Setup Guide

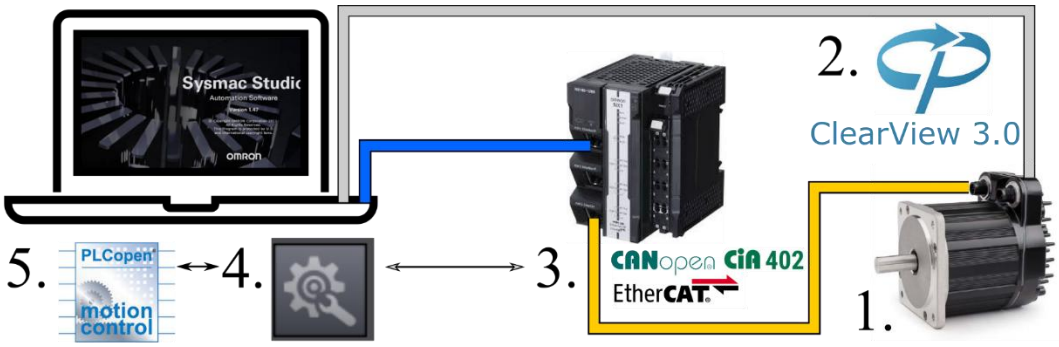
Omron NJ/NX Controller – Teknic ClearPath-EC Motor

Author: Jacob Rice, Ph. D.
Managing Director, FASN
Advanced Manufacturing Center,
Marquette University

Date: 11/12/2025

Overview

This setup guide shows how to configure an Omron NJ/NX series controller to operate a Teknic ClearPath-EC motor. The figure below shows a simplified "setup" with numbers indicating the main steps required to set up a motion control application.



Steps:

1. Physical Installation
2. ClearPath-EC Parameter Configuration
3. EtherCAT Communication Setup
4. Sysmac Studio Axis Configuration
5. PLCopen Motion Control Programming

This guide covers Steps 2-4.

The ClearPath-EC motor must be properly installed (mechanically and electrically) with appropriate input/output devices (e.g. limit switches, external brake) connected to the ClearPath digital I/O. ClearPath I/O functions and other drive parameters are most easily configured using ClearView 3.0. Refer to the *ClearPath-EC User Manual* for installation details (https://teknic.com/files/downloads/ClearPath-EC_User_Manual.pdf).

Omron NJ/NX series controllers are configured and programmed using Sysmac Studio. NJ/NX controllers use CANopen over EtherCAT (CoE) to communicate with CiA 402 drives. CiA 402 defines standard service data objects (SDOs) and process data objects (PDOs) for configuring, operating, and monitoring the drive. The CiA 402 drive interprets received target commands according to its current operating mode selected by the NJ/NX controller. NJ/NX controllers support the following CiA 402 operating modes:

- Cyclic Synchronous Position (CSP)*[1]
- Cyclic Synchronous Velocity (CSV)
- Cyclic Synchronous Torque (CST)

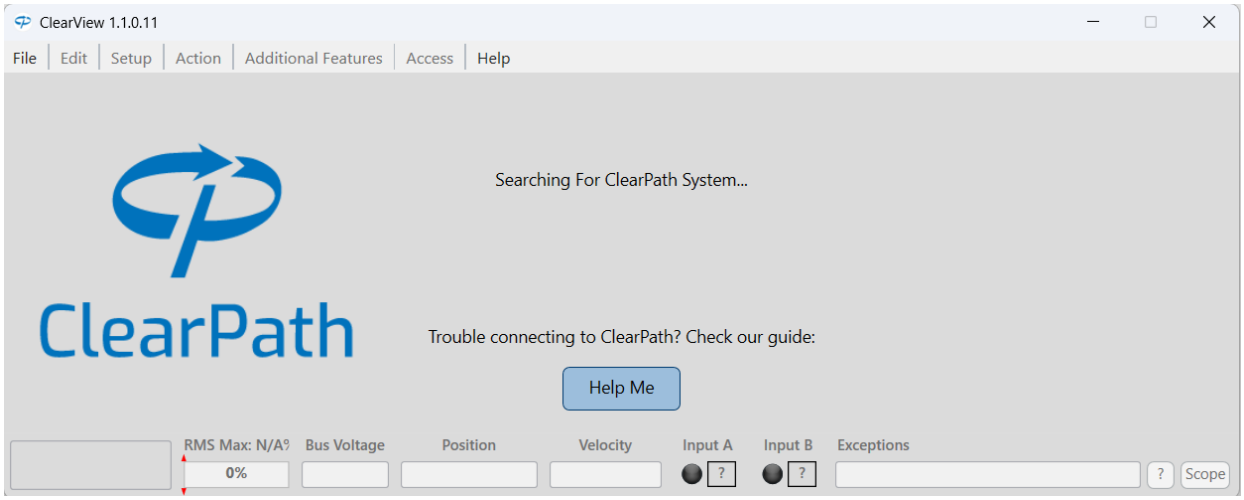
ClearPath-EC implements the CiA 402 device profile and supports all these operating modes (CPS, CSV, CST) and also supports Profile Position (PP), Profile Velocity (PV), Profile Torque (PT), and Homing (HM) operating modes. ClearPath-EC also provides the necessary PDOs to use the PLCopen motion control function blocks (instructions) in Sysmac Studio. An *Axis* object must be configured to map the appropriate CiA 402 PDOs to PLCopen parameters.

[1] Most NJ/NX motion control instructions use the CSP mode for commanding the servo drive – even those that are not strictly for positioning applications. For example, MC_Home, MC_MoveJog, and MC_MoveVelocity all use the CSP mode.

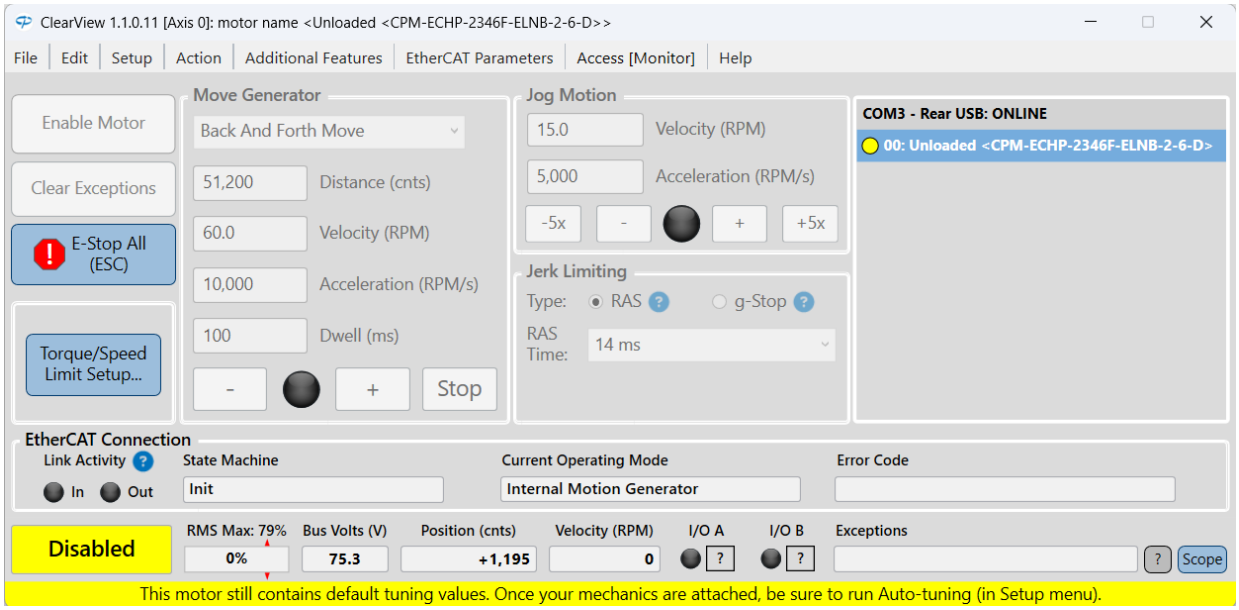
ClearPath-EC Parameter Configuration

This section briefly goes over using the ClearView 3.0 motor setup application to configure many drive parameters. For details on downloading, installing, and using ClearView 3.0, refer to the *ClearPath-EC User Manual* (https://teknic.com/files/downloads/ClearPath-EC_User_Manual.pdf).

