INOVANCE



GR10-2HCE EtherCAT Slave Counter Module User Guide

19011104A04

Overview

Thank you for purchasing the GR10 series EtherCAT slave counter module developed and manufactured independently by Inovance.

This is an expansion module based on the EtherCAT bus communication and supports 2-channel single-ended (or differential) pulse input. The module is designed to count phase A/B (1x, 2x, 4x), pulse+ direction, and CW/CCW pulses at a frequency of up to 2 Mhz (GR10-2HCE-2M). Each channel includes two high-speed inputs (probe function), two high-speed outputs (comparison output), two common inputs, and one common output. The module can be used as an encoder shaft to read the position and speed data, and also as a general counter to read the number of pulses or other data. This guide mainly covers the specifications, features, and instructions for use of the module. Before using the product, read this guide carefully to fully understand and ensure the safe use. The latest version of the guide can be available from the Inovance website (www.inovance.com).

Fundamental Safety Instructions

Safety Disclaimer

1. Read and comply with the safety instructions during installation, operation, and maintenance of the product.
2. To ensure the safety of humans and the products, follow the marks on the products and all the safety instructions in this document.
3. The "CAUTION", "WARNING", and "DANGER" are only supplements to the safety instructions.
4. Use this product according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
5. Inovance shall take no responsibility for any personal injury or property damage caused by improper use.

Safety Levels and Definitions

DANGER indicates that failure to comply with the notice will result in death or severe injury.

WARNING indicates that failure to comply with the notice may result in death or severe injury.

CAUTION indicates that failure to comply with the notice may result in minor or moderate injury, or equipment damage.

Unpacking

WARNING

- Do not install the product in case of any damage, rust, or signs of use on the product or accessories upon unpacking.
- Do not install the product in case of water seepage into the product or missing or damaged components upon unpacking.
- Do not install the product in the case of any discrepancy between the product you received and the product name on the packing list.

CAUTION

- Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package by following the unpacking sequence. Do not strike the package violently.Once the CPU of the PLC detects an exception in the system, all outputs may be closed. When a fault occurs in the controller circuit, the output may not be under control. Therefore, it is necessary to set up an external control circuit to ensure normal operation.
- Check for damage, rust, or dents on the surfaces of the product and accessories upon unpacking.
- After unpacking, check the contents against the packing list to ensure that the equipment and accessories are in the correct quantities, and that all documentation is complete.

Storage and transpostation

WARNING

- Large or heavy equipment must be handled by qualified professionals using specialized hoisting equipment. Failure to comply could result in personal injury or equipment damage.
- Before hoisting the equipment, ensure that components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injury or equipment damage.
- Never stand or stay under the equipment while it is being hoisted.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply could result in personal injury or equipment damage.

CAUTION

- Handle the equipment with care during transportation and mind your step to prevent personal injury or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply could result in personal injury.
- Do not store or transport the equipment in locations where the equipment may be exposed to splashing water or rain, direct sunlight, strong electric field, strong magnetic field, or strong vibration.
- Store the equipment for up to three months. Take stricter protective measures and carry out the necessary inspections for a longer storage time.
- Pack the equipment securely and properly before transportation. Use a fully enclosed container for long-distance transportation.
- Never transport the equipment with other devices or items that could impact or cause harm to the equipment.

Design

DANGER

- Provide a safety circuit and include an error handling program in the software to ensure that the product remains in a safe state in case of an external power failure or an internal fault.
- If a sustained overcurrent occurs due to overload or load short circuit, the product may smoke or catch fire. An external safety device (such as a fuse or circuit breaker) must be installed.

WARNING

- Any damaged output components such as relays or transistors in this product may result in uncontrolled output that stays in a constant ON or OFF state.
- The product design must comply with the overvoltage category requirements specified in the Environmental Specifications. The system-level power supply must have a lightning protection device, assuring that overvoltage due to lightning shock is not applied to the controller's terminals such as power supply input terminals, signal input terminals, and control output terminals, to prevent damage to the product.
- Ensure that appropriate actions have been taken to prevent product malfunction caused by a communication fault between the product and related devices. Failure to comply could cause personal injury or equipment damage.

