XINJE

EtherCAT motion control

User manual

Wuxi Xinje Electric Co., Ltd.

Data No. PG05 20190517 3.6

Basic explanation

- Thank you for purchasing Xinje XG series programmable controller.
- This manual mainly introduces the motion control function of EtherCAT.
- Before using the product, please read this manual carefully and operate on the premise of fully understanding the contents of the manual.
- For the introduction of software and programming, please refer to relevant manuals.
- Please deliver this manual to the end user.

User instructions

- Only operators with certain electrical knowledge can conduct wiring and other operations on the product. If there is any unclear use, please consult our technical support personnel.
- The examples listed in the manual and other technical materials are only for the user's understanding and reference, and certain actions are not guaranteed.
- When using this product in combination with other products, please confirm whether it conforms to relevant specifications and principles.
- When using the product, please confirm whether it meets the requirements and safety by yourself. When the failure of the product may cause machine failure or loss, please set backup and safety functions by yourself.

Declaration of liability

- Although the contents of the manual have been carefully checked, errors are inevitable and we cannot guarantee complete consistency.
- We will often check the contents of the manual and make corrections in subsequent versions. Please give us your valuable comments.
- If there is any change to the contents described in the manual, please understand without notice.

Contact us

If you have any questions about the use of this product, please contact the agent and office who purchased the product, or contact the company directly.

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Catalog

Preface

This manual mainly describes the EtherCAT communication between XG2 series (master station) and servo driver DS5C series (slave station).

This manual is based on the following information.

No.	Document	Note	Version	Date
ETG.1000.2	ETG1000_2_CHN_EcatPhysicalLayer_V1i0i2_C01	Physical layer service definition and protocol specification	V1.0.2	2013-06-24
ETG.1000.3	ETG1000_3_CHN_EcatDLLServices_V1i0i2_C01	Data link layer service definition	V1.0.2	2013-06-24
ETG.1000.4	ETG1000_4_CHN_EcatDLLProtocols_V1i0i2_C01	Data link layer protocol specification	V1.0.2	2013-06-24
ETG.1000.5	ETG1000_5_CHN_EcatALServices_V1i0i2_C01	Application layer service definition	V1.0.2	2013-06-24
ETG.1000.6	ETG1000_6_CHN_EcatALProtocols_V1i0i2_C01	Application layer protocol specification	V1.0.2	2013-06-24
ETG.1020	ETG1020_v1i1i0_S_D_Protocol Enhancements	Protocol enhancements	V1.1.0	2014-04-22
ETG.2000	ETG2000_S_D_V1i0i9i3_EtherCAT Slave Information Specification	Slave station information	V1.0.9.3	2017-11-27
ETG.6010	ETG6010_V1i1i0_D_R_CiA402_ImplDirective	Implementation instructions of CiA402 drive configuration file	V1.1.0	2014-11-19
-	EtherCAT_Communication_EN	EtherCAT communication	-	-
-	EtherCAT_Introduction_CN	EtherCAT– Ethernet fieldbus	-	-
ET1100	EtherCAT_ET1100_Datasheet_all_v1i8	Slave station controller	-	2010-05-03

Note:

(1) For the differences between the contents of this manual and the following reference materials, the contents of this manual shall prevail.

(2) It is not guaranteed that all contents of reference materials not recorded in this manual are recorded.

1. EtherCAT overview

1-1. EtherCAT introduction

EtherCAT, the full name is Ethernet for Control Automation Technology, which is developed by Beckhoff Atuomation GmbH. It is a kind of real-time Ethernet used for open network communication between master station and slave station. As a mature industrial Ethernet technology, EtherCAT has the characteristics of high performance, low cost and easy to use.

XG2 series controller (master station) and DS5C servo driver (slave station) comply with the standard EtherCAT protocol, supports the maximum 32-axis slave stations, 32-axis synchronization cycle is 1ms, 2-way touch probe function, position, speed, torque and other control modes, is widely applicable to various industries.

1-2. System composition (master and slave station)

The connection form of EtherCAT is: the network system of linear connection master station (FA controller) and multiple slave stations.

The number of nodes that can be connected by the slave station depends on the processing or communication period of the master station, the number of bytes transmitted, etc.

1-3. Communication specification

Item	Specification
Physical layer	100BASE-TX (IEEE802.3)
Baud rate	100[Mbps] (full duplex)
Topology	Line
Connection cable	JC-CA twisted pair (shielded twisted pair)
Cable length	Maximum 50m between nodes
Com port	2 Port (RJ45)
EtherCAT Indicators (LED)	[Run] RUN Indicator [L/A IN] Port0 Link/Activity Indicator (Green) [L/A OUT] Port1 Link/Activity Indicator (Green)
Station Alias (ID)	Setting range: 0~65535 Setting address: 2700h
Explicit Device ID	Not support
Mailbox protocol	COE (CANopen Over EtherCAT)
SyncManager	4
FMMU	3

<table>
<tr><td>Modes of operation</td><td>
<table>
<tr><td></td><td colspan="2">Modes of operation</td></tr>
<tr><td rowspan="3">position</td><td>csp</td><td>Cyclic synchronous position mode</td></tr>
<tr><td>PP</td><td>Profile position mode</td></tr>
<tr><td>hm</td><td>Homing mode</td></tr>
<tr><td rowspan="2">Speed</td><td>csv</td><td>Cyclic synchronous velocity mode</td></tr>
<tr><td>pv</td><td>Profile velocity mode</td></tr>
<tr><td rowspan="2">Torque</td><td>cst</td><td>Cyclic synchronous torque mode</td></tr>
<tr><td>tq</td><td>Torque profile mode</td></tr>
</table>
</td></tr>
<tr><td>Touch Probe</td><td>2 channels</td></tr>
<tr><td>Synchronization mode</td><td>DC (SYNCO event synchronization mode)
SM (SM Event synchronization)</td></tr>
<tr><td>Cyclic time (DC communication period)</td><td>500,1000,2000,4000[μs]</td></tr>
<tr><td>Communication object</td><td>SDO[Service data object], PDO[Process data object]</td></tr>
<tr><td>Maximum PDO allocation per station</td><td>TxPDO: 4 [piece] RxPDO: 4 [piece]</td></tr>
<tr><td>Single station PDO Max bytes</td><td>TxPDO: 24[byte] RxPDO: 24[byte]</td></tr>
<tr><td>Mailbox communication interval in PreOP mode</td><td>1ms</td></tr>
<tr><td>Mailbox</td><td>SDO requests and SDO information</td></tr>
</table>

Note: SDO and PDO refer to state machine.

1-4. EtherCAT communication connection

The wiring of EtherCAT motion control system is very simple. Thanks to EtherCAT, the star topology of Ethernet can be replaced by a simple linear structure. Taking Xinje DS5C series servo as an example, because EtherCAT does not need hub and switch, XG2 series PLC body and DS5C series servo are equipped with EtherCAT communication network port, so the consumption of cable and bridge is greatly reduced, the workload of connection design and joint calibration is also greatly reduced, which is convenient for saving installation cost.

Linear type connection is recommended for EtherCAT bus connection. The wiring mode is as follows:

Note: only LIN2 port in XG2 series PLC supports EtherCAT communication. The two communication network ports of the servo driver follow the principle of "down in and up out", that is, the link2 port of XG2 must be connected with the network port under the LIN1 port of the first servo, and then the network port above the first servo is connected with the network port under the second servo, and so on.

In the process of communication transmission, it will inevitably be affected by the surrounding electromagnetic environment. It is recommended that the user use the industrial CAT5e network cable, which can also be purchased in our company.

2. EtherCAT Communication specification

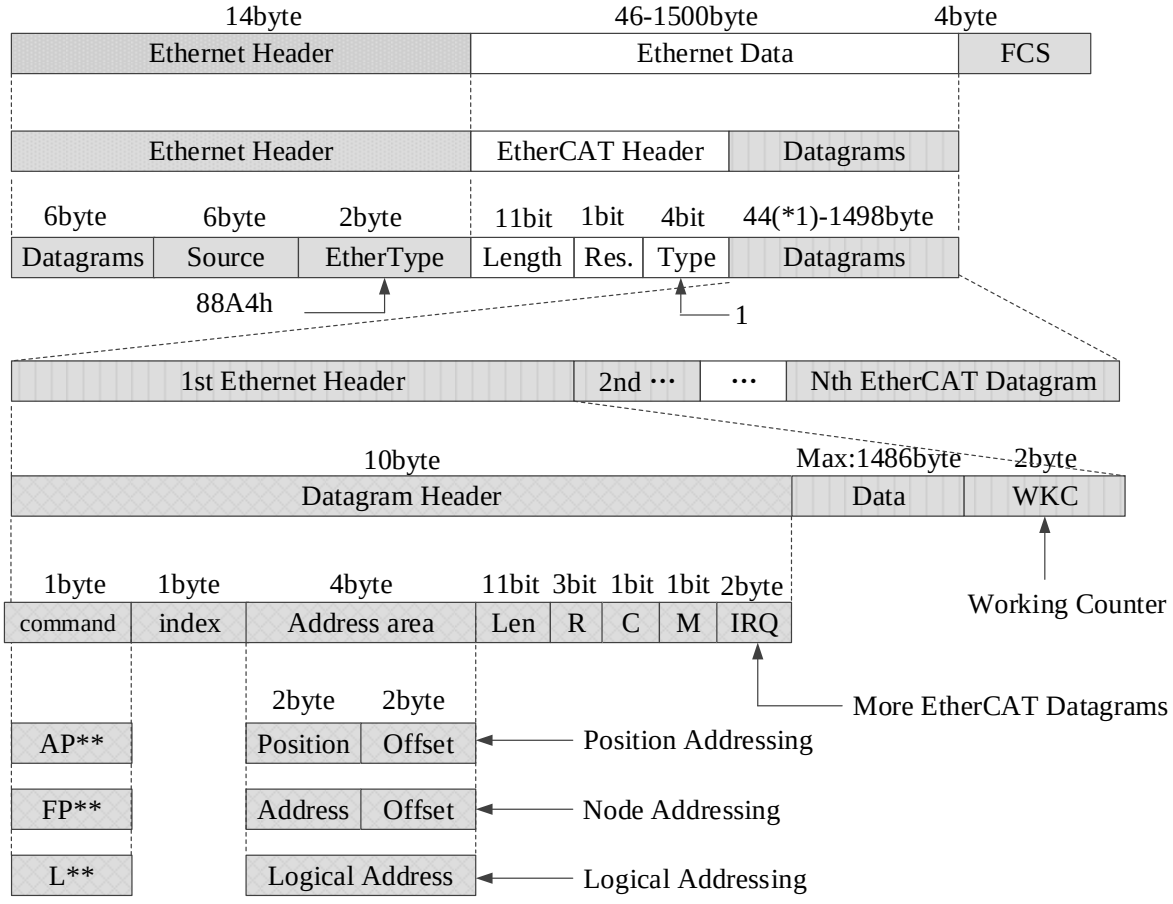
2-1. EtherCAT frame structure

EtherCAT is an industrial communication protocol based on real-time control of Ethernet. It only expands the IEEE 802.3 Ethernet specification and does not change the basic structure, so it can transmit the data within the standard Ethernet frame.

Because the EthernetType of the Ethernet Header is [88A4h], the subsequent Ethernet data is processed as the EtherCAT frame.

The EtherCAT frame is composed of the EtherCAT frame header and more than one EtherCAT sub message, which is further subdivided. Only the EtherCAT frame with type = 1 of the EtherCAT frame header is processed according to ESC.

EtherNet/EtherCAT frame structure



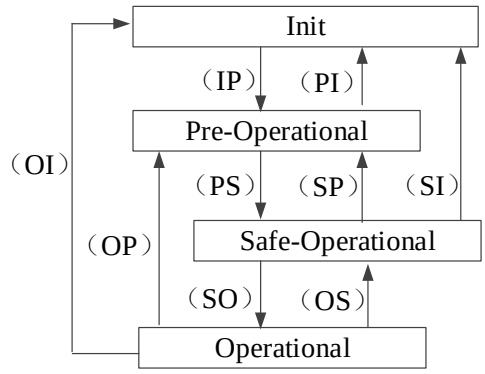
***1：** Ethernet frame is shorter than 64 byte, 1-32 byte is added.
(Ethernet Header + Ethernet Data + FCS)

2-2. ESM (EtherCAT State Machine)

The EtherCAT state machine (ESM) is responsible for coordinating the state relationship between the master and slave applications at initialization and runtime.

The state change request is executed by the master station, and the master station puts forward the control request to the application layer service. The latter generates the application layer control event in the slave station, and the slave station responds to the application layer control service through the local application layer state write service after the state change request succeeds or fails. If the status change fails, the slave station keeps the status and puts the error flag.

The figure below shows the state transformation diagram of ESM:



※The (IP) etc. in the state transformation diagram is the abbreviation of state transformation
(IP): Init→Pre-Operational
(PS): Pre-Operational→Safe-Operational

Init: Initialization status;
Pre-Operational: Pre operation status;
Safe-Operational: Safe operation status;
Operational: Operation status;

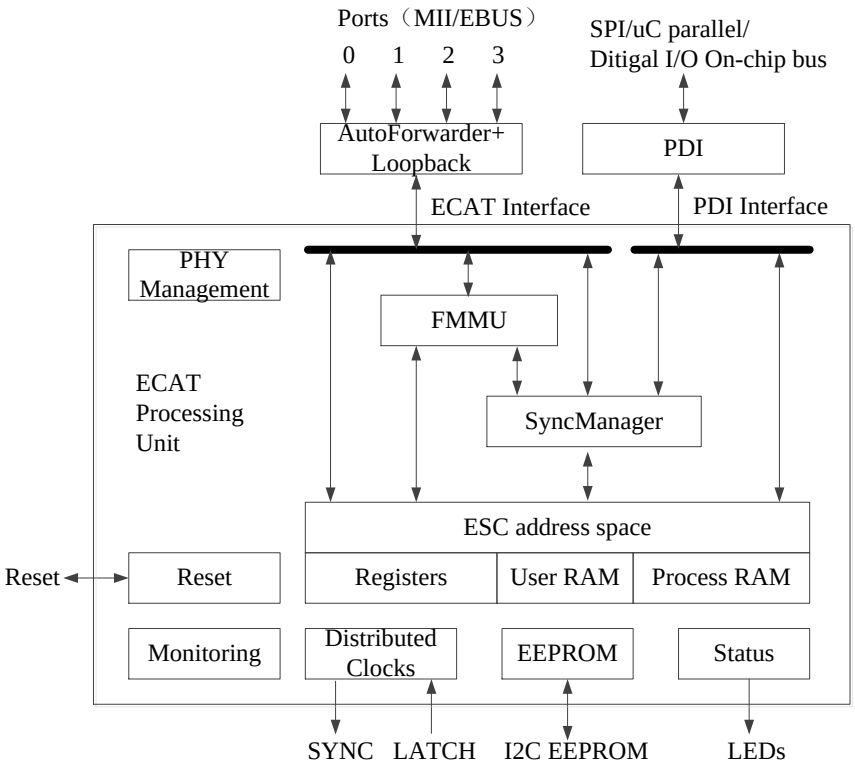
Slave station status	Actions in various states	Communication action		
		SDO (email) receive and send	PDO send	PDO receive
Init	Communication initialization, SDO, PDO unable to receive and send message	-	-	-
Pre-Operational (PreOP)	Only SDO receiving and sending status	Yes	-	-
Safe-Operational (SafeOP)	Status of SDO receiving and sending only, PDO sending	Yes	Yes	-
Operational (OP)	SDO receiving and sending, PDO receiving and sending all feasible status	Yes	Yes	Yes

Note:
The access from the master station to the ESC register is independent of the above table and is available at any time.
PDO (process data object) is used to transfer periodic communication data.
SDO (service data object) is used to transmit non periodic communication data.
Command or interface operation during ESM state switching may cause abnormal communication error.

2-3. Slave station controller ESC

2-3-1. Principle overview

ESC refers to the EtherCAT slave controller. The communication process is completely processed by ESC, which has four data receiving and transmitting ports, each with a TX and RX. Each port can send and receive Ethernet data frames. The data flow direction in ESC is fixed: port 0 - > port 3 - > port 1 - > port 2 - > port 0 are transmitted in sequence. If ESC detects that a port has no external PHY, it will automatically close the port and automatically forward to the next port through the internal loopback.



2-3-2. Address space

The DS5C series holds 8kbyte of physical address space.
The first 4kbyte (0000h-0FFFh) is used as register space, and the other 4kbyte (1000h-1FFFFh) is used as process data PDO in RAM field. For details of registers, please refer to the data table of IP (ET1810 / ET1811 / ET1812).

ESC register byte address	Length(Byte)	Explanation	Initial value*1
ESC Information			
0000h	1	Type	04h
0001h	1	Revision	02h
0002h~0003h	2	Build	0040h
0004h	1	FMMUs supported	03h
0005h	1	SyncManagers supported	04h
0006h	1	RAM Size	08h

0007h	1	Port Descriptor	0Fh
0008h~0009h	2	ESC Features supported	0184h
Station Address			
0010h~0011h	2	Configured Station Address	-
0012h~0013h	2	Configured Station Alias	-
…			
Data Link Layer			
…			
0100h~0103h	4	ESC DL Control	-
…			
0110h~0111h	2	ESC DL Status	-
Application Layer			
0120h~0121h	2	AL Control	-
0130h~0131h	2	AL Status	-
0134h~0135h	2	AL Status Code	-
…			
PDI			
0140h	1	PDI Control	08h
0141h	1	ESC Configuration	0Ch
0150h	1	PDI Configuration	-
0151h	1	SYNC/LATCH PDI Configuration	66h
0152h~153h	2	Extend PDI Configuration	-
…			
Watchdogs			
0400h~0401h	2	Watchdog Divider	-
0410h~0411h	2	Watchdog Time PDI	-
0420h~0421h	2	Watchdog Time Process Data	-
0440h~0441h	2	Watchdog Status Process Data	-
0442h	1	Watchdog Counter Process Data	-
0443h	1	Watchdog Counter PDI	-
…			
FMMU			
0600h~062Fh	3x16	FMMUs[2:0]	-
+0h~3h	4	Logical Start Address	-
+4h~5h	2	Length	-
+6h	1	Logical Start bit	-
+7h	1	Logical Stop bit	-
+8h~9h	2	Physical Start Address	-
+Ah	1	Physical Start bit	-
+Bh	1	Type	-
+Ch	1	Activate	-
+Dh~Fh	3	Reserved	-
…			
Distributed Clocks（DC）-SYNC Out Unit			

0981h	1	Activation	-
…			
0984h	1	Activation Status	-
098Eh	1	SYNCO Status	-
…			
0990h~0993h	4	Start Time Cyclic Operation/Next SYNC0 Pulse	-
…			
09A0h~09A3h	4	SYNC0 Cycle Time	-
…			

2-4. SII area (0000h~003Fh)

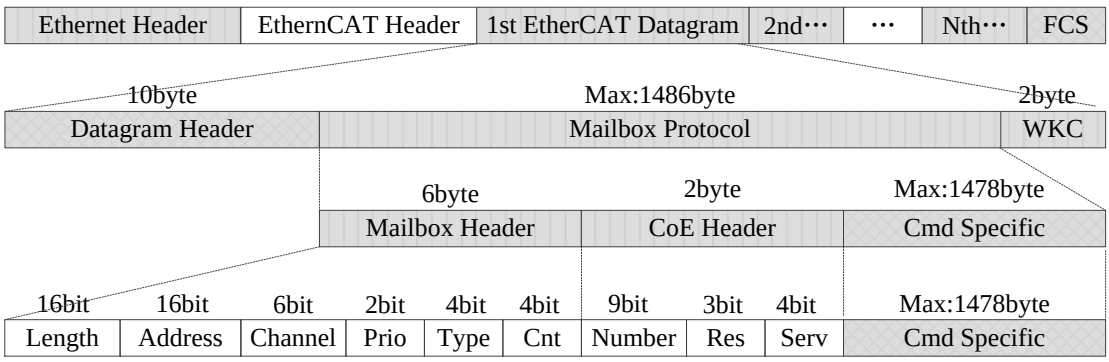
In the ESC configuration area (EEPROM word address 0000h~0007h), after the power of the drive is started, the configured station alias automatically reads and writes the ESC register according to ESC. When the value of SII EEPROM is reflected in the ESC register, the power supply needs to be started again. In addition, the initial value of IP core (ET1810 / ET1811 / ET1812) is set. Please refer to the data table of IP core (ET1810 / ET1811 / ET1812) for details.

2-5. SDO (Service Data Object)

DS5C series supports SDO (service data object). The data exchange of SDO uses mailbox communication, so the data refresh time of SDO becomes unstable.
The master station reads and writes data in the records in the object dictionary, which can set the object and monitor various states of the slave station. The response to a read-write action to SDO takes time. For objects refreshed with PDO, please do not refresh with SDO, and overwrite with PDO value.

2-5-1. Mailbox frame structure

The frame structure of mailbox/SDO is as follows. Please refer to ETG specification for details (ETG1000-5 and ETG1000-6).



Frame	Data area	Data type	Function
MailBox Header	Length	WORD	Mailbox data length
	Address	WORD	Address of the sender

	Channel	Unsigned6	(Reserved)
	Prority	Unsigned2	Priority
	Type	Unsigned4	Mailbox type 00h: error 01h: (Reserved) 02h: EoE (Not corresponding) 03h: CoE 04h: FoE (Not corresponding) 05h: SoE (Not corresponding) 06h-0Eh: (Reserved） 0Fh: VoE (Not corresponding)
	Cnt	Unsigned3	Mailbox counter
	Reserved	Unsigned1	(Reserved)
CoE Header	Number	Unsigned9	Reserved
	Reserved	Unsigned3	Reserved
	Service	Unsigned4	Message type
Cmd specific	Size Indicator	Unsigned1	Data Set Size use permission
	Transfer Type	Unsigned1	Normal transfer/Expedited transfer
	Data Set Size	Unsigned2	Data size
	Complete Access	Unsigned1	Object access method selection (not corresponding)
	Command Specfier	Unsigned3	Upload / download Selection of requirements / responses, etc
	Index	WORD	Object Index
	Subindex	BYTE	Object Subindex
			Object data or abort message, etc

2-5-2. Mailbox overtime

This servo driver performs the following timeout settings in mailbox communication.

Timeout of mailbox request: 100ms

The master station sends a request to the slave station (driver). If the WKC of the transmission data of the request frame is updated, the slave station is considered to receive the request normally. Until WKC is updated, retry again and again. However, if WKC is not updated until this set time, the master station side will time out.

Timeout for mailbox response: 10s

The master receives a response from a request from a slave (driver), which is considered normal if the WKC is updated. Until this set time, if the response of WKC being updated cannot be received, the master station side will time out.

The maximum time required by slave station (driver) response completion.

2-5-3. Alarm information

(1) Error code

Error code returns same value as 603Fh (Error code).

0000H ~ FEFFh is defined according to IEC61800-7-201.

FF00h ~ FFFFh are defined by the manufacturer, as shown below.

Index	Sub-Index	Name/Description	Range	Date Type	Access	PDO	Op-mode
603Fh	00h	Error code	0-65535	U16	ro	TxPDO	All
		The present alarm of the servo driver (only the main number). When the alarm does not occur, it will display 0000H. When an alarm occurs, an alarm is displayed. FF**h Alarm (main) number (00h~FFh) (Example) FF03h … 03h=3d E-030 (overvoltage) FF55h … 55h=85d E-850(TxPDO configuration abnormal protection), E-851(RxPDO configuration abnormal protection), any of them occurs. As an exception, A000h is displayed in the case of E-817 (syncmanager 2 / 3 setting error).					

(2) Error register

Error register returns same value as 1001h (Error register).

Index	Sub-Index	Name/Description	Range	Date Type	Access	PDO	Op-mode
1001h	00h	Error register	0-65535	U16	ro	TxPDO	All

Displays the type of alarm (status) that is occurring to the servo drive.

When the alarm does not occur, it will display 0000H.

Do not display warnings.

Bit	Content
0	Not support
1	
2	
3	
4	Alarm occurrence defined by Al status code *1
5	Not support
6	Reserved
7	Alarm occurrence undefined by Al status code *2

*1: The "alarm defined by AL status code" refers to the EtherCAT Communication Association abnormal E-800-7, E-810-7, E-850-7.

*2: The "AL status code undefined alarm" refers to the EtherCAT Communication Association abnormal E-880~7 and the exception of EtherCAT Communication Association.

2-6. PDO (Process Data Object)

The DS5C series supports PDO (process data object).

The real-time data transfer based on EtherCAT is carried out through the data exchange of PDO (process data object).

PDO has RxPDO transferred from master station to slave station and TxPDO transferred from slave station to master station.

	Sending side	Receiving side
RxPDO	Master station	Slave station
TxPDO	Slave station	Master station

2-6-1. PDO mapping objects

PDO mapping refers to the mapping from object dictionary to application object of PDO.

Tables for DS5C series PDO mapping can use 1600h~1603h mapping objects for RxPDO and 1A00h~1A03h mapping objects for TxPDO.

The maximum number of application objects that a mapping object can map is as follows:

RxPDO: 24 [byte], TxPDO: 24 [byte]

The following is an example of setting a PDO map.

< setting example >

Allocation of application objects 6040h, 6060h, 607Ah, 60B8h to mapping object 1600h (Receive PDO mapping 1: RxPDO_1).

Index	Sub	Object contents
1600h	00h	04h
	01h	6040 00 10 h
	02h	6060 00 08 h
	03h	607A 00 20 h
	04h	60B8 00 10 h
	05h	0000 00 00 h
	…	
	18h	0000 00 00 h

6040h	00h	Controlword	U16
6060h	00h	Mode of operation	I8
607Ah	00h	Target Position	I32
60B8h	00h	Touch probe function	U16

2-6-2. PDO distribution objects

In order to exchange PDO data, a table for PDO mapping must be assigned to syncmanager. The relationship between the table used for PDO mapping and syncmanager is described to PDO allocation object. As PDO allocation object, DS5C can use 1C12h for RxPDO (syncmanager2) and 1C13h for TxPDO (syncmanager3).

The maximum number of application objects that a mapping object can map is as follows:

RxPDO: 4 [Table] (1600h~1603h).

RxPDO: 4 [Table] (1A00h~1A03h).

Usually, because one mapping object is enough, there is no need to change by default.

Example of setting PDO assignment object:

Allocation mapping object 1600h to allocation object 1C12h (sync Manager Channel 2).

Index	Sub	Object contents
1C12h	00h	01h
	01h	1600h
	02h	0000h
	03h	0000h
	04h	0000h

Allocation mapping object 1600h to allocation object 1C13h (sync Manager Channel 3).

Index	Sub	Object contents
1C13h	00h	01h
	01h	1A00h
	02h	0000h
	03h	0000h
	04h	0000h

2-7. Communication synchronization mode

DS5C series can select the following synchronization modes.

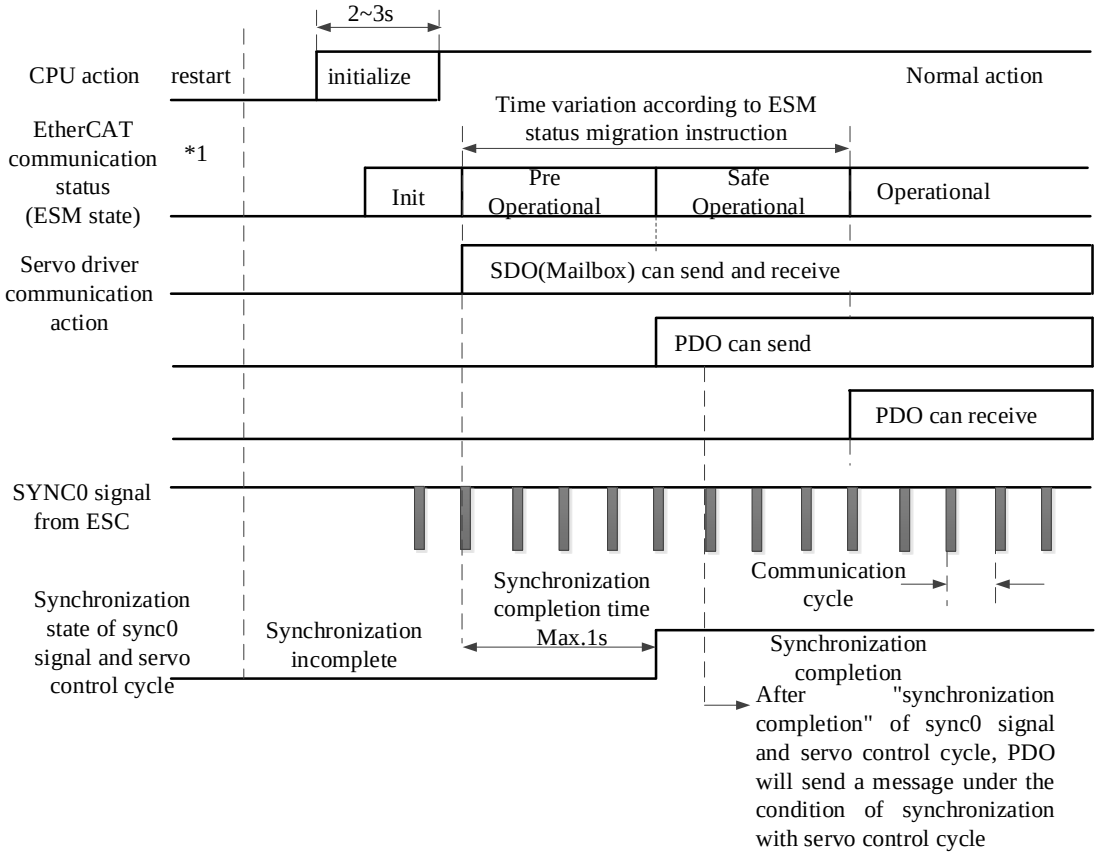
Synchronization mode	Content	Synchronization method	Feature
DC	SYNC0 Event synchronization	Synchronize the time information of other slave stations based on the time of the first axis	High-precision Compensation treatment shall be carried out at the main station side
SM2	SM2 Event synchronization	Synchronize according to RxPDO receiving time	No transmission delay compensation, poor accuracy Need to keep transmission time on controller side (special hardware, etc.)
FreeRun	Asynchronous	Asynchronous	Simple processing Poor real-time performance

2-7-1. DC (SYNC0 Event synchronization)

DS5C series has 64-bit DC (distributed clock).

The synchronization of EtherCAT communication is based on this DC. According to the DC slave station, synchronization is realized through the system time with the same reference. The local cycle from the slave station starts with the sync0 event. Since the slave processing (servo processing) starts from the sync0 event cycle, it is always synchronized with the sync0 event.

The master station needs to carry out transmission delay compensation (offset compensation) and regular deviation compensation during communication initialization. The following figure shows the process of synchronous completion from the input of control power to the event of sync0 and the processing of slave station (servo processing).



2-7-2. SM2 (SM2 Event synchronization)

The local cycle from the slave station starts with SM2 event.

Since the processing of the slave station starts from the SM2 event cycle, it is always synchronized with SM2 event.

Because SM2 event occurs when PDO receiving is completed, it is necessary to ensure that the upper (Master) side sends the message regularly. If the fluctuation (deviation) of sending time is too large, synchronization cannot be completed, or an alarm occurs.

If this happens, use DC (sync0 event synchronization).

2-8. LED

The XG2 series has two EtherCAT indicators (LEDs), L/A IN and L/A OUT.

L/A IN and L/A OUT indicator indicate the link status and action status of the physical layer of each port.

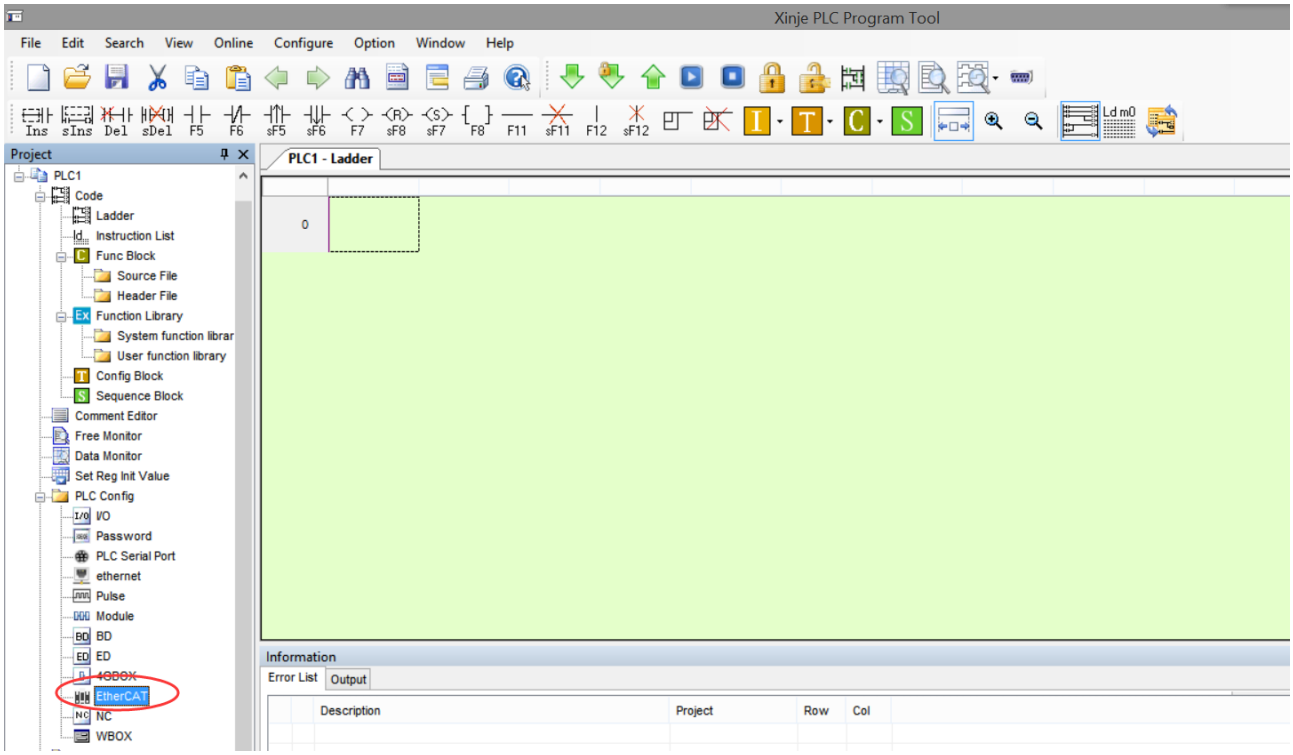
The light color is green.

LED state	Content
OFF	Link not established
Flickering	Link established, with data receiving and sending
ON	Link established, no data receiving and sending

3. EtherCAT parameter configuration

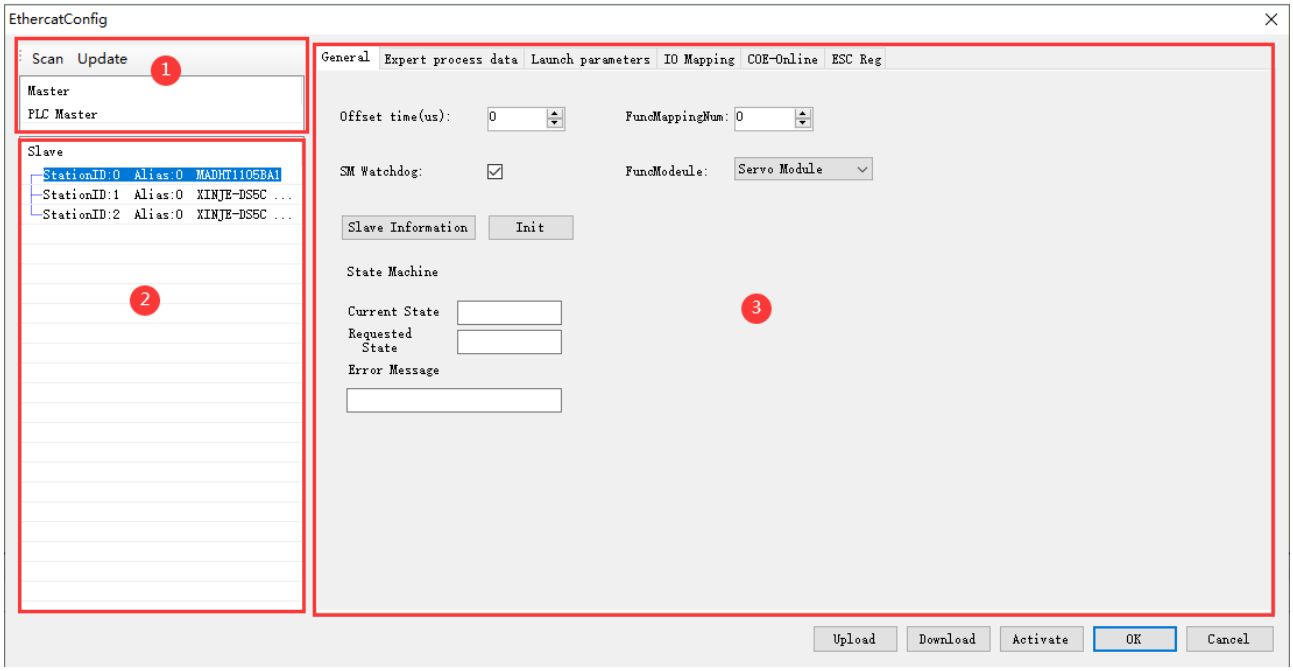
3-1. EtherCAT configuration interface

Create a new project. In the picture below, open EtherCAT in the PLC configuration branch of the project area.

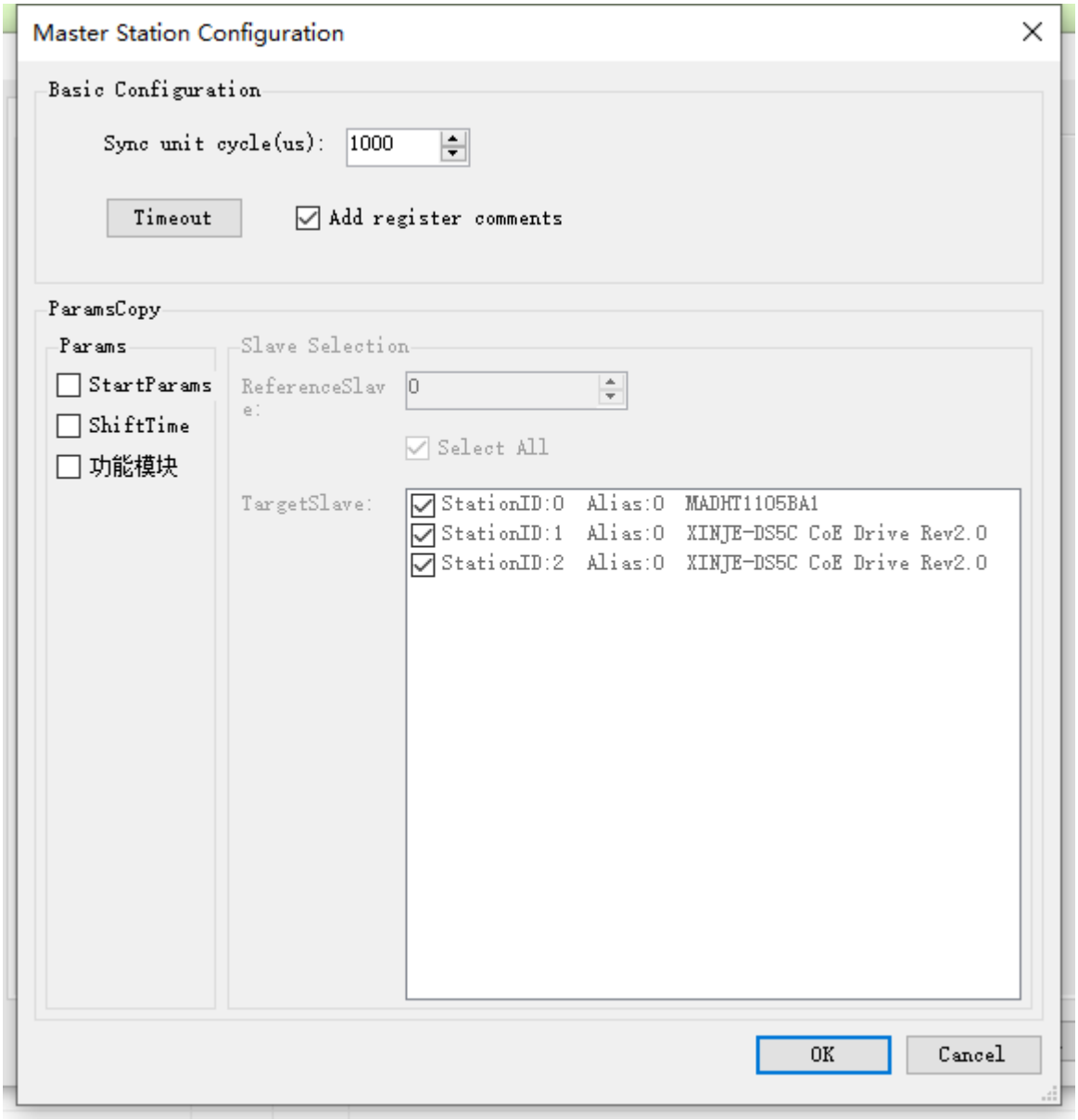


The EtherCAT parameter configuration interface is divided into master station configuration area, slave station display area and slave station configuration area.

① Configuration area of master station: set EtherCAT periodic synchronous communication interval, upper computer timeout, ESM state switching of all slaves. (ESM: Ethernet state machine, refer to [state machine])
② Display area of slave station: scan or manually add the slave station, and the corresponding configuration information of the slave station selected by the cursor will show on the right side.
③ Slave configuration area: corresponds to the configuration information of the currently selected slave station.

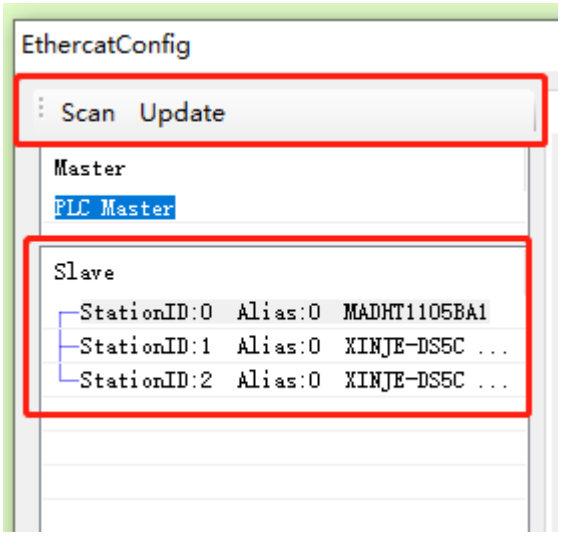

EthercatConfig
Scan
Update
1
Master
PLC Master
Slave
StationID:0 Alias:0 MADHT1105BA1
StationID:1 Alias:0 XINJE-DS5C ...
StationID:2 Alias:0 XINJE-DS5C ...
2
General
Expert process data
Launch parameters
IO Mapping
COE-Online
ESC Reg
Offset time(us):
0
FuncMappingNum:
0
SM Watchdog:
FuncModeule:
Servo Module
Slave Information
Init
State Machine
Current State
Requested State
Error Message
3
Upload
Download
Activate
OK
Cancel

3-2. Master station configuration



Parameter	Explanation
Synchronization unit cycle	The communication cycle between master station and slave station is 500~10000 (unit: μs) (that is, the sending data time interval between master station and slave station) and SFD2990 is set to the same value. Note: if 16 or less axis slave station is connected, it can be set to 500; if 32 or less axis slave station is connected, it can be set to 1000.
Timeout	Communication timeout setting of upper computer and related functions of EtherCAT.
Parameter copy	Tick the parameters to be copied (the contents include startup parameters and offset time, see 2-5 and 2-7 for the meaning), and copy them to the target slave station based on the parameters of [reference slave station] (the number here refers to station ID). The target slave station can be selected in full or selected in part.

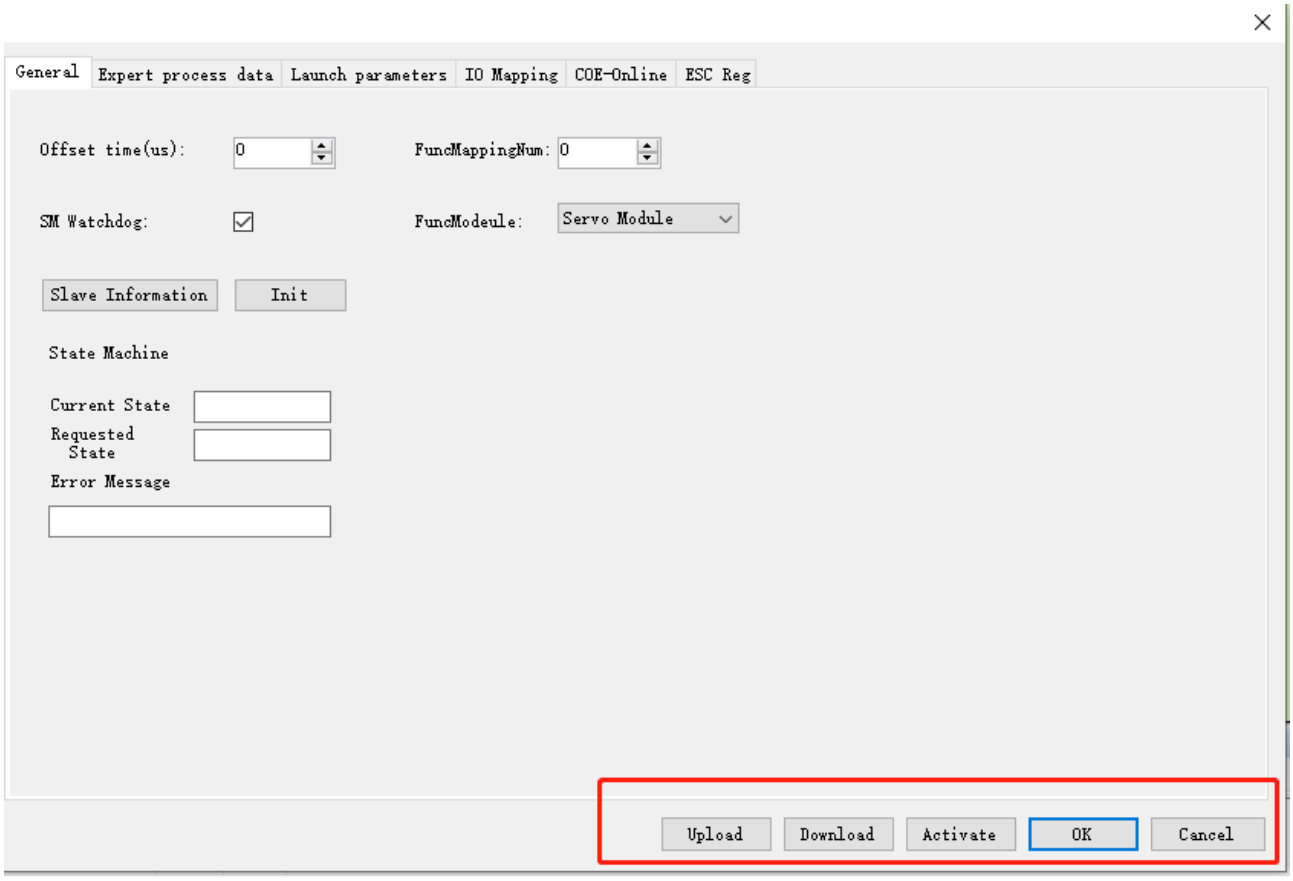
3-3. Slave station list



Parameter	Explanation
Scan	Scan to obtain the topology of the current slave, and find out whether there is a matching slave XML file locally. If not, try to read the EEPROM and object dictionary of the slave to generate temporary XML. There is no need to stop the PLC. Note: the scanned slave station distinguishes the first station by station ID, station ID: 0 represents the first station, and so on.
Add	Add the XML file of the slave station (the corresponding XML file is required, which is stored in the EtherCAT / folder under the installation directory of Xinje PLC programming software). The default configuration of the slave station is related to XML.
Copy	Copy the selected configuration item and add it to the last.
Delete	Delete the selected configuration item.
Up	Move up the selected configuration item.
Down	Move down the selected configuration item.
Update	Update the slave station list.

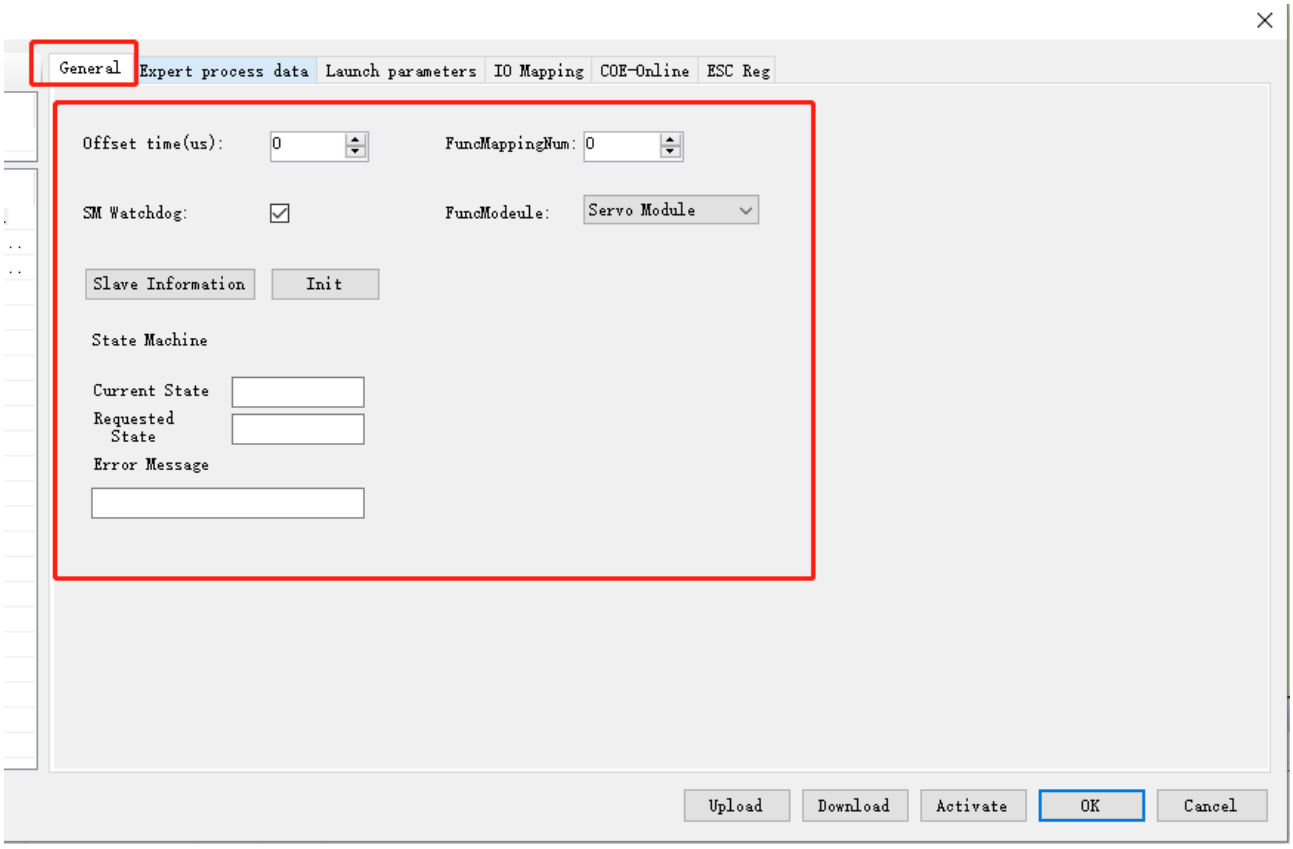
Note: the order in the slave station list must be consistent with the actual connection order. If not, after clicking [activate] (meaning of activation 3-4 [activate]), the upper computer system will give the following prompt, and the equipment will not work normally.

3-4. Slave station configuration



Parameter	Explanation
Download	Download the configuration parameters to the flash of PLC without stopping PLC. Note: (1) The downloaded configuration is stored in the flash of PLC. Click activate to take effect. (2) The download here is only for PLC debugging (also can be saved in case of power failure). Please tick the EtherCAT parameter option when downloading the PLC project, otherwise there is no Etherecat configuration data when uploading the PLC project.
Upload	The configuration information in PLC is uploaded to the upper computer without stopping PLC.
Activate	The configuration data in the current PLC will take effect immediately. It will switch from any state of the slave station to Init, and then to OP state (Init → PreOP → Safeop → OP). The effect is equivalent to stopping the PLC and then running the PLC. It is not necessary to stop PLC (for the meaning of slave station state, see the state machine in the general interface).
Ok	Exit the interface and save the currently modified data. Note: only the data will be saved, and the activation parameters will not take effect without downloading.
Cancel	Exit the interface without saving, which is equivalent to pressing the X button in the upper right corner.

3-5. General



Parameter	Explanation
Offset time	Its specific meaning is shown in the communication sequence diagram. The shift time in the diagram represents the experienced offset time.
SM watchdog	If the watchdog is selected, it will force set 0x420 (watchdog timing time) of ESC register to 1000. Note: the function of the watchdog is to reset the system when the program dead or crashes.
Initialzation	Restore all the configuration of the selected slave station to the default configuration, which needs to be downloaded again to take effect.
Slave information	It is used to download EEPROM during servo production and updating, and its download function is not open to users by default.
PreOP, OP, Init, SafeOP	Switch the slave station to specified state.
Current state	The current status of the slave. The current slave status can be monitored through SD [8021 + 20 * I]. * 1
Requested state	Status of the slave request. Mode switching control requirements can be monitored through SD [8029 + 20 * I] . *1
Error message	Error is reported when slave station state switching error. You can confirm the status switching error message through SD [8028 + 20 * I] . *1
Function module	It is used to map the EtherCAT slave station to the specified function module. For example, if the slave station 0 is the servo, the module selection is set as the servo module. At this time, the predefined functions of the motion control module will be associated with some necessary PDO objects. If you want to customize the operation, you can select user define. At this time, PDO data can be modified arbitrarily by the value of IO mapping. (note that IO module is not open temporarily, and its effect is equivalent to user define)

Function mapping number	Used to bind the EtherCAT slave to the specified module function. For example, there are two slave stations, namely, station 0 and station 1. You can set the [function mapping number] of station 0 to 1, and station 1 to 0. At this time, the slave station 1 is controlled by station 0 in the motion control module, while the slave station 0 is controlled by station 1 in the motion control module.

*1: See Chapter 9 "description of relevant registers" for details.

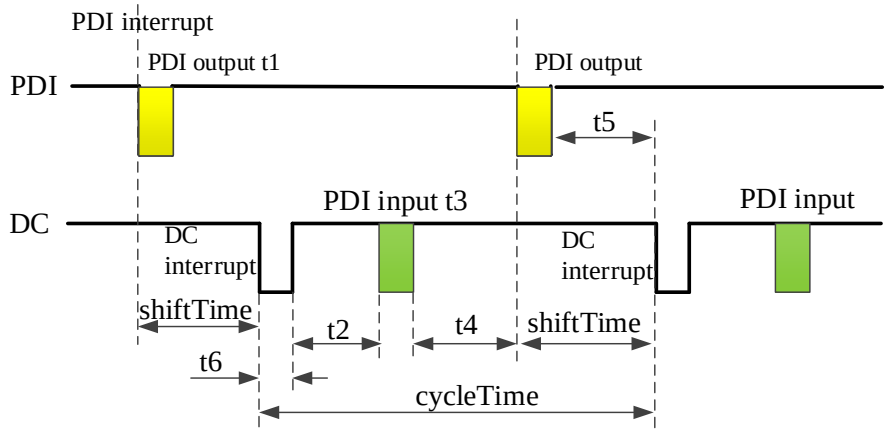
Slave station status	Actions in various states	Communication action		
		SDO (mail) receive and send	PDO send	PDO receive
Init	Communication initialization, SDO, PDO unable to receive and send messages	-	-	-
Pre-Operational (PreOP)	the status of only SDO sends and receives message	Yes	-	-
Safe-Operational (SafeOP)	the status of only SDO sends and receives, PDO sends message	Yes	Yes	-
Operational (OP)	all feasible status of SDO receiving and sending, PDO receiving and sending	Yes	Yes	Yes

Note: the access from the master station to the ESC register is independent of the above table and is available at any time.

PDO (process data object) is used to transfer periodic communication data.

SDO (service data object) is used to transmit non periodic communication data.

Command or interface operation during ESM state switching may cause abnormal communication error.



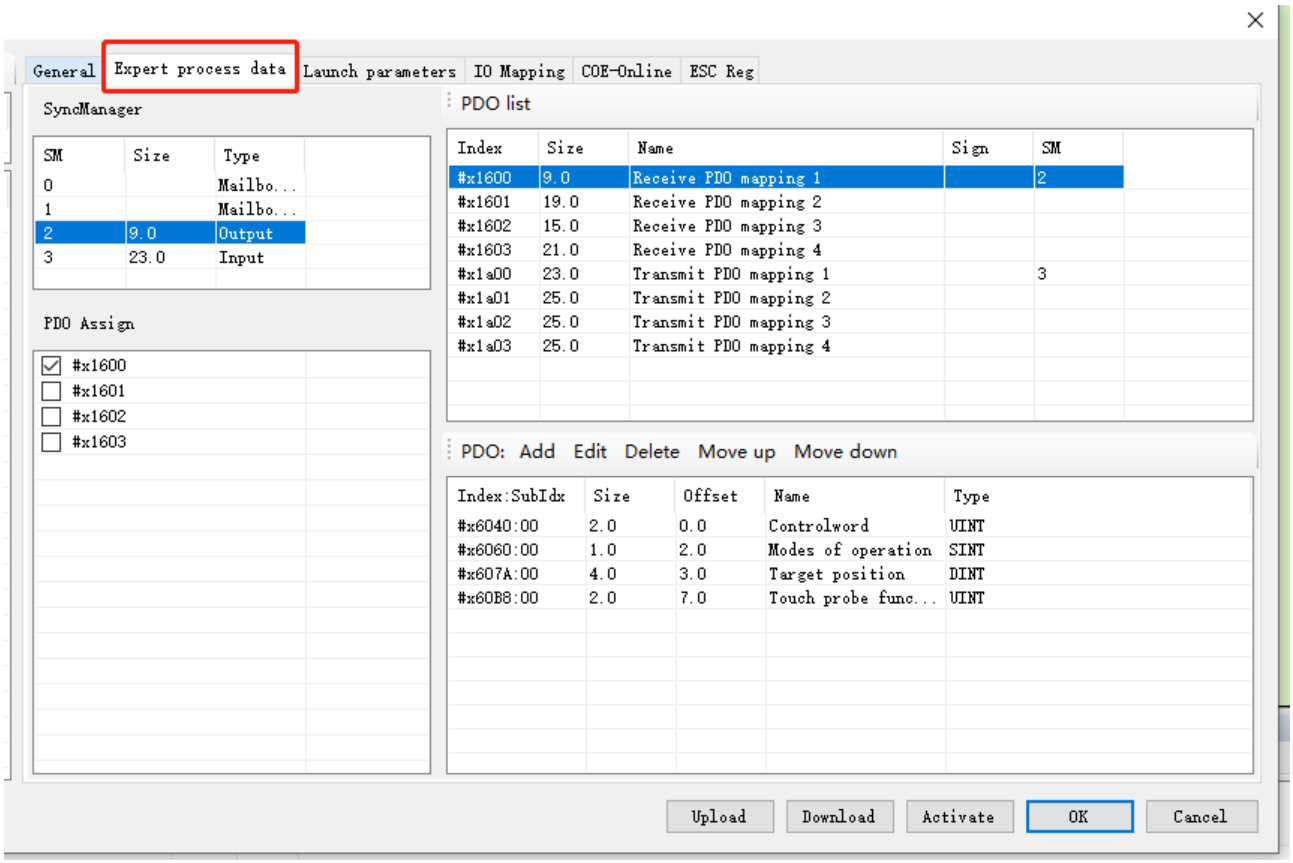
Communication sequence diagram

Related concepts and key time points are as follows:

PDI	Process data interface
DC	Distributed clock
ESC	EtherCAT slave station controller
MCU	Microprocessor
PDI interruption	This interrupt is triggered when the master sends data to the slave
PDI falling edge	EOF is the completion of acquiring data frame from the slave station ESC
PDI rising edge	The slave MCU has obtained the current PDO data from ESC

PDI output	Copy PDO data from ESC to MCU and wait for MCU to process, which takes time t1
DC interrupt	Timing interrupt with reference clock as time reference, whose cycle is cycleTime (i.e. synchronization unit cycle), is responsible for triggering data processing of slave station (the same as Xnet data processing)
DC rising edge	Trigger data processing of each slave station
PDI input	Copy PDO data from MCU to ESC and wait for master station to read next cycle, which takes time t3

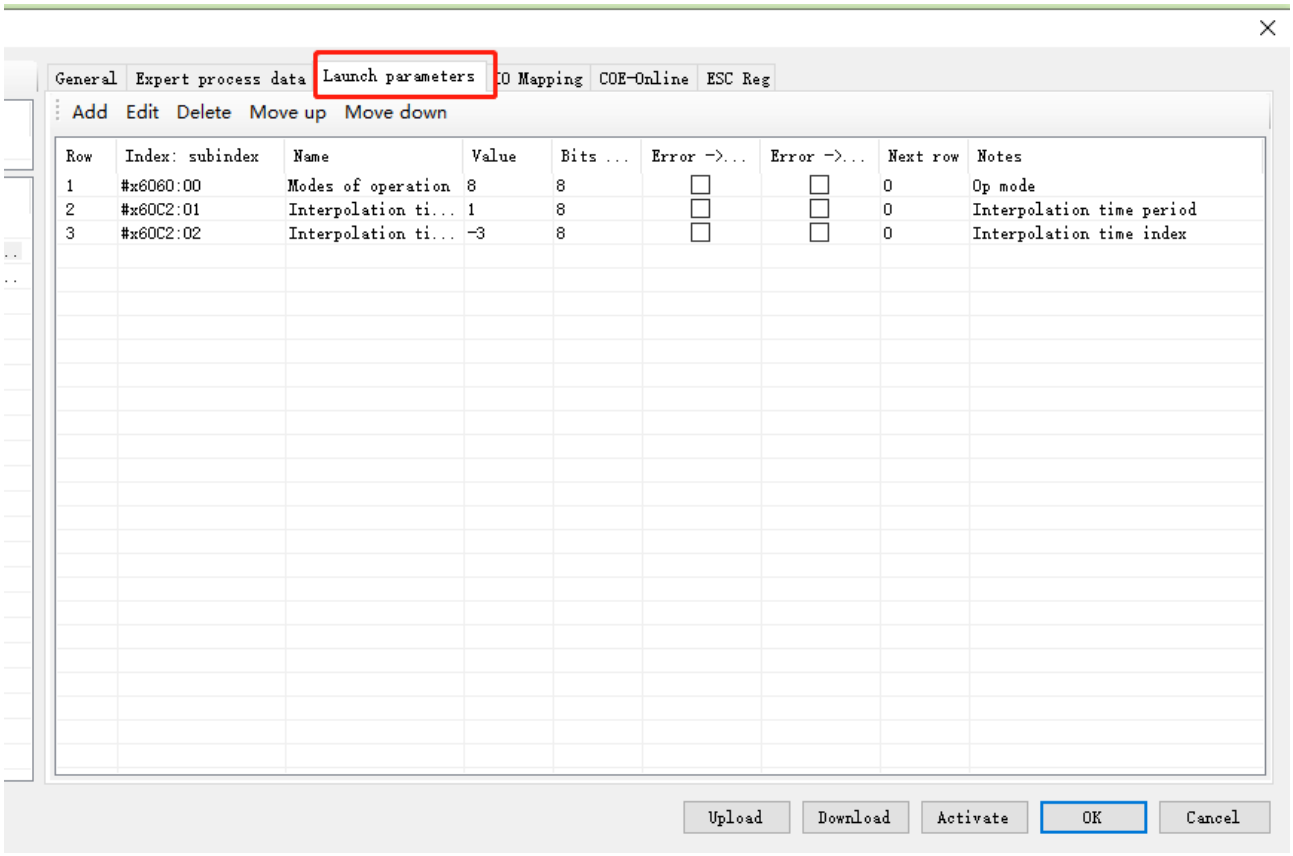
3-6. Expert process data



Parameter	Explanation
Synchronization manager	SM0, 1: for the interaction of mailbox data (SDO); SM2, 3 for the interaction of PDO data (its type input and output are relative to the master station). Note: (1) PDO (process data object) is used to transfer periodic communication data. (2) SDO (service data object) is used to transmit non periodic communication data.
PDO distribution	Specifies the PDO of the corresponding SM, up to 4 can be selected, and the size does not exceed 24 bytes. (the larger the PDO data is, the longer the transmission time is, and it may not be completed in the synchronization unit cycle. Therefore, it is impossible to guarantee the stability of data transmission when there are many slave stations and each slave station has a large PDO data.)
PDO list	Some PDO maps predefined in the servo XML, RxPDO represents PDO transmitted from the master station to the slave station, 1600h ~ 1603h can be used, TxPDO represents PDO transmitted from the slave station to the master station, and 1A00h ~ 1A03h can be used.

PDO content	The PDO objects to be mapped are specified from the object dictionary, and the objects are periodically exchanged through PDO. (RxPDO must have 6040h, 6060h, 607Ah, TxPDO must have 6041h, 6061h, 6064h, 606Ch)

3-7. Launch parameter



There are three default configurations in the startup parameters, of which 6060h is the operation mode of the slave station, with the default value of 8 (CSP mode); 60C2-1 and 60C2-2 are the synchronization unit cycle, 60C2-1 is the value of the synchronization unit cycle, and 60C2-2 is the unit of the synchronization unit cycle, for example, the default synchronization unit cycle is 100 × 10^{-5}s, that is, 1000us. (this parameter will change automatically with the synchronization period configured by the master station, and does not need to be modified manually.).

You can configure startup parameters and their execution order through [add], [edit], [delete], [move up] and [move down].

Note: the execution order is from top to bottom. You can write different values to the same parameter, indicating that the parameters are set in the order from top to bottom.

[Error -> Exit]: indicates that if there is an error in configuring this parameter, all the following configurations will be skipped.

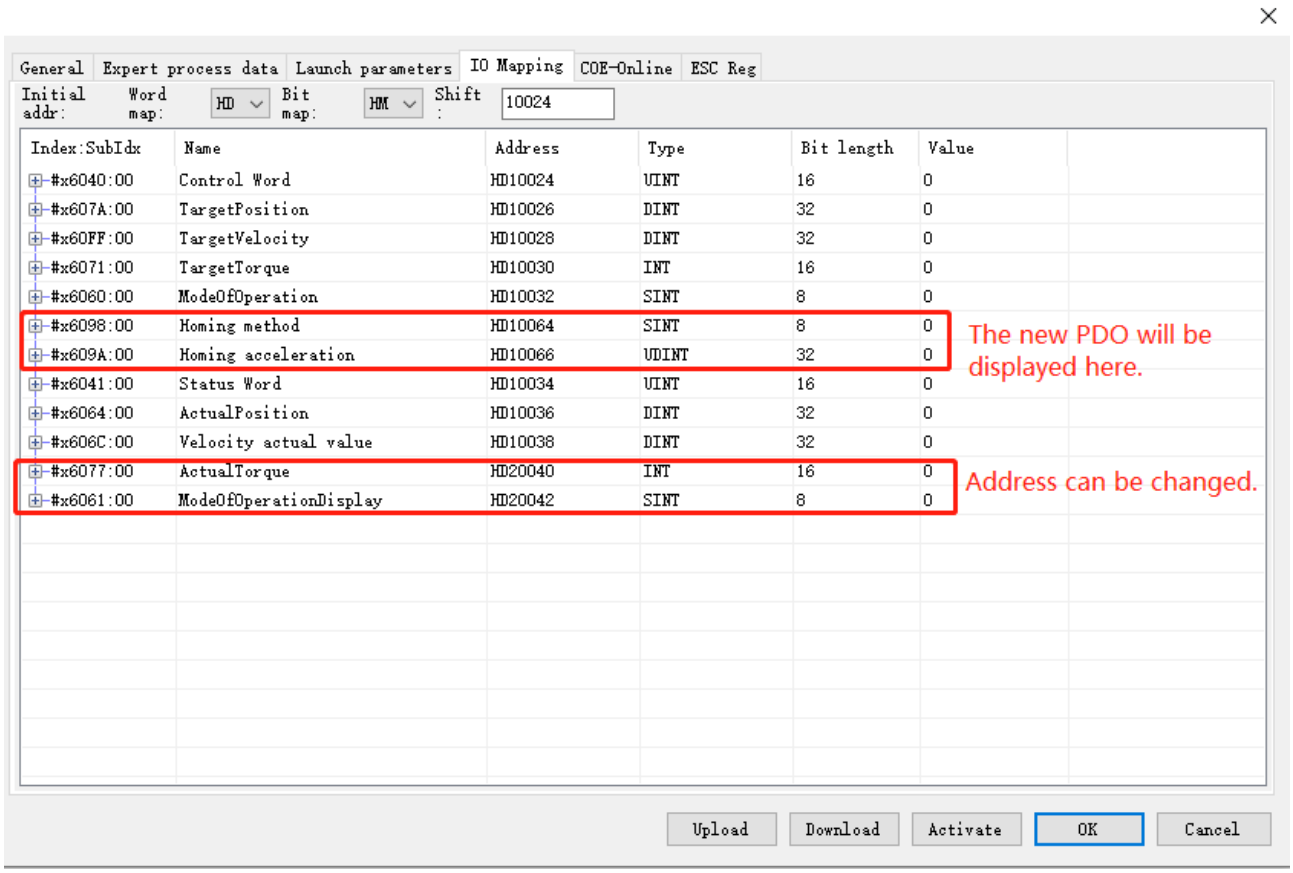
[Click error -> jump] and [next line] to specify to jump to the specified line to continue configuration when an error occurs.

3-8. IO mapping

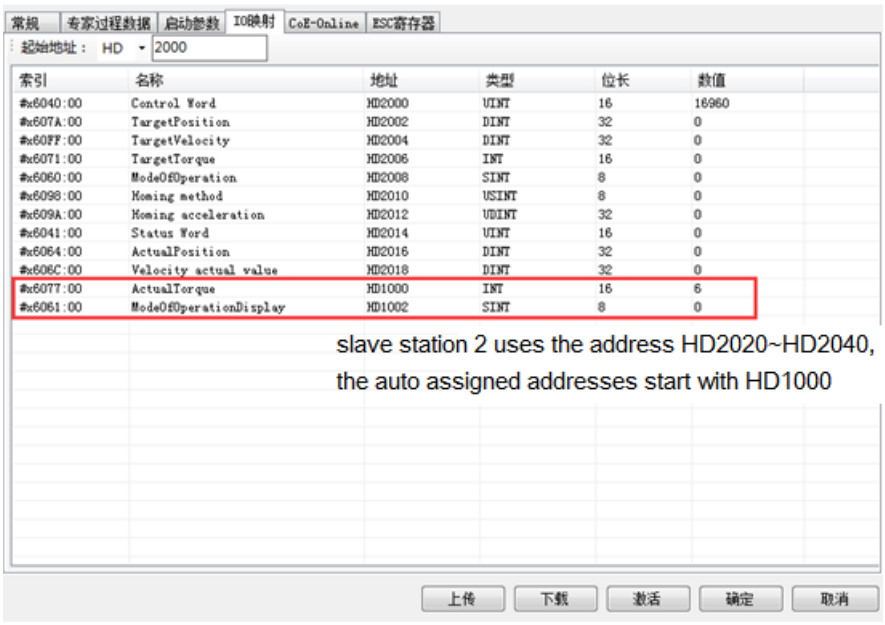
The allocated RxPDO and TxPDO will be mapped to the register starting from the [start address], and the register types can be HD and D. Modifying the [start address] will automatically arrange the addresses according to the parameter order. If there is a duplicate address with other stations, an error will be reported and the address will be automatically arranged to a non duplicate address.

Parameter types in IO mapping can be divided into read-only (RO) and read-write (RW). Parameter types can be seen in CoE-Online. In particular, 6040h (RW) is only writable in homing mode (6060h is 6), and 607A (RW) is not writable in any mode.

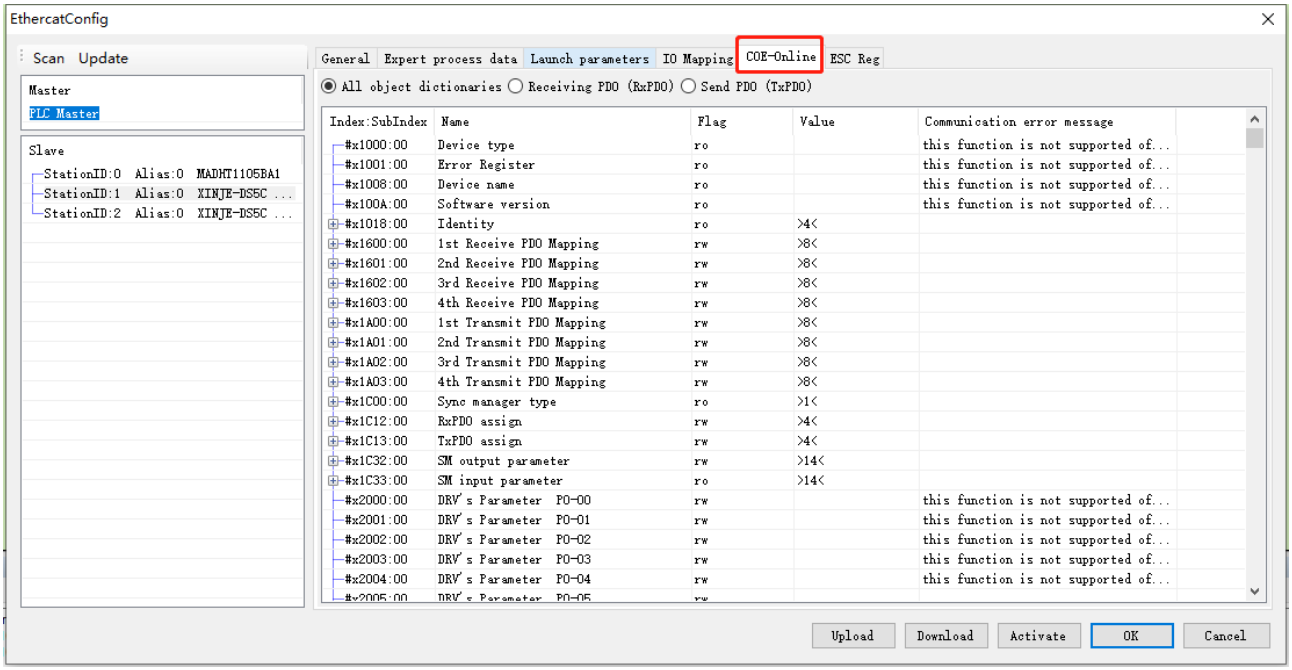
If a new PDO is added to the IO mapping, it will be automatically sorted in the order of RxPDO first and TxPDO later. The corresponding register addresses will also be allocated in order. If the allocated address conflicts with other set slave addresses, the unused addresses will be automatically selected.



