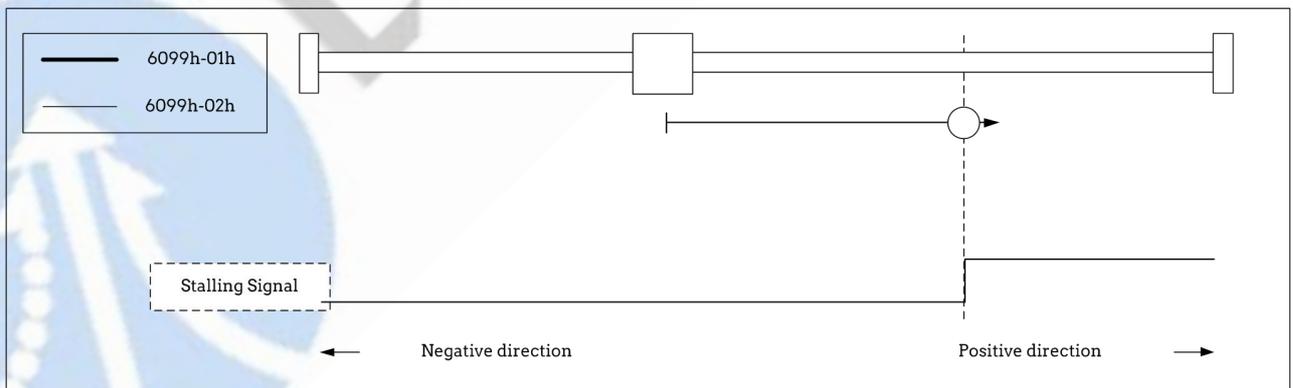
During the motor running in negative direction, when reaching the stalling signal, it will slow down and stop, then run in reverse, at last stops. (stop position as the zero position)



Method -4

- **Method -5 requires Stalling Signal.**

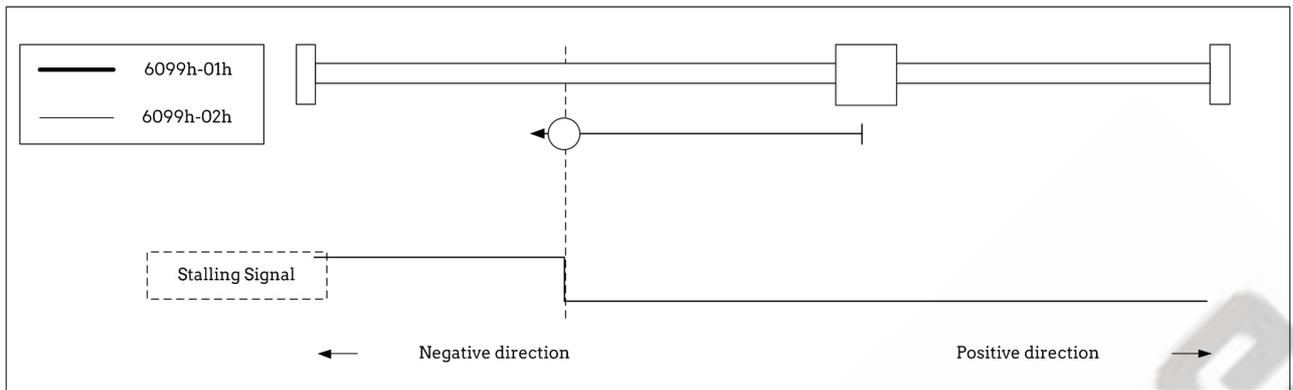
During the motor running in positive direction, when reaching the stalling signal, it will stop immediately. (Stalling Signal as the zero position)



Method -5

- **Method -6 requires Stalling Signal.**

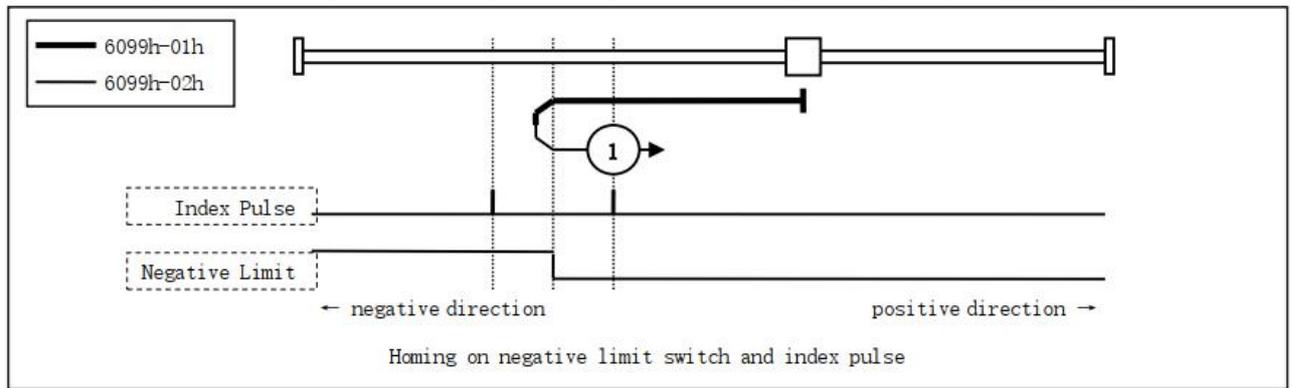
During the motor running in negative direction, when reaching the stalling signal, it will stop immediately. (Stalling Signal as the zero position)



Method -6

- **Method 1 requires Z signal and Negative Limit.**

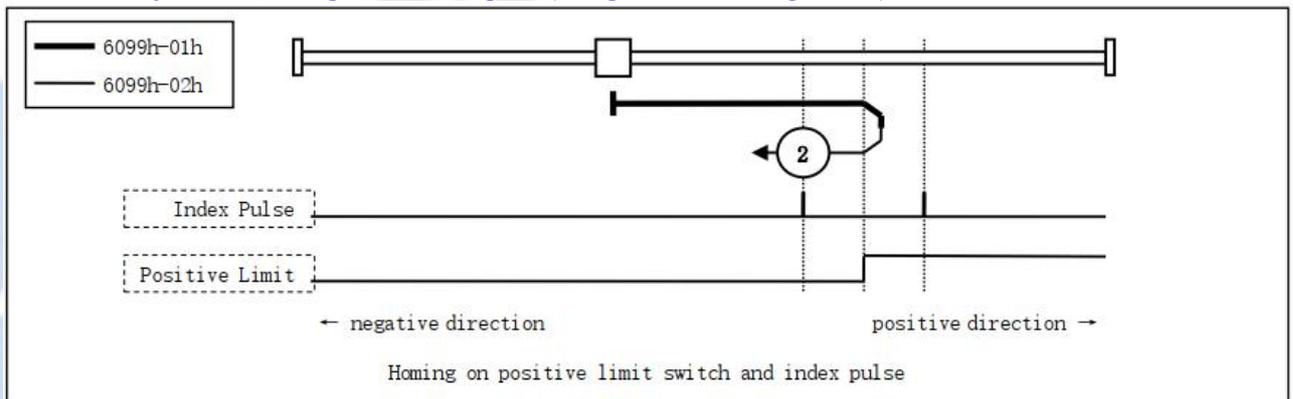
The load is located on the right side of the negative limit switch, and the motor running in negative direction. When reaching the negative limit signal, it will slow down and stop, then run in reverse, at last stops immediately when reaching the first Z signal. (Z signal as the zero position)



