ISMC servo drive

CANopen Application Manual

ISMC Servo drive CANopen Application Manual

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Preface

First of all, thank you for using the servo drive with the built-in CANopen 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 CANopen for servo drives with CANopen 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 CANopen, 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:

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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.

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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**

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	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	Drive wiring updates, homing method updates, etc.
Oct 2019	V1.2	Some parameters and case additions.
April 2020	V1.3	Update product pictures, 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	New adding of explanation for collision homing

Directory

Chapter 1 Hardware Configuration

1.1 interface definition

The CANopen communication interface of ISMC servo drive is standard RJ45 interface, and the front schematic diagram is as figure 1-1-1, and the J1 terminal is the connection terminal of CANopen, up is (IN) and down is (OUT).

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

Pin number	Signal name
1	CAN_ L_ IN
2	CAN_ H_ IN
3	-
4、	-
5~8	-

Chart 1-1-1 Saphhire Series CANopen Pin Introduction

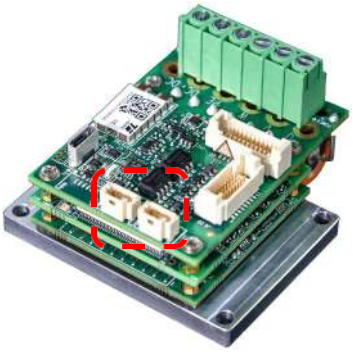


Figure 1-1-1 Diamond Series servo drive CANopen Interface Appearance

Pin number	signal name
1	NC
2	GND
3	CAN_ L
4	CAN_ H
5	PE

Chart 1-1-2 Diamond Series CANopen Pin Introduction

1.2 Drive wiring

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

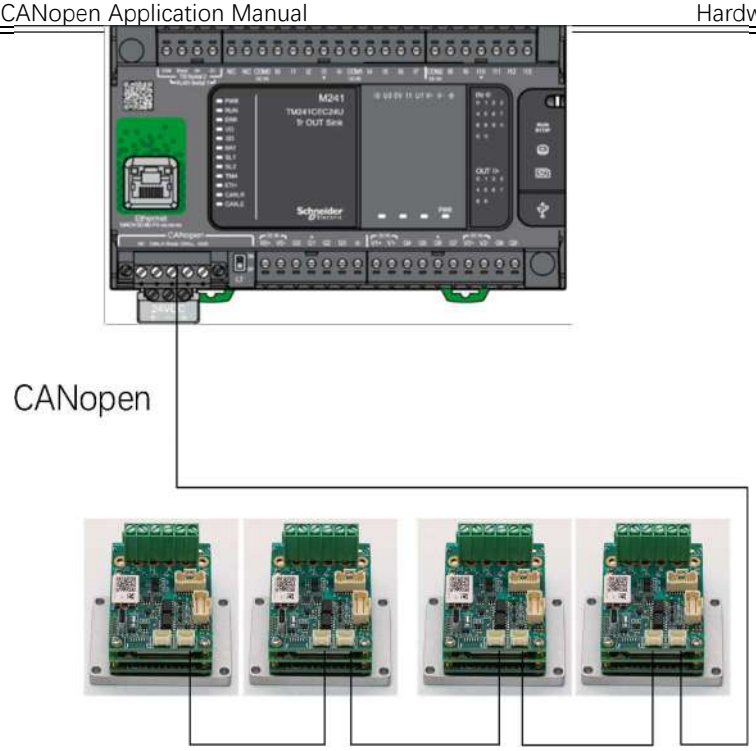


Figure 1-2 CANopen Communication Wiring Diagram

1.3 Comprehensive Description of CANopen

Table1-2 Comprehensive Description of CANopen

project	description
Link Layer Protocol	Can bus
Application layer protocol	CANopen protocol
CAN-ID type	11bit-CAN2.0A
Common Baud Rate	1Mbit/s,800kbit/s, 500kbit/s, 250kbit/s, 125kbit/s, 50kbit/s, 20kbit/s
Maximum number of slave stations	127
CAN frame length	0-8bytes
CAN frame type	Data frames, remote frames
Terminal resistor	120 Ω
Supporting sub protocols	CiA-301: CANopen Application Layer and Communication Protocol DSP-402: Drive and motion control sub protocol

Supported services	NMT: Network Management System SDO: Service Data Object PDO: Process Data Object Node Guarding: Node Protection Heartbeat: Heartbeat SYNC: including synchronous transmission and synchronous reception, applied to PDO transmission EMCY: Emergency Service Recipient
PDO transmission type	Synchronous triggering time triggering event triggering
Number of PDOs supported	4RPDOs, 4TPDOs
SDO transmission method	Accelerated (single frame) SDO transmission, segmented SDO transmission
Support control mode	Position profile mode, Velocity profile mode, Torque profile mode, Cyclic Sync Position Mode Homing mode

Chapter 2 Software Configuration

2.1 CANopen usage process

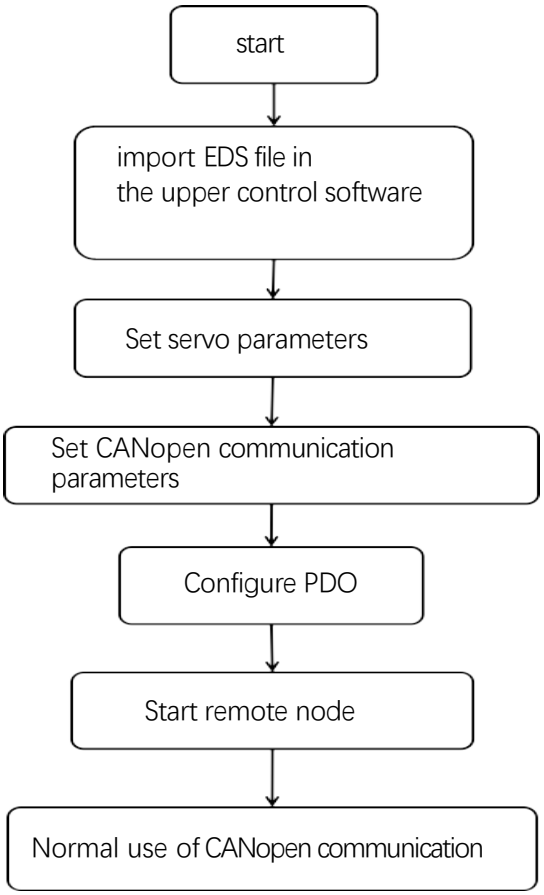


Figure 2-1 CANopen usage process

2.2 Servo parameter settings

Before using the CANopen servo drive, the following two parameters need to be set:

1. Modify the parameter 0x2004 (CAN Baud Rate) through ISMC software and set the CAN communication baud rate; The baud rate settings of the master and slave stations must be consistent, otherwise normal communication can't be achieved; The setting of the baud rate value is related to the length of the bus communication cable, as shown in Table2-1:

Table2-1 Relationship between Baud Rate and Communication cable Length

Baud rate (bit/s)	Communication cable length (m)
1000000	25
500000	100
250000	250
125000	500
50000	1000

20000	1000

2. Modify the parameter 0x2401(NodeID) through software and set the communication node IDs of each slave station; The node ID of each servo slave station cannot be duplicated with the node No of the master station (CNC or PLC), and the node numbers between each slave station cannot be duplicated

Note: Both of the above parameters take effect after the servo is restarted. After modifying the parameters, please power on again or "restart" the servo in the ISMC software.

2.3 CANopenprotocol

CANopen is an application layer protocol based on the CAN serial bus network transmission system, following the ISO/OSI standard model. In communication networks, different devices exchange data with each other through object dictionaries. The master node can obtain or modify data from other node object dictionaries through process data objects (PDO) or service data objects (SDO).

2.3.1 Object Dictionary

An object dictionary is an ordered collection of parameters and variables, containing all parameters for device description and device network status. A set of objects can be accessed in an orderly and predefined manner through the network.

The CANopen protocol adopts an object dictionary with a 16 bit index and an 8-bit sub index, and the structure of the object dictionary is as shown in Table2-2.

Table2-2 Object Dictionary Structure

index	object
0x0001- 0x0FFF	data type definition
0x1000- 0x1029	Communication parameter objects (such as CiA-301 protocol parameters)
0x1200- 0x12FF	SDO parameter object
0x1400- 0x15FF	RPDO parameter object
0x1600- 0x17FF	RPDO parameter mapping
0x1800- 0x19FF	TPDO parameter object
0x1A00- 0x1BFF	TPDO parameter mapping
0x1C00- 0x1FFF	Other communication parameters
0x2000- 0x5FFF	Manufacturer specific sub protocol parameter object
0x6000-	Standard device sub protocol parameter objects (such as DSP-402

0x9FFF	protocol parameters)
0xA000- 0xFFFF	reserve

2.3.2 CANopen Common Communication Objects

Network Management Objects(NMT)

The network management objects include Boot up messages, Heartbeat protocol, and NMT messages, based on master-slave communication mode,

NM Tis used to manage and monitor various nodes in the network, mainly achieving three functions: node status control, error control, and node startup.

Service Data Object (SDO)

Including receiving SDO - SDO (Rx) and sending SDO - SDO (Tx). By using indexes and sub indexes, SDO enable clients to access items in the device object dictionary. SDO is implemented through CMS objects in multiple domains in CAL, allowing for the transmission of data of any length. When the data exceeds 4 bytes, it is split into several packets. The protocol is to confirm the service type and generate a response for each message. SDO request and response messages always contain 8 bytes.

Process Data Object (PDO)

This includes receiving PDO (RPDO) and sending PDO (TPDO). Used to transmit real-time data from one creator to one or more recipients. The data transfer is limited to 1 to 8bytes. Each CANopen device contains 8 default PDO channels, 4 sending PDO channels and 4 receiving PDO channels. PDO includes two transmission methods: synchronous and asynchronous, which are determined by the corresponding communication parameters of the PDO. The content of PDO messages is predefined and determined by the mapping parameters corresponding to the PDO.

Sync Object (SYNC)

The synchronization object is a message periodically broadcasted by the CANopen master station to the CAN bus, used to implement basic network clock signals. Each device can decide whether to use this event to synchronize communication with other network devices based on its own configuration.

Emergency message (EMCY)

Message sent in case of internal communication failure or application failure error within the device.

2.3.3 CANopen frame COB-ID

CANopen 2.0A defines an 11 bit CAN-ID, which includes a 4-bit Function Code section and a 7-bit Node ID section.

For the convenience of networking between devices on the bus, CANopen defines a communication object identifier (COB-ID) based on CAN-ID: COB-ID specifies the priority of communication for each parameter object and the identification of each

communication object during the communication process. COB-ID and CAN-ID correspond one-to-one, with an 11 bit COB-ID consisting of two parts: a 4-bit object function code and a 7-bit node ID.

Table2-3 Corresponding COB-ID and CAN-ID Bits One by One

10	9	8	7	6	5	4	3	2	1	0
Function Code				Node-ID						

Each communication object of CANopen has a default COB-ID to identify devices and communication objects on the bus; And determine the priority of the communication object based on the size of the Function Code of COB-ID (the smaller the Function Code, the higher the priority). The communication object and its COB-ID are shown in Table 2-4.

Table2-4 Communication Objects and Their COB-IDs

communication object	COB-ID (hex)	function code	Related communication parameters in the object dictionary
NMT Network Control (Broadcast)	000	0000b	-
Sync synchronization object (broadcast)	080	0001b	0x1005,0x1006, 0x1007
EMCY Emergency Object	080+Node ID	0001b	0x1014, 0x1015
TPDO1	180+Node ID	0011b	0x1800
RPDO1	200+Node ID	0100b	0x1400
TPDO2	280+Node ID	0101b	0x1801
RPDO2	300+Node ID	0110b	0x1401
TPDO3	380+Node ID	0111b	0x1802
RPDO3	400+Node ID	1000b	0x1402
TPDO4	480+Node ID	1001b	0x1803
RPDO4	500+Node ID	1010b	0x1403
SDO (Tx)	580+Node ID	1011b	0x1200
SDO (Rx)	600+Node ID	1100b	0x1200
NMT network error control	700+Node ID	1110b	0x1016, 0x1017

2.4 Network Management System (NMT)

The Network Management System (NMT) is responsible for initializing, starting, and stopping networks and devices within the network, and is a master-slave system. There is only one NMT host in the CANopen network, which can configure CANopen network including itself.

2.4.1 NMT services

CANopen executes corresponding tasks according to the state machine specified in the protocol. Among them, some are automatically converted internally, while others must be converted by NMT host sending NMT messages. The specific state machine conversion is shown in Figure 2-2.

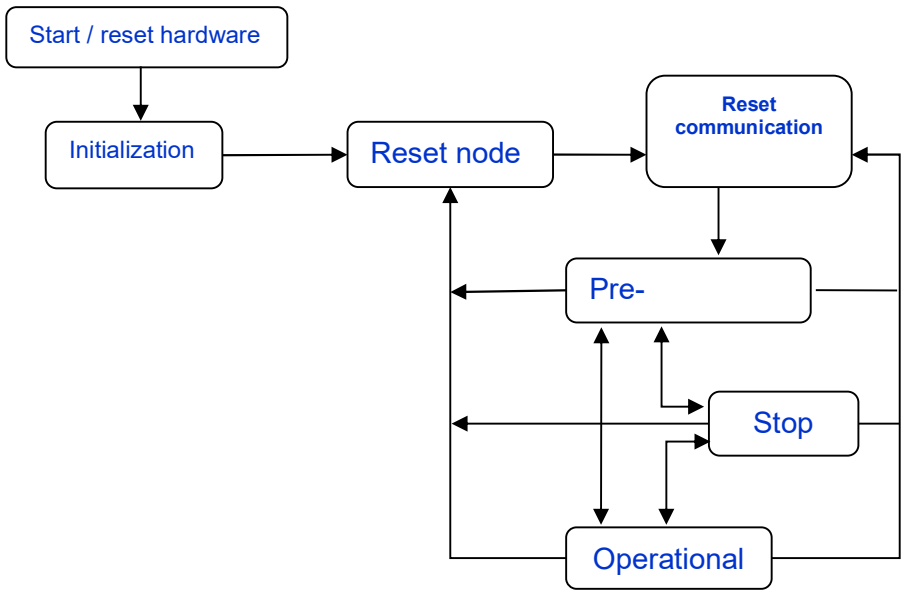


Figure 2-2 NMT State Machine Execution Diagram

Part of the conversion in the above figure is achieved through NMT messages, and only the NMT host can send NMT control messages. The message format is shown in Table 2-5.

Table2-5 NMT Message Format

COB-ID	RTR	Data/Byte	
		0	1
0x000	0	Command word	Node_ ID

The COB-ID of the NMT message is fixed to "0X000".

The data are consists of two bytes: the first byte is a command word , indicating the control function of the frame, as explained in Tables 2-6; The second byte is the CANopen node address, which is a broadcast message when it is "0", and all slave devices in the network are valid.

Table2-6 NMT Message Command Words

Command word	Jump state	illustration
0X01	Pre operation ->Run	Start remote node command
0X02	Run/Pre operation ->Stop	Stop remote node command
0X80	Run ->Pre operation	Enter pre operation state command
0X81	Run ->Reset Node	Reset node command
0X82	Run ->Reset Communication	Reset communication command

After the device is powered on, it will automatically enter the initialization state, including initializing, resetting nodes, and resetting communication. Initializing the loading of parameters for each module, while resetting the node restores the object dictionary manufacturer's definition and sub protocol area to the last saved value, and resetting communication restores the communication parameters in the object dictionary to the last saved value.

Then the device sends a Boot up and automatically enters the pre operation state, which is

the main configuration node state. After completing the configuration, the node needs the NMT host to send an NMT message to enter the operational state. The operating state is the state when CANopen is working normally, and all modules should be working properly.

When the NMT host sends a stop node message, the device enters a stop state, and CANopen communication only has the NMT module can be in normal operation.

The CANopen services supported in various NMT states are shown in Table 2-7.

Table2-7 Services Supported by Various NMT States

give service to	Pre operation	operate	stop
Process Data Object (PDO)	no	yes	no
Service Data Object (SDO)	yes	yes	no
Sync Object (SYNC)	yes	yes	no
Emergency message (EMCY)	yes	yes	no
Network Management System (NMT)	yes	yes	yes
error control	yes	yes	yes

2.4.2 NMT error control

NMT error control is mainly used to detect whether devices in the network are online and the status of the devices, including node protection, lifetime protection, and heartbeat.

Node/Lifetime Protection

Node protection refers to the NMT host periodically querying the status of NMT slaves through remote frames; Lifetime protection is when the slave station monitors the status of the master station by receiving remote frame intervals for monitoring the slave station. Node protection follows a master-slave model, and each remote frame must receive a response.

Related to node/lifetime protection is the object protection time 100Ch and the lifetime factor 100Dh.The value of100Ch is the remote frame interval for node protection under normal circumstances, measured in milliseconds. The product of 100Ch and 100Dh determines the latest query time for the host. Under normal circumstances, node protection can be achieved. When nodes 100Ch and 100D are both non-zero and a node protection request frame is received, lifetime protection is activated.

Every 100Ch the master station sends the node to protect the remote frame, and the slave station must do reply, otherwise it is considered that the slave station drops off the station; If the slave station does not receive the node protection remote frame within 100Ch X 100Dh time, the master station is considered to have dropped the line.

The NMT master node sends remote frames as shown in Table 2-8.

Table2-8 Node Protection Remote Frames

COB-ID	RTR
0x700+Node_ ID	1

The response message returned by NMT from the node is a one byte status word, as shown in

Table 2-9.

Table2-9 Node Protection Response Message

COB-ID	RTR	Data
0x700+Node_ ID	0	status word

The content of the 8bits of the status word is shown in Table 2-10.

Table 2-10 Explanation of Response Message Status

Data bits	Illustration
Bit7	Must alternate between "0" or "1" in each iteration
Bit6~bit0	4-Stop state 5- Operation status 127- Pre operation status

heartbeat

The heartbeat model adopts the producer-consumer model. The CANopen device can send heartbeat messages in unit:ms according to the period set by the producer heartbeat interval object 1017h. A node with a consumer heartbeat function in the network monitors the producer according to the consumer time set by the object 1016h, and once the consumer does not receive the heartbeat of the corresponding node within the heartbeat time range, it is considered that the node is now out of order.

After the producer heartbeat interval is configured for 1017h, the node heartbeat function is activated and heartbeat messages are generated. After configuring the valid sub-index of consumer heartbeat 1016h, the monitoring starts after receiving a frame heartbeat sent by the corresponding node.

If the host sends a heartbeat message according to its producer time and the slave of the monitoring host does not receive the heartbeat message within 1016h sub index time, it is considered that the host has dropped. The slave sends a heartbeat message every 1017h time to monitor the host of the slave. If the heartbeat message is not received within the consumer's time, it is considered that the slave has dropped.

The format of the heartbeat message is shown in the table below. The data segment only has one byte, and the highest bit is fixed to 0. The rest is consistent with the node protection response message.

Table 2-11 Heartbeat Message Format

COB-ID	RTR	Data
0x700+Node_ ID	0	status word

2.5 Service Data Object (SDO)

Service Data Object (SDO) establishes connections with the object dictionary through object indexes and sub indexes. SDO allows for the reading of object content in the object dictionary or the modification of object data when allowed.

2.5.1 SDO transmission framework

SDO transmission mode followsthe client-server mode, that is, the one-answer mode. It is initiated by SDO client in CAN bus network, and SDO server makes reply. Therefore, data exchange between SDO needs at least two CAN messages to realize.

2.5.2 SDO transmission message

The transmission of SDO is divided into object data transmission of no more than 4 bytes (SDO accelerated transmission) and object data transmission of no more than 4 bytes (SDO segmented transmission).

The SDO transmission message consists of COB-ID and data segments, as shown in Table 2-12.

Table 2-12 SDO Format

COB-ID	Data							
580h+Node_ ID/ 600h+Node_ ID	0	1	2	3	4	5	6	7
	command code	index		Sub-Index	data			

Among them, the command code indicates the transmission type and data length of the SDO segment, the index and sub index are the position of the object in the list, and the data is the value of the object.

Expedited SDO transfer (write)

For writing of no more than 4 bytes, use accelerated SDO transfer. The transmission message varies according to the reading/writing mode and the length of the content data. The message content is shown in Table 2-13 below.

Table 2-13 Expedited SDO transfer (write)

transmission		COB-ID	0	1	2	3	4	5	6	7
Client		600h+Node_ ID	23h	index		Sub-Index	data			
			27h				data			-
			2bh				data		-	-
			2fh				data	-	-	-
server	normal	580h+Node_ ID	60h	index		Sub-Index	-	-	-	-
	abnormal		80h				Abort Code			

"-" indicates that there is data but it will not be considered. It is recommended to write 0 when writing data, the same below.

Example:

The slave station number is 2, and the running speed value is 60FFh-00 in SDO write speed mode. The written value is 1000, which is 0x3E8. The master station sends the following message. (All in hexadecimal)

Table 2-14 Example of Main Station Sending Messages

COB-ID	0	1	2	3	4	5	6	7
602	23	FF	60	00	E8	03	00	00

Table 2-15 Example of Returning Messages from Station Drives

COB-ID	0	1	2	3	4	5	6	7
582	60	FF	60	00	00	00	00	00

If the data type written does not match, the fault code 0x06070010 is returned, and the message is as follows:

Table 2-16 example of writing a data type mismatch return message

COB-ID	0	1	2	3	4	5	6	7
582	80	FF	60	00	10	00	07	06

SDO Expedited SDO transfer (read)

When SDO reads object packets with no more than 4 bytes, acceleration mode is adopted. Accelerate SDO read messages as shown in Table 2-17.

Table 2-17 Expedited SDO transfer (read) Structure

transmission		COB-ID	0	1	2	3	4	5	6	7
Client		600h+Node_ ID	40h	index		Sub-Index	-	-	-	-
server	normal	580h+Node_ ID	43h	index		Sub-Index	data			
			47h				data			-
			4bh				data		-	-
			4fh				data	-	-	-
	abnormal		80h				Abort Code			

Example:

The slave station number is 2. In SDO read speed mode, the control mode displays a value of 6061h-00, and in speed mode, the value is 3, which is 0x03. The master station sends the following message. (All in hexadecimal)

Table 2-18 Example of Main Station Sending Messages

COB-ID	0	1	2	3	4	5	6	7
602	40	61	60	00	00	00	00	00

Table 2-19 Example of Returning Messages from Station Drive

COB-ID	0	1	2	3	4	5	6	7
582	4f	61	60	00	03	00	00	00

If the command word written does not match, an invalid command word error is returned with fault code 0x05040001. The message is as follows:

Table 2-20 Example of return message if writing command word does not match,

COB-ID	0	1	2	3	4	5	6	7
582	80	61	60	00	01	00	04	05

SDO segmented read transmission message

For objects larger than 4 bytes, segmented reading operations are required for execution. Segmented transmission messages are similar to accelerated transmission messages, with the starting frame being consistent with the accelerated transmission.

Table 2-21 Starting Transmission Message Structure

transmission		COB-ID	0	1	2	3	4	5	6	7
Client		600h+Node_ID	40h	index		Sub-Index	-	-	-	-
server	normal	580h+Node_ID	41h	index		Sub-Index	Length			
	abnormal		80h				Abort Code			

The transmission process is triggered by the trigger bit (bit6) of the command code, which interactively sends 0 and 1. The process message structure is shown in Table 2-22.

Table 2-22 Process Message Structure

transmission		COB-ID	0	1	2	3	4	5	6	7
Client		600h+Node_ID	60h			-	-	-	-	-
server	normal	580h+Node_ID	00h	Length						
	abnormal		80h	index		Sub-Index	Abort Code			
Client		600h+Node_ID	70h	-	-	-	-	-	-	-
server	normal	580h+Node_ID	10h	Length						
	abnormal		80h	index		Sub-Index	Abort Code			

The end frame response packet of segmented transmission contains the end frame marker and the effective data length of the end frame. The transmission message structure is shown in Table 2-23.

Table 2-23 End Message Structure

transmission		COB-ID	0	1	2	3	4	5	6	7
Client		600h+Node_ID	60h/0X70h	index		Sub-Index	-	-	-	-
server	normal	580h+Node_ID	01h/11h	data						
			03h/13h	data						
			05h/15h	data						
			07h/17h	data						
			09h/19h	data						
			0Bh/1Bh	data						
			0Dh/1Dh	data						
	abnormal		80h	index		Sub-Index				

2.6 Process Data Object (PDO)

Process Data Object (PDO) is used to transmit real-time data and is the primary data transmission method in CANopen. Due to the fact that PDO transmission does not require a response and the length of PDO can be less than 8 bytes, the transmission speed is fast.

2.6.1 PDO object

According to the different receiving and sending methods, PDO can be divided into RPDO and TPDO. PDO is determined by both communication parameters and mapping parameters to determine the final transmission method and content. The ISMC servo drive can use up to 4 sets of RxPDO and 4 sets of TxPDO to achieve PDO transmission. The relevant object list is shown in 2-24.

Table 2-24 PDO Message Structure

Name		COB-ID	Communication Object	Mapping Objects
RxPDO	1	200h+Node_ ID	1400h	1600h
	2	300h+Node_ ID	1401h	1601h
	3	400h+Node_ ID	1402h	1602h
	4	500h+Node_ ID	1403h	1603h
TxPDO	1	180h+Node_ ID	1800h	1A00h
	2	280h+Node_ ID	1801h	1A01h
	3	380h+Node_ ID	1802h	1A02h
	4	480h+Node_ ID	1803h	1A03h

2.6.2 PDO communication parameters

PDO CAN identifier

The CAN identifier of PDO, also known as the COB-ID of PDO, contains control bits and identification data to determine the bus of the PDO Priority. The COB-ID is located on sub index 01 of the communication parameters (RxPDO: 1400h~1403h and TxPDO: 1800h~1803h), and the highest bit determines whether the PDO is valid.

Example:

For the node which station no. is 1, TPDO3 should have a COB-ID of "80000381h" in an invalid state, when COB-ID is written to "381h", it indicates the activation of the PDO.

PDO transmission type

The transmission type of PDO is located on the sub index02: Transmission Type of communication parameters (RxPDO: 1400h~1403h and TxPDO: 1800h~1803h), which determines which transmission method PDO follows. The Transmission Type represents different types of transmission and defines the methods for triggering TxPDO transmission or receiving RxPDO. The specific correspondence is shown in the table below.

Table 2-25PDO Communication Types

Communication type value	synchronous		asynchronous
	circulate	acyclic	
0		√	
1~240	√		
241~253	-		
254、255			√

When the transmission type of TxPDO is 0, if the mapping data changes and a synchronization frame is received, the TxPDO is sent.

When the transmission type of TxPDO is 1-240, when the corresponding number of synchronization frames are received, the TxPDO is sent. When the transmission type of TxPDO is 254 or 255, the event timer is triggered and the TxPDO is sent.

When the transmission type of RxPDO is 0-240, as long as a synchronization frame is received, the latest data of that RxPDO will be updated to the application.

When the transmission type of RxPDO is 254 or 255, the received data will be directly updated to the application.

Prohibited time

A prohibition time has been set for TxPDO, stored on subindex03 of communication parameters(1800h~1803h), to prevent the CAN network from being continuously occupied by lower priority PDO. The unit of this parameter is 100us. After setting the value, the transmission interval of the same TxPDO must not be less than the time corresponding to this parameter.

event timer

For asynchronous transmission of TxPDO, define an event timer located on sub index 05 of communication parameters (1800h~1803h).

2.6.3 PDO mapping parameters

The PDO mapping parameters contain pointers to the process data corresponding to the PDO that PDO needs to send or receive, including indexes, sub indexes, and the length of the mapping object. Each PDO data can have a maximum length of 8 bytes and can map one or more objects simultaneously. The sub index 0 records the specific number of objects mapped by the PDO, while sub indexes 1-8 represent the mapping content. The mapping parameter content is defined as follows:

Table 2-26PDO mapping parameter definitions

Bit	31	.....	16	15	.....	8	7	.....	0
meaning	index			Sub-Index			Object length		

The index and subindex together determine the position of an object in the object dictionary, and the object length indicates the specific bit length of the object, represented in hexadecimal, that is:

Table 2-27 Relationship between Object Length and Object Bit Length

Object length	Bit length
08h	8 bits
10h	16 bits
20h	32 bits

2.7 Sync Object (SYNC)

Synchronization Object (SYNC) is a special mechanism to control the coordination and

synchronization between sending and receiving nodes, which is used for synchronous transmission of PDO. The transmission of synchronization objects follows the producer-consumer mode, and the synchronization producers send synchronization frames, all other nodes in the network can accept the synchronization frame as consumers without requiring feedback. Only one synchronization generator is allowed in the same CAN network.

The configuration process of the synchronous generator is as follows:

The transmission of synchronous PDO is closely related to the synchronization of frames:

1) For synchronous RxPDO, once the PDO is received, the received RxPDO will be updated to the application in the next SYNC.

2) For synchronous TxPDO, it is divided into synchronous loop and synchronous non loop. When the PDO transmission type is 0 synchronous non cyclic, the content of the PDO mapping object changes and is sent in the next SYNC; When the PDO transmission type is 1-240 synchronous loop, as long as the SYNC specified in the transmission type is reached, regardless of whether the data has changed, the TxPDO needs to be sent.