Note: the address automatically assigned due to address conflict is from HD1000 and is not used. The following picture:



3-9. COE-Online interface



COE-Online has the function of reading and writing all object Dictionaries Online. When the interface is opened, the data will be updated all the time. Select the slave of COE online from the list of slave stations on the left. Double click the RW type object dictionary to make online modification.

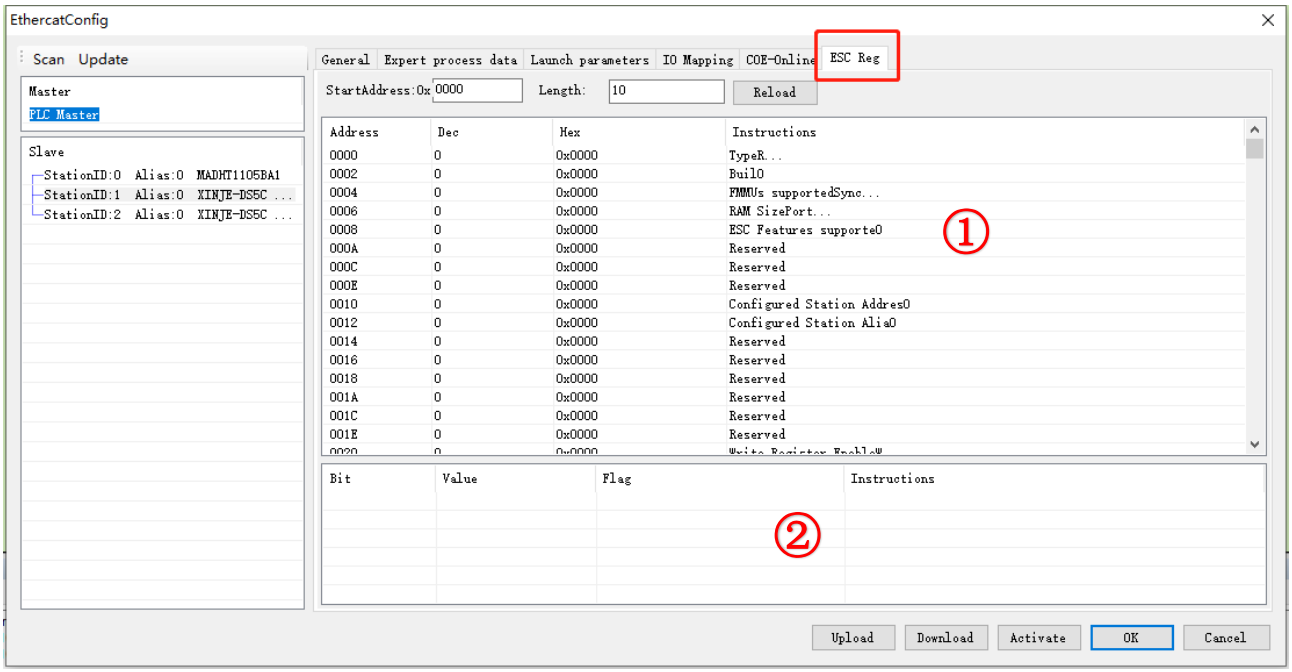
COE-Online contains object types:

Object type	Explanation
0x1000	Device type
0x1001	Servo driver alarm type (status)
0x1008	Manufacturer equipment name
0x1009	Manufacturer hardware version
0x100A	Manufacturer software version
0x1018	Device information

0x1C00	Synchronous management communication type (SyncManager)
0x1C12, 0x1C13	Process data object (PD0) mapping
1600h~1603h, 1A00h~1A03h	PDO mapping object
0x1C32, 0x1C33	Synchronous management SM2/3
0x6000-0x6fff	Cia402 Profile COE object
0x2000-0x5fff	Xinje customized object

3-10. ESC register

ESC refers to EtherCAT slave controller, and ESC register interface is the interface for monitoring and modifying slave registers.



Parameter	Explanation
Start address	Set the starting value (hexadecimal) of the register to be monitored.
Length	Number of registers to be monitored, decimal.
Reload	Click to display the value. The current value is displayed only once.
Interface 1	Only the value of each register is displayed and cannot be modified.
Interface 2	The meaning of each bit of the register determines the read/write permission according to the flag. R-readable, w-writable, w (CLR) - write as clear as 0.

Note: the value modification of some registers will disconnect the communication. If there is no special case, it is not necessary to modify.

4. Object dictionary (CoE-Online)

4-1. Object dictionary area assignment

All objects are configured in the object dictionary of each group through the 16-bit index configuration address represented by 4-bit hex.

The object dictionary of CoE (CANopen over EtherCAT) specified by CiA402 and the object dictionary of DS5C series are as follows:

Object dictionary according to CiA402		Object dictionary of DS5C series	
Index	Content	Index	Content
0000h~0FFFh	data type area	0000h~0FFFh	data type area
1000h~1FFFh	COE communication area	1000h~1FFFh	COE communication area
2000h~5FFFh	User-defined area	2000h~2FFFh	servo parameter area
		3000h~3FFFh	Reserved
		4000h~4FFFh	Reserved
		5000h~5FFFh	Reserved
6000h~9FFFh	Profile area	6000h~6FFFh	Driver Profile area
		7000h~9FFFh	Reserved
A000h~FFFFh	Reserved	A000h~FFFFh	Reserved

4-2. COE communication area (0x1000-0x1FFF)

4-2-1. Object list

(1) Device information object

Index	Sub-Index	Name
1000h	00h	Device type
1001h	00h	Error register
1008h	00h	Manufacturer device name
1009h	00h	Manufacturer hardware version
100Ah	00h	Manufacturer software version
1018h	-	Diagnosis history
	00h	Number of entries
	01h	Vendor ID
	02h	Product code
	03h	Revision number
	04h	Serial number

(2) RxPDO object mapping

Index	Sub-Index	Name
1600h	-	Receive PDO mapping 1
	00h	Number of entries

	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped
1601h	-	Receive PDO mapping 2
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped
1602h	-	Receive PDO mapping 3
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped
1603h	-	Receive PDO mapping 4
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped

(3) TxPDO object mapping

Index	Sub-Index	Name
1A00h	-	Transmit PDO mapping 1
	00h	Number of entries
	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped
1A01h	-	Transmit PDO mapping 2
	00h	Number of entries

	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped
1A02h	-	Transmit PDO mapping 3
	00h	Number of entries
	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped
1A03h	-	Transmit PDO mapping 4
	00h	Number of entries
	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped

(4) PDO object distribution

Index	Sub-Indx	Name
1C12h	-	Sync manager channel 2
	00h	Number of assigned PDOs
	01h	Assigned RxPDO 1
	02h	Assigned RxPDO 2
	03h	Assigned RxPDO 3
	04h	Assigned RxPDO 4
1C13h	-	Sync manager channel 3
	00h	Number of assigned PDOs
	01h	Assigned TxPDO 1
	02h	Assigned TxPDO 2
	03h	Assigned TxPDO 3
	04h	Assigned TxPDO 4

(5) PDO synchronous management channel

Index	Sub-Indx	Name
1C32h	-	Sync manager 2 synchronization
	00h	Number of sub-objects
	01h	Sync mode
	02h	Cycle time
	03h	Shift time
	04h	Sync modes supported

	05h	Minimum cycle time
	06h	Calc and copy time
	08h	Command
	09h	Delay time
	0Ah	Sync0 cycle time
	0Bh	Cycle time too small
	0Ch	SM-event missed
	0Dh	Shift time too short
	0Eh	RxPDO toggle failed
	20h	Sync error
1C32h	-	Sync manager 2 synchronization
	00h	Number of sub-objects
	01h	Sync mode
	02h	Cycle time
	03h	Shift time
	04h	Sync modes supported
	05h	Minimum cycle time
	06h	Calc and copy time
	08h	Command
	09h	Delay time
	0Ah	Sync0 cycle time
	0Bh	Cycle time too small
	0Ch	SM-event missed
	0Dh	Shift time too short
	0Eh	RxPDO toggle failed
	20h	Sync error

4-2-2. Device information

This section describes the equipment information.

Index	Sub-Index	Name/Description	Range	Date Type	Access	PDO	Op-mode
1000h	00h	Divece type	0~4294967295	U32	ro	NO	All
		Indicates the device type. In case of servo driver, the value is fixed to 04020192h.					
1001h	00h	Error register	0~65535	U16	ro	TxPDO	All
		Displays the type of alarm (status) that is occurring to the servo driver. When the alarm does not occur, it will display 0000H. Do not display warnings.					

Bit	Content
0	Not support
1	
2	
3	
4	Alarm occurrence defined by AL status code *1
5	Not support
6	Reserved
7	Alarm occurrence undefined by AL status code *2

		*1) The "alarm defined by AL status code" refers to the EtherCAT Communication Association Error E-800~7, E-810~7, E-850~7. *2) The "AL status code undefined alarm" refers to the EtherCAT Communication Association Error E-880~7 and the error except EtherCAT Communication Association.					
1008h	00h	Manufacturer device name	-	-	ro	TxPDO	All
		Device name.					
1009h	00h	Manufacturer hardware version	-	-	ro	TxPDO	All
		Hardware version.					

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
1018h	00h	Number of entries	0~255	U8	ro	TxPDO	All
		Sub-index number for this object. The value is fixed to 04H.					
	01h	Vendor ID	0~4294967295	U32	ro	TxPDO	All
		Manufacturer ID of EtherCAT. The value is fixed to 00000 556h.					
	02h	Product code	0~4294967295	U32	ro	TxPDO	All
		Product code. The value is 10305070h.					
	03h	Revision umber	0~4294967295	U32	ro	TxPDO	All
		Product version number. The value is 02040608h.					
	04h	Divece type	0~4294967295	U32	ro	TxPDO	All
		Product serial number. The value is 00000000h.					

4-2-3. Sync manager communication type (1C00h)

The action mode assigned to each syncmanager is set by 1C00h object.

The value is fixed for the servo driver.

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
1C00h	00h	Number of used sync manager channels	0~255	U8	ro	TxPDO	All
		The number of child indexes for this object. The value is fixed to 04H.					
	01h	Communication type sync manager 0	0~4	U8	ro	TxPDO	All
		Set the purpose of sync Manager 0. 0: unused. 1: Mailbox receive (master station→slave station) 2: Mailbox send (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because sync manager0 uses mailbox to receive messages, the value is fixed to 1.					
	02h	Communication type sync manager 1	0~4	U8	ro	TxPDO	All
		Set the purpose of sync Manager 1. 0: unused. 1: Mailbox receive (master station→slave station) 2: Mailbox send (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because sync manager1 uses mailbox to send messages, the value is fixed to 2.					
	03h	Communication type sync manager 2	0~4	U8	ro	TxPDO	All
		Set the purpose of sync Manager 2.					

		0: unused. 1: Mailbox receive (master station→slave station) 2: Mailbox send (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because sync manager2 uses process data output (RxPDO), the value is fixed to 3.					
	04h	Communication type sync manager 3	0~4	U8	ro	TxPDO	All
		Set the purpose of sync Manager 3. 0: unused. 1: Mailbox receive (master station→slave station) 2: Mailbox send (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because sync manager3 uses process data output (RxPDO), the value is fixed to 4.					

4-2-4. PDO mapping

1. PDO distribution object (1C12h~1C13h)

The type of PDO mapping table allocated by syncmanager is set by 1C12h to 1C13h objects.

Index	Sub-Index	Name/Description	Range	Date Type	Access	PDO	Op-mode
1C12h	00h	Number of assigned PDOs	0~4	U8	rw	NO	All
		The number of subindexes for this object.					
	01h	Assigned RxPDO 1	1600h~1603h	U16	rw	NO	All
		Specify the RxPDO mapping object.					
	02h	Assigned RxPDO 2	1600h~1603h	U16	rw	NO	All
		Specify the RxPDO mapping object.					
	03h	Assigned RxPDO 3	1600h~1603h	U16	rw	NO	All
		Specify the RxPDO mapping object.					
	04h	Assigned RxPDO 4	1600~1603	U16	rw	NO	All
		Specify the RxPDO mapping object.					
1C13h	00h	Number of assigned PDOs	0~4	U8	rw	NO	All
		The number of subindexes for this object. The value is fixed to 04h.					
	01h	Assigned TxPDO 1	1A00h~1A03h	U16	rw	NO	All
		Specify the TxPDO mapping object.					
	02h	Assigned TxPDO 2	1A00h~1A03h	U16	rw	NO	All
		Specify the TxPDO mapping object.					
	03h	Assigned TxPDO 3	1A00h~1A03h	U16	rw	NO	All
		Specify the TxPDO mapping object.					
	04h	Assigned TxPDO 4	1A00h~1A03h	U16	rw	NO	All
		Specify the TxPDO mapping object.					

Subindex01h-04h of 1C12h and 1C13h can only be changed when the ESM state is PreOP and subindex00h = 0. In addition, the status is the return port code (06010003h).

After the setting is changed, set the subindex number of subindex00h, and reflect PDO distribution object setting by converting ESM state to SafeOP.

2. PDO mapping object (1600h~1603h, 1A00h~1A03h)

As a table for PDO mapping objects, objects of 1600h~1603h for RxPDO and 1A00h~1A03h for TxPDO can be used. After subindex 01h, it represents the information of the mapped application layer object.

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
1600h	00h	Number of entries	0~4294967295	U8	rw	NO	All
		Subindex number of the object.					
	01h	1st receive PDO mapped	0~4294967295	U32	rw	NO	All
		Set the first mapping object. bit: 31 …16 | 15 ….8 | 7 ….0 Index number | Sub-index number | Bit length					
	02h	2nd receive PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	03h	3rd receive PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	04h	4th receive PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	05h	5th receive PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	06h	6th receive PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	…	…					
	18h	24th receive PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
1601h	-	Receive PDO mapping 2, the Subindex specification is same to 1600h.					
1602h	-	Receive PDO mapping 3, the Subindex specification is same to 1600h.					
1603h	-	Receive PDO mapping 4, the Subindex specification is same to 1600h.					

Do not map duplicate objects. The change of the repeated setting is unknown.

Subindex01h-18h of 1600h-1603h can only be changed when the ESM state is PreOP and subindex00h = 0. In addition, the status returns abort code (06010003h).

After the setting is changed, set the subindex number of subindex0h, and reflect PDO distribution object setting by converting ESM state to SafeOP.

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
1A00h	00h	Number of entries	0~4294967295	U8	rw	NO	All
		Subindex number of the object.					
	01h	1st transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Set the first mapping object. bit: 31 …16 | 15 ….8 | 7 … 0 Index number | Sub-index number | Bit length					
	02h	2nd transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	03h	3rd transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	04h	4th transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					

	05h	5th transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	06h	6th transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
	…	…					
	18h	24th transmit PDO mapped	0~4294967295	U32	rw	NO	All
		Setting method is same to Subindex01h.					
1A01h	-	Transmit PDO mapping 2, the Subindex specification is same to 1600h.					
1A02h	-	Transmit PDO mapping 3, the Subindex specification is same to 1600h.					
1A03h	-	Transmit PDO mapping 4, the Subindex specification is same to 1600h.					

Do not map duplicate objects. The change of the repeated setting is unknown.

Subindex01h-18h of 1A00h-1A03h can only be changed when the ESM state is PreOP and subindex00h = 0. In addition, the status returns abort code (06010003h).

After the setting is changed, set the subindex number of subindex0h, and reflect PDO distribution object setting by converting ESM state to SafeOP.

4-2-5. Sync manager 2/3 synchronization (1C32h, 1C33h)

The setting of Sync manager2 is executed as 1C32h (Sync maneger 2 synchronization).
The setting of Sync manager3 is executed as 1C33h (Sync maneger 3 synchronization).

Sync manager 2 synchronization (1C32h)

Index	Sub-Index	Name/Description	Range	Date Type	Access	PDO	Op-mode
1C32	00h	Number of entries	0~20h	U8	ro	NO	All
		Subindex number of the object. The value is fixed to 20h.					
	01h	Sync mode	0-65535	U16	rw	NO	All
		Set the synchronization mode of Sync Manager 2. 00h: FreeRun (not synchronized) 01h: SM2 (synchronized with SM 2 Event) 02h: DC SYNC0 (synchronized with Sync0 Event)					
	02h	Cycle time	0~4294967295	U32	rw	NO	All
		Set the cycle of Sync Manager. Please set it among 500000 (500μs), 1000000 (1ms), 2000000(2ms), 4000000(4ms). If a value other than the above is set, E-810 (abnormal protection of synchronization cycle setting) will occur.					
	03h	Shift time	0~4294967295	U32	rw	NO	All
		Offset time.					
	04h	Sync modes supported	0~65535	U16	ro	NO	All
		Set the supported synchronization type. BIT0: FreeRun mode supported 0: not support; 1: FreeRun mode supported This servo driver is set to 1. BIT1: SM synchronization mode supported 0: not support; 1: SM2 event synchronization supported This servo driver is set to 1. BIT4-2: DC synchronization mode supported					

		000b: not support 001b: DC sync0 event supported This servo driver is set to 001b. BIT6-5: output offset supported 00b: not support 01b: offset of local clock supported This servo driver is set to 00b. BIT15-7: Reserved					
1C32	05h	Minimum cycle time	0~4294967295	U32	ro	NO	All
		The minimum value of the communication cycle that can be set.					
	06h	Calc and copy time	0~4294967295	U32	ro	NO	All
		The time from SM2 event, sync0 event to ESC read completion. This time can also be extended when there is a deviation in the signal.					
	08h	Command	0~65535	U16	ro	NO	All
		Not support					
	09h	Delay time	0~4294967295	U32	ro	NO	All
		Not support					
	0Ah	Sync0 cycle time	0~4294967295	U16	ro	NO	All
		When DC SYNC0 (1C32h-01h=02h), the value of ESC register 09A0h is set. Except DC SYNC0, the setting is 0.					
	0Bh	Cycle time too small	0~65535	U16	ro	NO	All
		Not support					
	0Ch	SM-event missed	0~65535	U16	ro	NO	All
		Not support					
	0Dh	Shift time too short	0~65535	U16	ro	NO	All
		Not support					
	0Eh	RxPDO toggle failed	0~65535	U16	rw	NO	All
		Not support					
	20h	Sync error	0~1	BOOL	ro	NO	All
		Sync error					

This setting value is a reference value, not a guaranteed value.

Sync manager 3 synchronization (1C33h)

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
1C33h	00h	Number of entries	0~20h	U8	ro	NO	All
		The Subindex number of this object. The value is fixed to 20h.					
	01h	Sync mode	0~65535	U16	rw	NO	All
		Set the synchronization mode of Sync Manager 2. 00h: FreeRun (not synchronized) 01h: SM2 (synchronized with SM 2 Event) 02h: DC SYNC0 (synchronized with Sync0 Event)					
	02h	Cycle time	0~4294967295	U32	rw	NO	All
		Set the cycle of Sync Manager. Please set it among 500000 (500μs), 1000000 (1ms), 2000000(2ms), 4000000(4ms). If a value other than the above is set, E-810 (abnormal protection of synchronization cycle setting) will occur.					
	03h	Shift time	0~4294967295	U32	rw	NO	All
		Offset time.					

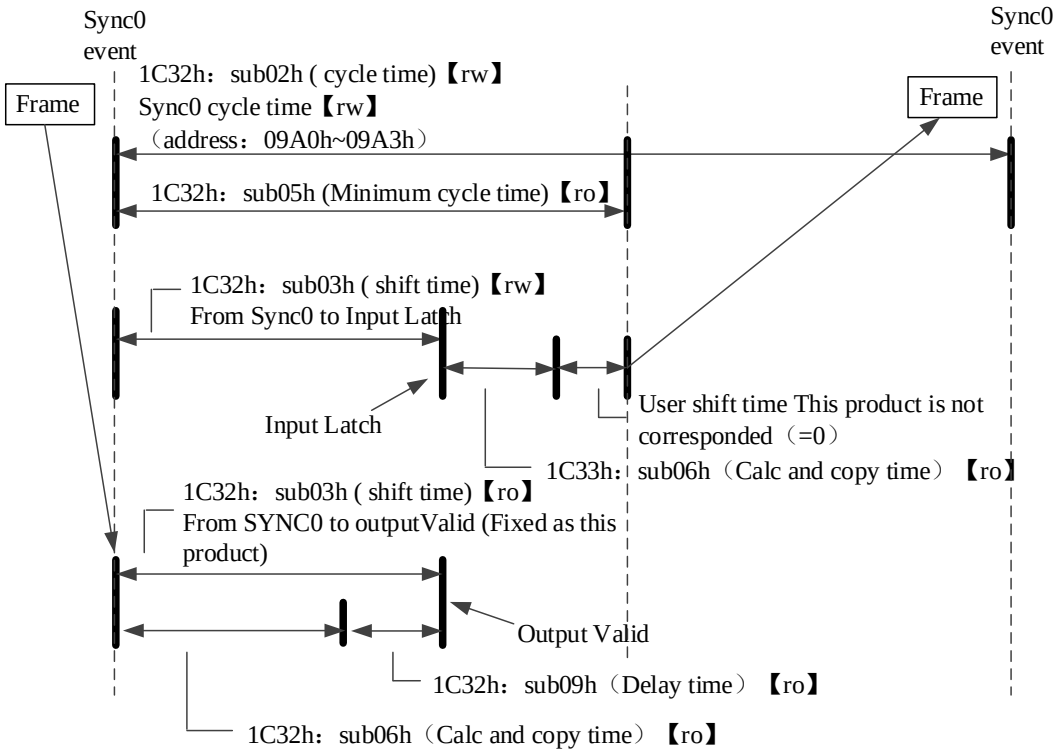
	04h	Sync modes supported	0~65535	U16	ro	NO	All
		Set the supported synchronization type. BIT0: FreeRun mode supported 0: not support; 1: FreeRun mode supported This servo driver is set to 1. BIT1: SM synchronization mode supported 0: not support; 1: SM2 event synchronization supported This servo driver is set to 1. BIT4-2: DC synchronization mode supported 000b: not support 001b: DC sync0 event supported This servo driver is set to 001b. BIT6-5: output offset supported 00b: not support 01b: offset of local clock supported This servo driver is set to 00b. BIT15-7: Reserved					
1C33h	05h	Minimum cycle time	0~4294967295	U32	ro	NO	All
		The minimum value of the communication cycle that can be set.					
	06h	Calc and copy time	0~4294967295	U32	ro	NO	All
		The time from SM2 event, sync0 event to ESC read completion. This time can also be extended when there is a deviation in the signal.					
	08h	Command	0~65535	U16	ro	NO	All
		Not support					
	09h	Delay time	0~4294967295	U32	ro	NO	All
		Not support					
	0Ah	Sync0 cycle time	0~4294967295	U16	ro	NO	All
		The same value with 1C32h-0Ah					
	0Bh	Cycle time too small	0~65535	U16	ro	NO	All
		Not support					
	0Ch	SM-event missed	0~65535	U16	ro	NO	All
		Not support					
	0Dh	Shift time too short	0~65535	U16	ro	NO	All
		Not support					
	0Eh	RxPDO toggle failed	0~65535	U16	rw	NO	All
		Not support					
	20h	Sync error	0~1	BOOL	ro	NO	All
		Sync error					

This setting value is a reference value, not a guaranteed value.

1. DC (SYNC0 event synchronization)

synchronization method	Features
Synchronize the time information of other slave stations based on the time of the first axis	High precision, need to compensate at the main station side

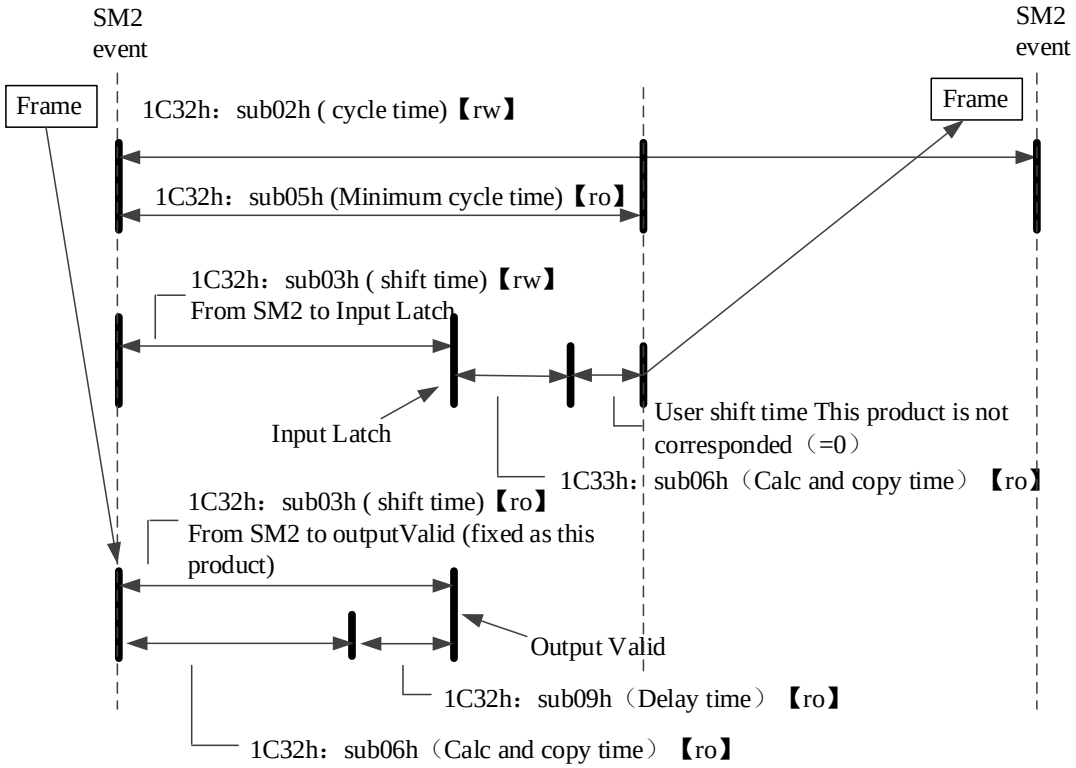
The specification of DC synchronous mode in this servo driver is as follows:



2. SM2 (SM2 event synchronization)

synchronization method	Features
Synchronize with RxPDO receiving time	No transmission delay compensation accuracy difference The transmission time must be ensured on the upper side (special hardware, etc.)

The specifications of SM2 synchronous mode in this servo driver are as follows:



4-3. Driver Profile area (0x6000~0x6FFF)

4-3-1. Object list

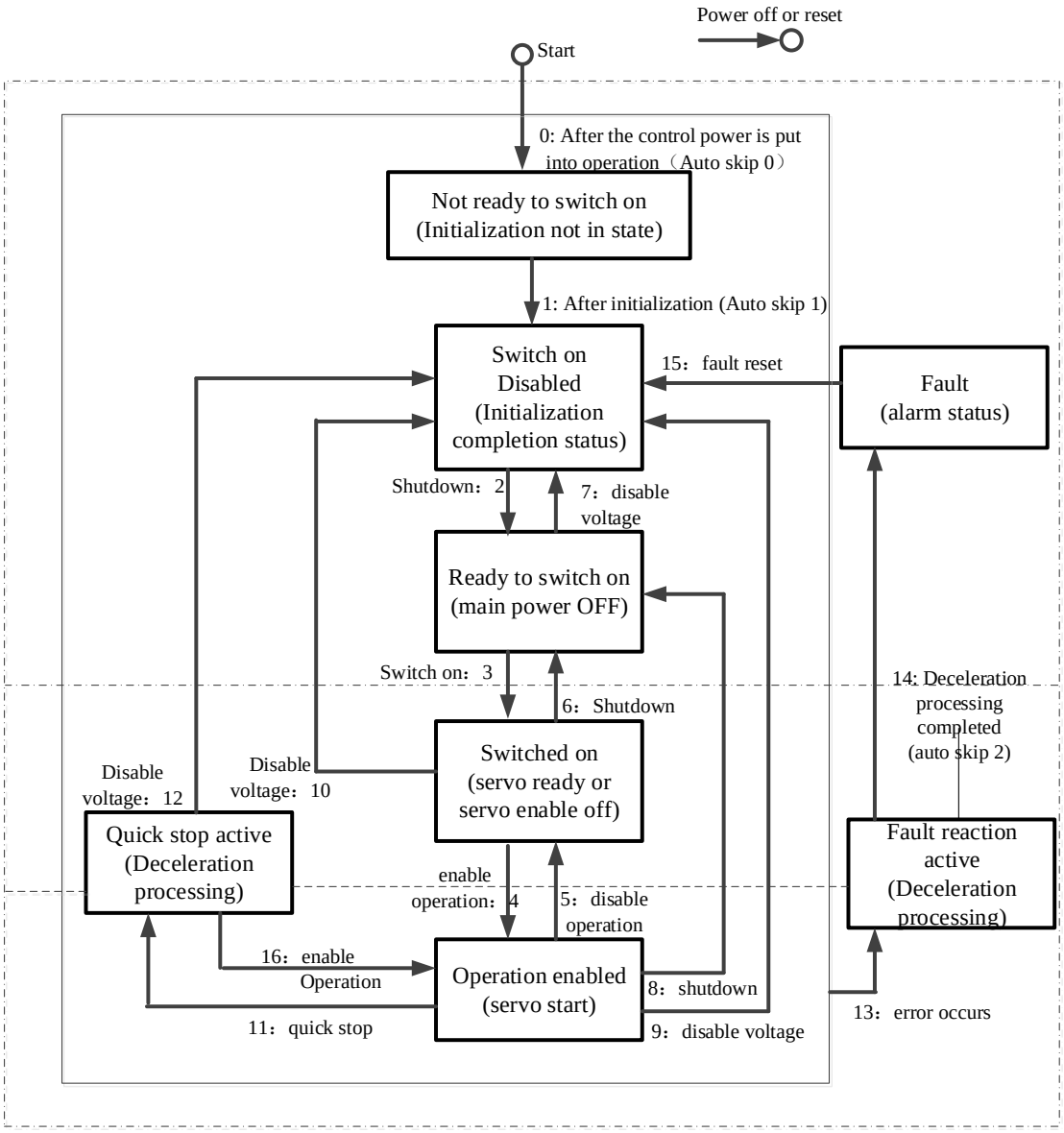
Index	Sub-Index	Name
603Fh	00h	Abort connection option code
6040h	00h	Controlword
6041h	00h	Statusword
605Ah	00h	Quick stop option code
605Bh	00h	Shutdown option code
605Bh	00h	Disable operation option code
605Bh	00h	Halt option code
605Eh	00h	Fault reaction option code
6060h	00h	Modes of operation
6061h	00h	Modes of operation display
6062h	00h	Position demand value
6063h	00h	Position actual internal value
6064h	00h	Position actual value
6065h	00h	Following error window
6066h	00h	Following error time out
6067h	00h	Position window
6068h	00h	Position window time
6069h	00h	Velocity sensor actual value
606Bh	00h	Velocity demand value
606Ch	00h	Velocity actual value
606Dh	00h	Velocity window
606Eh	00h	Velocity window time
606Fh	00h	Velocity threshold
6070h	00h	Velocity threshold time
6071h	00h	Target torque
6072h	00h	Max torque
6073h	00h	Max current
6074h	00h	Torque demand
6075h	00h	Motor rated current
6076h	00h	Motor rated torque
6077h	00h	Torque actual value
6078h	00h	Current actual value
6079h	00h	DC link circuit voltage
607Ah	00h	Target position
607Bh	-	Position range limit
	00h	Highest sub-index supported
	01h	Min position range limit
607Bh	02h	Max position range limit
607Ch	00h	Home offset

607Dh	-	Software position limit
	00h	Number of entries
	01h	Min position limit
	02h	Max position limit
606Eh	00h	Polarity
607Fh	00h	Max profile velocity
6080h	00h	Max motor speed
6081h	00h	Profile velocity
6082h	00h	End velocity
6083h	00h	Profile acceleration
6084h	00h	Profile deceleration
6085h	00h	Quick stop deceleration
6086h	00h	Motion profile type
6087h	00h	Torque slope
6088h	00h	Torque profile type
608Fh	-	Position encoder resolution
	00h	Highest sub-index supported
	01h	Encoder increments
	02h	Motor revolutions
6091h	-	Gear ratio
	00h	Number of entries
	01h	Motor revolutions
	02h	Shaft revolutions
6092h	-	Feed constant
	00h	Highest sub-index supported
	01h	Feed
	02h	Shaft revolutions
6098h	00h	Homing method
6099h	-	Homing speeds
	00h	Number of entries
	01h	Speed during search for switch
	02h	Speed during search for zero
609Ah	00h	Homing acceleration
60A3h	00h	Profile jerk use
60A4h	-	Profile jerk
	00h	Highest sub-index supported
	01h	Profile jerk1
	02h	Profile jerk2
60B0h	00h	Position offset
60B1h	00h	Velocity offset
60B2h	00h	Torque offset
60B8h	00h	Touch probe function
60B9h	00h	Touch probe status
60BAh	00h	Touch probe pos1 pos value
60BBh	00h	Touch probe pos1 neg value
60BCh	00h	Touch probe pos2 pos value
60BDh	00h	Touch probe pos2 neg value
60C2h	-	Interpolation time period

	00h	Highest sub-index supported
	01h	Interpolation time period value
	02h	Interpolation time index
60C5h	00h	Max acceleration
60C6h	00h	Max deceleration
60E3h	-	Supported homing method
	00h	Number of entries
	01h	1st supported homing method
	..	..
	20h	32nd supported homing method
60F2h	00h	Positioning option code
60F4h	00h	Following error actual value
60FAh	00h	Control effort
60FCh	00h	Position demand internal value
60FDh	00h	Digital inputs
60FEh	-	Digital outputs
	00h	Number of entries
	01h	Physical outputs
	02	Bit mask
60FEh	00h	Target velocity
6502h	00h	Supported drive modes

4-3-2. PDS (Power Drive Systems) specification

According to the user command or abnormal detection, the state transition of the PDS associated with the power control of the servo driver is defined as follows.



After migrating to operation enabled(servo is enabled), please increase the time to more than 100ms and input the action command.

The following table shows the PDS state migration events (migration conditions) and actions during migration.

For the migration of PDS, the status migration is performed at the same time as the handshake is obtained (through 6041h: Statusword confirm the status has been converted and then send the next migration instruction).

PDS conversion		Event	Action
0	Auto skip 0	After the power supply is put into operation, or after the application layer is reset, it will automatically migrate.	After the power supply is put into operation, or after the application layer is reset, it will automatically migrate.
1	Auto skip 1	Automatic conversion after initialization.	Communications are established.
2	Shut down	The condition of receiving the shutdown instruction.	Nothing special.
3	Switch on	When the power supply is on, the condition of receiving the switch on command.	Nothing special.
4	Enable operation	The condition of receiving the enable operation instruction.	The drive function is effective. In addition, all previous set point data are cleared.
5	Disable operation	The situation of receiving the disable operation	Invalid driver function.

		instruction.	
6	Shutdown	When the power supply is ON, the condition of receiving Shutdown instruction. Check out the condition that the power supply is OFF.	Nothing special.
7	Disable voltage	The condition of receiving Disable voltage instruction. The condition of receiving Quick stop instruction. When the ESM status is PreOP, SafeOP or OP, the condition of migrating to init.	Nothing special.
8	Shutdown	When the power supply is ON, the condition of receiving Shutdown instruction.	Driver function is invalid.
9	Disable voltage	the condition of receiving Disable voltage instruction.	Driver function is invalid.
10	Disable voltage	the condition of receiving Disable voltage instruction. the condition of receiving Quick stop instruction. When the ESM status is PreOP, SafeOP or OP, the condition of migrating to init.	Nothing special.
11	Quick stop	the condition of receiving Quick stop instruction.	Execute Quick stop function.
12	Disable voltage	When the quick stop selection code is the set value of 1, 2 and 3, and the quick stop action is completed. When the quick stop selection code is the set value of 5, 6 and 7, and the quick stop action is completed, the condition of receiving disable voltage instruction. Check the condition that the power supply is off.	Driver function is invalid.
13	Error occurs	Abnormal detection.	Execute Fault reaction function.
14	Auto skip 2	After the abnormal detection and deceleration processing is completed, it will be migrated automatically.	Driver function is invalid.
15	Fault reset	The situation of receiving the fault result instruction after the fault is removed.	If the fault factor does not exist, reset the fault status.
16	Enable operation	When the quick stop selection code is the set value of 5, 6 and 7, the condition of receiving Enable operation instruction.	Driver function is valid.

4-3-3. Controlword (6040h)

PDS status migration, etc. The command to control the slave station (servo driver) is set through 6040h (control word).

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
R						oms	h
7	6	5	4	3	2	1	0
fr	R			eo	qs	ev	so

		r = reserved (not corresponding) oms = operation mode specific (control mode based on bit) h = halt	fr = fault reset eo = enable operation qs = quick stop ev = enable voltage so = switch on

Command	bits of the controlword					PDS conversion
	bit7	bit3	bit2	bit1	bit0	
	fault reset	Enable operation	quick stop	Enable voltage	Switch on	
Shutdown	0	-	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
Enable operation	0	1	1	1	1	4, 16
Disable voltage	0	-	-	0	-	7, 9, 10, 12
Quick stop	0	-	0	1	-	7, 10, 11
Disable operation	0	0	1	1	1	5
Fault reset	0->1	-	-	-	-	13

The bit logic of the quick stop instruction is valid at 0.
Please execute other bit logic and the opposite actions.
Bit8 (HALT): 1, the motor deceleration pause is executed by 605Dh (halt selection code).
After the pause, the enable must be turned off to restart the action.

bit9, 6-4(operation mode specific):
The following shows the inherent change of OMS bit in the control mode (OP mode). (for details, please refer to the chapter of related objects of each control mode.)

Op-mode	Bit9	Bit6	Bit5	Bit4
pp	change on set-point	absolute /elative	change set immediately	new set-point
pv	-	-	-	-
tq	-	-	-	-
hm	-	-	-	start homing
csp	-	-	-	-
csv	-	-	-	-
cst	-	-	-	-

4-3-4. Statusword (6041h)

PDS status migration, etc. the command to control the slave station (servo driver) is set through 6040h (control word).

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Indicates the status of the servo driver.
Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
7	6	5	4	3	2	1	0
w	sod	qs	ve	f	oe	so	rsto

		r = reserved (not corresponding) oms = operation mode specific (control mode based on bit) ila = internal limit active rm = remote	w = warning sod = switch on disabled qs = quick stop ve = voltage enabled f = fault oe = operation enabled so = switched on rtso = ready to switch on

Bit6,5,3-0 (switch on disabled/quick stop/fault/operation enabled/switched on/ready to switch on): confirm PDS status according to this bit. The following shows the status and related bit.

StatusWord	PDS State	
xxxx xxxx x0xx 0000 b	Not ready to switch on	Initialization incomplete state
xxxx xxxx x1xx 0000 b	Switch on disabled	Initialization completion status
xxxx xxxx x01x 0001 b	Ready to switch on	Initialization completion status
xxxx xxxx x01x 0011 b	Switched on	Servo enable off/ servo ready
xxxx xxxx x01x 0111 b	Operation enabled	Servo enable on
xxxx xxxx x00x 0111 b	Quick stop active	Stop immediately
xxxx xxxx x0xx 1111 b	Fault reaction active	Error (alarm) judge
xxxx xxxx x0xx 1000 b	Fault	Error (alarm) status

bit4 (voltage enabled): In case of 1, it means that the power supply voltage is applied to PDS.

bit5 (quick stop): In the case of 0, PDS receives the quick stop request. The bit logic of quick stop is valid at 0. Please excute other bit logic and the opposite actions.

bit7 (warning): In the case of 1, a warning is occurring. When warning, PDS status will not change and motor will continue to operate.

bit9 (remote): In the case of 0(local), indicates the status that 6040 (controlword) cannot process. In the case of 1 (remote), indicates 6040 (Controlword) is in a manageable state. The ESM state changes to 1 when the transition is above PreOP.

bit13,12,10 (operation mode specific): the following means inherent change of OMS bit in control mode. (For details, please refer to the chapter of related objects of each control mode)

Op-mode	bit13	bit12	Bit10
pp	following error	set-point acknowledge	target reached
pv	-	speed	target reached
tq	-	-	target reached
hm	homing error	homing attained	target reached
csp	following error	drive follows command value	-
csv	-	drive follows command value	-
cst	-	drive follows command value	-

bit11 (internal limit active): The main reason for the internal limit is that the bit11 (internal limit active) of 6041h (status word) changes to 1.

bit15,14 (reserved): this bit is not used (fixed 0).

4-3-5. Control mode setting

1. Supported drive modes (6502h)

This servo driver can confirm the supported modes of operation according to 6502h (supported drive modes).

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6502h	00h	Supported drive modes	0~4294967295	U32	ro	TxPDO	All

Supported Mode of operation.

A value of 1 indicates the mode supported in this mode.

Bit information

31…16			15…10			9	8
r			r			cst	csv
0			0			1	1
7	6	5	4	3	2	1	0
csp	r	hm	r	tq	pv	r	pp
1	0	1	0	1	1	0	1

bit	Mode of operation	Abbr	corresponding
0	Profile position mode	pp	YES
2	Profile velocity mode	pv	YES
3	Torque profile mode	tq	YES
5	Homing mode	hm	YES
7	Cyclic synchronous position mode	csp	YES
8	Cyclic synchronous velocity mode	csv	YES
9	Cyclic synchronous torque mode	cst	YES

2. Modes of operation (6060h)

The control mode is set through 6060h (modes of operation).

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6060h	00h	Mode of operation	-128~127	I8	rw	RxPDO	All

Set the control mode of servo driver

Non corresponding control mode setting inhibit.

bit	Mode of operation	Abbr	Corresponding
-128~ -1	Reserved	-	-
0	No mode changed/No mode assigned	-	-
1	Profile position mode	pp	YES
3	Profile velocity mode	pv	YES
4	Torque profile mode	tq	YES
6	Homing mode	hm	YES
8	Cyclic synchronous position mode	csp	YES
9	Cyclic synchronous velocity mode	csv	YES
10	Cyclic synchronous torque mode	cst	YES
11~127	Reserved	-	-

Because 6060h (modes of operation) is default = (no mode change / no mode assigned), please set the control

mode value to be used after the power is put into operation. When the set value of 6060h is 0 and the set value of 6061h is 0, if the PDS state is migrated to operation enabled, E-881 (control mode setting abnormal protection) occurs.

After the initial state of 6060h = 0 (no mode assigned) is transferred to the supported control mode (PP, PV, TQ, HM, CSP, CSV, CST), set 6060h = 0 again is seemed as "no mode changed", and the control mode can not be switched. (keep the previous control mode).

3. Modes of operation display (6061h)

The confirmation of the control mode inside the servo driver is performed according to 6061h (modes of operation display). After 6060h (modes of operation) is set, please confirm whether it is feasible to set this object action through detection.

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td>6061h</td><td>00h</td><td>Mode of operation display</td><td>-128~127</td><td>I8</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Current control mode.
<table>
<tr><th>bit</th><th>Mode of operation</th><th>Abbr</th><th>Corresponding</th></tr>
<tr><td>-128~ -1</td><td>Reserved</td><td>-</td><td>-</td></tr>
<tr><td>0</td><td>No mode changed/No mode assigned</td><td>-</td><td>-</td></tr>
<tr><td>1</td><td>Profile position mode</td><td>pp</td><td>YES</td></tr>
<tr><td>3</td><td>Profile velocity mode</td><td>pv</td><td>YES</td></tr>
<tr><td>4</td><td>Torque profile mode</td><td>tq</td><td>YES</td></tr>
<tr><td>6</td><td>Homing mode</td><td>hm</td><td>YES</td></tr>
<tr><td>8</td><td>Cyclic synchronous position mode</td><td>csp</td><td>YES</td></tr>
<tr><td>9</td><td>Cyclic synchronous velocity mode</td><td>csv</td><td>YES</td></tr>
<tr><td>10</td><td>Cyclic synchronous torque mode</td><td>cst</td><td>YES</td></tr>
<tr><td>11~127</td><td>Reserved</td><td>-</td><td>-</td></tr>
</table></td></tr>
</table>

5. Motion instruction

5-1. Instruction list

List of bus motion control related instructions

Instruction	Function	Loop representation and available soft components	Chapter
MOTO	relative position motion	MOTO pos vel acc axNs	5-2-1
MOTOA	Absolute position motion	MOTOA pos vel acc axNs	5-2-2
MOTOS	Multiple speed motion	MOTOS data para axNs	5-2-3
MOSTOP	Stop moving	MOSTOP para axNs	5-2-4
MOGOON	Keep moving	MOGOON axNs	5-2-5
MOSYN	Synchronous binding	MOSYN para syn_axNs axNs	5-2-6
MOUSYN	Synchronous release	MOUSYN axNs	5-2-7
MOWRITE	Write current location	MOWRITE data axNs	5-2-8
MOREAD	Read current location	MOREAD data axNs	5-2-9

5-2. Instruction introduction

All command functions described in this chapter are only applicable to CSP mode (cyclic position control mode).

5-2-1. Relative position motion [MOTO]

(1) Instruction overview

The command is relative position motion, which can modify the absolute position, velocity and acceleration/ deceleration time of moving target in real time.

Relative position motion [MOTO]			
16-bit instruction		32-bit instruction	MOTO
Execution condition	Rising/falling edge coil trigger	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	Specify relative position	32-bit integer or register
S1	Specify motion speed	32-bit integer or register
S2	Specify acceleration deceleration time	32-bit integer or register
S3	Specify axis number	16-bit constant or register

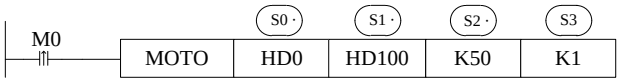
(3) Suitable software component

Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dnm
S0	●								●									
S1	●								●									
S2	●								●									
S3	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, hscd, HSD; DM represents DM, DHM; DS represents DS, DHS. M represents m, HM, SM; s represents s, HS; t represents T, HT; C represents C, HC.

(4) Function and action

《Instruction format》



- When M0 is from off to on, S3 axis accelerates to S1 speed with S2 acceleration time, and relative movement S0 stops.
  S0: is the relative value of the position, which can be set as a positive or negative value. If it is a positive value, the motor will rotate forward; if it is a negative value, the motor will reverse. Unit: pulse.
  S1: set to a positive value. If set to a negative value, it moves according to the absolute value.
  S2: the time of accelerating from 0 to the specified moving speed, unit: ms.
  S3: axis number N, N range is 1-32.
- The relative position is the distance from the current position to the target position.
  For example: the current position is 100, and the set position relative value is 300. Relative to the position before the command is executed, if the motor wants to move to the target point, it needs to send 300 pulses from the current position (that is, the set relative position value).

- When M0 is from off to on, the absolute target position (SD2030 + 60* (n-1)) changes the corresponding position relative value based on the original position value, and the motor takes this value as the target position.

- In the process of motion, the absolute target position can be modified in real time by modifying the register value (SD2030 + 60* (n-1)), and the set value is the absolute position value. Command will relative move to stop according to the modified target position. But completion signal SM2003 + 20* (n-1) will not ON.

For example, suppose that the relative value of the position in the instruction is 1000, and the current position is 0. After the trigger condition is set, the instruction will run to the position of 600. ① at this time, modify the target position in the register (SD2030 + 60 * (n-1)) to 400 or (- 400), then the S3 axis will decelerate to stop in the forward direction, and then decelerate to stop in the reverse direction to the position 400 or (- 400); ② at this time, modify the target position register (SD2030 + 60 * (n- 1)) to 1200, the S3 axis will move forward to the position of 1200 to slow down and stop. (when the motor is enabled, write the value directly to the register SD2030 + 60 * (n-1), the motor will run to the corresponding position, and the forward and reverse rotation of the motor can be realized without executing the instruction.)

- The servo enabled, and the initial value of speed register (SD2032 + 60 * (n-1)) is 1000. When M0 is from off to on, the value of (SD2032 + 60 * (n-1)) becomes S1.

In the process of motor movement, the movement speed can be modified in real time by modifying (SD2032 + 60 * (n-1)) register value, and the motor will change to a new speed after acceleration and deceleration time.

If the speed is set to 0, the motor stops with acceleration and deceleration time. Since the speed has been

reduced to 0 before the set target position is not reached, there will be no motion completion signal, that is, the moving flag (SM2001 + 20 * (n-1)) will not be reset. At this time, if a new speed (SD2032 + 60 * (n-1)) is given, the motor will run again.

(5) Related register

When the PLC is running and the servo is enabled on, the parameters such as the absolute position of the moving target, the moving speed and the acceleration and deceleration time can be modified through the corresponding SD register. The modified SD register value takes effect in 6 ~ 16ms. However, modifying the corresponding register in the instruction will not affect the target position, motion speed and acceleration / deceleration time. One channel of EtherCAT bus can be connected to 32 axes, with corresponding axis No.1 to 32. Users can modify the motion parameters of each axis (n = 1-32) through the parameters in the table.

Table 5-2-1: setting parameter value (N=1~32)

Address	Definition	Type	Unit	Note
SD2030+60*(N-1)	Absolute position	32-bit integer	Pulse number	Coordinate position, which is converted by the number of pulses given by the target position. In the process of stopping or running, modifying the position setting value will move to the set target at the set speed. The position setting is the absolute position value.
SD2032+60*(N-1)	Speed setting	32-bit integer	Pulse number/second	
SD2034+60*(N-1)	acceleration time	32-bit integer	ms	the time accelerating from 0 to max speed
SD2036+60*(N-1)	Deceleration time	32-bit integer	ms	The time decelerating from max speed to 0

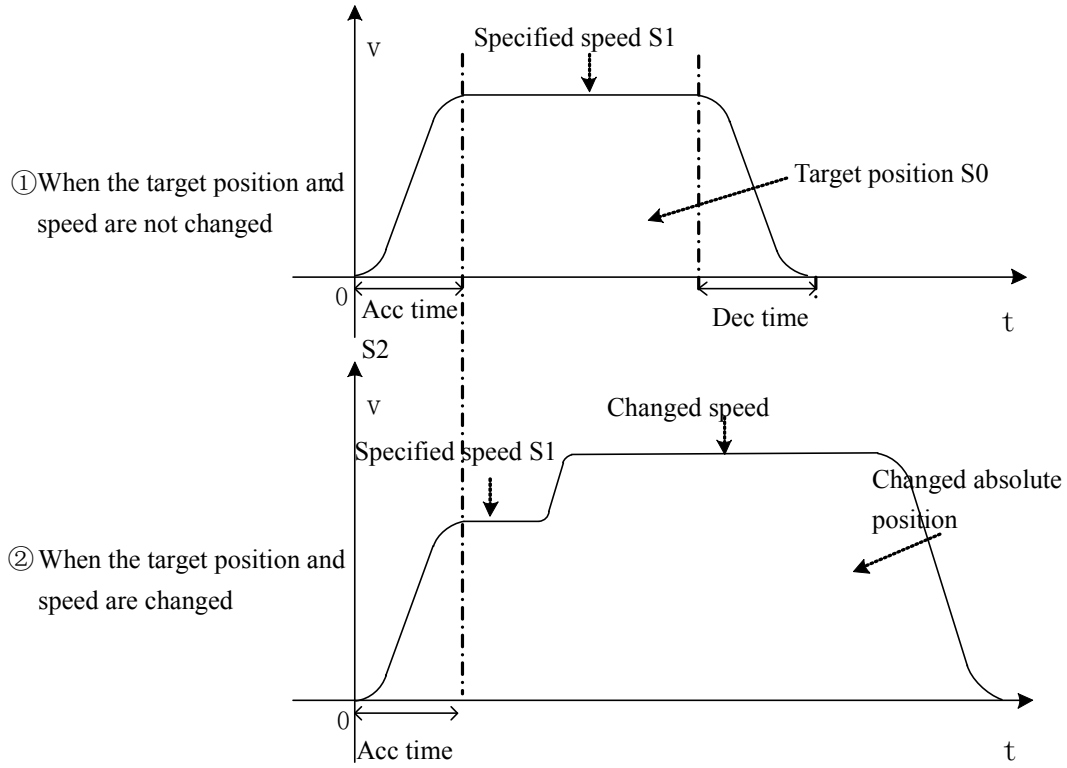
Table 5-2-2: state bit parameter (N=1~32)

Address	Definition	Note
SM2000+20*(N-1)	servo enable flag	ON: servo enable state
SM2001+20*(N-1)	Running flag	ON: pulse outputting
SM2003+20*(N-1)	motion completion flag	ON: instruction action completion
SM2004+20*(N-1)	axis error flag	ON: error

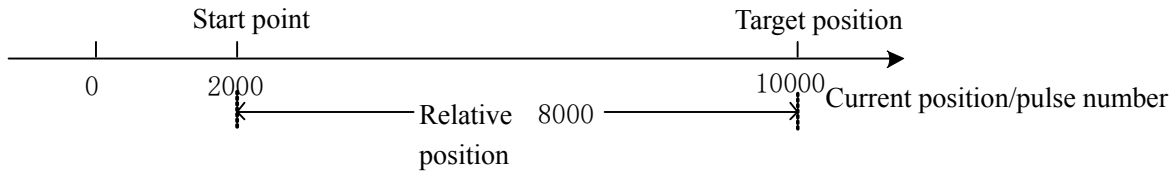
(6) Example

The current position of the motor is 2000, and the MOTO command is required to run to the target position of 10000 pulses at the speed of 5000Hz. Change the speed to 6000Hz halfway, and let the motor run to the absolute target position of 20000 pulses. The acceleration and deceleration time is 50ms.

- In relative position mode, the execution diagram is as follows:

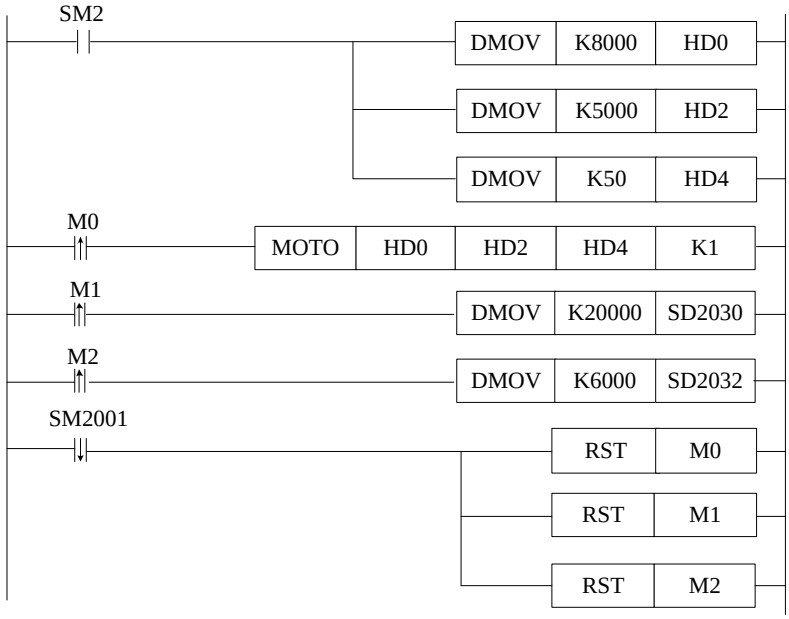


■ In the relative position mode, the schematic diagram of motor running distance is as follows:



The current position is 2000, and 8000 pulses need to be sent when running to the target position of 10000 pulses in relative position mode.

■ The ladder chart in relative mode:



Explanation:

PLC starts to run, the initial positive pulse coil SM2 will send the number of pulses, speed and acceleration deceleration time to the corresponding registers.

Servo enable is ON, M0 is from OFF to ON, it starts to execute MOTO command of relative position movement.

M1 is from OFF to ON, it sends the absolute target position to the corresponding register.

M2 is from off to on, the new speed is sent to the corresponding register.

When the pulse is sent, the running flag bit SM2001 is reset and the corresponding coil is reset.

5-2-2. Absolute position motion [MOTOA]

(1) Instruction overview

The command moves in absolute position, and can modify the absolute position, velocity and acceleration / deceleration time of the moving target in real time.

Absolute position motion [MOTOA]			
16-bit instruction		32-bit instruction	MOTOA
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	target position	32-bit integer or register
S1	motion speed	32-bit integer or register
S2	The time accelerating from 0 to S1	32-bit integer or register
S3	axis number	16-bit constant or register

(3) Suitable soft component

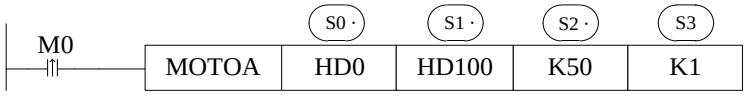
Operand	word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●								●									
S1	●								●									
S2	●								●									
S3	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, hscd, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents m, HM, SM; s represents s, HS; t represents T, HT; C represents C, HC.

(4) Function and action

《instruction format》



- When M0 is from off to on, S3 axis accelerates to S1 with S2 acceleration time, and absolute movement stops at S0 position.

S0: it is absolute position value, which can be set as positive or negative value. If the value is equal to the current position value, the motor will not rotate; if the value is greater than the current position value, the motor will rotate forward; if the value is less than the current position value, the motor will rotate reverse.

S1: set to a positive value. If set to a negative value, it moves according to the absolute value.

S2: the time accelerating from 0 to the specified moving speed, unit: ms.

S3: axis number n, N range is 1-32.

- Absolute position is the distance from zero point to target position.

For example: the current position is 100, and the setting absolute position is 300. Relative to the zero point, if the motor wants to move to the target point (i.e. the setting absolute position), it needs to send another 200 pulses at the current position.

- When M0 changes from off to on, the absolute target position (SD2030 + 60 * (n-1)) changes to S0. If the value of (SD2030 + 60 * (n-1)) increases, the motor will rotate forward; if the value of (SD2030 + 60 * (n-1)) decreases, the motor will rotate reverse.

- In the process of motion, the absolute target position can be modified in real time by modifying the register value (SD2030 + 60 * (n-1)), and the set value is the absolute position value. Command moves to stop according to the modified target position. But the completion signal SM2003 + 20 * (n-1) will not ON.

For example, if the target position in the instruction is 1000, and the trigger condition is set, the instruction will run to 600. ① at this time, modify the target position in the (SD2030 + 60 * (n-1)) register to 400 or (-400), then the S3 axis will decelerate the forward motion to stop, and then accelerate the reverse motion to 400 or (- 400) to stop; ② at this time, modify the target position in the (SD2030 + 60 * (n-1)) register to 1200, then the S3 axis will move forward to the position of 1200 to decelerate and stop. (positive and reverse rotation of motor can be realized)

- When the servo enable changes from off to on, the value of speed setting register (SD2032 + 60 * (n-1)) immediately changes to 1000. When M0 changes from off to on, the value of (SD2032 + 60 * (n-1)) changes to S1.

In the process of motor movement, the movement speed can be modified in real time by modifying (SD2032 + 60 * (n-1)) register value, and the motor will change to a new speed with acceleration and deceleration time.

If the speed is set to 0, the motor stops with acceleration and deceleration time. Since the speed has been reduced to 0 before the set target position is not reached, there will be no motion completion signal, that is, the moving flag (SM2001 + 20 * (n-1)) will not be reset. At this time, if a new speed (SD2032 + 60 * (n-1)) is given, the motor will run again.

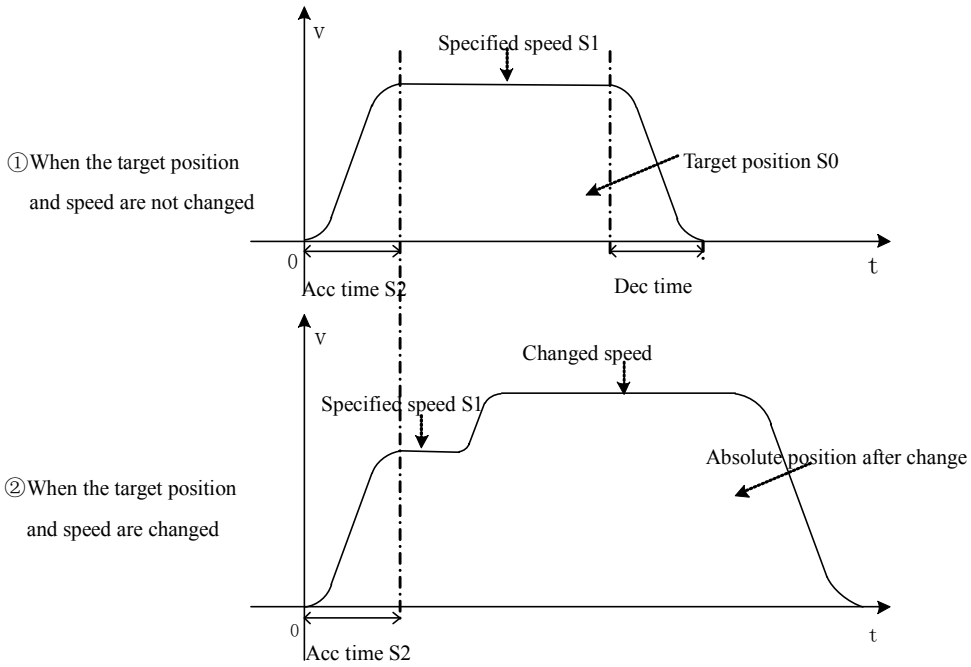
(5) Relative register

The special registers related to the position motion are the same as the relative position motion instructions. See table 5-2-1 and table 5-2-2 in chapter 5-2-1 for details.

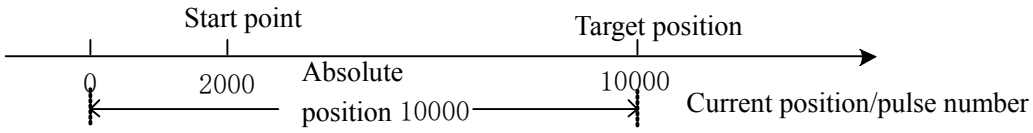
(6) Example

The current position of motor 1 is 2000, which requires MOTOA command to move to the target position of 10000 pulses at 5000Hz. Change the speed to 6000Hz halfway, and let the motor run to the absolute target position of 20000 pulses. The acceleration and deceleration time is 50ms.

■ In absolute position mode: the execution diagram is as follows:

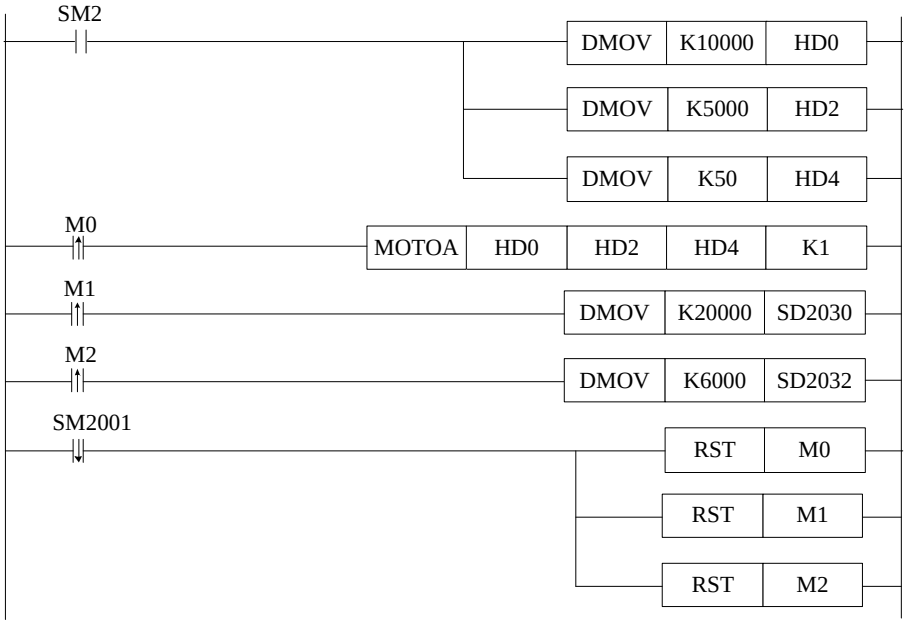


■ In absolute position mode, the schematic diagram of motor running distance is as follows:



The current position is 2000, and 8000 pulses need to be sent when the target position reaches 10000 pulses in absolute position mode.

■ In absolute position mode, the ladder chart is as follows:



Explanation:

PLC starts to run, the initial positive pulse coil SM2 will send the number of pulses, speed and acceleration deceleration time to the corresponding registers.

Servo enable on, M0 is from off to on, start to execute absolute position motion MOTOA command.

M1 is from off to on, the absolute target position is sent to the corresponding register.
M2 is from off to on, the new speed is sent to the corresponding register.
When the pulse is sent, the running flag bit SM2001 is reset and the corresponding coil is reset.

5-2-3. Multistage speed motion [MOTOS]

(1) Instruction overview

This command can not modify the target position in the process of motion, but can modify the motion speed of the current segment.

Multistage speed motion [MOTOS]			
16-bit instruction		32-bit instruction	MOTOS
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	data start address	32-bit register
S1	parameter start address	32-bit register
S2	axis number	16-bit constant or register

(3) suitable soft component

Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●																	
S1	●																	
S2	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents m, HM, SM; s represents S, HS; t represents T, HT; C represents C, HC.

(4) Instruction and action

《Instruction format》

- When M0 is from off to on, after setting S1 parameters, S2 axis will execute multistage speed motion(relative or absolute position motion) with S0 specified target and speed.
  S0: data starting address. The position and speed of each pulse segment can be set.
  S1: starting address of the parameter. Motion mode, number of motion segments and acceleration and deceleration time can be set.
  S2: axis number n, N range is 1-32.
- When the servo enable changes from off to on, the value of speed setting register (SD2032 + 60 * (n-1)) immediately changes to 1000. When M0 changes from off to on, the value of (SD2032 + 60 * (n-1)) changes to the speed value of the first segment of S0.

In the process of motor movement, the movement speed can be modified by modifying the register value of (SD2032 + 60 * (n-1)). The motor will change to a new speed with acceleration and deceleration time, and the modified movement speed is only valid for the current movement segment.

If the speed is set to 0, the motor stops with acceleration and deceleration time. Since the speed has been reduced to 0 before the set target position is not reached, there will be no motion completion signal, that is, the in motion flag (SM2001 + 20 * (n-1)) will not be reset. At this time, if a new speed (SD2032 + 60 * (n-1)) is given, the motor will run again.

- There is acceleration and deceleration time when the speed of each section changes, and the rising slope is the same as that of the first section.
- The current pulse can be monitored in the segment register (SD2016 + 60 * (n-1)).
- In the process of movement, it is not allowed to modify the target position, acceleration and deceleration time, movement mode and the total number of pulse segments by modifying the value in SD register.

(5) Related register

◆ Data start address:

Address	Contents	Note
S0+0 (double word)	Position	Segment 1
S0+2 (double word)	Speed	
S0+4	Reserved	
S0+6	Reserved	
S0+8	Reserved	
……	……	……
S0+(N-1)*10+0 (double word)	Position	Segment N
S0+(N-1)*10+2 (double word)	Speed	
S0+(N-1)*10+4	Reserved	
S0+(N-1)*10+6	Reserved	
S0+(N-1)*10+8	Reserved	

◆ Parameter start address:

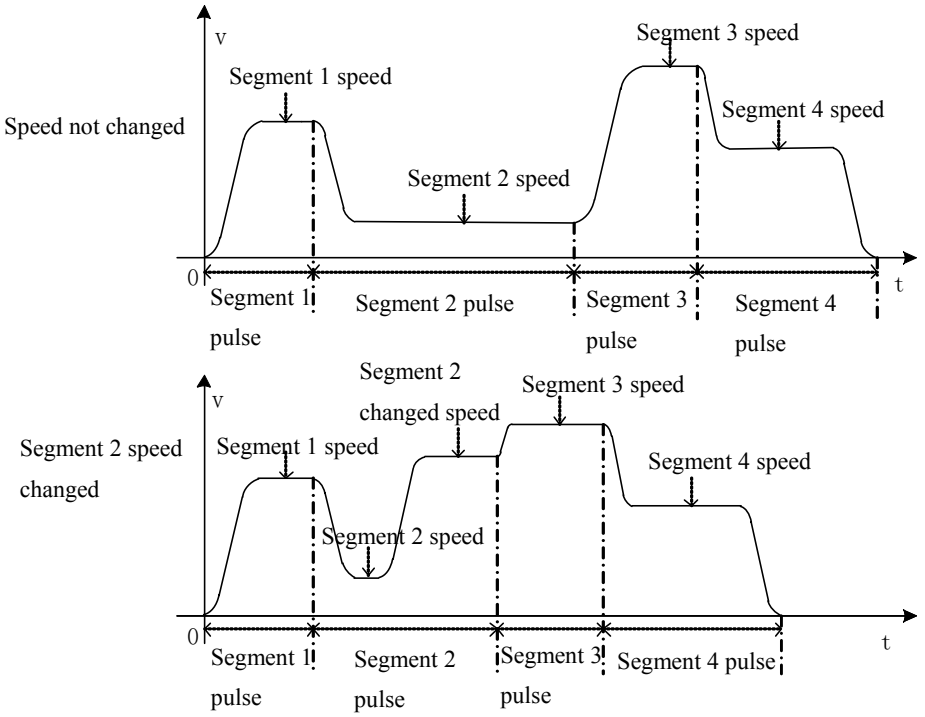
Address	Content
S1+0 (double word)	32-bit integer, motion relative absolute mode (0: relative; 1: absolute)
S1+2 (double word)	32-bit integer, total number of moving segments (1-100)
S1+4 (double word)	32-bit integer, acceleration time (acceleration time from 0 to the first speed, and the subsequent speed changes according to the same acceleration), unit: ms
S1+6 (double word)	32-bit integer, deceleration time (deceleration time from the last speed to 0), unit: ms

(6) Example

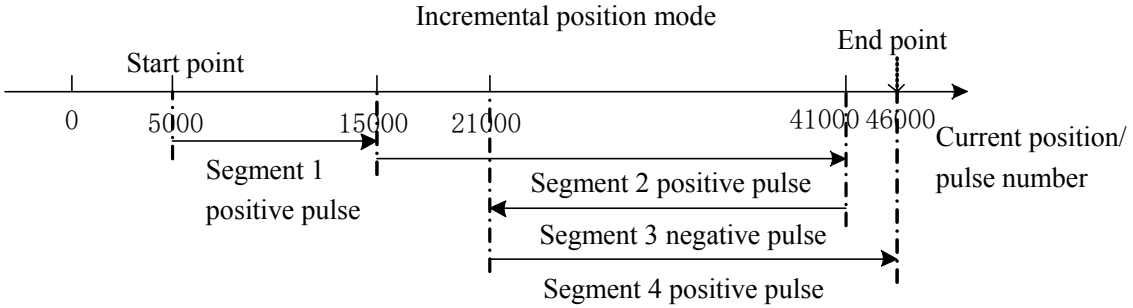
Send four pulses with MOTOS command, change the speed to 6000Hz during the second section, and the set value and acceleration and deceleration time of each section are shown in the table below:

Name	frequency (Hz)	pulse number
segment 1	5000	10000
segment 2	1000	26000
segment 3	7500	-20000
segment 4	4000	25000
acceleration and deceleration time	50ms	

■ Execution diagram:

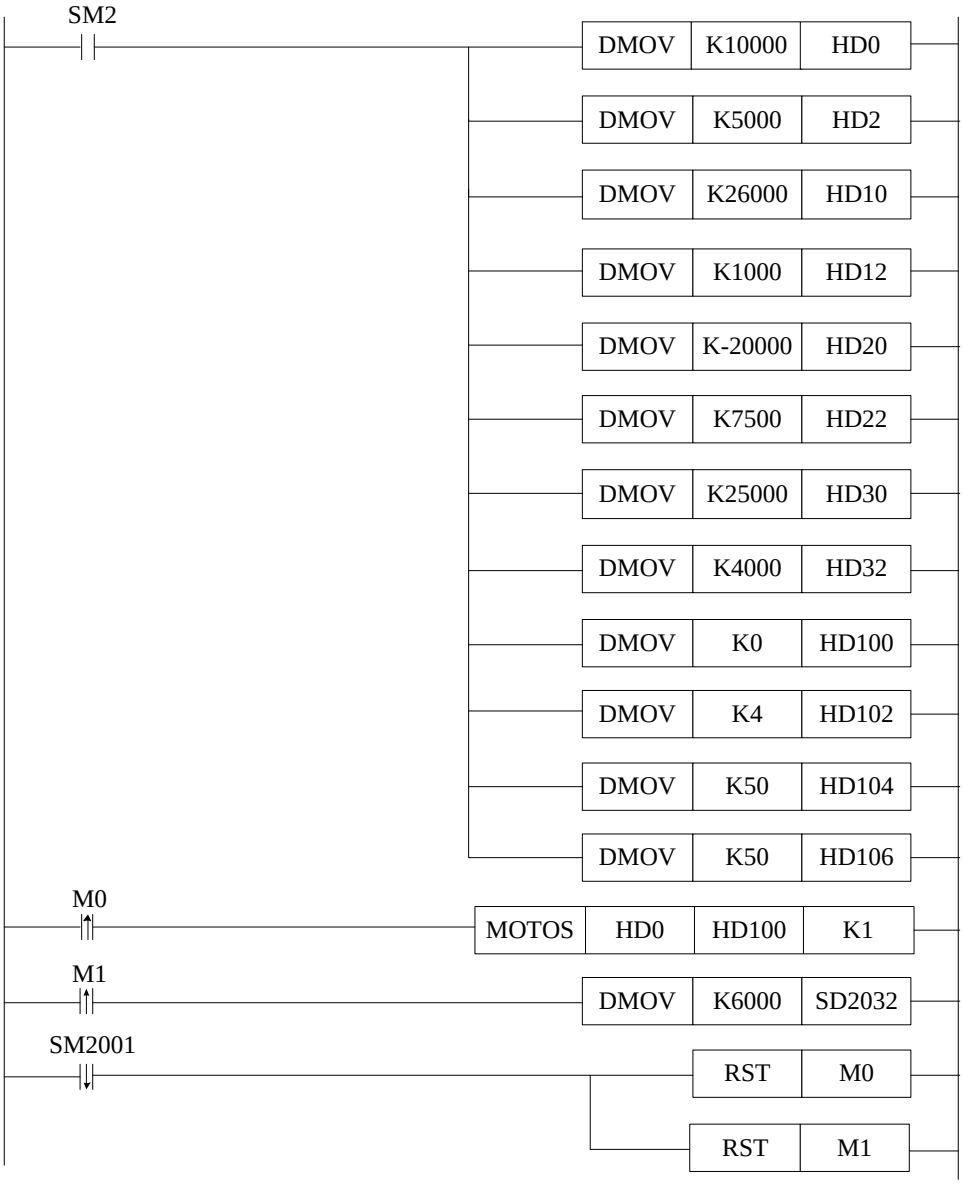


■ In the relative position mode, the schematic diagram of motor running distance is as follows:



The current position is 5000. In the relative position mode, the first section sends 10000 pulses, which should be turned forward to 15000 pulses; the second section sends 26000 pulses, which should be turned forward to 41000 pulses; the third section sends - 20000 pulses, which should be turned backward to 21000 pulses; the fourth section sends 25000 pulses, which should be turned forward to 46000 pulses.