Method 1

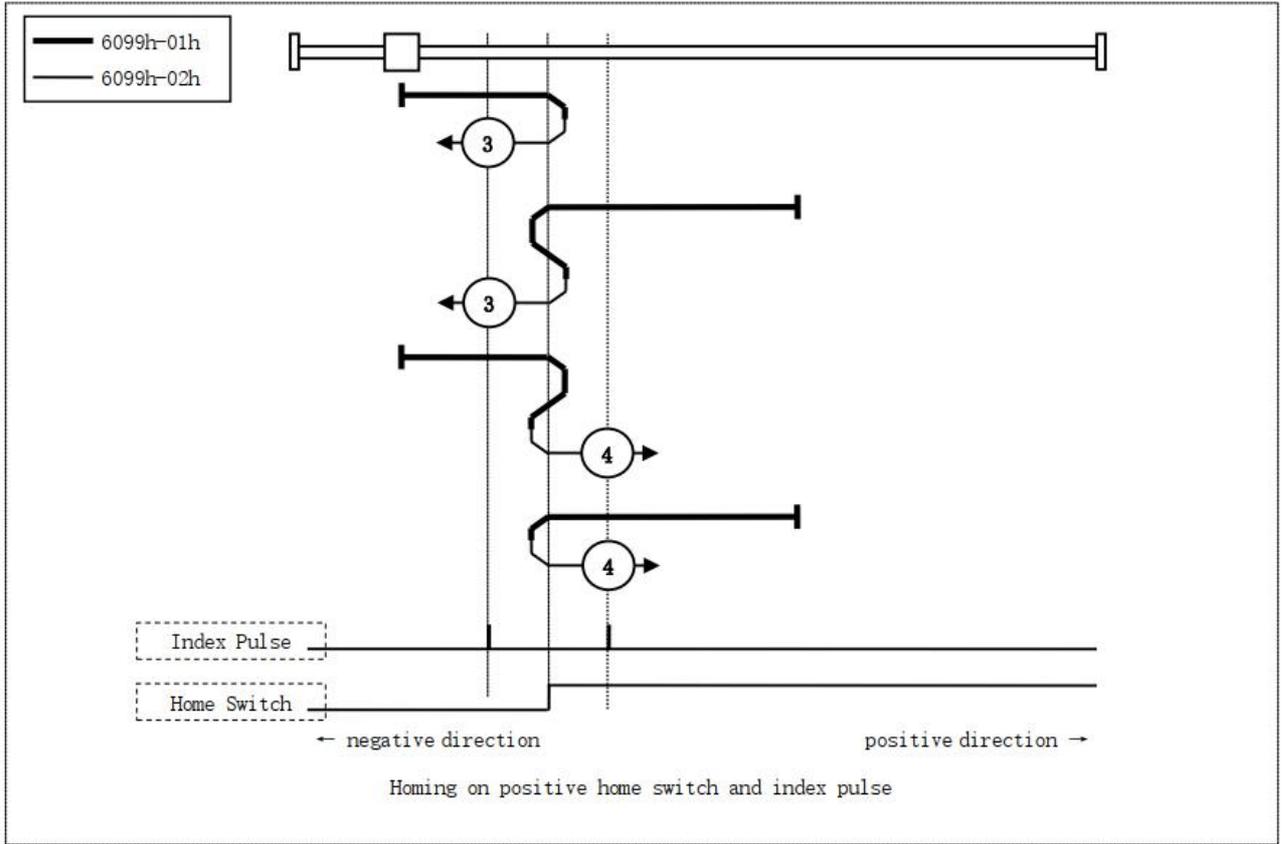
- **Method 2 requires Z signal and Negative Limit.**

The load is located on the left side of the positive limit switch, and the motor running in positive direction. When reaching the positive limit signal, it will slow down and stop, then run in reverse, then stops immediately when reaching the first Z signal. (Z signal as the zero position)

