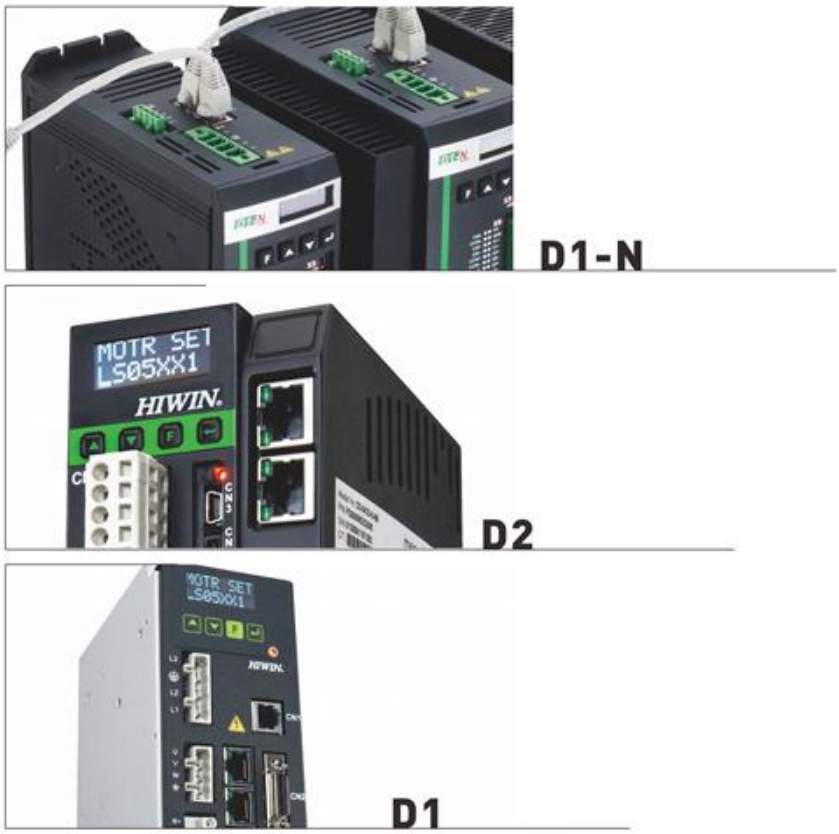
HIWIN CoE Drive User Guide



Version 1.1
September 29, 2016

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Revision History:

Version	Date	Applicability	Remarks
1.0	2014-03-17	D-series CoE drive	Frist release.
1.1	2016-09-29	D-series Drive: D1COE MDP 0.319 above D2COE MDP 0.118 above D1NCOE MDP 0.518 above Lightening 0.188 above abily-series: iKM MDP 0.402 above Storm 0.002 above	Re-write and re-organize this User Guide based on Chinese version of HIWIN CoE Drive User Guide v1.1.

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1. About the User Guide

1.1. Instructions before use

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Main purposes of this User Guide are to describe EtherCAT communication and CiA 402 drive profile applied to HIWIN CoE products. About their specifications, dimensions, connections and wiring, settings and operations, refer to the corresponding User Guide.

(1) For D1-series drive, refer to “D1 Drive User Guide”. Download path is: http://www.hiwinmikro.tw/hiwintree/Product_SubType.aspx?type=D1

(2) For D2-series drive, refer to “D2 Drive User Guide”. Download path is: http://www.hiwinmikro.tw/hiwintree/Product_SubType.aspx?type=D2

(3) For D1-N-series drive, refer to “D1-N Drive User Guide”. Download path is: http://www.hiwinmikro.tw/hiwintree/Product_SubType.aspx?type=D1-N

(4) For abily-series products, refer to “abilyrobot & abilymotor User Guide”. Download path is: http://www.hiwinmikro.tw/hiwintree/

Read User Guide carefully before using the product. HIWIN Mikrosystem Corp. (“the Company”) will not take any responsibility for damages, accidents or injuries caused by installation or use that is not performed according to these instructions.

◆ Do not dismantle or modify the product. The product has been subject to structural calculations, computer simulations, and physical tastings to verify its design. Do not dismantle or modify the product without the consent of professional technicians of the Company. The Company does not take any responsibility for accidents or damages resulting from such dismantling or modifications.

◆ Before installing or using the product, check the external appearance and ensure that there is no damage on the surface of the product. If any damage is identified, please contact the Company or one of the Company’s distributors immediately.

◆ Refer to the performance specifications on the product label or manufacturer's document before using the product. Install the product based on these performance limits and installation instructions indeed.

◆ Read the specification of power voltage on the label before using the product and confirm that the power supply meets the product requirement. The Company does not take any responsibility for product damages or personal injuries resulting from incorrect power supply.

◆ Do not use the product over the rated load. The Company does not take any responsibility for damages or injuries resulting from such misuse.

◆ Do not use the product in an environment where shocks may occur. The company does not take any responsibility for damages, accidents or injuries resulting from such shocks.

◆ If drive has any error, refer to the troubleshooting of the corresponding user guide. Follow instructions to turn off drive’s power to do troubleshooting. After the error is eliminated, turn on drive’s power again.

◆ Do not try to repair any produce malfunction. The product can only be repaired by qualified technicians.

The warranty period is one year from the ex-factory date. The Company does not take any responsibility for product replacement or repair caused by inappropriate use or natural disasters. (Refer to notes and installation instructions in User Guide.)

1.2. Safety instructions

- Read User Guide carefully before installation, transportation, maintenance and inspection, and ensure that the product is used correctly.
- Users should read EM information, safety information, and all related instructions before using the product.
- The safety instructions in User Guide are categorized into “Warning”, “Attention”, “Prohibited”, and “Required”.

⚠ Warning

Inappropriate operation may cause dangers resulting in the serious injury or death.
Inappropriate operation may cause dangers resulting in the disability, minor injury or material damage.

⚠ Attention

Actions marked ⚠ Attention may have serious consequences under different situations. All such instructions are important and must be followed.

Prohibited

Indicate that the action is forbidden and must not be done.

Required

Indicate that the action is compulsory and must be done.

⚠ Danger

- **Always ensure that drive is correctly earthed by using PE bar in the switch cabinet as reference potential. Safety is not guaranteed if there is no low-ohm earthing.**
- **Power connections may be live if motor is not moving. Never disconnect the electrical connections of motor and drive as live. In the worst case, electric arcs may form and cause personal injury and damage as contacts.**
- **After disconnecting drive from supply voltages, wait at least five minutes before touching live parts (e.g. contacts, threaded bolts etc.) or breaking connections. For your own safety, measure the voltage in the intermediate circuit and wait until it has fallen below 40 Vdc.**

◆ Usage instructions

⚠ Warning

- Do not touch the terminal or inside part when it is powered to avoid electric shock.
- Do not touch the terminal or inside within 10 minutes from power off. The residual voltage may cause electric shock.
- Do not change the wiring when it is powered to avoid electric shock.
- Do not cut the cable, apply too much stress to it, or place heavy objects on it. Laying the cable between objects may cause fire or electric shock.

⚠ Attention

- Do not install the product in a place exposed to moisture or erosion, or in an environment containing ignitable gas. Do not use the product close to any flammable objects.

◆ Storage

Prohibited

- Do not store the product in a place exposed to water, moisture, direct sunlight, harmful gas, or liquids.

◆ Handling

⚠ Attention

- Be careful of handling the product and avoid damaging it.
- Use appropriate handling methods and do not apply too much pressure to the case.
- The product shall not be stacked too high to avoid collapsing.

◆ Installation location

Required

- Do not install the product in a place exposed to high temperatures, high humidity, or flying dust, iron powder, or cutting powder.
- Install the product in a place where the ambient temperature meets the requirement of User Guide. Use one cooling fan if the temperature is potentially high.
- Do not install the product in a place exposed to direct sunlight.
- Since the product does not have one waterproof or moisture-proof case, do not use it outdoors or install it in a place where water or other liquid exists.
- Install the product in a place with low vibrations.
- When motor is moving continuously, heat is generated due to the use frequency. Use one cooling fan, or set to standby status when motor stops. So that, the ambient temperature of motor does not exceed its specified value.

◆ Installation

⚠ Attention

- Do not place any heavy objects on the product to avoid damage.
- Do not mix with debris to avoid fire.
- Ensure that the product is installed in the required direction to avoid fire.
- Protect the product from strong impact to avoid collapse or damage.
- The weight of mounting body must be taken into account during installation. Inappropriate installation may cause damage.
- Install the product on a metal or noncombustible object to avoid fire.

◆ Wiring

⚠ Attention

- Be correct and reliable wiring, otherwise it will cause motor to out of control or burn out, and make damage or fire.

◆ Operation and transportation

⚠ Attention

- Ensure that the specification of power source is correct to avoid damage or fire.
- The motor may suddenly start after power is restored instantly. Do not come too close to machine.

Required

- Wire an external emergency stop line to stop the operation and to cut off power at any time.

◆ Maintenance

Prohibited

- Do not dismantle or modify the product.
- Do not attempt to repair any product malfunction. Please send it back to professional technicians of the Company for repair.

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2. EtherCAT Communication

2.1. Communication specification

Table 2-1

EtherCAT communication	Communication standards	IEC 61158 Type 12 IEC 61800-7 CiA 402 drive profile
	Physical layer	100BASE-TX (IEEE802.3)
	SyncManager	SM0 – Mailbox output (master → slave) SM1 – Mailbox input (slave → master) SM2 – Process data outputs SM3 – Process data inputs
	Process data	Dynamic PDO mapping
	Mailbox (CoE)	SDO request
	Synchronization	Free run mode DC mode (DC cycle: 250us, 500us, 1ms, 2ms, 4ms)
CiA 402 drive profile	Homing mode	
	Profile position mode	
	Profile velocity mode	
	Profile torque mode	
	Cyclic synchronization position mode	
	Cyclic synchronization velocity mode	
	Cyclic synchronization torque mode	
	Touch probe function	

2.2. Communication architecture

The communication architecture of network module for CoE (CANopen over EtherCAT) drive can be divided into two layers: data link layer (DL) and application layer (AL), as shown in Fig. 2-1. The data link layer manages the interface of data transmission between the master and slave stations. On the other hand, the application layer implements the function of state transition compatible between CiA 402 (CANopen Drive Communication Protocol) and EtherCAT.

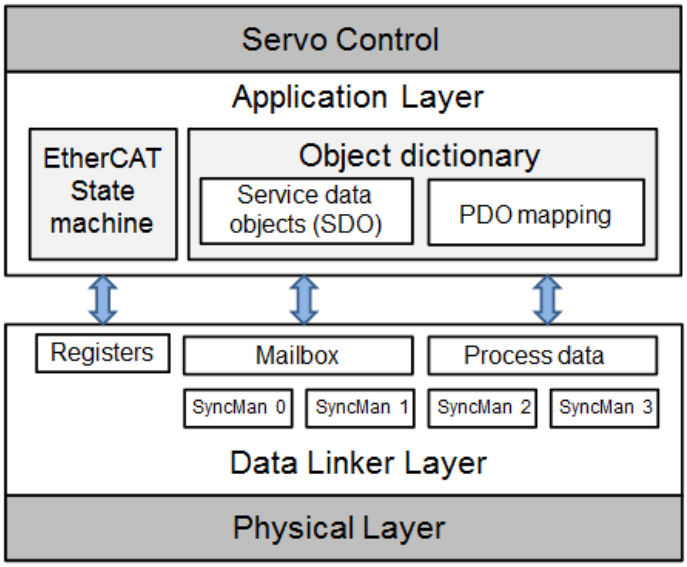

Fig. 2-1

There are two modes of data transition between application layer and data link layer: time-critical and non-time-critical data transitions. The time-critical data means that the data transition must be completed within a specific time. If not, it may cause the control failure. The time-critical data is normally used in the periodic communication and is called as cyclic process data communication. On the other hand, the non-time-critical data can be completed by using the non-periodic communication, i.e., using the non-periodic mailbox communication.
Process data object (PDO) in the application layer is consisted of objects which can be mapping to PDO and contents of process data defined in PDO mapping. It reads and writes data via periodic process data communication. However, service data object (SDO) reads and writes data in the object dictionary via mailbox data communication. Table 2-2 shows the layout between the process data of data link layer and the Sync Manager of mailbox data communication.

Table 2-2

Sync Manager	Purpose	Starting address
Sync Manager 0	Mailbox data communication - receive Mailbox	0x1800
Sync Manager 1	Mailbox data communication - transmit Mailbox	0x18F6
Sync Manager 2	Process data communication - receive PDO (RxPDO)	0x1000
Sync Manager 3	Process data communication - transmit PDO (TxPDO)	0x1100

Drive supporting EtherCAT communication should provide one file for master station to plan the layout and communication between the master and slave stations. This file is called as ESI (EtherCAT slave information) and is made by the extensible markup language (xml). ESI files for HIWIN CoE drives are given as follows:

(1) For D1-N CoE drive: D1NCOE_□□□□□□□□.xml

(2) For D1 CoE drive: D1COE_□□□□□□□□.xml

(3) For D2 CoE drive: D2COE_□□□□□□□□.xml

(4) For abily series products: abily_□□□□□□□□.xml

where □□□□□□□□ denotes the release date of ESI file. For example, 20150922 means the corresponding file is released by September 22, 2015.

2.3. EtherCAT state machine

EtherCAT state machine (ESM) is used to coordinate applications between the master and slave stations from start-up to operation. State transition is normally started by the master station. After receiving the request of state transition, the slave station begins to change state. State transitions of EtherCAT state machine are shown in Fig. 2-2. When the slave station begins to transit from “Initialization” state to “Operational” state, it must follow the process of Initialization (Init) → Pre-Operational (Pre-Op) → Safe-Operational (Safe-Op) → Operational (Op). Leapfrog switch is not allowed.

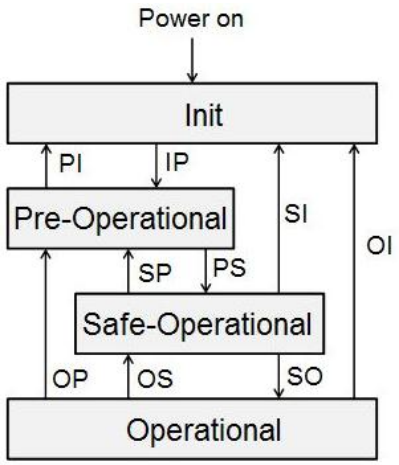

Fig. 2-2

Table 2-3

State	Description
Init	(1) No mailbox communication. (2) No process data communication.
IP (Init to Pre-Op)	(1) Master station sets following registers for mailbox communication: - DL Address; - Sync Manager channels. (2) Master station initializes the synchronization of distribute clock. (3) Master station requests to enter “Pre-Op” state. - Setting AL Control register. (4) Wait for response from AL Status register.
Pre-Op	(1) Able to use mailbox communication. (2) No process data communication.
PS (Pre-Op to Safe-Op)	(1) Master station uses mailbox communication to set contents of PDO mapping. (2) Master station allocates Sync Manager channels for process data communication. (3) Master station requests to enter “Safe-Operational” state. - Setting AL Control register. (4) Wait for response from AL Status register.
Safe-Op	(1) Able to use mailbox communication. (2) Able to use process data communication. - Only input type of process data communication being able to use.
SO (Safe-Op to Op)	(1) Master station requests to enter “Operational” state. - Setting AL Control register. (2) Wait for response from AL Status register.
Op	(1) Able to use mailbox communication. (2) Able to use both output and input types of process data communication.

2.4. PDO mapping

Based on user's requirements, the transmitted data between the master and slave stations via process data communication can be changed. Receiving process data communication can be implemented by setting RxPDO mapping object 0x1600; while transmitting process data communication can be implemented by setting TxPDO mapping object 0x1A00. The default of PDO mapping allocated for process data communication is shown in Table 2-4. For HIWIN CoE products, the maximum number of allowed RxPDO or TxPDO is 7, and the total size of RxPDO or TxPDO is 20 bytes.

Table 2-4

Mapping objects	**Data objects**						
RxPDO (0x1600)	Controlword (0x6040)	Target position (0x607A)	--	--	--	--	--
TxPDO (0x1A00)	Statusword (0x6041)	Position actual value (0x6064)	Following error actual value (0x60F4)	--	--	--	--

If users want to change the allocation of objects for process data communication, drive must be at "Pre-Operational" state of EtherCAT state machine. The procedure is done via mailbox data communication. The procedure of allocation is described as follows:

(1) Change EtherCAT state machine of drive to "Pre-Operational" state.

(2) Close PDO allocation of Sync Manager.
This can be done by setting sub-index 0 of communication objects 0x1C12 and 0x1C13, where 0x1C12 is used to set the PDO allocation of Sync Manager for RxPDO and 0x1C13 is used to set the PDO allocation of Sync Manager for TxPDO.

(3) Configure required data objects.
If data objects need to be transmitted by RxPDO, just assign them to sub-indexes 1~7 of mapping object 0x1600. If by TxPDO, just assign them to sub-indexes 1~7 of 0x1A00.

(4) Enable PDO allocation of Sync Manager.
Set sub-indexes 0 of 0x1C12 and 0x1C13 to 1 to enable PDO transmission.

(5) Change EtherCAT state machine of drive to "Operational" state.

2.5. Synchronization mode

HIWIN CoE drive provides two modes of synchronization: free-run mode and distributed clocks (DC) mode. The master station configures the synchronization mode by setting register 0x0980 of EtherCAT slave controller (ESC).

(1) Free-run mode

Set ESC register 0x0980 to be 0000h to enable free-run mode. This mode completes the synchronization function via the event of ESC application layer (register 0x0220). Its bits 10 and 11 are the flag generated by data transmission event. Drive detects these two bits to trigger the transmission of PDO data.

(2) DC mode

Set ESC register 0x0980 to be 0300h to enable DC mode. This mode completes the synchronization function via the mechanism of distribute clock. Drive takes the internal SYNC0 event generated by reference clock to complete it. The diagram of synchronization with DC reference clock is shown in Fig. 2-3.The supported cycle times of drive are 250us, 500us, 1ms, 2ms, and 4ms.

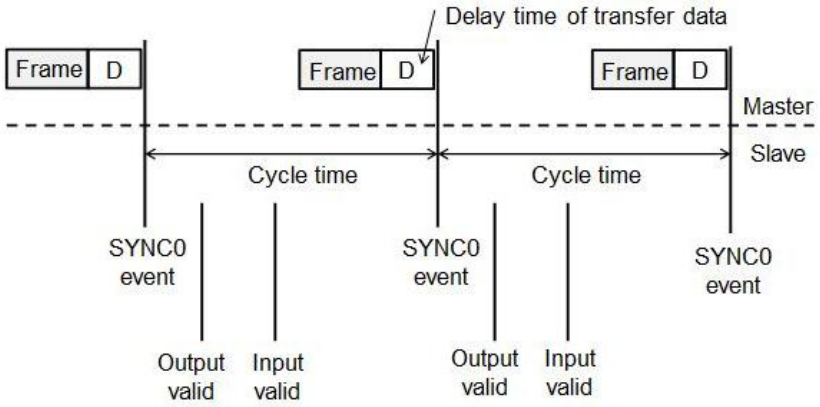

Fig. 2-3

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3. CiA 402 Drive Profile

3.1. Finite state automation

The servo drive utilizes the finite sate automation (FSA) of CANOpen to define its state with the corresponding servo control function. The master station uses Controlword (object 0x6040) to control the state transition of drive; while drive uses Statusword (object 0x6041) to response the current status of drive to master station. The flow chart of FSA state transition is shown in Fig. 3-1, and the definition of each state is given in Table 3-1.

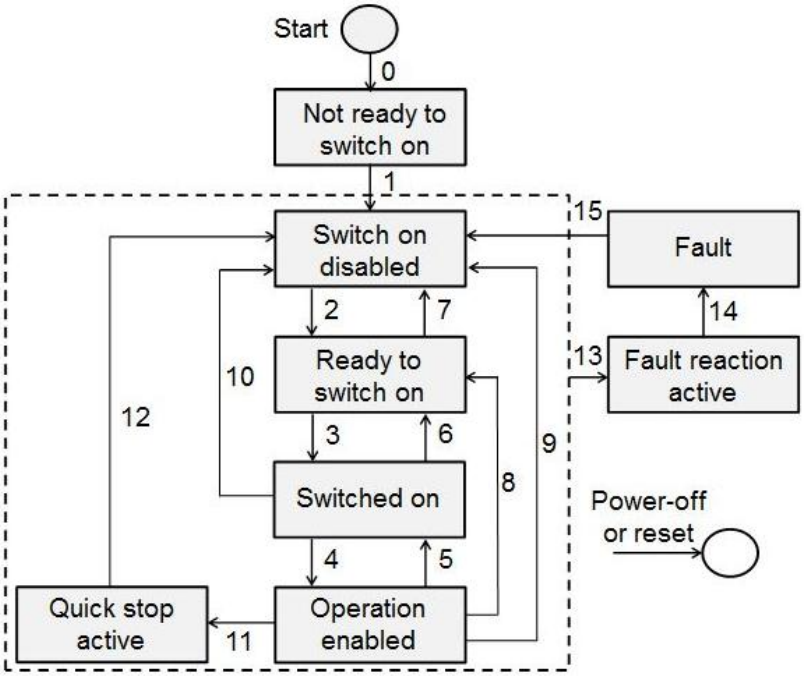


Fig. 3-1

Table 3-1

State	Definition
Not ready to switch on	Drive is not at the ready state.
Switch on disabled	The main power of drive is off and motor cannot be enabled.
Ready to switch on	The main power of drive is waiting to be turned on, but motor cannot be enabled.
Switched on	The main power of drive is turned on, and motor can be enabled by Controlword.
Operation enabled	Motor has been enabled and drive can be operated normally.
Quick stop active	Drive uses Quick stop deceleration (object 0x6085) to decelerate and stop motor.
Fault reaction active	Drive error occurred and the correspondiing action is started.
Fault	Drive error occurred and the corresponding action was done. Drive already disabled motor at this state.

Table 3-2 describes the bit definition of Controlword (object 0x6040) used by the master station and Table 3-3 the shows command of state transition.

Table 3-2

Bit of Controlword	Definition
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4 - 6	Operation-mode specific
7	Fault reset
8	Halt
9	Operation-mode specific
10	Reserved
11 - 15	Manufacturer specific

Table 3-3

Command \ Bit	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	Transition event
Shutdown	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3+4
Enable operation	0	1	1	1	1	4
Disable operation	0	0	1	1	1	5
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	7, 10, 11
Fault reset	0->1	X	X	X	X	15

Table 3-2 describes the bit definition of Statusword (object 0x6041) responded by drive and Table 3-3 shows the response of current status.

Table 3-4

Bit of Statusword	Definition
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick stop
6	Switch on disabled
7	Warning
8	Manufacturer specific
9	Remote
10	Target reached
11	Internal limit active
12, 13	Operation-mode specific
14, 15	Manufacturer specific

Table 3-5

Bit / Status	Bit 6	Bit 5	Bit 3	Bit 2	Bit 1	Bit 0
Not ready to switch on	0	X	0	0	0	0
Switch on disabled	1	X	0	0	0	0
Ready to switch on	0	1	0	0	0	1
Switch on	0	1	0	0	1	1
Operation enabled	0	1	0	1	1	1
Quick stop active	0	0	0	1	1	1
Fault reaction active	0	X	1	1	1	1
Fault	0	X	1	0	0	0

3.2. Homing mode

The relationship of input and output objects for homing (hm) mode is described in Fig. 3-2. The bit definition of Controlword for hm mode is given in Fig. 3-3 and the supported functions are described in Table 3-6. The bit definition of Statusword for hm mode is shown in Fig. 3-4, and the homing statuses are defined in Table 3-7.

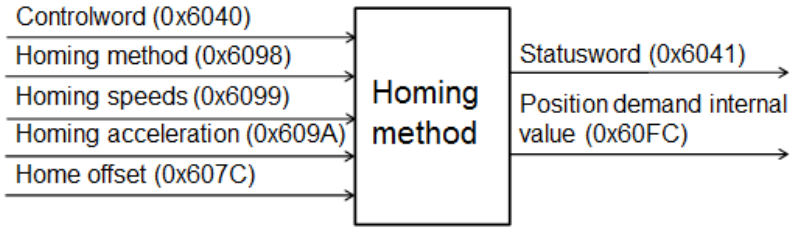


Fig. 3-2

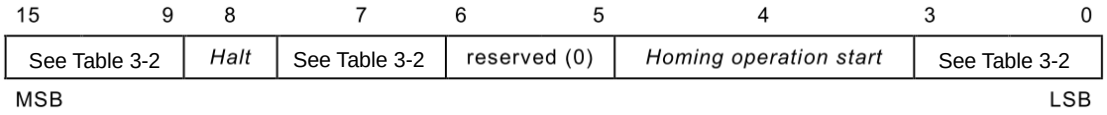


Fig. 3-3 Controlword for homing mode

Table 3-6

Bit	Value	Definition
4	0	Stop or do not start homing procedure.
	1	Start or continue homing procedure.
8	0	Enable bit 4.
	1	Stop motor based on Homing acceleration (object 0x609A).

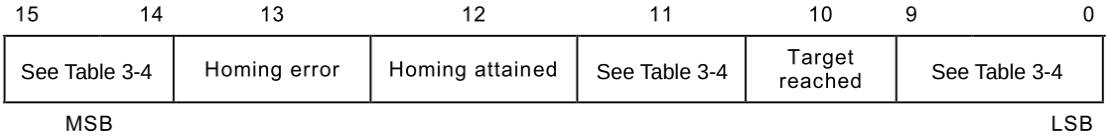


Fig. 3-4 Statusword for homing mode

Table 3-7

Bit of Statusword			Definition
13	12	10	
0	0	0	Homing procedure is in progress.
0	0	1	Homing procedure is interrupted or not started.
0	1	1	Homing procedure is completed successfully.
1	0	0	Homing error occurred and velocity is not 0.
1	0	1	Homing error occurred and velocity is 0.

