



GR10-1616ETNE

EtherCAT Slave I/O Module
User Guide



19011282A03

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Overview

Thank you for purchasing the GR10-1616ETNE EtherCAT communication slave I/O module developed and manufactured independently by Inovance.

This module is powered by an external 24 VDC power supply and supports EtherCAT communication with 16 digital NPN outputs and 16 digital inputs.

This guide describes the specifications, characteristics and usage instructions of the module. For proper and safe operation, please read this guide carefully before use. Visit our website (www.inovance.com) for the latest version of the guide.

Safety Instructions

- Safety disclaimer
- Before installation, operation, and maintenance, read through and comply with the safety instructions.
 - To ensure personal and equipment safety, follow all the safety instructions marked on the product and described in this guide.
 - The "CAUTION", "WARNING", and "DANGER" signs in this guide do not indicate all safety instructions; instead, they are only supplements to the safety instructions.
 - Use this product in an environment that meets the design specifications. Malfunctions or damage caused by failure to follow relevant specifications is not covered by warranty.
 - Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.
- Safety levels and definition
- : "WARNING" indicates that failure to comply with the notice may result in death or severe personal injuries.
- : "CAUTION" indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.
- Keep this user guide properly for future use and deliver it to the end user.

Control System Design

- WARNING**
- Provide a safety circuit to ensure that the control system can still work safely when external power failure or PLC fault occurs.
 - Add an external fuse or circuit breaker to prevent the module from smoking or catching fire due to long-time overcurrent caused by operation above rated current or load short-circuit.
- CAUTION**
- Set an emergency stop circuit, a protection circuit, a forward/reverse operation interlocked circuit, and an upper/lower position limit interlocked circuit in the external circuits of PLC to prevent damage to the module.
 - To ensure safe operation, use external protection circuits and safety mechanism for the output signals that may cause critical accidents.
 - The CPU of the PLC may shut down all outputs upon detecting system abnormalities. When partial circuit faults occur in the PLC, outputs may become uncontrollable. Therefore, it is necessary to design an appropriate external control circuit to ensure normal operation.
 - When the output units of the PLC (such as relays or transistors) are damaged, the output may fail to switch between ON and OFF states according to the commands.
 - The PLC is designed to be used in an indoor electrical environment compliant with overvoltage category II. The power supply must have a system-level surge protector to ensure that overvoltage caused by lightning shock cannot be applied to power supply input terminals, signal input terminals, and control output terminals of the PLC, therefore preventing damage to the product.

Installation

- WARNING**
- Installation must be carried out by skilled personal who have undergone specialized electrical training and possess comprehensive electrical expertise.
 - Disconnect all external power supplies of the system before installing/removing the module. Failure to do so may result in electric shock, module fault, or malfunction.
 - Do not use the controller in environments with dust, greasy smoke, conductive dust, corrosive or combustible gases, exposed to high temperature, condensation, wind & rain, or subject to vibration and shock. Electric shock, fire, and malfunction may also damage the product.
 - The PLC is open-type equipment that must be installed in a control cabinet with lock (cabinet housing protection > IP20). Only the skilled personnel who have undergone specialized electrical training and possess comprehensive electrical expertise can open the cabinet.

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- CAUTION**
- Prevent metal filings and wire ends from dropping into ventilation holes of the PLC during installation. Failure to comply may result in fire, fault, or malfunction.
 - Ensure there are no unwanted matters on ventilation surface. Failure to comply may result in poor ventilation, which may cause fire, fault, or malfunction.
 - Ensure the module is connected to the respective connector securely and hook the module firmly. Improper installation may result in malfunction, fault, or fall-off.

Wiring

- WARNING**
- Wiring must be carried out by skilled personnel who have undergone specialized electrical training and possess comprehensive electrical expertise.
 - Disconnect all external power supplies of the system before wiring. Failure to comply may result in electric shock, module fault, or malfunction.
 - After wiring, install the terminal cover attached to the product before power-on or operation. Failure to comply may result in electric shock.
 - 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 may result in electric shock or damage to the product.

