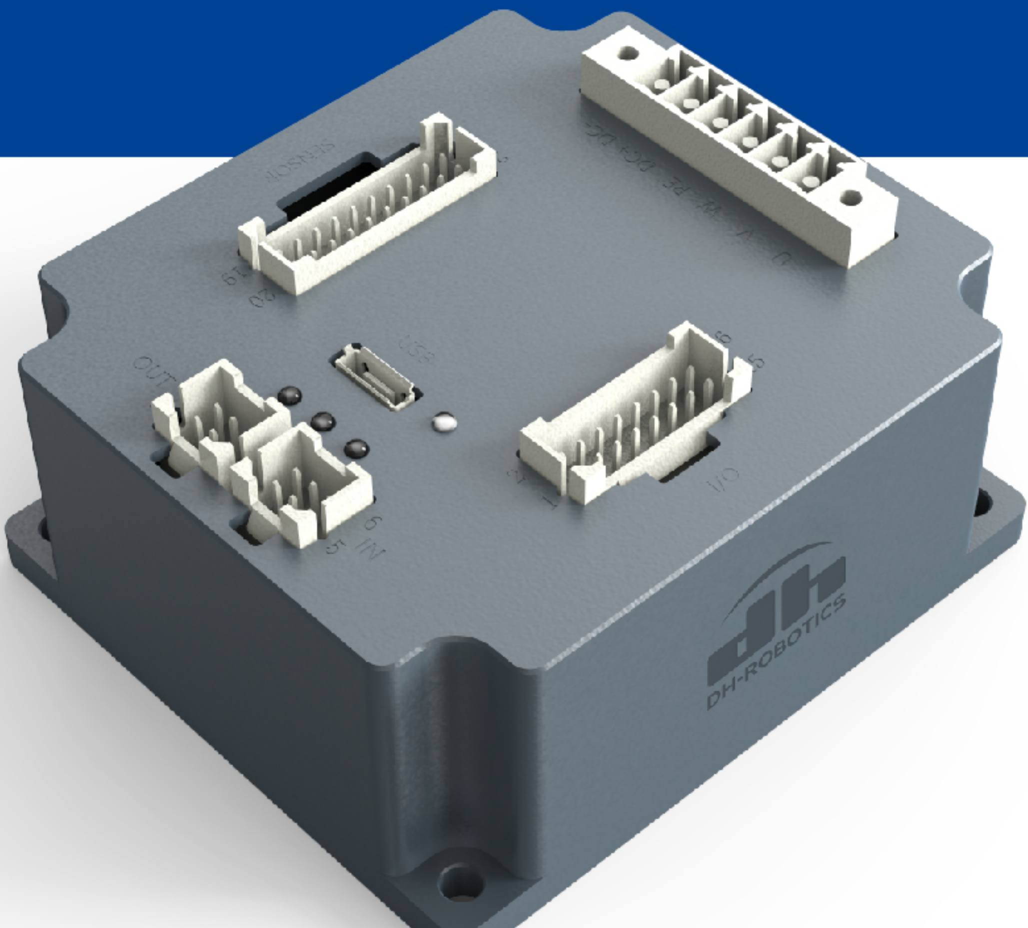
DH-ROBOTICS

Voice Coil Actuator Series Drive User Guide



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Contents

1 Installation

1.1 Dimension

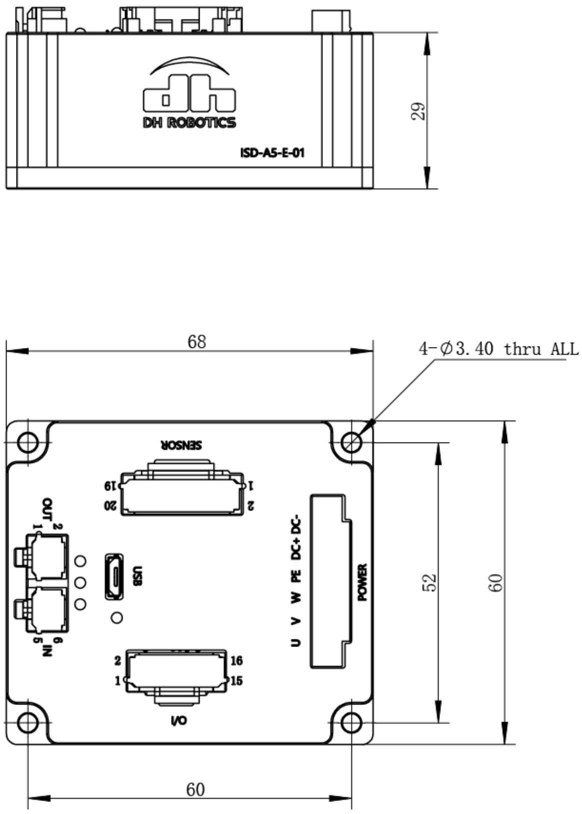


Fig. 1-1 Dimension (unit: mm)

1.2 Assembly and Disassembly

Before installation, please check the product package:

- Servo drive
- Connector corresponding to the servo drive
- User manual (scan the QR code card to access to the official website for download).

Please note the following during disassembly:

- Careful remove the box.
- Make sure the product is free of cosmetic damage.
  If there are such damages, please contact us.
- Check the model on the housing of the product and make sure the product is your desired one.
- Check if the rated voltage meets your demands.

1.3 Mechanical Installation

This servo is a pedestal type servo amplifier and failures may occur if installed in the wrong way.

1.3.1 Installation Site

- Please do not use this product in the vicinity of corrosive and flammable gas environments such as hydrogen sulfide, chlorine, ammonia, sulfur, chlorinated gases, acids, alkalis, salts, and combustible materials.
- Please do not install this product in the environments with high temperature, humid places and lots of dust and iron powder.
- Please do not use this product in a closed environment where will cause high temperature of the servo and shorten the service life.
- Please note the following:
  - ✓ For servo drives with 200W and below, there is no special requirements for installation.
  - ✓ For servo drives with 400W, please make sure that the temperature of the secondary cooling installation surface is below 55℃.
  - ✓ For servo drives with 750W, please make sure the temperature of the installation surface is below 55℃, and make sure at least 3 m/s wind convection with wind direction along the horizontal direction of PCB.

1.3.2 Environmental Condition

Table 1-1 Environmental conditions

Projects	Description
Ambient temperature	• 0: 0℃ - +50℃ • 1: -40℃ - +50℃ • 2: -55℃ - +50℃ • 3: -70℃ - +50℃
Environmental humidity	< 95% RH (no condensation)
Storage temperature	• -40℃ - +85℃ (no freezing) • 7-0℃ - +85℃ (no freezing)
Storage humidity	0% - 95% RH (no condensation)
Vibration	< 5 m/s^2

1.3.3 Installation Steps

Note: The servo drive should be vertically installed on the wall and M3 screws must be tightened. For other requirements.

1. On the back of the mounting plate, mark the position of screw hole.
   The hole spacing is shown as in Figure 2-1, and the specification of heat sink hole is M3,.
2. Tap threads according to the mark, and make sure threads have full contact.
   Note: The metal surface of the mounting plate should not be coated or painted, and if so, please scrape it off. Otherwise the electromagnetic compatibility will deteriorate.
3. Vertically mount the servo drive on the back of the mounting plate.
   Note: Please pay attention to the installation spacing, and make sure the mounting surface is in good contact.

2 System Wiring

2.1 Interface Definition

There are 6 interfaces on the servo drive. Among them, the following interfaces are external:

- J10-J11: EtherCAT communication interface
- J5: USB communication interface
- J6: IO interface
- J7: Motor encoder feedback interface
- J9: Power input and output interface

The pin definition of each interface is shown in Figure 2-1:

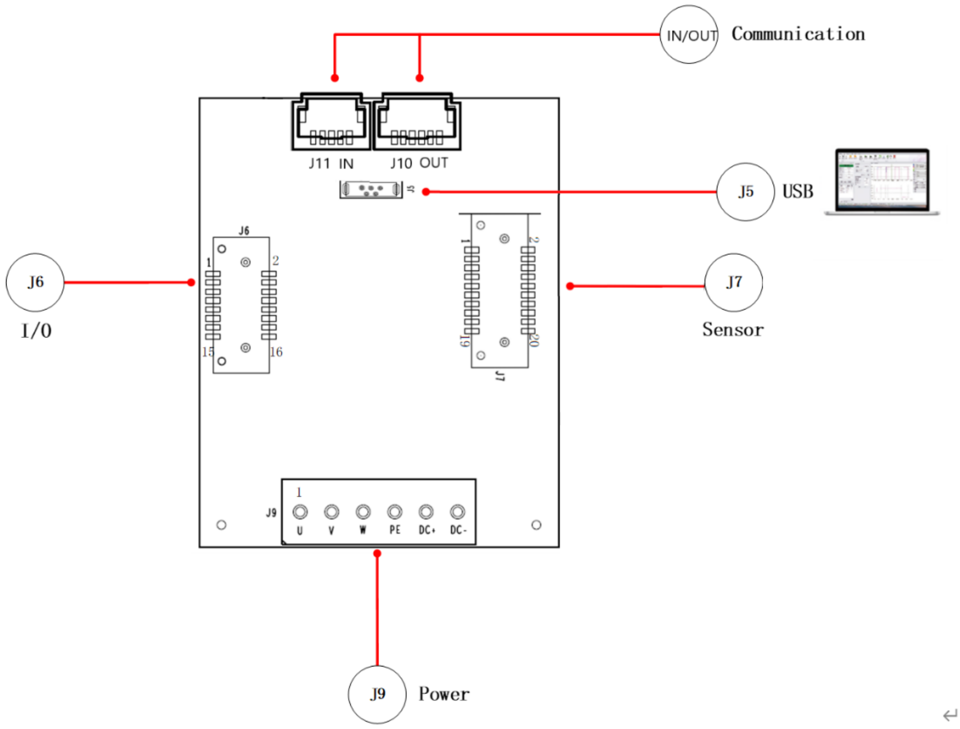


Figure2 -1 Interface definition

2.1.1 Pin Definition of J10 and J11

Table 2-1 Pin definition of J10 and J11

Interface	Pin	Pin Name
J10/J11-EtherCAT (J11-IN；J10-OUT)	1	TX+
	2	TX-
	3	RX-
	5	RX+
	4、6	PE

2.1.2 Pin Definition of J5

You can communicate with the servo drive for parameter settings and debugging via the standard Micro-USB cable.

2.1.3 Pin Definition of J6

Table 2-2 Pin definition of J6

Interface	Pin	Pin Name
J6-IO interface	1	+24V_OUT
	2	GND-OUT
	3	DO2_OUT
	4	DO3_OUT
	5	DO0_OUT
	6	DO1_OUT
	7	DI4_IN
	8	DI5_IN
	9	DI2_IN
	10	DI3_IN
	11	DI0_IN
	12	DI1_IN
	13	STO0
	14	GND-IN
	15	STO1
	16	STO_RET

2.1.4 Pin Definition of J7

Table 2-3 Pin definition of J7

Interface	Pin	Pin name				
		Absolute	Incremental	Hall	Analog	Power supply
J7-motor encoder feedback interface	1					PE
	2					GND
	3		INC_A+			
	4		INC_A-			
	5		INC_B+			
	6		INC_B-			
	7		INC_Z+			
	8		INC_Z-			
	9					
	10					
	11				AI1+	
	12				AI1-	
	13				AI2+	
	14				AI2-	
	15					
	16					
	17			HALL_U		
	18					5V
	19			HALL_W		
	20			HALL_V		

2.1.5 Pin Definition of J9

Table 2-4 Pin definition of J9

Interface	Interface Pins	Pin Name
J9-power input and output interface	1	U
	2	V
	3	W
	4	PE
	5	DC+
	6	DC-

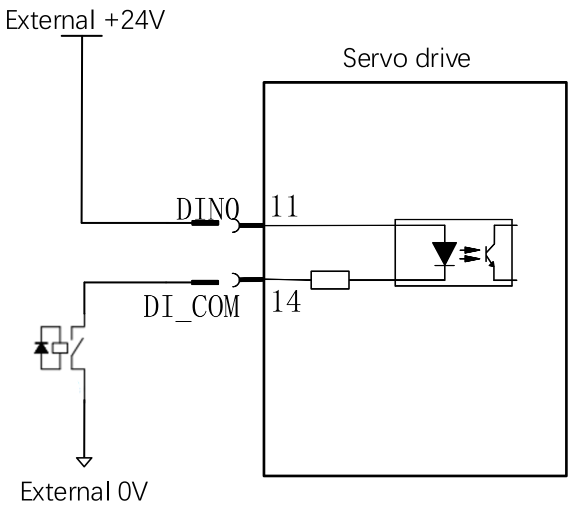
Caution:

1. For voice coil motor or DC brush motor, please connect the power cable to UV phase.
2. For two-phase four-wire stepping motor, please connect A+ and B+ of the power cable respectively to U phase and W phase, A- and B- to V phase.

2.2 IO wiring

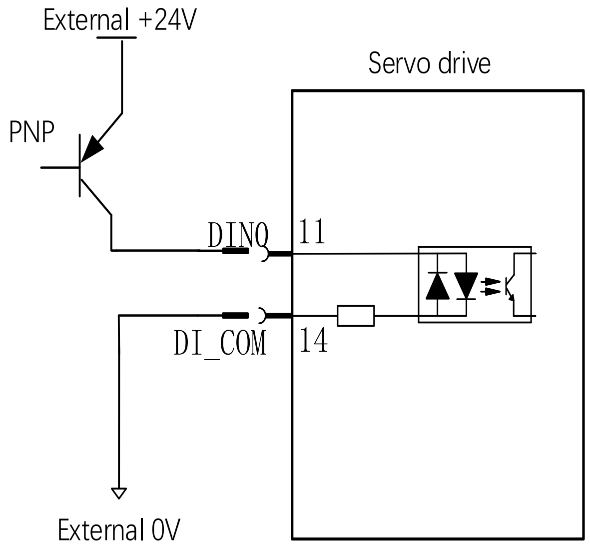
2.2.1 DI wiring

- When the upper unit uses relay to output (taking DI0 as an example)

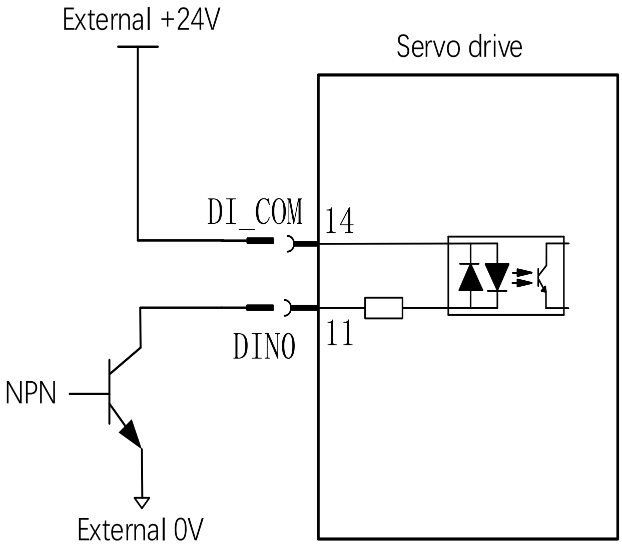


- When the upper unit uses open collector to output

  PNP connection


External +24V
Servo drive
PNP
DIN0
11
DI_COM
14
External 0V

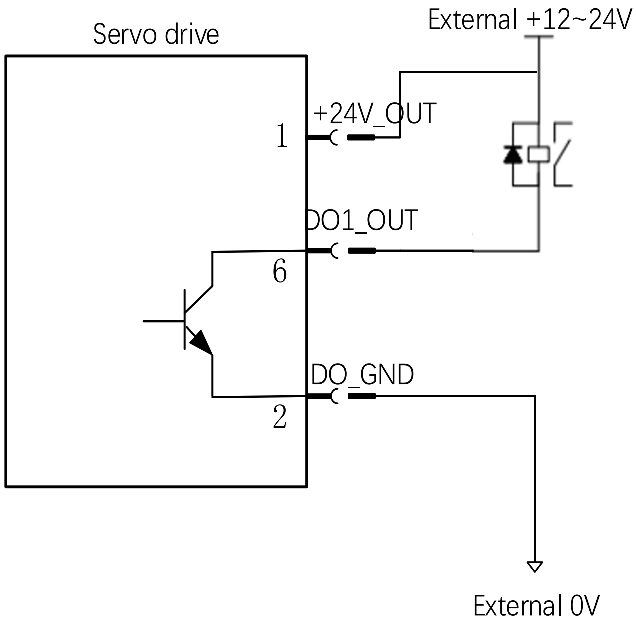
NPN connection



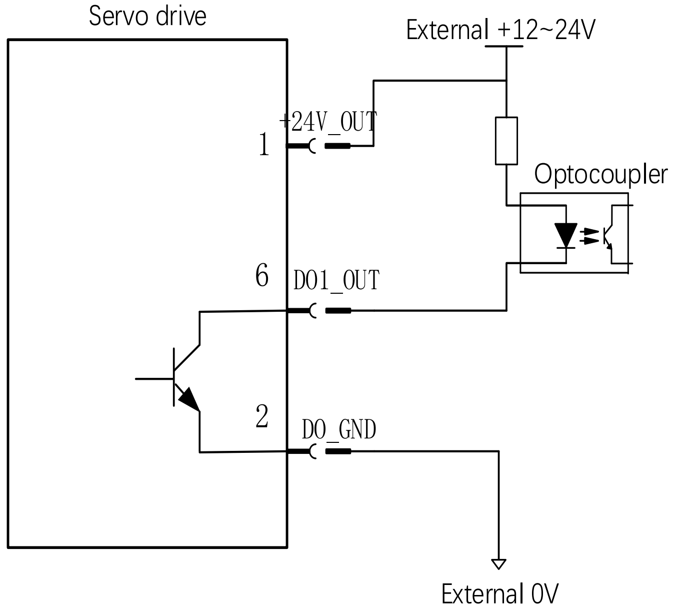
Note: The mixing case of PNP and NPN input is not supported.

2.2.2 DO Wiring

- When the upper unit uses relay to input (taking DO1 as an example).



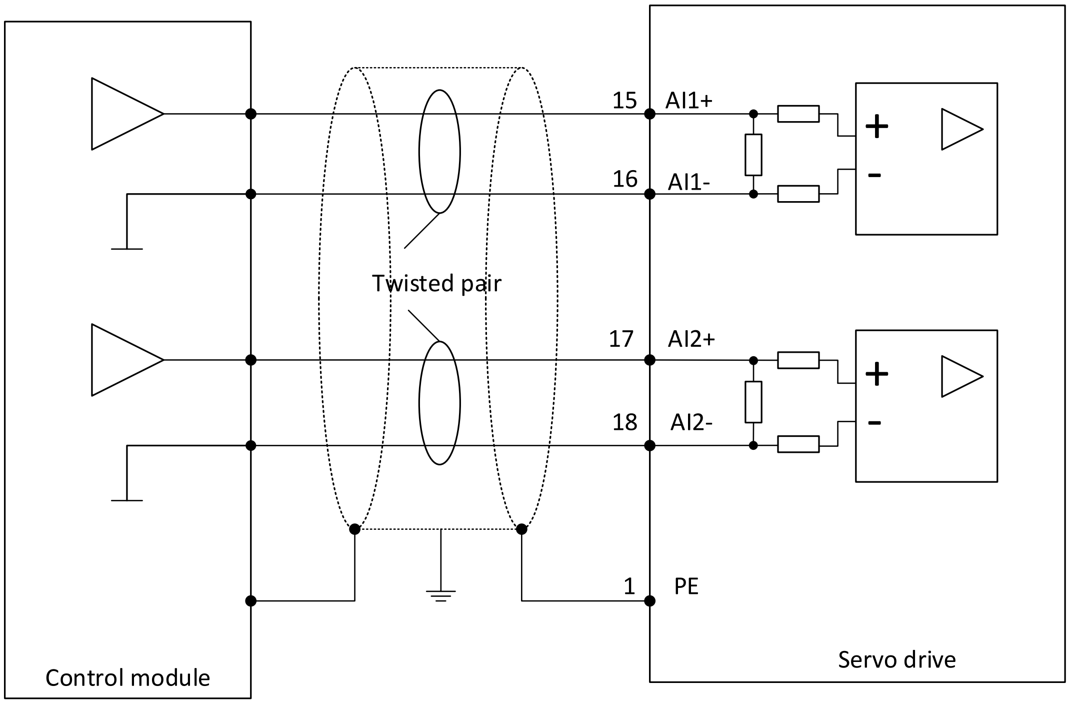
- When the upper unit uses optocoupler to input (taking DO1 as an example).



Note:

1. DO_OUT needs a pull-up resistor and current limiting resistor (it is optional. Please decide whether to use it according to the optocoupler specifications of the upper unit).
2. The maximum voltage and current of the internal optocoupler output is as follows.
   - Voltage: 30 V DC
   - Current: 400 mA DC

2.3 AI Wiring



Note:

1、The servo drive has 2 analog input circuits, i.e. AI1 and A12.

- Input voltage: -10 - +10 V
- AD accuracy: 12 bits

2、Please make sure the input voltage is within -12 - +12 V. Otherwise, damage to the circuit may occur.

3、Input impedance: 3.74 kΩ.

4、The upper unit can read values of 0x2413 (AI1) and 0x2414 (AI2) for external analog closed loop control.

2.4 Cables

Table 2-5 Cables

Name	Description	Length/m	Model
Power cables*1	Power cable between motor and servo drive with connector (for servo system ≤5 A)	1	SP-075-010-A
		3	SP-075-030-A
		5	SP-075-050-A
		X（non-standard）	SP-075-XXX-A
	Power cable between motor and servo drive with connector (for 10 A servo system)	1	SP-150-010-A
		3	SP-150-030-A
		5	SP-150-050-A
		X（non-standard）	SP-150-XXX-A
	Power cable between motor and servo drive with connector (for 20 A servo system)	1	SP-250-010-A
		3	SP-250-030-A
		5	SP-250-050-A
		X（non-standard）	SP-250-XXX-A
Encoder cables*1	Encoder signal cable between motor and servo drive with connector (For incremental encoders)	1	SDE15-010-A
		3	SDE15-030-A
		5	SDE15-050-A
		X（non-standard）	SDE-15-XXX-A
	Encoder signal cable between motor and servo drive with connector and battery (3.6 V, it is recommended to replace it every 15 - 24 months) (For absolute encoders)	1	SDE08-010B-A
		3	SDE08-030B-A
		5	SDE08-050B-A
		X（non-standard）	SDE08-XXXB-A
Digital I/O cables*1	Digital I/O cable (6 inputs, 4 outputs), 2-way STO, with connector	1	SDD16-010
		3	SDD16-030
		5	SDD16-050
		X（non-standard）	SDD16-XXX
Communication cables*2	EtherCAT communication cable 1 between the servo drive and upper unit PLC	X	SDC0X0-CC
	EtherCAT communication cable 2 between servo drives	X	SDC0X0-CD

Note:

1. It is recommended to purchase a set of cables for direct use. Otherwise, you need to purchase J2-J7 connectors separately.
2. It is recommended to purchase a set of bus communication cable, because the CAN / EtherCAT communication interface is not a standard RJ45 connector. And you can purchase USB cables by yourself.
3. Cable can be customized. For special needs, please contact us.

3 Trial Run and Debugging

The iSMC software is used for trial run and debugging. For details, please refer to ***User Manual of Servo Debugging Software ISMC***.

Debugging steps:

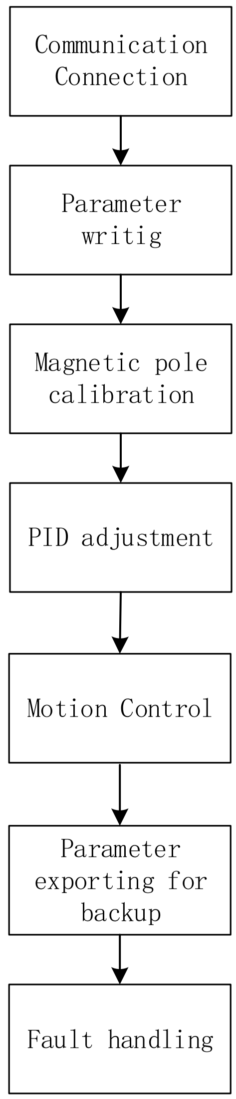


Figure 3-1 Parameter debugging steps

3.1 Communication Connection

1. Install the SMC software and USB driver.
2. Connect the upper computer and the servo drive via a USB cable (Mirco Type B).
3. Run I**SMC** software, enter the main interface, and select submenu **"Configuration"**:

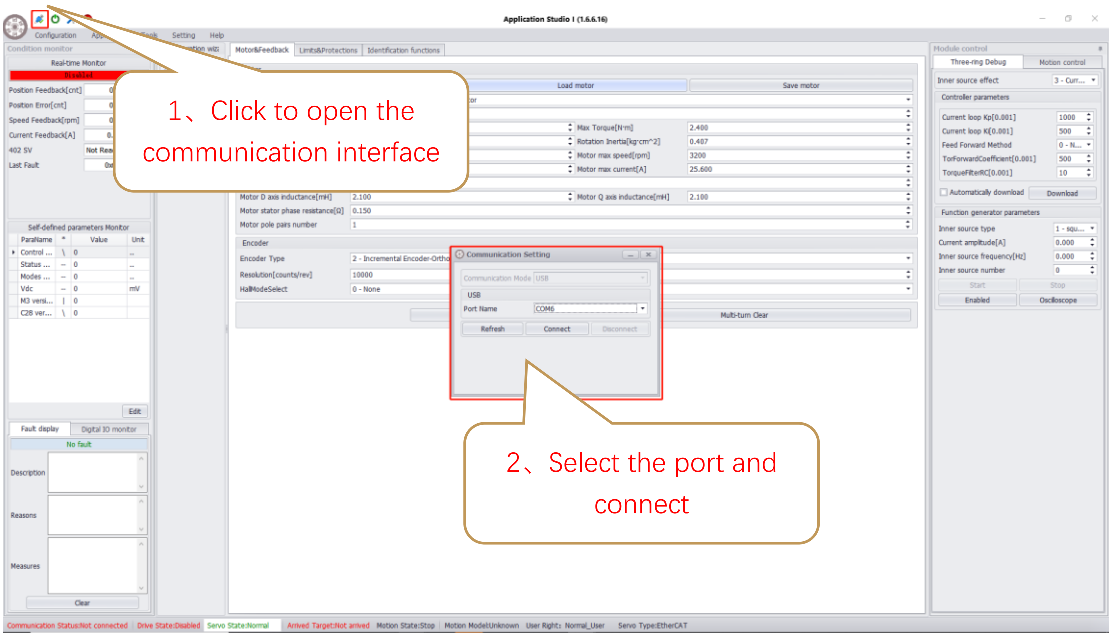


Figure 3-2 Open the communication interface

4. Click **"Refresh"**, and select the port connected to the servo drive in drop-down box **"Port"**.
5. Click **"Connect"**. The result shows as in Figure 3-3.

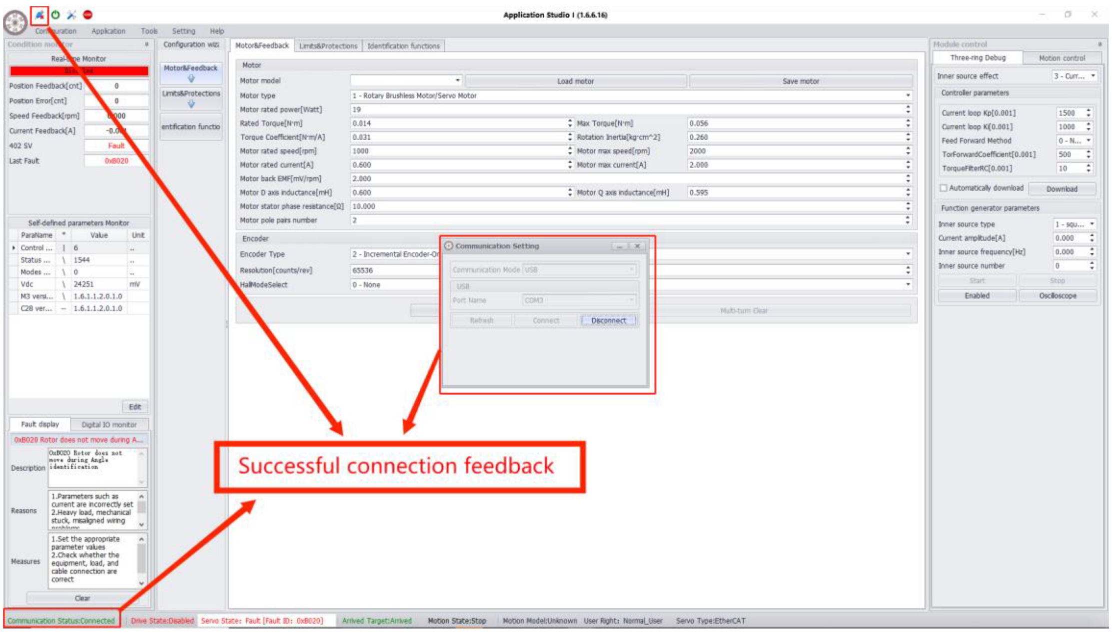


Figure 3-3 Communication connection succeeded

3.2 Parameter Writing

Parameter settings includes the settings of parameters about startup, motor feedback, limit protection and user unit.

3.2.1 Startup Parameters

Click **"Start Configuration"** in submenu **"Configuration"**, select the corresponding communication mode, and click **"OK"**.

3.2.2 Motor Feedback Parameters

Motor feedback parameters includes motor parameters and encoder parameters.

1. Select **"Motor Feedback"** in submenu **"Configuration".**
2. Set motor parameters and encoder parameters.
3. Click **"Download"** after settings are completed.

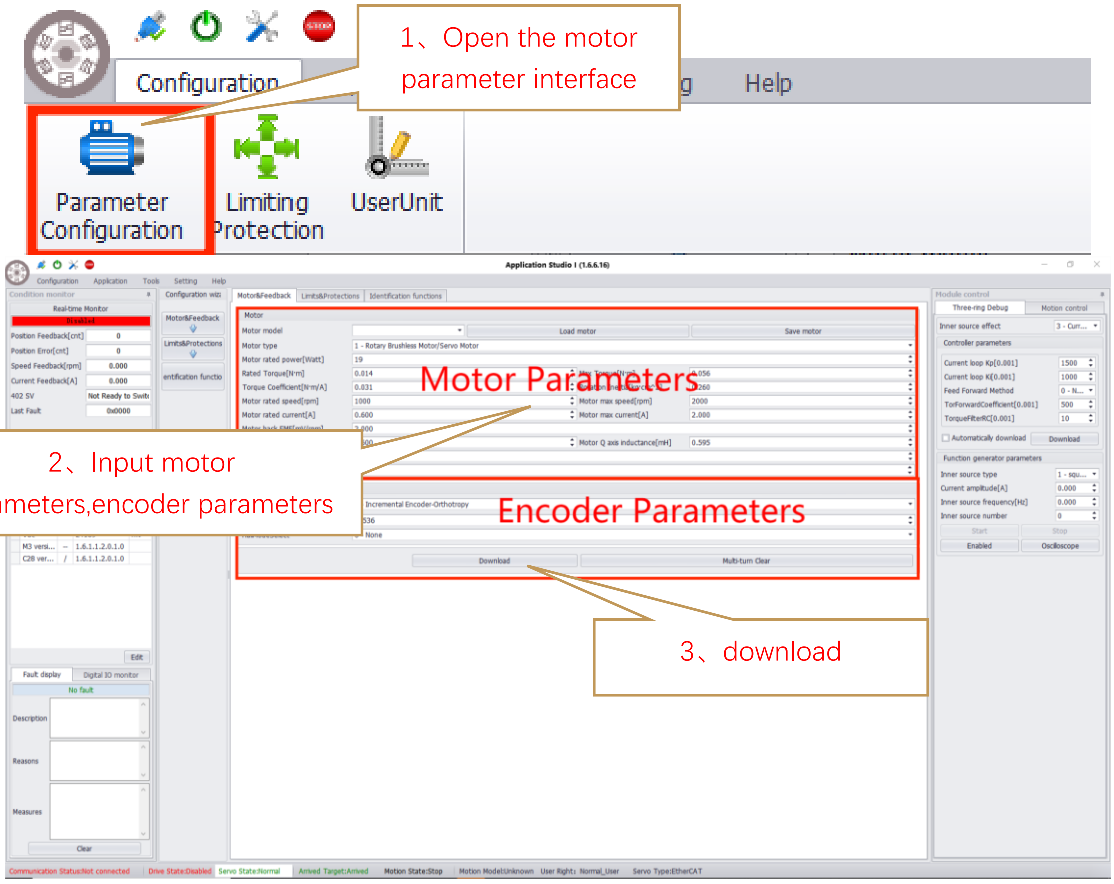


Figure 3-5 Settings of motor feedback parameters

Note: Please restart the servo drive after saving successfully, and reconnect the communication after restarting.

- **Motor parameters**

  1) To conveniently configure motor parameters, SMC supports motor database in which you can directly call the motor parameters of known models and save the motor parameters of new models.
  Note: The database only supports saving and loading motor feedback parameters. "**Import**" command is used to import all servo parameters and "**Export**" command is used to export all servo parameters.

Figure 3-6 Motor parameters-1

2) Please input the values of target motor parameters into the software according to the motor nameplate and the motor parameter manual provided by the manufacturer, as shown in Figure 3-7:

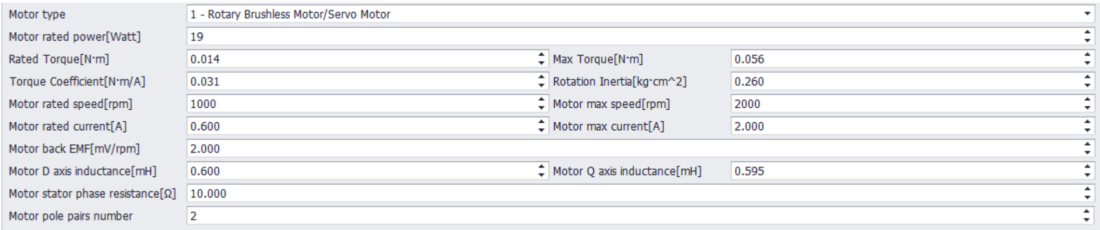


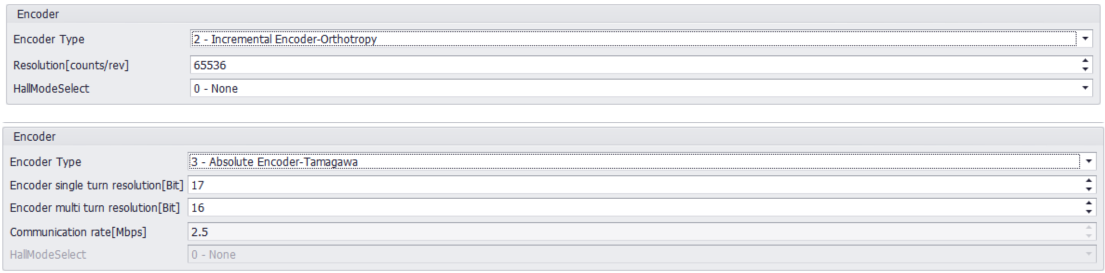
Figure 3-7 Motor parameters-2

3) The motor types include rotary brushless motor, linear brushless motor, rotary DC brush motor and voice coil motor. The parameters and units may vary with the motor type.

Note: Please pay attention to parameter unit when writing.

- **Encoder parameters**

According to the actual encoder type, in the encoder parameter interface, please select the encoder type and input the resolution.



Rotary encoder Linear encoder

Figure 3-8 Motor parameters-3

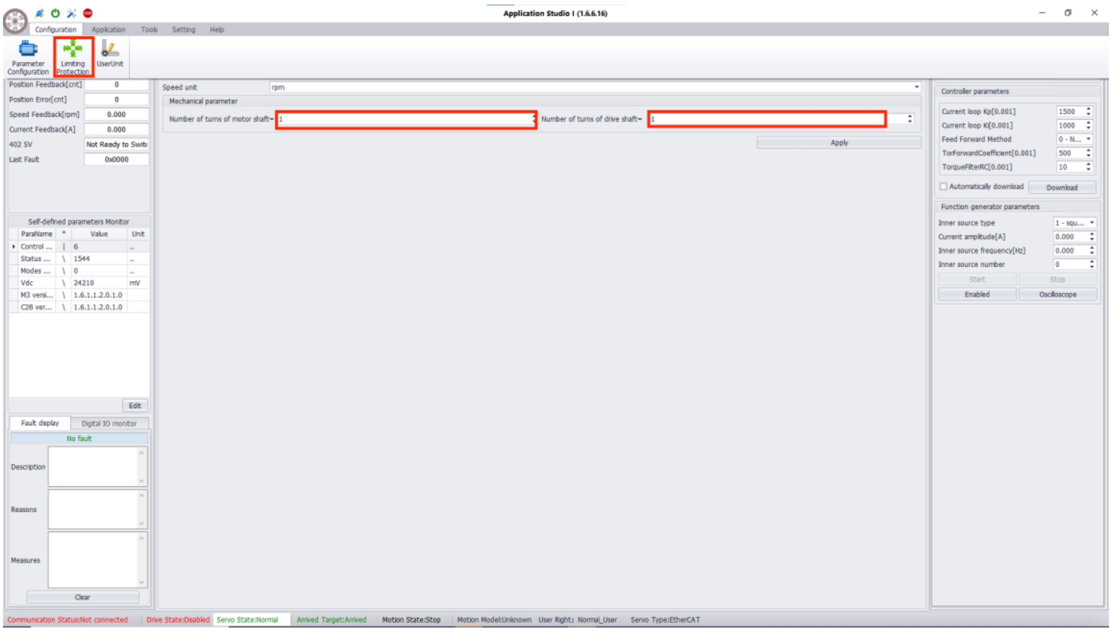
Encoder parameters are as shown in Table 3-1.

Table 3-1 Encoder parameters

Name	Unit	Definition
Absolute single-turn resolution	Bit	The pulse value output by one rotation of the encoder.
Absolute multi-turn resolution	Bit	The maximum number of turns recorded by the encoder.
Encoder multi-turn value reset		To clear the absolute encoder multi-turn value to zero.
Resolution	• Rotary: counts/revolution • Linear: counts/nm, um, mm	• The pulse value output by one rotation of the encoder. • The pulse value output by the grating ruler per unit distance.
Communication rate	M	The clock frequency at which data is sent to or received from the encoder.

3.2.3 Limit Protection

1. In **"Configuration"** submenu**,** select **"Limit Protection"**.
2. Set the peak current and the duration of the peak current.
   To protect motor i2t, please set the values according to the maximum current of the motor. Otherwise, damage to the motor may occur.