■ The ladder chart in relative position mode:



Explanation:

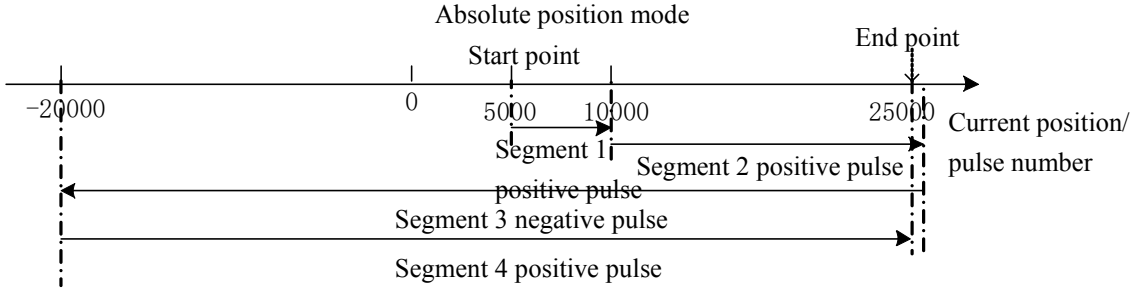
PLC starts to run, the initial positive pulse coil SM2 will send the number of pulses, speed, motion mode, total number of operation sections and acceleration and deceleration time to the corresponding registers.

Servo enable on, M0 from off to on, start to execute MOTOS command of multi segment speed movement.

M1 from off to on, the new speed is sent to the corresponding register.

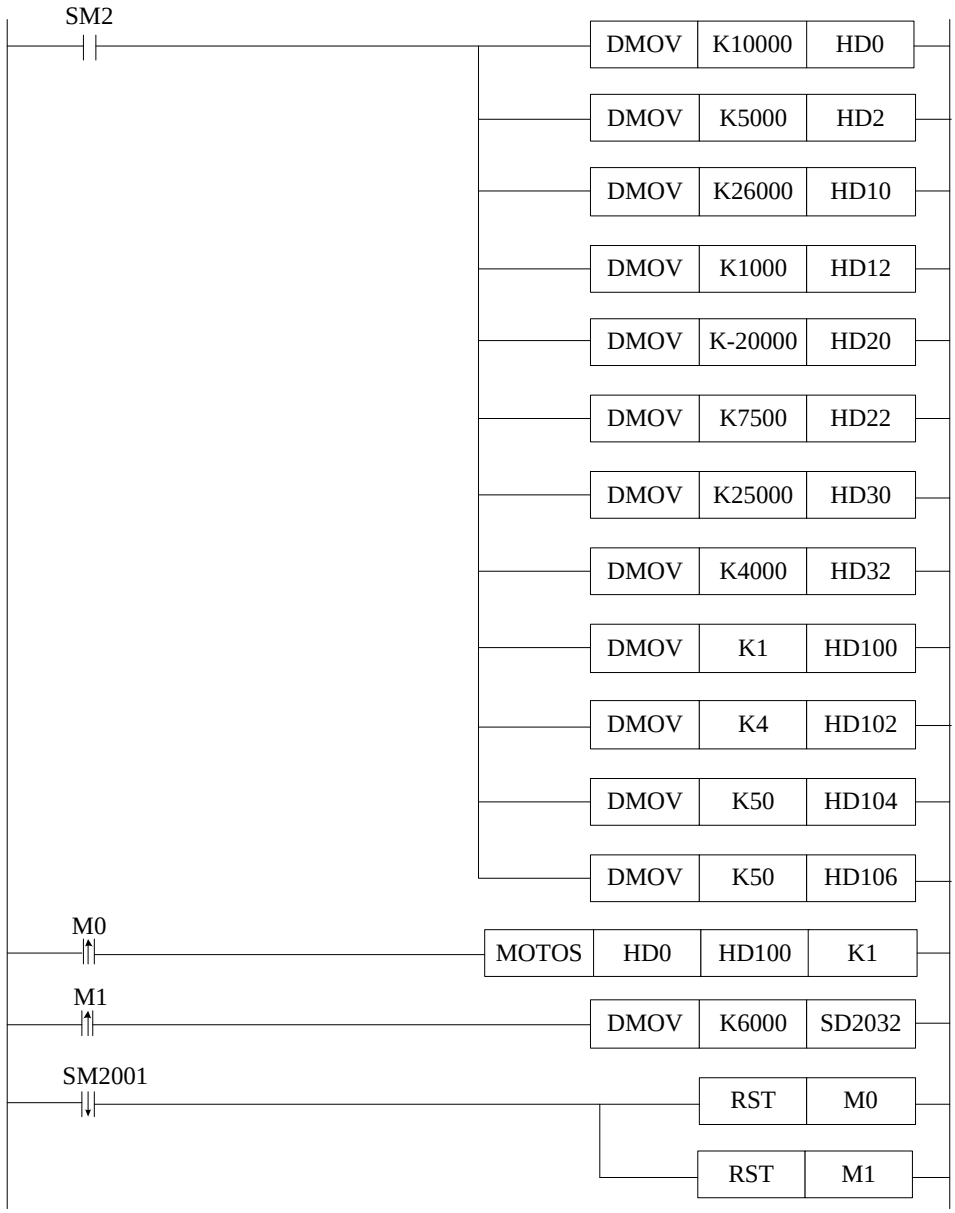
When the pulse is sent, the running flag bit SM2001 is reset and the corresponding coil is reset.

■ In absolute position mode, the schematic diagram of motor running distance is as follows:



The current position is 5000. In absolute position mode, 5000 pulses should be sent when the first section goes forward to 10000 pulses; 16000 pulses should be sent when the second section goes forward to 26000 pulses; -46000 pulses should be sent when the third section goes backward to -20000 pulses; 45000 pulses should be sent when the fourth section goes forward to 25000 pulses.

- The ladder chart in absolute position mode:



Explanation:

PLC starts to run, the initial positive pulse coil SM2 will send the number of pulses, speed, motion mode, total number of operation sections and acceleration and deceleration time to the corresponding registers.

Servo enable on, M0 from off to on, start to execute MOTOS command of multi segment speed movement.

M1 from off to on, the new speed is sent to the corresponding register.

When the pulse is sent, the running flag bit SM2001 is reset and the corresponding coil is reset.

5-2-4. Stop motion [MOSTOP]

(1) Instruction overview

The instruction can stop the movement in multiple modes.

Stop motion [MOSTOP]			
16-bit instruction		32-bit instruction	MOSTOP
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	stop mode or deceleration distance	32-bit integer
S1	axis number	16-bit constant

(3) Suitable soft component

Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●								●									
S1	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents M, HM, SM; S represents S, HS; T represents T, HT; C represents C, HC.

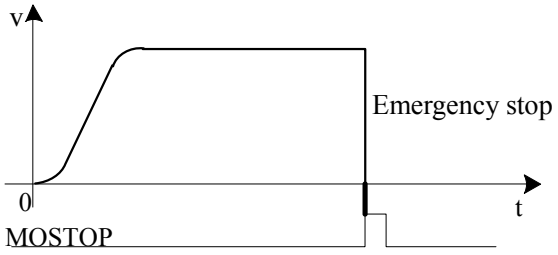
(4) Function and action

《Instruction format》

- When M0 is from off to on, S1 axis stops in different ways according to the value of S0 parameter. The MOSTOP command is executed. After the axis movement stops, the in motion flag (SM2001 + 20 * (n-1)) is set to off, but the command completion flag (SM2003 + 20 * (n-1)) is not set to on.
  S0: the mode of pulse stop or deceleration distance can be set.
  S1: axis number n, N range is 1-32.

- According to the different parameters of S0, the stop modes are divided into emergency stop and slow stop. Several modes are as follows:
  - Emergency stop (K-1):

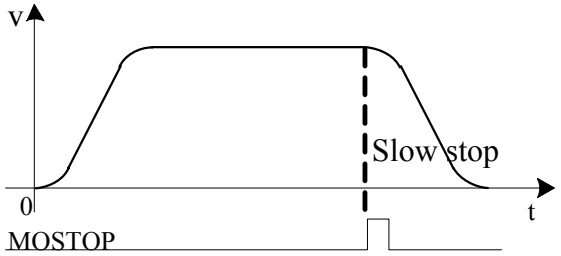
  When S0 is k-1 or other negative numbers, the motor performs an emergency stop.



Attention: stop the movement immediately, there will be mechanical damage.

■ Slow stop (K0):

When S0 is K0: decelerate to stop according to the deceleration time set in (SD2036 + 60 * (n-1)).



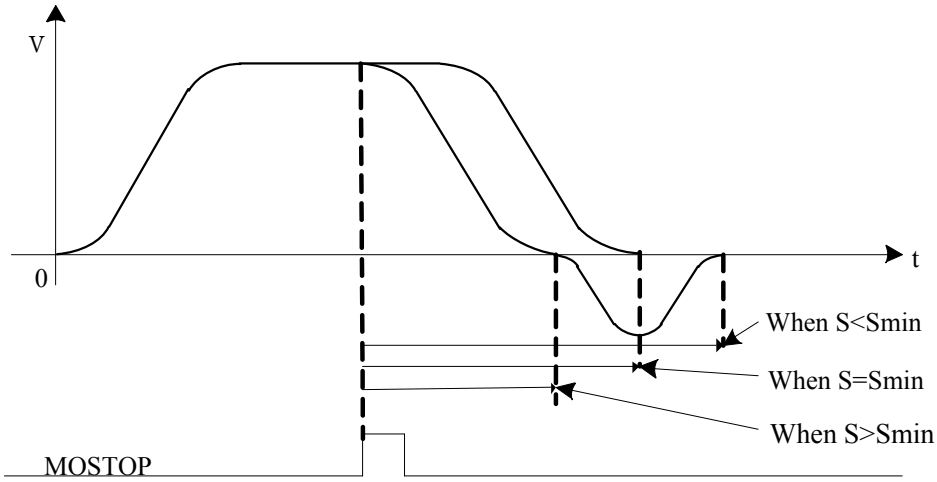
■ Fixed length stop (positive):

When S0 is positive: slow stop is executed, and deceleration distance is the given positive value;

① If the given deceleration distance is less than the minimum deceleration distance Smin (calculated according to the deceleration time set in (SD2036 + 60 * (n-1)), first decelerate forward to stop, and then move backward to the given deceleration distance;

② If the given deceleration distance is greater than the minimum deceleration distance Smin, decelerate to the stop according to the given deceleration distance. If the distance is too large, the motor will continue to run at a constant speed for a period of time and then slow down to stop.

③ If the deceleration distance is greater than the minimum deceleration distance and exceeds the limit, the motor will automatically take the limit as the target position.



5-2-5. Continue moving [MOGOON]

(1) Instruction overview

The command can make the motor to move to the target position after stopping halfway.

Continue moving [MOGOON]			
16-bit instruction		32-bit instruction	MOGOON
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S	Axis number	16-bit constant or register

(3) Suitable soft component

Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dnm
S	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents M, HM, SM; S represents S, HS; T represents T, HT; C represents C, HC.

(4) Function and action

《Instruction format》

- When M0 changes from off to on, the s-axis continues its unfinished motion. After the instruction is executed and the movement is completed, the instruction completion flag (SM2003 + 20 * (n-1)) is set to on.

S: Axis number n, the range of n is 1-32.

- In combination with MOSTOP, the pause function can be realized.
- If the MOSTOP command is executed and other commands are executed for the same motion axis, the execution of the MOGOON command will not work.

5-2-6. Synchronous binding [MOSYN]

(1) Instruction overview

This command binds the master shaft and the slave shaft (or high-speed counting) for synchronous movement.

Synchronous binding [MOSYN]			
16-bit instruction	-	32-bit instruction	MOSYN
Execution condition	Rising/falling edge of the coil	Suitable model	XG2

Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	Multiple of synchronous speed	32-bit floating-point register
S1	Master shaft number or high speed counting	16-bit constant or register
S2	Slave shaft number	16-bit constant or register

(3) Suitable soft component

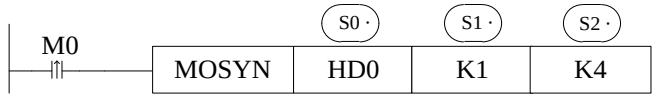
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●								●									
S1	●								●									
S2	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents M, HM, SM; S represents S, HS; T represents T, HT; C represents C, HC.

(4) Function and action

《Instruction format》



- When M0 is from off to on, the position of master shaft and slave shaft will be locked at the moment of execution to keep synchronization.

  S0: multiple of synchronous motion speed (floating point), i.e. multiple of synchronous motion speed = slave shaft speed / master shaft speed;

  S1: master shaft No. n, N range is 1~32 or -1~ -4. ;

  S2: slave shaft No. n, N range is 1~32;

- According to the different S0 parameters, the synchronization speed types are different:

(1) When S0 is a negative number, the slave shaft keeps synchronous motion with the master shaft with the reverse synchronous speed multiple |S0|.

(2) When S0 is 0, the slave shaft is bound to the master shaft, but the slave shaft speed is 0.

(3) When S0 is a positive number, the slave shaft keeps synchronous motion with the master shaft with the synchronous speed multiple S0.

- According to the different S1 parameters, the types of master shafts are different:

  (1) When S1 is 1~32, the master shaft is the pulse output shaft.

  (2) When S1 is -1~ -4, the master shaft is a high-speed counter. -1 corresponds to high-speed counter HSC0, -2 corresponds to high-speed counter HSC2, -3 corresponds to high-speed counter HSC4, -4 corresponds to high-speed counter HSC6, and the input port of each high-speed counter refers to the high-speed count input terminal of PLC.

- It shall be bound when the master shaft and slave shaft stop.

  In the unbound state, if the master shaft stops and the slave shaft executes its own command, then the slave shaft cannot bind at this time, and the slave shaft will stop after executing its own command.

- The synchronous speed multiple can be modified by modifying the register value (multiple must be floating-point number) of (SD2038 + 60 * (n-1)). After the real-time effect, the synchronous movement

will be carried out according to the modified speed multiple.

- When S1 is set to 1-32, it can be used with MOTO, MOTOA, MOTOS, MOSTOP instructions after binding to realize synchronous movement.
- When S1 is set to -1 to -4, it can be used with hand pulse generator to realize synchronous motion after binding.
- When the hand pulse generator is used, the weak vibration of the motor will be caused due to too large following multiple. At this time, it can be adjusted by modifying the value of register SD2059 + 60 * (n-1).

Table 5-2-3: setting value parameter（N=1~32）

Address	Definition	Type	Unit	Note
SD2038+60*(N-1)	Multiple of synchronous motion speed	32-bit floating number		Slave shaft speed/master shaft speed
SD2044+60*(N-1)	Positioning complete width	32-bit integer	Pulse number	Determine the threshold value of positioning completion. If the difference between the given value and the feedback value of the encoder is less than this value, the moving flag is off
SD2059+60*(N-1)	Filter coefficient	32-bit integer		The setting range is 0 ~ 9999. This parameter can be modified when using the hand pulse generator and the weak vibration of the motor is caused by too large follow multiple.

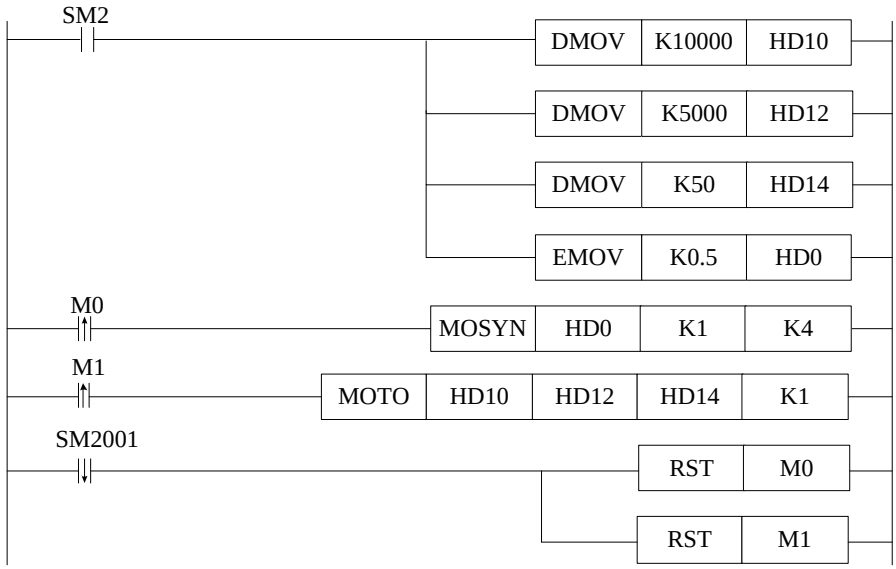
Table 5-2-4: state bit parameter（N=1~32）

Address	Definition	Note
SM2000+20*(N-1)	servo enable flag	ON: servo enable state
SM2001+20*(N-1)	Moving flag	ON: pulse outputting
SM2004+20*(N-1)	shaft error flag	ON: error

(5) Example 1

With the command of MOSYN, the motor 1 of master shaft is bound with the motor 4 of slave shaft, and the slave shaft follows the master shaft to run 10000 pulses at the speed of 5000Hz. Acceleration and deceleration are 50ms. The speed of the slave shaft is 0.5 times that of the master shaft.

The ladder chart is shown as below:



Explanation:

PLC starts to run, the initial positive pulse coil SM2 will send the pulse number, speed, acceleration and deceleration time and the multiple of synchronous speed to the corresponding register.

Servo enable on, M0 from off to on, bind the master shaft and slave shaft.

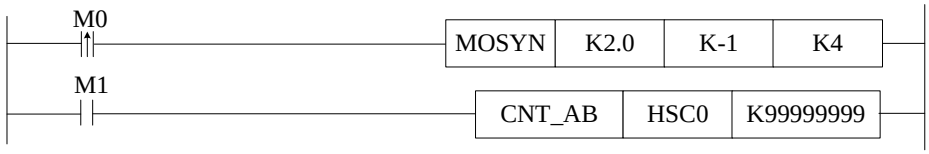
M1 from off to on, execute MOTO command of relative position movement.

When the pulse is sent, the running flag bit SM2001 is reset and the corresponding coil is reset.

(6) Example 2

The high-speed counter HSC0 is bound to the slave shaft 4 motor with the instruction of MOSYN to realize the movement of the slave shaft following the hand shaking pulse generator. The speed of the slave shaft is twice that of the master shaft.

The ladder chart is shown as below:



Explanation:

Servo enable on, M0 from off to on, bind high-speed counter HSC0 with driven shaft.

M1 starts from off to on to perform high-speed counting of counter HSC0. At this time, turn the handwheel, K4 axis will follow the handwheel.

5-2-7. Synchronization release [MOUSYN]

(1) Instruction overview

This instruction will release the synchronous motion between master shaft and slave shaft (or high speed counting).

Synchronization release [MOUSYN]			
16-bit instruction		32-bit instruction	MOUSYN
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S	Slave shaft number	16-bit constant or register

(3) Suitable soft component

Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents M, HM, SM; S represents S, HS; T represents T, HT; C represents C, HC.

(4) Function and action

《Instruction format》

- When M0 is from off to on, the two axis synchronization will be released instantly.
  S: Slave shaft No. n, N range is from 1 to 32.
- The binding shall be released when both the master shaft and the slave shaft are stopped.
- In the process of synchronous movement, the slave shaft can also be stopped by the emergency stop mode of MOSTOP command, and the binding can be released at the same time. At this time, the slave shaft stops abruptly and the master shaft continues to move; this stop mode has sudden change in speed and is not recommended to be used frequently.

5-2-8. Write current position [MOWRITE]

(1) Instruction overview

This command can modify the current absolute position value of the motion axis for correcting the position.

Write current position [MOWRITE]			
16-bit instruction		32-bit instruction	MOWRITE
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	current position value	32-bit integer or register
S1	shaft number	16-bit constant or register

(3) Suitable soft component

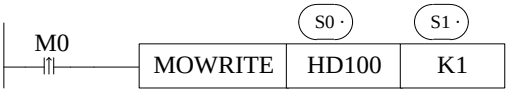
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●																	
S1	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents M, HM, SM; S represents S, HS; T represents T, HT; C represents C, HC.

(4) Function and action

《Instruction format》



- When M0 is from off to on, modify the current absolute position value of the motion axis (SD2008 + 60 * (n-1)) to S0.

S0: Specifies the current absolute position value of the motion axis.
S1: movement axis number n, N range is 1-32.

- This instruction is invalid in the process of multi segment speed movement and synchronous movement. This instruction is invalid after MOSTOP is used.
- When the current position value (SD2008 + 60 * (n-1)) is modified, the current displacement (SD2006 + 60 * (n-1)) and the current displacement pulse number (HSD108 + 20 * (n-1)) remain unchanged, and the target position given pulse number (HSD100 + 20 * (n-1)) and the target position feedback pulse number (HSD104 + 20 * (n-1)) change accordingly.
- When the motor is enabled on, the parameters in table 5-2-5 and table 5-2-6 can be cleared to 0.
- When the current position of the shaft (SD2008 + 60 * (n-1)) is greater than 224 (16777216), the accuracy will get worse, and the motion will shake. At this time, MOWRITE can be used to clear the current position, but the current displacement (SD2006 + 60 * (n-1)) will not be affected, and continue to accrue.
- There are four ways to modify the current location value:

①When returning to the original point through (SM2014 + 20*(n-1)) and (SM2015 + 20*(n-1)), the current position value will change;

② When PLC stops, manually modify the register value of target position feedback pulse number (HSD104 + 20 * (n-1)) and the current position value will also change;

③ During PLC operation, the register value (HSD104 + 20 * (n-1)) can also be modified by executing the MOWRITE instruction, and the current position value will also be changed.

④ When the PLC is running and the servo is not enabled, the external force causes the servo position to change. (HSD104 + 20 * (n-1)) register value will follow the change. When the servo is enabled on, the value is valid.

(5) Related register

Table 5-2-5: State quantity parameter（N=1~32）

Address	Definition	Type	Unit	Note
SD2006+60*（N-1）	Current displacement	32-bit integer	Pulse number	Displacement relative to last stop position
SD2008+60*（N-1）	Current position	32-bit integer	Pulse number	Coordinate position, converted from the number of pulses feedback by the target position

Table 5-2-6：Self hold state parameter（N=1~32）

Address	Definition	Type	Unit	Note
HSD100+20*（N-1）	Given pulse number of target position	64-bit integer	Encoder count	relative zero
HSD104+20*（N-1）	Target position feedback pulse number	64-bit integer	Encoder count	Relative zero
HSD108+20*（N-1）	Current pulse number of displacement	64-bit integer	Encoder count	Displacement of single movement instruction

5-2-9. Read current position [MOREAD]

(1) Instruction overview

This instruction is used to read the current absolute position value.

Read current position [MOREAD]			
16-bit instruction		32-bit instruction	MOREAD
Execution condition	Rising/falling edge of the coil	Suitable model	XG2
Hardware	V3.6	Software	V3.6

(2) Operand

Operand	Function	Type
S0	read current position	32-bit integer or register
S1	Shaft number	16-bit constant or register

(3) Suitable soft component

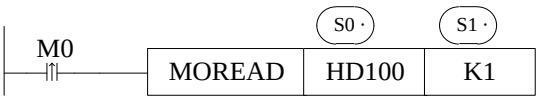
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●																	
S1	●								●									

Note: D represents D, HD; TD represents TD, HTD; CD represents CD, HCD, HSCD, HSD; DM represents DM, DHM; DS represents DS, DHS.

M represents M, HM, SM; S represents S, HS; T represents T, HT; C represents C, HC.

(4) Function and action

《Instruction format》



- When M0 is from off to on, the read instruction refreshes the state parameters in SD and reads the current absolute position value of S1 motion axis (SD2008 + 60 * (n-1)) into S0 register.

S0: Specifies the register address stored the read value of current absolute position.

S1: slave shaft No. n, N range is 1-32;

- If necessary, the parameters of SD status register can be transmitted with EMOV or DMOV instructions, and double words are required for monitoring.

5-2-10. Return to origin

The bus command does not need to be programmed to return to the origin. Set the near point signal (SFD3036 + 60 * (n-1)), the origin signal (SFD3037 + 60 * (n-1)), the high-speed VH (SFD3040 + 60 * (n-1)), the low-speed VL (SFD3042 + 60 * (n-1)) and the crawling speed (SFD3044 + 60 * (n-1)). When the servo is enabled on, the operation of each axis returning to the original point can be realized through the forward return to the original point system coil (SM2014 + 20 * (n-1)) and the reverse return to the original point system coil

(SM2015 + 20 * (n-1)). The parameters are shown in table 5-2-7.

Table 5-2-7: return to origin parameters

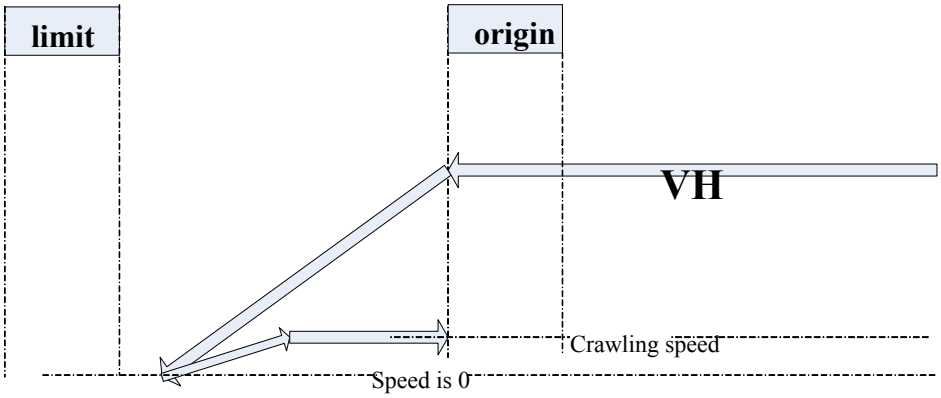
Address	Definition	Type	Unit	Initial value	Note
SFD3034 +60*(N-1)	Minimum limit terminal setting	16-bit integer		0xFF	Specify the number of terminal X, 0xFF is no terminal, negative number means anti logic, and the anti logic of X0 is set to -30000
SFD3035 +60*(N-1)	Maximum limit terminal setting	16-bit integer		0xFF	Specify the number of terminal X, 0xFF is no terminal, negative number means anti logic, and the anti logic of X0 is set to -30000
SFD3036 +60*(N-1)	Near point signal terminal setting	16-bit integer		0xFF	Specify the number of terminal X, 0xFF is no terminal, negative number means anti logic, and the anti logic of X0 is set to -30000
SFD3037 +60*(N-1)	Origin terminal setting	16-bit integer		0xFF	Specify the number of terminal X, 0xFF is no terminal, negative number means anti logic, and the anti logic of X0 is set to -30000
SFD3038 +60*(N-1)	Homing mode	16-bit integer		0	0: **No Z-phase mode.** Find the near point according to the regression speed VH, then find the origin according to the regression speed VL, slow down after finding the edge of the origin, and then find the edge of the origin according to the crawl speed in reverse; 2: **Z-phase mode.** Find the approach point according to the regression speed VH, then find the origin point according to the regression speed VL, decelerate after finding the edge of the origin point, then find the edge of origin point according to the crawl speed in reverse, and then find the Z phase of the servo encoder along the positive direction 10: **Hard limit return mode.** When the positive and negative hard limits are met, the origin will be found in reverse at -VH speed, and the speed will change to VH when touching the falling edge of the origin, and the subsequent action is the same as mode 0. 12: **Hard limit return to Z-phase mode.** When the positive and negative hard limits are met, the origin will be found in reverse at - VH speed, and the speed will change to VH when touching the falling edge of origin, and the subsequent action is the same

					as mode 2.
SFD3040 +60*(N-1)	Regression speed VH	32-bit integer	pulse number/second	0	
SFD3042 +60*(N-1)	Regression speed VL	32-bit integer	pulse number/second	0	
SFD3044 +60*(N-1)	Crawling speed	32-bit integer	pulse number/second	0	

There are three modes to return to the origin, namely, no Z-phase signal mode, Z-phase signal mode and hard limit return mode.

1. No Z-phase signal mode

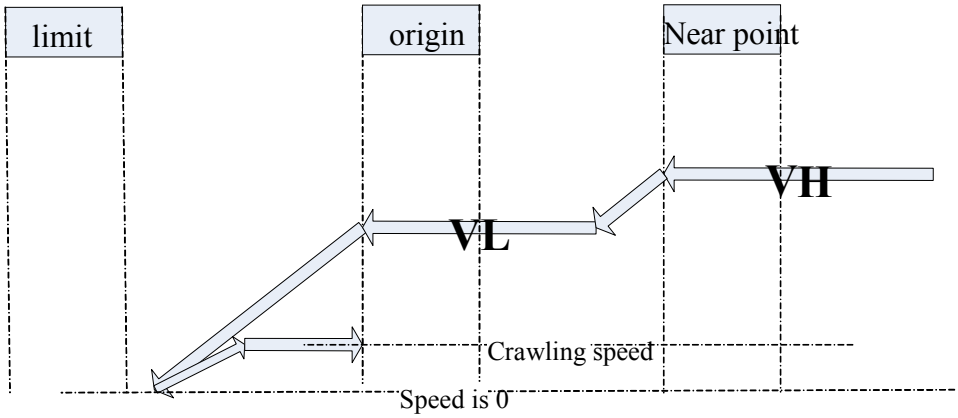
- In the case of reverse return to the origin and no near point signal:



Action description:

The motor returns to the origin with high-speed VH. In the process of returning to the origin, the speed changes to 0 when touching the falling edge of the origin signal, and then the motor returns to the origin with the creeping speed in reverse. When it touches the rising edge of the origin signal, the motor stops returning to the origin.

- In the case of reverse return to the origin and with near point signal:

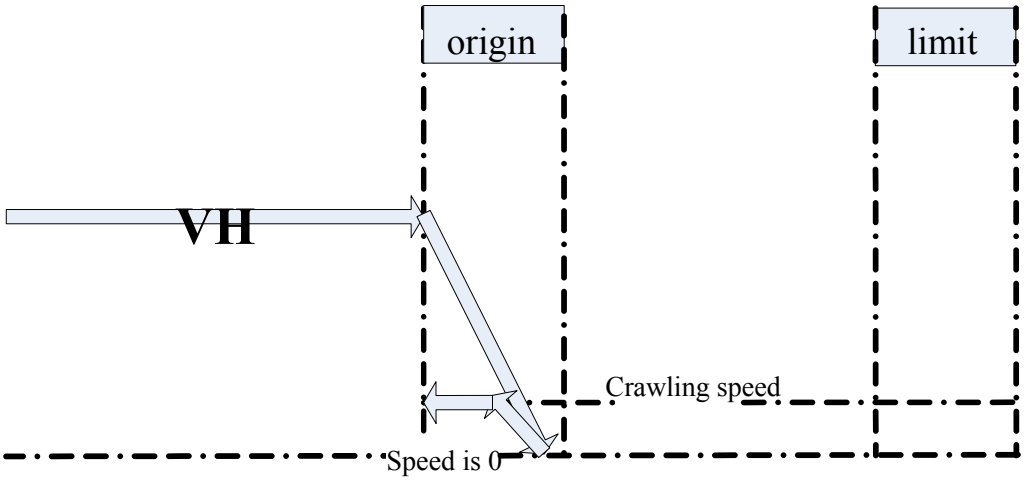


Action description:

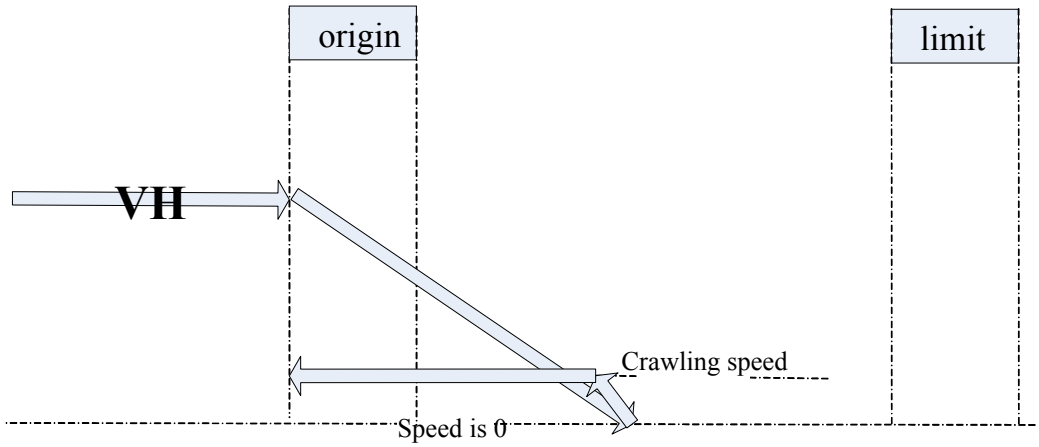
The motor returns to the origin with high-speed VH. In the process of returning to the origin, it encounters the falling edge of the near point signal. The motor speed drops to the low-speed VL and continues to return to the origin. The speed drops to 0 when touching the falling edge of the origin signal, and then it reverses to the origin with the crawling speed. When it encounters the rising edge of the origin signal, it stops returning to the origin.

■ In the case of positive return to the origin and no near point signal:

if the origin signal is too long:



if the origin signal is too short:

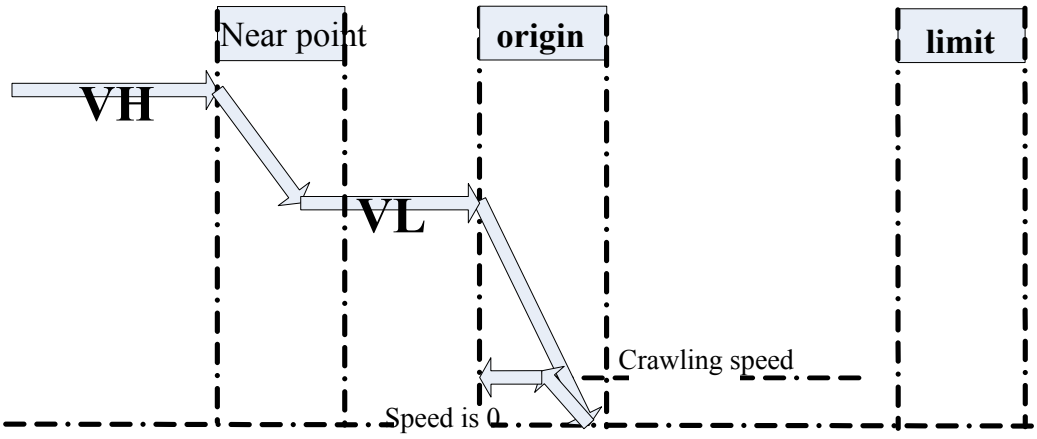


Action description:

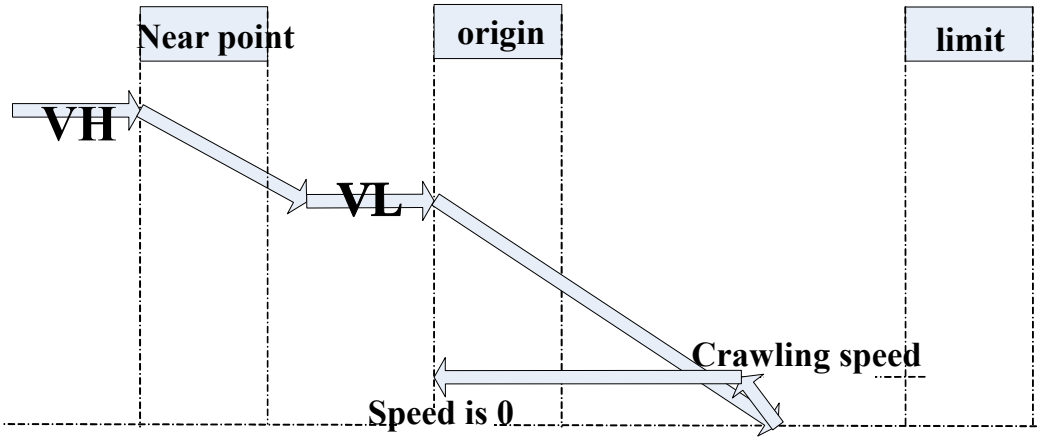
The motor returns to the origin with high-speed VH. In the process of returning to the origin, when it encounters the rising edge of the origin signal, the speed drops to 0 and starts to return to the origin with the creeping speed. When it encounters the falling edge of the origin signal, the motor stops returning to the origin.

■ In the case of positive return to the origin and with near point signal:

If the origin signal is too long:



If the origin signal is too short:

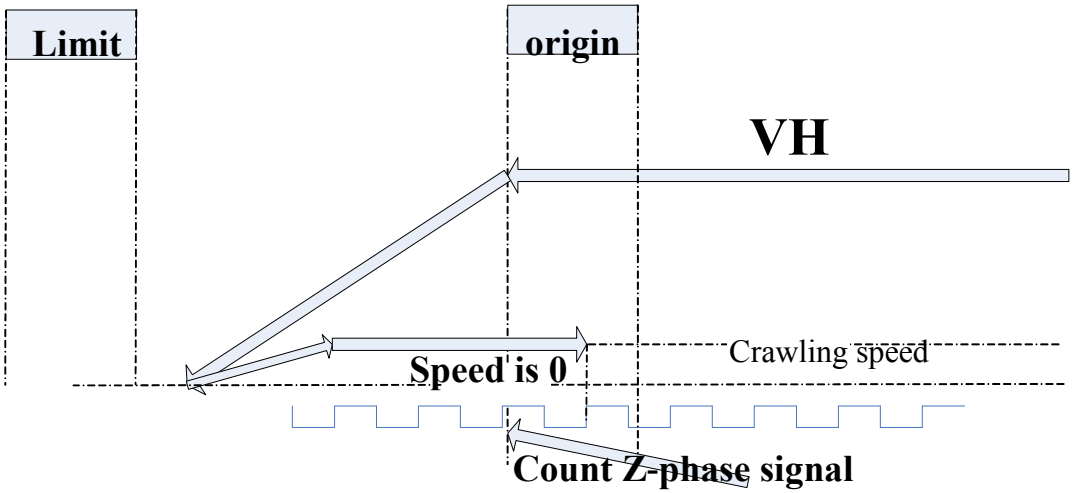


Action description:

The motor returns to the origin with high-speed VH. In the process of returning to the origin, it encounters the rising edge of the near point signal. The motor speed drops to the low-speed VL of returning to the origin and continues to return to the origin. When it encounters the rising edge of the origin signal, the speed drops to 0 and starts to return to the origin with the creeping speed in reverse direction. When it encounters the falling edge of the origin signal, it stops returning to the origin.

2. Z-phase signal mode

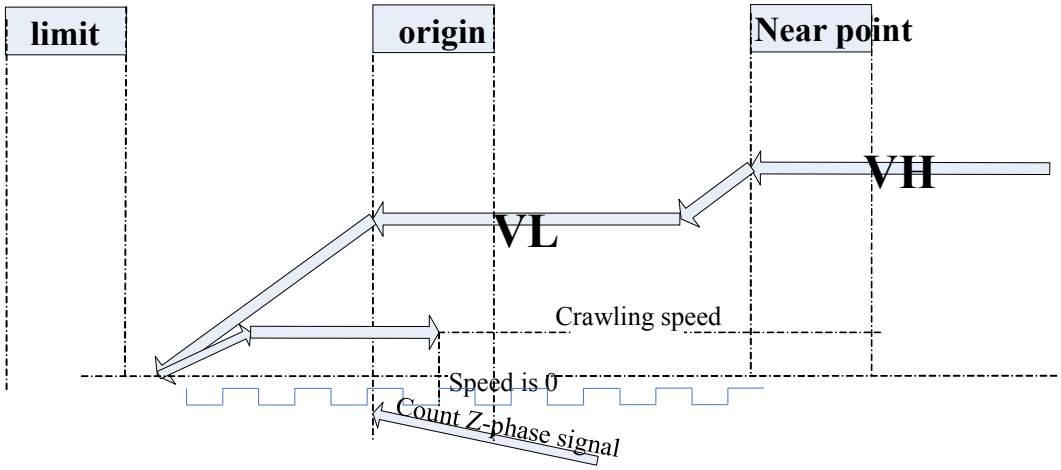
- In the case of reverse return to the origin and no near point signal:



Action description:

The motor returns to the origin with high-speed VH. In the process of returning to the origin, the speed changes to 0 when touching the falling edge of origin signal, and then returns to the origin with the creeping speed in reverse direction. When it touches the rising edge of the origin signal, it starts to find the z-phase signal of the servo motor, and stops returning to the origin when it finds the z-phase signal.

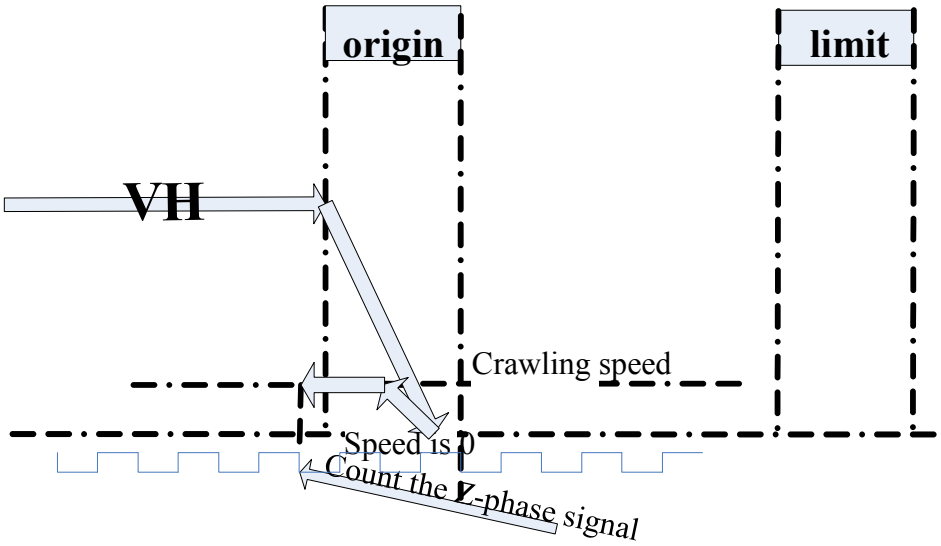
- In the case of reverse return to the origin and with near point signal:



Action description:

The motor returns to the origin with high-speed VH. In the process of returning to the origin, it encounters the near point signal. The motor speed drops to the low-speed VL and continues to return to the origin. The speed changes to 0 when touching the falling edge of origin, and then it reverses to the origin with the crawling speed. When it touches the rising edge of the origin signal, it starts to find the z-phase signal of the servo motor, and stops returning to the origin when it finds the z-phase signal.

■ In the case of positive return to the origin and no near point signal:

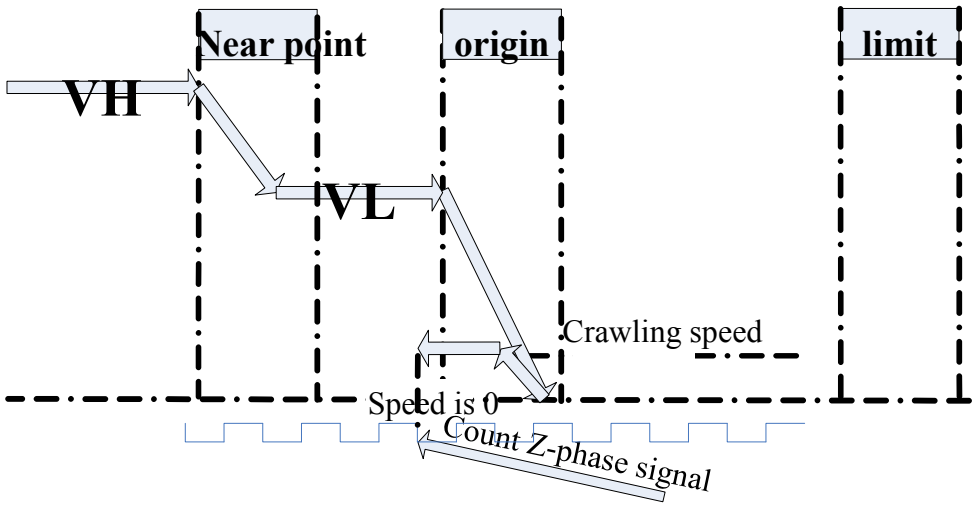


Action description:

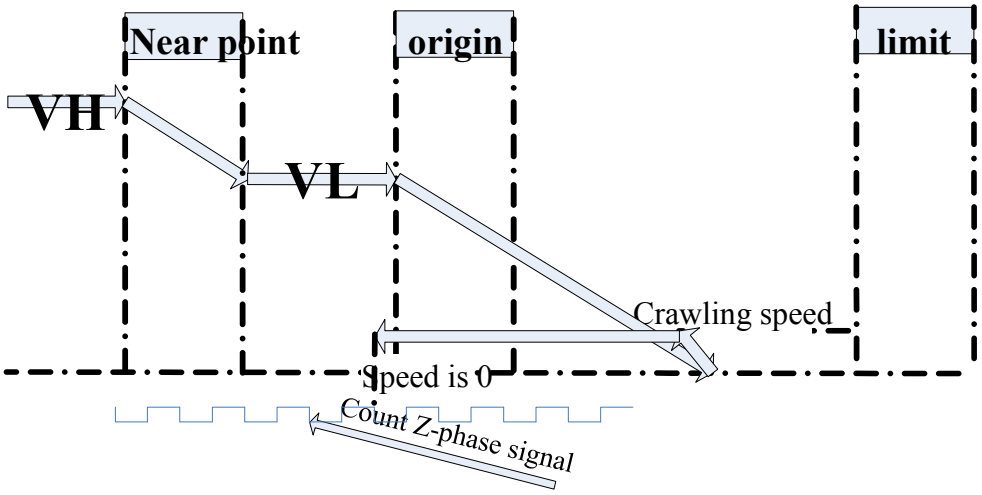
The motor returns to the origin with high-speed VH. In the process of returning to the origin, the speed drops to 0 when it touches the rising edge of the origin signal, and then it reverses to the origin with crawling speed. When it touches the falling edge of the far point signal, it starts to find the z-phase signal of the servo motor, and stops returning to the origin when it finds the z-phase signal.

■ In the case of positive return to the origin and with near point signal:

If the origin signal is too long:



If the origin signal is too short:

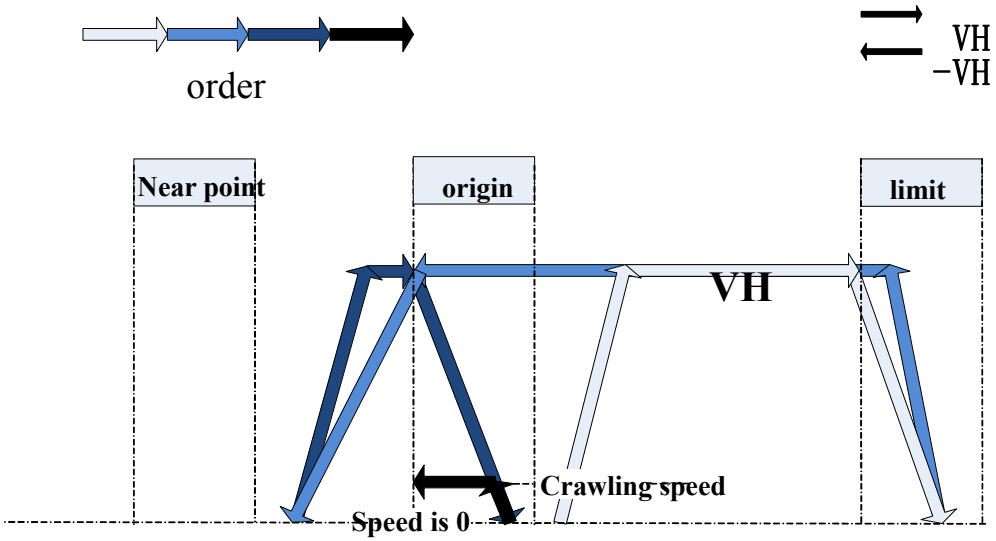


Action description:

The motor returns to the origin with high-speed VH. In the process of returning to the origin, it encounters the near point signal. The motor speed drops to the low-speed VL and continues to return to the origin. When it encounters the rising edge of the origin signal, the speed drops to 0 and starts to return to the origin with the creeping speed. When it encounters the falling edge of the origin signal, it starts to find the z-phase signal of the servo motor and stops returning to the origin when it finds the z-phase signal.

3. Hard limit return mode

(1) Return to the origin in the positive direction, and the initial position exists on the right side of the origin:



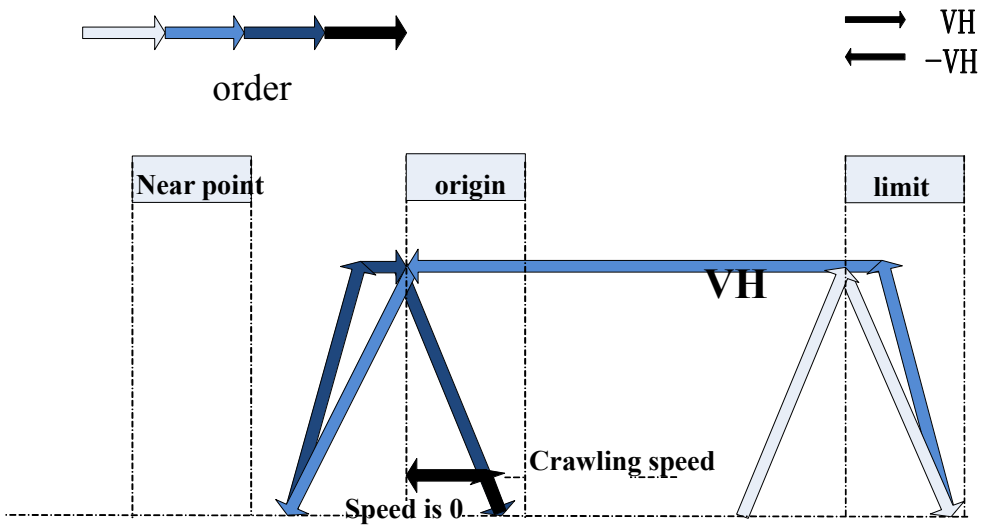
VH decelerates and reverses acceleration after touching the rising edge of the maximum limit at high speed;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerate to VH, after touching the rising edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(2) Forward return to the origin, the initial position exists on the right side of the origin, and just accelerates to the maximum limit.



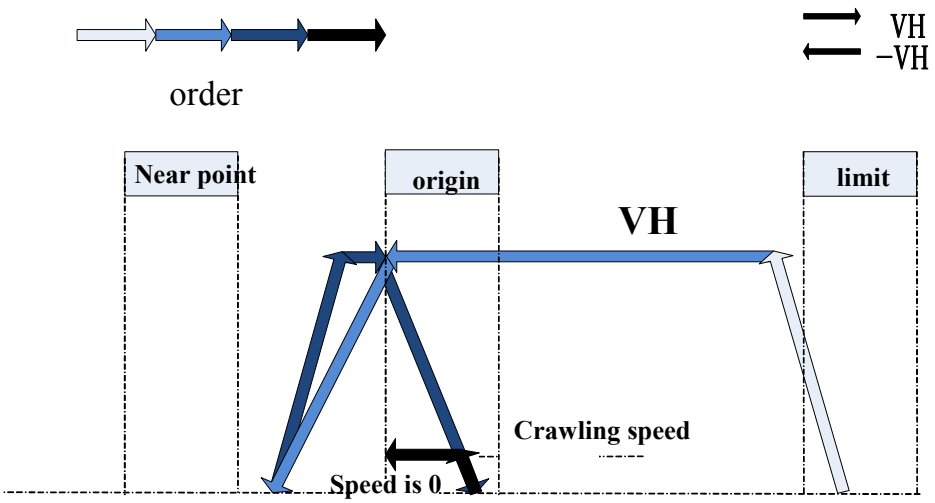
Accelerate to VH high speed, just touch the maximum limit rising edge, then decelerate and accelerate in reverse direction;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerate to VH, after touching the rising edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(3) Return to the origin in the forward direction, and the initial position is at the maximum limit.



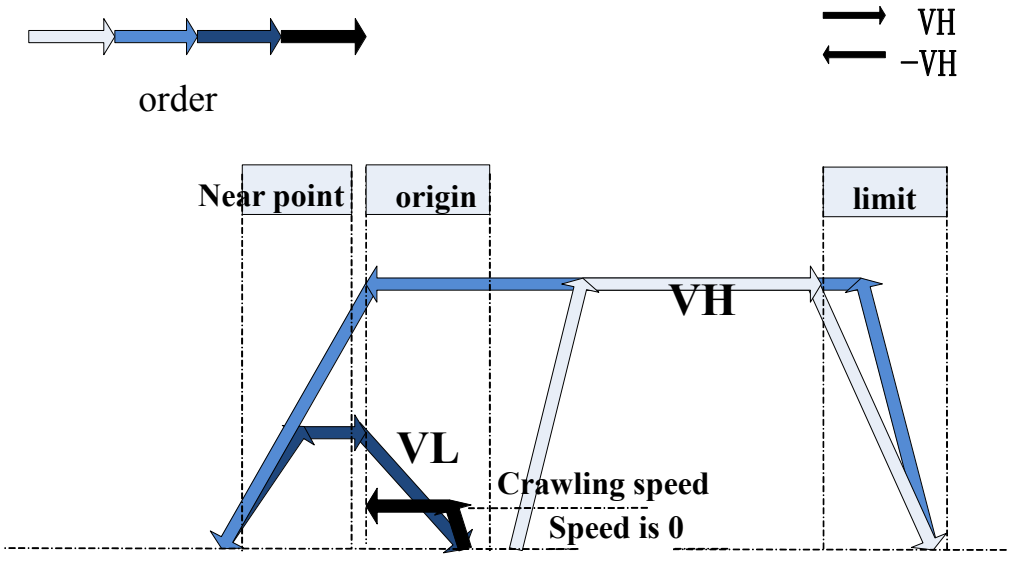
Accelerate to -VH high speed and reverse motion;

After touching the falling edge of the origin, decelerate and accelerate in reverse direction;

Reverse accelerate to VH, after touching the rising edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(4) Forward return to the origin, the origin signal is short and close to the near point signal, touching the near point signal.



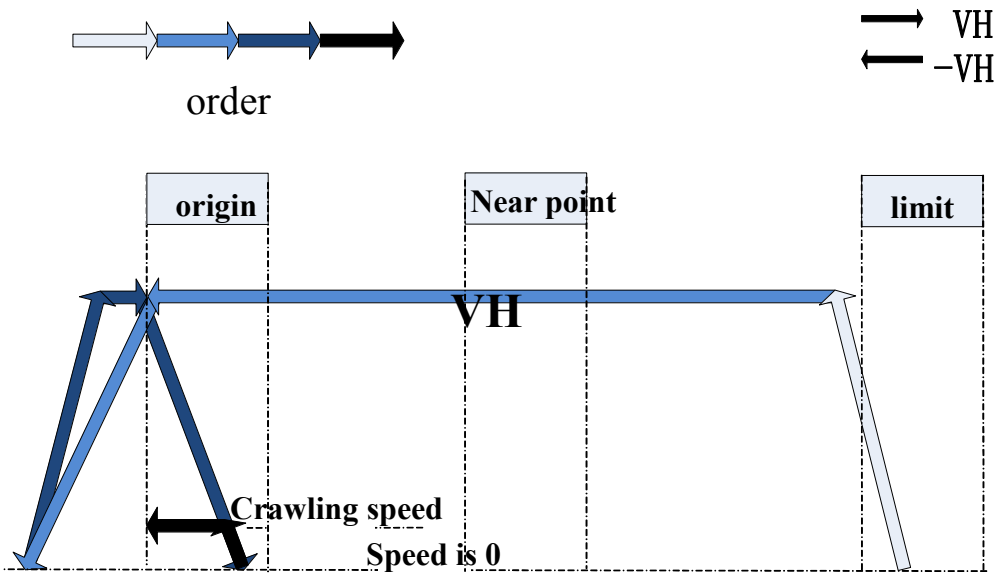
VH decelerates and reverses accelerates after touching the rising edge of the maximum limit at high speed;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

In the reverse acceleration section, the speed changes to VL when touching the rising edge of near point signal, keeps the VL moving forward to touch the rising edge of the origin, then decelerates and accelerates in the reverse direction;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(5) Forward return to the origin, the near point signal is between the origin and the maximum limit, and the initial position is at the maximum limit.



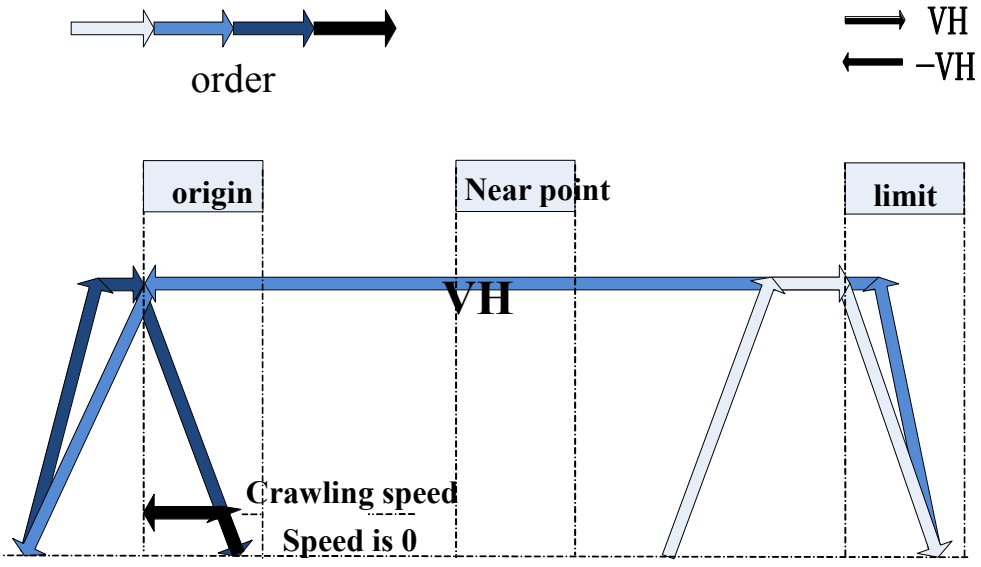
Accelerate to -VH high speed and reverse motion;

After touching the falling edge of the origin, decelerate and accelerate in reverse direction;

Reverse accelerate to VH, after touching the rising edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(6) Forward return to the origin, the near point signal is between the origin and the maximum limit, and the initial position is between the near point and the origin.



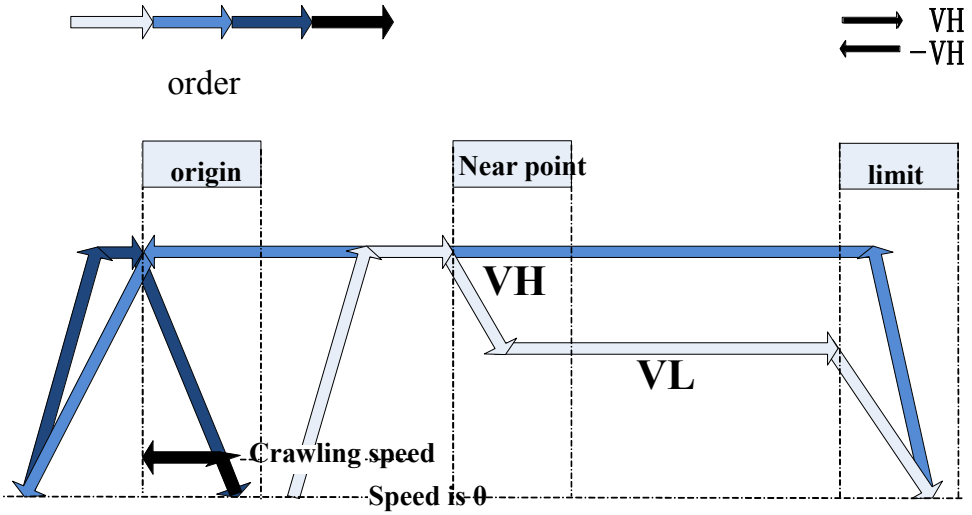
VH decelerates and reverses accelerates after touching the rising edge of the maximum limit at high speed;

Reverse accelerates to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerates to VH, after touching the rising edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(7) Forward return to the origin, the near point signal is between the origin and the maximum limit, and the initial position is between the origin and the near point.



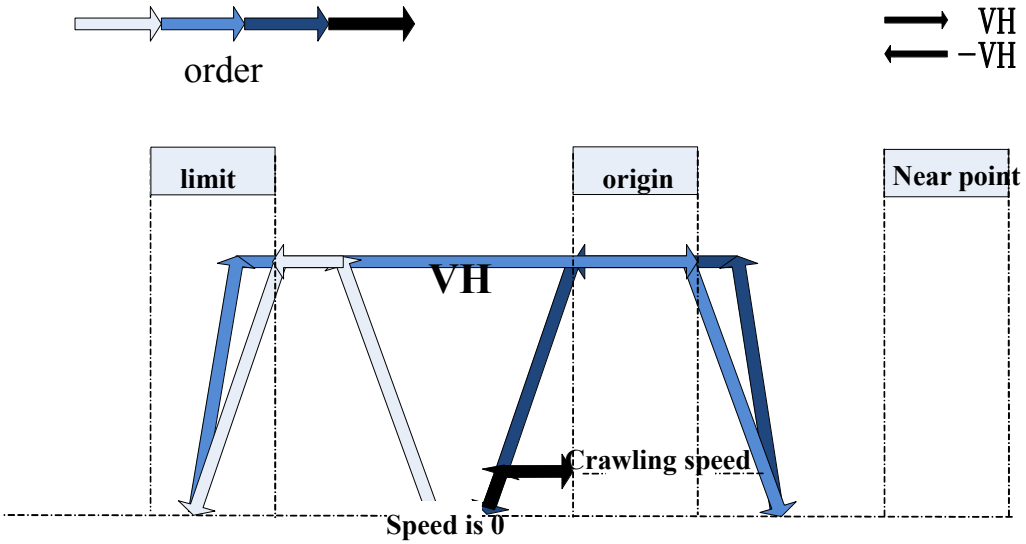
VH high speed touches rising edge of near point signal and decelerates to VL, decelerates and reverses accelerates after touching the rising edge of maximum limit;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerates to VH, after touching the rising edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the origin falling edge and decelerate to 0 to complete the action of returning to the origin.

(8) Reverse to the origin, the initial position is on the left of the origin.



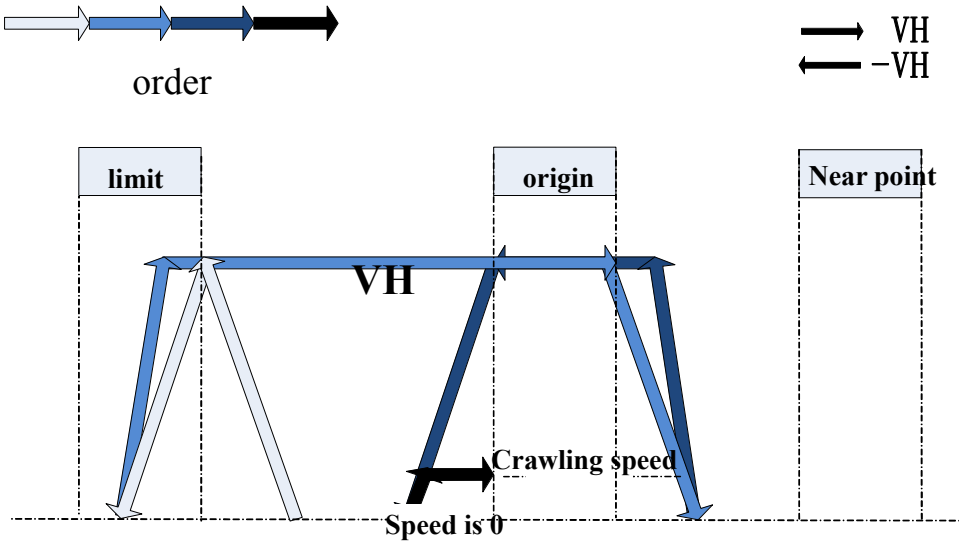
After touching the rising edge of the minimum limit at high speed, the -VH decelerates and accelerates in reverse direction;

Reverse accelerate to VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

(9) Reverse to the origin, the initial position is on the left of the origin, and just accelerate to the minimum limit.



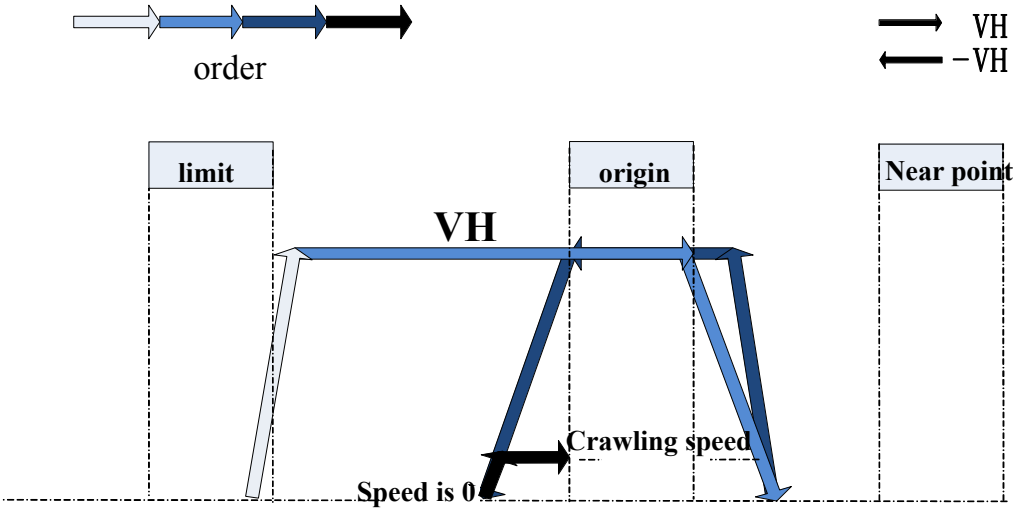
Accelerate to -VH high speed, just touch the rising edge of the minimum limit, then decelerate and accelerate in reverse direction;

Reverse accelerate to VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

(10) Reverse to the origin, the initial position is at the minimum limit.



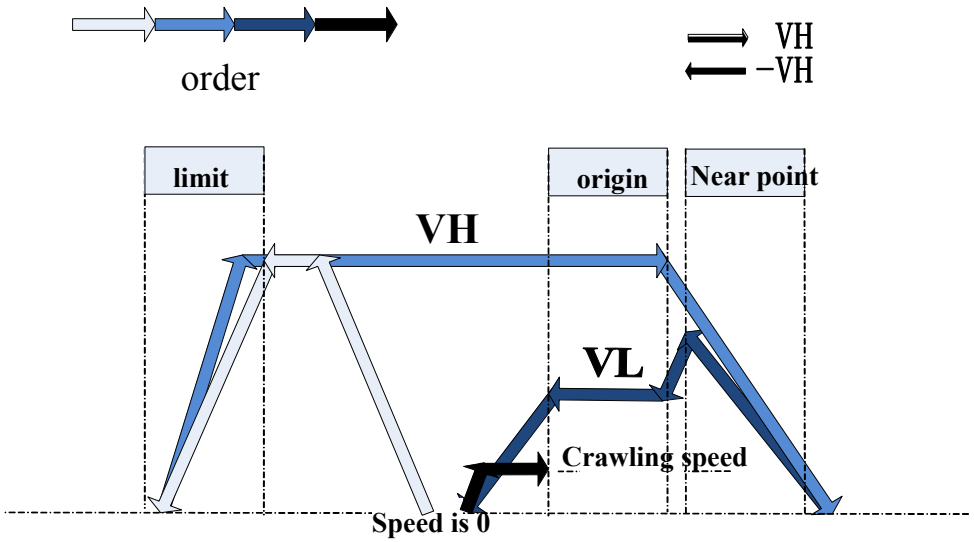
Accelerate to VH high speed and reverse motion;

After touching the falling edge of the origin, decelerate and accelerate in reverse direction;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

(11) Reverse to the origin, the initial position is on the left side of the origin, touching the near point signal.



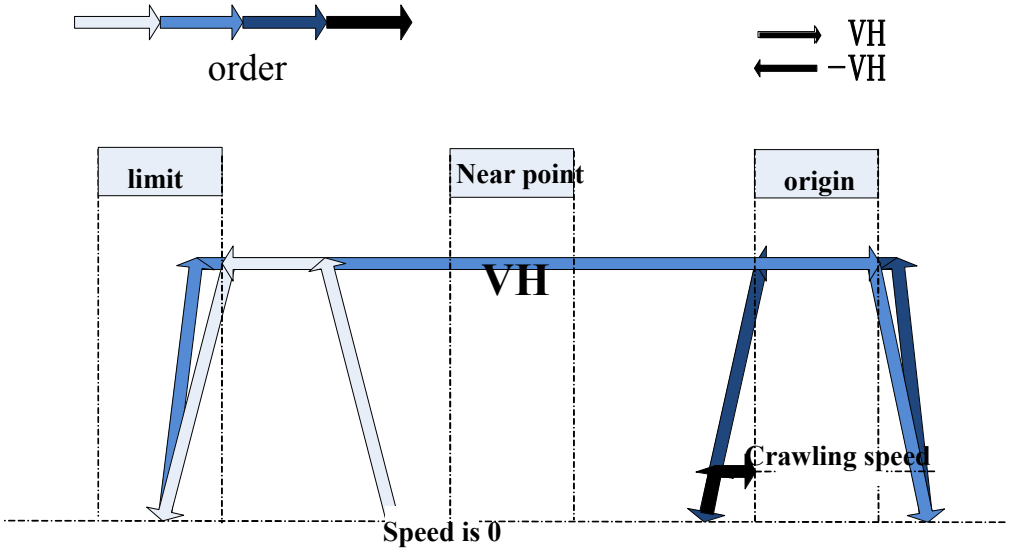
After touching the rising edge of the minimum limit at high speed, the VH decelerates and accelerates in reverse direction;

Reverse accelerate to VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

In the reverse acceleration section, the speed changes to -VL when touching the falling edge of near point, keeps the reverse motion of –VL and touches the falling edge of origin, decelerates and accelerates in the reverse direction;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

(12) Reverse to origin, the initial position is between the minimum limit and the near point.



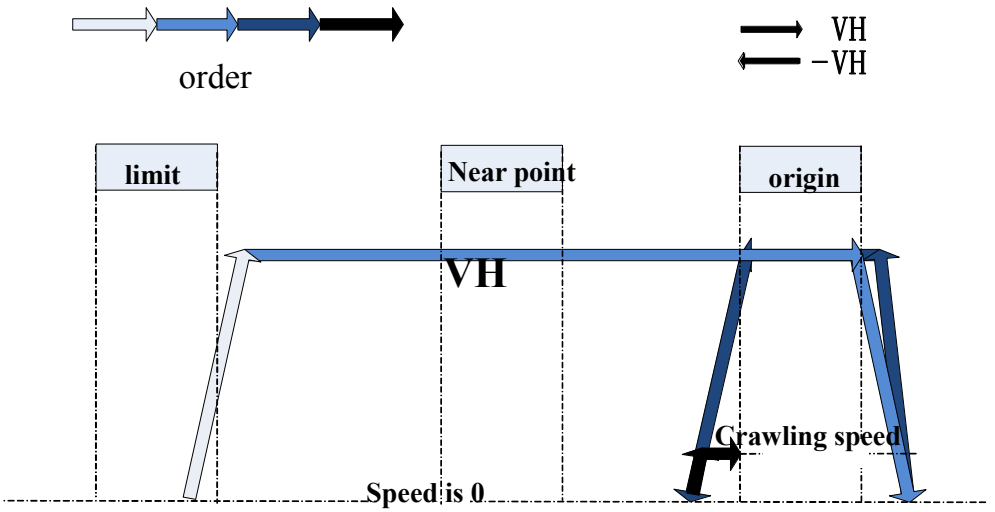
After touching the rising edge of the minimum limit at high speed, the -VH decelerates and accelerates in reverse direction;

Reverse accelerate to VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

(13) Reverse to the origin, the initial position is at the minimum limit.



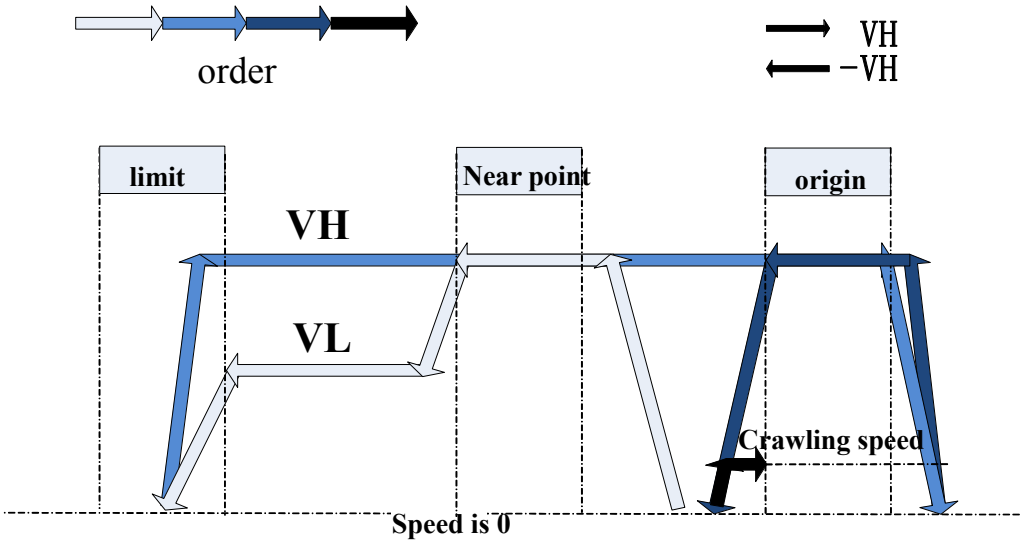
Accelerate to VH high speed and reverse motion;

After touching the falling edge of the origin, decelerate and accelerate in reverse direction;

Reverse accelerate to -VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

(14) Reverse to the origin, the initial position between the near point and the origin.



