INOVANCE

Advancing industrial technology,
for a better world



INT Version Small and Medium Payload Industrial Robots

Functional Safety Guide

Industrial Automation | New Energy Vehicle | Intelligent Elevator | Intelligent Robot | Digital Energy | Rail Transit

Data code 19013000A00

Legal and Disclaimer

Copyright

Copyright © 2024 Shenzhen Inovance Technology Co., Ltd. All rights reserved

This documentation is the exclusive property of Shenzhen Inovance Technology Co., Ltd. No individual or entity may excerpt, reproduce, modify, translate, or distribute any content herein without written consent from Inovance.

Legal action will be taken against infringement.

Trademarks

INOVANCE is a registered trademark of Shenzhen Inovance Technology Co., Ltd. and its affiliates. All other trademarks or registered trademarks mentioned in this documentation are the property of their respective owners. Unauthorized use of these trademarks by third parties for any purpose without written authorization could violate the rights of their owners.

Disclaimer of Liability

Due to continuous updates and improvements of products and technologies, the content of this documentation may not fully match the actual products. In the event of any discrepancies, the actual products shall prevail.

The contents are subject to change without notice due to product upgrade.

Waste Disposal

The storage, use, and disposal of this product (including optional accessories) must comply with local laws and regulations.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel can identify the risks of the product/system and prevent possible dangers.

Proper Use of the Product

Proper transportation, storage, assembly, installation, commissioning, operation, and maintenance are required to ensure the safe operation of the product without any problems. The required ambient conditions must be met. All operations must follow the guidelines provided in this documentation.

Preface

Introduction

This guide describes the safety functions of the IRCB501 series robot controllers. The robot controller realizes extended safety functions through safety parameter configuration and external terminal wiring. The safety functions protect the operator from dangerous moving parts of the machine, reducing the risks and improving the safety of the machine. This guide is applicable to all robot models matching with IRCB501 and IRCB501 high-protection robot controllers. The extended safety functions are implemented by the controller with an optional functional safety expansion card.

This guide provides product safety information, installation instructions on functional safety expansion cards, commissioning and maintenance of safety parameters. Read this guide carefully before using the robot.

More Data

Data name	Data code	Description
IRCB501-INT Series Robot Controller User Guide	19013032	This guide describes general specifications, installation and wiring, common fault diagnosis and solutions, and maintenance of the product.
IRCB501-INT High-Protection Series Robot Controller User Guide	19012937	This guide describes general specifications, installation and wiring, common fault diagnosis and solutions, and maintenance of the product.
IRCB501-EM Series Robot Controller User Guide	19012996	This guide describes the general specifications, installation and wiring, common fault diagnosis and solutions, and maintenance of the product.
IRCB501-EM High-Protection Series Robot Controller User Guide	19012997	This guide describes the general specifications, installation and wiring, common fault diagnosis and solutions, and maintenance of the product.
Robot Functional Safety Expansion Card User Guide	19012414	This guide provides product safety information, installation instructions on functional safety expansion cards, commissioning and maintenance of safety parameters.
INT Version Small and Medium Payload Industrial Robots Functional Safety Guide (this guide)	19013000	This guide provides product safety information, installation instructions on functional safety expansion cards, commissioning and maintenance of safety parameters.

Revision History

Revision date	Version	Revision
2026-08	19013000_A00	• Finished the guide migration and updated the data code to 19013000. • Updated the List of Safety Functions section. • Updated the Safety Standards and Specifications section. • Update the SAFETY Interface Wiring section, including introduction updates for standard models and EM series models. • Updated the Safety I/O section. • Updated the Safety Function Troubleshooting section.
2025-11	PS00016974_A04	• Updated the "External safety door control (relay output)" in the Wiring Procedure and Topology Diagram section, changing the relay switch to normally closed. • Updated the wiring diagram in the Wiring Procedure and Topology Diagram section, changing the relay switch to normally closed. • Made minor corrections.
2025-08	PS00016974_A03	• Updated "high resistance (High-Z)" to "low level (Lowlevel)" in List of Safety Functions and Safety Standards and Specifications sections. • Updated the safety state "Brake action" for SF15 to "Category 1 stop" in Safety Standards and Specifications section. • Updated the topology and wiring diagram for the external emergency stop, safety door, and start confirmation functions in Wiring Procedure and Topology Diagram section. • Updated the topology and wiring diagram for the SAFETY interface/safety DI in Wiring Procedure and Topology Diagram section. • Updated the topology and wiring diagram for the SAFETY interface/safety DO in Wiring Procedure and Topology Diagram section.

Revision date	Version	Revision
2025-02	PS00016974_A02	**Update** • Updated the List of Safety Functions section. • Updated the Wiring and Installation section. • Updated the timing diagrams in the sections from Joint Position Monitoring to Safety Low Speed Monitoring. • Update the wiring in the Safety Tool Mode Settings section. **Diagram update** • Updated the Configuring Safety Tool section. • Updated the chapter title for InoTeachPad teach pendant operation steps. • Updated the Safety Function Troubleshooting section. **Added:** • Added the Terminal Assignment section. • Added the Configuration on InoRobotTP section.
2024-08	PS00016974_A01	Minor error corrections.
2024-06	PS00016974_A00	Initial release.

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following ways:

- Visit https://www.inovance.com/global, and choose Service&Support > Support > Documentation Download.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install the My Inovance app, where you can search for and download guides.

Warranty Disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is caused by proper operation of the user. Maintenance will be charged after the warranty period expires.

Within the warranty period, maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the guide
- Damage caused by fire, flood, or unusual voltage
- Damage caused by unintended use of the product

- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (such as natural disaster, earthquake, and lightning strike)

The maintenance is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see Product Warranty Card.

Basic Safety Instructions

Safety Precautions

Safety Disclaimer

- This chapter presents essential safety instructions for a proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to observe the safety instructions may result in death, severe personal injuries, or equipment damage.
- "DANGER", "WARNING", and "CAUTION" items in this guide do not indicate all safety precautions that need to be followed; instead, they just supplement the safety precautions.
- Use this product according to designated environment requirements. Damage caused by improper use is not covered by warranty.
- This product is a standard industrial robot intended for general civil applications. It has not been certified under national safety standards for the specialized handling of high-energy explosives. The electrical system does not meet the nominal requirements stipulated by regulations applicable to high-energy explosives, and the robot is not designed with any functionality for explosive handling. Use in any operations involving explosives is strictly prohibited.
- This product is designed for conventional industrial environments and is not radiation-hardened. In environments where the ionizing radiation dose exceeding 5×10^4 Gy (Si), its performance may degrade significantly or fail completely. Operation under such conditions is strictly prohibited.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions



Indicates that failure to comply with the notice will result in severe personal injuries or even death.



Indicates that failure to comply with the notice may result in severe personal injuries or even death.



Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

Safety Instructions

- Drawings in the guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.
- The drawings in the guide are shown for illustration only and may be different from the product you purchased.
- Operators must take mechanical precautions to protect personal safety and wear protective equipment, such as safety shoes, safety clothing, safety glasses, protective gloves, and protective sleeves.

Unpacking



- Do not install the product when you find that the product and its accessories have any damage or corrosion or they have been used.
- Do not install the equipment if you find water seepage or missing or damaged components upon unpacking.
- Do not install the equipment if you find the packing list does not conform to the equipment you received.



- Before unpacking, check whether the outer package is intact, damaged, wet, damped, or deformed.
- Unpack the package in the correct layered sequence. Do not strike the package violently.
- Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation



- Large-scale or heavy equipment must be handled by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries 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 injuries or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- 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 may result in personal injuries or equipment damage.



- Handle the product with care and mind your steps to prevent personal injuries or product damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storage and transportation in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the product for more than 3 months. When the product needs to be stored for an extended period, take more strict protection and necessary inspection.
- Package the product strictly before transporting it, and use an enclosed container for long-distance transportation.
- Never transport the equipment with other equipment or materials that may harm or have negative impacts on this equipment.

Installation



- The equipment can only be operated by professionals with electrical knowledge. Non-professionals are not allowed to operate the equipment.



- Read through the guide and safety precautions before installation.
- Do not install the equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply will result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in yellow.
- When the equipment (such as controller) is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction.
- Install the product on an incombustible object such as metal and do not touch or attach the product to combustibles. Failure to comply can result in fire accident.



- Cover the top of the equipment (such as controller) 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 equipment and causing faults. After installation, remove the cloth or paper on top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.

Wiring



- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Before wiring, disconnect the power supplies of all equipment. Wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. Measure the direct voltage of the main circuit and ensure that the voltage is within the safety range. Failure to comply can result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply can result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply can result in an electric shock.



- Do not connect the input power supply to the output side of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to a motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Tighten the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may result in overheat, damage to the connecting parts, or a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in electric shock or equipment damage.



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

Power-On



- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Check that the power supply meets equipment requirements before power-on to prevent equipment damage or a fire.
- After power-on, do not open the cabinet door or protective cover of the equipment, touch any terminal, or disassemble any unit or component of the equipment. Failure to comply will result in electric shocks.



- After the completion of wiring and parameter setting, perform a robot test run to confirm that the robot can operate safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in fire accident.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.

Operation



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



- Do not touch the equipment enclosure, fan, or resistor with bare hands. Failure to comply may result in burns.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.
- The robot generates noise during operation. Be sure to wear hearing protection such as ear muffs or earplugs to prevent hearing damage.

Maintenance



- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply can result in an electric shock.
- Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- When a permanent magnet motor is used, do not touch the motor terminals immediately after power-off because the motor terminals can generate induced voltage during rotation even after the equipment is powered off. Failure to comply can result in an electric shock.



- Perform routine and regular inspection and maintenance on the equipment in accordance with maintenance requirements and keep a record.

Repair



- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply can result in an electric shock.
- Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.

WARNING

- Submit a request for repair services in accordance with the product 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 may result in death, personal injuries or equipment damage.
- Troubleshooting and repair must be performed by professionals in accordance with the repair instructions, with repair records kept properly.
- Replace quick-wear parts of the equipment in accordance with the replacement instructions.
- Do not operate on damaged equipment. Failure to comply may result in death, personal injuries, or severe equipment damage.
- After the equipment is replaced, check the wiring and set parameters again.

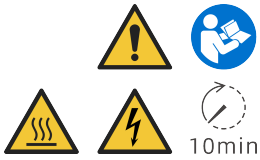
Disposal

WARNING

- Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in death, personal injuries, or property damage.
- Recycle retired equipment in accordance with industry waste disposal standards to avoid environmental pollution.

Safety Label

For safe equipment operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. See the following table for descriptions of the safety labels.

Safety Label	Description
	• Read through the safety instructions before operating the equipment. Failure to comply may result in equipment damage, physical injuries, or even death. • Do not touch the terminals or remove the cover with power ON or within 10 min after power-off. Failure to comply can result in an electric shock.

Industrial Information Security

The product provides an interface to connect to the network and transmits data through the network interface. To protect factories, systems, machines, and networks from cyber attacks and ensure safe operation, a proper industrial information security protection mechanism must be implemented.
The customer is responsible for providing and continuously ensuring a secure connection between the product and the customer network or any other network to prevent unauthorized access to its factories, systems, machines, and networks. The system or machine can be connected to the corporate network or the Internet only when secure connections are ensured and appropriate security measures are taken (for example, anti-virus software or firewall installed).
Inovance continuously develops and improves products and solutions to improve safety. It is strongly recommended that you update the product promptly and always use the latest version.



Malware (such as viruses, Trojans, and worms) can put the product in an unsafe running state, which may result in death, serious injuries, and property damage. Observe the following precautions:

- Always use the latest software version. If the product version is no longer supported or the latest version is not used, customers will be exposed to increased risk of cyber attacks.
- Take appropriate protection measures (including but not limited to installing anti-virus software, firewall, WAF, IPS/IDS, and situation awareness system, and applying authentication, data encryption) to prevent files in mobile storage devices from being damaged by malware, and to prevent products, networks, systems, and interfaces from unauthorized access, interference, intrusion, data leakage, or information breach.
- Check all safety-related interfaces and settings after commissioning.

Contents

1 Safety Overview 18
1.1 List of Safety Functions 18
1.2 Terms and Abbreviations 21
1.3 Safety Standards and Specifications 22
1.4 Precaution 24
2 Product Information 27
3 Wiring and Installation 29
3.1 SAFETY Interface Wiring 29
3.1.1 SAFETY Interface Wiring Method 1 29
3.1.1.1 Interface Definition 29
3.1.1.2 I/O Specifications 35
3.1.1.3 Wiring and Topology Diagram 36
3.1.1.3.1 Emergency Stop Wiring 36
3.1.1.3.2 Safety Door and Start Confirmation Wiring 39
3.1.1.3.3 Topology and Wiring for Emergency Stop, Safety Door and Start Confirmation Functions .. 45
3.1.2 SAFETY Interface Wiring Method 2 49
3.1.2.1 Interface Definition 49
3.1.2.2 Safety Specifications 53
3.1.2.2.1 Safety I/O Specifications 53
3.1.2.2.2 Safety ESOUT Specifications 54
3.1.2.3 Wiring and Topology Diagram 54
3.1.2.3.1 Emergency Stop Wiring 54
3.1.2.3.2 Wiring for Emergency Stop Switch Status Function 57
3.1.2.3.3 Safety Door and Start Confirmation Wiring 58
3.1.2.3.4 Topology and Wiring for Emergency Stop, Safety Door and Start Confirmation Functions . 63
3.2 Installing Expansion Card 67
3.3 Safety DI of Safety Expansion Card 70
3.3.1 Terminal Assignment 70
3.3.2 Terminal Specifications 71
3.3.3 Wiring Procedure and Topology Diagram 71
3.4 Safety DO of Safety Expansion Card 83
3.4.1 Terminal Assignment 83
3.4.2 Terminal Specifications 83
3.4.3 Wiring Procedure and Topology Diagram 84
4 Safety Functions 92
4.1 Overview of Safety Functions 92

4.2 Safety I/O 93
4.3 Joint Position Monitoring 96
4.4 Joint Speed Monitoring 98
4.5 Cartesian Position Monitoring 99
4.6 Cartesian Speed Monitoring 103
4.7 Safety Low Speed Monitoring 104
4.8 Safety Tool Mode Settings 106
5 Commissioning and Operation 108
5.1 Commissioning Preparation 108
5.2 Configuration on InoRobotTP 108
5.2.1 Configuring Basic Parameters 108
5.2.2 Configuring System Access 109
5.2.3 Configuring Safety Tool 109
5.2.4 Configuring Safety I/O Signal 112
5.2.5 Configuring Safety Stop Parameters 113
5.2.6 Configuring Safety Low Speed Monitoring Parameters 114
5.2.7 Configuring Joint Position Monitoring Parameters 115
5.2.8 Configuring Joint Speed Monitoring Parameters 117
5.2.9 Configuring Cartesian Position Monitoring Parameters 118
5.2.10 Configuring Cartesian Speed Monitoring Parameters 126
5.3 Configuration on InoRobotLab 128
5.3.1 Configuring Basic Parameters 128
5.3.2 Configuring System Access 129
5.3.3 Configuring Safety Tool 130
5.3.4 Configuring Safety I/O Signal 133
5.3.5 Configuring Safety Stop Parameters 134
5.3.6 Configuring Safety Low Speed Monitoring Parameters 135
5.3.7 Configuring Joint Position Monitoring Parameters 137
5.3.8 Configuring Joint Speed Monitoring Parameters 138
5.3.9 Configuring Cartesian Position Monitoring Parameters 139
5.3.10 Configuring Cartesian Speed Monitoring Parameters 148
5.4 Configuration on InoTeachPad 149
5.4.1 Configuring Basic Parameters 149
5.4.2 Configuring System Access 151
5.4.3 Configuring Safety Tool 151
5.4.4 Configuring Safety I/O Signal 154
5.4.5 Configuring Safety Stop Parameters 155

5.4.6 Configuring Safety Low Speed Monitoring Parameters 156
5.4.7 Configuring Joint Position Monitoring Parameters 158
5.4.8 Configuring Joint Speed Monitoring Parameters 159
5.4.9 Configuring Cartesian Position Monitoring Parameters 160
5.4.10 Configuring Cartesian Speed Monitoring Parameters 169
5.5 Verification and Validation 170
6 Inspection and Maintenance 173
6.1 Maintenance Precautions 173
6.2 Routine Inspection 174
6.3 Regular Inspection 175
6.4 File Backup and Recovery 175
7 Safety Function Troubleshooting 179
8 Certification and Standard Compliance 217

1 Safety Overview

1.1 List of Safety Functions

Mark SF ID	Safety Function	Classification	Description
SF1	Emergency Stop	Emergency Stop	Triggered by the emergency stop switch on the control cabinet or the teach pendant. Once triggered, the power to the motor is cut off and the brake is applied.
SF2	Additional Emergency Stop	Emergency Stop	Triggered by external emergency stop signal triggering device connected to safety IO in the control cabinet. Once triggered, execute Cat.0 stop and the brake is applied.
SF3	Emergency Stop Switch Status Output	Status Output	Safety Relay output, Emergency Stop Switch Status Output function, Used to feedback the status of the emergency stop triggered by the teach pendant or control cabinet emergency stop switch. When the teach pendant or control cabinet emergency stop switch is not pressed , Safety RO output closed. When the teach pendant or control cabinet emergency stop switch is pressed , Safety RO output open.
SF4	Protective Stop	Protective Stop	Triggered by a protective stop signal from the robot controller. Once triggered, the power to the motor is cut off and the brake is applied.
SF5	External Emergence Stop	Emergency Stop	Safety DI, configurable for emergency stop function. Can be configured to Category 0 or 1 stop.
SF6	External Protective Stop	Protective Stop	Safety DI, configurable for external protective stop function. Can be configured to Category 0 or 1 stop.
SF07	Emergency Stop Status Output	Status Output	Safety DO, configurable for teach pendant/ control cabinet emergency stop status function. Used to feedback emergency stop triggered by the teach pendant or control cabinet emergency stop switch. Outputs Low Level when the teach pendant or control cabinet emergency stop switch is pressed, and High level when the teach pendant or control cabinet emergency stop switch is not pressed.

Mark SF ID	Safety Function	Classification	Description
SF08	Additional emergency stop Status Output	Status Output	Safety DO, configurable for the status of external emergency stop signal connected to safety IO in the control cabinet .Used to feedback the status of external emergency stop signal triggering device connected to safety IO in the control cabinet. When the external emergency stop signal DI of the control cabinet safety IO input is at low level or floating (additional external emergency stop device triggered) inputs Low level or Floating, safety DO outputs Low Level; When the external emergency stop signal DI of the control cabinet safety IO input is at low level or floating (additional external emergency stop device triggered) inputs High level , safety DO outputs High level ;
SF09	System Emergency Stop Status Output	Status Output	Safety DO, configurable for system emergency stop status function.Used to feedback emergency stop triggered by the teach pendant or control cabinet emergency stop switch, external emergency stop devices or external protective stop devices. Outputs Low Level when the teach pendant or control cabinet emergency stop DI, the external emergency stop DI or the external protective stop DI inputs Low level or Floating, and High level when the teach pendant or control cabinet emergency stop DI, the external emergency stop DI or the external protective stop DI inputs High level.
SF10	Robot Moving Status Output	Status Output	Safety DO, configurable for robot moving status function. Outputs Low Level when the robot is moving, and High level when the robot is not moving.
SF11	Robot Stopped Status Output	Status Output	Safety DO, configurable for robot stopped status function. Outputs Low Level when the robot is stopped, and High level when the robot is not stopped.
SF12	Safety Status Output	Status Output	Safety DO, configurable for safety status function. If the status of any safety function is abnormal, the safety status will be abnormal. Outputs Low Level when the safety status is abnormal, and High level when the safety status is normal.

Mark SF ID	Safety Function	Classification	Description
SF13	Safety Manual Mode	Safety Operation Control	Monitors the TCP speed when the robot operates in the manual mode. If it exceeds 250 mm/s, a Category 0 or 1 stop will be triggered and the corresponding DO will be activated. You can configure the stop category and the way the function takes effect.
SF14	Joint Position Monitor	Safety Operation Control	Monitors whether the position of each joint is within the set safe range. If it exceeds the safe range, a Category 0 or 1 stop will be triggered and the corresponding DO will be activated. You can configure the stop category and the way the function takes effect.
SF15	Joint Speed Monitor	Safety Operation Control	Monitors whether the speed of each joint is within the set safe range. If it exceeds the safe range, a Category 0 or 1 stop will be triggered and the corresponding DO will be activated. You can configure the stop category and the way the function takes effect.
SF16	TCP Position Monitor	Safety Operation Control	Monitors whether the TCP position is within the set safe area. If it exceeds the safe range, a Category 0 or 1 stop will be triggered and the corresponding DO will be activated. You can select the safety tool and configure the safety envelope.
SF17	TCP Speed Monitor	Safety Operation Control	Monitors whether the TCP speed is within the set safe speed limit. If it exceeds the safe range, a Category 0 or 1 stop will be triggered and the corresponding DO will be activated. You can configure the stop category and the way the function takes effect.
SF18	3-Position Enabling Function	Safety Operation Control	This switch is provided on the teach pendant. When continuously held in a centre-enabled (ON) position, the robot shall be allowed to move. When in either the released or compressed (OFF) position, the robot stops, and the brake is applied. The switch is not configurable. Safety parameters cannot be configured.

NOTE

- The implementation of the above safety functions requires reference to the 3 Wiring and Installation, 4 Safety Functions, and 5 Commissioning and Operation sections.
- The safety functions of SF02, SF03, and SF08 are only available on the controller models IRCB501-6KD-EM-INT and IRCB501-6ND-EM-INT.

Safety functions characteristics

- The extended safety functions are implemented by a specific controller with a safety expansion card. When the controller model does not match or no safety expansion card is available, the safety functions are disabled.
- All safety functions meet the PLd/Cat 3 certification.

1.2 Terms and Abbreviations

Term/Abbreviation	Description
Cat.	Category of safety components in the control system, including B, 1, 2, 3, and 4
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
PFHd	Probability of a dangerous failure per Hour
PL	Performance level
SC	Systematic capability
SIL	Safety integrity level
T1	Test interval
DI	Digital input
DO	Digital output
MTTFd	Mean time to dangerous failure

1.3 Safety Standards and Specifications

Safety standards

Instruction	Standards compliance
Machinery Directive (MD)	2006/42/EC
Low Voltage Directive (LVD)	2014/35/EU
Electromagnetic Compatibility Directive (EMC)	2014/30/EU
RoHS Directive (ROHS)	2011/65/EU Amended by (EU)2015/863
Applicable Harmonized Standards	• EN 60204-1:2018 • EN ISO 10218-1:2011 • EN ISO 12100:2010 • EN 61000-6-2:2019 • EN 61000-6-4:2019 • ISO 13849-1:2023 • EN ISO 13849-1:2015

Safety parameter

ISO 13849-1	Safety parameter
PL	d
DC	Medium
Category	3
MTTFd	High
PFHd	< 0.2 x 10^{-6} (max. 20% of SIL2)

Mark	Safety function	Safety state	PFHd (6-axis robot)	PFHd (SCARA robot)
SF1	Emergency Stop	Category 0 Stop	1.19 x 10^{-7}	8.84 x 10^{-8}
SF2	Additional Emergency Stop	Category 0 Stop	4.29 x 10^{-8}	4.29 x 10^{-8}
SF3	Emergency Stop Switch Status Output	RO Output Open	4.29 x 10^{-8}	4.29 x 10^{-8}
SF4	Protective Stop	Category 0 Stop	4.29 x 10^{-8}	4.29 x 10^{-8}
The following are the functions that use with a safety card				

Mark	Safety function	Safety state	PFHd (6-axis robot)	PFHd (SCARA robot)
SF5	External Emergency Stop	Category 0/1 Stop for user configuration	4.94×10^{-8}	4.29×10^{-8}
SF6	External Protective Stop	Category 0/1 Stop for user configuration	4.94×10^{-8}	4.29×10^{-8}
SF7	Emergency Stop Status Output	DO Outputs Low level	5.79×10^{-8}	5.79×10^{-8}
SF8	Additional Emergency Stop Status Output	DO Outputs Low Level	4.29×10^{-8}	4.29×10^{-8}
SF9	System Emergency Stop Status Output	DO Outputs Low level	4.29×10^{-8}	4.29×10^{-8}
SF10	Robot Moving Status Output	DO Outputs Low Level	1.03×10^{-7}	5.79×10^{-8}
SF11	Robot Stop Status Output	DO Outputs Low Level	1.03×10^{-7}	5.79×10^{-8}
SF12	Safety Status Output	DO Outputs Low level	4.29×10^{-8}	4.29×10^{-8}
SF13	Safe Manual Mode	Category 0/1 Stop for user configuration	1.78×10^{-7}	1.03×10^{-7}
SF14	Joint Position Monitor	Category 0/1 Stop for user configuration	5.79×10^{-8}	4.29×10^{-8}
SF15	Joint Speed Monitor	Category 0/1 Stop for user configuration	5.79×10^{-8}	4.29×10^{-8}
SF16	TCP Position Monitor	Category 0/1 Stop for user configuration	1.78×10^{-7}	1.03×10^{-7}
SF17	TCP Speed Monitor	Category 0/1 Stop for user configuration	1.78×10^{-7}	1.03×10^{-7}
SF18	3-Position Enabling Function	Category 1 Stop	4.29×10^{-8}	4.29×10^{-8}

NOTE

- The SISTEMA Library file corresponding to the robot safety functions will be released on the Inovance official website. If needed, visit the Inovance official website to download them. If the safety parameters in the SISTEMA Library file are inconsistent with those in this guide, contact Inovance Technology to report the issue and obtain the latest version of the SISTEMA Library.
- The safety functions of SF02, SF03, and SF08 are only available on the controller models IRCB501-6KD-EM-INT and IRCB501-6ND-EM-INT.

1.4 Precaution

Safety Instructions

The chapter contains the warning symbols used in this guide and the safety instructions which you must obey when you install or connect a safety option module to the robot system. Failure to comply with the safety instructions may lead to injury, death or damage. Read through this chapter before installation.

Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.

The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.

Color	Indication	Description	Consequence of negligence
Example:  DANGER  Hazardous voltage Electric shock	DANGER	Critical risk	Ignoring the warning can result in severe physical injury or even death.
	WARNINGS	General risk	Ignoring the warning may result in severe physical injury or even death.
	CAUTION	Minor risk	Ignoring the warning may result in minor physical injury.
	STOP	Damage to equipment or environment	Ignoring the warning may result in damage to equipment or environment.



- High attention is required for electrical installation and at the system design to avoid hazards either in normal operation or in the event of equipment malfunction.
- System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read the operating instruction and this safety information.

It is the responsibility of the machine builder/OEM/system integrator to make sure that the stipulations specified in the Machinery Directive are met. Risk analysis and risk assessment is needed before using a product. Make sure that adequate measures are taken to eliminate/reduce the relating risks and components chosen must meet the safety requirements.

This section describes the information that is required before starting operation.

- Read the following safety precautions, risk assessment information, and limitations before starting operation.
- Use of the safety function: Use the safety function after properly understanding all of these information.

NOTE

Incorrect use of safety functions or use of safety functions that are not sufficient to meet the safety requirements of the site may result in personal injury.

Safety Measures

Carefully read and observe the following important precautions when using safety functions:

- An E-stop is often provided in a machine to allow for unexpected situations where an operator sees a hazard and can take action to prevent an accident.
- The design requirement for an E-stop differs from that of a safety interlock. The emergency stop function is typically required to operate independently of any complex or intelligent control systems, relying instead on dedicated electromechanical devices. It may either disconnect the power or initiate a rapid stop using other means such as dynamic or regenerative braking.

NOTE

- The design of safety-related systems requires specialist knowledge. To ensure that a complete control system is safe, it is necessary for the whole system to be designed according to recognized safety principles. An individual subsystem with the STO function is intentionally designed for safety-related applications. However, it cannot ensure the safety of the entire system.
- The STO function can be used to stop the drive in emergency stop situations.
- This publication is a guide to the application of safety function, and also on the design of safety-related systems for machinery control.
- It is the responsibility of designer of the end product or application to ensure that it is safe and in compliance with the relevant regulations.

Risk Assessment

- When using the safety functions, perform risk assessment on the robot system in advance. Make sure that the safety integrity level of the standards is met.
- Even when the STO function is in use, the following residual risks may exist. Therefore, safety must always be given consideration during risk assessment.

To ensure safety, users should decide all the risk assessments and residual risks in the entire machine equipment. Companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning. Additionally, when complying with a European machinery directive, the related sub system must acquire safety standards certification, and the whole equipment or system is subject to all risk assessments and safety class certification.

The following shows residual risks concerning the safety function of this product.

Common residual risks

- At the shipment to end-users, check the settings of safety related components with programming tools and monitored/displayed contents on display and record and save the setting data concerning the safety observation function and the programming tools you used. Perform them using a check sheet, etc.
- The safety will not be ensured such as in assembling machine until installing, wiring, and adjustment are completed properly. Install, wire, and adjust your system referring to installation guide for each unit.
- Only qualified personnel are authorized to install, start-up, repair or adjust the machines in which these components are installed. Only trained engineers should install and operate the equipment.
- Separate the wiring for safety observation function from other signal wiring.
- Protect the cables with appropriate ways (routing them in a cabinet, using a cable guard, etc.).
- We recommend using a switch, relay, sensor, etc. which comply with safety standards. When using a switch, relay, sensor, etc. which do not comply with safety standards, perform a safety confirmation.
- Keep the required clearance/creepage distance depending on voltage you use.

Residual risks in each function

- **Safety I/O (ensuring communication safety)**

Ensure that the wiring and external signals are correct for the safety I/O function.

- **Joint position monitoring**
  - The joint position is a soft limit relative to the base. It cannot guarantee the position of the robot in the space. It must be set according to actual working conditions. Otherwise, there may be a safety risk.
  - The joint position monitoring is only applicable to the internal robot axes. The position monitoring of the external axes does not meet the PLd standard.
- **Joint speed monitoring**

The joint speed is calculated based on the transmission mechanism from the motor end to the joint end. If the transmission mechanism is damaged or modified, the joint speed monitoring function may pose a risk.

- **Cartesian position monitoring**

The Cartesian position monitoring is based on the base frame. If the robot base moves, the TCP only represents a spatial position relative to the base. Set the safety parameters properly.

- **Cartesian speed monitoring**

The Cartesian speed monitoring is based on the base frame. If the robot base moves, the speed only represents a speed relative to the base. Set the safety parameters properly.

- **Safety low speed monitoring**

The safety low speed monitoring is active only in manual low-speed mode. For automatic mode and manual high-speed mode, use Cartesian speed monitoring.



The safety monitoring function cannot detect the wear of the robot brakes. Check the brakes regularly to ensure that they work properly. Check that the braking force meets the application requirements. Failure to comply the requirements may result in brake wear and personal injury.

2 Product Information

Product Information

For the international version ("-INT" model) small and medium payload industrial robot system, its corresponding nameplate and model information, component-related information, and corresponding technical specifications, see the "Nameplate and Model", "Components", and "Technical Specifications" sections of the following guides: 19013032 IRCB501-INT Series Robot Controller User Guide, 19012996 IRCB501-EM Series Robot Controller User Guide, and 19012997 IRCB501-EM High-Protection Series Robot Controller User Guide. Contact Inovance technical support for the specific certified models. The following shows the international version ("-INT" model) small and medium payload industrial robot series that have completed functional safety certification:

Functional safety certified small and medium payload industrial robot series (international version, -INT)

No.	Functional safety certified small and medium payload industrial robot series
1	IR-R4/R7/R10/R11/R12/R13/R15/R16/R20/R25/R35
2	IR-R4H/R7H/R10H/R15H/R20H/R25H/R35H
3	IR-CR4H/CR7H/CR10H/CR15H/CR20H/CR25H/CR35H
4	IR-GR4/GR7/GR10/GR11/GR12/GR13/GR15/GR16/GR20/GR25/GR35
5	IR-GR4H/GR7H/GR10H/GR15H/GR20H/GR25H/GR35H
6	IR-CS10/CS16/CS20/CS25/CS30/CS35/CS50/CS5/CS60/CS3/CS4/CS6/CS7/CS8
7	IR-C8/CTS3/CTS4/CTS5/TS4/TS5
8	IR-GS10/GS16/GS20/GS25/GS30/GS35/GS50/GS60/GS4/GS5/GS7/GS8
9	IR- S4/S7/S10/S16/S20/S25/S30/S35/S50/S60
10	IRGF-R10/R20
11	IR-GTS4/GTS5
12	HRTA100-4/5/7/10/20/25/35/50/60/GS20/GS60
13	HRTA300-10/11/12/16/25/30/35/4/R10H/R4H/R7H

Technical specifications

Technical specifications - functional safety certified small and medium payload industrial robot controllers (international version, -INT)

Item	Specification
Operating temperature	0℃ to 45℃, controller model: IRCB501-4AD-INT, IRCB501-4CD-INT, IRCB501-4MD-INT, IRCB501-6LD-INT, IRCB501-6ND-INT, IRCB501-6ND-EM-INT 0℃ to 40℃, controller model: IRCB501-4ED-INT, IRCB501-6FD-INT, IRCB501-6KD-INT, IRCB501-6KD-EM-INT
Operating humidity	20% RH to 95% RH (30℃) (without condensation)
Altitude	≤ 1000 m
EMI immunity	C2

Item	Specification
IP rating	IP20, controller model: IRCB501-4AD-INT, IRCB501-4CD-INT, IRCB501-4ED-INT, IRCB501-6LD-INT, IRCB501-6FD-INT, IRCB501-6KD-INT, IRCB501-6KD-EM-INT IP54, controller model: IRCB501-4MD-INT, IRCB501-6ND-INT, IRCB501-6ND-EM-INT
Overvoltage category	OVCIII
Pollution degree	PD2
Vibration	Application scenario: Tested according to IEC60068-2-6, 0.15 mm amplitude at 5 Hz to 55 Hz, 5 times per axis direction Transportation scenario: Tested according to IEC60068-2-64, 0.01 g^2/Hz power spectral density at 5 Hz to 100 Hz; 0.001 g^2/Hz power spectral density at 200 Hz; 1.14 g Grms

3 Wiring and Installation

3.1 SAFETY Interface Wiring

3.1.1 SAFETY Interface Wiring Method 1

This chapter provides the wiring instructions for the safety terminals (SAFETY terminals) of IRCB501 series and IRCB501 high protection series controllers (excluding IRCB501-6KD-EM-INT and IRCB501-6ND-EM-INT).

3.1.1.1 Interface Definition

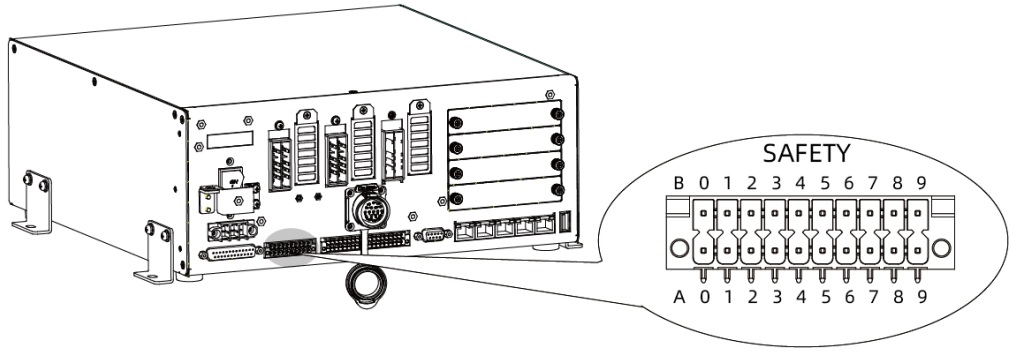
- The SAFETY interface includes input terminals for functions such as external emergency stop, external safety door, and start confirmation. To ensure the safe operation of the robot system, make sure to use these input terminals.
- The emergency stop function is used in emergency situations, usually connected in series with normally closed switches (such as mushroom shaped emergency stop switches). In case of emergency, you can stop the robot system urgently by pressing the emergency stop switch.
- The safety door function ensures the safe operation around the robot system by connecting peripheral gratings and switches. If you want to enter the safe range, you need to disconnect the gratings and switches installed on the periphery.
- The start confirmation function ensures that the robot system safely enters the fully automatic mode operation.

The emergency stop, safety door, and start confirmation functions all adopt dual confirmation signals. Only when both signals are normal can the controller operate normally.



- Connect safety door switch, emergency stop switch, and start confirmation switch, etc., to the SAFETY interface to ensure safety. If the SAFETY interface is not required on site, maintain the factory default wiring. Companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.
- If no safety connection is made or the safety connection is incorrect on the SAFETY interface, the robot system will not function properly.

IRCB501 Series



The emergency stop, safety door, start confirmation, etc. of the controller meet the certification requirements. The specific terminal assignments are as follows.

No.	Assignment	Description	No.	Assignment	Description
A0	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B0	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A1	E-STOP11	SW1 contact for emergency stop/external emergency stop	B1	E-STOP21	SW2 contact for emergency stop/external emergency stop
A2	E-STOP12		B2	E-STOP22	
A3	E-STOP_ RDY1	Positive terminal of the emergency stop input 1	B3	E-STOP_ RDY2	Positive terminal of the emergency stop input 2
A4	E-STOP_ GND	Negative terminal of the 24 V power supply for emergency stop	B4	E-STOP_ GND	Negative terminal of the 24 V power supply for emergency stop
A5	SAFETY-DOOR_COM	Common terminal for the two-channel safety door	B5	SAFETY-ENABLE_GND	Common terminal for the two-channel start confirmation
A6	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B6	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A7	SAFETY-DOOR1+	Safety Door 1	B7	SAFETY-ENABLE1+	Start confirmation 1

No.	Assignment	Description	No.	Assignment	Description
A8	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B8	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A9	SAFETY-DOOR2+	Safety Door 2	B9	SAFETY-ENABLE2+	Start confirmation 2

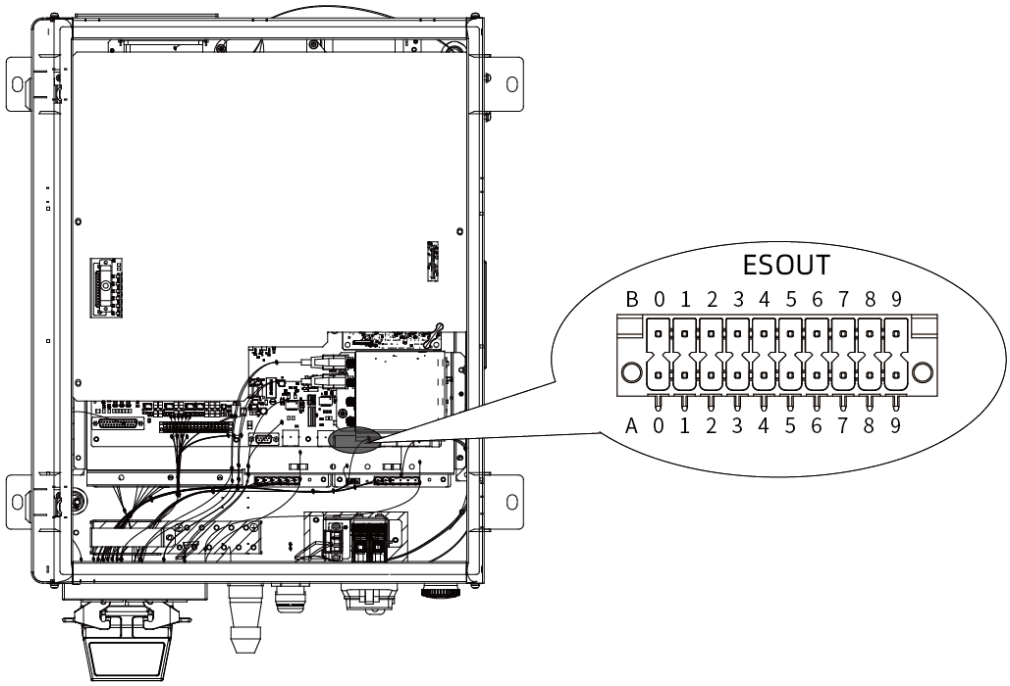
CAUTION

- E-STOP_24V and E-STOP_ GND are 24 V power supply outputs from the controller, with a maximum output current of 60 mA and can only supply power to the safety I/Os.
- If this power supply is used, the SAFETY interface supports passive switch-type devices.
- When an external emergency stop device is connected in series, it must not cause the voltage of E-STOP_24V to drop below 18 V. Otherwise, the emergency stop function may fail after the button is pressed, causing the robot to trigger an alarm and shut down.
- When external wiring causes a short circuit or the output current exceeds 60 mA for a long time, it can cause damage to the power supply inside the controller. The specific wiring method is described in the "Emergency Stop Wiring" below.
- When connecting an external emergency stop device to the SAFETY I/O terminals:
  - Connect the first contact of the external emergency stop device in series to A0/A1, and the second contact in series to B0/B1. For details, see the "Connection of external emergency stop switch (customer) + teach pendant/controller emergency stop switch" diagram in the 3.1.1.3.1 Emergency Stop Wiring section, and observe the corresponding notes in the connection diagram.
  - Connect the first contact of the external emergency stop device in series to A0/A3, and the second contact in series to B0/B3. For details, see the "Connection of external emergency stop switch (customer)" diagram in the 3.1.1.3.1 Emergency Stop Wiring section, and observe the corresponding notes in the connection diagram.
  - When the external emergency stop signal is triggered by the safety DO (PNP type) of an external mechanism/device, it is recommended to connect the external emergency stop signal to the safety DI of the safety expansion card. For details on related wiring and configurations, see the 3.3 Safety DI of Safety Expansion Card section and the 4.2 Safety I/O section. If the robot is not equipped with a safety expansion card, the safety DO (PNP type) output signal from the external mechanism must be converted to a switch signal before being connected to the corresponding SAFETY interface.

The default wiring diagram for the SAFETY interface of the IRCB501 series controller is shown below.

A0	E-STOP_24V	B0	E-STOP_24V
A1	E-STOP11	B1	E-STOP21
A2	E-STOP12	B2	E-STOP22
A3	E-STOP_RDY1	B3	E-STOP_RDY2
A4	E-STOP_GND	B4	E-STOP_GND
A5	SAFETY-DOOR_COM	B5	SAFETY-ENABLE_GND
A6	E-STOP_24V	B6	E-STOP_24V
A7	SAFETY-DOOR1+	B7	SAFETY-ENABLE1+
A8	E-STOP_24V	B8	E-STOP_24V
A9	SAFETY-DOOR2+	B9	SAFETY-ENABLE2+

IRCB501 High-Protection Series



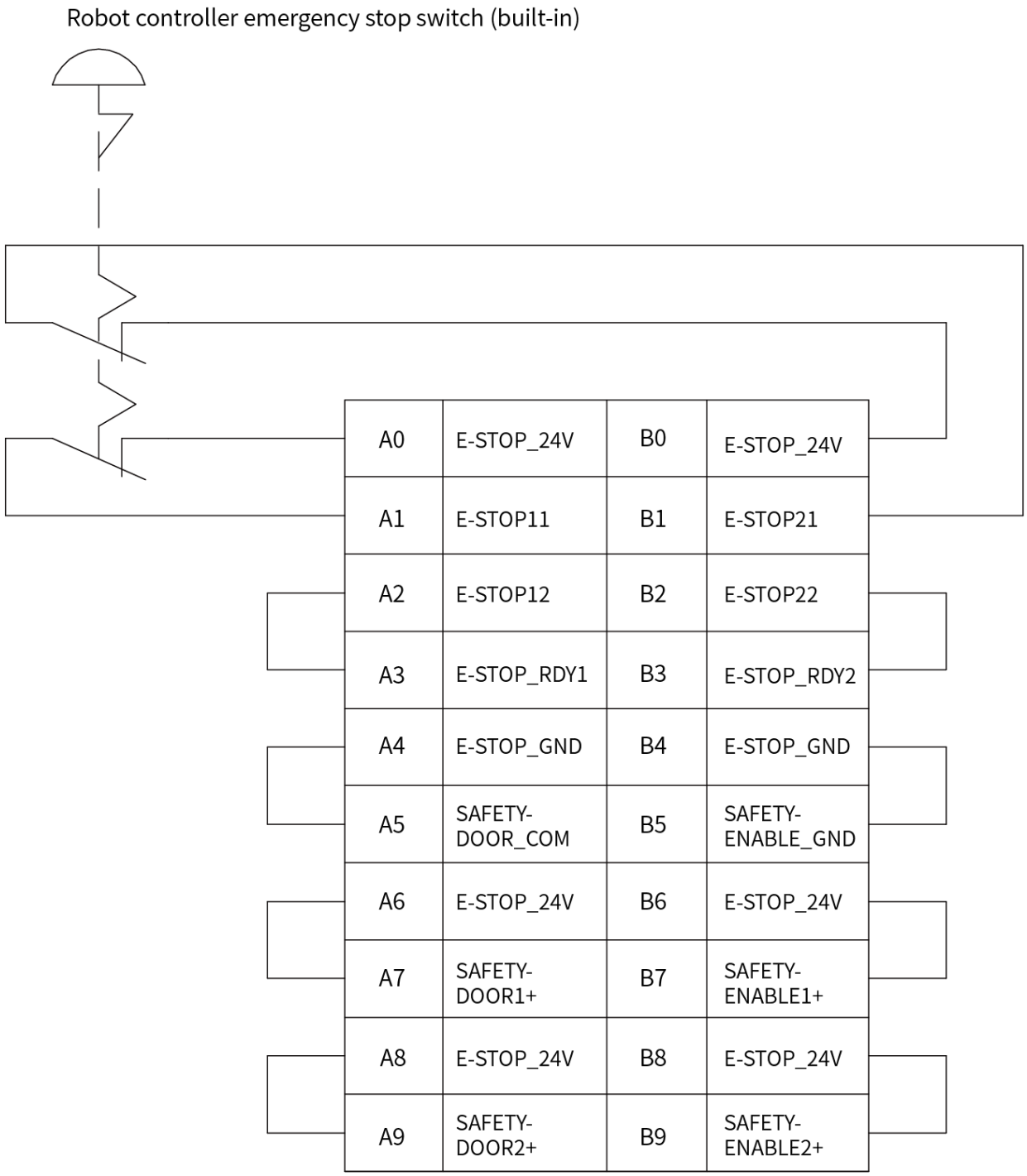
The emergency stop, safety door, and start confirmation functions of the controller meet the certification requirements. The specific safety terminal assignments are as follows.

No.	Assignment	Description	No.	Assignment	Description
A0	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B0	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A1	E-STOP11	SW1 contact for emergency stop/external emergency stop	B1	E-STOP21	SW2 contact for emergency stop /external emergency stop
A2	E-STOP12		B2	E-STOP22	
A3	E-STOP_ RDY1	Positive terminal of the emergency stop input 1	B3	E-STOP_ RDY2	Positive terminal of the emergency stop input 2
A4	E-STOP_ GND	Negative terminal of the 24 V power supply for emergency stop	B4	E-STOP_ GND	Negative terminal of the 24 V power supply for emergency stop
A5	SAFETY-DOOR_COM	Common terminal for the two-channel safety door	B5	SAFETY-ENABLE_GND	Common terminal for the two-channel start confirmation
A6	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B6	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A7	SAFETY-DOOR1+	Safety Door 1	B7	SAFETY-ENABLE1+	Start confirmation 1
A8	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B8	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A9	SAFETY-DOOR2+	Safety Door 2	B9	SAFETY-ENABLE2+	Start confirmation 2

CAUTION

- E-STOP_24V and E-STOP_ GND are 24 V power supply outputs from the controller, with a maximum output current of 60 mA and can only supply power to the safety I/Os.
- If this power supply is used, the SAFETY interface supports passive switch-type devices.
- When an external emergency stop device is connected in series, it must not cause the voltage of E-STOP_24V to drop below 18 V. Otherwise, the emergency stop function may fail after the button is pressed, causing the robot to trigger an alarm and shut down.
- When external wiring causes a short circuit or the output current exceeds 60 mA for a long time, it can cause damage to the power supply inside the controller. The specific wiring method is described in the "Emergency Stop Wiring" below.
- When connecting an external emergency stop device to the SAFETY I/O terminals:
  - Connect the first contact of the external emergency stop device in series to A0/A1, and the second contact in series to B0/B1. For details, see the "Connection of external emergency stop switch (customer) + teach pendant/controller emergency stop switch" diagram in the 3.1.1.3.1 Emergency Stop Wiring section, and observe the corresponding notes in the connection diagram.
  - Connect the first contact of the external emergency stop device in series to A0/A3, and the second contact in series to B0/B3. For details, see the "Connection of external emergency stop switch (customer)" diagram in the 3.1.1.3 Wiring Procedure and Topology Diagram section, and observe the corresponding notes in the connection diagram.
  - When the external emergency stop signal is triggered by the safety DO (PNP type) of an external mechanism, it is recommended to connect the external emergency stop signal to the safety DI of the safety expansion card. For details on related wiring and configurations, see the 3.3 Safety DI of Safety Expansion Card section and the 4.2 Safety I/O section. If the robot is not equipped with a safety expansion card, the safety DO (PNP type) output signal from the external mechanism must be converted to a switch signal before being connected to the corresponding SAFETY interface.

The default wiring diagram for the SAFETY interface of the IRCB501 High-protection series controller is shown below.



3.1.1.2 I/O Specifications

The specifications of I/Os for emergency stop input, safety door and start confirmation input are described below.

Item	Specification
Input connection method	Crimping wiring terminal
Input type	No common point design, supporting bidirectional input
Maximum input voltage	30 VDC

Item	Specification
Input current (typical at 24 V)	Approx. 5 mA
Input Impedance	> 4 kΩ
ON voltage range	18 VDC to 30 VDC
OFF voltage range	0 VDC to 3 VDC
Maximum signal frequency of input	1 kHz
Isolation mode	Optoelectric isolation

3.1.1.3 Wiring and Topology Diagram

3.1.1.3.1 Emergency Stop Wiring

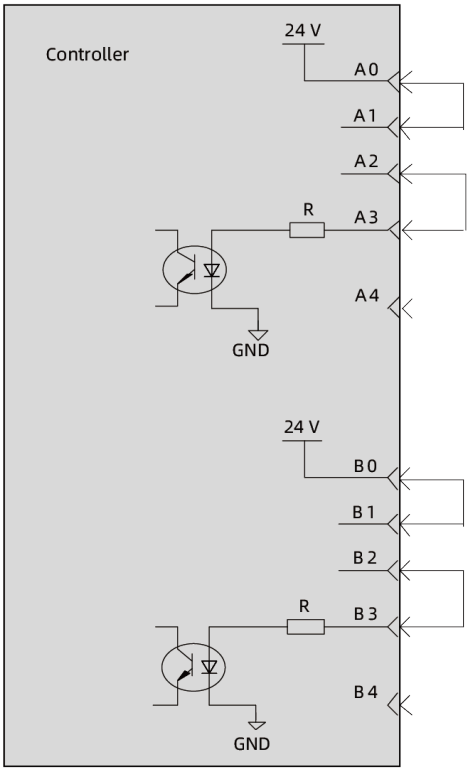
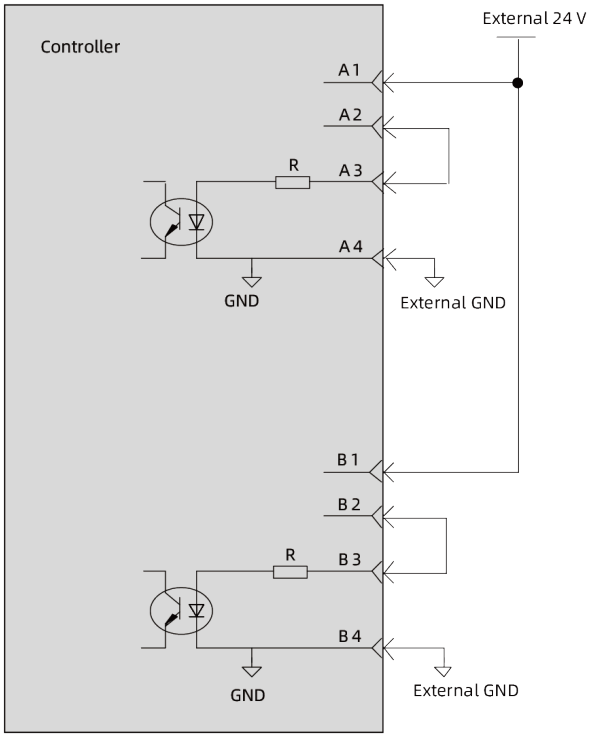
Emergency stop is a normally closed contact connection, with a dual circuit structure. The disconnection of any one circuit will trigger the emergency stop function. For different emergency stop wiring, note the corresponding precautions. The SAFETY interface only accepts passive emergency stop normally closed contact signal. When other signal is used on site, such as an active emergency stop safety DO signal, see the 3.3.3 Wiring Procedure and Topology Diagram section for wiring.



- During normal robot operation, minimize the use of the emergency stop function for non-emergency situations. Emergency stop may cause the robot stop trajectory to deviate from the normal operation trajectory, and the emergency stop shock can reduce the service life of the robot reducer and increase the wear and tear of the motor brake pads. If you want to enter the emergency stop state, first set the robot speed to 0, and then press the emergency stop button.
- In case of an emergency, press the emergency stop button directly to enter the emergency stop state.

The emergency stop function can be triggered by the emergency stop on the robot controller/teach pendant, or the emergency stop signal of a customer emergency stop device connected in series to the emergency stop circuit of the controller/teach pendant. When the emergency stop function of the SAFETY interface is triggered, the safety function **SF01 Emergency Stop** is activated, and the robot performs a Category 0 stop. The following are wiring diagrams for different emergency stop signal trigger sources on the SAFETY terminals:

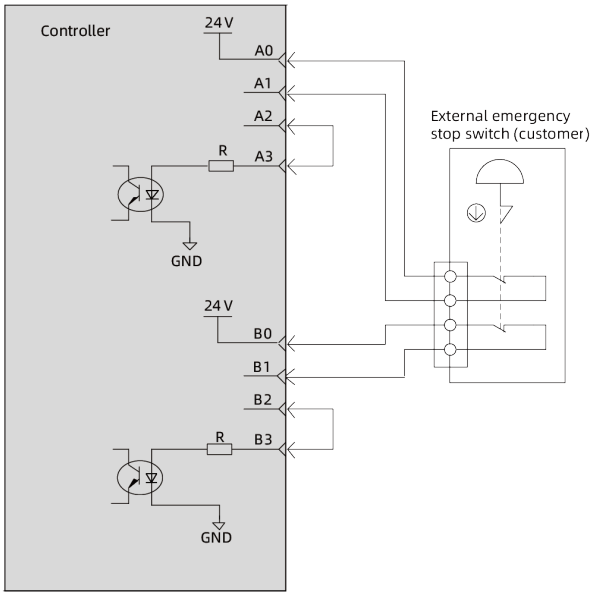
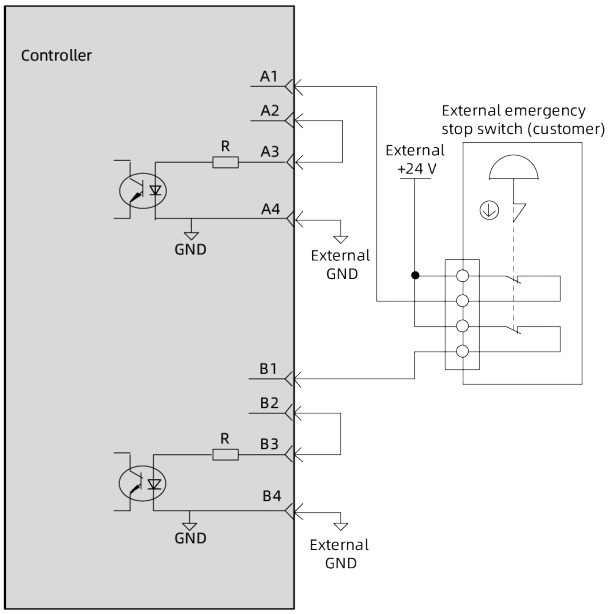
- For the connection using only robot side (teach pendant/controller) emergency stop (dual-circuit (A/B) interlocking mechanism), see the table below.

Using 24 V power supply provided by the controller (default wiring)	Using an external 24 V power supply
	

CAUTION

- The teach pendant emergency stop is not shown in the diagrams above, and "Emergency stop wiring on robot side only" should be consistent with the factory default wiring.
- When the "Connection using only robot side (teach pendant/controller) emergency stop" is adopted, and the safety expansion card is not configured for external emergency stop, the robot has no external emergency stop device (customer). Companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

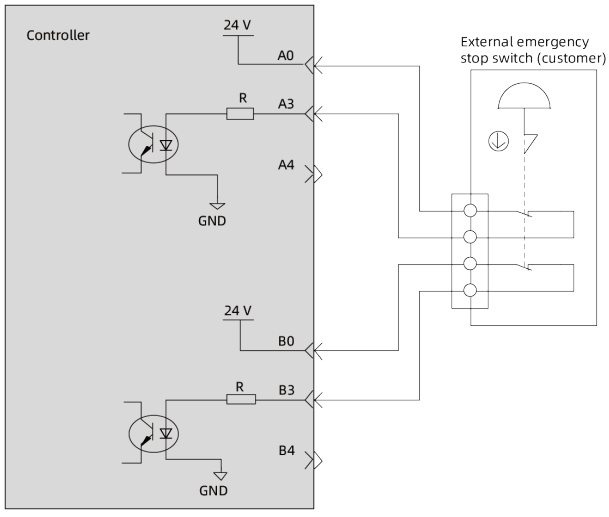
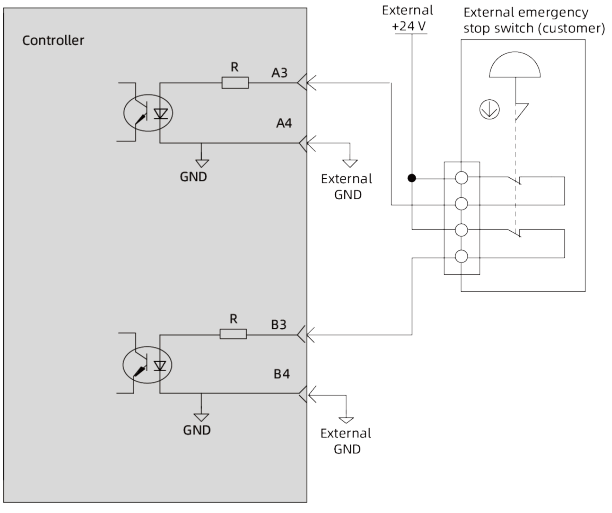
- For the connection using both external emergency stop switch (customer) and robot side (teach pendant /controller) emergency stop (dual-circuit (A/B) interlocking mechanism), see the table below.

Using 24 V power supply provided by the controller	Using an external 24 V power supply
	

CAUTION

When an external emergency stop device is connected to A0/A1/B0/B1 of the SAFETY interface in series, it must not cause the voltage of E-STOP_24V to drop below 18 V. Otherwise, the emergency stop function may fail after the button is pressed, causing the robot to trigger an alarm and shut down.

- For the connection using only external emergency stop (customer) switch (dual-circuit (A/B) interlocking mechanism), see the table below.

Using 24 V power supply provided by the controller	Using an external 24 V power supply
	

CAUTION

- When an external emergency stop device is connected to A0/A3/B0/B3 of the SAFETY interface in series, it must not cause the voltage of E-STOP_24V to drop below 18 V. Otherwise, the emergency stop function may fail after the button is pressed, causing the robot to trigger an alarm and shut down.
- When the "Connection using only external emergency stop switch (customer)" is adopted, the default wiring between A0/A1/A2/A3/B0/B1/B2/B3 will be removed. Note that after removing the default wiring between A0/A1/A2/A3/B0/B1/B2/B3, only the external emergency stop switch (customer) will be active in the system, and the teach pendant/controller emergency stop switch will trigger the emergency stop function. Companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

3.1.1.3.2 Safety Door and Start Confirmation Wiring

Safety door wiring

The wiring terminals for the protective stop function (safety door) can be used for controlling the safety door or safety grating on the surrounding protective fence during robot operation. When the safety door is opened, the safety door signal input is at a low level, the safety function **SF02 Emergency Stop** is activated, and the robot performs a Category 0 stop:

- The safety door utilizes a safety DI detection method with a dual circuit structure.
- The safety door is a normally closed dual-contact connection, with a dual circuit structure. The signal disconnection of any one circuit will trigger the Category 0 stop.

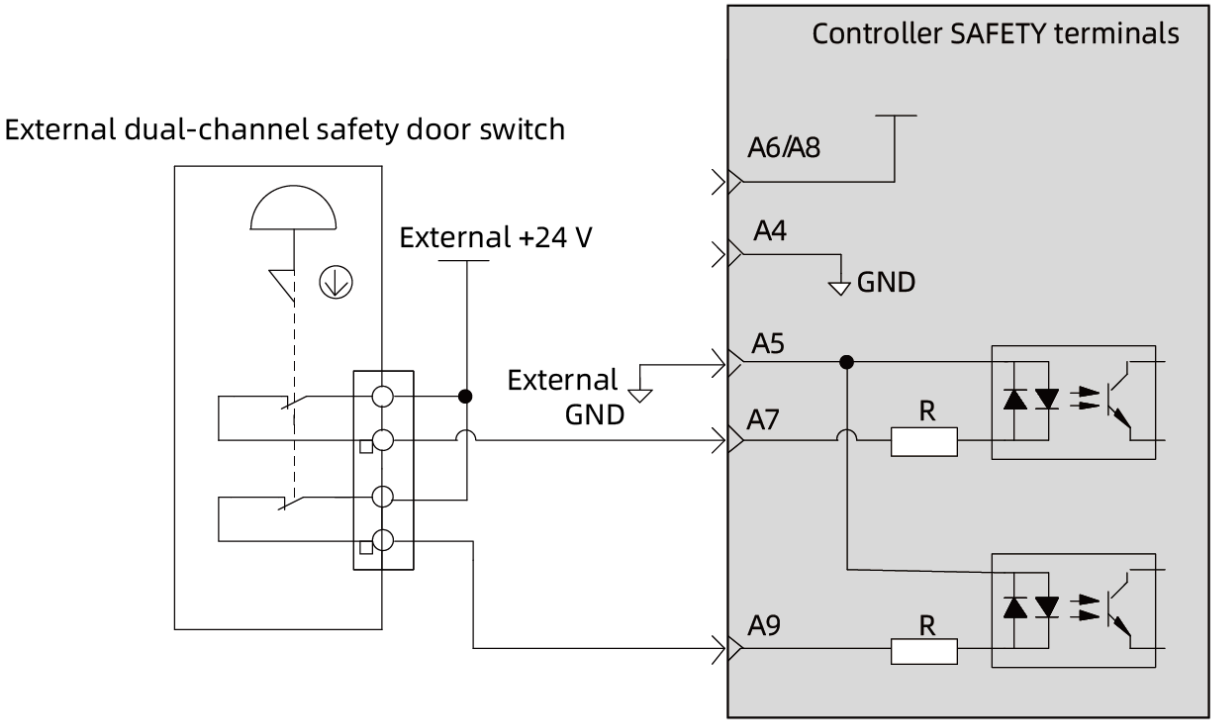
The controller system enables the safety door function by default (with factory default wiring). When using the safety door signal, connect the safety door trigger signal device to the corresponding interface.