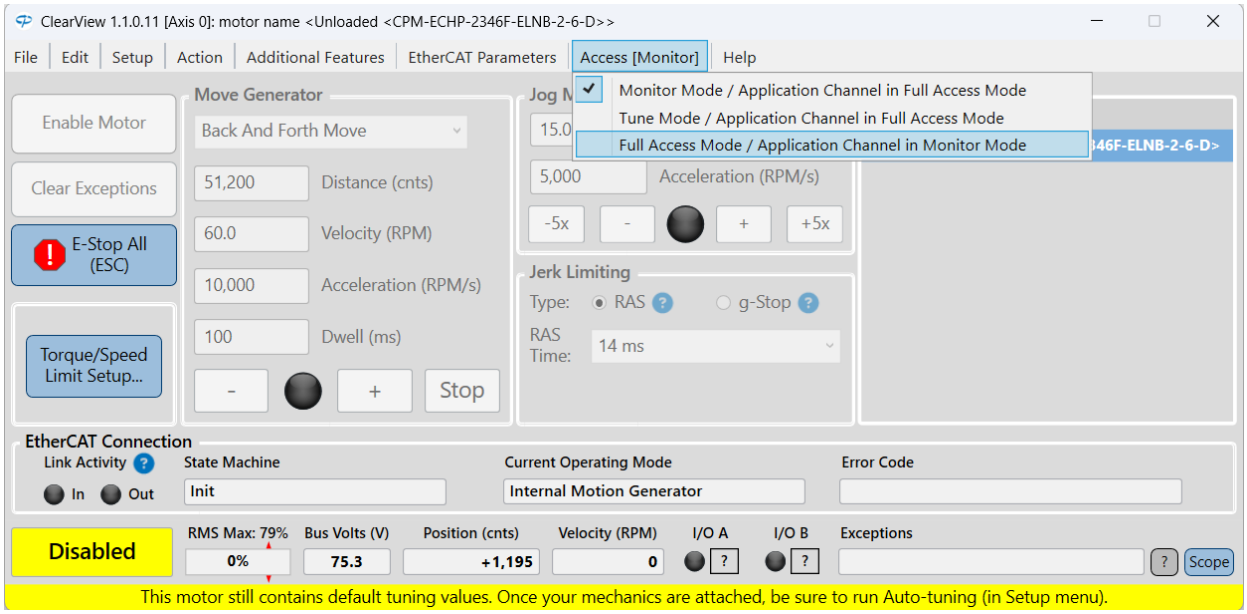
1. Open ClearView 3.0



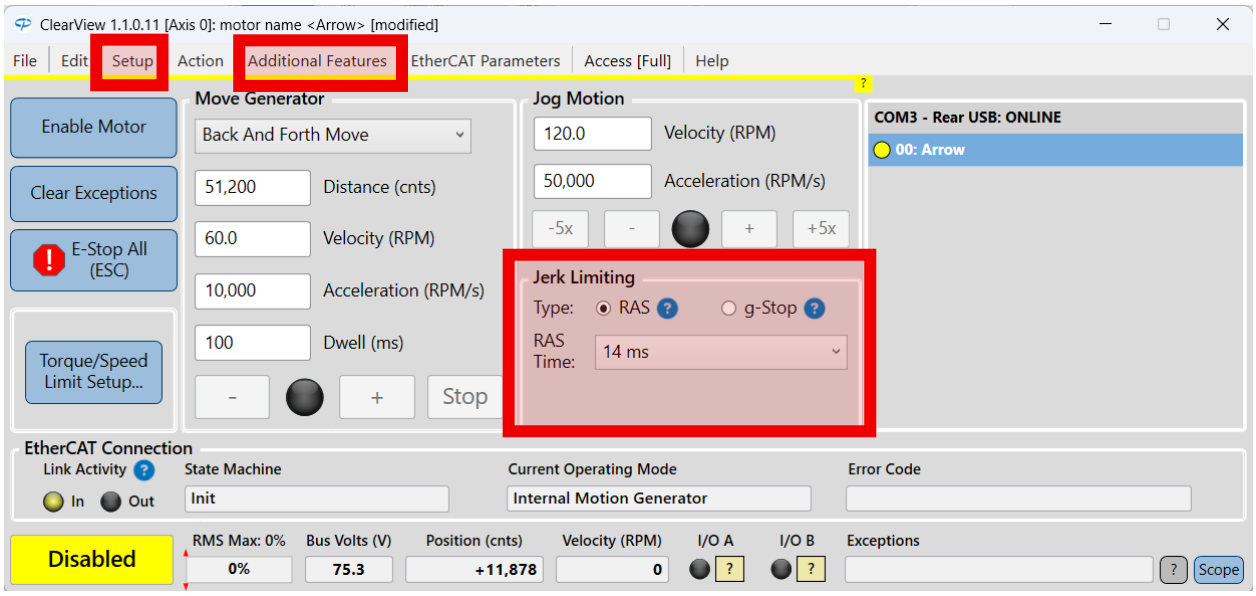
2. Connect a USB A-C data cable between the PC and the ClearPath USB C-IR Converter (magnetically attached to the ClearPath motor) and turn on power to the motor.



3. Click on the **Access [Monitor]** tab and click **Full Access Mode** to edit drive parameters.



4. Drive parameters can be configured within the **Setup** tab and **Additional Features** tab. The **RAS Time** parameter in the **Jerk Limiting** window can also be adjusted.

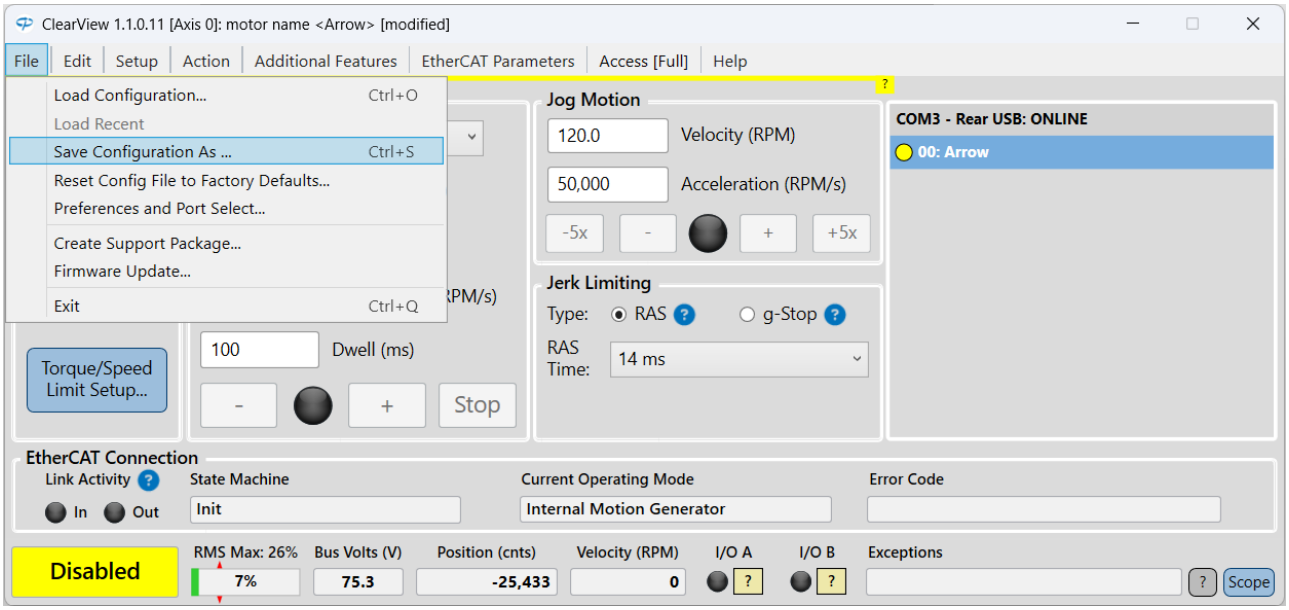


Some brief notes about these parameters:

- = Configuration highly recommended
- = Default setting often OK

  - **Tuning**: Run the auto-tune wizard in (Setup > Tuning > Auto-Tune). Auto-tuning modifies several control parameters. Perform tuning after configuring other parameters (e.g., I/O, torque/speed limits, and shutdown operations). It's recommended to re-tune the motor each time there is a change in the mechanical system.
  - **I/O Setup**: Configure the drive's treatment of ClearPath I/O (Input/Output A, B).
  - **Torque/Speed Limiting**: The torque limit for a specific direction (Positive Torque Limit, Negative Torque Limit) can be less than the "global torque" limit (useful for vertical applications). These parameters can be dynamically adjusted by the NJ/NX controller if Positive Torque Limit (0x60E0) and Negative Torque Limit (0x60E1) are added in the PDO mapping.
    - **Homing & Software Limits Setup**: ClearPath-EC supports several homing methods, any of which can be executed in the CiA 402 homing mode of operation. However, NJ/NX controllers using the Sysmac Studio Axis object do not use the drive's homing method, but instead perform the homing and keep track of the "home" position within the NJ/NX controller.
    - **Units**: To adjust the units displayed in ClearView 3.0. This selection does not affect the units used in the NJ/NX controller.
    - **Following Error**: To execute a drive shutdown if the (immediate) commanded position is different than the actual position by this configured window amount and duration of time. NJ/NX controllers have separate following error/warning parameters that are configured in the Axis object; these parameters function separate from the drive's following error (they are not linked - both can be active).
    - **In-Range**: To configure a window/amount to indicate the motion has reached a settled target. NJ/NX controllers have in-range window/time parameters that are configured in the Axis object that behave differently; NJ/NX controllers do not use the drive's In-Range check.
    - **Move Done Torque Foldback**: Enable to reduce torque at stand-still (can be useful for applications with high friction or low force disturbances).
    - **Input A, B Filtering**: To set a filter time appropriate for the connected sensor/switch.
    - **Vector Regen Shunt (VRS)**: To enable a feature to mitigate over-voltage shutdowns from regenerated energy.
  - **Disable and Stop Options:** To select appropriate stopping/disabling actions for different command signals or conditions.
    - **Power and Temperature**: To select the DC-bus low voltage threshold, DC-bus current trip point, and drive temperature trip point that trigger a shutdown.
    - **RAS Time**: Information about regressive auto spline here: (https://youtu.be/WOyP51-PiTs).

5. Changes made to parameters through ClearView 3.0 are automatically saved to the ClearPath-EC's non-volitile memory. For backup purposes, it's recommended to also save the configuration as a .mtr file by clicking **File > Save Configuration As.**