A. Home offset

During homing procedure, if Home offset (object 0x607C) is not 0, the found home position is set to be the value of Home offset.

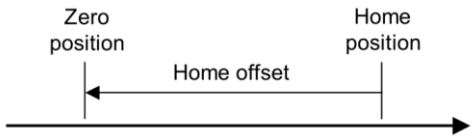


Fig. 3-5

B. Start homing procedure

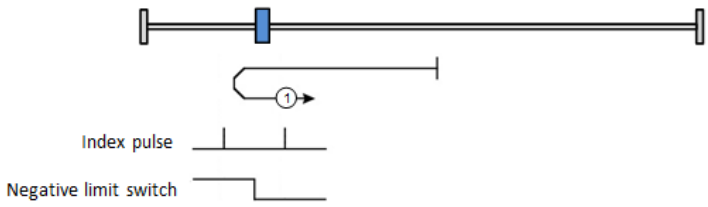
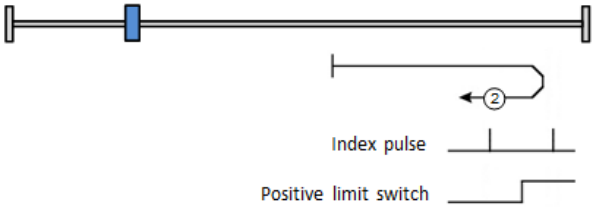
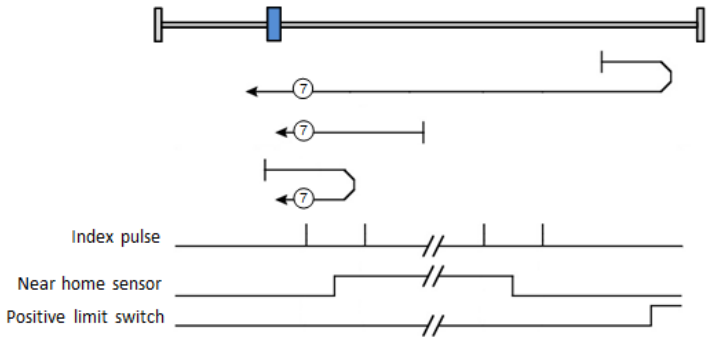
Steps of stating homing procedure are described as follows:

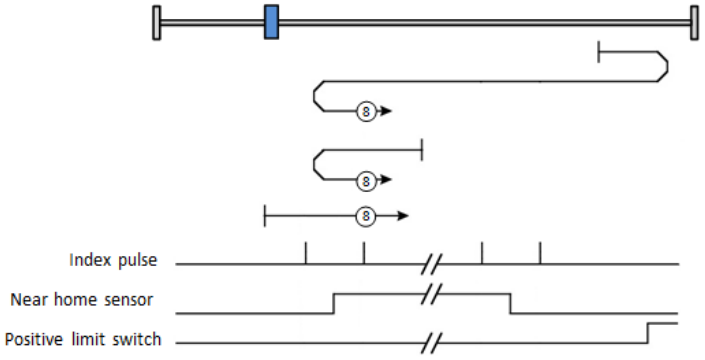
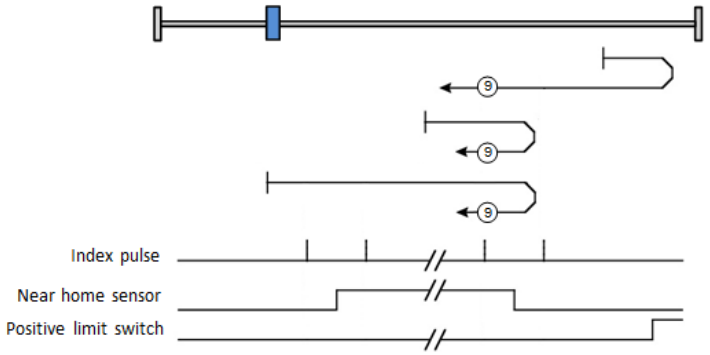
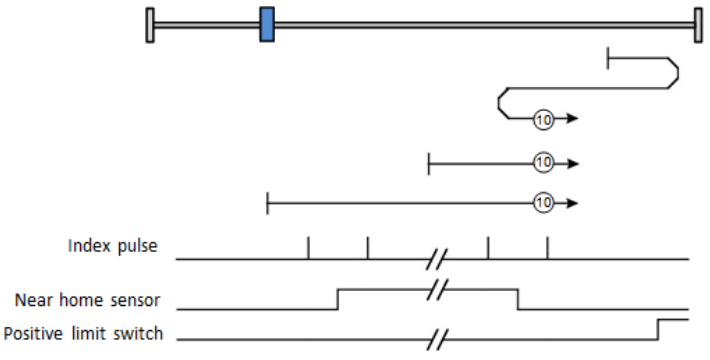
(1) Set object 0x6060 to be 6 to change drive mode to homing mode.
(2) Set object 0x6098 to be the required homing method. Homing methods supported by HIWIN CoE drive are given in Table 3-8.
(3) Set Homing acceleration (object 0x609A), Homing speeds (objects 0x6099:01 and 0x6099:02), and Home offset (object 607C).
Note. Object 0x6099:01 is the speed for searching limit switch and home switch. It is the faster speed. Object 0x6099:02 is the speed for searching index, and is the slower speed.
(4) Set bit 1 of Controlword (object 0x6040) to be 1 to start homing procedure.
(5) Wait for bits 10 and 12 of Statusword to be 1. This means that the homing procedure is completed successfully.
(6) Clear bit 4 of Controlword to be 0.

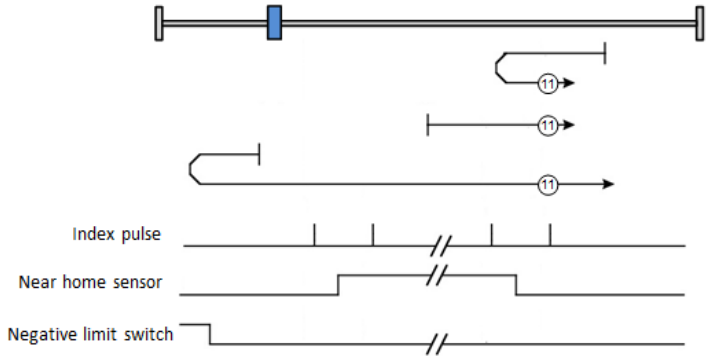
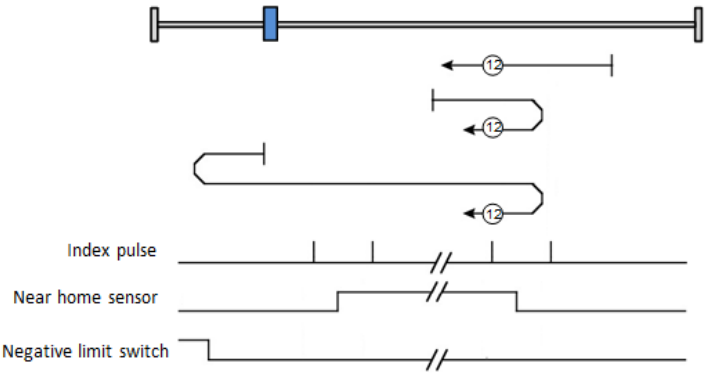
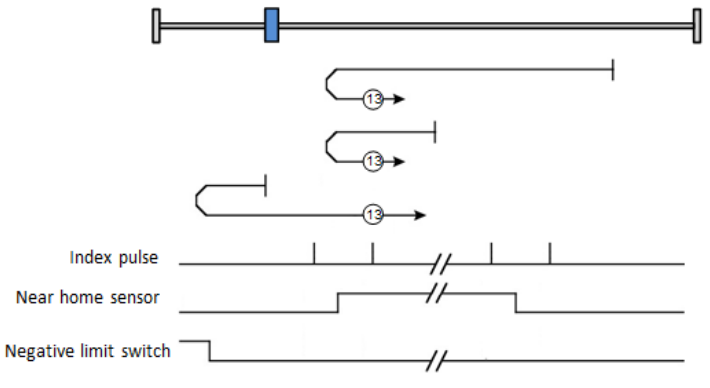
After the homing procedure is completed, there are two following methods to restart homing procedure.

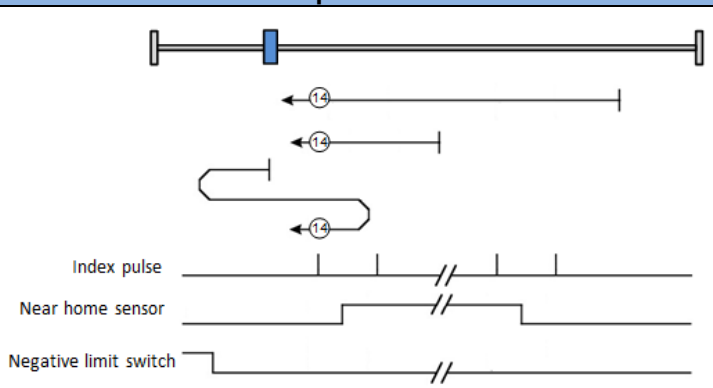
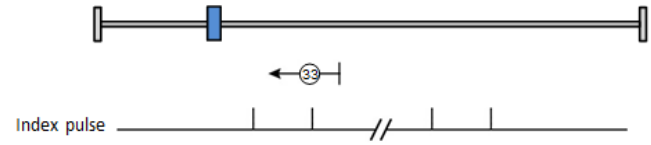
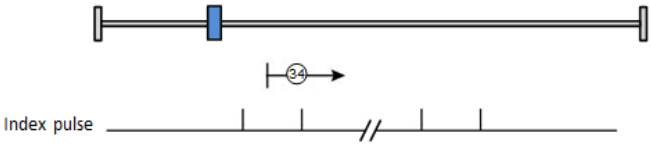
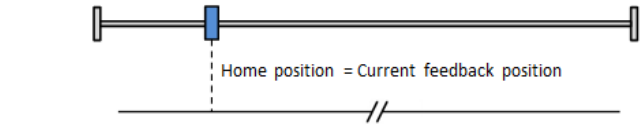
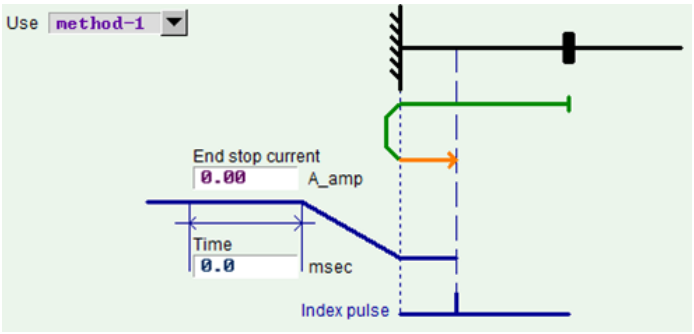
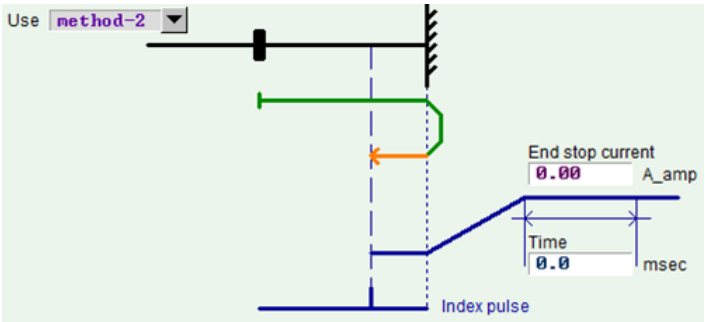
(1) For the case of bit 4 of Controlword being 1, set Mode of operation (object 0x6060) to be other supported operation mode. Then, set object 0x6060 back to be 6 (i.e., homing mode). Now, the homing procedure can be restarted.
(2) For the case of Mode of operation (object 0x6060) being 6, set bit 4 of Controlword to be 0, and then set this bit back to be 1. Now, the homing procedure can be restarted.

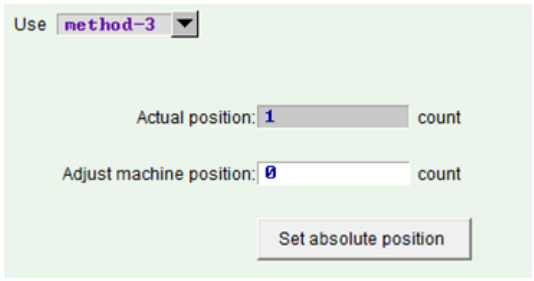
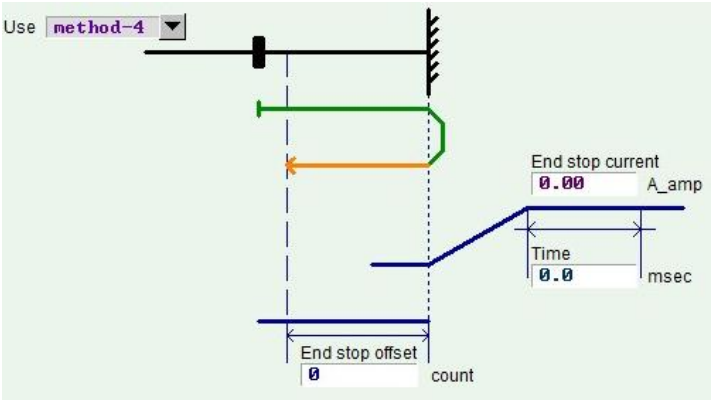
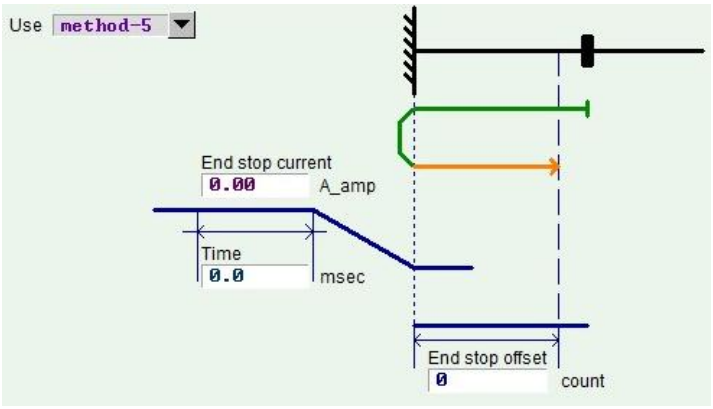
Table 3-8

No.	Description	Explanation
1	**Homing on negative limit switch and index pulse:** Motor searches negative limit swtich in the negative direction by using faster speed. After searched, motor searches index in the positive direction by using slower speed.	
2	**Homing on positive limit switch and index pulse:** Motor searches positive limit swtich in the positive direction by using faster speed. After searched, motor searches index in the negative direction by using slower speed.	
7	**Homing on home switch and index pulse – positive initial motion, left edge of home switch, left-side index:** (1) Outside home switch: Motor searches the left edge of home switch in the positive direction by using faster speed. After searched, motor searches the left-side index of this signal in the negative direction by using slower speed. (2) Inside home switch: Motor searches the left edge of home switch in the negative direction by using faster	

No.	Description	Explanation
	speed. After searched, motor searches the left-side index of this signal in the negative direction by using slower speed.	
8	**Homing on home switch and index pulse – positive initial motion, left edge of home switch, right-side index:** (1) Outside home switch: Motor searches the left edge of home switch in the positive direction by using faster speed. After searched, motor searches the right-side index of this signal in the positive direction by using slower speed. (2) Inside home switch: Motor searches the left edge of home switch in the negative direction by using faster speed. After searched, motor searches the right-side index of this signal in the positive direction by using slower speed.	
9	**Homing on home switch and index pulse – positive initial motion, right edge of home switch, left-side index:** Motor searches the right edge of home switch in the positive direction by using faster speed. After searched, motor searches the left-side index of this signal in the negative direction by using slower speed.	
10	**Homing on home switch and index pulse – positive initial motion, right edge of home switch, right-side index:** Motor searches the right edge of home switch in the positive direction by using faster speed. After searched, motor searches the right-side index of this signal in the positive direction by using slower speed.	

No.	Description	Explanation
11	**Homing on home switch and index pulse – negative initial motion, right edge of home switch, right-side index:** (1) Outside home switch: Motor searches the right edge of home switch in the negative direction by using faster speed. After searched, motor searches the right-side index of this signal in the positive direction by using slower speed. (2) Inside home switch: Motor searches the right edge of home switch in the positive direction by using faster speed. After searched, motor searches the right-side index of this signal in the positive direction by using slower speed.	
12	**Homing on home switch and index pulse – negative initial motion, right edge of home switch, left-side index:** (1) Outside home switch: Motor searches the right edge of home switch in the negative direction by using faster speed. After searched, motor searches the left-side index of this signal in the negative direction by using slower speed. (2) Inside home switch: Motor searches the right edge of home switch in the positive direction by using faster speed. After searched, motor searches the left-side index of this signal in the negative direction by using slower speed.	
13	**Homing on home switch and index pulse – negative initial motion, left edge of home switch, right-side index:** Motor searches the left edge of home switch in the negative direction by using faster speed. After searched, motor searches the right-side index of this signal in the positive direction by using slower speed.	

No.	Description	Explanation
14	**Homing on home switch and index pulse – negative initial motion, left edge of home switch, left-side index:** Motor searches the left edge of home switch in the negative direction by using faster speed. After searched, motor searches the left-side index of this signal in the negative direction by using slower speed.	
33	**Homing on index pulse – negative initial motion** Motor searches index pulse in the negative direction by using slower speed.	
34	**Homing on index pulse – positive initial motion** Motor searches index pulse in the positive direction by using slower speed.	
37	**Homing on current position** Take the current position of motor as home position.	
-1	**Homing on hard stop and index pulse – negative initial motion,** Motor searches hard stop in the negative direction by using faster speed. After searched, motor searches index pulse in the positive direction by using slower speed. (Refer to coressponding drive user guide to find the setting method of searching hard stop)	
-2	**Homing on hard stop and index pulse – positive initial motion,** Motor searches hard stop in the positive direction by using faster speed. After searched, motor searches index pulse in the negative direction by using slower speed. (Refer to coressponding drive user guide to find the setting method of searching hard stop)	

No.	Description	Explanation
-3	**Homing on absolute encoder：** This method is only available for motor with absolute encoder (the 9-th bit of motor model name is 4). Take the current position of motor as absolute target position. Motor does not move on this method. (D1 CoE and abily series products do not support this method)	
-4	**Homing on hard stop and home offset – positive initial motion,** Motor searches hard stop in the positive direction by using faster speed. After searched, motor moves to home offset (End stop offset) in the negative direction by using slower speed. (D1 CoE, D2 CoE, and abily series products do not support this method)	
-5	**Homing on hard stop and home offset – negative initial motion,** Motor searches hard stop in the negative direction by using faster speed. After searched, motor moves to home offset (End stop offset) in the positive direction by using slower speed. (D1 CoE, D2 CoE, and abily series products do not support this method)	

C. Stop homing procedure

When homing procedure is interrupted, motor will decelerate to stop according to Homing acceleration (object 0x609A).

(1) No error message reported

Following conditions will stop homing procedure, and report the message of homing procedure being stopped on Statusword, but do not report error message.

a. There is no error occurred during homing procedure. When FSA state is changed to other state except for “Operation enabled” state, drive should stop homing procedure and decelerate motor to stop.

b. Drive receives the command of stopping homing procedure (bit 4 of Controlword is 0).

c. Drive receives the command of halting homing procedure (bit 8 of Controlword is 1).

d. When drive receives the command of changing operation mode to 0 (no mode), it should stop homing procedure and decelerate motor to stop.

(2) Error message reported

Following conditions will stop homing procedure, report the message of homing error occurred on Statusword, and report homing error code on Error code (object

0x603F).

a. There is an error occurred during homing procedure. For example, the error of position error too big occurs when the incorrect hardware limit switch is searched. At this case, FSA state is changed to “Fault” state. Drive should stop homing procedure and decelerate motor to stop.
b. Drive receives the command of starting homing (bit 4 of Controlward is 1) at the illegal setting of Homing method (object 0x6098).
c. Reach hardware limit switch during searching index pulse. Drive should stop homing procedure and decelerate motor to stop.
d. Drive receives the command of changing to other supported operation mode. Drive should stop homing procedure and decelerate motor to stop.

3.3. Profile position mode

In profile position (pp) mode, the master station sends Profile velocity, Profile acceleration/ deceleration, and Target position (object 0x607A) to drive. Drive uses the internal profile generator to calculate motion commands. Through position, velocity, and current control loops, the output current is finally generated to drive motor to achieve the purpose of positioning. The relationship of input and output objects for pp mode is described in Fig. 3-6. The bit definition of Controlword for pp mode is given in Fig. 3-7, and the supported functions are described in Table 3-9. The bit definition of Statusword for pp mode is shown in Fig. 3-8, and the supported statuses are defined in Table 3-10.

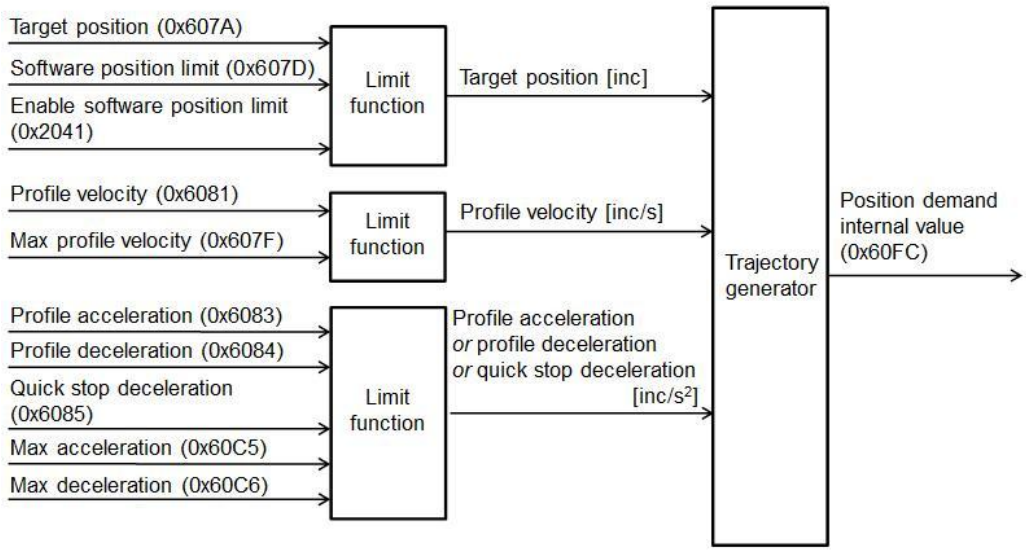


Fig. 3-6

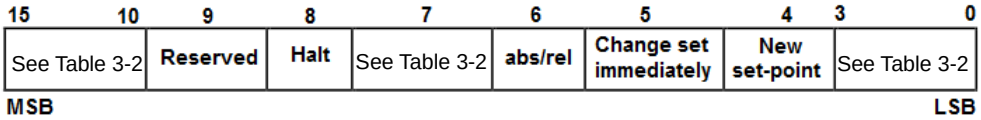


Fig. 3-7

Table 3-9

Bit of Controlword				Definition
8	6	5	4	
0	0	0	0->1	Take Target position (object 0x607A) as new absolute value of target position. If motor does not arrive the previous target position, it will complete the previous target, and then move to new target position.
0	1	0	0->1	Take Target position (object 0x607A) as new relative value of target position. If motor does not arrive the previous target position, it will complete the previous target, and then move to new target position.
0	0	1	0->1	Move to new absolute target position immediately.
0	1	1	0->1	Move to new relative target position immediately.
1	X	X	X	Stop motion. Motor should be decelerated to stop.

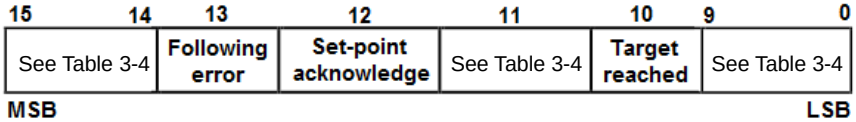


Fig. 3-8

Table 3-10

Bit	Value	Definition
10	0	Halt (bit 8 of Controlword) = 0: Target position not reached. Halt (bit 8 of Controlword) = 1: Motor decelerating.
	1	Halt (bit 8 of Controlword) = 0: Target position reached. Halt (bit 8 of Controlword) = 1: Motor speed being 0.
12	0	Previous set-point already processed and waiting for new set-point.
	1	Previous set-point still in process but set-point overwriting being accepted.
13	0	No following error.
	1	Following error occurred.

The pp mode supports functions of software and hardware limit protections. Instructions are given as follows.

(1) Use hardware limit protection

Set Enable hardware limit protection (object 0x2042) to be 1. When motor reaches hardware limit switch, motor stops motion. At this monent, only when motor receives the command of moving in the opposite direction, it moves and leaves the hardware limit switch in the opposite direcion.

(2) Use software limit protection

Set Enable software limit (object 0x2041) to be 1, and set Min software position limit (object 0x607D:1) and Max software position limit (object 0x607D:2) to the required positions. When motor reaches software limit position or the current position is over software limit position, motor will stop moving in the same direction of meeting software limit. At this monent, only when motor receives the command of moving in the opposite direction, it moves and leaves the software limit position in the opposite direcion.

3.3.1. Setting of set-point

The pp mode sets set-point by controlling the timing of the new set-point bit (bit 4) and the change set immediately bit (bit5) of Controlword. The setting of set-point is validated only when bit 4 of Controlword changes from 0 to 1 (rising edge). When drive sets the set-point acknowledge bit (bit 12) of Statusword to be 1, this means the new set-point is accepted, as shown in Fig. 3-9. If one set-point is still in progress and a new one is validated, drive supports two handling methods for this condition: single set-point and set of set-points.

