ISMC servo drive

EtherCAT Application Manual

ISMC Servo Drive EtherCAT Application Manual

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Preface

First of all, thank you for using the servo drive with the built-in EtherCAT fieldbus function of ISMC!

ISMC servo supports two kinds of communication methods: CANopen and EtherCAT, and each servo drive can only support CANopen or EtherCAT. This manual only describes the functional applications related to EtherCAT for servo drives with EtherCAT communication. For other general functions, please refer to the Servo drive User Manual. After reading the manual, if you still have any questions about using EtherCAT, please consult our company's technical personnel for assistance.

Our company reserves the right to continuously improve our products without prior notice.

When opening the box, please carefully confirm:

Confirm project	illustrate
Does the ordered model match the arrival?	Please determine the drive model based on the drive nameplate.
Are the product accessories complete?	Please check the entire machine and confirm if the drive terminals and connectors are complete (it is recommended to purchase cables recommended by the manufacturer).
Is there any damage of the product?	Please confirm if the product has been damaged during transportation.
If there are any issues with any of the above, please contact your supplier or our company for solution.	

Product Electrical Safety Usage Specification:

Dear user, hello! Before assembling and debugging the ISMC servo drive product, please carefully read the following safety usage specifications for servo drive products. Improper use of this product may cause personal injury or equipment damage. Be sure to strictly follow the relevant instructions and requirements.

1、Before powering on the equipment, please ensure that all system components of the equipment are grounded and ensure electrical safety through low impedance grounding (according to EN/IEC 618005-1 standard, protection level 1). At the same time, the motor should be connected to the protective ground through an independent grounding conductor, and the specification of the grounding conductor should not be lower than that of the motor power cable.

2. Only qualified technical personnel can carry out the installation, operation, maintenance, and repair procedures of this product. These qualified personnel must have received sufficient technical training and possess sufficient knowledge to predict and identify potential hazards that may arise when using products, modifying settings, and operating the mechanical, electrical, and electronic components of the entire machine system. Emergency stop switches must be

installed to ensure unpredictable operations that may cause personal injury or property damage.

3. This product contains components that are sensitive to static electricity. Improper placement can damage these components. Please avoid contact with high insulation materials (such as artificial fibers, plastic films, etc.) and place them on conductive surfaces. Before operation, operators must use an electrostatic wristband to release any potential static electricity.

4. To avoid serious personal injury or product damage during operation, please add a protective cover during product debugging and close all cabinet doors during equipment debugging.

5. This manual uses the following identification terms to further explain the precautions to be followed in preventing personal injury and equipment damage. Distinguish the harm and degree of damage caused by misoperation by identifying terminology. The content is all important content related to safety, please be sure to comply with:

	**Danger signs** ● Before powering on, please carefully read the product manual to ensure that the maximum power supply voltage does not exceed the voltage range specified in the product specifications. The actual maximum current used should not exceed the maximum peak current specified in the product. ● **Before powering on, check the wiring to avoid any short circuits or abnormal connections between U\V\W\PE\DC+\DC-, otherwise the drive may be burned or even sparks may occur, causing personal injury or death.** ● **It is necessary to avoid reverse connection of DC+\DC-, otherwise the drive may be burned or even sparks may occur, causing personal injury or death.** ● **To avoid the harm of electric arcs and other hazards to personnel and electrical contacts, it is prohibited to plug and unplug all servo connector cables while the servo is powered on.** ● Before wiring, inspection, maintenance and other operations, please make sure to cut off all power supply, confirm that the servo indicator light is off, and that the DC side voltage input is 0 volts, otherwise it may cause damage to the drive or the risk of electric shock to personnel.
	**Warning signs** ● In order to dissipate heat, a certain distance should be maintained between the drives as required, and the operating environment should comply with the product environmental standards. In addition, secondary heat dissipation plates should be added according to the actual situation. ● **USB does not support hot swapping, otherwise there may be a voltage difference between the drive and the PC, which can cause damage to the drive or the PC, and it must be powered off before plugging and unplugging.** ● **Please avoid using external power supply for encoder 5V unless**

	necessary. In case of special circumstances, external 5V power supply should be used. It is necessary to ensure that the 5V reference ground is shared with the ground (i.e. to avoid voltage difference), otherwise there is a risk of damaging the drive. ● **When controlling the power supply of the switch to power on or off the drive, it is necessary to do so on the AC input side of the switch power supply to avoid the instantaneous peak voltage generated during switch operation, which may cause overvoltage damage to the drive.** ● Products with STO function, please ensure that the safety torque cut-off function is effective before powering on and running. ● Ensure the drive working altitude does not exceed 1000m. ● To prevent the motor from being in an energy feeding state, which may cause overvoltage on the bus and damage the drive hardware, a braking module should be added according to the actual working conditions. ● Before powering on and debugging, please ensure that all safety measures have followed the installation steps in this manual.
	Anti static Peugeot ● This product is only suitable for standard ESD operating environments. Please ensure that there are no abnormal static power sources in the operating environment; ● **When operating with bare hands, operators must use an electrostatic wristband to release potential static electricity, wear anti-static gloves, and then come into contact with servo drive products for installation operations, avoiding contact with board components.** ● Please avoid contact with high insulation materials (such as artificial fibers, plastic films, etc.) and place them on the surface of conductive materials during installation.

	**Grounding sign** ● The heat dissipation plate, shell, and other system shielding ground of the product must be reliably connected to the ground, otherwise it may cause equipment abnormalities, damage, or other unpredictable dangers.

Version change record

Date	Revised version	Changes
Oct 2018	V1.0	First edition release
April 2019	V1.1	Change of Homing method description
Oct 2019	V1.2	Some parameters and case additions
April 2020	V1.3	Update product images, fault descriptions, and homing related instructions
April 2022	V1.4	Update 60FE Function Description
July 2022	V1.5	Revise product electrical safety usage specifications
Feb 2023	V1.6	Add explanation for collision homing function

目录

Chapter 1 Hardware Configuration

1.1 Interface Definition

The EtherCAT communication interface of the ISMC servo drive is standard RJ45 interface, as shown in the front schematic diagram. The Sapphire series J1 terminal is the wiring terminal of EtherCAT, with the upper (IN) input and lower (OUT) output; The Diamond series J3 and J4 terminals are EtherCAT interfaces, J3 (IN) and J4 (OUT).

Figure 1-1-1 Sapphire Series servo drive EtherCAT Interface Appearance

Pin numbe	Signal name	Abbreviation	Signal direction
1	Sending data+	TX+	output
2	Sending data-	TX-	output
3	Receiving data+	RX+	input
4、5	-	NC*	-
6	Receiving data-	RX-	input
7、8	-	NC	-
housing	protective earthing	FG	-

Chart 1-1-1 Saphhire Series Pin Introduction

*NC means not used

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Figure 1-1-2 Diamond Series EtherCAT Interface Appearance

Pin number	Signal name	Abbreviation	Signal direction
1	Sending data+	TX+	output
2	Sending data-	TX-	output
3	Receiving data+	RX+	input
6	Receiving data-	RX-	input
housing	protective earthing	FG	-

Chart 1-1-2 Diamond Series Pin Introduction

1.2 Drive wiring

The EtherCAT network usually consists of a master station (IPC or CNC) and multiple slave stations (servo drives or bus extension IO, etc.). Each EtherCAT slave station has two interfaces, which are cascaded in the EtherCAT network. The wiring diagram is shown in Figure 1-2.

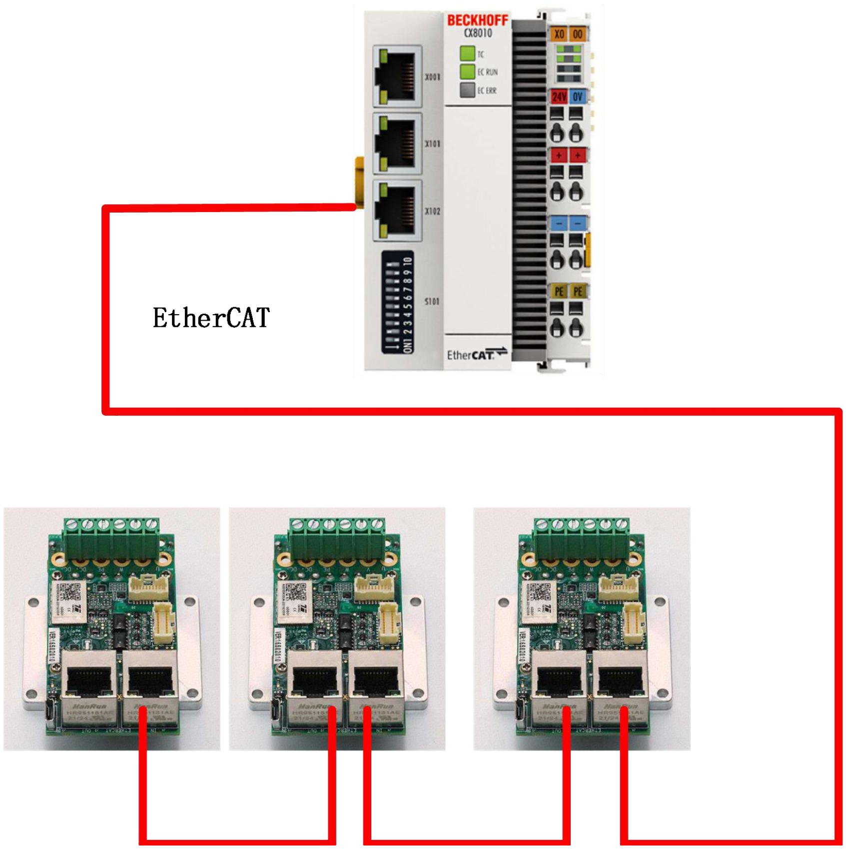

Figure 1-2 EtherCAT Communication Wiring Diagram

Chapter 2 Software Configuration

2.1 Basic Application Configuration

1) Motor parameter configuration and trial operation: Configure the motor parameters to ensure that the servo motor can run normally using the ISMC commissioning software. The trial operation can refer to the ISMC Servo Product Debugging Manual;

2) EtherCAT Master Type (0x2005) selection:

0: Supports 402 state machines controlled by most controllers such as Beckhoff;

1: Specific support for feedback requirements from state machine 6041 when the main control is Omron PLC;

3) Servo communication cycle setting: can support 1-4ms, default 4ms, configuration parameter index is 0x60C2:01;

4) The communication cycle of the controller needs to be set to be consistent with the communication cycle of the servo. If the communication cycle does not match, synchronization errors may occur during operation;

5) When the main controllers run CSP operation mode in SM and DC modes, it is recommended to select DC mode for multi axis synchronization.

Note:

1. Our sending and receiving PDO can be dynamically configured by the Master station, but the maximum number of parameters for each PDO is 10; After exceeding the range, the slave station will not be able to enter the OP state;
2. The order of network cables needs to be IN first and OUT after, otherwise it may cause some nodes can't enter the op state;

2.2 EtherCAT communication

2.2.1 CoE reference model

The following figure shows the internal CANopen over EtherCAT (COE) network model of ISMC servo:

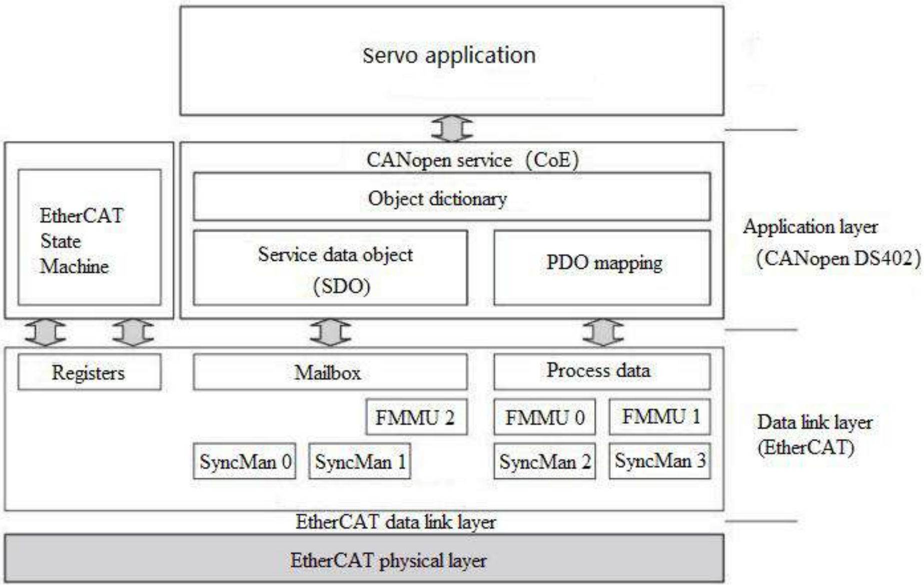

Figure 2-1 COE Reference Model

The EtherCAT (CoE) network reference model consists of two parts: the data link layer and the application layer. The data link layer is mainly responsible for the EtherCAT communication protocol, and the application layer embeds the CANopen drive profile (DS402) communication protocol. The object dictionary in CoE includes parameters, application data, and PDO mapping configuration information.

Process Data Object (PDO) is composed of objects in the object dictionary that can be mapped to PDO, and the content in PDO data is defined by PDO mapping. The reading and writing of PDO data are periodic and do not require searching the object dictionary; And Service Data Object (SDO) is non periodic communication, which requires searching the object dictionary when reading and writing.

2.2.2 EtherCAT slave station information

The EtherCAT slave information file (XML file) is used for the master station to read and construct the configuration between the master and slave stations. The XML file contains the necessary information for EtherCAT communication settings, and ISMC provides the "ISMC-E_XML.xml" file for the servo drive to establish master-slave configuration.

2.2.3 EtherCAT state machine

The EtherCAT state machine is used to describe the state and state changes of the slave application. State change requests are usually initiated by the master station and responded by the slave stations. The specific state transition method is shown in Figure 2-2.

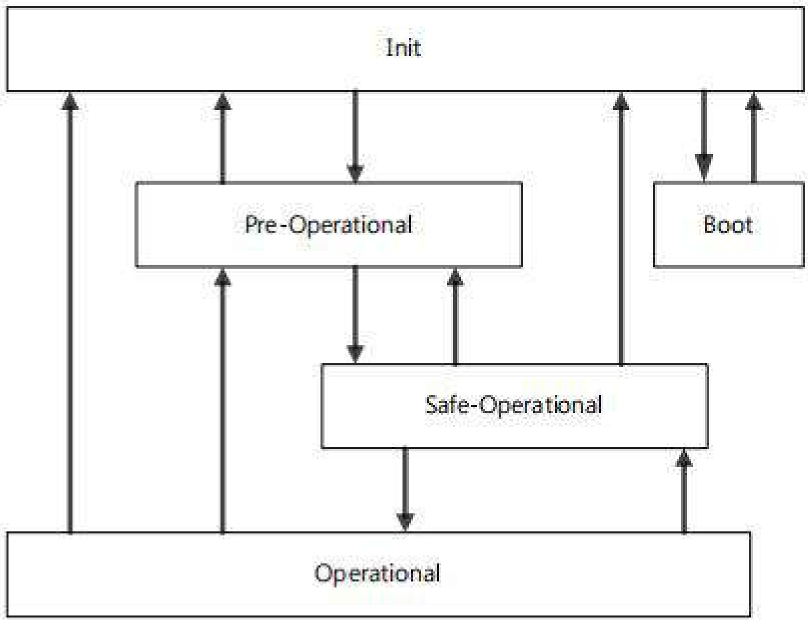

Figure 2-2 EtherCAT State Machine

The description of the state machine is shown in Table 2-2.

Table 2-1 Status Description

State	Description
Boot	◆ Firmware update status ◆ Drive can transition to Init state
Init	◆ Initialize communication status ◆ Unable to do SDO and PDO communication
Init ->Pre-OP	◆ Configure link layer addresses and SM channels on the main station, and initiate email communication ◆ Master station initializes DC clock synchronization ◆ The master station requests a transition to Pre-Op status ◆ Setting AL control register on the main station ◆ Determine whether the mailbox is properly initialized from the site
Pre OP	◆ Email communication activated ◆ Unable to perform process data communication (PDO)
Pre OP ->Safe-OP	◆ The master station configures the Sync Manager

	channel and FMMU channel for process data configuration ◆ The main station configures PDO data mapping and Sync Manager PDO parameter settings through SDO ◆ Master station requests Safe-Op status transition ◆ Check if the Sync Manager responsible for PDO data is configured correctly at the slave station. If the slave station issues a request to start synchronization, check if the distribution clock is set correctly
Safe-OP	◆ The slave application will transmit the actual input data without operating the output ◆ The output is set to "safe state"
Safe OP ->OP	◆ The main station sends valid output data ◆ The master station requests a transition to Op status
OP	◆ Can communicate via email ◆ Can communicate with PDO

2.2.4 PDO process data mapping

The ISMC servo has 4 configurable PDOs, including 2 RxPDOs (0x1600, 0x1601) and 2 TxPDOs (0x1A00, 0x1A01).

For different application requirements, when it is necessary to change the default PDO mapping, the XML file can be changed and configured in the servo.

Note: When using EtherCAT communication, the communication cycle of the master satation needs to be set to be consistent with the slave station servo, with a default of 4ms

The default PDO mapping is shown in the table below:

RxPDO

Table 2-2 Introduction to RxPDO

Sub index Number	name	object type	Default value
0x1600	1st Receive PDO	REC data type -	-
0x00	Number of mapped objects	UINT8	10
0x01	Mapped object 1	UINT16	0x6040 Controlword
0x02	Mapped object 2	INT32	0x607A Target position
0x03	Mapped object 3	INT32	0x60B1 Velocity offset
0x04	Mapped object 4	INT16	0x60B2 Torque offset
0x05	Mapped object 5	INT32	0x60FF Target velocity
0x06	Mapped object 6	INT16	0x6071 Target torque
0x07	Mapped object 7	UINT8	0x6060 Modes of Operation
0x08	Mapped object 8	UINT8	0x0000
0x09	Mapped object 9	UINT32	0x0000
0x0A	Mapped object 10	UINT32	0x0000

Table 2-3 Introduction to RxPDO

Sub index Number	name	object type	Default value
0x1601	2nd 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 2-4 Introduction to TxPDO

Sub index Number	name	object type	Default value
0x1A00	1st Transmit PDO	REC data type -	-
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT16	0x6041 Statusword
0x02	Mapped object 2	INT32	0x6064 Position actual value
0x03	Mapped object 3	INT32	0x606C Velocity actual value
0x04	Mapped object 4	INT16	0x6077 Torque actual value
0x05	Mapped object 5	UINT8	0x6061 Modes of operation display
0x06	Mapped object 6	UINT8	0x0000
0x07	Mapped object 7	UINT32	0x0000
0x08	Mapped object 8	UINT32	0x0000
0x09	Mapped object 9	UINT32	0x0000
0x0A	Mapped object 10	UINT32	0x0000
0x0B	Mapped object 11	UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

Table 2-5 Introduction to TxPDO

Sub index Number	name	object type	Default value
0x1A01	2nd 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: Detailed PDO mapping information can be queried in an XML file

2.3 Supported communication formats

Table 2-6 Introduction to Communication Format

EtherCAT communication	Trial communication standards	IEC 61158 Type12, IEC 61800-7 CiA402 Drive Profile
	physical layer	100BASE-TX (IEEE802.3)
	BUS connection	J3 (Smtec): EtherCAT Signal IN J4 (Smtec): EtherCAT Signal OUT
	Cable	Category 5 twisted pair cable
	SyncManager	SM0: Output mailbox SM1: Input valid SM2: Output process data SM3: Input process data
	FMMU	FMMU0: Map to process data (RxPDO) output area FMMU1: Map to process data (RxPDO) output area FMMU2: Map to mailbox status
	PDO data	Dynamic PDO mapping
	Mailbox (CoE)	Emergency events, SDO requests, responses, SDO information Note: TxPDO/RxPDO and remote TxPDO/TxPDO are not supported
	Distributed Clock (DC)	Free run, DC mode (requires activation through main control parameter selection), supported DC cycle: 1-4ms
	Slave Information IF	256Bytes (Read Only)
CiA402 Drive Profile	◆ Homing mode (6) ◆ Profile position mode (1)	

	◆ Profile velocity mode (3) ◆ Profile torque mode (4) ◆ Cyclic synchronous position mode (8) ◆ Cyclic synchronous speed mode (9) ◆ Cyclic synchronous torque mode (10)

Chapter 3 CiA402 Equipment Control

3.1 State Machine

The servo drive operates according to the state machine of CiA402. When connecting to the main station, the main station must also follow the CiA402 protocol to send 0x6040 Controlword to control the state machine of the servo. As shown in Figure 3-1.

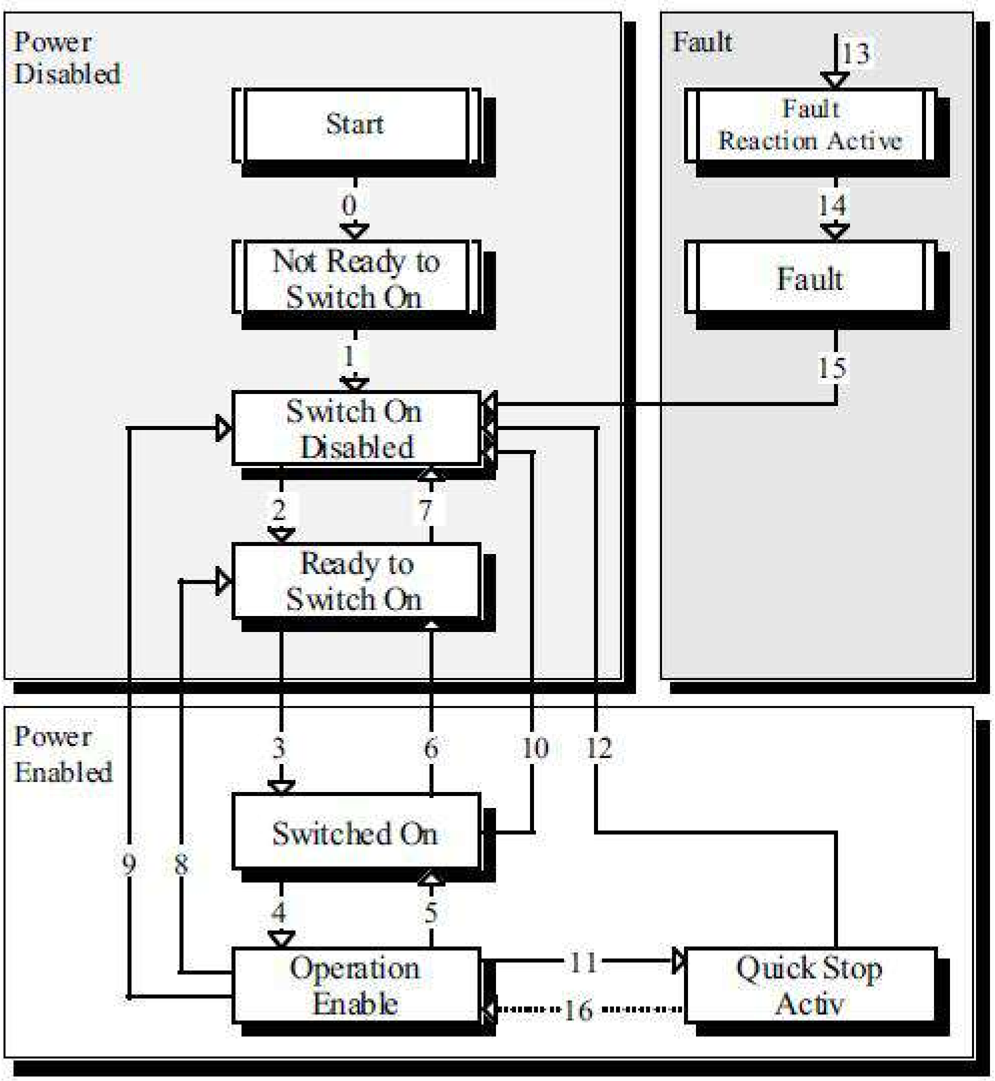

Figure 3-1 CiA402 State Machine

The corresponding servo functions in different states are shown in Table 3-1.

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Table 3-1 Servo functions under different states

Function	state machine							
	Not ready to switch on	Switch on disabled	Ready to switch on	Switch on	Operation enabled	Quick stop active	Fault reaction active	Fault
Enable holding brake	yes	yes	yes	yes	no	no	no	yes
Control power supply	yes	yes	yes	yes	yes	yes	yes	yes
Bus power supply	no	no	no	yes	yes	yes	yes	no
PWM drive	no	no	no	no	yes	yes	yes	no
Allow configuration	yes	yes	yes	yes	no	no	no	yes

The triggering events and actions of state transitions are shown in Table 3-2.

Table 3-2 Trigger Events and Actions for State Transitions

Transition	Event (s)	Action (s)
0	Automatically jump after power on or reset	Device self check and initialization
1	Automatic jump	Communication function enable
2	Received shutdown command	No
3	Received Switch on command	Powering on the bus
4	Received Enable operation command	Enable PWM output, clear all internal given points
5	Received the Disable operation command	Prohibited PWM output
6	Received shutdown command	Disconnect the bus
7	Received Quick stop or Disable voltage command	No
8	Received shutdown command	Prohibit PWM output and disconnect the bus
9	Received the Disable voltage command	Prohibit PWM output and disconnect the bus
10	Received Disable voltage or Quick stop command	Disconnect the bus
11	Received Quick stop command	Start Quick Stop Function
12	Automatically jump when fast stop is completed and 0x605A is 1,2,3,4, or receive a Disable voltage command	Prohibit PWM output and disconnect the busbar
13	Failure occurred	Start fault response function
14	Automatic jump	Prohibit PWM output and disconnect the busbar
15	Received Fault reset command	Start resetting the fault, and if the fault has been resolved, clear the fault flag bit
16	Not Supported	

3.2 Control related object parameters

0x6040: Controlword

Controlword is a control word.

Table 3-3 Introduction to 6040 Control Words

Index number	name	object type	mapping	access	Default value
0x6040	Controlword	VAR	RxPDO	RW	0
		data type	unit	range	
		UINT16	-	-	

The bit definitions of control words are shown in Table 3-4.

Table 3-4 Bit Definition of Controlword

bit	15~11	10~9	8	7	6~4	3	2	1	0
function	undefined	reserved	halt	fault reset	operation mode specific	enable operation	quick stop	Enable voltage	switch on

The control instructions of the servo are implemented by different bit combinations of control words (Bit 0-3, 7), as shown in Table 3-5.

Table 3-5 Control Instructions (X represents 0 or 1 is acceptable)

control command	**Bit of controlword**					**Transitions**
	Bit 7	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
Shut down	0	X	1	1	0	2,6,8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3+4
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset	0->1	X	X	X	X	15

Note: Bit4 to 6 have different meanings in different control modes.

0x6041: Statusword

Statusword is the status word.

Table 3-6 Introduction to 0x6041 Status Words

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x6041</td><td rowspan="3">Statusword</td><td>VAR</td><td>TxPDO</td><td>RO</td><td rowspan="3">0</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>UINT16</td><td>-</td><td>-</td></tr>
</table>

The meanings of the status words are shown in Table 3-7.

Table 3-7 Introduction to bit bits of status words

Bit	description
0	Ready to swtich on
1	Switch on
2	Operation enabled
3	Fault enabled
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Undefined
9	Remote
10	Target Reached
11	Internal limit active
12~13	Operation mode specific
14~15	Undefined

The different combinations of Bit 0-3, 5, and 6 in the status words represent the current state of the servo, as shown in Table 3-8.

Table 3-8 corresponds to the bit combinations of status words for different states (X represents 0 or 1 can be used)

Statusword	State machine state
Xxxx xxxx x0xx 0000b	Not ready to switch on
Xxxx xxxx x1xx 0000b	Switch on disabled
Xxxx xxxx x01x 0001b	Ready to switch on
Xxxx xxxx x01x 0011b	Switched on
Xxxx xxxx x01x 0111b	Operation enabled
Xxxx xxxx x00x0111b	Quick stop active
Xxxx xxxx x0xx 1111b	Fault reaction active
Xxxx xxxx x0xx 1000b	Fault

0x605A: Quick stop option code

When the state machine transits from Operation enable to Quick Stop active, 0x605A determines different quick stop modes.

Table 3-9 Introduction to 0x605A

Index number	name	object type	mapping	access	Default value
0x605A	Quick stop option code	VAR	-	RW	2
		data type	unit	range	
		INT16	-	0-3, 5-7	

The meaning of the set value of 0x605A is introduced in Table 3-10.

Table 3-10 Shutdown Methods Corresponding to the Setting Values of 0x605A

set value	Shutdown method
0	Turn off the output of the servo drive
1	Stop the machine at the deceleration slope and then switch to the Switch on disable state
2	Stop the main at the fast stop slope and then switch to the Switch on disable state
3	The speed is set to 0, the speed loop controls the shutdown, and then switches to the Switch on disable state
4	Not Supported
5	Stop the machine according to the deceleration slope and keep it in Quick stop active state
6	Stop the machine at the fast stop slope and keep it in the Quick stop active state
7	The speed is set to 0, the speed loop controls the shutdown and then keep it in Quick stop active state
8	Not Supported

0x605B: Shutdown option code

When the state machine transits from Operation enable to Ready to Switch on, 0x605B determines different shutdown methods.

Table 3-11 Introduction to 0x605B

Index number	name	object type	mapping	access	Default value
0x605B	Shutdown option code	VAR	-	RW	0
		data type	unit	range	
		INT16	-	0，1	

Table 3-12 Shutdown Methods Corresponding to the Setting Values of 0x605B

set value	**Shutdown method**
0	Turn off the output of the servo drive
1	Stop the machine at the deceleration slope and then turn off the output of the servo drive

0x605C: Disable operation option code

When the state machine transitions from Operation enabled to Switched on, 0x605C determines different shutdown methods.

Table 3-13 0x605C

Index number	name	object type	mapping	access	Default value
0x605C	Disable operation option code	VAR	-	RW	0
		data type	unit	range	
		INT16	-	0，1	

The shutdown methods corresponding to the set value of 0x605C are shown in Table 3-14

Table 3-14 Shutdown Methods Corresponding to the Setting Values of 0x605C

set value	Shutdown method
0	Turn off the output of the servo drive
1	Stop the machine at the deceleration slope and then turn off the output of the servo drive

0x605D: Halt option code

When Bit8 of control word 0x6040 is set to 1, 0x605D determines different shutdown methods.

Table 3-15 Introduction to 0x605D

Index number	name	object type	mapping	access	Default value
0x605D	Halt option code	VAR	-	RW	1
		data type	unit	range	
		INT16	-	1,2,3	

The shutdown methods corresponding to the set value of 0x605D are shown in Table 3-16.

Table 3-16 Shutdown Methods Corresponding to the Setting Values of 0x605D

set value	Shutdown method
0	Not Supported
1	Stop the machine at the deceleration slope and keep it in the Operation enabled state
2	Stop the machine at the fast stop slope and keep it in the sOperation enabled state
3	The speed is set to 0, the speed loop controls shutdown, and then remains in the Operation enabled state
4	Not Supported

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0x605E: Fault reaction option code

When an error is detected, 0x605E determines different shutdown methods.

Table 3-17 0x605E Introduction

Index number	name	object type	mapping	access	Default value
0x605E	Fault reaction option code	VAR	-	RW	0
		data type	unit	range	
		INT16	-	0,1,2,3	

The shutdown method corresponding to the set value of 0x605E is shown in Table 3-18.

Table 3-18 Shutdown Methods Corresponding to the Setting Values of 0x605E

set value	Shutdown method
0	Turn off the output of the servo drive
1	Stop according to deceleration slope
2	Stop according to the fast stop slope
3	Given a speed of 0, the speed loop controls shutdown
4	Not Supported

0x6060: Modes of operation

0x6060 is used to set the operating mode of the servo, and the supported modes are shown in Table 3-19.

Table 3-19 Introduction to 0x6060

Index number	name	object type	mapping	access	Default value
0x6060	Modes of operation	VAR	RxPDO	RW	0
		data type	unit	range	
		INT8	-	0,1,3,4,6,8	

The operating modes corresponding to the set value of 0x6060 are shown in Table 3-20.

Table 3-20 Operating modes corresponding to the set values of 0x6060

set value	Operating mode
0	no
1	Profile position mode
3	Profile velocity mode
4	Profile torque mode
6	Homing mode
8	Cyclic sync position mode
9	Cyclic sync speed mode
10	Cyclic synchronous torque mode

0x6061: Modes of operation display

The display value of 0x6061 represents the current operating mode of the servo, and the supported modes are the same as 0x6060, as shown in Table 3-21.

Table 3-21 0x6061 Introduction

Index number	name	object type	mapping	access	Default value
0x6060	Modes of operation	VAR	TxPDO	RO	0
		data type	unit	range	
		INT8	-	0,1,3,4,6,8	

The operating mode corresponding to the displayed value of 0x6061 is shown in Table 3-22.

Table 3-22 The operating modes

set value	Operating mode
0	No
1	Profile position mode
3	Profile velocity mode
4	Profile torque mode
6	Homing mode
8	Cyclic sync position mode
9	Cyclic sync speed mode
10	Cyclic synchronous torque mode

0x603F: Error code

0x603F provides the error code of the servo when the last error occurred, as shown in Table 3-23.

Table 3-23 0x6061 Introduction

Index number	name	object type	mapping	access	Default value
0x603F	Error code	VAR	-	RO	0
		data type	unit	range	
		UINT16	-	-	

0x6007: Abort connection option code

When controlling the servo through the EtherCAT master station, if there is a communication interruption or any error, the object sets different response measures for the servo, as shown in Table 3-24.

Table 3-24 Introduction to 0x6007

Index number	name	object type	mapping	access	Default value
0x6007	Abort connection option code	VAR	-	RW	0
		data type	unit	range	
		UINT16	-	0,1,2,3	

The definition corresponding to the value of 0x6007 is introduced in Table 3-25.

Table 3-25 0x6007

Value	Definition
0	Not responding
1	Error shutdown
2	Stop the machine according to the Disable voltage command
3	Stop the machine according to the Quick stop command

0x607E: Polarity

The introduction of 0x607E is shown in Table 3-26.

Table 3-26 0x607E Introduction

Index number	name	object type	mapping	access	Default value
0x607E	Polarity	VAR	RxPDO	RW	0
		data type	unit	range	
		UINT8	-	-	

Bit6 of 0x607E is used to configure the polarity of speed instructions in Profile velocity mode and Cycle sync velocity mode, while Bit7 is used to configure the polarity of position instructions in Profile position mode and Cycle sync position mode. If set to 0 in Table 3-27, it is the original value of the instruction value, which is multiplied by 1; If set to 1, the instruction value is reversed, i.e. multiplied by -1. The definitions corresponding to the values of 0x6007 in Table 3-27

Table 3-27

Bit	**7**	**6**	**5~0**
function	Position polarity	Velocity polarity	undefined

0X60C2: Interpolation time

This parameter is used to configure with synchronization cycle time.

Index number	name	object type	mapping	access	Default value
0x60C2	Interpolation time	ARRAY	-	-	4ms
		data type	unit	range	
		INT8	0.001s	1-4ms	

The sub index number 0x00 of 0x60C2 is introduced in the following table

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index number 0x01 of 0x60C2 is introduced in the table:

Sub index number	name	object type	mapping	access	Default value
0x01	InterpolationTimePeriodValue	-	-	RW	4
		data type	unit	range	
		UINT8	-	-	

The sub index number 0x02 of 0x60C2 is introduced in the table:

Sub index number	name	object type	mapping	access	Default value
0x02	InterpolationTimeIndex	-	-	RW	-3
		data type	unit	range	

		INT8	-	-	

The default Interpolation time is 4*10 ($^{-3}$) seconds.

3.3 Unit Conversion

The internal unit of operation of the servo drive is the Count value, abbreviated as cnt, which represents the unit pulse of the encoder. Increment (abbreviated as Inc) or Pulse both have the same meaning. The drive will convert User Unit (UU), which mainly includes user-defined position units, velocity units, acceleration units, etc., into internal units for calculation. The internal units corresponding to each physical quantity are shown in Table 3-28.

Table 3-28 Internal Units of Servo

physical quantity	internal unit
position	cnt
speed	cnt/s
acceleration	cnt/s ^ 2
Jerk	cnt/s ^ 3
torque	Rated torque/1000

0x608F: Position encoder resolution

0x608F calculates the resolution of the position encoder by configuring the incremental value of the encoder corresponding to the number of motor rotations using the following formula.

$$\text{Position encoder resolution} = \frac{\text{Encoder increments}}{\text{Motor revolutions}}$$

The introduction of 0x608F is shown in Table 3-29.

Table 3-29 Introduction to 0x608F

Index number	name	object type	mapping	access	Default value
0x608F	Position encoder resolution	ARRAY	-	-	-
		data type	unit	range	
		UINT32	-	-	

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The sub index0x00 of 0x608F is introduced in Table 3-30.

Table 3-30 Introduction to sub index 0x00 of 0x608F

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index0x01 of 0x608F is introduced in Table 3-31.

Table 3-31 Introduction to sub index 0x01 of 0x608F

Sub index number	name	object type	mapping	access	Default value
0x01	Encoder increments	-	-	RW	131072
		data type	unit	range	
		UINT32	cnt	-	

The sub index0x02 of 0x608F is introduced in Table 3-32.

Table 3-32 Introduction to sub index 0x02 of 0x608F

Sub index number	name	object type	mapping	access	Default value
0x02	Motor revolutions	-	-	RW	1
		data type	unit	range	
		UINT32	rev	-	

0x6091: Gear ratio

0x6091 calculates the gear ratio by configuring the number of motor shaft rotations corresponding to the number of drive shaft rotations using the following formula.

$$\text{Gear ratio} = \frac{\text{Motor shaft revolutions}}{\text{Driving shaft revolutions}}$$

The introduction of 0x6091 is shown in Table 3-33.

Table 3-33 0x6091 Introduction

Index number	name	object type	mapping	access	Default value
0x6091	Gear ratio	ARRAY	-	-	-
		data type	unit	range	
		UINT32	-	-	

The sub index 0x00 of 0x6091 is introduced in Table 3-34.

Table 3-34 Introduction to sub index 0x00 of 0x6091

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index 0x01 of 0x6091 is introduced in Table 3-35.

Table 3-35 Introduction to sub index 0x01 of 0x6091

Sub index number	name	object type	mapping	access	Default value
0x01	Motor revolutions	-	-	RW	1
		data type	unit	range	
		UINT32	rev	-	

The sub index 0x02 of 0x6091 is introduced in Table 3-36.

Table 3-36 Introduction to sub index 0x02 of 0x6091

Sub index number	name	object type	mapping	access	Default value
0x02	Shaft revolutions	-	-	RW	1
		data type	unit	range	
		UINT32	rev	-	

0x6092: Feed constant

0x6092 calculates the feed constant by configuring the measurement length corresponding to the number of turns of the drive shaft using the following formula.

$$\text{Feed constant} = \frac{\text{Feed}}{\text{Driving shaft revolutions}}$$

The introduction of 0x6092 is shown in Table 3-37.

Table 3-37 Introduction to 0x6092

Index number	name	object type	mapping	access	Default value
0x6092	Feed constant	ARRAY	-	-	-
		data type	unit	range	
		UINT32	-	-	

The sub index 0x00 of 0x6092 is introduced in Table 3-38.

Table 3-38 Introduction to sub index 0x00 of 0x6092

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index 0x01 of 0x6092 is introduced in Table 3-39.

Table 3-39

Sub index number	name	object type	mapping	access	Default value
0x01	Feed	-	-	RW	1
		data type	unit	range	
		UINT32	UU	-	

The sub index 0x02 of 0x6092 is introduced in Table 3-40.

Table 3-40

Sub index number	name	object type	mapping	access	Default value
0x02	Shaft revolutions	-	-	RW	1
		data type	unit	range	
		UINT32	rev	-	

3.4 Motor settings

The parameters of the motor and encoder can be configured through 0x2100, and must be strictly configured according to the nameplate of the motor to be driven or the actual parameters provided by the motor manufacturer. Otherwise, it may cause the motor to malfunction or operate abnormally, and may cause damage to the motor or mechanical equipment.

0x2100: Motor parameters

The introduction of 0x2100 is shown in Table 3-41.

Table 3-41 Introduction to 0x2100

Index number	name	object type	mapping	access	Default value
0x2100	Motor parameters	REC	-	-	-
		data type	unit	range	
		-	-	-	

The sub index 0x00 of 0x2100 is introduced in Table 3-42

Table 3-42

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	23
		data type	unit	range	
		UINT8	-	23	

The sub index 0x01 of 0x2100 is introduced in Table 3-43.

