

NEXCOBOT

Intelligent Solutions for IoT Automation

NexMotion Studio User Manual

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1. About NexMotion Studio

1.1. NexMotion Studio features



2. NexMotion Studio Installation

- 2.1. Hardware requirements
- 2.2. Software requirements



3. NexMotion Studio Settings

The home screen of NexMotion Studio is divided into six areas based on functions, as shown in the figure below:

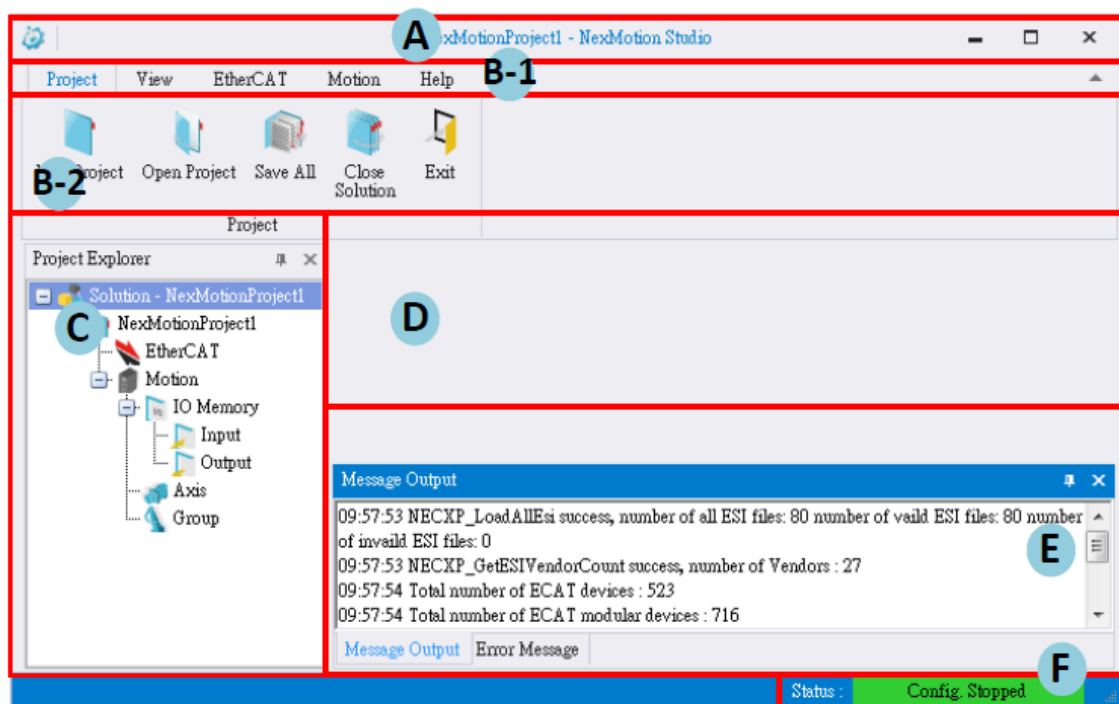


Figure NexMotion Studio home screen

The regional functions are detailed in the following table:

Table NexMotion Studio zone description

Zone	Zone name	Funtions
A	Title	Displaying the name of NexMotion Studio. If the project is opened, its name will also be displayed here.
B	Main menu	Providing common function shortcut keys, with the main functions including: Project, View, EtherCAT, Motion, and Help. After selecting the main menu in the B-1 region, the corresponding shortcut key will be displayed in the B-2 region.
C	Project content	After creating / opening a new project, the corresponding project content will be displayed in a dendritic form; please refer to sections 3.1.1, 3.1.2 , and 3.1.3 for details.
D	Operating window	Please refer to Chapter 3.2 and the chapters after 3.2 for details on the operating interface window display area.
E	Message display	Separate displays based on messages types; Message Output: Displaying the running program message.

		Error Message: Displaying error messages at run-time.
F	Status display	Displaying the current system core state; please refer to Chapter 4.1 and the chapters after it for details.

3.1. Create / Open / Save project

NexMotion Studio provides project features that enable users to save the current edit status to a project file through project functions. When the application situation changes and it is necessary to further modify the setting, quickly revert to the previous edit state to continue to edit, so as to expedite the development without repeating editing

This chapter will describe how to create a new project in NexMotion Studio, as well as saving and opening projects, as detailed in the following sections:

3.1.1. Create new project

When you open NexMotion Studio, you must first create a new project to perform the EtherCAT and Motion operations. Please refer to the following process for creating a new project:

Step1: Select **New Project** from the NexMotion Studio main menu

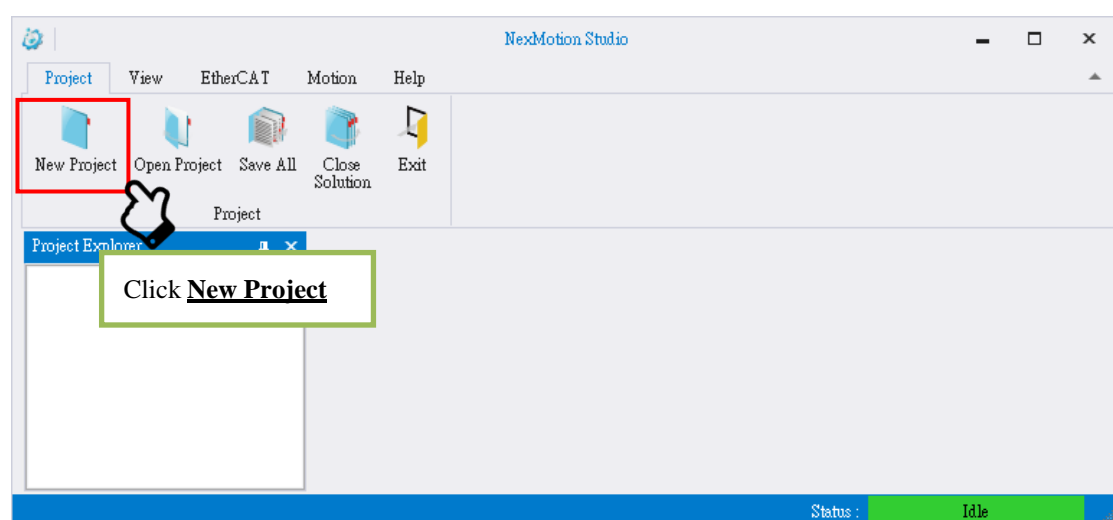


Figure Create a new project by clicking New Project

Step2: Set the project Name, the Location, and the Solution Name, and then press the



OK button, as shown in the figure below:



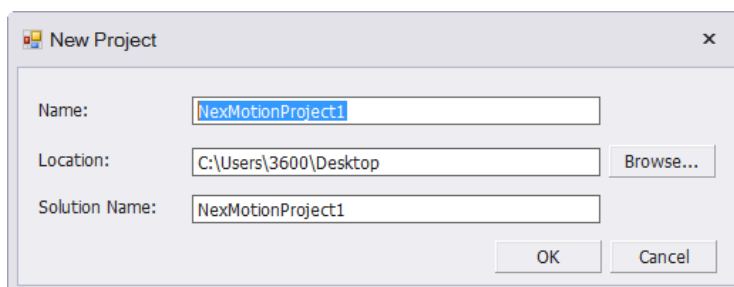


Figure New Project Dialog image

After pressing the **OK** button, you can see the current project contents in the Project Explorer area, including the Solution name, Project name, and two major functional groups: EtherCAT and Motion. At this point, the state of NexMotion Studio will be switched from Idle to Config. Stopped, which means that the user can start the setting, configuration, and operation of the functional groups (EtherCAT/ Motion). For details about functional groups, please refer to Chapter 3.2 and the chapters following it, as shown below:

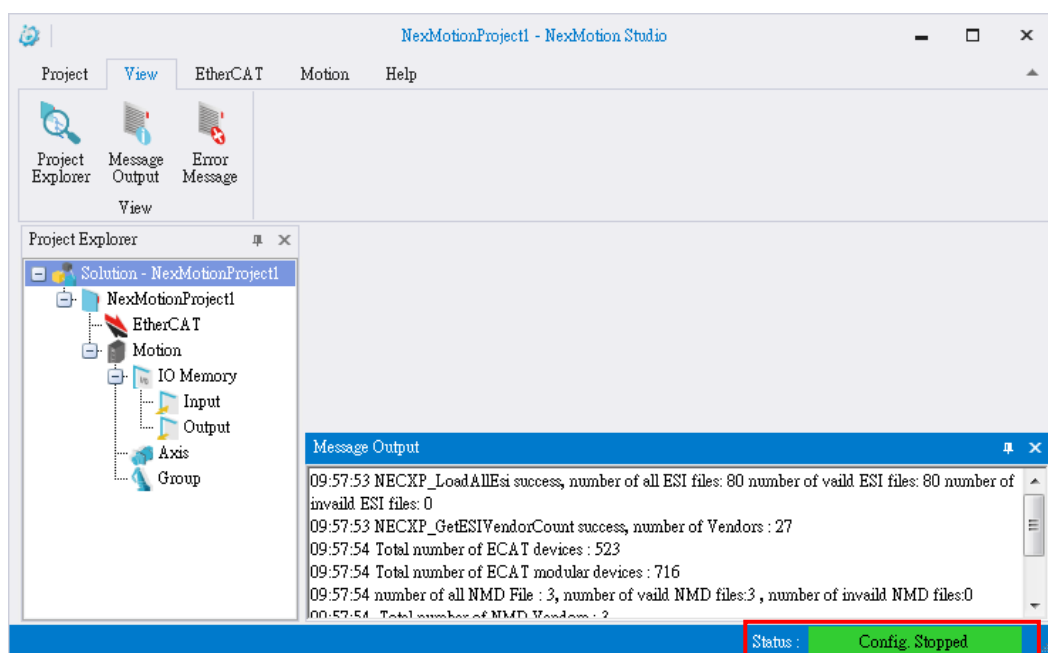


Figure Project Explorer content

3.1.2. Save project

On the NexMotion Studio main menu, select **Save All** and NexMotion Studio will save your current edit state to a specified folder, with the file format being nmsln and the specified folder path for the project being the one designated when creating a new project, as shown in the figure below:

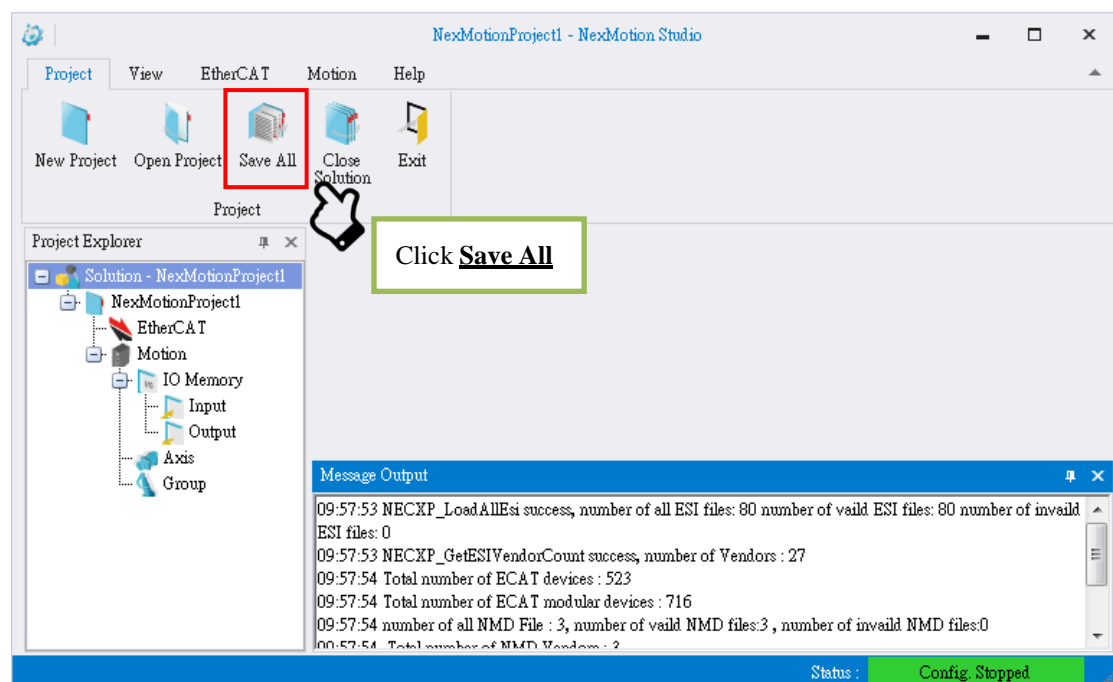


Figure Click Save All on the main menu to save the project.

In addition to selecting Save All on the main menu to save the project, NexMotion Studio will ask the user if they want to save it before closing the project and Solution in the event that they did not store it, with the details specified as follows:

When the user clicks **Close Solution** on the main menu or the close button on the screen (top right corner), the "Question" dialog will pop up, asking users if they are going to close it, with yes for the **OK** button otherwise the **Cancel** button, as shown in the figure below:

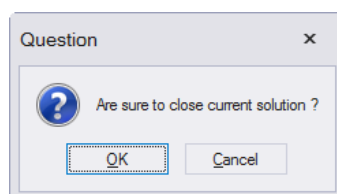


Figure Confirmation dialog—whether to close the current Solution and project

NexMotion Studio will show the second dialog Question, asking the user if they want to save the project in case that they close the project and Solution by mistake without saving it in advance. After clicking the OK button, NexMotion Studio will save the contents directly to the specified file of the project. If you do not need to save it, click the Cancel button, as exhibited in the figure below:

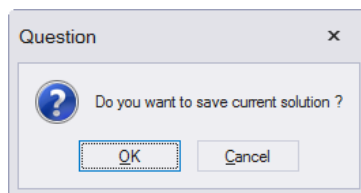


Figure Confirmation dialog—whether to save the current Solution and project

With the functions of saving projects and the reminder dialog as noted above, users can focus on editing the project content and operate the two primary functional groups EtherCAT and Motion, with NexMotion Studio, through the mechanism of project saving, perfectly saving the user's editing content.

3.1.3. Open project

The process for opening a project in NexMotion Studio is as follows:

Step1: Start NexMotion Studio and click Open Project on the main menu, and Open NEXCOM Project will pop up, as shown in the following figure:

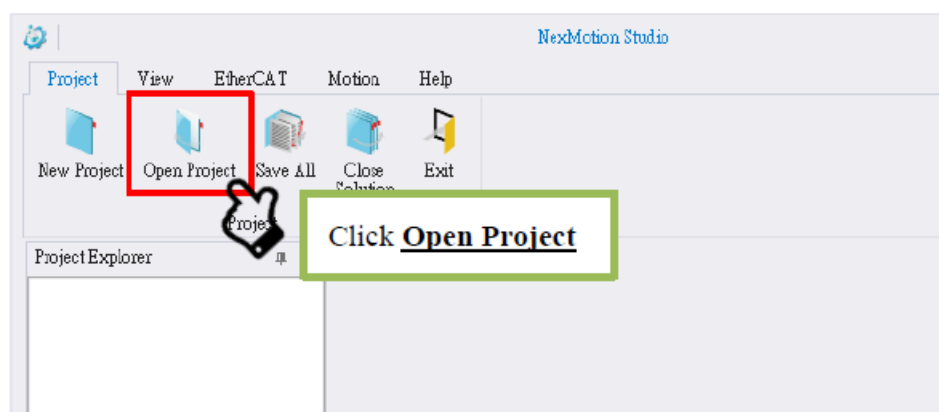


Figure Open Project—click Open Project on the main menu

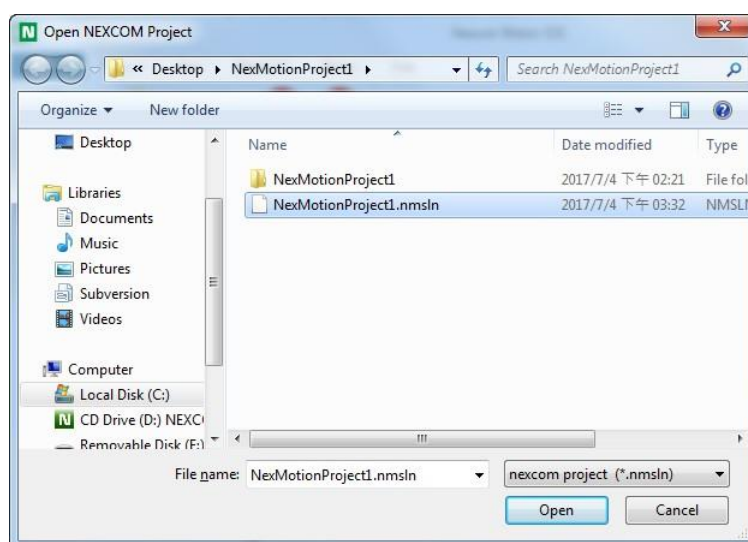


Figure Open NEXCOM Project pop-up window

Step2: Choose the Project you want to open on the Open NEXCOM Project window, with the file format being nmsln, and press the Open button to open the project the user has selected, with the details of the project in Project Explorer shown in the figure below:

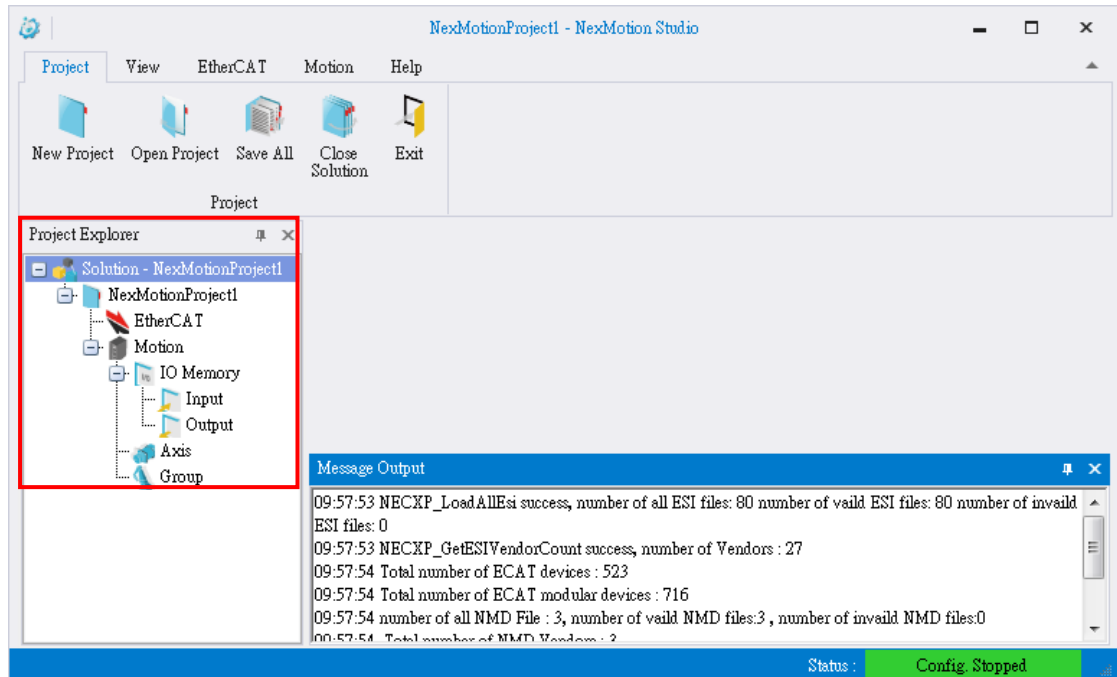


Figure Project details shown in the Project Explorer block

3.2. EtherCAT setting

Before the EtherCAT operation in NexMotion Studio, you need to add Master and configure a network interface card on Master. After the setting is completed, the Master can scan online and obtain the current quantity and type of the online Slaves; then start the network and operate on all Slaves. Please refer to the flowchart below:

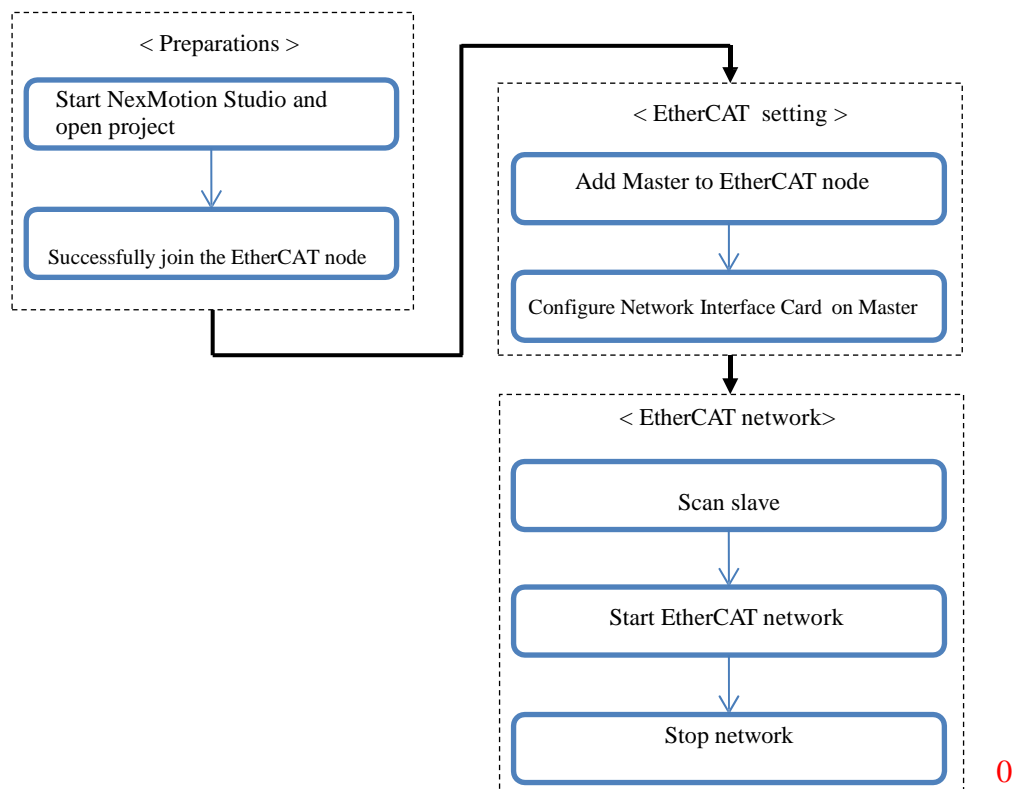


Figure EtherCAT setting

For a detailed operation and setting process, please refer to sections 3.2.1, 3.2.2, 3.2.3, and 3.2.4.

3.2.1. Add Master to EtherCAT node

Please refer to the following two approaches to add a Master node:

(A) Popup Menu: Right click on the EtherCAT node of Project Explorer and press **Add master**, as shown below:

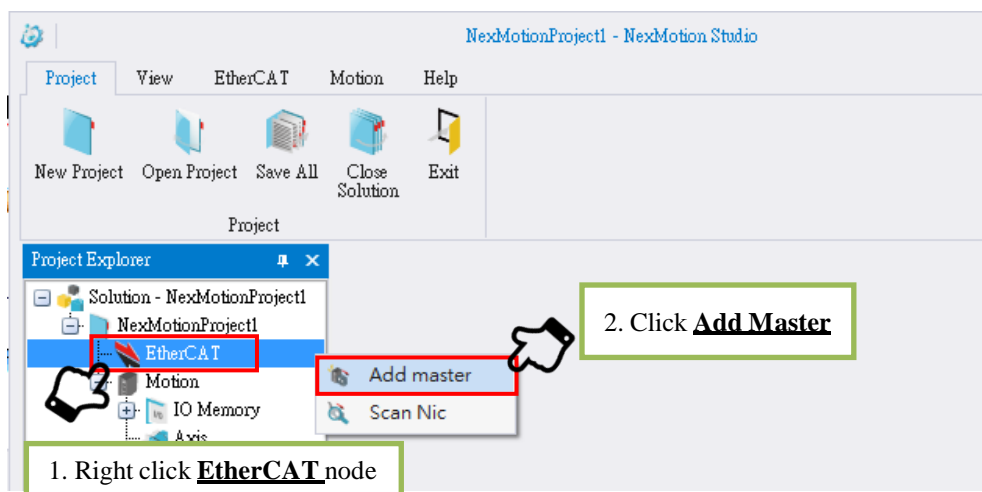


Figure Add EtherCAT Master—Popup menu

(B) Main Menu: After clicking the EtherCAT node of Project Explorer, select **Add master** on the EtherCAT menu at the top of NexMotion Studio, as shown in the figure below:

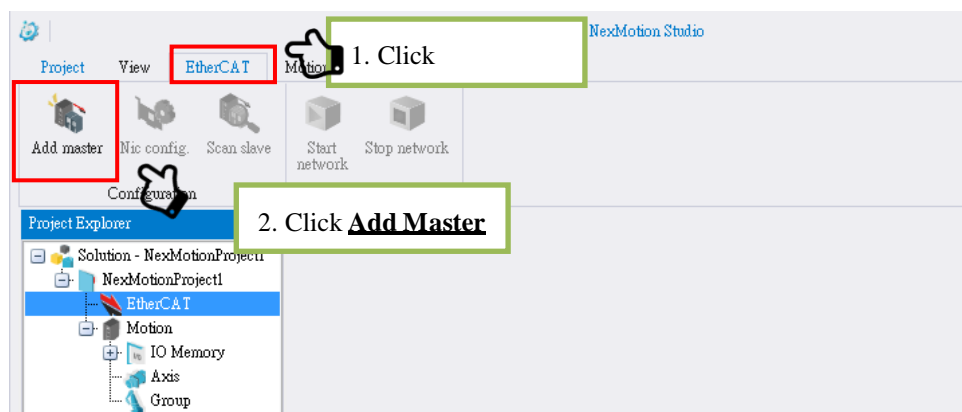


Figure Add EtherCAT Master—Main menu

3.2.2. Configure Network Interface Card on Master

The EtherCAT Master sends/receives packets via a specified network interface card and Slave. In the event of more than one network card configured on the user's computer, designate the network cards for Master with the following steps:

Step1: After selecting the Master node of Project Explorer, click on Nic config. under the EtherCAT menu at the top of NexMotion Studio, and then open the "Select Nic Dialog" window, as presented in the figure below:

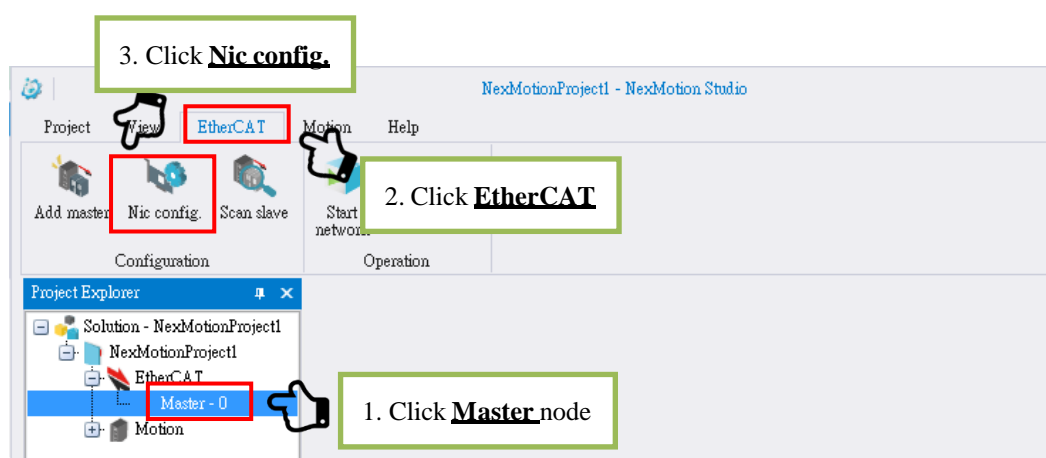


Figure Steps for opening the Nic Config window

Step2: The Select Nic Dialog window displays the currently available network interface cards and the number of slaves connected to the interface card, coupled with "Check one Nic. which is already connected to slave." The setting is completed upon pressing the OK button, as manifested below:

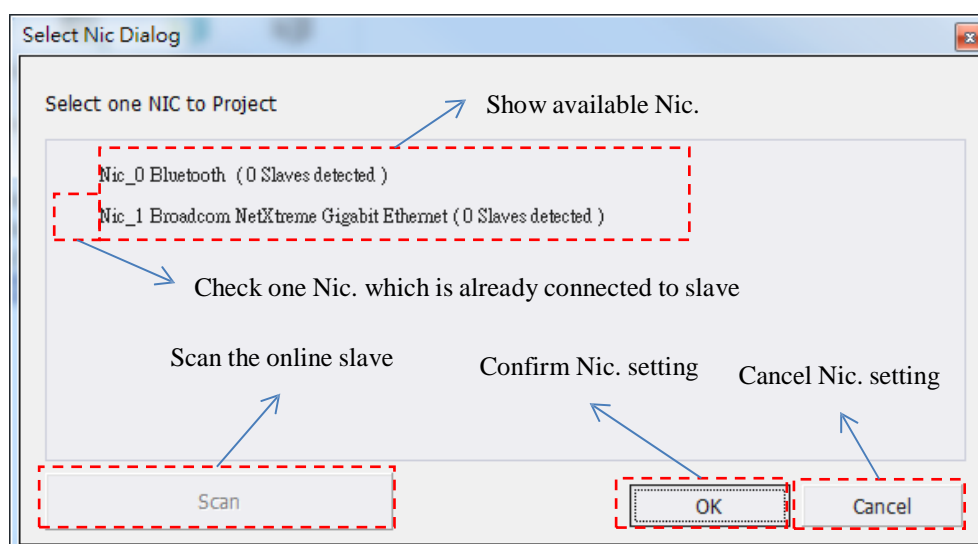


Figure Select Nic Dialog window

Upon completion of setting, double left click on the "Master" node of Project Explorer to open the "Master" window, resulting in the acquisition of relevant information about "Master" on the first tab "Info page," including network card information currently set.

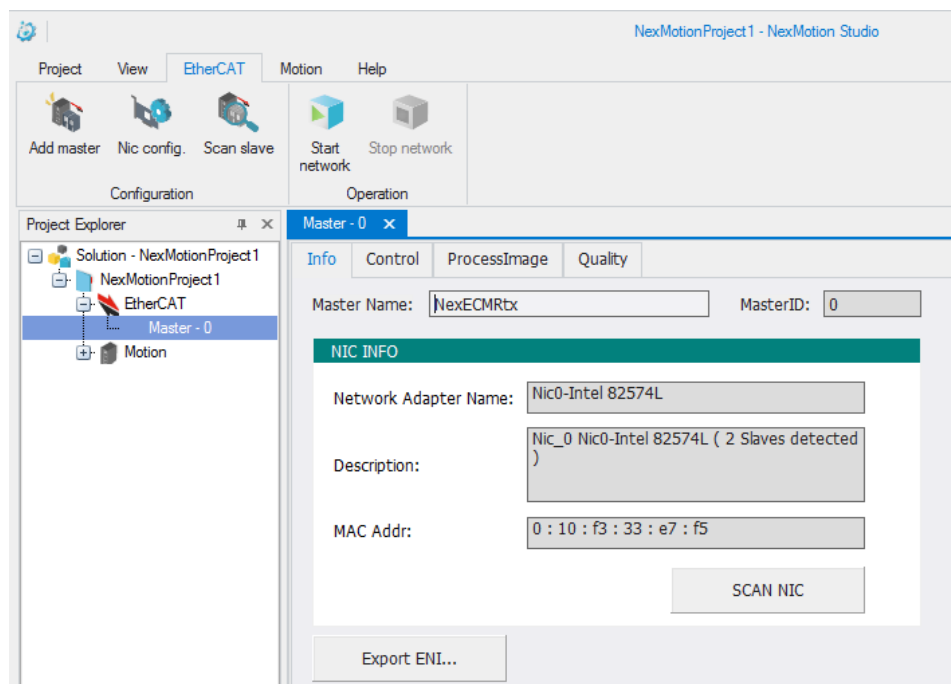


Figure Master Info window

3.2.3. Scan Slave

This section explains how to use NexMotion Studio for scanning to obtain the current number and type of online Slaves. Prior to scanning, please refer to sections 3.2.1 and 3.2.2 about adding Master and network interface card configuration.

NexMotion Studio provides three types of online Slave scanning methods, which are detailed below:

(A) Main menu: Select **Scan slave** from the EtherCAT group items on the main menu, as shown in the figure below:

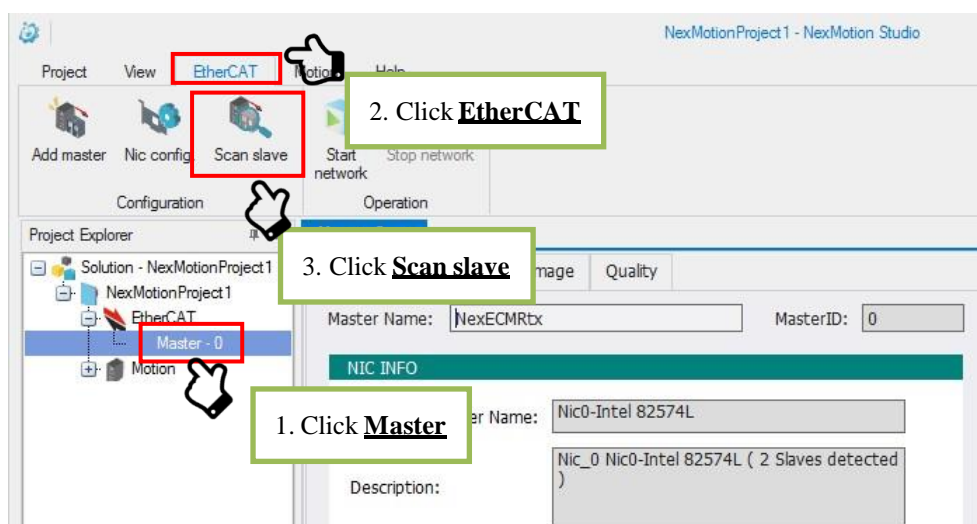


Figure Scan the online Slave—Main menu

(B) Popup Menu: Right click on the Master node of Project Explorer EtherCAT before choosing **Scan slave**, as displayed in the following figure:

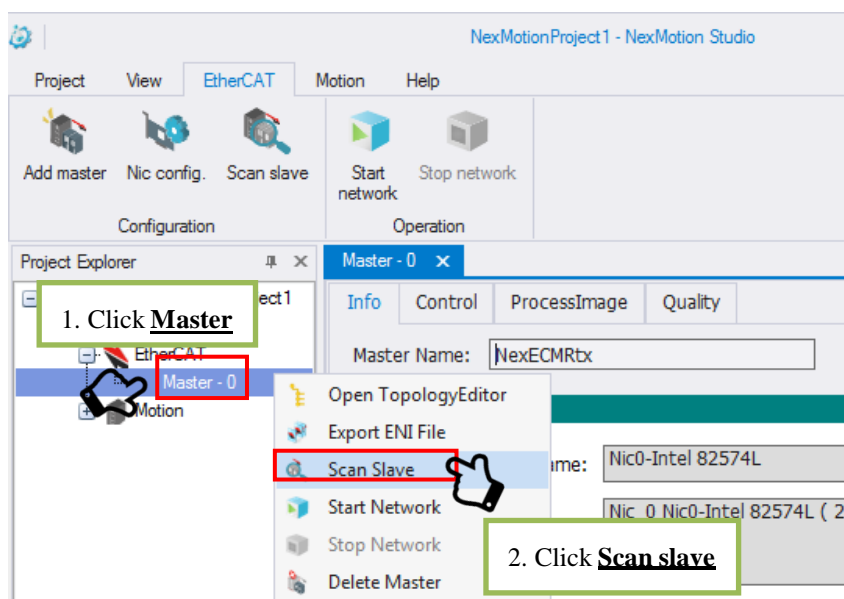


Figure Scan the online Slave—Popup menu

(C) Click Scan Nic: Double left click on the Master node of Project Explorer EtherCAT and press the SCAN NIC button on the Info window.

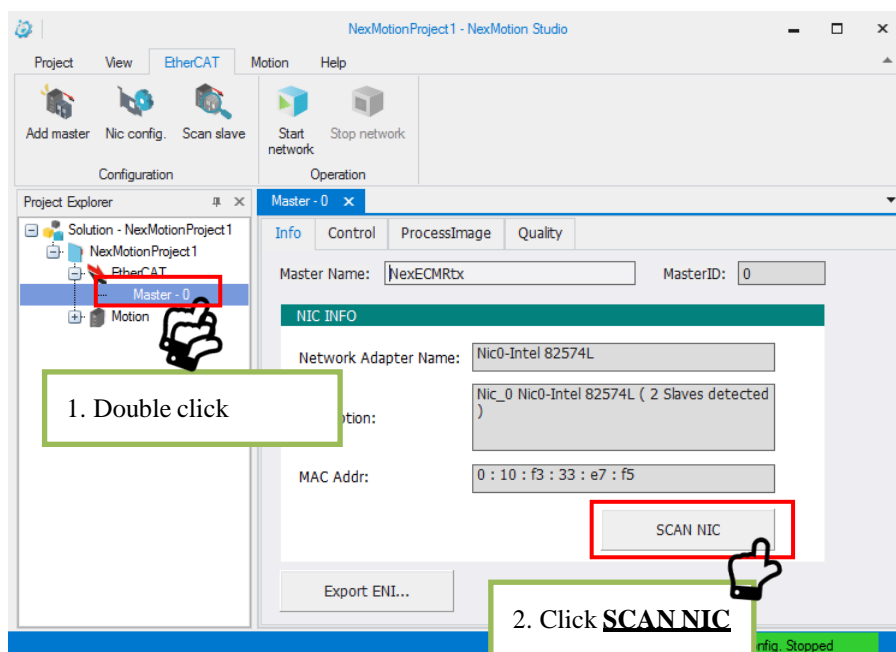


Figure Scan the online Slave—Click SCAN NIC

After scanning the slave using the above three methods, the Project Explorer will update and place the scan result under the EtherCAT Master node, which is termed the slave node, as shown in the figure below:

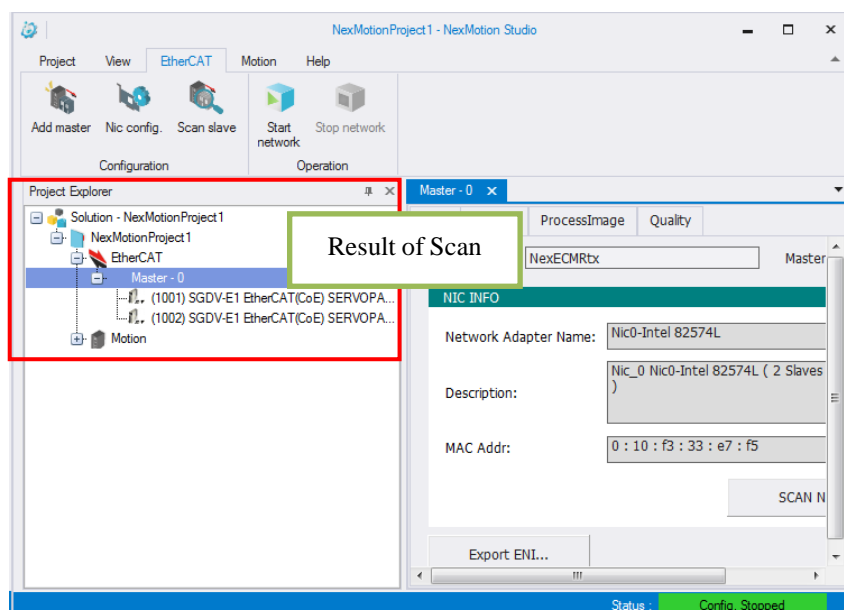


Figure Update and place the scan result under the EtherCAT Master node

FAQs:

Please confirm the following three points if a wrong window appears after selecting Scan slave:

- (1) Master mode: Please confirm whether the computer platform is installed with the software in line with NexMotion Studio Master mode. For example, if the NexMotion Studio Master mode is NexECMRtx, the platform must be equipped with RTX, as shown below:

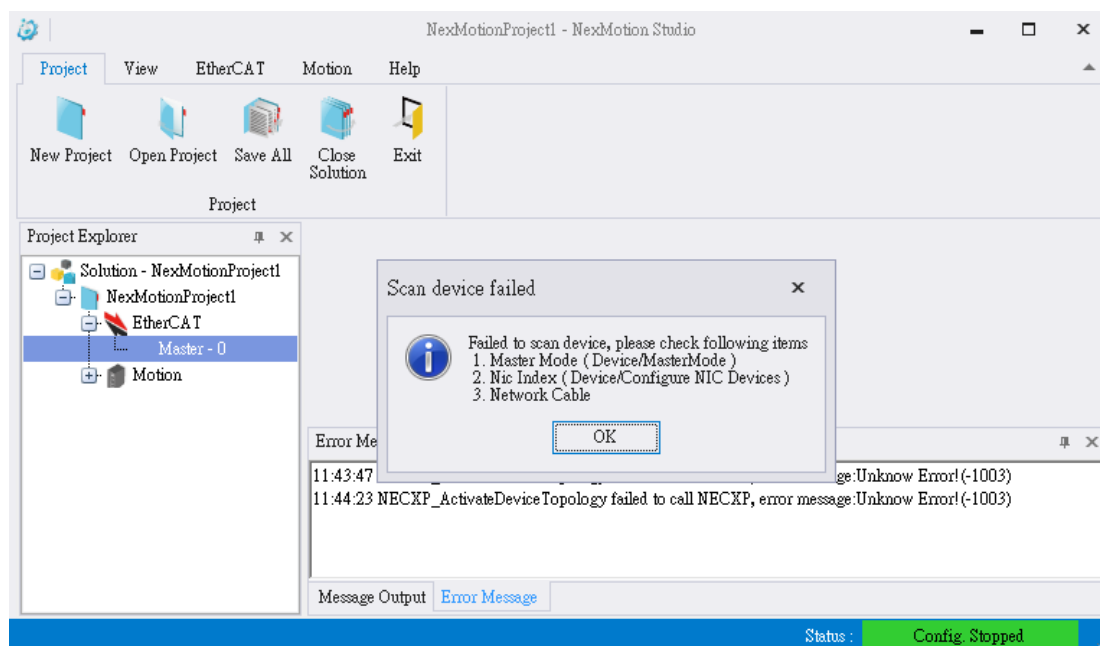


Figure Slave scanning error



- (2) Nic Index: Is a network interface card configured for Master before scanning?
- (3) Network Cable: Please confirm whether the network interface card selected by Master is connected to slave.

