HIWIN MIKROSYSTEM

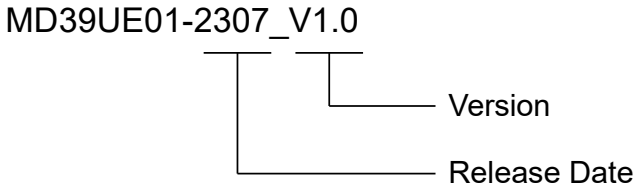
Application Note

E Series EtherCAT Drive Complete Setup with OMRON Sysmac Studio

www.hiwinmikro.tw
MD39UE01-2307_V1.0

Revision History

The version of the manual is also indicated on the bottom of the front cover.



Release Date	Version	Applicable Product	Revision Contents
Jul. 17th, 2023	1.0	E series EtherCAT drive	First edition.

Related Documents

Through related documents, users can quickly understand the positioning of this manual and the correlation between manuals and products. Go to HIWIN MIKROSYSTEM's official website → Download → Manual Overview for details (https://www.hiwinmikro.tw/Downloads/ManualOverview_EN.htm).

Preface

This manual provides detailed information on the operation of PLC software Sysmac Studio when E series EtherCAT drive is used with OMRON NJ and NX series PLC.

Specifications of Software/Hardware

Name	Version of Software/Firmware
E1 Series EtherCAT Drive	Software (Thunder): 1.8.10.0 or above Firmware: 2.8.10 or above ESI file: HIWIN_MIKROSYSTEM_ED1F_20221101 or above
E2 Series EtherCAT Drive	Software (Thunder): 1.9.16.0 or above Firmware: 3.9.10 or above ESI file: HIWIN_MIKROSYSTEM_ED2F_20230417 or above
OMRON Motion Controller (NJ, NX Series)	Software (Sysmac Studio): 1.45 or above Firmware: 1.15 or above

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1. Communication and module setup

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1.1 Create new project

1. Open Sysmac Studio and select **New Project**.

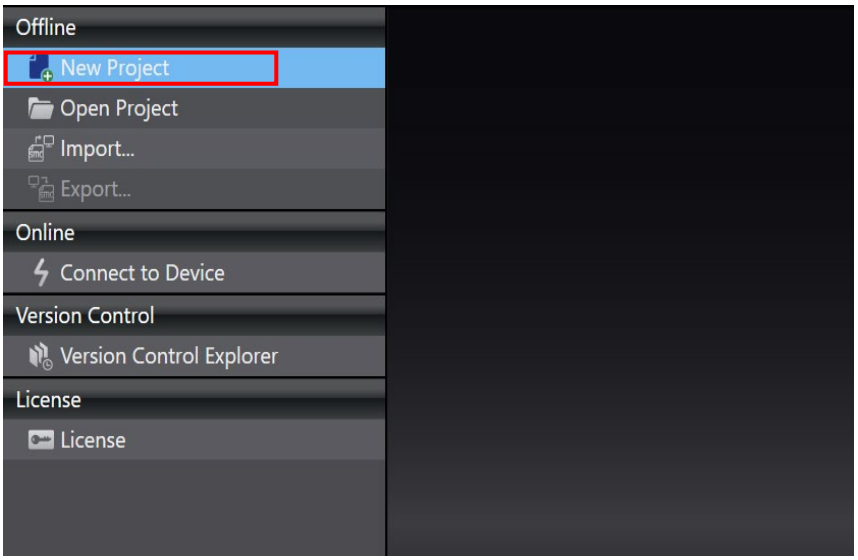

Figure 1.1.1

2. Enter Project name, Author, Device, and Version, and click **Create**.

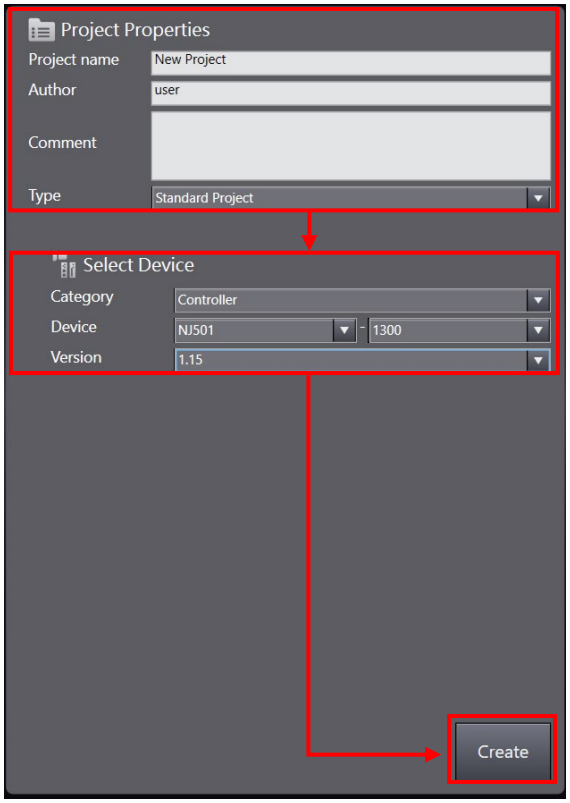

Figure 1.1.2

3. Successfully create a new project.

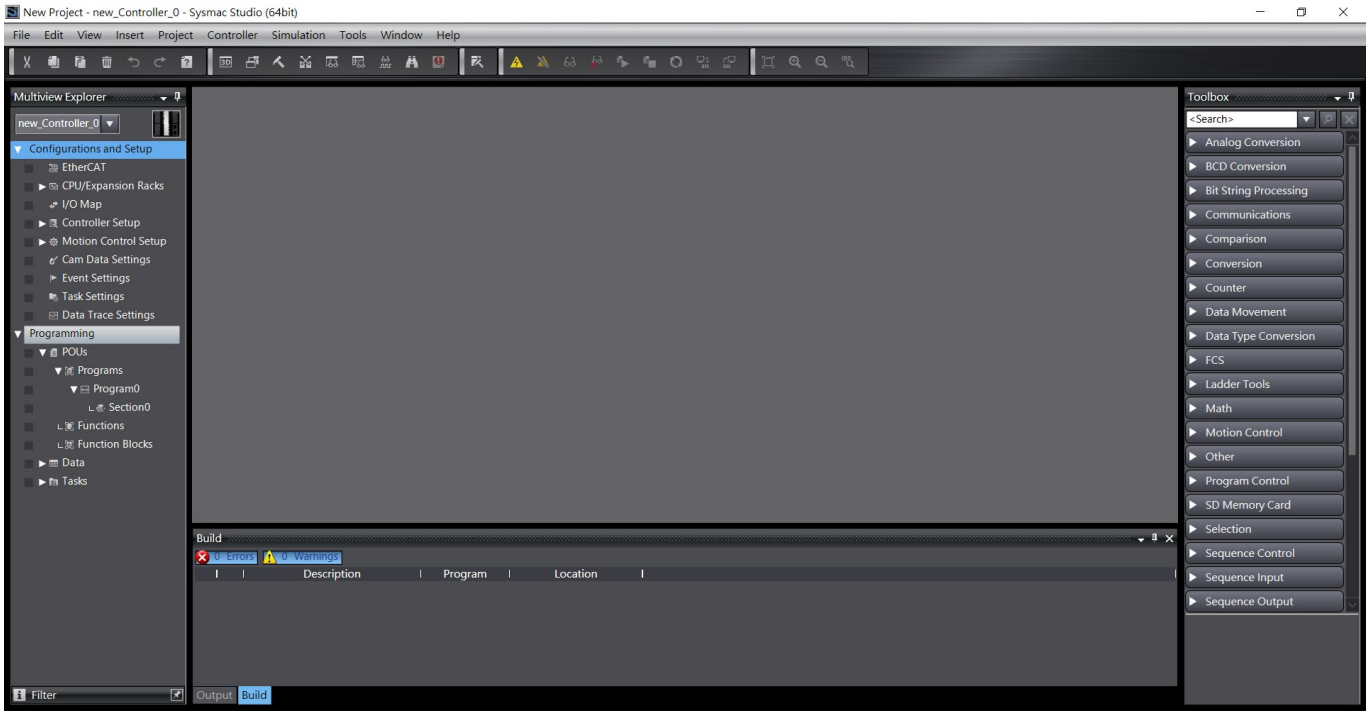

Figure 1.1.3

1.2 Select connection type

1. Select **Controller** on the upper screen and click **Communications Setup**.

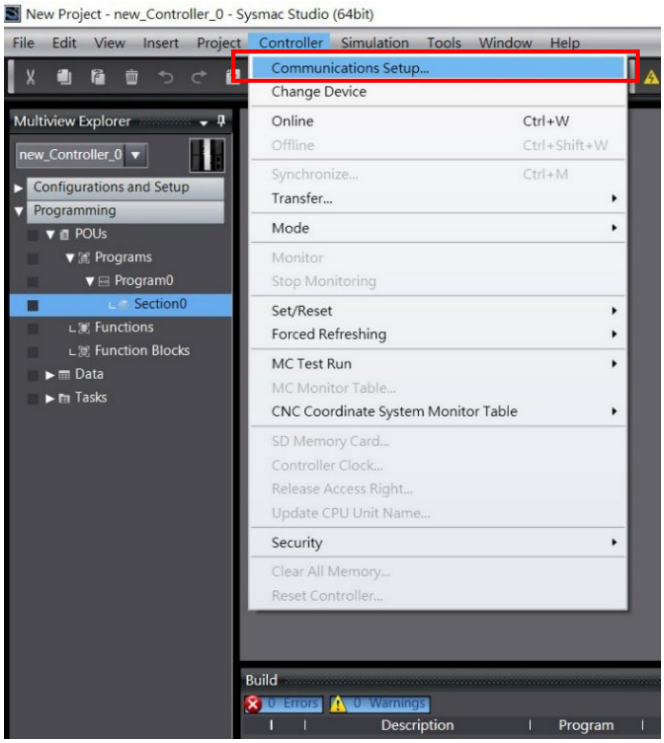

Figure 1.2.1

2. Select **Connection type** and click **OK**.

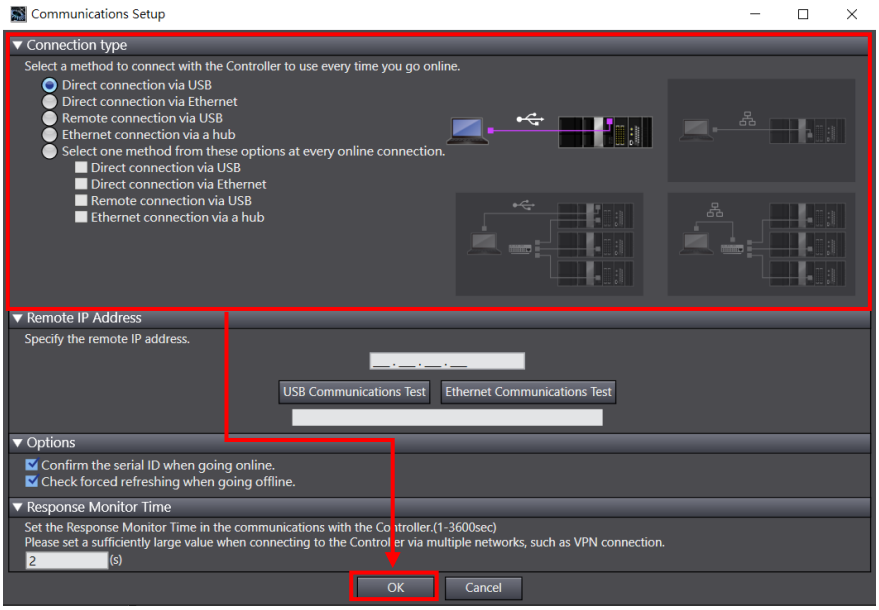

Figure 1.2.2

1.3 Install ESI files

1. On the left side of the screen, go to **Configurations and Setup** and double-click **EtherCAT** to open **EtherCAT** tab. Then, right-click the controller icon and select **Display ESI Library**.

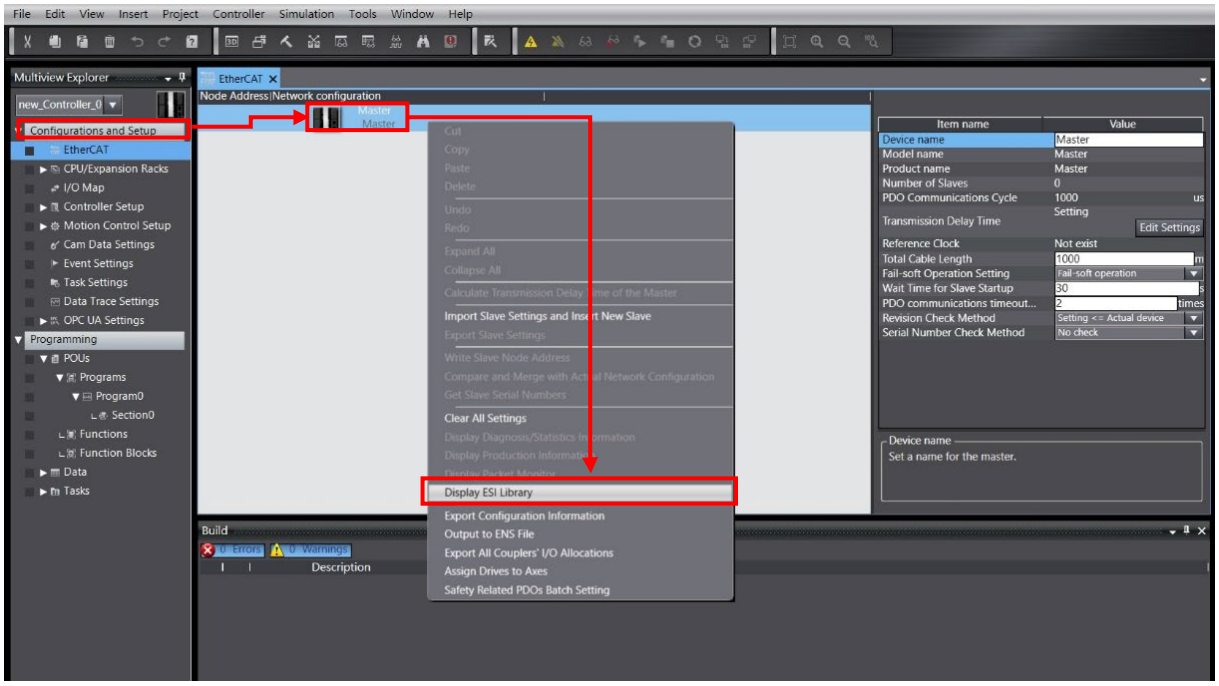

Figure 1.3.1

2. All the supported ESI files will be displayed in **ESI Library** window, please confirm if there is an ESI file for the drive. If there is none, users can select the ESI file and click **Install (File)**.

Important

(1) ESI file name of E1 series servo drive is: ED1F_date; ESI file name of E2 series servo drive is: ED2F_date.
The ESI files of E series servo drive can be found in the installation path of Thunder (the drive's human machine interface): **Thunder/doc/ESI Files**.

(2) If users would like to update to the latest version of ESI file, please select the old version first and click **Uninstall** to remove it before reinstalling a new one. (If the old version of ESI file has been used to create the drive network configuration in section 1.4, users need to remove the drive configuration first before removing the old version of ESI file.)

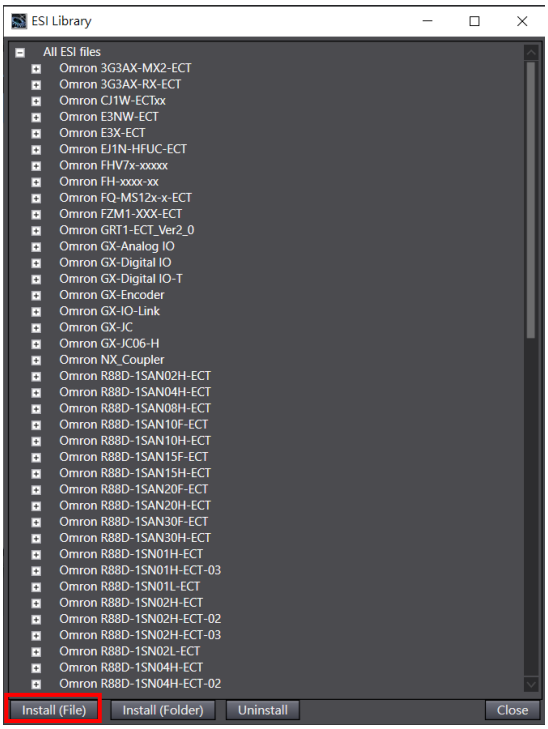

Figure 1.3.2

1.4 Configure drive network

Before configuring drive network, users must first set **Node Address** of the drive. Choose one of the following methods to set node address:

1. Set node address through the actual knob of the drive.
2. Set node address of the drive through the controller.

Important

The setting range of node address is 1~192 and cannot be 0.

1.4.1 Set node address through the actual knob of the drive

1. Open the top front cover of the drive and use a small Phillips screwdriver to screw and set the node address of the drive. The node address of same network topology cannot be repeated. After setting, the drive needs to be powered off and restarted.

2. After the drive restarts, go to **Toolbox** on the right side of the screen. Select the icon of the adopted E series servo drive and drag it under the controller icon in **EtherCAT** tab.

