

EC-TX509-U8 Industrial Ethernet Communication Card User Manual



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Preface

Overview

Thank you for choosing INVT industrial Ethernet communication card. This manual describes the product features, electrical connections, communication, as well as examples of communication with the PLC. To ensure that you install and operate the product properly, read this manual and the communication sections in the VFD operation manual carefully before you use the product.

This manual only describes how to operate the communication card and the related commands but does not provide details about the PROFINET, EtherCAT, PowerLink, EtherNet IP, Modbus TCP, and EtherNet UDP protocols. For more information about the protocols, read the related specialized articles or documentations.

Precautions

The expansion 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.
- We shall not be liable or responsible for any equipment damage or physical injury or death caused due to your or your customers' failure to follow the safety precautions.
- Before opening the VFD housing to install or remove the expansion card, disconnect all power supplies of the VFD and ensure that the voltage inside the VFD is far lower than the human safety voltage. For details, see the description in the VFD operation manual. Severe personal injury or even death can result if the instruction is not followed.
- Store the communication card in a place that is dustproof and damp-proof, free from electric shocks and mechanical pressure.
- The expansion card is electrostatic sensitive. Take measurements to prevent electrostatic discharge when performing related operations.
- When installing this expansion card, tighten the screws to ensure that it is firmly fixed and properly grounded.

Change history

The manual is subject to change irregularly without prior notice due to product version upgrades or other reasons.

No.	Change description	Version	Release date
1	First release.	V1.0	Jan 2025

Terminology and abbreviations

CAN	Controller area network
СОВ	Communication object, a transmitted unit on a CAN network. Data can be transmitted through the whole network. A COB is part of a CAN message frame.
EDS	Electronic datasheet, 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, state values, and actual values.
PDOn Tx	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4.
PDOn Tx PDOn Rx	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4. PDO command sent from the master to the slave; n indicates 1, 2, 3, or 4.
PDOn Tx PDOn Rx SDO	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4. PDO command sent from the master to the slave; n indicates 1, 2, 3, or 4. Service data object, a type of COB, used to transmit non-time key data, such as parameter values.
PDOn Tx PDOn Rx SDO RO	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4. PDO command sent from the master to the slave; n indicates 1, 2, 3, or 4. Service data object, a type of COB, used to transmit non-time key data, such as parameter values. Indicates read-only access.
PDOn Tx PDOn Rx SDO RO RW	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4. PDO command sent from the master to the slave; n indicates 1, 2, 3, or 4. Service data object, a type of COB, used to transmit non-time key data, such as parameter values. Indicates read-only access. Indicates the read and write access.
PDOn Tx PDOn Rx SDO RO RW SYNC	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4. PDO command sent from the master to the slave; n indicates 1, 2, 3, or 4. Service data object, a type of COB, used to transmit non-time key data, such as parameter values. Indicates read-only access. Indicates the read and write access. Indicates synchronous transmission.
PDOn Tx PDOn Rx SDO RO RW SYNC Node-ID	PDO command sent from the slave to the master; n indicates 1, 2, 3, or 4. PDO command sent from the master to the slave; n indicates 1, 2, 3, or 4. Service data object, a type of COB, used to transmit non-time key data, such as parameter values. Indicates read-only access. Indicates the read and write access. Indicates synchronous transmission. Node ID, that is, address of a communication card.

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1 Product confirmation

Check the following after receiving a communication expansion 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 ESD file or xml file of the communication card from INVT.

1.1 Product features

- Supports protocol selection through function codes.
- Supports up to eight protocols, including PROFINET, EtherCAT, EtherNet IP, Modbus TCP, EtherNet UDP, and PowerLink, with future support for BACnet/IP and CC-Link IE communication protocols.
- Certain protocols support the simultaneous operation of monitoring functions, thereby fulfilling the on-site oscilloscope monitoring requirements.
- Equipped with two RJ45 ports.
- Reaches the communication rate of up to 100 Mbit/s, with a short communication cycle.
- Supports both linear and star network topologies, with certain protocols also accommodating ring network topology.
- It is recommended to use double-twisted shielded Category 5e Ethernet cables, with crystal heads equipped with iron shells to meet the grounding shield protection.

Figure 1-1 Product components



Table 1-1 Environmental requirements

Item	Requirement	
Working temperature	-10–50°C	
Storage temperature	-20–60.0°C	
Relative humidity	5%–95% (No condensation)	
Other weather	No condensation, ice, rain, snow, or hail;	
conditions	Solar radiation < 700 W/m ²	
Air pressure	70–106kPa	
Vibration and impact	5.8m/s² (0.6g) at the sine vibration of 9Hz to 200Hz	

Figure 1-2 RJ45 interface



Table 1-2 RJ45 interface function

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

Figure 1-3 Expansion card configuration flowchart (taking GD350 for example)



Function code	Protocol	Description
	PROFINET	0 (Factory setting)
	EtherCAT	1
	PowerLink	2
	EtherNet IP	3
P16.00	Modbus TCP	4
	EtherNet UDP	5
	PROFINET+EtherNet UDP	6
	EtherCAT+EtherNet UDP	7
	Reserved	8–15

Protocol	Description		
PROFINET	1. 2. 3.	Supports the PROFINET protocol, accommodating PROFINET IO devices, medium redundancy protocol (MRP), and system redundancy protocol (S2). Equipped with the slave station GSDML configuration file, it can communicate with Siemens PLC and other master stations. Enables basic operations on VFDs, such as reading and writing process values, reading status values, and reading/writing function codes. This communication card supports up to 32 IOS. Applicable to linear, star, and ring network topologies.	
EtherCAT	1. 2. 3. 4.	Supports the CiA301 and CiA402 CoE protocols. Configured with a slave station XML configuration file, it can communicate with Beckhoff PLC, INVT AX controllers, and other master stations. Supports PDO and SDO services, manufacturer-defined object dictionaries, and SDO reading/writing of VFD function codes, meeting the EtherCAT compliance testing certification requirements within the factory. Applicable to linear, star, and ring network topologies. Equipped with two RJ45 ports, designated for IN and OUT directions.	
PowerLink	1. 2. 3.	Supports the CiA402 protocol. Configured with a slave station XDD configuration file, it can communicate with B&R PLC and other master stations. Supports PDO and SDO services, manufacturer-defined object dictionaries, and SDO reading/writing of VFD function codes. Applicable to linear and star network topologies.	
EtherNet IP	1. 2. 3.	Supports ODVA standards and DLR ring protocol. When configured with a slave station EDS configuration file, it can communicate with Rockwell PLC and other master stations. Enables basic operations on VFDs, such as reading and writing process values, reading status values, and reading/writing function codes. This communication card supports up to 32 IOs. Applicable to linear, star, and ring network topologies.	
Modbus TCP	1.	Supports the Modbus TCP protocol. A Modbus TCP slave	

Table 1-4 Protocol description

Protocol	Description		
	 station can communicate with multiple master stations simultaneously. It can communicate with Schneider PLC, INVT AX controllers, and other master stations. Enables basic operations on VFDs, such as reading and writing process values, reading status values, and reading/writing function codes. Applicable to linear and star network topologies 		
EtherNet UDP	 Supports INVT Ethernet protocol, connecting to the INVT Workshop for monitoring and oscilloscope functionalities, allowing for multi-card network monitoring. Applicable to linear and star network topologies. 		
PROFINET+ EtherNet UDP	Supports concurrent PROFINET and EtherNet UDP communications on the same network.		
EtherCAT+ EtherNet UDP	Supports concurrent EtherCAT and EtherNet UDP communications on the same network, with EtherCAT required to remain online.		

2 PROFINET protocol

2.1 Overview

The communication card using this protocol is defined as a PROFINET slave station, which can be used on VFDs that support PROFINET communication.

2.2 Product features

2.2.1 Supported functions

- Supports the PROFINET protocol and PROFINET IO devices.
- Supports the medium redundancy protocol (MRP) and system redundancy protocol (S2). Equipped with the slave station GSDML configuration file, it can communicate with Siemens PLC and other master stations.
- Equipped with two PROFINET IO ports, supporting 100M half/full duplex operating.
- Applicable to linear, star, and ring network topologies.
- Enables basic operations on VFDs, such as reading and writing process values, reading status values, and reading/writing function codes. This communication card supports up to 32 IOs.

2.2.2 Supported communication types

Standard Ethernet channel: Standardized channels are non-real-time communication channels using the TCP/IP protocol, mainly used for device parameterization, configuration, and reading diagnostic data.

Real-time communication channel (RT): The RT channel uses optimized communication mechanisms for real-time data transfer, with higher priority than TCP (UDP)/IP protocols, ensuring that different sites in the network can exchange data under strict time requirements and meet millisecond-level bus cycles. The RT channel is typically used to transmit real-time information such as process data, alarm data, and other real-time information.

Real-time communication channel (IRT) (not supported): The IRT channel is implemented based on hardware, using embedded Switch-ASIC synchronous real-time exchange chips for data transmission. IRT communication further improves the efficiency of program, data transmission, and device synchronization by reducing the processing time of the communication stack software, with a transmission delay of less than 1ms and jitter of less than 1µs. Typical applications include high-precision motion control systems.

2.2.3 Status indicator

The PROFINET communication card provides six LED indicators to indicate its states. For details, see Table 2-1.

Indicator	Color	Definition	Function
LED1 (RUN)	Green	Steady on	Communication established successfully, with normal IO data exchange.
		Blinking (on for 500ms, off for 500ms)	Communication established successfully, but without valid IO data exchange.
		Blinking (on for 100ms, off for 100ms)	In the communication configuration phase. For example, when DCP configuration commands are triggered, it will blink simultaneously with the ERR indicator.
		Steady off	The communication between the communication card and PLC is not in Online state.
	Green	Steady on	The communication card is in the process of handshaking with the VFD.
LED2 (HOST)		Blinking (on for 500ms, off for 500ms)	The communication card and VFD communicate normally. Note: After the handshaking is completed, it should blink regardless of whether there is data transmission between the communication card and the main control board.
		Steady off	The communication card is in the initialization or parameter configuration phase.
LED3 (DATA)	Green	Steady off	No data update or abnormal update between the communication card and main control board.
		Blinking (on for 500ms, off for 500ms)	The data update between the communication card and main control board is normal.
LED4	Red	Steady on	3.3V power indicator

Indicator	Color	Definition	Function
(POWER)			
		Steady off	No fault
LED5 (ERR)	Red	Blinking (on for 100ms, off for 100ms)	Communication establishment is abnormal.
LED6 (SYS)	Green	Blinking (on for 500ms, off for 500ms)	Communication card heartbeat indicator (communication card is running normally).

2.3 Electrical connection

The PROFINET communication card uses standard RJ45 interfaces, and its electrical connections are shown in Figure 2-1 and Figure 2-2.

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

Figure 2-1 Linear network topology electrical connection





∠Note: For the star network topology, you need to prepare switches.

Figure 2-3 Ring network topology electrical connection



2.4 Communication

2.4.1 Message format

Table 2-2 lists the RT frame (non-synchronous) structure.

Data header	Ethernet type	VLAN	Ethernet type	Frame identifier	RT user data	Cycle counter	Data status	Transmission status	FCS
-	2 bytes	2 bytes	2 bytes	2 bytes	36–1440 bytes	2 bytes	1 byte	1 byte	4 bytes
	0x8100	-	0x8892	-	-	-	-	-	-

Table 2-2 RT frame structure

Data header	Ethernet type	VLAN	Ethernet type	Frame identifier	RT user data	Cycle counter	Data status	Transmission status	FCS
	VLAN	flag	-	-	-	APDU status		1	
	Data header								
7.1.1.1.1.1.1.1.1.1		1-b	1-byte synchronization		6-byte source MAC		6-1	6-byte destination MAC	
7-Dyte	preamble		information		ado	address address		address	

Table 2-3 lists the IRT communication protocol and IRT frame (non-synchronous) structure.

Table 2-3 IRT frame structure

Data header			Ethernet type	VLAN	Ethernet type	Frame identifier	IRT user data	FCS	
7-byte pream ble	1-byte synchr onizati on	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 Communication

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

Figure 2-4 Message structure

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

Through the preceding 32 inputs/outputs, you can set the reference parameters, monitor status values, send control commands and monitor operation status of the VFD, and read and write VFD function parameters.

Parameter zone:

PKW1—Parameter identification

PKW2—Array index number

PKW3—Parameter value 1

PKW4—Parameter value 2

Process data:

CW—control word (from the master to the slave; see Table 2-4 and Table 2-5)

SW-status word (from the slave to the master; see Table 2-7 and Table 2-8)

PZD—process data (user specified)

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

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

CW and SW

Using CWs is the basic method for the fieldbus system to control VFD devices. It is sent from the fieldbus master 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 status information back to the master through an SW.

Reference value: The 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 communication cards as the controllers of the VFD devices.

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 sent to the master depends on the set function.

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

Task message (Master station -> VFD)

Control word (CW): The first word in a PZD task message is the control word (CW) of VFD. The representation method can be selected according to function code P15.43. Table 2-4 and Table 2-5 provide descriptions for Goodrive350 series VFD CWs for example.

Bit	Name	Value	Description		
0.7	Communication-based	1	FWD run		
0-7	control command	2	Run reversely		

Table 2-4 Goodrive350 series VFD CWs in decimal

Bit	Name	Value	Description
		З	Jog forward
		4	Jog reversely
		5	Stop
		6	Coast to stop
		7	Fault reset
		8	Stop jogging
		9	Stop in emergency manner
8	WIRTE ENABLE	1	Enable read and write (PKW1–PKW4)
0.10	Motor group cotting	00	MOTOR GROUP1 SELECTION
9-10	Motor group setting	01	MOTOR GROUP2 SELECTION
	Control mode	1	Enable the switchover between torque
11			control/ speed control
	Switchover selection	0	No switchover
		1	Enabling the function for resetting power
12	ELECTRIC	1	consumption to zero
12	CONSUMPTION CLEAR	0	Disabling the function for resetting power
		0	consumption to zero
12		1	Enable pre-exciting
15	PRE-EXCIATION	0	Disable pre-exciting
14		1	Enabling DC braking
14	DC BRAKE	0	Disabling DC braking
15	HEARTBEAT REF	1	Enable heartbeat
12	(Heartbeat reference)	0	Disable heartbeat

Table 2-5 Goodrive350 series VFD CWs in binary

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: No 1: Fault reset	3
3	Coast to stop	0: No 1: Coast to stop	4
4	Forward jogging	0: No 1: Forward jogging	5
5	Reverse jogging	0: No 1: Reverse jogging	6
6	Stop jogging	0: No 1: Jogging stop	7
7	-	Reserved	-
8	Enable read and write	0: Disable	-

Bit	Name	Description	Priority
	(PKW1-4)	1: Enable	
9	-	Reserved	-
10	Stop in emergency manner	0: No 1: Emergency stop	0: Top priority
11-15	-	Reserved	-

Reference value (REF): The second to twelfth words in a PZD task message are the main settings (REF). The main frequency settings are provided by the main setting signal source. Table 2-6 lists the settings of Goodrive350 series VFD for example.

Table 2-6	Sottings	of Goo	drivo350	corioc	
Table 2-0	Settings	01 000	unvesso	series	νгυ

Function code	Word	Value range	Default
P16.32	Received PZD2	0: Invalid 1: Set frequency (0–Fmax, unit: 0.01Hz)	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 motor rated current)	0
P16.36	Received PZD6	5: Setting of the upper limit of forward running frequency (0–Fmax, unit: 0.01Hz)	0
P16.37	Received PZD7	6: Setting of the upper limit of reverse running frequency (0–Fmax, unit: 0.01Hz)	0
P16.38	Received PZD8	7: Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to 100.0% of the motor	0
P16.39	Received PZD9	rated current) 8: Upper limit of braking torque (0–3000, in which	0
P16.40	Received PZD10	current)	0
P16.41	Received PZD11	9: Virtual input terminal command (range: 0x000–0x3FF, with bit 9–bit 10 corresponding to	0
P16.42	Received PZD12	10: Virtual output terminal command. Range: 0x00-0x0F (with bit3-bit0 corresponding to RO2/RO1/HDO/Y1 in sequence) 11: Voltage setting (special for V/F separation)	0

Function code	Word	Value range	Default
		(0–1000, in which 1000 corresponds to 100.0% of	
		the motor rated voltage)	
		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: High bit of position reference (signed)	
		15: Low bit of position reference (unsigned)	
		16–17: Reserved	
		18: Position feedback setting flag (position	
		feedback can be set only after this flag is set to 1	
		and then to 0)	
		19: Function parameter mapping (PZD2–PZD12	
		correspond to P14.49–P14.59)	
		20–31: Reserved	

Response message (VFD -> Master station)

Status word (SW): The first word in a PZD response message is the status word (SW) of VFD. The representation method can be selected according to function code P15.43. Table 2-7 and Table 2-8 provide descriptions for Goodrive350 series VFD SWs for example.

Bit	Name	Value	Description
		1	Running forward
		2	Running reversely
0-7	Running status	3	Stopped
		4	In fault
		5	VFD in POFF state
0	Bus voltage established	1	Ready to run
0	bus voltage established	0	Not ready to run
0-10	Mator group foodback	0	Feedback from motor 1
9-10	Motor group leedback	1	Feedback from motor 2
11	Matautura faadhaali	1	Synchronous motor
11	мотог туре теепраск	0	Asynchronous motor (AM)
12	Overload pre-alarm	1	Overload pre-alarm
12	feedback	0	No overload pre-alarm

Table 2-7 Goodrive350 series VFD SWs in decimal

Bit	Name	Value	Description
		0	Keypad-based control
12.14	RUN/STOP MODE	1	Terminal-based control
13-14	(Running mode	2	Communication-based control
	Selection	3	Reserved
15	HEARTBEAT FEEDBACK	1	Heartbeat feedback
12	(Heartbeat feedback)	0	No heartbeat feedback

Table 2-8 Goodrive350 series VFD SWs in binary

Bit	Name		Description	Priority
0	Forward running	0: No	1: Running forward	1
1	Reverse running	0: No	1: Running reversely	2
2	Stop	0: No 1: Stopped		3
3	Fault	0: No	1: In fault	4
4	POFF	0: No	1: VFD POFF state	5
5	Pre-exciting	0: No	1: Pre-exciting	6
6-15	-	Reserved		-

Actual value (ACT): The second to twelfth words in a PZD task message are the main actual values. The main frequency actual values are provided by the main actual value signal source. Table 2-9 lists the actual status values of Goodrive350 series VFD for example.

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

Table 2-9 Actual status values of Goodrive350 series VFD

Function code	Word	Value range	Default
	PZD8	13: Al2 input (×100, V)	
D16 E0	Sent	14: AI3 input (× 100, V)	0
P16.50	PZD9	15: HDIA frequency value (×1000, kHz)	0
D16 E1	Sent	16: Terminal input status	0
P10.31	PZD10	17: Terminal output status	0
D16 52	18: PID reference (×10, %)	0	
F10.32	PZD11	19: PID feedback (×10, %)	0
P16.53	Sent PZD12	20: Invalid 21: High bit of position reference (signed) 22: LSB of position reference (unsigned) 23: MSB of position feedback (signed) 24: LSB of position feedback (unsigned) 25: Status word 26: HDIB frequency value (×1000, kHz) 27: PG card pulse feedback count high bit 28: PG card pulse feedback count low bit 29: PG card pulse reference count MSB 30: PG card pulse reference count LSB 31: Function parameter mapping (PZD2–PZD12 correspond to P14.60–P14.70) 32: Status word 3 33–47: Reserved	0

PKW zone

PKW zone (parameter identification marks PKW1–value zone): PKW zone describes treatment of parameter identification interface, PKW interface is a mechanism which determine parameters transmission between two communication partners, such as reading and writing parameter values.

ide	Parame entification	Proce	ss data			
PKW1	PKW2	PKW4	CW SW	PZD2 PZD2		
Request No. Response No.	Parameter address	Parameter value error No.	Parameter value			

In the periodic communication, the PKW zone consists of four 16-bit words. The

First word PKW1 (16 bits)									
Task or response ID flag	0-7								
Second word PKW2 (16 bits)									
Bits 15–00 Basic parameter address									
Third word PKW3 (16 bits)									
Value (most significant word) of a parameter	00								
or error code of the returned value									
Fourth word PKW4 (16 bits)									
Value (least significant word) of a parameter	0-65535								
	First word PKW1 (16 bits) Task or response ID flag Second word PKW2 (16 bits) Basic parameter address Third word PKW3 (16 bits) Value (most significant word) of a parameter or error code of the returned value Fourth word PKW4 (16 bits) Value (least significant word) of a parameter								

following table lists the definition of each word.

Note: If the master station requests the value of a parameter, the values in PKW3 and PKW4 of the message 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.

F	Request No. (from the master to a slave)	Respons	e signal
Request	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	3,4
3	Modifying a parameter value (two words) [modifying the value only on RAM]	2	3,4
4	Modifying a parameter value (one word) [modifying the value on both RAM and EEPROM]	1	3,4
5	Modifying a parameter value (two words) [modifying the value on both RAM and EEPROM]	2	3,4

Table 2-10 Definitions of the task identification flag PKW1

▲Note: Request 3 "Modifying a parameter value (two words) [modifying the value only on RAM]" and request 5 "Modifying a parameter value (two words) [modifying the value on both RAM and EEPROM] are not supported currently.

	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: Incorrect password 6: Incorrect data frame 7: Parameter read only 8: Parameter cannot be modified in running 9: Password protection 10: Function code mapping operation failure
4	Reserved

Table 2-11 Definitions of the response identification flag PKW1

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 1388H (50.00) is in PKW4.

Request (Master station -> VFD)



Response (VFD -> Master station)

	PKW1		PK	W2	PK	W3	PK	W4	C	W	ΡZ	D2	PZ	D3	 PZI	012
Response	00	01	00	0A	00	00	13	88	хх	xx	хх	хх	xx	хх	 хх	хх
0001: Response (parameter value updated)																

PZD examples: The transmission of the PZD zone is implemented through VFD

function code settings. For details about related function codes, see the INVT operation manual.

Example 1: Reading the process data of VFD

In the example, PZD3 is set to "8: Running rotation speed" by setting P16.44 to 8. This operation is forcible. The setting remains until the parameter is set to another option.

Response (VFD -> Master station)

	PK	W1	PK	W2	PK	N3	PK	W4	C	W	PZ	D2	PZ	D3	 PZI	012
Response	хх	00	0A	 хх	хх											

Example 2: Writing process data to a VFD device

In this example, "2: PID reference" is taken from PZD3 by setting P16.33 to 2. The parameter specified in each request frame is updated with the information contained in PZD3 until another parameter is specified.

Request (Master station -> VFD)

	Pł	W1	PK	W2	PK۱	N3	PK	W4	C	W	PZ	D2	ΡZ	D3	 PZI	012
Response	хх	хх	хх	хх	хх	хх	хх	хх	хх	хх	хх	хх	00	00	 хх	хх

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

2.5 PLC communication example (S7-1200)

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

2.5.1 Parameter setup

Connect the PLC to your PC with a network cable. Set your PC IP address (such as 192.168.0.100) on your PC network. Set the IP address and name of the PLC.

Open the TIA PORTAL V13 software.

1 Click Online and Diagnostics on the left.

2 Then click Accessible devices.

③ In the pop-up Accessible devices window, set Type of PG/PC Interface to PN/IE.

④ Select Ethernet port for PG/PC Interface.

S Finally click $\textbf{Start}\ \textbf{Search}$ to scan for connected PLC devices. See the following figure.

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> Project view	

If the connection between the PLC and PC is normal, after the scan is completed, the PLC device will appear in the device column, as shown in the red box in the following figure. The device column will display the device, device type, and device MAC address. Click the **Show** button in the bottom right corner to access device settings.

Accessible devices		Type of the PGIPC interfa	ce: 🗨 PN/IE ce: 🖼 Realtek I	Cle GbE Family Cont	v roller V C
	Accessible hodes	or the selected intenace:			
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Flash LED					
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Retrieving device in	formation				=
					Show <u>C</u> ancel

1 Click Online and Diagnostics in the device tree on the left.

2 Choose Functions > Assign IP address in the menu bar on the right.

3 Set the PLC IP address and subnet mask in the red box to ensure that the PC IP and PLC IP address are in the same network segment, as shown in the following figure.



① Set the PLC IP address to **192.168.0.1**, and subnet mask to **255.255.255.0** (Use router can be chosen, which means the router assigns IP).

2 After setting, click the Assign IP address. See the following figure.



- 1) Click Assign PROFINET device name.
- ② On the right, enter the PLC name such as PLC1215C.
- ③ Click Assign name. See the following figure.

Online access Realtek PCIe GbE F									_ # = ×
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Diagnostic status									
Diagnostics buffer									
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Memory		PROFINET de	vice name:	PLC1200			Ø		
PROFINET interface [X1]			Device type:	\$7,1200			•		
 Functions 			rence type.	5741200					
Assign IP address									
Settime									
Firmware update									
Assign PROFINET device na									
Reset to factory settings									
Format memory card		Device filter							
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						Q Properties	🕄 Info 🔒	N Diagnostics	1

2.5.2 Creating a project

Double click the TIA Portal V13 icon to start the TIA Portal V13 project tool.

1) Click Create new project.

2 Enter project information such as $\mbox{Project}$ name, $\mbox{Path}, \mbox{Version}, \mbox{Author}, \mbox{and}$ Comment.

3 Click Create.

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	e Help	
Project view		

Then double click **Open Project View**. See the following figure.

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▶ Project view		Opened project: C:WsersWdminist	rator/Desktop/Pr	▶ Project view ofinet工程\Project1\P	roject1	Open the project view

2.5.3 Adding the GSD file

In the project view, choose **Option (N)** from the toolbar. Then choose **Manage** general station description files (GSD).