3.2.4 User Unit

1. In **"Configuration"** submenu**,** select **"User Unit"**.
2. Set parameter unit for motion control parameters, including position unit and velocity unit, and configure mechanical gear ratio, as shown in Figure 3-9:

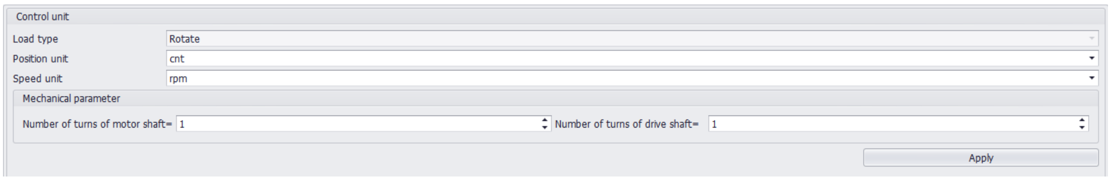


Figure 3-9 User units

3. After settings, click **"Apply".** The settings takes effect immediately.
   In the debugging mode and motion mode, the unit will be the same as the set unit.
   Please set user units for position and velocity modes according to the load type, as shown in Table 4-2.

Table 3-2 User units

Load Type / Motion Unit	Linear		Rotary	
Position unit	cnt	pulses	cnt	number of pulses
	um	microns	deg	angle
	mm	mm	rad	radian
	cm	centimeter	rev	Turn
	uu	customize	uu	customize
Velocity unit	cnt/s	pulses/sec	cnt/s	Pulses/sec
	um/s	μm/s	deg/s	angle/sec
	mm/s	mm/s	rad/s	radians/sec
	cm/s	cm/s	rpm	rpm
	uu	customize	rps	rev/sec
	-	-	uu	customize

3.3 Magnetic Pole Calibration

3.3.1 Phase Sequence Steering Detection

Phase sequence and motion direction of the incremental motors is required before motion control. With the phase sequence detection, the servo drive will automatically recognize UVW wire, and reverse the phase sequence and rotation direction according to the positive direction.

3.3.2 Hall Detection

When using the Hall sensor, the servo drive needs to automatically recognize the Hall angle. After that, the motor can be directly started with the Hall angle, which makes the motor start more smoothly, for it avoids the shock of magnetic pole identification when the incremental motor is powered on each time.

3.3.3 Commutation Offset Detection

Before motion control, detection of the magnetic pole zero is required. After calibration, the motion control can be performed normally. Otherwise, motor runway may occur.

Commutation offset detection is required after the phase sequence steering detection. Otherwise, calibration may fail. In this case, when the motion is enabled or started, the current feedback value observed in the motion monitoring is pretty large, the motor rotor is locked, or there is a risk of motor runaway. At this time, please set “**2002”** to “**1”** in “**Parameter Editor-PID**", to switch the phase sequence.

Parameter	Description
2002 Three-phase seq switch enable	The function of switching phase sequence. 0-no switching; 1-switching

The steps are as follows:

1. After setting parameters, in the parameter configuration interface, click "**Electric-degree Identify**":

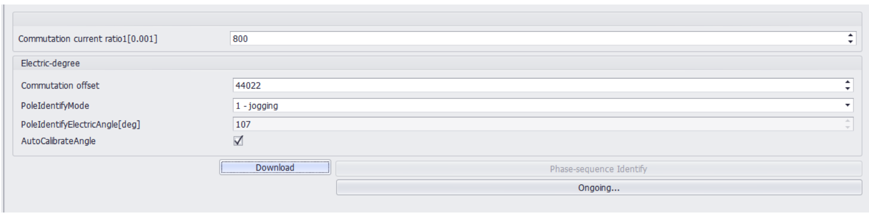


Figure 3-10 Automatic commutation detection

2. Wait for about 5 -10 seconds. The status turns green, as shown in figure 3-11, which indicates that the zero point calibration is completed.

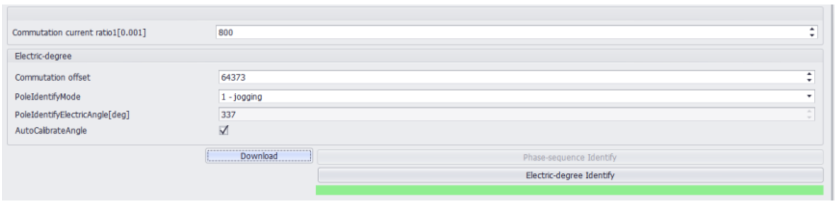
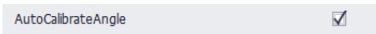


Figure 3-11 Completion of automatic commutation offset detection

Description:

1. For an absolute encoder, an accurate calibration is required at the first time. After that, motion control can be performed directly after the servo drive is powered on.
2. For an incremental encoder (without Hall signal), the calibration is required every time the servo drive is powered on. Otherwise, motion control is not allowed.
   Calibration can be done by sending calibration commands and enable commands (see note 2 for logic) or manually clicking automatic commutation offset detection.
   During calibration, please do not perform other motion control related operations. Otherwise, the servo drive will report the corresponding error.
   The servo drive owns the function of automatic calibration after power-on. With it enabled, you can check 

or set 0x2120 to 1. As a result, after saving, the servo drive will automatically start calibration every time it is powered on. After calibration, the servo is disabled, and the sign indicating the completion of calibration shows. At this time, please set 0x2121 to 1.
3. For an incremental encoder (with Hall signal), configuring HALL start (0x2103=1) and recognizing HALL angle are required at the first time. After that, motion control can be performed directly after the servo drive is powered on.
4. Setting of calibration current
   a. Gradually increase 0x2105 until the motor shaft can be fixed in a certain position quickly and stably.
   b. Rotate the shaft.
   c. Start calibration again several times until the position is basically the same (i.e. the value of 0x2102 is almost the same).

   Note:

   1. If the calibration current is not adjusted properly or the load of motor shaft is too large, the calibration will fail. For the error handling, please refer to ***Chapter 5 Troubleshooting***.
   2. After 0x6060 (control mode) is set to 0, 0x2101 is written to 1, 0x6040 (control word)

is executed according to the enable logic of 6 -> 7 -> 15, the servo enters calibration status. When 0x2101 turns to 0, it means the calibration process is completed.

Commutation offset related parameters

parameter	Description
2101 Calibrate commutation offset	The sign of manual zero calibration enable.
2102 Commutation offset	The value of zero calibration.
2103 HallModeSelect	Hall mode selection. 0: disable Hall;1: enable Hall.
2105 Commutation current ratio_1	D-axis calibration current amplitude = 2105 / 1000 * Rate current. Frequency: constant value
213E Hall_Angle	Hall calibration angle.
2120 AutoCalibrateAngle	Automatic calibration after power-on. 0-OFF; 1-ON.
2121 AutoCalibrateAngleFinish	The sign whether automatic calibration after power-on is completed. 0-Incomplete; 1-Complete.
2402 Commutation current ratio_2	Q-axis calibration current amplitude = 2402 / 1000 * 2105 Frequency: high frequency

3.4 PID Adjustment

If PID parameters are not set properly, the motor may vibrate or make abnormal noise. Thus, to achieve a better control effect, it is necessary to adjust PID parameters before controlling the motor.

The upper software SMC provides a function generator, which can output the given mode, wave form and step signal, and capture the given waveform and the feedback waveform for response analysis with an oscilloscope.

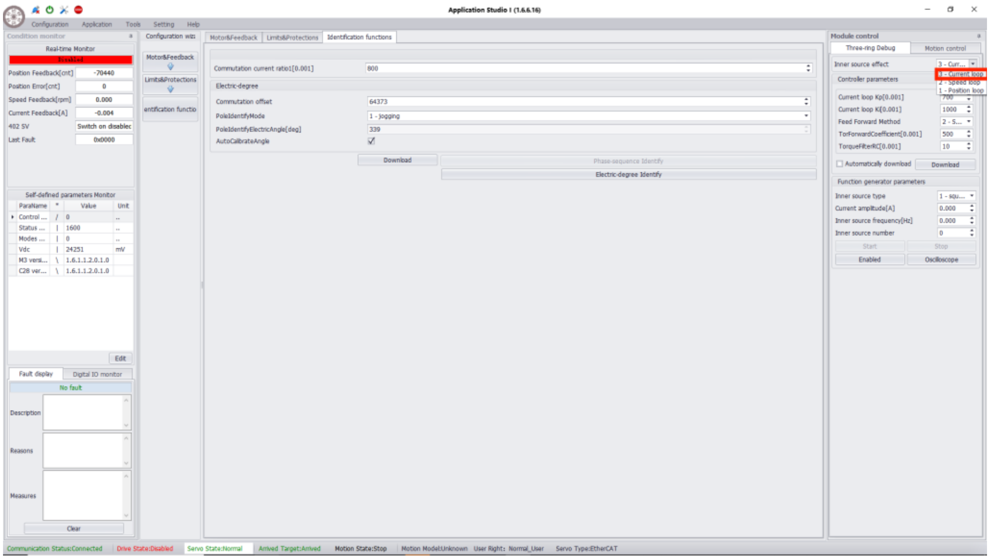
The whole debugging steps is as follows:

Adjustment for current loop → Adjustment for velocity loop → Adjustment for position loop

3.4.1 Current Loop

The first debugging is for the current loop.

1. Select **"Current Loop",** and then click **"Tool"** in the main menu,select **"Oscilloscope"**. The debugging interface of the current loop shows as in Figure 3-12:



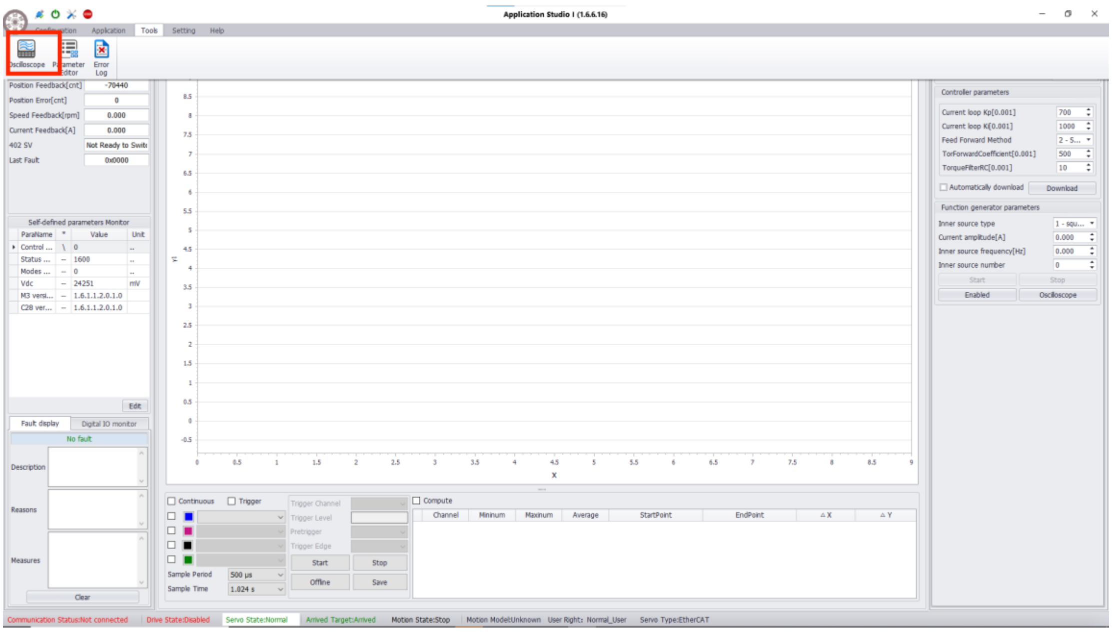


Figure 3-12 Current loop debugging interface

2. Adjust Kp.

   Main function: to increase the bandwidth with the increase of Kp. If it is too large, the motor makes noise, and if it is too small, the bandwidth is lowered.

   a. Set Ki to 0 and Kp to 100, and click "**Download**":

      Generally, you only need to slightly adjust the default values.

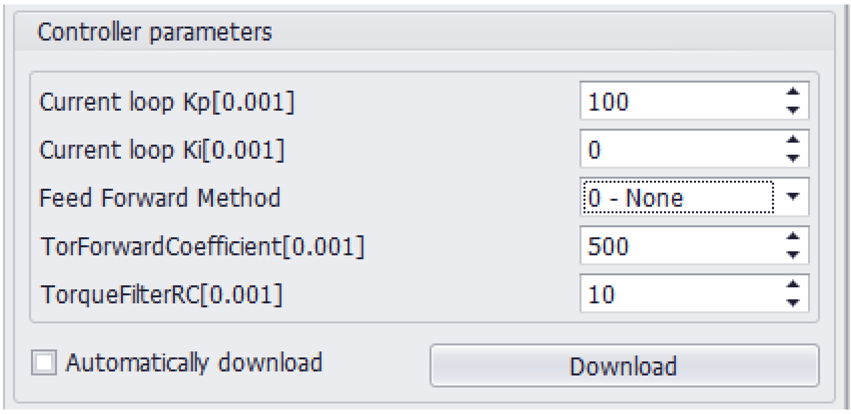


Figure 3-13 Control parameters of current loop

   b. Set the function type to sine wave, current amplitude to 25% of the motor rated current (the following takes 1 A as an example) and frequency to 1500 Hz.

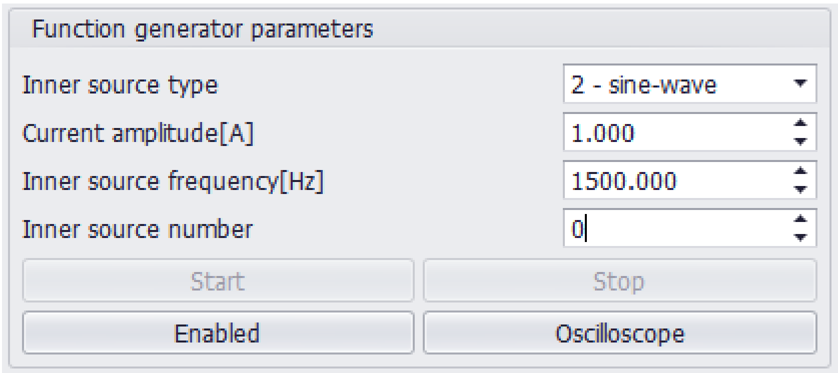


Figure 3-14 Function generator parameters of current loop

   c. Turn on oscilloscope again, set the sampling channel to Id/Iq reference (current given value) and Id/Iq feedback (current feedback value), set the sampling period to 50 us, and check continuous sampling**.**

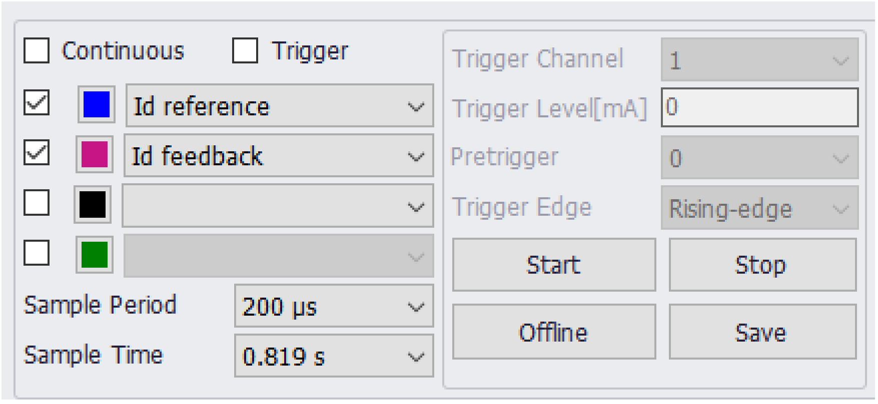


Figure 3-15 Oscilloscope sampling parameters of current loop

d. Enable the servo, start function generator, and click **"Start Acquisition"**.

e. Keep increasing Kp until the amplitude of Id/Iq feedback is between (0.707~1) of the amplitude of Id/Iq reference and the phase lag does not exceed 90°:

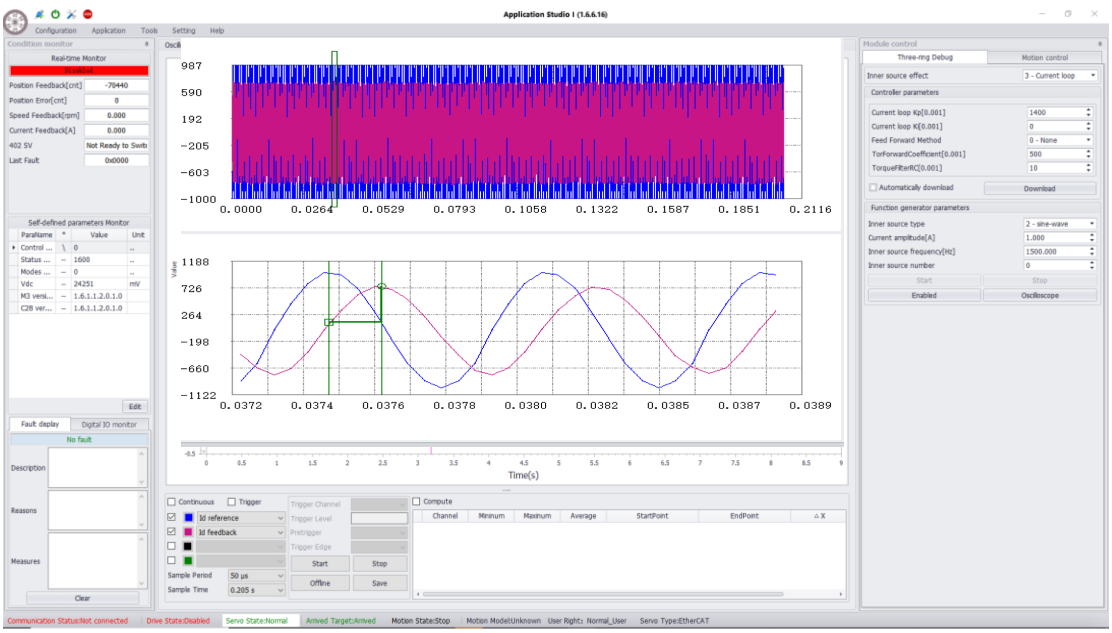


Figure 3-16 Current sampling waveform after adjusting Kp

3. Adjust Ki.

Main function: to eliminate the steady-state error. If it is too large, it will lead to overshoot and the motor will make noise.

a. Set the function type to square wave, current amplitude to 25% of the motor rated current (the following takes 1 A as an example) and frequency to 10 Hz.

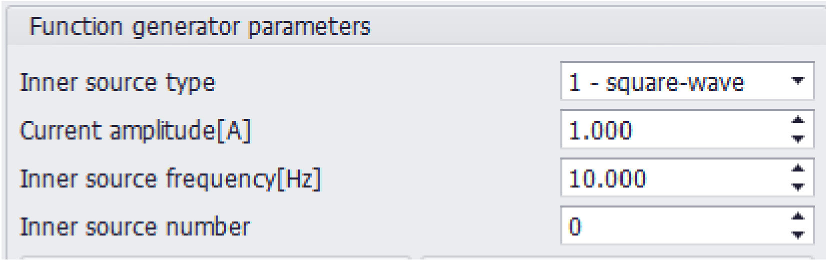


Figure 3-1 7 Function generator parameters of current loop

b. Gradually increase Ki, (generally increase 100 each time), and repeat step **c** and **d** of adjusting Kp until the steady-state error is eliminated, the waveform of Id/Iq feedback almost coincides with that of Id/Iq reference waveforms, and the overshoot is within 5%:

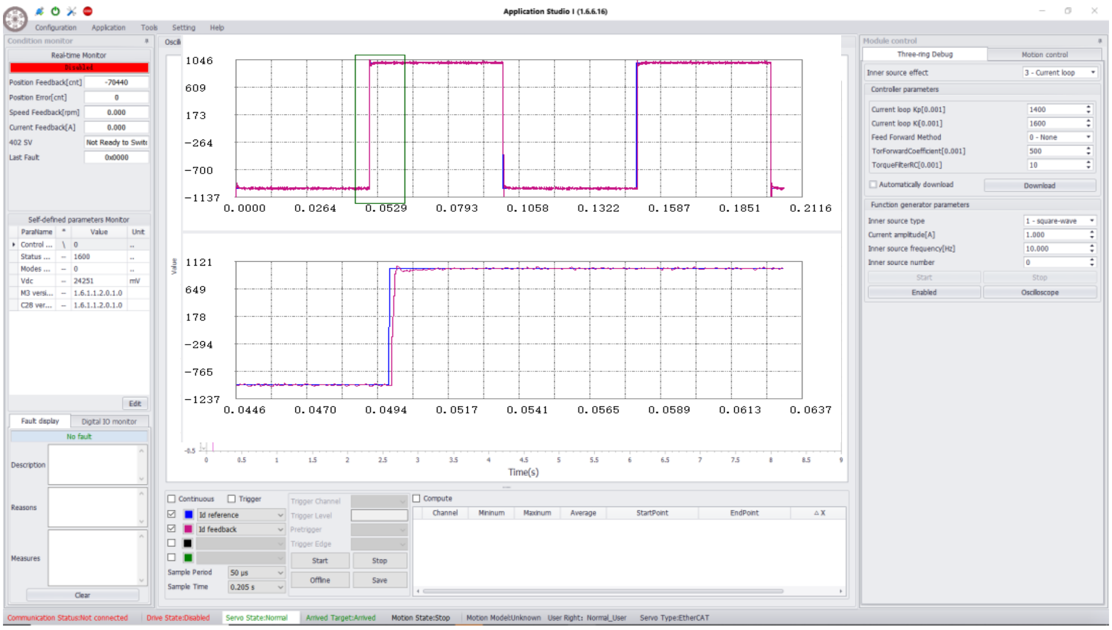


Figure 3-18 Current sampling waveform after adjusting Ki

Note: When adjusting the current loop, if the motor is a rotary brushless/linear motor, please select id for adjustment, and if the motor is DC brush/voice coil motor, please select iq for adjustment.

3.4.2 Velocity Loop

The second debugging is for the velocity loop.

1. Select **"Velocity Loop"**. The debugging interface of the velocity loop shows as in Figure 3-19:

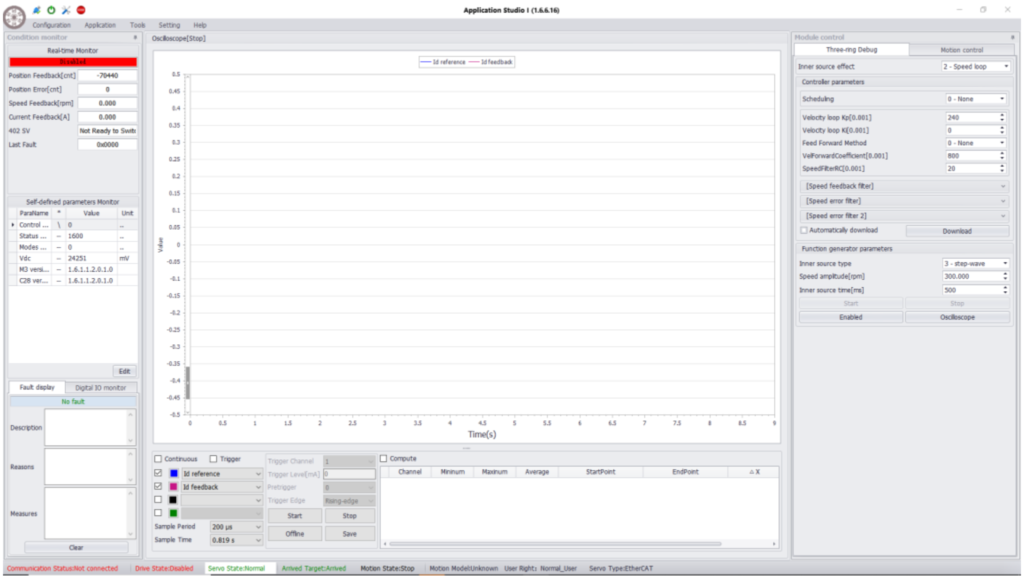


Figure 3-19 Velocity loop debugging interface

2. Do the following preparation works:
   a. Set the inertia ratio to 0X2422.
   b. Set the following parameters to 0:
      - ✓ 0x2020:01 Filter type of measured speed
      - ✓ 0x2021:01 Filter type of speed error filter
      - ✓ 2022:01 Filter type of speed error second filter
      - ✓ 2006 Feed forward method
3. Adjust Kp.
   a. Set Ki to 0 and Kp to 10, and click "**Download**":

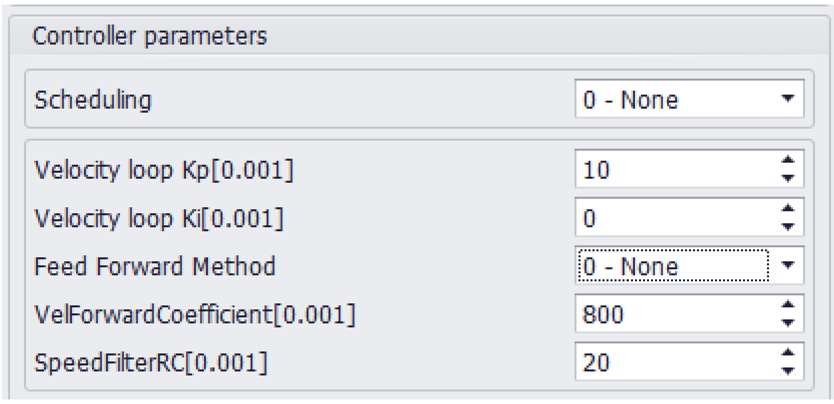


Figure 3-20 Control parameters of velocity loop

   b. Set the function type to step signal and velocity amplitude to 300 rpm, and set the duration according to the limit of running distance, i.e 500 ms.

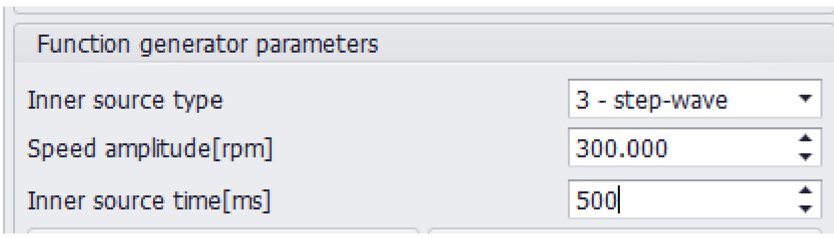


Figure 3-21 Function generator parameters of velocity loop

c. Turn oscilloscope again, set the sampling channel to velocity loop reference (speed given value) and velocity loop feedback (velocity feedback value), set the sampling period to 200 us, check "**Trigger Acquisition**", set the trigger edge to rising edge, set trigger channel to velocity loop reference, set trigger level to 10 rpm, and set pretrigger to 20%.

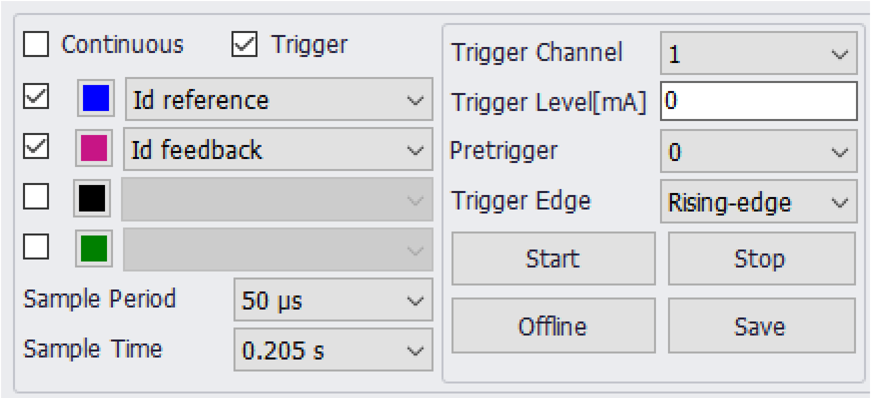


Figure 3-22 Oscilloscope sampling parameters of velocity loop

d. Enable the servo, start function generator, and click "Start Acquisition".
When the function type is set to step signal, there will be a delay of 4 - 5 seconds, to make sure that there is enough time for the oscilloscope to start acquisition.

e. Keep increasing Kp (generally increase 10 digits each time) and observe the waveform of velocity loop reference (speed given value) and velocity loop feedback (speed feedback value) until the critical oscillation shows in the velocity waveform:

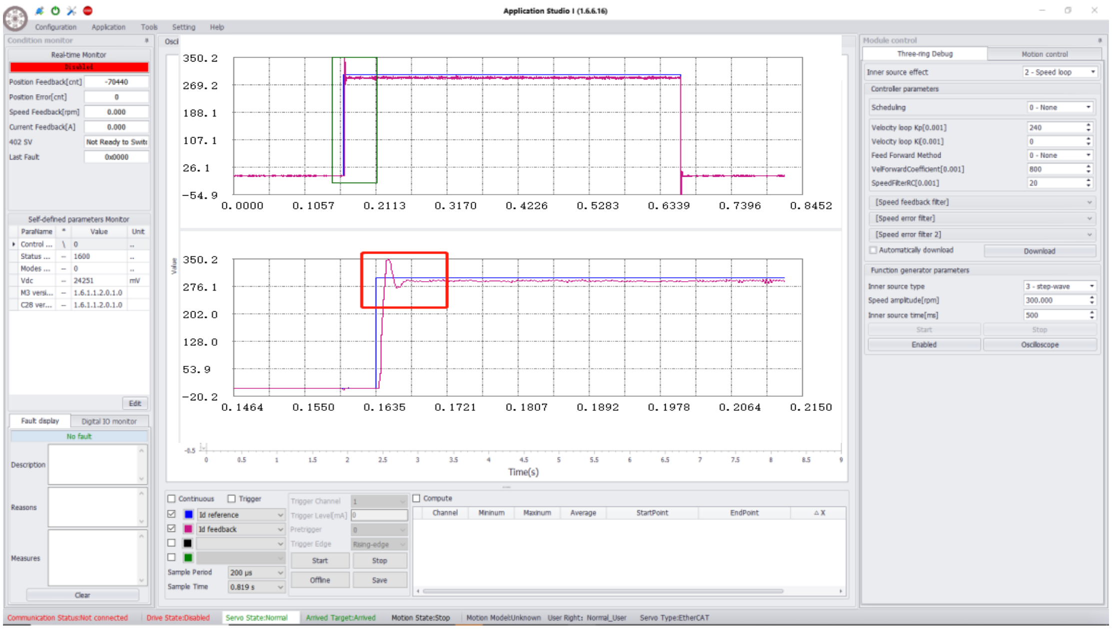


Figure 3-23 Velocity sampling waveform after adjusting Kp

f. Take 70% - 80% of the value of Kp, and stop the oscilloscope acquisition and function generator.

4. Adjust Ki.

Gradually increase Ki, and repeat step **c** and **d** of adjusting Kp until the steady-state error of velocity loop feedback is eliminated and the overshoot is within 30%:

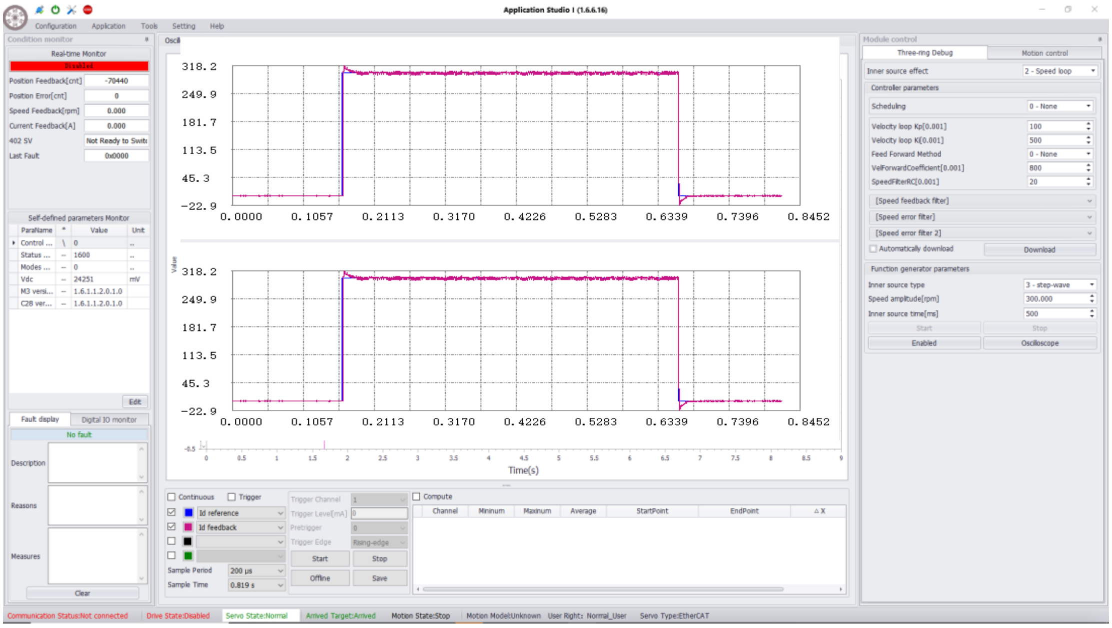


Figure 3-24 Velocity sampling waveform after adjusting Ki

To reduce the velocity deviation during acceleration, you can do debugging for torque feed forward as follows:

1. To enable the feed forward function, set 2006 to 2.
2. Set 2019 Torque feed forward time constant to a fixed value, and keep increasing 2016 Speed feed forward coefficient until a good result of velocity feed forward shows at a certain value.
3. Repeatedly adjust 2019 and 2016 to find a balance.

Note: Improper debugging will cause system oscillation. If oscillation or mechanical resonance occurs during debugging, you can set 0x2021 / 0x2022 Filter type of speed error filter to eliminate the oscillation frequency:

Parameter	Description
200C:01 Measured speed filter	The filter value of measured speed
200F:01 Speed error filter	The filter value of speed error
2010:01 Speed error second filter	The filter value 2 of speed error
2020:01 Filter type of measured speed filter	The filter type of measured speed
2020:02 Frequency of measured speed filter	The filter frequency of measured speed
2020:03 Quality factor of measured speed filter	The filter quality factor of measured speed
2021:01 Filter type of speed error filter	The filter type 1 of measured speed
2021:02 Frequency of speed error filter	The filter frequency 1 of measured speed
2021:03 Quality factor of speed error second filter	The filter quality factor 1 of measured speed
2022:01 Filter type of speed error filter	The filter type 2 of measured speed
2022:02 Frequency of speed error filter	The filter frequency 2 of measured speed
2022:03 Quality factor of speed error second filter	The filter quality factor 2 of measured speed
2421 Velocity Average Filtering	Velocity average filter (internal use)

3.4.3 Position Loop

The third debugging is for position loop.

1. Select **"Position Loop"**. The debugging interface of the position loop shows as in Figure 3-25.

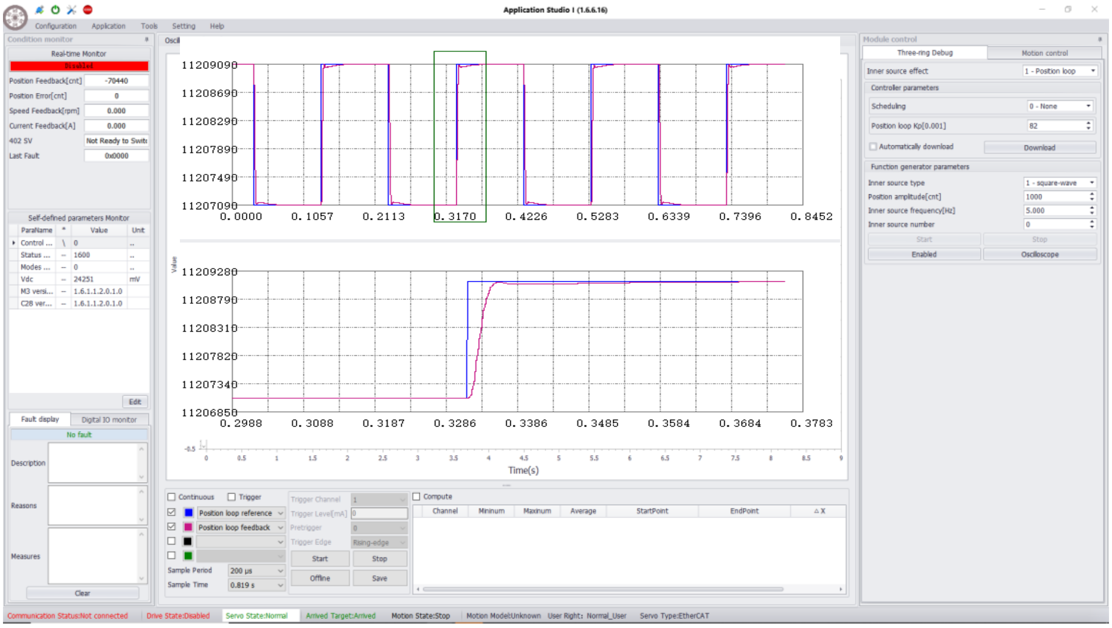


Figure 3-2 5 Debugging interface of position loop

2. Adjust Kp.

   a. Set Kp, and click "**Download**".

   It is recommended to use the default value 10 at first, and modify it after obtain the position curve.

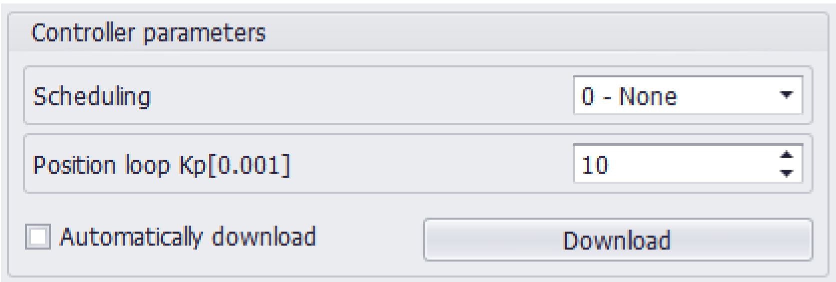


Figure 3-26 Control parameters of position loop

   b. Set the function type to square wave signal, position amplitude to 1000 cnt (the current position is zero, the motion amplitude is 1000 cnt. Please pay attention to the mechanical stroke), and signal frequency to 5 Hz.