3.2.4. Start EtherCAT network

This section explains how NexMotion Studio can start the EtherCAT network. Before activating the EtherCAT network, please confirm that the online Slave module and quantity have been obtained by scanning. Please refer to Section 3.2.3.

After starting the EtherCAT network, Master begins to sends/receives EtherCAT packets to/from all online Slaves on a regular basis to control Slave and obtain information on Slave.

NexMotion Studio comes with several ways to start the EtherCAT network, as detailed below:

- (1) Main menu: Select **Start Network** from the EtherCAT group items on the main menu, as shown in the figure below:

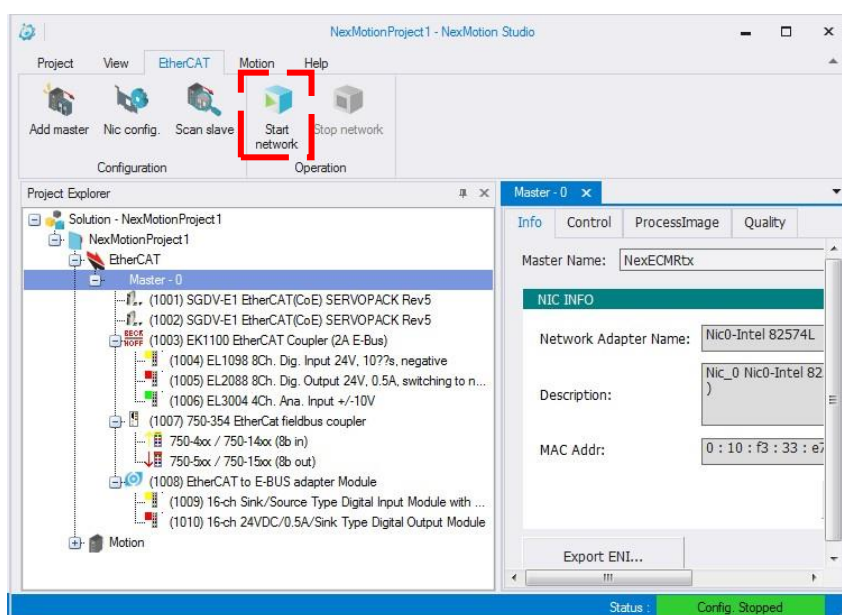


Figure Start EtherCAT network—Main menu

- (2) Popup menu: Right click on the Master node of Project Explorer EtherCAT before selecting **Start Network**, as shown in the figure below:

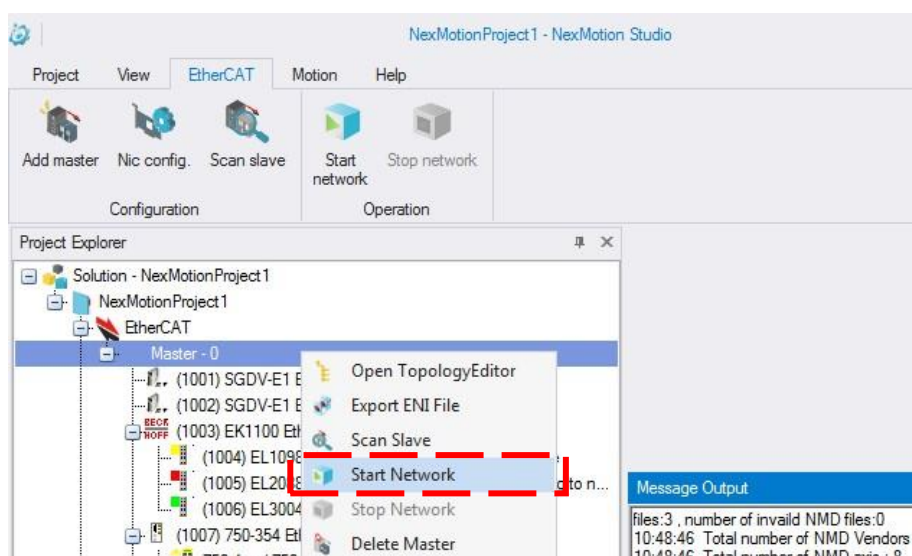


Figure Start EtherCAT network—Popup menu

Following the activation of the EtherCAT network, when the lower right corner of NexMotion Studio is changed to "Config. OP," it means that the network has been successfully established. At this time, the online Slave can be controlled through various operation interfaces. Please refer to the sections on EtherCAT operation for each operation interface, as exhibited in the following figure:

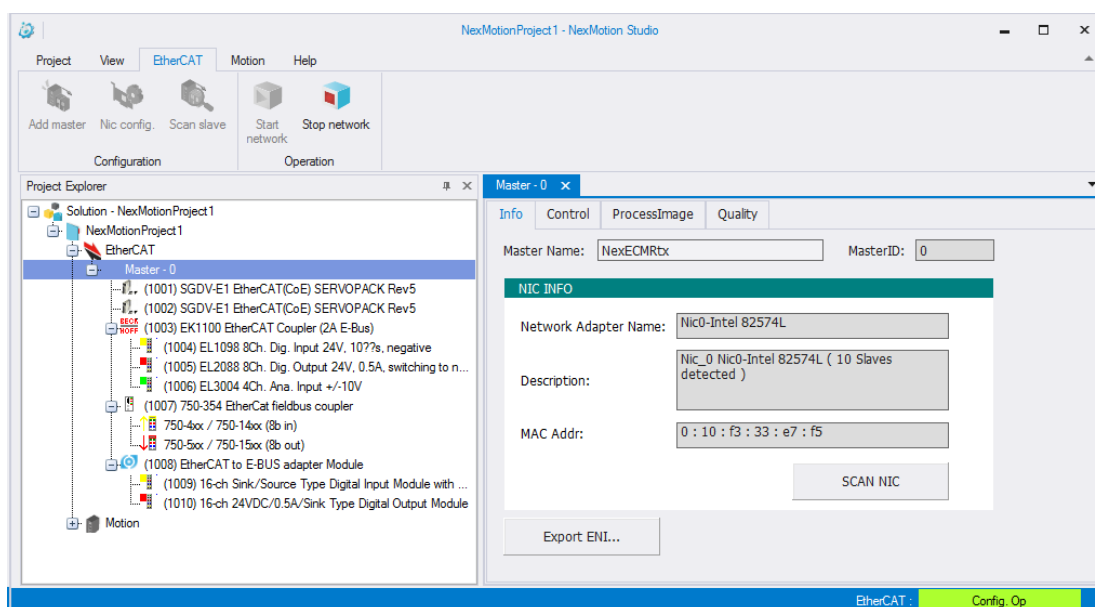


Figure Successful establishment of the EtherCAT network

3.2.5. Stop EtherCAT network

This section explains how NexMotion Studio stops the EtherCAT network, and when the EtherCAT network is ceased, Master suspends the periodic delivery/receipt of EtherCAT packets.

NexMotion Studio comes with several ways to stop the EtherCAT network, as detailed below:

- (1) Main menu: Select **Stop Network** from the EtherCAT group items on the main menu, as shown in the figure below:

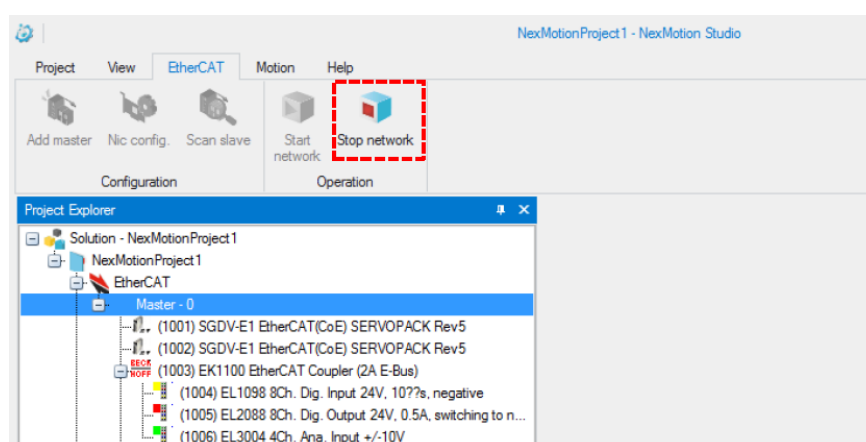


Figure Stop EtherCAT network—Main menu

- (2) Popup Menu: Right click on the Master node of Project Explorer EtherCAT before selecting **Stop Network**, as shown in the figure below:

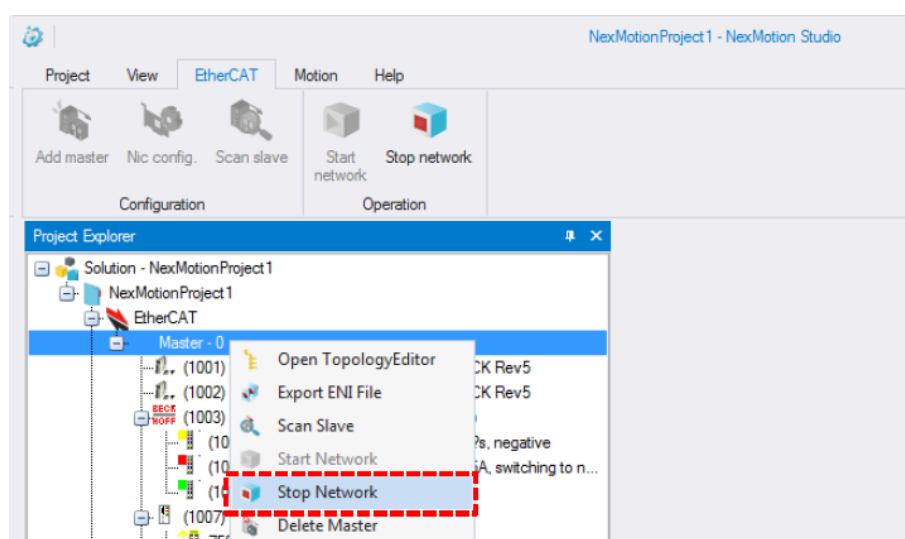


Figure Stop EtherCAT network—Popup menu

Following the stopping of the EtherCAT network, when the lower right corner of NexMotion Studio is changed to "Config. Running," it means that the network has been successfully ceased, as shown in the following figure:

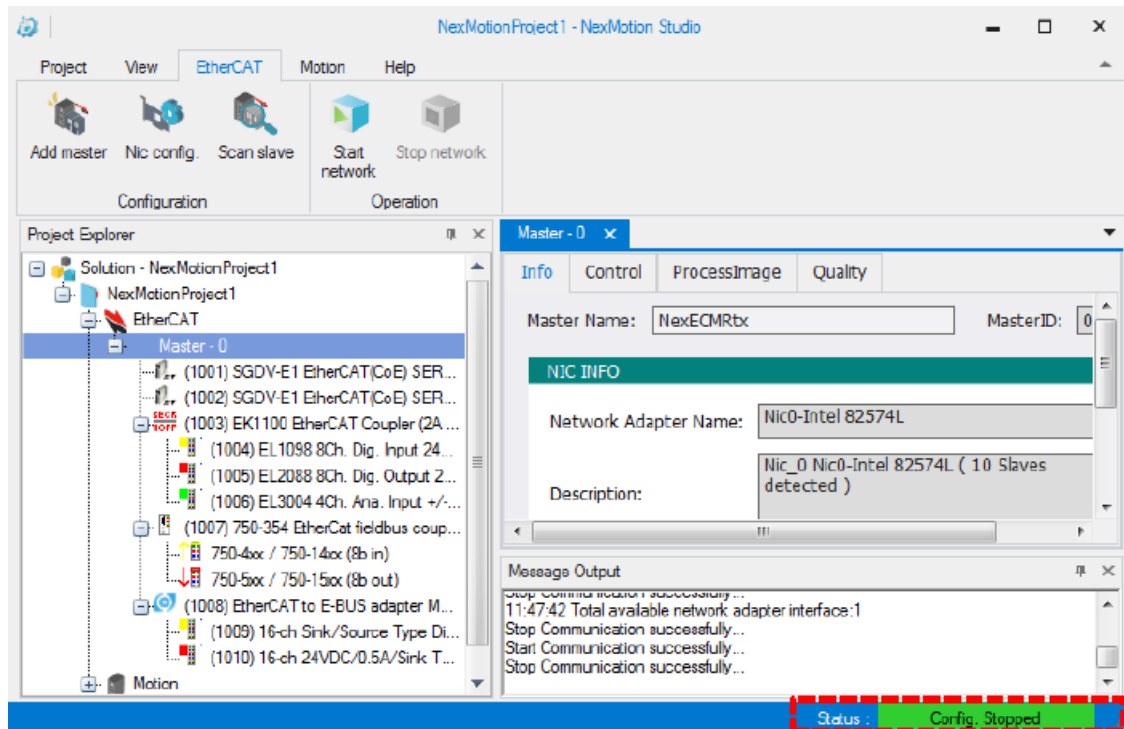


Figure EtherCAT network stopping

3.3. EtherCAT advanced setting

3.3.1. Offline editing of EtherCAT network topology

NexMotion Studio provides offline editing of network topology, which enables users to edit topology offline without actual connection to Slave. By manually editing network topology, you can further edit the Slave's ProcessData and export the EtherCAT Network Information (ENI) file to Master based on the application situation. In this way, it is convenient for the user to execute the environment without having to install the components required by NexMotion Studio.

For offline editing of network topology to exporting ENI steps, please refer to the following flowchart:

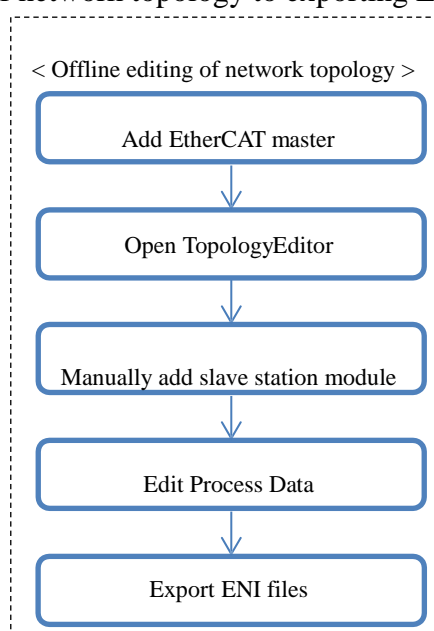


Figure Offline editing of network topology flowchart

Please refer to Section 3.2.1 for adding EtherCAT Master. As to editing Slave Process Data and exporting ENI files, please refer to sections 3.3.2 and 3.3.4.

Please refer to the following instructions for offline editing:

First, open Topology Editor View: Right click on the EtherCAT Master node of Project Explorer and click **Open TopologyEditor**.

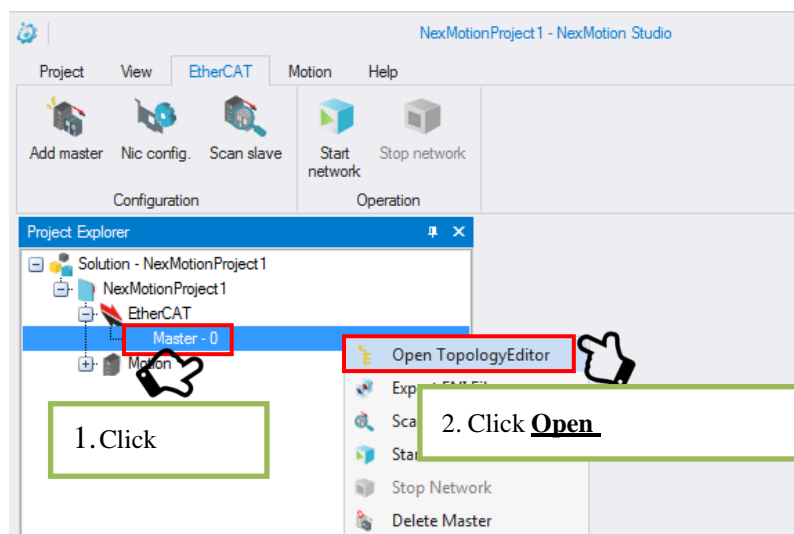


Figure Open Topology Editor View

Open TopologyEditor, as presented below:

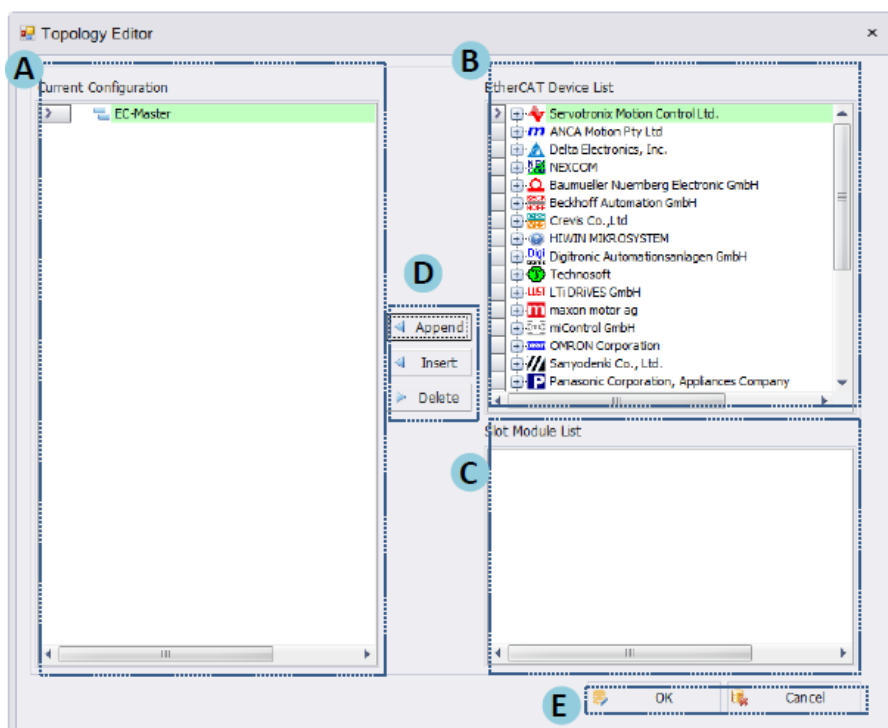


Figure TopologyEditor

Topology Editor is divided into five parts, as detailed in the following table:

(A)	Current Configuration	(1) Showing the slave under Master (2) Showing Topology Editor editing results	
(B)	EtherCAT Device List	Showing all the slaves in the ESI folder	
(C)	Slot Module List	Displaying all slots in the ESI folder. This List will dynamically switch supported EtherCAT Slot or Non EtherCAT Slot Module list based on selected Device type	
(D)	Append/ Insert/ Delete	Append	Append EtherCAT Device/ Slot Module to Current Configuration window
		Insert	Insert EtherCAT Device/ Slot Module into Current Configuration window
		Delete	Remove the device selected in Current Configuration
(E)	OK/ Cancel	OK	Upon finishing editing by Topology Editor, update the edit result to Project Explorer's EtherCAT Master and close Topology Editor window
		Cancel	Discard the edit result of Current Configuration and close Topology Editor window

The following details how to append EtherCAT Device, EtherCAT Slot Module, and Non EtherCAT Slot Module to Current Configuration

(A) Append EtherCAT Device to Current Configuration

Users can add EtherCAT Device via Append and Insert, as described below:

- Click **Append button** – Add EtherCAT Device to the bottom of Current Configuration
- Click **Insert button** – Insert EtherCAT Device above Device that is being clicked on in Current Configuration.

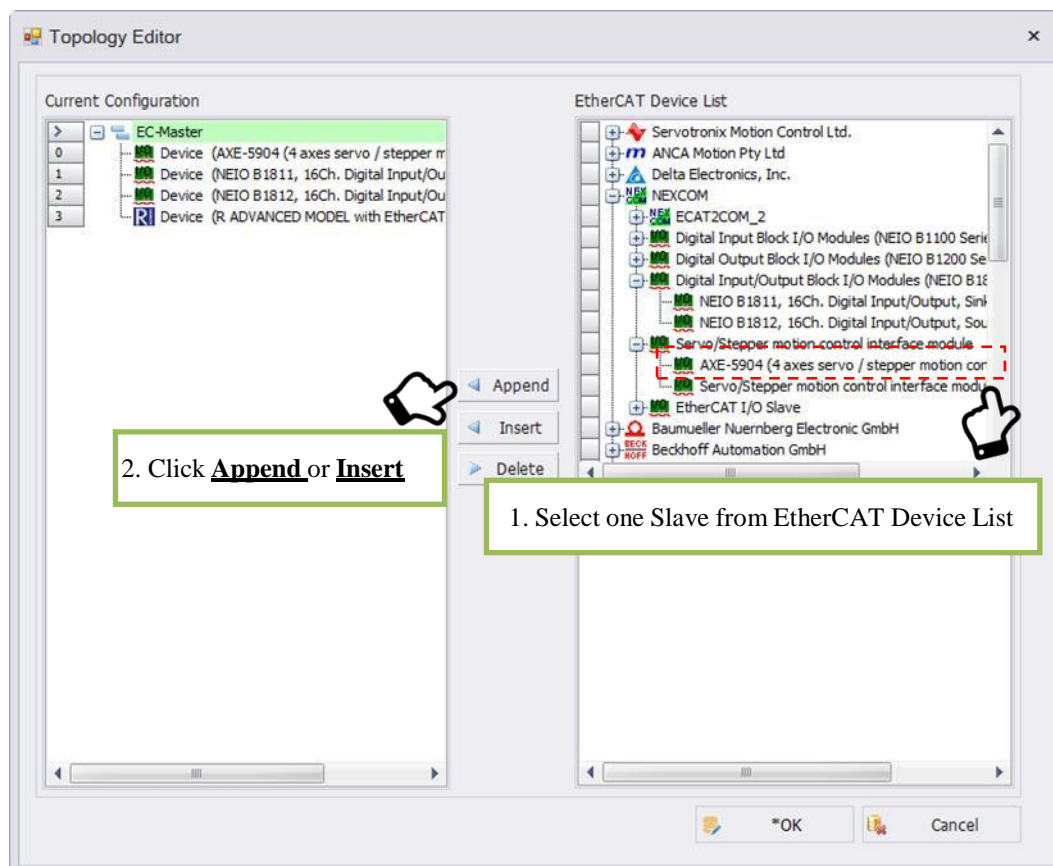


Figure Append EtherCAT Device to Current Configuration

(B) Append EtherCAT Slot Module to Current Configuration:

Take, for instance, Beckhoff EK1100 Coupler Device, append an EtherCAT Slot to Current Configuration, with steps as follows:

Step 1: Add EK1100 to Current Configuration from the EtherCAT Device List, as shown in the figure below:

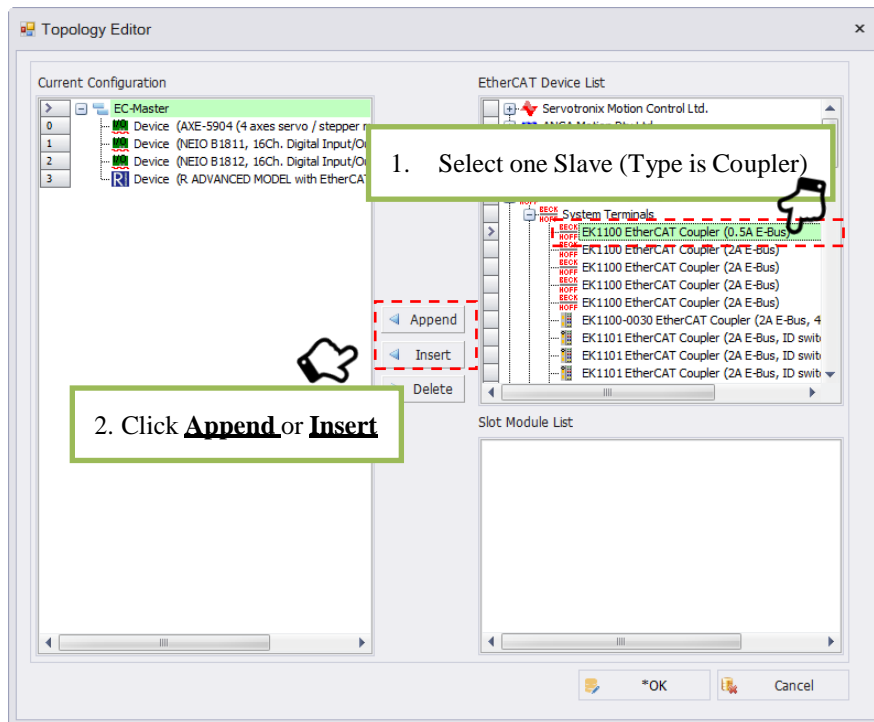


Figure Append EK1100 Coupler Device to Current Configuration

Step 2: After EK1100 is added to Current Configuration, click EK1100 on the Current Configuration window, and the Slot Module List window will immediately display the EtherCAT Slot Module in all ESI folders. Press the Append button to add the selected Slot Module to the bottom of Coupler, as shown in the figure below:

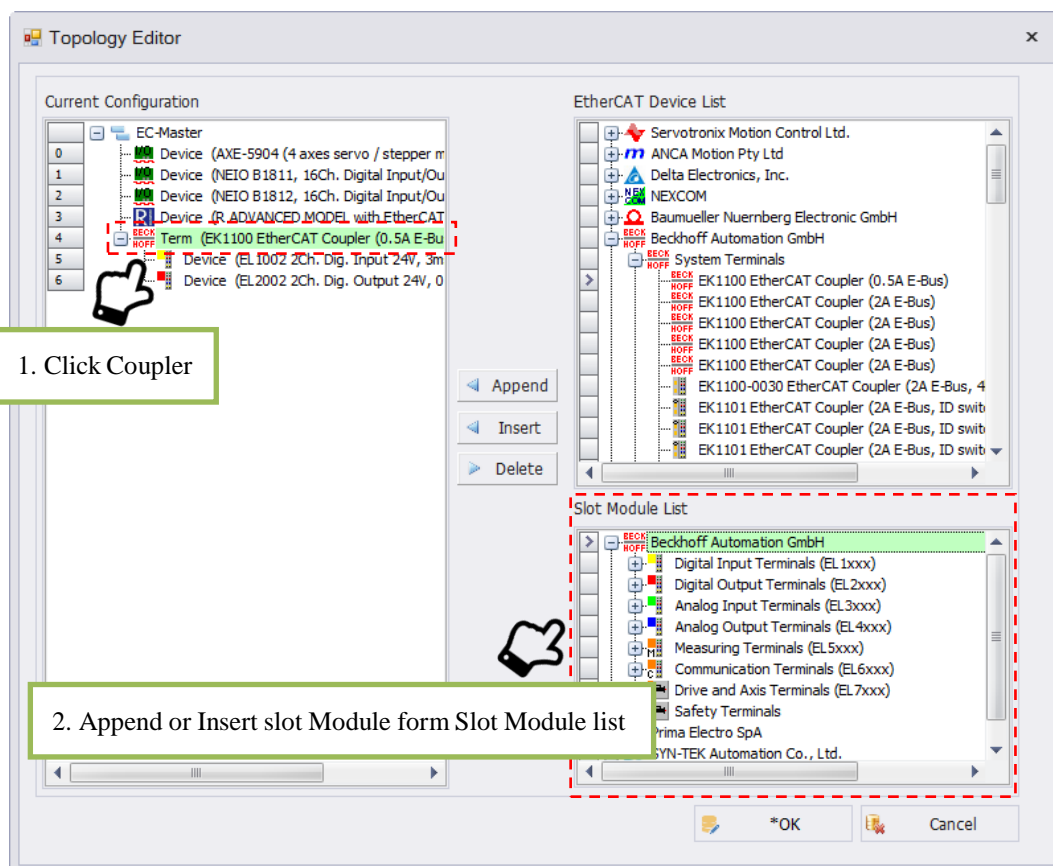


Figure Append Slot Module to Coupler Device

(C) Append Non EtherCAT Slot Module to Current Configuration:

Take WAGO 750-734 for instance, append a Non EtherCAT Slot to Current Configuration, with steps as follows:

Step 1: Add WAGO Coupler Device to Current Configuration from EtherCAT Device List, as presented in the figure below:

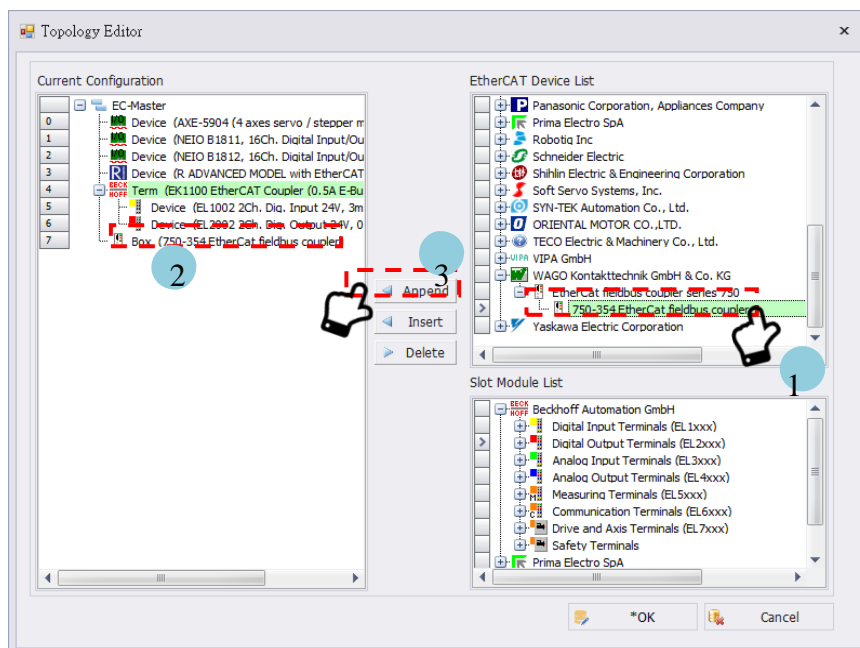


Figure Append WAGO Coupler Device to Current Configuration

Step 2: After WAGO Coupler Device is added to Current Configuration, click WAGO on the Current Configuration window, and the Slot Module List window will immediately display the EtherCAT Slot Module list supported by WAGO. Press the Append button to add the selected Slot Module to the bottom of Coupler, as shown in the figure below:

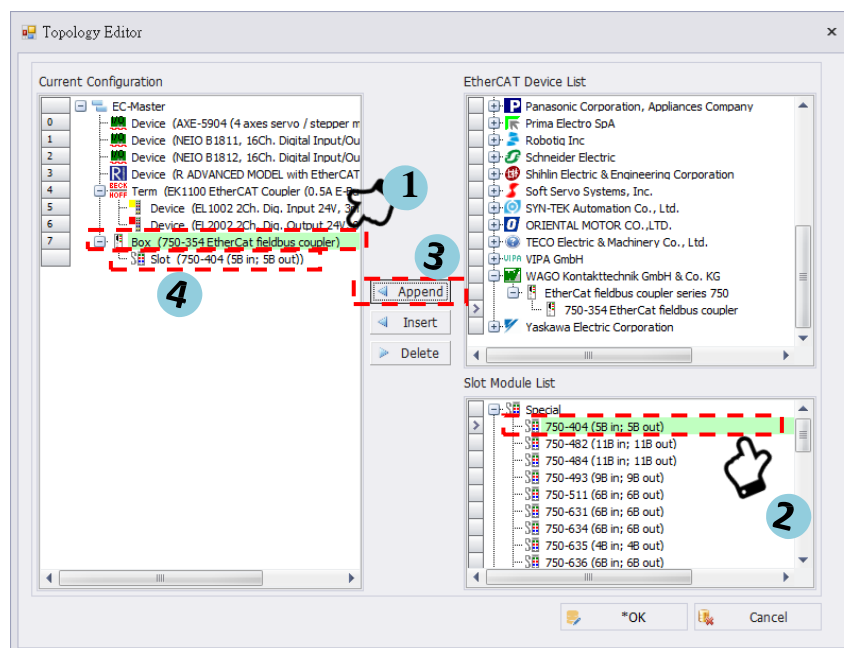


Figure Append Non EtherCAT Slot Module to Current Configuration

After finishing editing, if you want to update and place the edit result to EtherCAT Master, press the **OK** button, and if you want to abandon the edit result, please click the **Cancel** button.

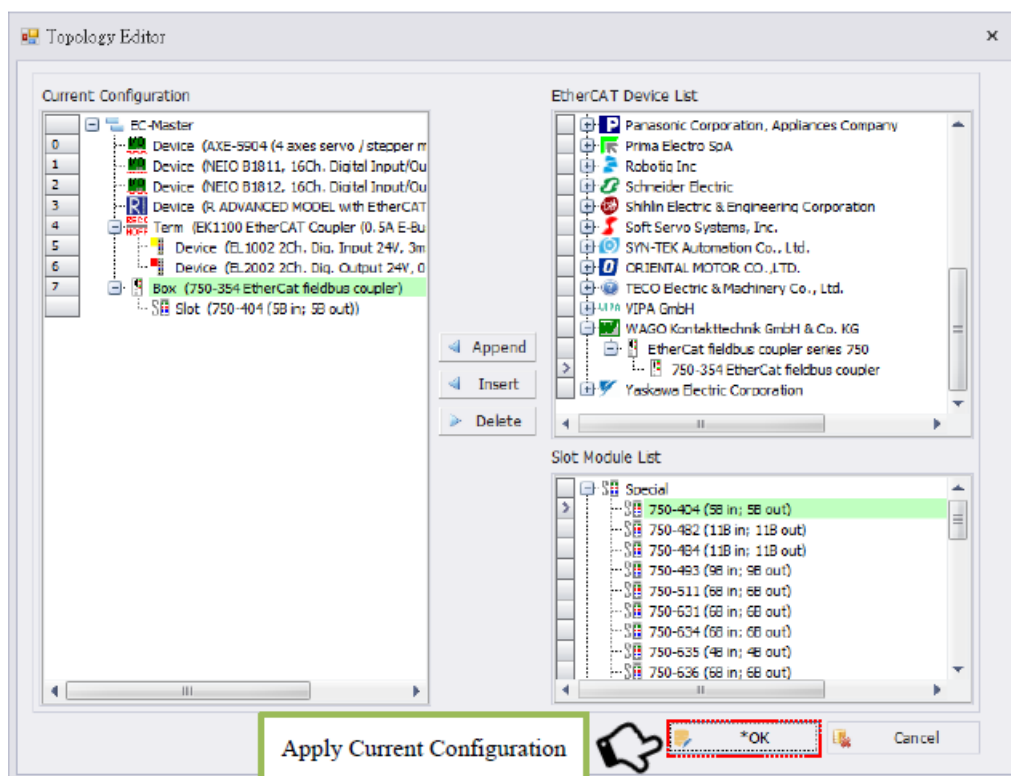


Figure Update/cancel edit results

After the OK button is pressed, NexMotion Studio will pop up, asking if the user want to save the current edit result. If yes, click **OK**, otherwise **Cancel**. Please note that the current edit result will be removed for clicking **Cancel**.