CAUTION

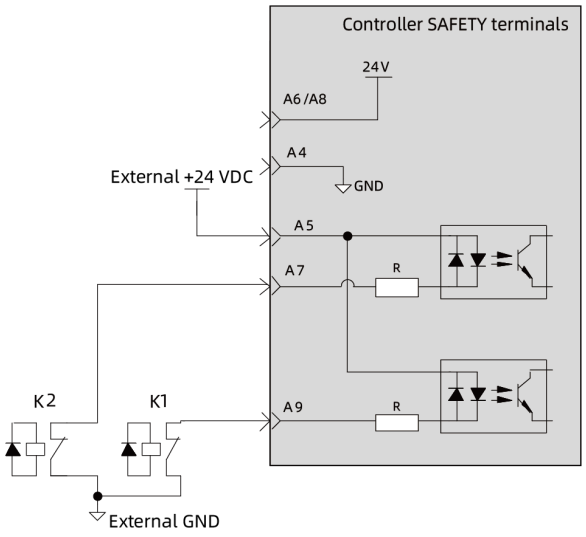
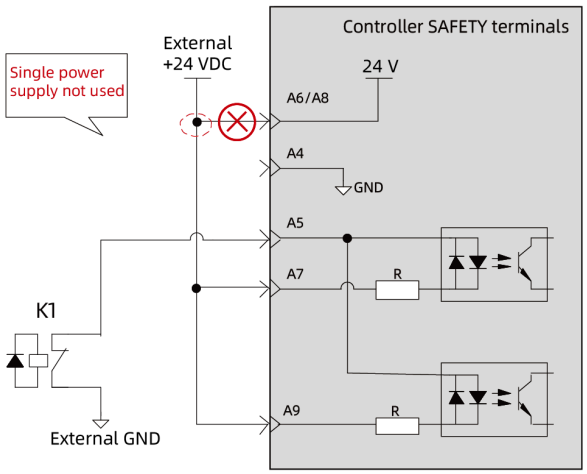
Connect the safety door circuit to the designated I/Os for SAFETY DOOR 1 and SAFETY DOOR 2. The safety door function is active only when both I/O inputs are valid. Otherwise, the system will alarm.

By default, the safety door terminal signal are powered by internal power supply. If you need to use the safety door to trigger the protective stop function, it is recommended to supply power to the safety door trigger device from an external +24 V power supply, and then connect the safety door signal to the corresponding interface terminal on the controller. The wiring for the safety door (protective stop function) is as follows:

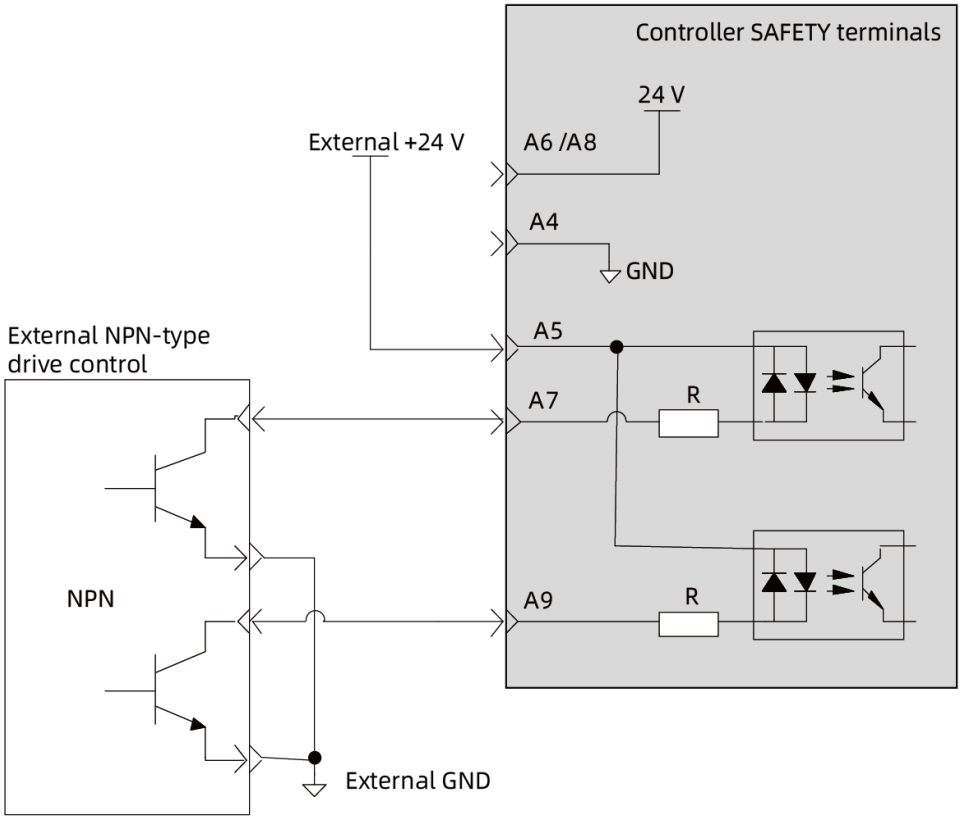
- When the external safety door control uses a dual-switch (recommended wiring with external 24 V power supply), the wiring is as shown below:



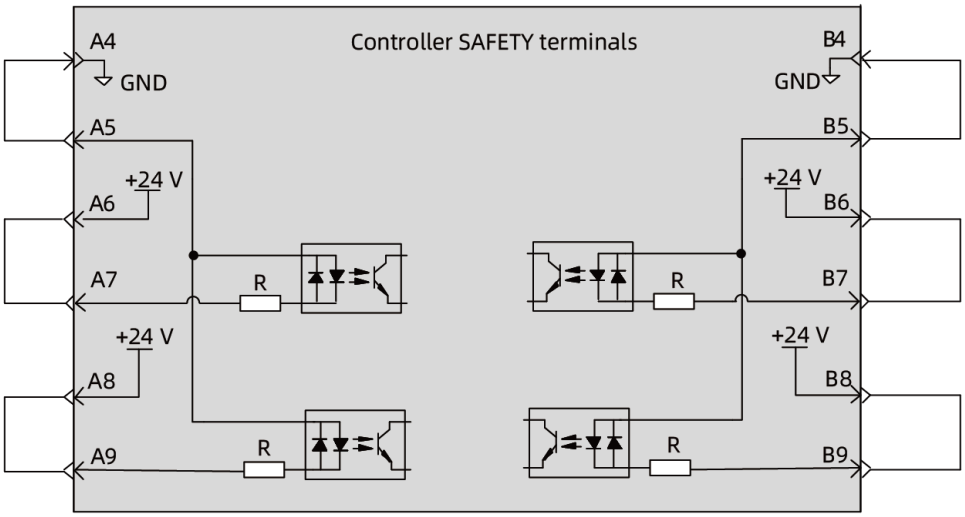
- When the external safety door control uses a relay output (recommended wiring with external 24 V power supply), the wiring is as shown below:

Correct wiring with relay	Incorrect wiring with relay
	

- When the external safety door control uses an NPN-type drive output (recommended wiring with external 24 V power supply), the wiring is as shown below:



- When the safety door function **is not enabled** (factory default wiring), the wiring is as shown below:



CAUTION

If the safety door function (protective stop) is left at factory default wiring, the function will not be enabled, and the robot has no safety door function (customer). Companies and individuals establishing safety-related systems must conduct a risk assessment according to relevant safety standards to ensure that the system meets the safety requirements. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

Start confirmation wiring

The start confirmation function is used to verify the robot's readiness before startup operation. It utilizes a universal DI detection method with a dual circuit structure and operates in the following manner:

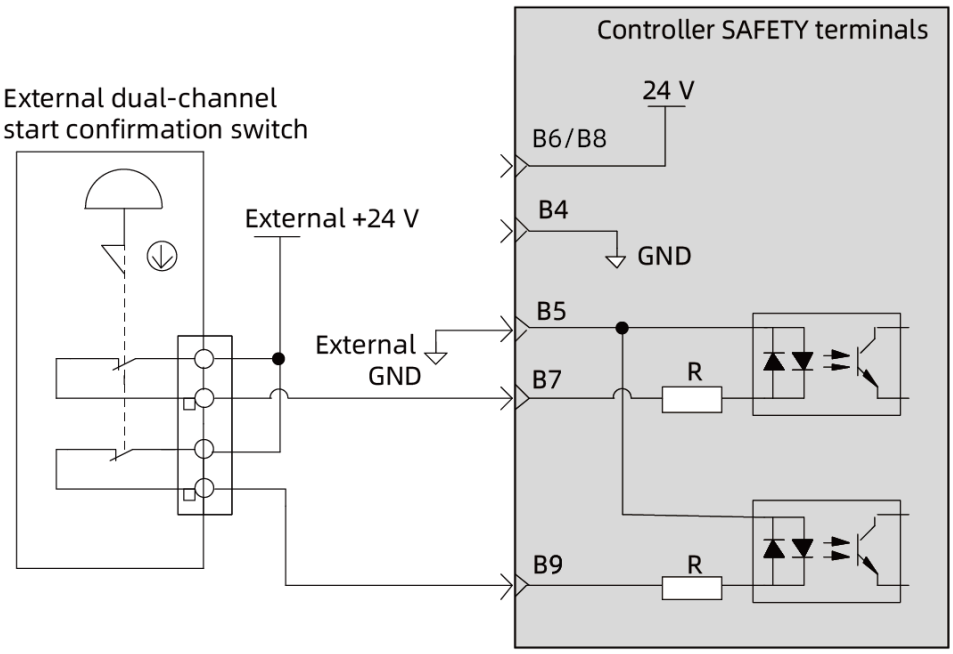
- Rising edge detection method. When the DI port detects a valid rising edge signal (with a pulse width greater than 500 μs) from 0 to 1, the start confirmation function is enabled and active. For example, the external control device uses a self-resetting type contact switch for control.
- If the DI port detects that there is always an ON input level, that is, this function is blocked. For example, the external control device uses a normally closed contact switch for control, and the input is always in a valid state.

The controller system turns on the start confirmation function by default. Therefore, note the wiring as follows:

- When the start confirmation function is active, the I/O detection circuit requires a rising edge input of 0 to 1 before each operation of the system. Otherwise, after the start button is pressed, the system will prompt "Please confirm the startup before automatic operation". Therefore, it is recommended to use a self-resetting switch in the start confirmation control circuit.

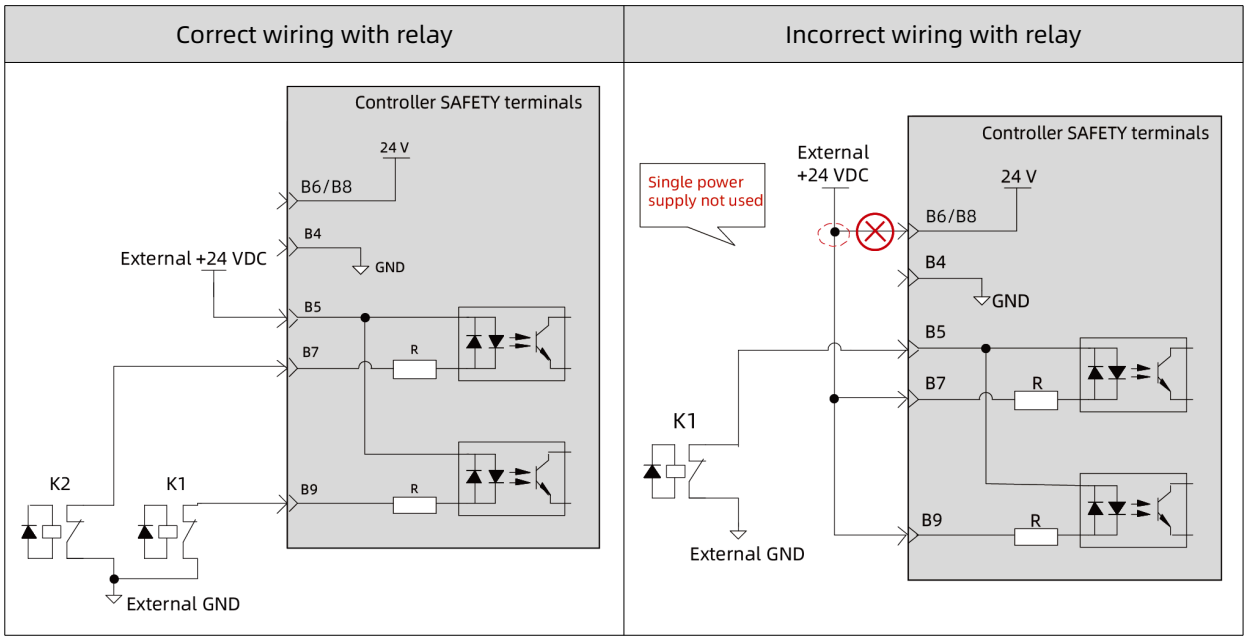
By default, the start confirmation function circuit are powered by internal power supply. If you need to connect an external control device to remotely operate the start confirmation function, it is recommended to use an external +24 V power supply. The wiring for the startup confirmation is as follows:

- When the external start confirmation control uses a dual-switch (recommended wiring with external 24 V power supply), the wiring is as shown below:

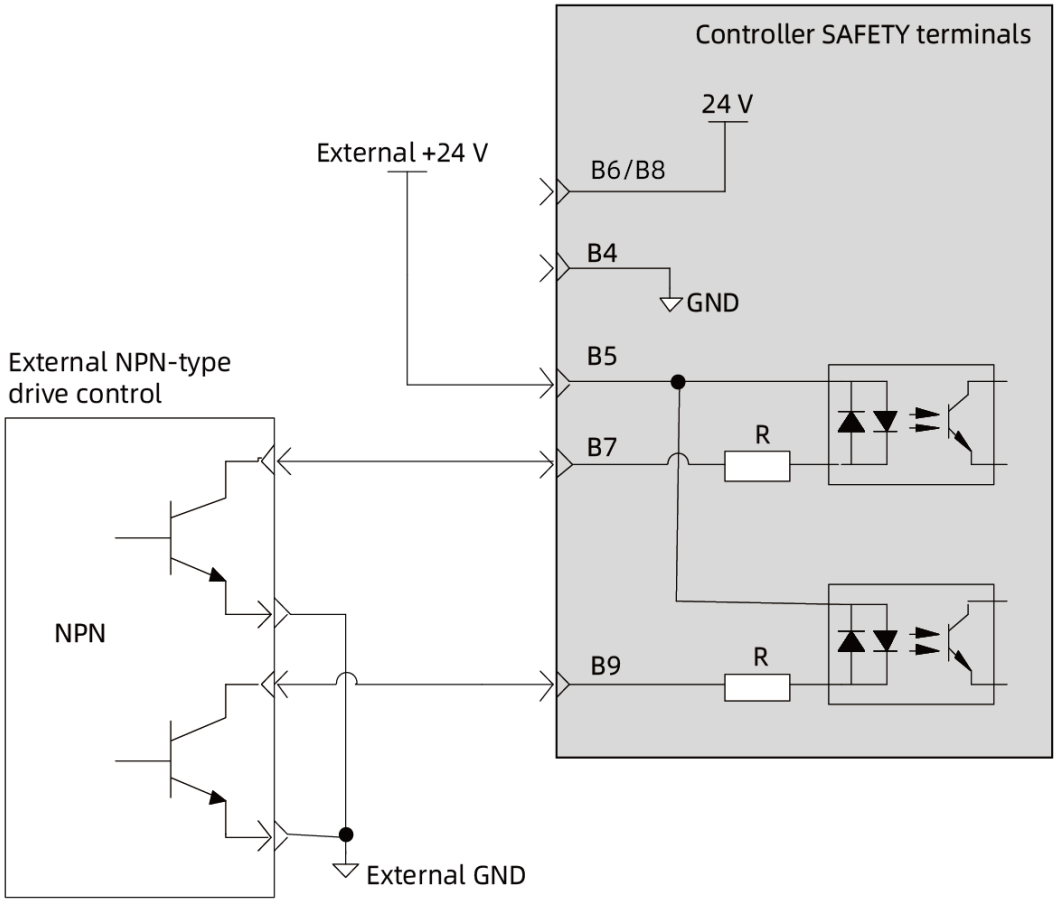


- When the external start confirmation control uses a relay output (recommended wiring with external 24 V power supply), the wiring is as shown below:

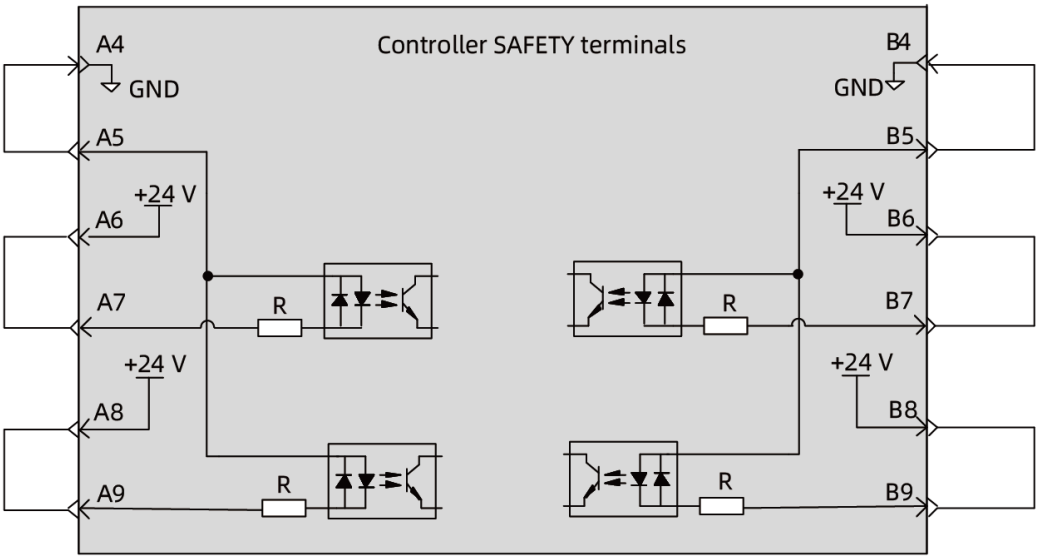
External safety door control (relay output)



- When the external safety door control uses an NPN-type drive output (recommended wiring with external 24 V power supply), the wiring is as shown below:



- The wiring for shielding the start confirmation function (factory default wiring) is as shown below:



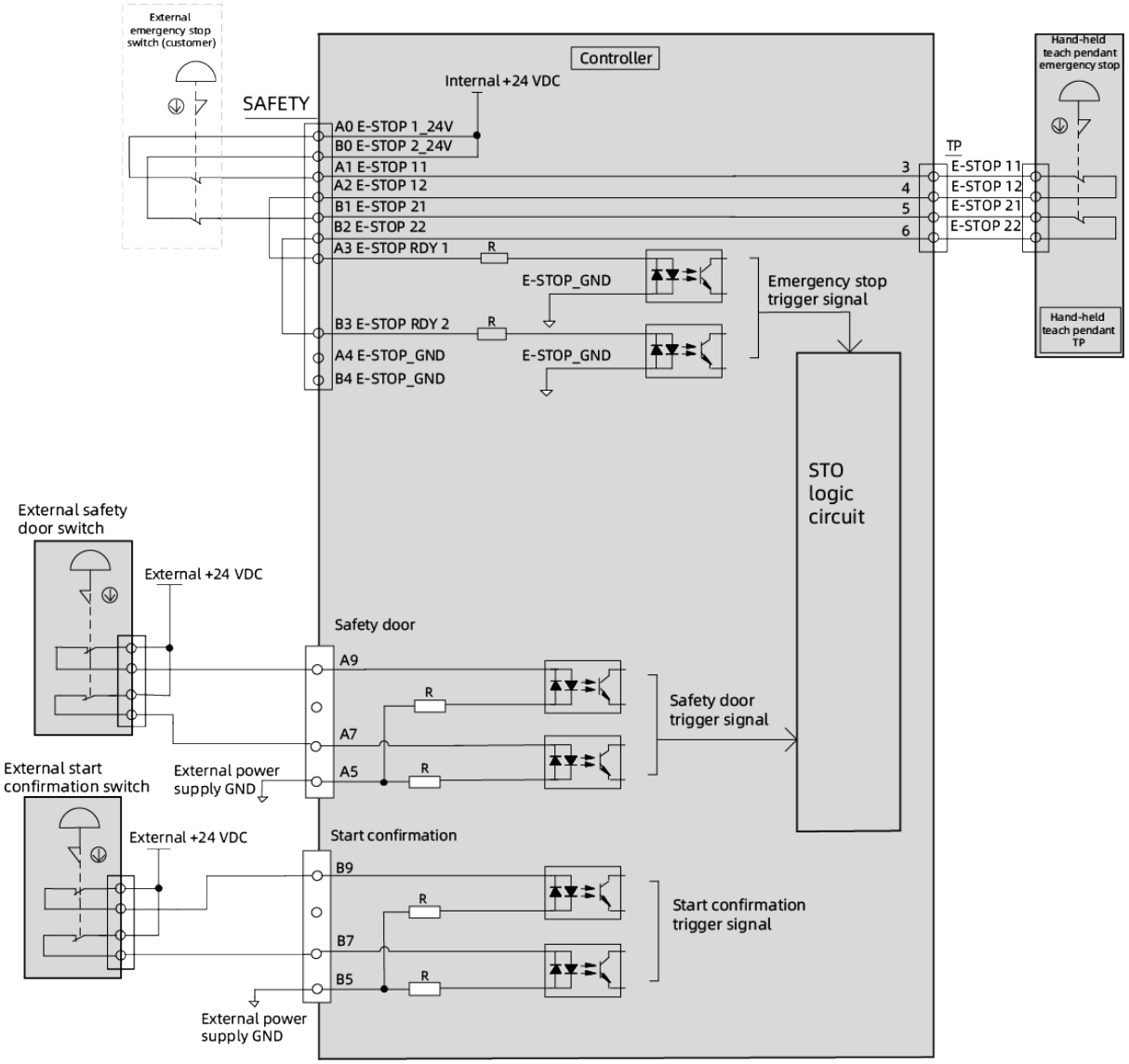
CAUTION

If the start confirmation function is left at factory default wiring, the function will not be enabled, and the robot has no start confirmation function. Companies and individuals establishing safety-related systems must conduct a risk assessment according to relevant safety standards to ensure that the system meets the safety requirements. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

3.1.1.3.3 Topology and Wiring for Emergency Stop, Safety Door and Start Confirmation Functions

Before wiring according to the following wiring topology for the SAFETY interface, read all the precautions in the 3.1.1 SAFETY Interface Wiring Method 1 section.

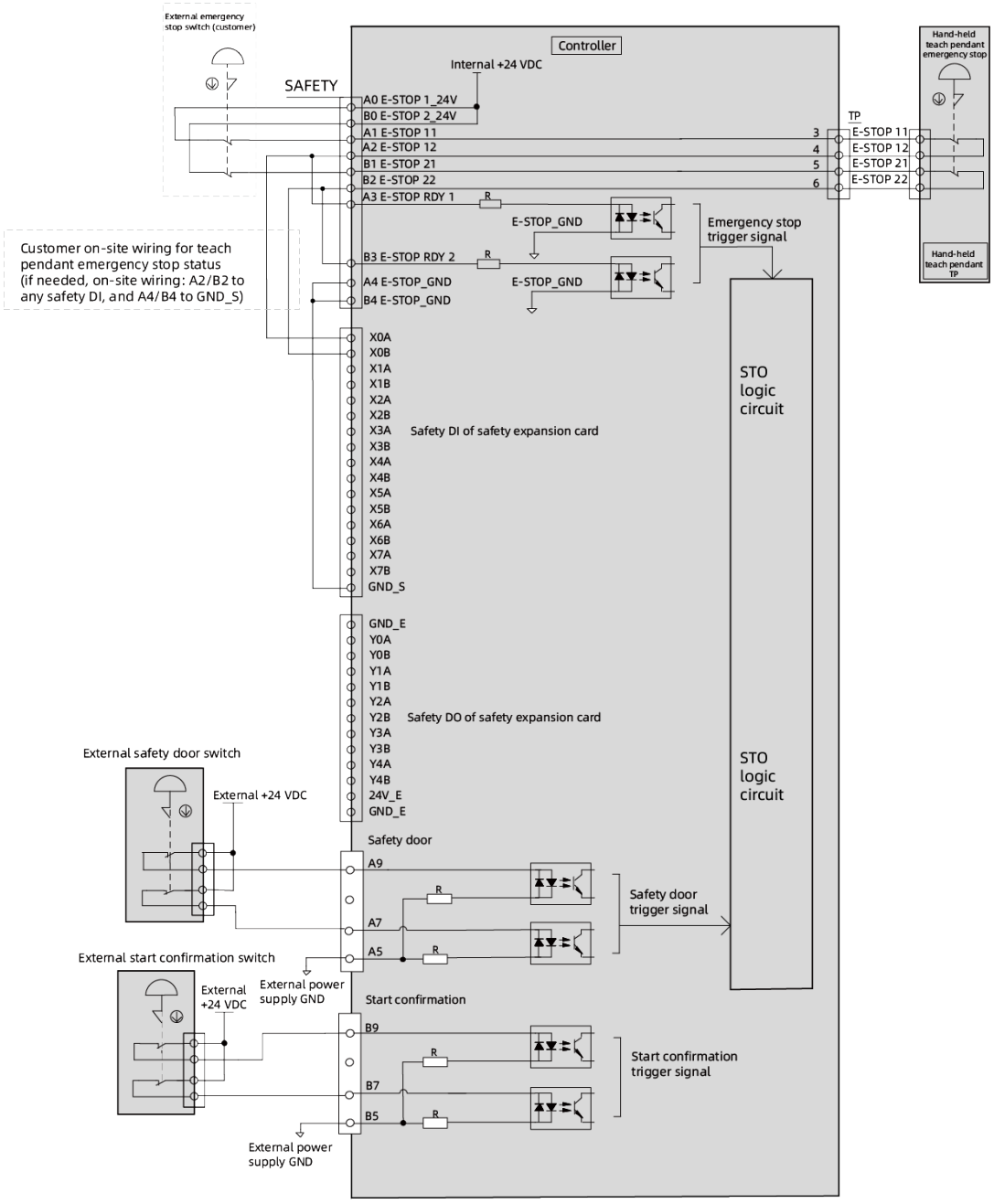
- Topology and wiring for the SAFETY interface of IRCB501 series controller (without safety expansion card):



Topology and wiring for the emergency stop, safety door and start confirmation functions (IRCB501 series controller)

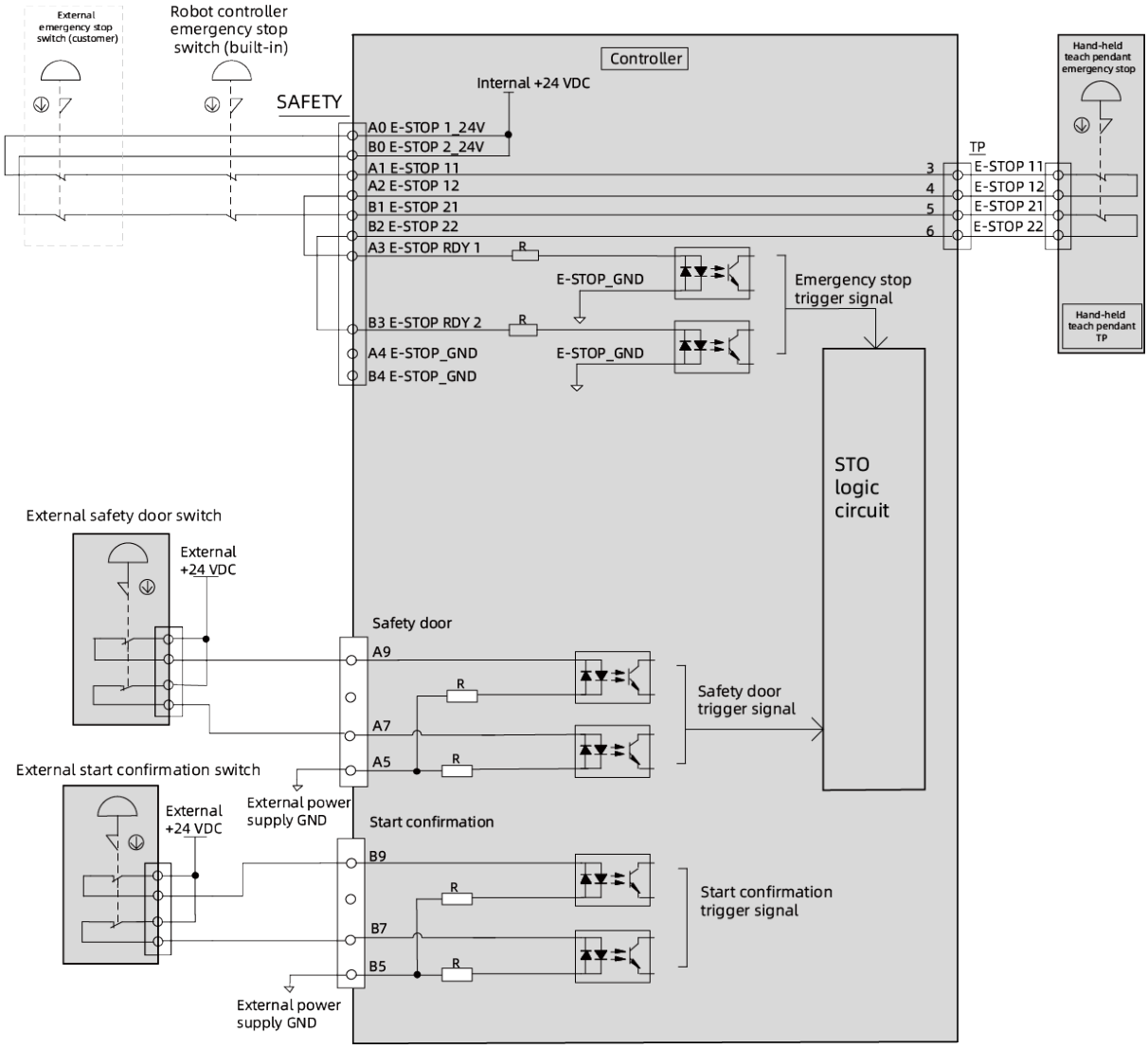
Figure 3-1-1-3-3-2

- Topology and wiring for the SAFETY interface of IRCB501 series controller (with safety expansion card):



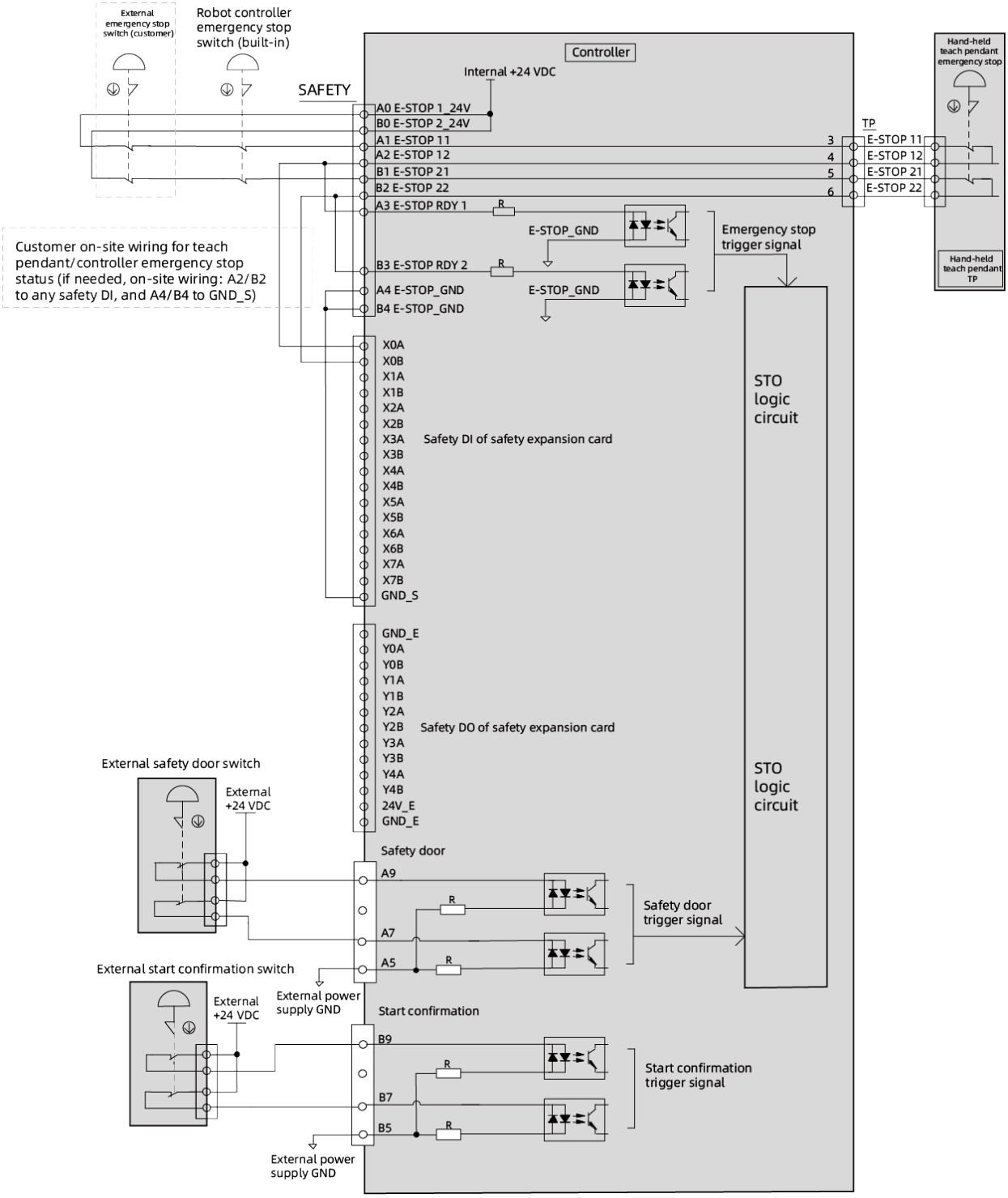
Topology and wiring for the external emergency stop switch, external safety door, external start confirmation and teach pendant/controller emergency stop status output (IRCB501 series controller)

- Topology and wiring for the SAFETY interface of IRCB501 high-protection series controller (without safety expansion card):



Topology and wiring for the emergency stop, safety door and start confirmation functions (IRCB501 high-protection series controller)

- Topology and wiring for the SAFETY interface of IRCB501 high-protection series controller (with safety expansion card):



Topology and wiring for the external emergency stop switch, external safety door, external start confirmation and teach pendant/controller emergency stop status output (IRCB501 high-protection series controller)

3.1.2 SAFETY Interface Wiring Method 2

This chapter provides the wiring instructions for the safety terminals (SAFETY terminals/emergency stop switch status terminals) of IRCB501-6KD-EM-INT and IRCB501-6ND-EM-INT controllers.

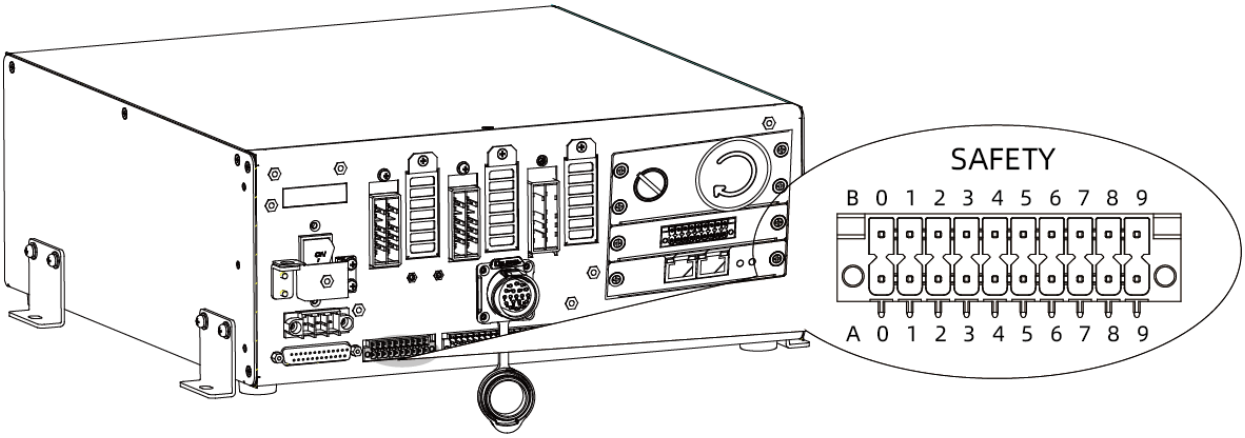
3.1.2.1 Interface Definition

- The SAFETY interface includes input terminals for functions such as external emergency stop, external safety door, and start confirmation. To ensure the safe operation of the robot system, make sure to use these input terminals.
- The emergency stop function is used in emergency situations, usually connected in series with normally closed switches (such as mushroom shaped emergency stop switches). In case of emergency, you can stop the robot system urgently by pressing the emergency stop switch.
- The emergency stop switch status function is used to feedback the status of the emergency stop button on the robot controller or teach pendant.
- The safety door function ensures the safe operation around the robot system by connecting peripheral gratings and switches. If you want to enter the safe range, you need to disconnect the gratings and switches installed on the periphery.
- The start confirmation function ensures that the robot system safely enters the fully automatic mode operation.

The emergency stop, safety door, and start confirmation functions all adopt dual confirmation signals. Only when both signals are normal can the controller operate normally.
The emergency stop switch status function is used to feedback the status of the emergency stop switch button on the robot controller or teach pendant.



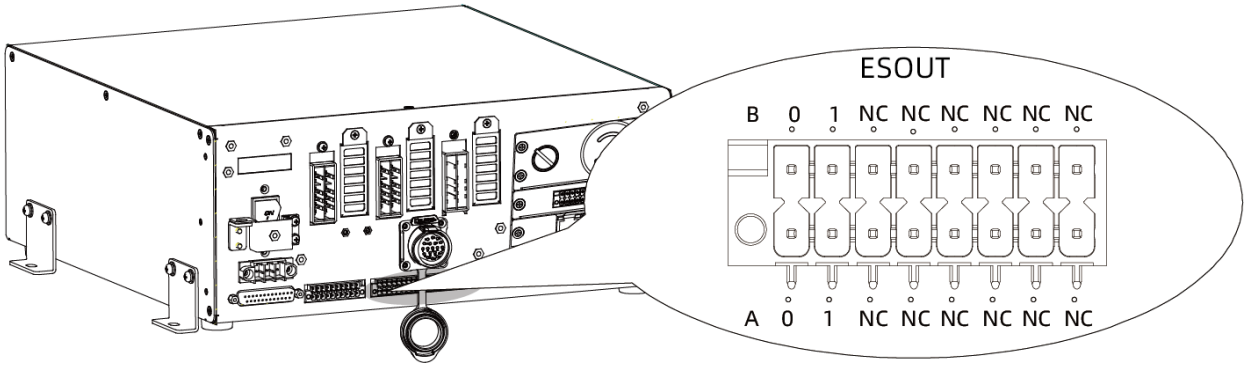
- Connect safety door switch, emergency stop switch, and start confirmation switch, etc., to the SAFETY interface to ensure safety. If the SAFETY interface is not required on site, maintain the factory default wiring. Companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.
- If no safety connection is made or the safety connection is incorrect on the SAFETY interface, the robot system will not function properly.



SAFETY terminals: The emergency stop, safety door, start confirmation, etc. of the controller meet the certification requirements. The specific terminal assignments are as follows.

No.	Assignment	Remarks	No.	Assignment	Remarks
A0	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B0	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A1	E-STOP11	SW1 contact for emergency stop	B1	E-STOP21	SW2 contact for emergency stop
A2	E-STOP12		B2	E-STOP22	
A3	E-STOP_ RDY1	SW1 contact for additional emergency stop	B3	E-STOP_ RDY2	SW2 contact for additional emergency stop
A4	E-STOP_ GND	Negative terminal of the 24 V power supply for emergency stop	B4	E-STOP_ GND	Negative terminal of the 24 V power supply for emergency stop
A5	SAFETY-DOOR_ COM	Common terminal for the two-channel safety door	B5	SAFETY-ENABLE_ GND	Common terminal for the two-channel start confirmation

No.	Assignment	Remarks	No.	Assignment	Remarks
A6	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B6	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A7	SAFETY-DOOR1+	Safety Door 1	B7	SAFETY-ENABLE1+	Start confirmation 1
A8	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)	B8	E-STOP_ 24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
A9	SAFETY-DOOR2+	Safety Door 2	B9	SAFETY-ENABLE2+	Start confirmation 2



ESOUT terminals: The emergency stop switch status output (RO Type) of the controller meets the certification requirements. The specific terminal assignments are as follows.

Emergency stop switch status terminal: ESOUT assignment (RO type)					
A0	ESOUTA0	Positive terminal 0 of emergency stop switch status	B0	ESOUTB0	Negative terminal 0 of emergency stop switch status
A1	ESOUTA1	Positive terminal 1 of emergency stop switch status	B1	ESOUTB1	Negative terminal 1 of emergency stop switch status

NOTE

NC indicates that the terminal is idle and has no electrical connection assigned.

CAUTION

- E-STOP_24V and E-STOP_ GND are 24 V power supply outputs from the controller, with a maximum output current of 60 mA and can only supply power to the safety I/Os.
- If this power supply is used, the SAFETY interface supports passive switch-type devices.
- When an external emergency stop device is connected in series, it must not cause the voltage of E-STOP_24V to drop below 18 V. Otherwise, the emergency stop function may fail after the button is pressed, causing the robot to trigger an alarm and shut down.
- When external wiring causes a short circuit or the output current exceeds 60 mA for a long time, it can cause damage to the power supply inside the controller. For the specific wiring method, see the 3.1.2.3.1 "Emergency Stop Wiring" section below.
- When connecting an external emergency stop device to the SAFETY I/O terminals: Connect the first contact of the external emergency stop device in series to A0/A3, and the second contact in series to B0/B1. For details, see the "Connection of external emergency stop switch (client) + teach pendant/ controller emergency stop switch" diagram in the 3.1.2.3.1 Emergency Stop Wiring section, and observe the corresponding notes in the connection diagram.

The default wiring diagram for the SAFETY interface of the IRCB501-EM series controller is shown below.

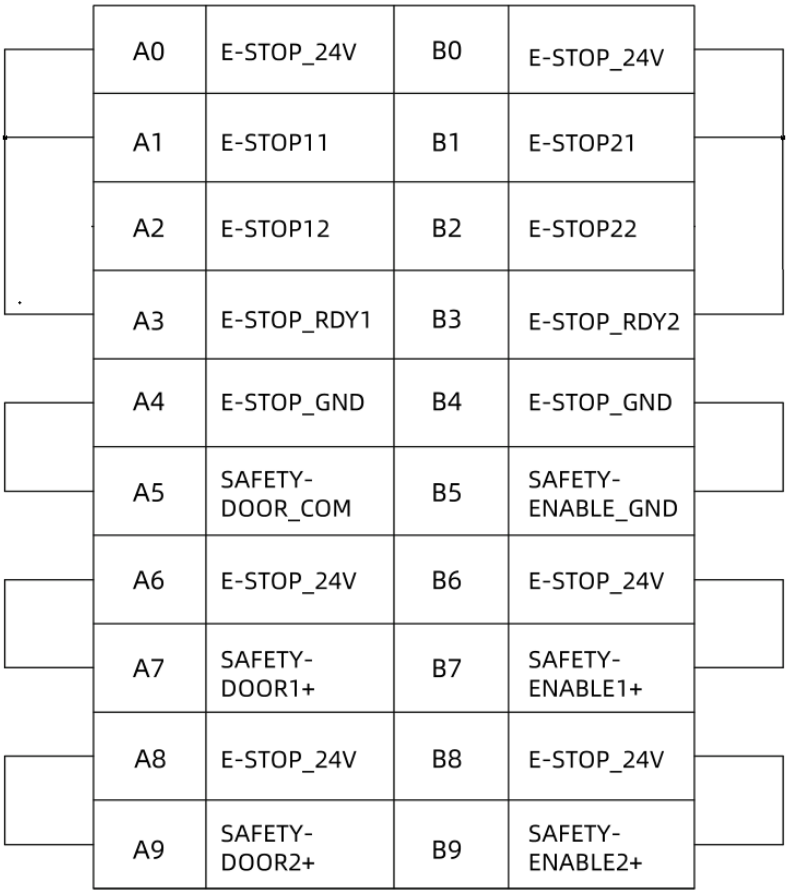


Figure 3-1-2-1-1 Default SAFETY terminal wiring

3.1.2.2 Safety Specifications

3.1.2.2.1 Safety I/O Specifications

The specifications of I/Os for emergency stop input, safety door and start confirmation input are shown in the table below.

Item	Specification
Input connection method	Crimping wiring terminal
Input type	No common point design, supporting bidirectional input
Maximum input voltage	30 VDC
Input current (typical at 24 V)	Approx. 5 mA
Input Impedance	> 4 kΩ
ON voltage range	18 VDC to 30 VDC
OFF voltage range	0 VDC to 3 VDC
Maximum signal frequency of input	1 kHz
Isolation mode	Optoelectric isolation

3.1.2.2.2 Safety ESOUT Specifications

The safety specifications of ESOUT are shown in the table below:

Item	Specification
Number of channels	2
Output mode	Dry contact
Voltage class	≤ 24 VDC
Resistive output load	Single circuit 1A
Hardware response time	< 15 ms (from OFF to ON) < 10 ms (from ON to OFF)
Isolation	Relay isolation, 4000 VAC for 1 min
Short circuit protection	None
Output frequency	< 40 Hz recommended for relay switch

3.1.2.3 Wiring and Topology Diagram

This chapter mainly introduces the wiring instructions and system topology diagram related to the SAFETY interface and the emergency stop switch status.

3.1.2.3.1 Emergency Stop Wiring

Emergency stop is a normally closed contact connection, with a dual circuit structure. The disconnection of any one circuit will trigger the emergency stop function. For different emergency stop wiring, note the corresponding precautions.
The SAFETY interface only provides one set of input terminals for emergency stop normally closed contact signals, which are used for connecting the customer's emergency stop trigger devices. You can connect either a single emergency stop signal or multiple emergency stop signals in series. When multiple external emergency stop signals need to be independently connected to the robot system for on-site applications, see the 3.3 Safety DI of Safety Expansion Card section or the 3.4 Safety DO of Safety Expansion Card section for wiring instructions.



- During normal robot operation, minimize the use of the emergency stop function for non-emergency situations. Emergency stop may cause the robot stop trajectory to deviate from the normal operation trajectory, and the emergency stop shock can reduce the service life of the robot reducer and increase the wear and tear of the motor brake pads. If you want to enter the emergency stop state, first set the robot speed to 0, and then press the emergency stop button.
- In case of an emergency, press the emergency stop button directly to enter the emergency stop state.

When the emergency stop function of the SAFETY interface is triggered, the robot performs a Category 0 stop. The emergency stop function has two types:

- The first type is the additional emergency stop (additional emergency stop function), which uses the safety-dedicated DI terminals for connecting the customer's emergency stop trigger devices.
- The second type is the internal emergency stop (emergency stop function), which refers to the robot controller/teach pendant emergency stop.

Additional emergency stop

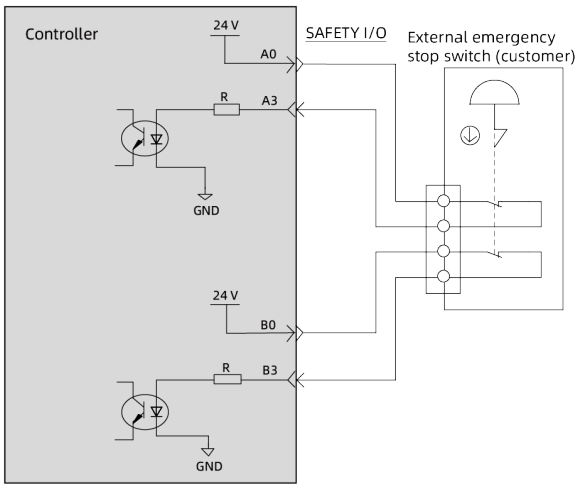
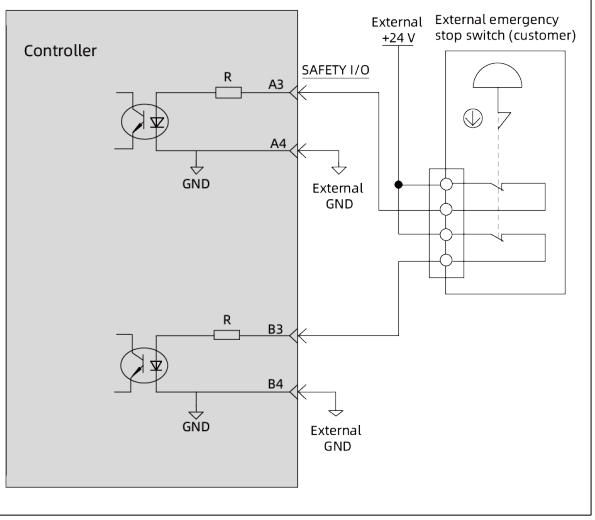
The additional emergency stop uses the safety-dedicated DI terminals for connecting the customer's emergency stop trigger devices. When the "connection of external emergency stop switch (customer)" is adopted, keep the default wiring for robot terminals A0/A1 and B0/B1 unchanged.

CAUTION

- When an external emergency stop device is connected to A0/A3/B0/B3 of the SAFETY interface in series (powered by robot internal 24 V power supply), it must not cause the voltage of EXT-SAFETY_24V_IN to drop below 18 V. Otherwise, the emergency stop function will be activated directly, causing the robot to trigger an alarm and shut down.
- If the default wiring between the robot terminals A0/A1/B0/B1 is accidentally removed, the emergency stop function of the teach pendant/controller emergency stop switch will be activated. Consequently, the robot will trigger an emergency stop and will not be able to start.
- If the controller emergency stop function is ineffective due to the modification of the default wiring for robot controller emergency stop, and the teach pendant is not connected, and the safety DI on the robot's safety expansion card is not configured for the emergency stop function, and the dedicated DI for additional emergency stop is not connected to the customer's emergency stop device, then the entire system will have no emergency stop function, posing a safety risk to the robot system. Companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards.

The following wiring diagram illustrates the connection of an external emergency stop switch (customer) to the SAFETY terminal, including two methods for using internal and external independent power supplies.

- For the connection using an external emergency stop (customer) switch (dual-circuit (A/B) interlocking mechanism), see the table below.

Using 24 V power supply provided by the controller	Using an external 24 V power supply
	

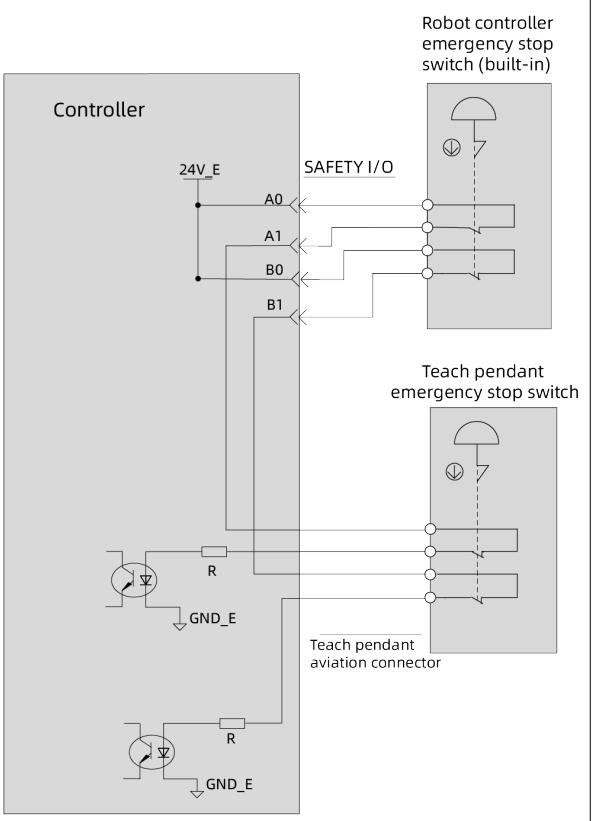
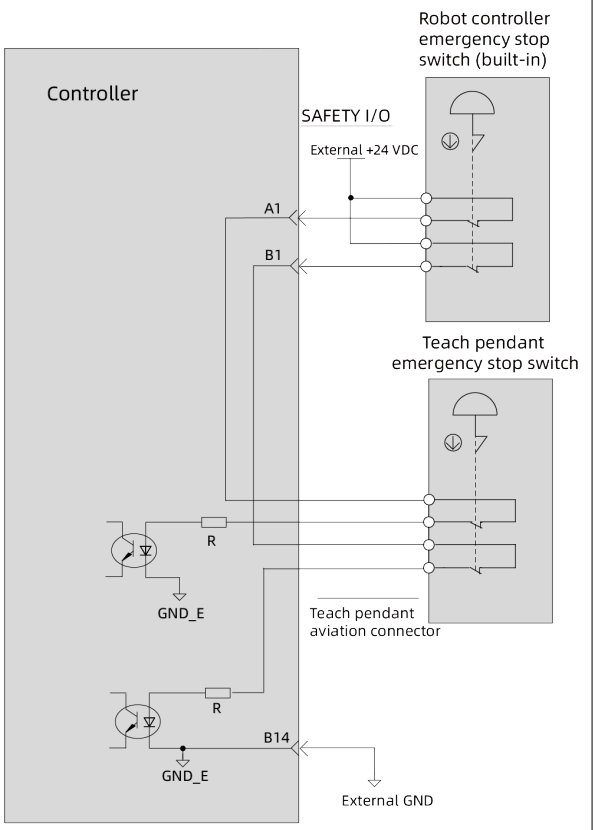
CAUTION

- When using an external emergency stop (customer) device, see the above diagram for emergency stop wiring. It is not recommended to connect the external emergency stop (customer) device in series with the internal emergency stop (controller/teach pendant emergency stop) via the A0/A1/B0/B1 terminals.
- When the "connection using only external emergency stop switch (customer)" is adopted, the default wiring between the terminals A0/A1/A3/B0/B1/B3 will be removed.
  At this point, the default wiring between A0/A1/B0/B1 should remain removed. Otherwise, the emergency stop switch on the teach pendant/controller will trigger an emergency stop.
- When the "Connection using only external emergency stop switch (customer)" is adopted, and the controller emergency stop function is ineffective due to the modification of the default wiring for robot controller emergency stop, and the teach pendant is not connected, and the safety DI on the robot's safety expansion card is not configured for the emergency stop function, then only the external emergency stop switch (customer) will be active in the system. At this point, companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

Internal emergency stop

The internal emergency stop refers to the robot controller/teach pendant emergency stop. Pressing any emergency stop switch on the robot controller or the teach pendant will trigger the emergency stop function. When the teach pendant is not connected, the teach pendant interface on the controller must be plugged with a cap. Otherwise, the emergency stop function will be triggered.
The following wiring diagram illustrates the connection of the internal emergency stop, including two methods for using internal and external independent power supplies.

- For the connection using robot controller/teach pendant emergency stop (dual-circuit (A/B) interlocking mechanism), see the table below.

Using 24 V power supply provided by the controller	Using an external 24 V power supply
	

CAUTION

- When the teach pendant is not connected, the teach pendant interface on the controller must be plugged with a cap. Otherwise, the emergency stop function will be triggered.
- When the "Connection using only robot side (teach pendant/controller) emergency stop" is adopted, if the robot has no external emergency stop device (customer), the companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

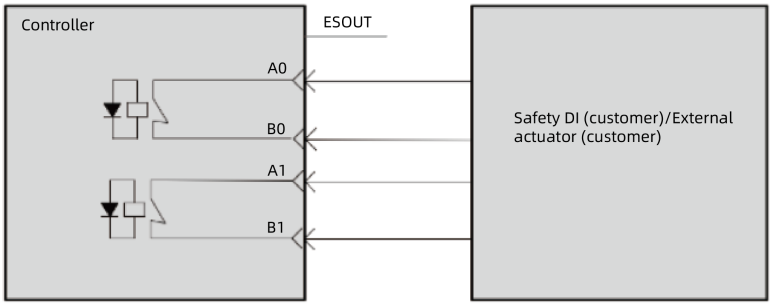
3.1.2.3.2 Wiring for Emergency Stop Switch Status Function

The emergency stop switch status function is used to feedback the status of the emergency stop switch button on the robot controller or teach pendant. The output is via a relay (RO), and the contact is normally closed by default.

When the emergency stop switch on the robot controller or teach pendant is pressed, the emergency stop switch status output provides a disconnection signal. When the emergency stop switch on the robot controller or teach pendant is in a normal state, the emergency stop switch status output provides a connection signal:

- The emergency stop switch function uses an ESOUT output method with a dual-circuit structure.

- The emergency stop switch status output is the status output of the emergency stop switch on the controller or teach pendant, with connection terminals A0/B0 and A1/B1 of ESOUT.
- The emergency stop switch status output is enabled by default. When not in use, the interface wiring remains in its factory state.
- When the robot integrated system needs to utilize the emergency stop switch signal from the robot controller or the teach pendant, the wiring is as shown below:



3.1.2.3.3 Safety Door and Start Confirmation Wiring

Safety door wiring

The wiring terminals for the protective stop function (safety door) can be used for controlling the safety door or safety grating on the surrounding protective fence during robot operation. When the safety door is opened, the safety door signal input is at a low level, the safety function SF02 Emergency Stop is activated, and the robot performs a Category 0 stop:

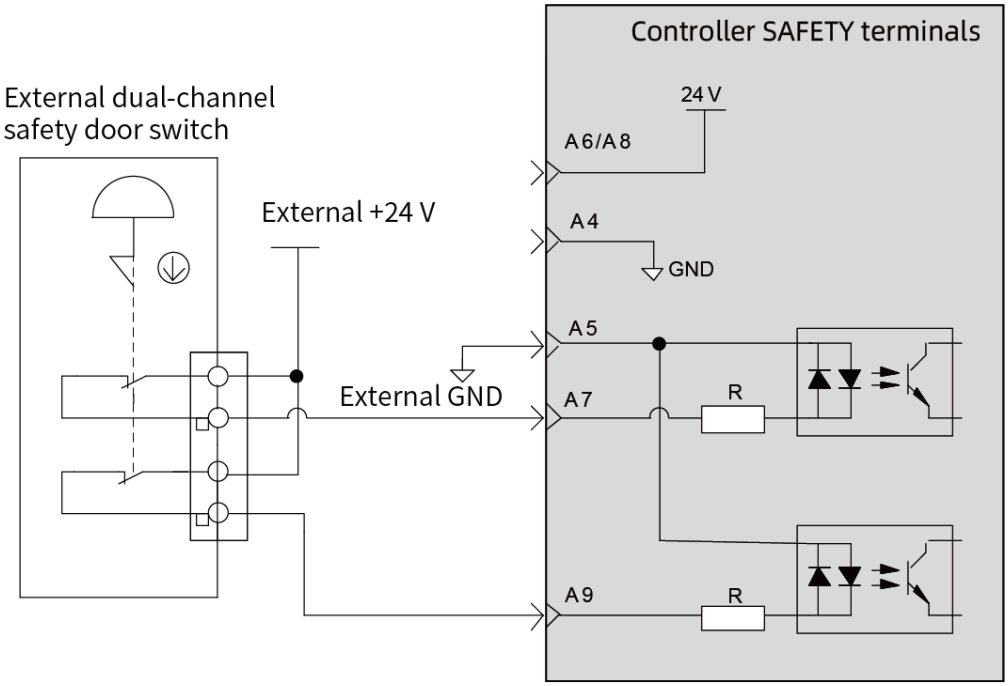
- The safety door utilizes a safety DI detection method with a dual circuit structure.
- The safety door is a normally closed dual-contact connection, with a dual circuit structure. The signal disconnection of any one circuit will trigger the Category 0 stop.

The controller system enables the safety door function by default (with factory default wiring). When using the safety door signal, connect the safety door trigger signal device to the corresponding interface.

> **CAUTION**
>
> Connect the safety door circuit to the designated I/Os for SAFETY DOOR 1 and SAFETY DOOR 2. The safety door function is active only when both I/O inputs are valid. Otherwise, the system will alarm.