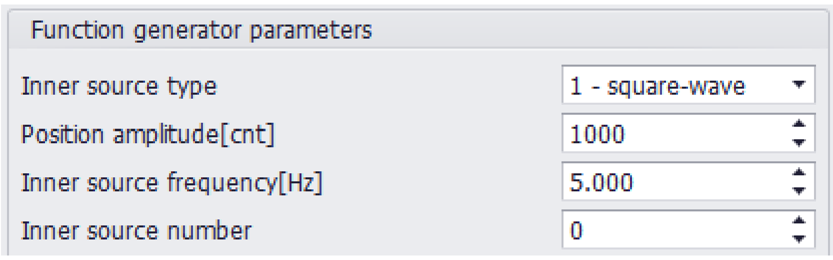


Figure 3-27 Function generator parameters of position loop

c. Turn on oscilloscope, set the sampling channel to position loop reference (position given value) and position loop feedback (position feedback value), set the sampling period and duration to proper values, and check continuous acquisition.

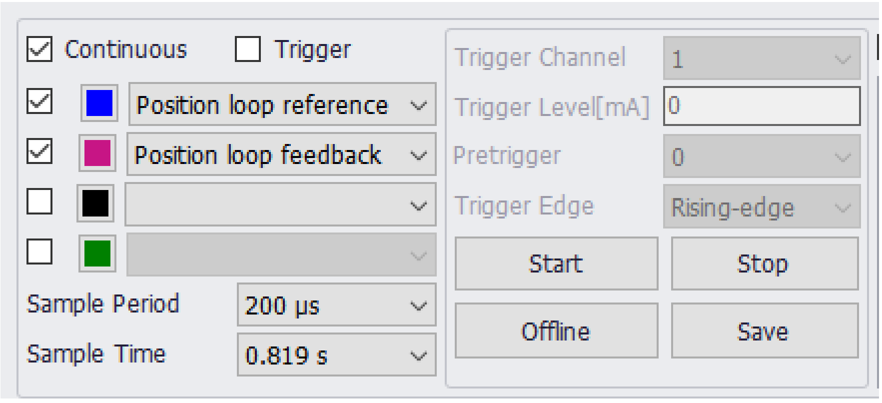


Figure 3-28 Oscilloscope sampling parameters of position loop

d. Observe the waveform of position loop reference (position given value) and position loop feedback (position feedback value), and adjust Kp as follows until the result of waveform is good with unsaturated current:

✓ Increase Kp when the position follow-up error is large or the response is slow.

✓ Reduce Kp when the position overshoot or jitter occurs.

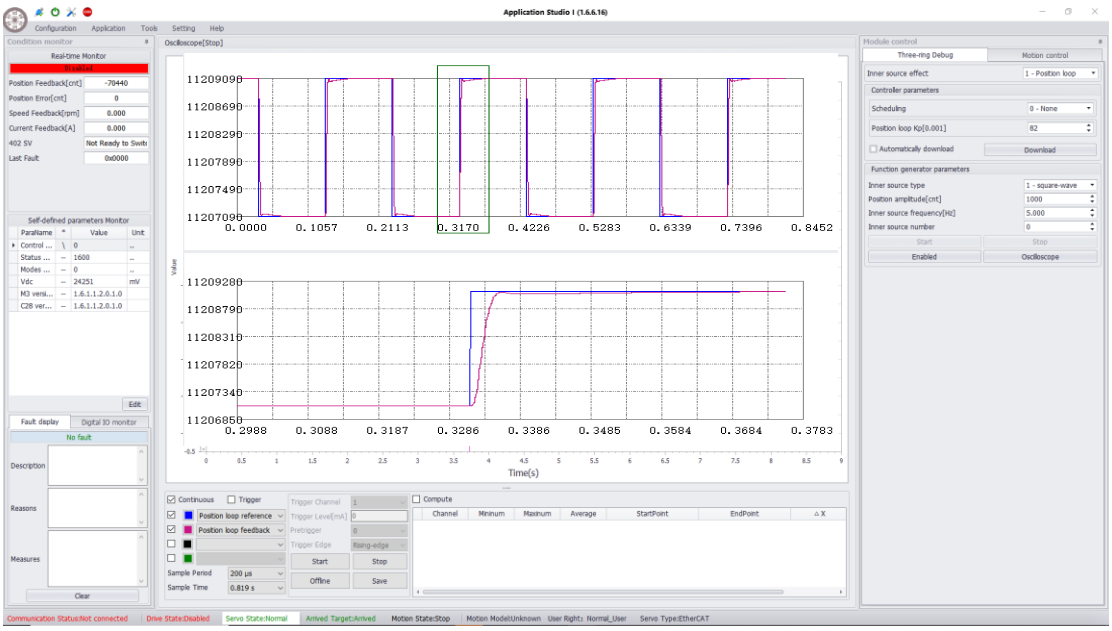


Figure 3-29 Position sampling waveform after adjusting Kp

In actual application, if not satisfied with the position follow-up error, you can carry out debugging for torque feed forward and speed feed forward as follows:

1. To enable the feed forward function, set 0x2006 to 2.
2. Set 0x2019 Torque feed forward time constant to a fixed value, and keep increasing 2016 velocity feed forward coefficient until a good result of velocity feed forward shows at a certain value.
3. Repeatedly adjust 0x2019 and 0x2016 to find a balance.

After adjusting the position loop gain, the motor makes low-frequency audible noise in the enabled but not running state, which will reduce the velocity loop Kp or the current loop Kp. If the value of position loop Kp is too small, the rigidity is weak.

3.4.4 Grouping Gain

Grouping gain can be set in the situation where the inertia load changes and a group of fixed gain parameters of velocity loop and position loop cannot satisfy high, medium and low speed. Its principle is as follows:

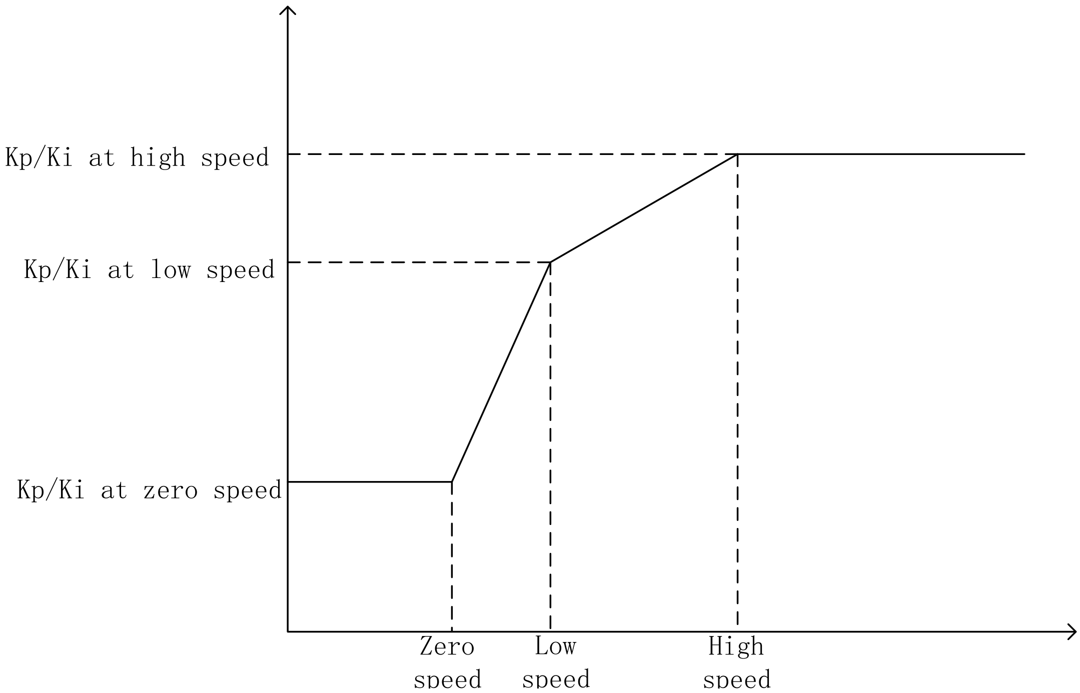


Figure 3-3 0 Principle of grouping gain

Take the velocity loop as an example: when setting the grouping gain, you can set the actual speed or the given speed:

Actual Speed / Given Speed:	Gain Parameter
0 - zero speed	Kp and Ki at zero speed
Zero speed - low speed	● Kp increases with the slope (Kp at low speed - Kp at zero speed) / (low speed - zero speed). ● Ki increases with the slope (Ki at low speed - Ki at zero speed) / (low speed - zero speed)
Low speed - high speed	● Kp increases with the slope (Kp at high speed - Kp at low speed) / (high speed - low speed). ● Ki increases with the slope (Ki at high speed - Ki at low speed) / (high speed - low speed)
> High speed	Kp and Ki at high speed

3.5 Motion Control

After setting motor parameters, encoder parameters and control parameters, the motor can be simply driven. The modes that the software controls the servo drive to drive the motor include the following:

- Position mode
- Speed mode
- Homing mode

- Torque mode

3.5.1 Position Control Mode

The process of motion control in position mode is as follows:

1. Click "**Motion**" in the main menu, and click "**Position Mode**". The interface of motion control in position mode shows as in Figure 4-31.

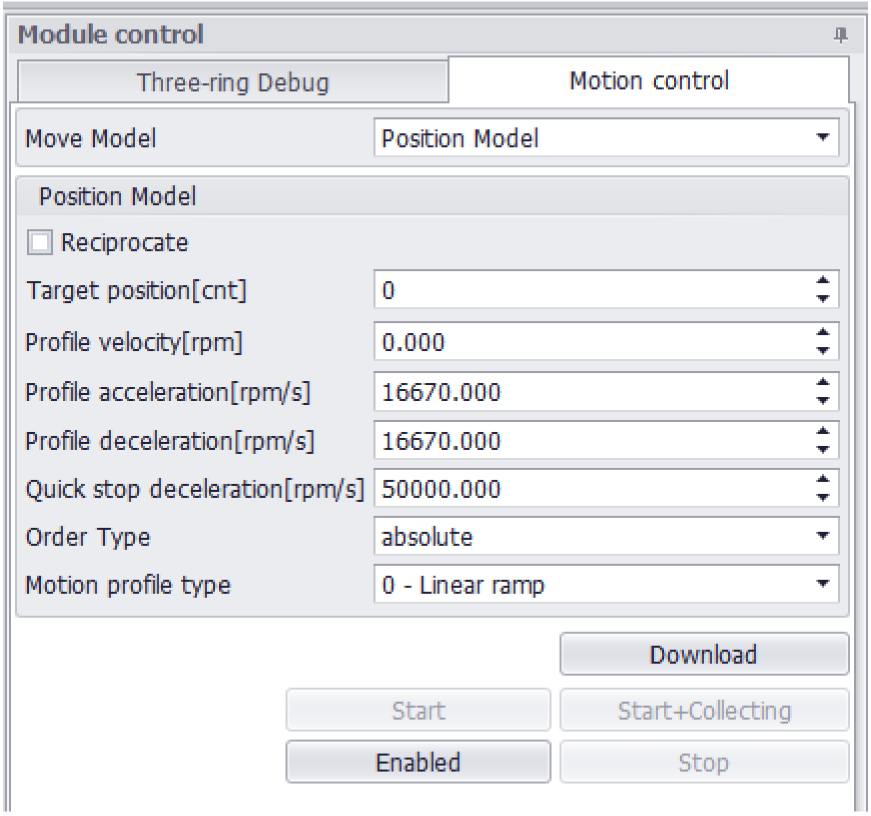


Figure 3-31 Interface of motion control in position mode

2. Set the following parameters:
   - ✓ Motion mode: to set the position motion as unidirectional motion or reciprocating motion.
   - ✓ Target position: to control the distance of motor movement. When the motion mode is set to reciprocating motion, you need to set two target positions.
   - ✓ Speed: the movement speed of the motor.
   - ✓ Acceleration: the acceleration to start the motor.
   - ✓ Deceleration: the deceleration to stop the motor.
   - ✓ Deceleration for quick stop: the deceleration to stop the motor when the motor is directly disabled.
   - ✓ Command type: absolute, to start movement with zero point of the encoder as the start point; relative, to start movement with current position of the encoder as zero point.
   - ✓ Curve type: including linear ramp (straight line) and Jerk-limited ramp (S-shaped curve).
   - ✓ Waiting time: the waiting delay time for the arrival of the target position when the motion mode is set to reciprocating motion.
   - ✓ Cycle times: the number of reciprocating cycles when the motion mode is set to

reciprocating motion. Infinite cycle means cycle will continue all the time.

3. To enable the servo drive, click "**Enable**".
4. To start motion control in position mode and start acquisition oscilloscope, click "**Start**" and **"Start Acquisition**".

3.5.2 Velocity Control Mode

The process of motion control in position mode is as follows:

1. Select **"Velocity Mode".** The interface of motion control in velocity mode shows as in Figure 3-32.

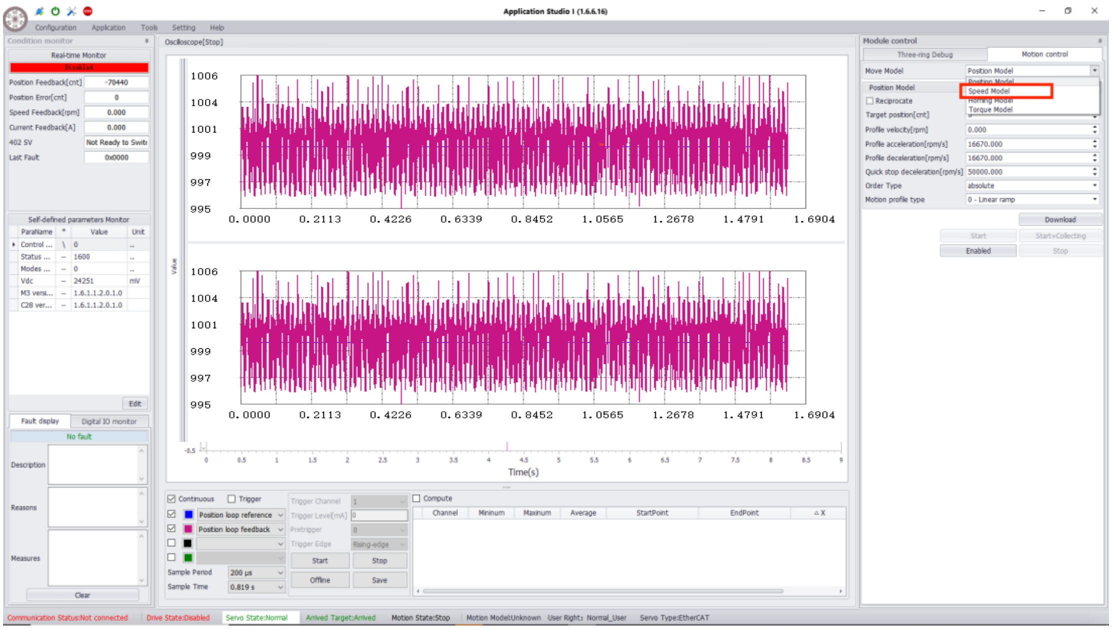


Figure 3-32 Interface of motion control in velocity mode

2. Set the following parameters:
   - ✓ Target speed: the movement speed of the motor.
   - ✓ Acceleration: the acceleration to start the motor.
   - ✓ Deceleration: the deceleration to stop the motor.
   - ✓ Deceleration for quick stop: the deceleration to stop the motor when the motor is directly disabled.
3. To enable the servo drive, click "**Enable**". **Servo Enable** shows in the interface.
4. To control the motor to move in the positive direction, click "**Forward**", to control the motor to move in the opposite direction, click "**Reverse**".

3.5.3 Homing Mode

The process of motion control in homing mode is as follows:

1. Select **"Homing Mode".** The interface of motion control in homing mode shows as in Figure 3-33.

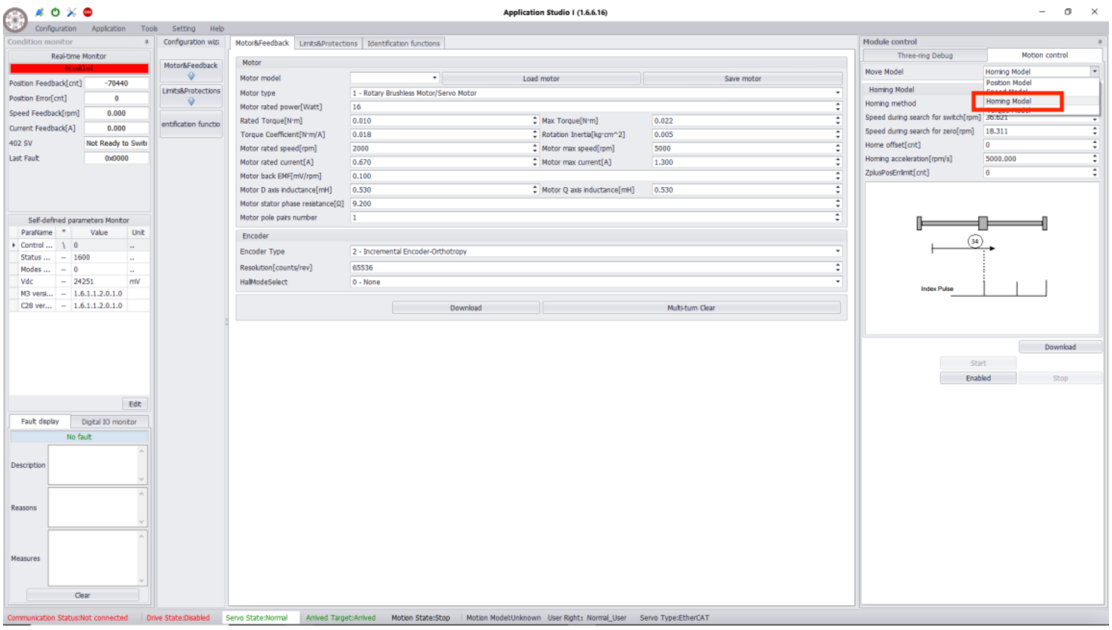


Figure 3-3 3 Interface of motion control in homing mode

2. Set the following parameters:
   - ✓ Homing method: there are 35 homing methods. When starting, the motor moves according to the selected homing method.
   - ✓ High speed for homing: when starting, the motor starts to find the zero point at high speed.
   - ✓ Low speed for homing: when starting, the motor moves to the zero point at low speed after it finds the zero point.
   - ✓ Zero offset: after setting the zero offset, the motor finally stops at the position behind the offset.
   - ✓ Acceleration and deceleration for homing: when starting, the acceleration and deceleration for homing.
3. To enable the servo drive, click "**Enable**". **Servo Enable** shows in the interface.
4. To make the motor move with the set homing method, click "**Start**", to stop the motor, click "**Stop**".

Homing

1. Homing method

- ✓ When using an incremental encoder, and when the servo does not know the position of the motor when it is powered on, homing is required every time it is powered on.
- ✓ When using an absolute encoder or incremental + Hall signal, homing is required only when the servo is powered on for the first time.

Note: The zero point calibration is the initial angle identification of the motor. If the initial angle identification is not performed, the motor may reverse or even run away. When using an incremental encoder, zero point calibration is required each time the power is on; when using an absolute encoder or incremental + Hall signal, zero point calibration is required only when the power is on for the first time.

2. **Related concepts**

Origin and zero point

- Home position: machine origin, which can represent origin switch or motor Z signal.
- Zero position: the position after homing finishes.

During homing, the motor stops at the home position. If the position deviation 607C is set, the motor stops at the zero position.

Zero position = Home position + 607C Home offset:

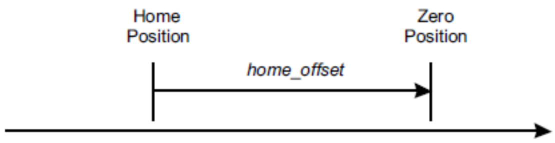


Figure 3-34 Relationship between origin and zero point

Speed

- High speed: the speed during finding the limit switch (different according to the origin mode). (6099-01h).
- Low speed: the speed during finding the origin after finding the limit switch. (6099-02h).
- Acceleration and deceleration: acceleration and deceleration during homing. (609A).

Direction

The direction in which the encoder value increases is the positive direction, and the direction in which the value decreases is the negative direction.

3.5.3.1 Homing Method

Note:

1. The numbers in the figure correspond to the corresponding homing methods. The same numbers indicates two ways of this homing method. For example, two ③ in the figure of method 3 indicates two different ways of the homing method 3.
2. The index pulse is the Z signal.
3. The bold color indicates homing at high speed.

3.5.3.2 Method 1: Homing on negative limit switch (falling edge) and index pulse

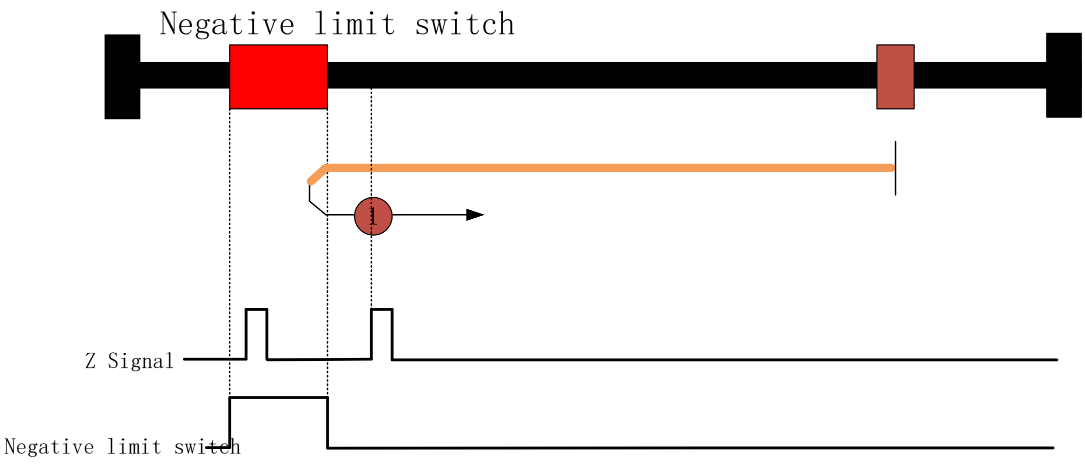


Figure 3-35 Method 1

When homing starts, the motor moves at a high speed (6099-01) in the negative direction. When the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the negative limit switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

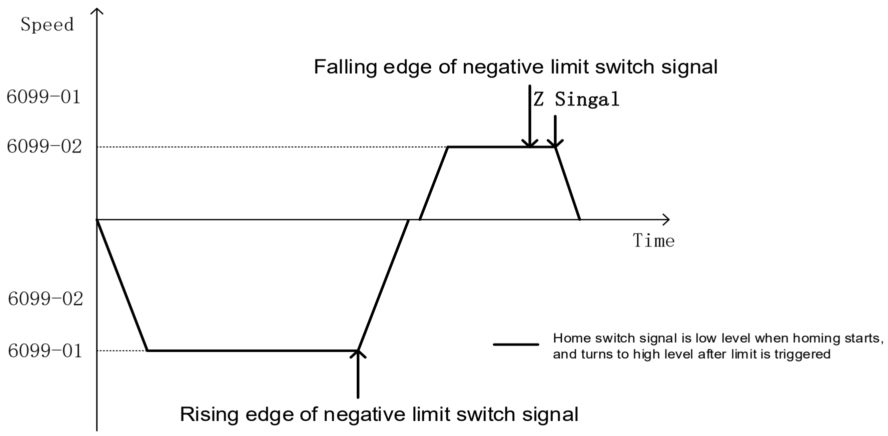


Figure 3-36 Speed-time curve of method 1

3.5.3.3 Method 2: Homing on positive limit switch (falling edge) and index pulse

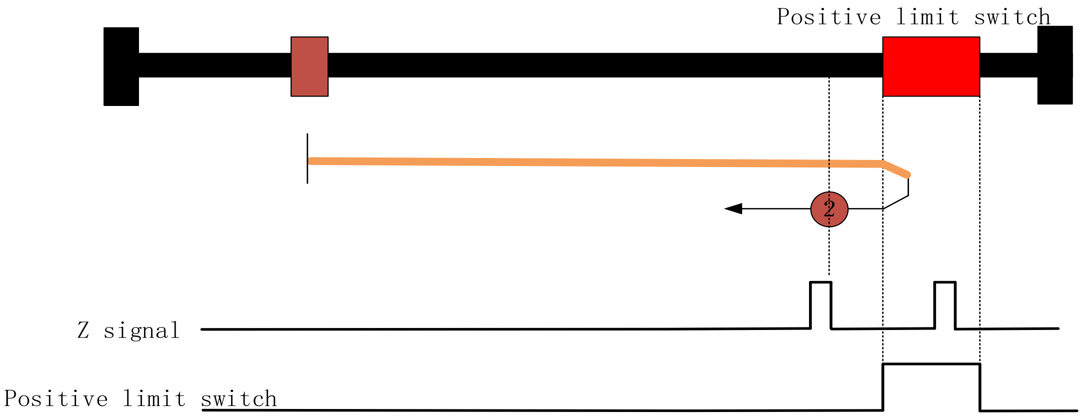


Figure 3-37 Method 2

When homing starts, the motor moves at a high speed (6099-01) in the positive direction. When the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive limit switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

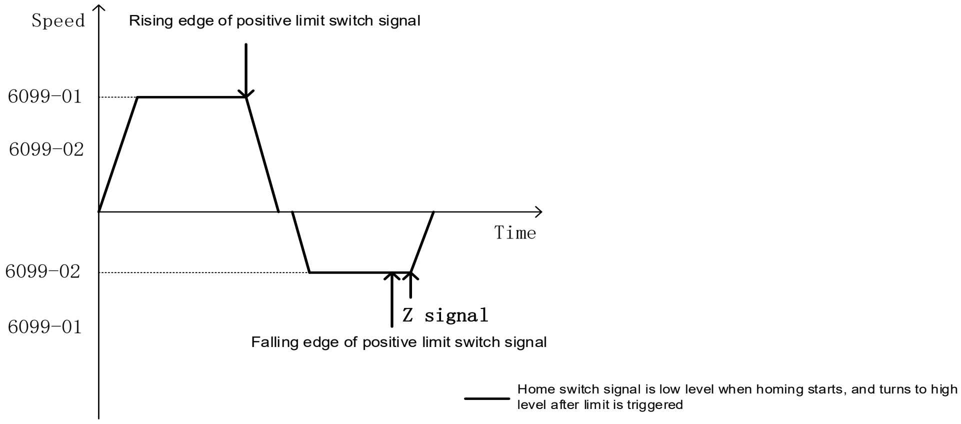


Figure 3-38 Speed-time curve of method 2

3.5.3.4 Method 3: Homing on positive home switch (falling edge) and index pulse

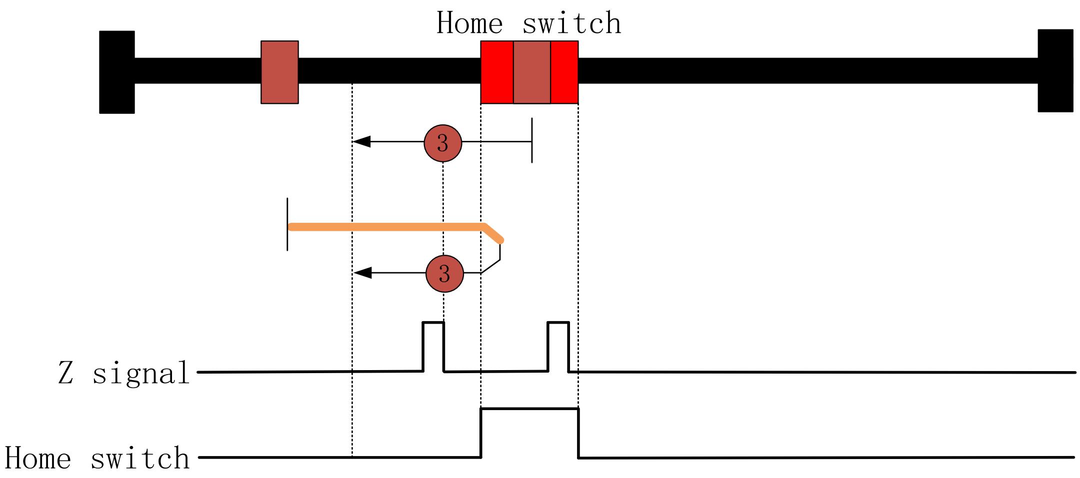


Figure 3-39 Method 3

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

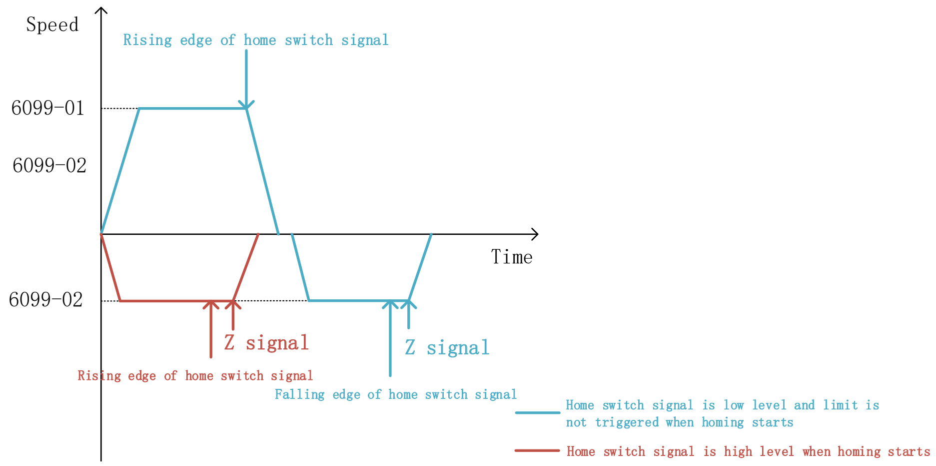


Figure 3-40 Speed-time curve of method 3

3.5.3.5 Method 4: Homing on positive home switch (rising edge) and index pulse

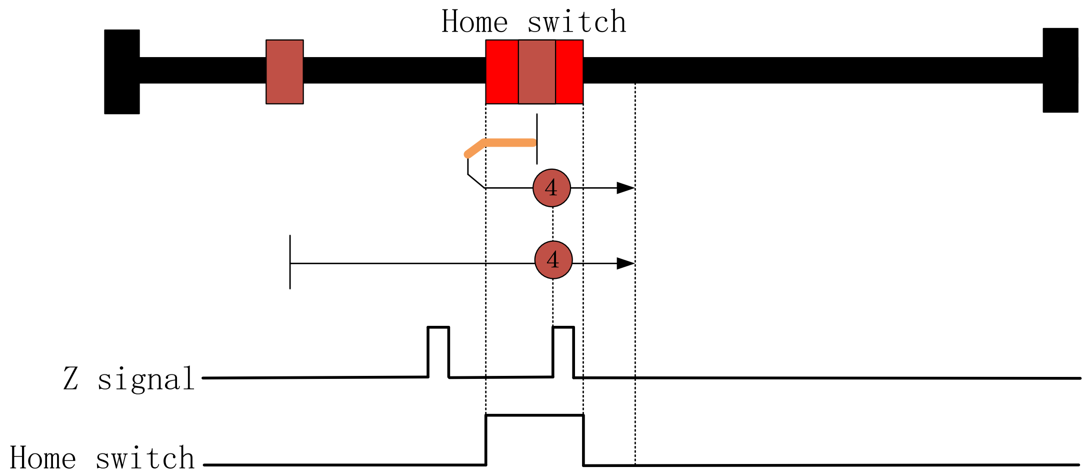


Figure 3-41 Method 4

原点开关：Home switch
Z 信号：Z signal

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally return to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally return to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.

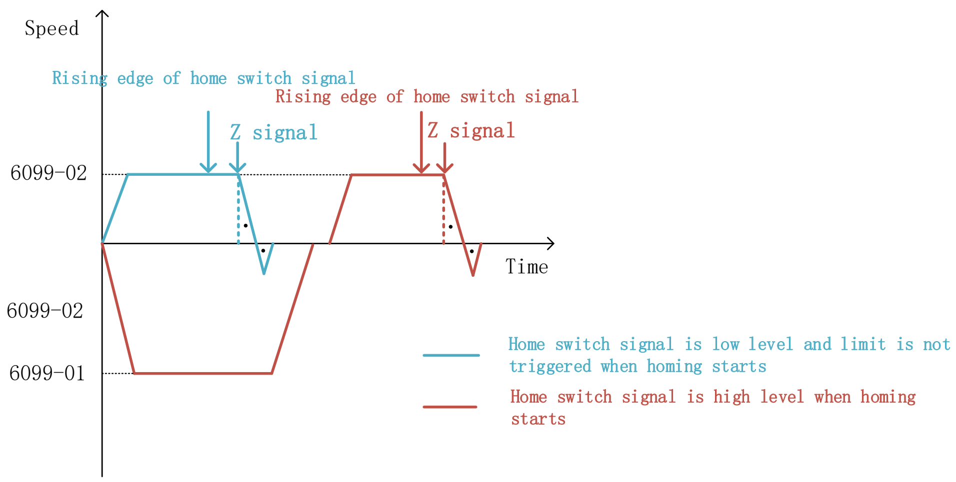


Figure 3-42 Speed-time curve of method 4

3.5.3.6 Method 5: Homing on negative home switch (falling edge) and index pulse

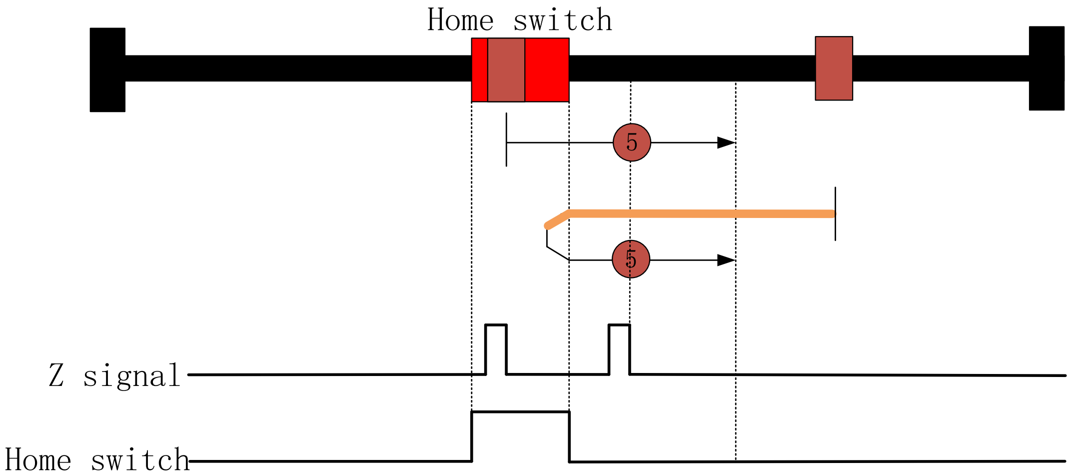


Figure 3-43 Method 5

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally returns to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally returns to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.

