

GR10-4PME

EtherCAT Slave Positioning Module User Guide



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Overview

Thank you for purchasing the GR10-4PME EtherCAT slave positioning module developed and manufactured independently by Inovance.

GR10-4PME is an expansion module based on the EtherCAT bus. It supports four channels of pulse output up to 200 kHz in format of A/B phase single frequency, pulse + direction, or CW/CCW. Each channel contains four digital input terminals (used for positive/negative limit, home switch, emergency stop input, and normal input) and one digital output terminal (used for normal output and servo ON signal). It can be used for positioning control of pulse-type servo drives and stepper motor drives. 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: "WARNING" indicates that failure to comply with the notice may result in death or severe personal injuries.

CAUTION: "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 outside the PLC so that the control system can still work safely once 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 PLC where there are dust, oil smoke, conductive dust, corrosive or combustible gases, or exposed to high temperature, condensation, wind & rain, or subject to vibration and impact. 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 (IP rating of the control cabinet enclosure > IP20). Only qualified professionals 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 with the specified tightening torque. 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 the product with an external equipment, use tools specified by the manufacturer for press-fitting and crimping, or weld properly. Improper connection may result in short-circuit, fire, or malfunction.
 - A label on the top of the module is to prevent foreign matters entering the module. 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

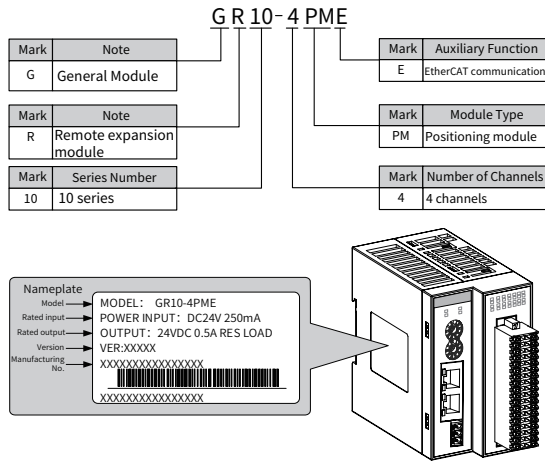


Figure 1 Model and nameplate

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Model	Type	Description
GR10-4PME	EtherCAT slave positioning module	EtherCAT slave 4-channel positioning module

External interfaces

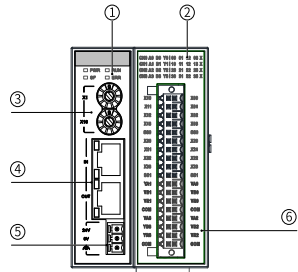


Figure 2 Module interfaces

No.	Interface	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. The SF indicator is solid on when the module is faulty.
		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 corresponding 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 power supply input
⑥	User output terminals	See "Electrical Design" for details.

General specifications

Item	Specification
Power supply voltage	24 VDC (20.4 VDC to 28.8 VDC) (-15% to +20%). The power supply can be externally connected by the user.
Communication protocol with CPU module	EtherCAT protocol with 100 M network speed
EtherCAT communication speed	Up to 100 M to adapt to EtherCAT master communication speed
Network port/network cable	Standard Ethernet port with standard Ethernet cables (Cat 5e)
Station number range	1 to 255. The internal addresses are automatically arranged according to the network bus connection sequence.

The specific performance indicators are as follows:

Item	Specification
Communication protocol	EtherCAT protocol
Supported services	CoE (PDO, SDO), FoE
Minimum synchronization period of 6-axis cam	1250μs (TYP)
Synchronization mode	DC-distributed clock for the servo, input and output synchronization for I/O
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 Ethernet frame
Synchronous jitter of two slaves	< 1μs
Update time	About 30μs for 1,000 digital inputs and outputs; about 100μs for 32 servo axes

Input specifications

Item	Specification
Signal name	Normal input (left and right limits, home, and emergency stop input) 24 V input
Rated input voltage	24 VDC (+20% to -15%)
Rated input current	7.3 mA (typical value) (@24 VDC)
ON current	3.5 mA or higher
OFF current	1.5 mA or lower
Input resistance	3.3 kΩ
Common terminal mode	A common terminal shared by four DIs

Output specifications

Item	Specification
Signal name	High speed output (phase A/B and ON signal YR) Sink output
Control circuit voltage	5 VDC to 24 VDC
Rated load current	0.5 A/point

ON response time	1μs
OFF response time	1μs
Output frequency	200 kHz (an external equivalent load of 20 mA or higher is required when the output frequency exceeds 50 kHz)
Common terminal mode	A common terminal shared by 3 DOs