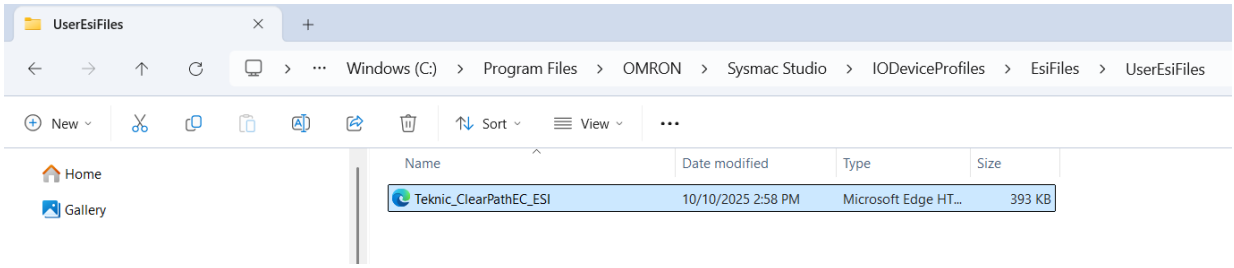


EtherCAT Communication Setup

Step 1: Load the ESI (EtherCAT Slave Identification) file

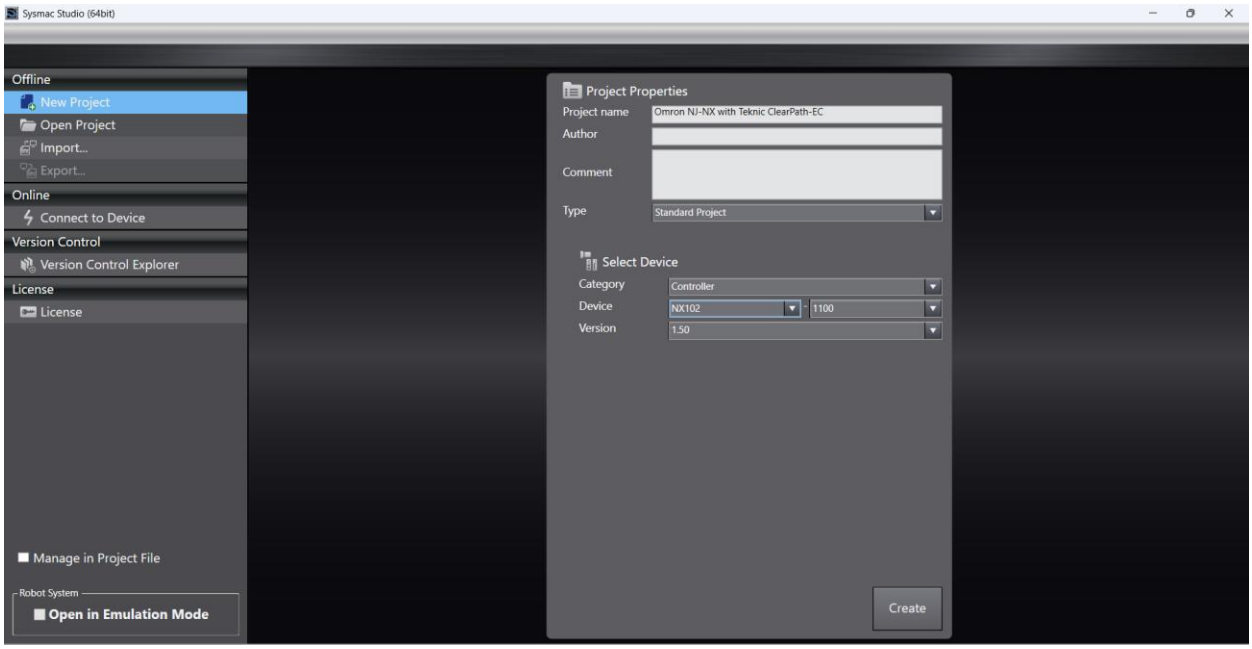
- Download the Teknic_ClearPathEC_ESI.zip file from https://teknic.com/downloads/.
- Extract the contents and place the Teknic_ClearPath_ESI.xml file in the folder referenced by Sysmac Studio's ESI Library. The default directory is:

  C:\Program Files\OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles.



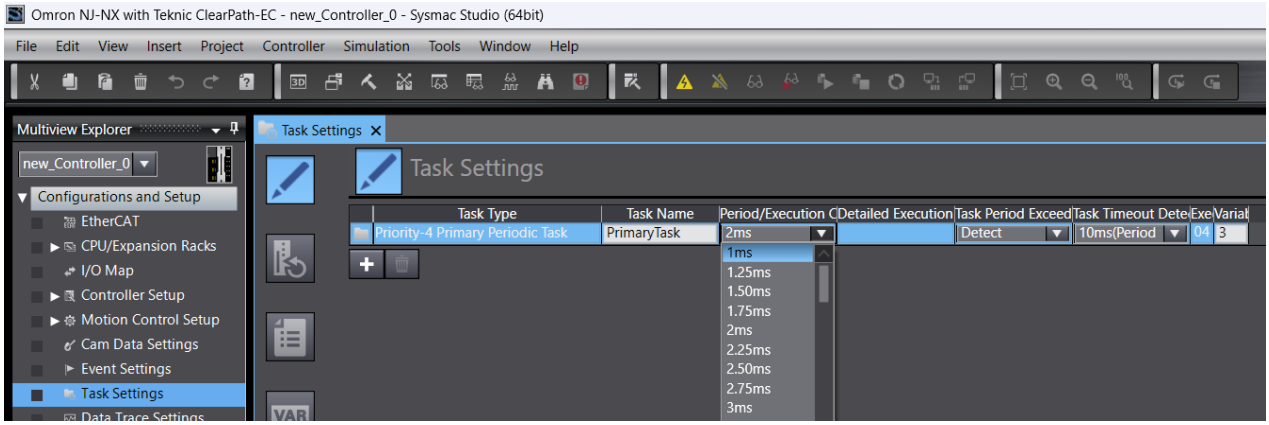
Step 2: Create a project in Sysmac Studio with an NJ/NX controller

- Open **Sysmac Studio**, Click **New Project**, enter a project name, select the controller model and version, and click **Create**.



Step 3: Set the EtherCAT communication cycle

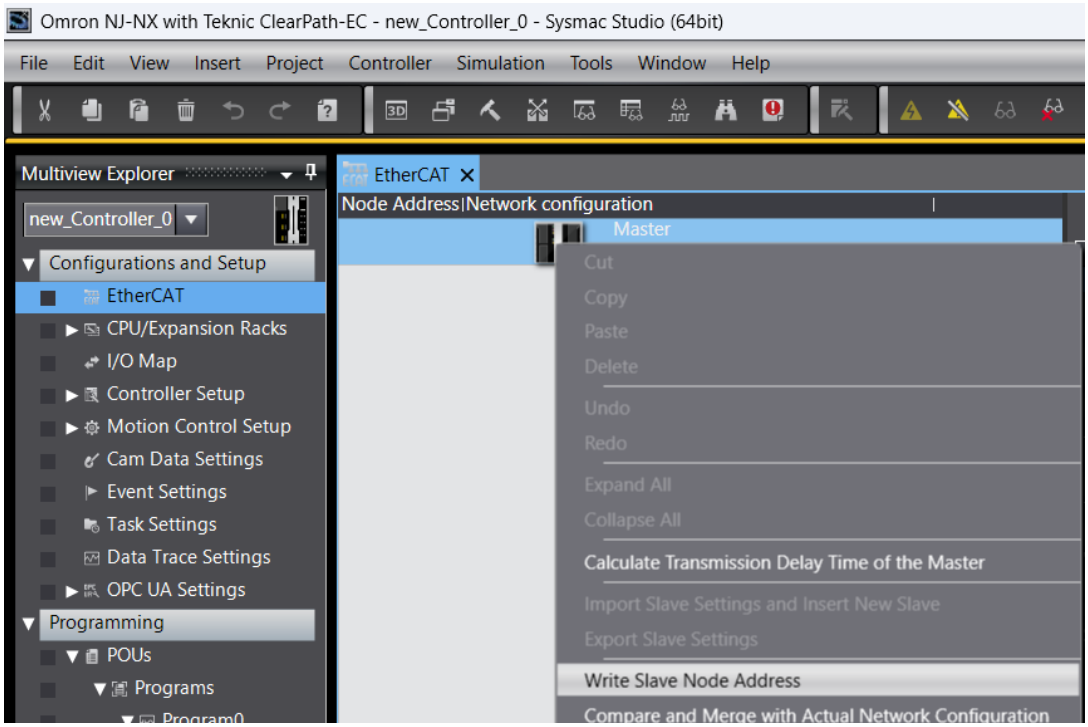
- Double click on **Task Settings** (in the **Multiview Explorer** pane on the left), select the desired **Period/Execution** for the **Primary Task** by clicking on the dropdown arrow.



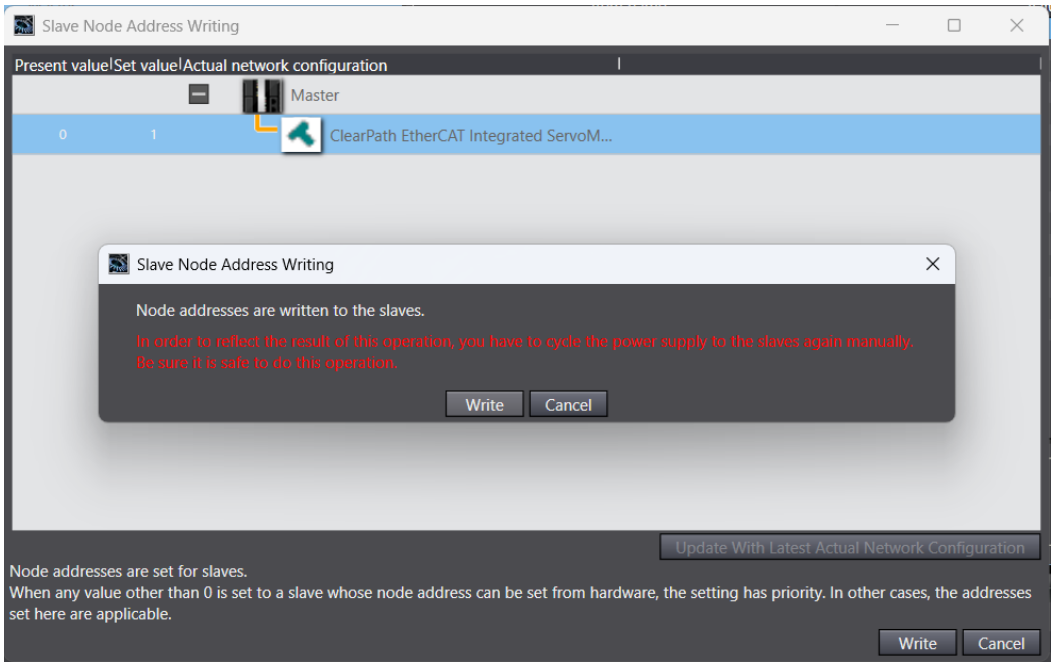
Step 4: Add the Teknic ClearPath-EC node to the EtherCAT network.

These instructions assume that the EtherCAT network is physically wired, the ClearPath-EC motor and controller are powered on, and the PC can connect to the controller.

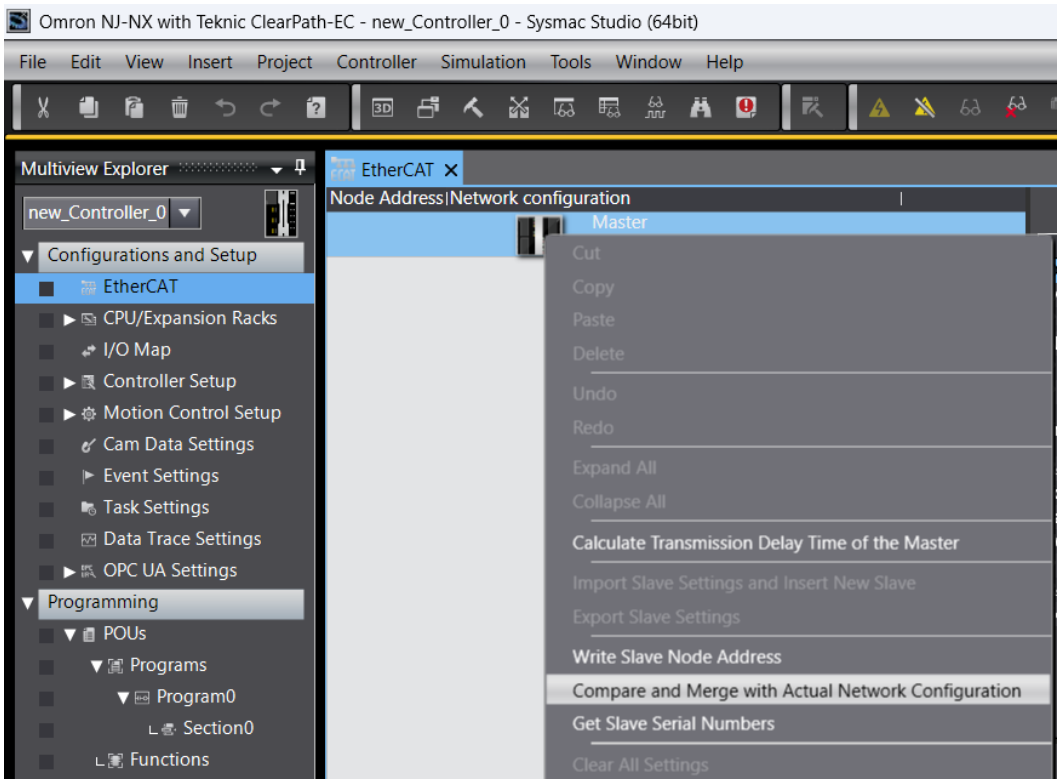
- Double click on **EtherCAT** in the **Configuration and Setup** menu.
- Click on the (go) **Online** icon (yellow triangle with lightning bolt). A yellow ribbon above the editor window indicates Sysmac Studio is connected to the controller.
- Right click on the controller image, click **Write Slave Node Address**



