INOVANCE

GR10-8PBE

EtherCAT Slave Touch Probe Module User Guide

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Thank you for purchasing the GR10-8PBE EtherCAT touch probe module developed and manufactured independently by Inovance.
This module is an expansion module based on the EtherCAT bus. It supports 8-channel probe inputs and 6-channel outputs. The inputs include counter inputs, probe digital inputs and ordinary digital inputs. The outputs are all ordinary digital OC outputs. This module supports multiple high-precision probe capture modes, making it applicable to EtherCAT-based multi-axis motion control applications and offering a user-friendly process module for field use. 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 Precautions

There are two grades of safety precautions: "WARNING" and "CAUTION". Make sure to operate properly with adequate safety assurance.

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

CAUTION : "CAUTION" indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

In some cases, failure to follow the "CAUTION" notice may also result in serious consequences. Make sure to follow notices of both grades; otherwise, it may cause death, serious injuries, or damage to product, relevant equipment, or system.

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 PLC 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 (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.

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.
- Wire the module correctly after making clear of the connector type. Failure to comply may result in module and 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 the product with an external equipment, use tools specified by the manufacturer for press-fitting and crimping, or wield 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

G R 10 - 8 PB E

Mark	Note
G	General Module
R	Remote expansion

Mark	Series
10	10 series

Mark	Auxiliary Function
E	EtherCAT communication

Mark	Module Type
PB	Touch probe module

Mark	Number of Channels
8	8 channels

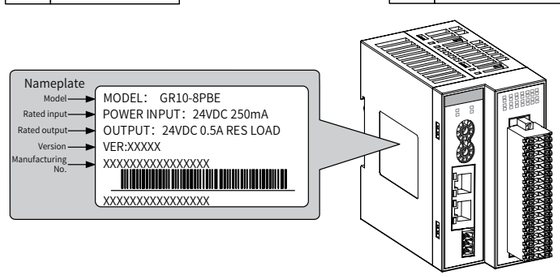


Figure 1 Model and nameplate

Model	Type	Description
GR10-8PBE	EtherCAT slave touch probe module	GR10 series 8-channel EtherCAT touch probe module

■ External interfaces

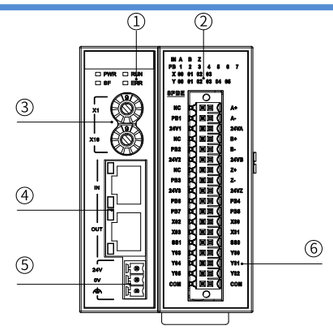


Figure 2 Module interfaces

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	Flashing: The network cable is disconnected in the operational state; solid on: 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 address is set in hexadecimal format, converted to decimal address as ADDR1*16 + ADDR0*1 (range: 1 to 255).
④ EtherCAT interface		X1 IN: EtherCAT input
		X2 OUT: EtherCAT output for connecting back-end EtherCAT slaves
⑤ 24 VDC power supply		Module power input
⑥ I/O 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.

■ Input specifications

The inputs include a counter input, eight probe digital inputs, and four ordinary digital inputs, with a 24 VDC input voltage. The input signal can be bipolar voltage. The input signal is defined as OFF when the absolute value of the voltage is below 5.0 VDC, and is defined as ON when the absolute value is above 15.0 VDC. The signal state is undefined when the absolute value is between 5.0 to 15.0 VDC.

Item		Counter Input (A, B)	Probe Input (Z, PB1 to PB3)	Probe Input Terminal (PB4 to PB7)	Normal Input Terminal (X0 to X3)
Signal input mode		Differential	Single-ended (sink)	Single-ended (sink/source)	
Electrical specifications	Input voltage class	5 VDC, differential drive level compliant with EIA RS-422-A (equivalent to AM26LS31)	24 VDC (-15% to +20%)		
	Input impedance		3.3 k	3.3 k	4.3 k
	Input current upon ON		Above 5 mA		
	Input current upon OFF		Below 1.5 mA		
Filtering function	Digital filter	Up to 200 kHz for single channel Up to 800 kpps for phase A/B 4X frequency	/		
	ON/OFF response time		1µs	1µs	10ms
High-speed function			/	/	
Common wiring terminal		A common terminal for each terminal		A common terminal (SS0 and SS1) shared by four terminals	

NOTE

- When all inputs are ON, the voltage must not exceed 26.4 VDC.
- The duty cycle is 40% to 60% at high speed input.
- When the input common terminal is shorted with a 24 VDC power supply, the input is of sink mode. When it is shorted with a 0 VDC power supply, the input is of source mode.

■ Output specifications

The output is in a closed state upon ON and it is in an open state upon OFF.