-VH high speed touches near point signal falling edge and decelerates to -VL, after touching the minimum limit rising edge decelerates and reverses acceleration;

Reverse accelerate to VH, after touching the falling edge of the origin, decelerate and reverse acceleration;

Reverse accelerate to -VH, touch the falling edge of the origin to slow down and reverse acceleration;

After accelerating to the reverse crawling speed, touch the rising edge of the origin and decelerate to 0 to complete the action of returning to the origin.

4. Hard limit return to z-phase mode

The return to the origin logic is the same as the hard limit return mode, and the number of z-phase is the same as the z-phase mode.

Notes:

(1) In the process of reverse return to the origin, for "no z-phase mode" and "z-phase mode", if the motor encounters the minimum limit, the motor stops moving. At this time, if it is unable to perform the reverse return to the origin, it can perform the forward return to the origin; otherwise, in the process of the forward return to the origin, if encountering the maximum limit, motor stops the movement. At this time, the forward return to the origin cannot be performed. You can perform the reverse return to the origin. "Hard limit return mode" is a mode that deal with the case of touching the hard limit.
(2) Execute forward return to origin SM2014 + 20 * (n-1), and the minimum limit will not work; similarly, execute reverse return to origin SM2015 + 20 * (n-1), and the maximum limit will not work.

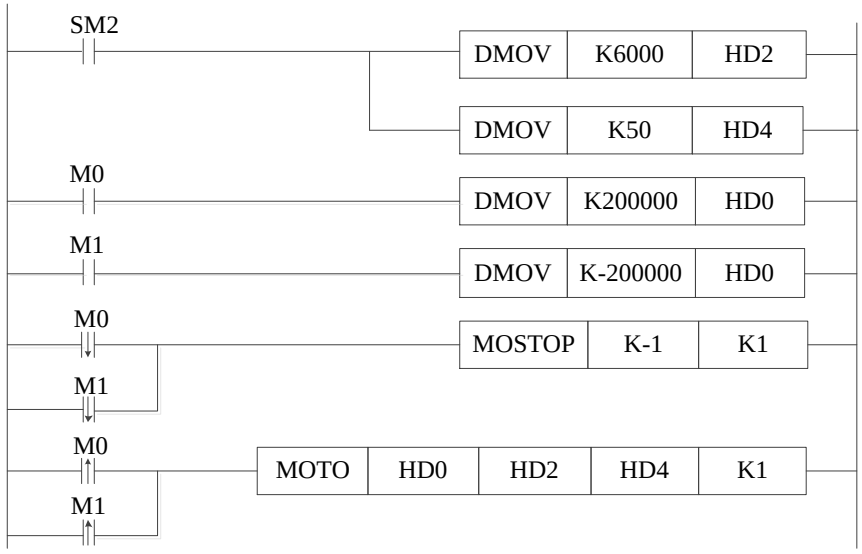
5-2-11. Jogging

Positive and negative inching function can be realized by controlling coils SM2011 + 20 * (n-1) and SM2012 + 20 * (n-1).
Set the number of pulses sent by PLC once in the inching step register (SD2040 + 60 * (n-1)) and the inching frequency in the inching speed register (SD2042 + 60 * (n-1)). Through the control of system coil (SM2011 + 20 * (n-1)), the forward inching of each axis is realized. Through the control of the system coil (SM2012 + 20 * (n-1)), the reverse inching of each axis is realized.
Inching signal SM2011 + 60 * (n-1), SM2012 + 60 * (n-1) will reset automatically immediately after setting. In order to continue jogging, the HMI or PLC program should be used to set the jogging signal on continuously within 100ms interval, and the motion axis will speed up until the jogging speed runs at a uniform speed.

(1) Method 1

With MOTO command, the target position is set as the larger number within the target limit value to achieve continuous inching.

Ladder chart is shown as below:



Explanation:

SM2: as soon as the PLC runs, it will pass the value into the corresponding register.

M0: forward jog button. When M0 is pressed, the motor rotates forward, and when M0 is reset, the motor

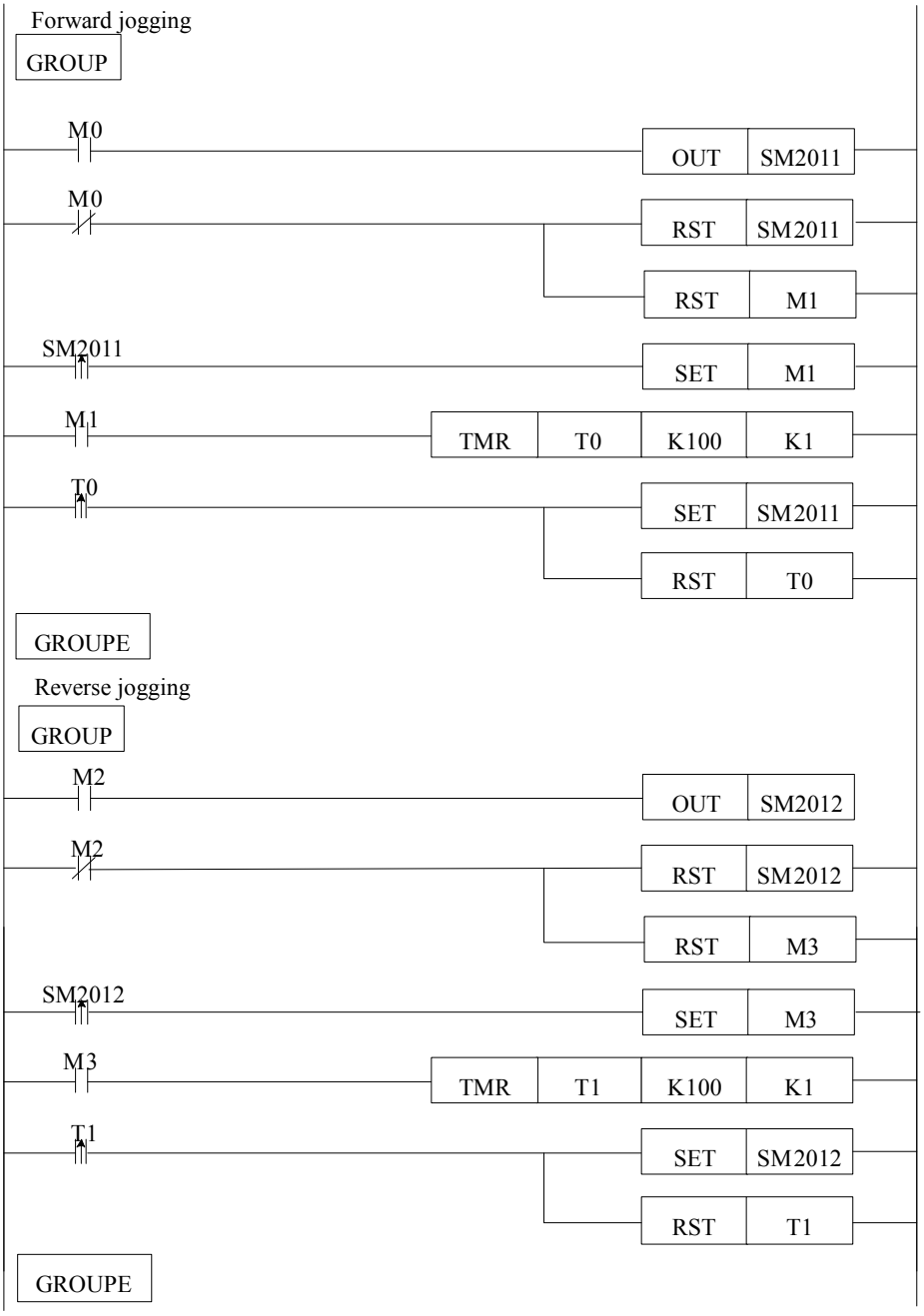
stops immediately.

M1: reverse jog button. When M1 is pressed, the motor rotates forward, and when M1 is reset, the motor stops immediately.

(2) Method 2

100ms timer is used to set the inching coil once. Motor 1 is in continuous forward and reverse inching motion at a frequency of 1500hz.

The ladder diagram is as follows:



Explanation:

In this example, when the motor is enabled, set the step length SD2040 to 1500 and the inching frequency SD2042 to 1500 Hz.

M0: forward jog. Press M0 forward jog button on the touch screen, and the motor starts to jog forward at 1500hz. Release the M0 forward inching button, and the motor stops.

M2: reverse jog. Press M2 reverse jog button on the touch screen, and the motor starts to reverse jog at 1500hz. Release M2 reverse inching button, and the motor stops.

The registers and coils involved in jog operation are shown in table 5-2-8 below:

Table 5-2-8: register and coil

Address	Definition	Type	Unit	Initial value	Explanation
SFD3024+60*(N-1)	Inching step initial value	32-bit integer	Pulse number	1000	--
SFD3026+60*(N-1)	Inching speed initial value	32-bit integer	Pulse number/second	1000	--
SD2040+60*(N-1)	Inching step	32-bit integer	Pulse number	0	--
SD2042+60*(N-1)	Inching speed	32-bit integer	Pulse number/second	0	--
SM2011+60*(N-1)	Forward jog	--	--	--	After enabling, the system will reset automatically
SM2012+60*(N-1)	Reverse jog	--	--	--	After enabling, the system will reset automatically

Note:

(1) The inching parameters in the SFD register need to be modified when the servo enable is off.

(2) The parameters of SD register need to be modified when servo enable is on.

5-2-12. Full closed loop

In some applications, the device uses grating ruler or encoder to control the position with high precision, and the full closed-loop motion is achieved by forming position and speed loops through high-speed counting and servo feedback.

The function involves coil and register:

(1) control bit

Address	Definition	Note
SM2016+20*(N-1)	Full closed loop enable	Set on: switch the system to the full closed-loop motion state, and the execution of motion instructions shall be subject to the high-speed counting position. The operation will take effect in 50ms at most. Set off: switch the system from full closed-loop motion state to normal motion state, i.e. the execution of motion command is subject to the position of servo encoder. The operation will take effect in 50ms at most.

(2) set the parameter

Address	Definition	Type	Unit	Initial value	Note
SFD3006 +60*(N-1)	Full closed-loop pulse ratio numerator	16-bit integer		0	When the register is set to the high-speed count value, the motor will rotate once as many high-speed count values as the PLC receives. The full closed-loop pulse ratio is the ratio of SFD3006 + 60 * (n-1) and SFD3004 +

					60 * (n-1). The denominator is the pulses per revolution of the servo motor. By default, the numerator can be set to 131072 (consistent with the number of pulses per revolution of the servo), and the full closed-loop pulse ratio is 1:1. SD2014 is consistent with the setting HSCD [2 * I] value
SFD3028 +60*(N-1)	High speed counter setting corresponding to full closed loop	16-bit integer		0	0：HSC0 1：HSC2 .....
SFD3052 +60*(N-1)	Initial value of full closed loop position gain	Floating number		0	When the servo is enabled, this register value will be assigned to SD2052 + 60 * n
SFD3058 +60*(N-1)	Full closed loop position deviation limit	Floating number		0	Deviation limit value of full closed-loop command and feedback

Address	Definition	Type	Unit	Note
SD2052+ 60*(N-1)	Full closed loop position gain	Floating number		This parameter can adjust the speed of acceleration process, that is, the speed of response command. It is recommended to take the ratio of servo pulse and full closed-loop high-speed count as the initial value, and then slowly increase to debug. The smaller the gain, the slower the full closed-loop response, the larger the deviation between the instruction and the feedback, and even cause the alarm of position deviation (the limit value of position deviation is SFD2058 + 60 * n floating-point data type); if the gain is too large, vibration and overshoot will occur. Set a suitable gain as needed.

(3) State quantity

Address	Definition	Type	Unit	Note
SD2014 +60*(N-1)	Current full closed loop position	32-bit integer	Pulse number	Coordinate position is converted from the pulse number of full closed-loop position feedback. When SFD3006 + 60 * n is 131072, this value is completely consistent with the value of high-speed counting.

Address	Definition	Type	Unit	Note
HSD112+20*(N-1)	full closed loop position feedback pulses	64-bit integer	Full closed loop encoder count	The full closed-loop (end) encoder (grating scale) counting as a unit, relative to the zero position

(4) Example

There is a thread rod device, the servo motor at one end of the screw rod drives the slider, and the position of the screw rod is fed back through the bound encoder counting. The slider is required to realize high-precision positioning through the encoder counting, and adjust the full closed-loop state to the best state.

Steps:

① Select the first axis as the motion axis, and set the basic parameters of the full closed loop:

SFD3006: 131072. Indicates that SD2014/HSD112 is consistent with the set HSCD[2 * I] at this time;

SFD3028: 0. Indicates the HSC0 of the first high-speed counter at this time;

SFD3052: 200. The initial gain value can be given a moderate value first. If the initial value of gain is too small, the position deviation will be reported, and if it is too large, the overshoot will cause large vibration;

SFD3058: 1000. Given deviation limit value 1000.

②Confirm whether the current servo state meets the working conditions:

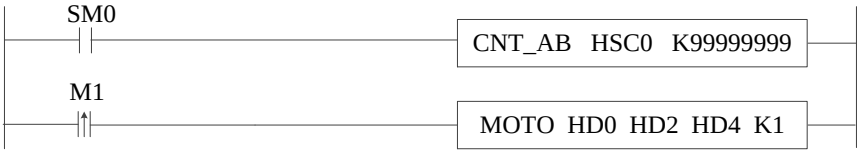
SD2000=2

SM2000=ON

SM2001=OFF.

After the above conditions are met, turn on the coil SM2016, and confirm that SFD3052 has been written into SD2052; and the value of HSD112/SD2014 is the same as that of HSCD0.

③ In the fully closed-loop state, MOTO and MOTOA motion instructions are supported. MOTO is used as reference, and CNT_AB instruction of corresponding channel are written in the program. At this time, the unit of target position set by the instruction is based on the position unit of position sensor (i.e. the count of SD2014 + 60 * (n-1) or HSCD[2 * I]), and the position of servo motor is only used as reference.



④ Execute the MOTO instruction, if the motor does not operate in the ideal state, adjust the SFD3052 value, enable SM2016 again, and then observe whether the motor operates in the best state.

Note: please write SFD value in non motion state.

(5) Phenomenon diagnosis and treatment

When using full closed-loop function, the problem can be solved by observing the error type of SD2002 + 60 * (n-1). If SD2002 + 60 * (n-1) reports position deviation, it may be one of the following situations:

- SFD3052+60*(N-1) The position gain setting value is too small;
- SFD3058+60*(N-1) The deviation limit value is set too small;
- Set too high pulse frequency for MOTO or MOTOA command;
- The positive direction of high-speed counting is inconsistent with the motor's moving direction; processing method: the moving direction is consistent by modifying the value of SFD3047 + 60 * (n-1).
- The current device / The mechanical principle of the equipment does not meet the full closed-loop operation conditions. (whether the grating ruler or encoder synchronizes the current axis correctly)

5-3. System coil and register

The instruction refresh cycle is set according to the EtherCAT synchronization unit cycle and must be consistent with the synchronization unit cycle setting. For example, SFD2990 is set to 1000 when the period of synchronization unit of 32 axis system is set to 1000 μs.

Address	Definition	Initial value	Note
SFD2990	Instruction refresh cycle (unit: us)	1000	The set value is consistent with the current synchronization unit cycle of EtherCAT. Set value range: 500, 1000, 2000, 4000.
SFD2991	Slave station number	32	
SFD2992	Error retry time	3	

Note: if SFD2990 does not keep the same cycle with the synchronization unit, the correct operation cannot be guaranteed.

Each axis of the motion instruction corresponds to a set of motion parameters. Currently, it supports 32 axes. The following table corresponds to the axis parameter address, and N represents the axis number.

Table 5-3-1: basic parameter（N=1~32）

Address	Definition	Type	Unit	Initial value	Note
SFD3000 +60*(N-1)	Operation mode	16-bit integer		0	0: position control with trajectory planning 1: Interpolation position mode
SFD3001 +60*(N-1)	motor encoder type	16-bit integer			1: Incremental encoder 2: Single turn absolute encoder 3: Multi turn absolute encoder
SFD3002 +60*(N-1)	Encoder ppr/1 turn	32-bit integer		131072	The counter value fed back by the encoder rotated for one turn, and the register is set according to the actual number of motor encoder lines. (if the motor encoder is a 17-bit encoder, the register is set to the 17th power of 2, which is 131072)
SFD3004 +60*(N-1)	Moving quantity/1 turn	32-bit integer	Pulse number	131072	The reference equivalent of motion (lead of screw rod). If the parameter unit is pulse number, it is based on the reference of displacement. The setting number of pulses is required for one revolution of the motor. This register is set to the number of pulses, then the PLC sends as many pulses as the motor turns one circle.
SFD3006 +60*(N-1)	Full closed-loop pulse ratio numerator	16-bit integer		0	The numerator is high-speed count and motion equivalent pulse ratio, and denominator is the number of pulses per revolution of servo motor. By default, they can be set to SFD3004 + 60 * (n-1)

					(the same as the number of pulses per revolution of servo motor). At this time, SD2014 is consistent with the set high speed count value HSCD [2 * i].
SFD3010 +60*(N-1)	Origin position	64-bit integer		0	After performing the operation of returning to the original point, the system will automatically assign the value to SD2008 + 60 * (n-1) for setting the original point position
SFD3014 +60*(N-1)	Minimum position limit	32-bit integer	Pulse number	-1000000000	Minimum soft limit position setting. If the current position SD2008 + 60 * (n-1) is less than this value, SD2002 + 60 * (n-1) will generate 20002 alarm, indicating the minimum soft limit over travel.
SFD3016 +60*(N-1)	Maximum position limit	32-bit integer	Pulse number	1000000000	Maximum soft limit position setting. If the current position SD2008 + 60 * (n-1) is greater than this value, SD2002 + 60 * (n-1) will generate 20001 alarm, indicating the maximum soft limit over travel.
SFD3018 +60*(N-1)	Maximum speed limit	32-bit integer	Pulse number/s	6553600	Set according to the maximum speed or rated speed of the motor. Exceeding the maximum speed limit will move at the maximum speed.
SFD3020 +60*(N-1)	Maximum acceleration time	32-bit integer	ms	10	PLC will automatically calculate the acceleration slope according to the set acceleration and deceleration time and calculate the time from 0 to the highest speed with this slope. If the deceleration time from 0 to the maximum speed limit is less than the maximum acceleration time, the movement will be based on the maximum acceleration time. Cannot be set to a value of 0 or less.
SFD3022 +60*(N-1)	Maximum deceleration time	32-bit integer	ms	10	PLC will automatically calculate the deceleration slope according to the set acceleration and deceleration time, and calculate the time from the highest speed to 0 during deceleration based on the slope. If the time from the maximum speed limit to 0 is less than the maximum deceleration time, it will move according to the maximum acceleration time.
SFD3024 +60*(N-1)	Inching step initial value	32-bit integer	Pulse number	100	When enabled, the PLC will jog at this step by default.
SFD3026 +60*(N-1)	Inching speed initial value	32-bit integer	Pulse number/s	1000	When enabled, the PLC will jog at this speed by default.

SFD3028 +60*(N-1)	High speed counter setting corresponding to full closed loop	16-bit integer		0	
SFD3029 +60*(N-1)	Upper limit of position feedback deviation	16-bit integer		2500	Positive integer: upper deviation value -1: Deviation value ignored
SFD3034 +60*(N-1)	Minimum limit terminal setting	16-bit integer		0xFF	Specify the number of the minimum electrical limit x terminal, 0xFF is no terminal, and negative number indicates anti logic. Note: the positive logic of X0 is set to 0, and the negative logic is set to - 30000.
SFD3035 +60*(N-1)	Maximum limit terminal setting	16-bit integer		0xFF	Specify the number of the maximum limit x terminal, 0xFF is no terminal, and a negative number indicates anti logic. Note: the positive logic of X0 is set to 0, and the negative logic is set to -30000.
SFD3036 +60*(N-1)	Near point signal terminal setting	16-bit integer		0xFF	Specify the number of the X terminal of the near point signal, 0xFF is no terminal, and a negative number indicates anti logic. Note: the positive logic of X0 is set to 0, and the negative logic is set to -30000.
SFD3037 +60*(N-1)	Origin terminal setting	16-bit integer		0xFF	Specify the number of X terminal of origin signal, 0xFF is no terminal, and negative number indicates anti logic. Note: the positive logic of X0 is set to 0, and the negative logic is set to -30000.
SFD3038 +60*(N-1)	Return to origin mode	16-bit integer		0	0: no z-phase mode. Find the near point according to the regression speed VH, then find the origin according to the regression speed VL, find the edge of the origin, then slow down, and then find the edge of the origin according to the crawl speed in reverse; 2: Z-phase mode. Find the approach point according to the regression speed VH, then find the origin point according to the regression speed VL, find the edge of the origin point, then decelerate, then find the edge of the origin point according to the crawl speed in reverse, and then find the Z phase of the servo encoder along the positive direction 10: Hard limit return mode. When the

					positive and negative hard limits are met, the origin will be found in reverse at -VH speed, and the speed changes to VH when touching the origin falling edge, and the subsequent action is the same as mode 0. 12: hard limit return z-phase mode. When the positive and negative hard limits are met, the origin will be found in reverse at -VH speed, and the speed will change to VH when touching the falling edge of origin signal, and the subsequent action is the same as mode 2.
SFD3040 +60*(N-1)	Regression speed VH	32-bit integer	Pulse number/s	0	The high speed of the origin regression speed.
SFD3042 +60*(N-1)	Regression speed VL	32-bit integer	Pulse number/s	0	The low speed of the origin return speed.
SFD3044 +60*(N-1)	Crawling speed	32-bit integer	Pulse number/s	0	Slow crawling speed of origin return.
SFD3047 +60*(N-1)	Motion direction logic	16-bit integer		0	Motion direction logic. 0 positive logic, that is, the command speed is positive, the motor is rotating forward, the command speed is negative, and the motor is reversing. 1 is negative logic, i.e. the instruction speed is positive, the motor reverses, the instruction speed is negative, and the motor rotates forward.
SFD3048 +60*(N-1)	Initial value of positioning completion width	32-bit integer	Pulse number	20	Initial value of positioning completion width. When the target instruction and the actual encoder feedback are within the width, PLC will have the positioning completion signal, and there is no need to wait until the movement stops completely.
SFD3052 +60*(N-1)	Initial value of full closed loop position gain	32-bit floating number			When the servo is enabled, this register value will be assigned to SD2052 + 60 * (n-1)
SFD3058 +60*(N-1)	Full closed loop position deviation limit	32-bit floating number			Deviation limit value of full closed-loop command and feedback

During the operation of the motor, the PLC status can be monitored through the following registers:

Table 5-3-2: status quantity parameter（N=1~32）

Address	Definition	Type	Unit	Note
SD2006+60*(N-1)	Current displacement	32-bit integer	Pulse number	The displacement relative to the last stop position, i.e. the displacement in this instruction
SD2008+60*(N-1)	Current position	32-bit	Pulse	Absolute position, converted from the

		integer	number	actual feedback pulse number of the motor
SD2010+60*(N-1)	Current speed	32-bit integer	Pulse number/s	Calculation of actual feedback speed of motor
SD2012+60*(N-1)	Instantaneous speed setting	32-bit integer	Pulse number/s	Speed given value of current control cycle
SD2014+60*(N-1)	Current full closed loop position	32-bit integer	Pulse number	The absolute position of full closed loop is converted from the pulse number of full closed loop position feedback. When SFD3006 + 60 * (n-1) and SFD3004 + 60 * (n-1) are the same, this value is completely consistent with the value of high-speed counting.
SD2016+60*(N-1)	Current segment (indicates segment n)	32-bit integer		

Table 5-3-3: setting value parameter（N=1~32）

Address	Definition	Type	Unit	Note
SD2030+ 60*(N-1)	Position setting	32-bit integer	Pulse number	Coordinate position, which is converted by the number of pulses given by the target position. Modify the set value of this position, and the motor will move to the set position according to the set speed (SD2032 + 60 * (n-1)).
SD2032+ 60*(N-1)	Speed setting	32-bit integer	Pulse number/s	
SD2034+ 60*(N-1)	Acceleration time	32-bit integer	ms	The time accelerating from 0 to the max speed
SD2036+ 60*(N-1)	deceleration time	32-bit integer	ms	the time decelerating from the max speed to 0
SD2038+ 60*(N-1)	Synchronous motion speed ratio	32-bit integer		Tracking axis speed / tracked axis speed
SD2040+ 60*(N-1)	Jog step length	32-bit integer	Pulse number	When the servo is enabled, the system will automatically assign SFD3024 + 60 * (n-1) as the initial value to this register. After the servo is enabled, the register value can be modified online in real time.
SD2042+ 60*(N-1)	Jog speed	32-bit integer	Pulse number/s	When the servo is enabled, the system will automatically assign SFD3026 + 60 * (n-1) as the initial value to this register. After the servo is enabled, the register value can be modified online in real time.
SD2044+ 60*(N-1)	Positioning complete width	32-bit integer	Pulse number	Determine the threshold value of positioning completion. If the difference between the given value and the feedback value of the encoder is less than the value, the moving flag is off. When the servo is enabled, the system will automatically assign SFD3048 + 60 * (n-1) as the initial value to the register. After the servo is enabled, the register value can be modified online in real time.
SD2052+	full closed loop	32-bit		This parameter can adjust the speed of acceleration

60*(N-1)	position gain	floating number		process, that is, the speed of response command. It is recommended to take the ratio of servo pulse and full closed-loop high-speed count as the initial value, and then slowly increase to debug. The smaller the gain, the slower the full closed-loop response, the larger the deviation between the instruction and the feedback, and even cause the alarm of position deviation (the limit value of position deviation SFD2058 + 60*n is floating-point data type); if the gain is too large, vibration and overshoot will occur. Set a suitable gain as needed. When the full closed-loop is enabled, the system will automatically assign SFD3052 + 60 * (n-1) as the initial value to the register. After the full closed-loop is enabled, the value of the register can be modified online in real time.
SD2059 +60*(N-1)	Synchronous motion filter coefficient	32-bit integer		Range: 0~9999.

Table 5-3-4: self-hold status parameter（N=1~32）

Address	Definition	Type	Unit	Note
HSD100+20*(N-1)	Given pulse number of target position	64-bit integer	Encoder counting	Encoder count value relative to absolute zero
HSD104+20*(N-1)	target position feedback pulse number	64-bit integer	Encoder counting	Encoder count value relative to absolute zero
HSD108+20*(N-1)	current displacement pulse number	64-bit integer	Encoder counting	Count value relative to the starting encoder position of the current motion instruction
HSD112+20*(N-1)	full closed loop position feedback pulse number	64-bit integer	Full closed loop encoder counting	The total closed-loop (end) encoder (grating scale) counting is the unit, relative to the zero position

Table 5-3-5: status bit parameter（N=1~32）

Address	Definition	Note
SM2000+20*(N-1)	servo enable flag	ON: servo is enabled
SM2001+20*(N-1)	moving flag	ON: Pulse is outputting. It is set to off as soon as the movement stops.
SM2003+20*(N-1)	instruction complete flag	ON: Command execution completed. Set off at the beginning of instruction execution.
SM2004+20*(N-1)	axis error flag	ON: error
SM2005+20*(N-1)	min limit status	ON: The current position is less than the minimum position limit or the minimum limit signal
SM2006+20*(N-1)	max limit status	ON: The current position is greater than the maximum position limit or the maximum limit signal
SM2009+20*(N-1)	slave axis binding flag	ON: The current axis is bound

Table 5-3-6: control bit parameter（N=1~32）

Address	Definition	Note
SM2010+20*(N-1)	Servo enable	ON: servo enable OFF: servo disable
SM2011+20*(N-1)	Jog forward	After enabling, the system will reset automatically
SM2012+20*(N-1)	Jog reverse	After enabling, the system will reset automatically
SM2013+20*(N-1)	Clear servo alarm	After enabling, the system will reset automatically
SM2014+20*(N-1)	Forward return to origin	After enabling, the system will reset automatically
SM2015+20*(N-1)	Reverse return to origin	After enabling, the system will reset automatically
SM2016+20*(N-1)	full closed loop enable	Set on: switch the system to the full closed-loop motion state, and the execution of motion instructions shall be subject to the high-speed counting position. The operation will take effect in 50ms at most. Set off: switch the system from full closed-loop motion state to normal motion state, i.e. the execution of motion command is subject to the position of servo encoder. The operation will take effect in 50ms at most.
SM2017+20*(N-1)	deceleration stop motion	After enabling, the system will reset automatically

5-4. Error and state information

During the movement, some errors may occur. Refer to table 5-4-1 for specific error and status information code.

Table 5-4-1: control bit parameter（N=1~32）

Address	Definition	Value	Explanation	Internal operation mode	Solution
SD2000 +60*(N-1) (single word)	Servo state	0	Cut off		Check the communication wiring between servo and PLC
		1	READY		
		2	ON		
SD2002 +60*(N-1) (double word)	Error information	20001	Maximum soft limit over travel	Emergency stop	The alarm flag and code can be cleared manually when reverse jogging out of the over travel area
		20002	Minimum soft limit over travel	Emergency stop	The alarm flag and code can be cleared manually when reverse jogging out of the over travel area
		20003	Maximum electrical limit over travel	Emergency stop	The alarm flag and code can be cleared manually when reverse jogging out of the over travel area
		20004	Minimum electrical limit over travel	Emergency stop	The alarm flag and code can be cleared manually when reverse jogging out of the over travel area
		20005	Overspeed alarm	Deceleration stop	Reduce command target speed

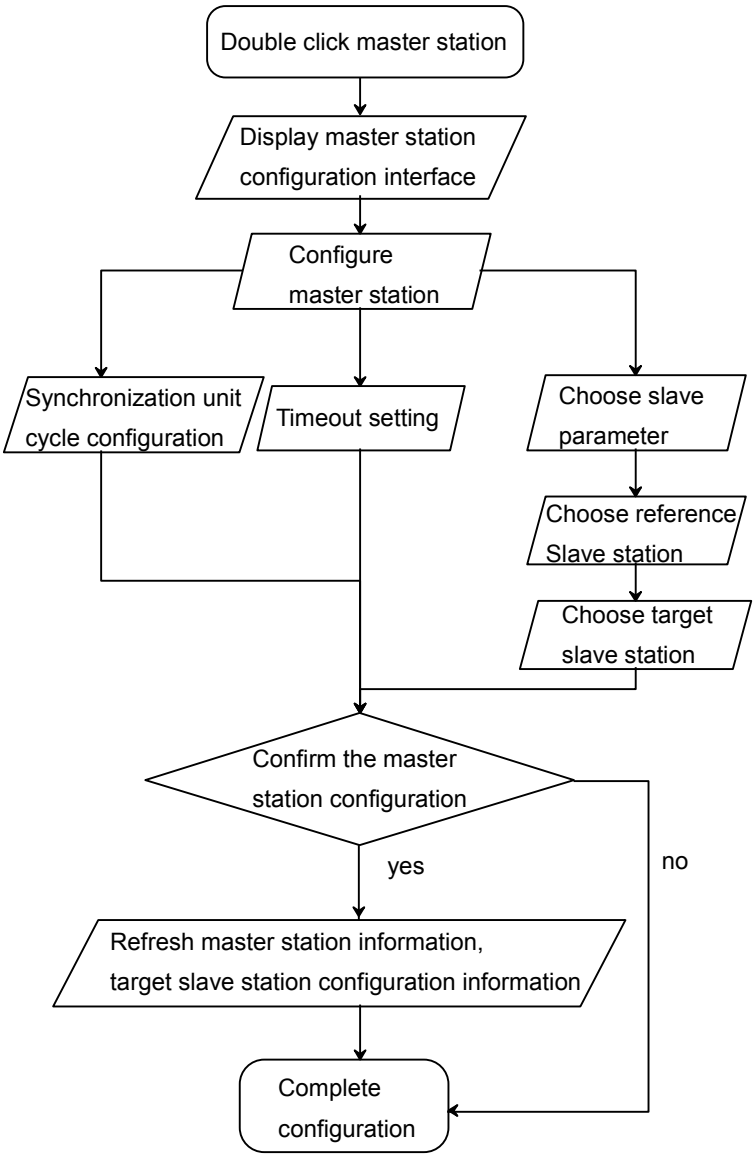
		20006	Position deviation alarm	Emergency stop, turn off the enable	Check whether the servo P0-05 is set correctly. The correct setting should be 0. Check whether the machine has locked rotor which causes excessive deviation of position command and position feedback. After elimination, enable it again
		20010	Servo alarm	Emergency stop, turn off the enable	The servo alarm information can be cleared manually through SM2013 + 20 * (n-1) or F0-00 of the servo panel. The servo alarm information that cannot be cleared needs to be cleared according to the servo manual. After the alarm is cleared, the alarm flag and alarm code can be cleared manually
		20011	servo communication error	Emergency stop, turn off enable, and switch PLC operation state to online download state	Check communication parameter setting and connection of communication
		20020	Movement command target point over range alarm	Invalid execution of motion instruction	Change to a reasonable command target location
		20021	Movement command target speed overrun	Invalid instruction execution	Change to a reasonable command target speed
		20022	Segment number of multi segment motion instruction exceeds the limit	Invalid execution of motion instruction	Change to a reasonable number of segments
		20023	Acceleration and deceleration time of motion command exceeds the limit	Invalid execution of motion instruction	Change to a reasonable acceleration and deceleration time
		20024	Reserved		
		20025	Axis number	Invalid execution	Check command binding axis

			of bound axis is out of limit	of motion instruction	number
		20026	Input point setting of return to zero terminal is out of limit	Cannot return to zero	Check the setting of relevant input points for zero return, including the setting of near point terminal and origin terminal
		20030	The current motion state does not meet the conditions for instruction execution	Invalid execution of motion instruction	Wait until the moving flag bit SM2001 + 20 * (n-1) is off and the servo enabled flag SM2000 + 20 * (n-1) is on before executing the command
		20031	The motion state of the bound axis does not meet the conditions for binding instruction execution	Invalid binding instruction execution	Wait until the flag bit SM2001 + 20 * (n-1) of the bound axis in motion is off and the flag SM2000 + 20 * (n-1) of the servo enable is on before executing the MOSYN command.
		20032	Current axis motion mode setting error SFD3000 + 60 * (n-1) setting error	SM2010 + 20 * (n-1) set on invalid, unable to enable servo	Check whether the single word SFD3000 + 60 * (n-1) is 0. After correction, perform the servo enable operation again.
		20033	Reserved		
		20034	When the user performs the enable operation, the motor is already in the enabled state	The enable operation is invalid	Check the causes of servo enable such as servo enable mode, and execute enable operation again after correction
		20035	Motor type not set	Motor cannot enable	Check the value of register SFD3001 + 60 * (n-1), and after correction, the PLC will run again. SFD3001+60* (N-1) motor type code: 1: Incremental encoder motor 2: Single turn absolute encoder motor 3: Multi turn absolute encoder motor 4: Stepping motor 5: Xinje encoder
		20036	Current home	Current motion	1: Check whether soft limit is

			return failure alarm	stop	touched 2: Is the homing process complete
SD2004 +60*(N-1) (double word)	Number of bus communication error				(1) Check the communication parameters of P7 group of servo driver (2) Check whether the communication wiring between servo and PLC is normal

6. EtherCAT operation process and use cases

6-1. EtherCAT operation flow chart



6-2. EtherCAT bus function

The following table shows the parameters that must be configured under CSP, CSV, CST, PP, PV and TQ modes.

Register	Explanation
RXPDO[0x6040]	The control word must be added to the PDO configuration. In CSP, CSV and CST modes, it is invalid to modify through IO mapping, which is controlled by the NC module
RXPDO[0x6060]	Mode control word, which must be added to PDO configuration, can be modified through IO mapping in task mode
RXPDO[0x607A]	Target location, i.e. program given location, must be added to the PDO configuration
TXPDO[0x6041]	Status word, must be added to PDO configuration
TXPDO[0x6061]	Mode status word, must be added to PDO configuration
TXPDO[0x6064]	Actual location, must be added to PDO configuration
TXPDO[0x606C]	Actual speed, must be added to PDO configuration
SFD2990(PLC register)	Same cycle as EtherCAT synchronization unit

6-2-1. CSP mode

CSP (periodic synchronous position mode), whose movement track is calculated by the upper computer, sends the target position to the slave station periodically.

1. Associated objects

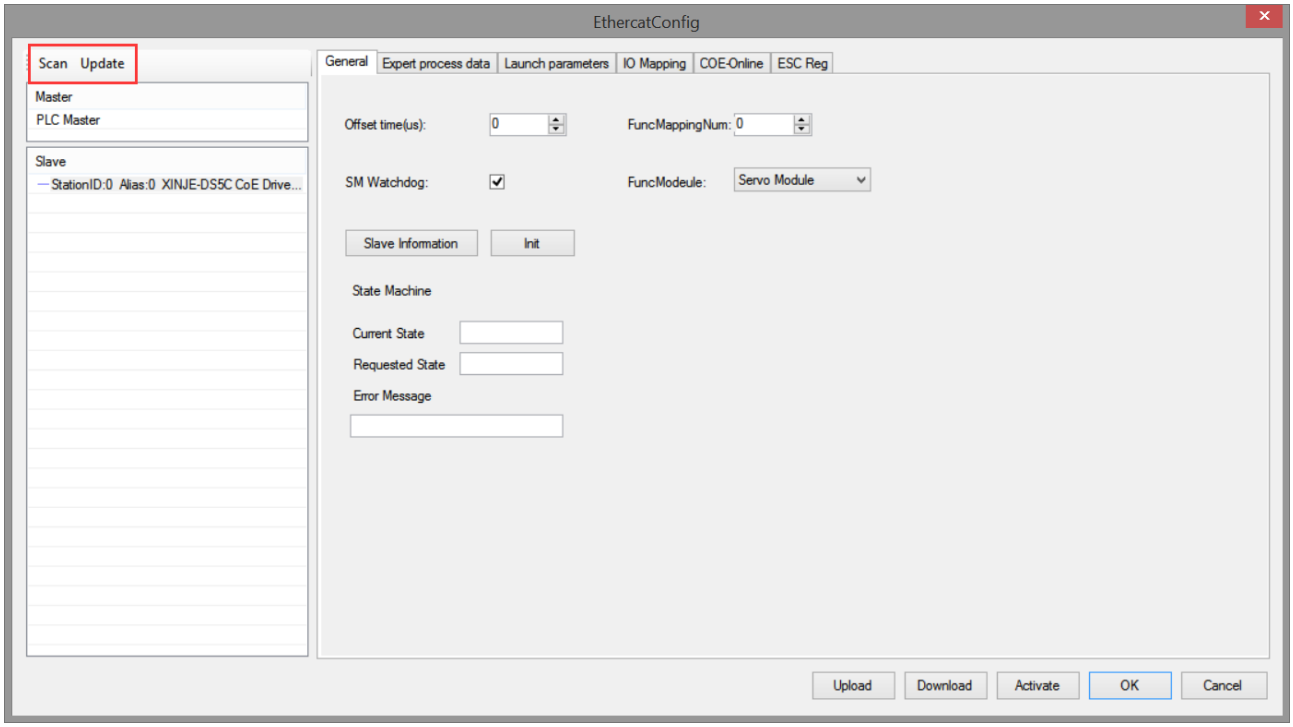
Register	Explanation	Unit
RXPDO[0x607A]	Given the position, it is invalid to modify it through IO mapping in CSP mode, which is controlled by NC module	Command unit
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Speed feedback	Command unit/s
RXPDO[0x6060]	Set to 8	-

2. Position control with trajectory interpolation
SFD3000+60*(N-1) (PLC register): set to 0
In this mode, the original xnet motion control instructions, system coils and registers can be supported (see Chapter 5 of the manual for details)

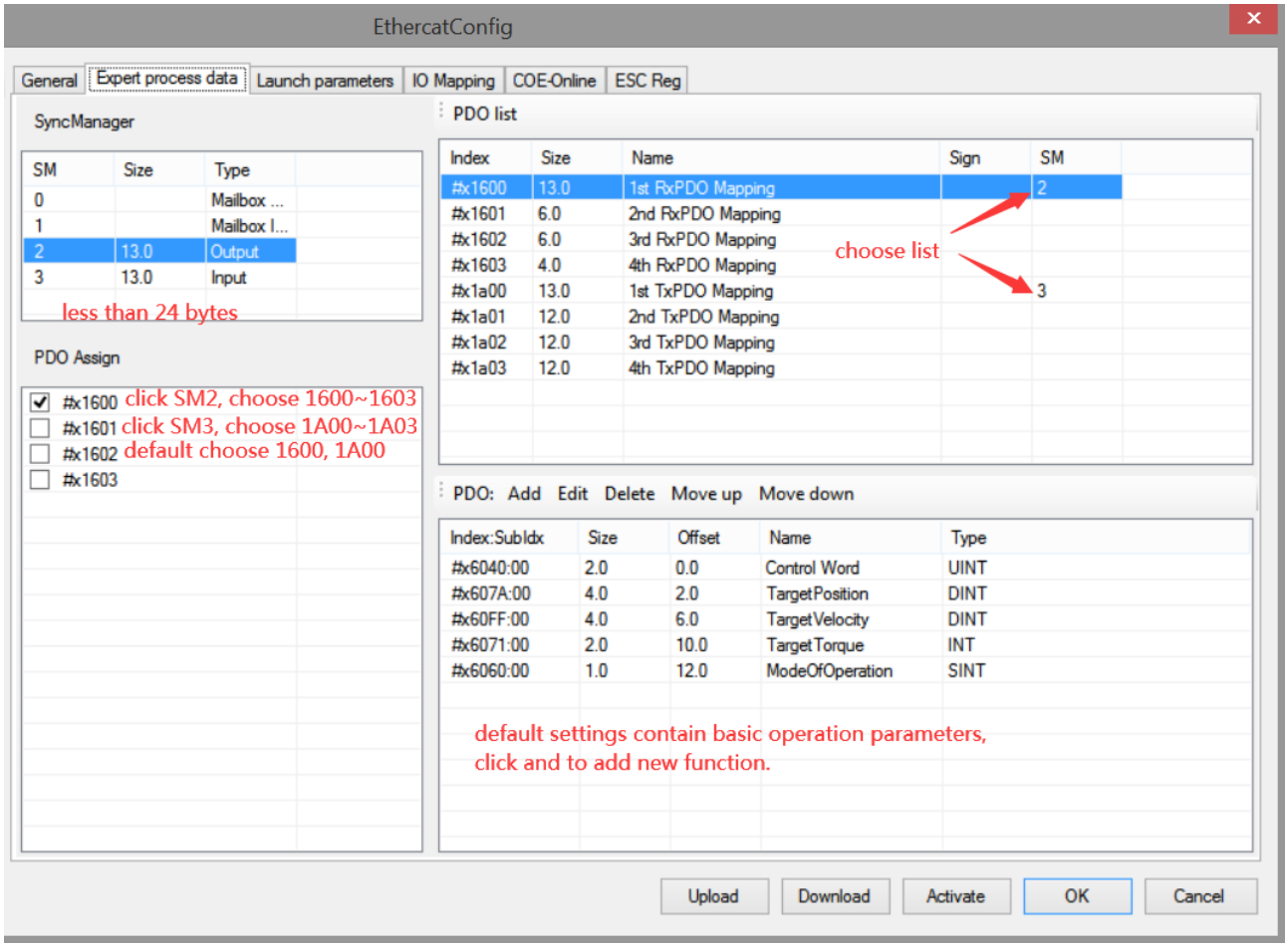
3. Interpolation mode mode
SFD3000+60*(N-1) (PLC register): set to 1
SM1995 (interrupt enable bit): set ON
In this mode, the user-defined interpolation position can be realized by modifying the value of SD2030 + 60 * (n-1) in real time in the I9900 interrupt.

4. Operation example: (take Xinje DS5C servo as an example)
① Click [scan] or [add] slave station on the EtherCAT interface, and the [general] interface uses the

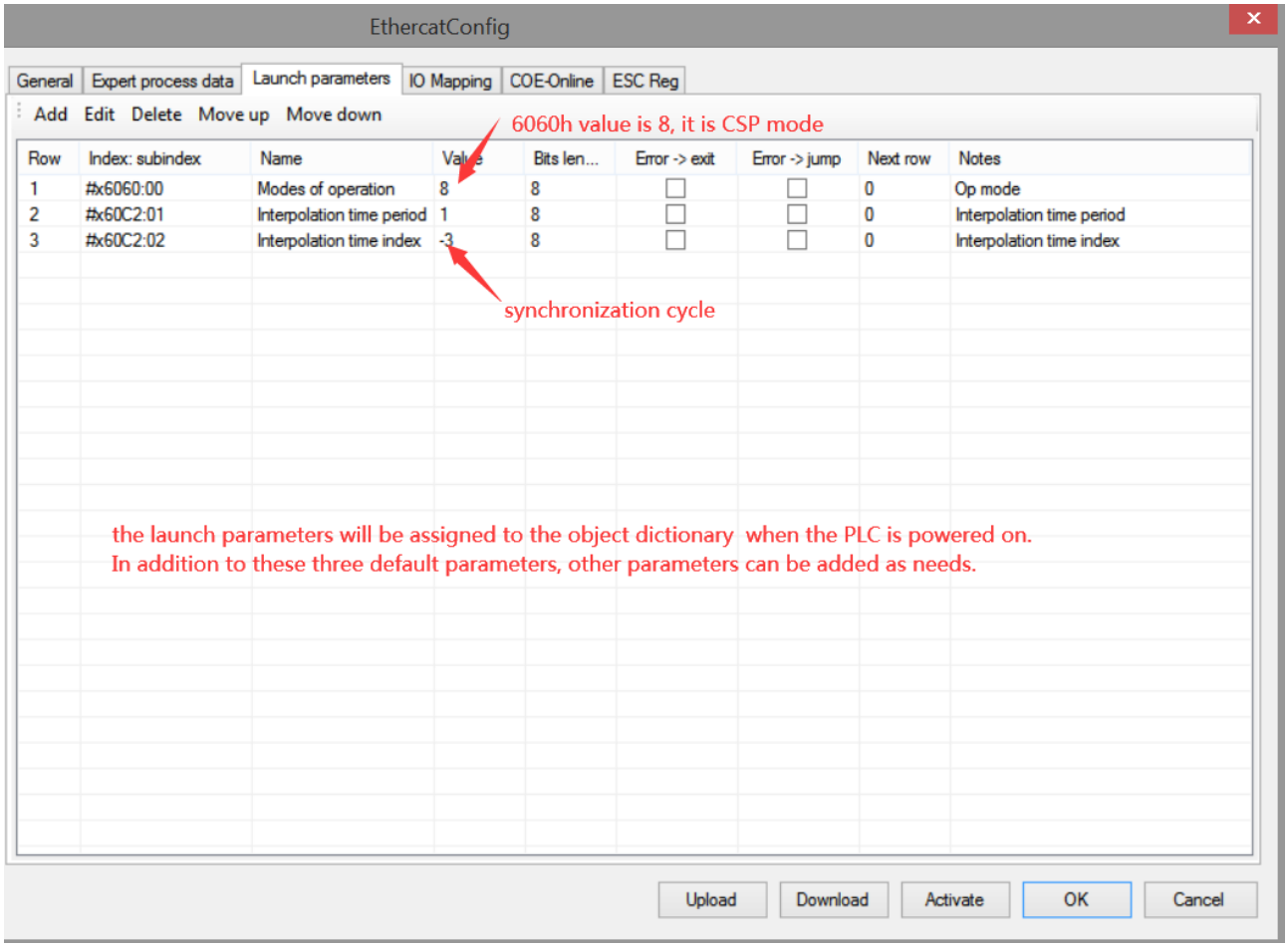
default configuration.



② Select 1600 and 1A00 in [expert process data] → [PDO assign]. (the default configuration can meet the basic use of CSP, and other PDO parameters can be added if necessary.)

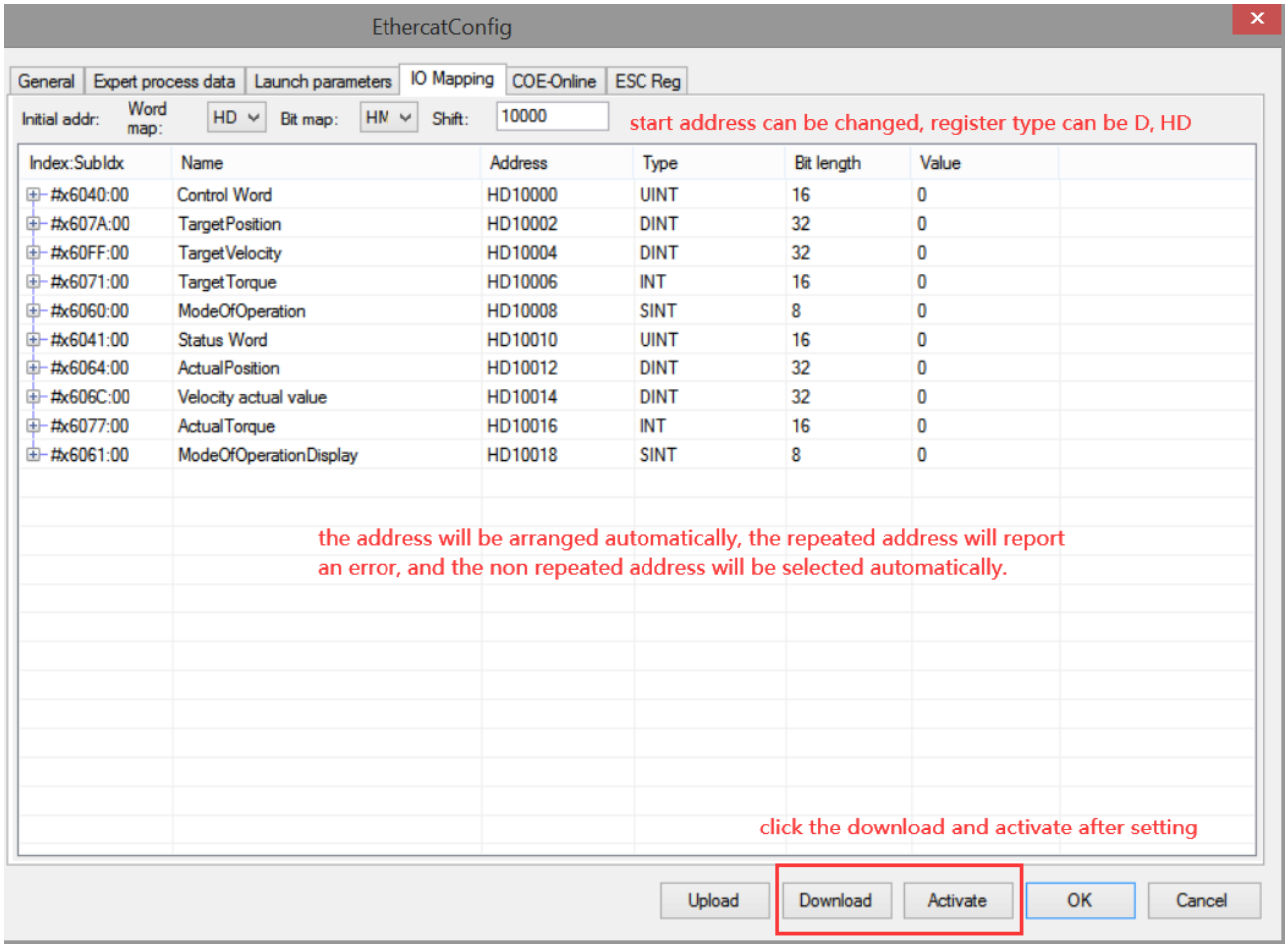


③ Confirm that the 6060h value in [start parameter] is 8.



④ [IO mapping] the default starting address is HD1000, which can be changed if necessary.

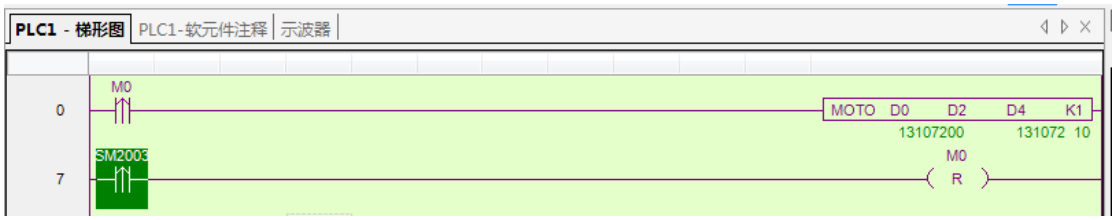
⑤ After parameter configuration, click [download] → [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the op status, at this time, SDO and PDO can receive and send messages.

⑦ SFD3000 is set to 0, SM2010 is set to on to enable the slave station (if set ON SM2010 when power on, the slave will be enabled after master station status SD8000 switches to 8), and the motor is operated by Xnet motion control command (MOTO, MOTOA, etc.).

⑧ In CSP mode, the current given position can be monitored by HD1002 (mapping of 607Ah), the actual position of the current motor can be monitored by HD1012 (mapping of 6064h), and the current actual speed can be monitored by HD1014 (mapping of 606Ch).



寄存器	监控值	字长	进制	注释
HD1008	8	双字	10进制	Station ID:0,#x6060:0
HD1002	28209496	双字	10进制	Station ID:0,#x607A:0
HD1012	28209496	双字	10进制	Station ID:0,#x6064:0
HD1014	60	双字	10进制	Station ID:0,#x606C:0
SM2010	ON	位	-	轴1使能
D0	13107200	双字	10进制	指定轴1的相对位置
D2	131072	双字	10进制	指定轴1的运动速度
D4	10	双字	10进制	指定轴1的加减速时间
SD2008	13107199	双字	10进制	轴1当前位置
HSD104	13107202	双字	10进制	轴1目标位置反馈脉冲数
SFD3000	0	单字	10进制	轴1运行模式
SFD3001	2	单字	10进制	轴1电机类型

6-2-2. CSV mode

CSV (periodic synchronous speed mode) makes the motor run at a constant speed through the speed given by the upper computer.

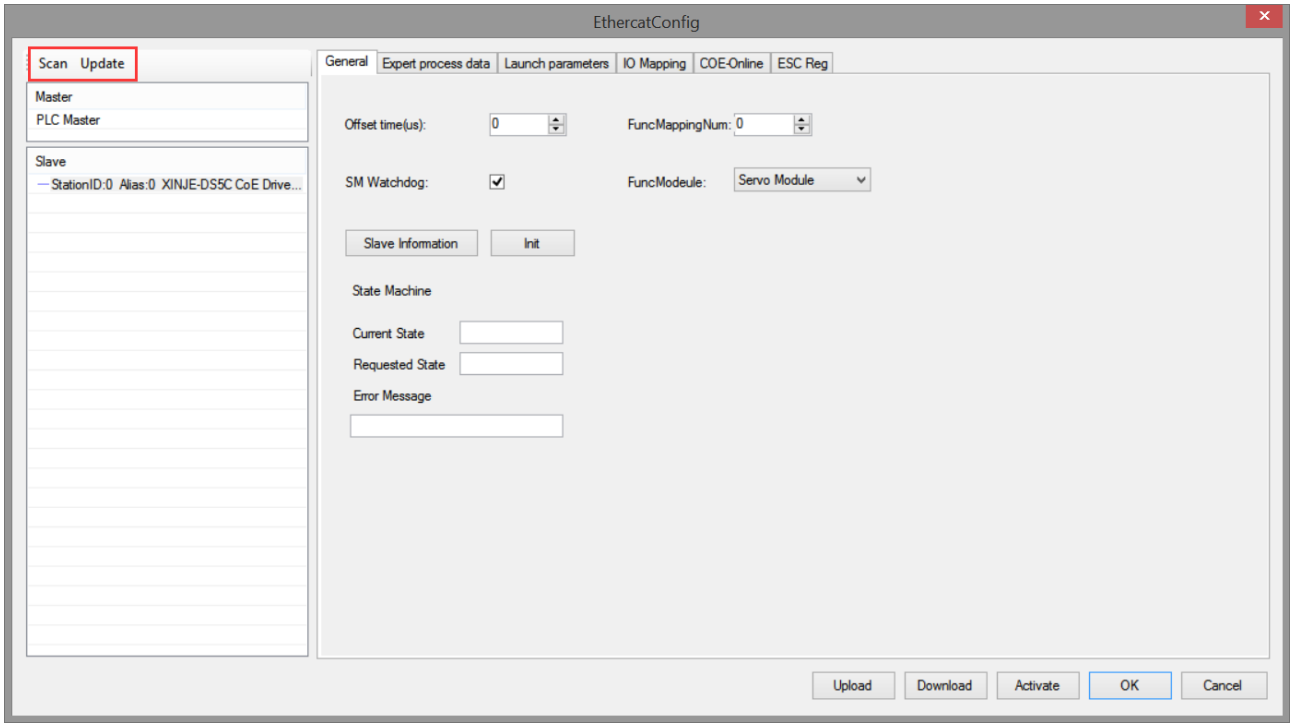
Related parameters

Register	Explanation	Unit
RXPDO[0x60FF]	Set speed	Command unit/s
TXPDO[0x6064]	Position feedback	Command unit
TXPDO[0x606C]	Speed feedback	Command unit/s
RXPDO[0x6080]	Maximum motor speed, which can be limited through online modification of COE-Online	r/min
RXPDO[0x6060]	Set to 9	-
SFD[3029+60*(N-1)]	Set to -1	-

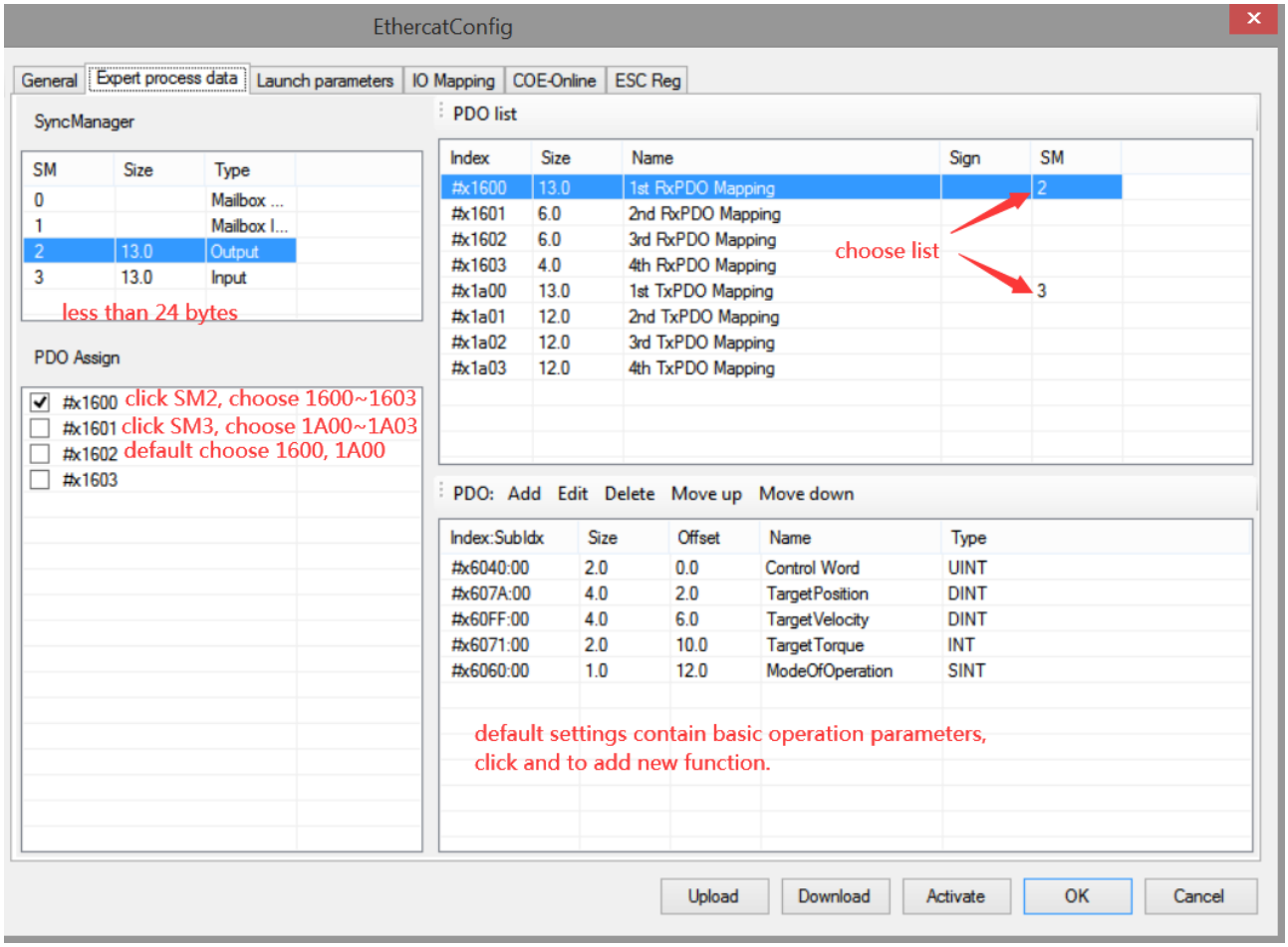
Note: in CSV mode, only the five parameters SM2000 + 20 * (n-1) (servo enable flag), SM2010 + 20 * (n-1) (servo enable), SD2002 + 60 * (n-1) (error message) and SM2013 + 20 * (n-1) (clear servo alarm) in the system coil and register related to master station motion control (not parameters in COE-Online) are valid, and the rest parameters are invalid. (refer to section 5-3 of this manual for details of parameters)

Operation example: (take Xinje DS5C servo as an example)

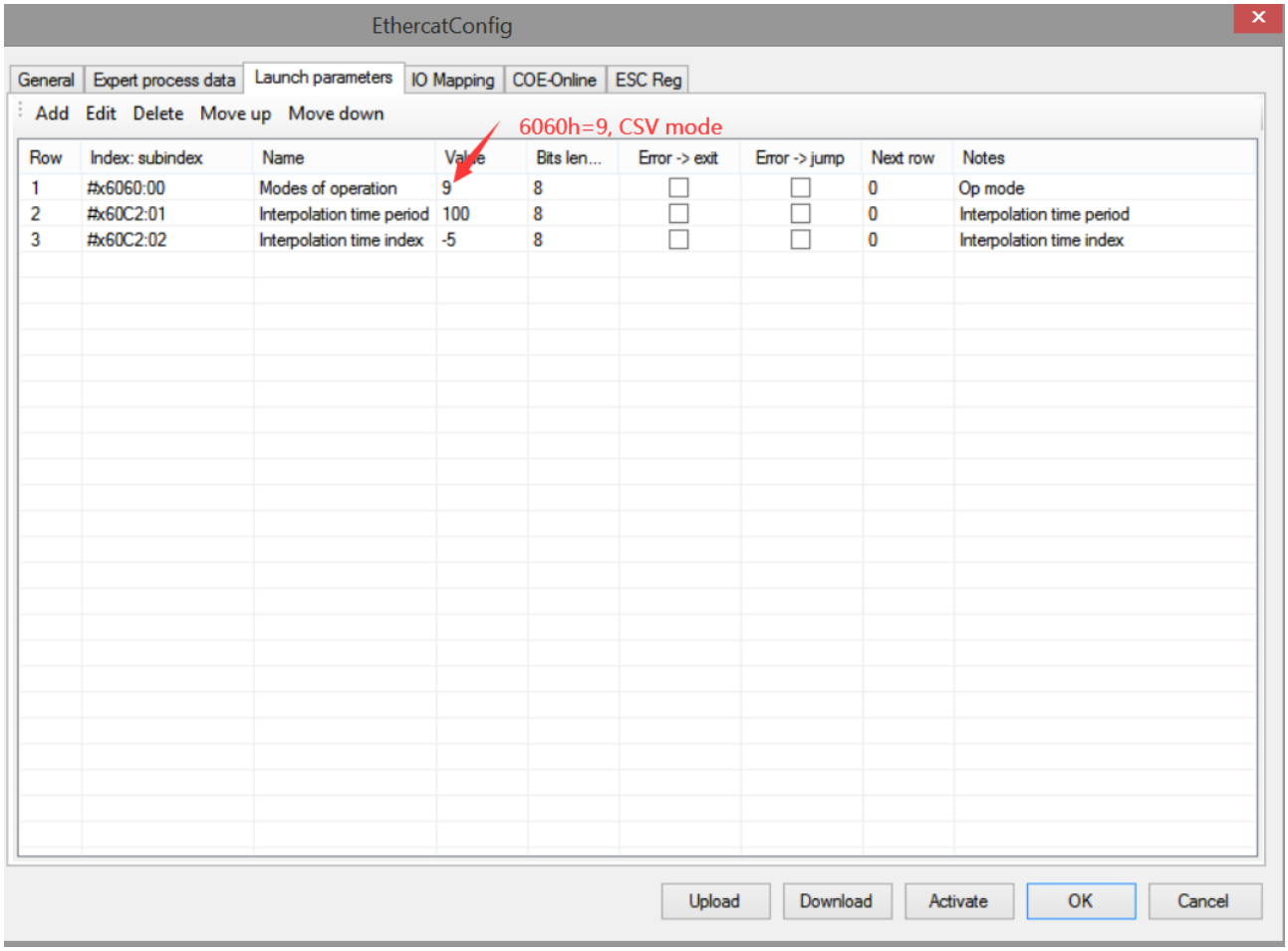
① Click [scan] or [add] slave station on the EtherCAT interface, and the [general] interface uses the default configuration.



② Select 1600 and 1A00 in [expert process data] → [PDO assign]. (the default configuration can meet the basic use of CSV, and other PDO parameters can be added if necessary.)

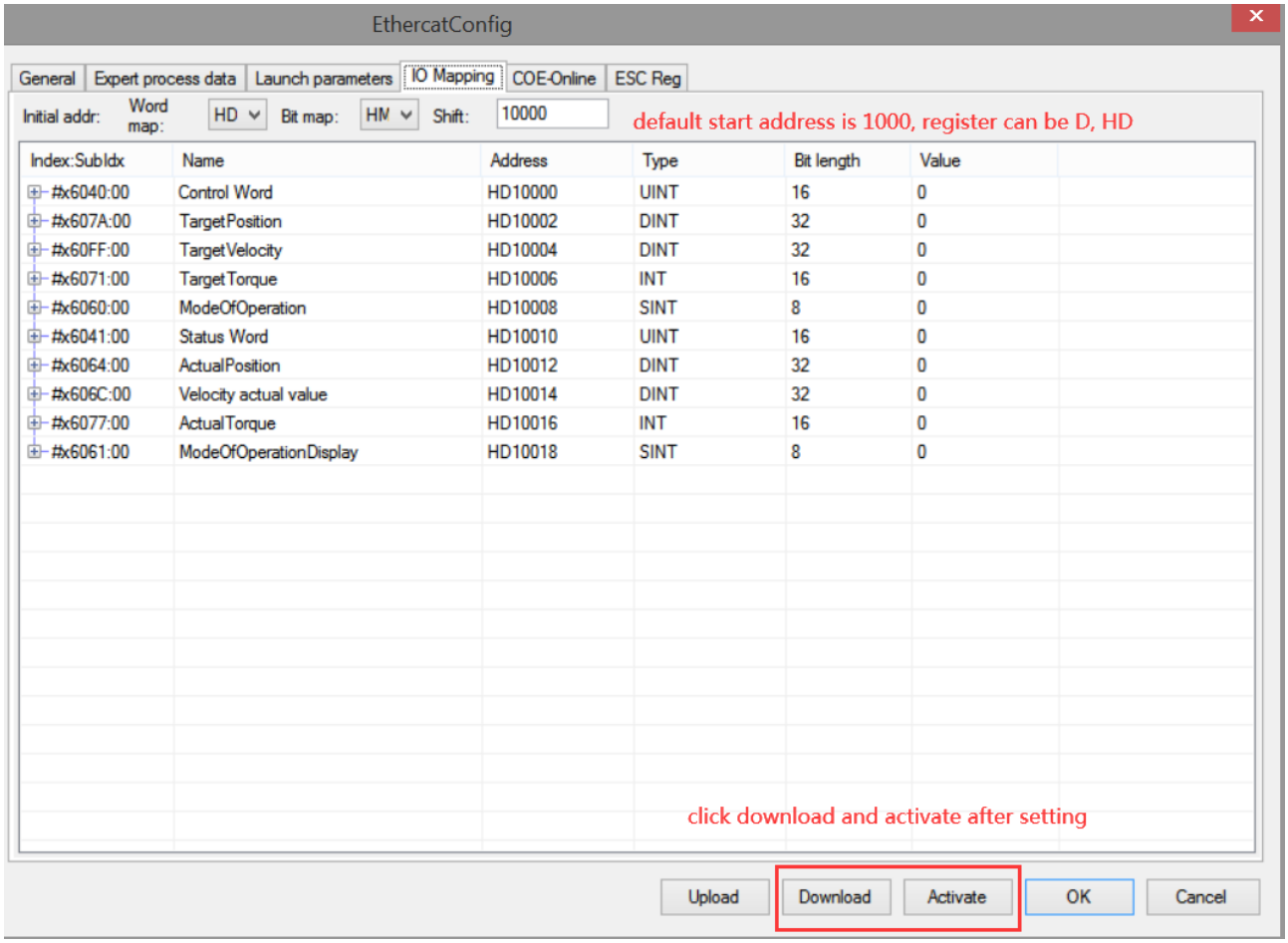


③ Confirm that the 6060h value in [start parameter] is 9.



④ [IO mapping] the default starting address is HD1000, which can be changed if necessary.

⑤ After parameter configuration, click [download] → [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the op status, at this time, SDO and PDO can receive and send messages. After the state is switched to OP, 6080h (maximum motor speed) can be modified through COE-Online.

⑦ After SM2010 is set to on to enable the slave station, HD1004 (mapping of 60FFh) can be assigned as the given speed in CSV mode. (real time speed interpolation can be realized by modifying HD1004 in I9900 interrupt)

⑧ In CSV mode, the current given speed can be monitored by HD1004 (mapping of 60FFh), the actual position of the current motor can be monitored by HD1012 (mapping of 6064h), and the current actual speed can be monitored by HD1014 (mapping of 606Ch).

寄存器	监控值	字长	进制	注释
HD1008	9	双字	10进制	Station ID:0,#x6060:0
HD1004	131072	双字	10进制	Station ID:0,#x60FF:0
HD1012	36426019	双字	10进制	Station ID:0,#x6064:0
HD1014	130440	双字	10进制	Station ID:0,#x606C:0
SM2010	ON	位	-	轴1使能

6-2-3. CST mode

CST (periodic synchronous torque mode) makes the motor run at a constant torque by setting the torque on the upper computer.

