HIWIN® MIKROSYSTEM

E Series Servo Drive

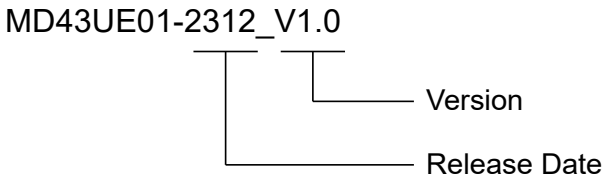
Thunder over EtherCAT
User Manual

www.hiwinmikro.tw

MD43UE01-2312_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
Dec. 15th, 2023	1.0	E series EtherCAT servo 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

Through the network protocol of Ethernet over EtherCAT, E series EtherCAT servo drive can do Thunder connection via EtherCAT network architecture. This manual aims to assist users to do the related setup of Ethernet over EtherCAT. In addition to connecting servo drive via USB, users can also choose to do Thunder connection via Ethernet over EtherCAT communication to set parameters, perform motor tuning and do troubleshooting.

Technical Terms

Term	Meaning
Ethernet	Ethernet is the most commonly used local network technology at present; its technical specifications are formulated by IEEE 802.3 standard.
EtherCAT	Ethernet for Control Automation Technology is an Ethernet-based Fieldbus system developed by Beckhoff Automation.
EoE	Ethernet over EtherCAT, a technology extended by EtherCAT, can transmit Ethernet packets under the architecture of EtherCAT network without affecting the data exchange within EtherCAT network.
ESI	EtherCAT Slave Information is a file describing the characteristics of the slave; its content is defined by ETG.2000.
EEPROM	Electrically-Erasable Programmable Read-Only Memory is a read-only memory that can be electronically rewritten multiple times.
IP address	A string of numbers used in Internet Protocol to transmit identifications or receive datagrams.
PreOp, SafeOp, Op	The states of ‘Pre-Operational’, ‘Safe-Operational’ and ‘Operational’ in EtherCAT State Machine. Refer to section 2.4 in “E Series Servo Drive EtherCAT Communication Command Manual” for detailed descriptions.

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1. Environment configuration

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1.1 Software and hardware requirements

Before executing EoE function, check if the specifications of software and hardware support EoE.

- **E1 series servo drive**

Table 1.1.1 Specifications of E1 series servo drive supporting EoE

Model	ED1F-E□ (EtherCAT model)
Firmware version	2.10.6 or above
ESI version	HIWIN_MIKROSYSTEM_ED1F_20231212.xml (and the versions with newer date)
EEPROM version	EEPROM_ED1F (Version_2.10.6_or_above)

- **E2 series servo drive**

Table 1.1.2 Specifications of E2 series servo drive supporting EoE

Model	ED2F-E□ (EtherCAT model)
Firmware version	3.10.6 or above
ESI version	HIWIN_MIKROSYSTEM_ED2F_20231212.xml (and the versions with newer date)
EEPROM version	EEPROM_ED2F (Version_3.10.6_or_above)

- **Host controller**

  Based on the specification, confirm that the product's **software** can support EoE's terminal setup.

- **Thunder software**

  The version of Thunder installation file must be 1.10.6.0 or above.

1.2 Update EEPROM

Before using EoE function for the first time, users must manually update EEPROM to support EoE function. This section explains how to update EEPROM with tools.

1.2.1 Connect the equipment

Connect the equipment with EEPROM to be updated in series (CN9) and connect them directly to the computer. During the connecting process, check if the IN/OUT connection is correct, as Figure 1.2.1.1 shows.

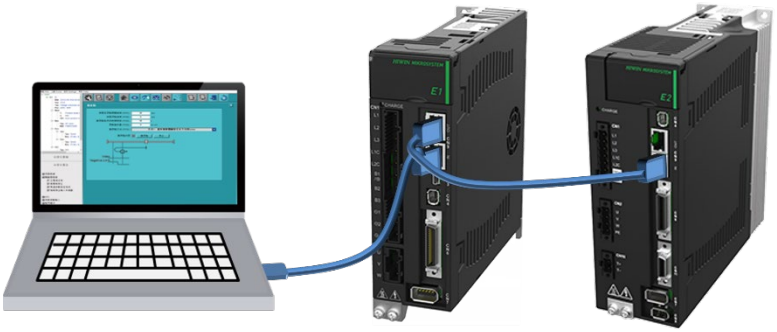

Figure 1.2.1.1

1.2.2 Open EEPROM burner

Open “EtherCAT Configuration Tool for HIWIN.exe” in “C:\Thunder\dce\toolswin\winkmi\EtherCAT Configuration Tool for HIWIN”. After entering the screen of the program, select the network card of the equipment connected to the computer and click **Scan**. After the scan is done, all the scanned equipment will be listed on the left.

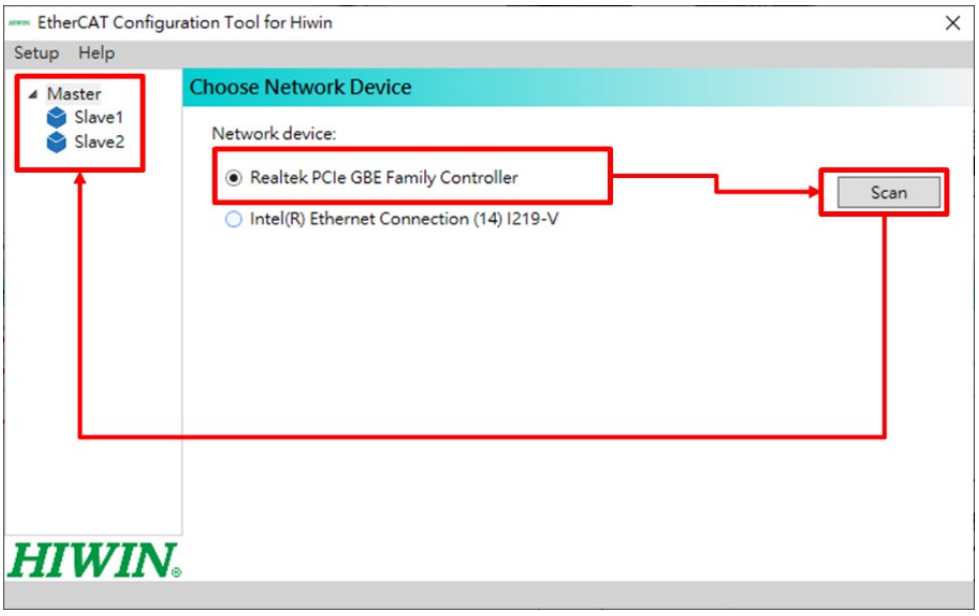

Figure 1.2.2.1

1.2.3 Check the equipment's EEPROM

Double-click the equipment to view the key information contained in its EEPROM.

