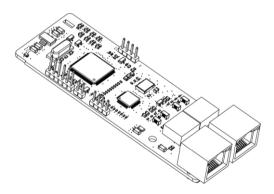


Operation Manual

Ethernet Communication Card



SHENZHEN INVT ELECTRIC CO., LTD.

No.	Change description	Version	Release date
1	First release	V1.0	October 2020
2	Updated EtherCAT communication card related content.	V1.1	March 2023
3	Updated Table 4-1 Supported synchronization cycle and Table 4-3 State indicator functions. Updated section 4.5.2 Device running mode. Updated Appendix A EtherCAT object dictionary and Appendix B Related function codes.	V1.2	October 2023



Safety precautions

The extension card can be installed and operated only by people who have taken part in professional training on electrical operation and safety knowledge, obtained the certification, and been familiar with all steps and requirements for installing, performing commissioning on, operating, and maintaining the device, and are capable of preventing all kinds of emergencies.

Before installing, removing, or operating the communication card, read the safety precautions described in this manual and the variable-frequency drive (VFD) operation manual carefully to ensure safe operation.

For any physical injuries or damage to the device caused due to your neglect of the safety precautions described in this manual and the VFD operation manual, our company shall not be held liable.

- You need to open the housing of the VFD when installing or removing the communication card. Therefore, you must disconnect all power supplies of the VFD and ensure that the voltage inside the VFD is safe. For details, see the description in the VFD operation manual. Severe physical injuries or even death may be caused if you do not follow the instructions.
- Store the communication card in a place that is dustproof and dampproof without electric shocks or mechanical pressure.
- The communication card is electrostatic sensitive. Take measurements to prevent electrostatic discharge when performing operations involving it.
- Tighten the screws up when installing the communication card. Ensure that it is firmly fixed and properly grounded.

Terminology, abbreviations, and acronyms

CAN	Controller Area Network									
СОВ	Communication object, a transmitted unit on a CAN network. Communication objects (COBs) carry data and can be transmitted through the whole network. A COB is part of a CAN message frame.									
EDS	Electronic data sheet (EDS), an ASCII file for node configuration, required when a CANopen network is configured. An EDS file contains general information about nodes and their dictionary objects (parameters).									
NMT	Network management, one of the CAN application-layer service elements in the CAN reference model. It is used for the initialization, configuration, and fault handling of a CAN network.									
Object dictionary	Stores information about all COBs identified by a device.									
PDO	Process data object, a type of COBs, used to transmit process data, such as control command, set values, status values, and actual values.									
PDOn Tx	PDO command transmitted by a slave station to the master station, where n refers to 1, 2, 3, 4.									
PDOn Rx	PDO command transmitted by the master station and received by a slave station, where n refers to 1, 2, 3, 4.									
SDO	Service data object, a type of COB, used to transmit non-time key data, such as parameter values.									
RO	Indicates read-only access.									
RW	Indicates the read and write access.									
SYNC	Indicates synchronous transmission.									
Node-ID	Node ID, that is, address of a communication card.									
0x	Indicates that a number with this prefix is a hexadecimal value, for example, 0x10 indicates the decimal value 16.									

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1 Product confirmation

Check the following after receiving a communication extension card product:

- Whether the communication card is damaged.
- Whether the received communication card is the one you purchase according to the bar code label on the PCB.
- Whether all the following items are contained in the product package:
- One communication card, one tie wrap, one tie, one M3 screw, and one manual
- If the communication card is damaged, a wrong model is delivered, or some items are missing, contact the supplier in a timely manner.
- Obtain the EDS or XML file of the communication card from INVT. The EDS file is named in the format of communication card model.eds.
- Confirm the environmental requirements for application.

Item	Requirement				
Operation temperature	-10-+50°C				
Storage temperature	-20-+60°C				
Relative humidity	5%–95%				
Other weather	No condensation, ice, rain, snow, or hail;				
conditions	solar radiation < 700 W/m ²				
Air pressure	70–106 kPa				
Vibration and impact	5.8m/s ² (0.6g) at the sine vibration of 9 Hz to 200 Hz				

Table 1-1 Environmental requirements

2 PROFINET communication card

2.1 Overview

- Thanks for choosing INVT PROFINET communication cards. This manual describes the function specifications, installation, basic operation and settings, and information about the network protocol. To ensure that you install and operate the product properly, read this manual and the communication protocol section in the VFD operation manual carefully before you use the product.
- This manual only describes how to operate the PROFINET communication card and the related commands but does not provide details about the PROFINET protocol. For more information about the PROFINET protocol, read the related specialized articles or books.
- This communication card is defined as a PROFINET slave station communication card and is used on a VFD that supports PROFINET communication.
- The communication card supports the linear network topology and star-shaped network topology.
- The communication card supports 32 inputs/outputs to read and write process data, read state data, and read and write function parameters of a VFD.

2.2 Features

1. Supported functions

- Supports the PROFINET protocol, and supports PROFINET I/O devices
- > Provides two PROFINET I/O ports and supports the 100 M full-duplex operation
- Supports the linear network topology and star-shaped network topology.

2. Supported communication types

Standard Ethernet channels:

Standard Ethernet channels are non real-time communication channels that use the TCP/IP protocol, and are mainly used for device parameterization and configuration and to read diagnosis data.

Real-time (RT) communication channels:

RT channels are optimized channels for real-time communication. They take precedence over TCP (UDP)/IP, which ensures that various stations on a network perform data transmission with high time requirements at a certain interval. The bus period may reach the precision of millisecond. These channels are used to transmit data such as process data and alarm data.

Isochronous real-time (IRT) communication channels

IRT channels are implemented through the built-in Switch-ASIC IRT chip. IRT communication can further shorten the processing time of the communication stack software, synchronizing data transmission of the program and device. The transmission delay is less than 1 ms, and the jitter is less than 1 μ s. The typical application is motion control.

3. Communication ports

Standard RJ45 ports are used in PROFINET communication. The communication card provides two RJ45 ports with no transmission direction defined, and therefore you can insert a cable into the port without regard to its direction. Figure 2-1 shows the ports, and Table 2-1 describes the functions of the ports.



Figure 2-1 Two standard RJ45 ports

Table 2-1	Standard	RJ45	port (oins
-----------	----------	------	--------	------

Pin	Name	Description					
1	TX+	Transmit Data+					
2	TX-	Transmit Data-					
3	RX+	Receive Data+					
4	n/c	Not connected					
5	n/c	Not connected					
6	RX-	Receive Data-					
7	n/c	Not connected					
8	n/c	Not connected					

4. State indicators

PROFINET communication card provides nine LED indicators to indicate its states. Table 2-2 describes the state indicators.

LED	Color	State	Description		
LED1	Green		3.3 V power indicator		
LED2	Red	On	Not connected through a network cable		
(Bus state indicator)		Blinking	Connected to the PROFINET controller		
(Dus state Indicator)			through a network cable, but no		

LED	Color State Description							
			communication established					
		Off	Communication established with the PROFINET controller					
LED3		On	PROFINET diagnosis enabled					
(System fault indicator)	Red	Off	PROFINET diagnosis disabled					
LED4		On	TPS-1 communication stack started					
(Slave ready indicator)	Green	Blinking	TPS-1 waits for the initialization of MCU					
(Slave ready indicator)		Off	TPS-1 communication stack not started					
LED5 (Maintenance state indicator)	Green		Defined by the manufacturer, depending on the characteristics of the device					
LED6/7 (Network port state	Green	On	PROFINET communication card connected to the PC/PLC through a network cable					
indicator)		Off	PROFINET communication card not connected to the PC/PLC					
LED8/9 (Network port		On	PROFINET communication card communicating with the PC/PLC					
communication indicator)	Green	Off	PROFINET communication card not communicating with the PC/PLC					

2.3 Electrical wiring

PROFINET communication card provides standard RJ45 ports and supports the linear and star topologies. Figure 2-2 and Figure 2-3 show the electrical wiring diagrams for different topologies.

Use CAT5, CAT5e, and CAT6 network cables for electrical wiring. When the communication distance is greater than 50 meters, use high-quality network cables that meet the national standards.

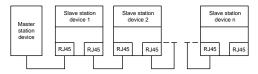


Figure 2-2 Electrical wiring diagram for a linear topology

Note: For the star-shaped network topology, you need to use a PROFINET switch.

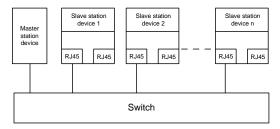


Figure 2-3 Electrical wiring diagram for a star topology

2.4 Communication

2.4.1 Packet format

Table 2-3 describes the structure of an RT frame (non-synchronous).

Data header	Ethe typ		VLAN	Ethern type	-	Frame identifier	RT user data	Period counte		Transmission state	FCS
	2 by	rtes	2 bytes	2 byte	s	2 bytes	36–1440 bytes	2 bytes	1 byte	1 byte	4 bytes
	0x8′	100		0x889	2						
	V	LAN	flag						APDL	J state	
	Data header										
7-byte preamble 1-byte synchronization information					i-by	te source l	MAC addr	ress	6-byte	e destination MA address	C

Table 2-4 describes the structure of the IRT frame (synchronous).

Table 2-4 Structure of an IRT frame

Data header			Ethernet type	VLAN	Ethernet type	Frame identifier	IRT user data	FCS	
7-byte preamble	1-byte synchronization	6-byte source MAC address	6-byte destination MAC address	2 bytes	2 bytes	2 bytes	2 bytes	36–1440 bytes	4 bytes

2.4.2 PROFINET I/O communication

The PROFINET communication card supports 16-word input/output. Figure 2-4 shows the packet format for transmitting data with a VFD.

Parameter identification (PKW)				Fixed -	Pi	rocess d (PZD) Distributa	
PKW1	PKW2	PKW3	PKW4	CW SW	PZD2 PZD2	PZD3 PZD3	 PZD12 PZD12

Figure 2-4 Packet structure

By using the 32 inputs/outputs, you can set the reference parameters of the VFD, monitor the status values, transmit control commands, monitor the running state, and read/write the function parameters of the VFD. For specific operations, see the following description.

Parameter zone:

PKW1—Parameter identification

PKW2—Array index number

PKW3—Parameter value 1

PKW4—Parameter value 2

Process data:

CW—Control word (transmitted from the master to a slave. For description, see Table 2-5 and Table 2-6.)

SW—Status word (transmitted from a slave to the master. For description, see Table 2-8 and Table 2-9.)

PZD—Process data (defined by users)

(When the process data is output by the master to a slave, it is a reference value; and when the process data is input by a slave to the master, it is an actual value.)

PZD zone (process data zone): The PZD zone in a communication packet is designed for controlling and monitoring a VFD. The master and slave stations always process the received PZD with the highest priority. The processing of PZD takes priority over that of PKW, and the master and slave stations always transmit the latest valid data on the interfaces.

CWs and SWs

Using CWs is the basic method of the fieldbus system to control VFDs. A CW is transmitted by the fieldbus master station to a VFD device. In this case, the adapter module functions as a gateway. The VFD device responds to the bit code information of the CW and feeds state information back to the master through an SW.

Reference value: A VFD device may receive control information in multiple channels, including analog and digital input terminals, VFD control panel, and communication modules (such as RS485 and CH-PA01 adapter modules). To enable the control over VFD devices through PROFINET, you need to set the communication module as the controller of the VFD device.

Actual value: An actual value is a 16-bit word that includes information about VFD device operation. The monitoring function is defined through VFD parameters. The conversion scale of an integer transmitted as an actual value from the VFD device to the master depends on the set function. For more description, see the related VFD operation manual.

Note: A VFD device always checks the bytes of a CW and reference value.

Task packet (master station -> VFD)

CW: The first word in a PZD task packet is a VFD CW. You can select the expression method according to P15.43. Table 2-5 and Table 2-6 describe the control words (CWs) of the Goodrive350 series VFD.

Bit	Name	Value	Description
		1	Forward running
		2	Reverse running
		3	Forward jogging
	Communication-based	4	Reverse jogging
0–7	control command	5	Stop
	control command	6	Coast to stop
		7	Fault reset
		8	Jogging to stop
		9	Emergency stop
8	Enable writing	1	Enable reading and writing (PKW1-PKW4)
9–10	Motor group potting	00	Motor 1
9-10	Motor group setting	01	Motor 2
11	Control mode evitabies	1	Enable torque/speed control switching
- 11	Control mode switching	0	Disable switching
12	Reset power consumption	1	Enable
12	to zero	0	Disable

Table 2-5 Goodrive350 series VFD CWs expressed in decimal format

Bit	Name	Value	Description
13 F	Pre-excitation	1	Enable
	Pre-excitation	0	Disable
14	DC braking	1	Enable
14		0	Disable
15	Heartbeat reference	1	Enable
		0	Disable

Table 2-6 Goodrive350 series VFD CWs expressed in binary format

Bit	Name	Description	Priority
0	Forward running	0: Decelerate to stop 1: Forward running	1
1	Reverse running	0: Decelerate to stop 1: Reverse running	2
2	Fault reset	0: Disable 1: Enable	3
3	Coast to stop	0: Disable 1: Enable	4
4	Forward jogging	0: Disable 1: Enable	5
5	Reverse jogging	0: Disable 1: Enable	6
6	Jogging to stop	0: Disable 1: Enable	7
7	/	Reserved	
8	Enable reading and writing (PKW1-PKW4)	0: Disable 1: Enable	
9	/	Reserved	
10	Emergency stop	0: Disable 1: Enable	0: Top priority
11 - 15	/	Reserved	

Reference value (REF): The second to twelfth words in a PZD task packet are the main settings. The main frequency settings are provided by the main setting signal source. Table 2-7 describes the settings of Goodrive350 series VFD.

Table 2-7 Settings of	Goodrive350 series VFD
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Function code	Word	Value range	Default value
P16.32		0: Invalid 1: Set frequency (0–Fmax, unit: 0.01 Hz)	0
P16.33		2: PID reference (-1000–1000, in which 1000 corresponds to 100.0%)	0
P16.34		3: PID feedback (-1000–1000, in which 1000 corresponds to 100.0%)	0

Function code	Word	Value range	Default value			
P16.35	Received PZD5	4: Torque setting (-3000-+3000, in which 1000 corresponds to 100.0% of the rated current of the motor)	0			
P16.36	Received PZD6	5: Setting of the upper limit of forward running frequency (0–Fmax, unit: 0.01 Hz)	0			
P16.37	Received PZD7	6: Setting of the upper limit of reverse running frequency (0–Fmax, unit: 0.01 Hz)	0			
P16.38	Received PZD8	7: Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to 100.0% of the rated current of	0			
P16.39	Received PZD9	the motor) 8: Upper limit of the brake torque (0–3000, in which 1000	0			
P16.40	Received PZD10	corresponds to 100.0% of the rated current of the motor) 9: Virtual input terminal command, 0x000–0x3FF				
P16.41	Received PZD11	(bit9-bit0 correspond to S8/S7/S6/S5/HDIB/HDIA/S4/S3/S2/S1 in sequence)				
P16.42	Received PZD12	 10: Virtual output terminal command, 0x00–0x0F (bit3–bit0 correspond to RO2/RO1/HDO/Y1 in sequence) 11: Voltage setting (for V/F separation) (0–1000, in which 1000 corresponds to 100.0% of the rated voltage of the motor) 12: AO1 output setting 1 (-1000–+1000, in which 1000 corresponds to 100.0%) 13: AO2 output setting 2 (-1000–+1000, in which 1000 corresponds to 100.0%) 14: MSB of position reference (signed number) 15: LSB of position reference (unsigned number) 16: MSB of position feedback (signed number) 17: LSB of position feedback (unsigned number) 18: Position feedback setting flag (position feedback can be set only after this flag is set to 1 and then to 0) 19: Function code mapping (PZD2–PZD12 correspond to P14.49–P14.59 respectively.) 20–31: Reserved 	0			

Response packet (VFD -> master station)

SW: The first word in a PZD response packet is a VFD SW. You can select the expression method according to P15.43.

Table 2-8 and Table 2-9 describe the control words (CWs) of the Goodrive350 series VFD.

Table 2-8 Goodrive350 series VFD SWs expressed in decimal format

Bit	Name	Value	Description
		1	Forward running
		2	Reverse running
0–7	Running state	3	Stopped
		4	Faulty
		5	POFF
8	Due veltere established	1	Ready to run
8	Bus voltage established	0	Not ready to run
0.40	Mater meur faarlikaali	0	Motor 1
9–10	Motor group feedback	1	Motor 2
11		1	Synchronous motor
TT	Motor type feedback	0	Asynchronous motor
12	Overload pre-alarm feedback	1	Overload pre-alarm generated
12	Overload pre-alarm leedback	0	No overload pre-alarm generated
		0	Keypad-based control
13 - 14	Bun/Stop mode	1	Terminal-based control
13 - 14	Run/Stop mode	2	Communication-based control
		3	Reserved
15	Heartbeat feedback	1	Heartbeat feedback
15	Hearibeat feedback	0	No heartbeat feedback

Table 2-9 Goodrive350 series VFD SWs expressed in binary format

Bit	Name	Description	Priority
0	Forward running	0: Disable 1: Enable	1
1	Reverse running	0: Disable 1: Enable	2
2	Stopped	0: Disable 1: Enable	3
3	Fault	0: Disable 1: Enable	4
4	POFF	0: Disable 1: Enable	5
5	Pre-excited	0: Disable 1: Enable	6
6–15	/	Reserved	

Actual value (ACT): The second to twelfth words in a PZD task packet are the main actual values. The main actual frequency values are provided by the main actual value signal source. Table 2-10 lists the actual status values of the Goodrive350 series VFD.

Function code	Word	Value range	Default value
P16.43	Transmitted PZD2	0: Invalid 1: Running frequency (×100, Hz)	0
P16.44	Transmitted PZD3	2: Set frequency (×100, Hz) 3: Bus voltage (×10, V)	0
P16.45	Transmitted PZD4	4: Output voltage (×1, V) 5: Output current (×10, A)	0
P16.46	Transmitted PZD5	6: Actual output torque (x10, %) 7: Actual output power (x10, %)	0
P16.47	Transmitted PZD6	8: Rotating speed of the running (x1, RPM) 9: Linear speed of the running (x1, m/s)	0
P16.48	Transmitted PZD7	10: Ramp frequency reference 11: Fault code	0
P16.49	Transmitted PZD8	12: Al1 value (×100, V) 13: Al2 value (×100, V)	0
P16.50	Transmitted PZD9	14: Al3 value (×100, V) 15: HDIA frequency (×1000, kHz)	0
P16.51	Transmitted PZD10	16: Terminal input state 17: Terminal output state 18: PID reference (×10, %)	0
P16.52	Transmitted PZD11	19: PID feedback (×10, %) 20: Rated torque of the motor	0
P16.53	Transmitted PZD12	 21: MSB of position reference (signed number) 22: LSB of position reference (unsigned number) 23: MSB of position feedback (signed number) 24: LSB of position feedback (unsigned number) 25: Status word 26: HDIB frequency value (x1000, kHz) 27: MSB of PG card pulse feedback count 28: LSB of PG card pulse feedback count 29: MSB of PG card pulse reference count 30: LSB of PG card pulse reference count 31: Function code mapping (PZD2–PZD12 correspond to P14.60–P14.70 respectively.) 32: Status word 3 33–47: Reserved 	0

PKW zone

PKW zone (parameter identification flag PKW1—numerical zone): The PKW zone describes the processing mode of the parameter identification interface. A PKW interface is not a physical interface but a mechanism that defines the transmission mode (such reading and writing a parameter value) of parameter between two communication ends.

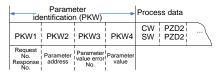


Figure 2-5 Parameter identification zone

In the periodic communication, the PKW zone consists of four 16-bit words. The following table describes the definition of each word.

First word PKW1 (16 bits)							
Bits 15-00	Bits 15–00 Task or response identification flag						
Second word PKW2 (16 bits)							
Bits 15-00	0–247						
	Third word PKW3 (16 bits)						
Bits 15-00	Value (most significant word) of a parameter or error code of the returned value	00					
	Fourth word PKW4 (16 bits)						
Bits 15–00 Value (least significant word) of a parameter 0–6553							

Note: If the master station requests the value of a parameter, the values in PKW3 and PKW4 of the packet that the master station transmits to the VFD are no longer valid.

Task request and response: When transmitting data to a slave, the master uses a request number, and the slave uses a response number to accept or reject the request.

	Request No. (from the master to a slave)	Response signal		
Request No.	Function	Acceptance	Rejection	
0	No task	0	_	
1	Requesting the value of a parameter	1, 2	3	
2	Modifying a parameter value (one word) [modifying the value only on RAM]	1	3 or 4	

Table 2-11 Task identification flag PKW1

	Request No. (from the master to a slave)	Response signal			
Request No.	Function	Acceptance	Rejection		
3	Modifying a parameter value (two words) [modifying the value only on RAM]	2	3 or 4		
4	Modifying a parameter value (one word) [modifying the value on both RAM and EEPROM]	1	3 or 4		
5	Modifying a parameter value (two words) [modifying the value on both RAM and EEPROM]	2	3 or 4		

Note: The requests #2, #3, and #5 are not supported currently.

Table 2-12 Response identification flag PKW1

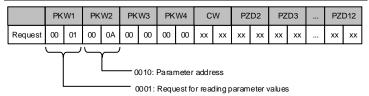
	Response No. (from a slave to the master)
Response No.	Function
0	No response
1	Transmitting the value of a parameter (one word)
2	Transmitting the value of a parameter (two words)
3	The task cannot be executed and one of the following error number is returned: 1: Invalid command 2: Invalid data address 3: Invalid data value 4: Operation failure 5: Password error 6: Data frame error 7: Parameter read only 8: Parameter cannot be modified during VFD running 9: Password protection 10: Function code mapping failed
4	Reserved

PKW examples

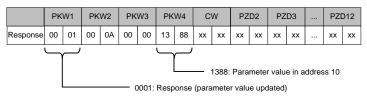
Example 1: Reading the value of a parameter

You can set PKW1 to 1 and PKW2 to 0A to read a frequency set through keypad (the address of the frequency set through keypad is 10), and the value is returned in PKW4. The following data is in hexadecimal format.

Request (master station -> VFD)



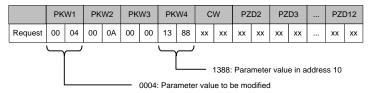
Response (VFD -> master station)



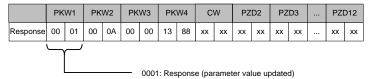
Example 2: Modifying the value of a parameter (on both RAM and EEPROM)

You can set PKW1 to 4 and PKW2 to 0A to modify a frequency set through keypad (the address of the frequency set through keypad is 10), and the value to be modified (50.00) is in PKW4.

Request (master station -> VFD)



Response (VFD-> master station)



PZD examples: The transmission of the PZD zone is implemented through VFD function code settings. For the function codes, see the related INVT VFD operation manual.

Example 1: Reading the process data of a VFD

In this example, PZD3 is set to "8: Rotating speed of the running" through the VFD parameter P15.14. This operation sets the parameter forcibly. The setting remains until the parameter is set to another option.