0 In the dialog box that appears, enter the source path of the GSD file. 0 Select the GSD file. 0 Click Install.

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	1						
L						3	
						Delete insta	Cancel

After the installation is successful, a message is displayed, indicating that the GSDML file has been installed successfully.



2.5.4 Configuring project basic information

1. Enter the device and network view interface.

Choose **Devices and networks** in the project tree on the left, and double click **Devices and networks** to enter the **Network overview** interface.

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2. Add the project device and PROFINET network.

A. Add PLC S7-1215C to the Devices and Networks view.

Choose Controllers > SIMATIC -1200 > CPU > CPU 1215C AC/DC/Rly > 6ES7 215-1BG40-0XB0 in the Hardware catalog panel on the right, and then double click or drag the 6ES7 215-1BG40-0XB0 icon to the project.



B. Add the INVT communication card to the Devices and networks view.

In the Hardware catalog panel on the right, choose Other field devices >

PROFINET IO > I/O > INVT > Frequency Inverter > ECTX509U8, and double click the EC-TX509U8_1.0.0.0 icon or drag it to the view of Devices & networks. The communication card is displayed as Not assigned.



Click the **Not assigned** option of **EC-TX509U8_1.0.0.0**, and select the IO controller **PLC_1.PROFINET interface_1**. In the network view, the CPU and INVT PROFINET have been connected to the same PROFINET sub network.

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C. Add INVT I/O sub modules to the project.

Double click the **EC-TX509U8_1.0.0.0** icon in the **Devices & networks** view to enter the INVT device view interface.



On the right, choose **Hardware catalog** > **Module**, or double click or drag the **32 Byte IN/OUT** module to the empty area in the **Device view**, as shown in the following figure. Then the **32 Byte IN/OUT** module has been added to the project.

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- D. Set S7-1215C and INVT PROFINET parameters.
 - a) Set PLC S7-1215C parameters.

- Double click **Devices & networks** to enter the **Devices & networks** interface.
- Double click the PLC S7-1215C icon in the Devices & networks view to enter the PLC device view interface.
- Double click the network interface position in the PLC icon to enter the PLC device PROFINET interface_1 property editing interface. See the following figure.
- Click General, choose Ethernet Address, and set the PLC address and name (taking 192.168.0.1 and PLC1215C for example).

The following figure shows the operation procedure.

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b) Set INVT PROFINET communication card parameters.

- Double click Devices & networks to enter the Devices & networks interface.
- Double click the EC-TX509U6_1.0.0.0 icon to enter the communication card device view.
- Double click the network interface position of the INVT PROFINET communication card icon to enter the PROFINET interface editing interface.
- Click the General tab, and choose PROFINET interface [X1] > Ethernet addresses. Set the parameters of the INVT PROFINET communication card according to the parameters shown in the figure, that is, the IP address and device name of the communication card (using IP

192.168.0.2 and name INVT1 as an example).

The following figure shows the operation procedure.

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2.5.5 Assigning a device name for the IO device (INVT communication card)

After the CPU and INVT PROFINET communication card are successfully connected to the computer through a network cable: ① Click **Online access** on the left. ② Find the network card corresponding to the computer connected to the PLC and communication card. ③ Double click **Update accessible devices** and wait for TIA PORTAL to respond.

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After the TIA PORTAL responds, the PLC and IVNT communication cards will be displayed as the accessible devices. See the following figure.

On all displayed devices, find the INVT communication card device and click it, for example, the device ectx509u8 in the figure.

Note: If the communication card is used for the first time, only the default device name can be found.

① Double click **Online and Diagnostics** to enter online diagnostics mode. ② Choose**Functions** > **Assign PROFINET device name**. ③ Access the **Assign PROFINET device name** and type, and click **Assign name**.

∠Note: The PROFINET communication card name that is set online must be the same as the PROFINET communication card name that is set during project configuration. Otherwise, devices cannot communicate through PROFINET.

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2.5.6 Saving, compiling, and downloading

After completing the entire project configuration, download the configuration data to the PLC S7-1215C.

1 Click Save project to save the entire project.

② Right-click PLC_1 [CPU 1215C AC/DC/Rly], and then choose Compile > Hardware and software (change only) to compile the project.

③ Click the icon of download to device icon to download the project configuration

to the PLC.

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Program in			
PLC alarm		Hardware and software only change	57
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Distributed Go online	Ctrl+K	Software (only changes)	
Go utline	Ctrl+M	Software (rebuild all)	
P 20 Secondy Second U Online & diaponstics	Ctrl+O	Software (reset memory reserve)	

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

① Select PN/IE_1 from the Connection to interface/subnet drop-down list box.

② Click **Start search** at the lower right corner to start scanning for PLC devices in the network.

Extended download to	device	_	_	_	_	×
	Configured access nod	es of "PLC_1"				
	Device	Device type	Slot	Interface type	Address	Subnet
—	PLC_1	CPU 1215C ACID	1 X1	PNIE	192.168.0.1	PNIE_1
	T	ype of the PGIPC inte PGIPC inte ection to interface/su 1st gat	rface: rface: ibnet: eway:	PNIE Realtek PCIe (PNIE_1	ibE Family Controller	• • • • • •
	Select target device:				Show all compatible	e devices 💌
	Device	Device type	Inter	ace type Ad	dress	Target device
Flash LED	-	-	Prote	~	cess address	
Online status information					Display only error	Etart search messages
					Los	d <u>C</u> ancel

After the search is completed, the PLC S7-1215C connected to the computer will be displayed in the **Show all compatible devices** list, as shown in the following figure.

① Select the target PLC in the following figure.

2 Click \pmb{Load} to download the configuration information and PLC program to the selected PLC.

	Device	Device type	Slot	Interface type	Address	Subnet	
	PLC_1	CPU 1215C DC/D	1 X1	PN/IE	192.168.0.1		
		Type of the PG/PC inte	rface:	PN/IE		•	
		PG/PC inte	rface:	Realtek PCIe C	bE Family Controller	- (0
		onnection to interface/su	bnet:			- (Ð
		1st gat	eway:			- (•
							_
	Select target device	e: Device type	Interf	ace type Ad	Show all compatible dress	a devices	
	Select target device Device CPUcommon	e: Device type CPU 1215C DC/D	Interfa	Ad	Show all compatible dress 2.168.0.1	Target device CPUcommon	
**	Select target device Device CPUcommon —	e: Device type CPU 1215C DC/D —	Interf. PN/IE PN/IE	ace type Ad 19 Act	Show all compatible dress 2.168.0.1 cess address	Target device CPUcommon —	
2	Select target device Device CPUcommon -	e: Device type CPU 1215C DC/D -	Interf. PN/IE PN/IE	ace type Ad	Show all compatible dress 2.168.0.1 cess address	Target device CPUcommon	
Flash LED	Select target device Device CPUcommon —	e: Device type CPU 1215C DC/D —	Interfi PN/IE PN/IE	ace type Ad	Show all compatible dress 2.168.0.1 cess address	Target devices Target device CPUcommon -	
Flesh LED	Select target device Device CPUcommon -	e: Device type CPU 1215C DCID —	Interfi PN/IE PN/IE	Ad Ad	Show all compatible dress 2.168.0.1 cess address	devices Target device CPUcommon - Start set	arch
Flash LED	Select target device <u>CPUcommon</u> -	e: Device type CPU 1215C DCID. —	Interfi	ace type Ad	Show all compatible dress 2.168.0.1 cess address Display only error	r devices Target device CPUcommon	arch
Flash LED	Select target device Device CPUcommon	e: Device type CPU 121SC DCID. - address 192.168.0.1.	Interfi PN/IE PN/IE	ace type Ad	Show all compatible dress 2.168.0.1 cess address	e devices Target device CPUcommon - Start sei gtart sei messages	arch
Flash LED	Select target devic Device CPUcommon	e: CPU 1215C DCID. 	Interfi PN/IE PN/IE	ace type Ad	Show all compatible dress 2.168.0.1 cess address Display only error	e devices Target device CPUcommon CPUcommon Substrate Start set messages	arch

2.5.7 Monitoring VFD parameters

Choose Watch and force tables > Add new watch table in the project tree on the left.

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Create target watch variables—PZD, PKW, CW and SW variables of the VFD in the newly created **Watch table_1** table.

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	1	Name Address	Display format	Monitor value	Modifyvalue	9	Comment	Tag comment	
7 Project1	01	nqva	Hes				PKM1(PLC Send)		
Add new device	2	5.0.04	Hex				PKW2(PLC Send)		
devices & retworks	2	1000	Hex				PKA3(PLC Seed)		
PLC_1 [OPU 1215C ACIDCR6]	4	50/0	Hex				PKW4(PLC Send)		
Rf Device configuration	5	50010	Hex				cantrol work/%C Servel)		
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· Se Program blocks	7	50/014	Hex				P209/PLC Service		
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		Project1 + PLC_1	CPU 1215C AODOR	y] + Watch and for	e tables + Wa	tch table_1			- * *
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		4 Norre	Address	Display format	Monitor value	Modify value	9	Comment	Tag
Project1	~	16	%QW92	Hex				P2D12(PLC Send)	
Add new device		17							
📥 Devices & networks		10	2010	Hex				PKINI (PLCaccept)	
PLC_1 (OPU 1215C AC/DC/Rb)		19	9///4	Hex				PKIIQ(PLCaccept)	
Device configuration		20	5/76	Hex				PICIES (PLCaccept)	
S Online & diagnostics		21	5///6	Hex				PKIH (PLCaccept)	
 Frogram blocks 		22	9/W10	Hex				status word/PLCaccept)	
Add new block		23	5////2	Hex				P2D2(PLCaccept)	
Their [081]		24	5/0/14	Hex				P2D3(PLCaccept)	
 System blocks 		25	9/0/16	Hex				P2D4(PLCaccept)	
Technology objects		26	5///18	Hex				PZD5(PLCaccept)	
External source files		27	1///20	Hex				P2D6(PLCaccept)	
* 🌄 FLC tags		28	961022	Hex				P2D7(PLCaccept)	
Show all tags		22	5///24	Hex				P2D8(PLCaccept)	
Add new tag table		30	5///26	Hex				P2D9(PLCaccept)	
🕌 Default tag table (38)		31	96/1/28	Hex				P2D10(PLCaccept)	
PLC data types		32	1 5///30	Hex				P2D11(PLCaccept)	
 Watch and force tables 		33	5///02	Hex				P2D12(PLCaccept)	
Add new watch table		34							
Force table									
Watch table_1									
Deline backups									
🕨 📴 Traces									
OPC UA communication									
Device proxy data									
Program info									
PLC alarm test lists									
 Local modules 	Y								

After creating the monitoring variables, click **Watch all** or **Modify value** in the monitoring table to monitor values or modify values, thereby achieving the goal of monitoring the VFD parameters through the PLC.

3 EtherNet IP protocol

3.1 Overview

The communication card using this protocol is defined as an EtherNet IP slave station, which can be used on VFDs that support EtherNet IP communication.

3.2 Product features

3.2.1 Supported functions

- Supports the EtherNet IP protocol and EtherNet IP slave nodes.
- Supports ODVA standards and DLR ring protocol. When configured with a slave station EDS configuration file, it can communicate with Rockwell PLC and other master stations.
- Equipped with two EtherNet IP ports, supporting 10/100M half/full duplex operating.
- Applicable to linear, star, and ring network topologies.
- Enables basic operations on VFDs, such as reading and writing process values, reading status values, and reading/writing function codes. This communication card supports up to 32 IOs.

3.2.2 Supported communication types

EtherNet IP uses the same application layer protocol CIP as DeviceNet and ControlNet,Therefore, they share the same object library and consistent industry standards, ensuring good compatibility.

CIP uses the User Datagram Protocol/Internet Protocol (UDP/IP) for connectionless control and information transmission, and the Transmission Control Protocol/Internet Protocol (TCP/IP) for connection-based transmission over Ethernet. It allows the transmission of both explicit and implicit messages. Implicit messages, which involve time-critical control information, are transmitted using UDP/IP. Explicit messages, which do not have strict time requirements and involve point-to-point information, are transmitted using TCP/IP. Explicit messages are used for configuring, downloading, and troubleshooting; implicit messages are used for real-time I/O data transmission.

3.2.3 Status indicator

The EtherNet IP communication card provides six indicators to indicate its states. For details, see Table 3-1.

Indicator	Color	Definition	Function		
		Steady on	The communication between the communication card and the PLC is online, and data exchange is allowed.		
LED1 (RUN)	Green	Green	Green	Blinking (on for 500ms, off for 500ms)	Abnormal setting of the IP address for either the communication card or the PLC.
		Steady off	The communication between the communication card and PLC is not in Online state.		
		Steady on	The communication card is in the process of handshaking with the VFD.		
LED2 (HOST)	Green	Blinking (on for 500ms, off for 500ms)	The communication card and VFD communicate normally. Note: After the handshaking is completed, it should blink regardless of whether there is data transmission between the communication card and the main control board.		
		Steady off	The communication card is in the initialization or parameter configuration phase.		
		Blinking (on for 500ms, off for 500ms)	The data update between the communication card and main control board is normal.		
(DATA)	Green	Steady off	No data update or abnormal update between the communication card and main control board.		
LED4 (POWER)	Red	Steady on	3.3V power indicator		
LED5 (ERR)	Red	Steady on	Failed to set up data communication between the communication card and PLC.		

Table 3-1	Indicator	description
-----------	-----------	-------------

Indicator	Color	Definition	Function
		Blinking (on for 500ms, off for 500ms)	Incorrect PLC configuration.
		Blinking (on for 250ms, off for 250ms)	The communication card failed to send data to the PLC.
		Blinking (on for 125ms, off for 125ms)	The connection between the communication card and PLC timed out.
		Steady off	No fault
LED6 (SYS)	Green	Blinking (on for 500ms, off for 500ms)	Communication card heartbeat indicator (communication card is running normally).

3.3 Electrical connection

The EtherNet IP communication card adopts standard RJ45 interfaces, which can be used in a linear network topology and a star network topology, as shown in Figure 3-1 and Figure 3-2.

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

Figure 3-1 Linear network topology electrical connection







∠Note: For the star network topology, you need to prepare EtherCAT switches.

Figure 3-3 Ring network topology electrical connection



3.4 Communication

3.4.1 Communication settings

The communication card can only be used as an EtherNet IP slave, and function codes should to be set on the VFD before communication. The procedure is as follows:

Step 1 Set the communication card IP address and subnet mask.

The factory IP address and subnet mask of each communication card are 192.168.0.20 and 255.255.0 respectively, which can be changed to a network segment address according to the actual requirements.

Step 2 Set the control method.

To control the VFD through EtherNet IP communication, set the control mode to EtherNet IP communication control. To be specific, set P00.01=2 and P00.02=3, which will implement the control of VFD start and stop. In short, if a value needs to be set through EtherNet IP communication, the corresponding function code should be modified to EtherNet IP communication control. For related function codes, see Appendix 2.

✓Note: After steps 1 and 2 are implemented properly, the communication card can communication properly. If a VFD needs to be controlled, related function nodes must be set and the control mode is EtherNet IP communication.

3.4.2 Message format

The TCP communication message is shown in Table 3-2.

Table 3-2 TCP	communication	message
---------------	---------------	---------

Header of MAC layer	Header of IP layer	Header of TCP layer	Valid data	Trailer
14 bytes	20 bytes	20 bytes	0–1488 bytes	4 bytes

The UDP communication message is shown in Table 3-3.

Table 3-3 UDP communication message

Header of MAC layer	Header of IP layer	Header of UDP layer	Valid data	Trailer
14 bytes	20 bytes	20 bytes	0–1488 bytes	4 bytes

3.4.3 Communication

The EtherNet IP communication card supports 16-word input/output. Figure 3-4 shows the message format for transmitting data with the VFD.

Figure 3-4 Message structure



Through the preceding 32 IOs, you can set the reference parameters, monitor status values, send control commands and monitor operation status of the VFD, and read and write VFD function parameters.

Parameter zone:

PKW1—Parameter identification

PKW2—Array index number

PKW3—Parameter value 1

PKW4—Parameter value 2

Process data:

CW—control word (from the master station to the slave station; see Table 3-4)

SW—status word (from the slave station to the master station; see Table 3-7)

PZD—process data (user specified)

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

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

CW and SW

Using CWs is the basic method for the fieldbus system to control VFD devices. It is sent from the fieldbus master 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 status information back to the master through an SW.

Reference value: The 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 on VFD devices through EtherNet IP, you need to set communication cards as the controllers of the VFD devices.

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 sent to the master depends on the set function.

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

Task message (Master station -> VFD)

Control word (CW): The first word in a PZD task message is the control word (CW) of VFD.

When P15.43=0 (CW defined in decimal), Table 3-4 provides the definitions of GD350 series VFD CWs in decimal.

Bit	Name	Value	Description
		1	FWD run
		2	Run reversely
		3	Jog forward
	с ·	4	Jog reversely
0-7	Communication-based	5	Stop
	control command	6	Coast to stop
		7	Fault reset
		8	Stop jogging
		9	Stop in emergency manner
8	WIRTE ENABLE 1 Enable read and write (PKW1–PKV		Enable read and write (PKW1–PKW4)
0_10	Motor group cotting	00	MOTOR GROUP1 SELECTION
9-10	Motor group setting	sed 4 Jog reversely 5 Stop 6 Coast to stop 7 Fault reset 8 Stop jogging 9 Stop in emergency manner 1 Enable read and write (PKW1–PKW4) 00 MOTOR GROUP1 SELECTION 01 MOTOR GROUP2 SELECTION 01 Enable the switchover between torque control/speed control 0 No switchover 1 Enabling the function for resetting power consumption to zero iAR 0 Disabling the function for resetting power consumption to zero 1 Enable ne service	
	Control modo	1	Enable the switchover between torque
11	control mode	Value Description 1 FWD run 2 Run reversely 3 Jog forward 4 Jog reversely 5 Stop 6 Coast to stop 7 Fault reset 8 Stop joging 9 Stop in emergency manne LE 1 10 MOTOR GROUP1 SELECTIO 01 MOTOR GROUP2 SELECTIO 11 Enable the switchover between 11 Consumption to zero 12 Enabling the function for resettin 0 Disabling the function for resettin 0 Disable pre-exciting 0 Disable pre-exciting 0 Disable pre-exciting 0 Disable pre-exciting 0 Disabl	control/ speed control
	Switchover Selection		No switchover
		d 6 Coast to stop 7 Fault reset 8 Stop jogging 9 Stop in emergency manner 1 Enable read and write (PKW1-PF 00 MOTOR GROUP1 SELECTION 01 MOTOR GROUP2 SELECTION 01 MOTOR GROUP2 SELECTION 01 MOTOR GROUP2 SELECTION 0 NO switchover between to control/ speed control 0 No switchover 1 Enabling the function for resetting consumption to zero 1 Enabling the function for resetting 0 Disabling the function for resetting 0 Disable pre-exciting 0 Disable pre-exciting	Enabling the function for resetting power
12	ELECTRIC	Т	consumption to zero
12	CONSUMPTION CLEAR	0	Disabling the function for resetting power
		7 Fault reset 8 Stop jogging 9 Stop in emergency manner 1 Enable read and write (PKW1–PKW4) ing 00 MOTOR GROUP1 SELECTION 01 MOTOR GROUP2 SELECTION 1 Enable the switchover between torque control/ speed control 0 N or switchover 1 Enabling the function for resetting pow consumption to zero LEAR 0 Disabling the function for resetting pow consumption to zero N 1 Enable pre-exciting 0 Disable pre-exciting 1	
13		1	Enable pre-exciting
15	TREERCIATION	0	Disable pre-exciting
14	DC BRAKE	1	Enabling DC braking
14	DC BRARL	0	2 Run reversely 3 Jog forward 4 Jog reversely 5 Stop 6 Coast to stop 7 Fault reset 8 Stop jogging 9 Stop in emergency manner 1 Enable read and write (PKW1-PKW4) 00 MOTOR GROUP1 SELECTION 01 MOTOR GROUP1 SELECTION 01 MOTOR GROUP2 SELECTION 0 No switchover between torque control/ speed control 0 No switchover 1 Enable the switchover between to zero 0 No switchover 1 Enabling the function for resetting power consumption to zero 1 Enable pre-exciting 1 Enable pre-exciting 1 Enabling DC braking 1 Enabling DC braking 1 Enabling DC braking 1 Enable heartbeat 0 Disable heartbeat
15	HEARTBEAT REF	1	Enable heartbeat
10	(Heartbeat reference)	0	Disable heartbeat

Table 3-4 Goodrive350 series VFD CWs in decimal

When P15.43=1 (CW defined in binary), Table 3-5 provides the definitions of GD350 series VFD CWs in binary.

y

Bit	Name	Description	Priority
0	Forward running	0: Decelerate to stop 1: Forward	1
		running	
1	Pewerse running	0: Decelerate to stop 1: Reverse	2
1	Reverse fulling	running	2
2	Fault reset	0: No 1: Fault reset	3

Bit	Name	Description	Priority
3	Coast to stop	0: No 1: Coast to stop	4
4	Forward jogging	0: No 1: Forward jogging	5
5	Reverse jogging	0: No 1: Reverse jogging	6
6	Stop jogging	0: No 1: Jogging stop	7
7	-	Reserved	-
Q	Enable read and write	0: Disable	
0	(PKW1-4)	Description 0: No 1: Coast to stop 0: No 1: Forward jogging 0: No 1: Reverse jogging 0: No 1: Jogging stop Reserved 0: Disable 1: Enable Reserved 0: No 1: Emergency stop Reserved	-
9	-	Reserved	-
10	Stop in emergency		0: Top
4 5 6 7 8 9 10 11–15	manner	U. NO I. Emergency stop	priority
11-15	-	Reserved	-

Reference value (REF): The second to twelfth words in a PZD task message are the main settings (REF). The main frequency settings are provided by the main setting signal source. Table 3-6 lists the main settings of Goodrive350 series VFD for example.

Function code	Word	Value range	Defau lt
P16.32	Received PZD2	0: Invalid 1: Set frequency (0–Fmax, unit: 0.01Hz)	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 motor rated current)	0
P16.36	Received PZD6	5: Setting of the upper limit of forward running frequency (0–Fmax, unit: 0.01Hz)	0
P16.37	Received PZD7	6: Setting of the upper limit of reverse running frequency (0–Fmax, unit: 0.01Hz)	0
P16.38	Received PZD8	7: Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to 100.0% of the motor rated	0
P16.39	Received PZD9	current) 8: Upper limit of braking torque (0–3000, in which 1000	0
P16.40	Received PZD10	corresponds to 100% of the motor rated current) 9: Virtual input terminal command (range: 0x000–0x3FF,	0

Table 3-6 Settings of Goodrive350 series VFD

Function code	Word	Value range	Defau lt
P16.41	Received PZD11	with bit 9–bit 10 corresponding to S8/S7/S6/S5/HDIB/HDIA/S4/S3/S2/S1 in sequence)	0
P16.42	Received PZD12	10: Virtual output terminal command. Range: 0x00–0x0F (with bit3–bit0 corresponding to RO2/RO1/HDO/Y1 in sequence) 11: Voltage setting (special for V/F separation) (0–1000, in which 1000 corresponds to 100.0% of the motor rated voltage) 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: High bit of position reference (signed) 15: Low bit of position reference (unsigned) 16–17: Reserved 18: Position feedback setting flag (position feedback can be set only after this flag is set to 1 and then to 0) 19: Function parameter mapping (PZD2–PZD12 correspond to P14.49–P14.59) 20–31: Reserved	0

Response message (VFD -> Master station)

Status word (SW): The first word in a PZD response message is the status word (SW) of VFD. When P15.43=0(SW defined in decimal), the VFD SW definitions are as follows.

Bit	Name	Value	Description
		1	Running forward
		2	Running reversely
0-7	Running status	s <u>3 Stopped</u>	
		4	In fault
		Value Description 1 Running forward 2 Running reversely 3 Stopped 4 In fault 5 VFD in POFF state 1 Ready to run 0 Not ready to run k 1 1 Feedback from motor 1	
0	Due velte se established	1	Ready to run
8	Bus voltage established	Value Description 1 Running forward 2 Running reversely 3 Stopped 4 In fault 5 VFD in POFF state 1 Ready to run 0 Not ready to run 0 Feedback from moto 1 Feedback from moto	Not ready to run
0.10	Matax group foodbook	0	Feedback from motor 1
9-10	Motor group reedback	1	Feedback from motor 2

Table 3-7 Goodrive350 series VFD SWs in decimal

Bit	Name	Value	Description
11	Matautura faadhaali	1	Synchronous motor
11	Motor type feedback	0	Asynchronous motor (AM)
12	Quarland pro plarm foodback	1	Overload pre-alarm
12	Overload pre-alarm leedback	Value Description 1 Synchronous motor 0 Asynchronous motor 1 Overload pre-alarr 0 No overload pre-alarr 0 No overload pre-alarr 1 Overload pre-alarr 0 Keypad-based contr 1 Terminal-based contr 2 Communication-base control 3 Reserved 1 Heartbeat feedbac 0 No beartheat feedbac	No overload pre-alarm
		0	Keypad-based control
		1	Terminal-based control
13-14	RUN/STOP MODE	2	Communication-based
		ack 1 Overload pre-alarm 0 No overload pre-alarm 0 Keypad-based control 1 Terminal-based control 2 Communication-based control	
		3	Reserved
15		1	Heartbeat feedback
12	TEARIDEAT FEEDBACK	0	No heartbeat feedback

When P15.43=1(SW defined in binary), the VFD SW definitions are as follows.