Table 3-43

Sub index number	name	object type	mapping	access	Default value
0x01	Motor type	-	-	RW	1
		data type	unit	range	
		UINT32	-	1,2	

The definition of motor type is shown in 3-44.

Table 3-44 Definition of Motor Type Values

value	definition
1	Rotary motor
2	Linear motor

The sub index 0x02 of 0x2100 is introduced in Table 3-45.

Table 3-45 Introduction to sub index 0x02 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x02	Motor rated power	-	-	RW	200
		data type	unit	range	
		UINT32	W	-	

The sub index 0x03 of 0x2100 is introduced in Table 3-46.

Table 3-46 Introduction to sub index 0x03 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x03	Motor rated current	-	-	RW	3300
		data type	unit	range	
		UINT32	MA	-	

The sub index 0x04 of 0x2100 is introduced in Table 3-47.

Table 3-47 Introduction to sub index 0x04 of 0x2100

Sub index number	name	object type	mapping	access	Defaul t value
0x04	Motor rated torque	-	-	RW	350
		data type	unit	range	
		UINT32	mNm	-	

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The sub index 0x05 of 0x2100 is introduced in Table 3-48.

Table 3-48 Introduction to sub index 0x05 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x05	Motor rated speed	-	-	RW	3000
		data type	unit	range	
		UINT32	rpm	-	

The sub index 0x06 of 0x2100 is introduced in Table 3-49.

Table 3-49 Introduction to sub index 0x06 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x06	Motor max current	-	-	RW	3000
		data type	unit	range	
		UINT32	Rated current/1000	-	

The sub index 0x07 of 0x2100 is introduced in Table 3-50.

Table 3-50 Introduction to sub index 0x07 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x07	Motor max torque	-	-	RW	3000
		data type	unit	range	
		UINT32	Rated torque/1000	-	

The sub index 0x08 of 0x2100 is introduced in Table 3-51.

Table 3-51 Introduction to sub index 0x08 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x08	Motor max speed	-	-	RW	3900
		data type	unit	range	
		UINT32	rpm	-	

The sub index 0x09 of 0x2100 is introduced in Table 3-52.

Table 3-52 Introduction to sub index 0x09 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x09	Motor static current	-	-	RW	1100
		data type	unit	range	
		UINT32	Rated current/1000	-	

The sub index 0x0A of 0x2100 is introduced in Table 3-53.

Table 3-53 Introduction to sub index 0x0A of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x0A	Motor pole pairs number	-	-	RW	4
		data type	unit	range	
		INT16	-	-	

The sub index 0x0B of 0x2100 is introduced in Table 3-54.

Table 3-54 Introduction to sub index 0x0B of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x0B	Motor stator phase resistance	-	-	RW	0
		data type	unit	range	
		INT16	mOhm	-	

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The sub index 0x0C of 0x2100 is introduced in Table 3-55.

Table 3-55 Introduction to sub indexes 0x0C of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x0C	Motor D axis inductance	-	-	RW	0
		data type	unit	range	
		INT16	μH	-	

The sub index 0x0D of 0x2100 is introduced in Table 3-56.

Table 3-56 Introduction to sub index 0x0D of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x0D	Motor Q axis inductance	-	-	RW	0
		data type	unit	range	
		INT16	μH	-	

The sub index 0x0E of 0x2100 is introduced in Table 3-57.

Table 3-57 Introduction to sub indexes 0x0E of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x0E	Motor rotor inertia	-	-	RW	0
		data type	unit	range	
		INT32	$g*cm^2$	-	

The sub index 0x0F of 0x2100 is introduced in Table 3-58.

Table 3-58 Introduction to sub index 0x0F of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x0F	Motor back EMF	-	-	RW	0
		data type	unit	range	
		UINT32	μV/rpm	-	

The sub index 0x10 of 0x2100 is introduced in Table 3-59.

Table 3-59 Introduction to sub indexes 0x10 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x10	Motor torque constant	-	-	RW	111
		data type	unit	range	
		UINT32	mNm/A	-	

The sub index 0x11 of 0x2100 is introduced in Table 3-60.

Table 3-60 Introduction to sub indexes 0x11 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x11	Encoder type	-	-	RW	3
		data type	unit	range	
		UINT32	-	1,2,3,4	

The definition of encoder type is shown in 3-61.

Table 3-61 Definition of Encoder Type Values

Value	Definition
1	Digital Hall sensor
2	Orthogonal incremental encoder
3	Tamagawa absolute encoder
4	Nikon absolute encoder

The sub index 0x12 of 0x2100 is introduced in Table 3-62.

Table 3-62 Introduction to sub index 0x12 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x12	Encoder single turn resolution Encoder single revolution resolution	-	-	RW	17
		data type	unit	range	
		UINT32	Bit	-	

The sub index 0x13 of 0x2100 is introduced in Table 3-63.

Table 3-63 Introduction to sub index 0x13 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x13	Encoder multi turn resolution Encoder multi turn resolution	-	-	RW	16
		data type	unit	range	
		UINT32	Bit	-	

The sub index 0x14 of 0x2100 is introduced in Table 3-64.

Table 3-64 Introduction to sub indexes 0x14 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x14	ABZ encoder pulses Incremental encoder single cycle pulse count	-	-	RW	0
		data type	unit	range	
		INT32	pulse /rev	-	

The sub index0x15 of 0x2100 is introduced in Table 3-65.

Table 3-65 Introduction to sub index 0x15 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x15	Encoder frequency division pulses	-	-	RW	0
		data type	unit	range	
		UINT32	pulse /rev	-	

The sub index0x18 of 0x2100 is introduced in Table 3-66.

Table 3-66 Introduction to sub indexes 0x18 of 0x2100

Sub index number	name	object type	mapping	access	Default value
0x18	Linear motor pole pair pitch	-	-	RW	0
		data type	unit	range	
		UINT32	mm	-	

3.5 Control Settings

The dynamic and steady-state performance during the servo drive load process can be achieved by configuring PID parameters the 0x2000 position loop, speed loop, and current loop.

0x2000: PID parameters

The introduction of 0x2000 is shown in Table 3-67.

Introduction to Table 3-67 0x2000

Index number	name	object type	mapping	access	Default value
0x2000	PID parameters	REC	-	-	-
		data type	unit	range	

The sub index 0x00 of 0x2000 is introduced in Table 3-68.

Table 3-68 Introductionto sub indexes 0x00 of 0x2000

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	5
		data type	unit	range	
		UINT8	-	5	

The proportional gain of the position loop can be set by 0x2000.01, with a unit of 0.001, which means the set value of 20000 represents 20.The larger the set value, the faster the servo response, the better the tracking ability to the position command, and the smaller the steady-state error of the position. However, excessive values can cause mechanical vibration and system instability.

The sub index 0x01 of 0x2000 is introduced in Table 3-69.

Table 3-69 Introduction to sub index 0x01 of 0x2000

Sub index number	name	object type	mapping	access	Default value
0x01	Position loop Kp	VAR	-	RW	20000
		data type	unit	range	
		INT32	0.001	-	

The proportional gain of the speed loop can be set by 0x2000.02, in units of 0.001, which means the set value of 5 represents 0.005.The larger the set value, the faster the servo response, the better the tracking ability to the speed command, and the smaller the steady-state error of the speed. However, excessive values can cause mechanical vibration and system instability.

The sub index 0x02 of 0x2000 is introduced in Table 3-70.

Table 3-70 Introduction to sub index 0x02 of 0x2000

Sub index number	name	object type	mapping	access	Default value
0x02	Velocity loop Kp	VAR	-	RW	5
		data type	unit	range	
		INT32	0.001	-	

The integral gain of the speed loop can be set to 0x2000.03, in units of 0.001, which means the set value of 26 represents 0.026.The larger the set value, the stronger the integration effect, and the faster the steady-state error of the speed approaches 0. However, excessive values can cause mechanical vibration and system instability.

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The sub index 0x03 of 0x2000 is introduced in Table 3-71.

Table 3-71 Introduction to sub index 0x03 of 0x2000

Sub index number	name	object type	mapping	access	Default value
0x03	Velocity loop Ki	VAR	-	RW	26
		data type	unit	range	
		INT32	0.001	-	

The proportional gain of the current loop can be set by 0x2000.04, with a unit of 0.001, which means the set value of 6300 represents 6.3. The larger the set value, the faster the servo response and the better the current tracking ability. However, excessive values can cause system instability.

The sub index 0x04 of 0x2000 is introduced in Table 3-72.

Table 3-72 Introduction to sub index 0x04 of 0x2000

Sub index number	name	object type	mapping	access	Default value
0x04	Current loop Kp	-	-	RW	6300
		data type	unit	range	
		INT32	0.001	-	

The integral gain of the current loop can be set to 0x2000.05, in units of 0.001, which means the set value of 85 represents 0.085. The larger the value set, the stronger the integration effect, and the faster the steady-state error of the current approaches 0. However, excessively large values can cause system instability.

The sub index 0x05 of 0x2000 is introduced in Table 3-73.

Table 3-73 Introduction to sub index 0x05 of 0x2000

Sub index number	name	object type	mapping	access	Default value
0x05	Current loop Ki	-	-	RW	85
		data type	unit	range	
		INT32	0.001	-	

3.6 Holding brake setting

When using a servo motor with a brake, it is necessary to enable the brake function of the servo and configure the relevant parameters of the brake reasonably to ensure that the mechanical load will not move unexpectedly due to gravity or external forces when powered on or off, resulting in equipment damage.

0x2805: Brake activation velocity

When the actual speed of the motor is below the set value of 0x2805, the holding brake process is initiated. The introduction of 0x2805 is shown in Table 3-74.

Table 3-74 Introduction to 0x2805

Index number	name	object type	mapping	access	Default value
0x2805	Brake activation velocity	VAR	-	RW	30
		data type	unit	range	
		UINT32	rpm	-	

0x2806: Brake disengage time

After the mechanical release of the brake starts, it will wait for the release time set by 0x2806 to consider that the motor's brake has been effectively released before allowing it to receive instructions from the upper controller. The introduction of 0x2806 is shown in Table 3-75.

Table 3-75 Introduction to 0x2806

Index number	name	object type	mapping	access	Default value
0x2806	Brake disengage time	VAR	-	RW	200
		data type	unit	range	
		UINT32	ms	-	

0x2807: Brake engage time

After the mechanical brake starts, it will wait for the brake holding time set by 0x2807 to be considered effective before disabling PWM output. The introduction of 0x2807 is shown in Table 3-76.

Table 3-76 Introduction to 0x2807

Index number	name	object type	mapping	access	Default value
0x2807	Brake engage time	VAR	-	RW	500
		data type	unit	range	
		UINT32	ms	-	

0x2808: Brake Enable

If it is necessary to control the motor's brake, 0x2808 must be set to 1 to enable the servo brake control function before all brake related parameters can take effect. The introduction of 0x2808 is shown in Table 3-77.

Table 3-77 Introduction to 0x2808

Index number	name	object type	mapping	access	Default value
0x2808	Brake enable	VAR	-	RW	0
		data type	unit	range	
		UINT16	-	-	

0x2809: Brake disengage software delay time

After receiving the enable command, the servo first applies the software delay according to the set value of 0x2809. The mechanical release process is only initiated after the delay has ended. The introduction of 0x2809 is shown in Table 3-78.

Table 3-78 Introduction to 0x2809

Index number	name	object type	mapping	access	Default value
0x2809	Brake disengage software delay time	VAR	-	RW	300
		data type	unit	range	
		UINT32	ms	-	

0x280A: Brake engage software delay time

After receiving the disable command, the servo will first delay the software according to the set value of 0x280A. The mechanical brake process is only started after the delay has ended. The introduction of 0x280A is shown in Table 3-79.

Introduction to Table 3-79 0x280A

Index number	name	object type	mapping	access	Default value
0x280A	Brake engage software delay time	VAR	-	RW	0
		data type	unit	range	
		UINT32	ms	-	

0x280B: Brake activation delay time

When there is a serious malfunction in the servo, the bus will be immediately disconnected and the motor will rotate freely. When the actual speed of the motor is below the speed threshold of 0x2805 or the waiting time exceeds the time threshold of 0x280B, the holding brake process will be started. The introduction of 0x280B is shown in Table 3-80.

Table 3-80 Introduction to 0x280B

Index number	name	object type	mapping	access	Default value
0x280B	Brake activation delay time	VAR	-	RW	500
		data type	unit	range	
		UINT32	ms	-	

Chapter 4 Profile position mode

4.1 Function Introduction

The profile position mode, is used for point-to-point motion. Given absolute or relative target position (0x607A) and control information such as velocity, acceleration, and deceleration of the position curve, the internal trajectory generator of the servo will generate a series of position commands (0x60FC) to the servo control system. As shown in Figure 4-1.

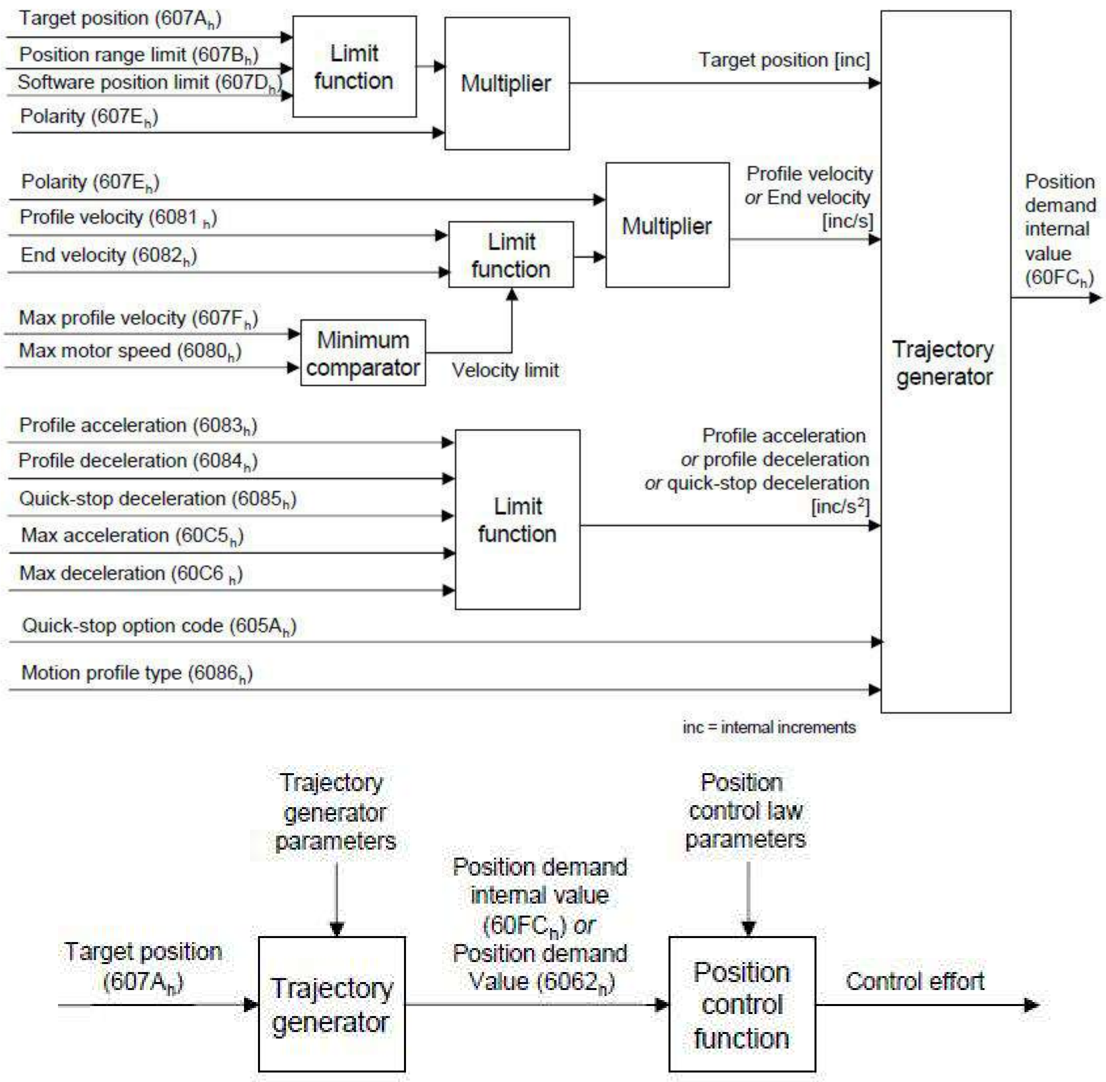

Figure 4-1 Profile position mode

4.2 Operation methods

1.Set [6060h: Mode of operation] to 1 (Profile position mode);

2.Set [6081h: Profile velocity] as the planned speed (unit: cnt/s);

3.Set [6083h: Profile acceleration] as the planned acceleration (unit: cnt/s^2);

4.Set [6084h: Profile deceleration] to the planned deceleration (unit: cnt/s^2);

5.Set [607Ah: Target position] as the target position (unit: cnt);

6.Set [6040h: Control word] to enable the servo drive and trigger the target position to take effect (enabled when set to 0x0F, other bits refer to Section 4.3 for detailed explanation of 6040h);

7.Query [6064h: Position actual value] to obtain feedback on the actual position of the motor;

8.Query [6041h: Status word] to obtain status feedback (following error, set point knowledge, target reached) of the servo drive.

4.3 Use of Control Word

Certain bits of control words and status words have specific meanings in positional control mode. The structure of control words is shown in Table 4-1

Table 4-1 Structure of Control Words in Profile position mode

Bit	15~10	9	8	7	6	5	4	3~0
function	General definition	Change on setpoint	Halt	General definition	abs/rel	Change set immediately	New setup	General definition

If no other positioning process is currently being executed, the rising edge of Bit4 will trigger the newly set positioning process; If other positioning processes are currently being executed, follow the definition in Table 4-2.

Table 4-2 Definition of Control Words Bit4, Bit5, and Bit9

Bit 9	**Bit 5**	**Bit 4**	**define**
0	0	0->1	After reaching the current set target position, start the positioning of the new set point
X	1	0->1	Immediately initiate the positioning of the new set point
1	0	0->1	Run at the current control speed to the current set point, and

			then start the positioning of the new set point

Bit6 determines whether the given target position is an absolute position value or relative position value. When Bit8 is set to 1, the axis's operation can be stopped, as shown in Table 4-3.

Table 4-3 Definition of Control Words Bit6 and Bit8

Bit	Value	define
6	0	0x607A Target position is an absolute value
	1	0x607A Target position is a relative value
8	0	Execute positioning process
	1	Stop the operation of the axis according to the definition of 0x605D Halt option code

4.4 Use of Status Word

The structure and definition of status words are shown in Tables 4-4 and 4-5 respectively.

Table 4-4 Definition of Status Words in Profile position mode

Bit	15~14	13	12	11	10	9~0
function	General definition	Following error	Setpoint acknowledge	General definition	Target Reached	General definition

The definitions of status words Bit10, Bit12, and Bit13 are shown in Table 4-5.

Table 4-5 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	define
10	0	Halt (Bit8 of control word)=0: Target position not reached
	0	Halt (Bit8 of control word)=1: Axis deceleration
	1	Halt (Bit8 of control word)=0: Target position reached
	1	Halt (Bit8 of control word)=1: Axis speed is 0
12	0	The previous set point has been executed, waiting for a new set point

	1	The previous set point is still being processed, allowing new set points to be received for overwrite
13	0	No following error
	1	Following error

4.5 Profile position mode related object parameters

0x607A: Target position

In profile position mode, the trajectory planner inside the servo will plan the expected target position (0x607A) based on parameters such as speed, acceleration, and deceleration. Corresponding to bit6 "abs/rel" in the control word, the given target position can be an absolute or relative value. The introduction of 0x607A is shown in Table 4-6.

Table 4-6 Introduction to 0x607A

Index number	name	object type	mapping	access	Default value
0x607A	Target position	VAR	RxPDO	RW	0
		data type	unit	range	
		INT32	UU	-	

0x607B: Position range limit

This object defines the maximum and minimum position ranges, which can limit the range of input values. When it reaches or exceeds the set range, the input value will automatically flip to the other end of the limit value. When the setting of 0x607D software position limit is valid, the object will not take effect. When the setting values of the object are all 0, the object will not take effect. The introduction of 0x607B is shown in Table 4-7.

Table 4-7 Introduction to 0x607B

Index number	name	object type	mapping	access	Default value
0x607B	Position range limit	ARRAY	-	-	-
		data type	unit	range	
		INT32	-	-	

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The sub index 0x00 of 0x607B is introduced in Table 4-8.

Table 4-8 Introduction to sub index 0x00 of 0x607B

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index 0x01 of 0x607B is introduced in Table 4-9.

Table 4-9 Introduction to sub index 0x01 of 0x607B

Sub index number	name	object type	mapping	access	Default value
0x01	Min position range limit	-	-	RW	-2^{31}
		data type	unit	range	
		INT32	UU	-	

The sub index 0x02 of 0x607B is introduced in Table 4-10.

Table 4-10 Introduction to sub index 0x02 of 0x607B

Sub index number	name	object type	mapping	access	Default value
0x02	Max position range limit	-	-	RW	$2^{31}-1$
		data type	unit	range	
		INT32	UU	-	

0x607D: Software position limit

This object defines the maximum and minimum software position limits, limiting position demand value and position actual value in absolute position form. Each new target location must undergo detection of the limit value configured for that object. The introduction of 0x607D is shown in Table 4-11.

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Table 4-11 Introduction to 0x607D

Index number	name	object type	mapping	access	Default value
0x607D	Software position limit	ARRAY	-	-	-
		data type	unit	range	
		INT32	-	-	

The sub index number 0x00 of 0x607D is introduced in Table 4-12.

Table 4-12 Introduction to sub index number 0x00 of 0x607D

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index number 0x01 of 0x607D is introduced in Table 4-13.

Table 4-13 Introduction to sub index number 0x01 for 0x607D

Sub index number	name	object type	mapping	access	Default value
0x01	Min position limit	-	-	RW	-2^{31}
		data type	unit	range	
		INT32	UU	-	

The sub index number 0x02 of 0x607D is introduced in Table 4-14.

Table 4-14 Introduction to sub index number 0x02 for 0x607D

Sub index number	name	object type	mapping	access	Default value
0x02	Max position limit	-	-	RW	$2^{31}-1$
		data type	unit	range	
		INT32	UU	-	

0x607F: Max profile velocity

This object defines the maximum allowable speed in the forward and backward directions in trajectory planning. The sub index number 0x01 of 0x607D is introduced in Table 4-15.

Table 4-15 Introduction to 0x607F

Index number	name	object type	mapping	access	Default value
0x607F	Max profile velocity	VAR	-	RW	2^{32}-1
		data type	unit	range	
		UINT32	UU	-	

0x6080: Max motor speed

This object defines the maximum allowable speed of the motor in both positive and negative directions, used to protect the motor. This value can be obtained from the motor manual or nameplate (currently not used, refer to motor parameter 0x2100:08 for maximum motor value).

The introduction of 0x6080 is shown in Table 4-16.

Table 4-16 Introduction to 0x6080

Index number	name	object type	mapping	access	Default value
0x6080	Max motor speed	VAR	-	RW	0
		data type	unit	range	
		UINT32	rpm	-	

0x6081: Profile velocity

This object defines the value that the velocity should typically reach in both directions after completing the acceleration ramp in the planned trajectory.

The introduction of 0x6081 is shown in Table 4-17.

Introduction to Table 4-17 0x6081

Index number	name	object type	mapping	access	Default value
0x6081	Profile velocity	VAR	-	RW	0
		data type	unit	range	
		UINT32	UU	-	

0x6083: Profile acceleration

This object defines the acceleration in trajectory planning. The introduction of 0x6083 is shown in Table 4-18.

Table 4-18 Introduction to 0x6083

Index number	name	object type	mapping	access	Default value
0x6083	Profile acceleration	VAR	-	RW	1310720
		data type	unit	range	
		UINT32	UU	-	

0x6084: Profile deceleration

This object defines the deceleration in trajectory planning. The introduction of 0x6084 is shown in Table 4-19.

Table 4-19 Introduction to 0x6084

Index number	name	object type	mapping	access	Default value
0x6084	Profile deceleration	VAR	-	RW	1310720
		data type	unit	range	
		UINT32	UU	-	

0x6085: Quick stop deceleration

This object defines the fast stop deceleration. The introduction of 0x6085 is shown in Table 4-20.

Table 4-20

Index number	name	object type	mapping	access	Default value
0x6085	Quick stop deceleration	VAR	-	RW	5242880
		data type	unit	range	
		UINT32	UU	-	

0x6086: Motion profile type

This object defines the curve type for position control planning. The current supported modes are shown in Table 3-6. The introduction of 0x6086 is shown in Table 4-21.

Table 4-21

Index number	name	object type	mapping	access	Default value
0x6086	Motion profile type	VAR	-	RW	0
		data type	unit	range	
		INT16	-	0,3	

The control curve types corresponding to the value of 0x6086 are shown in Table 4-22.

Table 4-22 Position control curve types

Value	define
0	Linear ramp
3	Jerk limited ramp

0x60A4: Profile jerk

This object defines the acceleration speed when the motion profile type is set to jerk limited ramp. The introduction of 0x60A4 is shown in Table 4-23.

Table 4-23 Introduction to 0x60A4

Index number	name	object type	mapping	access	Default value
0x60A4	Profile jerk	ARRAY	-	-	-
		data type	unit	range	
		UINT32	-	-	

The sub index 0x00 of 0x60A4 is introduced in Table 4-24.

Table 4-24 Introduction to sub index 0x00 of 0x60A4

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	1
		data type	unit	range	
		UINT8	-	1	

The sub index 0x01 of 0x60A4 is introduced in Table 4-25.

Table 4-25 Introduction to sub index 0x01 of 0x60A4

Sub index number	name	object type	mapping	access	Default value
0x01	Profile jerk 1	-	-	RW	1310720
		data type	unit	range	
		UINT32	UU	-	

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0x60C5: Max acceleration

This object defines the maximum acceleration in trajectory planning. The introduction of 0x60C5 is shown in Table 4-26.

Introduction to Table 4-26 0x60C5

Index number	name	object type	mapping	access	Default value
0x60C5	Max acceleration	VAR	-	RW	2^{32}-1
		data type	unit	range	
		UINT32	UU	-	

0x60C6: Max deceleration

This object defines the maximum deceleration in trajectory planning. The introduction of 0x60C6 is shown in Table 4-27.

Table 4-27 Introduction to 0x60C6

Index number	name	object type	mappin g	access	Default value
0x60C6	Max deceleration	VAR	-	RW	2^{32}-1
		data type	unit	range	
		UINT32	UU	-	

0x6062: Position demand value

This object defines the position command value input into the position controller. This value is a user-defined position unit. The introduction of 0x6062 is shown in Table 4-28.

Table 4-28 Introduction to 0x6062

Index number	name	object type	mapping	access	Default value
0x6062	Position demand value	VAR	-	RO	0
		data type	unit	range	
		INT32	UU	-	

0x6063: Position actual internal value

This object defines the actual position value obtained from the encoder. This value is an internal position unit. The introduction of 0x6063 is shown in Table 4-29.

Table 4-29 Introduction to 0x6063

Index number	name	object type	mapping	access	Default value
0x6063	Position actual internal value	VAR	-	RO	0
		data type	unit	range	
		INT32	cnt	-	

0x6064: Position actual value

This object defines the actual position value obtained from the encoder. This value is a user-defined location unit. The introduction of 0x6064 is shown in Table 4-30.

Table 4-30 Introduction to 0x6064

Index number	name	object type	mapping	access	Default value
0x6064	Position actual value	VAR	TxPDO	RO	0
		data type	unit	range	
		INT32	UU	-	

0x6065: Following error window

This object defines the allowable position following error threshold for the position command value and the actual value. If the value is set to 0xFFFF FFFF (2^{32}-1), this function is not used. The introduction of 0x6065 is shown in Table 4-31.

Table 4-31 Introduction to 0x6065

Index number	name	object type	mapping	access	Default value
0x6065	Following error window	VAR	-	RW	2^{32}-1
		data type	unit	range	
		UINT32	UU	-	

0x6066: Following error time out

This value defines the continuous cumulative maximum alarm time value when the position following error exceeds the threshold (0x6065). When the set time is exceeded, it is

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considered that a position following error has occurred. The introduction of 0x6066 is shown in Table 4-32.

Table 4-32 Introduction to 0x6066

Index number	name	object type	mapping	access	Default value
0x6066	Following error time out	VAR	-	RW	100
		data type	unit	range	
		UINT16	ms	-	

0x6067: Position window

The object defines the position where the diffrence between the target position and the actual position reaches the threshold. If the value is set to 0xFFFF FFFF (2^{32}-1), this function is not used. The introduction of 0x6067 is shown in Table 4-33.

Table 4-33 Introduction to 0x6067

Index number	name	object type	mapping	access	Default value
0x6067	Position window	VAR	-	RW	2^{32}-1
		data type	unit	range	
		UINT32	UU	-	

0x6068: Position window time

This object defines a continuous cumulative time value where the position difference is less than the threshold (0x6067). When the set time is reached, it is considered to have reached the target position. The introduction of 0x6068 is shown in Table 4-34.

Table 4-34 Introduction to 0x6068

Index number	name	object type	mappin g	access	Default value
0x6068	Position window time	VAR	-	RW	12
		data type	unit	range	
		UINT16	ms	-	

0x60FC: Position demand internal value

This object defines the position command value input into the position controller. This value is an internal position unit. The introduction of 0x60FC is shown in Table 4-35.

Table 4-35 Introduction to 0x60FC

Index number	name	object type	mapping	access	Default value
0x60FC	Position demand internal value	VAR	-	RO	0
		data type	unit	range	
		INT32	cnt	-	

4.6 Application examples

1. Set 6060h to 1 and select Profile position mode;

2. Set 6040h in the pre-enable Switch on state (0x06h->0x07h);

3. Enable the drive and trigger the position command to take effect:

1． Single point non immediate effective mode

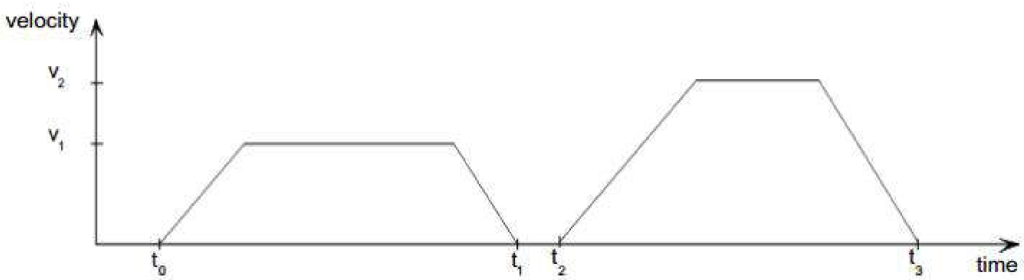

Figure 4-2 Single set point schematic diagram

① If the target position sent is in relative position mode, the following steps are required:

1) Set 6040h to 0x4F (where bit6 is to set the relative position mode and bit3~bit0 are for enabling the drive);

2) Set 607Ah as the target position command;

3) Set 6040h to 0x5F, and trigger the position command to take effect (where the 0->1 jump edge of bit4 indicates that the trigger target position command takes effect);

4) The drive received a set of 6041h. bit12 after receiving 6040h. bit4=1. After receiving it,the master station should clear the bit4 of 6040h in preparation for sending the next target position command.

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② If the target position being sent is in absolute mode, the following steps are required:

1) Set 6040h to 0x0F;

2) Set 607Ah as the target position command;

3) Set 6040h to 0x1F and trigger the position command to take effect;

4) The drive received a set of 6041h. bit12 after receiving 6040h. bit4=1. After receiving it, the master station should clear the bit4 of 6040h in preparation for sending the next target position command.

2. Multi point immediate effect mode

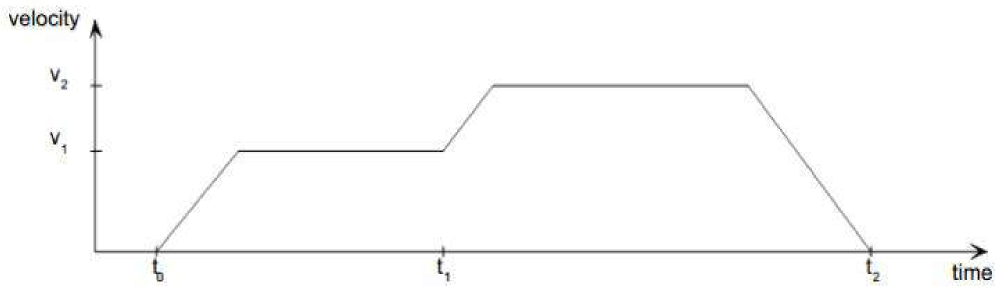

Figure 4-3 Schematic diagram of Multi point immediate effect mode

If the target position being sent is in incremental mode, the following steps are required:

1) Set 6040h to 0x6F (where bit6 is set to incremental mode, bit5 is set to take effect immediately, and bit3~bit0 are enabled drives);

2) Set 607Ah as the target position command;

3) Set 6040h to 0x7F, and trigger the position command to take effect (where the 0->1 jump edge of bit4 indicates that the trigger target position command takes effect);

4) After receiving 6040h. bit4=1, the drive sets it to 6041h. bit12. After receiving it, the master station should clear the bit4 of 6040h in preparation for sending the next target position command.

② If the target location being sent is in absolute mode, the following steps are required:

1) Set 6040h to 0x2F (bit5 is set to take effect immediately, and bit3~bit0 are enabled drives);

2) Set 607Ah as the target position command;

3) Set 6040h to 0x3F and trigger the position command to take effect;

4) After receiving 6040h. bit4=1, the drive sets it to 6041h. bit12. After receiving it, the master station should clear the bit4 of 6040h in preparation for sending the next target position command.

If multiple targets need to be sent, repeat step 3.

Note: The ISMC servo supports 16 target position buffers internally, and when the buffer exceeds 16, it will be set to 6041h.bit12.

3. Stopping ways

There are two ways to stop during Profile positioning operation:

1) By controlling the quickstop bit of the word, that is, the control word sends 0xB, and the servo emergency stop stops according to the 402 control parameter 0x605A mentioned above;

2) By controlling the halt bit of the word, the servo will stop according to the 402 control parameter 0x605D mentioned above;

If you need to continue running, you need to trigger the positioning again.

Chapter 5 Profile velocity mode

5.1 Function Introduction

Profile velocity mode, Given the target speed (0x60FF) and the acceleration and deceleration of the set speed curve, the internal trajectory generator of the servo will generate a series of speed commands (0x606B) to the servo control system. As shown in Figure 5-1.

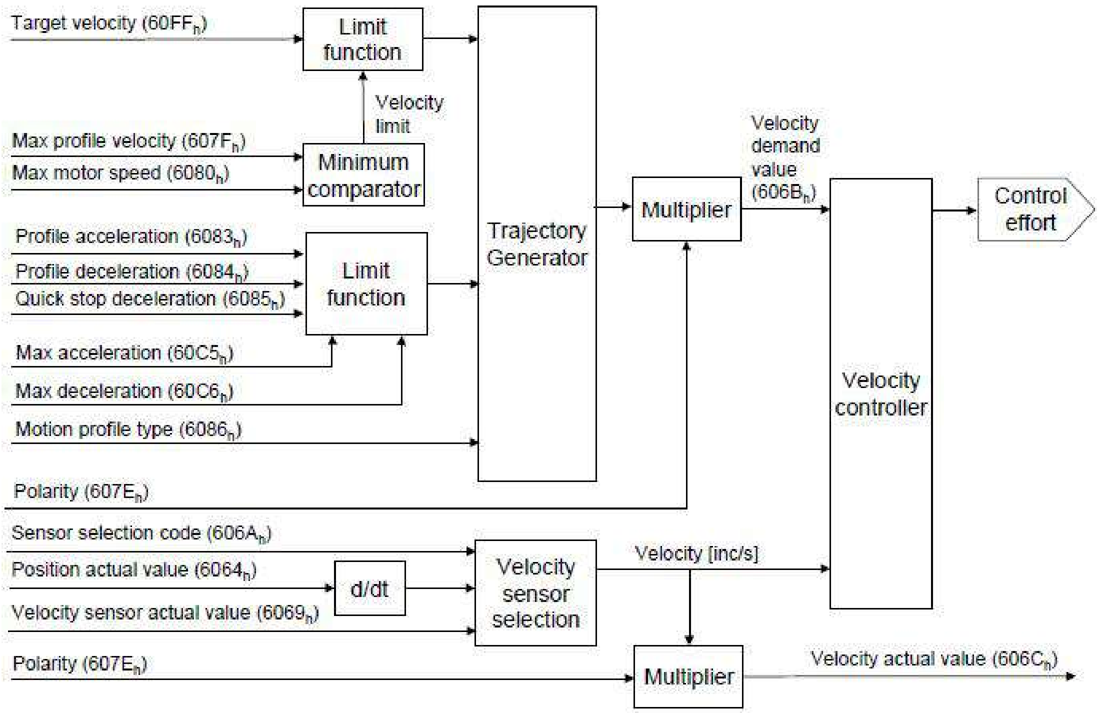

Figure 5-1 Profile velocity mode

5.2 Operation methods

1. Set [6060h: Mode of operation] to 3 (Profile velocity mode);
2. Set [6083h: Profile acceleration] to modify the acceleration curve (unit: cnt/s^2);
3. Set [6084h: Profile cancellation] to modify the deceleration curve (unit: cnt/s^2);
4. Set [6040h: Control word] to enable the servo drive and start the motor to run;
5. Set [60FFh: Target speed] to set the target speed (unit: cnt/s);
6. Query [6041h: Status word] to obtain the status feedback of the servo drive (Speed zero, Max slippage error, Target reached);

5.3 Use of Control Word

Some bits of the control word and status word have specific meanings in Profile velocity mode. The structure of control words is shown in Table 5-1.

Table 5-1 Structure of Control Words in Profile velocity mode

Bit	15~9	8	7	6~4	3~0
function	General definition	Halt	General definition	reserve	General definition

When Bit8 is set to 1, the operation of the axis can be stopped, as shown in Table 5-2.

Table 5-2 Definition of Control Word Bit8

Bit	Value	define
8	0	Execute the motion process
	1	Stop the operation of the axis according to the definition of 0x605D Halt option code

5.4 Use of Status Word

The structure and definition of status words are shown in Table 5-3.

Table 5-3 Definition of Status Words in Profile velocity mode

Bit	15~14	13	12	11	10	9~0
function	General definition	Max slippage error	Speed	General definition	Target R eached	General definition

The definitions of status words Bit10, Bit12, and Bit13 are shown in Table 5-4.

Table 5-4 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	define
10	0	Halt (Bit8 of controllword)=0: Target speed not reached
	0	Halt (Bit8 of controllword)=1: axis deceleration
	1	Halt (Bit8 of controllword)=0: Target speed reached
	1	Halt (Bit8 of controllword)=1: Axis speed is 0
12	0	Speed is not 0
	1	Speed is 0
13	0	Not Supported
	1	

5.5 Object parameters related to Profile velocity mode

0x6069: Velocity sensor actual value

This object defines the actual speed of the motor. This value is an internal speed unit, as shown in Table 5-5.

Table 5-5 Introduction to 0x6069

Index number	name	object type	mapping	access	Default value
0x6069	Velocity sensor actual value	VAR	-	RO	0
		data type	unit	range	
		INT32	Cnt/s	-	

0x606B: Velocity demand value

This object defines the speed command value input into the speed controller. This value is a user-defined speed unit, as shown in Table 5-6.

Table 5-6 Introduction to 0x606B

Index number	name	object type	mapping	access	Default value
0x606B	Velocity demand value	VAR	-	RO	0
		data type	unit	range	
		INT32	UU	-	

0x606C: Velocity actual value

This object defines the actual speed of the motor. This value is a user-defined speed unit, as shown in Table 5-7.

Table 5-7 Introduction to 0x606C

Index number	name	object type	mapping	access	Default value
0x606C	Velocity actual value	VAR	TxPDO	RO	0
		data type	unit	range	
		INT32	UU	-	

0x606D: Velocity window

The object defines the speed threshold for the difference between the target speed and the actual speed. If this value is set to 0xFFFF (-1), this function is not used, as shown in Table 5-8.

Table 5-8 Introduction to 0x606D

Index number	name	object type	mapping	access	Default value
0x606D	Velocity window	VAR	-	RW	
		data type	unit	range	
		UINT16	UU	-	

0x606E: Velocity window time

This object defines a continuous cumulative time value with a speed difference less than the threshold (0x606D). When the set time is reached, it is considered to have reached the target speed, as shown in Table 5-9.

