

Y2SS3-ECX

User Manual of EtherCAT Bus Stepper Driver



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<http://www.kaifull.net/>

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1. Foreword

1.1 Overview

The Y2SS3-ECX closed-loop bus stepper driver perfectly integrates closed-loop control technology into the stepper motor to greatly expand the functions of EtherCAT, with new excellent performance and a wide range of applications. Y2SS3-ECX is a high-performance bus controlled closed-loop stepper motor driver. Equipped with the EtherCAT communication protocol, the driver can serve as a standard EtherCAT slave and support CANopen over EtherCAT (CoE); it can also be used with various closed-loop stepper motors with different sizes.

EtherCAT® is a registered trademark and patented technology authorized by Beckhoff Automation Co., Ltd.

1.2 Technical Specifications

Input power voltage	24~48VDC
Output current	0.1~7A (peak)
Matching motor	20~86 closed-loop stepper motor
Digital input signal	Optoelectronic isolation, differential, 5-24VDC high-level logic Home position signal, positive limit, negative limit, emergency stop, probe
Digital output signal	Optoelectronic isolation, open collector, maximum 24V/100mA Brake output, alarm output, in-place output
Encoder input signal	5V differential, incremental encoder phase A/B/Z signal
Communication interface	EtherCAT (RJ45 connector) and Type-C (for configuring parameters)
Supported protocol	CoE (CiA 402 Protocol)
Operation mode	Profile Position, Profile Velocity, Cyclic Synchronous Position, Cyclic Synchronous Velocity, Homing mode
Electrical protection	Overvoltage protection, undervoltage protection, overtemperature protection, overcurrent protection, motor line open circuit detection, motor overload detection, etc.
Status indication	1 red LED light and 1 green LED light
Mass	0.293Kg

2. Preparation

2.1 Power Supply Selection

The supply voltage of the driver shall work normally within the specified range. To make the motor provide better high-speed performance, the supply voltage of the driver needs to be increased.

The supply current is generally determined based on the output phase current of the driver. Normally, the supply current of the driver can be 1.1 to 1.3 times the output current of the driver.

Meanwhile, the magnitude of the input current of the power supply is also related to the speed and load of the motor during operation. Therefore, for specific application scenarios, users need to make specific analysis and estimation.

2.2 Motor Selection

Y2SS3-ECX can output a maximum current of 7A and is suitable for two-phase DC stepper motors with flange sizes of 86 and below. Y2SS3-ECX has an integrated open and closed loop characteristic, and both open-loop and closed-loop stepper motors are compatible.

The selection of stepper motors must be determined based on the calculation according to the load of relevant mechanisms. You can contact Kaifull's hotline (400-960-1069) to inquire about the specific method of motor selection!

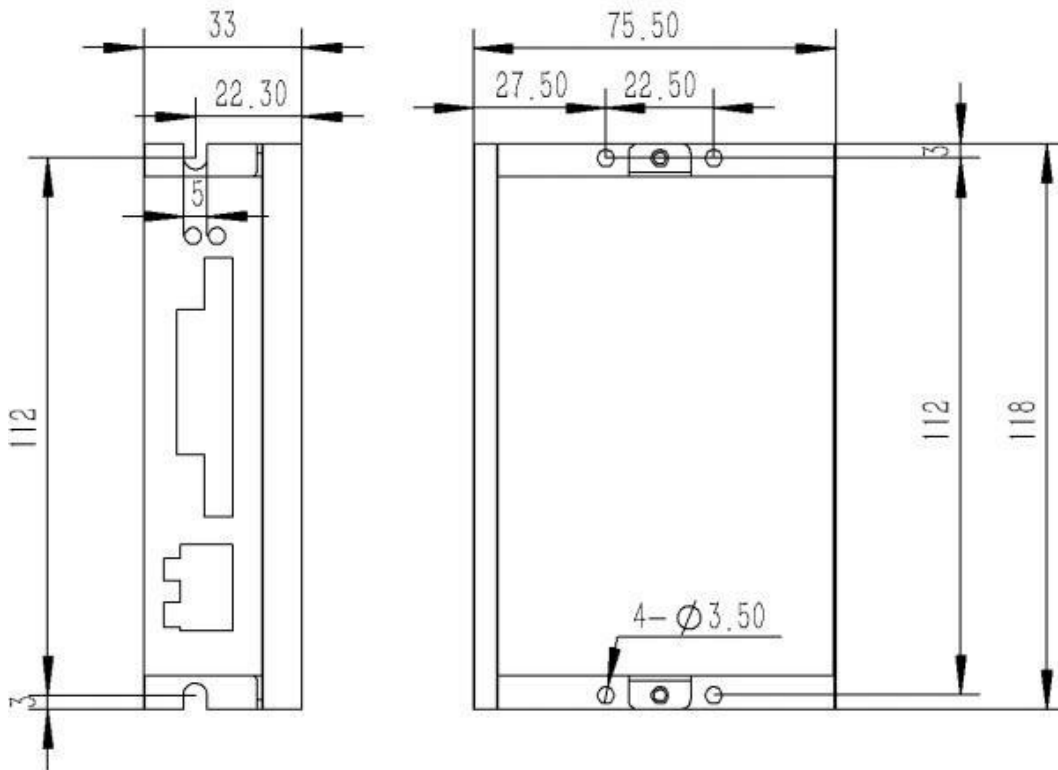
3. Installation

3.1 Service environment

Scenario	Avoid the sites with dust, oil mist, corrosive gases, high humidity, and strong vibration. Keep away from combustible gases and conductive dust, and maintain natural or forced air cooling;
Ambient temperature	0~50°C
Ambient humidity	40~90%RH
Vibration	10~55Hz/0.15m
Storage temperature	-20°C~65°C

3.2 Mechanical Dimensions

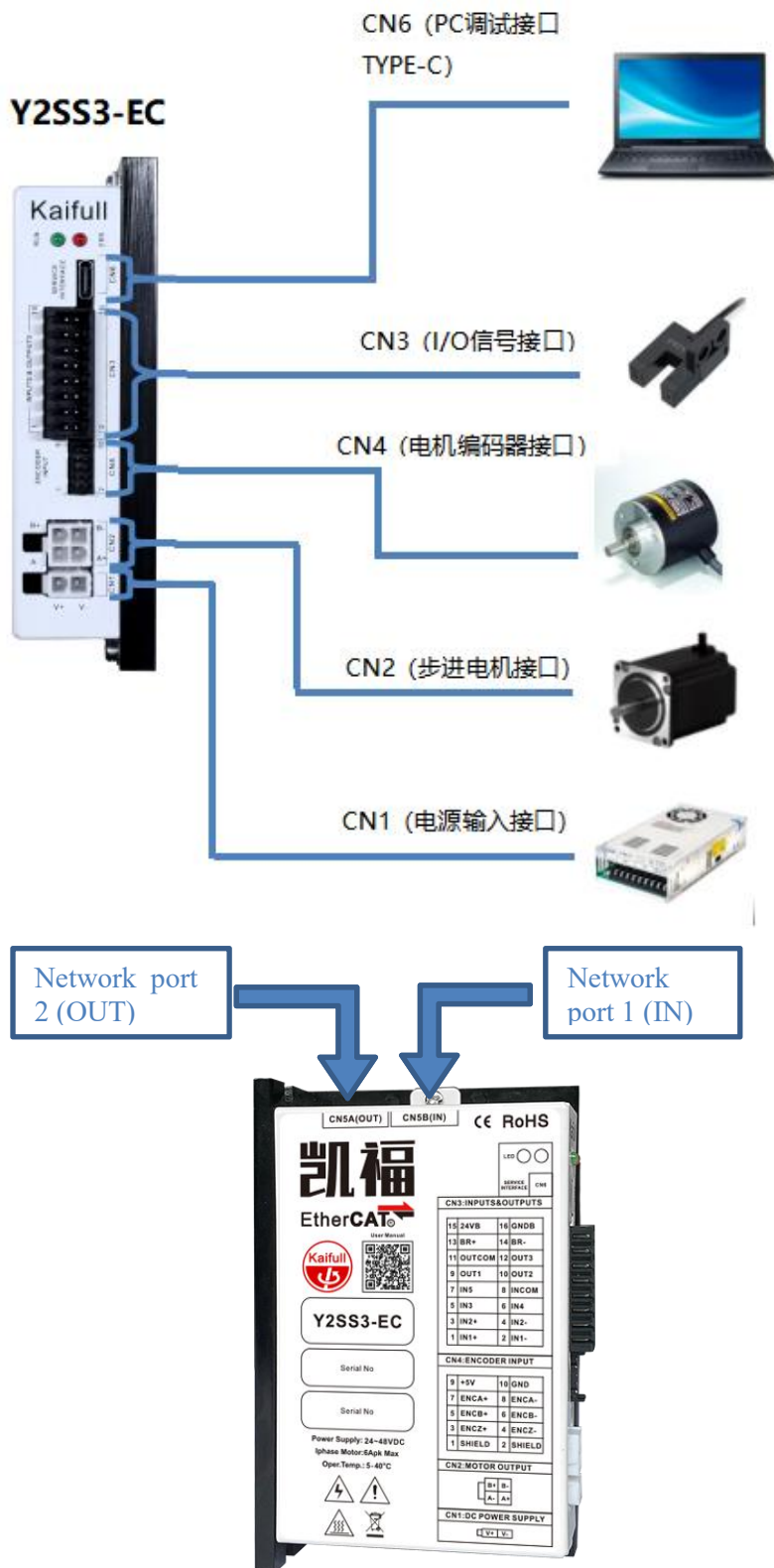
尺寸: 118 × 75.5 × 33 mm



*It is recommended to install vertically on the side to create strong air convection through the heat dissipation teeth. If necessary, install a fan near the driver to force heat dissipation and ensure that the driver operates within a reliable temperature range.

