
EtherCAT Connection Guide

With Beckhoff TwinCAT 2

Introduction

This document shows how to use Beckhoff EtherCAT host software TwinCAT 2 to connect and control an Applied Motion Products SSxx-EC-D StepSERVO Drive and Motor via an EtherCAT network connection. By following the steps below, you will be able to use the TwinCAT 2 NC controller to control the position, velocity and torque of an Applied Motion Products motor using an SSxx-EC-D drive.

Two connection methods will be introduced:

1. Using a PC as the master controller.
2. Using a Beckhoff PLC as the master controller.

For more advanced motion control functions, please contact Beckhoff.

Applies to

- Beckhoff TwinCAT 2 PC software (using Beckhoff CX2020-0112 PLC + EK1110 EtherCAT extension as example).
- SSxx-EC-D StepSERVO Drives and compatible StepSERVO Motors (e.g. HT23-SS2DGB).

Date

June, 2016

Connection Guide

Step 1 Download XML file for SSxx-EC-D drive from the Applied Motion Products website (www.applied-motion.com).

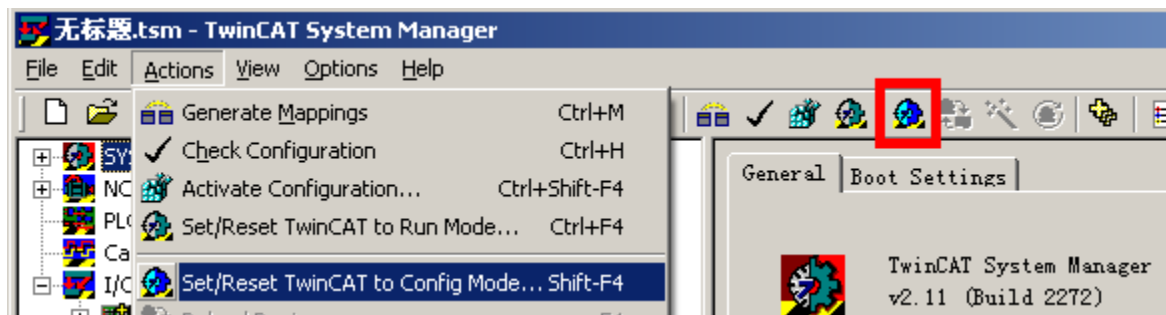
Step 2 Install Beckhoff TwinCAT 2 software.

Step 3 Copy XML file for SSxx-EC-D drive to TwinCAT 2 installation location, C:\TwinCAT\Io\EtherCAT.

Step 4 Connect Ethernet cable from master PC or PLC to the drive's "EtherCAT LINK IN" RJ45 port.

Step 5 Apply power to drive. Apply power to PLC if using PLC as the master controller.

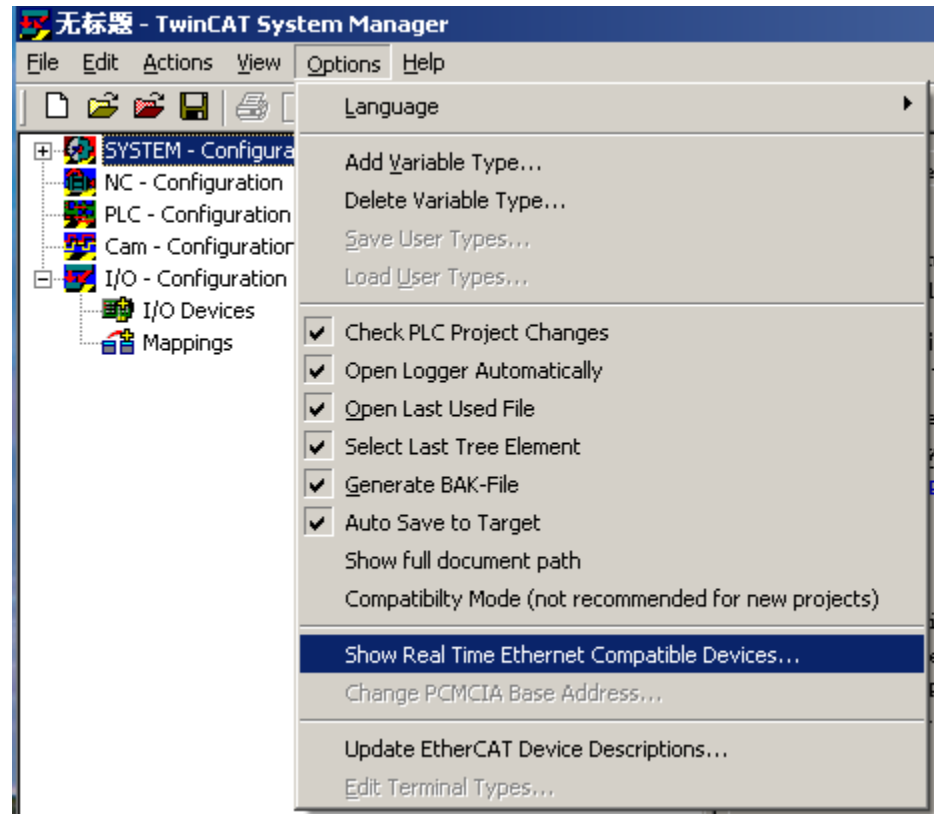
Step 6 Run the TwinCAT 2 System Manager and set it to Config Mode.



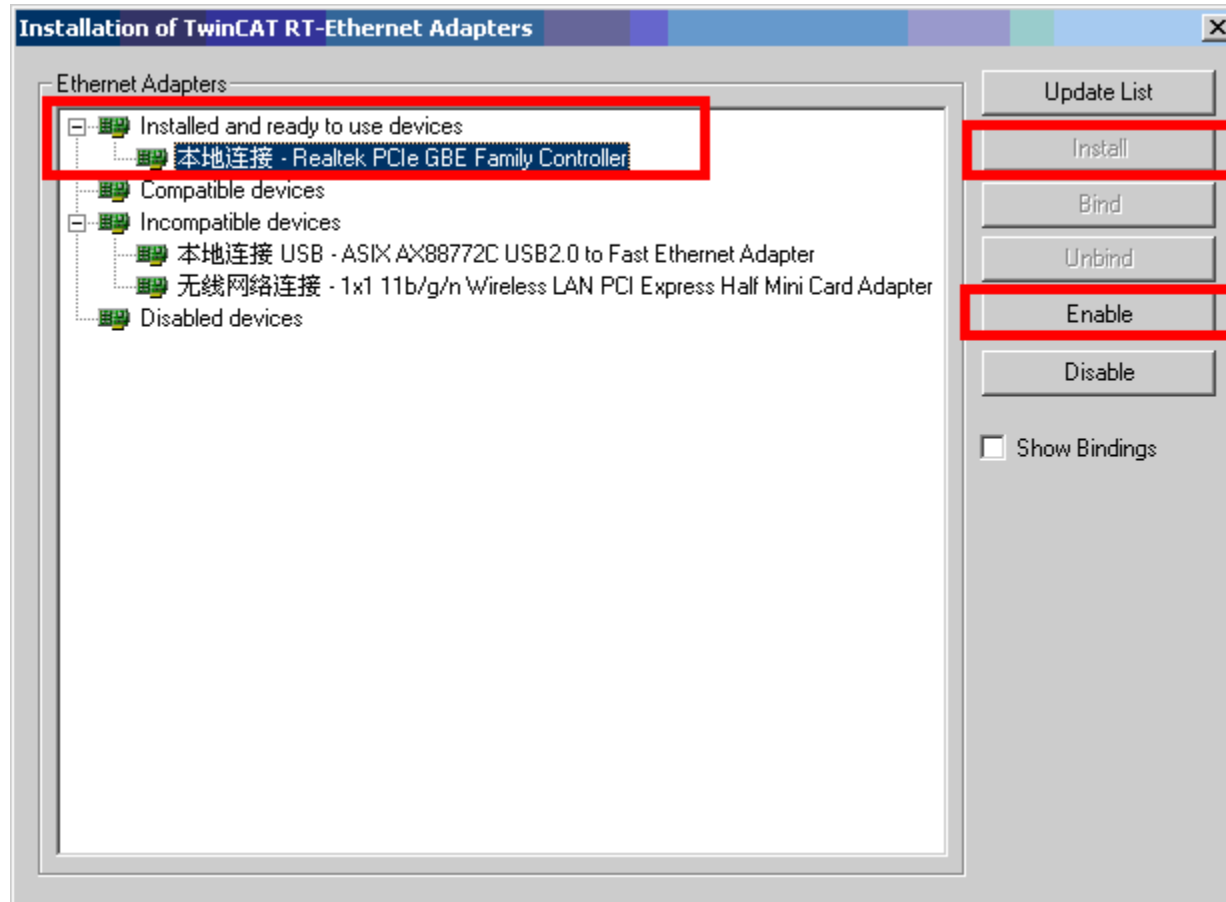
If using a PC as the master controller, please follow these steps:

Install and enable the network card

Click on **Options** – **Show Real Time Ethernet Compatible Devices**.

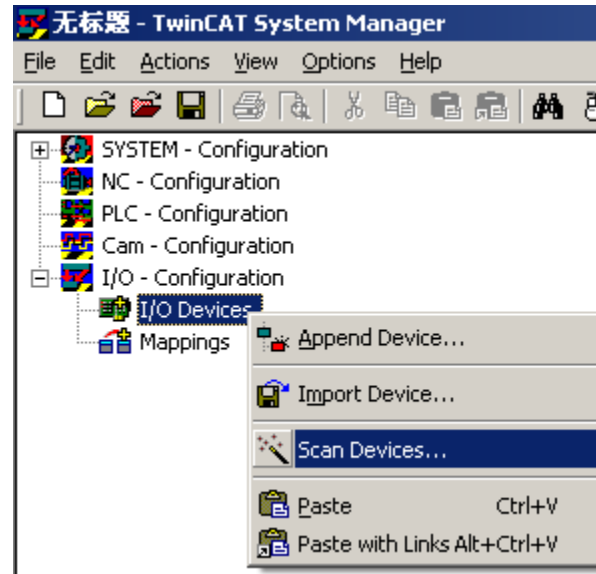


Select the network card. Click on **Install**, and then click on **Enable**. If the network card is successfully installed and enabled, its name will be shown under **Installed and ready to use devices**.