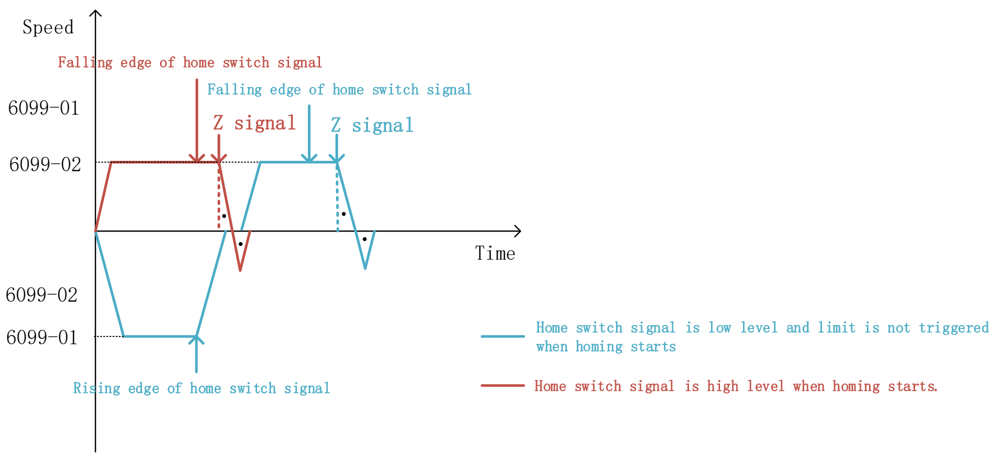


Figure 3-44 Speed-time curve of method 5

3.5.3.7 Method 6: Homing on negative home switch (rising edge) and index pulse

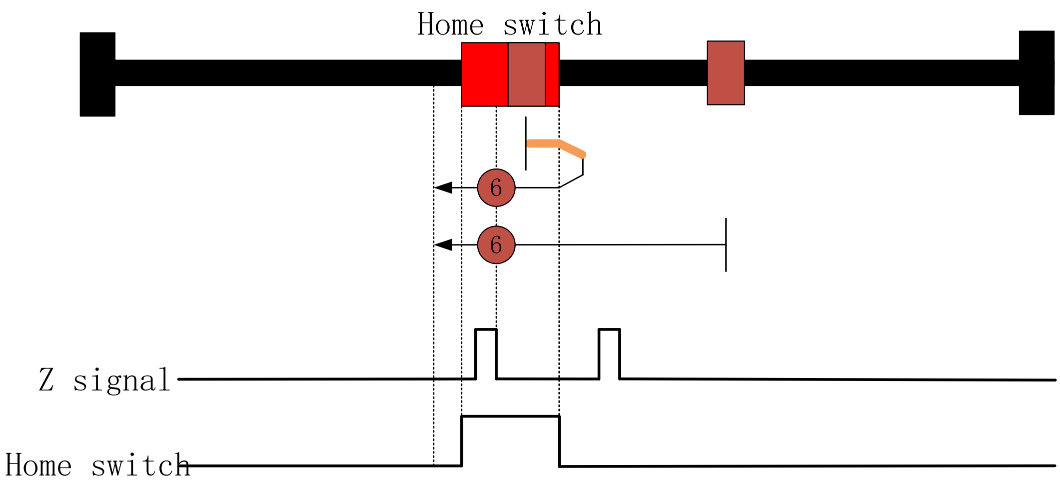


Figure 3-45 Method 6

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

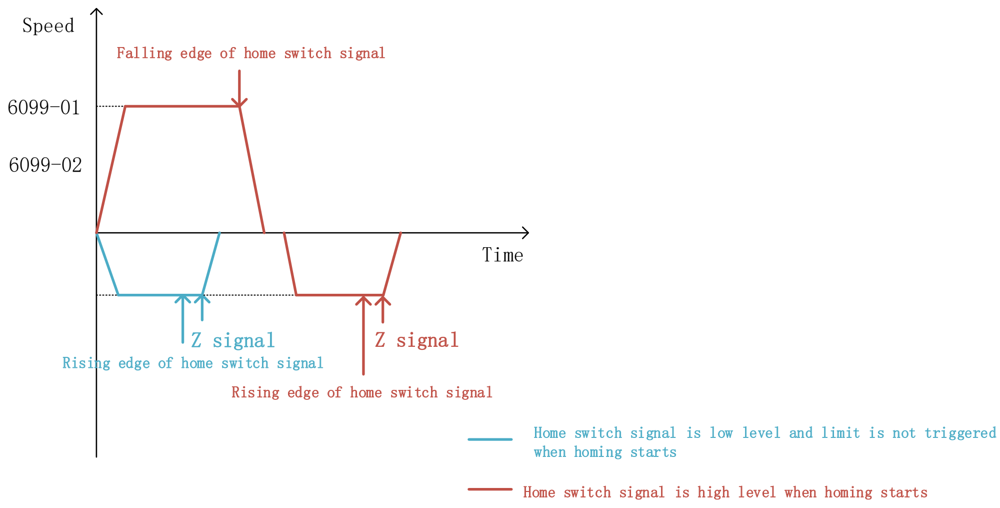


Figure 3-46 Speed-time curve of method 6

3.5.3.8 Method 7: Homing on negative home switch (falling edge) and index pulse-positive limit switch detection

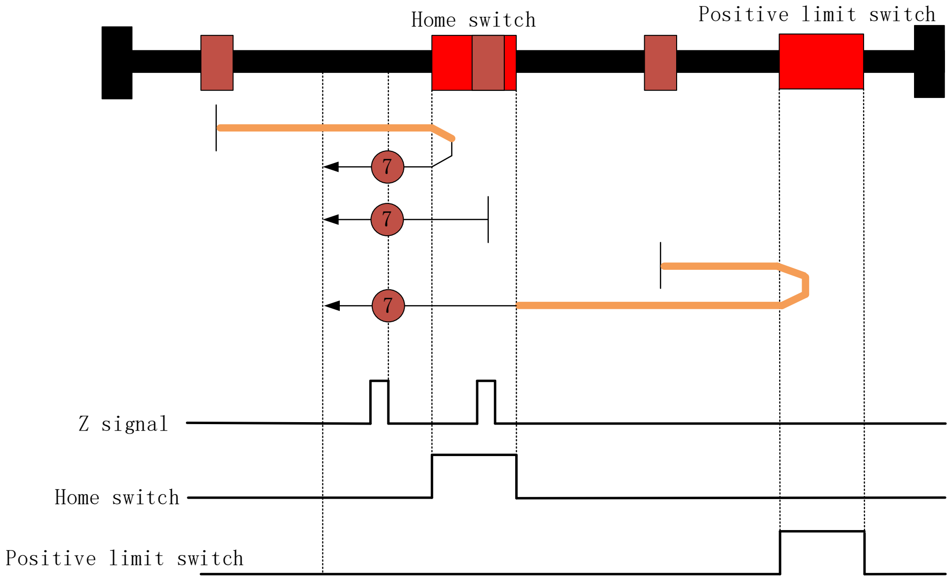


Figure 3-47 Method 7

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed in the positive direction.
  - ✓ After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates with homing deceleration (609A) to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the

motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

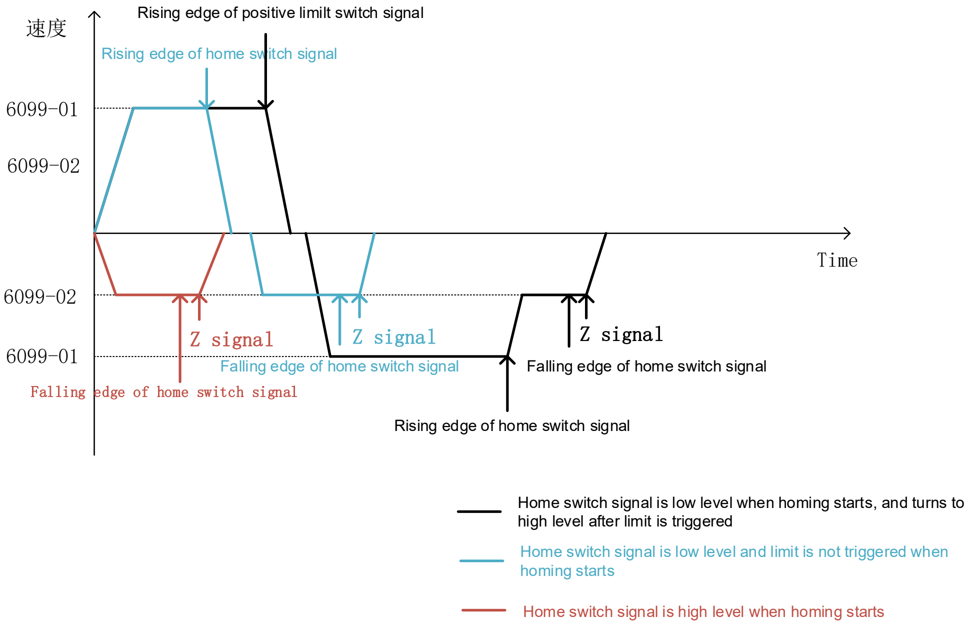


Figure 3-48 Speed-time curve of method 7

3.5.3.9 Method 8: Homing on positive home switch (rising edge) and index pulse-positive limit switch detection

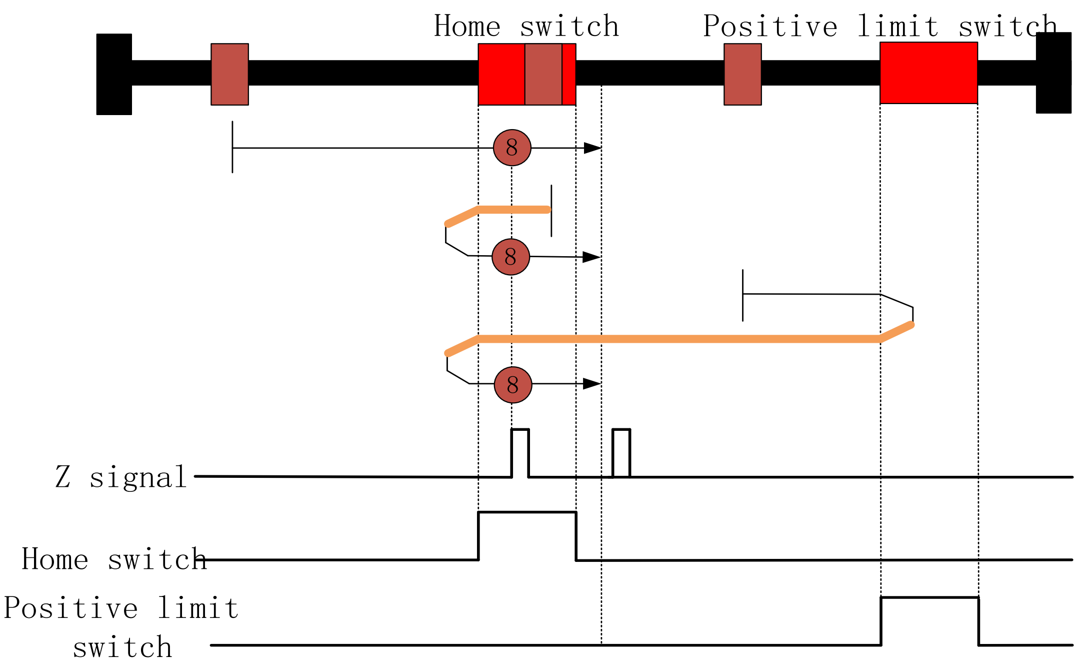


Figure 3-49 Method 8

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the positive direction.

✓ After the home switch signal becomes high level, the motor keeps moving at a low speed (6099-02) in the positive direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), move in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

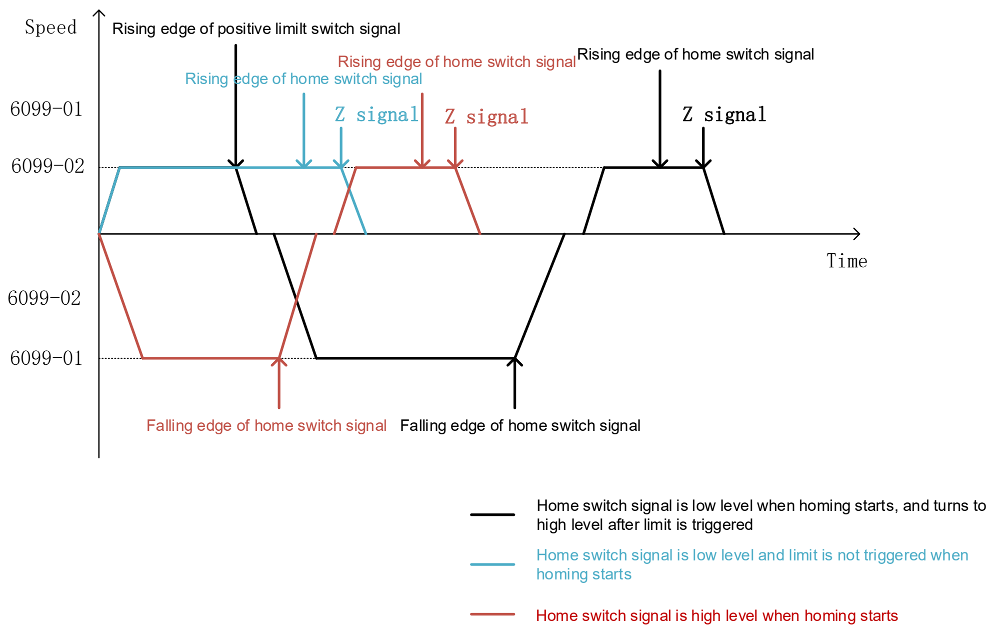


Figure 3-50 Speed-time curve of method 8

3.5.3.10 Method 9: Homing on negative home switch (rising edge) and index pulse-positive limit switch detection

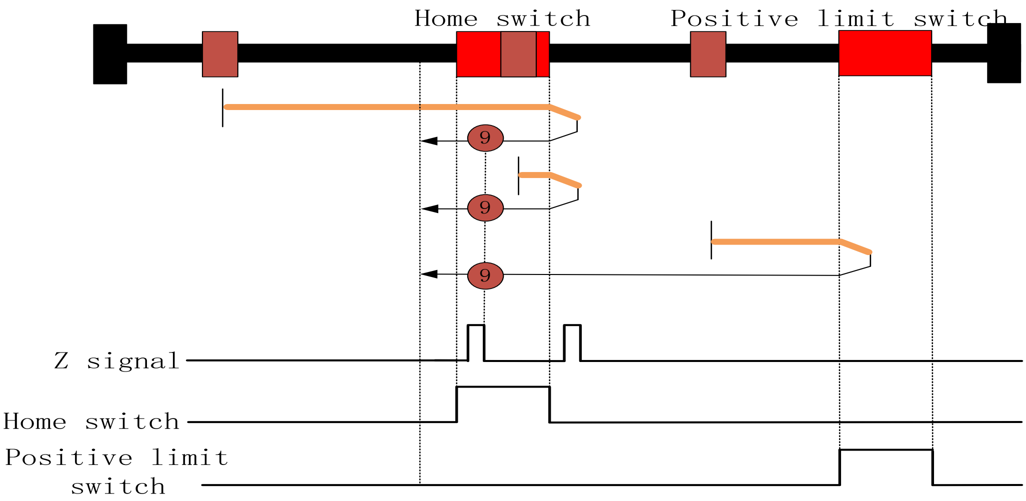


Figure 3-51 Method 9

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the positive direction.
  - ✓ After the home switch signal becomes high level, the motor keeps moving at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal changes from low level to high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing

attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

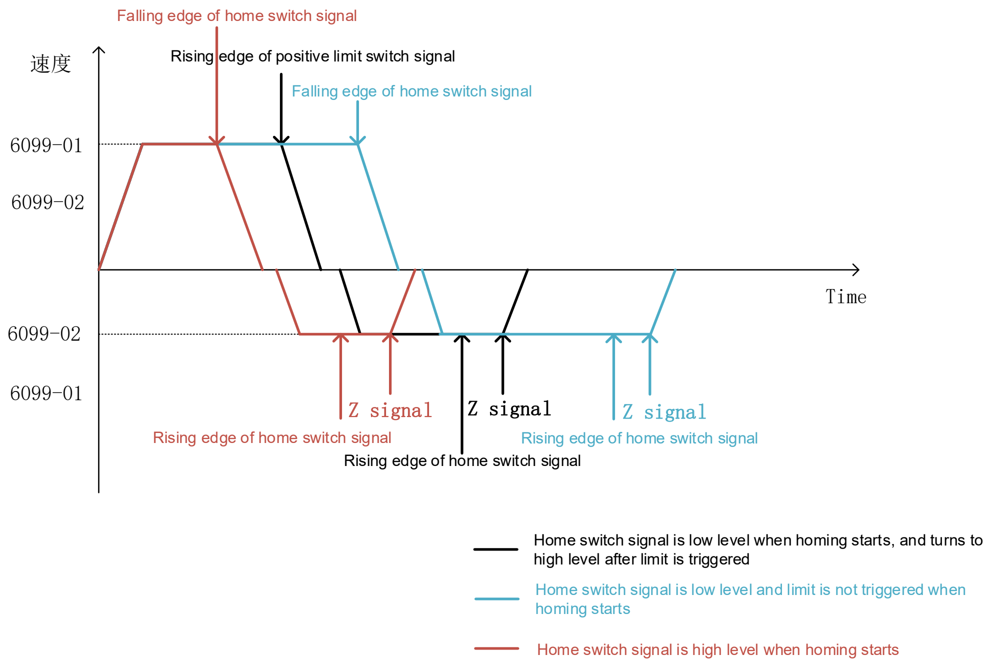


Figure 3-52 Speed-time curve of method 9

3.5.3.11 Method 10: Homing on positive home switch (falling edge) and index pulse-positive limit switch detection

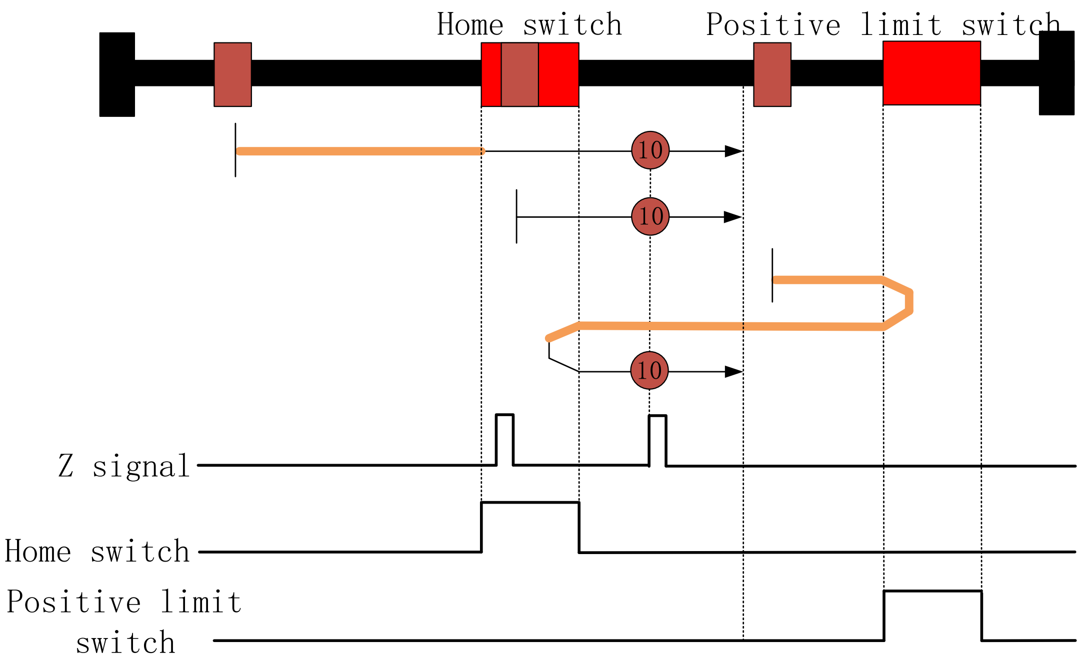


Figure 3-53 Method 10

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the positive direction.

- ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to a low speed (6099-02), and keeps moving at the low speed in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), move in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

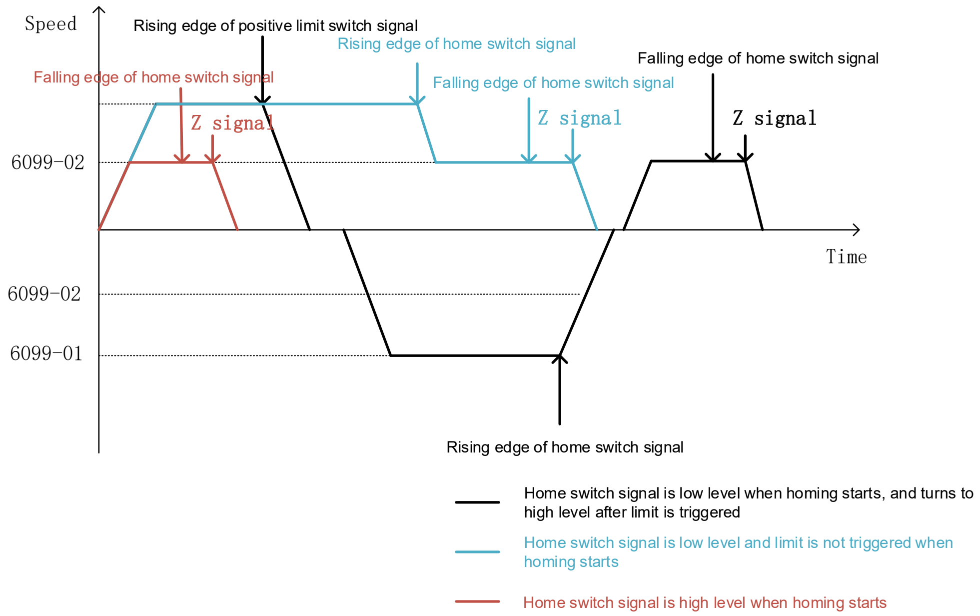


Figure 3-54 Speed-time curve of method 10

3.5.3.12 Method 11: Homing on positive home switch (falling edge) and index pulse-negative limit switch detection

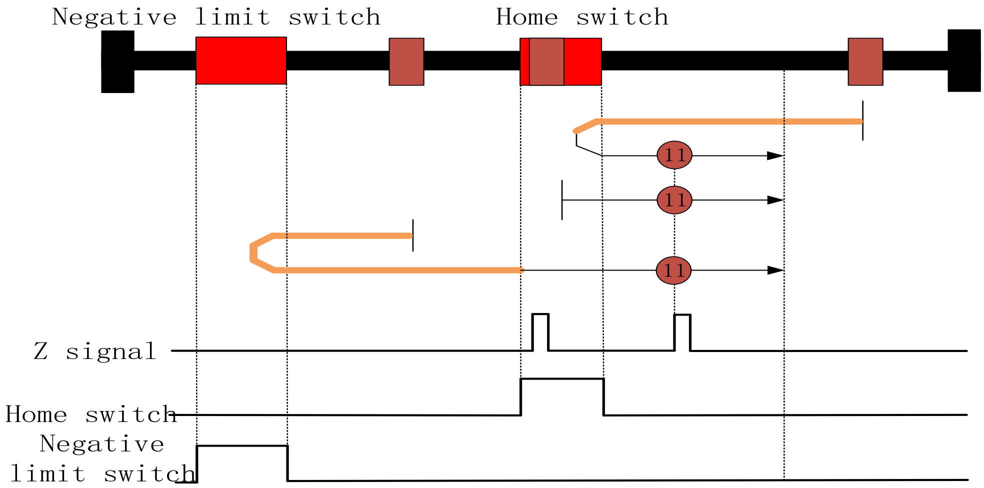


Figure 3-55 Method 11

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the negative direction.
  - ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to 0, and moves in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving at the low speed in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor decelerates to a low speed (6099-02) with the homing deceleration (609A), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

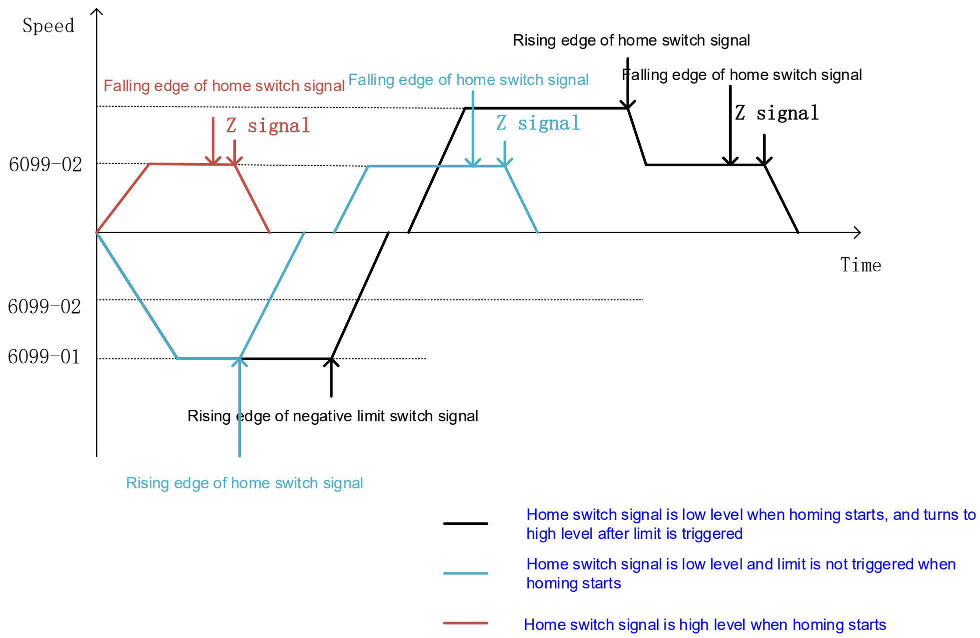


Figure 3-56 Speed-time curve of method 11

3.5.3.13 Method 12: Homing on negative home switch (rising edge) and index pulse-negative limit switch detection

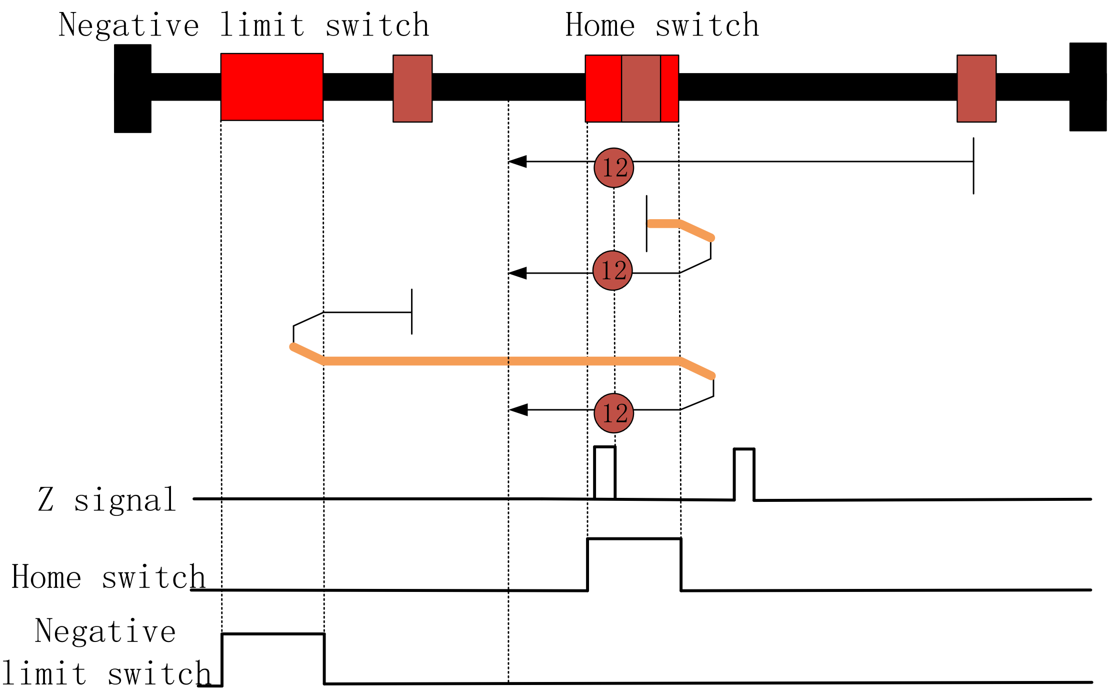


Figure 3-57 Method 12

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the negative direction.
  - ✓ After the home switch signal becomes high level, the motor keeps moving in the negative direction at a low speed (6099-02). After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status

word Target reached is set to 1 when the motor stops.

✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

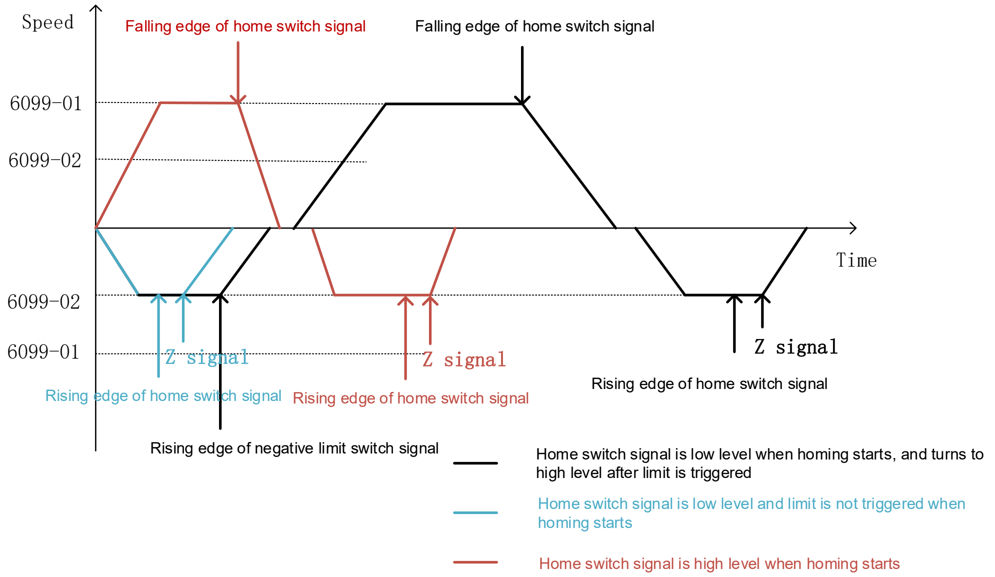


Figure 3-58 Speed-time curve of method 12

3.5.3.14 Method 13: Homing on positive home switch (rising edge) and index pulse-negative limit switch detection

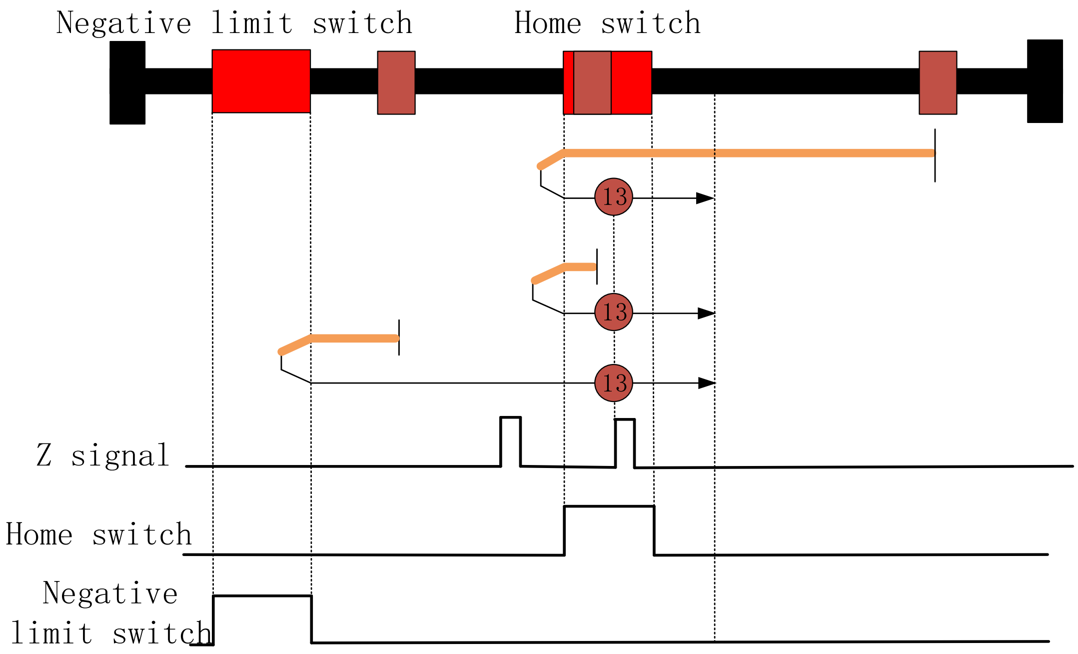


Figure 3-59 Method 13

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the negative direction.
  - ✓ After the home switch signal becomes high level, the motor keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the motor moves with the homing deceleration (609A) to decelerate to 0, and moves in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving at the low speed in the positive direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing

attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

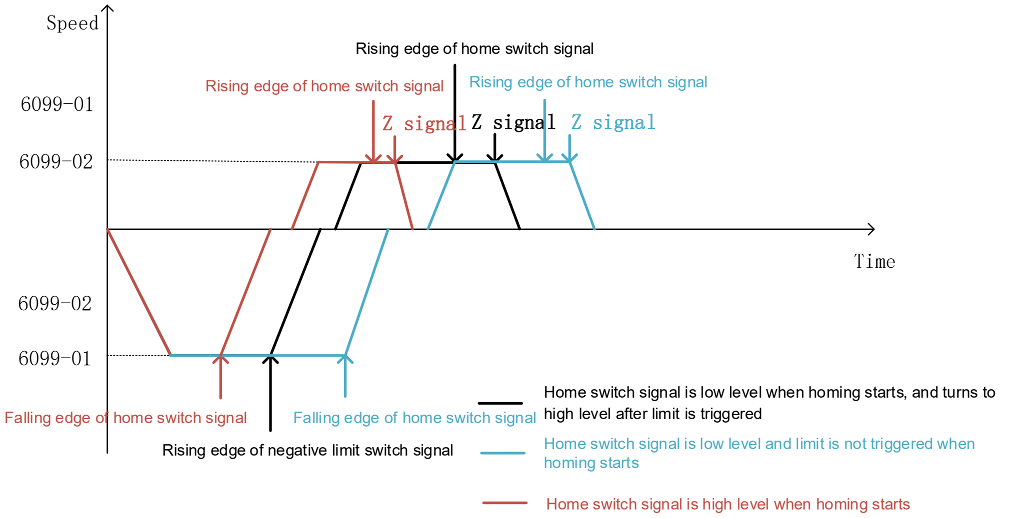


Figure 3-60 Speed-time curve of method 13

3.5.3.15 Method 14: Homing on negative home switch (falling edge) and index pulse-negative limit switch detection

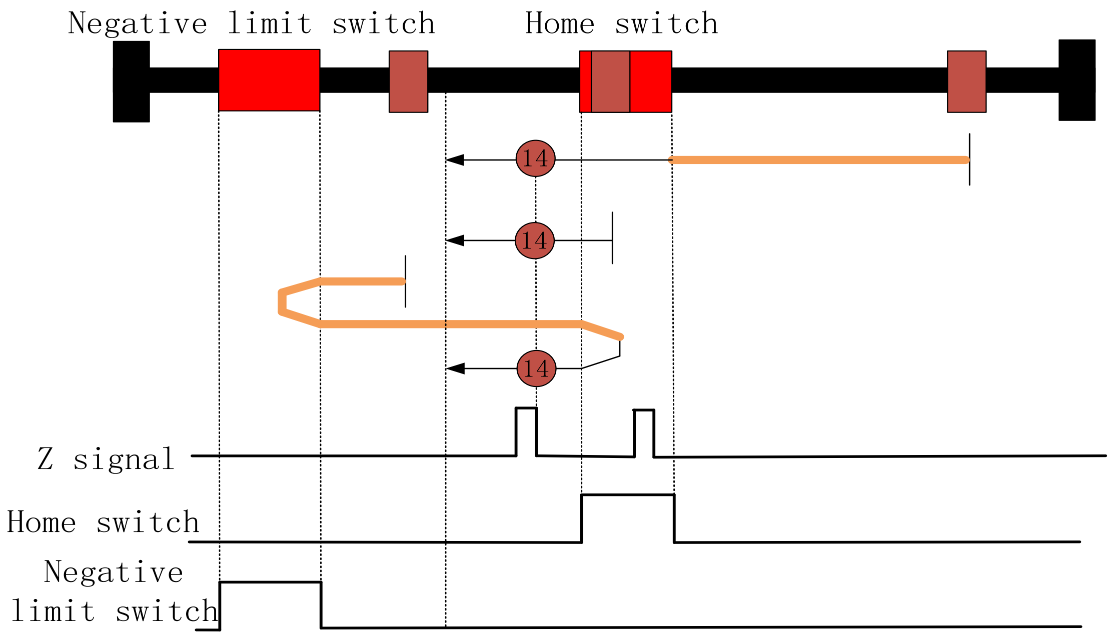


Figure 3-61 Method 14

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-02) in the negative direction.
  - ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to a low speed (6099-02), and keeps moving in the negative direction at a low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-01) in the negative direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

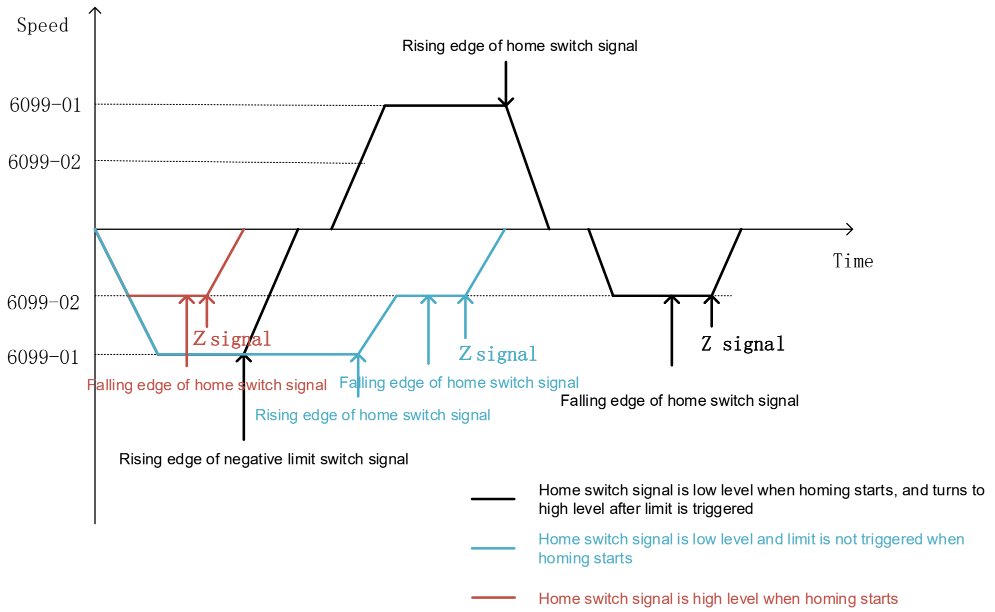


Figure 3-62 Speed-time curve of method 14

3.5.3.16 Method 15: Reserved

3.5.3.17 Method 16: Reserved

3.5.3.18 Method 17: Homing on negative limit switch (falling edge)

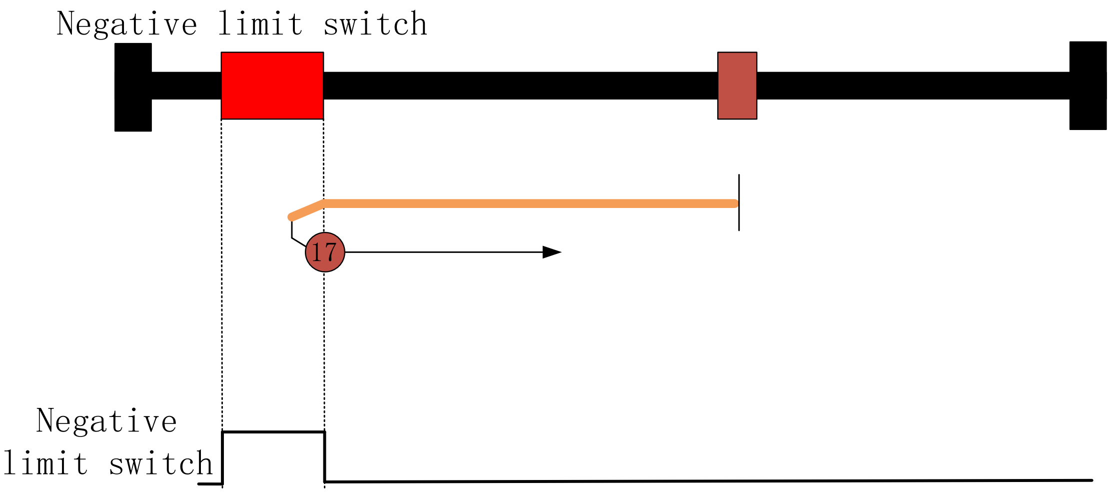


Figure 3-63 Method 17

When homing starts, the motor moves at a high speed (6099-01) in the negative direction. When the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the negative limit switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