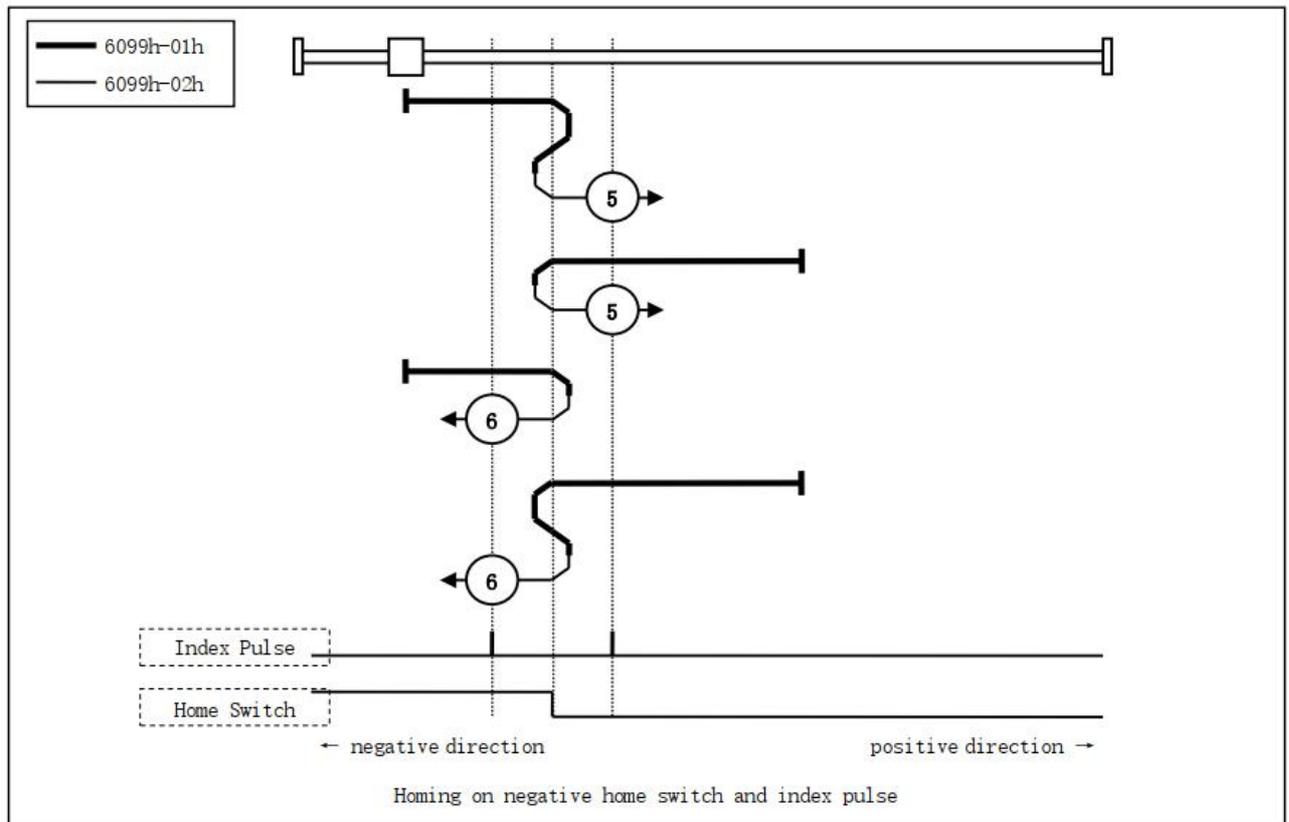


Method 2

● Method 3, 4, 5, 6 require Z signal and Home Switch

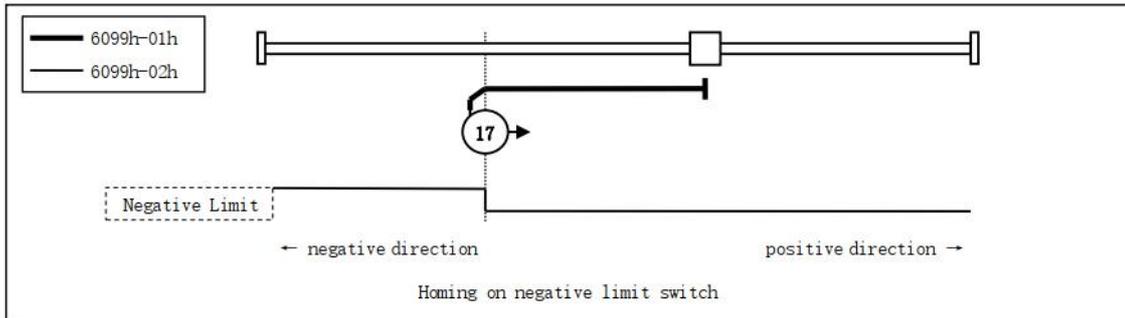


Method 3 & 4



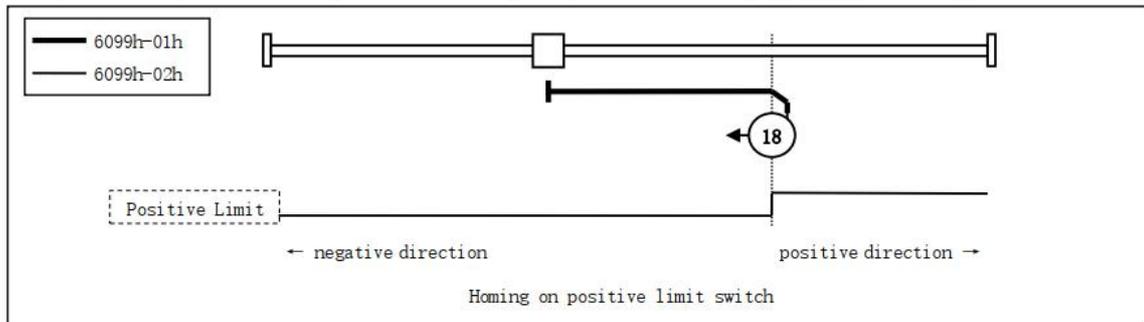
Method 5 & 6

- Method 17 requires negative limit switch, and method 18 requires positive limit switch.**
 The load is located on the right side of the negative limit switch, and the motor running in negative direction. When the motor reaching the negative limit signal for the first time, it will slow down and stop, then run in reverse, at last stops immediately when reaching the negative limit signal for the second time.



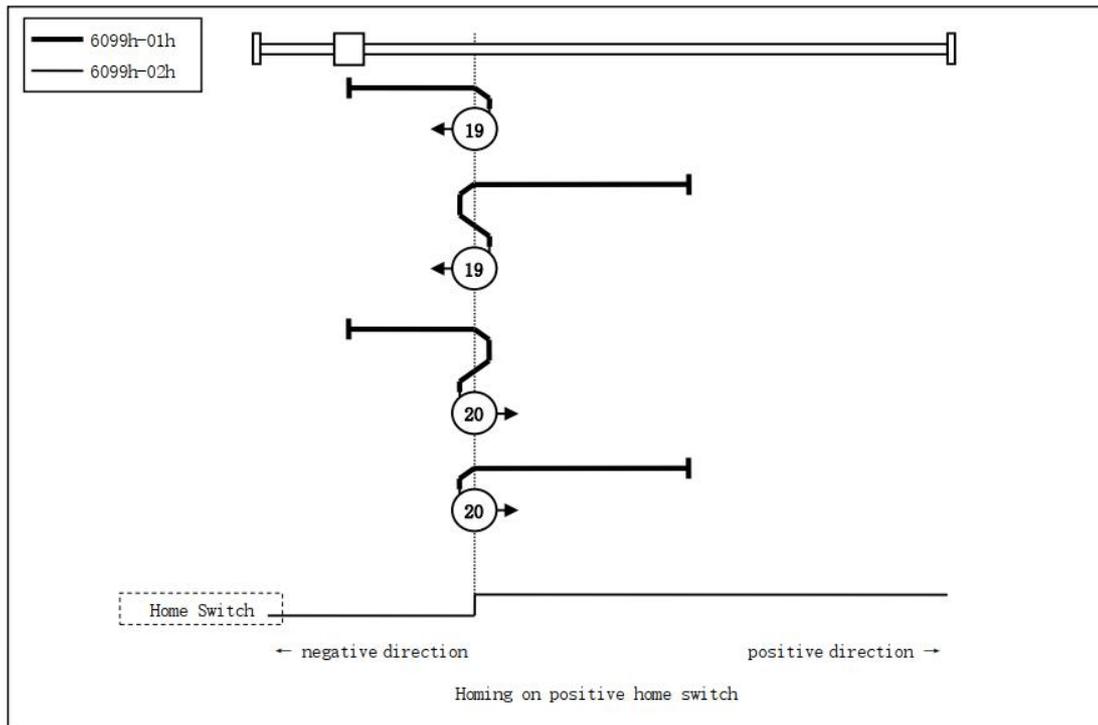
Method 17

- Method 18 requires positive limit switch.**
 The load is located on the left side of the positive limit switch, and the motor running in positive direction. When the motor reaching the positive limit signal for the first time, it will slow down and stop, then run in reverse, at last stops immediately when reaching the positive limit signal for the second time.