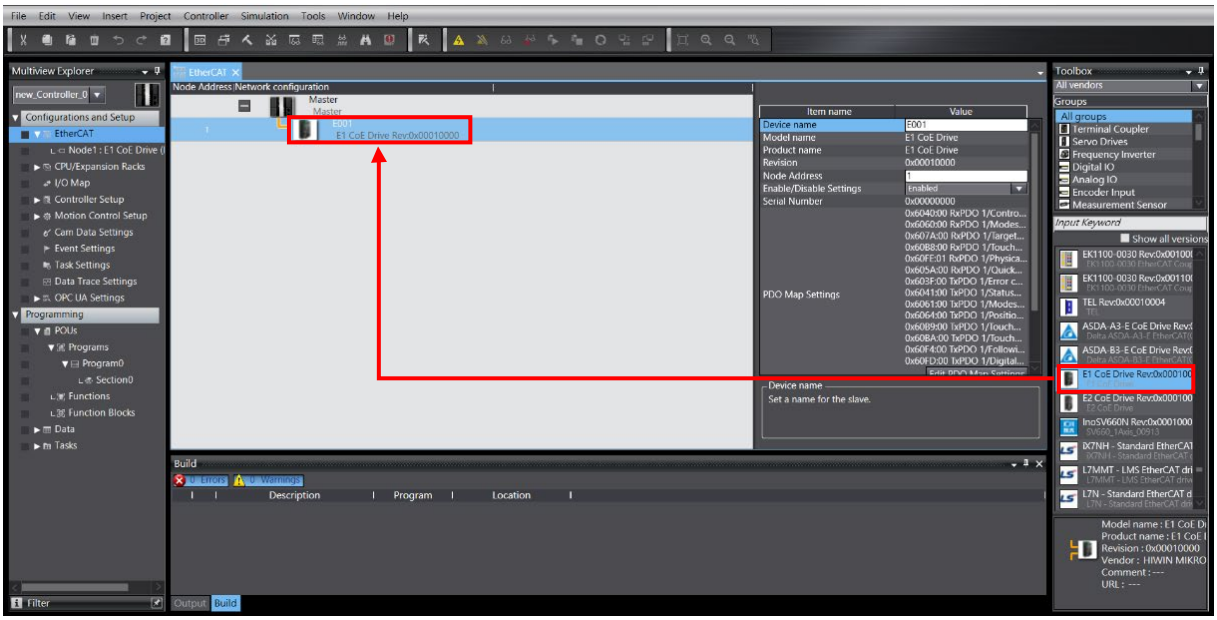

Figure 1.4.1.1

3. Click the **Online** icon  in the toolbar on the upper screen to connect to the controller. After the connection is established, a yellow line will appear below the icon. Then, right-click the controller icon and select **Compare and Merge with Actual Network Configuration**.

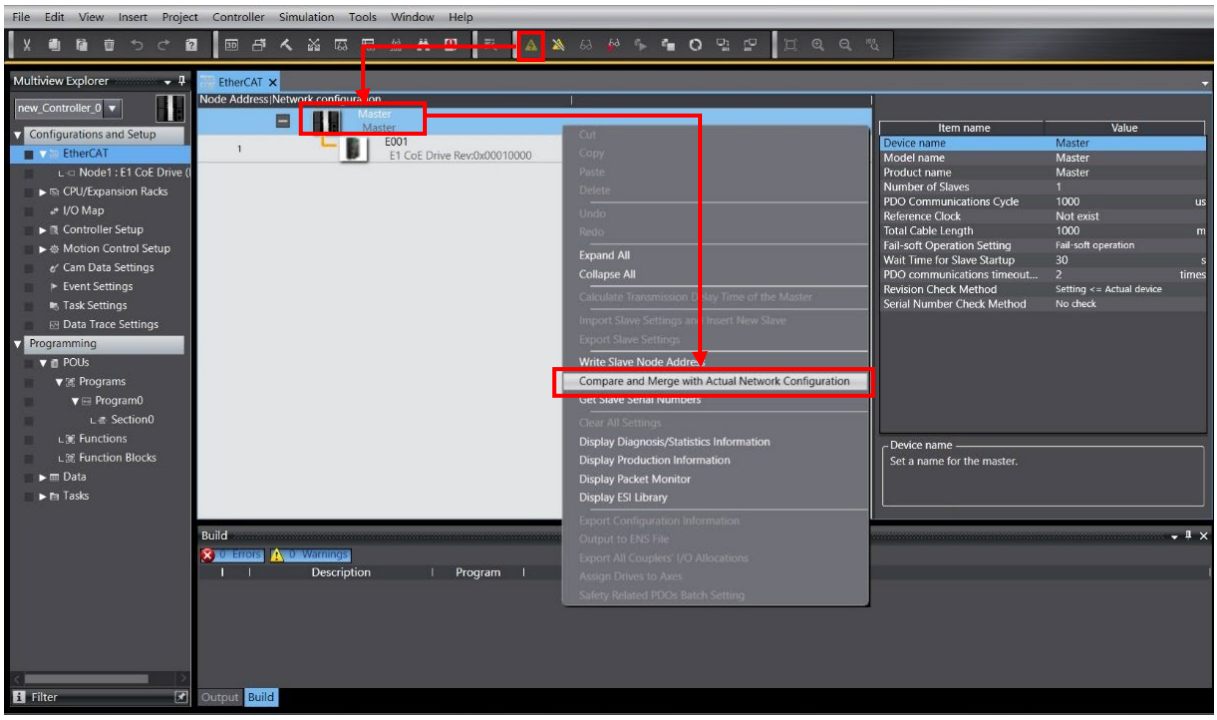

Figure 1.4.1.2

4. In **Compare and Merge with Actual Network Configuration** window, click **Apply actual network configuration** to apply the actual drive node address to the project, and the drive network configuration would be completed.

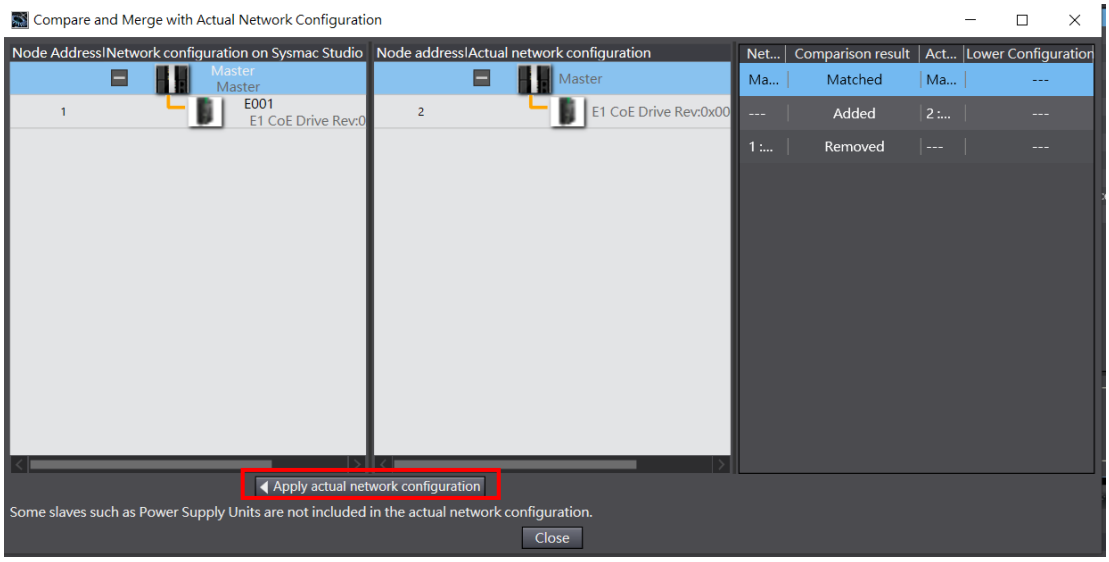

Figure 1.4.1.3

1.4.2 Set node address of the drive through the controller

1. In **Toolbox** on the right side of the screen, select the icon of the adopted E series servo drive and drag it under the controller icon in **EtherCAT** tab.

Important

Before setting node address through the controller, please set the knob inside the drive cover to 00.

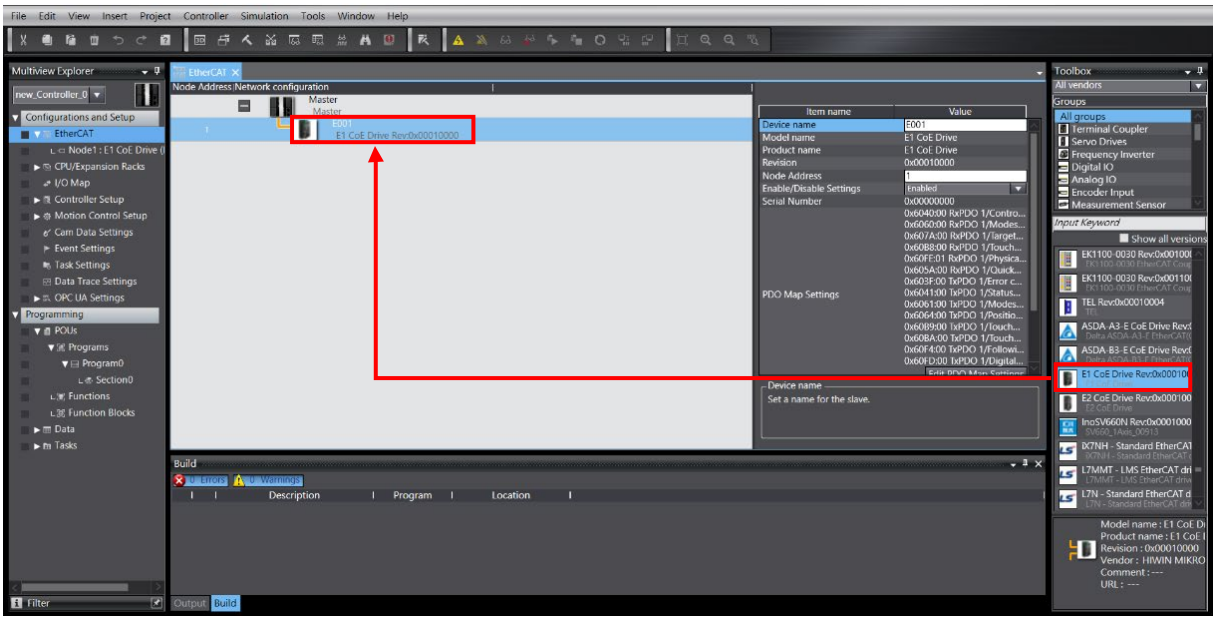

Figure 1.4.2.1

2. Click the **Online** icon in the toolbar on the upper screen to connect to the controller. After the connection is established, a yellow line will appear below the icon. Then, right-click the controller icon and select **Write Slave Node Address**.

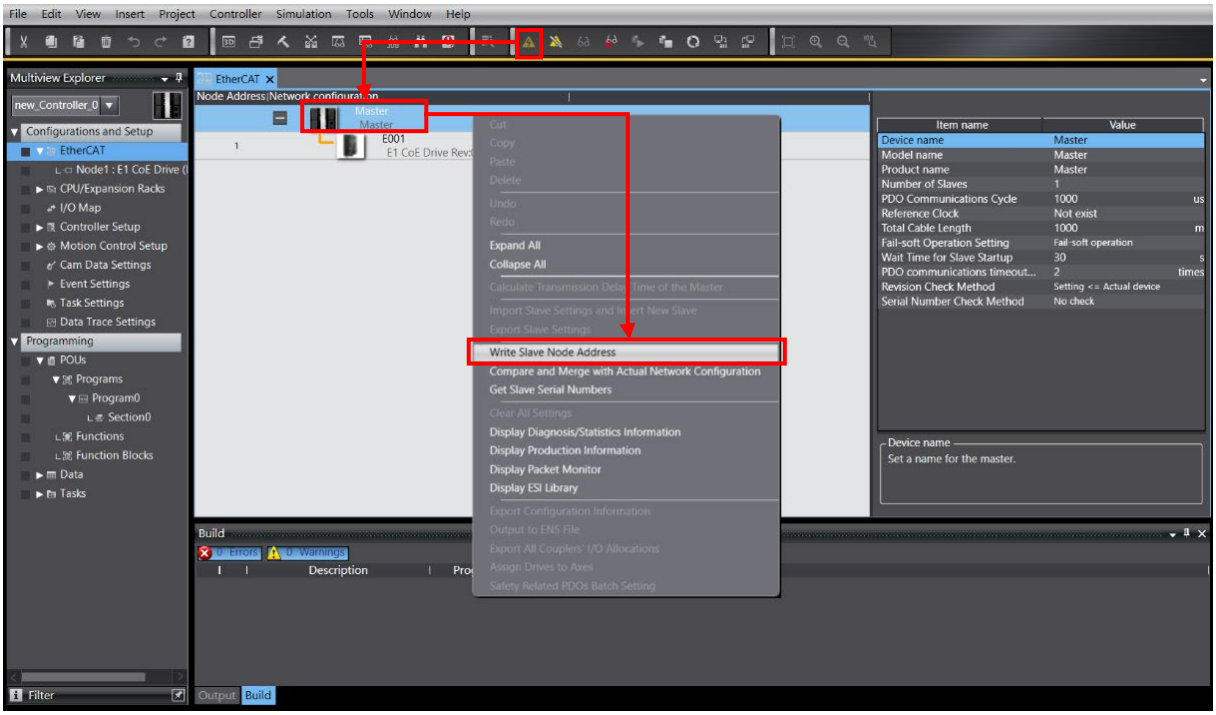

Figure 1.4.2.2

3. In **Slave Node Address Writing** window, first set the drive's node address in **Set value**, a reminder window will pop up after clicking **Write**. Users need to click **Write** again to write the node address into the controller and the drive. After finishing node address writing, please power off the controller and drive for 5 seconds and then power on again to complete the drive network configuration.

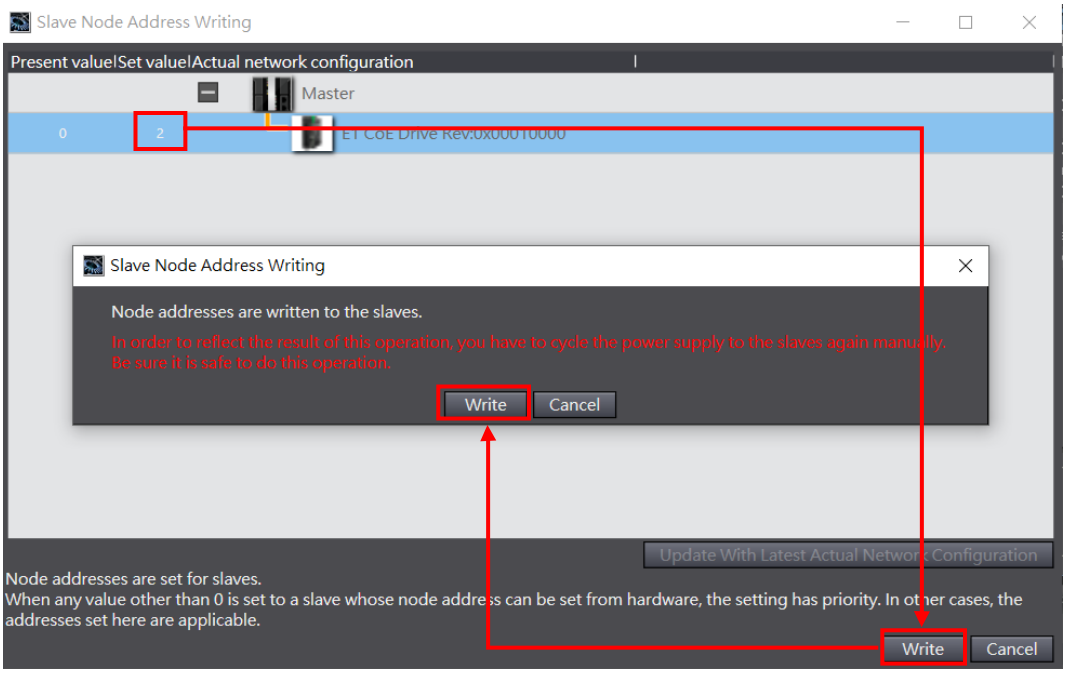

Figure 1.4.2.3

1.5 Edit PDO object

1. Click the drive icon in **EtherCAT** tab and then click **Edit PDO Map Settings** in the right window.

Important

When editing PDO object, it cannot be connected to the controller. If it is connected, please click the **Offline** icon in the toolbar on the upper screen to cut off the connection.