2.8 Emergency Object Service (EMCY)

When error occurs in CANopen node, According to the standardized mechanism, the node will send an emergency message. Emergency messages follow the producer-consumer model. After a node failure is sent, other nodes in CAN network can choose to deal with the failure.

When the node fails, the error register and the predefined error field need to be updated regardless of whether the emergency object is activated or not. Emergency message content according to the following specifications:

Table 2-28 Emergency Message Structure

COB-ID	0	1	2	3	4	5	6	7
80h+Node_ ID	error code		error register	reserve	Auxiliary byte			

Please refer to the chapter "Trouble shooting" for specific definitions of error codes and auxiliary bytes.

Chapter 3 Servo State Control

3.1 CiA402 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.

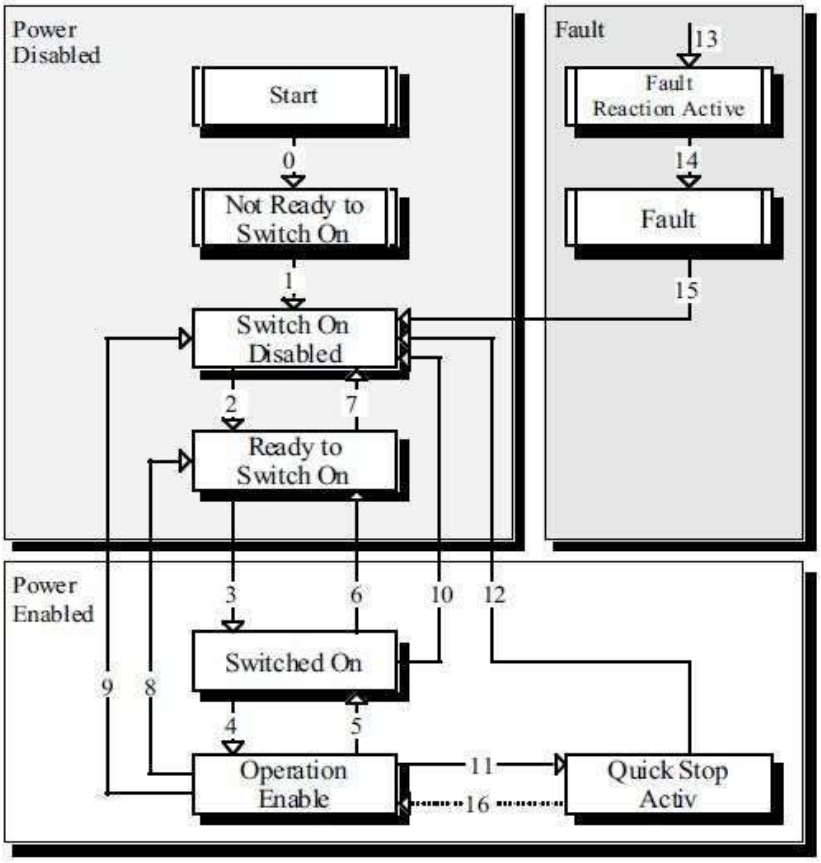


Figure 3-1 CiA402 State Machine

In different states, the corresponding servo functions are shown in Table 3-1.

Table3-1 Servo functions under different states

function	state machine							
	Not ready to switch on	Switch on disabled	Ready to switch on	Switched 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 the servo drive under different states are shown in Table 3-2.

Table 3-2 Trigger Events for State Transition

Transitions	Event (s)	Action (s)
0	Automatically jump after power on or reset	Device self-checking and initialization
1	automatic skip	Communication function enable
2	Received shutdown command	No
3	Received Switch on command	Powering on the busbar
4	Received Enable operation command	Enable PWM output and clear all internal given points
5	Received the Disable operation command	Disable PWM output
6	Received shutdown command	Disconnect the busbar
7	Received Quick stop or Disable voltage command	No
8	Received shutdown command	Disable PWM output, disconnect bus
9	Received the Disable voltage command	Disable PWM output, disconnect bus
10	Received Disable voltage or Quick stop command	Disconnect the busbar
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	Disable PWM output to, disconnect bus
13	Failure occurred	Start fault response function
14	automatic skip	Disable PWM output, disconnect bus
15	Received Fault reset command	Start resetting the fault, if the fault has been resolved, then Clear fault flag bit
16	Not Supported	

3.2 Control word 6040h

Table3-3 Controlword

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.

Table3-4 Definition of Control Characters

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 (Bit0~3,7), as shown in Table 3-5.

Table3-5 Control Instructions

Control command	Control the bit of a word					Transitions
	Bit7	Bit3	Bit2	Bit1	Bit0	
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: "X" represents both 0 and 1.

Assigning individual values to each bit of a control word is meaningless and must be combined with other bits to form a control instruction.

Bit0~3 and Bit7 have the same meaning in each mode, and commands must be sent in order to guide the servo drive into the expected state according to the CiA402 state machine switching process, with each command corresponding to a determined state.

Bit4~6 have different meanings in different control modes.

3.3 Statusword 6041h

The introduction of status words is shown in Table 3-6.

Table3-6 Statusword

Index number	name	object type	mapping	access	Default value
0x6041	Statusword	VAR	TxPDO	RO	0
		data type	unit	range	
		UINT16	-	-	

The meanings of the Statusword is shown in Table 3-7.

Table3-7 Statusword Definition

Bit	description
0	Ready to switch on
1	Switch on
2	Operation enabled
3	Fault
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 Bit0~3, 5, and 6 in the status words represent the current state of the servo, as shown in Tables 3-8.

Table3-8 Combination of Status Words in Different States

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

Note: 1. "X" indicates either 0 or 1.

Reading each bit of the status word individually is meaningless and must be combined with other bits to provide feedback on the current state.

Bit0-9 has the same meaning in each servo mode, and after sending commands in sequence with control word 6040h, the servo feedbacks a certain state.

Bit12~13 are related to various servo modes.

Bit10-11 and Bit15 have the same meaning in each servo mode, providing feedback on the status of the servo after executing a certain servo mode.

3.4 Shutdown method

CANopen supports the following shutdown methods:

- **Emergency stop**
- **Disable shutdown**
- **Fault shutdown**
- **Pause shutdown**
- **Fast stop**

0x605B- Emergency stop

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

Table 3-9 Introduction to 0x605B

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

The shutdown mode of0X605B is introduced in Table 3-10.

Table 3-10 0X605B Shutdown Methods

set value	Shutdown methods
0	Turn off the input of servo drive
1	Stop the machine according to the deceleration slope, and then turn off the output of the servo drive

0x605C- Disable shutdown

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

Table 3-11 Introduction to 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 mode of 0X605C is introduced in Table 3-12.

Table 3-12 0X605C Shutdown Methods

set value	Shutdown method
0	Turn off the input of servo drive
1	Stop the machine according to the deceleration slope, and then turn off the of the servo drive

0x605E- Fault shutdown

When a fault is detected, 0x605E determines different shutdown methods.

Table 3-13 Introduction to 0x605E

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 mode of 0X605E is introduced in Table 3-14.

Table 3-14 0X605E shutdown modes

set value	Shutdown method
0	Turn off the input of 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

0x605D- Halt shutdown

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 introduction of 0X605D shutdown mode is shown in Table 3-16.

Table 3-16 0X605D shutdown modes

set value	Shutdown method
0	Not Supported
1	Stop the machine at the deceleration slope and keep it in the Operation enabled state
2	Press the fast stop slope to stop the machine, then keep it in the Operation 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

0x605A- Quick stop

When the state machine transitions from Operation enable to Quick reaction active, 0x605A determines different quick stop methods.

Table 3-17 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 introduction of 0X605A shutdown method is shown in Table 3-18.

Table 3-18 0X605A Quick Stop Methods

set value	Shutdown method
0	Turn off the input of servo drive
1	Stop the machine at the deceleration slope and then switch to the Switch on disable state
2	Press the fast stop slope to stop the machine, 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 then maintain it in the Quick stop active state
7	Given aspeed of 0, the speed loop controls the shutdown and then maintains a Quick stop active state
8	Not Supported

Chapter 4 Servo Operation Mode

4.1 Mode selection

0X6060- Mode selection

The servo operation mode can be set through 0X6060h, and the supported modes are shown in Table 4-1.

Table4-1 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 introduction of 0X6060 method is shown in Table 4-2.

Table4-2 0X6060 Operation Mode Selection

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 sync torque mode

4.2 Mode display

0x6061- Mode display

The current operating mode of the servo is represented by the displayed value of 0X6061h, and the supported modes are the same as 0X6060, as shown in Table 4-3.

Introduction to Table 4-3 0x6061

Index number	name	object type	mapping	access	Default value
0x6061	Modes of operation	VAR	TxPDO	RO	0
		data type	unit	range	
		INT8	-	0,1,3,4,6,8	

The introduction of 0X6061 is shown in Table 4-4.

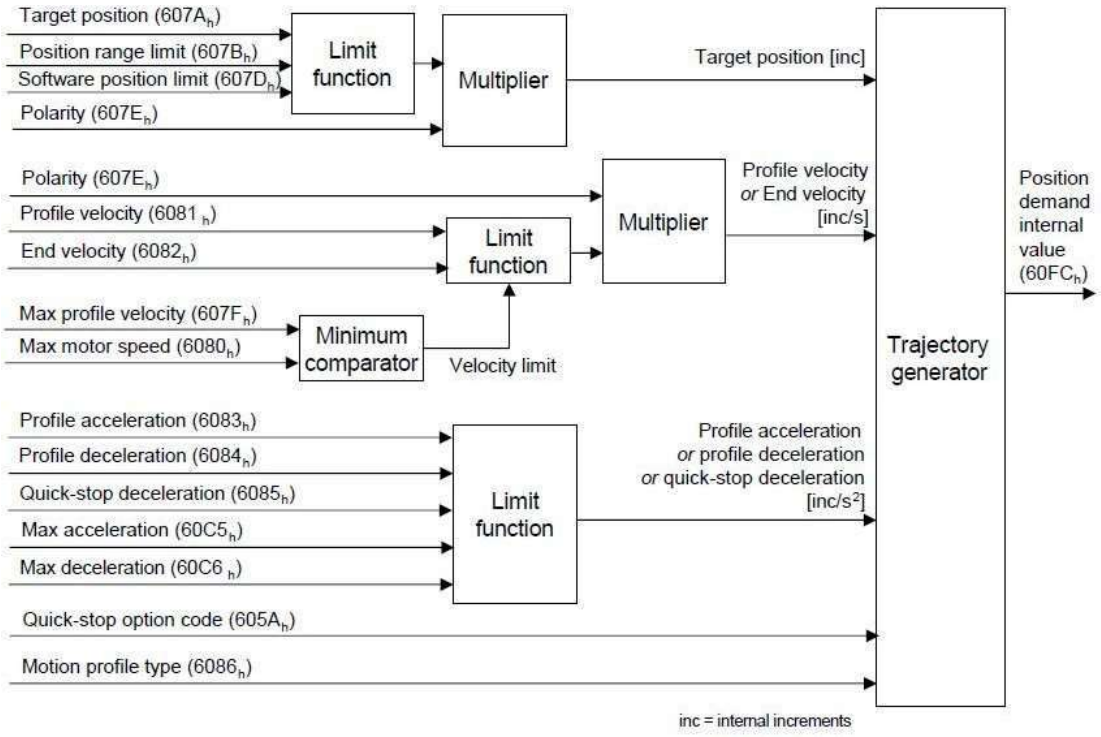
Table4-4 0X6061 Operating Mode Display

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 sync torque mode

4.3 Position profile mode

4.3.1 Function Introduction

The position profile mode, is used for point-to-point motion. Given absolute or relative target position (0x607A) and profile 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.



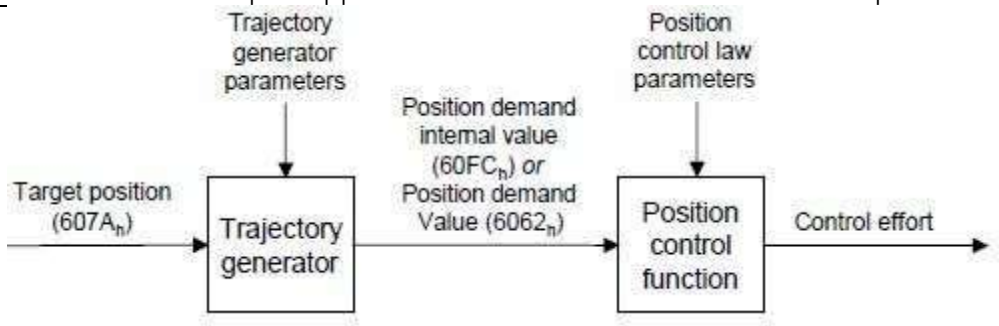


Figure 4-1 Position profile mode

4.3.2 Operation method

1. Set [6060h: Mode of operations] 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] as 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 (set to 0x0F to enable, other bits refer to Section 4.3 for detailed explanation of 6040h);

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

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

4.3.3 The use of the controlword

Certain bits of control words and status words have specific meanings in position profile mode. The structure of control words is shown in Table 4-5

Table4-5 Structure of Control Words in Position Profile 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 sis 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 definitions in Table 4-6.

Table4-6 Definition of Control Words Bit4, Bit5, and Bit9

Bit9	Bit5	Bit4	definition
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 profile 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 to the current position value. When Bit8 is set to 1, the axis's operation can be stopped, as shown in Tables 4-7.

Table4-7 Definition of Control Words Bit6 and Bit8

Bit	Value	definition
6	0	0x607ATarget position is an absolute value
	1	0x607ATarget 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

4.3.4 The use of the Statusword

The structure of status words is shown in Table 4-8.

Table4-8 Definition of Status Words in Position Profile Mode

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

The definitions of Status words Bit10, Bit12, and Bit13 are shown in Table 4-9.

Table4-9 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	definition
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 tracking error
	1	Tracking Error

4.3.5 Object parameters related to position profile mode

0x607B: Position range limit

This object defines the maximum and minimum position ranges, which can limit the numerical range of input values. When reaching or exceeding the set rang, 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 4-10.

Table 4-10 Introduction to 0x607B

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

The sub index 0x00 of 0x607B is introduced in Table 4-11.

Table 4-11 Introduction to sub index 0x00 of 0x607B

Subindex 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 4-12.

Table 4-12 Introduction to sub index 0x01 of 0x607B

Subindex 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 4-13.

Table 4-13 Introduction to sub index 0x02 of 0x607B

Subindex 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 4-14.

Table 4-14 Introduction to 0x607D

Index number	nam e	object type	mappin g	acces s	Default value
0x607D	Software position limit	ARRAY	-	-	-
		data type	unit	rang e	
		INT32	-	-	

The sub index number 0x00 of 0x607D is introduced in Table 4-15.

Table 4-15 Introduction to sub index number 0x00 for 0x607D

Subindex 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 4-16.

Table 4-16 Introduction to sub index number 0x01 for 0x607D

Subindex 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 4-17.

Table 4-17 Introduction to sub index number 0x02 for 0x607D

Subindex 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 position trajectory planning. The sub index number 0x01 of 0x607D is introduced in Table 4-18.

Table 4-18 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	-	

0x607A: Target position

In position profile 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 4-19.

Introduction to Table 4-19 0x607A

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

The introduction of 0x6080 is shown in Table 4-20.

Introduction to Table 4-20 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 4-21.

Introduction to Table 4-21 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 4-22.

Introduction to Table 4-22 0x6083

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

0x6084: Profile cancellation

This object defines the deceleration in trajectory planning. The introduction of 0x6084 is shown in Table 4-23.

Introduction to Table 4-23 0x6084

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

0x6085: Quick stop cancellation

This object defines the fast stop deceleration. The introduction of 0x6085 is shown in Table 4-24.

Introduction to Table 4-24 0x6083

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

0x6086: Motion profile type

This object defines the curve type for position profile planning. The current supported modes are shown in Table 3-6. The introduction of 0x6086 is shown in Table 4-25.

Introduction to Table 4-25 0x6086

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

The profile curve types corresponding to the position of 0x6086 are shown in Table 4-26.

Table 4-26 Position profile curve types

Value	definition
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 4-27.

Table 4-27 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 4-28.

Table 4-28 Introduction to sub index 0x00 of 0x60A4

Subindex 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 4-29.

Table 4-29 Introduction to sub index 0x01 of 0x60A4

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

0x60C5: Max acceleration

This object defines the maximum acceleration in trajectory planning. The introduction of 0x60C5 is shown in Table 4-30.

Table 4-30 Introduction to 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 cancellation

This object defines the maximum deceleration in trajectory planning. The introduction of 0x60C6 is shown in Table 4-31.

Table 4-31 Introduction to 0x60C6

Index number	name	object type	mapping	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 location unit. The introduction of 0x60C5 is shown in Table 4-32.

Table 4-32 Introduction to 0x6062

Index number	nam e	object type	mappin g	acces s	Default value
0x6062	Position demand value	VAR	-	RO	0
		data type	unit	rang e	

		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 4-33.

Table 4-33 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 4-34.

Table 4-34 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 (232-1), this function is not used. The introduction of 0x6065 is shown in Table 4-35.

Table 4-35 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 for the position following error exceeding the threshold (0x6065). When the time set by is exceeded, a position following error is considered to occur. 0x6066 is described in Table 4-36.

Table 4-36 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 position where the difference between the target position and the actual position defined by this object reaches the threshold, if this value is set to 0xFFFF FFFF (232-1), then this function is not used. The introduction of 0x6067 is shown in Table 4-37.

Table 4-37 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, then consider reaching the target location. The introduction of 0x6068 is shown in Table 4-38.

Table 4-38 Introduction to 0x6068

Index number	name	object type	mapping	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 4-39.

Table 4-39 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	-	

4.3.6 Application examples

1. Set 6060h to1 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

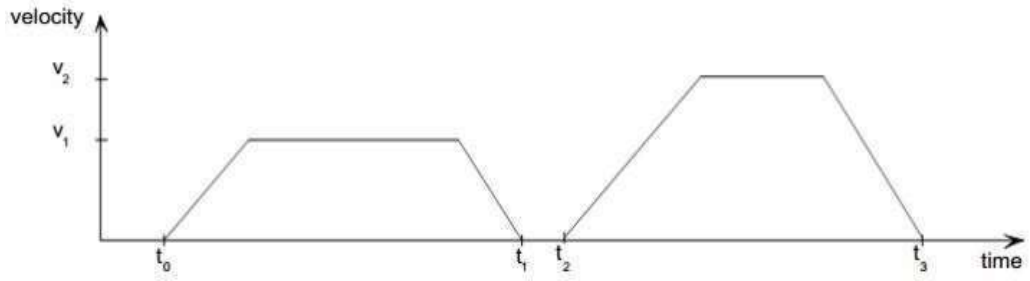


Figure 4-2 Single set point schematic diagram

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

1) Set6040h to 0x4F (where bit6 is the relative position mode and bit3~bit0 are to enable 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 set 6041h.bit12 after receiving 6040h. bit4=1. At the same time, the drive automatically determines the cache position and resets 6041h. bit12. The master station clears the bit4 of 6040h to prepare to send the next target position command.

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

5) Set 6040h to 0x0F;

6) Set 607Ah as the target position command;

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

8) After receiving 6041h.bit4=1 the drive set 6041h bit12, the master station should clear 6040h bit4 to prepare for sending the next target position command.

2. Multi point immediate effect mode

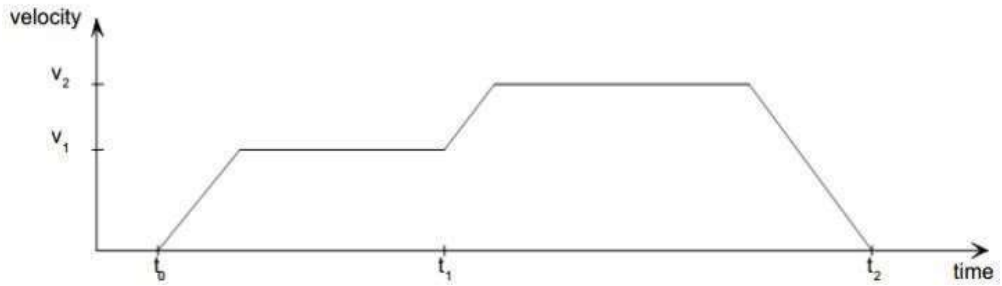


Figure 4-3 Schematic diagram of Change set immediate mode

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

1) Set6040h to 0x6F (where bit6 is set to relative position mode, bit5 is set to take effect immediately, and bit3~bit0 are enabling drive);

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 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) Set6040h to 0x2F (bit5 is set to take effect immediately, and bit3~bit0 are enabling drive);

2) Set607Ah as the target position command;

3) Set6040h to 0x3F and trigger the position command to take effect;

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

5) 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, 6041h.bit12 will be set.

3. Point to point stop:

There are two ways to stop during point to point operation:

1) By controlling the quickstop bit of the control word, i.e. sending 0xB, the servo emergency stop is controlled according to the 402 control parameters 0x605Arelated mentioned above to stop;

2) By controlling the halt bit of the control 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 point again.

4.4 Speed profile mode

4.4.1 Function Introduction

Speed profile mode, also known as 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 Figures 4-4.

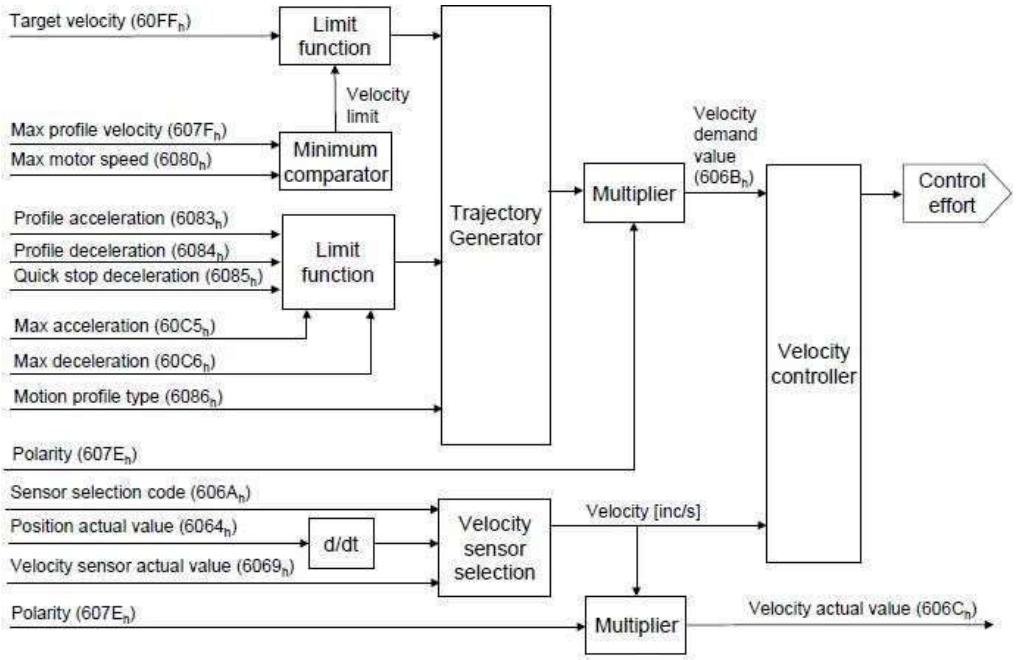


Figure 4-4 Speed profile mode

4.4.2 Operation method

1. Set [6060h: Mode of operations] 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 feedback on the status of the servo drive (Speed zero, Max slippage error, Target reached);

4.4.3 The use of the Controlword

Some bits of the control word and status word have specific meanings in speed profile mode. The structure of control words is shown in Table 4-40

Table 4-40 Structure of Control Words in Speed Profile Mode

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

WhenBit8 is set to 1, the operation of the shaft can be stopped, as shown in Table 4-42.

Table 4-41 Definition of Control Word Bit8

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

4.4.4 The use of the Statusword

The structure and definition of status words are shown in Table 4-42.

Table 4-42 Definition of Status Words in Speed Profile Mode

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

The definitions of Statusword Bit10, Bit12, and Bit13 are shown in Table 4-43.

Table 4-43 Definition of Statusword Bit10, Bit12, and Bit13

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

4.4.5 Object parameters related to velocity profile 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 4-44.

Table 4-44 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 4-45.

Table 4-45 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 4-46.

Table 4-46 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 at which the difference between the target speed and the actual speed is reached, if this value is set to 0xFFFF (216-1), then this function is not used, as shown in Table 4-47.

Table 4-47 Introduction to 0x606D

Index number	name	object type	mapping	access	Default value
0x606D	Velocity window	VAR	-	RW	2^{16}-1
		data type	unit	range	
		UINT16	UU	-	

0x606E: Velocity window time

This object defines a continuous cumulative time value during 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 4-48.

Table 4-48 Introduction to 0x606E

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

0x606F: Velocity 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 shaft is considered static. As shown in Table 4-49.

Table 4-49 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: Velocity threshold time

This object defines the continuous cumulative time value during which 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 4-50.

Table 4-50 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 velocity

This object defines the maximum allowable speed in the positive and negative 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 which is 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 cancellation

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 profile planning. The relevant instructions for 0x6086 are introduced in 4.3.5.

0x60A4: Profile jerk

This object defines the jerk speed when the motion profile 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 target speed value, as shown in Table 4-51.

Table 4-51 Introduction to 0x60FF

Index number	name	object type	mapping	access	Default value
0x60FF	Target velocity	VAR	-	RW	12
		data type	unit	range	
		UINT16	ms	-	

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 (2^{32}-1), then this function is not used, as shown in Table 4-52.

Table 4-52 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 for the speed following error exceeding the threshold (0x2200. 01). When the time set by is exceeded, a speed following error is considered to occur. As shown in table 4-53.

Table 4-53 Introduction to 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 4-54.

Table 4-54 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 speed profile curve types corresponding to 0x2117 are shown in Table 4-55.

Table 4-55 Position profile curve types

Value	Definition
0	Linear ramp
3	Jerk limited ramp

4.4.6 Application examples

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

1. Set6060h to3 and select Profile Velocity Mode;
2. Set6083h and 6084h to modify acceleration and deceleration times;
3. Set60FFh to modify the target speed command.
4. Set 6040h to enable the drive, send 0x06->0x07->0x0F to enable, and send 0x06/0x07 interrupt profile mode;
5. Stop: Stop as described in the 4.5 position profile mode.

4.5 Torque profile mode

4.5.1 Function Introduction

Torque profile mode, Giving 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 Figures 4-5.

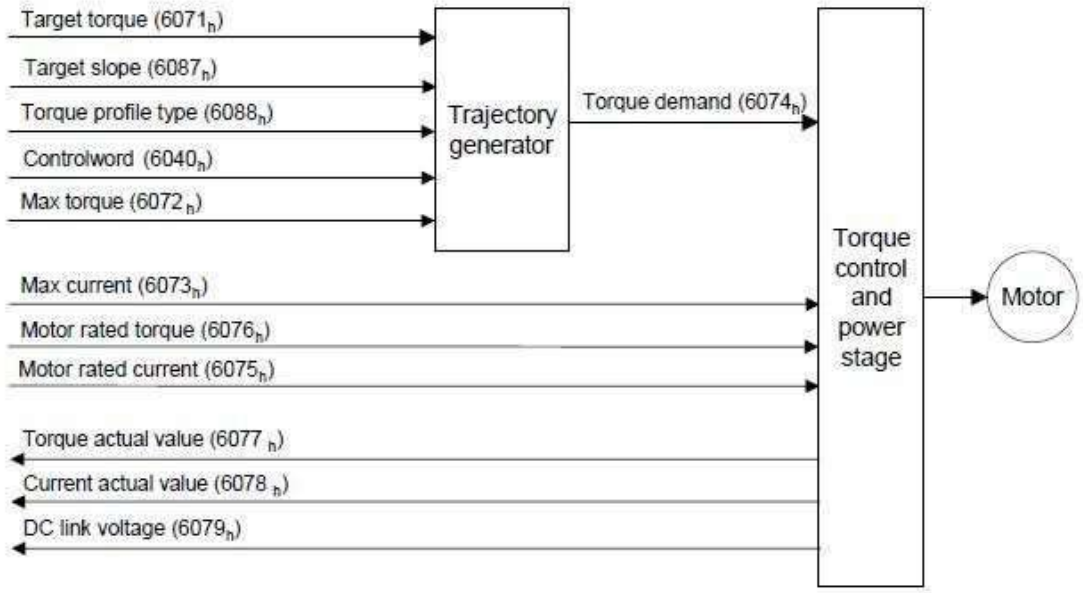


Figure 4-5 Torque Profile Mode

4.5.2 Operation method

1. Set [6060h: Mode of operations] to 4 (Torque profile 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;

4.5.3 The use of the Controlword

Some bits of the control word and status word have specific meanings in torque profile mode. The structure of control words is shown in Table 4-56.

Table 4-56 Structure of Control Words in Torque Profile Mode

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

WhenBit8 is set to 1, the operation of the shaft can be stopped, as shown in Table 4-57.

Table 4-57 Definition of Control Word Bit8

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

4.5.4 The use of the Statusword

The structure and definition of status words are shown in Table 4-58.

Table 4-58 Definition of Statusword in Torque Profile Mode

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

The definition of Statusword Bit10 is introduced in Table 4-59.