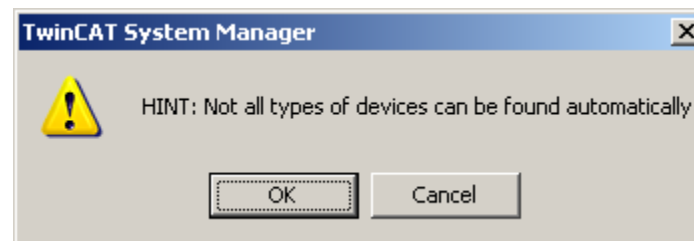


Scan Devices

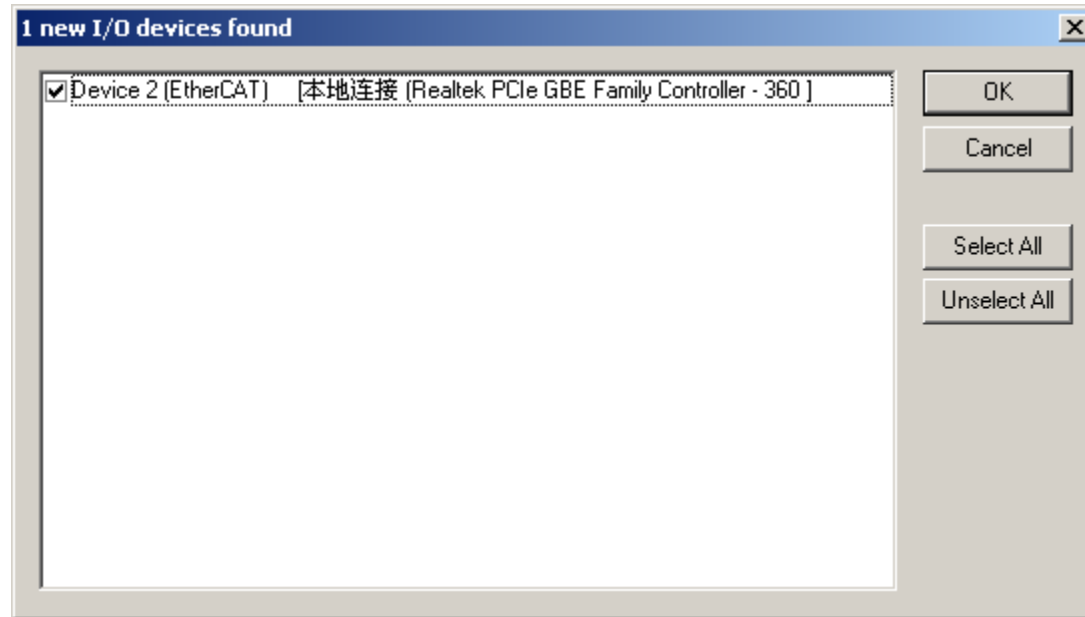
Right click on **I/O Devices** and then click on **Scan Devices**.



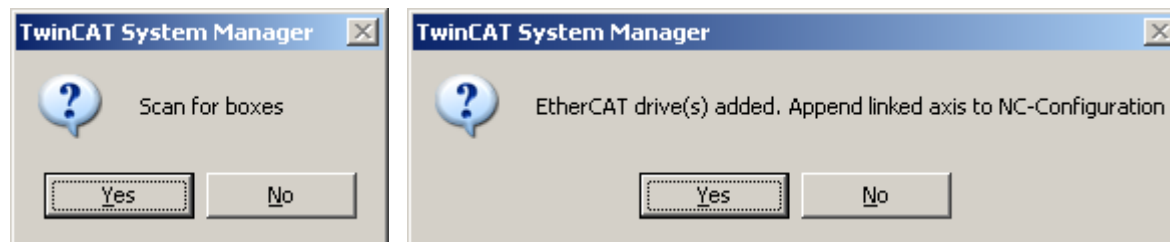
When this dialog appears, click OK.



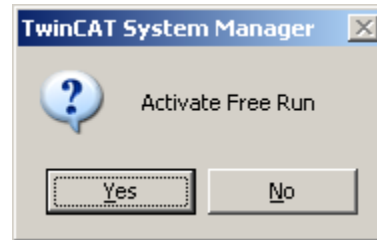
Select your network card and click OK.



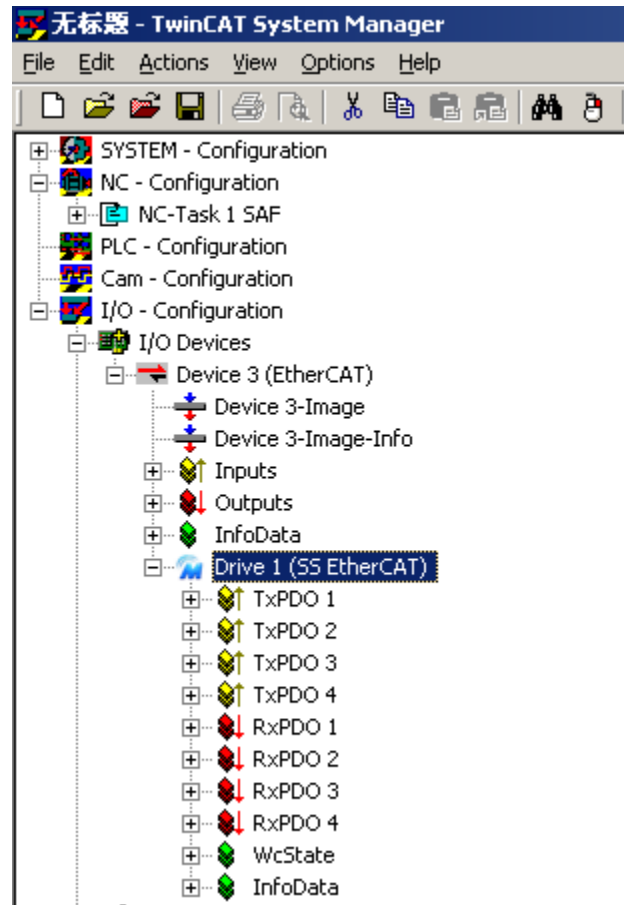
When these dialogs appear, click Yes to **Scan for boxes** and Yes to **Append linked axis to NC-Configuration**.



When this dialog appears, click Yes to **Activate Free Run**.



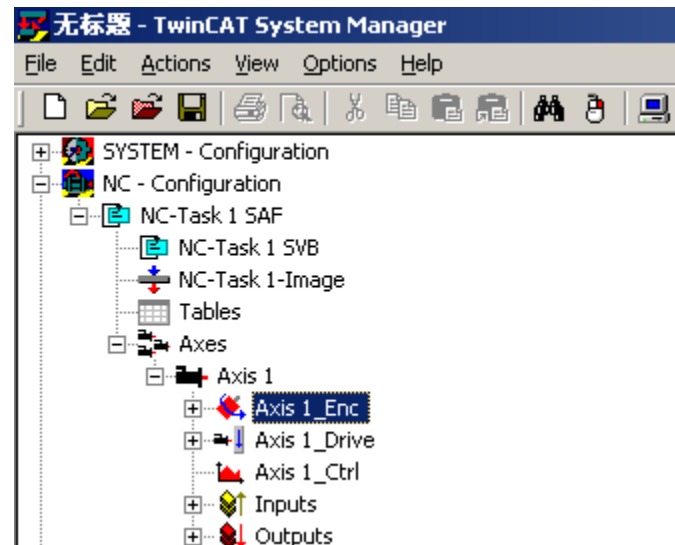
After the scan, the EtherCAT drive will be shown under **I/O Devices**.



Parameter settings for NC - Configuration

Click on **Axis 1_Enc**, then find the **Parameter** settings tab. Set values for **Modulo Factor** and **Scaling Factor**. These settings depend on the drive's Electronic Gearing setting in the *Step-Servo Quick Tuner* software. If Electronic Gearing is set to 20000 Steps/Rev, then Scaling Factor = Modulo Factor/20000. For example, if Modulo Factor is set to 200mm, the Scaling Factor needs to be set to $200/20000 = 0.01\text{mm}$.