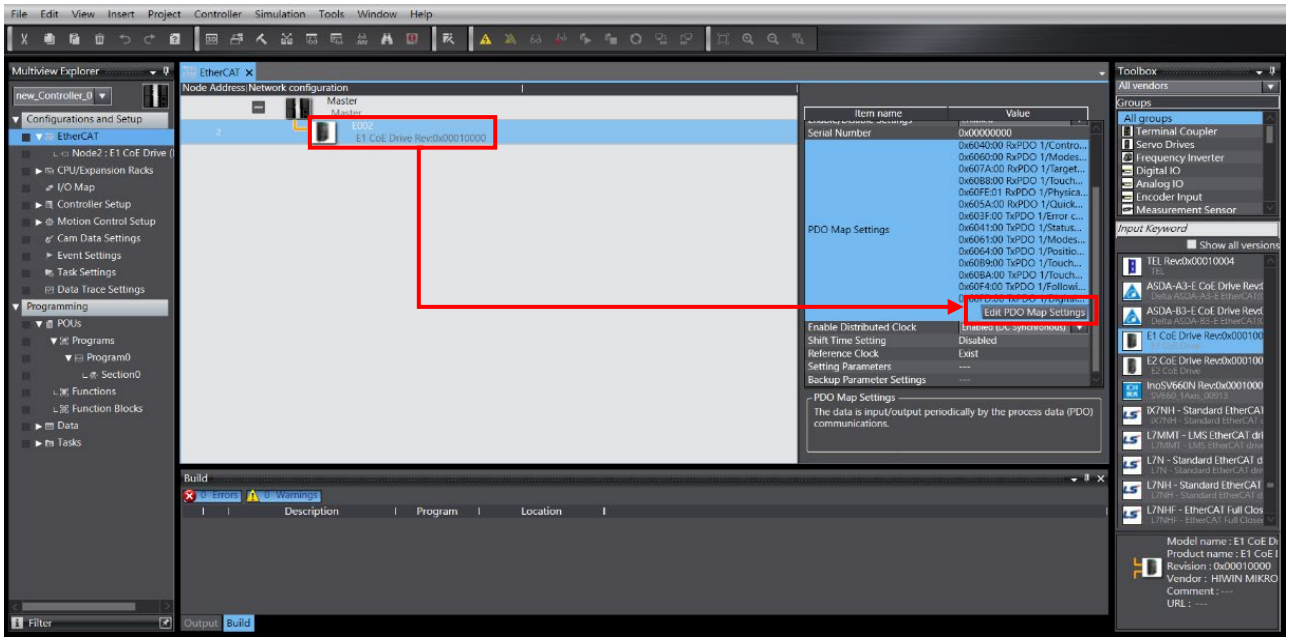

Figure 1.5.1

2. Select **TxPDO** and **RxPDO** groups that users would like to use and click **OK**.

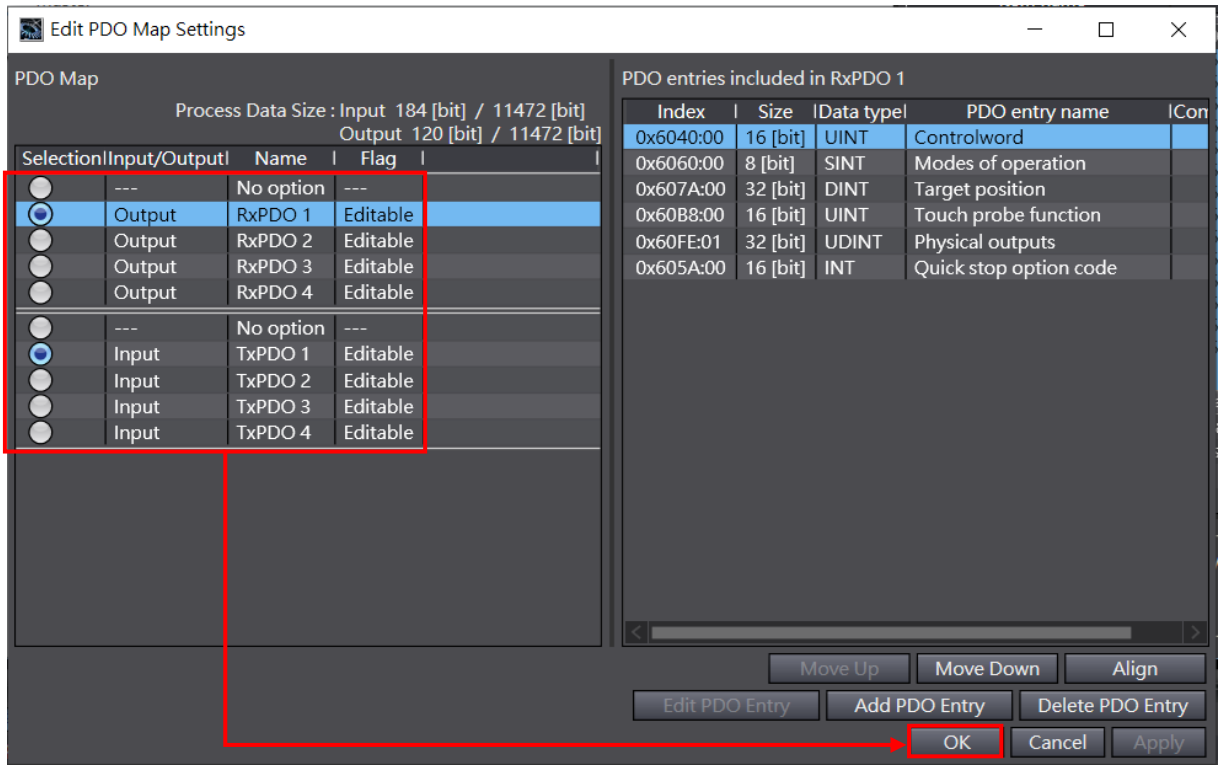

Figure 1.5.2

Important

(1) After clicking any of the PDO groups, the default PDO objects of the group would be displayed on the right side in **Edit PDO Map Settings** window.

(2) Users can click **Add PDO Entry** to add other objects to the group or click **Delete PDO Entry** to delete existing objects in the group.

(3) The maximum object number for RxPDO and TxPDO is eight each.

2. Parameters setup

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After completing the connection with controller and drive network configuration, users can start to set relevant parameters for motion control axis (such as PDO objects configuration, unit conversion, operation settings, and homing method).

Important

(1) When setting the parameters of the motion axis, it cannot be connected to the controller. If it is connected, please click the **Offline** icon in the toolbar on the upper screen to cut off the connection with the controller.

(2) This manual only introduces the basic settings. For other settings, please refer to the official operation manual of OMRON.

2.1 Add motion control axis

1. In **Configuration and Setup** on the left side of the screen, double-click to open **Motion Control Setup**. Then, right-click **Axis Settings** and click **Add** to add a **Motion Control Axis**.

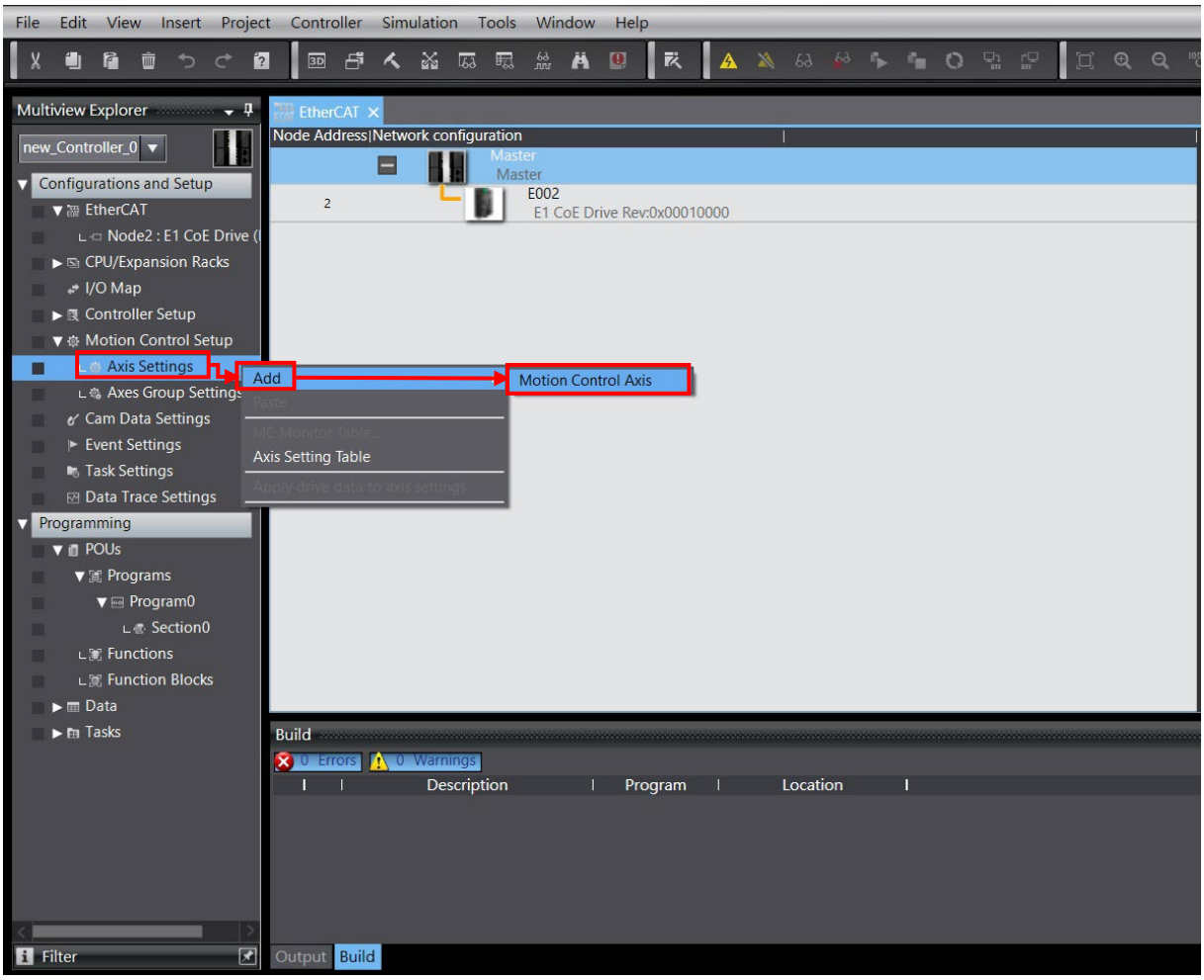


Figure 2.1.1

2. Motion control axis **MC_Axis000** will appear under **Axis Settings**.

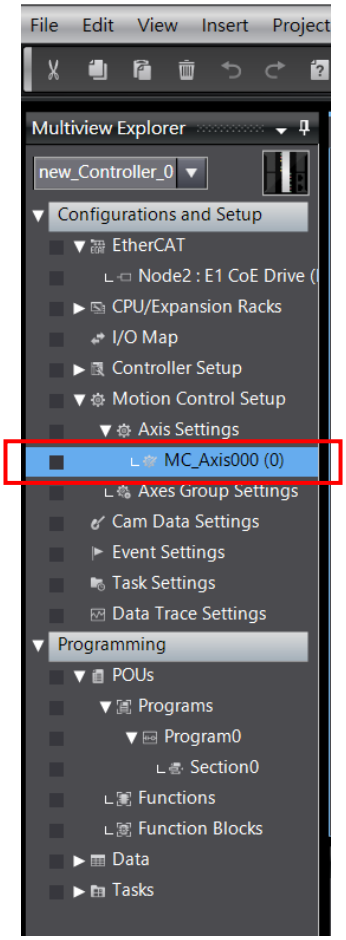


Figure 2.1.2

2.2 Configure PDO object

1. Click the added motion control axis **MC_Axis000** and select **Axis Basic Settings**  . Set **Axis type** to **Servo axis** and set **Output device 1** to the node number of the drive used by the motion axis.

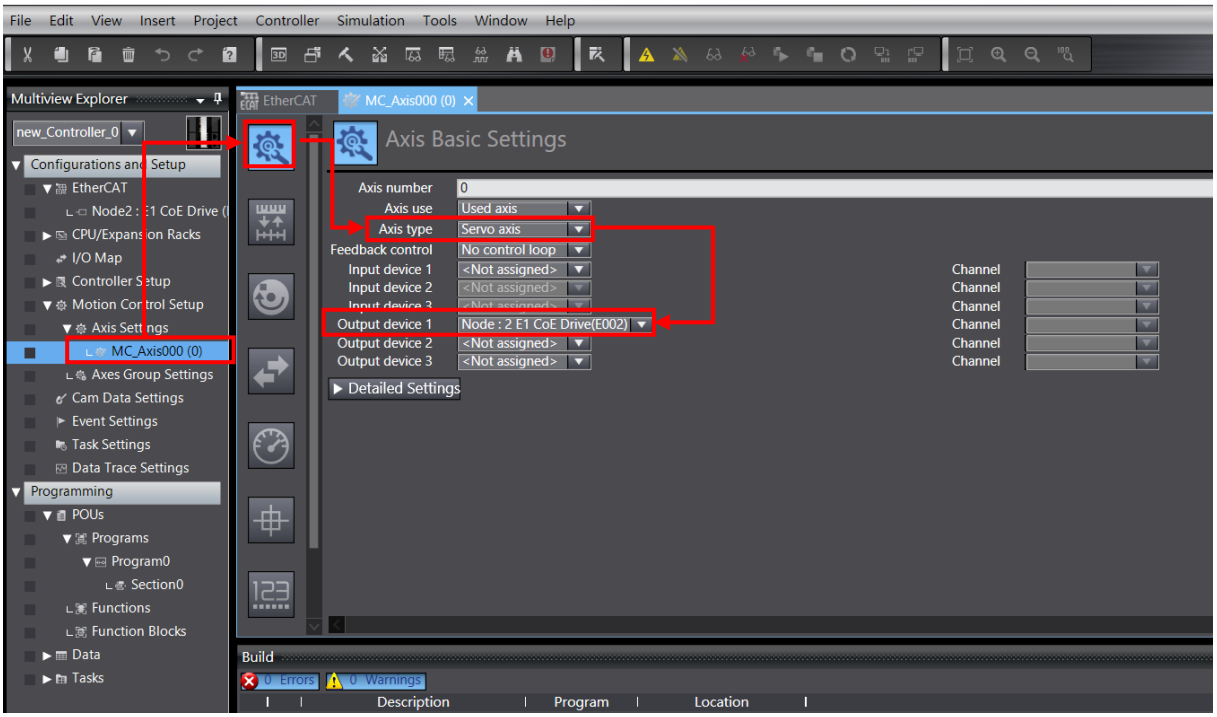


Figure 2.2.1

2. Click **Detailed Settings** and configure the PDO objects corresponding to **Output (Controller to Device)**, **Input (Device to Controller)**, and **Digital inputs** according to user needs.

Important

(1) When configuring PDO objects, please note that the definition of the **Process Data** must be consistent with the **Function Name**.

(2) For the bit definition of **Digital inputs** object **0x60FD**, please refer to "E Series Servo Drive EtherCAT(CoE) Communications Command Manual".