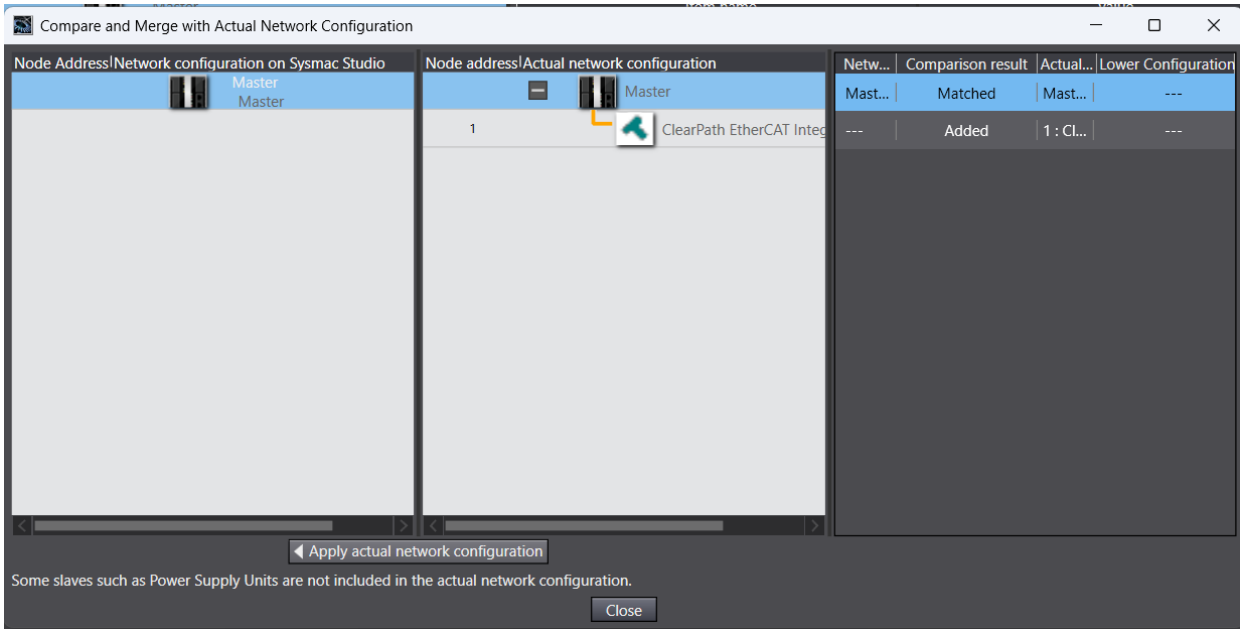
- Double click on the **Set value** field and enter **1**. Click **Write**. Click **Write** again in the warning window. Click **Close**. Cycle the power to the ClearPath-EC motor (EtherCAT slave).



- Right click on the controller image and click **Compare and Merge with Actual Network Configuration**.

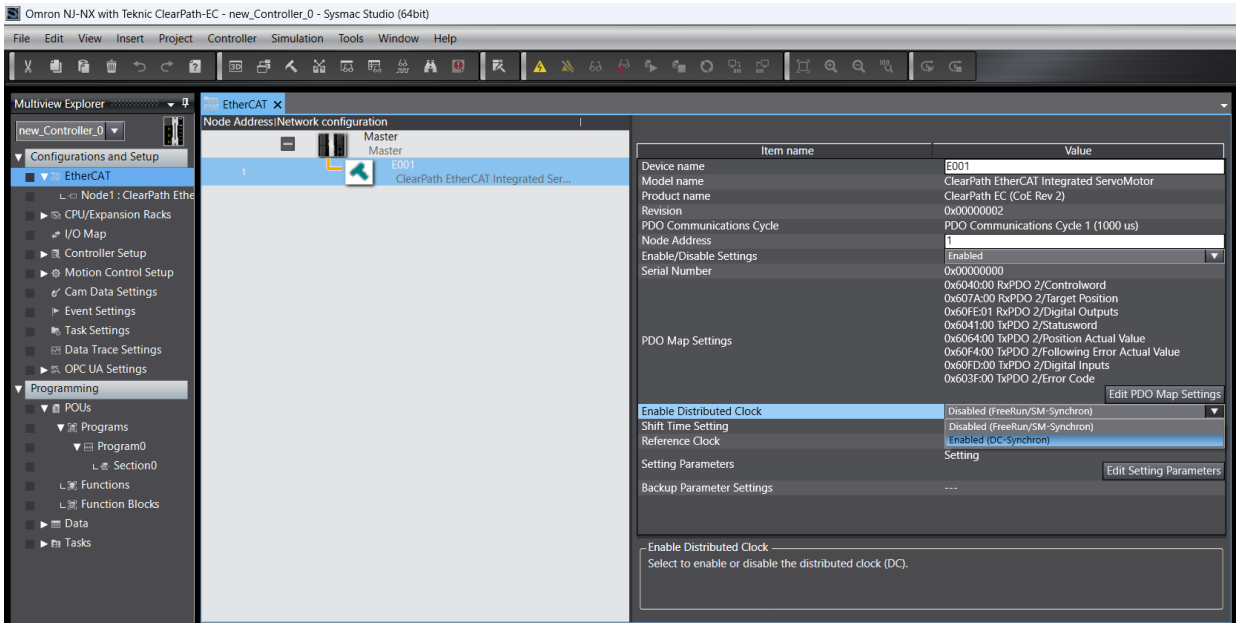


- Click **Apply actual network configuration**. Click **Close** in the popup. Click **Close**.

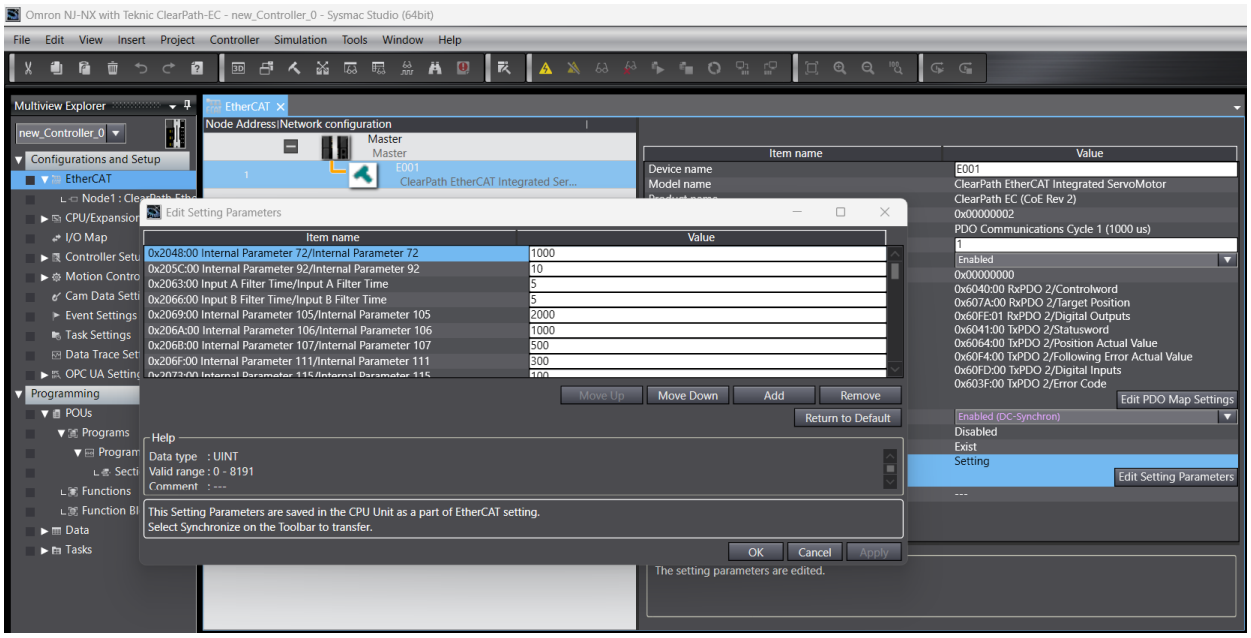


Step 5: Configure the EtherCAT communication settings.

- Click the (go) **Offline** icon (yellow triangle with a slash through it).
- Click on the **ClearPath** node. Select ***Enabled (DC-Syncron)*** from the **Enable Distributed Clock** dropdown list.

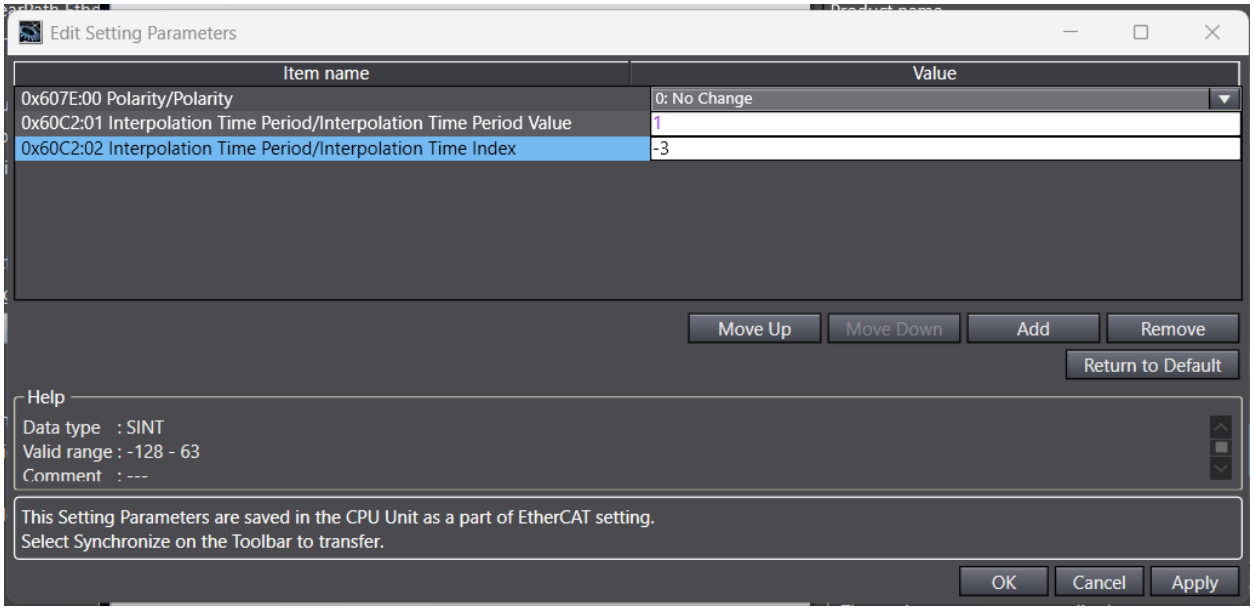


- Click **Edit Setting Parameters**.