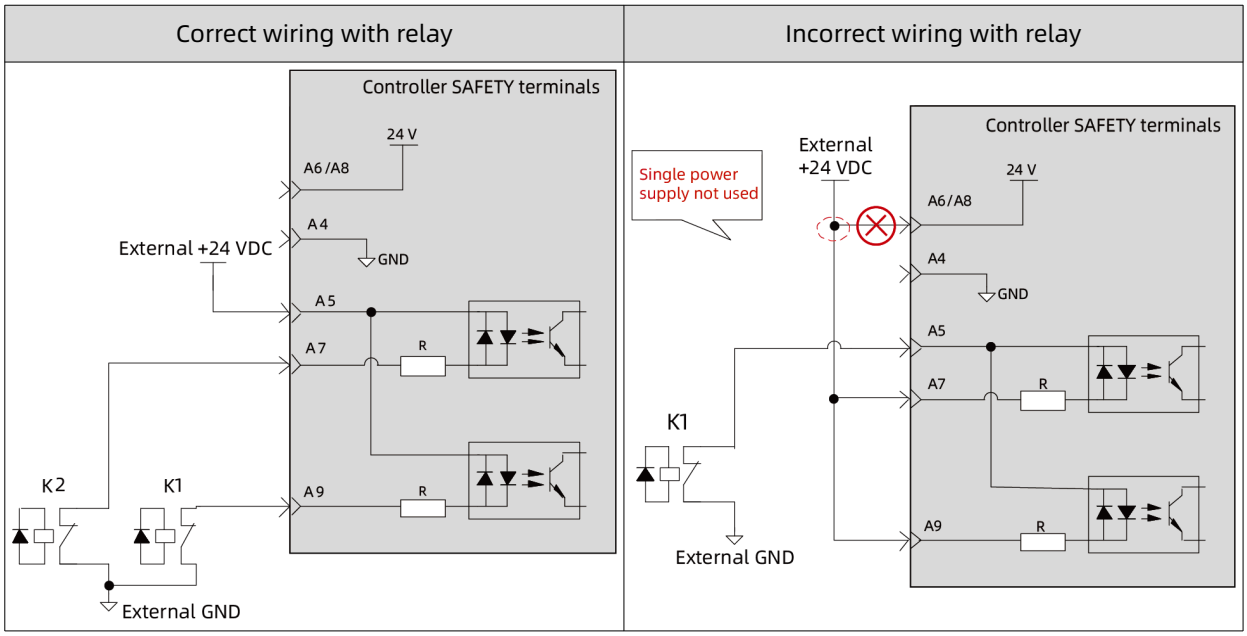
By default, the safety door terminal signal are powered by internal power supply. If you need to use the safety door to trigger the protective stop function, it is recommended to supply power to the safety door trigger device from an external +24 V power supply, and then connect the safety door signal to the corresponding interface terminal on the controller. The wiring for the safety door (protective stop function) is as follows:

- When the external safety door control uses a dual-switch (recommended wiring with external 24 V power supply), the wiring is as shown below:

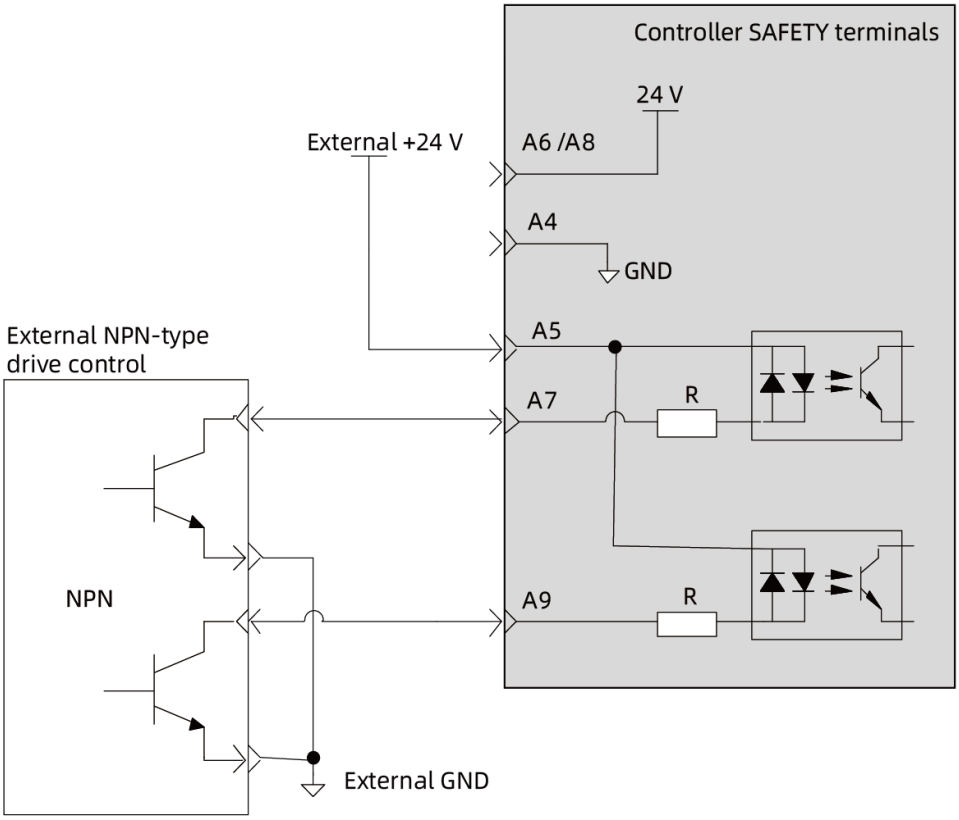


- When the external safety door control uses a relay output (recommended wiring with external 24 V power supply), the wiring is as shown below:

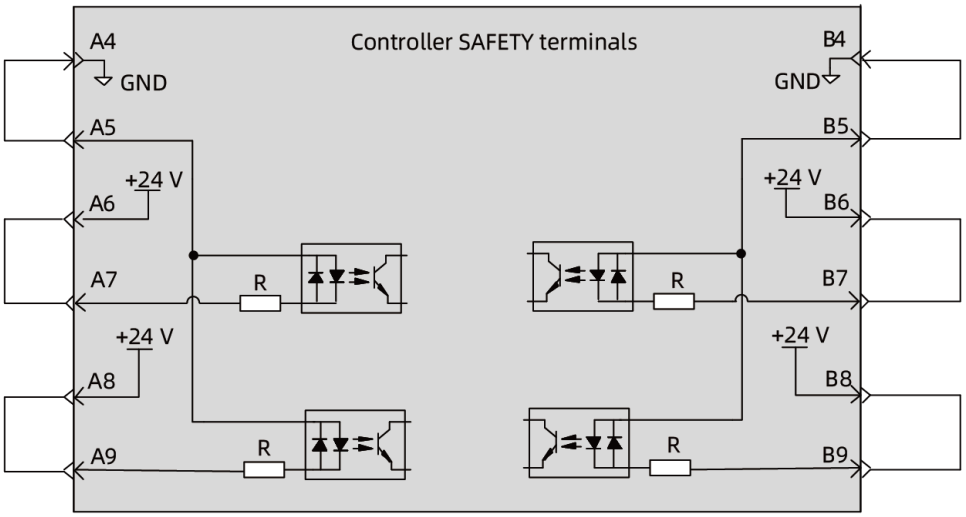
External safety door control (relay output)



- When the external safety door control uses an NPN-type drive output (recommended wiring with external 24 V power supply):



- When the safety door function is not enabled (factory default wiring), the wiring is as shown below:



CAUTION

If the safety door function (protective stop) is left at factory default wiring, the function will not be enabled, and the robot has no safety door function (customer). Companies and individuals establishing safety-related systems must conduct a risk assessment according to relevant safety standards to ensure that the system meets the safety requirements. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

Start confirmation wiring

The start confirmation function is used to verify the robot's readiness before startup operation. It utilizes a universal DI detection method with a dual circuit structure and operates in the following manner:

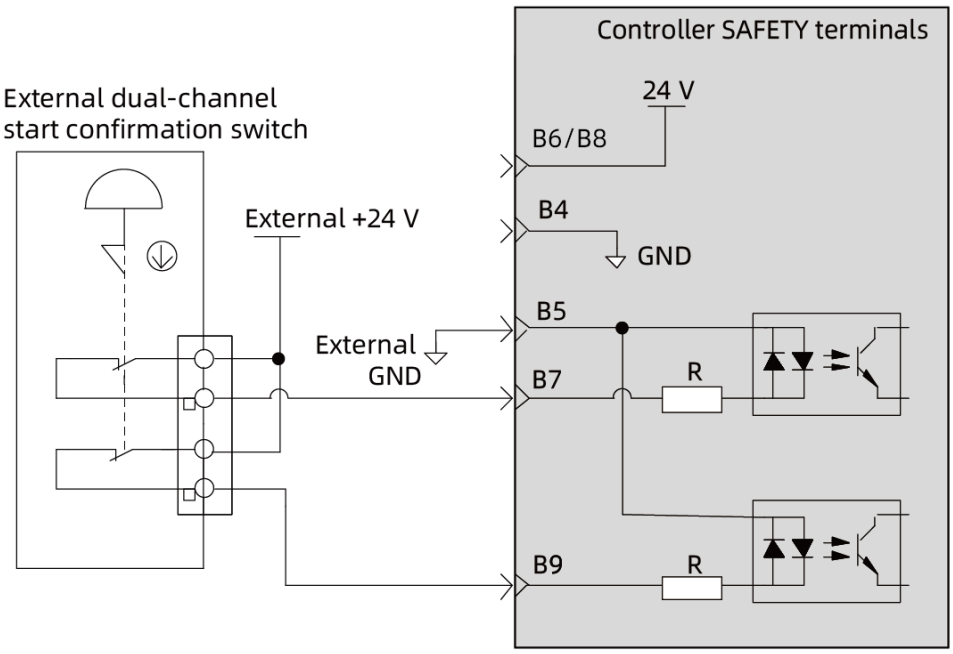
- Rising edge detection method. When the DI port detects a valid rising edge signal (with a pulse width greater than 500 μs) from 0 to 1, the start confirmation function is enabled and active. For example, the external control device uses a self-resetting type contact switch for control.
- If the DI port detects that there is always an ON input level, that is, this function is blocked. For example, the external control device uses a normally closed contact switch for control, and the input is always in a valid state.

The controller system turns on the start confirmation function by default. Therefore, note the wiring as follows:

- When the start confirmation function is active, the I/O detection circuit requires a rising edge input of 0 to 1 before each operation of the system. Otherwise, after the start button is pressed, the system will prompt "Please confirm the startup before automatic operation". Therefore, it is recommended to use a self-resetting switch in the start confirmation control circuit.

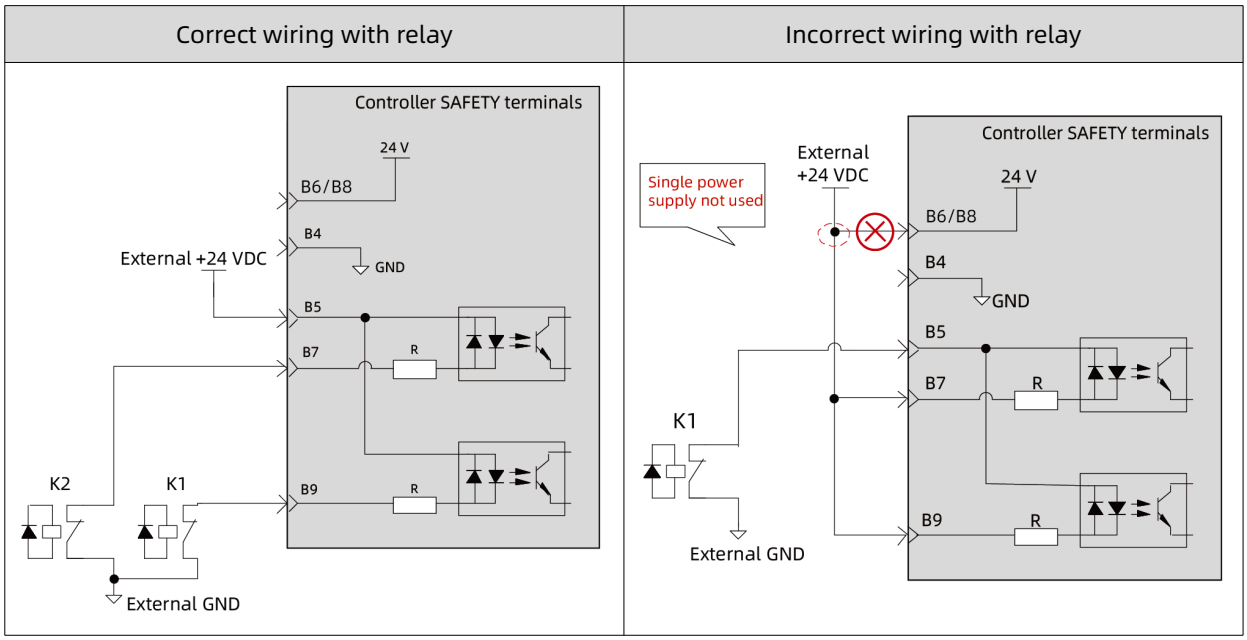
By default, the start confirmation function circuit are powered by internal power supply. If you need to connect an external control device to remotely operate the start confirmation function, it is recommended to use an external +24 V power supply. The wiring for the startup confirmation is as follows:

- When the external start confirmation control uses a dual-switch (recommended wiring with external 24 V power supply), the wiring is as shown below:

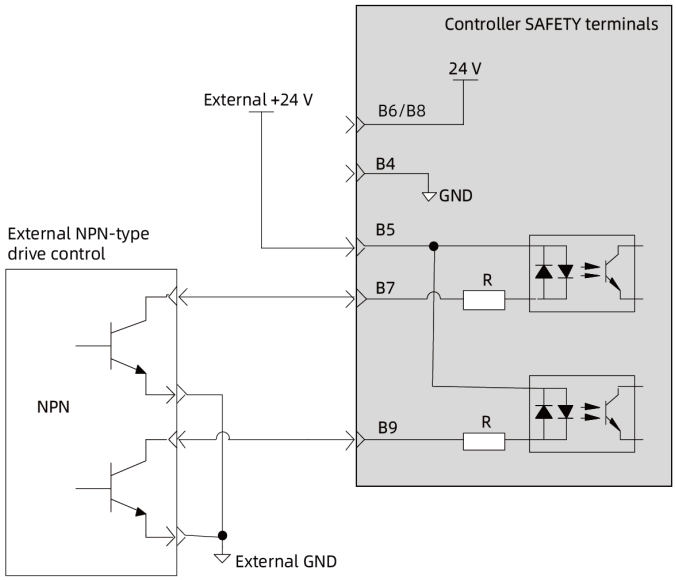


- When the external start confirmation control uses a relay output (recommended wiring with external 24 V power supply), the wiring is as shown below:

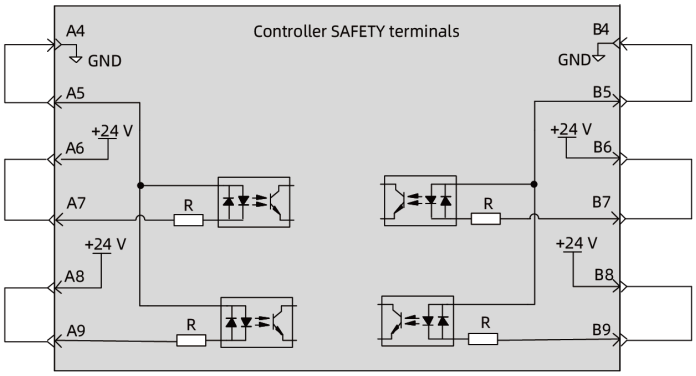
External dual-channel start confirmation switch (relay output)



- When the external dual-channel start confirmation switch control uses an NPN-type drive output (recommended wiring with external 24 V power supply), the wiring is as shown below:



- The wiring for shielding the safety door and the start confirmation functions (factory default wiring) is as shown below:



CAUTION

If the start confirmation function is left at factory default wiring, the function will not be enabled, and the robot has no start confirmation function. Companies and individuals establishing safety-related systems must conduct a risk assessment according to relevant safety standards to ensure that the system meets the safety requirements. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

3.1.2.3.4 Topology and Wiring for Emergency Stop, Safety Door and Start Confirmation Functions

Before wiring according to the following wiring topology for the SAFETY interface, read all the precautions in the 3.1.2 SAFETY Interface Wiring Method 2 section.

- Topology and wiring for the SAFETY interface of IRCB501 series controller (without safety expansion card) - using internal power supply:

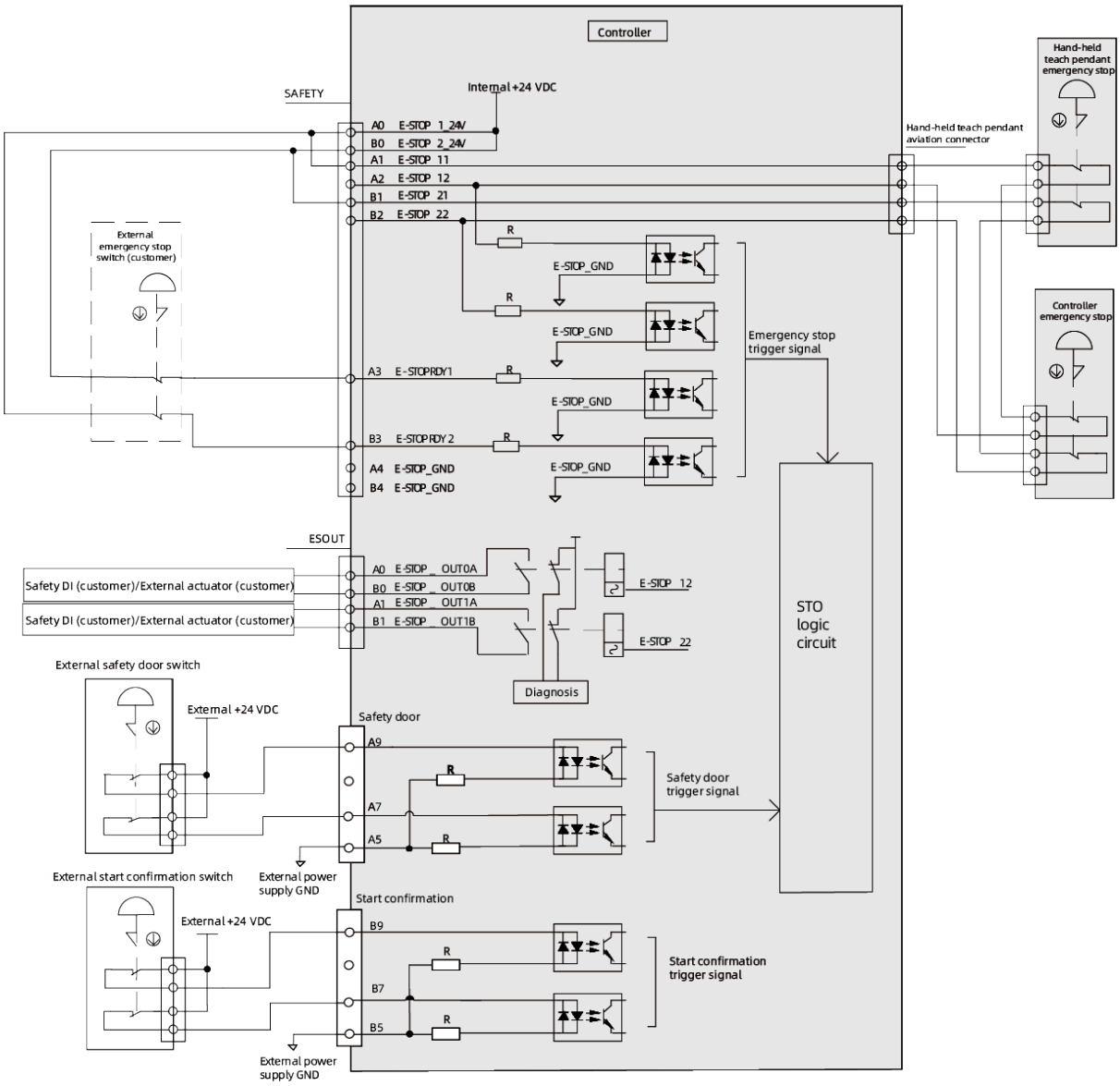


Figure 3-1-2-3-4-1 Topology and wiring for emergency stop, safety door and start confirmation functions

- Topology and wiring for the SAFETY interface of IRCB501 series controller (without safety expansion card) - using external power supply:

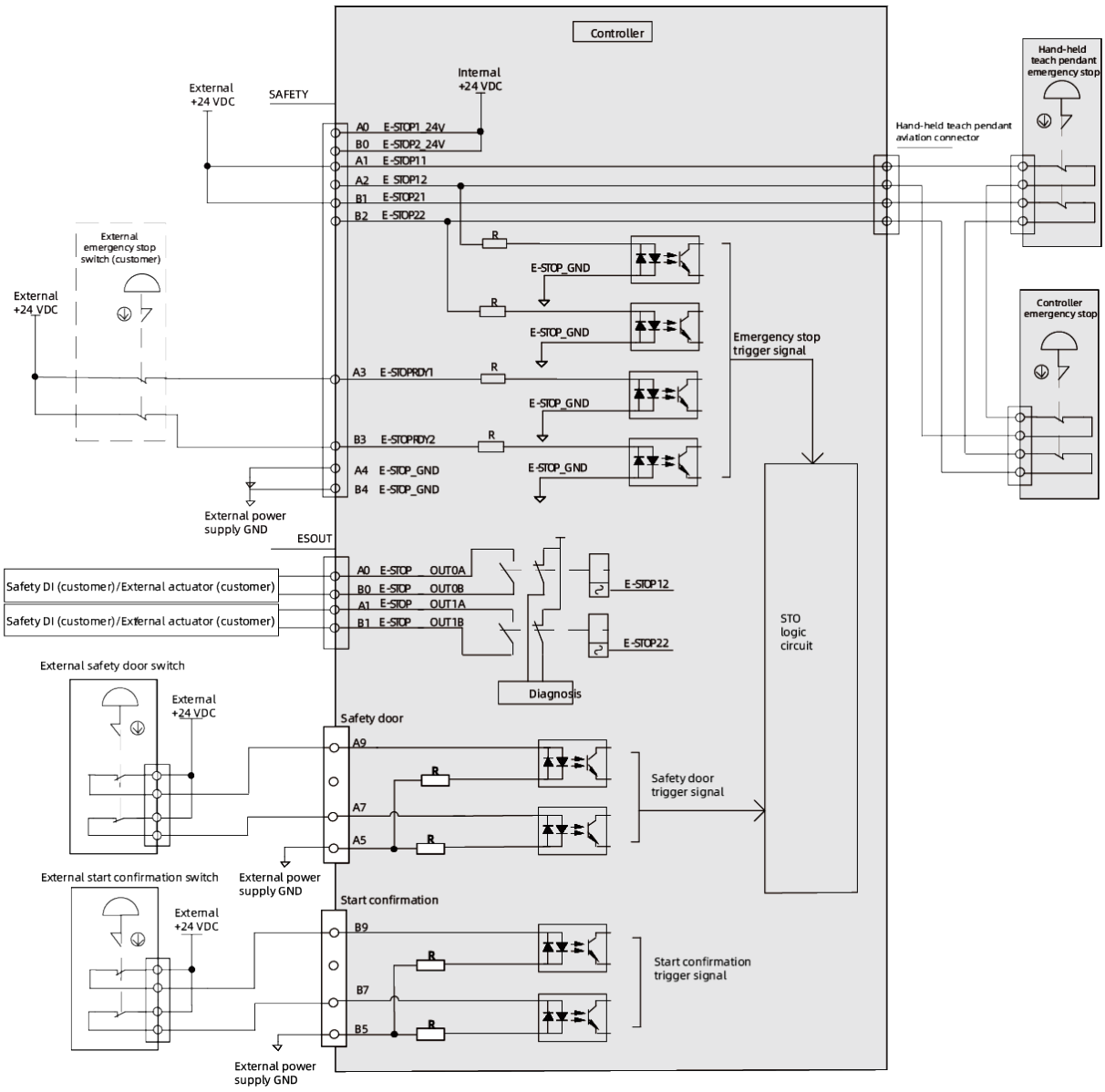


Figure 3-1-2-3-4-1 Topology and wiring for emergency stop, safety door and start confirmation functions

- Topology and wiring for the SAFETY interface of IRCB501 series controller (with safety expansion card) - using internal power supply:

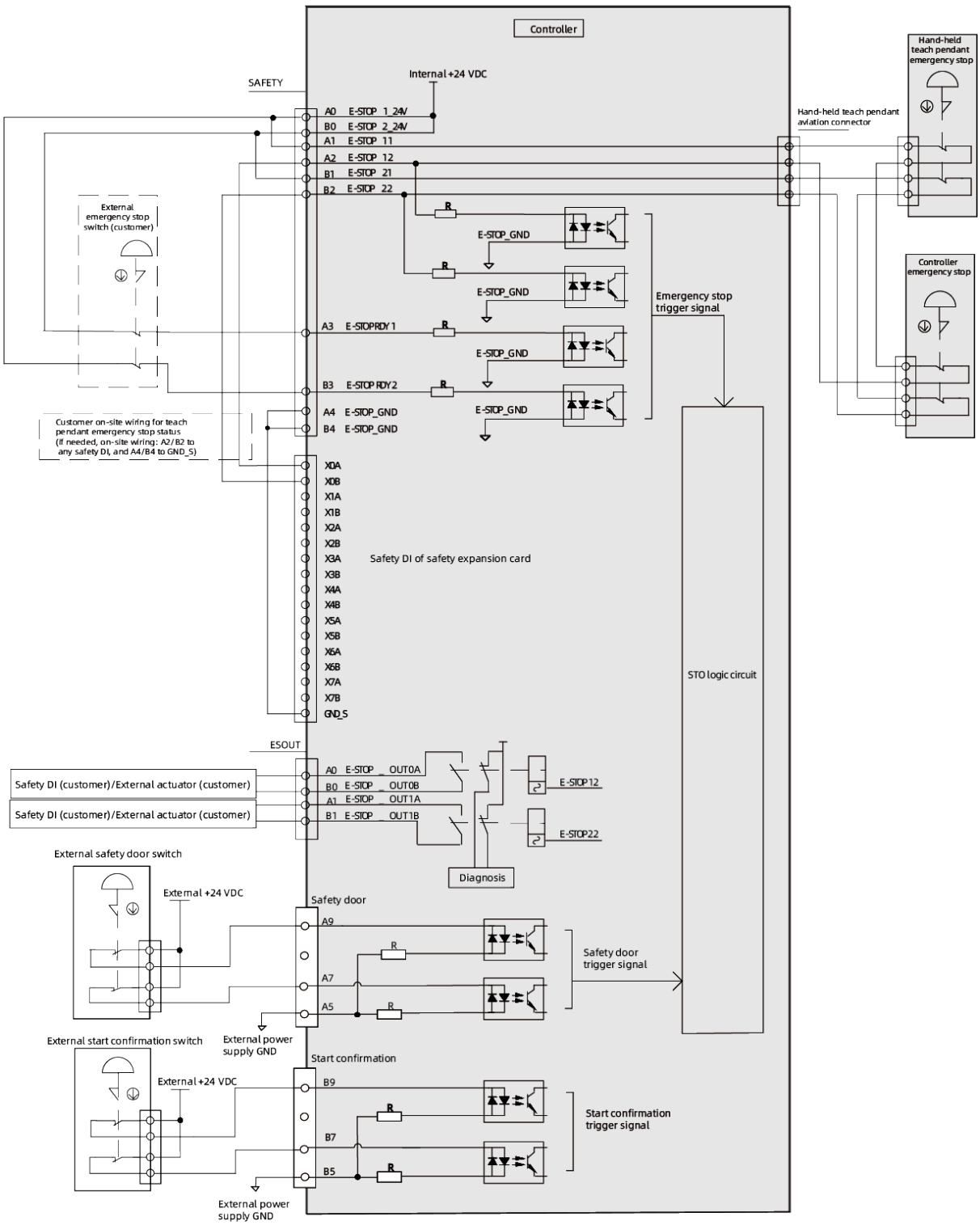


Figure 3-1-2-3-4-3 Topology and wiring for the external emergency stop switch, external safety door, external start confirmation and teach pendant/controller emergency stop status output

- Topology and wiring for the SAFETY interface of IRCB501 series controller (with safety expansion card) - using external power supply:

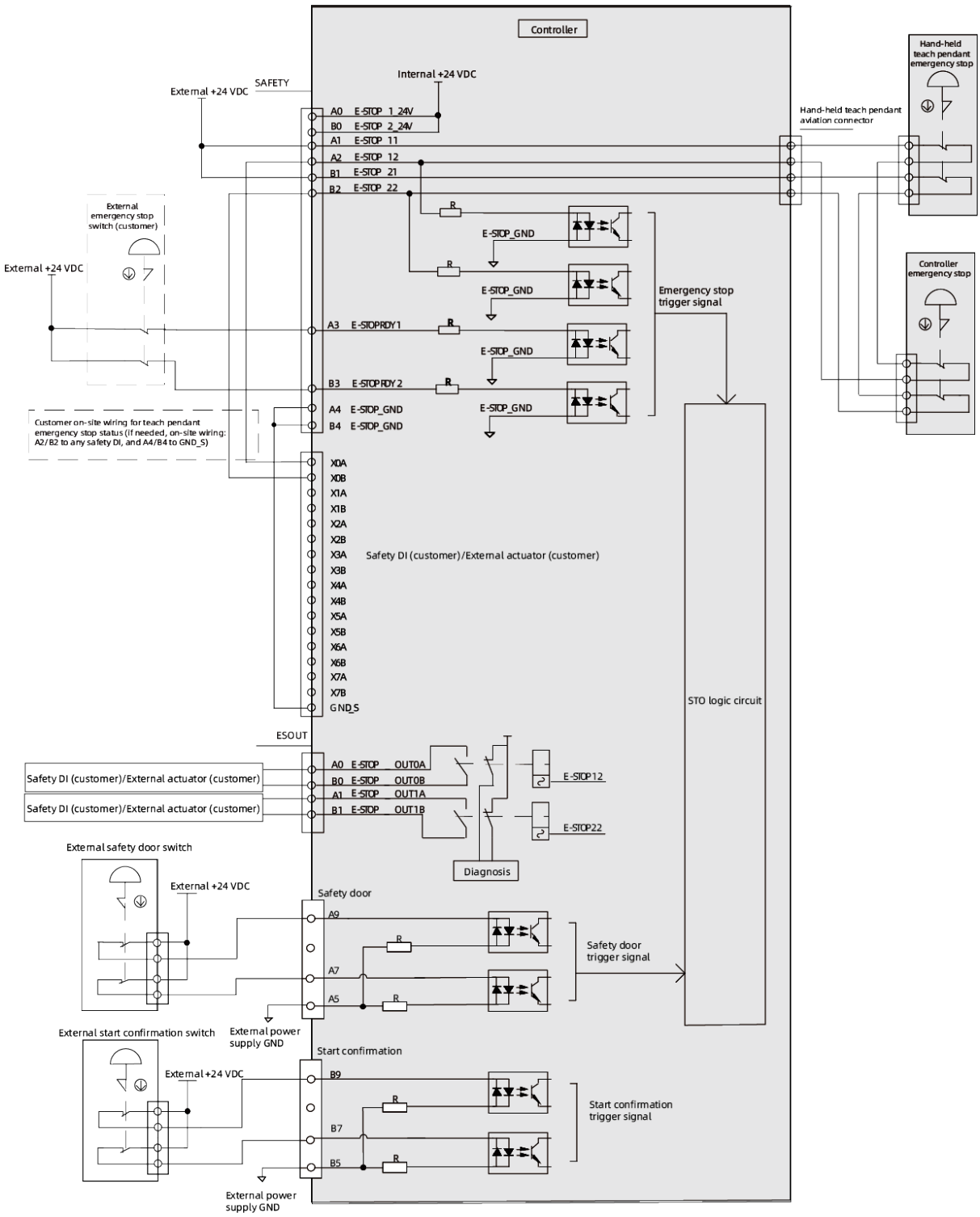


Figure 3-1-2-3-4-3 Topology and wiring for the external emergency stop switch, external safety door, external start confirmation and teach pendant/controller emergency stop status output

3.2 Installing Expansion Card

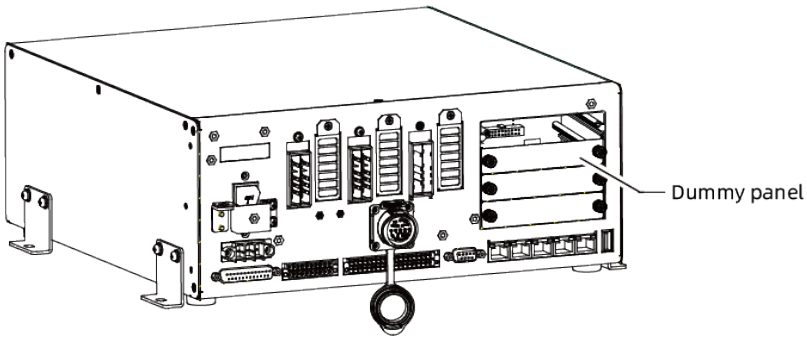
This chapter describes the installation of all expansion cards compatible with the robot controller series. To install the functional safety expansion card, refer to the following steps.

CAUTION

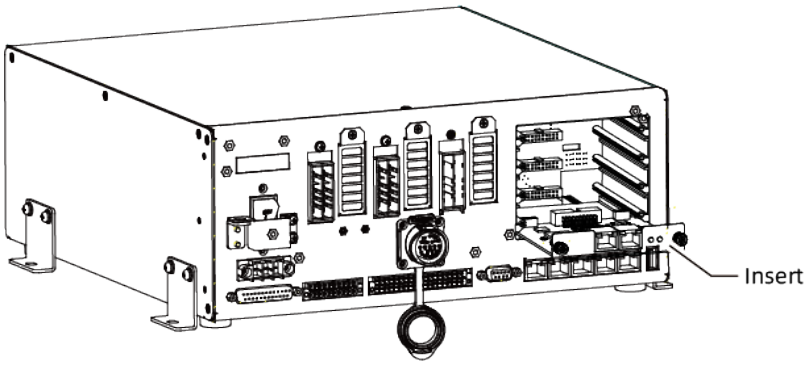
- Disconnect the external power supply of the system before removing/installing the expansion card. If the power supply is not disconnected, it may cause damage to the controller and failure of the expansion card.
- Unplugging the functional safety expansion card when it is powered on results in loss of safety functions.

Operation steps for IRCB501 series

1. Remove the screws fixing the dummy panel of card slot with a Phillips screwdriver, and then remove the panel.

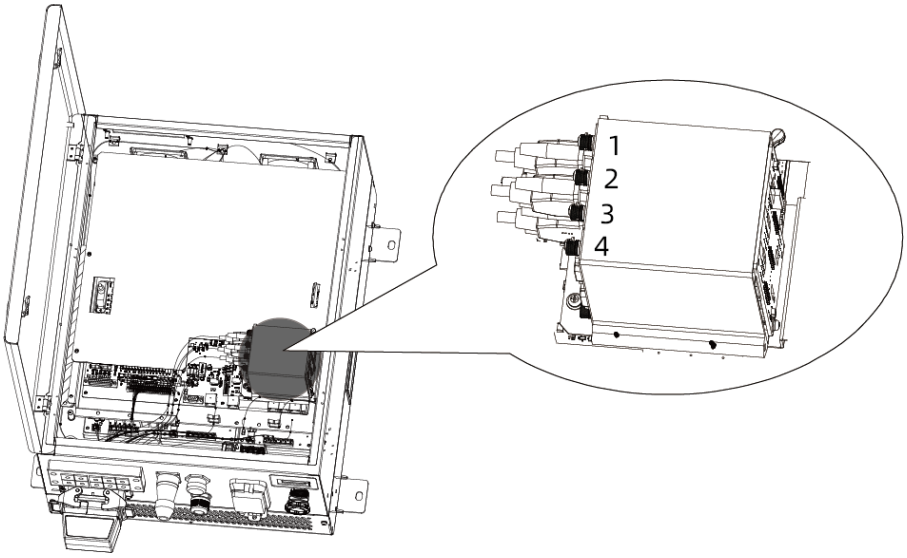


2. Align the expansion card with the card slot, insert it, and then tighten the expansion card with a Phillips screwdriver.



Operation steps for IRCB501 high protection series

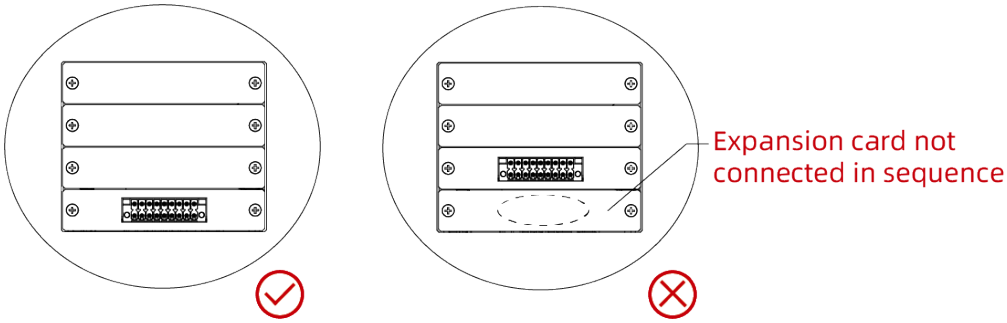
1. Open the top cover of the controller.



CAUTION

When installing the expansion cards, the expansion cards must be inserted sequentially according to the order of the control board, No. 1 - No. 4, otherwise it will cause the controller to alarm and fail to function properly.

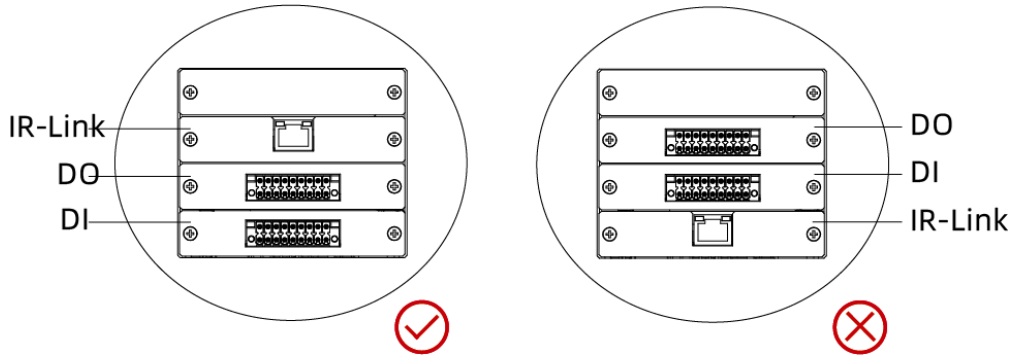
2. The controller provides four card slots each identified by a number. The expansion cards must be inserted in order, as shown below.



NOTE

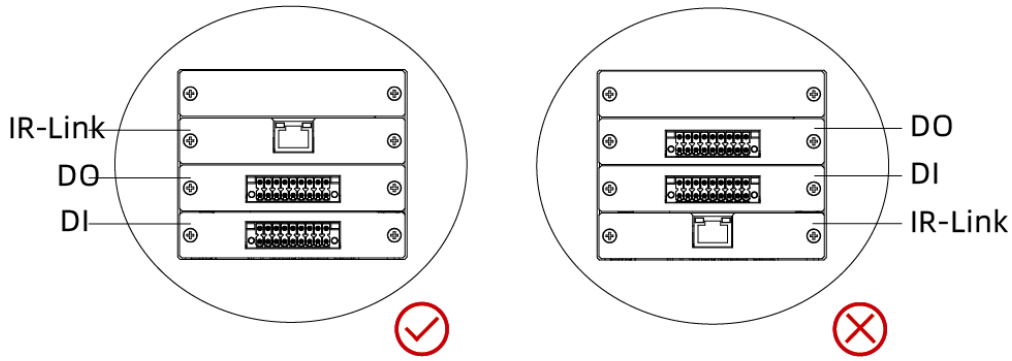
- If the slot #1 is vacant, insert the expansion card into slot 1 first.
- Card #2 can be inserted only if a card already exists in slot #1.
- Recommended card insertion priority for slots #1 to #4: DI > DO > Encoder > IR-Link > PROFINET > Functional Safety. Insert expansion cards in order according to this priority based on the currently available cards.

For example, if you need to insert a PROFINET card, a DO card, and an IR-Link card, the insertion order is: DO in slot #1, IR-Link in slot #2, and PROFINET in slot #3.



NOTE

The IR-Link card must be inserted after the DI, DO, and encoder expansion cards. When using only the IR-Link card, it must be inserted in slot #1. Otherwise, it will not function properly.



CAUTION

- The PROFINET card and functional safety expansion card must be mounted after the DI card, DO card, encoder card, and IR-LINK card.
- When only PROFINET card and functional safety expansion card are used, there is no limit on the order of slots in which they are mounted.
- Only one functional safety expansion card can be inserted per controller.

The table below lists the robot expansion card models:

Order number	Model	Name	Software configuration
01650027	IRCB501-0016ETNDBD	IRCB501 series I/O expansion card with 16 NPN outputs	0016
01650026	IRCB501-1600ENDBD	IRCB501 series I/O expansion card with 16 inputs	1600
01650025	IRCB501-2ENID-BD	IRCB501 series 2-channel incremental encoder expansion card	2ENC

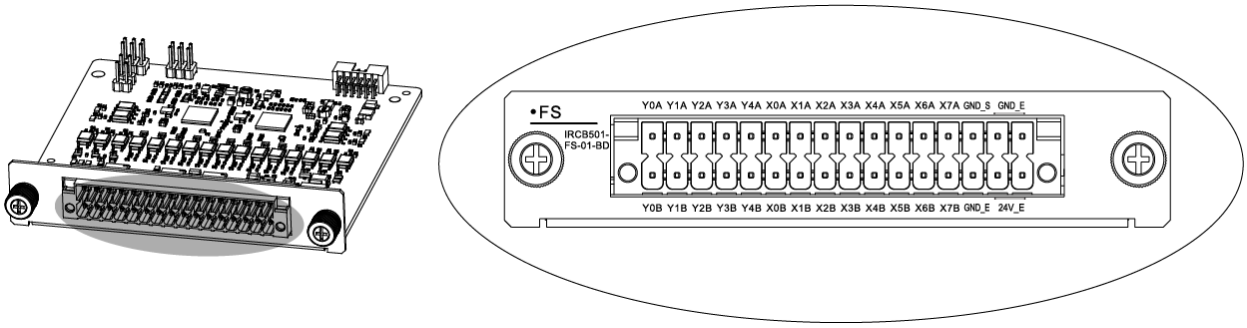
Order number	Model	Name	Software configuration
01650028	IRCB501-2PN-BD	IRCB501 series PROFINET expansion card	PROFINET
01650029	IRCB501-6LDI3-BD	IRCB501 series IR- Link expansion card	Subject to the model of external expansion card
01650030	IRCB501-FS-01-BD	Robot functional safety expansion card	-

3.3 Safety DI of Safety Expansion Card

This chapter provides the wiring instructions for the Safety DI. The implementation of functional safety should be based on this chapter in combination with other related chapters.

3.3.1 Terminal Assignment

The safety DI terminal assignment of the safety expansion card is shown below:



Assignment	I/O number	Assignment	I/O number	Terminal
X0A	DI0A	X0B	DI0B	Safety input DI
X1A	DI1A	X1B	DI1B	
X2A	DI2A	X2B	DI2B	
X3A	DI3A	X3B	DI3B	
X4A	DI4A	X4B	DI4B	
X5A	DI5A	X5B	DI5B	
X6A	DI6A	X6B	DI6B	
X7A	DI7A	X7B	DI7B	
GND_S	Common terminal of safety DI			

For details on the safety DI wiring diagram, see the 3.4.3 Wiring Procedure and Topology Diagram section.

3.3.2 Terminal Specifications

The safety DI specifications are as follows:

Item	Specification
Number of channels	16 channels (X0A to X7A and X0B to X7B)
Input type	Sourcing type (PNP)
Max. input voltage	30 V
Input Impedance	> 4 kΩ
Input voltage when input is ON	18 VDC to 30 VDC
Input voltage when input is OFF	0 VDC to 3 VDC
Hardware response time	ON/OFF: 250 μs/250 μs
Frequency range	1 kHz

3.3.3 Wiring Procedure and Topology Diagram

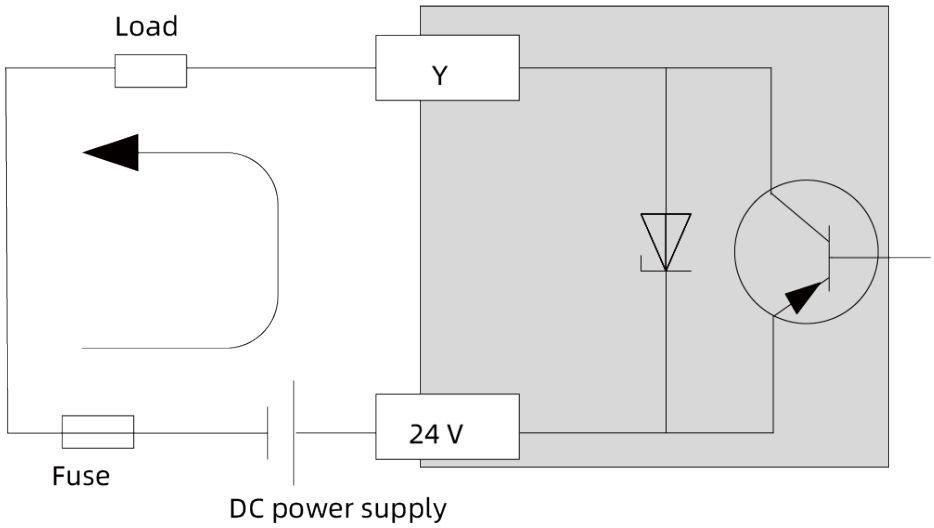
Wiring rules

The terminal GND_S is the common terminal for the 16-channel safety DI input. When GND_S is connected to 0V and the X*A/X*B is connected to 24V, the safety DI input signal is active (the on-board optocoupler is turned on; GND_S must be connected to 0V only). Therefore, the safety DI input signal supports only PNP-type output I/O devices (customer).

Regarding the description of PNP-type output and NPN-type output for I/O devices (customer), see the following (for the specific output type of the I/O device, consult the corresponding I/O device manufacturer):

- PNP type (source type) output (positive common terminal)

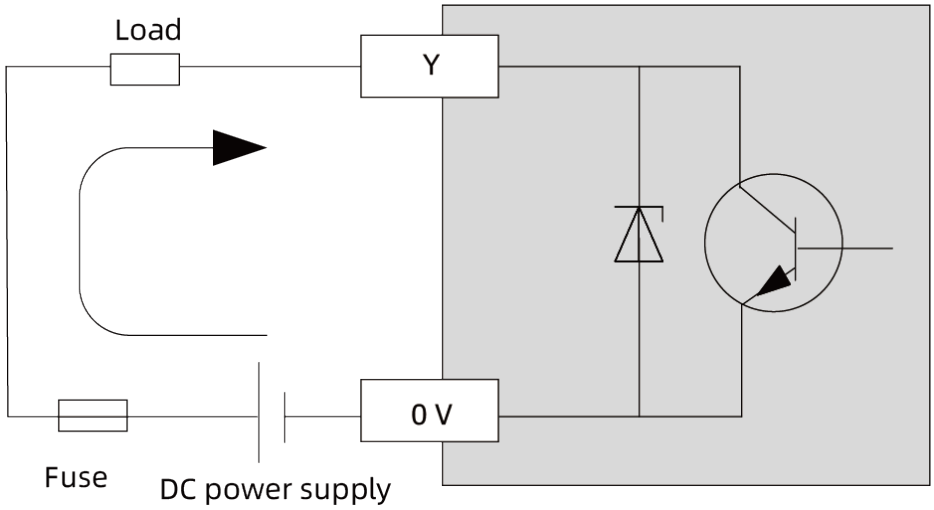
The load current flows from the output (Y) terminal, and such output is called a PNP type output, which is a high-level output. See the figure below:



PNP output

- NPN type (sink type) output (negative common terminal)

When the load current flows into the output (Y) terminal, this type of output is called an NPN type output, which is a low-level output. See the figure below:



NPN output

CAUTION

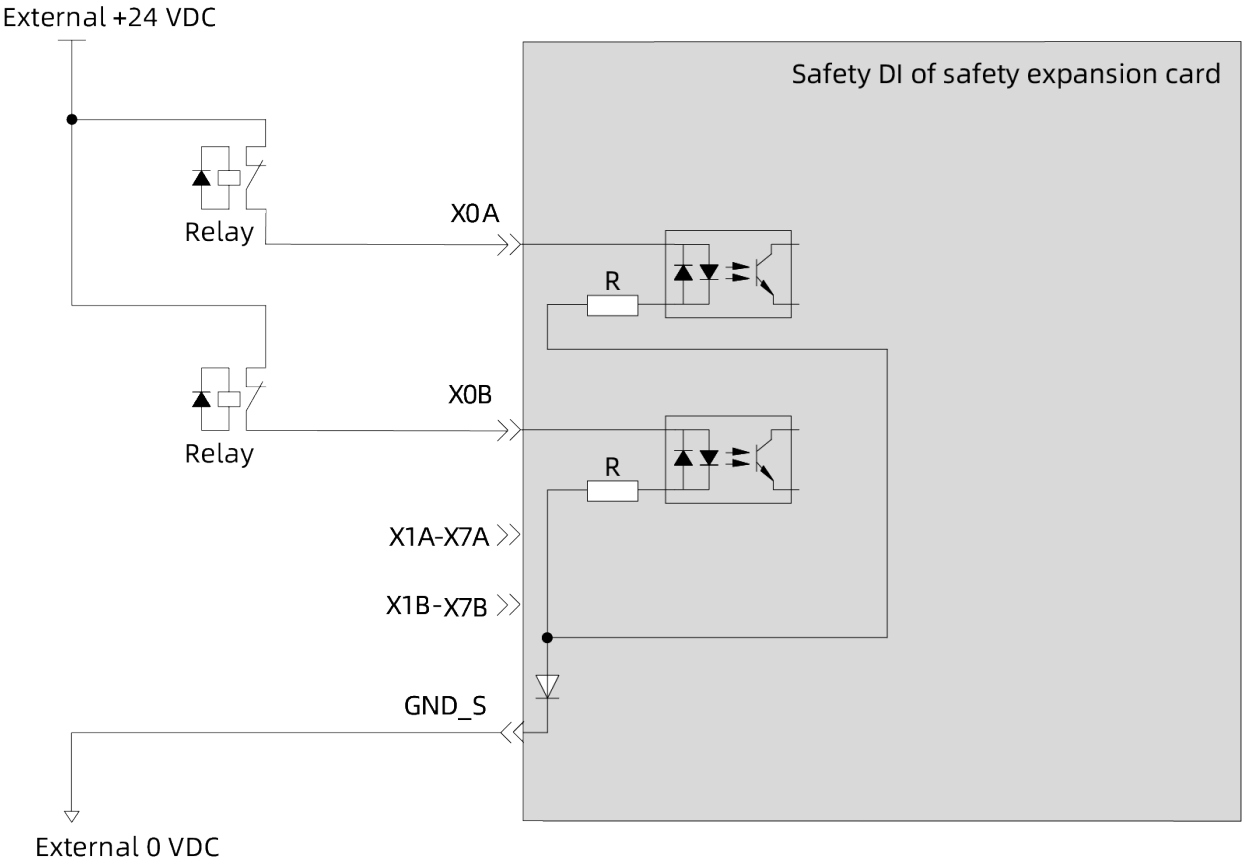
- NPN output is low level, while PNP output is high level.
- The terminal GND_S is the common terminal for the 16-channel DI input. When GND_S is connected to 0V and the X*A/X*B is connected to 24V, the input signal is active (the on-board optocoupler is turned on; GND_S must be connected to 0V only). Therefore, the DI input is connected to the PNP-type output I/O devices.
- When the emergency stop signal (A2/B2 signal output) of the teach pendant/controller is connected to the safety DI, it is prohibited to connect the A2/B2 signal in parallel or series to multiple different safety DI inputs. Connecting them to multiple DI inputs at the same time will cause functional failure.

Wiring diagram

Here we take X0A and X0B as an example (X1A to X7A and X0B to X7B are the same as X0A). It is recommended to use an external 24 V power supply.

Due to functional safety requirements, dual input circuits are required for connection of load. For example, X0_A and X0_B are in one group. If only X0_A is connected, an alarm occurs. If an external 24 V power supply is used to power DI and the DO function is not needed, then 24V_E and GND_E connections are optional. If the DO function is needed, it is necessary to perform wiring according to the DO wiring instructions.

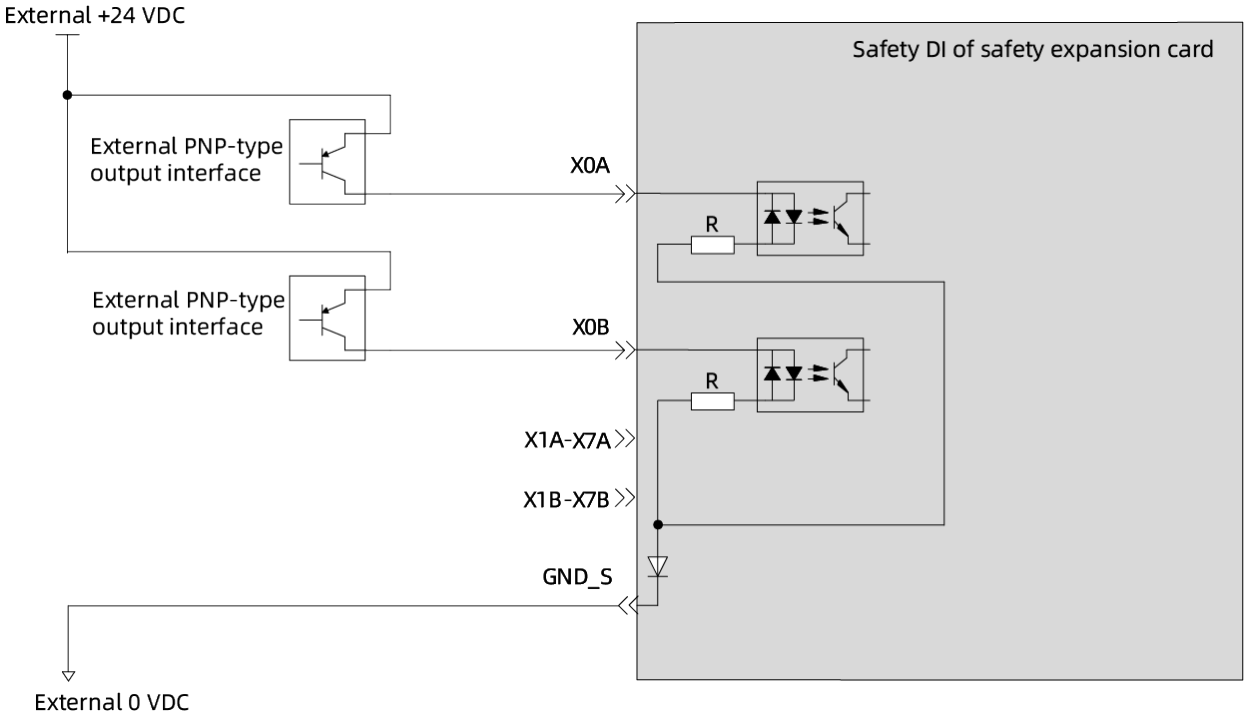
When the host controller provides relay output, the wiring is shown below:



NOTE

If on-site monitoring of the relay (customer) status is required, the safety DI dual-channel must be connected to the feedback signal of the relay (customer), and the safety DI should be configured as "relay status monitoring". For the configuration of the safety DI, see the corresponding section. To complete the corresponding wiring of the relay (customer), see the 3.4.3 Wiring Procedure and Topology Diagram section for wiring details. When on-site wiring is required to monitor the status of the relay (customer), note that the safety DI will be occupied. Meanwhile, the relay (customer) must meet relevant safety standard requirements.

When the host controller provides open-collector output, the wiring is shown below:



NOTE

When the emergency stop status output of the teach pendant/controller is required on site, the following wiring must be performed on site: Connect the A2/B2 signal to any group of safety DI on the safety expansion card, and connect the A4/B4 signal to the GND_S on the safety expansion card. At the same time, perform the necessary safety configuration in the safety I/O configuration. For details on safety I/O configuration, see the 4.2 Safety I/O section and observe the corresponding wiring notes.

Topology and wiring for the SAFETY interface/safety DI

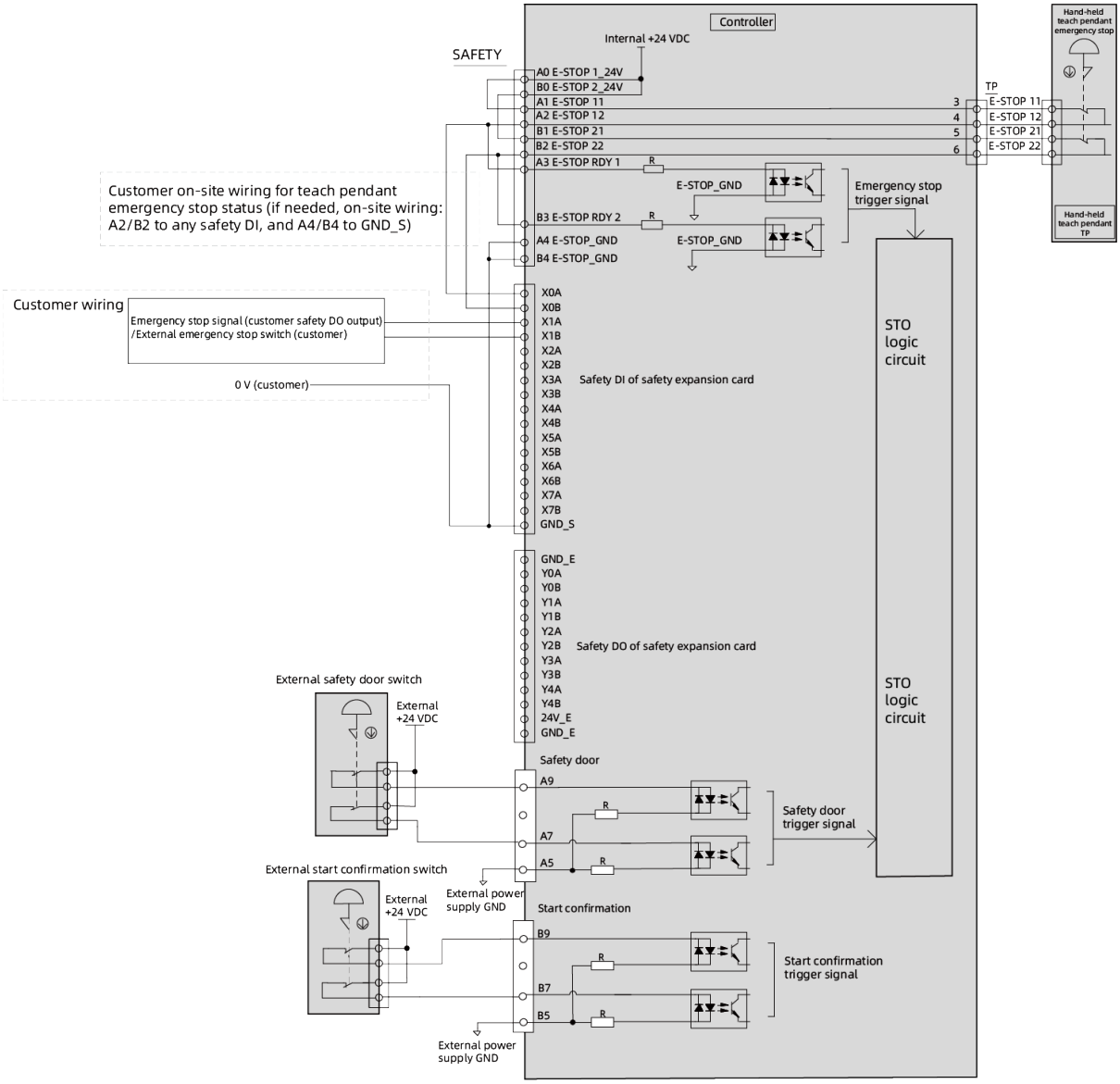
This subsection introduces the topology and wiring for the SAFETY interface/safety DI of IRCB501, IRCB501 high-protection, IRCB501-EM, and IRCB501-EM high-protection series controllers.

Before wiring according to the following topology and wiring diagram for the SAFETY interface/safety DO, read all the precautions in the 3 Wiring and Installation section.

NOTE

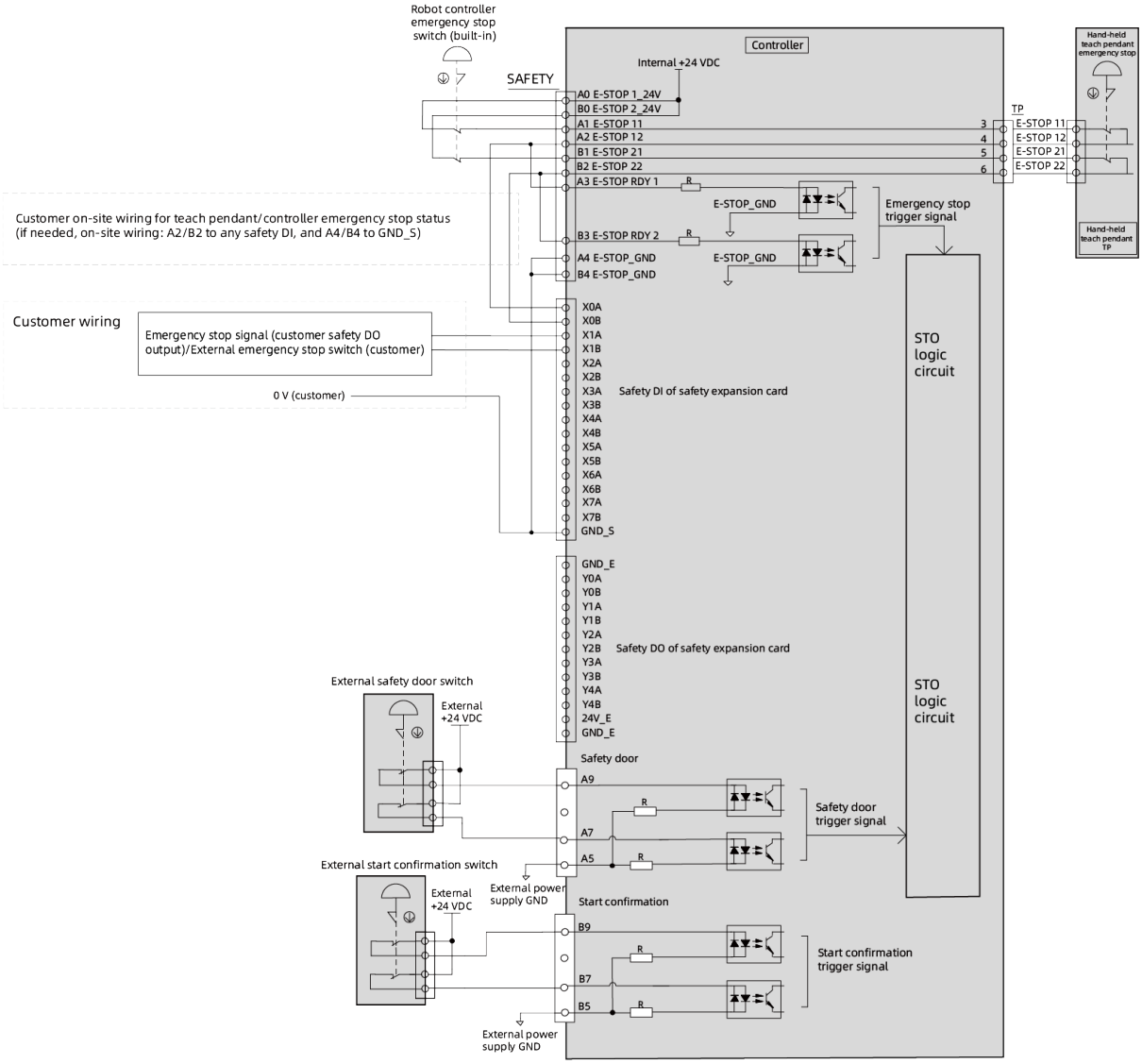
The ESOUT interface (emergency stop switch status function) for user I/O is not reflected in the topology and wiring for the SAFETY interface/safety DI of IRCB501-EM and IRCB501-EM high-protection series controllers. For detailed wiring, see the 3.1.2.3.4 Topology and Wiring for Emergency Stop, Safety Door, and Start Confirmation Functions section.

