

# **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.

#### MD43UE01-2312\_V1.0



Release DateVersionApplicable ProductRevision ContentsDec. 15th, 20231.0E series EtherCAT<br/>servo driveFirst 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  $\rightarrow$  Download  $\rightarrow$  Manual Overview for details (<u>https://www.hiwinmikro.tw/Downloads/ManualOverview\_EN.htm</u>).

## 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		
Ethemet	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.		
	Ethernet over EtherCAT, a technology extended by EtherCAT, can transmit		
EoE	Ethernet packets under the architecture of EtherCAT network without affecting		
	the data exchange within EtherCAT network.		
	EtherCAT Slave Information is a file describing the characteristics of the slave;		
	its content is defined by ETG.2000.		
	Electrically-Erasable Programmable Read-Only Memory is a read-only memory		
	that can be electronically rewritten multiple times.		
ID address	A string of numbers used in Internet Protocol to transmit identifications or receive		
IF address	datagrams.		
	The states of 'Pre-Operational', 'Safe-Operational' and 'Operational' in EtherCAT		
PreOp, SafeOp, Op	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

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

Table 1.1.1 Specifications of E1 series servo drive supporting EoE

#### 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
EStversion	HIWIN_MIKROSYSTEM_ED2F_20231212.xml
ESTVEISION	(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.

EtherCAT Configura	ation Tool for Hiwin	×
Setup Help		
⊿ Master	Choose Network Device	
<ul> <li>Slave1</li> <li>Slave2</li> </ul>	Network device:	
	Realtek PCIe GBE Family Controller	Scan
	<ul> <li>Intel(R) Ethernet Connection (14) I219-V</li> </ul>	
<b>HIWIN</b> <sub>®</sub>		

Figure 1.2.2.1

Environment configuration

#### **1.2.3 Check the equipment's EEPROM**

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

**** EtherCAT Configur	ration Tool for Hiwin			×
Setup Help				
▲ Master	Read EEPROM From	Slave		
Slave1	Local file path :			Browse
	Eeprom from drive		Eeprom from local	Clear
	Name	Value	Name	Value
	Slave	1		
	PDI Control	0E08		
	PDI Config	6600		
	Config Alias	0000		
	Checksum	0095		
	Vendor ID	0000AAAA		
	Product Code	0000006		
	Revision Number	00010001		
	Serial Number	0000000		
TTTTTTT	r			
HIWIN	0			
Select Slave 1				

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.

	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

Table 1.2.3.1 Corresponding table for Product Code and Revision Number

#### 1.2.4 Burn EEPROM

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

EtherCAT Configuration To	ol for Hiwin	×
Choose network device	rk Device	
Write EEPROM to slave	e	
Write Alias to slave	Cle GBE Family Controller	Scan
0	Intel(R) Ethernet Connection (14) I219-V	ocum
HIWIN.		

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

Figure 1.2.4.1

 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.

						_
	EtherCAT Configura	ration Tool for Hiwin			>	:
	Setup Help					
	4	Write EEPROM To Slave				
	Slave2	Binary file path				
					Browse	
		Binary file from local				
Select .bin file				×	Wite	
$\leftarrow$ $\rightarrow$ $\checkmark$ $\uparrow$ $\blacksquare$ « winkmi	> EtherCAT Configuration Tool for HIWIN	↓ > Bin Library ~ ひ	Search Bin Library	م		
Organize 👻 New folder			8==	• 🔳 🕜		
This PC	Name	Date modified	Туре	Size		
3D Objects	EEPROM_ED1F(Version_2.8.18_or_be	elow) 12/12/2023 6:18 PM	BIN File	2 KB		
Desktop	EEPROM_ED1F(Version_2.10.6_or_ab	oove) 12/12/2023 6:18 PM	BIN File	2 KB		
😫 Documents	EEPROM_ED2F(Version_3.9.20_or_bel	elow) 12/12/2023 6:18 PM	BIN File	2 KB		
🕹 Downloads	EEPROM_ED2F(Version_3.10.6_or_ab	bove) 12/12/2023 6:18 PM	BIN File	2 KB		
Music						
Pictures						
Videos						
🖆 OS (C:) 🗸						-
File name:	1		(*.bin)	~		
	U		0.000	Canad		
			Open			