- CAUTION**
- Do not drop metal filings or wire ends into ventilation holes of the PLC during wiring. Failure to comply may result in fire, fault, or malfunction.
 - The external wiring specifications and installation method must comply with local regulations. For details, see the wiring section in this guide.
 - To ensure safety of equipment and operator, use cables with sufficient diameter and connect the cables to ground reliably.
 - Ensure that all cables are connected to the correct interface. Failure to comply may result in module fault or external equipment fault.
 - Tighten bolts on the terminal block in the specified torque range. If the terminal is not tight, short-circuit, fire, or malfunction may occur. If the terminal is too tight, damage to the terminal and module, fall-off, short-circuit, fire, or malfunction may occur.
 - If a connector is used to connect to the external equipment, perform press-fitting, crimping, or welding with the tools specified by manufacturer. Improper connection may result in short-circuit, fire, or malfunction.
 - The module is attached with a label on the top to prevent unwanted matters from falling into the module during wiring. Do not remove the label during wiring. Remove the label before system operation for ventilation.
 - Route control cables, communication cables, main circuit cables, and power cables through different routes with a clearance of at least 100 mm among different types of cables. Failure to comply may result in malfunction caused by noise.
 - For scenarios with severe interference, select shielded cable for high-frequency signal input or output to enhance system anti-interference ability.

Operation and Maintenance

- WARNING**
- Operation and maintenance must be carried out by skilled personnel who have undergone specialized electrical training and possess comprehensive electrical expertise.
 - Do not touch the terminals with power on. Failure to comply may result in electric shock or malfunction.
 - Disconnect all external power supplies of the system before cleaning the module or re-tightening screws on the terminal block or the connector. Failure to comply may result in electric shock.
 - Disconnect all external power supplies of the system before installing/removing the module or connecting/disconnecting the communication cables. Failure to comply may result in electric shock or malfunction.
- CAUTION**
- Read through the user guide before operations such as online modification, forced output, RUN, and STOP commands to ensure safety.
 - Disconnect the power supply before installing/removing the expansion card.

Disposal

- CAUTION**
- Dispose of retired batteries as industrial waste according to local laws and regulations.

Product Information

Model and nameplate

GR 10 - 16 16 E TN E

① ② ③ ④ ⑤ ⑥ ⑦

①	Product Type	③	Number of Input Channels	⑤	Version Mark	⑦	Module Type
	GR: Inovance general remote module		16: 16 inputs		E: EtherCAT communication module		E: Logic I/O expansion module
②	Series Number	④	Number of Output Channels	⑥	Output Type	-	
	10: 10 series		16: 16 outputs		TN: Transistor output (sink mode)		

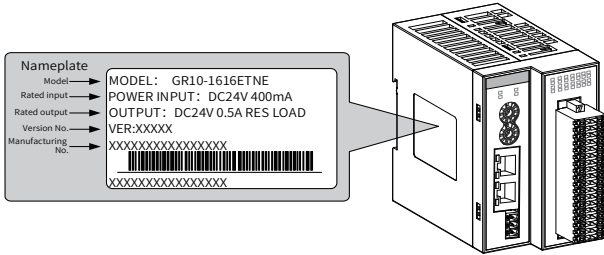


Figure 1 Model and nameplate

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Model	Type	Description
GR10-1616ETNE	EtherCAT communication slave module	16-channel digital transistor output (of sink mode); 16-channel digital input (of source and sink mode)

External interfaces

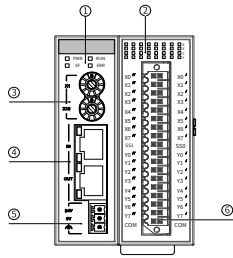


Figure 2 Module interfaces

Interface Name	Description	
① Signal indicator	PWR	The power supply indicator turns off when the power supply is disconnected, and turns on when it is connected.
	RUN	Operation state indicator. Flashing quickly: boot state; Off: initialization state; Flashing: pre-operational state; Single flashing: safe operational state; Solid on: operational state.
	SF	The SF indicator flashes and the RUN indicator turns solid on when the network cable is disconnected in the operational state.
	ERR	The ERR indicator turns on when the FPGA program is not loaded successfully. It flashes when the state machine is faulty.
② I/O signal indicator	The I/O signal indicator turns on when the input/output is active; otherwise, it turns off.	
③ Address DIP switch	Slave address setting switch: ADDR1/ADDR0. The slave address is set in hexadecimal format, converted to decimal address as ADDR1*16 + ADDR0*1 (range: 1 to 255).	
④ EtherCAT communication interface	X1 IN: EtherCAT input	
	X2 OUT: EtherCAT output for connecting back-end EtherCAT slaves	
⑤ 24 V power input terminal	For module power supply input	
⑥ User output terminal	See "Electrical Design Reference" for details.	