4. Connection

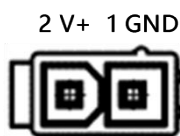
4.1 Instructions for Driver Connection



4.2 Definitions of Driver Interfaces

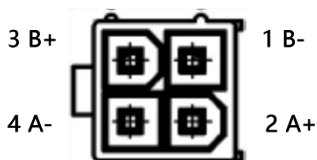
CN1：供电电源输入

CN1.1	GND
CN1.2	V+ (24~48V)



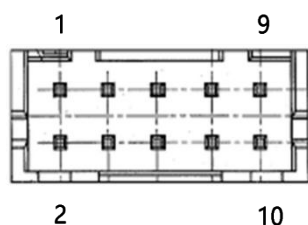
CN2：马达连接

CN2.1	马达线 B-
CN2.2	马达线 A+
CN2.3	马达线 B+
CN2.4	马达线 A-



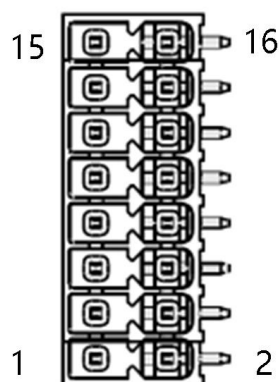
CN4：编码器输入连接

CN4.1	电缆屏蔽线
CN4.2	电缆屏蔽线
CN4.3	编码器输入Z+
CN4.4	编码器输入Z-
CN4.5	编码器输入B+
CN4.6	编码器输入B-
CN4.7	编码器输入A+
CN4.8	编码器输入A-
CN4.9	+5V 输出
CN4.10	GND



CN3：数字输入/输出

CN3.1	IN1+	数字输入1 正极
CN3.2	IN1-	数字输入1 负极 (探针1)
CN3.3	IN2+	数字输入2 正极 (接+24V)
CN3.4	IN2-	数字输入2 负极 (原点信号)
CN3.5	IN3	数字输入3 (正限位信号)
CN3.6	IN4	数字输入4 (负限位信号)
CN3.7	IN5	数字输入5
CN3.8	IN COM	数字输入3/4/5 公共端 (接+24V)
CN3.9	OUT1	数字输出1
CN3.10	OUT2	数字输出2
CN3.11	OUT COM	数字输出1/2/3 公共端
CN3.12	OUT3	数字输出3
CN3.13	BR+	断电刹车+
CN3.14	BR-	断电刹车-
CN3.15	24VB	断电刹车供电+24V
CN3.16	GNDB	断电刹车供电0V



CN6：PC调试接口

使用USB TYPE-C连接线连接电脑调试软件



Type-C

4.3 Input port connection

- IN1: Differential, NPN, PNP; can directly receive 5-24VDC at high level; default to probe 1 function input
- IN2: Differential, NPN, PNP; can directly receive 5-24VDC at high level; default to home position signal input
- IN3, IN4, IN5: PNP, NPN, single end; can directly receive 5-24VDC at the high level. The default IN3 is the positive limit signal input, and IN4 is the negative limit signal input
- IN1-IN5 can be used as general inputs, and the input port functions can be configured using the KF Step Drive Configuration debugging software, such as positive and negative limits, home position, enabling and alarm clearing, etc. IN1 and IN2 can be used as input ports for probes 1 and 2, respectively.
- Common wiring methods for each input port are listed below

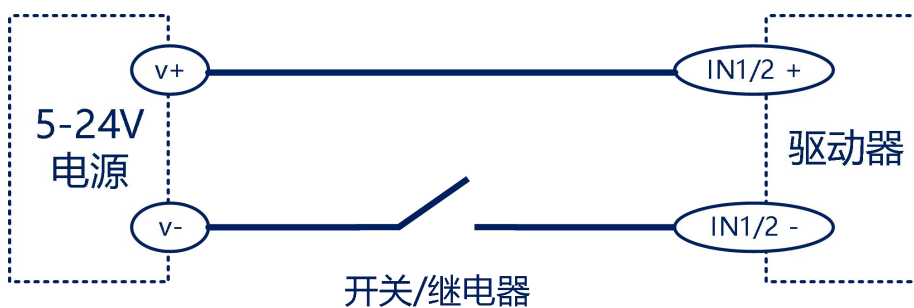
IN1、IN2:



NPN signal connection method



PNP signal connection method



Switch or relay connection method

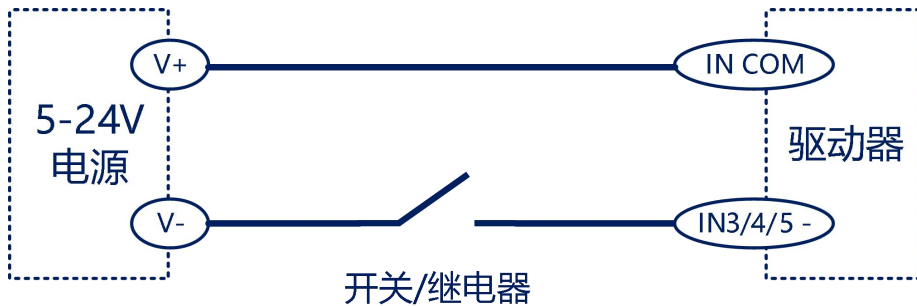
IN3, IN4, IN5: (IN-COM is CN3.8, which is the input port common terminal)



NPN signal connection method



PNP signal connection method

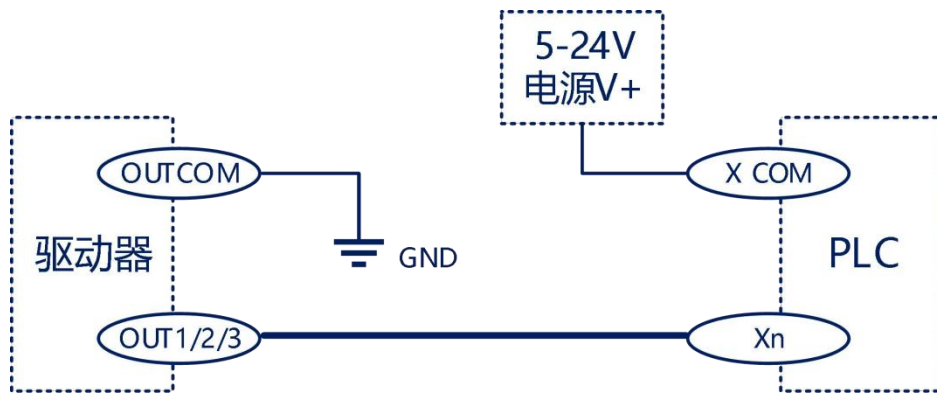


开关/继电器

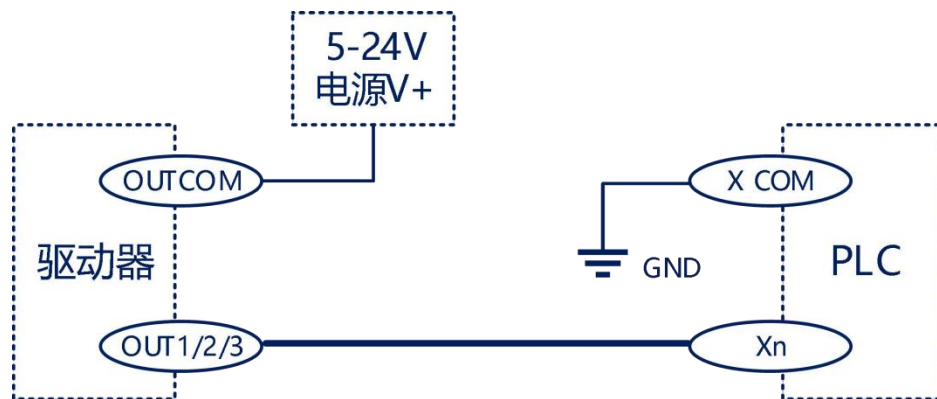
Switch or relay connection method

4.4 Output port connection

- OUT1, OUT2, OUT3: Optoelectronic isolation, single end, default normally on, maximum output current 100mA
- OUT1, OUT2, and OUT3 can all be used as general outputs, and the output port function can be configured using the KF Step Drive Configuration debugging software, such as in-place output and alarm output. The following are common wiring methods for output port: OUT1, OUT2, OUT3:



NPN output wiring method



PNP output wiring method

4.5 Power Connection

Connect the positive pole of the power supply to the V+ of the driver and the negative pole of the power supply to the V - of the driver.