Mechanical Design

Installation dimensions

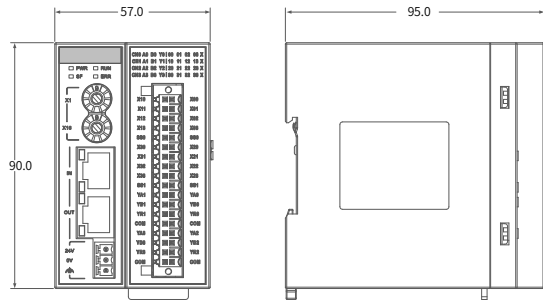
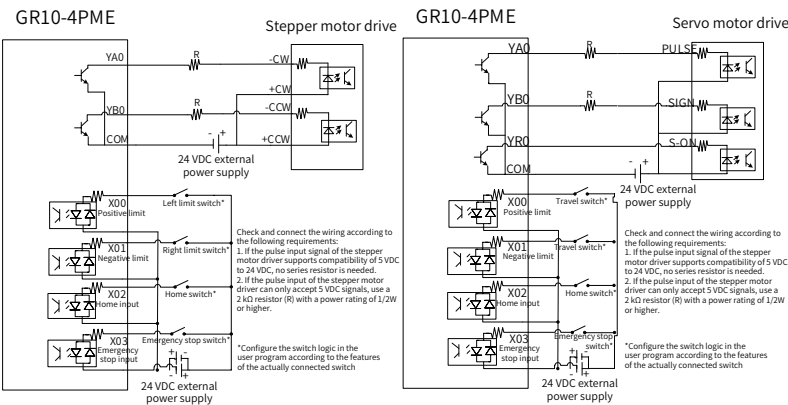


Figure 3 Installation dimensions (in mm)

Electrical Design

Connection of user output terminals



During wiring, follow the specifications of the corresponding servo drive or stepper motor drive.

Cable selection

Material Name	Model	Applicable Diameter		Manufacturer	Crimping Tool
		MM ²	AWG		
Tubular lug	GTVE07512	0.75	21	Suzhou Yuanli	YAC-5

This cable lug is applicable to this module. The rated temperature of the cable is required to be above 75°C.

Cable preparation

- Remove the cable insulation to 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.

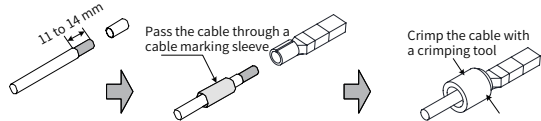


Figure 4 Cable preparation

Terminal layout

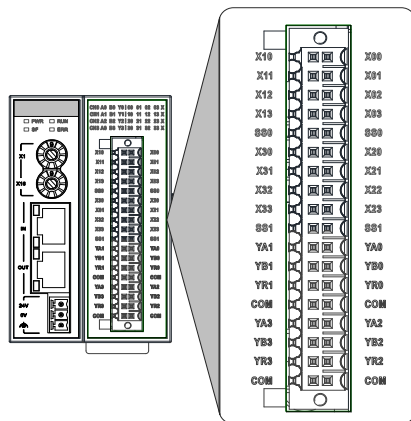


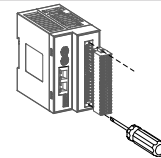
Figure 5 Terminal layout

External wiring

External Wiring					Internal Equivalent Circuit	
External Wiring	Signal Name Column B	Terminal No.	Signal Name Column A	External Wiring		
CH1 input 0 (X10 positive limit)	CH1 input 0 (X10 positive limit)	2	CH0 input 0 (X00 positive limit)	24VDC	3.3k	Input 0 (X0)
	CH1 input 1 (X11 negative limit)	4	CH0 input 1 (X01 negative limit)			
	CH1 input 2 (X12 home switch)	6	CH0 input 2 (X02 home switch)			
CH1 input 3 (X13 regular input)	CH1 input 3 (X13 regular input)	8	CH0 input 3 (X03 regular input)	24VDC	Isolation component	Output 0 (Y0)
	CH1 input common terminal (SS0)	1	CH0 input common terminal (SS0)			
	CH3 input 0 (X30 positive limit)	1	CH2 input 0 (X20 positive limit)			
CH3 input 1 (X31 negative limit)	CH3 input 1 (X31 negative limit)	1	CH2 input 1 (X21 negative limit)	24VDC	Isolation component	Output 0 (Y0)
	CH3 input 2 (X32 home switch)	1	CH2 input 2 (X22 home switch)			
	CH3 input 3 (X33 regular input)	1	CH2 input 3 (X23 regular input)			
CH3 input common terminal (SS1)	CH3 input common terminal (SS1)	2	CH2 input common terminal (SS1)	24VDC	Isolation component	Output 0 (Y0)
	CH1 output A (YA1)	2	CH0 output A (YA0)			
	CH1 output B (YB1)	2	CH0 output B (YB0)			
CH1 output R (YR1)	CH1 output R (YR1)	2	CH0 output R (YR0)	24VDC	Isolation component	Output 0 (Y0)
	CH1 output common terminal (COM)	2	CH0 output common terminal (COM)			
	CH3 output A (YA3)	3	CH2 output A (YA2)			
CH3 output B (YB3)	CH3 output B (YB3)	3	CH2 output B (YB2)	24VDC	Isolation component	Output 0 (Y0)
	CH3 output R (YR3)	3	CH2 output R (YR2)			
	CH3 output common terminal (COM)	3	CH2 output common terminal (COM)			