CAUTION

- Switches that could cause personal injury or equipment damage cannot be configured on the touch screen. Use independent switches for performing critical operations. Failure to comply could result in accidents caused by wrong outputs or faults.

Installation

DANGER

- This equipment must be operated only by trained and qualified electrical personnel.

WARNING

- Read through the guide and safety instructions before installation.
- Do not install this equipment in places with strong electric or magnetic field.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply may result in mechanical hazards.
- Before installation, ensure that the installation site meets the required environmental conditions. Failure to comply could result in equipment damage.
- Do not wear loose clothes or accessories during installation. Failure to comply could result in electric shock.
- When installing the equipment in an enclosed environment (such as a cabinet or case), use cooling devices (such as fans or air conditioners) to cool the space and meet the installation environment requirements. Failure to do so could result in equipment overheating or fire.
- Do not modify this equipment.
- Never loosen the fixing bolts on components and modules, or any bolts marked in red.
- This equipment must be installed inside an indoor cabinet or terminal equipment. The cabinet or terminal equipment itself must be provided with the necessary protective enclosures, such as a fireproof enclosure, an electrical protective enclosure, and a mechanical protective enclosure. The IP rating of these enclosures must comply with the relevant IEC standards, and applicable local laws and regulations.
- Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for this equipment to prevent malfunction.
- Install the equipment onto a non-combustible object such as metal. Keep the equipment away from combustible objects. Failure to comply may result in fire.
- For products not supporting hot swapping, disconnect all external power supplies of the system before installing/removing the product. Failure to comply could result in electric shock, product failure, or malfunction.

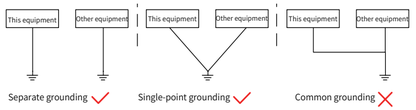
CAUTION

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the product and causing faults. After installation, remove the cloth or paper for effective ventilation and cooling.
- During installation, ensure the equipment is connected to the respective connector securely and hook the equipment firmly. Improper installation may cause the equipment malfunction, failure, or loosening.

Wiring

DANGER

- This equipment must be operated only by trained and qualified electrical personnel. Non-professionals cannot operate this equipment.
- Before wiring, disconnect all the power supplies of the equipment. Wait for at least the time designated on the warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply could result in electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply could result in electric shock.
- Ensure that the equipment is grounded properly. Failure to comply could result in electric shock. Ground the equipment separately or to a single point. Common grounding cannot be used.



- Insulate the cable terminals properly to ensure the insulation distance between cables will not be shortened after cables are connected to the terminal block. Failure to comply could result in electric shock or equipment damage.
- Install the terminal cover attached to the equipment before power-on or operation after wiring is completed. Failure to comply could result in electric shock

WARNING

- Never connect the power cable to output terminals of the equipment. Failure to comply could cause equipment damage or even fire.
- Cables used for wiring must comply with the requirements for the cross-sectional area and shielding. The shielding layer of the shielded cable must be reliably grounded at one end.
- Tighten the terminal screws with the torque specified in the user guide. Insufficient or excessive torque may cause overheating and damage of the joint, which could result in fire.
- After wiring is done, ensure that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply could result in electric shock or equipment damage.

CAUTION

- Follow the proper electrostatic discharge (ESD) procedure, and wear an anti-static wrist strap to perform wiring. Failure to comply could damage the equipment or its internal circuits.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply will result in equipment malfunction.

Power-on

DANGER

- This equipment must be operated only by trained and qualified electrical personnel.Before power-on, ensure that the equipment is installed and wired properly.
- Ensure that the power supply meets equipment requirements before power-on to prevent equipment damage or fire accident.
- Do not open the cabinet door or protective cover of the product, touch any wiring terminal of the product, or remove any components or parts while the product is powered on. Failure to comply could result in personal injury or even death.

WARNING

- Perform a trial run after wiring to ensure the equipment operates safely. Failure to comply could result in personal injury or equipment damage.

Operation

DANGER

- The equipment must be operated only by professionals. Failure to comply can result in injury or death.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply could result in electric shock.