Response (VFD -> master station)

	PK	W1	PK	W2	PK	W3	PK\	N4	C/	N	PZI	D2	PZ	D3	 PZ	D12
Resp	xx	xx	xx	xx	xx	xx	00	0A	 xx	xx						
onse																

Example 2: Writing process data to a VFD device

In this example, PZD3 is set to "2: PID reference" through the VFD parameter P15.03. The parameter specified in each request frame is updated with the information contained in PZD3 until another parameter is specified.

Request (master station -> VFD)

	PK	W1	PK	W2	PK'	W3	PK\	N4	C١	V	PZI	D2	PZ	D3	 PZ	D12
Resp	xx	xx	~	~~	xx	xx	xx	xx	xx	xx	xx	xx	00	00	~~	xx
onse	~~	**	~~	~~	~~	~~	**	~~	~~	~~	~~	~~	00	00	 ~~	**

Subsequently, the information contained in PZD3 is used as tractive force reference in each request frame until another parameter is specified.

2.5 Example of PLC communication

This example shows how to use a Siemens S7-1200 series PLC to communicate with the PROFINET adapter module (through using the TIA Portal V13 PC software as the configuration tool).

2.5.1 Parameter configuration

Connect the PLC to the PC with a standard network cable, and set the computer IP (e.g.

192.168.0.100) in the PC network settings. Set the IP and name of the PLC.

 Open the "TIA PORTAL V13" software, and click "Online & Diagnostics" --> "Accessible Devices" on the left. Select "PN/IE" in the drop-down list of "Type of the PG/PC interface", select the Ethernet port in the "PG/PC Interface", and finally click "Refresh" to scan the connected PLC devices, as shown in the following figure.

						Total	y Integrated Automation PORTAL
		Accessible desices	_		-	_	×
							e depter (Sigabit) 💌 🖲 🔍
			Accessible nodes	of the selected interface:			
			Device	Device type	7)14	Address 192166-0.23	MAC address AC 64-17-13-9P-OP
/		FachLED					
							- Bayer
	• Help	-		ed.			
		_				E	Show Cancel
	A = + + + + + + + + + + + + + + + + + +	Compared and a c	 Num of accurate Num of accur		A rando dorazo A rando		A constitute devices A constitute

2) If the connection between the PLC and PC is normal, after scanning is completed, the PLC device will appear in the device bar, as shown in the red box of the following figure. The device bar displays the device, device type and device MAC address. Then click the "Show" button in the lower right corner to enter the device settings.

Accessible devices					×
	Typ Accessible nodes of the s	e of the PGIPC interfa PGIPC interfa elected interface:		intel PCI Ethernet Ad	Ispter (Gigabit) V C
	Device	Device type	Туре	Address	MAC address
	PLC_1	CPU 1215C DC/D	PN/IE	192.168.0.23	AC-64-17-13-9F-DF
Flash LED					
Online status information	1:				ßefresh
Scan and informatio					×
Display only problem	reports				
					Show Cancel

3) Click "Online & Diagnostics" in the device tree, click "Assign IP Address" under the "Functions" on the right of the menu bar, and set the IP address and subnet mask of the PLC shown in the red box marked ③, to ensure that the IP address of the PC and the IP address of the PLC are in the same network segment, as shown in the following figure.



4) Set the IP address of the PLC to "192.168.0.1" and subnet mask to "255.255.255.0" (you can check "Use router", that is, the router assigns IP). Click the "Assign IP address" button after the setting is completed, as shown in the following figure.

Diagnostics	Assign IP address
 Functions 	Assign address
Assign IP address	
Set time	
Firmware update	MAC address: AC - 64 - 17 - 13 - 9F - DF Accessible devices
Assign name	
Reset to factory settings	IP address: 192 . 168 . 0 . 1
	Subnet mask: 255 . 255 . 0
	Ute router Router address: 0 0 0 0 Assign IP address

5) Click "Assign Name", and mark the PLC name in the position shown in the red box marked ②, such as "PLC1215C". Click the "Assign Device Name" button, as shown in the following figure.

Diagnostics		CON	пдигеа Ркотикст а	evice			^
 Functions 			PROFINET device name:	PLC1215C			
Assign IP address			Type:	\$7-1200			
Set time							=
Firmware update							
Assign name							
Reset to factory settings							
		Dev	ice filter				
			Only show devices o	f the same type			
			Only show devices v	ith bad parameter	settings		
	1		Only show devices v				
	1						
	are Teilne	hmer im Netzwerk:					
	is	MAC address	Туре	Name	Status		
			0 flashes	Update	Assign name	1	
						· ·	~
	<						

2.5.2 Create a new project

Double click the TIA PORTAL V13 icon to open the TIA PORTAL V13 project tool. Click the "Create new project" button to create a new project, add project name, project storage path, author, comment and other related information, and click the "Create" button to create a new project, as shown in the following figure.

		PORTA	
start 🔓	\$	Create new project	_
	Open existing project	Pojectneme: Pojecti Pub: Drivial V18/15_volksjece	
	Creato new project	Auber Advisition Comment	2
	🗢 🔍 Cone propert	Oreste	9
	Welcome Tour		
	See First streps		
	Installed suftware		
	Help		
	🛞 User Interface Language		

After creating a new project, double click "Open the project view", as shown in the following figure.

Siemens - Project1	5			
				Totally Integrated Automation PORTA
	1		First steps	
	33		Project: "Project?" was opened successfully. Please select the next stop:	
	-	 Create new project Migrate project 	100 M	
	-			
	1	Welcome Top	-> Contigue a device	
	1	First steps	Withe PLC program	
			Configure to Configure technology objects	
		 Installed withware Help 	-> Viscolitation D Configure as YM screen	
			Open the poject size	1
			Open the project siese	

2.5.3 Add GSD files

In the project view, click "Options" on the toolbar, select the "Manage general station description files (GSD)" option from the drop-down list, and a box pops up, as shown in the following figure. Enter the file directory where the INVT GSD file is located in the source path, select the GSD file, and click the "Install" button to start the installation.

Ins	tall genera	l station description file				×
S	ource path:	C:\Users\Administrator\Desktop				
C	ontent of i	mported path				
E	File		Version	Language	Status	
	GSDML-V2	.32-INVT-TPS1-Extended-20171110.xml	11/10/2017	English	Not yet installed	
						_
						_
<		11				>
					Install Car	ncel

After the installation was completely successful, a prompt pops up, indicating that the GSDML file has been installed successfully, as shown in the following figure.

Install general station description file	×
Installation result	
: Message	
Installation was completed successfully.	

2.5.4 Configure the basic information of the project

1) Enter the "Devices & networks" view interface.

In the project view, select and double click "Devices & networks" in the project tree on the left to enter the "Network overview" view interface, as shown in the following figure.

§ Siemens - Project1		-
		Totally Integrated Automation
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	Project1 > Devices & networks	_ # = X Hardware catalog # D >
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		A V Device V Catalog
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Devices & networks		Controllers
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· Online access		
T Displayhide interfaces		Intervents
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PLCSIMVS x [PN(E])	38	Distributed I/O
IninCATonel PO Ethemet Adap	e. 🗰	
La Update accessible devices		Company Contract Series
▼ ■ PLC 1 [192.168.0.23]	~	-
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✓ Details view		
Name		
		v
	< =	
		Properties Sinfo Diagnostics Information
Portal view Dvenie	m de Devices à re	Project Point

2) Add Project device and PROFINET network.

(1) Add PLC S7-1215C to the "Devices & networks" view.

In the "Hardware catalog" on the right sidebar, select "Controller" \rightarrow "SIMATIC S7-1200" \rightarrow "CPU" \rightarrow "CPU 1215C AC/DC/RIy" \rightarrow "6ES7 215-1BG40-0XB0", and double click the "6ES7 215-1BG40-0XB0" icon or drag it to the project, as shown in the following figure.

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hoject1 → Devices & networks			_ # = ×	Hardware catalog	
	a Topology view	A Network view	Device view	Options	
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		^	Y Device	✓ Catalog	_
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			 S7-1200 station, PLC_1 		- 0
PLC_1			> ruc_1	Pilter	
090 1215C				 Controllers 	
				 SIMATIC 57-1200 	
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				CPU 1211C ACIDCRIy	
				CPU 1211C DC/DC/DC	
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				CPU 1212C ACIDCRIy	
				CPU 1212C DC/DC/DC	
				CPU 1212C DC/DC/Rly	_
		2		CPU 1214C AC/DC/R/y	
				CPU 1214C DC/DC/DC	
				CPU 1214C DC/DC/Rly	
				CPU 1215C AC/DCRIV	
				CPU 1215C DC/DC/DC	
				6657 215-1AG31-0X80	
				6657 215-1AG40-0080	
				CPU 1215C DC/DC/Rly	-
				CPU 1217C DC/DC/DC	
				Unspecified CPU 1200	
				Communications modules	
				SIMATIC \$7-1500	
				SIMATIC 57-300	
		~		 SIMATIC \$7-400 	
1		> 🕤	< 11 >	SIMATIC FT 200 CPU	- 6
	Q Properties	🚺 Info 🚯 📳 Dia	anostics	> Information	

(2) Add the INVT communication card to the "Devices & networks" view.

In the "Hardware Catalog", click "Other field devices" \rightarrow "Profinet IO" \rightarrow "I/O" \rightarrow "INVT" \rightarrow "INVT Profinet Adapter" \rightarrow "INVT Profinet Adapter V1.0", and double click the "INVT Profinet

Adapter V1.0" icon or drag it to the view of "Devices & networks". The communication card is displayed as "Not assigned", as shown in the following figure.

54	Siemens - Project1		_ 0 >
			Totally Integrated Automation
	Save project 🔠 🐰 It 🕞 🗙 🍤	1 (* 1 🐨 1) 田田田県 & Contine & Contine 🔥 田田 🛪 🖃 🛛	PORTAL
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		Network 🖞 Connections Into connection 💌 🗮 🖽 🔍 🖬 🖬 🖬 🖬	
			✓ Catalog
	• 🖸 Project1 📃 🔿	Y Device • 57-120 5	10000
	Add new device		
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	Garden Bergene (CPU 1215C DC/DC/DC)	her anigned	1 10.0
	Common deta		
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1	Portal view E Overview	Devices & ne	Project Project1 created.

Click the "Not assigned" option of "INVT Profinet Adapter V1.0" and select the IO controller "PLC_1. PROFINET IO-System", then CPU and INVT Profinet in the network view are connected to the same Profinet subnet, as shown in the following figure.

36 Siemens - Project1		- *	ä
		Totally Integrated Automation	
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	< = > < <= :		
	Properties Minte I V Diagnostics	> Information	
			a
Portal view Overview	Devices 8 ne	Project Project1 created.	

(3) Add the INVT I/O sub-module to the project.

Double click the "INVT Profinet Adapter V1.0" icon in the "Devices & Networks" view to enter the "Device view" interface, as shown in the following figure.

35 Siemens - Project1							_ • • >
						Totally Integrated A	utomation
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Devices & networks	R. R.				0	Head module	1
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La Update accessible devices	-					32 Byte INIOUT	
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		3	Properties	😼 Info 💶 🔣 Diagr	iostics 👘 🖬 🗠 🔺	> Information	
Portal view Overview	tPS-1					Project Project1 created.	

Click the "Hardware Catalog" on the right \rightarrow "Module", double click the "32 Byte IN/OUT" module or drag it to the blank space in the "Device view", and the "32 Byte IN/OUT" module is added to the project, as shown in the following figure.

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Project tree			DODODC] + Distributed I/O +				TPS-1 -	X	Hardware catalog	
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devices & networks			a contraction of the contraction			Port 1 - R045	0	0 X1	Im Head module	
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Y Display/hide interfaces									12 Byte INIOUT	
US8 (\$7058)									16 Byte INIOUT	
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(4) Simple configuration of S7-1215C and INVT Profinet parameters.

<1> Configure parameters of PLC S7-1215C.

Double click the "Devices & Networks" option to enter the view interface of "Devices & Networks".

Double click the "PLC S7-1215C" icon in the interface to enter the "Device view" interface of the PLC.

Double click the network interface position in the PLC icon to enter the properties editing interface bar of "PROFINET interface_1".

Click the "Ethernet addresses" option in the "General" list to set the PLC address and name (In this example, IP address of the PLC is 192.168.0.1 and PLC name is PLC1215C).

Operations are shown in the following figure.

Mi Siemens - Project1																	
															Totally	Integra	ted Automation
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			<u>11</u>	<u>21</u>	1		2	3	4	5	6	7	· ·	Module		Slot	✓ Catalog
Project1 Add new device	^		Rack_0											AI2/AD2_	1	12 4	deartho Ng MT
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B PLC_1 [OPU 1215C DODOR	0(1		10											HSC_1 HSC_2		11	
) 🙀 Common data				1									1	HSC_2 HSC_3		11	Signal boards
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PLCSIMV5x[PNIE]	20	PROFINET		Module]							S P	roperties	- E In	fo 🛛 🖳 Diagn	ostics	101-1	• 3 Al
TwinCATIntel PCI Ethernet		General	IO tags	Syste	em consta	nts 1	Texts										▶ ■ AQ
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<2> Configure parameters of the INVT Profinet communication card.

Double click the "Devices & Networks" option to enter the view interface of "Devices & Networks".

Double click the "INVT Profinet Adapter V1.0" icon in the interface to enter the "Device view" interface of the communication card.

Double click the network interface position in the INVT Profinet communication card icon to enter the properties editing interface bar of PROFINET interface.

Click the "PROFINET interface [X1]" option in the "General" list, and click the "Ethernet addresses" option. Configure parameters of the INVT PROFINET communication card according to the parameters shown in the following figure such as IP address and device name of the communication card (in this example, IP address of the communication card is 192.168.0.2 and the name is invt1).

Operations are shown in the following figure.

34 Siemens - Project1					_ # X
				Totally inte	grated Automation
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B00 2	dr 1954	- 🔜 🚄 🖽 🔍 ± 100%	• 🖬	Device overview	
Ingenti Ingenti Second advancement Second advanceme	TPS-1 (Module)	en constants Texts	Set IP address in the project Software mask: 255 255 Software mask: 255 Software mask Ore record r Generate PROFINET device name aut (ment (ment	22 bye HOULT 4 m 2 Diagnostics	v Catalog Manual Catalog v Catalog </td
Portal view Dverview	₫ TP5-1				V > Information
Vortal View	(f) 1951			💙 Project Project1 create	d.

2.5.5 Assign the device name of the IO device (INVT communication card)

After the CPU and INVT Profinet communication card are successfully connected to the PC through the network cable, click "Online access" on the left to find the network card corresponding to the PC that is connected to the PLC and communication card.

In all displayed devices, find the INVT communication card device and click it, such as emc (192.168.0.2) device, as shown in the following figure (**Note:** When the communication card is used for the first time, there is no device name, and only the default IP can be scanned).

Double click "Online & Diagnostics" to enter the online diagnostics state.

Click "Functions" → "Assign name" to enter the "Assign name" interface.

Enter the communication card name in "PROFINET device name", and click "Assign Name" in the lower right corner to confirm.

Note: The name of the PROFINET communication card set online must be consistent with that set in the configuration project, otherwise PROFINET communication cannot be carried out between the devices.

The operation steps are shown in the following figure.

		Online access + TwinCAT-Intel					Online Ø 🗊 I
Devices							Options
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		General Cross-references	Compile				> Memory

2.5.6 Save, compile, and download

Download the project configuration information to the PLC S7-1215C after the entire project configuration is completed.

Click "Save Project" to save the entire project.

Right click "PLC_1 [CPU 1215C AC/DC/Rly]" \rightarrow left click "Compile" \rightarrow "Hardware and software (change only)" to compile the entire project.

Click the "Download to device" icon to download the project configuration to the PLC controller.

Operations are shown in the following figure.

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	Details view		• • •	hogram blocks	No block we					0	0	10:02:30 AM	

In the download dialog box, search for the connected PLC device, as shown in the following figure.

Select the "PN/ IE_1" option in the drop-down list of "Connection to interface/subnet".

Click the "Start search" button in the lower right corner to start scanning and detecting PLC devices in the subnet.

	Device	Device type	Slot	Туре	Address	Subnet
	PLC_1	CPU 1215C DC/D	1 X1	PN/IE	192.168.0.1	PN/IE_1
	Г	Type of the PG/PC inte PG/PC inte Connection to interface/s	rface:	Phile TwinCAT-b Phile_1	ntel PCI Ethernet Ad	apter (Gigahit) 💌 🕅
	Compatible de	ist gat			SH	now all compatible device
	Device	Device type	Туре		Address	Target device
		_	PN/IE		Access address	-
	-					
Flash LED						
	on:					

After searching is completed, the PLC S7-1215C that is connected to the PC will be displayed in the list of "Compatible devices in target subnet", as shown in the following figure.

Select the PLC to be downloaded in the following figure, and click the "Download" button to download the configuration information and PLC program to the selected PLC.

	Configured acce	ess nodes of "PLC_1"					
	Device	Device type	Slot	Туре	Address		Subnet
	PLC_1	CPU 1215C DC/D	1 X1	PN/IE	192.168.0.1		PNIE_1
		Type of the PG/PC inte PG/PC inte Connection to interface/s	erface: ubnet:	PN/IE_1	Intel PCI Ethernet Ad	dapter (Gigal	bit) V V
					_		
		ices in target subnet:	2.00		-		
	Compatible dev	ices in target subnet: Device type CPU 1215C DC/D.	Type PN/IE		Address 192.168.0.1	how all com Target d PLC_1	
80 - 80 8 - 10 8	Device	Device type			Address	Target d	
of Hesh LED	Device	Device type	PN/IE		Address 192.168.0.1	Target d	patible devices
Flash LED	Pecies	Device type	PN/IE		Address 192.168.0.1	Target d	
nline status informa	Pecies	Device type CPU 1215C DCID.	PN/IE		Address 192.168.0.1	Target d	evice

2.5.7 VFD parameter watching

Click "Watch and force tables" in the left menu bar, and double click "Add new watch table" in the drop-down menu, as shown in the following figure.

holect tree	(中)土 (半土 国 公 田 田 田 田 岡 戸 Granine J Cootline 品 田 田 田 田 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日	- # = X	Hardware catalog 🔗 🗊
Devices	Topologyview 👗 Network view 🎊 De	vice view	Options
900	2 Network U Connections Hill connection + U H + Connection	4.9	
	Ø 10 system: PLC_1.PROFINET IO-System (100)	7.04	v Catalog
Troject1		57-1200 51	
Add new device		CPU 1215C	
Devices & networks		GSD device	
· [# PLC 1 (CPU 1211C DCRCRC]		NVT Profes	
Device configuration	86.1		
Coline & diagnostics			FC systems
Internet blocks	 PLC 1 PROTINET ID Synte) 		Drives & starters
Technologyobjects	POCTORDANE TO System.		Interverk components
External source files			• Cal Detecting & Manitoring
E TLC tags			Distributed ID
 Eg RLC data types 			 Field devices
· Instch and force tables			Other field devices
📑 Add meas watch table			· Cal MORIMETIO
Force table			• Crives
Sa Taces			• a Cacoders
Trogram info	Properties Mario Spagnostics	los and	• Catevey
 Envice programa 		- Include	* (10 M/T
N Text Lats	General Cross-references Compile		INT INT holiset Adapter
 Iscal modules 			Bith/T Preferet Adapter
Distributed IIO	1 Message	Ge to 1	ident Sustema
Details view	• NC1		Sensors
Deale new	The hardware configuration has not been loaded, because it is up-to-date.		+ PROPAUS DP
	The software has not been loaded, because it is up-to-date.		
Name	Hardware configuration		
	Scanning for devices completed for interface TwinCKT-intel PCI Ethernet Adapter (Sigabit). Found 2 device(c) on the	- 18	1
	So Loading completed (evors: 0: warnings: 0).		< =
			> Information

Create target watch variables—PZD, PKW, control word and status word variables of the VFD in the newly created watch table, as shown in the following figure.

	1 Project1	PLC_1 [CPU 1215C 0	C/DC/DC] • Watch	and force table	s 🕨 Watch table	e_1		X Testing	
Devices								Options	
00	12 2 2	1 1 2 2 2 2							
	Jame	Address	Display format	Monitor value	Modify value	2	Comment	 CPU operator panel 	
Project1	A 1	%Q//2	Hex				PKW1(PLC send)		
Add new device	2	%Q///4	Hex				PKW2(PLC send)	No online connection	
d Devices & networks	3	50006	Mex				PKNS(PLC send)		
PLC_1 [OPU 1215C DODC/DC]	4	%QV/8	Hex				PKVH4(PLC send)		
Device configuration	5	%QW10	Hex				CW		
S Online & diagnostics	6	%QW12	Mex				P2D2(PLC send)		
Program blocks	= 7	%QW14	Hex				P203(PLC send)		
Technology objects	8	%QW16	Hex				P2D4(PLC send)		
External source files	2	%QW18	Mex				F2D5(FLC send)		
PLC tags	10	%QW20	Hex				FID6(FLC send)		
PLC data types	11	%QV/22	Hex				P2D7(PLC send)		
 Watch and force tables 	- 12	50/024	Hex				F206(FLC send)		
Add new watch table	12	%QV/26	Hex				F209(FLC send)		
Ell Force table	14	%QV/28	Hex				P2D10(PLC send)		
Watch table_1	15	50050	Hex				F2D11(FLC send)		
Teces	16	%QV/92	Hex				F2D12(FLC send)		
Program info	17								
Device proxy data	18								
M Text lists	19					0			
Local modules	20	<8dd news							
Details view								-	
Details free	٤							3	
	_			Rop	erties 🔄 🛄 Inf	o 🖫 🛙	Nagnostics	·	
Name	General	Cross-references	Compile						
	General	Cross-references	Compire					_	

		Projec							_ # =×	Testing	
Devices										Options	
300	12	10 1	0 🕼 🖦 🕫 2, 2								
		-	Address	Display format	Monitor unlue	Modify value	2	Comment	_	 CPU operator panel 	-
D Projecti			3///2	Hex	1640000			PKWT(PLC receive)			
Add new device		1	3004	Hex	1640000			PRIVID(PLC receive)		PLC_1 [CPU 1215C DCIDCIDC]	
Devices & networks			9/76	Hex	1640000			PKVB/PLC receive)		RUN / STOP RUN	
- PLC_1 [CPU 1215C DODODC]			5/08	Hex	1640000			PKNA(PLC receive)		F0000 5700	
Device configuration			9/010	Hex	1640004			SW		MANT MES	
Coline & diagnostics			9/012	Hex	1640000			P2D2(PLC receive)		MANT MES	
Frogram blocks	• *		50014	Hex	1640000			#2D3(#LC receive)			
Technology objects			3/016	Hex	16#0000			P2D4(PLC receive)		1	
External source files			5/W18	Hex	1640000			#2D5(#LC receive)		1	
FLC tags	•	0	16/10/20	Hex	16#0000			P2D6(PLC receive)		1	
FLC data types		11	9////22	Hex	1680000			P2D7(PLC receive)		1	
 Watch and force tables 		12	5/824	Hex	1640000			P2D6(PLC receive)		1	
Add new watch table		2	961026	Hex	16±0000			P2D9(PLC receive)		1	
Force table		4	9////28	Hex	1640000			P2D10(PLC receive)			
Watch table_1		5	14/830	Hex	1640000			P2D11(PLC receive)			
watch table_2		16	9/1/32	Hex	16±0000			P2D12(PLC receive)			
Traces		21								1	
Program info		5	-oldd newo-								
Device proxy data											
M Text lists	~										
Details view											
Details view		- E								1	
						Properties	Unfo	1 S Diagnostics		1	
Name			ice information	Connection in		larm display					

After the watch variables are created, click the "Watch all" button in the watch table to monitor the values of all variables, and click the "Modify parameters" button in the watch table to modify the parameters of the target variable, so as to watch the VFD through the PLC.