***Please note that the positive and negative terminals of the power supply should not be connected reversely. Otherwise, it may cause the drive to burn out.**

4.6 Connection of Motor and Encoder

The closed-loop stepper motor has two outgoing lines: a motor outgoing line and an encoder outgoing line. Use optional motor extension wire and encoder extension wire. Connect the A+, A-, B+, and B- of motor outgoing line to the A+, A-, B+ and B- of the motor connector CN2 on the driver in sequence. Connect the encoder outgoing line to the encoder connector CN4 on the driver.

Note: Do not damage or forcefully pull the outgoing lines of motor and encoder, and do not subject the outgoing lines to the excessive force (e.g., lifting the motor with the lines), place them under heavy objects or make them clamped.

4.7 EtherCAT communication connection

The dual-port RJ-45 connector is a 100BASE-TX (100Mbps) compliant interface that can be connected using the standard network cable. Please use CAT5 or CAT5e (or higher-level) network cable. The Ethernet input interface IN is connected to the Ethernet output interface OUT of the previous driver on the controller or bus. The Ethernet output interface OUT is connected to the Ethernet input interface IN of the next driver on the bus. If the driver is the last node on the bus, only the Ethernet input interface IN needs to be connected. The terminal matching resistor does not need to be used.

4.8 EtherCAT network indicator light

The indicator lights are used to display the status of EtherCAT, with a total of four status lights: RUN, ERR, Link/Activity In, and Link/Activity Out.

4.9 Setting EtherCAT station address

The EtherCAT site address of the driver can be written in the Kaifull configuration software or assigned by the PLC host. The main station can set the 0004h address from the station to the SII (Slave Information Interface) EEPROM. Once the driver is powered on, it can obtain the numerical value from the 0004h of SII to set the station address.

The indicator lights are used to display the status of EtherCAT, with a total of four status lights: RUN, ERR, Link/Activity In, and Link/Activity Out.

5. Motion Control

5.1 EtherCAT Control Mode

Y2SS3-ECX supports both synchronous and asynchronous modes. In synchronous motion mode, the master station performs trajectory planning and outputs cycle instructions. The driver receives the planning instructions from the master station according to the synchronization cycle, making it suitable for multi-axis synchronous motion.

Y2SS3-ECX synchronous motion mode supports cyclic synchronous position

mode (CSP). In the cyclic synchronous position mode (CSP), trajectory planning is completed at the master station. The position information sent by the master station is received based on the synchronization cycle, and the position information is immediately transmitted to the driver when the synchronization signal arrives. The synchronization cycles supported by Y2SS3-ECX include: 1000 us, 2000 us and 4000 us.

Control Mode	Index - Sub-index	Name	Data type	Access type	Unit	PDO configuration	SDO communication
CSP mode (8)	6040-00h	Control word	U16	RW	—	Must	-
	607A-00h	Target position	I32	RW	P	Must	-
	6041-00h	Status word	U16	RO	—	Must	-
	6064-00h	Actual position	I32	RO	P	Must	-
	606C-00h	Actual speed	I32	RO	P/S	Can	Can
PP mode (1)	607A-00h	Target position	I32	RW	P	Recommended	Can
	6081-00h	Target speed	U32	RW	P	Can	Can
PV mode (3)	60FF-00h	Target speed	I32	RW	P	Recommended	Can
Shared by PP mode (1) and PV mode (3)	6040-00h	Control word	U16	RW	—	Recommended	Can
	6083-00h	Acceleration	I32	RW	P/S ²	Can	Can
	6084-00h	Deceleration	U32	RW	P/S ²	Can	Can
HOME mode (6)	6040-00h	Control word	U16	RW	—	Recommended	Can
	6098-00h	Zeroing method	I8	RW	—	Can	Can
	6099-01h	Home position fast	U32	RW	P/S	Can	Can
	6099-02h	Home position slow	U32	RW	P/S	Can	Can
	609A-00h	Home position acceleration	U32	RW	P/S ²	Can	Can
	607C-00h	Home position offset	U32	RW	P	Can	Can
PP, PV and HOME modes	6041-00h	Status word	U16	RO	—	Recommended	Can
	6064-00h	Actual position	I32	RO	P	Recommended	Can
	606C-00h	Actual speed	I32	RO	P/S	Can	Can
Shared by all modes	60B8-00h	Probe function	U16	RW	—	Recommended	Can
	60B9-00h	Probe status	U16	RO	—	Recommended	Can
	60BA-00h	Probe 1 captured value	I32	RO	P	Can	Can
	60FD-00h	Digital input	U32	RO	—	Recommended	Can
	603F-00h	Latest error code	U16	RO	P	Recommended	Can
	6060-00h	Operation Mode	I8	RW	—	Can	Can
Other associated parameters	60B0-00h	Position offset	I32	RW	—	Can	Can
	6082-00h	Jump speed	U32	RW	P/S	Can	Can
	6085-00h	Emergency stop deceleration	U32	RW	P/S ²	Can	Can
	6061-00h	Operation mode display	I8	RO	—	Can	Can

5.2 Torque mode

- **CST mode**

The CST mode needs to be used to the following objects

Object	Definition	Access
0x6040	Control word	Reading and writing
0x6041	Status word	Read only
0x6060	Operation Mode	Reading and writing
0x6061	Operation mode status	Read only
0x6071	Maximum torque value (in milliamper)	Read/Write
0x60B2	Torque offset (in milliamper)	Read/Write
0x60FF	Operating speed (in pulses/second)	Read/Write
0x6077	Feedback torque value (in milliamper)	Read only

To activate CST torque mode, you need to set:

Object	value
0x6060	10
0x6040	Assign values 6-7-15 in sequence to enable the motor
0x6071	The motor current should not exceed the rated current of the motor used
0x60FF	Running speed; set to 0 when the motor stops; when it is greater than 0, the motor will rotate forward; when it is less than 0, the motor will rotate reversely.

5.3 COE object dictionary description

Object Dictionary	Sub-index	Name	Read/Write	Data size	Range	Default value	Unit	Remark
0x1010	01	Save all parameters	R/W	UDINT	0~0xFFFFFFFF	0	-	Save command: 0x65766173 Decimal system: 1702257011 Return to 1 after saving successfully
0x1011	01	Restore all parameter factory values	R/W	UDINT	0~0xFFFFFFFF	0	-	Recovery command: 0x64616f6c Decimal system: 1684107116 Return to 1 after factory reset
0x2000	00	Peak current	R/W	DINT	0~10000	800	mA	Set to the rated current of the stepper motor, in milliamperes.
0x2001	00	Pulse count per cycle	R/W	DINT	400~51200	4000	Pulse	Motor pulses per revolution, effective upon restart
0x2002	00	Minimum current	R/W	INT	0~10000	500	mA	Set to 50% of the rated current of the stepper motor, in milliamperes.
0x2003	00	Open loop/closed-loop control mode	R/W	USINT	0~8	0	-	8: Open loop mode 0: Closed loop mode
0x2007	00	Brake control mode	R/W	DINT	0~1	0	--	0: Brake function enabled 1: Brake function disabled
0x2008	00	Driver startup scanning current	R/W	U16	0~10000	1500	mA	In the closed-loop mode, the driver will be started to initiate the phase search scanning current and will be set to the rated current of the motor. in milliamperes
0x2029	00	The number of pulses per revolution of the encoder	R/W	DINT	4000~7FFFFFFF	4000	Pulse	The pulse count outputted by the encoder by rotating one turn. When a 1000-line encoder is used, it is set to 4000. When a 2000-line encoder is used, it is set to 8000; and so forth
0x2018	00	Control motor matching	R/W	USINT	0~16	0	--	1: 20/28 series motor (current 0.5A) 3: 42 series motor (current 1.5A) 6: 57 short series motor (current 4A) 8: 57 long series motor (current 4A) 9: 60 series motor (current 4A) C: 86 Short series motor (current 6A) E: 86 long series motor (current 6A)
0x2051	00	Motor running direction	R/W	USINT	0~1	0	-	0: Clockwise 1: Anti-clockwise