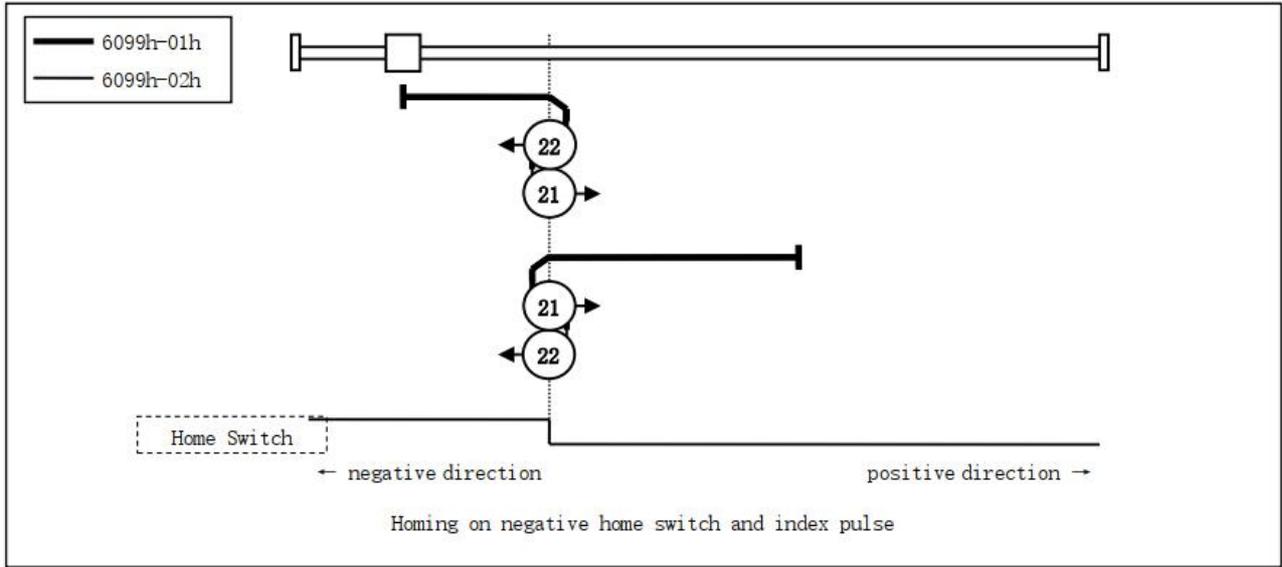
Method 18

- Method 19, 20, 21, 22 require home switch**



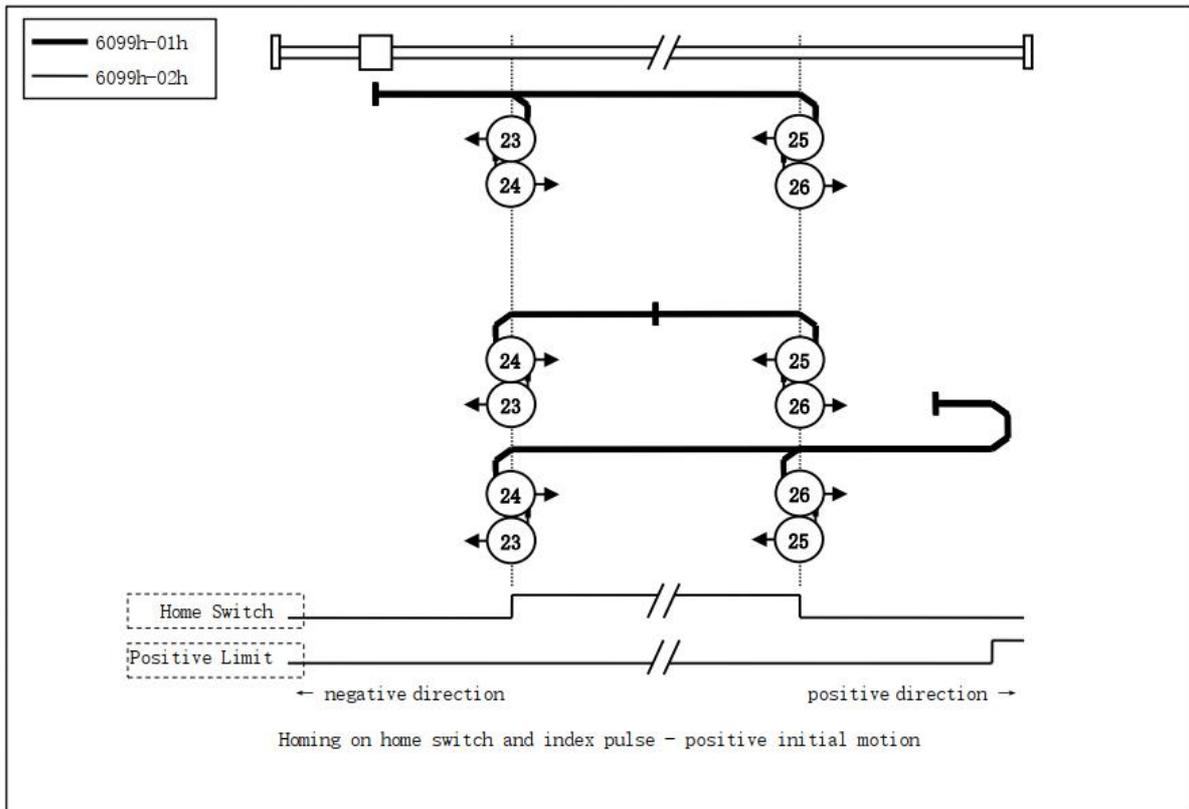
Method 19 & 20

- **Method 21 & 22 Description: The load is located on the home switch**



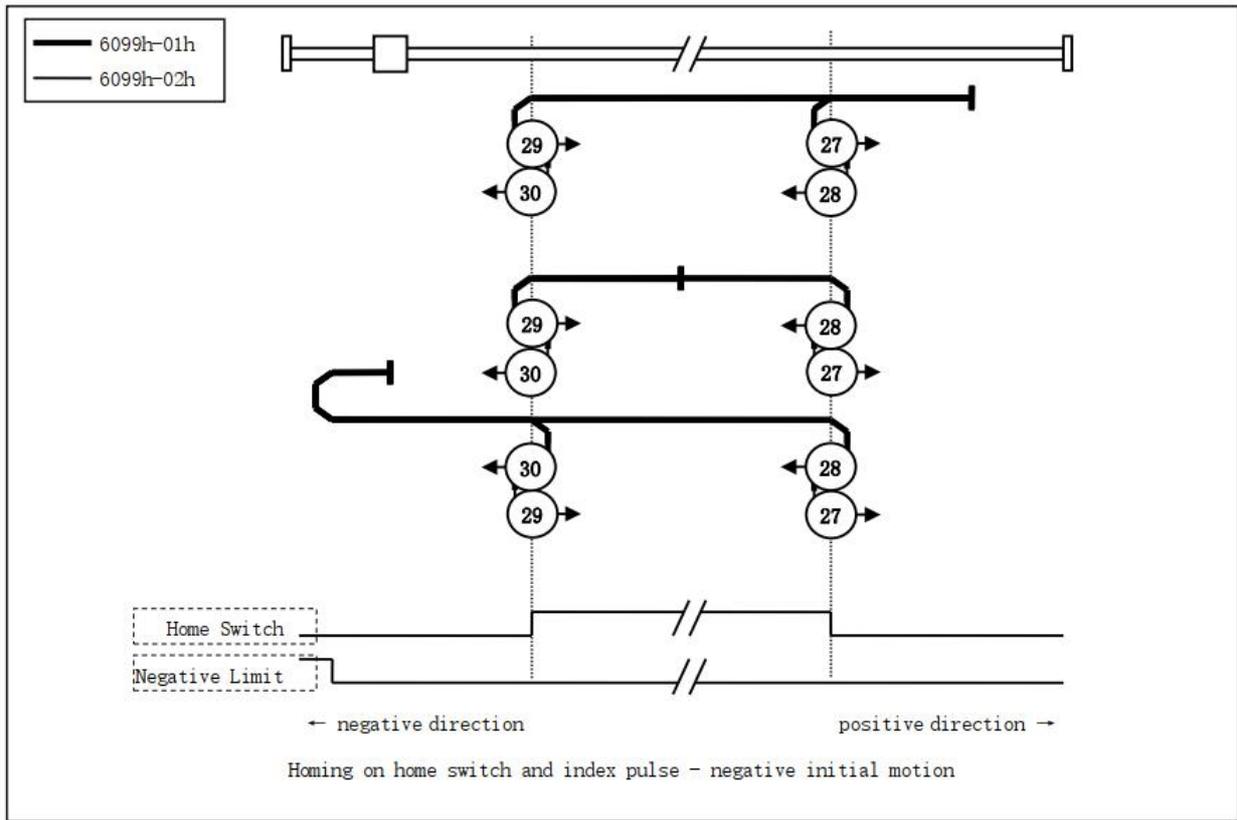
Method 21 & 22

- **Method 23, 24, 25, 26 require the home switch and positive limit switch.**



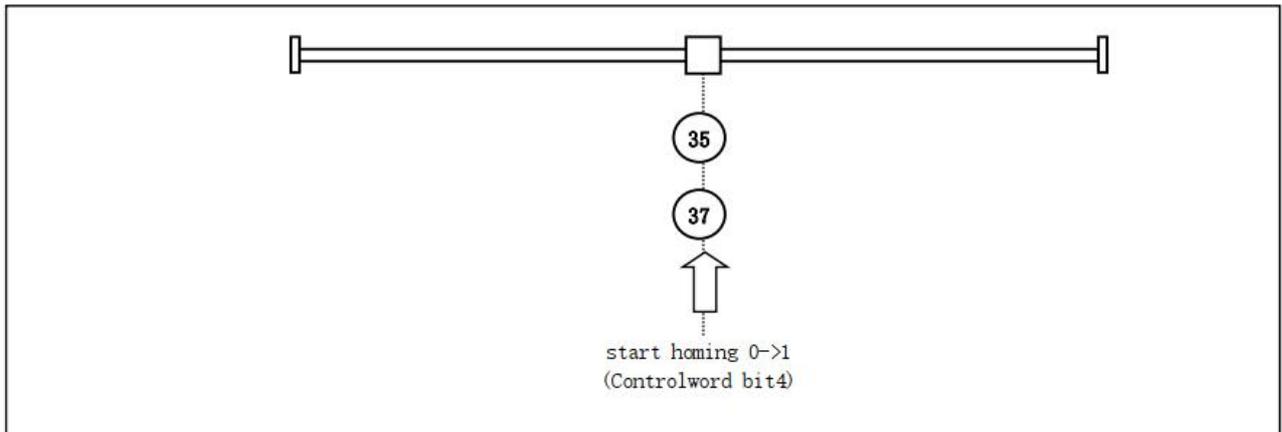
Method 23 & 24 & 25 & 26

- **Method 27, 28, 29, 30 require the home switch and negative limit switch.**



Method 27, 28, 29, 30

- Method 35 & 37 use the current position as the zero position, preferred method 37