WARNING

- Do not touch the enclosure, fan, or resistor with bare hands. Failure to comply could result in burns.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply could result in fire or equipment damage.
- During operation, do not bring live parts into contact with the metal enclosure of the product. Failure to comply could result in fire or product damage.

CAUTION

- Operate the equipment within the specified environmental conditions. Failure to comply could result in equipment failure or damage.
- Touch the HMI panel with hands only. Failure to comply could cause panel damage, which is out of the warranty range.

Safety recommendations

- In positions where the operator directly touches the mechanical components, for example, where a mechanical device is loaded/unloaded, or where a machine runs automatically, manually-operated devices or other alternative means must be carefully designed so that they are independent of the product to start or stop the automatic operation of the system.
- If you need to modify the program while the system is running, use the lock function or other protective measures. Ensure that only authorized personnel can make the necessary modifications.

Battery Usage

WARNING

- Do not use batteries that do not meet the product requirements. Failure to comply could result in death, personal injury, explosion, or fire.
- Do not throw batteries into a fire or heat oven. Do not crush or cut the battery. Failure to comply could result in death, personal injury, explosion, or fire.
- Do not expose the battery to extremely high temperatures. Failure to comply could result in death, personal injury, explosion, or fire.
- Do not swallow batteries. Failure to comply could result in chemical burns.
- Seek for medical treatment immediately if a button battery is swallowed by accident, because this may cause severe internal burns within two hours and even death.

CAUTION

- Keep batteries out of reach of children.
- If the battery compartment is not securely closed, stop using the product immediately and keep it out of reach of children.

Maintenance

DANGER

- Maintenance must be performed only by trained and qualified electrical personnel.
- Do not maintain the equipment with power ON. Failure to comply could result in electric shock.
- Before maintenance, disconnect all the power supplies of the equipment and wait for at least the time specified on the warning label.
- Disconnect all external power supplies of the system before cleaning the equipment or re-tightening screws on the terminal block or screws of the connectors. Failure to comply could result in electric shock.
- Disconnect all external power supplies of the system before removing or installing the product, or connecting or disconnecting cables. Failure to comply could result in electric shock or malfunction.

WARNING

- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair

DANGER

- Repair must be performed only by trained and qualified electrical personnel.
- Do not repair the equipment with power ON. Failure to comply could result in electric shock.
- Before inspection or repair, disconnect all the power supplies of the equipment and wait for at least the time specified on the warning label.

WARNING

- Submit a request for repair based on the warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage circuit breaker (ELCB) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply could result in equipment damage, personal injury, or death.
- Troubleshooting and repair of a faulty or damaged equipment must be performed by professionals based on the repair instructions, with the repair records kept properly.
- Replace quick-wear parts of the equipment according to the replacement instructions.
- Do not use damaged equipment. Failure to comply could result in death, personal injury, or severe equipment damage.
- Recheck the wiring and reset the parameters after equipment replacement.

Disposal

WARNING

- Dispose of the retired equipment in accordance with applicable national regulations and standards. Failure to comply could result in property damage, personal injury, or death.
- Recycle retired equipment in accordance with industry waste disposal standards to avoid environmental pollution.
- Treat the retired equipment as industrial waste. Dispose of used batteries according to local laws and regulations.

Safety Labels

To ensure safe operation, comply with safety labels on the equipment and do not damage or remove the labels. The following table describes the meanings of the safety labels.

Safety label	Description
	• Before using the equipment, read the guide and safety precautions carefully. Failure to comply could result in personal injury, death, or equipment damage. • Do not touch the terminals or remove the cover with power-on or within 10 min after power-off. Failure to comply could result in electric shock. • The surface of the running equipment may become very hot. Do not touch these hot areas. Failure to comply may cause burns.