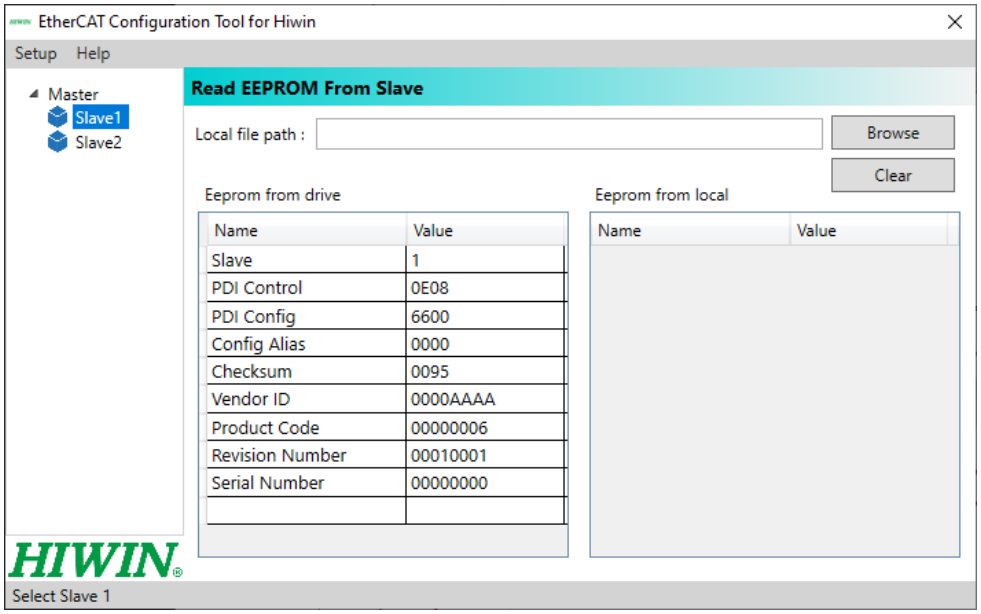

Figure 1.2.3.1

Check the equipment's Product Code and Revision Number. Product Code corresponds to the model of servo drive, while Revision Number corresponds to the version supporting EoE.

Table 1.2.3.1 Corresponding table for Product Code and Revision Number

	Product Code	Revision Number
ED1F (not support EoE)	0x00005	0x10000
ED2F (not support EoE)	0x00006	0x10000
ED1F (support EoE)	0x00005	0x10001
ED2F (support EoE)	0x00006	0x10001

1.2.4 Burn EEPROM

This section explains how to update servo drive's EEPROM via EEPROM burner. The steps are as follows:

1. Click **Write EEPROM to slave** in Setup in the upper left corner.

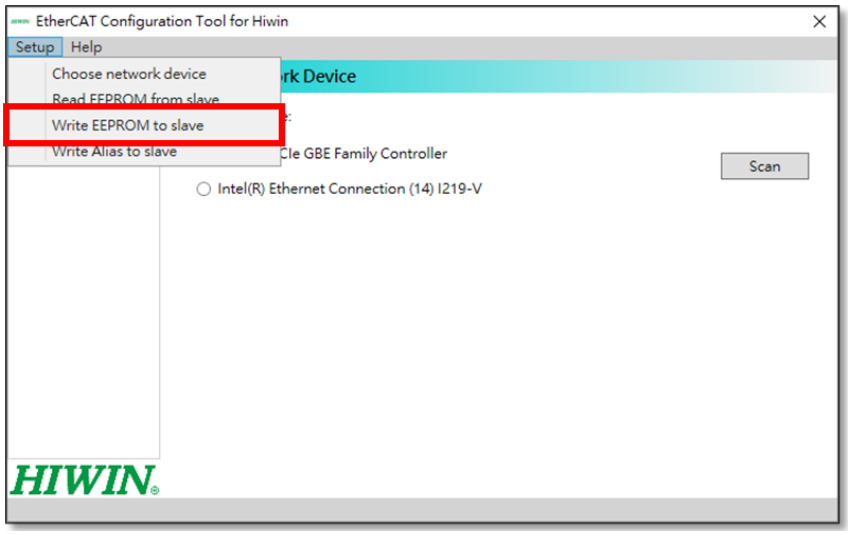

Figure 1.2.4.1

2. Select the equipment to be burned and search for the EEPROM file (.bin) to be burned. The EEPROM file is included in Thunder's path "C:\Thunder\dce\toolswin\winkmi\EtherCAT Configuration Tool for HIWIN\Bin Library". The corresponding content of the file is shown in Table 1.2.4.1.