Table 4-59 Definition of Statusword Bit10

Bit	Value	defi ne
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

4.5.5 Object parameters related to torque profile mode

0x6071: Target torque

This object defines the target torque value, as shown in Table 4-60.

Table 4-60 Introduction to 0x6071

Index number	name	object type	mapping	access	Default value
0x6071	Target torque	VAR	RxPDO	RW	0
		data type	unit	range	
		INT16	Rated torque/1000	-	

0x6074: Torque demand

This object defines the torque command values input into the torque controller, as shown in Table 4-61.

Table 4-61 Introduction to 0x6074

Index number	name	object type	mapping	access	Default value
0x6074	Torque demand	VAR	-	RO	0
		data type	unit	range	
		INT16	Rated torque/1000	-	

0x6077: Torque actual value

This object defines the actual torque value of the motor, as shown in Table 4-62.

Table 4-62 Introduction to 0x6077

Index number	name	object type	mapping	access	Default value
0x6077	Torque actual value	VAR	-	RO	0
		data type	unit	range	
		INT16	Rated torque/1000	-	

0x6078: Current actual value

This object defines the actual current value of the motor, as shown in Table 4-63.

Table 4-63 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 4-64.

Table 4-64 Introduction to 0x6087

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

0x6088: Torque profile type

This object defines the curve types for torque profile planning, as shown in Table 4-65.

Table 4-65 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 4-66.

Table 4-66 Types of torque profile curves

Value	define
0	**Linear ramp**

0x2115: TrqLoopPosVelLimit

This object defines the torque control forward speed limit values, as shown in Table 4-67.

Table 4-67 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 4-68.

Table 4-68 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	-	

4.5.6 Application examples

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

1. Set 6060h to 4 and select Torque profile mode;
2. Set 6087h the slope of torque;
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 profile mode;
7. Stop: Stop as described in the 4.5 position profile mode.

4.6 Periodic synchronization position mode

4.6.1 Function Introduction

Periodic synchronization position mode, as the cyclic sync position mode. 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 4-6.

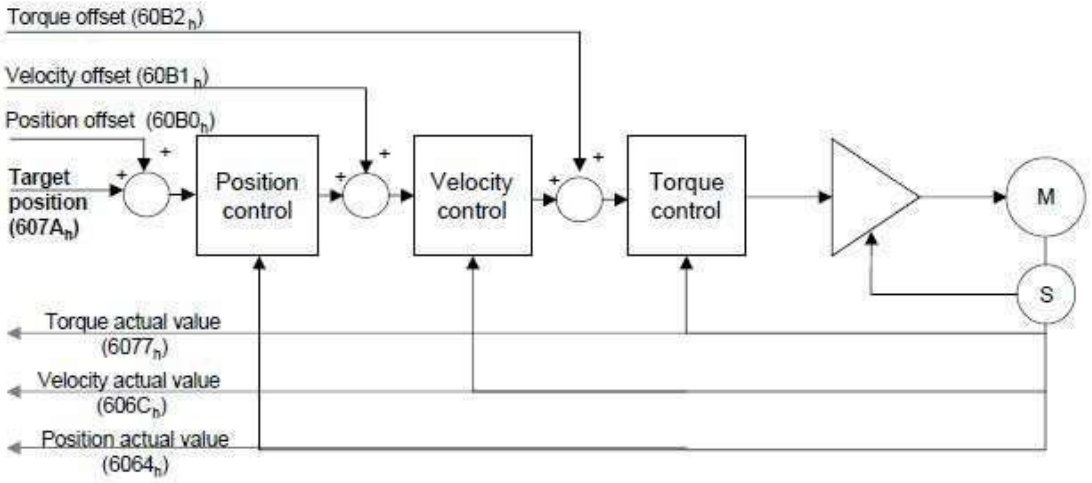


Figure 4-6 Cyclic Sync Position Mode

4.6.2 Operation mode

1. Set [60C2:01 synchronous interpolation cycle=1-4ms];
2. Set [6060h: Mode of operations] to 8(Cyclic synchronous position mode);
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); The corresponding parameter inside the drive is P4.12;
5. Query [6064h: Position actual value] to obtain feedback on the actual position of the motor;
6. Query [6041h: Status word] to obtain status feedback (following error, target reached) of the servo drive;

4.6.3 The use of the Controlword

The bit of the control word has no specific meaning in the Cyclic Sync Position Mode.

4.6.4 The use of the Statusword

Some bits of the status word have specific meanings in the Cyclic Sync Position Mode. The structure and definition of status words are shown in the table below. The structure of status words is shown in Table 4-69.

Table 4-69 Structure of State Words in Cyclic Syn 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 4-70.

Table 4-70 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	Definition
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 tracking error
	1	Tracking Error

4.6.5 Cyclic sync position mode related object parameters

0x607A: Target position

This object defines the target position, and the parameter description is introduced in 4.3.5.

0x6064: Position actual value

This object defines the actual position value obtained from the encoder, and the parameter description is introduced in 4.3.5.

0x60B0: Position offset

This object defines the bias value of target position (0x607A), as shown in Table 4-71.

Table 4-71 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 a bias value for velocity, which is known as velocity feedforward in the Cyclic sync position mode, as shown in Table 4-72.

Table 4-72 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 a bias value for torque, which is torque feedforward in the Cyclic sync position mode.

Table 4-73 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	-	

4.6.6 Application examples

1. Set 6060h to 8 and select Cyclic Sync Position Mode;
2. Set 6040h to enable the drive, sending 0x0F;
3. Set 607Ah has the target position (absolute position) and perform position control.

4.7 Homing mode

4.7.1 Function Introduction

Zero finding mode, also known as 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 Figures 4-7.

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 computer or PLC, a reset process led by the upper computer is required.

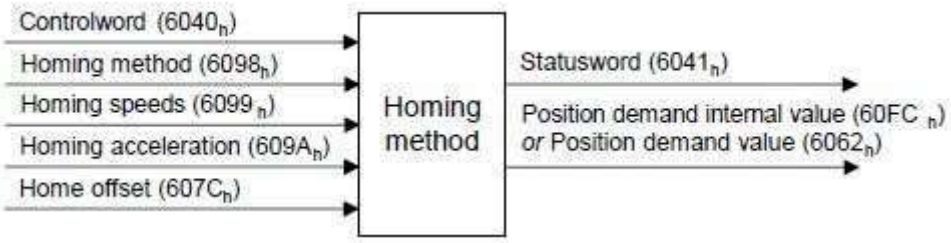


Figure 4-7 Homing mode

4.7.2 Operation method

1. Set [6060h: Mode of operations] to 6 (homing mode);
2. Set the [6098h: Homing method] in the arrange of 1-35 (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] and modify the speed (in cnt/s) at which the limit switch is searched during the Homing process;
5. Set [6099h Sub-02: Homing speeds] and modify the speed (in cnt/s) at which the zero position is searched during the Homing process;
6. Set [609Ah: Homing acceleration] and set the homing acceleration/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. Search for limits witches and home switches for the motor, and complete the homing action;
9. Query [6041h: Status word] to obtain the status feedback of the servo drive (Homing error, Homing attained, Target reached).

4.7.3 The use of the Controlword

Certain bits of a control word have specific meanings in homing mode. The structure of control words is shown in Table 4-74.

Table 4-74 Structure of Control Words in Homing Mode

Bit	15~9	8	7	6~5	4	3~0
function	General definition	Halt	General definition	reserved	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 4-75.

Table 4-75 Definition of Control Words Bit4 and Bit8

Bit	Value	definition
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

4.7.4 The use of the Statusword

Some bits of the status word have specific meanings in homing mode. The structure and definition of status words are shown in the table 4-76.

Table 4-76 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 4-77.

Table 4-77 Definition of Status Words Bit10, Bit12, and Bit13

Bit	Value	defintion
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

4.7.5 Object parameters related to homing mode

0x607C: Home offset

This object defines the deviation value between the zero point and the mechanical origin in the application. As shown in Figures 4-8.

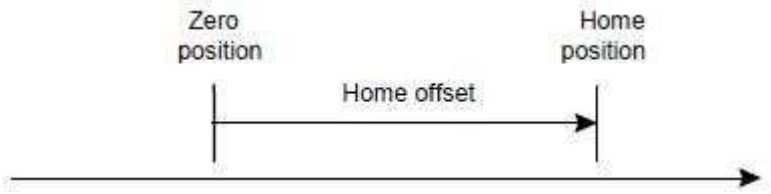


Figure 4-8 Relationship between Zero Point, Origin, and Home Offset

The introduction of 0x607C is shown in Table 4-78.

Table 4-78 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 8-5 and the introduction of section 8.5 and 0x0x6098 is shown in Table 4-79.

Table 4-79 Introduction to 0x0x6098

Index number	name	object type	mapping	access	Default value
0x6098	Home method	VAR	-	RW	35
		data type	unit	range	
		INT8	-	-	

The supported homing methods are shown in Table 4-80.

Table 4-80 Supported Homing Methods

Value	Definition
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 4-81.

Table 4-81 Introduction to 0x6099

Index number	name	object type	mapping	access	Default value
0x6099	Homing speeds	ARRAY	-	-	-
		data type	unit	range	
		UINT32	-	-	

The sub index 0x00 of 0x6099 is introduced in Table 4-82.

Table 4-82 Introduction to sub index 0x00 of 0x6099

Subindex 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 4-83.

Table 4-83 Introduction to sub index 0x01 of 0x6099

Subindex 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 4-84.

Introduction to sub index0x02 of Table 4-84 0x6099

Subindex 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 4-85.

Table4-85 0x609A Introduction

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

4.7.6 Homing method

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

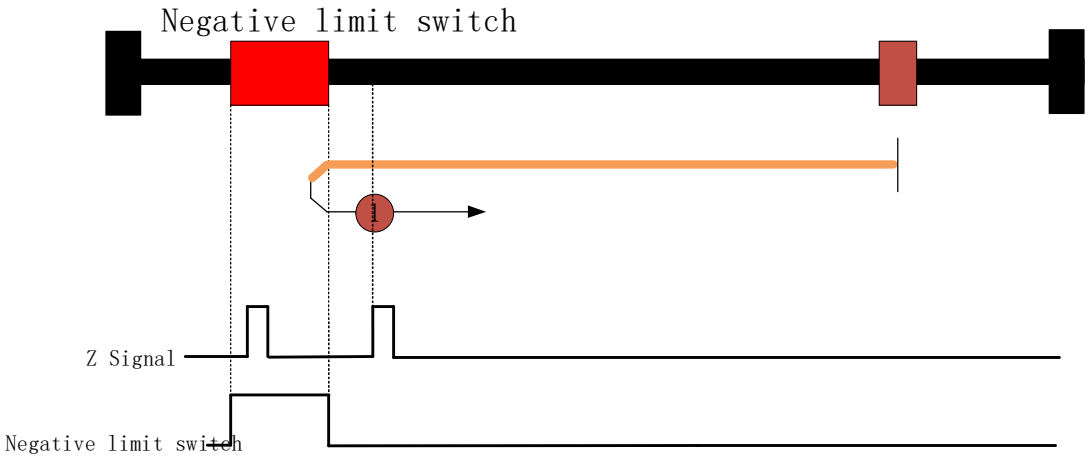


Figure 4-9 Method 1

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

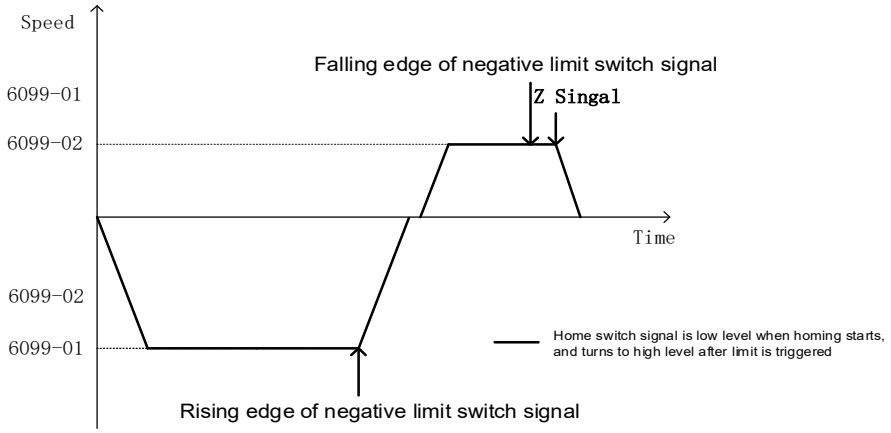


Figure 4-10 Speed-time curve of method 1

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

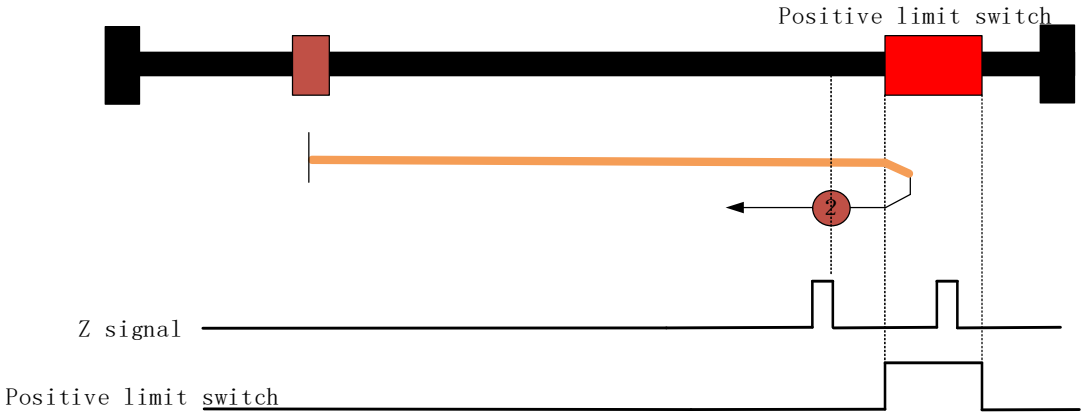


Figure 4-11 Method 2

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

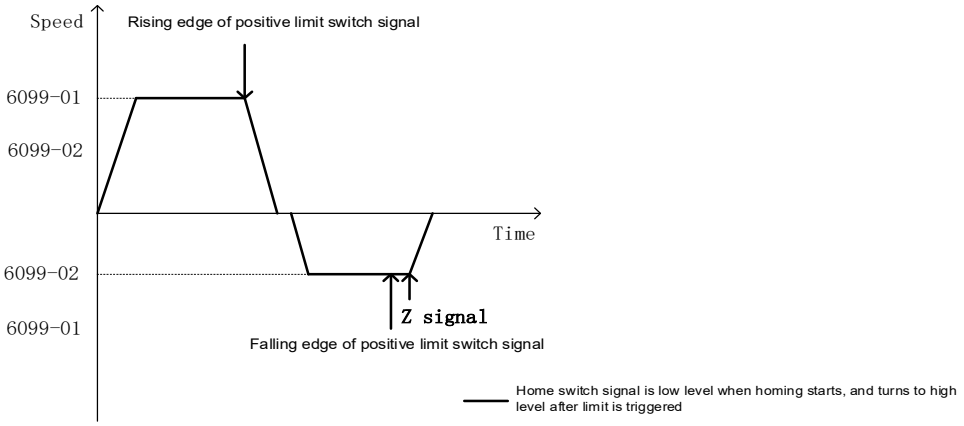


Figure 4-12 Speed-time curve of method 2

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

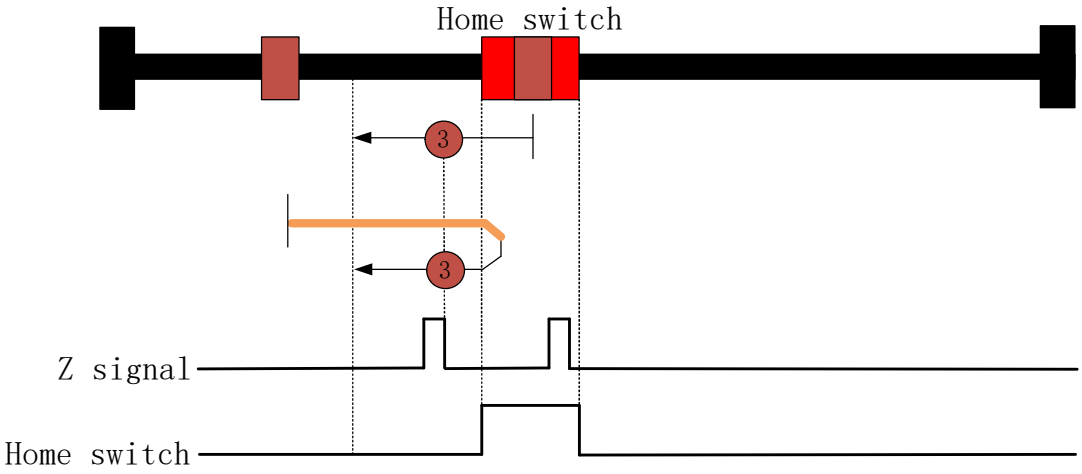


Figure 4-13 Method 3

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

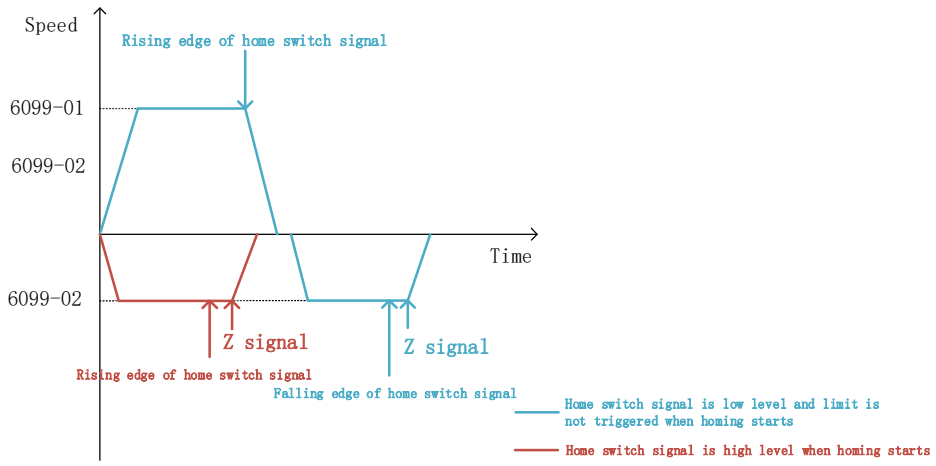


Figure 4-14 Speed-time curve of method 3

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

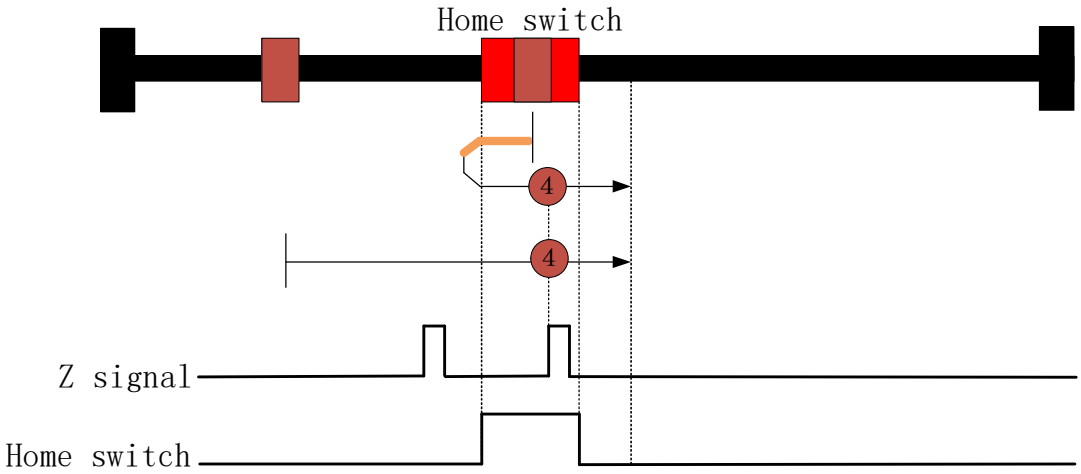


Figure 4-15 Method 4

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

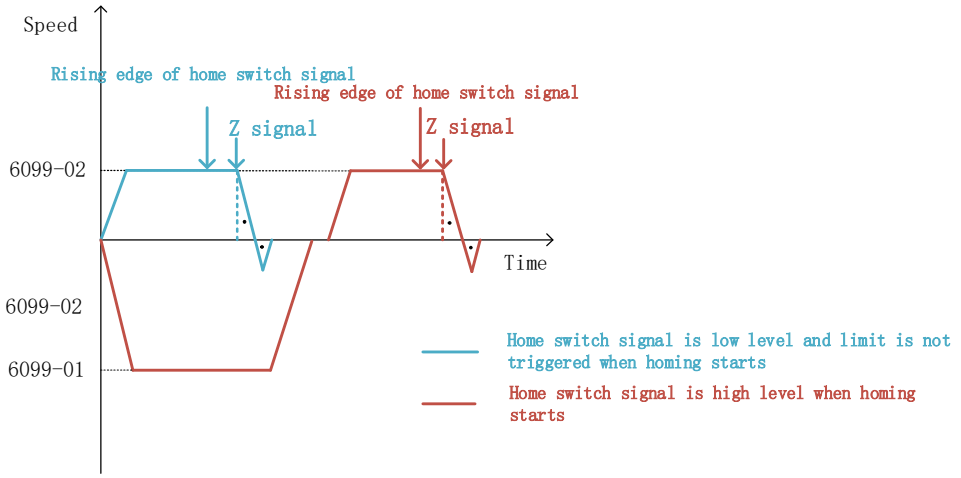


Figure 4-16 Speed-time curve of method 4

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

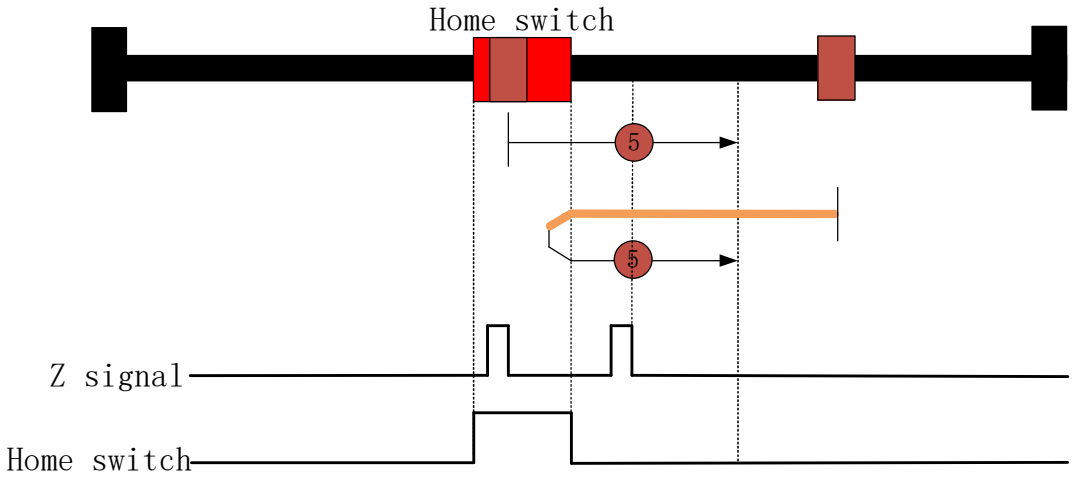


Figure 4-17 Method 5

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

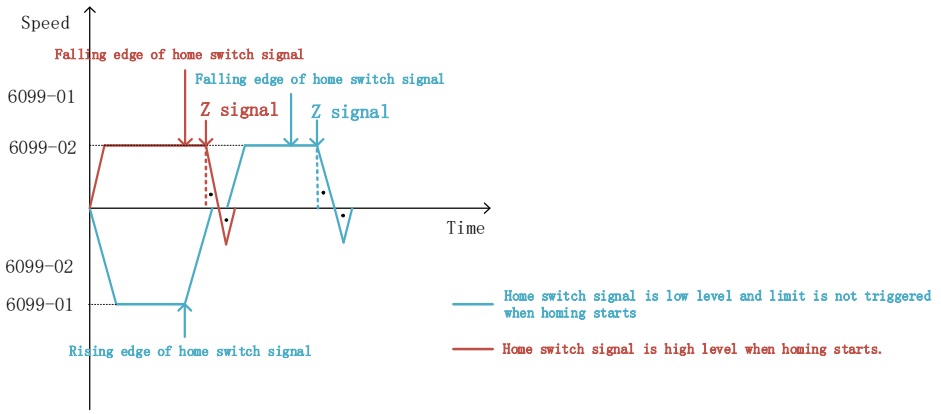


Figure 4-18 Speed-time curve of method 5

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

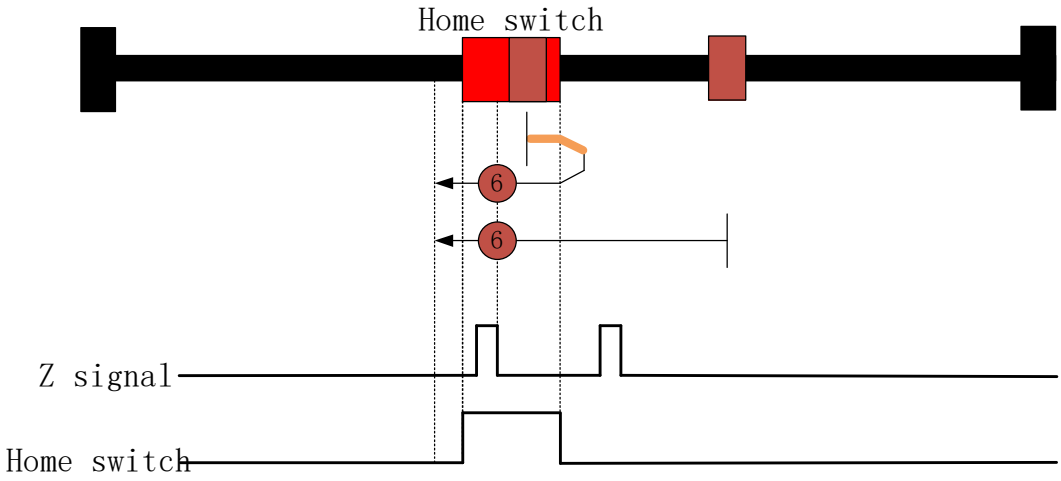


Figure 4-19 Method 6

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

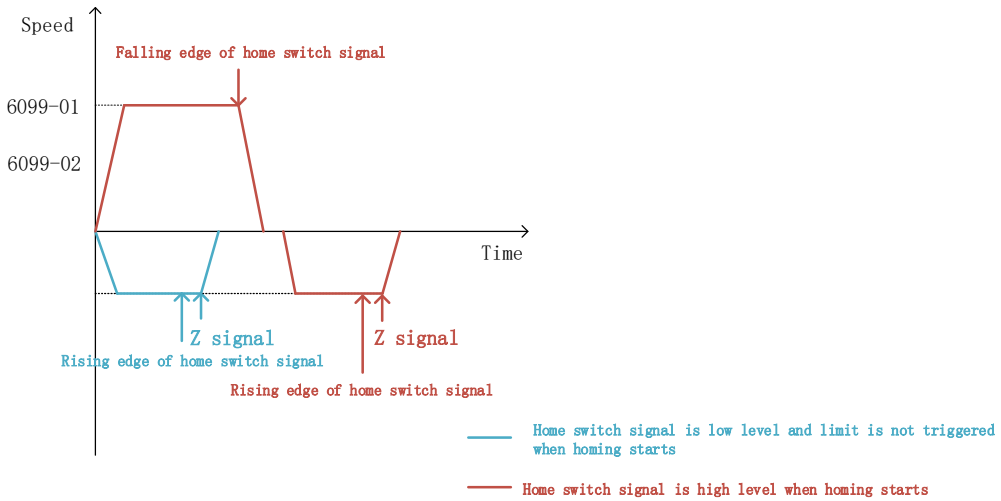


Figure 4-20 Speed-time curve of method 6

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

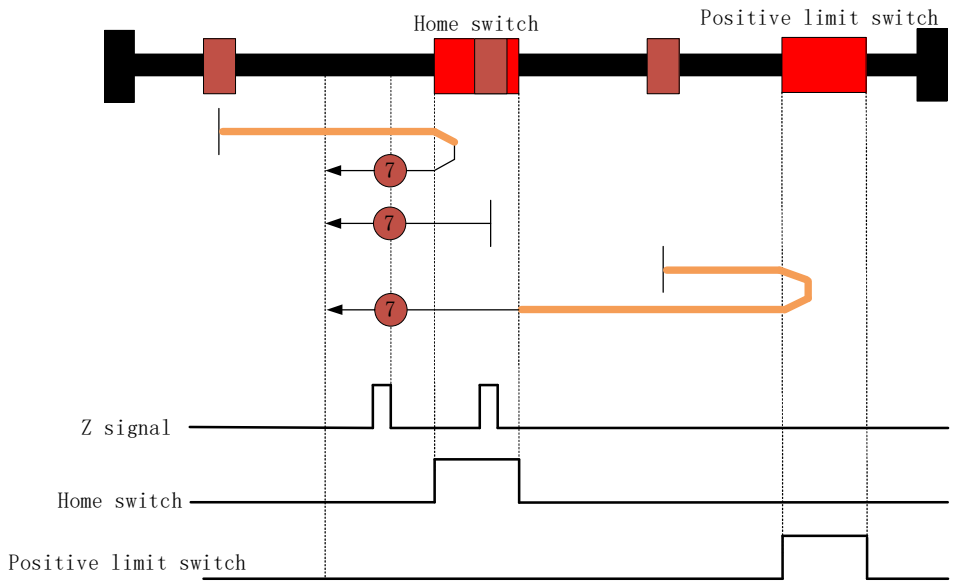


Figure 4-21 Method 7

1. When homing starts, if the home switch signal is low level, the motor moves at a high speed in the positive direction.