General specifications

Item	Specification
Power supply	24 VDC (20.4 VDC to 28.8 VDC) (-15% to +20%)
Communication protocol	EtherCAT industrial real-time bus protocol
Maximum communication speed	100 Mbps
Network port/network cable	Standard network port with Cat 5e network cables below 100 m
Station number range	1 to 255 if set by a DIP switch, or automatically allocated by a network bus
IP rating	IP20
Weight	About 250 g

Environmental parameters

Parameter Type		Operating Environment	Transportation Environment	Storage Environment
Environmental rating		IE33	IE22	IE12
Temperature		-5° C to 55° C	-40° C to +70° C	-25° C to +70° C
Humidity		10% RH to 95% RH, without condensation		
Vibration	Frequency	5 Hz to 150 Hz	2M2	1M2
	Displacement	3.5 mm (direct installation) (< 9 Hz)		
	Acceleration	1 g (direct installation) (> 9 Hz)		
	Direction	X/Y/Z directions		
Shock (collision)		The module can withstand a 15 g half-sine shock from X/Y/Z directions, with a duration of 11 ms.		
Altitude/Air pressure		0 to 2,000 m	0 to 3,000 m (> 70 kPa)	

EtherCAT specifications

Item	Specification
Communication protocol	EtherCAT protocol
Supported services	CoE (PDO, SDO), FoE
Minimum synchronization period of the 6-axis cam	1250 μs (TYP)
Synchronization mode	Input and output synchronization or DC-distributed clock
Physical layer	100Base-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Linear
Transmission medium	Network cables. For details, 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 frame
Synchronous jitter of two slaves	< 1 μs
Refresh time	About 30 μs for 1,000 digital inputs and outputs; About 100 μs for 32 servo axes

Output specifications

Item		Specification
Number of output channels		16
Output connection mode		Leaf spring terminal
Output type		Transistor, low-side output
Power supply voltage		24 VDC (-15% to +20%)
Output voltage		24 VDC (-15% to +20%)
Maximum leakage current upon OFF		Below 0.5 mA
ON response time		Below 0.5 ms (hardware response time)
OFF response time		Below 0.5 ms (hardware response time)
Maximum load	Resistive load	0.5 A/point; 2 A/common terminal ^[1]
	Inductive load	12 W/24 VDC (in total)
	Lamp load	2 W/24 VDC (in total)
Isolation mode		Optocoupler isolation
Output indicator		Output indicator turns on when the optocoupler drive is activated.
Short circuit-proof output		Supported



[1]: When the total load of the output terminals is too high (> 1 A), the COM and 0 V power terminals must be shorted.

NOTE

Input specifications

Item	Specification
Number of input channels	16
Input connection mode	Leaf spring terminal
Input type	Digital input
Input mode	Sink/source mode
Input voltage	24 VDC (30 VDC at most)
Input current (typical value)	4 mA
ON voltage	> 15 VDC
OFF voltage	< 5 VDC
Terminal hardware filter time constant	10 ms
Input resistance	4.3 kΩ
Input signal form	DC voltage input, supporting sink/source input
Isolation mode	Optocoupler isolation
Input indicator	The input indicator turns on when the DI circuit is in the active state.

Mechanical Design

Installation dimensions

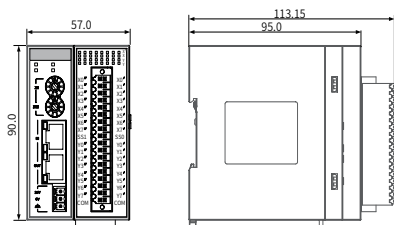
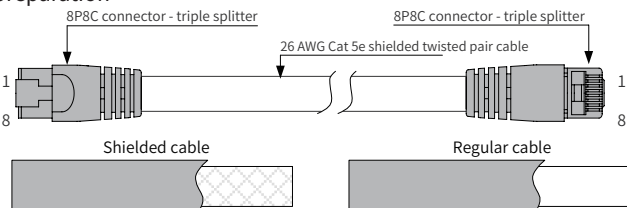


Figure 3 Installation dimensions (in mm)

Electrical Design

EtherCAT cable selection

Network cable preparation



* Use Cat 5e shielded twisted-pair (STP) cables, with injection molded and iron shelled connectors.