Introduction to Table 5-9 0x606E

Index number	name	object type	mapping	access	Default value
0x606E	Velocity window time	VAR	-	RW	12
		data type	unit	range	
		UINT16	ms	-	

0x606F: Zero speed threshold

This object defines a zero speed threshold, which is the range within which the speed approaches zero speed. When the actual speed is lower than this value, the axis is considered stationary. As shown in Table 5-10.

Table 5-10 Introduction to 0x606F

Index number	name	object type	mapping	access	Default value
0x606F	Velocity threshold	VAR	-	RW	100
		data type	unit	range	
		UINT16	UU	-	

0x6070: Zero speed threshold time

This object defines the continuous cumulative time value where the actual speed is greater than the zero speed threshold (0x606F). When the set time is reached, it is considered that the current axis is not in a stationary state, as shown in Table 5-11.

Table 5-11 Introduction to 0x6070

Index number	name	object type	mapping	access	Default value
0x6070	Velocity threshold time	VAR	-	RW	12
		data type	unit	range	
		UINT16	ms	-	

0x607F: Max profile speed

This object defines the maximum allowable speed in the forward and backward directions in velocity trajectory planning. The relevant instructions for 0x607F are introduced in 4.3.5.

0x6080: Max motor speed

This object defines the maximum allowable speed of the motor in both positive and negative directions, used to protect the motor. This value can be obtained from the motor manual or nameplate.

0x6083: Profile acceleration

This object defines the acceleration in trajectory planning. The relevant instructions for 0x6083 are introduced in 4.3.5.

0x6084: Profile deceleration

This object defines the deceleration in trajectory planning. The relevant instructions for 0x6084 are introduced in 4.3.5.

0x6086: Motion profile type

This object defines the curve type for control planning. The relevant instructions for 0x6086 are introduced in 4.3.5.

0x60A4: Profile jerk

This object defines the jerk speed when the motionprofile type is set to jerk limited ramp. The relevant instructions for 0x60A4 are introduced in 4.3.5.

0x60FF: Target velocity

This object defines the given value of the target speed value. When feedforward 0x60B1 is enabled, the target speed is the sum of 60FFh (Target speed) and 60B1h (Velocity offset). The parameters are shown in Table 5-12.

Table 5-12 Introduction to 0x60FF

Index number	name	object type	mapping	access	Default value
0x60FF	Target velocity	VAR	RxPDO	RW	0
		data type	unit	range	
		INT32	UU	-	

0x2200.01: Velocity tracking threshold

This object defines the allowable speed following error threshold for the speed command value and the actual value. If the value is set to 0xFFFF FFFF (232-1), then this function is not used, as shown in Table 5-13.

Table 5-13 Introduction to 0x2200.01

Index number	name	object type	mapping	access	Default value
0x2200.01	Velocity tracking threshold	VAR	-	RW	2^{32}-1
		data type	unit	range	
		UINT32	UU	-	

0x2200.02: Velocity tracking time

This value defines the continuous cumulative maximum alarm time value when the speed following error exceeds the threshold (0x2200.01). When the set time is exceeded, it is considered that a speed following error has occurred. As shown in Table 5-14.

Introduction to Table 5-14 0x2200.02

Index number	name	object type	mapping	access	Default value
0x2200.02	Velocity tracking time	VAR	-	RW	1000
		data type	unit	range	
		UINT32	ms	-	

0x2117: Motion profile type1

This value defines the speed curve planning method for stopping the process in speed mode. As shown in Table 5-15.

Table 5-15 Introduction to 0x2117

Index number	name	object type	mapping	access	Default value
0x2117	Motion profile type1	VAR	-	RW	0
		data type	unit	range	
		INT16	-	0,3	

The Motion profile types corresponding to 0x2117 are shown in Table 5-16.

Table 5-16 Velocity profile types

Value	define
0	Linear ramp
3	Jerk limited ramp

5.6 Application examples

When using the Profile Velocity mode, the required steps are:

1. Set 6060h to 3 and select Profile Velocity Mode;

2. Set 6083h and 6084h to modify acceleration and deceleration time;

3. Set 60FFh to modify the target speed command.

4. Set 6040h to enable the drive, send 0x06->0x07->0x0F enable, and send 0x06/0x07 interrupt control mode;

5. Stop: Stop according the description in 4.5.

Chapter 6 Profile torque mode

6.1 Function Introduction

Profile torque mode. Given the target torque (0x6071) and the speed of setting the torque curve, the internal trajectory generator of the servo will generate a series of torque commands (0x6074) to the servo control system. As shown in Figure 6-1.

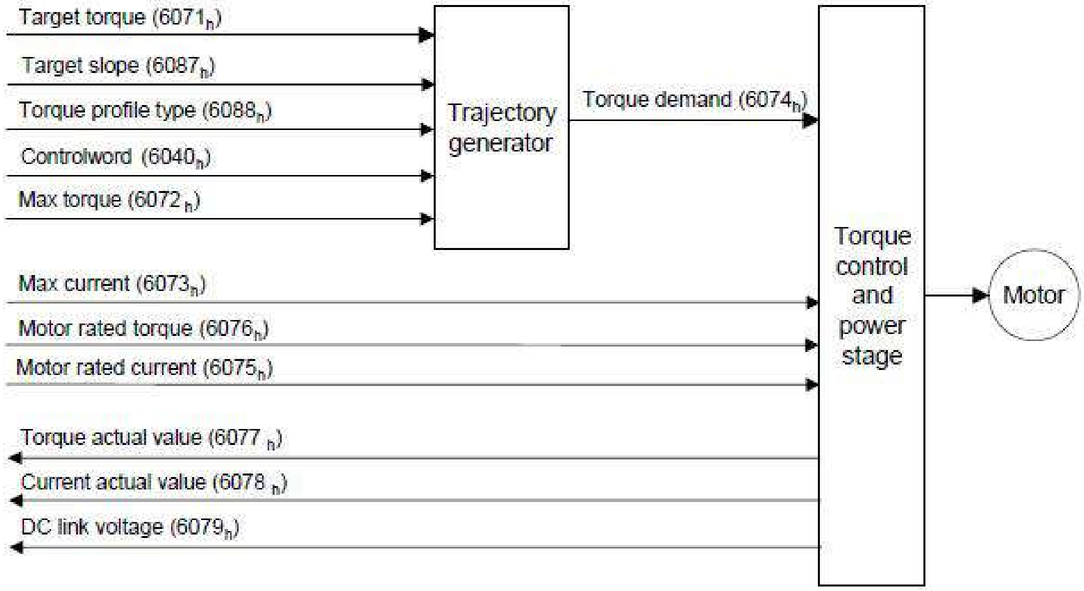

Figure 6-1 Profile torque mode

6.2 Operation methods

1.Set [6060h: Mode of operation] to 4 (Profile velocity mode);

2.Set [6071h: Target torque] to modify the target torque (unit: rated torque/1000);

3.Set [6087h: Torque slope] to modify the torque change rate (unit: rated torque/1000/s);

4.Set [6040h: Control word] to enable the servo drive and start the motor to run;

5.Query [6041h: Status word] to obtain the target received status feedback of the servo drive;

6.3 Use of Control Word

Some bits of the control word and status word have specific meanings in torque control mode. The structure of control words is shown in Table 6-1. As shown in Table 6-1.

Table 6-1 Structure of Control Words in Profile torque mode

Bit	15~9	8	7	6~4	3~0
function	General definition	Halt	General definition	reserve	General definition

When Bit8 is set to 1, the operation of the axis can be stopped, as shown in Table 6-2.

Table 6-2 Definition of Control Word Bit8

Bit	Value	define
8	0	Execute the motion process
	1	Stop the operation of the axis according to the definition of 0x605D Halt option code

6.4 Use of Status Word

The structure and definition of status words are shown in Table 6-3.

Table 6-3 Definition of Status Words in Profile torque mode

Bit	15~14	13~12	11	10	9~0
function	General definition	reserve	General definition	Target Reached	General definition

The definition of status word Bit10 is introduced in Table 6-4.

Table 6-4 Definition of Status Word Bit10

Bit	Value	define
10	0	Halt (Bit8 of control word)=0: Target torque not reached
	0	Halt (Bit8 of control word)=1: axis deceleration
	1	Halt (Bit8 of control word)=0: Target torque reached
	1	Halt (Bit8 of control word)=1: Axis speed is 0

6.5 Object parameters related to Profile torque mode

0x6071: Target torque

This object defines the target torque value, as shown in Table 6-5.

Table 6-5 Introduction to 0x6071

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x6071</td><td rowspan="3">Target torque</td><td>VAR</td><td>RxPDO</td><td>RW</td><td rowspan="3">0</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>INT16</td><td>Rated torque/1000</td><td>-</td></tr>
</table>

0x6074: Torque demand

This object defines the torque command values input into the torque controller, as shown in Table 6-6.

Table 6-6 Introduction to 0x6074

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x6074</td><td rowspan="3">Torque demand</td><td>VAR</td><td>-</td><td>RO</td><td rowspan="3">0</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>INT16</td><td>Rated torque/1000</td><td>-</td></tr>
</table>

0x6077: Torque actual value

This object defines the actual torque value of the motor, as shown in Tables 6-7.

Table 6-7 Introduction to 0x6077

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x6077</td><td rowspan="3">Torque actual value</td><td>VAR</td><td>-</td><td>RO</td><td rowspan="3">0</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>INT16</td><td>Rated torque/1000</td><td>-</td></tr>
</table>

0x6078: Current actual value

This object defines the actual current value of the motor, as shown in Tables 6-8

Table 6-8 Introduction to 0x6078

Index number	name	object type	mapping	access	Default value
0x6078	Current actual value	VAR	-	RO	0
		data type	unit	range	
		INT16	Rated current/1000	-	

0x6087: Torque slope

This object defines the rate of torque change, as shown in Table 6-9.

Table 6-9 Introduction to 0x6087

Index number	name	object type	mapping	access	Default value
0x6087	Torque slope	VAR	-	RW	0
		data type	unit	range	
		UINT32	Rated torque/1000/s	-	

0x6088: Torque profile type

This object defines the curve types for torque profile planning, as shown in Table 6-10.

Table 6-10 Introduction to 0x6088

Index number	name	object type	mapping	access	Default value
0x6088	Torque profile type	VAR	-	RW	0
		data type	unit	range	
		INT16	-	0	

The current supported modes are shown in Table 6-11.

0x2115: TrqLoopPosVelLimit

This object defines the torque control forward speed limit values, as shown in Table 6-12.

Table 6-12 Introduction to 0x2115

Index number	name	object type	mapping	access	Default value
0x2115	TrqLoopPosVelLimit	VAR	-	RW	1000
		data type	unit	range	
		UINT16	Rated speed/1000	-	

0x2116: TrqLoopNegVelLimit

This object defines the torque control reverse speed limit values, as shown in Table 6-13.

Table 6-13 Introduction to 0x2116

Index number	name	object type	mapping	access	Default value
0x2116	TrqLoopNegVelLimit	VAR	-	RW	1000
		data type	unit	range	
		UINT16	Rated speed/1000	-	

6.6 Application examples

When using the Profile Torque mode, the steps that need to be taken are:

1. Set 6060h to 4 and select Profile Torque Mode;

2. Set 6087h of the torque slope;

3. Set 6071h to modify the target torque command.

4. Set 2115h: TrqLoopPosVelLimit to set the forward torque speed limit (unit: 0.1% of rated torque);

5. Set 2116h: TrqLoopNegVelLimit to set the reverse torque speed limit (unit: 0.1% of rated torque);

6. Set 6040h to enable the drive, send 0x06->0x07->0x0F enable, and send 0x06/0x07 interrupt control mode;

7. Stop: Stop according to the description in 4.5.

Chapter 7 Periodic Synchronous Position Mode

7.1 Function Introduction

Periodic synchronous position mode ,as the Cyclic sync position mode, means the upper master completes the planning of the position trajectory, and then sends the planned target position to the servo drive in a periodic synchronization manner through the PDO object 0x607A, ultimately achieving position control by the servo. As shown in Figure 7-1.

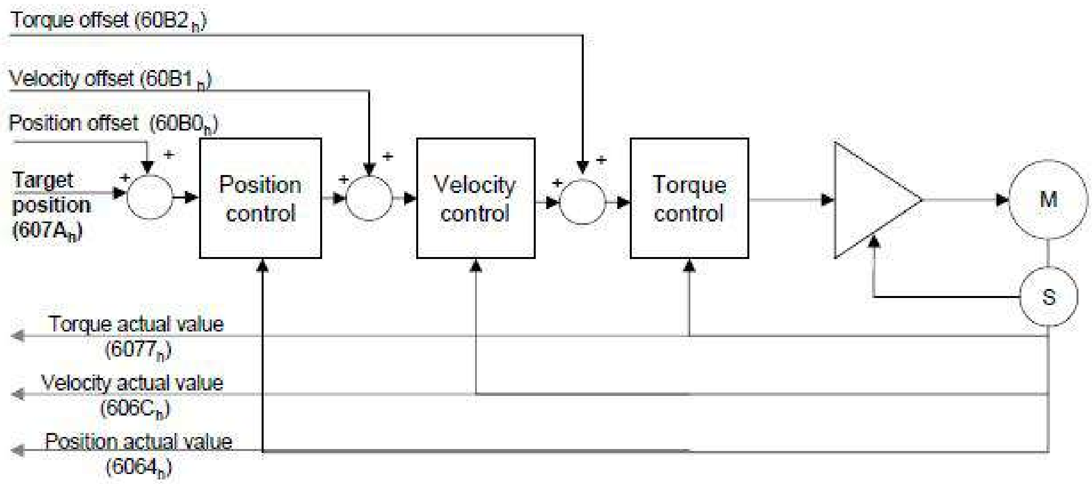

Figure 7-1 Periodic synchronous position mode

7.2 Operation methods

1.Set [6060h: Mode of operation] to 8 (Cyclic synchronous position mode);

2.Set the EtherCAT synchronization cycle and start the DC mode. The cycle should be consistent with the configuration of the lower 0x60C2, with a default of 4ms;

3.Set [6040h: Control word] to enable the servo drive (enable when set to 0x0F, other bits refer to Section 4.5 for detailed explanation of 6040h);

4.Set [607Ah: Target position] as the target position (unit: user unit);

5.Set [6064h: Position actual value] to obtain feedback on the actual position of the motor;

6.Query [6041h: Status word] to obtain the status feedback (following error, target reached) of the servo drive;

7.3 Use of Control Word

The bit of the control word has no specific meaning in the periodic synchronous position mode.

7.4 Use of Status Word

Some bits of the status word have specific meanings in the periodic synchronous position mode. The structure and definition of status words are shown in the table below.

The structure of status words is shown in Table 7-1.

Table 7-1 Structure of Status Words in Periodic Synchronous Position Mode

Bit	15~14	13	12	11	10	9~0
function	General definition	following error	Target position ignored	General definition	reserve	General definition

The definition of status words is shown in Table 7-2.

Table 7-2 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	define
10	0	reserve
	1	reserve
12	0	Ignore target location
	1	The target position is used as input to the position control loop
13	0	No following error
	1	Following error

7.5 Periodic synchronization position mode related object parameters

0x607A: Target position

This object defines the target position, and the parameter description is described in section 4.5.

0x6064: Position actual value

This object defines the actual position value obtained from the encoder, and the parameter description is described in section 4.5.

Technical forum: https://en.ismc.cn/e2eforums

0x60B0: Position offset

This object defines the offset value of target position (0x607A), as shown in Table 7-3.

Table 7-3 Introduction to 0x60B0

Index number	name	object type	mapping	access	Default value
0x60B0	Position offset	VAR	-	RW	0
		data type	unit	range	
		INT32	UU	-	

0x60B1: Velocity offset

This object provides an offset value for velocity, which is known as velocity feedforward in the periodic synchronous position, as shown in Table 7-4.

Table 7-4 Introduction to 0x60B1

Index number	name	object type	mapping	access	Default value
0x60B1	Velocity offset	VAR	-	RW	0
		data type	unit	range	
		INT32	UU	-	

0x60B2: Torque offset

This object provides an offset value for torque, which is torque feedforward in the periodic synchronous position.

Table 7-5 Introduction to 0x60B2

Index number	name	object type	mapping	access	Default value
0x60B2	Torque offset	VAR	-	RW	0
		data type	unit	range	
		INT16	Rated torque/1000	-	

Technical forum: https://en.ismc.cn/e2eforums

7.6 Application examples

1. Set 6060h to 8 and select Cyclic Synchronous Position Mode;

2. Set 6040h to enable the drive to send 0x0F;

3. Set 607Ah as the target position (absolute position) step by step and perform position control.

Technical forum: https://en.ismc.cn/e2eforums

Chapter 8 Periodic Synchronous Velocity Mode

8.1 Function Introduction

Periodic synchronous velocity mode, as the Cyclic sync speed mode. Means the upper master completes the planning of the speed trajectory, and then sends the planned target speed to the servo drive in a periodic synchronization manner through the PDO object 0x60FF, ultimately achieving speed control by the servo. As shown in Figure 8-1.

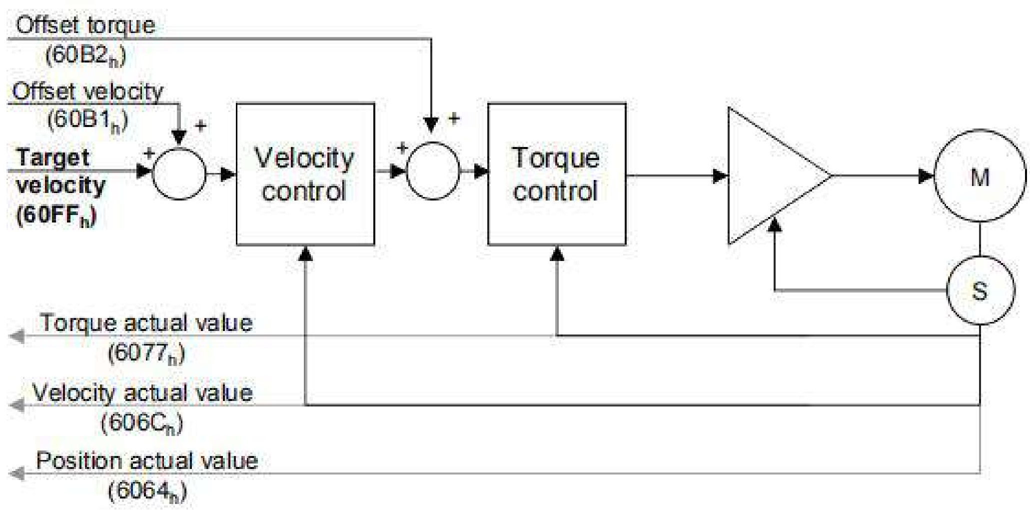

Figure 8-1 Periodic synchronous velocity mode

8.2 Operation methods

1.Set [6060h: Mode of operation] to 9 (Cyclic synchronous velocity mode);

2.Set the EtherCAT synchronization cycle and start the DC mode. The cycle should be consistent with the configuration of the lower 0x60C2, with a default of 4ms;

3.Set [6040h: Control word] to enable the servo drive (enable when set to 0x0F, other bits refer to Section 4.5 for detailed explanation of 6040h);

4.Set [60FFh: Target speed] as the target speed (unit: user unit);

5.Set [606Ch: Velocity actual value] to obtain feedback on the actual speed of the motor;

6.Query [6041h: Status word] to obtain the status feedback (following error, target reached) of the servo drive;

8.3 Use of Control Word

The bit of the control word has no specific meaning in the Periodic synchronous velocity mode.

8.4 Use of Status Word

Some bits of the status word have specific meanings in the Periodic synchronous velocity mode. The structure and definition of status words are shown in the table below.

The structure of status words is shown in Table 8-1.

Table 8-1 Structure of State Words in Periodic synchronous velocity mode

Bit	15~14	13	12	11	10	9~0
function	General definition	following error	Target velocity ignored	General definition	reserve	General definition

The definition of status words is shown in Table 8-2.

Table 8-2 Definition of Status Words Bit10, Bit12, and Bit13

Bit	**Value**	**define**
10	0	reserve
	1	reserve
12	0	Ignoring target speed
	1	The target speed is used as input to the speed control loop
13	0	No following error
	1	Following error

8.5 Periodic synchronization speed mode related object parameters

0x60FF: Velocity position

This object defines the target speed, and the parameter description is introduced in 5.5.

0x606C: Velocity actual value

This object defines the actual speed value, and the parameter description is introduced in 5.5.

0x60B1: Velocity offset

This object provides an offset value for speed, which is known as speed feedforward at periodic synchronous speed, as shown in Table 8-3.

Table 8-3 Introduction to 0x60B1

Index number	name	object type	mapping	access	Default value
0x60B1	Velocity offset	VAR	-	RW	0
		data type	unit	range	
		INT32	UU	-	

0x60B2: Torque offset

This object provides an offset value for torque, which is torque feedforward at periodic synchronous speed.

Introduction to Table 8-4 0x60B2

Index number	name	object type	mapping	access	Default value
0x60B2	Torque offset	VAR	-	RW	0
		data type	unit	range	
		INT16	Rated torque/1000	-	

8.6 Application examples

1. Set 6060h to 9 and select Cyclic Synchronous velocity mode;

2. Set 6040h to enable the drive to send 0x0F;

3. Set 60FFh as the target speed in each cycle for speed control.

Chapter 9 Periodic Synchronous Torque Mode

9.1 Function Introduction

Periodic synchronous torque mode means the upper master completes the planning of the torque, and then sends the planned target torque to the servo drive in a periodic synchronization manner through the PDO object 0x6071. Finally, the servo achieves torque control. As shown in Figure 9-1.

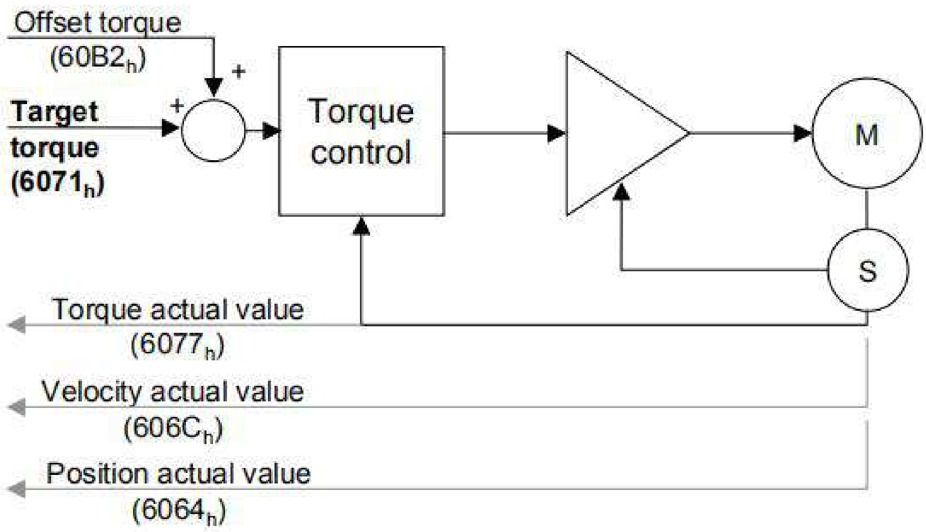

Figure 9-1 Periodic synchronous torque mode

9.2 Operation methods

1.Set [6060h: Mode of operation] to 10 (Cyclic synchronous torque mode);

2.Set the EtherCAT synchronization cycle and start the DC mode. The cycle should be consistent with the configuration of the lower 0x60C2, with a default of 4ms;

3.Set [6040h: Control word] to enable the servo drive (enable when set to 0x0F, other bits refer to Section 4.5 for detailed explanation of 6040h);

4.Set [6071h: Target torque] as the target torque (unit: rated torque/1000);

5.Set [6077h: Torque actual value] to obtain the actual torque feedback of the motor;

6.Query [6041h: Status word] to obtain the status feedback (following error, target reached) of the servo drive;

9.3 Use of Control Word

The bit of the control word has no specific meaning in periodic synchronous torque mode.

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9.4 Use of Status Word

Some bits of the status word have specific meanings in periodic synchronous torque mode. The structure and definition of status words are shown in the table below.

The structure of status words is shown in Table 9-1.

Table 9-1 Structure of State Words in Periodic Synchronous Torque Mode

Bit	15~14	13	12	11	10	9~0
function	General definition	following error	Target torque ignored	General definition	reserve	General definition

The definition of status words is shown in Table 9-2.

Table 9-2 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	define
10	0	reserve
	1	reserve
12	0	Ignoring target torque
	1	The target torque is used as input to the torque control loop
13	0	No following error
	1	Following error

9.5 Parameters of objects related to periodic synchronous torque mode

0x6071: Target torque

This object defines the target torque value, and the parameter description is described in section 6.5.

0x6077: Torque actual value

This object defines the actual torque value of the motor, and the parameter description is described in section 6.5.

0x60B2: Torque offset

This object provides a offset value for torque, which is torque feedforward in the periodic synchronous torque.

Table 9-3 Introduction to 0x60B2

Index number	name	object type	mapping	access	Default value
0x60B2	Torque offset	VAR	-	RW	0
		data type	unit	range	
		INT16	Rated torque/1000	-	

0x2115: TrqLoopPosVelLimit

This object defines the torque control forward speed limit values, as shown in Table 9-4.

Table 9-4 Introduction to 0x2115

Index number	name	object type	mapping	access	Default value
0x2115	TrqLoopPosVelLimit	VAR	-	RW	1000
		data type	unit	range	
		UINT16	Rated speed/1000	-	

0x2116: TrqLoopNegVelLimit

This object defines the torque control reverse speed limit values, as shown in Table 9-5.

Table 9-5 Introduction to 0x2116

Index number	name	object type	mapping	access	Default value
0x2116	TrqLoopNegVelLimit	VAR	-	RW	1000
		data type	unit	range	
		UINT16	Rated speed/1000	-	

9.6 Application examples

1. Set 6060 to 10 and select Cyclic Synchronous torque mode;

2. Set 60E0h: Positive torque limit to set the forward torque limit (unit: 0.1% of rated torque);

3. Set60E1h: Negative torque limit to set the reverse torque limit (unit: 0.1% of rated torque);

4. Set 2115h: TrqLoopPosVelLimit to set the forward torque speed limit (unit: 0.1% of rated speed);
5. Set 2116h: TrqLoopNegVelLimit to set the reverse torque speed limit (unit: 0.1% of rated speed);
6. Set 6040h to enable the drive to send 0x0F;
7. Set 607Ah as the target torque (unit: 0.1% rated torque) step by step and perform torque control.

Chapter 10 Homing Mode

10.1 Function Introduction

Homing mode is used to drive the servo drive to find the mechanical origin. Users set corresponding Homing methods and the speed and acceleration during the Homing process according to actual application needs. As shown in Figure 8-1.

Note: In this mode, it is necessary to connect the limit switch and origin switch signals to the switch input terminal J2 of the drive. If the limit switch signal is connected to the upper controller or PLC, a reset process led by the upper controller is required.

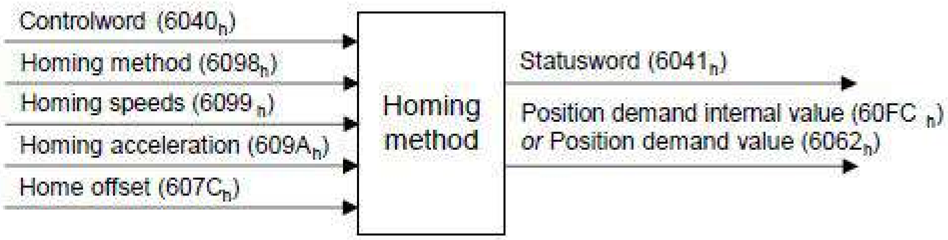

Figure 10-1 Homing mode

10.2 Operation methods

1.Set [6060h: Mode of operation] to 6 (homing mode);

2.Set the [6098h: Homing method] to a range of 1-35 (detailed details can be found in the DS402 standard);

3.Set [607Ch: Homing offset] to set the origin offset;

4.Set [6099h Sub-01: Homing speeds] to modify the speed of searching for limit switches during the Homing process (unit: cnt/s);

5.Set [6099h Sub-02: Homing speeds] to modify the speed (in cnt/s) for finding zero positions during the Homing process;

6.Set [609Ah: Homing acceleration] to set the zero return acceleration and deceleration speed (unit: cnt/s^2);

7.Set [6040h: Control word] to enable the servo drive, the Homing operation start (Bit4) starts from a change of 0->1, and the Homing operation start interrupts the Homing process from a change of 1->0;

8.Motor search for limit switches and home switches, complete the homing action;

9.Query [6041h: Status word] to obtain status feedback (Homing error, Homing attained, Target reached) of the servo drive.

10.3 Use of Control Word

Certain bits of a control word have specific meanings in Homing mode. The structure of control words is shown in Table 10-1.

Table 10-1 Structure of Control Words in Homing Mode

Bit	15~9	8	7	6~5	4	3~0
function	General definition	Halt	General definition	reserve	Homing operation start	General definition

Bit4 set to 1 is used to start the Homing process, while Bit8 set to 1 can stop the operation of the axis, as shown in Table 10-2.

Table 10-2 Definition of Control Words Bit4 and Bit8

Bit	**Value**	**define**
4	0	Stop the homing process
	1	Start or continue the homing process
8	0	Enable Bit4 control
	1	Stop the operation of the axis according to the definition of 0x605D Halt option code

10.4 Use of Status Word

Some bits of the status word have specific meanings in Homing mode. The structure and definition of status words are shown in the table.

The structure of status words is shown in Table 10-3.

Table 10-3 Definition of Status Words in Homing mode

Bit	15~14	13	12	11	10	9~0
function	General definition	Homing error	Homing attained	General definition	Target Reached	General definition

The definition of status words is shown in Table 10-4.

Table 10-4 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	define
10	0	Halt (Bit8 of control word) =0: The origin position has not been reached
	0	Halt (Bit8 of control word) =1: axis deceleration
	1	Halt (Bit8 of control word) =0: Origin position reached
	1	Halt (Bit8 of control word) =1: Axis speed is 0
12	0	The homing process is not yet completed
	1	The homing process has been completed
13	0	Homing process without errors
	1	An error occurred during the homing process

10.5 Homing mode Related Object Parameters

0x607C: Home offset

This object defines the deviation value between the zero point and the mechanical origin in the application. As shown in Figure 10-2.

Figure 10-2 Relationship between Zero Point, Origin, and Home Offset

The introduction of 0x607C is shown in Table 10-5

Table 10-5 Introduction to 0x607C

Index number	name	object type	mapping	access	Default value
0x607C	Home offset	VAR	-	RW	0
		data type	unit	range	
		INT32	UU	-	

0x6098: Home method

This object defines a Homing method. The supported Homing methods are shown in Table 10-5 and the introduction of 0x6098 in Chapter 10.5 is shown in Table 10-6.

Table 10-6 Introduction to 0x6098

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x6098</td><td rowspan="3">Home method</td><td>VAR</td><td>-</td><td>RW</td><td rowspan="3">35</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>INT8</td><td>-</td><td>-</td></tr>
</table>

The supported Homing methods are shown in Table 10-7.

Table 10-7 Supported Homing Methods

Value	**define**
0	No method
1	Homing method 0
2	Homing method 2
⋮	⋮
34	Homing method 34
35	Homing method 35

0x6099: Homing speeds

This object defines the speed during the homing process. The introduction of 0x6099 is shown in Table 10-8.

Table 10-8 Introduction to 0x6099

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x6099</td><td rowspan="3">Homing speeds</td><td>ARRAY</td><td>-</td><td>-</td><td rowspan="3">-</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>UINT32</td><td>-</td><td>-</td></tr>
</table>

The sub index 0x00 of 0x6099 is introduced in Table 10-9.

Table 10-9 Introductionto sub index 0x00 of 0x6099

Sub index number	name	object type	mapping	access	Default value
0x00	Number of entries	-	-	RO	2
		data type	unit	range	
		UINT8	-	2	

The sub index 0x01 of 0x6099 is introduced in Table 10-10.

Table 10-10 Introductionto sub index 0x01 of 0x6099

Sub index number	name	object type	mapping	access	Default value
0x01	Speed during search for switch	-	-	RW	0
		data type	unit	range	
		UINT32	UU	-	

The sub index 0x02 of 0x6099 is introduced in Table 10-11.

Table 10-11 Introductionto sub index 0x02 of 0x6099

Sub index number	name	object type	mapping	access	Default value
0x02	Speed during search for zero	-	-	RW	0
		data type	unit	range	
		UINT32	UU	-	

0x609A: Homing acceleration

This object defines the acceleration and deceleration during the homing process. As shown in Table 10-12.

Table 10-12 Introduction to 0x609A

Index number	name	object type	mapping	access	Default value
0x609A	Homing acceleration	ARRAY	-	RW	0
		data type	unit	range	
		UINT32	UU	-	

10.6 Homing method

Homing method 1: Descending edge of negative limit switch+zero position pulse

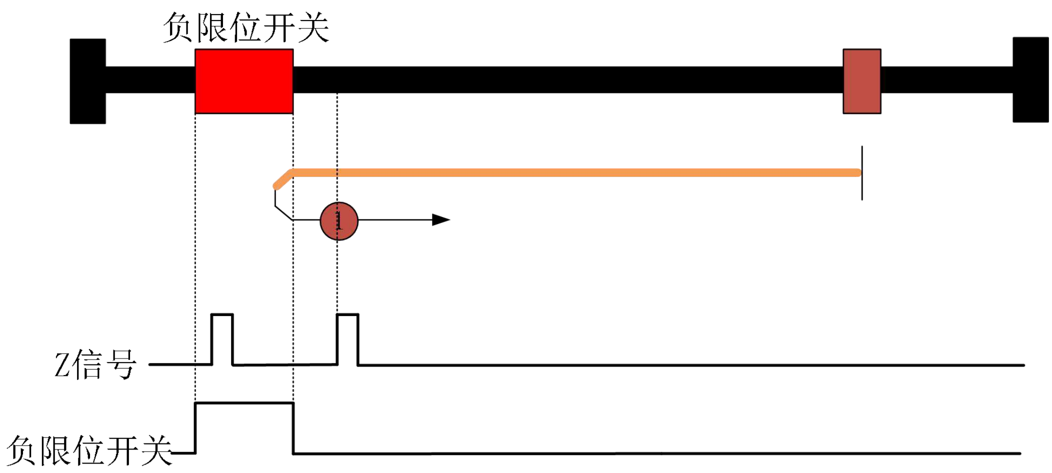

Figure 10-3 Homing method 1

When starting from the original position, the motor moves in the negative direction at high speed (6099-01). When encountering a negative limit switch signal that becomes higher, the motor decelerates to 0 at the homing deceleration (609A), and then accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), maintaining a forward low-speed motion until encountering the first Z signal after the negative limit switch signal changes from high level to low level. The status word "Homing attained" is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

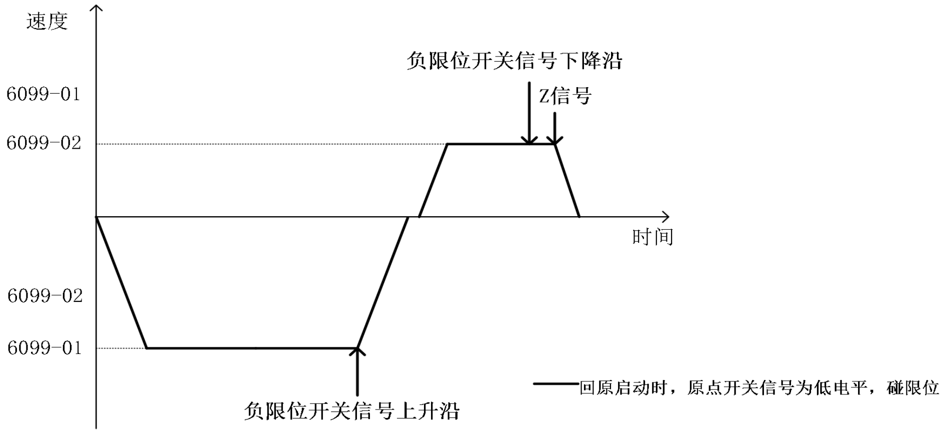

Figure 10-4 Speed-time curve of Homing method 1

Homing method 2: descending edge of positive limit switch+zero position pulse

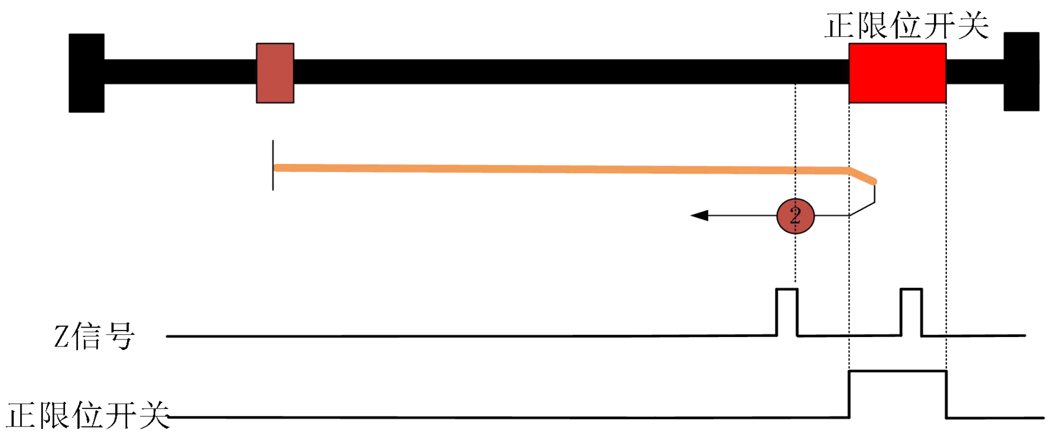

Figure 10-5 Homing method 2

When starting from the original position, the motor moves forward at high speed (6099-01). When encountering an increase in the positive limit switch signal, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) in the reverse direction at the original position acceleration (609A), maintaining a negative low-speed motion until encountering the first Z signal after the positive limit switch signal changes from high level to low level. The status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

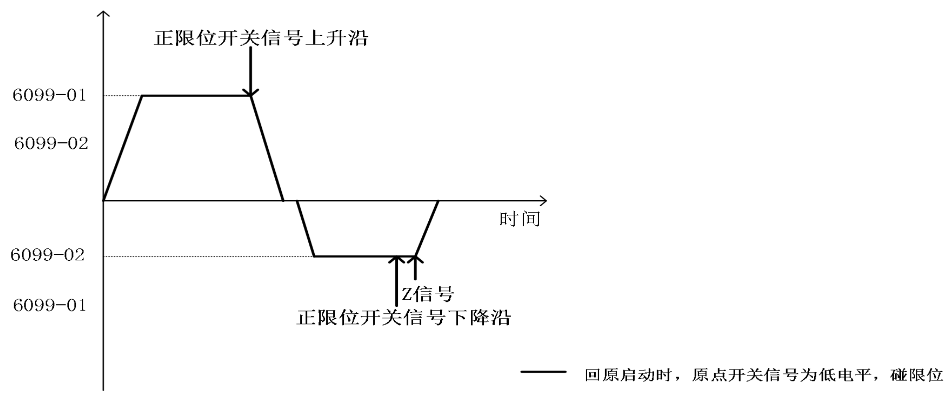

Figure 10-6 Speed-time curve of Homing method 2

Homing method 3: Descending edge of forward origin switch+zero position pulse

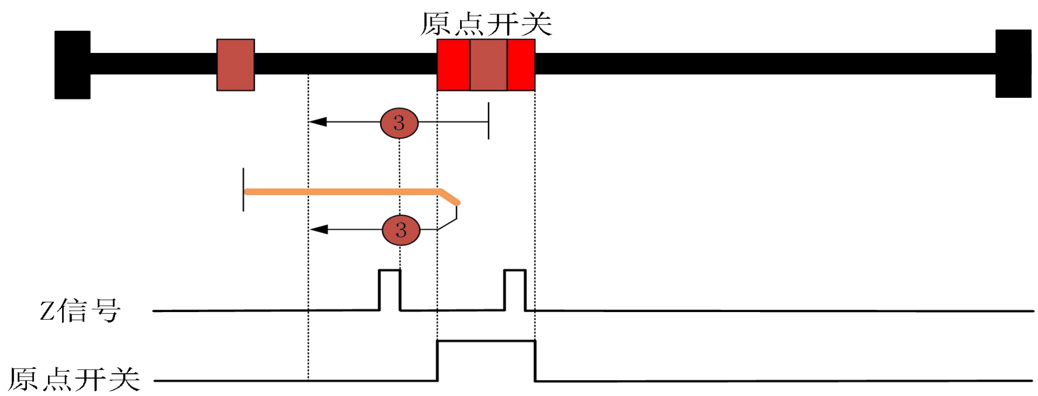

Figure 10-7 Homing method 3

1.Homing started, when the origin switch signal is low, the motor moves forward at high speed (6099-01). When encountering an increase in the origin switch signal, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) at the original position acceleration (609A) in the opposite direction, maintaining negative low-speed movement until encountering the first Z signal after the forward origin switch signal changes from high to low, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

2. Homing started, when the origin switch signal is high, the motor moves in a negative direction at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, starting to decelerate at the original deceleration speed (609A), and when stopping, the status word Target reached is set to 1.