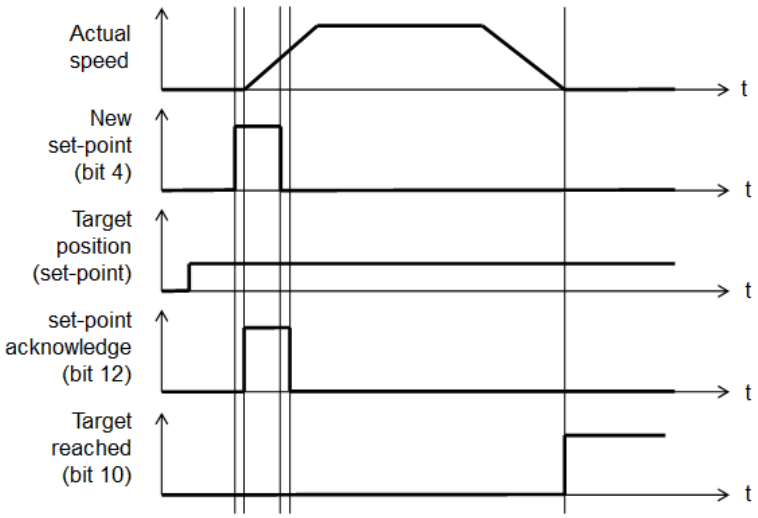


Fig. 3-9

(1) Single set-point (bit 5 of Controlword is 1)

If one set-point is in progress and a new one is set by setting bit 4 of Controlword, the new one will be processed immediately and the previous one is discarded, as shown in Fig. 3-10.

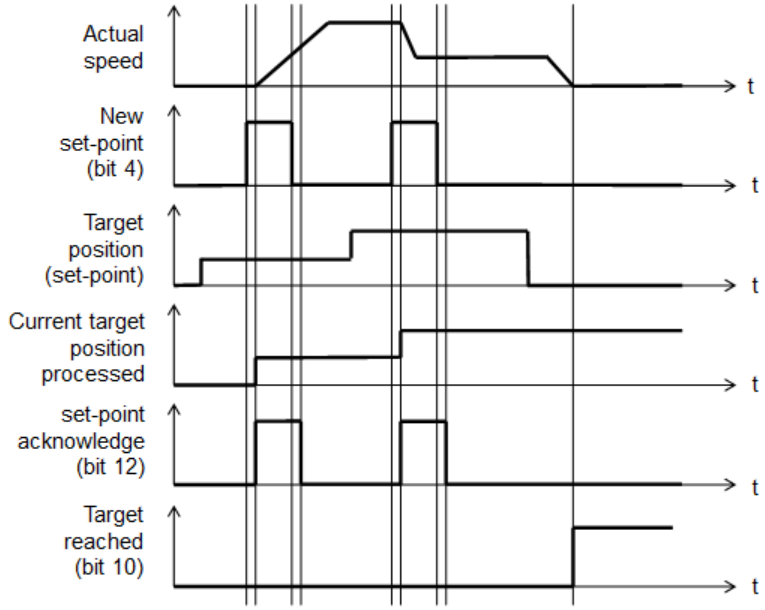


Fig. 3-10

(2) Set of set-points (bit 5 of Controlword is 0)

If one set-point is in progress and a new one is set by setting bit 4 of Controlword, the new one will be processed until the previous one has been completed, as shown in Fig. 3-11.

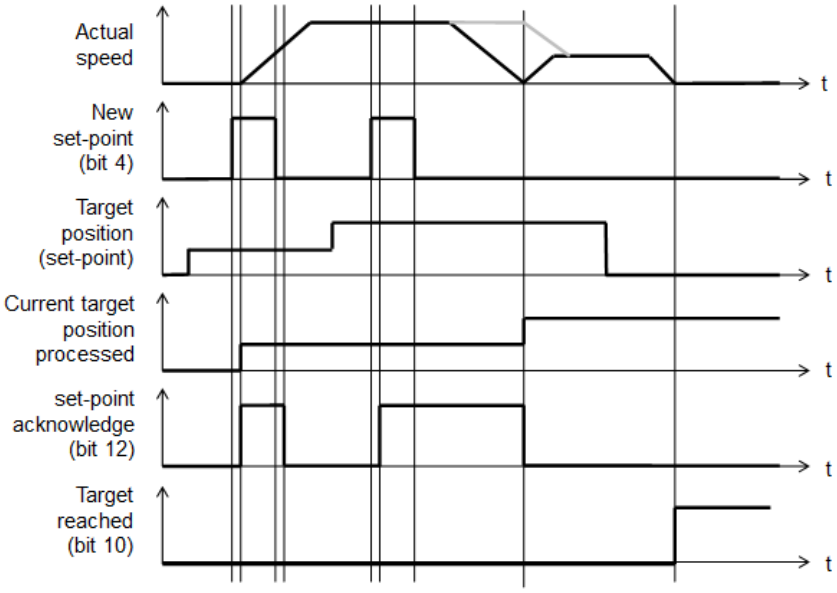


Fig. 3-11

HIWIN CoE products support two set-points. The handling of multiple set-points is shown in Fig. 3-12.

a. When set-point A is in progress, set-point B is stored in the buffer firstly after being set (①, ②). Bit 12 of Statusword will keep to 1 to inform host controller that drive cannot accept new set-point now.
b. Once set-point A is reached, set-point B is progressed immediately. Bit 12 of Statusword is changed to 0 to indicate that drive can accept new set-point.
c. If drive has the buffered set-point (③, ④), the new set-point D will be discarded immediately after being set, and does not be buffered in the set-point list.
d. If all buffers for set-points are occupied and a new set-point E needs to be progressed immediately, by setting bit 5 of Controlword to be 1, the progressed set-point B and buffered set-point C are discarded and set-point E is progressed immediately (⑤).

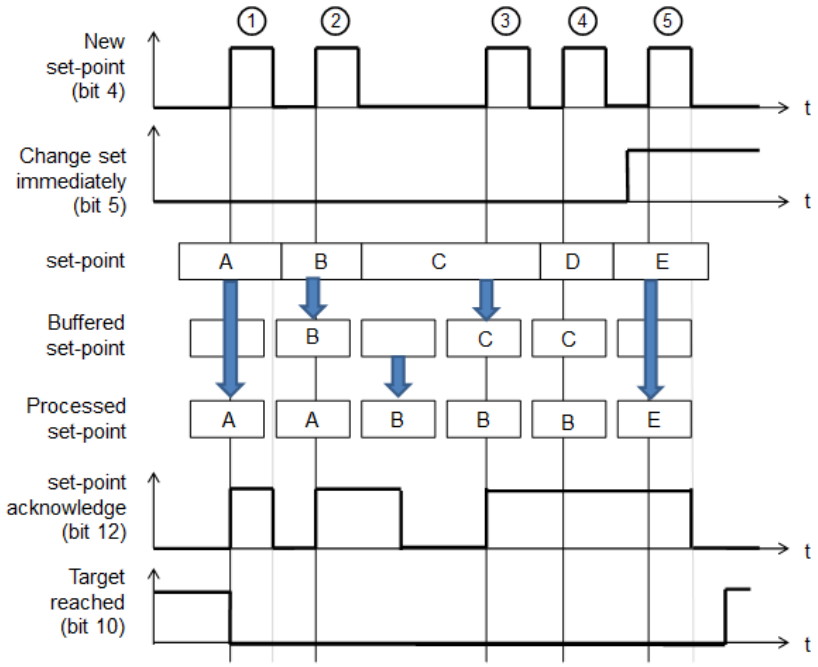


Fig. 3-12

3.3.2. Following error protection

HIWIN CoE drives support the function of following error protection. When the difference between Position demand internal value (object 0x60FC) and Position actual internal value (object 0x6063) is greater than Following error window (object 0x6065), and the continuous time is greater than Following error time out (object 0x6066), the following error bit (bit 13) of Statusword will be set to be 1. Also, drive will change to “Fault” state and perform the error handling mechanism subsequently.

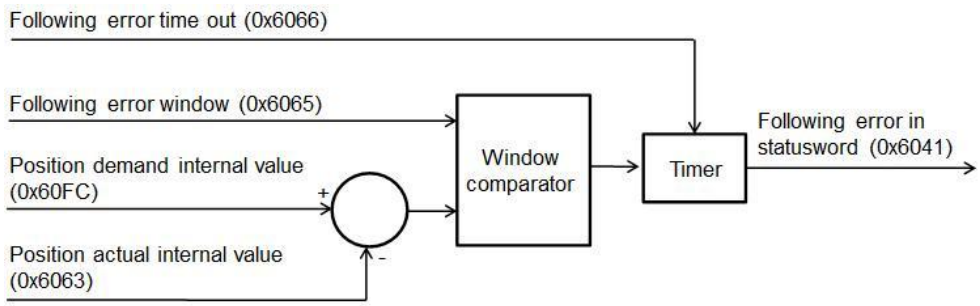


Fig. 3-13

3.4. Profile velocity mode

In profile velocity (pv) mode, the master station lets motor move with a fix velocity by setting Target velocity (object 0x60FF) and Controlword. The relationship of input and output objects for pv mode is described in Fig. 3-14, where Velocity actual value (object 0x606C) is calculated according to Position actual internal value (object 0x6063). The bit definition of Controlword for pv mode is given in Fig. 3-15, and the supported functions are described in Table 3-11. The bit definition of Statusword for pv mode is shown in Fig. 3-16, and the supported statuses are defined in Table 3-12.

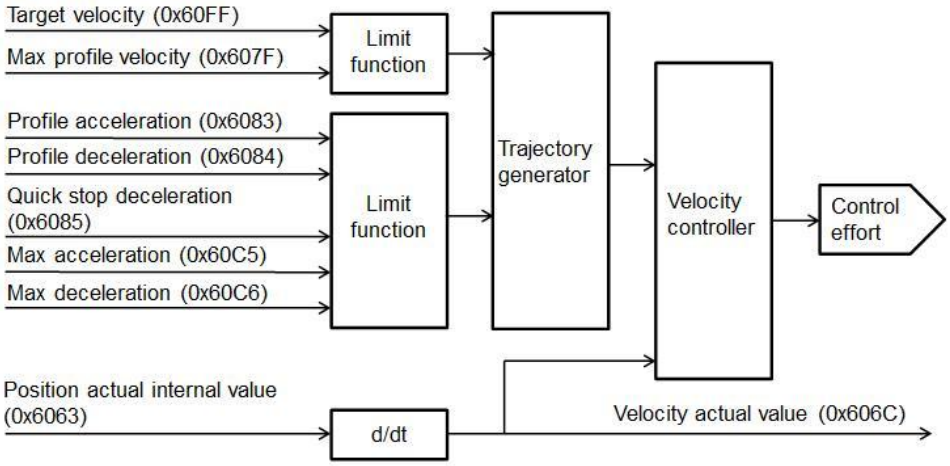


Fig. 3-14

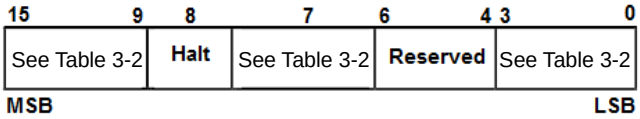


Fig. 3-15

Table 3-11

Bit	Value	Definition
8	0	The motion should be executed or continued.
	1	Stop motion. Motor should be decelerated to stop.

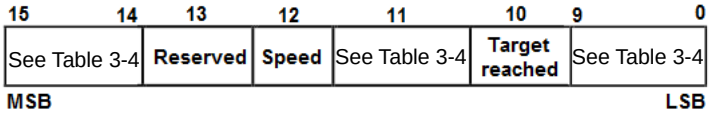


Fig. 3-16

Table 3-12

Bit	Value	Definition
10	0	Halt (bit 8 of Controlword) = 0: Target velocity not reached. Halt (bit 8 of Controlword) = 1: Motor decelerating.
	1	Halt (bit 8 of Controlword) = 0: Target velocity reached. Halt (bit 8 of Controlword) = 1: Motor speed being 0.
12	0	Motor speed being unequal to 0.
	1	Motor speed being equal to 0.

When drive is at “Operation enabled” state (Controlword = 000Fh), motor will accelerate to Target velocity (object 0x60FF) by using Profile acceleration (object 0x6083) as Target velocity being unequal to 0. When the reference speed of drive is unequal to 0, the speed bit (bit 12) of Statuswors is set to be 1. Only when the reference speed is equal to Target velocity, the target reached bit (bit 10) of Statusword is set to be 1.

The pv mode only supports the function of hardware limit protection, but does not support the function of software limit protection. Instructions of hardware limit protection please refer to Section 3.3.

3.5. Profile torque mode

In profile torque (tq) mode, the master station lets motor move with a fix torque by setting Target torque (object 0x6071) and Controlword. The relationship of input and output objects for tq mode is described in Fig. 3-17. The bit definition of Controlword for tq mode is the same as that for pv mode, referred to Fig. 3-15. The supported functions are described in Table 3-11. The bit definition of Statusword for tq mode is shown in Fig. 3-18, and the supported statuses are defined in Table 3-13.

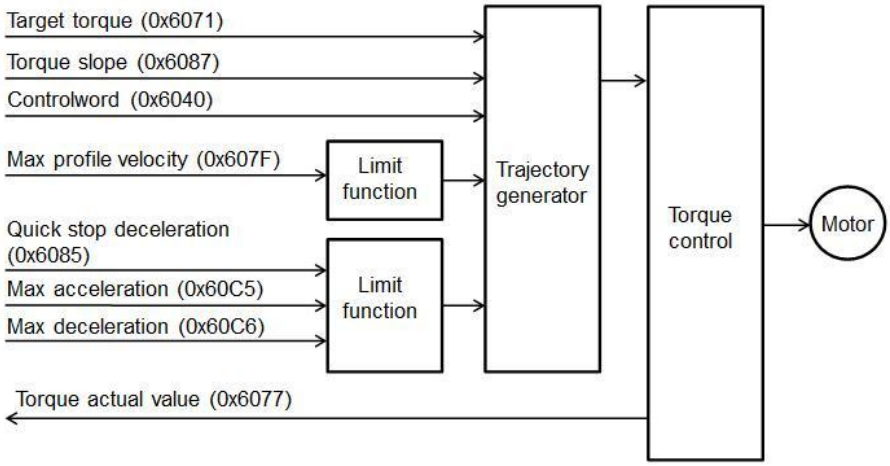


Fig. 3-17

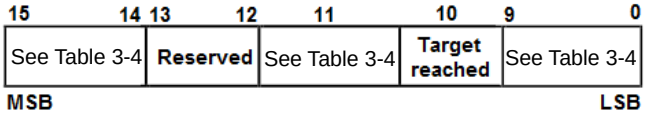


Fig. 3-18

Table 3-13

Bit	Value	Definition
10	0	Halt (bit 8 of Controlword) = 0: Target torque not reached. Halt (bit 8 of Controlword) = 1: Motor decelerating.
	1	Halt (bit 8 of Controlword) = 0: Target torque reached. Halt (bit 8 of Controlword) = 1: Motor speed being 0.

When drive is at “Operation enabled” state (Controlword = 000Fh), motor will move by using Target torque (object 0x60FF) as this value being unequal to 0. Only when the command current of drive reaches the corresponding current of Target torque, the target reached bit (bit 10) of Statusword is set to be 1. The relationship between the output target torque (force) of drive and Target torque is described by:

Output target torque (force) of drive = motor torque (force) constant * motor rated current * Target torque (object 0x6071)/1000.

The tq mode only supports the function of hardware limit protection, but does not support the function of software limit protection. Instructions of hardware limit protection please refer to Section 3.3.

3.6. Cyclic synchronous position mode

In cyclic synchronous position (csp) mode, the master station lets motor move to target position by setting Target position (object 0x607A). The relationship of input and output objects for csp mode is described in Fig. 3-19. Controlword for csp mode does not use the bit for operation-mode specific. The bit definition of Statusword for csp mode is shown in Fig. 3-20, and the supported statuses are defined in Table 3-14. The csp mode supports the function of following error protection. Details please refer to Section 3.3.2.

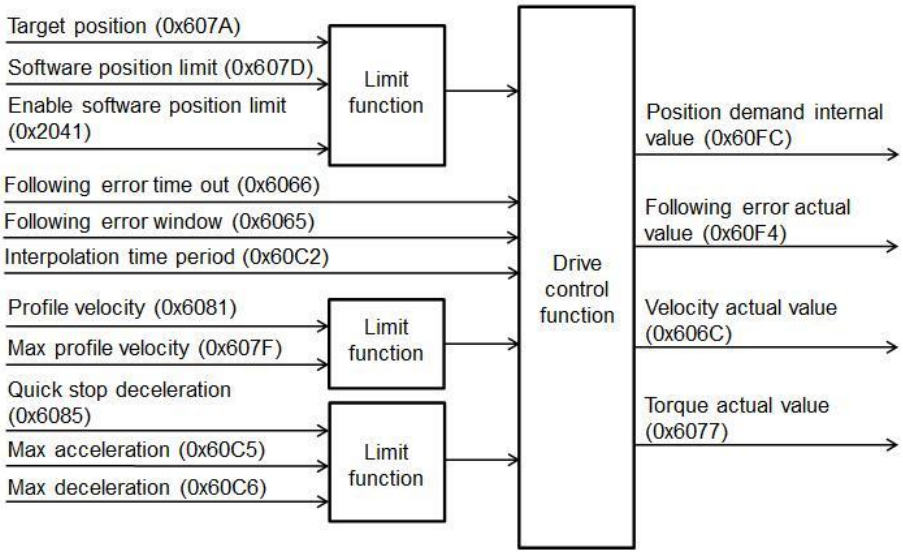


Fig. 3-19

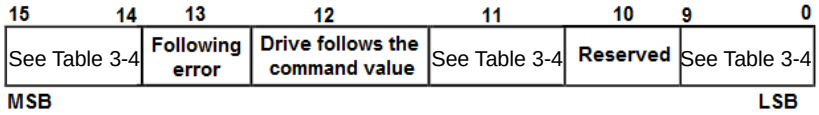


Fig. 3-20

Table 3-14

Bit	Value	Definition
12	0	Target position ignored.
	1	Target position used as input to position control loop.
13	0	No following error.
	1	Following error occurred.

When drive is at “Operation enabled” state (Controlword = 000Fh), motor will move to target position as Target position (object 0x607A) being different with Position actual internal value (object 0x6063).

The csp mode supports functions of software and hardware limit protections. Instructions please refer to Section 3.3. The cyclic synchronous mode does not support halt function. Therefore, motor will continue moving and does not stop as setting the halt bit (bit 8) of Controlword to be 1 during the motion.

3.7. Cyclic synchronous velocity mode

In cyclic synchronous velocity (csv) mode, the master station lets motor move with a fix velocity by setting Target velocity (object 0x60FF). The relationship of input and output objects for csv mode is described in Fig. 3-21. Controlword for csv mode does not use the bit for operation-mode specific. The bit definition of Statusword for csv mode is shown in Fig. 3-22, and the supported statuses are defined in Table 3-15.

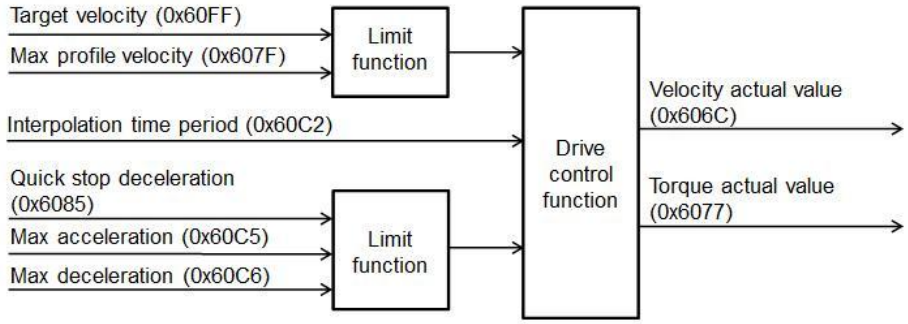


Fig. 3-21

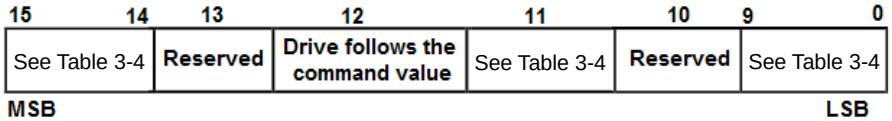


Fig. 3-22

Table 3-15

Bit	Value	Definition
12	0	Target velocity ignored.
	1	Target velocity used as input to velocity control loop.

When drive is at “Operation enabled” state (Controlword = 000Fh), motor will move with Target velocity (object 0x60FF) as this value being unequal to 0. When the reference speed of drive is unequal to 0, the speed bit (bit 12) of Statuswors is set to be 1.
The csv mode only supports the function of hardware limit protection, but does not support the function of software limit protection. Instructions of hardware limit protection please refer to Section 3.3. The cyclic synchronous mode does not support halt function. Therefore, motor will continue moving and does not stop as setting the halt bit (bit 8) of Controlword to be 1 during the motion.

3.8. Cyclic synchronous torque mode

In cyclic synchronous torque (cst) mode, the master station lets motor move with a fix torque (force) by setting Target torque (object 0x6071). The relationship of input and output objects for cst mode is described in Fig. 3-23. Controlword for cst mode does not use the bit for operation-mode specific. The bit definition of Statusword for cst mode is the same as that for csv mode, referred to Fig. 3-22. The supported statuses are defined in Table 3-15.

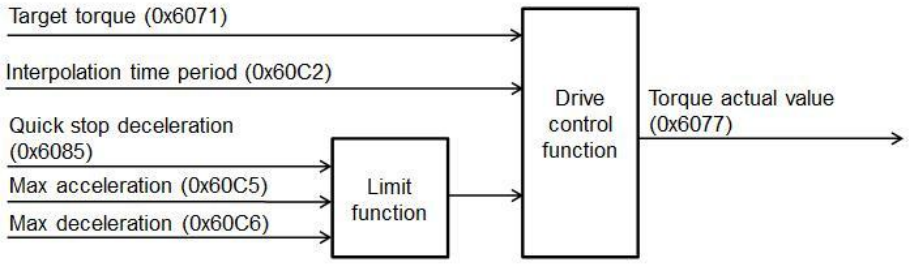


Fig. 3-23

When drive is at “Operation enabled” state (Controlword = 000Fh), motor will move by using Target torque (object 0x60FF) as this value being unequal to 0. Only when the command current of drive reaches the corresponding current of Target torque, the target reached bit (bit 10) of Statusword is set to be 1. The relationship between the output target torque (force) of drive and Target torque is described by:

Output target torque (force) of drive = motor torque (force) constant
* motor rated current * Target torque (object 0x6071)/1000.

The cst mode only supports the function of hardware limit protection, but does not support the function of software limit protection. Instructions of hardware limit protection please refer to Section 3.3. The cyclic synchronous mode does not support halt function. Therefore, motor will continue moving and does not stop as setting the halt bit (bit 8) of Controlword to be 1 during the motion.

3.9. Touch probe function

Drive supports Touch probe function (object 0x60B8) and takes index pulse as the source of Touch probe 1. Only Touch probe 1 is supported, but Touch probe 2 is not supported. Moreover, it does not support the sampling of both positive and negative edges of Touch probe 1 simulantously. Do not set bits 4 and 5 to be 1 simulantously. The bit definition of object 0x60B8 is shown in Table 3-16. The status response for this object is by using Touch probe status (0x60B9), and its bit definition is given in Table 3-17.

Note. Drive does not support functions of Touch probe source (object 0x60D0) and reserved touch probe input. When bits 2 and 3 or bits 6 and 7 of object 0x60B8 are set, index pulse is taken as the source of Touch probe 1.

Table 3-16

Bit	Value	Definition
0	0	Switch off touch probe 1.
	1	Enable touch probe 1.
1	0	Trigger first event.
	1	Continuous trigger.
2 - 3	-	Reserved.
4	0	Switch off sampling at positive edge of touch probe 1.
	1	Enable sampling at positive edge of touch probe 1.
5	0	Switch off sampling at negative edge of touch probe 1.
	1	Enable sampling at negative edge of touch probe 1.
6 - 15	-	Reserved.

Table 3-17

Bit	Value	Definition
0	0	Touch probe 1 is switched off.
	1	Touch probe 1 is enabled.
1	0	No positive edge of touch probe 1 is stored.
	1	Positive edge of touch probe 1 is stored.
2	0	No negative edge of touch probe 1 is stored.
	1	Negative edge of touch probe 1 is stored.
3 - 15	-	Reserved.

4. Object Dictionary

4.1. Common object

Table 4-1

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping(1)
0x1000	0x00	Device type	UINT32	RO	—	—	00020192h	—	X
0x1001	0x00	Error register	UINT8	RO	255	0	0	—	X
0x1010	Store parameters								
	0x00	Number of entries	UINT8	RO	—	—	1	—	X
	0x01	Save all parameters(2)	UINT32	RW	2^{32}-1	0	0	—	X
0x1018	Identity object								
	0x00	Number of entries	UINT8	RO	—	—	4	—	X
	0x01	Vendor ID	UINT32	RO	—	—	AAAAh	—	X
	0x02	Product code(3)	UINT32	RO	3	1	1	—	X
	0x03	Revision number	UINT32	RO	—	—	1	—	X
	0x04	Serial number	UINT32	RO	—	—	0	—	X

(1) O: PDO mapping supported;
X: PDO mapping unsupported.
(Hereinafter the same)

(2) When drive is at “Switch on disable” state (servo off status), the command from host controller received by sub-index 1 of this object is shown in Fig. 4-1. Drive will save parameters into EEPROM and respond to host controller on the same sub-index to indicate that parameters saving is completed. After saved, drive should be reset. If the received command sent by host controller is different with that shown in Fig. 4-1, drive omits this command.