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

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

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

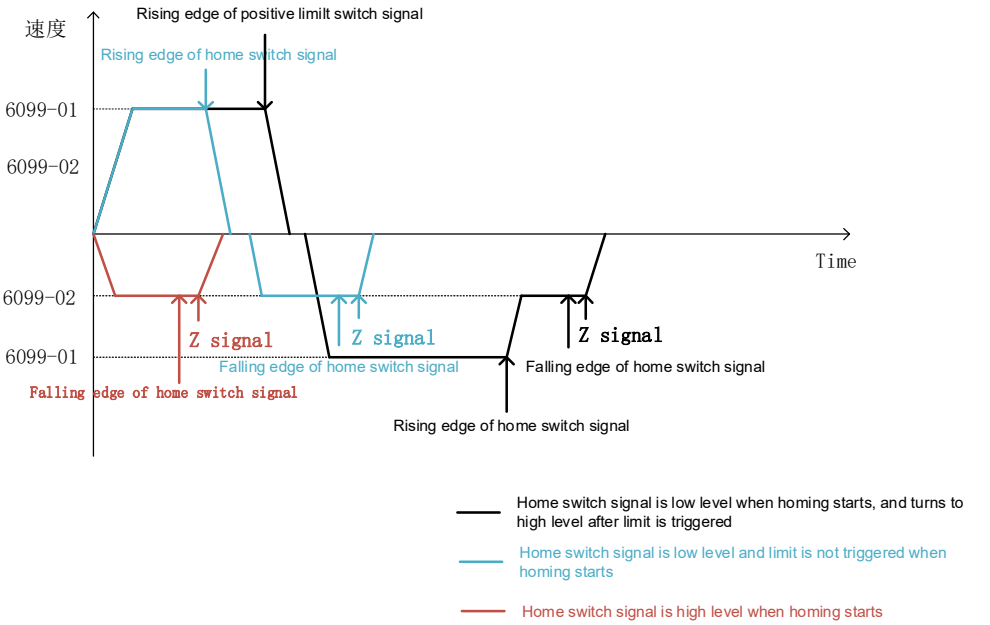


Figure 4-22 Speed-time curve of method 7

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

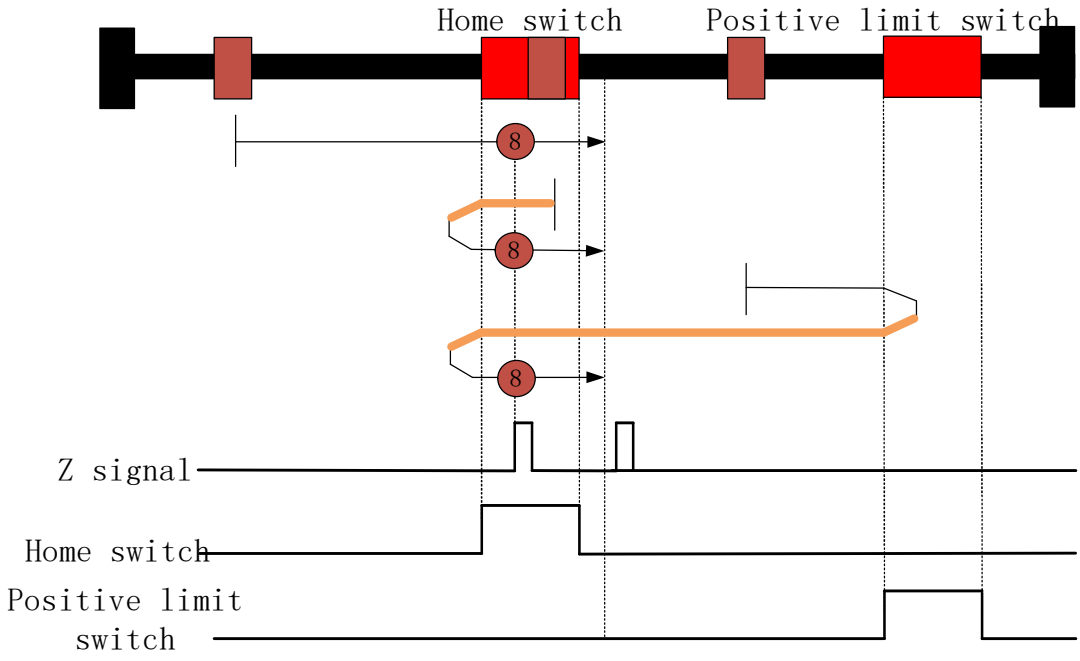


Figure 4-23 Method 8

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

1) After the home switch signal becomes high level, the motor keeps moving at a low speed (6099-02) in the positive direction. After the home switch signal becomes

high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

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

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

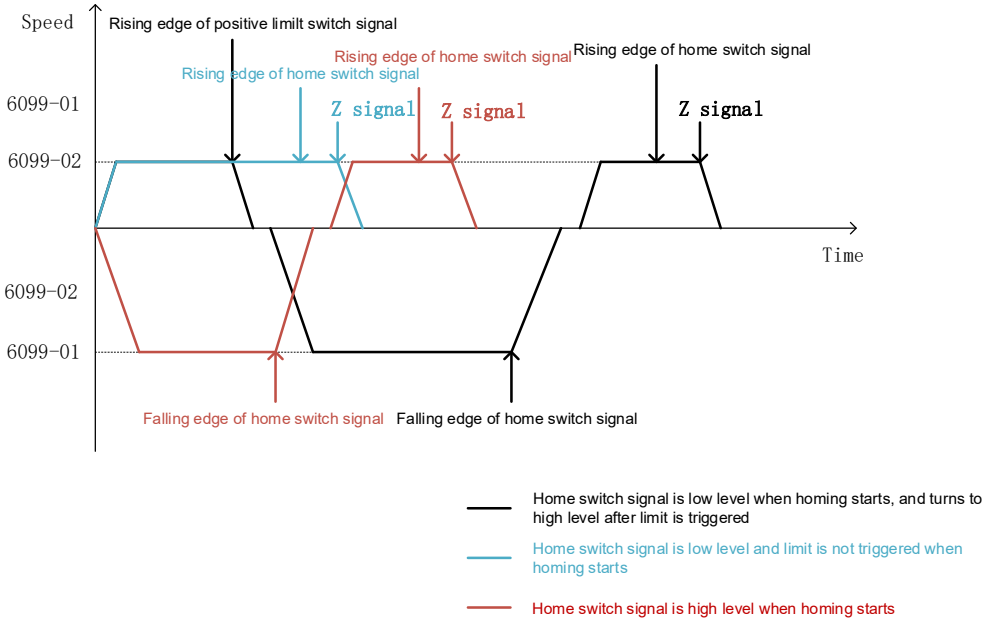


Figure 4-24 Speed-time curve of method 8

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

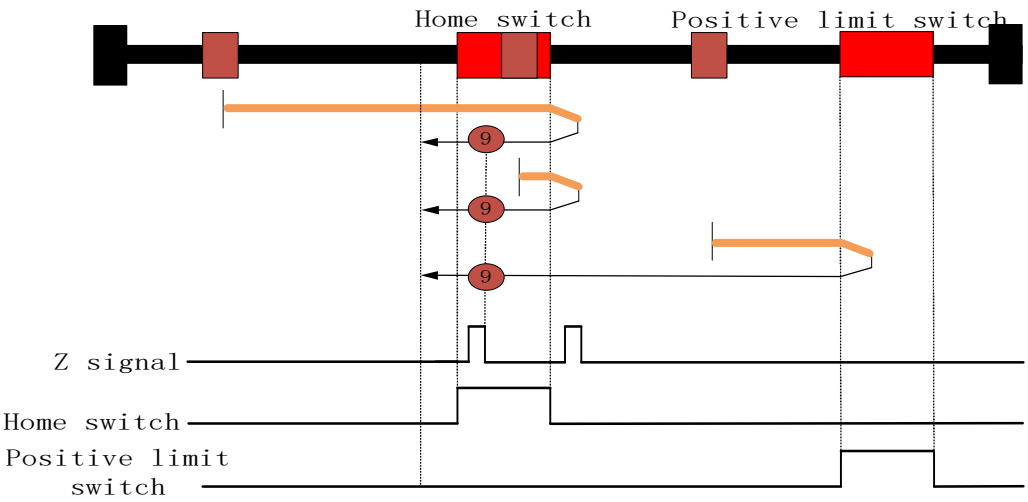


Figure 4-25 Method 9

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

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

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

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

Target reached is set to 1 when the motor stops.

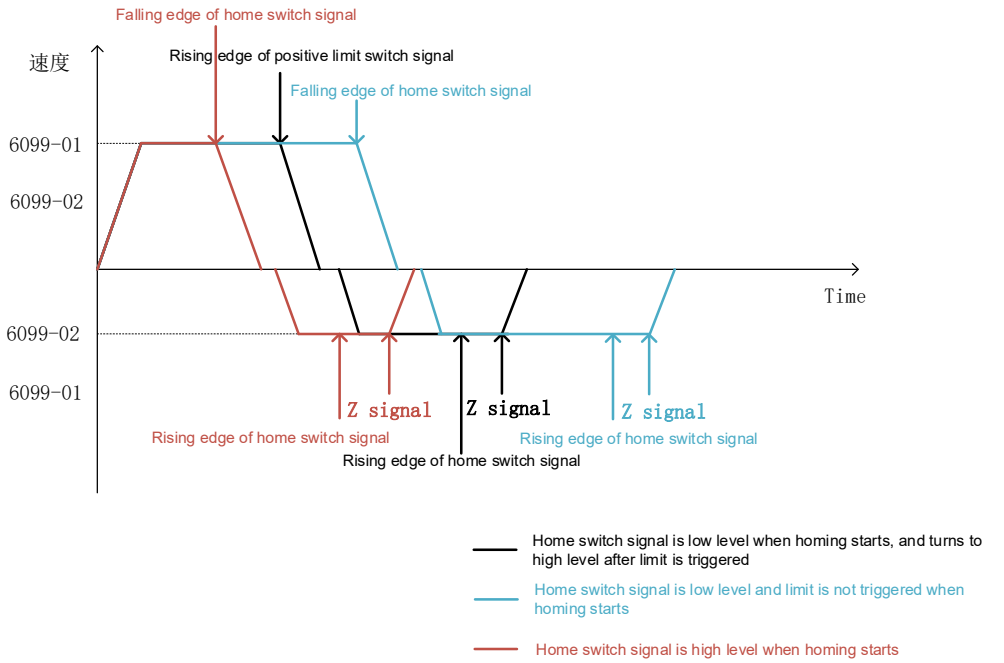


Figure 4-26 Speed-time curve of method 9

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

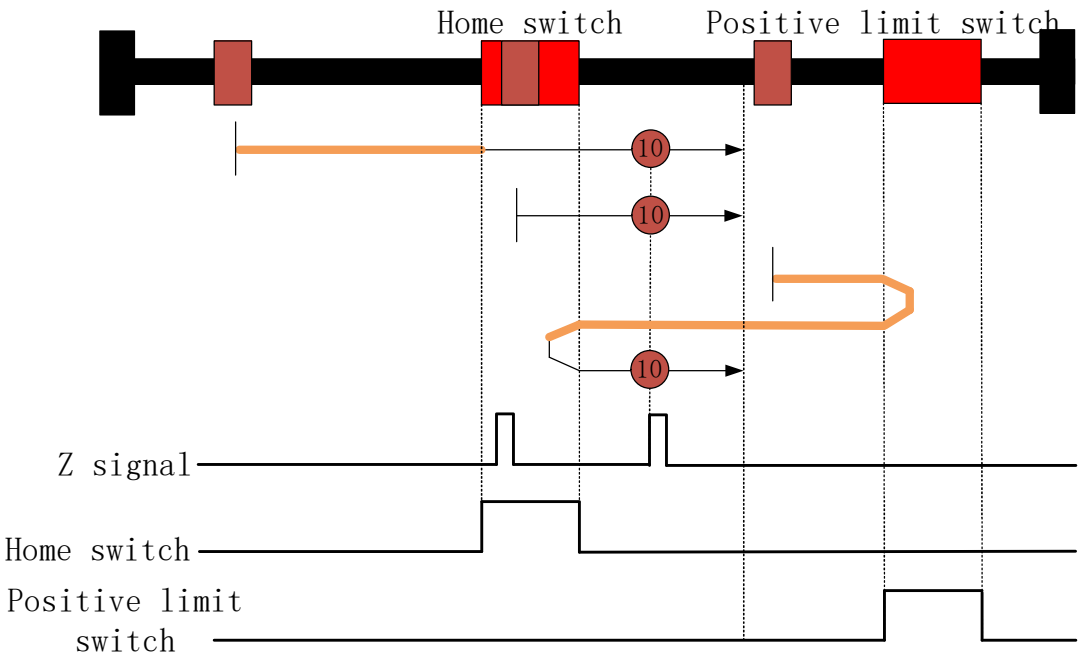


Figure 4-27 Method 10

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

1) After the home switch signal becomes high level, the motor moves with the

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

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

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

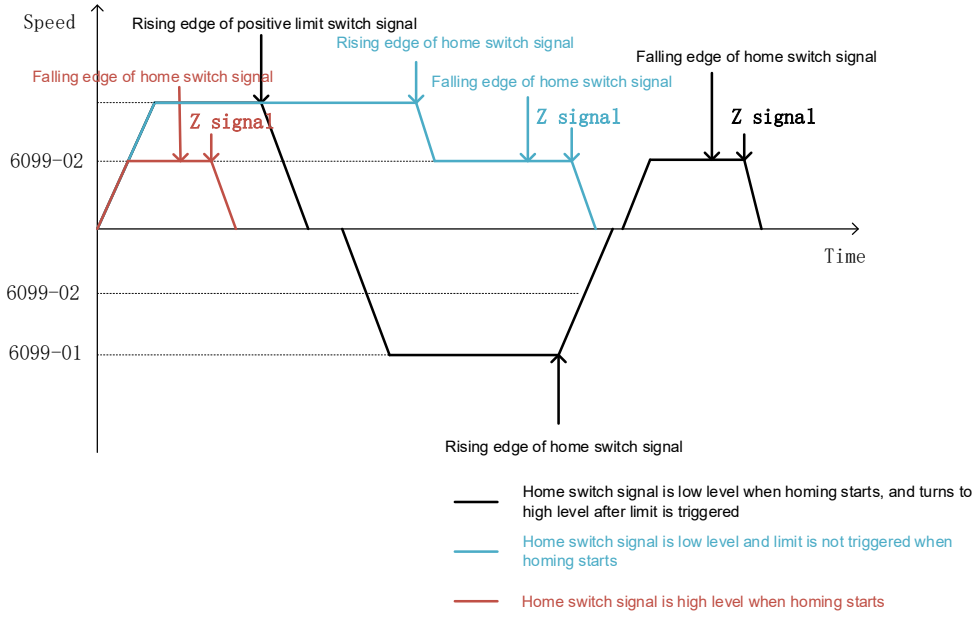


Figure 4-28 Speed-time curve of method 10

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

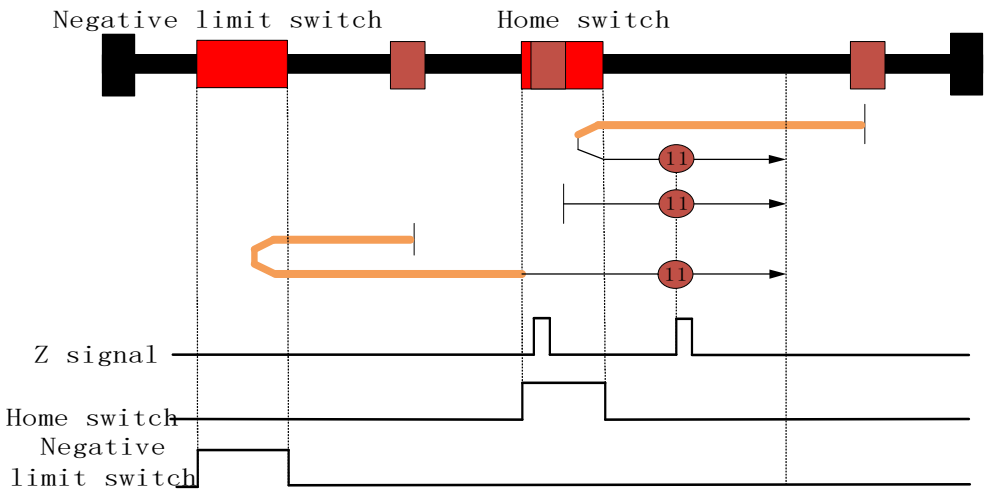


Figure 4-29 Method 11

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

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

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

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

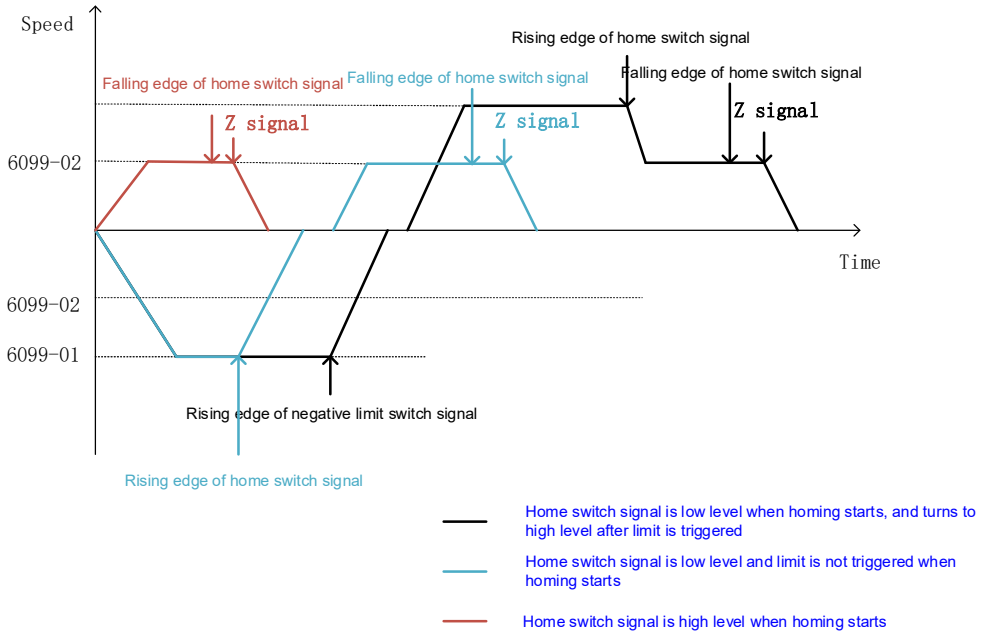


Figure 4-30 Speed-time curve of method 11

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

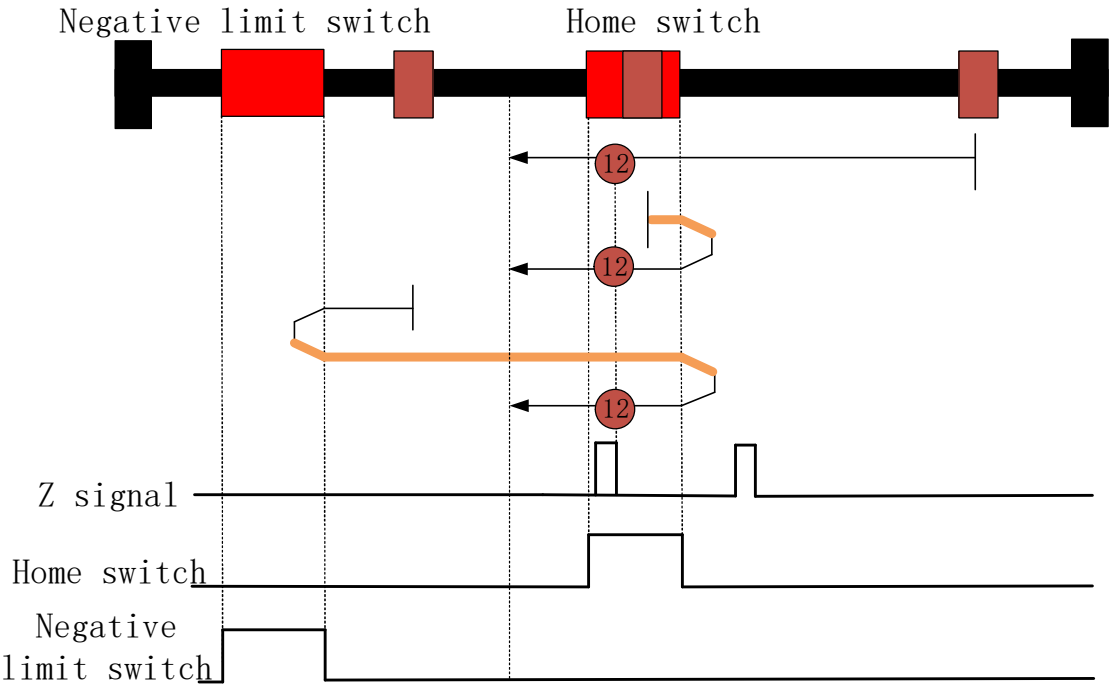


Figure 4-31 Method 12

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

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

when the motor stops.