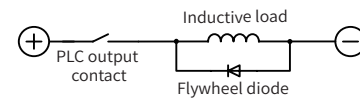
Wiring precautions

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:

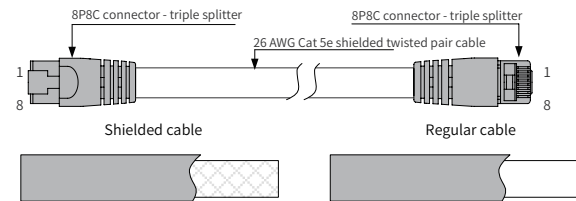
When the inductive load is applied, stopping the inductive load will produce a large back EMF between contacts, accompanied by arc discharge. This may result in contact failure or contact sag, shortening the contact lifetime. Therefore, it is necessary to connect a flywheel diode in parallel with the 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 expansion cable together with power cables (with high voltage and large current) that 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 to increase the anti-interference ability.

EtherCAT cable selection

Network cable preparation



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

Signal pin assignment

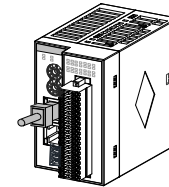
Pin	Signal	Type	Description	Pin	Signal	Type	Description
1	TD+	Output	Data transmission +	5	--	--	Not used
2	TD-	Output	Data transmission -	6	RD-	Input	Data reception -
3	RD+	Input	Data reception +	7	--	--	Not used
4	--	--	Not used	8	--	--	Not used

- Length requirements: According to FastEthernet technology, when an EtherCAT bus is used, the length of the cable between devices must not exceed 100 m. 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. Cables of the following specifications are recommended:

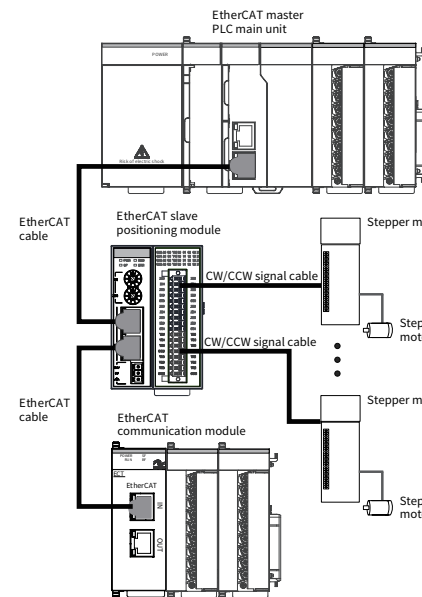
Item	Specification
Cable type	Flexible crossover cable, S-FTP, Cat 5e
Standard	EIA/TIA568A, EN50173, ISO/IEC11801 EIA/TI Abulletin TSB, EIA/TIA SB40-A&TSB36
Conductor type	Twisted pair
Number of pairs	4

Communication connection

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



Wiring diagram of the communication system



Note: To protect the communication cable from any tension and to ensure communication stability, fix the cable end which is near the device before EtherCAT communication.

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. For details, see the application manual of the module.

Software Troubleshooting

The faulty code of the four axes can be obtained respectively from 0x603F, 0x683F, 0x703F, and 0x783F.

The common fault code and solutions are as follows.

Fault code	Cause	Solution
0x0001	Emergency stop fault: The DI terminal is configured for emergency stop function and the DI terminal input is active.	Check whether the DI terminal is configured for the emergency stop function. Check whether the emergency stop input is active.
0x0002	Following deviation: The deviation between the target position and current position is too large.	Check whether there is an abrupt change in the target position in the PLC program. Check whether the following deviation threshold is set too small.
0x0003	Overfrequency: The target output frequency exceeds the maximum frequency.	Check the PLC program and ensure the target speed does not exceed the maximum output frequency.
0x7500	EtherCAT synchronization loss	Check whether the EtherCAT bus is subject to severe interference.

The common alarm code and solutions are as follows.

Alarm Code	Cause	Solution
0x0101	Limit active: The DI terminal is configured as a limit switch, and the input is active.	Check whether the DI terminal is configured for limit function. Check whether the limit switch is active.
0x0102	The output frequency reaches the maximum limit.	Check the PLC program and ensure the target speed does not exceed the maximum output frequency.
0x0104	Target position synchronization failed due to a deviation between the target position and the internal target position.	Check whether the limit switch is triggered during operation and whether the system continues operating in the same direction after the switch becomes invalid.