Object Dictionary	Sub-index	Name	Read/Write	Data size	Range	Default value	Unit	Remark
0x2058	00	Driver limit switch enabling	R/W	U32	0~1	0	-	Driver limit switch function; when encountering a limit switch during operation, the control word will be set and the driver will stop running. 0: The internal limit switch cannot be enabled 1: The internal limit switch function is enabled
0x2152	01	Motor input port function setting - IN1 (2152.02-05 correspond to IN2-IN5 respectively)	R/W	UDINT	0~1000	0	-	Decimal value= 1: Probe 1 2: Probe 2 3: Home position 4: Positive limit 5: Negative limit 6: Enabling control input 7: Alarm clear input 8: Emergency stop input 17: General IO1 18: General IO2 19: General IO3 20: General IO4 21: General IO3 <i>If the reverse signal needs to be taken, write the current value+128. For example, ①: Defined as positive limit and reverse signal taken, written to 132. ② Defined as negative limit and reverse signal taken, written to 133.</i>
0x2156	01	Motor output port function setting - OUT1 (2156.02 and 03 correspond to OUT2 and OUT3 respectively)	R/W	UDINT	0~1000	0	-	Decimal value= 1: In-place output 2: Error alarm output 3: Brake output 33: General output 1 34: General output 2 35: General output 3 36: Universal output 4 <i>If the reverse signal needs to be taken, write the current value+128. For example, ①: Defined as in-place output and reverse signal taken, written to 132. ② Defined as alarm output and reverse signal taken, written to 133.</i>

Object Dictionary	Sub-index	Name	Read/Write	Data size	Range	Default value	Unit	Remark
0x60FD	-	Digital input	RO	UDINT	0~0xFFFFFFFF	0	-	60FD is used to map the digital input, and the status of each bit represents the status of the digital input Bit0:: Negative limit Bit1: Positive limit Bit2: Home position Bit26: Probe 1 Bit31: Phase Z signal

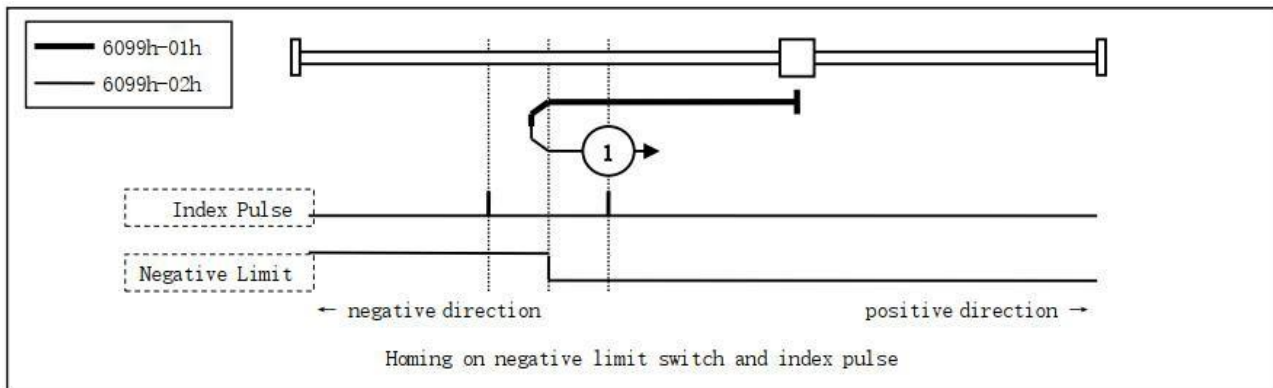
5.4 Homing method

The Y2SS3-ECX series driver product supports Z-phase signals and multiple ways for sensors to return to the home position. The specific definition and process of returning to the home position are described as follows.

Index Pulse: Encoder Z-phase signal; **Negative Limit:** Negative direction limit **Positive Limit:** Positive direction limit

Method 1

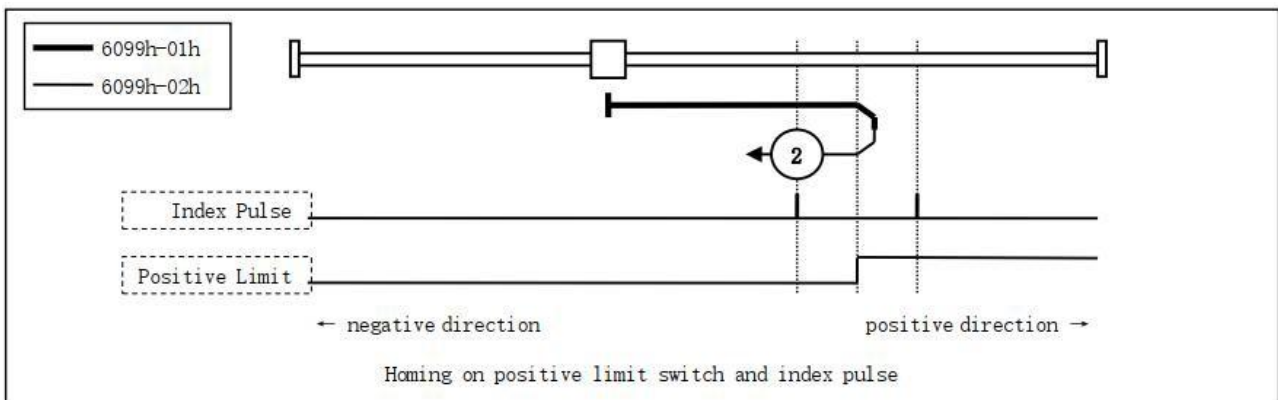
If the negative limit switch is not activated, the initial movement direction of motor is negative. After touching the negative limit switch, the motor will decelerate and run reversely, with the first detected Z signal as the home position signal. After triggering the Z signal, bit31 of object dictionary 60FD will be set to 1.



Method 1 diagram

Method 2

Activate the positive limit switch, and the initial movement direction of the motor is in the positive direction. After touching the positive limit switch, the motor will decelerate and run reversely, with the first detected Z signal as the home position signal. After triggering the Z signal, bit31 of object dictionary 60FD will be set to 1.