3 Ethernet IP communication card

3.1 Overview

- Thanks for choosing INVT Ethernet IP communication cards. This manual describes the function specifications, installation, basic operation and settings, and information about the network protocol. To ensure that you install and operate the product properly, read this manual and the communication protocol section in the VFD operation manual carefully before you use the product.
- This manual only describes how to operate the Ethernet IP communication card and the related commands but does not provide details about the EtherNet/IP protocol. For more information about the Ethernet IP protocol, read the related specialized articles or books.
- This communication card is defined as an Ethernet IP slave station communication card and is used on a VFD that supports EtherNet/IP communication.
- 4. The communication card supports the star, linear, and ring topologies.
- The communication card supports 32 inputs/outputs to read and write process data, read state data, and read and write function parameters of a VFD.

3.2 Features

1. Supported functions

- > Supports the EtherNet/IP protocol, and supports EtherNet/IP devices.
- Provides two EtherNet/IP ports and supports the 10/100M full-duplex/half-duplex operation.
- > Supports the star, linear, and ring topologies (but does not support ring-network monitoring).

2. Supported communication types

EtherNet/IP adopts the application layer protocol CIP, which is also used by DeviceNet and ControlNet. Therefore, they use the same object library and consistent industrial specifications.

CIP uses non-connected UDP/IP and connection-based TCP/IP for information control and transmission over the Ethernet, allowing the sending of explicit and implicit packets. Implicit packets are time-critical control messages and transmitted using UDP/IP. Explicit packets are point-to-point messages that are not time critical and transmitted using TCP/IP. Explicit packets are used for configuration, download, and fault diagnosis, while implicit packets are used for real-time I/O data transmission.

3. Communication ports

Standard RJ45 ports are used in EtherNet/IP communication. The communication card provides two RJ45 ports with no transmission direction defined, and therefore you can insert a cable into the port without regard to its direction. Figure 3-1 shows the ports, and Table 3-1 describes the port pins.



Figure 3-1 Two standard RJ45 ports

Pin	Name	Description
1	TX+	Transmit Data+
2	TX-	Transmit Data-
3	RX+	Receive Data+
4	n/c	Not connected
5	n/c	Not connected
6	RX-	Receive Data-
7	n/c	Not connected
8	n/c	Not connected

4. State indicators

The EtherNet/IP communication card provides four LED indicators and four net port indicators to indicate its states. Table 3-2 describes the state indicators.

Table	3-2	State	indicators
-------	-----	-------	------------

LED	Color	State	Description
		On	Indicating that the card and VFD identify each
		01	other.
LED1	Green		Indicating that the card and VFD communicate
LEDI		Blinking (1Hz)	normally.
		Off	Indicating that the card and VFD communicate
		Off	improperly.
			Indicating that communication between the card
LED2	Green	Green On	and PLC is online and data interchange is
			allowed.

LED	Color	State	Description		
		Blinking (1Hz)	Indicating IP address conflict between the card and PLC.		
		Off	Indicating that communication between the card and PLC is offline.		
		On	Failed to set up I/O between the card and PLC.		
		Blinking (1Hz)	Incorrect PLC configuration.		
LED3	Red	Blinking (2Hz)	The card failed to send data to the PLC.		
LED3	Rea	Blinking (4Hz)	The connection between the card and PLC timed out.		
		Off	No fault		
LED4	Red	On	3.3V power indicator		
Net port	et port On		Link indicator, indicating successful Ethernet connection.		
indicator	Yellow	Off	Link indicator, indicating that Ethernet connection is not established.		
Net port	Groon	On	ACK indicator, indicating that data interchange being performed.		
indicator		Off	ACK indicator, indicating that data interchange is not be performed.		

3.3 Electrical wiring

The Ethernet IP communication card provides standard RJ45 ports and supports the linear, star, and ring topologies. Figure 3-2, Figure 3-3, and Figure 3-4 show the electrical wiring diagrams for different topologies.

Use CAT5, CAT5e, and CAT6 network cables for electrical wiring. When the communication distance is greater than 50 meters, use high-quality network cables that meet the national standards.

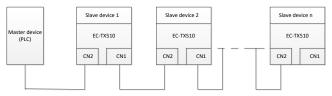
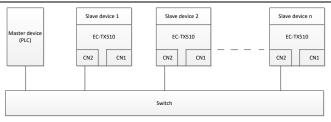
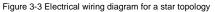


Figure 3-2 Electrical wiring diagram for a linear topology





Note: An Ethernet switch must be available when the star topology is used.

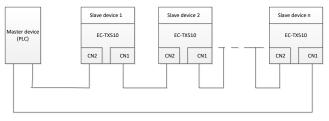


Figure 3-4 Electrical wiring diagram for a ring network

3.4 Communication

3.4.1 Communication settings

The EtherNet/IP communication card can function as only the EtherNet/IP slave station. Before communication, set Goodrive350 function codes, including:

IP address and subnet mask for the card

The default IP address and subnet mask for each communication card are 192.168.0.20 and 255.255.255.0. You can change them to the address of a network segment.

Control mode

If you want to control the VFD with the communication card, set the control mode to EtherNet/IP communication control. To be specific, set P00.01=2 (communication as the running command channel) and set P00.02=3 (EtherNet/IP communication channel) to control VFD start and stop. If you want to set a value through EtherNet/IP communication, change the control way of corresponding function codes to EtherNet/IP communication. Appendix B lists related function codes. Note: After the setting, the card can communicate normally. If you want to control the VFD with the card, set related function codes to enable EtherNet/IP communication control.

3.4.2 Packet format

Table 3-3 describes the structure of a TCP communication packet.

Table 3-3 Structure of a TCP communication packet

MAC-layer packet header	IP-layer packet header	TCP-layer packet header	Valid data	Packet trailer
14 bytes	20 bytes	20 bytes	0–1488 bytes	4 bytes

Table 3-4 describes the structure of a UDP communication packet.

Table 3-4 Structure of a UDP communication packet

MAC-layer packet header	IP-layer packet header	UDP-layer packet header	Valid data	Packet trailer
14 bytes	20 bytes	20 bytes	0-1488 bytes	4 bytes

3.4.3 Ethernet IP communication

The EtherNet/IP communication card supports 16-word input/output. Figure 3-5 shows the packet format for transmitting data with a VFD.

Parameter identification (PKW)			Fixed zone	₽	ocess d (PZD) Distributa	 	
PKW1	PKW2	PKW3	PKW4			PZD3 PZD3	PZD12 PZD12

Figure 3-5 Packet structure

By using the 32 inputs/outputs, you can set the reference parameters of the VFD, monitor the status values, transmit control commands, monitor the running state, and read/write the function parameters of the VFD. For specific operations, see the following description.

Parameter zone:

PKW1—Parameter identification

PKW2—Array index number

PKW3—Parameter value 1

PKW4—Parameter value 2

Process data:

CW-Control word (transmitted from the master to a slave. For description, see Table 3-5.)

SW—Status word (transmitted from a slave to the master. For description, see Table 3-8.)

PZD--Process data (user defined)

(The process data output from the master to a slave is a reference value, and the process data input from a slave to the master is an actual value.)

PZD zone (process data zone): The PZD zone in a communication packet is designed for controlling and monitoring a VFD. The master and slave stations always process the received PZD with the highest priority. The processing of PZD takes priority over that of PKW, and the master and slave stations always transmit the latest valid data on the interfaces.

CWs and SWs

Using CWs is the basic method of the fieldbus system to control VFDs. A CW is transmitted by the fieldbus master station to a VFD device. In this case, the adapter module functions as a gateway. The VFD device responds to the bit code information of the CW and feeds state information back to the master through an SW.

Reference value: A VFD device may receive control information in multiple channels, including analog and digital input terminals, VFD control panel, and communication modules (such as RS485 and CH-PA01 adapter modules). To enable the control over VFD devices through EtherNet/IP, you need to set the communication module as the controller of the VFD device.

Actual value: An actual value is a 16-bit word that includes information about VFD device operation. The monitoring function is defined through VFD parameters. The conversion scale of an integer transmitted as an actual value from the VFD device to the master depends on the set function. For more description, see the related VFD operation manual.

Note: A VFD device always checks the bytes of a CW and reference value.

Task packet (master station -> VFD)

CW: The first word in a PZD task packet is a VFD CW.

When P15.43=0, EtherNet IP control words are defined by byte. Table 3-5 describes Goodrive350 series VFD CWs defined by byte.

Bit	Name	Value	Description
		1	Forward running
		2	Reverse running
		3	Forward jogging
	Communication-based	4	Reverse jogging
0–7	control command	5	Stop
	control command	6	Coast to stop
		7	Fault reset
		8	Jogging to stop
		9	Emergency stop
8	Cashling writing		Enable writing (mainly through PKW1 to
0	Enabling writing	1	PKW4)
9–10	Motor group setting	00	Motor 1
9-10	wotor group setting	01	Motor 2
11	Control mode owitching	1	Enable torque/speed control switching
11	Control mode switching	0	Disable switching
12	Resetting power	1	Enable
12	consumption to zero	0	Disable
13	Pre-excitation	1	Enable
13	Pre-excitation	0	Disable
14	DC broking	1	Enable
14	DC braking	0	Disable
15	Heartbeat reference	1	Enable
15	meanbear reference	0	Disable

When P16.56=1, EtherNet/IP control words are defined by bit. Table 3-6 describes Goodrive350 series VFD CWs defined by bit.

Bit	Name	Description	Priority
0	Forward running	0: Decelerate to stop 1: Forward running	1
1	Reverse running	0: Decelerate to stop 1: Reverse running	2
2	Fault reset	0: Disable 1: Enable	3
3	Coast to stop	0: Disable 1: Enable	4
4	Forward jogging	0: Disable 1: Enable	5
5	Reverse jogging	0: Disable 1: Enable	6
6	Jogging to stop	0: Disable 1: Enable	7

Bit	Name	Name Description	
7	/	Reserved	
8	Enable reading and writing (PKW1-PKW4)	0: Disable 1: Enable	
9	/	Reserved	
10	Emergency stop	0: Disable 1: Enable	0: Top priority
11 - 15	/	Reserved	

Reference value (REF): The second to twelfth words in a PZD task packet are the main settings. The main frequency settings are provided by the main setting signal source. Table 3-7 describes the settings of Goodrive350 series VFD.

Table 3-7 Settings of Goodrive350 series VFD

Function code	Word	Value range	Default value
P16.32	Received PZD2	0: Invalid 1: Set frequency (0–Fmax, unit: 0.01 Hz)	0
P16.33	Received PZD3	2: PID reference (-1000–1000, in which 1000 corresponds to 100.0%)	0
P16.34	Received PZD4	3: PID feedback (-1000–1000, in which 1000 corresponds to 100.0%)	0
P16.35	Received PZD5	4: Torque setting (-3000-+3000, in which 1000 corresponds to 100.0% of the rated current of the motor)	0
P16.36	Received PZD6	5: Setting of the upper limit of forward running frequency (0–Fmax, unit: 0.01 Hz)	0
P16.37	Received PZD7	6: Setting of the upper limit of reverse running frequency (0–Fmax, unit: 0.01 Hz)	0
P16.38	Received PZD8	7: Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to 100.0% of the rated current of	0
P16.39	Received PZD9	the motor) 8: Upper limit of the brake torque (0–3000, in which 1000	0
P16.40	Received PZD10	corresponds to 100.0% of the rated current of the motor) 9: Virtual input terminal command, 0x000–0x3FF	0
P16.41	Received PZD11	(bit9–bit0 correspond to S8/S7/S6/S5/HDIB/HDIA/S4/S3/S2/S1 in sequence)	0
P16.42	Received PZD12	10: Virtual output terminal command, 0x00–0x0F (bit3–bit0 correspond to RO2/RO1/HDO/Y1 in sequence) 11: Voltage setting (for V/F separation) (0–1000, in which 1000 corresponds to 100.0% of the	0

Function code	Word	Value range	Default value
code		rated voltage of the motor) 12: AO1 output setting 1 (-1000-+1000, in which 1000 corresponds to 100.0%) 13: AO2 output setting 2 (-1000-+1000, in which 1000 corresponds to 100.0%) 14: MSB of position reference (signed number) 15: LSB of position reference (unsigned number) 16: MSB of position feedback (signed number) 17: LSB of position feedback (unsigned number) 18: Position feedback setting flag (position feedback can	value
		be set only after this flag is set to 1 and then to 0) 19: Function code mapping (PZD2–PZD12 correspond to P14.49–P14.59 respectively.) 20–31: Reserved	

Response packet (VFD -> master station)

Status word (SW): The first word in a PZD response packet is a VFD SW.

P15.43=0 (SWs are defined in decimal format), and the VFD SWs are defined as follows.

Table 3-8 Goodrive350 series VFD SWs expressed in decimal format	Table 3	3-8 G	oodrive350	series '	VFD	SWs	expressed	in	decimal	format
--	---------	-------	------------	----------	-----	-----	-----------	----	---------	--------

Bit	Name	Value	Description
		1	Forward running
		2	Reverse running
0–7	Running state	3	Stopped
		4	Faulty
		5	POFF
0	Due veltere established	1	Ready to run
8	Bus voltage established	0	Not ready to run
0.40	Mater meur faarlikaali	0	Motor 1
9–10	Motor group feedback	1	Motor 2
44		k 1 Synchronous motor 0 Asynchronous motor	
11	Motor type feedback		
10	Overland pro plarm foodbook	1	Overload pre-alarm generated
12	12 Overload pre-alarm feedback		No overload pre-alarm generated
12 14	Bun/Stop mode	0	Keypad-based control
13 - 14	Run/Stop mode	1	Terminal-based control

Bit	Name	Value	Description
		2	Communication-based control
		3	Reserved
15	Heartbeat feedback	1	Heartbeat feedback
15	Healibeal leedback	0	No heartbeat feedback

P15.43=1 (SWs are defined in binary format), and the VFD SWs are defined as follows.

Table 3-9 Goodrive350 series VFD SWs expressed in binary format

Bit	Name	Description	Priority
0	Forward running	0: Disable 1: Enable	1
1	Reverse running	0: Disable 1: Enable	2
2	Stopped	0: Disable 1: Enable	3
3	Fault	0: Disable 1: Enable	4
4	POFF	0: Disable 1: Enable	5
5	Pre-excited	0: Disable 1: Enable	6
6 - 15	/	Reserved	

Actual value (ACT): The second to twelfth words in a PZD task packet are the main actual values. The main actual frequency values are provided by the main actual value signal source.

Table 3-10 Actual status values of Goodrive350 series VFD

Function code	Word	Value range	Default value
P16.43	Transmitted PZD2	0: Invalid 1: Running frequency (×100, Hz)	0
P16.44	Transmitted PZD3	2: Set frequency (×100, Hz) 3: Bus voltage (×10, V)	0
P16.45	Transmitted PZD4	4: Output voltage (×1, V) 5: Output current (×10, A)	0
P16.46	Transmitted PZD5	6: Actual output torque (×10, %) 7: Actual output power (×10, %)	0
P16.47	Transmitted PZD6	8: Rotating speed of the running (x1, RPM) 9: Linear speed of the running (x1, m/s)	0
P16.48	Transmitted PZD7	10: Ramp frequency reference 11: Fault code	0
P16.49	Transmitted PZD8	12: Al1 value (×100, V) 13: Al2 value (×100, V)	0
P16.50	Transmitted	14: Al3 value (×100, V)	0

Function code	Word	Value range	Default value
	PZD9	15: HDIA frequency (×1000, kHz)	
P16.51	Transmitted PZD10	16: Terminal input state 17: Terminal output state	0
P16.52	Transmitted PZD11	18: PID reference (×10, %) 19: PID feedback (×10, %)	0
P16.53	Transmitted PZD12	 20: Rated torque of the motor 21: MSB of position reference (signed number) 22: LSB of position reference (unsigned number) 23: MSB of position feedback (signed number) 24: LSB of position feedback (unsigned number) 25: Status word 26: HDIB frequency value (x1000, kHz) 27: MSB of PG card pulse feedback count 28: LSB of PG card pulse feedback count 29: MSB of PG card pulse reference count 30: LSB of PG card pulse reference count 31: Function code mapping (PZD2–PZD12 correspond to P14.60–P14.70 respectively.) 32: Status word 3 33-47: Reserved 	0

PKW zone

PKW zone (parameter identification flag PKW1—numerical zone): The PKW zone describes the processing mode of the parameter identification interface. A PKW interface is not a physical interface but a mechanism that defines the transmission mode (such reading and writing a parameter value) of parameter between two communication ends.

⊲ ide	Parame entification			Proces	ss data	
PKW1	PKW2	PKW3	PKW4		PZD2 PZD2	
Request No. Response No.	Parameter address	Parameter value error No.	Parameter value			

Figure 3-6 Parameter identification zone

In the periodic communication, the PKW zone consists of four 16-bit words. The following table describes the definition of each word.

	First word PKW1 (16 bits)				
Bits 15-00	Bits 15–00 Task or response identification flag				
	Second word PKW2 (16 bits)				
Bits 15-00	Bits 15–00 Basic parameter address				
Bits 15-00	Bits 15–00 Value (most significant word) of a parameter or				
	error code of the returned value				
Fourth word PKW4 (16 bits)					
Bits 15-00	Value (least significant word) of a parameter	0 - 65535			

Note: If the master station requests the value of a parameter, the values in PKW3 and PKW4 of the packet that the master station transmits to the VFD are no longer valid.

Task request and response: When transmitting data to a slave, the master uses a request number, and the slave uses a response number to accept or reject the request.

	Request No. (from the master to a slave)	Response signal	
Request No.	Function	Acceptance	Rejection
0	No task	0	_
1	Requesting the value of a parameter	1, 2	3
2	Modifying a parameter value (one word) [modifying the value only on RAM]	1	3 or 4
3	Modifying a parameter value (two words) [modifying the value only on RAM]	2	3 or 4
4	Modifying a parameter value (one word) [modifying the value on both RAM and EEPROM]	1	3 or 4
5	Modifying a parameter value (two words) [modifying the value on both RAM and EEPROM]	2	3 or 4

Table 3-11 Task identification flag PKW1

Note: The requests #2, #3, and #5 are not supported currently.

Table 3-12 Response identification flag PKW1

Response No. (from a slave to the master)					
Response No. Function					
0	No response				
1	Transmitting the value of a parameter (one word)				
2	Transmitting the value of a parameter (two words)				
3	The task cannot be executed and one of the following error number				

Response No. (from a slave to the master)							
Response No.	Response No. Function						
	is returned:						
	1: Invalid command						
	2: Invalid data address						
	3: Invalid data value						
	4: Operation failure						
	5: Password error						
	6: Data frame error						
	7: Parameter read only						
	8: Parameter cannot be modified during VFD running						
	9: Password protection						
	10: Function code mapping failed						
4	Reserved						

Model specified in the standard ODVA agreement

The standard ODVA protocol specifies the data transmission format and CWs/SWs definitions, and the packet format for data transmission with the VFD is shown in Table 3-13.

Table 3-13 Transmission modes specified in standard ODVA protocol

No.	Input/Output	Data length (bytes)	Format (word)
2	70/20	4	CW1/SW1 + Speed_ref/act
3	71/21	4	CW2/SW2 + Speed_ref/act
4	72/22	6	CW1/SW1 + Speed_ref/act + Torque_ref/act
5	73/23	6	CW2/SW2 + Speed_ref/act + Torque_ref/act

CW1/SW1 and CW2/SW2 are defined as shown in Table 3-14, Table 3-15, Table 3-16 and Table 3-17.

Table 3-14 CW	specified in standard	ODVA protocol
---------------	-----------------------	---------------

Bit	Name	Value	Description
0	Forward running	0	Disable
		1	Enable
1	Reserved	/	/
2	Fault reset	0	Disable
2	Fault leset	1	Enable

Bit	Name	Value	Description
3–15	Reserved	/	/

Table 3-15 SW1 specified in standard ODVA protocol

Bit	Name	Value	Description	
	E. H. Hatala	0	No fault	
0	Fault State	ault state 1	Fault	
1	Reserved	/	/	
0	2 Running state	2 Dunning state	0	Not forward running
2		1	Forward running	
3–15	Reserved	/	/	

Table 3-16 CW2 specified in standard ODVA protocol

Bit	Name	Value	Description
0	Forward running	0	Disable
0	Forward furning	1	Enable
1	Reverse running	0	Disable
1	Reverse furthing	1	Enable
2	Fault reset	0	Disable
2	Fault leset	1	Enable
3–4	Reserved	/	/
5	Control reference source	0	Local control (keypad)
5	Control reference source		Remote control (Ethernet IP communication)
	Frequency reference	0	Local reference (keypad)
6	. ,	4	Remote reference (Ethernet IP
	source	1	communication)
7–15	Reserved	/	/

Table 3-17 SW2 specified in standard ODVA protocol

Bit	Name	Value	Description
0	Fault	0	No fault
0	Fault	1	Fault
4	Overload pre-alarm	0	No overload
	feedback	1	Overload pre-alarm
0	a Distributed	0	Stopped
2 Running state 1	Running state 1	1	Forward running
3	Running state 2	0	Stopped
		1	Reverse running

Bit	Name	Value	Description
4	Pus valtage established	0	Ready to run
4	Bus voltage established	1	Not ready to run
5	Control reference source	0	Local control (keypad)
5	Control reference source	1	Remote control (not keypad)
6	Frequency/torque	0	Local control (keypad)
0	reference source	1	Remote control (not keypad)
7	Reference reached	0	Not reached
		1	Reached
8–15	Reserved	/	/

INVT extended data model based on the ODVA Protocol

Based on the ODVA protocol provisions, these four modes are combined with PZD process data defined by INVT, and the packet format for data transmission with the VFD is shown in Table 3-18.

Table 3-18 INVT extended data model based on the ODVA protocol

No.	Input/Output	Data length (bytes)	Format (word)
6	74/24	24	CW1/SW1 + Speed_ref/act + Null +PZD4–12
7	75/25	24	CW2/SW2 + Speed_ref/act + Null +PZD4–12
8	76/26	24	CW1/SW1 + Speed_ref/act + Torque_ref/act + PZD4–12
9	77/27	24	CW2/SW2 + Speed_ref/act + Torque_ref/act + PZD4-12

In these four modes, definitions of CWs and SWs are consistent with that of "Model specified in the standard ODVA agreement", and definitions of PZD4–12 are consistent with that of "INVT self-defined mode".