Method 35 & 37

Appendix B: Object Dictionaries

| Index | Sub-index | Name | Access | Type | Range | Default Value | Unit | Remark |
|-------|---------------------|---|---------------------|---------|--------------------|---------------|------|---|
| 1000 | 0 | Device type | R | UINT | 0-32767 | 0x40912 | - | Refer to CIA 402 profile |
| 1001 | 0 | Error register | R | USINT | 0-255 | 0 | -- | Refer to Chapter 5.1 |
| 1008 | 0 | Device name | R | UINT | 0-32767 | CL3C-X | - | - |
| 1010 | 00 | Number of sub-index | R | UINT | 0-32767 | 4 | - | - |
| | 01 | Save all parameters | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | Need to write 0x65766173 or 1702257011 (decimal) into sub-index. It will return 1 if save successfully |
| | 02 | Save communication parameters | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | |
| | 03 | Save motion parameters | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | |
| | 04 | Save factory parameters | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | |
| 00 | Number of sub-index | R | UINT | 0-32767 | 4 | - | - | |
| 1011 | 01 | Restore all parameters to default setting | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | Need to write 0x64616f6c or 1684107116 (decimal) into sub-index. It will return 1 if save successfully |
| | 02 | Reset communication parameters to factory setting | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | |
| | 03 | Reset motion parameters to factory setting | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | |
| | 04 | Reset user parameters to factory setting | R/W | UDINT | 0-0xFFFFFFFF FF | 0 | - | |
| | 00 | Number of sub-index | R | UINT | 0-32767 | 4 | - | |
| 1018 | 01 | Vendor ID | R | UINT | 0-32767 | 4321 | - | Leadshine code |
| | 02 | Product code | R | UINT | 0-32767 | 8X00 | - | - |
| | 03 | Revision number | R | UINT | 0-32767 | 1 | - | - |
| | 04 | Series number | R | UINT | 0-32767 | 1 | - | - |
| | 1600 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 3 | - |
| 01-08 | | 1 st RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF FF | - | - | Default number of 1 st RXPDO-Map object |
| 1601 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 6 | - | Default number of 2 nd mapping object |

| | | | | | | | | |
|------|-------|----------------------------------|-------|-------|--------------|-------|-------|---|
| | 01-08 | 2 nd RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF | - | - | Default number of 2 nd RXPDO-Map object |
| 1602 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 5 | - | Default number of 3 rd mapping object |
| | 01-08 | 2 nd RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF | - | - | Default number of 3 rd RXPDO-Map object |
| 1603 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 7 | - | Default number of 4 th mapping object |
| | 01-08 | 3 rd RXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF | - | - | Default number of 4 th RXPDO-Map object |
| 1A00 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 7 | - | Default number of 1 st mapping object |
| | 01-08 | 1 st TXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF | - | - | Default number of 1 st TXPDO-Map object |
| 1A01 | 0 | Number of sub-index | R/W | UINT | 0-32767 | 0 | - | Default number of 2 nd mapping object |
| | 01-08 | 2 nd TXPDO-Map object | R/W | UDINT | 0-0xFFFFFFFF | - | - | Default number of 2 nd TXPDO-Map object |
| 1C00 | 0 | Number of sub-index | R | UINT | 0-32767 | 4 | - | - |
| | 01 | Output type of email | R | UINT | 0-32767 | 1 | - | - |
| | 02 | Input type of email | R | UINT | 0-32767 | 2 | - | - |
| | 03 | Output type of process data | R | UINT | 0-32767 | 3 | - | - |
| | 04 | Input type of process data | R | UINT | 0-32767 | 4 | - | - |
| 1C12 | 0-04 | RXPDO assign | R/W | UINT | 0-32767 | 1600 | - | - |
| 1C13 | 0-02 | TXPDO assign | R/W | UINT | 0-32767 | 1A00 | - | - |
| 1C32 | 0-0A | RXPDO administrative parameters | R | UINT | 0-32767 | - | - | - |
| 1C33 | 0-0A | TXPDO administrative parameters | R | UINT | 0-32767 | - | - | - |
| 2000 | 00 | Peak current | R/W/S | DINT | 1-100 | 60 | 0.1A | Drive's max output current. CS3E-D503E is 25 by default; CS3E-D507E is 60 by default. |
| 2001 | 00 | Microstep resolution | R/W/S | DINT | 200-51200 | 10000 | Pulse | Required number of pulse to rotate 1 revolution of motor. But it is recommended to modify via 6092+01 |

| | | | | | | | | |
|------|----|---|-------|------|-----------|------|--------|--|
| 2007 | 00 | Action when disabled | R/W/S | UINT | 0-1 | 0 | - | 0: Don't respond to commands, and the motor shaft is not locked; 1: Don't respond to commands, but the motor shaft is locked; |
| 2010 | 01 | Internal filtering time | R/W/S | UINT | 0-32767 | 100 | 0.1 ms | Internal smoothing time for control command. |
| 2012 | 00 | Soft-starting time | R/W/S | UINT | 10-3000 | 1 | ms | Internal smoothing time for starting current. |
| 2013 | 00 | Auto-tuning at power on | R/W/S | UINT | 0-2 | 1 | -- | 1: Yes. 0: No |
| 2019 | 01 | In-position pulse compensation | R/W/S | UINT | 0-1 | 1 | -- | 0: With compensation, the value of 6064 = 607A in position; 1: Without compensation |
| 2019 | 02 | In-position mode at disabled state | R/W/S | UINT | 0-1 | 0 | -- | 0: Not allowed in-position signal output when disabled; 1: Allowed in-position signal output when disabled; |
| 201A | 01 | Locking current percentage of power on | R/W/S | UINT | 0-100 | 100 | % | Usually keep the default value. |
| 201A | 02 | Closed loop holding current percentage | R/W/S | UINT | 0-100 | 50 | % | Multiply by the value of object 0x2000, the drive output current will change between these according to the load. |
| 201B | 00 | Locking duration time | R/W/S | UINT | 0-1500 | 200 | ms | Appropriately reduce this value if you want to shorten the time of locking shaft. |
| 201C | 00 | Max time to close brake | R/W/S | UINT | 100-10000 | 1000 | ms | Usually keep the default value |
| 201D | 00 | Zero speed point | R/W/S | UINT | 0-500 | 10 | 0.1r/s | - |
| 2024 | 00 | Control Mode | R/W/S | UINT | 0~10 | 2 | -- | 0: Open Loop Control; 2: Closed Loop Control |
| 2025 | 01 | Speed point for open loop switching closed loop | R/W/S | UINT | 0~200 | 18 | 0.1r/s | - |
| 2025 | 02 | Delay for open loop switching closed loop | R/W/S | UINT | 0~32767 | 12 | ms | - |
| 2025 | 03 | Speed point for closed loop switching open loop | R/W/S | UINT | 0~200 | 5 | 0.1r/s | - |
| 2025 | 04 | Delay for closed loop switching open loop | R/W/S | UINT | 0~32767 | 250 | ms | - |