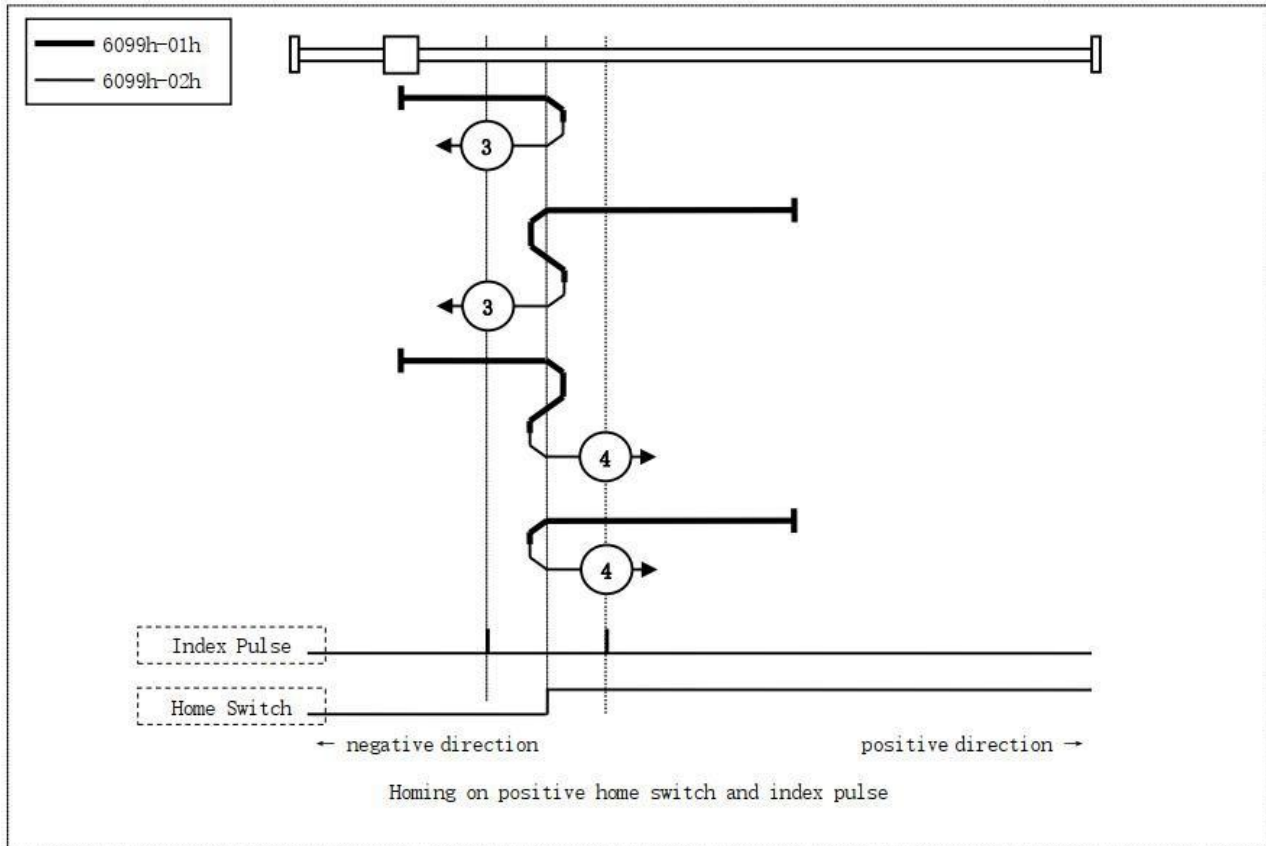


Method 2 diagram

Methods 3, 4

The direction of initialization operation is determined based on the status of the home position switch during startup.

The home detection position is at the the negative direction side after the status change of the home position switch, or the initial Z signal position at the negative direction side. After triggering the Z signal, bit31 of object dictionary 60FD will be set to 1.



Diagrams of Methods 3 and 4

Methods 5, 6

The direction of initialization operation is determined based on the status of the home position switch during startup.

The home detection position is at the negative direction side after the status change of the home position switch or the initial Z signal position at the positive direction side. After triggering the Z signal, bit31 of object dictionary 60FD will be set to 1.

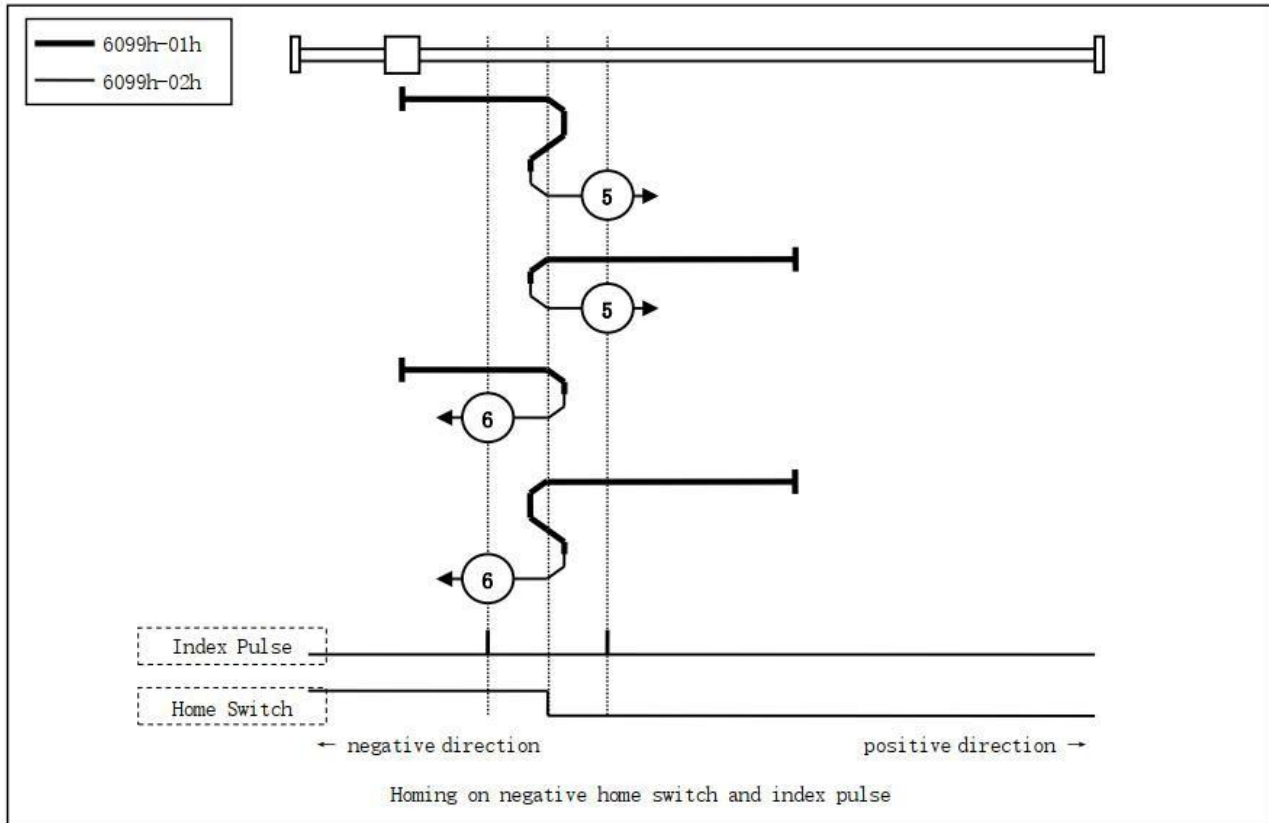


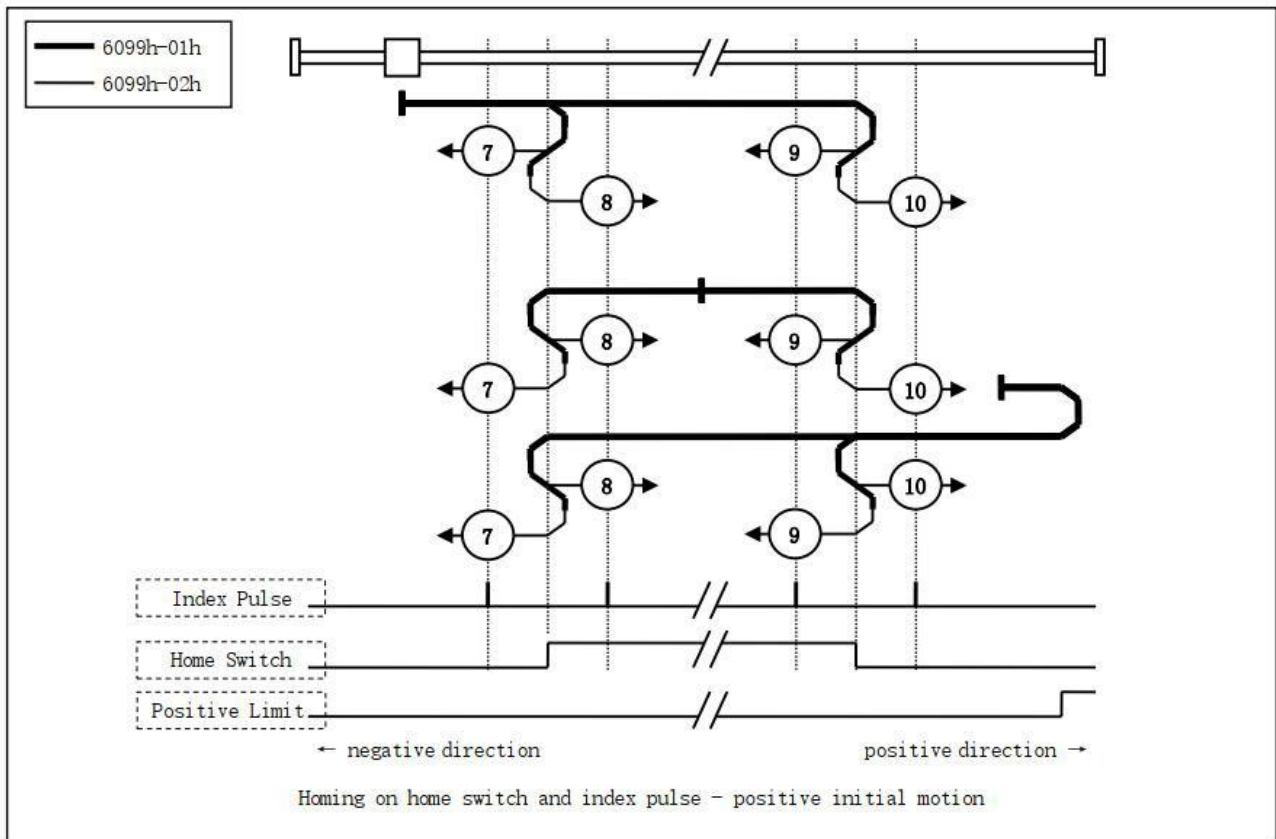
Diagram of Methods 5 and 6

Methods 7, 8, 9, 10

In this method, the home position switch and Z signal are used.

