

# EtherNet/IP Debugging Manual of ER Series Industrial Robot

**RCS2** V1.04

ESTUN Automation Co., Ltd. ESTUN Robotics Engineering Co., Ltd.

- This document is ISO compliant and will be updated in line with changes to the IPD system-

S/N	Version	<b>Revision Date</b>	Content	Reviser
1	V1.00	2021.06.24	Create a new document	Zang Xiujuan
2	V1.01	2021.07.28	Add the content of "Section 2.2 Function configuration"	Zang Xiujuan
3	V1.02	2022.02.10	Modify the content of "Section 2.2 Function configuration"	Zang Xiujuan
4	V1.03	2022.07.15	Add Demo_EIP_Heartbeat function block for communication verification; add the descriptions for "Chapter 4 Configuration of EIP Communication Data Size Modification"	Han Zicong
5	V1.04	2022.10.27	Modify the "Section 2.2.2 Teach pendant configuration"	Zang Xiujuan

### **Revision History**



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## Preface

This manual is applicable to the RCS2 control system version V1.29.00 and above, and it provides a guide for debugging the EtherNet/IP functionality of ESTUN ER Series Robots.

#### **Target Audience**

This manual is intended for technical support personnel specifically working with ESTUN Robotics.

#### Precautions

- During the installation and debugging of these components, operators must strictly follow the instructions and explanations provided in this document.
- Relevant responsible personnel must ensure that the application or use of the mentioned products fulfils all safety requirements, including applicable laws, regulations, guidelines, and standards.
- While this document has been carefully prepared, the products described herein are subject to continuous updates and advancements. We may not always verify that the performance data, standards, or other characteristics described herein are consistent with the physical products after each update.
- Technical or editorial errors may occur in this document. We reserve the right to modify the document information without prior notice. If the data, diagrams and text descriptions in this document have not been modified for a product that has been changed, we will not make any specific statement to this effect.
- No modifications to the hardware or software configuration other than those specified in the text file are permitted, and ESTUN shall not be liable for any consequences resulting therefrom.
- The unit of measurement in the illustrations is in millimeters (mm) unless otherwise stated.

#### **Safety Instructions**

Warning	Injury Failure to comply with the safety instructions associated with this symbol may jeopardize personal life and health safety.				
Caution	Danger to Environment and Equipment Failure to comply with the safety instructions associated with this symbol may pose significant risks to the environment and equipment safety.				
<b>1</b> Note	Notes or Tips This symbol indicates that the information is provided to help you better understand the Safety Instructions.				

## **Chapter 1 Function Overview**

The EtherNet/IP interface refers to a communication method in which an external logic controller (such as a PLC acts as an EtherNet/IP Scanner) and communicates with a robot (acting as an EtherNet/IP Adapter) using the standard EtherNet/IP protocol.

## **Chapter 2 Protocol Introduction**

EtherNet/IP (Ethernet Industrial Protocol) is a protocol system designed for industrial applications. It is the latest addition introduced by two major industrial organizations, ODVA (OpenDeviceNet Vendors Association) and CI (ControlNet International). Similar to DeviceNet and ControlNet, EtherNet/IP is a network based on the Control and Information Protocol (CIP), utilizing the same object library and adhering to consistent industry specifications, ensuring good consistency and interoperability.

EtherNet/IP is an object-oriented protocol that ensures the effective transmission of both implicit realtime I/O information and explicit information (including configuration parameter settings, diagnostics, etc.) on the network. It utilizes standard Ethernet and TCP/IP technologies to transport CIP communication packets. By combining the widely used Ethernet and TCP/IP protocols with the universal and open application layer protocol CIP, the architecture of the EtherNet/IP protocol is formed. The layers of the protocol structure are as follows:



EtherNet/IP Protocol OSI Model

#### 2.1 Main indicators

- 1. The robot has EtherNet/IP Adapter functionality, supporting a maximum of 256 bytes for implicit data input/output, and the communication data size can be adjusted.
- 2. In the Multiprog programming environment, users can access the data area through the provided interface and parse the data for command/status interaction.
- 3. The communication cycle is set by the EtherNet/IP Scanner.
- 4. The device's EDS file is provided by the manufacturer.