Table 3-8 Goodrive350 series VFD SWs in binary

Bit	Name	Description	Priority
0	Forward running	0: No 1: Running forward	1
1	Reverse running	0: No 1: Running reversely	2
2	Stop	0: No 1: Stopped	3
3	Fault	0: No 1: VFD in fault	4
4	POFF	0: No 1: VFD in POFF state	5
E	Dre eveiting	0: No 1: VFD in	G
5	Pre-excluing	pre-exciting state	0
6-15	-	Reserved	-

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

Table 3-9 Actua	l status values o	of Goodrive350	series VFD
-----------------	-------------------	----------------	------------

Function code	Word	Value range	Default
P16.43	Sent PZD2	0: Invalid 1: Running frequency (×100, Hz)	0
P16.44	Sent PZD3	2: Set frequency (×100, Hz) 3: Bus voltage (×10, V)	0
P16.45	Sent PZD4	4: Output voltage (×1, V) 5: Output current (×10, A)	0

Function code	Word	Value range	Default			
P16.46	Sent PZD5	5: Actual output torque (×10, %) 7: Actual output power (×10, %)				
P16.47	Sent PZD6	8: Rotation speed of running (×1, RPM) 9: Linear speed of running (×1, m/s)	0			
P16.48	Sent PZD7	10: Ramp reference frequency 11: Fault code	0			
P16.49	Sent PZD8	12: Al1 input (×100, V) 13: Al2 input (×100, V)	0			
P16.50	Sent PZD9	14: Al3 input (× 100, V) 15: HDIA frequency value (×1000, kHz)	0			
P16.51	Sent PZD10	L6: Terminal input status L7: Terminal output status				
P16.52	Sent PZD11	18: PID reference (×10, %) 19: PID feedback (×10, %)				
P16.53	Sent PZD12	 21: High bit of position reference (signed) 22: Low bit of position reference (unsigned) 23: MSB of position feedback (signed) 24: LSB of position feedback (unsigned) 25: Status word 26: HDIB frequency value (×1000, kHz) 27: PG card pulse feedback count high bit 28: PG card pulse feedback count low bit 29: PG card pulse reference count MSB 30: PG card pulse reference count LSB 31: Function parameter mapping (PZD2–PZD12 correspond to P14.60–P14.70) 32: Status word 3 33-47: Reserved 	0			

PKW zone

PKW zone (parameter identification marks PKW1–value zone): PKW zone describes treatment of parameter identification interface, PKW interface is a mechanism which determine parameters transmission between two communication partners, such as reading and writing parameter values.

	Parameter identification (PKW)					ss data	
	PKW1	PKW2	PKW3	PKW4	CW SW	PZD2 PZD2	
F	Request No. Response No.	Parameter address	Parameter value error No.	Parameter value			

Figure 3-5 PKW zone

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

First word PKW1 (16 bits)						
Bits 15–00 Task or response ID flag 0–						
	Second word PKW2 (16 bits)					
Bits 15–00 Basic parameter address 0–247						
Third word PKW3 (16 bits)						
Dite 15-00	Value (most significant word) of a parameter	00				
BILS 15-00	or error code of the returned value	00				
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 message 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.

R	equest No. (from the master to a slave)	Respons	se signal
Request	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	3,4
3	Modifying a parameter value (two words) [modifying the value only on RAM]	2	3,4
4	Modifying a parameter value (one word) [modifying the value on both RAM and EEPROM]		3,4
5	Modifying a parameter value (two words)	2	3,4

Table 3-10 Definitions of the task identification flag PKW1

R	equest No. (from the master to a slave)	Respon	se signal
Request	Function	Acceptance	Rejection
	[modifying the value on both RAM and EEPROM]		

▲Note: Request 3 "Modifying a parameter value (two words) [modifying the value only on RAM]" and request 5 "Modifying a parameter value (two words) [modifying the value on both RAM and EEPROM] are not supported currently.

Table 3-11 Definitions of the response identification flag PKW1

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

Mode specified by the standard ODVA protocol

The standard ODVA protocol specifies the data transmission format and defines the control word/status word. Table 3-12 provides the message format for data transmission with the VFD.

No.	Input/Output	Data length (byte)	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

Table 3-12 Standard ODVA protocol specified transmission mode

See Table 3-13, Table 3-14, Table 3-15, and Table 3-16 for the definitions of CW1,

SW1, CW2, and SW2.

Note: The ODVA protocol messages do not support P15.43=1 (binary definition).

Bit	Name	Value	Description
0	FWD run	0	FWD run disabled
		1	FWD run
1	Reserved	-	-
2 Fa	Foult reset	0	No function
	Fault Teset	1	Fault reset
3–15	Reserved	-	-

Table 3-13 Standard ODVA protocol specified CW1

Table 3-14 Standard ODVA protocol specified SW1

Bit	Name	Value	Description
0	F I1 I I I	0	No fault
	Fault state	1	Fault occurred
1	Reserved	-	-
2 Run st	Due status	0	Not in FWD run
	Run status	1	FWD run
3-15	Reserved	-	-

Table 3-15 Standard ODVA protocol specified CW2

Bit	Name	Value	Description
0		0	FWD run disabled
0	FWDTull	1	FWD run
1	Bup roversely	0	REV run disabled
T	Run reversely	1	Run reversely
2	Fault recet	0	No function
2	Fault reset	1	Fault reset
3–4	Reserved	-	-
	Control reference	0	Local control (keypad)
5	source	1	Remote control (EtherNet IP
		1	communication)
	Frequency reference source	0	Local reference (keypad)
6		1	Remote reference (EtherNet IP
		1	communication)
7–15	Reserved	-	-

Bit	Name	Value	Description
0		0	No fault
0	Fault	1	Fault occurred
1	Overload pre-alarm	0	No overload pre-alarm
1	feedback	1	Overload pre-alarm
2	Dup status word 1	0	Stop
2	Ruff Status Word 1	1	FWD run
2	Run status word 2	0	Stop
3		1	Run reversely
4	Bus voltage established	0	Not ready to run
4		1	Ready to run
-	Control reference	0	Local control (keypad)
Э	source	1	Remote control (non keypad)
c	Frequency/torque	0	Local control (keypad)
6	reference source	1	Remote control (non keypad)
7	Desching reference	0	Not reached
	Reaching reference	1	Reached
8-15	Reserved	-	-

Table 3-16 Standard ODVA protocol specified extended SW2

INVT extended data modes based on ODVA protocol

Table 3-17 lists the transmission message format for communication with VFDs in the four modes, based on the ODVA protocol and combined with the PZD process data defined by INVT.

Table 3-17 INVT extended data modes based on ODVA protocol

No.	Input/Output	Data length (byte)	Format (word)
6	74/24	24	CW1/SW1+Speed_ref/act+Empty word+PZD4–12
7	75/25	24	CW2/SW2+Speed_ref/act+Empty word+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, the definitions of control word and status word are consistent with the "mode defined by the standard ODVA protocol", and PZD4–12 is consistent with the "custom mode defined by INVT", which will not be described further here.

3.5 PLC communication example 1 (1769_L36ERMS)

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

3.5.1 Creating a project

Use a printer cable or Ethernet cable to connect the computer and PLC, open the



software, and click New Project.



Choose the correct PLC model, fill in the project name, click **Next**, and then click **Finish**.

🕘 New Project	7 ×	New Project 7 X
Project Types	Search ×	1769-L36ERMS Compact GuardLogix® 5370 Safety Controller GD_350_(themstif=_ODVA_049
💰 Logix	 Compared Council Aged S 1015 Motify C Controller THR LLARINK Compared Council Aged S 1026 Motify C (1996) THR LLARINK Compared Council Aged S 1025 Motify C (1996) THR LLARINK Compared Council Aged S 1025 Motify C (1996) THR LLARINK Compared Council Aged S 1025 Motify C (1996) THR LLARINK Compared Council Aged S 1025 Motify C (1996) THR LLARINK Compared Council Aged S 1025 Motify C (1996) Compared Council Aged S 1026 Motify C (1996) Compared Council Aged C council Aged S 1026 Motify C (1996) Compared Council Aged S 1026 Motify C (1996) 	Replace 1 Involve Juntov
	Connectionic ²⁵ 5/80 Controllar	
	Location: D\\#EP Browse.	
	Cancel Back Next Finish	Cancel Back Next Einish

3.5.2 Importing the EDS file

The Electronic Data Sheet (EDS) file is used to specify the device properties of an EtherNet IP client. The client identifies a device by product code, device type, and main version.

You can request the EDS file of the card from the supplier, or download it from our website.

Website: www.invt.com.cn, file name: EC-TX509U8_1.0.0.0.eds

Right click TOOLS and choose EDS Hardware Installation Tool.



Click Next.

Rockwell Automation's EDS W	fizard		×
	Welcome to Rockwell Automation's EDS Wizard		
	The EDS Wizard allows you to:		
	- register ED-Stated devices unregister a device.		
	- change the graphic images associated with a device.		
	- create an EDS file from an unknown device.		
	- upload EDS file(s) stored in a device.		
	To continue click Next		
	[Next >	Cancel

Select the method shown in the following figure and click Next.

NOCKWEII A	Itomation's EDS Wizard			~
Options What	task do you want to complete?			¥,
b	 Register an EDS file(s). This option will add a device(s) to our database. 			
	¹ Unregister a device. This option will remove a device that has been registered by an EDS file from our database.			
R	^C Create an EDS file. This option creates a new EDS file that allows our software to recognize your device.			
1	Upload EDS Re(s) from the device. This option uploads and registers the EDS Re(s) stored in the device.			
		< Back	Next >	Cancel

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

Rockwell Automation's EDS Willard	×		Rockwell Automation's EDS Waard	×
Registration Electronic Data Sheet file(i) will be added to your system for use in Rockwell Automation applications.			EDS File Installation Test Results This test evaluates each EDS file for errors in the EDS file. This test does not guarantee EDS file validay.	V
6 Recitire a sincle file			© ⁶ 0 <mark>http://www.search.com/se</mark>	
C Register a directory of EDS files T Look in subfolders				
Naned.				
		\rightarrow		
*If there is an icon file (ico) with the same name as the file(b) you are registering then this image will be associated with the device.				
To perform an installation test on the file(s), click New			Wew Ne	
< Back Net >	Cancel		<bek net=""></bek>	Cancel

Click Next to complete the installation.

Oxange Graph You can cha	o Image nge the graphic image that is associated with a device.	J.
Dange icon	Totala Tore	

3.5.3 Creating a device object

On the left, choose I/O Configuration, right click Ethernet option, then right click and choose New Module.



Choose EC-TX509U8 and click Create.

	tule Type Clear Filters Hide Filte	rs
Module Type Cate Analog CIP Notion Conver Communication C	gory Filters Advanced Energy Industries, Inc. ter Dialight Compared Energy Industries, Inc. Compared Energy Industries, Inc.	
Catalog Number CMB CMB DACS EtherWet/ DACS EtherWet/ DrivelogitS730 El Plus El21 El51 EAS800 EtherWe	Description - 2007/407 FLORENT IPS - 5007 Dialight TuberHert PAdapter Dialight TuberHert PAdapter Dialight TuberHert PF et a Dirivalgiar7520 Electronic Overload Fairy Comanications Interface Flowerry 2007/1007/eta/220706. Flowerry 6007/100766.	
EC-TX50908 EC-TX80905	BC-TX80905_1.0.0.0 BC-TX80905_1.0.0.0 SoftLogix5800 EtherNet/IP Communic AthenNet/IP (TR Puides	

Fill in the module name, and set the module IP address, which needs to be consistent with P16.58–P16.61 on the GD350 EtherNet IP card, otherwise communication will fail.

New Module	
Conversion Marcine Instrume Name Name Varie 000 2000000000 ED 200000000 ED 20000000000	21mmt A33me Privat Native: ■ PA35es: 102 152 152 152 103 152 000 201 Hot Rare:
Modula Colinition Reveain: 2006 Bestans: Keying Compatible Module Committans: Exclusive Denner	
Status: Creating	OK Cancel Help

Click **Change** in the preceding figure, and select the protocol type adopted by the module; the IO format of each type is different and needs to be correspondingly selected, as shown in the following table. "Exclusive Owner" is used as an example for explanation.

1	6 1	Aodule Definition*									x
	Re Be	vision: 2 ctronic Keying: Compa	, 66	• le Mo	d	006 🗠 ule	1	•]		
	Cor	nnections:									
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		Exclusive Owner	10	put	Ī	16		1		EIP1:I1	
			¢.	utput		16	IN I		1	EIP1:01	
		Exclusive Owner 20/70 Basic speed contro 21/71 Extended speed co 22/72 Basic Speed and T 23/73 Extended Speed a		-							
		NVT 24/74 Basic Speed NVT 25/75 Basic Speed NVT 26/76 Basic Speed NVT 27/77 Basic Speed Input Only Listen Only					ОК			Cancel He	lp

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 Basic Speed Control plus Drive Parameters	12	INT
INVT 26/76 Basic Speed Control plus Drive Parameters	12	INT
INVT 27/77 Basic Speed Control plus Drive Parameters	12	INT

Click OK, Yes, OK, OK, and OK in sequence.

Vender	Module De	finition"	×
Parent:	Revision:	1 🗸 013 🔃	
gix Designer			×
Chang	e module defini	ition?	
Revision		Yes No	
Revision: Bectronic K		Yes No	
Revision: Bectronic K Connections		Ves No	_

After the module is successfully created, you can see and verify the device information under **Ethernet** under **I/O Configuration** on the left.

All Look Conjugar - Manual P 10(0) - 30(0)/5 (4-117)		
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3.5.4 Using RSLinx Classic

This software is used for the connection between the PC and PLC. Open the Rslinx Classic software.



Click the S-shaped icon. Choose **EtherNet/IP Driver**, and click **Add New**.... In the pop-up **Configure Drivers** window, select **Ethernet/IP Driver** from the **Available Driver Types** dropdown menu.

Available Driver Types:		
TPS4LDPH for DH- devices PS2LDPH advices EndedWork PD Prove TOSHTD 2019 PD Prov	Configure Startup Startup Start Delete	

Click Add New. In the pop-up Add New RSLinx Classic Driver window, click OK.

NRSLinx Classic Gateway	_	
File Edit View Communications Station DDE/OPC Security Window Help		
<u>≥ # 20 @ / %</u>		
Configure Drivers	? ×	
Available Driver Types:	Close	
EtherNet/IP Driver	Help	
Configured Drivers:		
Name and Descriptiv Add New RSLinx Classic Driver		
AB_VEP1 RUD Choose a name for the new driver. 0K [15] cheacter maximum]	Configure Statjup Stat Stop	
	Delete	
For Help, press F1	04/29/20	10:44 AM

In the pop-up **Configure driver** window, select the computer network card and click **OK**.

Configure driver: AB_ETHIP-1 ?	×
EtherNet/IP Settings	
C Browse Local Subnet	
Description IP Address	^
Windows Default Realitek PCIe GhE Eamily Controller #4 192 168 1 90	
TAP-Windows Adapter V9 unknown	_
Bluetooth Device (Personal Area Network) #3 unknown Intel(R) Wi-Fi 6 AX201 160MHz 192.168.247.7	71
<	>
OK Cancel Apply	Help

3.5.5 Writing PLC programs

On the left, choose Tasks > MainTask > MainProgram > MainRoutine to enter the program editing interface. Right clicking Parameters and Local Tag can create global variables.

Logix Designer - EthernetIP (1769-L36ERMS 31.11)*					
FILE EDIT VIEW SEARCH LOGIC COMMUNICATIONS TOOLS WI	NDOW HELP		New Param	eter or Tag	×
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Construction → Construction → Construction Construction → Construction → Construction Construction → Construction Construction → Construction Construction → Construction Construction Construction → Construction	inputiGutput Compane Computeriliath MexelLogical FileMac. File		Description:	^	Cancel
Controller Organizer v 9 ×	Medule Preperties: Local (EC-TX509US 2.006) ×				Help
0 1	General Descention Module Into Internet Protocol Network		1		ſ
Controller EthernedD Controller Tags Controller Fault Handler Power-Up Handler	Type: EC-TXX09U8 EC-TXX09U8_1.0.0.0 Vendor: HINS Industrial Networks AB		Usage:	Input Parameter ~	
C Tasks	Name: EP1 B	,	Typg:	Base ~ Connection	
A MainProgram Parameters and Local Tags	Desciption:		Alias Eor:		
B Main Vew Local Tag. Ctrl+W SofetyTask New Parameter. D _ SofetyPe		→	Data <u>T</u> ype:	INT	
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Assets Logical Model Knowledge	Pevision: 2.005 Bectronic Keying: Compatible Module		Scope:	🗄 MainProgram 🗸 🗸	
ID Configurate Print ID D Configurate Print ID D Dus ID 1209-1 30FBMS EthermetIP	Connections: Exclusive Owner		Cl <u>a</u> ss:	Standard \vee	
A A Dhemet B1709-L3GERMS EthemetP			Esternal Access:	Read/Write ~	
EC-TX509UB EIP1	Change		Style:	Decimal \checkmark	
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			Seguencin	9	
			Open Confi	guration	
		L	Open Para	meter Connections	

Example: Create four variables.

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Double click **MainRoutine** and write the following program in the program interface.

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Controller Organizer BC Logical Collarizer	

3.5.6 Host controller connection and program download

Choose **OMMUNICATIONS** > Who Active. In the pop-up interface, click the PLC project under **USB**, and click **Download**.

Note: The PLC position cannot be set to "RUN" at this time.



In the pop-up dialog box, select the connected PLC, and click **Download**; wait for the download to complete.

🗳 Who Active (RSLinx Classic)		[Download		×
○	Go Dnine Upload Download Ubdate Pirmane Close Help	→		Download offline project 'EthernetP' to the controller. Connected Controller: Name: SingleTest Type: 17/94-3058/5/A Compact GuardLogx(6) 537 Path: USIS/5 Serail Number: 60/95528 Security: No Protection A the controller is in Remote Run mode. The mode will be change Remote Program prior to download. DMUGRET: The controller being downloaded to is the system time	0 d to
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After the download is complete, the host controller enters the online status, and you can see the VFD feedback parameters on the program interface.



Choose Logic > Monitor Tags to monitor the real-time data sent by the PLC and uploaded by the VFD.

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3.5.7 Setting the PLC IP address using Studio 5000 V31

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



3.5.8 DLR ring network configuration

1. Set up using Logix Designer.

Open Studio 5000 software, and use Allen-Bradley CompactLogix PLC equipped with ring networking capability. At least two GD350 EtherNet IP communication cards are required. More GD350 EtherNet IP communication cards can be added, but it is recommended to add 32 nodes on the DLR ring network at most, as shown in the following diagram for the connection method.



✓Note: The EDS file must be added.

2. Add the EtherNet IP communication cards in the Studio 5000.

The adding method is the same as the line or star connection method.

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3. Enable the PLC ring network monitor function.

Double click **1769-L36ERMS EtherNet IP** under the **I/O Configuration** folder, as shown in the following figure.

Go to Controller Properties and select Network*, choose Enable Supervisor

Mode, then click OK.

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

Return to Logix Designer and ensure that none of the communication cards are experiencing the following faults.

 1	1769-L36ERMS EthernetIP
7	EC-TX509U8 EIP1
7	EC-TX509U8 EIP2

5. Download the project to the PLC, make the PLC online and in the programming mode.

3.6 PLC communication example 2 (NJ501-1400)

This example illustrates how to use an EtherNet IP adapter module to communicate with an ORMON PLC (model: NJ501-1400) (by using Studio 5000 software as the configuration tool).

3.6.1 Hardware connection

NJ501-1400 is equipped with a USB interface and an EthernetIP interface; the connection between the host controller and PLC is done through USB, with the EthernetIP port used as a communication connection method.



3.6.2 Network Configurator software setting

3.6.2.1 Starting the Network Configurator software

Start the Network Configurator software in the following directory as an administrator:

C:\Program Files (x86)\OMRON\CX-One\NetworkConfigurator\Program\NetConfigurator.exe

3.6.2.2 Uploading the EDS file

Choose EDS File > Install.

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Add devices NJ501-1400 and EC-TX509U8_1.0.0.0 to the EtherNet IP bus at the following location. After completion, two devices will be displayed on the bus. The default IP addresses are 192.168.250.1 and 192.168.250.2. Modify the GD350 function codes P16.58–P16.61 to 192.168.250.2.



3.6.2.3 Connection setting

Choose Option > Select Interface > NJ/NX Series USB Port.

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Click the icon for connection.

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Choose Backplane > 0 NJ501-1400 > TCP:2, and then click OK.

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Choose Use the existing network, select EtherNet/IP_1, and click OK. PLC connection is successful.

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After the connection is successful, the blue indicator above the PLC device icon will turn on. Choose the PLC, click the icon for **Device Property**. On the **Controller Information** tab in the pop-up interface, you can switch between the **Program** and **Run** states for the PLC.

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3.6.2.4 Changing the IP address

Right click the device icon, and choose **Change Node Address** to change the PLC IP address.

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3.6.3 Configuring Sysmac Studio software

3.6.3.1 Creating a project

Double click the



icon to open the software. Choose New Project, enter the

project name, select the device type, and click Create.



After the creating, enter the following interface, right-click the device icon, and choose **Rename** to change the device name (it can also remain unchanged).

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3.6.3.2 Connection setting

Choose Controller > Communications Setup.



Choose **USB Direct connection via USB**, and click **USB Communications Test**. The status bar displays **Test OK**. Click **OK**.

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3.6.3.3 Setting data tags

On the left, choose **Programming** > **Data** > **Global Variables**, and add global variables according to actual needs. Note that **Data Type** is **WORD** and **Network Publish** is **Input** or **Output**.

In this example, the "ODVA Basic speed control assembly" transmission mode is used to create four global variables.



In the top menu bar, choose Tools > EtherNet/IP Connection Settings.

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Double click Built-in EtherNet/IP Port Settings.

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Right click on the blank area under Tag Set, and choose Create New Tag Set.

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Enter the tag set name as **INPUT**, right click the tag set and choose **Create New Tag**, and add input global variables to the tag set **INPUT**. Pay attention to the order of data arrangement.



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3.6.4 Importing or exporting data tags

3.6.4.1 Exporting data tags from Sysmac Studio

After data tags are set, click **Export** to export the data tag to the local storage and save it as **EthernetIP.csv**.

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3.6.4.2 Importing data tags to the Network Configurator

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



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



3.6.4.3 Connection corresponding data tags

Choose device ${\bf 192.168.250.2}$ under the ${\bf Connections}$ tab and click the down button.



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

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3.6.5 PLC program downloading and online monitoring

3.6.5.1 Downloading from Sysamc Studio

Click the online button.

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Click Yes.



Click the synchronization button.



Select device NJ501-1400, and click Transfer to Controller.



Click Yes.

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At this time, there are two green lights under **Controller Status** in the bottom right corner. Click **Close**.



3.6.5.2 Downloading from Network Configurator

Click on the **Download to Device** icon.

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3.6.5.3 Sysamc Studio online monitoring

Choose **Controller** > **Mode** > **RUN mode** (or click the Run button) to switch the PLC to the Run mode, and then click **Yes**.



Choose View > Watch Tab Page.

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Enter the variable name in the **Watch** window to monitor the variable value; you can change the variable value in real time in the **Modify** column.

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Right click the PLC and choose Monitor.

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View **Target Node Status** under **Status**. The status is displayed in blue if communication is successful, and in red if communication fails.

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4 EtherCAT

4.1 Overview

The communication card using this protocol is defined as an EtherCAT slave station, which can be used on VFDs that support EtherCAT communication.

4.2 Product features

4.2.1 Supported functions

- Supports the EtherCAT CiA 402 protocol. Configured with a slave station XML configuration file, it can communicate with Beckhoff PLC, INVT AX controllers, and other master stations.
- Automatic network address configuration
- Equipped with two RJ45 ports, supporting 10/100M half/duplex operating, designated for IN and OUT directions.
- Applicable to linear, star, and ring network topologies.

4.2.2 Supported services

- PDO service
- SDO service
- Use of SDO to read and write VFD function codes
- Manufacturer-defined object dictionary
- Two types of objects for VFD reading and writing, that is, PDOs and SDOs (requiring the object dictionary defined by the manufacturer)

Supported EtherCAT synchronization cycles

Table 4-1 Supported EtherCAT synchronization cycles

Item	Supported specification
Synchronization cycle	1ms
	2ms

4.2.3 Status indicator

The EtherCAT communication card provides six indicators to indicate its states. Figure 4-1 shows the positions of the four indicators. Table 4-2 provides the indicator definitions.

Figure 4-1Status indicator positions



Table 4-2 Status	indicator	definitions
------------------	-----------	-------------

Indicator	Color	Definition	Function		
		Steady on	In OP state.		
LED1	Croop	Blinking (on for 200ms, off for 200ms)	In PreOP state.		
(RUN)	Green	Single flash (on for 200ms, off for 1s)	In SafeOP state.		
		Steady off	In Init state.		
		Steady on	IN Link established, without data transmission.		
(L/A IN)	Green	Blinking (on for 50ms, off for 50ms)	IN Link established, with data transmission.		
		Steady off	IN LINK not established.		
	Green	Steady on	OUT Link established, without data transmission.		
(L/A OUT)		Blinking (on for 50ms, off for 50ms)	OUT Link established, with data transmission.		
		Steady off	OUT LINK not established.		
LED4 (POWER)	Red	Steady on	3.3V power indicator		
		Steady on	The OP fault occurred.		
LED5	Blinking (on for 200ms, for 200ms)		The Init/Preop fault occurred.		
(ERR)	кеа	Single flash (on for 200ms, off for 1s)	The Safeop fault occurred.		
		Steady off	No fault		
LED6 (SYS)	Green	Blinking (on for 500ms, off for 500ms)	Communication card heartbeat indicator (communication card is running normally).		

4.3 Electrical connection

An EtherCAT network often consists of a master station (such as PLC) and multiple slave stations (such as drives or bus expansion terminals). Each EtherCAT slave station has two standard Ethernet interfaces. Figure 4-2 and Figure 4-3 show the electrical connections.

Figure 4-2 Linear network topology electrical connection



Note: For the star network topology, you need to prepare EtherCAT switches.