3.5 Example 1 of PLC communication (communicate with Allen-Bradley PLC)

This example shows how to use an Allen-Bradley PLC (model: 1769_L36ERMS) to communicate with an Ethernet IP adapter module (through using the Studio 5000 software as the configuration tool).

3.5.1 Create a new project

Connect the PC to the PLC with a printer cable or network cable. Open



software,

and click "New Project".



Select the correct PLC model, fill in the project name, click "Next", and click "Finish".

🗿 New Project		? ×
Project Types	Search	×
Logix	Compact GuardLogix® 5370 Safety Controller T69-L30ERMS Compact GuardLogix® 5370 Safety Contr T769-L32ERMS Compact GuardLogix® 5370 Safety Contr T769-L37ERMS Compact GuardLogix® 5370 Safety Contr T769-L32ERMS Compact GuardLogix® 5370 Safety Contr Compact GuardLogix® 5370 Safety Controller CompactLogix® 5370 Controller CompactLogix® 5380 Controller CompactLogix® 540 Controller Location: C(\Users\Administrator\Documents\Studio 5000 v B	oller oller oller oller
	Cancel Back <u>N</u> ext	<u>F</u> inish

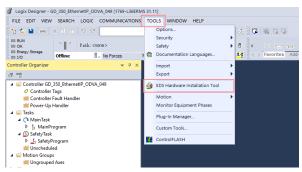
🙆 New Project					?	×
1769-L36ERMS C GD_350_EthernetIP_C	ompact GuardLogix® 5370 ^{DVA_049}) Safety Co	ntroller			
Re <u>v</u> ision:	31 ×					
Security Authority:	No Protection			Ŷ		
	Use only the selected Secur authorization	ity Authority	for authe	ntication and	-	
Secure With:	Logical Name <controller n<="" p=""></controller>	lame>				
	<u>Permission</u> Set			v		
Description:						
	Can	cel	<u>B</u> ack	<u>N</u> ext	<u> </u>	ish

3.5.2 Import an EDS file

The EDS file is used to specify device attributes for Ethernet IP client. The client identifies the device through product code, device type, and major version attributes.

You can obtain the EDS file of the communication card from the vendor, or downloaded it (file name: GD350_EthernetIP_V1.01.eds) from the INVT website at www.invt.com.

Right click "TOOLS", and select "EDS Hardware Installation Tool".



Click "Next".

Rockwell Automation's EDS Wi	zard		>
	Welcome to Rockwell Automation's EDS Wizar	d	
	The EDS Wizard allows you to:		
	- register EDS-based devices.		
	- unregister a device.		
	- change the graphic images associated with a device.		
	- create an EDS file from an unknown device.		
	- uplaad EDS file(s) stared in a device.		
	To continue dick Newt		
		Next > Cance	

Select the option as shown in the following figure, and click "Next".

Rockwell Automation's EDS Wizard Options What task do you want to complete?			×
Register an EDS file(s). This option will add a device(s) to our database.			
C Unregister a device. This option will remove a device that has been registered by an EDS from our database.	file		
Create an EDS file. This option creates a new EDS file that allows our software to recogn your device.	size		
C Upload EDS Fle(s) from the device. This option uploads and registers the EDS Fle(s) stored in the device	τ.		
	< Back	Next >	Cancel

Click "Browse" to select the EDS file that you want to download, and then click "Next".

ckwell Automation's EDS Wizard Registration Electronic Data Sheet file(s) will be added to	o your system for use in Rockwell Automation applications.	, V
Register a gingle file C Register a directory of EDS files ■	🗆 Look in subfolders	
Named:		
If there is an icon file (ico) with the s registering then this image will be asso		
	To perform an installation test on the file(s), click Next	
	< Back Next > Cance	ы

Continue to click "Next".

ockwell Automation's EDS Wizard		>
EDS File Installation Test Results This test evaluates each EDS file for errors in the EDS file. This te	st does not guarantee EDS file validity.	Q.
Hereit Installation Test Results		
e:\ invt_gd350_ethernetip_v1.20.eds		

Click "Next" again, and the installation is successful.

Rockwell Automatio	n's EDS Wizard			×
Change Graphic You can chan;	: Image ge the graphic image that is associated with a device.			
	Product			
Change icon	Generic Device(deprecated for new devices)			
		< Back	Next >	Cancel

3.5.3 Create a new device object

Select "I/O Configuration"->"Ethernet item" on the left, and right click "New Module".

Logix Designe FILE EDIT V		-					S WINDOW	V HELP						
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Select "GD350_EthernetIP_MODULE", and click "Create".

Catalog Banbar	Bensription	Tender	Category	
E1760-SER?	Ethernet Valve Manifold 519	SMC Corporation	Commination	
EE260-SERO	Ithernet Valve Manifold SIV	INC Corporation.	Commication	
EE260-SEM4	Ethernet Valve Manifold SIV	32C Corporation	Communication	
E2500-GEBL	Ethernet Outway	12MC Corporation.	Communication	
PARK CRC	EtherHet/IF CHC	FAMIC CORPORATION	Specialty	
PARC Robert	EtherHet/IF Robert	FAIRUE Robotics America	Specialty	
FARRY Robert B3018 Flux	RtharHot/IF Robert \$3018 Flux	FARTY Roberties Associes	Specialty	
62000_2theree12f_000013.	1WI	ANG Industrial Betworks AB	Osmarie Revise (depression)	
1000-236390-0	Cilcinet to Rolling Linking Device	180 Industrial Setrophy AD	Communications	
HED-ENZED-R	Ethernet to Frofibus Linking Device	MES Industrial Matworks AB	Concumination	
HOU-EXCLE-R	Etharnet to Serial Linking Device	MME Industrial Hetworks AB	Commination	
IB-801	2 Zone Controller (Stundard)	Itak Danki Co., Ltd.	Communication	
18-8038	2 Zune Controller (Standard)	Inah Benki Co., Ltd.	Communication	
18-8047	2 Zone Controller (Stundard)	Itoh Benki Co., Ltd.	Communication	
ISD131 Ethernet/IF	Scale Terminal	Mattler-Teledo	Commination	
INCOLO Ethernet/27	Scale Terminal	Mattler-Teledo	Commication	
ISEG70 Ethernot/2P	Scale Terminal	Mattler-Tolado	Communication	
ISD/00 Ethernet/2P	Scale Terminal	Mattler-Tolado	Commination	- 14
In-Sight 1700 Series	Winion System	Cogness Corporation	Commination	- 18
In-Sight 3400 Series	Vision System	Cognes Corporation	Communication	
In-Sight 5000 Series	Vision System	Cogness Corporation.	Communication	
In-Sight Micro Series	Vinien System	Cognes Corporation	Communication	
Link Of Printer	Lind-OD Printer	Zahra Tashnalogian	Communication	
Ligniline CABOos	fitherHen/TP Analysis	Indross Manser	Specialty	

Fill in the module name, and set the IP address of the module. The IP address must be consistent with P16.58–P16.61 on the GD350 Ethernet IP communication card, otherwise communication fails.

I New Module		×
	met Protocol Port Configuration Network	
Type: GD350_EthemetIP_MO Vendor: HMS Industrial Network: Parent: Local		
Name: test_0429_3	Ethernet Address	
Description:	O Private Network: 192.168.1 0 Image: Straight of the straight o	
Module Definition		
Revision: 1.013 Electronic Keying: Compatible Modu Connections: Exclusive Owne		
	Change	
Status: Creating	OK Cancel He	p

Click the "Change" option to select the protocol type used by the module. Each type differs in IO format, so you need to select the corresponding IO format based on the protocol type, as shown in the following table. Take "Exclusive Owner" as an example.

Rew Modu	e ection Module Info Internet Protocol Port Configuration Network	×
Type: Vendor:	Module Definition* X	
Parent:	Revision: 1 V 013 🜩	
Name:	Bectronic Keying: Compatible Module V	
Description:	Connections:	
	Name Size Tag Suffix 1 . 3]
	Exclusive Owner Vinjut: 16 Output: 16 Output: 16	
Module Defir Revision: Electronic K Connections	21/17 Extended speed on 22/72 Easts: Opeed and 22/72 Easts: Opeed and 22/72 Easts: Opeed and 22/72 Easts: Opeed avv7 22/73 East: Opeed avv7 22/77 East: Opeed av	
	ciange	
Status: Creating	OK Cancel Help	,

Name	Size	Format
Exclusive Owner	16	INT
20/70 Basic speed control	2	INT
21/71 Extended speed control	2	INT
22/72 Basic Speed and Torque control	3	INT
23/73 Extended Speed and Torque control	3	INT
INVT 24/74 Basic Speed Control plus Drive Parameters	12	INT
INVT 25/75 Enhanced Speed Control plus Drive Parameters	12	INT
INVT 26/76 Basic Speed and torque Control plus Drive Parameters	12	INT
INVT 27/77 Enhanced Speed and torque Control plus Drive Parameters	12	INT

Click "OK", "Yes", "OK", "OK", "OK", and "OK" in turn.

General* Conr Type:	Module Info	Internet Protocol Port Co	onfiguration Netw	ork	×	
Vendor:			•		~	
Parent: Logix Designer	Revision:	1 ~ 013	•			×
Verify	module properti ge module definiti	ult values unless it can es before Applying cha on? <u>Yes</u>		rom the existing	g module propert	ies.
Connections					_	

Once the module has been created successfully, you can see it under "Ethernet" item under "I/O Configuration" on the left, and click it to check the device information.

Logix Designer - GD_553_EthernetiP_COVA_648 [1768-LS653]	M\$ 31.11]*	
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Power-Up Handler	Peret: Looi	
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[0] 1769-L36ERMS GD_350_EthemetiP_ODVA_049		
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3.5.4 Use of Rslinx Classic

Rslinx Classic is used to connect the PC to the PLC. Open the "Rslinx Classic" software.

Click the "S" icon, and a window of "Configure Drivers" pops up. Select "Ethernet/IP Driver" in the drop-down menu of "Available Driver Types", click "Add New", a window of "Add New RSLinx Classic Driver" pops up, and click "OK".

🎨 RSLinx Classic Gateway		-	\Box \times
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EtherNet/IP Driver	•	Add New	Help		
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			Stop		
			Delete		
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For Help, press F1		CAP	04/29/20	10:44 A	м //

In the "Configure driver" window that pops up, select your computer's network card and click "OK".

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3.5.5 Writing PLC programs

Click on "Tasks"-->"MainTask"-->"MainProgram"--> on the left. Right click on "MainProgram" and "Parameters and Local Tag" above "MainRoutine" to create global variables. Right click "Parameters and Local Tag" above "MainProgram" to create global variables.

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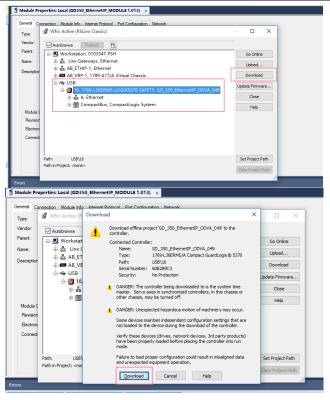
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External Access:	Read/Write	\sim	
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• Controller Organizer 🖁 Logical Organizer	Geneth Results		resonation Software, ISLina Classic 418			

3.5.6 PC connection and program download

Click on "COMMUNICATIONS" under "Who Active", and in the pop-up screen, click on PLC Project under the "USB" option and click "Download". **Note:** The PLC dial code cannot be "RUN" at this time.

Logix Designer - GD_350_EthernetIP_ODVA_049 [176]	9-L36ERMS 31.11]
FILE EDIT VIEW SEARCH LOGIC COMMUNIC	CATIONS TOOLS WINDOW HELP
15 🖆 🖨 🗶 🗗 요 🤊 연 🚮 Who A	
	Recent Path Communication Software Communication Software Communication Software Communication Software Castery Unided C C C Forcettes ASSOn Safety Alarms St Timer/Counter Input
Controller Organizer Upload	
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	Module Defeten Revisor: 1013 Becteric Keyre: Exclusive Gener VA, Mod
	Errors



3.5.7 Configuring PLC IP Addresses through the studio5000 V31 software

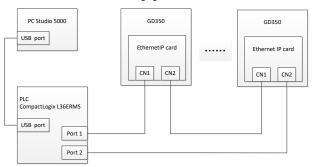
Make sure that the PLC is in REM or PROG mode, click "1769-L36ERMS" at the bottom left to enter the "Controller Properties" interface, and then click "Internet Protocol" to change the IP address of the PLC.

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3.5.8 DLR Ring Network Configuration

(1) Using Logix Designer for setup

Open the Studio 5000 software and use an Allen-Bradley CompactLogix PLC with ring networking capability, which requires at least two GD350 Ethernet IP communication cards. More GD350 Ethernet IP communication cards can be added, but it is recommended that the maximum number of nodes used on the DLR ring network shall not exceed 32. The connection method is shown in the following figure.



Note: An EDS file must be added.

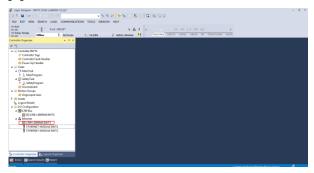
(2) Add an Ethernet IP communication card to the Studio 5000 software

The method of addition is the same as that of the linear star connection.

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(3) Enabling PLC ring network monitor function

Double click "1769-L36ERMS INVTS" under the "I/O Configuration" folder, as shown in the following figure.

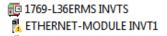


Enter "Network" under the "Controller Properties" option and select "Enable Supervisor Mode".

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Note: The ring network monitor function is enabled only when the PLC is in programming mode.

(4) Return to Logix Designer and make sure that none of the communication cards has encountered the following fault.



(5) Download the project to the PLC, bring the PLC online, and put it in programming mode.

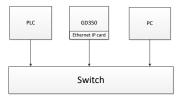
3.6 Example 2 of PLC communication (communicate with ORMON PLC)

This example shows how to use an ORMON PLC (model: NX1P2-9024DT) to communicate

with an Ethernet IP adapter module (through using the Sysmac Studio software as the configuration tool).

3.6.1 Hardware connections

The NX1P2-9024DT is not configured with a USB download port, and communication and download between the PC and PLC is conducted through the built-in Ethernet IP port. In this case, a switch is needed in the experiment, and the connection method is as follows.



3.6.2 Network Configurator software setting

3.6.2.1 Launch Network Configurator software



Start the Network Configurator software

as an administrator in the following

directory: "C:\Program Files

(x86)\OMRON\CX-One\NetworkConfigurator\Program\NetConfigurator.exe".

3.6.2.2 Load the EDS file

Select "EDS File"->"Install", and add EDS file: INVT_GD350_EthernetIP_V1.01. Click "Open", "Yes", and then click "Cancel".

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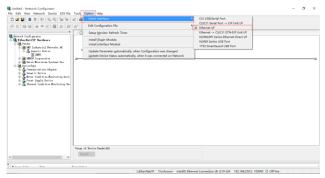
Add "NX1P2" and "INVT" in the following location to the Ethernet IP bus. After these two devices are added successfully, the bus shows two devices. The default IP addresses are "192.168.250.1" and "192.168.250.2", and GD350 function codes P16.58–P16.61 are changed into 192, 168, 250 and 1 respectively.

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3.6.2.3 Connection setting

Click "Option" \rightarrow "Select Interface", and select "Ethernet I/F".



Click the "Connect" icon to select the corresponding network port, and click "OK".

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Select "TCP:2", and click "OK".

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Select "Use the existing network"→"EtherNet/IP_1", click "OK", and the PLC is connected successfully.

After the PLC is connected successfully, the blue indicator above the PLC device icon is on.

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Click the "Device Property" icon, and the "Controller Information" tab pops up. You can switch the PLC status between "Program" and "Run" in the tab.

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3.6.2.4 Modify IP address

Right click the device icon and select "Change Node Address" to change the PLC IP address.

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3.6.3 Sysmac Studio software settings

3.6.3.1 Create a new project

Double click the

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icon to open the software, select "New Project", enter "Project name",

select the device type, and click "Create".

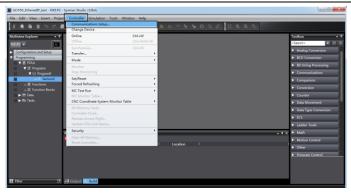
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After a new project is created completely, you can enter the following interface. Right click the device icon and select "Rename" to change the device name (you can choose not to change it).

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3.6.3.2 Connection setting

Click "Controller" in the menu bar, and select "Communications setup".



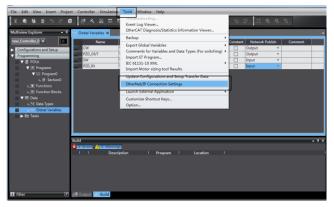
Select "Ethernet-Hub Connection" as the connection method, enter the remote IP address "192.168.250.1", and click "Ethernet communication test". Click "OK" when the status bar shows "Test succeeded".

3.6.3.3 Set data labels

Select "Programming" \rightarrow "Data" \rightarrow "Global Variables" in the left menu bar, and add global variables as needed. Note that you shall select "WORD" in the "Data Type" column and select "Input/Output" in the "Network Publish" column. Take "ODVA Basic speed control assembly" as an example, and create four global variables.

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Click "Tools" in the top menu bar, and select "EtherNet/IP Connection Settings".



Double click "Built-in EtherNet/IP Port Settings".

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Right click the blank area under "Tag Set", and select "Create New Tag Set".

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The input tag set is named "INPUT", right click "INPUT" to select "Create New Tag", and add the input global variables to the "INPUT" tag set. Pay attention to the order of the data sequence.

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Repeat above steps for "OUTPUT" tag set and "OUTPUT" tag.

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3.6.4 Import and export data tags

3.6.4.1 Export data tags from Sysmac Studio

After data tags are set completely, click "Export" to export the data tag to a local folder, and save it as "GD350_test.csv" format.

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3.6.4.2 Import data tags into Network Configurator

In the "Network Configurator" software, double click the PLC device icon, click "To/From File" in the lower right corner, and select "Import from File...".

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Select the file "GD350_test.csv" exported from Sysmac Studio, and click "Open".

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3.6.4.3 Data tag corresponding connection

Select the device "192.168.250.2" under the "Connections" tab, and click the Move Down button.

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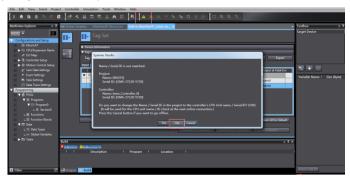
Double click the device "192.168.250.2", set the data input/output tags, and click "Regist".

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3.6.5 PLC program downloading and online monitoring

3.6.5.1 Sysamc Studio downloading

Click the Online button (If the device name has been changed, the following interface will pop up, and you can click "No").



Click "Transfer to Controller" under the "Built-in EtherNet/IP Port Settings" tab.

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Click "Yes".

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Click the "Sync" function button.

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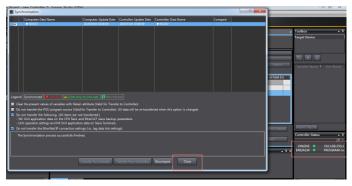
Select the device "NX1P2", and click "Transfer To Controller".

Synchronization				
Computer. Data Name	Computer: Update Date	Controller: Update Date	Controller: Data Name	Compare
🔽 😝 — NX1P2	2020/9/18 18:08:59	2020/6/24 11:28:15	NX1P2	
Legend: Synchronized				
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Do not transfer the following. (All items are no		All data will be re-transie	neu when this option is changed.	
 NX Unit application data on the CPU Rack an Unit operation settings and NX Unit application 	d EtherCAT slave backup	parameters.		
Do not transfer the EtherNet/IP connection setting	ngs (i.e., tag data link settir	ngs).		
All data will be transferred because the projects	in the computer and the	controller are different.		
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	Restart		Tr	ansfer to Controller	Transfer from Contro		All to Default
Output							- 4 ×

Click "Close" when the "Controller" status in the lower right corner is two green lights.



3.6.5.2 Network Configurator downloading

Click the icon of "Download to Device", and click "Yes".

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3.6.5.3 Sysamc Studio online monitoring

Click the "Run" icon, turn the PLC to "Run Mode", and click "Yes".

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Click "View" on the top menu bar, and select "Watch Tab Page".

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Enter the variable name in the "Watch Tab Page" to monitor the value of the variable, and

change the value in real time in the "Modify" box.

			1		•
Name	Online value	Modify I	Comment	I Data type	I AT
CW	0001	1		WORD	
PZD_OUT	1388	1388		WORD	
SW	0004			WORD	
PZD_IN	1388			WORD	
PZD_IN	1388			WORD	

4 EtherCAT communication card

4.1 Overview

- Thanks for choosing INVT EC-TX508 communication cards. This manual describes the function specifications, installation, basic operation and settings, and information about the EtherCAT protocol. To ensure that you install and operate the product properly, read this manual and the communication protocol section in the VFD operation manual carefully before you use the product.
- This manual only describes how to operate the EC-TX508 communication card and the related commands but does not provide details about the EtherCAT protocol. For more information about the EtherCAT protocol, read the related specialized articles or books.
- 3. EC-TX508 communication card is defined as an EtherCAT slave station communication card and is used on a VFD that supports EtherCAT communication.
- 4. The EtherCAT communication of this communication card supports two types of process data for reading data from and writing data to VFDs. They are PDOs (process data objects) and SDOs (service data objects) for reading data from and writing data to the object dictionary defined by the manufacturer.

4.2 Features

1. Supported functions

- Supports the EtherCAT COE 402 protocol.
- Supports automatic network address setting
- 2. Supported services
- Supports the PDO service
- Supports the SDO service
- > Supports the object dictionary defined by the manufacturer
- > Allowing SDOs to read data from and write data to VFD function codes

3. Supported EtherCAT synchronization cycle

Table 4-1 Supported synchronization cycle

ltem	Supported specification
Synchronization cycle	1ms
Synchronization cycle	2ms

4. Communication ports

Standard RJ45 ports are used in EtherCAT communication. The communication card provides two RJ45 ports with transmission direction defined. Figure 4-1 shows the ports. IN (indicating input) and OUT (indicating output) are EtherCAT wiring network ports. Table 4-2 describes the port pins.



IN

OUT



Table 4-2 RJ45 port pins

Pin	Name	Description
1	TX+	Transmit Data+
2	TX-	Transmit Data-
3	RX+	Receive Data+
4	n/c	Not connected
5	n/c	Not connected
6	RX-	Receive Data-
7	n/c	Not connected
8	n/c	Not connected

5. State indicators

The EtherCAT communication card provides five LED indicators and four net port indicators to indicate its states. Figure 4-2 shows the state indicator positions. Table 4-3 describes the state indicator functions.