The NJ/NX controller writes these parameter values to the ClearPath-EC motor in the pre-operational state of the EtherCAT slave state machine (but does not save these values to non-volatile memory). However, most of these parameters have been configured using ClearView 3.0 and should not be overwritten.

- Remove all entries except: **Polarity**, **Interpolation Time Period Value**, and **Interpolation Time Index**.



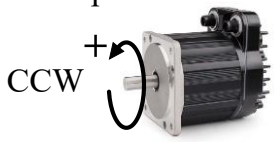
- Teknic's *ClearPath-EC EtherCAT Software Reference Manual* provides a table/equation for assigning the correct **Interpolation Time Period** and **Interpolation Time Index** based on the EtherCAT communication cycle time. Values not included in the table must satisfy the below equation (0x60C2[1] is an unsigned 8-bit integer, 0x60C2[2] is a signed 8-bit integer).

Cycle Time	Interpolation Time Period Value (0x60C2[1])	Interpolation Time Index (0x60C2[2])
2 ms (default)	2 (default)	-3 (default)
1 ms	1	-3
500 µs*	50*	-5*
250 µs*	25*	-5*

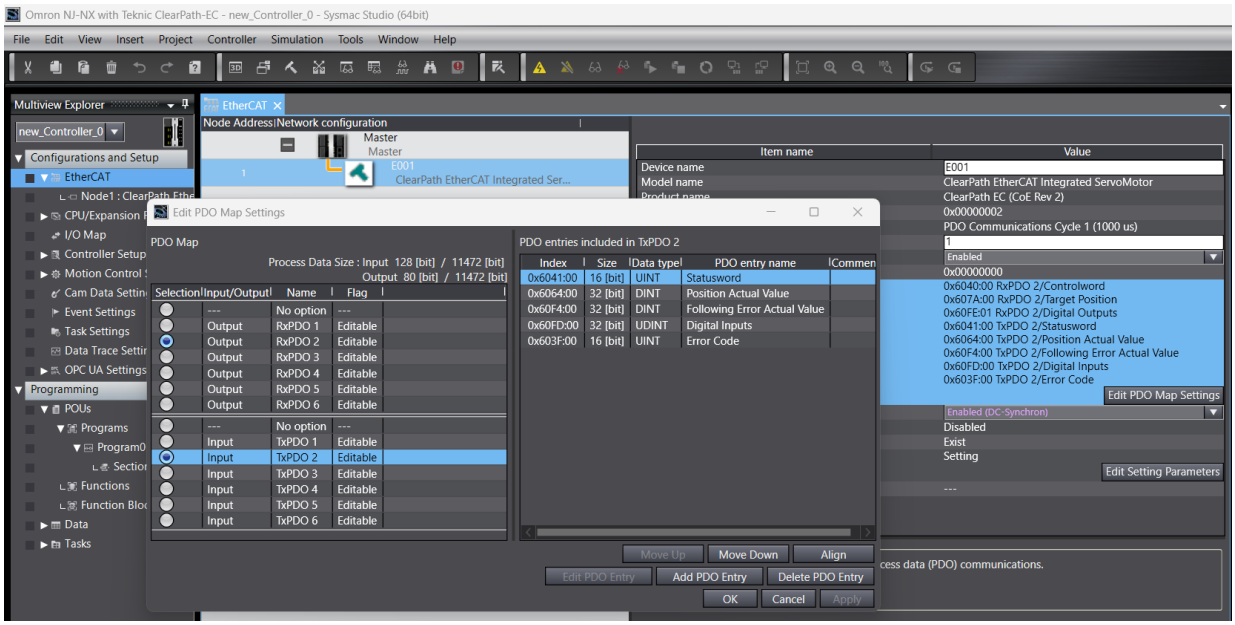
$$\text{Interpolation Time Period (in seconds)} = \textit{Interpolation Time Period Value} * 10^{\textit{Interpolation TIme Index}}$$

- The default polarity treats counterclockwise motor rotation as the positive direction. This can be inverted for velocity (and torque) applications or for position (and torque) applications.

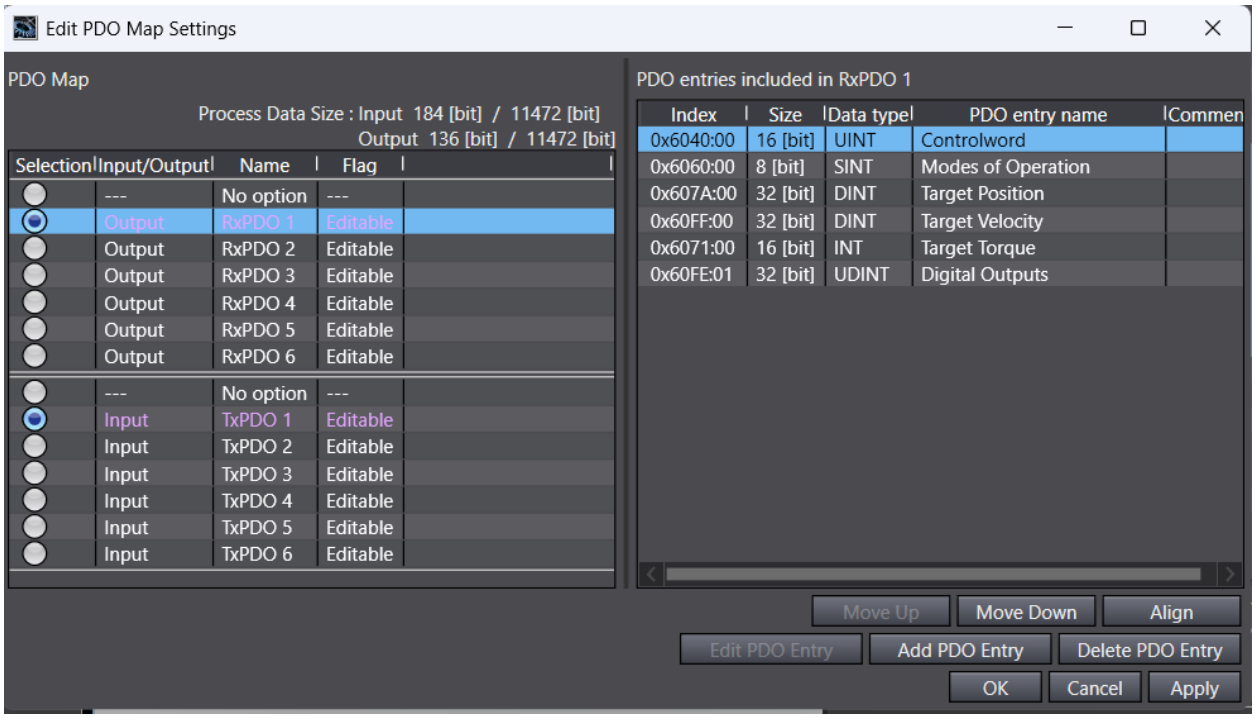
  Default positive direction:



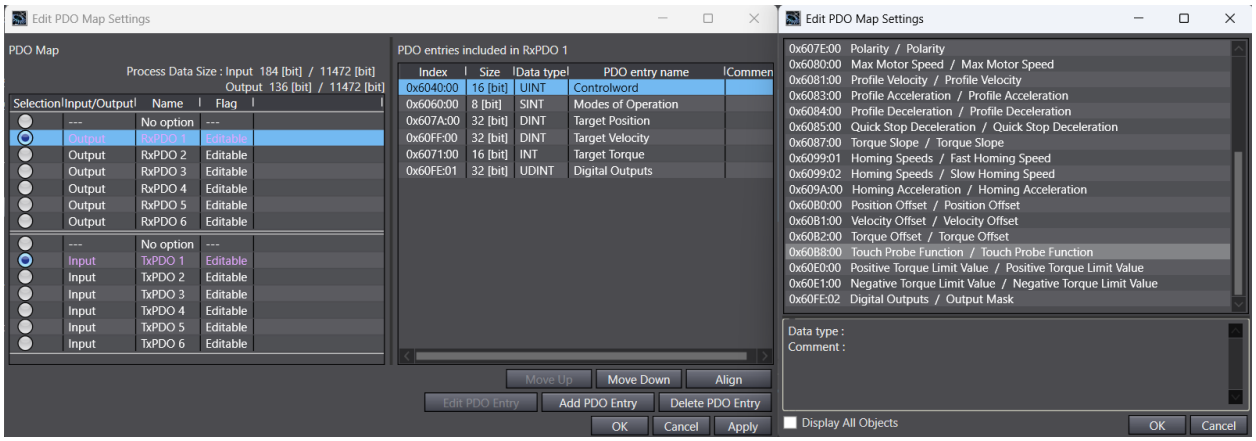
- Click **OK** after setting these parameters.
- Click **Edit PDO Map Settings** to assign the process data objects. ClearPath-EC allows for up to 8 Output objects and 8 Input objects to be assigned to the PDO mapping. Adding more than 8 objects will result in an EtherCAT communication error.



- Select **Input TxPDO 1** and select **Output RxPDO 1.** These selections provide the most flexibility/utility in control/feedback for the ClearPath-EC motor operated by NJ/NX controllers.