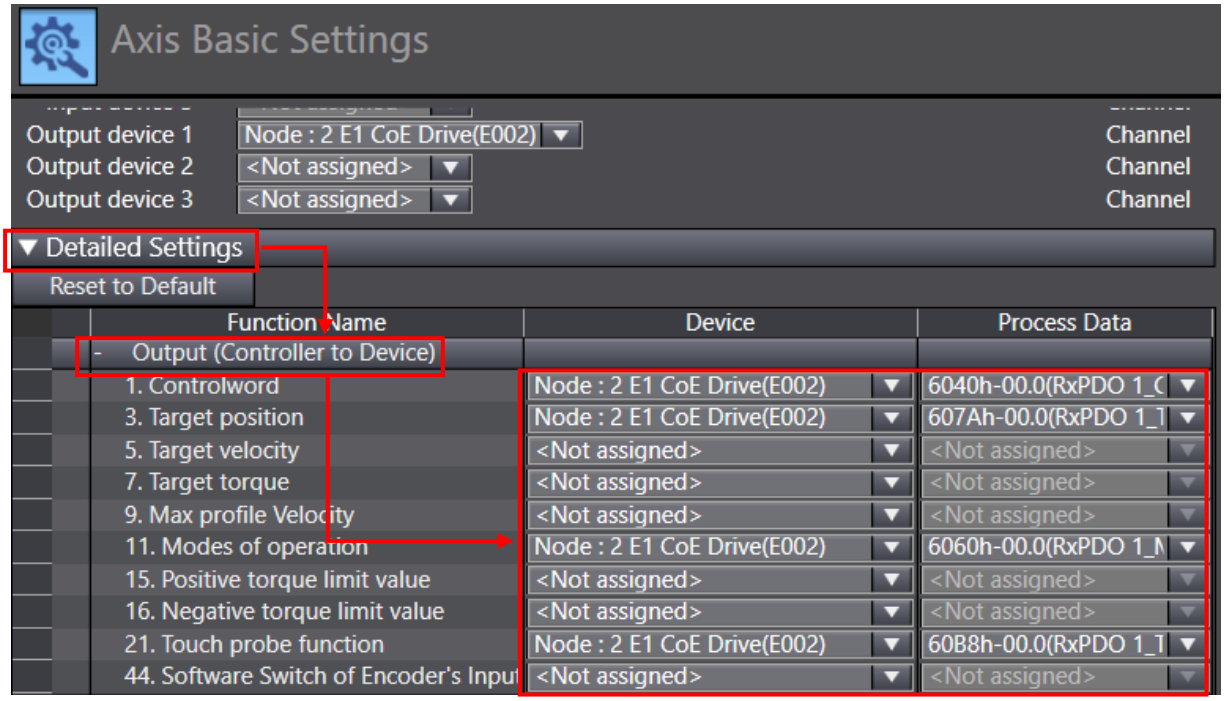


Figure 2.2.2

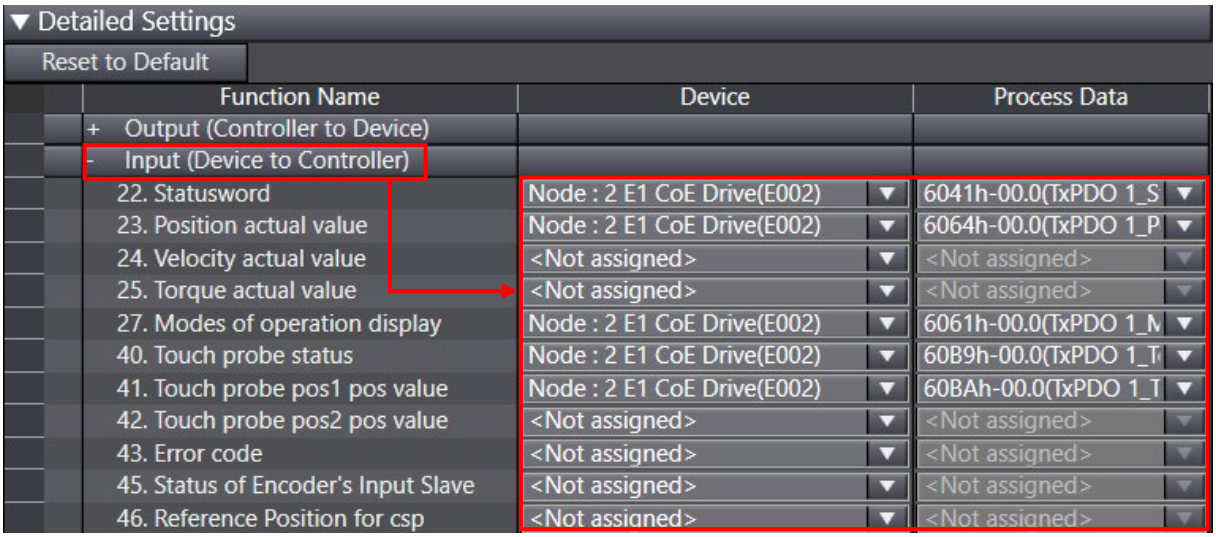


Figure 2.2.3

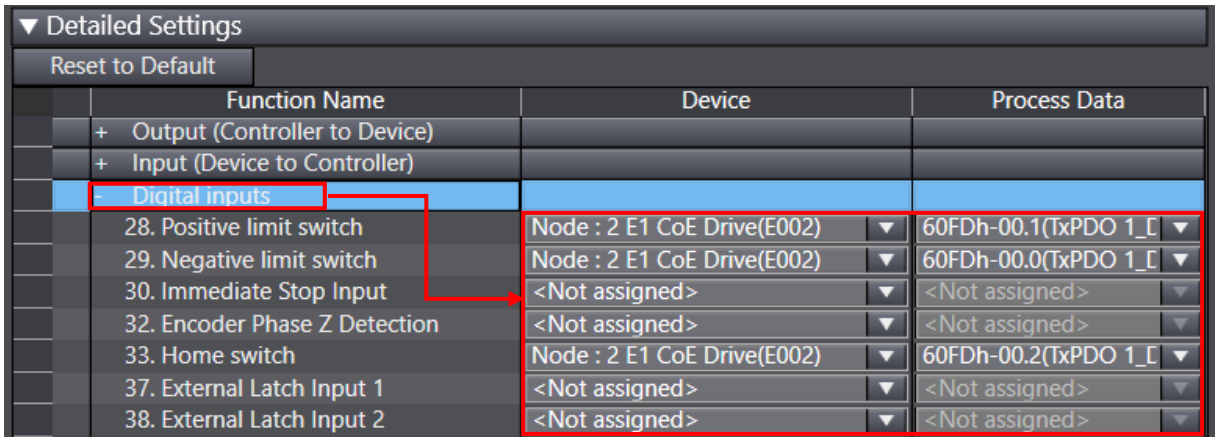
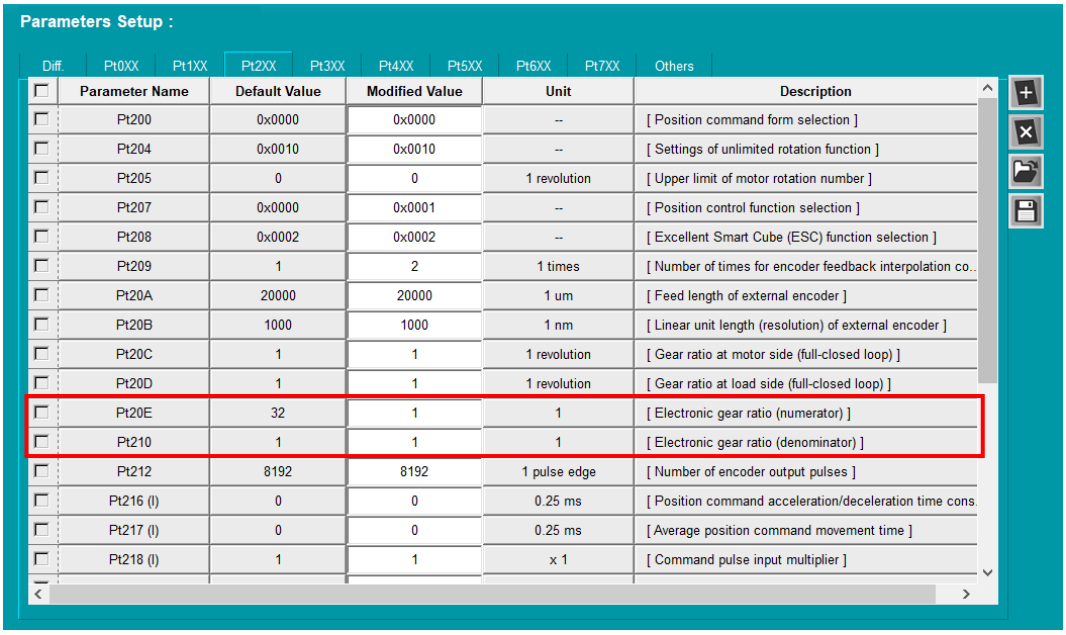

Detailed Settings
Reset to Default
Function Name
Device
Process Data
+ Output (Controller to Device)
+ Input (Device to Controller)
- Digital inputs
28. Positive limit switch
Node : 2 E1 CoE Drive(E002)
60FDh-00.1(TxPDO 1_[
29. Negative limit switch
Node : 2 E1 CoE Drive(E002)
60FDh-00.0(TxPDO 1_[
30. Immediate Stop Input
<Not assigned>
<Not assigned>
32. Encoder Phase Z Detection
<Not assigned>
<Not assigned>
33. Home switch
Node : 2 E1 CoE Drive(E002)
60FDh-00.2(TxPDO 1_[
37. External Latch Input 1
<Not assigned>
<Not assigned>
38. External Latch Input 2
<Not assigned>
<Not assigned>

Figure 2.2.4

2.3 Set unit conversion

1. Set the electronic gear ratio Pt20E, Pt210 to 1:1 or 2^n:1 in Thunder. Save the parameters to the drive and restart to take effect.



Parameter Name	Default Value	Modified Value	Unit	Description
Pt200	0x0000	0x0000	--	[Position command form selection]
Pt204	0x0010	0x0010	--	[Settings of unlimited rotation function]
Pt205	0	0	1 revolution	[Upper limit of motor rotation number]
Pt207	0x0000	0x0001	--	[Position control function selection]
Pt208	0x0002	0x0002	--	[Excellent Smart Cube (ESC) function selection]
Pt209	1	2	1 times	[Number of times for encoder feedback interpolation co..
Pt20A	20000	20000	1 um	[Feed length of external encoder]
Pt20B	1000	1000	1 nm	[Linear unit length (resolution) of external encoder]
Pt20C	1	1	1 revolution	[Gear ratio at motor side (full-closed loop)]
Pt20D	1	1	1 revolution	[Gear ratio at load side (full-closed loop)]
Pt20E	32	1	1	[Electronic gear ratio (numerator)]
Pt210	1	1	1	[Electronic gear ratio (denominator)]
Pt212	8192	8192	1 pulse edge	[Number of encoder output pulses]
Pt216 (I)	0	0	0.25 ms	[Position command acceleration/deceleration time cons
Pt217 (I)	0	0	0.25 ms	[Average position command movement time]
Pt218 (I)	1	1	x 1	[Command pulse input multiplier]

Figure 2.3.1

Important

When using linear motor and direct drive motor, it is recommended to set the drive's electronic gear ratio to 1:1 and set the unit conversion in Sysmac Studio.

2. Click the added motion controller MC_Axis000 and select **Unit Conversion Settings** icon .

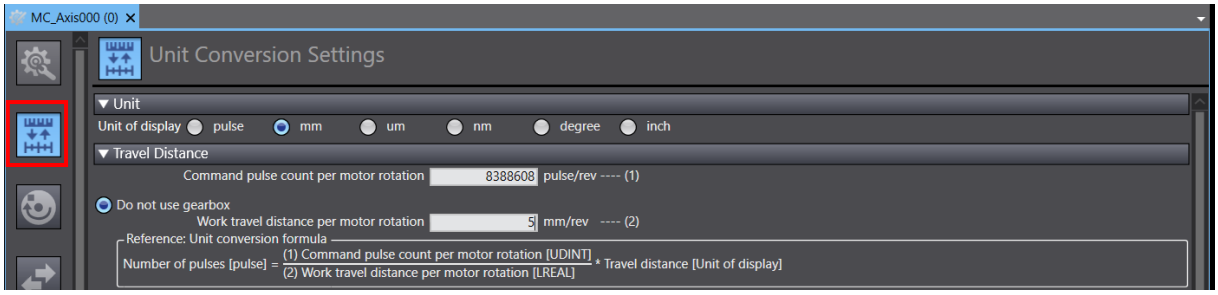


Figure 2.3.2

3. Set the variables of **Unit of display**, **Work travel distance per motor rotation**, **Work gear ratio**, and **Motor gear ratio** according to the user scenarios. Set **Command pulse count per motor rotation** according to the motor resolution, Pt20E, and Pt210.

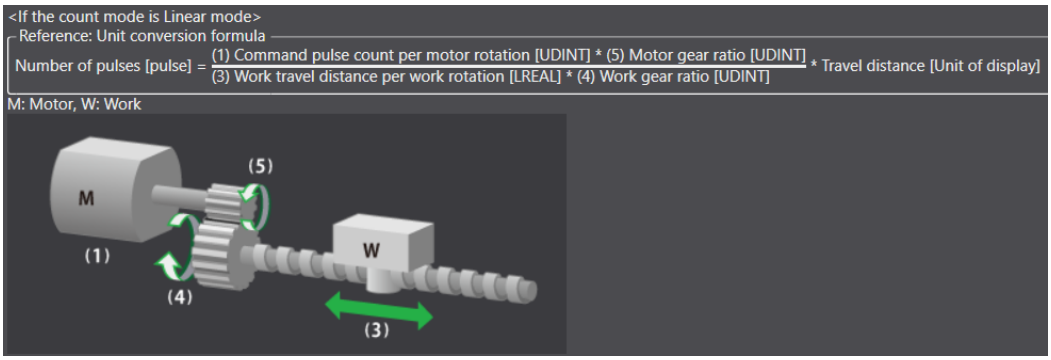
Example

Take EM1 series servo motor with a 5 mm/rev lead screw for example:

(1) If motor resolution is 8388608 cnt/rev, set **Command pulse count per motor rotation** to 8388608 * Pt210 / Pt20E.

(2) Select **mm** in **Unit of display** and set **5 mm/rev** for **Work travel distance per motor rotation**. If there is no matching reducer, select **Do not use gearbox**; if there is a matching reducer, select **Use gearbox** and set **Work gear ratio** and **Motor gear ratio** according to the reduction ratio.

(3) Refer to the example diagram of the linear mechanism in **Unit Conversion Settings** for setting.



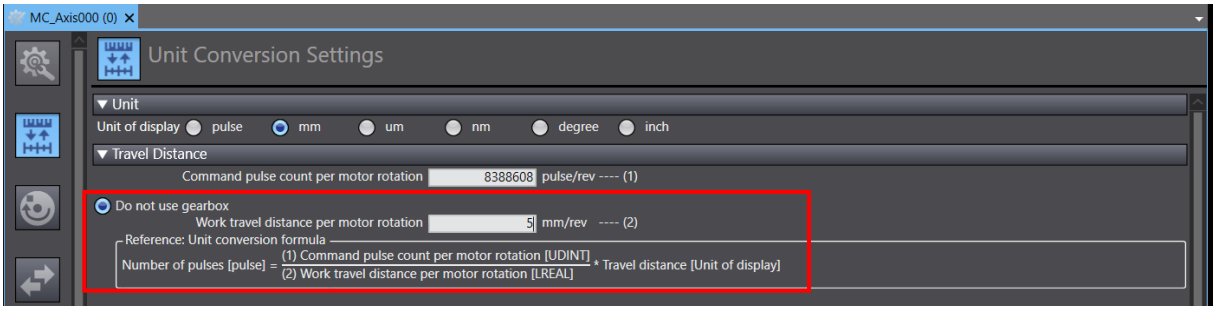


Figure 2.3.3

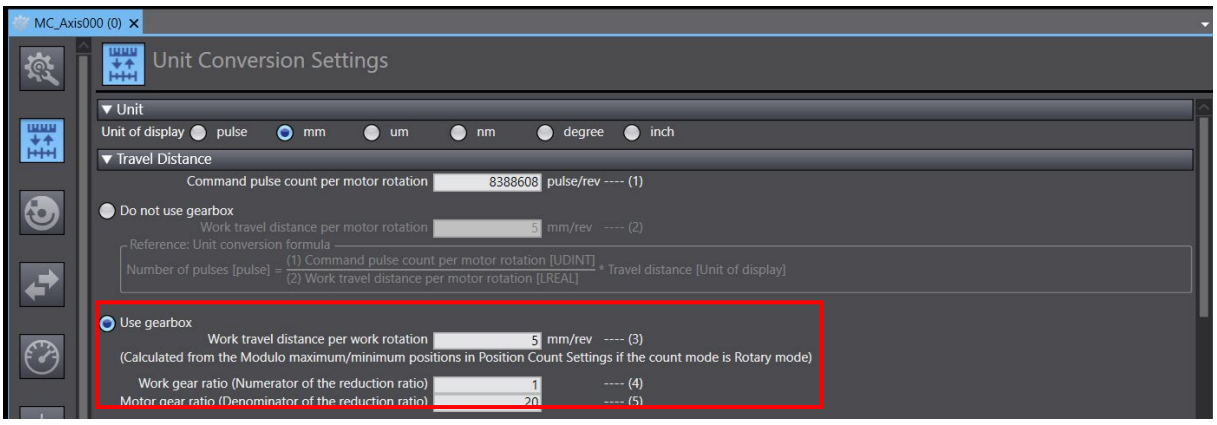


Figure 2.3.4

2.4 Operation settings

1. Click the added motion control axis **MC_Axis000** and select the **Operation Settings** icon  .

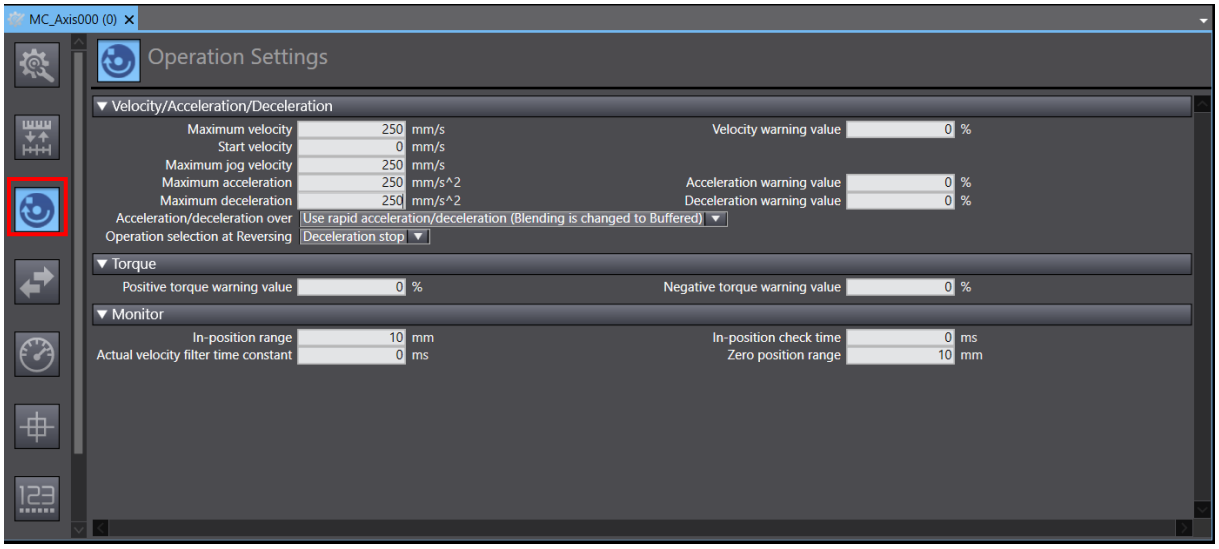


Figure 2.4.1

2. Set the parameter of **Maximum velocity**, **Maximum jog velocity**, **Maximum acceleration**, and **Maximum deceleration** according to the user scenarios.

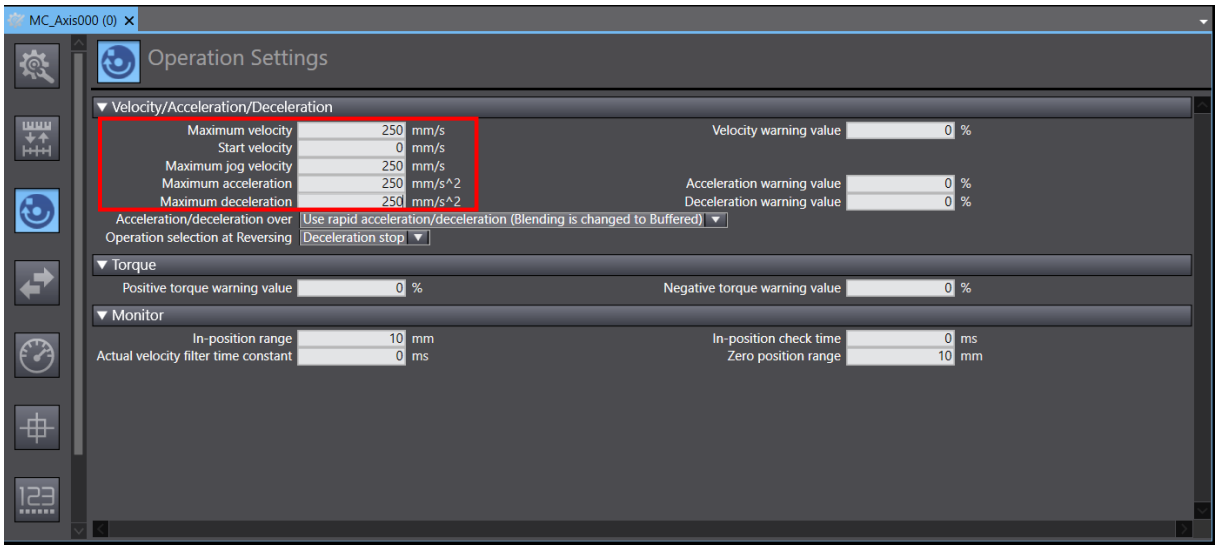


Figure 2.4.2

3. If the setting value of parameter exceeds the limit of controller, take **Maximum velocity** for example, if the value after conversion into pulse unit pulse exceeds the upper limit 500MHz, there will be a red frame line to remind users to reduce the value.