Figure 4-2 State indicator positions

Table 4-3	State	indicator	functions
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Item	Color	Function description
RUN	Green	The green indicator indicates EtherCAT running state. Init state: It remains off. Pre-OP state: It blinks off 0.2s and on 0.2s (Blinking). Safe-OP state: It flashes off 1s and on 0.2s (Single flash). OP state: It remains on.
ERR	Red	The red indicator indicates EtherCAT fault state. No fault: It remains off. Init or Pre-OP state: It blinks off 0.2s and on 0.2s (Blinking). Safe-OP fault state: It flashes off 1s and on 0.2s (Single flash). OP state: It remains on. Process data watchdog timeout: (Double flash).
L/A IN	Green	Off: Without connection. On: With connection but inactive. Flickers: With connection and active (Flickering).
L/A OUT	Green	Off: Without connection. On: With connection but inactive. Flickers: With connection and active (Flickering).
PWR	Red	3.3V power indicator
Net port	Yellow	Off: Indicates that Ethernet connection is not established. On: Indicates that Ethernet connection is established successfully.
(IN)	Green	Off: Without connection On: With connection but inactive Blinks: With connection and active
Net port	Yellow	Off: Indicates that Ethernet connection is not established. On: Indicates that Ethernet connection is established successfully.
(OUT)	Green	Off: Without connection. On: With connection but inactive. Blinks: With connection and active.

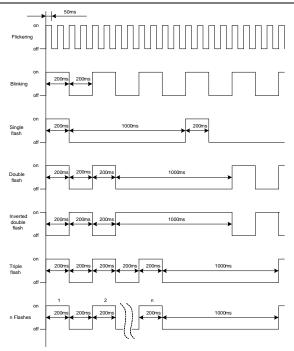


Figure 4-3 Indicator flashing/blinking/flickering frequency

6. EtherCAT compliance test

The product has passed the EtherCAT compliance test. EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.



Figure 4-4 EtherCAT compliance qualification marking

4.3 Electrical wiring

The EtherCAT network usually consists of a master station (PLC) and several slave stations (drives or bus extension terminals). Each EtherCAT slave station is configured with two standard Ethernet interfaces, and the electrical wiring diagram is shown in Figure 4-5. The network also supports the star topology, which requires professional switches.

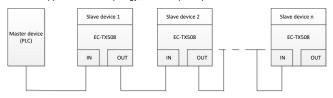


Figure 4-5 Electrical wiring diagram for a linear topology

4.4 Communication

4.4.1 CoE reference model

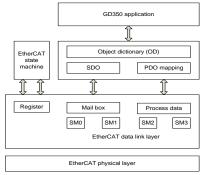


Figure 4-6 CoE reference model

CoE network reference model consists of the data link layer and application layer. The data link layer is responsible for EtherCAT communication protocol. CANopen drive Profile (DS402) communication rules are embedded in the application layer. The object dictionary in CoE includes the parameters, application data, and PDO mapping configuration information.

PDOs are composed of the objects (in the object dictionary) that can perform PDO mapping. The content in PDO data is defined by PDO mapping. PDO data is periodically read and written, which does not require searching the object dictionary. Mail box communication (SDO) is not periodic, which requires searching the object dictionary.

Note: To parse SDO and PDO data correctly on the EtherCAT data link layer, it is necessary to configure FMMU and Sync Manager (SM).

Synchronization management	Configuration	Size	Start address
Sync Manager 0	Assigned to receive SDO	512byte	0x1000
Sync Manager 1	Assigned to send SDO	512byte	0x1400
Sync Manager 2	Assigned to receive PDO	128byte	0x1800
Sync Manager 3	Assigned to send PDO	128byte	0x1C00

Table 4-4	EtherCAT	Sync	Manager	configuration
	LUICIOAI	Oynic	manager	configuration

4.4.2 EtherCAT slave station information

EtherCAT slave station information file (.xml) is read by the master station to construct the master and slave station configuration. This file contains mandatory information about EtherCAT communication settings. INVT provides this file EC-TX508_100.xml.

4.4.3 EtherCAT state machine

EtherCAT state machine is used to describe the states and state change of slave station applications. Generally, the master station sends a state change request, while the slave station responds. The state change flow is shown in the following figure.

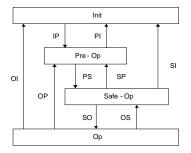


Figure 4-7 EtherCAT state machine flowchart

Table 4-5 EtherCAT state machine description	
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State	Description
Init	Both SDO and PDO communication are unavailable.
Init to Pre-Op	The master station configures the data link layer address and SM channel for SDO communication. The master station initializes DC synchronization information. The master station requests the jump to the Pre-Op state. The master station configures the application layer control register. The slave station checks whether the mailbox is initialized properly.
Pre-Op	SDO communication is available but PDO is unavailable.
Pre-Op to Safe-Op	The master station configures the SM and FMMU channels for PDO communication. The main station configures PDO mapping through SDO communication. The master station requests the jump to the Safe-Op state. The slave station checks whether the PDO and DC are configured correctly.
Safe-Op	SDO communication is available. Communication of receiving PDOs is available, but that of sending PDOs is unavailable, in the Safe state.
Safe-Op to Op	The master station requests the jump to the Op state.
Ор	Both SDO and PDO communication are available.

4.4.4 PDO mapping

The process data of an EtherCAT slave station is composed of SM channel objects. Each SM channel object describes the consistent area of the EtherCAT process data and includes multiple PDOs. An EtherCAT slave station with the application control function shall support PDO mapping and reading of SM PDO assigned objects.

The master station can select objects from the object dictionary to perform PDO mapping. PDO mapping configuration is located in the range of 1600h–1603h (RxPDOs: receiving PDOs) and range of 1A00h–1A03h (TxPDOs: sending PDOs) in the object dictionary. The PDO mapping method is shown in the following figure.

Ethernet Communication Card

	Object d	ictionary		
Index	Sub- index	Object content	6	6064 indicates index 00h indicates sub-index 20h indicates parameter bit length
1A00h	0	0x03		
1A00h	1	0x60410010		
1A00h	2	0x60640020	+	
1A00h	3	0x60B90010		
Index	Sub- index	Object content	Bits	1A00h(PDO-1) B E G
6040h	0	Object A	10h	
6041h	0	Object B	10h	
6042h	0	Object C	10h	
6060h	0	Object D	8h	
6064h	0	Object E	20h	
60D8h	0	Object F	10h	
60B9	0	Object G	10h	

Figure 4-8 PDO mapping method

In addition to PDO mapping, EtherCAT process data switching needs to assign PDOs to SM channels. The relationship between PDOs and SM channels is established through SM PDO assigned objects (1C12h and 1C13h). The mapping between SM channels and PDOs is shown in the following figure.

	Object d	ictionary
Index	Sub- index	Object content
1C13h	0	0x02
1C13h	1	0x1A00
1C13h	2	0x1A01
Index	C	Object content
1A00h		PDO_1
1A01h		PDO_2
1A02h	I.	PDO_3
1A03h		PDO_4



Default PDO mapping (Position, Velocity, Torque, Torque limit, Touch probe):

RxPDO (0x1600)	Control word (0x6040)	Target Position (0x607A)	Target Velocity (0x60FF)	Target Torque (0x6071)		Mode of Operation (0x6060)	Profile velocity (0x6081)	Touch Probe Function (0x60B8)
TxPDO (0x1A00)	Statusw ord (0x6041)	Position Actual Value (0x6064)	Speed Actual Value (0x606C)	Torque Actual Value (0x6077)	Following Error Actual Value (0x60F4)	woue or	Error Code (0x603F)	Touch Probe Value (0x60BA)

4.4.5 DC-based network synchronization

The DC (distributed clock) can enable all EtherCAT devices to use the same system time so as to control the synchronous execution of all device tasks. In the EtherCAT network, the clock with the DC function of the first slave station connected to the master station is used as the reference clock across the network. The other slave stations and master station use this reference clock for synchronization.

Free-Run: The running cycle and communication cycle of each servo drive are not related to the communication cycle of the master station.

DC Mode: The servo drive performs synchronization through Sync0 of the master station.

4.5 CiA402 device protocol

The master station controls the drive through the control word (0x6040) and obtains the current state of the drive by reading the status word (0x6041). The servo drive implements motor control based on master station control commands.

4.5.1 CoE state machine

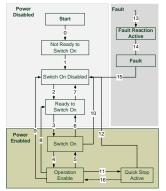


Figure 4-10 CANopen over EtherCAT state machine

Status	Description
Not Ready to Switch On	The drive is in the initialization process.
Switch On Disabled	Drive initialization completes.
Ready to Switch On	The drive is preparing to enter the Switch On state, but the motor is not excited.
Switched On	The drive is in the ready state, and the main circuit power supply is normal.
Operation Enable	The drive is enabled and controls the motor based on the control mode.
Quick Stop Active	The drive stops in the set manner.
Fault Reaction Active	When detecting an alarm, the drive stops in the set manner, but the motor still has the exciting signal.
Fault	The drive is in the faulty state, and the motor has no exciting signal.

6040h control word includes:

- 1. Bit for status control;
- 2. Bit related to control mode;
- 3. Factory-defined control bit.

15	11	10	9	8	7	6	4	3	2	1	0
Facto defir	-	Rese	erved	Suspend	Fault reset		ration ode	Servo running	Quick stop	Switch on main circuit	Servo being running
0		C)	0	М		0	М	М	М	М
MS	SВ				LSB						

The bits of 6040h are described as follows.

BITS 0-3 AND 7 (used for status control):

		Bit of the	ne control wo	rd		
Command	Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	Transitions
Shutdown	0	Х	1	1	0	2,6,8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	Х	Х	0	Х	7,9,10,12
Quick stop	0	Х	0	1	Х	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset	0-1	Х	Х	Х	Х	15

BITS 4, 5, 6 AND 8 (related to control mode)

		Operation mode	
Bit	Profile position mode	Profile position mode Profile velocity mode	
4	New set-point	Reserved	Homing operation start
5	Change set immediately	Reserved	Reserved
6	Rel	Reserved	Reserved
8	Halt	Halt	Halt

Note: You can set bit 4 in Profile position mode to a new set-point to trigger the position.

Control word is set to 0x0F for enabling the drive. Otherwise, the drive will stop. When a fault occurs, if bit 7 of the control word is set to 1, the reset command is enabled.

6041h status word includes:

- 1. Current status bit of drive;
- 2. Status bit related to control mode;

3. Factory-defined status bit.

The bits of 6041h are described as follows:

Bit	Description	M/O
0	Ready to switch on	М
1	Switched on	М
2	Operation enabled	М
3	fault	М
4	Voltage enable	М
5	Quick stop	М
6	Switch on disabled	М
7	Warning	0
8	Manufacture specific	0
9	Remote	М
10	Target reached	М
11	Internal limit active	М
12-13	Operation mode specific	0
14-15	Manufacturer specific	0

BIT0-3, 5, AND6:

Value(binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active

Value(binary)	State
xxxx xxxx x0xx 1000	Fault

BIT4: Voltage enable, when this bit is 1, it indicates that the main circuit power supply is normal.

BIT9: Remote, when this bit is 1, it indicates that the slave station is in the OP state, and the master station can control the drive through PDO.

BIT10: Target reached, this bit differs in meaning under different control modes. When this bit is 1, in cyclic synchronous position mode, it indicates that target position is reached, while in cyclic synchronous velocity mode, it indicates that reference speed is reached; in homing mode, it indicates that homing is completed.

BIT14: When this bit is 1, it indicates motor zero-speed state.

BIT7-8, BIT11-13, and BIT15: Reserved.

4.5.2 Device running mode

Set P00.01=2 (communication as the command running channel), P00.02=3 (EtherCAT communication channel), and P16.75 Communication timeout time. Position mode and homing mode are achieved only when the drive is in the closed-loop mode.

4.5.2.1 Profile Position Mode

1. Set 【6060h: Mode of operations】 to 1 (Profile Position Mode).

2. Set P20.01 (Encoder pulse count) according to the encoder model, set the tens place of P21.00 (Position command source) to 1, and set P21.16 (Digital positioning mode) (16#0200, Bit9=1 position source given through EtherCAT communication).

3. Set 【6081h: Profile velocity】 and frequency mapping relationship: V=60f/p, (the unit of V is rotation/min, f indicates frequency, while p indicates the number of motor pole pairs).

4. Set **[**6083h: Profile acceleration**]** and **[**6084h: Profile deceleration**]** to write related parameters to P21.20 and P21.21. (**Note:** The units of 6083h and 6084h are ms.)

5. Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling).

6. Set 【607Ah: Target position】 to the target position (unit: user unit).

7. Query for 【6064h: Position actual value】 to obtain the actual motor position feedback.

8. Query for 【6041h: Status word】 to obtain the drive status feedback (following error, target reached and internal limit active).

9. For function details, see function parameters in group P21 in function code list chapter and commissioning chapter in the GD350 operation manual.

4.5.2.2 VFD Mode

1. Set 【6060h: Mode of operations】 to 2 (VFD mode).

2. Set 【6046h: vI velocity min max amount】 to set the max. and min. rotation speeds. If you do not set it, the default values on the drive are used.

3. Set [6048h: vl velocity acceleration] and [6049: vl velocity deceleration] to set the acceleration time and deceleration time. The acceleration time is [6046h:02 vl velocity max amount] * [6048h:02 Acceleration Delta Time] *0.1/ [6048h:01 Acceleration Delta Speed], and the time unit is second, corresponding to P00.11. The deceleration time is [6046h:02 vl velocity max amount]*[6049h:02 Deceleration Delta Time]*0.1/[6049h:01 Deceleration Delta Speed], and the time unit is second, corresponding to P00.12.

4. Set [604Ch: vl dimension factor] to adjust the e-gear ratio, which is 1:1 by default.

5. Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling).

6. Set [6042h: vl target velocity] to set the target rotation speed.

7. Set 【6040h: Control word】 to run the drive (set it to 0x7F for running), and start the motor.

8. Query for 【6044h: vl velocity actual value】 to obtain the actual motor speed feedback.

4.5.2.3 Profile Velocity Mode

1. Set 【6060h: Mode of operations】 to 3 (Profile Velocity Mode).

2. Set **[**6083h: Profile acceleration **]** and **[**6084h: Profile deceleration **]** to write related parameters to P00.11 and P00.12. (**Note:** The units of 6083h and 6084h are ms.)

3. Set P00.01=2, P00.02=3, and P00.06=13.

4. Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling) to start the motor.

5. Set 【60FFh: Target velocity】 to set the target rotation speed (unit: rpm).

6. Query for 【6041h: Status word】 to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, and Internal limit active).

4.5.2.4 Profile Torque Mode

1. Set 【6060h: Mode of operations】 to 4 (Profile Torque Mode).

2. Set [6087h] to set the torque ramp.

3 Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling) to start the motor.

4. Set P03.11=11.

5. Set 【6071h: Target torque】 to the target torque.

6. Query for 【6041h: Status word】 to obtain the status feedback of the drive (Speed zero, Max slippage error, Target reached, Internal limit active).

4.5.2.5 Homing Mode

1. Set 【6060h: Mode of operations】 to 6 (Homing Mode).

2. Set bit 0 of P22.00 to 1 to enable spindling positioning, and set P22.03–P22.06 to set zero positions.

3. Set **[**6040h: Control word**]** to enable the drive (set it to 0x0F for enabling). When bit4 changes from 0 to 1, the homing operation starts, and when bit4 changes from 1 to 0, the homing operation is interrupted.

4. The motor queries for the limit switch and home switch to complete the homing action.

5. Query for 【6041h: Status word】 to obtain drive status feedback (Homing error, Homing attained, and Target reached).

6. For function details, see function group P22 description in function code list chapter and commissioning chapter in GD350 operation manual.

4.5.2.6 Touch Probe Function

Record the present position according to the Z phase rising edge or falling edge signal, and set the control word to record one or multiple times.

1. When the control word (60B8h: Touch Probe Control) is 23 (2#01 0111), the function indicates that the Z phase rising edge triggers recording the present position continuously. The recorded value is Turns of motor rotation x 10000. Every time the motor rotates a turn, a value is updated. The status word is 3 (60B9h: Touch Probe Statu).

2. When the control word (60B8h: Touch Probe Control) is 21 (2#01 0101), the function indicates that the Z phase rising edge triggers recording the present position continuously. The recorded value is Turns of motor rotation x 10000. The status word is 3 (60B9h: Touch Probe Statu).

3. When the control word (60B8h: Touch Probe Control) is 39 (2#11 0111), the function indicates that the Z phase falling edge triggers recording the present position continuously. The recorded value is Turns of motor rotation x 10000. Every time the motor rotates a turn, a value is updated. The status word is 5 (60B9h: Touch Probe Statu).

4. When the control word (60B8h: Touch Probe Control) is 21 (2#01 0101), the function indicates that the Z phase rising edge triggers recording the present position continuously. The recorded value is Turns of motor rotation x 10000. The status word is 5 (60B9h: Touch Probe

Statu).

Note: Only one type of probe is supported and one locked value can be recorded at one time.

4.5.2.7 Cyclic Synchronous Position Mode

1. Set 【6060h: Mode of operations】 to 8 (Cyclic synchronous position mode).

2. Set P00.00=3, P00.01=2, P00.02=3, and P00.06=13.

3. Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling).

4. Set 【607Ah: Target position】 to the target position (unit: user unit).

5. Query for 【6064h: Position actual value】 to obtain the actual motor position feedback.

6. Query for 【6041h: Status word】 to obtain the drive status feedback (following error, target reached and internal limit active).

7. For function details, see function group P21 description in function code list chapter and commissioning chapter in GD350 operation manual.

4.5.2.8 Cyclic Synchronous Velocity Mode

1. Set [6060h: Mode of operations] to 9 (Cyclic synchronous velocity mode).

2. Set 【6083h: Profile acceleration】 and 【6084h: Profile deceleration】.

3. Set P00.01=2, P00.02=3, and P00.06=13.

4. Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling) to start the motor.

5. Set 【60FFh: Target velocity】 to set the target rotation speed (unit: rpm).

6. Query for 【6041h: Status word】 to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, and Internal limit active).

4.5.2.9 Cyclic Synchronous Torque Mode

1. Set 【6060h: Mode of operations】 to 10 (Cyclic synchronous torque mode).

2. Set P03.11=11 (Communication as the setting mode) and P03.32=1 (Torque control enabling).

3. Set 【6040h: Control word】 to enable the drive (set it to 0x0F for enabling) to start the motor.

4. Set 【6072h: Max torque】 and 【6071h: Target torque】.

5. Query for 【6041h: Status word】 to obtain the drive status feedback (Speed zero, Max

slippage error, Target reached, and Internal limit active).

4.6 Example of TwinCAT2 application

This example shows how to use TwinCAT2 as the main station to communicate with the EtherCAT module of the VFD.

1. Install TwinCAT2 software

2. Copy the EtherCAT configuration file (EC-TX508_100.xml) of GD350 to the installation directory of TwinCAT2 ("C:\TwinCAT\lo\EtherCAT").

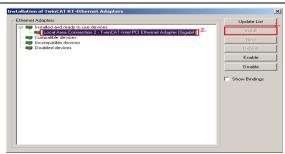
3. Open TwinCAT2



4. Install the network card drive

	stem Manager - "CX-26A00E"		_ O ×
File Edit Actions View			
] 🗅 🚅 📽 🔛 🎯 🛙	Language	• 🐘 🔨 🛞 🗎 🔍 🚜 🔐 🍢 🔊 🖉 🗑 🕈	
Organization Organization) (Target) Boot Settings (Target) System Manager Choose Target	
	Oreck RLC Project Oranges Open Logger Automatically Open Last Used File Select Last There Element Generate DAR-File Auto Serve to Tanget Show full document path Compatible Vieles forther commended for new projects)	au 2244 K FPLC Build 2232 HECKNOFF # 158-2011 HECKNOFF # 158-2011	
	Comparatively more (non-recommender for their protects) Show Real Time Ethernet Compatible Devices Charge RCMICE Base Address Update EtherCAFT Device Descriptions Edit Termini Types	or: Beckholf Automation : Beckholf Automation BmBH : OFBE-AREC-0001-10 DF	

Open the menu as shown in the above figure, select "Show Real Time Ethernet Compatible Devices...". In the dialog box as shown in the following figure, select the local area network card, and click "Install". After the network card is installed successfully, it will be shown under the menu "Installed and ready to use devices". (Note: Please choose the network cards configured with Intel chips.)



5. Set TwinCAT2 to be in the configuration mode



6. Scan device

Select "I/O Devices" menu, and right-click to select "Scan Devices..." to scan the device.



In the following dialog box that appears, select "OK".



In the following dialog box that appears, select "OK".

new I/O devices found	×
Device 1 (EtherCAT) Device 2 (RT-Ethernet) Device 3 (RT-Ethernet)	OK Cancel
	Select All Unselect All

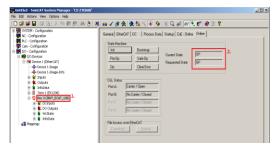
In the following dialog box that appears, select "Yes".



In the following dialog box that appears, select "Yes". Then the device enters the free running mode.



The following figure shows "Box3" which is the slave device scanned, and view that the device enters the "OP" state.



7. Process data input and output

Select "DO Outputs" menu, and there are data sent from the master station to the VFD, which can be used to set commands and rotation speed.

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SYSTEM - Configuration	None	Online	Type	Size	>Addr	InfOut	User ID	Linked to
Section NC - Configuration	 Control Word 	0x000F (15)	LOVE	2.0	71.0	Output	0	
PLC - Configuration	 Target Position 	0:00000000 (0)	DINT	4.0	73.0	Output	0 2.	
Cam - Configuration	Target Velocity	0x000005DC (1500)	DINT	4.0	77.0	Output	0	
I/O - Configuration	 Target Torque 	0x0000 (0)	DNT	2.0	81.0	Output	0	
E 10 Devices	 Max Torque 	0x0000 (0)	DNT	2.0	83.0	Output	0	
Device 1 (EtherCAT)	 Mode of Operation 	0x09 (9)	SINT	1.0	85.0	Output	0	
	Profile Velocity	0:00000000 (0)	DONT	4.0	86.0	Output	0	
- Device 1-Image-Info	 Touch Probe Con 	0:0000 (0)	LONT	2.0	90.0	Output	0	
H Inputs							_	
R Dutputs								
R InfoData								
F Term 1 (EK1200)								
Box 3 (INVT_ECAT_100)								
The set of termine								
8-1 DO Outputs 1.								
Control Word								
Target Position								
Target Velocity								
Target Torque								
Max Torque								
- Mode of Operation								
Profile Velocity								
Touch Probe Control								
🔅 🎈 InfoData								
- 🔐 Mappings	1							

Select "DI Intputs" menu, and there are data sent from the VFD to the master station, which can be used to return the statuses and and rotation speed.

😅 📽 🔛 🕼 🕰 🕺 🖉 📾 🖉 🛤 👌 📠								
SYSTEM - Configuration	Name	Online	Type	Size			User ID U	nànd
MC - Configuration	Status Word	0+0637 (1591)	UINT	2.0	71.0	Trend	2.	
PLC - Configuration	Position Actual V	0+00000000 (0)	OBVE	4.0	73.0	Incast		
Cam - Configuration	Velocity Actual V	0x0000000F (15)	DINT	4.0	77.0	Input	0	
UO - Configuration	Torque Actual Value	0×0000 (0)	INT	2.0	81.0	Input	0	
IS IN LO Devices	Set Following Error A	0x00000000 (0)	OINT	4.0	83.0	Input	0	
ID M Device 1 (EtherCAT)	Mode of operatio	0×09 (9)	DONT	1.0	87.0	Inguit	0	
	Carror code	0×0000 (0)	UDVT	2.0	85.0	Input	0	
- Device 1-Image-Info	Touch probe pisiti	0x00000000 (0)	OINT	4.0	90.0	Input	0	
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(i) - WcState	1							
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8. SDO data operation

Select "CoE–Online" menu, as shown in the figure below. Read the VFD function code parameters through index 0x2000, and double click 0x2000 to pop up a dialog box. Write the parameter address in the dialog box, and click "OK". The returned results are stored in index 0x2001. Similarly, Write the VFD function code parameters through index 0x2002, and the written results are stored in index 0x2003.