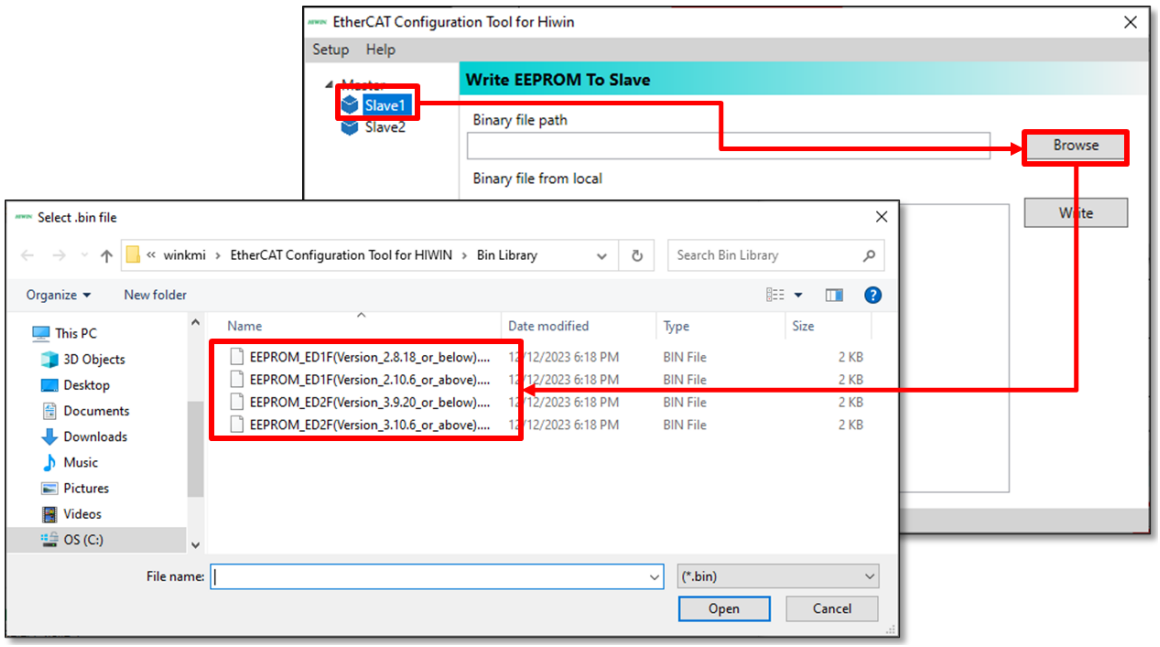

Figure 1.2.4.2

Table 1.2.4.1 Corresponding table for EEPROM file's content

	Product Code	Revision Number	Applicable Firmware Version
EEPROM_ED1F (Version_2.8.18_or_below)	0x00005	0x10000	All versions (but cannot support EoE function)
EEPROM_ED2F (Version_3.9.20_or_below)	0x00006	0x10000	All versions (but cannot support EoE function)
EEPROM_ED1F (Version_2.10.6_or_above)	0x00005	0x10001	2.10.6 or above
EEPROM_ED2F (Version_3.10.6_or_above)	0x00006	0x10001	3.10.6 or above

3. Click **Write** to burn EEPROM. When the progress bar below is completed and **Success** is displayed, EEPROM updating is done.

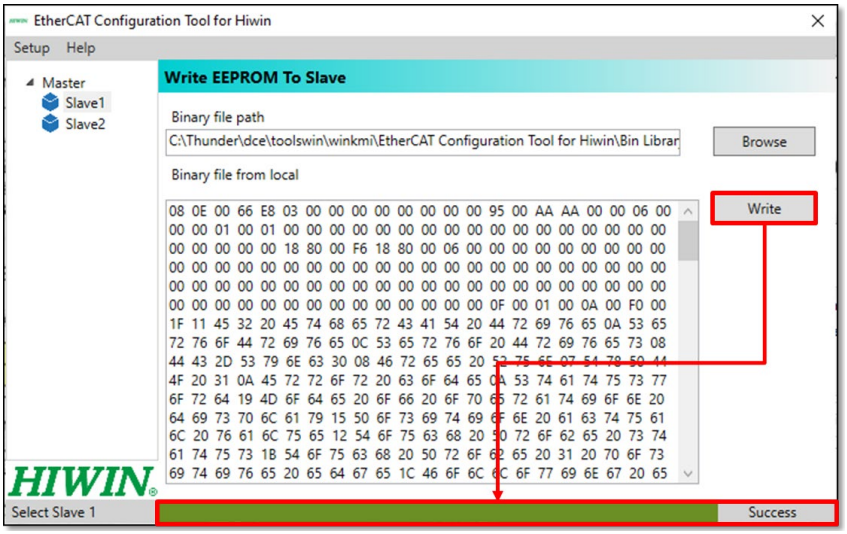

Figure 1.2.4.3

Important Reminder

- EEPROM burner only supports the burning of HIWIN series. Do not perform the related operations on other servo drives.
- If servo drive's EEPROM has been updated, do not use old firmware version, or communication errors will occur. If users need to use old firmware version, re-burn the corresponding equipment with Revision Number of 0x10000 (refer to Table 1.2.4.1).

1.3 EoE wiring setup

The main characteristic of EoE is that the controller can be used as a gateway to convert Ethernet packets into EoE packets and transmit them to slave. Therefore, if it complies with the network segment protocol and confirms that Ethernet packets can reach the terminal through IP protocol (such as executing Ping test), Thunder connection can be made through EoE. The wiring methods are given as follows:

- **Example 1: Computer (Thunder) - Controller - Drive**

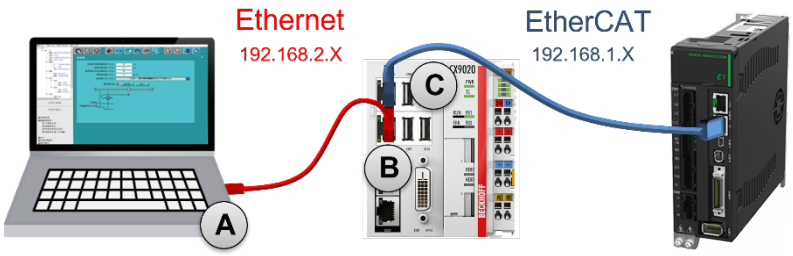

Figure 1.3.1

- **Example 2: Computer (Thunder) - Switch - Controller - Drive**

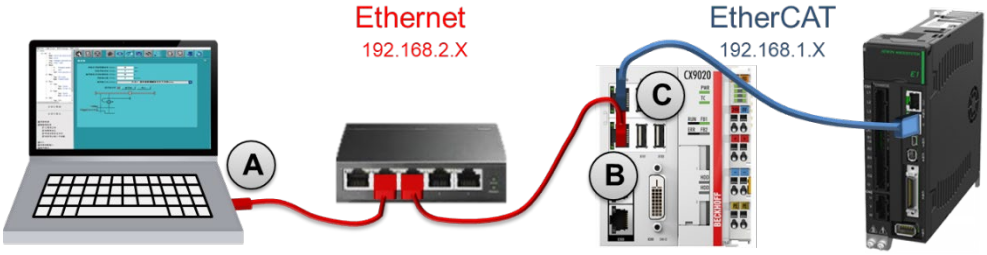

Figure 1.3.2

- **Example 3: Industrial computer (Thunder) - Drive**

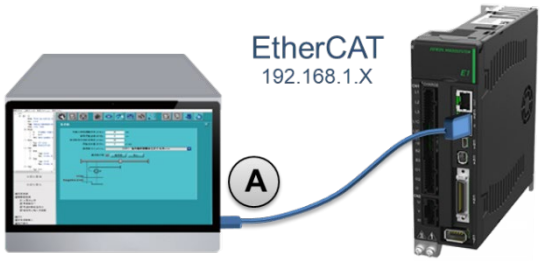

Figure 1.3.3

Note:

1. For the first time of EoE application, it is recommended to conduct a stand-alone test with the above examples. Users can modify the network architecture for development after becoming familiar with it.