Item		Comparison Output Terminal (Y0 to Y1)	Ordinary Output Terminal (Y2 to Y5)
Circuit power supply voltage		5 VDC to 24 VDC	
Output type		Transistor open-collector (OC) output of NPN type	
Circuit insulation		Optocoupler isolation	
Leakage current upon open circuit		Less than 0.1 mA/30 VDC	
Min. load		5 mA	
Max. output current	Resistive load	0.8 A/4 points; 0.5 A/point	
	Inductive load	12 W/24 VDC	
	Lamp load	1.5 W/24 VDC	
ON response time		1µs	0.5ms
OFF response time			
High-speed output frequency		/	
Output common terminal		A common terminal shared by three terminals, with groups isolated with each other	
Fuse protection		/	

Mechanical Design

■ Installation dimensions

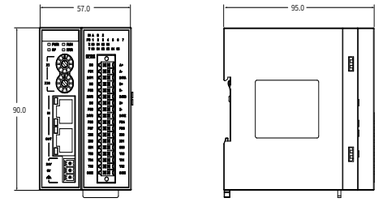
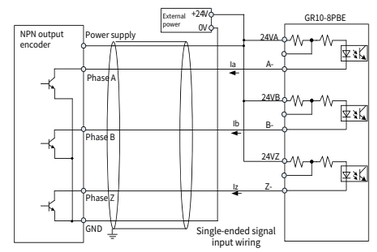
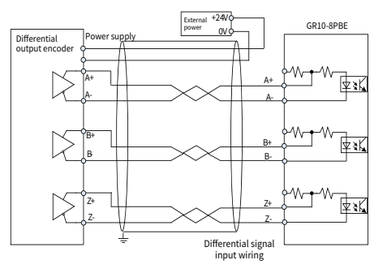


Figure 3 Installation dimensions (in mm)

Electrical Design

■ Connection of user output terminals





※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

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

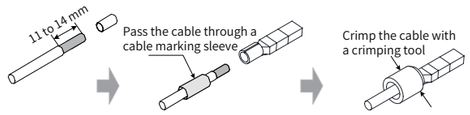


Figure 4 Cable preparation

Terminal layout

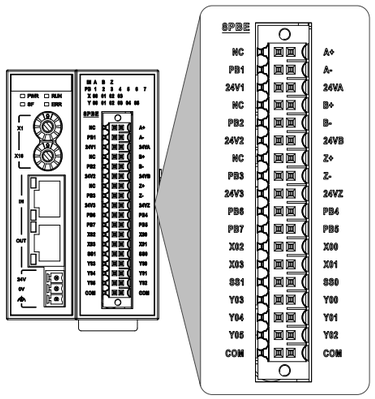


Figure 5 Terminal layout

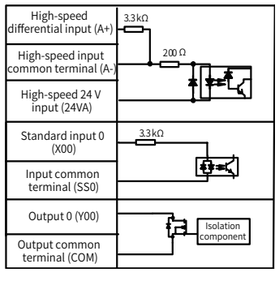
NOTE

When terminals Z+ and Z- are not used for reset, they can serve as the trigger signal PB0.

External wiring

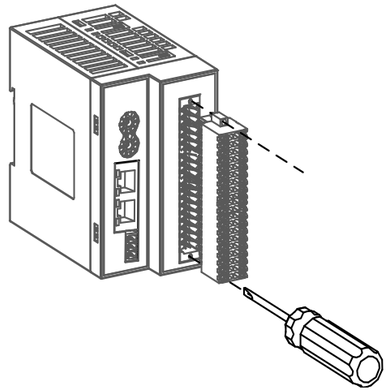
External Wiring	Signal Name Column B	No.		Signal Name Column A	External Wiring
	Unconnected (NC)	2	1	High-speed differential input (A+)	
24/DC	Single-ended probe input 1 (PB1)	4	3	High-speed differential input (A-)	24/DC
	24 V common terminal (24V1)	6	5	Phase A 24 V single-ended input (24VA)	
	Unconnected (NC)	8	7	High-speed differential input (B+)	
24/DC	Single-ended probe input 2 (PB2)	10	9	High-speed differential input (B-)	24/DC
	24 V common terminal (24V2)	12	11	Phase B 24 V single-ended input (24VB)	
	Unconnected (NC)	14	13	High-speed differential input (Z+)	
24/DC	Single-ended probe input 3 (PB3)	16	15	High-speed differential input (Z-)	24/DC
	24 V common terminal (24V3)	18	17	Phase Z 24 V single-ended input (24VZ)	
	Probe input 6 (PB6)	20	19	Probe input 4 (PB4)	
	Probe input 7 (PB7)	22	21	Probe input 5 (PB5)	
	Standard input (digital input X02)	24	23	Standard input (digital input X00)	
	Standard input (digital input X03)	26	25	Standard input (digital input X01)	
24/DC	Input common terminal (SS1)	28	27	Input common terminal (SS0)	24/DC
Load	Standard output (digital output Y03)	30	29	Standard output (digital output Y00)	Load
Load	Standard output (digital output Y04)	32	31	Standard output (digital output Y01)	Load
Load	Standard output (digital output Y05)	34	33	Standard output (digital output Y02)	Load
24/DC	Output common terminal (COM)	36	35	Output common terminal (COM)	24/DC

Internal equivalent circuit



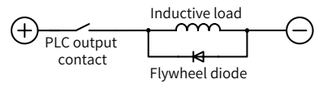
Wiring precautions

After the I/O terminal block is mounted to the user terminal, fix it with a torque of 0.2 to 0.25 N·m, as shown below:



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.