| | | | | | | | | |
|------|----|--|-------|------|------------|-------|--------|---|
| 2025 | 05 | Feedback speed point for closed loop switching open loop | R/W/S | UINT | 0~200 | 50 | 0.1r/s | - |
| 2029 | 00 | Encoder resolution | R/W/S | UINT | 4000-20000 | 4000 | Count | 4 times the encoder resolution. But it is recommended to modify by 0x608F+01 |
| 2030 | 00 | Allowed max position following error pulses | R/W/S | UINT | 0~32767 | 4000 | Count | 4000 indicates the error of one turn |
| 2032 | 00 | Distance to send "In Position" output signal | R/W/S | UINT | 0-1000 | 4 | Pulse | - |
| 2033 | 00 | Delay of in-position error de-jitter | R/W/S | UINT | 0-1000 | 3 | ms | - |
| 2047 | 00 | Over voltage point | R | UINT | 0-1000 | 75 | V | - |
| 2048 | 00 | Bus-voltage | R | UINT | 0-65535 | - | V | - |
| 2051 | 00 | Motor running direction | R/W | DINT | 0-1 | 0 | -- | 0: CCW direction 1: CW direction But it is recommended to modify by 0x607E |
| 2056 | 00 | Alarm detection selection | R/W/S | DINT | 0~65535 | 65535 | -- | Bit setting: =1: Yes; =0: No Bit0: over-current (invalid) Bit1: over-voltage Bit2: Position following error Bit3: Encoder wiring error Bit4: over speed alarm |
| 2057 | 00 | Reset alarm | R/W/S | UINT | 0~65535 | 0 | -- | Write value 1 to clear the alarm. But it is recommended to write value 128(Decimal) to 0x6040 |
| 2090 | 01 | Current loop Kp | R/W | DINT | 0~32767 | 1500 | -- | -- |
| | 02 | Current loop Ki | R/W | DINT | 0~32767 | 300 | -- | -- |
| | 03 | Current loop Kc | R/W | DINT | 0~32767 | 300 | -- | -- |
| 2091 | 01 | Speed Loop Kp | R/W | UINT | 0~10000 | 25 | - | |
| | 02 | Speed Loop Ki | R/W | UINT | 0~10000 | 3 | - | |
| 2092 | 01 | Position Loop Kp | R/W | UINT | 0~100 | 25 | - | |
| 2150 | 00 | Slave ID | R/W/S | UINT | 0-256 | 1 | -- | Valid when 0x2151= 1; |
| 2151 | 00 | Slave ID resource | R/W/S | UINT | 0-10 | 0 | -- | 0: DIP switches 1: Setting by 0x2150 2: ESC |
| 2232 | 00 | Synchronous compensation1 | R/W | DINT | 0—65535 | 2 | -- | -- |
| 2233 | 00 | Synchronous compensation2 | R/W | DINT | 0—65535 | 100 | -- | -- |

| | | | | | | | | |
|------|-------|---------------------------|-------|-------|---------|-----|--------|--|
| 225C | 00 | Special function register | R/W | DINT | 0~32767 | 0 | -- | Bit1=1: Set motor running direction by 0x607E Bit2=1: Set virtual input by 0x5012-03 |
| 22A9 | 00 | Limit Mode | R/W | DINT | 0-10 | 0 | -- | 0: Stop normally 1: Invalid 2: Alarm, error code 260 |
| 22B4 | 00 | Quick stop selection | R/W | DINT | 0~32767 | 0 | -- | 0: Alarm, error code 570, 1: Refer to 0x605A |
| 22C2 | 01 | JOG acceleration | R/W | UINT | 0~32767 | 200 | | |
| | 02 | JOG speed | R/W | UINT | 0~32767 | 60 | | |
| | 03 | JOG distance | R/W | UINT | 0~32767 | 0 | | |
| | 04 | JOG cycles | R/W | UINT | 0~32767 | 1 | | |
| | 05 | JOG direction | R/W | UINT | 0~32767 | 0 | | |
| | 06 | JOG preparation time | R/W | UINT | 0~32767 | 100 | ms | |
| 3100 | 01 | Control software version | R | UINT | | | -- | |
| | 02 | Firmware version | R | UINT | | | -- | |
| | 03 | EtherCAT protocol version | R | UINT | | | -- | |
| 3FFE | 01-0E | Alarm record | R | USINT | 0~32767 | -- | -- | 0x3FFE+01 is the current error code (current alarm) or the most recent error code (currently no alarm); 0x3FFE+02-0E are followed by the historical error code. |
| 4003 | 01 | Delay of closing brake | R/W/S | UINT | 0-1500 | 250 | ms | |
| 4003 | 02 | Delay of loosening brake | R/W/S | UINT | 0-1500 | 250 | ms | |
| 4003 | 03 | Max speed to close brake | R/W/S | UINT | 0-500 | 10 | 0.1r/s | |
| 5000 | 01 | Trajectory generator | R | UINT | 0~32767 | 1 | -- | Internal protocol stack parameters |
| | 02 | Motion state machine | R | UINT | 0~32767 | 0 | -- | 0: Disabled 0x9A9A: Enabled |
| | 03 | Internal enable state | R | UINT | 0~32767 | 0 | -- | 0: Disabled 1: Enabled |
| | 04 | Reach the target state | R | UINT | 0~32767 | -- | -- | Bit0=0: Not reach Bit0=1: Reach Bit1=0: No stall Bit1=1: Stalled |
| 5002 | 01 | ESC ID | R/W | UINT | 0~32767 | 0 | -- | Write 0, return the ID data in ESC to 0x5002-02 ; Write 0x12, return the current ID setting by DIP switches |
| | 02 | ESC data | R | UINT | 0~32767 | 408 | -- | Return ID data |

| 5004 | 01-0E | Sync0 Synchronization interface parameters | R | UINT | 0~32767 | -- | -- | -- | | | | | | | | | | | |
|-------------------------|-------------|--|-----|-------|---------|-----|----|--|--------|-------------|----------------|----------|-------------|---------|----------------|---------|----------------|---------|-------------------------|
| | 0F | Sync0 Synchronization interface parameters | R/W | UINT | 0~32767 | -- | -- | Bit0 =1: RPDO mapping can't be written by SDO; Bit0 =0: RPDO mapping can be written by SDO; Bit1=1: Detect the number of PDO mapping; Bit1=1: Don't detect the number of PDO mapping; Bit2=1: Send 0xF directly to enable; Bit2=0: Send 0xF can't be enabled. | | | | | | | | | | | |
| 5005 | 00 | DC compensation base value | R/W | UINT | 0~32767 | 500 | -- | -- | | | | | | | | | | | |
| 5006 | 00 | Synchronization error detection | R/W | UINT | 0~32767 | 0 | -- | -- | | | | | | | | | | | |
| 5010 | 00 | Effective input and output watchdog time | R/W | UINT | 0~32767 | 0 | -- | -- | | | | | | | | | | | |
| 5011 | 00 | Internal actual location | R | UDINT | 0~32767 | -- | -- | -- | | | | | | | | | | | |
| 5012 | 01 | Homing arrival position | R/W | DINT | 0~32767 | 0 | -- | -- | | | | | | | | | | | |
| | 02 | Homing trigger position | R/W | DINT | 0~32767 | 0 | -- | -- | | | | | | | | | | | |
| | 03 | Homing virtual input | R/W | UDINT | 0~32767 | 0 | -- | <p>When 0x225C=4, activate the virtual input function; 60FD different bits, corresponding to different virtual inputs;</p> <table border="1"> <thead> <tr> <th>Inputs</th> <th>Bit of 60FD</th> </tr> </thead> <tbody> <tr> <td>Probe signal 1</td> <td>Bit 26=1</td> </tr> <tr> <td>Home switch</td> <td>Bit 2=1</td> </tr> <tr> <td>Positive limit</td> <td>Bit 1=1</td> </tr> <tr> <td>Negative limit</td> <td>Bit 0=1</td> </tr> <tr> <td>Z signal (index signal)</td> <td>Bit 31=1</td> </tr> </tbody> </table> <p>For example: 0x225C=4 and start homing, set 0x5012-03=4, Home switch input; set 0x5012-03=2, Positive limit input; set 0x5012-03=2, Negative limit input</p> | Inputs | Bit of 60FD | Probe signal 1 | Bit 26=1 | Home switch | Bit 2=1 | Positive limit | Bit 1=1 | Negative limit | Bit 0=1 | Z signal (index signal) |
| Inputs | Bit of 60FD | | | | | | | | | | | | | | | | | | |
| Probe signal 1 | Bit 26=1 | | | | | | | | | | | | | | | | | | |
| Home switch | Bit 2=1 | | | | | | | | | | | | | | | | | | |
| Positive limit | Bit 1=1 | | | | | | | | | | | | | | | | | | |
| Negative limit | Bit 0=1 | | | | | | | | | | | | | | | | | | |
| Z signal (index signal) | Bit 31=1 | | | | | | | | | | | | | | | | | | |

