INOVANCE



GR10-1616ETNE

EtherCAT Slave I/O Module User Guide

19011282A04

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.

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 could result in death or severe injury.

CAUTION indicates that failure to comply with the notice could 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 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.
- 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

GR 10 - 16 16 E TN E

① ② ③ ④ ⑤ ⑥ ⑦

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

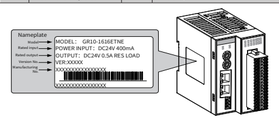


Figure 1 Model and nameplate

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

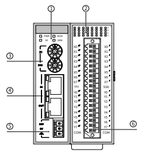


Figure 2 Module interfaces

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 specifications

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 "Wring" 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

NOTE

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

■ 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

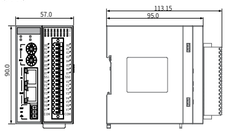
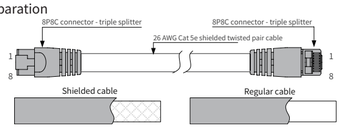


Figure 3 Installation dimensions (in mm)

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 cannot exceed 100 meters. Exceeding this length will attenuate the signal and affect communication.

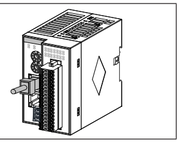
· Technical requirements:

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

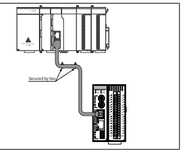
■ Communication wiring

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.

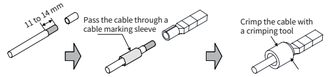


Figure 4 Cable preparation

■ Terminal layout

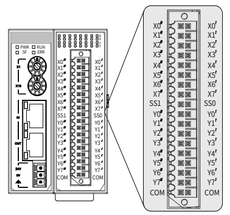
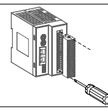


Figure 5 Terminal layout

■ External wiring

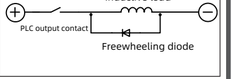
· Wiring precautions

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.

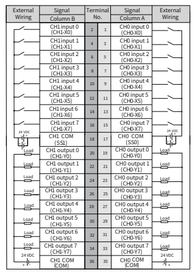
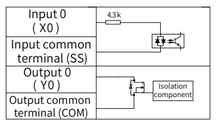


Contact protection in the case of inductive load:

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.



1) 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.
2) Use recommended cables and adapter boards. Use shielded cables as terminal cables for increased anti-interference ability.

External Wiring	Internal Equivalent Circuit
	

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.