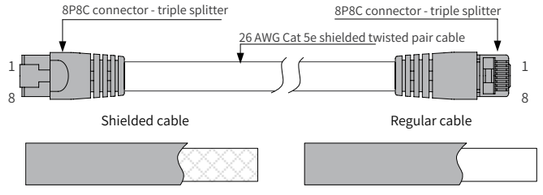


NOTE

1) 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.
2) 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 connector.

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

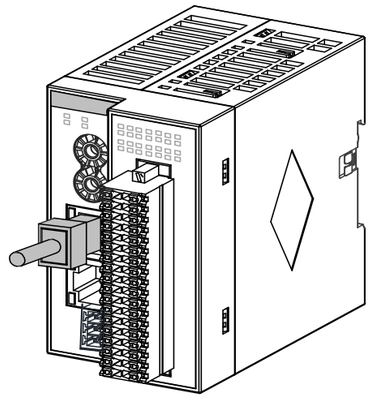
Length requirements: According to FastEthernet technology, when an EtherCAT bus is used, the length of the cable between devices must not exceed 100 m. Exceeding this length will attenuate the signal and affect communication.

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:

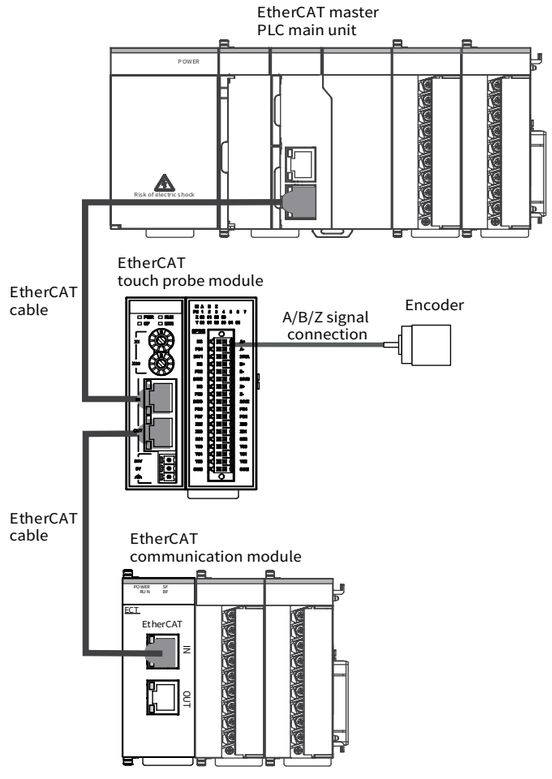
Item	Specification
Cable type	Flexible crossover cable, S-FTP, Cat 5e
Standard	EIA/TIA568A, EN50173, ISO/IEC11801 EIA/TI Abulletin TSB, EIA/TIA SB40-A&TSB36
Conductor type	Twisted pair
Number of pairs	4

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 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 following table shows the fault codes for the GR10-8PBE module. Some faults can be recovered by the control word.

Code	Cause	Solution
0002h	The preset value is incorrect.	Check whether the preset value exceeds the upper or lower limits.
0003h	The comparison value is incorrect.	Check whether the comparison value exceeds the upper or lower limits.
0010h	The preset function of X input terminal is set incorrectly.	Check whether the function of X input terminal is set to the preset function.
0011h	The reset function of X input terminal is set incorrectly.	Check whether the function of X input terminal is set to the reset function.
0030h	The comparison function of Y output terminal is set incorrectly.	Check whether the function of Y output terminal is set to the comparison output function.
0050h	The input frequency is overloaded.	Check whether the input frequency exceeds 200 k.
0051h	Linear counter overflow	Check whether the linear counter reaches the maximum count value.
0052h	Linear counter underflow	Check whether the linear counter reaches the minimum count value.

NOTE

To solve a setting-related fault, it is necessary to correct the corresponding settings.

When the AM600 background function block is used, the faults that can be detected by the block are shown below.

Code	Cause	Solution
1001h	The preset mode parameter is out of range.	Check whether the preset mode parameter is within the settable range.
1002h	The counter is disabled.	Check whether the counter enabling function block is operating correctly before performing the block.
1003h	The touch probe parameters are set incorrectly.	Check whether the ID, type, edge, and triggering mode of the touch probe are within the settable range.
1004h	The comparison channel parameters are set incorrectly.	Check whether the input parameters of the comparison channel, such as ID and comparison value, are within the settable range.
1005h	There is no fault to be reset.	Check whether the reset function block is called when there is no fault.
1006h	The fault cannot be reset.	Power off and on again.
1100h	The command is not configured with corresponding PDO.	To execute a command, the corresponding PDO needs to be configured. Log out and add the PDO required by the command.

The following table describes the related object dictionary.

Index	Subindex	Note
3200h	1	Ch0: Fault code in case of a channel fault
6000h	1	Ch0: Channel status word Bit8: Fault status of the module 0: No fault 1: Faulty
7000h	1	Ch0: Channel control word Bit12: Fault reset command 0: Invalid 1: Valid

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