Signature	MSB			LSB
ASCII	e	v	a	s
hex	65h	76h	61h	73h

Fig. 4-1

(3) Product codes of HIWIN CoE products are shown in Table 4-2.

Table 4-2

Drive	Product code
D1-N	1
D1	2
D2	3
abily	4

4.2. PDO mapping objects

For HIWIN CoE products, the maximum number of allowed RxPDO or TxPDO is 7, and the total size of RxPDO or TxPDO is 20 bytes.

Table 4-3

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping
0x1600	1st receive PDO mapping								
	0x00	Number of objects	UINT8	RW	7	1	2	—	X
	0x01	Mapping entry 1	UINT32	RW	FFFFFFFFh	0	60400010h	—	X
	0x02	Mapping entry 2	UINT32	RW	FFFFFFFFh	0	607A0020h	—	X
	0x03	Mapping entry 3	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x04	Mapping entry 4	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x05	Mapping entry 5	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x06	Mapping entry 6	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x07	Mapping entry 7	UINT32	RW	FFFFFFFFh	0	0	—	X
0x1A00	1st transmit PDO mapping								
	0x00	Number of objects	UINT8	RW	7	1	3	—	X
	0x01	Mapping entry 1	UINT32	RW	FFFFFFFFh	0	60410010h	—	X
	0x02	Mapping entry 2	UINT32	RW	FFFFFFFFh	0	60640020h	—	X
	0x03	Mapping entry 3	UINT32	RW	FFFFFFFFh	0	60F40020h	—	X
	0x04	Mapping entry 4	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x05	Mapping entry 5	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x06	Mapping entry 6	UINT32	RW	FFFFFFFFh	0	0	—	X
	0x07	Mapping entry 7	UINT32	RW	FFFFFFFFh	0	0	—	X

4.3. Communication objects of Sync manger

Table 4-4

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping
0x1C00	Sync manager communication type								
	0x00	Number of used sync manager	UINT8	RO	—	—	4	—	X
	0x01	Communication type sync manager 0	UINT8	RO	—	—	1: mailbox receive	—	X
	0x02	Communication type sync manager 1	UINT8	RO	—	—	2: mailbox send	—	X
	0x03	Communication type sync manager 2	UINT8	RO	—	—	3: process data output	—	X
	0x04	Communication type sync manager 3	UINT8	RO	—	—	4: process data input	—	X
0x1C10	Sync manager 0 PDO assignment								
	0x00	Number of assigned PDOs	UINT8	RO	—	—	0	—	X
0x1C11	Sync manager 1 PDO assignment								
	0x00	Number of assigned PDOs	UINT8	RO	—	—	0	—	X
0x1C12	Sync manager 2 PDO assignment								
	0x00	Number of assigned RxPDO	UINT8	RW	—	—	1	—	X
	0x01	PDO mapping index of assigned RxPDO	UINT16	RW	—	—	1600h	—	X
0x1C13	Sync manager 3 PDO assignment								
	0x00	Number of assigned TxPDO	UINT8	RW	—	—	1	—	X
	0x01	PDO mapping index of assigned TxPDO	UINT16	RW	—	—	1A00h	—	X
0x1C32	Sync manager 2 synchronization								
	0x00	Number of synchronization parameters	UINT8	RO	—	—	9	—	X
	0x01	Synchronization type(1)	UINT16	RW	2	0	2	—	X
	0x02	Cycle time	UINT32	RW	—	—	125000	—	X
	0x03	Reserved 1	UINT32	RW	—	—	—	—	—
	0x04	Synchronization types supported(2)	UINT16	RO	—	—	0x5	—	X
	0x05	Minimum cycle time	UINT32	RO	—	—	125000	—	X
	0x06	Calc and copy time	UINT32	RO	—	—	62500	—	X
	0x07	Reserved 2	UINT32	RO	—	—	—	—	—
	0x08	Reserved 3	UINT16	RW	—	—	—	—	—
	0x09	Delay time	UINT32	RO	—	—	0	—	X

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping
0x1C33	Sync manager 3 synchronization								
	0x00	Number of Synchronization Parameters	UINT8	RO	—	—	9	—	X
	0x01	Synchronization Type(1)	UINT16	RO	2	0	2	—	X
	0x02	Cycle Time	UINT32	RO	—	—	125000	—	X
	0x03	Reserved 1	UINT32	RW	—	—	—	—	—
	0x04	Synchronization Types Supported(2)	UINT16	RO	—	—	5	—	X
	0x05	Minimum Cycle Time	UINT32	RO	—	—	125000	—	X
	0x06	Calc and Copy Time	UINT32	RO	—	—	62500	—	X
	0x07	Reserved 2	UINT32	RW	—	—	—	—	—
	0x08	Reserved 3	UINT16	RW	—	—	—	—	—
	0x09	Delay Time	UINT32	RO	—	—	0	—	X

(1) 0: Use free-run mode;
1: Use DC mode (Synchronous with SYNC0).

(2) The definition of this sub-index is given in Table 4-5.

Table 4-5

Bit	Value	Definition
0	1	Free-run mode supported
3, 2	01_b	DC mode supported

4.4. Manufacturer defined objects

Table 4-6

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping
0x2000	0x00	Motor type(1)	UINT16	RO	2	0	2	—	X
0x2001	0x00	Inner encoder resolution	INT32	RO	2^{31}-1	0	0	count	X
0x2002	0x00	Outer encoder resolution	INT32	RO	2^{31}-1	0	0	count	X
0x2003	0x00	Screw pitch	INT32	RO	2^{31}-1	1	1	mm	X
0x2004	Electronic gear								
	0x00	Number of entries	UINT8	RO	—	—	2	—	X
	0x01	Numerator of gear ratio	INT32	RW	2^{31}-1	1	1	—	X
	0x02	Denominator of gear ratio	INT32	RW	2^{31}-1	1	1	—	X
0x2010	0x00	Input function(2)	UINT16	RW	3	0	0	—	O
0x2020	0x00	Index signal(3)	INT8	RO	1	0	0	—	O
0x2021	0x00	Latched index position	INT32	RO	2^{31}-1	-2^{31}	0	count	O
0x2022	0x00	Motor actual current	REAL32	RO	$3.4*10^{38}$	$-3.4*10^{38}$	0	A_rms	O
0x2040	0x00	2nd encoder option(4)	UINT16	RO	1	0	0	—	X
0x2041	0x00	Enable software position limit(5)	UINT16	RW	1	0	0	—	X
0x2042	0x00	Enable hardware limit protection(6)	UINT16	RW	1	0	1	—	X
0x2043	0x00	Input logic inversion	INT16	RW	7FFFh	8000h	07EFh	—	X
0x2050	0x00	Common gain	REAL32	RW	10	0.01	0.3	—	X
0x2051	0x00	Velocity proportional gain	REAL32	RW	1	0.000001	0.001	—	X
0x2052	0x00	Proportional gain of the current loop	REAL32	RW	7F7FFFFFh	FF7FFFFFh	500	—	X
0x2053	0x00	Integral gain of the current loop	REAL32	RW	7F7FFFFFh	FF7FFFFFh	100	—	X
0x2054	0x00	Integral gain of the velocity loop	REAL32	RW	7F7FFFFFh	FF7FFFFFh	314	—	X
0x2055	0x00	Proportional gain of the position loop	REAL32	RW	7F7FFFFFh	FF7FFFFFh	314	—	X
0x2060	0x00	Multi Turn Encoder Reset Flag	UINT8	RW	1	0	0	—	X
0x2100	0x00	Drive error events 1(7)	UINT32	RO	FFFFFFFFh	0	0	—	X
0x2101	0x00	Drive error events 2(8)	UINT32	RO	FFFFFFFFh	0	0	—	X
0x2110	0x00	Drive Warning Events 1	UINT16	RO	FFFFh	0	0	—	X
0x2111	0x00	Drive Warning Events 2	UINT16	RO	FFFFh	0	0	—	X
0x2112	0x00	Drive Warning Events 3	UINT16	RO	FFFFh	0	0	—	X
0x2113	0x00	Drive Warning Events 4	UINT16	RO	FFFFh	0	0	—	X

Note. Object 0x2060 is only supported by D2 CoE drive with SA35.

(1) Motor type

Table 4-7

Motor type	Value
Linear	0
Torque	1
AC servo	2

(2) Input function

Table 4-8

Bit	Value	Definition
0	0	Deactivate error mapping
	1	Activate error mapping
1	0	Do not reset drive
	1	Reset drive

(3) Index signal

Table 4-9

Bit	Value	Definition
0	0	Index signal is not detected
	1	Index signal is detected

(4) 2nd encoder option

Table 4-10

Bit	Value	Definition
0	0	Disable dual loop
	1	Enable dual loop

(5) Enable software position limit (This object is only valid in pp and csp modes)
This object determines whether software limits defined in object 0x607D (Software position limit) are valid or not.

Table 4-11

Bit	Value	Definition
0	0	Disable software position limit protection
	1	Enable software position limit protection

(6) Enable hardware limit protection (This object is valid in all operation modes)

Table 4-12

Bit	Value	Definition
0	0	Disable hardware position limit protection
	1	Enable hardware position limit protection

(7) Drive error events 1

Table 4-13

Bit	Definition
0	—
1	Encoder error
2 - 5	—
6	Position error too big
7	Soft-thermal threshold reached
8	—
9	HFLT inconsistent error (D1NCOE)
10 - 12	—
13	Serial encoder communication error
14	Motor over temperature sensor activated
15	Amplifier over temperature
16 - 17	—
18	Motor short (over current) detected
19	Over voltage detected
20	Under voltage detected
21	Motor maybe disconnected
22 - 30	—
31	5V for encoder card fail

(8) Drive error events 2

Table 4-14

Bit	Definition
0	—
1	Phase initialization error
2 - 4	—
5	Hall sensor error
6	Hall phase check error
7	STO active
8 - 15	—
16	Current control error
17	HFLT inconsistent error (D1COE/D2COE)
18	Auto phase center not complete error
19	—
20	Hybrid deviation too big
21 - 22	—
23	DC bus voltage abnormal
24	—
25	Fan fault error
26 - 29	—
30	EtherCAT interface disconnected
31	CiA-402 home failed

Note. For D1-N CoE drive, HFLT inconsistent error is at bit 9 of Drive error events 1.
For D1 CoE and D2 CoE drives, it is at bit 17 of Drive error events 2.

4.5. Device profile

Table 4-15

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping
0x603F	0x00	Error code(1)	UINT16	RO	FFFFh	0	0	—	O
0x6040	0x00	Controlword	UINT16	RW	FFFFh	0	0	—	O
0x6041	0x00	Statusword	UINT16	RO	FFFFh	0	0	—	O
0x6060	0x00	Mode of operation(2)	INT8	RW	10	0	8	—	O
0x6061	0x00	Mode of operation display	INT8	RO	10	0	8	—	O
0x6063	0x00	Position actual internal value	INT32	RO	2^{31}-1	-2^{31}	0	count	X
0x6064	0x00	Position actual value	INT32	RO	2^{31}-1	-2^{31}	0	count	O
0x6065	0x00	Following error window	UINT32	RW	2^{32}-1	0	0	count	X
0x6066	0x00	Following error time out	UINT16	RW	2^{16}-1	0	0	ms	X
0x606C	0x00	Velocity actual value	INT32	RO	2^{31}-1	-2^{31}	0	count/s	O
0x6071	0x00	Target torque	INT16	RW	1000	-1000	0	0.1%	O
0x6075	0x00	Motor Rated Current	UINT32	RO	FFFFFFFFh	0	0	—	X
0x6077	0x00	Torque actual value	INT16	RO	1000	-1000	0	0.1%	O
0x607A	0x00	Target position	INT32	RW	2^{31}-1	-2^{31}	0	count	O
0x607C	0x00	Home offset	INT32	RW	2^{31}-1	-2^{31}	0	count	X
0x607D	Software position limit								
	0x00	Highest sub-index supported	UINT8	RO	—	—	2	—	X
	0x01	Min software position limit	INT32	RW	2^{31}-1	-2^{31}	-2^{31}	count	X
	0x02	Max software position limit	INT32	RW	2^{31}-1	-2^{31}	-2^{31}	count	X
0x607F	0x00	Maximum profile velocity	UINT32	RW	2^{32}-1	0	0	count/s	X
0x6081	0x00	Profile velocity	UINT32	RW	2^{32}-1	0	0	count/s	X
0x6083	0x00	Profile acceleration	UINT32	RW	2^{32}-1	0	0	count/s^2	X
0x6084	0x00	Profile deceleration	UINT32	RW	2^{32}-1	0	0	count/s^2	X
0x6085	0x00	Quick stop deceleration	UINT32	RW	2^{32}-1	0	0	count/s^2	X
0x6087	0x00	Torque slope	UINT32	RW	2^{32}-1	0	0	0.1%/s	X
0x6098	0x00	Homing method	INT8	RW	37	-3	0		X

Index	Sub-index	Name	Type	Access	Max	Min	Default	Unit	PDO mapping
0x6099	Homing Speeds								
	0x00	Highest sub-index supported	UINT8	RD	—	—	2	—	X
	0x01	Speed during search for switch	UINT32	RW	2^{31}-1	0	0	count/s	X
	0x02	Speed during search for zero	UINT32	RW	2^{31}-1	0	0	count/s	X
0x609A	0x00	Homing acceleration	UINT32	RW	2^{32}-1	0	0	count/s^2	X
0x60B1	0x00	Velocity offset	INT32	RW	—	—	—	—	—
0x60B2	0x00	Torque offset	INT16	RW	—	—	—	—	—
0x60B8	0x00	Touch probe function(3)	UINT16	RW	FFFFh	0	0	—	O
0x60B9	0x00	Touch probe status	INT32	RO	FFFFFFFFh	0	0	—	O
0x60BA	0x00	Touch probe 1 positive edge	INT32	RO	2^{31}-1	-2^{31}	0	Count	O
0x60BB	0x00	Touch probe 1 negative edge	INT32	RO	2^{31}-1	-2^{31}	0	count	O
0x60C2	Interpolation Time Period								
	0x00	Highest sub-index supported	INT8	RO	—	—	1	—	X
	0x01	Interpolation time period	UINT8	RW	255	0	0	—	X
	0x02	Interpolation time index	INT8	RW	63	-128	0	—	X
0x60C5	0x00	Max acceleration	UINT32	RW	2^{31}-1	0	10000	count/s^2	X
0x60C6	0x00	Max deceleration	UINT32	RW	2^{31}-1	0	10000	count/s^2	X
0x60F4	0x00	Following error actual value	INT32	RO	2^{31}-1	-2^{31}	0	Count	O
0x60FC	0x00	Position demand internal value	INT32	RO	2^{31}-1	-2^{31}	0	Count	X
0x60FD	0x00	Digital inputs(4)	UINT32	RO	FFFFFFFFh	0	0	—	O
0x60FE	Digital Outputs								
	0x00	Highest sub-index supported	INT8	RO	—	—	2	—	O
	0x01	Physical outputs(5)	UINT32	RW	FFFFFFFFh	0	0	—	O
	0x02	Bit mask(6)	UINT32	RW	FFFFFFFFh	0	0	—	O
0x60FF	0x00	Target velocity	INT32	RW	2^{31}-1	-2^{31}	0	count/s^2	O
0x6502	0x00	Supported drive mode	UINT32	RO	—	—	03ADh	—	X

(1) Error code

Table 4-16

Error #	Describe	Value	D1 CoE	D2 CoE	D1-N CoE
1	Motor short(over current)	2310h	O	O	O
2	Over voltage	3110h	O	O	O
3	Position error too big	8611h	O	O	O
4	Encoder error	7380h	O	O	O
5	Soft-thermal	2350h	O	O	O
6	Motor maybe disconnected	7180h	O	O	O
7	Amplifier over temperature	4310h	O	O	O
8	Motor over temperature	7383h	O	X	O
9	Under voltage	3220h	O	O	O
10	5V for encoder card fail	5280h	O	O	O
11	Phase initialization error	FF06h	O	O	O
12	Serial encoder com. Error	7381h	O	O	O
13	Hall sensor error	7382h	O	O	O
14	Hall phase error	7384h	O	X	O
15	Current control error	FF02h	O	O	O
17	Hybrid deviation too big	86FFh	X	O	O
18	STO active	FF03h	X	O	O
19	HFLT inconsistent error	FF04h	O	O	O
20	Auto phase center not complete yet	FF05h	O	X	O
22	DC bus voltage abnormal	3210h	O	O	O
23	EtherCAT interface is not detected	7580h	O	O	O
24	CiA-402 Homing error	8613h	O	O	O
25	Fan fault error	5180h	X	O	X

Note. O: Device supports this error code.
X: Device does not support this error code.

(2) Mode of operation
If set to unsupported operation mode, the operation mode will keep to the original operation mode.

Table 4-17

Value	Definition
0	Stand-alone mode
1	Profile position mode
3	Profile velocity mode
4	Torque profile mode
6	Homing mode
8	Cyclic sync position mode
9	Cyclic sync velocity mode
10	Cyclic sync torque mode

(3) Touch probe function

Table 4-18

Bit	Value	Definition
5, 4	00_b	Switch off sampling of touch probe 1.
	01_b	Enable sampling at positive edge of touch probe 1.
	10_b	Enable sampling at negative edge of touch probe 1.
	11_b	Reserved.

(4) Digital input

I. D1-N CoE drive

31 ~ 27	26	25	24	23	22	21	20	19	18	17	16	15 ~ 4	3	2	1	0
Unused	I10	I9	I8	I7	I6	I5	Motor Over Temperature	I4	I3	I2	I1	reserved	Unused	home switch	positive limit switch	negative limit switch

II. D1 CoE drive

31 ~ 26	25	24	23	22	21	20	19	18	17	16	15 ~ 4	3	2	1	0
Unused	I10	I9	I12	I11	I6	I5	I4	I3	I2	I1	reserved	Unused	home switch	positive limit switch	negative limit switch

III. D2 CoE drive

31 ~ 26	25	24	23	22	21	20	19	18	17	16	15 ~ 4	3	2	1	0
Unused	I10	I9	I8	I7	I6	I5	I4	I3	I2	I1	reserved	Unused	home switch	positive limit switch	negative limit switch

Fig. 4-2

a. As bit 0 of object 0x2042 (Enable hardware limit protection) being true, bit 1/0 of object 0x60FD (Digital input) will be set to true after positive/negative hardware limit switch is triggered. At this moment, drive only receives the command of moving in the opposite direction. When motor moves in the opposite direction, bit 1/0 of this object will be set to false.
b. If the operation mode is changed from Homing mode (object 0x6060 = 6) to other operation mode supported by drive, bit 1/0 of this object will be set to false.
c. Suppose that negative or positive limit switch is set to I☐. As bit 0 of object 0x2042 (Enable hardware limit protection) being true, the signal of I☐ will be changed to high and the corresponding bit (bit 0 or bit 1) is also set to high at negative or positive limit switch being triggered to high.
d. Suppose that home switch (near home sensor) is set to I☐. The signal of I☐ will be changed to high and the corresponding bit 2 is also set to high at home switch being triggered to high.

Note. ☐ denotes the input index of D-series CoE device.

(5) Digital output – physical outputs

Table 4-19

Bit	Output	Definition
0 - 15	-	Reserved
16	Brake	0: off; 1: on
17	O1	0: off; 1: on
18	O2	0: off; 1: on
19	O3	0: off; 1: on
20	O4	0: off; 1: on
21	O5	0: off; 1: on
22 - 31	-	Reserved

(6) Digital output – bit mask

Table 4-20

Bit	Output	Definition
0 - 15	-	Reserved
16	Brake	0: disable; 1: enable
17	O1	0: disable; 1: enable
18	O2	0: disable; 1: enable
19	O3	0: disable; 1: enable
20	O4	0: disable; 1: enable
21	O5	0: disable; 1: enable
22 - 31	-	Reserved

Table 4-21 Digital output function description

PDL usage	0x60FE: bit 16 (Brake)	0x60FE: bits 17-20
1	Enable: X (only control by drive) Disable: { 1:unlock 0:lock	1: ON 0: OFF
0		Control by internal

a. If host controller wants to output signal via O1-O5, bits 16-20 of object 0x60FE:02 (Digital output – bit mask) must be set to true. Also, O1-O5 in I/O center of Lightening should be set to PDL usage (General purpose). After that, host controller can control the output status of drive by setting bits 16-20 of object 0x60FE:01 (Digital output – physical outputs).
b. As the trigger condition of O1-O5 in I/O center of Lightening being not set to PDL usage (General purpose), drive will not set output status based on object 0x60FE:01 (Digital output – physical outputs) even if host controller sets bits 16-20 of object 0x60FE:02 (Digital output – bit mask) to true.
c. If disable, brake status can be controlled by bit 16 (Brake) of object 0x60FE. However, if enable, brake status cannot be controlled by bit 16 (Brake) of object 0x60FE, but is controlled by drive.

Note. For D-series CoE devices, host controller controls statuses of all outputs even if all output statuses do not be checked, so called as PDL usage.

4.6. Objects and device table

Table 4-22

Index	Name	D1 CoE	D1-N CoE	D2 CoE	abily
0x1000	Device type	O	O	O	O
0x1001	Error register	O	O	O	O
0x1010	Store parameters	O	O	O	O
0x1018	Identity object	O	O	O	O
0x1600	1st receive PDO mapping	O	O	O	O
0x1A00	1st transmit PDO mapping	O	O	O	O
0x1C00	Sync manager communication type	O	O	O	O
0x1C10	Sync manager 0 PDO assignment	O	O	O	O
0x1C11	Sync manager 1 PDO assignment	O	O	O	O
0x1C12	Sync manager 2 PDO assignment	O	O	O	O
0x1C13	Sync manager 3 PDO assignment	O	O	O	O
0x1C32	Sync manager 2 synchronization	O	O	O	O
0x1C33	Sync manager 3 synchronization	O	O	O	O
0x2000	Motor type	O	O	O	O
0x2001	Inner encoder resolution	O	O	O	O
0x2002	Outer encoder resolution	O	O	O	O
0x2003	Screw pitch	O	O	O	O
0x2004	Electronic gear	O	O	O	O
0x2010	Input function	O	O	O	O
0x2020	Index signal	O	O	O	O
0x2021	Latched index position	O	O	O	O
0x2022	Motor actual current	O	O	O	O
0x2040	2nd encoder option	O	O	O	O
0x2041	Enable software position limit	O	O	O	O
0x2042	Enable hardware limit protection	O	O	O	O
0x2043	Input logic inversion	O	O	O	O
0x2050	Common gain	O	O	O	O
0x2051	Velocity proportional gain	O	O	O	O
0x2052	Proportional gain of the current loop	O	O	O	O
0x2053	Integral gain of the current loop	O	O	O	O
0x2054	Integral gain of the velocity loop	O	O	O	O
0x2055	Proportional gain of the position loop	O	O	O	O
0x2060	Multi Turn Encoder Reset Flag	O	X	O	O
0x2100	Drive error events 1	O	O	O	O
0x2101	Drive error events 2	O	O	O	O
0x2110	Drive Warning Events 1	O	X	O	X
0x2111	Drive Warning Events 2	O	X	O	X
0x2112	Drive Warning Events 3	O	X	O	X
0x2113	Drive Warning Events 4	O	X	O	X
0x603F	Error code	O	O	O	O
0x6040	Controlword	O	O	O	O
0x6041	Statusword	O	O	O	O
0x6060	Mode of operation	O	O	O	O
0x6061	Mode of operation display	O	O	O	O
0x6063	Position actual internal value	O	O	O	O
0x6064	Position actual value	O	O	O	O
0x6065	Following error window	O	O	O	O
0x6066	Following error time out	O	O	O	O
0x606C	Velocity actual value	O	O	O	O

Index	Name	D1 CoE	D1-N CoE	D2 CoE	abily
0x6071	Target torque	O	O	O	O
0x6075	Motor Rated Current	O	X	O	O
0x6077	Torque actual value	O	O	O	O
0x607A	Target position	O	O	O	O
0x607C	Home offset	O	O	O	O
0x607D	Software position limit	O	O	O	O
0x607F	Maximum profile velocity	O	O	O	O
0x6081	Profile velocity	O	O	O	O
0x6083	Profile acceleration	O	O	O	O
0x6084	Profile deceleration	O	O	O	O
0x6085	Quick stop deceleration	O	O	O	O
0x6087	Torque slope	O	O	O	O
0x6098	Homing method	O	O	O	O
0x6099	Homing Speeds	O	O	O	O
0x609A	Homing acceleration	O	O	O	O
0x60B1	Velocity offset	O	O	O	O
0x60B2	Torque offset	O	O	O	O
0x60B8	Touch probe function	O	O	O	O
0x60B9	Touch probe status	O	O	O	O
0x60BA	Touch probe 1 positive edge	O	O	O	O
0x60BB	Touch probe 1 negative edge	O	O	O	O
0x60C2	Interpolation Time Period	O	O	O	O
0x60C5	Max acceleration	O	O	O	O
0x60C6	Max deceleration	O	O	O	O
0x60F4	Following error actual value	O	O	O	O
0x60FC	Position demand internal value	O	O	O	O
0x60FD	Digital inputs	O	O	O	O
0x60FE	Digital Outputs	O	O	O	O
0x60FF	Target velocity	O	O	O	O
0x6502	Supported drive mode	O	O	O	O

Note. O: Device supports this object;
X: Device does not support this object.