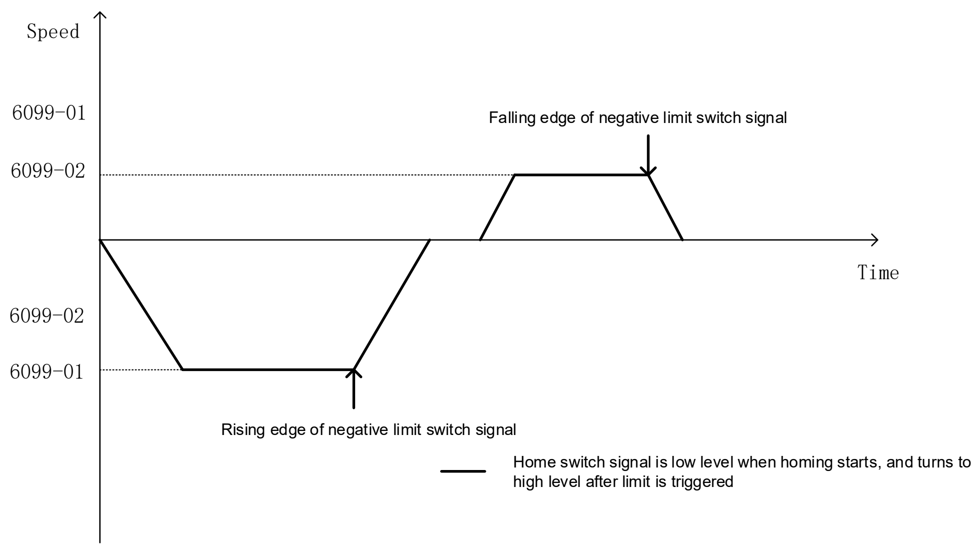


Figure 3-64 Speed-time curve of method 17

3.5.3.19 Method 18: Homing on positive limit switch (falling edge)

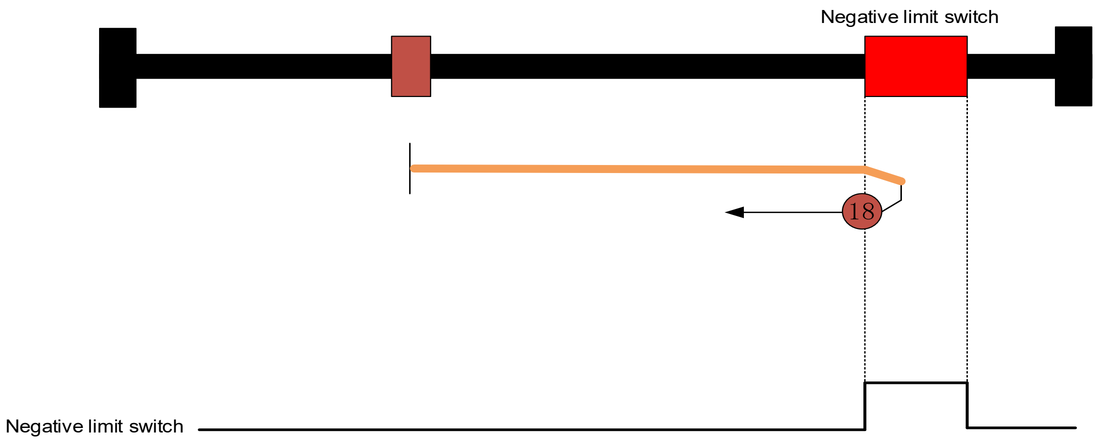


Figure 3-65 Method 18

When homing starts, the motor moves at a high speed (6099-01) in the positive direction. When the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive limit switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

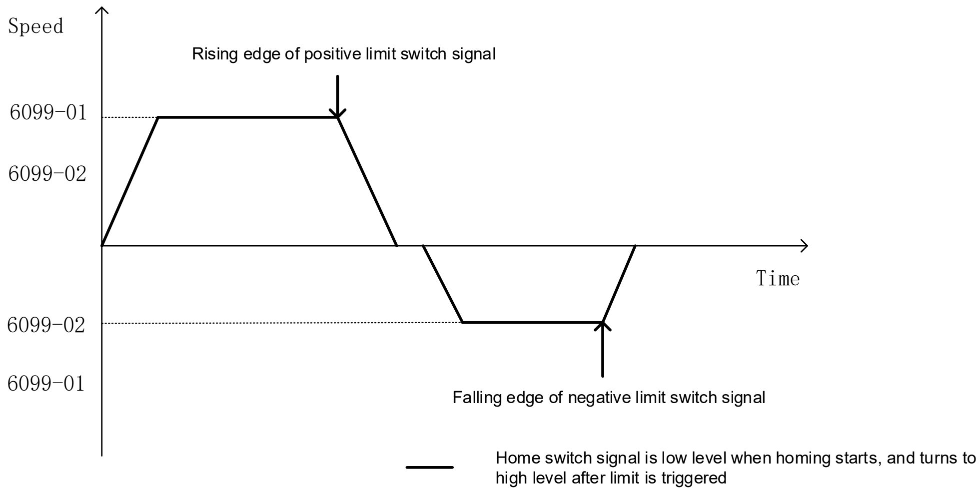


Figure 3-66 Speed-time curve of method 18

3.5.3.20 Method 19: Homing on negative home switch (falling edge)

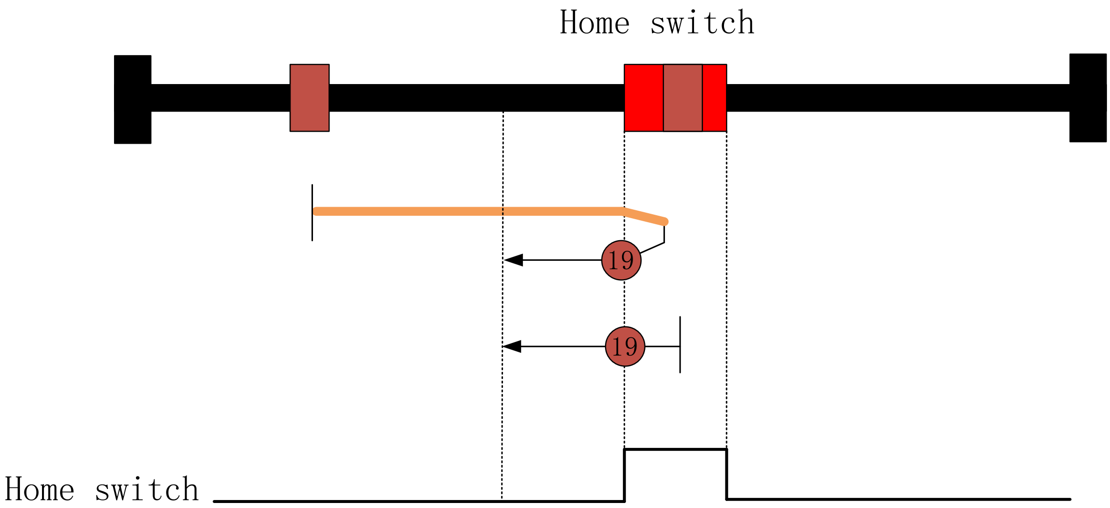


Figure 3-67 Method 19

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the positive direction. After the positive home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

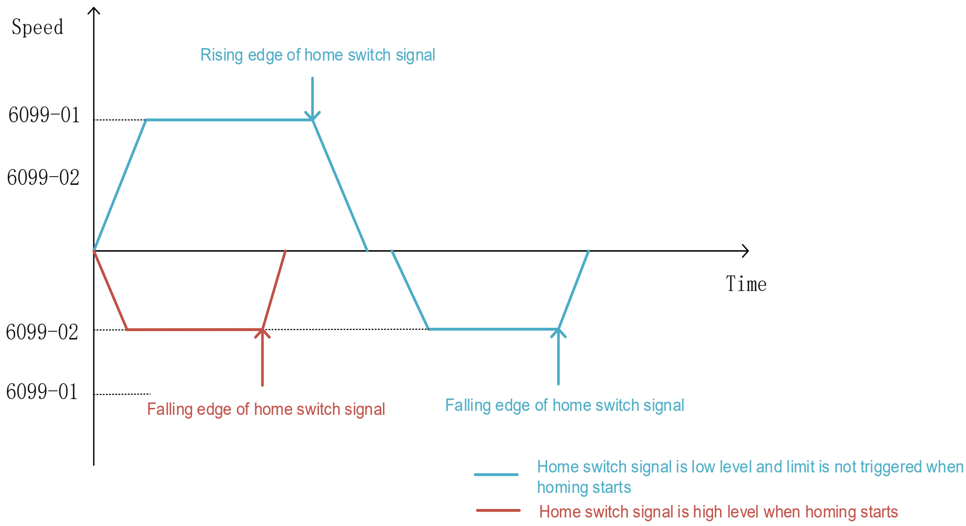


Figure 3-68 Speed-time curve of method 19

3.5.3.21 Method 20: Homing on positive limit switch (rising edge)

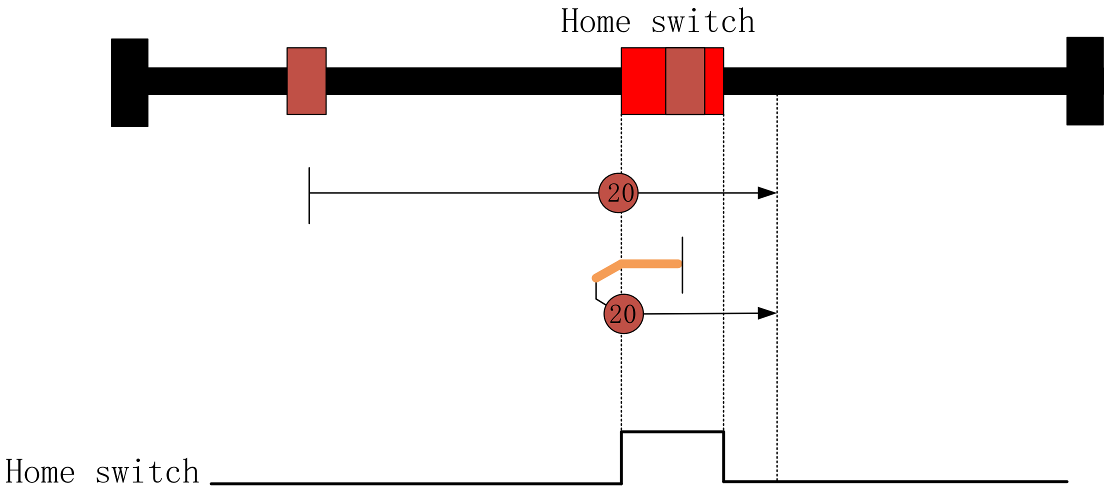


Figure 3-69 Method 20

- **When homing starts, if the positive home switch signal is low level,** the motor moves at a low speed (6099-02) in the positive direction. After the positive home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the positive home switch signal is high level,** the motor moves at a high speed (6099-01) in the negative direction. After the positive home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the positive home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

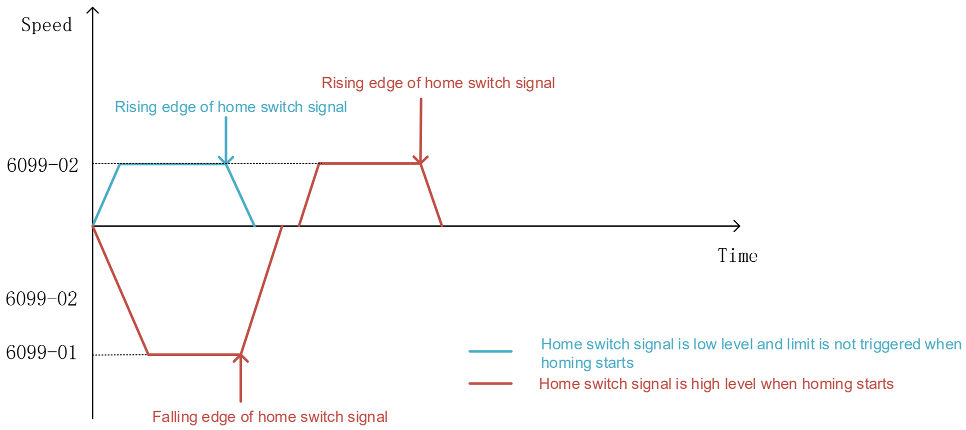


Figure 3-70 Speed-time curve of method 20

3.5.3.22 Method 21: Homing on negative home switch (falling edge)

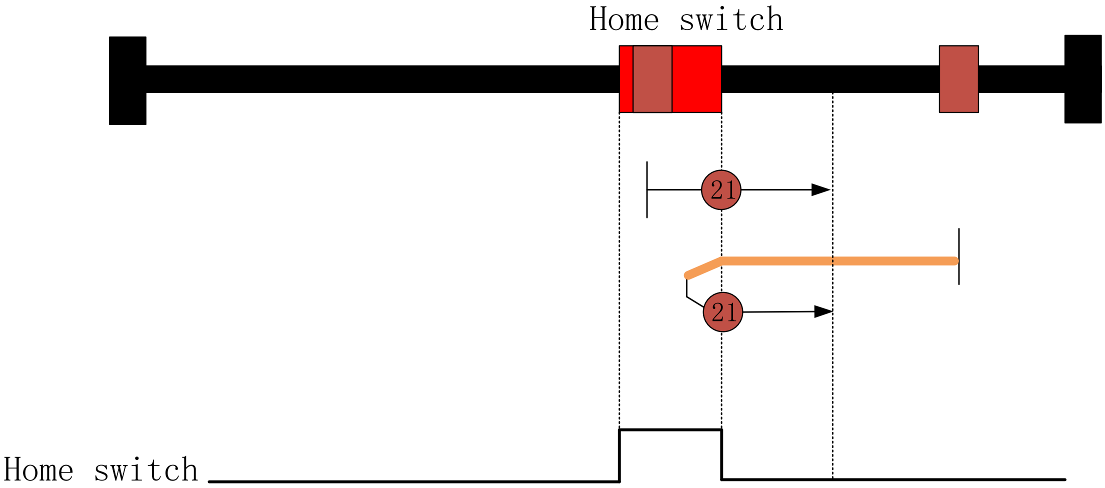


Figure 3-71 Method 21

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

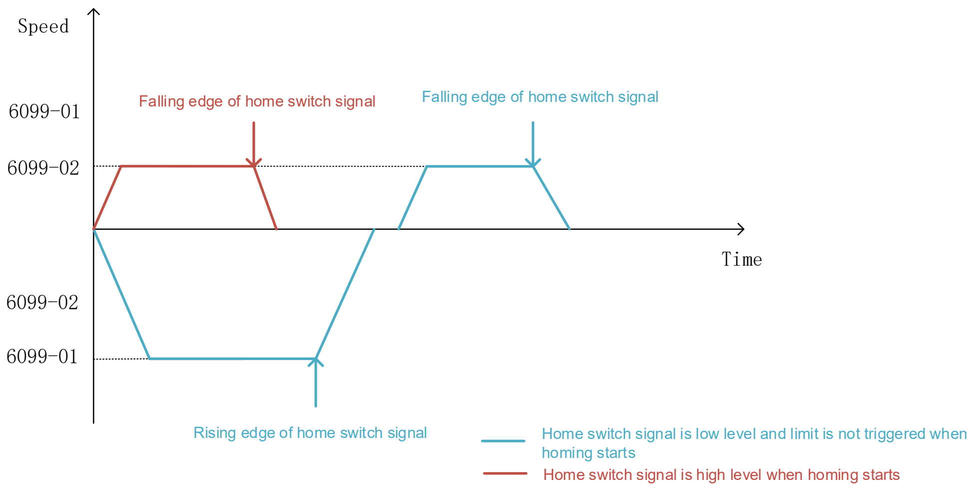


Figure 3-72 Speed-time curve of method 21

3.5.3.23Method 22: Homing on negative home switch (rising edge)

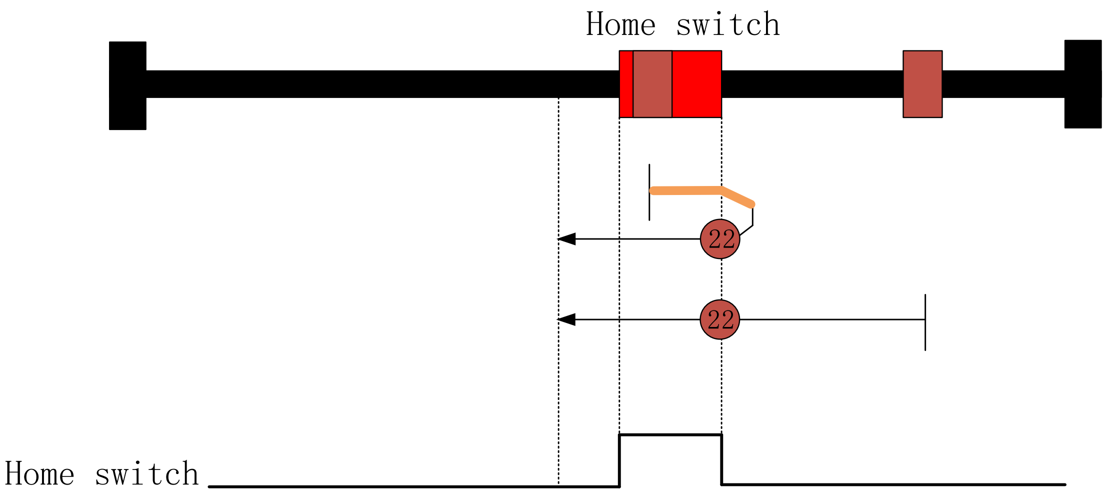
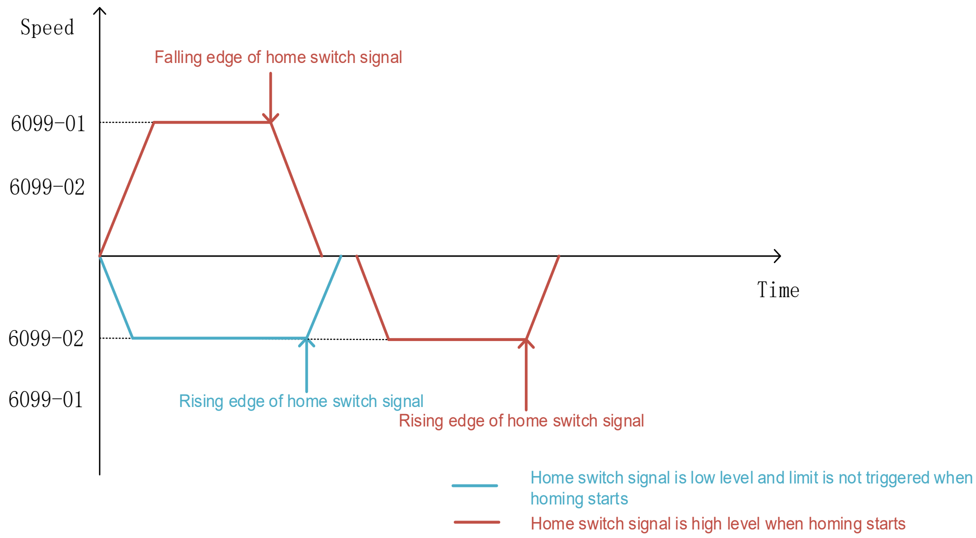


Figure 3-73 Method 22

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



-

Figure 3-74 Speed-time curve of method 22

3.5.3.24 Method 23: Homing on negative home switch (falling edge) -positive limit switch detection

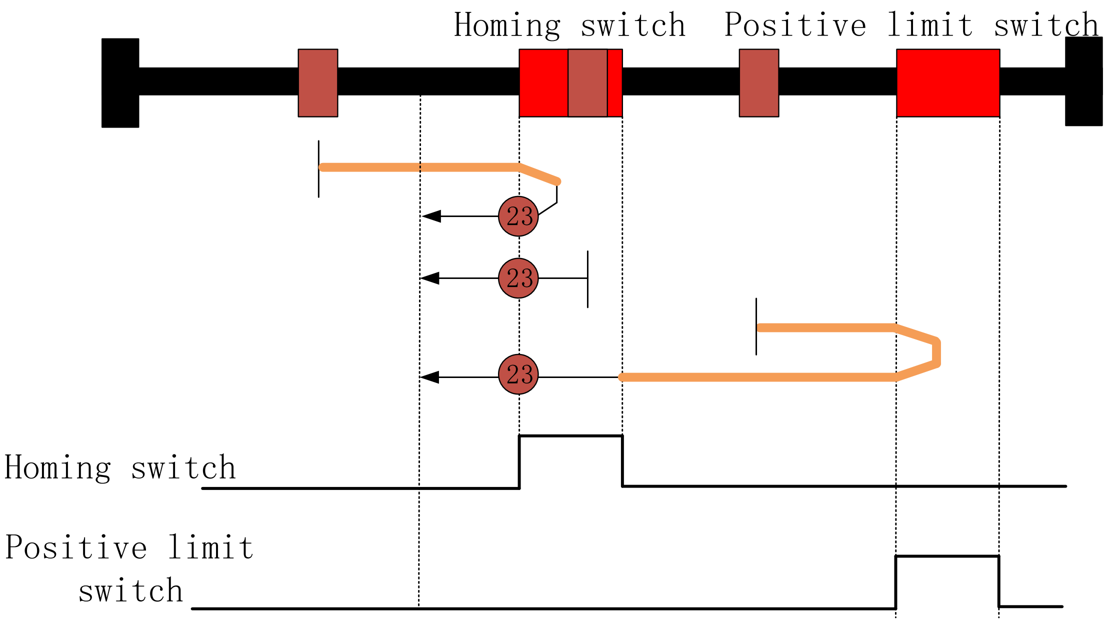


Figure 3-75 Method 23

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the positive direction.
  - ✓ After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates to a low speed (6099-01) with the homing deceleration (609A), and keeps moving in the negative direction at the low speed. After the home switch becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

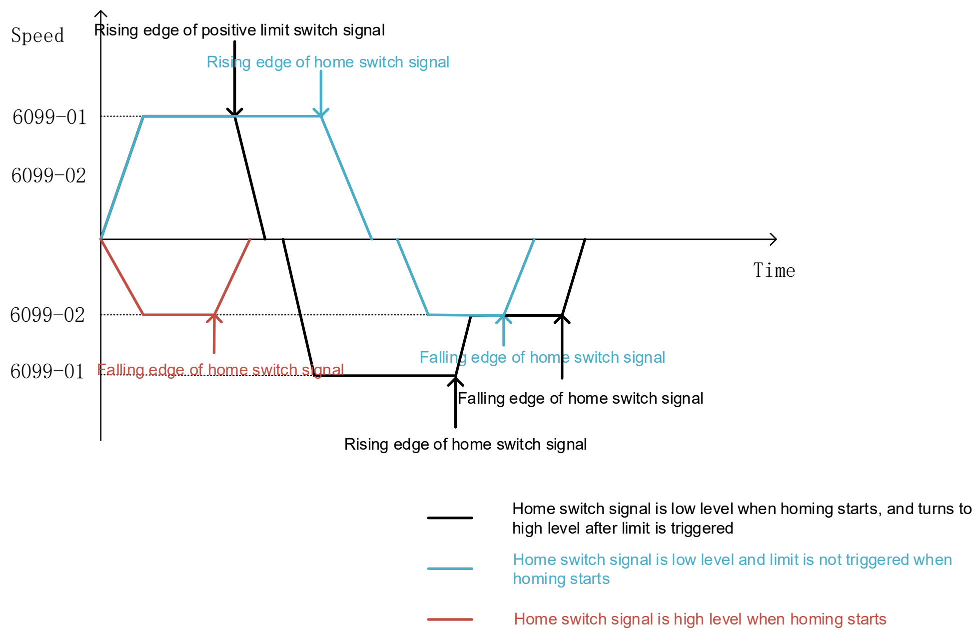


Figure 3-76 Speed-time curve of method 23

3.5.3.25 Method 24: Homing on positive home switch (rising edge)-positive limit switch detection

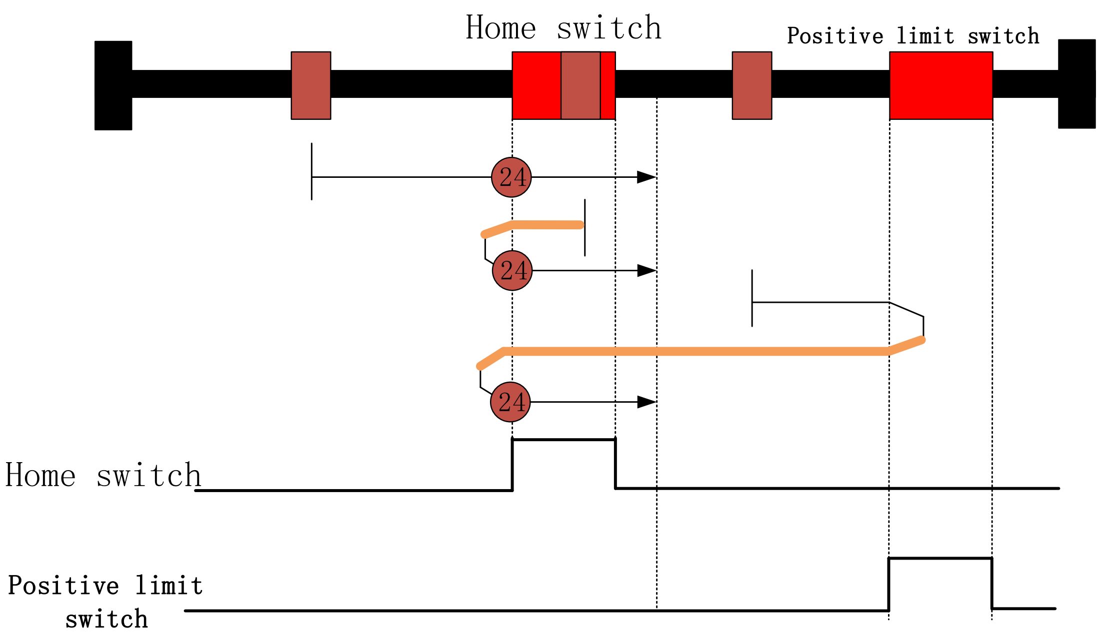


Figure 3-77 Method 24

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the positive direction.
  - ✓ After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

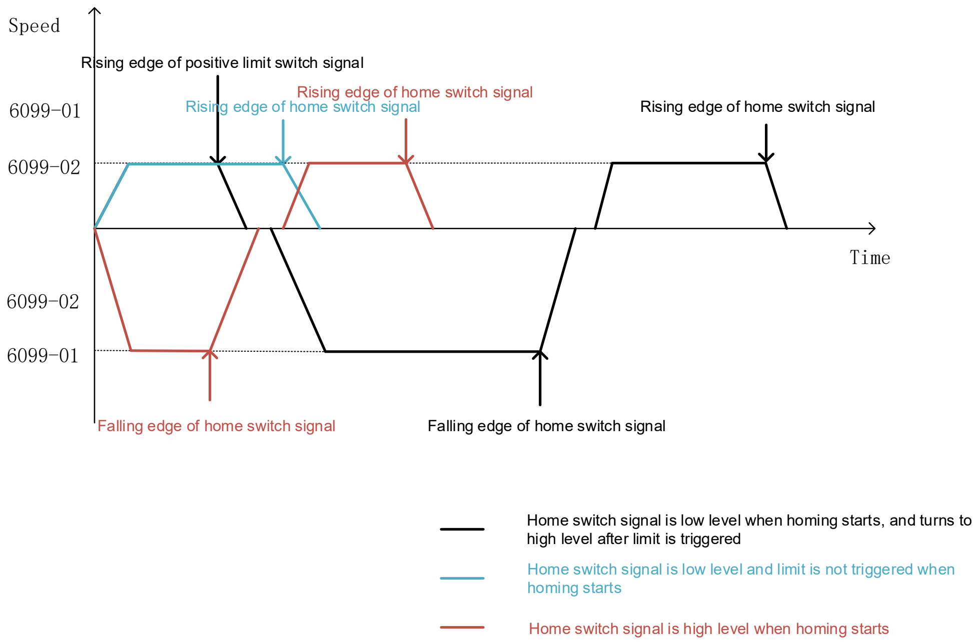


Figure 3-78 Speed-time curve of method 24

3.5.3.26 Method 25: Homing on negative home switch (rising edge)-positive limit switch detection

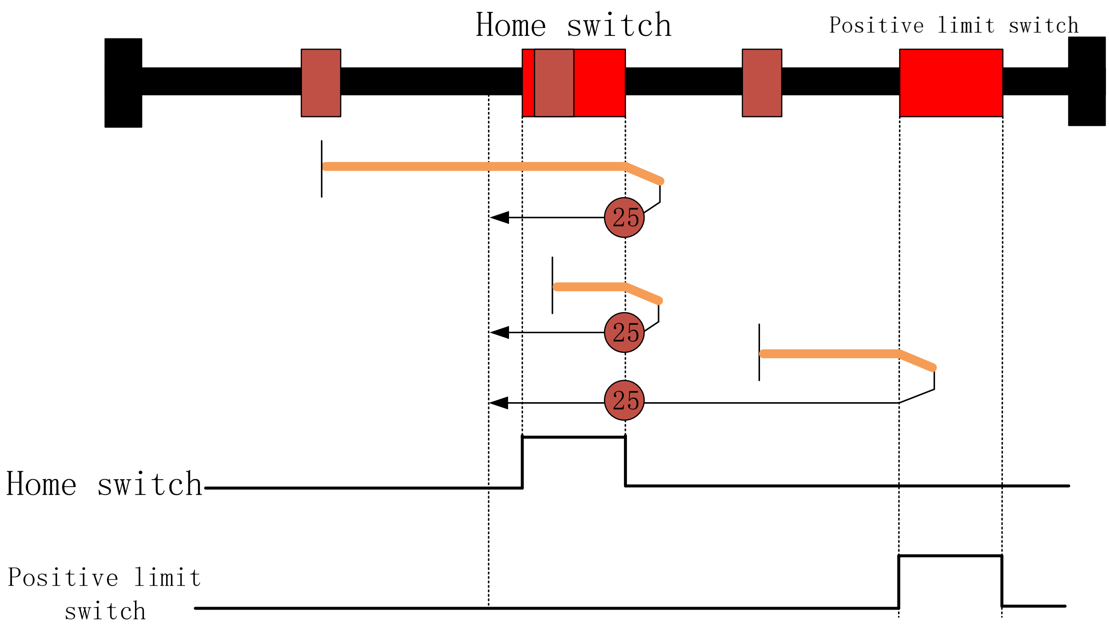


Figure 3-79 Method 25

Regardless of the high level or low level of the home switch signal, the motor moves in the positive direction.

When homing starts, the motor moves in the positive direction at a high speed (6099-01). After the home switch signal becomes low level or the positive limit switch becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

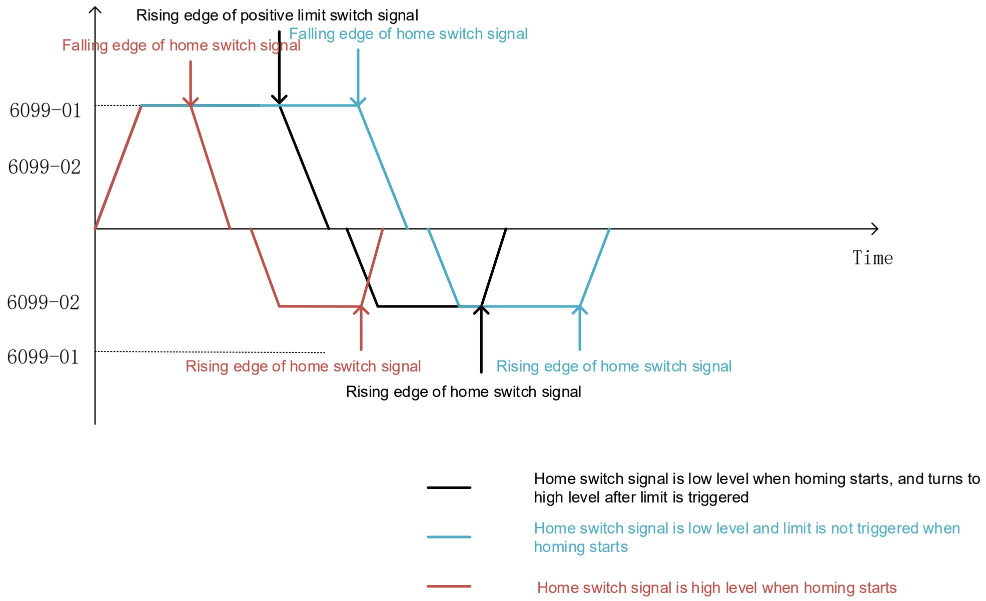


Figure 3-80 Speed-time curve of method 25

3.5.3.27 Method 26: Homing on positive home switch (falling edge)-positive limit switch detection

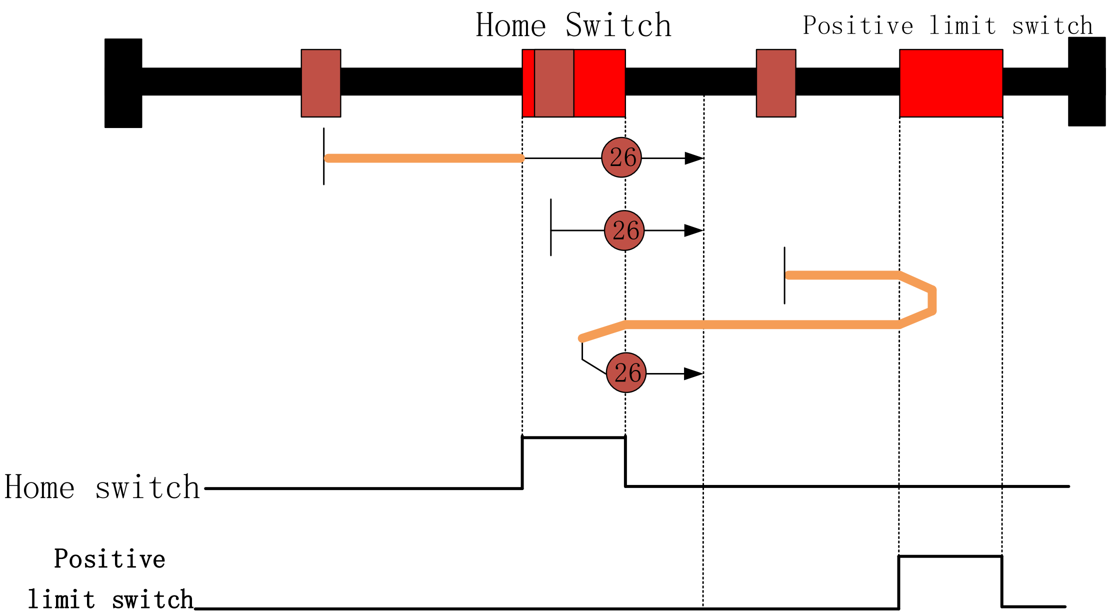


Figure 3-81 Method 26

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the positive direction.
  - ✓ After the home switch signal becomes high level, the motor decelerates to a low speed (6099-02) with the homing deceleration (609A), and keeps moving in the

positive direction at the low speed (6099-02). After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

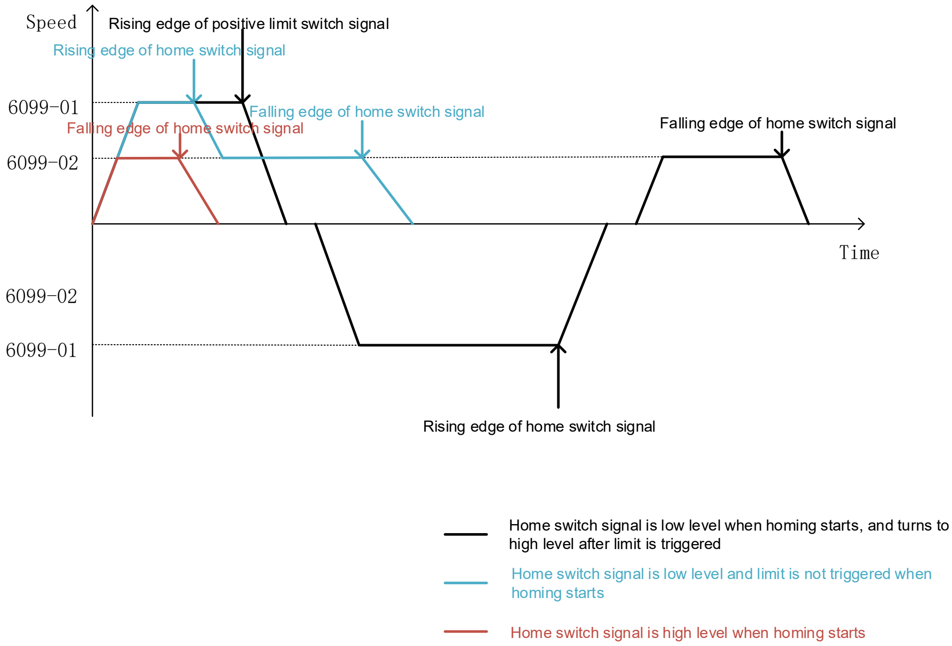


Figure 3-82 Speed-time curve of method 26

3.5.3.28 Method 27: Homing on positive home switch (falling edge)-negative limit switch detection

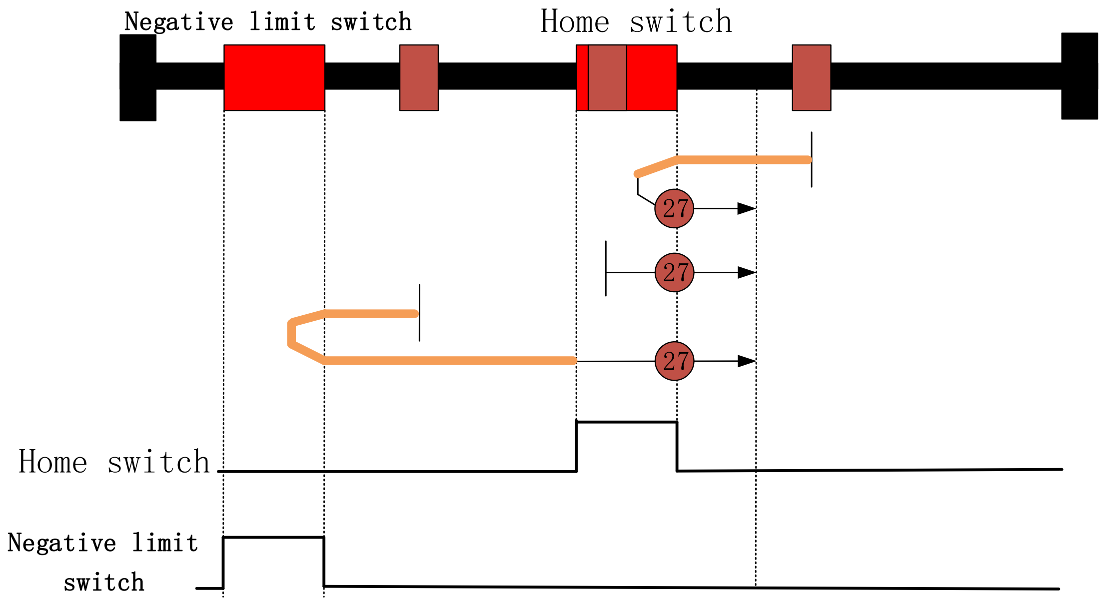


Figure 3-83 Method 27

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the negative direction.
  - ✓ After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the positive direction with the homing acceleration to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed (6099-02). After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