#### 2.2 Function configuration



Currently, there are two versions of the EtherNet/IP module functionality in the system: trial version and standard version. By default, the EtherNet/IP functionality is not enabled in the standard robot products upon factory delivery.

Before using the EtherNet/IP functionality on-site, users need to activate it. The system supports two activation methods:

- 1. Configuration in the PLC project
- 2. Configuration on the teach pendant

#### 2.2.1 PLC configuration

Support is provided in the Multiprog template project to enable the trial version or directly register as the standard version by calling the function blocks. The detailed instructions are as follows:

1. Trial Version

In the Multiprog project, the EtherNet/IP trial version can be enabled by using the ER\_EIP\_SetTrialRunMode function block. The trial period is 30 days (counting from the first call to this function block), and the EtherNet/IP functionality will be automatically disabled after the trial period expires.

Example program to enable the trial version:



Note: In the above diagram, TrialDaysRemain indicates the remaining trial days available for use (unit: days).

#### 2. Standard Version

The standard version has no time limit. In the Multiprog project, you can register as the standard version by following these steps:

- 1) Use the ER\_EIP\_GetProductCode function block to obtain the product serial number and send it to the manufacturer. The manufacturer will provide the corresponding product license code.
- Use the ER\_EIP\_SetLicenseCode function block to register the obtained product license code into the EtherNet/IP module. After successful registration, restart the controller for the changes to take effect.

Note: The product license code needs to be registered only once. Registering it multiple times may cause the license code to become invalid.



Example program to register the standard version:



Note: The assignment of the activation code DINT#11 in the diagram is for demonstration purposes only. Please use the actual activation code in practice.

#### 2.2.2 Teach pendant configuration

Support is available to enable the trial version or directly register it as a standard version on the teach pendant.

		24	0
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	EtherNet/IP激活	Å1	$\overline{}$
A D	<b>说明:</b> 试用版:启用试用版后,支持标准的ItherNet/IF接口,但只有一个月的使用时间,且只能试用一次。 标准版:注册标准版后,支持标准的ItherNet/IP接口,无使用期限的限制。	A2	•+
<b>(x)</b>		АЗ	-+
	标准版	A4	-+
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	ESTUN         南京埃斯顿机器人工程有限公司           ROBOTICS         ESTUN ROBOTICS CO., LTD	A6	
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#### 1. Trial Version

Under the Admin permission of teach pendant, access the software licensing in advanced settings. Click on the trial version to enter the trial version interface. After clicking the activate button, the interface will display the remaining trial days. The trial period is 30 days (counting from the first established communication), and the EtherNet/IP functionality will be automatically disabled after the trial period expires.





#### 2. Standard Version

To register as the standard version on the teach pendant, follow these steps:

 Under the Admin permission, access the software licensing in advanced settings. Click on the standard version to enter the Standard Version interface. Click the "Get" button on the interface to get the product serial number. Send this serial number to the manufacturer to obtain the corresponding product license code (matching the product serial number). (If the activation status is already activated when entering the interface, this activation configuration process is not necessary)

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2) Enter the obtained product license code into the activation code editing box on the teach pendant. Click the Activate button. If the entered product license code is correct, a successful activation message will be displayed, and the activation status will be activated. If the entered product license code is incorrect, a successful activation message will be displayed, and the activation status will be deactivated.





## **Chapter 3 Instructions for Debugging**

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In this section, the hardware Omron PLC PA202, CJ2M CPU31 is used as an example of an EtherNet/IP Scanner to illustrate how to use the EtherNet/IP interface to interact with the robot.

#### **3.1 EtherNet/IP Scanner**

1. Install the software corresponding to the Omron PLC. After successful installation, the files should be displayed as shown in the following image:

OMRON				
	Communications Middleware			
	CX-One			
	CX-Server			

2. Connect the computer with the installed software to the Omron PLC hardware using a USB cable, and then configure the EtherNet/IP settings through the software.