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5. Setting Examples

5.1. HIWIN CoE drive setting

Human-machine interface (HMI) for HIWIN drives is called Lightening. It performs functions of motor initialization, motor configuration, motion control, test run, parameters saving, and so on. Details please refer to user guide for each series drive. If users want to opearate a new HIWIN CoE drive normally, its setting is the same as that for HIWIN standard drive. However, there are three different items given in the following.

Note. If D1 CoE drive is implemented with the hardware version A1 (check if there is “A1” mark at the end of serial number on the drive label), it needs the firmware version of D1COE MDP 0.320 (above) to complete EtherCAT communication.

(1) Different operation-mode setting

The setting page of operation mode for HIWIN CoE drive is different with that for other HIWIN drives. When Lightening communicates with HIWIN CoE drive successfully, it sets operation mode to “EtherCAT operation mode” automatically, as shown in Fig. 5-1. Users do not set any parameter for operation mode, but just do next step directly. For D1/D2 CoE drives, press the “OK” button under the window. For D1-N CoE drive, after setting the main power of drive (do not forget this step), press the “OK” button under the window.

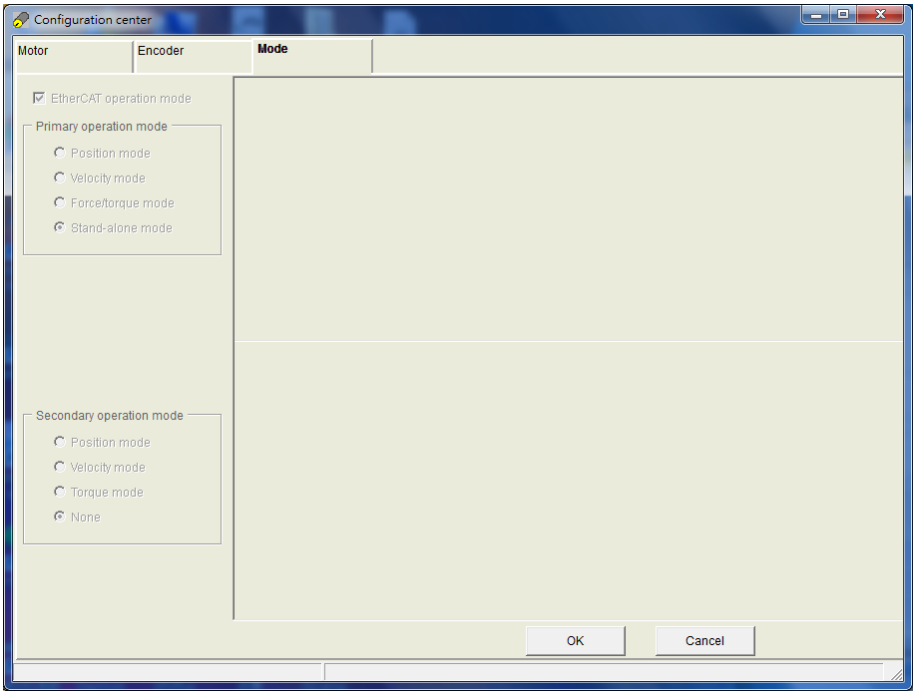


Fig. 5-1

(2) Different enable method

a. Software enable

The software enable of HIWIN CoE drive is controlled by EtherCAT controller. Therefore, before saving parameters into Flash, execute the function of software disable (Disable(F12)) on performance center.

b. Hardware enable

For EtherCAT applications, host controller normanlly does not wire a line for hardware enable to drive. Therefore, before EtherCAT communication, drive should be at the status of hardware enable. Press the icon of I/O center (I/O) on the toolbar of Lightening main window to open I/O center. Check if there is any input function set to “Axis Enable” on “Inputs” tab. If yes, change its function to “Not Configured” by clicking the drop-down button ( ) of input function menu, as shown in Fig. 5-3.

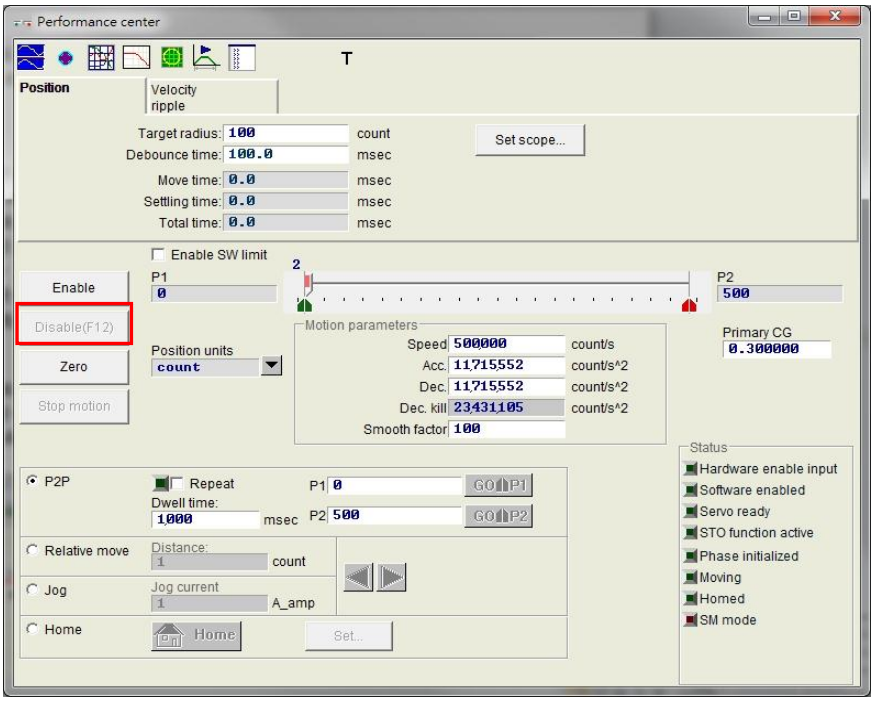


Fig. 5-2

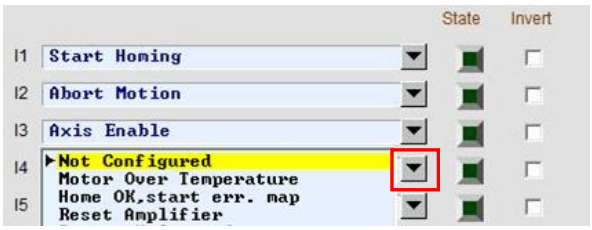


Fig. 5-3

(3) Reset after saving parameters into Flash

After completing parameters setting, save current parameters into Flash by pressing the icon of “Save parameters from amplifier RAM to Flash” ( ) on Lightening main window. Therefore, if the drive power is turned off, set parameters do not disapper. After saving parameters into Flash, reset drive by pressing the icon of “Reset” ( ) on Lightening main window. After resetting, drive will go to the status of EtherCAT communication automatically. Open “Access” on the toolbar of Lightening main window and check if it is at the “EtherCAT” status, as shiown in Fig. 5-4. At this moment, parameter setting and motion controlling for HIWIN CoE drive only can be done by EtherCAT controller, but not by Lightening. If users want to modify drive parameter via Lightening, select “Lightening” on “Access”.

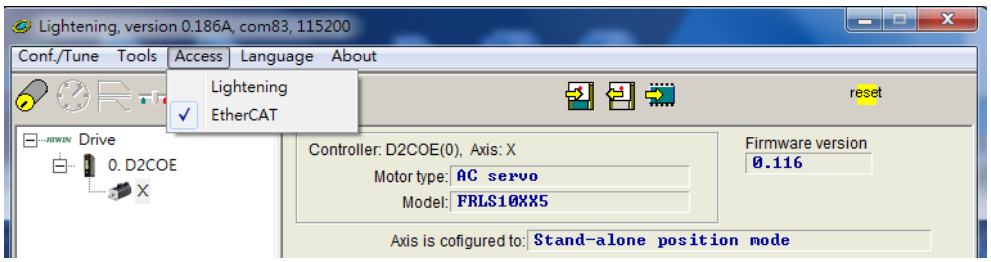


Fig. 5-4

5.2. Beckhoff controller (TwinCAT 2) setting

Before communicating with HIWIN CoE drive, set its parameters by referring to Section 5.1 and connect it to Beckhoff EtherCAT controller via network cable.

Note. Please place ESI files for HIWIN CoE drives in the folder at the installation path ..\TwinCAT\Io\EtherCAT.

5.2.1. DC cycle time setting

There is an important function of HIWIN CoE drive – DC SYNC signal. This subsection describes how to set DC cycle time for HIWIN CoE drive via TwinCAT 2 and enable PDO communication. In the following, take D1 CoE drive as an example.

(1) Start TwinCAT 2.

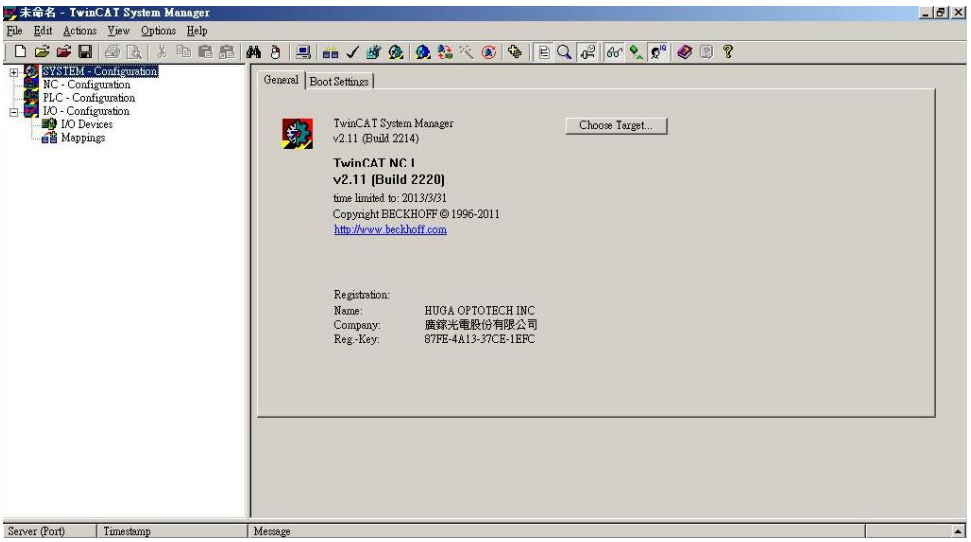


Fig. 5-5

(2) After selecting “New” at the toolbar, click the right key of mouse at “I/O Devices” and select “Scan Devices” within its menu, as shown in Fig. 5-6. The warning window of Fig. 5-7 will appear to remind that not all types of devices can be found automatically. Press the “OK” button.

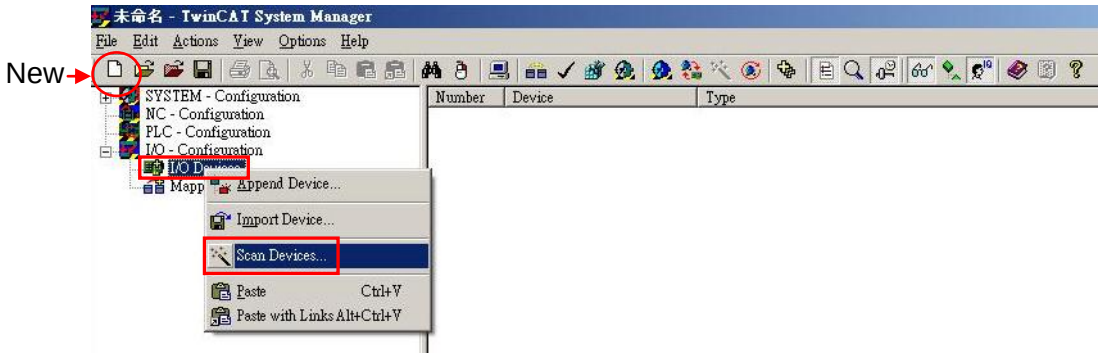


Fig. 5-6

Fig. 5-7

(3) When EtherCAT device is detected, it will be shown in the dialogue window of Fig. 5-8. This example is “Device 2 (EtherCAT)” detected. Press the “OK” button.

Fig. 5-8

(4) The dialogue window of Fig. 5-9 appears to ask if users want to sacn for boxes. Press the “Yes” button.

Fig. 5-9

(5) When HIWIN CoE drive is added to TwinCAT 2, it will ask if users want to append linked axis to NC-Configuration. Press the “Yes” button.

Fig. 5-10

(6) The following window appers to ask if users want to change TwinCAT system to Free Run mode. Press the “No” button to keep in Configuration mode.

Fig. 5-11

(7) Open “Device 2 (EtherCAT)” in “I/O Devices”. If setting is successful, “Drive 1 (D1 CoE Drives)” can be found under “Device 2 (EtherCAT)”. If other device is connected, the corresponding device name will show in the parentheses.

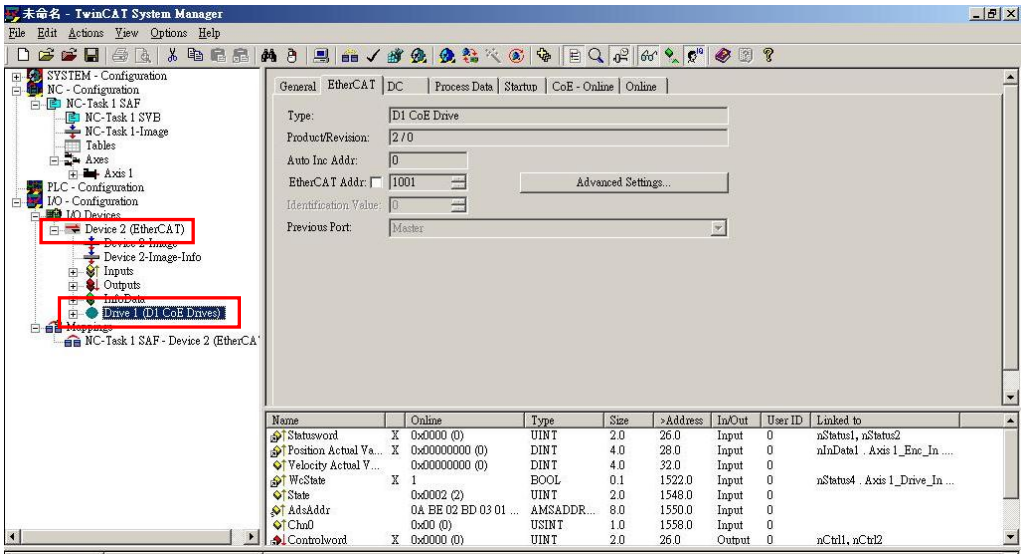


Fig. 5-12

(8) Click “Drive 1 (D1 CoE Drives)” and go to “DC” tab at the right-side window. Set “DC-Synchron” for “Operation Mode”.

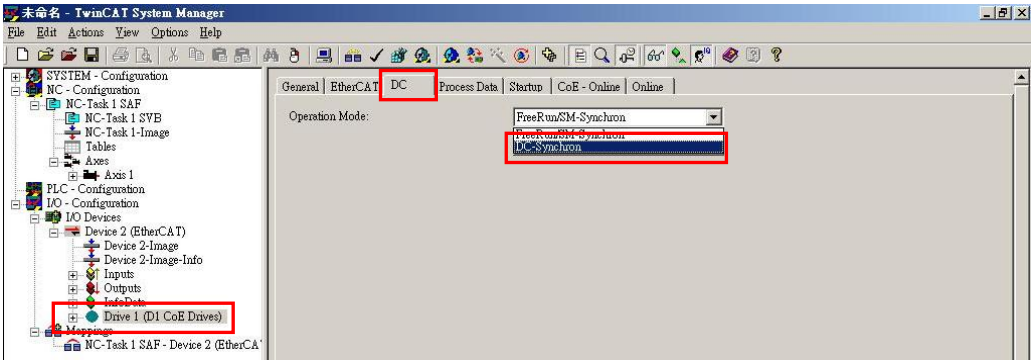


Fig. 5-13

(9) Select “NC-Task 1 SAF” in “NC-Configuration” at the left side of main window. Go to “Task” tab at the right-side window and set DC cycle time for “Cycle ticks”. Fig. 5-14 gives an example of setting cycle time to be 2 ms.

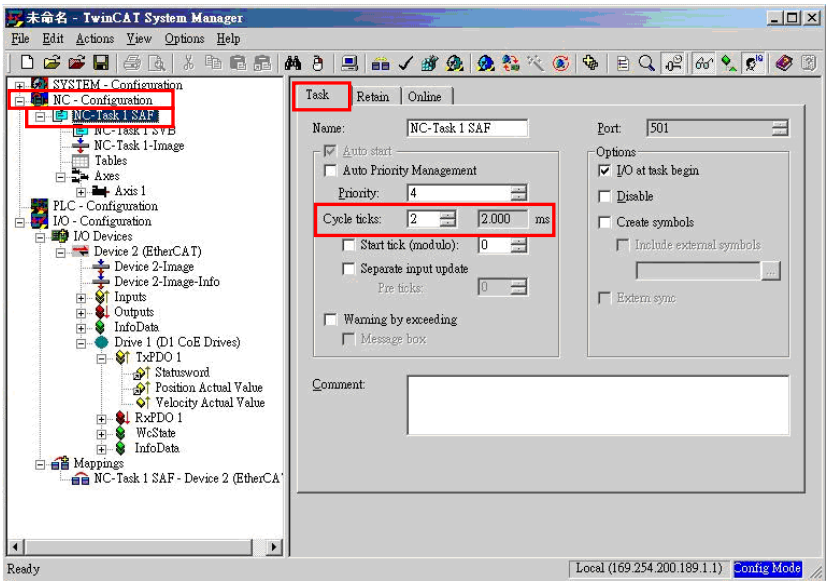


Fig. 5-14

(10) Press the icon of “Set/Reset TwinCAT to Config Mode” ( ) on the toolbar to reset TwinCAT, as shown in Fig. 5-15. The dialogue window of Fig. 5-16 appears to ask if users want to reset TwinCAT system to Configuration mode. Press the “OK” button.

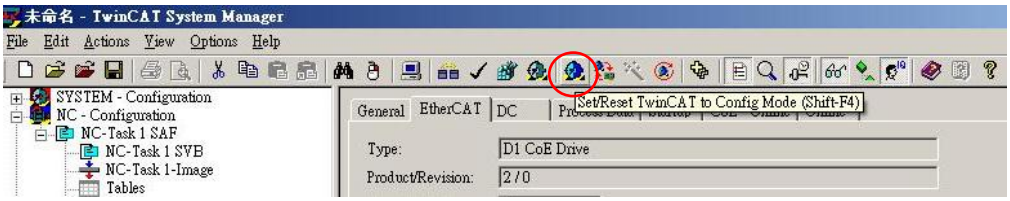


Fig. 5-15

Fig. 5-16

(11) The following dialogue window appears to ask if users want to load I/O devices. Press the “Yes” button.

Fig. 5-17

(12) The dialogue window of Fig. 5-11 appears to ask if users want to change TwinCAT system to Free Run mode. Press the “Yes” button to enable PDO communication between TwinCAT and drive.

(13) Ensure PDO communication between TwinCAT and drive.

a. Click “Drive 1 (D1 CoE Drivers)” at the left side of TwinCAT main window. Select “Position Actual Value” under TxPDO. Go to “Online” tab at the right side of main window.
b. At the status of motor disable, move motor in manual to check if the feedback position of motor (X_enc_pos) is the same as the value shown in “Online” tab of TwinCAT.

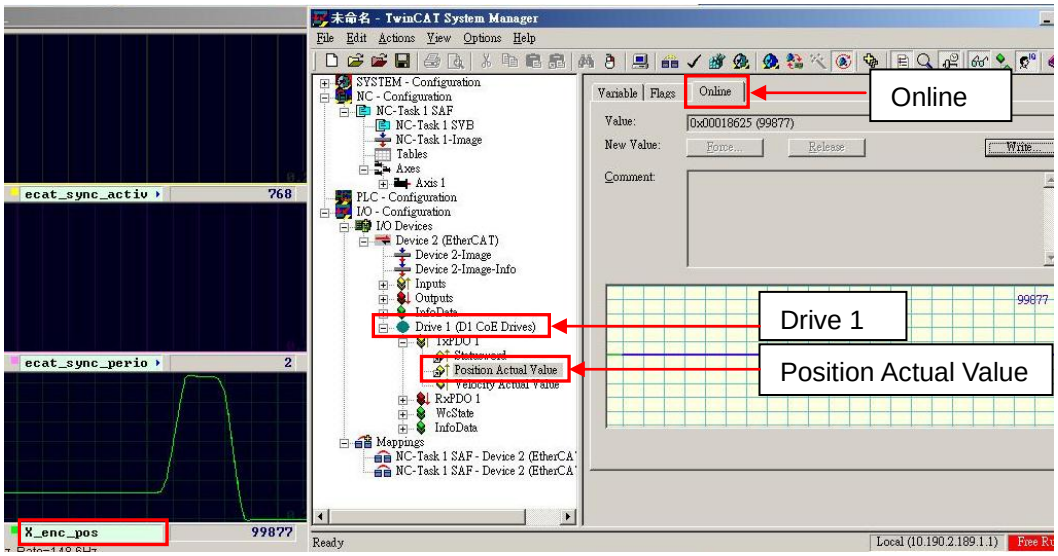


Fig. 5-18

5.2.2. EEPROM update

This subsection describes how to update EEPROM of HIWIN CoE drive via TwinCAT 2.

(1) Execute Steps (1)-(6) given in Section 5.2.1.

(2) Select “Devices 2 (EtherCAT)” in “I/O Devices” at the left side of TwinCAT main window. There is one sub-item of “Box 1 (FB1111 SPI-Slave)” or unkwnon device. After selecting device needed to update EEPROM, press the button of “Advanced Settings” on “EtherCAT” tab at the right-side window, as shown in Fig. 5-19.

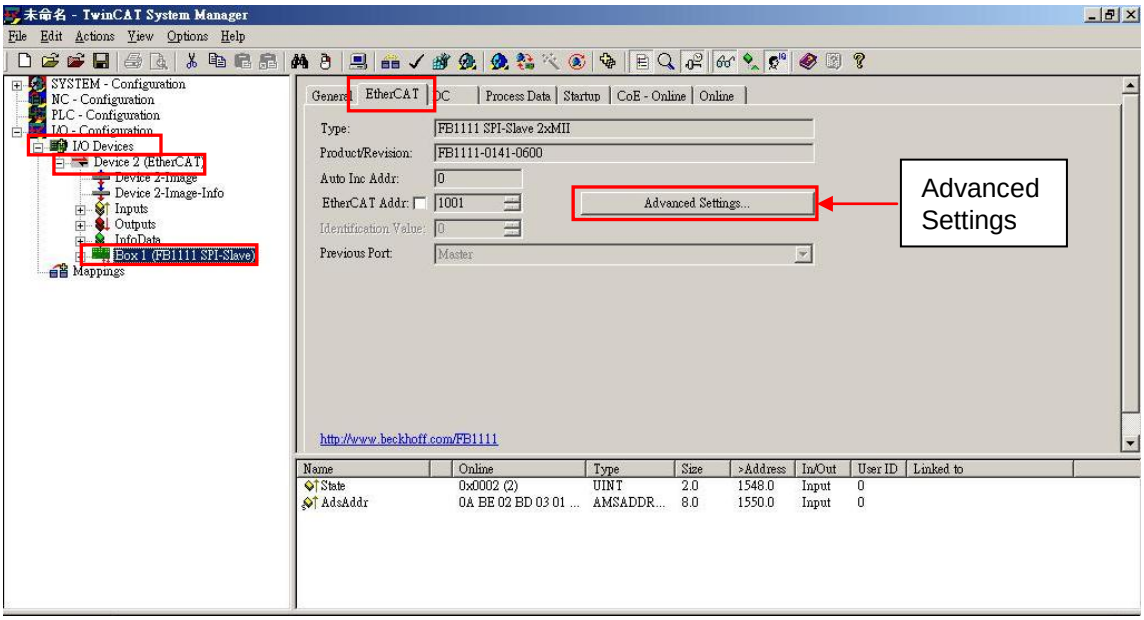


Fig. 5-19

(3) Select “E2PROM” in “ESC Access” at the left side of “Advanced Settings” window. After clicking “Hex Editor”, it can be found that “FB1111 SPI-Slave”, unknown device, or blank content is on the program note area at the right-side window, as shown in Fig. 5-20.
   a. Press the button of “Read from File” under the window to open the location of HIWIN EtherCAT EEPROM file (.bin file). Let TwinCAT read this file.
   b. Press the “Download” button under the window to load new EEPROM file into drive.
   c. After completing EEPROM file download, press the “OK” button at the bottom of window.

(4) Power cycle drive to complete EEPROM update.