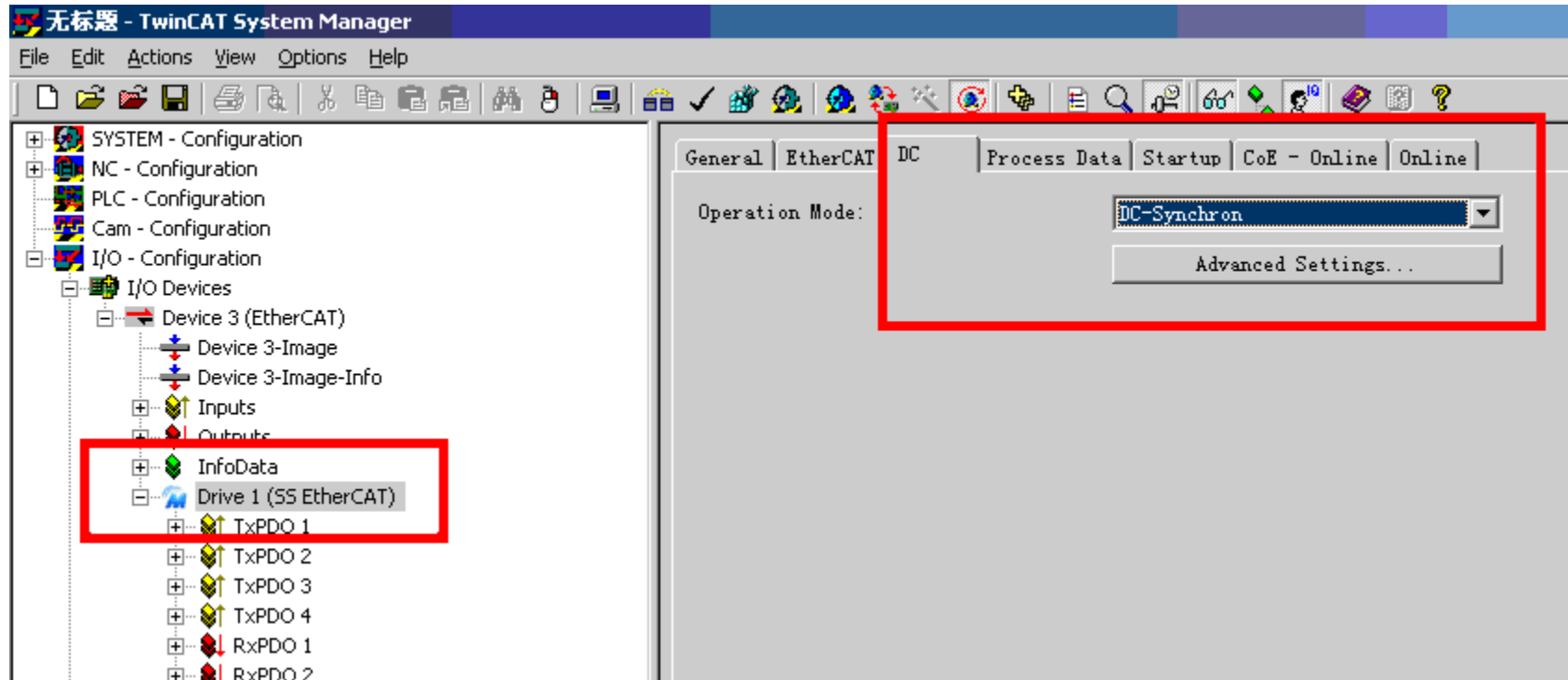
Electronic Gearing Steps/Rev



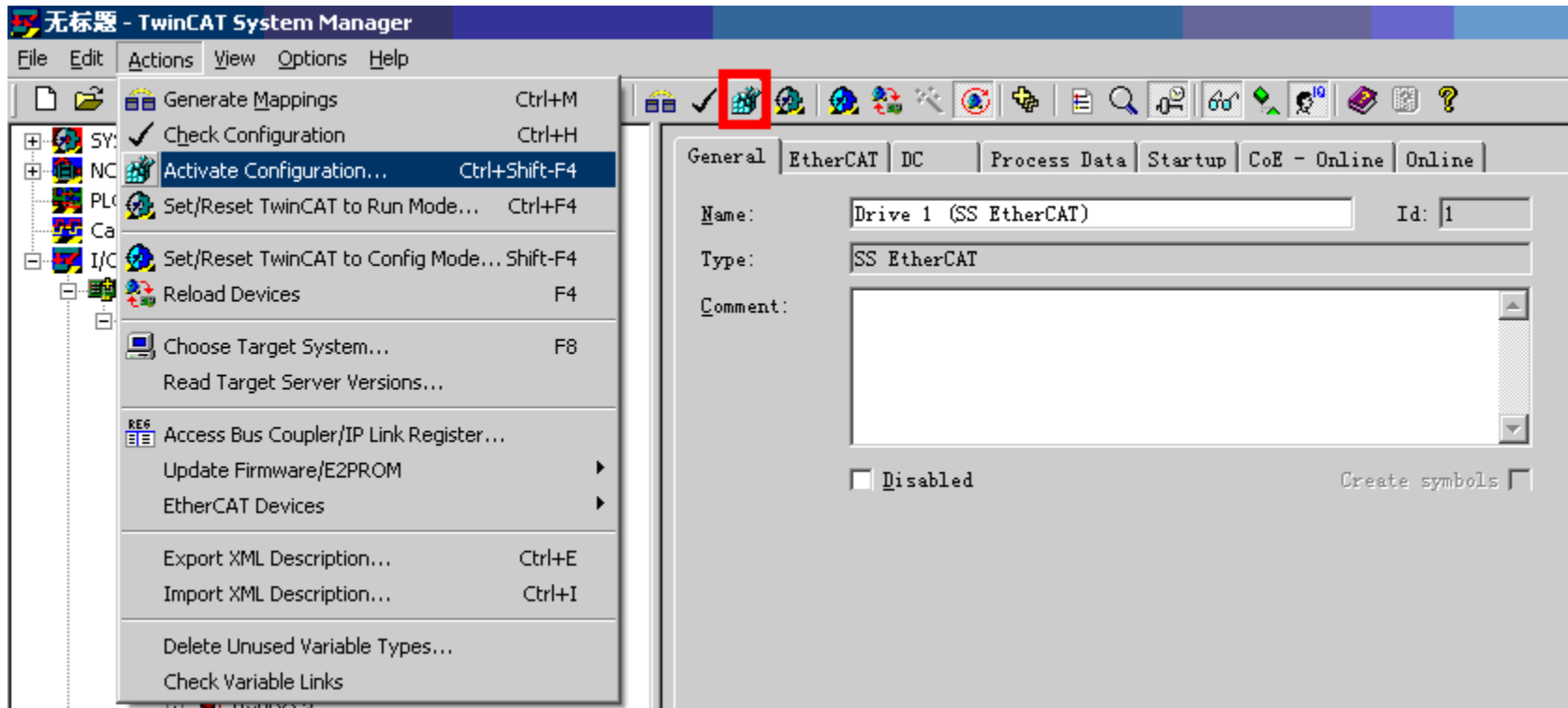
Parameter	Value	Type	Unit
Encoder Evaluation:			
Invert Encoder Counting Direction	FALSE	B	
Scaling Factor	0.01	F	mm/INC
Position Bias	0.0	F	mm
Modulo Factor (e.g. 360.0°)	200.0	F	mm
Tolerance Window for Modulo Start	0.0	F	mm

Parameter settings for drive

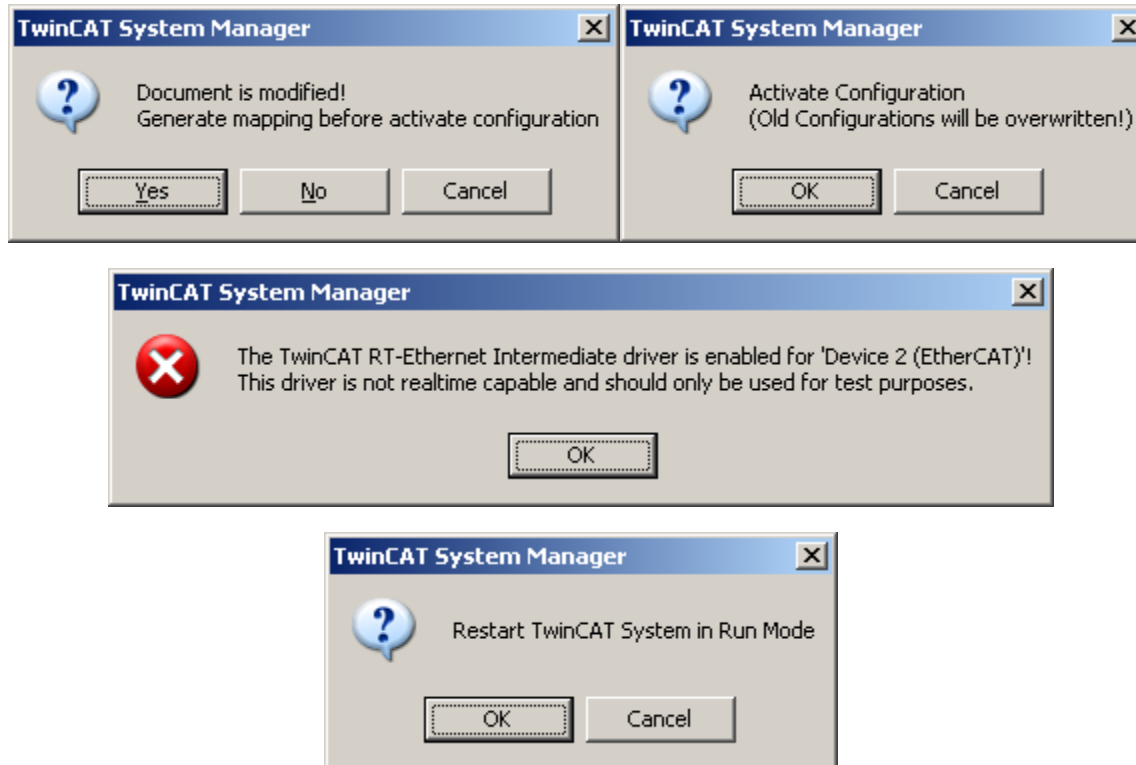
Select drive and find the **DC** settings tab. Set **Operation Mode** to DC-Synchron.



Click on **Activate Configuration** under **Actions** to activate the configuration and switch TwinCAT to Run Mode.



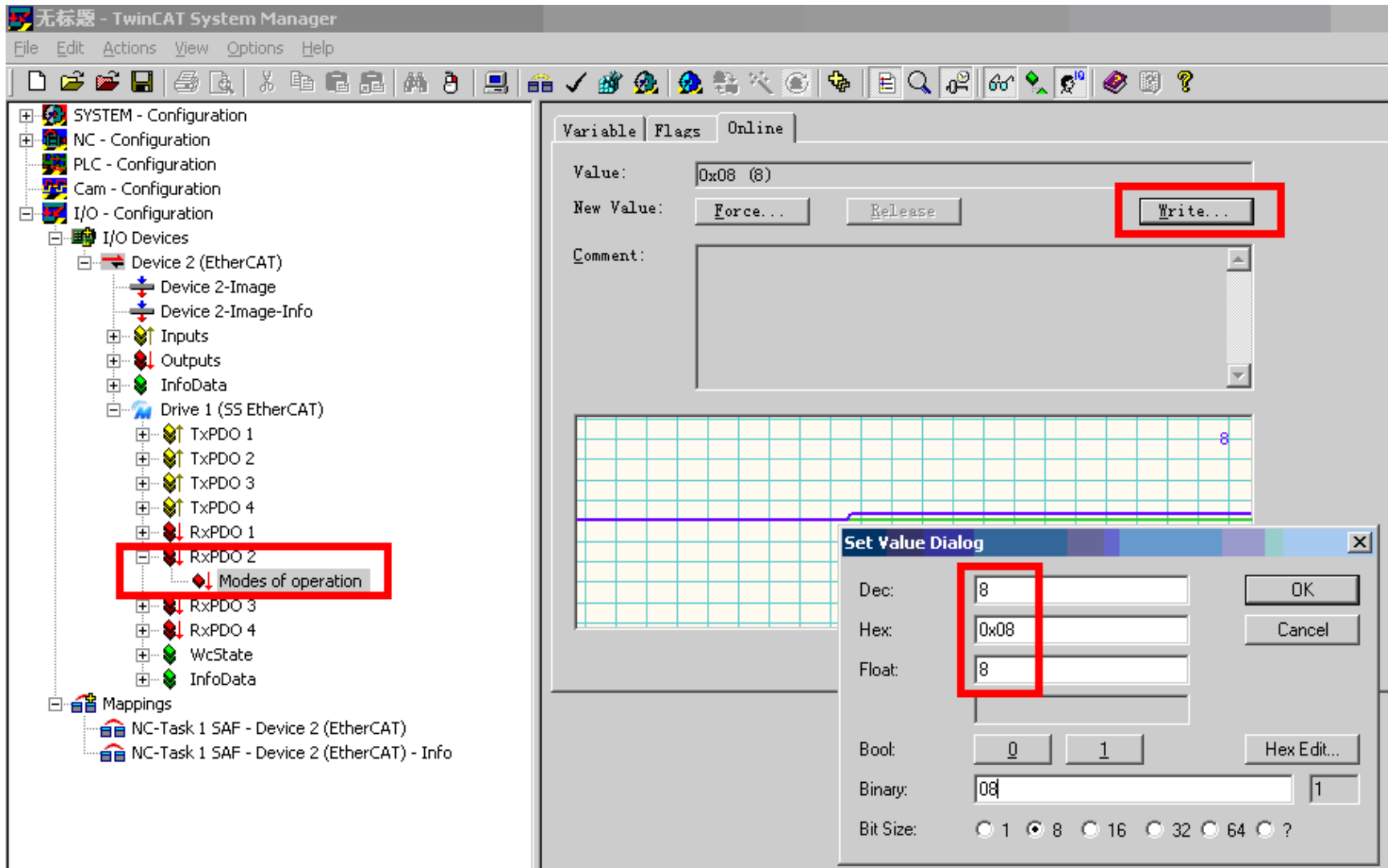
When these dialogs appear, click Yes or OK for all.



TwinCAT is now in Run Mode.