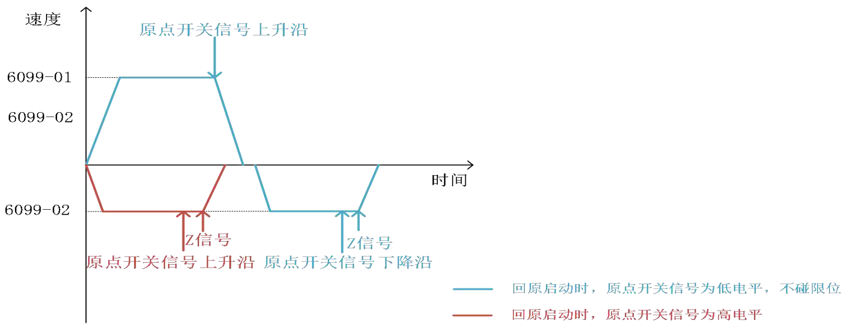

Figure 10-8 Speed-time curve of Homing method 3

Homing method 4: Rising edge of forward origin switch+zero position pulse

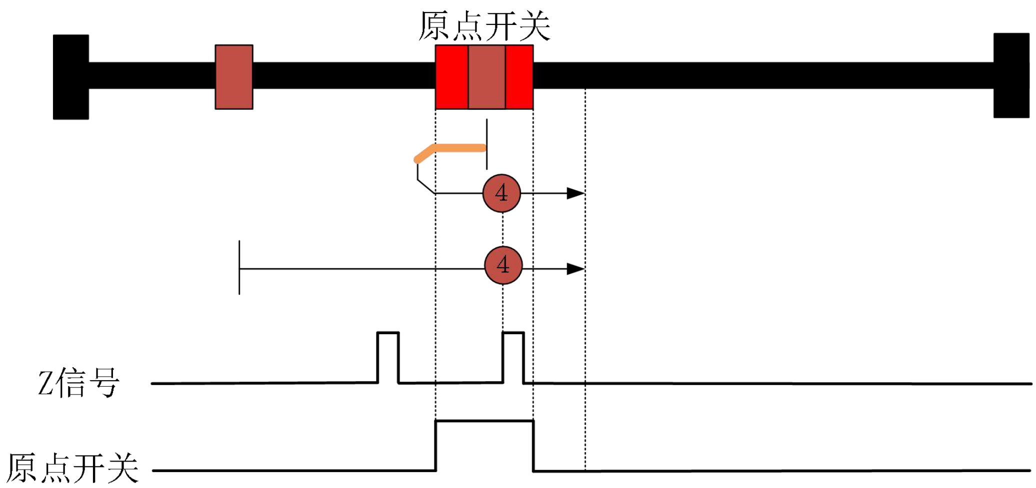

Figure 10-9 Homing method 4

1.Homing started, when the origin switch signal is low, the motor moves forward at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from low level to high level. The status word Homing attained is set to 1, starting to decelerate at the original deceleration speed (609A), and finally returning to zero to the Z pulse latch position. When stopping, the status word Target reached is set to 1.

2.Homing started, when the origin switch signal is high, the motor moves in the negative direction at high speed (6099-01). When the origin switch signal becomes low, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) in the reverse direction at the original position acceleration (609A), maintaining forward low-speed motion until the first Z signal after the origin switch signal changes from low level to high level is encountered, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and finally return to zero at the Z pulse latch position. When stopped, set the status word Target reached to 1.

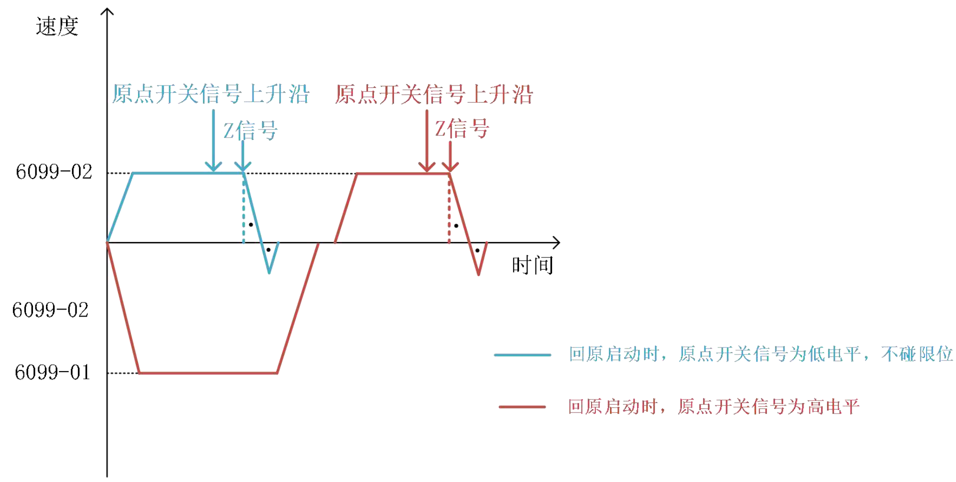

Figure 10-10 Speed-time curve of Homing method 4

Homing method 5: Descending edge of negative origin switch+zero position pulse

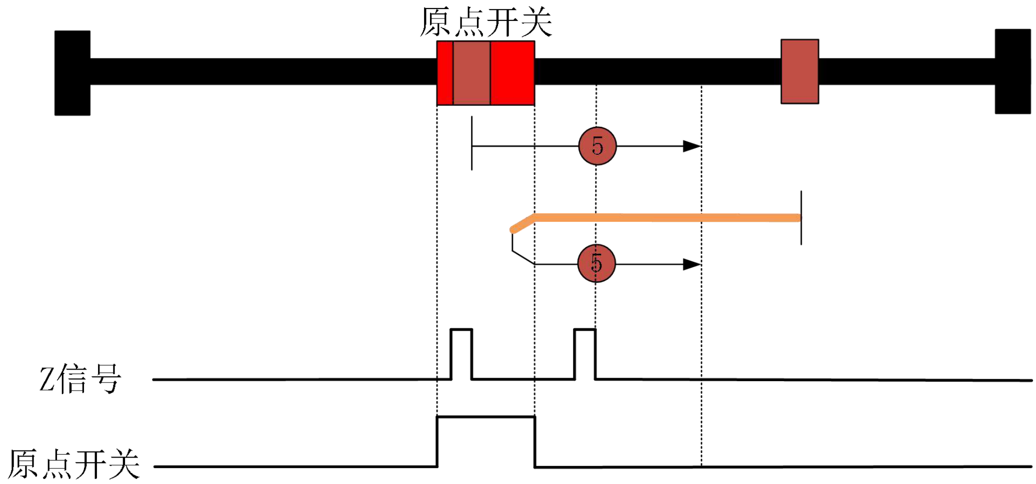

Figure 10-11 Homing method 5

1.Homing started, when the origin switch signal is low, the motor moves in a negative direction at high speed (6099-01). When the origin switch signal becomes high, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) at the original position acceleration (609A) in the reverse direction, maintaining a low speed forward motion until it encounters the first Z signal after the origin switch signal changes from high level to low level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and finally return to zero at the Z pulse latch position. When stopped, set the status word Target reached to 1.

2.Homing started, when the negative origin switch signal is high, the motor will move in a low-speed direction (6099-02) until it encounters the first Z signal after the origin switch signal changes from high to low. The status word "Homing attained" is set to 1, starting to decelerate at the original deceleration speed (609A), and finally returning to zero until it reaches the Z pulse lock position. When stopping, the status word "Target reached" is set to 1.

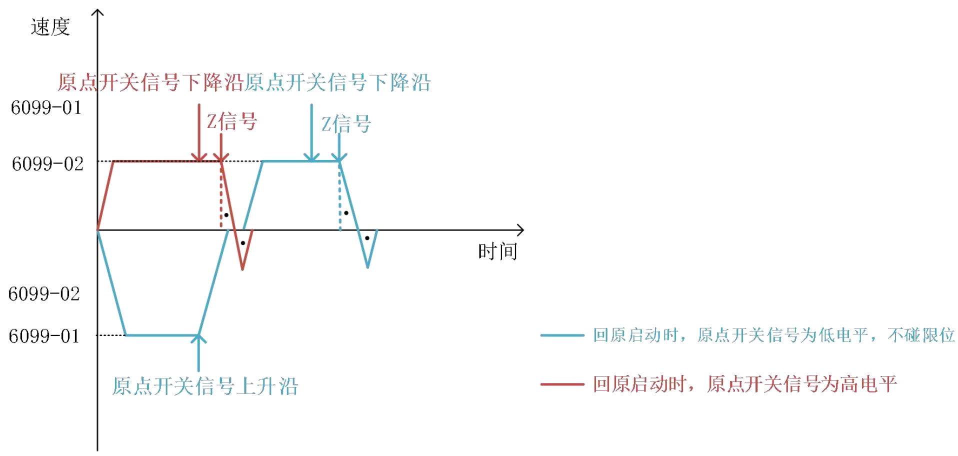

Figure 10-12 Speed-time curve of Homing method 5

Homing method 6: Rising edge of negative origin switch+zero position pulse

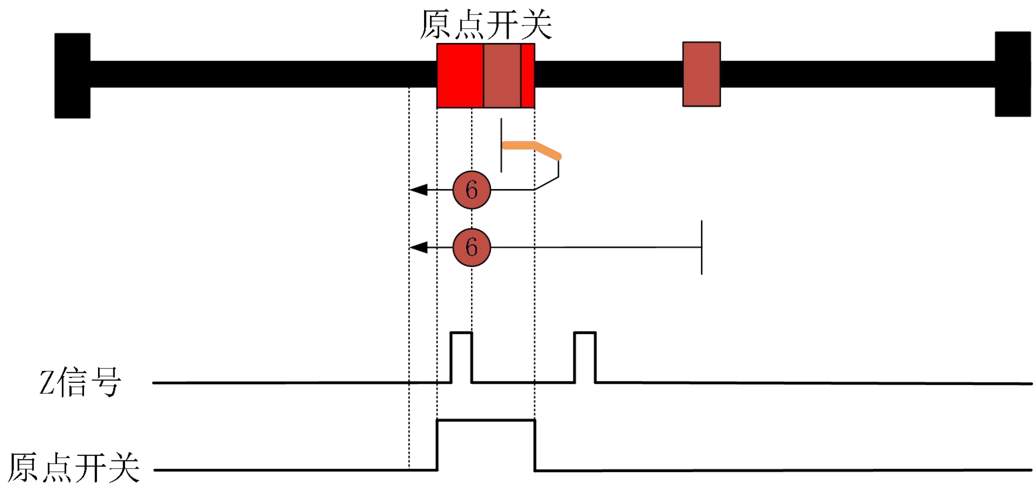

Figure 10-13 Homing method 6

1.Homing started, when the origin switch signal is low, the motor moves in the negative direction at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from low level to high level. The status word Homing attained is set to 1, starting to decelerate at the original deceleration speed (609A), and when stopping, the status word Target reached is set to 1.

2. Homing started, when the origin switch signal is high, the motor moves forward at high speed (6099-01). When the origin switch signal becomes low, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) in

the opposite direction at the original position acceleration (609A), maintaining a low speed negative motion until the first Z signal after the origin switch signal changes from low level to high level is encountered, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

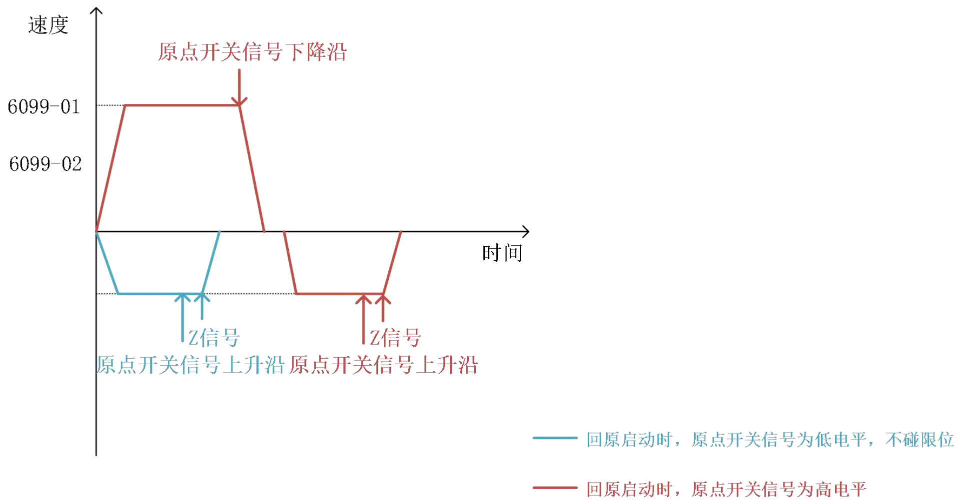

Figure 10-14 Speed-time curve of Homing method 6

Homing method 7: Negative origin switch's descending edge+zero position pulse, positive limit switch detection

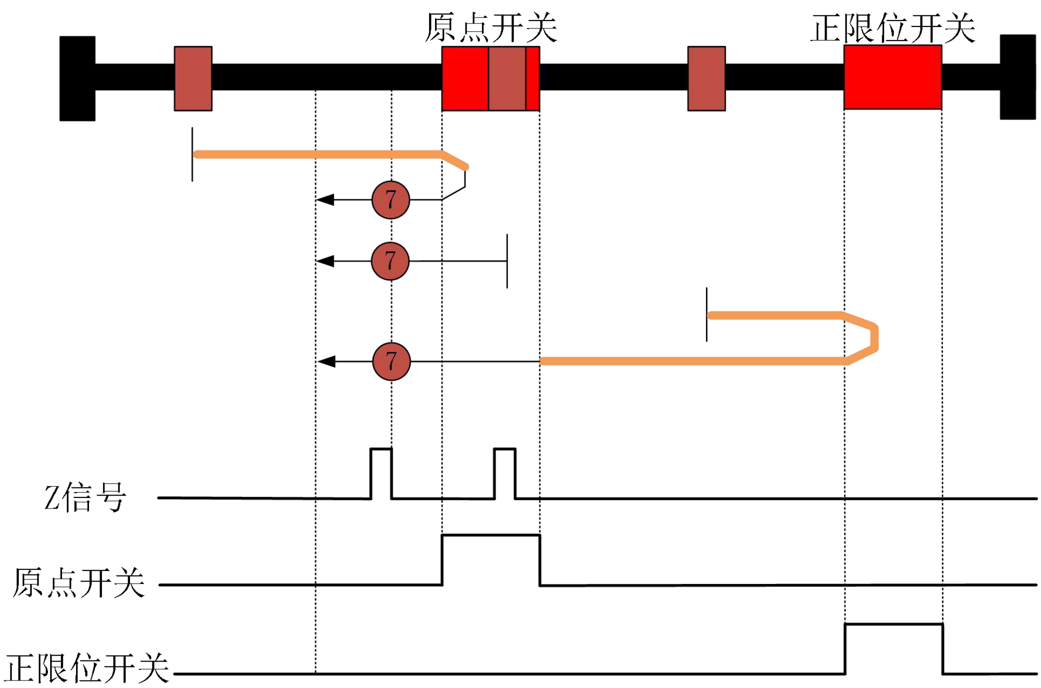

Figure 10-15 Homing method 7

1.Homing started, when the signal of the origin switch is low, and the motor moves forward at high speed,

1) When the origin switch signal is at a high level, the motor decelerates to 0 at the homing deceleration (609A), and then accelerates in the reverse direction at the homing acceleration (6099-02) to low speed (6099-02), maintaining negative motion at low speed until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

2) When the positive limit switch becomes high level, the motor decelerates to 0 at the homing deceleration (609A), then accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), maintaining high-speed negative motion. When encountering the origin switch signal, it becomes high level, decelerates to low speed (6099-02) at the homing deceleration (609A), and maintains low-speed negative motion until encountering the first Z signal after the origin switch signal changes from high level to low level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

2. Homing started, when the origin switch signal is high, the motor moves in a negative direction at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, starting to decelerate at the original deceleration speed (609A), and when stopping, the status word Target reached is set to 1.

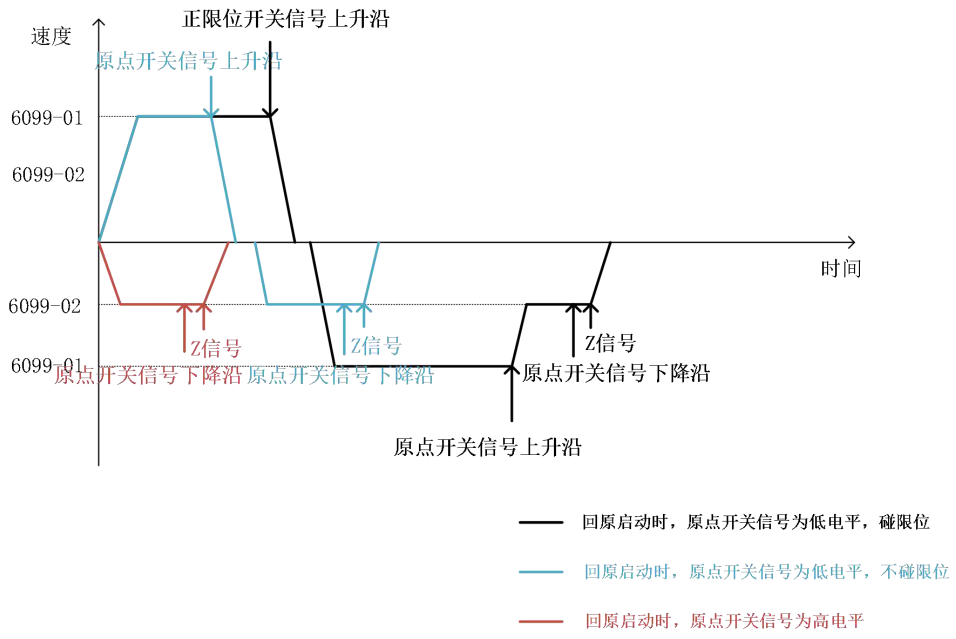

Figure 10-16 Speed-time curve of Homing method 7

Homing method 8: Rising edge of the forward origin switch+zero position pulse, detected by the positive limit switch

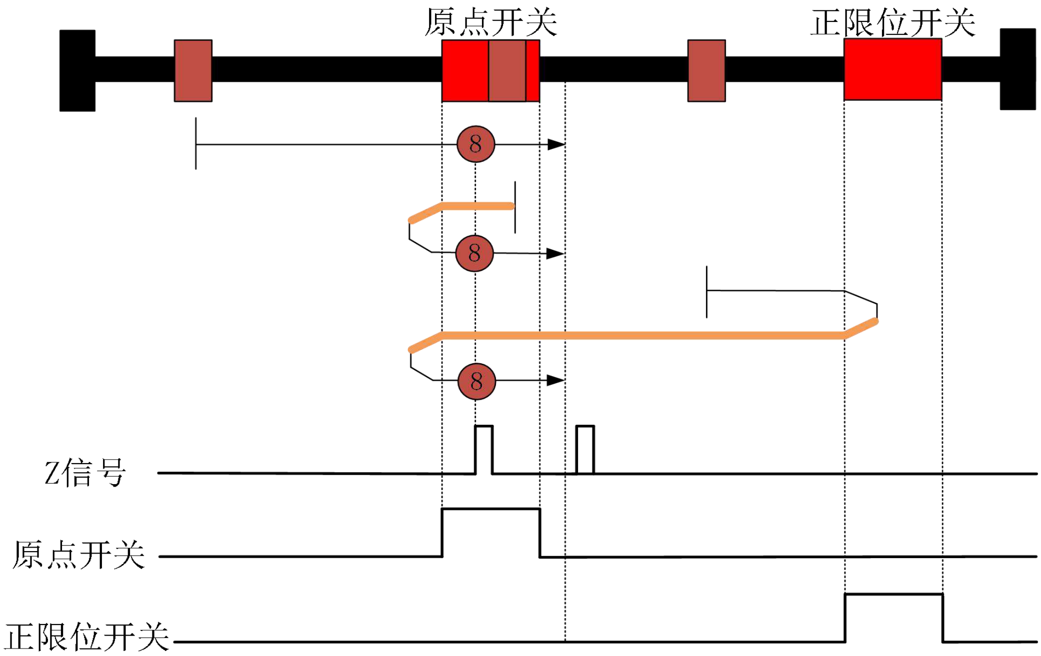

Figure 10-17 Homing Method 8

1.Homing started, when the origin switch signal is low, and the motor moves forward at low speed (6099-02)

1）The origin switch signal becomes high level, and the motor continues to move forward at low speed (6099-02) until it encounters the first Z signal after the origin switch signal becomes high level. The status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopped.

2）The positive limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), then accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), maintaining high-speed negative motion. When encountering the origin switch signal, it changes from a high level to a low level, and the motor decelerates to 0 at the homing deceleration (609A), then accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), maintaining forward low-speed operation, Until encountering the first Z signal after the origin switch signal changes from low level to high level, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopped.

2.Homing started, when the origin switch signal is at a high level, and the motor moves in the negative direction at high speed (6099-01). When encountering the origin switch signal changing from high level to low level, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) in the reverse direction at the original position acceleration (609A), maintaining forward low-speed operation until encountering the first Z signal after the origin switch signal changes from low level to high level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

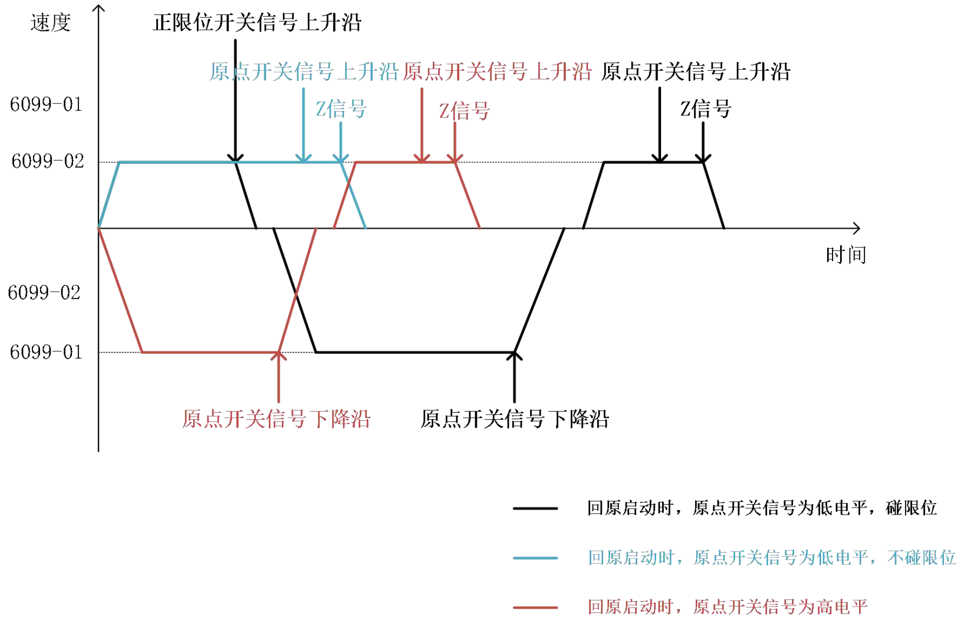

Figure 10-18 Speed-time curve of Homing method 8

Homing method 9: Rising edge of negative origin switch+zero position pulse, positive limit switch detection

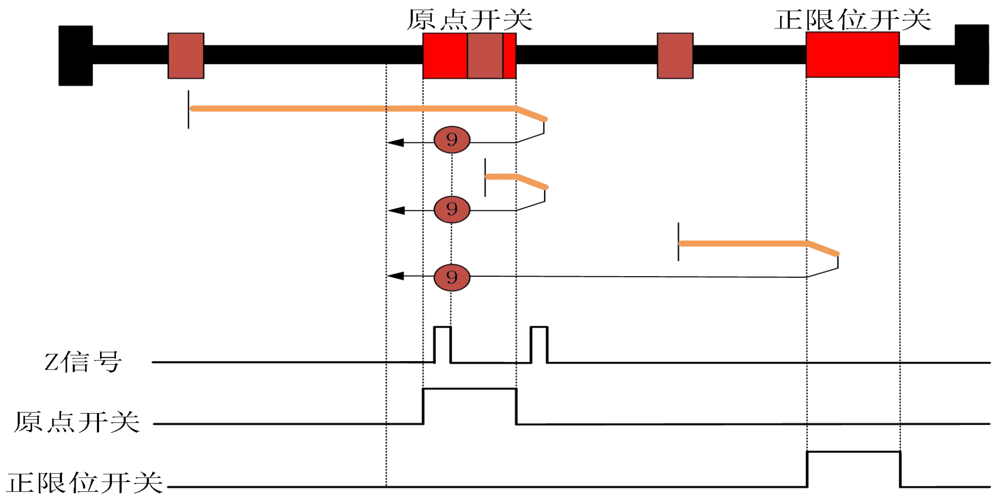

Figure 10-19 Homing method 9

1.Homing started, the origin switch signal is low, and the motor moves forward at high speed (6099-01)

1) The origin switch signal changes to a high level, and the motor maintains a high speed (6099-01) forward motion. When encountering the origin switch signal changing from a high level to a low level, the motor decelerates to 0 at the homing deceleration (609A), and then accelerates to a low speed (6099-02) in the opposite direction at the homing acceleration (609A), maintaining a low speed negative motion until encountering the first Z signal after the origin switch signal changes from a low level to a high level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

2) The positive limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), then accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), maintaining negative motion at low speed until it encounters the first Z signal after the origin switch signal changes from low level to high level. The status word Homing attained is set to 1, and the motor starts to decelerate at the homing deceleration (609A). When it stops, the status word Target reached is set to 1.

2.Homing started, when the origin switch signal is at a high level, and the motor moves forward at high speed. When encountering the origin switch signal changing from a high level to a low level, the motor decelerates to 0 at the original position deceleration (609A), and then accelerates to low speed (6099-02) in the reverse direction at the original position

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acceleration (609A), maintaining a low speed and negative motion until encountering the first Z signal after the origin switch signal changes from a low level to a high level, the status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

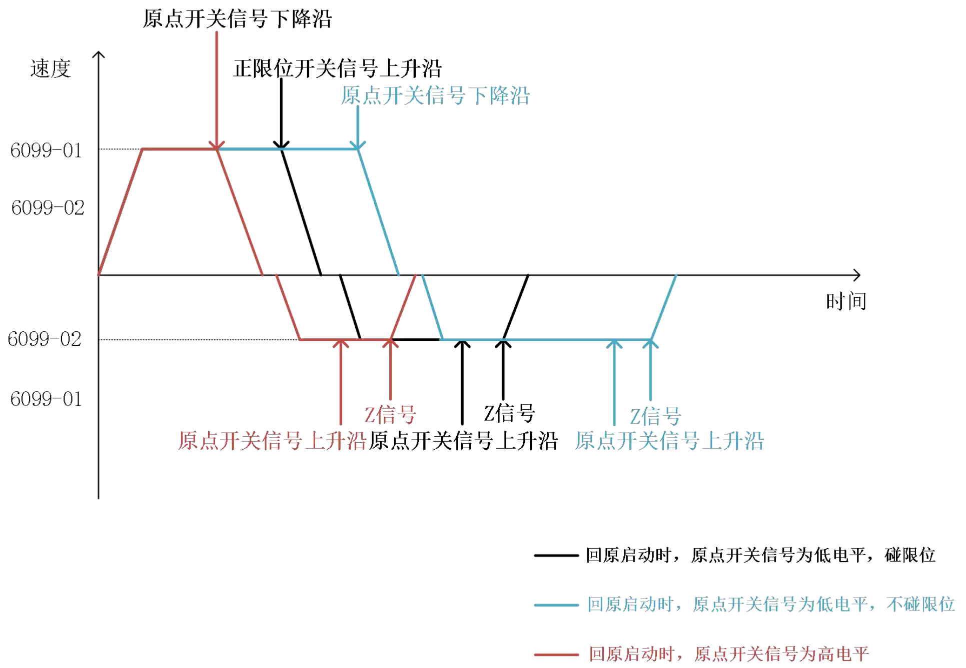

Figure 10-20 Speed-time curve of Homing method 9

Homing method 10: The descending edge of the forward origin switch+zero position pulse, detected by the positive limit switch

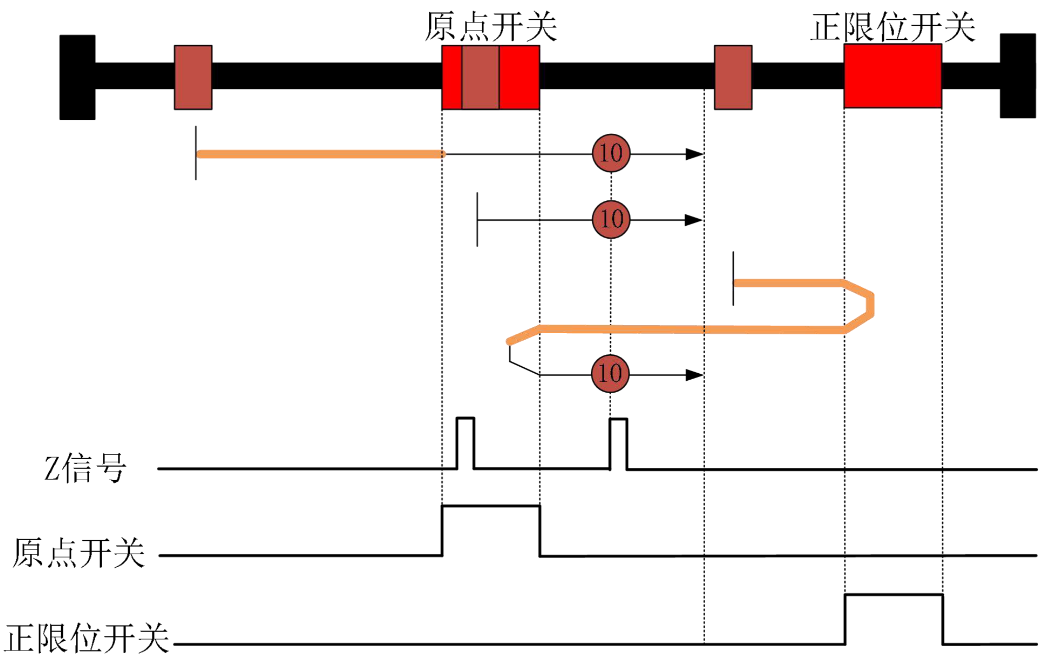

Figure 10-21 Homing Method 10

1.Homing started, when the origin switch signal is low, and the motor moves forward at high speed (6099-01)

1) The origin switch signal changes to a high level, and the motor decelerates to a low speed (6099-02) at its homing deceleration (609A), maintaining a forward motion at low speed until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, and the motor begins to decelerate at its homing deceleration (609A). When it stops, the status word Target reached is set to 1.

2) The positive limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), and maintains high-speed negative motion. When encountering the origin switch signal changing from low level to high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains low-speed forward motion, Until encountering the first Z signal after the origin switch signal changes from high to low, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopped.

2. Homing started, when when the origin switch signal is high, the motor moves forward at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, starting to decelerate at the original deceleration speed (609A), and when stopping, the status word Target reached is set to 1.

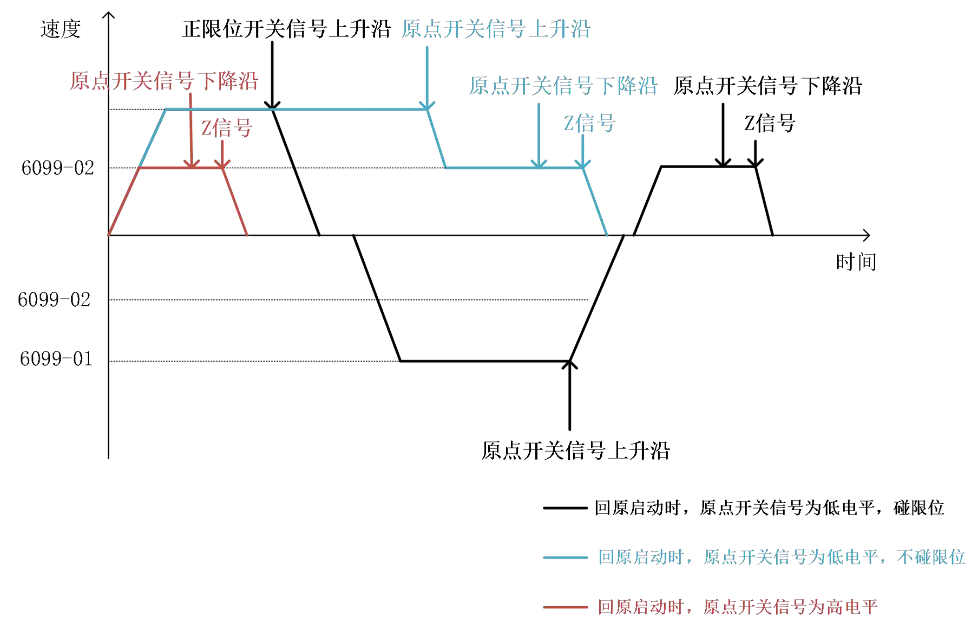

Figure 10-21 Speed-time curve of Homing method 10

Homing method 11: The descending edge of the positive origin switch+zero position pulse, and the detection of the negative limit switch

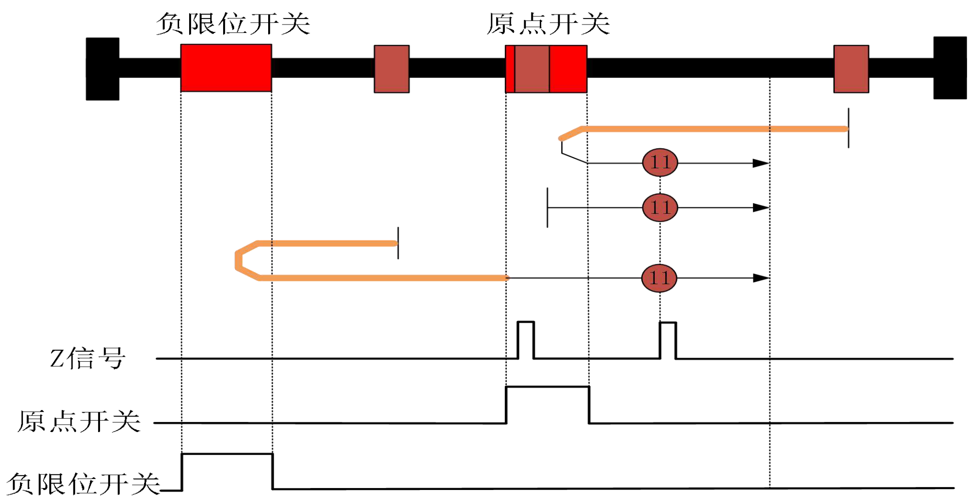

Figure 10-22 Homing method 11

1.Homing started, when the origin switch signal is low, and the motor moves in the negative direction at high speed (6099-01)

1）The origin switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains forward low-speed operation until it encounters the first Z signal after the origin switch signal changes from high level to low level.

The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

2）The negative limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A) and accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), maintaining a forward high-speed operation. When encountering the origin switch signal that changes from low level to high level, the motor decelerates to low speed (6099-02) at the homing deceleration (609A) and maintains a forward low-speed operation, Until encountering the first Z signal after the origin switch signal changes from high to low, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopped.

2. Homing started, when the origin switch signal is high, the motor runs forward at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, starting to decelerate at the original deceleration speed (609A), and when stopping, the status word Target reached is set to 1.

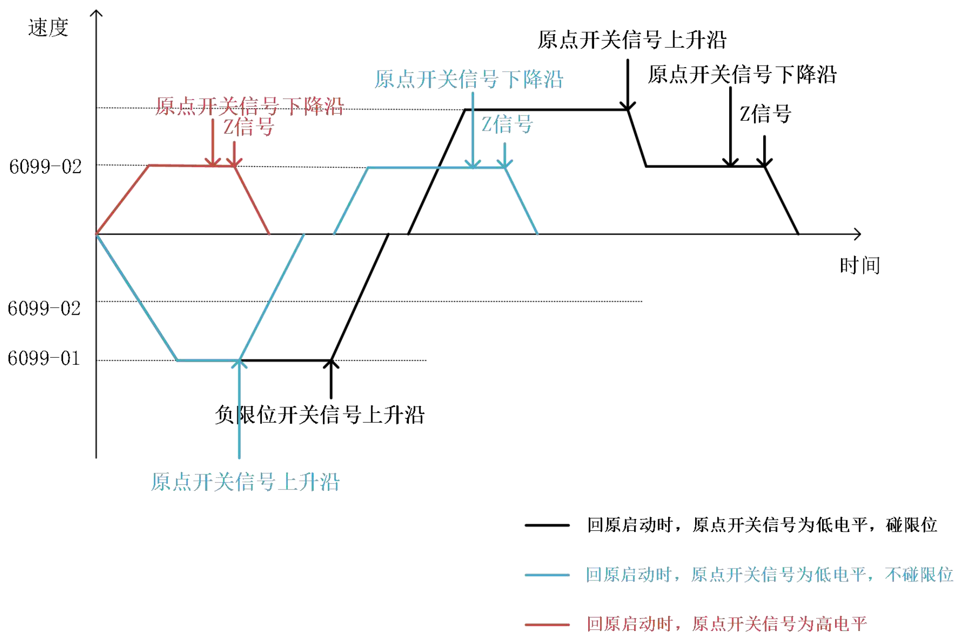

Figure 10-23 Speed-time curve of Homing method 11

Homing method 12: The rising edge of the negative origin switch+zero position pulse, detected by the negative limit switch

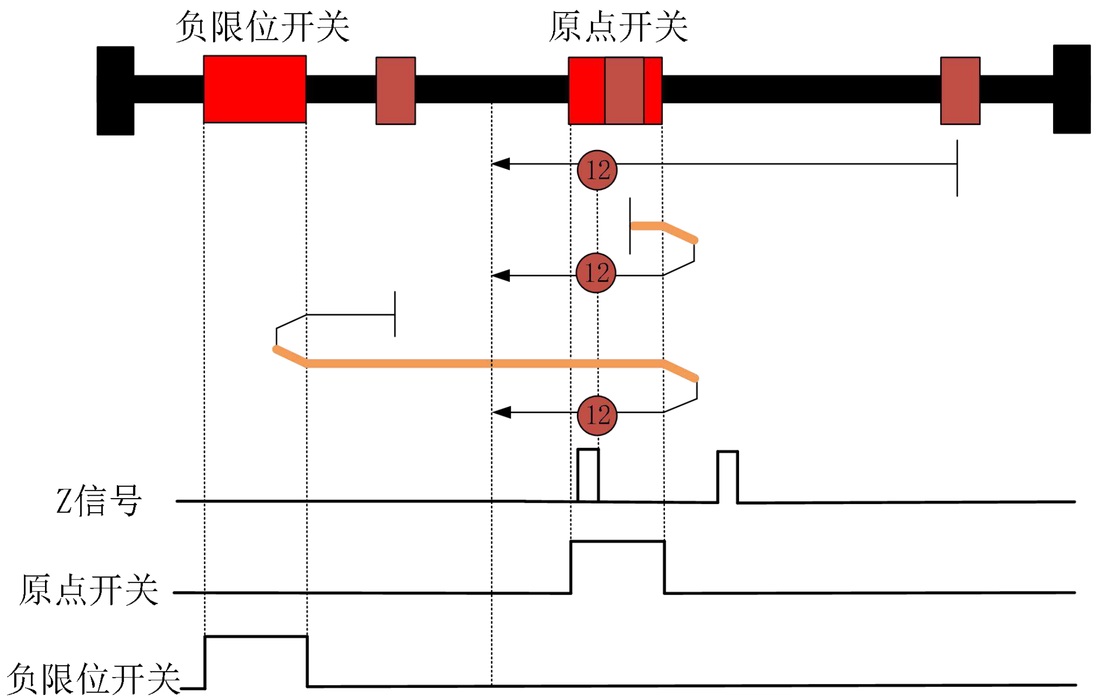

Figure 10-24 Homing method 12

1. Homing started, when the signal of the origin switch is low, and the motor is at low speed in the negative direction (6099-02)

1) When the origin switch signal changes to high level, the motor maintains negative low-speed (6099-02) operation. When encountering the first Z signal after the origin switch signal changes from low level to high level, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and when stopped, the status word Target reached is set to 1.