1) Open the Omron Network Configurator software for EtherNet/IP configuration. Install the EDS file for the EtherNet/IP Adapter. Drag the device from the left side to the right side of the EtherNet/IP network and modify the corresponding IP address (set the IP address of the EtherNet/IP Adapter according to the actual device). For example, refer to the following image:



2) Click on "Connect" under the "Network" section to connect to the hardware device. The status in the status bar will show "Online". The process is as follows:





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Ready L:	EtherNet/IP T:EtherNet/IP OMR0:TOOLBUS CJ2-CPUxc 115200 Bit/s @ On-line NUM

3) Double-click on the CJ2M device to configure the relevant parameters on the Omron PLC side. In this example, choose address D0 in the Omron PLC memory area as the starting address with a size of 256 bytes for inputs, which will receive output data from the robot controller. Choose address D300 as the starting address with a size of 256 bytes for outputs, which will be inputs on the robot controller side.

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4) Double-click on the Omron PLC icon to register the device you want to connect, which in this case is the robot controller.

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Click on "NEW" to create a mapping relationship. In the example, map D00000 to the Input\_100 output port provided by the controller (named "Input" because the external PLC treats this interface as an input), and map D00300 to the Output\_150 output port provided by the controller. The input and output ports are defined in the controller's EDS file.



Configurator		
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5) Download the relevant configuration to the PLC device by clicking on "Download" in the figure to complete the network configuration. (If the EtherNet/IP function is not enabled on the controller side, an alarm will appear, and communication cannot be established.)

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Download Configu	ration to Network L:E	therNet/IP T	EtherNet/IP OMR0:TOOLBUS CJ2-CPUxx: 115200 Bit/s: 🔮 On-line NUM

3. Connect the computer with the installed software to the Omron PLC hardware using a USB cable and perform data exchange through the software.

1) Open the Omron PLC programming software CX-Programmer and upload the actual connected PLC program to the programming software. For example, refer to the following image:





Define EipInput and EipOutput as inputs and outputs, and set their starting addresses as D0 and D300, respectively. Establish the mapping relationship. (Note: This Omron PLC device uses a two-byte addressing, and the data type of array elements is selected as UINT, which occupies two bytes. 2 bytes  $\times$ 

128 = 256 bytes.)

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	X	名称	数据类型	地址 / 值	网络变量	机架位置	使用	注释	
	□	- EipInput	UINT[128]	D0			工作		
	□ 〒 新PLC1[CJ2M] 运行模式	- EipOutput	UINT[128]	D300			工作		
		• P_0_01s	BOOL	CF105			工作	0.01秒时钟脉冲位	
	- <mark></mark>	• P_0_02s	BOOL	CF103			工作	0.02秒时钟脉》中位	
		* P_0_1ms	BOOL	CF107			工作	0.1 室秒时钟脉冲位	
	- 🐻 设置	* P_0_1s	BOOL	CF100			工作	0.1秒时钟脉冲位	
		* P_0_2s	BOOL	CF101			工作	0.2秒时钟脉\冲位	

2) In the program editing interface, there is only one statement assigning a value to EipOutput[0], which is not actually used (the programming interface cannot be empty). EipOutput serves as the output interface of the Omron PLC. Users can use this interface to communicate with the robot controller based on their actual requirements. After the previous network configuration, communication has been successfully established.

⑦ 文件(E) 編輯(E) 视图(V) 插入(I) PLC 編程(P) 模拟(S) 工具(T) 窗口(W) 帮助(H)	
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3) Open the monitoring window and copy EipInput to the monitoring window. You can see that the data in the EipInput array is constantly changing. Since it uses a two-byte addressing, the range of variation is

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from 0x0000 to 0xFFFF. If you observe the low 8 bits and high 8 bits of a specific data, you will notice that they change in the same way, cyclically accumulating. This behavior aligns with the logic on the controller side, indicating that communication is functioning properly.



#### 3.2 EtherNet/IP Adapter

Perform the following operations under the condition that the robot control system has started normally:

1. Open the Multiprog project and configure the EtherNet/IP functionality (refer to section 2.2 for functional configuration). After enabling the EtherNet/IP functionality, proceed with the following steps.

2. Open the Multiprog project and locate the EtherNet/IP data area (the data type of this area can be defined by the user). Users can write their own code to implement the desired functionality in the User Control Task or create a new Task.