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

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

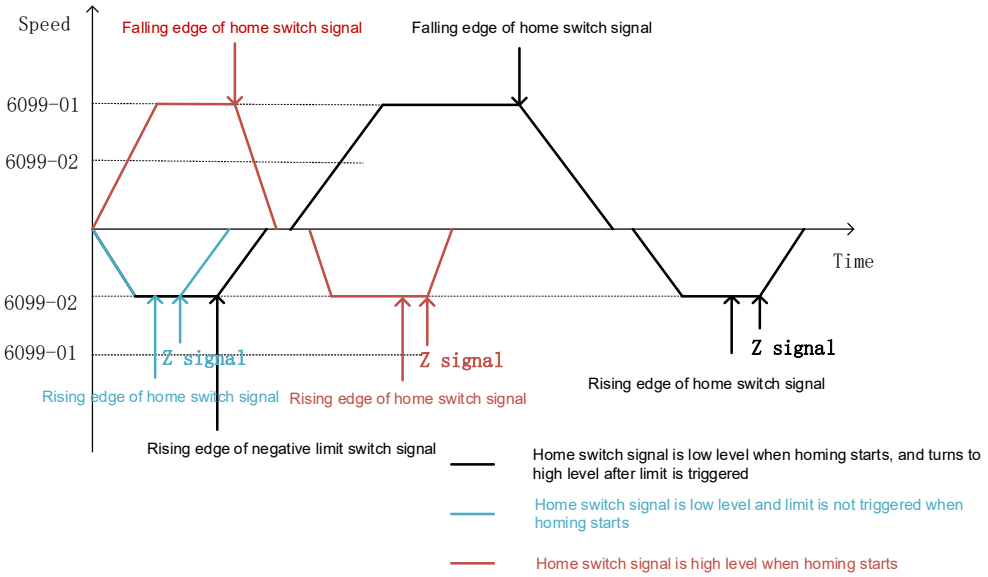


Figure 4-32 Speed-time curve of method 12

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

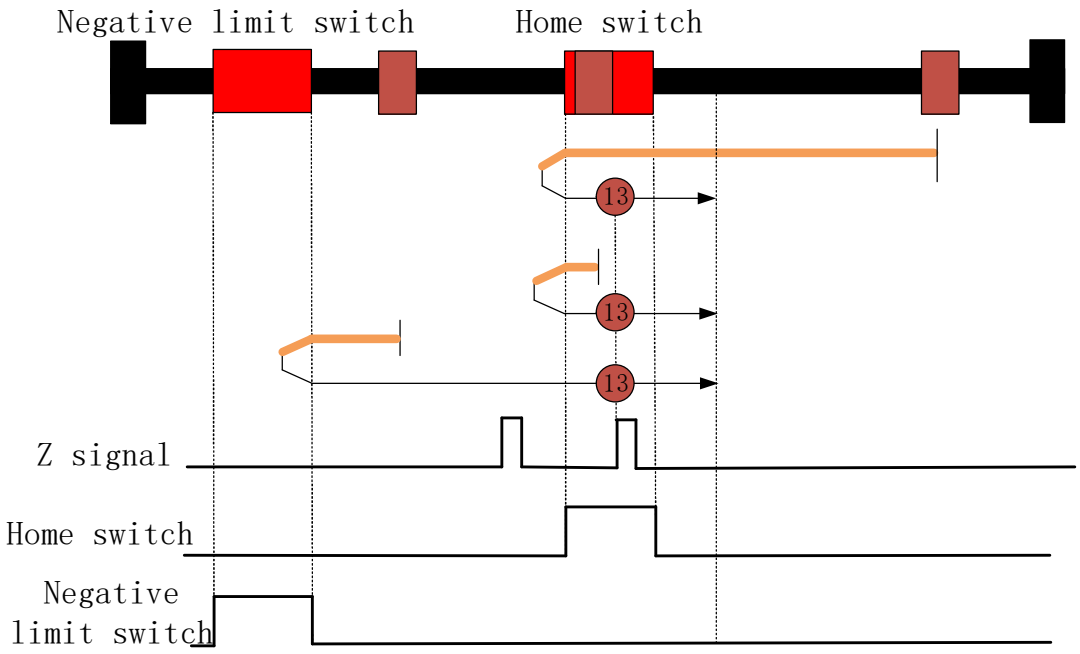


Figure 4-33 Method 13

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

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

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

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

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

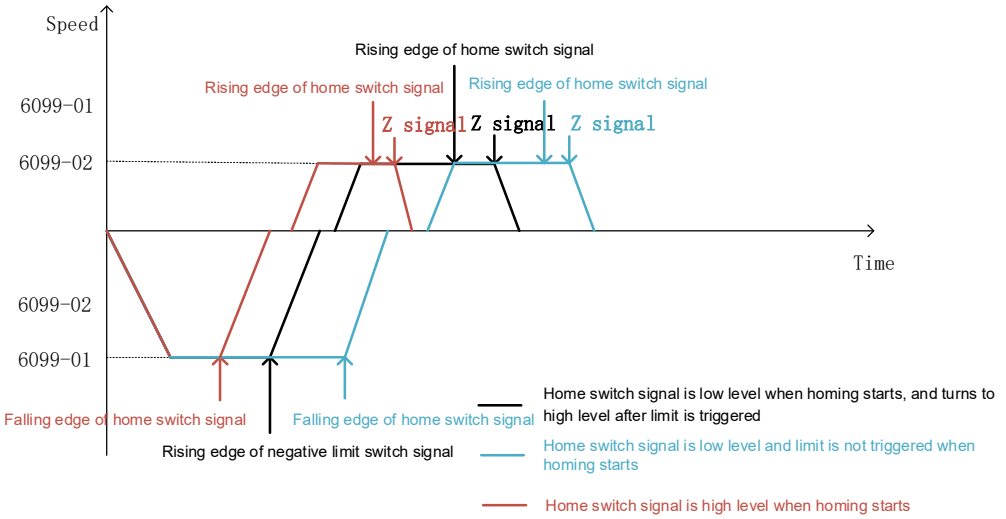


Figure 4-34 Speed-time curve of method 13

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

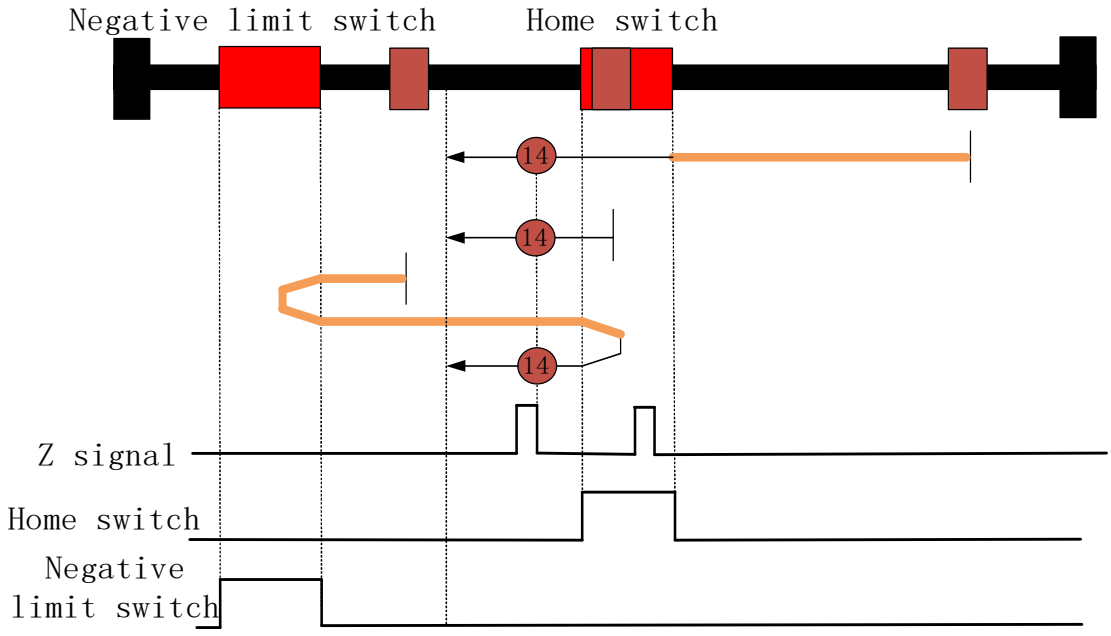


Figure 4-35 Method 14

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

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

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

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

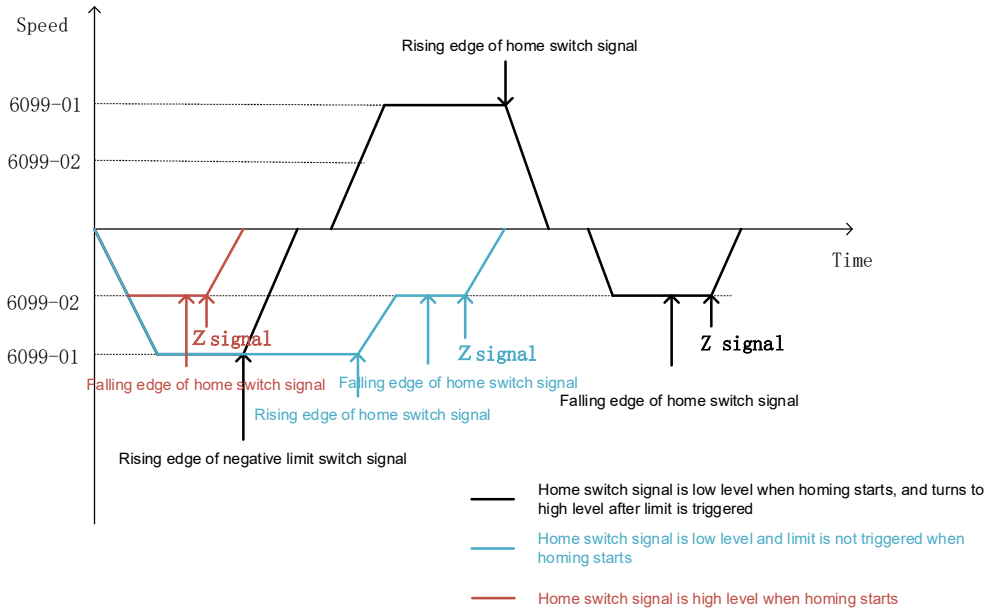


Figure 4-36 Speed-time curve of method 14

Method 15: Reserved

Method 16: Reserved

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

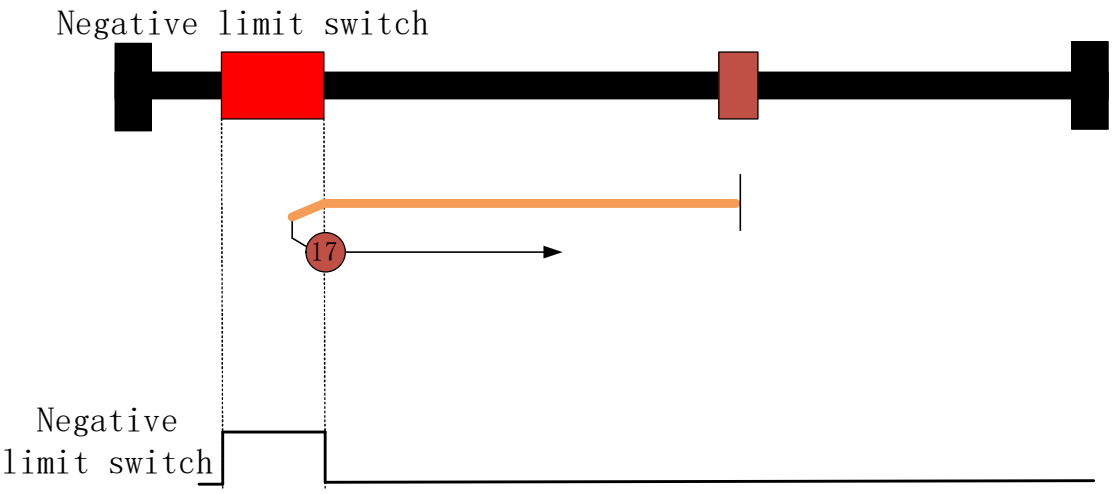


Figure 4-37 Method 17

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

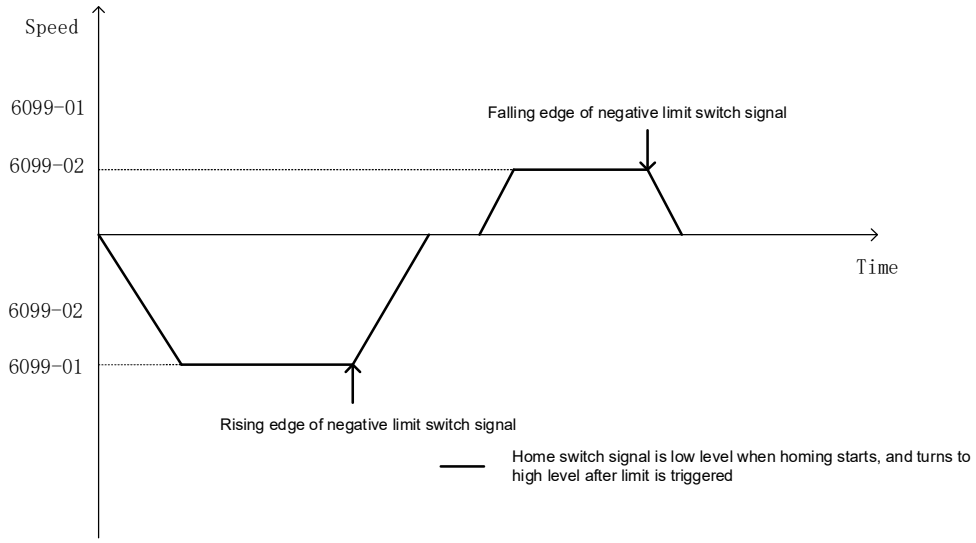


Figure 4-38 Speed-time curve of method 17

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

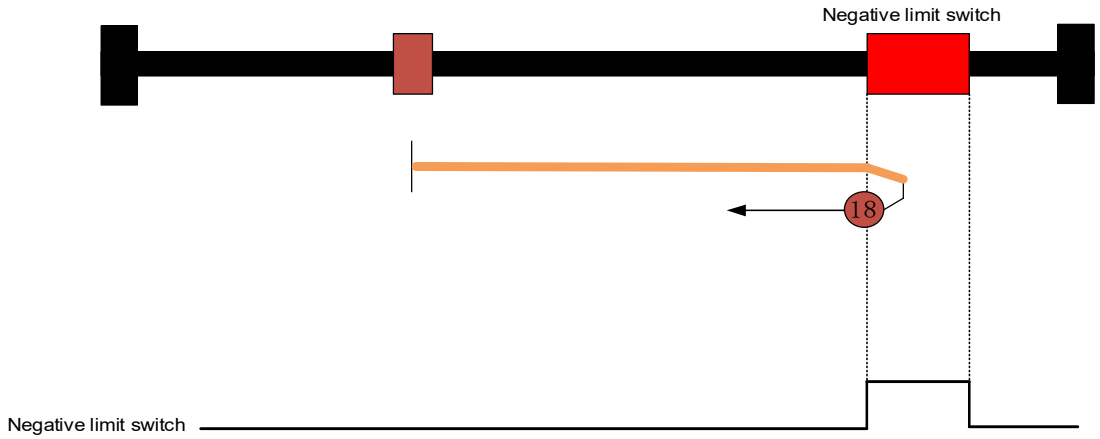


Figure 4-39 Method 18

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

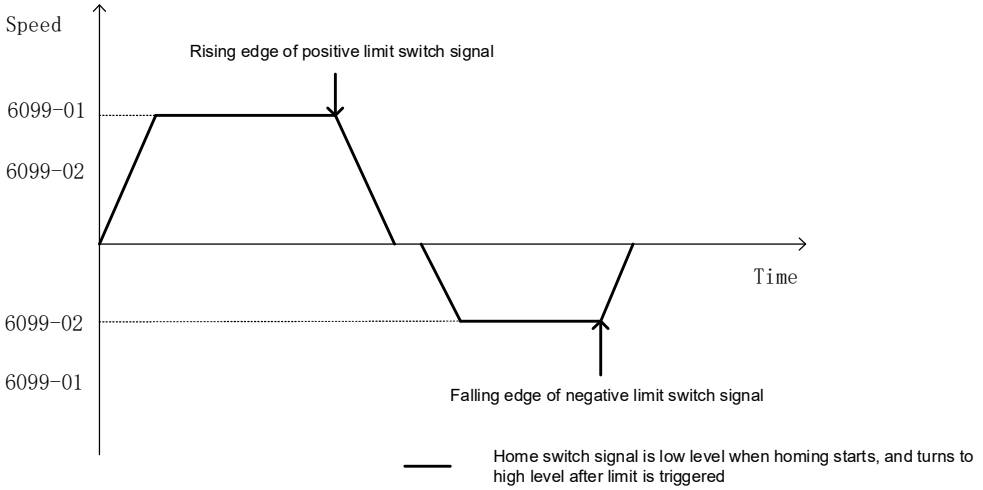


Figure 4-40 Speed-time curve of method 18

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

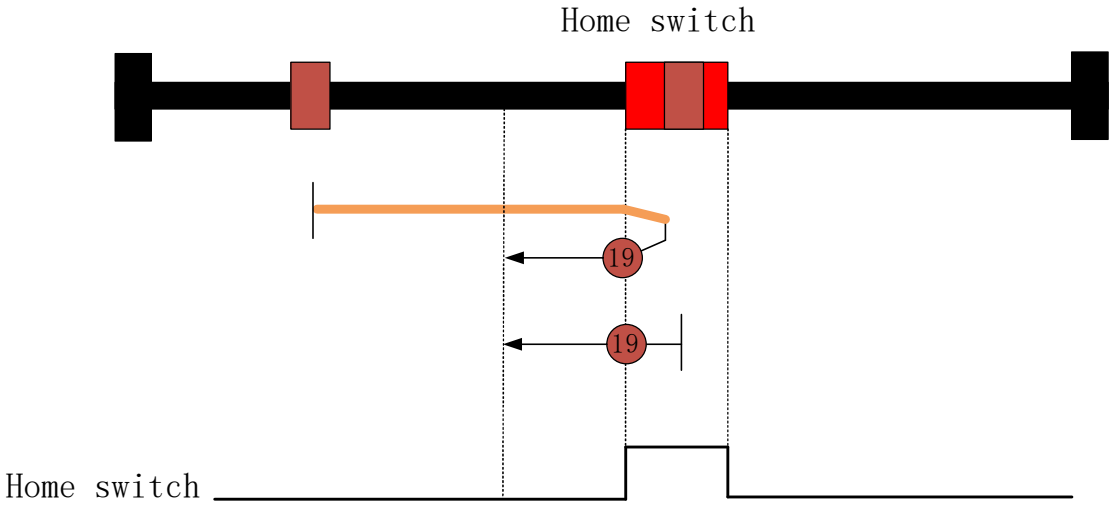


Figure 4-41 Method 19

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

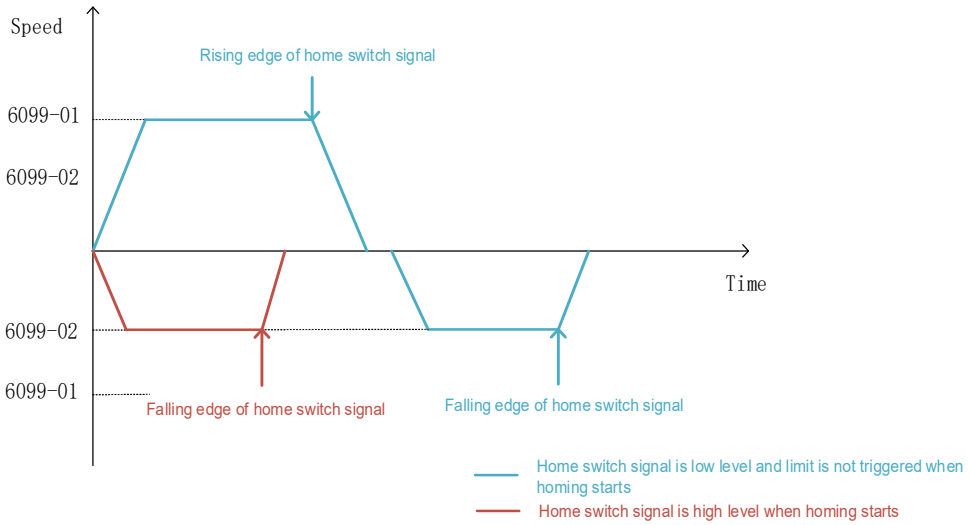


Figure 4-42 Speed-time curve of method 19

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

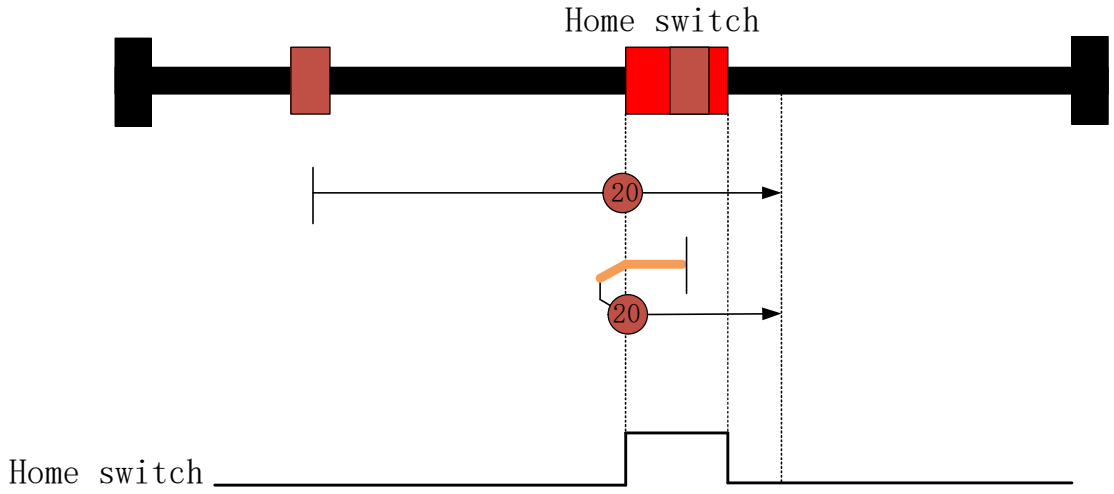


Figure 4-43 Method 20

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

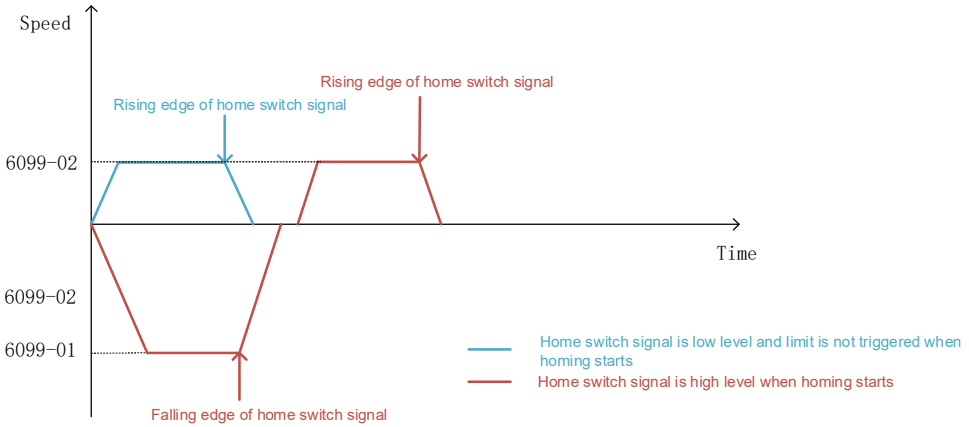


Figure 4-44 Speed-time curve of method 20

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

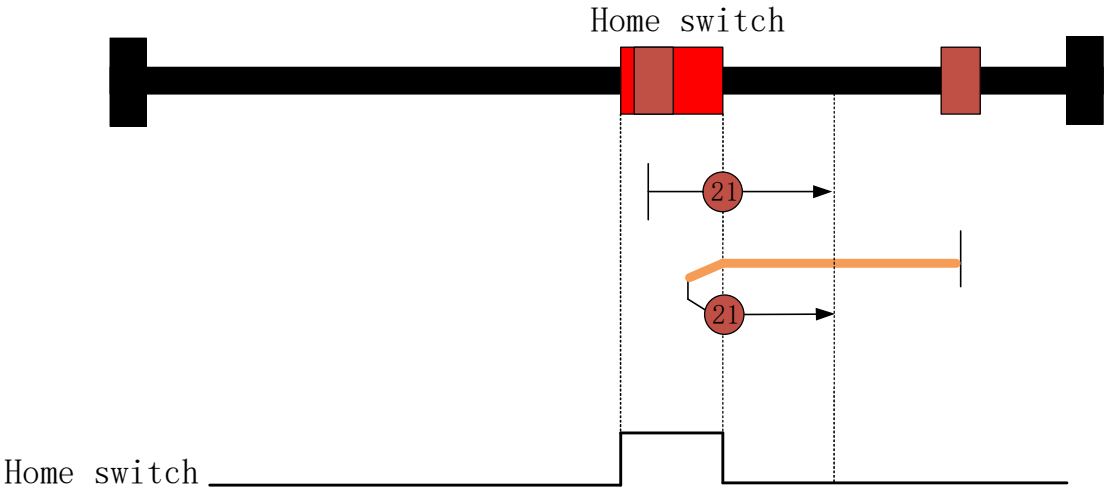


Figure 4-45 Method 21

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

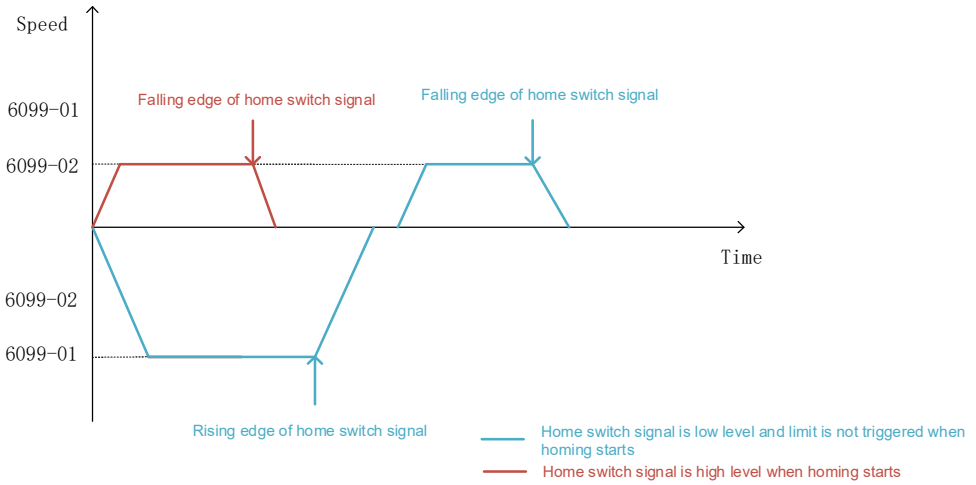


Figure 4-46 Speed-time curve of method 21

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

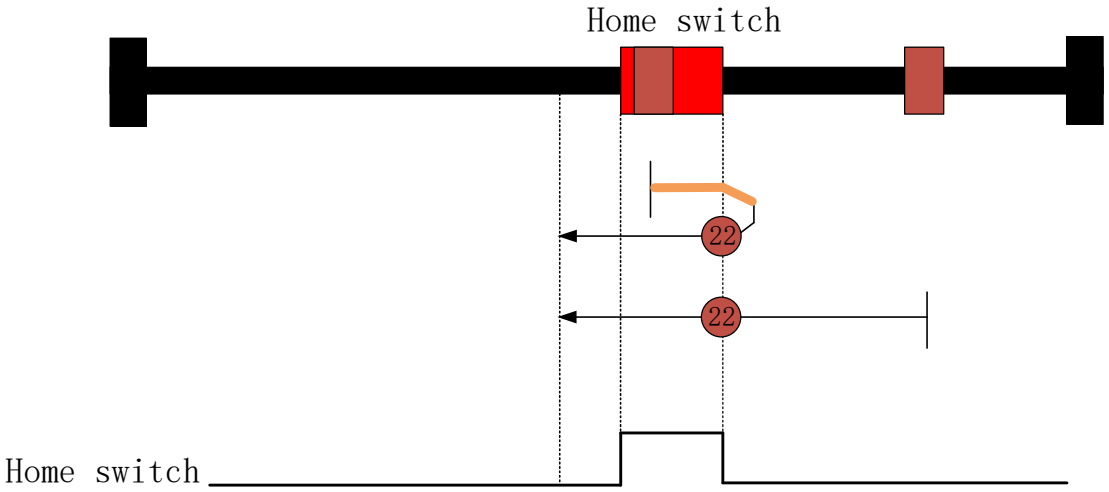


Figure 4-47 Method 22

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

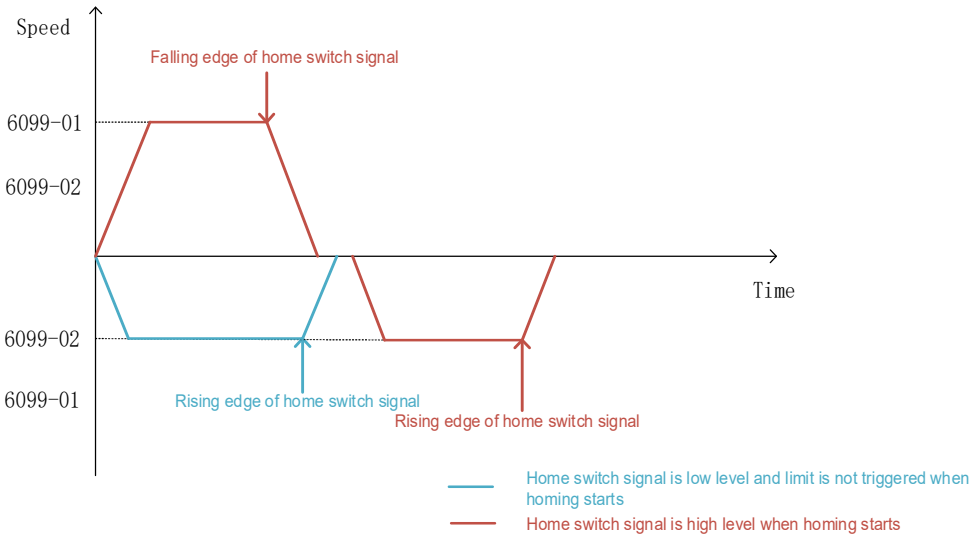


Figure 4-48 Speed-time curve of method 22

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

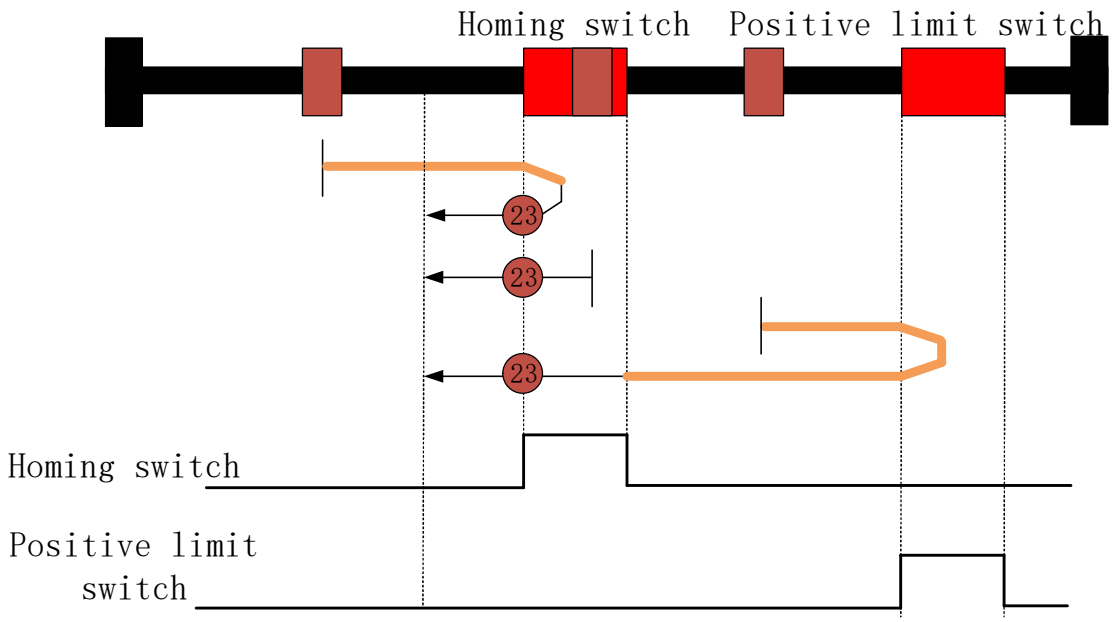


Figure 4-49 Method 23

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

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

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