4.4 Communication

4.4.1 CANopen over EtherCAT reference model

Figure 4-5 CoE reference model



The EtherCAT (CoE) network reference model consists of two parts: the data link layer and the application layer. The data link layer is mainly responsible for the EtherCAT communication protocol, and the application layer embeds the CANopen Drive Profile (DS402) communication protocol. The object dictionary in CoE includes parameters, application data, and PDO mapping configuration information.

Process data objects (PDO) are composed of mappable objects from the object

dictionary, and the content of PDO data is defined by PDO mappings. The reading and writing of PDO data is periodic and does not require searching for the object dictionary, while email communication (SDO) is non-periodic communication and requires searching for the object dictionary when reading and writing.

Note: In order to correctly parse SDO and PDO data on the EtherCAT data link layer, it is necessary to configure the FMMU and Sync Manager. See the following table.

Sync Manager	Configuration	Size	Start address
Sync Manager 0	Assigned to received SDOs.	512 bytes	0x1000
Sync Manager 1	Assigned to send SDOs.	512 bytes	0x1400
Sync Manager 2	Assigned to received PDOs.	128 bytes	0x1800
Sync Manager 3	Assigned to sent PDOs.	128 bytes	0x1C00

Table 4-3 EtherCAT Sync Manager configuration

4.4.2 EtherCAT slave node information

The EtherCAT slave station information file (XML file) is used for the master station to read, in order to construct the configuration between the master and slave stations. The XML file contains the information necessary for EtherCAT communication settings.

4.4.3 EtherCAT state machine

The EtherCAT state machine is used to describe the states of the slave application and state transitions. State change requests are typically initiated by the master station, with responses from the slave station. The specific state transition method is as shown in the following figure.





Status	Description			
SDO communication is unavailable; PDO communication Init unavailable.				
Init to Pre-Op	The master station configures the data link layer address and synchronization management (SM) channel for SDO communication. The master station initializes the distributed clock (DC) synchronization information. The master station requests to transition to the Pre-Op state. The master station configures the application layer control register. The slave station checks whether the mailbox has been properly initialized.			
Pre-Op	SDO communication is available; PDO communication is unavailable.			
Pre-Op to Safe-Op	The master station configures the synchronization management (SM) channel and FMMU channel for PDO communication. The master station configures PDO mappings through SDO communication. The master station requests to transition to the Safe-Op state. The slave station checks whether the PDOs and distributed clocks (DCs) are correctly configured.			
Safe-Op	SDO communication is available; PDO receiving communication is available; PDO sending communication is unavailable, in Safe state.			
Safe-Op to Op	The master station requests to switch to the Op state.			
Ор	SDO communication is available; PDO communication is available.			

Table 4-4 EtherCAT state machine description

4.4.4 PDO process data mapping

The process data of an EtherCAT slave station is composed of synchronization manager channel objects. Each synchronization manager channel object describes the consistency area of the EtherCAT process data and contains multiple process data objects. EtherCAT slave stations with application control functions should support PDO mapping and the reading of SM PDOs Assign objects.

The master station can select the required objects for PDO mapping from the object dictionary. PDO mapping configuration is located in the Object Dictionary from the 1600h to 1603h area (RxPDOs: Receive PDOs) and from 1A00h to 1A03h area (TxPDOs: Transmit PDOs). Figure 4-7 shows the PDO mapping method.



Figure 4-7 PDO mapping method

In addition to mapping the PDO objects, the exchange of EtherCAT process data also requires assigning the PDOs to the Sync Manager channels. The relationship between PDOs and Sync Managers is established through synchronous management of PDO allocation objects (1C12h and 1C13h). Figure 4-8 shows the method for mapping between PDOs and Sync Manager.

	Object di	ictionary]			
Index	Sub index	Object content	\vdash			
1C13h	0	0x02				
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1A00h		PDO_1				
1A01h	1	PDO_2				
1A02h		PDO_3	1			
1A03h	1	PDO_4	1			

Figure 4-8 Mapping between PDOs and Sync Managers

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

RxPDO (0x1600)	Control word (0x6040)	Target Position (0x607A)	Target Velocity (0x60FF)	Target Torque (0x6071)	Max. Torque (0x6072)	Mode of Operation (0x6060)	Profile velocity (0x6081)	Touch Probe Function (0x60B8)
TxPDO (0x1A00)	Statusword (0x6041)	Position Actual Value (0x6064)	Speed Actual Value (0x606C)	Torque Actual Value (0x6077)	Followi ng Error Actual Value (0x60F4)	Mode of Operation Display (0x6061)	Error Code (0x603F)	Touch Probe Value (0x60BA)

4.4.5 Network synchronization based on distributed clocks

The Distributed Clock (DC) function ensures that all EtherCAT devices share a unified system time, thus enabling synchronized execution of device tasks. In the EtherCAT network, the first slave station with DC function, has its clock selected as the reference clock of the network, and the rest of the slave and master stations synchronize with this reference clock.

Free-Run mode: The servo drive's run cycle is independent of the master station's communication cycle, allowing for independent run.

DC mode: The servo drive achieves synchronization operations through the Sync0 events sent by the master station.

4.5 CiA402 device profile

The main station controls the drive through control word (0x6040), and reads status word (0x6041) to obtain the actual status of the drive. The servo drive achieves motor control internally based on the control instructions from the master station.

4.5.1 CANopen over EtherCAT state machine





State	Description
Not Ready to Switch On	The drive is in the initialization process.
Switch On Disabled	Drive initialization is completed.
Ready to Switch On	The drive is waiting to enter the Switch On state, and the motor is not excited.
Switched On	The drive is ready, and the main circuit power is normal.
Operation Enable	The drive is enabled and it controls the motor in accordance with the control mode.
Quick Stop Active	The drive stops according to the set mode.
Fault Reaction Active	The drive detects that an alarm has occurred, and stops according to the set mode, while the motor still has

State	Description
	excitation signal.
Fault	The drive is in a fault state and the motor has no excitation
Fault	signal.

The control word 6040h includes the following content:

- Bits for state control
- Bits related to control mode
- Bits defined by manufacturer

The detailed description of each bit of 6040h is as follows.

15 11	10 9	8	7	6	43	2	1	0
Factory defined	Reserved	Reserved	Fault reset	Operation mode	Servo running	Quick stop	Switch on main circuit	Servo being ready
0	0	0	М	0	М	М	М	М
MSB		LSB						

Bits 0–3 and bit 7 (bits for state control):

	Bit of the control word					
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 (bits related to control mode):

D:4	Operation mode			
ыс	Profile position mode	Profile velocity mode	Homing mode	
4	New set-point	Reserved	Homing operation start	

D:4	Operation mode				
ыс	Profile position mode	Profile velocity mode	Homing mode		
5	Change set immediately	Reserved	Reserved		
6	Rel	Reserved	Reserved		
8	Halt	Halt	Halt		

∠Note: In the Profile position mode, when bit4=New set-point, a new position can be triggered.

When the control word is set to 0x0F, the drive is enabled; otherwise, the driver stops. If a fault occurs, a reset command is issued when bit 7 in the control word is set to 1.

6041h status word includes the following content:

- Drive's present status bit
- Status bits related to control mode
- Status bits defined by manufacturer

The detailed description of each bit of 6041h is 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	-	-
14-15	Manufacturer specific	0

Bits0-3, 5, and 6:

Value(binary)	State	
xxxx xxxx x0xx 0000	Not ready to switch on	

Value(binary)	State
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
xxxx xxxx x0xx 1000	Fault

Bit4: Voltage enable, when this bit is set to 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 OP state, and the master station can control the drive through PDO.

Bit 10: Target reached.

Mode 1 and mode 8: After the present positioning is completed, set it to 1 for keeping. If the positioning is restarted, clear it to 0.

Mode 6: Set it to 1 after homing is completed; set it to 0 if homing is not completed.

Mode 2: Set it to 1 when the ramp reference frequency reaches the set frequency and the control word's bit 4, bit 5, and bit 6 are all set to 1; otherwise, set it to 0.

Other modes: 0

Bit 11: External limitations

Mode 1 and mode 8: Set it to 1 when FWD/REV limit is reached; otherwise set it to 0.

Mode 4 and mode 10: In electric mode: If the electric torque reaches the upper limit (upper limit is not 0), set it to 1; otherwise, set it to 0. In braking mode, if the braking torque reaches the upper limit (upper limit is not 0), set it to 1; otherwise set it to 0.

Mode 2, mode 3, and mode 9: Set it to 1 when the output frequency reaches P00.03; otherwise, set it to 0.

Other modes: 0

Bit 12: Manufacturer defined 1

Mode 1: Set to 1 when bit 4 of the control word is 1; otherwise, set to 0.

Mode 8, mode 9, and mode 10: Set it to 1 when the VFD is in running state; otherwise, set it to 0.

Other modes: 0

Bit 14: When this bit is 1, it indicates the motor is in zero-speed state.

Bit7-bit8, bit15: reserved.

4.5.2 Device run mode

Set the VFD parameters P00.01=2 (Running command channel), P00.02=3 (EtherCAT communication channel), and P16.75 (Communication timeout time). The position mode and homing mode require the drive to operate in closed-loop mode.

4.5.2.1 Profile Position Mode

- 1. Set [6060h: Mode of operations] to 1 (Profile Position Mode).
- Set the appropriate number of encoder pulses P20.01 according to the encoder model, set the position command source P21.00 tens place to 1; for digital position, set P21.16 digital positioning mode (16#0200, bit 9=1 Position source EtherCAT given).
- 3. Set [6081h: Profile velocity] , with the frequency-to-velocity relationship V=60f/p, where V is the velocity in RPM (revolutions per minute), f is the frequency, and p is the number of motor pole pairs.
- 4. Set [6083h: Profile acceleration] and [6084h: Profile deceleration] and write the corresponding values 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 to 0x4F to enable, bit 6 set to 1: only relative position supported).
- 6. Set [607Ah: Target position] to the target position (unit: user unit).
- 7. Query [6064h: Position actual value] to obtain the motor actual position feedback.
- 8. Query [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 user manual.
- 10. During the positioning process, if you need to change the Profile Velocity (6081h), please make the change when the system is stopped.

4.5.2.2 VFD Mode

- 1. Set 【6060h: Mode of operations】 to 2 (VFD mode).
- 2. Set [6046h: vl 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.

- Set the object dictionary [6048h: vl velocity acceleration], [6049: vl velocity deceleration], and [604Ah:02 QuickStop Speed]. Do not set them to the default values of the drive.
 - The acceleration time is 60* [6048h:02 Acceleration Delta Time] *P00.04/([6048h:01 Acceleration Delta Speed] * Number of motor pole pairs) * 0.1, with second as the unit, corresponding to P00.11. The value will remain the same as the previous one when it exceeds 3600.0 seconds.
 - The deceleration time is 60* [6049h:02 Deceleration Delta Time]
 *P00.04/([6049h:01 Deceleration Delta Speed] * Number of motor pole pairs)*0.1, with second as the unit, corresponding to P00.12. The value will remain the same as the previous one when it exceeds 3600.0 seconds.
 - The emergency stop time is 60 * [604Ah:02 QuickStop Delta Speed] * P00.04/([604Ah:01 QuickStop Delta Time] * Number of motor pole pairs)*0.1, with second as the unit, corresponding to P00.12. The value will remain the same as the previous one when it exceeds 60.0 seconds.
- Set [604Ch: vl dimension factor] to adjust the electronic gear ratio, which is 1:1 by default.
- 5. Set [6040h: Control word] to enable the drive (set to 0x0F to enable) and start the motor operation.
- 6. Set [6042h: vl target velocity] to set the target speed.
- 7. Set 【6040h: Control word】 to run the drive (when it is set to 0x7F, the drive runs).
- 8. Query [6044h: vl velocity actual value] to obtain the motor actual position 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] and write the corresponding values 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 to 0x0F to enable) and start the motor operation.
- 5. Set [60FFh: Target velocity] to set the target rotational speed (unit: rpm).
- 6. Query 【6041h: Status word】 to obtain the drive status feedback (Speed zero,

Max slippage error, Target reached, 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 ramp torque.
- 3. Set [6040h: Control word] to enable the drive (set to 0x0F to enable) and start the motor operation.
- 4. Set P03.11=11 and P03.32=1 (torque control enabled).
- 5. Set [6071h: Target torque] to set the target torque.
- 6. Query [6041h: Status word] to obtain the drive status feedback (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 P22.00.Bit0=1 to enable spindle positioning function, and set P22.03–P22.06 zero positions.
- 3. Set the [6040h: Control word] to enable the drive (set to 0x0F to enable). When bit 4 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 [6041h: Status word] to obtain the drive status feedback (Homing error, Homing attained, Target reached).
- 6. For function details, see function parameters in group P22 in function code list chapter and commissioning chapter in the GD350 user 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. When the status word (60B9h: Touch Probe Statu) is 67/195, in continuous triggering mode, the probe status word bit 6 is 1, and each triggering will cause bit 7 to toggle.

- 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. 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. When the status word is 5 (60B9h: Touch Probe Statu), in continuous triggering mode, the probe status word bit 6 is 1, and each triggering will cause bit 7 to toggle.
- 4. When the control word (60B8h: Touch Probe Control) is 37 (2#01 0101), the function indicates that the Z phase rising edge triggers recording the present position. The recorded value is Turns of motor rotation x 10000, which is recorded only once. When th status word (60B9h: Touch Probe Statu) is 5, the falling edge triggering control word is 37.

✓Note: The difference from CiA 402 is that this mode only supports one probe, and only one locked value can be recorded at the same 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 to 0x0F to enable).
- 4. Set [607Ah: Target position] to the target position (unit: user unit).
- 5. Query [6064h: Position actual value] to obtain the motor actual position feedback.
- 6. Query [6041h: Status word] to obtain the drive status feedback (following error, target reached, and internal limit active).
- 7. For function details, see function parameters in group P21 in function code list chapter and commissioning chapter in the GD350 user 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 to 0x0F to enable) and start
the motor operation.

- 5. Set 【60FFh: Target velocity】 to set the target rotational speed (unit: rpm).
- 6. Query [6041h: Status word] to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, 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) and P03.32=1 (Torque control enabled).
- 3. Set [6040h: Control word] to enable the drive (set to 0x0F to enable) and start the motor operation.
- 4. Set [6072h: Max torque] to the maximum torque and [6071h: Target torque] to the target torque.
- 5. Query [6041h: Status word] to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, Internal limit active).

4.6 PLC communication example 1 (TwinCAT2)

This example illustrates how to use the VFD EtherCAT module to communicate with Beckhoff TwinCAT2 that serves as the master station.

Step 1 Install the TwinCAT2 software.

Step 2 Copy GD350 EtherCAT configuration file (EC-TX509U8_1.0.0.0.xml) to the TwinCAT2 installation directory C:\TwinCAT\lo\EtherCAT.

Step 3 Open TwinCAT2.



Step 4 Install the network card driver.

EtherCAT

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In the top menu bar, choose **Options** > **Show Realtime Ethernet Compatible Devices...** In the pop-up dialog box, choose the local network card, click **Install**. Once the network card is installed, it is displayed under **Installed and ready to use devices**.

Note: Please use a network card with an Intel chipset.



Step 5 Set TwinCAT2 to configuration mode.

EtherCAT



Step 6 Scan for devices.

A. Right click I/O Devices and choose Scan Devices... to scan for devices.



B. Click OK in the pop-up dialog box.



C. Click OK in the pop-up dialog box.

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D. Click **Yes** in the pop-up dialog box.

TwinCAT Systen	n Manager 🛛 🔀
Scan f	or boxes
Yes	No

E. Click Yes in the pop-up dialog box. The device will enter free run mode.

TwinCAT System	n Manager 🛛 🔀
Activa	te Free Run
Yes	No

F. As shown in the following figure, Drive 1 (EC-TX509U8_1.0.0.0) is the scanned slave station device. Check whether the device enters the OP state.



- Step 7 Perform process data input and output.
 - A. Choose **DO RxPDO-Map0**. The data is sent from the master station to the VFD. Command giving and speed giving, and other operations can be performed.

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B. Choose **DI TxPDO-Map0**. The data is sent from the VFD to the master station, including the VFD status and speed.



Step 8 Perform SDO data read and write operations.

A. Click **CoE-Online**. Select 0x2000–0x2063, and select **Auto Update**. Then you can view the parameters of the corresponding function codes.

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B. Similarly, you can write function parameters through 0x2000–0x2063. Select 0x2000, double click 2000:0B, a read dialog box will pop up, write the parameters, click OK, check the keypad, and you can see the parameter has been successfully written.

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4.7 PLC communication example 2 (TM753)

This example illustrates how to use the VFD EtherCAT module to communicate with TM753 that serves as the master station.

Step 1 Open the Invtmatic Studio software and create a new project TM753. Select device **TM753**. The interface is shown in the following figure.

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Step 2 Add an EtherCAT device. In the top menu bar, choose **Tools** > **Device Repository**, and import the EtherCAT configuration file of EC-TX509U8.



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Step 3 Right click **Device**, and choose **Add Device**. In the pop-up window, choose **Fieldbuses > EtherCAT > Master**, and double click **EtherCAT Master**.



Step 4 Right click EtherCAT Master, and choose Add Device. In the pop-up

window, choose Fieldbuses > EtherCAT > Slave > INVT > Frequency Inventory > EC-TX509U8_1.0.0.0.



Step 5 Perform PDO configuration. Double click EC-TX509U8_1.0.0.0 that was added to enter the parameter configuration interface. Enter the Expert Process Data interface to configure the PDO parameters. PDO parameter configuration can be done according to requirements. This example uses the default PDO configuration.

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			15#6077:00	4.3 5.0 Target Velocity	DON	π	
			16#6071.00	2.8 18.0 Target Torque	247		
			1646072-00	2.8 12.0 MexTonpue	UN	π	
			15#6060:00	1.8 14.0 Mode of Operation	500	т	
			15#6081:00	4.8 15.0 ProfileVelocity	U01	NT	
			1626068:00	2.8 18.0 Touch Prohe Control	UN	π	
		Download					
		PD0 Assignment PD0 configuration	Load PDO of s from the I	Device			
	Nessages - Total 3 error(s), 0 marries	(b), 1 message(b)					
	Devices	- O 0 errorisi = 0 warningts	0 1 message(s) X X				
	Description		1.1.1	Donlard	054	et Baskine	-
	Conception			Project		NI POINCE	

Step 6 Choose EtherCAT I/O mapping, and change Always update variables to Enabled 2 (always in bus cycle task).

- * X	/mt tc_tx50908_1_0_0_0 >								
UnitedT	General	find		filter, Show all		1.4.	Add 18 for 10 Charr	eL. " Go to Instance	
g Device (19(753)		Vedeble	Manalan	Channel	Address	T-ma	their Description		
D to b down and a second	Expert Process Data	a. 14		Combined Millioned	1000	1997	Control little		
B RC Look	Process Data			Tarnet English	5002	CONT	Tarret Profe		
a C Amiration	1000000000			Tarrat Valority	5000	CONT	Target Veloci	h	
1 Library Manager	Startup Parameters			Tarret Tarren	1000	D.T	Target Torget		
and sections and				Max Torone	B-CHIR	1817	May Target		
Tex Configuration	EoE Settings			Mode of Doeration	10820	SINC	Made of One	nation	
S PROCAT THE	RherCAT DO Mapping	8.9		Profile Velocity	1006	LODT	Profile Velocit	×	
H-19 Martaik				Touch Probe Control	50014	LENT	Touch Drobe	Control	
- #1 PLC PRG	EtherCAY IEC Objects	8.10		Profie acceleration	14008	LOONT	Profile accele	reton	
Tariable usage		8.10		Profile deceleration	16009	LCONT	Profile decele	ration	
- FT TH/75x+ISEO (TM/25x+ISEO)	5000	8.9		Status Word	1002	UDIT	Status Word		
ExtCard (ScanModule)	Information	* *		Position Actual Value	14202	CONT	Position Actu	al Value	
8 EterCAT_Haster (EterCAT Master)		8.9		Velocity Actual Value	1603	CONT	Velocity Actu	al Value	
M EC_TX509U8_1_0_0_0 (EC-TX509U8_1.0.0.0)		* *		Torque Actual Value	5208	INT	Torque Actua	i Value	
SoftMotor General Avis Pool		8.9		Touch probe pisition 1 positive value	9405	CONT	Touch probe	pisition 1 positive value	
		8.9		Mode of operation display	9/824	5347	Mode of oper	ation depkay	
		8-19		Error code	942013	UDVT	Error code		
		8.9		Touch probe status	92819	UBNT	Touch probe	status	
		8.19		Current actual value	100115	INT	Current actu	al value	
		8- 9		Digital inputs	1420	LCONT	Digital inputs		
		-			Rest Mago	12 A	ways update variables	Probled 2 follows in hor r	urle tesk)
		🍫 – Create new variable	°≱ − 19	p to existing variable				Use parent device setting probled 1 juse but cycle is probled 2 (always in but cycle)	et in an rde task)
	Hessages - Total 0 error(s), 0 warring	(i), 1 message(s)							
	Devices	• O 0 er	ror(s) 🙂 0 i	varning(s) 0 1 message(s) 🗙	×				
	Description						Project	Object	Position
	Oreated task 'EtherCAT, Task'.								

Step 7 Scan for the PLC. Double click **Device**, click **Scan Network...**, select the scanned PLC, and click **OK**.

Construction C		
ing to provide 1,9,00 BC holders 1,83.00	Manda Atano Atan	
	e e e e e e e e e e e e e e e e e e e	
< 0 2000 0 2000 >	The direct solution of last time.	

Step 8 Perform EtherCAT master station configuration. Double click EtherCAT_Master, choose General, click Browse, and double click to

select eth0.

• • • ×	/mt cc_mseeue_1.0_0.0	Device B therCAT_Heater x			
Central C ⇒ 0 h m h m m ⇒ 0 h m h m m m m m ⇒ 0 h m h m m m m m ⇒ 0 h m h m m m m m m ⇒ 0 h m h m m m m m m m ⇒ 0 h m h m m m m m m m m m m m m ⇒ 0 h m h m m m m m m m m m m m m m m m m	Function Code General General Bacc Unit Assignment Ling DerroLT 120 Mapping DerroLT 120 Mapping Seture Setu	Construction C	EtherCAT		
				33	Abort

Step 9 Download the program.

• • * K / M EC,D30K8_1	0.0.3 B Deviz / B BleeCAT_Haster H
Puntion Code	R Autocoming Mester Seven
Auto acan General	Thereat NC Seller
Pault degross summery Pric Logic Sync Unit Assignment	Cestrative address (NAC)
= O Application (res)	Source address (MAC) 58-52-12-58-04-46 Browse
Rc_His (Hs) EtherCAT (IO Happin	Network Name #00 Refer setwork by MMC O Select network by name
B EtherCAT Task EtherCAT IEC Objects	Chatched Code
= (\$) Heritak	Overtime with the second secon
taskie usge improvement	Instructs Studio X
E INCELESC (INCELESC)	Warrier de aminister derinster is namet is it it in mole en the D.C. is
EtherCAT_Master (EtherCAT Naster)	there is no matching comple information, the existing application needs to be replaced.
Inf BC_TISERUB_1_0_B_3 (BC-TISERUB_1.0.0.0) SoftMatery Conversitions Pred	Click Yes' to download the latest code or No' to abort.
	Yes So Qatala
	Cisprostics message
	Bue load 8 %

Step 10 Perform parameter monitoring. TPDO data can be monitored in real time and RPDO data can be written by choosing **EtherCAT I/O mapping**.