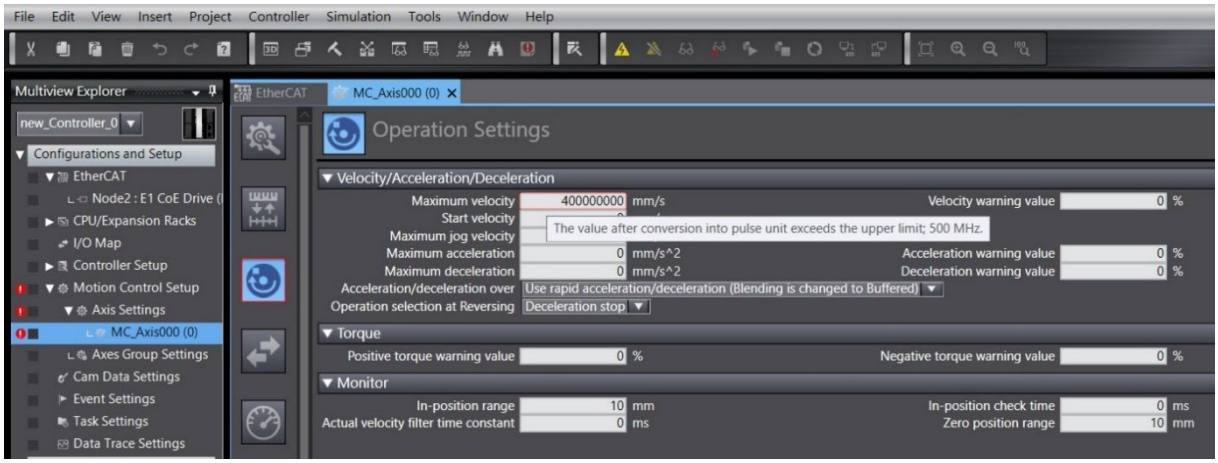


Figure 2.4.3

2.5 Select homing methods

If there are any requirements for homing operation, click the added motion control axis **MC_Axis000** and select **Homing Settings** icon  . Users can select different homing methods according to incremental or absolute encoders.

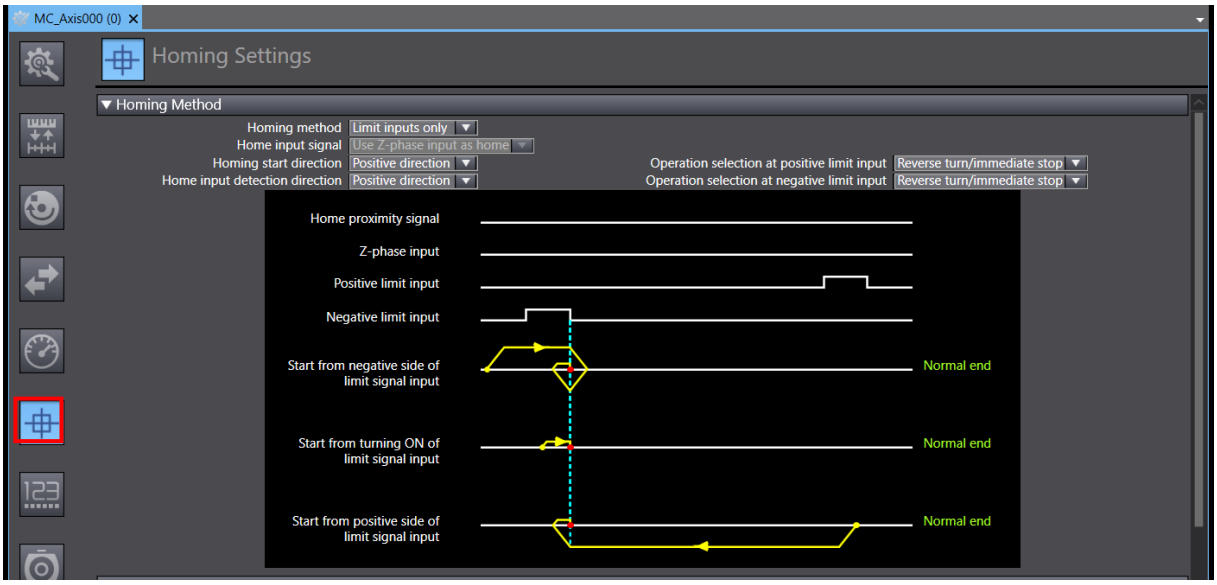


Figure 2.5.1

2.5.1 Incremental homing method

1. Select incremental homing method (need to use methods of **Z-phase**, **Positive limit**, and **Negative limit)**, and set the relevant parameters.

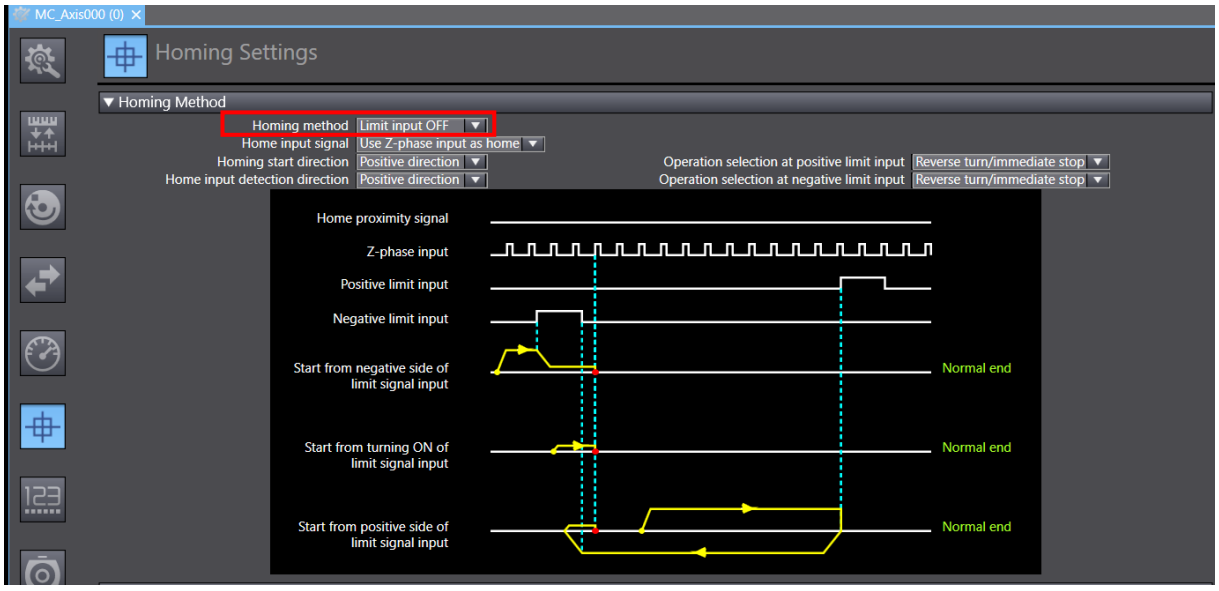


Figure 2.5.1.1

2. Set **Homing velocity** and **Homing approach velocity**.

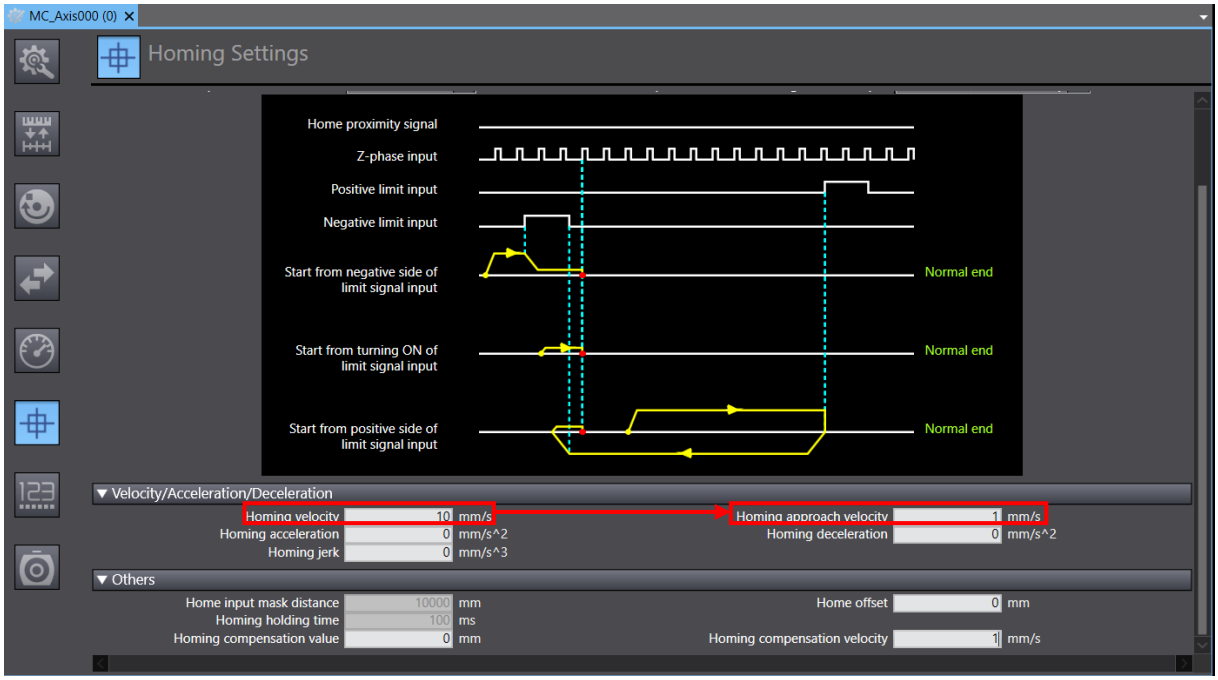


Figure 2.5.1.2

2.5.2 Absolute homing method

1. Select absolute homing method **Zero position preset**.

Important

Absolute homing method **Zero position preset** needs to be used with an absolute encoder. When performing homing, the current position would be used as the home position, which may still be recorded after power off and restart.

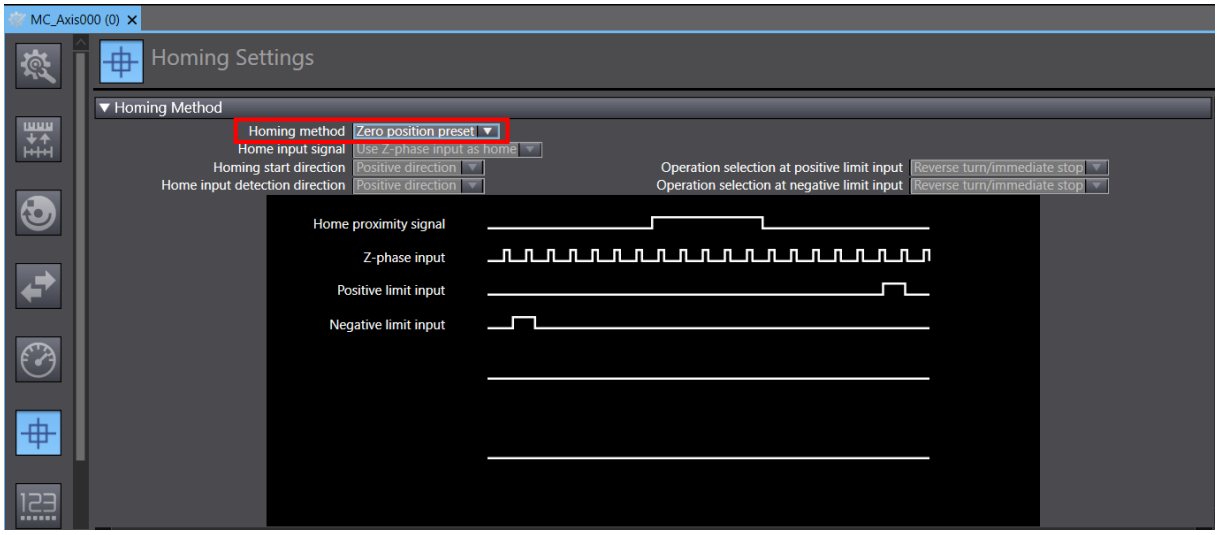


Figure 2.5.2.1

2. Select **Position Count Settings** icon  . In **Position Count Settings** window, set **Encoder type** to **Absolute encoder**.

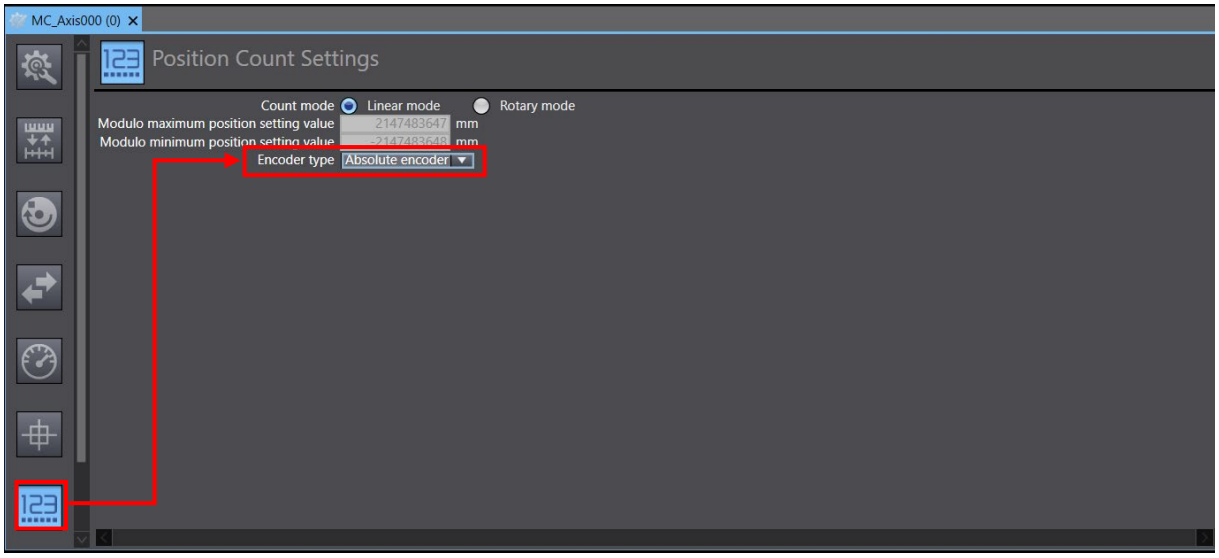


Figure 2.5.2.2

2.6 Transfer parameter settings to the controller

1. After completing parameter settings of the motion control axis, click **Build Controller** icon in the upper toolbar to compile the project. Check if there are no errors in the message window below.

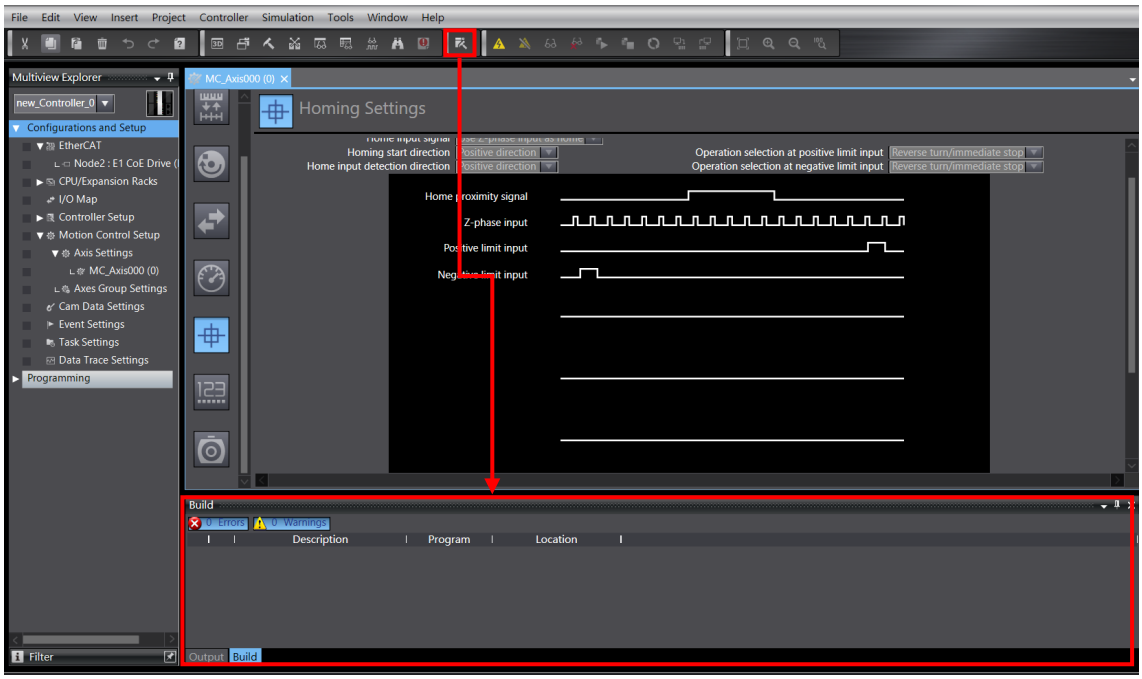


Figure 2.6.1

2. Click the **Online** icon to connect to the controller. After the connection is established, click **Synchronize** icon to compare if the setting of Sysmac Studio is consistent with the setting of the controller.

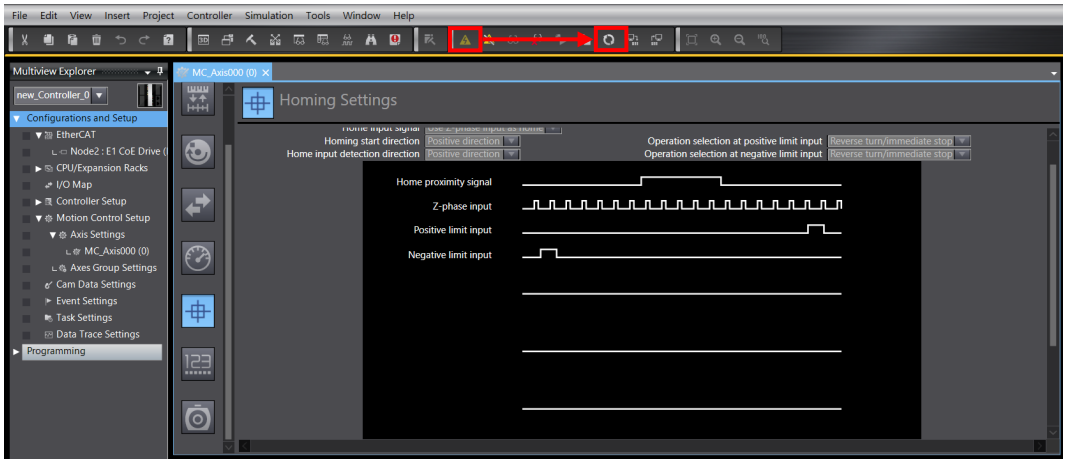


Figure 2.6.2

3. In **Synchronize** window, click **Transfer To Controller**, and transfer the settings of the project to the controller.