The initialization action direction of methods 7 and 8 is the negative direction if the home position switch has already been activated at the beginning; the initialization action direction of methods 9 and 10 is the positive direction if the home position switch has already been activated at the beginning; the home detection position is the Z signal of the rising or falling edge attachment of the home position switch.

After triggering the Z signal, bit31 of object dictionary 60FD will be set to 1.



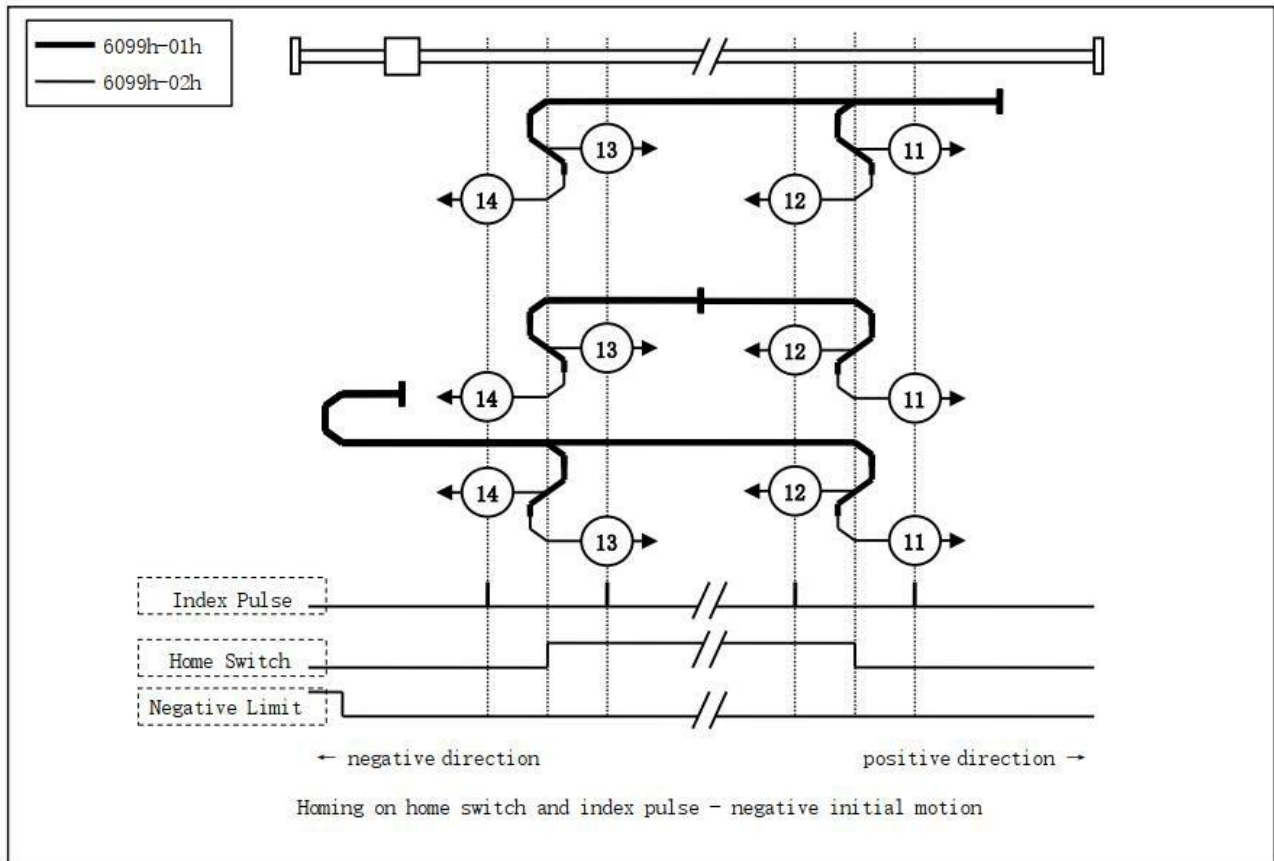
Diagrams of methods 7, 8, 9 and 10

Methods 11, 12, 13 and 14

In this method, the home position switch and Z signal are used.

The initialization action direction of methods 11 and 12 is the positive direction when the home position switch has already been activated at the beginning; the initialization action direction of methods 13 and 14 is the negative direction if the home position switch has already been activated at the beginning; the home detection position is the Z signal of the rising or falling edge attachment of the home position switch.

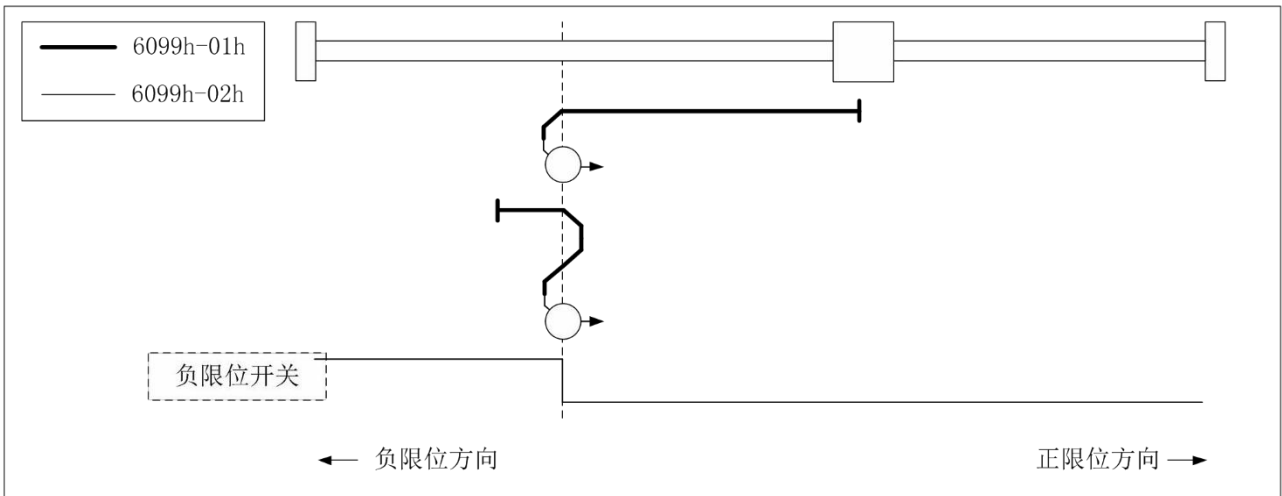
After triggering the Z signal, bit31 of object dictionary 60FD will be set to 1.



Diagrams of methods 11, 12, 13 and 14

Method 17:

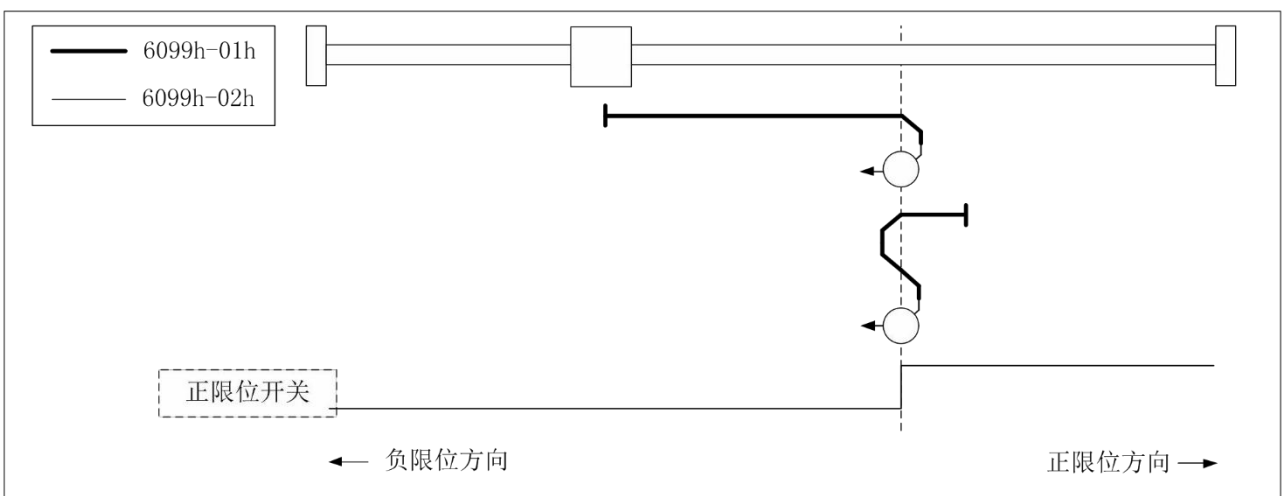
If the negative limit switch is not activated, the initial movement direction of motor is negative. After encountering the negative limit switch, the motor will decelerate and run reversely, and the home detection position is the position where the negative limit switch status changes.