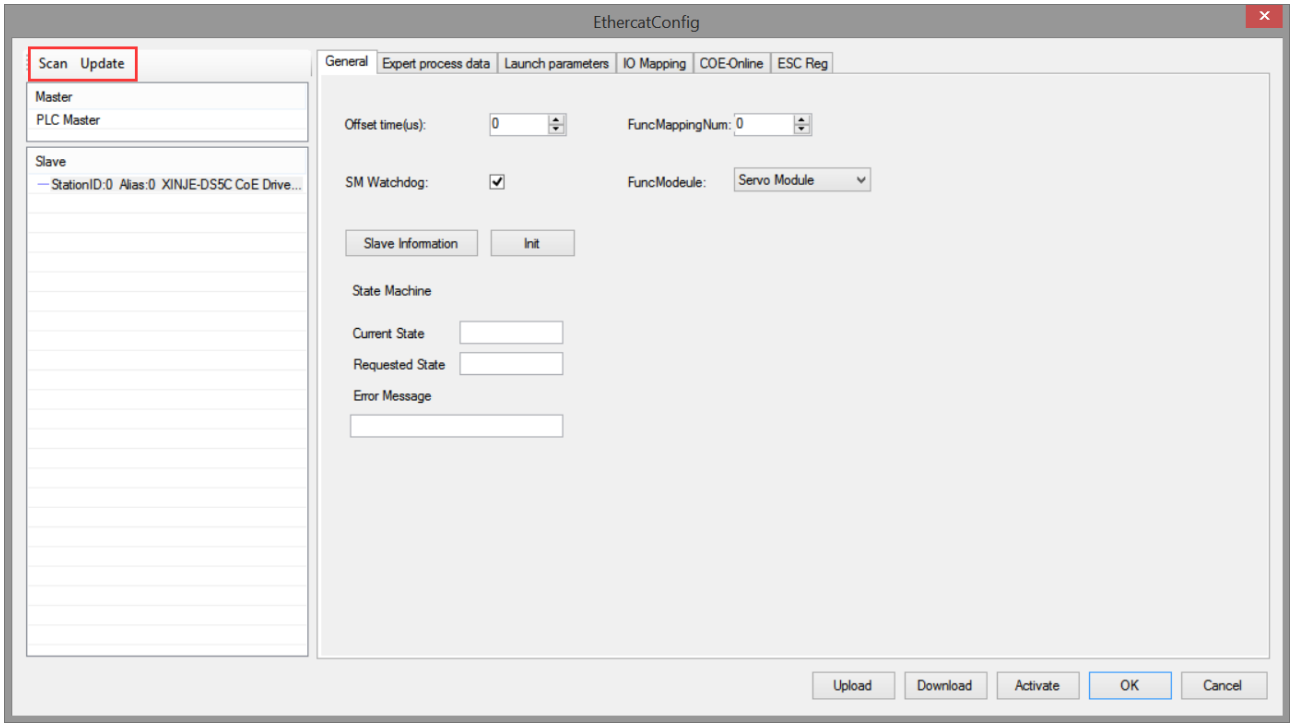
Related parameters

Register	Explanation	Unit
RXPDO[0x6071]	Set torque	0.1%
TXPDO[0x6064]	Position feedback	Command unit
TXPDO[0x606C]	Speed feedback	Command unit/s
TXPDO[0x6077]	Torque feedback	0.1%
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6060]	Set to 10	-
SFD[3029+60*(N-1)]	Set to -1	-

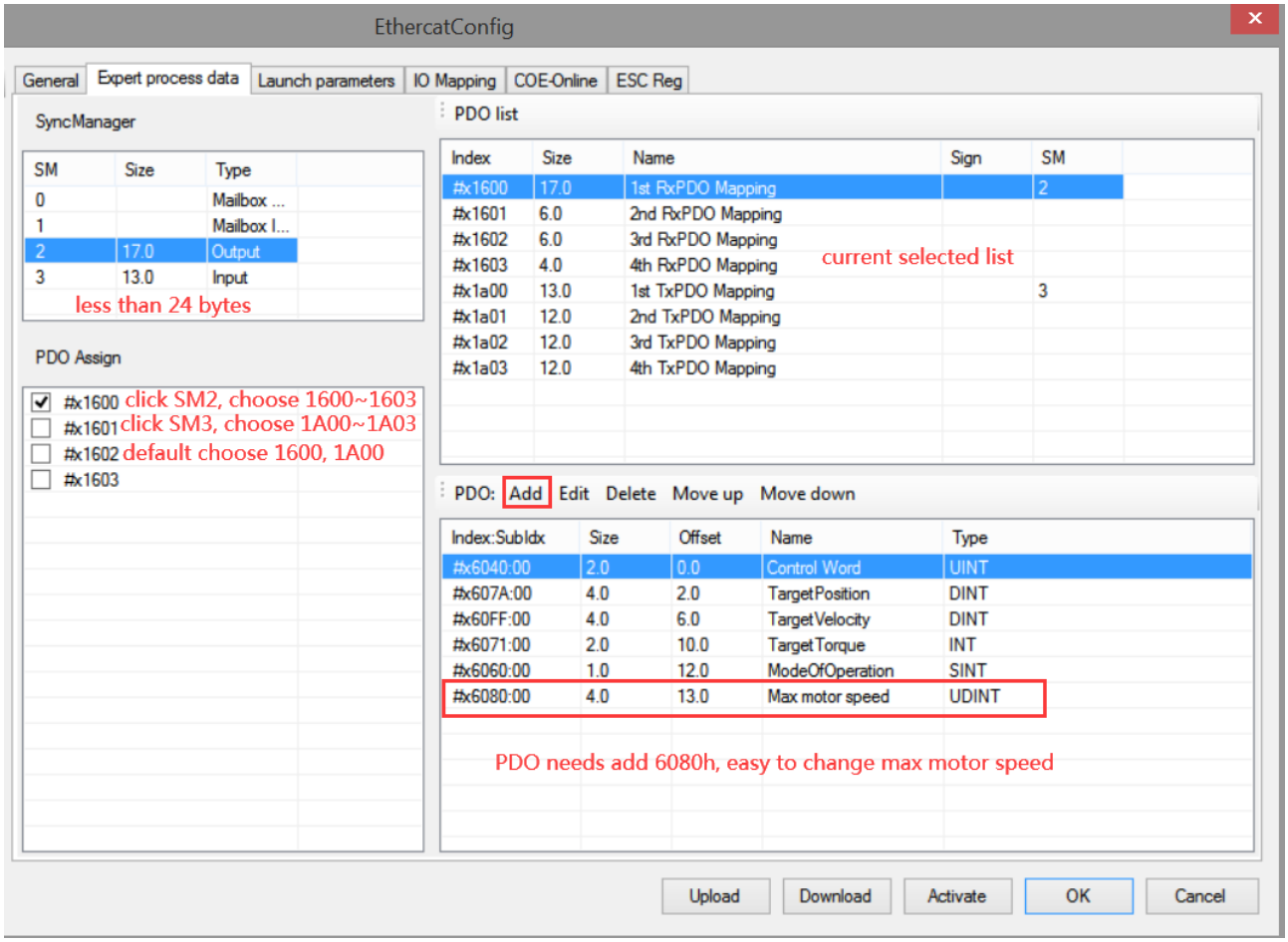
Note: in CST mode, only SM2000 + 20 * (n-1) (servo enable flag), SM2010 + 20 * (n-1) (servo enable), SD2002 + 60 * (n-1) (error message) and SM2013 + 20 * (n-1) (clear servo alarm) are valid in the system coil and register related to master station motion control (not parameters in COE-online), and the other parameters are invalid. (refer to section 5-3 of the manual for details of parameters)

Operation example: (take Xinje DS5C servo as an example)

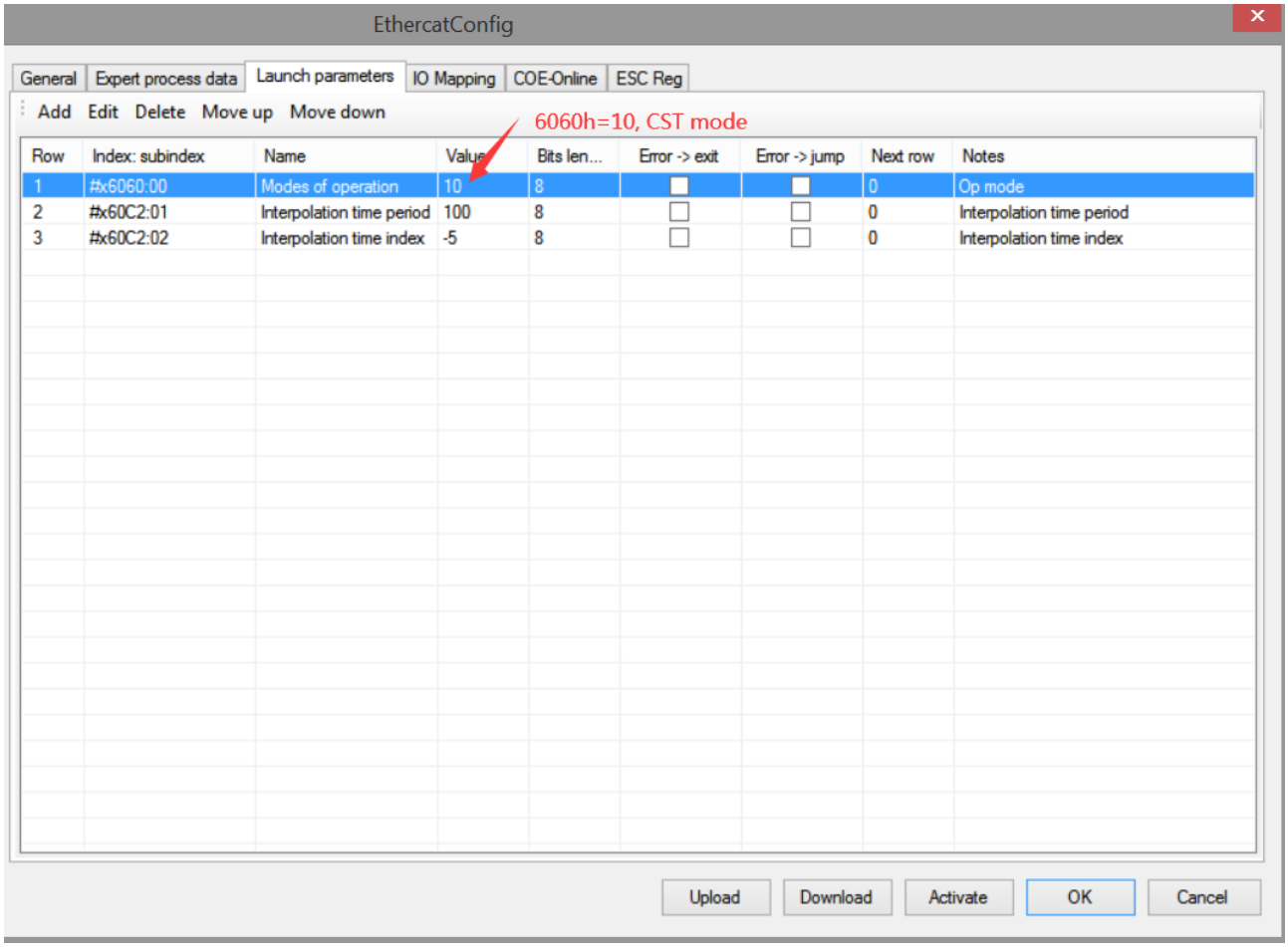
① Click [scan] or [add] slave station on the EtherCAT interface, and the [general] interface uses the default configuration.



② Select 1600 and 1A00 in [expert process data] → [PDO allocation]. The default configuration can meet the basic use of CST. If necessary, add other PDO parameters, such as 6080h in 1600, to facilitate changing the maximum motor speed to limit torque.

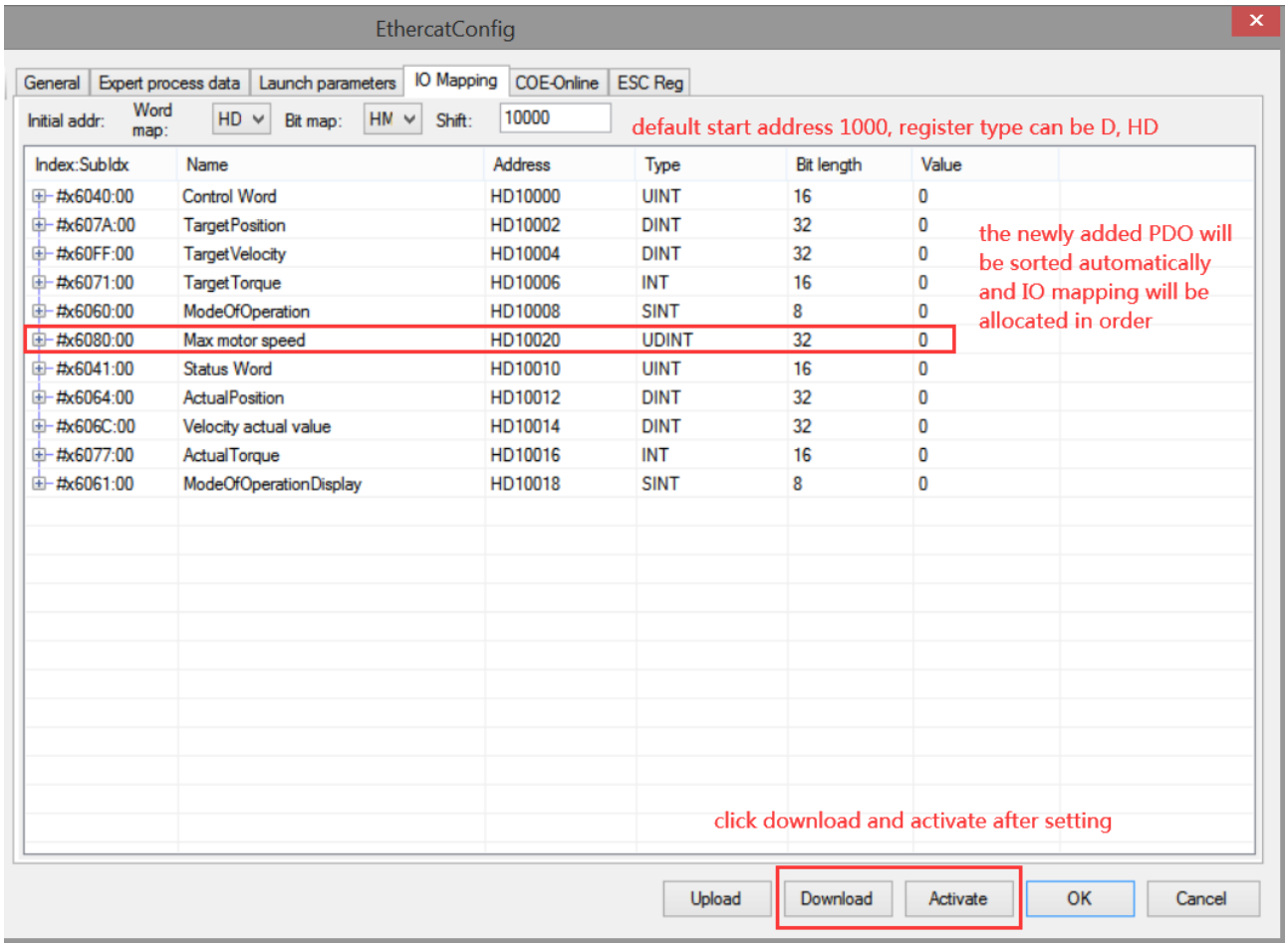


③ Confirm that the 6060h value in [start parameter] is 10.



④ [IO mapping] the default starting address is HD1000, which can be changed if necessary.

⑤ After parameter configuration, click [download] → [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the op status, at this time, SDO and PDO can receive and send messages.

⑦ After SM2010 is set on to enable the slave station, HD1006 (mapping of 6071h) can be assigned as the given torque in CST mode. (real time torque interpolation can be realized by modifying HD1006 in I9900 interrupt)

⑧ In CST mode, the current given torque can be monitored by HD1006 (mapping of 6071h), the current actual position can be monitored by HD1012 (mapping of 6064h), the current actual speed can be monitored by HD1014 (mapping of 606Ch), the current actual torque can be monitored by HD1016 (mapping of 6077h), and the maximum motor speed can be limited by 6080h.

寄存器	监控值	字长	进制	注释
HD1008	10	双字	10进制	Station ID:0,#x6060:0
HD1006	300	双字	10进制	Station ID:0,#x6071:0
HD1010	30	双字	10进制	Station ID:0,#x6080:0
HD1014	-679904	双字	10进制	Station ID:0,#x6064:0
HD1016	65459	双字	10进制	Station ID:0,#x606C:0
HD1018	11	双字	10进制	Station ID:0,#x6077:0
SM2010	ON	位	-	轴1使能

6-2-4. HM mode

HM mode (i.e. homing mode) is used for initialization of the slave position.

1. Associated objects

Register	Explanation
RXPDO[0x6040]	Control word, modify the control word to open the origin return
RXPDO[0x6098]	homing mode
RXPDO[0x609A]	homing acceleration speed
RXPDO[0x6060]	Set to 6 when the motor is not enabled
SDO[0x6099]	Speed of returning to origin, online modification through COE-Online

2. Control word (6040h)

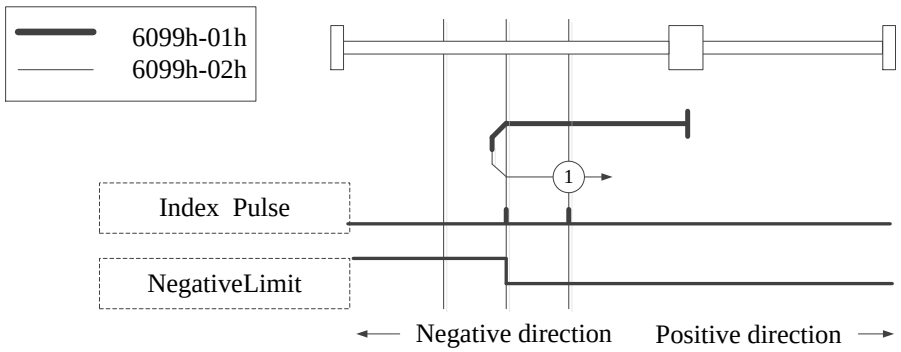
Set to (0x06 > 0x0f > 0x1f) in sequence, enable the driver and let the motor start to operate, startup the homing function.

3. Homing method (6098h)

At present, the homing modes supported by Xinje DS5C series servo are 1-14, 17-30, 33, 34, 35, 37. If the slave station of other brands is used, the way to return to the origin shall be subject to the slave station Manual of the corresponding brand.

- Method 1:

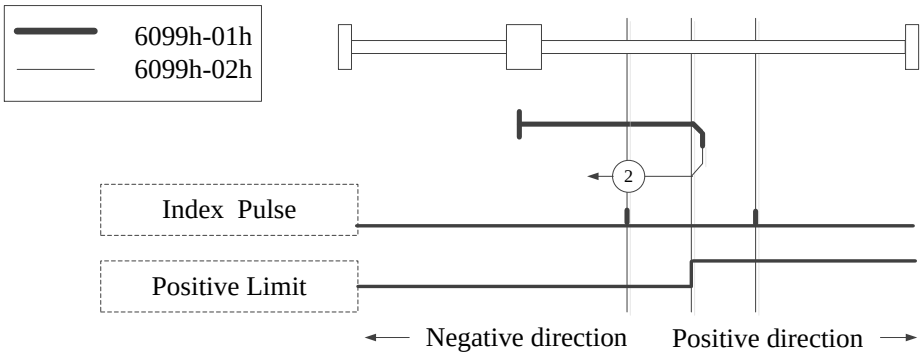
When using method 1 to return to origin, if the reverse limit switch is in the non triggered state, the initial moving direction is left. The first z-phase pulse on the right of the position where the zero position becomes invalid at the negative limit switch.



Homing on negative limit switch and index pulse

- Method 2:

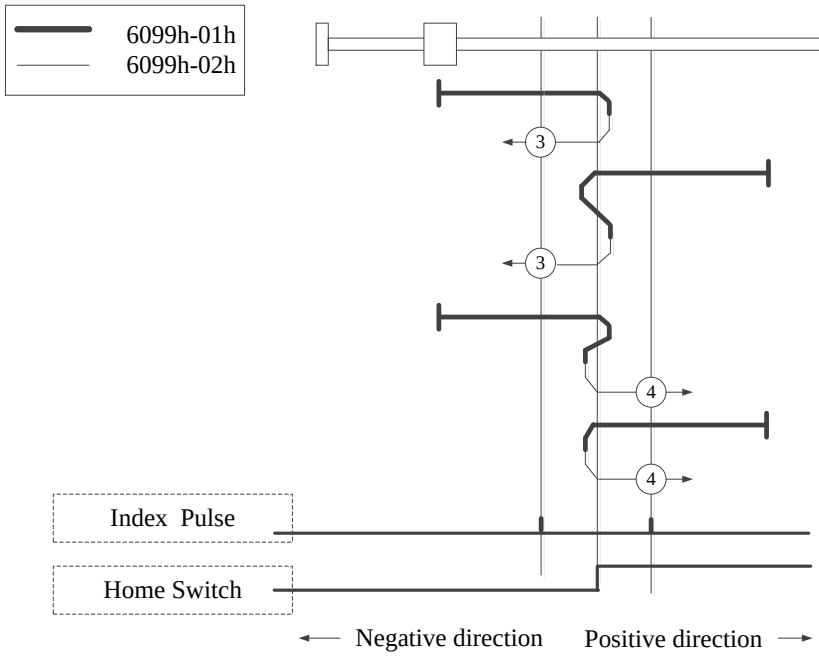
When using method 2, if the forward limit switch is not triggered, the initial direction of movement is right. The home position is at the first z-phase pulse on the left of the position where the forward limit switch becomes invalid.



Homing on positive limit switch and index pulse

■ Method 3, 4:

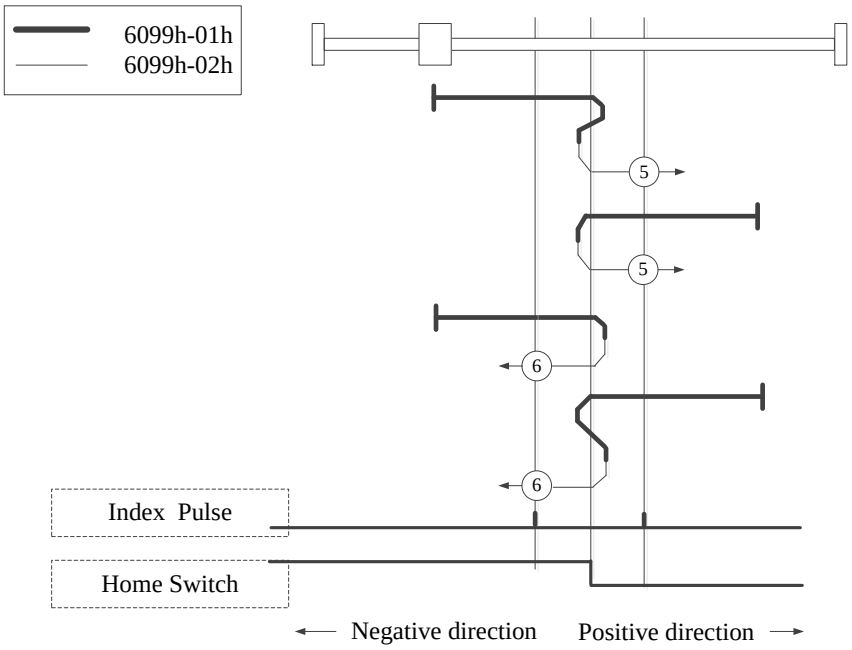
Using methods 3 or 4, the initial direction of movement depends on the state of the origin switch. The origin position is on the reverse side of the origin switch or on the z-phase position initially detected in the forward direction.



Homing on positive home switch and index pulse

■ Method 5, 6:

Using method 5 or 6, the initial direction of movement depends on the state of the origin switch. The origin position is on the reverse side of the origin switch or on the z-phase position initially detected in the forward direction.



Homing on negative home switch and index pulse

■ Method 7~14:

The origin switch and z-phase signal are used in 7-14;

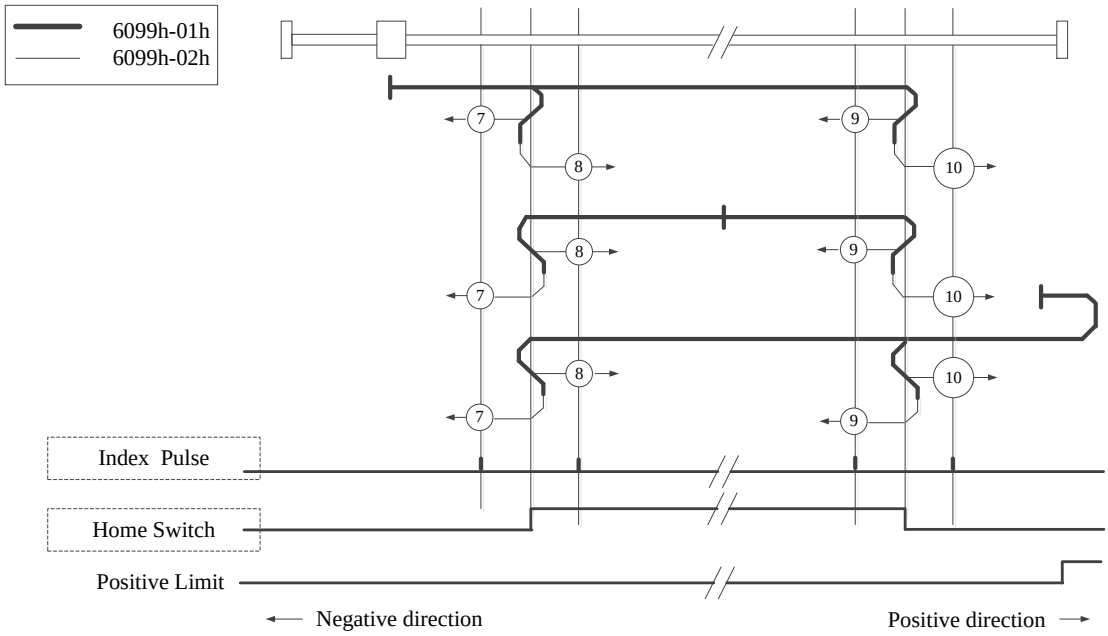
The initial action direction of modes 7 and 8 is negative if the origin switch has been activated at the beginning of the action;

The initialization action direction of modes 9 and 10 is positive if the origin switch has been activated at the beginning of the action;

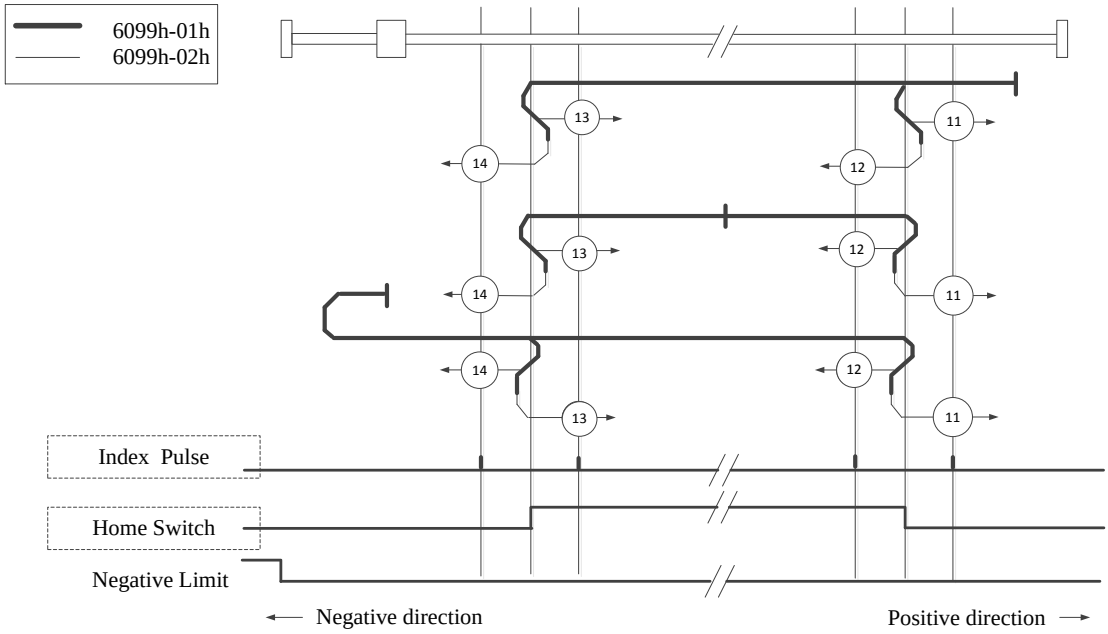
The initialization action direction of modes 11 and 12 is a positive direction if the origin switch has been activated at the beginning of the action;

The initialization action direction of modes 13 and 14 is negative if the origin switch has been activated at the beginning of the action;

The position of the final return origin is the z-phase signal near the rising or falling edge of the origin switch.



Homing on home switch and index pulse – positive initial motion



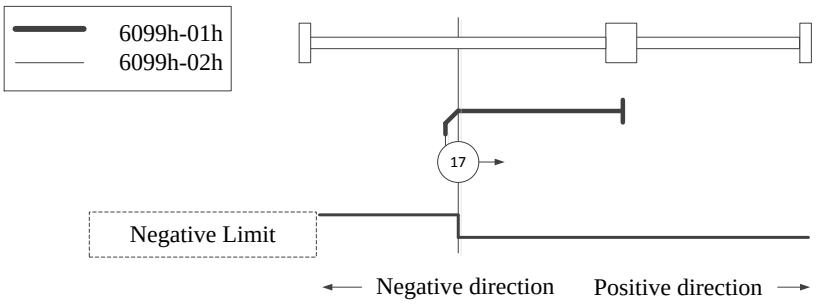
Homing on home switch and index pulse – Negative initial motion

■ Method 17:

This method is similar to method 1.

The difference is that the detection position of the origin is not the Index pulse, but the position where the limit switch changes. (please refer to the figure below)

When NOT is not assigned, Homing error = 1.



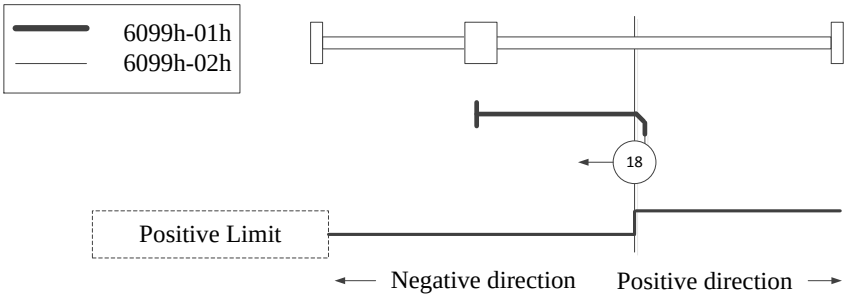
Homing on negative limit switch

■ Method 18:

This method is similar to method2.

The difference is that the detection position of the origin is not the Index pulse, but the position where the limit switch changes. (please refer to the figure below)

When the POT is not assigned, Homing error = 1.



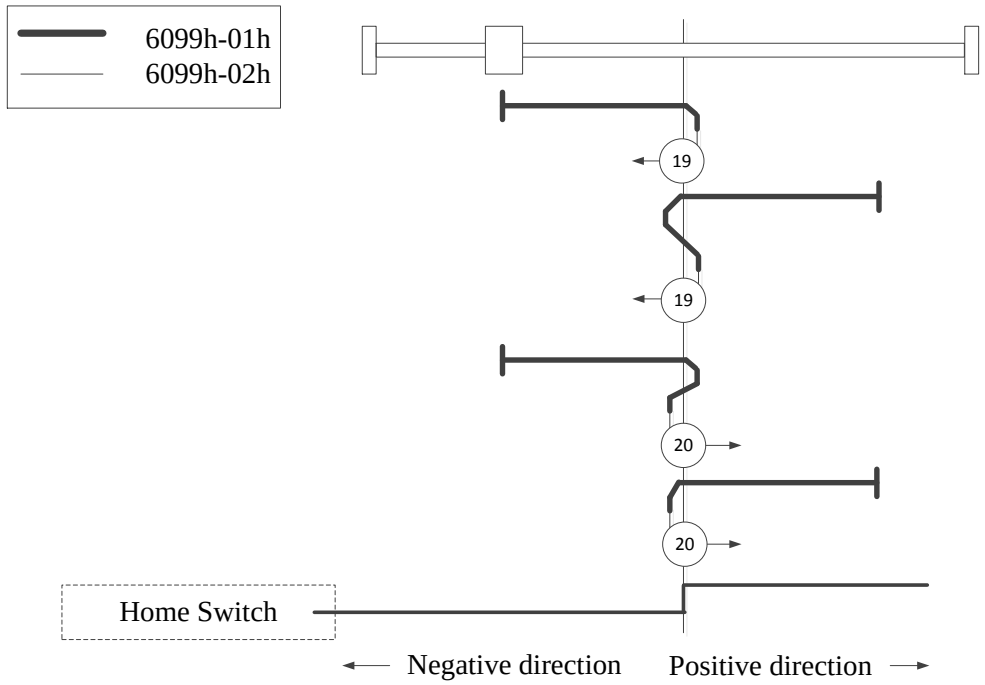
Homing on positive limit switch

■ Method 19, 20:

This method is similar to method 3, 4.

The difference is that the origin detection location is not Index pulse, but the location where the Home switch changes. (please refer to the figure below)

When HOME is not assigned, Homing error = 1.



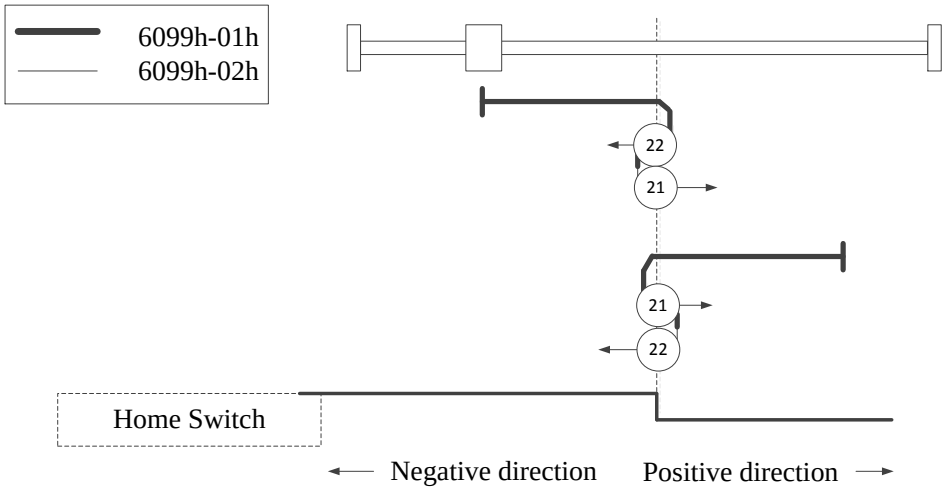
Homing on positive home switch

■ Method 21, 22:

This method is similar to method 5, 6.

The difference is that the origin detection location is not Index pulse, but the location where the Home switch changes. (please refer to the figure below)

When HOME is not assigned, Homing error = 1.



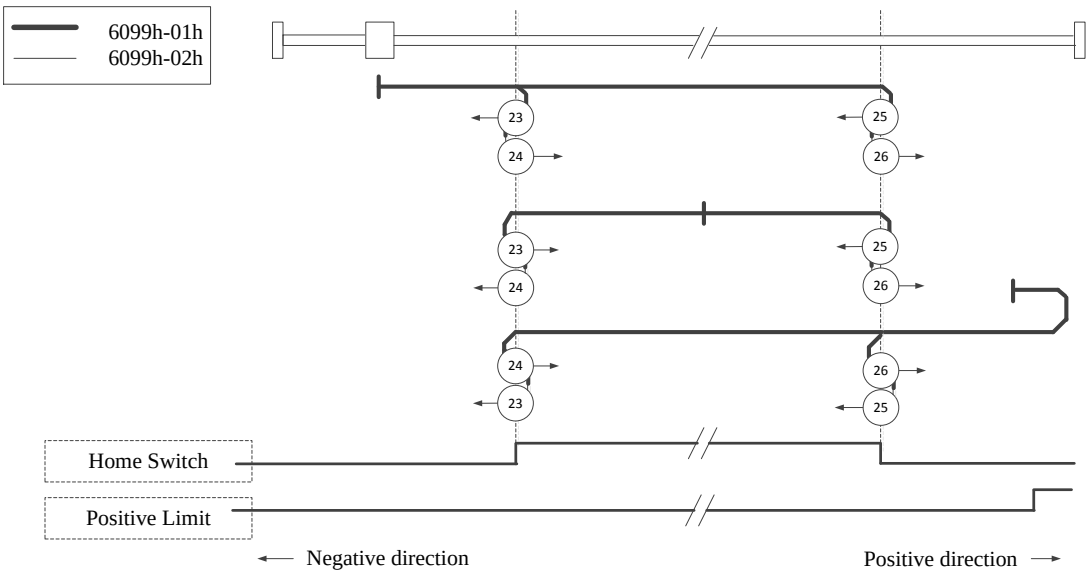
Homing on positive home switch and index pulse

■ Method 23, 24, 25, 26:

This method is similar to method 7, 8, 9, 10.

The difference is that the origin detection location is not Index pulse, but the location where the Home switch changes. (please refer to the figure below)

When HOME and POT are not allocated, Homing error = 1.



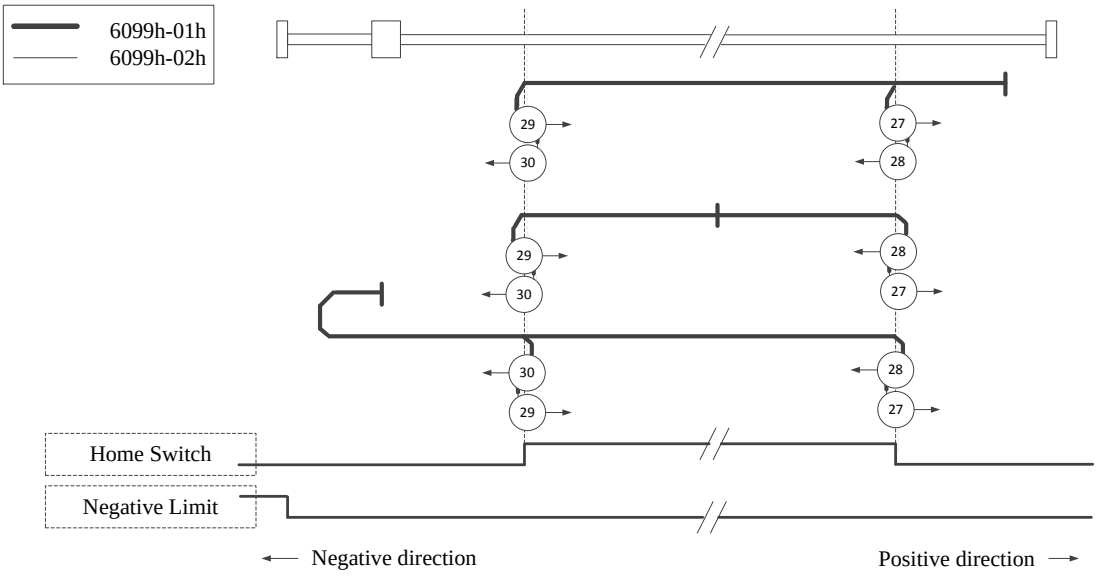
Homing on home switch and index pulse – positive initial motion

■ Method 27, 28, 29, 30:

This method is similar to method 11, 12, 13, 14.

The difference is that the origin detection location is not Index pulse, but the location where the Home switch changes. (please refer to the figure below)

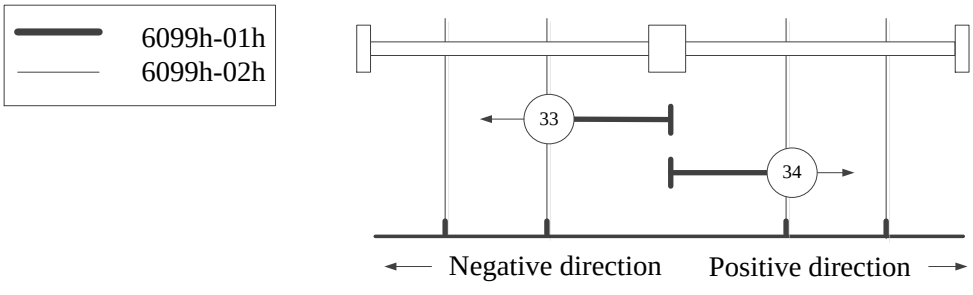
When HOME and NOT are not assigned, Homing error = 1.



Homing on home switch and index pulse – Negative initial motion

■ Method 33, 34:

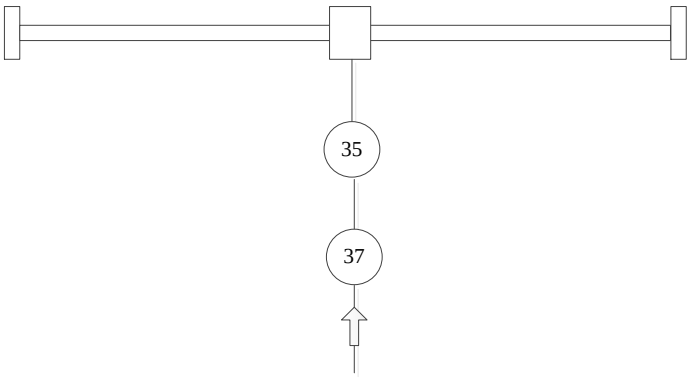
Using methods 33 or 34, the homing direction is negative or positive, respectively. The original position is located near the Z phase of the selected direction.



Homing on index pulse

■ Method 35, 37:

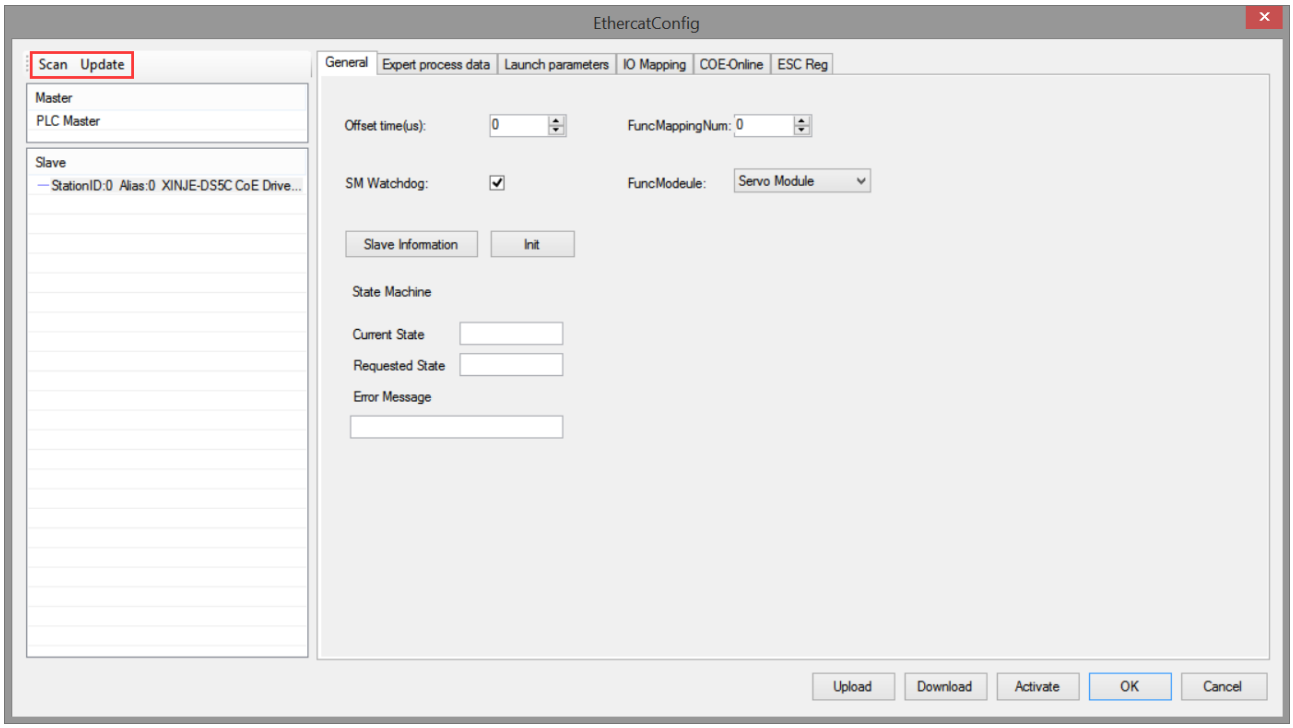
In modes 35 and 37, the position after power on is the origin position.



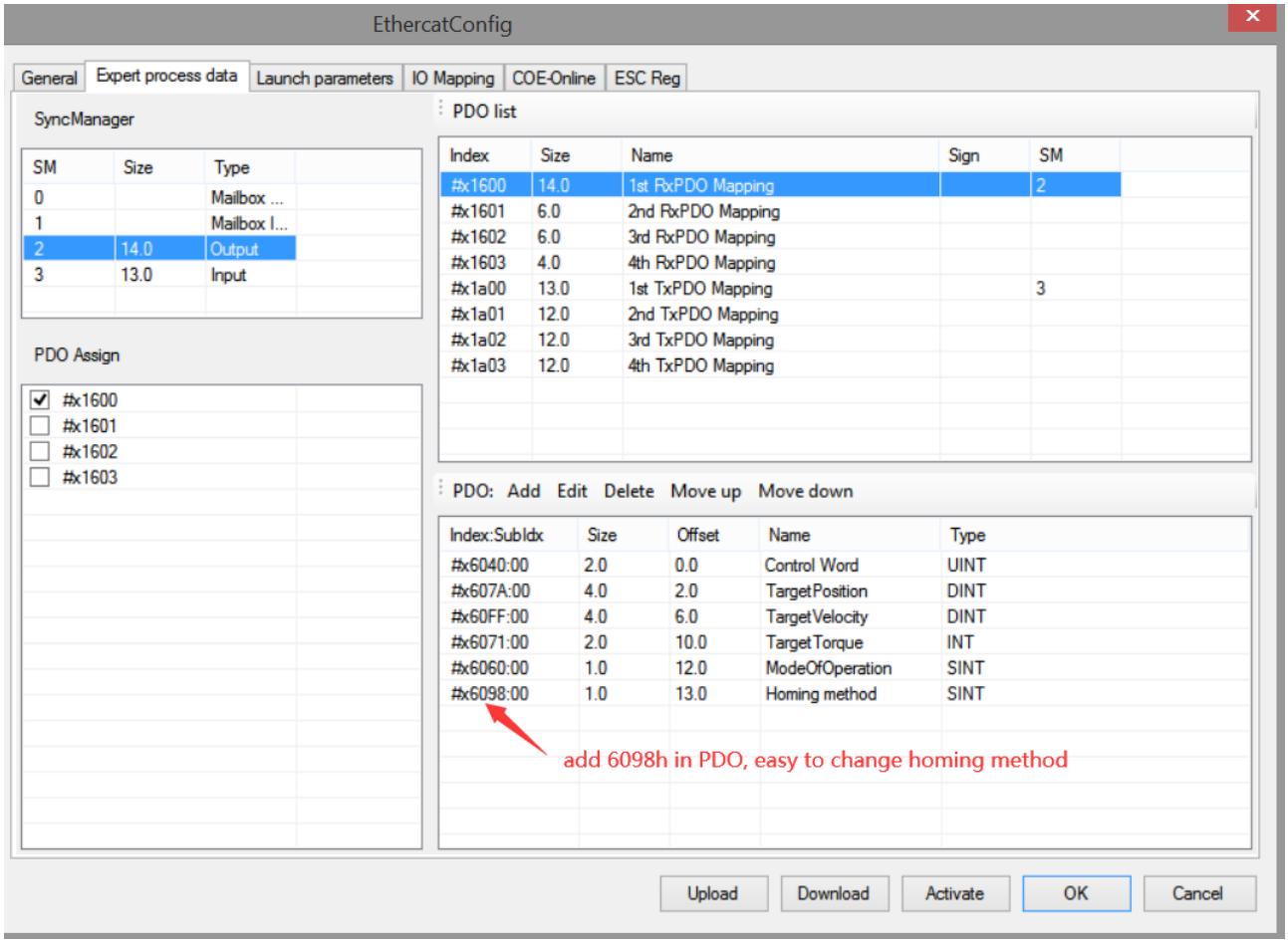
4. Operation example: (take Xinje DS5C servo as an example)

① Terminal distribution. P5-22 is the setting address of positive limit, the default value is 1, i.e. corresponding to servo terminal SI1; P5-23 is the setting address of inverse limit NOT, the default value is 2, i.e. corresponding to servo terminal SI2; P5-27 is the setting address of origin, the default value is 3, i.e. corresponding to servo terminal SI3.

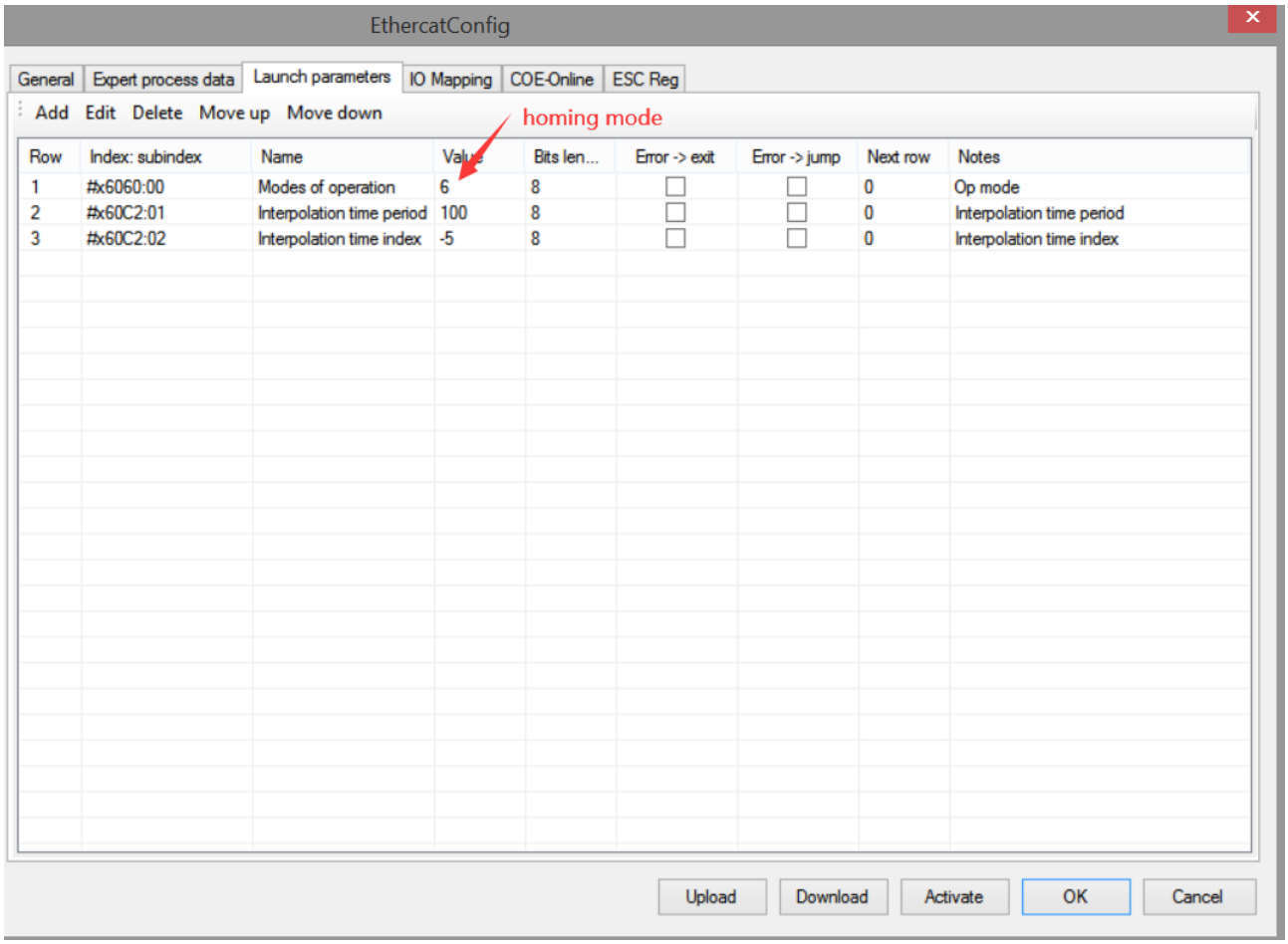
② Click [scan] or [add] slave station on the EtherCAT interface, and the [general] interface uses the default configuration.



③ Choose 1600 and 1A00 in [expert process data] → [PDO allocation] and add 6098h to 1600.

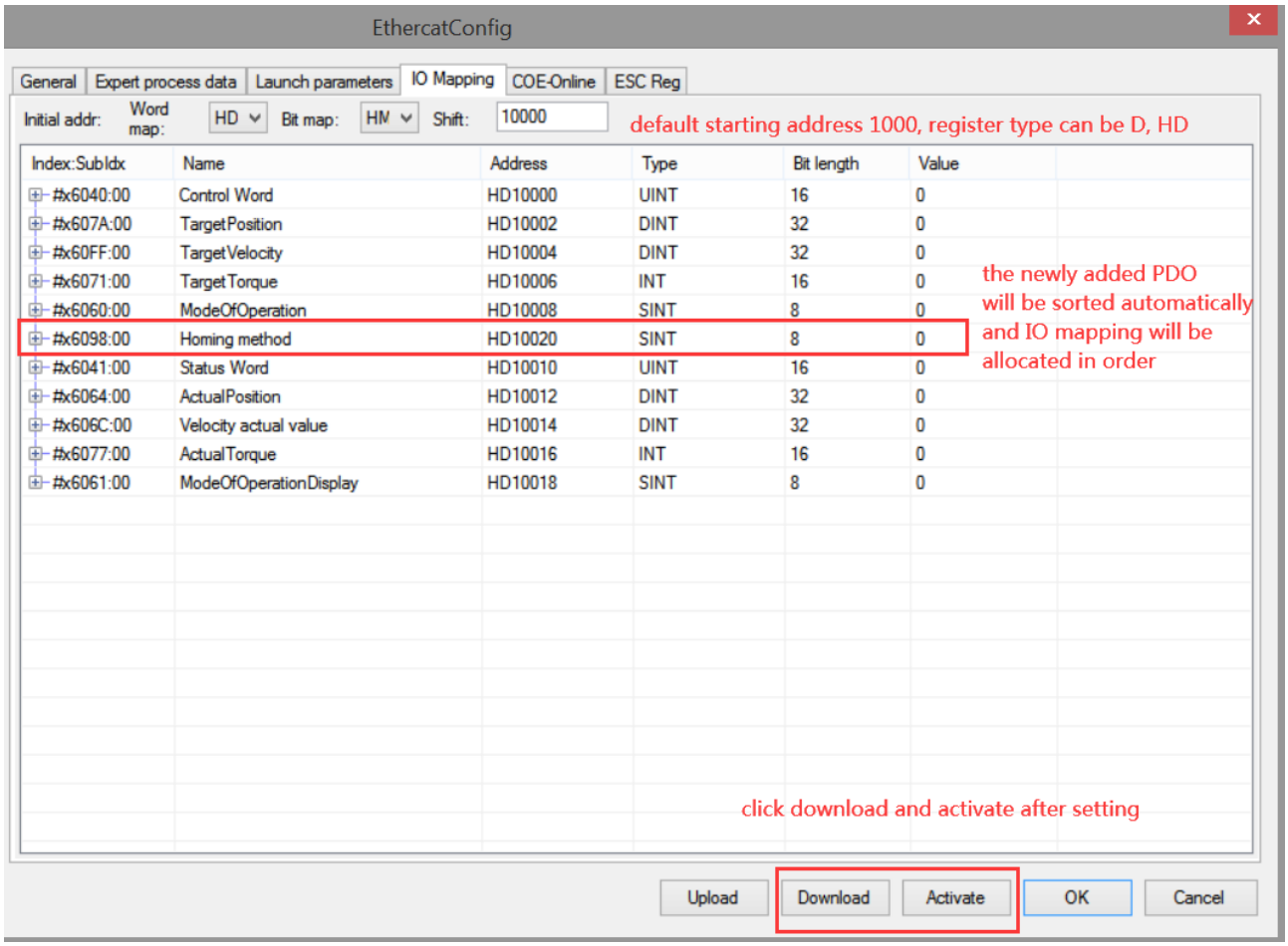


④ Confirm that the 6060h value in [start parameter] is 6.



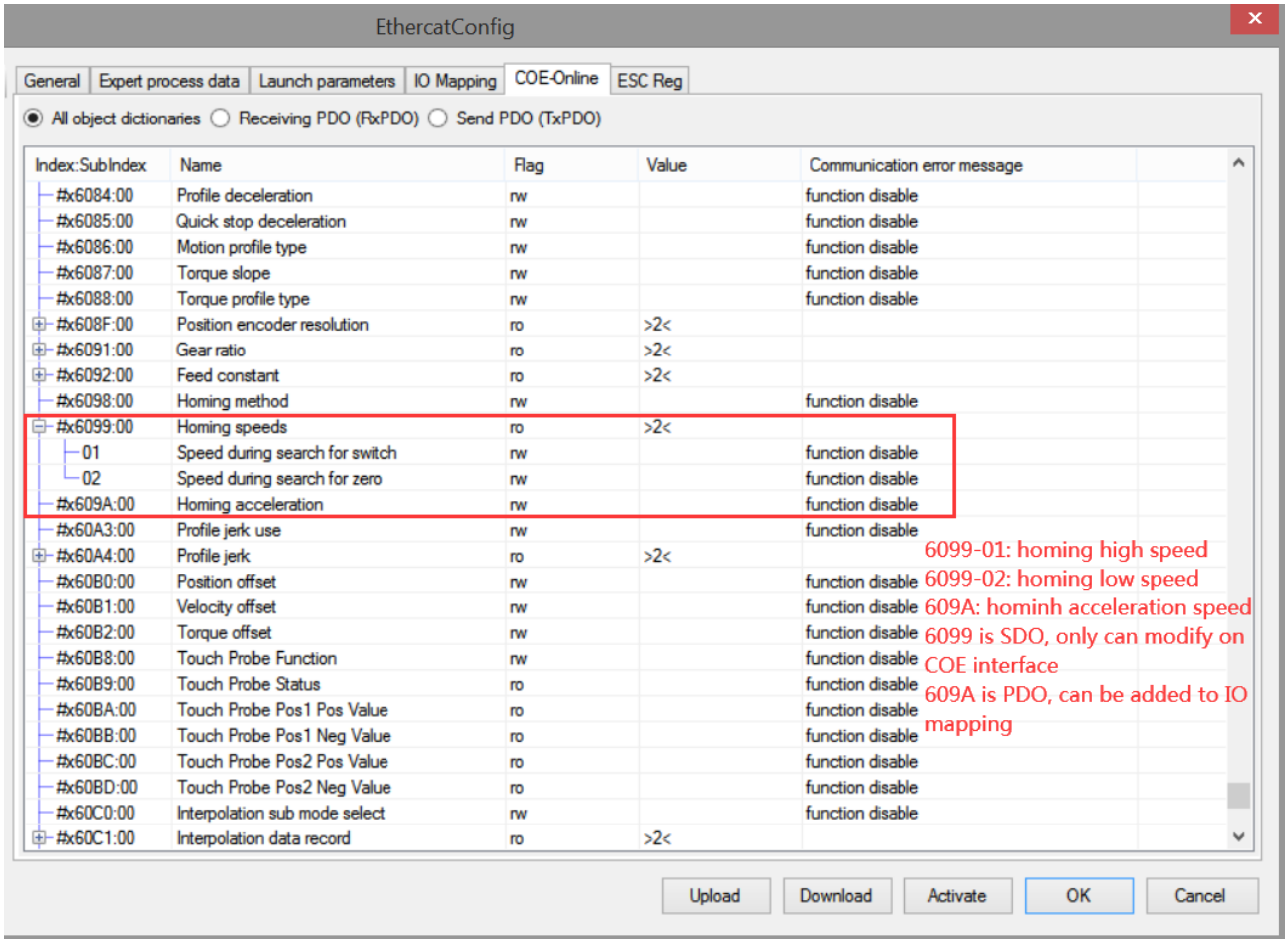
⑤ [IO mapping] the default starting address is HD1000, which can be changed if necessary.

⑥ After parameter configuration, click [download] → [activate]. After activation, the parameters will take effect.



⑦ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the op status, at this time, SDO and PDO can receive and send messages.

⑧ After the status is switched to OP, you can modify the speed and acceleration of origin return through COE-Online.



⑨ Set the homing mode (6098h). The setting range is 1-37 (currently supported modes 1-14, 33, 34, 35, 37).

⑩ Turn HD1000 (mapping of 6040h) from 6 to 15, enable the slave station, and then turn 15 to 31, start the homing function. During the homing process, if the homing signal is triggered, it will slow down and stop according to the corresponding homing mode. If you need to return to the original point again, first change 6040h to 6, and then repeat the above operation.

6-2-5. PP mode

PP (profile position control mode) is a position control mode that acts after generating position instructions inside the servo driver by specifying the target position, target speed, acceleration and deceleration, etc. Please use this control mode in the communication period of more than 500 μs.

1. Association parameter

PP control mode associated object (instruction · setting)

Register	Explanation	Unit
RXPDO[0x6040]	Control bit	-
RXPDO[0x6060]	Set to 1	-
RXPDO[0x607A]	Position setting	Command unit
RXPDO[0x6072]	max torque	0.1%
RXPDO[0x607F]	max internal speed	Command unit /s
RXPDO[0x6080]	max motor speed	r/min
RXPDO[0x6081]	internal speed setting	Command unit /s
RXPDO[0x6083]	internal acceleration speed	Command unit /s²

RXPDO[0x6084]	internal deceleration speed	Command unit /s²
RXPDO[0x60C5]	max acceleration speed	Command unit /s²
RXPDO[0x60C6]	max deceleration speed	Command unit /s²
RXPDO[0x6065]	Set the number of follow error pulses	Command unit
RXPDO[0x6066]	Follow error timeout	ms
RXPDO[0x6067]	Position window	Command unit
RXPDO[0x6068]	Position window time	ms

Note:

(1) 6081h (profile velocity) is limited by the smaller of 607Fh (max profile velocity) and 6080h (max motor speed).

(2) Changing the set value of 607Fh (max profile velocity) or 6080h (max motor speed) in the action is not reflected in the action.

Object associated with PP control mode (instruction · monitoring)

Register	Explanation	Unit
TXPDO[0x6041]	Status word	-
TXPDO[0x6063]	internal actual position	Command unit
TXPDO[0x6064]	position feedback (motor actual position)	Command unit
TXPDO[0x606C]	speed feedback	Command unit /s
TXPDO[0x6077]	actual torque	0.1%
TXPDO[0x60F4]	actual follow error	Command unit

2. control word (6040h) < pp control mode function >

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
r						om	h
7	6	5		4	3	2	1	0
fr	oms				eo	qs	ev	so
	Abs /rel	Change set immediately		New set point				

r = reserved (not corresponding)

oms = operation mode specific (control mode is based on bit)

h = halt

fr = fault reset

eo = enable operation

qs = quick stop

ev = enable voltage

so = switch on

Bit4-6 (operation mode specific):

Bit	Name	Value	Definition
4	new set-point	0-> 1	Start the positioning action and trigger the setting value update. Get the new location determination task (607Ah (target position), 6081h (profile velocity), etc.).
5	change set immediately	0	Complete the positioning action that is currently running. In the process of motion, if the target position 607A, acceleration 6083, deceleration 6084 are changed, and then the control command is sent, it will not run according to the new motion parameters. After the last motion is completed, the new motion will be executed .

		1	Interrupt the current positioning action, and immediately start the downward positioning action. That is, in the process of motion, change the target position 607A, acceleration 6083, deceleration 6084, and then send the control command, for example, change the control word 0x6F (111) → 0x7F (127) (relative mode) or 0x2F (47) → 0x3F (63) (absolute mode), and immediately run according to the new motion parameters.
6	absolute/ relative	0	607Ah (Target position) treated as absolute position.
		1	607Ah (Target position) treated as relative position.

Do not change the acceleration and deceleration (*) during motor operation.

If the acceleration and deceleration are changed, please change bit4 (new set-point) from 0 to 1 after the motor stops.

6083h (Profile acceleration)

6084h (Profile deceleration)

60C5h (Max acceleration)

60C6h (Max deceleration)

3. Status word (6041h) < pp control mode function >

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td>6041h</td><td>00h</td><td>Statusword</td><td>0~65535</td><td>U16</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="8">Indicates the status of the servo driver.
Bit information
<table>
<tr><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th></tr>
<tr><td colspan="2" rowspan="2">r</td><td colspan="2">oms</td><td rowspan="2">Ila</td><td>oms</td><td rowspan="2">rm</td><td rowspan="2">r</td></tr>
<tr><td>Following Error</td><td>set- point acknowledge</td><td>Target Reached</td></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>w</td><td>sod</td><td>Qs</td><td>ve</td><td>F</td><td>oe</td><td>so</td><td>rsto</td></tr>
</table>
r = reserved (not corresponding)
oms = operation mode specific
(control mode is based on bit)
ila = internal limit active
rm = remote
w = warning
sod = switch on disabled
qs = quick stop
ve = voltage enabled
f = fault
oe = operation enabled
so = switched on
rtso = ready to switch on</td></tr>
</table>

bit13,12,10 (operation mode specific):

Bit	Name	Value	Definition
10	target reached	0	halt=0 (normal): positioning incomplete halt=1 (stop as halt): shaft decelerating
		1	halt=0 (normal): positioning complete halt=1 (stop as halt): shaft stop (shaft speed is 0)
12	set-point acknowledge	0	The new-setpoint is 0, and the buffer is empty after the current target position action is executed (in execution)
		1	The new location task puts data into the buffer, which is not empty
13	following error	0	60F4h (Following error actual value) (=6062h(Position demand value)–6064h(Position actual value)) is not over the range of 6065h (Following error window), or 60F4h value is over setting value of 6065h, not pass the time setting in 6066h

		1	60F4h (Following error actual value) value is over the setting range of 6065h (Following error window), above the setting time of 6066h (Following error time out), continue

4. Action description of PP control mode

The bit6 (absolute / relative) of 6040h (Controlword) can be used to determine whether to adopt relative mode or absolute mode.

Action 1: basic set-point

① master station, after setting the value of 607Ah (Target position), 6040h (Controlword) bit4 (new set-point changes from 0 to 1. At this time, please set 6081h (Profile velocity).

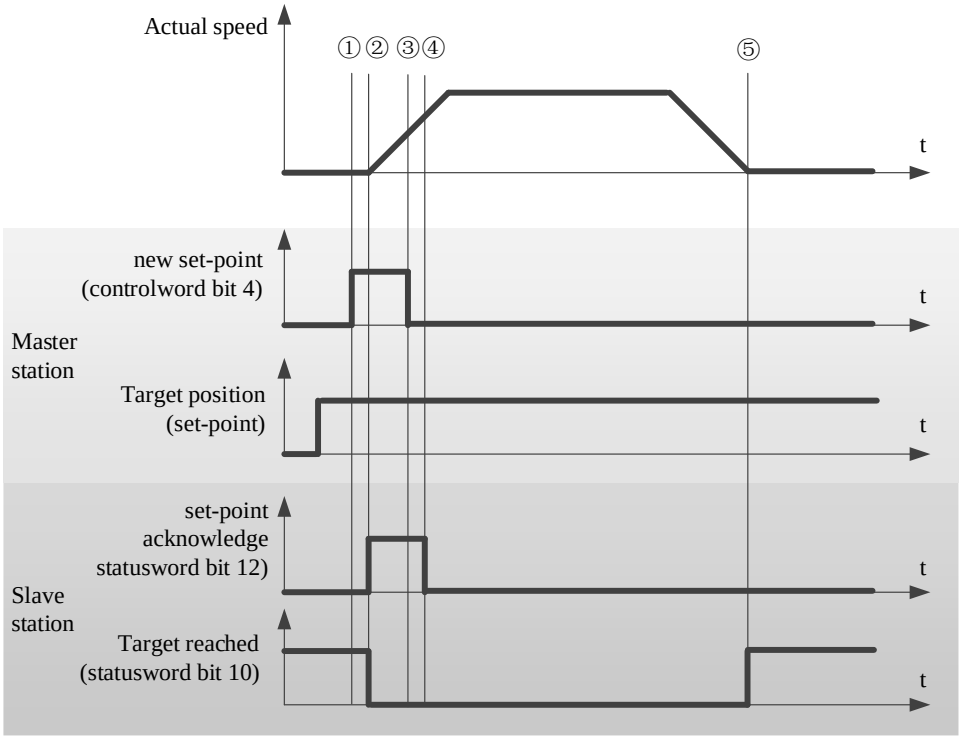
6081h (Profile velocity) is 0, motor has no motion.

② slave station, confirm 6040h (Controlword) bit4 (new set-point) rising edge (0→1), 607Ah (Target position) start positioning as target position. At this time, 6041h (status word) bit12 (set-point acknowledge) is from 0 to 1.

③ master station, confirm 6041h (Statusword) bit12 (set-point acknowledge) has changed from 0 to 1, 6040h (Controlword) bit4 (new set-point) returns 0.

④ slave station, confirm 6040h (Controlword) bit4 (new set-point) has been 0, 6041h (status word) bit12 (set-point acknowledge) changed to 0.

⑤ when reached the target position, 6041h (Controlword) bit10 (target reached) changed from 0 to 1.



< Set-point example >

Action 2: action data change without buffer: single set-point

When bit5 (change set immediately) of 6040h (control word) is 1, if the data used for positioning action in the action has been changed, the current positioning action will be interrupted and the next positioning action will be started immediately.

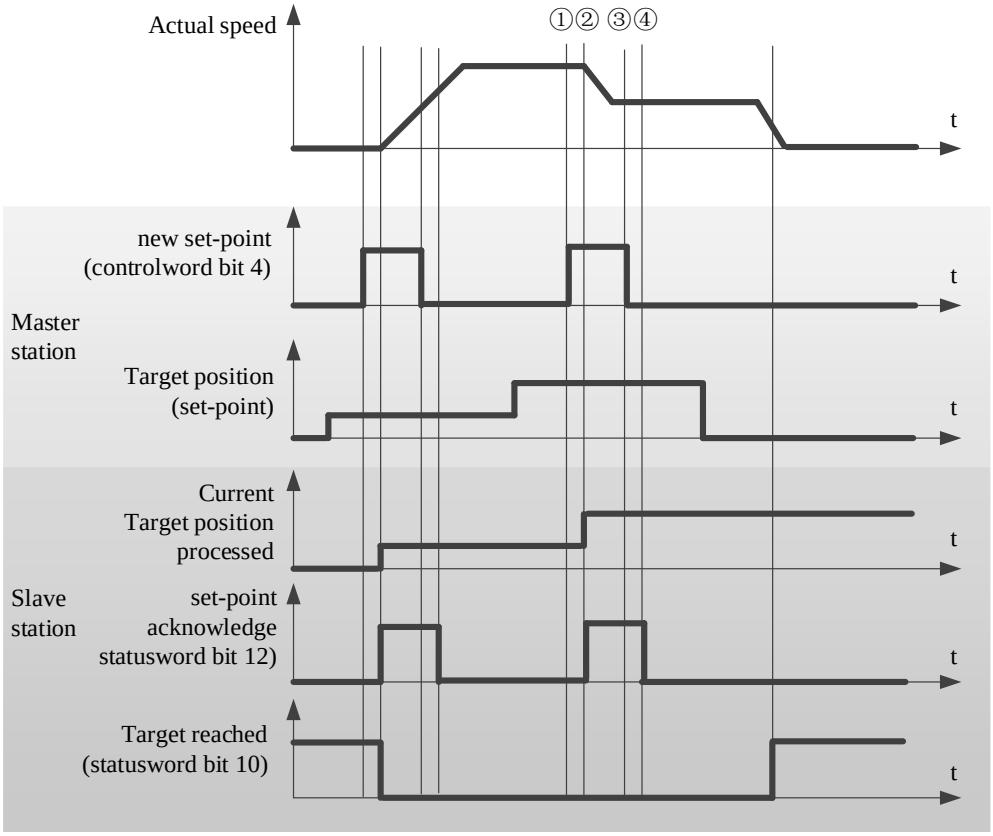
① Master station, confirm that bit12 (set point acknowledge) of 6041h (status word) is 0, change the value of 607AH (target position), change bit4 (new set point) of 6040h (control word) from 0 to 1.

Note: at this time, please do not change the acceleration and deceleration.

② Slave station, confirm the rising edge (0 → 1) of bit4 (New set-point) of 6040h (control word), 607AH (target position) and 6081H (profile velocity) as the new target location and new internal execution speed to update immediately. At this time, bit12 (set point acknowledge) of 6041h (status word) is changed from 0 to 1.

③ Master station, confirm that bit12 (set point acknowledge) of 6041h (status word) has changed from 0 to 1, bit4 (new set point) of 6040h (control word) returns 0.

④ Slave station, confirm that the bit4 (new set point) of 6040h (control word) has been 0, 6041h (status word) bit12 (set point acknowledge) is 0.

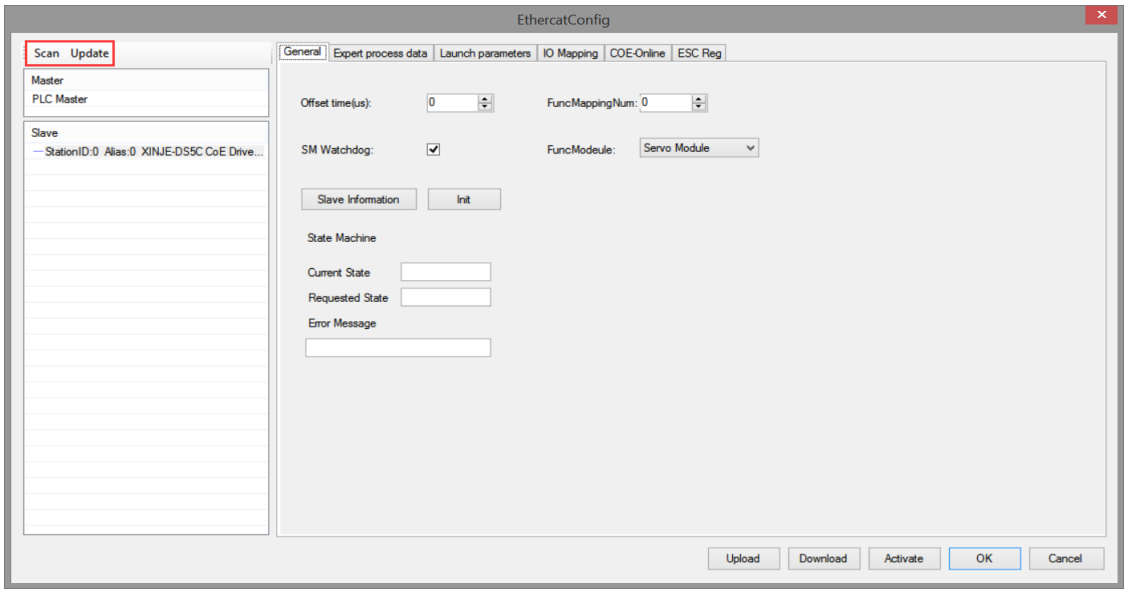


< handshaking procedure for the single set-point method >

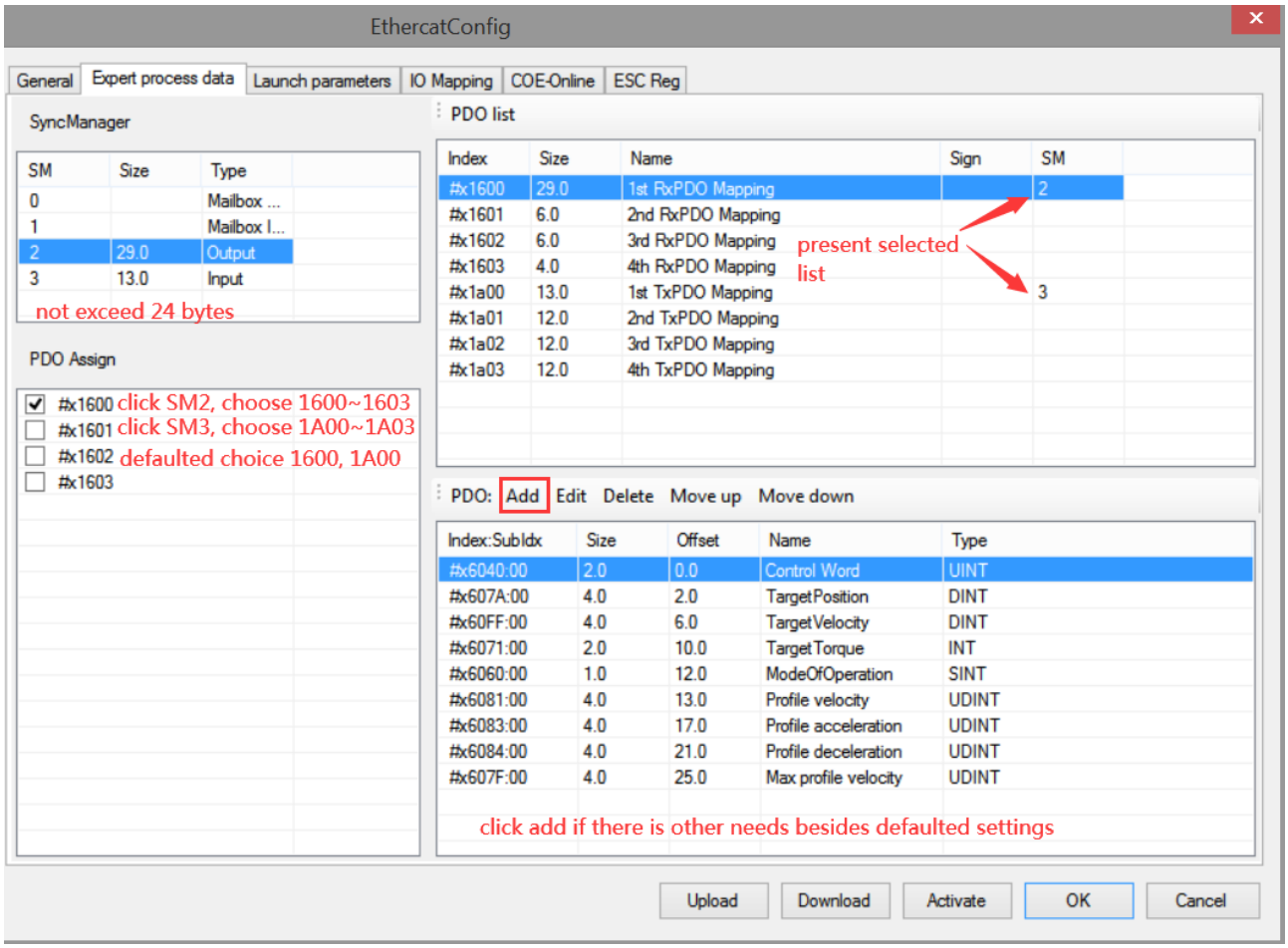
5. Operation example

Take connecting Panasonic servo and Xinje DS5C servo as an example.