2) The negative limit switch signal becomes a high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), and maintains forward high-speed operation. When encountering the high level of the origin switch signal, it becomes a low level, decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains negative low-speed operation, Until encountering the first Z signal after the origin switch signal changes from low level to high level, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopped.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at high speed (6099-01) in the forward direction. When encountering the origin switch signal changing from high level to low level, the motor decelerates to 0 at the original position deceleration (609A), and accelerates to low speed (6099-02) in the reverse direction at the original position acceleration (609A). It maintains negative low-speed operation until encountering the first Z signal after the origin switch signal changes from low level to high level, and the status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

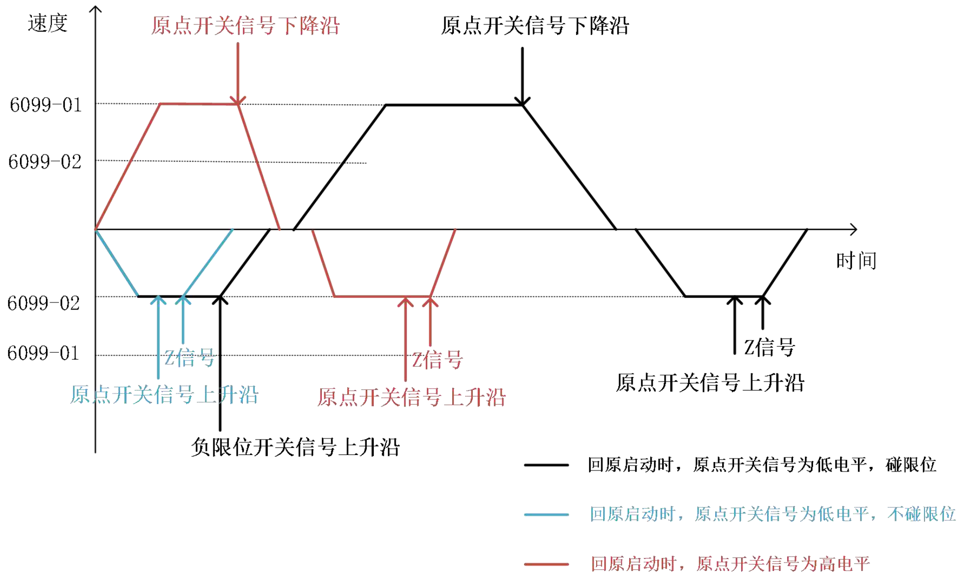

Figure 10-25 Speed-time curve of Homing method 12

Homing method 13: Rising edge of positive origin switch+zero position pulse, negative limit switch detection

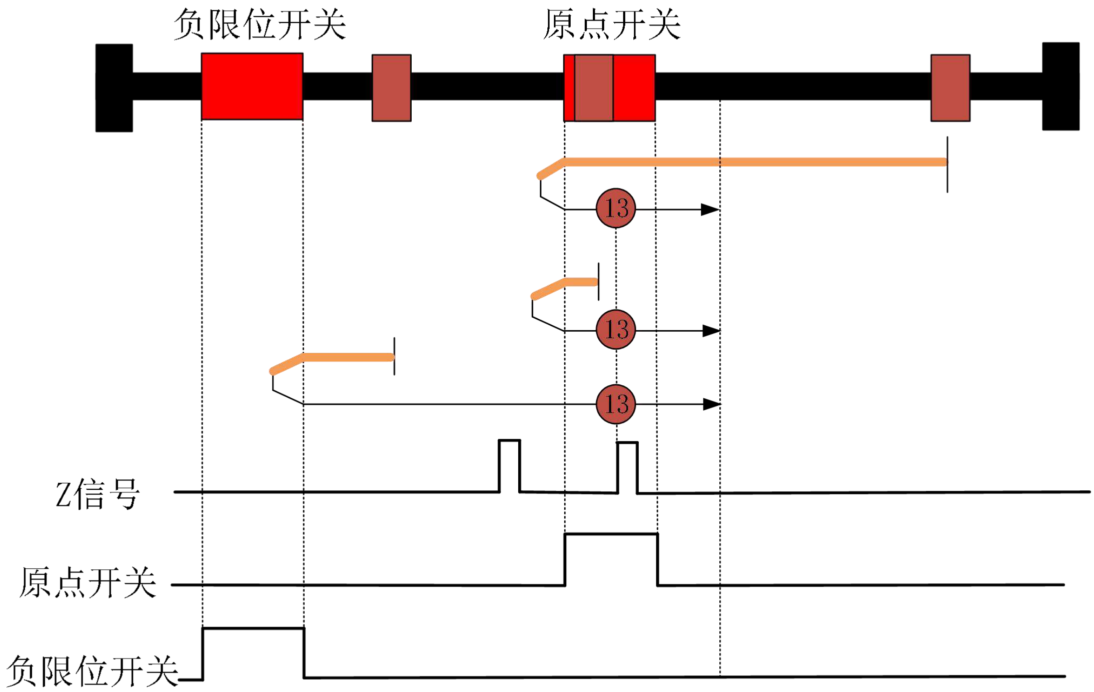

Figure 10-26 Homing method 13

1. Homing started, when the origin switch signal is low and the motor runs at high speed (6099-01) in the negative direction,

1) The origin switch signal becomes high level, and the motor maintains negative high-speed operation. When encountering the origin switch signal, it changes from high level to low level. The motor decelerates to 0 at the homing deceleration (609A), and accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A). It maintains positive low-speed operation until encountering the first Z signal after the origin switch signal changes from low level to high level. The status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

2) The negative limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), then accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), maintaining forward low-speed operation until it encounters the first Z signal after the origin switch signal changes from low level to high level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

2. Homing started, when the origin switch signal is high, the motor maintains a negative high-speed (6099-01) operation. When encountering the origin switch signal changing from high to low, the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains a forward low-speed operation until encountering the first Z signal after the origin switch signal changes from low to high, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

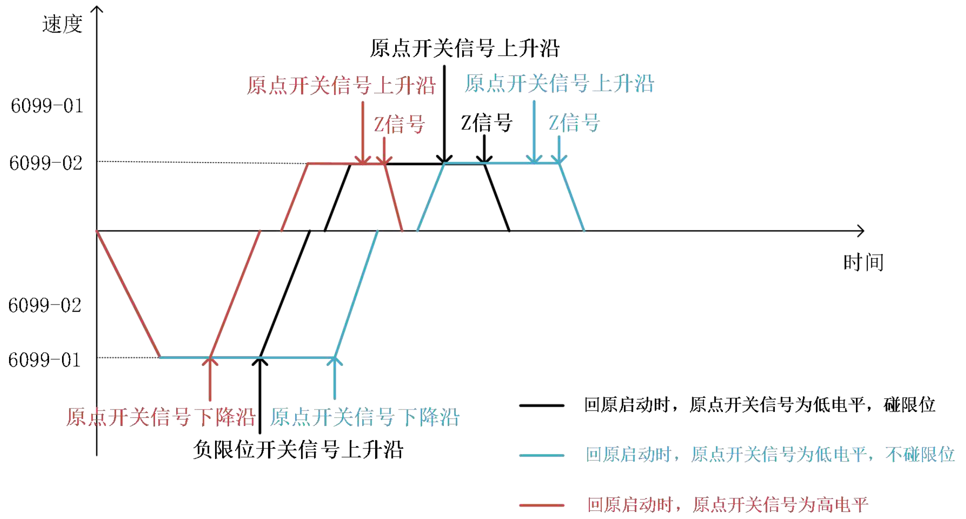

Figure 10-27 Speed-time curve of Homing method 13

Homing method 14: The descending edge of the negative origin switch+zero position pulse, detected by the negative limit switch

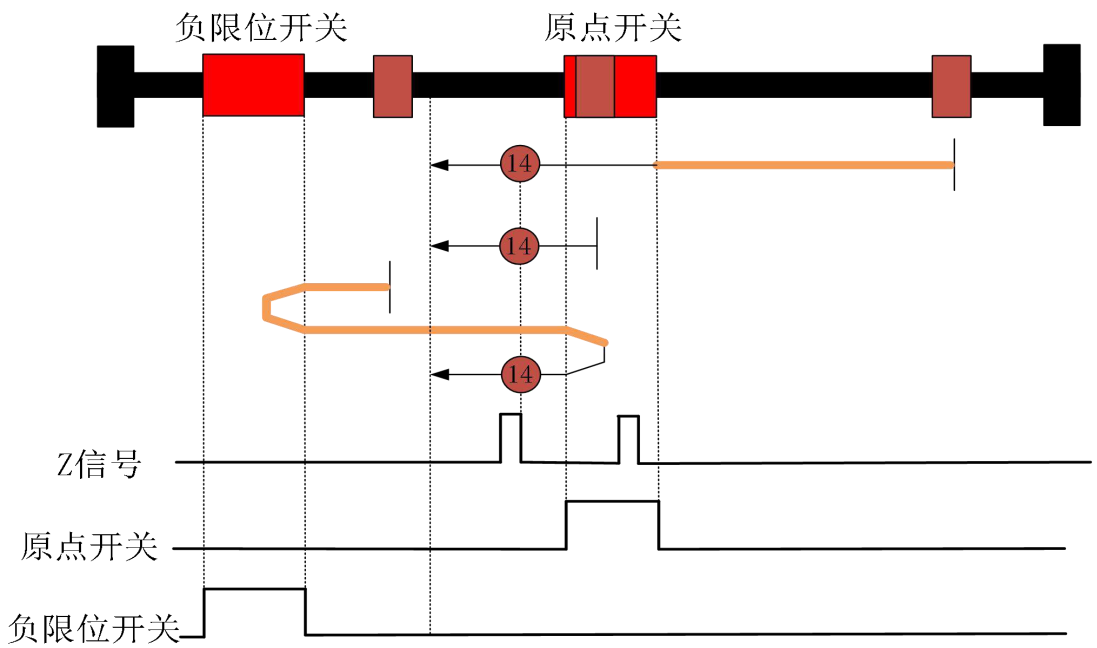

Figure 10-28 Homing method 14

1. Homing started, when the origin switch signal is low and the motor runs at high speed (6099-01) in the negative direction

1) The origin switch signal changes to a high level, and the motor decelerates at a low speed (6099-02) in the negative direction until it encounters the first Z signal after the origin switch signal changes from a high level to a low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When it stops, the status word Target reached is set to 1.

2) The negative limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction with the homing acceleration (609A), and maintains negative high-speed operation. When encountering the origin switch signal, it changes from low level to high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction with the homing acceleration (609A), and maintains negative low-speed operation, Until encountering the first Z signal after the origin switch signal changes from high to low, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopped.

2. Homing started, when the origin switch signal is high, the motor runs in the negative direction at low speed (6099-02) until it encounters the first Z signal after the origin switch signal changes from high level to low level. The status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and the status word Target reached is set to 1 when stopping.

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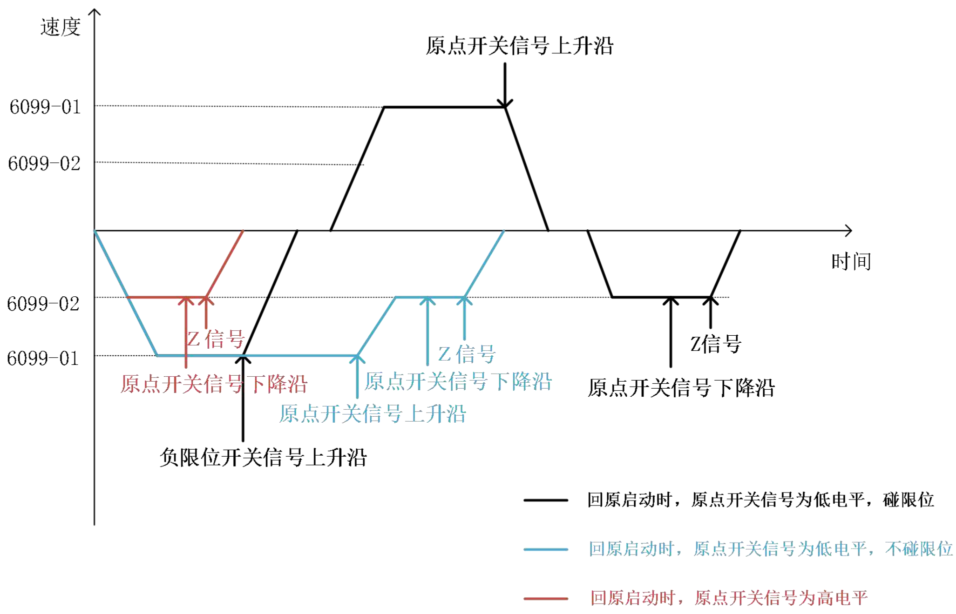

Figure 10-29 Speed-time curve of Homing method 14

Homing method 15: reserved, used for expanding the definition of homing method

Homing method 16: reserved, used for expanding the definition of homing method

Homing method 17: Descending edge of negative limit switch

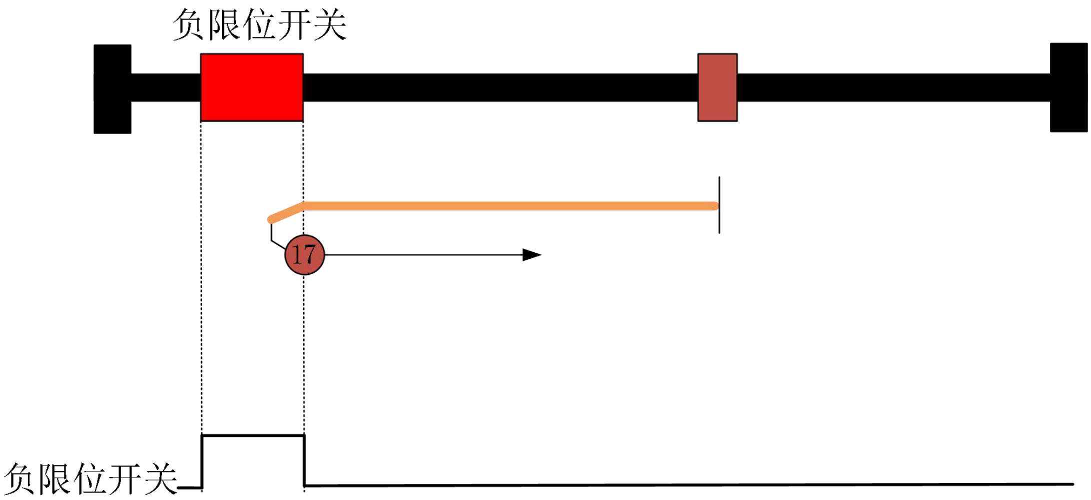

Figure 10-30 Homing Method 17

The motor runs at high speed in the negative direction (6099-01). When encountering a negative limit switch signal that changes to a high level, the motor decelerates to 0 at the homing deceleration (609A) and accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A). It maintains forward low-speed operation until encountering a negative limit switch signal that changes from a high level to a low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A), Set the status word Target reached to 1 when stopping.

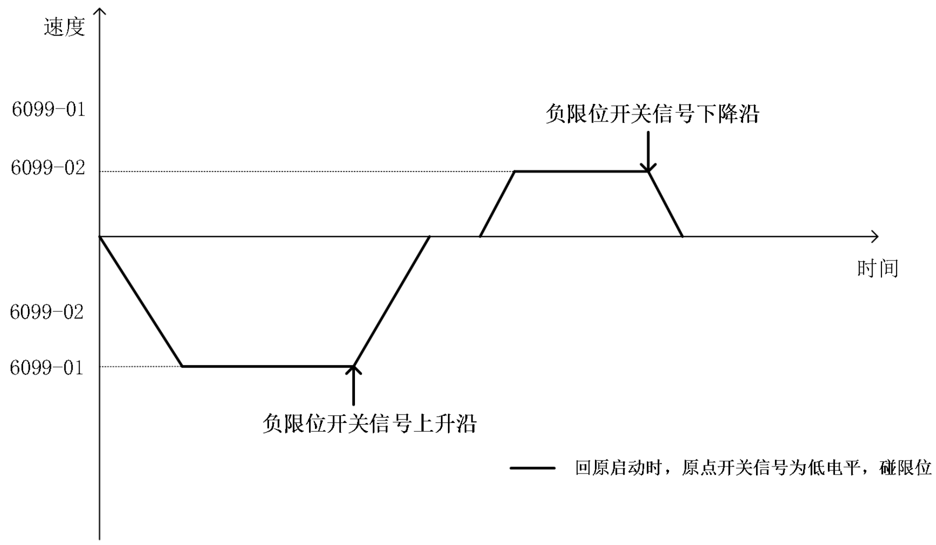

Figure 10-31 Speed-time curve of Homing method 17

Homing method 18: Descending edge of positive limit switch

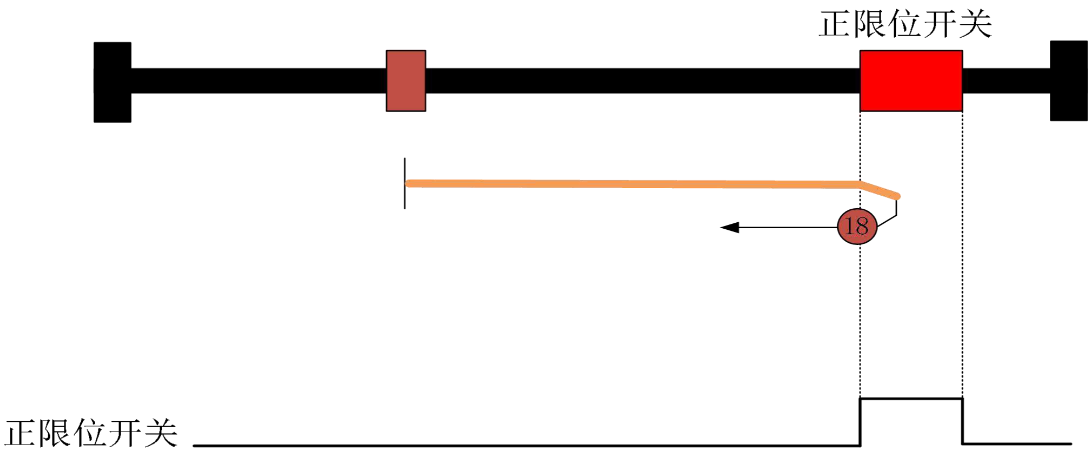

Figure 10-32 Homing method 18

The motor runs at high speed (6099-01) in the forward direction. When encountering a positive limit switch signal that changes to a high level, the motor decelerates to 0 at the homing deceleration (609A) and accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A). It maintains a negative low-speed operation until encountering a positive limit switch signal that changes from a high level to a low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A), Set the status word Target reached to 1 when stopping.

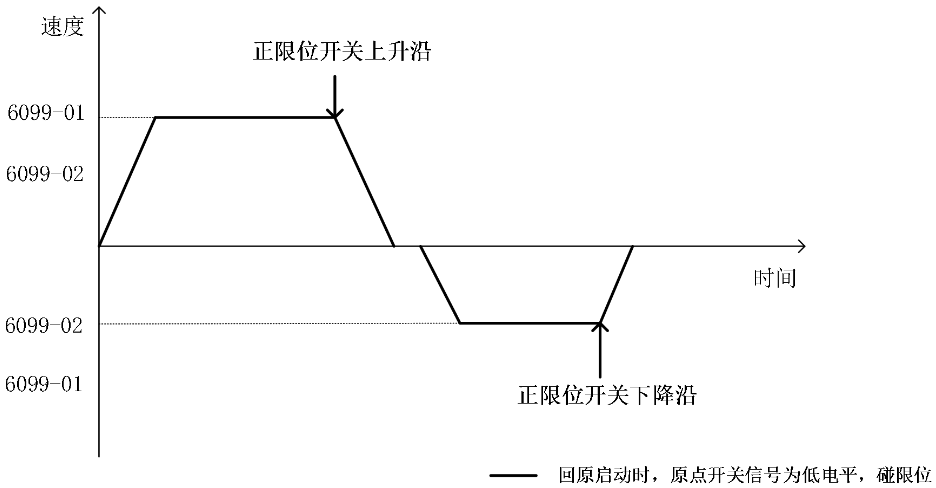

Figure 10-33 Speed-time curve of Homing method 18

Homing method 19: Descending edge of negative origin switch

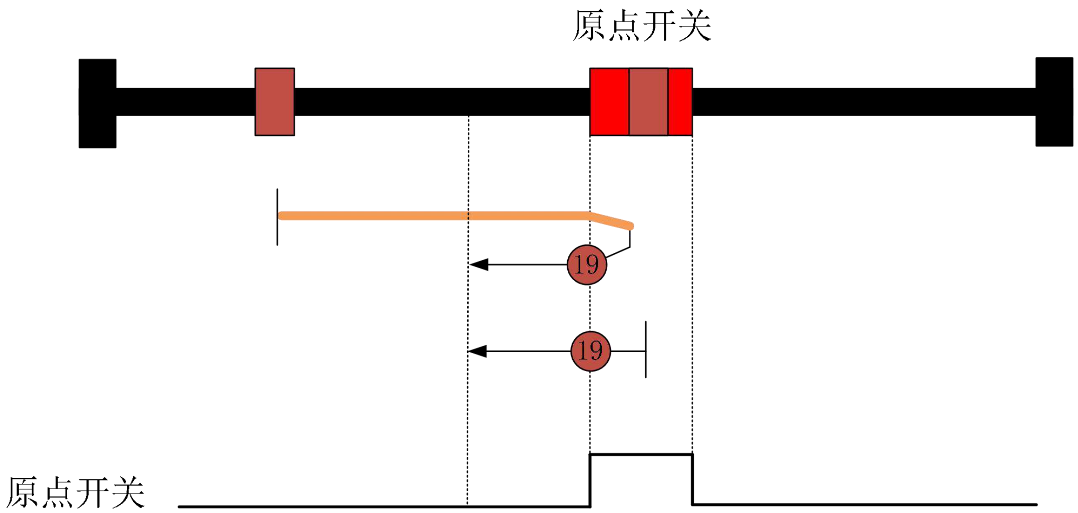

Figure 10-34 Homing method 19

1. Homing started, when the origin switch signal is low, and the motor runs at high speed (6099-01) in the forward direction. When encountering the forward origin switch signal, it becomes high level, and the motor decelerates to 0 at the homing deceleration (609A). In the reverse direction, it accelerates to low speed (6099-02) at the homing acceleration (609A), maintaining negative low-speed operation until encountering the forward origin switch signal, which changes from high level to low level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at a low speed (6099-02) in the negative direction until it encounters a positive origin switch signal that changes from a high level to a low level. The status word "Homing attained" is set

to 1, and it begins to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

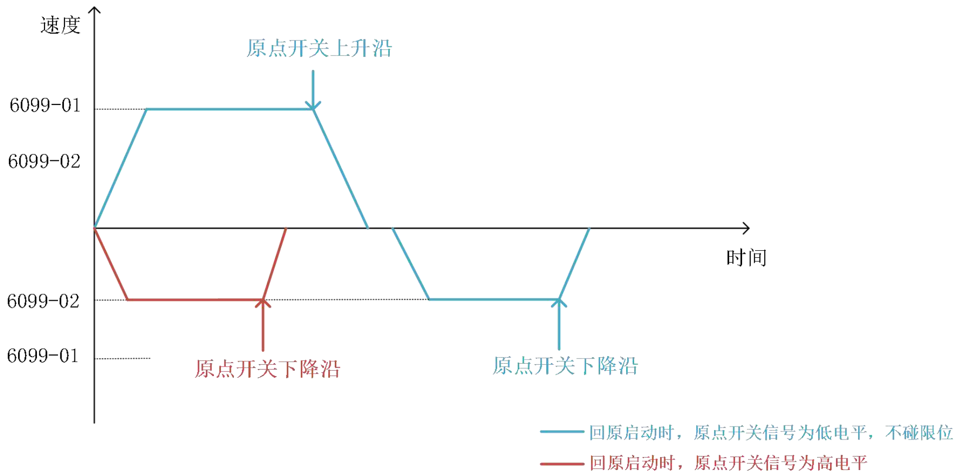

Figure 10-35 Speed-time curve of Homing method 19

Homing method 20: Rising edge of forward origin switch

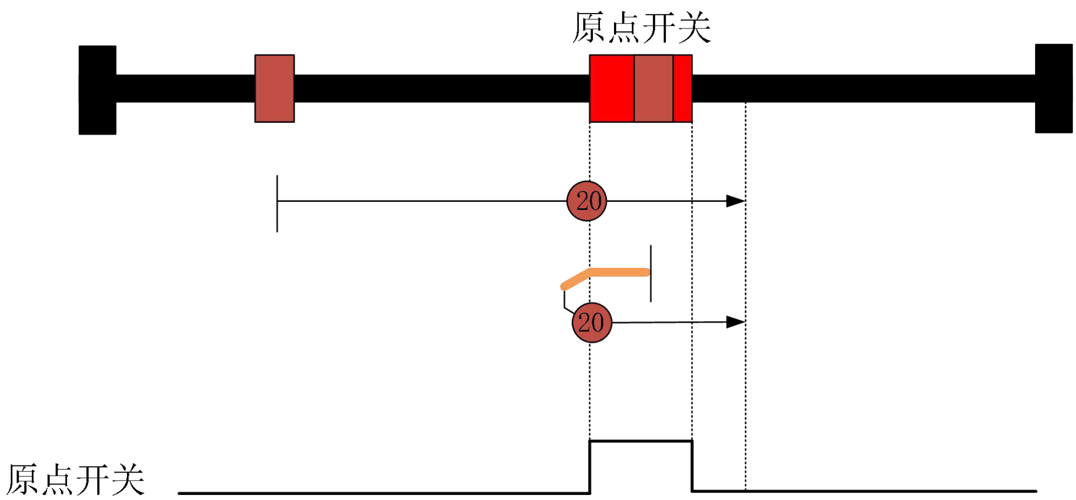

Figure 10-36 Homing method 20

1. Homing started, when the forward origin switch signal is low, and the motor runs at low speed (6099-02) in the forward direction until it encounters the forward origin switch signal that changes from low level to high level. The status word Homing attained is set to 1, and it begins to decelerate at the homing deceleration (609A). When stopping, the status word Target reached is set to 1.

2. Homing started, when the forward origin switch signal is at a high level, and the motor runs at a negative high speed (6099-01). When encountering a forward origin switch signal that becomes low level, the motor decelerates to 0 at the homing deceleration (609A), and accelerates to low speed (6099-02) at the homing acceleration (609A) in the reverse

direction. Keep running at a forward low speed until encountering a forward origin switch signal that changes from low level to high level. The status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

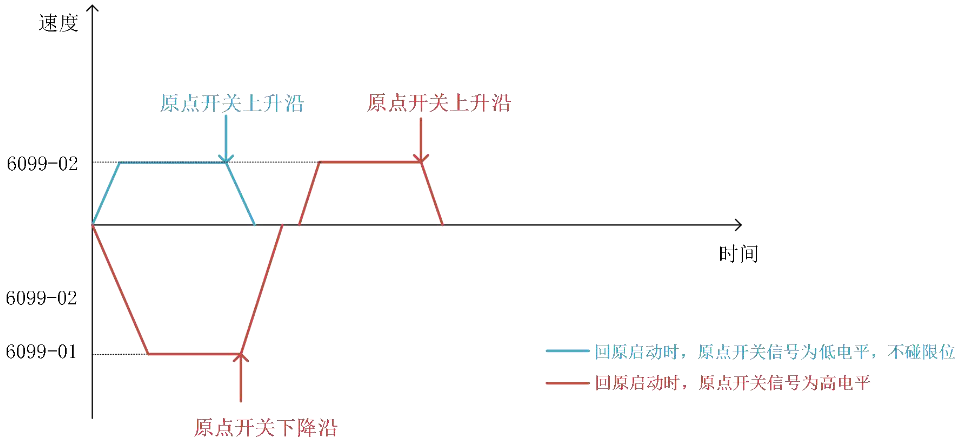

Figure 10-37 Speed-time curve of Homing method 20

Homing method 21: Descending edge of negative origin switch

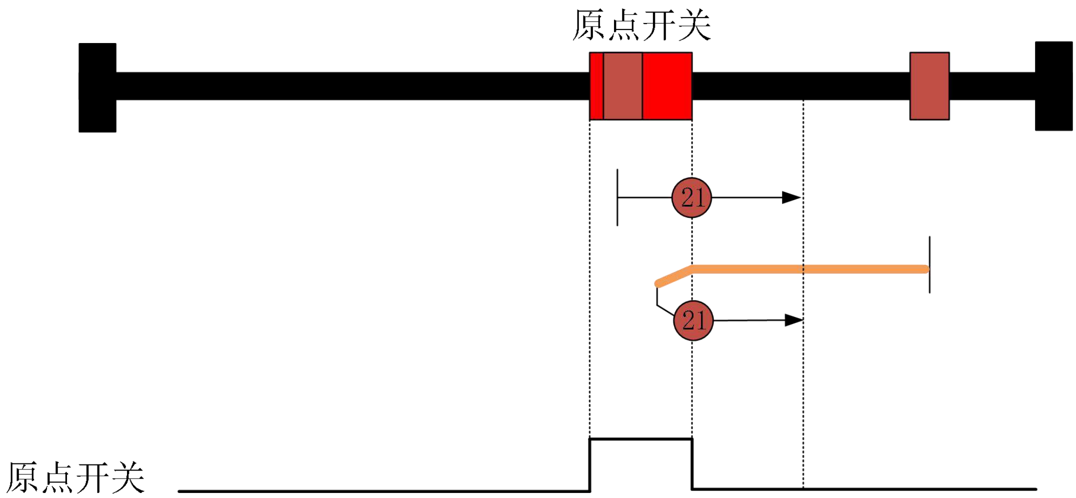

Figure 10-38 Homing Method 21

1. Homing started, when the origin switch signal is low, and the motor runs at a negative high speed (6099-01). When encountering the origin switch signal, it becomes high, and the motor decelerates to 0 at the homing deceleration (609A). In the reverse direction, it accelerates to low speed (6099-02) at the homing acceleration (609A), maintaining a forward low speed operation until encountering the origin switch signal that changes from high level to low level. The status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at

a forward low speed (6099-02) until it encounters the origin switch signal changing from a high level to a low level. The status word "Homing attained" is set to 1, and it begins to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

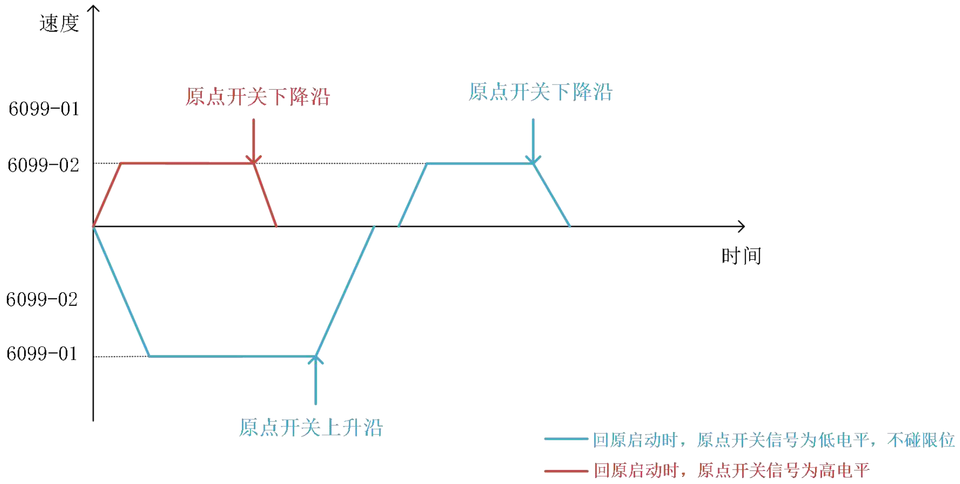

Figure 10-39 Speed-time curve of Homing method 21

Homing method 22: Rising edge of negative origin switch

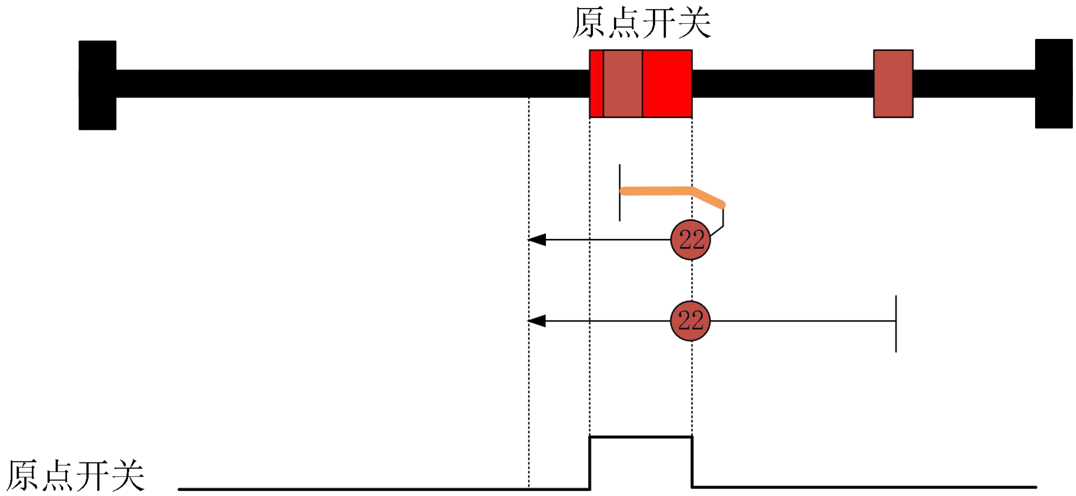

Figure 10-40 Homing Method 22

1. Homing started, when the origin switch signal is low, and the motor runs at low speed (6099-02) in the negative direction until it encounters the origin switch signal that changes from low level to high level. The status word "Homing attained" is set to 1, and it begins to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at a high speed (6099-01) in the forward direction. When encountering the origin switch signal,

it becomes a low level. The motor decelerates to 0 at the original position deceleration (609A) and accelerates to low speed (6099-02) in the reverse direction at the original position acceleration (609A), maintaining a negative low speed operation until encountering the origin switch signal that changes from a low level to a high level. The status word "Homing attained" is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

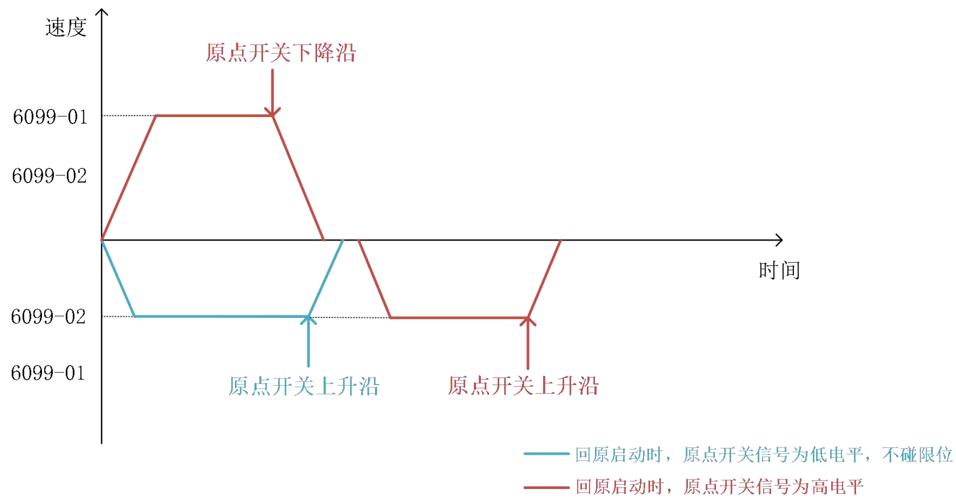

Figure 10-41 Homing Method 22 Speed-time curve

Homing method 23: Detection of the descending edge of the negative origin switch and the positive limit switch

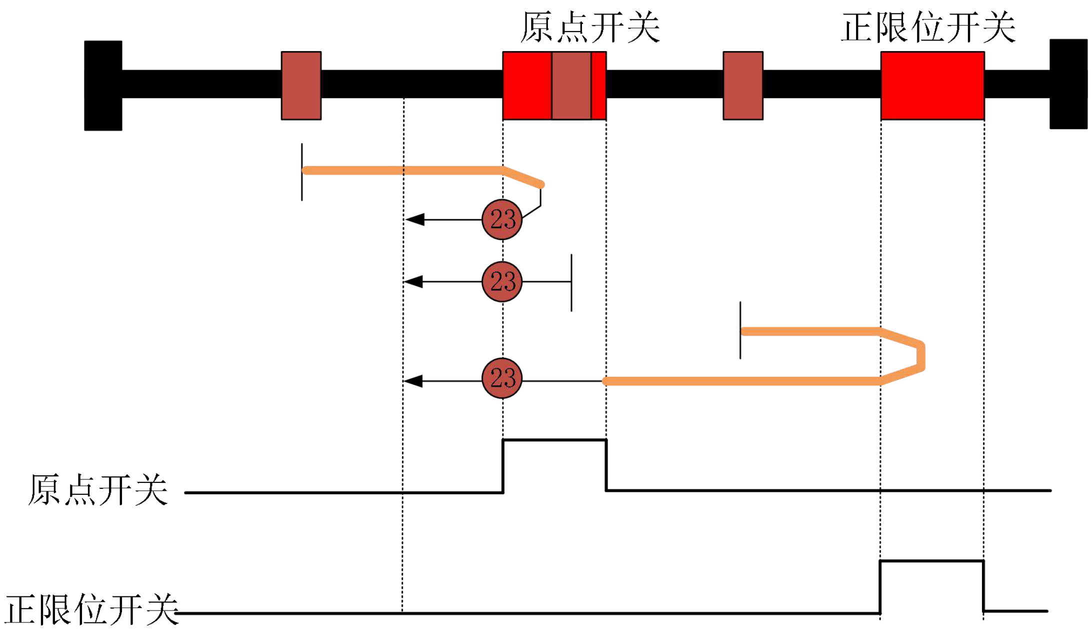

Figure 10-42 Homing Method 23

1.Homing started, when the origin switch signal is low and the motor runs at high speed

(6099-01) in the forward direction

1) The origin switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), then accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), maintaining negative low-speed operation until encountering the origin switch signal changing from high level to low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopping, the status word Target reached is set to 1.