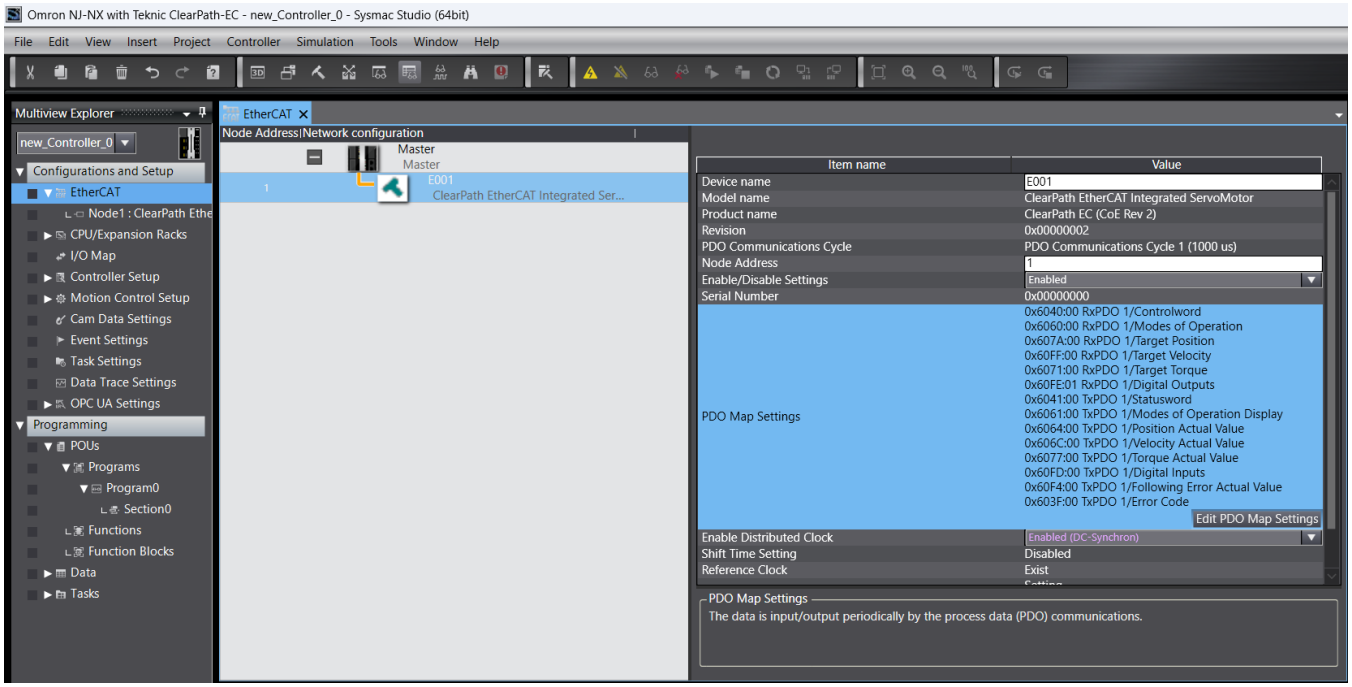


- Entries can be Added or Deleted according to the needs of the application. For example, the Touch probe function can be added.



- Click **OK**.

EtherCAT Parameters/PDO mappings are complete. The EtherCAT window in Sysmac Studio should look like this:

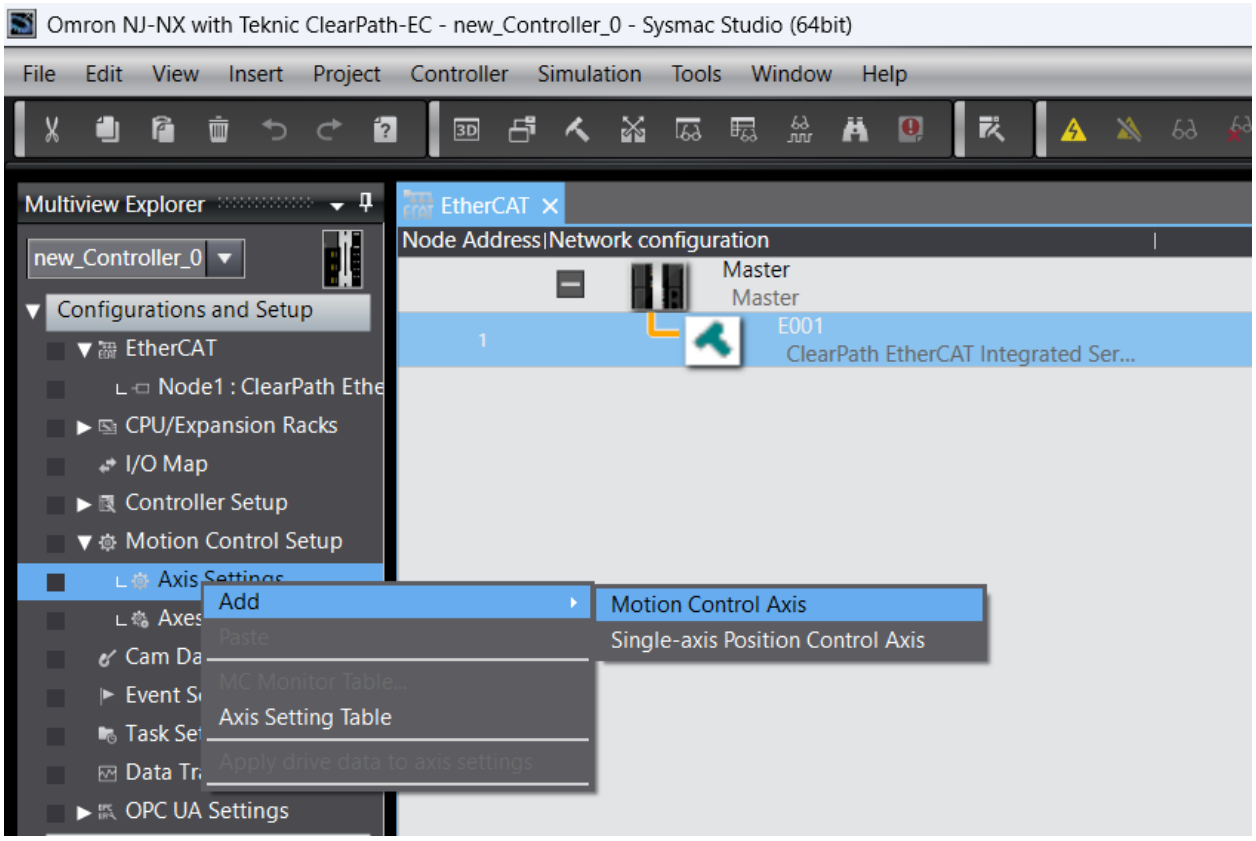


Sysmac Studio Axis Configuration

Step 1: Add the Axis

- Click on the arrow to expand **Motion Control Setup**, right click **Axis Settings**, and select **Add / Motion Control Axis**.

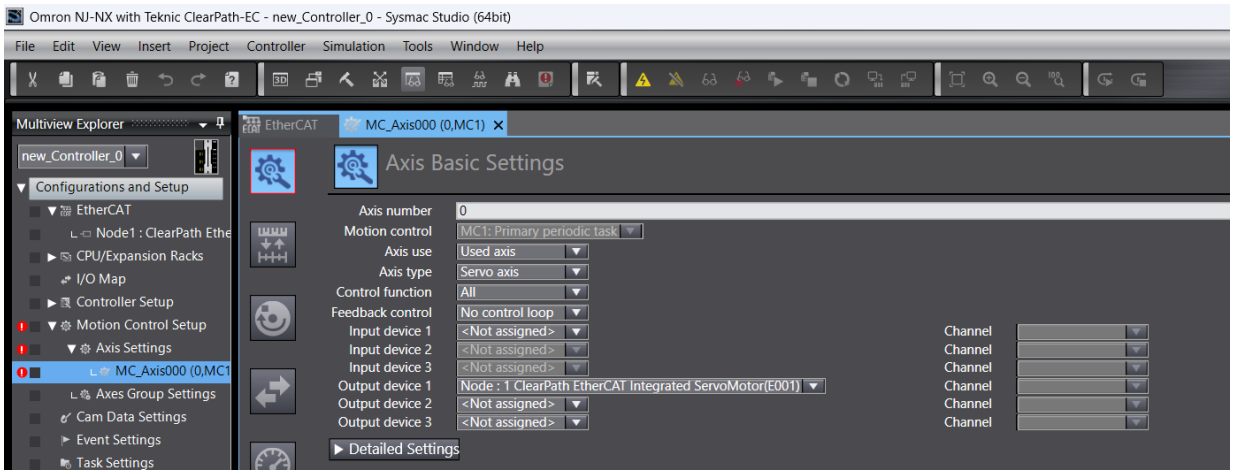
  Note: *Motion Control Axis* allows for more control capability (e.g., use of control instructions that use CSV, CST modes and ability to group multiple axes for coordinated motion). Omron NJ/NX controllers provide a finite number of *motion control* axes, and a finite number of *single-axis position control* axes (depends on controller model).



Step 2: Axis Basic Settings

Refer to Omron's *NJ/NX-series CPU Unit Motion Control User's Manual* for Axis parameter details.

- Double click on **MC_Axis000 (0, MC1)**. In **Axis Basic Settings,** select **Servo axis** from the **Axis type** drop down, select **Node : 1 ClearPath** from the **Output device 1** drop down.

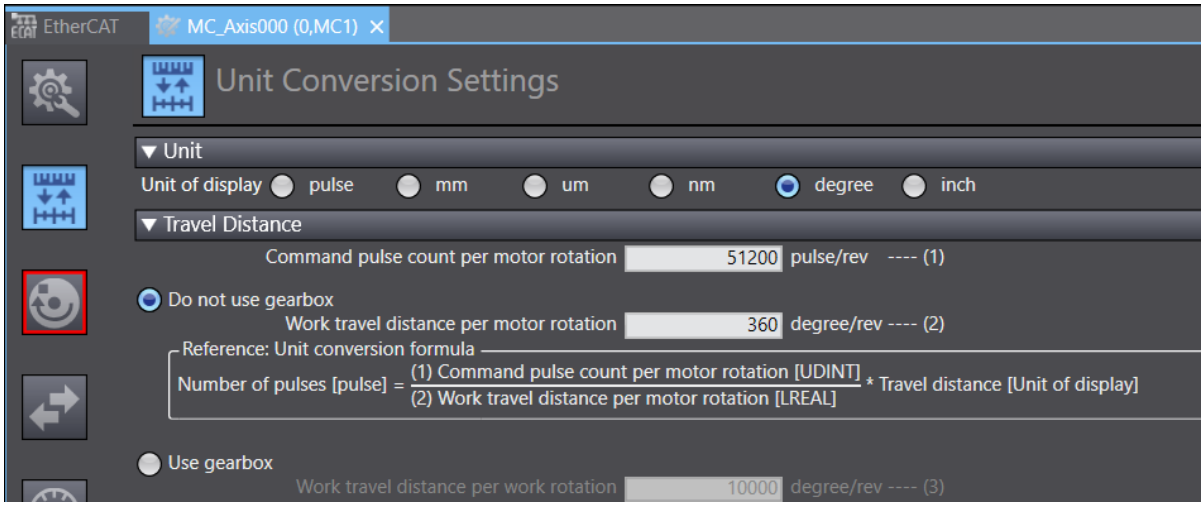


- Click **Detailed Settings**, expand the **Output**, **Input**, and **Digital inputs** fields, and map the Axis function name to the appropriate PDO. Note: selections below are based on the previous PDO selections and ClearPath I/O (A, B) configured as limit switches. Refer to the PDO 0x60FD description in *ClearPath-EC EtherCAT Software Reference Manual* for alternative I/O usage.