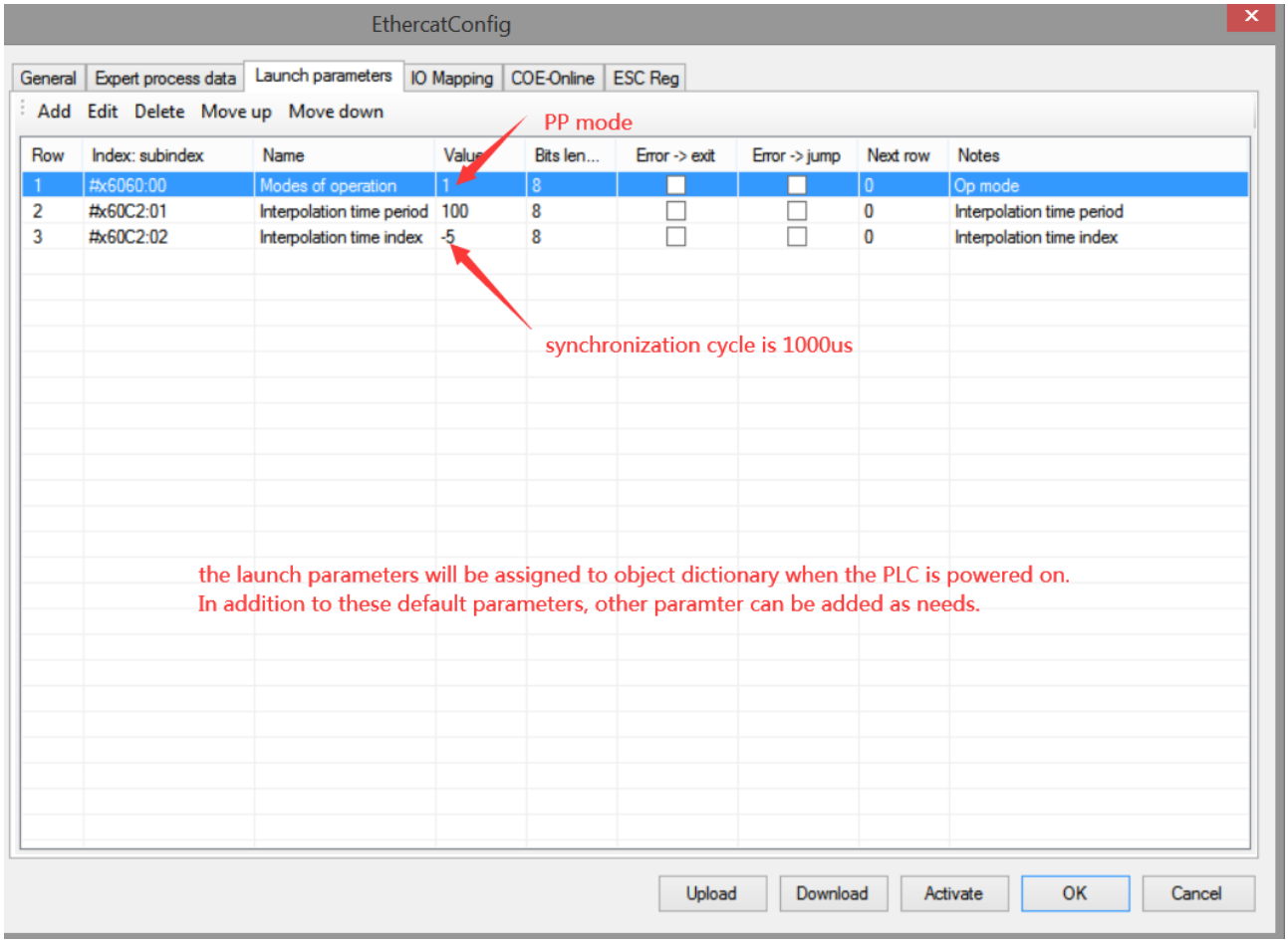
① click [scan] or [add] slave station on Ethercat interface, the general interface keeps default settings.



② [expert process data] → [PDO assign】choose 1600, 1A00, add PDO parameters related to mode (1600 and 1A00 cannot add more than 24 bytes respectively).

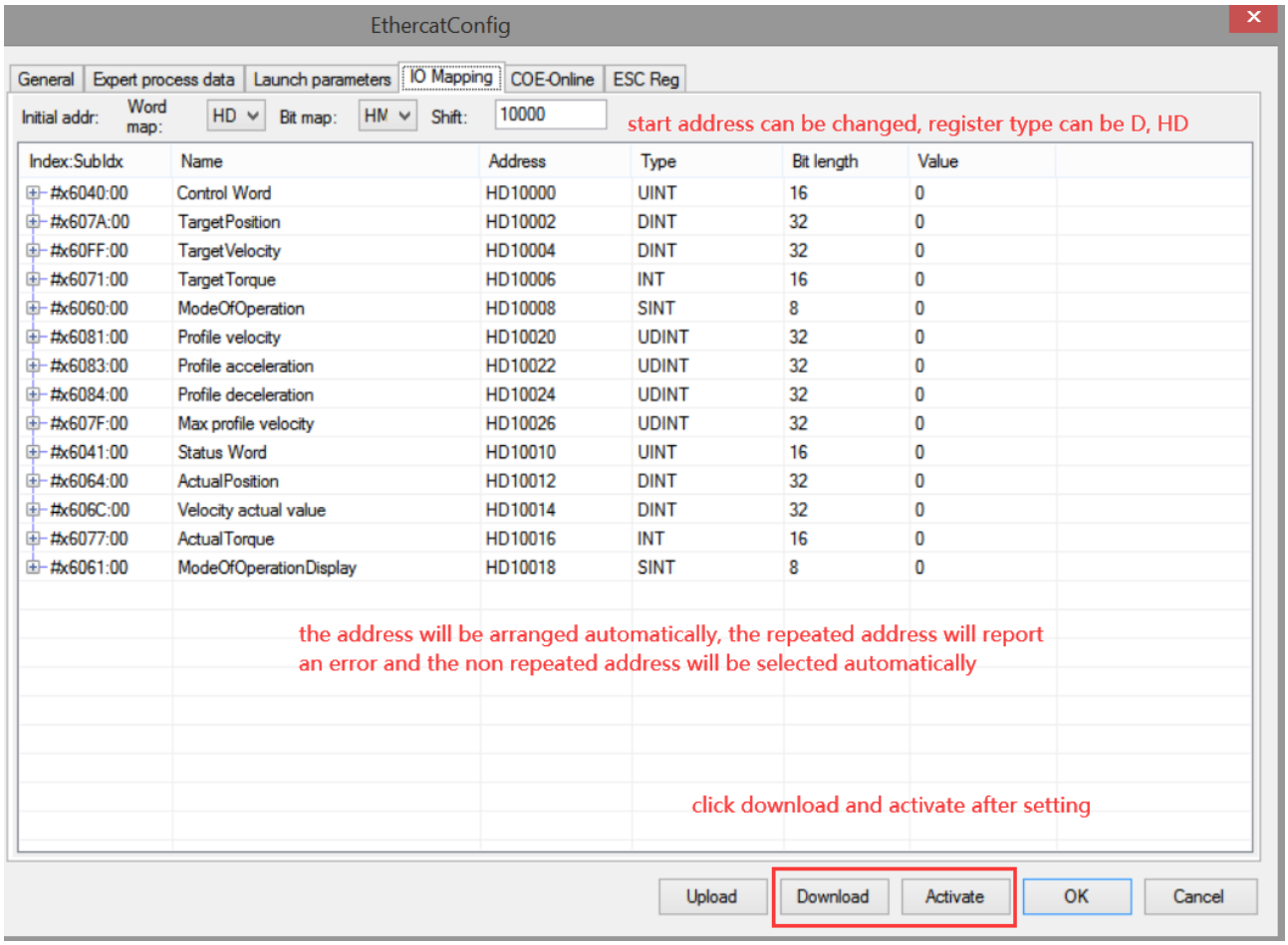


③ confirm the value of 6060h in [launch parameters] is 1.



④ [IO mapping] the default starting address is HD1000, which can be changed if necessary.

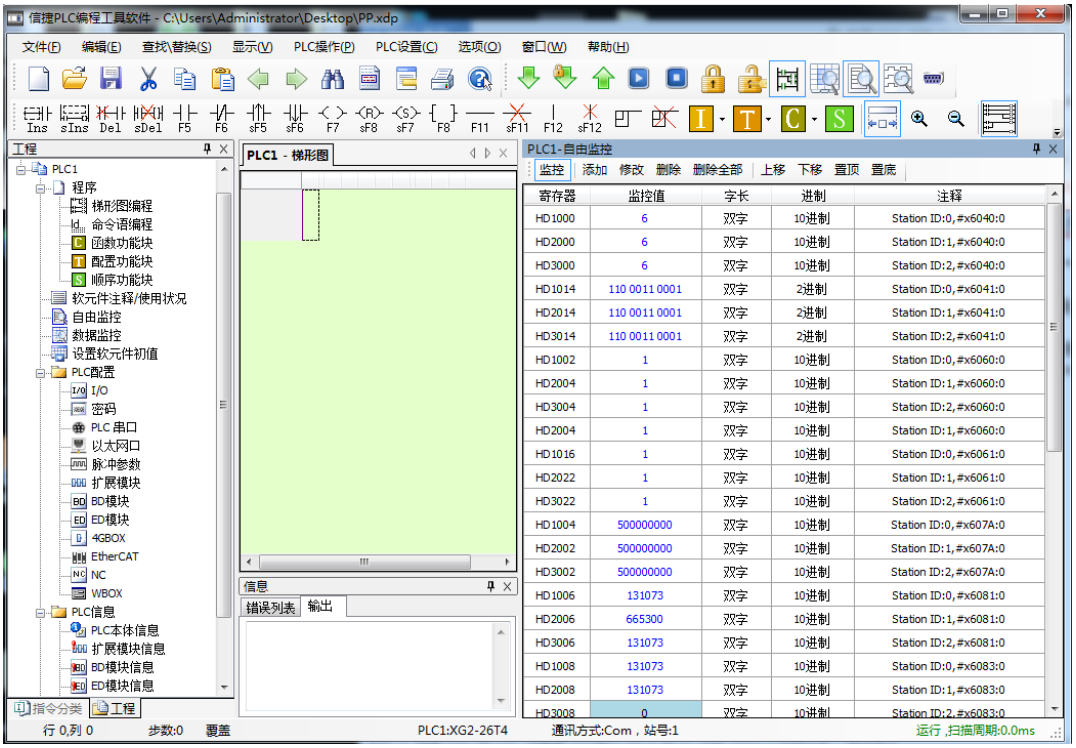
⑤ After parameter configuration, click [download] – [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the OP status, at this time, SDO and PDO can receive and send messages.

⑦ Modify the control word 6040 (absolute mode: 6 → 15 → 31 relative mode: 6 → 79 → 95) to enable the slave station, and make the motor move by setting the target position, target speed, acceleration and deceleration and other parameters.

⑧ In PP mode, you can set and monitor data through I/O mapping address. For example, the control word of axis 1 can be modified by HD1000 (mapping of 6040h) to enable or disable the motor, and the given position of current axis 1 can be monitored by HD1004 (mapping of 607AH).



6-2-6. PV mode

PV (profile speed control mode) is a speed control mode that specifies the target speed, acceleration and deceleration, etc., and generates position command action inside the servo driver. Please use this control mode in the communication period of more than 500 μs.

1. Related parameters

PV control mode related object (command · setting type)

Register	Explanation	Unit
RXPDO[0x6040]	Control word	-
RXPDO[0x6060]	Set to 3	-
RXPDO[0x60FF]	Speed setting	Command unit/s
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x607F]	Max internal speed	Command unit /s
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6083]	Internal acceleration speed	Command unit /s²
RXPDO[0x6084]	Internal deceleration speed	Command unit /s²
RXPDO[0x60C5]	Max acceleration speed	Command unit /s²
RXPDO[0x60C6]	Max deceleration speed	Command unit /s²
RXPDO[0x606D]	Velocity window	Command unit /s
RXPDO[0x606E]	Velocity time out	ms
RXPDO[0x606F]	Velocity threshold	Command unit /s
RXPDO[0x6070]	Velocity threshold time	ms

PV control mode related object (command · monitoring type)

Register	Explanation	Unit
TXPDO[0x6041]	Status word	-
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Speed feedback	Command unit /s
TXPDO[0x6077]	Actual torque	0.1%

2. Control word (6040h) < the function of pv control mode >

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
r						om	h
7	6	5	4	3	2	1	0
fr	oms			eo	qs	ev	so
	r	r	r				

r = reserved (No correspondence)
oms = operation mode specific
(control mode is based on bit)
h = halt

fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage
so = switch on

PV mode, without OMS bit.

Modify control word 6040 (6 → 15) to enable slave station.

3. Control word (6041h) < the function of pv control mode >

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Indicates the status of the servo driver.

Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
		r	speed		Target reached		
7	6	5	4	3	2	1	0
w	sod	qs	ve	f	oe	so	rsto

r = reserved (No correspondence)

oms = operation mode specific
(control mode is based on bit)
ila = internal limit active

rm = remote

w = warning
sod = switch on disabled
qs = quick stop
ve = voltage enabled
f = fault
oe = operation enabled
so = switched on
rtso = ready to switch on

bit10 (target reached (Velocity reached)):

The difference between the total value of 60FFh (target velocity) and 60B1h (velocity offset) and 606Ch (velocity actual value) is within the range set by 606Dh (velocity window). If the time set by 606Eh (velocity window time) passes, the bit10 of 6041h (status word) becomes 1.

Bit	Name	Value	Definition
10	Target reached	0	halt=0 (normal): speed control not complete halt=1 (stop as halt): shaft decelerating
		1	halt=0 (normal): speed control completed halt=1 (stop as halt): shaft stop (shaft speed is 0)

bit12 (speed):

606Ch (velocity actual value) passes the value set by 606Fh (velocity threshold), and if it is higher than the time set by 6070h (velocity threshold time), bit12 of 6041h (status word) becomes 0. If 606Ch (velocity actual value) is lower than the value set by 606Fh (velocity threshold), bit12 of 6041h (status word) becomes 1, indicating that the motor stops.

Bit	Name	Value	Definition
10	speed	0	Motor in operation
		1	Motor stop

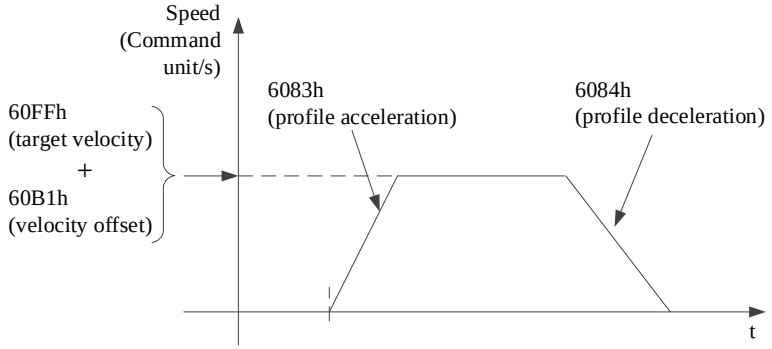
4. Action description of PV control mode

PV control mode generates speed command based on the following parameters:

Target Velocity (60FFh)　Profile acceleration (6083h)

Profile deceleration (6084h)

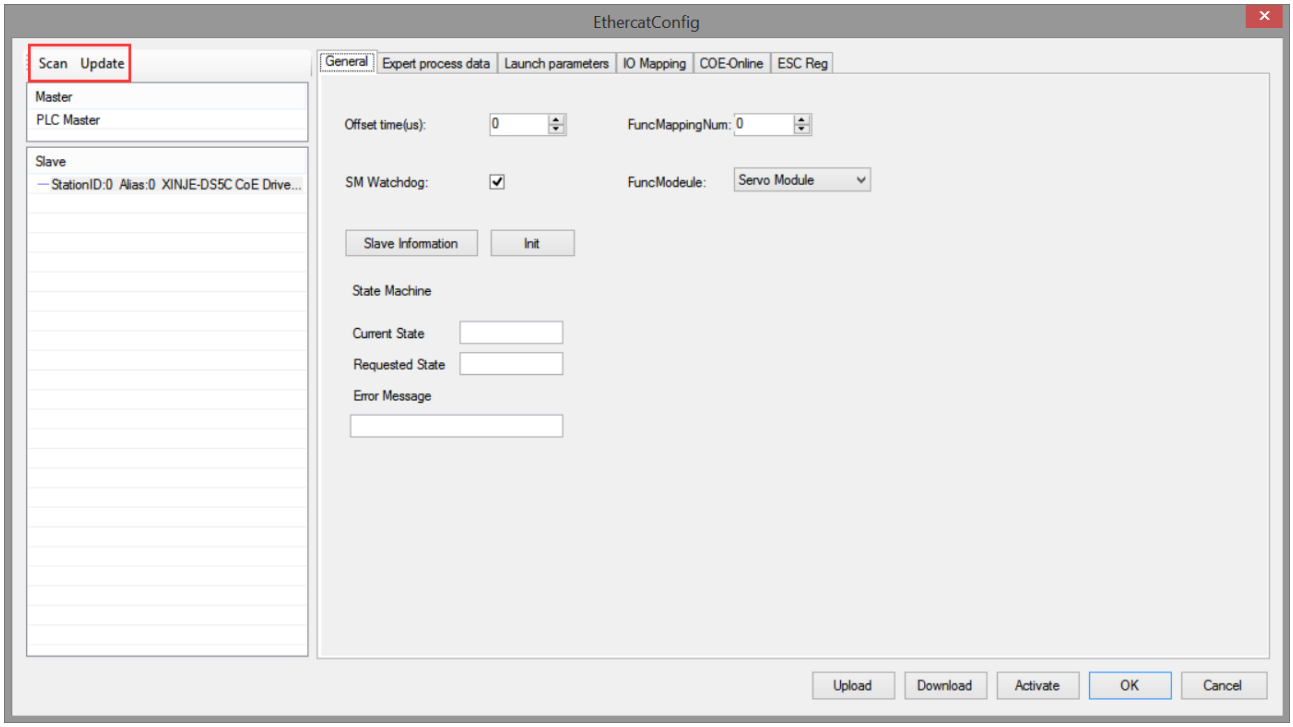
Turn off the motor enabling, set the COE object word 6060 to 3, set the target speed 60FFh, the acceleration and deceleration speed 6083h and 6084h, and the speed 6080h and the torque limit 6072h; the target speed 60FFh, limit the maximum speed through 6080h (max motor speed), the torque is limited by 6072h (max torque), and the speed feedforward is 60B1h (velocity offset), which is not supported temporarily. Turn on the motor to enable, and the motor shall start to operate according to the set value.



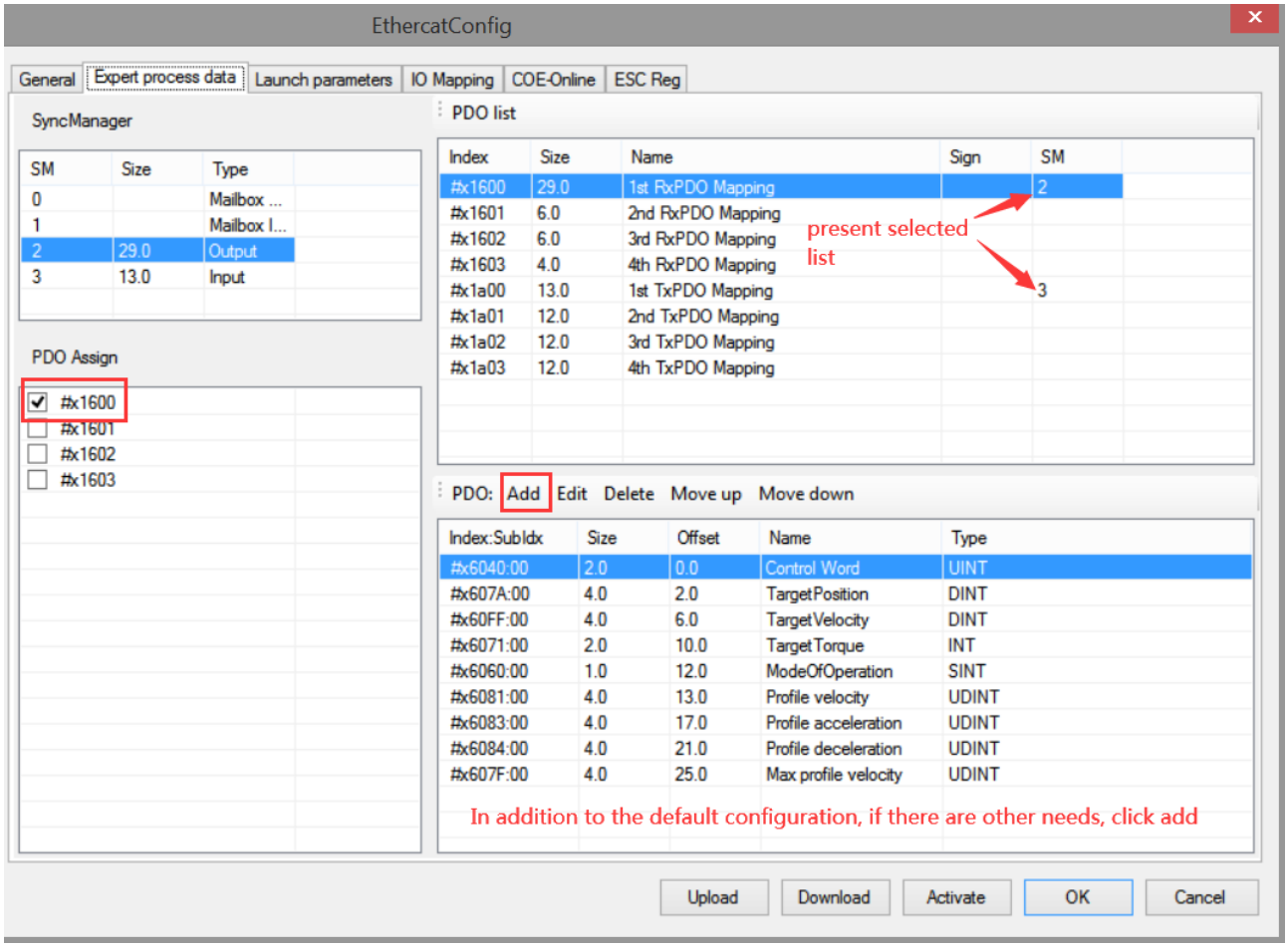
5. Operation example

Take connecting Panasonic servo and Xinje DS5C servo as an example.

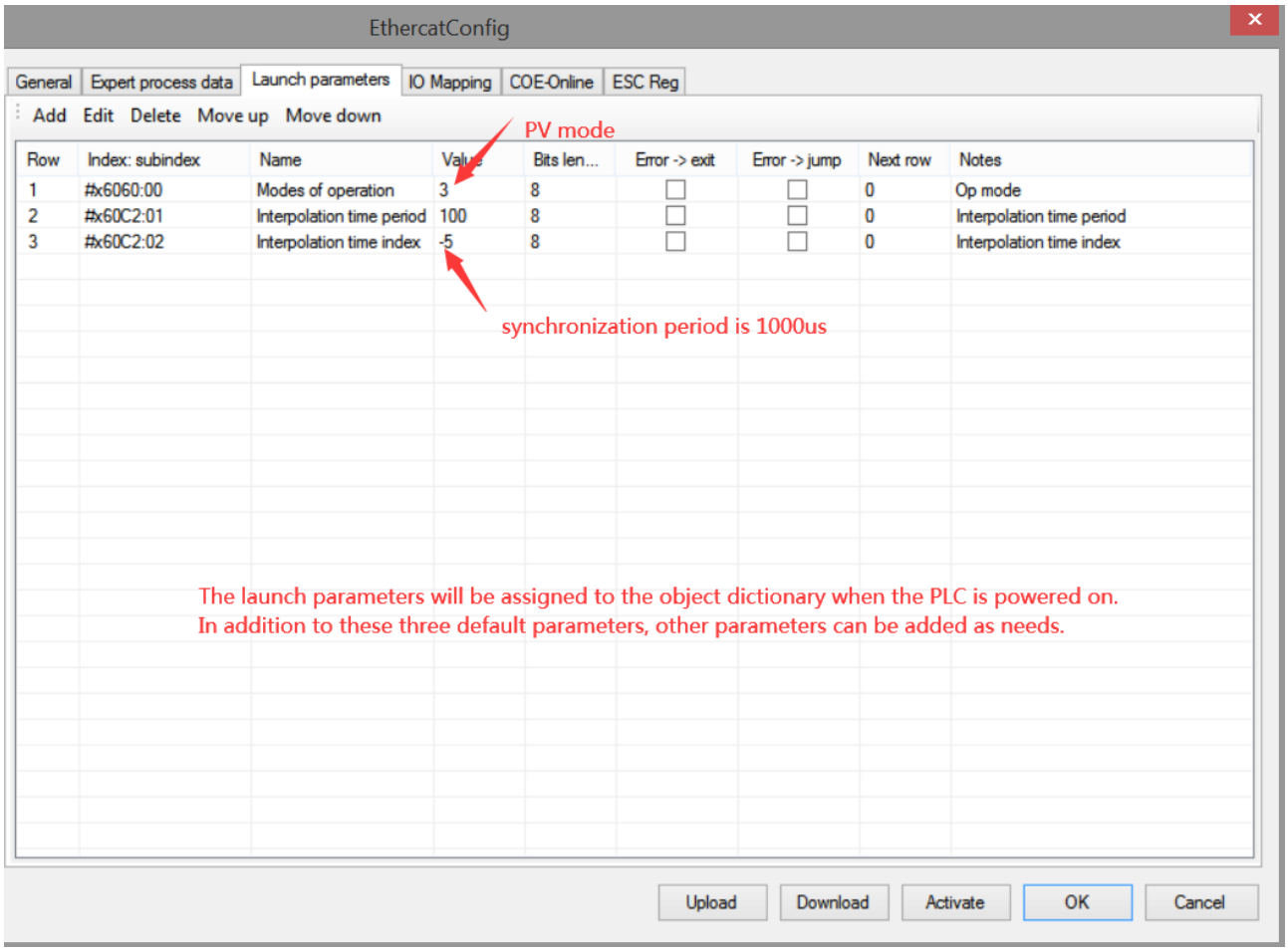
① [scan] or [add] slave station on Ethercat interface, please use default setting for [general] interface.



② Choose 1600, 1A00 in [expert process data] → [PDO assign]. PDO parameters associated with the mode can be added (1600 and 1A00 can not be added more than 24 bytes respectively).

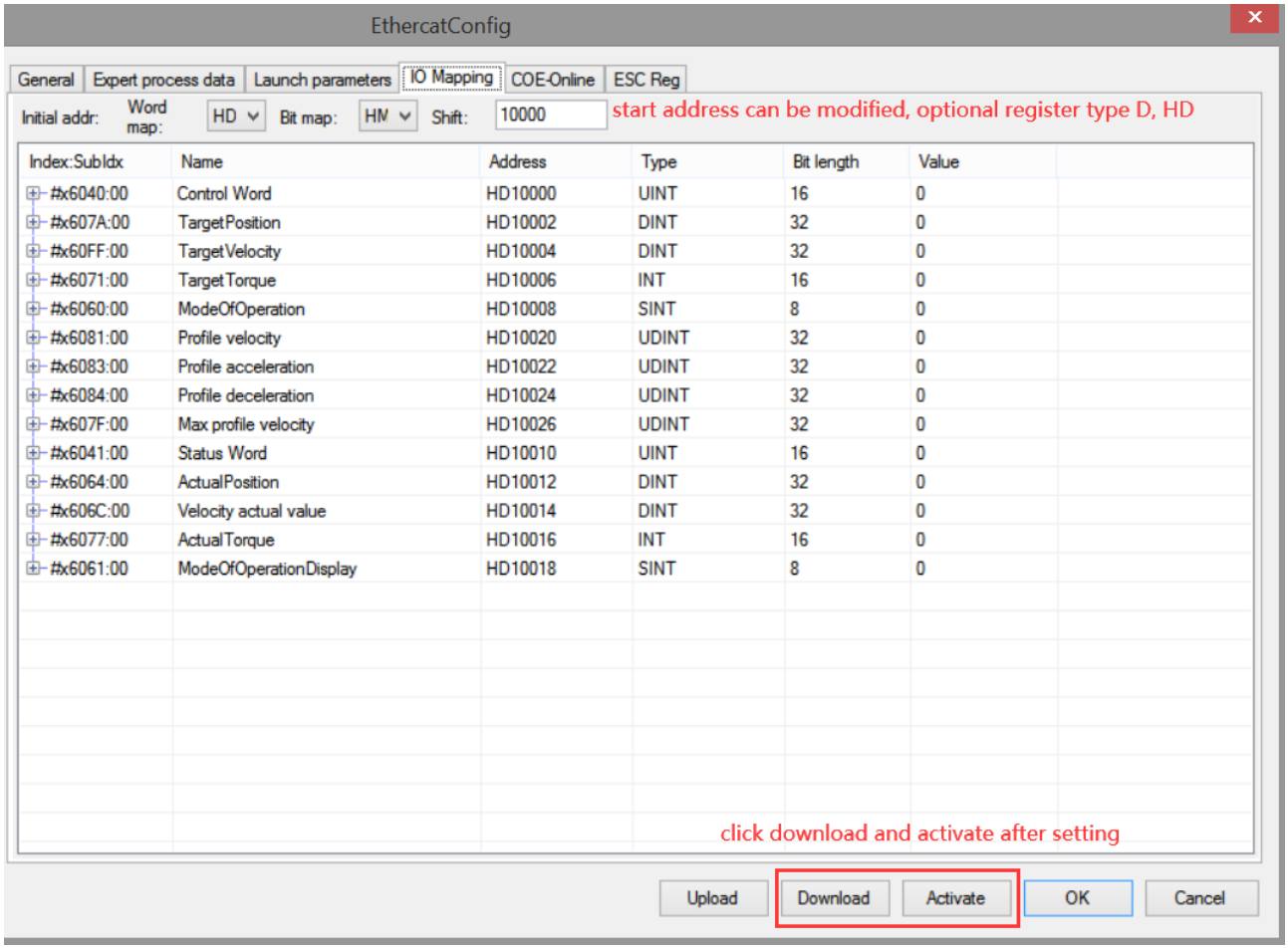


③ Confirm the value of 6060h in [launch parameters] is 3.



④ [IO mapping] starting address can be customized.

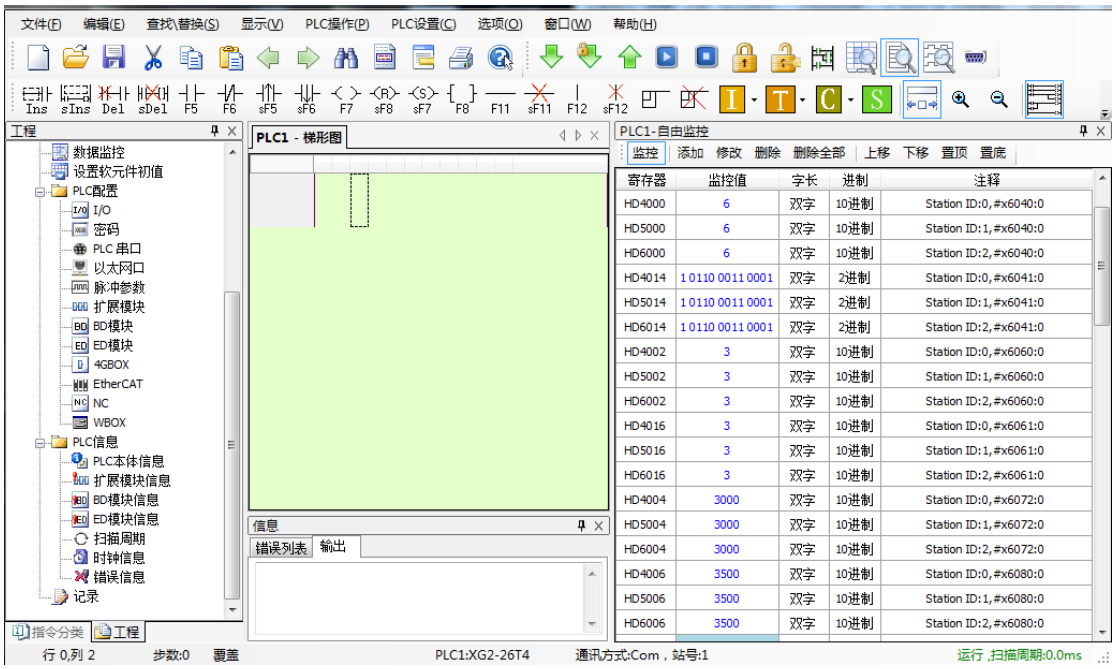
⑤ After parameter configuration, click [download] – [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the OP status, at this time, SDO and PDO can receive and send messages.

⑦ Modify the control word 6040 (6 → 15) to enable the slave station, and make the motor move by setting the target speed, acceleration and deceleration speed and other parameters.

⑧ In PV mode, you can set and monitor data through I/O mapping address. For example, the control word of axis 1 can be modified by HD4000 (mapping of 6040h) to enable or disable the motor, the actual position of the current motor of axis 1 can be monitored by HD4018 (mapping of 6064h), and the current actual speed of axis 1 can be monitored by HD4020 (mapping of 606Ch).



6-2-7. Tq mode

Tq (profile torque control mode) is a torque control mode that specifies the target torque, acceleration and deceleration, etc., and acts after the position command is generated inside the servo driver. Please use this control mode in the communication period of more than 500 μs.

1. Related parameters

Tq control mode associated object (instruction · setting type)

Register	Explanation	Unit
RXPDO[0x6040]	Control word	-
RXPDO[0x6060]	Set to 4	-
RXPDO[0x6071]	Target torque setting	0.1%
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6087]	Set torque slope	0.1%/s
RXPDO[0x6088]	Set the type of used torque profile	-

Torque type

Index	Sub-index	Name	Units	Range	Datatype	Access	PDO	OP-mode
6087h	00h	Torque slope	0.1 %	0~4294967295	U32	rw	RxPDO	Tq cst
		Set the parameter value to give the incline torque command. Cyclic synchronous torque mode (CST) is only valid when deceleration stops. If set to 0, internal processing operates with 1.						
6088h	00h	Torque profile type	-	-32768~32767	I16	rw	RxPDO	tq
		To make a torque change, set the type of used torque profile. 0: linear slope 1：Not supported						

Tq control mode associated object (instruction · monitoring type)

Register	Explanation	Unit
TXPDO[0x6041]	Status word	-
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Speed feedback	Command unit /s
TXPDO[0x6077]	Actual torque	0.1%

2. Control word (6040h) <tq control mode function>

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
r						om	h
7	6	5		4	3	2	1	0
fr	oms				eo	qs	ev	so
	r	r		r				

r = reserved (not corresponded) fr = fault reset

		oms = operation mode specific (control mode is based on bit) h = halt	eo = enable operation qs = quick stop ev = enable voltage so = switch on

Tq mode, not use oms bit.

Slave station can be enabled through modifying the control word 6040 (6→15).

3. Status word (6041h) < tq control mode function >

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Indicates the status of the servo driver.

Bit information

15	14	13	12	11	10	9	8
R		oms		ila	oms	rm	r
		r	r		Target reached		
7	6	5	4	3	2	1	0
w	Sod	qs	ve	f	oe	so	rsto

r = reserved (not corresponded)

oms = operation mode specific
(control mode is based on bit)
ila = internal limit active

rm = remote

w = warning
sod = switch on disabled
qs = quick stop
ve = voltage enabled
f = fault
oe = operation enabled
so = switched on
rtso = ready to switch on

bit13,12,10 (operation mode specific):

Bit	Name	Value	Definition
10	target reached	0	halt=0 (normal): 6074h (Torque demand) target torque not achieved halt=1 (stop as halt): shaft decelerating
		1	halt=0 (normal): 6074h (Torque demand) target torque achieved halt=1 (stop as halt): shaft stop (shaft speed is 0)
12	reserved	-	Not used
13	reserved	-	Not used

4. Action description of tq control mode

The Tq control mode generates torque commands based on the following parameters:

Target torque (6071h)

Torque slope (6087h)

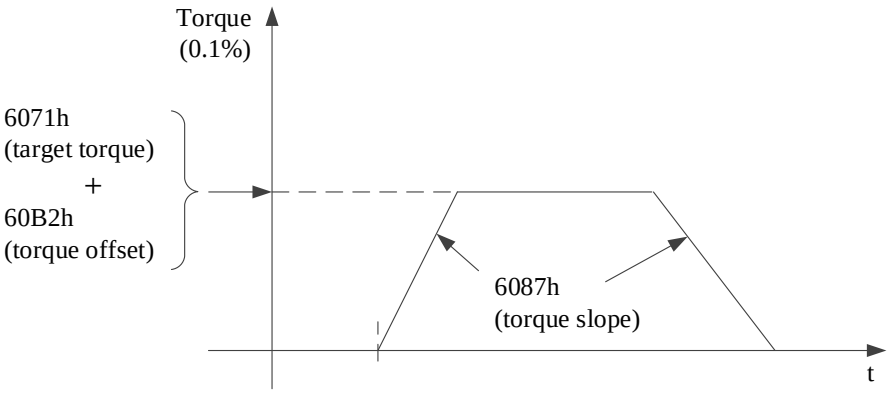
The target torque is 6071h (target torque), the torque slope is 6087h (torque slope), the maximum speed is limited by 6080h (max motor speed), the minimum value in 6072h (max torque), 2312h (P3-28), 2313h (P3-29) limits the maximum torque (P3-28, P3-29 here are the setting parameter addresses of Xinje DS5C series servo), torque offset (60b2h) (not supported temporarily).

Operation steps:

① Turn off the motor enabling, set the COE object word 6060 as 4, set the target torque of 6071h (target torque), the maximum speed of 6080h (max motor speed) and the maximum torque of 6072h (max torque);

② Turn on the motor enabling, the motor shall increase the output torque according to the set torque slope until

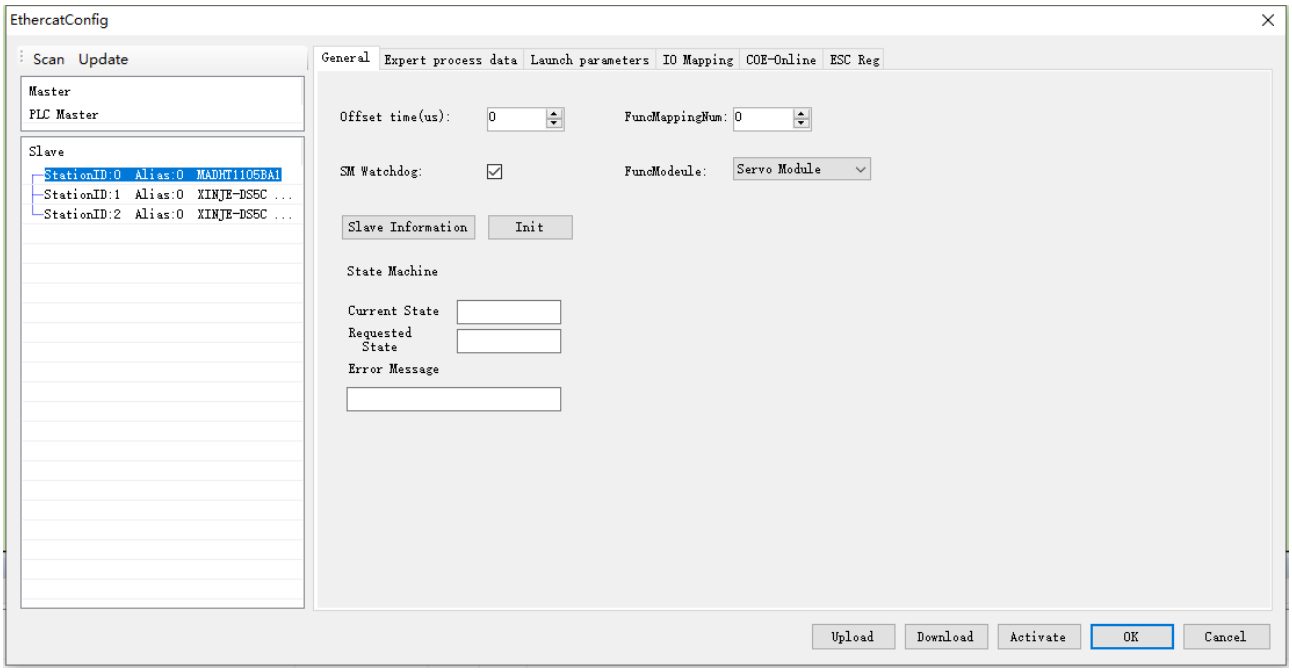
the set value and the speed does not exceed the set maximum speed.



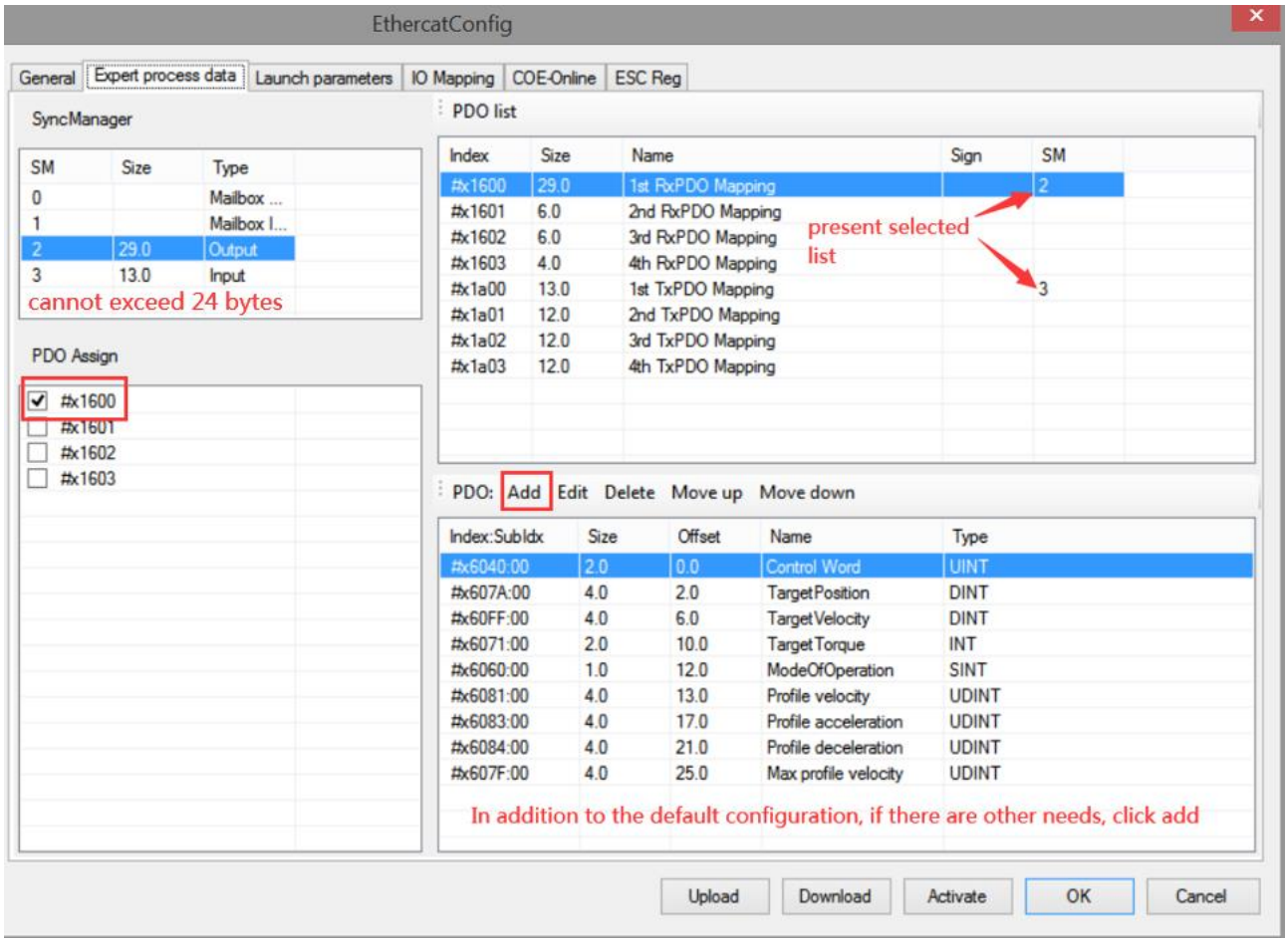
5. Operation example

Take connecting Panasonic servo and Xinje DS5C servo as an example.

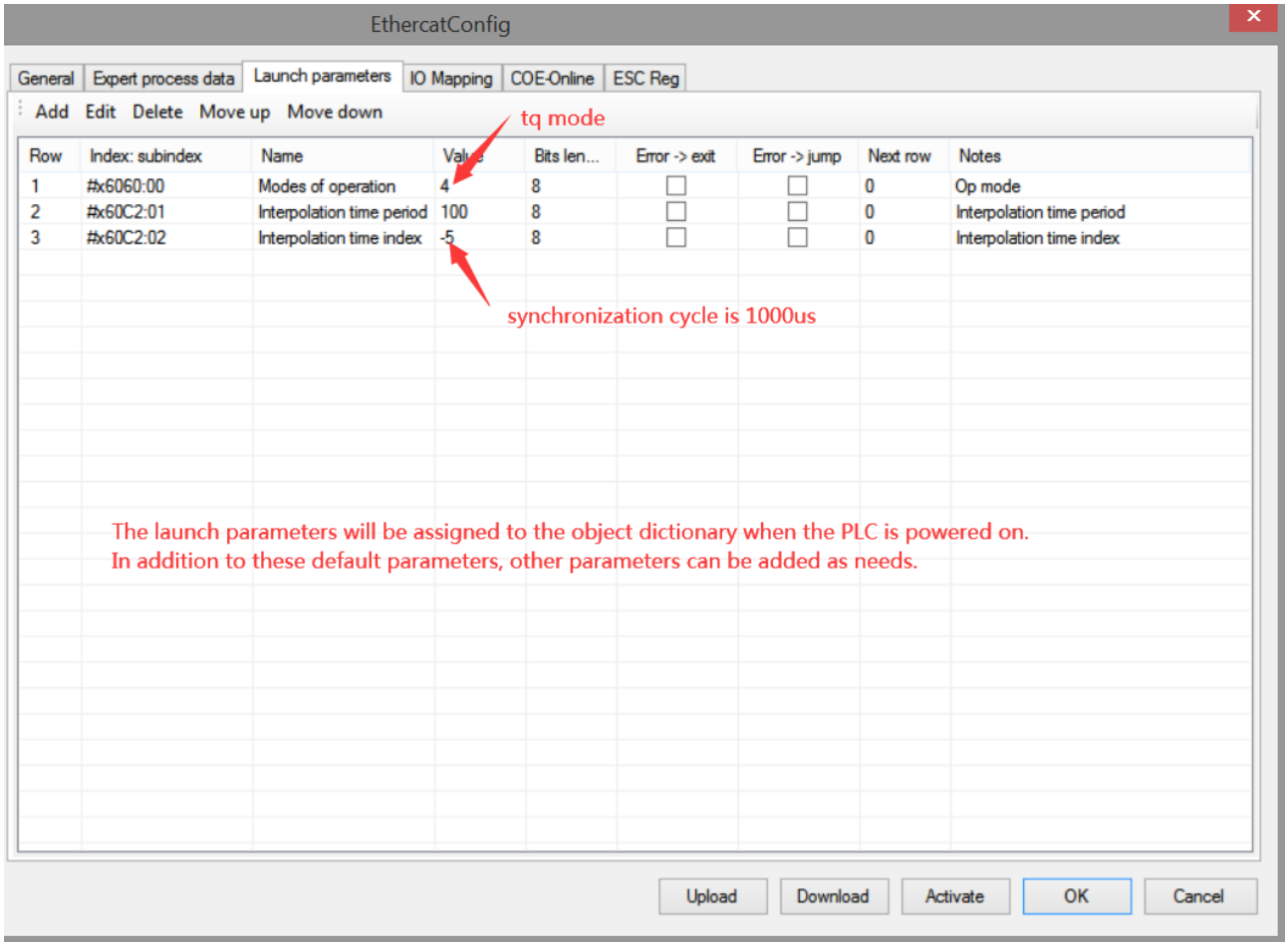
① Click [scan] or [add] in the Ethercat interface, [general] interface please keep default settings.



② Choose 1600, 1A00 in [expert process data]→[PDO assign], PDO parameters associated with the mode can be added (1600 and 1A00 can not be added more than 24 bytes respectively).

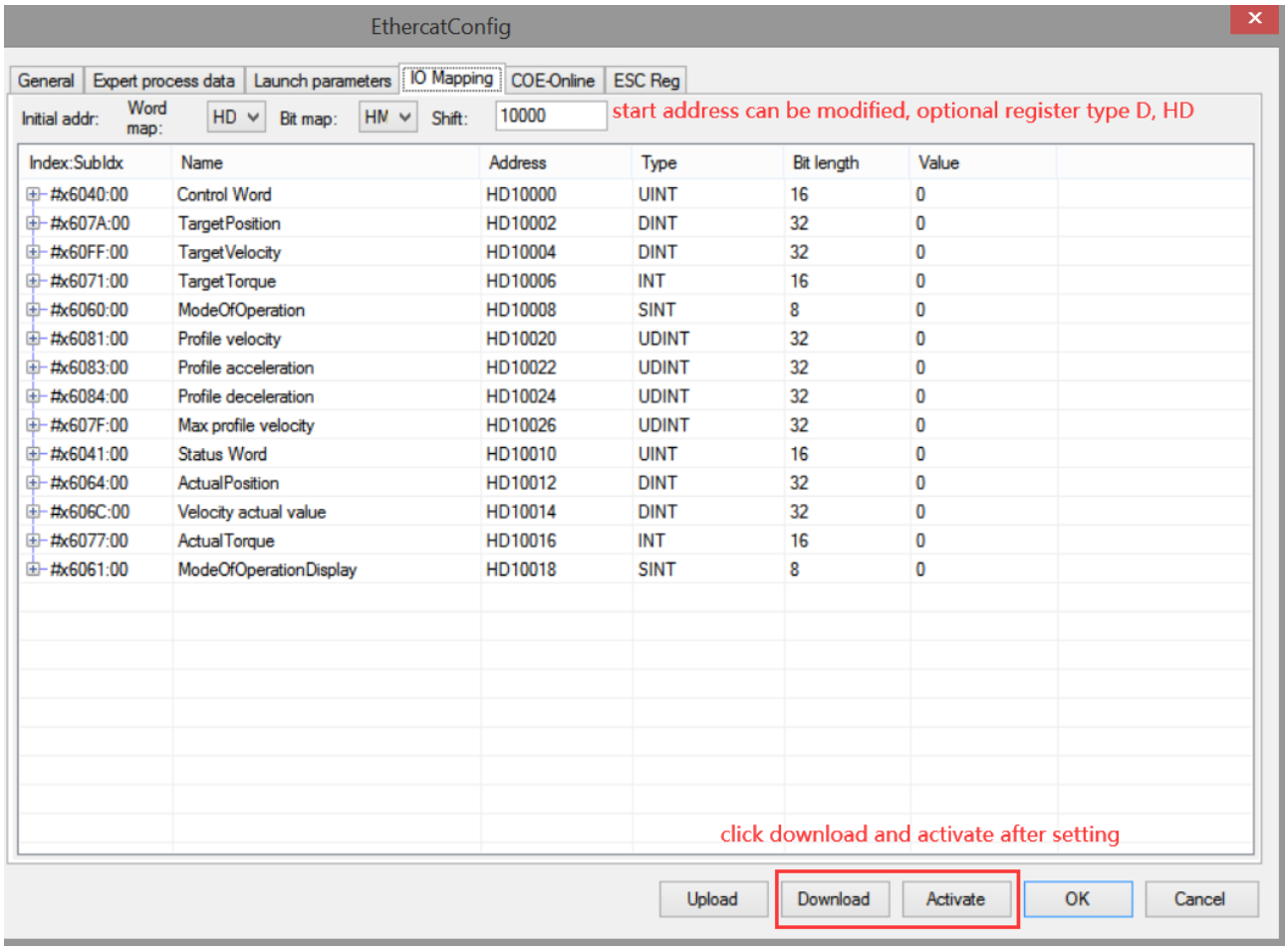


③ confirm the value of 6060h in [launch parameters] is 4.



④ The starting address of [IO mapping] can be customized.

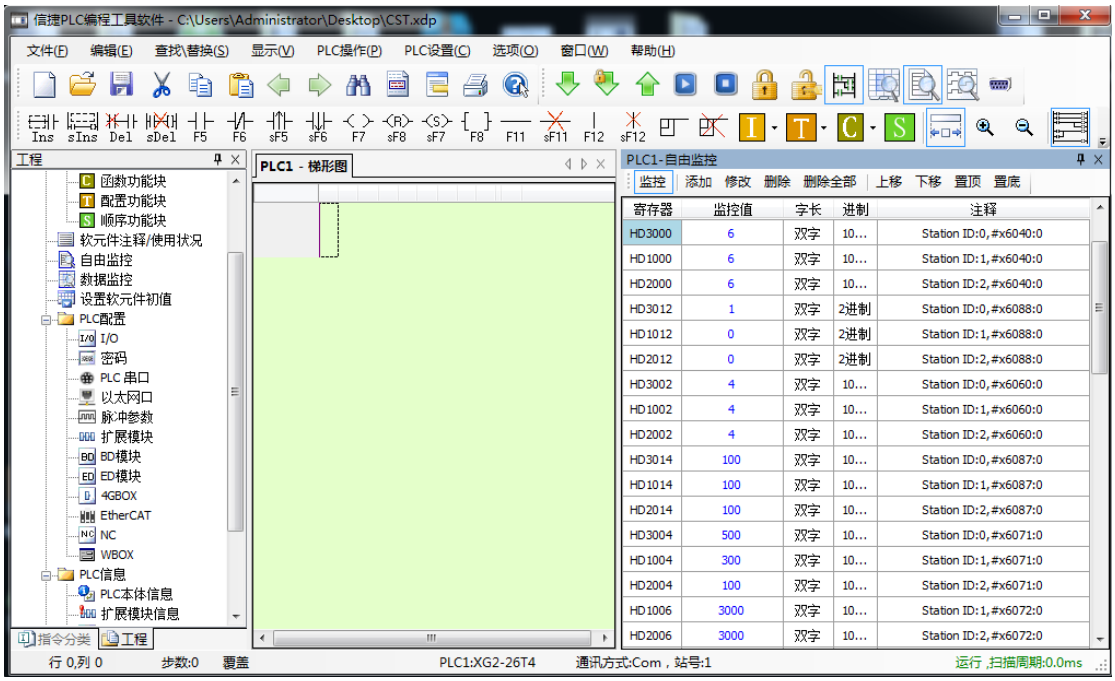
⑤ After parameter configuration, click [download] – [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the OP status, at this time, SDO and PDO can receive and send messages.

⑦ Modify the control word 6040 (6 → 15) to enable the slave station, and make the motor move by setting the target torque, torque slope and other parameters.

⑧ In Tq mode, you can set and monitor data through I/O mapping address. For example, the control word of axis 1 can be modified by HD3000 (mapping of 6040h) to enable or disable the motor, the actual torque of current motor of axis 1 can be monitored by HD3026 (mapping of 6077h), and the torque slope of axis 1 can be set by HD3014 (mapping of 6087h).



6-2-8. Mode switching

The mode switching function is to switch between three position control modes (CSP, PP, HM) in the servo enabled state, which is convenient for users to realize multi-mode switching control in project engineering.
The specific functions are as follows:

"√" indicates that switching between modes is supported; "×" indicates that switching between modes is not supported;

Switching mode	CSP→PP	CSP→HM	PP→CSP	PP→HM	HM→CSP	HM→PP
Switching result	√	√	×	×	√	√

Note: this function is only applicable to Xinje XG2 series controller as master station and DS5C series servo as slave station at present. This function also has certain requirements for product version, as follows:

Product name	Firmware version
XG2 series PLC	V3.6x (firmware date: 20190212 and later)
DS5C series servo	V3.7.20 (firmware date: 20190222 and later)

6-2-9. Touch probe

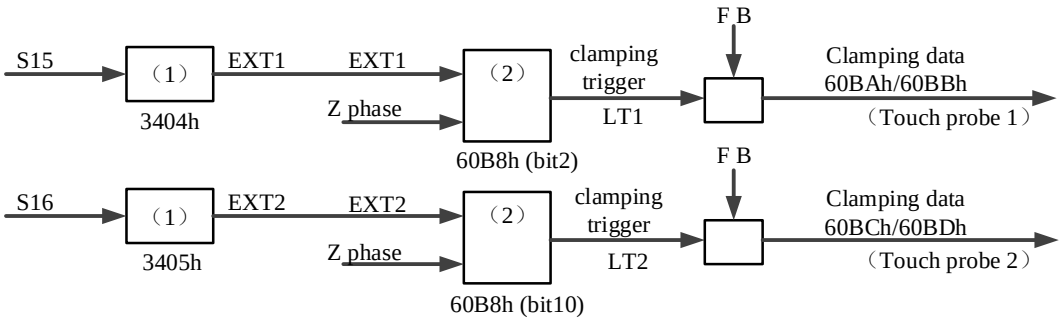
1. Function overview

The probe function is the position locking function. When the trigger condition (EXT1/ EXT2 / Z phase) is met, the probe function is triggered and the motor encoder value when the condition is triggered is locked. According to the setting of probe control word 60b8, single or multiple triggering can be realized.

Note:

(1) Probe function is not supported in hm mode.

(2) Currently, only external signals are supported as trigger sources.



Composition of touch probe functions

If the trigger position is at the same point of motor rotation for one cycle, the difference between the two latched probe values in theory shall be the number of pulses emitted by motor encoder for one cycle.

It should be noted that it takes a certain time from the generation of external trigger signal to the reception of signal by driver and the execution of latch operation. Therefore, the value of probe latch must have error with the actual value, and the error size is related to motor speed, hardware performance and software processing.

2. Touch probe related objects

Register	Explanation	Unit
RXPDO[0x60B8]	Touch probe function Execute the function setting of touch probe	-
TXPDO[0x60B9]	Touch probe status Indicates the status of the touch probe function	-
TXPDO[0x60BA]	Touch probe pos1 pos value Indicates the clamping position of the rising edge of touch probe1	Command unit
TXPDO[0x60BB]	Touch probe pos1 neg value Indicates the clamping position of the falling edge of touch probe1	Command unit
TXPDO[0x60BC]	Touch probe pos2 pos value Indicates the clamping position of the rising edge of touch probe2	Command unit
TXPDO[0x60BD]	Touch probe pos2 neg value Indicates the clamping position of the falling edge of touch probe2	Command unit

3. Touch probe function setting (60B8h)

The start of touch probe action, basic objects for various settings.

Corresponding bit Description:

Bit	Value	Explanation	
0	0	switch off Touch probe 1	Touch probe1 stop/run
	1	enable Touch probe 1	
1	0	Trigger first event	Touch probe1 time mode selection (single trigger / continuous trigger)
	1	Continuous	
2	0	Trigger with Touch probe1 input	Touch probe1 trigger mode selection (external input / Z phase)
	1	Trigger with zero impulse signal of position encoder	
3	-	Reserved	not used
4	0	switch off sampling at positive edge of touch probe1	Touch probe1 rising edge selection
	1	enable sampling at positive edge of touch probe1	
5	0	switch off sampling at negative edge of touch probe1	Touch probe1 falling edge selection
	1	enable sampling at negative edge of touch probe1	

6-7	-	reserved	Not used
8	0	switch off Touch probe 2	Stop/run Touch probe2
	1	enable Touch probe 2	
9	0	Trigger first event	Touch probe2 event mode selection (single trigger / continuous trigger)
	1	Continuous	
10	0	Trigger with Touch probe2 input	Touch probe2 trigger selection (external input / Z phase)
	1	Trigger with zero impulse signal of position encoder	
11	-	Reserved	Not used
12	0	switch off sampling at positive edge of touch probe2	Touch probe2 rising edge selection
	1	enable sampling at positive edge of touch probe2	
13	0	switch off sampling at negative edge of touch probe2	Touch probe2 falling edge selection
	1	enable sampling at negative edge of touch probe2	
14-15	-	reserved	Not used

Note:

(1) At present, Z-phase trigger mode is not supported, only external signal is supported as trigger source;

(2) For the same probe, do not set the rising edge and the falling edge at the same time.

4. Touch Probe status (60B9h)

Indicates the status of the touch probe function.

Corresponding bit description:

Bit	Value	Explanation	
0	0	Touch probe1 is switch off	Probe 1 action stop
	1	Touch probe1 is enabled	Probe 1 in action
1	0	Touch probe1 no positive edge value stored	Rising edge probe 1 not completed
	1	Touch probe1 positive edge value stored	Rising edge probe 1 completed
2	0	Touch probe1 no negative edge value stored	Falling edge probe 1 not completed
	1	Touch probe1 negative edge value stored	Falling edge probe 1 completed
3-5	-	reserved	Not used
6-7	-	Not supported	Not used
8	0	Touch probe2 is switch off	Probe 2 action stop
	1	Touch probe2 is enabled	Probe 2 in action
9	0	Touch probe2 no positive edge value stored	Rising edge probe 2 not completed
	1	Touch probe2 positive edge value stored	Rising edge probe 2 completed
10		Touch probe2 no negative edge value stored	Falling edge probe 2 not completed
		Touch probe2 negative edge value stored	Falling edge probe 2 completed
11-13	-	Reserved	Not used
14-15	-	Not supported	Not used

5. Touch probe action startup

When bit0/bit8 of 60B8h (touch probe function) is from "0 (stop) → 1 (start)", obtain various setting conditions (60b8h: bit1 ~ 7 / bit9 ~ 15), and start touch probe action.

To make the changes of various setting conditions valid, bit0 / bit8 please return to "0 (stop)" and then to "1 (start)" again.

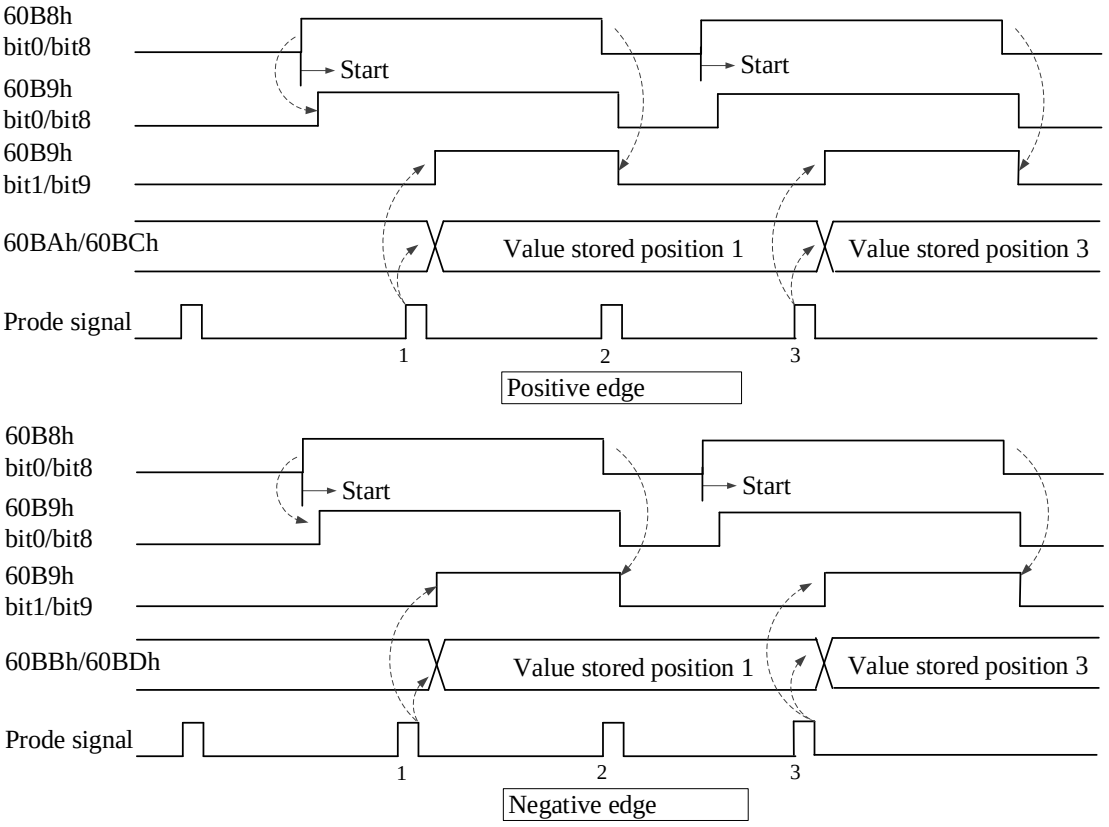
To switch the control mode then to use the probe function, also return bit0 / bit8 to "0 (stop)" and then to "1 (start)" again.

6. Touch probe event mode

According to bit1 / bit9 (event mode selection) of 60B8 (touch probe function), you can select "0 (trigger first event single triggering mode)" and "1 (continuous triggering mode)".

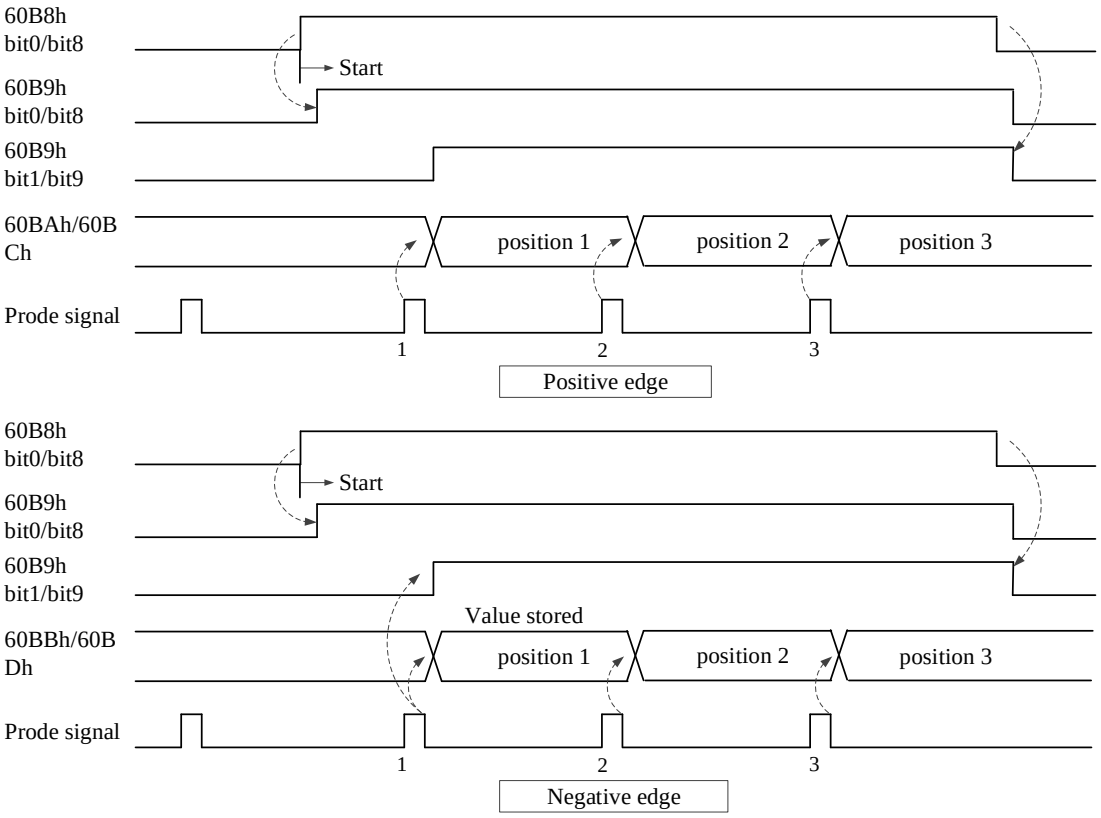
(1) Trigger first event single triggering mode (60B8: bit1=0/bit9=0)

After startup, only the first trigger signal is embedded in the mode. To get it again, it is necessary to start touch probe again.



(2) Continuous triggering mode (60B8: bit1=0/bit9=0)

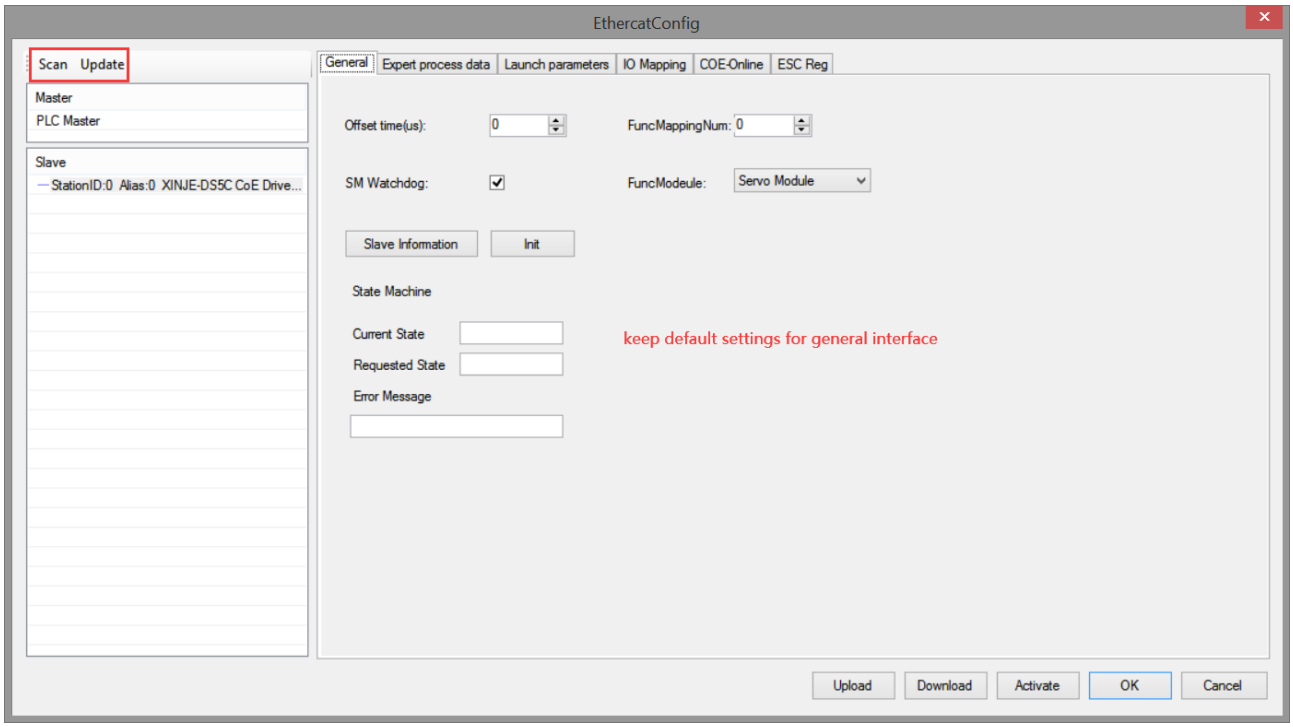
After startup, the mode detecting out trigger signal embedding every time. The acquired value is held to the next coming probe signal.