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NC - Configuration	General EtherCAT	DC Process Data St	artup Lot Drane	Drine			
PLC - Configuration	Undate Lin	1 -					
Cam - Configuration	Updake Lis	Update List Auto Update 🔽 Single Update 🗖 Show Offine Date					
IJO - Configuration	Advanced	-					
10 Devices					_		
Device 1 (EtherCAT)	Add to Starts	o Online Data	Module DI	(AuE Port) 0			
		Name	Flags	Value			
R- M Inputs		DI TxPDO-Map2	RW/	>2<			
Outputs		DI TxPDO-Map3	RW	>2<			
E S InfoData	IC00.0	Sync manager type	RD	>4<			
Figure 1 (EX1200)	+ 1012.0	RxPDO assign	BW	>1<			
Box 3 (INVT_ECAT_200) 1.	+ 10130 + 10320	TxPDD assign	BW BW	> 1 < > 32 <			
E M DI Inputs	+ 10320	SM output parameter SM input parameter	RD	> 32 <			
- Of Status Word		SM input parameter Parameter read	RW	0.00000000		_	
Position Actual Value	2000	Parameter read display	R0	0x00000000			
Velocity Actual Value	2002	Parameter reau unipsay	BW	0x00000000			
Torque Actual Value	- 2063	Parameter write display	BO	0+00000000			
Following Error Actual Value	- 600F	Error code	PI0	0x0000.00	M		
• Mode of operation display	6040	Control word	M RW	0x000F (15)			
Error code	6041	Status wood	MBO	0x4637 (1797	100		
 Touch probe pisition 1 positive value 	- 6050	Hait potion code	RW.	0			
H- DO Outputs	6060	Mode of operation	M RW	9			
Control Word	- 6061	Mode of operation display	RD	9			
Target Position	6062	Position demand value	BD	0			
Target Velocity	- 6063	Position actual value*	BD	0			
Target Velocity	6064	Position actual value	M RO	0			
Max Torque	- 6065	Following error window	Rw/	0x00000000	(0)		
Mode of Operation	8966	Following error time out	R/w/	Dx0000 (0)		-	
Profile Velocity							
Touch Prohe Control							
R- WcState	Norte	Online	Type	Size >Addr	In/Out 1	Juer ID Linked	
wcstate InfoData	Satus Word	0:4637 (17975)		2.0 71.0	Input 0		
Mappings	Position Actual V			1.0 73.0	Input 0		
a mappings	Velocity Actual V			1.0 77.0	Input 0		
	Torque Actual Valu		INT	2.0 81.0	Input 0		
	Following Error A		DBNT	1.0 83.0	Input 0		
	Mode of operatio			1.0 87.0	Input 0	é la companya de la c	
	1						

Set Value Di	alog	×
Dec:	65536	2. OK
Hex:	0x00010000 1.	Cancel
Float:	65536	
Bool:	0 1	Hex Edit
Binary:	00 00 01 00	4
Bit Size:	○1 ○8 ○16 ● 32 ○ 64 ○	72

5 Modbus TCP communication card

5.1 Overview

- Thanks for choosing INVT Modbus TCP communication cards. This manual describes the function specifications, installation, basic operation and settings, and information about the network protocol. To ensure that you install and operate the product properly, read this manual and the communication protocol section in the VFD operation manual carefully before you use the product.
- This manual only describes how to operate the Modbus TCP communication card and the related commands but does not provide details about the Modbus TCP protocol. For more information about the Modbus TCP protocol, read the related specialized articles or books.
- This communication card is defined as a Modbus TCP slave station communication card and is used on a VFD that supports Modbus TCP communication.
- The communication card supports the star-shaped network topology and linear network topology.
- The communication card supports 32 inputs/outputs to read and write process data, read state data, and read and write function parameters of a VFD.

5.2 Features

1. Supported functions

- > Supports the Modbus TCP protocol and Modbus TCP slave stations.
- > Provides two Modbus TCP ports and supports the 10/100M full/half-duplex operation
- Supports the star-shaped network topology and linear network topology.

2. Supported communication types

Modbus TCP uses TCP/IP for information control and transmission over the Ethernet, allowing the sending of explicit packets, namely, point-to-point messages that are not time critical. The Modbus TCP application layer adopts the Modbus protocol, which is also used by Modbus RTU.

Same as Modbus RTU, Modbus TCP requires the PLC/PC to send the read or write commands, and the communication card returns the operation result after data forwarding to complete the data transmission.

3. Communication ports

Standard RJ45 ports are used in Modbus TCP communication. The communication card provides two RJ45 ports with no transmission direction defined, and therefore you can insert a cable into the port without regard to its direction. Figure 5-1 shows the ports, and Table 5-1 describes the functions of the ports.



Figure 5-1 Two standard RJ45 ports

Table 5-1 Standard RJ45 port pins

Pin	Name	Description
1	TX+	Transmit Data+
2	TX-	Transmit Data-
3	RX+	Receive Data+
4	n/c	Not connected
5	n/c	Not connected
6	RX-	Receive Data-
7	n/c	Not connected
8	n/c	Not connected

4. State indicators

The Modbus TCP communication card provides 4 LED indicators and 4 network port indicators to indicate its states. Table 5-2 describes the state indicators.

Table	5-2	State	indicators
-------	-----	-------	------------

LED	Color	State	Description				
		On	Indicating that the card and VFD identify each				
		01	other.				
LED1	Green	Dipking (147)	Indicating that the card and VFD				
LEDI	Green	Blinking (1Hz)	communicate normally.				
		Off	Indicating that the card and VFD				
		Oli	communicate improperly.				
			The communication between the card and				
LED2	Green	On	PLC is online and data interchange is				
			allowed.				

LED	Color	State	Description				
		Blinking (1Hz)	Indicating IP address conflict between the card and PLC.				
		Off	Indicating that communication between the card and PLC is offline.				
		On	Modbus TCP has not received valid data.				
LED3	Red	Blinking (1Hz)	Indicating that the packet address is unused or undefined.				
		Blinking (8Hz)	Indicating incorrect packet address.				
		Off	No fault				
LED4	Red	On	3.3V power indicator				
Network	Yellow	On	Link indicator, indicating successful Ethernet connection.				
port indicator	renow	Off	Link indicator, indicating that Ethernet connection is not established.				
Network	Green	On	ACK indicator, indicating that data interchange being performed.				
port indicator	Gieen	Off	ACK indicator, indicating that data interchange is not be performed.				

5.3 Electrical wiring

The Modbus TCP communication card provides standard RJ45 ports and supports the linear and star topologies. Figure 5-2 and Figure 5-3 show the electrical wiring diagrams for different topologies.

Use CAT5, CAT5e, and CAT6 network cables for electrical wiring. When the communication distance is greater than 50 meters, use high-quality network cables that meet the national standards.

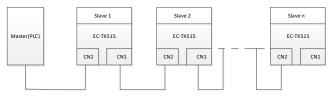
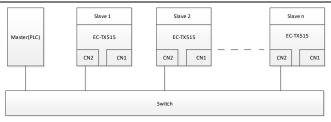
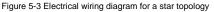


Figure 5-2 Electrical wiring diagram for a linear topology





Note: An Ethernet switch must be available when the star topology is used.

5.4 Communication

5.4.1 Communication settings

The Modbus TCP communication card can function as only the Modbus TCP slave station. Before communication, set Goodrive350 function codes, including:

1. Communication station address, IP address and subnet mask for the card

The default station address, IP address, and subnet mask for each communication card are 1, 192.168.0.20, and 255.255.255.0 respectively. You can change them to the address of a network segment.

2. Control mode

If you want to control the VFD with the communication card, set the control mode to Modbus TCP communication control. To be specific, set P00.01=2 (communication as the running command channel) and set P00.02=0 (Modbus TCP communication channel) to control VFD start and stop. If you want to set a value through Modbus TCP communication, change the control way of corresponding function codes to Modbus TCP communication. Appendix B lists related function codes.

Note: After the setting, the card can communicate normally. If you want to control the VFD with the card, set related function codes to enable Modbus TCP communication control.

5.4.2 Packet format

Table 5-3 describes the structure of a TCP communication packet.

MAC-layer	IP-layer	TCP-layer		
packet	packet	packet	Valid data	Packet trailer
header	header	header		
14 bytes	20 bytes	20 bytes	0-1488 bytes	4 bytes

Table 5-3 Structure of a TCP communication packet

5.4.3 Modbus TCP communication

The application layer of the Modbus TCP communication card supports the Modbus protocol. The Modbus TCP protocol packet is located in the valid data area of the TCP communication packet. It consists of two parts. The first part is MBAP (packet header, occupying 7 bytes), and the second part is PDU (protocol data unit whose length is variable), as shown in Table 5-4.

Table 5-4 Modbus TCP protocol packet

	MBAP						
Transaction identifier	Protocol identifier	Length field	Unit identifier	Function Code	Data		
2 bytes	2 bytes	2 bytes	1 byte	1 byte	n bytes		
Sequence number of packets, incremented by 1 after each communication for distinguishing between different packets	0000=Modbu s-TCP protocol	Data length	Device address (station number)	Modbus function code	Includes VFD function codes and data, and the length is variable.		

Through the above packets, you can set the VFD reference parameters, monitor the status value, send control commands, monitor the running status of the VFD, and read and write the VFD function codes. For specific operations, see the follow-up.

Parameter description:

Unit identifier: Slave station number (1-247).

Function code: Modbus function codes, as shown in Table 5-5.

Table 5-5 Modbus function codes

Function code	Description
0x01	Read coils
0x05	Write single coil
0x0F	Write multiple coils
0x02	Read discrete quantity
0x04	Read input register

Function code	Description
0x03	Read holding register
0x06	Write single holding register
0x10	Write multiple holding registers

Data: The data of the first word is the address of the VFD function code, for example, P00.00 corresponds to the address of 0000h, and the subsequent data is the value to be read and written.

Packet examples:

(1) Command code 03H, reading N words (continuously up to 16 words)

The command code 03H is used by the master to read data from the VFD. The count of data to be read depends on the "data count" in the command. A maximum of 16 pieces of data can be read. The addresses of the read parameters must be contiguous. Each piece of data occupies 2 bytes, that is, one word. The command format is presented using the hexadecimal system (a number followed by "H" indicates a hexadecimal value). One hexadecimal value occupies one byte.

The command is used to read parameters and operation status of the VFD.

For example, starting from the data address of 0004H, to read two contiguous pieces of data (that is, to read content from the data addresses 0004H and 0005H) of the VFD whose address is 01H, the frame structures are described in the following.

	Request	0001	0000	0006	01	03	0004	0004
E	Meaning	MBAP			Function code	Write address	Number of bytes	
Example	Response	0001	0000	0007	01	03	04	1388 0000
	Mooning		MDA			Function	Number of	Data
	Meaning MBAP					code	bytes	Dala

From the response, the data in 0004H is 1388H (50.00Hz), and that in 0005H is 0000H (00.00Hz).

(2) Command code 06H, writing one word

This command is used by the master to write data to the VFD. One command can be used to write only one piece of data. It is used to modify the parameters and running mode of the VFD.

For example, to write 5000 (1388H) to 0004H of the VFD whose address is 02H, the frame structures are described in the following.

Example	Request	0001	0000	0006	02	06	0004	1388
	Meaning	MBAP				Function code	Write address	Data
	Response	0001	0000	0006	02	06	0004	1388
	Meaning	MBAP				Function code	Write address	Data

(3) Command code 10H, continuous writing

The command code 10H is used by the master to write data to the VFD. The quantity of data to be written is determined by "Data count", and a maximum of 16 pieces of data can be written.

For example, to write 5000 (1388H) and 50 (0032H) respectively to 0004H and 0005H of the VFD whose slave address is 02H, the frame structures are described in the following.

	Request	0001	0000	000B	02	10	0004	0002	04	1388 0032
Exa	Meaning		MBA	٩P		Function code	Write address	Number of registers	Number of bytes	Data
mple	Response	0001	0000	0006	02	10	0004	0002		
	Meaning	MBAP			Function code	Write address	Number of registers			

5.4.4 Data address definition

This section describes the address definition of communication data. The addresses are used for controlling the running, obtaining the status information, and setting function parameters of the VFD.

The address of a function code consists of two bytes, with the MSB on the left and LSB on the right. The MSB ranges from 00 to ffH, and the LSB also ranges from 00 to ffH. The MSB is the hexadecimal form of the group number before the dot mark, and LSB is that of the number behind the dot mark. Take P14.00 as an example: The group number is 14, that is, the MSB of the parameter address is the hexadecimal form of 0E; and the number behind the dot mark is 00, that is, the LSB is the hexadecimal form of 00. Therefore, the function code address is 0E00H in the hexadecimal form. For example, the parameter address of P14.03 is 0E03H.

Function code	Name	Parameter description	Setting range	Default value
P14.00	Local communication address	1–247	1–247	1
P14.03	Communication response delay	0–200ms	0–200	5ms

Note:

- The parameters in the P99 group are set by the manufacturer and cannot be read or modified. Some parameters cannot be modified when the VFD is running; some cannot be modified regardless of the VFD status. Pay attention to the setting range, unit, and description of a parameter when modifying it.
- The service life of the Electrically Erasable Programmable Read-Only Memory (EEPROM) may be reduced if it is frequently used for storage. Some function codes do not need to be stored during communication. The application requirements can be met by modifying the value of the on-chip RAM, that is, modifying the MSB of the corresponding function code address from 0 to 1. For example, if P00.07 is not to be stored in the EEPROM, you need only to modify the value in the RAM, that is, set the address to 8007H. The address can be used only for writing data to the on-chip RAM, and it is invalid when used for reading data.

Description of other function addresses

In addition to modifying the parameters of the VFD, the master can also control the VFD, such as starting and stopping it, and monitoring the operation status of the VFD. The following table describes other function parameters.

Function	Address	Data description	R/W
Communication-		0001H: Forward running	
		0002H: Reverse running	
		0003H: Forward jogging	
		0004H: Reverse jogging	R/W
based control	2000H	0005H: Stop	r./ v v
command		0006H: Coast to stop	
		0007H: Fault reset	
		0008H: Jogging to stop	
		0009H: Emergency stop	
	2001H	Communication-based frequency setting	R/W
	20016	(0–Fmax, unit: 0.01 Hz)	R/W
	2002H	PID setting, range (0–1000, 1000	R/W
Communication-		corresponding to 100.0%)	N/ W
based value	2003H	PID feedback, range (0-1000, 1000	R/W
setting	200311	corresponding to 100.0%)	11/11
setting		Torque setting (-3000-+3000, 1000	
	2004H	corresponding to 100.0% of the motor rated	R/W
		current)	
	2005H	Setting of the upper limit of the forward	R/W

Function	Address	Data description	R/W	
		running frequency (0-Fmax, unit: 0.01 Hz)		
	2006H	Setting of the upper limit of the reverse	R/W	
	20061	running frequency (0–Fmax, unit: 0.01 Hz)	R/ W	
		Upper limit of the electromotion torque		
	2007H	(0-3000, 1000 corresponding to 100.0% of	R/W	
		the motor rated current)		
		Upper limit of the brake torque (0-3000, 1000		
	2008H	corresponding to 100.0% of the motor rated	R/W	
		current)		
		Special control command word:		
		Bit0–Bit1: =00: Motor 1 =01: Motor 2		
		Bit2: =1 Enable speed/torque control		
		switchover		
		=0: Disable speed/torque control		
	2009H	switchover	R/W	
		Bit3: =1 Clear electricity consumption		
		=0: Not clear electricity consumption		
		Bit4:=1 Pre-excitation; =0: Disable		
		pre-excitation		
		Bit5: =1 DC brake =0: Disable DC brake		
		Virtual input terminal command, range:		
	200AH	0x000-0x3FF	R/W	
		Corresponding to		
		S8/S7/S6/S5/HDIB/HDIA/S4/ S3/ S2/S1		
		Virtual output terminal command, range:		
	200BH	0x00-0x0F	R/W	
		Corresponding to local RO2/RO1/HDO/Y1		
		Voltage setting (used for V/F separation)		
	200CH	(0-1000, 1000 corresponding to 100.0% of	R/W	
		the motor rated voltage)		
	200DH	AO output setting 1 (-1000-+1000, 1000	R/W	
		corresponding to 100.0%)		
	200EH	AO output setting 2 (-1000-+1000, 1000	R/W	
		corresponding to 100.0%)		
		0001H: Forward running		
VFD status word	2100H	0002H: Reverse running	R	
1	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0003H: Stopped	-	
		0004H: Faulty		

Function	Address	Data description	on	R/W
		0005H: POFF		
		0006H: Pre-excited		
VFD status word 2	2101H	Bit0: =0: Not ready to run =1 Bit1-Bit2: =00: Motor 1 =0 Bit3: =0: Asynchronous motor Synchronous motor Bit4: =0: No overload alarm = alarm Bit5-Bit6: =00: Keypad-based Terminal-based control =10: Communication-based c Bit7: Reserved Bit8: =0: Speed control =1: Bit9: =0: Non position control =1: Position control Bit11-Bit10: =0: Vector 0 =1 =2: Closed-loop v =3: Space voltag	1: Motor 2 =1: 1: Overload 1 control =01: ontrol Forque control : Vector 1 vector	R
VFD fault code	2102H	See the description of fault types.		R
VFD identification code	2103H	GD3500x01A0		R
Running frequency	3000H	0–Fmax (Unit: 0.01Hz)		R
Set frequency	3001H	0–Fmax (Unit: 0.01Hz)		R
Bus voltage	3002H	0.0-2000.0V (Unit: 0.1V)		R
Output voltage	3003H	0–1200V (Unit: 1V)	Compatible	R
Output current	3004H	0.0-3000.0A (Unit: 0.1A)	Compatible with	R
Rotating speed	3005H	0–65535 (Unit: 1RPM)	CHF100A	R
Output power	3006H	-300.0-300.0% (Unit: 0.1%)	and CHV100	R
Output torque	3007H	-250.0-250.0% (Unit: 0.1%)	communicati	R
Closed-loop setting	3008H	-100.0–100.0% (Unit: 0.1%)	on addresses	R
Closed-loop feedback	3009H	-100.0–100.0% (Unit: 0.1%)		R
Input state	300AH	000–3F Corresponding to the local HDIB/ HDIA/S4/S3/S2/S1		R

Function	Address	Data descriptio	n	R/W
Output state	300BH	000–0F Corresponding to the local RO2/RO1/HDO/Y1		R
Analog input 1	300CH	0.00-10.00V (Unit: 0.01V)		R
Analog input 2	300DH	0.00-10.00V (Unit: 0.01V)		R
Analog input 3	300EH	-10.00–10.00V (Unit: 0.01V)		R
Analog input 4	300FH			R
Read input of HDIA high-speed pulse	3010H	0.00–50.00kHz (Unit: 0.01Hz)		R
Read input of HDIB high-speed pulse	3011H			R
Read current step of multi-step speed	3012H	0–15		R
External length	3013H	0–65535		R
External count value	3014H	0–65535		R
Torque setting	3015H	-300.0-300.0% (Unit: 0.1%)		R
Identification code	3016H			R
Fault code	5000H			R

The Read/Write (R/W) characteristics indicate whether a function can be read and written. For example, "Communication-based control command" can be written, and therefore the command code 6H is used to control the VFD. The R characteristic indicates that a function can only be read, and W indicates that a function can only be written.

Note: Some parameters in the preceding table are valid only after they are enabled. Take the running and stop operations as examples, you need to set "Running command channel" (P00.01) to "Communication", and set "Communication running command channel" (P00.02) to the Modbus communication channel. For another example, when modifying "PID setting", you need to set "PID reference source" (P09.00) to Modbus communication.

The following table describes the encoding rules of device codes (corresponding to the identification code 2103H of the VFD).

Eight MSBs of code	Meaning	Eight LSBs of code	Meaning
	GD	0x08	GD35 vector VFD
		0x09	GD35-H1 vector VFD
		0x0a	GD300 vector VFD
0x01		0xa0	GD350 vector VFD
		0xa1	GD350-UL vector VFD
		0xa2	GD350A vector VFD

5.4.5 Fieldbus scale

In practical applications, communication data is represented in the hexadecimal form, but hexadecimal values cannot represent decimals. For example, 50.12 Hz cannot be represented in the hexadecimal form. In such cases, we can multiply 50.12 by 100 to obtain an integer 5012, and then 50.12 can be represented as 1394H (5012 in the decimal form) in the hexadecimal form.

In the process of multiplying a non-integer by a multiple to obtain an integer, the multiple is referred to as a fieldbus scale.

The fieldbus scale depends on the number of decimals in the value specified in "Detailed parameter description" or "Default value". If there are *n* decimals in the value, the fieldbus scale m is the n^{th} -power of 10. Take the following table as an example, m is 10.

Function code	Name	Description	Setting range	Default
P01.20	Wake-up-from-sl eep delay	0.0–3600.0s (valid when P01.15 is 2)	0.00–3600.0	0.0s
P01.21	Restart after power failure	0: Disable 1: Enable	0–1	0

The value specified in "Setting range" or "Default" contains one decimal, so the fieldbus scale is 10. If the value received by the upper computer is 50, the value of "Wake-up-from-sleep delay" of the VFD is 5.0 (5.0=50/10).

To set the "Wake-up-from-sleep delay" to 5.0s through Modbus communication, you need first to multiply 5.0 by 10 according to the scale to obtain an integer 50, that is, 32H in the hexadecimal form.

After receiving the command, the VFD converts 50 into 5.0 based on the fieldbus scale, and then sets "Wake-up-from-sleep delay" to 5.0s.

5.4.6 Error message response

Operation errors may occur in communication-based control. For example, some parameters

can only be read, but a write command is transmitted. In this case, the VFD returns an error message response.

Error message responses are sent from the VFD to the master. The following table describes the codes and definitions of the error message responses.

Code	Name	Description
		The command code received by the upper computer is
		not allowed to be executed. The possible causes are as
		follows:
01H	Invalid command	• The function code is applicable only on new devices
		and is not implemented on this device.
		• The slave is in the faulty state when processing this
		request.
	La sella de te	For the VFD, the data address in the request of the upper
02H	Invalid data	computer is not allowed. In particular, the combination of
	address	the register address and the number of the to-be-transmitted bytes is invalid.
		The received data domain contains a value that is not
		allowed. The value indicates the error of the remaining
		structure in the combined request.
03H	Invalid data value	Note: It does not mean that the data item submitted for
		storage in the register includes a value unexpected by
		the program.
		The parameter is set to an invalid value in the write
04H	Operation failure	operation. For example, a function input terminal cannot
		be set repeatedly.
05H	Password error	The password entered in the password verification
0011		address is different from that set in P07.00.
		The length of the data frame transmitted by the upper
06H	Data frame error	computer is incorrect, or in the RTU format, the value of
		the CRC check bit is inconsistent with the CRC value
	Parameter	calculated by the lower computer.
07H	read-only	The parameter to be modified in the write operation of the
	Parameter cannot	upper computer is a read-only parameter. The parameter to be modified in the write operation of the
08H	be modified in	upper computer cannot be modified during the running of
0011	running	the VFD.
	Password	A user password is set, and the upper computer does not
09H	protection	provide the password to unlock the system when
L		

Code	Name	Description					
		performing a read or write operation. The error of					
		"system locked" is reported.					