Figure 1.2.4.2

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	Product Code	Revision Number	Applicable Firmware Version	
EEPROM_ED1F	0×00005	0×10000	All versions	
(Version_2.8.18_or_below)	0x00005	0810000	EoE function)	
EEPROM_ED2F	0x00006	0×10000	All versions	
(Version_3.9.20_or_below)	0x00000	0810000	EoE function)	
EEPROM_ED1F	0x00005	0v10001	2.10.6 or above	
(Version_2.10.6_or_above)	0x00005	0010001	2.10.0 01 above	
EEPROM_ED2F	0x00006	0×10001	2.10.6 ar above	
(Version_3.10.6_or_above)	0x00000	0010001	5.10.0 OF above	

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

EtherCAT Configurat	tion Tool for Hiwin	×
Setup Help		
▲ Master	Write EEPROM To Slave	
Slave1	Binary file path	
	C:\Thunder\dce\toolswin\winkmi\EtherCAT Configuration Tool for Hiwin\Bin Librar Brow	wse
	Binary file from local	
	08 0E 00 66 E8 03 00 00 00 00 00 00 00 00 95 00 AA AA 00 00 06 00 A	ite
	00 00 00 00 00 00 00 00 00 00 00 00 00	
	00 00 00 00 00 00 00 00 00 00 00 00 00	
	00 00 00 00 00 00 00 00 00 00 00 00 00	
	72 76 6F 44 72 69 76 65 0C 53 65 72 76 6F 20 44 72 69 76 65 0A 53 65	
	44 43 2D 53 79 6E 63 30 08 46 72 65 65 20 52 75 6E 07 54 78 50 44 4F 20 31 0A 45 72 72 6F 72 20 63 6F 64 65 0A 53 74 61 74 75 73 77	1
	6F 72 64 19 4D 6F 64 65 20 6F 66 20 6F 70 65 72 61 74 69 6F 6E 20	
	6C 20 76 61 6C 75 65 12 54 6F 75 63 68 20 50 72 6F 62 65 20 73 74	
	61 74 75 73 18 54 6F 75 63 68 20 50 72 6F 62 65 20 31 20 70 6F 73	
HIWIN <sub>®</sub>	09 14 09 10 03 20 03 04 01 03 1C 40 0F 0C 0C 0F 11 09 0E 01 20 05	
Select Slave 1	Su	ccess



EEPROM burner only supports the burning of HIWIN series. Do not perform the related operations on other servo drives.
 Important
 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





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





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.

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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**  $\rightarrow$  **Network and Internet**  $\rightarrow$  **Network and Sharing Center**.

Network and Sharing Center		X
← → ~ ↑ 💆 > Control Panel > Netwo	k and Internet > Network and Sharing Center	م ٽ v
Control Panel Home View yo	ur basic network information and set up co	nnections
View your Change adapter settings	active networks	
Change advanced sharing hiwing	nikro.com.tw Access	type: Internet
Media streaming options	Connec	tons U Ethernet
💚 Etherret Status	Ethernet Properties	Internet Protocol Version 4 (TCP/IPv4) Properties
General	Networking Sharing	General
Connect on IPv4 connectivity: IPv6 connectivity: No netw	Connect using: II TN9710P 10GBase-T/NBASE-T Ethemet Adapte	You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Media State: Duration: 2 day	E This connection uses the following items:	figur Ohtain an IP address automatically
Spee :	1 Client for Microsoft Networks	IP address: 192 . 168 . 2 . 129
De tais	QoS Packet Scheduler     Internet Protocol Version 4 (TCP/IPv4)	Subnet mask: 255 , 255 , 255 , 0 Default gateway:
Activity	Alicrosoft Retrieve Adapter Multipletor Protocol	Obtain DNS server address automatically  OUse the following DNS server addresses:
Byte:: 517,547,835   5,87	Install Uninstall Pro	Perferred DNS server:
Properties Disuble Diagnose	Transmission Control Protocol/Internet Protocol. The wide area network protocol that provides communical across diverse interconnected networks.	defai tion Validate settings upon exit Advanced
	ОК	C OK Cancel

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.