Important

Transfer To Controller is to overwrite the controller's current settings with the project's settings. **Transfer From Controller** is to overwrite the project's settings with the controller's current settings.

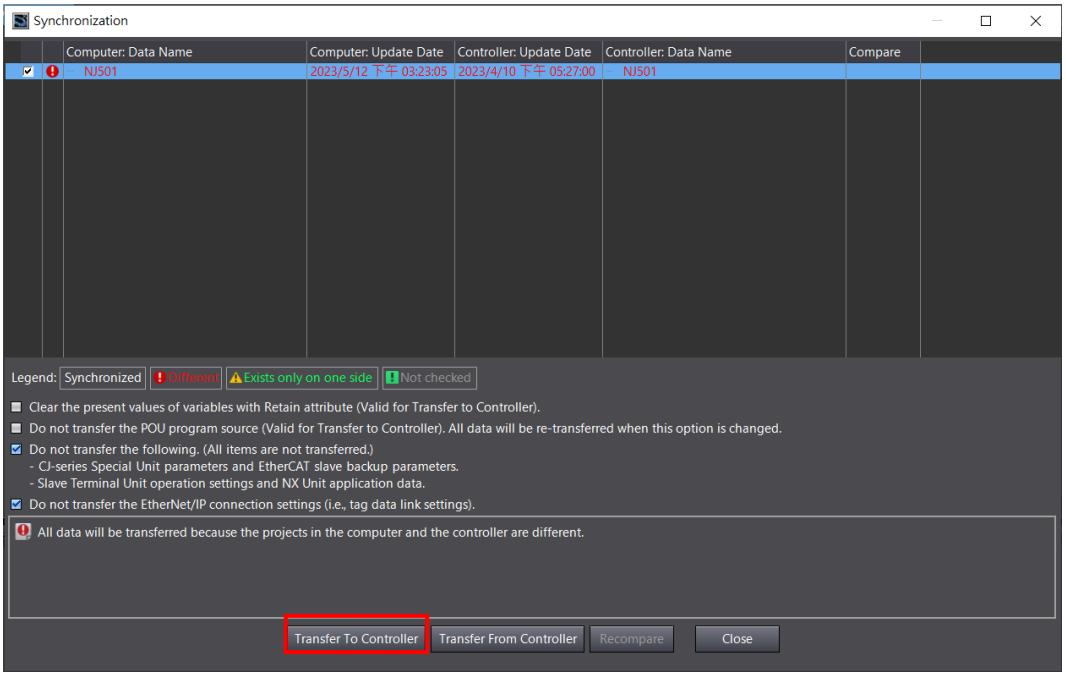


Figure 2.6.3

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3. Test run

3. Test run 3-1
3.1 Add program 3-2
3.2 Enable and homing 3-4
3.3 Relative movement 3-8

This chapter will introduce the way to compile simple programs with function blocks through **Programming** in Sysmac Studio for test run.

Important

(1) When setting the parameters of the motion axis, it cannot be connected to the controller. If it is connected, please click the **Offline** icon in the toolbar on the upper screen to cut off the connection with the controller.

(2) This manual only introduces the basic functions. For other functions, please refer to the official operation manual of OMRON.

(3) The test run follows the example in section 2.3: an EM1 series servo motor with a 5 mm/rev lead screw.

3.1 Add program

1. Go to **Programming** → **POUs** on the left side of the screen and double-click **Section0** to open the programming screen.

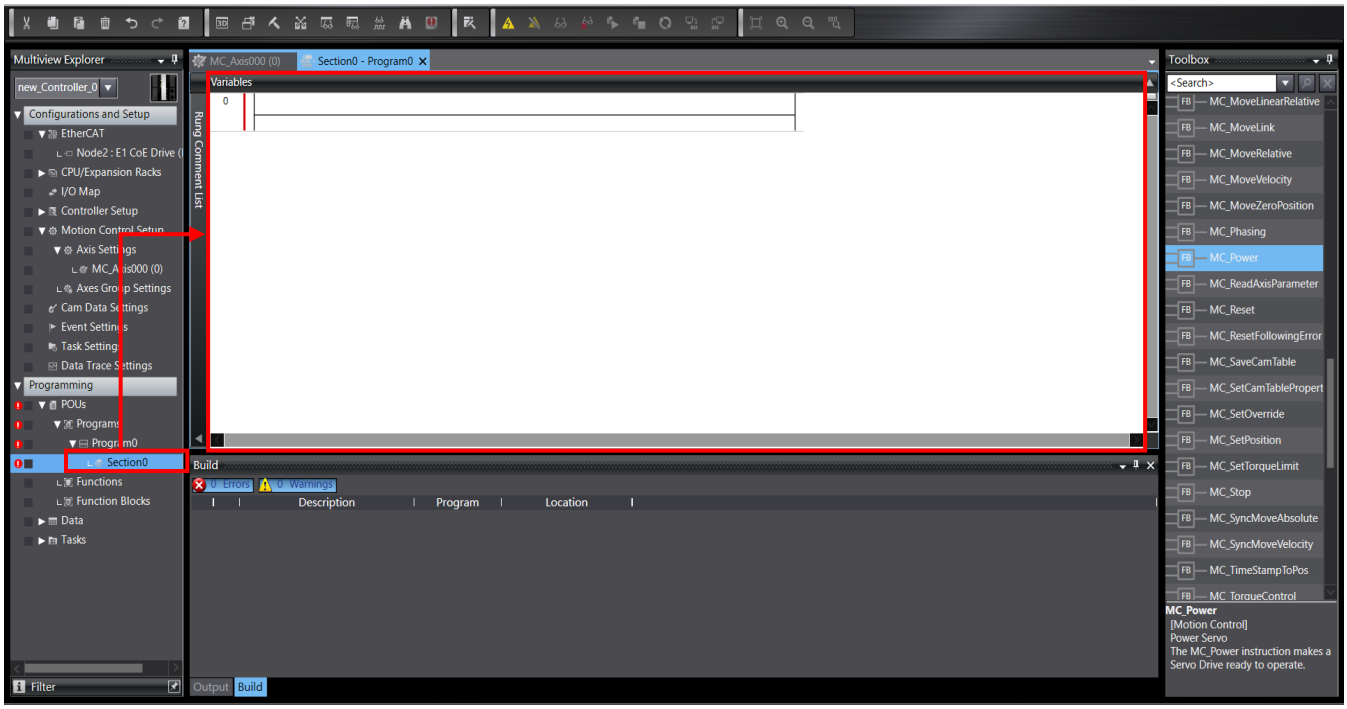

Figure 3.1.1

2. Go to **Toolbox** on the right side of the screen, select the desired function block and drag it to the line on the screen to start programming.

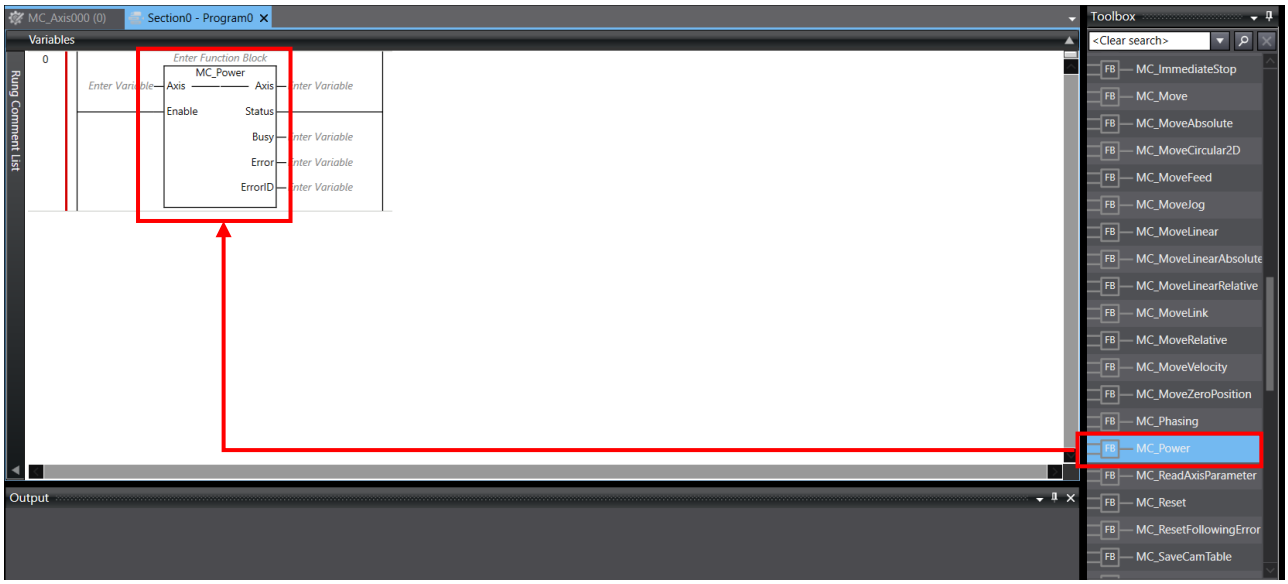

Figure 3.1.2

3. After programming is completed, transfer the program to the controller, which applies the same steps for transferring parameter settings to the controller in section 2.6: first click **Build Controller** icon in the upper toolbar to compile the project. If there are no errors in the message window below, click the **Online** icon to connect to the controller. After the connection is established, click **Synchronize** icon , and click **Transfer To Controller** in **Synchronize** window to upload the project settings and programs to the controller.

3.2 Enable and homing

1. The motor needs to be enabled before homing. Drag the motor enabled function block **MC_Power** to the line, customize the block name (such as servo_on), and input the motion control axis **MC_Axis000** to **Axis** parameter.

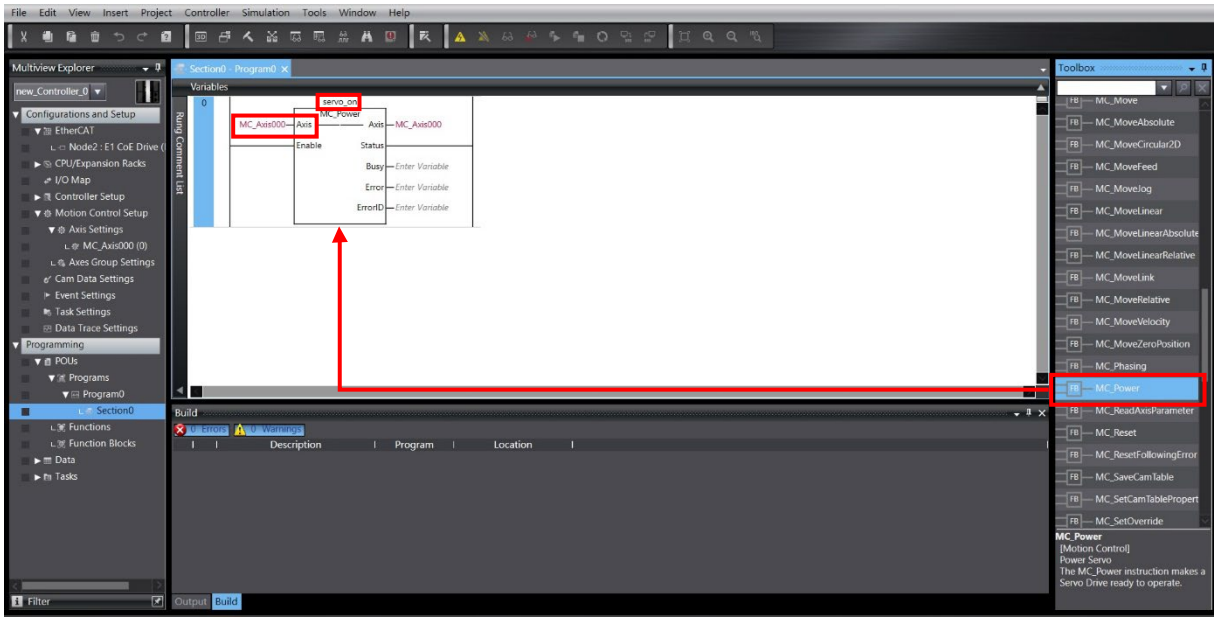

Figure 3.2.1

2. On the line corresponding to **Enable** parameter of the function block **MC_Power**, right-click and select **Insert Input** to add a switch.

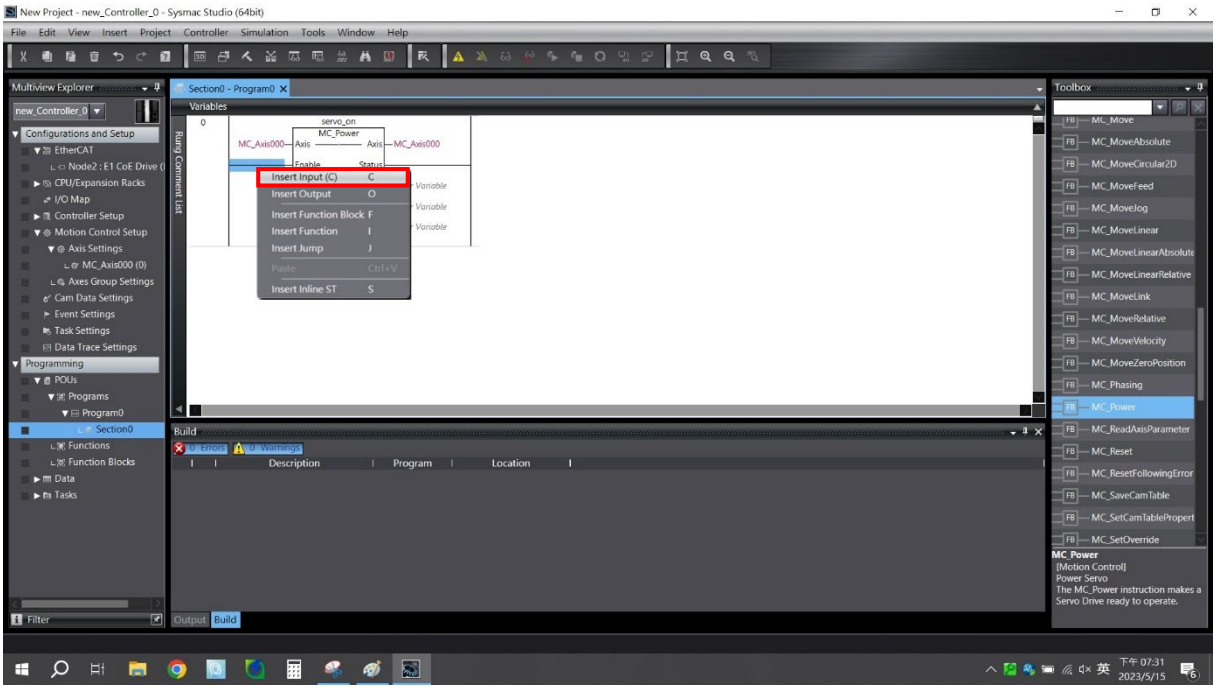

Figure 3.2.2

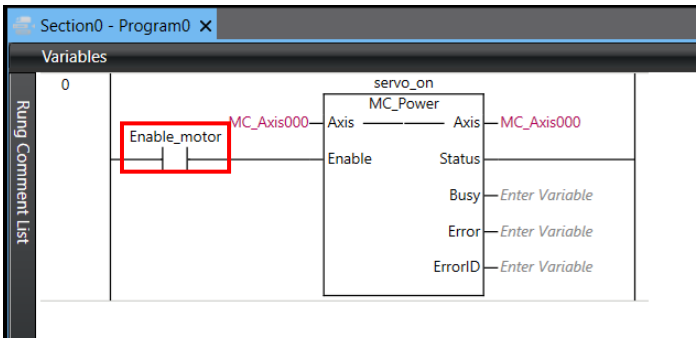

Figure 3.2.3

3. Drag the homing function block **MC_Home** to the line, input the block name and **Axis** parameter, and add a switch.

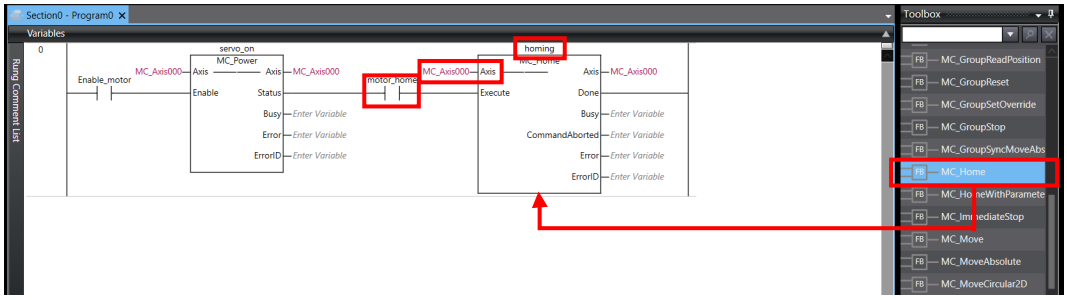

Figure 3.2.4

4. Compile the program and transfer to the controller.

5. In the case of connecting to the controller, check if **Contoller Status** light on the lower right of the screen is green.