| | | | | | | | | |
|------|----|--------------------------------|-------|------|-----------|----------------------|----|---|
| | 04 | Homing setting | R/W | UINT | 0~32767 | 5 | -- | <p>Bit0=0: Homing protection is not turned on; Bit0=1: Homing protection is turned on; (Homing protection: when start homing, If the limit signal takes effect, bit0=0 means homing normally, bit0=1 means stop homing as limit protection)</p> <p>Bit2=0: The value of current position after in position = 0x607C; Bit2=1: The value of 0x607C is used as the motion offset, and finally 0x6064 = 0; Bit3=0: 0x6064= 0x607C after in position; Bit3=1: 0x6064 = 0x607C after in position;</p> |
| 5015 | 05 | Protocol setting | R/W | UINT | 0~32767 | 255 | -- | <p>Bit8 is used to select whether the speed arrival in PV mode comes from bit0 of 0x5000-04 or bit8 of 0x5000-04.</p> |
| 5400 | 01 | Minimum synchronization period | R/W | UINT | 250~2000 | 250 | us | -- |
| | 02 | Maximum synchronization period | R/W | UINT | 250~20000 | 10000 | us | -- |
| 5503 | 04 | Special function register | R/W | UINT | 0~65535 | 2 | -- | <p>Bit0 = 0: Asynchronous mode, the host will track 0x607A-00 in real time; Bit0=1: Asynchronous mode, the host does not track 0x607A-00in real time.</p> |
| 2152 | 01 | Input1 function | R/W/S | DINT | 0-65535 | 0x17 (Decimal 23) | -- | Default is touch probe1, take effect changes need restart power |
| | 02 | Input2 function | R/W/S | DINT | 0-65535 | 0x18 (Decimal 24) | -- | Default is touch probe2, take effect changes need restart power |
| | 03 | Input3 function | R/W/S | DINT | 0-65535 | 0x16 (Decimal 22) | -- | Default is Home switch, take effect changes need restart power |
| | 04 | Input4 function | R/W/S | DINT | 0-65535 | 0x01 (Decimal 1) | -- | Default is positive limit, take effect changes need restart power |
| | 05 | Input5 function | R/W/S | DINT | 0-65535 | 0x02 (Decimal 2) | -- | Default is negative limit, take effect changes need restart power |
| | 06 | Input6 function | R/W/S | DINT | 0-65535 | 0x19 (Decimal 25) | -- | Default is user defined, take effect changes need restart power |
| 2155 | 00 | Digital I/O status | R | DINT | 0-65535 | 0 | -- | Upper 8 bits indicate the status |

| | | | | | | | | |
|------|----|----------------------------------|-------|-------|------------|------|------|--|
| | | | | | | | | of digital outputs |
| 2156 | 01 | Output1 function | R/W/S | DINT | 0-65535 | 0x01 | -- | Default is alarm output, take effect changes need restart power |
| | 02 | Output2 function | R/W/S | DINT | 0-65535 | 0x03 | -- | Default is brake output, take effect changes need restart power |
| 603F | 00 | Error code | R | UINT | 0-65535 | 0 | -- | Refer to chapter 5.2 |
| 6040 | 00 | Control word | R/W | UINT | 0-65535 | 0 | -- | Refer to chapter 6.1 |
| 6041 | 00 | Status word | R | UINT | 0-65535 | 0 | -- | Refer to chapter 6.1 |
| 605A | 00 | Quick stop type selection | R/W | UINT | 0-65535 | 6 | -- | 0: After stopping immediately, switch on disable state; 1: After decelerating to stops at a speed value of 0x6084, switch on disable state; 2: After decelerating to stops at a speed value of 0x6085, switch on disable state; 3: After decelerating to stops at a speed value of 0x60C6, switch on disable stat; 4: After stopping immediately, switch on quick stop state; 5: After decelerating to stops at a speed value of 0x6084, switch on quick stop state; 6: After decelerating to stops at a speed value of 0x6085, switch on quick stop state; 7: After decelerating to stops at a speed value of 0x60C6, switch on quick stop stat; |
| 605D | 00 | Asynchronous mode halt selection | R/W | INT | 0~65535 | 1 | -- | 1: After decelerating to stops at a speed value of 0x6084, keep operation enable state; 2: After decelerating to stops at a speed value of 0x6085, keep operation enable state; 3: After decelerating to stops at a speed value of 0x60C6, keep operation enable state; 4: After stopping immediately, keep operation enable state. |
| 6060 | 00 | Operation mode | R/W | USINT | 0-255 | 8 | -- | 1: PP mode, 3: PV mode, 6: Home mode, 8: CSP mode |
| 6061 | 00 | Operation mode display | R | USINT | 0-255 | 8 | -- | - |
| 6062 | 00 | Position | R | DINT | -214748364 | 0 | Puls | - |

| | | | | | | | | |
|------|----|--|-------|-------|------------------------------------|------|-------|--|
| | | command | | | 8 ~214748364 7 | | e | |
| 6064 | 00 | Position actual value | R | DINT | -214748364 8 ~214748364 7 | 0 | Pulse | - |
| 6067 | 00 | Distance to send "In Position" output signal | R/W/S | UINT | 0-1000 | 4 | Pulse | It is recommended to use this object in preference, Can also set by 0x2032, |
| 606B | 00 | Velocity command | R | DINT | -214748364 8 ~214748364 7 | 0 | P/s | - |
| 606C | 00 | Velocity actual value | R | DINT | -214748364 8 -214748364 7 | 0 | P/S | - |
| 607A | 00 | Target position | R/W | DINT | -214748364 8 ~214748364 7 | 0 | P | Target position under PP mode |
| 607C | 01 | Home offset | R/W | DINT | -214748364 8 ~214748364 7 | 0 | P | The value of difference between zero position and mechanical zero point under Homing mode . If the value is set to10000, it means that at homing mode 19, the motor reaches the Home switch and stops immediately, then reverses at low speed until it leaves the Home switch, at last stops at a distance of 10000P. |
| 607D | 01 | Software negative limit | R/W | DINT | -214748364 8 ~214748364 7 | 0 | P | New target positions are checked against these limits. The limits are relative to the machine home position, which is the result of homing. As default the software position limits are switched off. Changed values must be saved and the drive must be restarted to take enable the new the software limits. |
| 607D | 02 | Software positive limit | R/W | DINT | -214748364 8 ~214748364 7 | 0 | P | |
| 607E | 00 | Motor direction | R/W | USINT | 0~255 | 0 | -- | Need to set 0x225C first |
| 60FF | 00 | Target velocity | R/W | DINT | -214748364 8 ~214748364 7 | 0 | P/S | Profile velocity under PV mode |
| 6080 | 00 | Max limit velocity | R/W/S | UDINT | -214748364 8 ~214748364 7 | 3000 | rpm | - |

| | | | | | | | | |
|------|----|--------------------------|-------|-------|----------------------------|----------|-------|---|
| 6081 | 00 | Max profile velocity | R/W/S | DINT | -2147483648 ~2147483647 | 50000 | -- | Max. Allowable velocity under PP mode |
| 6082 | 00 | Start velocity | R/W/S | DINT | -2147483648 ~2147483647 | 0 | -- | Start velocity under PP mode |
| 6083 | 00 | Profile acceleration | R/W/S | DINT | -2147483648 ~2147483647 | 4000 | P/S^2 | Acceleration under PP and PV mode |
| 6084 | 00 | Profile deceleration | R/W/S | DINT | -2147483648 ~2147483647 | 4000 | P/S^2 | Deceleration under PP and PV mode |
| 6085 | 00 | Quick stop deceleration | R/W/S | DINT | -2147483648 ~2147483647 | 40000000 | P/S^2 | Deceleration of quick stop under PP, PV and Home mode |
| 608F | 01 | Encoder resolution | R/W/S | UINT | 4000-20000 | 4000 | Count | It is recommended to use this object in preference, can also set by 0x2029, |
| 6092 | 01 | Microstep resolution | R/W/S | DINT | 200-51200 | 10000 | Pulse | It is recommended to use this object in preference, can also be modified via 0x2001, |
| 6098 | 00 | Homing method | R/W/S | USINT | 1-100 | 19 | - | Methods of searching zero position under homing mode, refer to Appendix A |
| 6099 | 01 | Fast homing velocity | R/W/S | DINT | -2147483648 ~2147483647 | 50000 | P/S | Speed during search for limit switch signal |
| 6099 | 02 | Slow homing velocity | R/W/S | DINT | -2147483648 ~2147483647 | 25000 | P/S | Speed during search for Home switch |
| 607C | 00 | Home offset | R/W/S | DINT | -2147483648 ~2147483647 | 0 | P | The value of difference between zero position and mechanical zero point under Homing mode |
| 609A | 00 | Homing acceleration | R/W/S | USINT | -2147483648 ~2147483647 | 25000 | P/S^2 | Acc / Dec velocity under Home mode |
| 60B0 | 00 | Position offset | R/W | DINT | -2147483648 ~2147483647 | 0 | P | Position offset under PP mode |
| 60B8 | 00 | Touch probe control word | R/W | UINT | 0-65535 | 0 | - | Set touch probe function, refer to chapter 6.3 |