2. The industrial computer in Example 3 must support EtherCAT's transmission.

2. Connecting methods

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2.1 Controller's connection setup

This section outlines the required setup on the controller side. For the actual operations, refer to the relevant operating instructions of the controller.

2.1.1 Network configuration

Connect the computer and the controller, set the IP of each network port, and configure the network segmentation. Take Windows as an example, the setting can be performed in **Control Panel** → **Network and Internet** → **Network and Sharing Center**.

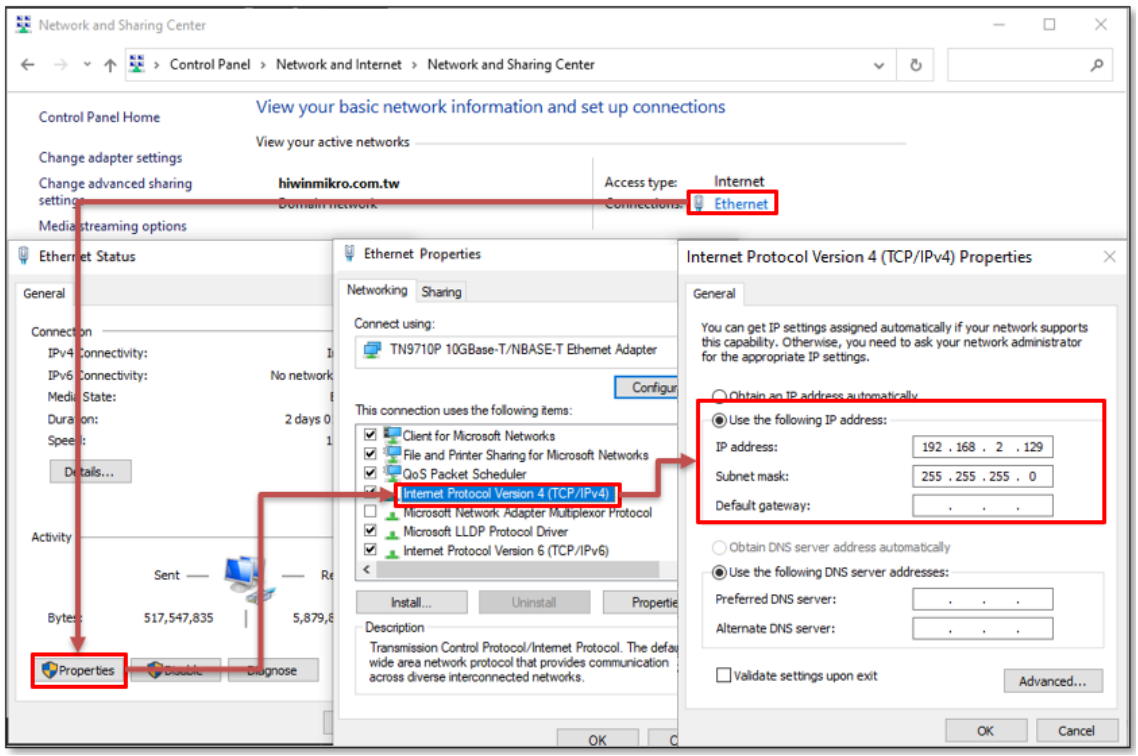


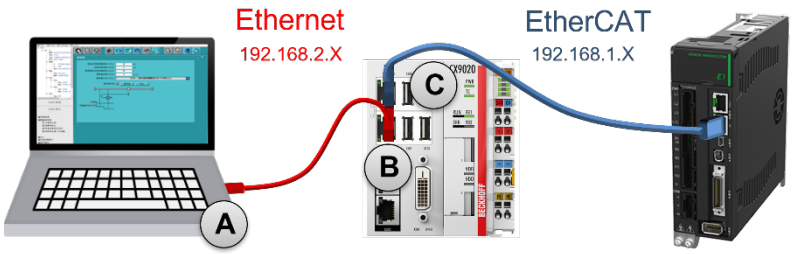
Figure 2.1.1.1

Note:

EoE does not support the network segmentation of 169.254.X.X (the IP that **Obtain an IP address automatically** is checked). Please avoid this kind of setup.

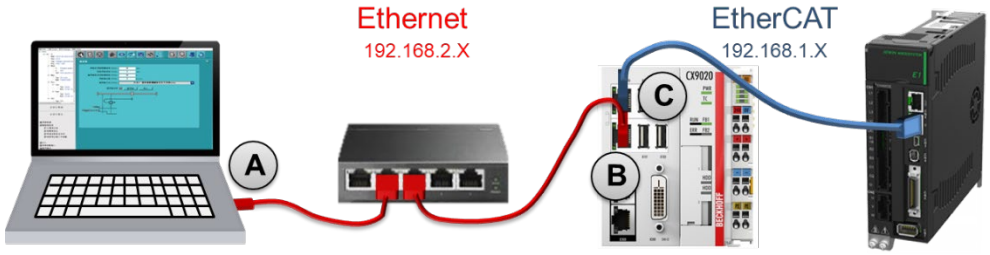
The following are the setting examples of mesh and network segmentation:

■ Example 1



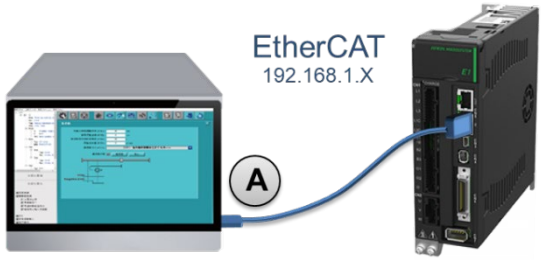
Port A	Port B	Port C
IP address: 192.168.2.129 Subnet mask: 255.255.255.0	IP address: 192.168.2.128 Subnet mask: 255.255.255.0	IP address: 192.168.1.128 Subnet mask: 255.255.255.0

■ Example 2



Port A	Port B	Port C
IP address: 192.168.2.129 Subnet mask: 255.255.255.0	IP address: 192.168.2.128 Subnet mask: 255.255.255.0	IP address: 192.168.1.128 Subnet mask: 255.255.255.0