7. Operation example: (take Xinje DS5C servo as an example)

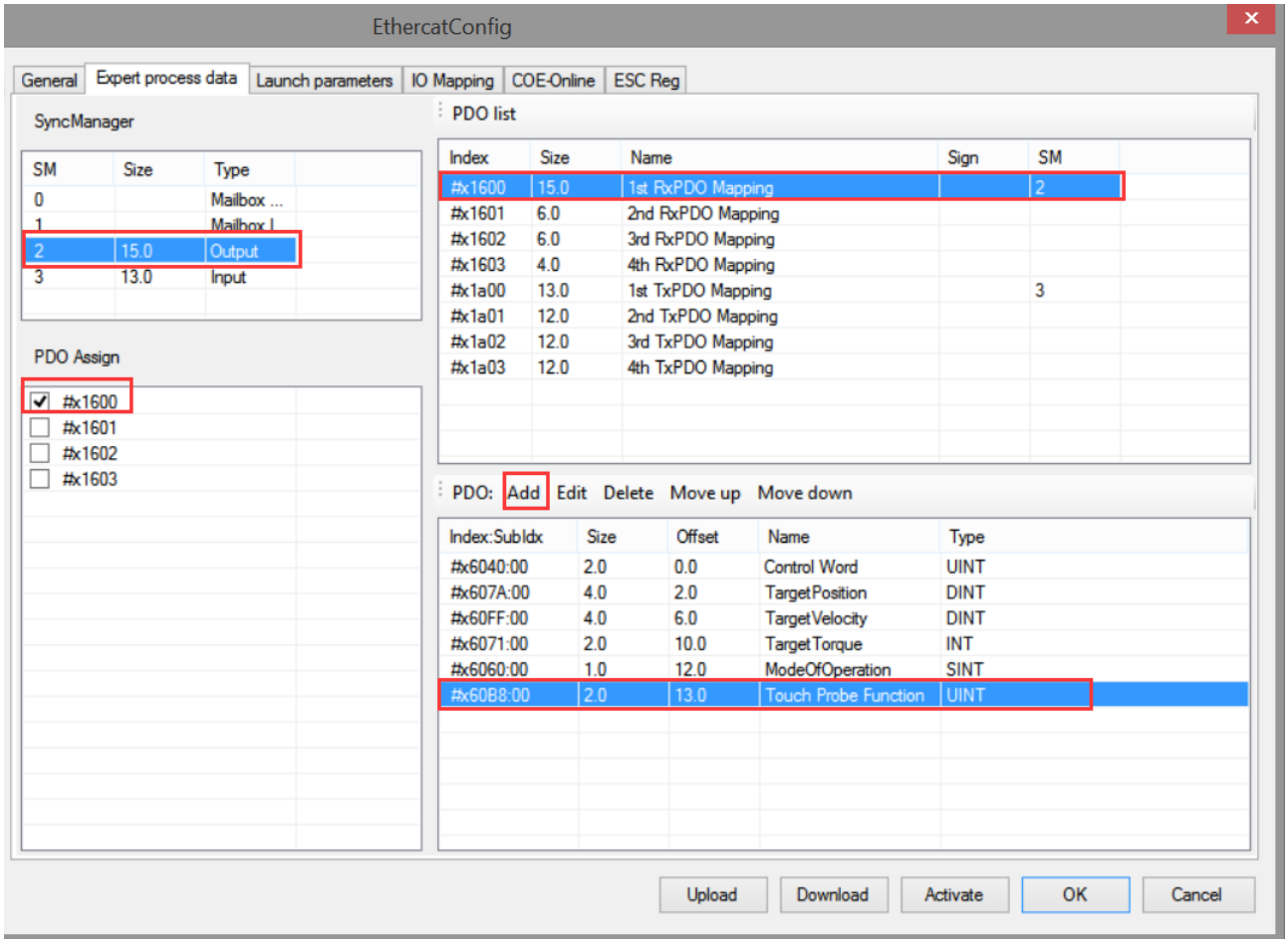
① External wiring and probe terminal assignment: P5-62 and P5-63 are used for terminal assignment of probe function, probe1 can only be assigned to P-, probe2 can only be assigned to D- (in bus control mode, P- and D- of servo driver can only be used as probe terminals), when P- is assigned, write 5 in P5-62, and when D- is assigned, write 6 in P5-63.

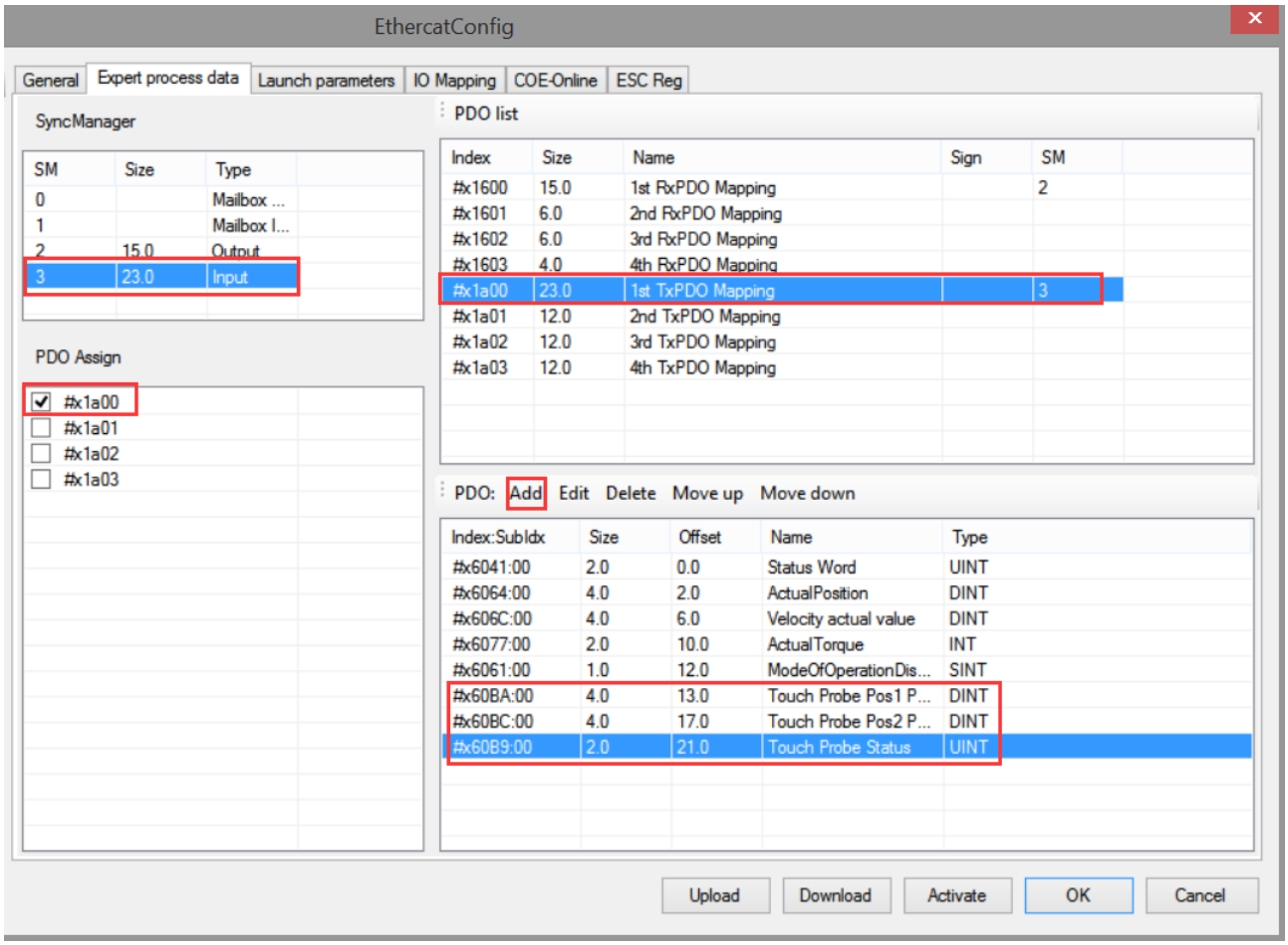
② click [scan] or [add] in Ethercat interface, [general] interface please keep default settings.



③ When the signal connected to the driver P- or D- jumps, the probe function is triggered and the probe value is locked in the corresponding COE object word 0x60BA ~ 0x60BD. When reading the probe value, you need to add the corresponding probe value object (0x60BA-0x60BD) to TxPDO for data collection.

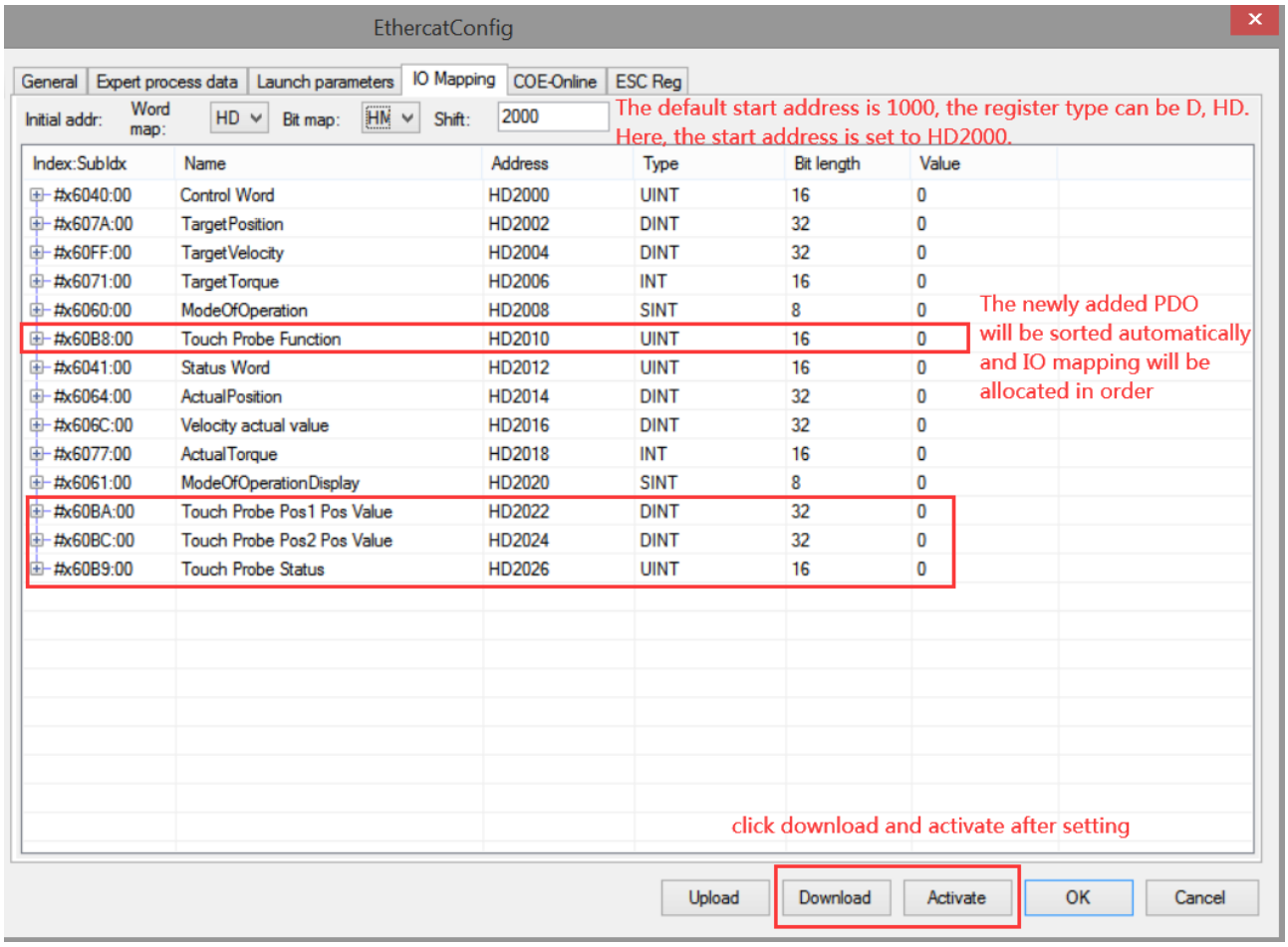
Choose 1600 and 1A00 in [expert process data] → [PDO assign], add 60B8h in 1600, add 60BAh and 60BCh in 1A00 (here, take collecting the rising edge of two probe signals as an example, if collecting the falling edge, add 60BBh and 60BDh).





④ [IO mapping] default starting address is HD1000, which can be changed if necessary.

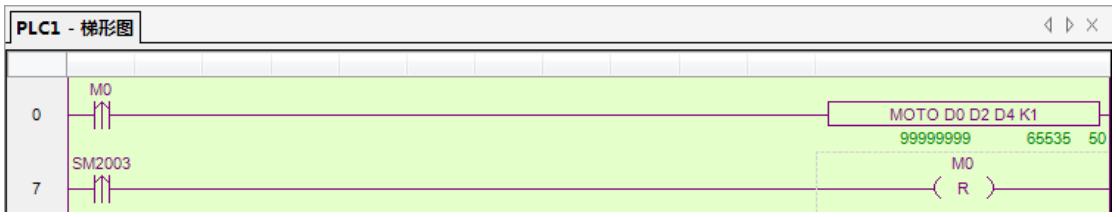
⑤ After parameter configuration, click [download] – [activate]. After activation, the parameters will take effect.



⑥ After activation, the slave station state machine (SD8021) will go from 1 → 2 → 4 → 8, 8 indicates the OP status, at this time, SDO and PDO can receive and send messages.

⑦ After SM2010 is set to on to enable the slave station, the probe function can be started by modifying HD2010 (mapping of 69B8h).

⑧ After the probe function is started, the rising edge embedding value of probe 1 can be monitored by HD2022 (mapping of 60BAh), the rising edge embedding value of probe 2 can be monitored by HD2024 (mapping of 60BCh), the status of current probe can be monitored by HD2026 (mapping of 60B9h), the current actual position of motor can be monitored by HD2014 (mapping of 6064h), and the current actual speed can be monitored by HD2014 (mapping of 606Ch).



寄存器	监控值	字长	进制	注释
SM2010	ON	位	-	轴1使能
HD2008	8	单字	10进制	Station ID:0,#x6060:0
HD2010	1 0011 0001 0011	双字	2进制	Station ID:0,#x60B8:0
HD2026	1 0000 0001	双字	2进制	Station ID:0,#x60B9:0
HD2014	13	双字	10进制	Station ID:0,#x6064:0
HD2016	-16	双字	10进制	Station ID:0,#x606C:0
HD2022	0	双字	10进制	Station ID:0,#x60BA:0
HD2024	0	双字	10进制	Station ID:0,#x60BC:0
D0	99999999	双字	10进制	指定轴1的相对位置
D2	65535	双字	10进制	指定轴1的运动速度
D4	50	双字	10进制	指定轴1的加减速时间

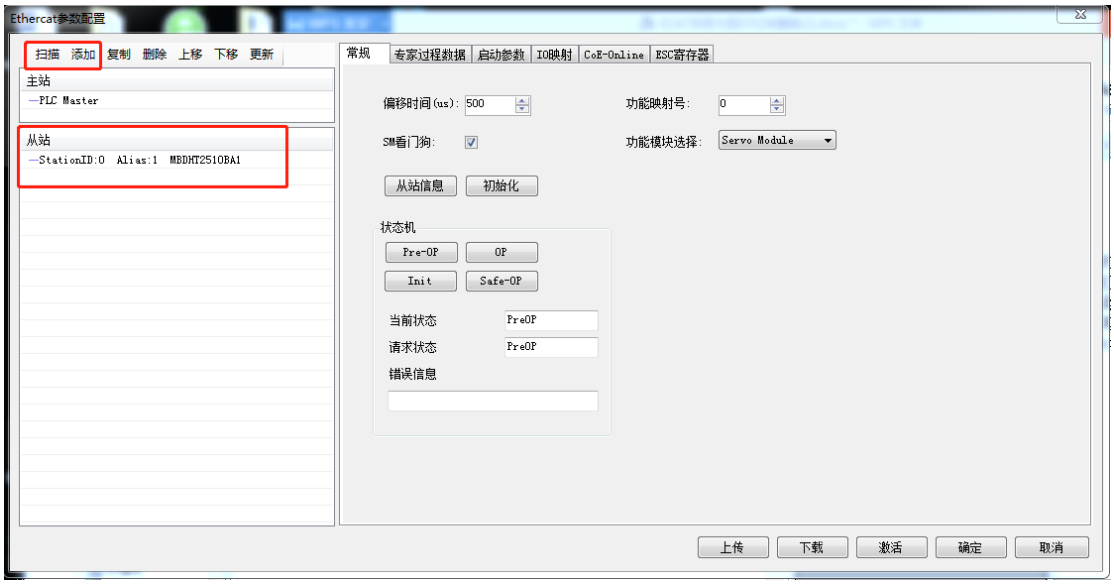
6-3. Application of other brands slave station

Take the configuration of Panasonic servo and CSP mode as an example.

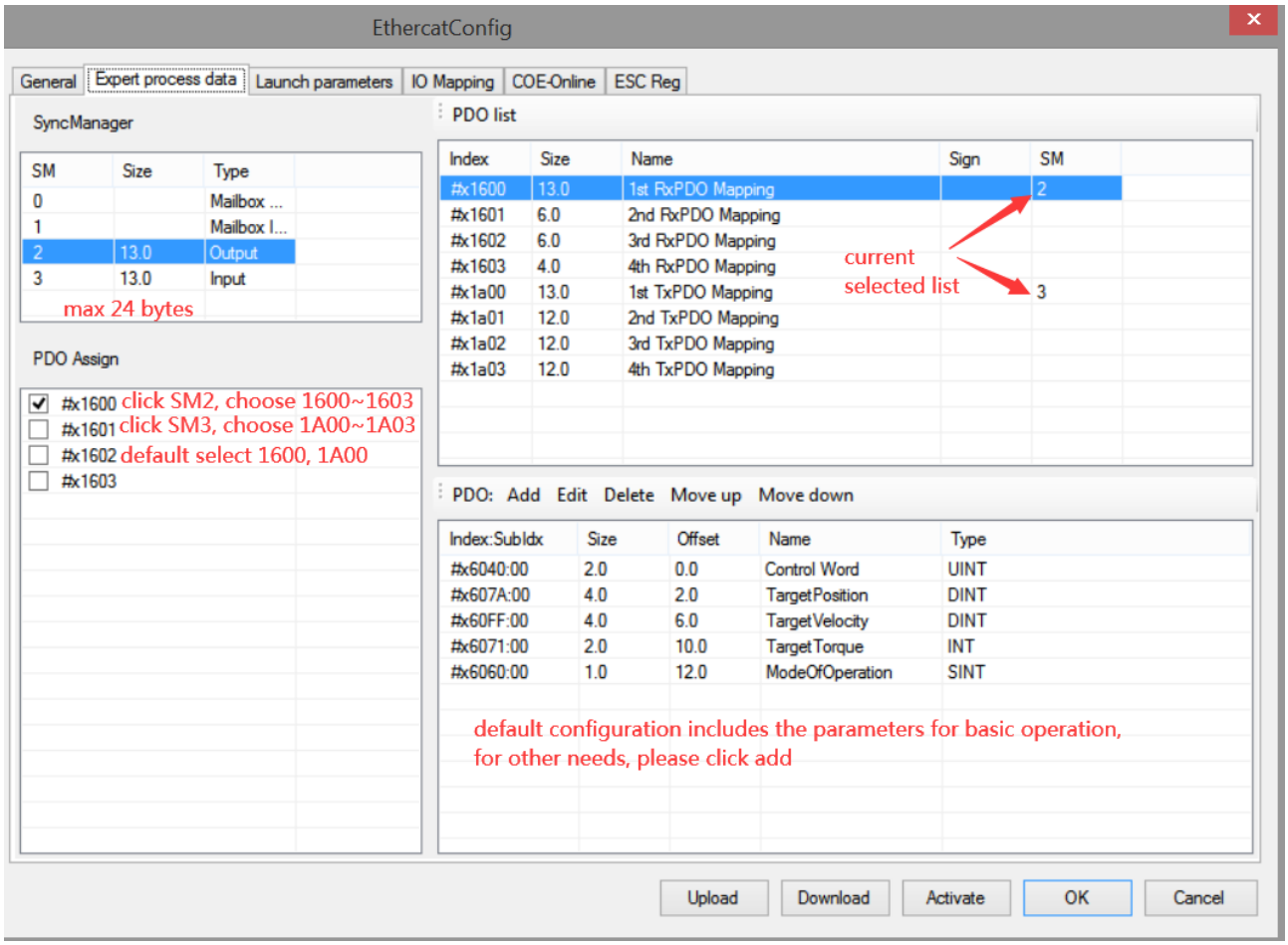
① Connect the XG2 host with the Panasonic servo in the same way as the communication structure diagram described in section 1-4.

② In the case of confirming the normal communication between PLC and Xinje PLC programming tool software, click [scan] or [add] slave station on the EtherCAT interface, and the [general] interface uses the default configuration.

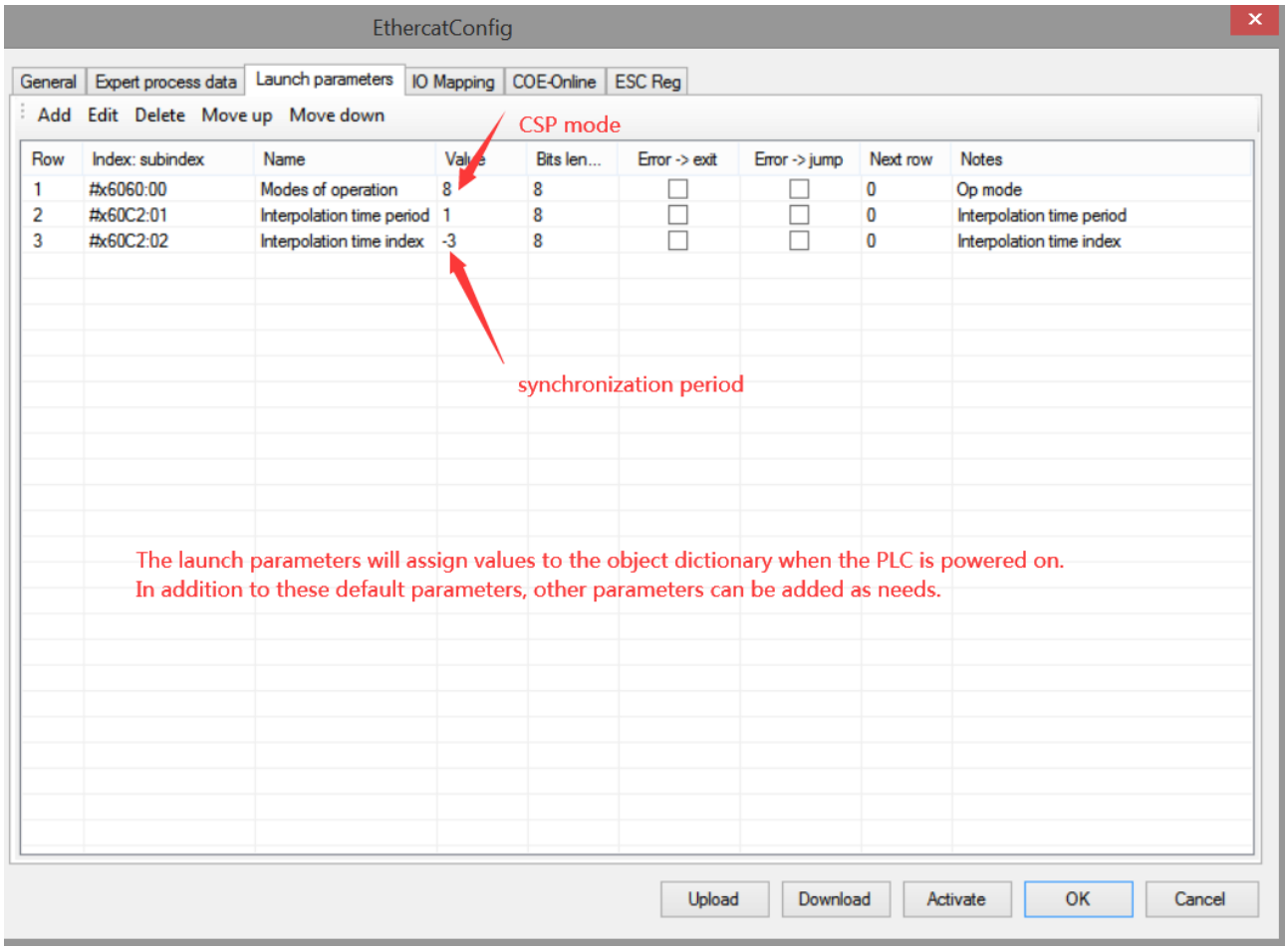
Note: [scan] to obtain the topology of the current slave, it will try to read the EEPROM and object dictionary of the slave to generate temporary XML. If there is a ready-made XML file locally (it exists in the EtherCAT/ folder under the XDPpro installation directory), you can directly [add] it to the list of slave stations without stopping the PLC.



③ choose 1600, 1A00 in [expert process data] → [PDO assign]. (The default configuration can meet the basic use of CSP, and other PDO parameters can be added if necessary)

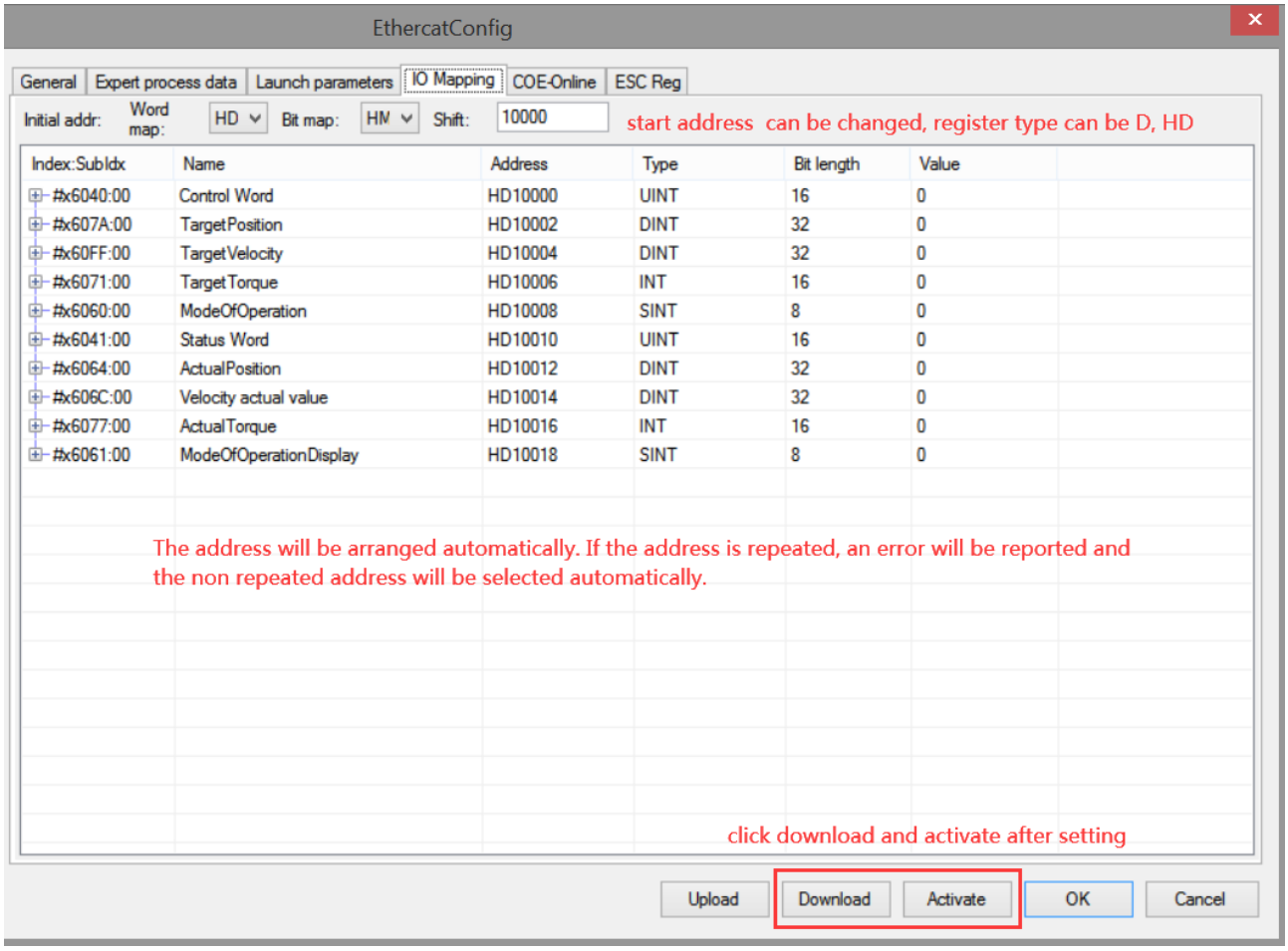


④ Confirm the value in【Launch parameters】6060h is 8.



⑤【IO mapping】default start address is HD1000, it can be changed as needs.

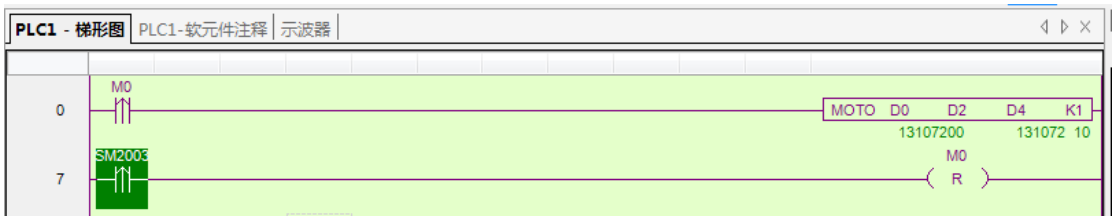
⑥ After parameter configuration, click [download] – [activate]. After activation, the parameters will take effect.



⑦ After activation, the slave state machine (SD8021) will change from 1 → 2 → 4 → 8, and 8 represents OP state. At this time, SDO and PDO can receive and send message

⑧ Set SFD3000 to 0, set SM2010 on to enable the slave station (if set on SM2010 as soon as power is on, the slave station will be enabled after the master station status (SD8000) is switched to 8), and make the motor run through Xnet motion control commands (MOTO, MOTOA, etc.).

⑨ In CSP mode, HD1002 (mapping of 607Ah) can be used to monitor the current given position, HD1012 (mapping of 6064h) can be used to monitor the actual position of the current motor, and HD1014 (mapping of 606Ch) can be used to monitor the current actual speed.



寄存器	监控值	字长	进制	注释
HD1008	8	双字	10进制	Station ID:0,#x6060:0
HD1002	28209496	双字	10进制	Station ID:0,#x607A:0
HD1012	28209496	双字	10进制	Station ID:0,#x6064:0
HD1014	60	双字	10进制	Station ID:0,#x606C:0
SM2010	ON	位	-	轴1使能
D0	13107200	双字	10进制	指定轴1的相对位置
D2	131072	双字	10进制	指定轴1的运动速度
D4	10	双字	10进制	指定轴1的加减速时间
SD2008	13107199	双字	10进制	轴1当前位置
HSD104	13107202	双字	10进制	轴1目标位置反馈脉冲数
SFD3000	0	单字	10进制	轴1运行模式
SFD3001	2	单字	10进制	轴1电机类型

7. NC configuration interface

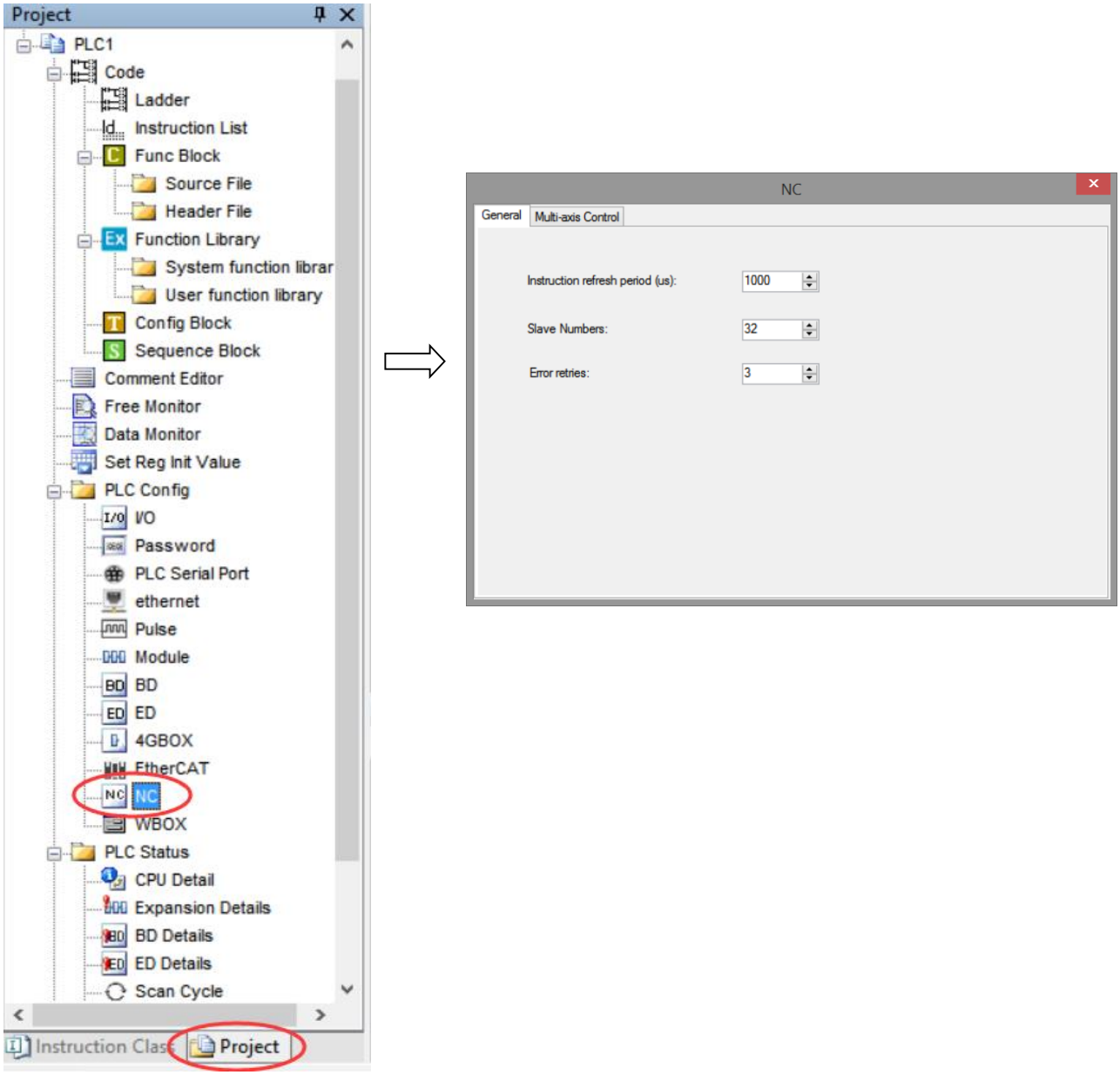
7-1. Function overview

The NC control function of Xinje PLC programming software is a pure software motion control based on PC. Its function is similar to the traditional motion control module and motion control card. Because NC and PLC run on the same CPU, the data exchange between motion control and logic control is more direct and fast, NC is more flexible and powerful than traditional motion controller. Due to the powerful function of bus motion control, more parameters are involved. This function is specially developed to facilitate customers to configure parameters of all axis registers of slave station.

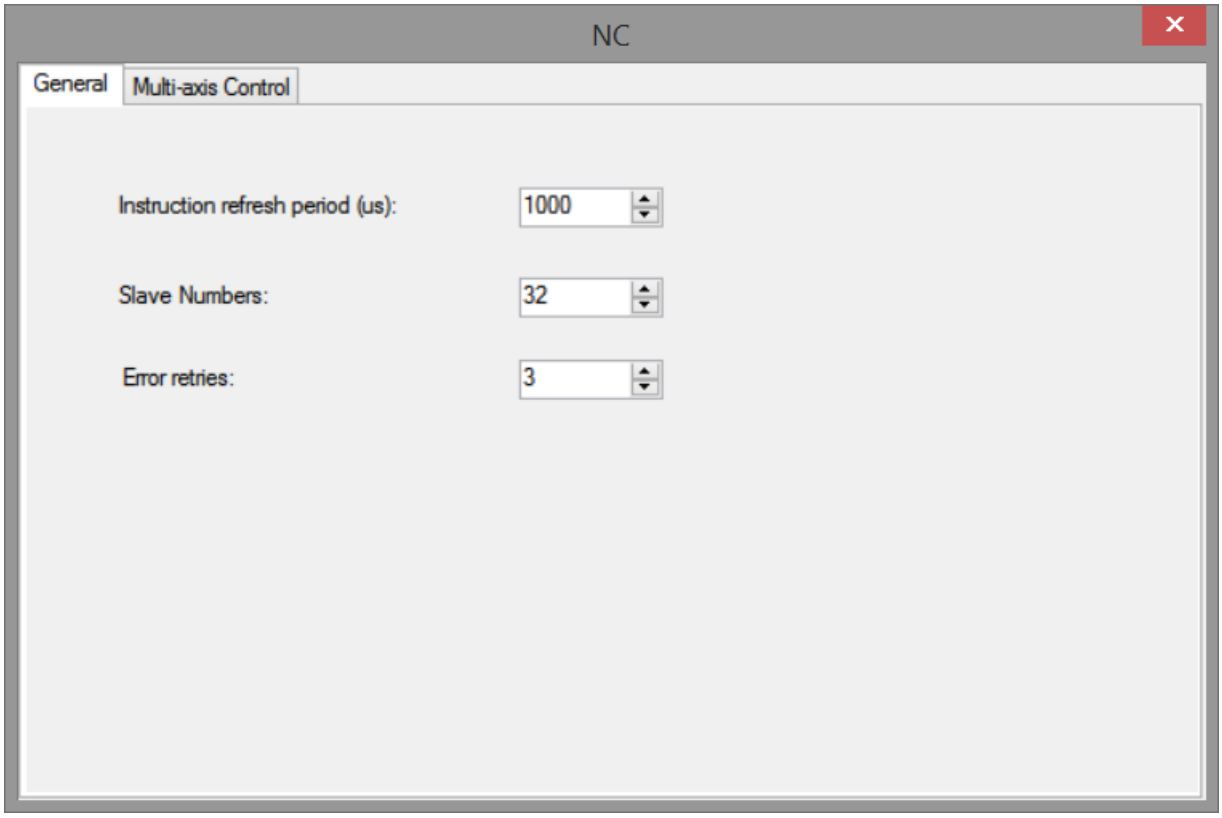
7-2. Function description

7-2-1. Open NC

When the Xinje PLC programming software is opened and the PLC is successfully connected, open [Project] → [NC], and a communication configuration interface will pop up.



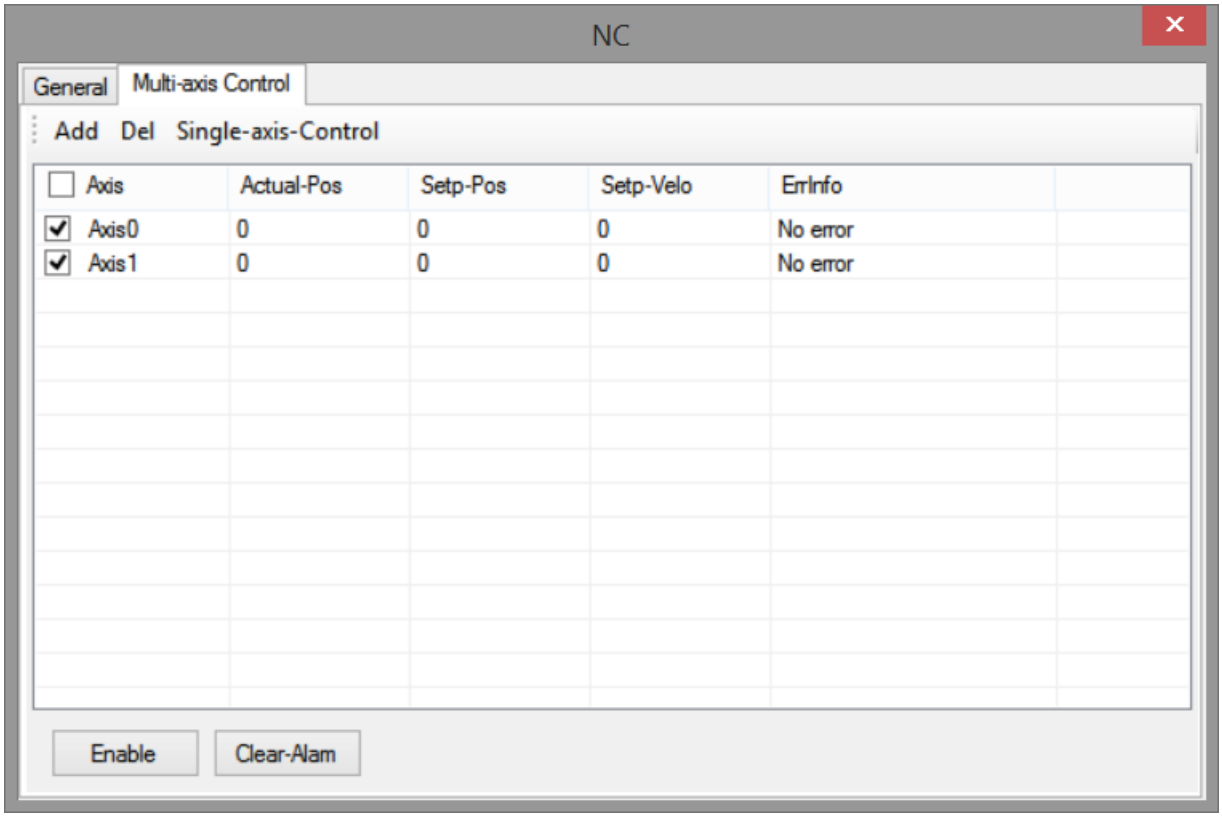
7-2-2. General interface



The value of the function interface will be refreshed in real time.

Parameter	Explanation
Instruction refresh period	Synchronization unit period. That is, the time interval between master station and slave station which can be monitored by SFD2990.
Slave numbers	Range 1~32, can be monitored by SFD991.
Error retries	Can be monitored by SFD2992.

7-2-3. Multi-axis control interface



Parameter	Explanation
Add	Add the axis
Del	Delete the axis
Single-axis-control	Single axis debugging for the axis selected by the mouse
Enable	Enable the axis selected by the check box
Clear-alarm	Clear the alarm for the axis selected by the check box

Note:

(1) The multi-axis debugging interface is in real-time refresh state.

(2) When enable is turned on, the check box of the axis cannot be operated.

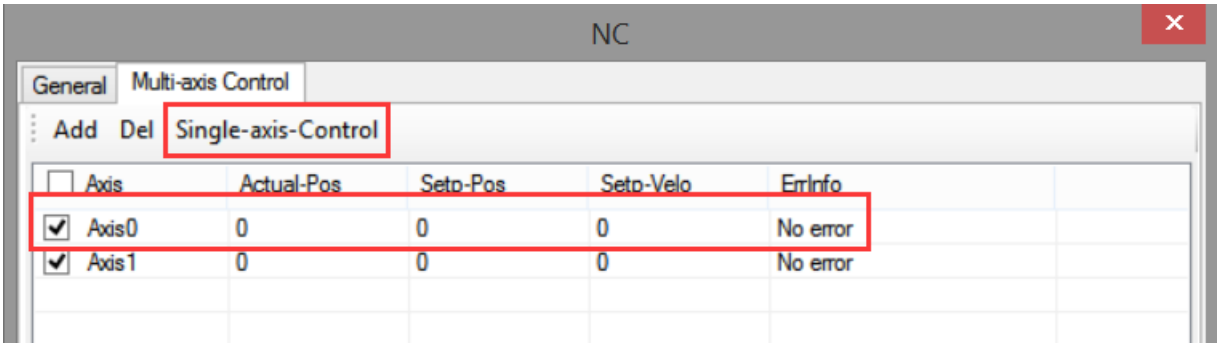
(3) When you delete an axis, you cannot delete an axis whose check box is selected.

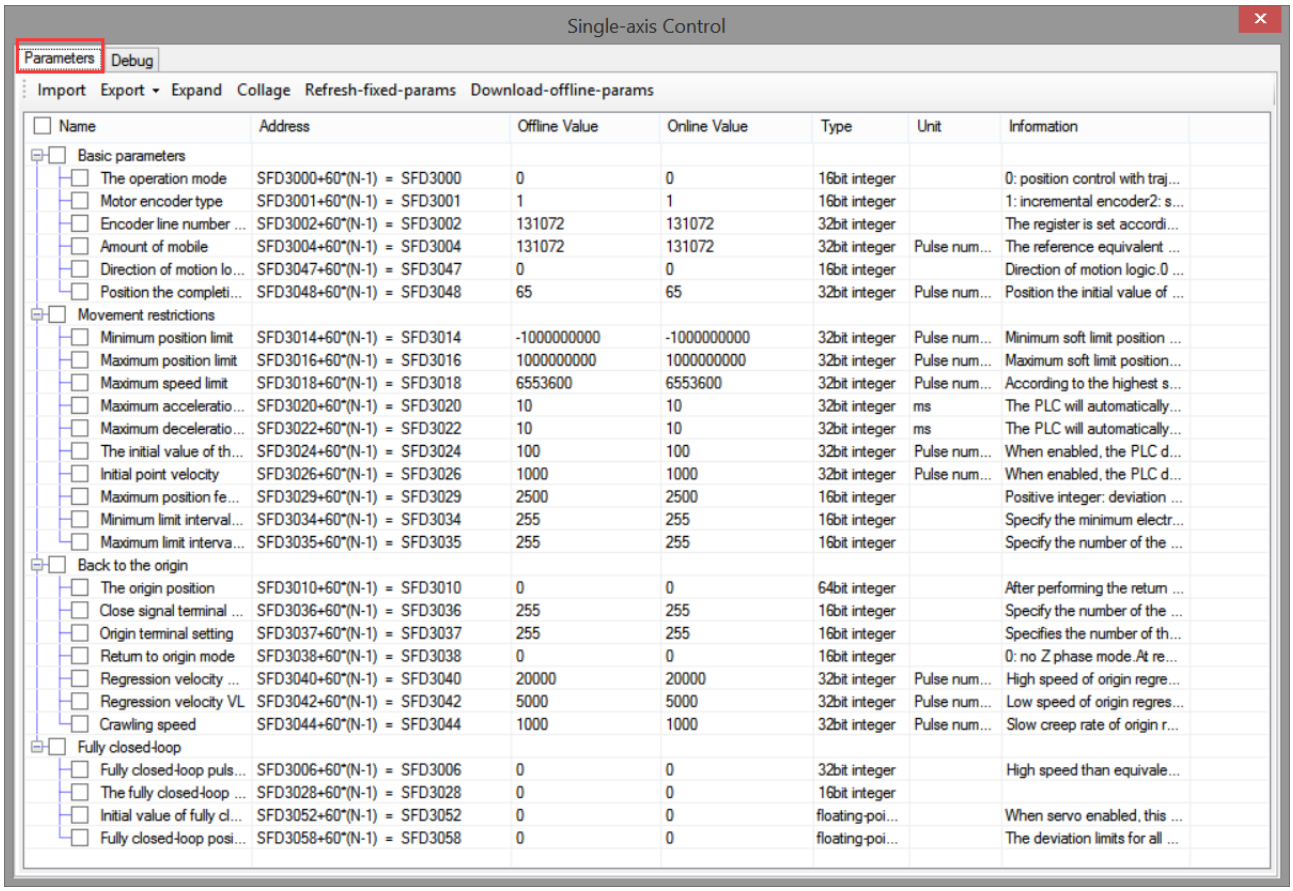
(4) Single axis debugging can also be carried out by double clicking the selected axis.

(5) Motion operations operate only on the axis selected by the check box.

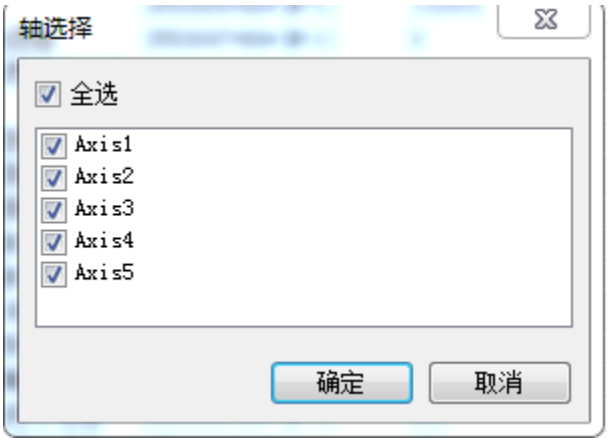
7-2-4. Single-axis-control interface

Select the axis to be debugged, and the background color of the selected axis is blue. Click [single-axis-control] to display the following interface to configure the parameters of the axis. Double click the selected axis to enter the single axis control interface.





Parameter	Explanation
Import	Import the saved single axis parameter file, and the parameters are displayed in the column of "offline value".
Export→export to file	Save the parameters selected in the check box to a file.
Export→export to axis	Copy the online value selected in the check box to one axis (can copy to multi-axis at the same time), the axis selection interface is shown below.



Parameter	Explanation
Expand	Expand to display all parameters
Collage	Only all primary nodes are displayed, not child nodes
Refresh-fixed-parameter	Refresh online values
Download-offline-parameter	Download the offline value selected in the check box to the PLC

Note:

(1) Open the interface and all parameters are not selected.

(2) If the "offline value" is not consistent with the "online value" after editing, the check box will be automatically checked; if it is consistent, the check box will be cancelled.

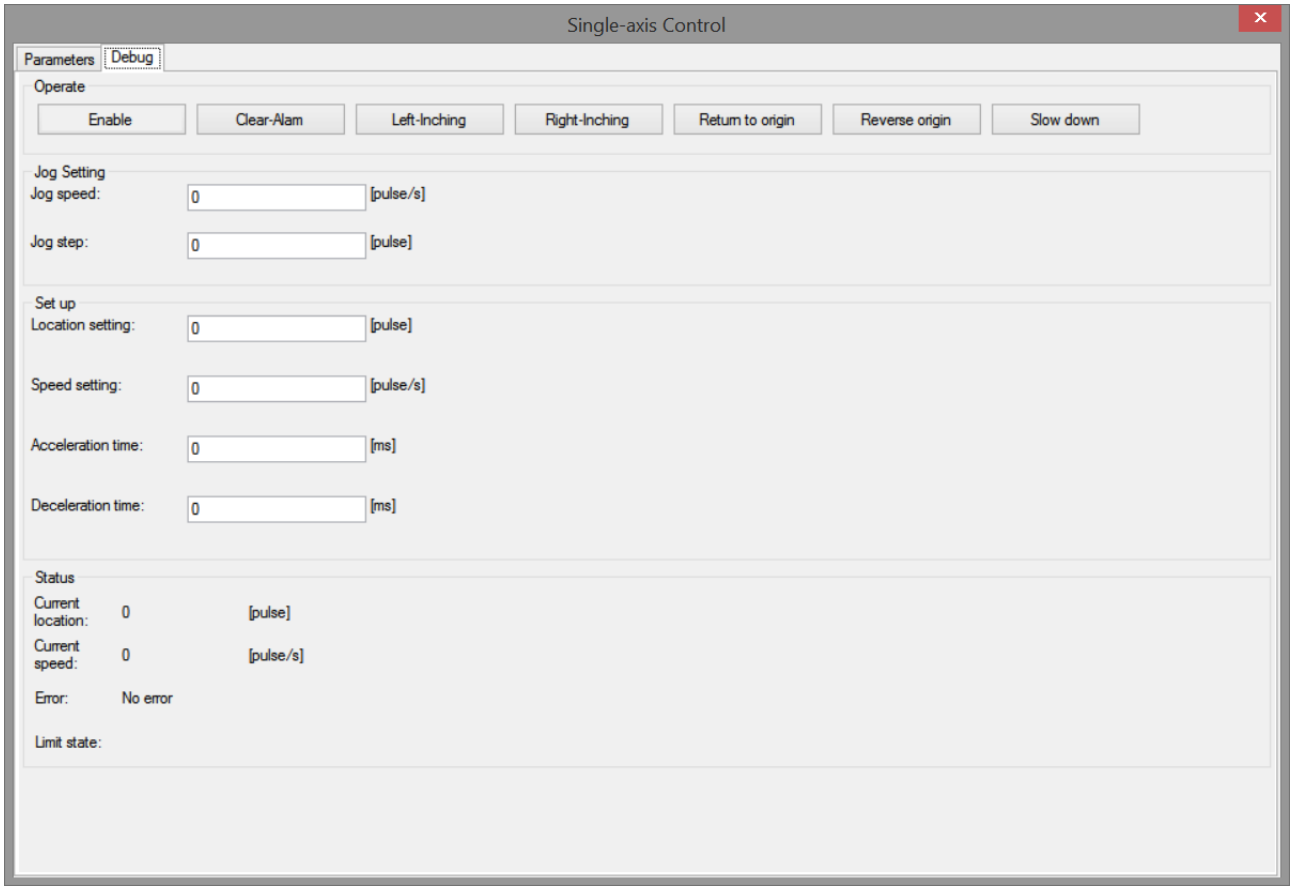
(3) At present, all parameters displayed in the interface are fixed parameters, which cannot be refreshed in real time. Click refresh fixed parameters to refresh the online values of fixed parameters.

(4) Modify the online value of the fixed parameter by modifying the offline value, and click [download offline parameter] to write the parameter value in the checked state. After writing, click refresh fixed parameter to refresh the online value of fixed parameter to check whether the modification is successful.

(5) [download offline parameters] the offline parameters downloaded are the ones selected in the check box. If they are not selected, they will not be downloaded.

(6) The exported content of the [export] function is the parameter selected in the check box. If the parameter is not selected, it will not be exported.

7-2-5. Debug interface



Parameter	Explanation
Enable	Display enable status and give enable signal at the same time
Clear alarm	Clear the alarm
Left-inching, right-inching	Jog operation
Return to origin, reverse origin	Return to origin in forward or reverse direction
Slow down	Stop as the setting deceleration time
Jog setting	Jog operation setup
Set up	Motion parameter setup
Status	Display current motion status

Note: the parameters in [jog setting] and [set up] can be modified and refreshed in real time after the drive is enabled, and can be executed according to the newly set parameters. If enable is turned off and enabled again, the data set in "online value" in "parameter configuration interface" will still be displayed.

8. Oscilloscope function

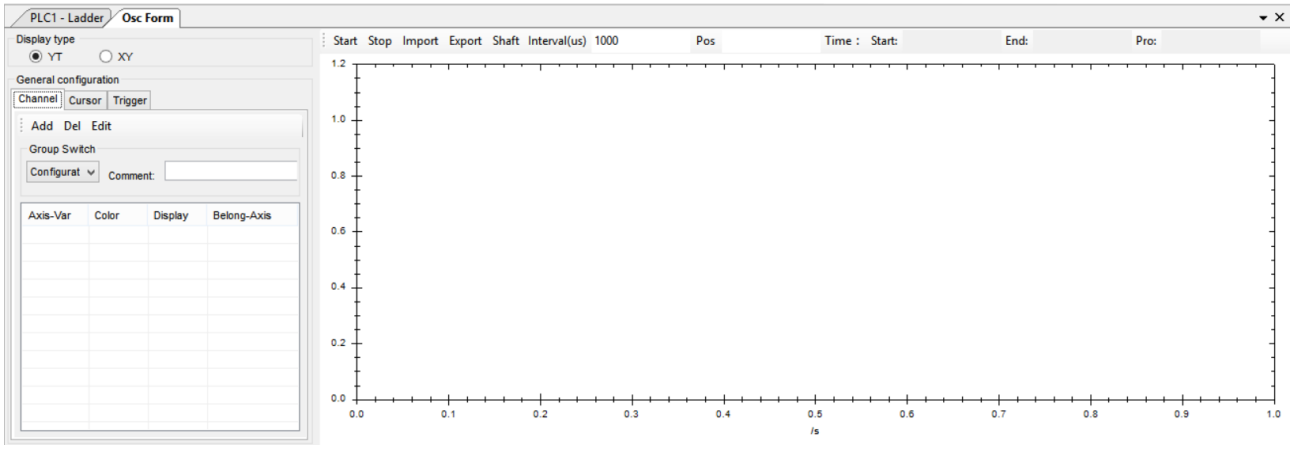
8-1. Operating conditions of oscilloscope

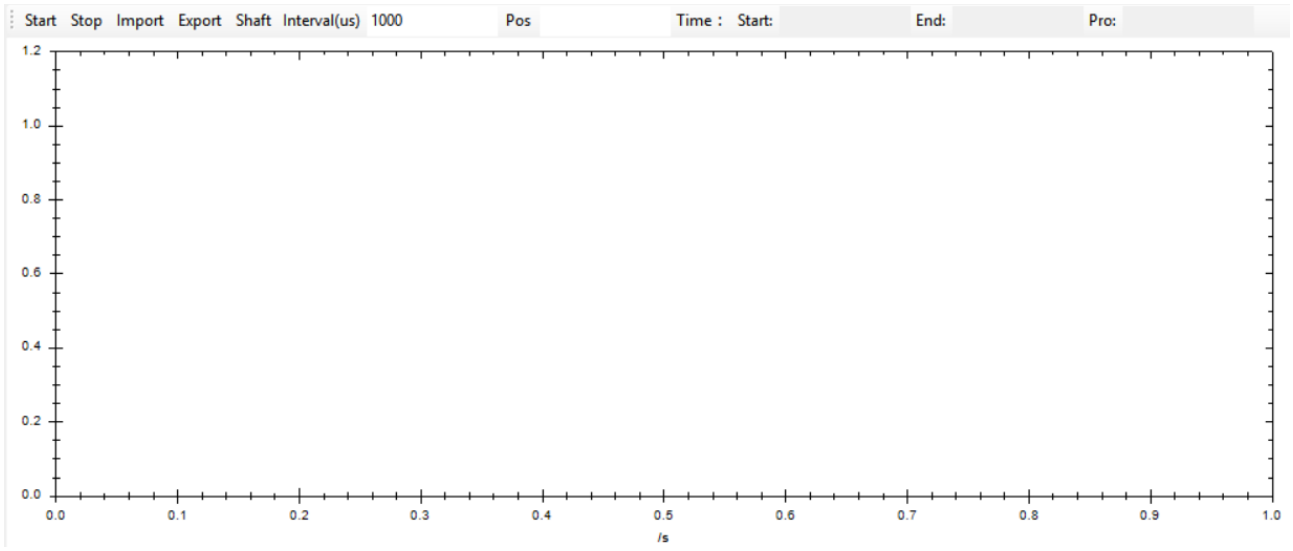
The oscilloscope function can only be used when the EtherCAT slave is connected and the programming software is in the X-NET monitoring mode.

8-2. Oscilloscope interface

Click the oscilloscope icon as shown in the figure to open the oscilloscope interface.

The interface is shown as below:





Parameter	Explanation
Start	The oscilloscope starts to work
Stop	Oscilloscope stops working
Import	Open saved oscilloscope data
Export	Save all the oscilloscope data (curve configuration, cursor, trigger, image data, oscilloscope working time, etc.) under the current situation

Shaft	Display different Y-axes of the same display area into different regions. Note: this function is valid only when the curve is configured with different axes; when there is only one axis, axis splitting cannot be realized. When the user configures different axes, multiple Y-axes are displayed. Only when there are more than one y-axis, the function of axis splitting can be realized.
Interval (us)	The time interval between the two sampling points, the unit is us (default is the value of the synchronization unit cycle in EtherCAT)
Pos	Locate a curve starting from one time or value
Time	Display start, end and oscilloscope working time

Interface operation instructions

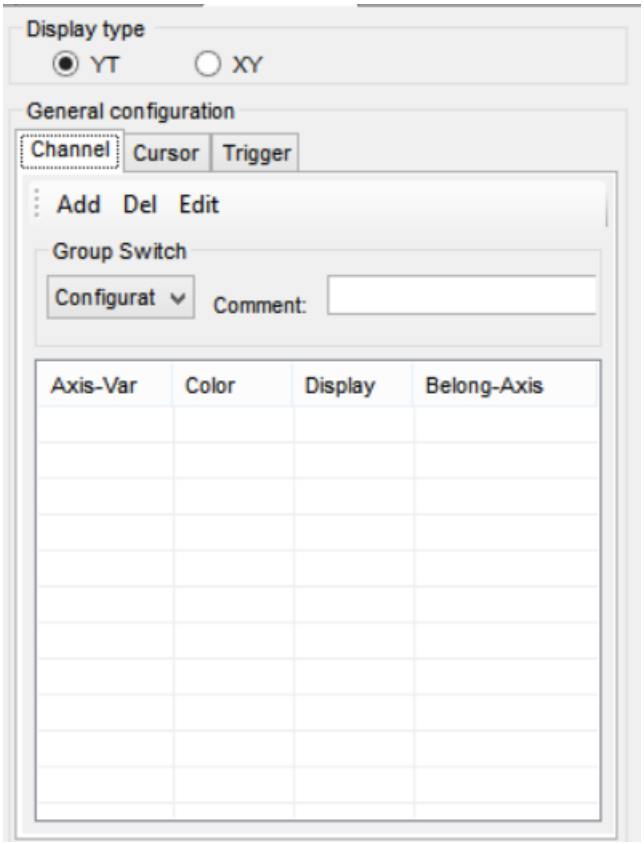
Parameter	Explanation
Zoom in	Hold the left mouse button and drag to select the area to be enlarged. The default zooming method is to zoom in both horizontally and vertically (region magnification). Right click the menu displayed in the display area to modify the zoom mode (horizontal zoom in and vertical zoom in).
Zoom out	Right click the display area and click restore to original/restore to previous zoom in the display menu to zoom out
Drag	There are three ways to drag: ① hold the Ctrl + left button, the cursor changes to hand type and drag the image; ② press and hold the middle button (wheel) of the mouse to drag the image; ③ when the horizontal zoom and vertical zoom in the right-click menu are not selected (there is no zoom function at this time), press and hold the left mouse button to drag the image.

Right mouse button function:

Parameter	Explanation
Save chart	Save the image of the current interface in picture format
Export data	Save the image data in Excel format
Restore to original scale	Display the entire curve
Display node value	When the mouse moves to a node on the curve, the coordinate axis value of the node is displayed
Restore to previous scale	The image zoom out to the previous display scale and area
Scale horizontally	Zoom in / out X axis only
Zoom vertically	Zoom in / out Y axis only (region can be zoomed only if both horizontal and vertical scaling are selected)

Note: when the interface displays data for more than one minute, the data curve before one minute will be cleared, but the data still exists. Users need to click export data in the right-click menu to view all data.

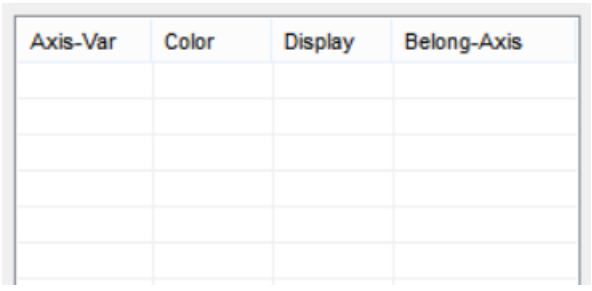
8-4. Oscilloscope configuration interface



8-4-1. Oscilloscope type configuration

Parameter	Explanation
YT	Abscissa is time variable, ordinate is single register variable, only single register variable is needed to configure curve
XY	Abscissa and ordinate are both register variables. When configuring the curve, two register variables need to be configured

8-4-2. Axis variable configuration

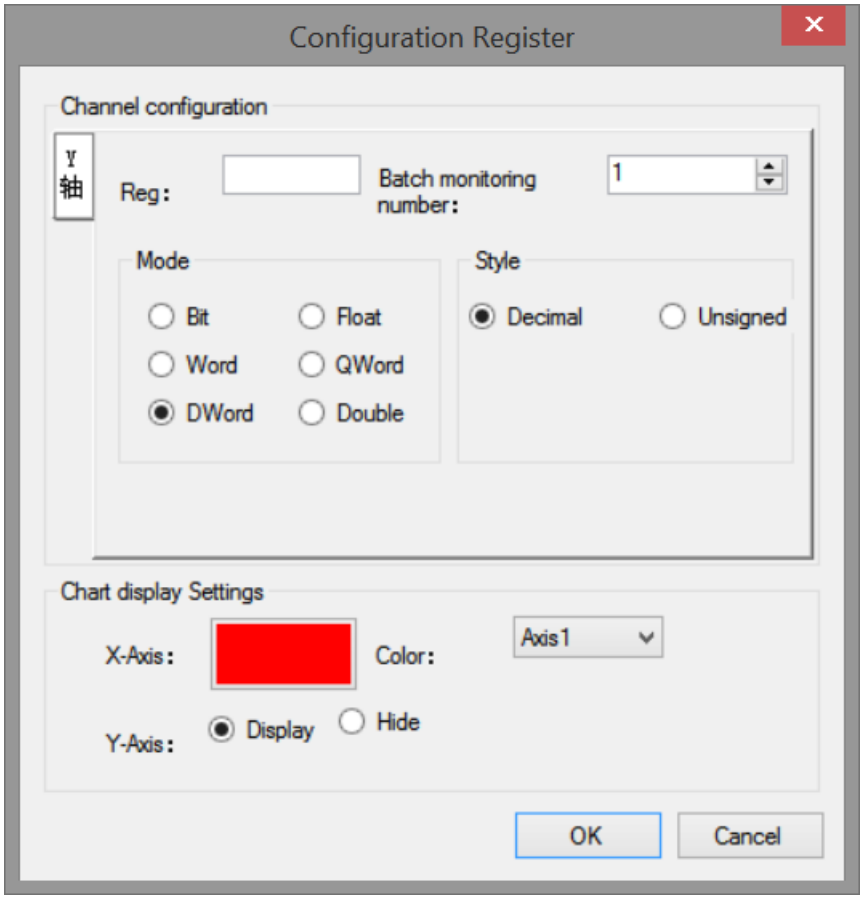


Parameter	Explanation
Add	Add the curve
Delete	Delete the curve
Edit	Edit curve properties

Note: when the oscilloscope starts to work, can not add or delete curves, only can edit curve attributes.

8-4-3. Register configuration

Cick add to show the register configuration interface:



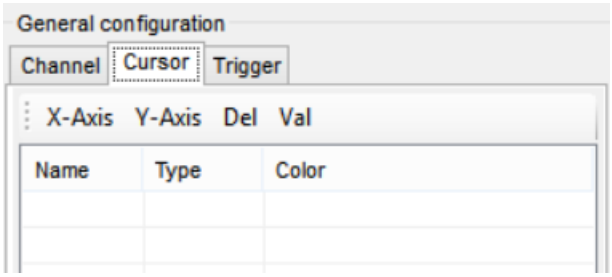
Parameter	Explanation
X axis	Register type (HD, D, SD) + register offset (number)+ register data type
Y axis	Register type (HD, D, SD) + register offset (number)+ register data type
Color	Curve display color (click the color block to modify the curve color)
Display	The curve displays on the oscilloscope display interface or not
Axis1	Which axis is the curve displayed on the oscilloscope display interface (for the realization of the axis splitting function)

Note:

(1) When the oscilloscope type is YT, the [X-axis] cannot be configured, and the abscissa displays the time.

(2) When the oscilloscope starts to work, it can only adjust the color, display and axis attribute of the curve, and the register of XY axis cannot be modified.

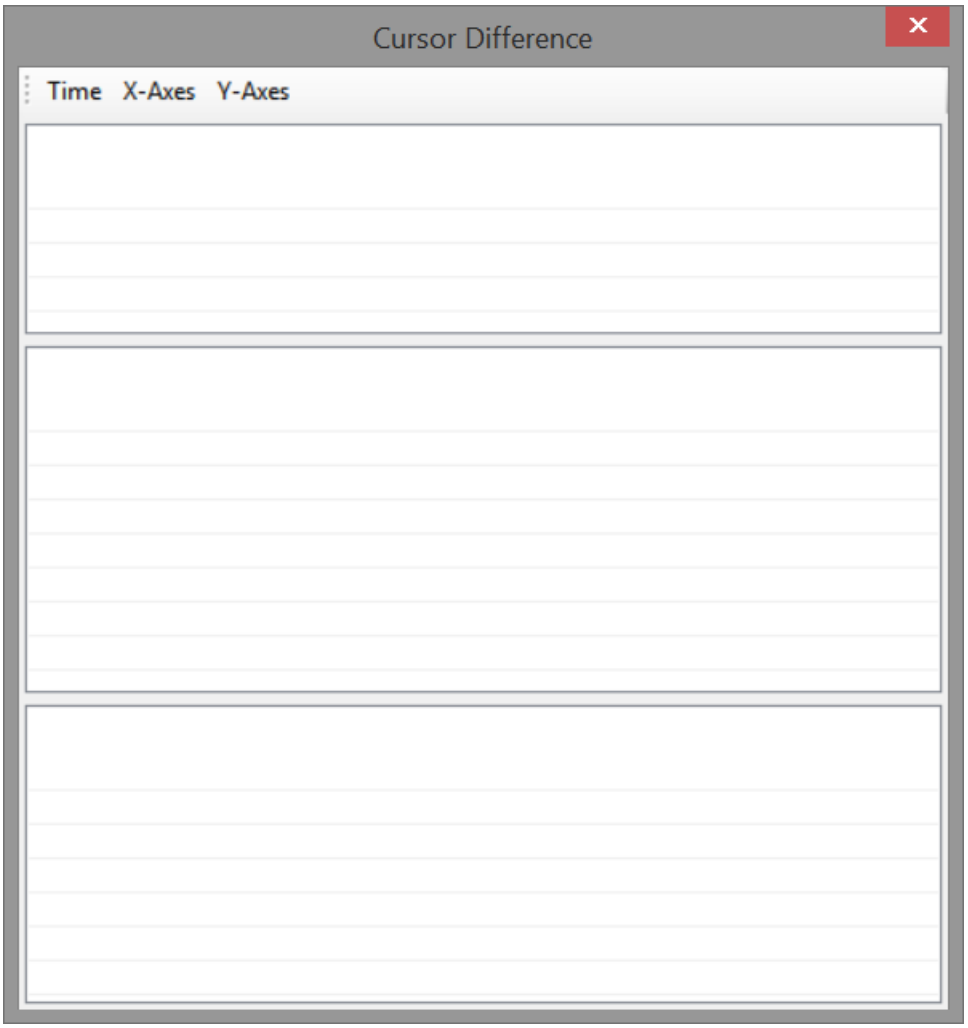
8-4-4. Cursor configuration



Parameter	Explanation
X axis	Add X-axis cursor (vertical cursor, perpendicular to X-axis)
Y axis	Add Y-axis cursor (horizontal cursor, perpendicular to Y-axis)
Delete	Delete the cursor
Value	Display cursor difference data

8-4-5. Difference interface

Click [value] to show below window:



Parameter	Note
Time	Show / hide the status time area (this area is only available when the oscilloscope type is YT).
X-axes	Show / hide Channel/ X-Axes area
Y-axes	Show/ hide Y-Axes area

Note:

(1) Display rules of status time area:

A. Display two time: computer time (PC time); oscilloscope working display time

B. Time data source: the value of the x-axis cursor on the x-axis (time axis).

(2) Channel area display rules:

A. Data source: Y-axis register data corresponding to X-axis cursor (data on Y-axis corresponding to X-axis in coordinate system). For example, the time of x-axis cursor on x-axis is 1s, and the data at 1s of y-axis register variable is used as display data source.

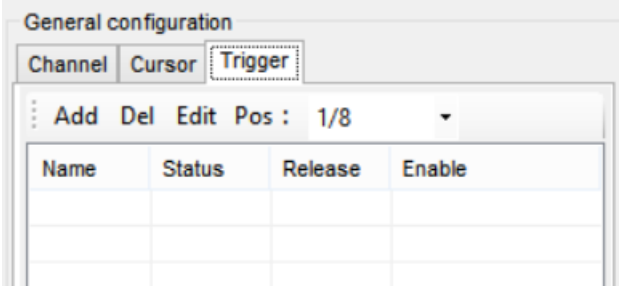
B. Channel column: displays all the register variables monitored on the oscilloscope.

(3) Display rules of Y-axes area:

A. Data source: data of y-axis cursor on vertical axis.

B. For each additional y-axis, a piece of data is added and displayed in the table.

8-4-6. Trigger configuration



Parameter	Note
Add	Add the trigger
Del	Delete the trigger
Edit	Edit the trigger
Pos	The location on the screen after the trigger is triggered

Note:

(1) Trigger position description: for example, if the trigger position is 1/8, the trigger will stop and will not stop immediately. When the data obtained after trigger can occupy 7/8 of the current interface, the display will stop.

(2) After the trigger is triggered, the state changes to red. At the same time, a dotted line is displayed on the trigger position on the interface to indicate the trigger position.

(3) When the trigger version is XY, it stops immediately after the trigger is triggered.

After click [add], it will show below window:

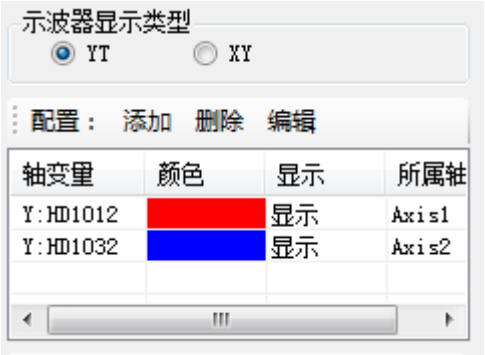
Parameter	Note
Object	Configured register variables
Condition	Logical relationship between triggers of the same register object
Mode	Trigger edge (Risingedg, fallingedge)
Threshold	Trigger threshold
Action	The action after triggering (StopDisplay, ReStartDisplay)

Enable	Enable the trigger

8-4-7. Examples of oscilloscope application

For example: Xinje XG2 series PLC controls two DS5C servo drivers, the CSP mode is used to make the motor forward and reverse, and the actual position waveform is monitored.

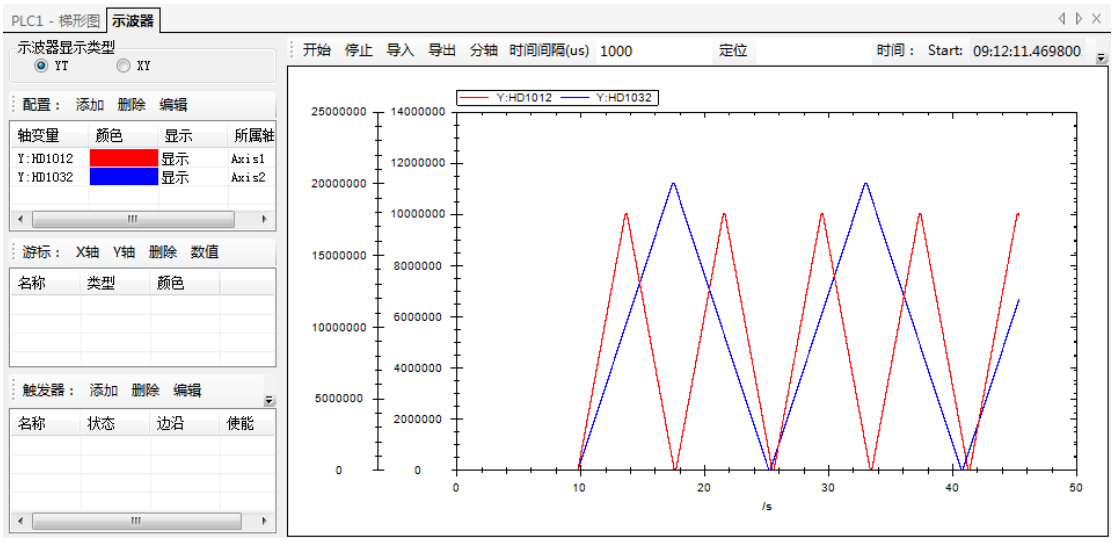
The oscilloscope interface configuration is as follows:



Among them, HD1012 is the mapping of axis 1-6064h, and HD1032 is the mapping of axis 2-6064h.