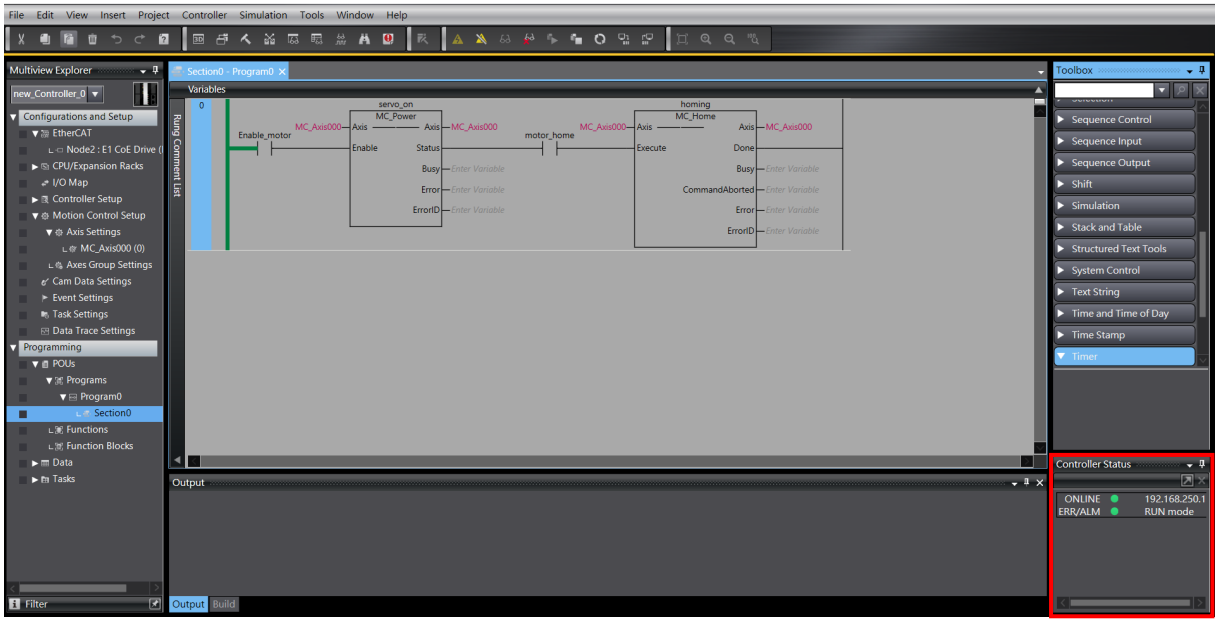

Figure 3.2.5

6. Double-click the switch of the function block **MC_Power** and select **True** to enable the motor. Check if the motor is enabled via **Servo ready** light on the lower left in Thunder.

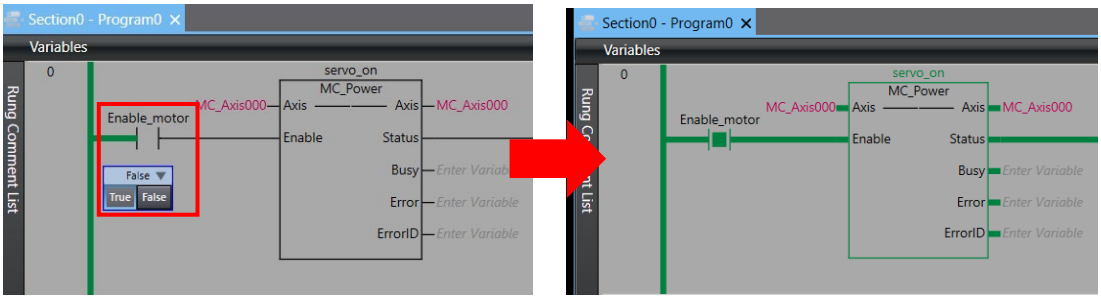

Figure 3.2.6

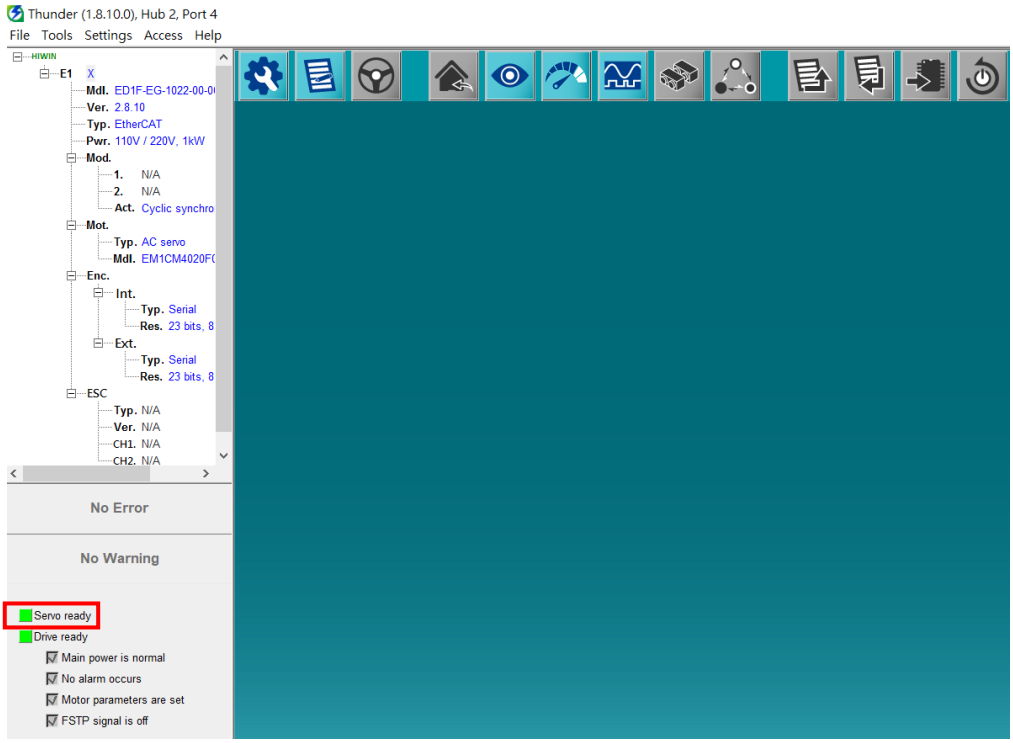

Figure 3.2.7

7. Double-click the switch of the function block **MC_Home** and select **True** to start the homing method selected in section 2.5.

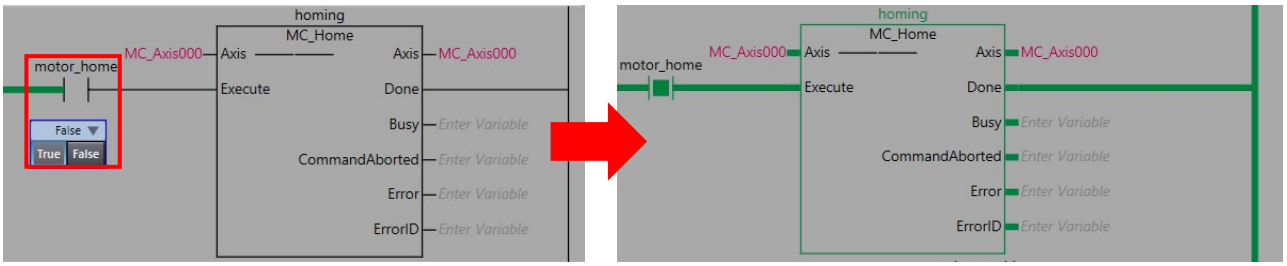

Figure 3.2.8

8. After homing is completed, select **View** on the upper screen and click **Watch Tab Page**.

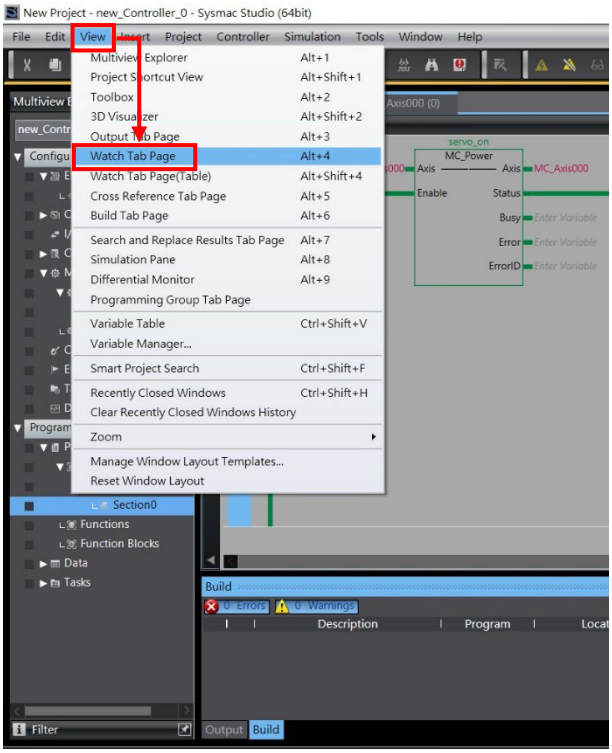

Figure 3.2.9

9. In **Watch** window on the lower screen, enter **MC_Axis_000.Act.Pos** (motor position feedback, unit: mm) in **Name** column to check if the value is close to 0.

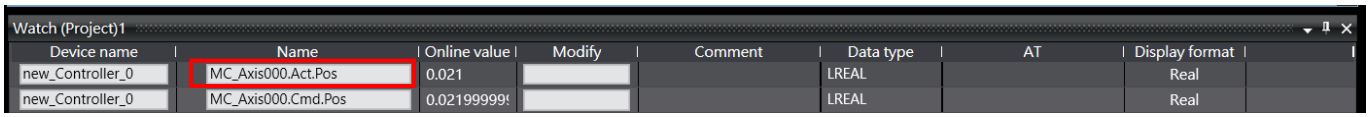

Figure 3.2.10

Important

The units of variables in **Watch** window are the same as **Unit of display** set in section 2.3.

3.3 Relative movement

1. Since the motor needs to be enabled before performing relative movement, the motor enabled function block **MC_Power** should be added into the program first.

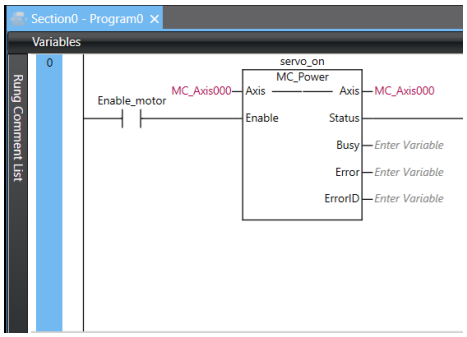

Figure 3.3.1

2. Add the relative moving function block **MC_MoveRelative** to the program and input the block name. Then, set **Axis** parameter to **MC_Axis000**; **Distance** to 100 mm; **Velocity** to 50 mm/s; **Acceleration/ Deceleration** to 50 mm/s^2, and add a switch.

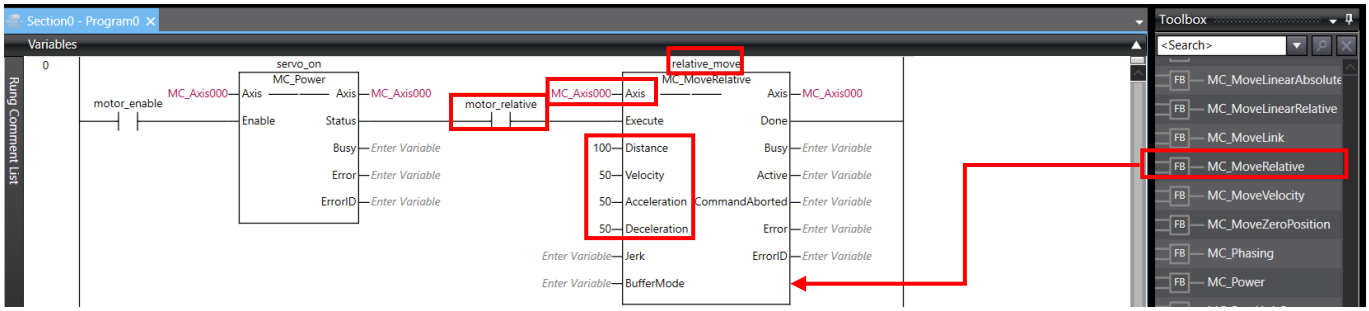

Figure 3.3.2

Important

The units of motion-related variables in function blocks are the same as **Unit of display** set in section 2.3.

3. Compile the program and transfer to the controller.

4. In the case of connecting to the controller, check if **Contoller Status** light on the lower right of the screen is green.

5. Double-click the switch of the function block **MC_Power** and select **True** to enable the motor. Check if the motor is enabled via **Servo ready** light on the lower left in Thunder.

6. Before the motor moving, ensure there are no obstacles within the moving distance.

7. Double-click the switch of the function block **MC_MoveRelative** and select **True** to start moving to the position of 100 mm.

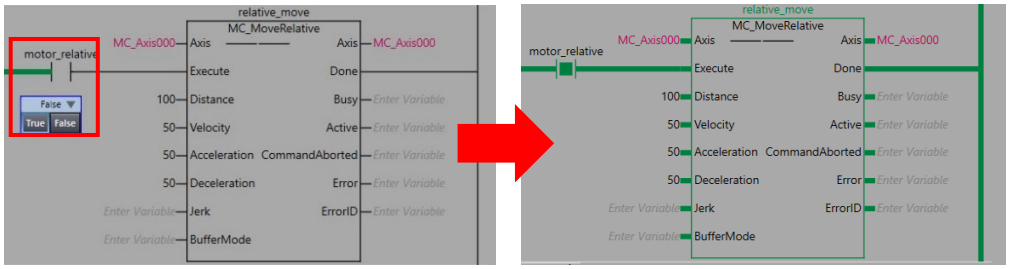

Figure 3.3.3

8. After the motor stops, select **View** on the upper screen and click **Watch Tab Page**. In **Watch** window on the lower screen, enter **MC_Axis_000.Act.Pos** in **Name** column and check if the value is 100 mm.

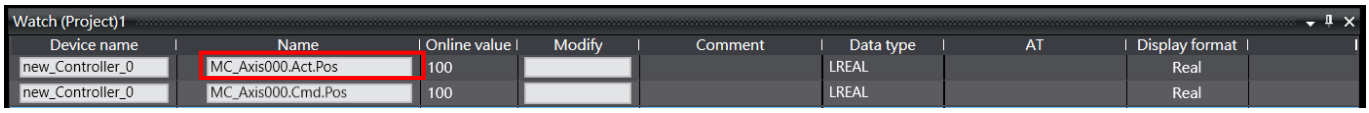

Figure 3.3.4

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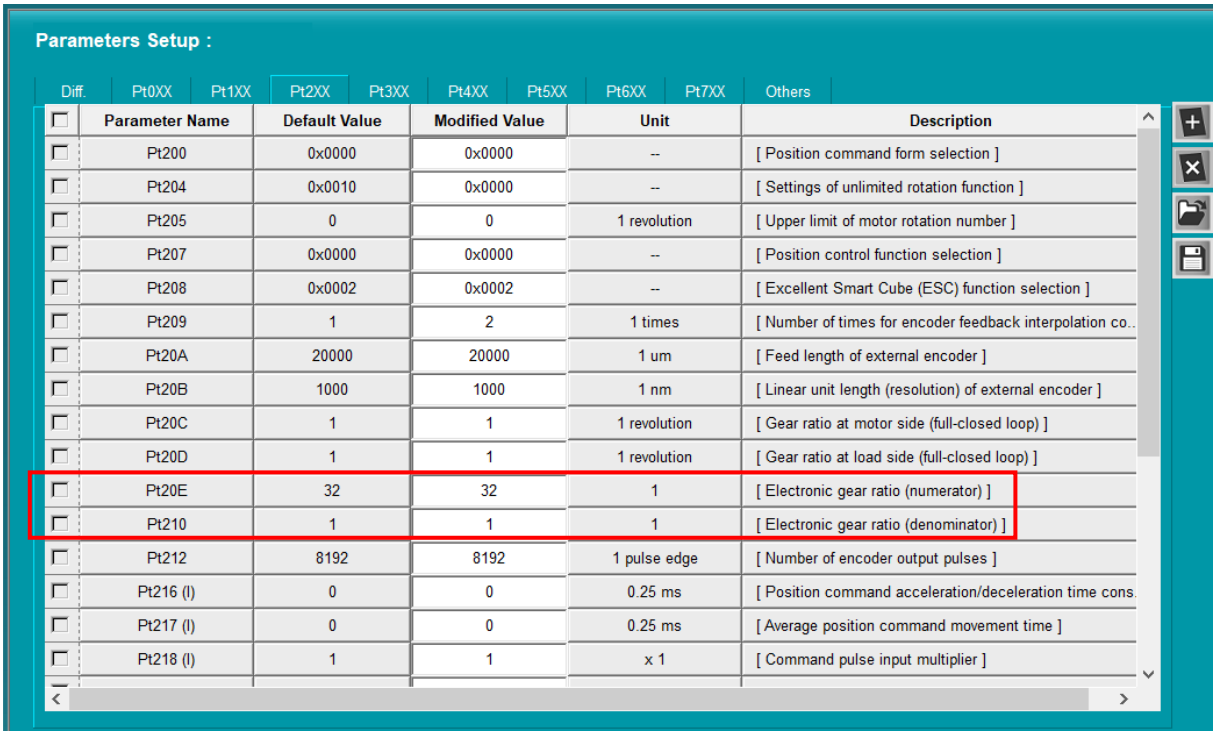
4. Other applicational settings

4. Other applicational settings 4-1
4.1 Example: Rotary mechanism of a multi-turn absolute servo motor with a reducer 4-2

4.1 Example: Rotary mechanism of a multi-turn absolute servo motor with a reducer

When using EM1 multi-turn absolute servo motor with the rotary mechanism of the reducer (with such as 1:50 reduction ratio), if the motor continuously runs in one direction, the motor's absolute position may eventually exceed the memorized turns, which may cause absolute position loss of the drive and controller after powered off and restarted. To avoid this situation, E series servo drive and OMRON controller should be set based on the following steps:

1. Set the electronic gear ratio **Pt20E** and **Pt210** to 2^n:1 (such as the default value of 32:1) in Thunder.



Parameter Name	Default Value	Modified Value	Unit	Description
Pt200	0x0000	0x0000	--	[Position command form selection]
Pt204	0x0010	0x0000	--	[Settings of unlimited rotation function]
Pt205	0	0	1 revolution	[Upper limit of motor rotation number]
Pt207	0x0000	0x0000	--	[Position control function selection]
Pt208	0x0002	0x0002	--	[Excellent Smart Cube (ESC) function selection]
Pt209	1	2	1 times	[Number of times for encoder feedback interpolation co..
Pt20A	20000	20000	1 um	[Feed length of external encoder]
Pt20B	1000	1000	1 nm	[Linear unit length (resolution) of external encoder]
Pt20C	1	1	1 revolution	[Gear ratio at motor side (full-closed loop)]
Pt20D	1	1	1 revolution	[Gear ratio at load side (full-closed loop)]
Pt20E	32	32	1	[Electronic gear ratio (numerator)]
Pt210	1	1	1	[Electronic gear ratio (denominator)]
Pt212	8192	8192	1 pulse edge	[Number of encoder output pulses]
Pt216 (I)	0	0	0.25 ms	[Position command acceleration/deceleration time cons.
Pt217 (I)	0	0	0.25 ms	[Average position command movement time]
Pt218 (I)	1	1	x 1	[Command pulse input multiplier]

Figure 4.1.1

2. Set Pt204.□□0□ and disable the multi-turn absolute encoder rotation number overflow error detection. This is to avoid the occurrence of drive alarm AL.800 when the motor runs in one direction for a long time.