Product Information

■ Model and nameplate

GR10-2HC E-2M

Code	Description
G	General module
R	Remote expansion module

Code	Series No.
10	Series 10

Code	Number of channels
2	2 channels

Code	Input frequency
Null	200kHz
2M	2MHz
zu	200kHz, customerized comparison input function

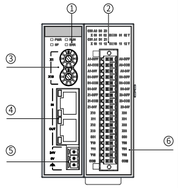
Code	Auxiliary function
E	EtherCAT communication

Code	Module type
HC	High-speed counter module



Model	Description	Code	Applicable device types
GR10-2HCE	EtherCAT slave 2-channel counter module (200 kHz)	01440072	All small and medium PLCs (supporting the basic comparison function in medium PLCs)
GR10-2HCE-2M	EtherCAT slave 2-channel counter module (200 MHz)	01440297R	
GR10-2HCE-ZG	EtherCAT slave 2-channel counter module(200 kHz, supporting the customized output comparison function)	01440933	All small and medium PLCs (supporting the basic comparison function in medium PLCs and advanced 1D and 2D comparison functions in small PLCs)

■ External terminals

Diagram	Terminal	Function definition				
	① Signal indicator	PWR	Power indicator	Green	Steady ON when the power supply is turned on	
		RUN	Operation indicator	Green	Steady ON when the module is functioning normally	
		SF	Fault indicator	Red	Steady ON when the module malfunctions	
		ERR	State machine error indicator	Red	Steady ON when an error occurs in the state machine	
	② I/O signal indicator	Indicates the input and output signals; steady ON for active input or output signals and OFF in the other cases				
	③ Address DIP switch	Slave address setting switch. ADDR1/ADDR0: address DIP switch; the address is set in hexadecimal format; decimal address of the slave = ADDR1*16+ADDR0*1 (Address: 1-255)				
	④ EtherCAT interface	X1 IN: EtherCAT input port				
		X2 OUT: EtherCAT output port for connecting the downstream EtherCAT slave				
	⑤ 24 V power supply	Module power input terminal				
	⑥ User output terminal	See the Electrical Design Reference section for details				

■ General specifications

Item	Specification
Power supply voltage	24 V DC (20.4 V DC to 28.8 V DC) (–15% to +20%); external power supply supported
Communication protocol with CPU module	EtherCAT; speed: 100 M
EtherCAT communication speed	Up to 100 M; adapt to the EtherCAT master communication speed
Network port/cable	Standard Ethernet port with standard Ethernet cables (Cat 5e cables)
Station number range	1–255; the internal addresses are automatically assigned according to the connection sequence of the network bus.

Performance indicator	Specification
Communication protocol	EtherCAT protocol
Service supported	CoE (PDO, SDO), FoE
Synchronization mode	Servo: distributed clock (DC); IO: synchronized input and output
Physical layer	100BASE-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Linear
Transmission medium	Network cables; see the Wiring section
Transmission distance	Less than 100 m between two nodes
EtherCAT frame length	44 to 1,498 bytes
Process data	Max. 1,486 bytes per Ethernet frame
Synchronous jitter of two slaves	< 1 μs

■ Input specifications

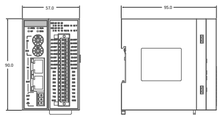
Item	Specification		
Signal type	High speed input signal (single-ended or differential input); see the following for details		Common input signal
Wiring method	Single-ended input	Differential input	--
Rated input voltage	24 V DC (+20% to –15%)	EIA standard RS-422-A Differential line drive level (equivalent to AM26LS31)	24 V DC (+20% to –15%)
Rated input current	7.3 mA (typical value @ 24 V DC)		5.6 mA (typical value @ 24 V DC)
ON current	5 mA or higher		3.5 mA or higher
OFF current	1.5 mA or lower		1.5 mA or lower
Input resistance	3.3 kΩ		4.3 kΩ
Max. input frequency	GR10-2HCE: 200 kHz GR10-2HCE-2M: 2 MHz		--
Least ideal duty cycle of 2-phase input	(40%: 60%) to (60%: 40%)		--
Common terminal mode	Each point has a separate common terminal.	--	A common terminal is shared by 4 points.

■ Output specifications

Item	Specification	
Signal name	High-speed output (comparison output)	Common output
	Sink output	Sink output
Voltage of control circuit	5 V DC to 24 V DC	5 V DC to 24 V DC
Rated load current	0.5 A/point	0.5 A/point
ON response time	1 μs	0.5 ms
OFF response time	1 μs	0.5 ms
Output frequency	200 kHz (external load of 20 mA or more is required when the output frequency is above 50 kHz)	--
Common terminal mode	A common terminal is shared by 3 points.	
Comparison output signal response speed	< 10 μs; this parameter is supported for GR10-2HCE-ZG only.	