	1 / MI EC_TX509UB_1_0_0_0 3	K 🗐 Devke 🛛 🗐 Et	herCAT_Master								
hdfedi	Canada Canada	Fied		Filter, Show all		1.4	Add FB for	IO Ch	reel_ "I Go to	Instanc	
Device (connected) (TH/T53)		N 241									a
Autoscan	Digest Process Date	vanacie	wapping	Unannei	ADDIESS	type	Current	value	rrepared value	ONE	Lescripson
- U, Fault dagness summary				Control therd	962972	UNT					Corte al Word
(g) Accupe	Process Lites			Target Poston	16002	CONT					Target Poston
- O Appendice (run)	Startup Parameters			Target tecoty	nquo	COPIE					Target velocity
Lorary Hanager				I argen I orque	74200	211					Farget Forque
PLC_PRG (PRG)	Online			Max Torque	squo	UNT	÷				Hex Torque
= 20 Tesk Configuration				Mode of Operation	94(830	SIM					Hode of Operation
- G B EDerCAT_TAK	CEE ONINA	1.2		Profile Velocity	NQ06	UCINT					Profile Velocity
in the second	tot Settings			1auch Habe Contra	1620114	Uper					Touch wrobe cantrol
- Marian				Profile acceleration	nuçua -	CONT					Prome acceleration
C vanage usage	RtherCRT & O Mapping			Profile Decoder alton	5007	0034		-			Prome deceleration
 III TH75x HS20 (TH75x HS20) 				Status Word	52//2	UBIT	546	10			Status Word
C III ExiCard (ScanPackle)	EDIA/CAT BC ODJects			Pesition Actual Value	9602	CONT					Pestion Actual Value
BENECAT Place (ETerCAT Name)	. 2mm	17		Velocity Actual value	9403	CONT					veocity Actual value
CAM ECTOSORUE 1000 (EC-RESORUE)10				Torque Actual Value	1600	241					Torque Actual table
3 SoftMotion General Axis Fool	Information			Touch probe plotton 1 positive value	%405	ONT					Touch probe pisition 1 poets
				Hode of operation deplay	54824	SINT	,				Hode of operation deplay
				Error code	5/2W13	UBNT					Error code
				Tauch prabe status	567024	UDIT	•				Touch probe status
				Current actual value	9620/35	247					Current actual value
		* *		Digital inputs	16208	UCINT					Digital inputs

Step 11 In the COE online interface, you can monitor the values of the function codes, and you can also directly modify the values of the function codes (Note: P00.00 modification is invalid).

un ≁ ∔ ¥	M EC_TX509U8_1_0_0_0	x B Devke B I	the CAT_Master				
3 United I							
- G 🗐 Devce (connected) (TM753)	General	regiteed Object	F Auto update (ii) Offline from the second secon	m ESI file ⊡ Qelle	e from device		
Auto scan	Excert Process Data	IndexSubindex	Name	Flegs	Type	Value	
- Q. Fault degreese summary		* 16g1803 16g00	DI TVPDO-Masil				
PLC Logic	Process Data	* 16/#10000 16/#00	Sync manager broe				
Application (nan)		* 16#101212116#00	RuPDO assign				
💕 Library Manager	startup Parameters	* 16#1C13:16#00	TuPOD MININ				
 Incluse (set) 	Online	*- 56#3C32:56#00	SH output parameter				
🖹 🧱 Task Configuration		* 56#3C33156#00	SM input parameter				
- G D EtherCAT_Task	CoE Online	8-16#2000-16#00	ROD Basic Austines				
H 😳 🤀 ManTask		: 15(#01	P00.00 SpdCtr/Node	80	LENT	2	
 PLC_PRG 	EEE Setsings	: 16(10)2	P00.01 RunCredChannel	80	LENT	2	
- 🙆 Variable usage	EtherCAT 3/0 Happing	:26:000	P00.02 Comp Ond Channel	80	LENT	2	
- G 🗐 TM/9xH520 (TM/9xH520)		:25804	P00.03 Max OutpFreq	80	LENT	20000	
- G 🗐 ExtCard (ScanModule)	EtherCAT IEC Objects	:35405	P00.04 RunFreg Up limit	80	LENT	20000	
G B EfferCAT_Master (EfferCAT Master)		:25406	P00.05 RunFreg Low limit	80	LENT	0	
G MI EC_TX809U8_1_0_0_0 (EC-TX809U8_1.0.0	20010	: 15#07	POD.06 A Freq Ond	80	LENT		(2)
- 😳 🐍 SoftMotion General Axis Pool	Information	:25400	P00.078 Free Crid	80	UDIT	15	F
		:25#09	POD.08 8 Free Ref Object	80	LENT	0	
		- :25#0A	P00.09 SettingSrc Combine	80	LENT	0	
		:25408	P00.10 Keyped Set Frep	80	LENT	5000	
		:25400	P00.11 ACC time1	80	LENT	100	
		:15400	P00.12 D0C tme1	80	LENT	100	
		:25405	P00.13 Run Direction	80	LENT	0	
		: 15407	P00.14 Carrier Freg	80	LENT	00	
		: 15#10	P00.15 Notor Para Autotuning	84	LENT	0	
		:15#11	POD.15 AVR Func	RW	UDAT	1	
		:15#12	P00.17 VPD Type	RW	UDIT	0	
		:10#13	P00.13 PuncParam Restore	RW	UDAT	0	
		8-16#2001:15#00	P01 Start and altop control				•
		8 1542002-15400	202 Recemptors of motor 1				
		8 1642003-15400	203 Jester control of notes 1				
		E 10 4 2004 10 400	POLY 5 central				

5 Modbus TCP protocol

5.1 Overview

The communication card using this protocol is defined as a Modbus TCP slave station, which can be used on VFDs that support Modbus TCP communication.

5.2 Product features

5.2.1 Supported functions

- Supports the Modbus TCP protocol and Modbus TCP slave stations
- Supports the concurrent communication with multiple master stations. It can communicate with Schneider PLCs, INVT AX controllers, and other master stations.
- Equipped with two RJ45 ports, supporting 10/100M half/full duplex operating.
- Supports basic operations on VFDs, such as reading and writing process values, reading status values, and reading/writing function codes.
- Applicable to linear and star network topologies.

5.2.2 Supported communication types

Modbus TCP application layer uses the same Modbus protocol as Modbus RTU, based on the Transmission Control Protocol/Internet Protocol (TCP/IP) as the transmission protocol for Ethernet online control and information. It allows for the transmission of explicit messages between points without strict timing requirements.

Similar to Modbus RTU, Modbus TCP requires the PLC/host controller to send read or write commands, with the communication card forwarding the data and returning the operation result in order to complete a data transmission.

5.2.3 Status indicator

Modbus TCP communication card provides six indicators to indicate its states. For details, see Table 5-1.

Indicator	Color	Definition	Function
LED1 (RUN)	Green	Steady on	The communication between the communication card and the PLC is online, and data exchange is

Table 5-1 Indicator description

Indicator	Color	Definition	Function				
			allowed.				
		Blinking (on for 500ms, off for 500ms)	Abnormal setting of the IP address for either the communication card or the PLC.				
		Steady off	The communication between the communication card and PLC is not in Online state				
		Steady on	The communication card is in the process of handshaking with the VFD.				
LED2 (HOST)	Green	Blinking (on for 500ms, off for 500ms)	The communication card and VFD communicate normally. Note: After the handshaking is completed, it should blink regardless of whether there is data transmission between the communication card and the main control board.				
		Steady off	The communication card is in the initialization or parameter configuration phase.				
1500		Blinking (on for 500ms, off for 500ms)	The data update between the communication card and main control board is normal.				
(DATA)	Green	Steady off	No data update or abnormal update between the communication card and main control board.				
LED4 (POWER)	Red	Steady on	3.3V power indicator				
		Steady on	The communication between the communication card and PLC is offline.				
LED5 (ERR)	Red	Blinking (on for 500ms, off for 500ms)	An attempt to operate an unsupported CMD control word instruction or PR function code value.				
		Blinking (on for 62.5ms, off	An attempt to operate on a				

Indicator	Color	Definition	Function			
		for 62.5ms)	non-existent node address.			
			The communication between the			
		Steady off	communication card and PLC is			
			normal.			
	26	Plinking (on for 500ms, off	Communication card heartbeat			
(SVS)	Green	for E00ms)	indicator (communication card is			
(313)		101 5001115)	running normally).			

5.3 Electrical connection

The Modbus TCP communication card adopts standard RJ45 interfaces, which can be used in a linear network topology and a star network topology, as shown in Figure 5-1 and Figure 5-2.

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

Figure 5-1 Linear network topology electrical connection



Figure 5-2 Star network topology electrical connection



Note: For the star network topology, you need to prepare switches.

5.4 Communication

5.4.1 Communication settings

The communication card can only be used as a Modbus TCP slave, and function codes should to be set on the VFD before communication. The procedure is as follows:

1. Set the communication card communication station address, IP address and subnet mask.

The factory station address, IP address, and subnet mask of each communication card are 1, 192.168.0.20, and 255.255.255.0 respectively, which can be changed to a network segment address according to the actual requirements.

2. Set the control method.

To enable the VFD control through Modbus TCP communication, set the control mode to Modbus TCP communication control. To be specific, set P00.01=2 and P00.02=0 to control VFD start and stop. In short, if a value needs to be set through Modbus TCP communication, the corresponding function code should be modified to Modbus TCP communication control. For related function codes, see Appendix C Related function codes.

▲Note: After steps 1 and 2 are implemented properly, the communication card can communication properly. If a VFD needs to be controlled, related function nodes must be set and the control mode is Modbus TCP communication.

5.4.2 Message format

The TCP communication message is shown in Table 5-2.

Header of MAC Header of IP Head layer layer layer		Header of TCP layer	Valid data	Trailer
14 bytes	20 bytes	20 bytes	0–1488 bytes	4 bytes

Table 5-2 TCP communication message

5.4.3 Modbus TCP communication

The Modbus TCP communication card supports the Modbus protocol at the application layer. Modbus TCP protocol messages are located in the TCP message valid data zone and divided into two parts: the first part is the MBAP (message header, 7 bytes), and the second part is the PDU (protocol data unit, with variable length). See Table 5-3.

	MBAP			PD	U
Transaction processing identifier	Protocol identifier	Length	Unit identifier	Function code	Data
2 bytes	2 bytes	2 bytes	1 byte	1 byte	n bytes
The message sequence number increments by 1 after each communication to differentiate between different messages.	0000=Modbus -TCP protocol	Subseque nt data length	Device address (Station No.)	Modbus function code	Includes VFD function codes and data, with variable length.

Table 5-3 Modbus TCP protocol message

Through the preceding messages, you can set the reference parameters, monitor status values, send control commands and monitor operation status of the VFD, and read and write VFD function parameters.

Parameter description:

- Unit identifier: Station address (1–247)
- Function code: Modbus function code

Table 5-4 Modbus function code

Function code	Description
0x01	Read coil (not supported)
0x05	Write a single coil (not supported)
0x0F	Write multiple coils (not supported)
0x02	Read discrete input (not supported)
0x04	Read input register (not supported)
0x03	Read holding register
0x06	Write a single holding register
0x10	Write multiple holding registers

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

Message example:

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 03H command is used to read information including the parameters and running status of the VFD.

For example, if the master reads two contiguous pieces of data (that is, to read content from the data addresses 0004 H and 0005 H) from the VFD whose address is 01H, the command frame structure is described in the following.

Example	Request	0001	0000	0006	01	03	0004	0004
	Meaning	MBAP				Function code	Read address	Data byte
	Response	0001	0000	0007	01	03	04	13880000
	Meaning	MBAP				Function code	Data byte	Data

According to the data, the value at 0004H is 1388H (50.00Hz), and the value at 0005H is 0000H (00.00Hz).

2. Function code 06H: writing a 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, if the master writes 5000 (1388H) to 0004H of the VFD whose address is 02H, the frame structure is as follows.

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

3. Function 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, if the master writes 5000 (1388H) and 50 (0032H) to 0004H and 0005H of the VFD whose address is 02H, the frame structure is as follows.

	Request	0001	0000	000B	02	10	0004	0002	04	13880032
F irem	Meaning		MB	٩P		Function code	Write address	Number of registers	Data byte	Data
ple	Respons e	0001	0000	0006	02	10	0004	0002		
	Meaning		MB	٩P		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 state information, and setting related 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 high-order byte is the hexadecimal form of the group number before the dot mark, and low-order byte 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 00. Therefore, the function code address is 0E00H in the hexadecimal form. For example, the parameter address for function code P14.03 is 0E03H.

Function code	Name	Parameter description	Setting range	Default
	Local			
P14.00	$\operatorname{communication}$	1–247	1-247	1
	address			
D14 02	Communication	0-200mc	0-200	5mc
F14.03	response delay	0-2001115	0-200	JIIIS

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 of 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.

Addresses of other Modbus functions

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 lists other function parameters.

Function description	Address definition	Data description	R/W	
		0001H: Forward running		
		0002H: Reverse running		
		0003H: Forward jogging		
Communication-	2000H	0004: Reverse jogging		
based control		0005H: Stop	R/W	
command		0006H: Coast to stop		
		0007H: Fault reset		
		0008H: Jogging to stop		
		0009H: Emergency stop		
	2001H	Communication-based frequency setting		R/W
		(0–Fmax, unit: 0.01Hz)	10,00	
	2002H 2003H	PID reference (0–1000, in which 1000		
		corresponds to 100.0%)		
		PID feedback (0–1000, in which 1000	R/W	
		corresponds to 100.0%)	,	
Communication-		Torque setting (-3000–3000, in which 1000	-	
based setting address	2004H	corresponds to 100.0% of the motor rated current)	R/W	
	200511	Upper limit setting of forward running	D/M	
	2005H	frequency (0–Fmax; unit: 0.01Hz)	R/W	
	20061	Upper limit setting of reverse running		
	20001	frequency (0–Fmax; unit: 0.01Hz)	r(/ VV	
	2007H	Upper limit of the electromotive torque (0–3000, in which 1000 corresponds to	R/W	

Function description	Address definition	Data description	R/W
		100.0% of the motor rated current)	
		Braking torque upper limit. (0–3000, in	
	2008H	which 1000 corresponds to 100.0% of the	R/W
		motor rated current)	
	2009H	Special control command word Bit1-bit0=00: Motor 1 =01: Motor 2 Bit2: =1: Enable speed/torque control switchover =0: Disable Bit3: =1 Clear electricity consumption data =0: Keep electricity consumption data Bit4: =1 Enable pre-excitation =0: Disable pre-excitation	R/W
		Bit5: =1: Enable DC braking =0: Disable DC braking	
	200AH	Virtual input terminal command. Range: 0x000–0x3FF (corresponding to S8/S7/S6/S5/HDIB/HDIA/S4/S3/S2/S1 in sequence)	R/W
	200BH	Virtual output terminal command (0x00–0x0F) Corresponding to local RO2/RO1/HDO/Y1	R/W
	200CH	Voltage setting (used for V/F separation) (0–1000, in which 1000 corresponds to 100.0% of the motor rated voltage)	R/W
	200DH	AO setting 1 (-1000–+1000, in which 1000 corresponding to 100.0%)	R/W
	200EH	AO setting 2 (-1000–+1000, in which 1000 corresponding to 100.0%)	R/W
VFD status word 1	2100H	0001H: Forward running 0002H: Running reversely 0003H: Stopped 0004H: Faulty 0005H: In POFF state	R
		0006H: In pre-exciting state	

Function description	Address definition	Data description		R/W
VFD status word 2	2101H	Bit0: =0: Not ready to run =: run Bit2-bit1=00: Motor 1 =01: Mc Bit3: =0: AM =1: SM Bit4: =0: Disable overload Enable overload alarm Bit6-Bit5: =00: Keypad-based cc =01: Tern control =10: Communica control Bit7: Reserved Bit8: =0: Speed control control Bit8: =0: Speed control control Bit9: =0: Non position control =1: Position control Bit11-Bit10: =00: Vector 0 =0 =10: Closed-loop vector voltage vector	1: Ready to ptor 2 alarm =1: pntrol ninal-based ation-based =1: Torque 1: Vector 1 =11: Space	R
VED fault code	2102H	See the description of fault type	s	R
VFD identification code	2103H	GD3500x01A0	5.	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)	Compatibl	R
Output voltage	3003H	0–1200V (Unit: 1V)	e with	R
Output current	3004H	0.0–3000.0A (Unit: 0.1A)	CHF100A	R
Rotation speed of running	3005H	0–65535 (Unit: 1 RPM)	and CHV100	R
Output power	3006H	-300.0–300.0% (Unit: 0.1%)	communic	R
Output torque	3007H	-250.0–250.0% (Unit: 0.1%)	ation	R
Closed-loop setting	3008H	-100.0–100.0% (Unit: 0.1%)	addresses	R
Closed-loop feedback	3009H	-100.0–100.0% (Unit: 0.1%)		R

Function description	Address definition	Data description	R/W
Input IO state	300AH	0x00–0x3F Corresponding to the local HDIB/ HDIA/S4/S3/S2/S1	R
Output IO state	300BH	0x0–0xF Corresponding to 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 the actual step of multi-step speed	3012H	0-15	R
External length value	3013H	0–65535	R
External counting value	3014H	0–65535	R
Torque setting	3015H	-300.0–300.0% (Unit: 0.1%)	R
VFD identification code	3016H		R
Fault code	5000H		R

The Read/Write (R/W) characteristics indicate whether a function parameter can be read and written. For example, "Communication-based control command" can be written, and therefore the command code 06H is used to control the VFD. The R characteristic indicates that a function parameter can only be read, and W indicates that a function parameter 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 mode of running commands" (P00.02) to Modbus. For another example, when modifying "PID reference", 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 VFD identification code 2103H).

8 MSBs	Meaning	8 LSBs	Meaning
		0x08	GD35 series VFD
		0x09	GD35-H1 series VFD
0.01	CD	0x0a	GD300 series VFD
0X01	GD	0xa0	GD350 series VFD
		0xa1	GD350-UL series VFD
		0xa2	GD350A series 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, multiply 50.12 by 100 to obtain an integer 5012, and then 50.12 can be represented as 1394H in the hexadecimal form (5012 in the decimal 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 decimal places in the value specified in "Setting range" or "Default". If there are n (for example, 1) decimal places in the value, the fieldbus scale m (then m=10) is the result of 10 to the power of n.

Function code	Name	Parameter description	Setting range	Default
P01.20	Wake-up-from- sleep delay	0.0–3600.0s (valid when P01.15 is 2)	0.00–3600.0	0.0s
P01.21	Power-off restart selection	0: Disable restart 1: Enable restart	0-1	0

The value specified in "Setting range" or "Default" contains one decimal place, and therefore the fieldbus scale is 10. If the value received by the upper computer is 50, "Delay of auto fault reset" of the rectifier is 5.0 (5.0=50/10).

To set "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 sent. In this case, the VFD returns an error message response.

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

Code	Name	Meaning
		The command code received by the host controller is
		not allowed to be executed. The possible causes are as
01H In	Invalid command	follows:
0111		The function code is applicable only on new devices and
		is not implemented on this device.
		The slave is in faulty state when processing this request.
		For the VFD, the data address in the request of the upper
02H	Invalid data	computer is not allowed. In particular, the combination
	address	of the register address and the number of the to-be-sent
		bytes is invalid.
		The received data domain contains a value that is not
		allowed. The value indicates the error of the remaining
03H	Invalid data value	Note: It does not meen that the data item submitted
		for storage in the register includes a value unexpected
		by the program
		The parameter setting is invalid in the write operation
04H	Operation failure	For example, a function input terminal cannot be set
official operation randice		repeatedly.
0511	Incorrect	The password entered in the password verification
05H	password	address is different from that is specified by P07.00.
		The data frame sent from the upper computer is
061	Incorrect data	incorrect in the length, or in the RTU format, the value of
0011	frame	the CRC check bit is inconsistent with the CRC value
		calculated by the lower computer.
07H	Parameter	The parameter to be modified in the write operation of
0/11	read-only	the upper computer is a read-only parameter.
08H	Parameter	The parameter to be modified in the write operation of
0011	cannot be	the upper computer cannot be modified during the

Code	Name	Meaning
	modified in running	running of the VFD.
09H	Password protection	If the upper computer does not provide the correct password to unlock the system to perform a read or write operation, the error of "system being locked" is reported.

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

For example, if the master sends a request message to a slave for reading a group of function code address data, the following code is generated:

0000011 (03H in the hexadecimal form)

In a normal response, the slave returns the same function code. In an exception response, the slave returns the following code:

1000011 (83H in the hexadecimal form)

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

5.5 PLC communication example 1 (S7-1200)

This example illustrates how to use the Modbus TCP communication expansion card to communicate with a SIEMENS PLC (using TIA Portal V15 software as a configuration tool), where Modbus TCP does not have a device description file.

- Step 1 Use the TIA Portal V15 software to add a Modbus TCP program block.
- Step 2 Open TIA Portal V15, create a new project as shown in the following figure.

Project name:	Modbus TCP	
Path:	C:\Users\Administrator\Desktop\Profinet工程	
Version:	V16	
Author:	Administrator	
Comment:		

Step 3 After creating, click the **Project View** in the bottom left corner. Double click **Add new device** in the opened interface. See the following figure.

Project tree	
Devices	
1	🔲 🖬
Modbus TCP	
📫 Add new device	
Devices & networks	
🕨 🖳 Ungrouped devices	
🕨 🚟 Security settings	
Cross-device functions	
🕨 🙀 Common data	
Documentation settings	
🕨 🐻 Languages & resources	
Version control interface	
Online access	
Card Reader/USB memory	

Step 4 Select the corresponding PLC model. The PLC model used in this example is shown in the following figure. Click **OK**.



Step 5 On the left, choose **Program Block**, and double click **Main[OB1]** to open the programming interface, as shown in the following figure.



Step 6 On the right, choose Instructions > Communication > Others > MODBUS TCP, double click or drag MB_CLIENT to add it to Main[OB1], as shown in the following figure.

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Step 7 On the left, choose Program blocks > Add new block, a global data block named MB_CLIENT_TCON for mapping the pin CONNECT of the function block MB_CLIENT. Open the data block, create a variable MB_Client, manually enter ${\sf TCON_IP_v4}$ in the data type box, and configure the parameters of the data block.

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Step 8 Add another global data block for data storage, named **MB_Client_Data**. Open this data block and create variable **DATA**.

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Step 9 Change the attributes of data blocks MB_CLIENT_TCON and MB_Client_Data, and deselect Optimized block access.



Step 10 In PLC variables, create a new variable table and define the following variables.

										😋 Tags	User constants
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3	>###	1									
		ame	Data type	Address	Retain	Acces	Wita_	Visibl.	Comment		
		MB_Client_REQ	Bool	54/10.0							
		MB_Client_DISCONNECT	Bool	50/10.1							
	a	M8_Client_MODE	USINE	50830							
	•	MB_Client_ADDR	Word	%MW100							
	•	MB_Client_LEN	Ulint	%MV102							
		MB_Client_DONE	Bool	16//10.2							
		MB_Client_BUSY	Bool	5000.3							
		NB_Client_ERROR	8col	50/10.4							
		MB_Client_STATUS	Word	5449104							
	a	ENABLE	Bool	50/20.0							
	•	RUN	Bool	50/20.1							

Step 11 Connect the variables to the corresponding pins of the MB_CLIENT block.



Step 12 Change the ID in the MB_CLIENT background data block to match the connection ID. This can be modified by choosing Program blocks > System blocks > Program resources > MB_Client_DB on the left. Modify the ID to be consistent with the ID in MB_CLIENT_TCON.

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Step 13 Change the PLC IP address to match the Modbus TCP slave station. Double click **Device view**, right-click the network interface position, choose **Properties**, and set the parameters in the pop-up interface.

odbus TCP + PLC_	I [CPU 121	ISC DC/D	C/DC]								- 6 8
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+ PLC_1 (CPU 1215C	P	- 11	241	11 @.±		- 84	Device overview				
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			.0					101			
			~				 RC_1 	1			CPU 1215C DO/DC/
							DI 14/DI	010_1 11	01	0_1	DI 14/DQ 10
	100 1						AI 2/AQ	2_1 12	6467	6467	AL2IAQ 2
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Step 14 At this point, a Modbus TCP connection has been established. Right click PLC_1 [CPU 1215C DC/DC/DC], and choose Compile > Hardware and software (change only) to compile the entire project. Click Save Project to save the entire project, then click the **Download to Device** icon to download the project configuration to the PLC. See the following figure.



Step 15 You can now write and download the following PLC program. Additionally, set P00.01=2, P00.02=0, P00.06=8, P14.00=2 (consistent with the ID in MB_CLIENT_TCON), P16.58–P16.61=192.168.0.20 (consistent with the IP in MB_CLIENT_TCON), and keep P16.62–P16.69 at their default values. This will allow control of the VFD to run at 50.00Hz using the Modbus TCP protocol.



5.6 PLC communication example 2 (TM753)

This example illustrates how to use the VFD Modbus TCP module to communicate with TM753 that serves as the master station.

Step 1 Open the Invtmatic Studio software and create a new project TM753. Select device **TM753**. The interface is shown in the following figure.



Step 2 Add Modbus TCP related configuration.

According to the actual cable connection to the Ethernet port of TM753, select Modbus TCP Master1 or Modbus TCP Master2; in this example, the Ethernet 1 port is actually connected, so select Modbus TCP Master1. After adding the master station, select the corresponding Modbus TCP Slave1.

Add devices.


• Add the Modbus TCP master station.



• Add the Modbus TCP slave station.



The adding is completed.



The Modbus TCP configuration is completed. If there are multiple Modbus TCP slave stations, add multiple **Modbus TCP Slave**.

Step 3 Perform Modbus TCP master station parameter setting.

Double click the master station device in the device tree to open the Modbus master station configuration window. Double click **Modbus_TCP_Master1** as shown in the following figure for Modbus TCP master station parameter configuration.

Perform Modbus TCP master station configuration.



The frame interval refers to the time interval between the main station receiving the last response data frame and waiting for the next request data frame. This parameter can be used to adjust the data exchange rate.

Step 4 Perform Modbus TCP slave station configuration.

Double click the slave device in the device tree to open the Modbus TCP slave station configuration window, and double click **Modbus_TCP_Slave1** to set the Modbus TCP slave parameters.

• Modbus TCP slave station configuration



Table 5-5 Configuration parameters

Configuration item	Function
IP address	IP address of the Modbus TCP slave station to which the master station connects.
Port	TCP port number of the Modbus TCP slave station to which the master station connects.
Station number	Protocol station address of the Modbus TCP slave station to which the master station connects.
Timeout time (ms)	If the slave station does not respond within this duration after the master station sends a frame, the master station will report a receiving timeout.

Configuration item	Function
Slave enable	After enabling the variable in the program, the master station
variable	will start sending communication frames to the slave station.

Example

Configuration item	Setting
IP address	192.168.0.20
Port	502
Station number	1
Timeout time (ms)	1000
Slave enable variable	4001

Click **ModbusTCP communication settings** to configure Modbus TCP commands. After clicking **Add**, a dialog box will appear for adding a new channel for the Modbus TCP slave station. Select the function code, set the operation address and length, and click **OK** button to create a new channel. Each channel represents an independent Modbus TCP request.

• Configure Modbus TCP commands.

s • I X	/ Hodou 10 Master_1	H Hodbur	TOP_Slave_1 x						
Billion, forces B Billion, and the starts of the start of the starts of the starts of the starts of the start	Historia VI denovatore Historia VI computatione Facil depose Balan Drimator	Modess comman Modess comman Pass entig Pass Past Past Past Past Past Past Past	Another with a location	netu- Orde transfed Readed	ten Keskeyh	brer handing	Wriskdoless	Witten	Reby times
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Modbus communi	cation settings	
Base config		
Name	Channel 00	
Function code	(0x03) Read holding registers	
Enable type	Loop execute	
Circle time(ms)	100 🗘 Enable variab	ble(SM)
	(1~65535)	(0~7999)
Retry times	1 Comment	
Read		
Address	8448 Length(WORD)	1
	(0°0xFFFF)	(1~125)
Error handling	Keep last value	
Write		
dhus TCP sl	OK Cancel	is completed
dbus TCP sl b b b b b b b b b b b b b b b b b b b	OK Carel	is completed.