2) The positive limit switch signal changes to a high level, the motor decelerates to 0 at the homing deceleration (609A), and accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), maintaining negative high-speed operation. When encountering the origin switch signal, it changes from low level to high level, and the motor decelerates to low speed (6099-01) at the homing deceleration (609A), maintaining negative low-speed operation until encountering the origin switch signal, it changes from high level to low level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at a low speed (6099-02) in the negative direction until it encounters the origin switch signal changing from a high level to a low level. The status word "Homing attained" is set to 1, and it begins to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

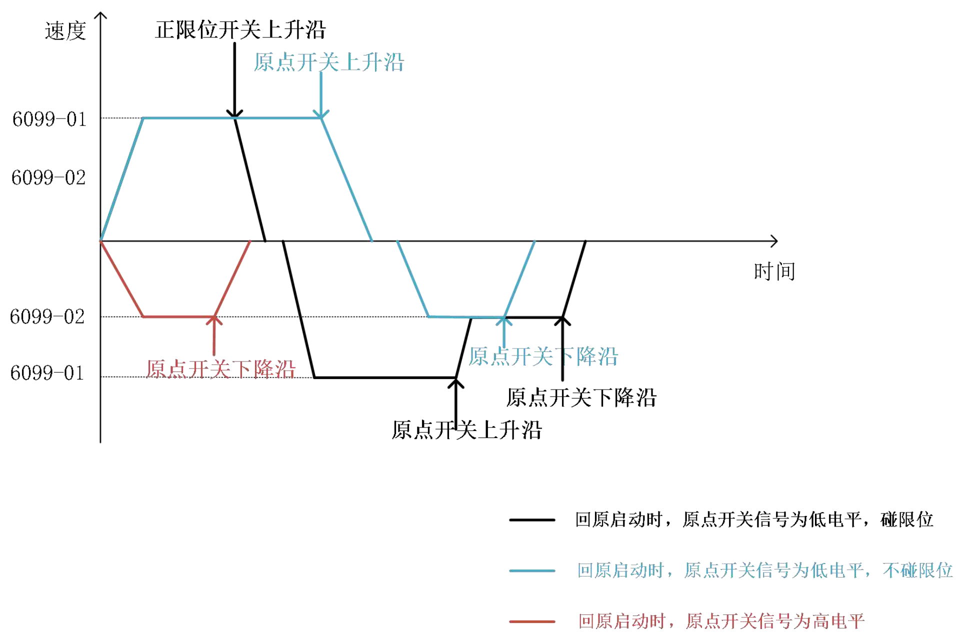

Figure 10-43 Speed-time curve of Homing method 23

Homing method 24: The rising edge of the positive origin switch is detected by the positive limit switch

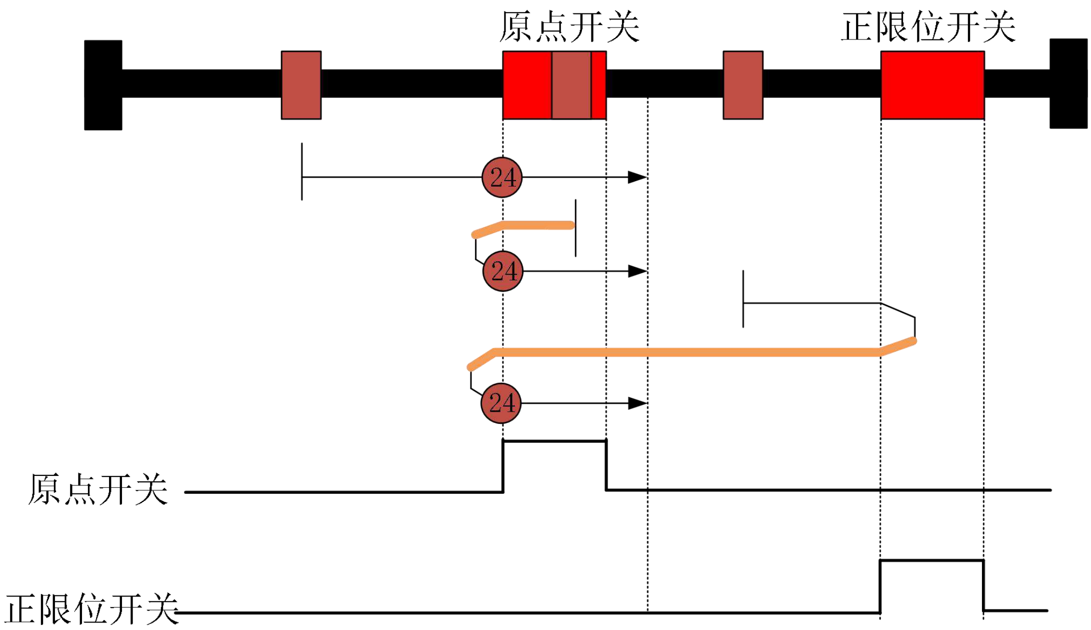

Figure 10-44 Homing method 24

1. Homing started, when the origin switch signal is low, and the motor runs at a forward low speed (6099-02)

1) The origin switch signal becomes high level, and the status word Homing attained is set to 1. It begins to decelerate at the homing deceleration (609A), and when stopped, the status word Target reached is set to 1.

2) The positive limit switch signal changes to a high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction with the homing acceleration (609A), and maintains negative high-speed operation. When encountering the origin switch signal that changes from high level to low level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-01) in the reverse direction with the homing acceleration (609A), and maintains positive low-speed operation until encountering the origin switch signal that changes from low level to high level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopping, the status word Target reaped. Ched set to 1.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at

a negative high speed (6099-01). When encountering the origin switch signal changing from a high level to a low level, the motor decelerates to 0 at the original position deceleration (609A), and accelerates to a low speed (6099-02) in the reverse direction at the original position acceleration (609A), maintaining a forward low speed operation until encountering the origin switch signal changing from a low level to a high level. The status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

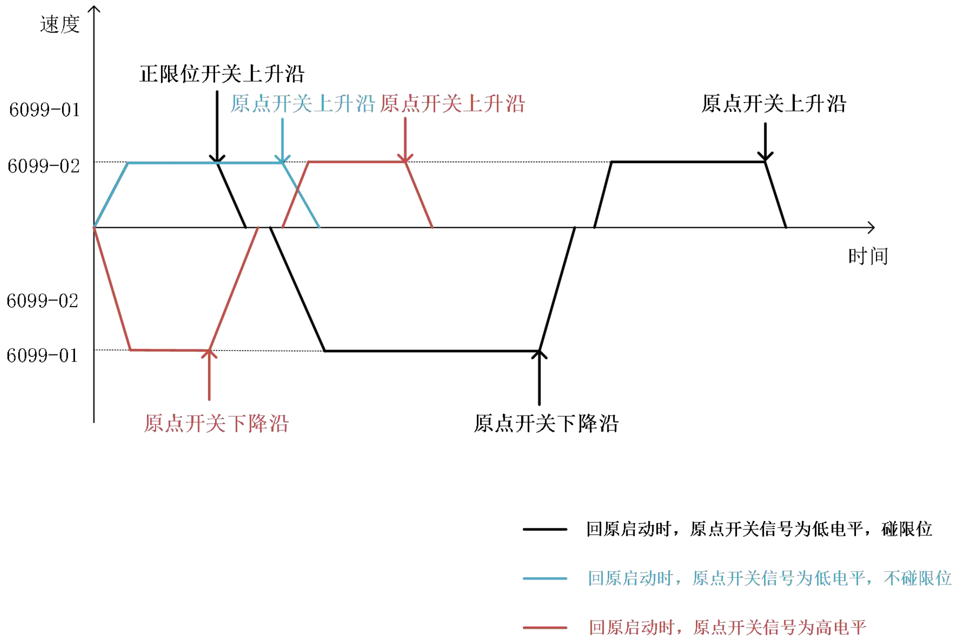

Figure 10-45 Speed-time curve of Homing method 24

Homing method 25: The rising edge of the negative origin switch is detected by the positive limit switch

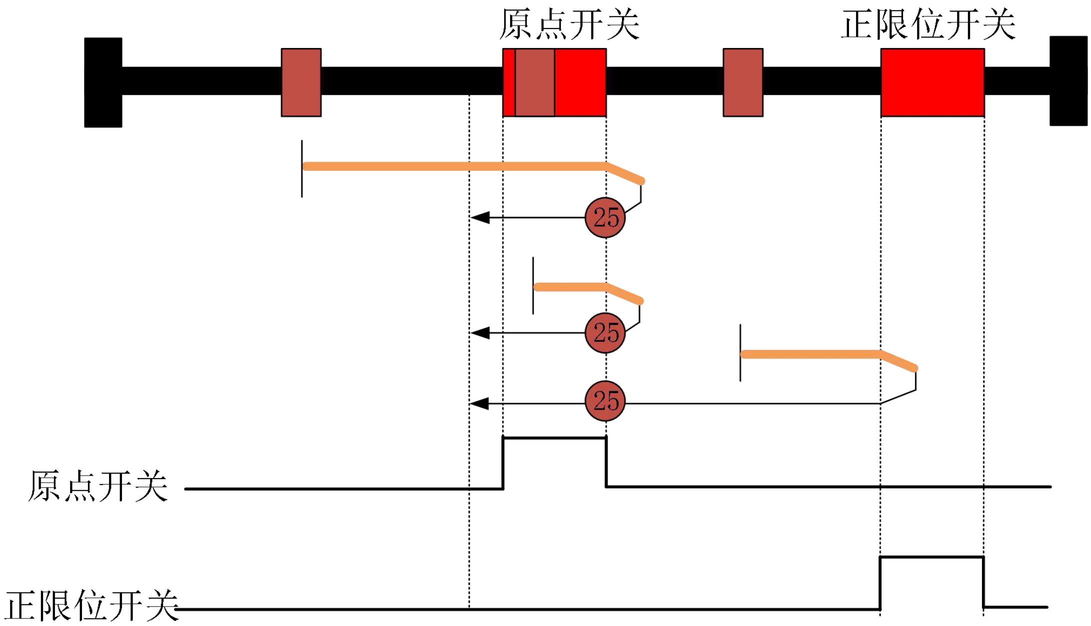

Figure 10-46 Homing method 25

Regardless of whether the origin switch signal is at a high or low level, the motor's movement is in the positive direction.

-The motor runs at high speed (6099-01) in the forward direction. When encountering a change in the origin switch signal from high level to low level or a change in the positive limit switch to high level, the motor decelerates to 0 at the homing deceleration (609A) and accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A). It maintains a negative low-speed operation until encountering a change in the origin switch signal from low level to high level. The status word Homing attained is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

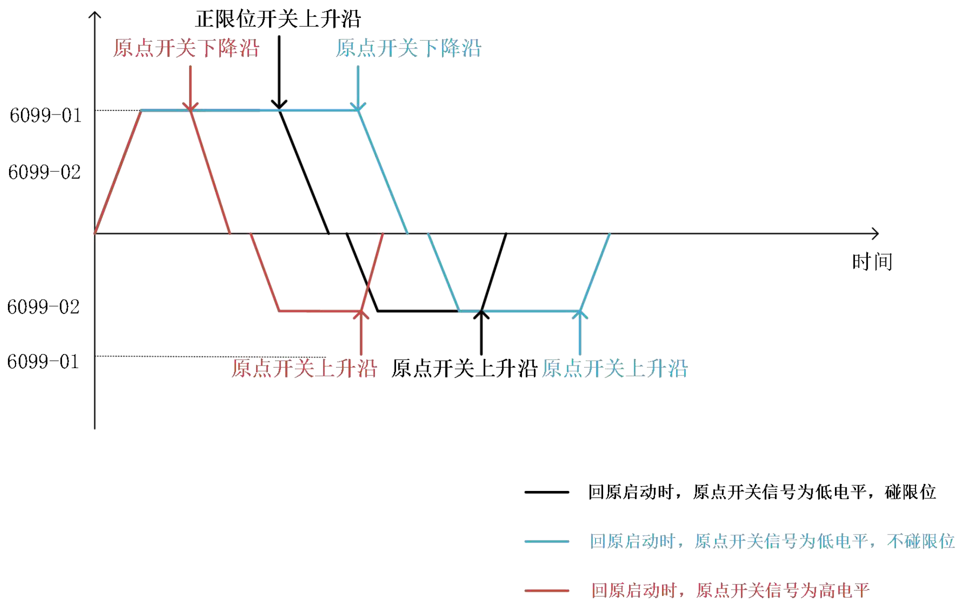

Figure 10-47 Speed-time curve of Homing method 25

Homing method 26: Detection of the descending edge of the forward origin switch and the positive limit switch

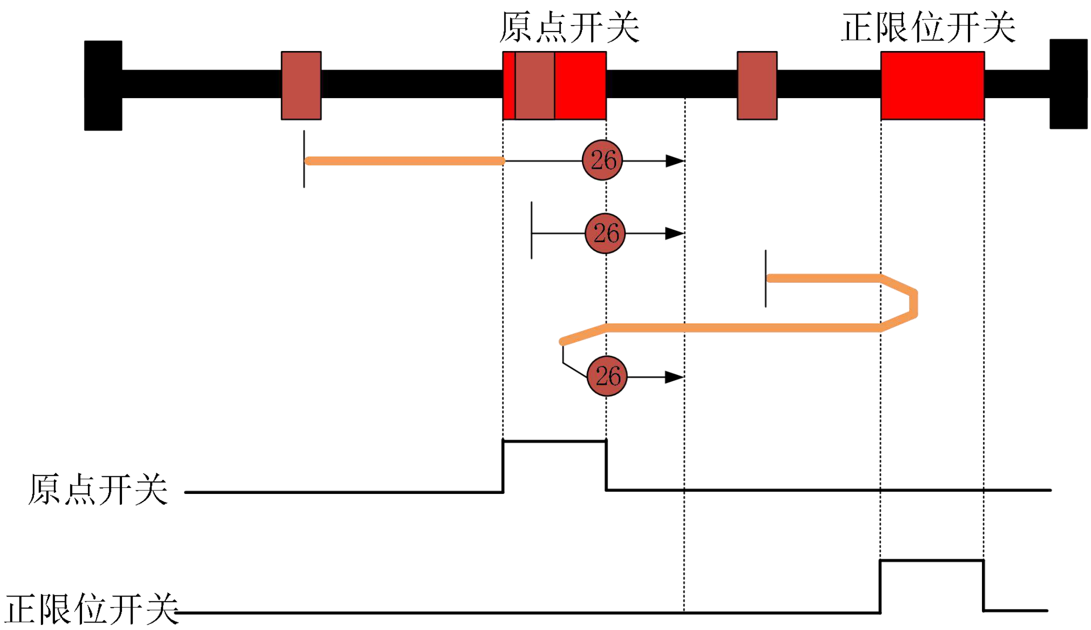

Figure 10-48 Homing Method 26

1. Homing started, when the origin switch signal is low and the motor runs at high speed (6099-01) in the forward direction

1) The origin switch signal changes to a high level, and the motor decelerates from the homing deceleration (609A) to a low speed (6099-02), maintaining a forward low-speed (6099-02) operation until it encounters the origin switch signal changing from a high level to

a low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

2) The positive limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), and maintains negative high-speed operation. When encountering the origin switch signal that changes from low level to high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains forward low-speed operation, Until encountering the origin switch signal changing from high level to low level, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and when stopped, the status word Target reached is set to 1.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at a forward low speed (6099-02) until it encounters the origin switch signal changing from a high level to a low level. The status word "Homing attained" is set to 1, and it begins to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

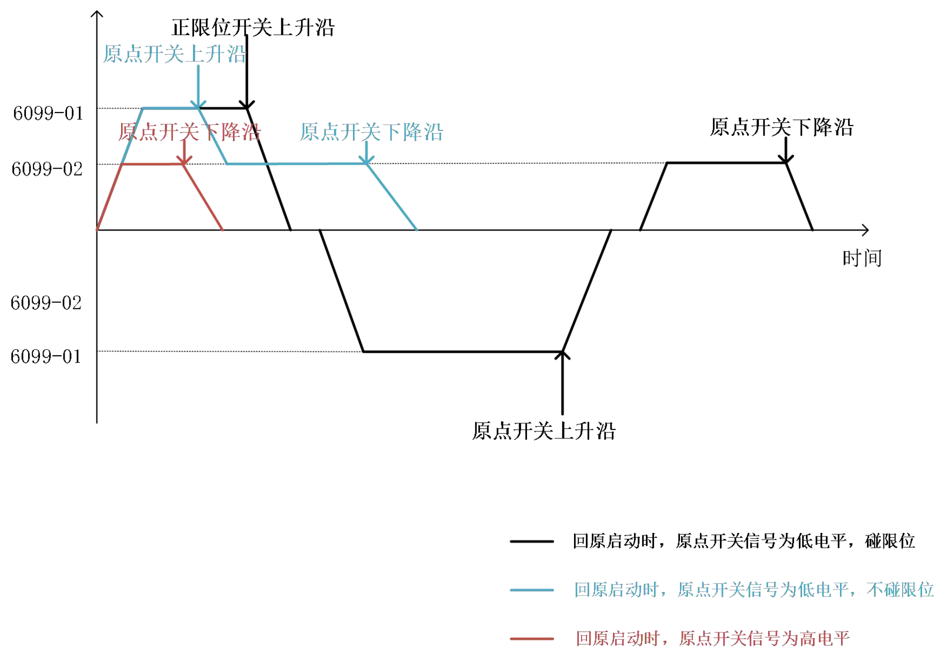

Figure 10-49 Homing Method 26 Speed-time curve

Homing method 27: Detection of the descending edge of the positive origin switch and the negative limit switch

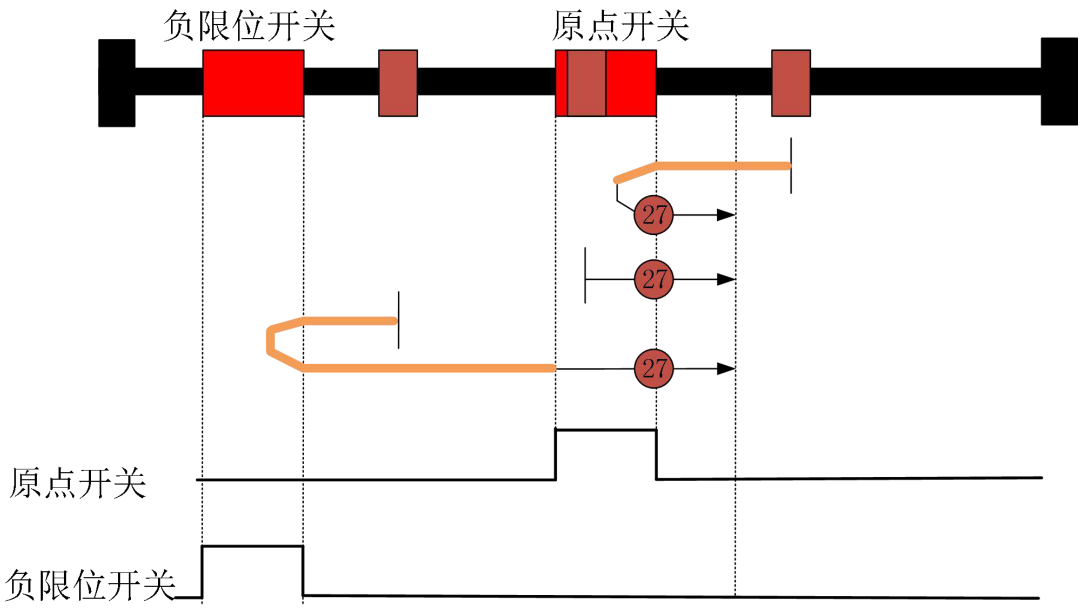

Figure 10-50 Homing Method 27

1. Homing started, when the origin switch signal is low and the motor runs at high speed (6099-01) in the negative direction

1）The origin switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains forward low-speed operation until it encounters the origin switch signal changing from high level to low level. The status word "Homing attained" is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopped, the status word "Target reached" is set to 1.

2）The negative limit switch signal becomes high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), and maintains forward high-speed operation. When encountering the origin switch signal changing from low level to high level, the motor decelerates to low level (6099-02) at the homing deceleration (609A), and maintains forward low-speed operation until the origin switch signal changes from high level to low level, Set the status word Homing attained to 1, start decelerating at the homing deceleration (609A), and set the status word Target reached to 1 when stopping.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at a forward low speed (6099-02) until the origin switch signal changes from a high level to a

low level. The status word "Homing attained" is set to 1, starting to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

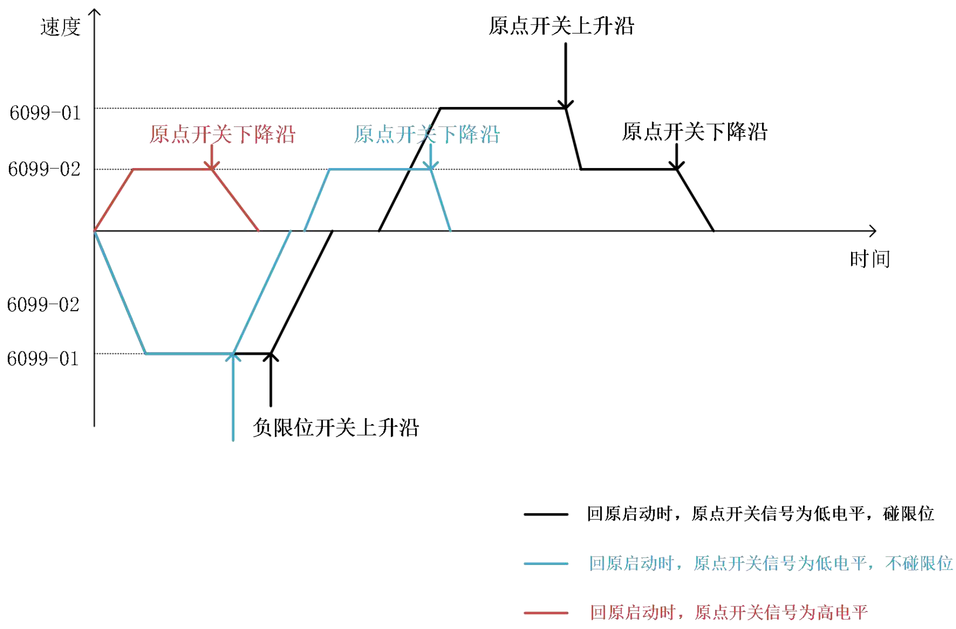

Figure 10-51 Homing Method 27 Speed-time curve

Homing method 28: The rising edge of the negative origin switch is detected by the negative limit switch

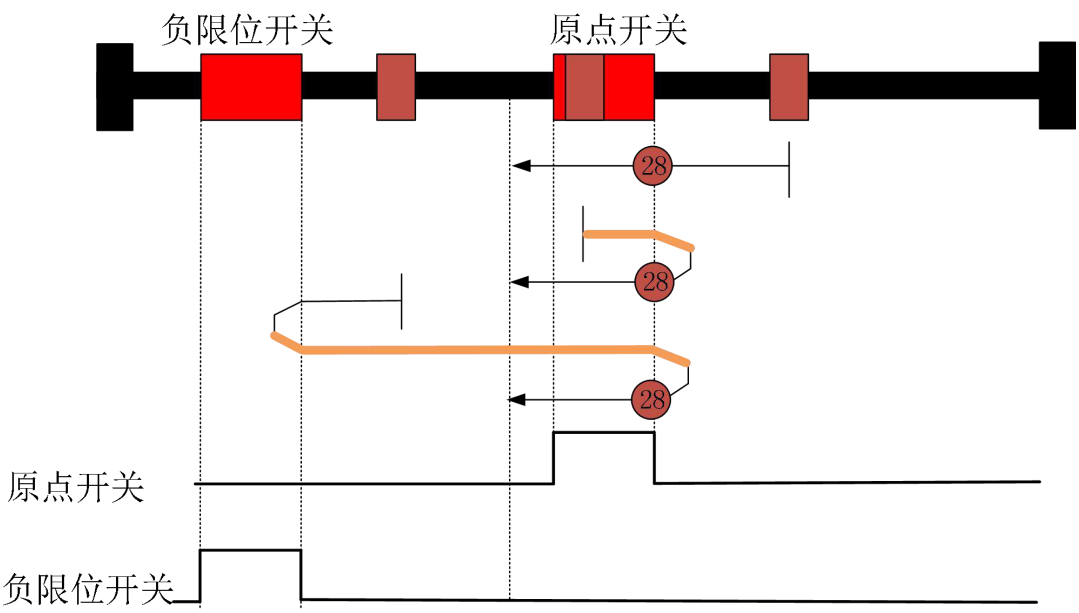

Figure 10-52 Homing Method 28

1. Homing started, when the origin switch signal is low, and the motor runs at low speed (6099-02) in the negative direction

1) The origin switch signal becomes high level, and the status word Homing attained is

set to 1. It begins to decelerate at the homing deceleration (609A), and when stopped, the status word Target reached is set to 1.

2) The negative limit switch signal changes to a high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), and maintains forward high-speed operation. When encountering the origin switch signal changing from high level to low level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains negative low-speed operation, Until the origin switch signal changes from low level to high level, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and when stopped, the status word Target reached is set to 1.

2. Homing started, when the origin switch signal is at a high level, and the motor runs forward at high speed (6099-01). When encountering the origin switch signal becoming low level, the motor decelerates to 0 at the original position deceleration (609A), accelerates to low speed (6099-02) at the original position acceleration (609A) in the reverse direction, and maintains negative low-speed operation until the origin switch signal changes from low level to high level. The status word "Homing attained" is set to 1, Start decelerating at the homing deceleration (609A) and set the status word Target reached to 1 when stopping.

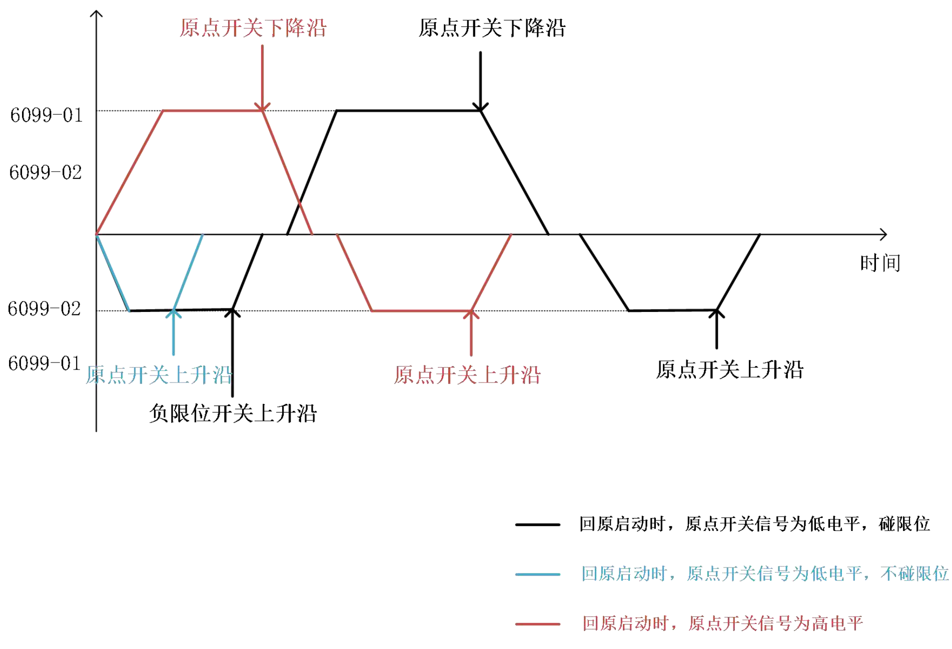

Figure 4-53 Homing Method 28 Speed-time curve

Homing method 29: positive origin switch rising edge, negative limit switch detection

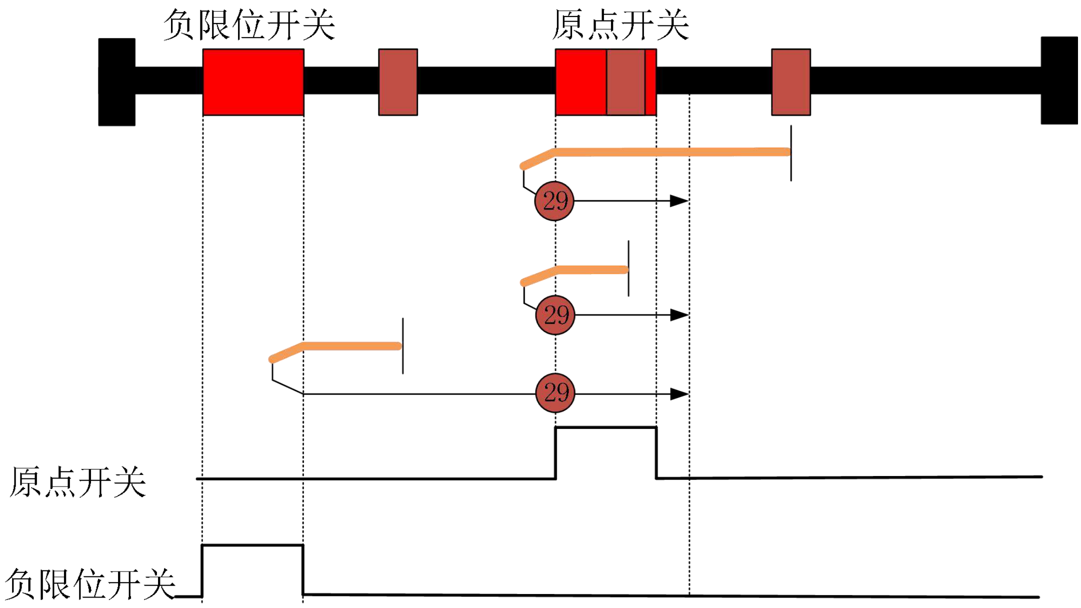

Figure 10-54 Homing method 29

Regardless of whether the origin switch signal is at a high or low level, the movement mode of the motor is in the negative direction.

The motor runs at high speed in the negative direction (6099-01). When encountering a change in the origin switch signal from high level to low level or a change in the negative limit to high level, the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains a forward low-speed operation until the origin switch signal changes from low level to high level. The status word "Homing attained" is set to 1, and begins to decelerate at the homing deceleration (609A), Set the status word Target reached to 1 when stopping.

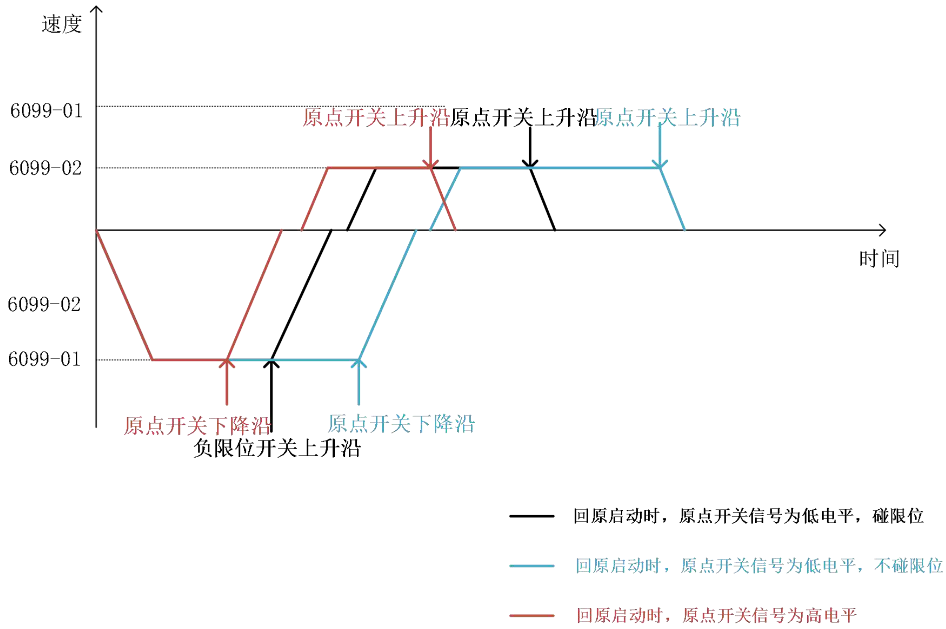

Figure 10-55 Homing Method 29 Speed-time curve

Homing method 30: Negative origin switch descending edge, negative limit switch detection

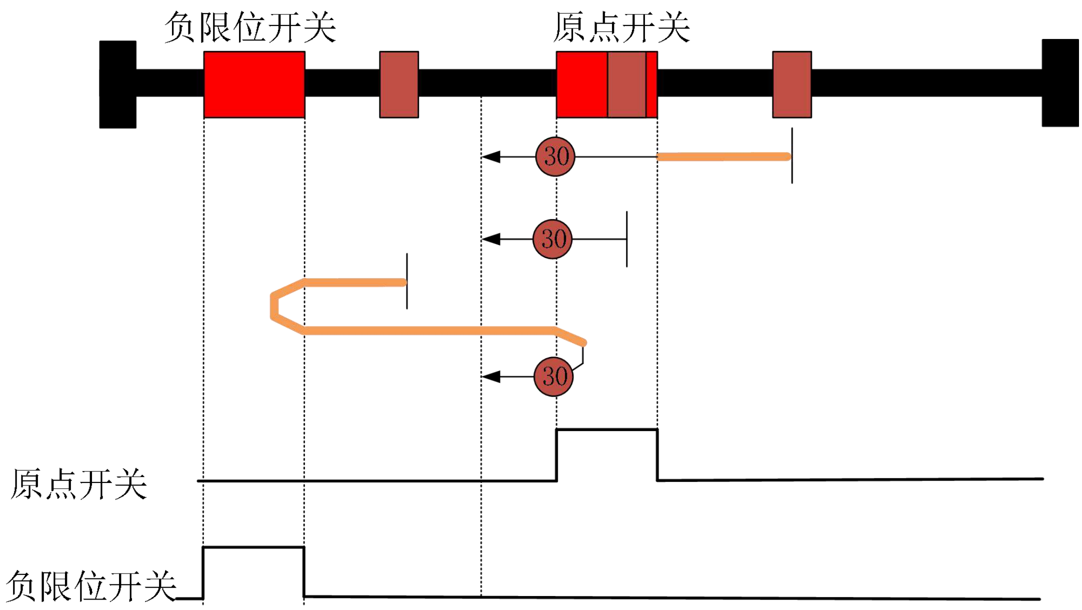

Figure 10-56 Homing method 30

1. Homing started, when the origin switch signal is low and the motor runs at high speed (6099-01) in the negative direction

1) The origin switch signal changes to a high level, and the motor decelerates from the homing deceleration (609A) to a low speed (6099-02), maintaining a negative low-speed

operation until the origin switch signal changes from a high level to a low level. The status word Homing attained is set to 1, and the motor begins to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

2) The negative limit switch signal changes to a high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to high speed (6099-01) in the reverse direction at the homing acceleration (609A), and maintains a forward high-speed operation. When encountering the origin switch signal, it changes from low level to high level, and the motor decelerates to 0 at the homing deceleration (609A), accelerates to low speed (6099-02) in the reverse direction at the homing acceleration (609A), and maintains a negative low-speed operation, Until the origin switch signal changes from high level to low level, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A), and when stopped, the status word Target reached is set to 1.

2. Homing started, when the origin switch signal is at a high level, and the motor runs at a low speed (6099-02) in the negative direction until the origin switch signal changes from a high level to a low level. The status word "Homing attained" is set to 1, starting to decelerate at the original deceleration speed (609A). When stopping, the status word "Target reached" is set to 1.

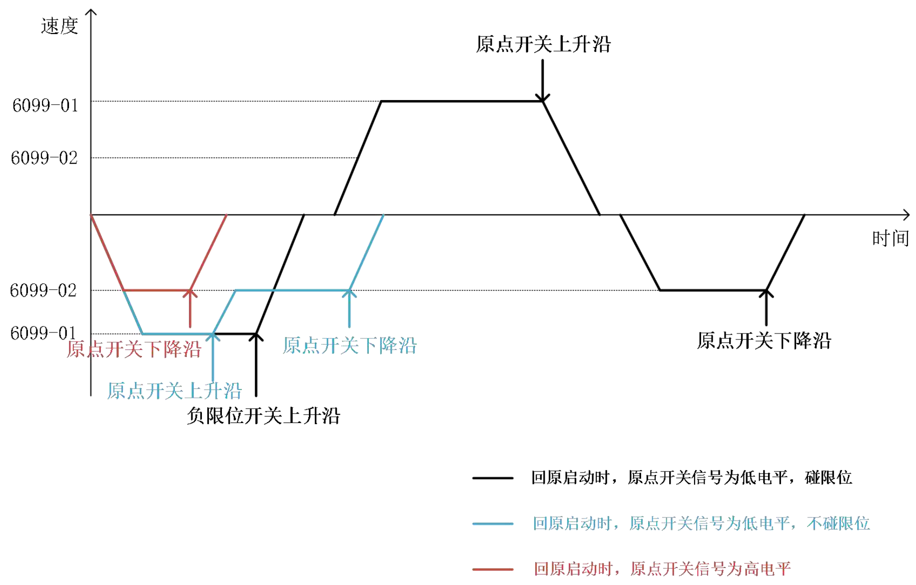

Figure 10-57 Speed-time curve of Homing method 30

Homing method 31: reserved, used to expand the definition of returning to the original method

Homing method 32: reserved, used to expand the definition of the return to original method

Homing method 33: Zero position pulse with negative movement

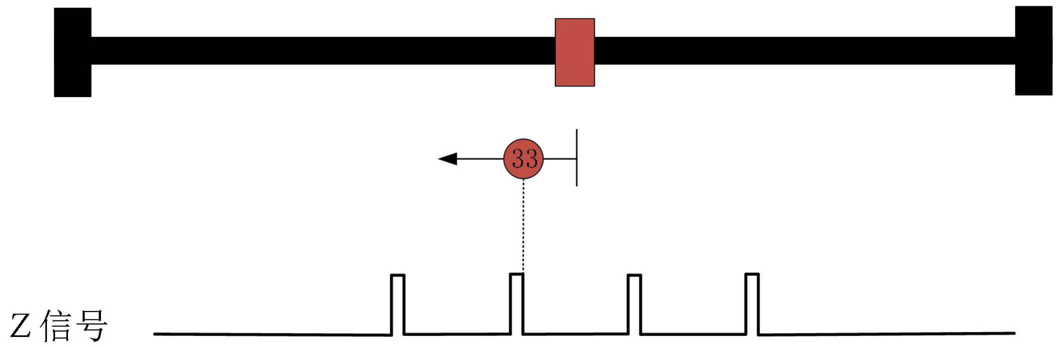

Figure 10-58 Homing Method 33

The motor runs at low speed in the negative direction (6099-02). When encountering the first Z signal, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

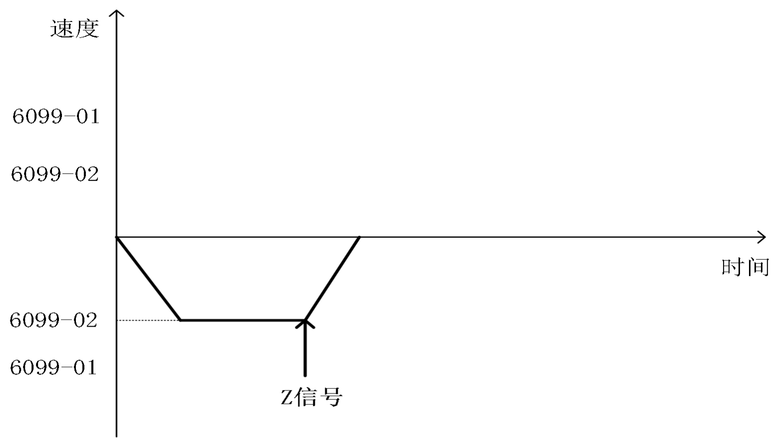

Figure 10-59 Speed-time curve of Homing method 33

Homing method 34: forward moving zero position pulse

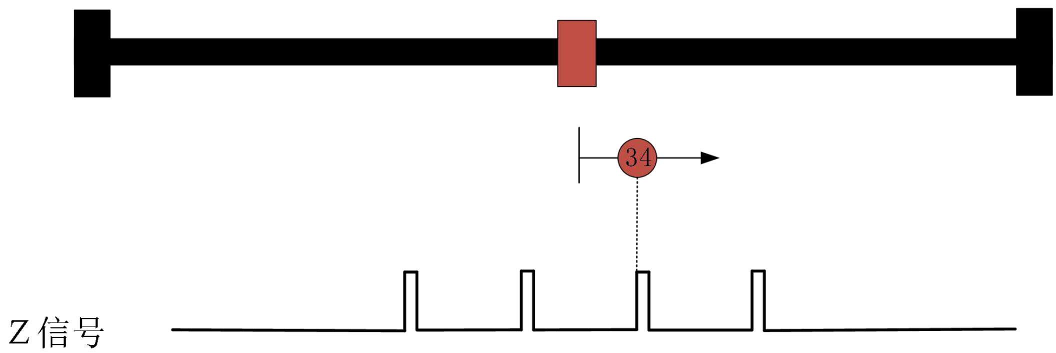

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Figure 10-60 Homing Method 34

The motor runs at a forward low speed (6099-02). When encountering the first Z signal, the status word Homing attained is set to 1, starting to decelerate at the homing deceleration (609A). When stopped, the status word Target reached is set to 1.

Homing method 35: Current position

The current position is the origin position.

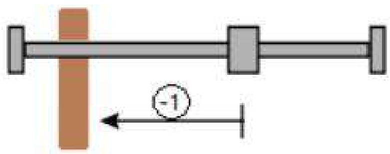
Note:

1. The numbers in the diagram correspond to the corresponding origin method. The same number represents different manifestations of the same way of returning to the original. As introduced in section 3 of the original method, the two ③ in the diagram represent two different forms of the original method 3.

2. The zero pulse is the Z signal.

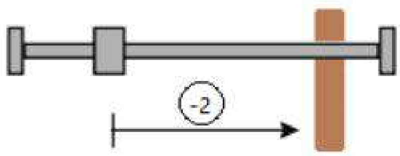
3. Bold colors indicate high-speed movement.

Homing method -1: The position of negative contact with the baffle is zero



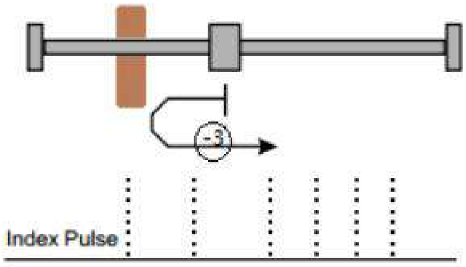
The motor runs in the negative direction first, and when it encounters a blocking block, the torque reaches the set value of 0x2138 and lasts for the set time of 0x2137 before stopping. If the backoff distance is not set, the current position is set as the zero point. If the backoff distance is set, the motor will backoff by the corresponding distance and then set the current position as the zero point.