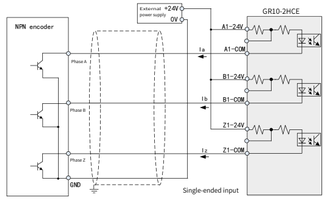
Mechanical Design

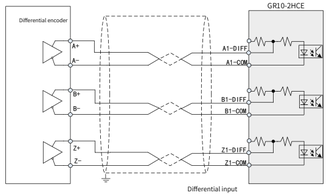
■ Installation dimensions (in mm)



Electrical Design

■ User terminal connection





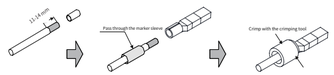
· Cable selection

Supporting material	Model	Cable diameter		Manufacturer	Crimping tool
		MM^2	AWG		
Tubular lug	GTVE07512	0.75	21	Suzhou Yuanli	YAC-5

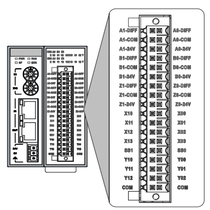
Those cable lugs are applicable to this module, and the rated temperature must be above 75°C.

■ Cable preparation

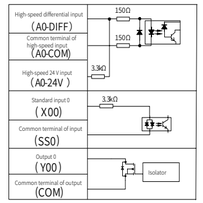
◆ Strip the cable insulation layer to expose 11–14 mm of copper, and then pass the cable through the cable marker sleeve.
◆ Insert the exposed conductor into the hole of the cable lug, and then crimp it with the crimping tool recommended by the cable lug manufacturer.



■ Terminal arrangement

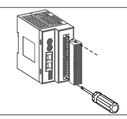
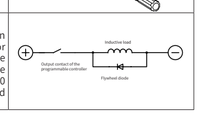


■ External wiring

External wiring			No.			Internal equivalent circuits
	Signal Column B			Signal Column A	External wiring	
	High-speed differential input (A1 DIFF)	2	1	High-speed differential input (A0-DIFF)		
	Common terminal of high-speed input (A1-COM)	4	3	Common terminal of high-speed input (A0-COM)		
	High-speed 24 V input (A1-24V)	6	5	High-speed 24 V input (A0-24V)		
	High-speed differential input (B1-DIFF)	8	7	High-speed differential input (B0-DIFF)		
	Common terminal of high-speed input (B1-COM)	10	9	Common terminal of high-speed input (B0-COM)		
	High-speed 24 V input (B1-24V)	12	11	High-speed 24 V input (B0-24V)		
	High-speed differential input (Z1-DIFF)	14	13	High-speed differential input (Z0-DIFF)		
	Common terminal of high-speed input (Z1-COM)	16	15	Common terminal of high-speed input (Z0-COM)		
	High-speed 24 V input (Z1-24V)	18	17	High-speed 24 V input (Z0-24V)		
	Standard input (X10 probe 1)	20	19	Standard input (X10 probe 1)		
	Standard input (X11 probe 2)	22	21	Standard input (X01 probe 2)		
	Standard input (X12 common input)	24	23	Standard input (X02 common input)		
	Standard input (X13 common input)	26	25	Standard input (X03 common input)		
	Common terminal of input (SS1)	28	27	Common terminal of input (SS0)		
	Output (Y10 high-speed comparison output 1)	30	29	Output (Y00 high-speed comparison output 1)		
	Output (Y11 high-speed comparison output 2)	32	31	Output (Y01 high-speed comparison output 2)		
	Output (Y12 common output)	34	33	Output (Y02 common output)		
	Common terminal of output (COM)	36	35	Common terminal of output (COM)		

* The first 10 input terminals of the module support high-speed input, among which the first 6 terminals support 24 V single-ended input or 5 V differential input, and the other 4 terminals support 24 V single-ended input.