When returning a response, the slave device uses a function code domain and fault address to indicate whether it is a normal response (no error) or exception response (some errors occur). In a normal response, the device returns the corresponding function code and data address or sub-function code. In an exception response, the device returns a code that is equal to a normal code, but the first bit is logic 1.

For example, if the master device transmits a request message to a slave device for reading a group of function code address data, the code is generated as follows:

```
0000011 (03H in the hexadecimal form)
```

For an exception response, the following code is returned:

```
1000011 (83H in the hexadecimal form)
```

In addition to the modification of the code, the slave device returns a byte of exception code that describes the cause of the exception. After receiving the exception response, the typical processing of the master device is to transmit the request message again or modify the command based on the fault information.

5.5 Example of PLC communication

This example shows how to use SIEMENS PLC (S7-1200) to communicate with Modbus TCP communication extension card (through the TIA Portal V13 software), and Modbus TCP is not configured with device description file.

Use TIA Portal V13 software to add a Modbus TCP block.

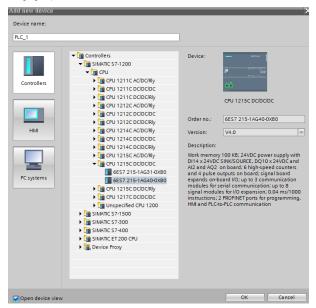
Open TIA Portal V13, and create a new project as shown in the following figure.

Create new project		
Project name:	ModbusTCP_BookletDemoProject_s1200	
Path:	D:Protal V13IV15_workspace	
Author:	Administrator	
Comment:		^
		\sim
	Crea	te

After a new project is created, click "Project view" in the lower left corner, and double click "Add new device" in the interface, as shown in the following figure.

Project tree	
Devices	
00	
ModbusTCP_BookletDemoProject_S1200)
Add new device	
曲 Devices & networks	
PLC_1 [CPU 1215C DC/DC/DC]	
🕨 🙀 Common data	
Documentation settings	
🕨 🐻 Languages & resources	

Select the correct PLC model, and click "OK" (PLC models used by our company are shown in the following figure).



Click "Program blocks", and double click "Main[OB1]" to open the programming interface, as

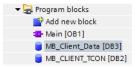
shown in the following figure.

Devices						
00	2	명 및 특	🎭 🗄 🚍 🚍 😭	🗏 ± 🚑 ± 🚍 🔛	C 60 68 68	1 🖓 🖕 1 🖉 🚱 🥸 🔢
		Main				
- 0 PLC_1 [CPU 1215C DC/DC/DC]	^	Name		Data type	Default value	Comment
T Device configuration		1 🔩 🕶 Input				
😼 Online & diagnostics		2 🔩 🖬 Init	tial_Call	Bool	1	Initial call of this OB
🕶 😹 Program blocks		3 💶 🔹 Rei	manence	Bool		=True, if remanent data are available
💕 Add new block						ent
Main [OB1]			· 🗇 🛶 🖃			
Technology objects		- Black titles	"Main Program Sweet	- /0 -1-11		
External source files			Main Program Swee	p (cycle)		
PLC tags		Comment				
PLC data types		 Network 	1:			
Watch and force tables		Comment				
Marces 🗹		comment				
Program info						
Device proxy data	~					
Details view						

Select "Others" under the "Communication" bar on the right, then select "MODBUS TCP" \rightarrow "MB_CLIENT", as shown in the following figure.

>	Favorites						
>	Basic instructions						
>	Extended instruction	ons					
>	Technology						
~	Communication						
Nai	me		Desc				
۲	🛅 S7 communication						
۲	🛅 Open user commur	nicati					
۰.	🔄 WEB Server						
•	🛅 Others						
	🕶 🛅 MODBUS TCP						
	MB_CLIENT		Com				
	MB_SERVER		Com				
۲	Communication processor						
۰.	TeleService						

Add 2 data blocks in "Add new block" under "Program blocks", namely "MB_CLIENT_TCON" and "MB_Client_Data", as shown in the following figure.



Set the variables of these two data blocks respectively, as shown in the following figure.

(1) MB_CLIENT_TCON data block

	MB_CLIENT_TCON											
		Na	me				Data type	Start value				
1		•	St	atic								
2	-00	•	•	TC	лc		TCON_IP_v4					
З			•		Int	erfaceId	HW_ANY	64				
4			•		ID		CONN_OUC	2				
5	-00		•		Co	nnectionType	Byte	16#0B				
6	-00		•		Ac	tiveEstablished	Bool	1				
7	-00		•	•	Re	moteAddress	IP_V4					
8	-00			•	•	ADDR	Array[14] of Byte					
9	-00				•	ADDR[1]	Byte	192				
10	-00				•	ADDR[2]	Byte	168				
11	-00				•	ADDR[3]	Byte	0				
12	-00				•	ADDR[4]	Byte	2				
13	-00		•		Re	motePort	UInt	502				
14	-00		•		Lo	calPort	UInt	0				

(2) MB_Client_Data data block

	MB_Client_Data										
		Name		Data type	Start value						
1		👻 St	atic								
2		• •	data	Array[09] of Int							
З	-00		data[0]	Int	0						
4			data[1]	Int	0						
5			data[2]	Int	0						
6			data[3]	Int	0						
7	-00		data[4]	Int	0						
8			data[5]	Int	0						
9			data[6]	Int	0						
10	-00		data[7]	Int	0						
11	-		data[8]	Int	0						
12			data[9]	Int	0						

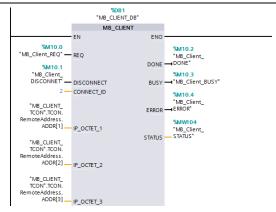
Uncheck the "Optimized block access" of the block, as shown in the following figure.

М	B_Client_Data [DB	3]
_	General	
	General	Attributes
	Information	Attributes
	Time stamps	
	Compilation	Only store in load memory
	Protection	Data block write-protected in the device
	Attributes	
	Download with	Optimized block access

Double click "Show all" under "PLC tags", and create variables, as shown in the following figure.

Р	PLC tags										
		Name	Name Tag table Data type Address								
1	-	MB_Client_REQ	Default tag table	Bool	%M10.0						
2	-	MB_Client_DISCONNET	Default tag table	Bool	%M10.1						
3	-	MB_Client_MODE	Default tag table	USInt	%MB20						
4	-	MB_Client_ADDR	Default tag table	Word	%MW100						
5	-00	MB_Client_LEN	Default tag table	UInt	%MW102						
6	-00	MB_Client_DONE	Default tag table	Bool	%M10.2						
7	-00	MB_Client_BUSY	Default tag table	Bool	%M10.3						
8	-00	MB_Client_ERROR	Default tag table	Bool	%M10.4						
9	-00	MB_Client_STATUS	Default tag table	Word	%MW104						
10	-00	AUTO_RUN	Default tag table	Bool	%M0.0						
11	-00	RUN_TERM	Default tag table	Bool	%10.0						

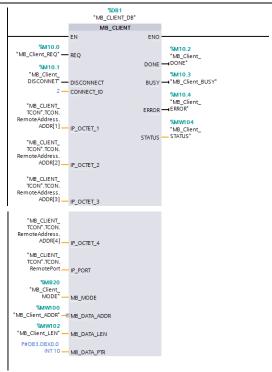
Configure the Modbus TCP block as shown in the following figure.

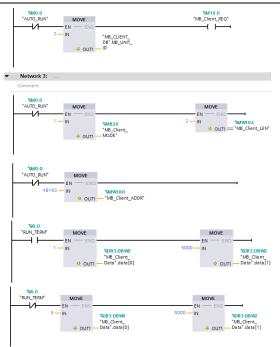


Double click "Device configuration", right click the network port to select "Properties", set the following parameters in the pop-up interface, and modify the local Ethernet network segment to be the same as the following network segment.

								a To	pology	view	di N	etwor	k viev	v 📑 Dev	ice vie
A PLC_1			-		6 🖽	۹	100%		-			E	1	Device over	erview
		101		1			2	3	4	5	6	7	^	- Y Module	
	Rack_0	103 - 101	;:::::::::::::::::::::::::::::::::::::										II III III III		PROFINI
ROFINET in	III terface,	_1 [M	Iodule]					3	Proper	ties	1 Info	_	V Di	∢ II agnostics	
General	IO ta	gs	Syste	m con	stants		Texts								
General Ethernet ad	dresses	-		Ether	net ad	dress	es								
Time synchr Operating m Advanced o Hardware id	nod e ptions			Inte	erface i	netwo	orked wit Su	Г	PNNE_1 Ad	dd new s	ubnet]		×
				IP p	rotocol	I		(ss in the p ress: 11 nask: 2	92.1	68 . C	. 23	

Write the PLC program as follows.





Download the PLC program to the PLC after the program has been written completely. Set VFD function codes such as P00.01=2, P00.02=0, P00.06=8, P14.00=2, P16.58–P16.61= 192.168.0.2, and keep default values of P16.62–P16.69. Then, you can use the I0.0 input terminal to control the VFD to start and stop at 50.00Hz through Modbus TCP protocol.

Appendix A EtherCAT object dictionary

Index	Subindex	Description	Access permission	Data type	Default value
1000h	0	Device type	RO	UINT32	0x00000192
1001h	0	Error register	RO	UINT8	0
		Pre-defi	ned error informa	ation	
1003h	0	Number of errors	RO	UINT8	0x00
	1	Fault code	RO	UINT32	0x0000
1008h	0	Factory device name	RO	String	INVT-EtherCAT
1009h	0	Factory hardware version	RO	String	Hardware version depended
100Ah	0	Factory software version	RO	String	Software version depended
			ID object		
	0	Included max. sub-index	RO	UINT8	4
1018h	1	Supplier ID	RO	UINT32	0x000004D8
	2	Product code	RO	UINT32	0x00009252
	3	Revision number	RO	UINT32	0x0000001
	4	Serial number	RO	UINT32	0x00000001
			mapping para	meter	
	0	Number of supported mapping objects	RW	UINT8	8
	1	First mapping object	RW	UINT32	0x60400010
	2	Second mapping object	RW	UINT32	0x607A0020
1600h	3	Third mapping object	RW	UINT32	0x60FF0020
	4	Fourth mapping object	RW	UINT32	0x60710010
	5	Fifth mapping object	RW	UINT32	0x60720010
	6	Sixth mapping object	RW	UINT32	0x60600008
	7	Seventh mapping	RW	UINT32	0x60810020

Index	Subindex	Description	Access permission	Data type	Default value
	8	Eighth mapping object	RW	UINT32	0x60B80010
		RX PDO2	2 mapping para	neter	
1601h	0	Number of supported mapping objects	RW	UINT8	2
	1	First mapping object	RW	UINT32	0x60400010
	2	Second mapping object	RW	UINT32	0x607A0020
		RX PDO3	3 mapping para	neter	
1602h	0	Number of supported mapping objects	RW	UINT8	2
	1	First mapping object	RW	UINT32	0x60400010
	2	Second mapping object	RW	UINT32	0x607A0020
		RX PDO4	I mapping para	neter	
1603h	0	Number of supported mapping objects	RW	UINT8	2
	1	First mapping object	RW	UINT32	0x60400010
	2	Second mapping object	RW	UINT32	0x607A0020
		TX PDO1	mapping para	neter	
	0	Number of supported mapping objects	RW	UINT8	8
	1	First mapping object	RW	UINT32	0x60410010
1A00h	2	Second mapping object	RW	UINT32	0x60640020
TAUUN	3	Third mapping object	RW	UINT32	0x606C0020
	4	Fourth mapping object	RW	UINT32	0x60770010
	5	Fifth mapping object	RW	UINT32	0x60F40020
	6	Sixth mapping object	RW	UINT32	0x60610008

Index	Subindex	Description	Access permission	Data type	Default value
	7	Seventh mapping object	RW	UINT32	0x60B90010
	8	Eighth mapping object	RW	UINT32	0x60BA0020
		TX PDO2	2 mapping parar	neter	
1A01h	0	Number of supported mapping objects	RW	UINT8	8
	1	First mapping object	RW	UINT32	0x60410010
	2	Second mapping object	RW	UINT32	0x60640020
		TX PDO3	mapping parar	neter	
1A02h	0	Number of supported mapping objects	RW	UINT8	8
	1	First mapping object	RW	UINT32	0x60410010
	2	Second mapping object	RW	UINT32	0x60640020
		TX PDO4	mapping parar	neter	
1A03h	0	Number of supported mapping objects	RW	UINT8	8
	1	First mapping object	RW	UINT32	0x60410010
	2	Second mapping object	RW	UINT32	0x60640020
		SM co	mmunication ty	pe	
	0	Max. sub-index	RO	UINT8	4
	1	SM0 communication type	RO	UINT8	0x01
1C00h	2	SM1 communication type	RO	UINT8	0x02
	3	SM2 communication type	RO	UINT8	0x03
	4	SM3 communication type	RO	UINT8	0x04
10101		RxP	DO assignment	t	
1C12h	0	Max. sub-index	RW	UINT8	1

Index	Subindex	Description	Access permission	Data type	Default value
	1	RxPDO assigned object index	RW	UINT16	0x1600
		TxP	DO assignment		
1C13h	0	Max. sub-index	RW	UINT8	1
10130	1	TxPDO assigned object index	RW	UINT16	0x1A00
		SM synchron	ization output p	arameter	
	0x00	Max. sub-index	RO	UINT8	0x20
	0x01	Synchronization mode	RW	UINT16	0x02
	0x02	Cycle time	RO	UINT32	0
	0x03	Switching time	RO	UINT32	0
	0x04	Supported synchronization type	RO	UINT16	0x4006
	0x05	Min. periodic time	RO	UINT32	0x0003D090
	0x06	Calculation and replication time	RO	UINT32	0
1C32h	0x07	Reserved	RW	UINT32	0
	0x08	Obtained periodic time	RW	UINT16	0
	0x09	Delay time	RO	UINT32	0
	0x0A	Sync0 time	RW	UINT32	-
	0x0B	SM event loss counter	RO	UINT32	0
	0x0C	Circulation timeout counter	RO	UINT32	0
	0x0D	Counter of too short switching	RO	UINT32	0
	0x20	Synchronization error	RO	UINT8	0
		SM synchro	nization input p	arameter	
	0x00	Max. sub-index	RO	UINT8	0x20
1C33h	0x01	Synchronization mode	RW	UINT16	0x02
	0x02	Cycle time	RO	UINT32	0

Index	Subindex	Description	Access permission	Data type	Default value
	0x03	Switching time	RO	UINT32	0
	0x04	Supported synchronization type	RO	UINT16	0x4006
	0x05	Min. periodic time	RO	UINT32	0x0003D090
	0x06	Calculation and replication time	RO	UINT32	0
	0x07	Reserved	RW	UINT32	0
	0x08	Obtained periodic time	RW	UINT16	0
	0x09	Delay time	RO	UINT32	0
	0x0A	Sync0 time	RW	UINT32	-
	0x0B	SM event loss counter	RO	UINT32	0
	0x0C	Circulation timeout counter	RO	UINT32	0
	0x0D	Counter of too short switching	RO	UINT32	0
	0x20	Synchronization error	RO	UINT8	0
2000h	0x00-0x13	Function code	RW	UINT16	-
2001h	0x00-0x23	Function code	RW	UINT16	-
2002h	0x00-0x21	Function code	RW	UINT16	-
2003h	0x00-0x42	Function code	RW	UINT16	-
2004h	0x00-0x3C	Function code	RW	UINT16	-
2005h	0x00-0x35	Function code	RW	UINT16	-
2006h	0x00-0x23	Function code	RW	UINT16	-
2007h	0x00-0x56	Function code	RW	UINT16	-
2008h	0x00-0x84	Function code	RW	UINT16	-
2009h	0x00-0x1D	Function code	RW	UINT16	-
200Ah	0x00-0x20	Function code	RW	UINT16	-

Index	Subindex	Description	Access permission	Data type	Default value
200Bh	0x00-0x40	Function code	RW	UINT16	-
200Ch	0x00-0x21	Function code	RW	UINT16	-
200Dh	0x00-0x14	Function code	RW	UINT16	-
200Eh	0x00-0x47	Function code	RW	UINT16	-
200Fh	0x00-0x46	Function code	RW	UINT16	-
2010h	0x00-0x55	Function code	RW	UINT16	-
2011h	0x00-0x40	Function code	RW	UINT16	-
2012h	0x00-0x2D	Function code	RW	UINT16	-
2013h	0x00-0x28	Function code	RW	UINT16	-
2014h	0x00-0x28	Function code	RW	UINT16	-
2015h	0x00-0x22	Function code	RW	UINT16	-
2016h	0x00-0x19	Function code	RW	UINT16	-
2017h	0x00-0x14	Function code	RW	UINT16	-
2018h	0x00-0x28	Function code	RW	UINT16	-
2019h	0x00-0x21	Function code	RW	UINT16	-
201Ah	0x00-0x35	Function code	RW	UINT16	-
201Bh	0x00-0x1E	Function code	RW	UINT16	-
201Ch	0x00-0x1E	Function code	RW	UINT16	-
603Fh	0	Error code	RO	UINT16	0
6040h	0	Control word	RW	UINT16	0
6041h	0	Status word	RO	UINT16	0
6043h	0	Output speed	RO	UINT16	0
6044h	0	Feedback speed	RO	UINT16	0
			Speed range		
6046h	1	Min. value	RO	UINT32	0
	2	Max. value	RO	UINT32	0
		Velo	city acceleration		
6048h	1	ACC increment	RO	UINT32	0
	2	ACC time increment	RO	UINT16	0

Index	Subindex	Description	Access permission	Data type	Default value	
		Velo	city deceleration	1		
6049h	1	DEC increment	RO	UINT32	0	
	2	DEC time increment	RO	UINT16	0	
	Velocity quick stop					
604Ah	1	Fast stop speed increment	RW	UINT32	0	
	2	Fast stop time increment	RW	UINT16	0	
		Sr	beed gear ratio			
604Ch	1	Numerator of speed gear	RW	INT32	1	
	2	Denominator of speed gear	RW	INT32	1	
6060h	0	Operation mode	RW	UINT16	0	
6061h	0	Operation mode display	RO	UINT16	0	
6062h	0	Position command	RO	DINT32	0	
6063h	0	Position feedback	RO	DINT32	0	
6064h	0	Position feedback	RO	DINT32	0	
6065h	0	Position deviation range	RW	UDINT32	0	
6066h	0	Too-large position deviation timeout	RW	UINT16	0	
6067h	0	Position pulse range	RW	UDINT32	0	
606Ch	0	Actual speed	RW	DINT32	0	
6071h	0	Target torque	RW	INT16	0	
6072h	0	Max. torque	RW	UINT16	0	
6077h	0	Actual torque	RO	INT16	0	
6078h	0	Actual current	RO	INT16	0	
6079h	0	Bus voltage	RO	UDINT32	0	
607Ah	0	Target position	RW	INT16	0	
607Ch	0	Coordinate deviation	RW	DINT32	0	
6081h	0	Speed in industrial regulations	RW	UDINT32	0	

Index	Subindex	Description	Access permission	Data type	Default value		
6083h	0	ACC in industrial regulations	RW	UDINT32	0		
6084h	0	DEC in industrial regulations	RW	UDINT32	0		
6087h	0	Torque ramp	RW	UDINT32	0		
			Gear ratio				
6091h	0	Number of sub-indexes	RW	UINT8	2		
009111	1	Motor resolution	RW	UINT32	0x00000001		
	2	Bearing axle resolution	RW	UINT32	0x00000001		
6098h	0	Zeroing mode	RW	INT16	0		
6099h		Zeroing speed					
00990	0	Reserved	RW	UINT32	0		
60B8h	0	Probe control	RW	UINT16	0		
60B0h	0	Position offset	RW	INT32	0		
60B1h	0	Speed offset	RW	INT32	0		
60B2h	0	Torque offset	RW	INT16	0		
60B9h	0	Probe status	RO	UINT16	0		
60BAh	0	Probe position rising edge	RO	INT32	0		
60BBh	0	Probe position falling edge	RO	INT32	0		
60E0h	0	Forward torque limit	RW	UINT16	0		
60E1h	0	Reverse torque limit	RW	UINT16	0		
60F4h	0	Position deviation	RO	INT32	0		
60FDh	0	Digital input	RO	UINT32	0		
60FEh	0	Digital output	RO	INT32	0		
60FFh	0	Target speed	RW	INT32	0		
6502h	0	Drive mode	RO	UINT32	0x000003A5		

Appendix B Related function codes

Function code	Name	Parameter description	Setting range	Default value
	Channel of	0: Keypad		
P00.01	running	1: Terminal	0–2	0
	commands	2: Communication		
P00.02	Communication channel of running commands	0: Modbus/Modbus TCP communication 1: PROFIBUS/CANopen/DeviceNet communication 2: Ethernet communication 3: EtherCAT/PROFINET/EtherNet IP communication 4: PLC programmable extension card 5: Wireless communication card 6: USB communication (Reserved) Note: Channels 1, 2, 3, 4, and 5 are extension functions that require corresponding extension cards.	0–6	0
	Frequency A	0: Keypad		
P00.06	command setting		0–15	0
	mode	8: Modbus RTU/Modbus TCP		
P00.07	Frequency B command setting mode	communication 9: PROFIBUS/CANopen/DeviceNet communication 10: Ethernet communication 11–12: Reserved 13: EtherCAT/PROFINET/EtherNet IP communication 14–15: Reserved	0–15	15
P00.11	ACC time 1	0.0–3600.0s	0.0– 3600.0s	Model depended
P00.12	DEC time 1	0.0–3600.0s	0.0– 3600.0s	Model depended
P03.11	Torque setting mode	0–1: Keypad 2–6: Reserved 7: Modbus RTU/Modbus TCP communication 8: PROFIBUS/CANopen/DeviceNet communication	0–12	0