- Topology and wiring for the SAFETY interface/safety DI of IRCB501 series controller (with safety expansion card):



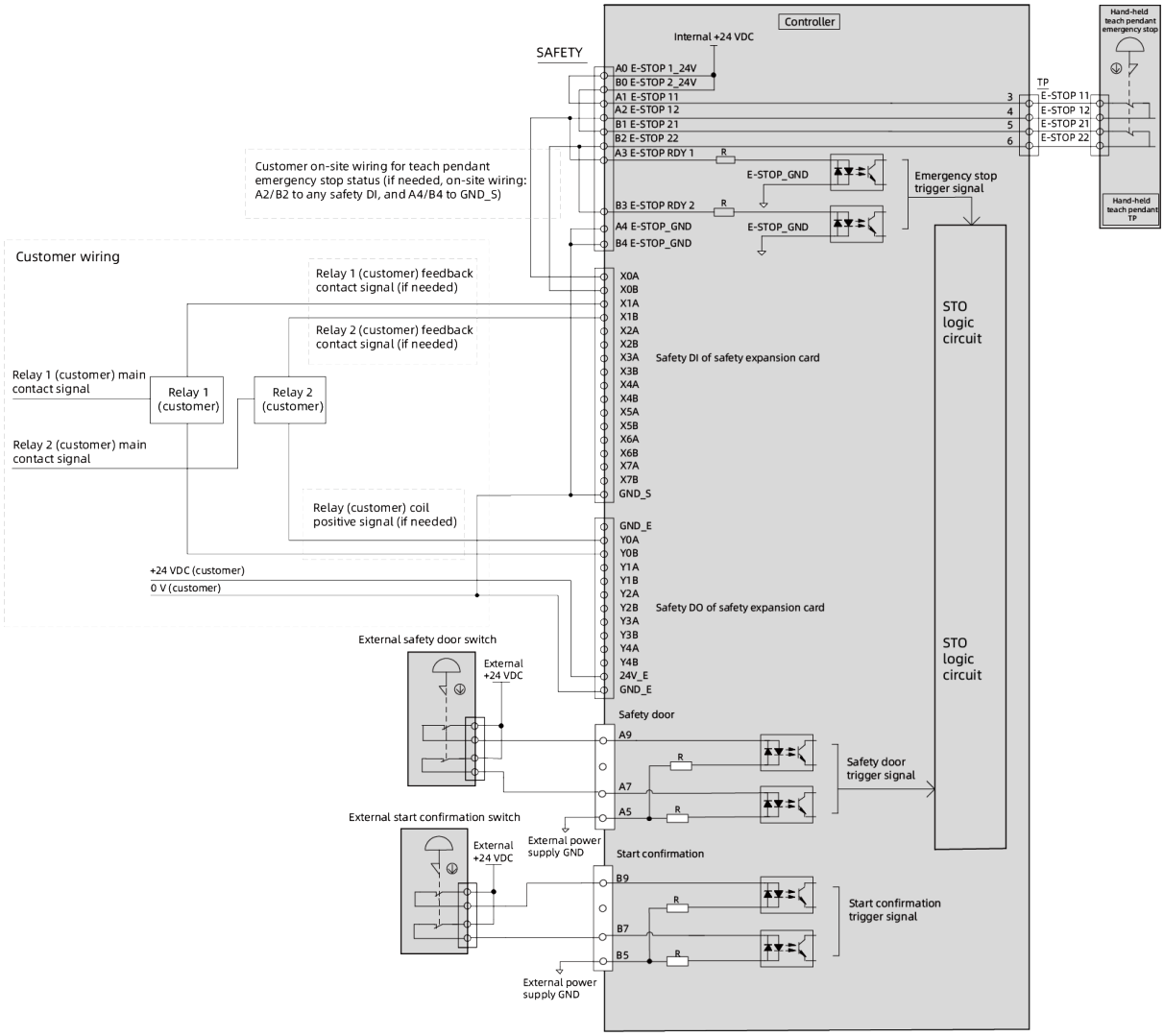
Topology and wiring for the SAFETY interface/safety DI of IRCB501 series controller (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI of IRCB501 high-protection series controller (with safety expansion card):



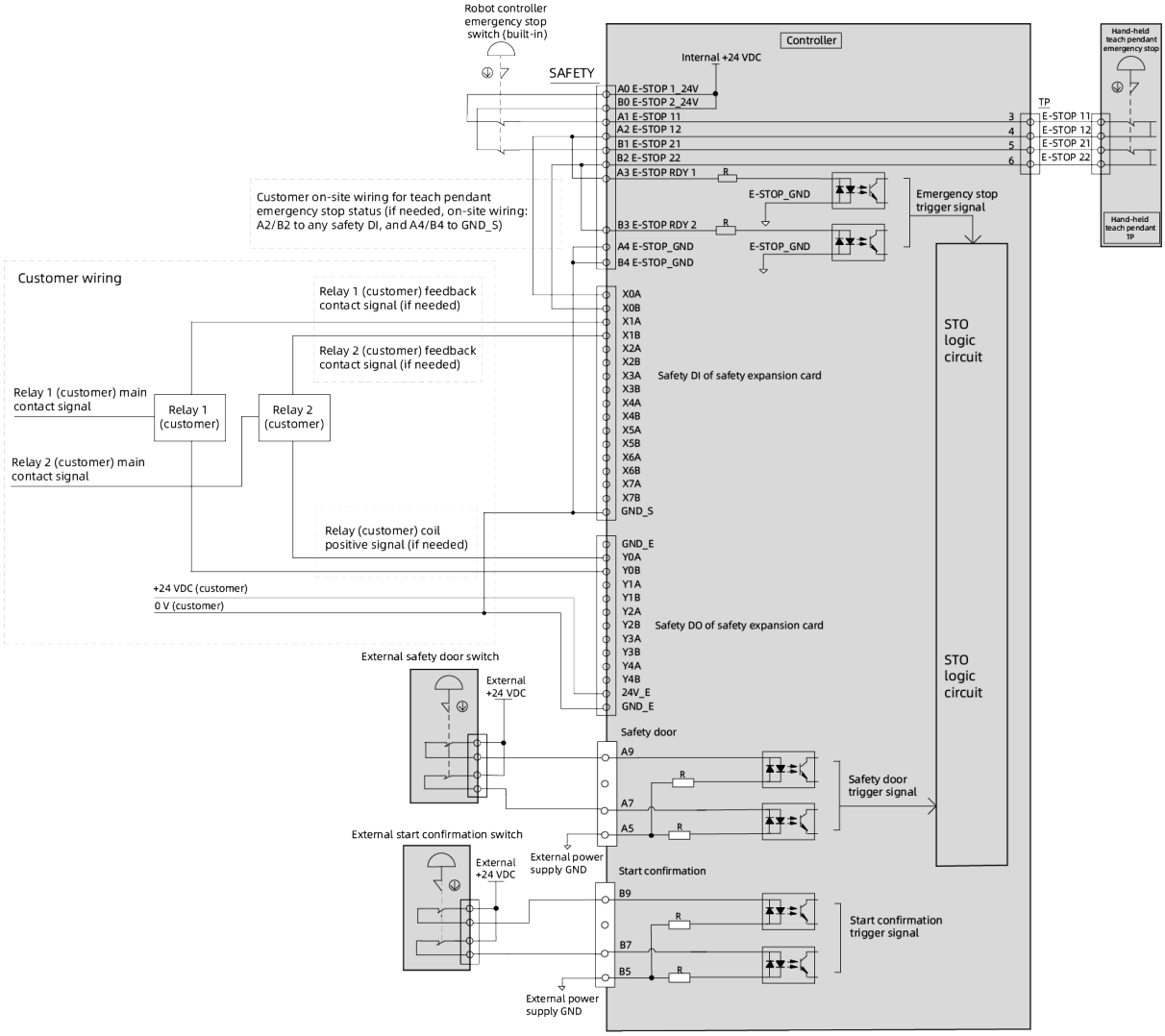
Topology and wiring for the SAFETY interface/safety DI of IRCB501 high-protection series controller (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501 series controller (with safety expansion card):



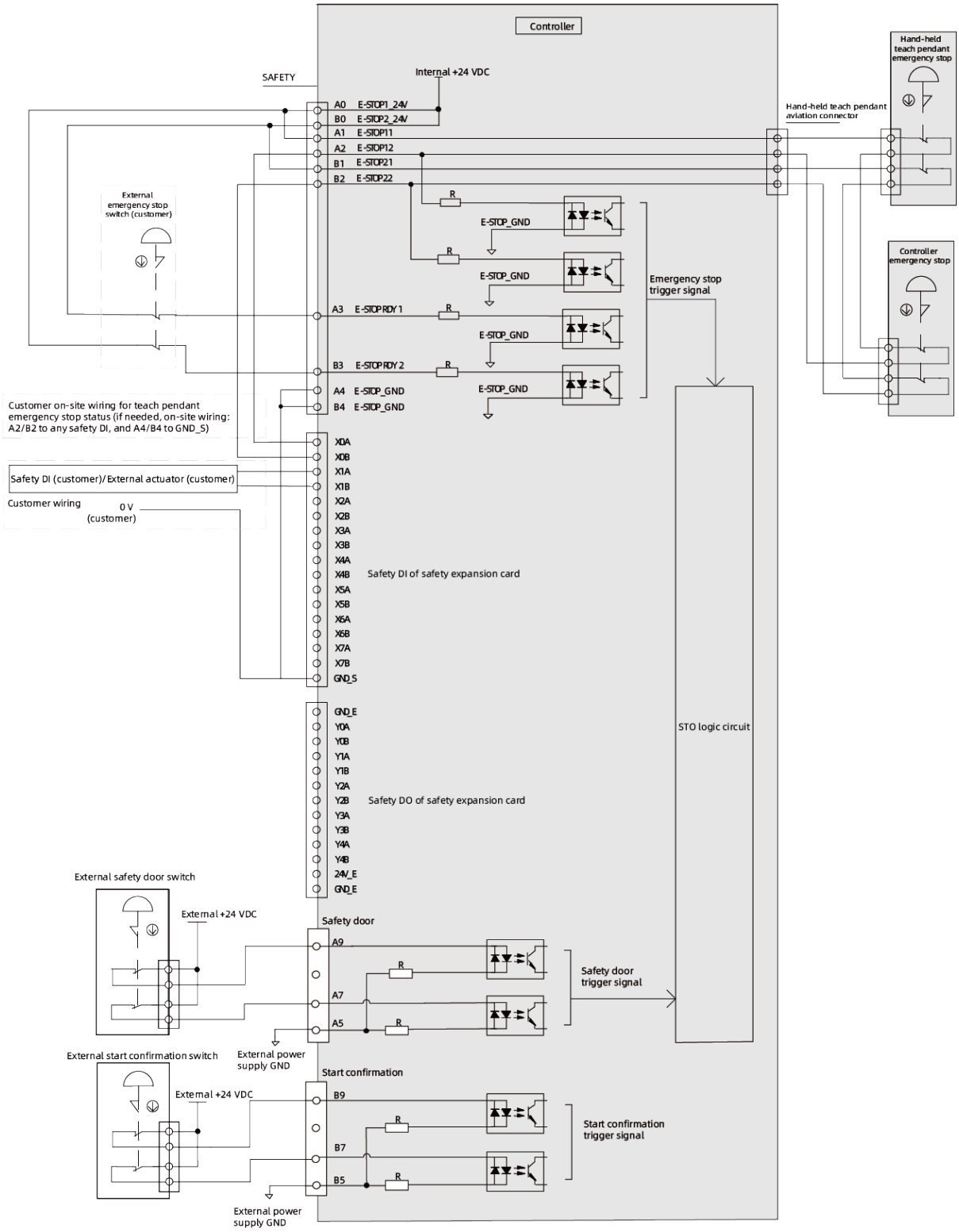
Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501 series controller (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501 high-protection series controller (with safety expansion card):



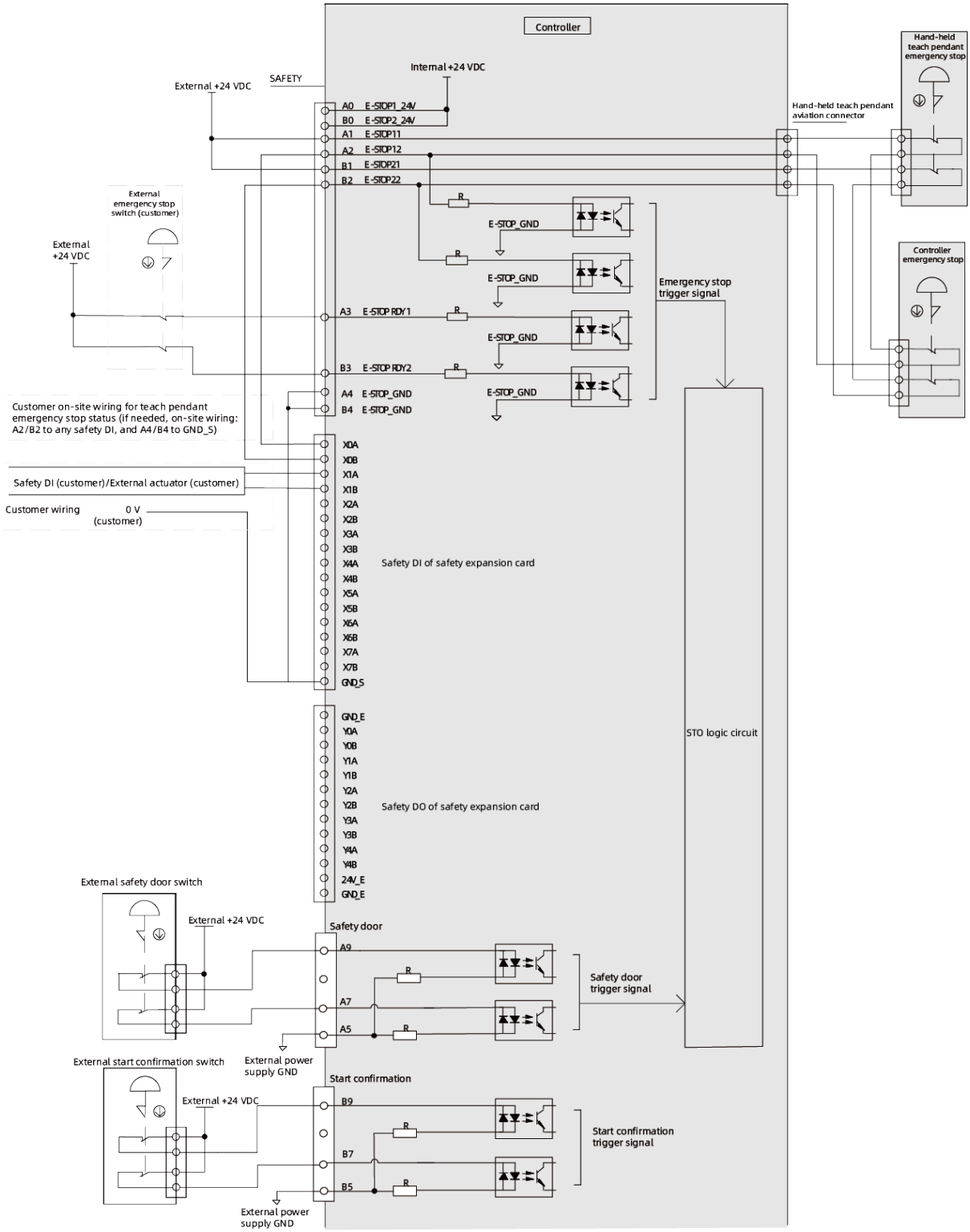
Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501 high-protection series controller (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card) - using internal power supply:



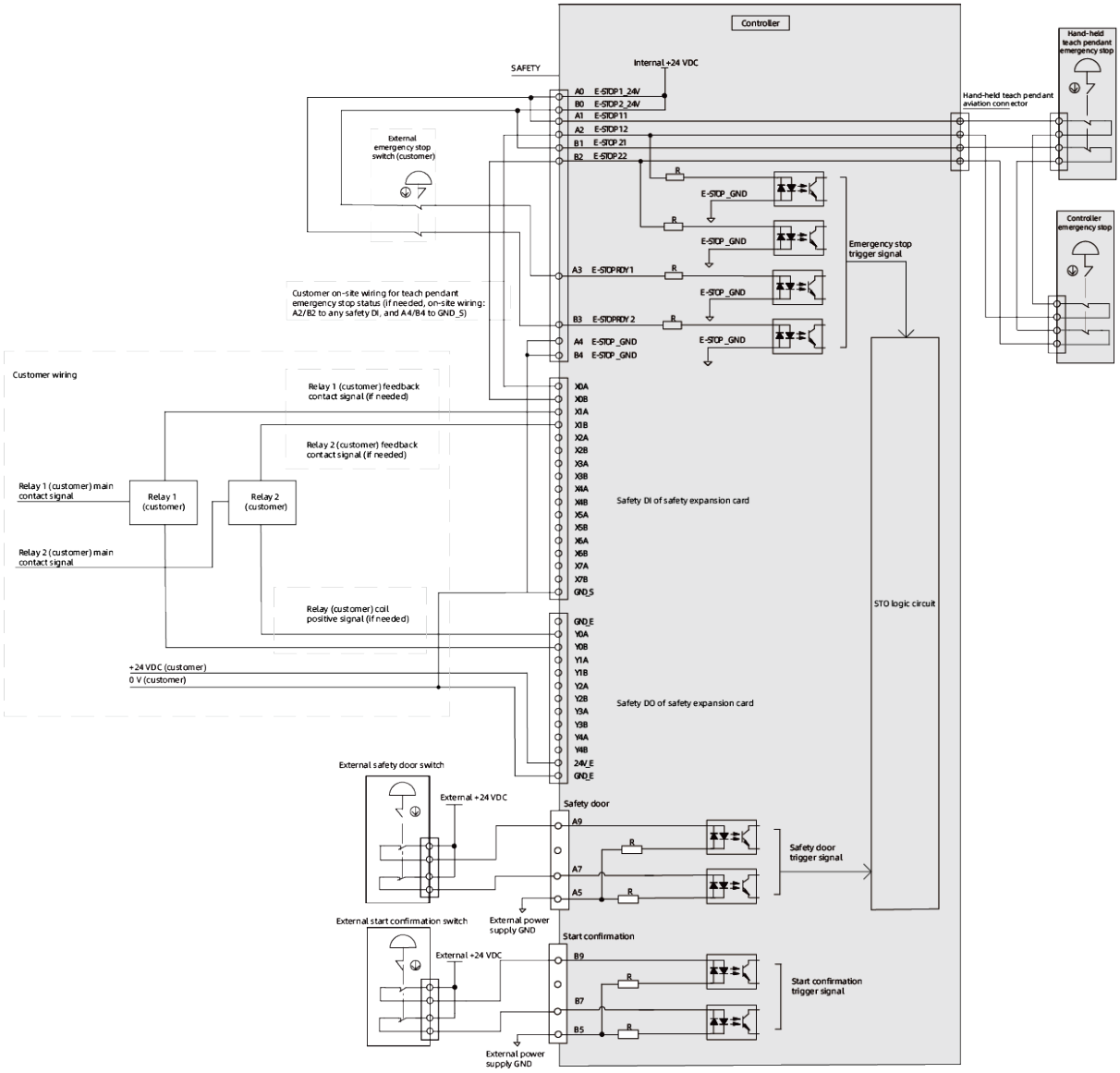
Topology and wiring for the SAFETY interface/safety DI of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card) - using external power supply:



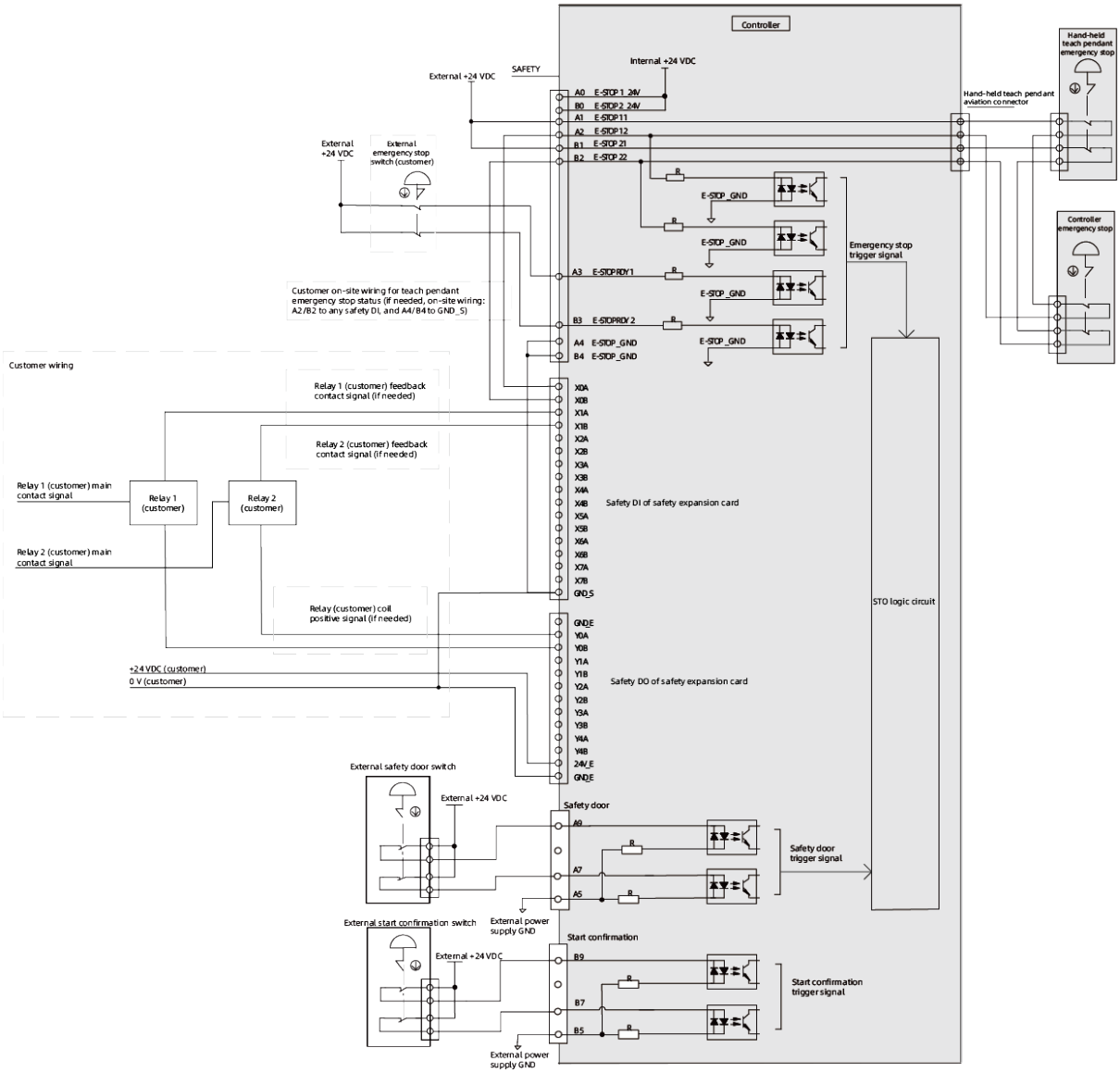
Topology and wiring for the SAFETY interface/safety DI of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card) - using internal power supply:



Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card) - using external power supply:



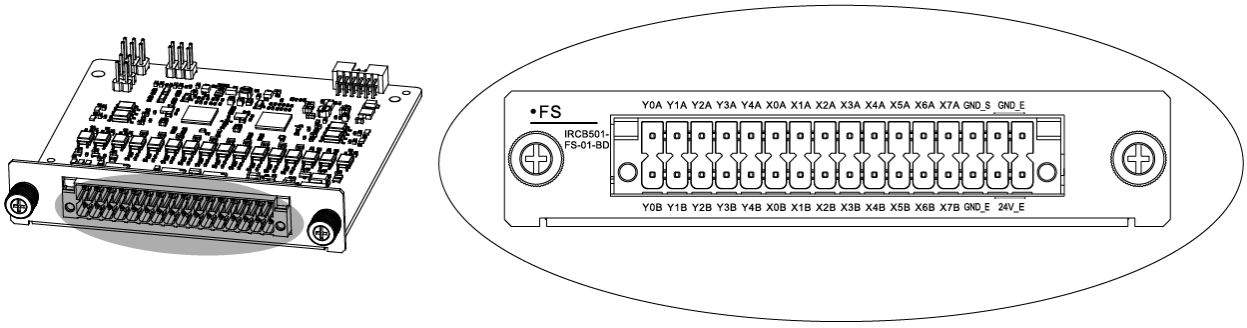
Topology and wiring for the SAFETY interface/safety DI (relay status monitoring) of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card)

3.4 Safety DO of Safety Expansion Card

This chapter provides the wiring instructions for the Safety DO. The implementation of functional safety should be based on this chapter in combination with other related chapters.

3.4.1 Terminal Assignment

The safety DO terminal assignment of the safety expansion card is shown below:



Assignment	I/O number	Assignment	I/O number	Terminal
Y0A	DO0A	Y0B	DO0B	Safety output DO
Y1A	DO1A	Y1B	DO1B	
Y2A	DO2A	Y2B	DO2B	
Y3A	DO3A	Y3B	DO3B	
Y4A	DO4A	Y4B	DO4B	
24V_E	External power supply interface of DO circuit, with built-in overvoltage and overcurrent protection circuit			
GND_E				

For details on the safety DO wiring diagram, see the 3.3.3 Wiring Procedure and Topology Diagram section.

3.4.2 Terminal Specifications

The safety DO specifications are as follows:

Item	Specification
Number of channels	10 channels (Y0A to Y4A and Y0B to Y4B)
Output mode	Sourcing type (PNP)
Operating voltage range	0 VDC to 29 VDC
24V_E and GND_E power supply	24 V±20%/3 A
Resistive output load	0.3 A/point

Item	Specification
Hardware response time	< 300 μs (from OFF to ON), 300 μs (from ON to OFF)
Leakage current	Max. 350 μA, 24 V
Short circuit protection	Overcurrent protection (0.4 A)
Output frequency	1 kHz

3.4.3 Wiring Procedure and Topology Diagram

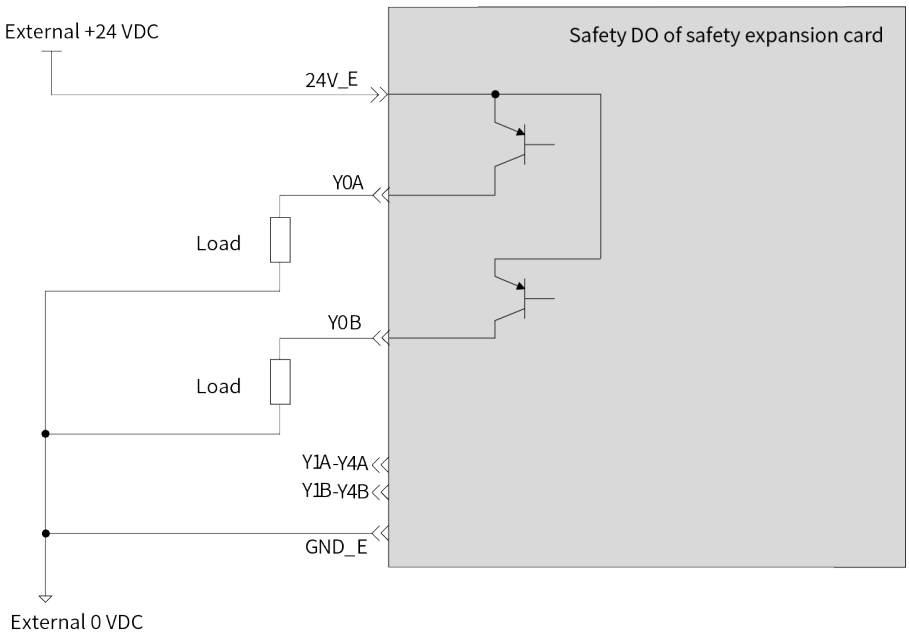
CAUTION

- 24V_E/GND_E must be connected to 24 V power supply to ensure that the DOs work properly.
- If an external 24 V power supply is used, connect the positive and negative terminals of the external power supply to 24V_E and GND_E terminals respectively. Note that the maximum driving current for each DO is 0.3 A. If the single output current exceeds 0.4 A, an over-current alarm occurs.
- Do not short-circuit outputs directly to +24 V.
- Do not connect outputs to 0V and GND_E to +24 V of the power supply.
- The input voltage of the external power supply should be less than 29 V.

Failure to follow the above precautions may damage the circuit or cause the safety DO to fail to output.

Wiring of the power supply

Here we take Y0A and Y0B as an example (Y1A to Y4A and Y0B to Y4B are the same as Y0A). It is recommended to use an external 24 V power supply. Due to functional safety requirements, dual output circuits are required for connection of load. For example, Y0_A and Y0_B are in one group, as shown in the figure below:



Wiring example

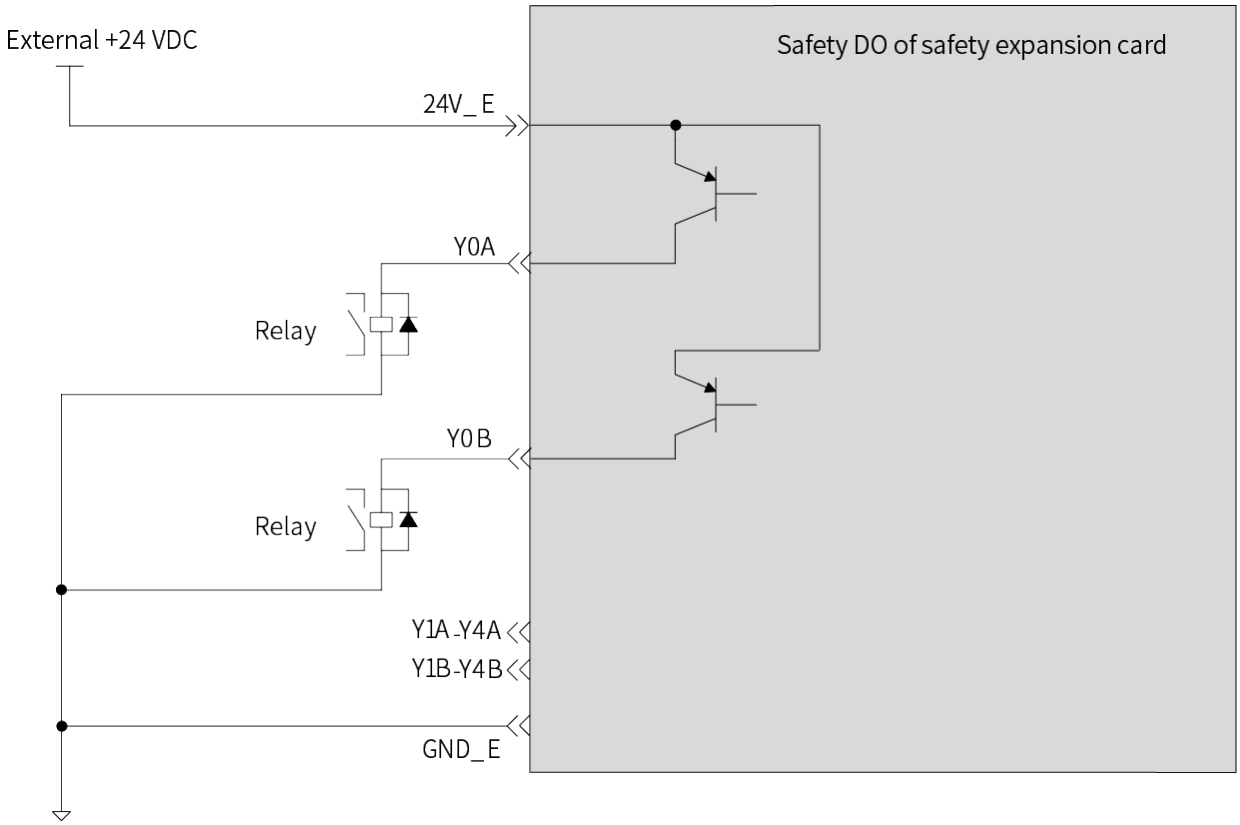
- When driving an inductive load:

> **NOTE**
>
> - When the inductive load is applied, stopping the load will produce a large back EMF between contacts, accompanied by arc discharge. This may result in contact failure or sag, shortening the contact lifetime. Therefore, it is necessary to connect a flywheel diode in parallel with the load to extend the product lifetime.
> - If the safety DO is connected to a relay (customer), when monitoring of the relay (customer) status is required, see the 3.4.3 Wiring Procedure and Topology Diagram section.

The flywheel diode must meet the following requirements:

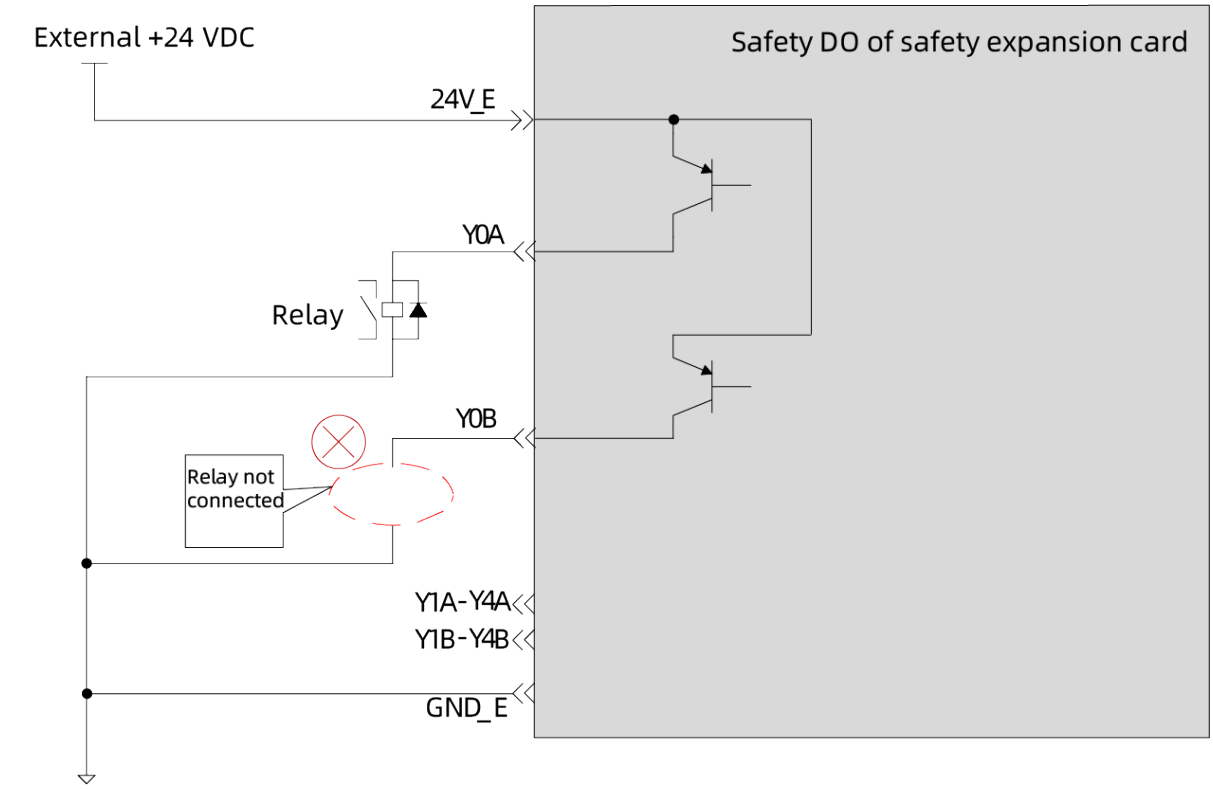
- Reverse voltage: 5 to 10 times the load voltage
- Forward current: greater than the load current

The correct wiring is shown in the figure below:

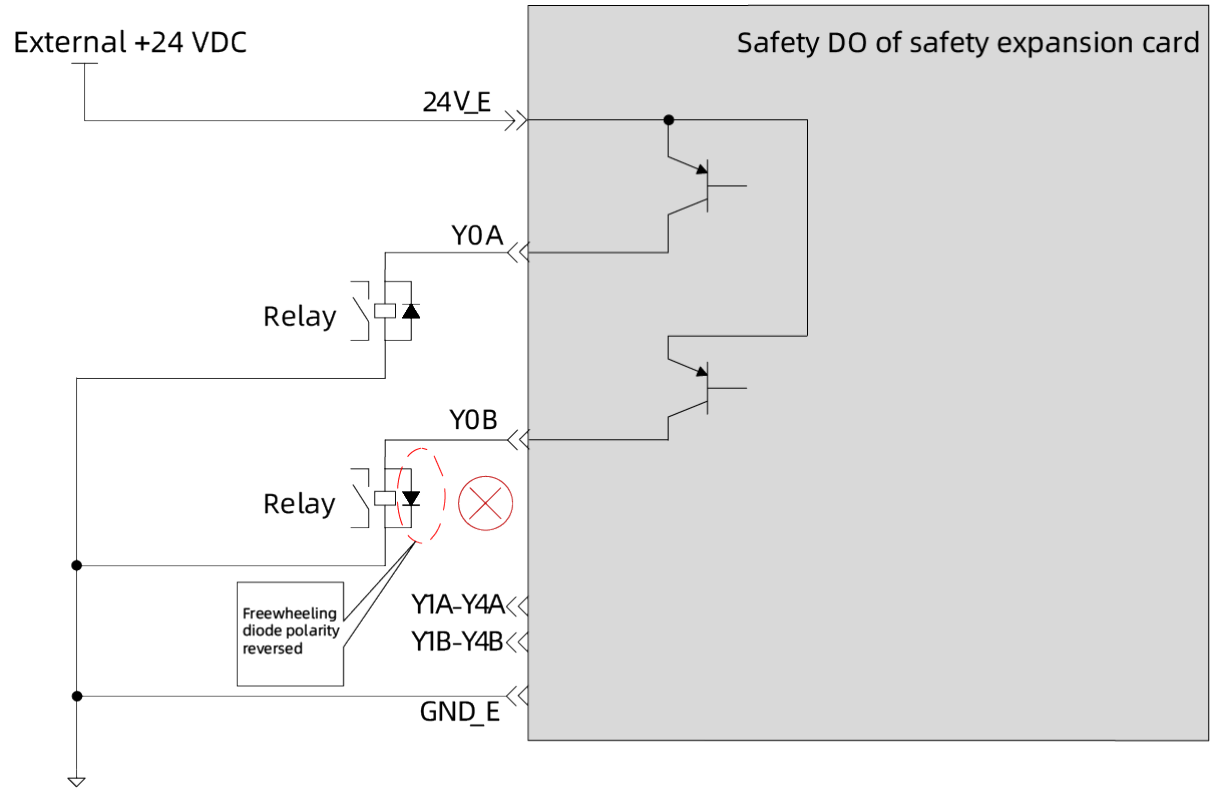


The incorrect wiring is shown in the figure below:

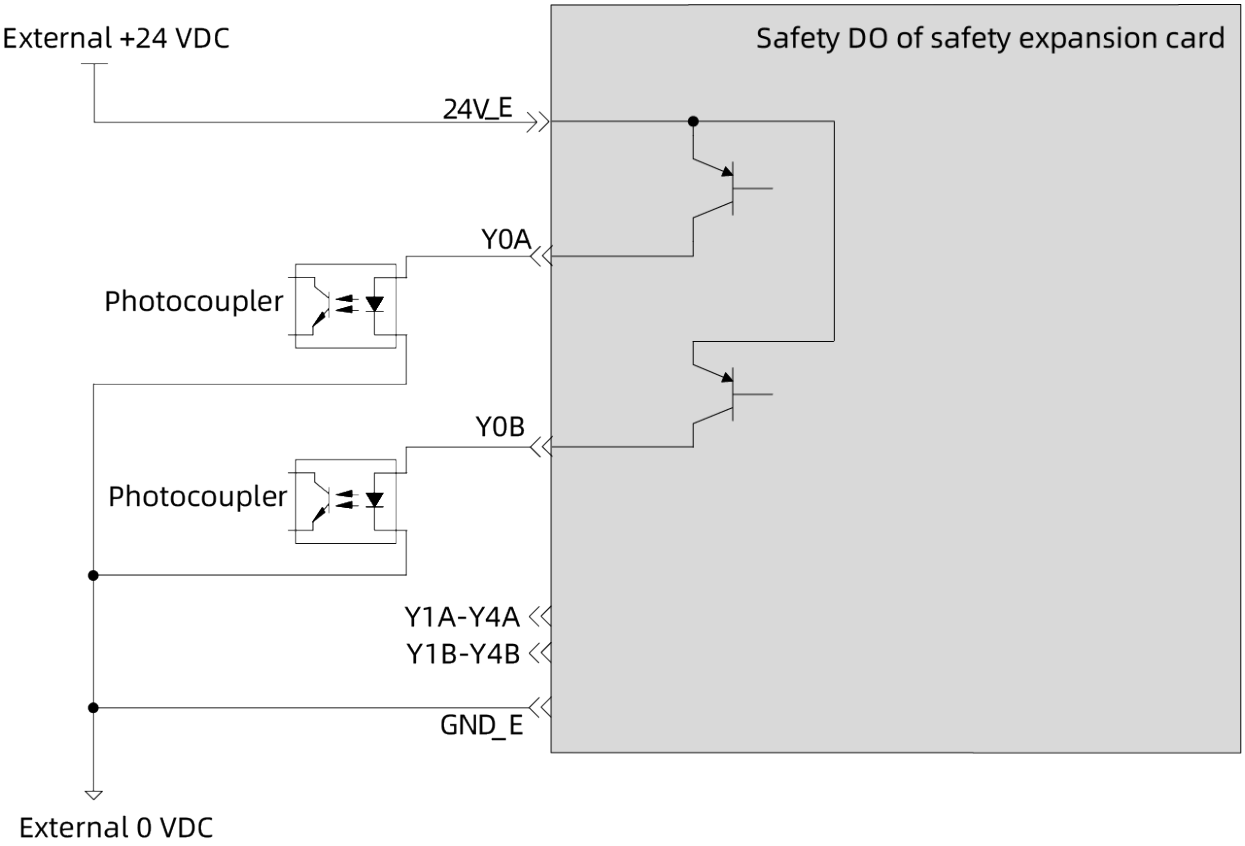
1. Either circuit is not connected to a relay or both circuits are not connected to a relay:



2. The polarity of the freewheeling diode of either relay is incorrect or the polarity of the freewheeling diode of both relays is incorrect:



When driving an optocoupler load:



Topology and wiring for the SAFETY interface/safety DO

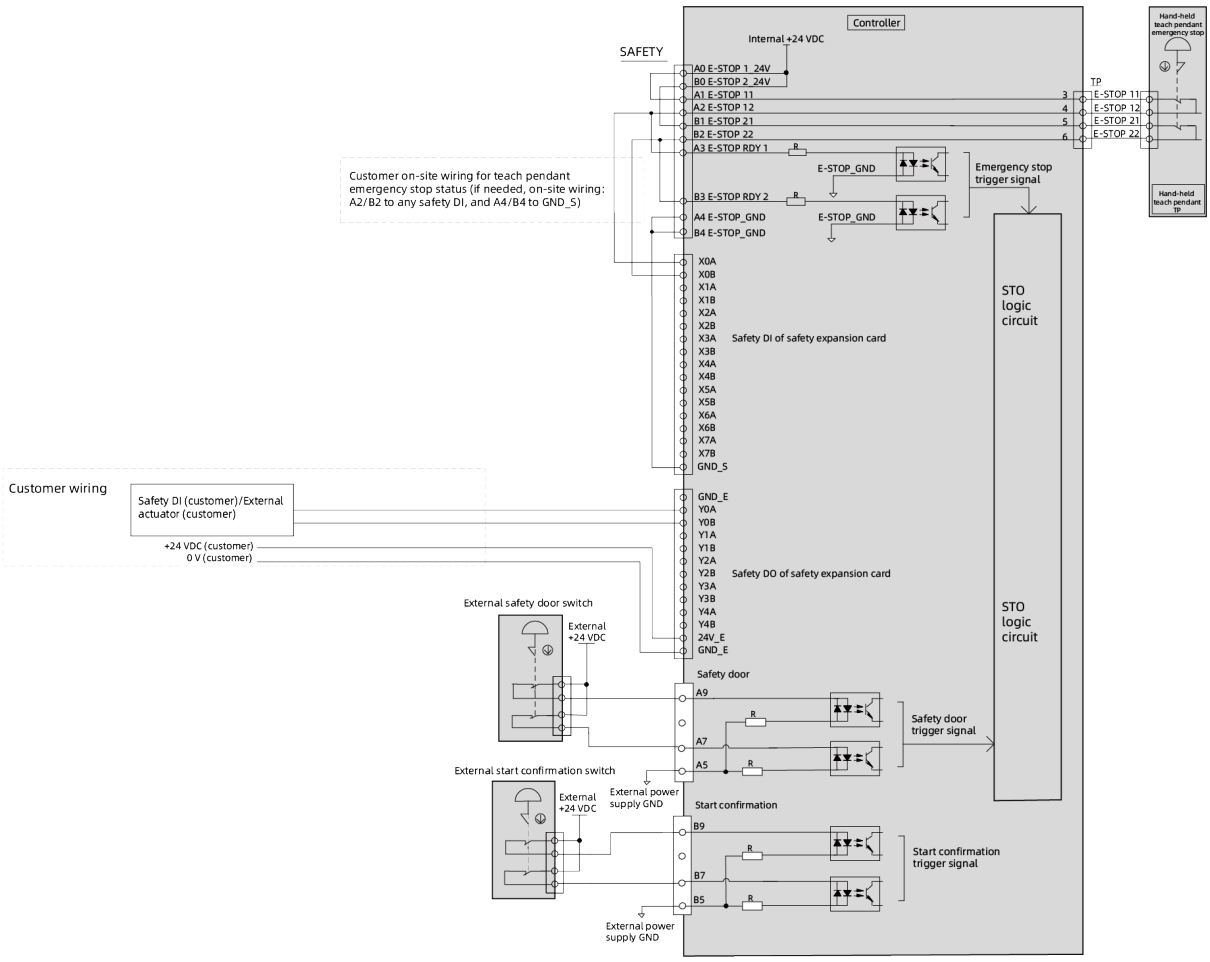
This subsection introduces the topology and wiring for the SAFETY interface/safety DO of IRCB501, IRCB501 high-protection, IRCB501-EM, and IRCB501-EM high-protection series controllers.

Before wiring according to the following topology and wiring diagram for the SAFETY interface/safety DO, read all the precautions in the 3 Wiring and Installation section.

NOTE

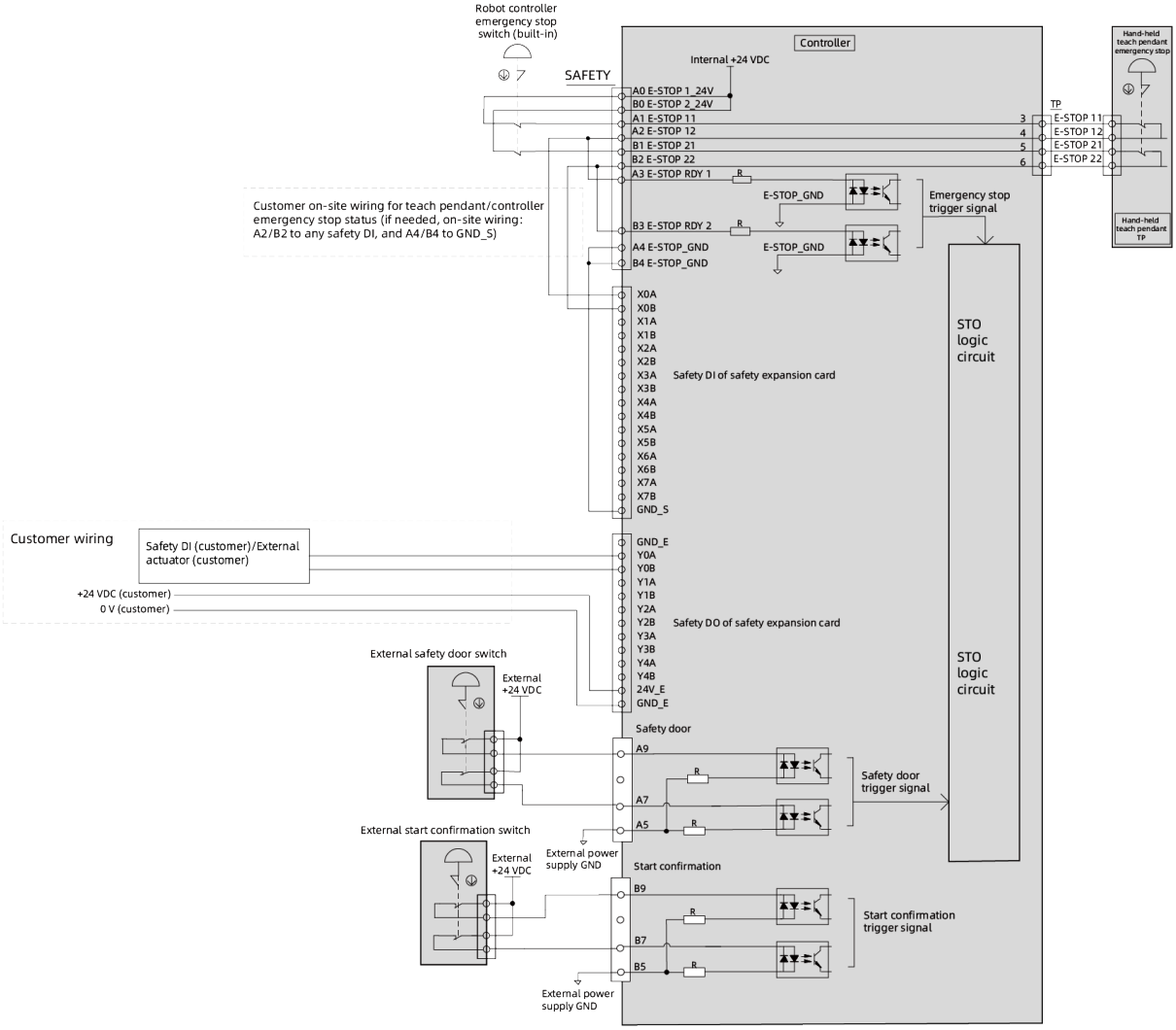
The ESOUT interface (emergency stop switch status function) for user I/O is not reflected in the topology and wiring for the SAFETY interface/safety DI of IRCB501-EM and IRCB501-EM high-protection series controllers. For detailed wiring, see the 3.1.2.3.4 Topology and Wiring for Emergency Stop, Safety Door, and Start Confirmation Functions section.

- Topology and wiring for the SAFETY interface/safety DO of IRCB501 series controller (with safety expansion card):



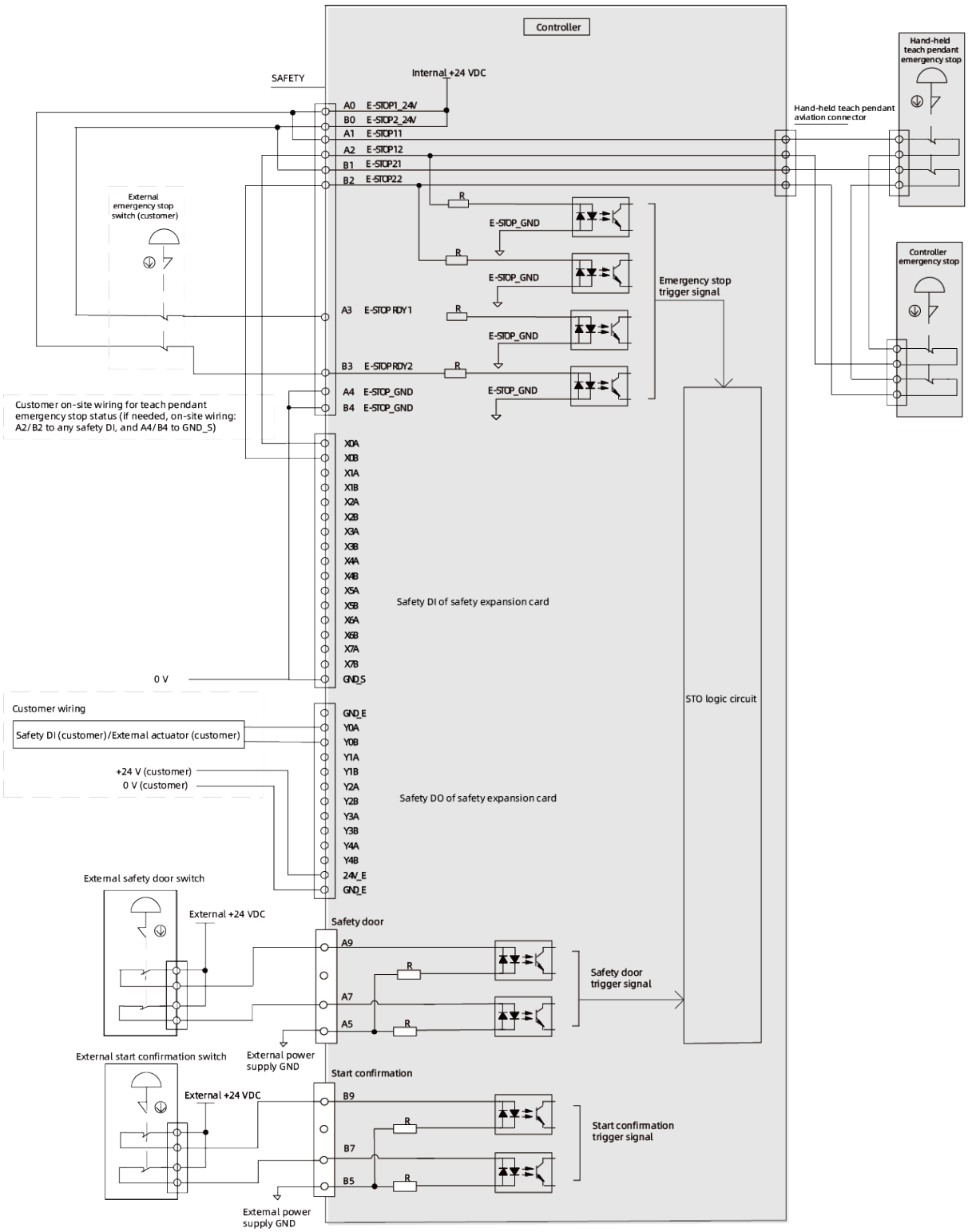
Topology and wiring for the SAFETY interface/safety DO of IRCB501 series controller (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DO of IRCB501 high-protection series controller (with safety expansion card):



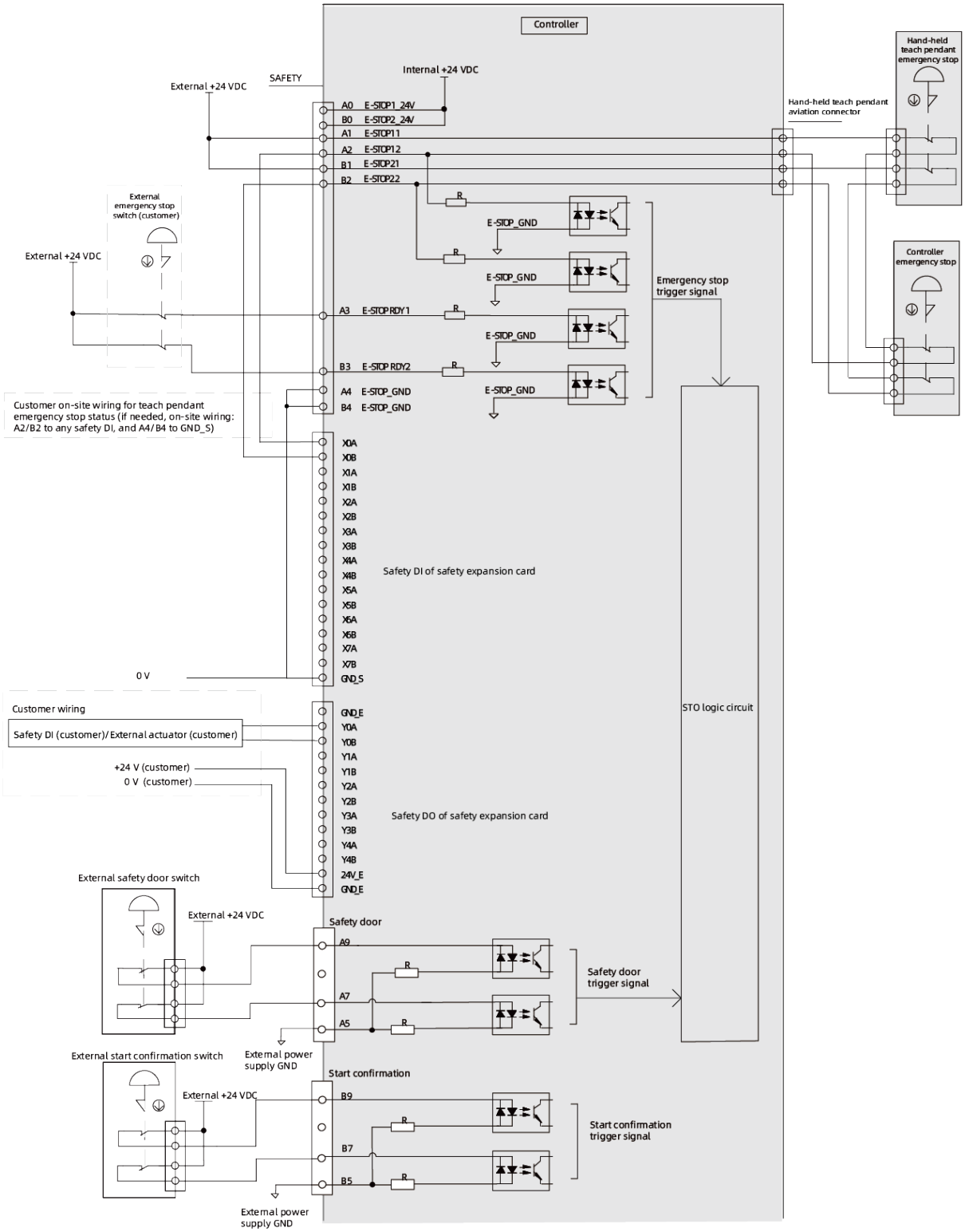
Topology and wiring for the SAFETY interface/safety DO of IRCB501 high-protection series controller (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DO of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card) - using internal power supply:



Topology and wiring for the SAFETY interface/safety DO of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card)

- Topology and wiring for the SAFETY interface/safety DO of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card) - using external power supply:



Topology and wiring for the SAFETY interface/safety DO of IRCB501-EM and IRCB501-EM high-protection series controllers (with safety expansion card)

4 Safety Functions

4.1 Overview of Safety Functions

Safety Function	Description
Safety I/O (ensuring communication safety)	All safety I/O are dual-channel. The safety DI can be configured for emergency stop, protective stop (i.e., safety door), activation of each safety function, and safety tool mode and number. The safety DO can be configured for emergency stop status, operation status, stop status, and the status of each safety function.
Safety low speed monitoring	A safety monitoring function. When activated, if the Cartesian speed of the robot exceeds 250 mm/s in manual mode, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal.
Joint position monitoring	A safety monitoring function. When activated, if the position of any robot axis exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to eight groups of joint position monitoring parameters. Each group of parameters can be used to monitor up to six axes of the robot.
Joint speed monitoring	A safety monitoring function. When activated, if the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to eight groups of joint speed monitoring parameters. Each group of parameters can be used to monitor up to six axes of the robot.
Cartesian position monitoring	A safety monitoring function. When activated, if the Cartesian position of the robot exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to 16 groups of Cartesian position monitoring parameters. Each group of parameters can be used to monitor the selected robot end monitoring object.
Cartesian speed monitoring	A safety monitoring function. When activated, if the Cartesian speed of the robot exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to eight groups of Cartesian speed monitoring parameters.
Safety tool mode settings	A function that determines the target TCP to be monitored by the safety module. This function allows you to set the target TCP point to be monitored during the monitoring process.

4.2 Safety I/O

Overview

- All safety I/O are dual-channel. The safety DI can be configured for external emergency stop, external protective stop, emergency stop, additional emergency stop, activation of each safety function, and safety tool mode and number.
- The safety DO can be configured for system emergency stop status, emergency stop status, additional emergency stop status, operation status, stop status, and the status of each safety function.
- To implement the required safety functions, in addition to the corresponding function settings in the safety I/O configuration, you also need to complete the corresponding wiring. For details on wiring methods, see the 3 Wiring and Installation section.

Related parameters

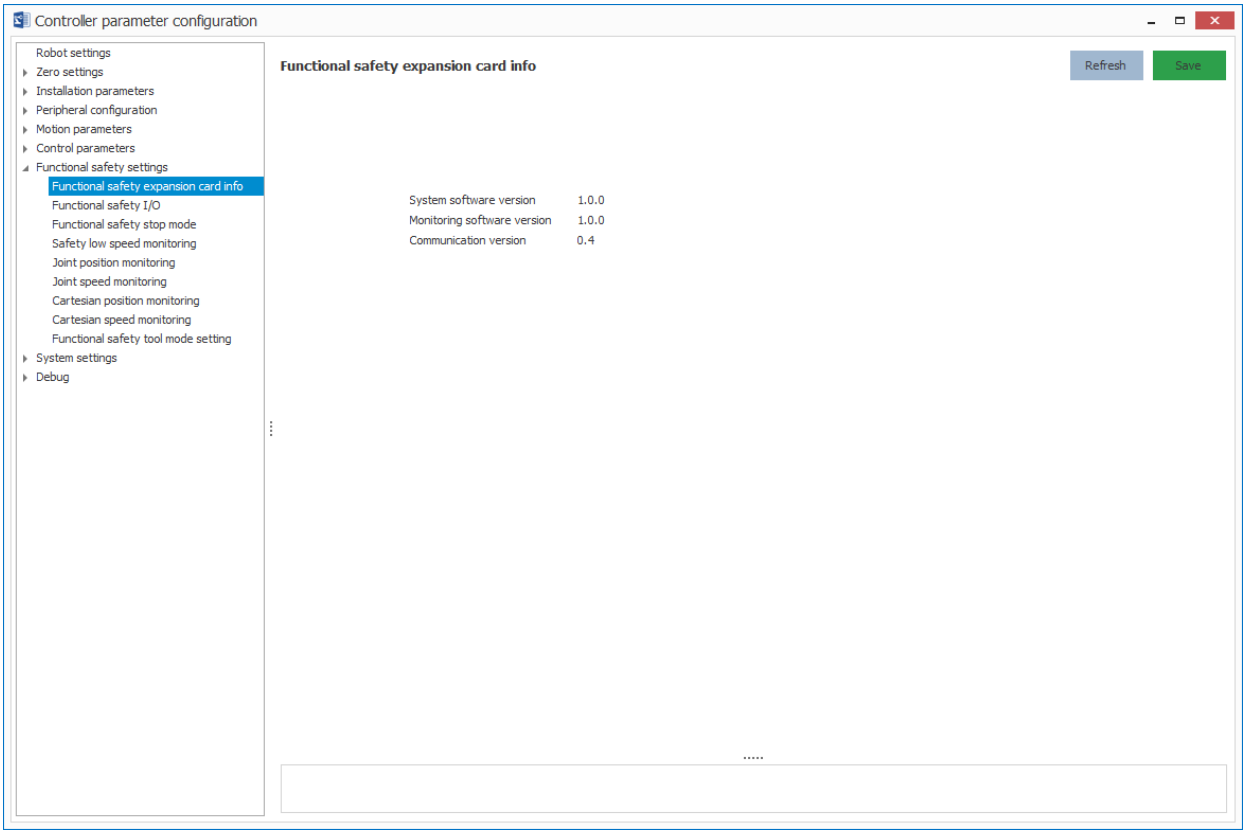
The following table lists the safety I/O function parameters.