Homing method -2: The position of the forward contact with the baffle is zero



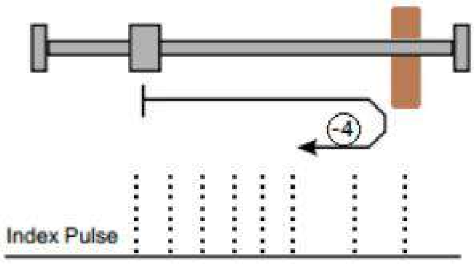
The motor first runs in the positive direction and reaches the set value of 0x2138 when it encounters the blocking block, and stops after the set time of 0x2137. If the setback distance is not set, the current position is set as the zero point. If the setback distance is set, the motor will setback by the corresponding distance and then set the current position as the zero point.

Homing method -3: Contact the baffle in the negative direction and find the Z pulse as the zero point in the opposite direction



The motor runs in the negative direction first, and when it encounters the blocking block, the torque reaches the set value of 0x2138 and lasts for the set time of 0x2137. Then, the motor looks for the Z pulse in the opposite direction and uses the first Z pulse as the zero point.

Homing method -4: Contact the baffle in the forward direction and find the Z pulse as the zero point in the reverse direction



The motor runs in the positive direction first, andwhen it encounters the blocking block, the torque reaches the set value of 0x2138 and lasts for the set time of 0x2137. Then, the motor looks for the Z pulse in the opposite direction, and the first Z pulse is used as the zero point.

Chapter 11 Common Functions of Patterns

11.1 Touch probe function

11.1.1 Function Introduction

The Touch probe function is used to lock the position feedback when a trigger signal or an event occurs, and currently only supports using the encoder Z signal as the trigger signal. When using the encoder Z signal as the trigger signal, only the rising edge of the Z signal can be captured, and the capture result is stored in 60BAh.

11.1.2 Related object parameters

0x60B8: Touch probe function

This object defines the basic objects used for starting touch probe actions and various settings.

Table 11-1 Introduction to 0x60B8

Index number	name	object type	mapping	access	Default value
0x60B8	Touch probe function	VAR	-	RW	0
		data type	unit	range	
		Uint16	-		

The bit values corresponding to 0x60B8 are explained in the table below.

Bit	Value	definition
0	0	Probe not enabled
	1	Probe Enable
1	0	Single trigger, only trigger probe 1 when the trigger signal is effective for the first time
	1	Continuous triggering, each time the triggering signal is effective, probe 1 will be triggered
2	0	External IO input as probe trigger signal 1
	1	Z pulse as probe trigger signal 1
3	0	reserve
	1	reserve

4	0	Not enabling probe 1 rising edge latch position
	1	Enable probe 1 rising edge latch position
5	0	Do not enable probe 1's descending edge latch position
	1	Enable probe 1's descending edge latch position

0x60B9: Touch probe status

This object defines the state used for Touch probe actions.

Table 11-2 Introduction to 0x60B9

Index number	name	object type	mapping	access	Default value
0x60B9	Touch probe status	VAR	-	RO	0
		data type	unit	range	
		Uint16	-		

The corresponding bit values for 0x60B9 are explained in the table below.

Bit	Value	define
0	0	Probe 1 not enabled
	1	Probe 1 Enable
1	0	Probe 1 Z pulse rising edge position latch not executed
	1	Probe 1 rising edge position latch executed
2	0	Probe 1 Z pulse descending edge position latch not executed
	1	Probe1 descending edge position latch executed
3~5	0	reserve
	1	reserve
6	0	Trigger from external DI
	1	Trigger from Z pulse

0x60BA: Touch probe pos1

This object displays the obtained clamping position.

Table 11-3 Introduction to 0x60BA

Index number	name	object type	mapping	access	Default value
0x60BA	Touch probe pos1	VAR	-	RO	0
		data type	unit	range	
		INT32	-		

Note: For versions V1.04 and above, this object value represents the repeated positioning deviation value of the position deviation of two adjacent Z pulses. Users can directly set the threshold for repeated positioning deviation to 0x2001. When the repeated positioning deviation value of the position difference between two adjacent Z pulses exceeds the set value of 0x2001, a repeated positioning error error of 0x7320 will be prompted.

11.2 Digital inputs/Digital outputs

11.2.1 Function Introduction

1) 60FDh Digital inputs

In some cases, some switch signals (such as origin and limit signals) are not directly sent to the servo drive for logical control, but the servo needs to transmit the state to the upper controller for logical control (such as Homing). At this point, it is necessary to use object 60FDh Digital inputs to transmit the relevant signals.

TheDI status corresponding to different bit positions of 60FDh Digital inputs is shown in the table below:

31~7	6	5	4	3	2	1	0
reserved	Z pulse	DI5	DI4	DI3	DI2	DI1	DI0

Note: When used as a limit and origin signal, the general controller judgment criteria are that DI0 (Bit0) is the negative limit, DI1 (Bit1) is the positive limit, and DI2 (Bit2) is the origin.

2) 60FEh Digital outputs

In some cases, it is necessary for the upper controller to borrow the servo's DO for logical control. The ISMC servo drive has 4 DO channels. At this time, the upper controller operates on the DO0~DO3 pins corresponding to the bit 16 bit 19 of the 60FE: 01h Physical Outputs object. When the bit corresponding to the bitmask (60FE: 02h) object is set to 1, the corresponding bit output is valid.

<table>
<tr><td>31~20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15~0</td></tr>
<tr><td rowspan="2">reserved</td><td>DO3</td><td>DO2</td><td>DO1</td><td>DO0</td><td rowspan="2">reserved</td></tr>
<tr><td colspan="4">The definitions of bits 16 to 19 for each DO are as follows:
60FE: 01h: 0 Nooutput; 1 Output
60FE: 02h: 0 Output invalid, 1 output valid
If the 60FE: 02h Bit mask=0 output is invalid, mask the corresponding bit output of 60FE: 01h Physical Outputs.</td></tr>
</table>

Note: When borrowing servo DO, the corresponding digital output function needs to be configured as "remote DO" using commissioning software.

11.2.2 Related object parameters

0x60FD: Digital inputs

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x60FD</td><td rowspan="3">Digital inputs</td><td>VAR</td><td>-</td><td>RO</td><td rowspan="3">0</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>UINT32</td><td>-</td><td>-</td></tr>
</table>

0x60FE: Digital output

<table>
<tr><th>Index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x60FE</td><td rowspan="3">Digital outputs</td><td>ARRAY</td><td>-</td><td>RO</td><td rowspan="3">0</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>UINT32</td><td>-</td><td>-</td></tr>
</table>

<table>
<tr><th>Sub index number</th><th>name</th><th>object type</th><th>mapping</th><th>access</th><th>Default value</th></tr>
<tr><td rowspan="3">0x00</td><td rowspan="3">Number of entries</td><td>-</td><td>-</td><td>RO</td><td rowspan="3">2</td></tr>
<tr><td>data type</td><td>unit</td><td>range</td></tr>
<tr><td>UINT8</td><td>-</td><td>2</td></tr>
</table>

Sub index number	name	object type	mapping	access	Default value
0x01	Physical outputs	-	-	RW	0
		data type	unit	range	
		UINT32	-	-	

Sub index number	name	object type	mapping	access	Default value
0x02	Bitmask	-	-	RW	0
		data type	unit	range	
		UINT32	-	-	

11.3 Torque limitation

11.3.1 Function Introduction

To protect the drive and motor, torque limits are in effect for each motion mode. The torque limit function limits the positive and negative torques through two parameters: 0x60E0 and 0X60E1.

11.3.2 Related Object Parameters

0x60E0: PosTorLimit

This object represents the forward torque limit value, in units of 0.1% of the rated torque:

Index number	name	object type	mapping	access	Default value
0x60E0	PosTorLimit	VAR	-	RW	3000
		data type	unit	range	
		INT16	Rated torque/1000	-	

0x60E1: NegTorLimi

This object represents the negative torque limit value, with a unit of 0.1% of the rated torque:

Index number	name	object type	mapping	access	Default value
0x60E1	NegTorLimit	VAR	-	RW	3000
		data type	unit	range	
		INT16	Rated torque/1000	-	

Technical forum: https://en.ismc.cn/e2eforums

Chapter 12 Trouble shooting

When a Servo fails, the LED on the servo panel will flash red on a beat-by-beat basis. The fault code based on CiA402 standard will be displayed in the fault handling screen after connecting to the commissiongging software tool.

In case of servo alarm, please refer to the following table to check the servo and follow the corresponding strategy to solve the servo fault.

Table 12-1 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 load 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.	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;

Error Code	Name	Cause	Solution
		5.Failure of U-phase current detecting circuit.	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.
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 load 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.	1. Check the power circuit. 2. Check the DC bus insulation. 3. Lower the load. 4. Check the drive cable.

Error Code	Name	Cause	Solution
		4.Poor insulation of the driver cable. 5.Failure of DC bus undervoltage detecting circuit. 6.Basic power module failure.	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 or 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 temperature	1.Low ambient temperature. 2.Temperature	1.Check whether the ambient temperature is too low;

Error Code	Name	Cause	Solution
	underheating	detecting circuit failure.	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	1.The encoder wiring is	1.Check the encoder wiring;

Error Code	Name	Cause	Solution
	tracking error	wrong or the connector is in poor contact. 2.The gain does not match. 3.Large external load fluctuations or interference.	2.Adjust the servo gain again. 3.Increase anti-interference measures.
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	1. Wrong encoder parameters.	1.Check the settings of encoder parameters.

Error Code	Name	Cause	Solution
	CRC error	2. Encoder cable failure.	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 +15V undervoltage.	Check whether the control power +24V is connected properly.
0x8612	Exceed position limit	Given position or actual position exceeds position limit.	1.Check the setting of limit position. 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	1.The set termination speed must be less than or equal to the profile speed.

Error Code	Name	Cause	Solution
		planned track unsuccessful.	
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 than or equal to the maximum value.	1. Set the minimum value greater than the maximum when the minimum / maximum position limit is not set to 0.
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.

Error Code	Name	Cause	Solution
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.
0x6181	Stop speed greater than initial speed	Stop speed is not set to 0	Set stop speed to 0.

Error Code	Name	Cause	Solution
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.
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.

Error Code	Name	Cause	Solution
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 Model 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 Model is 0	The planned deceleration or quick stop deceleration in the position Model 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 Model is 0	The planned deceleration or quick stop deceleration in the position Model 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	Set appropriate parameter values. Check device, load and wiring.

Error Code	Name	Cause	Solution
		wiring is wrong.	
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 Model.	Check the wring of Hall Sensor. Make sure 0x2103 is set to 0.

Chapter 13 Communication Cases

Example of communication configuration with Beckhoff PLC

① Hardware connection and configuration confirmation

Complete the hardware and preliminary configuration between the servo and PLC as described in Chapters 1 and 2

② Configuration file placement

Integrate ISMC_ Place the E XML. XML file under the TwinCAT fixed directory:

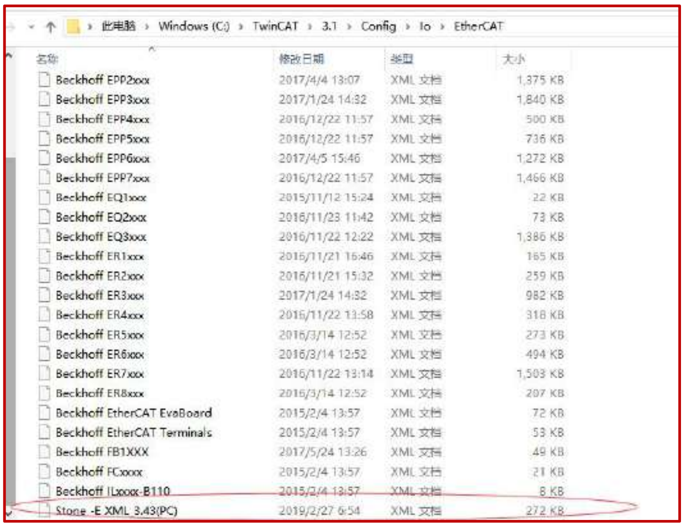


Figure 13-1 ISMC_ E XML. XML file placement location

③ Establish engineering and connectivity

Open TwinCAT software, create a project, modify the computer IP address to be on the same local area network as the controller, and then select the target system that needs to be connected:

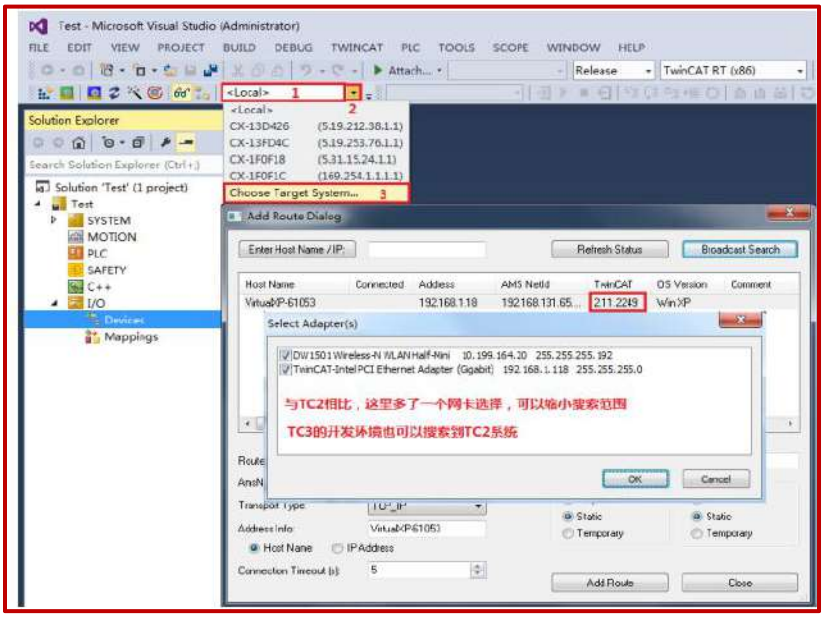


Figure 13-2 TwinCAT Modifying IP Address

④ Scan slave station equipment and automatically configure NC axis

Right click on I/O Devices, click Scan Devices, scan the ErherCAT slave station, scan to the slave station, click Scan boxes, and then click Automatically Add NC Axis Configuration.

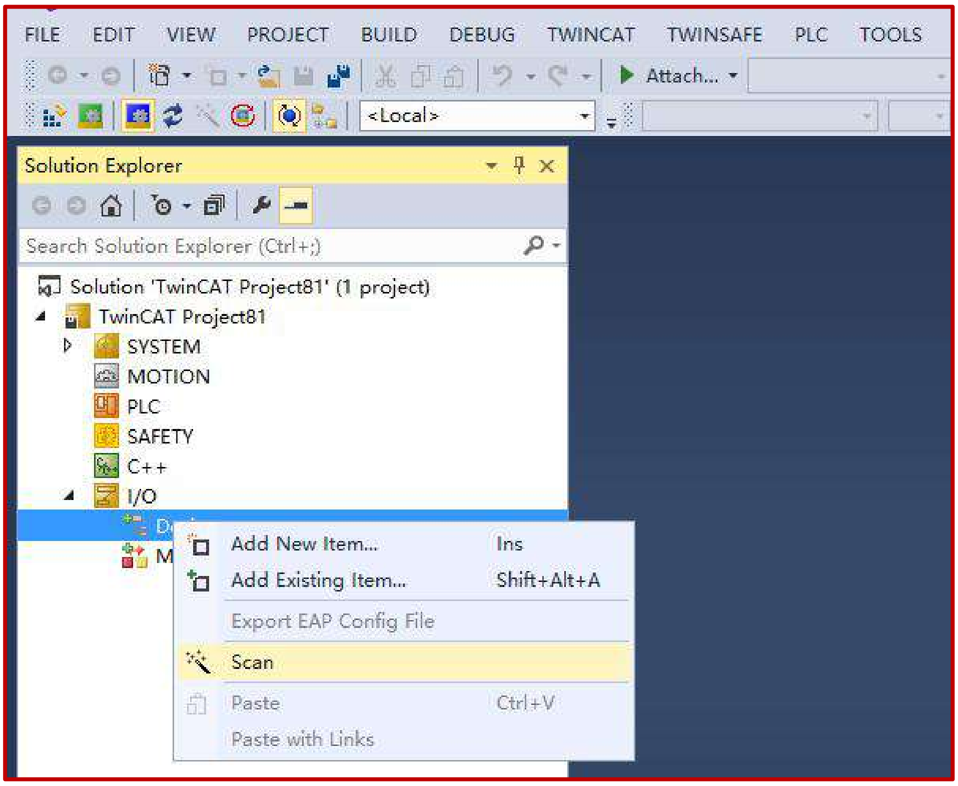


Figure 13-3 Automatic scanning and configuration of slave stations in TwinCAT

Scan successful: ISMC appears as shown in the following image_ LOGO icon, and servo status in OP status:

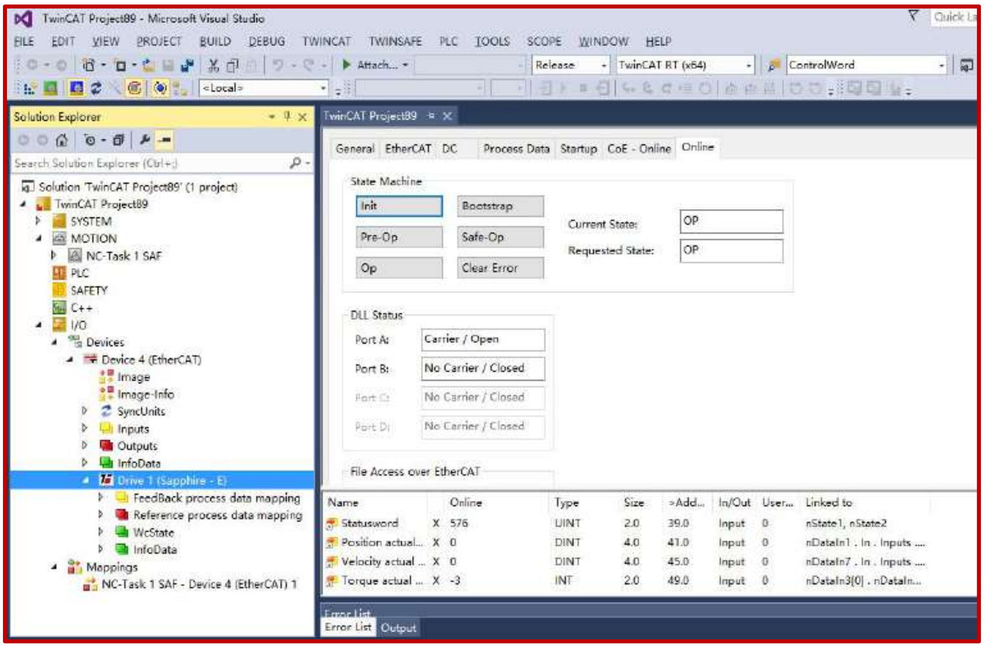


Figure 13-4 TwinCAT scan ISMC servo successfully

Note: When scanning the slave station, TwinCat needs to be in Configuration Mode

⑤ Read ISMC servo COE data

As shown in the figure below, the data of the servo slave station can be read and written through SDO. Note: If PDO data is configured, writing it here is invalid; The COE instruction function module can also be called in the PLC program through the EtherCAT function library to read and write parameters. For details, refer to the TwinCat user manual. Whether the reading and writing are successful can be monitored and compared through the servo commissioning software SMC of ISMC.

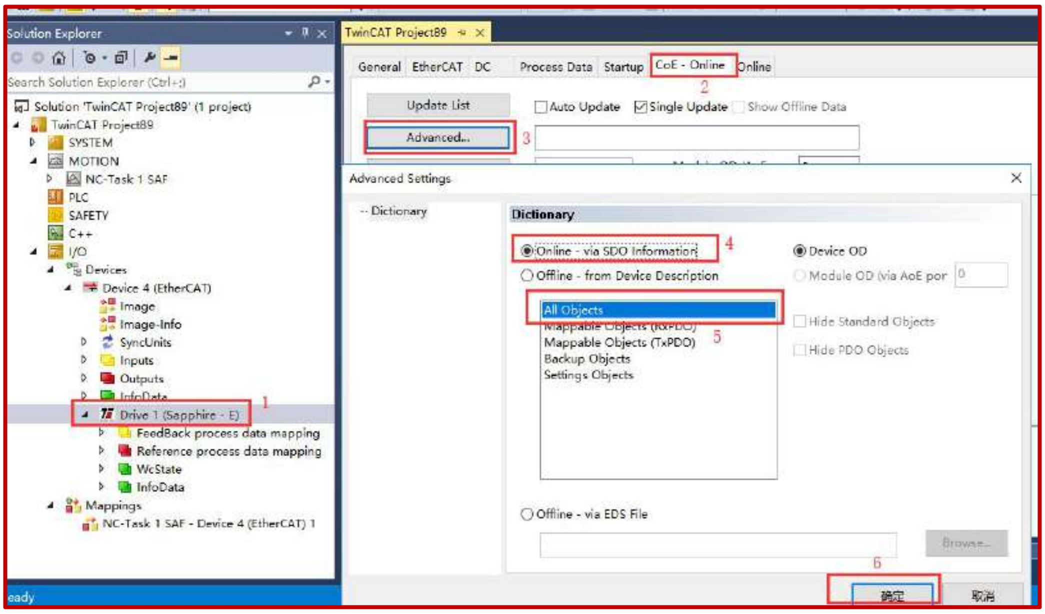


Figure 13-5 Configuring SDO in TwinCAT

⑥ Read and configure PDO mapping

TwinCAT will automatically read the default PDO configuration from the lower position when scanning the slave XML file. The servo default PDO mapping object and configuration are shown in the following figure:

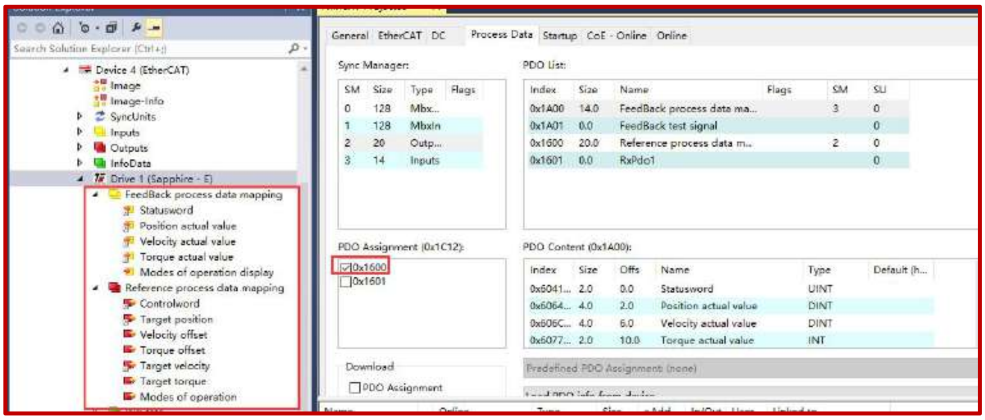


Figure 13-6 PDO configuration in TwinCAT

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

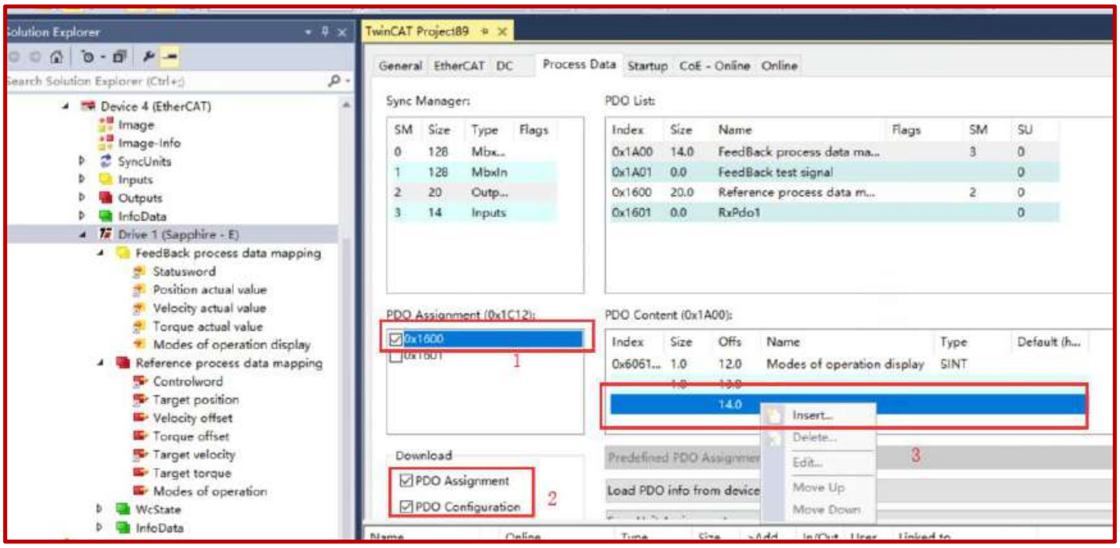


Figure 13-7 Adding PDO parameters in TwinCAT

⑦ NC Control Configuration and Instructions for Use

When using NC function control, the following configurations need to be made:

1）NC TASK cycle configuration: As shown in the screenshot below, configure the cycle ticks in NC Task 1 SAF to 4ms. In this task, NC determines the position, velocity, acceleration generation and calculation, and determines the direction:

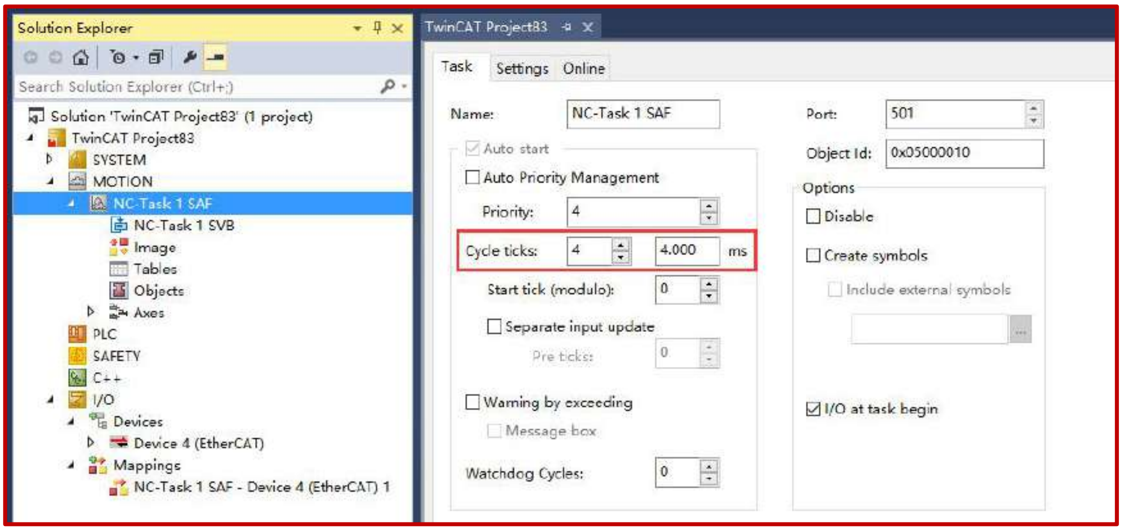


Figure 13-8 NC Function NC TASK Cycle Configuration in TwinCAT

2) Enable configuration of DC synchronization clock: As shown in the screenshot below, check the clock synchronization enable option. Pay attention to the setting of Cycle Time, which should be consistent with the synchronization cycle (4ms) of the servo drive. Inconsistent cycles can cause servo operation jitter errors

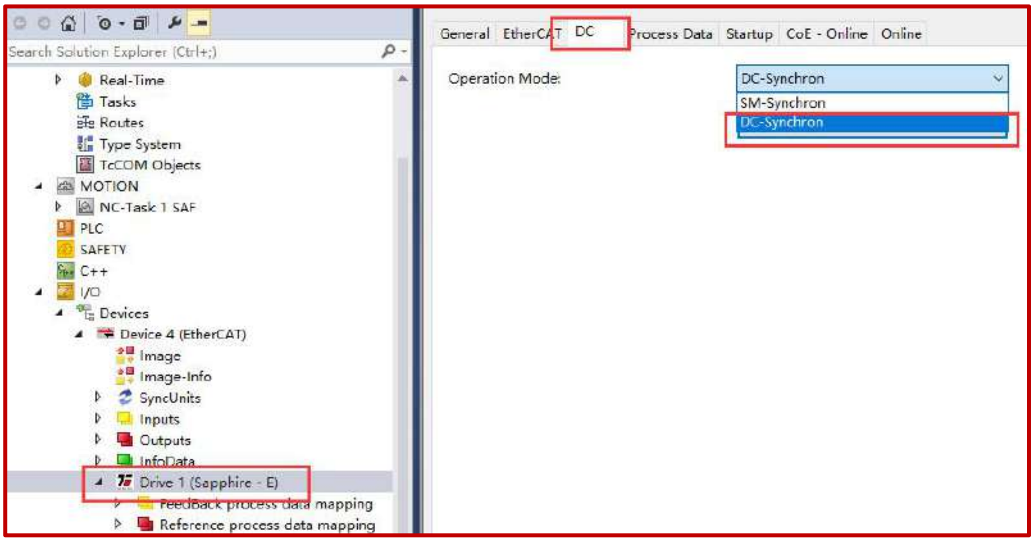


Figure 13-9: Checking DC synchronous clock in TwinCAT

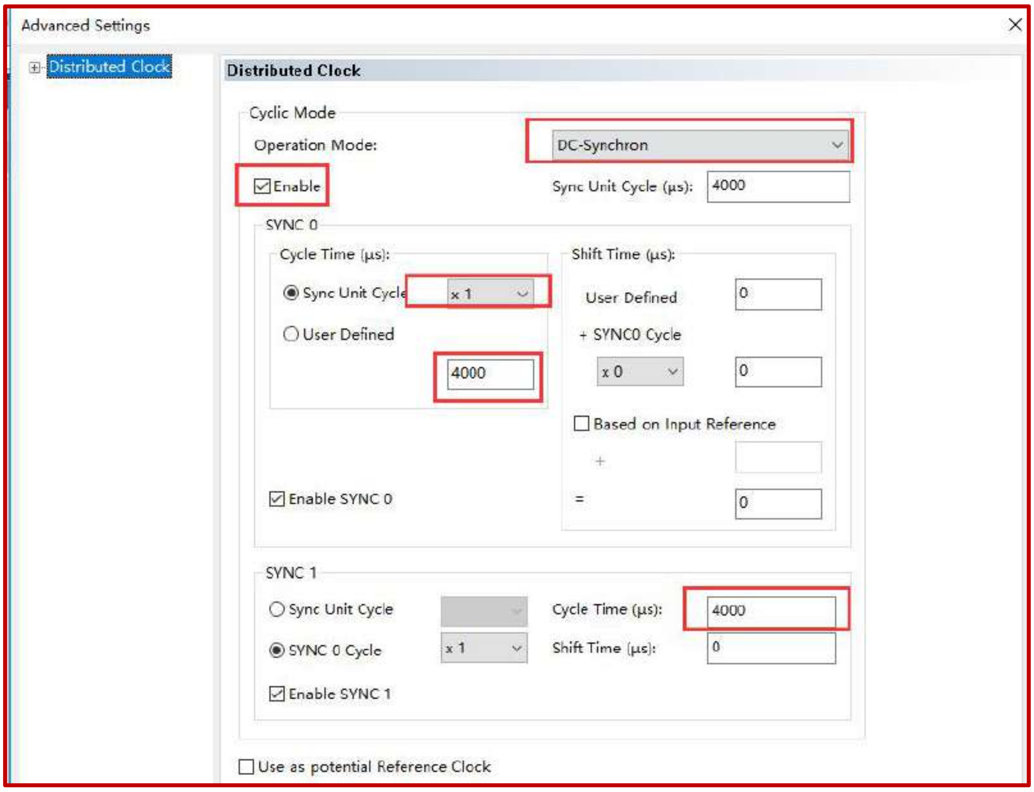


Figure 13-10 Cycle Time Setting in TwinCAT

3) Set the unit of NC operation in the NC axis, in Axix 1_ In ENC, the distance corresponding to the encoder pulse feedback for each position of the Scaling Factor can be set. For example, if the servo motor rotates 10000 pulses per revolution, and if the motor rotates 1mm per revolution, the Scaling Factor should be 1/10000=0.0001mm/Inc. If the target position increases by 10mm, the actual servo position should increase by 100000 INC. Usually, it is necessary to set the corresponding NC control speed and other parameters in Axis, otherwise the servo is prone to alarms;

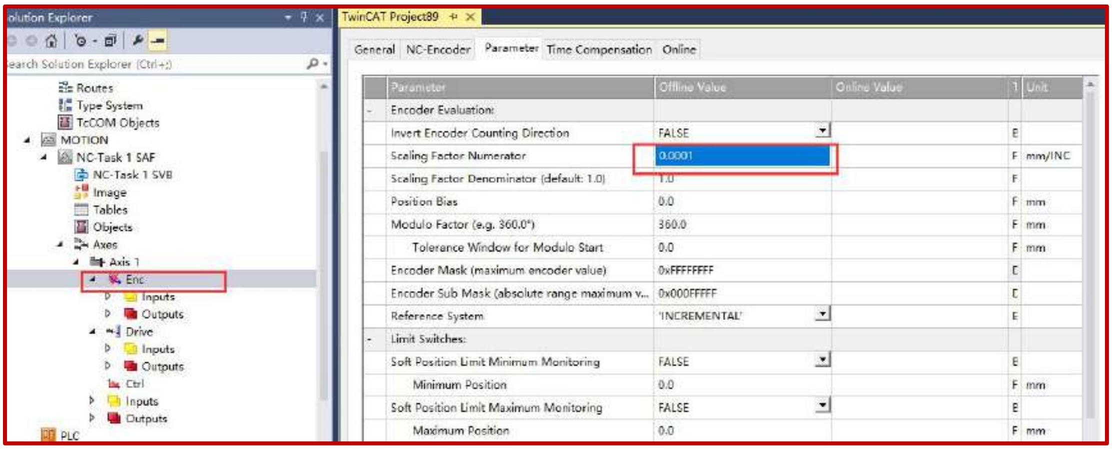


Figure 13-11 Setting of Scaling Factor for NC Axis Running Units in TwinCAT

4) To prevent PLC error following, set the Following Error Calculation to External:

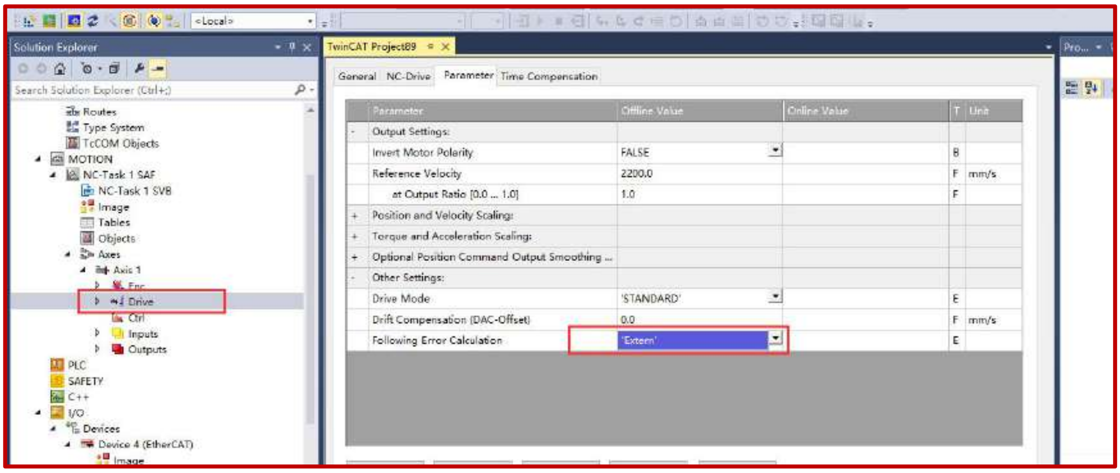


Figure 13-12 Setting of Following Error Calculation in TwinCAT

5) If you want to reverse the polarity of the motor control, you can reverse the feedback of the encoder and the polarity of the motor shaft separately. The default is FALSE, and both are set to

True:

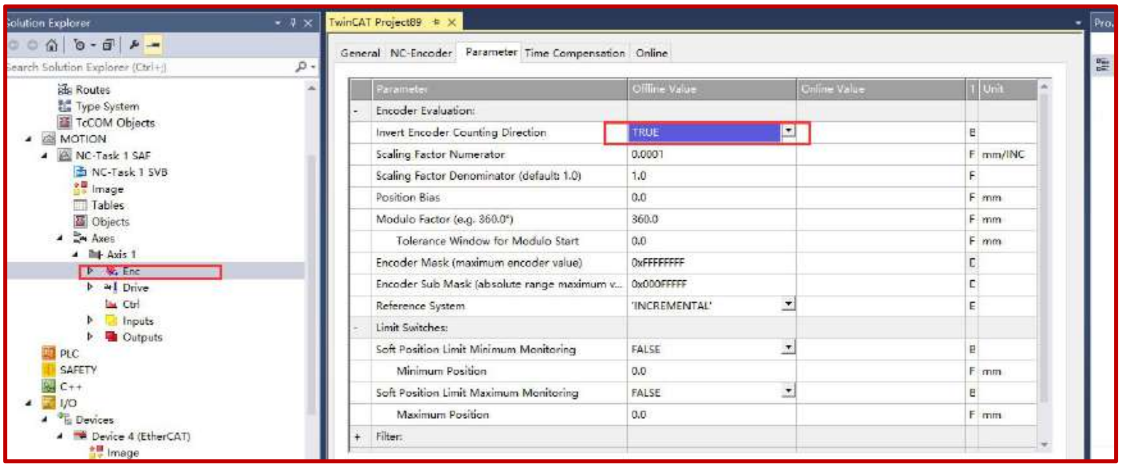


Figure 13-13 TwinCAT Encoder Reverse Setting

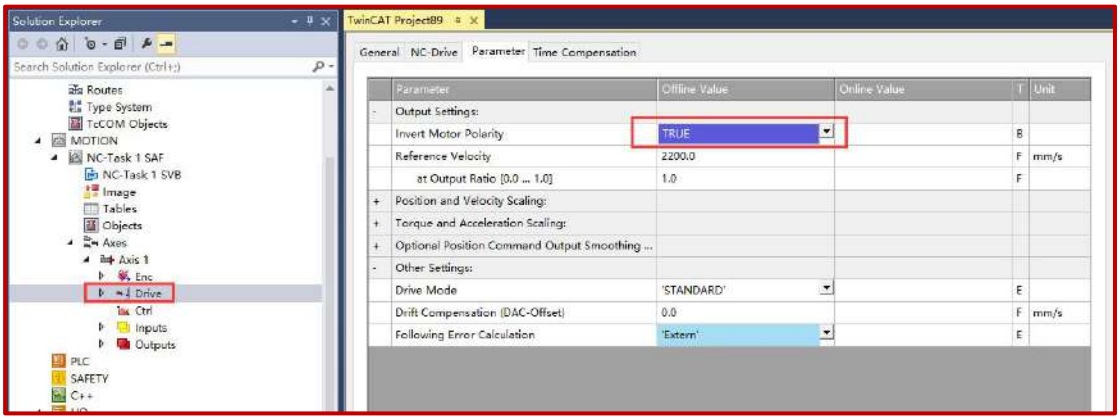


Figure 13-14 TwinCAT motor polarity reverse setting

6）Activate the configuration and then proceed to the NC debugging interface to control the servo operation. In running mode, use the Oline function in NC to simulate the servo operation. First, let the servo lock the axis, then click the button to let the servo run:

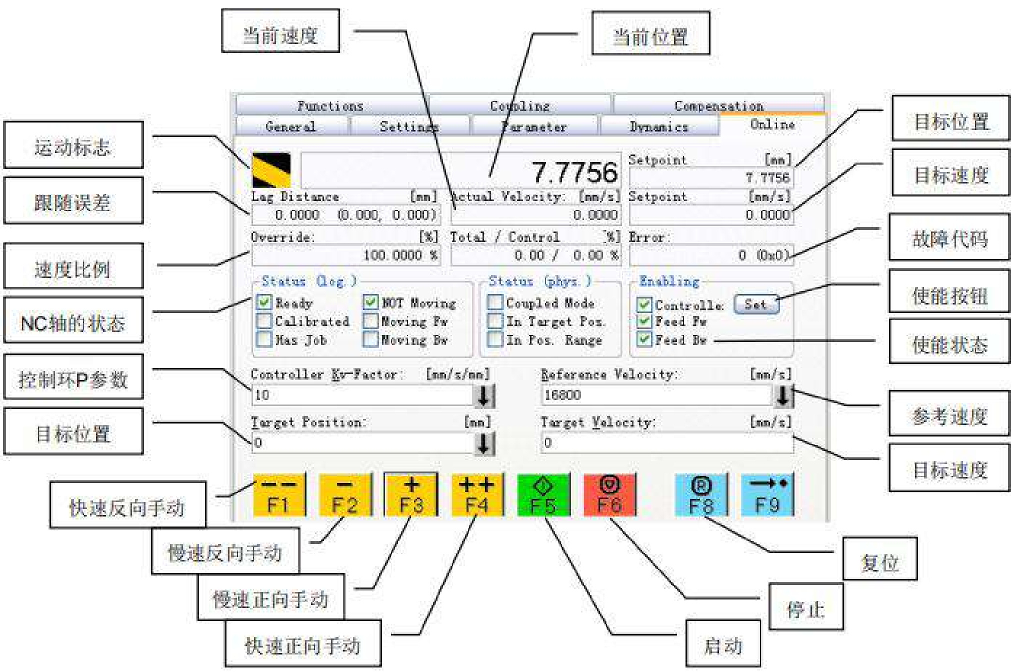


Figure 13-15 Introduction to NC Debugging Interface in TwinCAT

⑧ PLC Engineering Establishment

1）New PLC project:

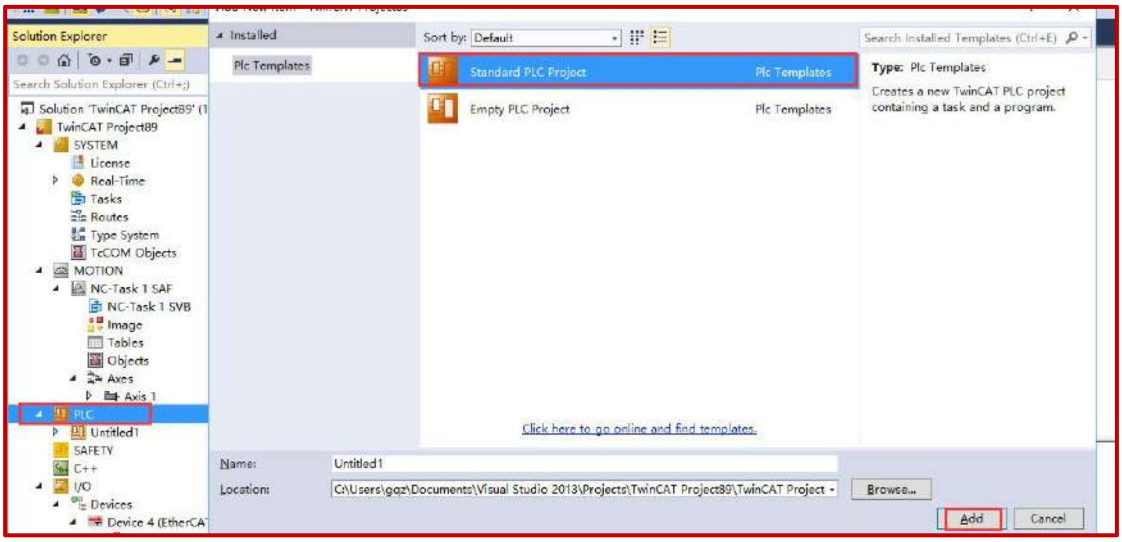


Figure 13-16 TwinCAT New PLC Project

2） Set the PLC Task cycle to 4ms:

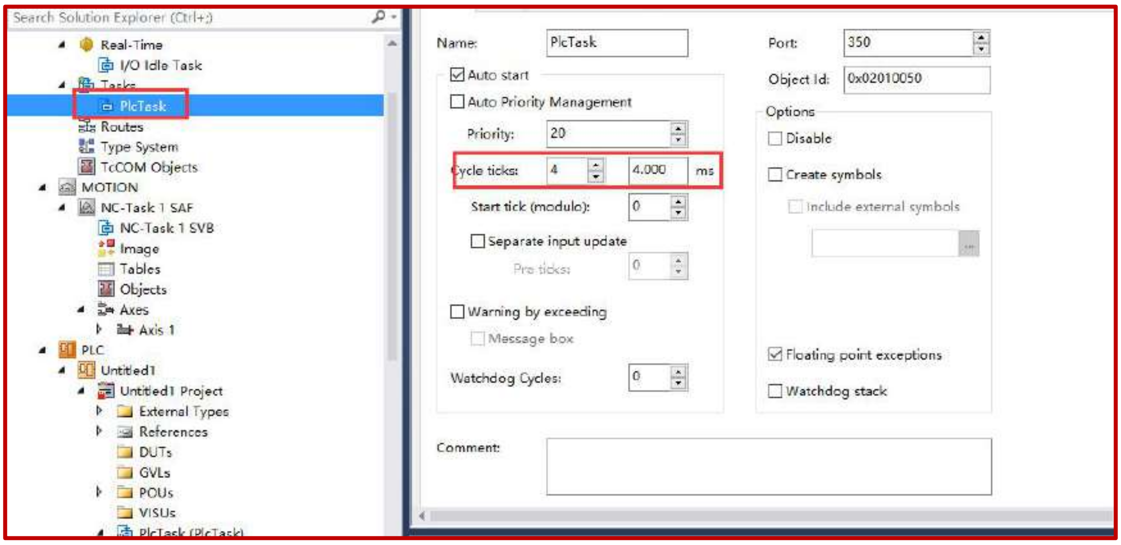


Figure 13-17 Setting PLC Task Cycles in TwinCAT

⑨ Use of CoeSDO

CoeSDO, similar to SDO in CANOPEN, can be used to read and write data that is not frequently exchanged or objects that do not support PDO communication. The steps to use it are as follows:

1) Add "Tcd_EtherCAT. lib" to the TwinCAT PLC library manager;

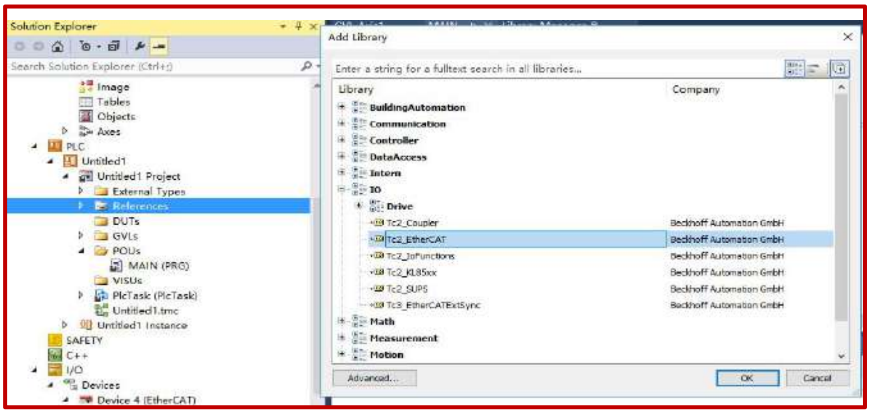


Figure 13-18: Adding "Tcd_EtherCAT. lib" to the TwinCAT PLC Library Manager

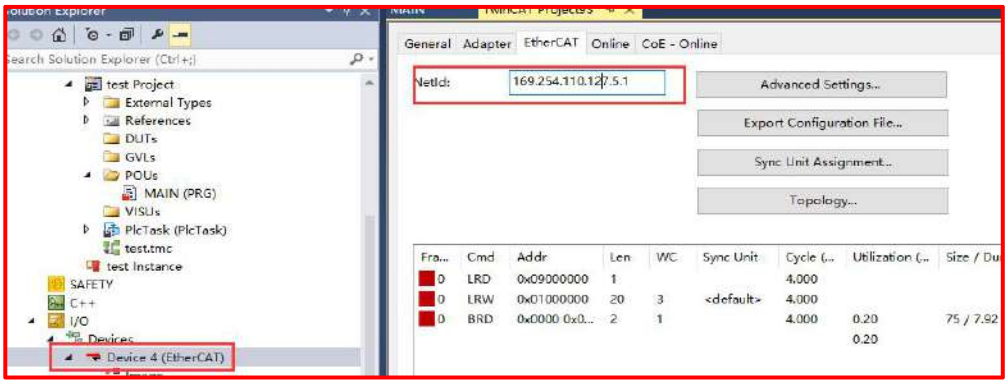
3) After adding, declare the CoeSDO read and write function block in the program. We take reading servo status word 60410010 and writing Homing method 60980008 as examples, both of which are unsigned:

```
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 13-19 Adding CoeSDO Function Block to TwinCAT Program

4) Determine the T of the EtherCAT main station_ AmsNetId



Technical forum: https://en.ismc.cn/e2eforums

Figure 13-20 T for determining the EtherCAT master station in TwinCAT_ AmsNetId

5）Determine the address of the slave station, SlaveAddr

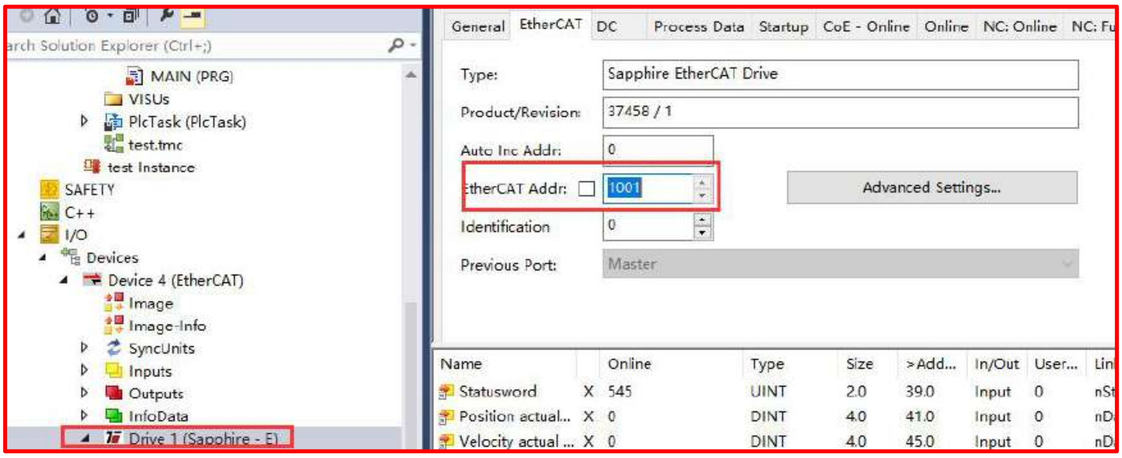


Figure 13-21 Determine the SlaveAddr address of the slave station in TwinCAT

6) Call the read/write function block in the program, trigger the read, 0X6041 status word is 545, write zero seeking mode 0X6089 mode 7

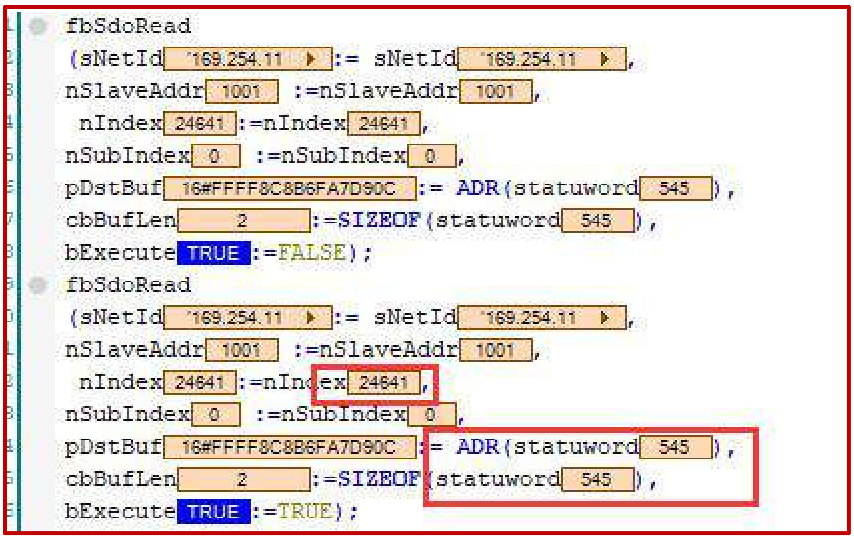


Figure 13-22 Trigger read in TwinCAT program, 0X6041 status word is 545

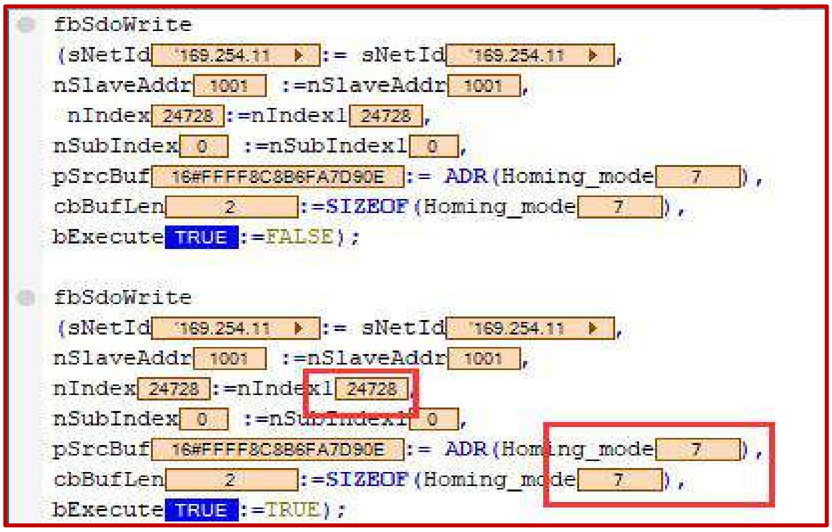


Figure 13-23 Writing Zero Search Mode 0X6089 Mode 7 in TwinCAT Program

7) Verify read and write OK through servo upper software ISMC tool

Figure 13-24 Verification Control Word and Zero Return Mode in ISMC

Communication case with Omron PLC

① Hardware connection

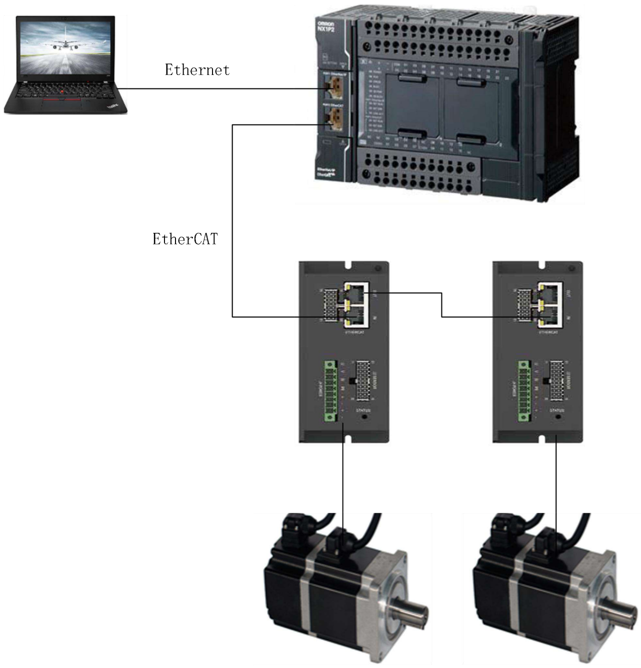


Figure 13-25 Omron PLC and servo hardware

②Communication connection

1) Connection between PC and PLC

The PC and PLC are connected in a 1:1 manner, without specifying an IP address or connecting device. They can be directly connected by clicking "Online" in Sysmac Studio and observing the controller status to determine if communication is successful. The first green light indicates that the PC and PLC are communicating. The second green light indicates that the PLC has communicated with the drive.

Figure 13-26 Controller Status Display

2) PLC and drive connection

Import XML file

Right click on the main device inEtherCAT in Sysmac Studio Configuration and Settings, and click to display the ESI library. Integrate ISMC-E XML_ 3.43 (PC). XML is stored in this path.

Figure 13-27 Import XML file

Node allocation

Create a project in Sysmac Studio, compile it correctly, and log in online. The default node address of the drive is 0. When the following warning pops up for physical network and application merging before communication connection or device replacement, node allocation is required.

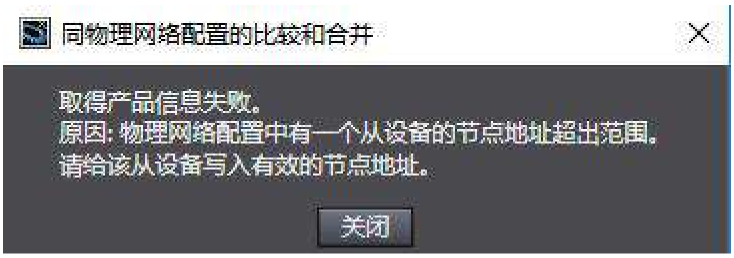


Figure 13-28 Node Address Out of Range Warning

Select Configuration and Settings - EtherCAT in the left tree window, right-click on the maindevice, select Write Slave Node Address, and the following interface will pop up. Modify it to an address greater than 1 and press Enter to write. Multiple drive node addresses cannot be duplicated. After writing, press write and restart the servo.

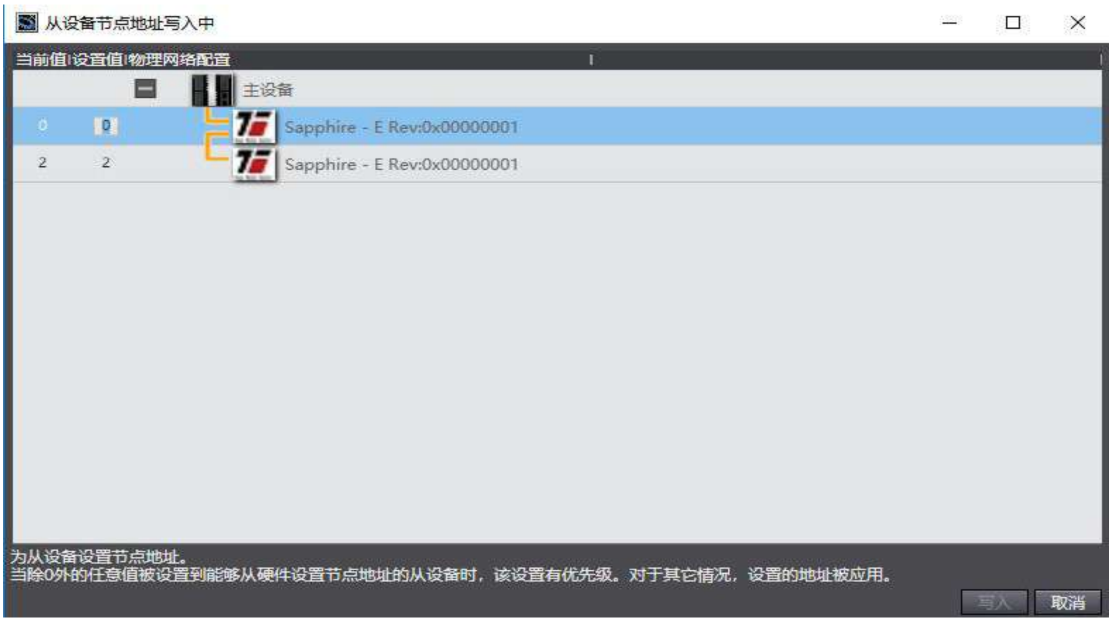


Figure 13-29 Modifying Node Address

Connectivity

Select Configuration and Settings - EtherCAT in the left tree window, right-click on the main device, and select Compare and Merge with Physical Network Configuration.

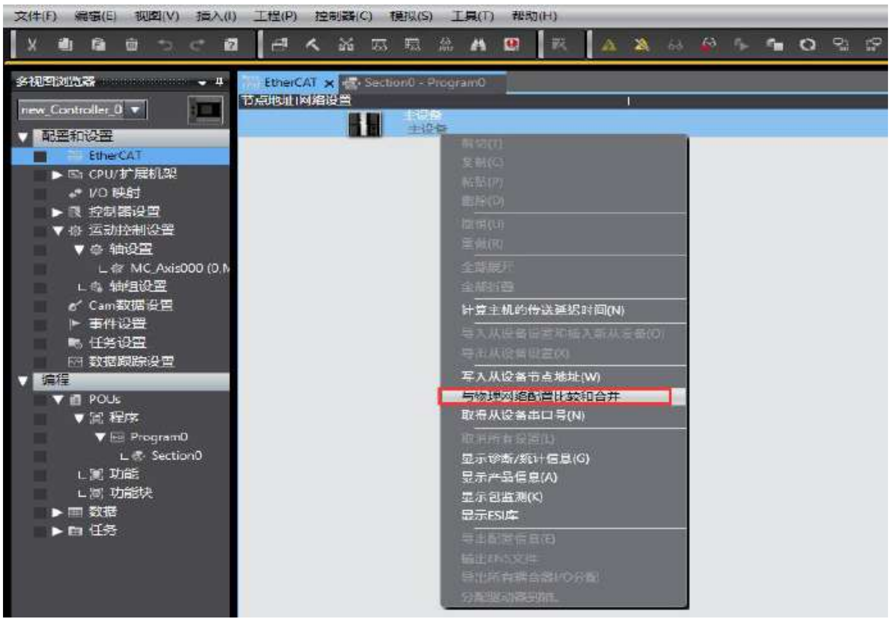


Figure 13-30 Comparison and Merge Interface with Physical Network Configuration

After the comparison and merging interface with the physical network configuration pops up, click on Apply Physical Network Configuration to complete the communication configuration between the PLC and the drive. Click to download the program to the PLC. The two yellow lights on the servo network port and the flashing green light indicate that the communication between the PLC and the drive is completed.

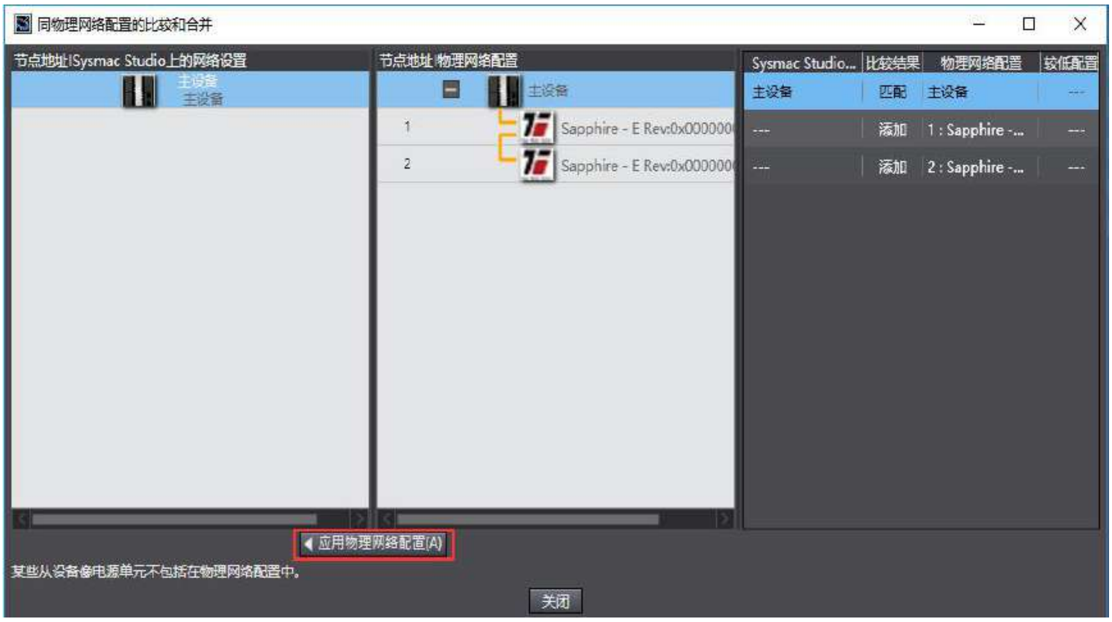


Figure 13-31 Application Physical Network Configuration Interface

③ Communication configuration

1） Drive Configuration

Drive parameter settings:

EtherCAT Master Type (0x2005) selection: Set 2005=1: When the specific support master is Omron PLC, the state machine 6041 provides feedback requirements;

In the left tree window, select Configuration and Settings - EtherCAT interface, click on the drive, and on the right side, you can configure the drive. PDO mapping and distributed clock settings are required.

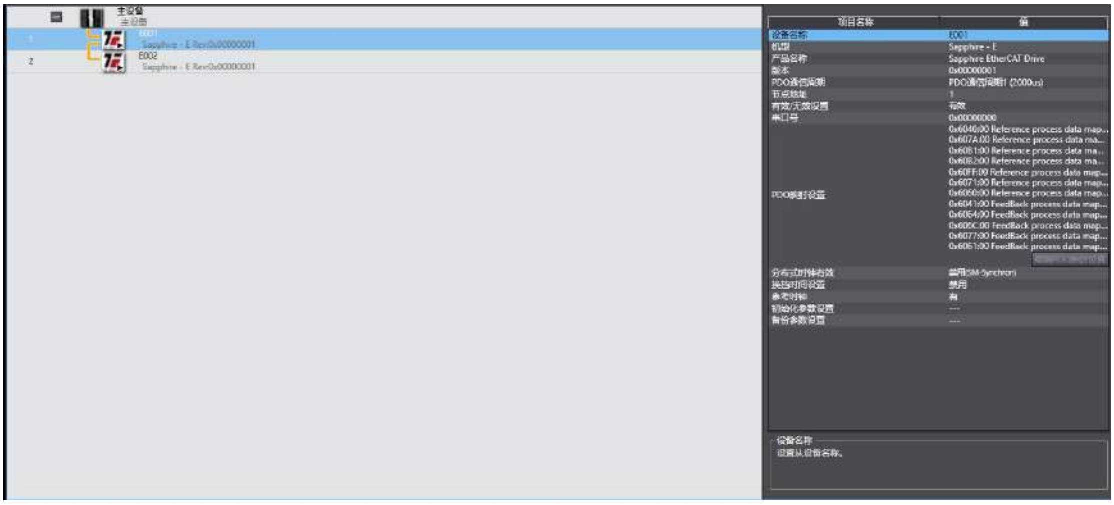


Figure 13-32 PDO modification and distributed clock modification interface

PDO mapping settings

Use default settings.

Distributed clock

Enable DC distributed clock. Otherwise, the program will not run properly.

2) Axis configuration

In the motion control settings, right-click on the axis settings to add a motion control axis.

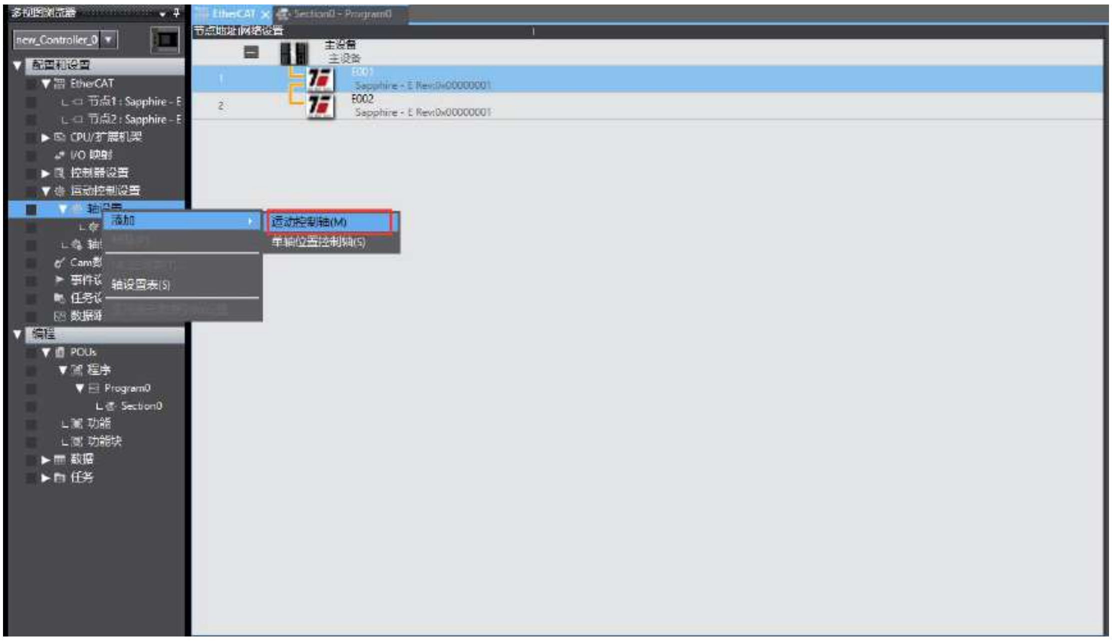


Figure 13-33 Adding motion control axis

Basic Axis Settings

Axis usage: The axis used.

Axis type: Server axis.

Output device 1: Select the drive for the corresponding node.

Detailed settings: Perform axis PDO settings. Each axis is configured with corresponding PDO according to the functional blocks used. If there is digital input, perform digital input settings.

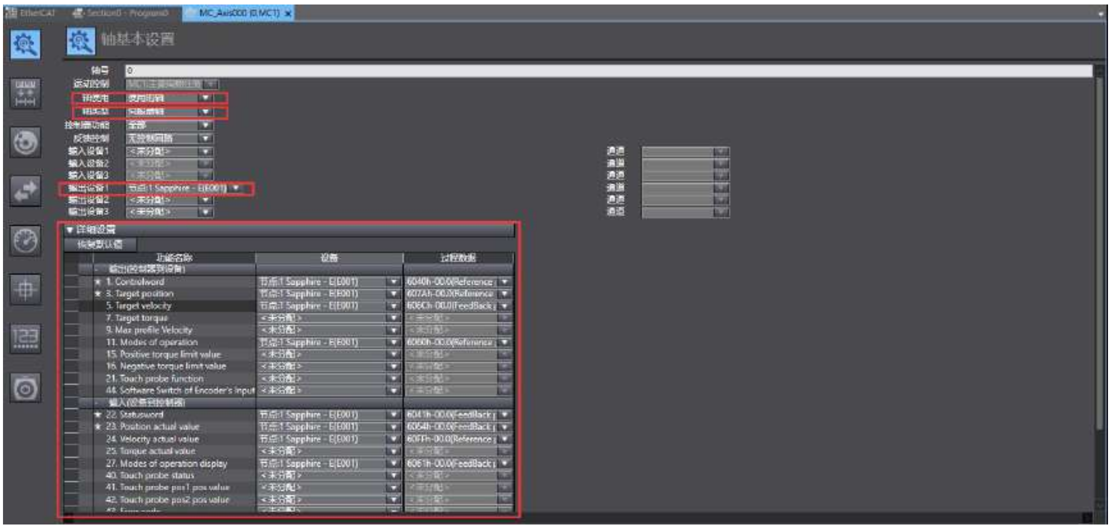


Figure 13-34 Basic Axis Settings

Unit settings

Unit: Set the required units according to actual needs.

Travel distance: The number of command pulses for one revolution of the motor is set to the resolution of the encoder.

According to whether there is a gearbox to use or not to use the gearbox.

The stroke of the motor after one revolution is set according to the actual load movement distance of the motor after one revolution.

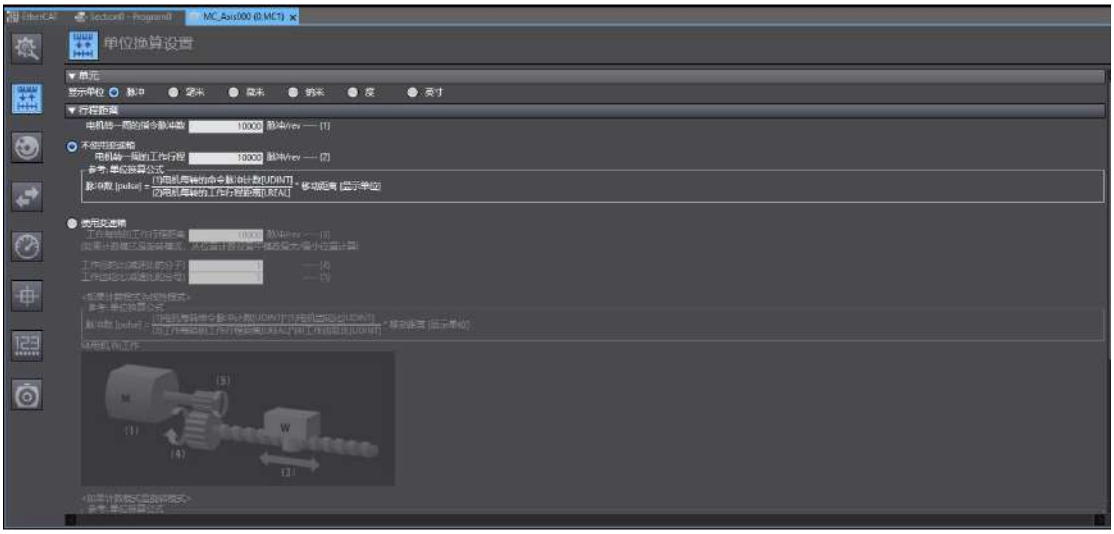


Figure 13-35 Unit Conversion Settings

Homing setting

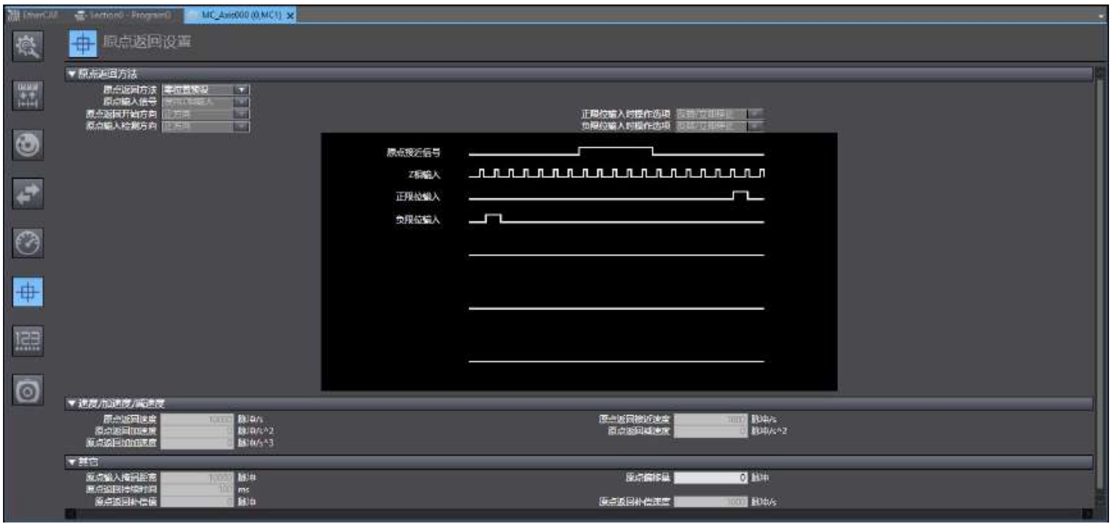


Figure 13-36 Zero return setting

Choose the appropriate homing method as needed.

If you choose to use external origin input,you need toconnect the origin input signal to the digital input of the servo. Additionally, it is necessary to configure the digital inputs in the detailed settings of the axis basic settings.

Figure 13-37 Digital Input Configuration

The origin proximity signal of the Home Switch servo input.

Positive limit switch servo input positive limit signal

Negative limit switch servo input negative limit signal

Other settings

Set the maximum value of velocity and acceleration, taking into account that they are all in actuator units. Units are set in the unit settings.

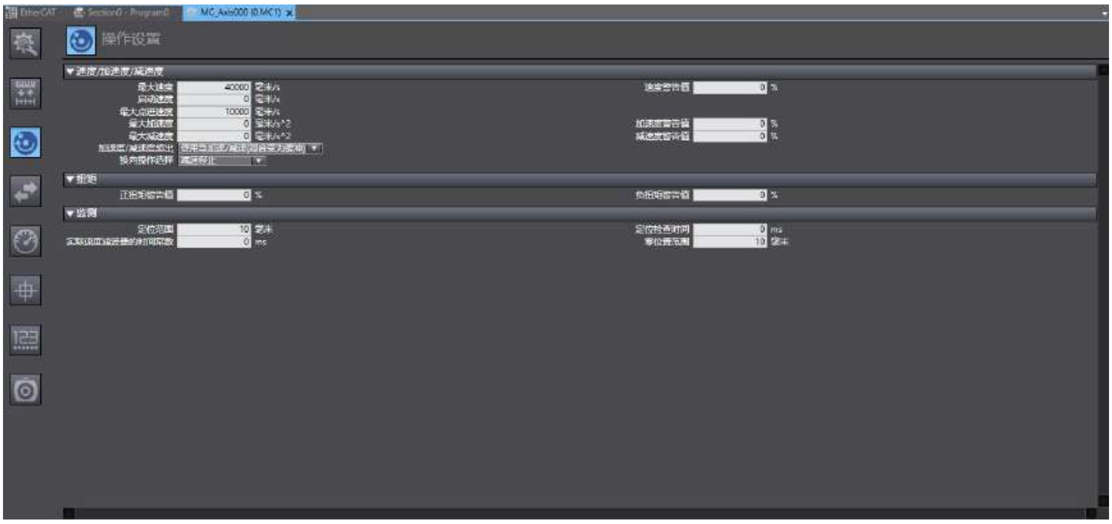


Figure 13-38 Setting the maximum value of velocity acceleration

Maximum torque setting

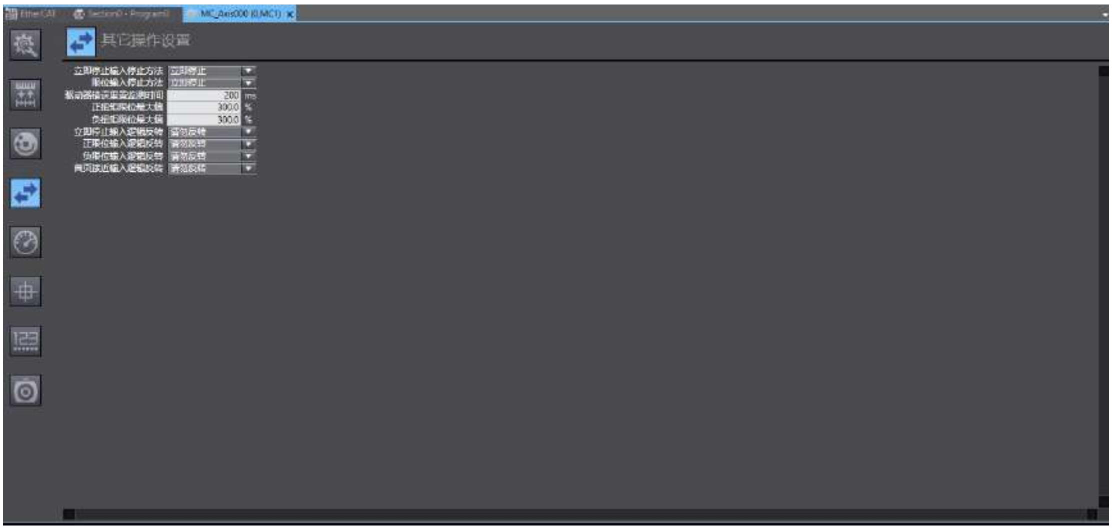


Figure 13-39 Setting the maximum torque

Other settings, similarly, pay attention to units.

3) Task cycle

The task cycle time needs to be consistent with the lower synchronization cycle, changed to 4ms (default).

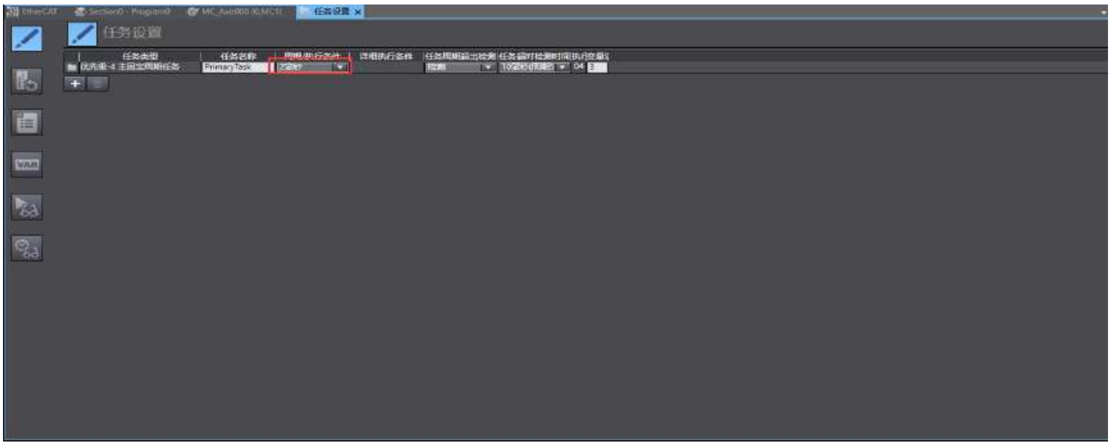


Figure 13-40 Task Cycle Setting

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Email: sales@ismc.cn

Web: www.ismc.cn

Technical forum: https://en.ismc.cn/e2eforums