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

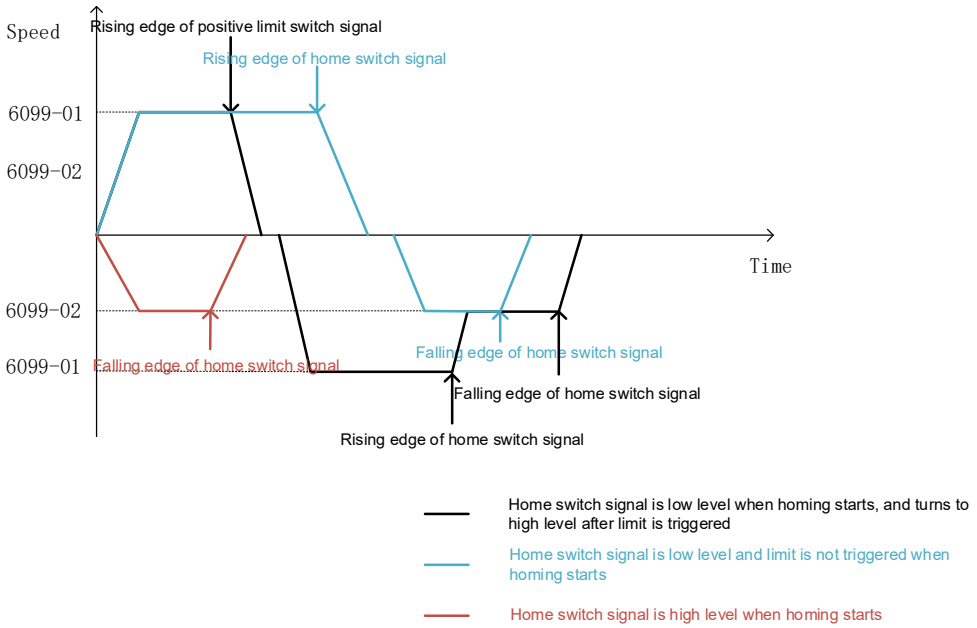


Figure 4-50 Speed-time curve of method 23

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

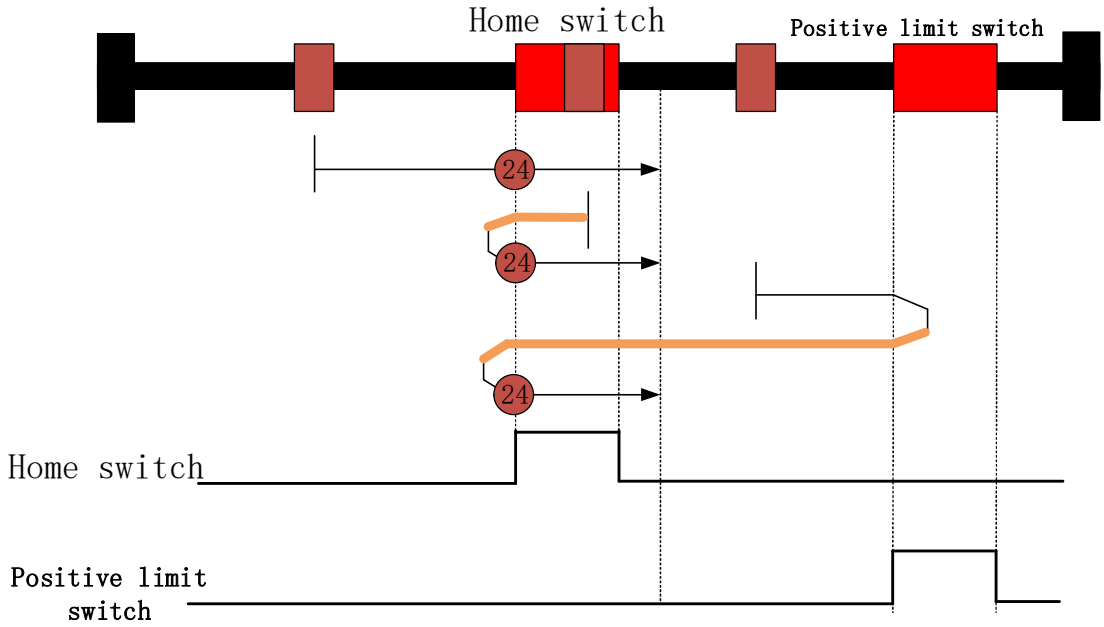


Figure 4-51 Method 24

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

1) After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

2) After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration

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

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

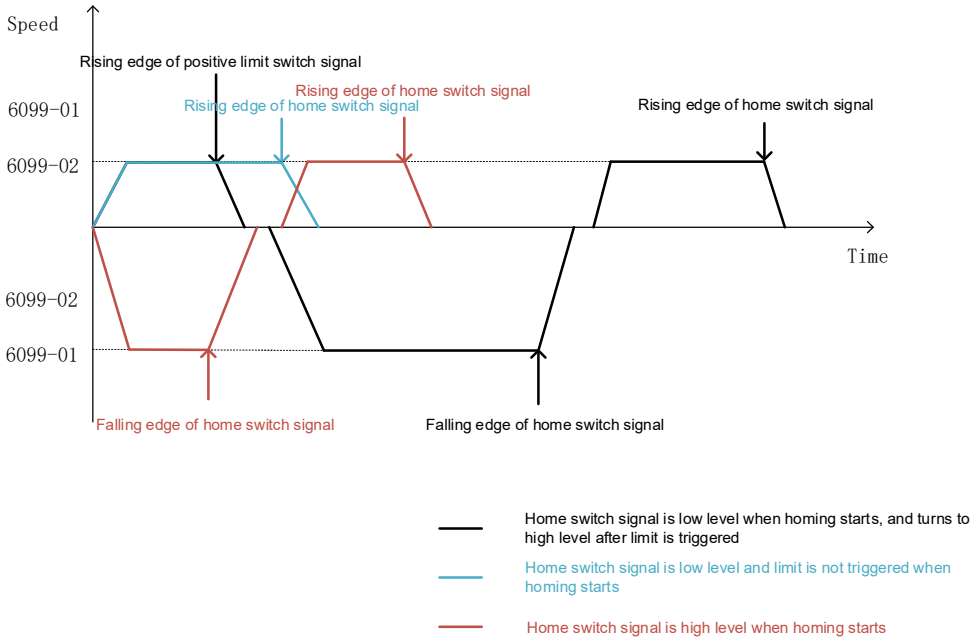


Figure 4-52 Speed-time curve of method 24

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

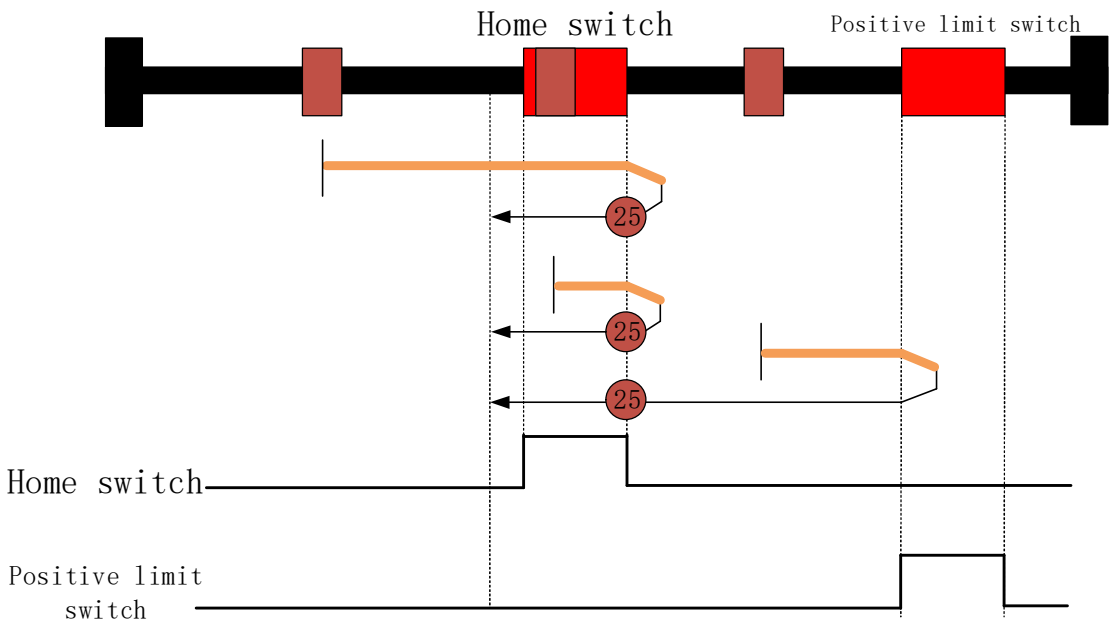


Figure 4-53 Method 25

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

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

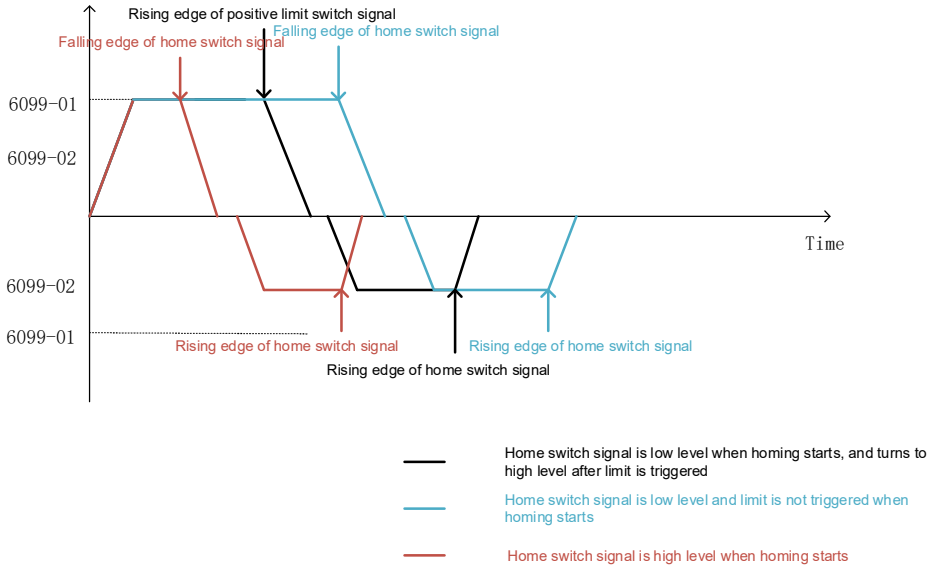


Figure 4-54 Speed-time curve of method 25

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

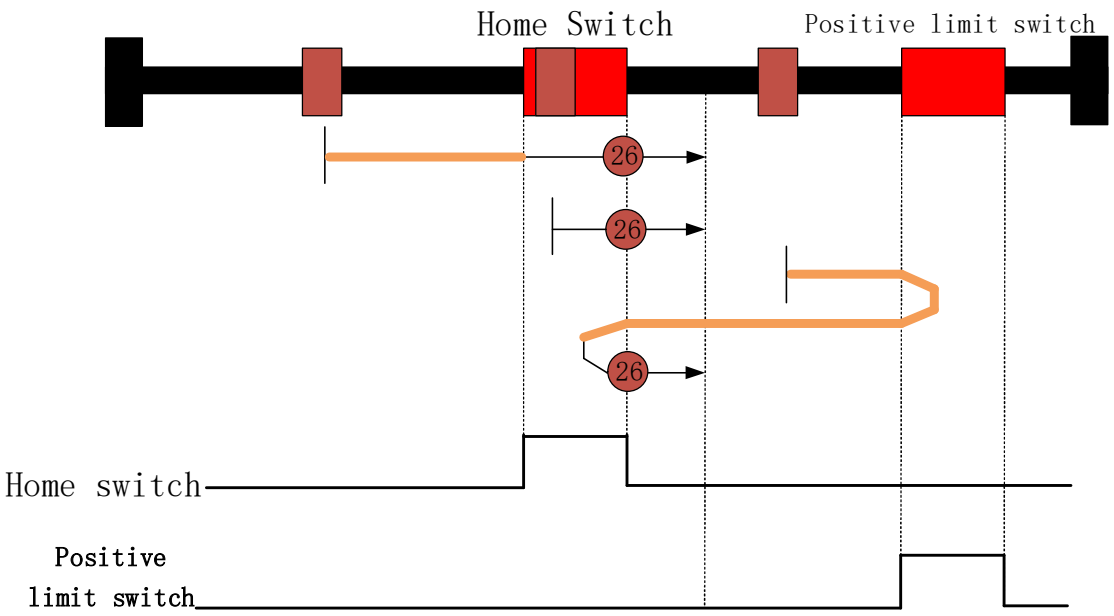


Figure 4-55 Method 26

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

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

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

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

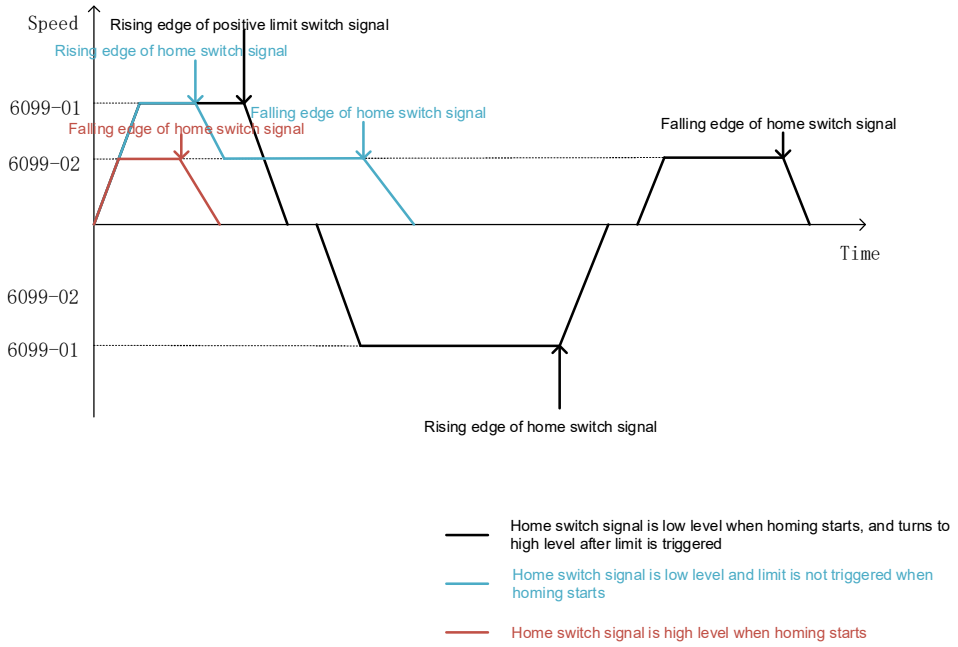


Figure 4-56 Speed-time curve of method 26

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

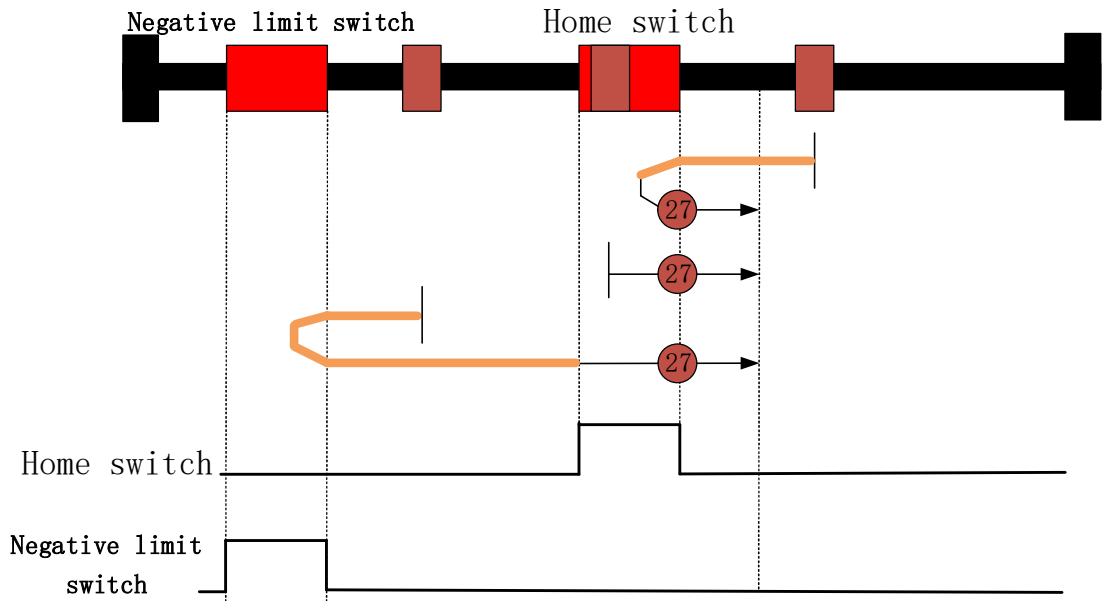


Figure 4-57 Method 27

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

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

reached is set to 1 when the motor stops.

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

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

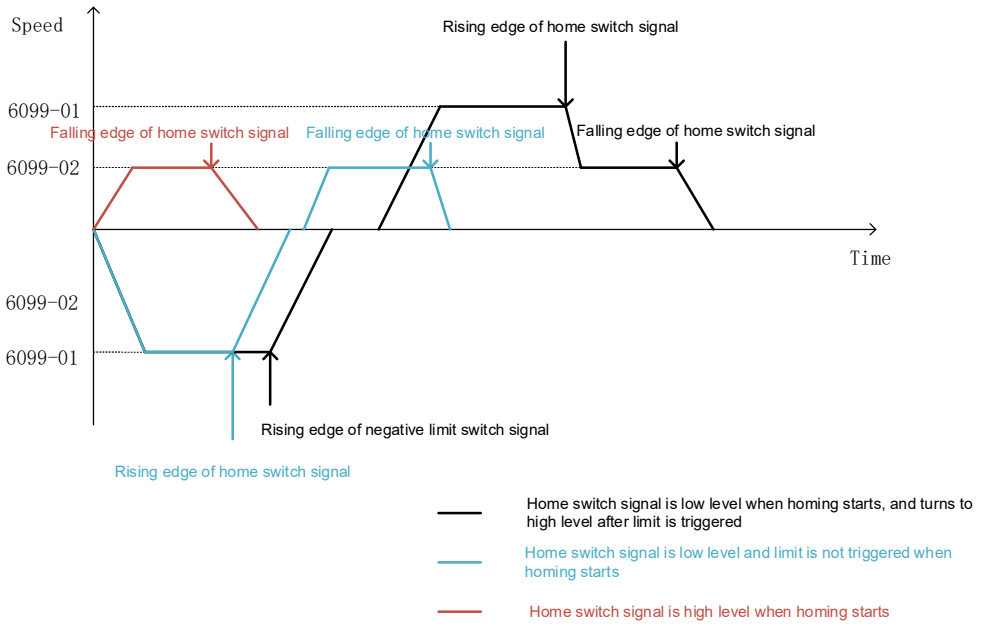


Figure 4-58 Speed-time curve of method 27

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

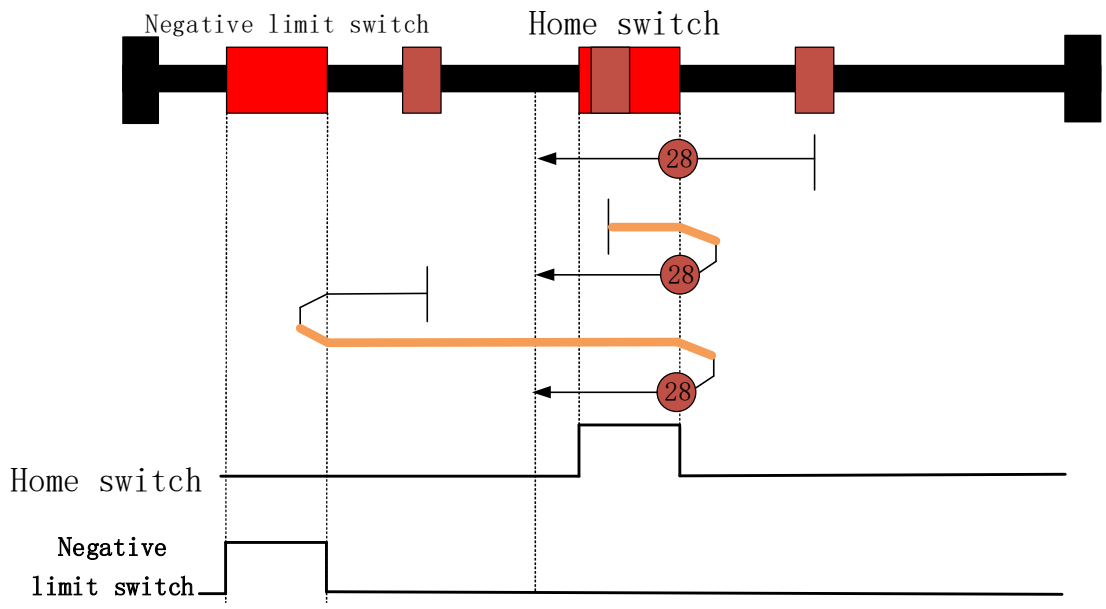


Figure 4-59 Method 28

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

1) After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

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

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

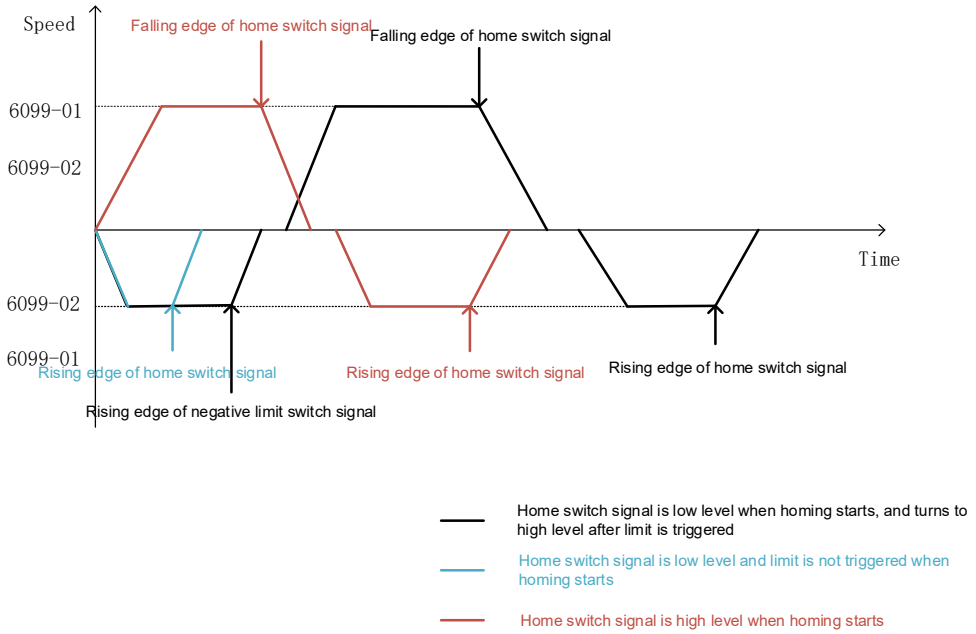


Figure 4-60 Speed-time curve of method 28

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

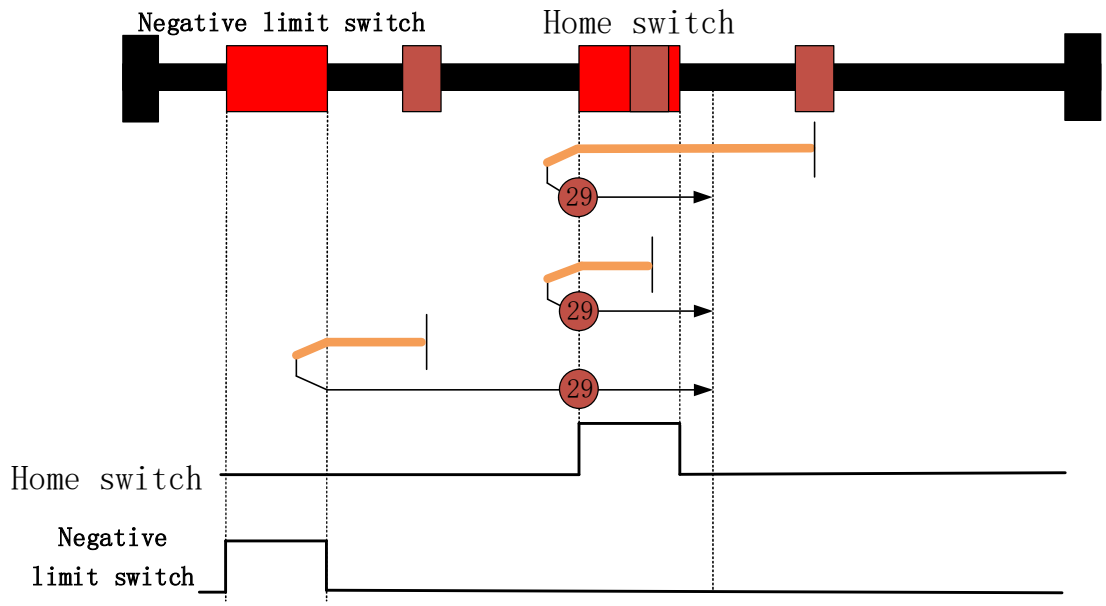


Figure 4-61 Method 29

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

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

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

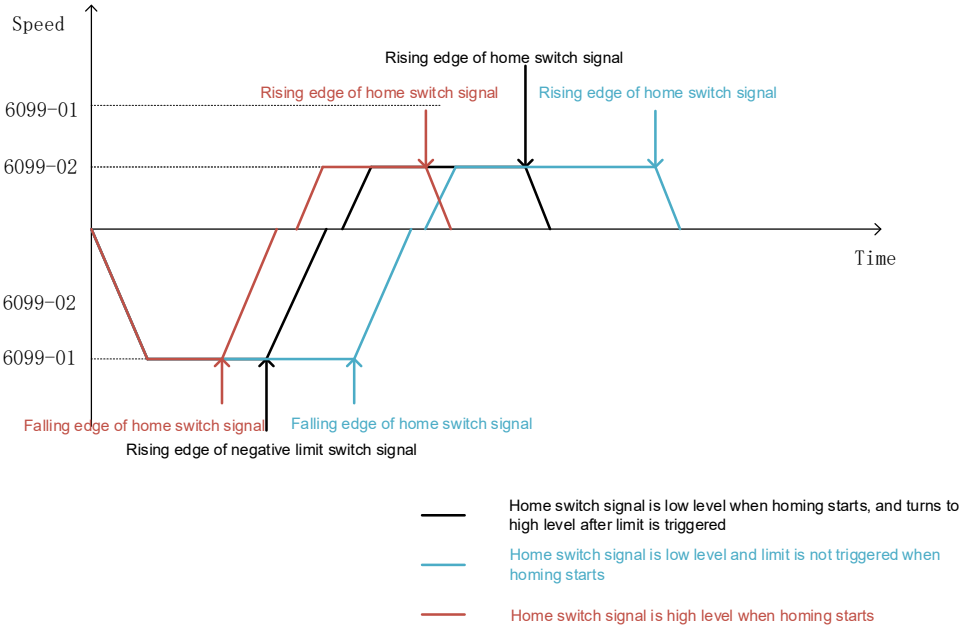


Figure 4-62 Speed-time curve of method 29

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

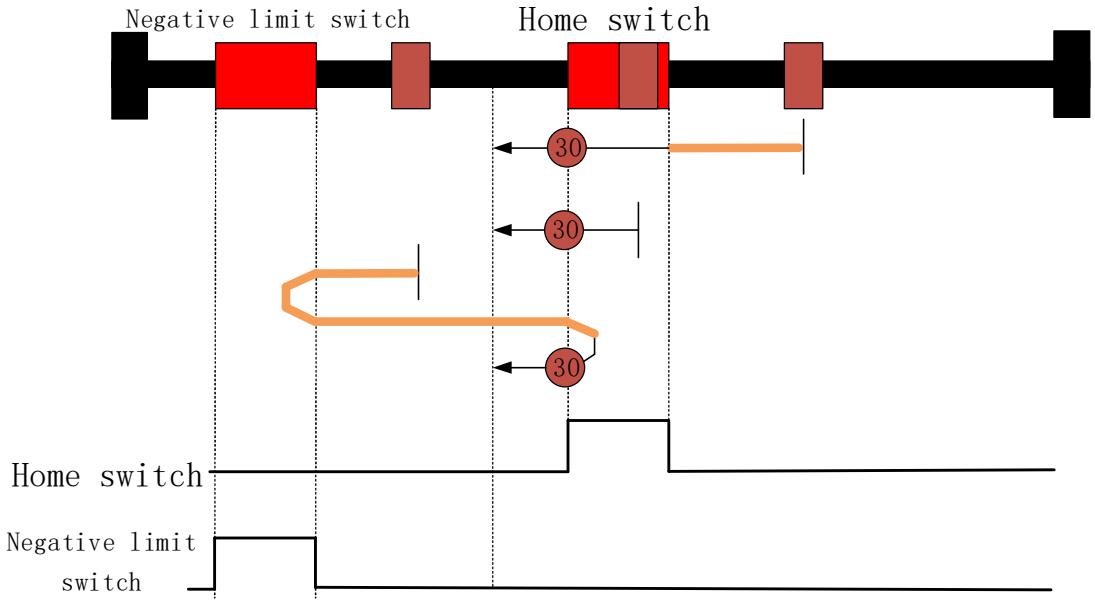


Figure 4-63 Method 30

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

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

(609A). The status word Target reached is set to 1 when the motor stops.