Name	Value range	Default	Description
Safety DI configuration	NULL	NULL	When the safety DI is configured as "Emergency stop trigger", the on-site wiring of the SAFETY interface A2/B2 signal must be connected to any safety DI interface of the safety expansion card, and the connected safety DI should also be configured as "Emergency stop trigger".
	External emergency stop trigger		
	Emergency stop trigger		
	Additional emergency stop trigger		
	External protective stop trigger		
	Joint position monitoring trigger		
	Joint speed monitoring trigger		
	Cartesian position monitoring trigger		
	Cartesian speed monitoring trigger		
	Safety low speed monitoring trigger		
	TCP/ECP mode		
	Relay status monitoring		
	Tool number Bit0		
	Tool number Bit1		
	Tool number Bit2		
	Tool number Bit3		

Name	Value range	Default	Description
DI trigger threshold configuration	0 ms to 1000 ms	4 ms (default value)	Dual-channel DI inputs must be synchronized within the DI trigger threshold. Otherwise, an error will be reported. Note: When DI is configured as external protective stop trigger, external emergency stop trigger, or teach pendant/controller emergency stop trigger, a discrepancy between the dual-channel DI inputs exceeding 6 ms will trigger a stop.
Safety DO configuration	NULL	NULL	1. The safety DO can be configured for system emergency stop status, emergency stop status, additional emergency stop status, operation status, stop status, and the status of each safety function. 2. System emergency stop status is the output of all emergency stop signal states, including external emergency stop, emergency stop, and additional emergency stop (requires on-site wiring), and external protective stop. To output this status, the safety DI must be configured as the corresponding trigger source (external emergency stop trigger, emergency stop trigger, additional emergency stop trigger, and external protective stop trigger), and the safety DO must be configured as "system emergency stop status". 3. For the use of functions such as joint position monitoring status, joint speed monitoring status, Cartesian position monitoring status, Cartesian speed monitoring status, and safety low speed monitoring status, see the corresponding safety function introduction sections.
	System emergency stop status		
	Emergency stop status		
	Additional emergency stop status		
	Run status		
	Stop status		
	Joint position monitoring status		
	Joint speed monitoring status		
	Cartesian position monitoring status		
	Cartesian speed monitoring status		
	Safety low speed monitoring status		

> **NOTE**
>
> The configurable functions and function names of safety DI/safety DO may vary depending on the version. For detailed information on the available functions, see the robot programming guide or teach pendant programming guide, or consult Inovance technical support personnel.

Safety parameter initialization function



After the safety parameter initialization, the parameters saved in the safety expansion card will be restored to factory settings. Use this function with caution.

> **NOTE**
>
> After initialization, restart the controller.

4.3 Joint Position Monitoring

Overview

This function is a safety monitoring function. When activated, if the position of any robot axis exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to eight groups of joint position monitoring parameters. Each group of parameters can be used to monitor up to six axes of the robot.

Related parameters

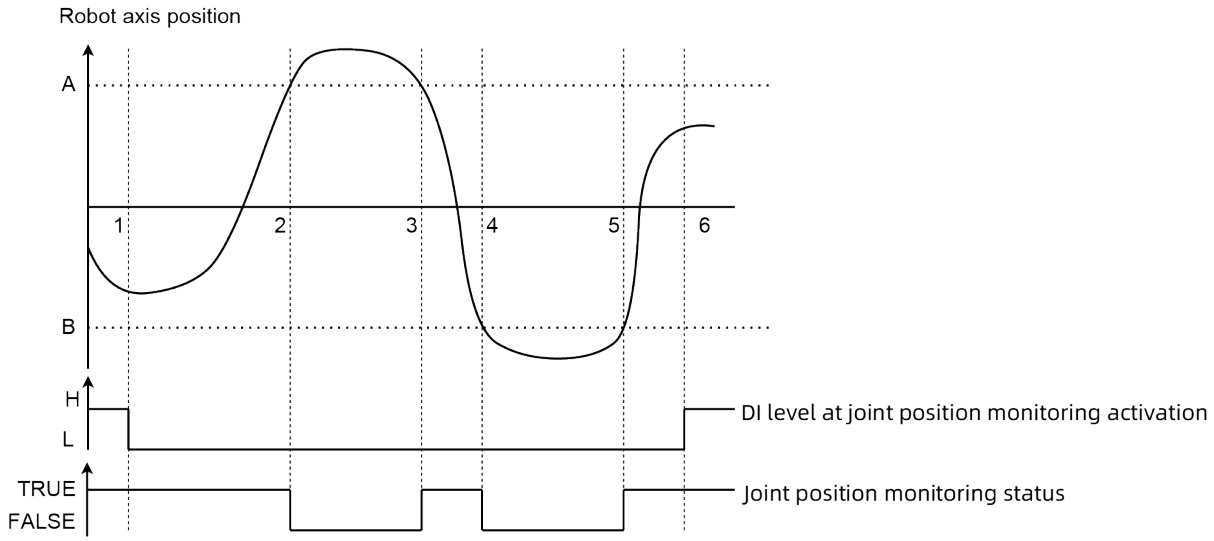
The following table lists the joint position monitoring function parameters.

Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the joint position monitoring function is deactivated and does not provide safety monitoring for the robot axis positions. When "Permanent trigger" is selected, the joint position monitoring is permanently active and provides the real-time safety monitoring for the robot axis positions. When "I/O trigger" is selected, the joint position monitoring function is activated or deactivated based on the status of the bound I/O.
	Permanent trigger		
	I/O trigger		
Axis position safety range	The range is model-dependent and must not exceed the maximum axis limit of the robot.	0	You can set the positive and negative safety ranges for the monitored robot axis positions.
Stop mode	Category 0 stop	Category 0 stop	If the position of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current axis position group. If not activated, this set of parameters will not be used for joint position monitoring.
	Activate		

Function Triggering

- Method 1: Select "Permanent trigger" for the trigger method.
- Method 2: Select "I/O trigger" for the trigger method and set the bound DI status to TRUE.

Time sequence diagram



Name	Definition	Description
A	Joint position monitoring upper limit	User-defined upper position limit for each axis
B	Joint position monitoring lower limit	User-defined lower position limit for each axis
-	Joint position monitoring limit (A and B)	Joint limit position range based on the robot model parameter

Procedure	Behavior
1	When the joint position monitoring function is activated, the safety module begins to monitor the axis position.
2	If any axis position exceeds the upper limit (A), the joint position monitoring status switches to an abnormal state.

4.4 Joint Speed Monitoring

Overview

This function is a safety monitoring function. When activated, if the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to eight groups of joint speed monitoring parameters. Each group of parameters can be used to monitor up to six axes of the robot.

Related parameters

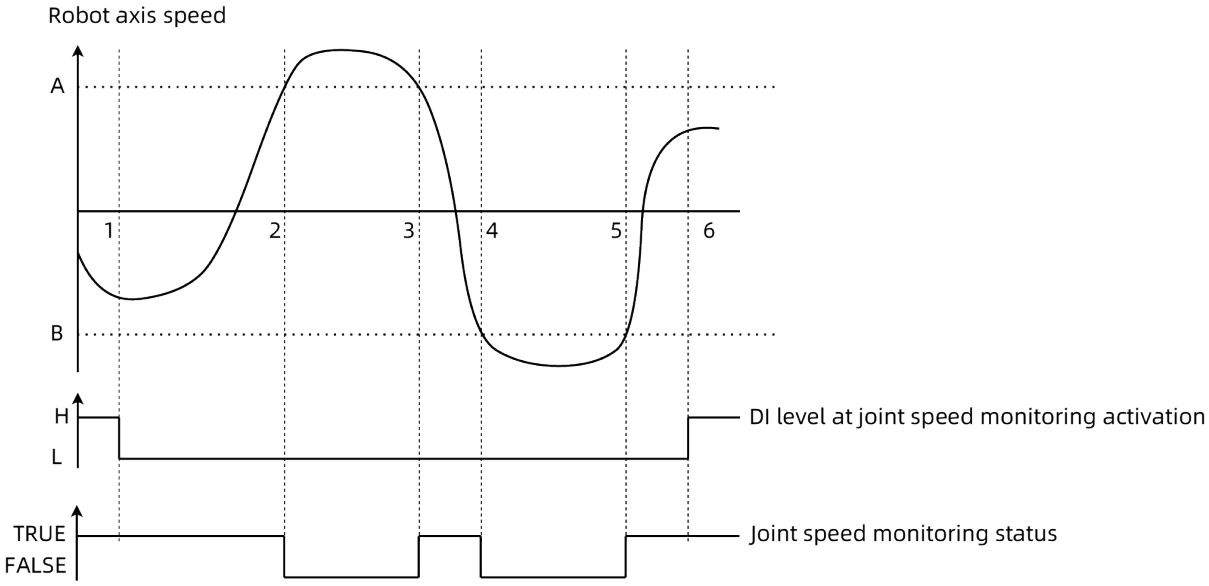
The following table lists the joint speed monitoring function parameters.

Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the joint speed monitoring function is deactivated and does provide safety monitoring for the robot axis speed.
	Permanent trigger		When "Permanent trigger" is selected, the joint speed monitoring is permanently active and provides the real-time safety monitoring for the robot axis speed.
	I/O trigger		When "I/O trigger" is selected, the joint speed monitoring function is activated or deactivated based on the status of the bound I/O.
Axis speed safety range	The range is model-dependent and must not exceed the joint speed range of the robot.	0	You can set the safety ranges for the monitored robot axis speed.
Stop mode	Category 0 stop	Category 0 stop	If the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current axis speed group. If not activated, this set of parameters will not be used for joint speed monitoring.
	Activate		

Function Triggering

- Method 1: Select "Permanent trigger" for the trigger method.
- Method 2: Select "I/O trigger" for the trigger method and set the bound DI status to TRUE.

Time sequence diagram



4.5 Cartesian Position Monitoring

Overview

This function is a safety monitoring function. When activated, if the Cartesian position of the robot exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to 16 groups of Cartesian position monitoring parameters. Each group of parameters can be used to monitor the selected robot end monitoring object.

Related parameters

The Cartesian position monitoring function parameters are divided into trigger methods, safety zone parameters, and end monitoring object parameters. Details are as follows.

Trigger methods:

Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the Cartesian position monitoring function is deactivated and does not provide safety monitoring for the Cartesian position of the robot's end monitoring object.
	Permanent trigger		When "Permanent trigger" is selected, the Cartesian position monitoring is permanently active and provides the real-time safety monitoring for the Cartesian position of the robot's end monitoring object.

Name	Value range	Default	Description
	I/O trigger		When "I/O trigger" is selected, the Cartesian position monitoring function is activated or deactivated based on the status of the bound I/O.

Interference zone parameters:

Name	Value range	Default	Description
Interference zone activation	Deactivate Activate	Deactivate	Indicates the activation of the current interference zone. If not activated, this set of parameters will not be used for Cartesian position monitoring.
Remarks	Length limit: 31 characters (a Chinese character counts as two characters)	NULL	Descriptive information of the current safety zone.
Inside and outside	Inside Outside	Inside	Specifies the inside or outside of the safety zone as the interference zone.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the Cartesian position of the robot's end monitoring object exceeds the safety zone set by the user, it triggers a Category 0 or 1 emergency stop.
Safety distance	[0, 10000], unit: mm	0	Increases or decreases the interference zone as a whole according to the "Inside and outside" option.
Safety zone setting method	Diagonal point Datum point + offset	Diagonal point	Sets the safety zone by diagonal point, or by datum point + offset. The points are taken in the current workobject frame.
Safety zone point parameters	The range of the point value is [-10000, 10000], in mm. The range of the offset is [-10000, 0), (0, 10000], in mm.	0	You can enter the point parameter manually or click the "Get current point" button to acquire the current point automatically.

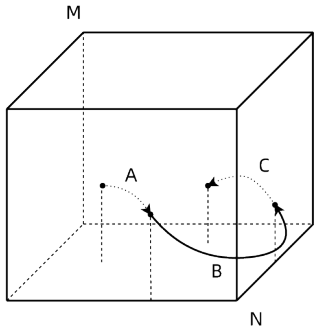
End monitoring object parameters:

Name	Value range	Default	Description
End monitoring object activation	Deactivate	Deactivate	Indicates the activation of the current end monitoring object. If not activated, this set of parameters will not be used for Cartesian position monitoring.
	Activate		
Remarks	Length limit: 31 characters (a Chinese character counts as two characters)	NULL	Descriptive information of the current monitoring object.
Monitoring object type	TCP (the tool selected in the safety tool mode settings)	TCP	Specifies the inside or outside of the set zone as the interference zone.
	MTCP		
	Sphere		
	Cuboid bounding box		
Monitoring object parameters	The range of the point value is [-10000, 10000], in mm. The range of the offset is [-10000, 0), (0, 10000], in mm.	0	• TCP: When the robot grips the tool, the current TCP is used for monitoring. When the robot grips the workobject, the flange center is used for monitoring. • MTCP: Supports up to four tools at the same time. You must select a reference point for the tool. The current TCP of the robot is not used for monitoring any more. You can view the parameters of the tool frame in the lower part of the interface. • Sphere: The spherical center is offset from the Z direction of the flange frame. The eccentric sphere is not supported. • Cuboid bounding box: There are three methods to acquire the points, namely, diagonal point, datum point + offset, and get point.
	The spherical center range is [-10000, 10000] and the radius range is (0, 10000], in mm.		

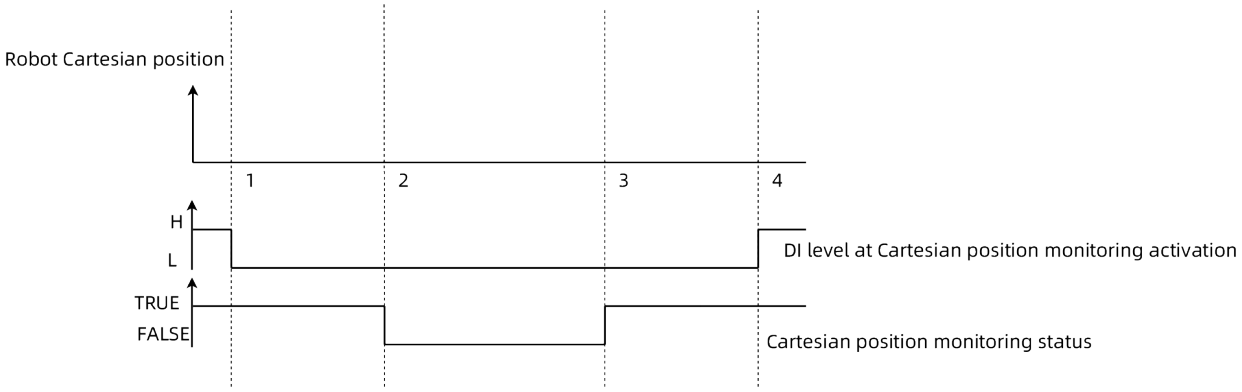
Function Triggering

- Method 1: Select "Permanent trigger" for the trigger method.
- Method 2: Select "I/O trigger" for the trigger method and set the bound DI status to TRUE.

Time sequence diagram



In the diagram: 1 and 4 are inside the safety zone, 2 and 3 are on the safety zone boundary. For the trajectory, segments A and C are inside the safety zone, while segment B is outside.



Name	Definition	Description
M, N	The safety zone is a cube with M and N as the diagonal points.	-
-	Diagonal points M and N of the safety zone	The X, Y, and Z coordinate values are within the range of -10000 mm to +10000 mm.

Procedure	Behavior
1	When the Cartesian position monitoring function is activated, the safety module begins to monitor the Cartesian position.
2	If the Cartesian position exceeds the safety zone, the Cartesian position monitoring status switches to an abnormal state.

4.6 Cartesian Speed Monitoring

Overview

This function is a safety monitoring function. When activated, if the Cartesian speed of the robot exceeds the user-configured range, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal. You can configure up to eight groups of Cartesian speed monitoring parameters.

Related parameters

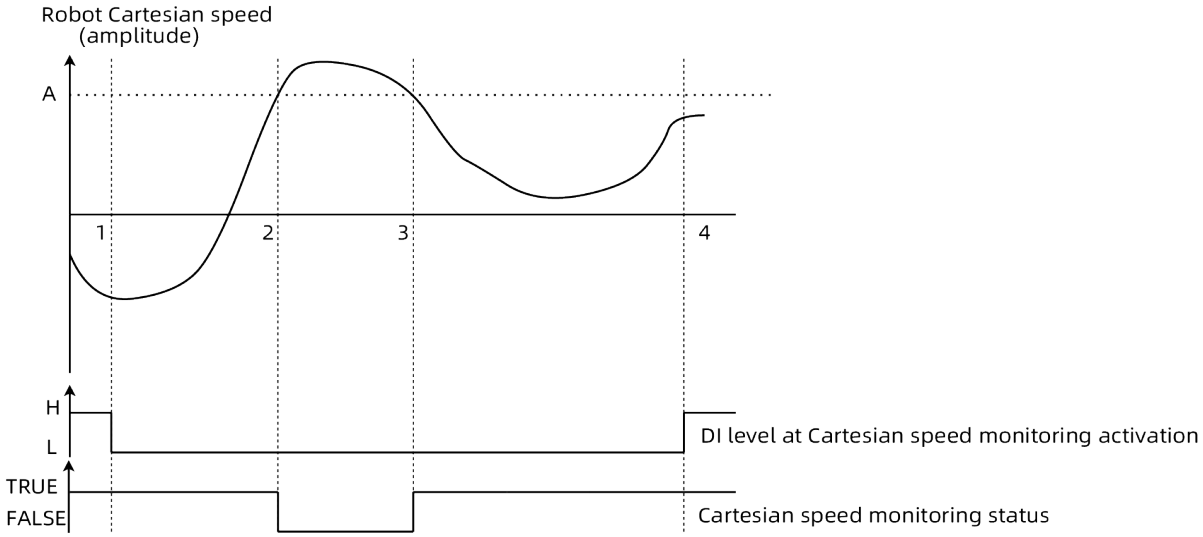
The following table lists the Cartesian speed monitoring function parameters.

Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the Cartesian speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot.
	Permanent trigger		When "Permanent trigger" is selected, the Cartesian speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot.
	I/O trigger		When "I/O trigger" is selected, the Cartesian speed monitoring function is activated or deactivated based on the status of the bound I/O.
Cartesian speed safety range	0-10000 mm/s	0	You can set the safety ranges for the monitored robot Cartesian speed.
Stop mode	Category 0 stop	Category 0 stop	If the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current Cartesian speed. If not activated, this set of parameters will not be used for Cartesian speed monitoring.
	Activate		

Function Triggering

- Method 1: Select "Permanent trigger" for the trigger method.
- Method 2: Select "I/O trigger" for the trigger method and set the bound DI status to TRUE.

Time sequence diagram



Name	Definition	Description
A	Cartesian speed monitoring upper limit	Defines the upper limit of the TCP speed
-	Cartesian speed monitoring limit (speed amplitude)	0-10000 mm/s
Procedure	Behavior	
1	When the Cartesian speed monitoring function is activated, the safety module begins to monitor the Cartesian speed.	
2	If the Cartesian speed exceeds the upper limit, the Cartesian speed monitoring status switches to an abnormal state.	

Procedure	Behavior
1	When the Cartesian speed monitoring function is activated, the safety module begins to monitor the Cartesian speed.
2	If the Cartesian speed exceeds the upper limit, the Cartesian speed monitoring status switches to an abnormal state.

4.7 Safety Low Speed Monitoring

Overview

This function is a safety monitoring function. When activated, if the Cartesian speed of the robot exceeds 250 mm/s in manual mode, the function triggers a Category 0 or Category 1 emergency stop according to the user configuration, and sets an output signal.

Related parameters

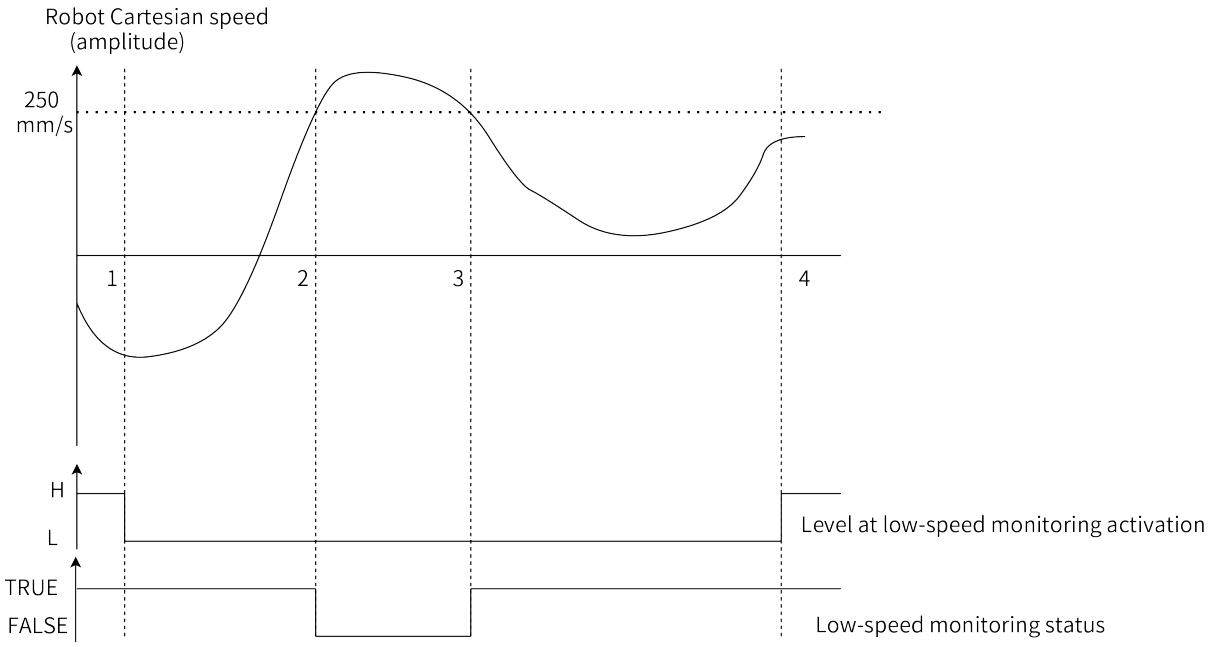
The following table lists the safety low speed monitoring function parameters.

Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the safety low speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot safety tool.
	Permanent trigger		When "Permanent trigger" is selected, the safety low speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot safety tool.
	I/O trigger		When "I/O trigger" is selected, the safety low speed monitoring function is activated or deactivated based on the status of the bound I/O.
Stop mode	Category 0 stop	Category 0 stop	If the Cartesian speed of the robot safety tool exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		

Function Triggering

- Method 1: Select "Permanent trigger" for the trigger method.
- Method 2: Select "I/O trigger" for the trigger method and set the bound DI status to TRUE.

Time sequence diagram



Name	Definition	Description
A	Cartesian speed monitoring upper limit	Defines the upper limit of the TCP speed
-	Cartesian speed monitoring limit (speed amplitude)	250 mm/s

Procedure	Behavior
1	When the Cartesian speed monitoring function is activated, the safety module begins to monitor the Cartesian speed.
2	If the Cartesian speed exceeds the upper limit, the Cartesian speed monitoring status switches to an abnormal state.

4.8 Safety Tool Mode Settings

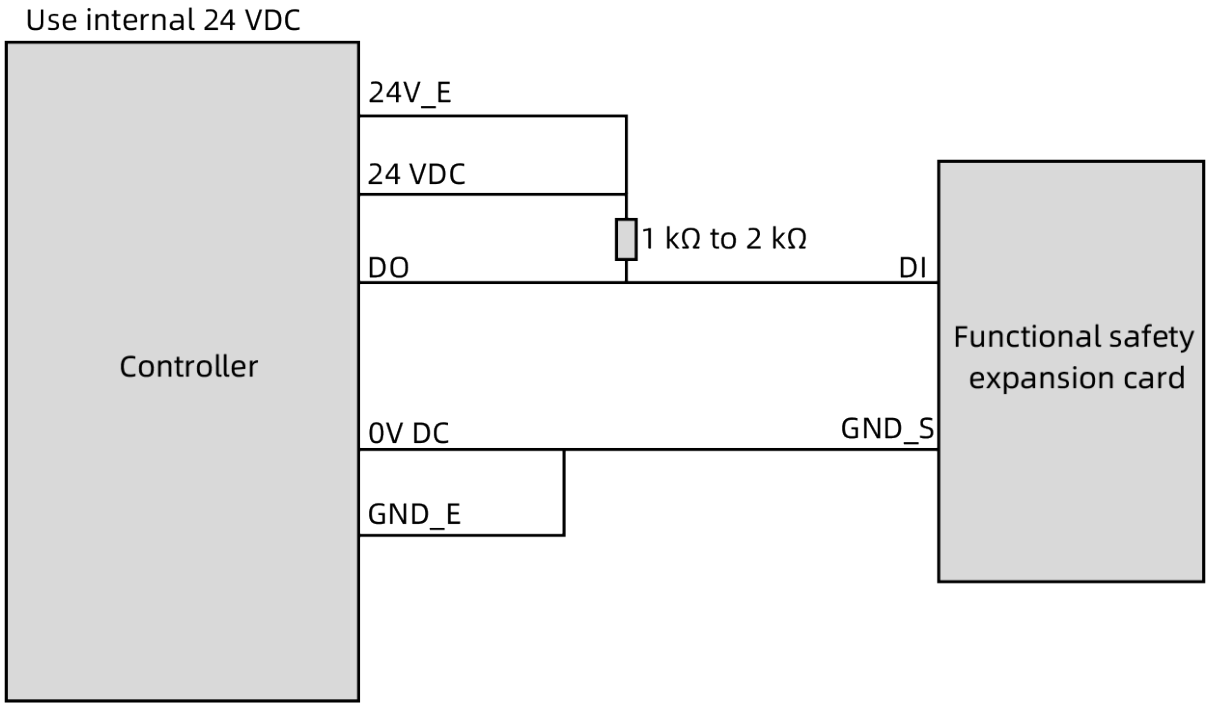
Overview

This is a function that determines the target TCP to be monitored by the safety module. This function allows you to set the target TCP point to be monitored during the monitoring process.

Related parameters

Name	Value range	Default	Description
Safety tool mode	Follow system tool	Fixed safety tool	When "Follow system tool" is selected, you need to perform the configuration for 5 standard DOs, along with corresponding configurations in the safety DI and physical connections, to set the tool TCP/ECP mode and the corresponding sequence number.
	Fixed safety tool		When a fixed tool is selected, you need to set the tool number or workobject number for monitoring.
	Manual tool switch		When "Manual tool switch" is selected, no parameter configuration is required on this interface. However, configuration must be performed in the safety DI, along with a physical connection.

Safety tool wiring diagram



5 Commissioning and Operation

5.1 Commissioning Preparation

This chapter describes the operation procedures for using the safety functions. Before using the safety functions, you must complete the installation of the safety function software and hardware. For software installation, see the InoRobotLab user guide and the teach pendant user guide. For hardware installation, see the 3.2 Installing Expansion Card section of this guide.

5.2 Configuration on InoRobotTP

Teach pendant model: IR-TP200-L5

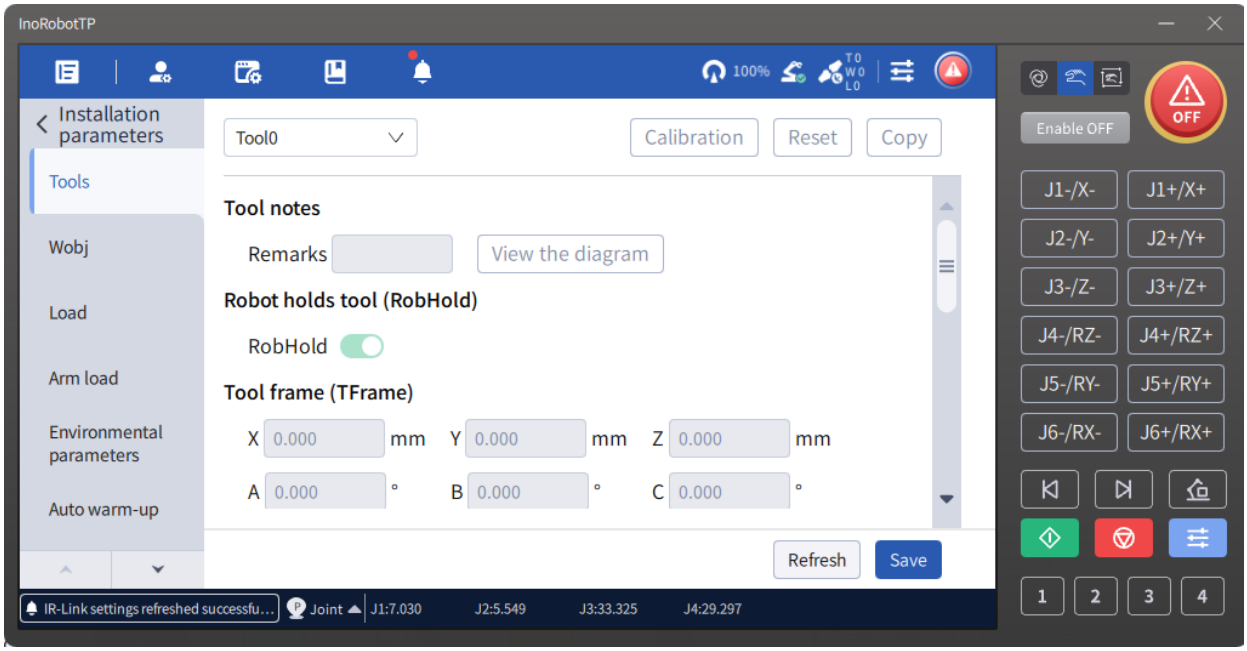
The following table describes the safety function configuration steps.

No.	Operation
1	Configure basic parameters
2	Configure system access
3	Configure safety tool
4	Configure safety I/O signal
5	Configure safety stop parameters
6	Configure safety low speed monitoring parameters
7	Configure joint position monitoring parameters
8	Configure joint speed monitoring parameters
9	Configure Cartesian position monitoring parameters
10	Configure Cartesian speed monitoring parameters

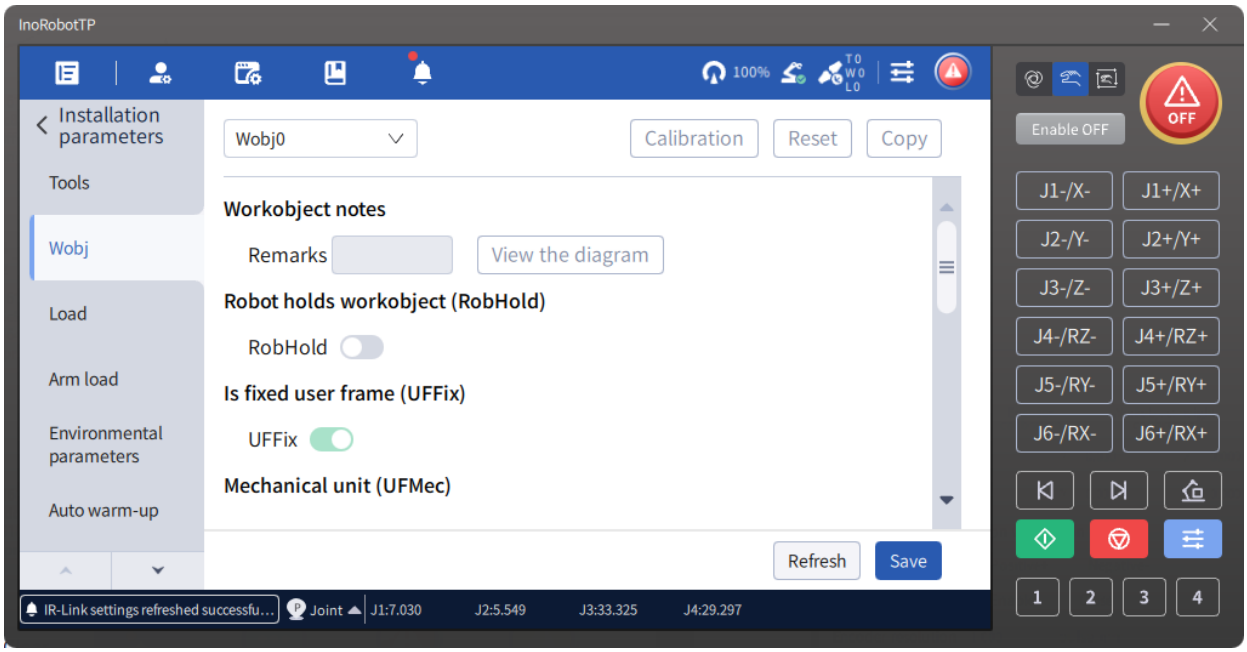
5.2.1 Configuring Basic Parameters

Before using the safety functions after flashing or upgrade of the robot system, complete the following operations.

1. Configure and save the tool parameters required by the robot.



2. Configure and save the workobject parameters required by the robot.



5.2.2 Configuring System Access

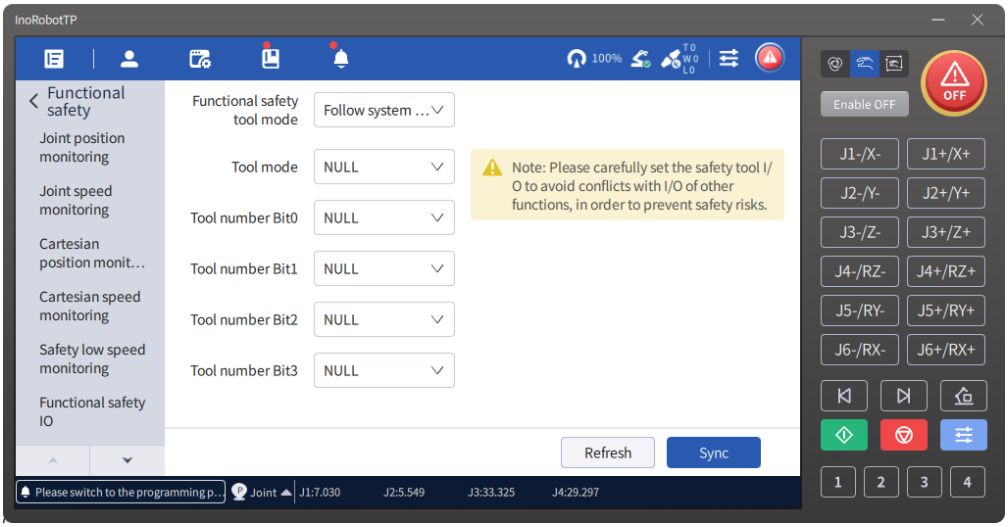
Only authorized operators (editor, administrator and manufacturer) are allowed to modify the safety function parameters. Safety function password is required.

5.2.3 Configuring Safety Tool

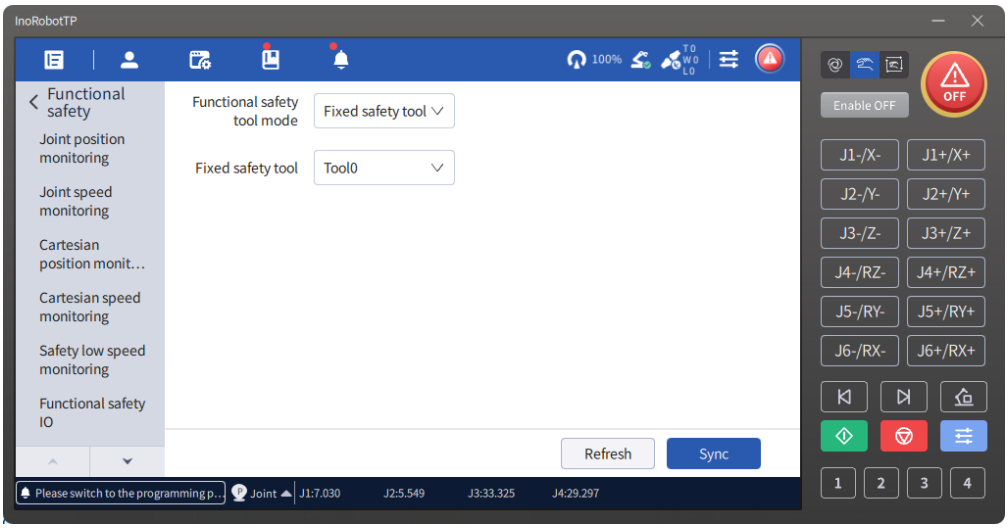
The safety tool has three modes: follow system tool, fixed safety tool, and manual tool switch. You can configure the safety tool as needed.

See the following instructions for setting up the three modes:

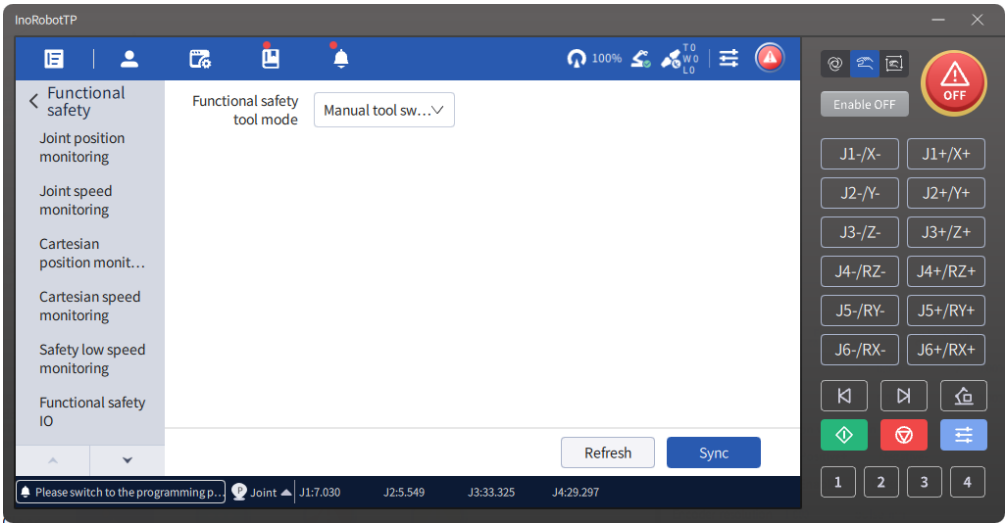
1. When the mode is set to "Follow system tool", it occupies five standard I/O points. The OUT number is specified by the user, and other functions cannot use these five OUT numbers. During wiring, connect the DI (3-7) on the safety module in the order corresponding to the specified OUT numbers. The controller must be configured to trigger the corresponding standard OUT when switching tools.



2. When the mode is set to "Fixed safety tool", you need to specify a tool (TCP) or workobject (ECP) as the safety tool/workobject, and it cannot be switched via safety I/O or standard I/O. When a workobject is selected, its "RobHold" parameter must be set to "True".



3. When the mode is set to "Manual tool switch", you need to connect the external I/O to the DI (3-7) on the safety module, allowing the tool switching by the operator or an external device.



After the parameters are configured and saved, the safety tool set takes effect immediately.

CAUTION

- It is important to set the safety tool for the safety function. Be cautious when setting the safety tool to avoid safety accidents caused by a mismatch between the Cartesian position/speed monitored by the safety function and the actual Cartesian position/speed.
- When selecting the mode as "Follow system tool" or "Manual tool switch", configure the safety DI3 to DI7 and make physical connections according to the tool number required for switching.
- In the Cartesian position monitoring function, when the end monitoring object type is not TCP, the actual settings prevail and are not affected by the safety tool mode settings.
- In the V4R24C2 version, the default values will be restored after the controller is restarted, and reconfiguration is required after restarting. For other versions, this parameter is retained upon power-off. After restarting, the last set value is retained.

Example:

When the safety tool mode is configured to follow system tool, the standard DOs configured on the interface are DO23, DO34, DO56, DO67 and DO78.

Safety tool mode configuration	Safety configuration terminal	Connection/Status	Description
Follow system tool	DI3	Robot standard DO23 to safety DI3	Configure the TCP/ECP mode.
	DI4	Robot standard DO34 to safety DI4	When switching of up to 16 tool/ workobjects is required, configure the safety DI4 as the tool number Bit0.
	DI5	Robot standard DO56 to safety DI5	Configure the safety DI5 as the tool number Bit1.
	DI6	Robot standard DO67 to safety DI6	Configure the safety DI6 as the tool number Bit2.
	DI7	Robot standard DO78 to safety DI7	Configure the safety DI7 as the tool number Bit3.
Manual tool switch	DI3	Configure the safety DI8 as the tool number Bit3.	Configure the safety DI3 as TCP/ECP mode for the switching between TCP/ECP modes.
	DI4	The user controls the status of safety DI4.	When switching of up to 16 tool/ workobjects is required, configure the safety DI4 as the tool number Bit0.
	DI5	The user controls the status of safety DI5.	Configure the safety DI5 as the tool number Bit1.

Safety tool mode configuration	Safety configuration terminal	Connection/Status	Description
	DI6	The user controls the status of safety DI6.	Configure the safety DI6 as the tool number Bit2.
	DI7	The user controls the status of safety DI7.	Configure the safety DI7 as the tool number Bit3.

Set the status of DI4 to DI7 according to the desired tool/workobject number to be switched:

- To switch the safety tool to tool number 7, set DI4, DI5, and DI6 to low level.
- To switch the safety tool to tool number 11, set DI4, DI5, and DI7 to low level, and DI6 to high level.

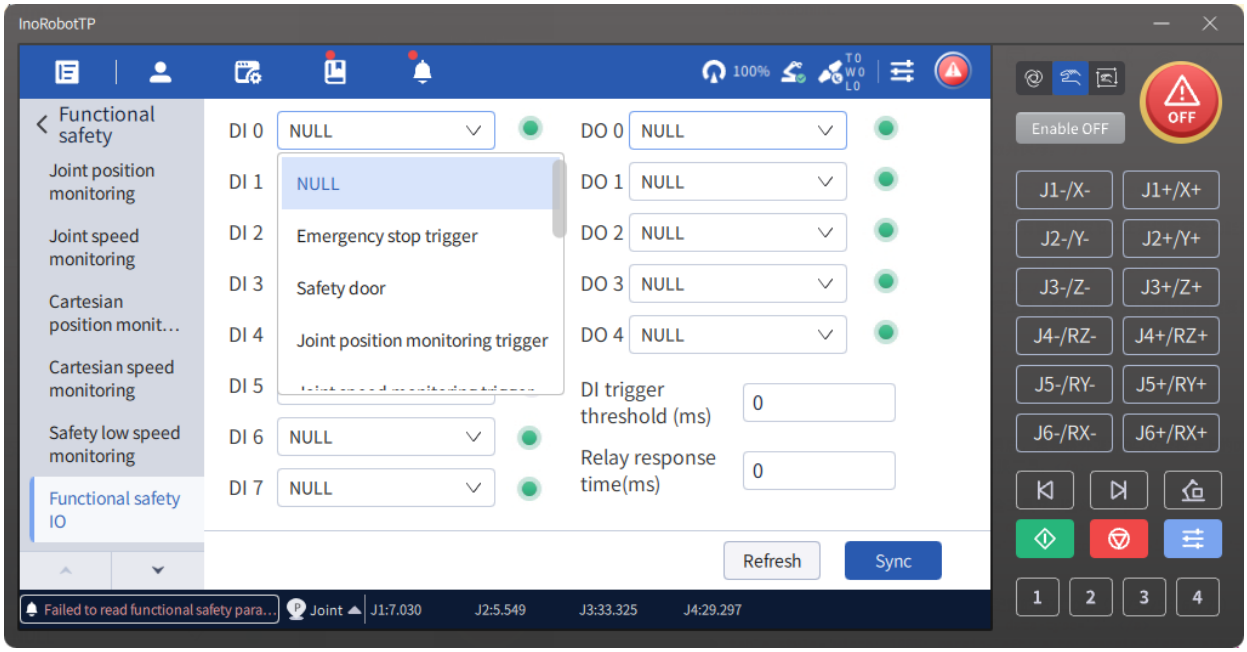
CAUTION

It is not always necessary to configure safety DI4-DI7.

- If the range of tool/workobject number to be switched is less than 8, only DI4 to DI6 need to be configured.
- If the range of tool/workobject number to be switched is less than 4, only DI4 to DI5 need to be configured.
- If the range of tool/workobject number to be switched is less than 2, only DI4 needs to be configured.

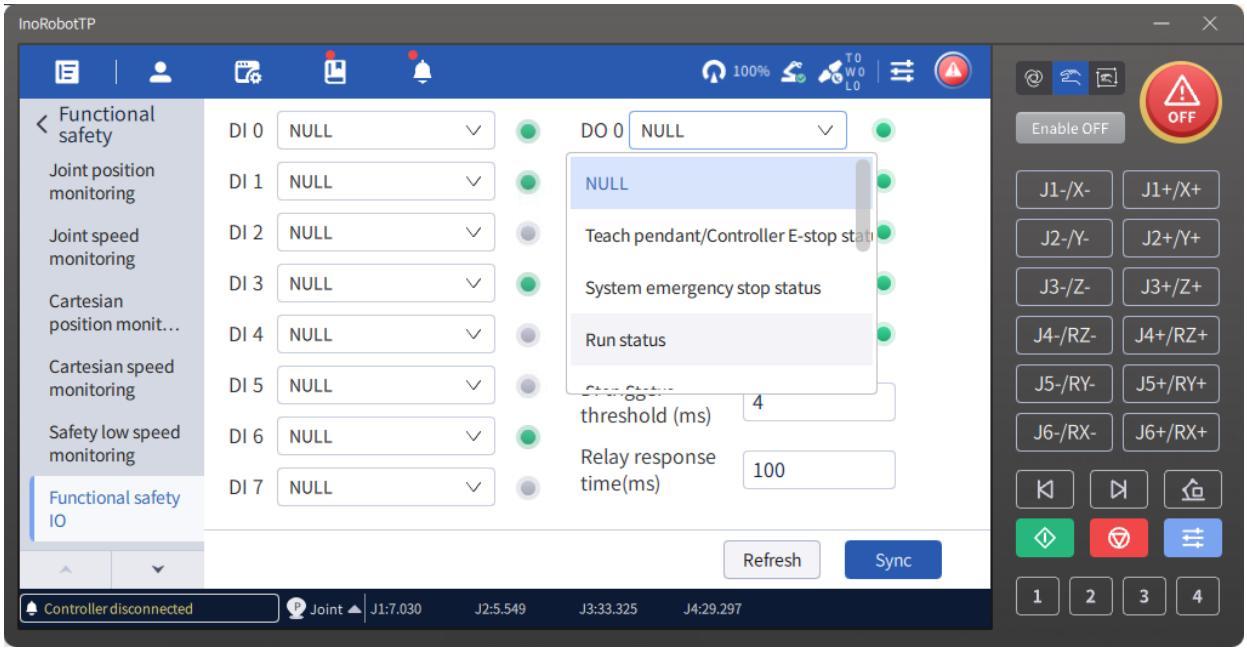
5.2.4 Configuring Safety I/O Signal

1. The safety DI can be configured for external emergency stop, external protective stop, emergency stop, additional emergency stop, activation of each safety function, and safety tool mode and number. After configuration, you can view the DI status via the status indicator. See the figure below:



> **NOTE**
>
> DI3 is added with TCP/ECP mode option, DI4 is added with Bit0 option, DI5 is added with Bit1 option, DI6 is added with Bit2 option, and DI7 is added with Bit3 option.

2. The safety DO can be configured for system emergency stop status, emergency stop status, additional emergency stop status, operation status, stop status, and the status of each safety function. After configuration, you can view the DO status via the status indicator. See the figure below:



After the above parameters are configured and saved, the safety I/O signals take effect immediately.

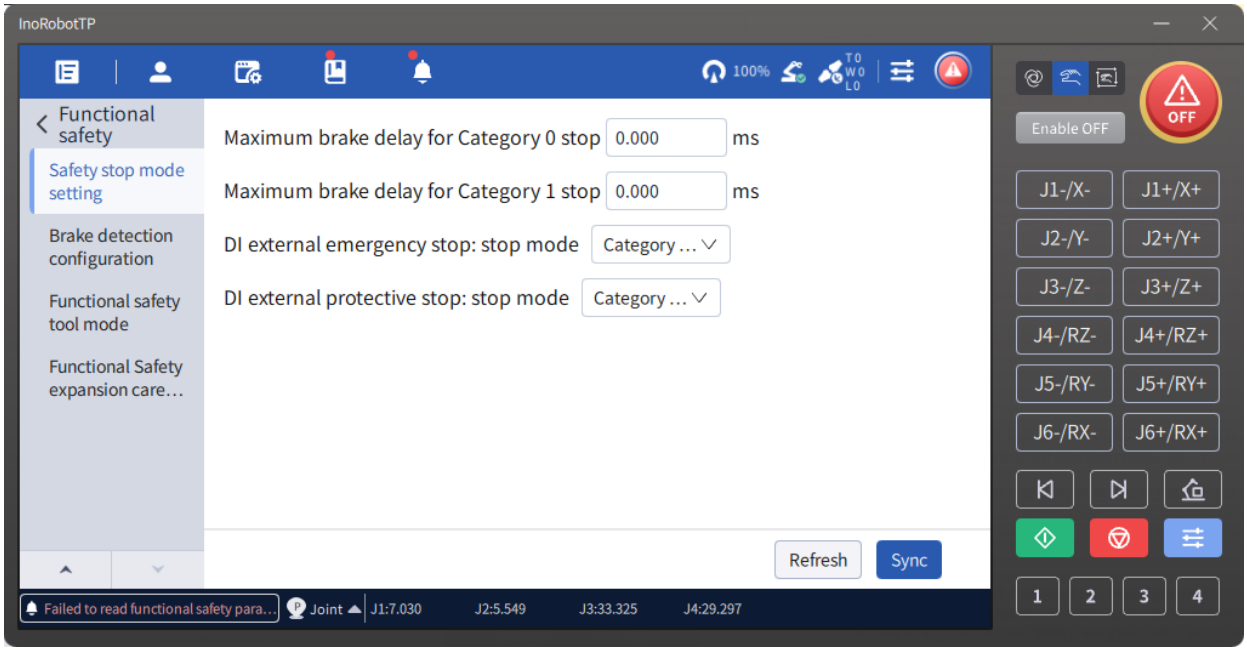
5.2.5 Configuring Safety Stop Parameters

As shown in the figure below, the safety stop parameters include:

- Maximum brake delay for Category 0 stop, in ms.
- Maximum brake delay for Category 1 stop, in ms.

You can configure the safety stop parameter as needed.

- DI external emergency stop methods are classified into Category 0 emergency stop and Category 1 emergency stop.
- DI external protective stop methods are classified into Category 0 emergency stop and Category 1 emergency stop.

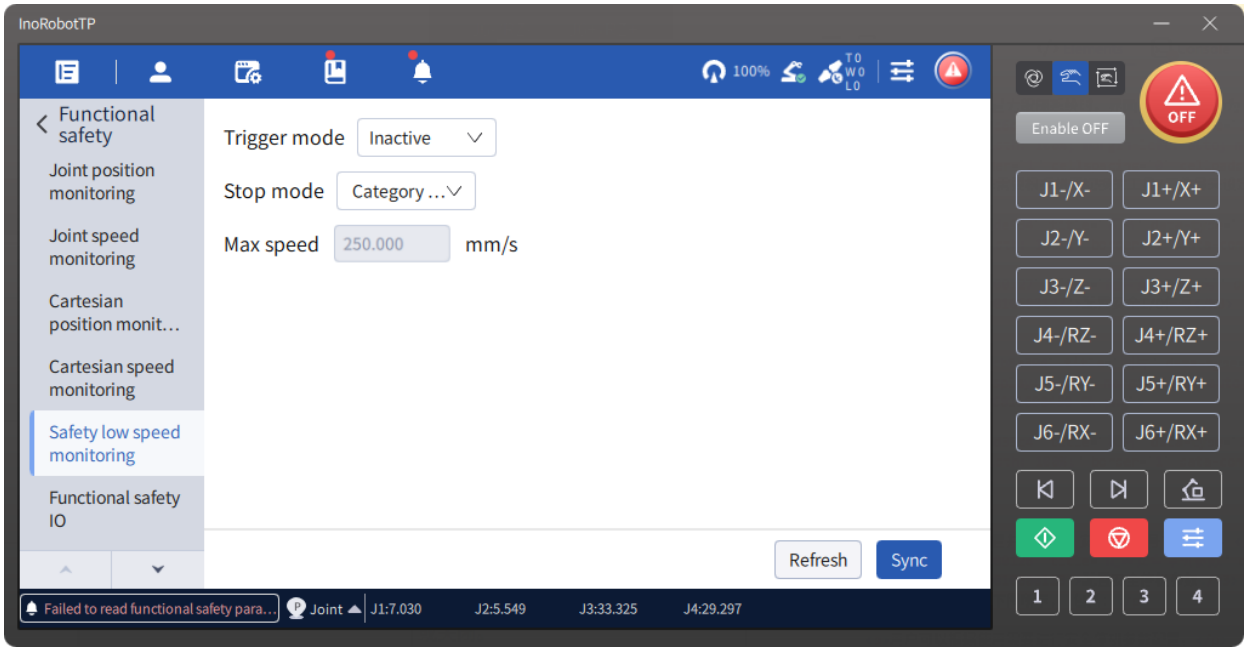


After the above parameters are configured and saved, the safety stop parameters take effect immediately.

> **NOTE**
>
> The maximum brake delay for Category 0 or 1 stop affects the application of the brake after a Category 0 or 1 emergency stop is triggered. Be cautious when setting the maximum brake delay. A too large delay may result in that the robot fails to apply the brake after an abnormality occurs, which may cause safety accidents.

5.2.6 Configuring Safety Low Speed Monitoring Parameters

You can configure the safety low speed monitoring parameters as needed. See the figure below:

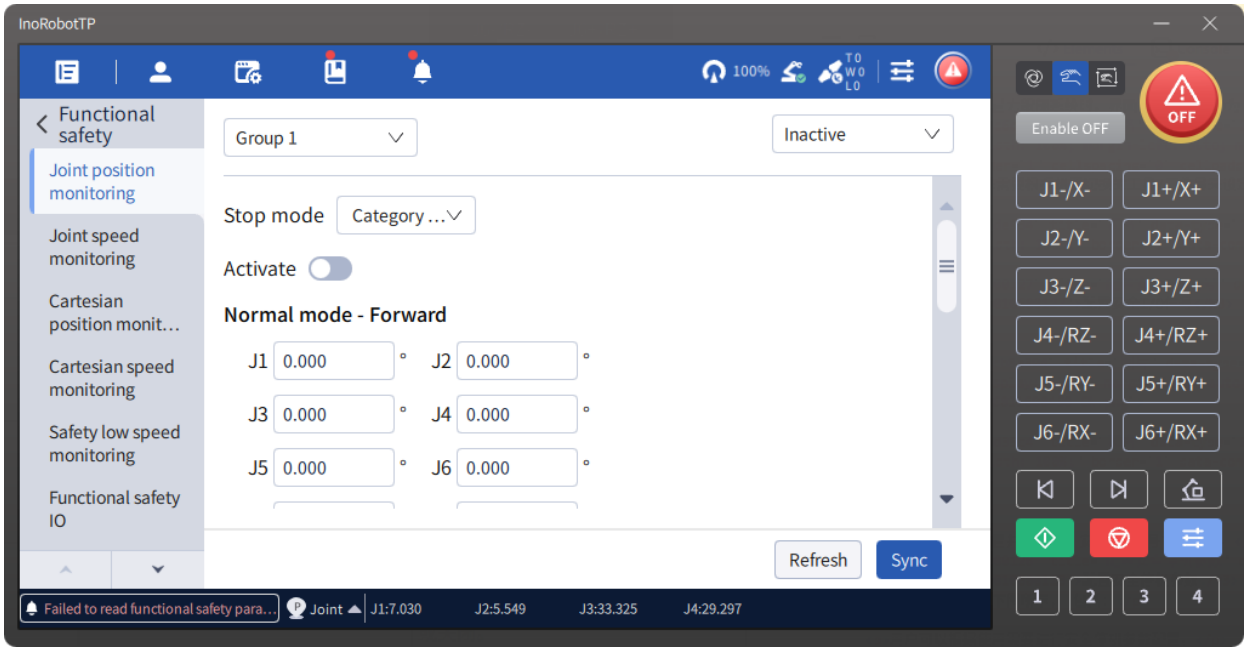


Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the safety low speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot safety tool.
	Permanent trigger		When "Permanent trigger" is selected, the safety low speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot safety tool.
	I/O trigger		When "I/O trigger" is selected, the safety low speed monitoring function is activated or deactivated based on the status of the bound I/O.
Stop mode	Category 0 stop	Category 0 stop	If the Cartesian speed of the robot safety tool exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Value	Not user-configurable	250 mm/s	In manual mode, the Cartesian speed of the safety tool is monitored; once it exceeds 250 mm/s, the corresponding operation is triggered.

After the parameters are configured and saved, the safety low speed monitoring function takes effect immediately.

5.2.7 Configuring Joint Position Monitoring Parameters

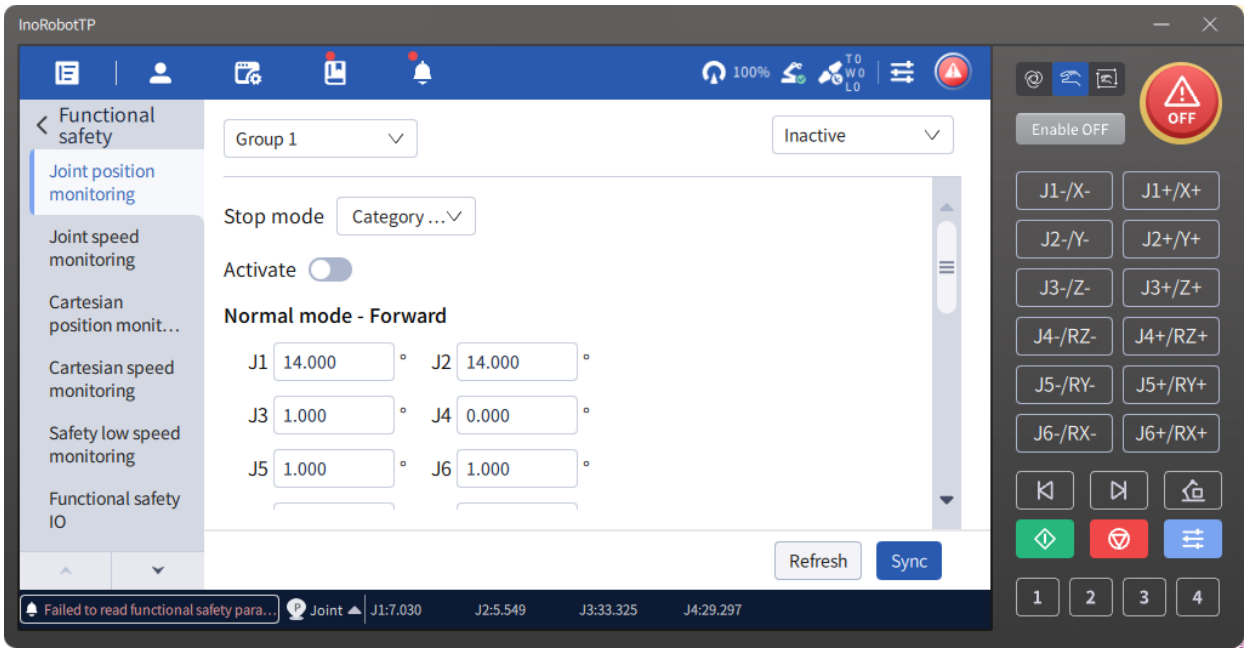
You can configure the joint position monitoring parameters as needed. See the figure below:



Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the joint position monitoring function is deactivated and does not provide safety monitoring for the robot axis positions.
	Permanent trigger		When "Permanent trigger" is selected, the joint position monitoring is permanently active and provides the real-time safety monitoring for the robot axis positions.
	I/O trigger		When "I/O trigger" is selected, the joint position monitoring function is activated or deactivated based on the status of the bound I/O.
Axis position safety range	The range is model-dependent and must not exceed the maximum axis limit of the robot.	0	You can set the positive and negative safety ranges for the monitored robot axis positions.
Stop mode	Category 0 stop	Category 0 stop	If the position of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current axis position group. If not activated, this set of parameters will not be used for joint position monitoring.
	Activate		

5.2.8 Configuring Joint Speed Monitoring Parameters

You can configure the joint speed monitoring parameters as needed. See the figure below:



Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the joint speed monitoring function is deactivated and does provide safety monitoring for the robot axis speed.
	Permanent trigger		When "Permanent trigger" is selected, the joint speed monitoring is permanently active and provides the real-time safety monitoring for the robot axis speed.
	I/O trigger		When "I/O trigger" is selected, the joint speed monitoring function is activated or deactivated based on the status of the bound I/O.
Axis speed safety range	The range is model-dependent and must not exceed the joint speed range of the robot.	0	You can set the safety ranges for the monitored robot axis speed.
Stop mode	Category 0 stop	Category 0 stop	If the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		

Name	Value range	Default	Description
Activation	Deactivate	Deactivate	Indicates the activation of the current axis speed group. If not activated, this set of parameters will not be used for joint speed monitoring.
	Activate		

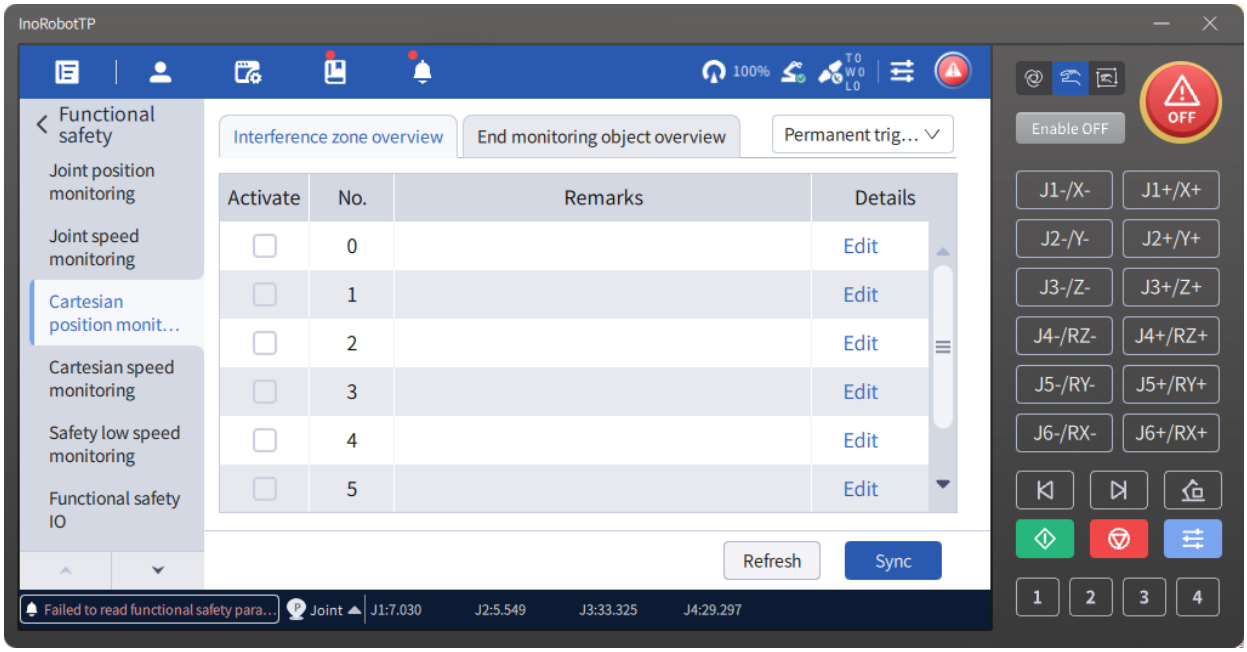
NOTE

The joint speed monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the joint speed monitoring function takes effect immediately.