■ Example 3



Port A
IP address: 192.168.2.129 Subnet mask: 255.255.255.0

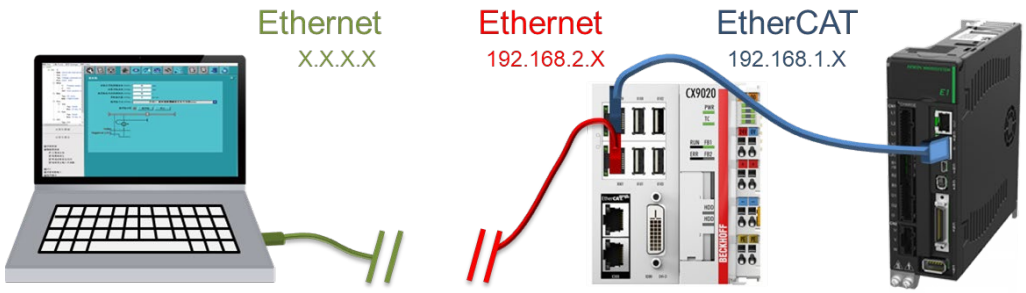


Figure 2.1.1.2

Important Reminder	Since EoE's data exchange is implemented through Ethernet packets, if there is a network topology between HMI (Thunder) and the controller (as Figure 2.1.1.2 shows), check if the Ethernet packets can be transmitted and received between HMI and the controller first, or EoE function cannot be applied. For example, send the packets to 192.168.2.128 via Ping test and ensure the reply can be received.

2.1.2 EoE setup

Refer to the product manual of the controller or the relevant teaching documents to complete EtherCAT connection for performing EoE setup, including:

1. Open EoE function on the controller side.
2. Set EoE's terminal.
   When setting EoE's terminal, users must set the virtual IP of servo drive. Please set the virtual IP of servo drive to the address within EtherCAT network segmentation, and it cannot be the same as the IP of controller. Take Example 1, 2, 3 in section 2.1.1 as examples:

   IP address: 192.168.1.1
   Subnet mask: 255.255.255.0

After the setup is done, ensure the servo drive has entered **PreOp**, **SafeOp** or **Op** before proceeding to the next step. If the servo drive has not entered the above states, check if the firmware has been updated to the version supporting EoE.

Note:
Refer to section 4.2 for the example of TwinCAT 3.

2.2 Drive's connection setup

2.2.1 Add the route

If the EoE wiring setup that the HMI is connected to the servo drive via the controller is adopted, it indicates that the controller is used as a gateway. At this time, a route must be added for the network to send Ethernet packets. Users can add the route by **opening command prompt** and perform the related operations:

- **Add the route**
  ROUTE ADD <destination subnet> MASK <Destination subnet mask> <Gateway> -p
  ```
  C:\Windows\System32>ROUTE ADD 192.168.1.0 MASK 255.255.255.0 192.168.2.128 -p
  ```

- **Delete the route**
  ROUTE DELETE <destination subnet> -p
  ```
  C:\Windows\System32>ROUTE DELETE 192.168.1.0 -p
  ```

- **Check the route**
  ROUTE PRINT
  ```
  C:\Windows\System32>ROUTE PRINT
  ```

> **Important Reminder** The actual operations for network setting may be different. Please contact the system administrator for detailed setup.

2.2.2 Thunder connection

1. Open Thunder, select **Fieldbus** in Drive type.

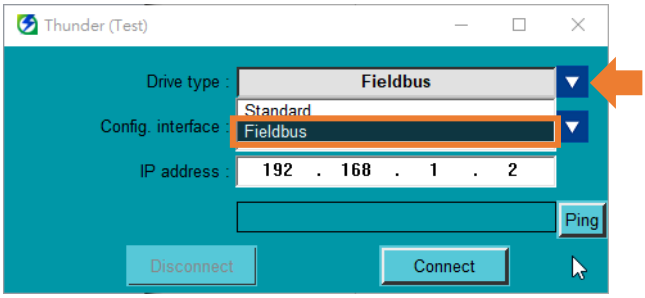


Figure 2.2.2.1

2. Select **Network (Ethernet over EtherCAT)** in Config. interface.

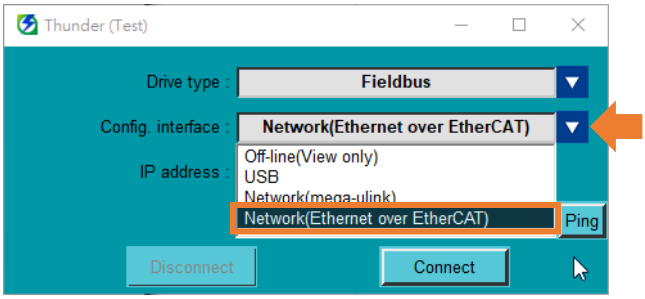


Figure 2.2.2.2

3. Set the IP address of servo drive connected to the controller (that is, the virtual IP of servo drive set in section 2.1.2).

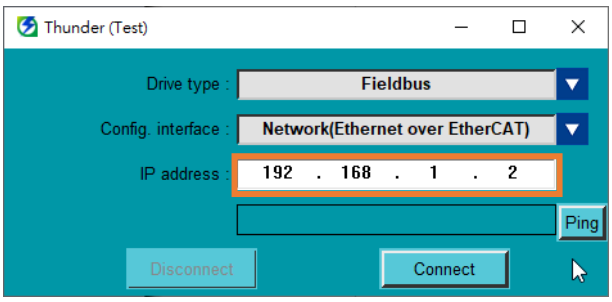


Figure 2.2.2.3

4. Click **Ping** to simply test if the computer can send packets to servo drive via the controller.

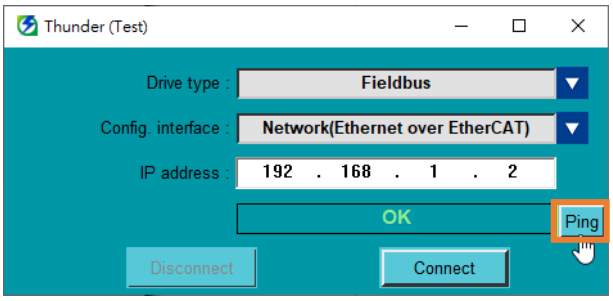


Figure 2.2.2.4

5. Click **Connect**.

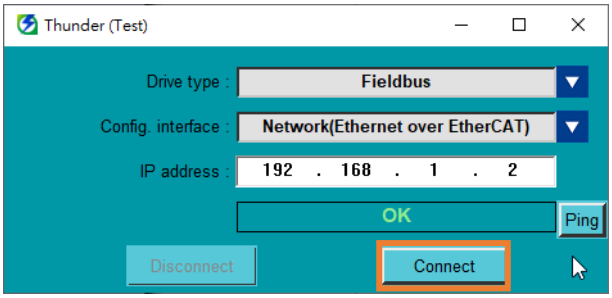


Figure 2.2.2.5

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3. Precautions

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3.1 Supported functions

The following table shows the functions supported by Thunder through EoE connection. Refer to “E Series Servo Drive Thunder Software Operation Manual” for the applications:

Table 3.1.1

Supported Function		Corresponding Chapter
Drive configuration	Edit parameters	section 4.4.2
	Save / Load parameters file	section 4.4.3
	Save to drive	section 4.4.4
	Reset drive	section 4.4.5
	I/O configuration	section 4.5
	Phase initialization setup	section 4.6
Test run function	Test run	section 5.2
	Homing operation	section 5.3
Tuning	Auto tune	section 6.2
	Tuneless	section 6.3
	Spectrum analyzer	section 6.4
Monitoring	Monitor drive’s status	section 7.3
	Scope	section 7.5
	Real-time data collection	section 7.6
Troubleshooting	Real-time monitoring	section 8.2
	Error log	section 8.3
Advanced functions	Absolute encoder initialization	section 9.3
	Gantry control	section 9.7

Note:

EoE does not support the functions such as **firmware updating**, **multi-motion burning** and **Error Map burning**.

3.2 Mastership setup

Before performing motion control, ensure the setup of the mastership (Access). The mastership will decide the permissions of motion commands, as Table 3.2.1 shows. Users can switch the mastership in Thunder's menu bar and check the current mastership. Besides, users can also check the status of the mastership through Bit 9 (Remote) of Statusword (object 0x6041) from the host controller.

Table 3.2.1

Mastership (Access)	Description
Thunder	The motion mastership is Thunder command, so the motion commands of controller cannot be executed.
Controller	The motion mastership is controller command, so the motion commands of Thunder cannot be executed. Refer to section 3.2 in "E Series Servo Drive EtherCAT Communication Command Manual" for the motion commands of controller.

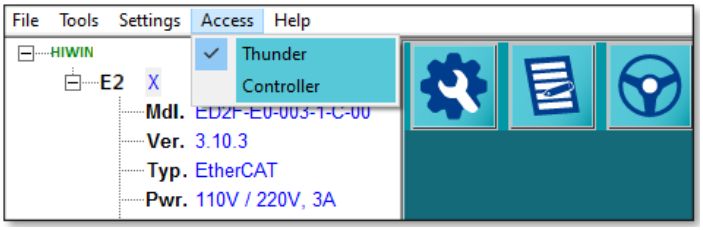

Figure 3.2.1

Table 3.2.2

	Value	Definition
Statusword Bit 9 (Remote)	0	The motion mastership is Thunder command. Controlword cannot control it.
	1	The motion mastership is controller command. Controlword can control it.

Important Reminder Do not perform master switching at "Servo ready" state. Disable the motor first, and then perform master switching.

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4. Appendix

4. Appendix 4-1
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4.1 Troubleshooting

If users cannot successfully perform EoE connection, follow the flowchart below to check if any part has not been completed:

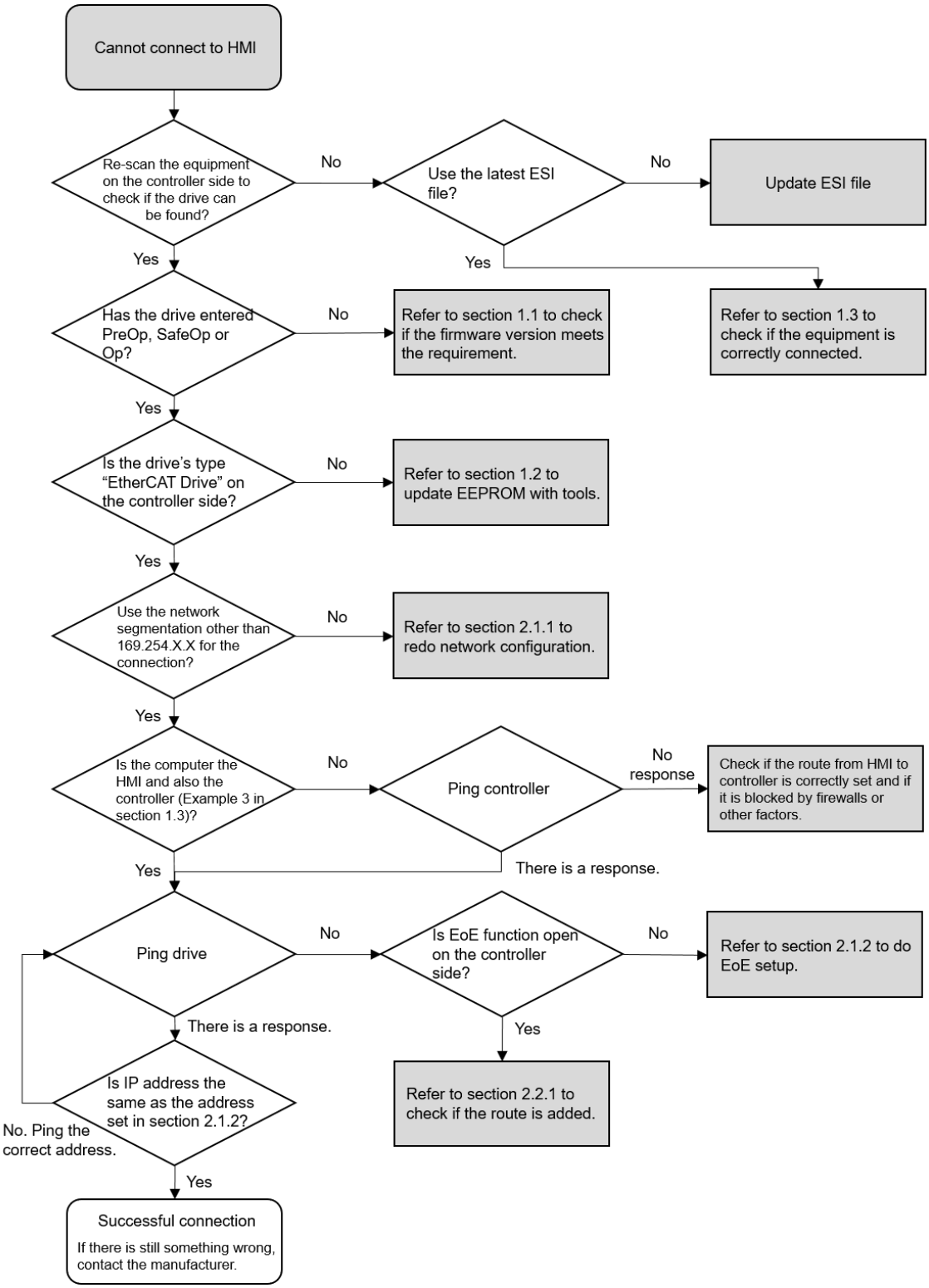

Figure 4.1.1

4.2 EoE setup example - TwinCAT 3

The following are the connection setup steps for Beckhoff controller:

Step 1: Complete network configuration.

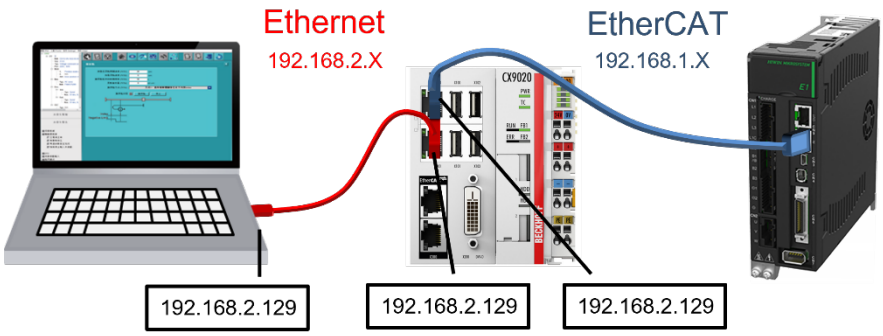

Figure 4.2.1

Step 2: Complete EtherCAT connection and scan the equipment.

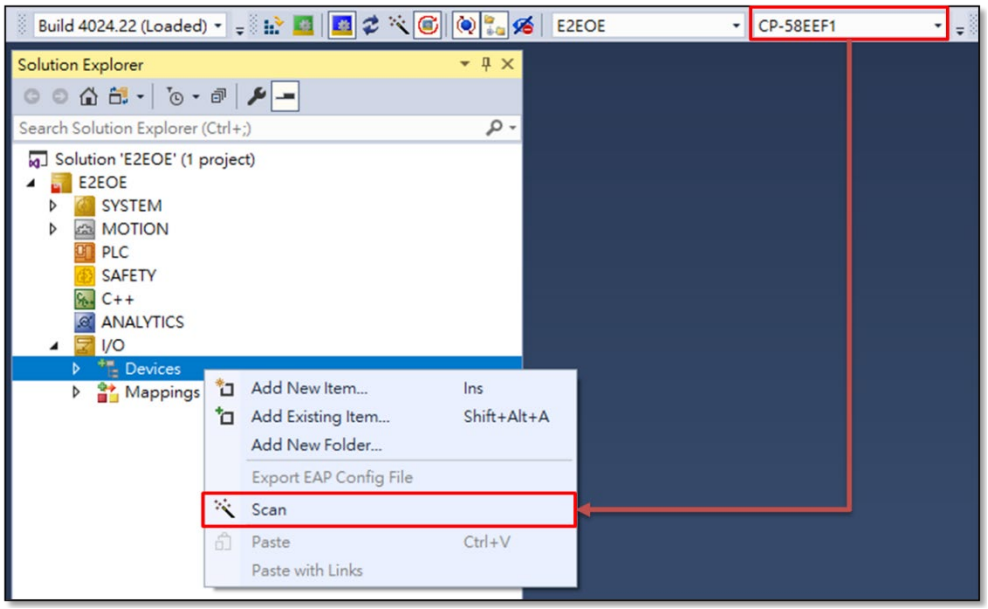

Figure 4.2.2

Step 3: Ensure the controller's IP can be pinged.

```
C:\Windows\System32>PING 192.168.2.128

Pinging 192.168.2.128 with 32 bytes of data:
Reply from 192.168.2.128: bytes=32 time=1ms TTL=128
Reply from 192.168.2.128: bytes=32 time=2ms TTL=128
Reply from 192.168.2.128: bytes=32 time=1ms TTL=128
Reply from 192.168.2.128: bytes=32 time=2ms TTL=128

Ping statistics for 192.168.2.128:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms
```

Figure 4.2.3

Step 4: Configure master's EoE setting.