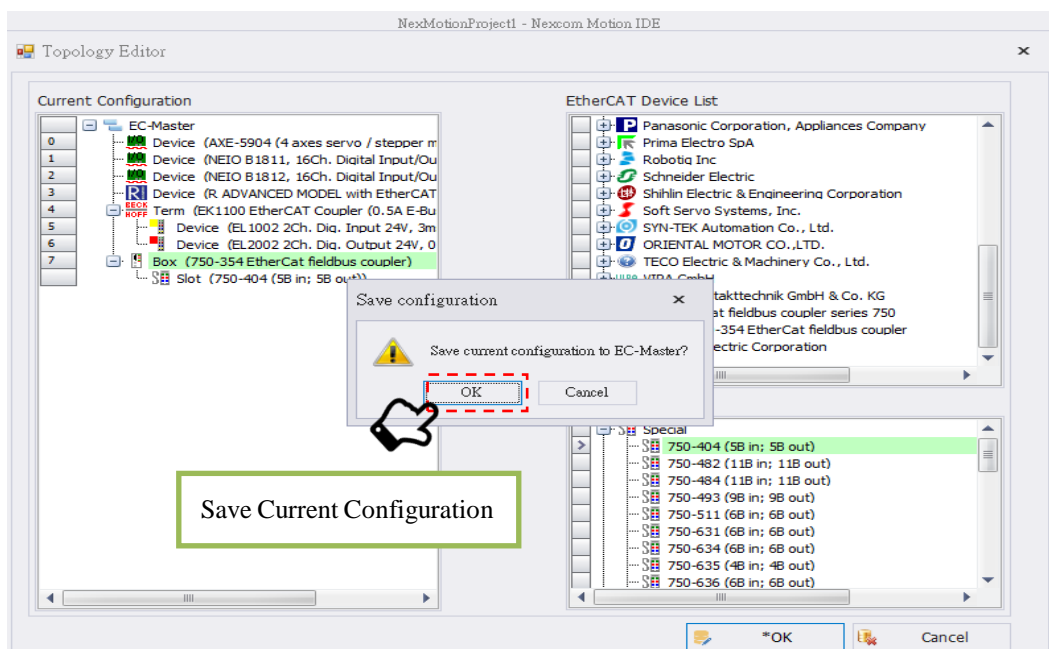


Figure Save updated edit results to Master

Press **OK** on the "Save configuration" window to save the current edit results and NexMotion Studio will update the saved edit results of users to Slave nodes under Project Explorer EtherCAT Master, as shown below:

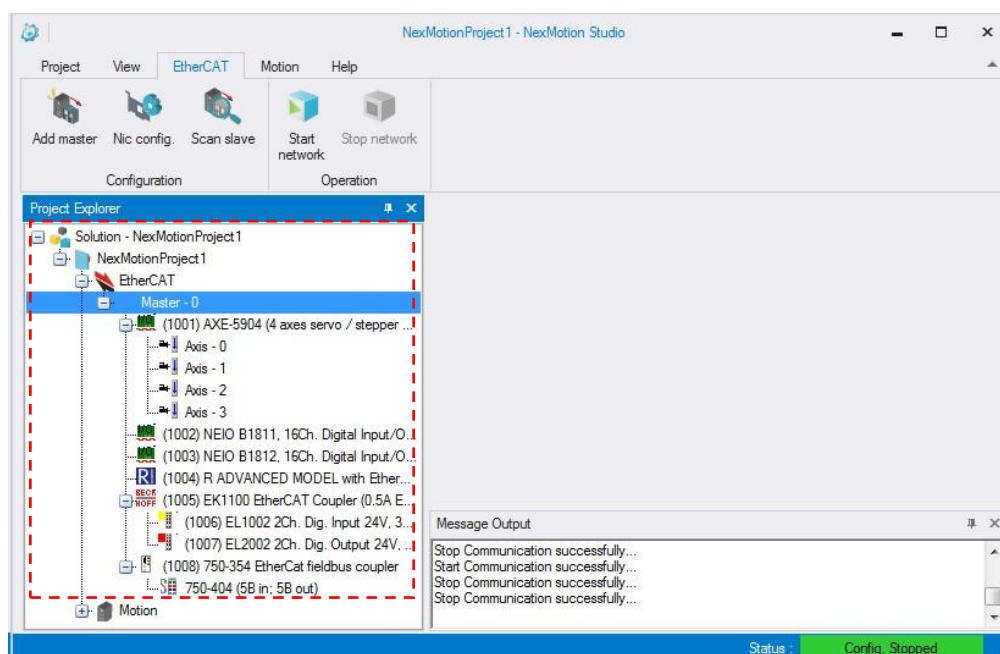


Figure Offline network topology updated to Project Explorer



3.3.2. Slave PDO editing

This section explains how to edit Slave PDO in NexMotion Studio, allowing the user to adjust the objects that need to be mapped to ProcessData based on the application context. Objects that are mapped to ProcessData are periodically updated with the Master cycle time.

NexMotion Studio provides an "Ec-Slave Configuration" interface, allowing the user to edit PDO mapping. The user can double left click on Slave to show the operating interface of the module and click the **Configuration** button on the "DevInfo" page to call out the "Ec-Slave Configuration" window, as shown below:

Users can observe/edit PDO information and settings on the Ec-Slave Configuration interface. For information about PDO, please refer to the Slave manual that supports the CoE protocol.

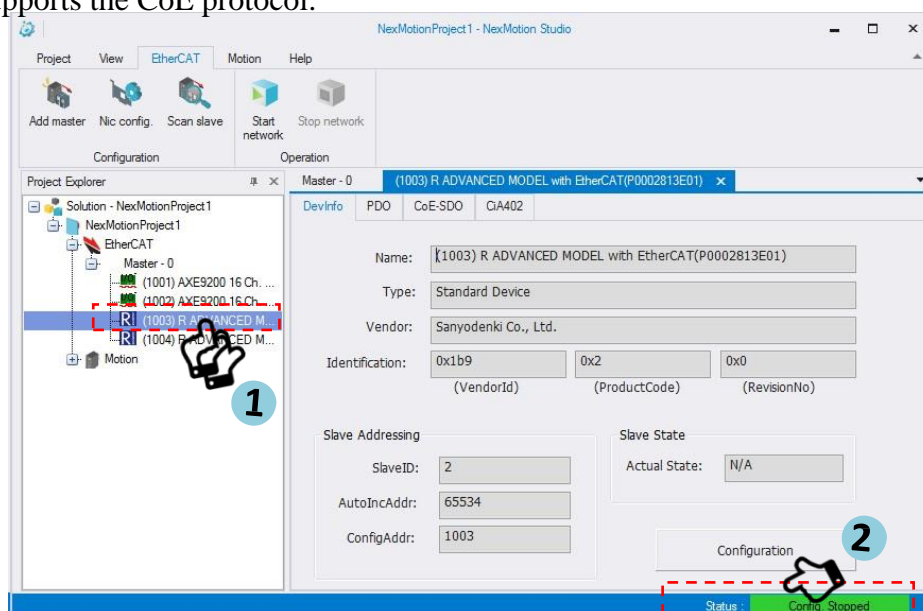


Figure Double click Slave to show the Slave interface

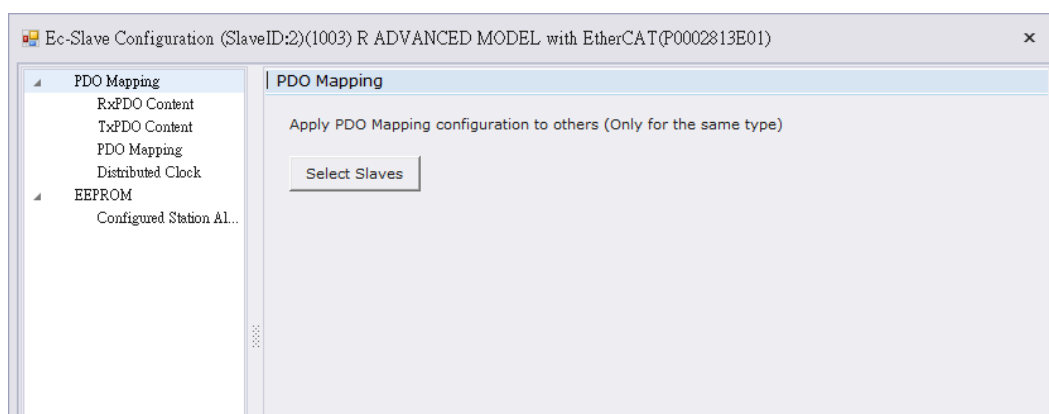


Figure Ec-Slave Configuration

The user can complete the following tasks on the "Ec-Slave Configuration" window:

1. Check RxPDO and TxPDO lists
2. Edit RxPDO and TxPDO mapping objects
3. Check SyncManager used by RxPDO and TxPDO
4. Set up the RxPDO and TxPDO lists
5. Check all RxPDO and TxPDO mapping object lists
6. Apply the RxPDO and TxPDO settings to other same types of Ec-Slave
7. Check and set DC-related parameters

The tasks are detailed as follows:

■ Check the RxPDO and TxPDO lists

Click "RxPDO Content" or "TxPDO Content," with the right window displaying the PDO list and PDO mapping objects, as shown below:

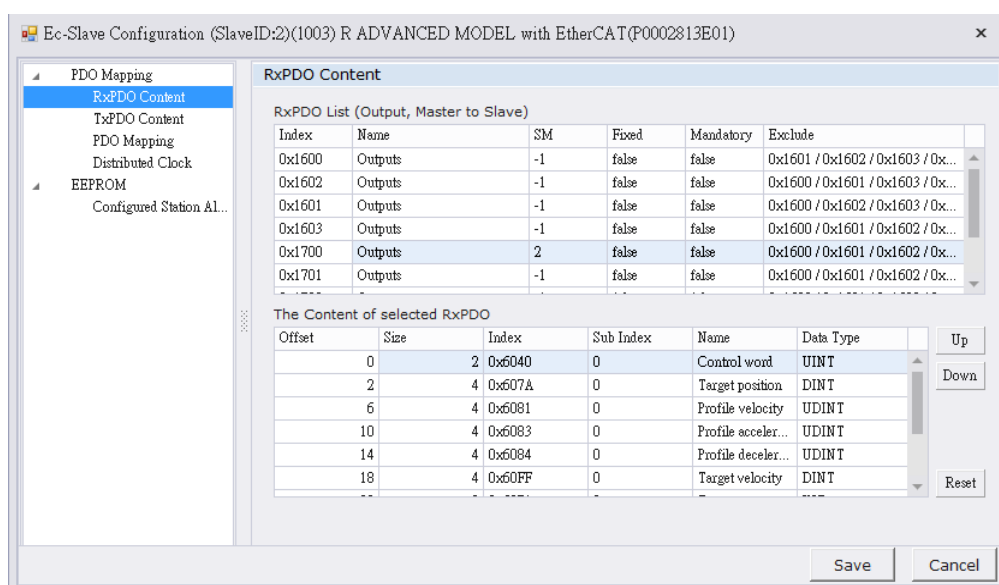


Figure PDO List and PDO inward mapping objects

The user can read the list of PDO in the upper half of the window on the right side, as shown below:

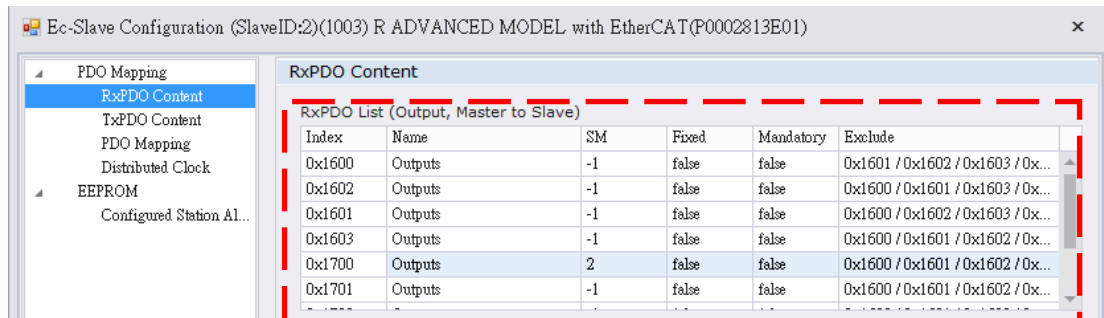


Figure PDO List

The field description is listed as follows:

Table PDO field description

Field	Description
Index	PDO Index information will be written to 0x1C12 or 0x1C13.
Name	PDO name information
SM	Sync Manager-1 used by PDO means that the group PDO is not used.
Fixed	Whether inward mapping in PDO can be modified False: Not allowed True: Allowed
Mandatory	Whether PDO is mandatory False: Not mandatory True: Mandatory
Exclude	Other groups of PDO lists mutually exclusive in PDO

■ Edit PDO mapping objects

When the user clicks on the item in the PDO list, the table below shows the CoE object mapping list set by PDO. The mapped CoE object will be arranged in ProcessImage and updated periodically according to the EtherCAT specification, as shown in the figure below:

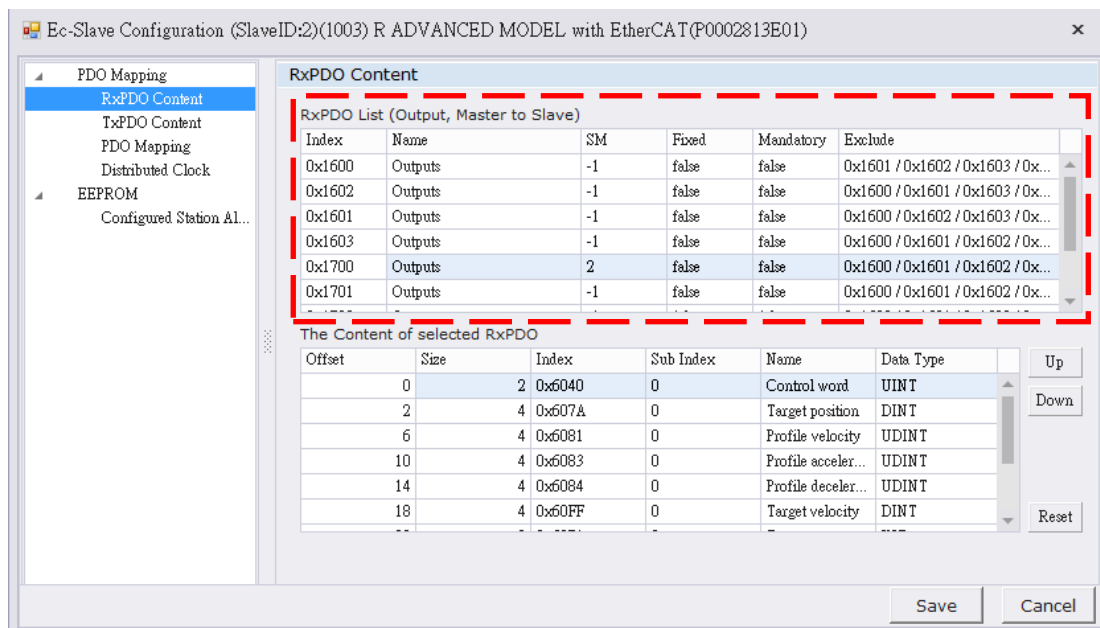


Figure PDO mapping object table

The field description is listed as follows:

Table Mapping object field description

Field	Description
Offset	The Offset position of the object in Slave, with the unit being Byte
Size	Object data length, with the unit being Byte
Index	Object Index information, which will be written to PDO
Sub Index	Object Sub Index information, which will be written to PDO
Name	Object name
DataType	Object data type

When the PDO Fixed attribute is not of true, the user can append, insert, or delete objects by right clicking on the mapping object list to show Popup Menu, or can arrange the order of items using the Up and Down buttons in the lower right corner of the window, or click the Reset button to restore ESI default content, as shown below:

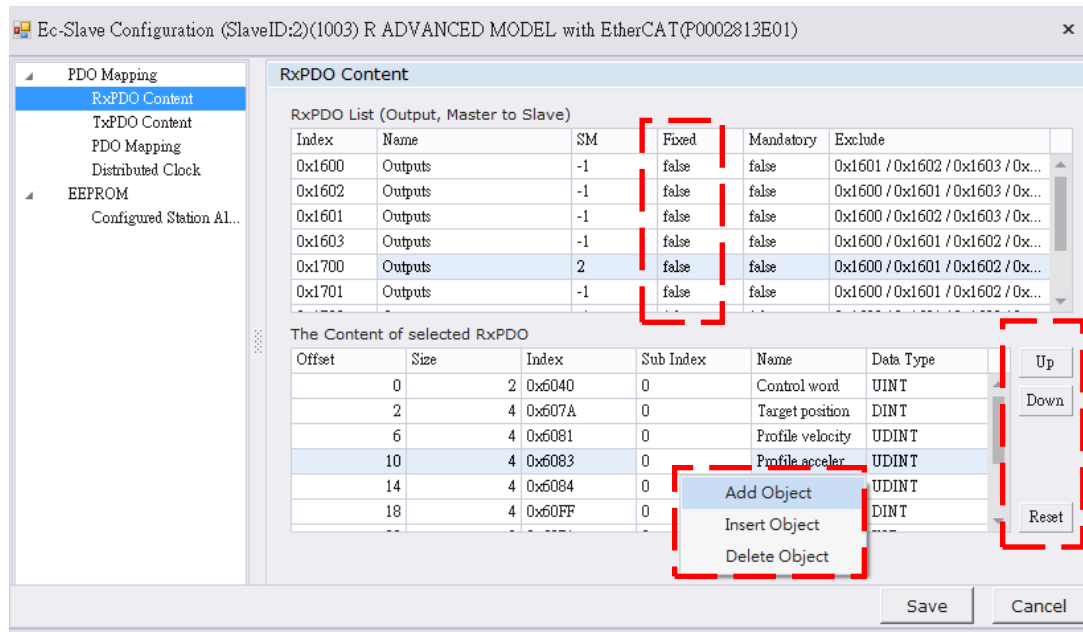


Figure Edit PDO inward mapping object table

■ Check SyncManager used by RxPDO and TxPDO

Click on PDO Mapping, with the top left corner of the window on the right side displaying all Sync Manager information, as well as Sync Manager used by PDO, as demonstrated below:

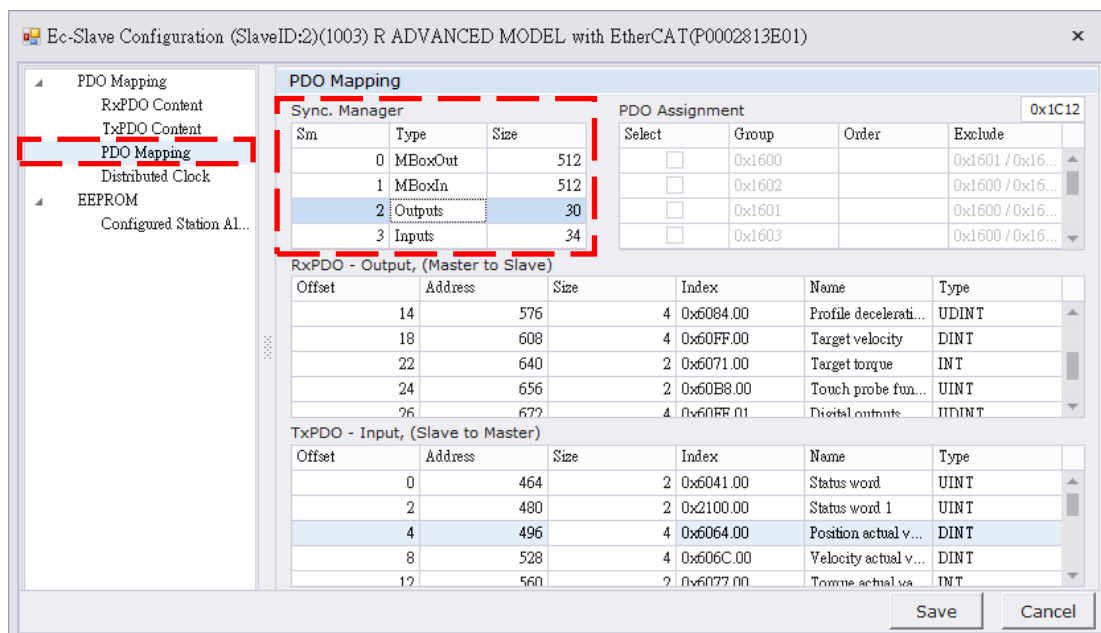


Figure Sync Manager setting

- Set up the RxPDO and TxPDO lists
- Check all RxPDO and TxPDO mapping object lists

Select the PDO you want to use by clicking on the Select field in the PDO Assignment table, as shown in the figure below:

Ec-Slave Configuration (SlaveID:2)(1003) R ADVANCED MODEL with EtherCAT(P0002813E01)

PDO Mapping

Sync. Manager

Sm	Type	Size
0	MBoxOut	512
1	MBoxIn	512
2	Outputs	30
3	Inputs	34

PDO Assignment

Select	Group	Order	Exclude
<input type="checkbox"/>	0x1600		0x1601 / 0x16...
<input type="checkbox"/>	0x1602		0x1600 / 0x16...
<input type="checkbox"/>	0x1601		0x1600 / 0x16...
<input type="checkbox"/>	0x1603		0x1600 / 0x16...

RxPDO - Output, (Master to Slave)

Offset	Address	Size	Index	Name	Type
14		576	4	0x6084.00	Profile decelerati...
18		608	4	0x60FF.00	Target velocity
22		640	2	0x6071.00	Target torque
24		656	2	0x60B8.00	Touch probe fun...
26		672	4	0x60FF.01	Digital outputs

TxPDO - Input, (Slave to Master)

Offset	Address	Size	Index	Name	Type
0		464	2	0x6041.00	Status word
2		480	2	0x2100.00	Status word 1
4		496	4	0x6064.00	Position actual v...
8		528	4	0x606C.00	Velocity actual v...
12		560	2	0x6077.00	Torque actual va...

Save Cancel

Figure Select PDO

When the Select field in PDO Assignment has a change, the object mapping form below will be updated based on the current settings.

Ec-Slave Configuration (SlaveID:2)(1003) R ADVANCED MODEL with EtherCAT(P0002813E01)

PDO Mapping

Sync. Manager

Sm	Type	Size
0	MBoxOut	512
1	MBoxIn	512
2	Outputs	30
3	Inputs	34

PDO Assignment

Select	Group	Order	Exclude
<input type="checkbox"/>	0x1600		0x1601 / 0x16...
<input type="checkbox"/>	0x1602		0x1600 / 0x16...
<input type="checkbox"/>	0x1601		0x1600 / 0x16...
<input type="checkbox"/>	0x1603		0x1600 / 0x16...

RxPDO - Output, (Master to Slave)

Offset	Address	Size	Index	Name	Type
14		576	4	0x6084.00	Profile decelerati...
18		608	4	0x60FF.00	Target velocity
22		640	2	0x6071.00	Target torque
24		656	2	0x60B8.00	Touch probe fun...
26		672	4	0x60FF.01	Digital outputs

TxPDO - Input, (Slave to Master)

Offset	Address	Size	Index	Name	Type
0		464	2	0x6041.00	Status word
2		480	2	0x2100.00	Status word 1
4		496	4	0x6064.00	Position actual v...
8		528	4	0x606C.00	Velocity actual v...
12		560	2	0x6077.00	Torque actual va...

Save Cancel

Figure PDO mapping object list

- Apply the RxPDO and TxPDO settings to other same types of Ec-Slave

Click on the PDO Mapping node on the left side of the Ec-Slave Configuration window, with the right-side portion showing application settings; users can apply the current settings to other identical modules by checking, as shown in the following figure:

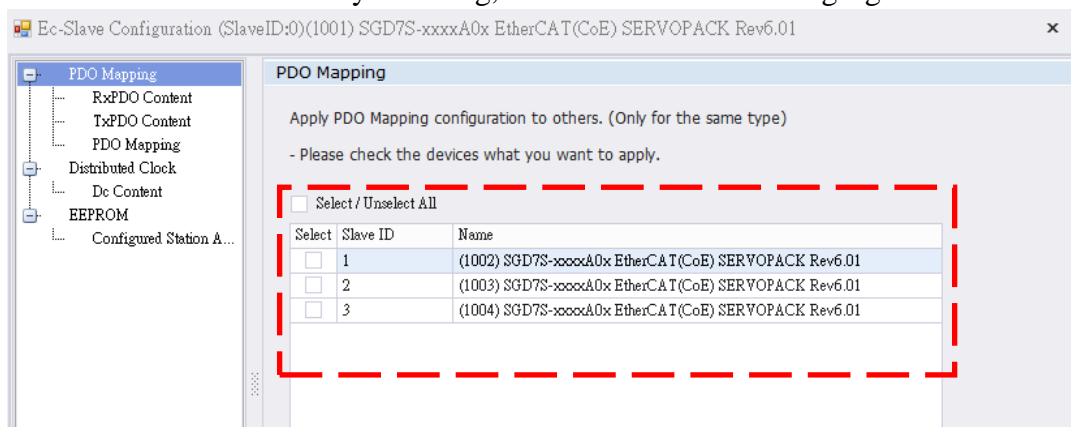


Figure Apply current settings

3.3.3. Slave DC editing

This section explains how to set DC (Distributed Clock) parameters in NexMotion Studio, allowing the user to adjust the DC mode or parameter based on the application context.

As in Section 3.3.2 Slave PDO editing, NexMotion Studio provides an "Ec-Slave Configuration" interface, allowing the user to set DC parameters. The user can double left click on Slave to show the operating interface of the module and click the **Configuration** button on the "DevInfo" page to call out the "Ec-Slave Configuration" window, as shown below:

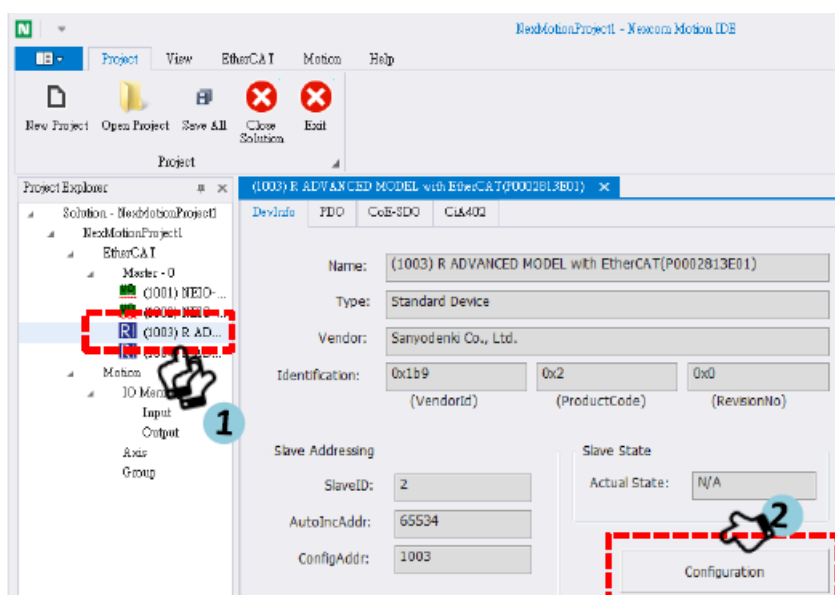


Figure Double click Slave to show the Slave interface

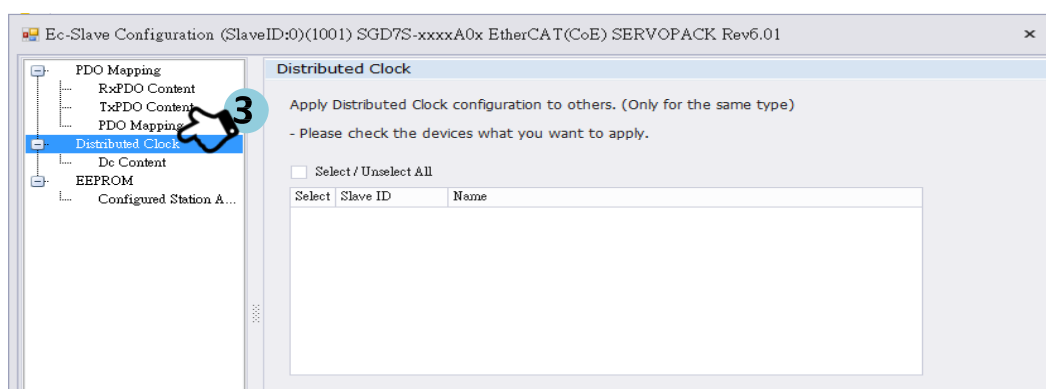


Figure Ec-Slave Configuration

Users can observe/reset DC parameters on the Ec-Slave Configuration interface. For information about DC, please refer to the Slave manual. NexMotion Studio will set DC as preset parameters according to ESI content. If the connected Slave module does not support DC parameter settings, there is no "Distributed Clock" option available on the "Ec-Slave Configuration" window.

The user may complete the following tasks on the "Distributed Clock" and "Dc Content" feature pages:

1. Apply DC parameters to other Slave modules
2. Check and set DC-related parameters

The tasks are detailed as follows:

■ Apply DC parameters to other Slave modules

Click on the Distributed Clock option on the left side of the Ec-Slave Configuration window, with the right-side portion showing application settings; users can apply the current DC settings to other identical modules by checking, as shown in the following figure:

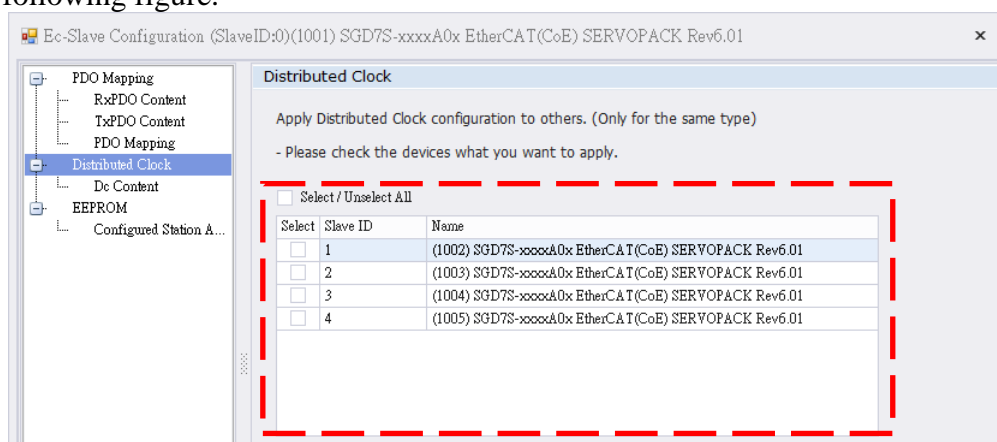


Figure Apply current settings

■ Check and set DC-related parameters

Select the Dc Content option on the left side of the Ec-Slave Configuration window with Dc settings shown on the right. The user can adjust the DC setting from the upper half of the list (the default value is obtained by the Slave module ESI), or directly adjust the parameters setting field (not yet available) of the lower half according to personal needs, as manifested below:

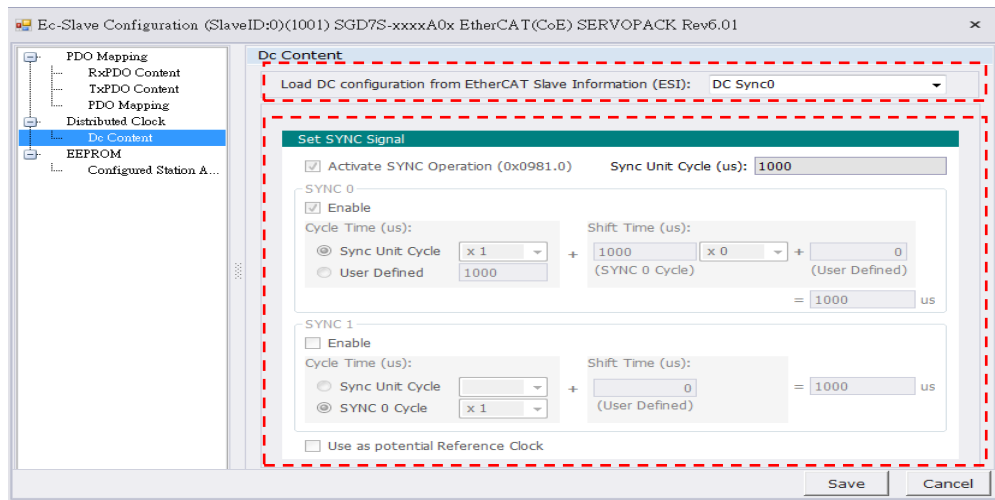


Figure Select DC mode/Set DC-related parameters

3.3.4. Export EtherCAT Network Information (ENI) files

The user can use NexMotion Studio to make the current network topology of the Project Explorer EtherCAT Master into the ENI file, including Slave Process data and Slave set values, with the ENI file in xml format.

There are two methods to export EtherCAT Network Information (ENI) files:

- (1) Popup Menu: Right click on the Project Explorer EtherCAT Master node and select **Export ENI file**, as shown in the following figure:

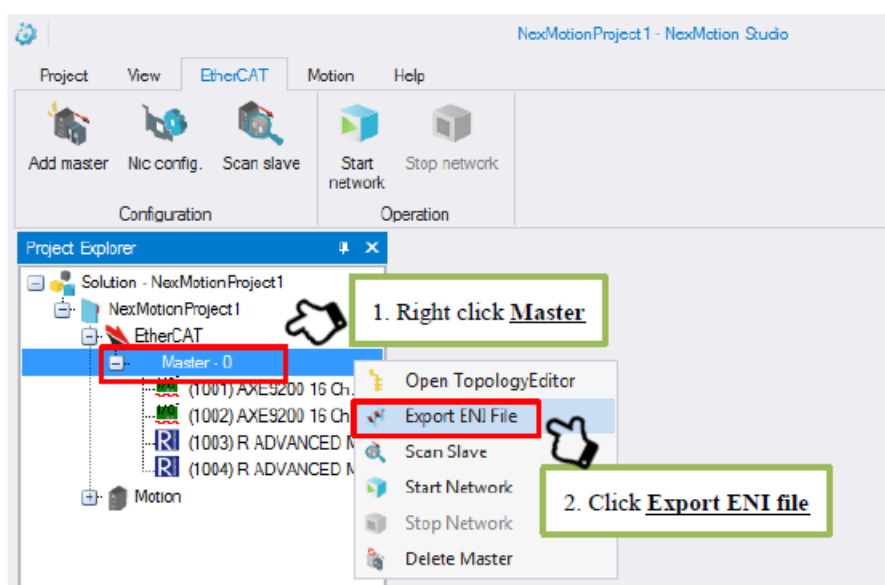


Figure Export ENI with Popup Menu

- (2) Click the Export ENI button: Double left click on the EtherCAT Master node of Project Explorer to open the Master window, and select the **Export ENI** button on the "Master Info" window, as exhibited in the figure below:

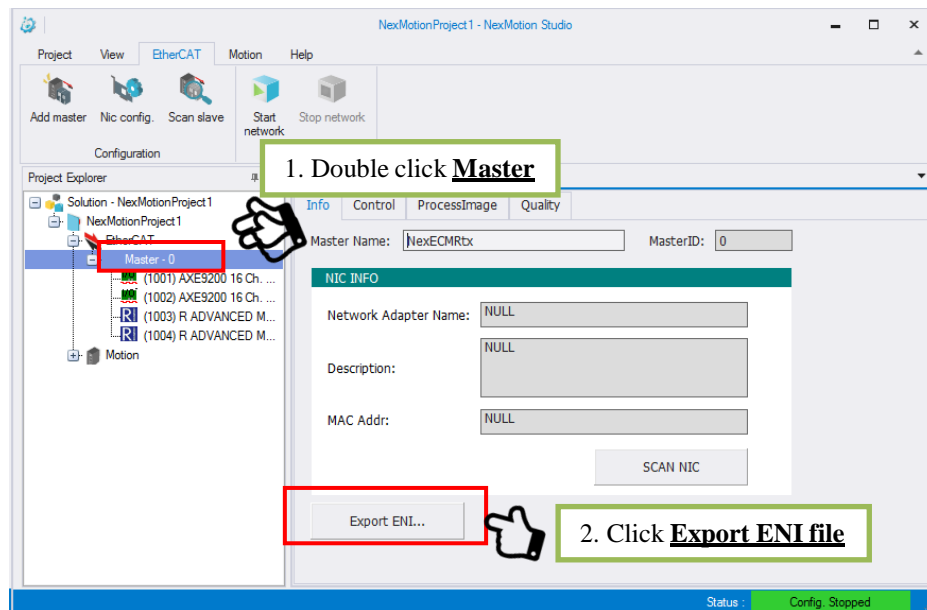


Figure Export ENI by clicking Export ENI

3.4. Motion setting

3.4.1. Append single axis

3.4.1.1. Generate Edit Axis dialog window

(1) Menu toolbar

Select the **Edit Axis** button from the "Motion" menu to create a "Edit Axis" dialog window.

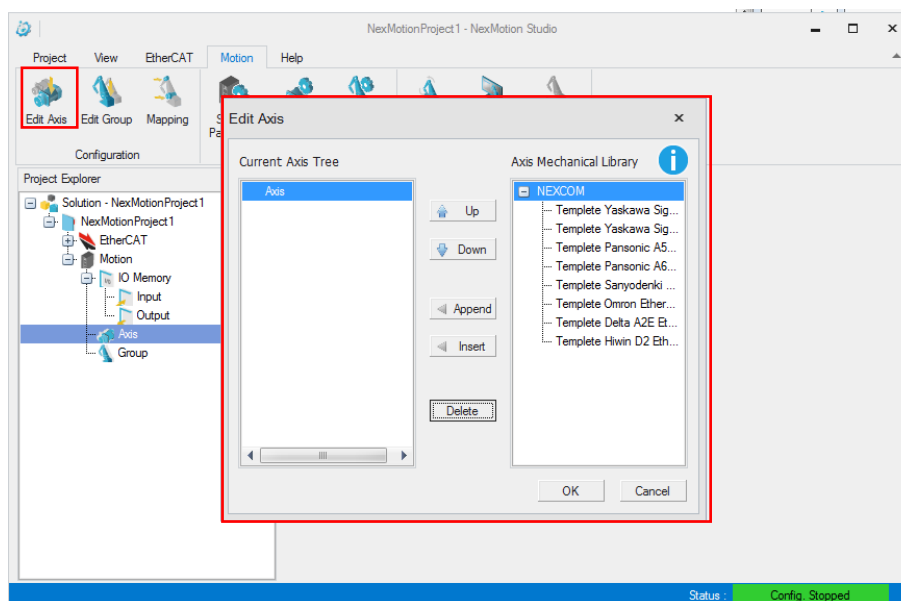


Figure Menu toolbar-open the Edit Axis window

(2) Dendritic nodes

On the Axis node in Project Explorer, right click the mouse button to show a pop-up window, and press **Edit Axis** on the pop-up window to produce an Edit Axis dialog window.

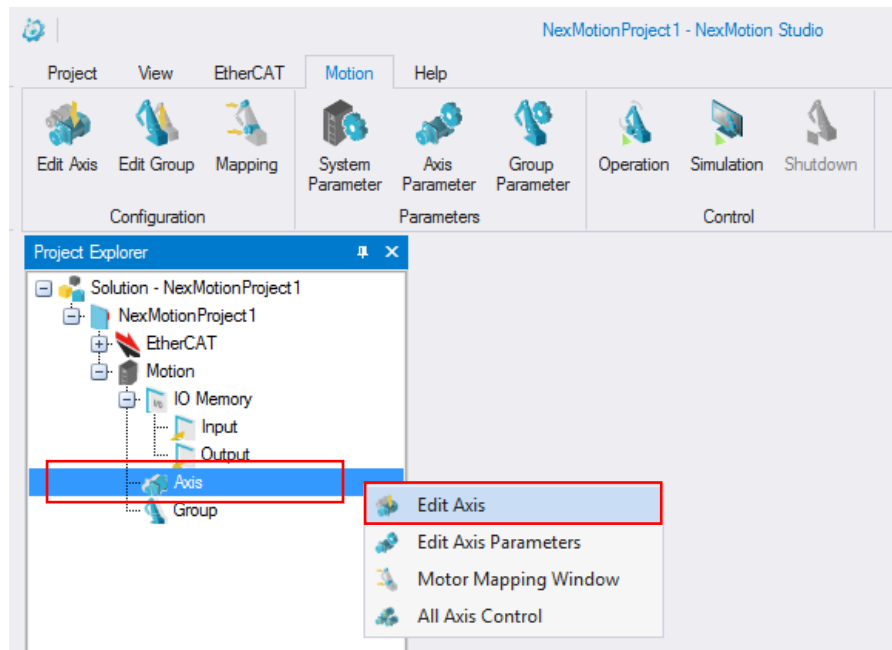


Figure Project Explorer-open the Edit Axis window

3.4.1.2. Edit Axis dialog window operating instructions

(1) Information description

On the Edit Axis window, click the information display icon in the upper right corner to show the Mechanical Information dialog window, which displays the parameter information and icons of this mechanical structure.