5.2.9 Configuring Cartesian Position Monitoring Parameters

The following figure shows the setting interface of the Cartesian position monitoring function.

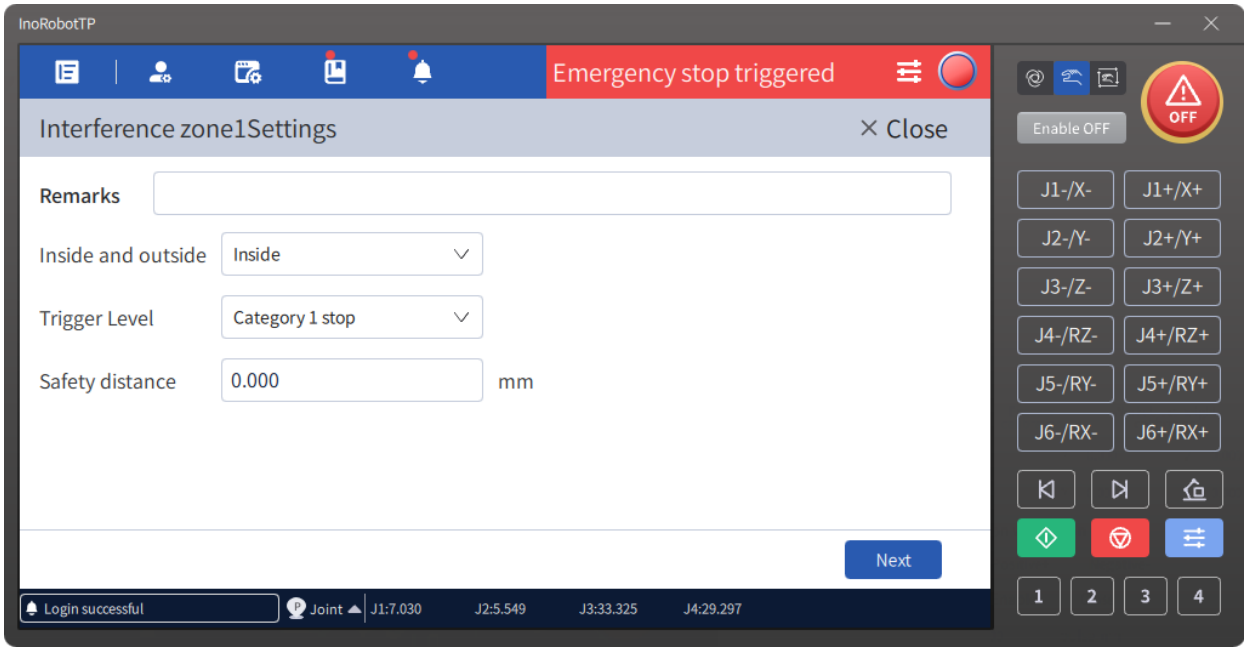


You can activate or deactivate the 16 interference zones and 16 monitoring objects, and view the description of the interference zones and monitoring objects.

CAUTION

Multiple interference zones can be activated simultaneously, but only one end monitoring object can be activated.

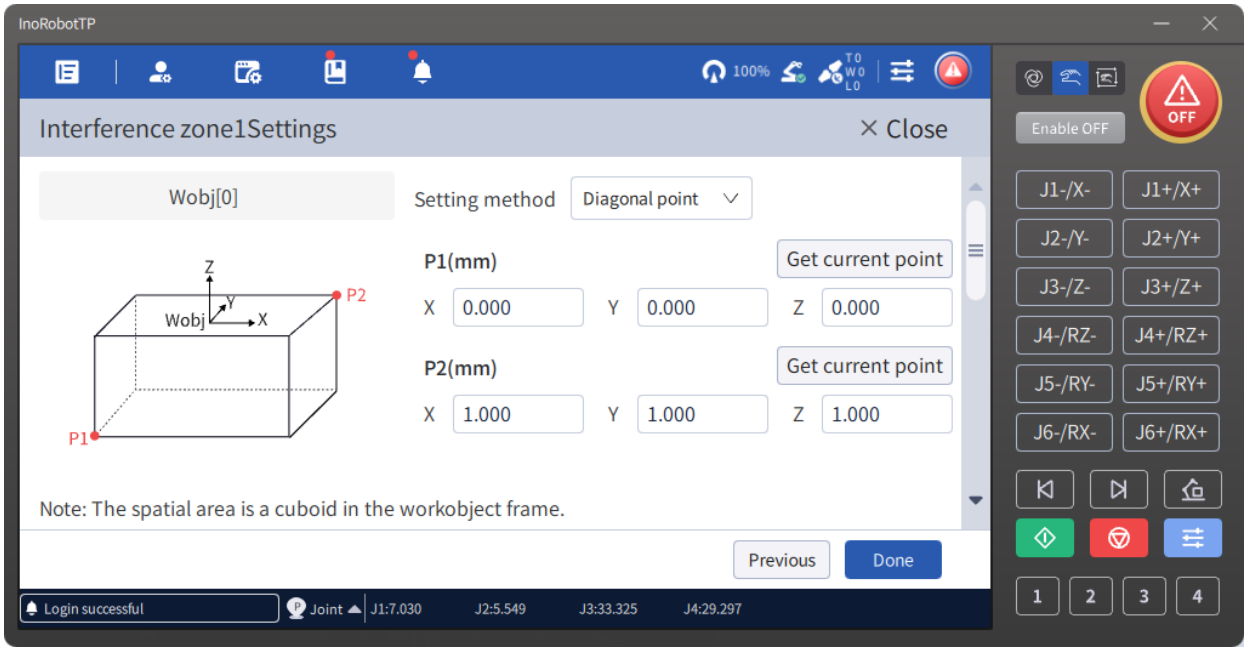
1. Select an interference zone and click the "Edit" button to enter the parameter setting interface.



Parameter	Description
Remarks	Descriptive information of the current interference zone.
Inside and outside	Specifies the inside or outside of the interference zone as the interference zone.
Parameter	Description
Stop mode	Category 0 stop, Category 1 stop. When the Cartesian position of the robot's end monitoring object exceeds the safety zone set by the user, it triggers a Category 0 or 1 emergency stop.
Safety distance	Increases or decreases the interference zone as a whole according to the "Inside and outside" option. The range of safety distance is [0, 10000], in mm.

2. Select an interference zone and click the "Edit" button to enter the parameter setting interface.

3. Click "Next" in the lower right corner.



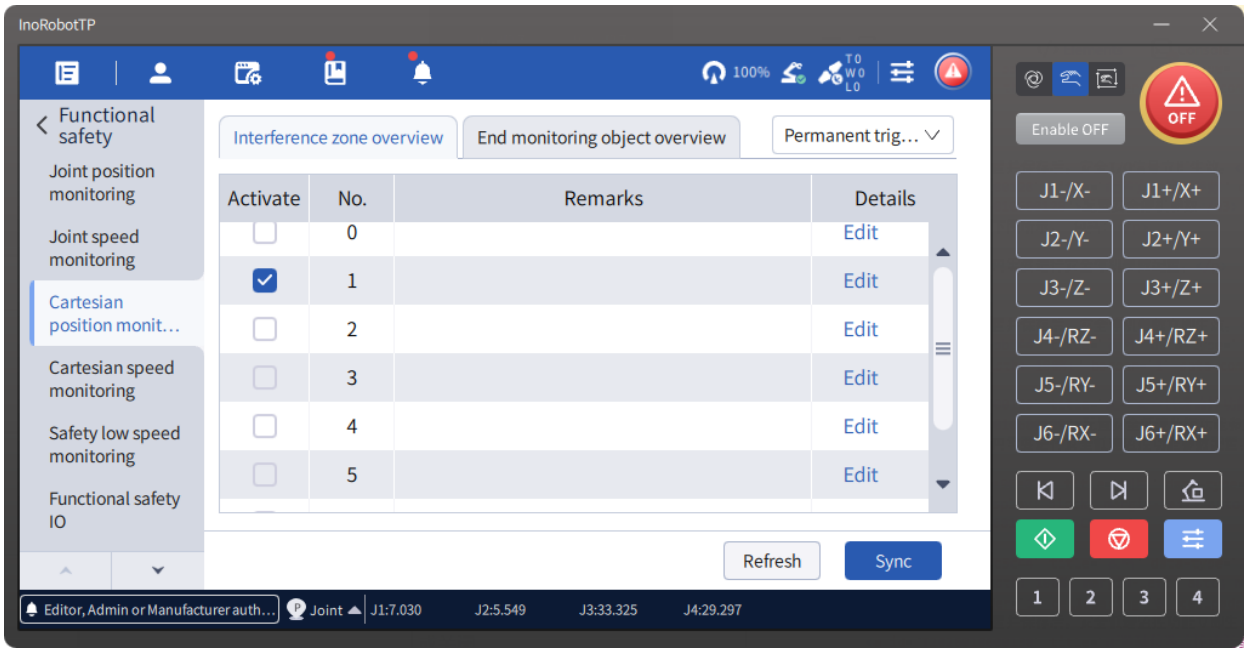
Parameter description:

- Setting method: Sets the interference zone by diagonal point, or by datum point + offset. The points are taken in the current workobject frame.
- You can enter the point manually or click the "Get current point" button to acquire the current point automatically. The range of the point value is [-10000, 10000], in mm. The range of the offset value is [-10000, 0), (0,10000], in mm.
- After getting the points or configuring the points of the interference zone, you can view the frame parameters in the lower part of the interface.

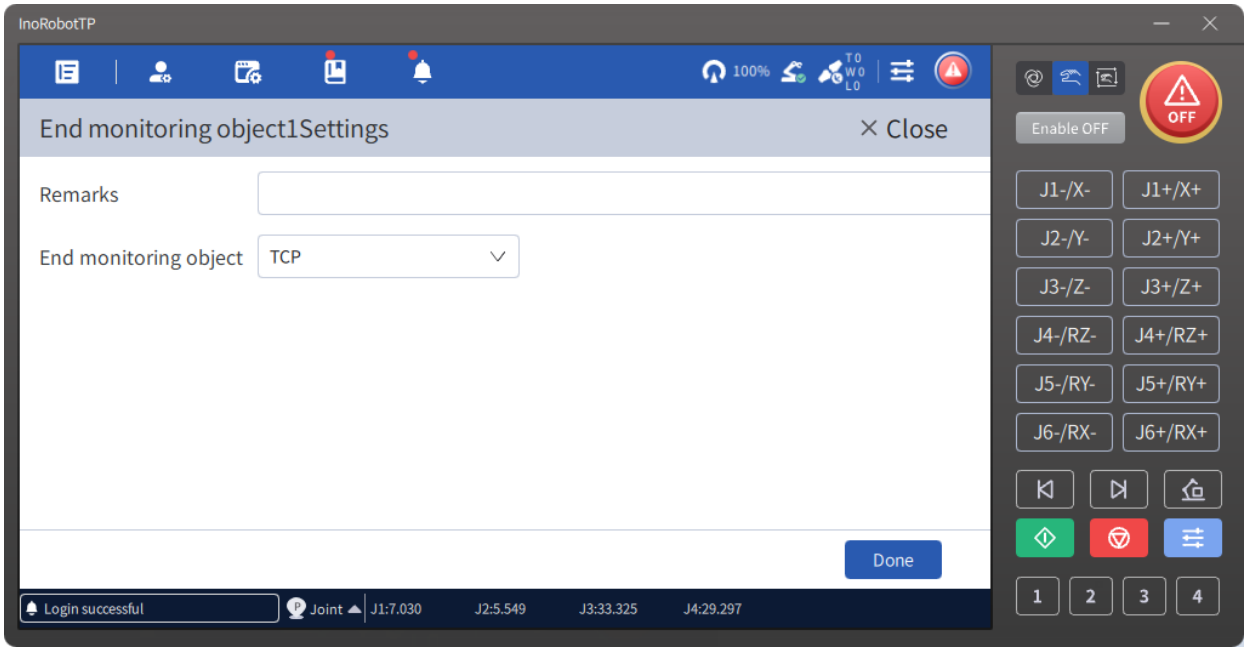
CAUTION

- The value of the safety distance cannot be less than 0.
- The position of the interference zone is relative to the active workobject frame.
- You cannot get the points of the interference zone in a workobject frame where the workobject is not held by the robot.
- You cannot get the points of the interference zone in a workobject frame where the user frame is not fixed.
- If the points cannot form a cuboid, the settings cannot be saved.
- The robot decelerates to stop from the time the end monitoring object enters the interference zone. Therefore, the actual stop position of the robot is inside the interference zone, or the robot passes through the interference zone when the interference zone is small. Note that the greater the robot speed, the greater the distance the robot enters the interference zone. Therefore, set the interference zone as large as possible.

4. Click the "Done" button to save the interference zone parameters and return to the interference zone overview interface.

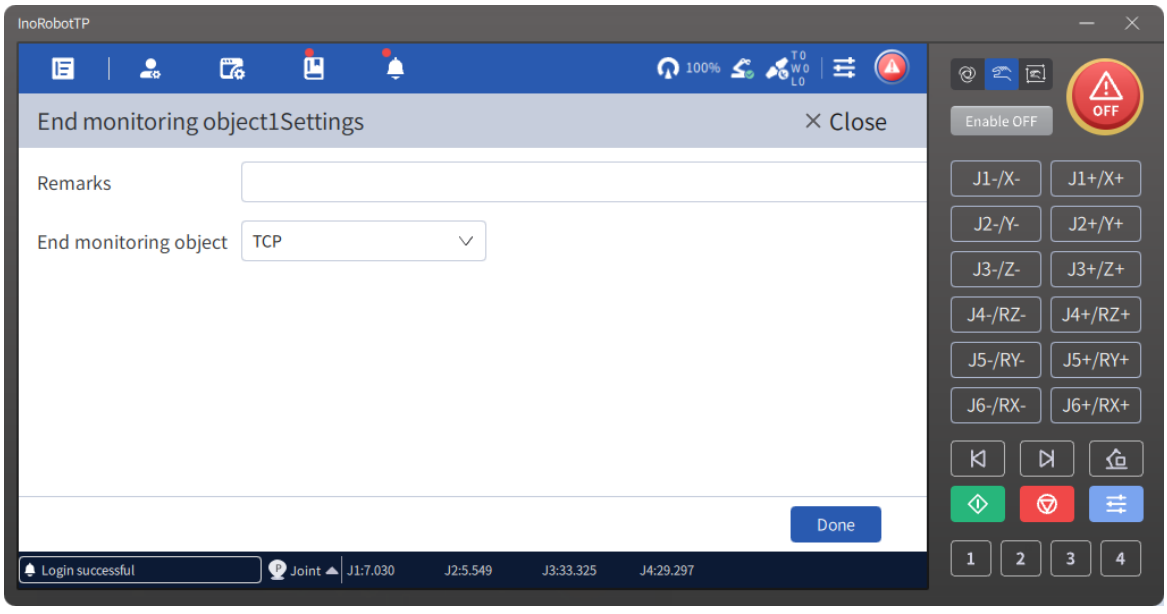


5. Select an end monitoring object and click the "Edit" button to open the parameter setting interface.

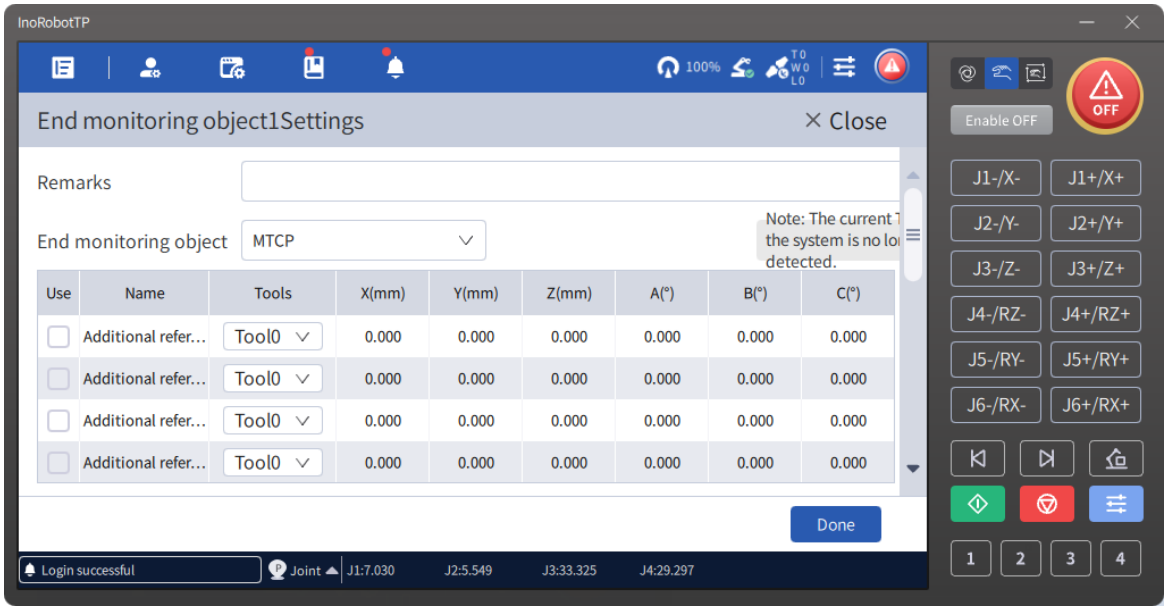


Parameter description:

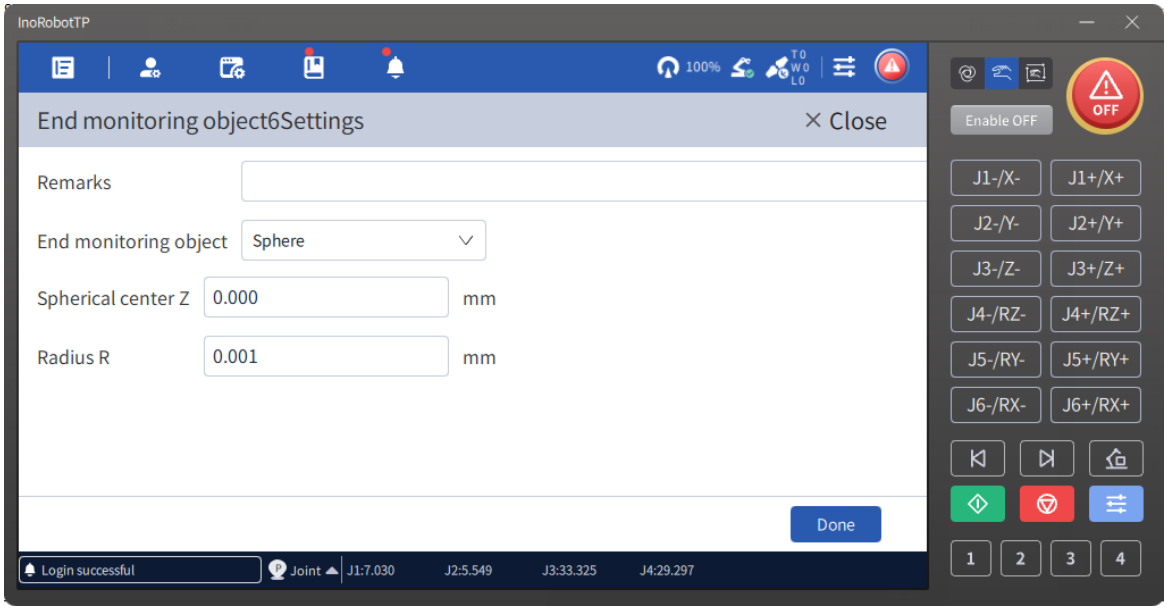
- Remarks: Descriptive information of the current monitoring object.
- Monitoring object type: Includes TCP, MTCP, sphere, and cuboid bounding box. TCP by default.
  - TCP: When the robot grips the tool, the current TCP is used for monitoring. When the robot grips the workobject, the flange center is used for monitoring.



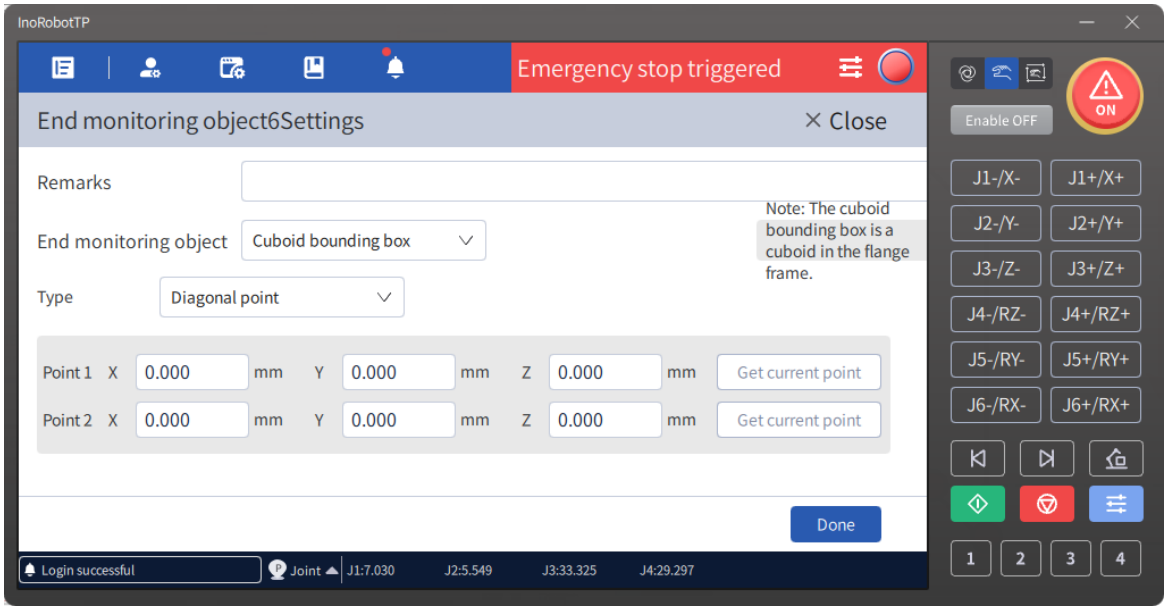
  - MTCP: Supports up to four tools at the same time. You must select a reference point for the tool. The current TCP of the robot is not used for monitoring any more. You can view the parameters of the tool frame in the lower part of the software interface.



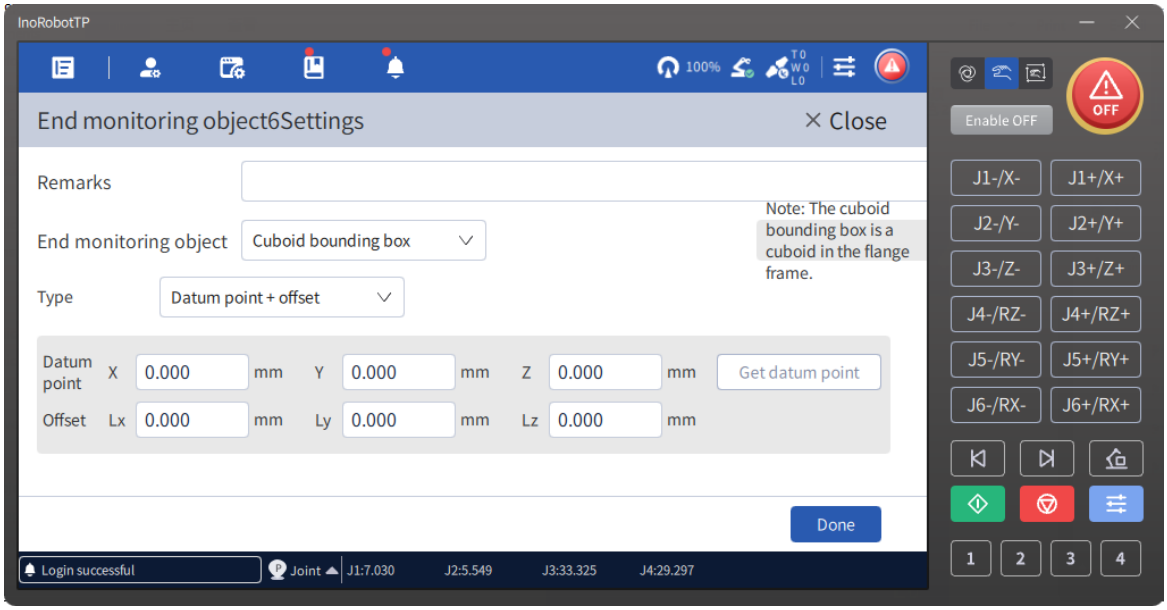
- Sphere: The spherical center is offset from the Z direction of the flange frame, the spherical center range is [-10000, 10000] and the radius range is (0, 10000], in mm. The eccentric sphere is not supported.



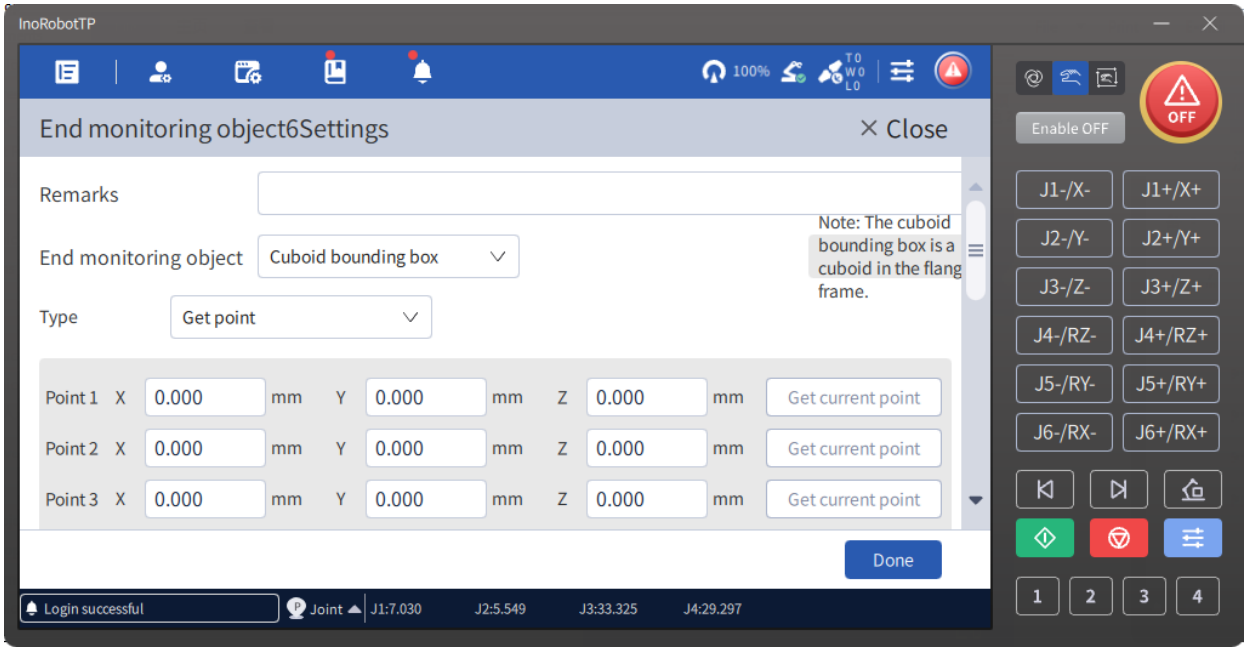
- Cuboid bounding box: There are three methods to acquire the points, namely, diagonal point, datum point + offset, and get point.



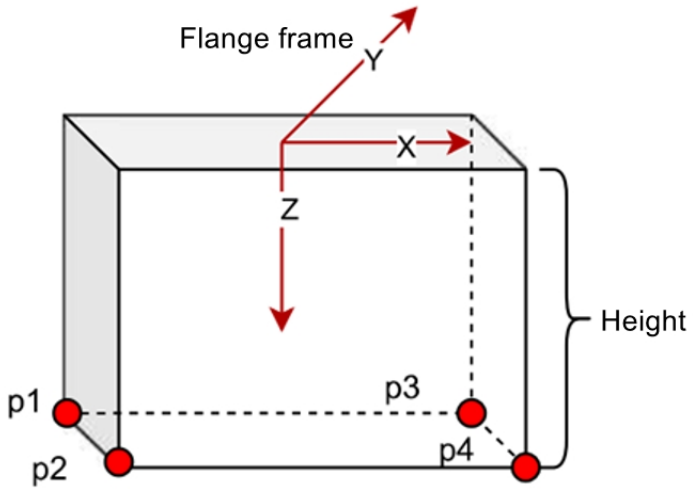
When the point acquisition method is set to "Diagonal point", you can enter the point manually or click the "Get current point" button to acquire the current point automatically. Note that the "Get current point" button is active only when the robot is in ECP mode. The points are taken in the flange frame. The range of the point value is [-10000, 10000], in mm.



When the point acquisition method is set to "Datum point + offset", you can enter the datum point and the offset manually, or click the "Get datum point" button to get the point automatically and then manually enter the offset. Note that the "Get datum point" button is active only when the robot is in ECP mode. The point and offset are taken in the flange frame. The range of the point value is [-10000,10000], and the range of the offset is [-10000, 0), (0, 10000], in mm.



When the point acquisition method is set to "Get point", you can enter the point manually, or click the "Get current point" button to get the point automatically. Note that the "Get current point" button is active only when the robot is in ECP mode. The points are taken in the flange frame. Note that the points 1-4 are the four points on the bottom face of the cuboid. The height is the distance in the Z direction under the flange frame. The range of the point value is [-10000, 10000] and the range of height is [0, 10000], in mm, as shown in the figure below.

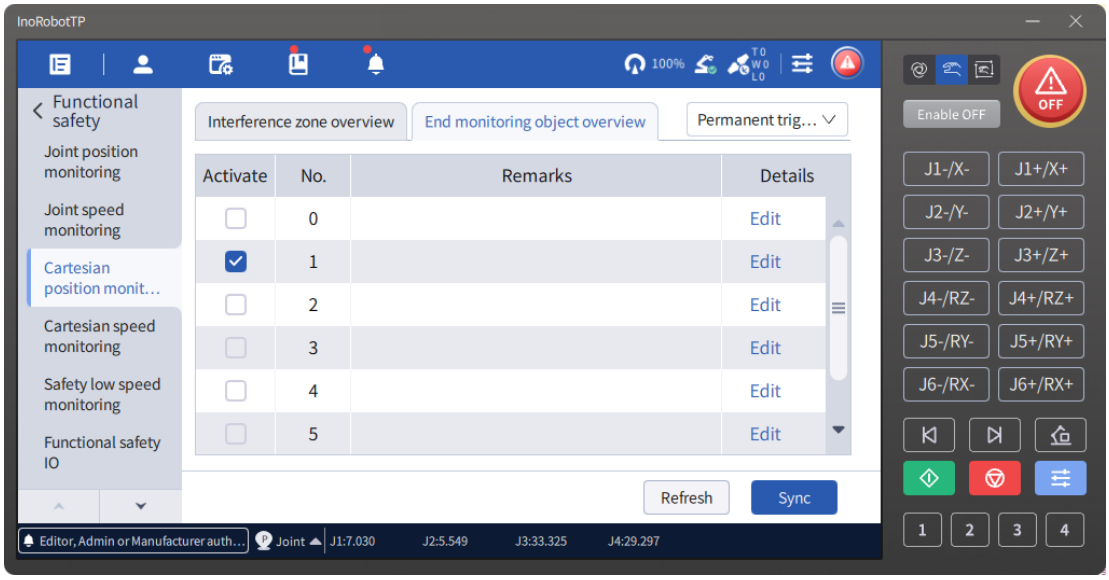


CAUTION

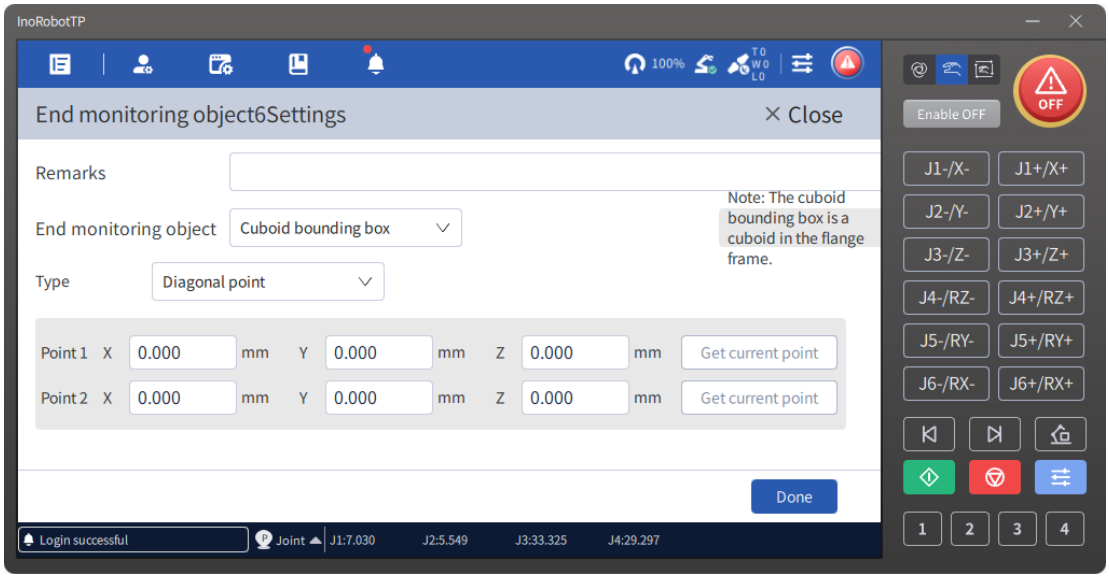
Notes of the cuboid bounding box:

- The orientation of the cuboid bounding box is the same as that of the flange frame. That is, a tilted cuboid bounding box cannot be defined under the flange frame.
- Before getting a point, you must calibrate an external tool and then move the robot to the point on the external tool.
- Regarding the setting of the four points + height, for the 6-axis robots, you need to rotate the J5 axis so that the Z axis of the flange frame points downwards before setting the points and height; for the SCARA robots, just set the points and height normally.

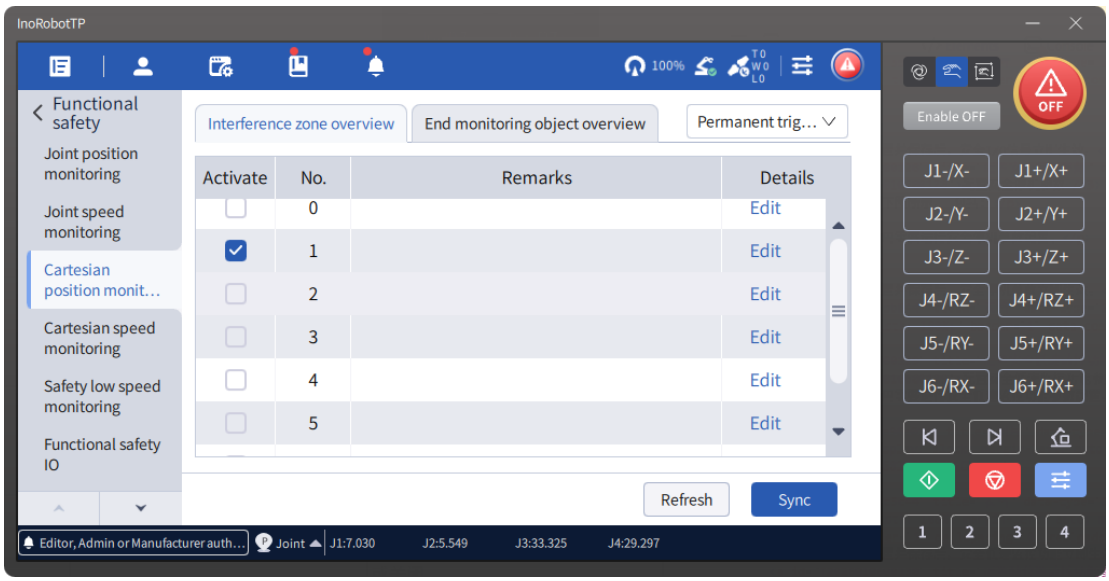
6. Select an end monitoring object and click the "Edit" button to open the parameter setting interface.



7. After configuring the monitoring object, click the "Done" button.



8. Check the interference zone and monitoring object to be used.



After the parameters are configured and saved, the Cartesian position monitoring function takes effect immediately.

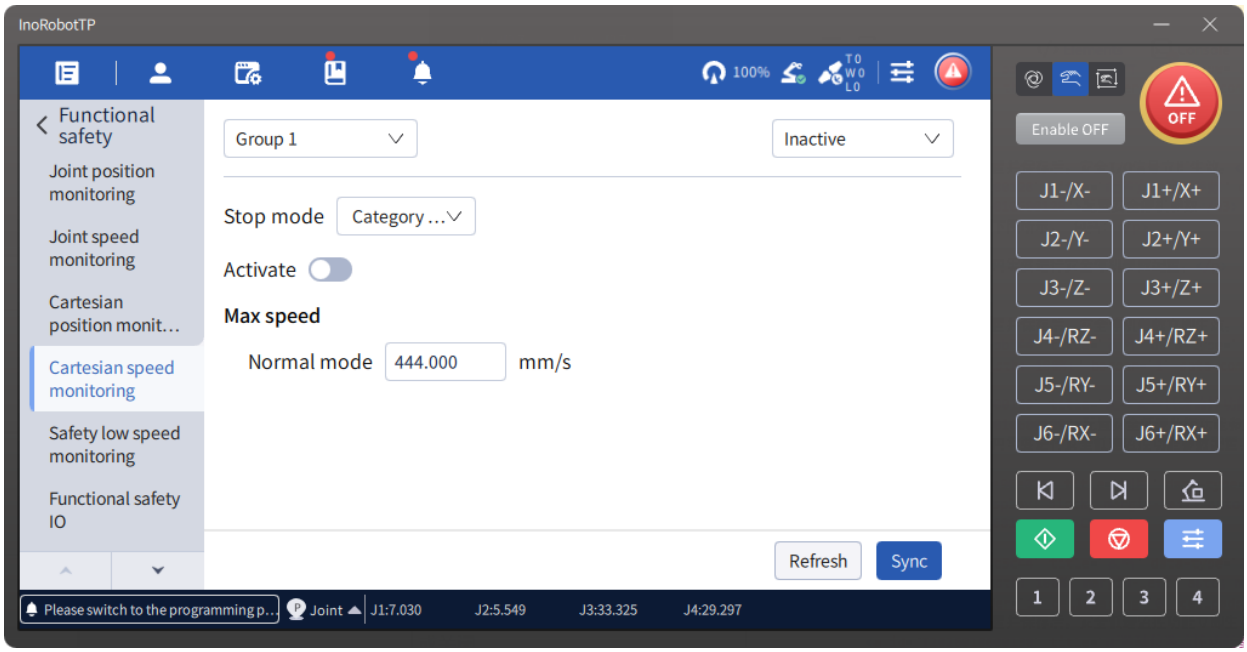
CAUTION

When using the Cartesian position monitoring function, the following precautions/restrictions need to be taken.

- Once determined, the position of the interference zone under the world frame will not change even if the corresponding tool/workobject parameters are modified. If you need to modify the position of the interference zone, you need to modify the points of the interference zone and save the changes.
- After the monitoring object at the end of robot enters the interference zone, you need to disable the interference zone function to clear the alarm and continue motion.
- The larger the robot speed, the greater the distance the robot enters the interference zone. Therefore, you need to set the interference zone and safety distance as large as possible according to the actual working conditions.
- When the robot grips the workobject, if you set the monitoring object type to "TCP", the flange center is used for detection, which may result in collision between the workobject and external devices or obstacles. In this case, it is recommended to set the monitoring object type to sphere or cuboid bounding box.
- When the interference zone is activated, it is detected in any motion mode.
- When the cuboid bounding box is defined by the four points + height,for the 6-axis robots, you need to rotate the J5 axis so that the Z axis of the flange frame points downwards before setting the points and height. Otherwise, the cuboid cannot be formed properly.

5.2.10 Configuring Cartesian Speed Monitoring Parameters

You can configure the Cartesian speed monitoring parameters as needed. See the figure below:



Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the Cartesian speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot.
	Permanent trigger		When "Permanent trigger" is selected, the Cartesian speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot.
	I/O trigger		When "I/O trigger" is selected, the Cartesian speed monitoring function is activated or deactivated based on the status of the bound I/O.
Cartesian speed safety range	0-10000 mm/s	0	You can set the safety ranges for the monitored robot Cartesian speed.
Stop mode	Category 0 stop	Category 0 stop	If any robot Cartesian speed exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current Cartesian speed. If not activated, this set of parameters will not be used for Cartesian speed monitoring.
	Activate		



The Cartesian speed monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the Cartesian speed monitoring function takes effect immediately.

5.3 Configuration on InoRobotLab

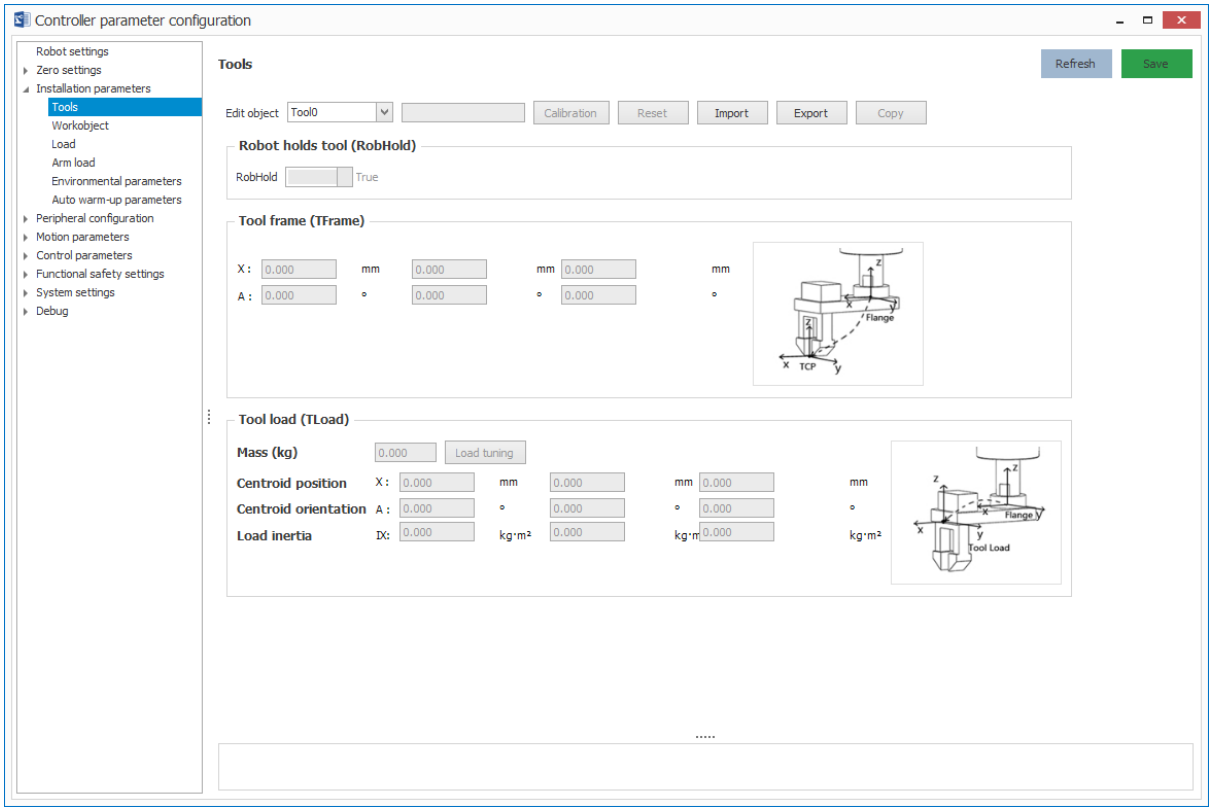
The following table describes the safety function configuration steps.

No.	Operation
1	Configure basic parameters
2	Configure system access
3	Configure safety tool
4	Configure safety I/O signal
5	Configure safety stop parameters
6	Configure safety low speed monitoring parameters
7	Configure joint position monitoring parameters
8	Configure joint speed monitoring parameters
9	Configure Cartesian position monitoring parameters
10	Configure Cartesian speed monitoring parameters

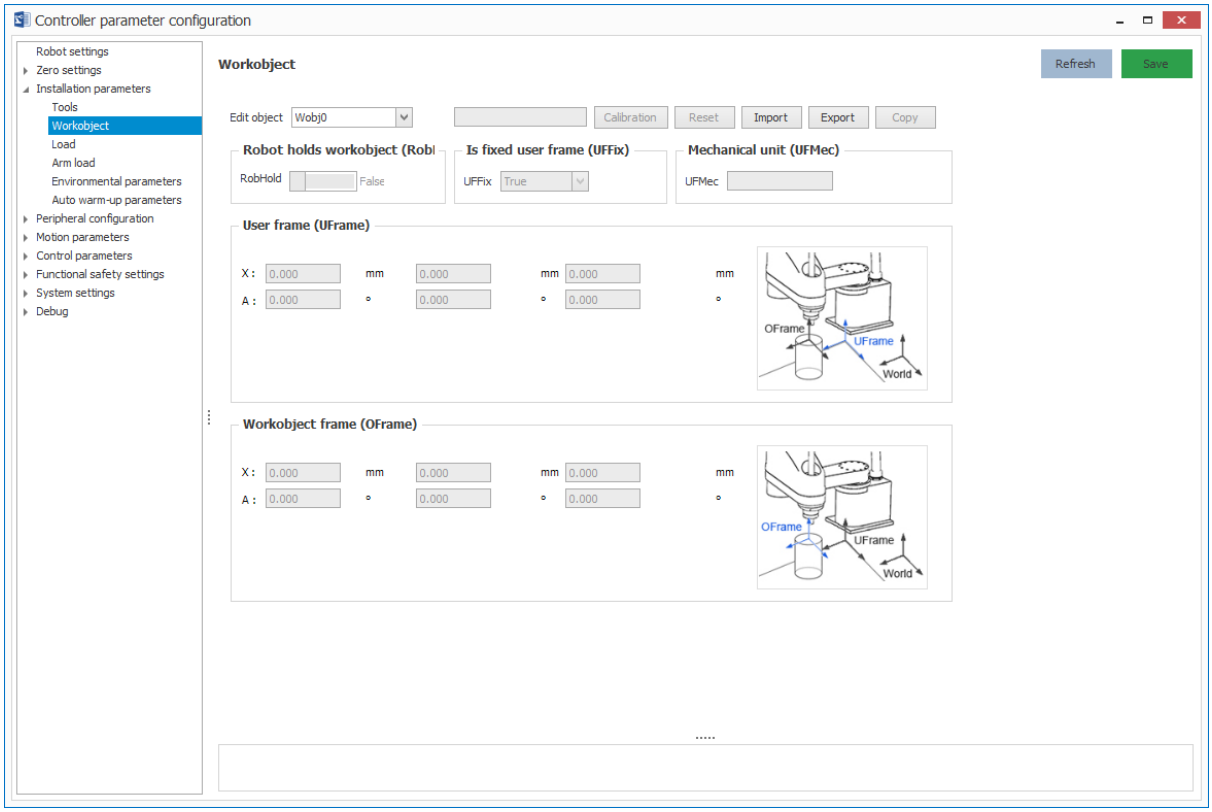
5.3.1 Configuring Basic Parameters

Before using the safety functions after flashing or upgrade of the robot system, complete the following operations.

1. Configure and save the tool parameters required by the robot.



2. Configure and save the workobject parameters required by the robot.



5.3.2 Configuring System Access

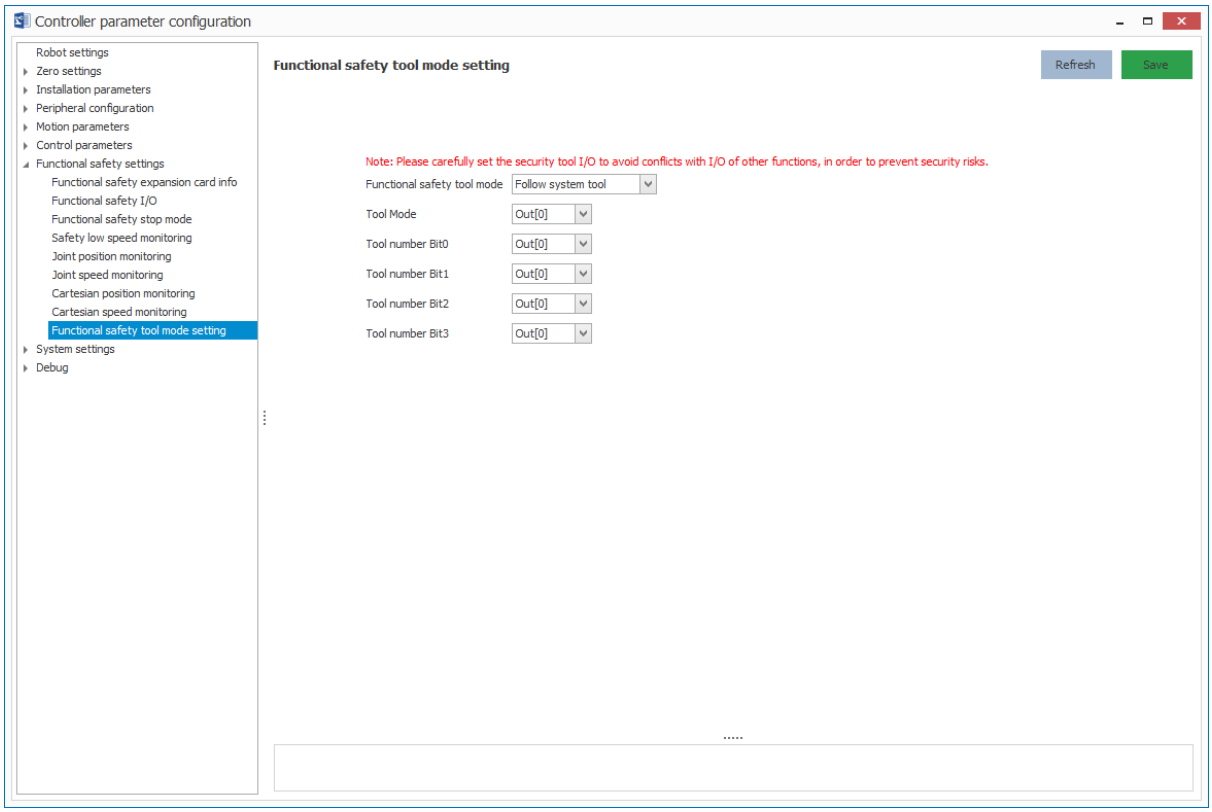
Only authorized operators (editor, administrator and manufacturer) are allowed to modify the safety function parameters. Safety function password is required.

5.3.3 Configuring Safety Tool

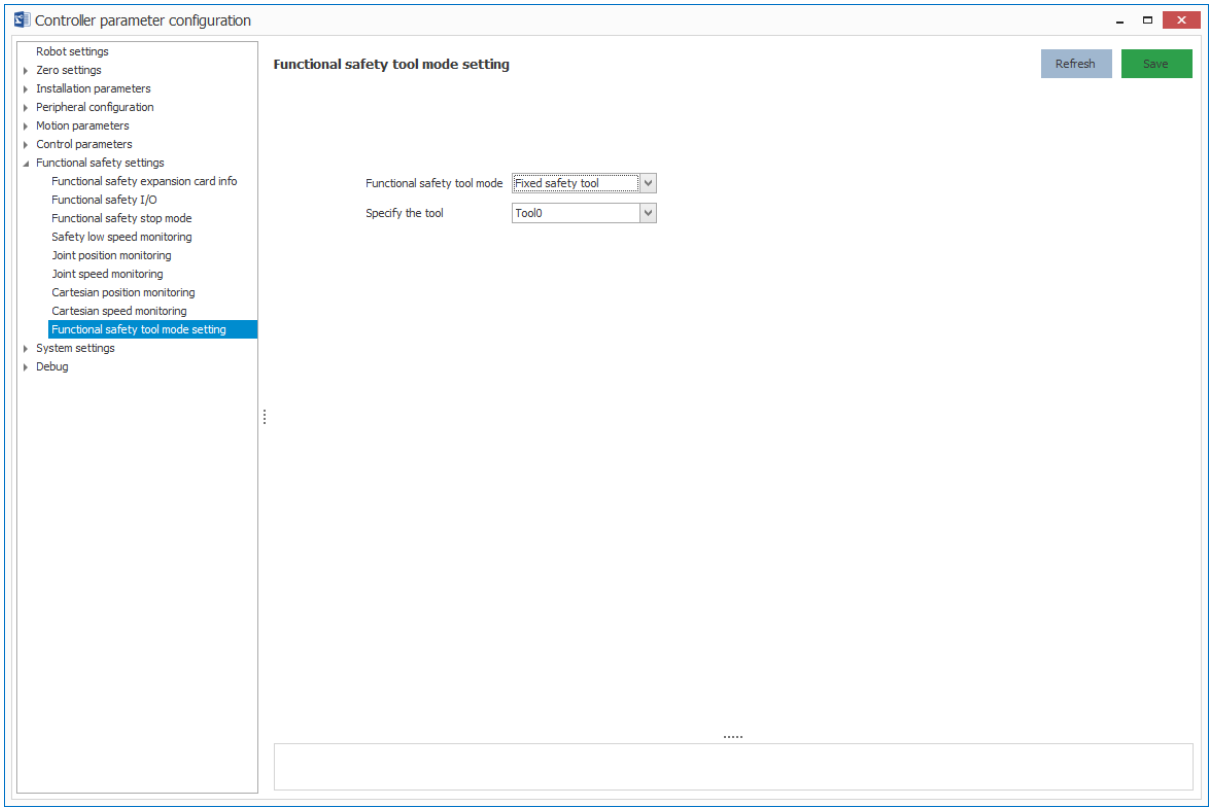
The safety tool has three modes: follow system tool, fixed safety tool, and manual tool switch. You can configure the safety tool as needed.

See the following instructions for setting up the three modes:

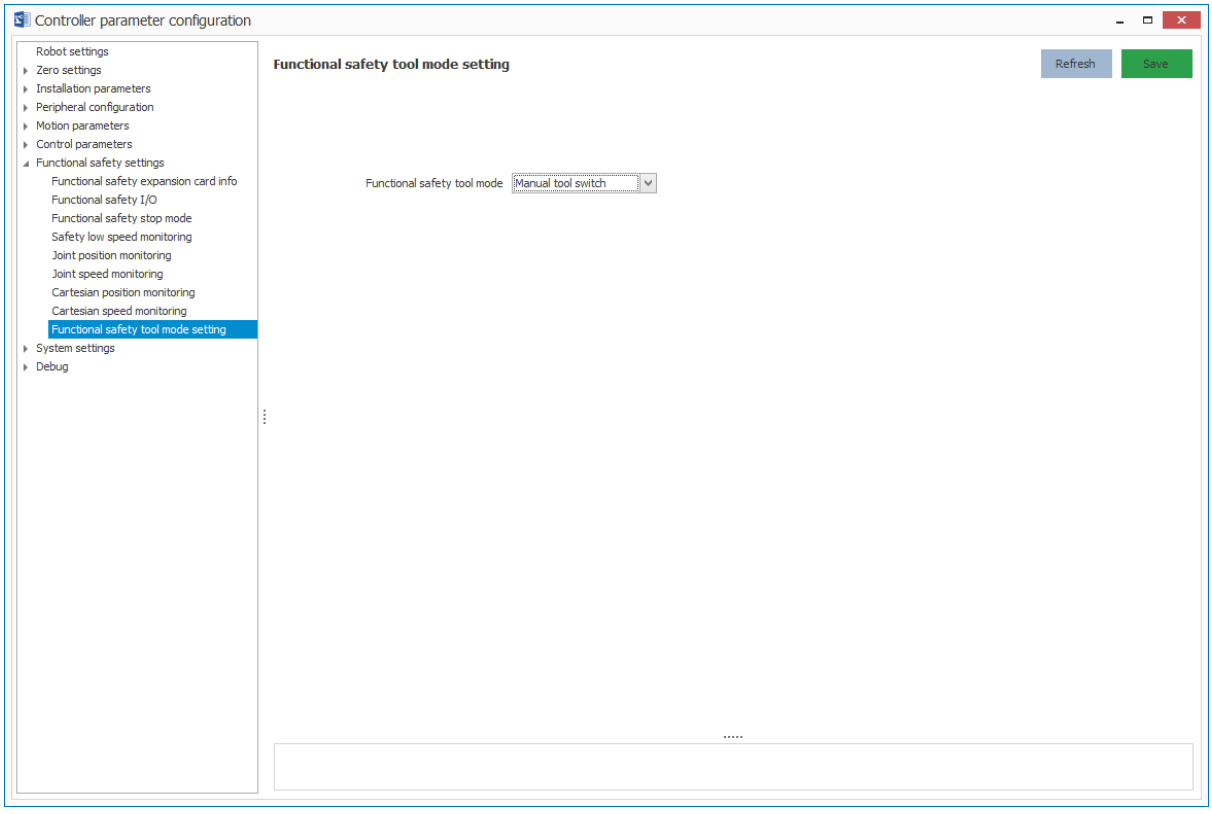
1. When the mode is set to "Follow system tool", it occupies five standard I/O points. The OUT number is specified by the user, and other functions cannot use these five OUT numbers. During wiring, connect the DI (3-7) on the safety module in the order corresponding to the specified OUT numbers. The controller must be configured to trigger the corresponding standard OUT when switching tools.



2. When the mode is set to "Fixed safety tool", you need to specify a tool (TCP) or workobject (ECP) as the safety tool/workobject, and it cannot be switched via safety I/O or standard I/O. When a workobject is selected, its "RobHold" parameter must be set to "True".



3. When the mode is set to "Manual tool switch", you need to connect the external I/O to the I/O (3-7) on the safety module, allowing the tool switching by the operator or an external device.



After the parameters are configured and saved, the safety tool set takes effect immediately.

CAUTION

- It is important to set the safety tool for the safety function. Be cautious when setting the safety tool to avoid safety accidents caused by a mismatch between the Cartesian speed monitored by the safety function and the actual Cartesian speed.
- When selecting the mode as "Follow system tool" or "Manual tool switch", configure the safety DI3 to DI7 and make physical connections according to the tool number required for switching.
- In the V4R24C2 version, the default values will be restored after the controller is restarted, and reconfiguration is required after restarting. For other versions, this parameter is retained upon power-off. After restarting, the last set value is retained.

Example:

When the safety tool mode is configured to follow system tool, the standard DOs configured on the interface are DO23, DO34, DO56, DO67 and DO78.

Safety tool mode configuration	Safety configuration terminal	Connection/Status	Description
Follow system tool	DI3	Robot standard DO23 to safety DI3	Configure the TCP/ECP mode.
	DI4	Robot standard DO34 to safety DI4	When switching of up to 16 tool/ workobjects is required, configure the safety DI4 as the tool number Bit0.
	DI5	Robot standard DO56 to safety DI5	Configure the safety DI5 as the tool number Bit1.
	DI6	Robot standard DO67 to safety DI6	Configure the safety DI6 as the tool number Bit2.
	DI7	Robot standard DO78 to safety DI7	Configure the safety DI7 as the tool number Bit3.
Manual tool switch	DI3	The user controls the status of safety DI3.	Configure the safety DI3 as TCP/ECP mode for the switching between TCP/ ECP modes.
	DI4	The user controls the status of safety DI4.	When switching of up to 16 tool/ workobjects is required, configure the safety DI4 as the tool number Bit0.
	DI5	The user controls the status of safety DI5.	Configure the safety DI5 as the tool number Bit1.
	DI6	The user controls the status of safety DI6.	Configure the safety DI6 as the tool number Bit2.

Safety tool mode configuration	Safety configuration terminal	Connection/Status	Description
	DI7	The user controls the status of safety DI7.	Configure the safety DI7 as the tool number Bit3.

Set the status of DI4 to DI7 according to the desired tool/workobject number to be switched:

- To switch the safety tool to tool number 7, set DI4, DI5, and DI6 to low level.
- To switch the safety tool to tool number 11, set DI4, DI5, and DI7 to low level, and DI6 to high level.