As shown in the preceding figure, a Modbus TCP request is defined to cyclically read the holding register (function code 03) with a 100ms period. The read address is 0x2100 (VFD status word).

Step 5 Compile and download.

So far, the communication configuration is completed, and compile and download to the PLC. Click **Log** in to download, and after the download is complete, run the PLC. Set the VFD IP address, P16.58–P16.61 to **192.168.0.20**, set the station address P14.00 to **1**, keep default settings for P16.62–P16.69. Keep consistent with Modbus TCP slave settings, and set SM4001 enabling to

True to establish successful Modbus TCP communication.

• Compile and download.



After adding the master/slave communication configuration in the Modbus TCP slave communication settings, the values that are read can be viewed in the Internal I/O mapping interface. The internal I/O mapping will automatically allocate a mapping address for each configured mapping, such as %IW1 in the first row of the following figure, which represents mapping a value read from a register to address %IW1.

• View internal I/O mapping parameters.

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Anti-scan	Hobut TCP comunication addings	Toriable In: •	Mapping	Orannel Orannel 00	Address NZ/F1	Tipe annur p. of or won	Current Value	Prepared Value Unit	Description (InIC) Goal holding register
 C Analysica [cm] 	Fault diagnosis	1.9		(7avel 00)1	10/13	NORD	4		READ 38/F2/20(+0H4()
Likrary Manager	Stramal 30 Mapping								
- 23 Test Configuration	2464								
(2) NC, NG	Diferentiation								
Nantos casos SE protectas monetarios									
Balced (surmate)									
Nobus TO Heter 1 Nobus TO Heter 1									
G B Redux 10 Darr 1 (Helius 10 Darr	1								
A SUPPOSO SUPPOSO									
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	Watch 1								
	Expression.	Application	3,94	Value	Pr Pr	epared ratue Execution	n point.	Address 1	Carrent.

Similarly, multiple Modbus TCP commands can be added to control the VFD, for example, adding control word (address 0x2000), setting the set frequency (address 0x2001), checking status word (address 0x2100) and running frequency (address 0x3000) settings. Adding commands are shown in the following figure. The control word and set frequency addresses are contiguous, directly adding the function of writing multiple registers, with a length set to 2.

• Multiple Modbus TCP command settings



After adding, download to PLC and run it. Enable SM4001, then check the Internal I/O mapping interface.

Set VFD function codes, P00.01=2, P00.02=0, and P00.06=8.

As shown in the following figure, give the running command (1: forward run) and set the frequency (1000: 10Hz) on the internal I/O mapping interface to control the VFD to run at 10Hz frequency using Modbus TCP.

• Parameter reference

• • • ×	🖉 Device 🏠 SoftMotor G	eneral Axis Pool 🛛 👔 Mods	No. TOP Mart	e_1 ()] I	Hodbus_TCP	Slave_1 X				
unded:	Modbus TCP size settings	Find		Riter Show all			+ Add FB for IO C	NameL. * Go to I	stance	
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Parameter view

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Application (res)				Channel 02[1]	16QW2	WORD	1900			WRITE 35#2003[-0:00
👔 Lbrary Manager	Internal \$10 Mapping	8.9		Channel 00	5201	ARRAY (D0) OF WORD				(2x03) Read holding reg
1 PLC_PRG (PRG)	Out of	A		Channel 00(0)	5691	WORD	1			READ 16#2100(+0196)
🗏 🧱 Task Configuration		× • •		Channel 01	9672	ARRAY [0. 0] OF WORD				(5x03) Read holding reg
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6 PowerLink protocol

6.1 Overview

The communication card using this protocol is defined as a PowerLink slave station, which can be used on VFDs that support PowerLink communication.

6.2 Product features

6.2.1 Supported functions

- Supports the PowerLink CiA 402 protocol.
- Configured with a slave station XDD configuration file, it can communicate with B&R PLC and other master stations.
- Automatic network address configuration
- Equipped with two RJ45 ports, supporting 10/100M half duplex operating.
- Applicable to linear and star network topologies.

6.2.2 Supported services

- PDO service
- SDO service
- Use of SDO to read and write VFD function codes
- Manufacturer-defined object dictionary
- Two types of objects for VFD reading and writing, that is, PDOs and SDOs (requiring the object dictionary defined by the manufacturer)

6.2.3 Status indicator

The EtherCAT communication card provides six indicators to indicate its states. Figure 6-1 shows the positions of the four indicators. Table 6-1 provides the indicator definitions.

Figure 6-1Status indicator positions



Table 6-1 Status indicator definitions

Indicator	Color	Definition	Function	
		Steady on	In NMT_CS_OPERATIONAL state	
		Blinking (on for 50ms, off for 50ms)	In NMT_CS_BASIC_ETHERNET state.	
		Blinking (on for 200ms, off for 200ms)	In NMT_CS_STOPPED state	
LED1 (RUN)	Green	Green	Single flash (on for 500ms, off for 500ms)	In NMT_CS_PRE_OPERATIONAL_1 state.
		Double flashes (on for 250ms, off for 250ms)	In NMT_CS_PRE_OPERATIONAL_2 state.	
		Triple flashes (on for 125ms, off for 125ms)	In NMT_CS_READY_TO_OPERATE state	
		Steady off	In Init state.	
		Steady on	The communication card is in the process of handshaking with the VFD.	
LED2 (HOST)	Green	Blinking (on for 500ms, off for 500ms)	The communication card and VFD communicate normally. Note: After the handshaking is completed, it should blink regardless of whether there is data transmission between the communication card and the main control board.	
		Steady off	The communication card is in the initialization or parameter configuration phase.	
LED3 (DATA)	Green	Blinking (on for 500ms, off for 500ms)	The data update between the communication card and main control board is normal.	
		Steady off	No data update or abnormal update	

Indicator	Color	Definition	Function
			between the communication card and main control board.
LED4 (POWER)	Red	Steady on	3.3V power indicator
LED5 (ERR)	Red	Steady on	Data frame lost, communication disconnected, or NMT internal critical error (such as illegal interruption and memory overrun).
		Steady off	No fault
LED6 (SYS)	Green	Blinking (on for 500ms, off for 500ms)	Communication card heartbeat indicator (communication card is running normally).

6.3 Electrical connection

A PowerLink network often consists of a master station (such as PLC) and multiple slave stations (such as drives or bus expansion terminals). Each PowerLink slave station has two standard Ethernet interfaces. Figure 6-2 and Figure 6-3 show the electrical connections.

Figure 6-2 Linear network topology electrical connection



Figure 6-3 Star network topology electrical connection



Note: For the star network topology, you need to prepare switches and hubs.

6.4 Communication

6.4.1 PowerLink reference model



Figure 6-4 PowerLink reference model

The PowerLink network reference model consists of two parts: the data link layer and the application layer. The data link layer is primarily responsible for the PowerLink communication protocol, which utilizes an additional bus scheduling mechanism to extend the standard Ethernet data link layer, ensuring that only one node can access the network at the same time. The scheduling mechanism is divided into isochronous phase and asynchronous phase. The application layer embeds the CANopen drive Profile (DS402) communication protocol. The object dictionary in CoE includes parameters, application data, and PDO mapping configuration information.

Process data objects (PDO) are composed of mappable objects from the object dictionary, and the content of PDO data is defined by PDO mappings. The reading and writing of PDO data is periodic and does not require searching for the object dictionary, while email communication (SDO) is non-periodic communication and requires searching for the object dictionary when reading and writing.

6.4.2 PowerLink slave station information

The PowerLink slave station information file (XML file) is used for the master station to read, in order to construct the configuration between the master and slave stations. The XML file contains the information necessary for PowerLink communication settings.

6.4.3 PowerLink state machine

The PowerLink state machine is used to describe the states of the slave application and state transitions. State change requests are typically initiated by the master station, with responses from the slave station. The specific state transition method is as shown in the following figure.



Figure 6-5 PowerLink state machine flowchart

Status	Description
NMT_GS_INITIALISATION	In the power-up phase, the communication attributes are initialized, and the node ID configuration phase is established.
NMT_MS_NOT_ACTIVE	During the node management phase, the Master Node (MN) acquires the operational status of the slave nodes through the Service Object Address (SOA) and Service Object Command (SOC) frames. SDO data is unavailable, and PDO data is also unavailable.
NMT_MS_PRE_OPERATIONAL_1	The MN executes non-real-time cyclical communication, completing the transmission of communication attribute configuration data while verifying IDs and downloading the configuration PDO mapping. SDO data is available, whereas PDO data remains unavailable.
NMT_MS_PRE_OPERATIONAL_2	The MN performs a synchronous cycling process, initiating the polling of identified Communication Nodes (CN), as well as those not flagged as AsyncOnly by the Preq frames. Simultaneously, it verifies the heartbeat of the nodes, searching for configured but unrecognized CNs through the SoA IdentRequest frame. SDO data is accessible, while PDO data remains unavailable.
NMT_MS_READY_TO_OPERATE	The MN continues with the synchronous cycling process and is expected to begin identifying time-critical CNs according to PDO mapping requirements. The MN cyclically accesses recognized asynchronous CNs through the SoA StatusRequest frames. SDO data is available, whereas PDO data remains unavailable.
NMT_MS_OPERATIONAL	The MN engages in a synchronous cycling process, sending the NMTStartNode command to force the CN from NMT_CS_READY_TO_OPERATE

Table 6-2 PowerLink state machine description

Status	Description
	to NMT_CS_OPERATION.
	Cyclic access to recognized asynchronous CNs is
	performed through the SoA status request
	frames.
	The search for configured but unrecognized CNs
	is performed via the SoA IdentRequest frames.
	SDO data is available; PDO data is available.

6.4.4 PDO process data mapping

The process data of the PowerLink slave station is always executed in a synchronous manner through PReq and/or PRes frames. Among them, PRes frames are sent in broadcast mode using a producer/consumer pattern, while PReq frames with unicast addresses follow a master/slave relationship. The transfer type of PDO is continuous transfer, and does not support "event-driven" or "change-driven" transfer types.

From the perspective of devices, the use of PDOs can be divided into two types: data transmission and data reception. The distinction between transmitting PDOs (TPDOs) and receiving PDOs (RPDOs) needs to be made. Devices that support TPDO are called PDO producers or PDO master devices, while devices that can receive PDOs are called PDO consumers or PDO slave devices. The PowerLink slave station with application control function should support the reading of PDO mapping objects, with a maximum data size of 10 for each single PDO access.

The master station can select the required objects for PDO mapping from the object dictionary. PDO mapping configuration is located in the Object Dictionary from the 1600h to 1603h area (RxPDOs: Receive PDOs) and from 1A00h to 1A03h area (TxPDOs: Transmit PDOs).

The master station can select the required objects for PDO mapping from the object dictionary. The PDO mapping configuration is located in the following area of the object dictionary:

- 1600h to 1603h: Receive PDOs (RxPDOs)
- 1A00h to 1A03h: Transmit PDOs (TxPDOs)

Note: Mapping is only supported for 0x6000 series objects, and not supported for 0x4000 series manufacturer-specific parameter mapping. Even if added to the PDO mapping, they will still be transmitted through the SDO channel. In the EPL, the maximum number of data accessed in a single SDO is 10. When the number exceeds 10, only the last 10 data can be successfully written.

Figure 6-6 shows the PDO mapping method.



Figure 6-6 PDO mapping method

6.4.5 Clock synchronization

PowerLink complies with the IEEE1588 distributed clock system standard to achieve high-precision clock synchronization. Each device comes with a clock to ensure precise synchronization during data exchange. The PowerLink cycle consists of two main roles: master node (MN, management node) and child node (CN, controlled node, also known as slave).

During the startup phase of the PowerLink cycle, the master node will send configuration information to each slave node and multicast synchronization start frames (SoC) to all nodes through Ethernet. After receiving the SoC, a slave node enters a waiting state for data communication.

After the SoC, the master node (MN) starts communicating with each slave node in turn:

- 1. The MN first sends PReq1 to the first node, which will broadcast PRs1 to the network after receiving it.
- 2. Subsequently, the MN sends PReq2 to the second node, which will broadcast PRs2 to the network after receiving it.
- 3. This process continues in a cyclic manner until the final slave node broadcasts

PRsN.

4. Finally, the MN sends the Start of Asynchronous frame (SoA), marking the beginning of the asynchronous communication phase.

After SoA, the network entered the asynchronous data transmission phase. The entire process forms a complete PowerLink loop frame, consisting of the following two stages:

Isochronous synchronization phase: This is accomplished through the SoC and $\mathsf{PReq}/\mathsf{PRs}.$

Asynchronous data transmission phase: This phase begins with the SoA.

The timing for all phases is configurable to accommodate various application requirements.

6.5 CiA402 device profile

The main station controls the drive through control word (0x6040), and reads status word (0x6041) to obtain the actual status of the drive. The servo drive achieves motor control internally based on the control instructions from the master station.

6.5.1 CANopen over PowerLink state machine



Figure 6-7 CANopen over PowerLink state machine

State	Description
Not Ready to Switch On	The drive is in the initialization process.

Switch On Disabled	Drive initialization is completed.				
Ready to Switch On	The drive is waiting to enter the Switch On state, and the motor is not excited.				
Switched On	The drive is ready, and the main circuit power is normal.				
Operation Enable	he drive is enabled and it controls the motor in ccordance with the control mode.				
Quick Stop Active	The drive stops according to the set mode.				
Fault Reaction Active	The drive detects that an alarm has occurred, and stops according to the set mode, while the motor still has excitation signal.				
Fault	The drive is in a fault state and the motor has no excitation signal.				

The control word 6040h includes the following content:

- Bits for state control
- Bits related to control mode
- Bits defined by manufacturer

The detailed description of each bit of 6040h is as follows.

15 11	10 9	8	7	6	4 3	2	1	0
Factory defined	Reserved	Reserved	Fault reset	Operation mode	Servo running	Quick stop	Switch on main circuit	Servo being ready
0	0	0	М	0	М	М	М	М
MSB				LSB				

Bits 0-3 and bit 7 (bits for state control):

Command	Fault	Enable	Quick	Enable	Switch	Transitions
	reset	operation	stop	voltage	on	
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

Command	Fault	Enable	Quick	Enable	Switch	Transitions
	reset	operation	stop	voltage	on	
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 (bits related to control mode):

D:4	Operation mode						
BIC	Profile position mode	Profile velocity mode	Homing mode				
4	New set-point	Reserved	Homing operation start				
5	Change set immediately	Reserved	Reserved				
6	Rel	Reserved	Reserved				
8	Halt not supported	Halt not supported	Halt not supported				

Note: In the Profile position mode, when bit4=New set-point, a new position can be triggered.

When the control word is set to 0x0F, the drive is enabled; otherwise, the drive stops. If a fault occurs, a reset command is issued when bit 7 in the control word is set to 1.

6041h status word includes the following content:

- Drive's present status bit
- Status bits related to control mode
- Status bits defined by manufacturer

The detailed description of each bit of 6041h is as follows.

Bit	Description	M/O
0	Ready to switch on	Μ
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

Bit	Description	M/O
10	Target reached	М
11	Internal limit active	М
12–13	-	-
14-15	Manufacturer specific	0

Bits0-3, 5, and 6:

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
xxxx xxxx x0xx 1000	Fault

Bit 4: Voltage enable, when this bit is set to 1, it indicates that the main circuit power supply is normal.

Bit 9: Remote, when this bit is 1, it indicates that the slave station is in OP state, and the master station can control the drive through PDOs.

Bit 10: Target reached.

Mode 1 and mode 8: After the present positioning is completed, set it to 1 for keeping. If the positioning is restarted, clear it to 0.

Mode 6: Set it to 1 after homing is completed; set it to 0 if homing is not completed.

Mode 2: Set it to 1 when the ramp reference frequency reaches the set frequency and the control word's bit 4, bit 5, and bit 6 are all set to 1; otherwise, set it to 0.

Other modes: 0

Bit 11: External limitations

Mode 1 and mode 8: Set it to 1 when FWD/REV limit is reached; otherwise set it to 0.

Mode 4 and mode 10: In electric mode: If the electric torque reaches the upper limit (upper limit is not 0), set it to 1; otherwise, set it to 0. In braking mode, if the braking torque reaches the upper limit (upper limit is not 0), set it to 1; otherwise set it to 0.

Mode 2, mode 3, and mode 9: Set it to 1 when the output frequency reaches P00.03; otherwise, set it to 0.

Other modes: 0

Bit 12: Manufacturer defined 1

Mode 1: Set to 1 when bit 4 of the control word is 1; otherwise, set to 0.

Mode 8, mode 9, and mode 10: Set it to 1 when the VFD is in running state; otherwise, set it to 0.

Other modes: 0

Bit 14: When this bit is 1, it indicates the motor is in zero-speed state.

Bit 7–Bit8, Bit 15: Reserved

6.5.2 Device run mode

Set the VFD parameters P00.01=2 (Running command channel), P00.02=3 (PowerLink communication channel), and P16.75 (Communication timeout time). The position mode and homing mode require the drive to operate in closed-loop mode.

6.5.2.1 Profile Position Mode

- 1. Set 【6060h: Mode of operations】 to 1 (Profile Position Mode).
- Set the appropriate number of encoder pulses P20.01 according to the encoder model, set the position command source P21.00 tens place to 1; for digital position, set P21.16 digital positioning mode (16#0200, bit 9=1 Position source PowerLink given).
- 3. Set 【6081h: Profile velocity】, with the frequency-to-velocity relationship V=60f/p, where V is the velocity in RPM (revolutions per minute), f is the frequency, and p is the number of motor pole pairs.
- 4. Set [6083h: Profile acceleration] and [6084h: Profile deceleration] and write the corresponding values 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 to 0x4F to enable, bit 6 set to 1, only relative position supported).
- 6. Set [607Ah: Target position] to the target position (unit: user unit).
- 7. Query [6064h: Position actual value] to obtain the motor actual position feedback.
- 8. Query [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 user manual.

6.5.2.2 VFD Mode

- 1. Set 【6060h: Mode of operations】 to 2 (VFD mode).
- 2. Set [6046h: vl 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 the object dictionary [6048h: vl velocity acceleration], [6049: vl velocity deceleration], and [604Ah: QuickStop Speed]. Do not set them to the default values of the drive.
 - The acceleration time is 60* [6048h:02 Acceleration Delta Time] *P00.04/([6048h:01 Acceleration Delta Speed] * Number of motor pole pairs) * 0.1, with second as the unit, corresponding to P00.11. The value will remain the same as the previous one when it exceeds 3600.0 seconds.
 - The deceleration time is 60* [6049h:02 Deceleration Delta Time] *P00.04/([6049h:01 Deceleration Delta Speed] * Number of motor pole pairs)*0.1, with second as the unit, corresponding to P00.12. The value will remain the same as the previous one when it exceeds 3600.0 seconds.
 - The emergency stop time is 60 * [604Ah:02 QuickStop Delta Speed] * P00.04/([604Ah:01 QuickStop Delta Time] * Number of motor pole pairs)*0.1, with second as the unit, corresponding to P00.12. The value will remain the same as the previous one when it exceeds 60.0 seconds.
- 4. Set 【604Ch: vl dimension factor】 to adjust the electronic gear ratio, which is 1:1 by default.
- 5. Set **[**6040h: Control word**]** to enable the drive (set to 0x0F to enable) and start the motor operation.
- 6. Set [6042h: vl target velocity] to set the target speed.
- 7. Set 【6040h: Control word】 to run the drive (when it is set to 0x7F, the drive runs).
- 8. Query [6044h: vl velocity actual value] to obtain the motor actual position feedback.

6.5.2.3 Profile Velocity Mode

- 1. Set 【6060h: Mode of operations】 to 3 (Profile Velocity Mode).
- 2. Set [6083h: Profile acceleration] and [6084h: Profile deceleration] and write the corresponding values 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 to 0x0F to enable) and start the motor operation.
- 5. Set 【60FFh: Target velocity】 to set the target rotational speed (unit: rpm).
- 6. Query [6041h: Status word] to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, Internal limit active).

6.5.2.4 Profile Torque Mode

- 1. Set 【6060h: Mode of operations】 to 4 (Profile Torque Mode).
- 2. Set 【6087h】 to set the ramp torque.
- 3. Set 【6040h: Control word】 to enable the drive (set to 0x0F to enable) and start the motor operation.
- 4. Set P03.11=11 and P03.32=1 (torque control enabled).
- 5. Set [6071h: Target torque] to set the target torque.
- 6. Query [6041h: Status word] to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, Internal limit active).

6.5.2.5 Homing Mode

- 1. Set 【6060h: Mode of operations】 to 6 (homing mode).
- 2. Set P22.00.Bit0=1 to enable spindle positioning function, and set P22.03–P22.06 zero positions.
- 3. Set the 【6040h: Control word】 to enable the drive (set to 0x0F to enable). When bit 4 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 【6041h: Status word】 to obtain the drive status feedback (Homing error, Homing attained, Target reached).
- 6. For function details, see function parameters in group P22 in function code list chapter and commissioning chapter in the GD350 user manual.

6.5.2.6 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. When the status word (60B9h: Touch Probe Statu) is 3, in continuous triggering mode, the probe status word bit 6 is 1, and each triggering will cause bit 7 to toggle.
- 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. When the status word is 5 (60B9h: Touch Probe Statu), in continuous triggering mode, the probe status word bit 6 is 1, and each triggering will cause bit 7 to toggle.
- 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, which is recorded only once. When th status word (60B9h: Touch Probe Statu) is 5, the falling edge triggering control word is 37.

✓Note: The difference from CiA 402 is that only one type of probe is supported and only one locking value can be recorded at a time.

6.5.2.7 Cyclic Synchronous Position Mode (Not supported)

- 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 to 0x0F to enable).
- 4. Set 【607Ah: Target position】 to the target position (unit: user unit).
- 5. Query [6064h: Position actual value] to obtain the motor actual position feedback.
- 6. Query [6041h: Status word] to obtain the drive status feedback (following error, target reached, and internal limit active).
- 7. For function details, see function parameters in group P21 in function code list chapter and commissioning chapter in the GD350 user manual.

6.5.2.8 Cyclic Synchronous Velocity Mode (Not supported)

- 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 to 0x0F to enable) and start the motor operation.
- 5. Set 【60FFh: Target velocity】 to set the target rotational speed (unit: rpm).
- 6. Query [6041h: Status word] to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, Internal limit active).

6.5.2.9 Cyclic Synchronous Torque Mode (Not supported)

- 1. Set 【6060h: Mode of operations】 to 10 (Cyclic Synchronous torque Mode).
- 2. Set P03.11=11 (Communication) and P03.32=1 (Torque control enabled).
- 3. Set 【6040h: Control word】 to enable the drive (set to 0x0F to enable) and start the motor operation.
- 4. Set [6072h: Max torque] to the maximum torque and [6071h: Target torque] to the target torque.
- 5. Query [6041h: Status word] to obtain the drive status feedback (Speed zero, Max slippage error, Target reached, Internal limit active).

6.6 PLC communication example (x20CP3684)

This example illustrates how to use the communication card to establish simple PowerLink communication between the Beckhoff x20CP3684 as the master station and a VFD.

Install Beckhoff Automation Studio 4.12 English.

Open Automation Studio software, and create a new project named X20CP3684. Select device **X20CP3684**. See the following figure.

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	Note: A subfolder with the same name as the project will be created automatically.	
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∠Note: Please ensure that the path created here is entirely in English.

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Import the PowerLink configuration file (EC-TX509U8_1.0.0.XDD). In the menu bar, choose Tool > Manage 3rd-Party Devices.... In the dialog that appears, select Import Fieldbus Device(s), specify the location of the configuration file (EC-TX509U8_1.0.0.XDD), select the imported XDD file, and click Open; wait for the import to be successful.

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Add devices.

Click **Configuration View**, double click **Hardware** to enter the configuration interface, right click and choose **Add Hardware Model**..., then search for EC-TX509U8 on the right side to quickly locate the device; double click or drag it to a blank area, connecting the device port to the PLC's PowerLink port, thus completing the configuration.





Set slave station parameters.

Click **Physical View** to enter the **Physical View** interface, right click the added PowerLink slave station **EC-TX509U8_1.0.0.0**, and modify the slave site (1 for example).



∠Note: The slave station site number setting need to be consistent with the function code P16.78.

After modifying the address, right click the added PowerLink slave **EC-TX509U8_1.0.0.0** again and choose **Configuration** to enter the configuration interface; when setting up the PowerLink network, disable the PLC's service mode: set **Module Supervised** to **OFF**.

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Select **Channels** to configure the PDO parameters. Choose **Control Write**, and set **Cyclic Transmission** to **Write**.

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Similarly, set the following parameters to Write: Mode of Operation; Target Velocity. Choose Status Word, and set Cyclic Transmission to Read.

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Similarly, set the following parameters to **Read**: Error Code; Mode of Operation Display; VelocityActualValue; DCLinkCircuitVoltage. Once configuration is complete, click **Save**.

Right click the added **EC-TX509U8_1.0.0.0** and choose **I/O Mapping** to enter the PDO mapping interface, where you can view the completed PDO parameters.

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Perform PLC connection and download.

Connect the ETH port of the PLC to the computer's network port. In the Automation Studio menu bar, choose **Online > Setting...** to enter the scanning interface, where the detected PLC will be visible.



When the scanned PLC IP address is 0, right click the scanned PLC, and choose **Set IP Parameters** to set the IP address. After the IP setting is completed, right click **Connect**. See the following figure.

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∠Note: The set IP address should be in the same network segment as the computer.

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After successful connection, you can see the status of the PLC below.

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Click **Build** to initiate the compilation. Once the compilation is complete without errors, click **Transfer** on the pop-up window, and then click **Transfer** in the pop-up **Transfer to target** window. Wait for the download to complete.