Click [start] to run the oscilloscope. At this time, the oscilloscope displays the current positions of the two axes. When the axis is not running, it will be two straight lines (the waveform will have a small jitter, and the proportion of ordinates will be obvious when the two axes are running). After the two axes are running, the waveform will change, and the coordinate proportion will be automatically adjusted during the operation of the oscilloscope. If you want to view the waveform, click [stop] and right click [restore to the original zoom ratio], you can view the complete waveform (the waveform will only be displayed within 60s, but all data will be saved. Right click menu [export data] can display data in Excel form).

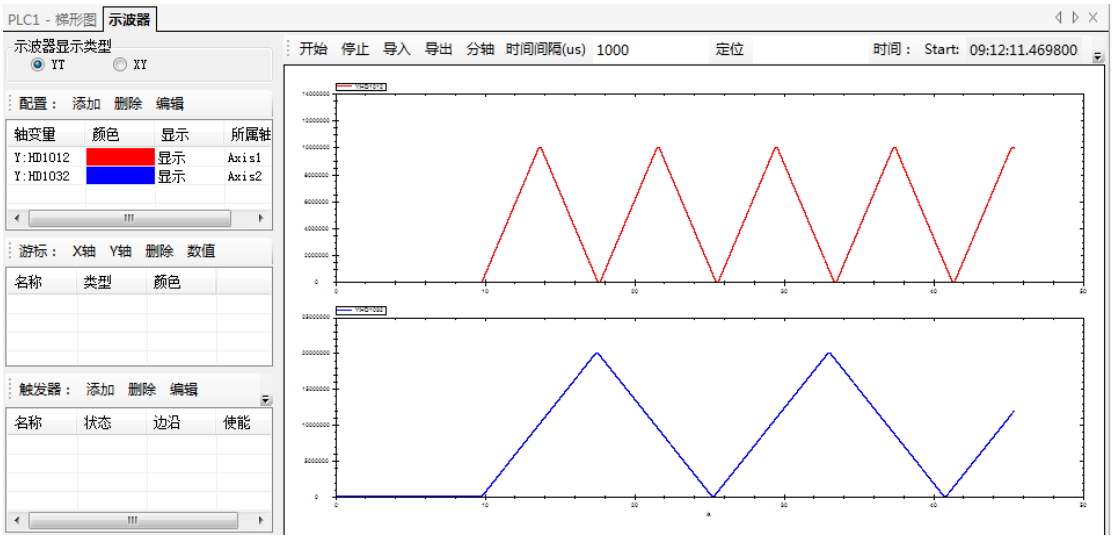
The waveform is shown as below:



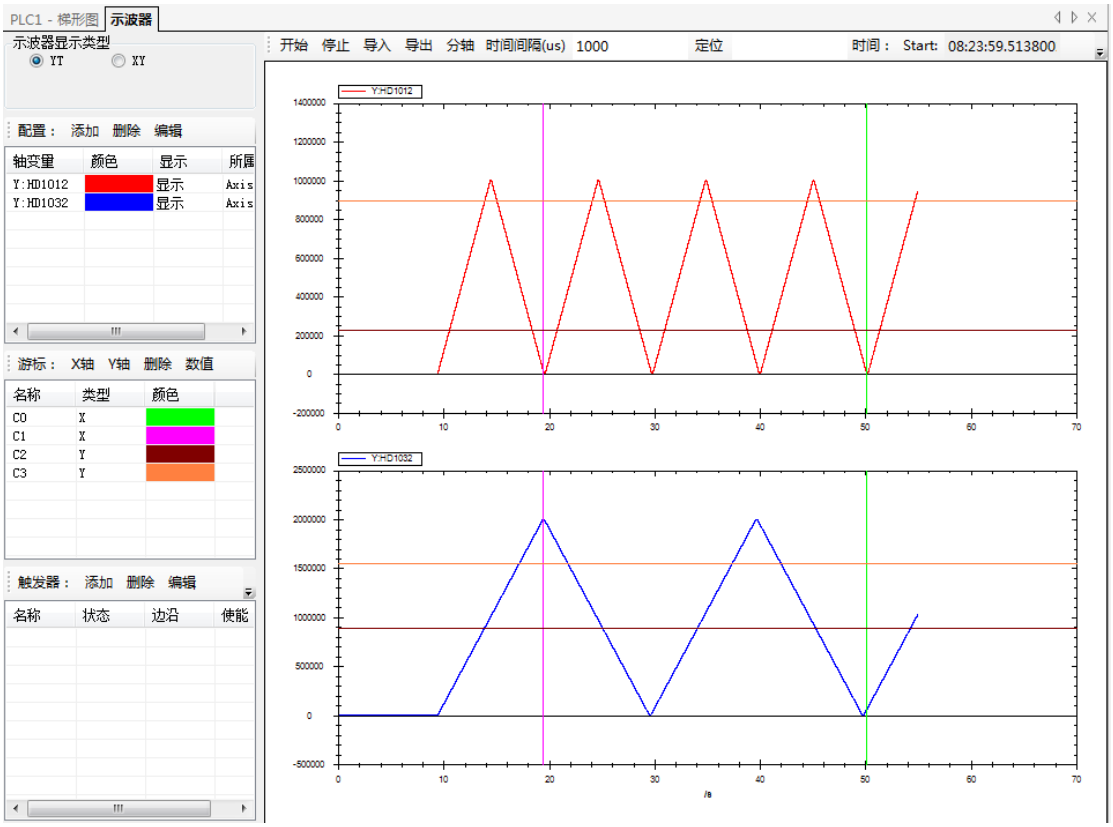
There are two coordinate axes on the left, axis 2 ordinate on the left and axis 1 ordinate on the right.

If it needs to be divided into two coordinate axes, click [sub axis] (the axis variable needs to be set to two different axes).

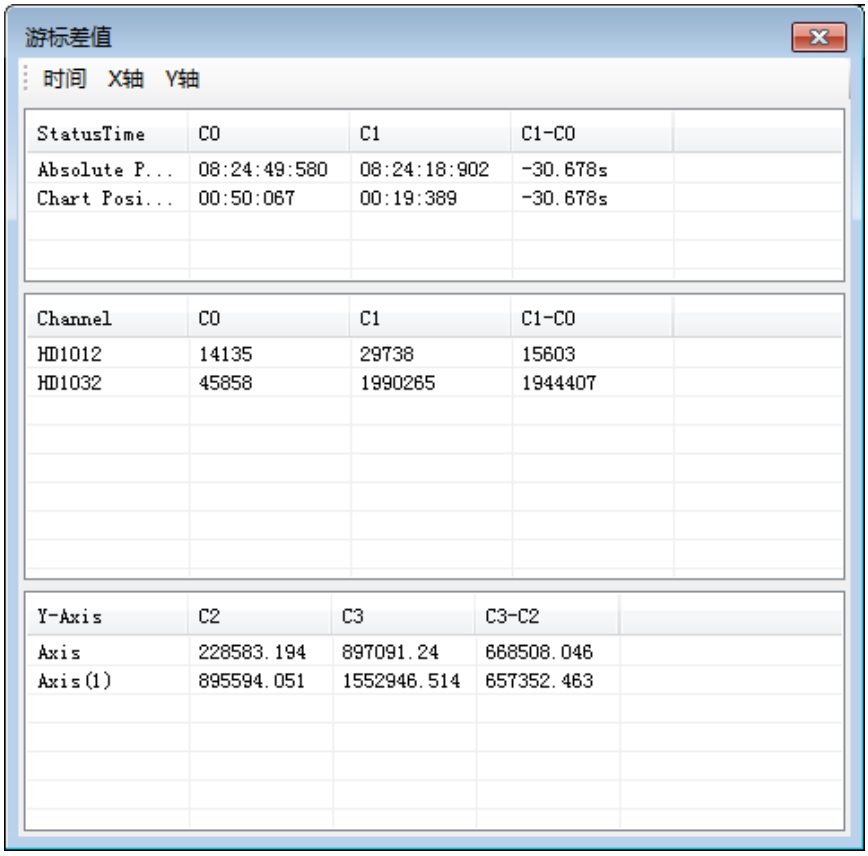
After [sub axis], the figure is as follows:



Click the cursor configuration [X axis] [Y axis] to generate a cursor (two cursors are configured for X axis and Y axis in the figure), and the cursor position can be dragged by the mouse.



Click the cursor configuration [value] to enter the cursor difference interface, which can monitor the specific value of the register with the cursor.



StatusTime area:

Absolute Position represents the current actual time (that is, computer time) indicated by the cursor.

Chart Position indicates the working time of oscilloscope (i.e. abscissa of cursor position).

Channel area:

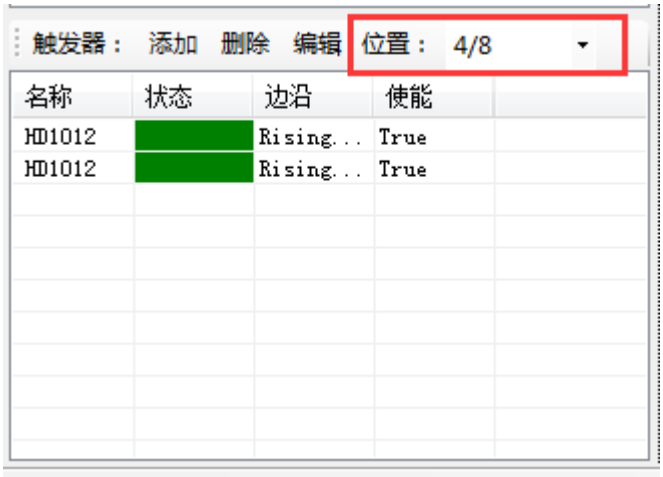
The data in the region represents the value of the register corresponding to the cursor position. Combined with the [status time] area, the real-time value of the register can be monitored. As shown in the figure, the value of register HD1012 in 50.067s is 14135 and that in register HD1032 is 45858. In 19.389s, the value of register HD1012 is 29738 and the value of register HD1032 is 1990265; [C1-C0] represents the difference between the positions of two cursors (Note: when the number of cursors set on one axis is greater than or equal to 2, the cursor difference interface will automatically generate cursor difference data)

Axis area:

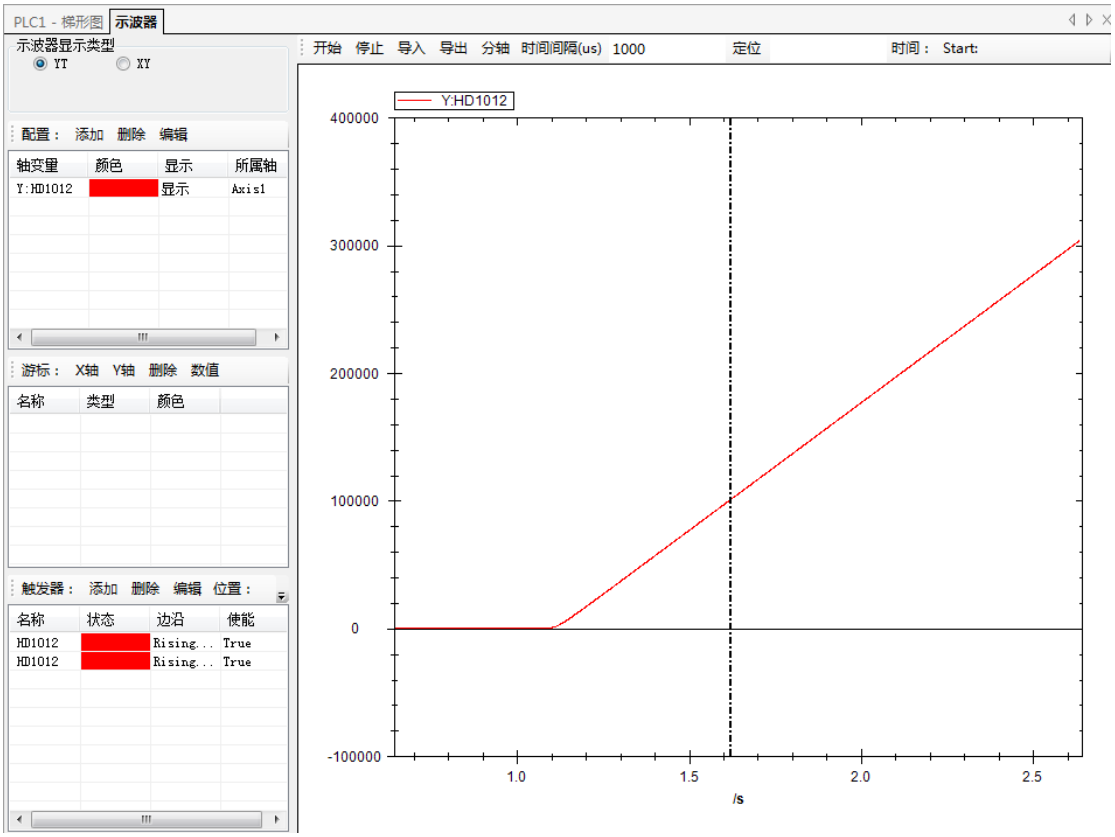
The data in the area represents the value corresponding to the cursor of [Y axis], as shown in the figure, the value of [C2] in Axis1 is 228583.194, the value in Axis2 is 895594.051; the value of [C3] in Axis1 is 897091.24, and the value in Axis2 is 1552946.514; and [C3-C2] represents the difference between the corresponding values of the two cursors.

The trigger configuration is show as below:

Configure two triggers, the object of which are all HD1012, the condition is AND, the mode is rising edge, the threshold value is 50000 and the other is 100000, the action is StopDisplay, enable is True.



Trigger position is set to 4/8, the results of oscilloscope operation are as follows:



The dotted line in the figure is the trigger position of the trigger. When the trigger is triggered, the trigger position accounts for 4/8 of the current waveform diagram, and the oscilloscope will stop (that is, the dotted line position accounts for half of the current waveform diagram). You can see that the trigger status has turned red, indicating that both triggers have been triggered. If the trigger condition is selected AND, it means that the trigger will stop only when both triggers are triggered, so the trigger position register value is 100000 (if the trigger condition is OR, any one of the triggers will stop if it is triggered; if one of the two trigger conditions is AND the other is OR, the trigger condition will be judged as OR).

9. EtherCAT instruction

9-1. SDO read [EC_SDORD]

(1) Instruction overview

The SDO value is read from the target station and stored in the local register.

SDO read [EC_SDORD]			
Execution condition	Edge triggering	Suitable model	XG2
Hardware	V3.6 and above	Software	V3.6 and above

(2) Operand

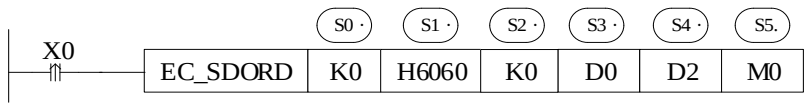
Operand	Function	Range	Type
S0	EtherCAT slave station no.: Station ID	0~63	16-bit constant or single word register
S1	Object index	0x1000~0xffff	16-bit constant or single word register
S2	Object subIndex	0~255	16-bit constant or single word register
S3	Value register		Single word register
S4	Status register		Single word register
S5	Completion flag bit		Bit

(3) Suitable software component

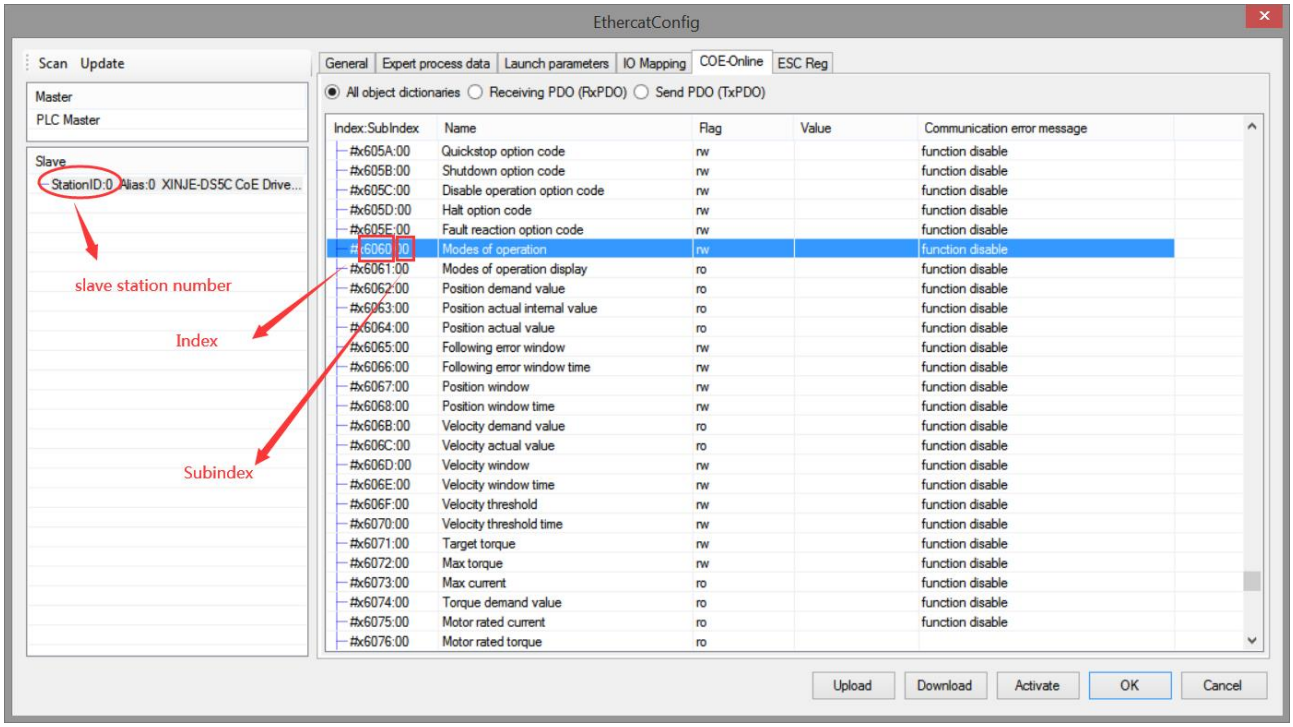
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dn.m
S0	●								●									
S1	●								●									
S2	●								●									
S3	●																	
S4	●																	
S5												●	●	●	●	●	●	

Note: D is D and HD; TD is TD and HTD; CD is CD, HCD, HSCD and HSD; DM is DM and DHM; DS is DS and DHS.
M is M, HM and SM; S is S and HS; T is T and HT; C is C and HC.

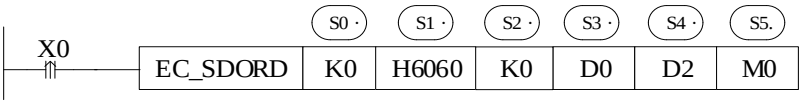
(4) Function and action



- Instruction meaning: Read the value in slave object dictionary 0x6060: 00 of StationID0 to D0.
- Instruction description: EC_SDORD is used to read the value in slave object dictionary.



The figure shows the slave and the corresponding object dictionary index, read the value in slave object dictionary 0x6060: 00 of StationID0 to D0.



S0：K0 or write 0 in the corresponding register. Note: the first slave station ID is 0, not 1.

S1：H6060 or write K24672 in the corresponding register (H6060).

S2：It is 00 at present, write K0 or 0 in the corresponding register.

S3：The read value is saved in local register D0.

S4：The processing status of instruction.

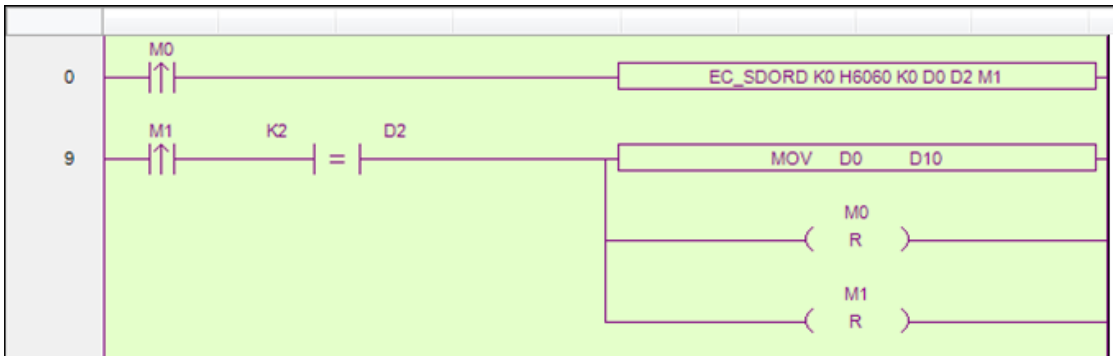
S5：Instruction processing completion flag. **Whether the value is read successfully or not, it only indicates that the instruction processing is finished and will not reset actively.**

The status code of operand S4 is shown in below table:

Operand	Status code	Meaning	Note
S4	0	Wait for processing	Set to 0 once the instruction is triggered
	1	In processing	
	2	Instruction processing successful	
	3	No instruction	Confirm the firmware and software version is matched
	4	No slave station	Confirm the S0 parameter is correct, check the slave station connection
	5	Slave station busy	
	6	Instruction processing overtime	
	7	Parameter error	Check S1, S2 parameters
	8	Unknown error	Check the program
	20	Write value too large	Check S1, S2 parameters
	21	Slave station in unread status	

	22	the object is write only	
	23	the object is read only	
	24	No SDO	
	25	No subindex of SDO	

When using EC_SDORD, it should be standardized according to the meaning of instruction operands. The S5 instruction completion flag in the instruction indicates that the instruction processing has been completed when it is set. At this time, other EtherCAT communication instructions can be read and written. No matter the current reading and writing is successful or not, S5 will be set. Therefore, during programming, other EtherCAT communication instructions need to wait for it to be set ON before executing, as shown in the following figure:



After operand S5 (M1) is set ON, check the status of S4 (D2). According to the status code, if the instruction is processed successfully, the read register can be set value. Since the completion mark M1 will not reset actively, it needs to be reset manually, so RST M1.

9-2. SDO write [EC_SDOWR]

(1) Instruction overview

Write the local register value in target slave station object SDO.

SDO object write [EC_SDOWR]			
Execution condition	Edge triggering	Suitable model	XG2
Firmware	V3.6 and above	Software	V3.6 and above

(2) Operand

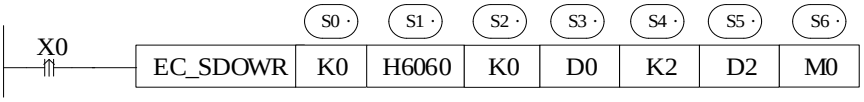
Operand	Function	Range	Type
S0	EtherCAT slave station no.: Station ID	0~63	16-bit constant or single word register
S1	Object index	0x1000~0xffff	16-bit constant or single word register
S2	Object subIndex	0~255	16-bit constant or single word register
S3	Write value register		single word register
S4	write value byte length		16-bit constant or single word register
S5	Status register		single word register
S6	Completion flag bit		Bit

(3) Suitable software component

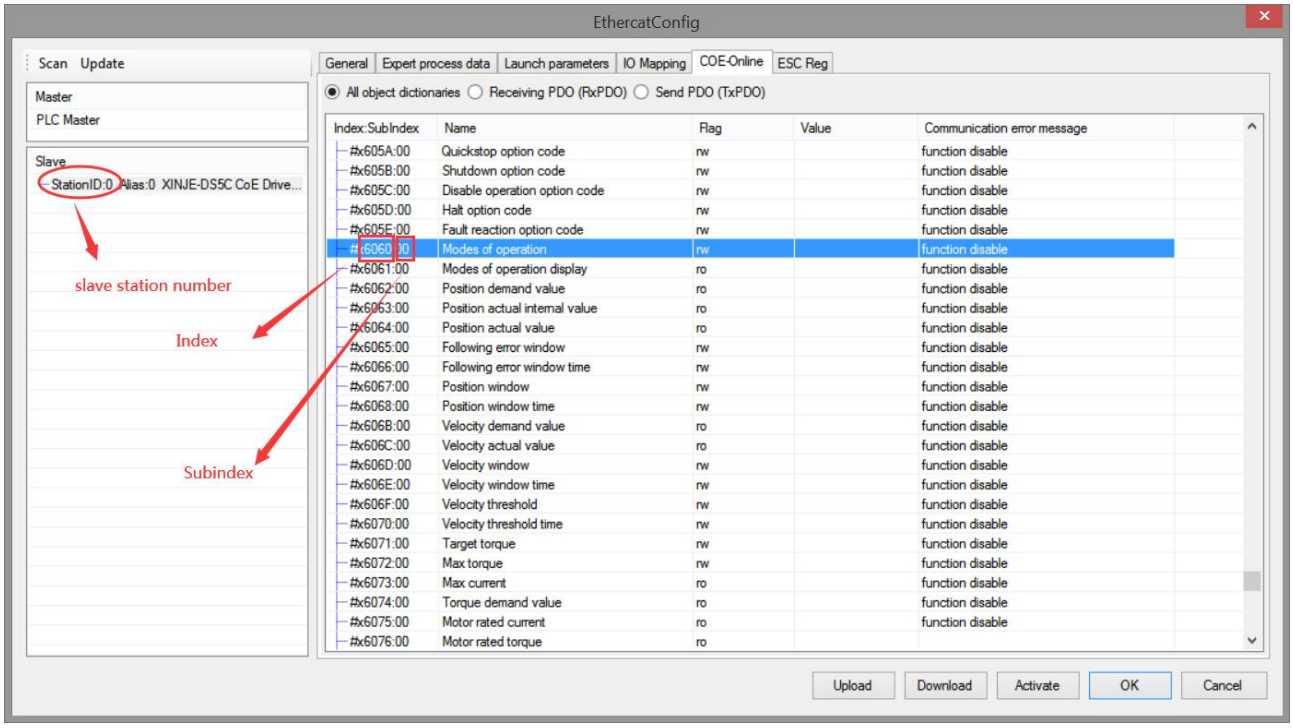
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dnm
S0	●								●									
S1	●								●									
S2	●								●									
S3	●																	
S4	●								●									
S5	●																	
S6												●	●	●	●	●	●	

Note: D is D and HD; TD is TD and HTD; CD is CD, HCD, HSCD and HSD; DM is DM and DHM; DS is DS and DHS.
M is M, HM and SM; S is S and HS; T is T and HT; C is C and HC.

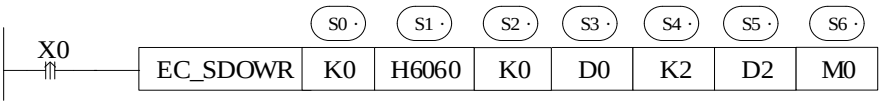
(4) Function and action



- Instruction meaning: write 2 bytes starting from D0 in slave object dictionary 0x6060:00 of StationID0.
- Instruction description: EC_SDOWR is used to write value in slave object dictionary.



The figure shows the slave and the corresponding object dictionary index.



S0：K0 or write 0 in corresponding register. Note: the first station ID is 0 but not 1.
S1：H6060 or write K24672 in corresponding register (H6060).
S2：It is 00 at present, write K0 or 0 in corresponding register.
S3：The value starting from D0 will be written in object SDO.
S4：Write in length, eg. K2 is 2 bytes (one single word register). K4 will occupy two registers eg. D0 D1.

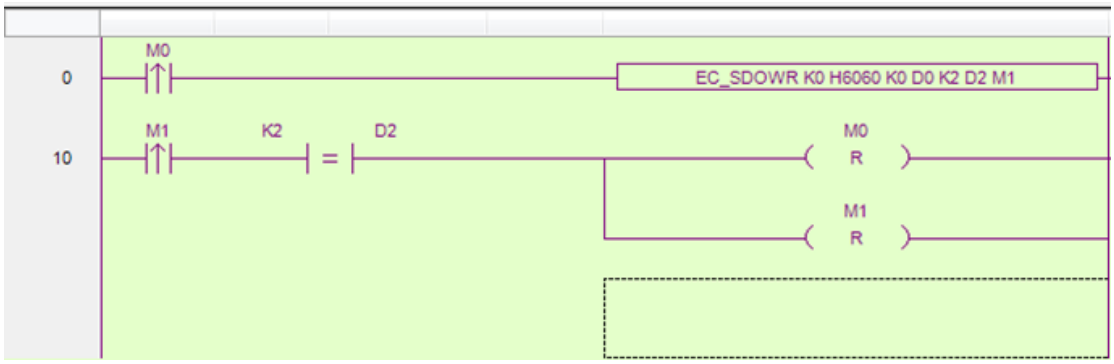
S5：Instruction processing status.

S6：Instruction processing completion flag. **Whether the value is written successfully or not, it only indicates that the instruction processing is finished and will not reset actively.**

The status code of operand S4 is shown in below table:

Operand	Status code	Meaning	Note
S4	0	Wait for processing	Set to 0 once the instruction is triggered
	1	In processing	
	2	Instruction processing successful	
	3	No instruction	Confirm the firmware and software version is matched
	4	No slave station	Confirm the S0 parameter is correct, check the slave station connection
	5	Slave station busy	
	6	Instruction processing overtime	
	7	Parameter error	Check S1, S2 parameters
	8	Unknown error	Check the program
	20	Write value too large	Check S1, S2 parameters
	21	Slave station in unread status	
	22	the object is write only	
	23	the object is read only	
	24	No SDO	
	25	No subindex of SDO	

When using EC_SDOWR, it should be standardized according to the meaning of instruction operands. The S6 instruction completion flag in the instruction indicates that the instruction processing has been completed when it is set. At this time, other EtherCAT communication instructions can be read and written. No matter the current reading and writing is successful or not, S6 will be set. Therefore, during programming, other EtherCAT communication instructions need to wait for it to be set ON before executing, as shown in the following figure:



After operand S6 (M1) is set ON, check the status of S5 (D2). According to the status code, if the instruction is processed successfully, the read register can be set value. Since the completion mark M1 will not reset actively, it needs to be reset manually, so RST M1.

9-3．ESC read [EC_REGRD]

(1) Instruction overview

Read ESC register value of target station to local register.

ESC register read [EC_REGRD]			
Execution condition	Edge triggering	Suitable model	XG2
Hardware	V3.6 and above	Software	V3.6 and above

(2) Operand

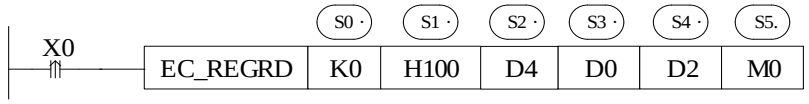
Operand	Function	Range	Type
S0	EtherCAT slave station no.: Station ID	0~63	16-bit constant or single word register
S1	ESC register starting address	0x000~0xfff	16-bit constant or single word register
S2	Read byte length	0~255	single word register
S3	Save value register starting address		single word register
S4	Status register		single word register
S5	Completion flag bit		Bit

(3) Suitable softw component

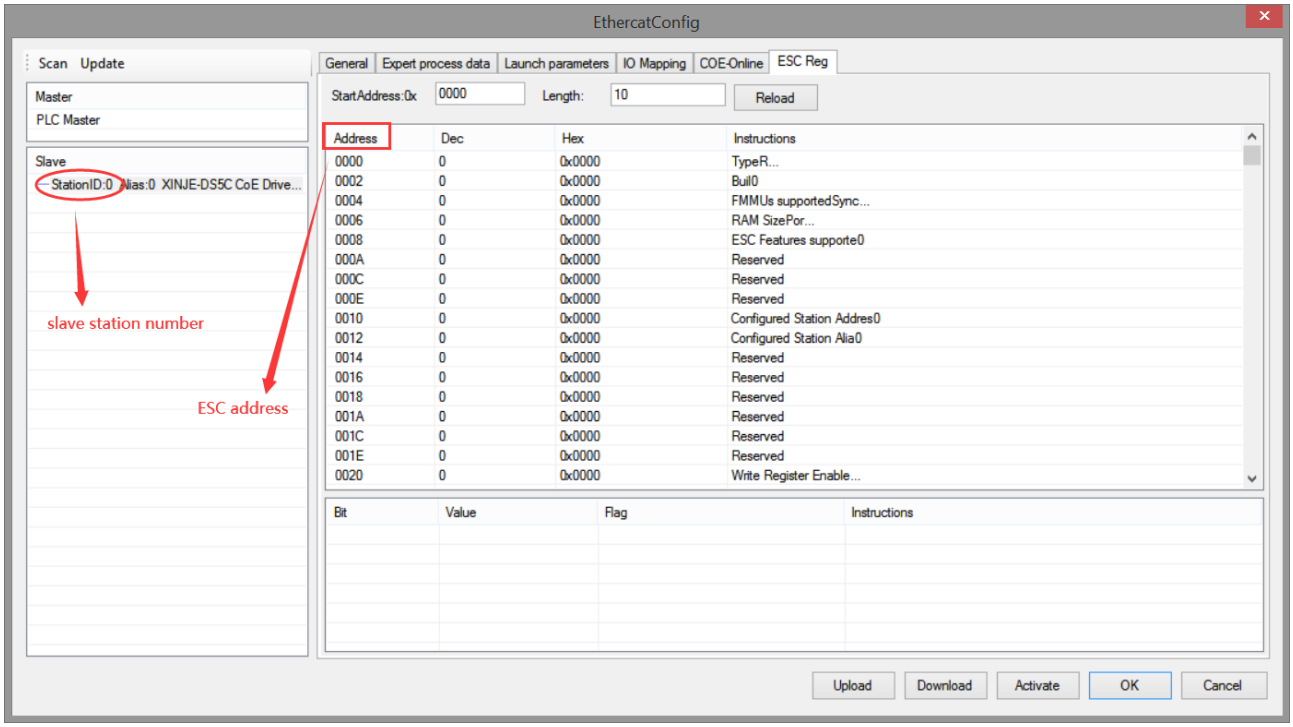
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dnm
S0	●								●									
S1	●								●									
S2	●																	
S3	●																	
S4	●																	
S5												●	●	●	●	●	●	

Note: D is D and HD; TD is TD and HTD; CD is CD, HCD, HSCD and HSD; DM is DM and DHM; DS is DS and DHS.
M is M, HM and SM; S is S and HS; T is T and HT; C is C and HC.

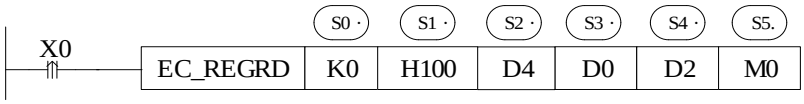
(4) Function and action



- Instruction meaning: read ESC register value of StationID0 to D0.
- Instruction description: EC_REGRD is used to read ESC value of slave station.



The figure is ESC parameter interface, if it needs to read ESC address H100 of slave station StationID0, please see below example.



S0：K0 or write 0 in corresponding register. Note: the first station ID is 0 but not 1.

S1：H100 or write K256 (H100) in corresponding register.

S2：ESC address corresponds to one byte. If D4 is written 1, it means read the value of H100 to D0. If it is written 2, it means read H100 H102 to D0 D1.

S3：The read value is saved in local register D0.

S4：The instruction processing status.

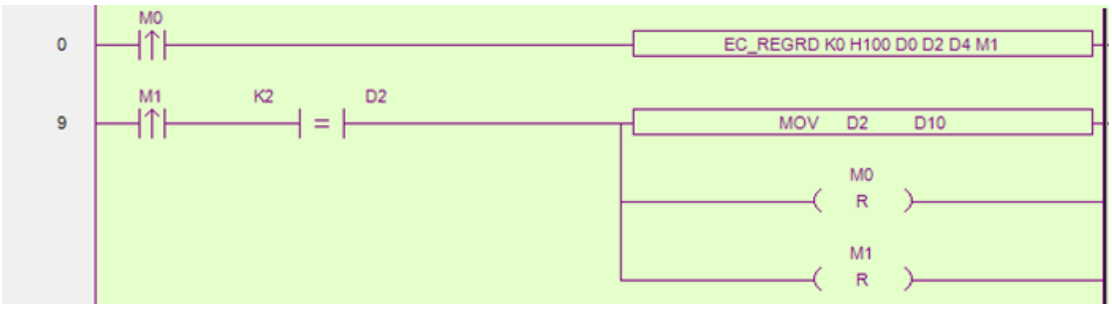
S5：Instruction processing completion flag. **Whether the value is written successfully or not, it only indicates that the instruction processing is finished and will not reset actively.**

The status code of operand S4 is shown in below table:

Operand	Status code	Meaning	Note
S4	0	Wait for processing	Set to 0 once the instruction is triggered
	1	In processing	
	2	Instruction processing successful	
	3	No instruction	Confirm the firmware and software version is matched
	4	No slave station	Confirm the S0 parameter is correct, check the slave station connection
	5	Slave station busy	
	6	Instruction processing overtime	
	7	Parameter error	Check S1, S2 parameters
	8	Unknown error	Check the program
	20	Address parameter overlimit	Check S1 parameters

	21	Length invalid	Check S1, S2 parameters
	22	Slave station position error	Check whether there is the slave station
	23	Request failure	Retry

When using EC_REGRD, it should be standardized according to the meaning of instruction operands. The S5 instruction completion flag in the instruction indicates that the instruction processing has been completed when it is set. At this time, other EtherCAT communication instructions can be read and written. No matter the current reading and writing is successful or not, S5 will be set. Therefore, during programming, other EtherCAT communication instructions need to wait for it to be set ON before executing, as shown in the following figure:



After operand S5 (M1) is set ON, check the status of S4 (D2). According to the status code, if the instruction is processed successfully, the read register can be set value. Since the completion mark M1 will not reset actively, it needs to be reset manually, so RST M1.

9-4. ESC write [EC_ESCWR]

(1) Instruction overview

Write the value in local register to target slave station ESC address.

ESC object write [EC_ESCWR]			
Execution condition	Edge triggering	Suitable model	XG2
Hardware	V3.6 and above	Software	V3.6 and above

(2) Operand

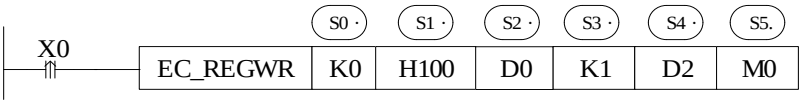
Operand	Function	Range	Type
S0	EtherCAT slave station no.: Station ID	0~63	16-bit constant or single word register
S1	ESC register starting address	0x000~0xfff	16-bit constant or single word register
S2	Write value starting register		single word register
S3	Write value byte length		16-bit constant or single word register
S4	Status register		single word register
S5	Completion flag bit		Bit

(3) Suitable soft component

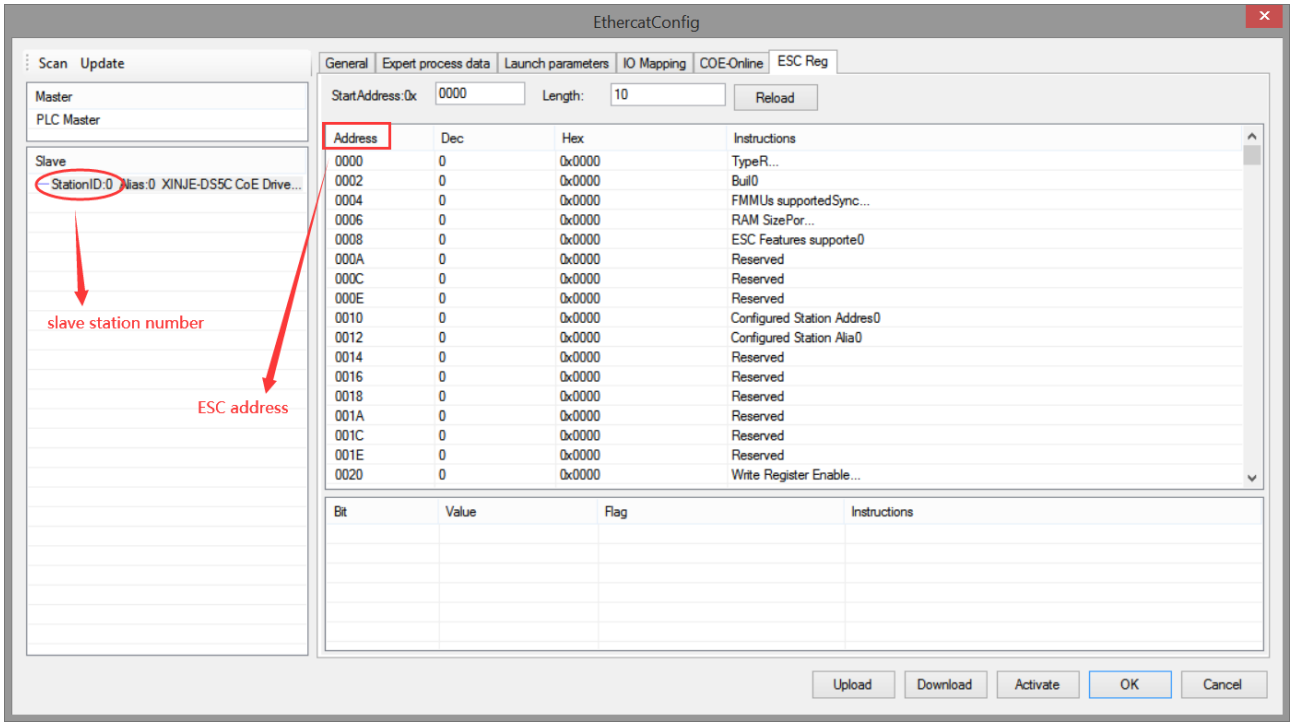
Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dnm
S0	●								●									
S1	●								●									
S2	●																	
S3	●								●									
S4	●																	
S5												●	●	●	●	●	●	

Note: D is D and HD; TD is TD and HTD; CD is CD, HCD, HSCD and HSD; DM is DM and DHM; DS is DS and DHS.
M is M, HM and SM; S is S and HS; T is T and HT; C is C and HC.

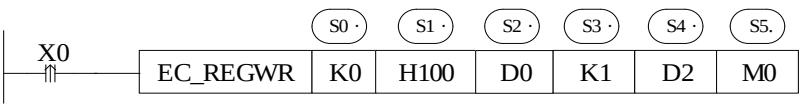
(4) Function and action



- Instruction meaning: write the value starting from D0 into ESC register of slave station StationID0.
- Instruction description: EC_REGWR is used to write value in slave station ESC address.



The figure is ESC parameter interface. If it needs to write value in ESC address H100 of slave station ID0, the example is shown as below:



S0：K0 or write 0 in corresponding register. Note: the first station ID is 0 but not 1.

S1：H100 or write K256 (H100) in corresponding register.

S2：write in register starting address.

S3：ESC address corresponds to one byte. K1 means write D0 value to H100. K2 means write D0, D1 value to H100, H102.

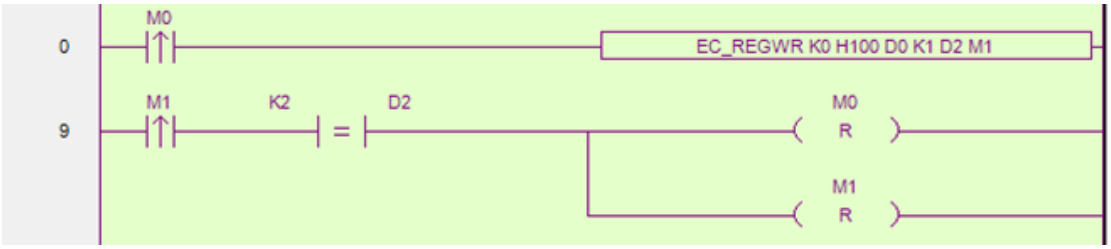
S4：instruction processing status.

S5：instruction processing completion flag. **Whether the value is written successfully or not, it only indicates that the instruction processing is finished and will not reset actively.**

The status code of operand S4 is shown in below table:

Operand	Status code	Meaning	Note
S4	0	Wait for processing	Set to 0 once the instruction is triggered
	1	In processing	
	2	Instruction processing successful	
	3	No instruction	Confirm the firmware and software version is matched
	4	No slave station	Confirm the S0 parameter is correct, check the slave station connection
	5	Slave station busy	
	6	Instruction processing overtime	
	7	Parameter error	Check S1, S2 parameters
	8	Unknown error	Check the program
	20	Address parameter overlimit	Check S1 parameters
	21	Length invalid	Check S1, S2 parameters
	22	Slave station position error	Check whether there is the slave station
	23	Request failure	Retry

When using EC_REGWR, it should be standardized according to the meaning of instruction operands. The S5 instruction completion flag in the instruction indicates that the instruction processing has been completed when it is set. At this time, other EtherCAT communication instructions can be read and written. No matter the current reading and writing is successful or not, S5 will be set. Therefore, during programming, other EtherCAT communication instructions need to wait for it to be set ON before executing, as shown in the following figure:



After operand S5 (M1) is set ON, check the status of S4 (D2). According to the status code, if the instruction is processed successfully, the read register can be set value. Since the completion mark M1 will not reset actively, it needs to be reset manually, so RST M1.

9-5. ESM status switch [EC_SETSS]

(1) Instruction overview

Slave station state machine instruction switching.

ESM status switch [EC_ESCWR]			
Execution condition	Edge triggering	Suitable model	XG2
Hardware	V3.6 and above	Software	V3.6 and above

(2) Operand

Operand	Function	Range	Type
S0	EtherCAT slave station no.: Station ID	0~63, 0xFFFF means switch all the slave stations	16-bit constant or single word register
S1	ESM status	1, 2, 4, 8	16-bit constant or single word register

(3) Suitable soft component

Operand	Word											Bit						
	System								Constant	Module		System						
	D	FD	TD	CD	DX	DY	DM	DS	K/H	ID	QD	X	Y	M	S	T	C	Dnm
S0	●								●									
S1	●								●									

Note: D is D and HD; TD is TD and HTD; CD is CD, HCD, HSCD and HSD; DM is DM and DHM; DS is DS and DHS.

M is M, HM and SM; S is S and HS; T is T and HT; C is C and HC.

(4) Function and action

- Instruction meaning: switch ESM state machine of slave station ID0 to 8.
- Instruction description: slave station ESM (EtherCAT Status Machine) can be switched through instruction. The state 1: INT, 2: Pre-OP, 4: Safe-OP, 8: OP.

The instruction must be triggered by the rising edge. After the instruction is executed, the slave station is requested to switch to the specified state. There is no guarantee of immediate switching or successful switching. The switching status can be confirmed by SD [8021 + 20*i]. If it is unable to switch, the status switching error message can be confirmed through SD [8028 + 20 * i].

Appendix

Appendix 1. Related registers

Appendix 1-1. Master station related registers

Register	Type	Note
SD8000	Single word	Master station state, the value should be the bit or of all the slave station state
SD8001	Single word	Master station error code, refer to error code table
SD8002	Single word	Master station error count
SD8003	Single word	Set to 1 clear the error code
SD8004	Double word	Communication overtime error count
SD8006	Double word	Data packet format error count
SD8008	Double word	Data packet not match error count
SD8010	Double word	Current communication interval, unit: ns
SD8012	Double word	Current processing time, unit: ns
SD8014~SD8019		Reserved

Appendix 1-2. Slave station related registers (i means slave station no., starting from 0)

Register	Type	Note
SD[8020+20*i]	Single word	Slave station connection status 0: disconnected 1: connected
SD[8021+20*i]	Single word	Slave station communication status 1: INIT 2: PreOP 4: SafeOP 8: OP Other: error
SD[8022+20*i]	Double word	Slave station error code, refer to error code table
SD[8024+20*i]	Double word	Slave station error count
SD[8026+20*i]	Single word	Set to 1 clear slave station error count
SD[8027+20*i]	Single word	Servo application layer status: (refer to CANopen402) SMS_NOREADY_SWON = 0, SMS_SWON_DISABLE, SMS_READY_SWON, SMS_SWON, SMS_OP_ENABLE, SMS_QSTOP_ACTIVE, SMS_FAULT_REACTIVE, SMS_FAULT
SD[8028+20*i]	Single word	Mode switching error code, whose value is the storage value of 0x134 in ESC register during communication mode switching
SD[8029+20*i]	Single word	Mode switching control bit. Write: 0x8001: switch to Init

		0x8002: switch to PreOP 0x8004: switch to SafeOP 0x8008: switch to OP Read: Same to SD[8021+20*i]
SD[8030]~SD[8039]	Reserved	

Appendix 2. Error code

Appendix 2-1. Master station error code (SD8001)

Error code	Note
0	No error
1	Master station initialization error
10	CRC parity error of master station configuration file
12	Master station configuration file write flash
13	Master station flash loading configuration file error
14	The master station is waiting for periodic communication to stop
16	The master station configuration file does not contain configuration information
17	The number of slaves configured by master station exceeds the maximum limit
18	Master station configuration file has no slave configuration information
100	Request master station error
101	No slave stations were found
102	Not switch to PreOP mode
103	Send pdo configuration error
104	Receive pdo configuration error
105	Master station activation error
106	Obtain send domain data error
107	Obtain receive domain data error
108	Enable cycle communication error
109	Recover cycle communication error
110	Pause cycle communication error
200	Slave station information does not match
201	Slave station obtained configuration data error
202	Slave station pdo configuration error
203	Slave station module mapping configuration error
400	coeOnline instruction file error
401	coeOnline slave station not match
402	coeOnline instruction file crc parity error
403	coeOnline file no monitoring instruction
404	coeOnline obtained edit instruction error
405	coeOnline executed edit instruction error
406	coeOnlineInitialization error
500	Oscilloscope initialization failure
501	Failed to configure the oscilloscope
550	Slave station scan initialization failed
551	Slave station scan request file CRC error
552	Slave station scan request file format error

600	ESC register function initialization failure
602	ESC register request format error
900	Startup parameter configuration error

Appendix 3. EtherCAT communication related servo driver alarm

Appendix 3-1. Alarm list

Alarm code	Explanation	Reason	Solution
E-800	Incorrect ESM requires fault protection	Accept the requires cannot tranform from the current status: Init→Safeop Init→OP PreOP→OP ESM status after alarm: when the current status is Init, PreOP, it stops in current status, and transforms to SafeOP when OP. ESC register AL Status Code: 0011h	Confirm the state transformation of the upper device. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
801	Undefined ESM requires fault protection	Accept status transform requires except the followings: 1：Request Init State 2：Request Pre-Operational State 3：Request Bootstrap State 4：Reauest Safe-operational State 8：Request Operational State ESM status after alarm: when the current status is Init, PreOP, SafeOP, it stops in current status, and transforms to SafeOP when OP. ESC register AL Status Code: 0012h	Confirm the state transformation of the upper device. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
802	Leading status requires fault protection	Accept the following status transforming requires: 3：Request Bootstrap State ESM status after alarm: Init ESC register AL Status Code: 0013h	Confirm the state transformation of the upper device. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
803	PLL not finish fault protection	After 1s of synchronization, the phase combination (PLL locking) of communication and servo still cannot be completed. ESM status after alarm: PreOP ESC register AL Status Code: 002Dh	Confirm the setting of DC, and whether transmission delay compensation and deviation compensation are correct. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
804	PDO watchdog fault protection	For PDO communication (SafeOP or OP status), bit 10 that setting time 0220 (AL Event Request) through ESC register address 0400 (Watchdog Divider) and 0420 (Watchdog Time Process Data) is not ON. ESM status after alarm: Safe OP ESC register AL Status Code: 001Bh	Confirm whether the transmission time of PDO from the upper device is fixed (whether it is interrupted); Confirm that the PDO watchdog detection delay value is too large; Confirm whether there is any problem

			in the wiring of EtherCAT communication cable and whether there is serious noise on the cable. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
806	PLL fault protection	ESM state is the case that the phase (PLL lock) of communication and servo does not match in SafeOP or OP state. ESM status after alarm: SafeOP ESC register AL Status Code: 0032h	Confirm the setting of DC, and confirm whether transmission delay compensation and deviation compensation are correct. The alarm can be cleared through cutting off the control power or set servo parameter F0-00 = 1.
807	Synchronization signal fault protection	After the completion of synchronization, according to SYNC0 or IRQ, interrupt processing occurs above the setting threshold. ESM status after alarm: SafeOP ESC register AL Status Code: 002Ch	Confirm the setting of DC, and confirm whether transmission delay compensation and deviation compensation are correct. The alarm can be cleared through cutting off the control power or set servo parameter F0-00 = 1.
810	Synchronization period setting error protection	Cannot support the setting period: Synchronization period should be 500us, 1ms, 2ms, 4ms. ESM status after alarm: PreOP ESC register AL Status Code: 0035h	Set correct synchronization period. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
811	Mailbox setting fault protection	Bad SM0 / 1 setting for mailbox: The receiving and sending area of the mailbox overlaps, overlaps with SM2/3, and the address of the receiving and sending area is odd; The mailbox start address is out of the range of SyncManager0: 1000h~10FFh, SyncManager1: 1200h~12FFh. SyncManager0/1 length (ESC register: 0802h, 0803h/080Ah, 080Bh) setting error: SyncManager0: out of the range of 32~256byte SyncManager1: out of the range of 40~256byte SyncManager0/1 Control Register (ESC register: 0804h/080Ch) setting error conditions: Not set 100110b to 0804h: bit5-0 Not set 100110b to 080Ch: bit5-0 ESM status after alarm: Init ESC register AL Status Code: 0016h	Set SyncManager as ESI file. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
814	PDO watchdog setting fault protection	PDO watchdog setting error. PDO watchdog trigger is valid (syncmanager: bit6 of register 0804h is 1), the setting value of PDO watchdog detection timeout value (register 0400h, 0402h) does not meet the condition of "communication cycle * 2" ESM status after alarm: PreOP	Set the watchdog detection timeout value correctly. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.

		ESC register AL Status Code: 001Fh	
815	DC setting error protection	The setting of DC is wrong. Bit2-0 of ESC register 0981h (activation) is set to a value other than the following. bit2-0=000b；bit2-0=011b ESM status after alarm: PreOP ESC register AL Status Code: 0030h	Confirm the DC setting. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
816	SM event mode setting error protection	Unsupported SM time mode is set. 1C32 / 1C33-01 sets values other than 00, 01 and 02. Bit2-0 = 000b of ESC register 0981 and only SM2 of 1C32h-01h and 1C33h-01h are set. ESM status after alarm: PreOP ESC register AL Status Code: 0028h	Confirm that the settings of 1C32h-01h and 1C33h-01h are the same and the values are in 00h, 01h and 02h. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
817	SyncManager 2/3 setting error protection	SM2/3 is set to error value. The physical address of SM2/3 is set incorrectly (ESC register: 0810h / 0818h): the receiving and sending areas overlap, coincide with SM2/3, the starting address is odd, and the completion address of the starting address is outside the range SM2/3 length setting (ESC register: 0812h/081A) is different from RxPDO, TxPDO. The control register (ESC register: 0814h/081ch) of SM2/3 is not set correctly. Not set 100110b to bit5-0. ESM status after alarm: PreOP ESC register AL Status Code: 001Dh/001Eh	Set correct value of SyncManager2/3 as ESI file. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
850	TxPDO distribution error protection	Data size of TxPDO mapping exceeds 24 bytes. ESM status after alarm: PreOP ESC register AL Status Code: 0024h	Confirm that the data size of TxPDO mapping is set within 24 bytes. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
851	RxPDO distribution error protection	Data size of RxPDO mapping exceeds 24 bytes. ESM status after alarm: PreOP ESC register AL Status Code: 0025h	Confirm that the data size of RxPDO mapping is set within 24 bytes. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
881	Control mode setting error protection	When the set value of 6060h is 0 and the set value of 6061h is 0, the PDS status will be converted to "operation enabled". 6060h is set to not corresponding control mode. In full closed-loop control, 6060h is not set to position control mode. ESM status after alarm: stop in the current ESM status ESC register AL Status Code: 0000h	Confirm the setting value of 6060h. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.
882	ESM requires in operation	When PDS status is "Operation enabled" or "Quick stop active", other ESM status conversion commands are received.	Confirm the state transformation requirements from the upper device. Set ON SM2013+20*(N-1) or set

	error protection	ESM status after alarm: based on the requirement of state transformation from upper device. ESC register AL Status Code: 0000h	servo parameter F0-00=1 to clear the alarm.
883	abnormal action protection	When the input signal EXT1 / EXT2 is not allocated, select the external trigger condition through Touch probe function; The calculation result of electronic gear ratio is 1/1000 to 1000 times; The calculation process of electronic gear ratio, when the denominator or numerator is not signed and more than 64-bit; The final calculation result of electronic gear ratio, when the denominator or numerator is not signed and more than 32-bit; ESM status after alarm: stop in current ESM status ESC register AL Status Code: 0000h	Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm.

Appendix 3-2. Read the alarm

0000H ~ FEFFh is defined according to IEC61800-7-201.

FF00h ~ FFFFh can be defined according to users, as follows.

The lower 8 bits of the defined value (FF00h ～ FFFFh) shown in the following table indicates the main code of the alarm number of the servo abnormal (alarm). (the secondary code of the alarm number is not read.)

In addition, the main code of alarm number is represented by hexadecimal number.

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
603Fh	00h	Error code	0-65535	U16	ro	TxPDO	All
		Now the alarm of the servo driver (only the main number). When the alarm does not occur, it will display 0000H. When an alarm occurs, an alarm is displayed. FF**h Alarm (main) No. (00h ～ FFH) (Example) FF03h … 03h = 3d E-030 (overvoltage protection) occurs FF55h … 55h = 85d E-850 (TxPDO configuration error protection), E-851 (RxPDO configuration error protection) any one of them occurs As an exception, A000h is displayed in the case of E-817 (Syncmanager 2/3 setting error).					

Appendix 3-3. Clear the alarm

Reset method of protection function associated with EtherCAT that can be cleared in case of abnormal (alarm)

The following methods ① ② ③ can be used for abnormal (alarm) clearing no matter which method.

In addition, for protection functions other than EtherCAT association, please refer to the basic function specifications of technical manual.

Method ①: bit4 (Error Ind ACK) of AL control is set to "1".

After that, bit7 of 6040h (control word) is cleared by setting 0 → 1 (sending Fault result command).

After the alarm is cleared, the PDS status is converted from Fault to Switch on disabled.

Method ②: carry out abnormal (alarm) clearing by servo driver (panel F0-00, upper computer software).

After the alarm is cleared, the PDS status is transferred from Fault to Switch on disabled.

Method ③: the external alarm clear input (A-CLR) of servo driver changes from OFF state to ON state.

After the alarm is cleared, the PDS status is migrated from Fault to Switch on disabled.

Appendix 4. Phraseology

Abbreviation	Full name
EtherCAT	Ethernet for Control Automation Technology
COE	CANopen Over EtherCAT
FMMU	Fieldbus Memory Management Unit
SM	Sync Manager
pp	Profile position
pv	Profile velocity
tq	Torque profile
csp	Cyclic synchronous position mode
hm	Homing mode
csv	Cyclic synchronous velocity mode
cst	Cyclic synchronous torque mode
DC	Distributed Clock
SDO	Service Data Object
PDO	Process Data Object
TxPDO	-
RxPDO	-
ESM	EtherCAT State Machine
ESC	EtherCAT Salve Controller
PHY	Physical layer device that converts data from the Ethernet controller to electric or optical signals.
PDI	Process Data Interface or Physical Device Interface
EEPROM	Electrically Erasable Programmable Read Only Memory
ESI	EtherCAT Slave Information, stored in ESI EEPROM（formerly known as SII）

Appendix 5. List of object dictionaries

Appendix 5-1. COE communication area (0x1000-0x1FFF)

Index	Subindex	Name	Unit	Data arange	Data type	Flag	PDO
1000h	00h	device type	-	0-429496795	U32	RO	N0
1001h	00h	error register	-	0-65535	U16	RO	N0
1008h	00h	Device name	-	-	-	RO	N0
1009h	00h	Hardware version	-	-	-	RO	N0
100Ah	00h	software version	-	-	-	RO	N0
1018h	00h	Identity	-	-	-	RO	-
	01h	vendor ID	-	0-255	U8	RO	N0
	02h	product code	-	0-429496795	U32	RO	N0
	03h	Revision	-	0-429496795	U32	RO	N0
	04h	Serial number	-	0-429496795	U32	RO	N0
1600h	00h	1st RxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1601h	00h	2nd RxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1602h	00h	3rd RxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1603h	00h	4th RxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1A00h	00h	1st TxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1A01h	00h	2nd TxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1A02h	00h	3rd TxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0

	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1A03h	00h	4th TxPDO mapping	-	0-24	U8	RW	N0
	01h	SubIndex 001	-	0-4294967295	U32	RW	N0
	02h	SubIndex 002	-	0-4294967295	U32	RW	N0
	03h	SubIndex 003	-	0-4294967295	U32	RW	N0
	...	...	-	0-4294967295	U32	RW	N0
	18h	SubIndex 024	-	0-4294967295	U32	RW	N0
1C00h	00h	Sync mangager communication type	-	0-255	U8	RO	N0
	01h	SubIndex 001	-	0-4	U8	RO	N0
	02h	SubIndex 002	-	0-4	U8	RO	N0
	03h	SubIndex 003	-	0-4	U8	RO	N0
	04h	SubIndex 004	-	0-4	U8	RO	N0
1C12h	00h	RxPDO assign	-	0-4	U8	RW	N0
	01h	SubIndex 001	-	1600h-1603h	U16	RW	N0
	02h	SubIndex 002	-	1600h-1603h	U16	RW	N0
	03h	SubIndex 003	-	1600h-1603h	U16	RW	N0
	04h	SubIndex 004	-	1600h-1603h	U16	RW	N0
1C13h	00h	TxPDO assign	-	0-4	U8	RW	N0
	01h	SubIndex 001	-	1A00h-1A03h	U16	RW	N0
	02h	SubIndex 002	-	1A00h-1A03h	U16	RW	N0
	03h	SubIndex 003	-	1A00h-1A03h	U16	RW	N0
	04h	SubIndex 004	-	1A00h-1A03h	U16	RW	N0
1C32h	00h	SM output parameter	-	0-20h	U8	RO	N0
	01h	Synchronization Type	-	0-65535	U16	RW	N0
	02h	Cycle Time	ns	0-4294967295	U32	RW	N0
	03h	SubIndex 003	ns	0-4294967295	U32	RW	N0
	04h	Synchronization Type supported	-	0-65535	U16	RO	N0
	05h	Minimum Cycle Time	ns	0-4294967295	U32	RO	N0
	06h	Calc and Cope Time	ns	0-4294967295	U32	RO	N0
	08h	Get Cycle Time	ns	0-65535	U16	RO	N0
	09h	Delay Time	ns	0-4294967295	U32	RO	N0
	0Ah	Sync0 Cycle Time	-	0-4294967295	U32	RO	N0
	0Bh	SM -Event Missed	-	0-65535	U16	RO	N0
	0Ch	Cycle Time Too Small	-	0-65535	U16	RO	N0
	0Dh	Shift Time Too Short	-	0-65535	U16	RO	N0
	0Eh	SubIndex 0014	-	0-65535	U16	RW	N0
	20h	Sync Error	-	0-1	BOOL	RO	N0
1C33h	00h	SM input parameter	-	0-20h	U8	RO	N0
	01h	Synchronization Type	-	0-65535	U16	RW	N0
	02h	Cycle Time	ns	0-4294967295	U32	RW	N0
	03h	SubIndex 003	ns	0-4294967295	U32	RW	N0
	04h	Synchronization Type supported	-	0-65535	U16	RO	N0
	05h	Minimum Cycle Time	ns	0-4294967295	U32	RO	N0
	06h	Calc and Cope Time	ns	0-4294967295	U32	RO	N0
	08h	Get Cycle Time	ns	0-65535	U16	RO	N0
	09h	Delay Time	ns	0-4294967295	U32	RO	N0
	0Ah	Sync0 Cycle Time	-	0-4294967295	U32	RO	N0
	0Bh	SM -Event Missed	-	0-65535	U16	RO	N0
	0Ch	Cycle Time Too Small	-	0-65535	U16	RO	N0
	0Dh	Shift Time Too Short	-	0-65535	U16	RO	N0

	0Eh	SubIndex 0014	-	0-65535	U16	RW	N0
	20h	Sync Error	-	0-1	BOOL	RO	N0

Appendix 5-2. Servo parameter area

Index	Subindex	Name
2000h	00h	P0-00
2001h	00h	P0-01
2002h	00h	P0-02
2003h	00h	P0-03
...	...	...
205Fh	00h	P0-95
2100h	00h	P1-00
2101h	00h	P1-01
2102h	00h	P1-02
2103h	00h	P1-03
...	...	...
214Ah	00h	P1-74
2200h	00h	P2-00
2201h	00h	P2-01
2202h	00h	P2-02
2203h	00h	P2-03
...	...	...
2263h	00h	P2-99
2300h	00h	P3-00
2301h	00h	P3-01
2302h	00h	P3-02
2303h	00h	P3-03
...	...	...
232Eh	00h	P3-46

Index	Subindex	Name
2500h	00h	P5-00
2501h	00h	P5-01
2502h	00h	P5-02
2503h	00h	P5-03
...	...	...
2547h	00h	P5-71
2700h	00h	P7-00
2701h	00h	P7-01
2702h	00h	P7-02
2703h	00h	P7-03
...	...	...
2715h	00h	P7-21
2800h	00h	P8-00
2801h	00h	P8-01
2802h	00h	P8-02
2803h	00h	P8-03
...	...	...
281Ah	00h	P8-26

Appendix 5-3. Servo driver Profile area (0x6000~0x6FFF)

Index	Subindex	Name	Unit	Data range	Data type	Flag	PDO
6007h	00h	Abort connection option code		0-3	I16	RW	NO
603Fh	00h	Error Code		0 - 65535	U16	RO	TxPDO
6040h	00h	Controlword		0 - 65535	U16	RW	RxPDO
6041h	00h	Statusword		0 - 65535	U16	RO	TxPDO
605Ah	00h	Quickstop option code	-	0 - 7	I16	RW	NO
605Bh	00h	Shutdown option code	-	0 - 1	I16	RW	NO
605Ch	00h	Disable operation option code	-	0 – 1	I16	RW	NO
605Dh	00h	Halt option code	-	1 – 3	I16	RW	NO
605Eh	00h	Fault reaction option code	-	0 – 2	I16	RW	NO
6060h	00h	Modes of operation		--128-127	I8	RW	RxPDO
6061h	00h	Modes of operation display		--128-127	I8	RO	TxPDO
6062h	00h	Position demand value [PUU]	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
6063h	00h	Position actual internal	pulse	-2147483648 –	I32	RO	TxPDO

		value		2147483647			
6064h	00h	Position actual value	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
6065h	00h	Following error window	Command unit	0 – 4294967295	U32	RW	RxPDO
6066h	00h	Following error time out	1ms	0 – 65535	U16	RW	RxPDO
6067h	00h	Position windows	Command unit	0 – 4294967295	U32	RW	RxPDO
6068h	00h	Position window time	1ms	0 – 65535	U16	RW	RxPDO
6069h	00h	Velocity sensor actual value			I32	RO	TxPDO
606Ah	00h	Sensor selection code				RW	
606Bh	00h	Velocity demand value	Command unit /s	-2147483648 – 2147483647	I32	RO	TxPDO
606Ch	00h	Velocity actual value	Command unit /s	-2147483648 – 2147483647	I32	RO	TxPDO
606Dh	00h	Velocity window	Command unit	0 – 4294967295	U32	RW	RxPDO
606Eh	00h	Velocity window time	1ms	0 – 65535	U16	RW	RxPDO
606Fh	00h	Velocity threshold	Command unit	0 – 4294967295	U32	RW	RxPDO
6070h	00h	Velocity threshold time	1ms	0 – 65535	U16	RW	RxPDO
6071h	00h	Target torque	0.10%	-32768 – 32767	I16	RW	RxPDO
6072h	00h	Max torque	0.10%	0 – 65535	U16	RW	RxPDO
6073h	00h	Max current	0.10%	0 - 65535	U16	RO	NO
6074h	00h	Torque demand value	0.10%	-32768 – 32767	I16	RO	TxPDO
6075h	00h	Motor rated current	1mA	0 – 4294967295	U32	RO	TxPDO
6076h	00h	Motor rated torque	Mn m	0 – 4294967295	U32	RO	TxPDO
6077h	00h	Torque actual value	0.10%	-32768 – 32767	I16	RO	TxPDO
6078h	00h	Current actual value	0.10%	-32768 – 32767	I16	RO	TxPDO
6079h	00h	DC link circuit voltage				RO	
607Ah	00h	Target position	Command unit	-2147483648 – 2147483647 E208	I32	RW	RxPDO
607Bh	-	Position range limit	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	NO
	01h	SubIndex 001	Command unit	-2147483648 – 2147483647	I32	RW	RxPDO
	02h	SubIndex 002	Command unit	-2147483648 – 2147483647	I32	RW	RxPDO
607Ch		Home Offset	Command unit	-2147483648 – 2147483647	I32	RW	RxPDO
607Dh	-	Software position limit	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	NO
	01h	SubIndex 001	Command unit	-2147483648 – 2147483647	I32	RW	RxPDO
	02h	SubIndex 002	Command unit	-2147483648 – 2147483647	I32	RW	RxPDO
607Eh	00h	Polarity	-	0 – 255	U8	RW	NO
607Fh	00h	Max profile velocity	Command unit /s	0 – 4294967295	U32	RW	RxPDO
6080h	00h	Max motor speed	r/min	0 – 4294967295	U32	RW	RxPDO
6081h	00h	Profile velocity	Command	0 – 4294967295	U32	RW	RxPDO

			unit /s				
6082h	00h	End velocity	Command unit /s	0 – 4294967295	U32	RW	RxPDO
6083h	00h	Profile acceleration	Command unit /s²	0 – 4294967295	U32	RW	RxPDO
6084h	00h	Profile deceleration	Command unit / s²	0 – 4294967295	U32	RW	RxPDO
6085h	00h	Quick stop deceleration	Command unit / s²	0 – 4294967295	U32	RW	RxPDO
6086h	00h	Motion profile type	-	-32768 – 32767	I16	RW	RxPDO
6087h	00h	Torque slope	0.1%/S	0 – 4294967295	U32	RW	RxPDO
6088h	00h	Torque profile type	-	-65535	I16	RW	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	NO
	01h	SubIndex 001	pulse	1 – 4294967295	U32	RO	NO
	02h	SubIndex 002	r (motor)	1 – 4294967295	U32	RO	NO
6091h	-	Gear ratio	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	NO
	01h	SubIndex 001	r (motor)	1 – 4294967295	U32	RW	NO
	02h	SubIndex 002	r (shaft)	1 – 4294967295	U32	RW	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	NO
	01h	SubIndex 001	Command unit	1 – 4294967295	U32	RW	NO
	02h	SubIndex 002	r (shaft)	1 – 4294967295	U32	RW	NO
6093h	00h	Position factor	No supported				
6098h	00h	Homing method	-	-128 – 127	I8	RW	RxPDO
6099h	-	Homing speeds	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	NO
	01h	SubIndex 001	Command unit /s	0 – 4294967295	U32	RW	RxPDO
	02h	SubIndex 002	Command unit/s	0 – 4294967295	U32	RW	RxPDO
609Ah	00h	Homing acceleration	-	0 – 4294967295	U32	RW	RxPDO
60A3h	-	Profile jerk use	The version cannot support these two parameters, for backup				
60A4h	00h	Profile jerk					
	01h	SubIndex 001					
	02h	SubIndex 002					
60B0h	00h	Position offset	These three parameters are used for driving three loop control. Since the servo underlying algorithm does not support feedforward control, these three parameters are not used, and the modification will not affect the effect.				
60B1h	00h	Velocity offset					
60B2h	00h	Torque offset					
60B8h	00h	Touch probe function	-	0 - 65535	U16	RW	RxPDO
60B9h	00h	Touch probe status	-	0 - 65535	U16	RO	TxPDO
60BAh	00h	Touch probe pos1 pos value	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
60BBh	00h	Touch probe pos1 neg value	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
60BCh	00h	Touch probe pos2 pos value	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
60BDh	00h	Touch probe pos2 neg value	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
60C0h		Interpolation sub mode select	No supported				

60C1h	-	Interpolation data record					
	00h	Number of entries					
	01h	SubIndex 001					
	02h	SubIndex 002					
60C2h	-	Interpolation time period	-	-	-	-	-
	00h	Number of entries	-	2	U8	RO	TxPDO
	01h	SubIndex 001	-	0– 4294967295	U32	RW	TxPDO
	02h	SubIndex 002	-	0– 4294967295	U32	RW	TxPDO
60C5h		Max acceleration	Command unit /s²	0 – 4294967295	U32	RW	RxPDO
60C6h		Max deceleration	Command unit/s²	0 – 4294967295	U32	RW	RxPDO
60E0h	00h	Positive torque limited	No supported				
60E1h	00h	Negtive torque limited	No supported				
60E3h	-	Supported homing method	-	-	-	-	TxPDO
	00h	Number of entries	-	1 - 254	U8	RO	TxPDO
	01h	1st supported homing method	-	0 - 32767	U16	RO	TxPDO
	..	..	..	..	..	..	..
	20h	32nd supported homing method	-	0 - 32767	U16	RO	TxPDO
60F2h	00h	Positioning option code					
60F4h	00h	Following error actual value	Command unit	-2147483648 – 2147483647	I32	RO	TxPDO
60FA	00h	Following error actual value	Command unit/s	-2147483648 – 2147483647	I32	RO	TxPDO
60FCh	00h	Position demand value	pulse	-2147483648 – 2147483647	I32	RO	TxPDO
60FDh	00h	Digital inputs	No supported				
60FEh	-	Digital outputs	No supported				
	00h	Number of entries					
	01h	Physical outputs					
	02h	Bit mask					
60FFh	00h	Target velocity	Command unit /s	0 – 4294967295	U32	RW	RxPDO
6502h	00h	Supported drive modes		0-4294967295	U32	RO	TxPDO

Note:

(1) The object dictionary default value of 607Bh (Position range limited) and 607Dh (softward position limited): Min range limited: -2147483648; Max range limited: 2147483647.
This parameter modification does not work.

(2) 6086h (Motion profile type)
0: step type 1: slope type
This parameter is only fit for HM mode. In PP, PV mode, trajectory planning is directly used for slope type.
In CSP and CSV mode, it is unnecessary to use this parameter, and the trajectory planning is completed in the master station.

(3) 6088h (Torque profile type)
0: step type 1: slope type
In TQ mode, the slope type is used for torque planning directl, this parameter does not work.

Appendix 6. Key points for attention

(1) Do not activate the parameters when the servo is enabled. If you want to activate the parameters, please activate them in the servo disabled state, otherwise the correct execution of the action cannot be guaranteed;
(2) If it is necessary to power down and power on the driver or the host, please power off and power on both, otherwise the correct execution of the action cannot be guaranteed.
(3) In CSP, CSV and CST modes, do not manually modify the value of 6040h (control word) during motor operation.

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