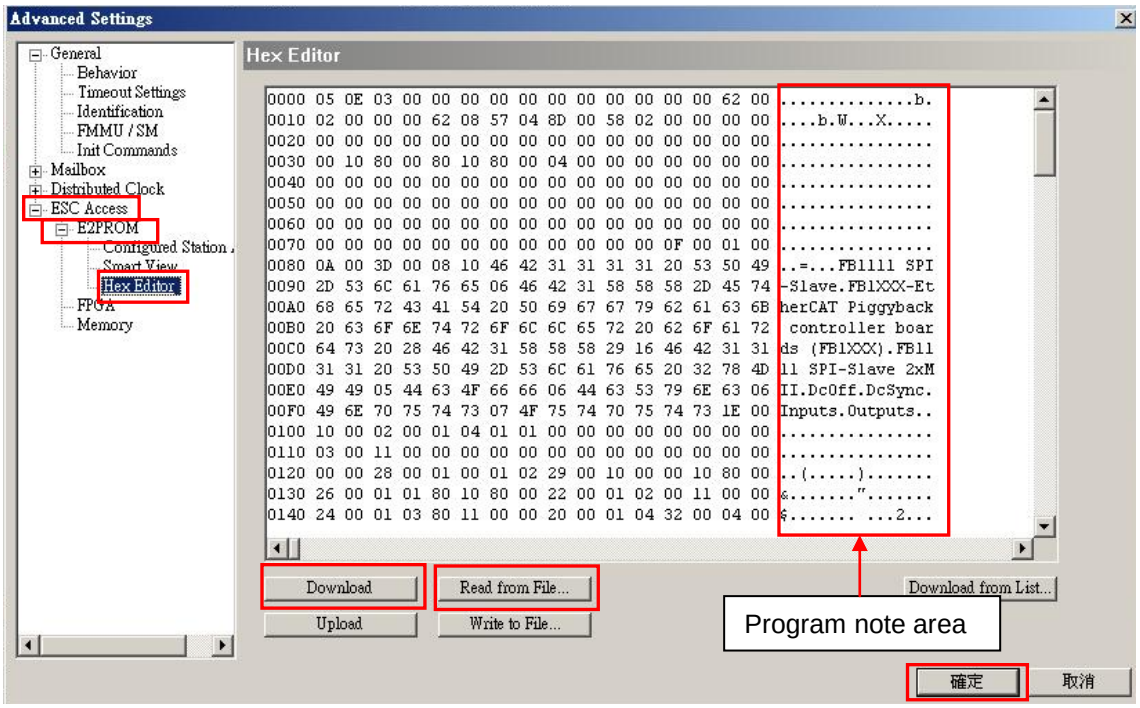


Fig. 5-20

5.3. Beckhoff controller (TwinCAT 3) setting

Before communicating with HIWIN CoE drive, set its parameters by referring to Section 5.1 and connect it to Beckhoff EtherCAT controller via network cable.

Note. Please place ESI files for HIWIN CoE drives in the folder at the installation path ..\TwinCAT\3.1\Config\Io\EtherCAT.

5.3.1. Communication setting

This subsection describes how to communicate TwinCAT 3 to HIWIN CoE drive. In the following, take D2 CoE drive as an example.

(1) Start TwinCAT 3 and select “New TwinCAT Project”.

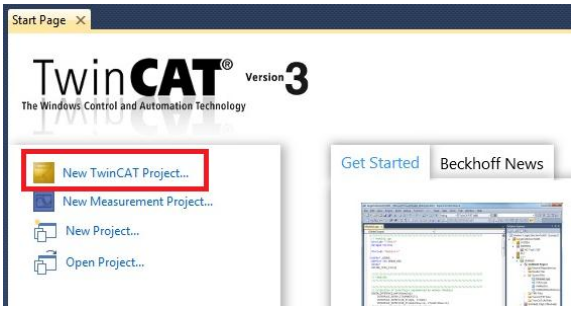


Fig. 5-21

(2) Select “TwinCAT project” and enter project name and location at the bottom of “New Project” window. After that, press the “Ok” button to build new project.

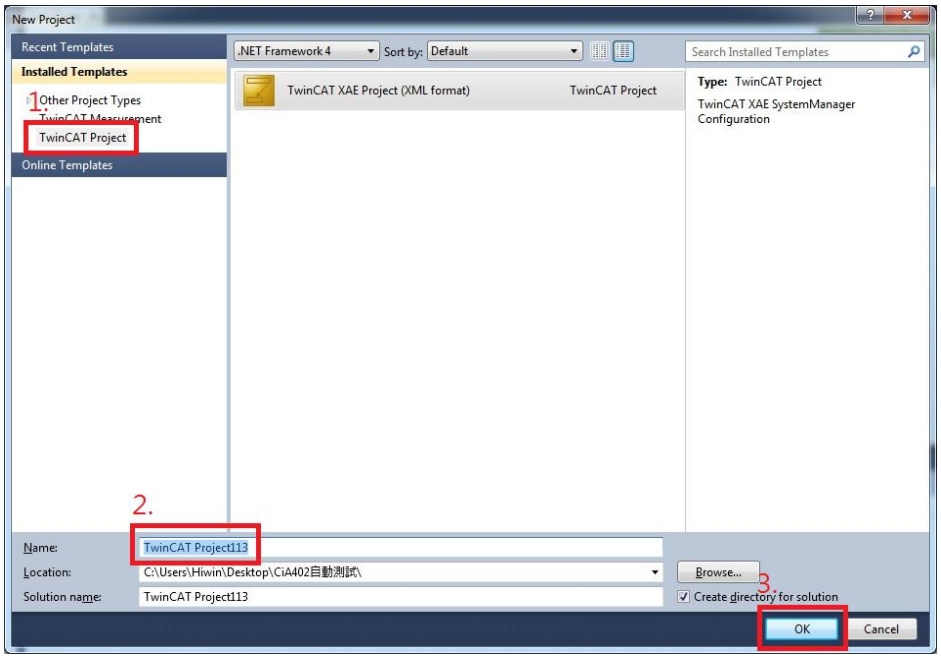


Fig. 5-22

(3) Click the icon of “Restart TwinCAT (Config Mode)” ( ) on the toolbar of TwinCAT main window to change TwinCAT operation mode to Configuration mode. Choose “I/O” at the left-side window, and click the right key of mouse at “Devices” to execute the function of “Scan” in the menu.

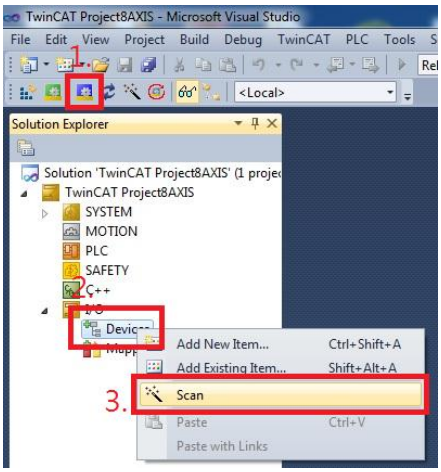


Fig. 5-23

(4) The warning window of Fig. 5-24 appears to remind that not all types of devices can be found automatically. Press the “OK” button.

Fig. 5-24

(5) If one EtherCAT device is detected, it will be shown in the dialogue window of Fig. 5-25. This example shows two devices detected. Check the option of “Device 3 (EtherCAT)” and press the “OK” button.

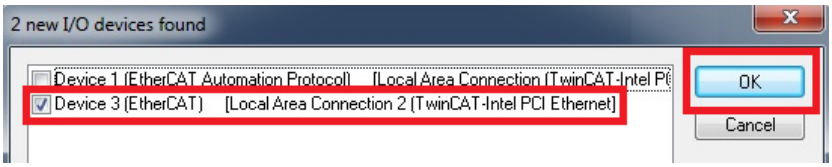


Fig. 5-25

(6) The dialogue window of Fig. 5-26 appears to ask if users want to scan for boxes. Press the “Yes” button.

Fig. 5-26

(7) After HIWIN CoE drive is added to TwinCAT, it will ask if users want to append linked axis to NC- Configuration. Press the “Yes” button.

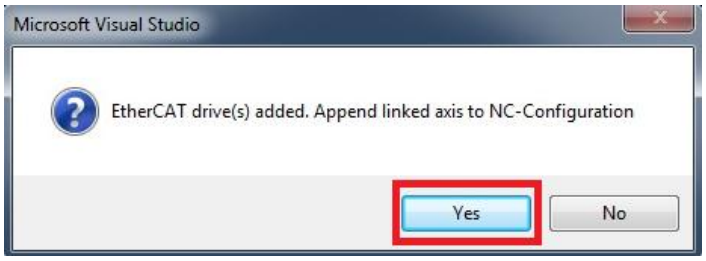


Fig. 5-27

(8) The following dialogue window appears to ask if users want to change the TwinCAT operation mode to Free Run mode. Press the “Yes” button to activate Free Run mode.

Fig. 5-28

(9) Go to “Devices” in “I/O” at the left side of TwinCAT main window. Check if “Drive 1 (D2 CoE Drive)” appears in “Device 1 (EtherCAT)” or not. If not, the ESI file or drive EEPROM should be updated.

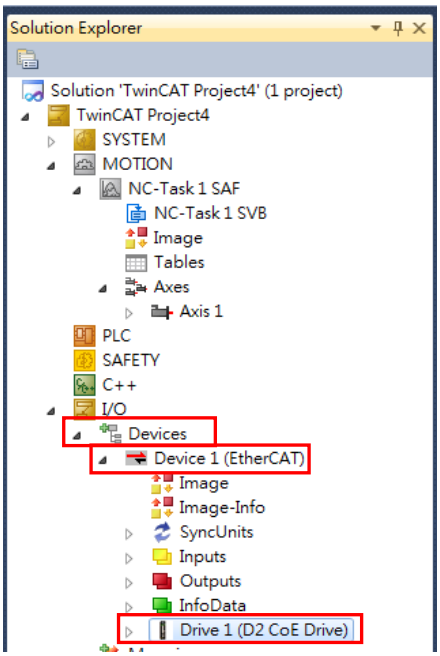


Fig. 5-29

5.3.2. EEPROM update

This subsection describes how to update the EEPROM data of HIWIN CoE drive via TwinCAT 3. In the following, take D2 CoE drive as an example.

Note. Before update, please check if the correct ESI file is placed in the folder at the installation path..\TwinCAT\3.1\Config\Io\EtherCAT. For example, the ESI file for D2 CoE drive is D2COE_□□□□□□□□.xml.

(1) Execute Steps (1)-(6) given in Section 5.3.1.

(2) Select “Device 1 (EtherCAT)” in “Devices” at the left side of TwinCAT main window. Go to “Online” tab at the right-side window. Press the right key of mouse at the drive needed to update EEPROM (D2 CoE Drives) and select “EEPROM Update” in the menu.

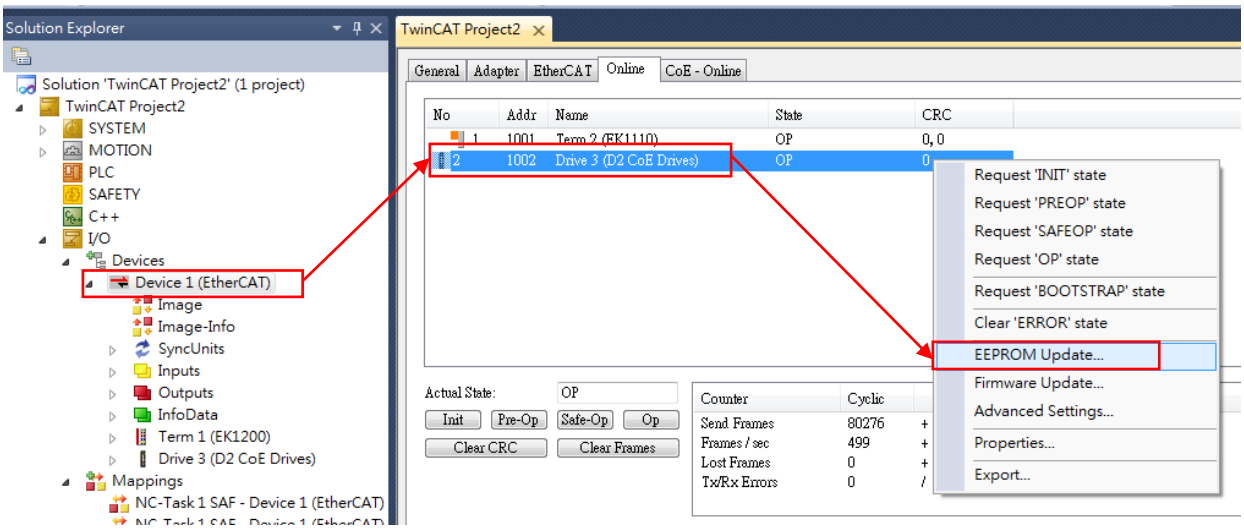


Fig. 5-30

(3) The “Write EEPROM” window shows the supported EEPROM files for drives. Select one matched EEPROM file for drive. Here, the EEPROM file for D2 CoE drive is selected to update. If D1/D1-N CoE drive is used, the EEPROM file for D1/D1-N CoE drive should be selected. After that, press the “OK” button to write EEPROM.

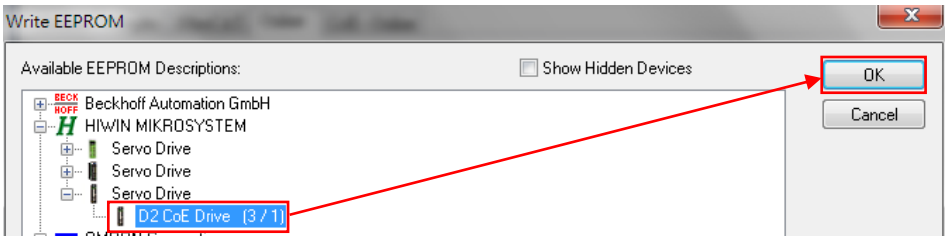


Fig. 5-31

(4) During writing process, the lower left corner of TwinCAT main window displays “Writing” and the lower right corner shows the current programming schedule.

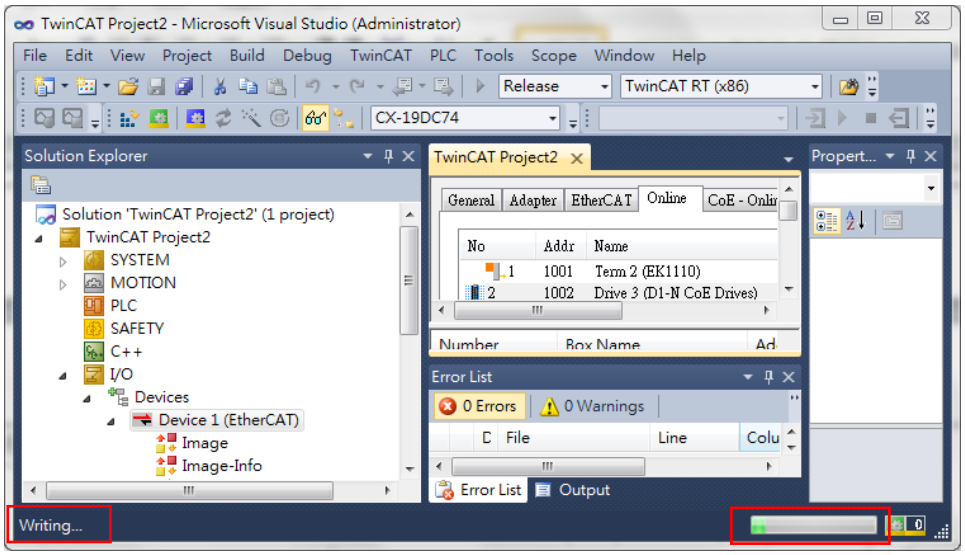


Fig. 5-32

(5) After completing EEPROM writing, the lower left corner of TwinCAT main window displays “Ready”.

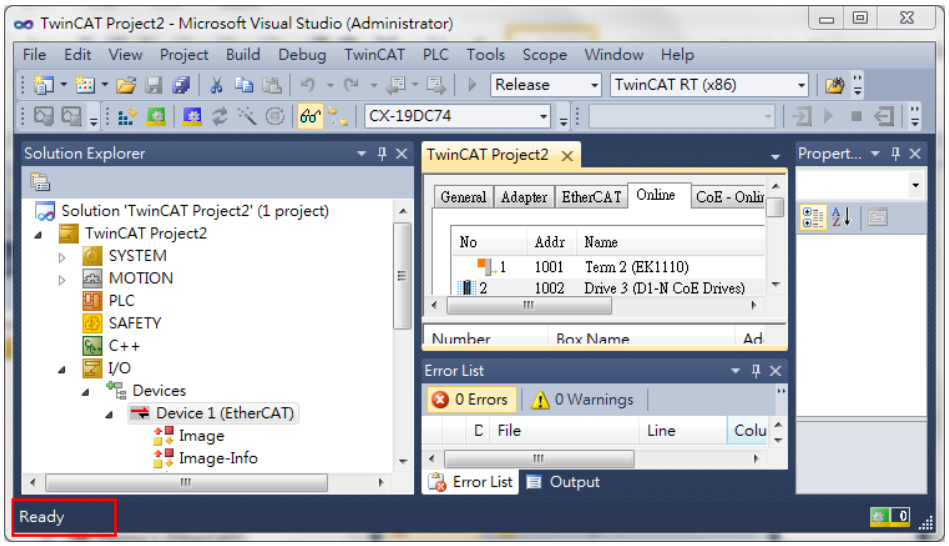


Fig. 5-33

(6) Power cycle HIWIN CoE drive to complete EEPROM update.

5.4. OMRON controller setting

Before communicating with HIWIN CoE drive, set its parameters by referring to Section 5.1 and connect it to OMRON EtherCAT controller (NJ series) via network cable.

5.4.1. ESI file update

This subsection describes how to update the ESI file for HIWIN CoE drive at the environment of OMRON software – Sysmac Studio.

(1) Start Sysmac Studio and select “New Project”. After entering project properties and setting controller parameters, press the “Create” button.

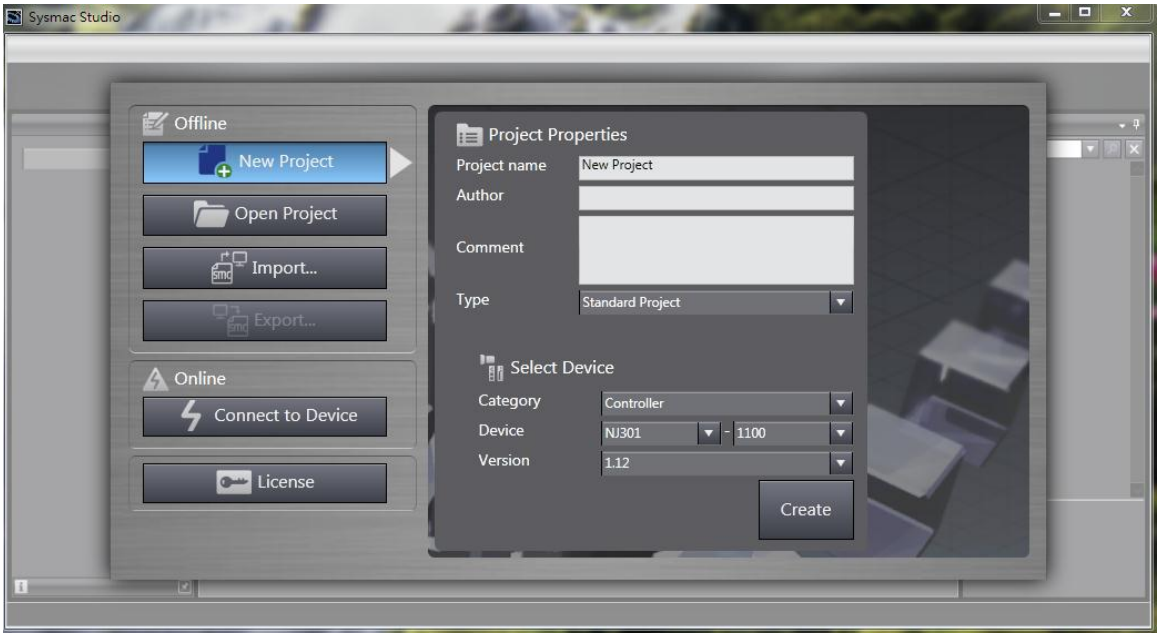


Fig. 5-34

(2) Select “EtherCAT” in “Configurations and Setup” at the left side of Sysmac Studio main window, and click the left key of mouse twice to open “EtherCAT” page. Click the right key of mouse at the controller icon ( ), and select “Display ESI Library”, as shown in Fig. 5-35.

(3) The “ESI Library” window shows ESI files supported by Sysmac Studio, as given in Fig. 5-36. Check if there is the ESI file for HIWIN CoE drive or not.
   a. If there is no HIWIN ESI file, press the green word of “this folder” in the window to open the folder contained customer’s ESI files. Place the least HIWIN ESI file in this folder. The path of folder is the installation path ..\OMRON \Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles.
   b. If there is the old HIWIN ESI file, open the folder contained customer’s ESI files. After deleting the old file, place the least HIWIN ESI file in this folder.

(4) Close Sysmac Studio and re-start it. Now, Sysmac Studio can support the least HIWIN ESI file.

Note. If the existed project is built according to the old HIWIN ESI file, the corresponding drive allocation should be removed. After updating HIWIN ESI file and re-starting Sysmac Studio, HIWIN CoE drives should be re-allocated and set to let them work normally.

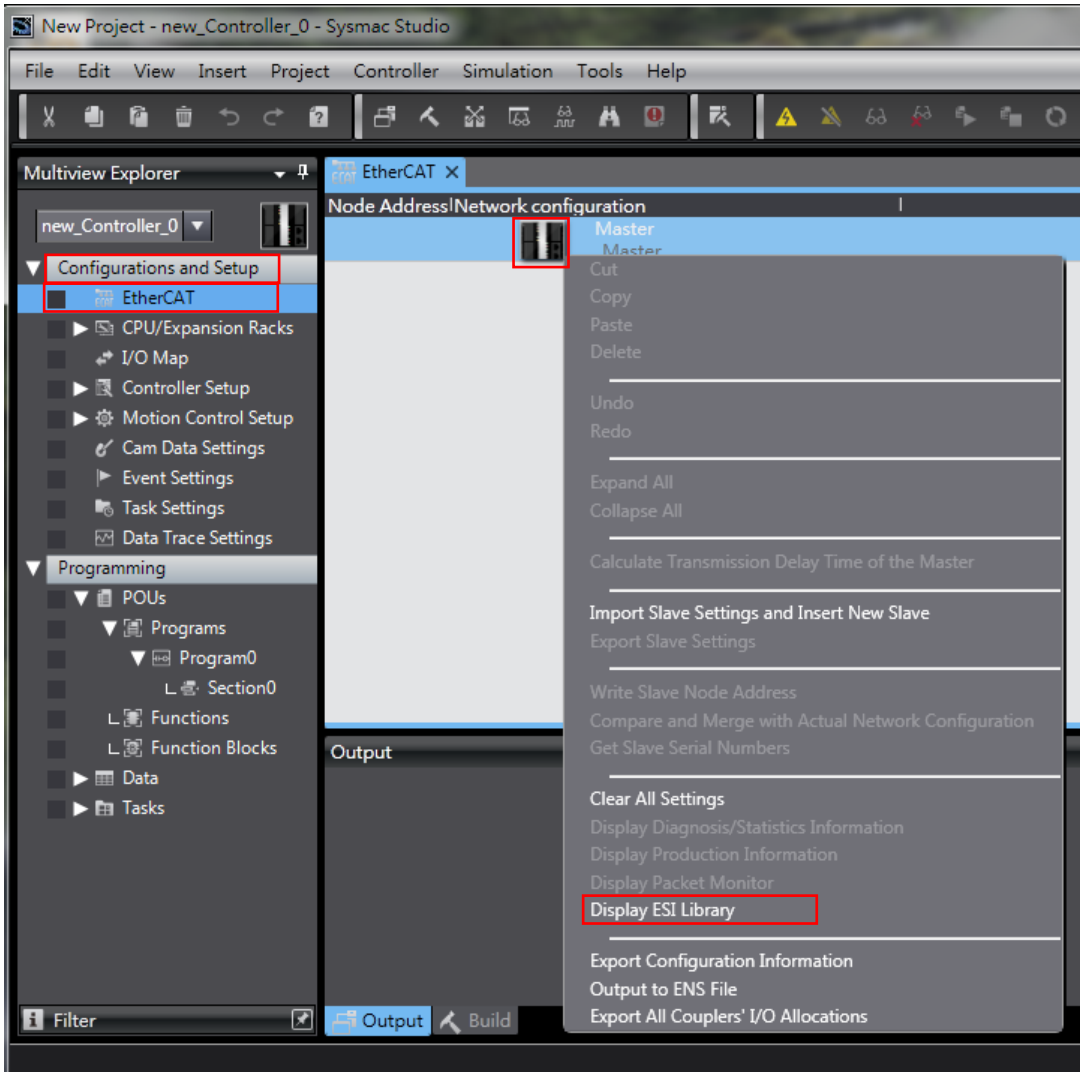


Fig. 5-35

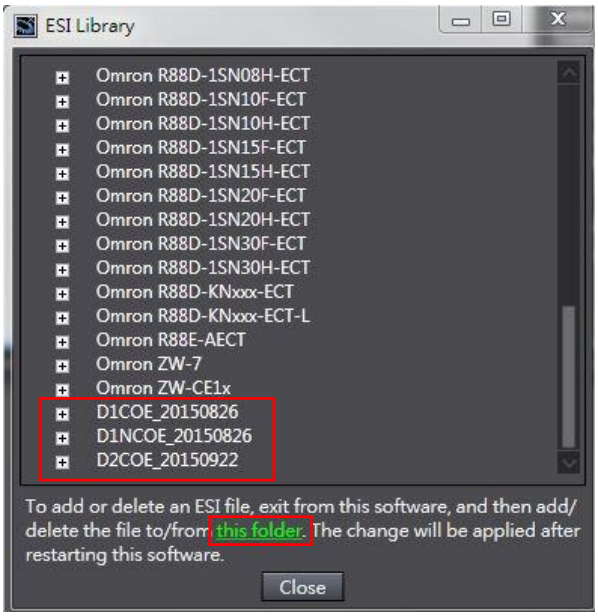


Fig. 5-36

5.4.2. Slave ID writing

This subsection describes how to set one slave ID for HIWIN CoE drive via OMRON software – Sysmac Studio. In the following, take D2 CoE drive as an example.

Note. With OMRON EtherCAT controller, each CoE drive should have one different slave ID to let controller configurate network successfully.

(1) Start Sysmac Studio and build one new project.

(2) Set the connection between OMRON EtherCAT controller and HIWIN CoE drive.
   a. Select “EtherCAT” in “Configurations and Setup” at the left side of Sysmac Studio main window.
   b. Select the icon of D2 CoE drive ( ) in “Toolbox” at the right-side window.
   c. Drag the drive icon to “EtherCAT” tab and put it under the icon of OMRON controller ( ).