Set the drive's mode of operation to 8 (CSP mode)

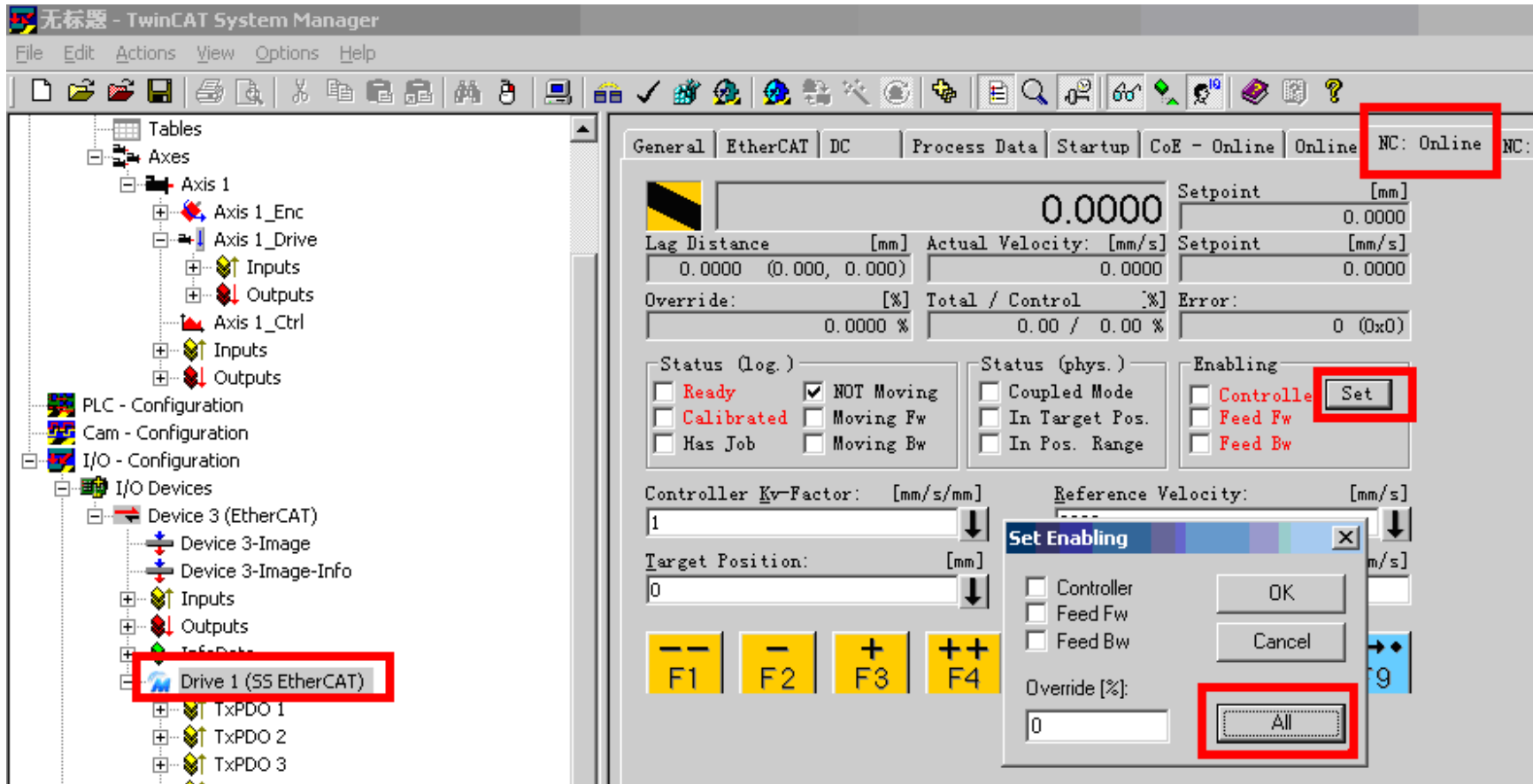
Select **Modes of operation** under **RxPDO 2**. Find the **Online** tab and click on **Write**. In the pop up window set the value to 8.



The screenshot displays the TwinCAT System Manager interface. On the left, the 'I/O - Configuration' tree is expanded to 'I/O Devices', then 'Device 2 (EtherCAT)', and finally 'RxPDO 2'. The 'Modes of operation' sub-item under 'RxPDO 2' is highlighted with a red box. On the right, the 'Variable' tab is active, showing a 'Value' of '0x08 (8)'. The 'Write...' button is highlighted with a red box. Below this, a 'Set Value Dialog' box is open, with the 'Dec' field containing '8' and the 'Hex' field containing '0x08', both highlighted with red boxes. The dialog also shows 'Float' as '8', 'Boot' as '0', 'Binary' as '08', and 'Bit Size' as '8'.

Enable the motor

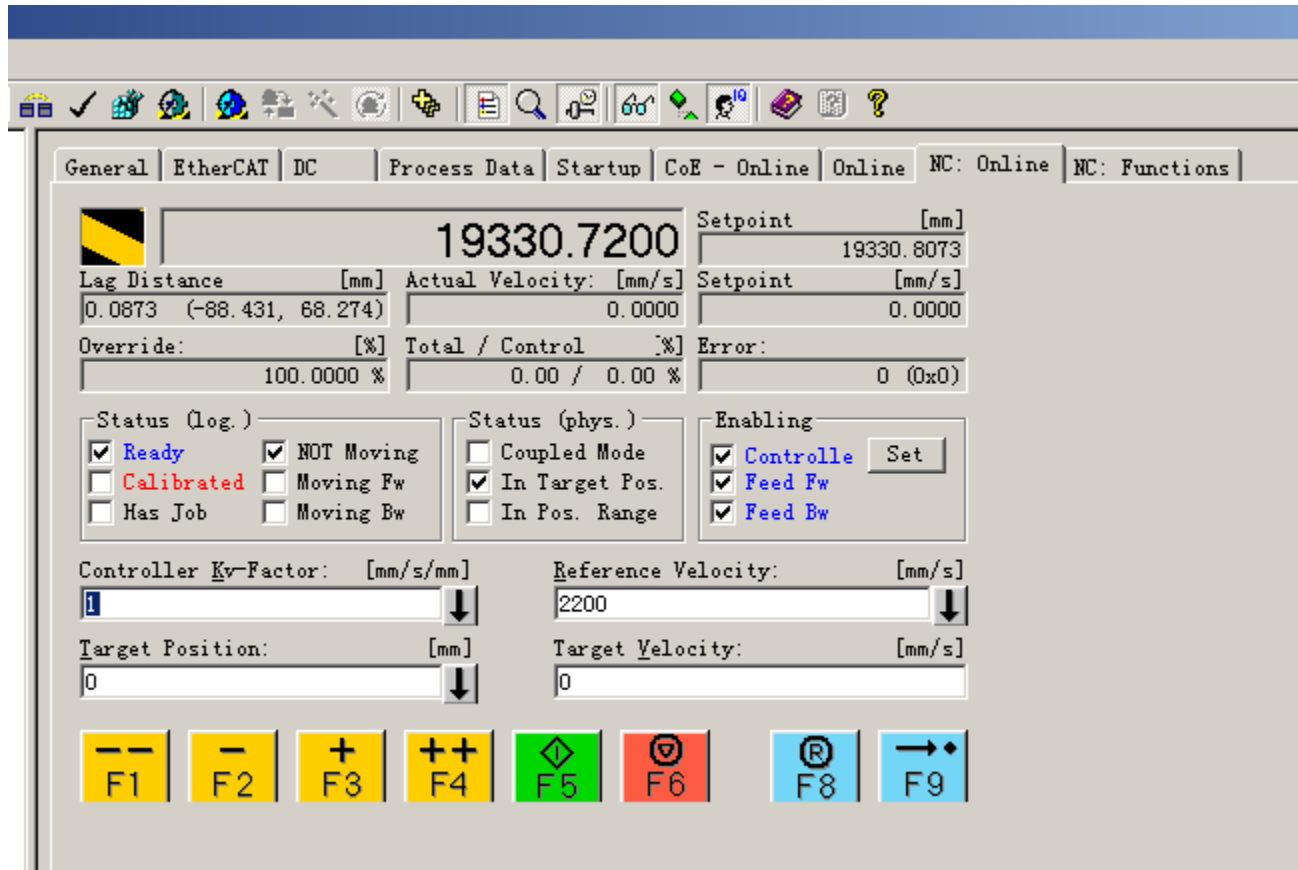
Select the drive and find the **NC: Online** tab. Click **Set**. In the pop up window click **All**.



When the motor is successfully enabled, the LED on the drive will show that the motor has been switched to enabled status.

Click on the different buttons under the tabs shown below to control the motor.

NC: Online tab



The screenshot displays the 'NC: Online' tab of a control interface. At the top, there is a toolbar with various icons. Below it, a series of tabs includes 'General', 'EtherCAT', 'DC', 'Process Data', 'Startup', 'CoE - Online', 'Online', 'NC: Online', and 'NC: Functions'. The 'NC: Online' tab is active, showing a large digital readout (DRO) of '19330.7200' with a yellow and black diagonal warning flag to its left. Below the DRO, there are several data fields:

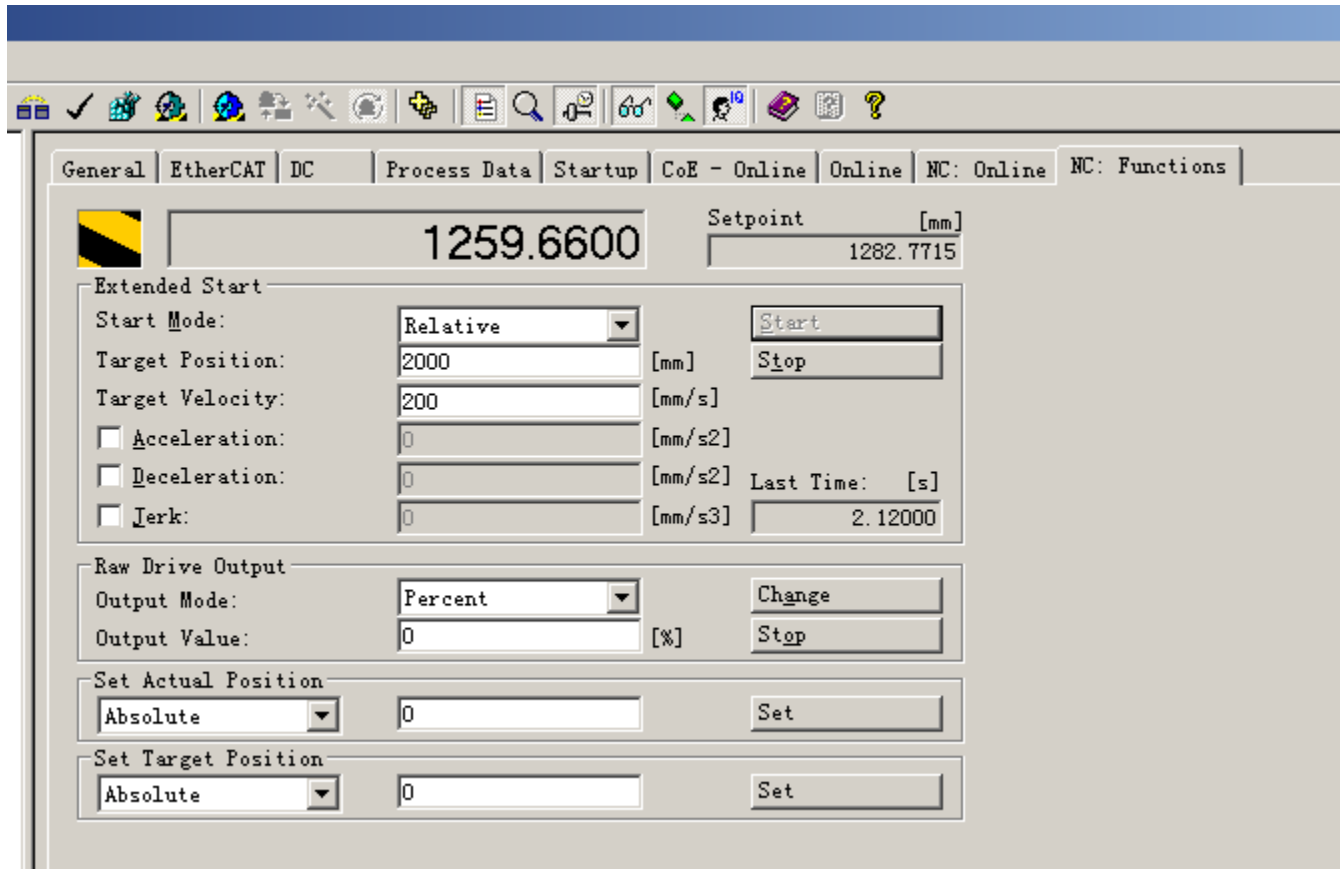
- Setpoint [mm]:** 19330.8073
- Actual Velocity [mm/s]:** 0.0000
- Setpoint [mm/s]:** 0.0000
- Lag Distance [mm]:** 0.0873 (-88.431, 68.274)
- Override [%]:** 100.0000 %
- Total / Control [%]:** 0.00 / 0.00 %
- Error:** 0 (0x0)

Below these fields are three status sections:

- Status (log.):** Includes checkboxes for 'Ready' (checked), 'Calibrated' (unchecked), 'Has Job' (unchecked), 'NOT Moving' (checked), 'Moving Fw' (unchecked), and 'Moving Bw' (unchecked).
- Status (phys.):** Includes checkboxes for 'Coupled Mode' (unchecked), 'In Target Pos.' (checked), and 'In Pos. Range' (unchecked).
- Enabling:** Includes checkboxes for 'Controlle' (checked), 'Feed Fw' (checked), and 'Feed Bw' (checked), along with a 'Set' button.