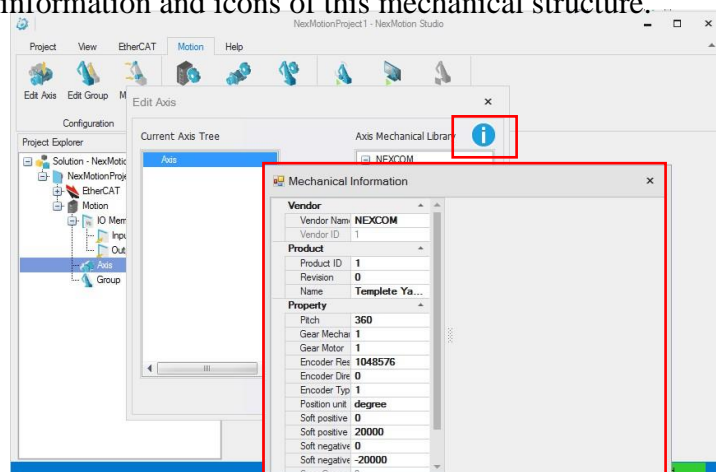


Figure Edit Axis & Mechanical Information windows

(2) Append single axis objects

On the Edit Axis Tree dialog window, the Axis Mechanical Library on the right represents a variety of mechanical structure descriptions that can be added to the Axis nodes under Motion. Select the mechanical structure to be added, and then double left click the mouse button or press the Append button to add the specified mechanical structure to the Axis node under Motion.

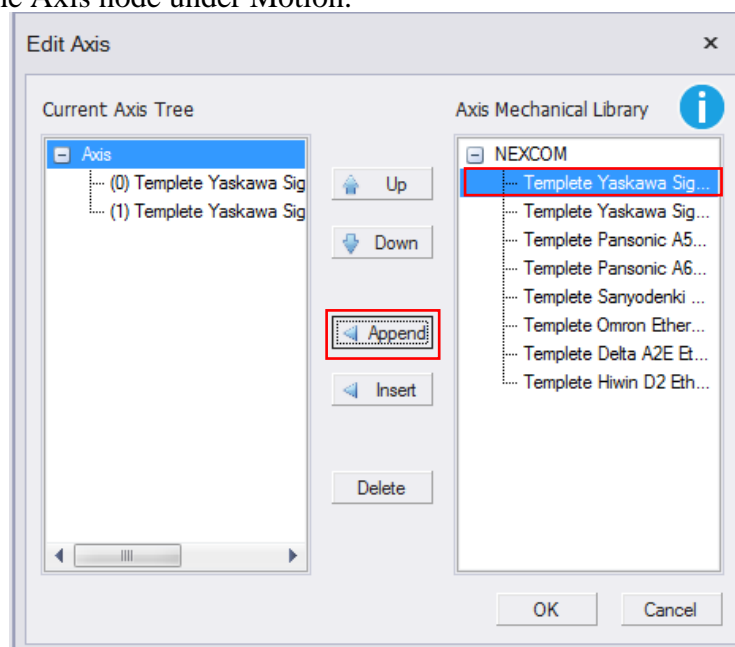


Figure Append uniaxial objects to Current Axis Tree

(3) Insert uniaxial objects

Select the mechanical structure in the right part you want to insert, choose the position to insert in the Axis node on the left, and the added node will appear above the specified insertion location.

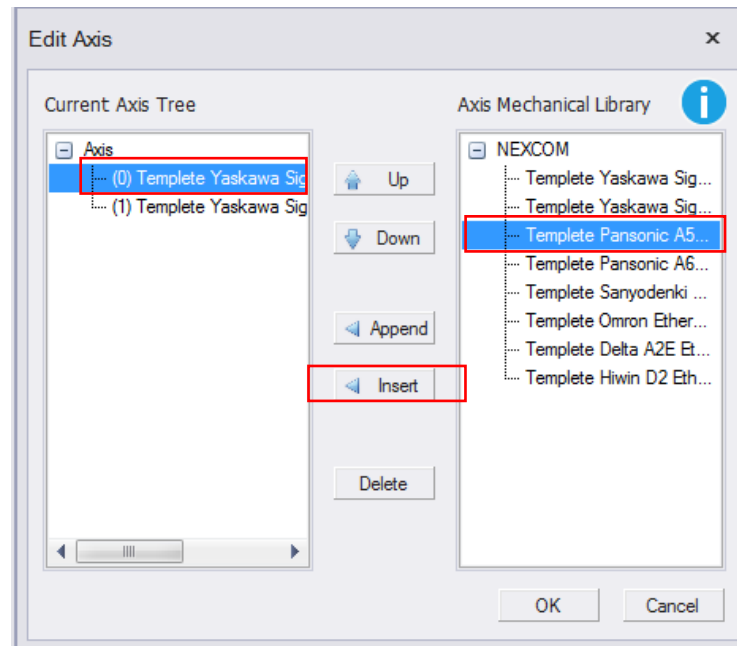


Figure Insert uniaxial objects to Current Axis Tree(before)

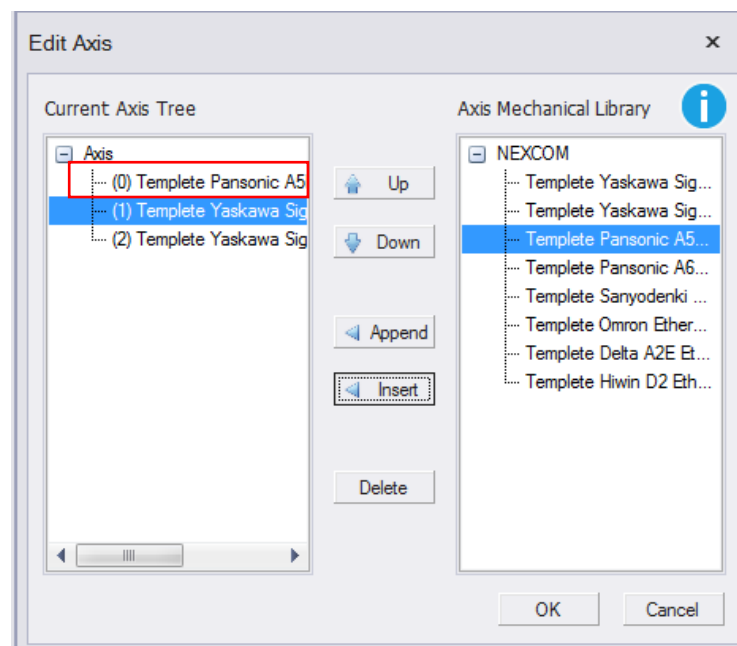


Figure Insert uniaxial objects to Current Axis Tree (after)

(4) Adjust the sequence of uniaxial topology nodes

The Axis topology node sequence in the left portion can be moved to the desired order by the Up and Down buttons.

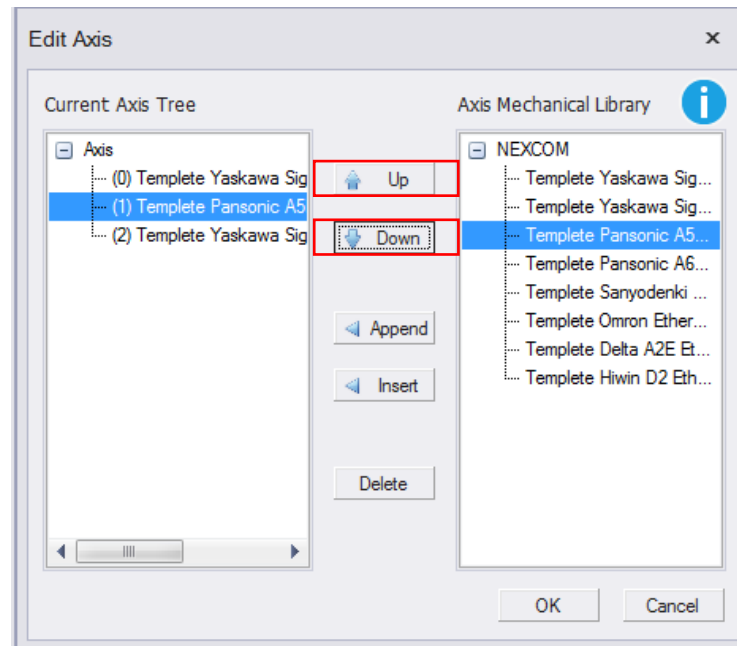


Figure Adjust the order of objects in Current Axis Tree

(5) Delete uniaxial objects

Specify the node you want to delete in Axis on the left, and then press the Delete button.

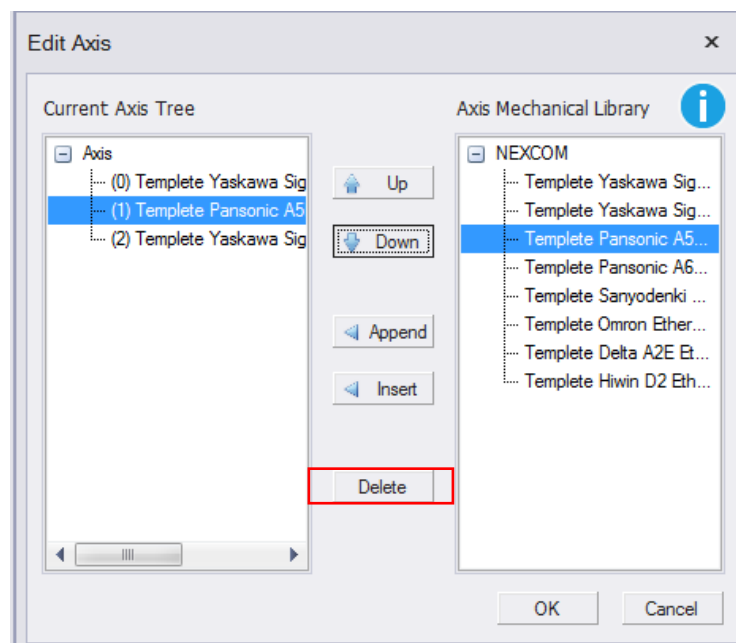


Figure Delete Current Axis Tree objects (before)

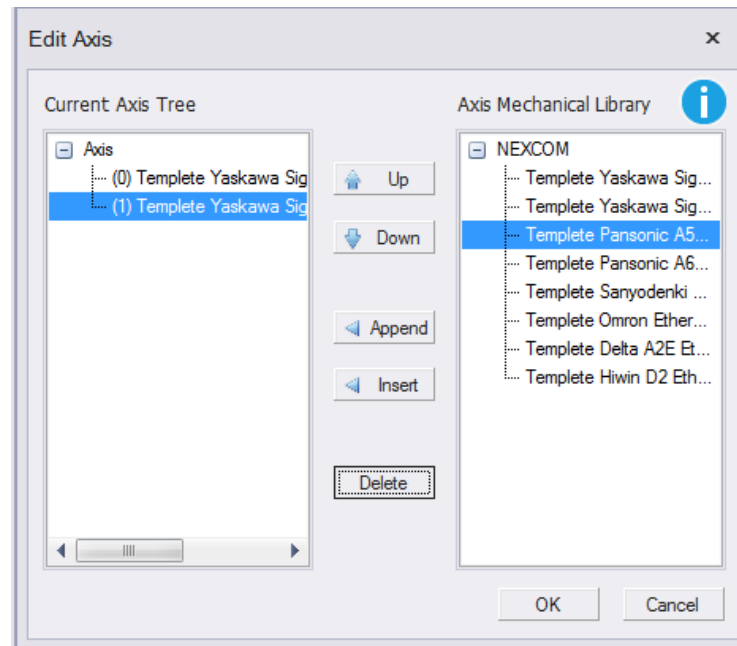


Figure Delete Current Axis Tree objects (after)

(6) OK and Cancel

Press the OK button, the newly appended mechanical structure will appear in the Axis node of Project Explorer. If you press Cancel, you will abandon the current settings, and the Axis node will not change.

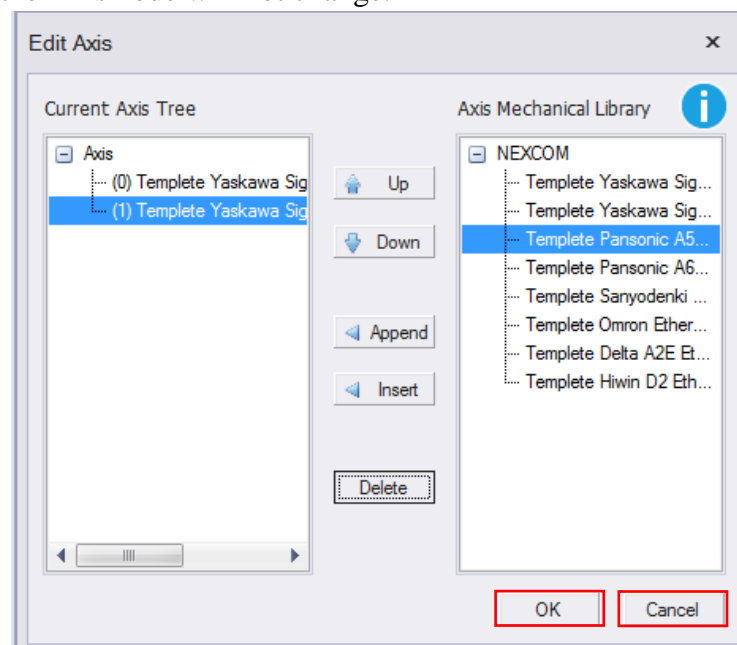


Figure OK for editing

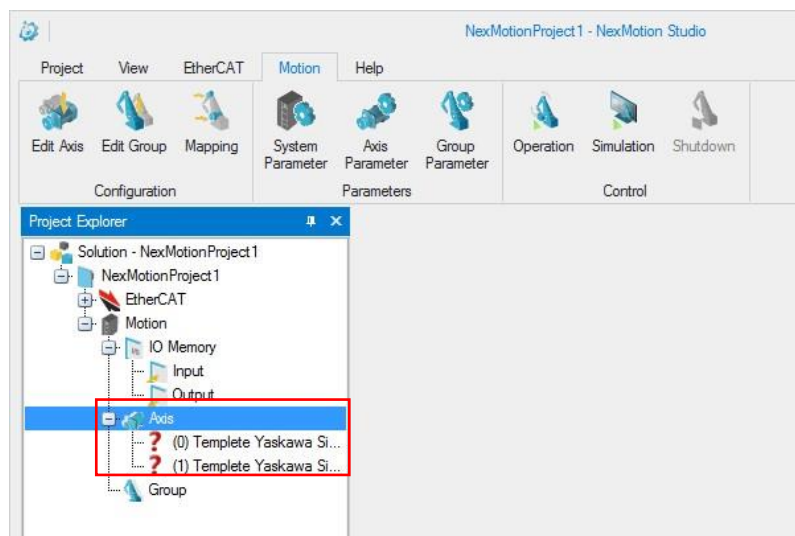


Figure Update Project Explorer

3.4.2. Edit Group

3.4.2.1. Create Edit Group dialog window

(1) Menu toolbar

Select the **Edit Group** button from the "Motion" menu to create an "Edit Group" dialog window.

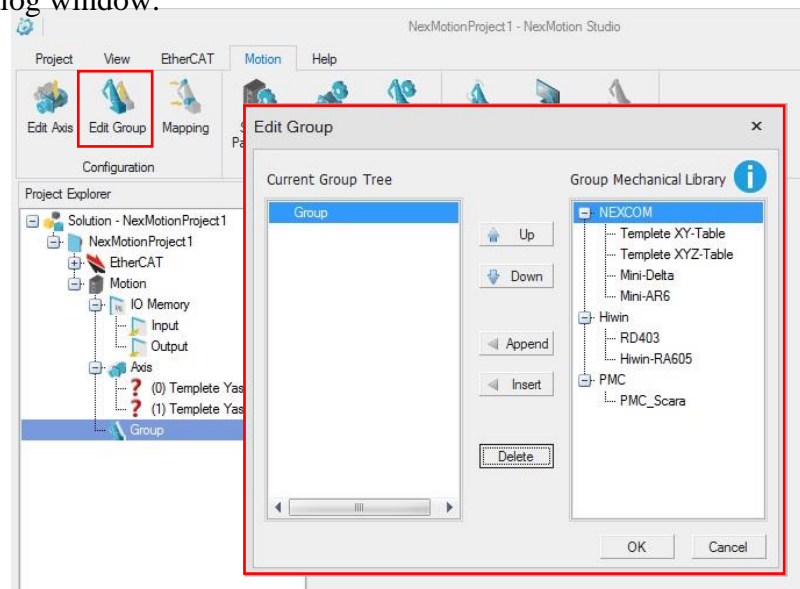


Figure Menu toolbar-open the Edit Group window

(2) Dendritic nodes

On the group node in Project Explorer, right click the mouse button to show a pop-up window, and press Edit Group on the pop-up window to produce an Edit Group dialog window.

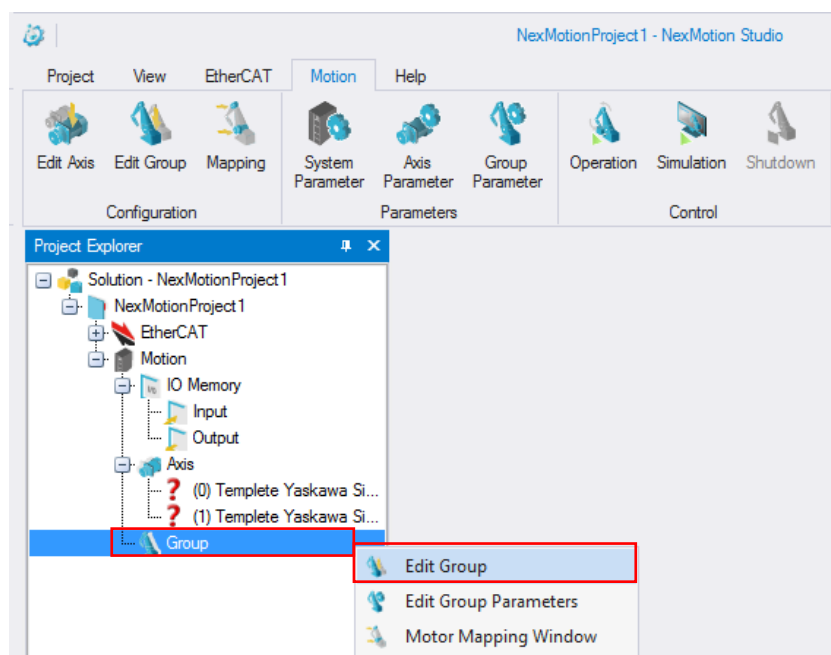


Figure Project Explorer–open the Edit Group window

3.4.2.2. Edit Axis Group window operating instructions

(1) Information description

On the Edit Group window, click the information display icon in the upper right corner to show the Mechanical Information dialog window, which displays the parameters of this mechanical structure.

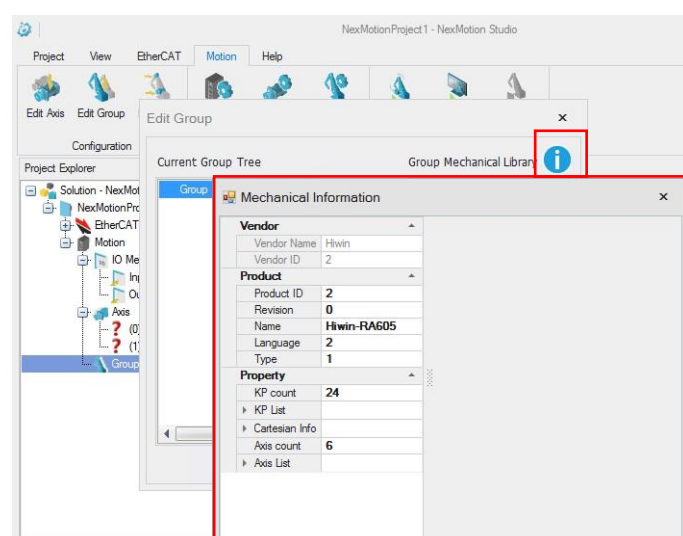


Figure Edit Axis Group & Mechanical Information windows

(2) Append axis group objects

On the Edit Group Tree dialog window, the Group Mechanical Library on the right represents a variety of mechanical structure descriptions that can be added to the Group nodes under Motion. Select the mechanical structure to be added, and then double left click the mouse button or press the Append button to add the specified mechanical structure to the Group node under Motion.

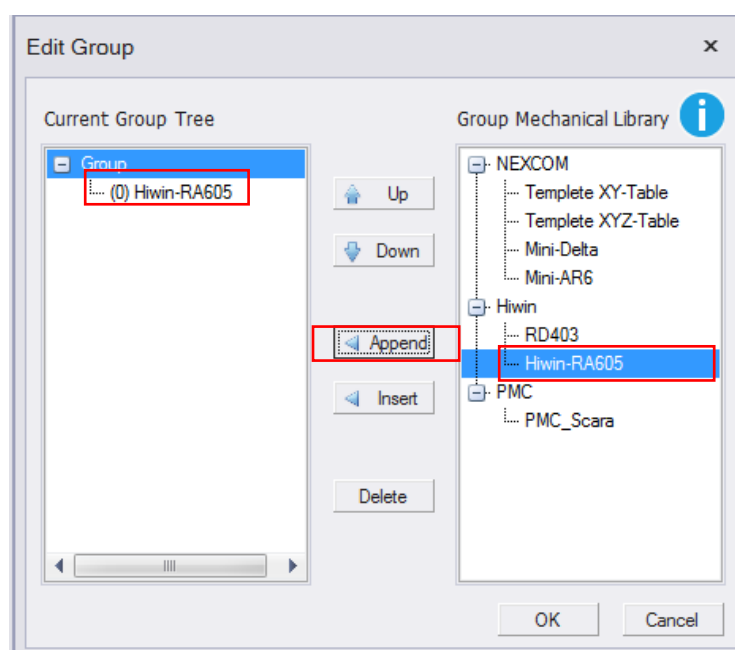


Figure Append uniaxial objects to Current Axis Tree

(3) Insert axis group objects

Select the mechanical structure in the right part you want to insert, choose the position to insert in the Group node on the left, and the added node will appear above the specified insertion location.

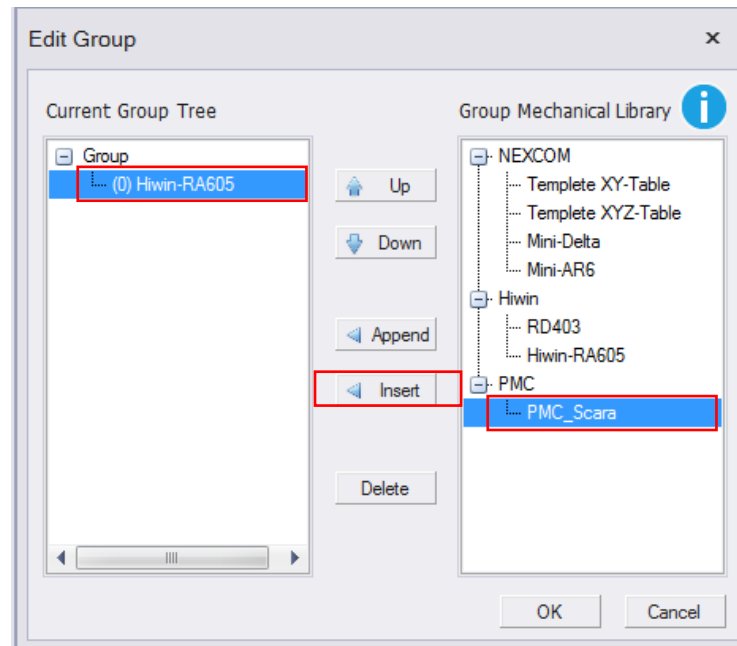


Figure Insert uniaxial objects to Current Group Tree (before)

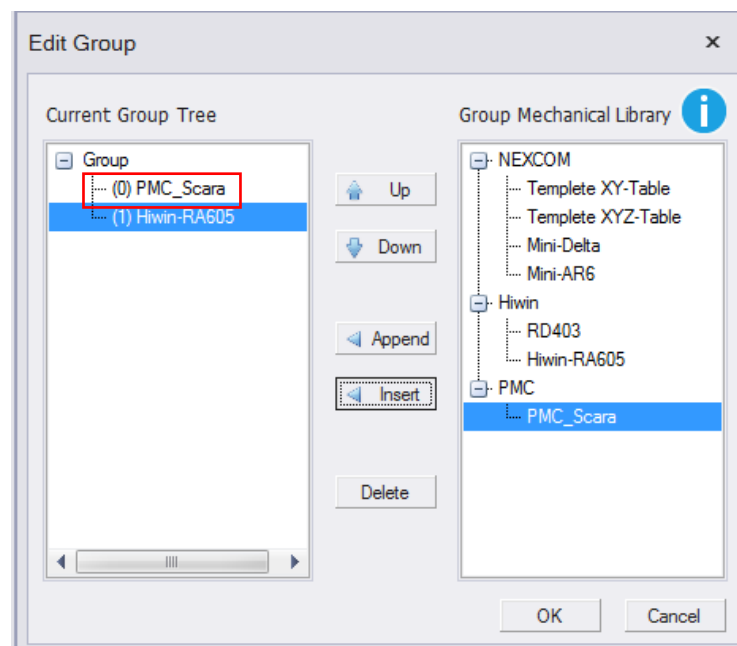


Figure Insert uniaxial objects to Current Group Tree (after)

(4) Adjust the sequence of axis group topology nodes

The Group topology node sequence in the left portion can be moved to the desired order by the Up and Down buttons.

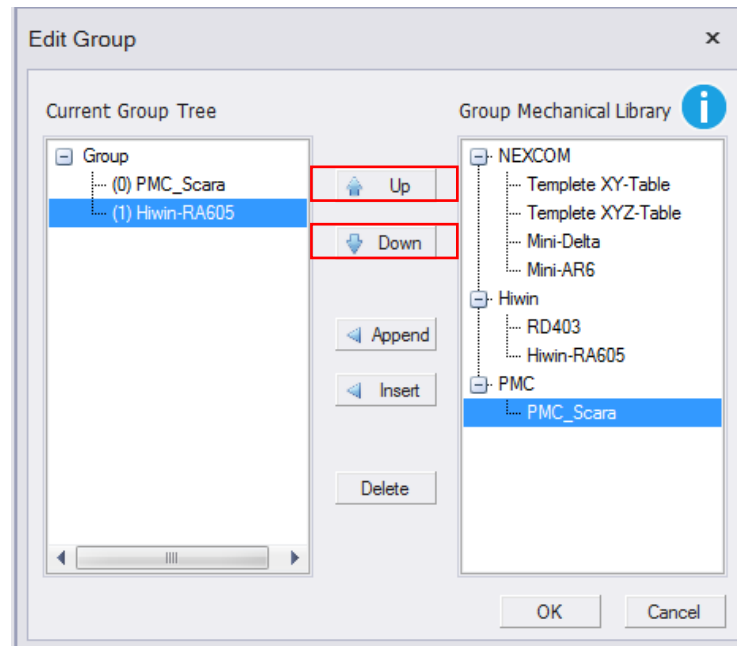


Figure Adjust the order of objects in Current Group Tree

(5) Delete axis group objects

Specify the node you want to delete in Group on the left, and then press the Delete button.

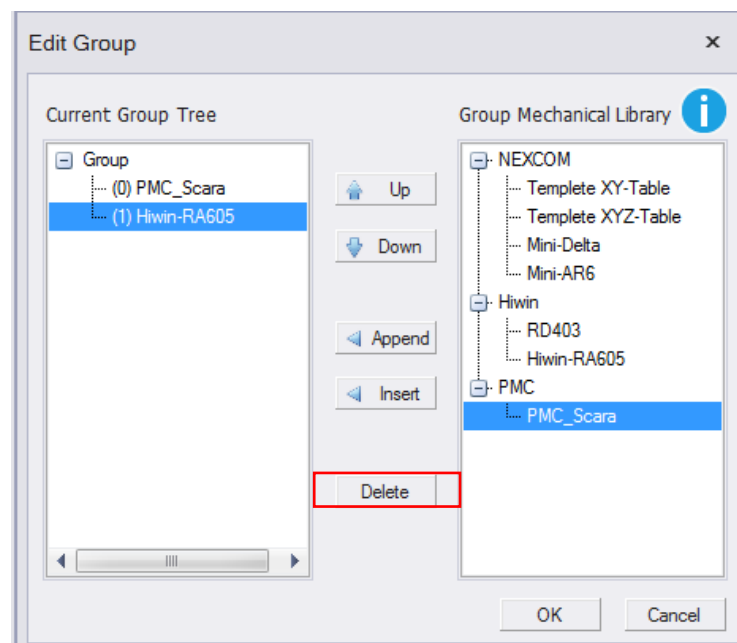


Figure Delete Current Group Tree objects (before)

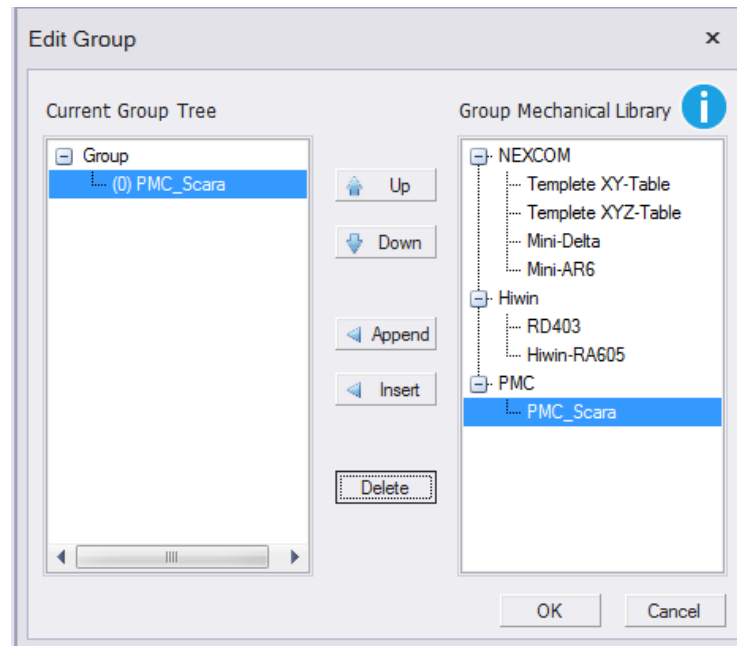


Figure Delete Current Group Tree objects (after)

(6) OK and Cancel

Press the OK button, the newly appended mechanical structure will appear in the Axis node of Project Explorer. If you press Cancel, you will abandon the current settings, and the Group node will not change.

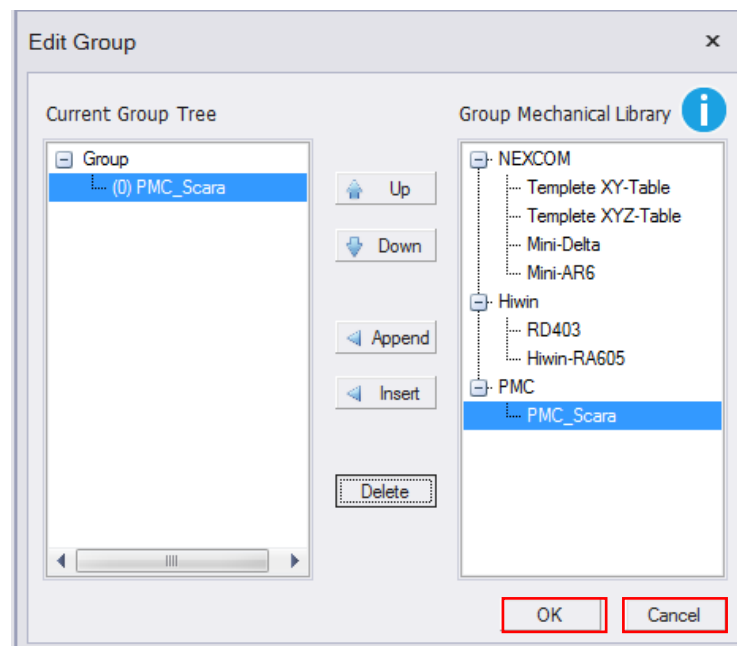


Figure OK for Group editing

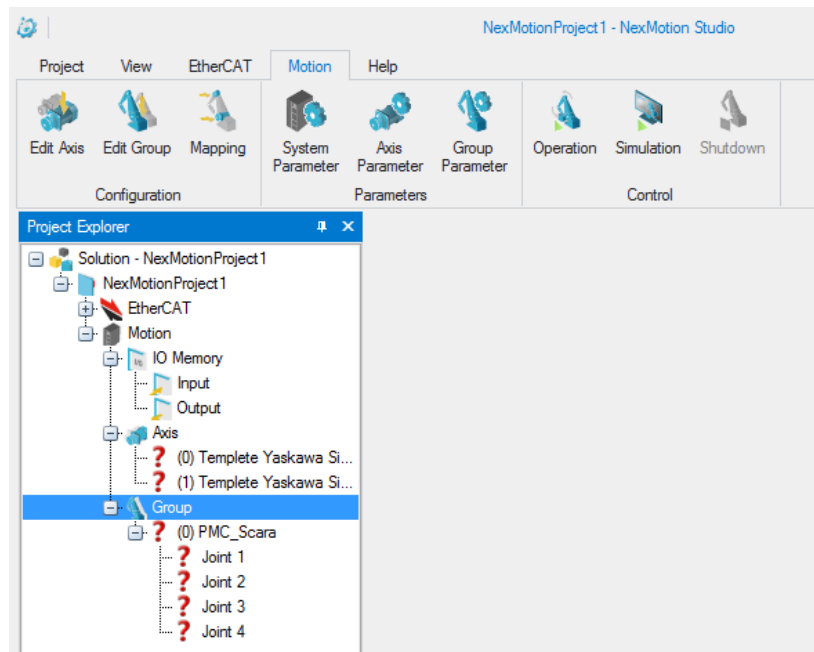


Figure Update the Edit Group content to Project Explorer

3.4.3. Motor mapping

3.4.3.1. Generate Motor Mapping dialog window

(1) Menu toolbar

Choose the **Mapping** button from the "Motion" menu to create an Motor Mapping dialog window.

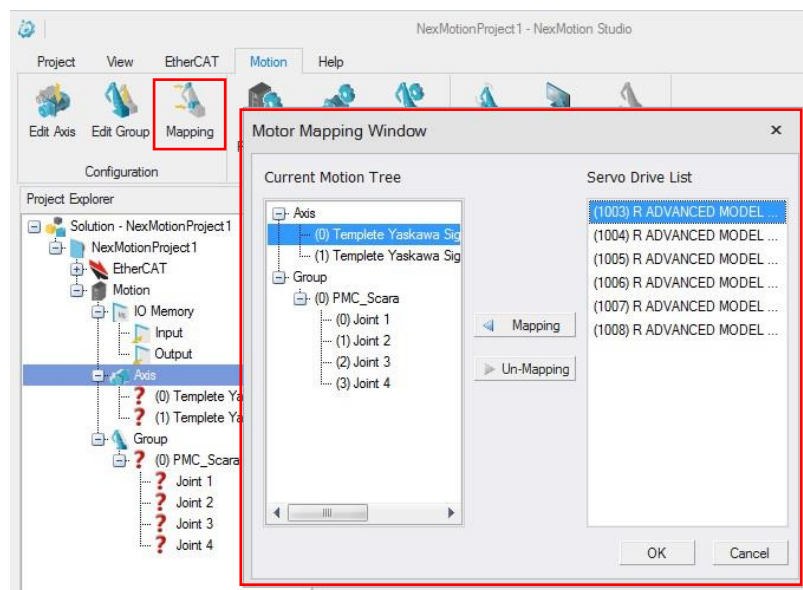


Figure Menu toolbar-open the Motor Mapping dialog window

(2) Project Explorer

On the Axis node in Project Explorer, right click the mouse button to show a pop-up window, and press **Motor Mapping Window** on the pop-up window to produce a Motor Mapping dialog window.

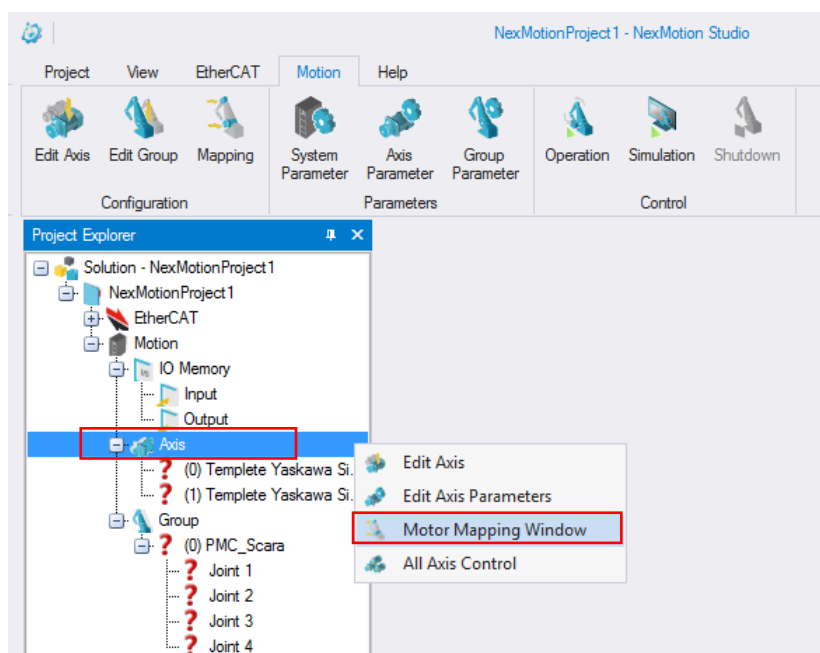


Figure Project Explorer–open the Motor Mapping dialog window

3.4.3.2. Motor mapping dialog window operating instructions

(1) Mapping

In terms of motor mapping, the physical motor (please refer to 3.2 for how to append physical motor) added by EtherCAT is mapped to the corresponding mechanical uniaxial structure or the single axis in the axis group. Specify the mechanical structure node on the left first before specifying the physical motor on the right side, and then press the Mapping button to assign the physical motor to the mechanical structure.