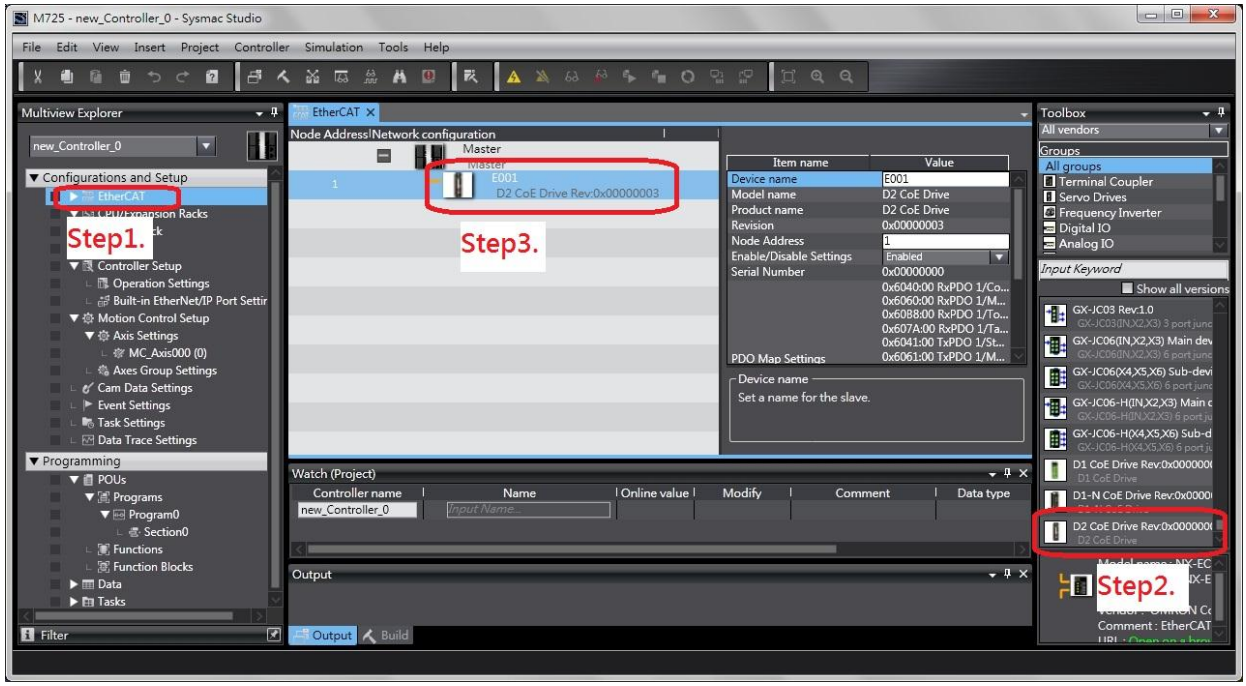


Fig. 5-37

(3) Open the window of “Write Slave Node Address”, as shown in Fig. 5-38.
   a. Click the icon of “Online” ( ) at the toolbar of Sysmac Studio to let controller connect with drive.
   b. Click the right key of mouse at the controller icon to appear menu.
   c. Select “Write Slave Node Address” in the menu.

(4) Write slave ID in drive in the window of “Slave Node Address Writing”, as shown in Fig. 5-39.
   a. Write slave ID in drive (range: 1~192).
   b. After pressing the “Write” button at the lower right corner of window, the warning window will appear to remind that the node address is written to the slave.
   c. Press the “Write” button in the warning window to write slave ID in drive.
   d. After completing slave ID writing, turn off the main power of controller and drive. After 5 seconds, turn on their main power again.

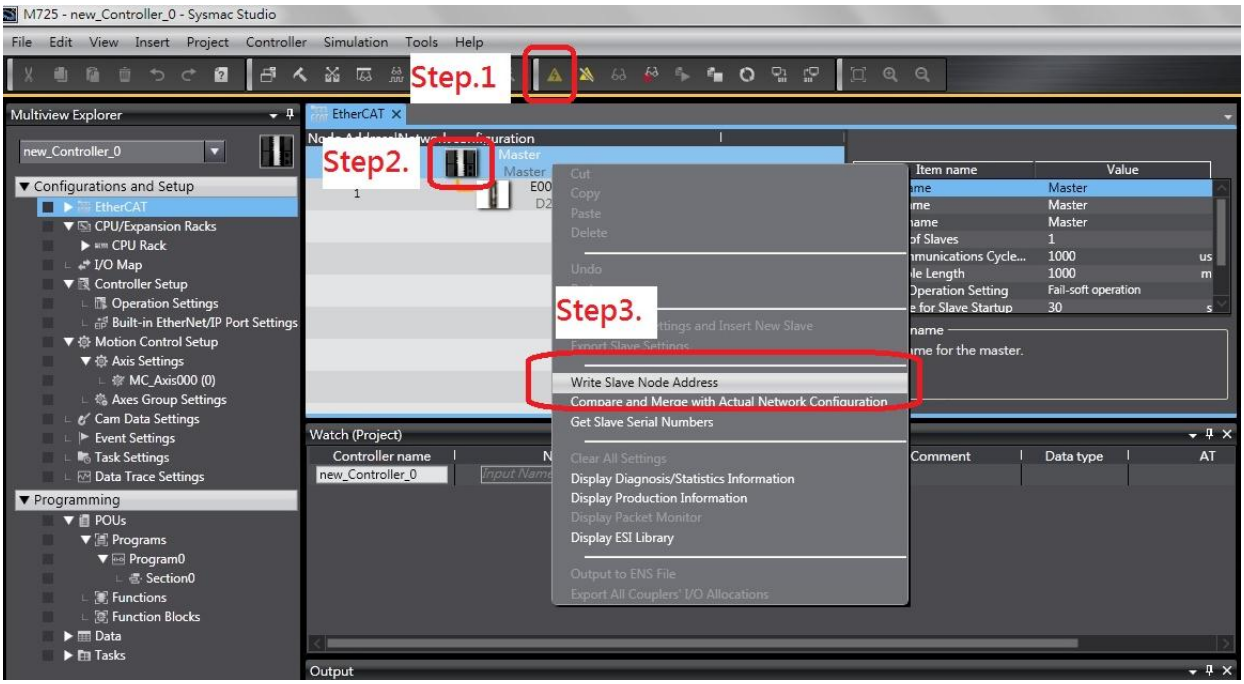


Fig. 5-38

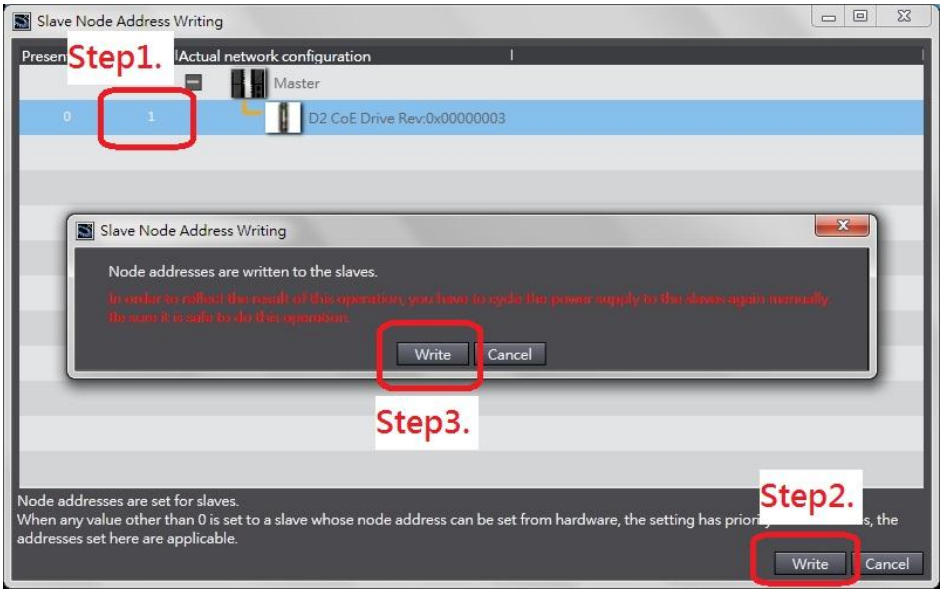


Fig. 5-39

(5) Open the window of “Compare and Merge with Actual Network Configuration”, as shown in Fig. 5-40.

a. Click the icon of “Online” ( ) at the toolbar of Sysmac Studio to let controller connect with drive.
b. Click the right key of mouse at the controller icon to appear menu.
c. Select “Compare and Merge with Actual Network Configuration” in the menu. If the warning window appears, it should be that drive or controller does not power cycle yet. Power cycle drive or controller.

(6) Check if “Node Address” is the same as the value written in Step (4). If they are the same, it means that slave ID writing is successful. If the exclamation point appears in the front of drive, it means that the actual slave ID of drive is different with that in the network configuration of Sysmac Studio. Press the button of “Apply actual network configuration” to let the network configuration of Sysmac Studio is the same as the actual network configuration.

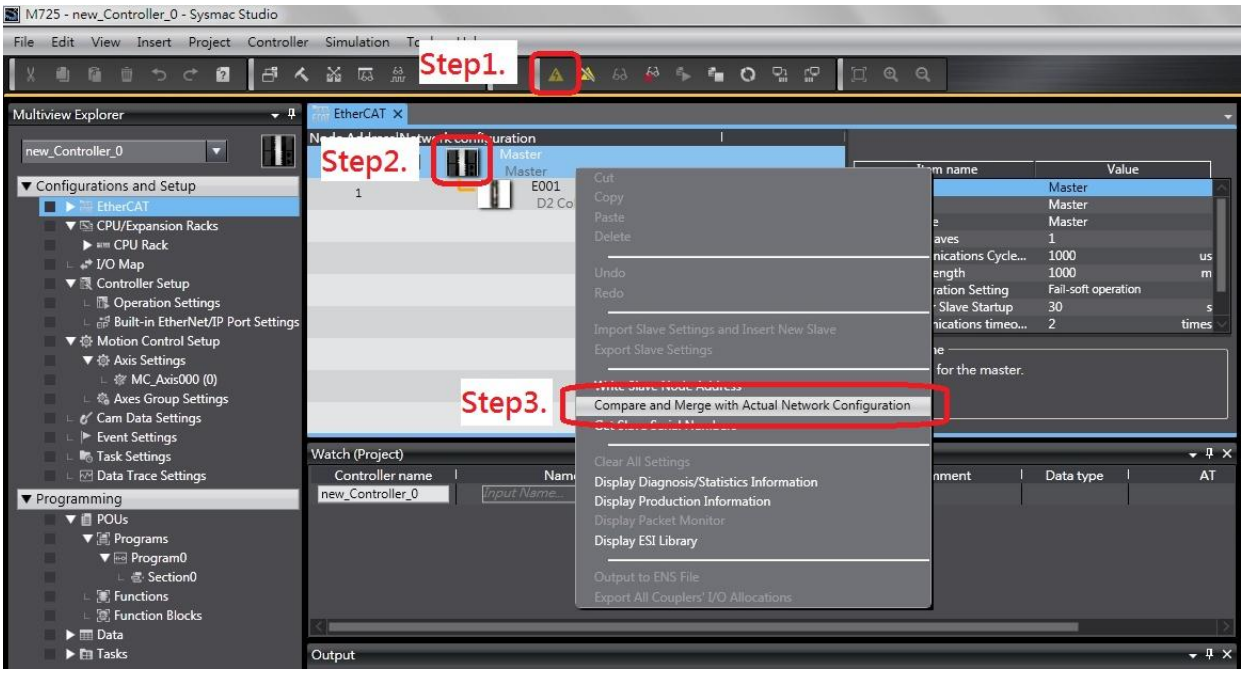


Fig. 5-40

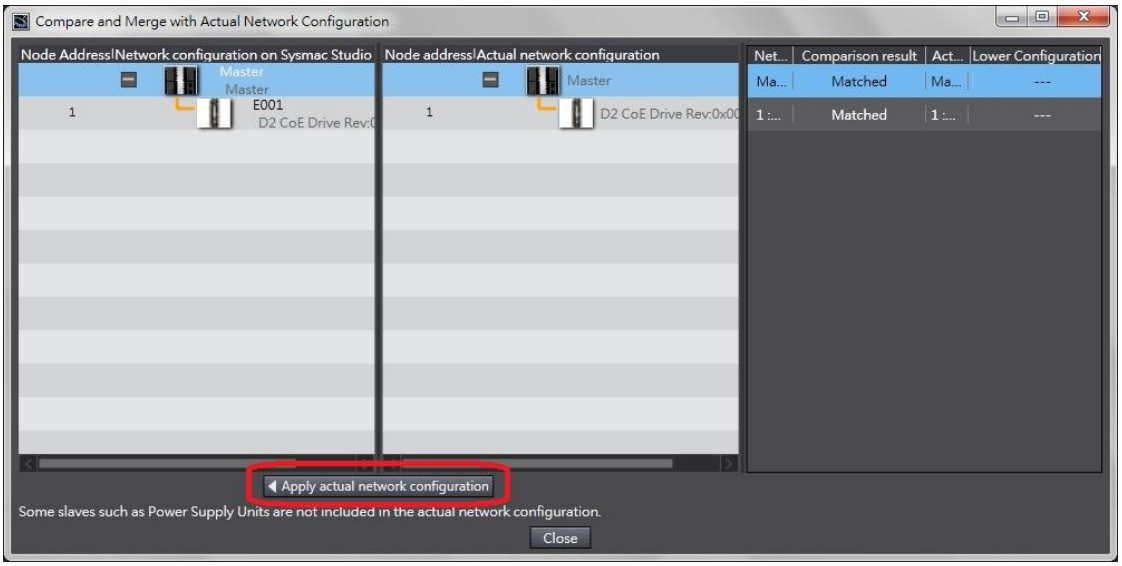


Fig. 5-41

5.4.3. Homing example

This subsection describes how to let HIWIN CoE drive perform homing via OMRON software – Sysmac Studio. In the following, take D2 CoE drive as an example.

(1) Execute steps given in Section 5.4.2 to complete the network configuration of OMRON controller with HIWIN CoE drive (Slave ID is set to be 5).

(2) Click the icon of D2 CoE drive ( ) on “EtherCAT” tab and press the button of “Edit PDO Map Settings” at the right-side window.

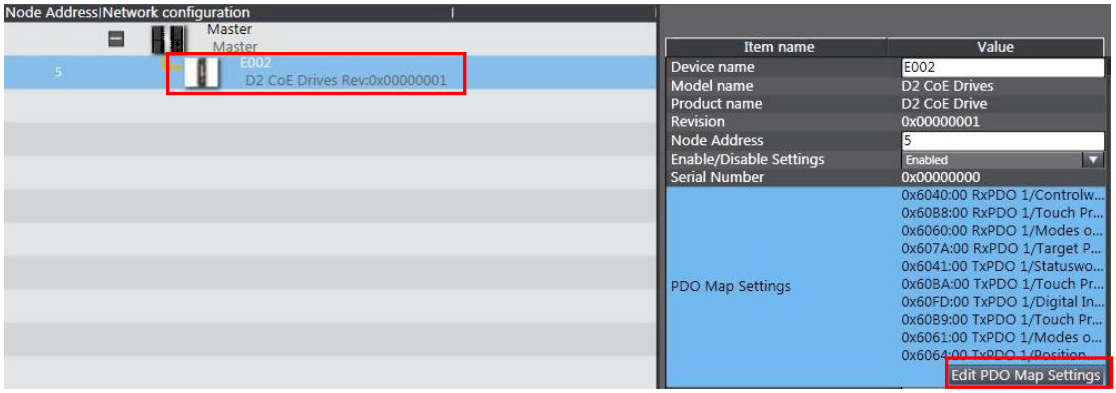


Fig. 5-42

(3) Select TxPDO1 and press the button of “Add PDO Entry” in the window of “Edit PDO Map Settings”. Add objects given in Table 5-1 into TxPDO1, as shown in Fig. 5-43.

Table 5-1

Object	Definition	Description
0x6041	Statusword	Default
0x60BA	Touch Probe 1 Position value	For homing
0x60FD	Digital Inputs	For homing
0x60B9	Touch Probe Status	For homing
0x6061	Modes of Operation Display	For OMRON communication
0x6064	Position Actual Value	Default

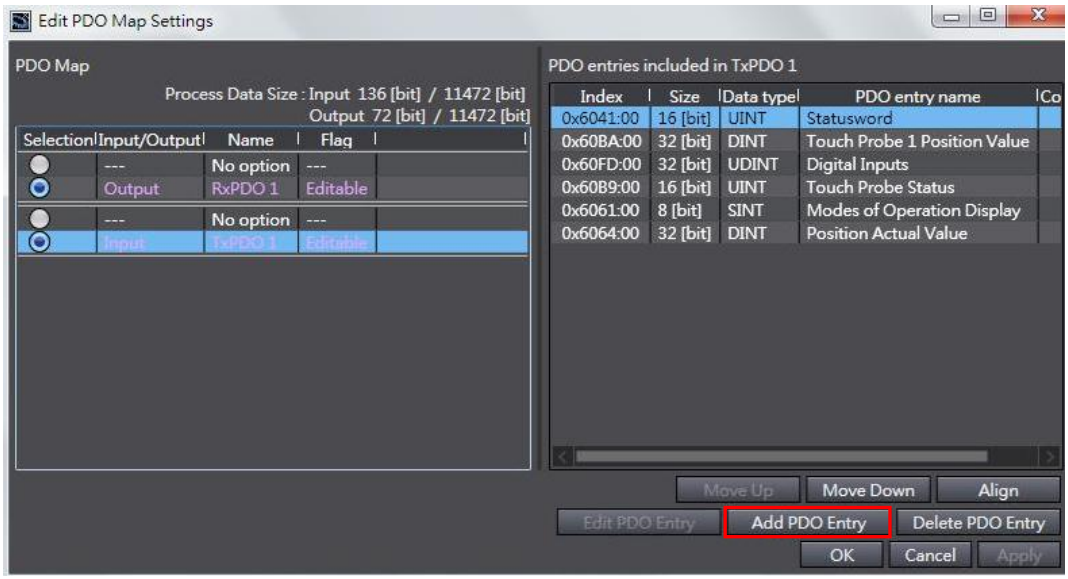


Fig. 5-43

(4) Select RxPDO1 and press the button of “Add PDO Entry” in the window of “Edit PDO Map Settings”. Add objects given in Table 5-2 into RxPDO1, as shown in Fig. 5-44.

Table 5-2

Object	Definition	Description
0x6040	Controlword	Default
0x60B8	Touch Probe function	For homing
0x6060	Modes of Operation	For OMRON communication
0x607A	Target Position	Default

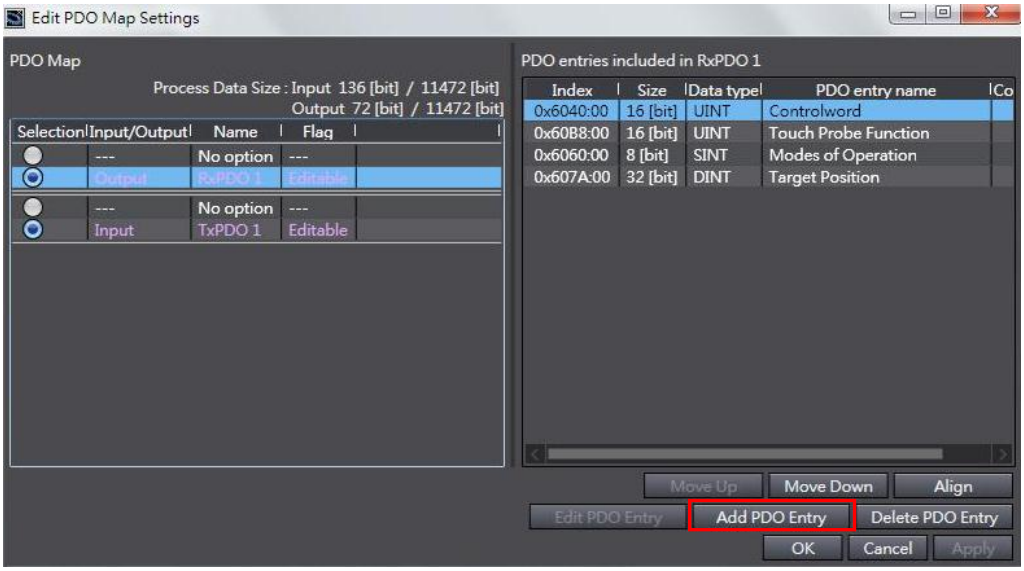


Fig. 5-44

(5) Set PDO mapping between controller and drive.

a. Select “Motion Control Setup” in “Configurations and Setup” at the left side of Sysmac Studio main window. Click “MC_Axis000 (0)” in “Axis Settings”.

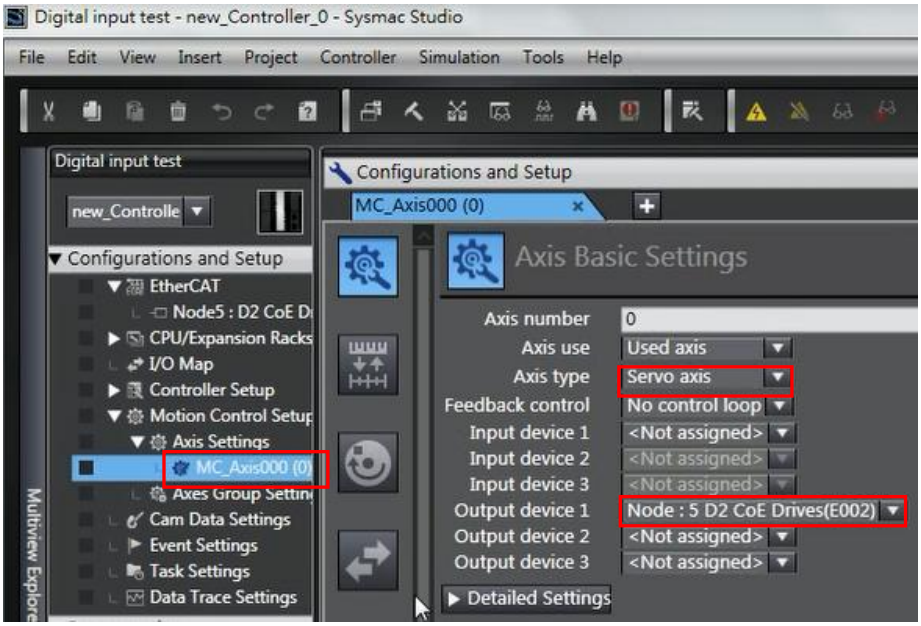


Fig. 5-45

b. Click the icon of “Axis Basic Settings” () in “MC_Axis000 (0)” tab to open the “Axis Basic Settings” page. Set “Axis type” to be “Servo axis” and “Output device 1” to be drive linked to this axis. In the example of Fig. 5-45, it is “Node：5 D2 CoE Drives (E002)”.

c. Open “Detailed Settings” in “Axis Basic Settings” to set PDO mapping for “Output (Controller to Device)”, as shown in Fig. 5-46. Note that, the definition of “Process Data” should be the same as “Function Name”.

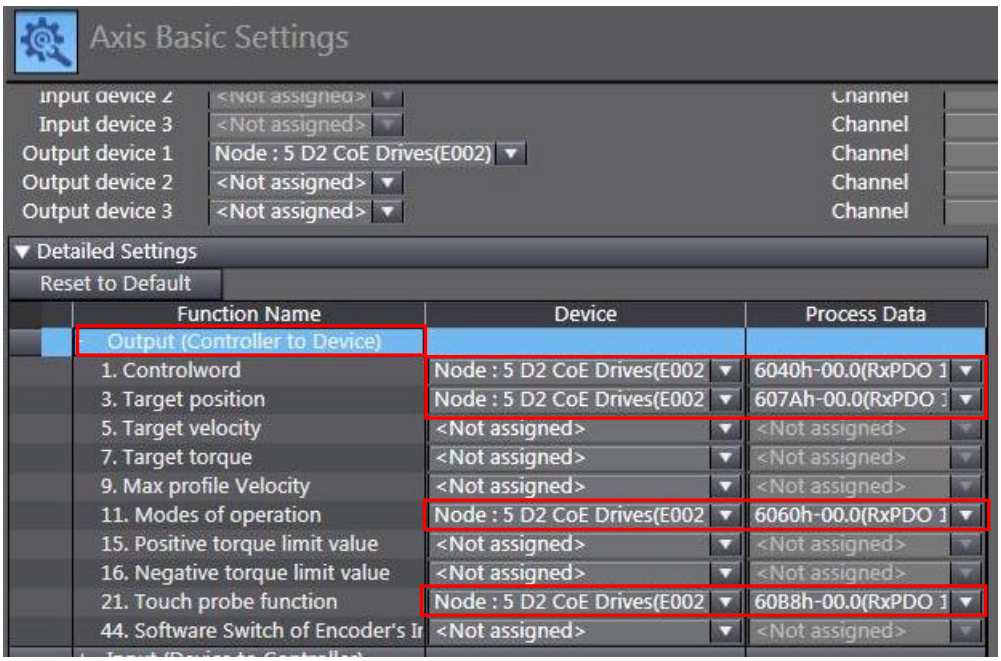


Fig. 5-46

d. Set PDO mapping for “Input (Device to Controller)” and “Digital Inputs”, as shown in Fig. 5-47.