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

#### Example 1

	Ethernet 192.168.2.X Billion	AT I.X
Port A	Port B	Port C
IP address: 192.168.2.129	IP address: 192.168.2.128	IP address: 192.168.1.128
Subnet mask: 255.255.255.0	Subnet mask: 255.255.255.0	Subnet mask: 255.255.255.0

#### Example 2

	Ethernet 192.168.2.X	EtherCAT 192.168.1.X
Port A	Port B	Port C
IP address: 192.168.2.129	IP address: 192.168.2.128	IP address: 192.168.1.128
Subnet mask: 255.255.255.0	Subnet mask: 255.255.255.0	Subnet mask: 255.255.255.0

#### Example 3



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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

ImportantThe actual operations for network setting may be different. Please contact the systemReminderadministrator for detailed setup.

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#### 2.2.2 Thunder connection

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





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

🔁 Thunder (Test)	- 0	$\times$
Drive type :	Fieldbus	
Config. interface :	Network(Ethernet over EtherCAT)	
IP address :	Off-line(View only) USB Network(mega-ulink)	
	Network(Ethernet over EtherCAT)	Ping
Disconnect	Connect	Þ

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.

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Figure 2.2.2.4

5. Click Connect.

🧭 Thunder (Test)	- 0	×
Drive type:	Fieldbus	
Config. interface :	Network(Ethernet over EtherCAT)	
IP address :	192 . 168 . 1 . 2	
	ОК	Ping
Disconnect	Connect	Þ

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:

Sup	ported Function	Corresponding Chapter
	Edit parameters	section 4.4.2
	Save / Load parameters file	section 4.4.3
	Save to drive	section 4.4.4
Drive configuration	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
Test full function	Homing operation	section 5.3
	Auto tune	section 6.2
Tuning	Tuneless	section 6.3
	Spectrum analyzer	section 6.4
	Monitor drive's status	section 7.3
Monitoring	Scope	section 7.5
	Real-time data collection	section 7.6
Troubloohacting	Real-time monitoring	section 8.2
	Error log	section 8.3
Advanced functions	Absolute encoder initialization	section 9.3
	Gantry control	section 9.7

Table 3.1.1

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.

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

File Tools Settings	Access Help
HIWIN HI	Thunder Controller ED2F-EU-003-1-C-00 3.10.3
──Typ. ──Pwr.	EtherCAT 110V / 220V, 3A

Figure 3.2.1

Table	3	.2.2

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

ImportantDo not perform master switching at "Servo ready" state. Disable the motor first, andReminderthen perform master switching.

Table	3.2.1
-------	-------

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Appendix

# 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:

Ethernet

192.168.2.X

**EtherCAT** 

192.168.1.X

192.168.2.129

Step 1: Complete network configuration.

Step 2: Complete EtherCAT connection and scan the equipment.

192.168.2.129

Build 4024.22 (Loaded)	💌 🕫 🞼 🛄	2 🏹 🙆 🍋 🛣	E2EOE •	CP-58EEF1
Solution Explorer	@ <b>/ / _</b>	¥ ∓ × • م		
Solution 'E2EOE' (1 p)         ■ E2EOE         ▶ ▲ SYSTEM         ▶ ▲ MOTION         ■ PLC         SAFETY         ▶ C++         ▲ ANALYTICS         ▲ Z/O	iroject)			
Devices Mappings	Add New Add Exist Add New Export E/	v Item Ins ting Item Shift+Alt+ v Folder AP Config File	·A	
	Scan C Paste Paste wit	Ctrl+V h Links	<del>&lt;</del>	

192.168.2.129

Figure 4.2.1

Figure 4.2.2

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Appendix

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



Figure 4.2.4

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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