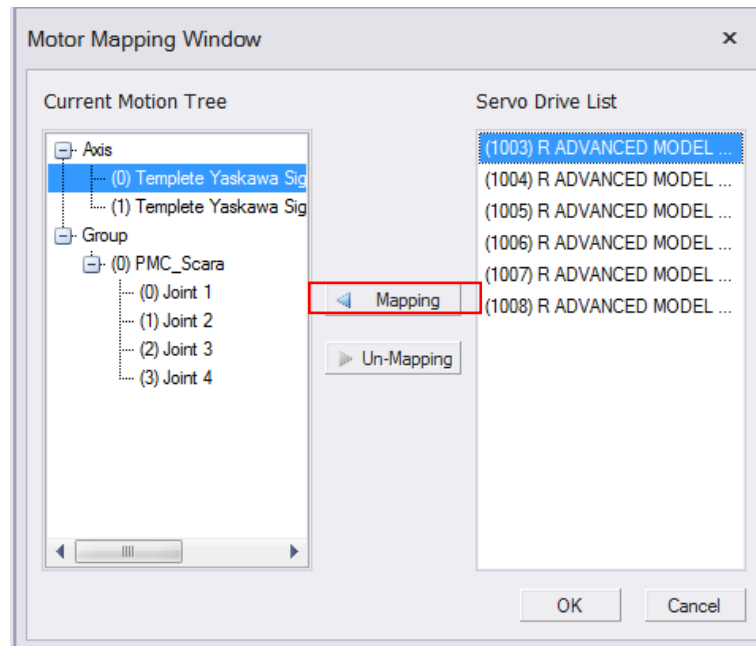


Figure Edit motor mapping (before)

The specified physical motor will show a grey-based color, and the child node of the physical motor will appear on the specified mechanical structure node.

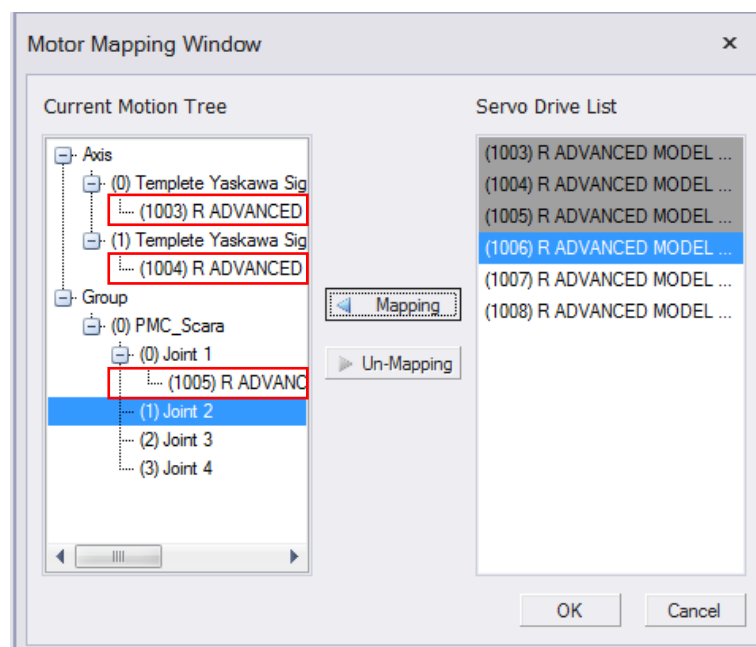


Figure Edit motor mapping (after)

(2) Un-Mapping

Specify the motor nodes that have been mapped under the mechanical structure on the left, and press the Un-Mapping button to cancel the physical motor mapping.

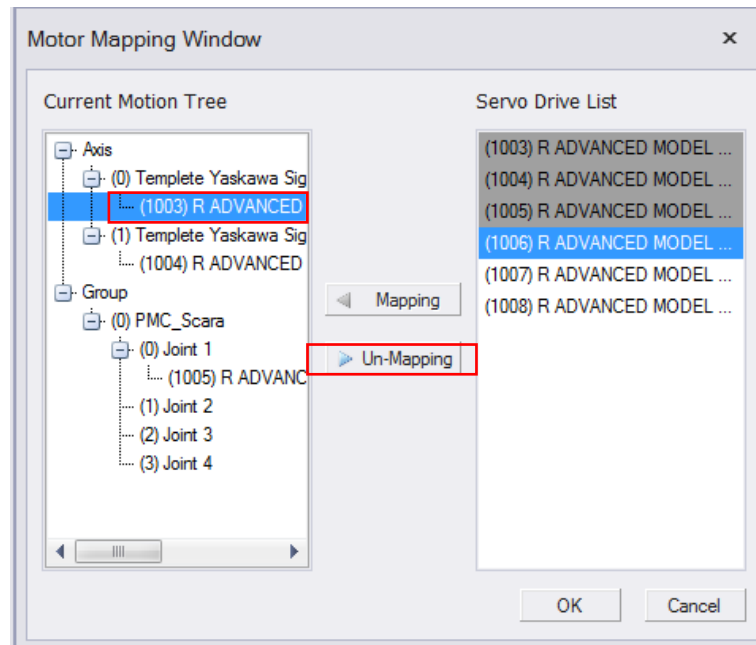


Figure Cancel motor mapping (before)

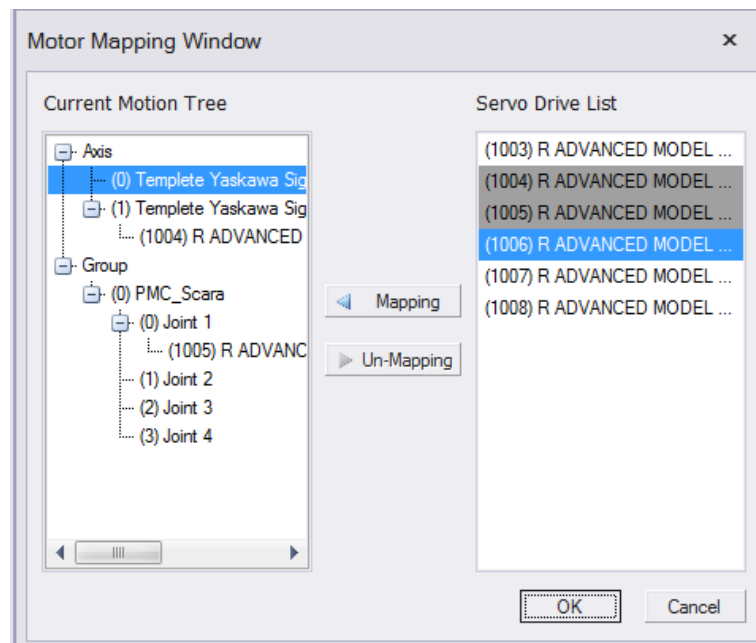


Figure Cancel motor mapping (after)

(3) OK and Cancel

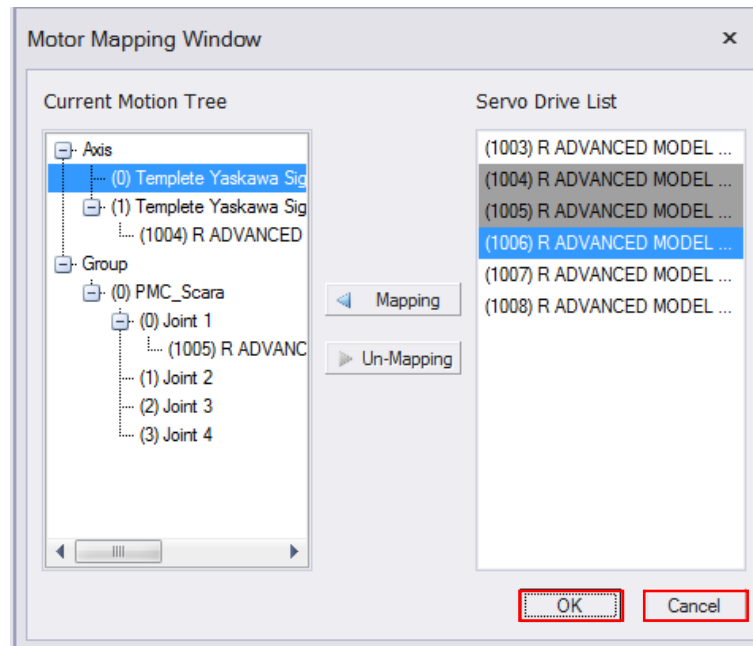


Figure OK for motor mapping editing

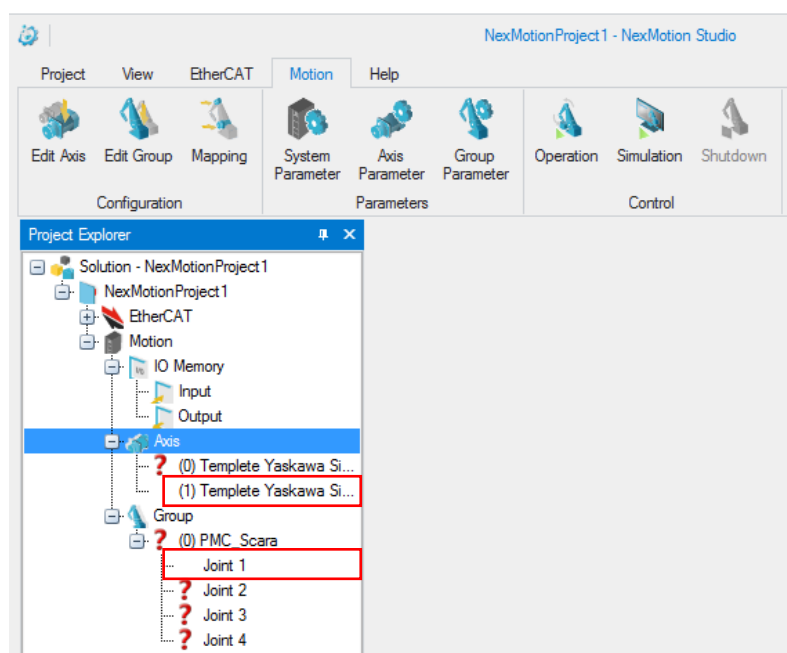


Figure Update motor mapping editing to Project Explorer

3.4.4. I/O setting

3.4.4.1. Generate I/O mapping dialog window

On the IO Memory node under Motion in Project Explorer, right click the mouse button to show a pop-up window, and press IO Memory Mapping on the pop-up window to produce an I/O Memory Mapping dialog window.

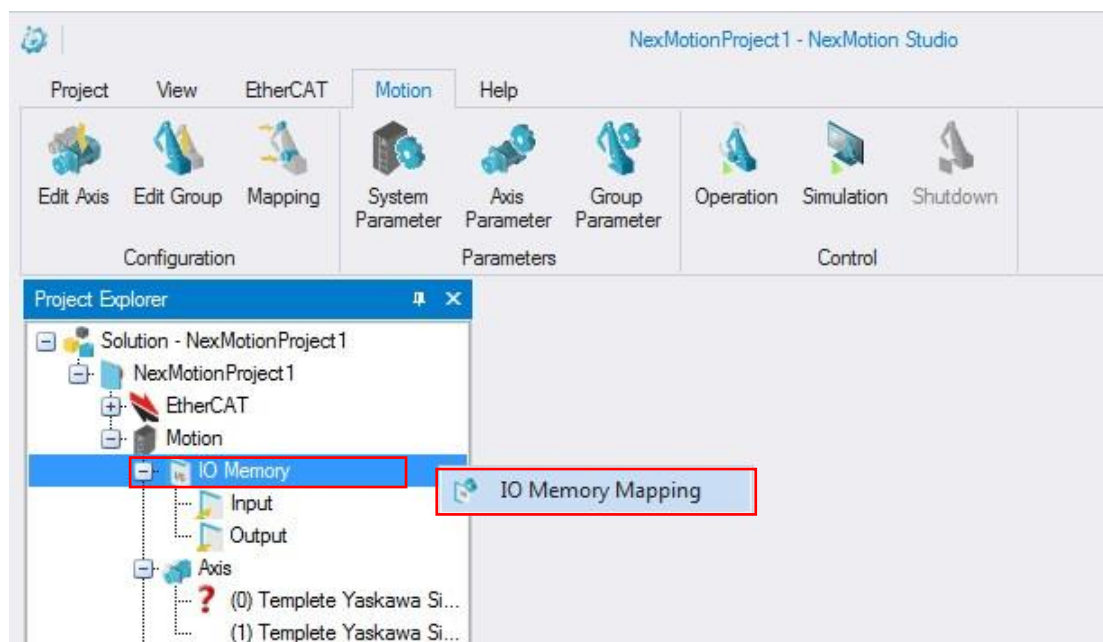


Figure Click the IO Memory Mapping button

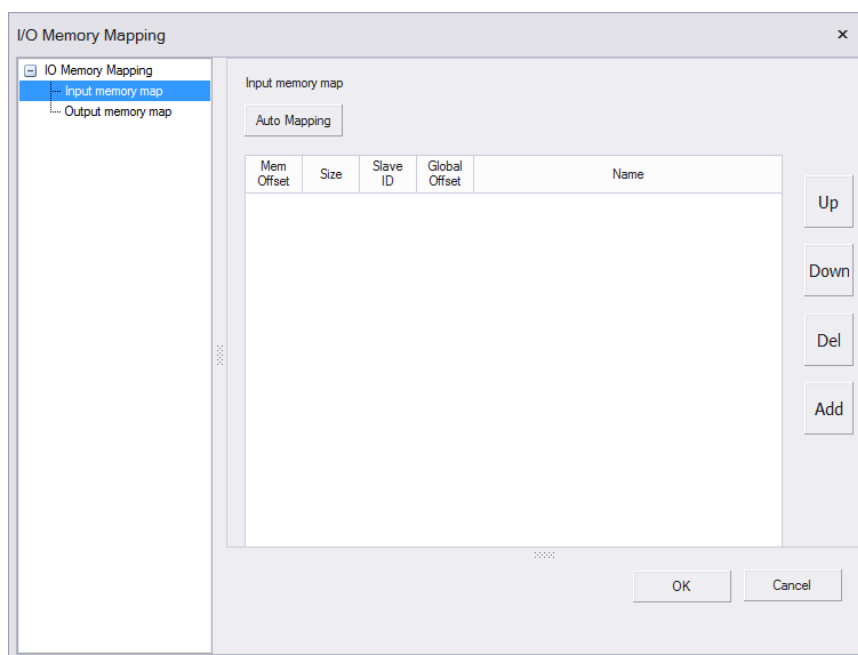


Figure Memory Mapping window

3.4.4.2. I/O mapping dialog window operating instructions

(1) Auto Mapping

When you first open the I/O Memory Mapping window, the modules that can be mapped will not be automatically queued until you press Auto Mapping or Edit. The **Auto Mapping** button will automatically queue the modules that are already added

(except Servo Drive) under EtherCAT in Project Explorer to the corresponding Input area or Output area.

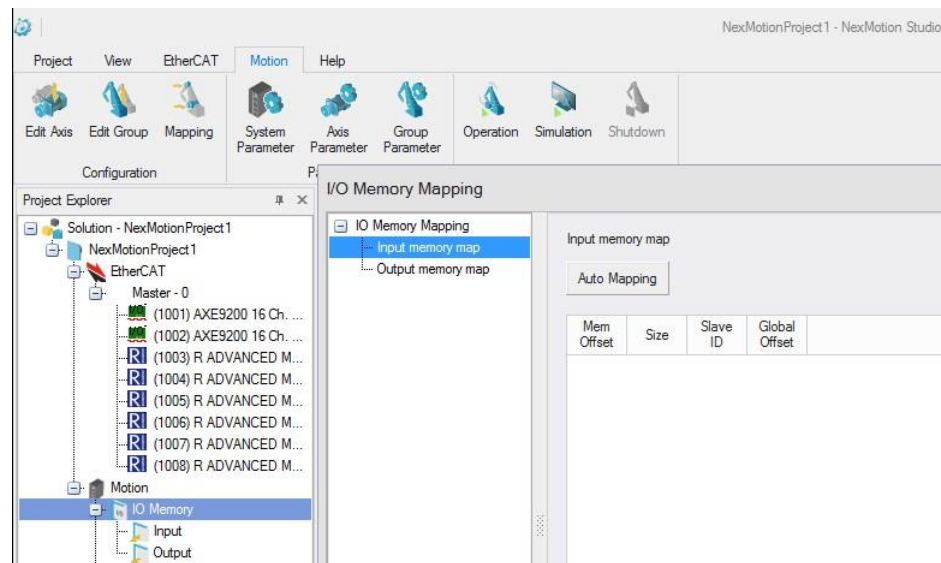


Figure Auto Mapping button

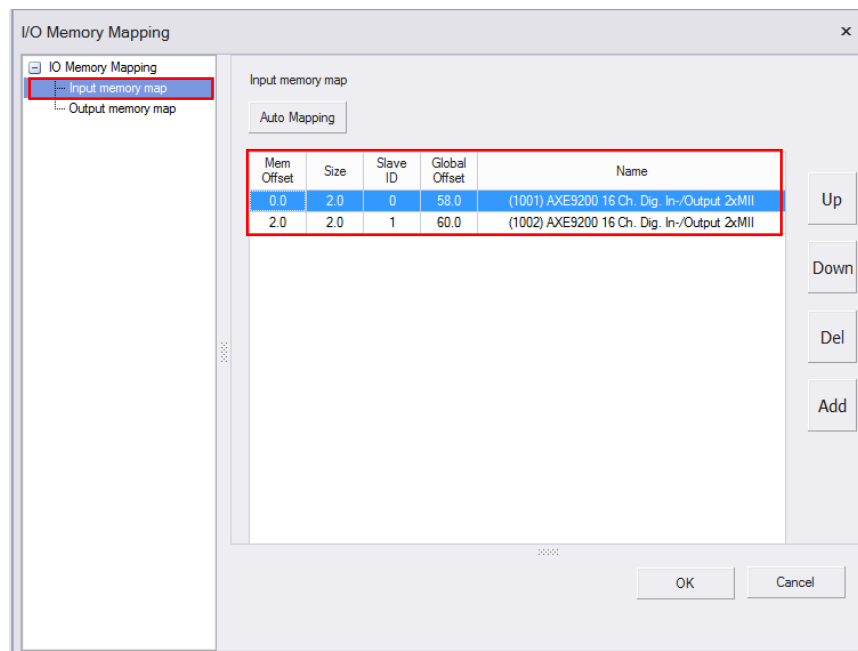


Figure Input memory map area

(2) Up & Down

Specify the device that you want to arrange order, and press Up or Down to adjust the order of I/O Mapping.

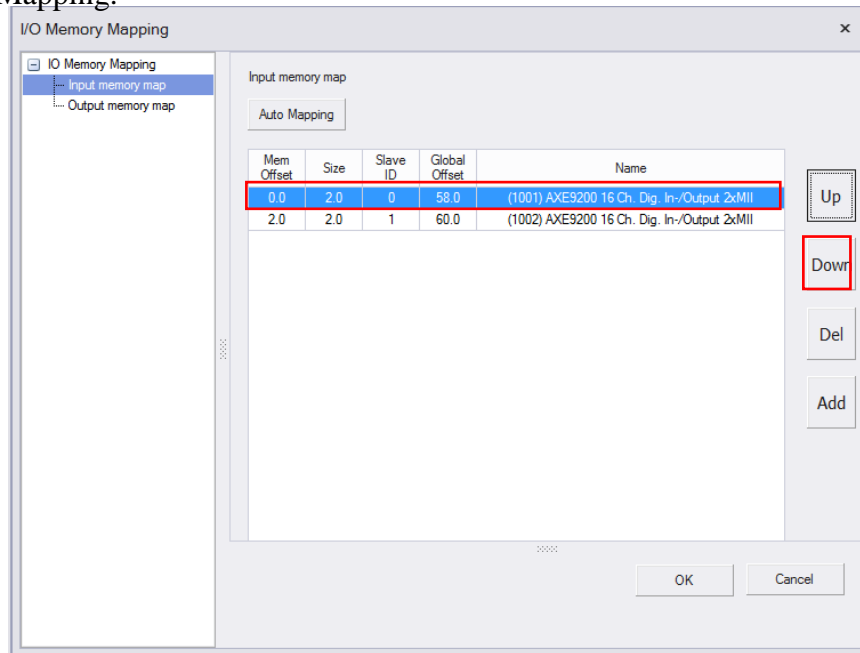


Figure Adjust IO Mapping (before)

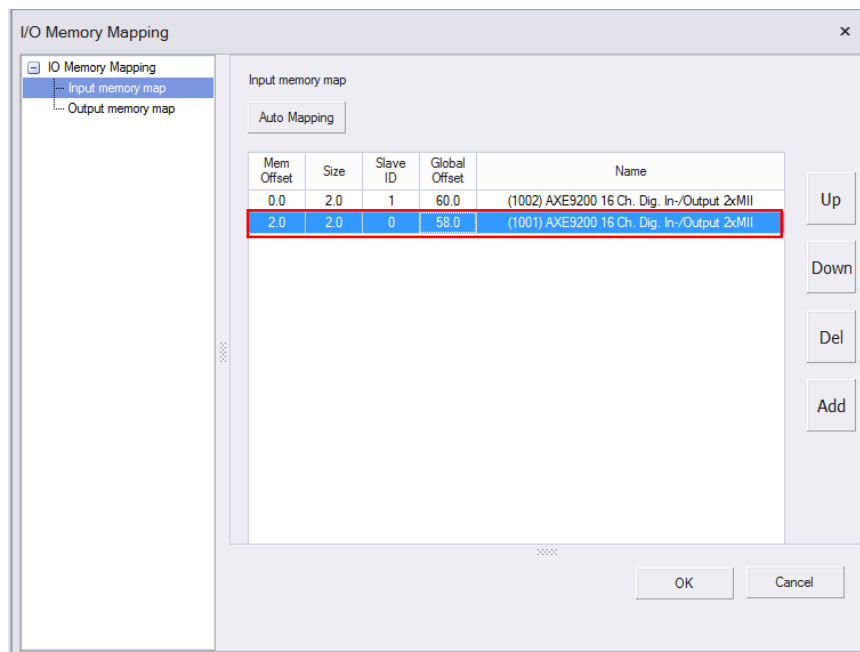


Figure Adjust IO Mapping (after)

(3) Del

Specify the device you want to remove, and press the **Del** button to delete the device specified in I/O Mapping.

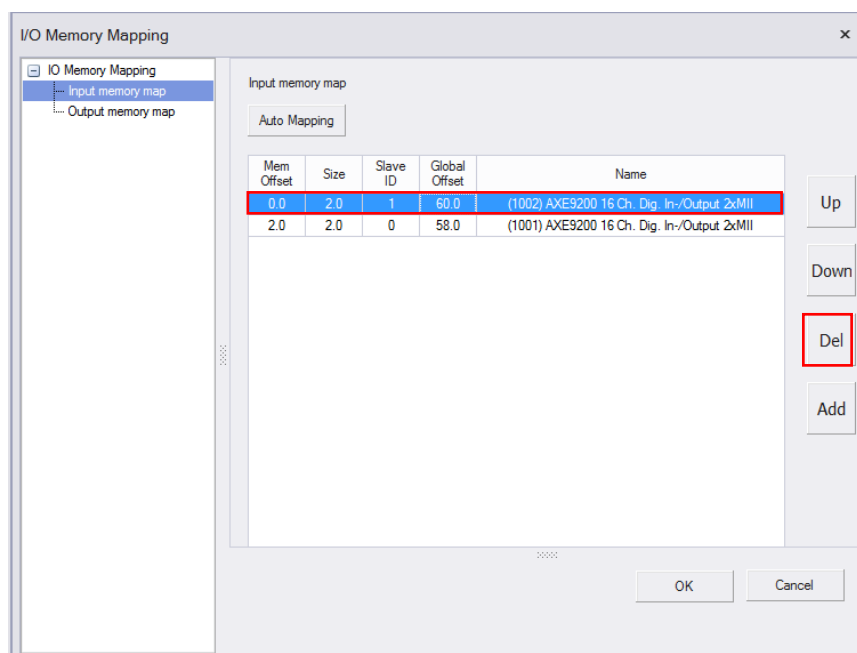


Figure Delete IO Mapping (before)

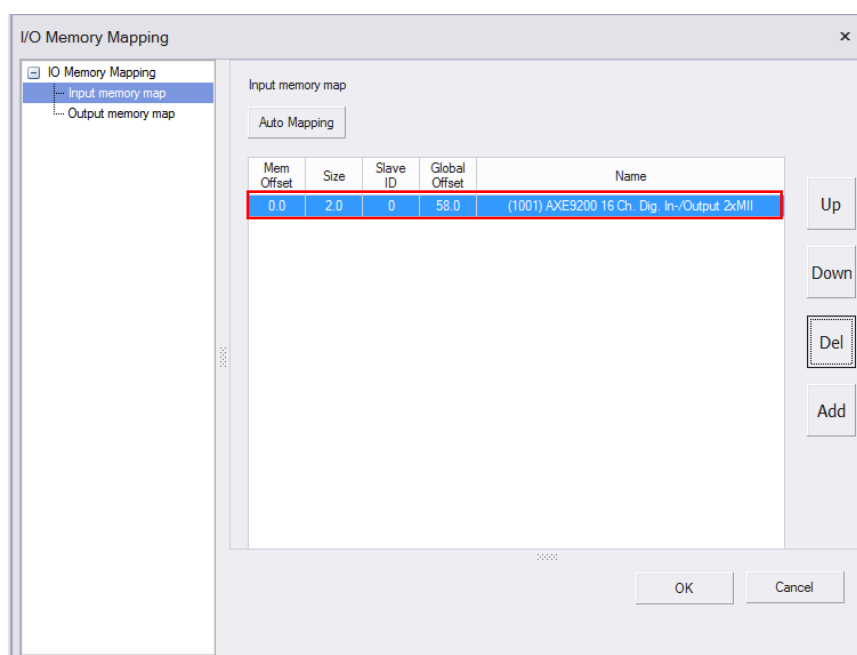


Figure Delete IO Mapping (after)

(4) Add

Press the Add button to pop up the Add Input(Output) Memory Mapping dialog window.

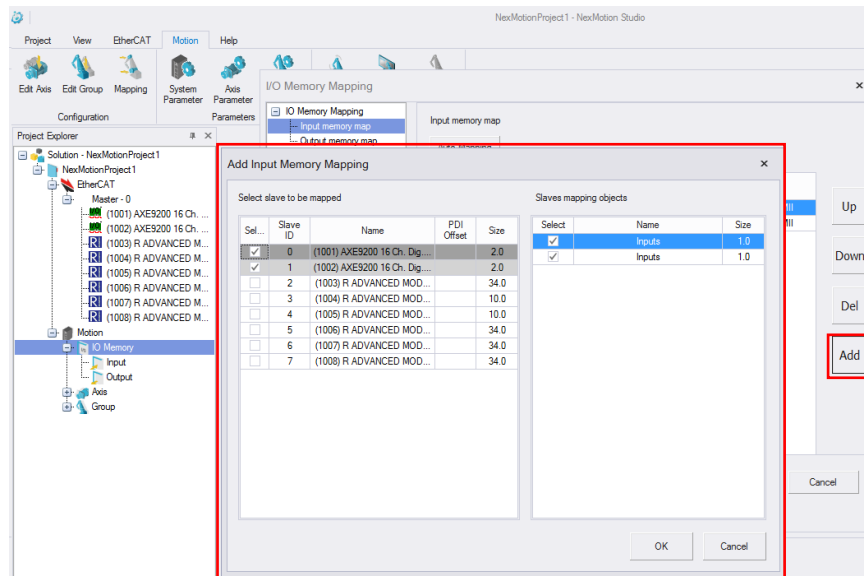


Figure Add Input(Output) Memory Mapping window

On the Add Input (Output) Memory Mapping dialog window, you may choose to add all the devices that have been set up under EtherCAT in Project Explorer, including Servo Drive. Check the left-side box of the device you want to add, and press OK.

Note: The current version does not support the selection of different objects in a single device as a mapping object.

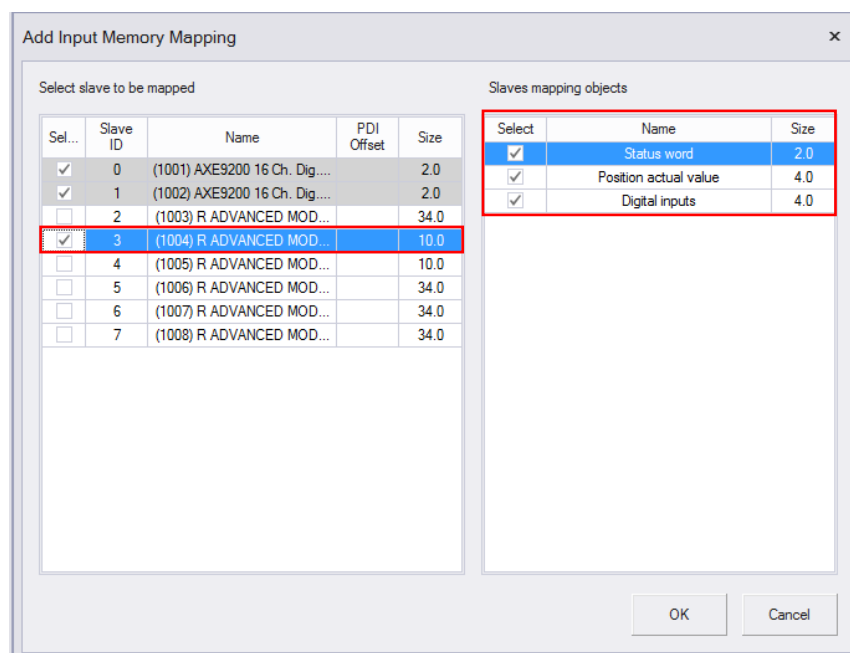


Figure Select the device mapped to the IO Map Memory area.

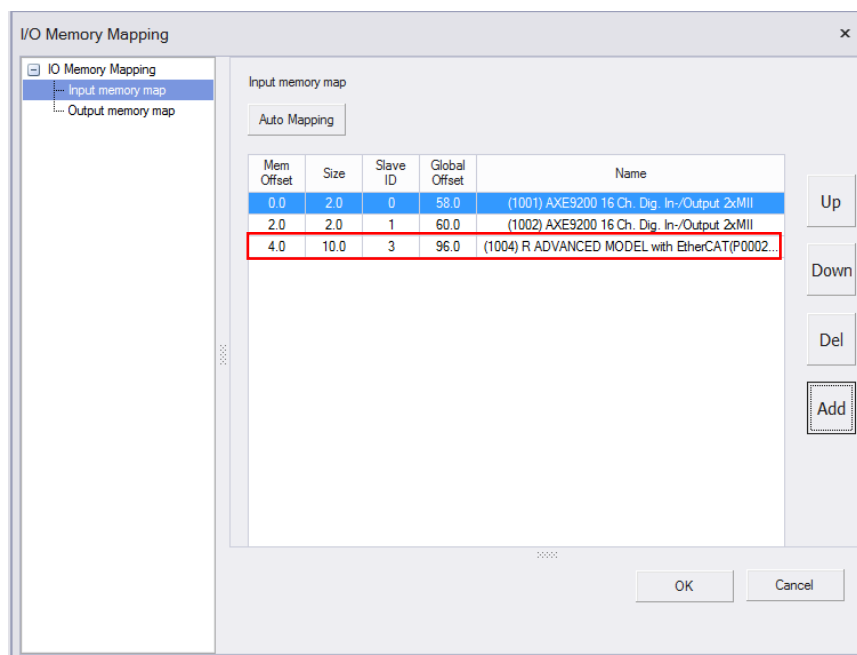


Figure Add the device to the IO Map Memory area

(5) OK or Cancel

After the **OK** button is pressed, the newly added I/O Mapping device will appear in the Input and Output nodes under I/O Memory in Project Explorer. If pressing Cancel, you will abandon the current setting, and the I/O Memory node will not change.

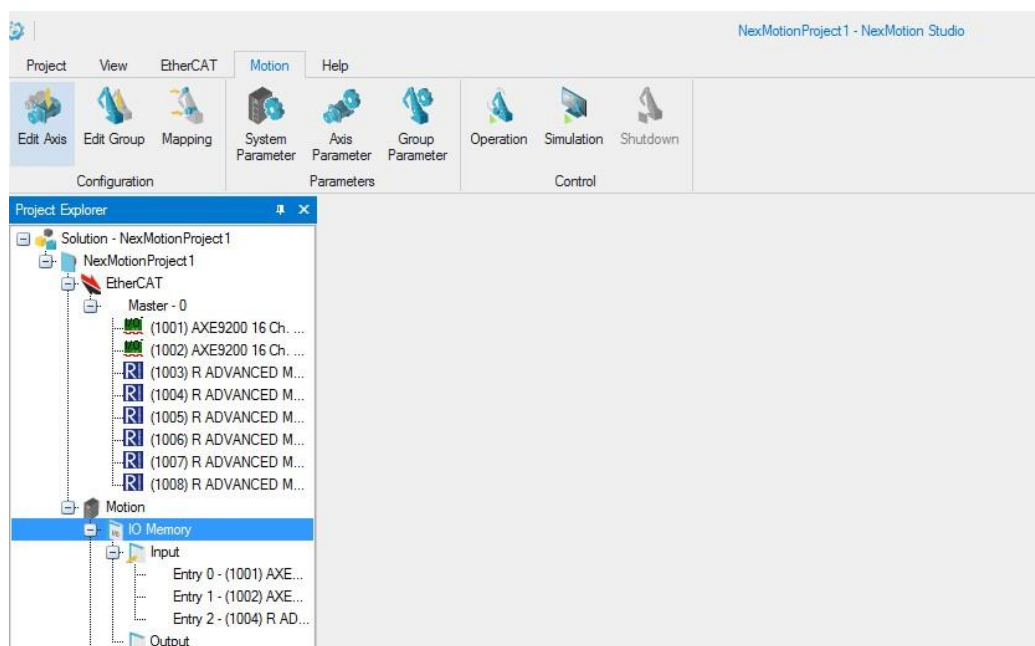


Figure Add the device to Project Explorer IO Memory nodes



3.5. Output NCF file

4. NexMotion Studio Operating Instructions

4.1. EtherCAT operation

This chapter introduces the EtherCAT-related operation interface provided by NexMotion Studio, which can be used by the user to control online Slave and obtain internal information of Slave.

The flow chart for operating EtherCAT is presented below. This chapter will introduce “Switch EtherCAT state,” “Read and write Process Data,” “CoE-SDO network,” “Slave function test,” and relevant operation interfaces. For the rest, please refer to 3.2 and 3.3 chapters.

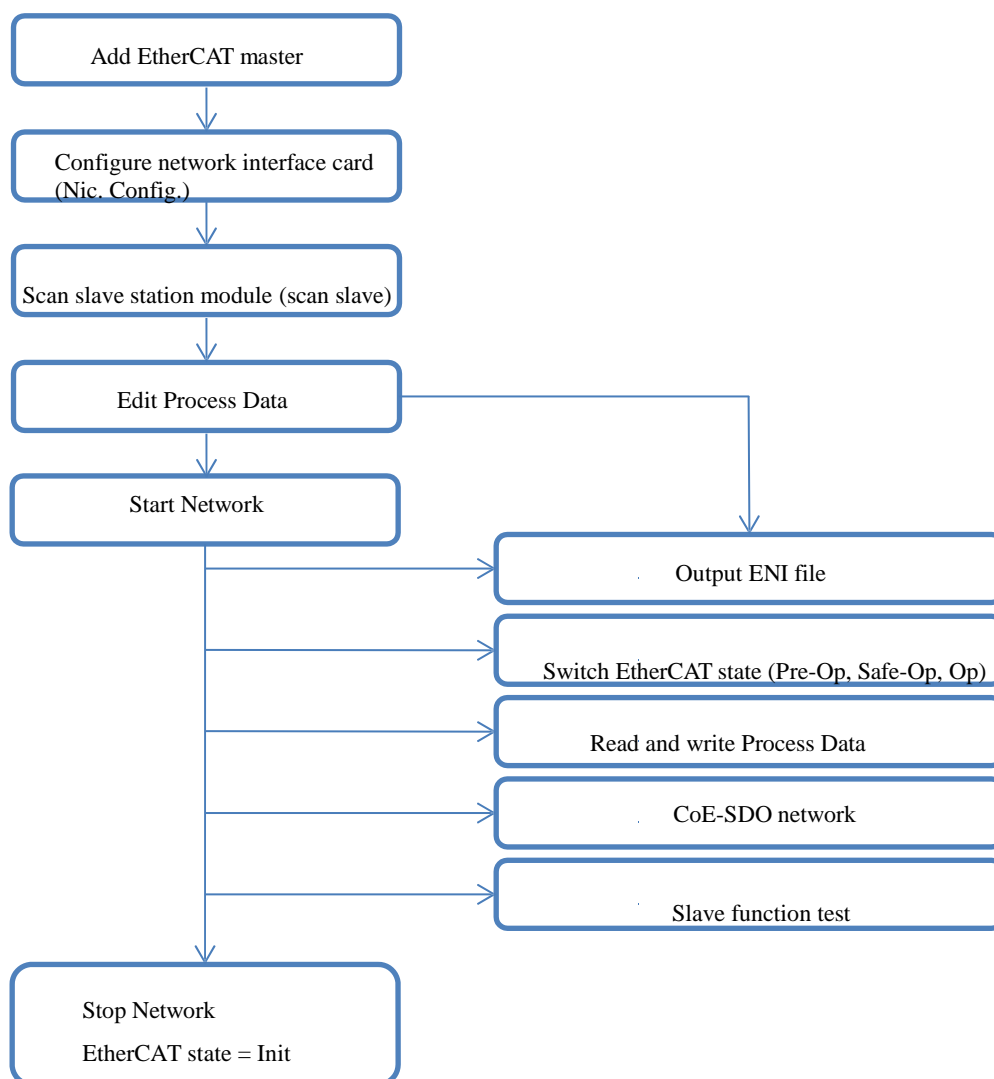


Figure EtherCAT operation process

4.1.1. Master operation interface

The Master operation interface is made up of three pages: "Info," "Control," and "ProcessImage." Users can get Master information from these three pages, switch the Master state and browse all Slave ProcessData information, which are detailed in the following sections.

4.1.1.1. Master Info operation page

The Info operation page comes with the following functions:

- Basic information on Master: Master Name, Master ID, and specified network card information
- SCAN NIC button: Network topology scanning of the NIC currently set by Master
- Export ENI button: Export EtherCAT Network Information (ENI) files

As shown below:

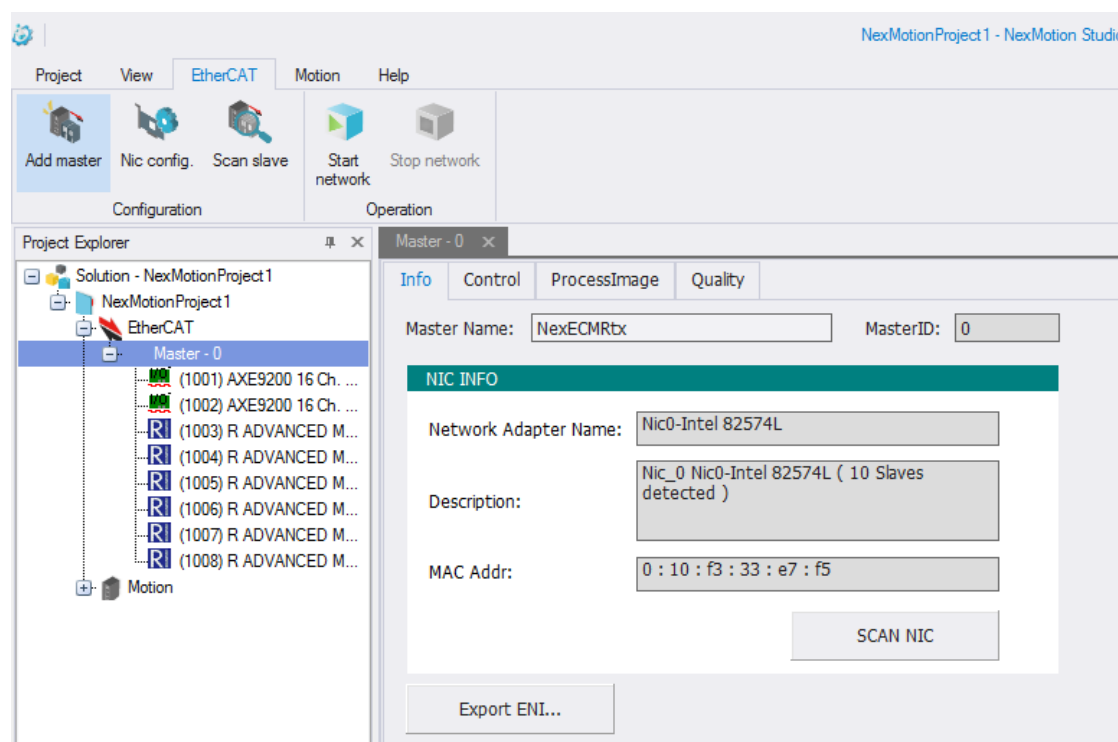


Figure Master Info page

4.1.1.2. Master Control operation page

The user can set Master cycle time, EtherCAT Master state switch operation through this page to display the Master actual state, and all the slave states on the network topology.