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

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

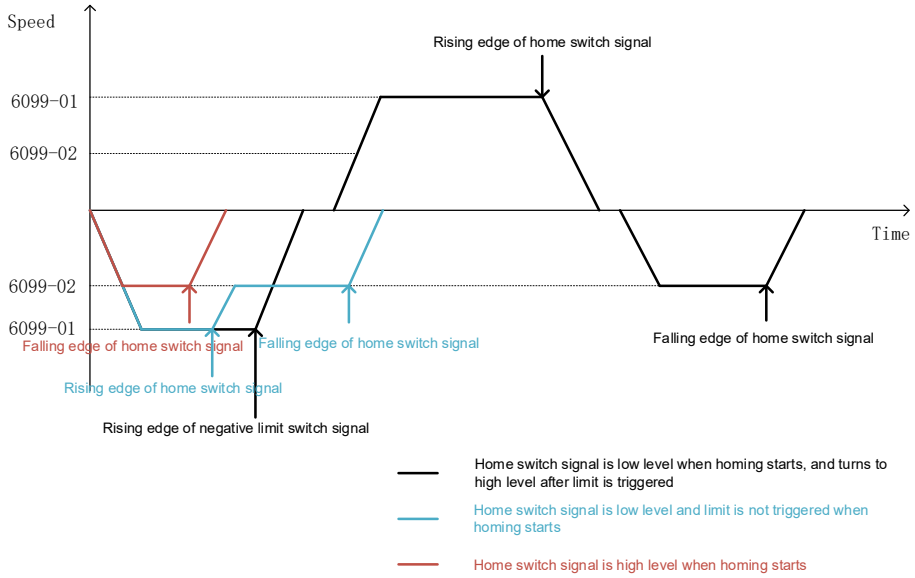


Figure 4-64 Speed-time curve of method 30

Method 31: Reserved

Method 32: Reserved

Method 33: Homing on index pulse in negative direction

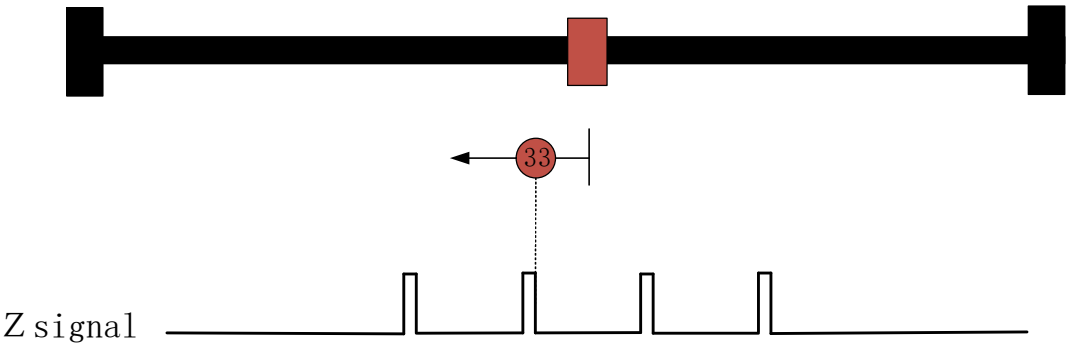


Figure 4-65 Method 33

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

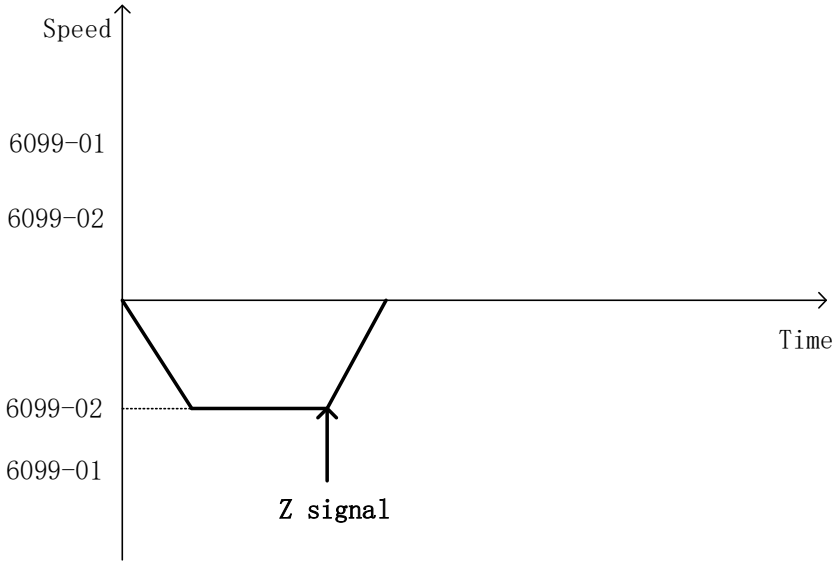


Figure 4-66 Speed-time curve of method 33

Method 34: Homing in index pulse in positive direction

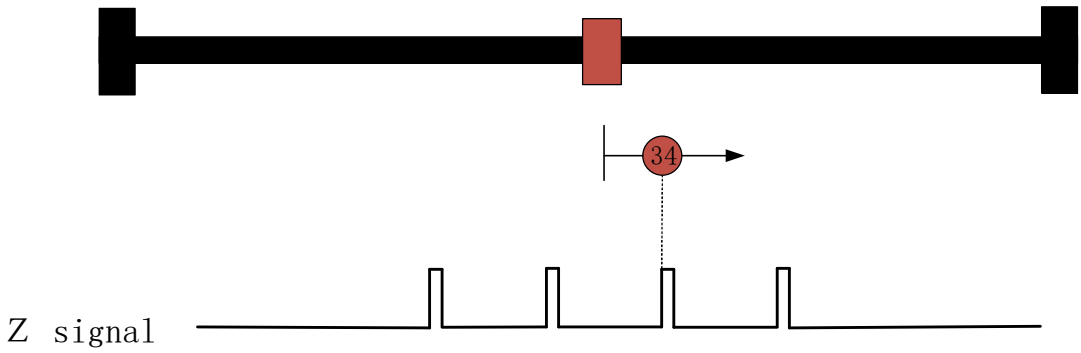


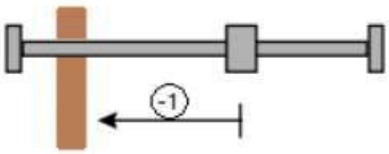
Figure 4-67 Method 34

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

Method 35: Current position

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

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

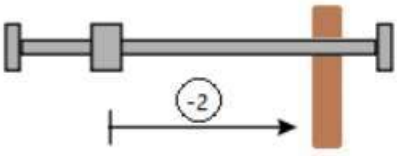


When homing starts, the motor moves in the negative direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. The motor stops after the time set by 0x2137:

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

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

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

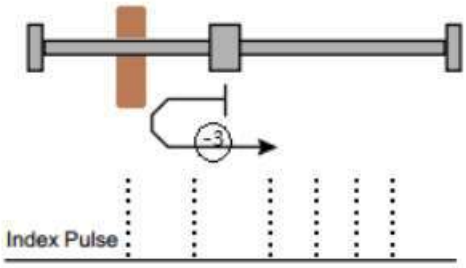


When homing starts, the motor moves in the positive direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. The motor stops after the time set by 0x2137:

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

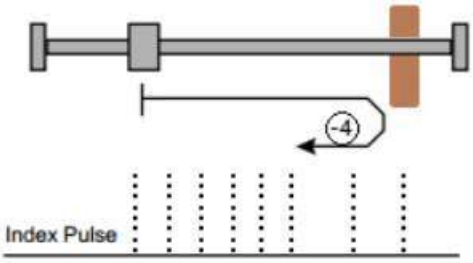
If the retraction distance is set, the motor will retract the corresponding distance and set the current position as the home point.

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



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

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



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

4.8 Mode Common Functionality

4.8.1 Touchprobe function

4.8.1.1 Function Introduction

The Touch probe function is used to lock the position feedback when at rigger signal or 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.

4.8.1.2 Related object parameters

0x60B8: Touch probe function

This object defines the basic objects used for starting touch probe actions and various settings shown in the Table 4-86.

Table 4-86 Introduction to 0x60B8

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

The bit values corresponding to 0x60B8 are explained in the table 4-87 below.

Table 4-87 Introduction to the bits of 0x60B8

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	Disable probe 1 rising edge latch position
	1	Enable probe 1 rising edge latch position
5	0	Disable probe 1's falling edge latch position
	1	Enable probe 1's falling edge latch position

0x60B9: Touch probe status

This object defines the state used for Touch probe actions as shown in Table 4-88.

Table 4-88 Introduction to 0x60B9

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

The corresponding bit values for 0x60B9 are explained in the table 4-89 below.

Table 4-89 Introduction to bit of 0x60B9

Bit	Value	definition
0	0	Probe 1 not enabled
	1	Probe 1 Enable
1	0	Probe1 Z pulse rising edge position latch not executed
	1	Probe 1 rising edge position latch executed
2	0	Probe1 Z pulse falling edge position latch not executed
	1	Probe 1 falling 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 in the table 4-90 below.

Table 4-90 Introduction to 0x60BA

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

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 of 0x7320 will be prompted.

4.8.2 Digital inputs/Digital outputs

4.8.2.1 Function Introduction

1) 60FDh Digital inputs

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

The DI status corresponding to different bit positions of 60FDh Digital inputs is shown in the table 4-91 below:

Table 4-91

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, the upper position needs to borrow the servo DO for logic control. ISMC servo drive has four channels of DO. At this time, the upper position operates bit16-bit19 bits of 60FE: 01h object corresponding to DO0~DO3 pins output, and when the corresponding bit of bitmask (60FE: 02h) object is set to 1, the corresponding bit is valid for output.

Table 4-92

31~20	19	18	17	16	15~0
Reserved	DO4	DO3	DO1	DO0	Reserved
	The bit16 ~ bit19 bits of each DO are defined as follows: 60FE: 01h: 0 no output; 1 output 60FE: 02h: 0 output is invalid, 1 output is valid 60FE: 02h Bit mask=0 If output is invalid, mask 60FE: 01h Physical outputs corresponding bits				

Note: When using servo DO, you need to use the upper computer software to configure the corresponding digital output function as "remote DO".

4.8.2.2 Related object parameter

0x60FD: Digital inputs

Index number	name	object type	mapping	access	Default value
0x60FD	Digital inputs	VAR	-	RO	0
		data type	unit	range	
		INT32	-	-	

0x60FE: Digital output

Index number	name	object type	mapping	access	Default value
0x60FE	Digital output	ARRAY	-	RO	0
		data type	unit	range	
		UINT32	-	-	

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

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

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

4.8.3 Torque limitation

4.8.3.1 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.

4.8.3.2 Related object parameter

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: NegTorLimit

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	-	

Chapter 5 Troubleshooting

When a Diamond servo fails, the LED on the servo panel will flash red on a beat-by-beat basis.After connecting to the upper control software tool, a fault code based on the CiA402 standard will be displayed in the troubleshooting screen.

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

Table 5-1 Fault description

Error Code	Name	Cause	Solution
0x2230	Bus overcurrent	1. DC bus with excessive voltage. 2. Short circuit at periphery. 3. Encoder failure. 4. Internal components of the servo are damaged.	1. Check power supply and whether high inertia loads leads to rapid stop without dynamic braking. 2. Check whether the servo and the output wiring are short circuit, whether earthing is short circuit, and whether the braking resistor is short circuit. 3. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x2310	U-phase overcurrent	1. U-phase output is short circuit. 2. High load. 3. Cable insulation is damaged. 4. Poor motor insulation. 5. Failure of U-phase current detecting circuit.	1. Check U-phase wiring. 2. Lower the load. 3. Check U-phase cable and replace it if necessary. 4. Measure the motor insulation, repair and replace it if necessary; 5. Repair or replace the drive.
0x2311	V-phase overcurrent	1. V-phase output is short circuit; 2. High load. 3. Cable insulation is damaged. 4. Poor motor insulation. 5. Failure of V-phase current detecting circuit.	1. Check V-phase wiring. 2. Lower the load. 3. Check V-phase cable and replace it if necessary. 4. Measure the motor insulation, repair and replace it if necessary. 5. Repair or replace the drive.
0x2320	Hardware short circuit	1. DC bus with excessive voltage. 2. Short circuit at periphery. 3. Encoder failure. 4. Internal components of the servo are damaged.	1. Check power supply and whether high inertia loads leads to rapid stop without dynamic braking. 2. Check whether the servo and the output wiring are short circuit, whether earthing is short circuit, and whether the braking resistor is short circuit. 3. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x3220	Servo	1. Low input voltage	1. Check the power circuit.

Error Code	Name	Cause	Solution
	undervoltage	of the power circuit. 2. Poor insulation of DC bus. 3. High load. 4. Poor insulation of the driver cable. 5. Failure of DC bus undervoltage detecting circuit. 6. Basic power module failure.	2. Check the DC bus insulation. 3. Lower the load. 4. Check the drive cable. 5. Repair or replace the drive. 6. Repair or replace the basic power module.
0x3210	Servo overvoltage	1. Insufficient capacity of brake circuit. 2. Insufficient capacity of braking resistor. 3. Basic power module failure	1. Reduce the start-stop frequency; increase the acceleration/deceleration time constant; lower the load inertia; increase the drive and motor capacity. 2. Increase the power of the braking resistor. 3. Repair or replace the basic power module;
0x4110	Ambient temperature overheating	1. High ambient temperature. 2. Abnormal cooling system. 3. Temperature detecting circuit failure.	1. Lower the ambient temperature and strengthen ventilation and heat dissipation. 2. Check the cooling fan speed and air volume. If they are abnormal, replace the fan with the same Model. 3. Check whether the servo cooling channel is blocked by foreign objects.
0x4120	Ambient temperature underheating	1. Low ambient temperature. 2. Temperature detecting circuit failure.	1. Check whether the ambient temperature is too low; 2. Check the value of parameter minimum ambient temperature.
0x4310	Power module overheating	1. High ambient temperature. 2. Abnormal cooling system. 3. Temperature detecting circuit failure.	1. Lower the ambient temperature and strengthen ventilation and heat dissipation. 2. Check the cooling fan speed and air volume. If they are abnormal, replace the fan with the same Model. 3. Check whether the servo cooling channel is blocked by foreign objects.
0x8482	Exceed maximum speed	1. Motor run away. 2. Wrong encoder parameters. 3. Encoder failure 4. Instruction error 5. Load mutation	1. Check the phase sequence of the motor power cable. 2. Check the settings of encoder parameter. 3. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable. 4. Check the position / speed / torque command. 5. Check whether the load is mutated and related cause. 6. Correct the phase zero again. 7. Adjust PID parameters.
0x8483	Large speed tracking error	1. The encoder wiring is wrong or the connector is in poor contact. 2. The gain does not match.	1. Check the encoder wiring; 2. Adjust the servo gain again. 3. Increase anti-interference measures.

Error Code	Name	Cause	Solution
		3. Large external load fluctuations or interference.	
0x8611	Large position deviation	1. The encoder wiring is wrong or the connector is in poor contact. 2. The gain does not match. 3. Large external load fluctuations or interference.	1. Check the encoder wiring; 2. Adjust the servo gain again. 3. Increase anti-interference measures.
0x7380	Encoder connection error	1. Wrong encoder parameters. 2. Encoder cable failure. 3. The encoder cable is not connected. 4. The internal components of the servo are damaged.	1. Check the settings of encoder parameters. 2. Check the line sequence of encoder cable. 3. Connect the encoder cable.
0x7383	Encoder multi-turn info error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x7385	Encoder count error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x7389	Encoder count overflow error	Internal encoder error.	Clear the encoder multi-turn value, power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x738A	Encoder communication CRC error	1. Wrong encoder parameters. 2. Encoder cable failure.	1. Check the settings of encoder parameters. 2. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x738B	Encoder delimiter error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x3221	PWM drive abnormal	PWM drive +15 V undervoltage.	Check whether the control power +24V is connected properly.
0x8612	Exceed 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°C.	1. Test again after the motor has cooled down. 2. Improve the heat dissipation conditions and check whether the motor overheats during running. 3. Internal encoder error.
0x6280	Wrong profile value	There is a zero value in the set value of the profile track, which makes the planned track unsuccessful.	1. Make sure the set speed is not zero. 2. Make sure the set acceleration is not zero.
0x6281	Termination speed setting error	The termination speed is greater than the profile speed, which makes the planned track unsuccessful.	1. The set termination speed must be less than or equal to the profile speed.

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

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

Error Code	Name	Cause	Solution
	identification	High load. The machine is stuck, or the 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 6 Communication Cases

Communication case with Schneider PLC

①Hardware connection and configuration confirmation

Complete the hardware and preliminary configuration between the servo and PLC as described in 1.2.

②Create project

1) Open the Schneider SoMachine software, which uses version 4.3. Create a new blank project named test according to the standard project_ CAN.

Figure 5-1 OpeningSoMachine software

2) Double click onthe configuration to add the master station device. In this example, TM241CEC2U, click OK:

Figure 5-2 Adding Master Station Equipment to SoMachine

3) Double click on the controller to add application design:

Figure 5-3 Creating Projects in SoMachine

③Import EDS files for slave devices

1) Click on the toolbar ->Device Library

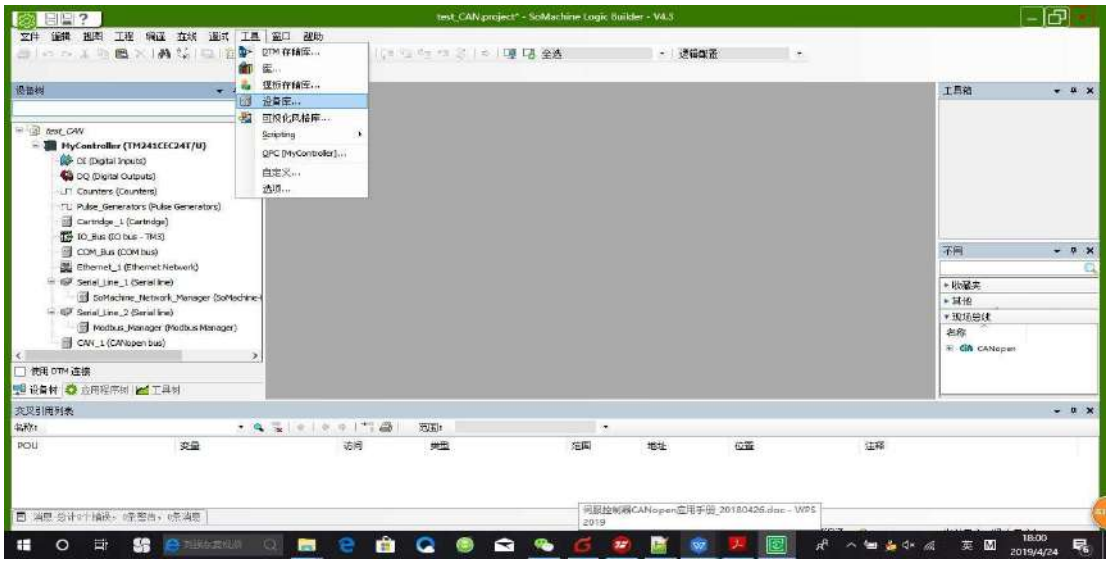


Figure 5-4 Open Device Library in SoMachine

2) Click Install, select the device EDS file "ISMC. eds", and click Open

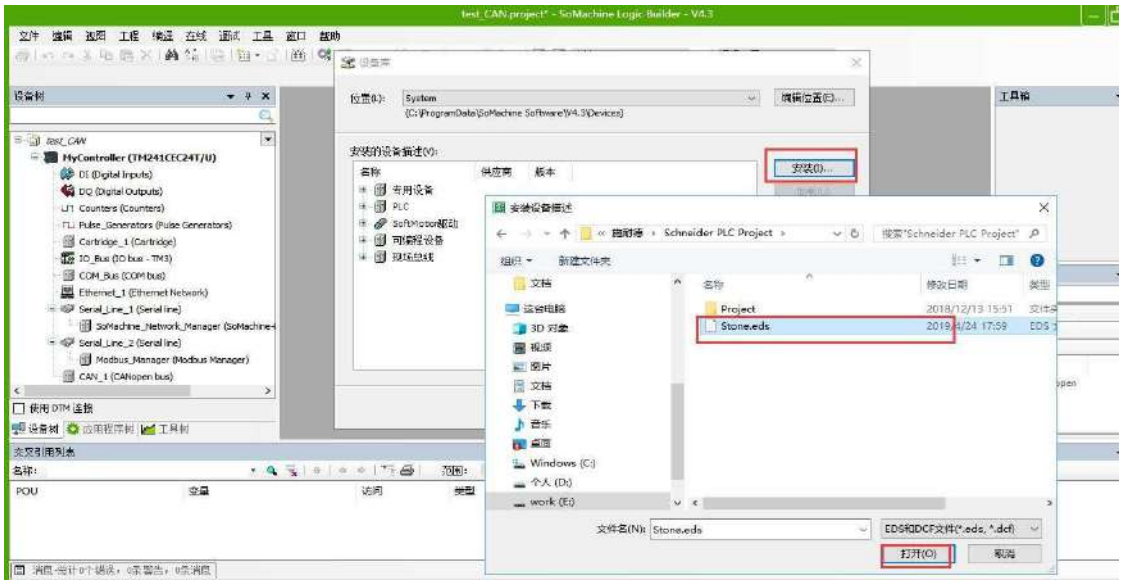


Figure 5-5 Importing EDS files in SoMachine

④Add CANopen gateway and slave devices

1) Add a device under the CANopen bus in the device tree, select Schneider Electric as the supplier, select CANopen Performance, and click Add Device.

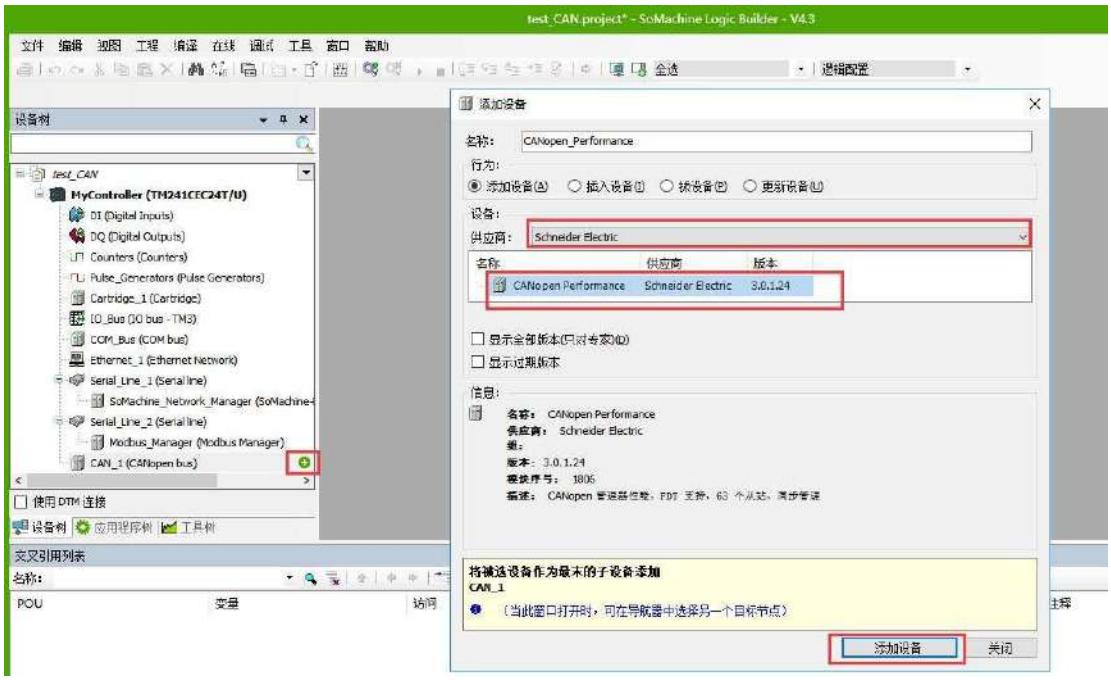
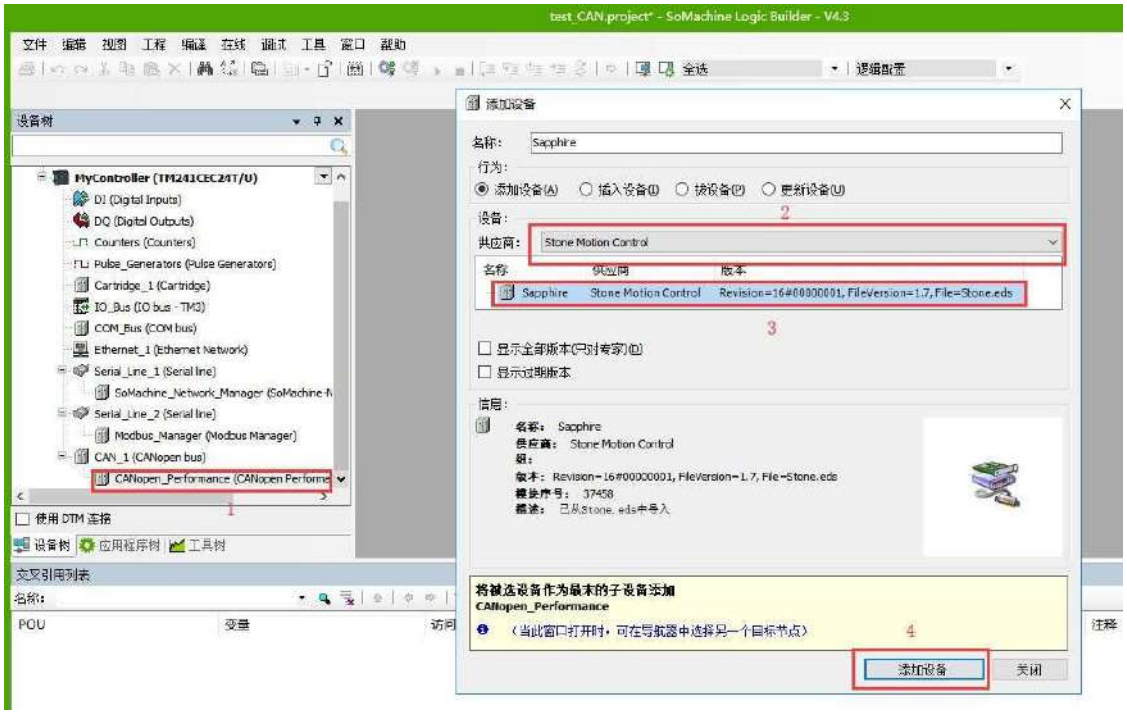


Figure 5-6 Adding CANopen to SoMachine

2) Rightclick on CANopen_ Add a slave device to Performance and select the supplier's slave



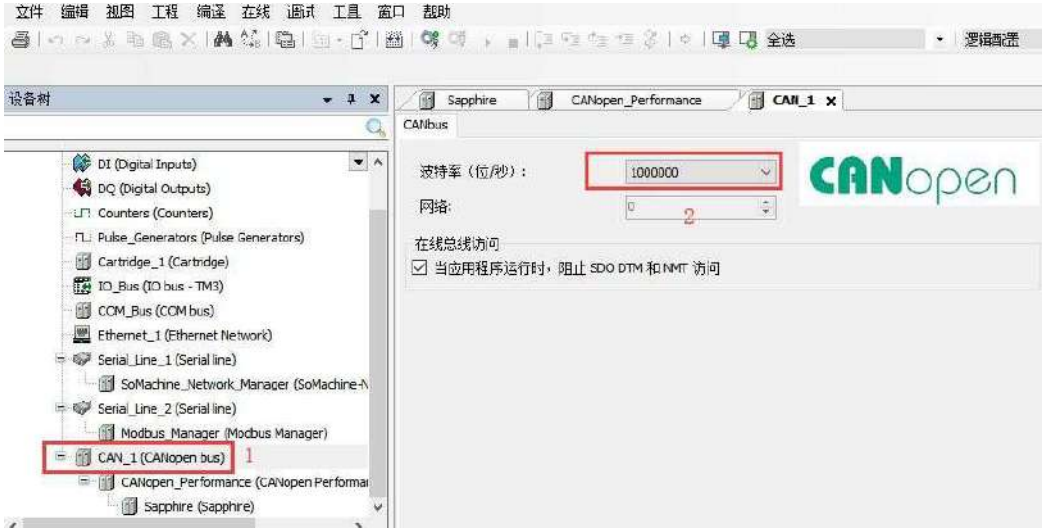
device name.

Figure 5-7 Adding CANopen Slave Station in SoMachine

⑤Master slave CANopen configuration

1) Main station CAN baud rate setting: Set the baud rate to 1M/s, the servo default baud rate is 1M/s,and it can also be customized according to application requirements

Change, but make sure that the baud rate setting of the servo is consistent with the baud rate



setting of the main station.

Figure 5-8 Setting the Master Station Baud Rate in SoMachine

2) Slave node address setting: Set the node address to 1, and the default Node ID of the servo is 1. It can also be changed according to application requirements, but it is necessary to ensure that the lower address setting of the servo is consistent with the address set by the master station.

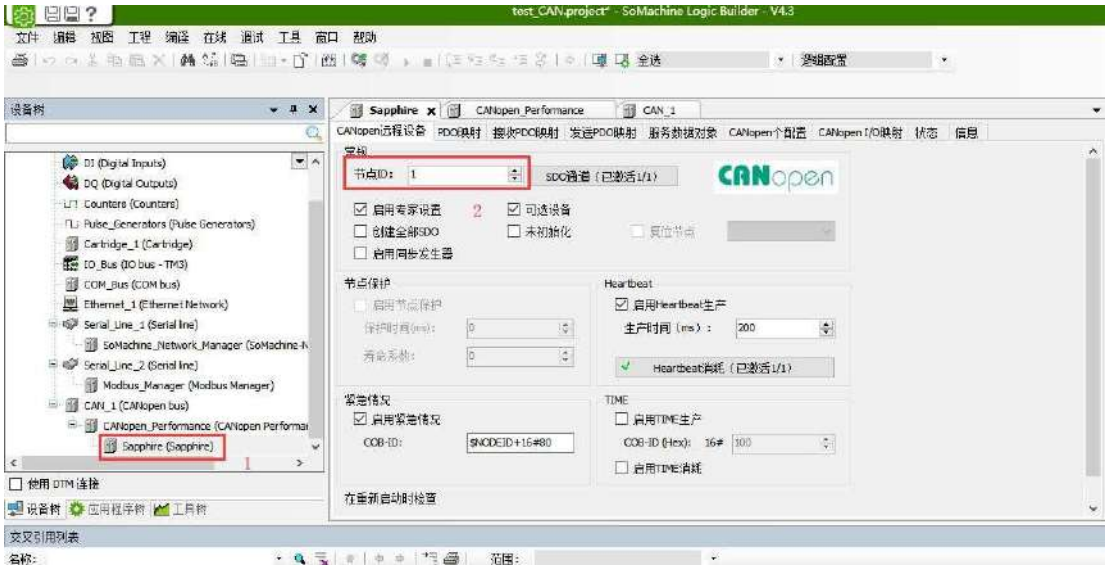


Figure 5-9 Setting the Slave Node Address in SoMachine

3) Modify the parameter 0x2004 (CAN Baud Rate) through ISMC software and set the CAN communicationbaud rate; The baud rate settings of the master and slave stations must be consistent, otherwise normal communication cannot be achieved; The setting of baud rate value is related to the length of the bus communication cable, as shown in Table 5-1.

Table5-1 Relationship between Baud Rate and Communication Line Length

Baud rate (bit/s)	Communication cable length (m)
1000000	25
500000	100
250000	250
125000	500
50000	1000
20000	1000

4) Modify the parameter0x2401 (Node ID) through software and set the communication node IDs of each slave station; The node ID of each servo slave station cannot be duplicated with the node number of the master station (CNC or PLC), and the node numbers between each slave station cannot be duplicated.

Note: Both of the above parameters take effect after the servo is restarted. After modifying the parameters, please power on again or "restart" the servo in the ISMC software

⑥Configure PDO mapping and SDO

We will explain the position mode. For specific operations in the position mode, please refer to the ISMC Servo drive CANopen Application Manual. In the position profile mode, the PDO configuration is shown in the table below.

Table5-2 PDO Configuration Table in Position Profile Mode

PDO	object	meaning	bit length
RPDO1	6040h-00h	control word	16
	6060h-00h	control model	8
	607Ah-00h	Target Position	32
RPDO2	60FFh-00h	target speed	32
	6081h-00h	Planning speed	32
TPDO1	6041h-00h	status word	16
	6061h-00h	Control mode display	8
	6064h-00h	Position feedback	32
TPDO2	606Ch-00h	SPEED FEEDBACK	32
	6078h-00h	Current Feedback	16

1) Add PDO mapping

Start expert settings, configure PDO mapping, select 2 groups to receive PDO, and 2 groups to send PDO.