At the bottom, there are several control fields and buttons:

- Controller Kv-Factor [mm/s/mm]:** A dropdown menu showing '1'.
- Reference Velocity [mm/s]:** A dropdown menu showing '2200'.
- Target Position [mm]:** A dropdown menu showing '0'.
- Target Velocity [mm/s]:** A dropdown menu showing '0'.
- Buttons:** A row of nine function buttons labeled F1 through F9. F1-F4 are yellow with minus, minus, plus, and plus signs respectively. F5 is green with a diamond symbol. F6 is red with a stop symbol. F8 and F9 are blue with a registered trademark symbol and a right-pointing arrow with a diamond respectively.

NC: Function tab


The screenshot shows the 'NC: Functions' tab in a motion control software interface. The interface includes a toolbar at the top with various icons for navigation and control. Below the toolbar, there are several tabs: 'General', 'EtherCAT', 'DC', 'Process Data', 'Startup', 'CoE - Online', 'Online', 'NC: Online', and 'NC: Functions'. The 'NC: Functions' tab is currently selected.

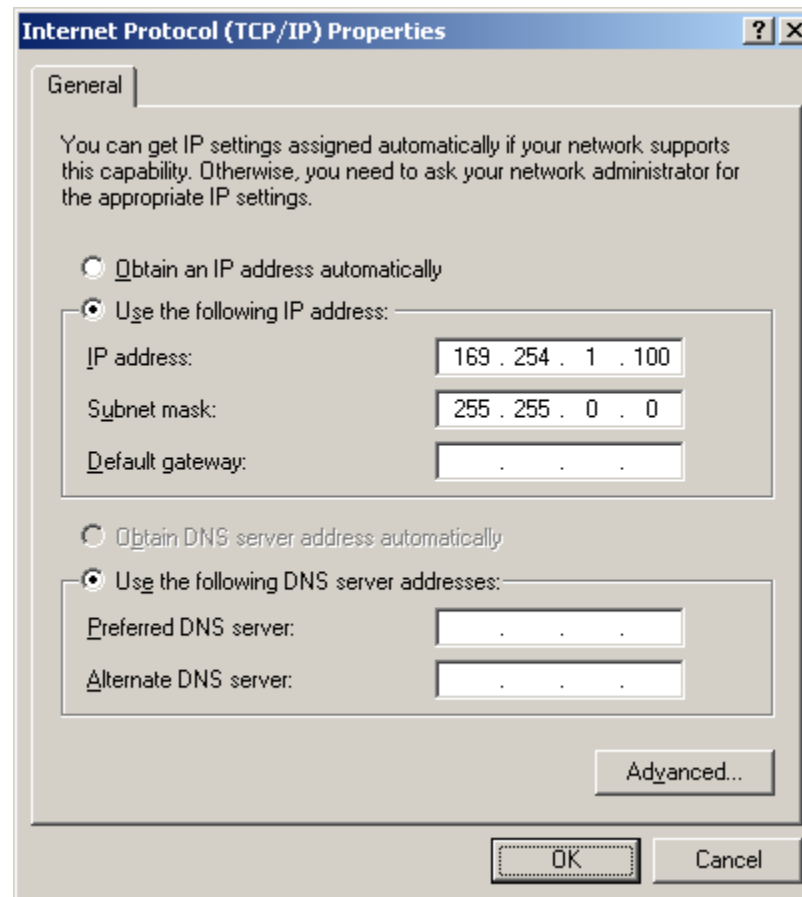
The main content area of the 'NC: Functions' tab is divided into several sections:

- Position and Setpoint:** A large display shows the current position as **1259.6600**. To its right, the 'Setpoint' is set to **1282.7715** [mm].
- Extended Start:** This section contains several input fields and buttons:
 - Start Mode:** A dropdown menu is set to 'Relative'. A 'Start' button is located to its right.
 - Target Position:** A text box contains '2000' [mm]. A 'Stop' button is located to its right.
 - Target Velocity:** A text box contains '200' [mm/s].
 - Acceleration:** A checkbox is unchecked, followed by a text box containing '0' [mm/s²].
 - Deceleration:** A checkbox is unchecked, followed by a text box containing '0' [mm/s²].
 - Jerk:** A checkbox is unchecked, followed by a text box containing '0' [mm/s³].
 - Last Time:** A text box contains '2.12000' [s].
- Raw Drive Output:** This section contains:
 - Output Mode:** A dropdown menu is set to 'Percent'. A 'Change' button is located to its right.
 - Output Value:** A text box contains '0' [%]. A 'Stop' button is located to its right.
- Set Actual Position:** A dropdown menu is set to 'Absolute', followed by a text box containing '0' and a 'Set' button.
- Set Target Position:** A dropdown menu is set to 'Absolute', followed by a text box containing '0' and a 'Set' button.

If using a Beckhoff PLC as the master controller, please follow these steps:

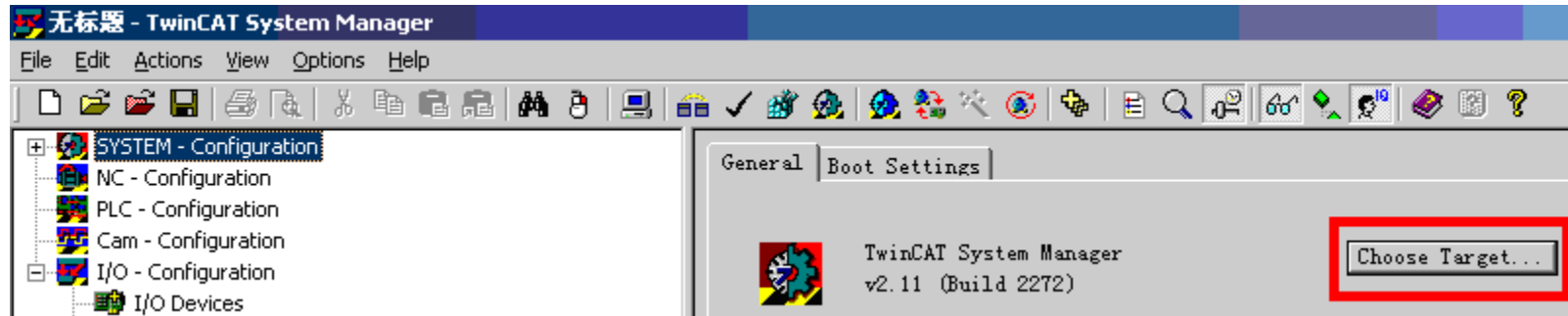
IP Setting

The IP address of a Beckhoff PLC is usually 169.254.X.X and the subnet mask is 255.255.0.0. You need to set the PC's IP address in the same subnet as the Beckhoff PLC. For example, set the PC's IP address to 169.254.1.100 and the subnet mask to 255.255.0.0.