The following table shows Master Actual state:

Table Master Actual State

Master state	State description
N/A	No network has been started on Slave.
Init	State Machine defined by EtherCAT
Pre-Op	
Safe-Op	
Op	
Boot	
Error	Network connection error
Slave retry	Connection lost. Master is restoring the connection

The user selects the four buttons in State Machine Control to switch the Master state and see whether the Master state has been switched successfully by looking at the status displayed in the lower right corner of Master Actual State and NexMotion Studio, with the following four images showing the results of the successful switch of these four states.

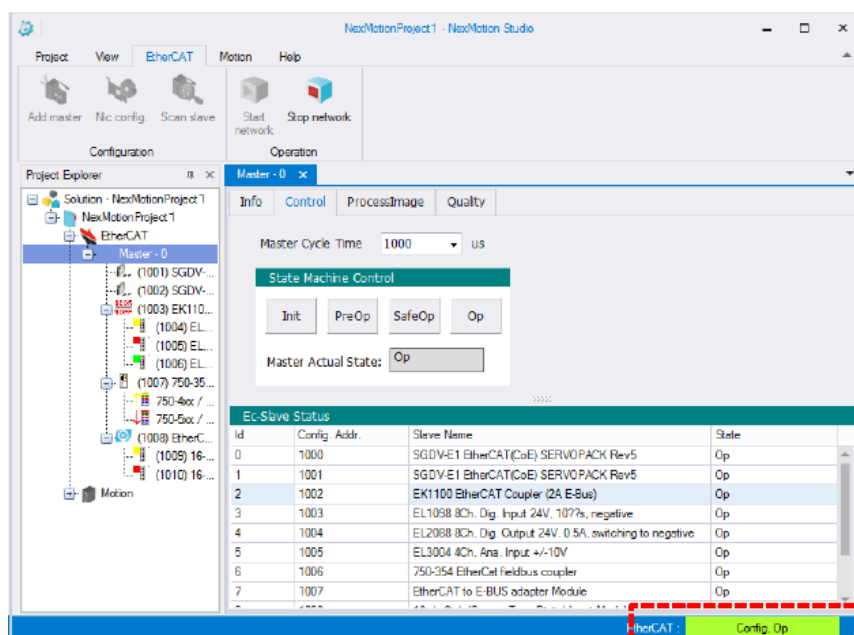


Figure EtherCAT Master in Op State

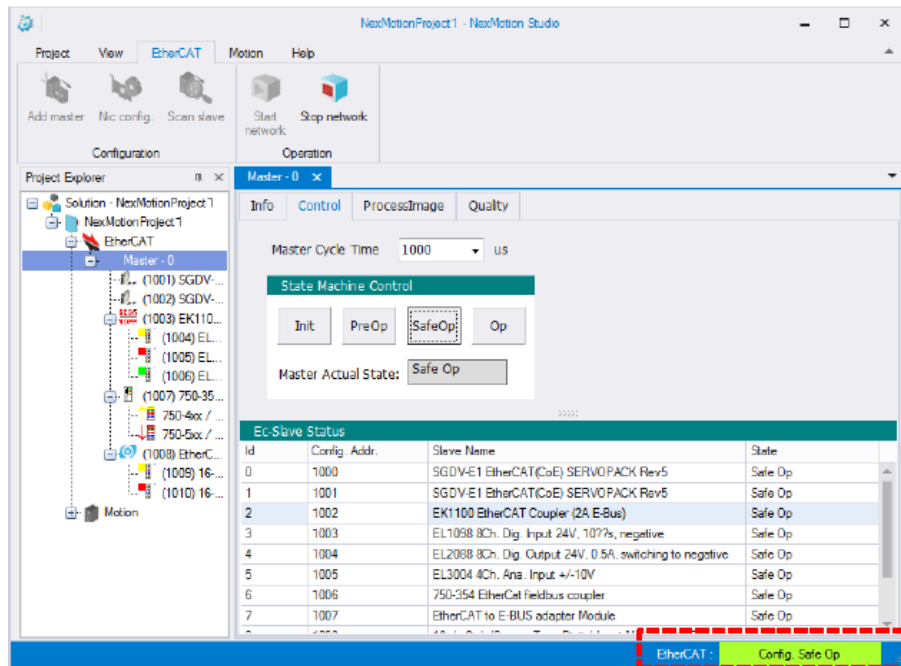


Figure EtherCAT Master in Safe Op State

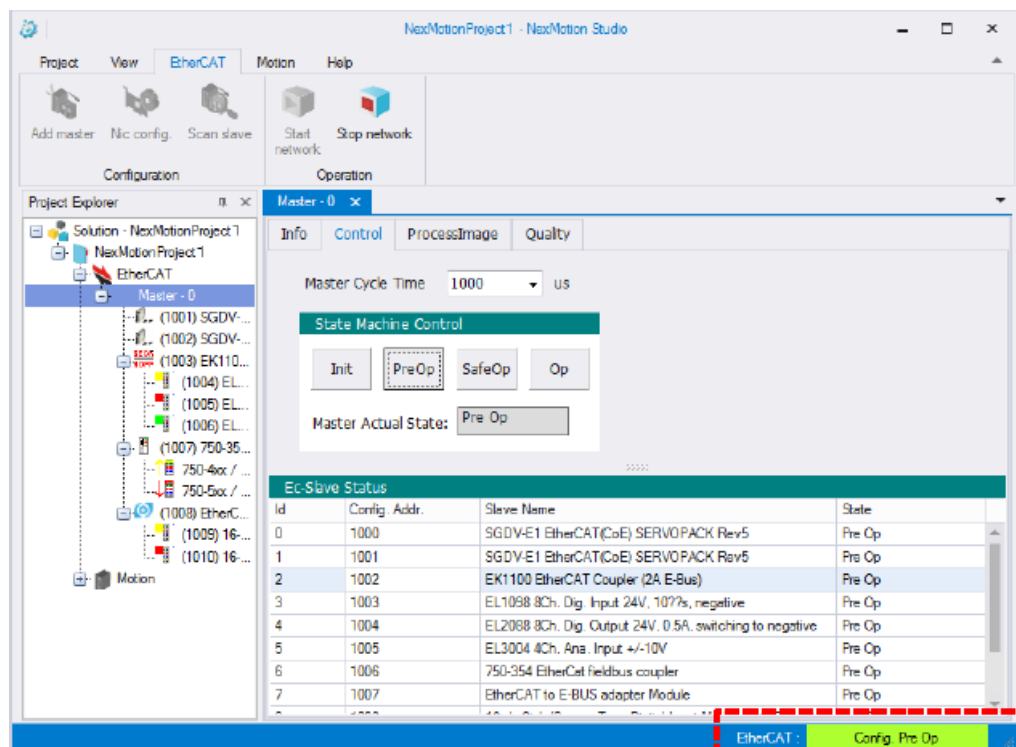


Figure EtherCAT Master in Pre Op State

When the Master state switches to Init, NexMotion Studio will enter Config.Init state, as shown below:

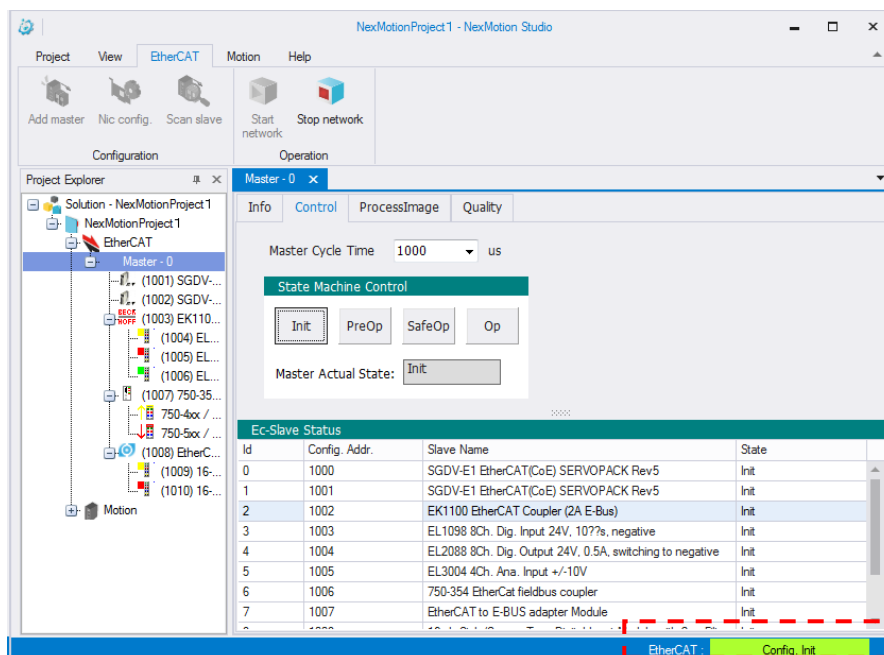


Figure NexMotion Studio enters Config. Init state

When the Master state is either in the ProOp, SafeOp or Op, it means that Master has started to networked with slave. If an abnormal break occurs at this time, such as network line loosening, the Master Actual State will show "Slave retry," while the state of NexMotion Studio will switch to Config. Stopped, as shown below:

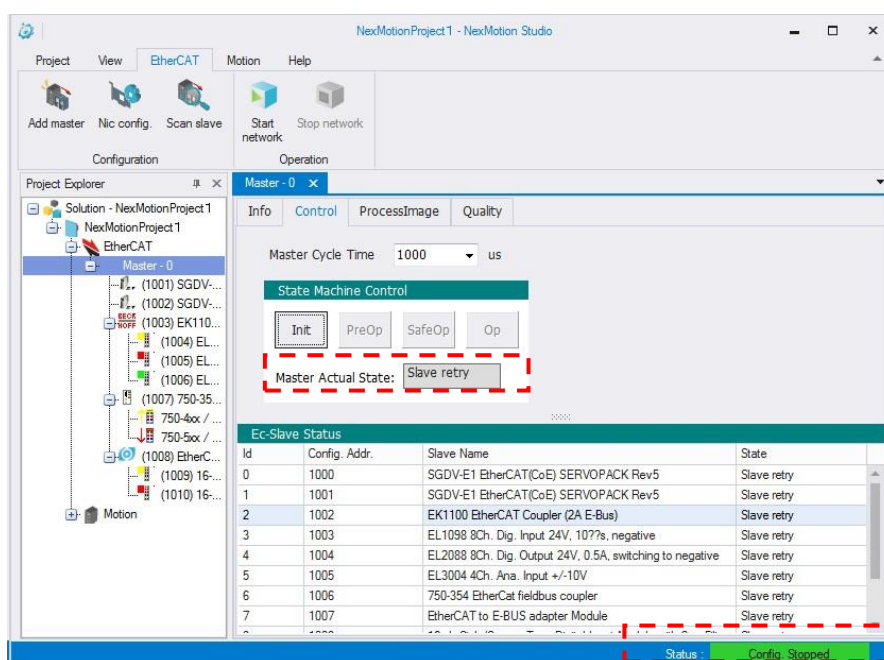


Figure Master enters Slave retry state



4.1.1.3. Master ProcessImage operation page

The ProcessImage operation page displays all the Process Data information that Master currently connects to slave. Process Image is divided into two forms: Input and Output, covering:

- Slave Id: Slave's location on the topology, beginning with 0
- Variable Name: Mapped slave object name
- Data Type: Mapped slave object's data format
- Byte Size: Mapped slave object's data length
- Byte Offset: The location of the mapped slave object on the ProcessImage memory
- Online Value: The current value of the object

The user can select the Online Value displayed to be decimal or hexadecimal from the **Hex** control item on the page, with the default being the control item not checked, and the online value decimal. To switch to hexadecimal, check the control item of **Hex**. Please note that when the **Hex** control is ticked, the format of the input parameter should be in line with the hexadecimal system, and the Master State switched to the Op State, so that the input values can be valid, as shown below:

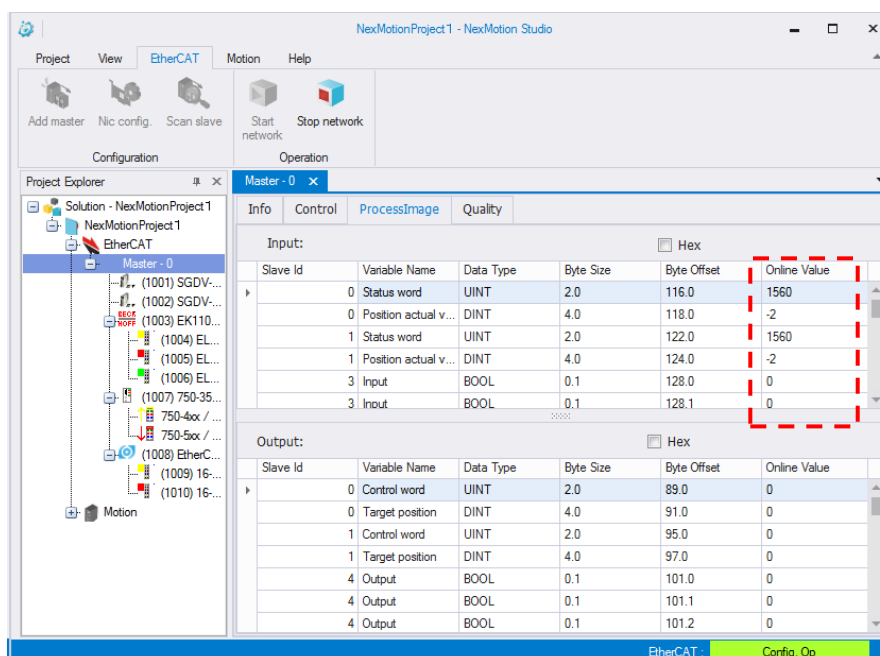


Figure Master ProcessImage page (decimal display)

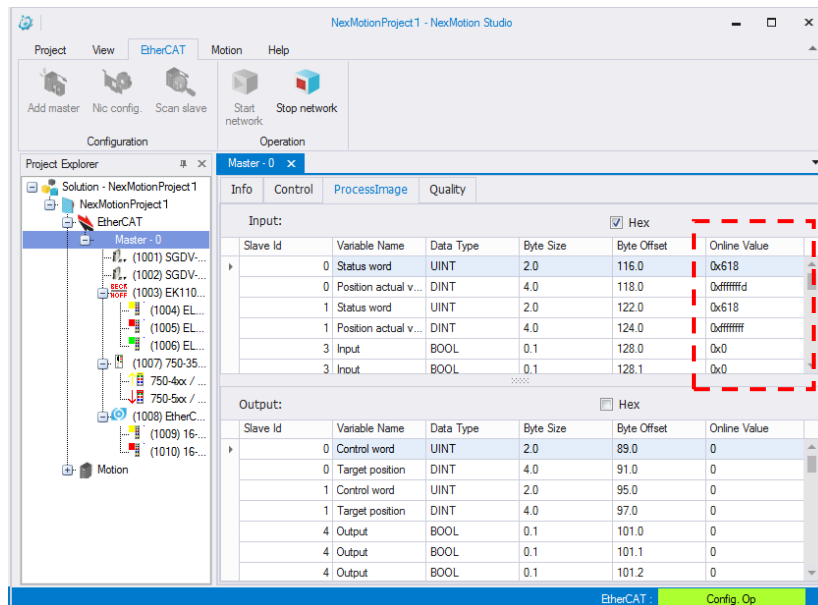


Figure Master ProcessImage page (hexadecimal display)

4.1.2. Slave operation interface

4.1.2.1. Slave DevInfo operation interface

The "Slave DevInfo" page provides basic information about Slave, such as vendor name, Slave type and name, while there is also a **Configuration** button to open the slave advanced settings window. Please note that if Master and slave are networking (Master state in either Pro-Op, Safe-Op or Op), this function will be closed. To make advanced settings for slave, switch the Master state to Init state, as manifested in the following figure:

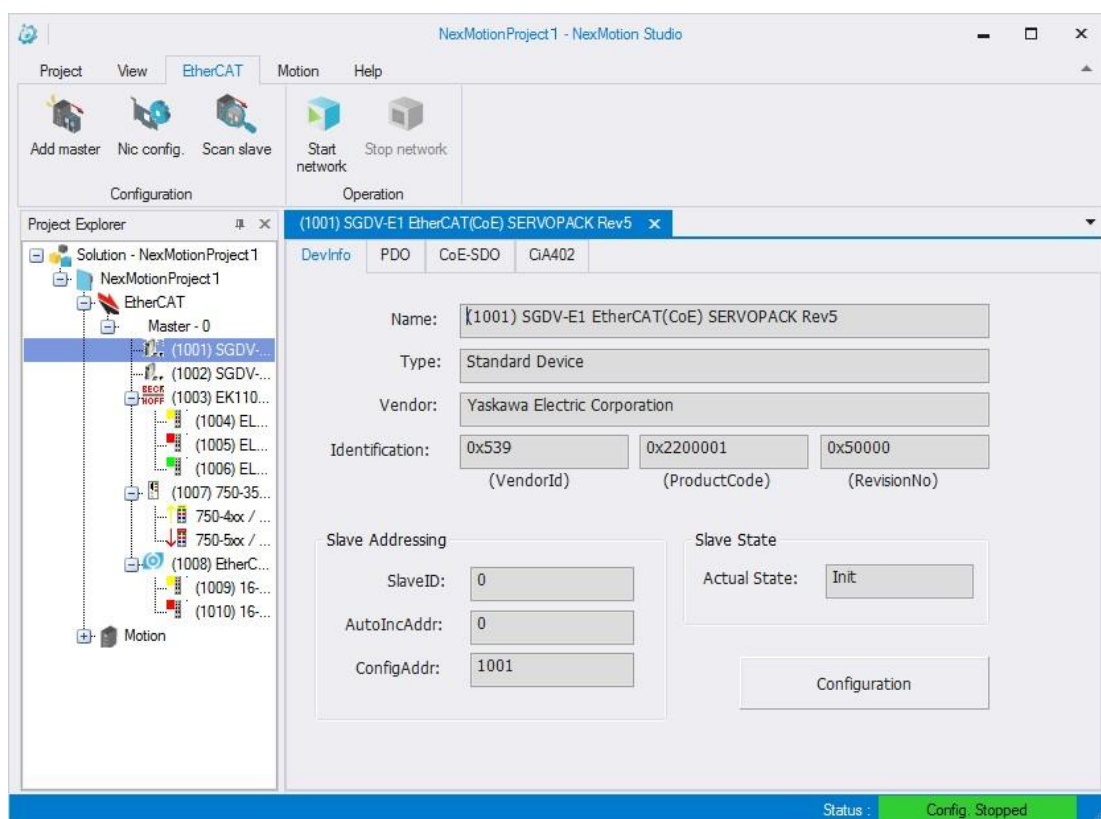


Figure Slave operation page: DevInfo

4.1.2.2. Slave PDO operation page

The "Slave PDO" page mainly shows the details on Slave Process Data. The Process Image is divided into two blocks: Input and Output, with each block containing Local offset(byte), Name, Type, Global offset(byte), Size(byte), and Online Value. Users can choose the Online Value to be displayed in decimal or hexadecimal systems. The Input and Output block display mode is switched via the **Hex** control item above the block, with the default being the control item not checked, and the online value decimal. To switch to hexadecimal, check the control item of **Hex**. Please note that when the **Hex** control is ticked, the format of the input parameter should be in line with the hexadecimal system, and the Master State switched to the Op State, so that the input values can be valid, as shown below:

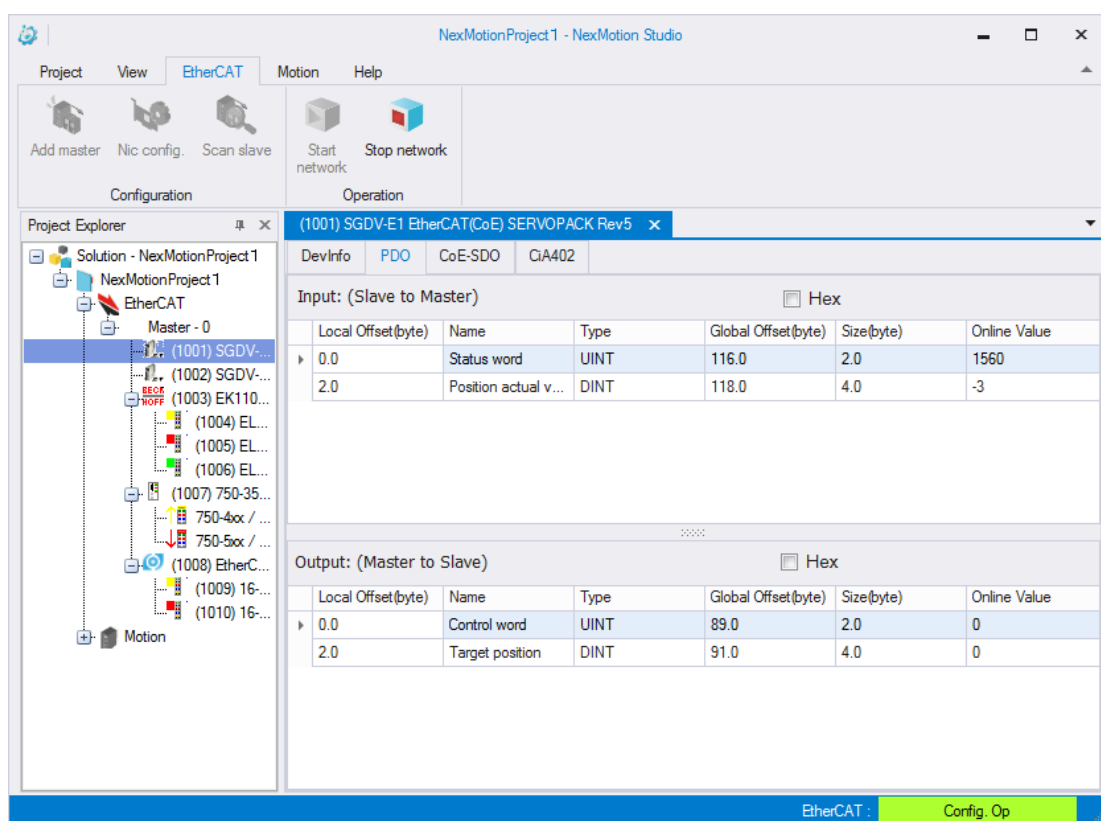


Figure Slave operation page: PDO

4.1.2.3. Slave CoE-SDO operation page

CANOpen technology has been a fairly common and mature technology in the application of industrial automation. The EtherCAT protocol implements this CANOpen protocol in terms of application; that is, "CANOpen over EtherCAT (CoE)."

The EtherCAT Slave supporting the CoE protocol can read and write CoE objects that are made available in Slave through the CoE-SDO operation interface.

It should be noted that the object data will be updated periodically when the "CoE object" is mapped to ProcessData, and thus when the user writes values to the mapped "CoE object" via the "CoE-SDO" operation interface, the values will be immediately overwritten by that of ProcessData.

This operation page, based on the "CoE object" nature, is subdivided into four sub-pages: 0x1000~0x1FFF, 0x2000~0x5FFF, 0x6000~0x9FFF, and 0xA000~0xFFFF, as shown in the following figure:

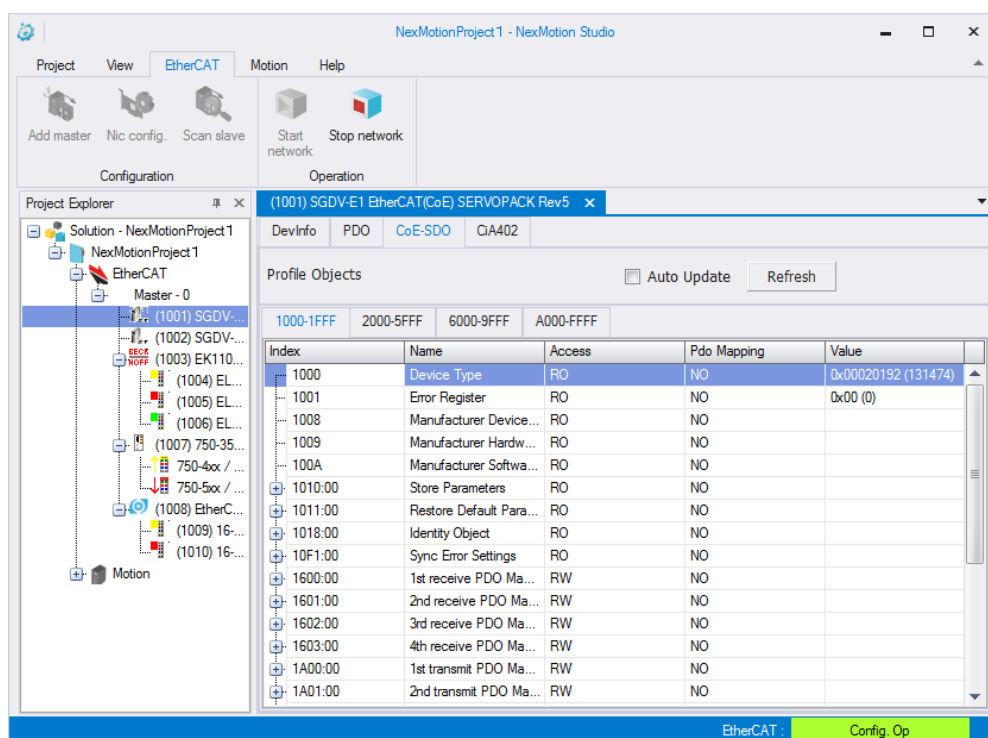


Figure Slave operation page: CoE-SDO

The way to edit object value: Double click the left mouse button for the line of the objects to be edited to pop up the edit window: Set CoE Object Value Dialog. The user can choose to edit using the decimal or hexadecimal system and enter the value in the corresponding field. Press the **OK** button when the editing is finished, and click

the **Cancel** button if you want to abandon the edit, as shown in the figure below:

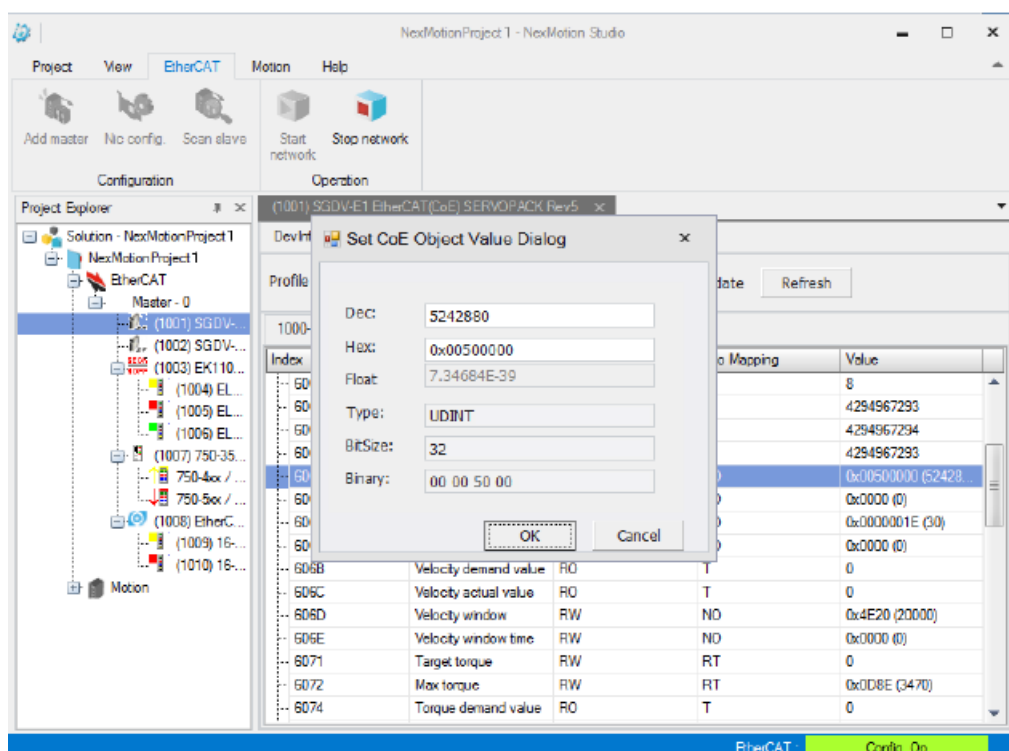


Figure Set CoE Object Value Dialog

4.1.2.4. DIO operation interface

The DIO operation interface is option page, and if the type of Slave is the integrated digital input and output device, the option page will display the DIO page, which is divided into three sections:

- (A) Digital output: Display corresponding light signals based on the slave digital output bit quantity and value. The area will show the value of slave digital output only when the Master is in the Safe-Op/Op state. To control the value of each bit by clicking on the left mouse button, the Master state must first be switched to the Op state.
- (B) Digital output cyclic control: Control the digital output value in the way of a marquee.
- (C) Digital input: Display corresponding light signals based on the slave digital input bit quantity and value. The area will show the value of slave digital input only when the Master is in the Safe-Op/Op state.

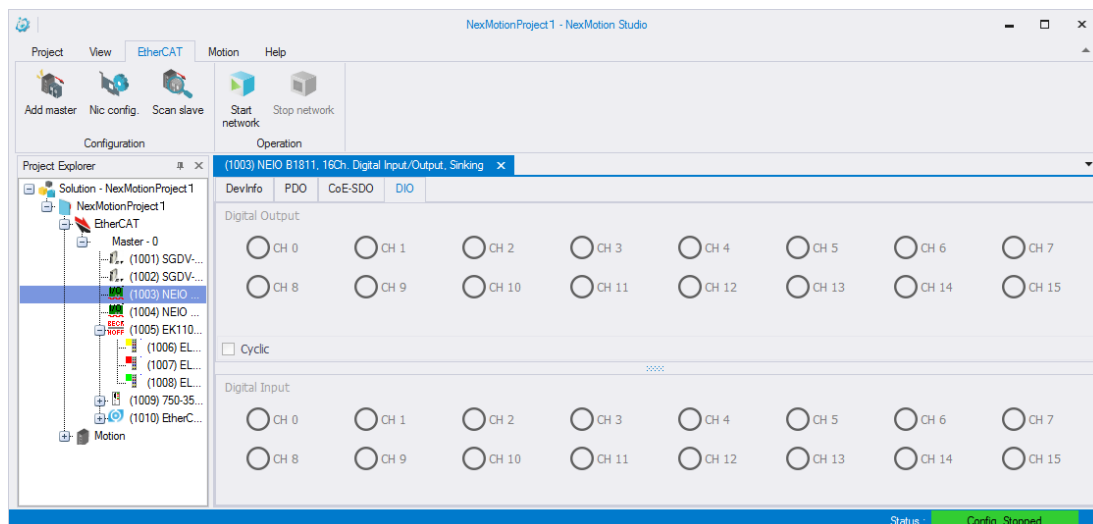


Figure Option page: DIO (Config. Stopped state)

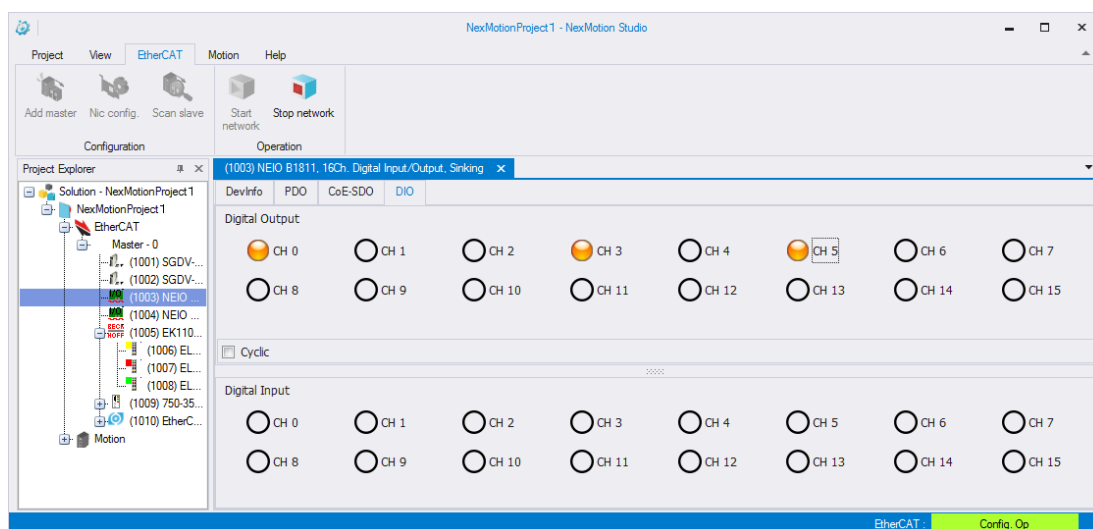


Figure Option page: DIO (EtherCAT Config. Op state)

Option page: DI page; if the type of Slave is digital input device, the option page will display the DI page as well as corresponding light signals based on the digital input bit quantity and value. The area will show the value of slave digital input only when the Master is in the Safe-Op/Op state.

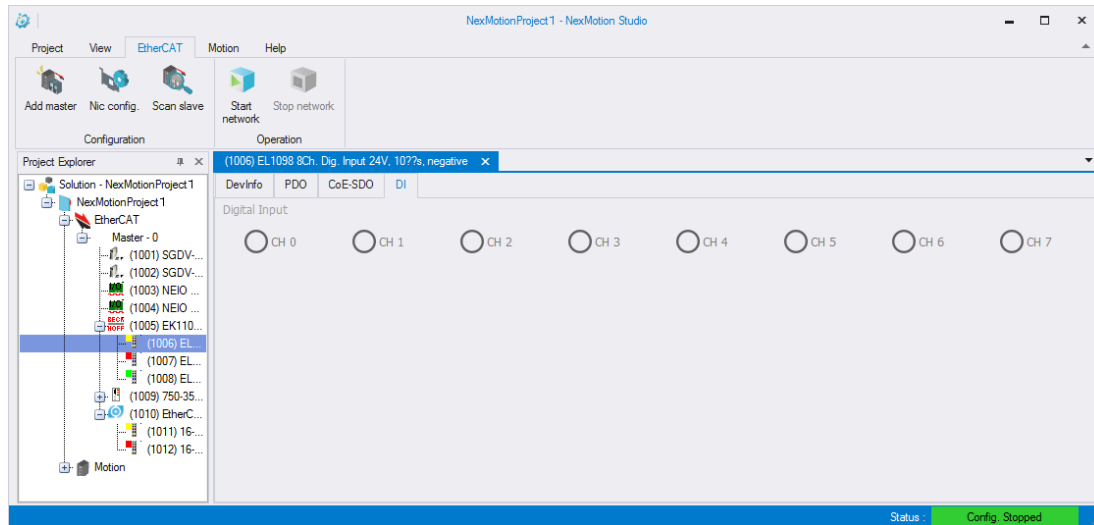


Figure Option page: DI

Option page: DO page; if the type of Slave is digital output device, the option page will display the DO page, which is divided into two blocks:

- (A) Digital output: Display corresponding light signals based on the digital output bit quantity and value. The area will show the value of slave digital output only when the Master is in the Safe-Op/Op state. To control the value of each bit by clicking the left mouse button, the Master state must first be switched to the Op state.
- (B) Digital output cyclic control: Control the digital output value in the way of a marquee

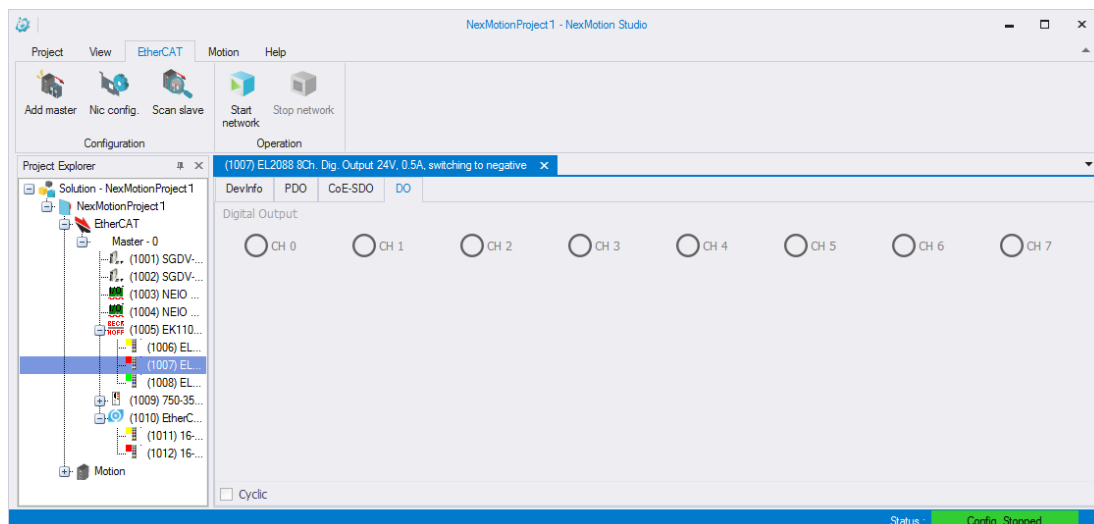


Figure Option page: DO

4.1.3. CiA402 operation interface

The CiA402 operation interface is the option page, and if the type of Slave is the driver with the CiA402 specification, the option page will display the CiA402 page, which is divided into five parts:

(A) State Control: The user can control the value of driver Control Word with the following six buttons:

No.	button	Function
1	Disable	Control bit 0, 1, 2, 3 turned off
2	Ready	Control bit 1, 2 turned on Control bit 0 off
3	Switch on	Control bit 0, 1, 2 turned on Control bit 3 turned off
4	Enable	Control bit 0, 1, 2, 3 turned on
5	Quick stop	Control bit 1 turned on Control bit 2, 7 turned off
6	Fault reset	Control bit 7 turned on

P.S: The CiA402 state machine switches between No.1 to No.4. To switch the driver to Enable (Servo on), the user must comply with the CiA402 specification. Switch the driver to Servo on following the four states from button No.1, button No.2....