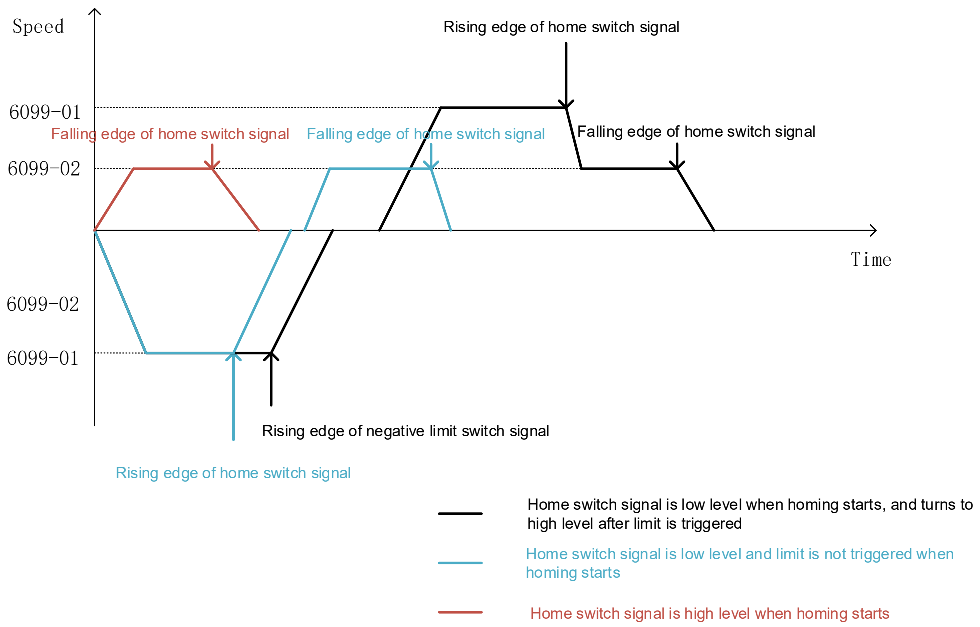


Figure 3-84 Speed-time curve of method 27

3.5.3.29 Method 28: Homing on negative home switch(rising edge)-negative limit switch detection

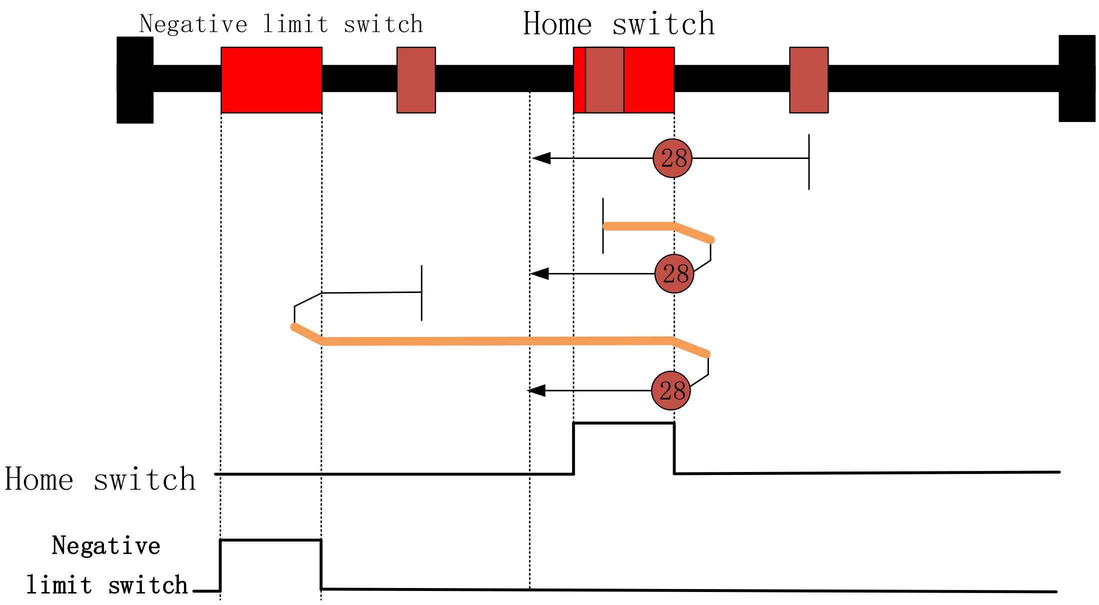


Figure 3-85 Method 28

- **When homing starts, if the home switch signal is low level,** the motor moves at a low speed (6099-02) in the negative direction.
  - ✓ After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps

moving in the positive direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- **When homing starts, if the home switch signal is high level,** the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

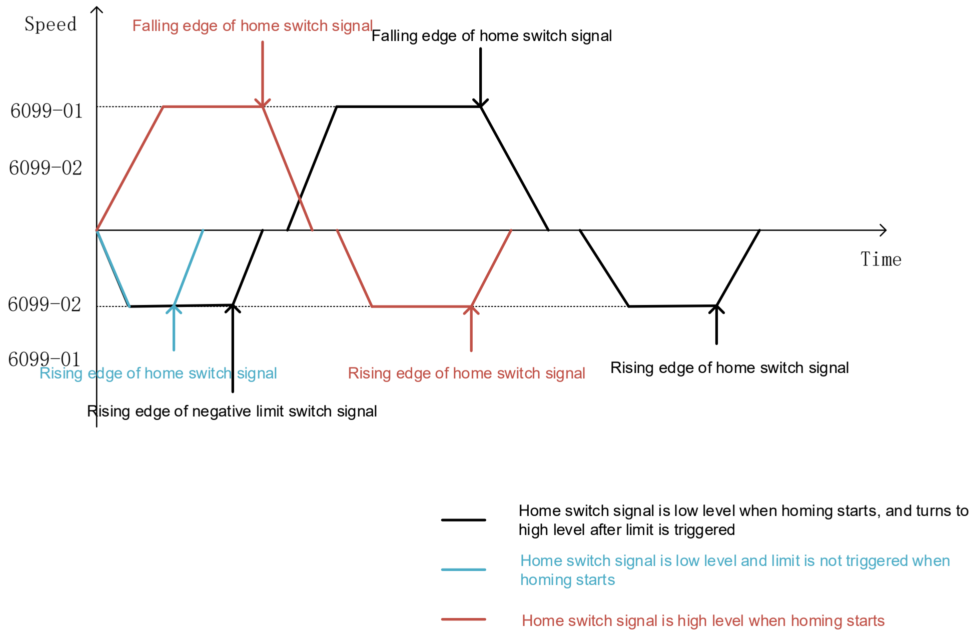


Figure 3-86 Speed-time curve of method 28

3.5.3.30 Method 29: Homing on positive home switch(rising edge)-negative limit switch detection

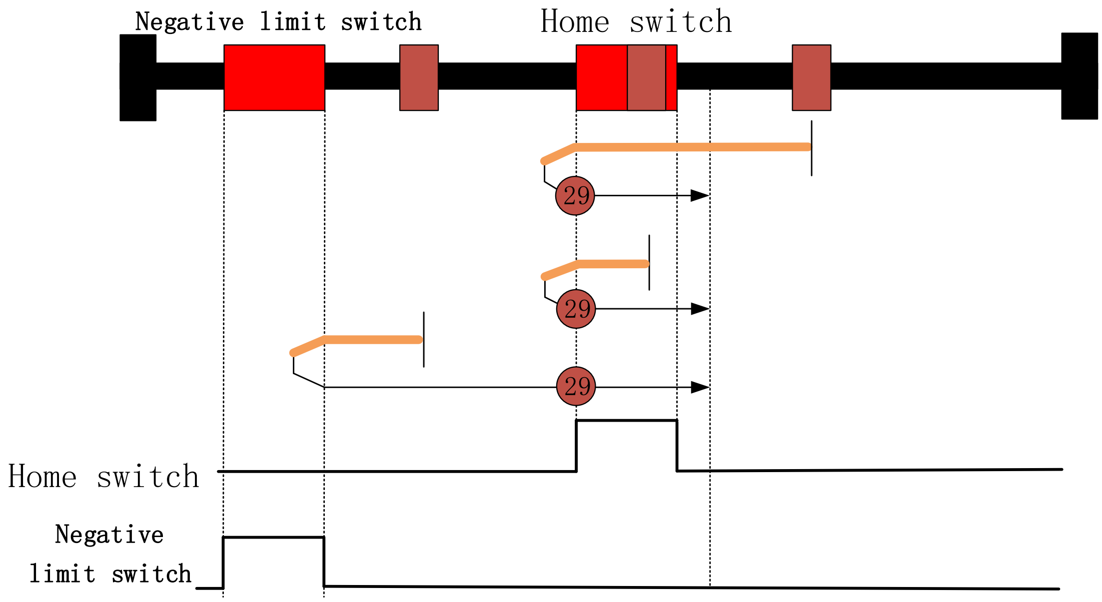


Figure 3-87 Method 29

Regardless of the high level or low level of the home switch signal, the motor moves in the negative direction.

When homing starts, the motor moves in the negative direction at a high speed (6099-01). After the home switch signal becomes low level or the negative limit switch becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

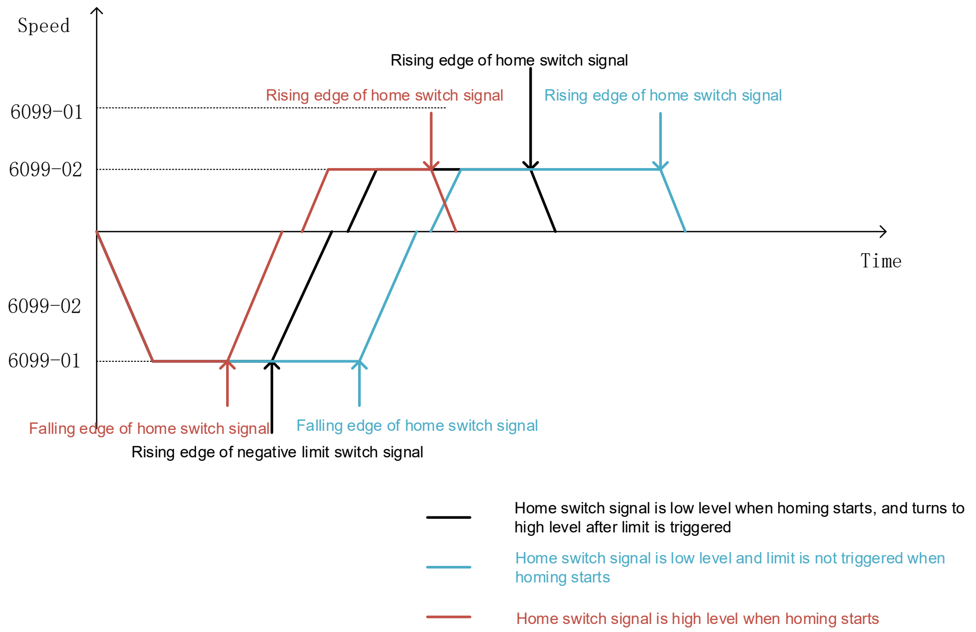


Figure 3-88 Speed-time curve of method 29

3.5.3.31 Method 30: Homing on negative home switch (falling edge)-negative limit switch detection

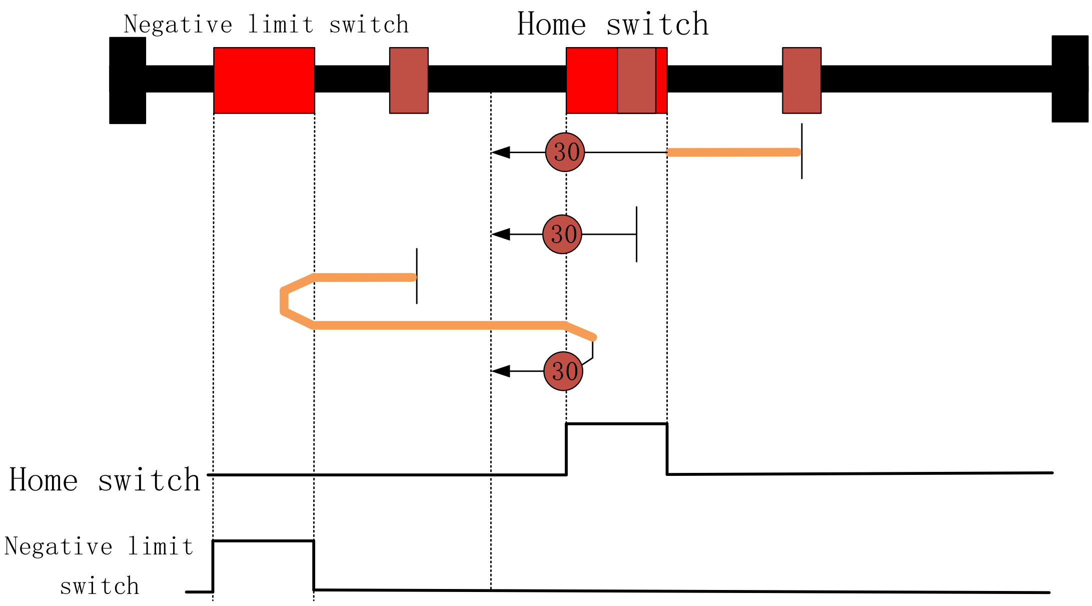


Figure 3-89 Method 30

- **When homing starts, if the home switch signal is low level,** the motor moves at a high speed (6099-01) in the negative direction.
  - ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to a low speed (6099-02), and keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
  - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- **When homing starts, if the home switch signal is high level,** the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

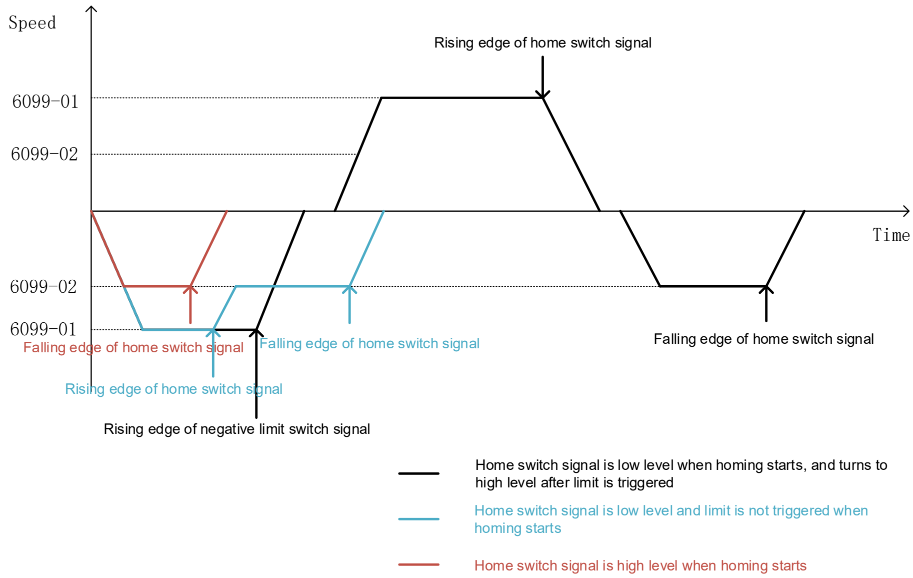


Figure 3-90 Speed-time curve of method 30

3.5.3.32 Method 31: Reserved

3.5.3.33 Method 32: Reserved

3.5.3.34 Method 33: Homing on index pulse in negative direction

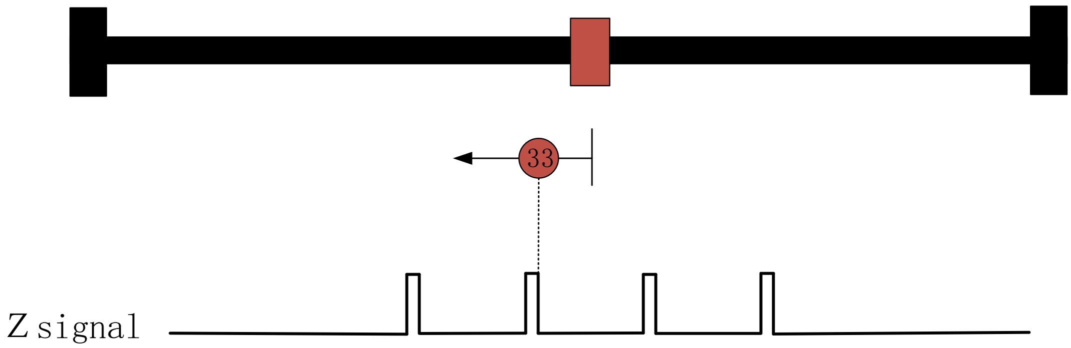


Figure 3-91 Method 33

When homing starts, the motor moves at a low speed (6099-02) in the negative direction. After the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

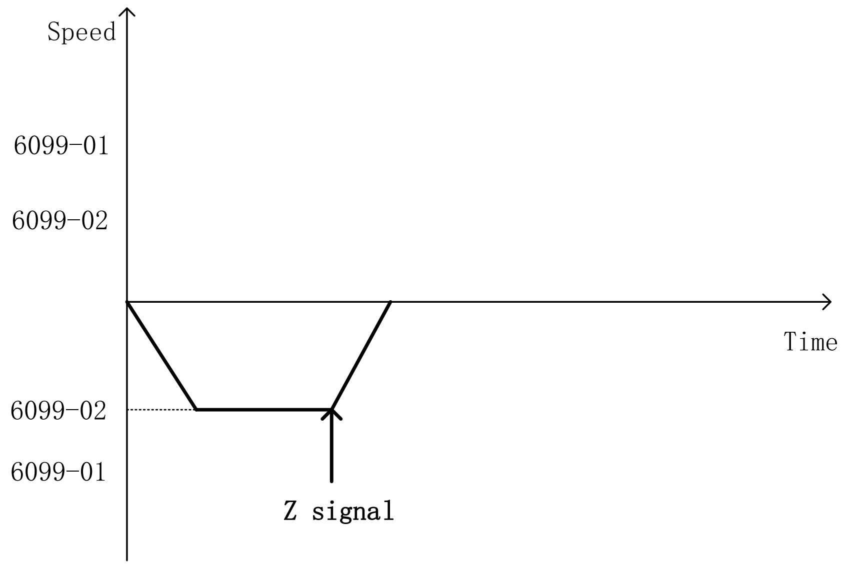


Figure 3-92 Speed-time curve of method 33

3.5.3.35 Method 34: Homing in index pulse in positive direction

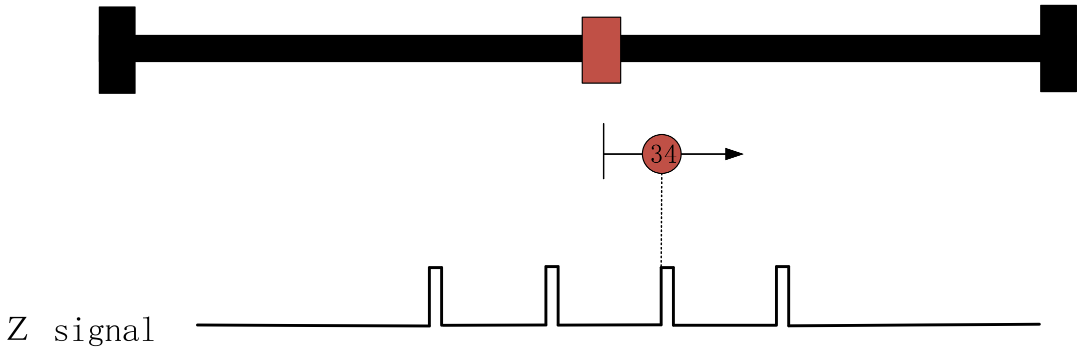


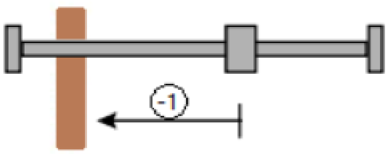
Figure 3-93 Method 34

When homing starts, the motor moves at a low speed (6099-02) in the positive direction. After the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

3.5.3.36 Method 35: Current position

In this method, the current position shall be taken to the home position.

3.5.3.37 Method -1: Guard position as home point in negative direction

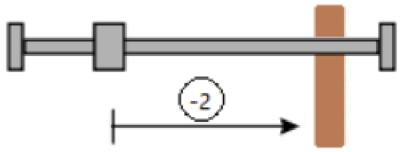


When homing starts, the motor moves in the negative direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. The motor stops after the time set by 0x2137:

✓ If the retraction distance is not set, the current position is set as the home point.

✓ If the retraction distance is set, the motor will retract the corresponding distance and set the current position as the home point.

3.5.3.38 Method -2: Guard position as home point in positive direction

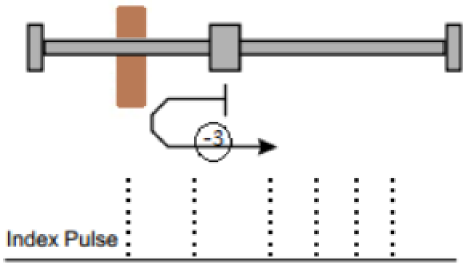


When homing starts, the motor moves in the positive direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. The motor stops after the time set by 0x2137:

✓ If the retraction distance is not set, the current position is set as the home point.

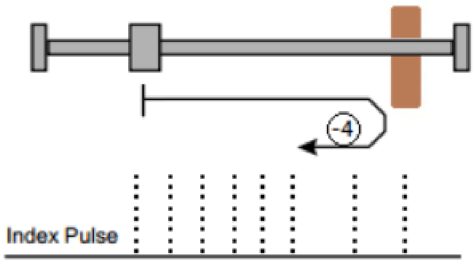
✓ If the retraction distance is set, the motor will retract the corresponding distance and set the current position as the home point.

3.5.3.39 Method -3: C pulse as home point after guard is touched in negative direction



When homing starts, the motor moves in the negative direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. After the time set by 0x2137, the motor moves in the positive direction. The first C pulse is home point.

3.5.3.40 Method -4: C pulse as home point after guard is touched in positive direction



When homing starts, the motor moves in the positive direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. After the time set by 0x2137, the motor moves in the negative direction. The first C pulse is home point.

3.5.4 Torque Control Mode

Torque mode is generally used for servo to act as loading.

The process of motion control in torque mode is as follows:

1. Select **"Torque Mode".** The interface of motion control in torque mode shows as in Figure 3-96.

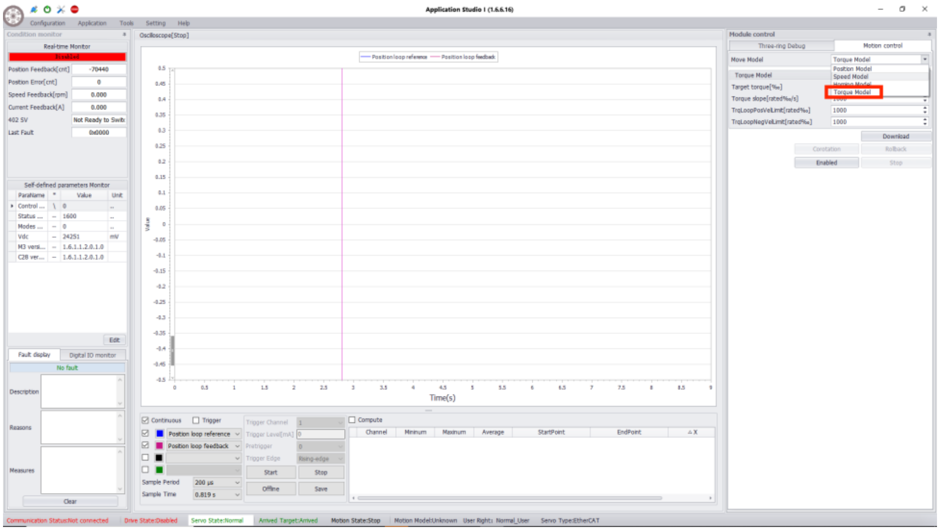


Figure 4- 96 Interface of motion control in torque mode

2. Set the following parameters:
   - ✓ Target torque: the torque output by the motor. (unit: permillage of rated torque)
   - ✓ Torque Ramp: The acceleration when the motor starts to output torque. (unit: permillage of rated torque / second)
3. To enable the servo drive, click **"Enable"**. **Servo Enable** shows in the interface.
4. To control the motor to move with a positive given torque, click "**Forward**", to control the motor to move with a negative given torque, click "**Reverse**".

3.5.5 Pulse Control Mode

- **External wiring of the servo drive**

  Currently Diamond Plus series is supported only with CANopen communication mode. You can control it in one of the following pulse modes:

  1. A/B-phase quadrature pulse control: respectively connect pulse signal A/B to J2 (3, 4, 5, 6) of the incremental encoder.
  2. Direction + pulse control: connect direction signal to J2 (5, 6) of the incremental encoder and the position pulse signal to J2 (3, 4).

3	Encoder_2A+	PULSE+
4	Encoder_2A-	PULSE-
5	Encoder_2B+	SIGN+
6	Encoder_2B-	SIGN-

Note: The voltage of differential pulse input signal is ±5 V. Due to the best anti-noise ability of this signal transmission method, it is recommended to use this connection method first; if the upper unit is 24 V output, it needs to be converted to 5 V input with a conversion module.

- **Configuration of the upper computer**

  To configure the upper computer, do the following:

  1. Correctly set the motor and encoder parameters.
  2. Carry out debugging for the motor and PID parameters.
     Please refer to the relevant debugging manual for details.
  3. Open the upper computer, click "**Tools**" → "**Parameter Editor**" → "**AI, pulse control parameters**", and set the following parameters:

No.	Name	Description	Set Value
0x2023	PulseControlEnable	Pulse control enable	1
0x2024	InputResolution	Input resolution: ✓ Rotary motors: it corresponds to one rotation of the motor. ✓ Linear / voice coil motors: it corresponds to a magnetic pole pitch.	1000
0x2025	PositionControlLPFFreq	-	0
0x2026	PulseControlMode	Selection of pulse control mode: ✓ 1: A/B-phase quadrature pulse control. ✓ 2: Direction + pulse control ✓ 3: not support.	1

After the above parameters are set and the motor debugging is finished, it can directly receive the pulse input signal for position control.

3.5.6 Analog Control Mode

The servo drive supports receiving analog quantities to control the position, speed and current of the motor. The relevant parameters are as follows:

No.	Name	Description
0x201B	Analog control mode	✓ 0: not used ✓ 1: position control ✓ 2: velocity control ✓ 3: current control ✓ 4: position feedback ✓ 5: speed feedback ✓ 6: current feedback
0x 201C	Analog input offset	Set according to the initial 0 drift
0x201D	AI 1 input dead-time	Default: 0
0x201E	AI1 input low-pass filter cutoff frequency	Default: 3000
0x201F	AI1 control gain	Unit: position-cnt/V, speed-rpm/V, current-mA/V. (Please set it according to specific control range.)
0x2413	AI1 analog input value	Unit: mv (Currently this group is used by default)
0x2414	AI2 analog input value	Unit: mv (Reserved)

Please refer to the relevant documents of analog control for details.

3.6 Troubleshooting

If an error occurs during debugging, please troubleshoot the error by following the error description, possible causes and troubleshooting methods displayed by the upper computer software, as shown in Figure 3-98.

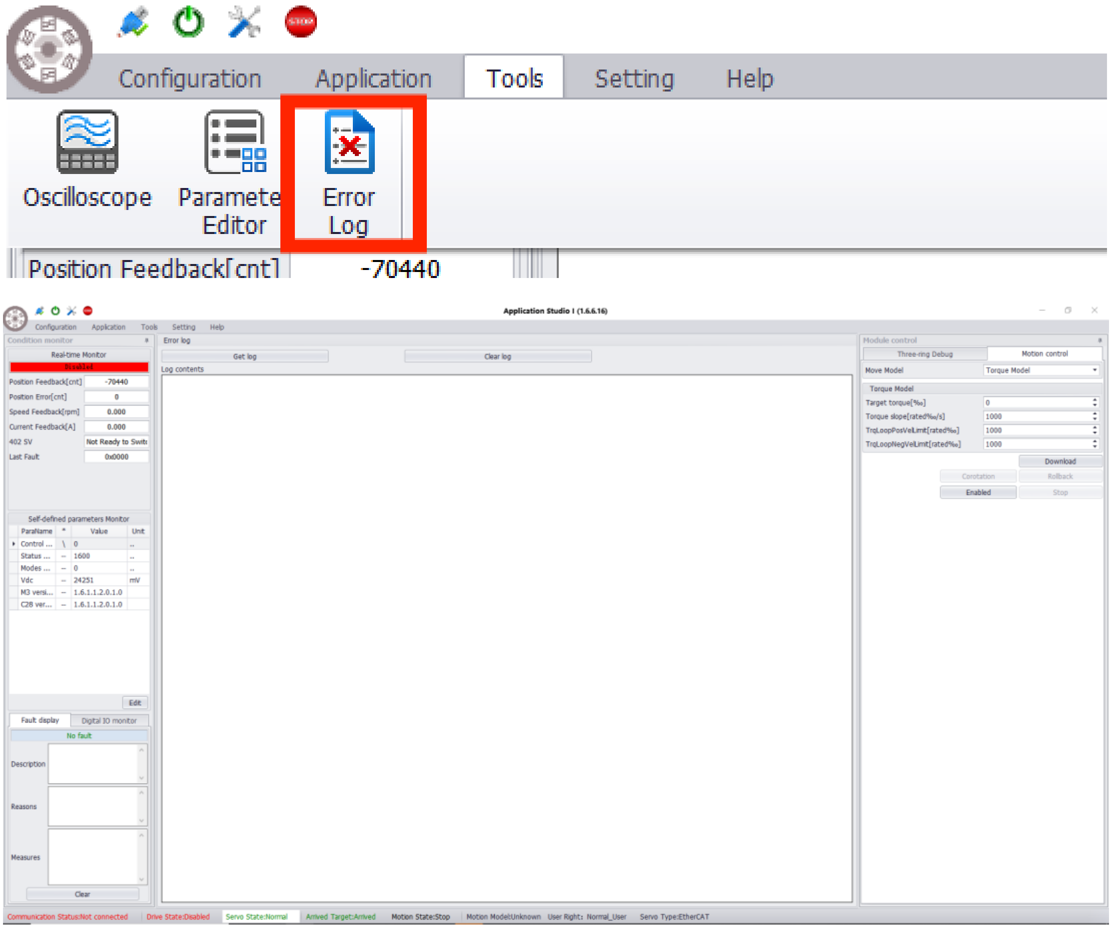


Figure 3- 96 Fault Display

After the error is successfully troubleshooted, click "**Clear Alarm**" in the toolbar. Debugging can be continued after the system shows no error.

Note: If you have any questions during debugging, please seek technical support. Please do not arbitrarily modify the parameters, so as to avoid damages to personnel and property.

4 Troubleshooting

When an error occurs, the LED on the Diamond Plus servo panel will flash red in rhythm. After connecting the upper computer software, the error code based on the CiA402 standard will be displayed in the error handling interface.

When the servo alarms, please refer to the following table to check the servo, and solve the servo error according to the corresponding solution.

Table 4-1 Fault description

Error Code	Name	Cause	Solution
0x2230	Bus overcurrent	1. DC bus with excessive voltage. 2. Short circuit at periphery. 3. Encoder failure. 4. Internal components of the servo are damaged.	1. Check power supply and whether high inertia loads leads to rapid stop without dynamic braking. 2. Check whether the servo and the output wiring are short circuit, whether earthing is short circuit, and whether the braking resistor is short circuit. 3. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x2310	U-phase overcurrent	1. U-phase output is short circuit. 2. High load. 3. Cable insulation is damaged. 4. Poor motor insulation. 5. Failure of U-phase current detecting circuit.	1. Check U-phase wiring. 2. Lower the load. 3. Check U-phase cable and replace it if necessary. 4. Measure the motor insulation, repair and replace it if necessary; 5. Repair or replace the drive.
0x2311	V-phase overcurrent	1. V-phase output is short circuit; 2. High load. 3. Cable insulation is damaged. 4. Poor motor insulation. 5. Failure of V-phase current detecting circuit.	1. Check V-phase wiring. 2. Lower the load. 3. Check V-phase cable and replace it if necessary. 4. Measure the motor insulation, repair and replace it if necessary. 5. Repair or replace the drive.

Error Code	Name	Cause	Solution
0x2320	Hardware short circuit	1.DC bus with excessive voltage. 2.Short circuit at periphery. 3. Encoder failure. 4.Internal components of the servo are damaged.	1. Check power supply and whether high inertia loads leads to rapid stop without dynamic braking. 2. Check whether the servo and the output wiring are short circuit, whether earthing is short circuit, and whether the braking resistor is short circuit. 3. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x3220	Servo undervoltage	1.Low input voltage of the power circuit. 2.Poor insulation of DC bus. 3. High load. 4.Poor insulation of the driver cable. 5. Failure of DC bus undervoltage detecting circuit. 6.Basic power module failure.	1. Check the power circuit. 2. Check the DC bus insulation. 3. Lower the load. 4. Check the drive cable. 5. Repair or replace the drive. 6. Repair or replace the basic power module.
0x3210	Servo overvoltage	1. Insufficient capacity of brake circuit. 2.Insufficient capacity of braking resistor. 3.Basic power module failure	1. Reduce the start-stop frequency; increase the acceleration/deceleration time constant; lower the load inertia; increase the drive and motor capacity. 2. Increase the power of the braking resistor. 3. Repair or replace the basic power module;
0x4110	Ambient temperature overheating	1.High ambient temperature. 2.Abnormal cooling system. 3.Temperature detecting circuit failure.	1. Lower the ambient temperature and strengthen ventilation and heat dissipation. 2. Check the cooling fan speed and air volume. If they are abnormal, replace the fan with the same model. 3. Check whether the servo cooling channel is blocked by foreign objects.
0x4120	Ambient	1.Low ambient	1. Check whether the ambient

Error Code	Name	Cause	Solution
	temperature underheating	temperature. 2.Temperature detecting circuit failure.	temperature is too low; 2. Check the value of parameter minimum ambient temperature.
0x4310	Power module overheating	1. High ambient temperature. 2. Abnormal cooling system. 3.Temperature detecting circuit failure.	1. Lower the ambient temperature and strengthen ventilation and heat dissipation. 2. Check the cooling fan speed and air volume. If they are abnormal, replace the fan with the same model. 3. Check whether the servo cooling channel is blocked by foreign objects.
0x8482	Exceed maximum speed	1. Motor run away. 2. Wrong encoder parameters. 3. Encoder failure 4. Instruction error 5. Load mutation	1. Check the phase sequence of the motor power cable. 2. Check the settings of encoder parameter. 3. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable. 4. Check the position / speed / torque command. 5. Check whether the load is mutated and related cause. 6. Correct the phase zero again. 7. Adjust PID parameters.
0x8483	Large speed tracking error	1.The encoder wiring is wrong or the connector is in poor contact. 2.The gain does not match. 3.Large external load fluctuations or interference.	1. Check the encoder wiring; 2. Adjust the servo gain again. 3. Increase anti-interference measures.

Error Code	Name	Cause	Solution
0x8611	Large position deviation	1. The encoder wiring is wrong or the connector is in poor contact. 2. The gain does not match. 3. Large external load fluctuations or interference.	1. Check the encoder wiring; 2. Adjust the servo gain again. 3. Increase anti-interference measures.
0x7380	Encoder connection error	1. Wrong encoder parameters. 2. Encoder cable failure. 3.The encoder cable is not connected. 4.The internal components of the servo are damaged.	1. Check the settings of encoder parameters. 2. Check the line sequence of encoder cable. 3. Connect the encoder cable.
0x7383	Encoder multi-turn info error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x7385	Encoder count error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x7389	Encoder count overflow error	Internal encoder error.	Clear the encoder multi-turn value, power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x738A	Encoder communication CRC error	1.Wrong encoder parameters. 2.Encoder cable failure.	1. Check the settings of encoder parameters. 2. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x738B	Encoder delimiter error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x3221	PWM drive abnormal	PWM drive +15 V undervoltage.	Check whether the control power +24V is connected properly.
0x8612	Exceed	Given position or	1.Check the setting of limit position.

Error Code	Name	Cause	Solution
	position limit	actual position exceeds position limit.	2.Check the settings of given position. 3.Check whether the limit switch is triggered.
0x7384	Encoder overheating	The working temperature of the encoder exceeds 95℃.	1. Test again after the motor has cooled down. 2. Improve the heat dissipation conditions and check whether the motor overheats during running. 3. Internal encoder error.
0x6280	Wrong profile value	There is a zero value in the set value of the profile track, which makes the planned track unsuccessful.	1. Make sure the set speed is not zero. 2. Make sure the set acceleration is not zero.
0x6281	Termination speed setting error	The termination speed is greater than the profile speed, which makes the planned track unsuccessful.	1. The set termination speed must be less than or equal to the profile speed.
0x6282	Termination speed setting error	The target position is too close to the current position to reach the termination speed.	1. Check whether the set termination speed is too large.
0x6283	Software limit setting error	When the minimum / maximum software limit is not set to 0, the minimum value is greater than or equal to the maximum value; or exceed the position limit.	1. Set the minimum value greater than the maximum when the minimum / maximum software limit is not set to 0. 2. Check whether the maximum value is too large. 3. Check whether the minimum value is too small.
0x6284	Wrong position limit	When the minimum / maximum position limit is not set to 0, the minimum value is greater	1. Set the minimum value greater than the maximum when the minimum / maximum position limit is not set to 0.

Error Code	Name	Cause	Solution
		than or equal to the maximum value.	
0x6285	Wrong planned curve type	The set planned curve type is not supported.	1. Set the planned curve type to 0 (Linear ramp)
0x6286	Wrong planned curve type	The set planned curve type is not supported.	1. Set the planned curve type to 0 (Linear ramp) or 3 (Jerk-limited ramp).
0x6287	Wrong planned torque curve	The set planned torque type is not supported.	1. Set the planned torque curve type to 0 (Linear ramp).
0x6288	Wrong homing method	The limit switch was accidentally triggered.	1. Start homing again after setting a suitable homing method.
0x6289	Wrong homing method	The set homing method is not supported.	1. Start homing again after setting a suitable homing method.
0x628B	Homing process timed out	The zero point was not found during homing.	1.Check the lower limit switch or the origin switch. 2.Set a suitable homing method.
0x628C	Initial speed not zero when planning Jerk-limited ramp	When the planned curve type is Jerk-limited ramp, the initial speed is not zero.	1. Make sure the motor is still before enabling the curve planning of the Jerk-limited ramp.
0x6180	Execution time of planned curve less than 0	The settings of position, speed, or acceleration / deceleration are incorrect.	Reset position, speed, acceleration and deceleration.

Error Code	Name	Cause	Solution
0x6181	Stop speed greater than initial speed	Stop speed is not set to 0	Set stop speed to 0.
0x6182	Position, speed, acceleration and deceleration not set for continuous motion of multiple points	The position, speed, acceleration and deceleration are not set for continuous motion of multiple points	Reset the target position, speed, acceleration and deceleration.
0x6184	Internal state transition error in homing	Jump exception of the internal homing state.	Execute homing again.
0x7124	Motor overtheating	The motor temperature is detected by the external temperature sensor and then connected to the servo through the DI port, and its upper limit is determined by the external temperature sensor.	1. High load. 2. Lack of phase. 3. Fault related to motor machinery, including lack of lubricating grease, improper assembly of bearings and end caps, eccentricity of inner holes, etc.