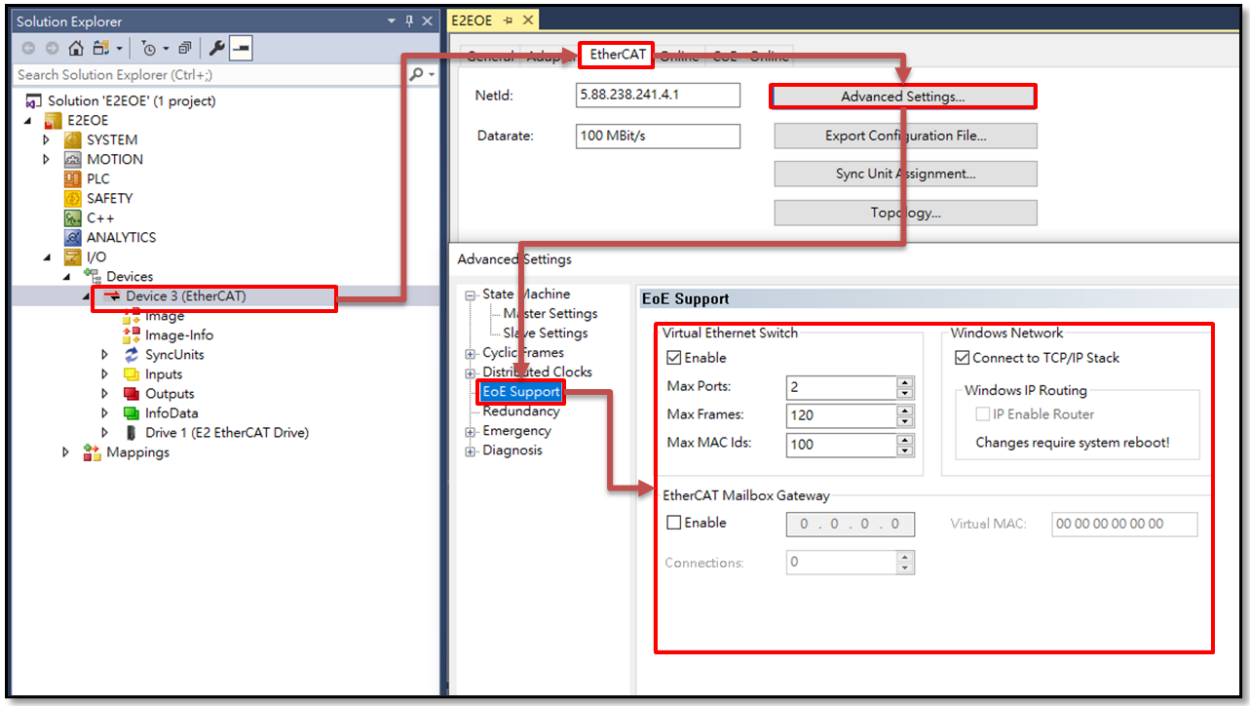

Figure 4.2.4

Step 5: Configure slave's EoE setting.

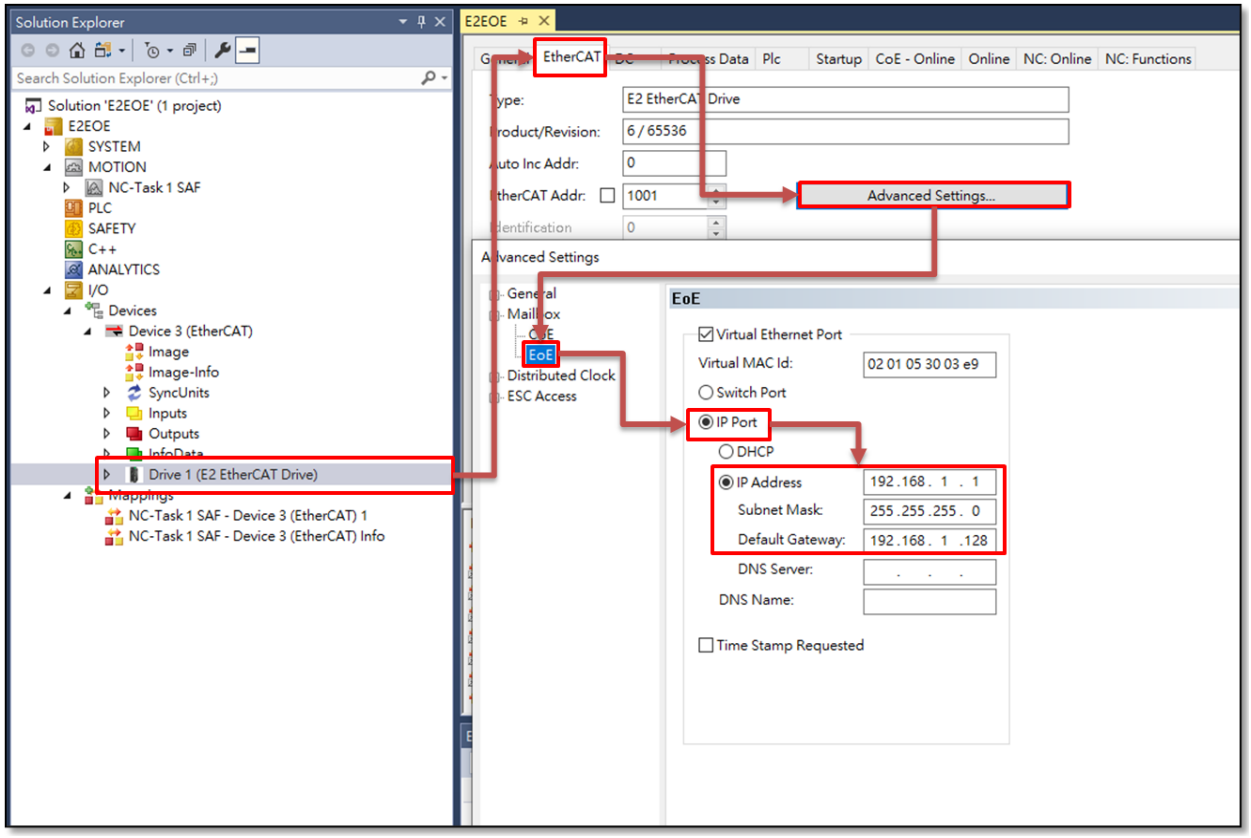

Figure 4.2.5

Step 6: Activate the settings and ensure EtherCAT has entered **PreOp**, **SafeOp** or **Op**.

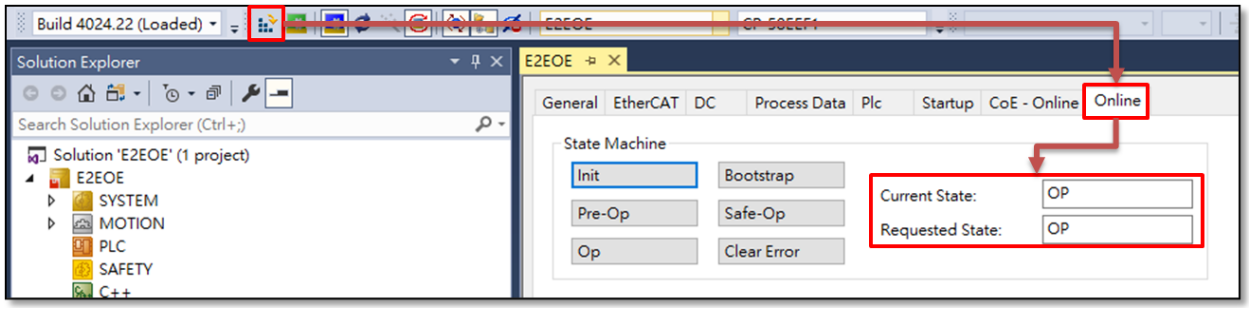

Figure 4.2.6