In the process of Control, NexMotion Studio will synchronously read the online value of Control Word from the driver through the network, and display it in the Actual State and Control Word fields, so that the user can confirm whether there is any exception during the switching process by reading the actual value of the driver.

(B) Status Word: Read the Status Word of the driver through the network. Because the length of Status Word data is 16 bit and the on/ off of each bit represents different meanings, in order for the user to be able to observe the change of the driver Status Word more clearly, this zone is displayed in the form of bit. If the bit value is 1, the control item will be displayed in the form of a tick; otherwise no tick.

(C) Axis Position Info: Read and display the Target Position and Actual Position of the driver through the network.

(D) Axis Operation Control: Select the motion mode to be set by the driver from the pull-down menu of the Mode of operation before pressing the **Set** button to complete the setting. NexMotion Studio will also read the driver's current Operation Mode Display actual value and display it in the Operation Mode Display control item via the network.

(E) Axis Control: This area provides the operation pages for the five motion modes, as listed below:

- PP(Profile Position Mode)
- PV(Profile Velocity Mode)
- Home(Homing Mode)
- PT(Profile Torque Mode)
- CSP(Cyclic Synchronized Position Mode)

Switch the Master state to Op state before using the CiA402 page for the actual operation of the driver; otherwise, the page of CiA402 will be in the state of Lock, as shown below:

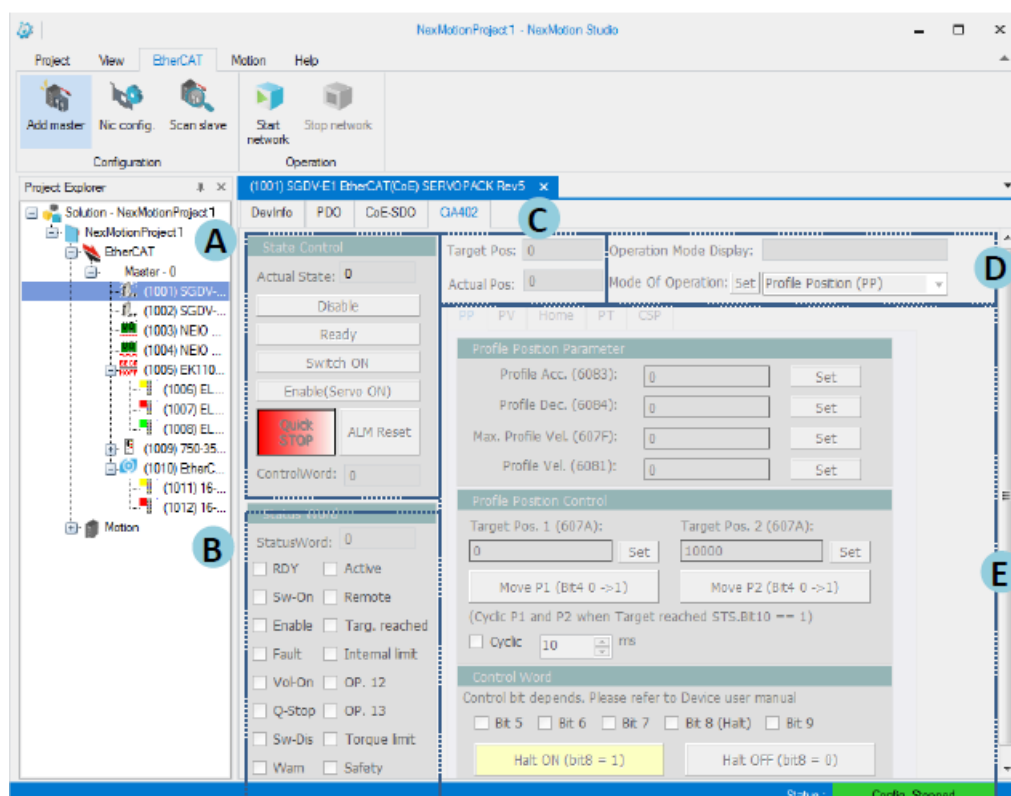


Figure The CiA402 page will appear in the state of lock

After switching the Master state to the Op state, NexMotion Studio will enter EtherCAT Config.Op state, where the user can set the parameters of the driver through the CiA402 page and operate each motion mode, as exhibited below:

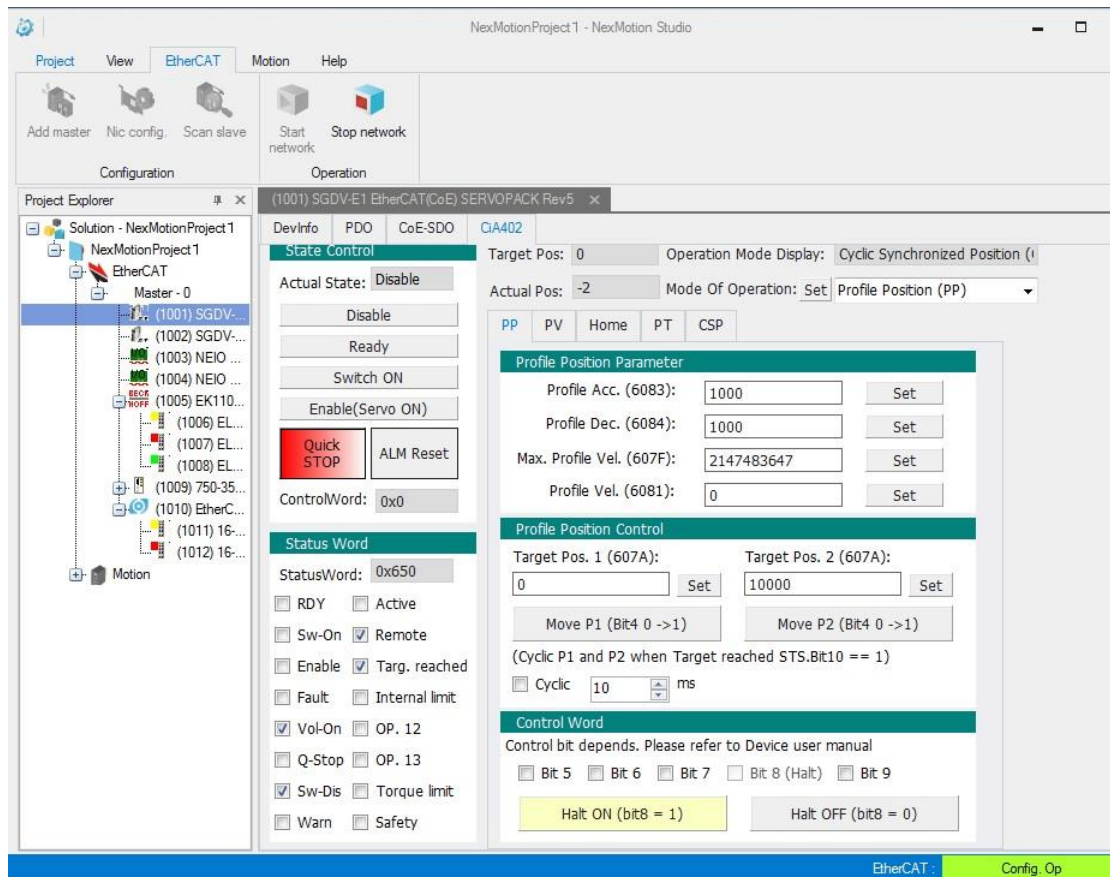
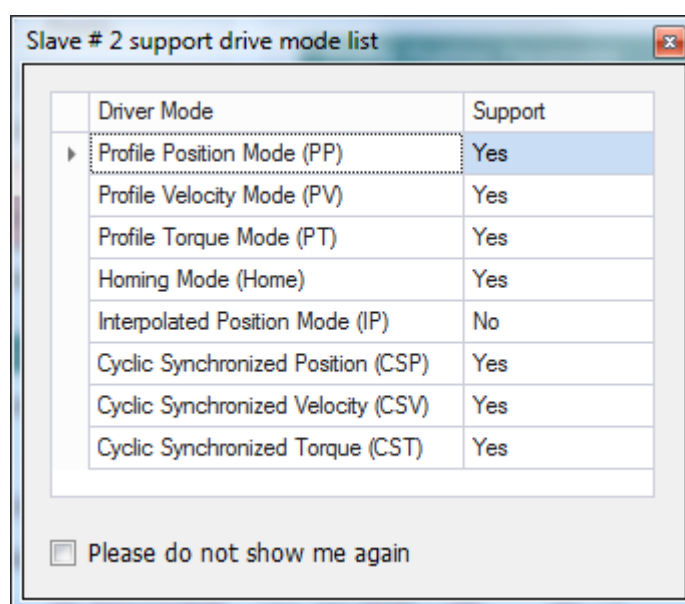


Figure The CiA402 page will appear in the state of unlock

After the Master switches to Op state, the support drive mode list of the driver will pop up, users can determine whether the list pops up every time the CiA402 page is opened by ticking **Please don't show me again** below.



Driver Mode	Support
Profile Position Mode (PP)	Yes
Profile Velocity Mode (PV)	Yes
Profile Torque Mode (PT)	Yes
Homing Mode (Home)	Yes
Interpolated Position Mode (IP)	No
Cyclic Synchronized Position (CSP)	Yes
Cyclic Synchronized Velocity (CSV)	Yes
Cyclic Synchronized Torque (CST)	Yes

☐ Please do not show me again

Figure support drive mode list

Please note that if the Object dictionary of the driver does not support the driver mode (0x6052), the window will not pop up.

4.1.3.1. PP operation page

The PP Page is divided into three zones:

- (A) Profile Position Parameter: Set the acceleration and deceleration and the maximum speed parameter associated with the PP mode; after putting the desired value, press the **Set** button and the CiA402 page will write the value to the driver.
- (B) Profile Position Control: Set the target position and the actual operation of the motor. Please note that before the motor is running, switch the driver to Enable (Servo on) through State Control first. This area provides two sets of Target Position for the user to set. After the **Set** button is pressed, the corresponding value will be written to the driver based on the **Set** button in the Target Position 1 or Target Position 2. For example, the user needs to press **Move P1** to move the motor to Target Position 1 while pressing **Move P2** to move to Target Position 2. In addition to a single Profile Position move, the PP page also provides Profile Position periodic reciprocating motion, which is set in the following manner:

Step1: Set the switchback station of reciprocating motion to Target Position 1 and Target Position 2.

Step2: Tick the **Cyclic** control item

Step3: Set the time interval between reciprocating motion, and put the time interval to be set on the right side of the Cyclic control item, with the unit being Millisecond.

Step4: Press either **Move P1** or **Move P2** and selecting the button can be determined based on where the user wants the motor to move first.

- (C) Control Word: In this area, Control Word bit 5, bit 6, bit 7, and bit 9 are open to users for control. If users need to control the value of Control Word bit 8, they can directly select the **Halt ON** button below. Please refer to the driver's instructions for the value of each bit of Control Word corresponding to the meaning.

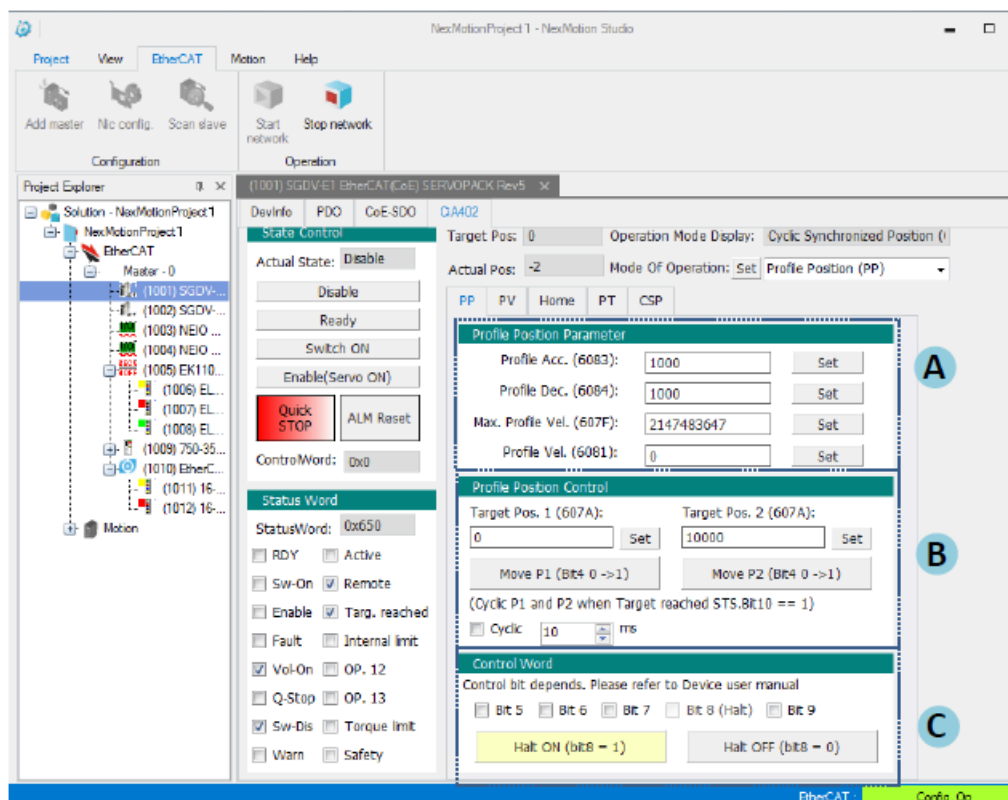


Figure PP operation page

4.1.3.2. PV operation page

The PV Page is divided into three zones:

- (A) Profile Velocity Parameter: Set the acceleration and deceleration and the maximum speed parameter associated with the PV mode; after putting the desired value, press the **Set** button and the CiA402 page will write the value to the driver.
- (B) Profile Velocity Control: Set the target position and the actual operation of the motor. Please note that before the motor is running, switch the driver to Enable (Servo on) through State Control first.

(C) Control Word: In this area, Control Word bit 5, bit 6, bit 7, and bit 9 are open to users for control. If users need to control the value of Control Word bit 8, they can directly select the **Halt ON** button below. Please refer to the driver's instructions for the value of each bit of Control Word corresponding to the meaning.

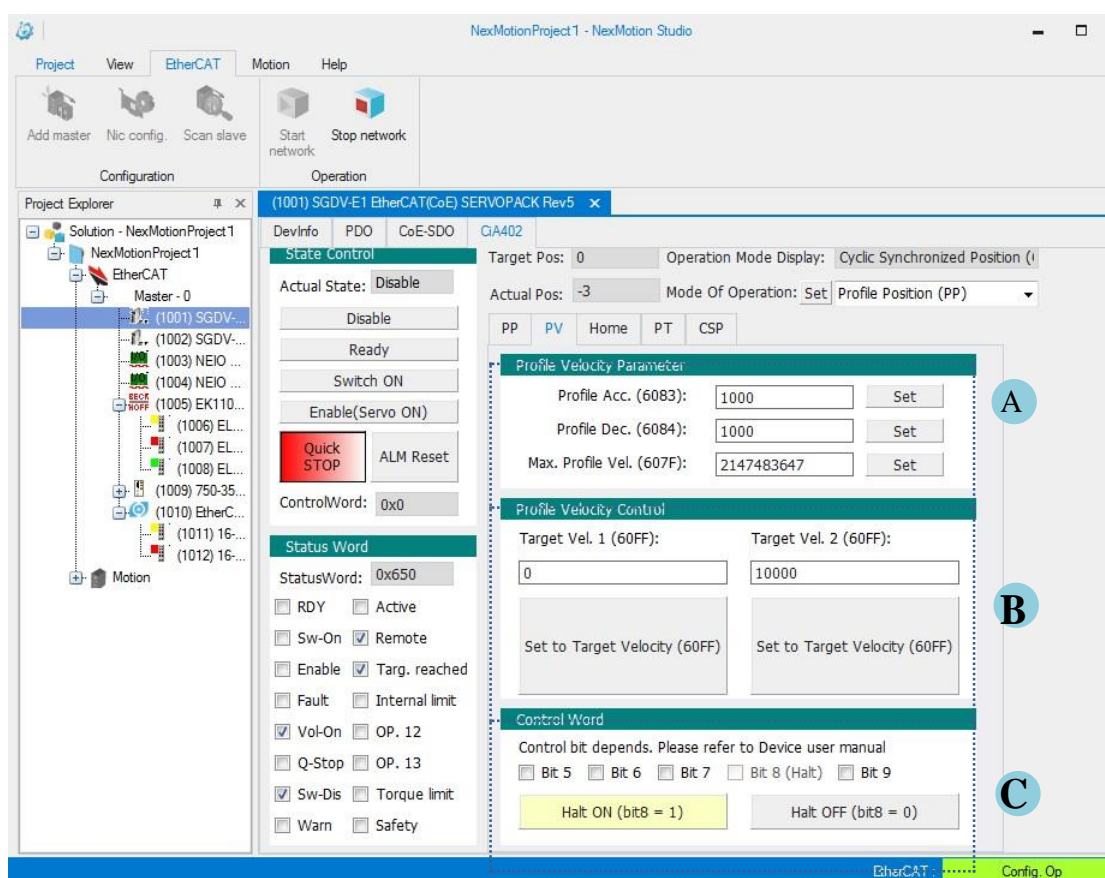


Figure PV operation page

4.1.3.3. HOME operation page

The Home Page is divided into three areas:

(A) Homing Parameter: Set the parameters associated with the Home mode, including Home Method, Home Offset, Home Acceleration, Home Speed Switch, and Home Speed Zero; after putting the desired value, press the **Set** button and the CiA402 page will write the value to the driver. Please refer to the driver's instructions for each value corresponding to the meaning.

(B) Homing Control: After setting the value in zone A, press the **Control Word Bit 4 = 1** button if you want to start Home. To stop Home, press the **Control Word Bit 4 = 0** button or HaltON button, depending on the driver feature.

(C) Control Word: In this area, Control Word bit 5, bit 6, bit 7, and bit 9 are open to users for control. If users need to control the value of Control Word bit 8, they can directly select the **Halt ON** button below. Please refer to the driver's instructions for the value of each bit of Control Word corresponding to the meaning.

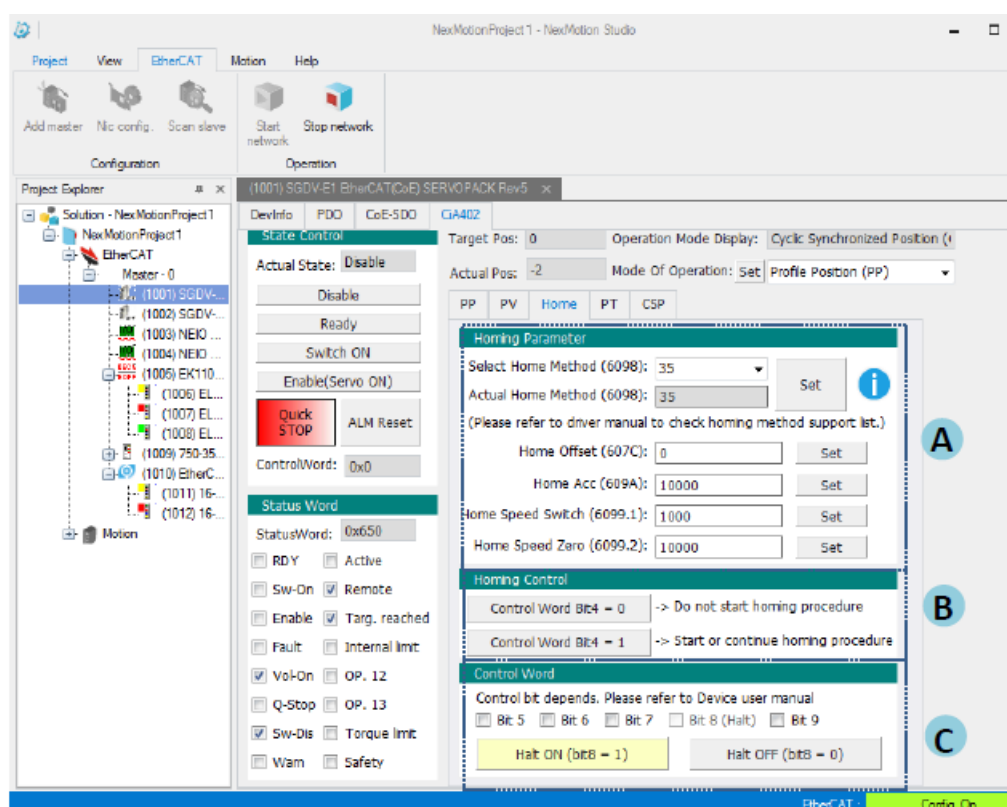


Figure Home operation page

4.1.3.4. PT operation page

(A) Profile Torque Parameter: Set the parameter associated with the PT mode; after putting the desired value, press the Set button and the CiA402 page will write the value to the driver. Please refer to the driver's instructions for each value corresponding to the meaning.

- (B) Profile Torque Control: Set the Target Torque and the actual operation of the motor. Please note that before the motor is running, switch the driver to Enable (Servo on) through State Control first. This area provides two sets of Target Torque for the user to set. To set the value of Target Torq.1 to the driver, press the **Set to Target Torque** button right below Target Torq.1.
- (C) Control Word: In this area, Control Word bit 5, bit 6, bit 7, and bit 9 are open to users for control. If users need to control the value of Control Word bit 8, they can directly select the **Halt ON** button below. Please refer to the driver's instructions for the value of each bit of Control Word corresponding to the meaning.

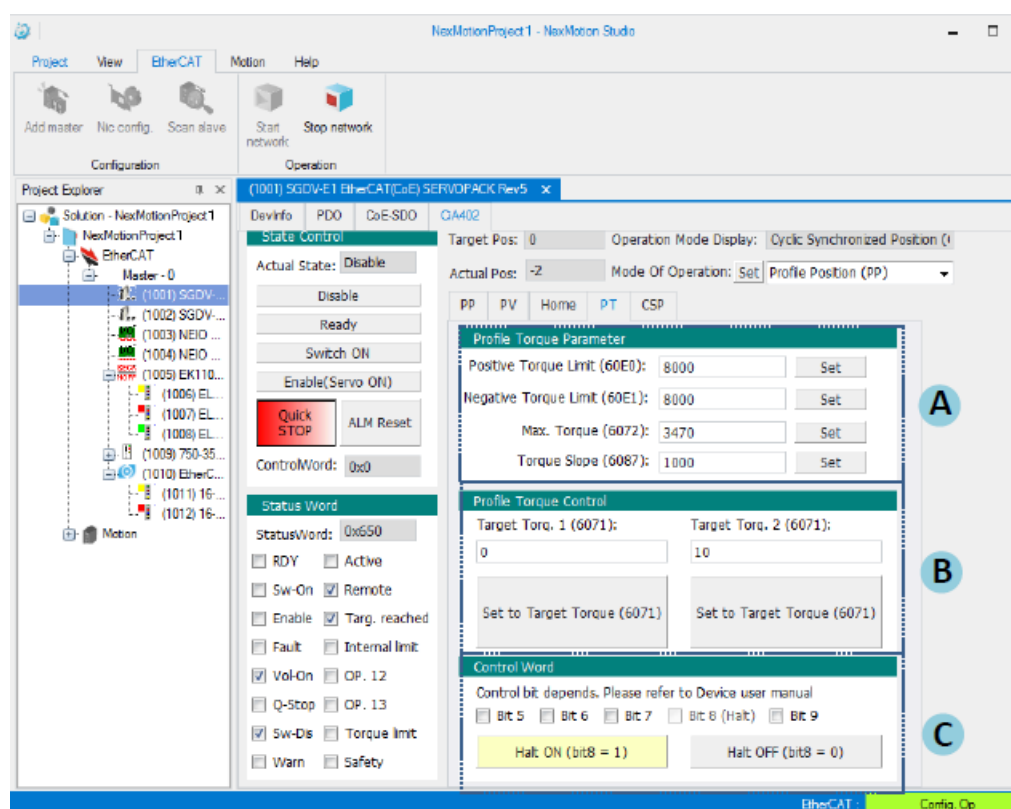


Figure PT operation page

4.1.3.5. CSP operation page

- (A)Cyclic Synchronized Position Control: Set the Target Position and the actual operation of the motor. Please note that before the motor is running, switch the driver to Enable (Servo on) through State Control first.

In addition to entering the value directly into the Target Position field, the user may fine tune the value in the Target Position field via the \leq and \geq buttons, with the value adjusted based on the one between the \leq and \geq buttons

(B) Control Word: In this area, Control Word bit 8 is open to users for control. Press **Halt ON** (Control bit 8 = 1) and the motor will stop running. To cancel Halt ON (Control bit 8 = 1), click **Halt OFF** (Control bit 8 = 0). Please refer to the driver's instructions for the actual behavior of the motor after clicking **Halt OFF** (Control bit 8 = 0).

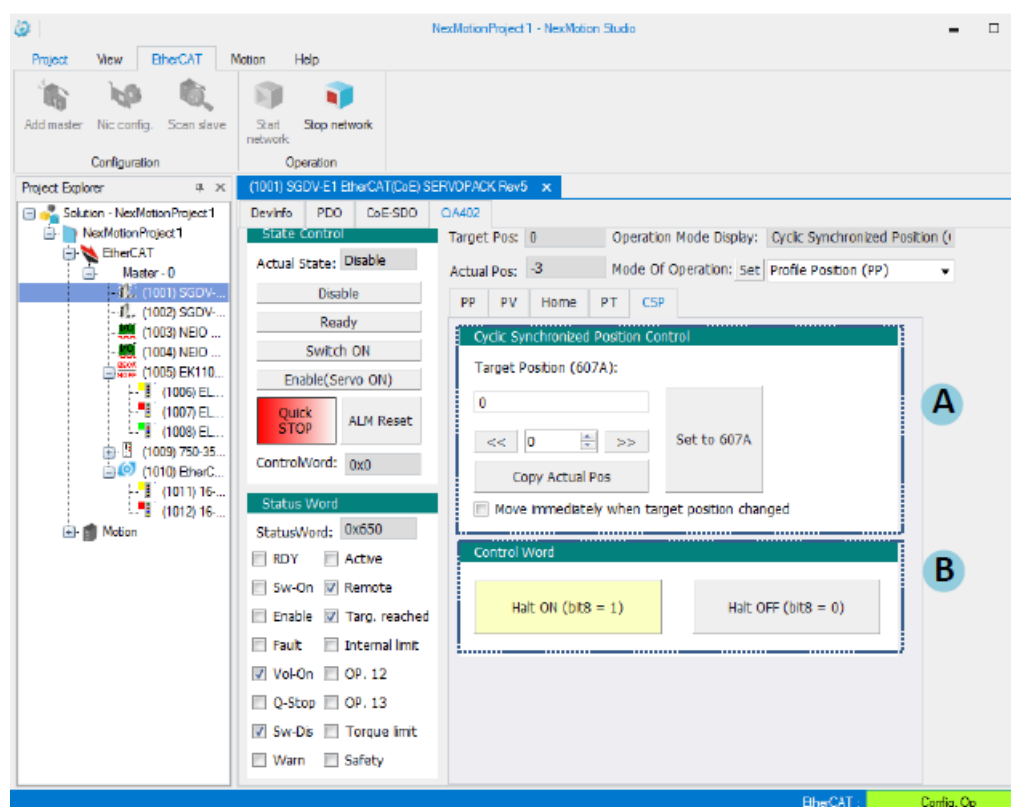


Figure CSP operation page

4.2. Motion operation

NexMotion Studio provides customers with flexibility for axis control and IO control features. According to the application, the user can add the control object, set the control object parameters, and establish the relation between the control object and the actual hardware chain before launching the Motion core, and by using the control interface provided by NexMotion Studio, perform uniaxial and group operation control.

The following figure is the operation flow chart of the NexMotion Studio Motion. Please refer to the "Motion setting" section for finishing control object establishment, object parameter setting, and the relation between the control object and the actual hardware chain, with the rest detailed in the following sections.

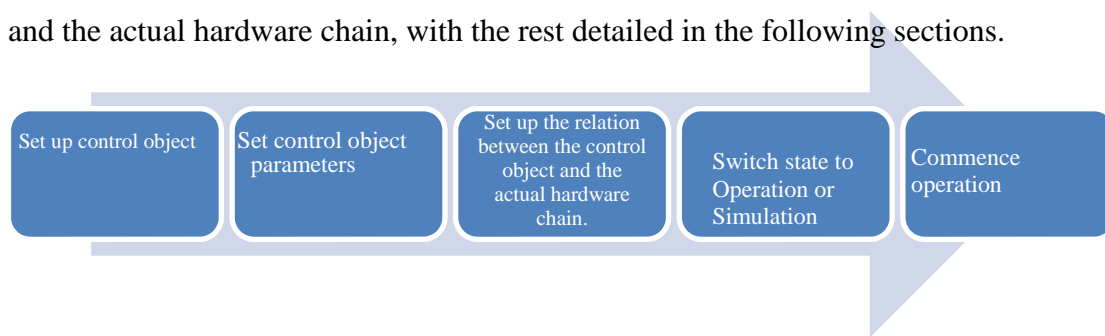


Figure NexMotion Studio Motion operation process

4.2.1. Start Motion

NexMotion Studio comes with the control operation interface of uniaxial and group mechanisms. Before using these operation interfaces, you need to start the Motion core system. Before the Motion core system is started, the operation interfaces are locked and cannot be used, as manifested below:

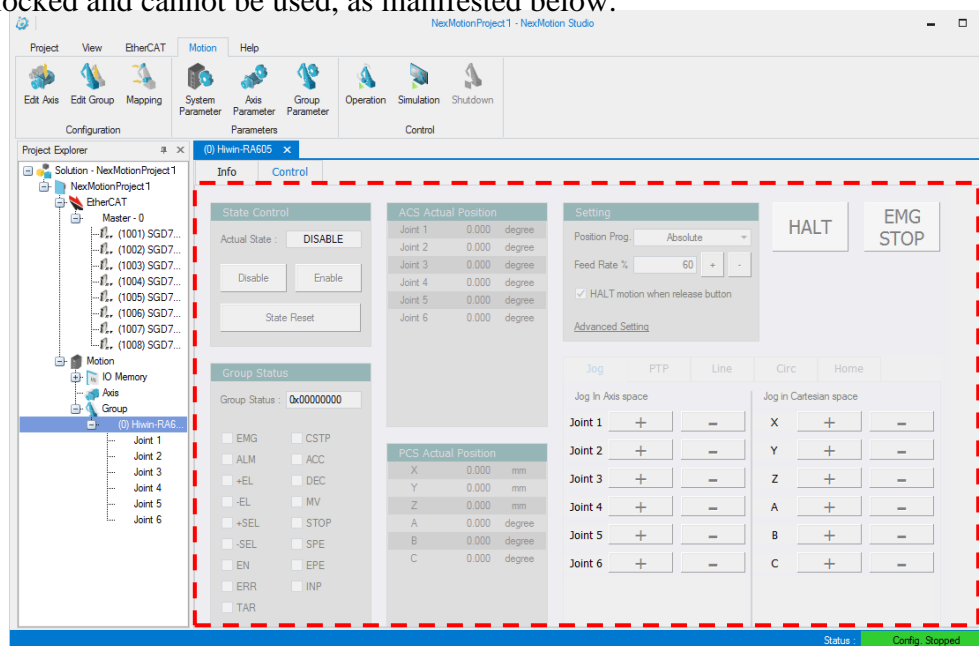


Figure The Motion core system is not started and the operation interface is locked.

The Motion core system supports the two running modes Operation and Simulation. Users can choose the operating mode of the Motion core system according to the application requirements, with the differences between the two modes as follows:

- Operation mode: In this mode, the Motion core system requires a physical device.
- Simulation mode: In this mode, the Motion core system simulates the behavior of the physical device, and no physical device is required.

The user can click the **Operation** or **Simulation** button to start the Motion core system from the Motion menu of the Menu toolbar, with the **Shutdown** button for stopping the core of the Motion system, as shown in the following figure:

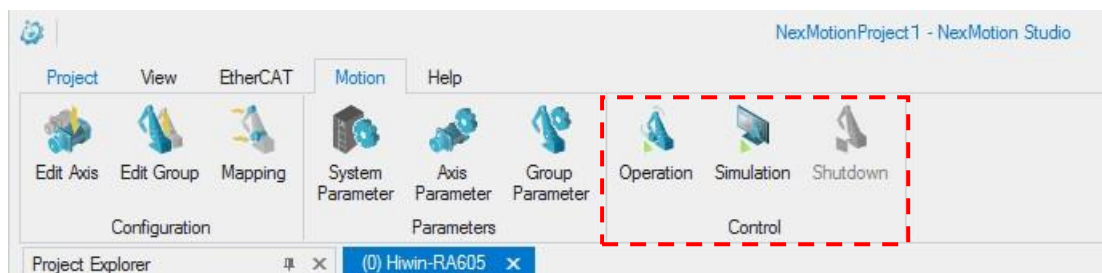


Figure Start the Motion core system button

When the Motion core system is successfully launched, the lower right corner of NexMotion Studio will show the current core state mode, as shown in the following figure:

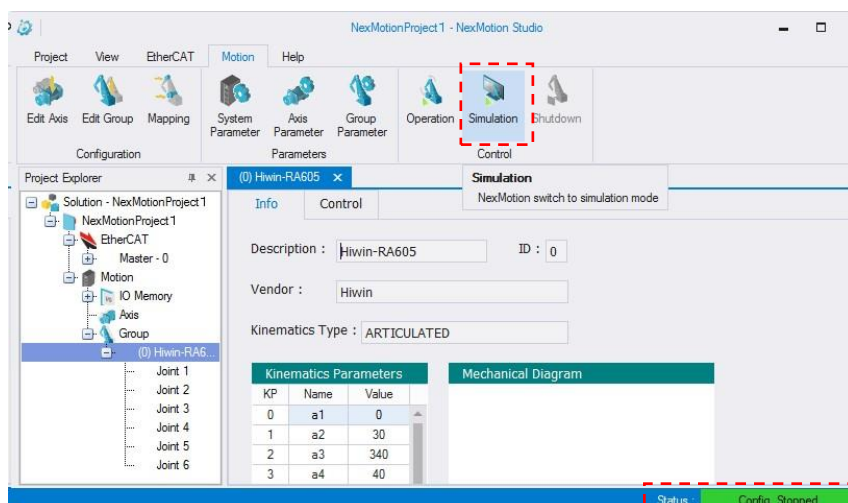


Figure Motion system core starts as Simulation mode

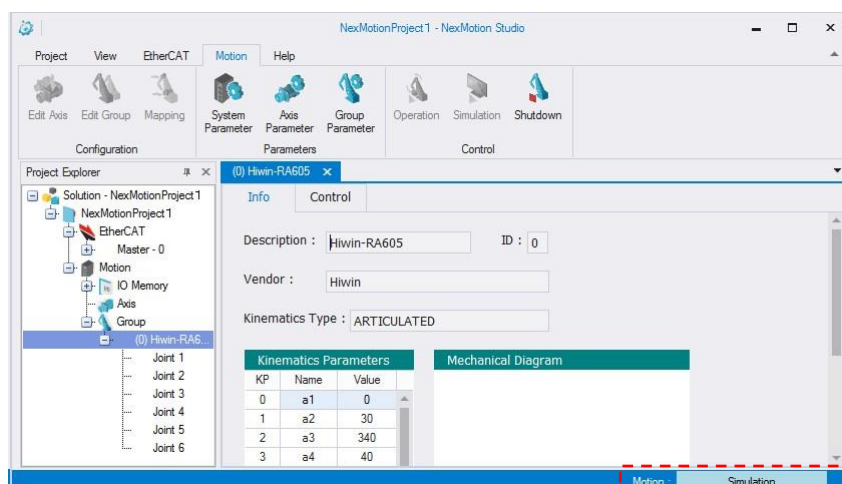


Figure Motion system core successfully starts as Simulation mode

4.2.2. Uniaxial control interface

Users can observe uniaxial hardware setting information and complete uniaxial movement control via the uniaxial control interface. Double click the uniaxial object node under Axis to display the uniaxial control interface, as shown in the figure below:

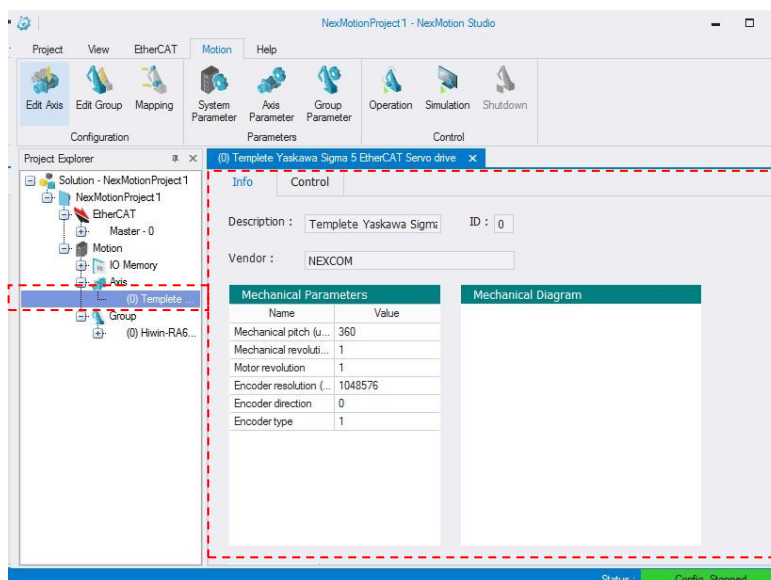


Figure Double click the "Axis" node to display the uniaxial control interface

The uniaxial control interface includes the following two function pages "Info" and "Control"

■ “Info” page

The user can browse relevant information about the axis on this page, including the hardware manufacturer, hardware description, hardware diagram, and relevant hardware parameters, as shown in the figure below:

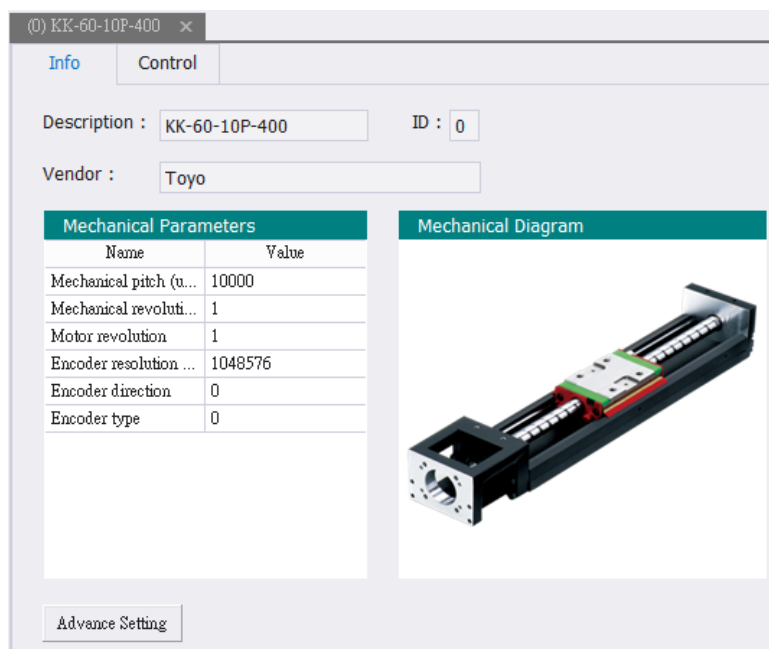


Figure Uniaxial control interface -Info page

The user can click the **Advance Setting** button to display the "Axis Parameter" window, showing all uniaxial control parameters, as shown in the figure below:

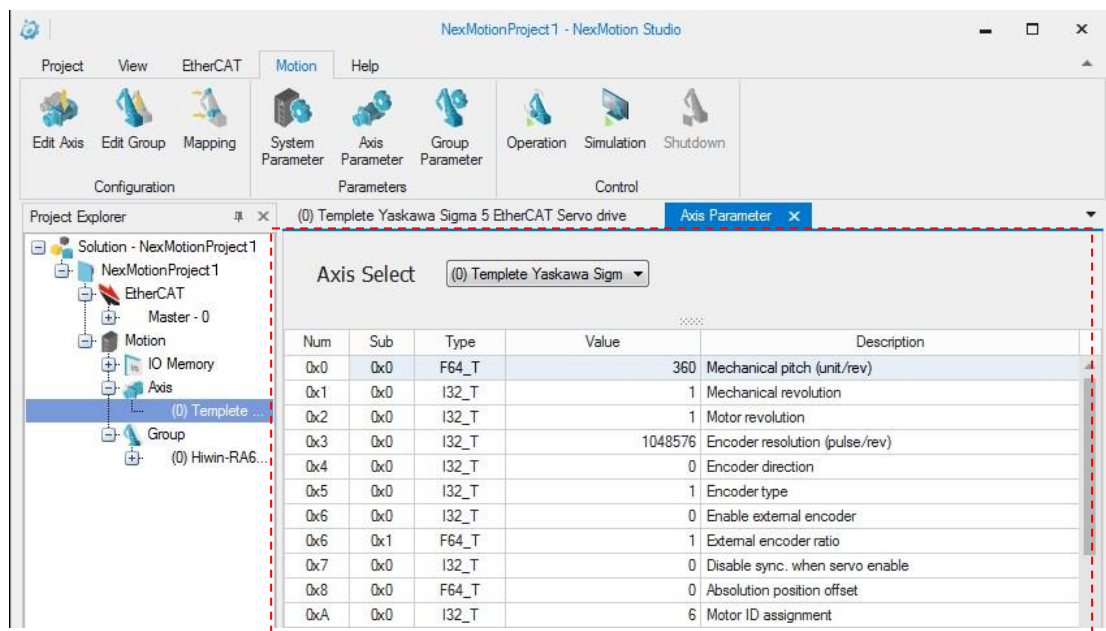


Figure Uniaxial control advanced setting

■ “Control” page

The user can observe the current state of the axis and perform uniaxial movement control through this page. When the Motion system is not in the "Operation" state, the "Control" page is locked, as shown in the following figure:

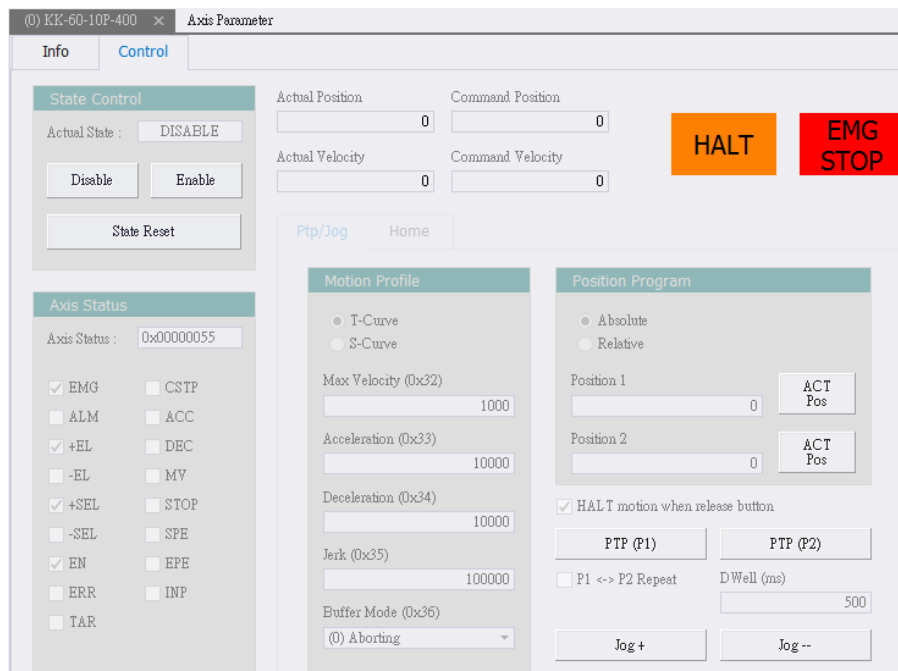


Figure When the Motion state is not "Operaiton," the Control page is locked.