Method 17 diagram

Method 18:

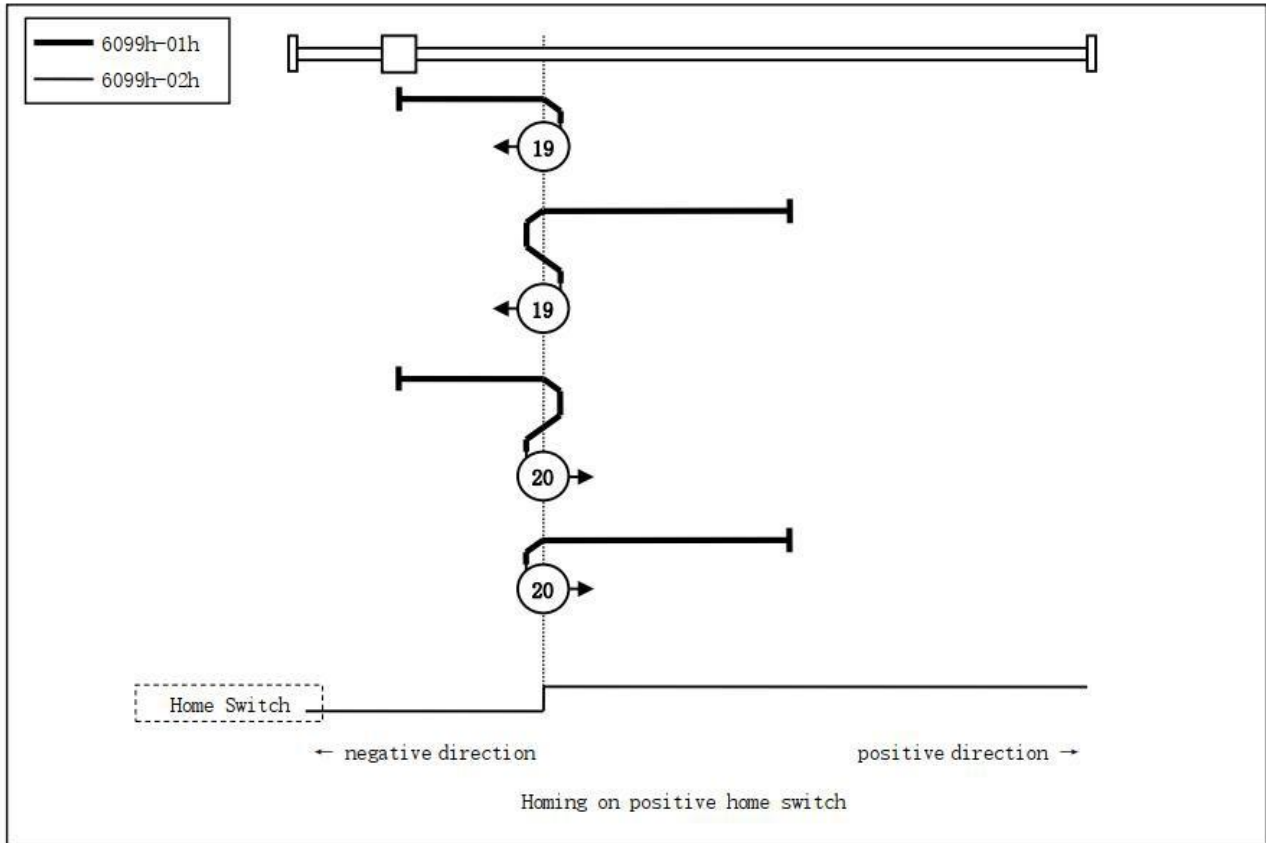
If the negative limit switch is not activated, the initial movement direction of motor is positive. After encountering the negative limit switch, the motor will decelerate and run reversely, and the home detection position is the position where the position limit switch status changes.



Method 18 diagram

Methods 19 and 20

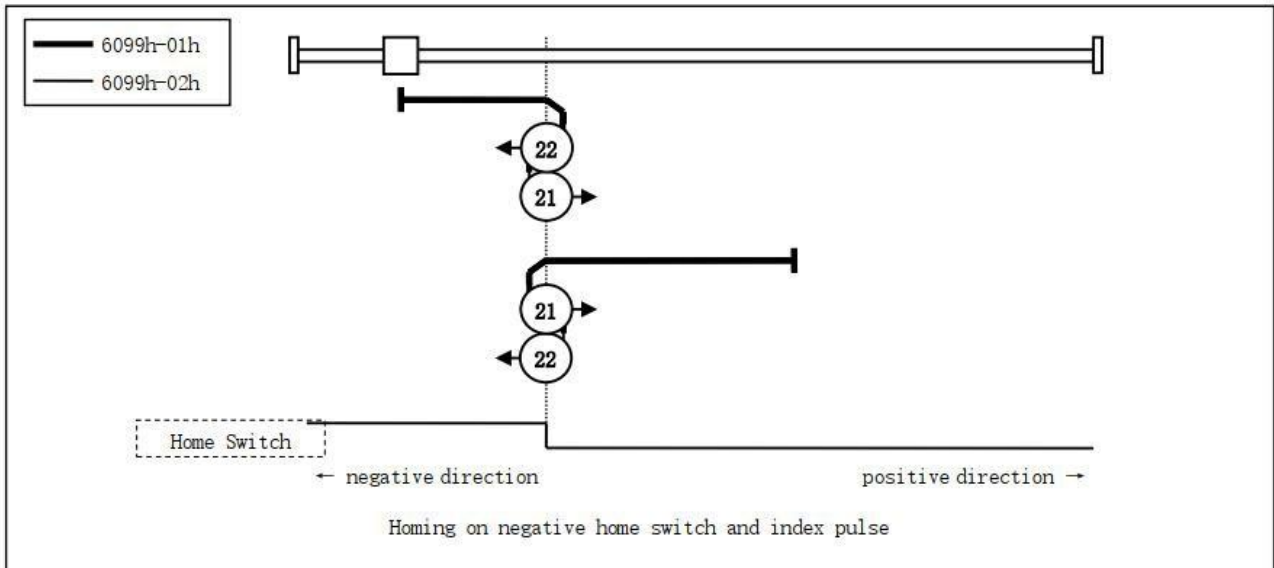
The direction of initialization operation is determined based on the status of the home position switch during startup. The home detection position is at the the negative direction side after the status change of the home position switch, or the negative direction side.



Diagrams of methods 19 and 20

Methods 21 and 22

This method is similar to methods 19/20. The direction of initialization operation is determined based on the status of the home position switch during startup. The home detection position is at the positive direction side after the status change of the home position switch, or the negative direction side.