Function Name	Device	Process Data
- Output (Controller to Device)		
★ 1. Controlword	Node : 1 ClearPath EtherCAT Int	6040h-00.0(RxPDO 1_Controlword_6040_00)
★ 3. Target position	Node : 1 ClearPath EtherCAT Int	607Ah-00.0(RxPDO 1_Target Position_607A_00)
5. Target velocity	Node : 1 ClearPath EtherCAT Int	60FFh-00.0(RxPDO 1_Target Velocity_60FF_00)
7. Target torque	Node : 1 ClearPath EtherCAT Int	6071h-00.0(RxPDO 1_Target Torque_6071_00)
9. Max profile Velocity	<Not assigned>	<Not assigned>
11. Modes of operation	Node : 1 ClearPath EtherCAT Int	6060h-00.0(RxPDO 1_Modes of Operation_6060_00)
15. Positive torque limit value	<Not assigned>	<Not assigned>
16. Negative torque limit value	<Not assigned>	<Not assigned>
21. Touch probe function	<Not assigned>	<Not assigned>
44. Software Switch of Encoder's Input	<Not assigned>	<Not assigned>
- Input (Device to Controller)		
★ 22. Statusword	Node : 1 ClearPath EtherCAT Int	6041h-00.0(TxPDO 1_Statusword_6041_00)
★ 23. Position actual value	Node : 1 ClearPath EtherCAT Int	6064h-00.0(TxPDO 1_Position Actual Value_6064_00)
24. Velocity actual value	Node : 1 ClearPath EtherCAT Int	606Ch-00.0(TxPDO 1_Velocity Actual Value_606C_00)
25. Torque actual value	Node : 1 ClearPath EtherCAT Int	6077h-00.0(TxPDO 1_Torque Actual Value_6077_00)
27. Modes of operation display	Node : 1 ClearPath EtherCAT Int	6061h-00.0(TxPDO 1_Modes of Operation Display_6061_00)
40. Touch probe status	<Not assigned>	<Not assigned>
41. Touch probe pos1 pos value	<Not assigned>	<Not assigned>
42. Touch probe pos2 pos value	<Not assigned>	<Not assigned>
43. Error code	Node : 1 ClearPath EtherCAT Int	603Fh-00.0(TxPDO 1_Error Code_603F_00)
45. Status of Encoder's Input Slave	<Not assigned>	<Not assigned>
46. Reference Position for csp	<Not assigned>	<Not assigned>
- Digital inputs		
28. Positive limit switch	Node : 1 ClearPath EtherCAT Int	60FDh-00.1(TxPDO 1_Digital Inputs_60FD_00)
29. Negative limit switch	Node : 1 ClearPath EtherCAT Int	60FDh-00.0(TxPDO 1_Digital Inputs_60FD_00)
30. Immediate Stop Input	<Not assigned>	<Not assigned>
32. Encoder Phase Z Detection	<Not assigned>	<Not assigned>
33. Home switch	<Not assigned>	<Not assigned>
37. External Latch Input 1	<Not assigned>	<Not assigned>
38. External Latch Input 2	<Not assigned>	<Not assigned>

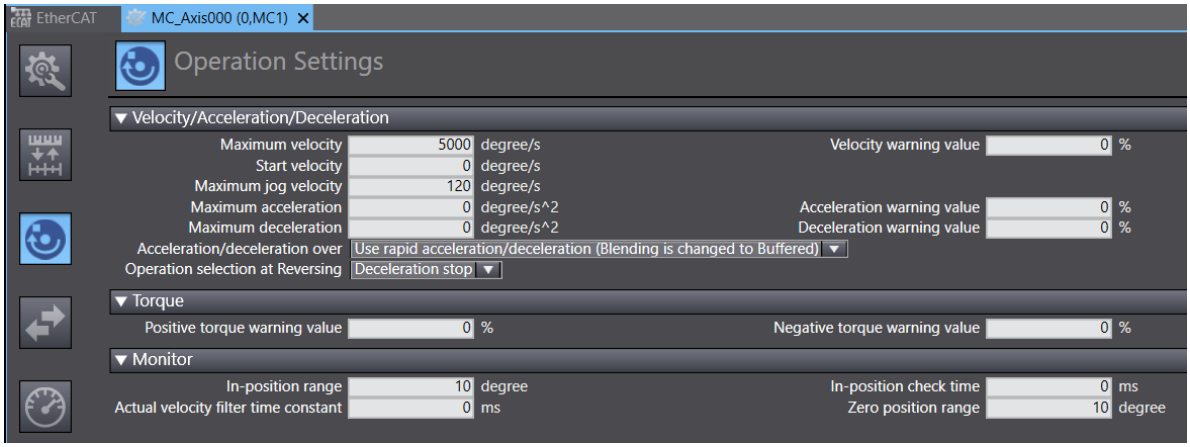
Step 3: Unit Conversion Settings

- Click on the icon for **Unit Conversion Settings** (ruler icon).
- Select the **Unit of display** for the motion application (e.g., mm, deg, etc.).
- Enter the **command pulse counts per motor rotation.** This value depends on the motor's encoder. Use:
  - 51200 for Enhanced Positioning Resolution ClearPath-EC motors,
  - 12800 for Regular Positioning Resolution ClearPath-EC motors.
- Enter the work travel distance per motor rotation. Value depends on selected units and attached mechanical transmission (e.g., 360 for direct-attachment rotary applications in units of degrees).



Step 4: Operation Settings

- Click on the **Operation Settings** icon (looks like a rotating disk)
- Set **Maximum velocity** to the desired limit of the application. The motion control instructions will not exceed this value even if the user inputs a higher velocity value in a motion control instruction.
- Set **Maximum jog velocity** to the desired limit for the jogging motion control instruction (MC_MoveJog).

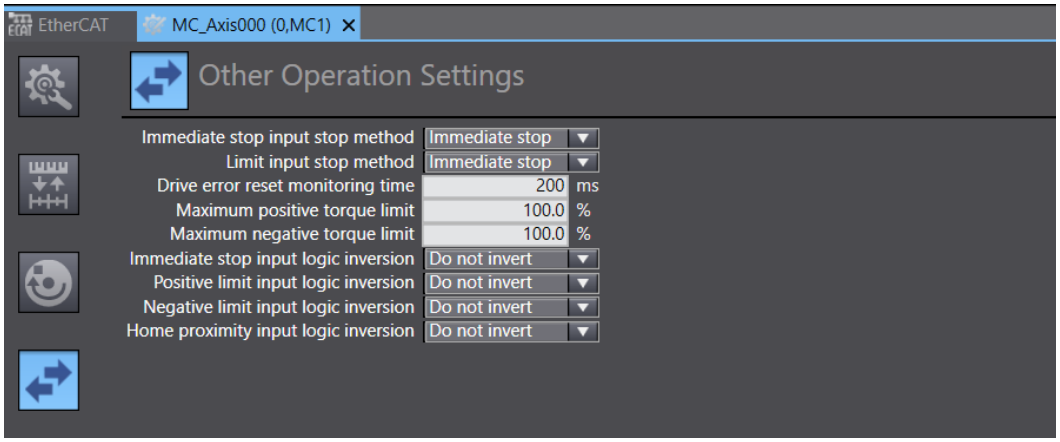


Other settings in this window are optional; some brief notes are provided here:

- **Maximum acceleration** and **Maximum deceleration**: a value of 0 will not impose a limit. In general, non-zero limits are respected by the PLCopen motion control instructions. However, the maximum acceleration/deceleration values may be exceeded if a motion command is executed (or re-executed) while a motion command is in progress, or if a limit switch or emergency stop is triggered.
- **Start velocity**: used for some stepper-motor systems to avoid commanding steps at the fundamental frequency. This should be 0 for servo-motor systems.
- **Acceleration/deceleration over** and **Operation selection at Reversing:** relate to handling motion cases when motion commands are executed while another is processing.
- **Velocity/acceleration/deceleration/positive torque/negative torque warning values**: used to provide an early warning if a motor is approaching a limit.
- **In-position range** and **In-position check time:** after a motion command finished its processing, the actual position is monitored. The move is considered done when the following error is less than or equal to this "in-position range" (this does not check for overshoot settling). If the following error does not attain this value before the in-position check time is reached, an error is produced. If **In-position check time** is 0, the move is considered done immediately after processing (no actual position monitoring).
  Note: These settings are separate from the in-position window/time settings that are configured on the ClearPath-EC drive. NJ/NX motion control applications use the Axis in-position window and time settings to determine when a move is complete – not the drive's internal settings.
- **Zero position range:** same as In-position range, but applies this value to determine if the motor is in the home position (as understood by the NJ/NX controller).
- **Actual velocity filter time constant:** used to smooth out the reported velocity value (recommendation: leave this at 0 ms, and filter elsewhere as necessary).

Step 5: Other Operation Settings

- Click on the **Other Operation Settings** icon (looks like forward/backward arrows)
- Set the **Maximum positive torque limit** and **Maximum negative torque limit** to 100 (or less).
  Note: Omron 1S-Servodrives use percentage of the *rated* torque; Teknic ClearPath-EC uses percentage of the *peak* torque.