When the Motion system state is switched to "Operation," the "Control" page is unlocked, during which the axis can be controlled, as shown below:

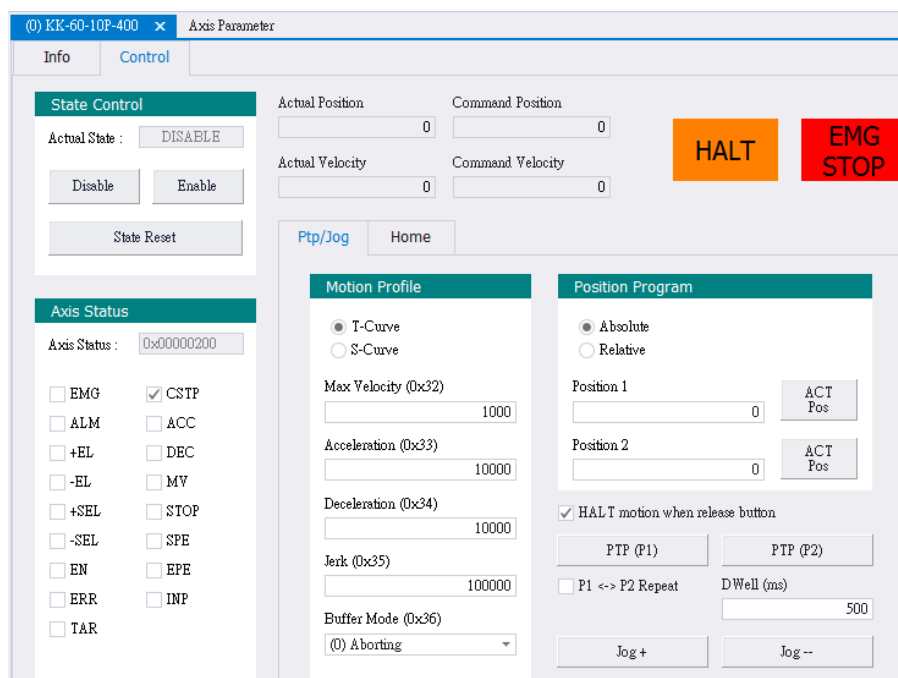


Figure When the Motion system state is "Operaiton," "Control" is unlocked

The functions of the uniaxial interface Control page are detailed as follows:

1. State Control block

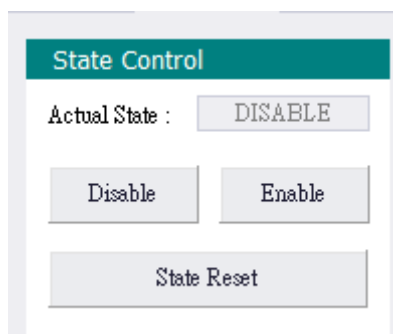


Figure Uniaxial interface Control page, State Control block

- Disable/Enable/State Reset: Axis state (refer to the following table)
- Actual State: Show the current state of the axis; please refer to the following table:

Table Uniaxial Actual State list

State	Description
DISABLE	The current state of the axis is ServoOff.
STAND_STILL	The current state of the axis is ServoOn
HOMING	The axis is performing Home control
DISCRETE_MOTION	The axis is executing control with a final position
CONTINUOUS_MOTION	The axis is executing control without a final position
STOPPING	The axis is in deceleration control, usually in the state right before STOPPED.
STOPPED	The axis is in the stop state, usually in the state right after STOPPED.
WAIT_SYNC	The axis is in the waiting-for-a message state.
GROUP_MOTION	Reserve.
ERROR	The axis is in the error state

* For detailed Actual State, please refer to the section...

2. Axis Status block

It displays the current import and export point positions of the Axis and the current motion state of the Axis.

Axis Status

Axis Status : 0x00000200

☐ EMG

☒ CSTP

☐ ALM

☐ ACC

☐ +EL

☐ DEC

☐ -EL

☐ MV

☐ +SEL

☐ STOP

☐ -SEL

☐ SPE

☐ EN

☐ EPE

☐ ERR

☐ INP

☐ TAR

Figure Uniaxial interface control page, Axis Status block

Table Axis Status point positions

Point position	Description
EMG	External emergency stopping of digital input point positions
ALM	External digital input point positions come from the driver. When the driver gives an alert, its value is 1
+EL	External limit+ digital input point positions
-EL	External limit- digital input point positions
+SEL	Software internal limit+reach signal
-SEL	Software internal limit-reach signal
EN	When the current axis state is "Enable State" (Servo On), its value is 1; please refer
ERR	When the current axis state is "Error State", its value is 1; please refer to...
TAR	When the axis reaches the current position, its value is 1
CSTP	When the velocity command is delivered, its value is 1
ACC	When the current axial state is positive for acceleration, its value is 1.
DEC	When the current axial state is negative for acceleration, its value is 1.
MV	When the current axial state is at its maximum velocity, its value is 1
STOP	When the current axial state is in "Stopped State," its value is 1; please refer to...
SPE	When the current position reaches the Start Position Offset, its value is 1; please refer to...
EPE	When the current position reaches the End Position Offset, its value is 1; please refer to...
INP	When the current location reaches the target location range set by software, its value is 1; please refer to...

3. Command and feedback display block

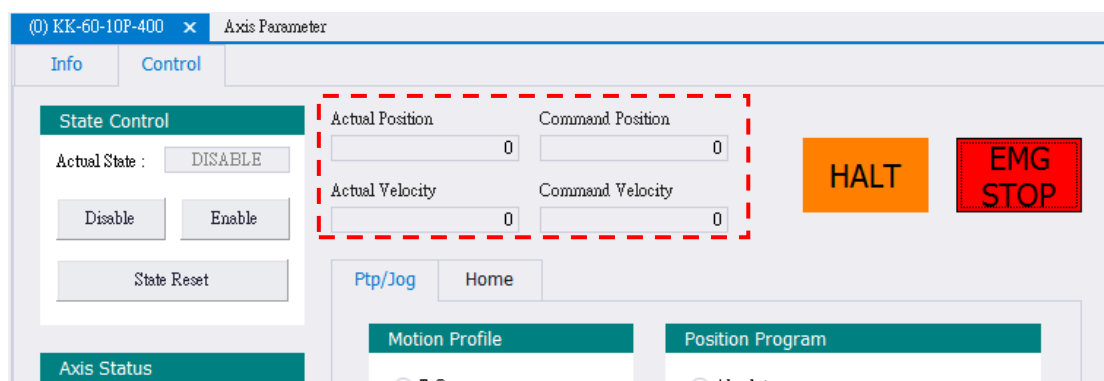


Figure Controller commands and driver feedback display block

- Actual Position: Current position value of the driver
- Actual Velocity: Current velocity value of the driver
- Command Position: Controller's current output command position value
- Command Velocity: Controller's current output command velocity value

4. Stop block

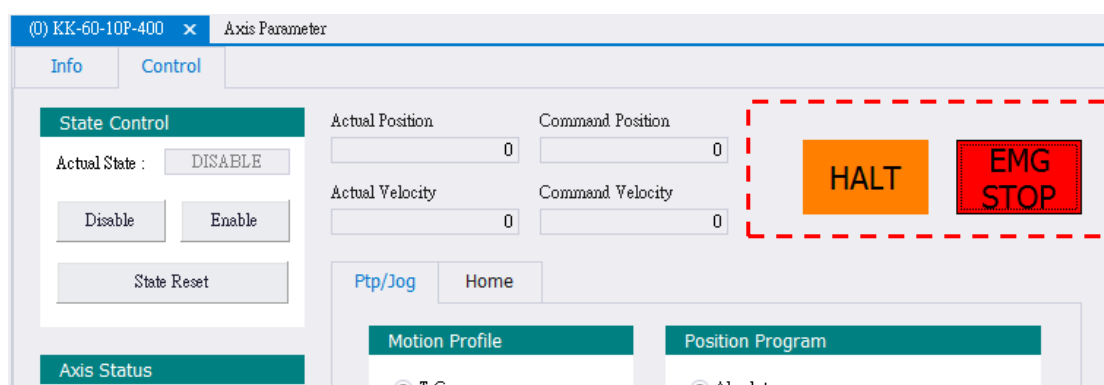


Figure Controller commands and driver feedback display block

- HALT: Switch the axial state to HALT (please refer to...), with the movement control for deceleration and stopping action.
- EMG STOP: Switch the axial state to EMG STOP (please refer to...), with the movement control for emergency stop action.

4.2.2.1. PTP/Jog operation interface

Users can complete uniaxial movement control on this interface, with the functions of each position detailed as follows:

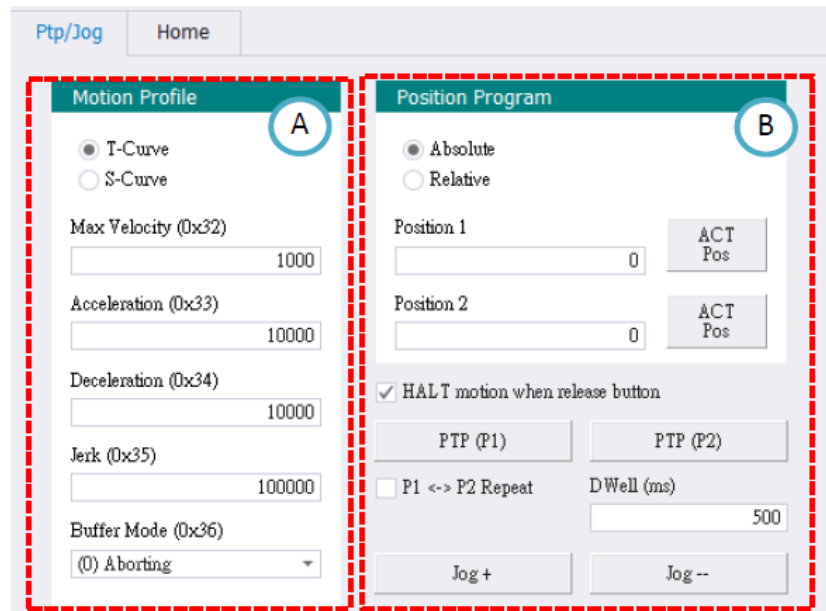


Figure Control: Ptp/Jog interface

1. Area A:

Position	Description
T-Cure/S-Cure	Choose the type of acceleration or deceleration
Max Velocity	Maximal acceleration setting
Acceleration/Deceleration	Acceleration or deceleration setting
Jerk	+acceleration / -deceleration, with the acceleration and deceleration type for S-Cure.
Buffer Mode	Continuous execution of the motion command mode setting, with the supported modes listed as follows: (0)Aborting (1)Buffered (2)Blending Low (3)Blending Previous (4)Blending Next (5)Blending High For the details of each mode, please refer to...

2. Area B:

Position	Description
----------	-------------



Absolute/Relative	Select absolute or relative movement
Position 1/Position 2	Set two goal positions
ACT Pos	Copy the current Actual Position into Target
HALT motion when release button function	When this function is started, release the PTP button and the movement stops immediately; otherwise, the movement goes to the target position
PTP button	Execute the move command; this button goes with HALT motion when release button for different behaviors
P1 <-> P2 Repeat Dwell (ms)	Perform reciprocating motion, and the middle interval time can be set by Dwell.
Jog+/Jog-	Perform inching control

4.2.2.2. Home operation interface

The user can complete the single-axis Home control via this interface, as shown in the figure below:

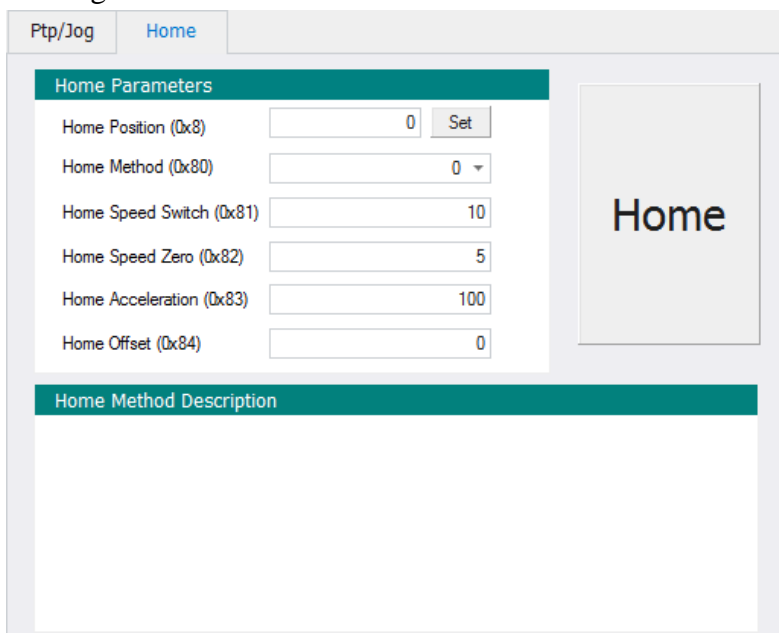


Figure Single-axi Home operation interface

The functions of each position are listed as follows:

Table Home operation page positions

Position	Description
Home Position	Set the Home point offset value
Home Method	Set Home type
Home Speed Switch	Set to find the Home point speed
Home Speed Zero	Set to find the speed at zero position.
Home Acceleration	Set Home acceleration
Home Offset	Set Home position offset
Home button	Set Home control

4.2.3. Group control interface

NexMotion Studio offers the concept of the group member made up of multiple axes. A group mechanism may be an AR6 mechanical arm, a Delta mechanical arm, a SCARA mechanical arm, or other configurations composed of any multiple axes, such as XY two-axis platforms and XYZ three-axis platforms.

NexMotion Studio comes with a “group control” interface to browse the hardware parameters and operation control of the group member. Users can display the group control interface by double clicking the child nodes of the Group under Project Explorer, as shown in the figure below:

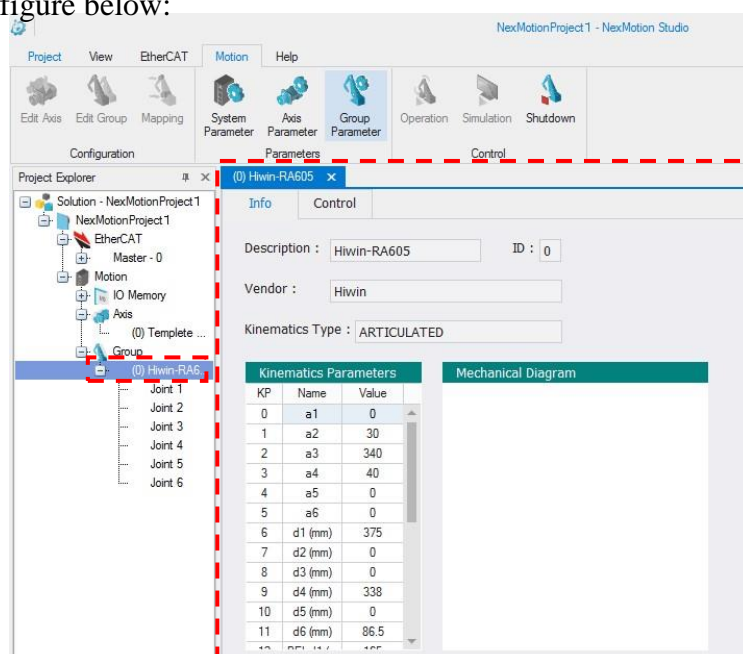


Figure Group control interface

The group control interface provides "Info" and "Control" pages; with each detailed below:

- Info page: provides information about group mechanism, including mechanism hardware description, mechanism manufacturer, machine form, mechanism parameters, and mechanism design, as shown in the figure above.
Note: "Info" page information comes from mechanism information files.
- Control page: This page provides information about the current running state of the group mechanism, current information on each axis, and related functions for controlling the group member, including Jog operation, PTP operation, Line operation, Circle operation, and Home operation functions, as exhibited below:

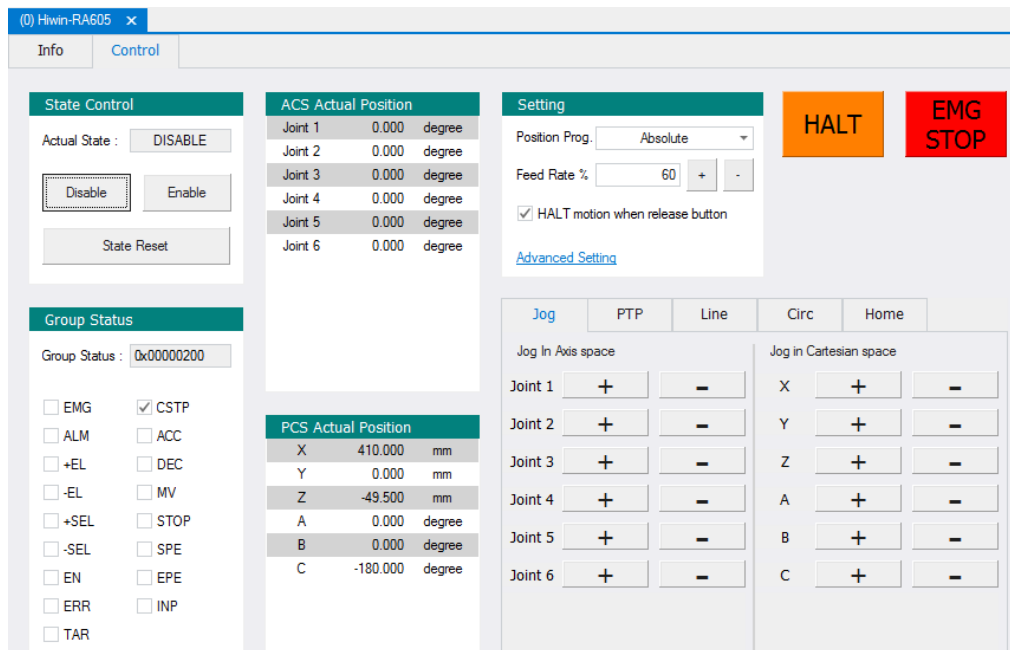


Figure Group control interface Control page

The functions of each block on the "Control" page are detailed as follows:

1. State Control block: Display and switch the group mechanism's current operation state; please refer to Section 4.2.2
2. Group Status block: Display the group mechanism's current running state; please refer to Section 4.4.2
3. ACS Actual Position block: Standing for Axis Coordinate System, the ACS display the current location information of each axis, with the axis quantity, name, and unit provided by mechanism information files; please refer to section xxxx.
4. PCS Actual Position block: Standing for Product Coordinate System, the PCS displays the current location information of End Effector based on Product, with the axis quantity, name, and unit provided by mechanism information files; please refer to section xxxx.
5. Setting block: This block is used to set the behavior mode of the run command, as listed below:

Table Setting block functions

Position	Description
Position Prog.	Please refer to the XXXX document in detail for the successive actions of setting two consecutive run commands.
Feed Rate	Set the running speed of the group mechanism as the maximum speed percentage
HAL motion when Release button	When this function is ticked, the group mechanism will start to move after the button is clicked on the group mechanism movement control page (Jog/PTP/Line/Circ/Home), while when the button is released, the group mechanism stop moving immediately;



	otherwise, moving to the target position. When the function is not ticked, the movement goes to the target location.
Advanced	Reserve.

6. Jog/PTP/Line/Circ/Home: Please refer to the later sections for the group member movement control page.

4.2.3.1. Jog operation interface

Users can give Jog (continuous movement) commands to group mechanisms through the Jog operation interface, where “Jog In Axis Space” and “Jog In Cartesian Space” are offered, so that the user is able to select the options based on their usage habit, with the number of axes determined by the mechanism information files, as shown below:

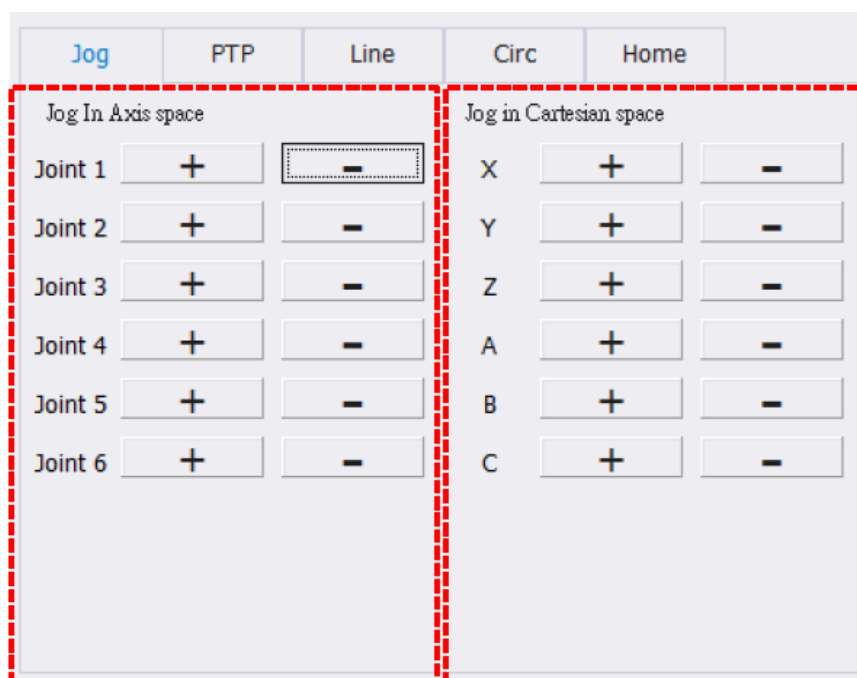


Figure Group control interface – Jog operation interface

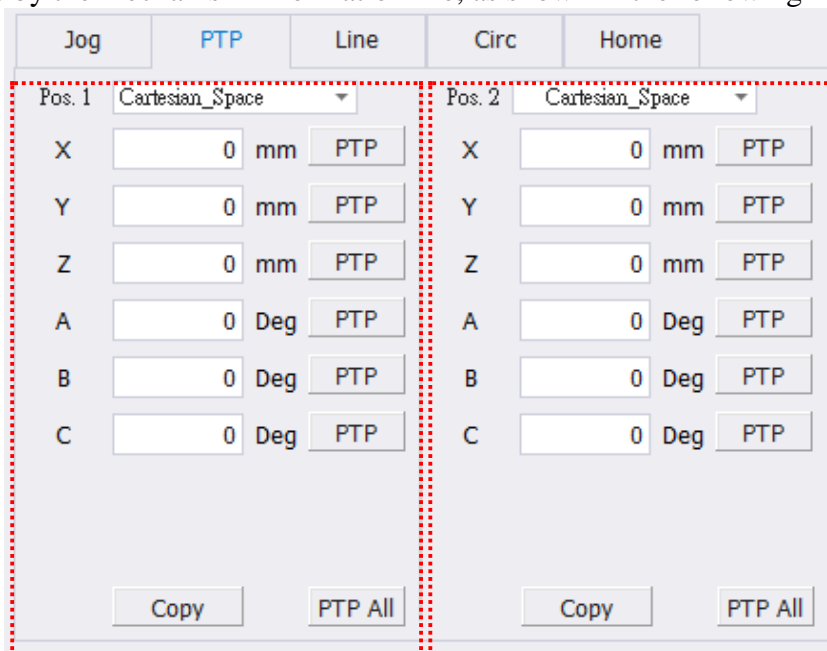
Click the + button to move in the positive direction; otherwise in the negative direction. Note that when the button is released, the movement behavior is determined by the **HALT motion when Release** option in the Setting block. When **HALT motion when Release** is ticked, the movement stops immediately after the button is released; otherwise the motion continues. On the other hand, when **HALT motion when Release** is not ticked, the movement slows to a halt by "HALT" above or stops immediately by "EMG STOP." The action behaviors of the two regional control group mechanisms are as follows:

- Jog In Axis space area: Give a continuous movement command in the positive or negative direction to each axis of the group mechanism.
- Jog In Cartesian space area: Carry out continuous movement control for all orientations of the group mechanism "End Effector"

When **HALT motion when Release** is not ticked, every press on the button will generate a new movement command. The connection mode between old and new movement commands is determined by "Position Prog." in the "Setting block," for which please refer to section xxxx.

4.2.3.2. PTP operation interface

Users can use the "PTP" operation interface to issue the Point to Point movement command on each axis of the group mechanism. The "PTP" operation page provides two sets of input values for users, with the quantity of the axis and orientation determined by the mechanism information file, as shown in the following figure:



Jog		PTP		Line		Circ		Home	
Pos. 1	Cartesian_Space					Pos. 2	Cartesian_Space		
X	0 mm	PTP	X	0 mm	PTP				
Y	0 mm	PTP	Y	0 mm	PTP				
Z	0 mm	PTP	Z	0 mm	PTP				
A	0 Deg	PTP	A	0 Deg	PTP				
B	0 Deg	PTP	B	0 Deg	PTP				
C	0 Deg	PTP	C	0 Deg	PTP				
Copy		PTP All		Copy		PTP All			

Figure PTP operation page

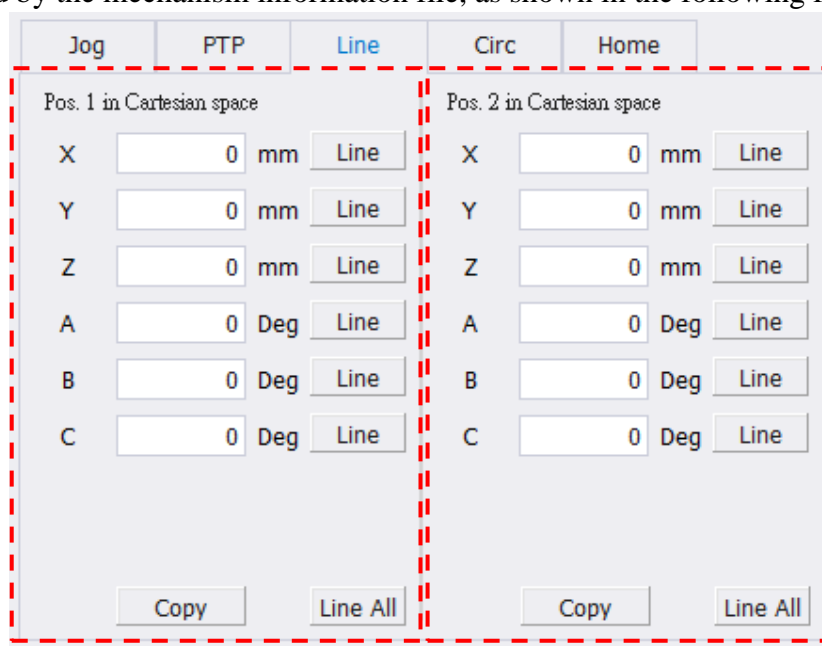
Users may choose the Cartesian space coordinates or axial angles for motion control according to their usage habit, as well as based on operational requirements, clicking the "PTP" button to issue a move command for a single axis or direction or click "PTP All" for all axes/directions.

After the "PTP" or "PTP All" button is clicked, the group mechanism movement control will be carried out immediately. When the button is released, the group mechanism movement control behavior will be determined by **HALT motion when Release** in the "Setting" block. When **HALT motion when Release** is ticked, the movement stops immediately after the button is released; otherwise the motion continues. On the other hand, when **HALT motion when Release** is not ticked, the movement slows to a halt by "HALT" above or stops immediately by "EMG STOP."

When **HALT motion when Release** is not ticked, every press on the button will generate a new movement command. The connection mode between old and new movement commands is determined by "Position Prog." in the "Setting block," for which please refer to section xxxx.

4.2.3.3. Line operation interface

The user can give a linear movement command to each axis of the group mechanism via the "Line" operation interface. The "Line" operation page provides two sets of input values for users, with the quantity of the axis and orientation determined by the mechanism information file, as shown in the following figure:



Jog	PTP	Line	Circ	Home
Pos. 1 in Cartesian space				
X	0 mm	Line	X	0 mm
Y	0 mm	Line	Y	0 mm
Z	0 mm	Line	Z	0 mm
A	0 Deg	Line	A	0 Deg
B	0 Deg	Line	B	0 Deg
C	0 Deg	Line	C	0 Deg
Copy		Line All	Copy	
Pos. 2 in Cartesian space				
X	0 mm	Line	X	0 mm
Y	0 mm	Line	Y	0 mm
Z	0 mm	Line	Z	0 mm
A	0 Deg	Line	A	0 Deg
B	0 Deg	Line	B	0 Deg
C	0 Deg	Line	C	0 Deg
Copy		Line All	Copy	

Figure Line operation page

The user may, according to operational requirements, click the "Line" button to issue a move command for a single direction or click "Line All" for all directions.

After the "Line" or "Line All" button is clicked, the linear group mechanism motion control will be carried out immediately. When the button is released, the movement behavior is determined by **HALT motion when Release** in the "Setting" block. When **HALT motion when Release** is ticked, the movement stops immediately after the button is released; otherwise the motion continues. On the other hand, when **HALT motion when Release** is not ticked, the movement slows to a halt by "HALT" above or stops immediately by "EMG STOP."

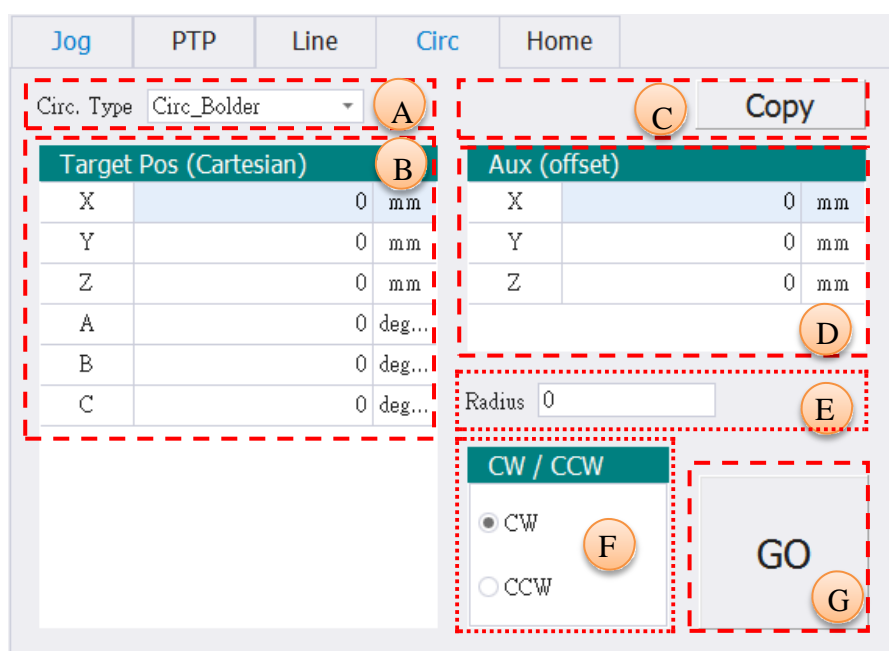
When **HALT motion when Release** is not ticked, every press on the button will generate a new movement command. The connection mode between old and new movement commands is determined by "Position Prog." in the "Setting block," for which please refer to section xxxx.

4.2.3.4. Circ operation interface

Users can use the "Circ" operation interface to issue circular arc movement commands to the end points of the group mechanism. The "Circ" page provides three circular arc methods: radius, circular center, and transit, and the user can decide which to use according to the application situation. The "Aux" fields on the page have different meanings depending on the three methods, as described below:

Table The meaning of the "Aux" fields in various circular arc methods

Circular arc method	Aux field meaning
Radius	Normal vector
Circular center	Circle center position
Transit	Point position



The screenshot shows the "Circ" operation interface. At the top, there are tabs: Jog, PTP, Line, Circ (selected), and Home. Below the tabs, there is a "Circ. Type" dropdown menu set to "Circ_Bolder" (labeled A). To the right of this is a "Copy" button (labeled C). The main area is divided into two columns. The left column is titled "Target Pos (Cartesian)" (labeled B) and contains input fields for X, Y, Z, A, B, and C, each with a unit (mm or deg...). The right column is titled "Aux (offset)" (labeled D) and contains input fields for X, Y, and Z, each with a unit (mm). Below the "Aux (offset)" section is a "Radius" input field (labeled E) set to 0. At the bottom, there is a "CW / CCW" section (labeled F) with radio buttons for CW and CCW. To the right of this is a "GO" button (labeled G).

Figure Circle operation page

The positions are listed as follows:

Table Circ page positions

Position	Description
A	Select the circular arc movement mode
B	Enter the circular arc movement target position
C	Copy the current location to the TargetPos field
D	Please refer to Table The meaning of the "Aux" fields in various circular arc methods
E	When the movement mode is based on the "radius method," the positive radius



	follows a path with shorter arcs, otherwise longer.
F	When the movement mode is based on the "circular center method," CW follows a path with shorter arcs, while CCW longer.
G	Start the circular arc movement

4.2.3.5. Home operation interface

The user can give "Home" control on each axis of the group mechanism via the "Home" operation interface, with the quantity of the axis and orientation determined by mechanism information files, as shown below:

Jog			PTP			Line			Circ			Home		
Axis	Method		Home			Axis	Home Pos.	Set						
0	0		Home			0	0	Set						
1	0		Home			1	0	Set						
2	0		Home			2	0	Set						
3	0		Home			3	0	Set						
4	0		Home			4	0	Set						
5	0		Home			5	0	Set						

Figure Home operation interface

After clicking the "Home" button, the group mechanism Home motion control will be immediately launched. When the button is released, the movement behavior is determined by **HALT motion when Release** in the Setting block. When **HALT motion when Release** is ticked, the movement stops immediately after the button is released; otherwise the motion continues. On the other hand, when **HALT motion when Release** is not ticked, the movement slows to a halt by "HALT" above or stops immediately by "EMG STOP."

The fields are described as follows:

- Method: Select Home method by referring to the driver's instructions. Click on the field to show the menu, and the user chooses Home method based on application, as shown in the figure below:

Jog			PTP			Line			Circ			Home		
Axis	Method		Home			Axis	Home Pos.	Set						
0	0		Home			0	0	Set						
1	0		Home			1	0	Set						
2	0		Home			2	0	Set						
3	0		Home			3	0	Set						
4	0		Home			4	0	Set						
5	0		Home			5	0	Set						

Figure Select Home method

- Home Pos: For the offset of the origin, please refer to section XXXX for the NexMotion library manual. As shown in the figure below:



Jog		PTP	Line	Circ	Home	
Axis	Method		Home	Axis	Home Pos.	Set
0	0		Home	0	0	Set
1	0		Home	1	0	Set
2	1		Home	2	0	Set
3	2		Home	3	0	Set
4	3		Home	4	0	Set
5	4		Home	5	0	Set
6	5		Home			
7	6		Home			
8	0		Home			

Figure Set Home Position