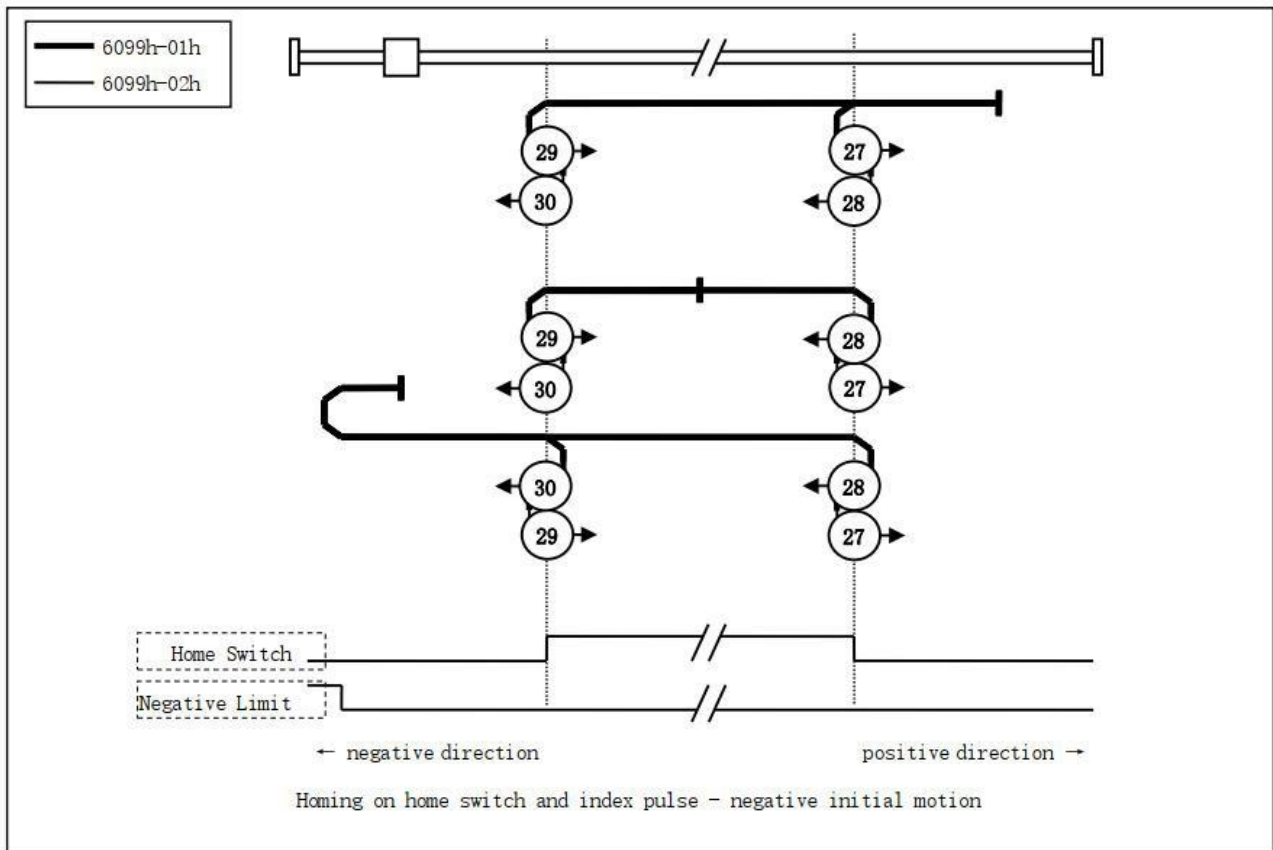


Diagrams of methods 21 and 22

Methods 27, 28, 29 and 30:

In this method, the home position switch and negative signal are used.

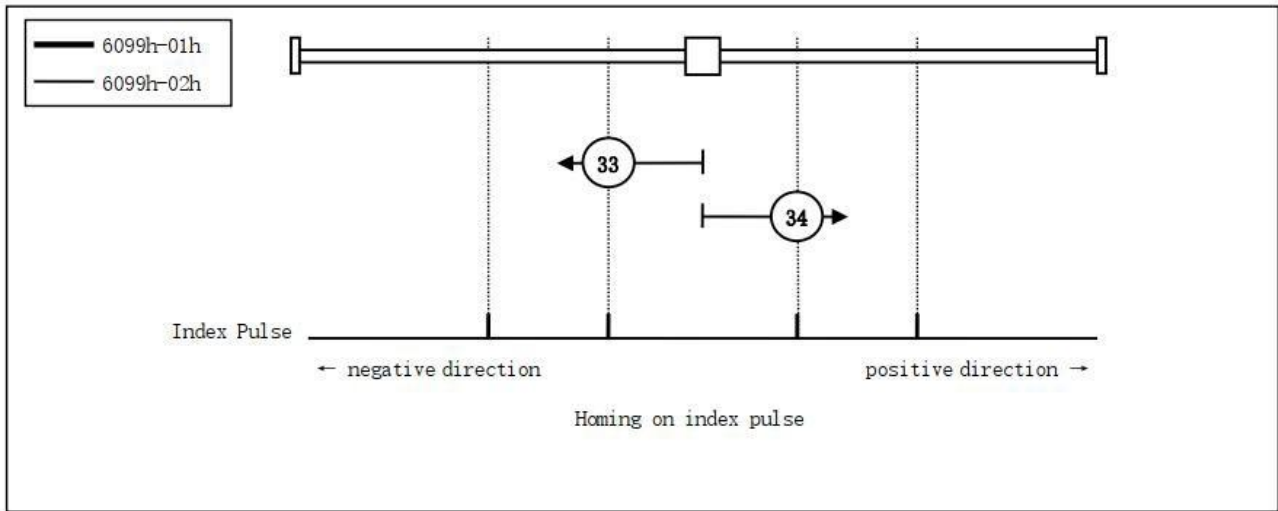
The initialization action direction of methods 27 and 28 is the positive direction when the home position switch has already been activated at the beginning; the initialization action direction of methods 29 and 30 is the negative direction if the home position switch has already been activated at the beginning; the home detection position is the position where the status of the home position switch changes.



Diagrams of methods 27, 28, 29 and 30:

Methods 33 and 34

In this method, only Z signal is used. The Z signal is detected as the home position after moving at the direction shown in the figure.

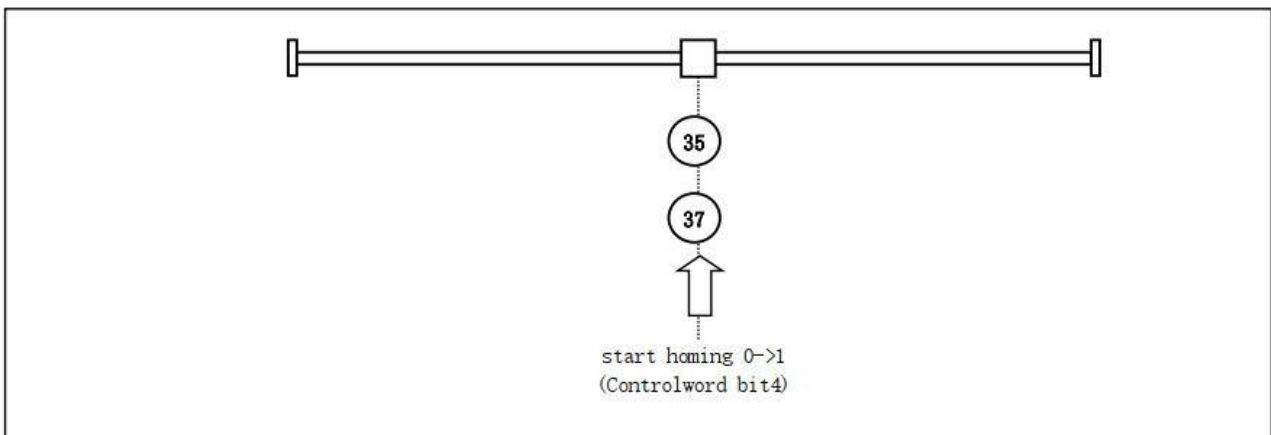


Diagrams of methods 33 and 34

Methods 35, 37:

The current point is used as the home position

35 and 37 have the same functions, but based on the ETG specifications, it is recommended to use 37.



Diagrams of methods 35 and 37

7. Alarm

7.1 Error Code

The driver has two (red/green) LED lights to display status and error, and can also read the value of the error register object 603F.

When the motor is in the enabled state, the green indicator light will be always on. If the red LED light flashes, it indicates that an error has occurred. The error is displayed by combining the flashing red and green lights, and the specific meaning is as follows:

LED indicator light	Meaning	Error object 603F	Resolution
Green light flashing	Motor not enabled	0	Driver enabling signal
Green light normally on	Motor enabled normally	0	-
4 red lights and 1 green light	Excessively high bus voltage	0x70c0	<ol style="list-style-type: none"> 1. Check whether the supply voltage of the driver is too high; 2. In case of overvoltage during movement, the motor deceleration time can be increased.
4 red LED lights and 2 green LED lights	Excessively low bus voltage	0x60d0	Check whether the supply voltage of the driver is too low;
5 red lights +1 green light	Motor overcurrent	0x3052	<ol style="list-style-type: none"> 1. Check whether the motor has been damaged; 2. Check whether the set current of the driver is too high;
6 red lights +1 green light	Motor open circuit	0x60d1	<ol style="list-style-type: none"> 1. Check whether the motor wiring is correct; 2. Check whether the motor has been damaged
5 red LED lights and 2 green LED lights	Position deviation	0x100	These two types of error have similar causes <ol style="list-style-type: none"> 1. Check whether the encoder wire is connected correctly and securely 2. Check whether the encoder resolution is set correctly 3. Check whether the motor is blocked 4. Increase the acceleration and deceleration time appropriately
6 red LED lights and 2 green LED lights	Motor overload	0x180	

8. Contact Kaifull



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