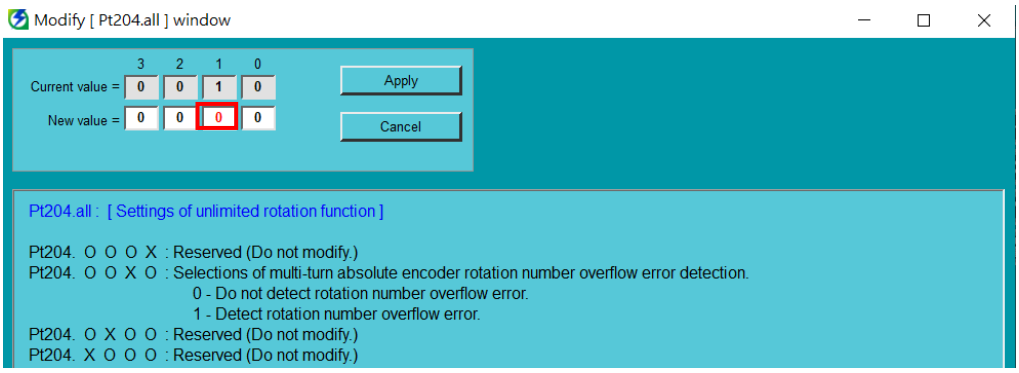


Figure 4.1.2

3. After saving the parameters to the drive, restart to take effect.

4. In Sysmac Studio, please set **Unit Conversion Settings** according to the electronic gear ratio in step 1 in Thunder: set **Unit of display** to **degree**; **Command pulse count per motor rotation** to 262144 pulse/rev.

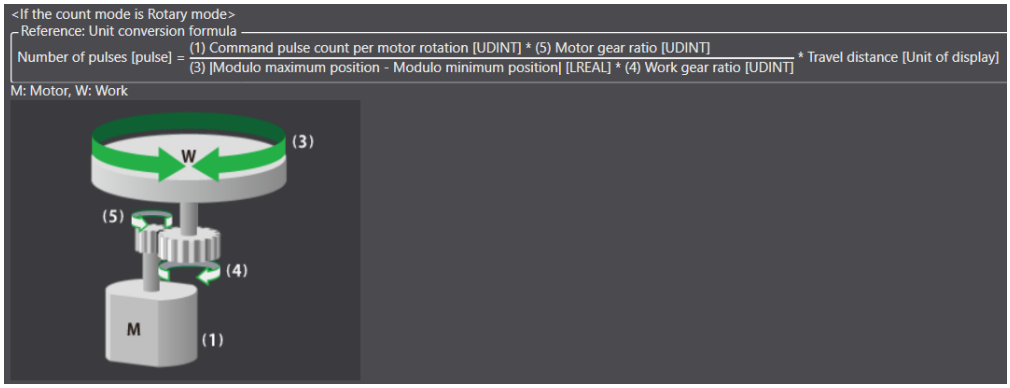
5. Select **Use gearbox**, and set **Work travel distance per motor rotation** to 360 degree/rev. If the reduction ratio is 1:50, set **Work gear ratio** to 1; **Motor gear ratio** to 50.

Important

The calculation formula of **Command pulse count per motor rotation** is: EM1 series motor resolution of 8388608 (cnt/rev) * Pt210 / Pt20E.

Example

For the settings, users can refer to the example diagram of the rotary mechanism in **Unit Conversion Settings**.



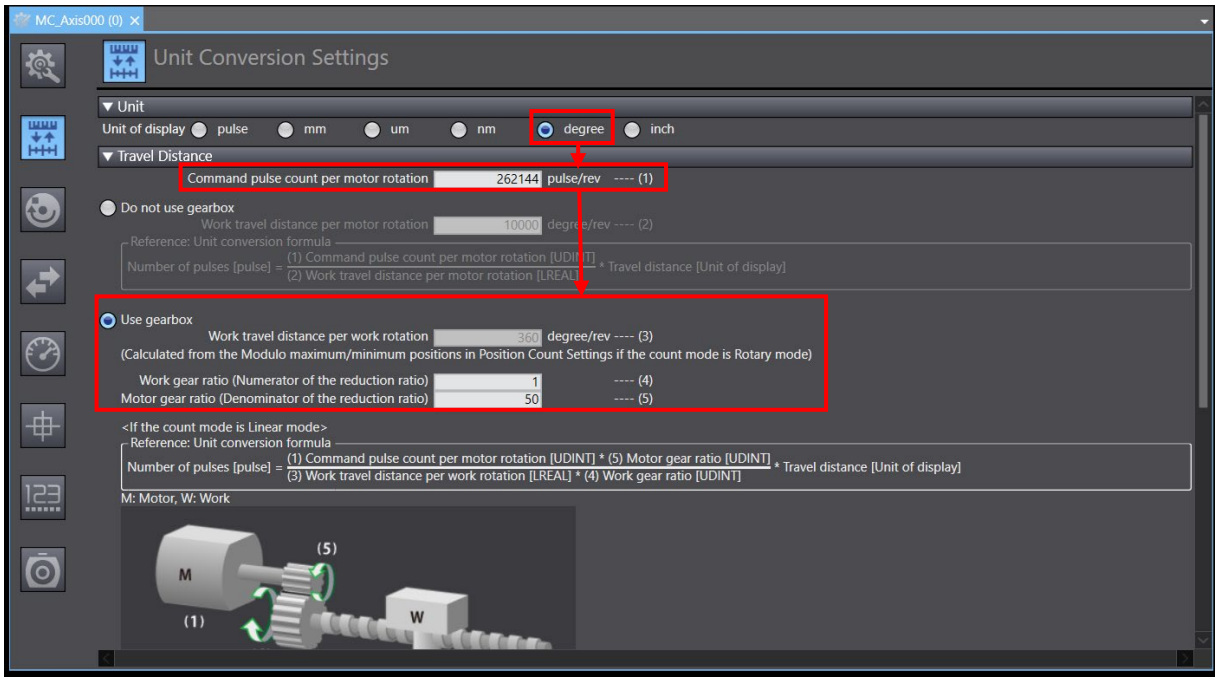


Figure 4.1.3

6. In **Position Count Settings** window in Sysmac Studio, set **Count mode** to Rotary mode; **Modulo maximum/minimum position setting value** to 360 deg/0 deg; **Encoder type** to Absolute encoder.

Important

In **Position Count Settings** window, set **Count mode** to Rotary mode, and the value of the controller would maintain between **Modulo minimum position setting value** and **Modulo maximum position setting value**. If the value is set to 0~360 deg, the position range could be corresponding to the single-turn position of the load side.

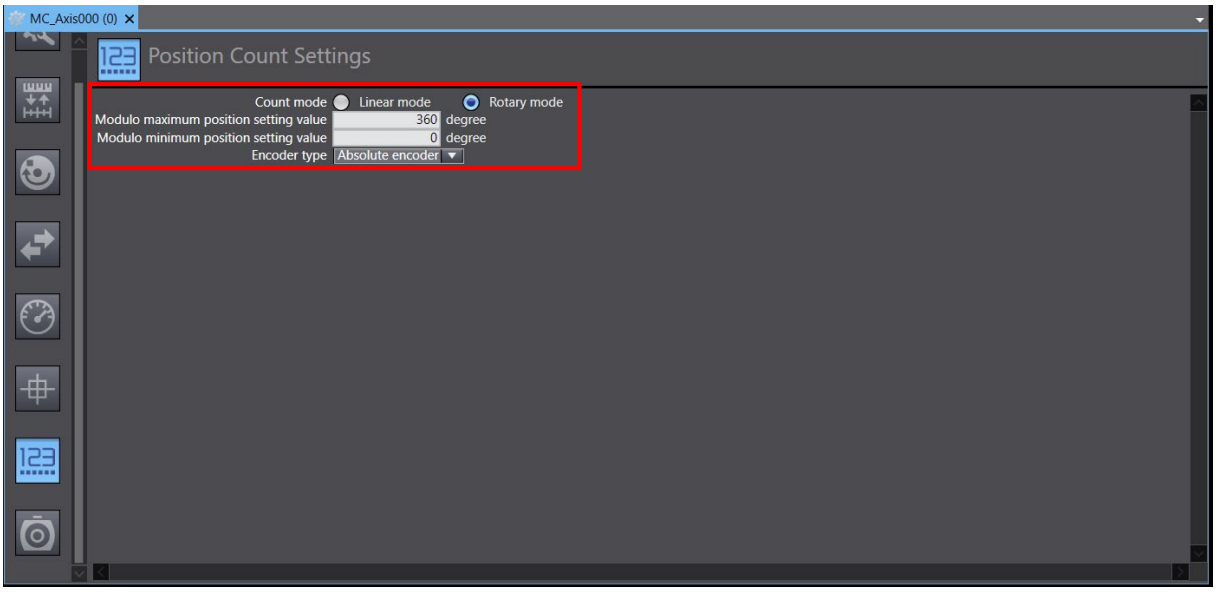


Figure 4.1.4

7. Add a new program for test run. Add the motor enabled function block **MC_Power**, the JOG function block **MC_MoveJog**, and the homing function block **MC_Home** to the program.

8. For **MC_MoveJog** variables, set **Velocity** to 20 deg/s; **Acceleration/Deceleration** to 20 deg/s^2, and run the load side at a speed of 20 deg/s.

Important

(1) The variables of the function block **MC_MoveJog** may correspond to the load side.

(2) To jog in a negative direction, set a variable for the jogging function block parameter **NegativeEnable**.

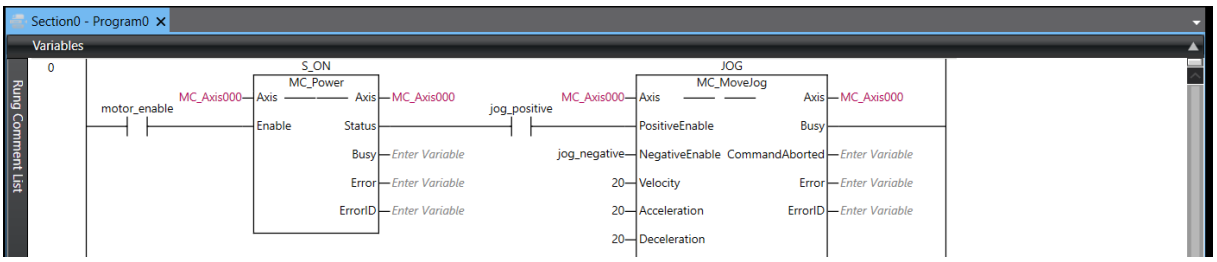


Figure 4.1.5

9. First click the switch of **MC_Power** to enable the motor, and then click the switch of **MC_MoveJog** to jog the motor in a positive direction.

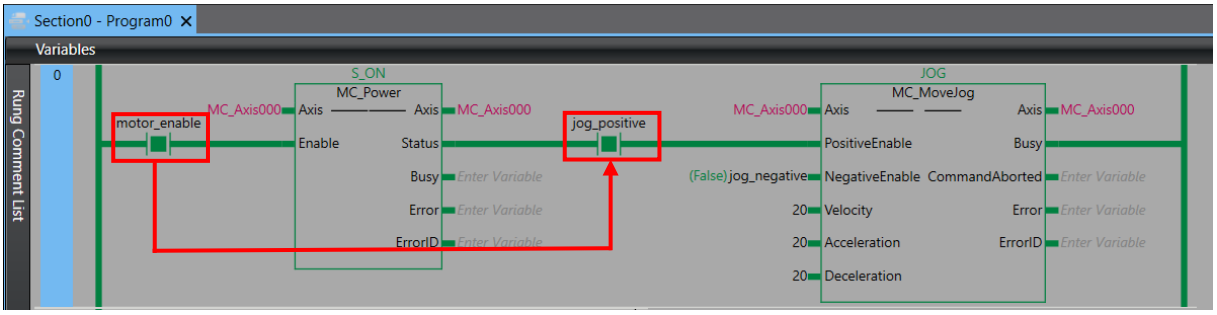


Figure 4.1.6

10. It is visible that after the variable **MC_Axis_000.Act.Pos** accumulated from 0 deg to 360 deg, it will be accumulated again from 0 deg.

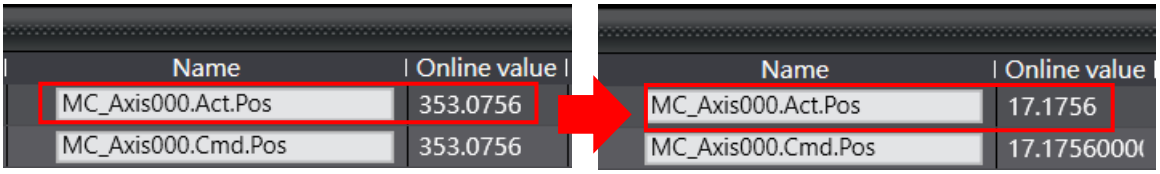


Figure 4.1.7

11. First, turn off the switch of **MC_MoveJog** and click the variable (such as **jog_negative**) which is corresponded to the parameter **NegativeEnable**. Then, select **True** to jog the motor in a negative direction.

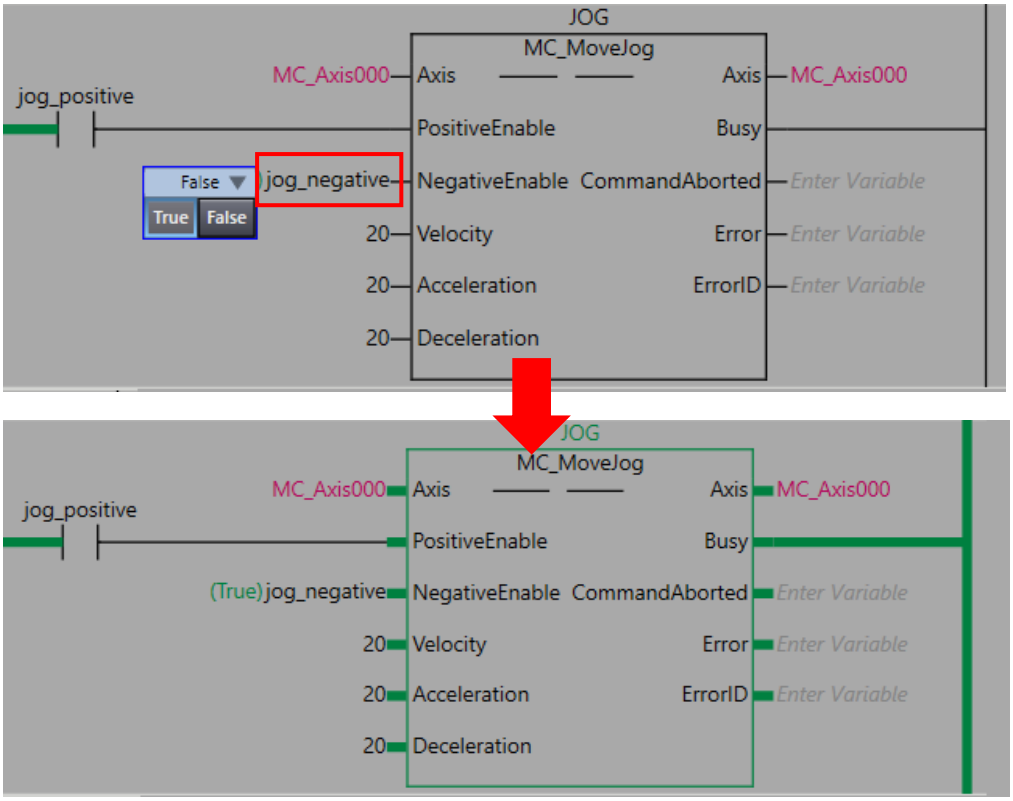


Figure 4.1.8

12. It is visible that after the variable **MC_Axis_000.Act.Pos** decreased from 360 deg to 0 deg, it will be decreased again from 360 deg.

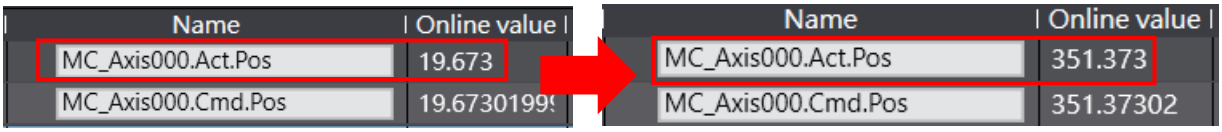


Figure 4.1.9