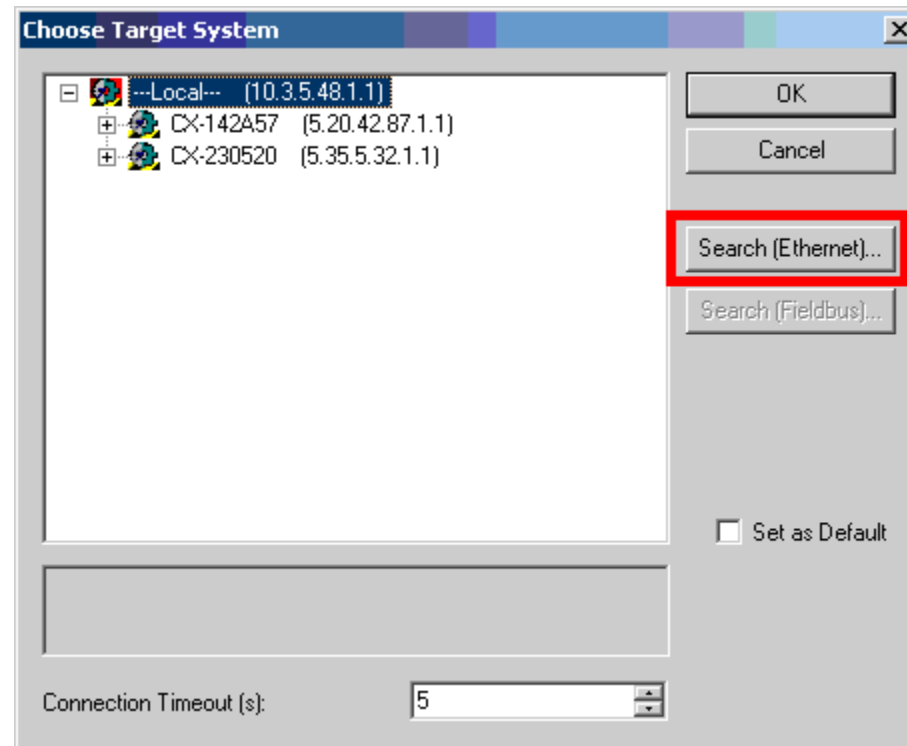


Search and connect to PLC

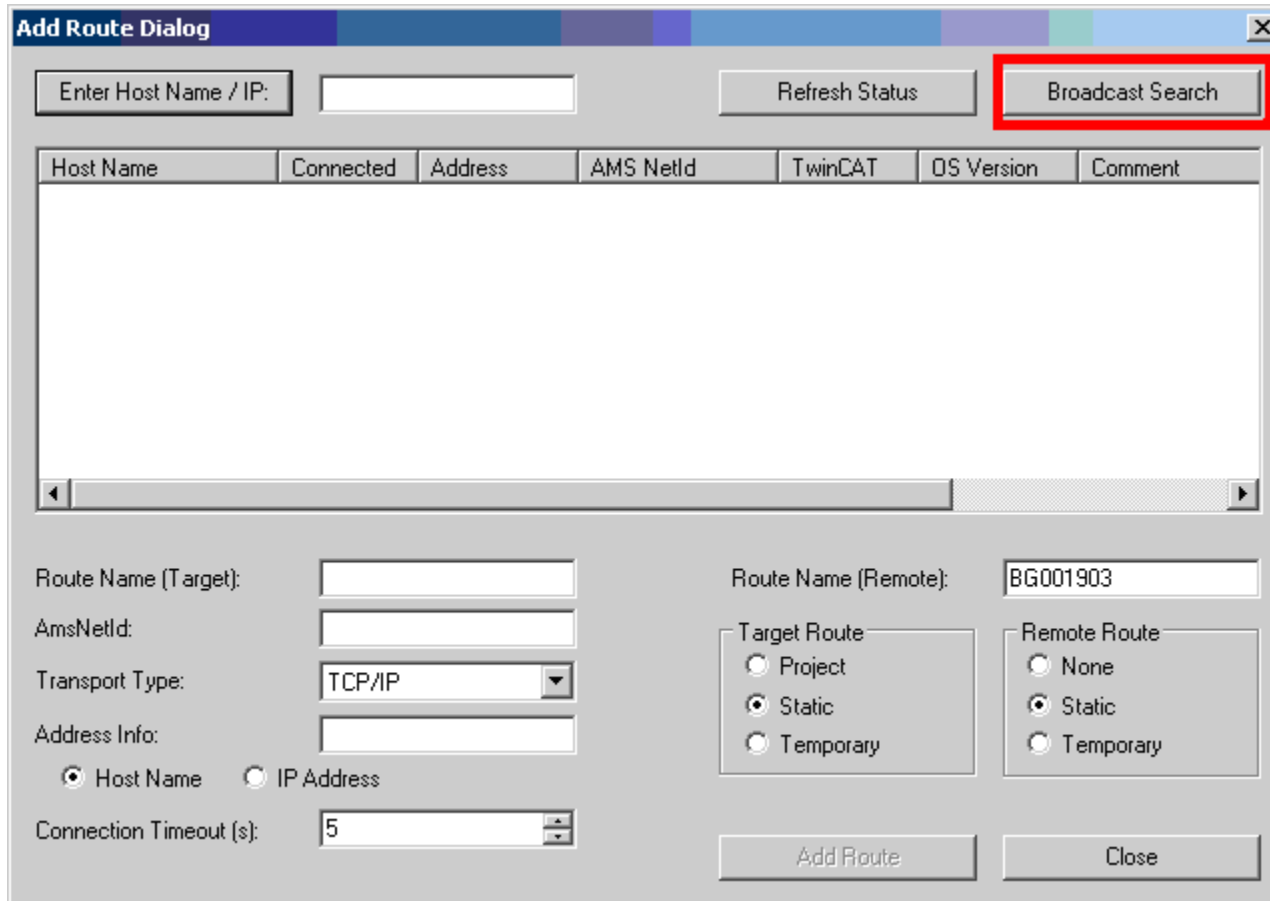
Select **SYSTEM – Configuration** and find the **General** tab. Click **Choose Target**.



In the pop up window, click **Search (Ethernet)**.



Click **Broadcast Search**.



Add Route Dialog

Enter Host Name / IP: Refresh Status

Host Name	Connected	Address	AMS NetId	TwinCAT	OS Version	Comment
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Route Name (Target):

AmsNetId:

Transport Type:

Address Info:

Host Name IP Address

Connection Timeout (s):

Route Name (Remote):

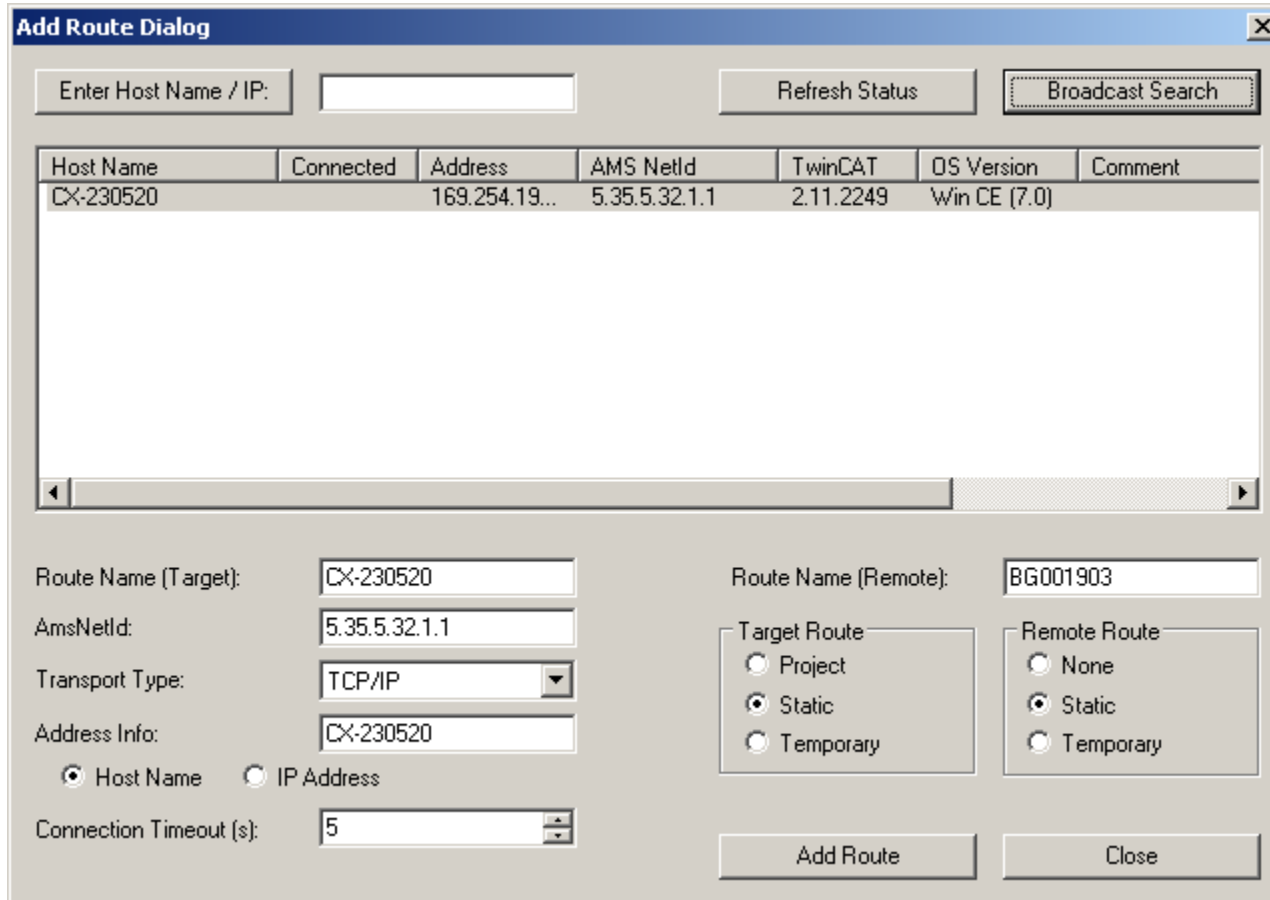
Target Route

- Project
- Static
- Temporary

Remote Route

- None
- Static
- Temporary

When the host PLC is found, it will be shown in window below.



The screenshot shows the 'Add Route Dialog' window. At the top, there is a text input field for 'Enter Host Name / IP:', a 'Refresh Status' button, and a 'Broadcast Search' button. Below this is a table with the following data:

Host Name	Connected	Address	AMS NetId	TwinCAT	OS Version	Comment
CX-230520	X	169.254.19...	5.35.5.32.1.1	2.11.2249	Win CE (7.0)	

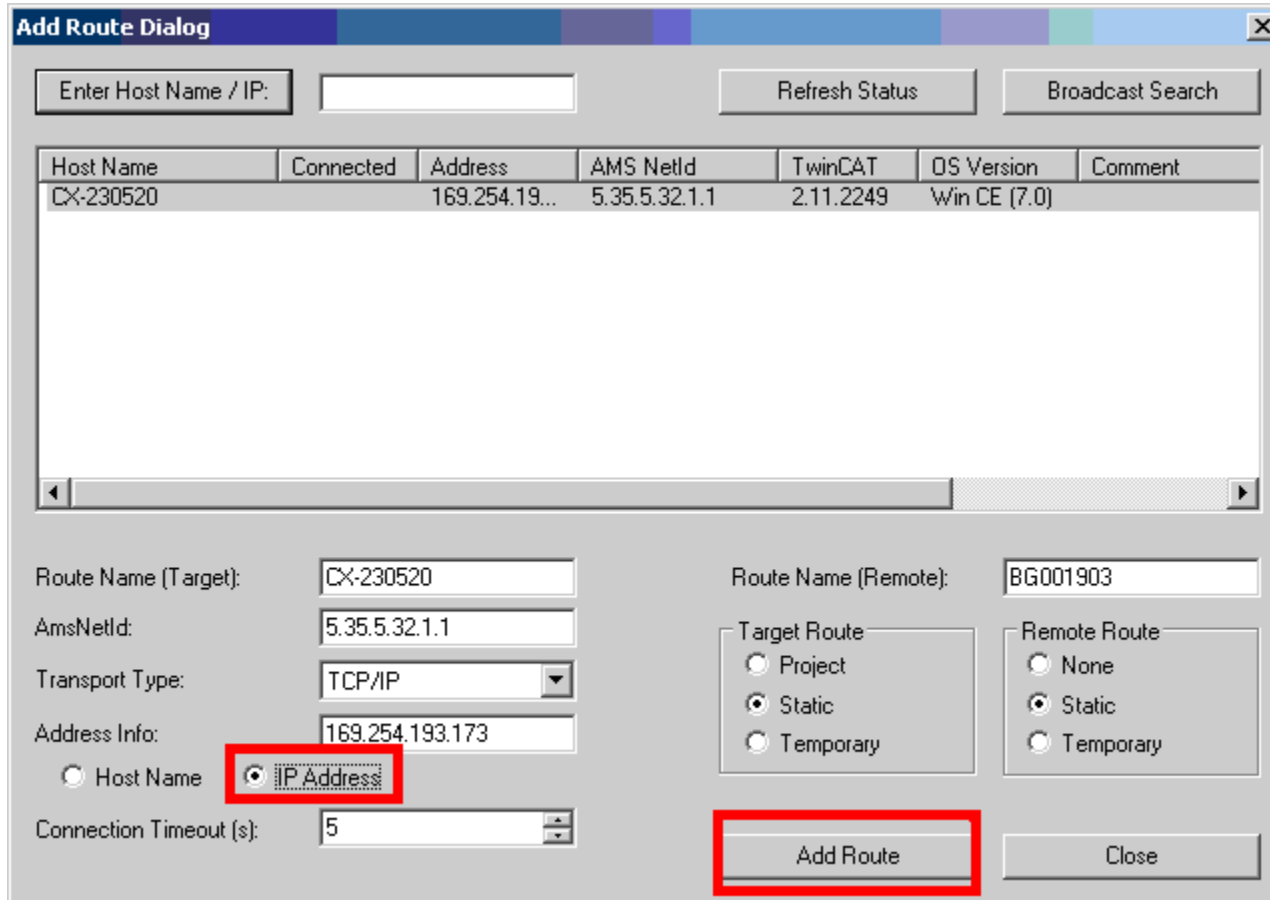
Below the table, there are configuration fields for the route:

- Route Name (Target): CX-230520
- Route Name (Remote): BG001903
- AmsNetId: 5.35.5.32.1.1
- Transport Type: TCP/IP
- Address Info: CX-230520
- Radio buttons: Host Name, IP Address
- Connection Timeout (s): 5
- Target Route radio buttons: Project, Static, Temporary
- Remote Route radio buttons: None, Static, Temporary

At the bottom right, there are 'Add Route' and 'Close' buttons.