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Configure the VFD: set P16.78=1 (station address); P00.01=2; P00.02=3; P00.06=13. Connect the PLC's PLK port to the EC-TX509U8 port. Click **Monitor** to monitor PDO parameters in real time. If **ModuleOk** displays as **True**, it indicates that communication has been successfully established.

annel Name	Physical Value	ForceActivated	ForceActivated Value
ModuleOk	TRUE		FALSE
ErrorCode 1603F S01	0		0
ControlWord 16040 S01Out	0		0
StatusWord_I6041_S01	2609		0
 ModeolOperation_8060_S01Out 	0		0
ModeOfOperationDisplay_16061_S01	0		0
VelocityActualValue_I606C_S01	0		0
 TargetVelocity I60FF_S01Out 	0		0
DCLinkCircuitVoltage_16079	326200		0

Parameter reference

The PDO parameters can be directly assigned in the **I/O Mapping** interface. Enter the parameters under **Force Activated Value** and select **Force Activated** to successfully write the parameters.

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ModeOfOperationDisplay_I6061_S01	3			0	
VelocityActualValue_I606C_S01	0			0	
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Parameters can also be set through PLC programming.

Click **Logical View**, where various programming languages can be selected on the right side to create a program (this example will use ST Program). Simply double click **ST Program** to complete the creation of an ST language program.

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Double click **Global.Var** to define global variables, such as **Control Word**. After completion, click **Save**.

	■ ■ × Since The Solution of Control Contro	[guration] 🛃 EC-TXS05	(UIL_1.0.0.0 [UO Mapping]	Global.var (Variable De	daratioe) ×	*
a a b a b a b a b a b a b a b a b a b a	Non V Construction V Constru	(594- 0947 2927 2011	a Constant PRA	as ∰Arstochte B B G	Value	Vesceiption [1]

Assign values to the defined variables. Choose **Program** > **Cyclic.st**, double click **Cyclic**, and enter the assignment statements, as shown in the following figure.



Once the program is written, return to the **I/O Mapping** interface to map the created variables to the relevant parameters.

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After mapping, if compilation is successful, proceed with the download; then click **Monitor** to confirm the successful setting of parameters.

iannel Name	Physical Value	ForceActivated	ForceActivated Value
ModuleOk	TRUE		FALSE
e ErrorCode 1603F S01	0		0
ControlWord 16040 S01Out	15		0
StatusWord 16041 S01	2615		0
ModeotOperation_I6050_S01Out	3		3
ModeOfOperationDisplay_16061_S01	3		0
VelocityActualValue_I606C_S01	749		0
TargetVelocity_I60FF_S01Out	750		750
DCLinkCircuitVoltage_16079	325300		0

While monitoring, access the programming interface. In the **Watch** window, right click and choose **Insert Variable**... to add the corresponding variables for observation and modification.

	😤 C:\Users\Administrator\De	zsktop\Example\Pow	erlink/Powerlink.apj/Config1 - Automation	Studio V 4.12.6.106 # AS Evalu	ation License				
	File Edit View Insert Open	Project Debug Sou	roe Control Online Tools Window Help						
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				x1 x 9 FC-TX509UB 10.00 B	O Manninel Giebaluar	Wariable Declacat	on NEC-TREPUBLIC	0 Konfountied	v 177
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For SDO read/write operations, choose **Program** > **Cyclic.st**, double click **Cyclic** to enter the programming interface. Click the top left corner **Insert Function/Function Block...** to add the **EplSDORead** function block (or **EplSDOWrite**).

Telericii (0				
PROGRAM _CYCLIC ControlWords ModeOfOperat	🎋 Select Data Type			×
TargetVelocs	Category:	Name sepsObjUnconnectMessage	Scope Description Descripti AsNx sends an	^
END_PROGRAM	Functions and Function blocks ${\bf \curlyvee}$	12 eipsSubscribe 13 eipsUnsubscribe	AsNx. subscribe AsNx. unsubscri	
	Show project structure	EplCreateObject	AsEPL creates a AsEPL creates a	
	Show external libraries	EpiSDORead	AsEPL reads no	
	Show only used	→ EQ → ERRofatal ③	ubrar compare sys_lib_makes an	
	Show only local	ERRaread ERRawarning	sys_lib reads an sys_lib makes an	
	Array index range:	ERR_read ERR_warming	sys_lb makes an sys_lb reads an sys_lb makes an	
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	0	ETHinfo	ETH	
	Subrange:	*ative ETHodato	AsE I retrieves ETH	~
	Rilter	۲	× a	
		or	Canaal Hala	



Define the following variables in **Global.Var** (for example, using **EpISDORead**) and configure them within the program.

Program::Cyclic.st [Structur	ed Text] 👂 EC-TX5	09U8_1.0.0.0 [I/O N	lapping] 🛛 🖗 Glo	obal.var [Variable De	claration] ×	1.0 EC-TX509U8_1
Name ControlWord ModeOfOperation TargetVelocity	Type UINT SINT DINT	Constant	Retain	ji Replicable ♥ ♥	Value	Description [1]
EpiSDORead_0 Enable icnable index subindex DATA datalen	Episdoread BOOL UINT USINT UINT[0.15] UDINT			2 X X X X X		
Program::Cyclic.st (Structured Te	xt] × € EC-TX509U8_1.0.0.) [VO Mapping] 🖉 Globs	ilvar (Variable Declaratio	n) 🏫 EC-TX509U8_1.0.0.0	(Configuration) ն X	20CP3684.IF2 (Configure
PROSAN_CYCLIC						
Controlword Node/Operation; TargetVelocity; EpiSIORead_0(enable := END_TROOMER	Enable , pDevice :=ADR(')	73') , node :=1 , in	dex :=index , subin	idex :==ubindex , pDate	:=ADR(DATA) , d	stalen :=datalen);

Upon completing the configuration, if the compilation is error-free, proceed with the download; assign values to parameters. For example, to read the status word (0x6041), set Index=16#6041 and subIndex=1; set datalen=2; Enable=True; the read

value can be observed in Data[0].

X20CP3684 [Software] Rogram::Cyclic.st [Structured Text] ×	۱	C-TX509U8_1.0.0.0 [I/O Mapping]	EC-TX509U8_1.0.0.0 [Configuration]	Ŧ
🛎 🖉 🏧 🗐 建 建 🗟				
	×	Watch [Program::Cyclic.st]		å ×
PODEN _CCLIC Source	^ · · · · · · · · · · · · · · · · · · ·	Base Cerem/Word ● Cerem/Word ● Cerem/Word ● Page/Add/scate ● Scate ● Scate	Value 0 1 166055,C688 166057,0240 2 166050,2740 2 160050,2740 2 160051,11 16050,2740 2 160000 0 2 10 2 11 2 2 10 2 0 0	^

Appendix A EtherCAT object dictionary

Index	Subindex	Description	Access permission	Data type	Default
1000h	0	Device type	RO	UINT32	0x00000192
1001h	0	Error register	RO	UINT8	0
1008h	0	Manufacturer device name	RO	String	EC-TX509U8
1009h	0	Manufacturer hardware version	RO	String	Hardware version depended
100Ah	0	Manufacturer software version	RO	String	Software version depended
			D object		
	0	Included max. subindexes	RO	UINT8	4
1018h	1	Supplier ID	RO	UINT32	0x0000072C
	2	Product code	RO	UINT32	0x00009000
	3	Revision No.	RO	UINT32	0x0000001
	4	SN.	RO	UINT32	0x0000001
		RX PDO1 ma	apping para	meters	
	0	Number of supported mapping objects	RW	UINT8	8
	1	First mapping object	RW	UINT32	0x60400010
	2	2 Second mapping object		UINT32	0x607A0020
1600h	3	Third mapping object	RW	UINT32	0x60FF0020
100011	4	Fourth mapping object	RW	UINT32	0x60710010
	5	Fifth mapping object	RW	UINT32	0x60720010
	6	Sixth mapping object	RW	UINT32	0x60600008
	7	Seventh mapping object	RW	UINT32	0x60810020
	8	Eighth mapping object	RW	UINT32	0x60B80010

Index	Subindex	Description	Access permission	Data type	Default
		RX PDO2 ma	apping para	meters	
		Number of			
	0	supported mapping	RW	UINT8	2
1601h		objects			
	1	First mapping object	RW	UINT32	0x60400010
	2	Second mapping	RW	LIINT32	0x607A0020
	-	object		0111132	0000000020
		RX PDO3 ma	apping para	meters	
		Number of			
	0	supported mapping	RW	UINT8	2
1602h		objects			
	1	First mapping object	RW	UIN132	0x60400010
	2	Second mapping	RW	UINT32	0x607A0020
		object			
		RX PDO4 ma	apping para	meters	
	0	Number of	DW/		2
10026		supported mapping	RW	UINT8	Z
16030	1	ODJECIS	D\\/		0×60400010
	1	First mapping object	RVV	0111132	0x60400010
	2	object	RW	UINT32	0x607A0020
		TX PDO1 ma	meters		
		Number of			
	0	supported mapping	RW	UINT8	8
		objects			
	1	First mapping object	RW	UINT32	0x60410010
	2	Second mapping	RW	LIINT32	0x60640020
	2	object	1.00	0111132	0x000+0020
1A00h	з	Third mapping	RW	LIINT32	0x606C0020
	,	object		0111132	000000020
	4	Fourth mapping	RW	UINT32	0x60770010
	•	object		002	0,000110010
	5	Fifth mapping object	RW	UINT32	0x60F40020
	6	Sixth mapping	RW	UINT32	0x60610008
		object			
	7	Seventh mapping	RW	UINT32	0x60B90010

Index	Subindex	Description	Access permission	Data type	Default					
		object								
	8	Eighth mapping object	RW	UINT32	0x60BA0020					
		TX PDO2 mapping parameters								
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 ma	apping para	meters						
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 parameters									
1A03h	0	Number of supported mapping objects	RW	UINT8	8					
	1	First mapping object	RW	UINT32	0x60410010					
	2	Second mapping object	RW	UINT32	0x60640020					
		Sync Manager	communica	tion type						
	0	Max. subindexes	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					
1C12h		RxPD	O allocating	ç –						
	0	Max. subindexes	RW	UINT8	1					

Index	Subindex	Description	Access permission	Data type	Default				
	1	RxPDO allocated object index	RW	UINT16	0x1600				
	TxPDO allocating								
1012h	0	Max. subindexes	RW	UINT8	1				
101311	1	RxPDO allocated object index	RW	UINT16	0x1A00				
	9	Sync Manager synchr	onization ou	tput param	neters				
	0x00	Max. subindexes	RO	UINT8	0x20				
	0x01	Synchronization mode	RW	UINT16	0x02				
	0x02	Cycle time	RO	UINT32	0				
	0x03	Switchover time	RO	UINT32	0				
	0x04	Supported synchronization type	RO	UINT16	0x4006				
	0x05	Min. cycle time RO		UINT32	0x0003D090				
	0x06 Calculation and replication time		RO	UINT32	0				
1C32h	0x07	Reserved RW		UINT32	0				
	0x08	Obtain cycle time	RW	UINT16	0				
	0x09	Delay time	RO	UINT32	0				
	0x0A	Sync0 time	RW	UINT32	-				
	0x0B	SM event loss counter	RO	UINT32	0				
	0x0C Cyclic timeout counter		RO	UINT32	0				
	0x0D	Counter of too short switching	RO	UINT32	0				
	0x20	Synchronization error	RO	UINT8	0				
		Sync Manager synch	ronization ir	put param	eters				
	0x00	Max. subindexes	RO	UINT8	0x20				
1C33h	0x01	Synchronization mode	RW	UINT16	0x02				
	0x02	Cycle time	RO	UINT32	0				
	0x03	Switchover time	RO	UINT32	0				
	0x04	Supported	RO	UINT16	0x4006				

Index	Subindex	Description	Access permission	Data type	Default
		synchronization type			
	0x05	Min. cycle time	RO	UINT32	0x0003D090
	0x06	Calculation and replication time	RO	UINT32	0
	0x07	Reserved	RW	UINT32	0
	0x08	Obtain cycle time	RW	UINT16	0
	0x09	Delay time	RO	UINT32	0
	0x0A	Sync0 time	RW	UINT32	-
	0x0B	SM event loss counter	RO	UINT32	0
	0x0C	Cyclic 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	-
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	-

Index	Subindex	Description	Access permission	Data type	Default		
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	Fault code	RO	UINT16	0		
6040h	0	Control word	RW	UINT16	0		
6041h	0	Status word	RO	UINT16	0		
6043h	0	Output speed	RO	INT16	0		
6044h	0	Feedback speed	RO	INT16	0		
	Speed range						
6046h	1	Min. value	RO	UINT32	0		
	2	Max. value	RO	UINT32	0		
		Acceleration					
6048h	1	1 Acceleration increment		UINT32	0		
	2	Acceleration time increment	RO	UINT16	0		
		De	celeration				
6049h	1	Deceleration increment	RO	UINT32	0		
	2	Deceleration time increment	Deceleration time increment RO		0		
		Q	uick stop				
604Ah	1	Fast stop speed increment	RW	UINT32	0		
	2	Fast stop time increment RW		UINT16	0		
		Spee	d gear ratio				
604Ch	1	Numerator of speed gear ratio	RW	INT32	1		
	2	Denominator of	RW	INT32	1		

Index	Subindex	Description	Access permission	Data type	Default
		speed gear ratio			
6060h	0	Operation mode selection	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 value	RO	INT16	0
6078h	0	Actual current value	RO	INT16	0
6079h	0	Bus voltage	RO	UDINT32	0
607Ah	0	Target position	RW	INT16	0
6081h	0	Speed in industrial regulations	RW	UDINT32	0
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
		G	ear ratio		
C001h	0	Number of subindexes	RW	UINT8	2
609TU	1	Motor resolution	RW	UINT32	0x00000001
	2	Bearing axle resolution	RW	UINT32	0x00000001
6098h	0	Homing method	RW	INT16	0
C0001-		Hor	ning speed		
6099h	0	Reserved	RW	UINT32	0

Index	Subindex	Description	Access permission	Data type	Default
60B0h	0	Position offset	Position offset RW INT32		0
60B1h	0	Speed offset	RW	INT32	0
60B2h	0	Torque offset	RW	INT16	0
60B8h	0	Probe control	RW	UINT16	0
60B9h	0	Probe status	RO	UINT16	0
60BAh	0	Probe position rising edge	rising RO INT32		0
60BBh	0	Probe position falling edge RO IN		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	0x00003A5

Appendix B PowerLink object dictionary

Index	Subindex	Description	Access permission	Data type	Default
1000h	0	Device type	RO	UINT32	0x00010192
1001h	0	Error register RO UINT8		0	
1006h	0	NMT cycle length	RW	UINT32	3000
1008h	0	Manufacturer device name	RO	String	EC-TX509U8
1009h	0	Manufacturer hardware version	RO	String	Hardware version depended
100Ah	0	Manufacturer software version	RO	String	Software version depended
			D object		
	0	Included max. subindexes	RO	UINT8	4
1018h	1	Supplier ID	RO	UINT32	0x000004D8
	2	Product code	RO	UINT32	0x00009252
	3	Revision No.	RO	UINT32	0x00000001
	4	SN.	RO	UINT32	0x0000001
		CFM check c	onfiguratior	n object	
1020h	0	Included max. subindexes	RO	UINT8	2
	1	Configuration data	RW	UINT32	0x00000000
	2	Configuration time	RW	UINT32	0x00000000
		NMT interf	ace record o	object	
	0	Number of supported mapping objects	RO	UINT8	9
	1	Interface index	RW	UINT16	1
	2	Interface description	RW	String	Interface 1
	3	Interface type	RW	UINT8	0x06
1030h	4	Max. transmission bytes of interface	RW	UINT16	1518
	5	PHY physical address	RW	String	-
	6	Interface name	RW	String	Interface 1
	7	Open state	RW	UINT8	1
	8	Management state	RW	UINT8	1
	9	Valid	RW	Boolean	true

Index	Subindex Description		Access permission	Data type	Default			
1300h	0	SDO timeout time RW UINT		UINT32	150000			
		PDO RX communica	ation config	uration obje	ect			
1400h	0	Included max.	RO	UINT8	2			
	1	Subilidexes	DW/	ιιινίτο	0			
	2	Mannedversion			0			
	2	PX PDO1 m		meters	0			
		Number of supported		licters				
	0	mapping objects	RW	UINT8	8			
	1	First mapping object	RW	UINT32	0x00000000			
	2	Second mapping object	RW	UINT32	0x00000000			
	3	Third mapping object	RW	UINT32	0x00000000			
1600h	4	Fourth mapping object	RW	UINT32	0x00000000			
	5	Fifth mapping object	RW	UINT32	0x00000000			
	6	Sixth mapping object	RW	UINT32	0x00000000			
	7	Seventh mapping object	RW	UINT32	0x00000000			
	8	Eighth mapping object	RW	UINT32	0x00000000			
		PDO TX communication configuration object						
1800h	0	Number of supported mapping objects	RW	UINT8	2			
	1	Node ID	RW	UINT8	254			
	2	Mapped version	RW	UINT8	0			
		TX PDO1 ma	apping para	neters				
	0	Number of supported mapping objects	RW	UINT8	8			
	1	First mapping object	RW	UINT32	0x00000000			
14006	2	Second mapping object	RW	UINT32	0x00000000			
IAUUN	3	Third mapping object	RW	UINT32	0x00000000			
	4	Fourth mapping object	RW	UINT32	0x00000000			
	5	Fifth mapping object	RW	UINT32	0x00000000			
	6	Sixth mapping object	RW	UINT32	0x00000000			
	7	Seventh mapping	RW	UINT32	0x00000000			

Index	Subindex Description		Access permission	Data type	Default				
		object							
	8	Bighth mapping Object		UINT32	0x00000000				
	DLL SoC node missing object								
	0	Number of supported mapping objects	RW	UINT8	3				
1C0Bh	1	Number of communication activations	RW	UINT32	0				
	2	Number of threshold exceeding times	RW	UINT32	0				
	3	Threshold size	RW	UINT32	15				
		DLL PReq no	ode missing	object					
	0	Number of supported mapping objects	RW	UINT8	3				
1C0Dh	1	Number of communication activations	RW	UINT32	0				
	2	Number of threshold exceeding times	RW	UINT32	0				
	3	Threshold size	RW	UINT32	15				
		DLL CR	C error obje	ct					
	0	0 Number of supported mapping objects Number of 1 communication activations		UINT8	3				
1C0Fh	1			UINT32	0				
	2	Number of threshold exceeding times	RW	UINT32	0				
	3	Threshold size	RW	UINT32	15				
1C14h	0	DLL SoC node missing coefficient	RW	UINT32	100000				
1F82h	0	NMT feature value	RO	UINT32	0x45				
1F83h	0	NMT EPL version	RO	UINT8	0x20				
1F8Ch	0	Present NMT state	RO	UINT8	-				
		EPL no	ode ID objec	t					
1F93h	0	Number of supported mapping objects	RW	UINT8	2				

Index	Subindex	Description	Access permission	Data type	Default
	1	Node ID	RO	UINT8	-
	2 Node hardware ID		RO	Boolean	-
		NMT cycle tii	ne recordin	g object	
	0	Number of supported mapping objects	RO	UINT8	9
	1	Max. payload of Tx	RO	UINT16	100
	2	Max. payload of Rx	RO	UINT16	100
	3	PRes max. delay	RO	UINT32	100000
1F98h	4	PRes valid payload upper limit	RW	UINT16	36
	5	PRes valid payload lower limit	RW	UINT16	36
	6	ASnd max. delay	RO	UINT32	150000
	7	Multi-cycle counting	RW	UINT8	0
	8	ASnd max. bytes	RW	UINT16	1518
	9	Polarity	RW	UINT16	2
1F99h	0	NMT basic communication timeout time	RW	UINT8	5000000
1F9Eh	0	NMT reset command	RW	UINT32	0xFF
4000h	0x00-0x13	Function code	RW	UINT16	-
4001h	0x00-0x23	Function code	RW	UINT16	-
4002h	0x00-0x21	Function code	RW	UINT16	-
4003h	0x00-0x42	Function code	RW	UINT16	-
4004h	0x00-0x3C	Function code	RW	UINT16	-
4005h	0x00-0x35	Function code	RW	UINT16	-
4006h	0x00-0x23	Function code	RW	UINT16	-
4007h	0x00-0x56	Function code	RW	UINT16	-
4008h	0x00-0x84	Function code	RW	UINT16	-
4009h	0x00-0x1D	Function code	RW	UINT16	-
400Ah	0x00-0x20	Function code	RW	UINT16	-
400Bh	0x00-0x40	Function code	RW	UINT16	-
400Ch	0x00-0x21	Function code	RW	UINT16	-
400Dh	0x00-0x14	Function code	RW	UINT16	-
400Eh	0x00-0x47	Function code	RW	UINT16	-
400Fh	0x00-0x46	Function code	RW	UINT16	-
4010h	0x00-0x55	Function code	RW	UINT16	-
4011h	1h 0x00–0x40 Function code		RW	UINT16	-

Index	Subindex	Description	Access permission	Data type	Default		
4012h	0x00-0x2D	Function code	RW	UINT16	-		
4013h	0x00-0x28	Function code	RW	UINT16	-		
4014h	0x00-0x28	Function code	RW	UINT16	-		
4015h	0x00-0x22	Function code	RW	UINT16	-		
4016h	0x00-0x19	Function code	RW	UINT16	-		
4017h	0x00-0x14	Function code	RW	UINT16	-		
4018h	0x00-0x28	Function code	RW	UINT16	-		
4019h	0x00-0x21	Function code	RW	UINT16	-		
401Ah	0x00-0x35	Function code	RW	UINT16	-		
401Bh	0x00-0x1E	Function code	RW	UINT16	-		
401Ch	0x00-0x1E	Function code	RW	UINT16	-		
603Fh	0	Fault code	RO	UINT16	0		
6040h	0	Control word	RW	UINT16	0		
6041h	0	Status word	RO	UINT16	0		
6043h	0	Output speed	RO	INT16	0		
6044h	0) Feedback speed RO		INT16	0		
	Speed range						
6046h	1	Min. value	RO	UINT32	0		
	2	Max. value	RO	UINT32	0		
	Acceleration						
6048h	1 Acceleration increment		RO	UINT32	0		
	2	Acceleration time increment	RO	UINT16	0		
		De	celeration				
6049h	1	Deceleration increment	RO	UINT32	0		
	2	Deceleration time increment	RO	UINT16	0		
		Q	uick stop				
604Ah	1	Fast stop speed increment	RW	UINT32	0		
	2	Fast stop time increment	RW	UINT16	0		
		Spee	d gear ratio				
604Ch	1	Numerator of speed gear ratio	RW	INT32	1		
	2	Denominator of	RW	INT32	1		

Index	Subindex	Description	Access permission	Data type	Default
		speed gear ratio			
6060h	0	Operation mode RW UINT16 selection		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 value	RO	INT16	0
6078h	0	Actual current value	RO	INT16	0
6079h	0	Bus voltage	RO	UDINT32	0
607Ah	0	Target position	RW	INT16	0
6081h	0	Speed in industrial regulations	RW	UDINT32	0
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
		G	ear ratio		
C001h	0	Number of subindexes	RW	UINT8	2
609TU	1	Motor resolution	RW	UINT32	0x00000001
	2	Bearing axle resolution	RW	UINT32	0x0000001
6098h	0	Homing method	RW	INT16	0
60006		Hor	ning speed		
00990	0	Reserved	RW	UINT32	0
60B0h	0	Reserved	RW	INT32	0
60B1h	0	Reserved	RW	INT32	0

Index	Subindex	Description Access permission Data type		Default		
60B2h	0	Reserved	RW	INT16	0	
60B8h	0	Probe control	RW	UINT16	0	
60B9h	0	Probe status	RO	UINT16	0	
60BAh	0	Probe position rising edge	g 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 C Related function codes