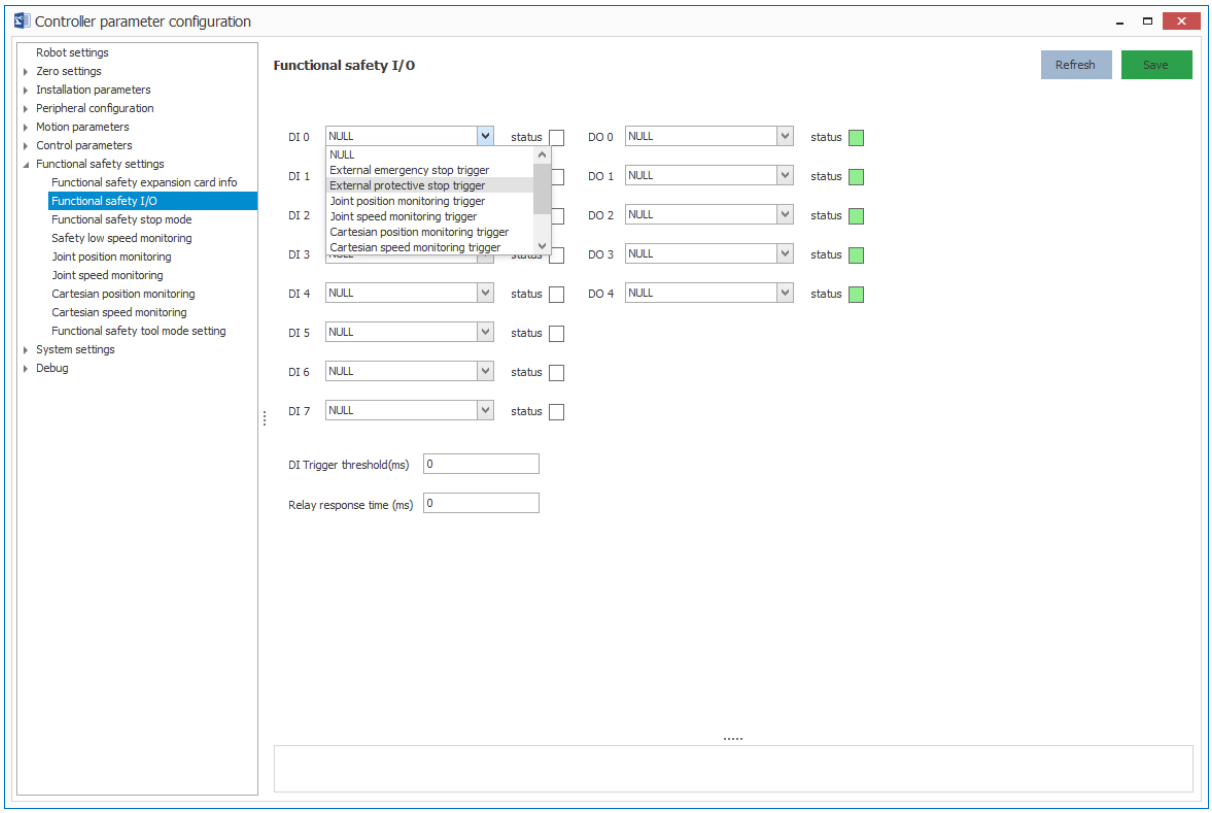
CAUTION

It is not always necessary to configure safety DI4-DI7.

- If the range of tool/workobject number to be switched is less than 8, only DI4 to DI6 need to be configured.
- If the range of tool/workobject number to be switched is less than 4, only DI4 to DI5 need to be configured.
- If the range of tool/workobject number to be switched is less than 2, only DI4 needs to be configured.

5.3.4 Configuring Safety I/O Signal

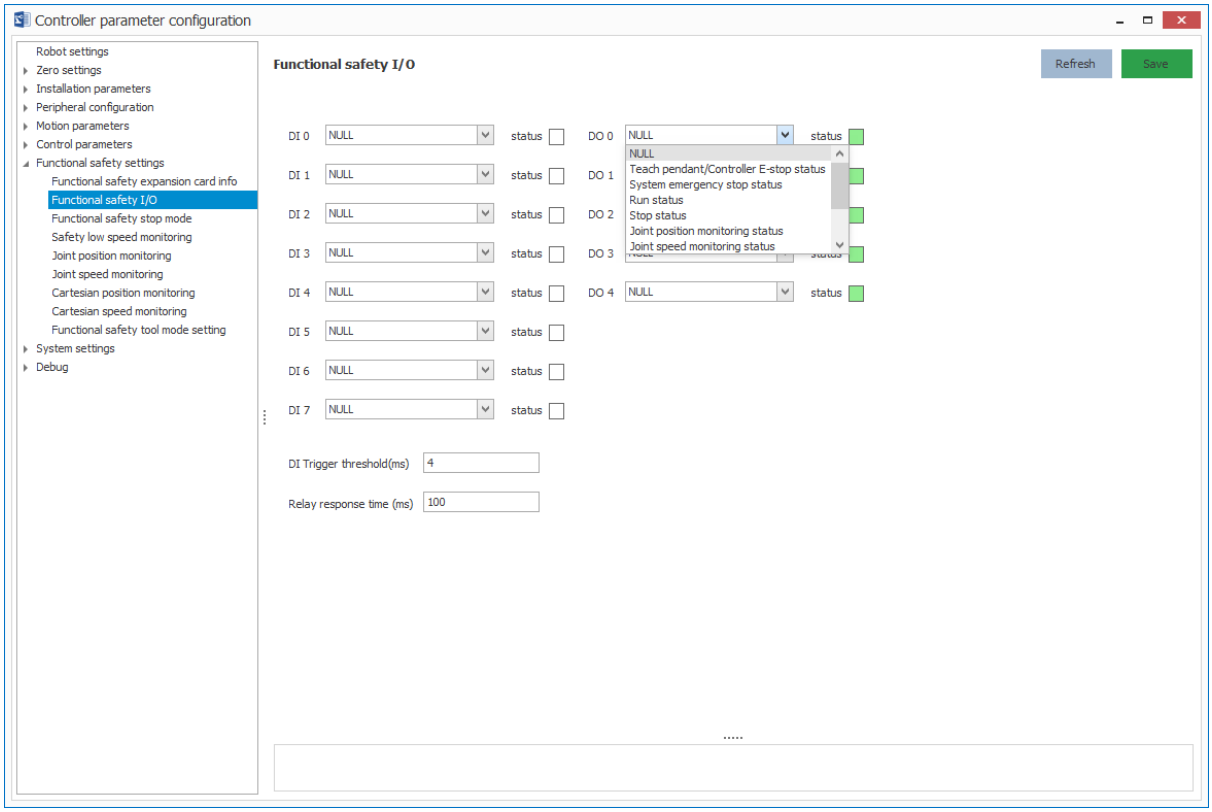
1. The safety DI can be configured for external emergency stop, external protective stop, emergency stop, additional emergency stop, activation of each safety function, and safety tool mode and number. After configuration, you can view the DI status via the status indicator. See the figure below:



NOTE

- The TCP/ECP mode option is added to safety DI3.
- The tool number Bit0 option is added to safety DI4.
- The tool number Bit1 option is added to safety DI5.
- The tool number Bit2 option is added to safety DI6.
- The tool number Bit3 option is added to safety DI7.

2. The safety DO can be configured for system emergency stop status, emergency stop status, additional emergency stop status, operation status, stop status, and the status of each safety function. After configuration, you can view the DO status via the status indicator. See the figure below:



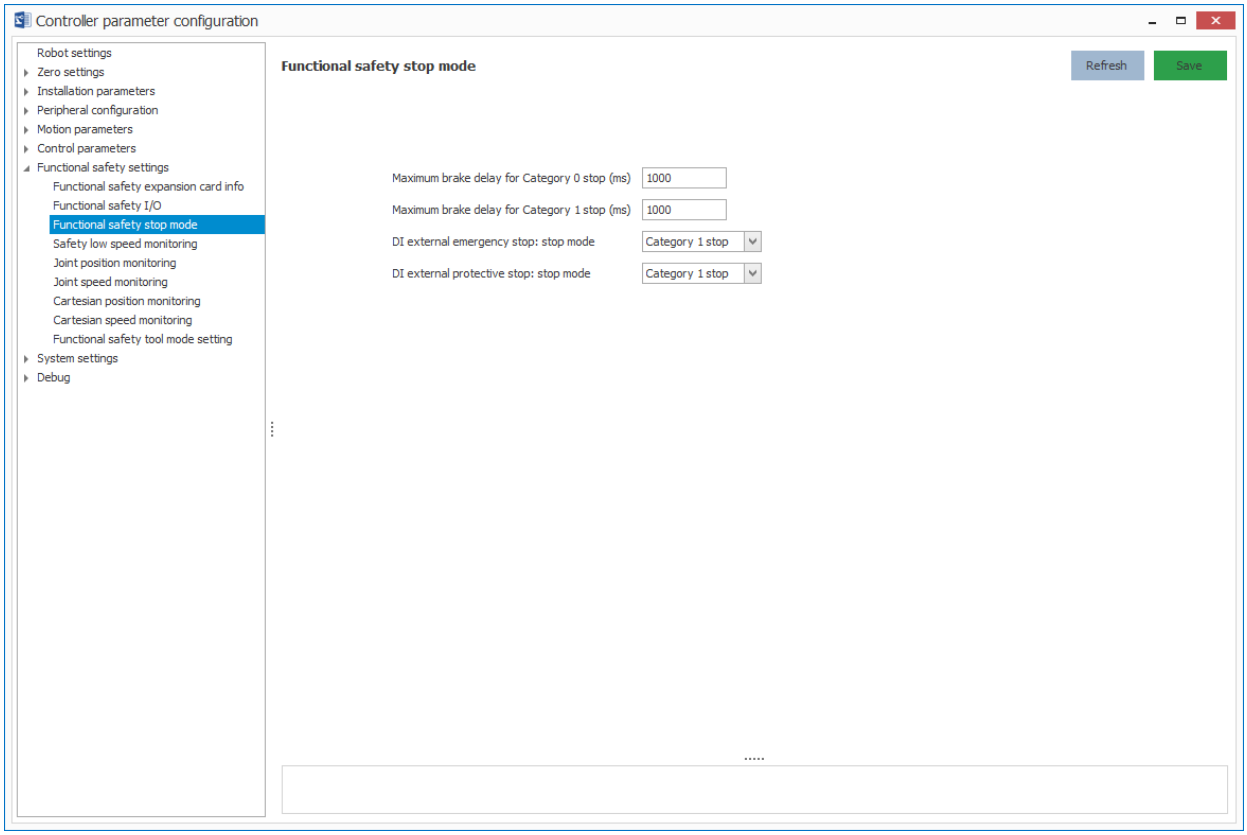
5.3.5 Configuring Safety Stop Parameters

As shown in the figure below, the safety stop parameters include:

- Maximum brake delay for Category 0 stop, in ms.
- Maximum brake delay for Category 1 stop, in ms.

You can configure the safety stop parameter as needed.

- DI external emergency stop methods are classified into Category 0 emergency stop and Category 1 emergency stop.
- DI external protective stop methods are classified into Category 0 emergency stop and Category 1 emergency stop.



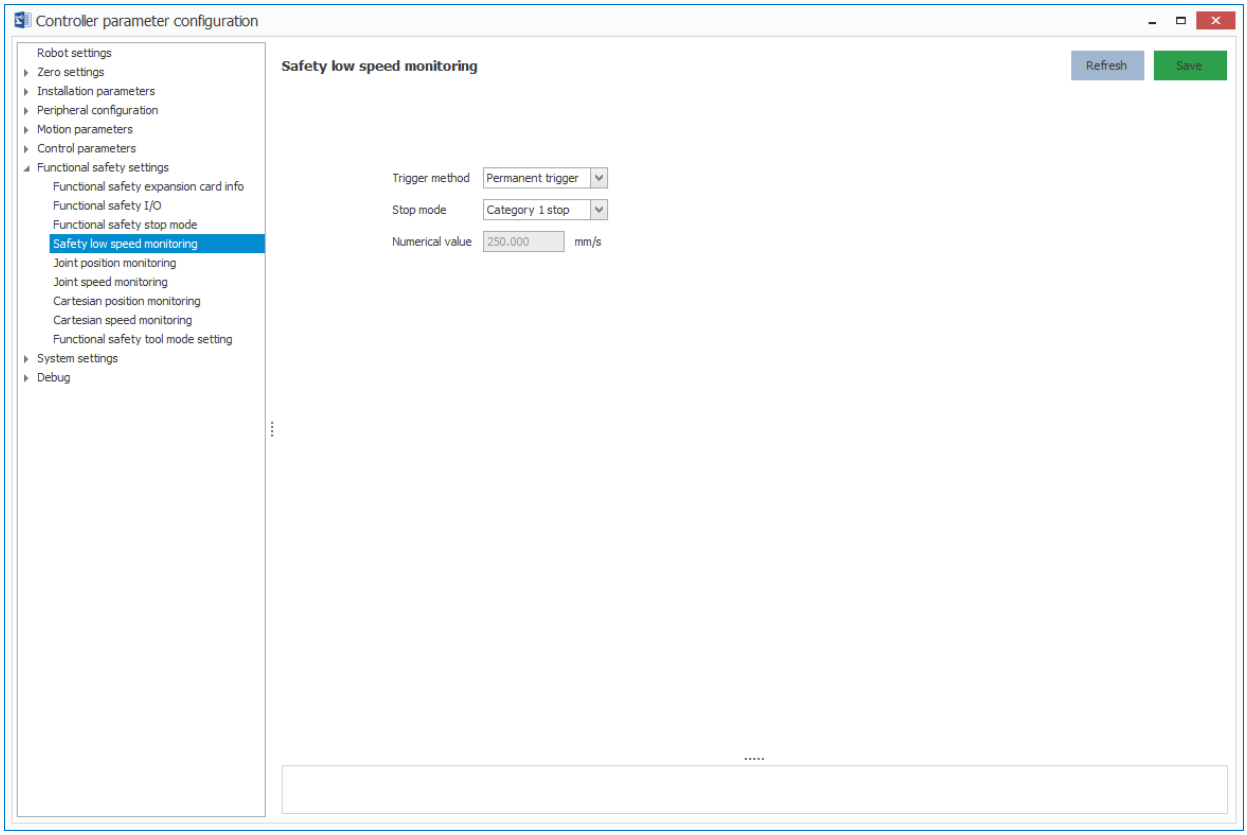
After the above parameters are configured and saved, the safety stop parameters take effect immediately.

CAUTION

The maximum brake delay for Category 0 or 1 stop affects the application of the brake after a Category 0 or 1 emergency stop is triggered. Be cautious when setting the maximum brake delay. A too large delay may result in that the robot fails to apply the brake after an abnormality occurs, which may cause safety accidents.

5.3.6 Configuring Safety Low Speed Monitoring Parameters

You can configure the safety low speed monitoring parameters as needed, as shown in the figure below:

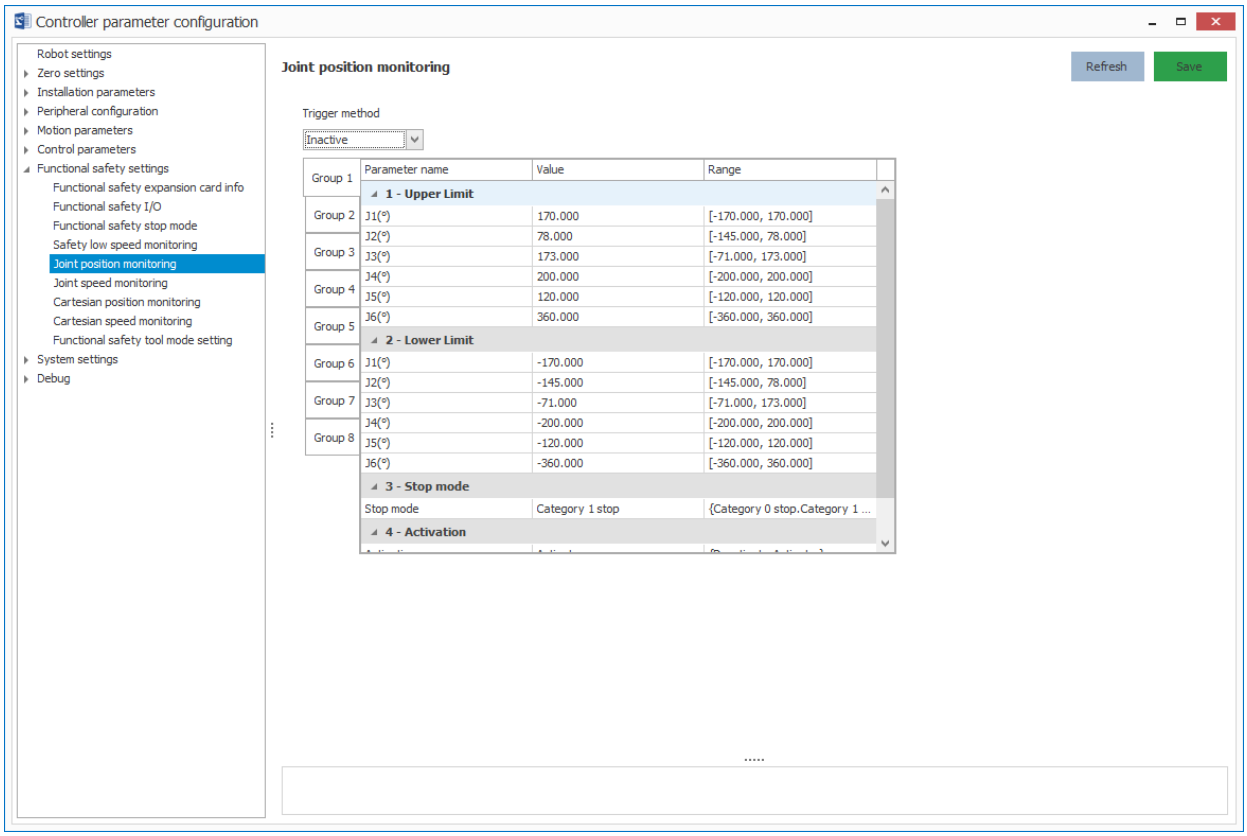


Name	Value range	Default	Description
Trigger method	Inactive Permanent trigger I/O trigger	Inactive	• When "Inactive" is selected, the safety low speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot safety tool. • When "Permanent trigger" is selected, the safety low speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot safety tool. • When "I/O trigger" is selected, the safety low speed monitoring function is activated or deactivated based on the status of the bound I/O.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	If the Cartesian speed of the robot safety tool exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
Value	Not user-configurable	250 mm/s	In manual mode, the Cartesian speed of the safety tool is monitored; once it exceeds 250 mm/s, the corresponding operation is triggered.

After the parameters are configured and saved, the safety low speed monitoring function takes effect immediately.

5.3.7 Configuring Joint Position Monitoring Parameters

You can configure the joint position monitoring parameters as needed, as shown in the figure below:



Name	Value range	Default	Description
Trigger method	Inactive Permanent trigger I/O trigger	Inactive	• When "Inactive" is selected, the joint position monitoring function is deactivated and does not provide safety monitoring for the robot axis positions. • When "Permanent trigger" is selected, the joint position monitoring is permanently active and provides the real-time safety monitoring for the robot axis positions. • When "I/O trigger" is selected, the joint position monitoring function is activated or deactivated based on the status of the bound I/O.
Axis position safety range	The range is model-dependent and must not exceed the maximum axis limit of the robot.	0	You can set the positive and negative safety ranges for the monitored robot axis positions.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	If the position of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.

Name	Value range	Default	Description
Activation	Deactivate Activate	Deactivate	Indicates the activation of the current axis position group. If not activated, this set of parameters will not be used for joint position monitoring.

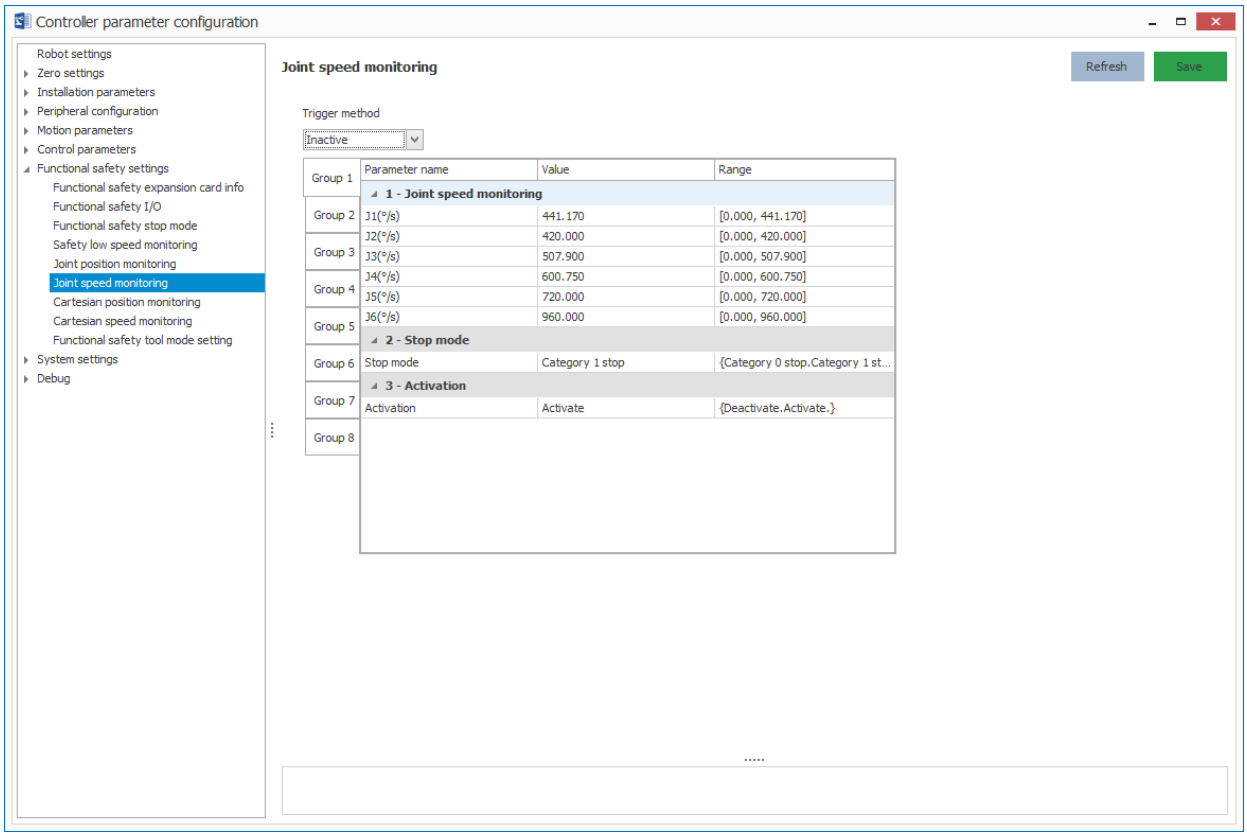
NOTE

The joint position monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the joint position monitoring function takes effect immediately.

5.3.8 Configuring Joint Speed Monitoring Parameters

You can configure the joint speed monitoring parameters as needed, as shown in the figure below:



Name	Value range	Default	Description
Trigger method	Inactive Permanent trigger I/O trigger	Inactive	• When "Inactive" is selected, the joint speed monitoring function is deactivated and does provide safety monitoring for the robot axis speed. • When "Permanent trigger" is selected, the joint speed monitoring is permanently active and provides the real-time safety monitoring for the robot axis speed. • When "I/O trigger" is selected, the joint speed monitoring function is activated or deactivated based on the status of the bound I/O.
Axis speed safety range	The range is model-dependent and must not exceed the joint speed range of the robot.	0	You can set the safety ranges for the monitored robot axis speed.
Name	Value range	Default	Description
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	If the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
Activation	Deactivate Activate	Deactivate	Indicates the activation of the current axis speed group. If not activated, this set of parameters will not be used for joint speed monitoring.

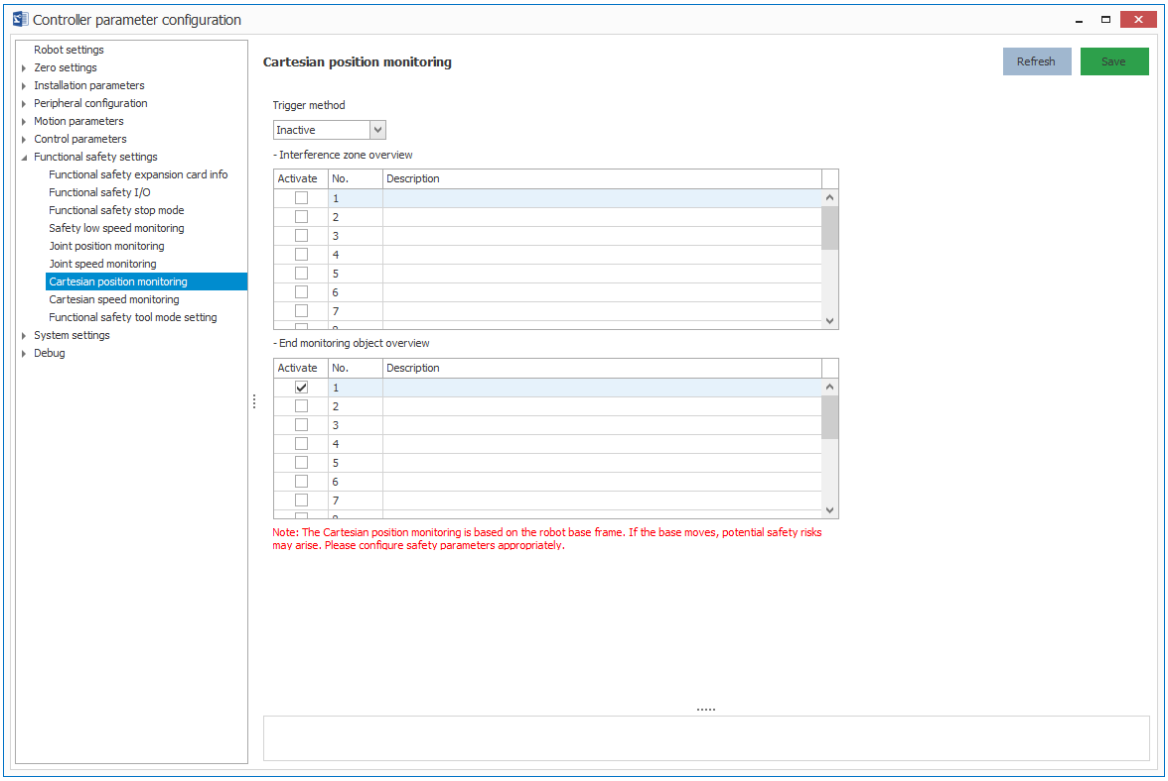
NOTE

The joint speed monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the joint speed monitoring function takes effect immediately.

5.3.9 Configuring Cartesian Position Monitoring Parameters

The following figure shows the setting interface of the Cartesian position monitoring function.

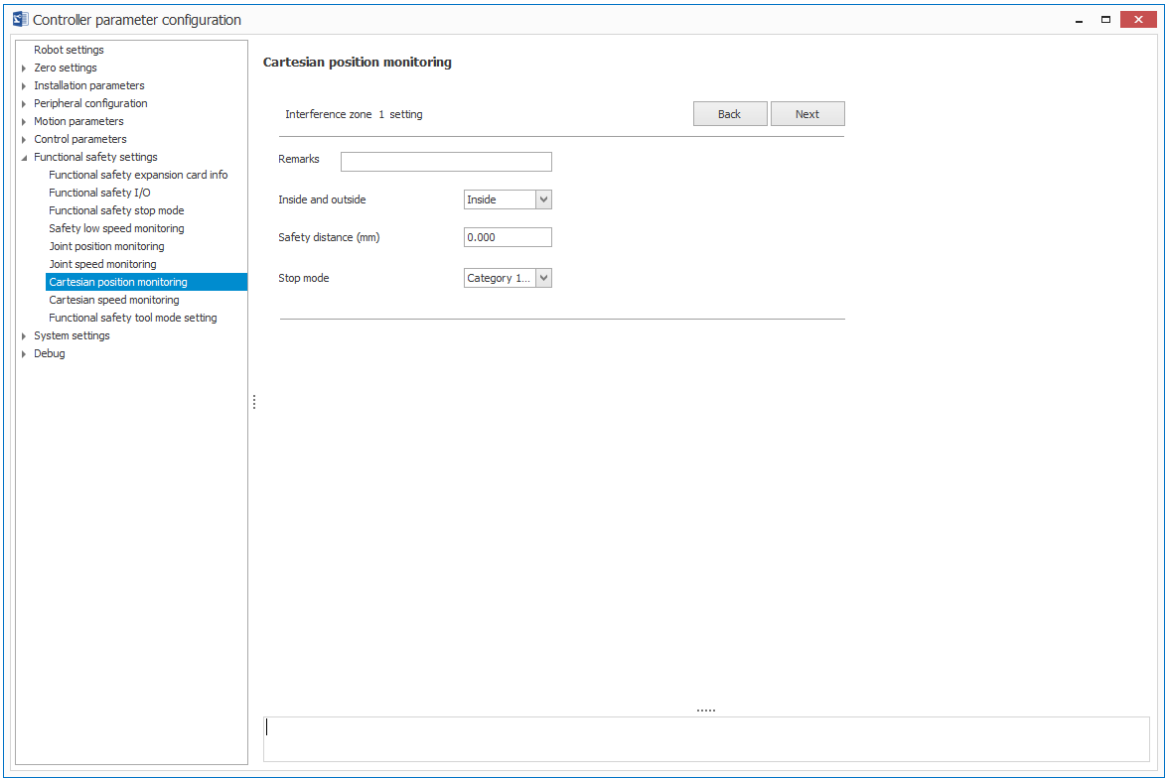


You can activate or deactivate the 16 interference zones and 16 monitoring objects, and view the description of the interference zones and monitoring objects.

CAUTION

Multiple interference zones can be activated simultaneously, but only one end monitoring object can be activated.

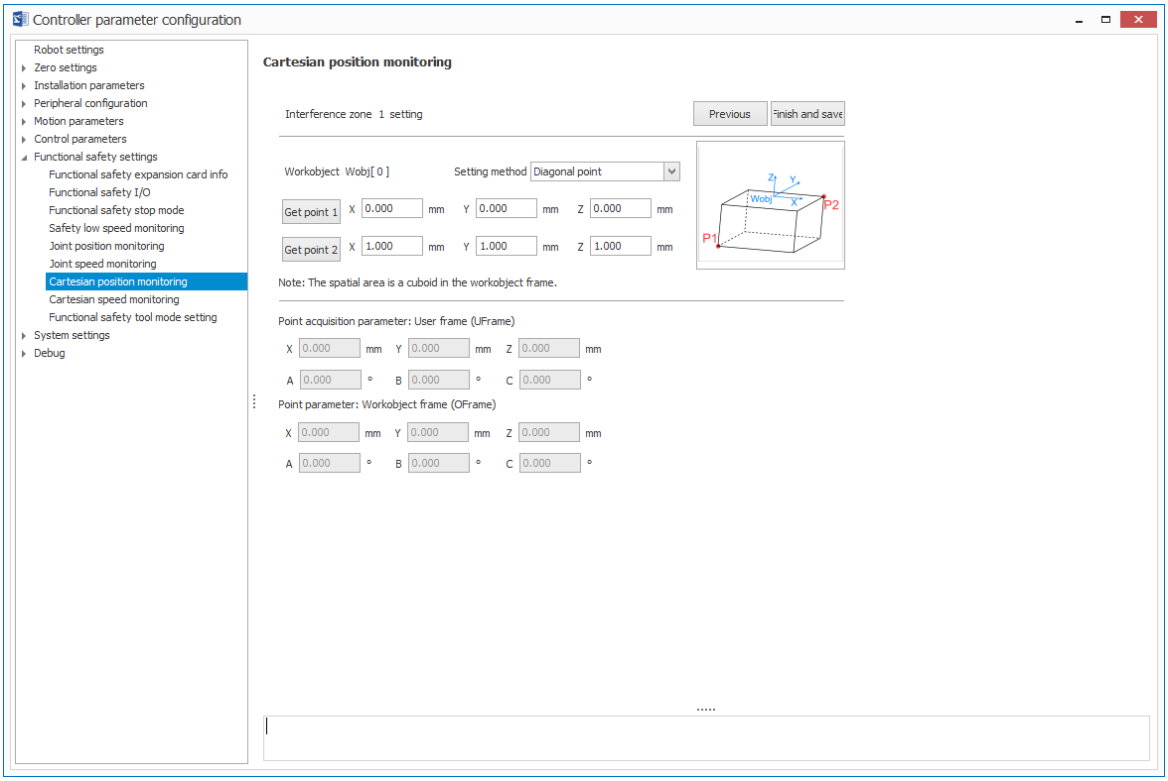
1. Select an interference zone and double-click it to open the parameter setting interface.



Parameter description:

- Remarks: Descriptive information of the current interference zone
- Inside and outside: Specifies the inside or outside of the interference zone as the interference zone.
- Stop mode: Category 0 stop, Category 1 stop.
  When the Cartesian position of the robot's end monitoring object exceeds the safety zone set by the user, it triggers a Category 0 or 1 emergency stop.
- Safety distance: Increases or decreases the interference zone as a whole according to the "Inside and outside" option. The range of safety distance is [0, 10000], in mm.

2. Click "Next" in the upper-right corner.



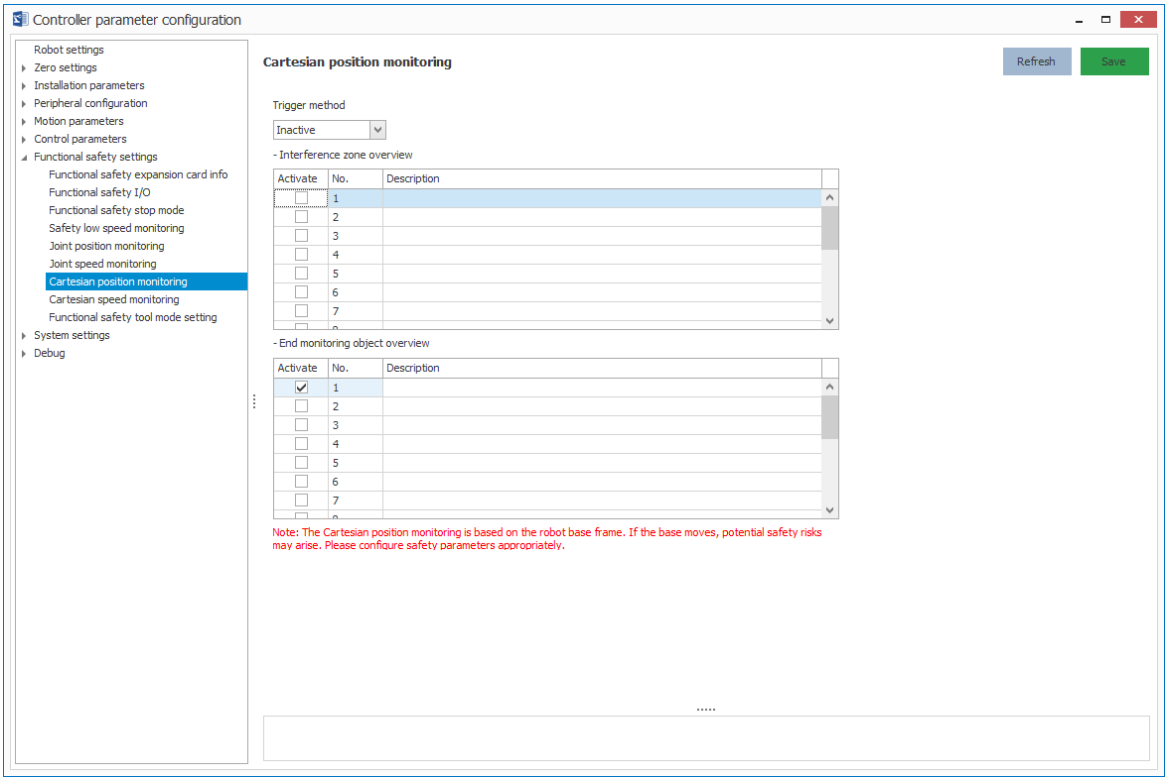
Parameter description:

- Setting method: Sets the interference zone by diagonal point, or by datum point + offset. The points are taken in the current workobject frame.
- You can enter the point manually or click the "Get point" button to acquire the current point automatically. The range of the point value is [-10000,10000], in mm. The range of the offset value is [-10000, 0), (0, 10000], in mm.
- After getting the points or configuring the points of the interference zone, you can view the frame parameters in the lower part of the interface.

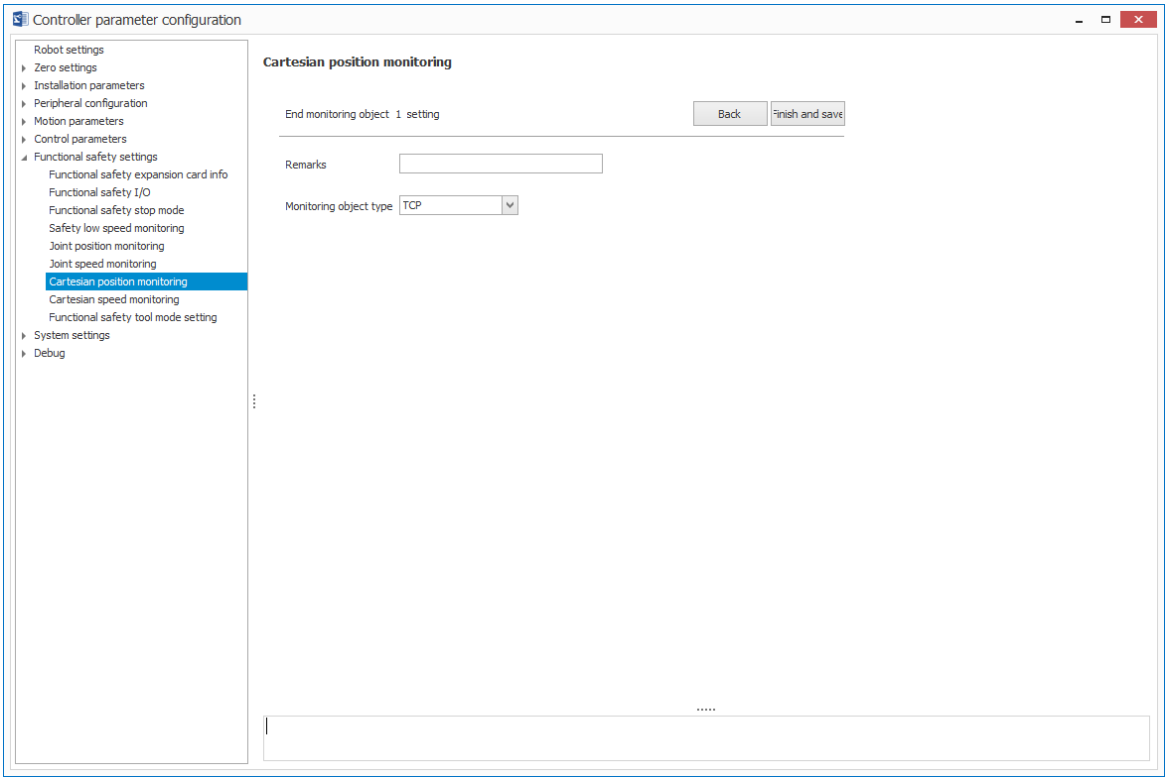
CAUTION

- The value of the safety distance cannot be less than 0.
- The position of the interference zone is relative to the active workobject frame.
- You cannot get the points of the interference zone in a workobject frame where the workobject is not held by the robot.
- You cannot get the points of the interference zone in a workobject frame where the user frame is not fixed.
- If the points cannot form a cuboid, the settings cannot be saved.
- The robot decelerates to stop from the time the end monitoring object enters the interference zone. Therefore, the actual stop position of the robot is inside the interference zone, or the robot passes through the interference zone when the interference zone is small. Note that the greater the robot speed, the greater the distance the robot enters the interference zone. Therefore, set the interference zone as large as possible.

3. Click the "Finish and save" button to save the interference zone parameters and return to the interference zone overview interface.

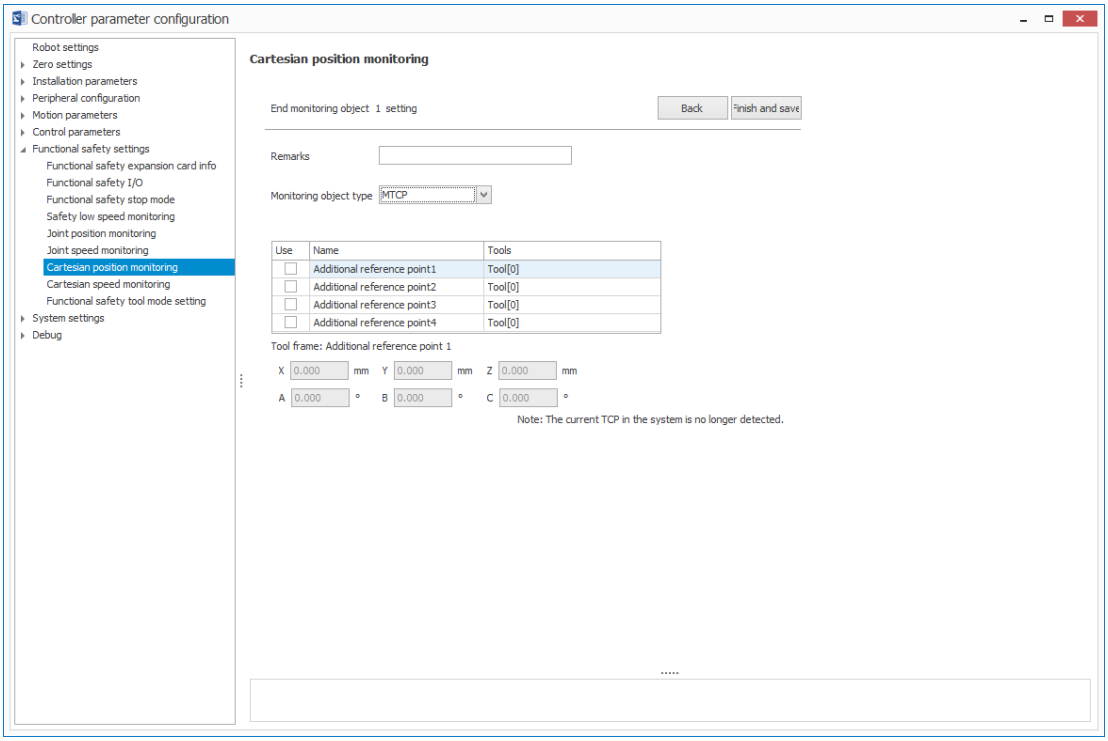


4. Select an end monitoring object and double-click it to open the parameter setting interface.

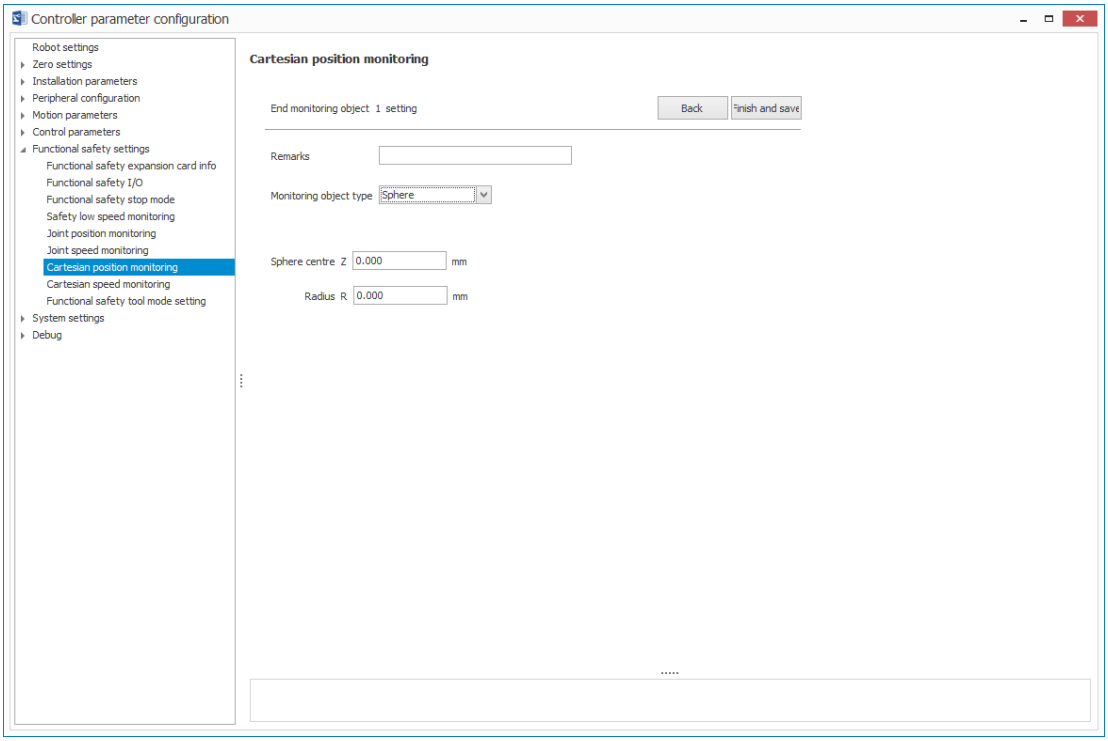


Parameter description:

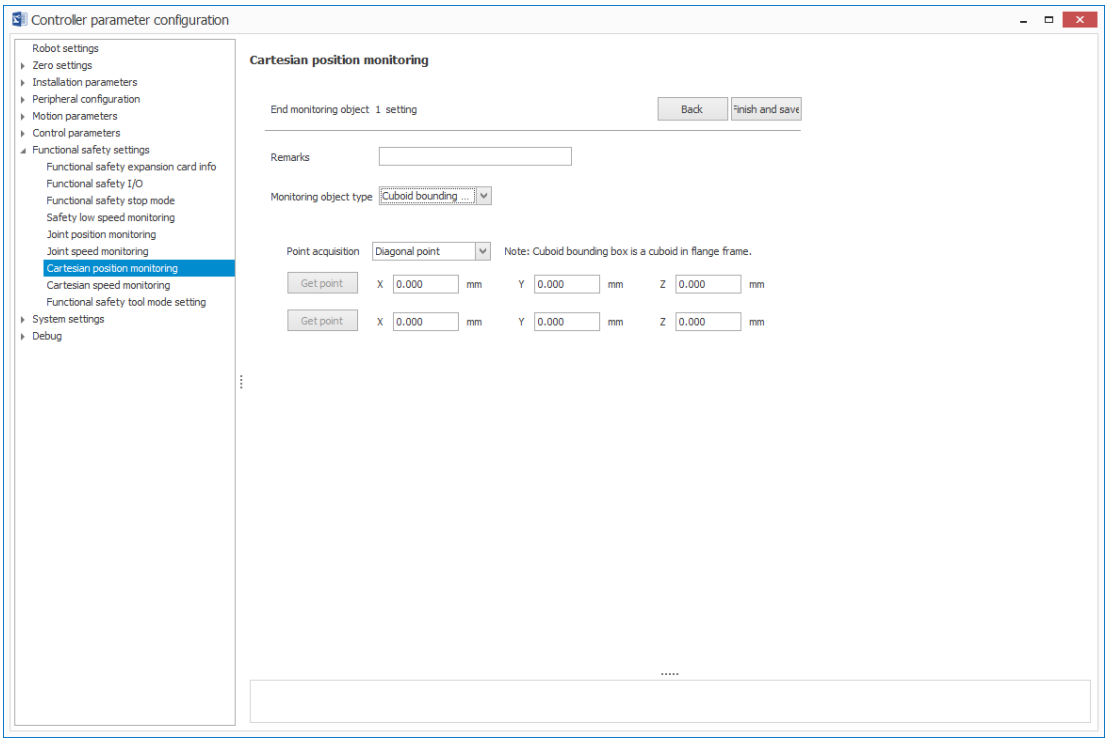
- Remarks: Descriptive information of the current monitoring object.
- Monitoring object type: Includes TCP, MTCP, sphere, and cuboid bounding box. TCP by default.
  - TCP: When the robot grips the tool, the current TCP is used for monitoring. When the robot grips the workobject, the flange center is used for monitoring.
  - MTCP: Supports up to four tools at the same time. You must select a reference point for the tool. The current TCP of the robot is not used for monitoring any more. You can view the parameters of the tool frame in the lower part of the software interface.



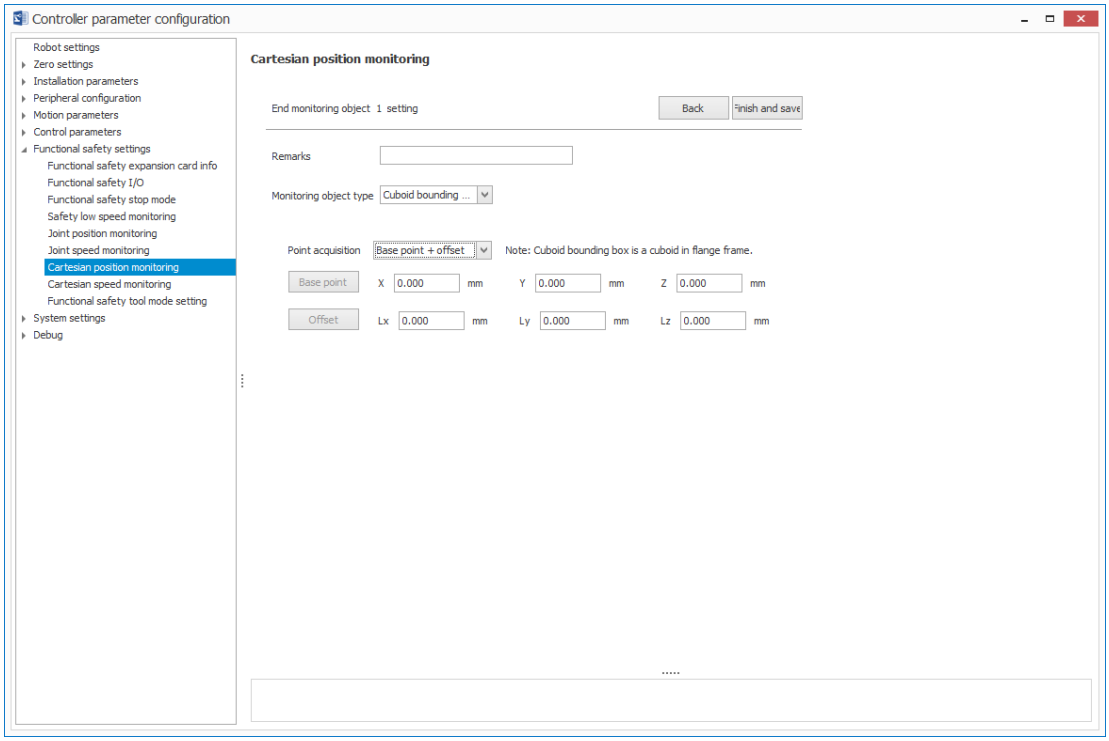
  - Sphere: The spherical center is offset from the Z direction of the flange frame, the spherical center range is [-10000, 10000] and the radius range is (0, 10000], in mm. The eccentric sphere is not supported.



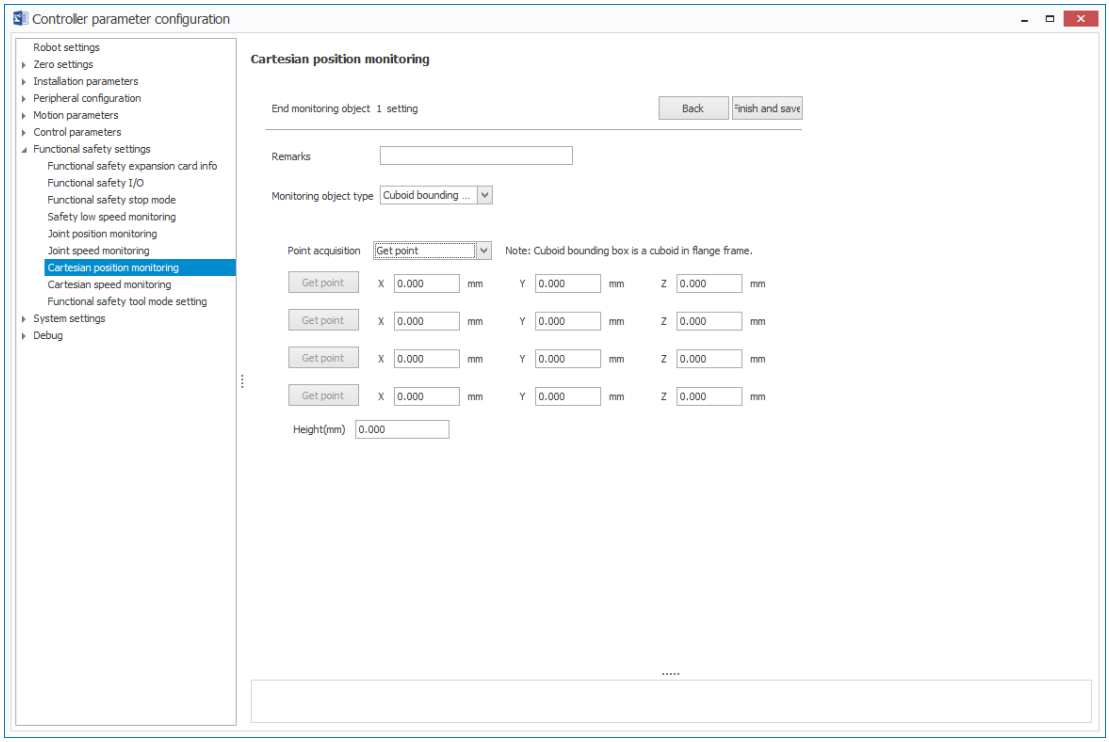
- Cuboid bounding box: There are three methods to acquire the points, namely, diagonal point, datum point + offset, and get point.



When the point acquisition method is set to "Diagonal point", you can enter the point manually or click the "Get current point" button to acquire the current point automatically. Note that the "Get point" button is active only when the robot is in ECP mode. The points are taken in the flange frame. The range of the point value is [-10000, 10000], in mm.

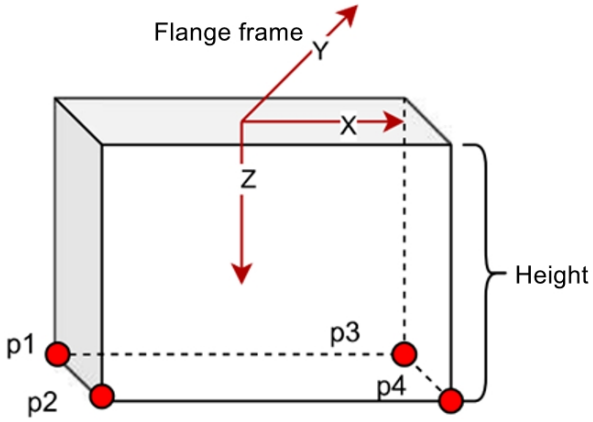


When the point acquisition method is set to "Datum point + offset", you can enter the datum point and the offset manually, or click the "Datum point" button to get the point automatically and then manually enter the offset. Note that the "Datum point" button is active only when the robot is in ECP mode. The point and offset are taken in the flange frame. The range of the point value is [-10000, 10000], and the range of the offset is [-10000, 0), (0, 10000], in mm.



When the point acquisition method is set to "Get point", you can enter the point manually, or click the "Get point" button to get the point automatically. Note that the "Get point" button is active only when the robot is in ECP mode. The points are taken in the flange frame.

Note that the points 1-4 are the four points on the bottom face of the cuboid. The height is the distance in the Z direction under the flange frame. The range of the point value is [-10000, 10000] and the range of height is [0, 10000], in mm. See the figure below:

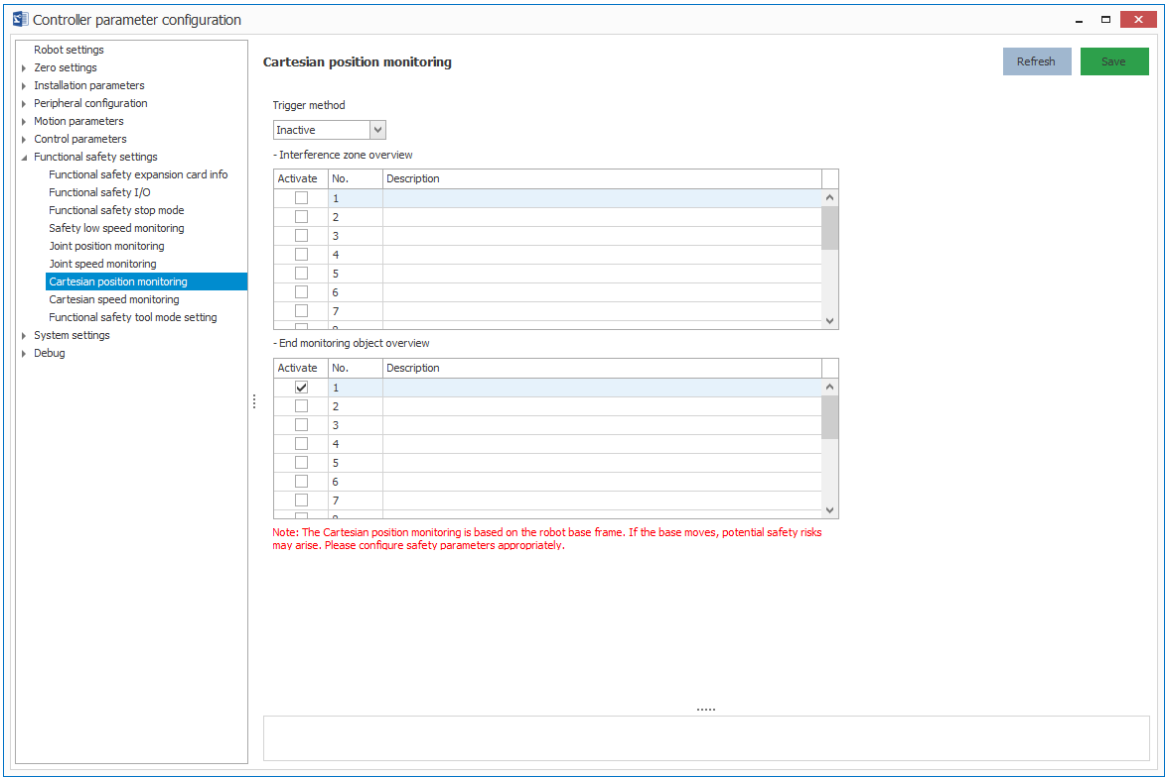


CAUTION

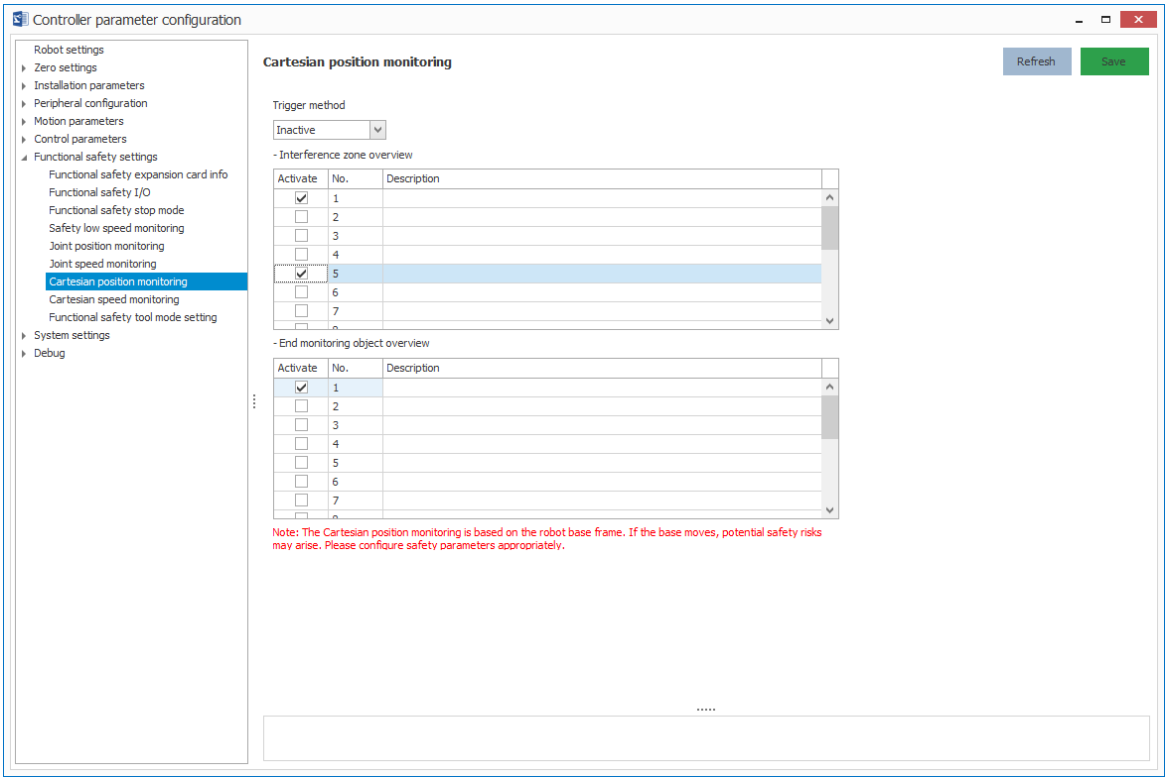
Notes of the cuboid bounding box:

- The orientation of the cuboid bounding box is the same as that of the flange frame. That is, a tilted cuboid bounding box cannot be defined under the flange frame.
- Before getting a point, you must calibrate an external tool and then move the robot to the point on the external tool.
- Regarding the setting of the four points + height, for the 6-axis robots, you need to rotate the J5 axis so that the Z axis of the flange frame points downwards before setting the points and height; for the SCARA robots, just set the points and height normally.

5. After configuring the monitoring object, click the "Finish and save" button.



6. Check the interference zone and monitoring object to be used.



After the parameters are configured and saved, the Cartesian position monitoring function takes effect immediately.

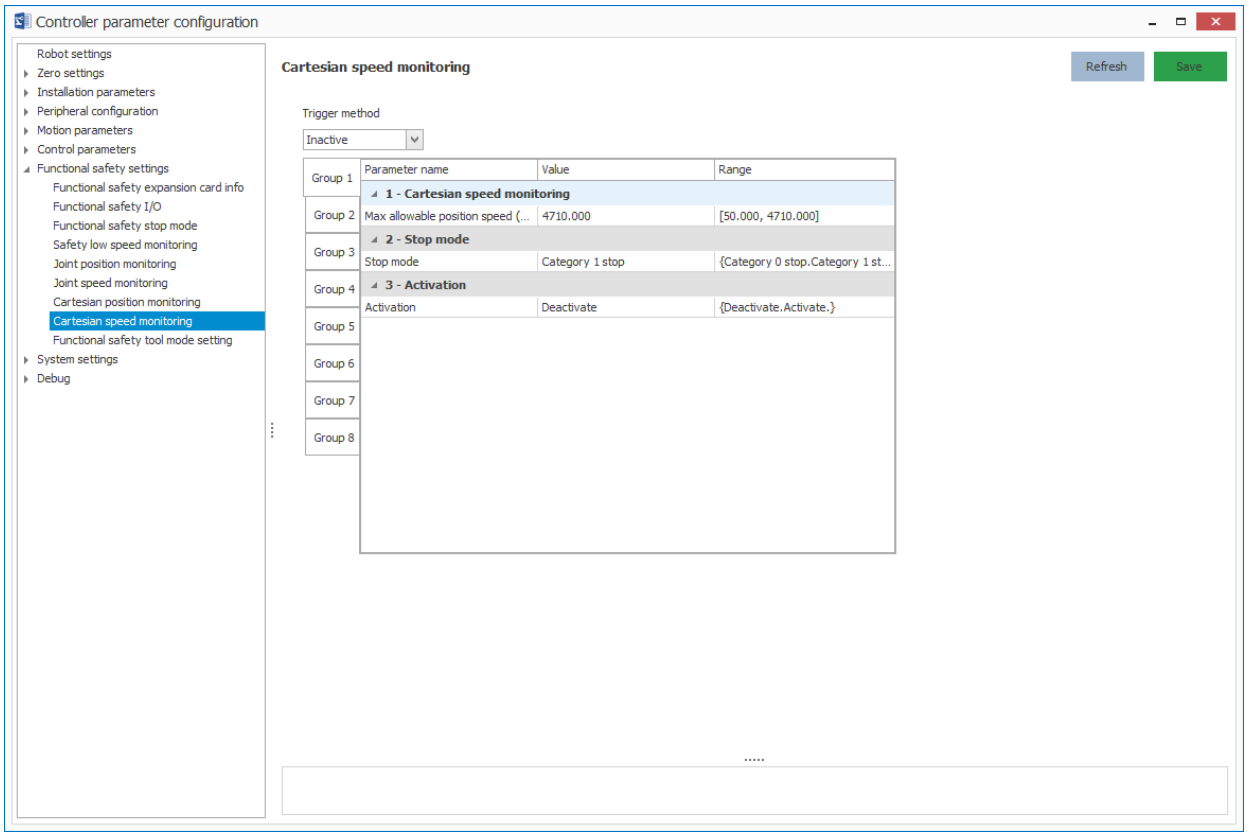
CAUTION

When using the Cartesian position monitoring function, the following precautions/restrictions need to be taken.