Function code	Name	Parameter description	Setting range	Default value
		9: Ethernet communication		
		10: Reserved		
		11: PROFINET/EtherNet IP		
		communication		
		12: Reserved		
		0: Keypad (P03.16)		
		1–5: Reserved		
		6: Modbus RTU/Modbus TCP		
	Setting mode of	communication		
	upper frequency	7: PROFIBUS/CANopen/DeviceNet		
P03.14	limit of forward	communication	0–12	0
	running in torque	8: Ethernet communication		
	control	9: Reserved		
		10: PROFINET/EtherNet IP		
		communication		
		11–12: Reserved		
		0: Keypad (P03.17)		
		1–5: Reserved		
		6: Modbus RTU/Modbus TCP		
	Setting mode of	communication		
	upper frequency	7: PROFIBUS/CANopen/DeviceNet		
P03.15	limit of reverse	communication	0–12	0
	running in torque	8: Ethernet communication		
	control	9: Reserved		
		10: PROFINET/EtherNet IP		
		communication		
		11–12: Reserved		
		0: Keypad (P03.20)		
		1–4: Reserved		
		5: Modbus RTU/Modbus TCP		
		communication		
	Setting mode of	6: PROFIBUS/CANopen/DeviceNet		
P03.18	upper limit of electromotive torque	communication	0–11	0
		7: Ethernet communication		
		8: Reserved		
		9: EtherCAT/PROFINET/EtherNet IP		
		communication		
		10–11: Reserved		

Function code	Name	Parameter description	Setting range	Default value
P03.19	Setting mode of upper limit of brake torque	0: Keypad (P03.21) 1–4: Reserved 5: Modbus RTU/Modbus TCP communication 6: PROFIBUS/CANopen/DeviceNet communication 7: Ethernet communication 8: Reserved 9: EtherCAT/PROFINET/EtherNet IP communication 10–11: Reserved	0–11	0
P04.27	Voltage setting channel	0: Keypad (P04.28) 1–6: Reserved 7: Modbus RTU/Modbus TCP communication 8: PROFIBUS/CANopen/DeviceNet communication 9: Ethernet communication 10: Reserved 11: EtherCAT/PROFINET/EtherNet IP communication 12–13: Reserved	0–13	0
P06.01	Y1 output	0: Invalid	0–63	0
P06.02	HDO output	1–22: Reserved	0–63	0
P06.03	Relay output RO1	23: Modbus RTU/Modbus TCP	0–63	1
P06.04	Relay output RO2	communication virtual terminal output 24: PROFIBUS/CANopen/DeviceNet communication virtual terminal output 25: Ethernet communication virtual terminal output 26–33: Reserved 34: EtherCAT/PROFINET/EtherNet IP communication virtual terminal output 35–63: Reserved	0–63	5
P06.14	Analog output AO1	0: Running frequency 1–13: Reserved	0–63	0
P06.16	HDO high-speed pulse output	14: Modbus RTU/Modbus TCP communication setting 1	0–63	0

Function code	Name	Parameter description	Setting range	Default value
		15: Modbus RTU/Modbus TCP		
		communication setting 2		
		16: PROFIBUS/CANopen/DeviceNet		
		communication setting 1		
		17: PROFIBUS/CANopen/DeviceNet		
		communication setting 2		
		18: Ethernet communication setting 1		
		19: Ethernet communication setting 2		
		20: Reserved		
		21: EtherCAT/PROFINET/EtherNet IP		
		communication setting 1		
		22–26: Reserved		
		27: EtherCAT/PROFINET/EtherNet IP		
		communication setting 2		
		28–63: Reserved		
D07.07	Type of current	0: No fault	,	,
P07.27	fault	18: 485/Modbus TCP communication	/	/
P07.28	Type of last fault	fault (CE)	/	/
B 07.00		29: PROFIBUS communication fault	,	,
P07.29	fault	(E-DP)	/	/
	Type of 3rd-last	30: Ethernet communication fault	,	,
P07.30	fault	(E-NET)	/	/
D 07.04	Type of 4th-last	31: CANopen communication fault	,	,
P07.31	fault	(E-CAN)	/	/
		57: PROFINET communication timeout		
		fault (E-PN)		
		58: CAN communication timeout fault		
		(SECAN)		
		60: Card identification failure in slot 1		
		(F1-Er)		
D 07.00	Type of 5th-last	61: Card identification failure in slot 2	,	,
P07.32	fault	(F2-Er)	/	/
		62: Card identification failure in slot 3		
		(F3-Er)		
		63: Card communication failure in slot 1		
		(C1-Er)		
		64: Card communication failure in slot 2		
		(C2-Er)		

Function code	Name	Parameter description	Setting range	Default value
code		65: Card communication failure in slot 3 (C3-Er) 66: EtherCAT communication fault (E-CAT) 67: BACnet communication fault (E-BAC) 68: DeviceNet communication fault (E-DEV) 69: CAN slave fault in master/slave synchronous communication (S-Err) 72: EtherNet IP communication timeout	<u>range</u>	value
P08.31	Motor 1 and motor 2 switching channel	(E-EIP) 0x00-0x14 LED ones place: Switching channel 0: Terminal 1: Modbus/Modbus TCP communication 2: PROFIBUS/CANopen/DeviceNet communication 3: Ethernet communication 4: EtherCAT/PROFINET/EtherNet IP communication LED tens place: Switching in running 0: Disabled 1: Enabled	00–14	0x00
P09.00	PID reference source	0: Keypad (P09.01) 1–5: Reserved 6: Modbus RTU/Modbus TCP communication 7: PROFIBUS/CANopen/DeviceNet communication 8: Ethernet communication 9: Reserved 10: PROFINET/EtherNet IP communication 11–12: Reserved	0–12	0
P09.02	PID feedback source	0: Al1 1–3: Reserved 4: Modbus RTU/Modbus TCP	0–10	0

Function code	Name	Parameter description	Setting range	Default value
		communication 5: PROFIBUS/CANopen/DeviceNet communication 6: Ethernet communication 7: Reserved 8: PROFINET/EtherNet IP communication 9-10: Reserved		
P14.00	Local communication address	1–247	1–247	1
P14.03	Communication response delay	1–200ms	1–200	5
P14.05	Transmission error processing	0: Report an alarm and coast to stop 1: Keep running without reporting an alarm 2: Stop in enabled stop mode without reporting an alarm (applicable only to communication mode) 3: Stop in enabled stop mode without reporting an alarm (applicable to any mode)	1–3	0
P14.06	Communication processing action	0x00–0x11 Ones place: 0: Respond to write operations 1: Not respond to write operations Tens place: Communication encrypting 0: Disable 1: Enable Hundreds place: Self-define the communication command address 0: Disable 1: Enable	0x000–0x 111	0x000
P14.09	Modbus-TCP communication timeout time	0.0 (invalid)–60.0s	0.0–60.0	0.0s
P15.01	Module address	0–127	0–127	2
P15.02	Received PZD2	0: Invalid	0–31	0

Function code	Name	Parameter description	Setting range	Default value
P15.03	Received PZD3	1: Set frequency (0-Fmax, unit: 0.01 Hz)	0–31	0
P15.04	Received PZD4	2: PID reference (-1000–1000, in which	0–31	0
P15.05	Received PZD5	1000 corresponds to 100.0%)	0–31	0
P15.06	Received PZD6	3: PID feedback (-1000–1000, in which	0–31	0
P15.07	Received PZD7	1000 corresponds to 100.0%)	0–31	0
P15.08	Received PZD8	4: Torque setting (-3000-+3000, in	0–31	0
P15.09	Received PZD9	which 1000 corresponds to 100.0% of	0–31	0
P15.10	Received PZD10	the rated current of the motor)	0–31	0
P15.11	Received PZD11	5: Setting of the upper limit of forward	0–31	0
P15.12	Received PZD12	running frequency (0–Fmax, unit: 0.01 Hz) 6: Setting of the upper limit of reverse running frequency (0–Fmax, unit: 0.01 Hz) 7: Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to 100.0% of the rated current of the motor) 8: Upper limit of the brake torque (0–3000, in which 1000 corresponds to 100.0% of the rated current of the motor) 9: Virtual input terminal command, 0x000–0x3FF (corresponding to S8, S7, S6, S5, HDIB, HDIA, S4, S3, S2, and S1 in sequence) 10: Virtual output terminal command, 0x00–0x0F (corresponding to RO2, RO1, HDO, and Y1 in sequence) 11: Voltage setting (for V/F separation) (0–1000, in which 1000 corresponds to 100.0% of the rated voltage of the motor) 12: AO1 output setting 1 (-1000–+1000, in which 1000 corresponds to 100.0%) 13: AO2 output setting 2 (-1000–+1000, in which 1000 corresponds to 100.0%) 14: MSB of position reference (signed number)	0–31	0

Function code	Name	Parameter description	Setting range	Default value
code		15: LSB of position reference (unsigned number) 16: MSB of position feedback (signed number) 17: LSB of position feedback (unsigned number) 18: Position feedback setting flag (position feedback can be set only after this flag is set to 1 and then to 0) 19: Function code mapping (PZD2–PZD12 correspond to P14.49–P14.59 respectively.) 20–31: Reserved	range	value
P15.13	Transmitted PZD2	0: Invalid 1: Running frequency (×100, Hz)	0–47	0
P15.14	Transmitted PZD3	2: Set frequency (×100, Hz) 3: Bus voltage (×10, V)	0–47	0
P15.15	Transmitted PZD4	4: Output voltage (×1, V) 5: Output current (×10, A)	0–47	0
P15.16	Transmitted PZD5	6: Actual output torque (×10, %) 7: Actual output power (×10, %)	0–47	0
P15.17	Transmitted PZD6	8: Rotating speed of the running (×1, RPM)	0–47	0
P15.18	Transmitted PZD7	9: Linear speed of the running (x1, m/s) 10: Ramp frequency reference	0–47	0
P15.19	Transmitted PZD8	11: Fault code 12: Al1 value (×100, V)	0–47	0
P15.20	Transmitted PZD9	13: Al2 value (×100, V) 14: Al3 value (×100, V)	0–47	0
P15.21	Transmitted PZD10	15: HDIA frequency (×1000, kHz) 16: Terminal input state	0–47	0
P15.22	Transmitted PZD11	17: Terminal output state 18: PID reference (x10, %)	0–47	0
P15.23	Transmitted PZD12	 PID feedback (×10, %) Rated torque of the motor MSB of position reference (signed number) LSB of position reference (unsigned 	0–47	0

Function code	Name	Parameter description	Setting range	Default value
code		number) 23: MSB of position feedback (signed number) 24: LSB of position feedback (unsigned number) 25: Status word 26: HDIB frequency value (×1000, kHz) 27: MSB of PG card pulse feedback count 28: LSB of PG card pulse feedback count 29: MSB of PG card pulse reference count	range	value
		30: LSB of PG card pulse reference count 31: Function code mapping (PZD2–PZD12 correspond to P14.60–P14.70 respectively.) 32: Status word 3 33–47: Reserved		
P15.25	DP communication timeout time	0.0 (invalid)–60.0s	0.0–60.0	5.0s
P15.26	CANopen communication timeout time	0.0 (invalid)–60.0s	0.0–60.0	5.0s
P15.27	CANopen communication baud rate	0: 1000 kbps 1: 800 kbps 2: 500 kbps 3: 250 kbps 4: 125 kbps 5: 100 kbps 6: 50 kbps 7: 20 kbps	0–7	3
P15.28	CAN communication address	0–127	0–127	1
P15.29	CAN baud rate	0: 50Kbps	0–5	2

Function code	Name	Parameter description	Setting range	Default value
	setting	1: 100Kbps 2: 125Kbps 32: 250Kbps 4: 500Kbps 5: 1M bps		
P15.30	CAN communication timeout time	0.0 (invalid)–60.0s	0.0–60.0	5.0s
P15.31	DeviceNet communication timeout time	0.0 (invalid)–60.0s	0.0–60.0	5.0s
P15.32	Displayed node baud rate	0	0	0
P15.33	Enable polling	0–1	0–1	1
P15.34	Output instance in polling	 19: INVT self-defined output 20: ODVA basic speed control output 21: ODVA extended speed control output 22: ODVA speed and torque control output 23: ODVA extended speed and torque control output 24: INVT basic speed control output 25: INVT extended speed control output 26: INVT speed and torque control output 27: INVT extended speed and torque control output 	19–27	19
P15.35	Input instance in polling	69: INVT self-defined input 70: ODVA basic speed control input 71: ODVA extended speed control input 72: ODVA speed and torque control input 73: ODVA extended speed and torque control input 74: INVT basic speed control input 75: INVT extended speed control input 76: INVT speed and torque control input	69–77	69

Function code	Name	Parameter description	Setting range	Default value
		77: INVT extended speed and torque control input		
P15.36	Enable state change/period	0–1	0–1	0
P15.37	Output instance in state change/period	 19: INVT self-defined output 20: ODVA basic speed control output 21: ODVA extended speed control output 22: ODVA speed and torque control output 23: ODVA extended speed and torque control output 24: INVT basic speed control output 25: INVT extended speed control output 26: INVT speed and torque control output 27: INVT extended speed and torque control output 	19–27	19
P15.38	Input instance in state change/period	 69: INVT self-defined input 70: ODVA basic speed control input 71: ODVA extended speed control input 72: ODVA speed and torque control input 73: ODVA extended speed and torque control input 74: INVT basic speed control input 75: INVT extended speed control input 76: INVT speed and torque control input 77: INVT extended speed and torque control input 	69–77	69
P15.39	Output length of component 19	8–32	8–32	32
P15.40	Input length of component 69	8–32	8–32	32
P15.41	BACnet communication mode setting	0: Enable P16.22 (I-Am service) 1: Enable P15.42 (Baud rate of BACnet_MSTP)	0–1	0
P15.42	Baud rate of	0–5	0–5	0

Function code	Name	Parameter description	Setting range	Default value
	BACnet_MSTP			
P15.43	Communication control word expression method	0: In decimal format 1: In binary format	0–1	0
P15.44	Communication control word/status word	0: Display currently identified card (only one) 1: DP card 2: CANopen card 3: PROFINET card 4: Ethernet IP card 5: Modbus TCP card 6: EtherCAT card	0–6	0
P15.45– P15.69	Reserved			
P16.14	Ethernet card monitoring variable address 1	0x0000-0xFFF	0000–FFF F	0x0000
P16.15	Ethernet card monitoring variable address 2	0x0000-0xFFFF	0000–FFF F	0x0000
P16.16	Ethernet card monitoring variable address 3	0x0000-0xFFFF	0000–FFF F	0x0000
P16.17	Ethernet card monitoring variable address 4	0x0000-0xFFFF	0000–FFF F	0x0000
P16.24	Extension card identification time of slot 1	0.0–600.0s When this parameter is set to 0.0, disconnection fault detection is not performed.	0.0–600.0 s	0.0s
P16.25		0.0–600.0s When this parameter is set to 0.0,	0.0–600.0 s	0.0s

Function code	Name	Parameter description	Setting range	Default value
	of slot 2	disconnection fault detection is not performed.		
P16.26	Extension card identification time of slot 3	0.0–600.0s When this parameter is set to 0.0, disconnection fault detection is not performed.	0.0–600.0 s	0.0s
P16.27	Extension card communication timeout time of slot 1	0.0–600.0s When this parameter is set to 0.0, disconnection fault detection is not performed.	0.0–600.0 s	0.0s
P16.28	Extension card communication timeout time of slot 2	0.0–600.0s When this parameter is set to 0.0, disconnection fault detection is not performed.	0.0–600.0 s	0.0s
P16.29	Extension card communication timeout time of slot 3	0.0–600.0s When this parameter is set to 0.0, disconnection fault detection is not performed.	0.0–600.0 s	0.0s
P16.31	PROFINET communication timeout time	0.0 (invalid)–60.0s	0.0–60.0s	5.0s
P16.32	Received PZD2	0: Invalid	0–31	0
P16.33	Received PZD3	1: Set frequency (0-Fmax, unit: 0.01 Hz)	0–31	0
P16.34	Received PZD4	2: PID reference (-1000–1000, in which	0–31	0
P16.35	Received PZD5	1000 corresponds to 100.0%)	0–31	0
P16.36	Received PZD6	3: PID feedback (-1000–1000, in which	0–31	0
P16.37	Received PZD7	1000 corresponds to 100.0%)	0–31	0
P16.38	Received PZD8	4: Torque setting (-3000–+3000, in	0–31	0
P16.39		which 1000 corresponds to 100.0% of	0–31	0
P16.40	Received PZD10	the rated current of the motor)	0–31	0
P16.41	Received PZD11	5: Setting of the upper limit of forward	0–31	0
P16.42	Received PZD12	running frequency (0–Fmax, unit: 0.01 Hz) 6: Setting of the upper limit of reverse running frequency (0–Fmax, unit: 0.01 Hz) 7: Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to	0–31	0

Function code	Name	Parameter description	Setting range	Default value
		100.0% of the rated current of the motor)		
		8: Upper limit of the brake torque		
		(0–3000, in which 1000 corresponds to		
		100.0% of the rated current of the motor)		
		9: Virtual input terminal command,		
		0x000–0x3FF (bit9–bit0 correspond to		
		S8/S7/S6/S5/HDIB/HDIA/S4/S3/S2/S1		
		in sequence)		
		10: Virtual output terminal command,		
		0x00–0x0F (bit3–bit0 correspond to		
		RO2/RO1/HDO/Y1 in sequence)		
		11: Voltage setting (for V/F separation)		
		(0–1000, in which 1000 corresponds to		
		100.0% of the rated voltage of the		
		motor)		
		12: AO1 output setting 1 (-1000-+1000,		
		in which 1000 corresponds to 100.0%)		
		13: AO2 output setting 2 (-1000–+1000,		
		in which 1000 corresponds to 100.0%)		
		14: MSB of position reference (signed		
		number)		
		15: LSB of position reference (unsigned		
		number)		
		16: MSB of position feedback (signed		
		number)		
		17: LSB of position feedback (unsigned		
		number)		
		18: Position feedback setting flag		
		(position feedback can be set only after		
		this flag is set to 1 and then to 0)		
		19: Function code mapping		
		(PZD2–PZD12 correspond to		
		P14.49–P14.59 respectively.)		
		20–31: Reserved		
	Transmitted	0: Invalid		
P16.43	PZD2	1: Running frequency (×100, Hz)	0–47	0
	Transmitted	2: Set frequency (×100, Hz)		
P16.44	PZD3	3: Bus voltage (×10, V)	0–47	0

Function code	Name	Parameter description	Setting range	Default value
P16.45	Transmitted PZD4	4: Output voltage (×1, V) 5: Output current (×10, A)	0–47	0
P16.46	Transmitted PZD5	6: Actual output torque (×10, %) 7: Actual output power (×10, %) -8: Rotating speed of the running (×1,	0–47	0
P16.47	Transmitted PZD6	RPM) 9: Linear speed of the running (x1, m/s)	0–47	0
P16.48	Transmitted PZD7	10: Ramp frequency reference 11: Fault code	0–47	0
P16.49	Transmitted PZD8	12: Al1 value (×100, V) 13: Al2 value (×100, V)	0–47	0
P16.50	Transmitted PZD9	14: Al3 value (×100, V) 15: HDIA frequency (×1000, kHz) 16: Terminal input state	0–47	0
P16.51	Transmitted PZD10	17: Terminal output state 18: PID reference (×10, %)	0–47	0
P16.52	Transmitted PZD11	19: PID feedback (×10, %) 20: Rated torque of the motor	0–47	0
P16.53	Transmitted PZD12	 21: MSB of position reference (signed number) 22: LSB of position reference (unsigned number) 23: MSB of position feedback (signed number) 24: LSB of position feedback (unsigned number) 25: Status word 26: HDIB frequency value (x1000, kHz) 27: MSB of PG card pulse feedback count 28: LSB of PG card pulse feedback count 29: MSB of PG card pulse reference count 30: LSB of PG card pulse reference count 31: Function code mapping (PZD2–PZD12 correspond to P14.60–P14.70) 32: Status word 3 33–47: Reserved 	0-47	0
P16.54	Ethernet IP	0.0–60.0s	0.0-60.0s	5.0s

Function code	Name	Parameter description	Setting range	Default value
	communication timeout time			
P16.55	Ethernet IP communication	0: Self-adaption 1: 100M full duplex 2: 100M half duplex 3: 10M full duplex 4: 10M half duplex	0–4	0
P16.58	Industrial Ethernet communication card IP address 1	0–255	0–255	192
P16.59	Industrial Ethernet communication card IP address 2	0–255	0–255	168
P16.60	Industrial Ethernet communication card IP address 3	0–255	0–255	0
P16.61	Industrial Ethernet communication card IP address 4	0–255	0–255	20
P16.62	Industrial Ethernet communication card subnet mask 1	0255	0–255	255
P16.63	Industrial Ethernet communication card subnet mask 2	0–255	0–255	255
P16.64	Industrial Ethernet communication card subnet mask 3	0–255	0–255	255

Function code	Name	Parameter description	Setting range	Default value
P16.65	Industrial Ethernet communication card subnet mask 4	0–255	0–255	0
P16.66	Industrial Ethernet communication card gateway 1	0–255	0–255	192
P16.67	Industrial Ethernet communication card gateway 2	0–255	0–255	168
P16.68	Industrial Ethernet communication card gateway 3	0–255	0–255	0
P16.69	Industrial Ethernet communication card gateway 4	0–255	0–255	1
P16.70	Save EtherCAT written function codes	0: No 1: Yes	0–1	0
P16.72	EtherCAT input unit selection	0: PRM as the input rotation speed unit 1: plus/s as the input rotation speed unit	0–1	0
P16.73	EtherCAT slave address	0x0000–0xffff	0x0000– 0xffff	Oxffff
P16.74	EtherCAT-DC synchronization period selection	0: Reserved 1: Reserved 2: 1ms 3: 2ms 4: Reserved 5: Reserved	0–5	0
P16.75	EtherCAT communication timeout time	0.0–60.0(s)	0.0–60.0	5.0s

Function code	Name	Parameter description	Setting range	Default value
P16.76	EtherCAT supported PLC type	0: Beckhoff 1: AX70 2: OMRON 3: Trio 4: LNC 5–8: Reserved	0–8	0
P16.77	EtherCAT run mode	0: Free-run mode 1: SM mode (synchronized in data input and output) 2: DC mode (synchronized in distributed clocks)	0–2	0
P19.00	State of extension card at slot 1	0: No card 1: PLC programmable card 2: I/O card	0–65535	0
P19.01	State of extension card at slot 2	4: Incremental PG card with UVW	0–65535	0
P19.02	State of extension card at slot 3	5: Ethernet communication card 6: DP communication card 7: Bluetooth card 8: Resolver PG card 9: CANopen communication card 10: WIFI card 11: PROFINET communication card 12: Sine-cosine PG card without CD signals 13: Sine-cosine PG card with CD signals 14: Absolute encoder PG card 15: CAN master/slave communication card 16: Modbus TCP communication card 17: EtherCAT communication card 18: BACnet communication card 19: DeviceNet communication card 20: PT100/PT1000 temperature detection card 21: Ethernet IP communication card 22: MECHATROLINK card (Reserved) 23: Bluetooth card 2	0–65535	0

Function code	Name	Parameter description	Setting range	Default value
		24–31: Reserved		
		32: SSI-PG card		
		33–65535: Reserved		
P21.20		Acceleration time of positioning means		
	ACC time of	the time needed for the VFD to	0.01-	3.00s
	positioning	accelerate from 0Hz to Max. output	300.00s	
		frequency (P00.03).		
P21.21		Deceleration time of positioning means		
	DEC time of	the time needed for the VFD to	0.01-	3.00s
	positioning	decelerate from Max. output frequency	300.00s	
		(P00.03) to 0hz.		



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