Name	Parameter description	Setting range	Default
Channel of running commands	0: Keypad 1: Terminal 2: Communication	0–2	0
Communication mode of running commands	0: Modbus/Modbus TCP communication 1: PROFIBUS/CANopen/DeviceNet communication 2: Ethernet communication 3: EtherCAT/PROFINET/EtherNet IP/PowerLink communication 4: Programmable card 5: Wireless communication card 6: USB (reserved) //Note: The options 1, 2, 3, 4, and 5 are add-on functions and are available only when corresponding expansion cards are configured.	0-6	0
Setting channel of A	0: Keypad digital	0-15	0
frequency command Setting channel of B frequency command	1: Al1 2: Al2 3: Al3 4: High-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 7: PID control 8: Modbus/Modbus TCP communication 9: PROFIBUS/CANopen/DeviceNet communication 10: Ethernet communication 11: High-speed pulse HDIB 12: Pulse train AB 13: EtherCAT/PROFINET/EtherNet	0-15	15
	Name Channel of running commands Communication mode of running commands Setting channel of A frequency command Setting channel of B frequency command	NameParameter descriptionChannel of running commands0: Keypad 1: Terminal 2: Communication0: Modbus/Modbus TCP communication0: Modbus/Modbus TCP communication1: PROFIBUS/CANopen/DeviceNet communication1: PROFIBUS/CANopen/DeviceNet communication2: Ethernet communication 3: EtherCAT/PROFINET/EtherNet IP/PowerLink communication card 6: USB (reserved) #Note: The options 1, 2, 3, 4, and 5 are add-on functions and are available only when corresponding expansion cards are configured.Setting channel of A frequency command frequency command frequency command Firequency command Setting channel of B frequency command fies thigh-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 7: PID control 8: Modbus/Modbus TCP communication 9: PROFIBUS/CANopen/DeviceNet communication 10: Ethernet communication 11: High-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 7: PID control 8: Modbus/Modbus TCP communication 10: Ethernet communication 11: High-speed pulse HDIA 5: Simple PLC PROFINET/EtherNet IP/D controlSetting channel of B frequency command firequency command <b< td=""><td>NameParameter descriptionSetting rangeChannel of running commands0: Keypad 1: Terminal 2: Communication0-20: Modbus/Modbus TCP communication0-20: Modbus/Modbus TCP communication01: PROFIBUS/CANopen/DeviceNet communication02: Ethernet communication 3: EtherCAT/PROFINET/EtherNet0P/PowerLink communication 3: EtherCAT/PROFINET/EtherNet0P/PowerLink communication card 6: USB (reserved)0Note: The options 1, 2, 3, 4, and 5 are add-on functions and are available only when corresponding expansion cards are configured.0Setting channel of A frequency command0: Keypad digital 1: Al102: Al2 3: Al34: High-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 7: PID control0Setting channel of B frequency command8: Modbus/Modbus TCP communication 10: Ethernet communication 10: Ethernet communication 10: Ethernet communication 11: High-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 1: PID control 8: Modbus/Modbus TCP communication 10: Ethernet communication 11: High-speed pulse HDIB 12: Pulse train AB 13: EtherCAT/PROFINET/EtherNet 13: EtherCAT/PROFINET/EtherNet 13: EtherCAT/PROFINET/EtherNet</td></b<>	NameParameter descriptionSetting rangeChannel of running commands0: Keypad 1: Terminal 2: Communication0-20: Modbus/Modbus TCP communication0-20: Modbus/Modbus TCP communication01: PROFIBUS/CANopen/DeviceNet communication02: Ethernet communication 3: EtherCAT/PROFINET/EtherNet0P/PowerLink communication 3: EtherCAT/PROFINET/EtherNet0P/PowerLink communication card 6: USB (reserved)0Note: The options 1, 2, 3, 4, and 5 are add-on functions and are available only when corresponding expansion cards are configured.0Setting channel of A frequency command0: Keypad digital 1: Al102: Al2 3: Al34: High-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 7: PID control0Setting channel of B frequency command8: Modbus/Modbus TCP communication 10: Ethernet communication 10: Ethernet communication 10: Ethernet communication 11: High-speed pulse HDIA 5: Simple PLC program 6: Multi-step speed running 1: PID control 8: Modbus/Modbus TCP communication 10: Ethernet communication 11: High-speed pulse HDIB 12: Pulse train AB 13: EtherCAT/PROFINET/EtherNet 13: EtherCAT/PROFINET/EtherNet 13: EtherCAT/PROFINET/EtherNet

Function code	Name	Parameter description	Setting range	Default
		14: Programmable card 15: Reserved		
P00.11	ACC time 1	0.0–3600.0s	0.0-3600.0	Model depended
P00.12	DEC time 1	0.0–3600.0s	0.0-3600.0	Model depended
P03.11	Torque setting method selection	0: Keypad (P03.12) 1: Keypad (P03.12) 2: Al1 3: Al2 4: Al3 5: Pulse frequency HDIA 6: Multi-step torque 7: Modbus/Modbus TCP communication 8: PROFIBUS/CANopen/DeviceNet communication 9: Ethernet communication 10: Pulse frequency HDIB 11: EtherCAT/PROFINET/EtherNet IP/PowerLink communication 12: Programmable card	0-12	0
P03.14	Setting source of forward rotation frequency upper limit in torque control	0: Keypad (P03.16) 1: Al1 (100% corresponding to the max. frequency) 2: Al2 (same as the above) 3: Al3 (same as the above) 4: Pulse frequency HDIA (same as the above) 5: Multi-step setting (same as the above) 6: Modbus/Modbus TCP communication (same as the above) 7: PROFIBUS/CANopen/DeviceNet communication (same as the above)	0-12	0

Function code	Name	Parameter description	Setting range	Default
		8: Ethernet communication (same as the above) 9: Pulse frequency HDIB 10: EtherCAT/PROFINET/EtherNet IP/PowerLink communication (same as the above) 11: Programmable card (Same as the above) 12: Reserved		
P03.15	Setting source of reverse rotation upper-limit frequency in torque control	0: Keypad (P03.17) 1: Al1 (100% corresponding to the max. frequency) 2: Al2 (same as the above) 3: Al3 (same as the above) 4: Pulse frequency HDIA (same as the above) 5: Multi-step setting (same as the above) 6: Modbus/Modbus TCP communication (same as the above) 7: PROFIBUS/CANopen/DeviceNet communication (same as the above) 8: Ethernet communication (same as the above) 9: Pulse frequency HDIB (same as the above) 10: EtherCAT/PROFINET/EtherNet IP/PowerLink communication (same as the above) 11: Programmable card (Same as the above) 12: Reserved	0-12	0
P03.18	Setting source of electromotive torque upper limit	0: Keypad (P03.20) 1: Al1 2: Al2	0-11	0

Function code	Name	Parameter description	Setting range	Default
		3: AI3 4: Pulse frequency HDIA 5: Modbus/Modbus TCP communication 6: PROFIBUS/CANopen/DeviceNet communication 7: Ethernet communication 8: Pulse frequency HDIB 9: EtherCAT/PROFINET/EtherNet IP/PowerLink communication 10: Programmable card 11: Reserved		
P03.19	Setting source of braking torque upper limit	0: Keypad (P03.21) 1: Al1 2: Al2 3: Al3 4: Pulse frequency HDIA 5: Modbus/Modbus TCP communication 6: PROFIBUS/CANopen/DeviceNet communication 7: Ethernet communication 8: Pulse frequency HDIB 9: EtherCAT/PROFINET/EtherNet IP/PowerLink communication 10: Programmable card 11: Reserved	0-11	0
P04.27	Voltage setting channel selection	0: Keypad (The output voltage is determined by P04.28.) 1: Al1 2: Al2 3: Al3 4: HDIA 5: Multi-step speed running (The setting is determined by related parameters in group P10.) 6: PID	0-13	0

Function code	Name	Parameter description	Setting range	Default
		7: Modbus/Modbus TCP communication 8: PROFIBUS/CANopen/DeviceNet communication 9: Ethernet communication 10: HDIB 11: PROFINET/EtherNet IP communication 12: Programmable card 13: Reserved		
P06.01	Y1 output	0: Invalid	0-63	0
P06.02	HDO output	1: Running	0-63	0
P06.03	RO1 output	2: Running forward	0-63	1
P06.04	RO2 output	 A: Jogging 4: Jogging 5: VFD in fault 6: Frequency level detection FDT1 7: Frequency level detection FDT2 8: Frequency reached 9: Running in zero speed 10: Frequency upper limit reached 11: Frequency lower limit reached 12: Ready for running 13: Pre-exciting 14: Overload pre-alarm 15: Underload pre-alarm 16: Simple PLC stage completed 17: Simple PLC cycle completed 18: Set counting value reached 19: Designated counting value reached 20: External fault is valid 21: Reserved 22: Running time reached 23: Modbus/ Modbus TCP communication virtual terminal 	0–63	5

Function code	Name	Parameter description	Setting range	Default
		output		
		24:		
		PROFIBUS/CANopen/DeviceNet		
		communication virtual terminal		
		output		
		25: Ethernet communication		
		virtual terminal output		
		26: DC bus voltage established		
		27: Z pulse output		
		28: Superposing pulses		
		29: STO action		
		30: Positioning completed		
		31: Spindle zeroing completed		
		32: Spindle indexing completed		
		33: Reserved		
		34: EtherCAT/PROFINET/EtherNet		
		IP/PowerLink communication		
		virtual terminal output		
		35: Reserved		
		36: Speed/position control		
		switchover completed		
		37: Any frequency reached		
		38–40: Reserved		
		41: Y1 from the programmable		
		card		
		42: Y2 from the programmable		
		card		
		43: HDO from the programmable		
		card		
		44: RO1 from the programmable		
		card		
		45: RO2 from the programmable		
		card		
		46: RO3 from the programmable		
		card		
		41: RO4 from the programmable		
		card		

Function code	Name	Parameter description	Setting range	Default
		48: IO card detected PT100 OH pre-alarm 49: IO card detected PT1000 OH pre-alarm 50: AIAO detected OT pre-alarm 51: Stopped or running in zero speed 52: Tension control disconnection 53: Specified roll diameter reached 54: Roll diameter of stop reached 55: Length reached 56: Fire mode enabled	Tunge	
		57–63: Reserved		
P06.14	AO1 output	0: Running frequency	0-63	0
P06.16	HDO high-speed pulse output	1: Set frequency 2: Ramp reference frequency 3: Rotational speed (100% corresponds to the speed corresponding to the max. output frequency) 4: Output current (100% corresponds to twice the VFD rated current) 5: Output current (100% corresponds to twice the motor rated current) 6: Output voltage (100% corresponds to 1.5 times the VFD rated voltage) 7: Output power (100% corresponds to twice the motor rated power) 8: Set torque (100% corresponds to twice the motor rated torque) 9: Output torque (Absolute value, 100% corresponds to twice the	0-63	0

Function code	Name	Parameter description	Setting range	Default
		motor rated torque)		
		10: Al1 input		
		11: Al2 input		
		12: AI3 input		
		13: HDIA input value		
		14: Value 1 set through		
		Modbus/Modbus TCP		
		communication		
		15: Value 2 set through		
		Modbus/Modbus TCP		
		communication		
		16: Value 1 set through		
		PROFIBUS/CANopen/DeviceNet		
		communication		
		17: Value 2 set through		
		PROFIBUS/CANopen/DeviceNet		
		communication		
		18: Value 1 set through Ethernet		
		communication		
		19: Value 2 set through Ethernet		
		communication		
		20: HDIB input value		
		21: Value 1 set through		
		EtherCAT/PROFINET/EtherNet IP		
		communication		
		22: Torque current (100%		
		corresponds to triple the motor		
		rated current)		
		23: Exciting current (100%		
		corresponds to triple the motor		
		rated current)		
		24: Set frequency (bipolar)		
		25: Ramp reference frequency		
		(bipolar)		
		26: Rotational speed of running		
		(bipolar)		
		27: Value set through		

Function code	Name	Parameter description	Setting range	Default
code		EtherCAT/PROFINET/EtherNet IP communication 28: AO1 from the programmable card 29: AO2 from the programmable card 30: Rotational speed of running (100% corresponds to the speed at twice the motor rated frequency) 31: Output torque (Actual value,	range	
		100% corresponds to twice the motor rated torque) 32: AIAO detected temperature output 33: Set tension output		
		34–63: Reserved		
P07.27	Present fault type	0: No fault		
P07.28	Last fault type	0: No fault		
P07.29	2nd-last fault type	1: Inverter unit U-phase		
P07.30	3rd-last fault type	protection (OUt1)		
P07.31	4th-last fault type	2: Inverter unit V-phase		
P07.32	5th-last fault type	protection (OUt2) 3: Inverter unit W-phase protection (OUt3) 4: Overcurrent during ACC (OC1) 5: Overcurrent during DEC (OC2) 6: Overcurrent during constant speed running (OC3) 7: Overvoltage during ACC (OV1) 8: Overvoltage during DEC (OV2) 9: Overvoltage during constant speed running (OV3) 10: Bus undervoltage fault (UV) 11: Motor overload (OL1) 12: VFD overload (OL2) 13: Phase loss on input side (SPI)	/	1

Function code	Name	Parameter description	Setting range	Default
		14: Phase loss on output side		
		(SPO)		
		15: Rectifier module overheating		
		(OH1)		
		16: Inverter module overheating		
		(OH2)		
		17: External fault (EF)		
		18: Modbus/Modbus TCP		
		communication fault (CE)		
		19: Current detection fault (ItE)		
		20: Motor autotuning fault (tE)		
		21: EEPROM operation error (EEP)		
		22: PID feedback offline fault		
		(PIDE)		
		23: Braking unit fault (bCE)		
		24: Running time reached (END)		
		25: Electronic overload (OL3)		
		26: Keypad communication error		
		(PCE)		
		27: Parameter upload error (UPE)		
		28: Parameter download error		
		(DNE)		
		29: PROFIBUS communication		
		fault (E_dP)		
		30: Ethernet communication fault		
		(E-NEI)		
		31: CANopen communication		
		Tault (E-CAN)		
		32: TO-ground short-circuit lault 1		
		(EITI)		
		(ETUS)		
		(LIIIZ) 24: Speed doviation fault (dEv.)		
		35. Mal-adjustment fault (CTA)		
		36. Underload fault (LL)		
		37: Encoder disconnection fault		
		(ENC10)		

Function code	Name	Parameter description	Setting range	Default
		38: Encoder direction reversal		
		fault (ENC1D)		
		39: Encoder Z-pulse		
		disconnection fault (ENC1Z)		
		40: Safe torque off (STO)		
		41: Exception to safety circuit of		
		channel 1 (STL1)		
		42: Exception to safety circuit of		
		channel 2 (STL2)		
		43: Exception in both channels 1		
		and 2 (STL3)		
		44: Safety code FLASH CRC fault		
		(CrCE)		
		45: Programmable card		
		customized fault 1 (P-E1)		
		46: Programmable card		
		customized fault 2 (P-E2)		
		47: Programmable card		
		customized fault 3 (P-E3)		
		48: Programmable card		
		customized fault 4 (P-E4)		
		49: Programmable card		
		customized fault 5 (P-E5)		
		50: Programmable card		
		customized fault 6 (P-E6)		
		51: Programmable card		
		customized fault 7 (P-E7)		
		52: Programmable card		
		customized fault 8 (P-E8)		
		53: Programmable card		
		customized fault 9 (P-E9)		
		54: Programmable card		
		customized fault 10 (P-E10)		
		55: Duplicate expansion card type		
		(E-Err)		
		56: Encoder UVW lost (ENCUV)		
		57: PROFINET communication		

Function code	Name	Parameter description	Setting range	Default
		timeout fault (E-PN)		
		58: CAN communication timeout		
		fault (SECAN)		
		59: Motor overtemperature fault		
		(OT)		
		60: Failure to identify the card in		
		slot 1 (F1-Er)		
		61: Failure to identify the card in		
		slot 2 (F2-Er)		
		62: Failure to identify the card in		
		slot 3 (F3-Er)		
		63: Communication timeout of		
		the card in slot 1 (C1-Er)		
		64: Communication timeout of		
		the card in slot 2 (C2-Er)		
		65: Communication timeout of		
		the card in slot 3 (C3-Er)		
		66: EtherCAT communication		
		timeout fault (E-CAT)		
		67: BACnet communication		
		timeout fault (E-BAC)		
		68: DeviceNet communication		
		timeout fault (E-DEV)		
		69: CAN slave fault in		
		master/slave synchronization		
		(S-Err)		
		70: EC PT100 detected OH (OtE1)		
		71: EC PT1000 detected OH (OtE2)		
		72: EtherNet IP communication		
		timeout fault (E-EIP)		
		73: No upgrade bootload (E-PAO)		
		74: Al1 disconnection (E-Al1)		
		75: AI2 disconnection (E-AI2)		
		76: AI3 disconnection (E-AI3)		
		77–80: Reserved		
		81: Tension communication		
		timeout fault (E-tC)		

Function code	Name	Parameter description	Setting range	Default
		82: PowerLink communication timeout fault (E-EPL)		
P08.31	Channel for switching between motor 1 and motor 2	Ones place: Switchover channel 0: Switch over through terminals 1: Modbus/Modbus TCP communication 2: PROFIBUS/CANopen/DeviceNet communication 3: Ethernet communication 4: EtherCAT/PROFINET/EtherNet IP communication Tens place: indicates whether to enable switchover during running 0: Disable 1: Enable	0x00-0x14	0x00
P09.00	PID reference source selection	0: Setting through P09.01 1: Al1 2: Al2 3: Al3 4: High-speed pulse HDIA 5: Multi-step running 6: Modbus/Modbus TCP communication 7: PROFIBUS/CANopen/DeviceNet communication 8: Ethernet communication 9: High-speed pulse HDIB 10: PROFINET/EtherNet IP communication 11: Programmable card 12: Reserved	0-12	0
P09.02	PID feedback source selection	0: AI1 1: AI2 2: AI3 3: High-speed pulse HDIA 4: Modbus/Modbus TCP communication	0-10	0

Function code	Name	Parameter description	Setting range	Default
		5: PROFIBUS/CANopen/DeviceNet communication 6: Ethernet communication 7: High-speed pulse HDIB 8: PROFINET/EtherNet IP communication 9: Programmable card 10: Reserved		
P14.00	Local communication address	1–247	1–247	1
P14.03	Communication response delay	1–200ms	1-200	5ms
P14.05	Transmission fault 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	Ones place: 0: Respond to write operations 1: Not respond to write operations Tens place: 0: Communication user password protection is invalid. 1: Communication user password protection is valid. Hundreds place: 0: User-defined addresses specified by P14.07 and P14.08 are invalid.	0x000- 0x111	0x000

Function code	Name	Parameter description	Setting range	Default
		1: User-defined addresses specified by P14.07 and P14.08 are valid.		
P14.09	Modbus TCP communication timeout time	0.0 (invalid)–60.0s	0.0–60.0	0.0s
P15.43	Communication control word expression format	0: Decimal format 1: Binary format	0-1	0
P16.00	Expansion card protocol selection	0: PROFINET 1: EtherCAT 2: PowerLink 3: EtherNet IP 4: Modbus TCP 5: EtherNet UDP 6: PROFINET+EtherNet UDP 7: EtherCAT+EtherNet UDP 8–15: Reserved	0–15	0
P16.14	Ethernet card monitoring variable address 1	0x0000-0xFFFF	0x0000- 0xFFFF	0x0000
P16.15	Ethernet card monitoring variable address 2	0x0000-0xFFFF	0x0000- 0xFFFF	0x0000
P16.16	Ethernet card monitoring variable address 3	0x0000-0xFFFF	0x0000– 0xFFFF	0x0000
P16.17	Ethernet card monitoring variable address 4	0x0000-0xFFFF	0x0000- 0xFFFF	0x0000
P16.24	Time to identify expansion card in card slot 1	0.0–600.0s The value 0.0 indicates that identification fault will not be detected.	0.0-600.00	0.0s
P16.25	Time to identify expansion card in card slot 2	0.0–600.0s The value 0.0 indicates offline fault will not be detected.	0.0-600.00	0.0s

Function code	Name	Parameter description	Setting range	Default
P16.26	Time to identify expansion card in card slot 3	0.0–600.0s The value 0.0 indicates offline fault will not be detected.	0.0-600.0	0.0s
P16.27	Communication timeout time of expansion card in card slot 1	0.0–600.0s The value 0.0 indicates offline fault will not be detected.	0.0–600.0	0.0s
P16.28	Communication timeout time of expansion card in card slot 2	0.0–600.0s The value 0.0 indicates offline fault will not be detected.	0.0–600.0	0.0s
P16.29	Communication timeout time of expansion card in card slot 3	0.0–600.0s The value 0.0 indicates offline fault will not be detected.	0.0-600.0	0.0s
P16.31	PROFINET communication timeout time	0.0 (invalid)–60.0s	0.0-60.0	5.0s
P16.32	Received PZD2	0: Invalid	0-31	0
P16.33	Received PZD3	1: Set frequency (0–Fmax, unit:	0-31	0
P16.34	Received PZD4	0.01Hz)	0-31	0
P16.35	Received PZD5	2: PID reference (-1000–1000, in	0-31	0
P16.36	Received PZD6	which 1000 corresponds to	0-31	0
P16.37	Received PZD7	100.0%)	0-31	0
P16.38	Received PZD8	3: PID feedback (-1000–1000, in	0-31	0
P16.39	Received PZD9	which 1000 corresponds to	0-31	0
P16.40	Received PZD10	100.0%)	0-31	0
P16.41	Received PZD11	4: Torque setting (-3000–+3000, In	0-31	0
P16.42	Received PZD12	100.0% of the motor rated current) 5: Setting of the upper limit of forward running frequency (0–Fmax, unit: 0.01Hz) 6: Setting of the upper limit of reverse running frequency (0–Emax, unit: 0.01Hz)	0–31	0
Function code	Name	Parameter description	Setting range	Default
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		7: Upper limit of the	Ø	
		electromotive torque (0–3000, in		
		which 1000 corresponds to		
		100.0% of the motor rated		
		current)		
		8: Upper limit of braking torque		
		(0–3000, in which 1000		
		corresponds to 100% of the		
		motor rated current)		
		9: Virtual input terminal		
		command (range: 0x000–0x3FF,		
		with bit 9–bit 10 corresponding to		
		S8/S7/S6/S5/HDIB/HDIA/S4/S3/S		
		2/S1 in sequence)		
		10: Virtual output terminal		
		command (range: 0x00–0x0F,		
		bit3-bit0 corresponding to		
		RO2/RO1/HDO/Y1 in sequence)		
		11: Voltage setting (special for V/F		
		separation)		
		(0–1000, in which 1000		
		corresponds to 100.0% of the		
		motor rated voltage)		
		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: High bit of position reference		
		(signed)		
		15: Low bit of position reference		
		(unsigned)		
		16: High bit of position feedback		
		(signed)		
		17: Low bit of position feedback		
		(unsigned)		

Function code	Name	Parameter description	Setting range	Default
		18: Position feedback setting flag (position feedback can be set only after this flag is set to 1 and then to 0) 19: Function parameter mapping (PZD2–PZD12 correspond to P14.49–P14.59) 20-31: Peranued		
P16 43	Sent P7D2	0: Invalid	0-47	0
P16.44	Sent PZD3	1: Running frequency (×100 Hz)	0-47	0
P16.45	Sent PZD4	2: Set frequency (×100, Hz)	0-47	0
P16.46	Sent PZD5	3: Bus voltage (×10, V)	0-47	0
P16.47	Sent PZD6	4: Output voltage (×1, V)	0-47	0
P16.48	Sent PZD7	5: Output current (×10, A)	0-47	0
P16.49	Sent PZD8	6: Actual output torque (×10, %)	0-47	0
P16.50	Sent PZD9	7: Actual output power (×10, %)	0-47	0
P16.51	Sent PZD10	8: Rotation speed of running (×1,	0-47	0
P16.52	Sent PZD11	RPM)	0-47	0
P16.53	Sent PZD12	9: Linear speed of running (×1, m/s) 10: Ramp reference frequency 11: Fault code 12: Al1 input (×100, V) 13: Al2 input (×100, V) 14: Al3 input (× 100, V) 15: HDIA frequency value (×1000, kHz) 16: Terminal input status 17: Terminal output status 18: PID reference (×10, %) 19: PID feedback (×10, %) 20: Invalid 21: High bit of position reference (signed) 22: Low bit of position reference (unsigned) 23: MSB of position feedback	0-47	0

Function code	Name	Parameter description	Setting range	Default
		(signed) 24: LSB of position feedback (unsigned) 25: Status word 26: HDIB frequency value (×1000, kHz) 27: PG card pulse feedback count high bit 28: PG card pulse feedback count low bit 29: PG card pulse reference count MSB 30: PG card pulse reference count LSB 31: Function parameter mapping (PZD2–PZD12 correspond to P14.60–P14.70) 32: Status word 3 33–47: Reserved		
P16.54	EtherNet IP communication timeout time	0.0–60.0s	0.0–60.0	5.0s
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	0–255	0-255	255

Function code	Name	Parameter description	Setting range	Default
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
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	Saving EtherCAT written function codes	0: No 1: Yes	0-1	0
P16.72	EtherCAT input unit selection	0: Input rotation speed unit is PRM 1: Input rotation speed unit is plus/s	0-1	0
P16.73	EtherCAT slave node address	0x0000–0xFFFF	0x0000– 0XFFFF	0xFFFF
P16.74	EtherCAT-DC synchronization cycle (reserved)	0–1: Reserved 2: 1ms 3: 2ms 4–5: Reserved	0–5	0
P16.75	EtherCAT communication timeout time	0.0–60.0s	0.0-60.0	5.0s

Function code	Name	Parameter description	Setting range	Default
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
P16.78	PowerLink slave station address	0x00–0xFF	0x00–0xFF	0x01
P16.79	PowerLink communication timeout time	0.0–60.0s	0.0–60.0	5.0s
P19.00	Type of expansion card in slot 1	0: No card 1: PLC card	0-50	0
P19.01	Type of expansion card in slot 2	2: I/O card 3: Incremental PG card 4: Incremental PG card with UVW 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 (reserved) 15: CAN master/slave communication card	0–50	0
P19.02	Type of expansion card in slot 3		0-50	0

Function code	Name	Parameter description	Setting range	Default
		16: Modbus TCP communication		
		card		
		17: EtherCAT communication		
		card		
		18: BACnet communication card		
		(reserved)		
		19: DeviceNet communication		
		card (reserved)		
		20: PT100/PT1000 temperature		
		detection card		
		21: EtherNet IP card		
		22: MECHATROLINK card		
		(reserved)		
		23–25: Reserved		
		26: PROFINET+Ethernet		
		communication card		
		27–35: Reserved		
		36: All-in-one expansion		
		card—PROFINET communication		
		card		
		37: Reserved		
		38: PowerLink communication		
		card		
		39–40: Reserved		
		41: All-in-one expansion		
		card—EtherCAT communication		
		card		
		42: All-in-one expansion		
		card—PowerLink communication		
		card		
		43: All-in-one expansion		
		card—EtherNet IP		
		communication card		
		44: All-in-one expansion		
		card—Modbus TCP		
		communication card		
		45: All-in-one expansion		

Function code	Name	Parameter description	Setting range	Default
		card—Ethernet communication		
		card		
		46: All-in-one expansion		
		card—PROFINET + EtherNet UDP		
		communication card		
		47: All-in-one expansion		
		card—EtherCAT + EtherNet UDP		
		communication card		
		48–50: Reserved		
P21.20	Positioning ACC time	0.00–300.00s	0.00-300.00	3.00s
P21.21	Positioning DEC time	0.00–300.00s	0.00-300.00	3.00s

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