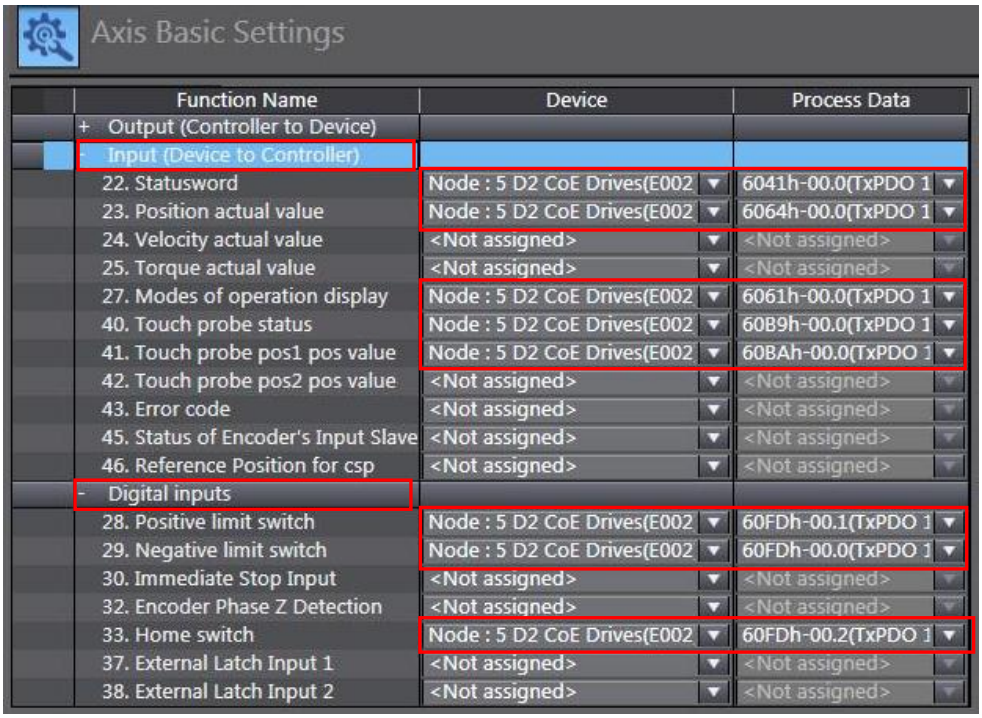


Fig. 5-47

(6) Click the icon of “Homing Settings” ( ) in “MC_Axis000 (0)” tab to open the “Homing Settings” page. Set homing method, homing velocity, and homing acceleration based on the actual demand. In the example of Fig. 5-48, “Homing method” is set to be “Home proximity input ON” and “Home input signal” is set to be “Use Z-phase input as home”.

Fig. 5-48

(7) Open “POUs” in “Programming” at the left side of Sysmac Studio main window. Select “Program0” in “Programs”. Use two function blocks of “MC_Power” and “MC_Home” to code a simple homing program on “Section0”, as shown in Fig. 5-49.

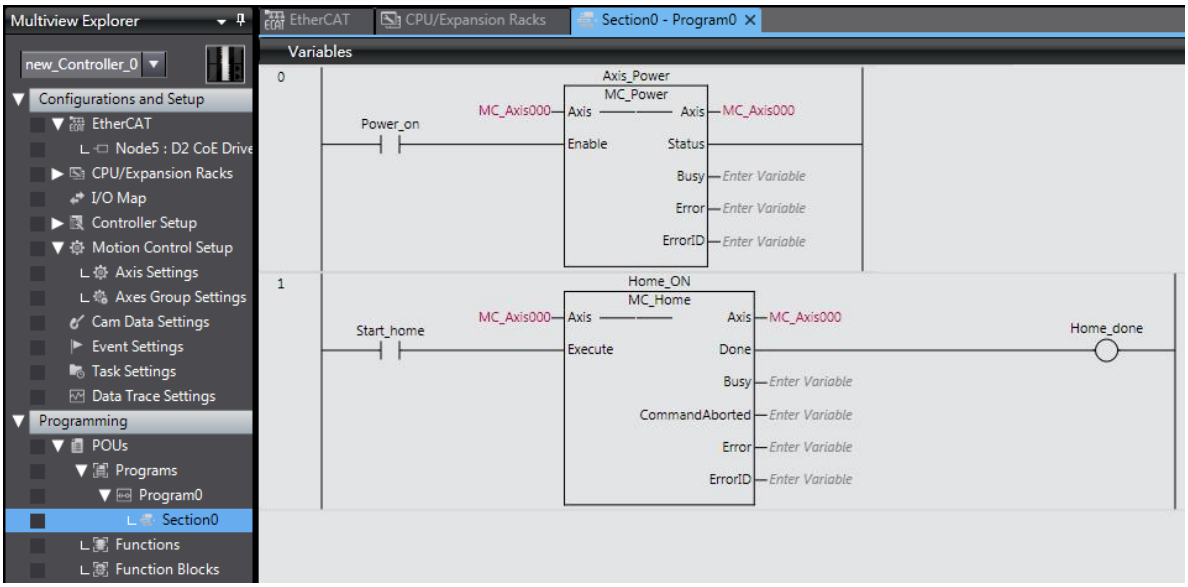


Fig. 5-49

(8) Execute homing program.

a. Click the icon of “Online” ( ) at the toolbar of Sysmac Studio to let controller connect with drive.
b. Click the icon of “Synchronize” ( ) at the toolbar of Sysmac Studio to compare the program in Sysmac Studio with that in controller. Load program into controller.
c. After completing program loading, set “Power_on” on “Section0” page to be “True” to enable motor.
d. Set “Start_home” on “Section0” page to be “True” to let motor execute homing.
e. The homing result is given in Fig. 5-50.

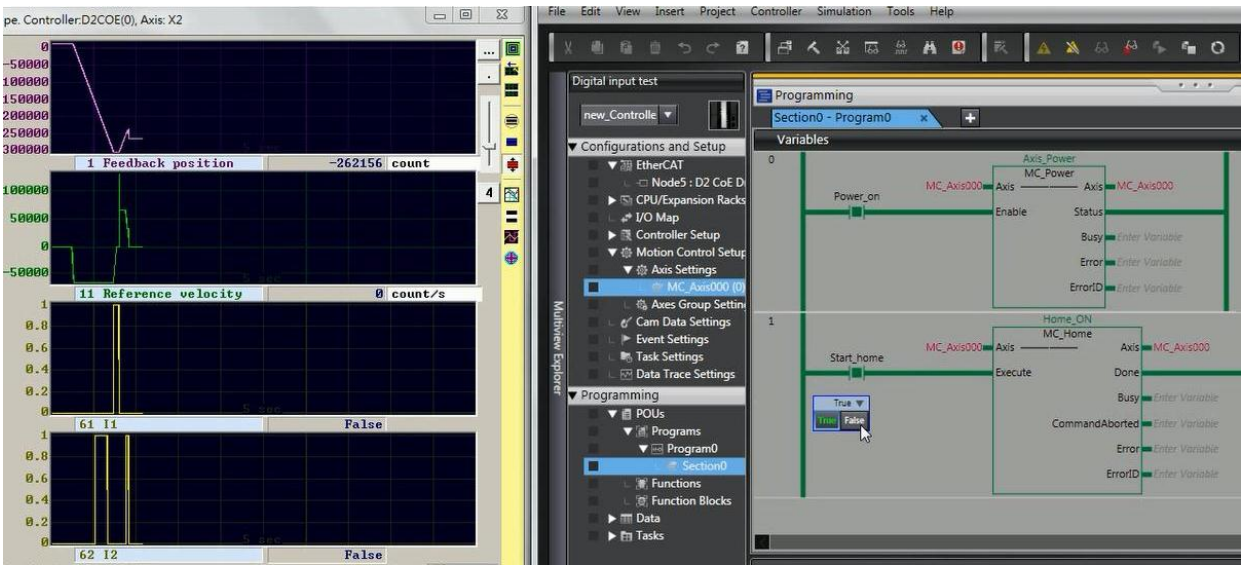

pe. Controller:D2COE(0), Axis: X2
1 Feedback position
-262156 count
11 Reference velocity
0 count/s
61 I1
False
62 I2
False
File Edit View Insert Project Controller Simulation Tools Help
Digital input test
new_Controlle
Configurations and Setup
EtherCAT
Node5 : D2 CoE D
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Axis Settings
Axes Group Settin
Cam Data Settings
Event Settings
Task Settings
Data Trace Settings
Programming
POUs
Programs
Program0
Section0
Functions
Function Blocks
Data
Tasks
Multiview Explorer
Programming
Section0 - Program0
Variables
Axis_Power
MC_Power
MC_Axis000
Axis
Power_on
Enable
Status
Busy
Error
ErrorID
Enter Variable
Home_ON
MC_Home
Start_home
Execute
Done
CommandAborted
True
False

Fig. 5-50

5.5. TRIO controller setting

Before communicating with HIWIN CoE drive, set its parameters by referring to Section 5.1 and connect it to TRIO EtherCAT controller via network cable.

5.5.1. Communication setting

This subsection describes how to connect with HIWIN CoE drive via TRIO software – Motion Perfect. In the following, take D2 CoE drive as an example.

(1) Open Motion Perfect and select “Connection settings” in “Controller”.

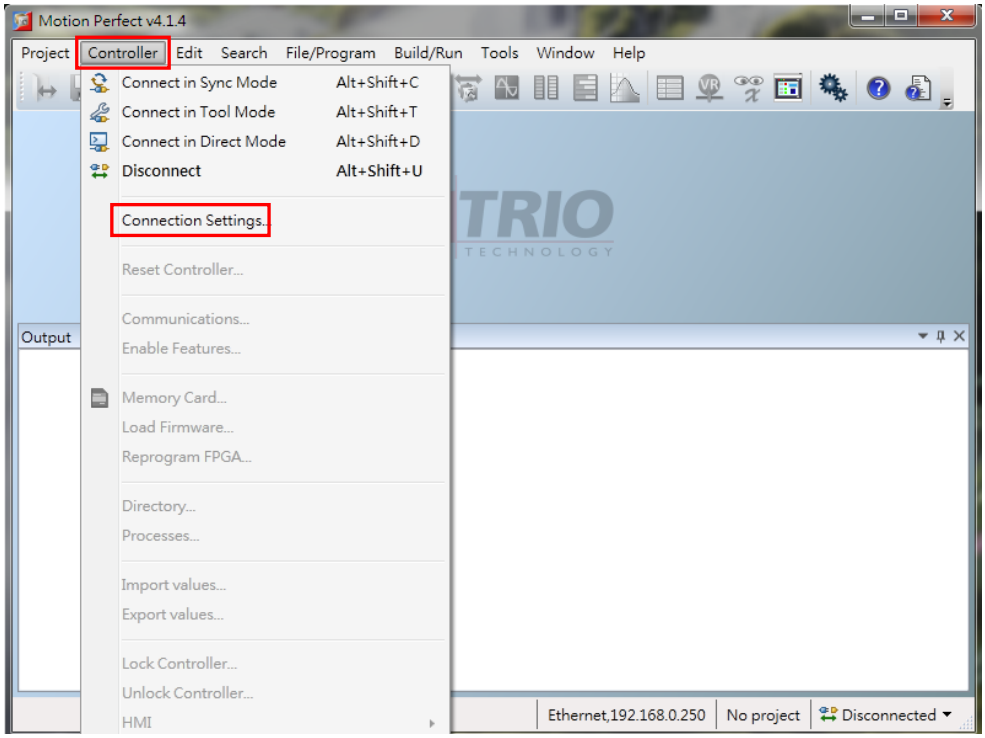


Fig. 5-51

(2) Set suitable parameters according to actual connection. In the following, take Ethernet connection as an example. Select “Ethernet” in “Interface”, use default values in “Connection parameters”, and choose “Apply & Connect in Sync Mode” in “Apply & Connect”.

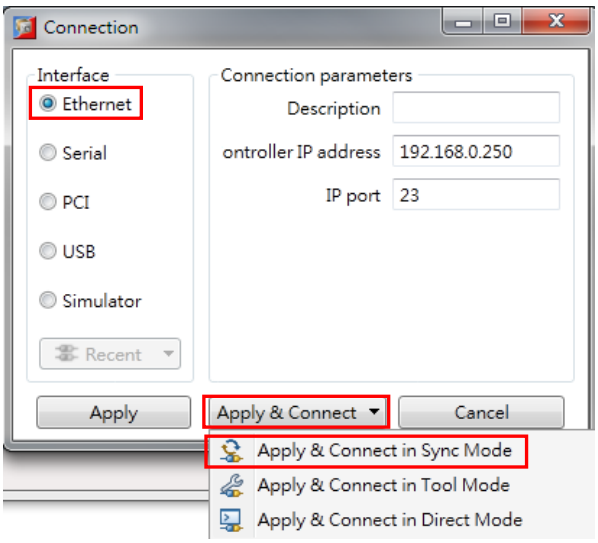


Fig. 5-52

(3) After connecting with controller successfully, the information of TRIO controller is shown in the left side of Motion Perfect main window. The current status is “Sync mode” and is shown in the lower right corner. Click the icon of “Intelligent drives configuration” ( ) at the toolbar to open the window for EtherCAT connection setting.

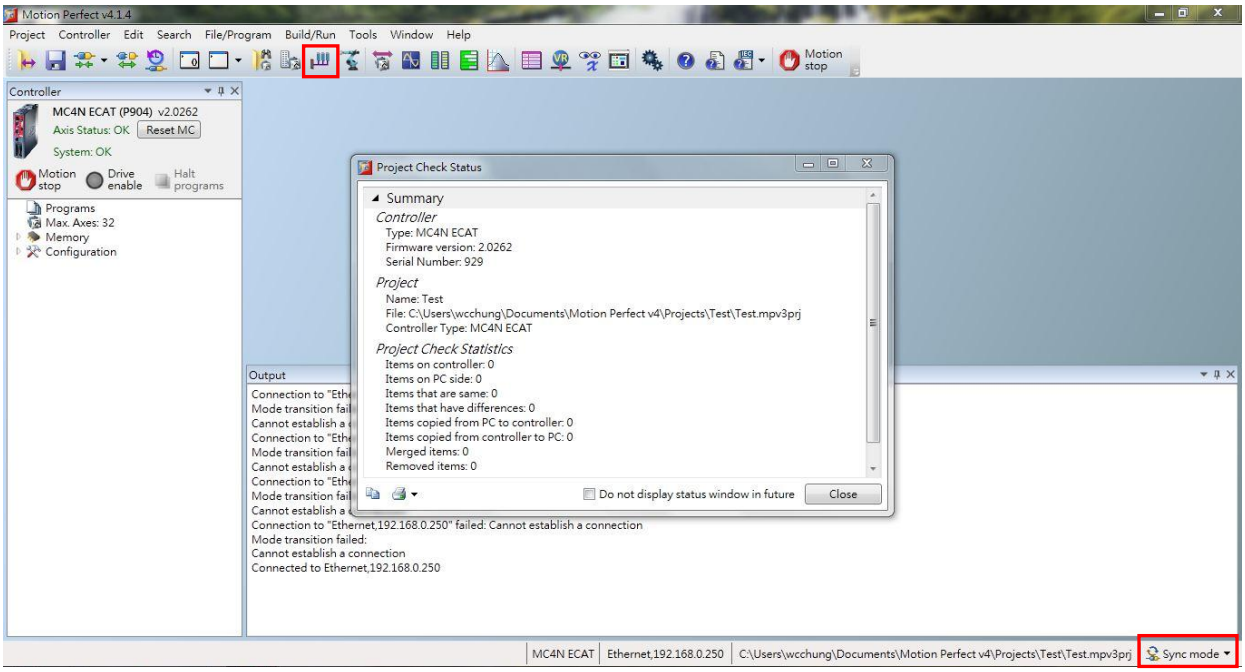


Fig. 5-53

(4) Click the icon of “Re-initialize” ( ) on “Slot 0 - EtherCAT” tab to re-initialize EtherCAT connection.

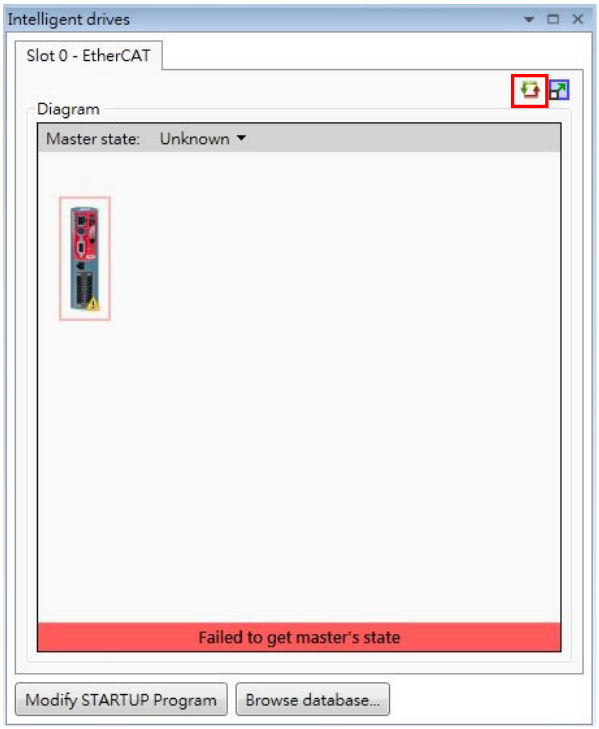


Fig. 5-54

a. If the icon of HIWIN drive is shown in “Diagram” and “Master state” is “Operational”, it means that the communication between TRIO controller and HIWIN CoE drives is built successfully.

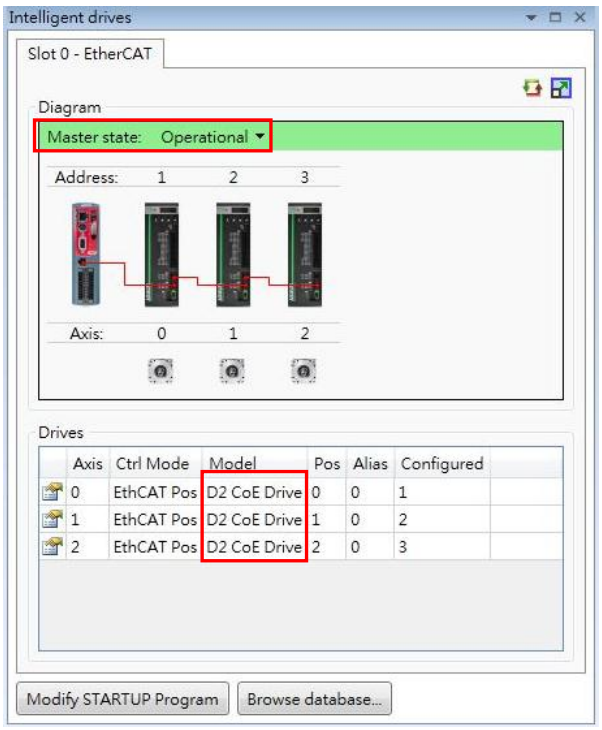


Fig. 5-55

b. If the icon of HIWIN drive does not show in “Diagram”, it may be caused by the following two reasons.
   (a) The EEPROM data of HIWIN drive does not match with the ESI version supported by TRIO controller. Please write the EEPROM file supported by TRIO controller in drive via TwinCAT.
   (b) If the ESI or EEPROM file of HIWIN CoE drive is updated, the current firmware of TRIO controller cannot distinguish it. Please update the firmware of TRIO controller, or contact HIWIN engineer for assistance.

   Note. TRIO software version above “MC4NE_20262” begins to support HIWIN COE drives. ESI files corresponding to “MC4NE_20262” are D1COE_20150826.xml, D1NCOE_20150826.xml, and D2COE_20150922.xml.

5.5.2. Motion parameter setting

This subsection describes how to set motion parameters for each axis via TRIO software – Motion Perfect. In the following, take D2 CoE drive as an example.

(1) Open Motion Perfect and select the icon of “Axis Parameters” () at the toolbar of Motion Perfect main window.

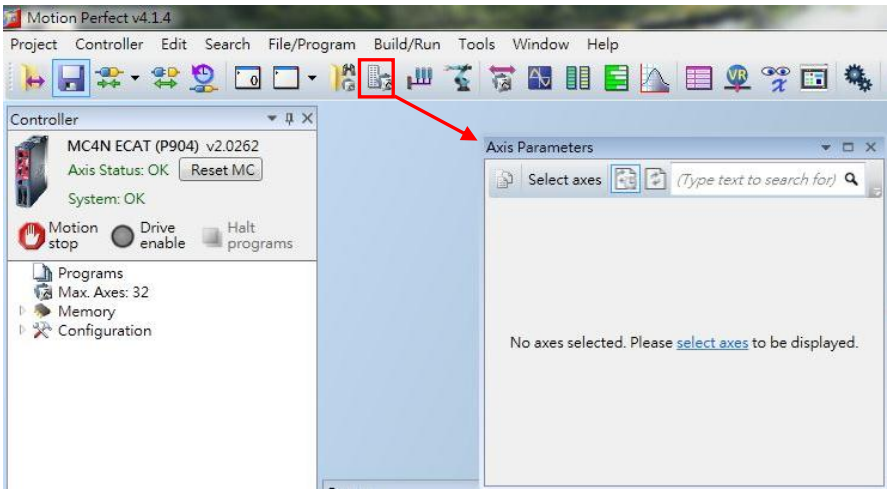


Fig. 5-56

(2) Click “Select axes” in the window of “Axis Parameters” to open the window of “Show/Hide Axes”. Check the option of axis wanted to be shown. After that, press the “OK” button.

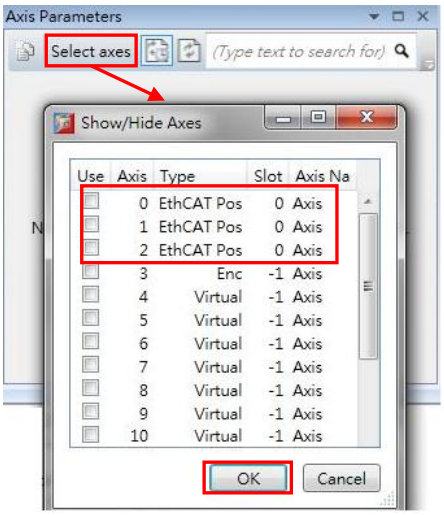
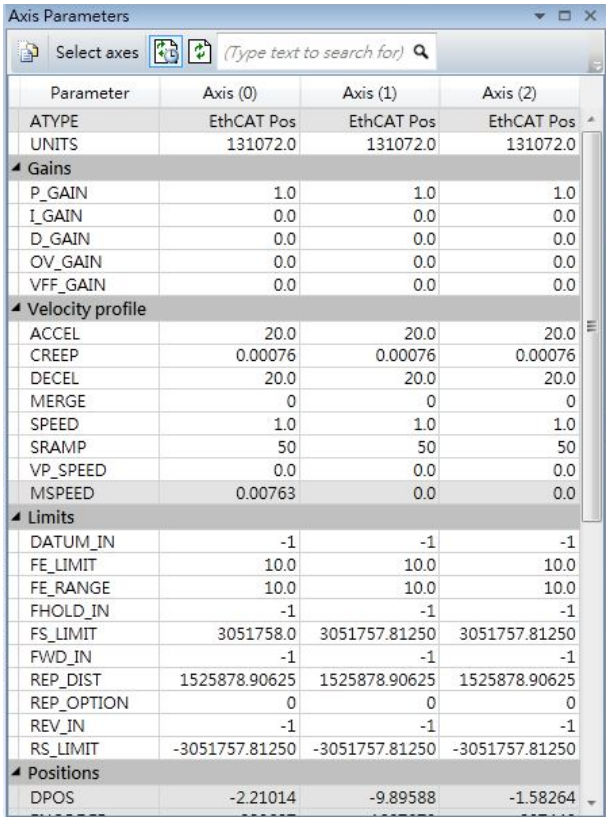


Fig. 5-57

(3) Motion parameters can be modified in the window of “Axis Parameter”, e.g., speed, acceleration, and so on. The definition of motion parameter can be obtained by searching its name on “Trio BASIC help” located at “Help” of main window.

Note. The setting of “UNIT” is very important at the setting of axis parameter. Suppose that 17-bit AC servo motor with the screw pitch of 10 mm is used. One revolution of motor is equal to 131072 counts (= 10 mm). If “Unit” is set to be 131072, the motion parameter and distance will take 131072 (= 10 mm) as the unit. For example, if the acceleration (ACCEL) is set to be 20, it means that the acceleration is 20*10 = 200 mm/s^2. Hence, please check this parameter carefully to avoid an accident.



Parameter	Axis (0)	Axis (1)	Axis (2)
ATYPE	EthCAT Pos	EthCAT Pos	EthCAT Pos
UNITS	131072.0	131072.0	131072.0
Gains			
P_GAIN	1.0	1.0	1.0
I_GAIN	0.0	0.0	0.0
D_GAIN	0.0	0.0	0.0
OV_GAIN	0.0	0.0	0.0
VFF_GAIN	0.0	0.0	0.0
Velocity profile			
ACCEL	20.0	20.0	20.0
CREEP	0.00076	0.00076	0.00076
DECEL	20.0	20.0	20.0
MERGE	0	0	0
SPEED	1.0	1.0	1.0
SRAMP	50	50	50
VP_SPEED	0.0	0.0	0.0
MSPEED	0.00763	0.0	0.0
Limits			
DATUM_IN	-1	-1	-1
FE_LIMIT	10.0	10.0	10.0
FE_RANGE	10.0	10.0	10.0
FHOLD_IN	-1	-1	-1
FS_LIMIT	3051758.0	3051757.81250	3051757.81250
FWD_IN	-1	-1	-1
REP_DIST	1525878.90625	1525878.90625	1525878.90625
REP_OPTION	0	0	0
REV_IN	-1	-1	-1
RS_LIMIT	-3051757.81250	-3051757.81250	-3051757.81250
Positions			
DPOS	-2.21014	-9.89588	-1.58264

Fig. 5-58

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