Confirmation : oftp		名称	地址	类型	用法	描述
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🖻 🍘 Tasks		B SHM				
- 🗊 UTask : CYCLIC		slOshmManage	%MB3.12000000	ER_IO_SHM_MANAGE	VAR_GLOBAL	
ER_UserControl : ER_UserControl		EipDataShm	%MB3.13050000	ERC_EIP_DATASHM	VAR_GLOBAL	
- PLCTask : CYCLIC		PDO_SHM	%MB3 1000000	PDO_SHM_TYPE	VAR GLOBAI	_
Global Variabley		EipInput	%MB3.13010000	ERC_EIP_ARRAY	VAR_GLOBAL	
II IO Configuration	П	EipOutput	%MB3.13030000	ERC_EIP_ARRAY	VAR_GLOBAL	
<u> </u>		E System Variables				
		PLC_SYS_TICK_CNT	%MD1.0	UDINT	VAR_GLOBAL	
		PLC_TASK_DEFINED	%MW1.4	INT	VAR_GLOBAL	
		PLCMODE_ON	%MX1.2016.0	BOOL	VAR GLOBAL	TRUE
		PLCMODE_LOADING	%MX1.2017.0	BOOL	VAR_GLOBAL	TRUE
		PLCMODE STOP	%MX1.6.0	BOOL	VAR GLOBAL	TRUE
		PLCMODE RUN	%MX1.7.0	BOOL	VAR GLOBAL	TRUE
		PLCMODE_HALT	%MX1.8.0	BOOL	VAR GLOBAL	TRUE
		PLC TICKS PER SEC	%MW1.2000	UINT	VAR GLOBAL	
		PLC MAX ERRORS	%MD1.2004	UDINT	VAR GLOBAL	
		PLC ERRORS	%MD1.2008	UDINT	VAR GLOBAL	
		PLC TASK AVAILABLE	%MW1.2012	INT	VAR GLOBAL	
		PLC SYSTASK AVAILABLE	%MW1.2016	INT	VAR GLOBAL	
		PLCDEBUG FORCE	%MX1 2018 0	BOOL	VAR GLOBAL	TRUE
		PLODEBUG BESET	%MX1 2019 0	BOOL	VAR GLOBAL	TRUE
	1				1	•

In this example, the ERC\_EIP\_ARRAY is an array of BYTE type with a size of 256 bytes (this data type can be defined by the user, and the data definitions are in ER\_UserDataType), as shown in the figure:



The main logic of Demo\_EIP\_HeartBeat is as follows:

Ⅲ 文件(E) 编辑(E) 视图(V) 工程(P) 建立	(B) 对象(Q) 布局(L) 联切(N) 附加(X) 窗口(W) 2	
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■  空里   值   EipInput   ???		• 7



Demo\_ER\_EIP and Demo\_EIP\_HeartBeat are called by default in ER\_UserControl. After establishing communication, users can customize the logic and use EipInput and EipOutput to send and receive data.

□ 文件(E) 編編(E) 视图(V) 工程(P) 建式	立(B) 对象(O) 布局(L) 目	兆机(№) 附加(※) 窗口(№) 2			
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3. After compiling and debugging the project, download it to the controller. You will see that the output data cyclically accumulates and changes (the figure below shows the monitoring effect on the Multiprog side). If communication with an external PLC is successfully established at this point, the corresponding ports will also show changes.

HP	MULTIPROG Express - ERC10 -	[代码:Demo_EIP_HeartBeat - Config	uration.Resource.UTask.ER_UserControl.Demo_EIP_HeartBeat_1.代码]
	文件(E) 编辑(E) 视图(V) 工程(P)	)建立(B)对象(Q)布局(L)联机(N	Mtha(X) @□(W) 2
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		1 2 3 6 6 7 7 7 8 9 9 0 10 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	<ul> <li>*1. 在工作单位仅用于漂示ER_EtherNetTP通信效果,未在任何程序中调用。)</li> <li>*3. 通信建立后,外部PLC端的EipInput输入变量会循环常加。)</li> <li>*3. 通信建立后,外部PLC端的EipInput输入变量会循环常加。)</li> <li>*4. 通信建立后,外部PLC端的EipInput输入变量会循环常加。)</li> <li>*4. 用品物发挥加。)</li> <li>*1. HTA:=BUTCH:=FONL:=CONS:=C</li></ul>
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	∰ EipInput [1] [2]	IE         ###]           ERC_EIP_AREA         16#99           BYTE         16#99           BYTE         16#99	天例 T Configuration. Resource. UTask ER, Use Configuration. Resource. UTask ER, Use Configuration. Resource. UTask ER, Use 日本設備特型数据所需的存储空间: 75806字节 資本設備用程序映像所屬的存储空间: 75806字节 資本設備用程序映像所屬的存储空间: 25806字节
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# **Chapter 4 Configuration of EIP Communication Data Size**