Signal pin assignment

Pin	Signal	Type	Description	Pin	Signal	Type	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, when an EtherCAT bus is used, the length of the cable between devices must not exceed 100 meters. Exceeding this length will attenuate the signal and affect communication.

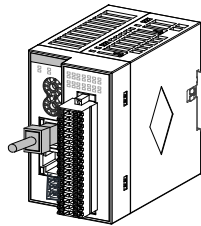
Technical requirements:

The product is required to pass the 100% continuity test and show no sign of short circuit, open circuit, misalignment, or poor contact. Use a shielded cable as the EtherCAT bus for network data transmission, with the following recommended specifications:

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

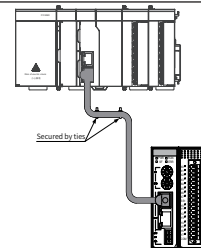
Communication wiring

Insert the registered jack of the cable into the EtherCAT port of the communication module until you hear a click.



Requirements for securing communication cable

To protect the communication cable from any tension and to ensure communication stability, secure the cable end which is near the device before EtherCAT communication, as shown on the right:



Fault indication and troubleshooting for EtherCAT slave modules

LED Indicator		Description	Solution
RUN	Off	The EtherCAT master and slave are in initialization state.	Check configuration and parameter assignment; check communication address. Ensure that the length and other specifications of the network cable are as specified.
	Flashing	The EtherCAT slave is in a non-OP state.	Check slave configuration for any missing, faulty, or unconfigured module.
ERR	Flashing	Communication fault occurs between the EtherCAT master and slave.	Ensure that the parameter configurations for EtherCAT master and slave are correct.
SF	Solid on	The output channel encounters a fault.	Check the output channel for short circuit or overtemperature.

Connection of user output terminals

Cable selection

Material Name	Model	Applicable 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 cable rated temperature is required to be above 75°C.

Cable preparation procedures

- Remove the cable insulation expose 11 to 14 mm of the conductor. Pass the cable through a cable marking sleeve.
- Insert the exposed conductor into the hole of the cable lug and then crimp it with a crimping tool recommended by the lug manufacturer.

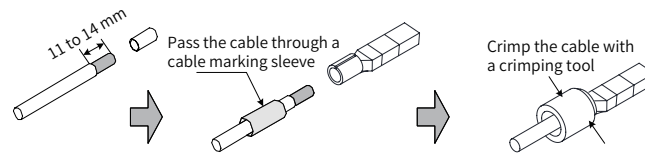


Figure 4 Cable preparation

Terminal layout

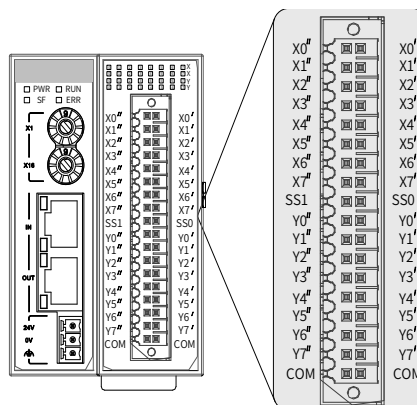
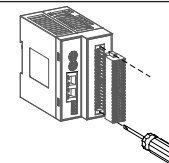


Figure 5 Terminal layout

External wiring

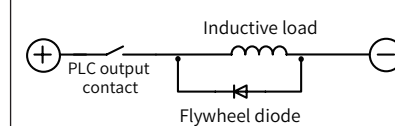
Wiring precautions

After the IO terminal block is mounted to CN5, fix it with a torque of 0.2 to 0.25 N·m, as shown in the right figure.



Contact protection in the case of inductive load:

When the inductive load is applied, stopping the inductive load will produce a large back EMF between contacts, accompanied by arc discharge. This may result in contact failure or contact sag, shortening the contact lifetime. Therefore, it is necessary to connect a flywheel diode in parallel with the load to extend the product lifetime. The reverse voltage of the freewheel diode must be 5 to 10 times of load voltage and the forward current must be larger than load current.