When the **Connected** column is empty, the PLC is not connected. If the PLC is connected, there will be an X under **Connected**.

Select the host PLC. Select **IP Address** and click **Add Route**.



Add Route Dialog

Enter Host Name / IP: Refresh Status Broadcast Search

Host Name	Connected	Address	AMS NetId	TwinCAT	OS Version	Comment
CX-230520		169.254.19...	5.35.5.32.1.1	2.11.2249	Win CE (7.0)	

Route Name (Target): Route Name (Remote):

AmsNetId:

Transport Type:

Address Info:

Host Name IP Address

Connection Timeout (s):

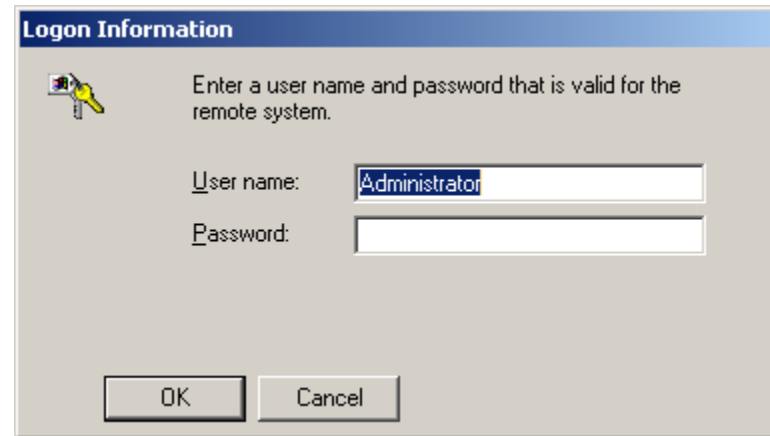
Target Route: Project Static Temporary

Remote Route: None Static Temporary

Enter User name and password.

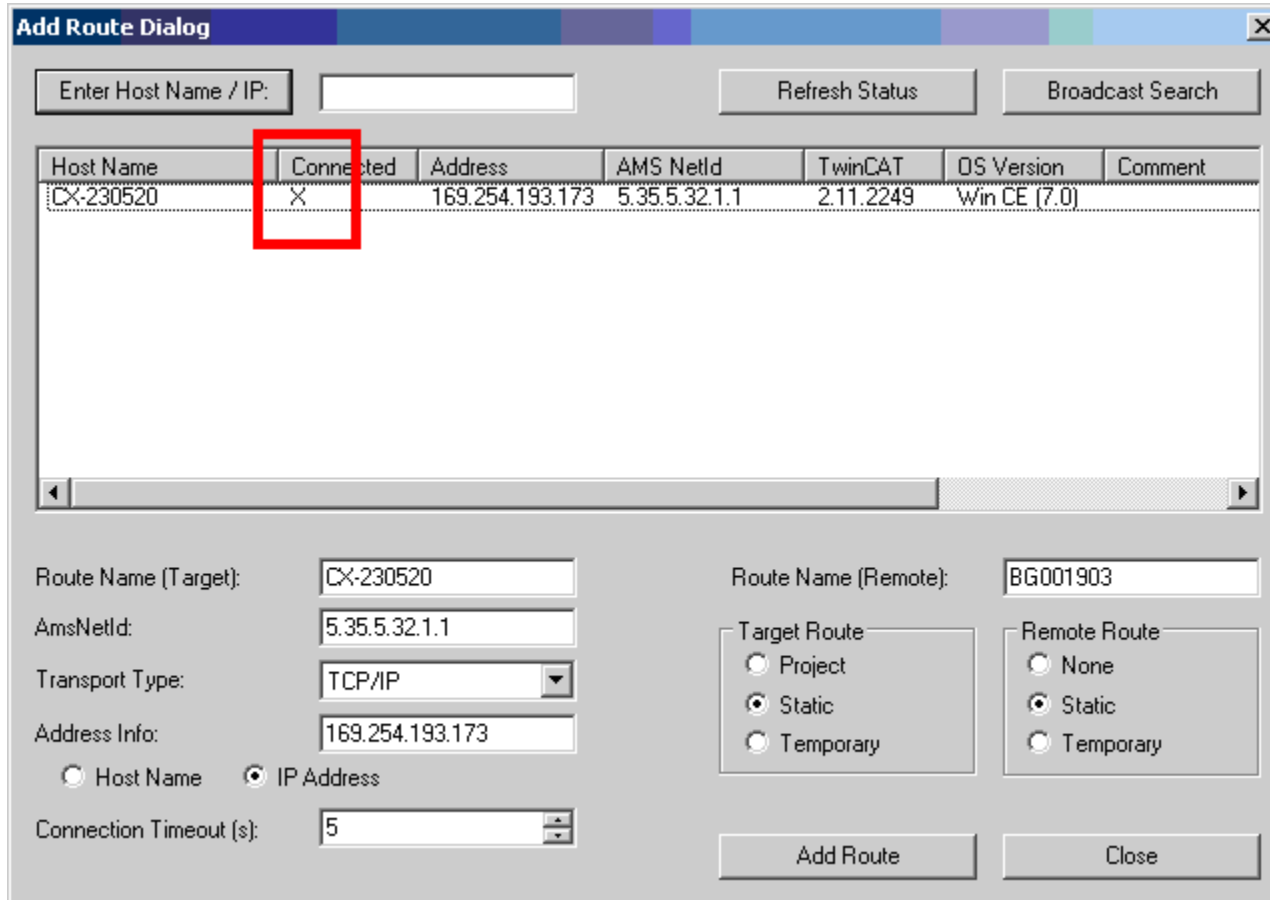
Factory defaults:

- Windows XP/WIN7 ... User name: Administrator ... Password: 1
- For Windows CE ... User name: Administrator ... Password is blank



Using a Beckhoff PLC as the master controller

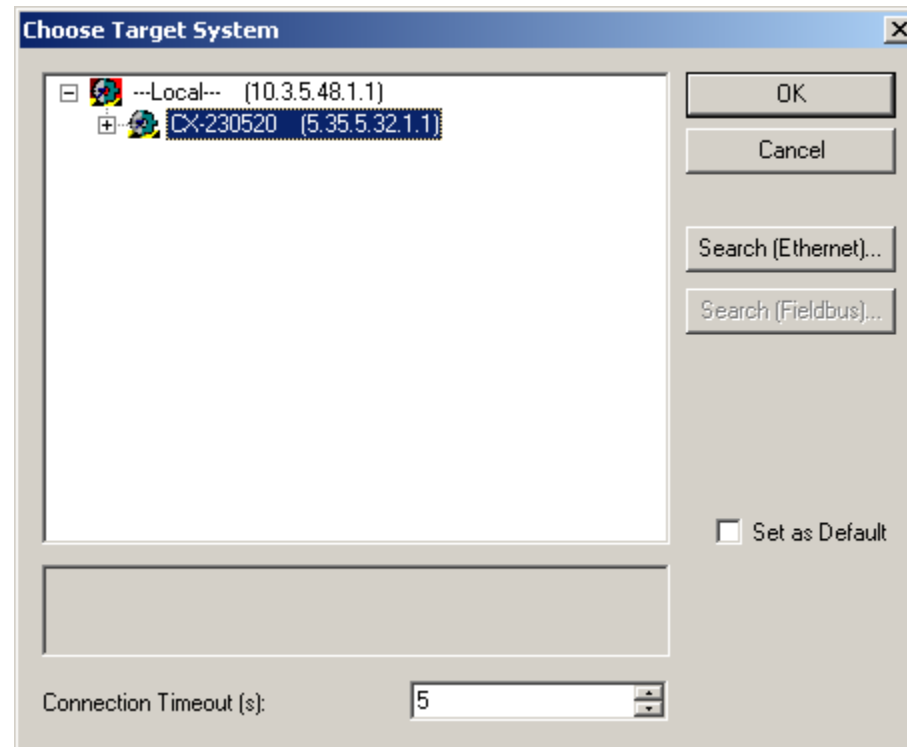
When the PLC is successfully connected, there will be an X under **Connected**. Click **Close** to go back to previous window.



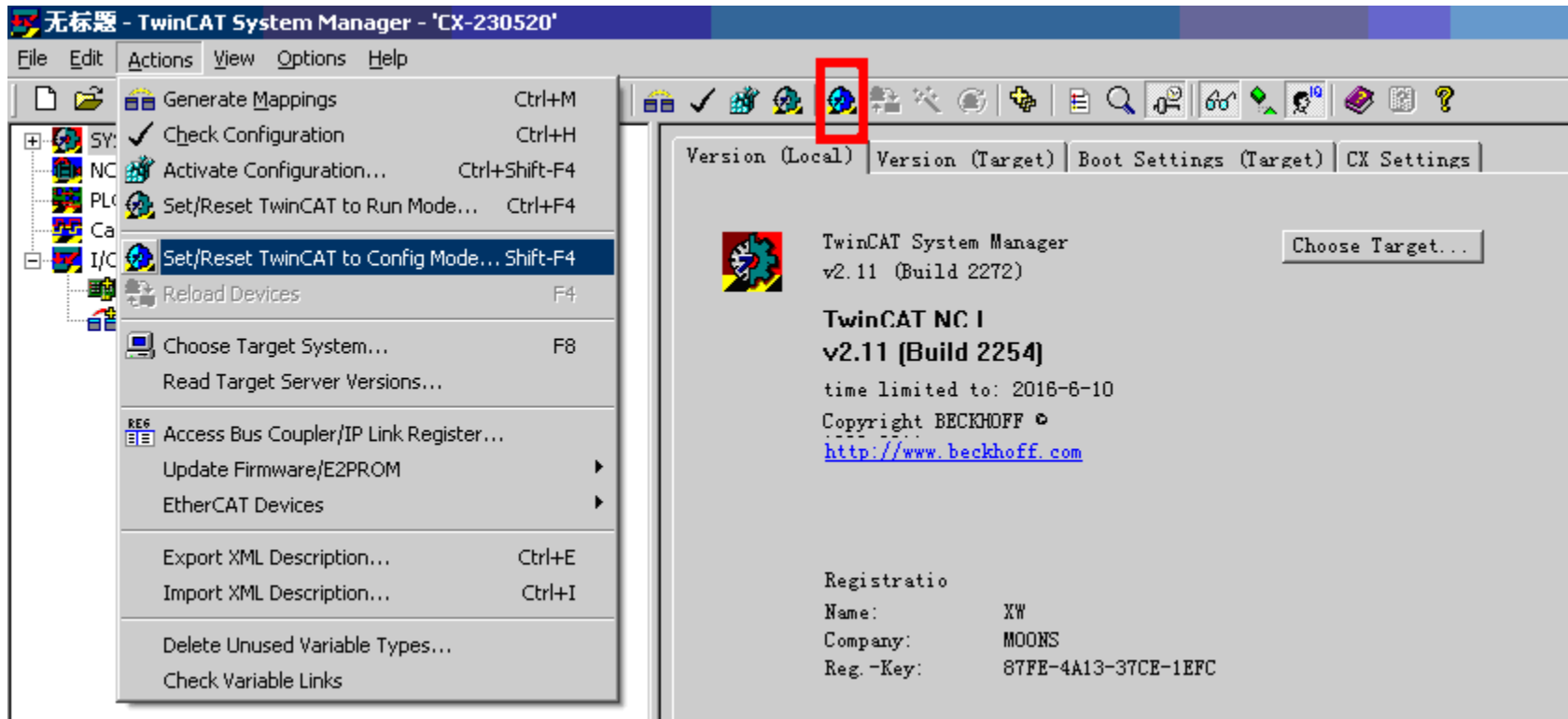
The screenshot shows the 'Add Route Dialog' window. At the top, there is a text input field for 'Enter Host Name / IP:' and two buttons: 'Refresh Status' and 'Broadcast Search'. Below this is a table with the following columns: Host Name, Connected, Address, AMS NetId, TwinCAT, OS Version, and Comment. The table contains one row with the following data: Host Name: CX-230520, Connected: X, Address: 169.254.193.173, AMS NetId: 5.35.5.32.1.1, TwinCAT: 2.11.2249, OS Version: Win CE (7.0). The 'Connected' column has a red box around the 'X'. Below the table are several input fields and radio buttons for configuring the route. The 'Route Name (Target)' is CX-230520, 'Route Name (Remote)' is BG001903, 'AmsNetId' is 5.35.5.32.1.1, 'Transport Type' is TCP/IP, 'Address Info' is 169.254.193.173, and 'Connection Timeout (s)' is 5. There are also radio buttons for 'Host Name' and 'IP Address', and radio buttons for 'Target Route' (Project, Static, Temporary) and 'Remote Route' (None, Static, Temporary). At the bottom right, there are two buttons: 'Add Route' and 'Close'.