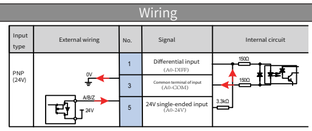
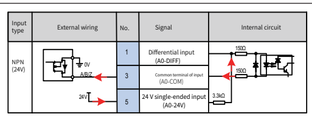
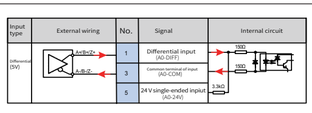
· Wiring precautions

After the IO terminal block is mounted to CN5, fix it with a torque of 0.2–0.25 N m, as shown in the right figure.	
Contact protection in the case of inductive load: Stopping an inductive load generates a high back electromotive force between contacts and produces arc discharge, which may result in contact failure or contact sag and shorten the contact lifetime. When necessary, a flywheel diode can be connected in parallel with the load to extend the product lifetime. The diode must satisfy the following requirements: ① The reverse voltage is 5 to 10 times of the on-load voltage; ② The forward current is larger than the on-load current.	

1) Do not bundle the terminal connection cables with power cables (high voltage, large current) and other cables that produce strong interference signals. Separate the terminal connection cables from power cables or other aforementioned cables and avoid cabling in parallel.
2) Select the recommended cables and adapter boards for connection. It is recommended to use shielded cables as terminal connection cables for increased anti-interference ability.

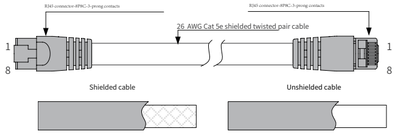
· Instances

The module supports input of high-speed single-ended and differential A, B, and Z signals. Perform wiring correctly before using the module. Take A0 as an example in the following table.

Example	Wiring
24 V input, PNP output	
24 V input, NPN output	
5 V input, differential output	

■ EtherCAT cable selection

· Network cable preparation



* Use the Cat 5e shielded twisted pair cables with iron shelled molded connector.

· Signal pin assignment

Pin	Signal	Direction	Description	Pin	Signal	Direction	Description
1	TD+	Output	Data transmission+	5	--	--	Not used
2	TD-	Output	Data transmission-	6	RD-	Input	Data reception-
3	RD+	Input	Data reception+	7	--	--	Not used
4	--	--	Not used	8	--	--	Not used

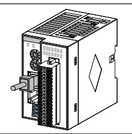
· Length requirements: According to FastEthernet technology, the length of an EtherCAT bus (if used) between the devices cannot exceed 100 m; otherwise, it can result in signal attenuation and thus affect normal communication.

· Technical requirements: 100% continuity test must be performed to eliminate the risks of short circuit, open circuit, miswiring, and improper contact. The shielded cable meeting the following specifications is recommended to be used as the EtherCAT bus for network data transmission.

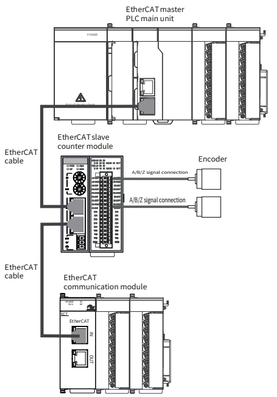
Item	Specification
Cable type	Flexible crossover cable, S-FTP, Cat 5e
Reference standards	EIA/TIA568A, EN50173, ISO/IEC11801 EIA/TI Abulletin TSB, EIA/TIA SB40-A&TSB36
Conductor type	Twisted pair
Number of pairs	4

■ Communication connection

Insert a RJ45 connector into the EtherCAT interface of the communication module until you hear a clicking sound.



· Communication system wiring



Note: Secure the cable near the equipment before communication to prevent other tensions being applied on the communication cable and ensure the communication stability.

■ Fault indication and troubleshooting for EtherCAT slave module

LED indicator		Description	Solution
RUN	Steady OFF	EtherCAT master and slave are in the initialization state.	Check the configuration and parameter assignment; check the communication address; Check whether the length and other specifications of the network cable are consistent with the recommended values.
	Flashing	EtherCAT slave is in a state other than OP	Check the slave configuration for any missing, faulty or unconfigured module.
ERR	Flashing	Communication error between EtherCAT master and slave	Check whether the parameter configurations of the master and slave are correct.
SF	Steady ON	An error occurs in the output channel	See the application guide of the module for details.