| | | | | | | | | |
|------|----|------------------------------------|-------|-------|----------------------------|-----|----|---|
| 60B9 | 00 | Touch probe statue word | R | UINT | 0-65535 | 0 | - | Status of touch probe 1/2, refer to chapter 6.3 |
| 60BA | 00 | Touch probe 1 positive value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 1 at rising edge |
| 60BB | 01 | Touch probe 1 negative value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 1 at falling edge |
| 60BC | 02 | Touch probe 2 positive value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 2 at rising edge |
| 60BD | 00 | Touch probe 2 negative value | R | DINT | -2147483648 ~2147483647 | 0 | P | Data value sensed by touch probe 2 at falling edge |
| 60C2 | 01 | Interpolation time period value | R/W | USINT | 0-255 | 2 | -- | Only for internal tuning. |
| 60C2 | 02 | Interpolation time unit | R/W | SINT | -128-127 | 0 | -- | |
| 60D5 | 00 | Touch probe 1 rising edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 1 rising edge |
| 60D6 | 00 | Touch probe 1 falling edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 1 falling edge |
| 60D7 | 01 | Touch probe 2 rising edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 2 rising edge |
| 60D8 | 02 | Touch probe 2 falling edge counter | R | UINT | 0-65535 | 0 | -- | Frequency for capture of touch probe 2 falling edge |
| 60FD | 00 | Digital input statue | R | UDINT | 0-4294967296 | 0 | -- | Statue of digital input signals, refer to chapter 4.3.1 |
| 60FE | 01 | Open physical output | R/W/S | UDINT | 0-4294967296 | 0 | -- | Able to control user output through this object, refer to chapter 4.3.4 |
| | 02 | Enable physical output | R/W/S | UDINT | 0-4294967296 | 0 | -- | |
| 6502 | 00 | Supported operation mode | R | UDINT | 0-4294967296 | 165 | -- | Operation modes the drive supported |

Appendix C: Connectors

| Pic | Description | Brand&Specification | Model | Number | Package Inside |
|---|-------------------|--------------------------------|-----------------------------|--------|----------------|
|  | Motor Connector | MOLEX 4PIN, 13A | 39012040 | 1 | No |
|  | | MOLEX | 39000038 | 4 | No |
|  | Encoder Connector | MOLEX | 513531200 | 1 | No |
|  | | MOLEX | 561349000 | 8 | No |
|  | I/O Connector | ANYTEK 2*5PIN, 3.5mm | NL10100200G0G | 1 | Yes |
|  | Power Connector | DEGSON 2PIN, 5.0mm | 2EDGK-5.0-02P-13-100 0AH | 1 | Yes |

Note: For CS3E Series drives, motor connector and encoder connector are on the extension cable

Appendix D: FAQ

● Communicate errors.

- ▶ If it is the first time to use this EtherCAT drive, check whether the version of XML file is correct. Most masters support scanning slave, it is recommended to create configuration in scanning way.
- ▶ Some masters require the connection of the network cable according to the ECAT IN and ECAT OUT.
- ▶ Check whether the PDO synchronization period set by master and slave is the same.
- ▶ The PDO synchronization period (Ethercat communication period) not supported by CS3E-E, such as 1.1ms, 0.9ms, etc. The common PDO synchronization period is 250us/500us/ 1ms/2ms/4ms, etc.
- ▶ Some masters require DIP switches to be set to the same node ID as the configuration setting.
- ▶ The network cable is faulty or has poor contact, replace the cable. Or check the problem by swapping it with the network cable on a normally connected node.
- ▶ The EtherCAT drive is faulty, replace the cable. Or check the problem by swapping it with a normally worked drive.

● Drive cannot be enabled

- ▶ Check the status of the drive. Under normal conditions, the PWR green light of the driver is on for a long time and the ALM red light is off. the L/A green light of the ECAT IN and ECAT OUT network ports blinks rapidly, the run green light is on for a long time and the Err red light is off.
- ▶ PDO configuration or PDO mapping error. It needs to configure PDO or PDO mapping correctly.
- ▶ Check if the value of object 0x6040 is 16#F and if bit0~bit3 of object 0x6041 is 0111.
- ▶ Check the master for warnings or errors. Clear the master station alarm or warning.
- ▶ If the master station shows enable complete, but the motor is not enabled. Check whether the motor wire is connected wrongly or disconnected. Or check if the output current of drive is set correctly.

● Alarm when send instruction to slave

- ▶ Check the drive for alarms. Check if the drive ALM red light and ERR red light are flashing, if there is an alarm, check the drive instruction manual and locate the problem according to the alarm instructions.
- ▶ The operation mode is not correct. Check if object 0x6060 is 8 (CSP mode).
- ▶ PDO configuration exception. Some masters need to check if the slave's object 0x6061 returns the correct value. If 0x6061 is not configured, the slave may not work or the master may alarm.
- ▶ The limit switch is activated. Check that the limit switch input is the same as the logic set by the master. Is the polarity of the slave input port the same as the limit switch used. The limit switch is not damaged. Whether the wiring between the limit switch and the slave is correct. The bit bit of object 0x60FD is mapped incorrectly with the master.

● Motor does not turn

- ▶ The controller instruction is not sent to the driver. Check if the value of 0x607A (Target position) has changed, if not, then maybe the program has an exception.
- ▶ Limit switch is activated. Check if the limit switch logic status is consistent with the set by the master. Or whether the polarity of the slave input port is consistent with the limit switch. Or whether the limit switch is damaged. Or whether the wiring between the limit switch and the slave is correct. Or the mapping between the bit of 0x60FD and the master is wrong.
- ▶ The control instruction is normal, but the motor does not turn. It may be that the output current setting is too small. Or the load is too heavy. Or the starting speed is too large. Or the acceleration time is too short. Or the motor is damaged. All of the above can be tested by letting the motor unload and setting the motor speed to 60rpm with acceleration time 200ms to check the problem.

- **Homing Error**

- ▶ Wrong homing method. There are three modes of homing, when using the master homing mode, the operation mode object $0x6060 = 8$; when using the slave homing mode, the $0x6060 = 6$; when using the master-slave combination homing method, the $0x6060$ value is first 8 and then 6. Please check master manufacturer for default homing mode, and then check the selected homing method, the relevant parameters are correct, and the limit switch needed in the selected homing method is normal.

- ▶ Stop on the limit switch and keep processing Busy state. Some master stations are master-slave combination homing mode (Panasonic and Keyence), the $0x6060$ value is first 8 and then 6. If there is no configuration $0x6060$ in PDO or wrong configuration, then will cause homing error.

- **Occasional dropouts during operation**

- ▶ Always a certain drive dropouts. Maybe network cable problem: Poor contact between network cable and drive interface. Or the OUT port of the last drive has a problem. Or the drive itself has problem. All of the above can be tested by swapping the drive or swapping the network cable.

- ▶ Random drive dropouts. Interference problem: Poor quality of network cable, it is recommended to use a Category 5 Fast Ethernet cable or above, industrial grade network cable with twisted pair shielding. Ensure that the equipment is well grounded. When laying out the electrical cabinet, strong and weak power need to be separated. Keep away from high power strong interference devices such as plasma generators, laser generators, VFD etc.