Error Code	Name	Cause	Solution
0x3130	Lack of phase	UVW phases have open circuit.	Check the wiring of UVW phases.
0x8700	Sync error	Bus synchronization error.	Restart the servo.
0x738C	Hall error	Hall signal is disconnected.	Check the wring of Hall.
0x6551	Wrong target speed	The target speed is 0 in position control.	Check the value of 0x6081 and make sure it is not 0.
0x6552	Wrong acceleration and deceleration in position and velocity control	The track planning is unsuccessful when acceleration and deceleration is set to 0.	Make sure acceleration or deceleration is not 0.
0x6553	Wrong position track planning period	The position track planning is set to 0.	Make sure the set period is not 0.
0x7320	Z pulse repetition positioning position error	The difference of adjacent Z pulses exceeds 0x2001.	1. Check the scale installation or accuracy. 2. Check the Z pulse positioning deviation.
0x8620	Failed to enable auto calibration	Failed to enable automatic calibration.	1. Check whether the motion control mode is 0. 2. Check whether the device is stuck, the frictional resistance increases or the load is abnormal, etc. 3. Check whether there is an open circuit or short circuit in the three-phase wiring. 4. Check whether the settings of 0x2105 and 0x2402 are proper. 5 Check whether the phase sequence of the UVW wiring and the setting of 0x2002 are correct. 6. Check the encoder wiring.

Error Code	Name	Cause	Solution
0x6542	Planned deceleration or quick stop deceleration in the position mode is 0	The planned deceleration or quick stop deceleration in the position mode is 0.	Check the deceleration or quick stop deceleration and make sure it is not 0.
0x6572	Planned deceleration or quick stop deceleration in the position mode is 0	The planned deceleration or quick stop deceleration in the position mode is 0.	Check the deceleration or quick stop deceleration and make sure it is not 0.
0x9100	DI external input alarm	DI external input condition triggers an alarm.	Check the external input conditions.
0x8900	I2T protection alarm	Exceed the I2T setting threshold	1. Adjust limiter protection peak current. 2. Adjust limiter protection peak current duration. Note: The alarm takes effect when 0x2017 bit1 is set to 1.
0x8901	Alarm of no calibration	Operation is enabled without performing angle identification.	Enable operation after If Hall is connected and angle identification is finished.
0xB010	Position feedback jitter during angle identification	Wrong encoder wiring. Abnormal load or external disturbance.	Check the encoder wiring. Check the load or external disturbance.
0xB020	Rotor not moving during angle identification	Parameter settings such as current are incorrect. High load. The machine is stuck, or the wiring is wrong.	Set appropriate parameter values. Check device, load and wiring.

Error Code	Name	Cause	Solution
0xB030	Large action of angle identification	Large setting of current. Fault, including device, load, wiring (phase sequence), etc.	Set appropriate parameter values. Check device, load and wiring (phase sequence).
0xB040	Angle identification timed out	Software exception	Check the upper computer software, M3 and C28. Check each parameter setting. Check device, load and wiring.
0xB102	Motor hardly rotates during phase sequence detection	Wrong encoder wiring. High load or friction. Problem with current loop configuration The commutation current ratio 1 is too small.	Check the encoder wiring. Increase commutation current ratio 1.
0xB104	Hall status feedback abnormal	Wrong wiring of Hall sensor. Wrong Hall mode.	Check the wring of Hall Sensor. Make sure 0x2103 is set to 0.

5 Debugging Software ISMC

Stone Motion Control (ISMC) is a servo debugging software independently developed by our company. Through USB serial communication, you can configure and modify servo parameters, debug controller parameters, realize motion control, monitor system status in real time, diagnose faults, check error logs, and realize update and maintenance.
This chapter only focuses on software download and setup. For software operations, please refer to "***Servo Debugging Software ISMC User Manual***".

5.1 Software Download

5.1.1 System Requirements

System environment requirements:

- Memory: 1 GB or more (1.5 GB or more for running on a virtual machine)
- Display: above 800x600
- System type: 32-bit or 64-bit Windows 7 / Windows 8 / Windows 10
- Processor: above 1.6 GHZ

5.1.2 Software Installation

The setup process of SMC is as follows:

1. Download the setup package from the official website.
2. Double click the .exe application file, and wait for the decompression. After decompression, the setup wizard pops up, as shown in Figure 6-1.

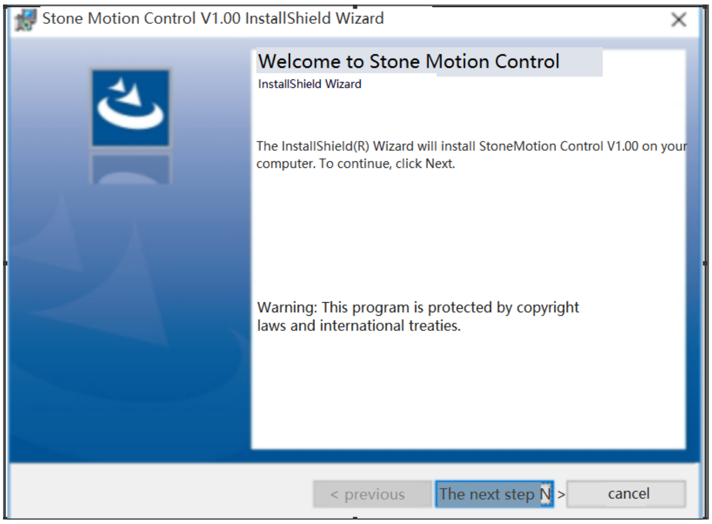


Figure 5-1 SMC installation wizard

3. Click "**Next**". The agreement dialog box pops up, as shown in Figure 5-2.

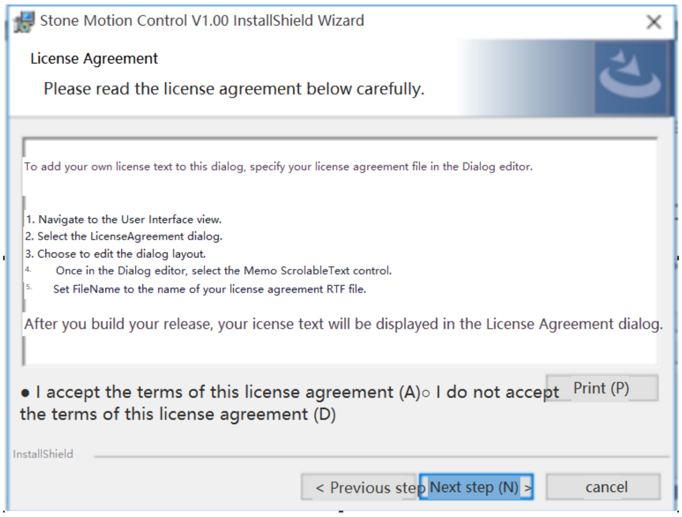


Figure 5- 2 Installation agreement

4. Select "**I Agree**", click "**Next**" and enter the user information, as shown in Figure 5-3.

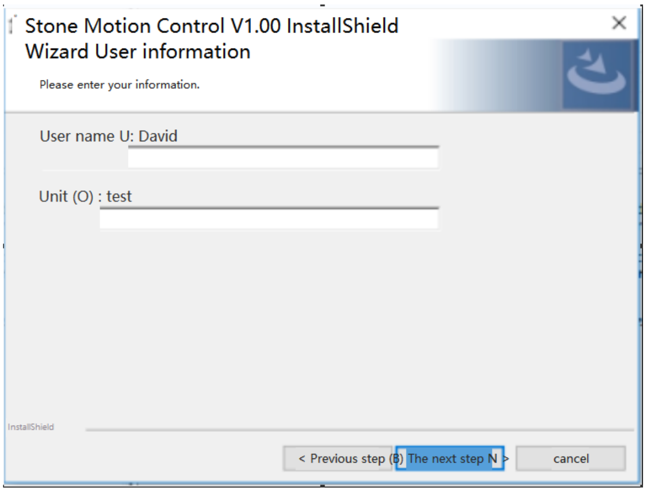


Figure 5-3 User information

5. Click "**Next**", and select the setup type, as shown in Figure 5-4. Generally, please use the default type.

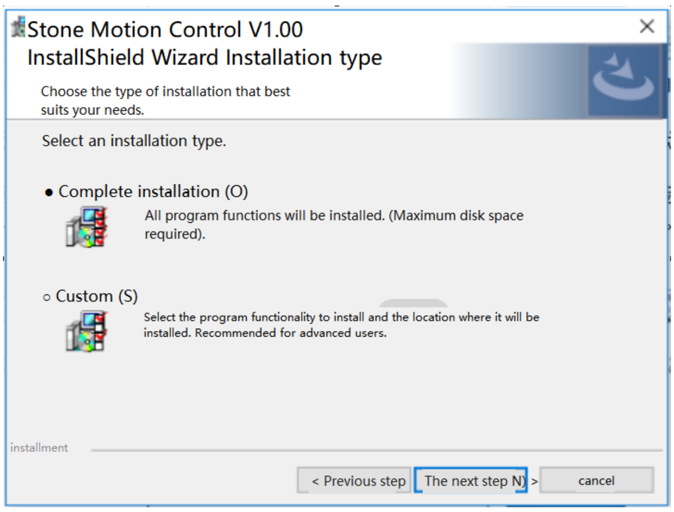


Figure 5-4 Setup type

6. Click “**Next**”, and click "**Finish**" after the setup is finished to exit the setup interface and complete the setup, as shown in Figure 6-5.

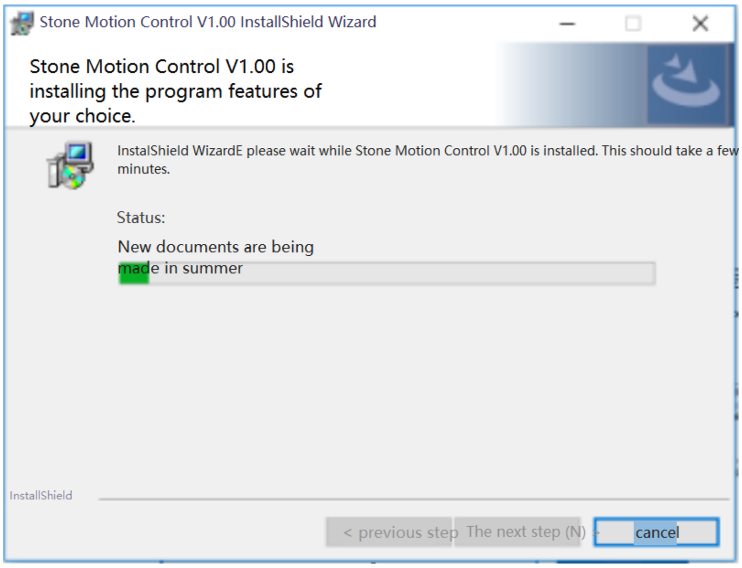


Figure 5-5 Installing

7. After setup, check the shortcut of SMC software by accessing "**Desktop**" → "**Start**" →"**All Programs**" on your computer, as shown in Figure 5-6.

Figure 5-6 Start menu

5.2 Driver Installation

When using USB communication for the first time, you need to install the USB driver.

Note: The driver will be automatically installed on Windows 10 after connecting the USB data cable.

Taking Windows 7 as an example, the process of driver installation is as follows:

1. Connect the upper computer and the servo drive via the USB data cable. A prompt that the driver cannot be installed automatically, as shown in Figure 6-7.

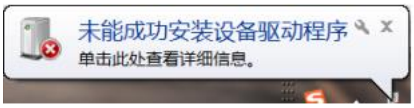


Figure 5-7 Failed to install the driver

2. Open the Windows main menu, and right click "**Computer**".

Figure 5-8 Windows main menu

3. To open the computer management, click "**Manage**":

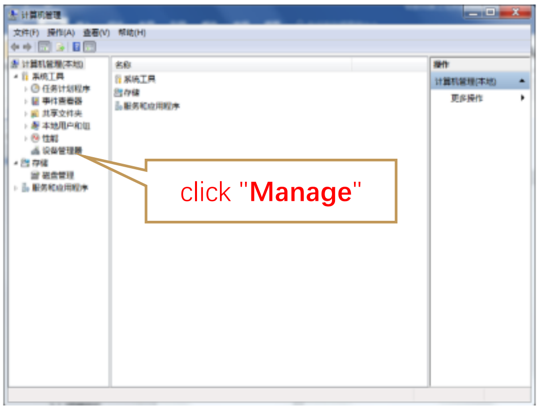


Figure 5-9 Computer management window

4. Select "**Device Manager**" → "**Others**", and find the unrecognized device **Virtual COM Port**.

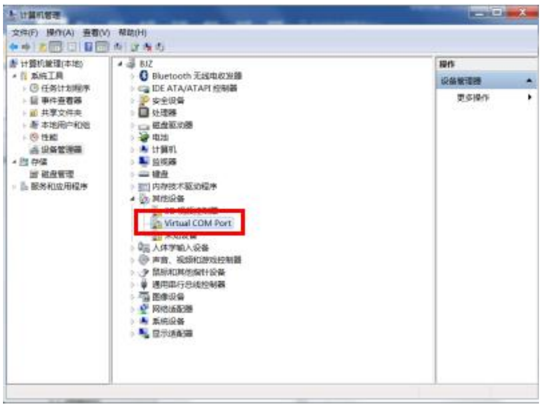


Figure 5-10 Device manager

5. Right click "**Virtual COM Port**", and select **"Update Driver Software**".

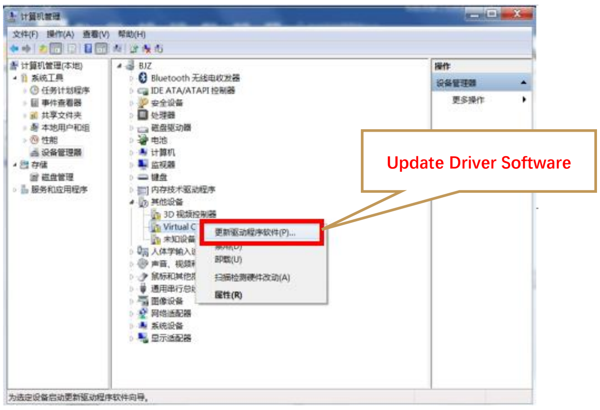


Figure 5-11 Update driver software

6. Select "**Browse my computer for driver software**".

Figure 5-12 Find driver software

7. Click **"Browse",** find and select the driver folder "**windows_drivers"** in the SMC installation directory.
   Default path: C:\Program Files(x86)\SMC\Files\windows_drivers.

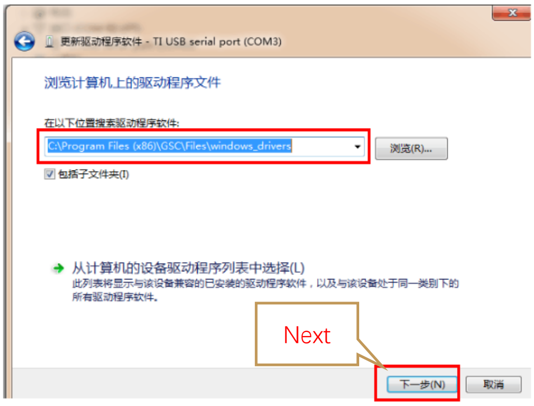


Figure 5-13 Browse the driver installation path

8. Click **"Next"** to start installation, and select "**Always install this driver software**" in the pop-up security warning window.

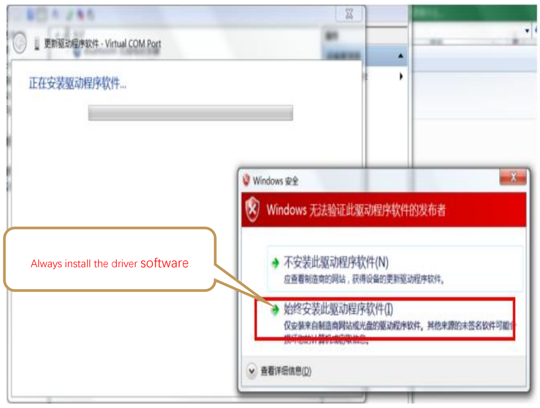


Figure 5-14 Security warning pop-up

9. Finish driver installation.

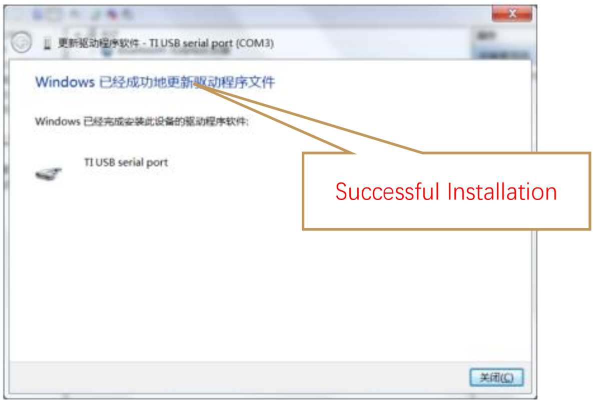


Figure 5-15 Finish driver installation

Note: If the driver fails to be installed successfully, please contact the technician.

5.3 Firmware Upgrade

You can burn and upgrade the M3 and C28 files in the servo through SMC.

The process of firmware upgrade is as follows:

1. Select **"Setting"** in the main menu, and click **"Firmware Updata"** to open the firmware upgrade interface, as shown in Figure 5-16.

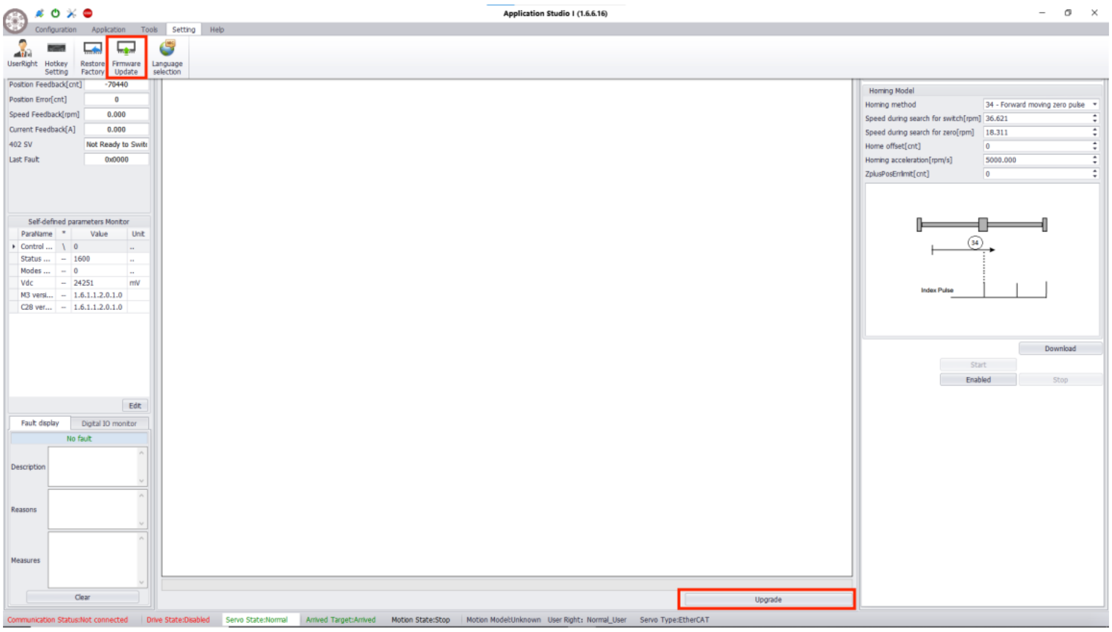


Figure 5-16 Firmware upgrade

2. Click **"Select File"** to open the folder and select the M3 or C28 file to be upgraded.
3. Click **"Upgrade"** to start upgrading. After the upgrade is successful, SMC software and the servo are restarted.
4. After reconnecting, repeat the above steps to upgrade the next program until all programs are upgraded.

Note:

1. For firmware upgrade, please contact our technical team.
2. Servo DC+/DC- power supply is required when upgrading, and 24 V power supply is recommended.
3. The names of the upgraded files are fixed, i.e. C28-APP.bin and M3-APP.bin.
4. For the first time, please flash M3-APP.bin first, and then flash C28-APP.bin.

6 Communication

6.1 EtherCAT Communication

6.1.1 Principle

6.1.1.1 CoE reference model

The internal CANopen over EtherCAT (CoE) network model of Stone servo is shown in Figure 7-30.

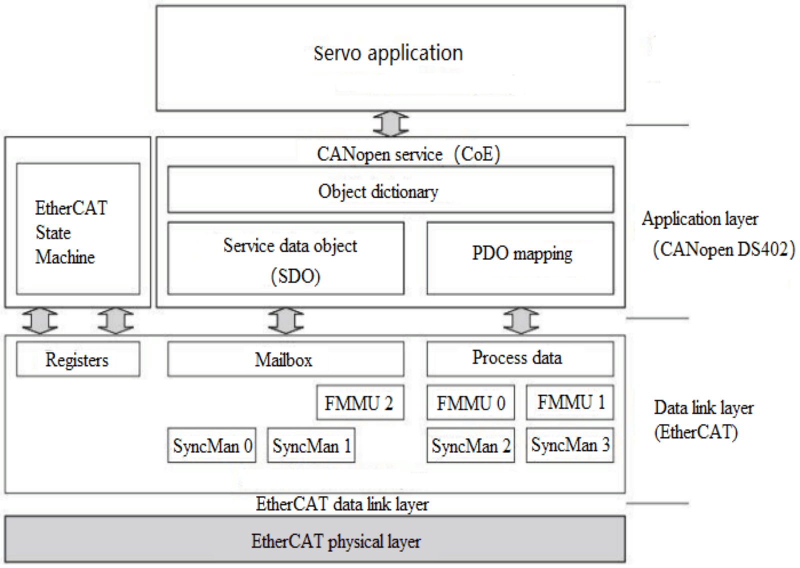


Figure 6-30 COE reference model

The EtherCAT (CoE) network model consists of two parts:

- Data link: mainly responsible for EtherCAT communication protocol
- Application: it embeds the CANopen drive Profile (DS402) communication protocol.

The object dictionary in CoE includes parameters, application data, and PDO mapping information.

Process data object (PDO) consists of objects in the object dictionary that can do PDO mapping, and the content in PDO data is defined by PDO mapping. The read and write of PDO data is periodic with no need to look up the object dictionary; while the mailbox communication (SDO) is non-periodic communication with a need to look up the object dictionary.

6.1.1.2 EtherCAT slave information

The EtherCAT slave information file (XML file) is read by the master and used to construct the configuration of the master and slave. The XML file contains the necessary information for EtherCAT communication. STONE provides the "Stone_E XML.xml" file for the servo drive to construct the configuration of the master and slave.

6.1.1.3 EtherCAT State Machine

It is used to describe the states and state changes of the slave. The state change request is usually initiated by the master and the slave responds. The details is shown in Figure 6-31.

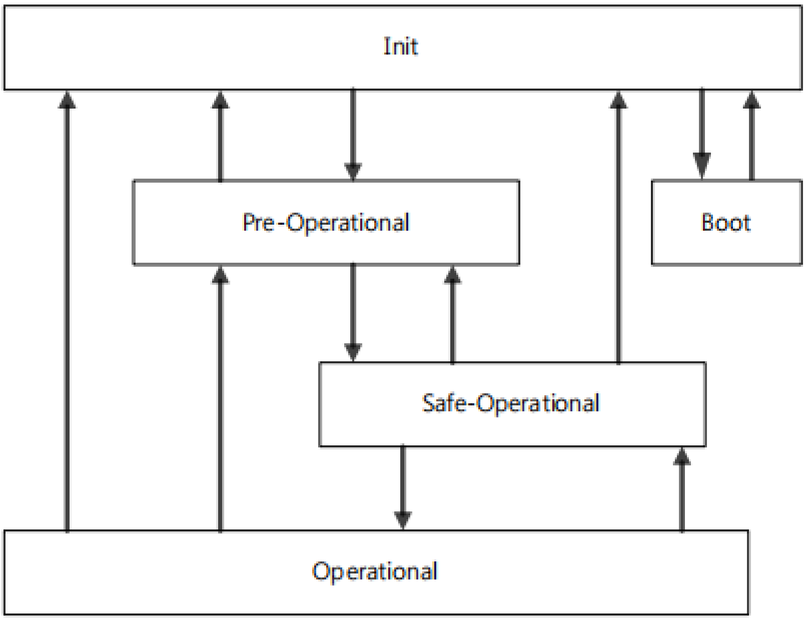


Figure 6-31 EtherCAT state machine

The status of state machine is shown in Table 6-31.

Table 6-31 Status

Status	Description
Boot	◆ Firmware update. ◆ Drive can transit to Init state.
Init	◆ Initialize the communication. ◆ Unable to communicate with SDO and PDO.
Init->Pre-OP	◆ The master configures the link address and SM channel to start mailbox communication. ◆ The master initializes DC clock synchronization. ◆ The master requests a transition to the Pre-Op state. ◆ The master sets the AL control register. ◆ The slave checks if mailbox is normally initialized.
Pre-OP	◆ Mailbox communication is activated. ◆ Unable to communicate with PDO.
Pre-OP->Safe-OP	◆ The master configures the Sync Manager channel and FMMU channel for PDO. ◆ The master configures PDO data mapping and Sync Manager PDO parameters through SDO. ◆ The master requests transition to Safe-Op state. ◆ The slave checks if the Sync Manager responsible for the PDO data is correctly configured, and check the distributed clock when the slave sends a request to start synchronization.
Safe-OP	◆ The slave application will transfer the actual input data and will not respond to the output. ◆ Output is set to "safe state".
Safe-OP->OP	◆ The master sends valid output data. ◆ The master requests a transition to the Op state.
OP	◆ Mailbox communication is available. ◆ PDO communication is available.

6.1.1.4 PDO mapping

ISD-A5-E-01 servo has 4 configurable PDOs, including 2 RxPDOs (0x1600 and 0x1601) and 2 TxPDOs (0x1A00 and 0x1A01). When you need to change the default PDO mapping, you can change the xml file and configure it into the servo.

Note: When using EtherCAT communication, it is necessary to set the communication cycle of the upper computer to be the same as that of the lower servo (default: 4 ms).

The default PDO mapping of STONE servo is as follows:

RxPDO

Table 6-32 RxPDO

(sub) index	Name	Object Type	Default
0x1600	1st Receive PDO	REC Data type -	-
0x00	Number of mapped objects	UINT8	10
0x01	Mapped object 1	UINT 16	0x6040 Control word
0x02	Mapped object 2	UINT32	0x607A Target position
0x03	Mapped object 3	UINT32	0x60B1 Velocity offset
0x04	Mapped object 4	UINT 16	0x60B2 Torque offset
0x05	Mapped object 5	UINT32	0x60FF Target velocity
0x06	Mapped object 6	UINT 16	0x6071 Target torque
0x07	Mapped object 7	UINT 8	0x6060 Modes of operation
0x08	Mapped object 8	UINT 8	0x0000
0x09	Mapped object 9	UINT32	0x0000
0x0A	Mapped object 10	UINT32	0x0000

Table 6-33 RxPDO

(sub) index	Name	Object Type	Default
0x1601	2st Receive PDO	REC Data type -	-
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT32	0x0000
		UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

TxPDO

Table 6-34 TxPDO

(sub) index	Name	Object Type	Default
0x1A00	1st Transmit PDO	REC Data type -	-
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT 16	0x6041 Statusword
0x02	Mapped object 2	UINT32	0x6064 Position actual value
0x03	Mapped object 3	UINT32	0x 606C Velocity actual value
0x04	Mapped object 4	UINT 16	0x 6077 Torque actual value
0x05	Mapped object 5	UINT 8	0x 6061 Modes of operation

(sub) index	Name	Object Type	Default
			display
0x06	Mapped object 6	UINT 8	0x0000
0x07	Mapped object 7	UINT32	0x0000
0x08	Mapped object 8	UINT32	0x 0000
0x09	Mapped object 9	UINT32	0x0000
0x0A	Mapped object 10	UINT32	0x 0000
0x0B	Mapped object 11	UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

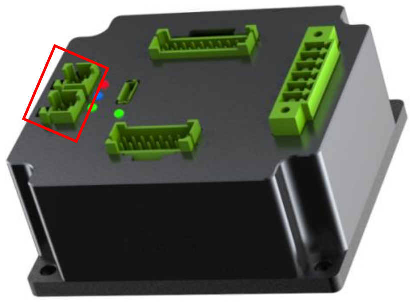
Table 6-35 TxPDO

(sub) index	Name	Object Type	Default
0x1A01	2 st Receive PDO	REC Data type -	-
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT32	0x0000
		UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

Note: You can query detailed PDO mapping information in the xml file

6.1.2 EtherCAT

6.1.2.1 Communication Interface



Pin	Name	Definition	Direction
1	TX+	Send data+	Output
2	TX-	Send data-	Output
3	RX+	Receive data+	Input
4	RX-	Receive data-	Input
5	PE	Shield	-

Figure 6-32 Definition of EtherCAT communication interface

6.1.2.2 Communication Wiring

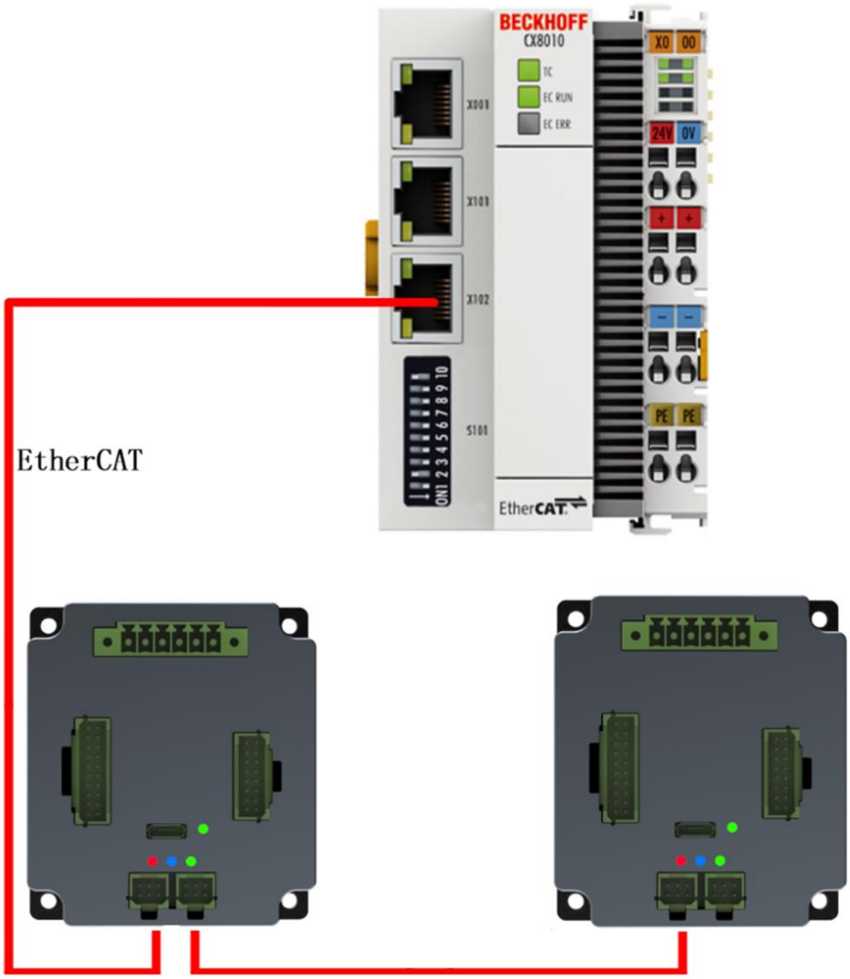


Figure 6-33 Communication wiring

6.1.2.3 Software Settings

1. Configure the motor parameters, and make sure that the servo motor can be operated normally with the ISMC software.
   For the trial run, please refer to "***Diamond Plus Servo User Manual***".
2. Select master type (0x2005):
   - ✓ 0: support the 402 state machine of most masters, including Beckhoff.
   - ✓ 1: specially support the 6061 state machine of Omron PLC.
3. Set servo communication cycle, set 0x60C2 to 01.
   Communication cycle range is within 1 - 4 ms (default value: 4 ms).
   The communication cycle of controller and servo should be the same. Otherwise, a synchronization error will occur during running.

The master triggers DC mode in the CSP mode. Otherwise, it will not operate normally.

Note:

1. The transferring and receiving PDOs can be dynamically configured by the master, but the maximum number for each PDO parameter is 10. If the range is exceeded, the slave will be unable to enter the op state.
2. The sequence of network cables is IN → OUT. Otherwise, some nodes may be unable to enter the op state.

6.1.3 Communication with Beckhoff PLC

1. **Connect hardware and check configuration**

   Refer to chapter 1 and 2 and complete the hardware and basic configuration between the servo and PLC.

2. **Place the configuration file**

   Place file Stone_E XML.xml under the TwinCAT directory as follows:

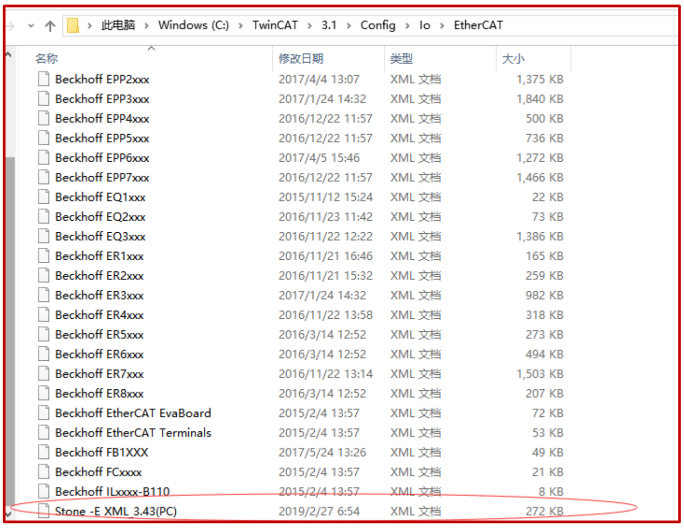


Figure 6-34 Directory of file Stone_E XML.xml

3. **Establish project and connection**

   Run TwinCAT software, create a project, modify the IP address of the computer and the controller in the same local area network, and select the target system to be connected:

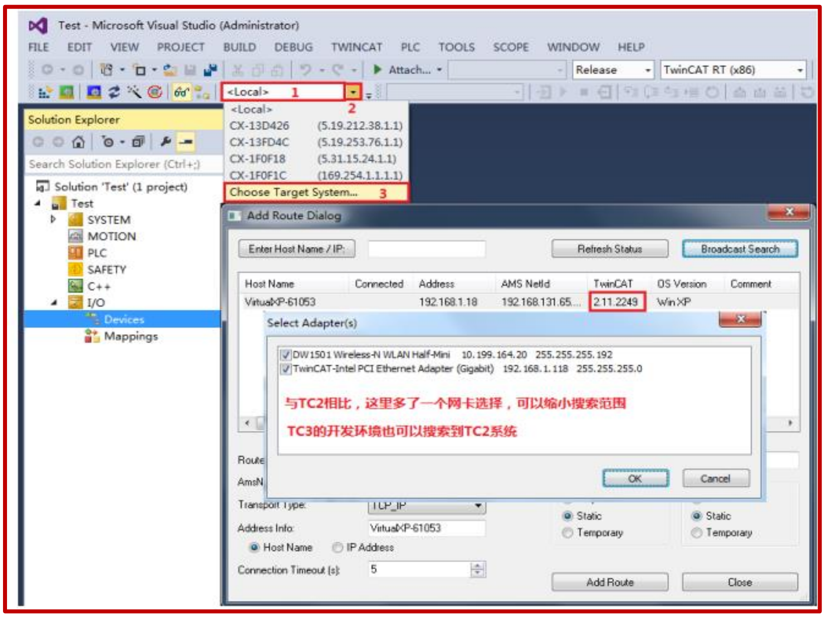


Figure 6-35 Modify IP address in TwinCAT

4. **Scan the slave and automatically configure NC axis**

   Right click on "**I/O**", select "**Scan**", scan EtherCAT slave, click "**Scan boxes**" after scanning the slave, and click "**Automatically add NC axis**".

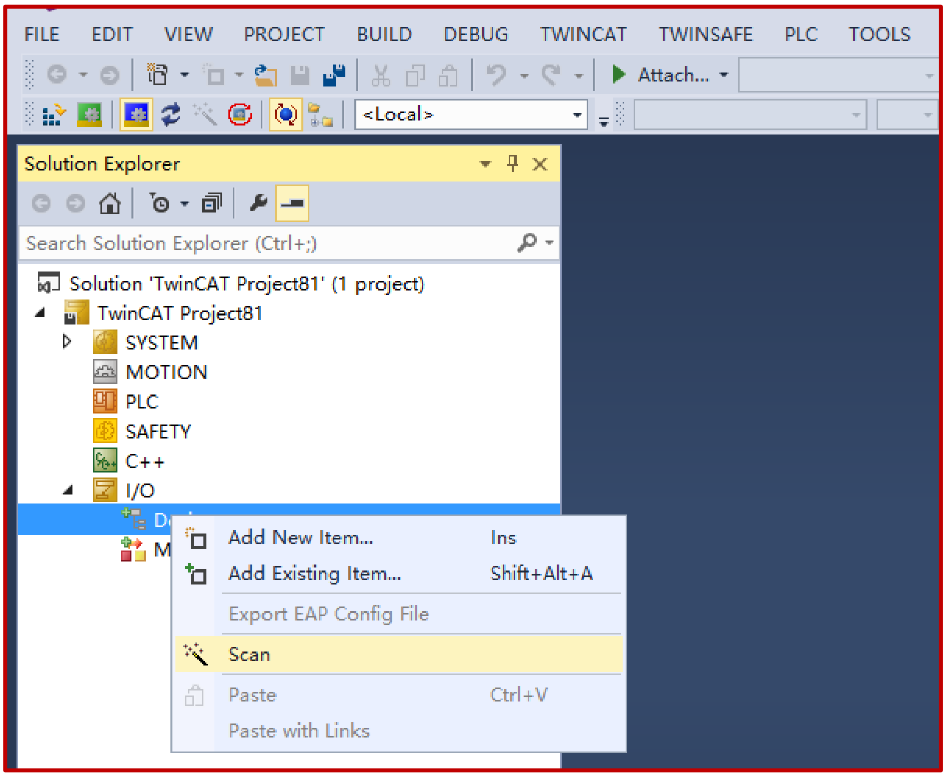


Figure 6-36 Automatic scanning and configuration of slaves in TwinCAT

After scanning is successful, icon StoneLOGO appears as shown in the below, and the servo status is in the OP state.