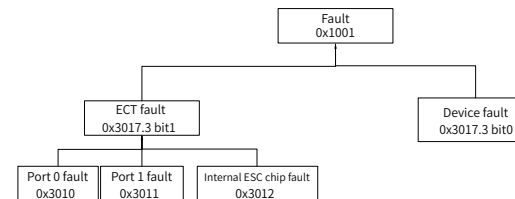
- Do not bundle the terminal connection cables together with power cables (high voltage, large current) which produce strong interference signals. Separate it from other cables and avoid cabling in parallel.
- Use recommended cables and adapter boards. Use shielded cables as terminal cables for increased anti-interference ability.

External Wiring					Internal Equivalent Circuit	
External Wiring	Signal Column B	Terminal No.	Signal Column A	External Wiring		
	CH0 input 0 (CH0-30)	2	1	CH0 input 0 (CH0-30)		
	CH1 input 1 (CH1-31)	4	3	CH0 input 1 (CH0-31)		
	CH1 input 2 (CH1-32)	4	5	CH0 input 2 (CH0-32)		
	CH1 input 3 (CH1-33)	4	7	CH0 input 3 (CH0-33)		
	CH1 input 4 (CH1-34)	4	9	CH0 input 4 (CH0-34)		
	CH1 input 5 (CH1-35)	4	11	CH0 input 5 (CH0-35)		
	CH1 input 6 (CH1-36)	4	13	CH0 input 6 (CH0-36)		
	CH1 input 7 (CH1-37)	4	15	CH0 input 7 (CH0-37)		
	CH1 COM (SS)	4	17	CH0 COM (SS)		
	CH0 output 0 (CH0-30)	20	19	CH0 output 0 (CH0-30)		
	CH0 output 1 (CH0-31)	20	21	CH0 output 1 (CH0-31)		
	CH0 output 2 (CH0-32)	20	23	CH0 output 2 (CH0-32)		
	CH0 output 3 (CH0-33)	20	25	CH0 output 3 (CH0-33)		
	CH0 output 4 (CH0-34)	20	27	CH0 output 4 (CH0-34)		
	CH0 output 5 (CH0-35)	20	29	CH0 output 5 (CH0-35)		
	CH0 output 6 (CH0-36)	20	31	CH0 output 6 (CH0-36)		
	CH0 output 7 (CH0-37)	20	33	CH0 output 7 (CH0-37)		
	CH0 COM (COM)	20	35	CH0 COM (COM)		

Software Troubleshooting

Fault type

All faults of the GR10-1616ETNE module can be accessed through the object dictionary, as shown in the following figure.



Solution

DO external fault

When the DO channel detects a hardware fault signal, bit0 of object dictionary 0x3017.3 is set to 1. The module then performs two processes:

EtherCAT state machine processing (controlled by object dictionary 0x1029) and DO output state control (controlled by object dictionary 0x6206).

- When 0x1029.2 = 0, the ECT state machine transitions to the PreOP state.
- When 0x1029.2 = 1, the machine keeps the present state.
- When 0x6206 = 0, the DO channel outputs the current value.
- When 0x6206 = 1, the DO channel outputs the value reset by object dictionary 0x6207.

ECT internal register fault

When the sub-indices of object dictionaries 0x3010/3011/3012 in the ECT internal fault register trigger counting, the module processes the fault as follows:

- When 0x1029.3 = 0, the device reports no fault.
- When 0x1029.3 = 1, the device fault indicator turns on and the bit1 of object dictionary 0x3017.3 is active.
- When 0x6206 = 0, the DO channel outputs the current value.
- When 0x6206 = 1, the DO channel outputs the value set by object dictionary 0x6207.

Open circuit fault for port 0 in operational state

When the ECT state machine is in OP state and port 0 loses hardware connection, the module processes the fault according to object dictionary 0x1029.1.

- When 0x1029.1 = 0, the ECT state machine triggers a timeout fault and enters SafeOp state.
- When 0x1029.1 = 1, the machine remains in the current state and the SF indicator flashes.
- When 0x6206 = 0, the DO channel outputs the current value.
- When 0x6206 = 1, the DO channel outputs the value set by object dictionary 0x6207.