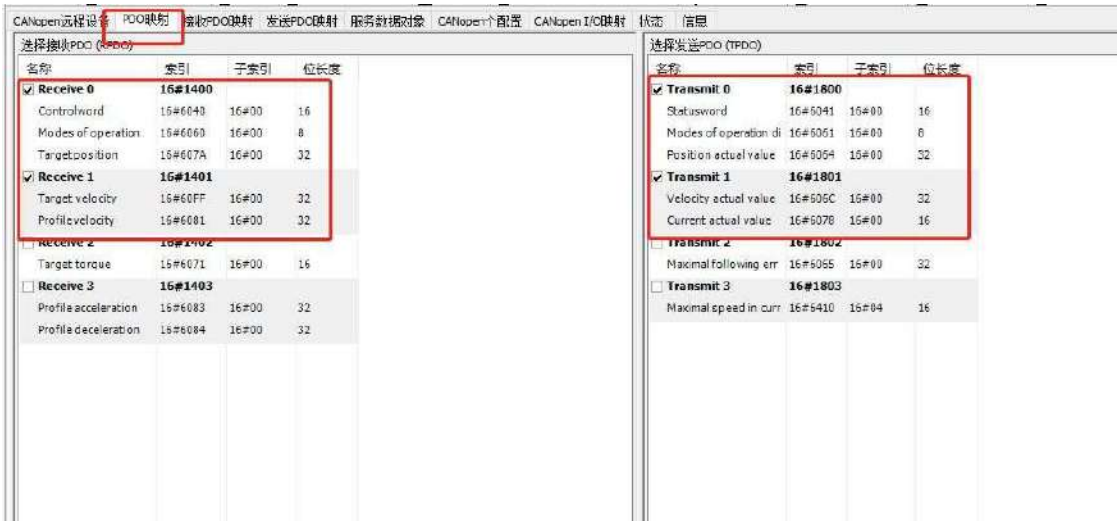


Figure5-10 Adding RPDO and TPDO mappings

When the default RPDO and default TPDO do not contain the set control word, PDO mapping can be added separately. The steps are as follows.

①Add PDO mapping parameters: Receive PDO1and PDO2 mapping parameters as follows, set the transmission type to 255 asynchronous mode.

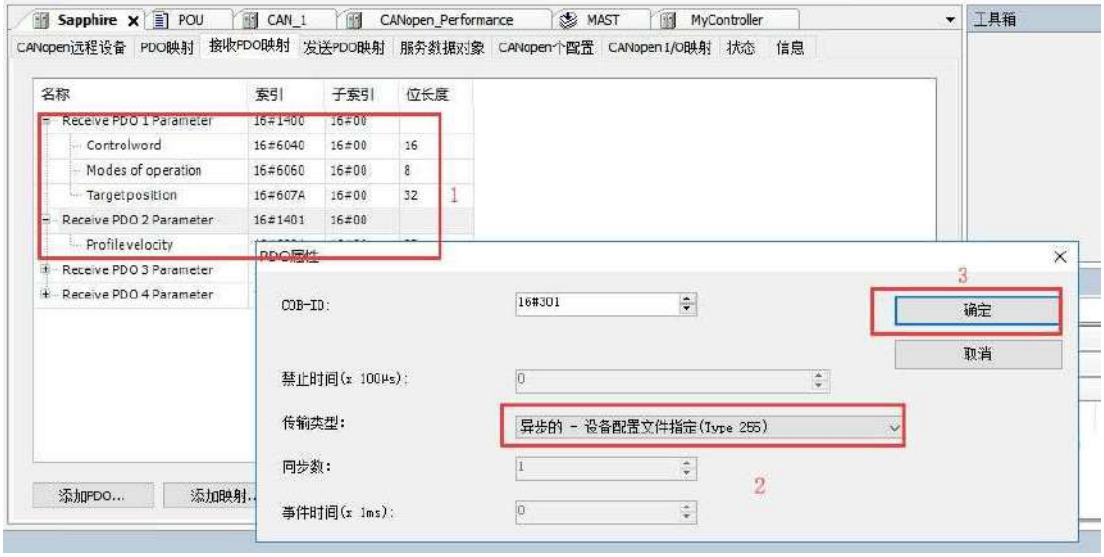


Figure5-11 Adding RPDO mapping

②Add PDO mapping parameters: Send PDO1 and PDO2 mapping parameters as follows, set the transmission type to 255 asynchronous mode.

Figure5-12 Adding TPDO mapping

2) Configure SDO data

Use SDO to configure the acceleration and deceleration for 6083h in position profile mode.

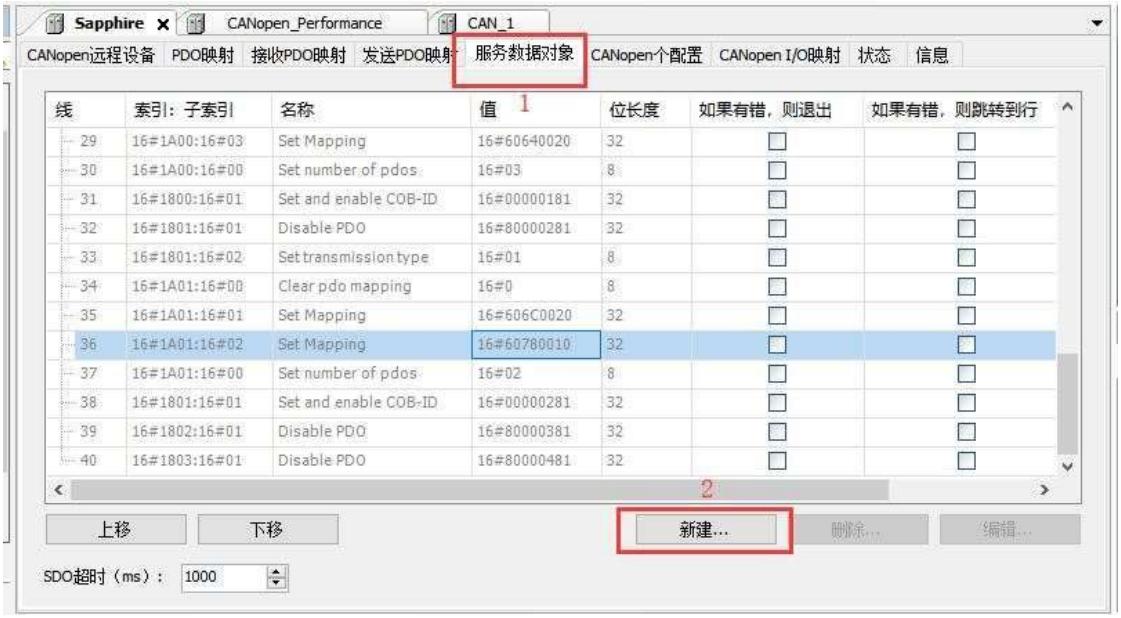


Figure5-13 Adding SDO Step 1

Figure5-14 Adding SDO Step 2

⑦Create POU program

1) In the application device tree, select Application, add POU program, select program language, and click Add.

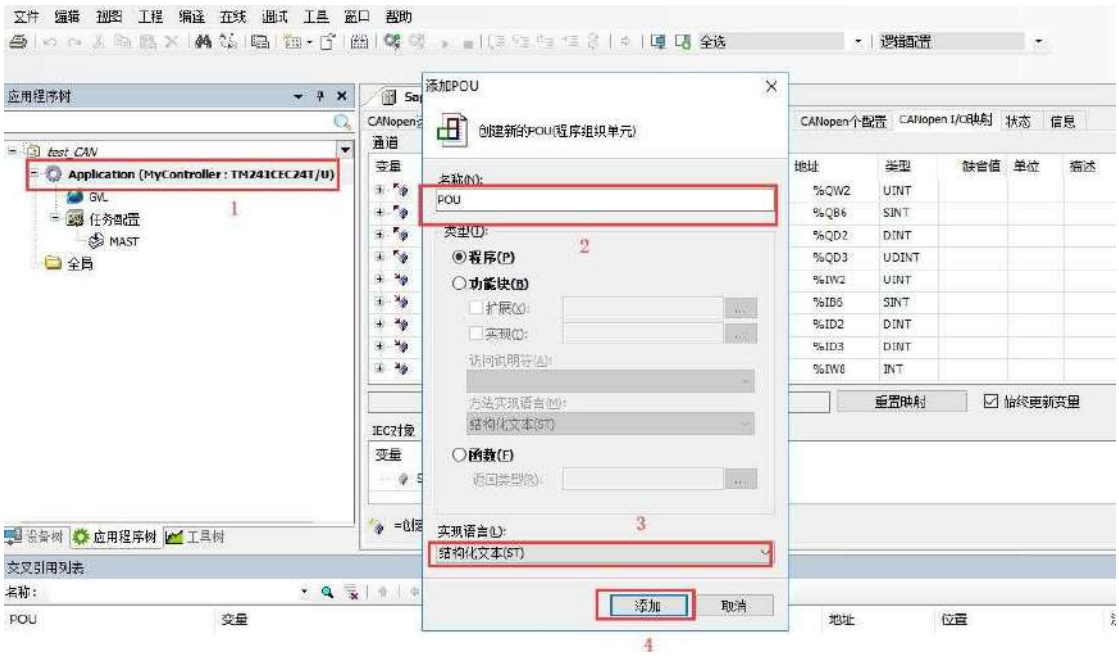


Figure5-15 Creating a POU

2) Double click on POU, as shown in Figure 5-16. Define variables in the "2" area, write logical programs in the "3" area, then click compile, confirm that there are no errors, and proceed to the next step.

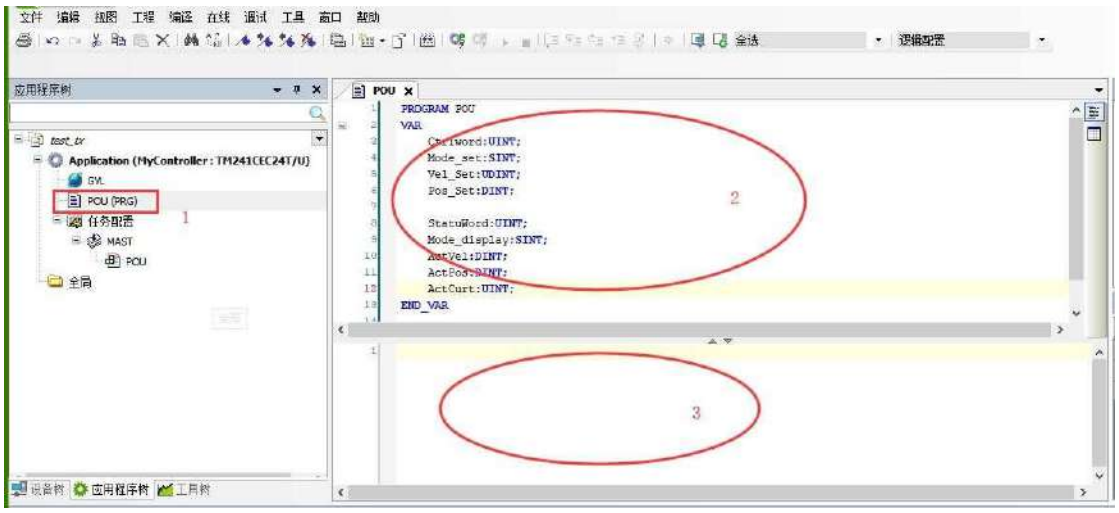


Figure5-16 Writing POU Program

3) Double click on "Master" to set the program cycle period.

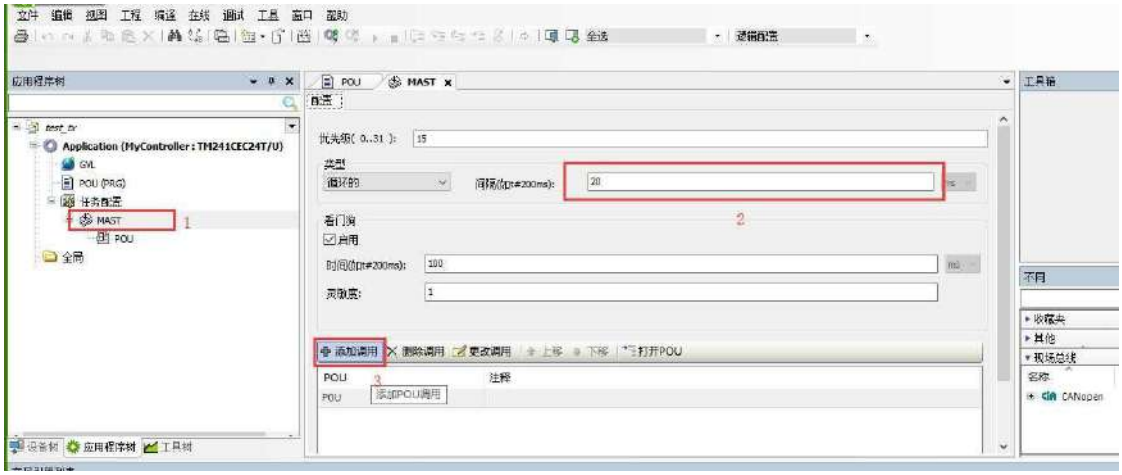


Figure5-17 Setting the program cycle period

4) Double click on "Master" to add a POU call.

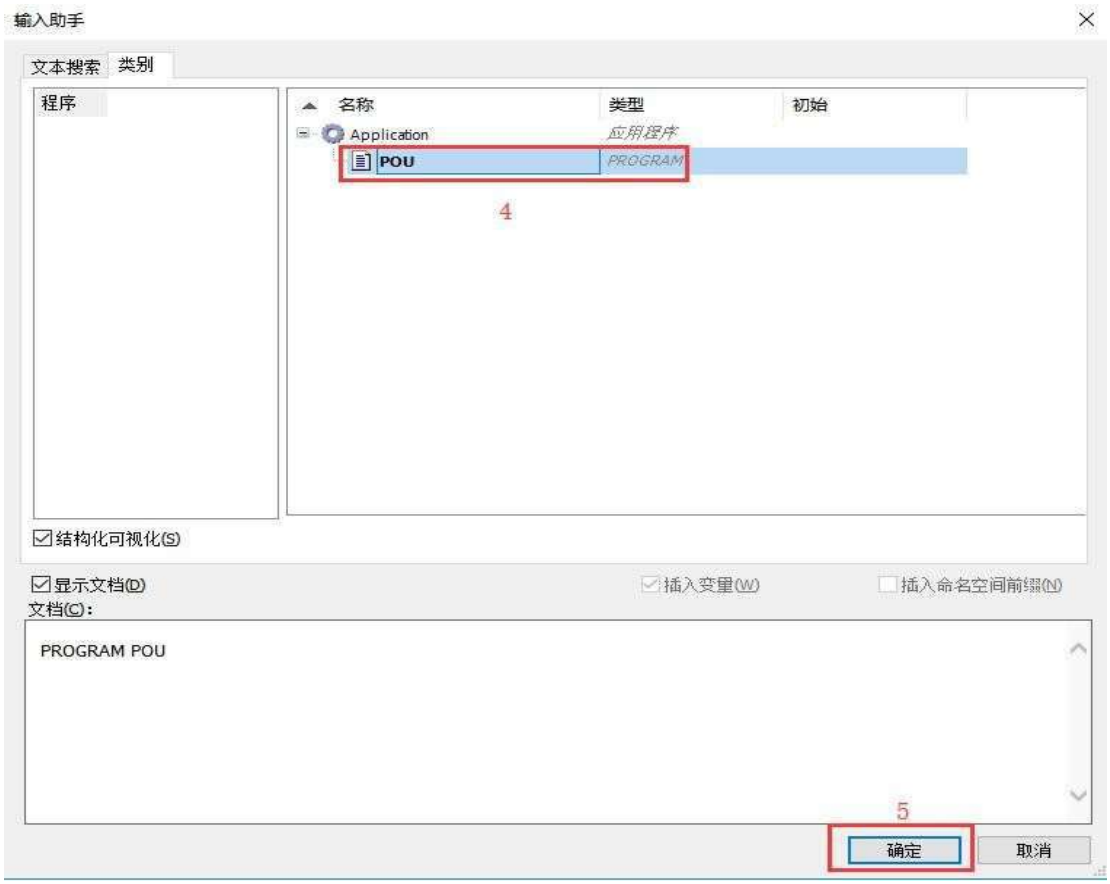


Figure5-18 Adding POU calls

⑧Link CANopen I/O mapping to POU variables.

1) Select "Sapphire", click on "CANopen I/O mapping", and link POU variables to PDO parameters.

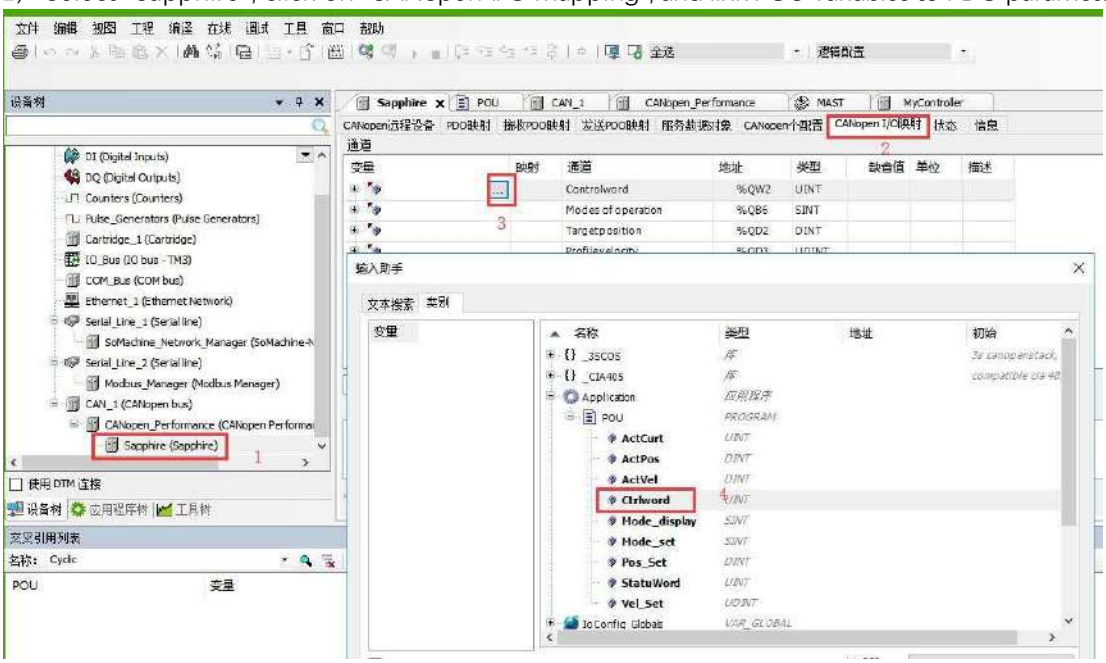


Figure5-19 CANopen I/O mapping

2) Link all variables one by one.

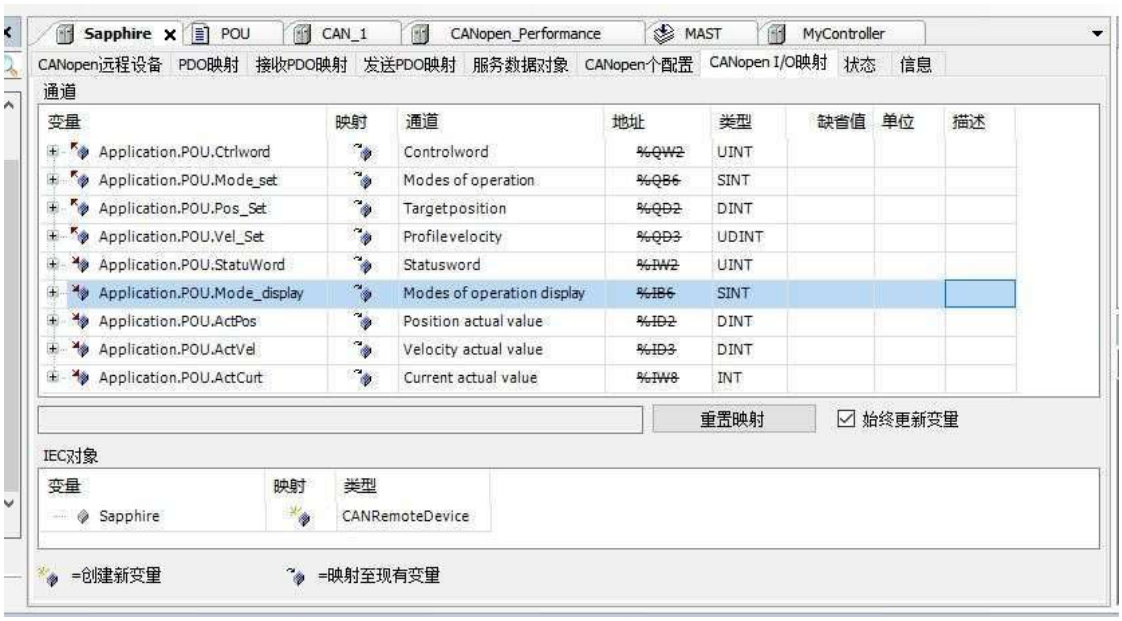


Figure5 - 20 Linking POU variables to PDO parameters

⑨Login, trial run, debugging

1) Click the login button  or press "Alt+F8" to log in to PLC, and play the block diagram below as 5-21.

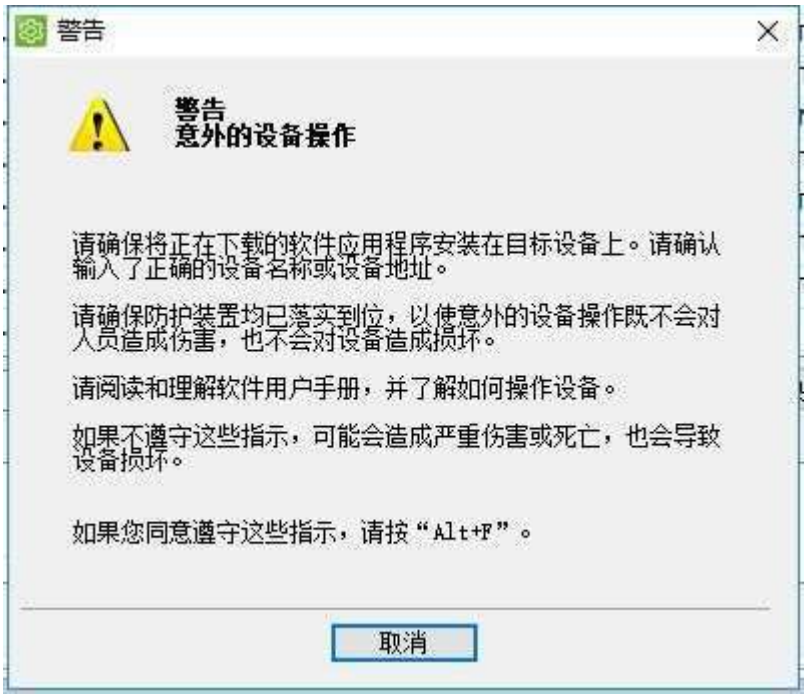


Figure5-21 Clicking on the login button

2） Press "Alt+7" and click "Yes" in sequence to complete the PLC login and download.

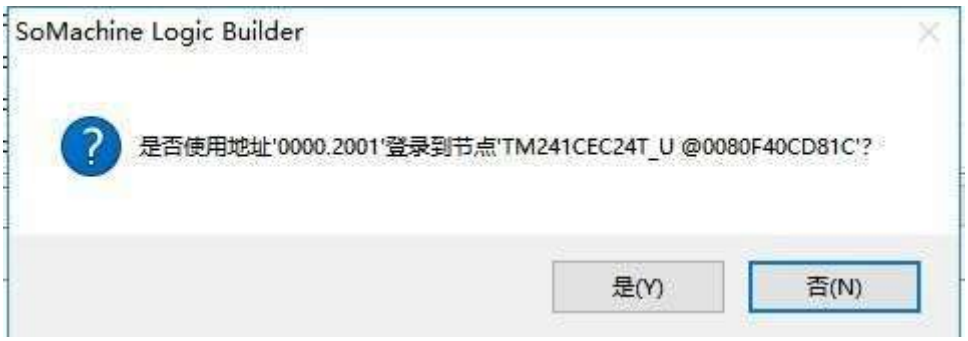


Figure5-22 PLC login confirmation

4） Figure5-23 Program Download Confirmation

3） Start the PLC

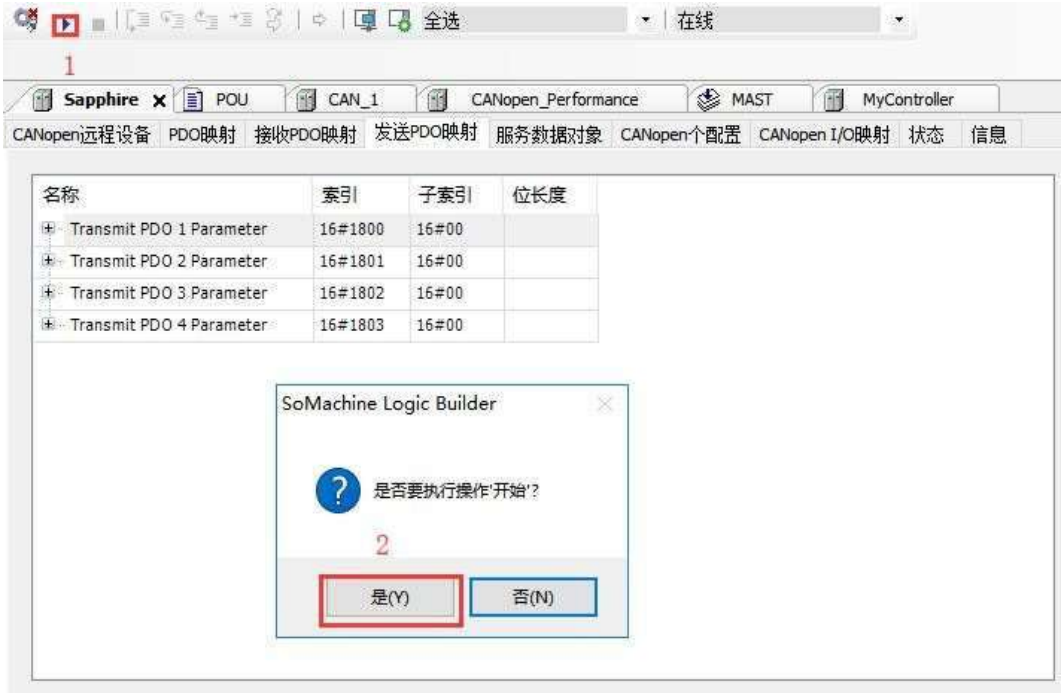


Figure5-24 Program Running

5） Program modification and debugging.

The mandatory configuration parameters are as follows: press F7 to force writing, for example: run relative position 10 times: set the control mode to "1", target position 100000cnt, planned speed 1000000cnt/s, control words 0x06->0x07->0x4F ->0x5F, to control the motor operation.

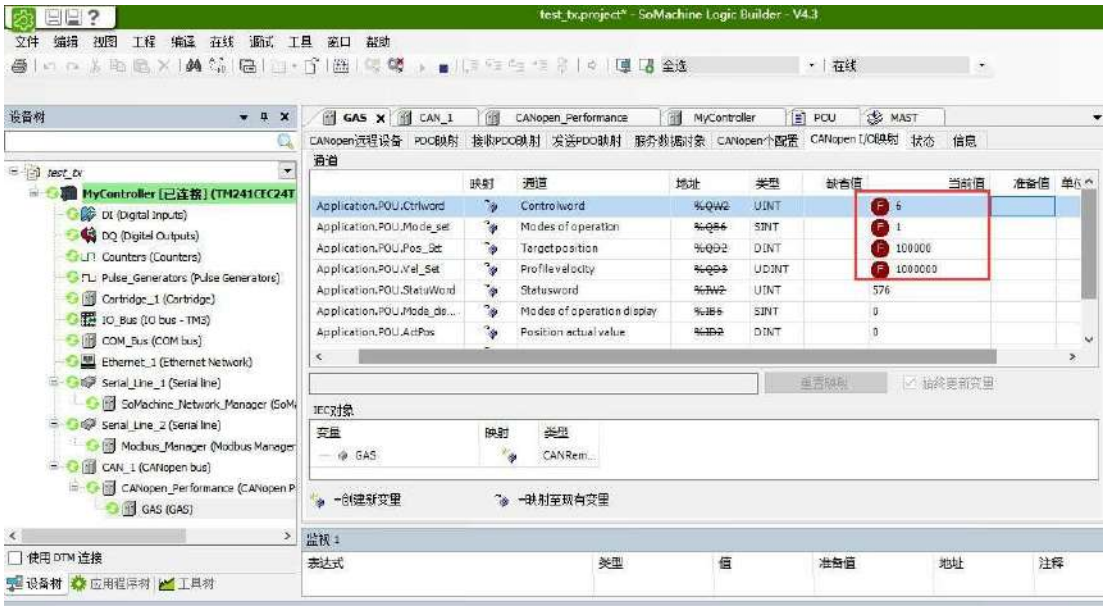


Figure5-25 Program Debugging

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Hotline: 021-64030375
Email: sales@ismc.com
Web: www.ismc.cn