For most applications with Teknic ClearPath-EC, other settings in this window do not need to be changed; some brief notes are provided here:

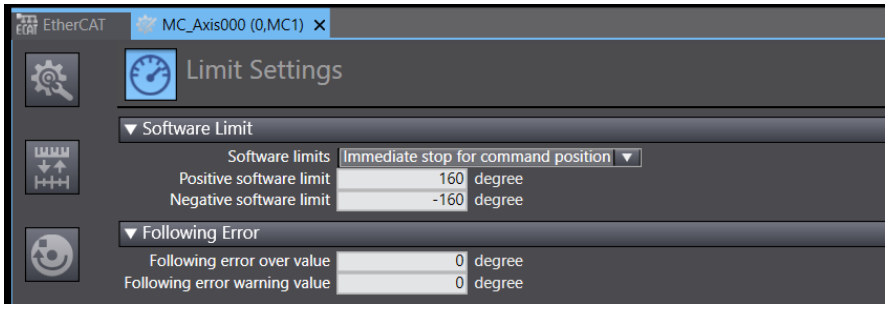
- **Immediate stop input stop method:** used if the **Immediate stop input** Axis parameter is mapped to an I/O point (e.g., ClearPath I/O configured as Interlock). This provides the option of resetting drive error or disabling the motor after an immediate stop is executed.
- **Limit stop input method:** used if the **Positive/Negative limit switch** Axis parameter is mapped to an I/O point (e.g., ClearPath I/O configured as a limit switch). This provides the option of resetting drive error or disabling the motor after an immediate stop is executed.
- **Drive error reset monitoring time:** associated with the auto-reset error option selected for the above parameters. This is a maximum time duration that a reset signal is sent to the drive (waits for the drive to respond to the reset signal).
- **Maximum positive torque limit** and **Maximum negative torque limit:** these parameters only take effect if the Positive Torque Limit (0x60E0) and Negative Torque Limit (0x60E1) are added in the PDO mapping and are mapped to the Axis parameters.
- **Immediate stop input logic inversion**: this parameter is used to invert the logic of a generic input signal (external to the drive I/O). If a Teknic I/O is used for this function, handle the inversion in the drive parameter settings, leave this setting here as "Do not invert".
- **Positive limit inversion logic**: see note for **Immediate stop input logic inversion.**
- **Negative limit inversion logic**: see note for **Immediate stop input logic inversion.**
- **Home proximity inversion logic**: see note for **Immediate stop input logic inversion.**

Step 6: Limit Settings (Optional)

- Click on the **Limit Settings** icon (looks like a gauge).
- Select a stopping condition and limit values if software position limits are to be used.

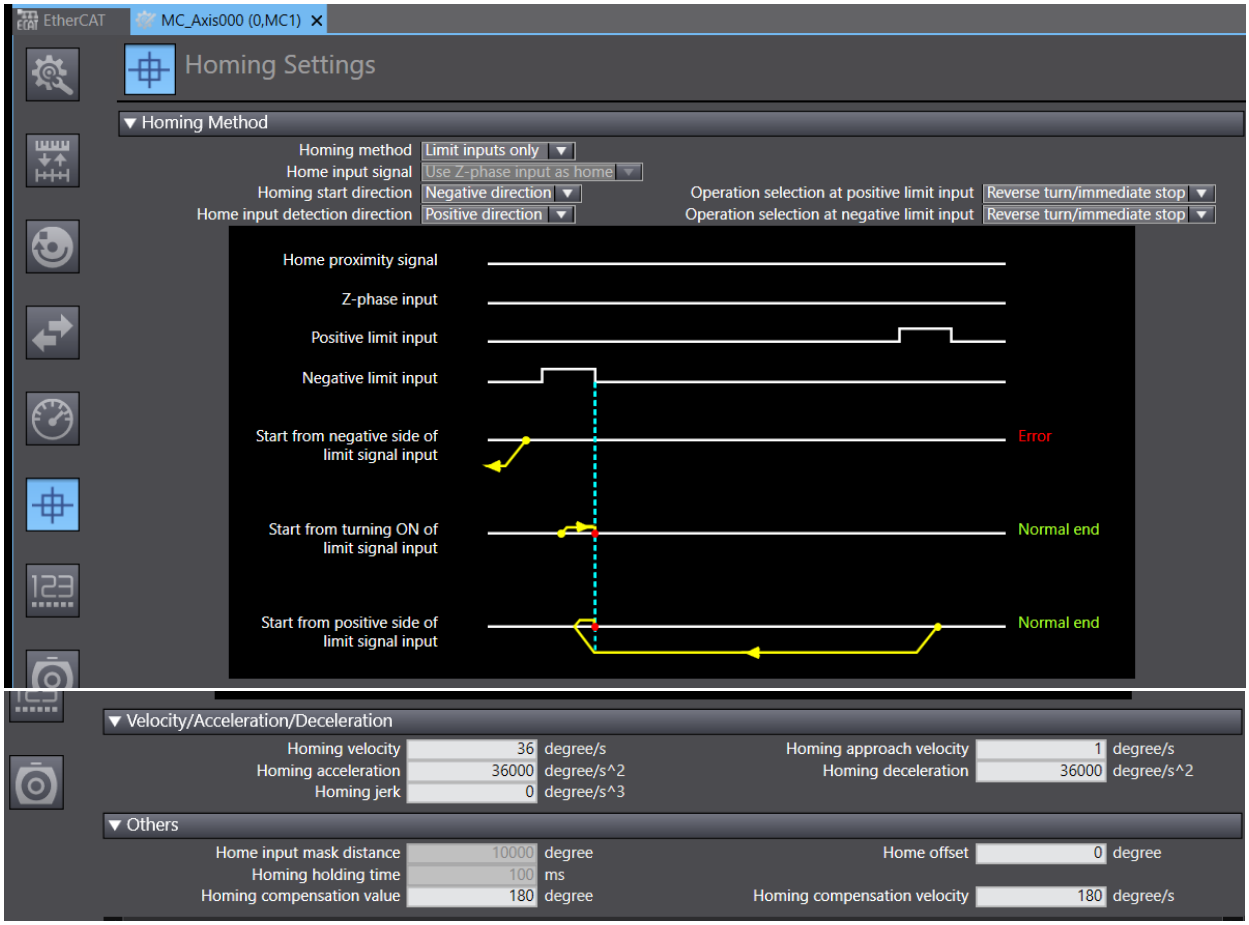
  Notes:
  - Software limits only function after the drive is homed.
  - This function is used to prevent operator error; it will produce an error if a motion control instruction is attempted that has a target position outside the software defined range.

- **Following error over value**: if the (immediate) commanded position is different than the actual position by this amount, the drive will be commanded to immediately stop. This is a separate value from the Following Error parameters set in the ClearPath-EC drive via ClearView 3.0.
- **Following error warning value**: similar to **Following error over value,** but produces a warning – it does not trigger an immediate stop.



Step 7: Homing Settings

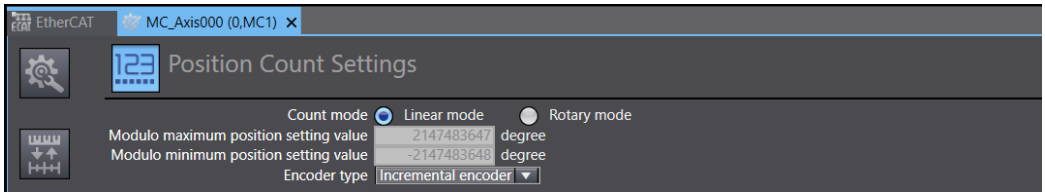
- Click on the **Homing Settings** icon (looks like a target).
- Select the homing method and associated motion parameters.



NJ/NX controllers using the Axis object do not use the drive's homing method, but instead keep track of the "home" position within the NJ/NX controller. (This means the drive's understanding of a "home" position is not the same as the master controller's understanding of a home position).

Step 8: Position Count Setting

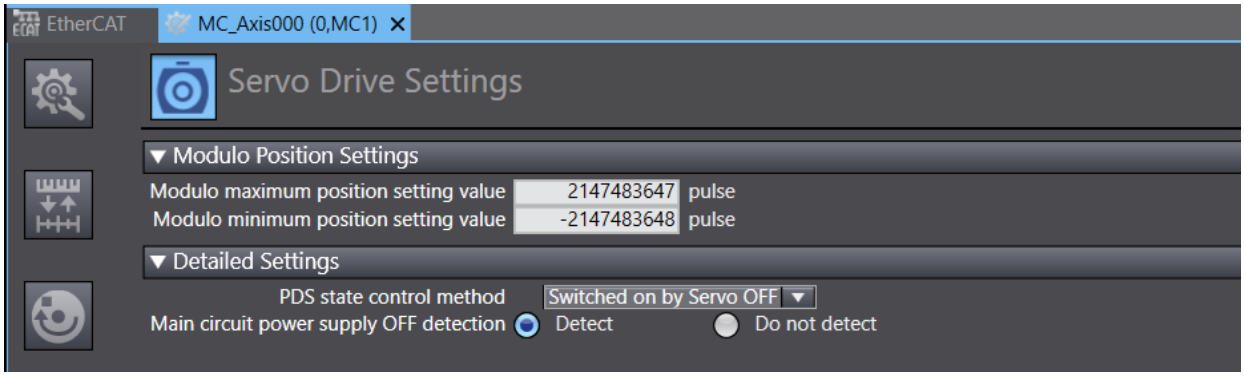
- Click on the **Position Count Setting** icon (123).
- Select **Incremental Encoder** for **Encoder type** (ClearPath-EC contains an incremental encoder)
  - If the motor is used in an application with an unbounded number of turns (e.g., conveyor belt), select **Rotary mode** for the **Count mode** and define what the maximum and minimum values should be (e.g., [360, 0], [180, -180]).



Step 9: Servo Drive Settings (leave at default)

For applications with Teknic ClearPath-EC, these settings should be left at the default values; some brief notes are provided here:

- Click on the **Servo Drive Settings** icon (looks like a camera) to access these parameters.
- **Modulo maximum/minimum position value**: The default values define the valid range of a 32-bit signed integer, which is the format of the target/actual position communicated in the CSP operating mode. These values may be modified to interface with drives/encoders that use a different modulus.
- **PDS state control method**: used to change how the MC_Power instruction affects the drive's internal power drive system (PDS) state machine defined in the CiA 402 Drive profile.
    - 0: MC_Power output turning FALSE results in a transition to the "Switched on" state (one transition away from "Operation enabled" state).
    - 1: MC_Power output turning FALSE results in a transition to the "Ready to switched on" state (two transitions away from the "Operation enabled" state).
- **Main circuit supply OFF detection**: Leave as **Detect** for use with ClearPath-EC motors. The *NJ/NX-series CPU Unit Motion Control User's Manual* states: "Select the **Do not detect** option if a Servo Main Circuit Power Off error occurs even after the MC_Power (Power Servo) instruction is executed."



The Sysmac Studio Axis is configured and ready to be programmed with PLCopen motion control function blocks (instructions).

Some useful function blocks for basic positioning applications include:

- MC_Reset: used to reset the drive to a "Ready to be switched on" state
- MC_Power: used to enable/disable the drive
- MC_Jog: used to jog the motor
- MC_Home: used to execute the homing method defined in the Axis object
- MC_MoveAbsolute: used to perform a discrete motion to a position defined relative to home

When ready, transfer the project to the controller, and cycle the power to the ClearPath-EC motor.