Host Name	Connected	Address	AMS NetId	TwinCAT	OS Version	Comment
CX-230520	X	169.254.193.173	5.35.5.32.1.1	2.11.2249	Win CE (7.0)	

The connected PLC will be shown in the list. Select the PLC and click OK.

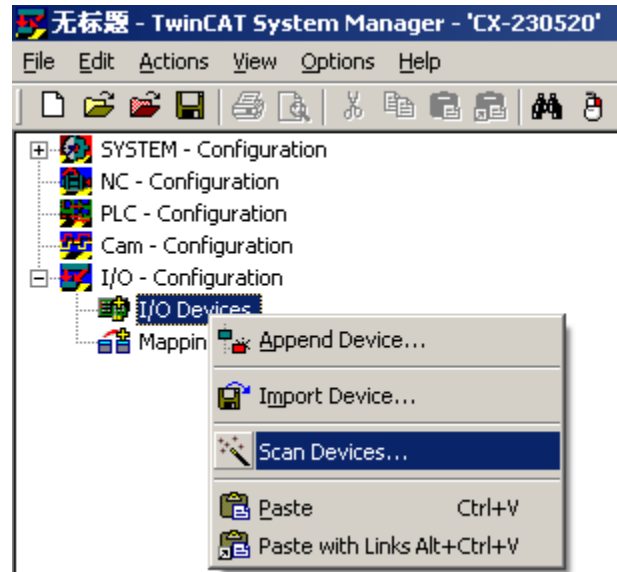


Click on **Set/Reset TwinCAT to Config Mode** under **Actions** to switch TwinCAT to Config Mode.

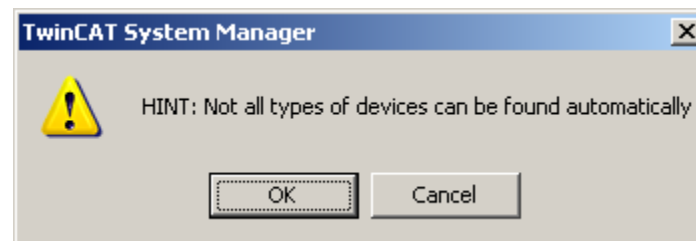


Scan Devices

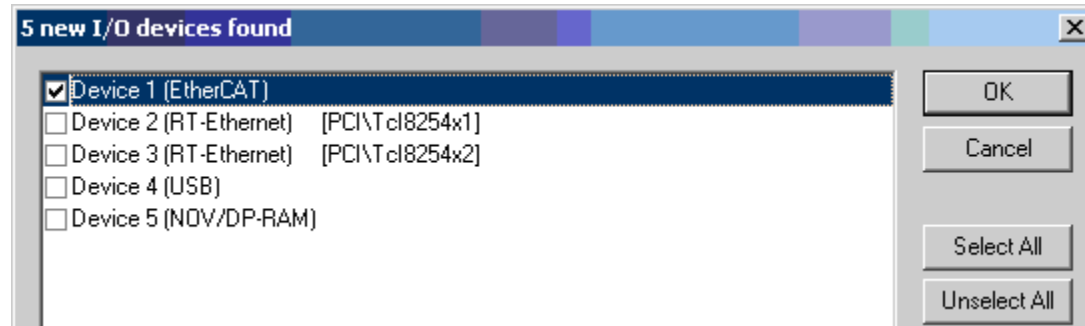
Right click on **I/O Devices** and then click **Scan Devices**.



When this dialog appears, click OK.



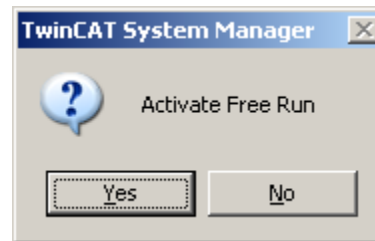
After I/O device is found, select **EtherCAT** only and click OK.



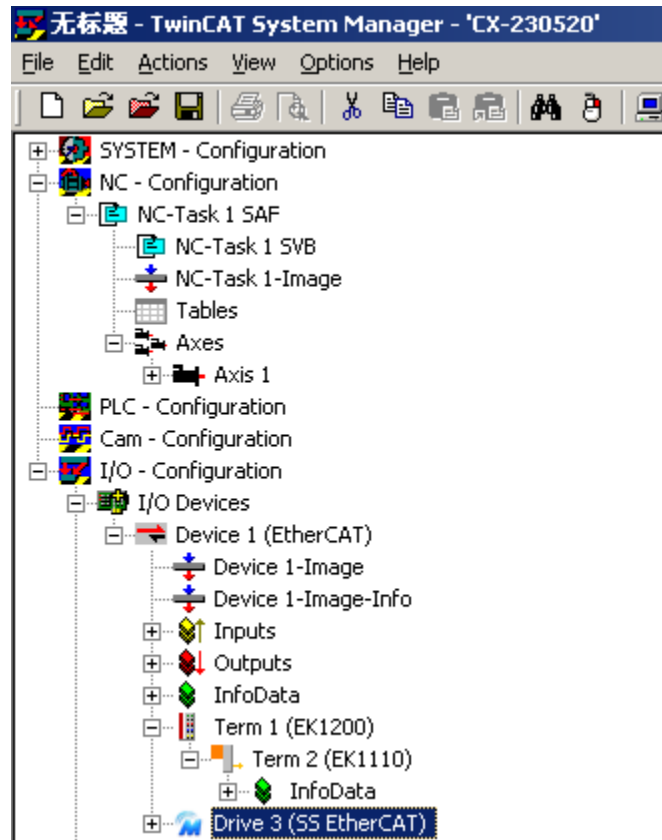
When these dialogs appear, click Yes to **Scan for boxes** and Yes to **Append linked axis to NC-Configuration**.



When this dialog appears, click Yes to **Activate Free Run**.



After scan, the EtherCAT drive will be shown under **I/O Devices**.

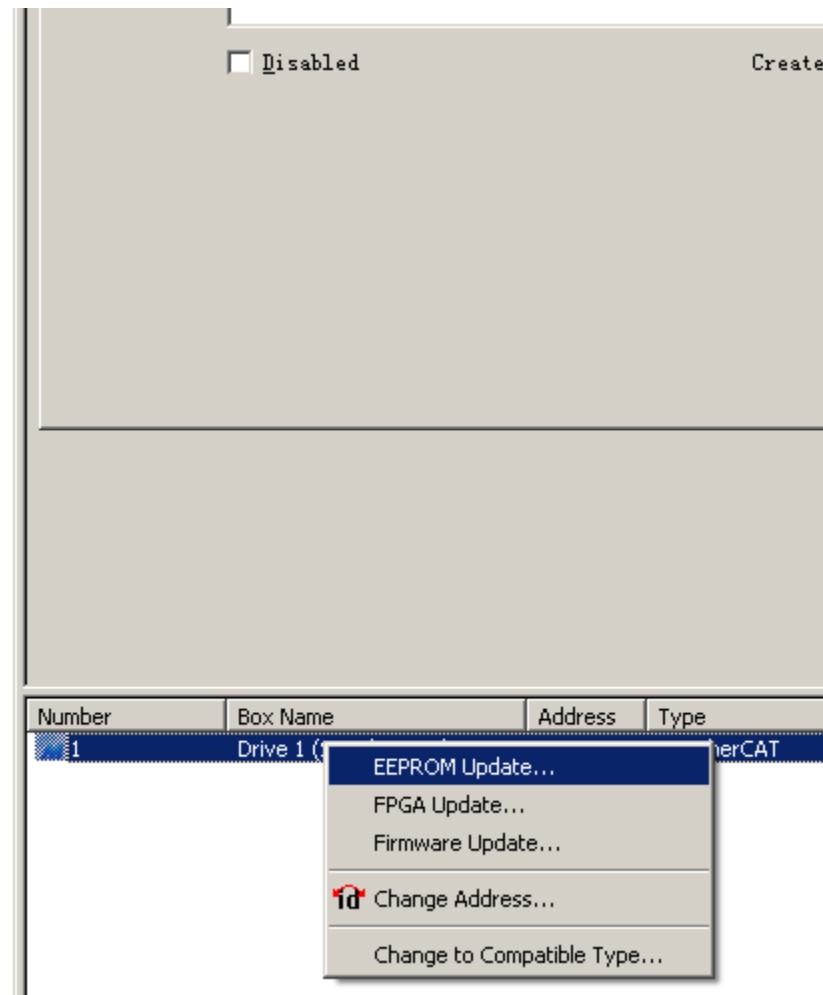
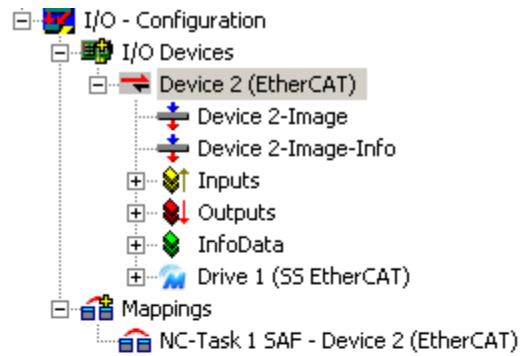


The rest of the steps are the same as the previous section, starting from **Parameter settings for NC – Configuration** on page 9.

Other:

Update a drive's EEPROM

If you need to update a drive's EEPROM, select Device 2 (EtherCAT). Right-click on the drive shown in the bottom right and select EEPROM Update.



In the pop-up window, select the drive's EEPROM description file and click OK to start updating the EEPROM.