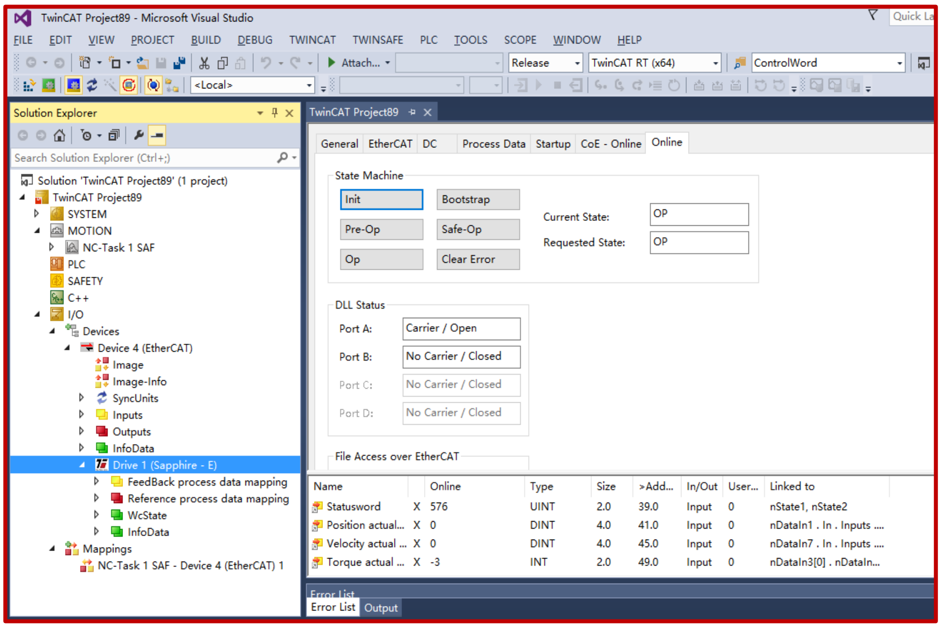


Figure 6-37 Successfully scan stone servo

Note: When scanning slave, please make sure TwinCat is in Config Mode.

5. Read COE data from Stone servo

As shown in Figure 7-39, you can read and write the data of the servo slave through SDO. Or you can call the COE command function module through the EtherCAT function library in the PLC program (Please refer to “TwinCat User Manual” for details).

Note: If the data is configured as PDO, write is invalid.

To check if read and write are successful, you can monitor and compare data through the SMC software.

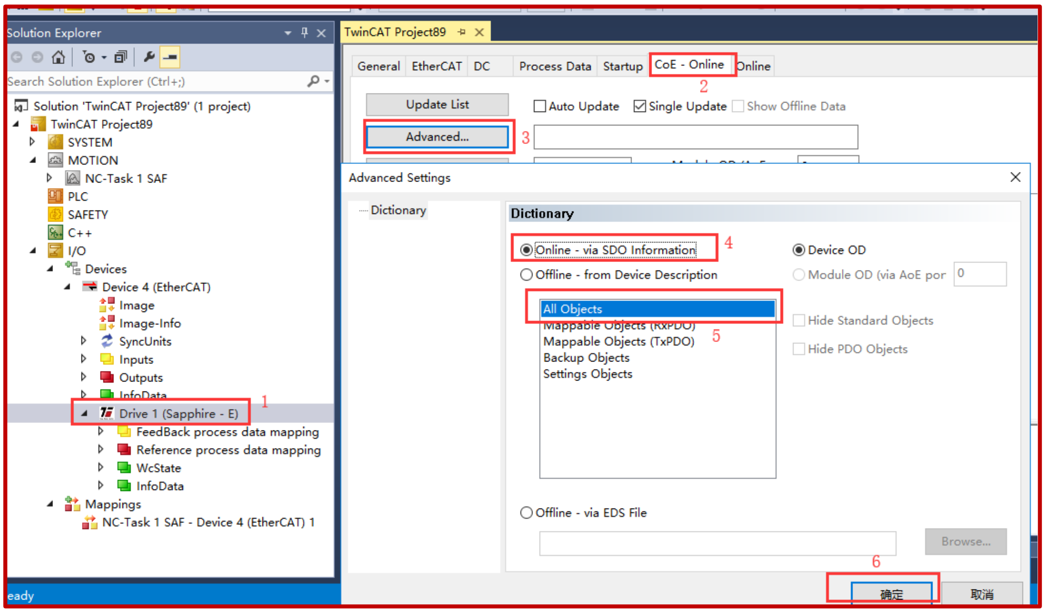


Figure 6-39 Configure SDO in TwinCAT

6. Read and configure PDO mapping

TwinCAT will automatically read the default PDO configuration of the lower computer when scanning the XML file of the slave. The default PDO mapping object and configuration are shown in Figure 7-40.

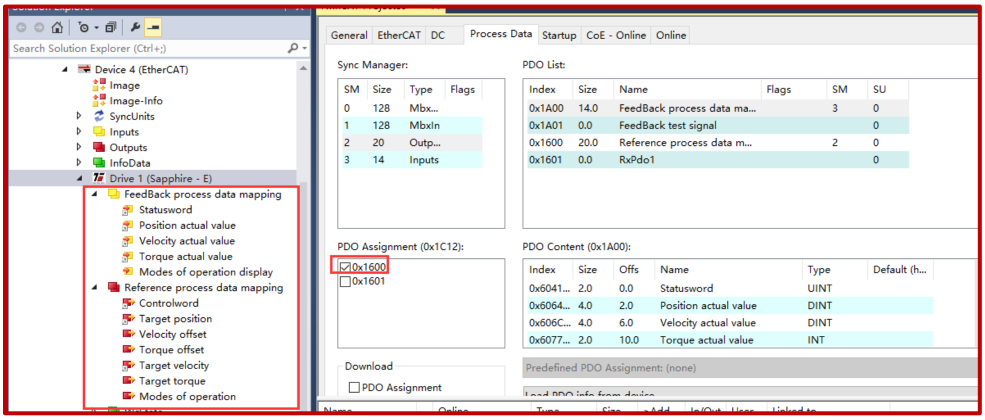


Figure 6-40 Configure PDO in TwinCAT

If the target PDO parameter is not in the default PDO configuration, you can add PDO parameter mapping through TWinCAT. For example, if you would like to add DI (0X2701) status when transferring PDO (1600):

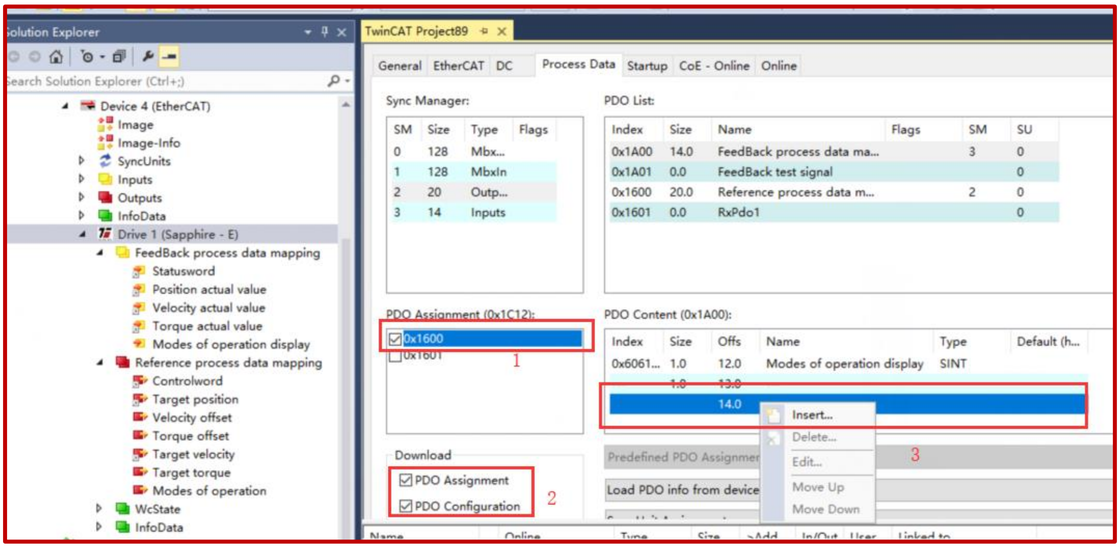


Figure 6-41 Add PDO parameters in TwinCAT

7. **Configure NC control**

   a. Configure NC TASK cycle: set "Cycle ticks" in NC-Task 1 SAF to "4" (unit: ms). NC determines generation and calculation of position, velocity, acceleration and the direction.

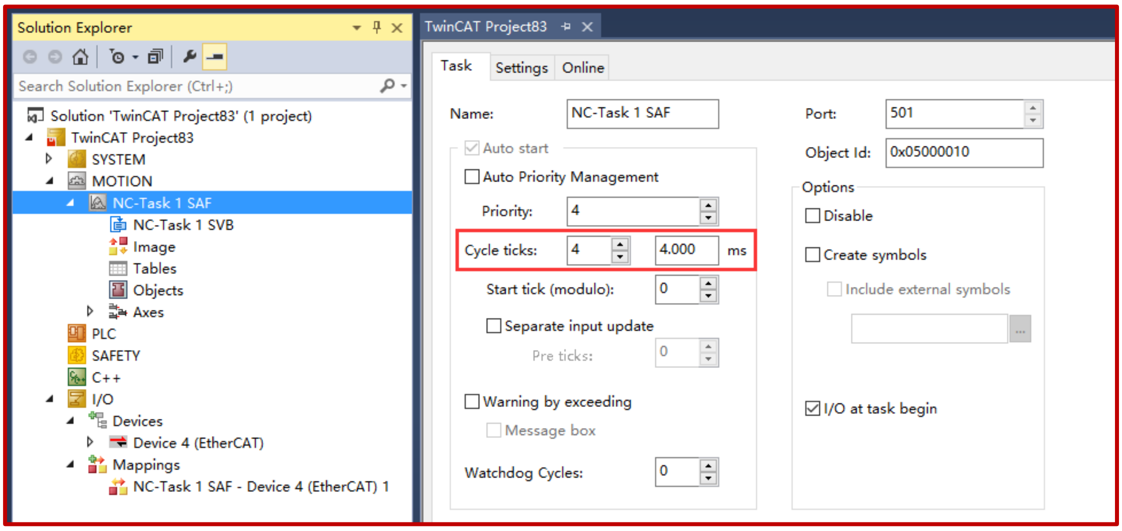


Figure 6-42 a. Configure NC TASK cycle in TwinCAT

   b. Configure the synchronization clock: enable distributed clock.
   Please note that the setting of Cycle Time should be the same with the synchronization period (4 ms) of the servo drive. Otherwise, the servo may vibrates during running.

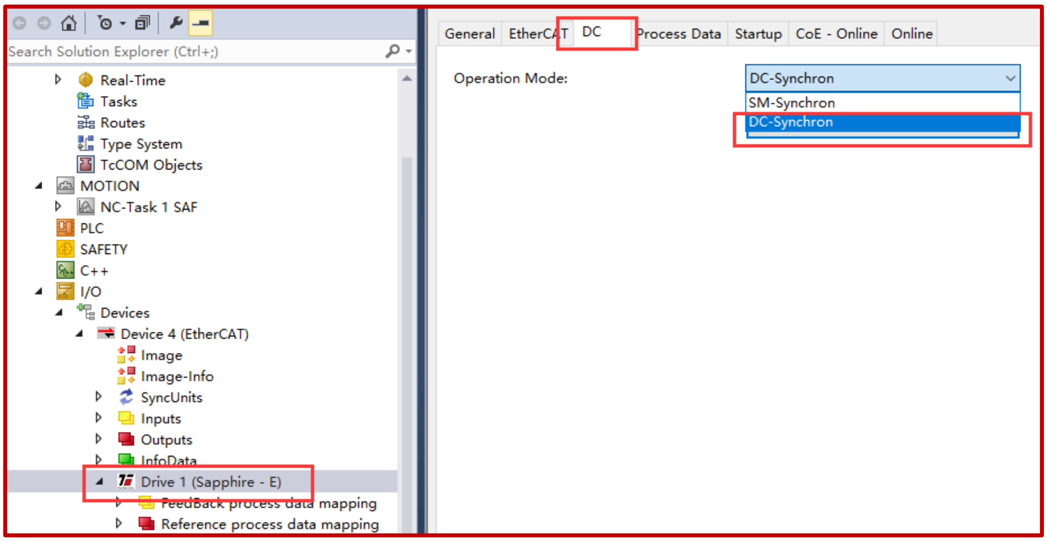


Figure 6-43 Check synchronization clock in TwinCAT

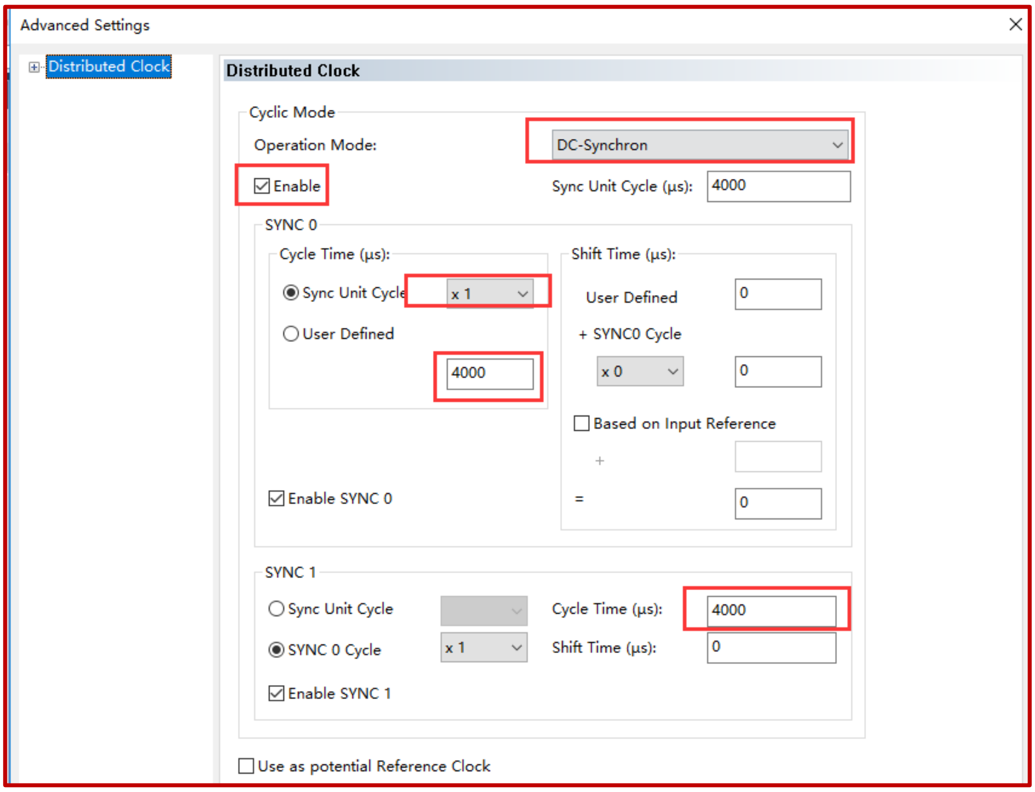


Figure 6-44 Set cycle time in TwinCAT

c. Set the following in the NC axis:

- Set Scaling Factor: the distance corresponding to the encoder pulse of each position feedback.

  e.g. If one turn of the servo motor is 10000 pulses, and each turn is 1 mm, the scaling factor should be set to 1/10000 = 0.0001 mm/Inc; if the target position increases by 10 mm, the actual servo position should increase by 100000 INC. Generally,

- Set the speed of NC control.

  Otherwise, an alarm will occur.

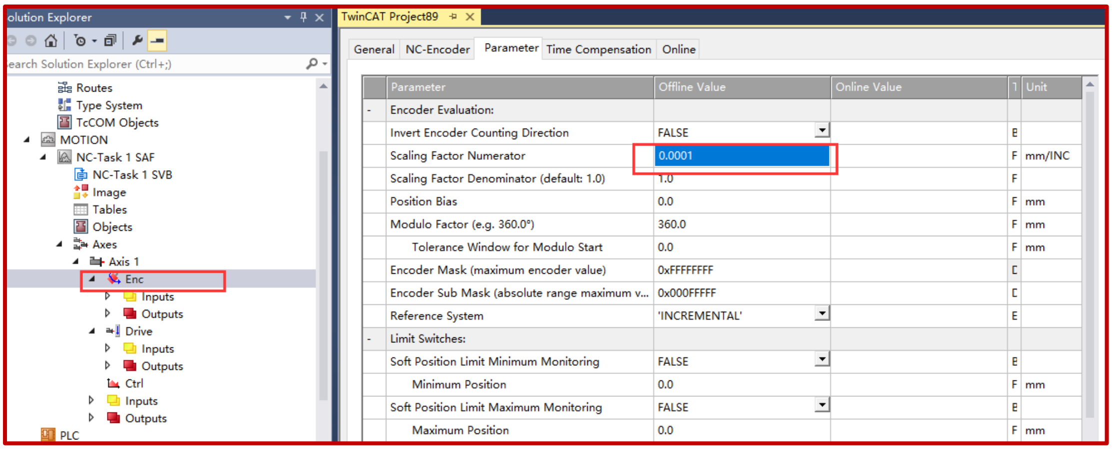


Figure 6-45 Set scaling factor in TwinCAT

d. To prevent the PLC from reporting a following error, set “**Following Error Calculation**” to “**Extern**”.

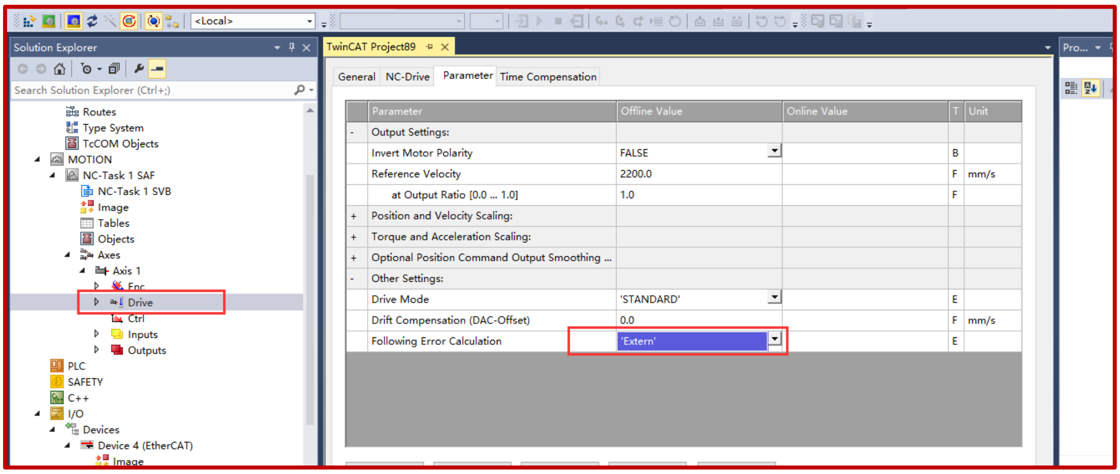


Figure 6-46 Set following error calculation in TwinCAT

e. To reverse the motor control polarity, set “Invert Encoder Counting Direction” to “TRUE” and “Invert Motor Polarity” to “TRUE”.

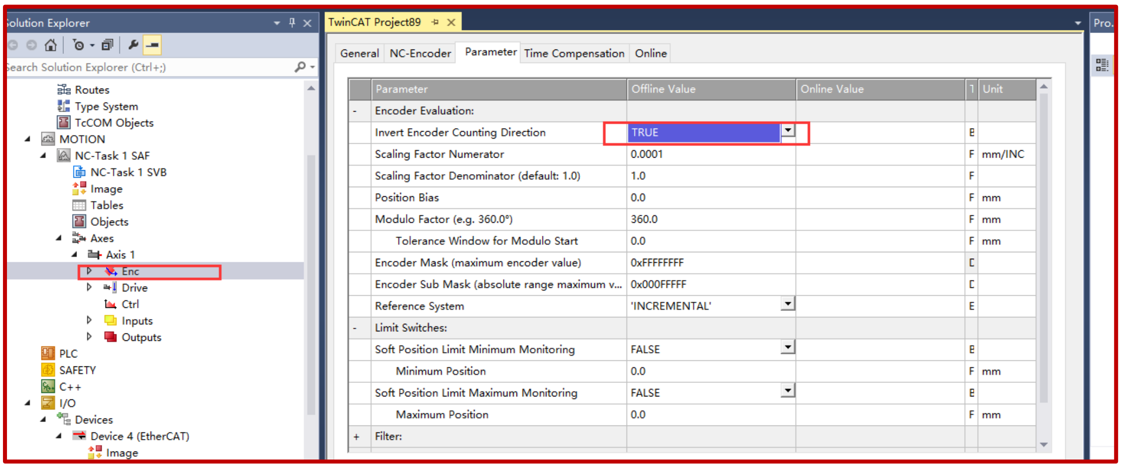


Figure 6-47 Set invert encoder counting direction in TwinCAT

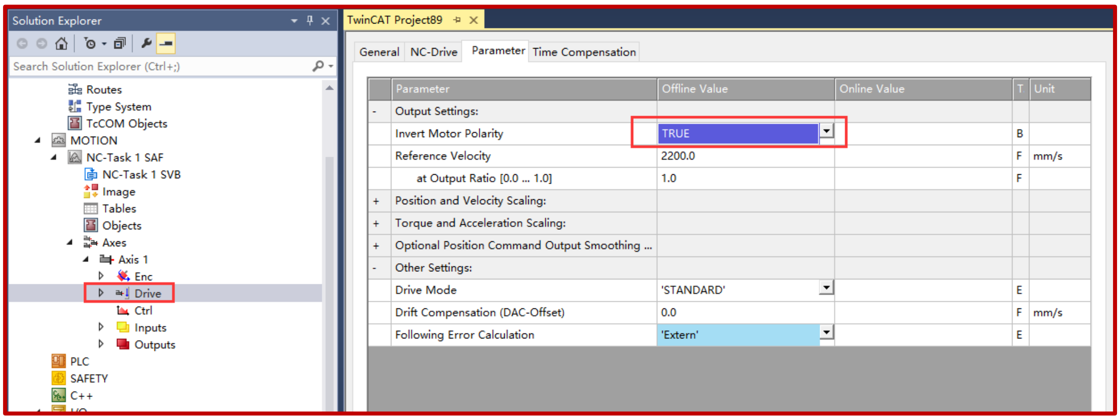


Figure 6-48 Set invert motor polarity in TwinCAT

f. Activate the configuration, control the servo working via the NC debugging interface, use Online function to simulate the servo working in the running mode (Make the servo lock the shaft, and click the button to make the servo run).

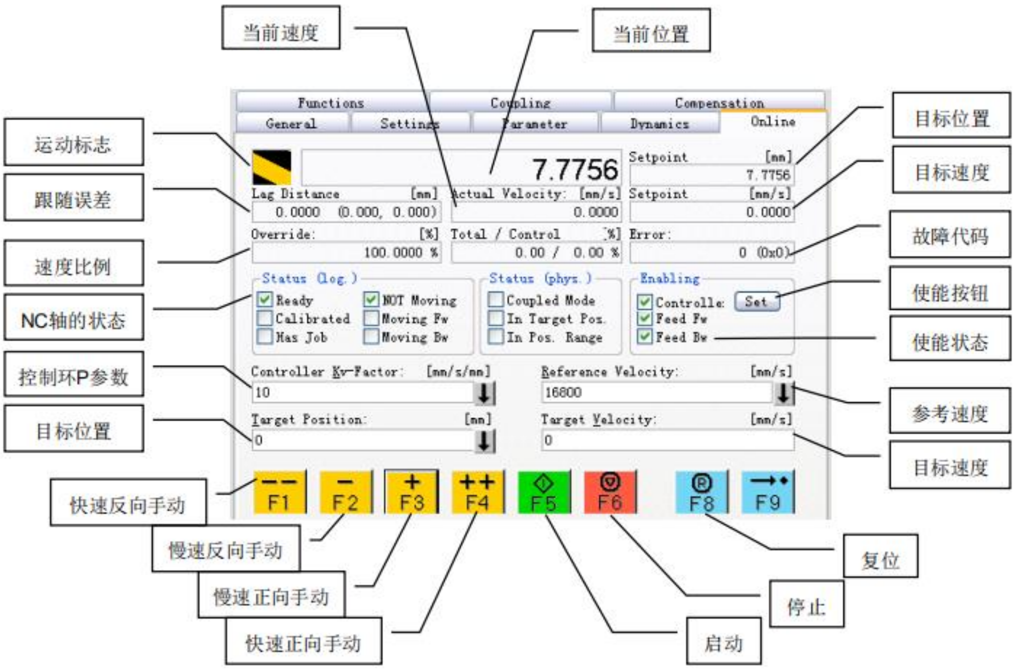


Figure 6-49 NC debugging interface in TwinCAT

当前速度：Current speed
当前位置：Current position
目标位置：Target position
目标速度：Target speed
故障代码：Error code
使能按钮：Enable button
使能状态：Enable status
参考速度：Reference speed
目标速度：Target speed
复位：Reset
停止：Stop
启动：Start
快速正向手动：Fast positive debugging
慢速正向手动：Slow positive debugging
慢速反向手动：Slow negative debugging

快速反向手动：Fast negative debugging
目标位置：Target position
控制环 P 参数：Control loop P parameter
NC 轴的状态：NC axis Status
速度比例：Speed rate
跟随误差：Follow-up error
运动标志：Movement sign

8. Create a PLC project

a. Create a new PLC project.

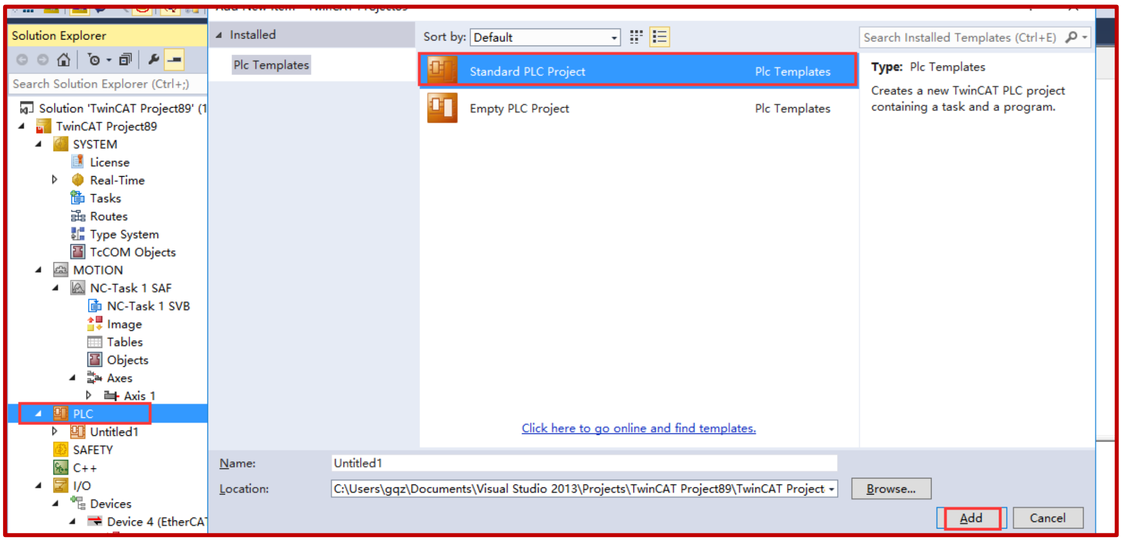


Figure 6-50 Create a new PLC project in TwinCAT

b. Set “**Cycle ticks**” of PLC Task to 4 ms.

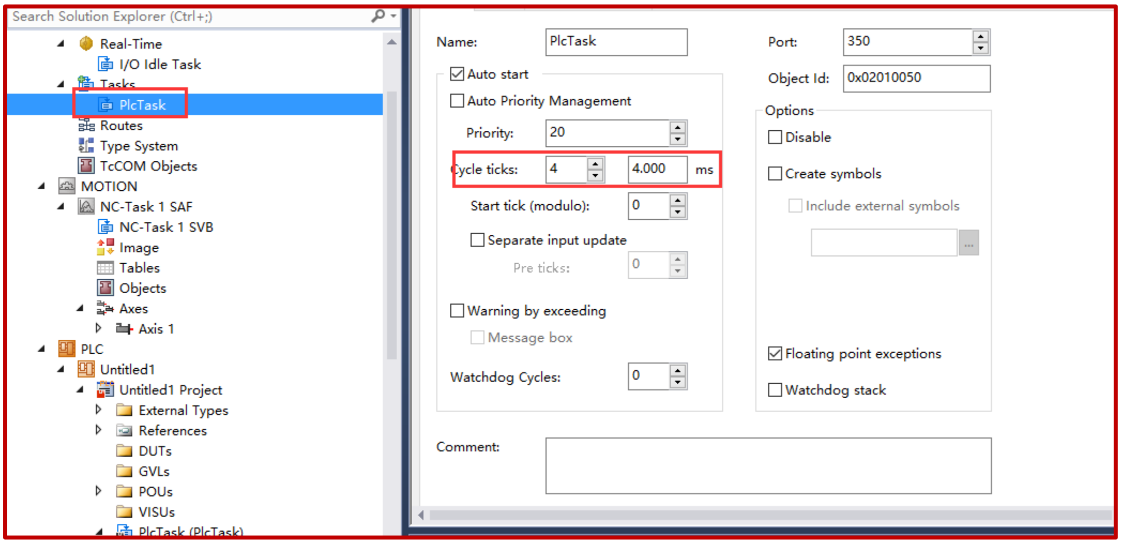


Figure 6-51 Set cycle ticks of PLC task in TwinCAT

9. Use of CoeSDO

CoeSDO is similar to SDO in CANOPEN. It can be used to read and write some objects whose exchange is not frequent or that are not supported by PDO communication. The steps are as follows:

a. Add "**Tc2_EtherCAT.lib**" in TwinCAT PLC library manager.

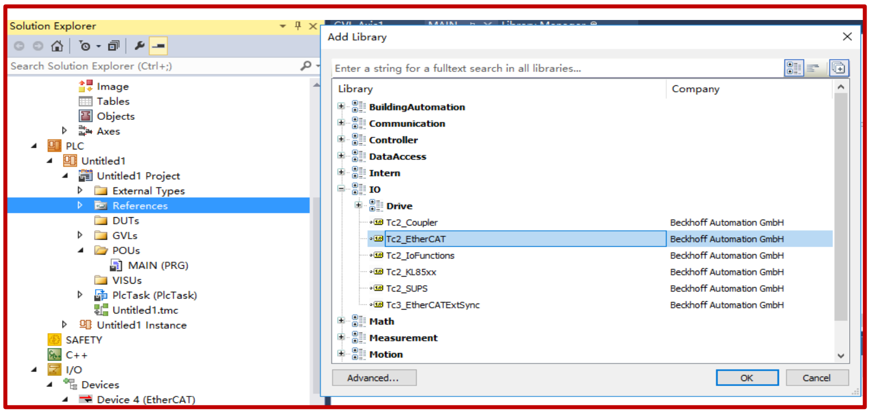


Figure 6-52 Add "Tc2_EtherCAT.lib" to the TwinCAT PLC library manager

b. After adding, declare the CoeSDO read and write in the program.

Taking read of status word 60410010 and write of homing mode 60980008 as examples, both of which have no symbols.

```
PROGRAM MAIN
VAR
    sNetId      : T_AmsNetId := '169.254.110.127.5.1';
    bExecute    : BOOL:=FALSE;
    bExe    : BOOL:=FALSE;
    nSlaveAddr : UINT := 1001;
    nIndex      : WORD := 16#6041;
    nSubIndex   : BYTE :=0;
    nIndex1      : WORD := 16#6098;
    nSubIndex1   : BYTE :=0;
    bError      : BOOL;
    nErrId      : UDINT;
    fbSdoRead   : FB_EcCoESdoRead;
    fbSdoWrite  : FB_EcCoESdoWrite;
    statuword: UINT;
    Homing_mode: INT:= 7;

END_VAR
```

Figure 6-53 Add CoeSDO function to program in TwinCAT

c. Set the T_AmsNetId of the EtherCAT master.

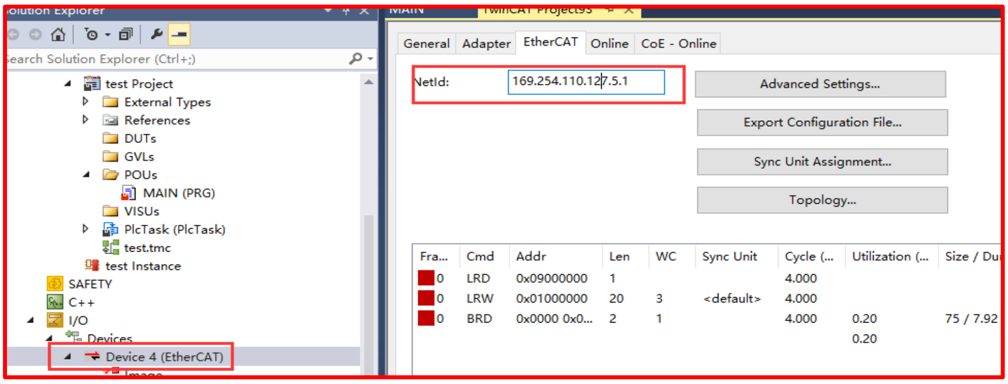


Figure 6-54 Set T_AmsNetId of EtherCAT master in TwinCAT

d. Set the slave's address SlaveAddr.

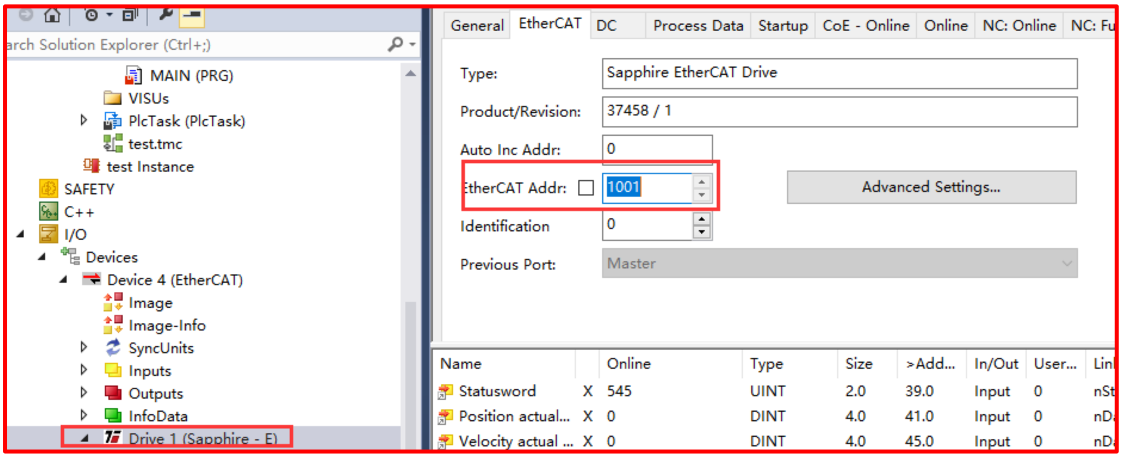


Figure 6-55 Set slave's address SlaveAddr in TwinCAT

e. Call the read and write function in the program, e.g. trigger read 0X6041 status word as 545, and write homing mode 0X6098 as 7.

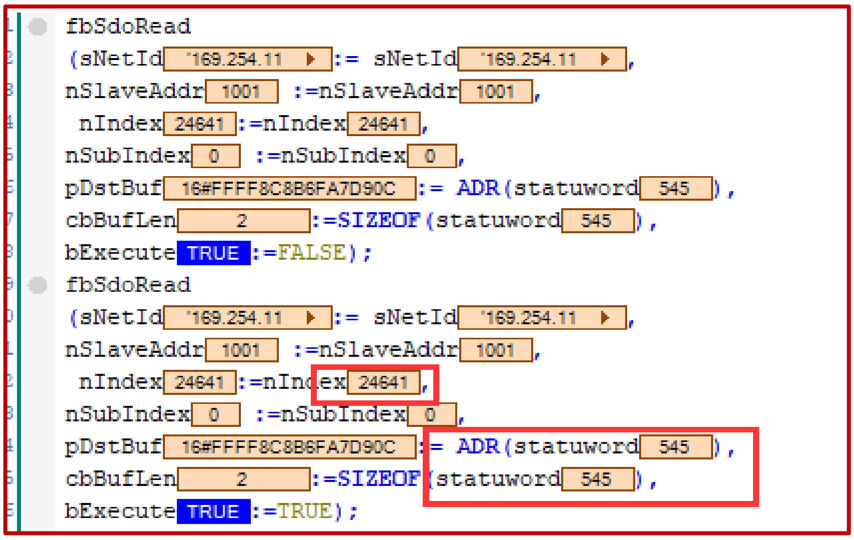


Figure 6-56 Trigger read of 0X6041 as 545 in TwinCAT

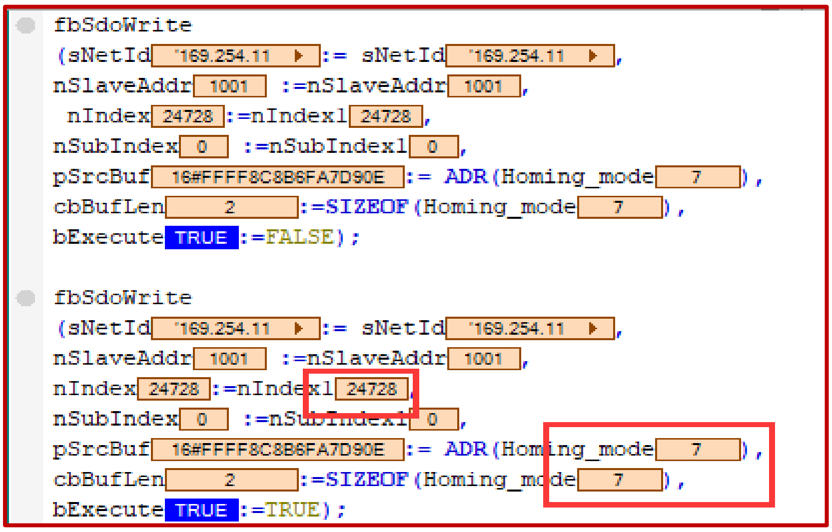


Figure 6-57 Trigger write of homing mode 0X6098 as 7 in TwinCAT

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