Taking into account actual working conditions, it is not necessary to transmit 256 bytes of data when using EtherNet/IP communication. The EtherNet/IP functionality supports the modification of communication byte size.

In this section, we will continue to use the Omron PLC PA202, CJ2M CPU31 as an example of an EtherNet/IP Scanner. The following are the steps to modify the communication byte size of EtherNet/IP.

#### 4.1 Modifying the EipCfg.ini configuration file

Modify the EipCfg.ini configuration file located in runtime -> rtk -> EipAdapter.

Open the EipCfg.ini configuration file as shown in the figure below. The parameters ConfigInSize and ConfigOutSize under the [Config] section represent the input and output byte sizes (here, "In" and "Out" refer to the direction from the external PLC).



Taking the example of modifying it to 8 bytes (the byte size can be any integer value between 1 and 256), change the assigned values of the two parameters in the above figure to 8. For example, ConfigInSize=8 and ConfigOutSize=8. Save the document and restart the controller.

#### 4.2 Modifying EDS files

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When configuring EtherNet/IP communication on certain PLCs, it may be necessary to load the EDS files of external devices and reconfigure the network (as described in section 3.1). The runtime package provides the EDS file for the robot controller, located in runtime -> rtk -> EipAdapter, with the file name ER\_Adapter.eds.

After modifying the parameters in the EipCfg.ini configuration file, the ER\_Adapter.eds file also needs to be modified accordingly. You can open the EDS file using a text editor, as shown in the figure below.



Locate the section [Assembly] and make the corresponding modifications in the EipCfg.ini file. Similarly, change it to 8 bytes. Change the value from 256 to 8, as shown in the diagram. There are two places that need to be modified: Assem100 and Assem150, which correspond to the input and output of the external PLC and the input and output of the robot controller, respectively.

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,,,, \$ mult, div, base, offset links ; \$ decimal places	Ξ
<pre>[Assembly] Object_Name = "Assembly Object"; Object_Class_Code = 0x04; Number_Of_Static_Instances = 6; Assem100 = "Input Assembly",</pre>	
256, 0x0000, ,, , , , , , , , , , , , , , ,	
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After modifying the EDS file, reload it. During network configuration, you will see that the corresponding interfaces have also changed. Additionally, you need to modify the byte size mapped by the external PLC; otherwise, an error may occur. In the figure, it is modified to 8 bytes.

Once the modifications are completed, you can download the changes to the PLC (as described in section 3.1).

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	It will add a connection configuration to originator device. Please configure the Tag Set each of originator device and target
C EtherNet/IP_1     EtherNet/IP_1     IT2:31.6.1 172:31.6.6     CU2M-EIP21 ESTUN Ethe     J	Connection I/O Type Exlusive Owner  Originator Device Node Address 172.31.6.1 Comment : CJ2M-EIP21 Input Tag Set D000000 - [8Byte] Connection Type : Multi-cast connection Unput Tag Set Input Tag Set
	If rag Sets         D00300 - [6Byte]         Connection         Type :         Detail         Detail Farameter         Packet Interval         50.0         ms (10.0 - 10000.0)         Timeout Value :         Packet Interval (RFI) x 4
Usage of Device Bandwidth Detail cription 1.31.6.1 CJZM-EIP21 : The configuration	Connection Structure
.work download was completed. Tify of network structure was completed .work download was completed.	Regist Close

(Note: Some PLCs may not require loading the controller's EDS file. In such cases, modifying the configuration parameters in the EipCfg.ini file is sufficient.)