- Once determined, the position of the interference zone under the world frame will not change even if the corresponding tool/workobject parameters are modified. If you need to modify the position of the interference zone, you need to modify the points of the interference zone and save the changes.
- After the monitoring object at the end of robot enters the interference zone, you need to disable the interference zone function to clear the alarm and continue motion.
- The larger the robot speed, the greater the distance the robot enters the interference zone. Therefore, you need to set the interference zone and safety distance as large as possible according to the actual working conditions.
- When the robot grips the workobject, if you set the monitoring object type to "TCP", the flange center is used for detection, which may result in collision between the workobject and external devices or obstacles. In this case, it is recommended to set the monitoring object type to sphere or cuboid bounding box.
- When the interference zone is activated, it is detected in any motion mode.
- When the cuboid bounding box is defined by the four points + height,for the 6-axis robots, you need to rotate the J5 axis so that the Z axis of the flange frame points downwards before setting the points and height. Otherwise, the cuboid cannot be formed properly.

5.3.10 Configuring Cartesian Speed Monitoring Parameters

You can configure the Cartesian speed monitoring parameters as needed, as shown in the figure below:



Name	Value range	Default	Description
Trigger method	Inactive Permanent trigger I/O trigger	Inactive	• When "Inactive" is selected, the Cartesian speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot. • When "Permanent trigger" is selected, the Cartesian speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot. • When "I/O trigger" is selected, the Cartesian speed monitoring function is activated or deactivated based on the status of the bound I/O.
Cartesian speed safety range	0-10000 mm/s	0	You can set the safety ranges for the monitored robot Cartesian speed.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	If any robot Cartesian speed exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.

Name	Value range	Default	Description
Activation	Deactivate	Deactivate	Indicates the activation of the current Cartesian speed. If not activated, this set of parameters will not be used for Cartesian speed monitoring.
	Activate		

NOTE

The Cartesian speed monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the Cartesian speed monitoring function takes effect immediately.

5.4 Configuration on InoTeachPad

Robot teach pendant models: IRTP80-L5 and IRTP80-L5-INT

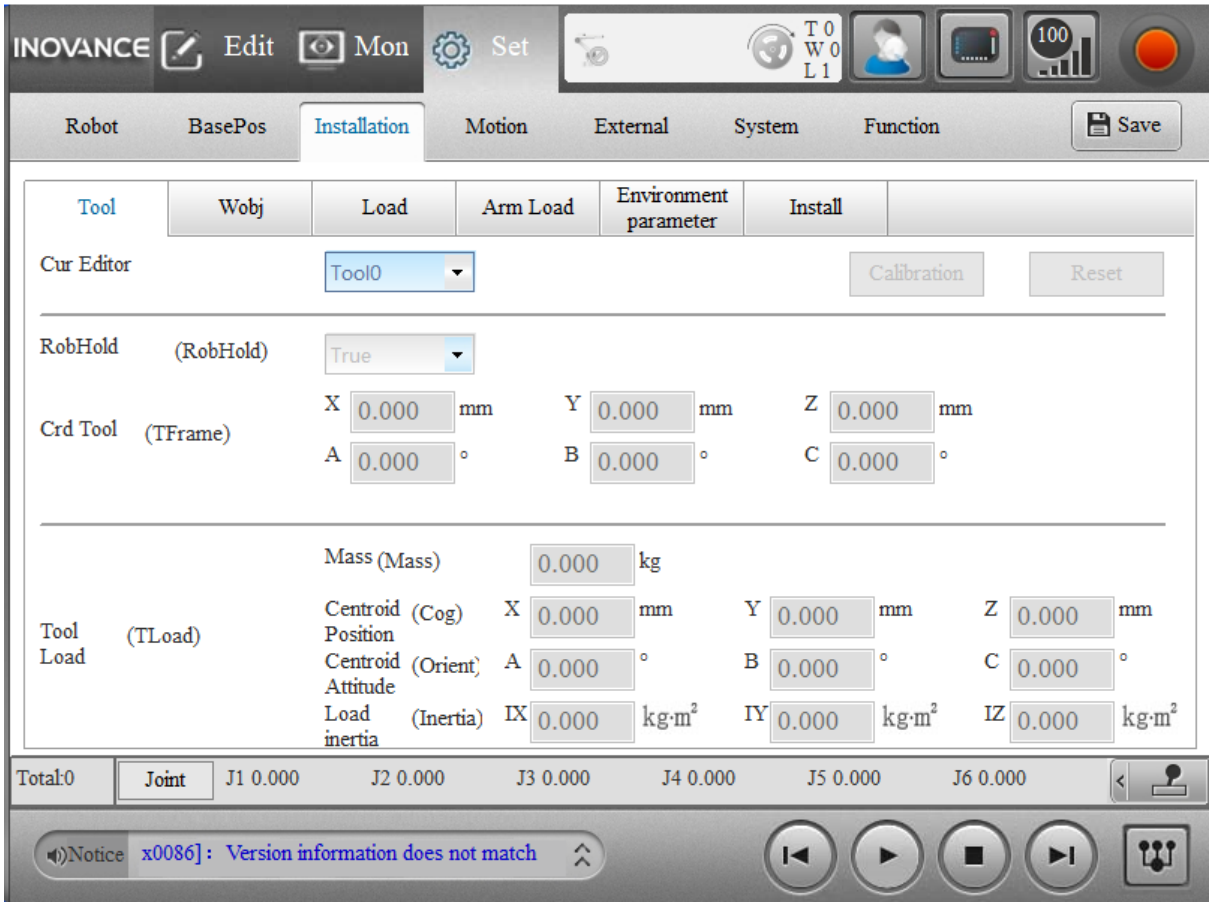
The following table describes the safety function configuration steps.

No.	Operation
1	Configure basic parameters
2	Configure system access
3	Configure safety tool
4	Configure safety I/O signal
5	Configure safety stop parameters
6	Configure safety low speed monitoring parameters
7	Configure joint speed monitoring parameters
8	Configure joint position monitoring parameters
9	Configure Cartesian position monitoring parameters
10	Configure Cartesian speed monitoring parameters

5.4.1 Configuring Basic Parameters

Before using the safety functions after flashing or upgrade of the robot system, complete the following operations.

1. Configure and save the tool parameters required by the robot.



2. Configure and save the workobject parameters required by the robot.



5.4.2 Configuring System Access

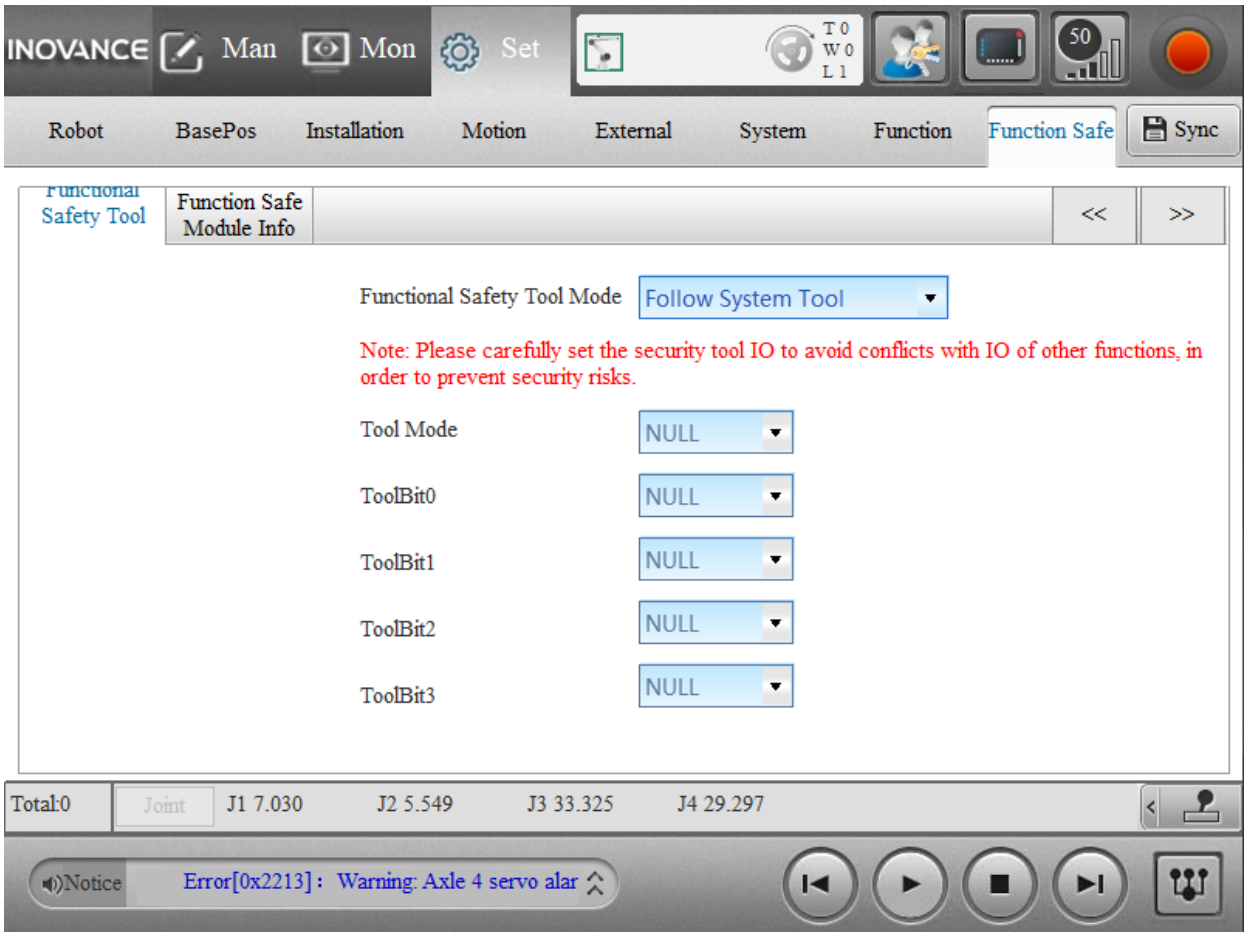
Only authorized operators (editor, administrator and manufacturer) are allowed to modify the safety function parameters. Safety function password is required.

5.4.3 Configuring Safety Tool

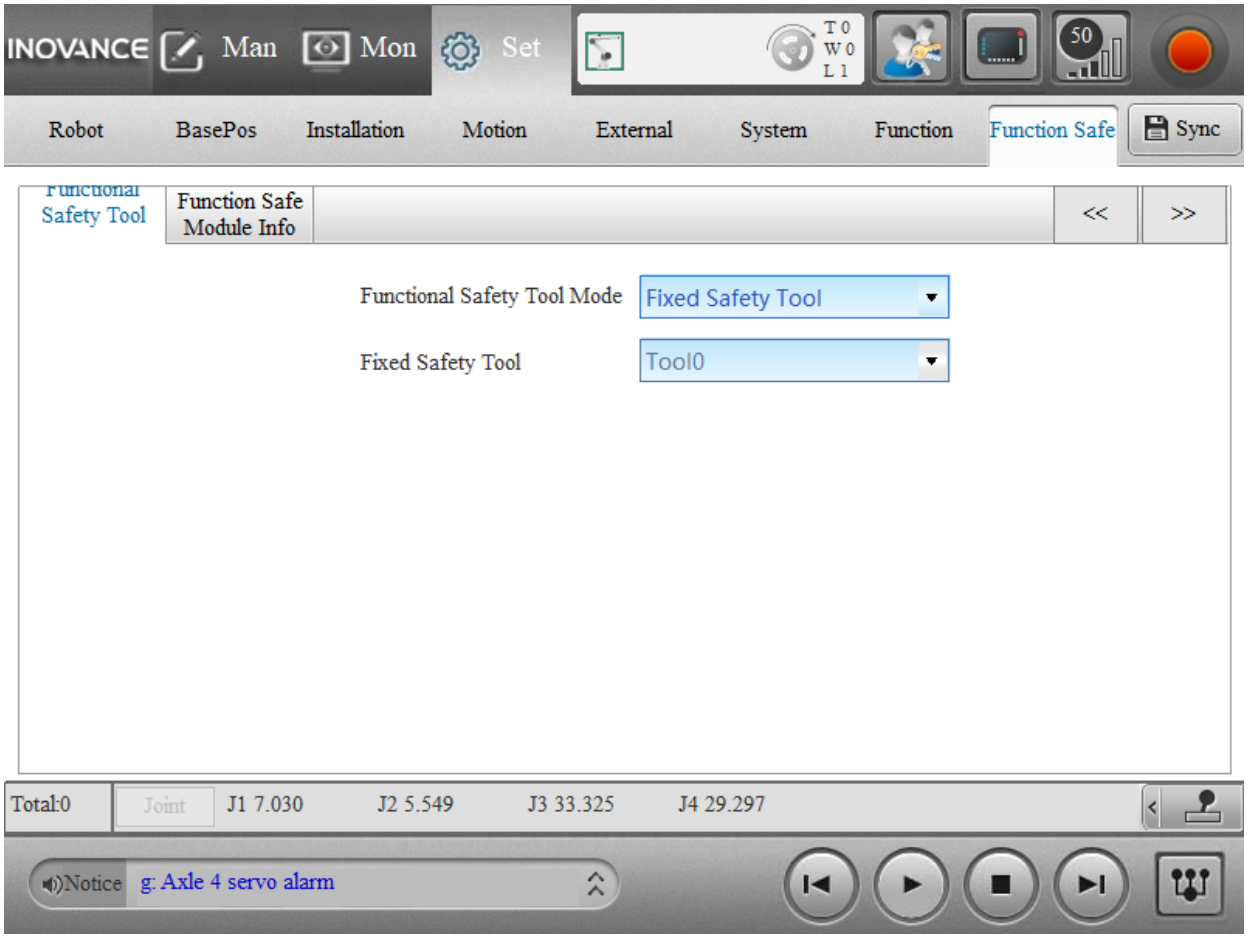
The safety tool has three modes: follow system tool, fixed safety tool, and manual tool switch. You can configure the safety tool as needed.

See the following instructions for setting up the three modes:

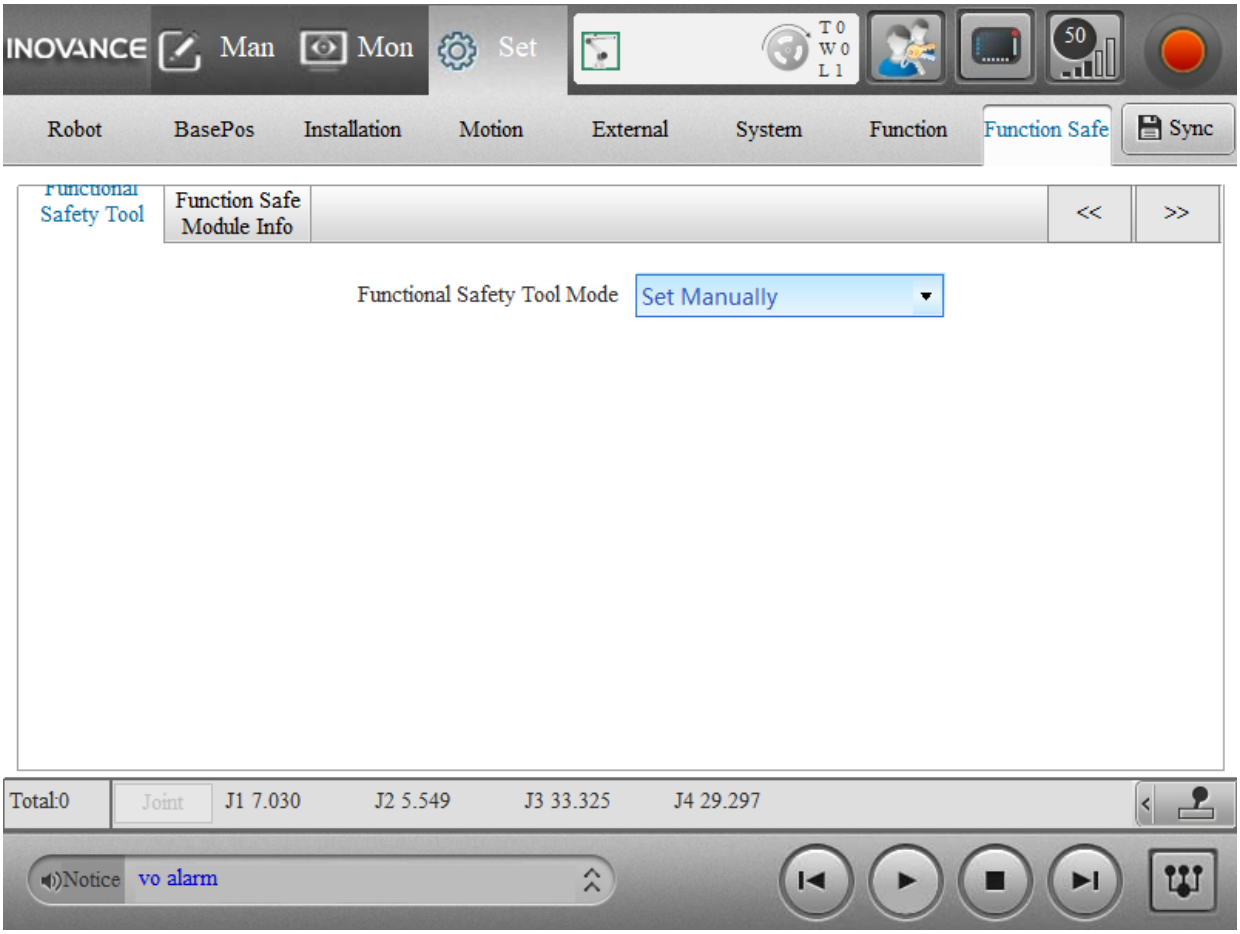
1. When the mode is set to "Follow System Tool", it occupies five standard I/O points. The OUT number is specified by the user, and other functions cannot use these five OUT numbers. During wiring, connect the DI (3–7) on the safety module in the order corresponding to the specified OUT numbers. The controller must be configured to trigger the corresponding standard OUT when switching tools.



2. When the mode is set to "Fixed Safety Tool", you need to specify a tool (TCP) or workobject (ECP) as the safety tool/workobject, and it cannot be switched via safety I/O or standard I/O. When a workobject is selected, its "RobHold" parameter must be set to "True".



3. When the mode is set to "Set Manually", you need to connect the external I/O to the I/O (3-7) on the safety module, allowing the tool switching by the operator or an external device.



After the parameters are configured and saved, the safety tool set takes effect immediately.

CAUTION

- It is important to set the safety tool for the safety function. Be cautious when setting the safety tool to avoid safety accidents caused by a mismatch between the Cartesian position/speed monitored by the safety function and the actual Cartesian position/speed.
- When selecting the mode as "Follow system tool" or "Manual tool switch", configure the safety DI3 to DI7 and make physical connections according to the tool number required for switching.
- In the Cartesian position monitoring function, when the end monitoring object type is not TCP, the actual settings prevail and are not affected by the safety tool mode settings.
- In the V4R24C2 version, the default values will be restored after the controller is restarted, and reconfiguration is required after restarting. For other versions, this parameter is retained upon power-off. After restarting, the last set value is retained.

Example:

When the safety tool mode is configured to follow system tool, the standard DOs configured on the interface are DO23, DO34, DO56, DO67 and DO78.

Safety tool mode configuration	Safety configuration terminal	Connection/Status	Description
Follow System Tool	DI3	Robot standard DO23 to safety DI3	Configure the TCP/ECP mode.
	DI4	Robot standard DO34 to safety DI4	When switching of up to 16 tool/ workobjects is required, configure the safety DI4 as the tool number Bit0.
	DI5	Robot standard DO56 to safety DI5	Configure the safety DI5 as the tool number Bit1.
	DI6	Robot standard DO67 to safety DI6	Configure the safety DI6 as the tool number Bit2.
	DI7	Robot standard DO78 to safety DI7	Configure the safety DI7 as the tool number Bit3.
Set Manually	DI3	The user controls the status of safety DI3.	Configure the safety DI3 as TCP/ECP mode for the switching between TCP /ECP modes.
	DI4	The user controls the status of safety DI4.	When switching of up to 16 tool/ workobjects is required, configure the safety DI4 as the tool number Bit0.
	DI5	The user controls the status of safety DI5.	Configure the safety DI5 as the tool number Bit1.

Safety tool mode configuration	Safety configuration terminal	Connection/Status	Description
	DI6	The user controls the status of safety DI6.	Configure the safety DI6 as the tool number Bit2.
	DI7	The user controls the status of safety DI7.	Configure the safety DI7 as the tool number Bit3.

Set the status of DI4 to DI7 according to the desired tool/workobject number to be switched:

- To switch the safety tool to tool number 7, set DI4, DI5, and DI6 to low level.
- To switch the safety tool to tool number 11, set DI4, DI5, and DI7 to low level, and DI6 to high level.

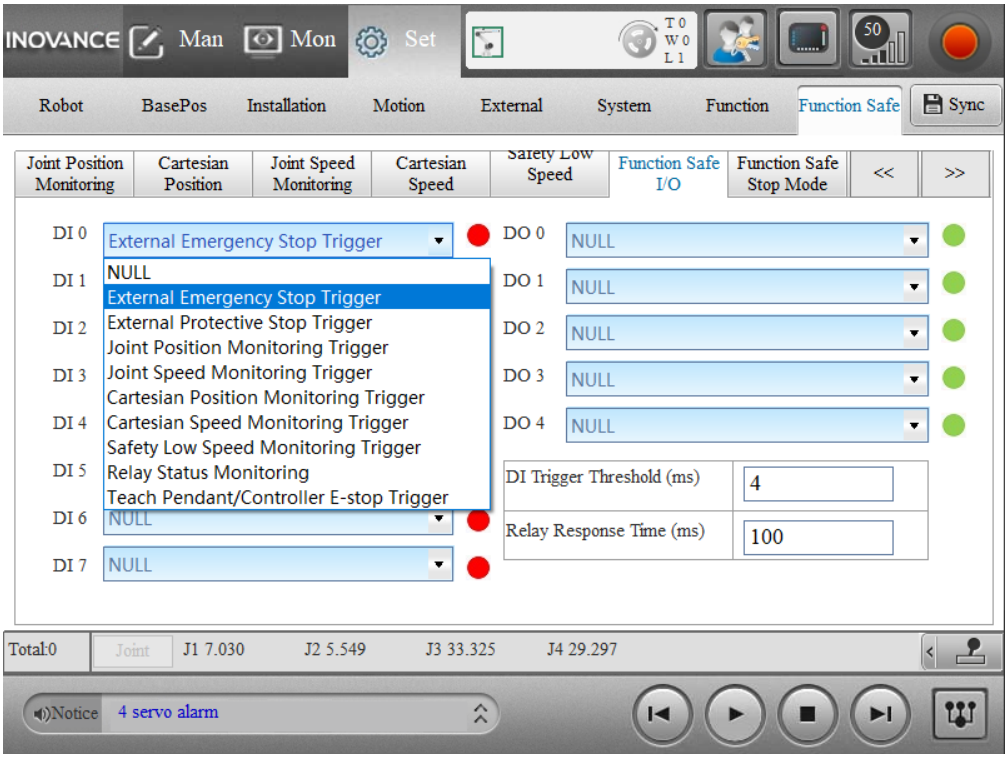
CAUTION

It is not always necessary to configure safety DI4-DI7.

- If the range of tool/workobject number to be switched is less than 8, only DI4 to DI6 need to be configured.
- If the range of tool/workobject number to be switched is less than 4, only DI4 to DI5 need to be configured.
- If the range of tool/workobject number to be switched is less than 2, only DI4 needs to be configured.

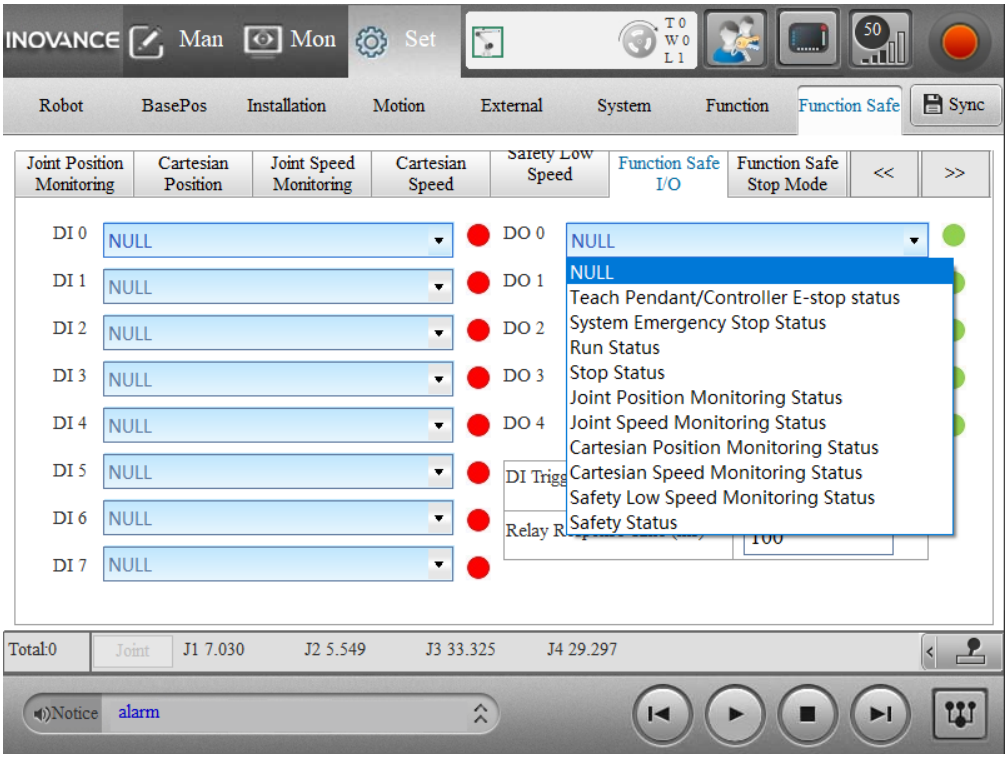
5.4.4 Configuring Safety I/O Signal

1. The safety DI can be configured for external emergency stop, external protective stop, emergency stop, additional emergency stop, activation of each safety function, and safety tool mode and number. After configuration, you can view the DI status via the status indicator. See the figure below:



> **NOTE**
>
> DI3 is added with TCP/ECP mode option, DI4 is added with Bit0 option, DI5 is added with Bit1 option, DI6 is added with Bit2 option, and DI7 is added with Bit3 option.

2. The safety DO can be configured for system emergency stop status, emergency stop status, additional emergency stop status, operation status, stop status, and the status of each safety function. After configuration, you can view the DO status via the status indicator. See the figure below:



After the above parameters are configured and saved, the safety I/O signals take effect immediately.

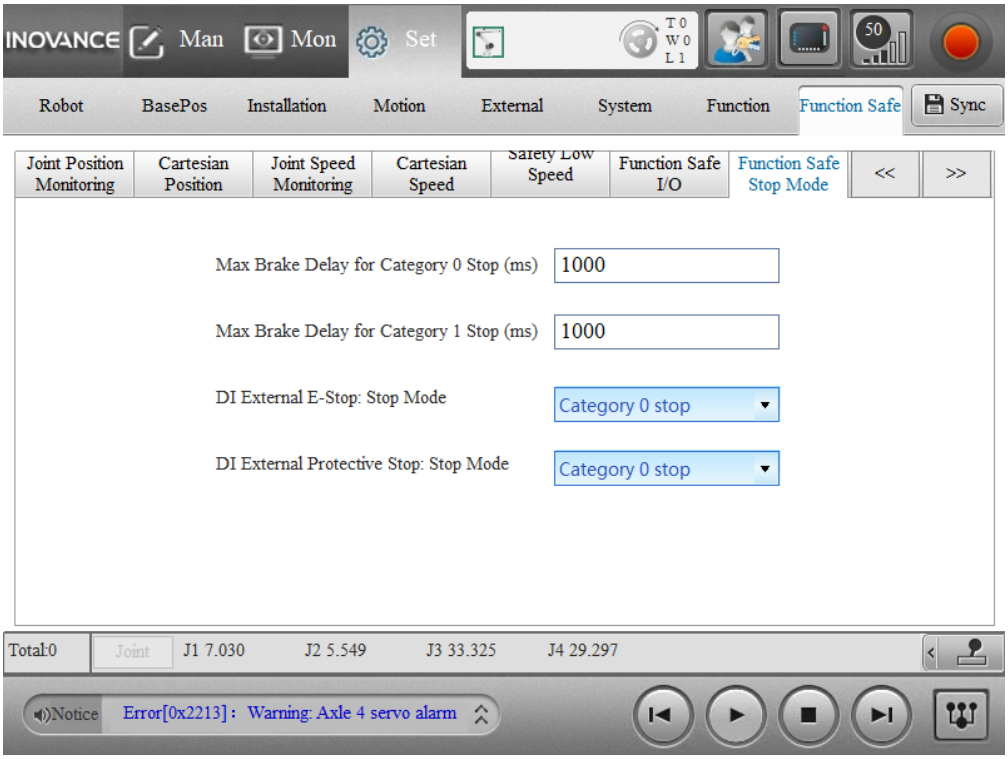
5.4.5 Configuring Safety Stop Parameters

As shown in the figure below, the safety stop parameters include:

- Max Brake Delay for Category 0 Stop (ms)
- Max Brake Delay for Category 0 Stop (ms)

You can configure the safety stop parameter as needed.

- DI emergency stop methods are classified into Category 0 emergency stop and Category 1 emergency stop.
- DI protective stop methods are classified into Category 0 emergency stop and Category 1 emergency stop.



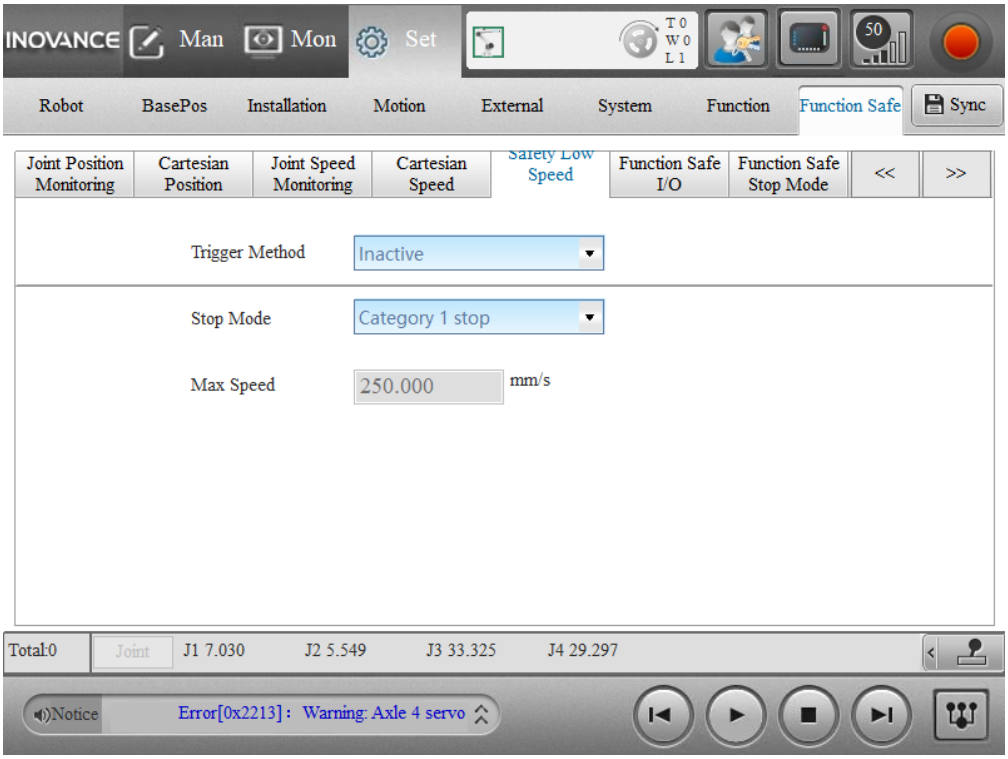
After the above parameters are configured and saved, the safety stop parameters take effect immediately.

CAUTION

The maximum brake delay for Category 0 or 1 stop affects the application of the brake after a Category 0 or 1 emergency stop is triggered. Be cautious when setting the maximum brake delay. A too large delay may result in that the robot fails to apply the brake after an abnormality occurs, which may cause safety accidents.

5.4.6 Configuring Safety Low Speed Monitoring Parameters

You can configure the safety low speed monitoring parameters as needed. See the figure below:

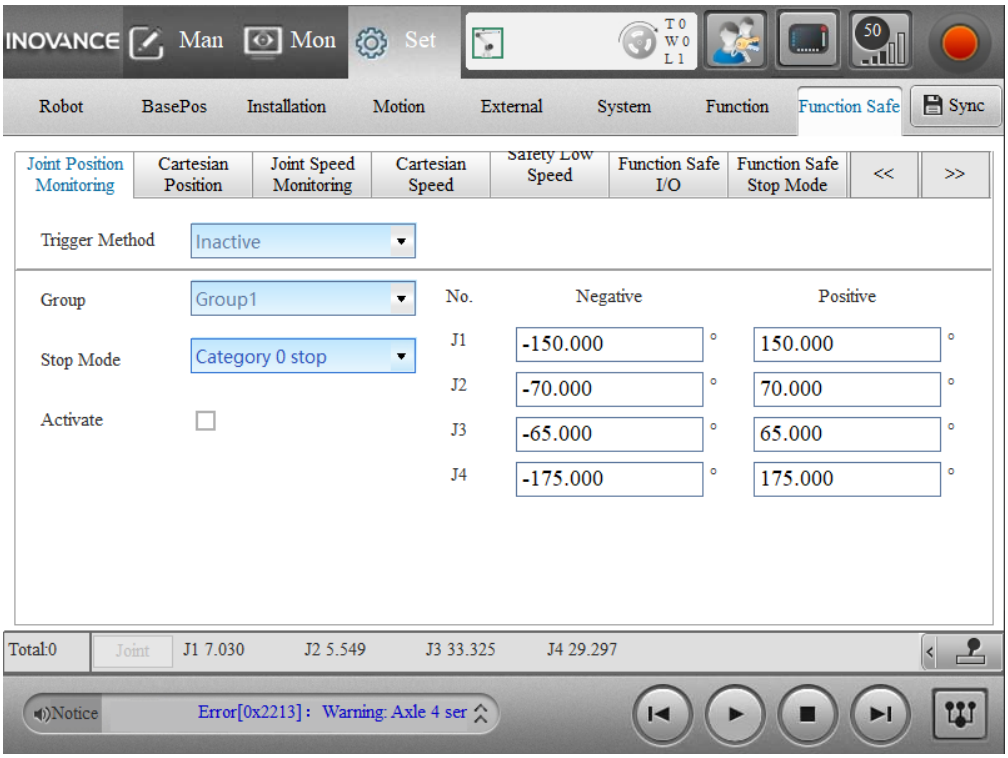


Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the safety low speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot safety tool.
	Permanent trigger		When "Permanent trigger" is selected, the safety low speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot safety tool.
	I/O trigger		When "I/O trigger" is selected, the safety low speed monitoring function is activated or deactivated based on the status of the bound I/O.
Stop mode	Category 0 stop	Category 0 stop	If the Cartesian speed of the robot safety tool exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Value	Not user-configurable	250 mm/s	In manual mode, the Cartesian speed of the safety tool is monitored; once it exceeds 250 mm/s, the corresponding operation is triggered.

After the parameters are configured and saved, the safety low speed monitoring function takes effect immediately.

5.4.7 Configuring Joint Position Monitoring Parameters

You can configure the joint position monitoring parameters as needed. See the figure below:



Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the joint position monitoring function is deactivated and does not provide safety monitoring for the robot axis positions.
	Permanent trigger		When "Permanent trigger" is selected, the joint position monitoring is permanently active and provides the real-time safety monitoring for the robot axis positions.
	I/O trigger		When "I/O trigger" is selected, the joint position monitoring function is activated or deactivated based on the status of the bound I/O.
Axis position safety range	The range is model-dependent and must not exceed the maximum axis limit of the robot.	0	You can set the positive and negative safety ranges for the monitored robot axis positions.
Stop mode	Category 0 stop	Category 0 stop	If the position of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		

Name	Value range	Default	Description
Activation	Deactivate Activate	Deactivate	Indicates the activation of the current axis position group. If not activated, this set of parameters will not be used for joint position monitoring.

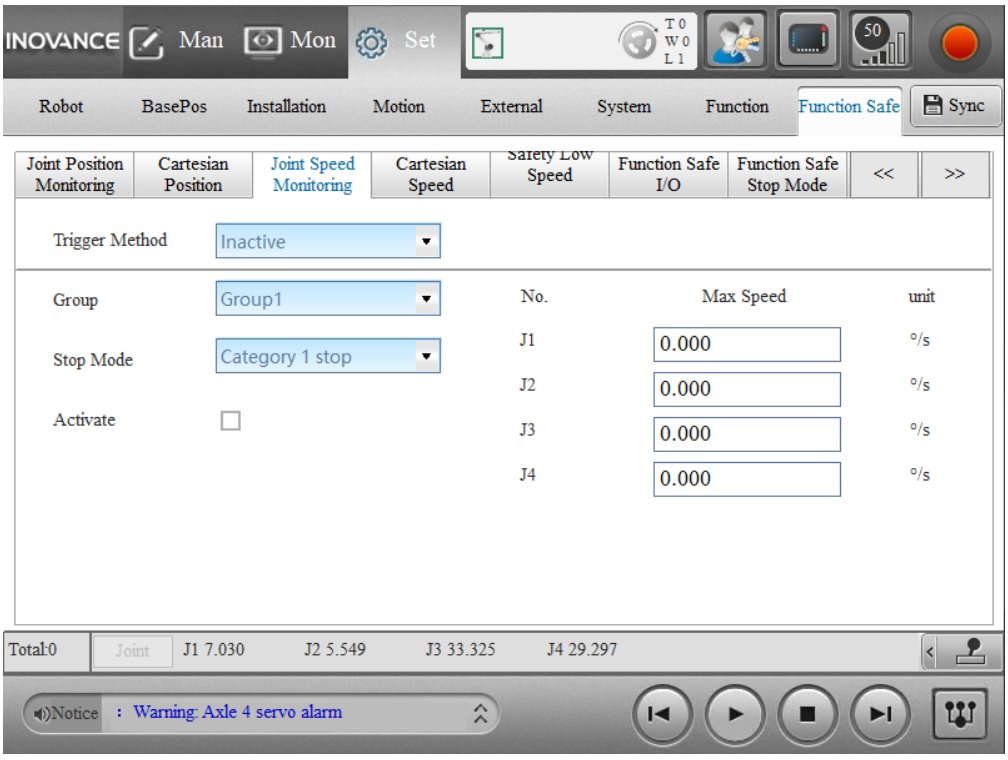
NOTE

The joint position monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the joint position monitoring function takes effect immediately.

5.4.8 Configuring Joint Speed Monitoring Parameters

You can configure the joint speed monitoring parameters as needed. See the figure below:



Name	Value range	Default	Description
Trigger method	Inactive	Inactive	When "Inactive" is selected, the joint speed monitoring function is deactivated and does provide safety monitoring for the robot axis speed.
	Permanent trigger		When "Permanent trigger" is selected, the joint speed monitoring is permanently active and provides the real-time safety monitoring for the robot axis speed.

Name	Value range	Default	Description
	I/O trigger		When "I/O trigger" is selected, the joint speed monitoring function is activated or deactivated based on the status of the bound I/O.
Axis speed safety range	The range is model-dependent and must not exceed the joint speed range of the robot.	0	You can set the safety ranges for the monitored robot axis speed.
Stop mode	Category 0 stop	Category 0 stop	If the speed of any robot axis exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current axis speed group. If not activated, this set of parameters will not be used for joint speed monitoring.
	Activate		

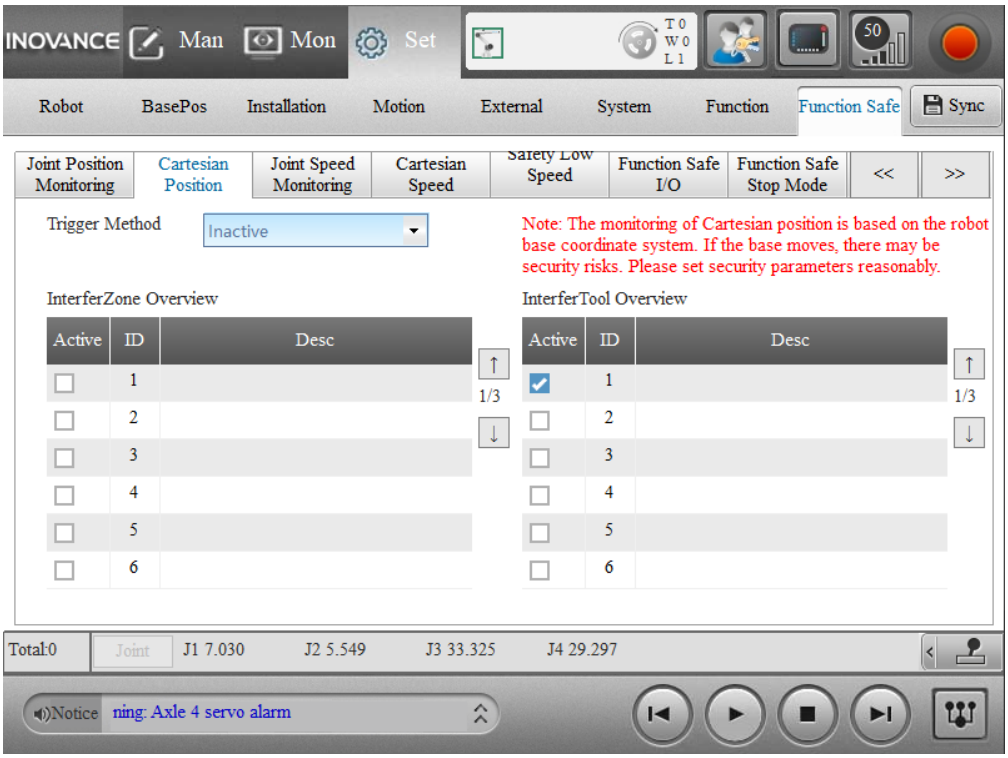
NOTE

The joint speed monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the joint speed monitoring function takes effect immediately.

5.4.9 Configuring Cartesian Position Monitoring Parameters

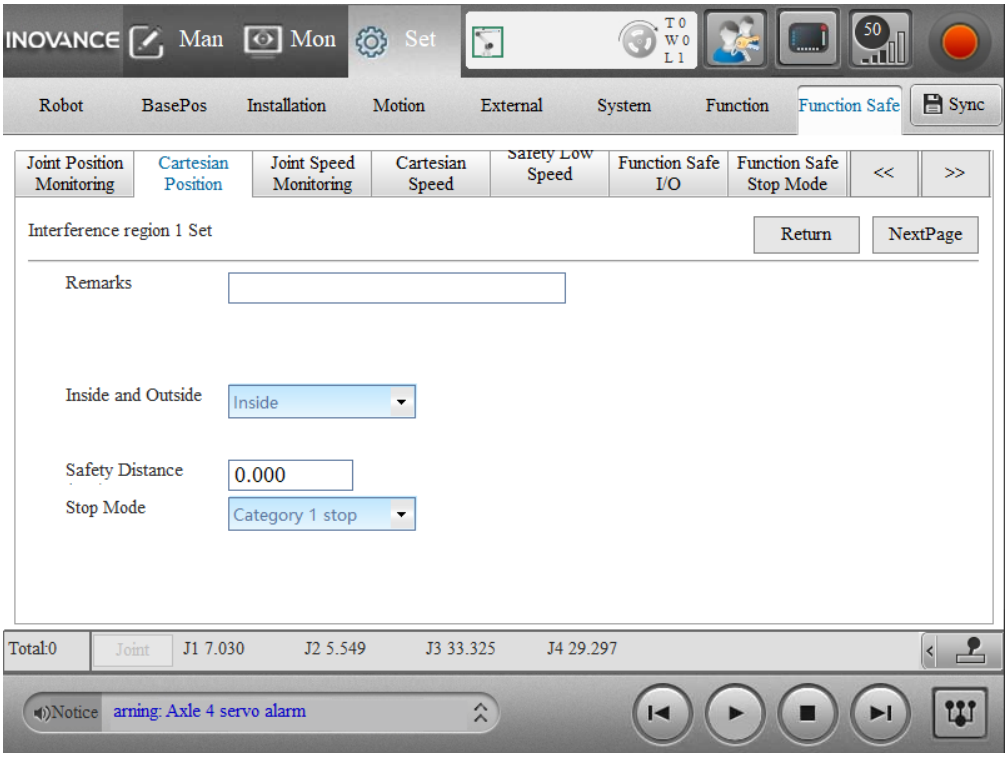
The following figure shows the setting interface of the Cartesian position monitoring function.



You can activate or deactivate the 16 interference zones and 16 monitoring objects, and view the description of the interference zones and monitoring objects.

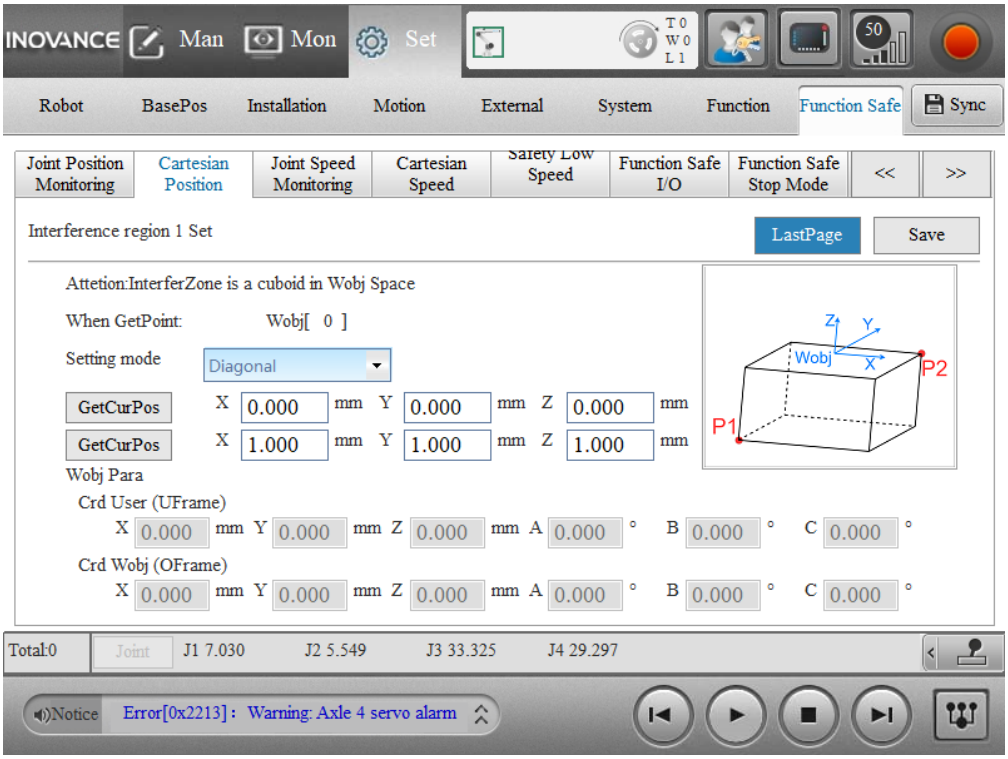
> **CAUTION**
>
> Multiple interference zones can be activated simultaneously, but only one end monitoring object can be activated.

1. Select an interference zone and double-click it to open the parameter setting interface.



Parameter	Description
Remarks	Descriptive information of the current interference zone.
Inside and Outside	Specifies the inside or outside of the interference zone as the interference zone.
Stop Mode	Category 0 stop, Category 1 stop. When the Cartesian position of the robot's end monitoring object exceeds the safety zone set by the user, it triggers a Category 0 or 1 emergency stop.
Safety Distance	Increases or decreases the interference zone as a whole according to the "Inside and Outside" option. The range of safety distance is [0, 10000], in mm.

2. Select an interference zone and double-click it to open the parameter setting interface.
3. Click "NextPage" in the upper-right corner.



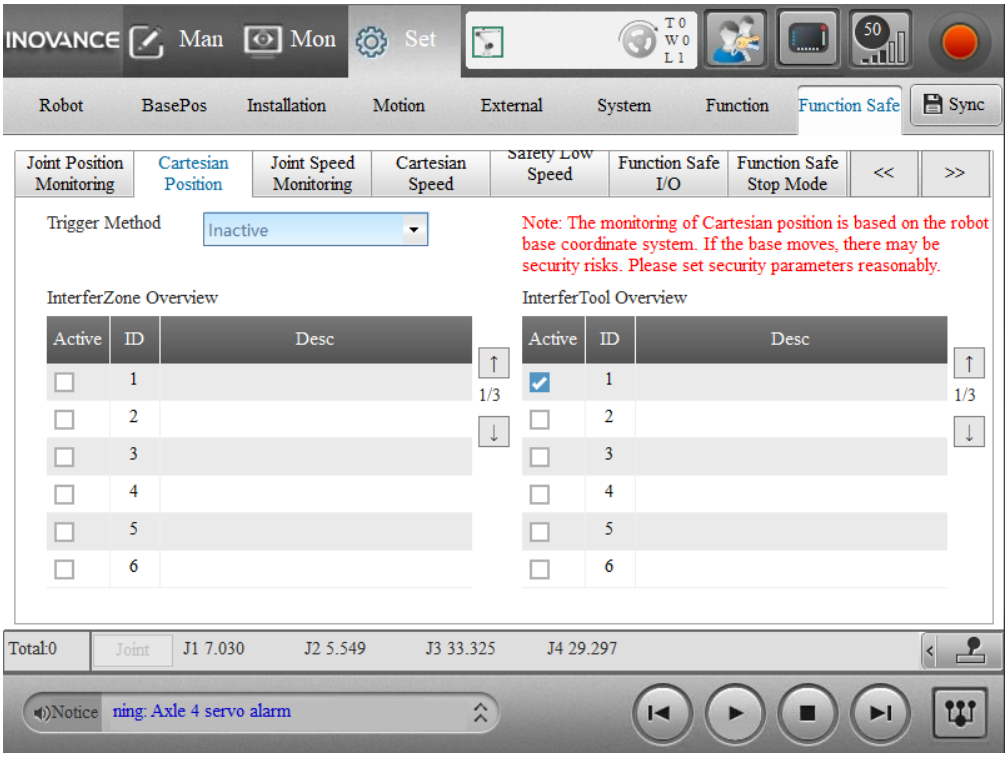
Parameter description:

- Setting mode: Sets the interference zone by diagonal point, or by datum point + offset. The points are taken in the current workobject frame.
- You can enter the point manually or click the "GetCurPos" button to acquire the current point automatically. The range of the point value is [-10000,10000], in mm. The range of the offset value is [-10000, 0), (0, 10000], in mm.
- After getting the points or configuring the points of the interference zone, you can view the frame parameters in the lower part of the interface.

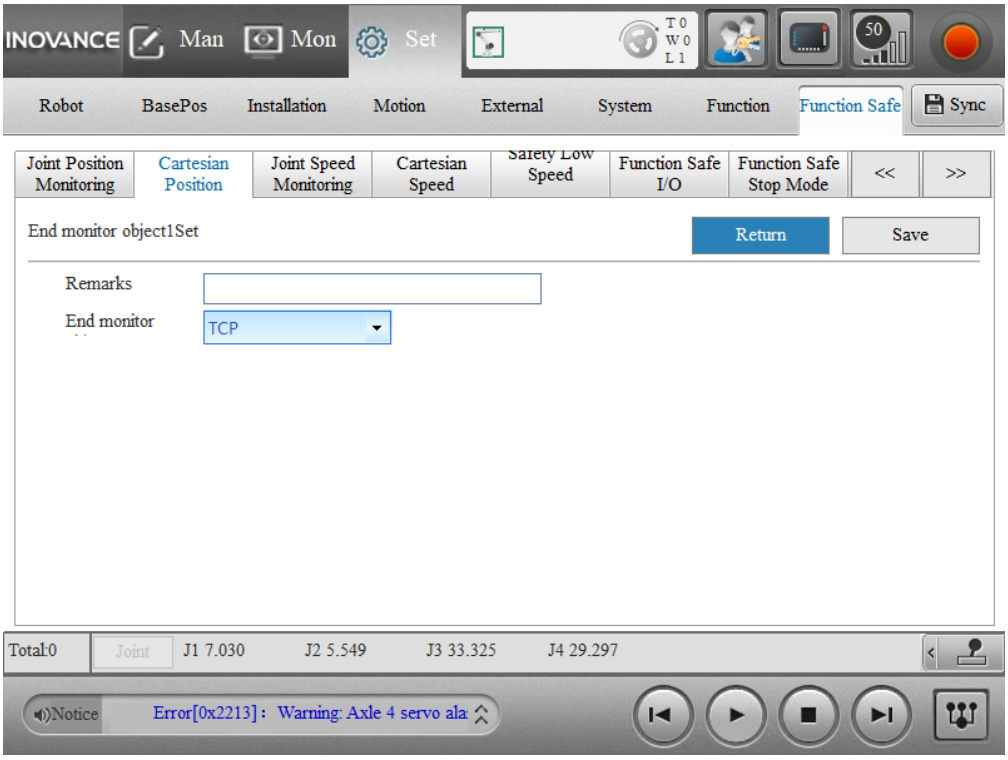
CAUTION

- The value of the safety distance cannot be less than 0.
- The position of the interference zone is relative to the active workobject frame.
- You cannot get the points of the interference zone in a workobject frame where the workobject is not held by the robot.
- You cannot get the points of the interference zone in a workobject frame where the user frame is not fixed.
- If the points cannot form a cuboid, the settings cannot be saved.
- The robot decelerates to stop from the time the end monitoring object enters the interference zone. Therefore, the actual stop position of the robot is inside the interference zone, or the robot passes through the interference zone when the interference zone is small. Note that the greater the robot speed, the greater the distance the robot enters the interference zone. Therefore, set the interference zone as large as possible.

4. Click the "Save" button to save the interference zone parameters and return to the interference zone overview interface.

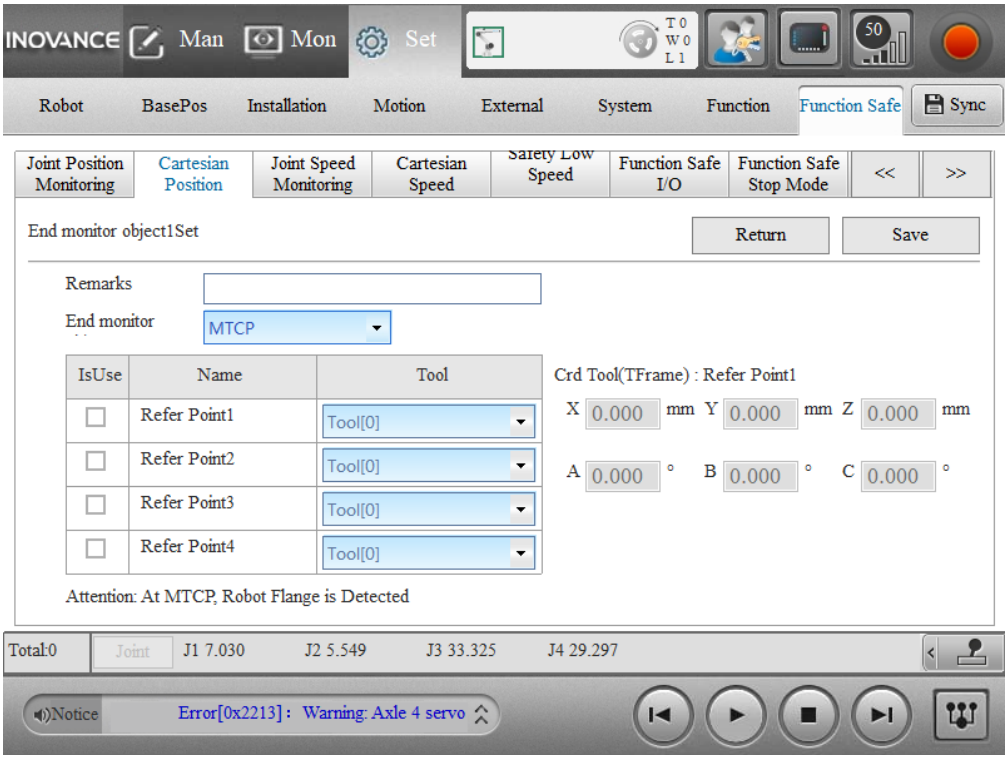


5. Select an end monitoring object and double-click it to open the parameter setting interface.

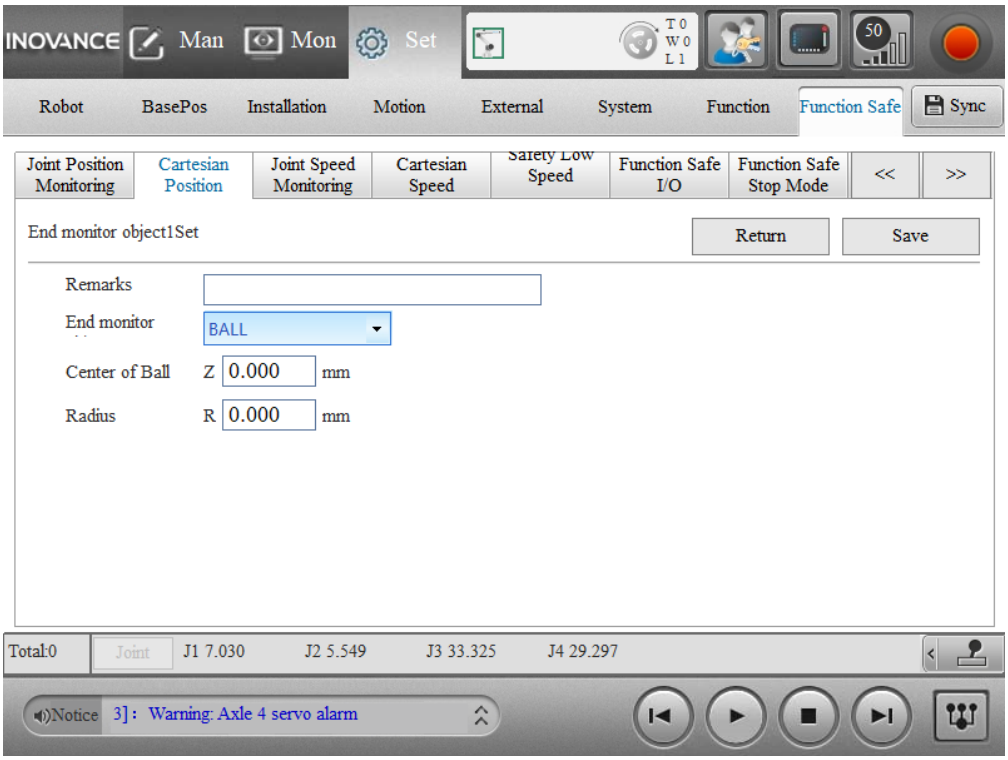


Parameter description:

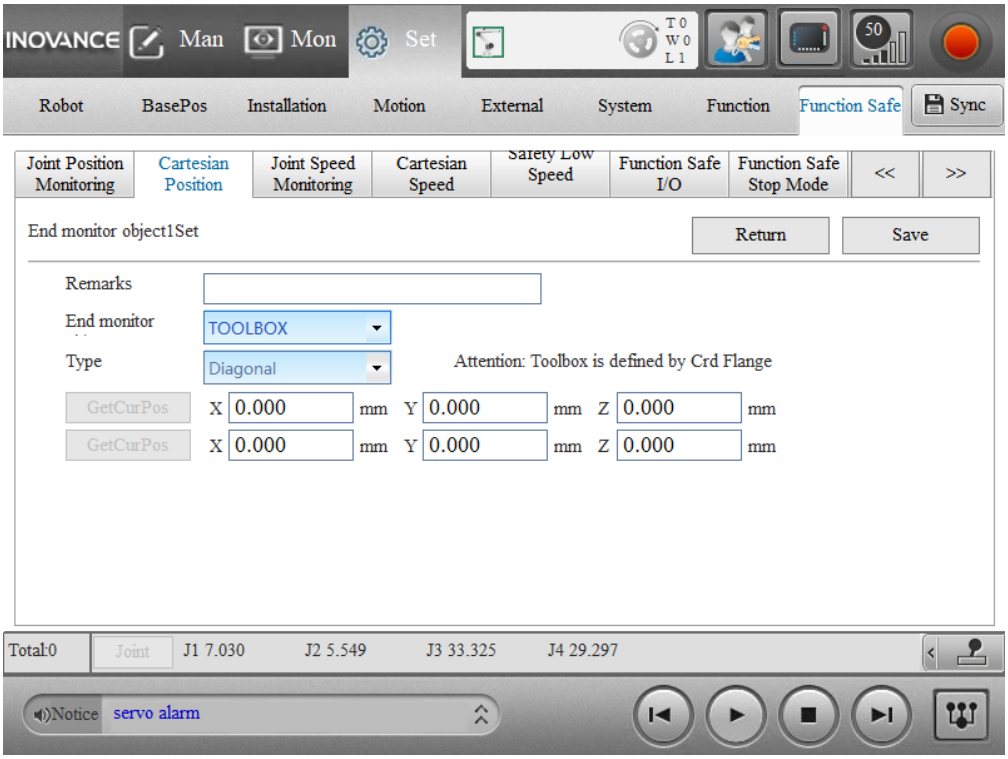
- Remarks: Descriptive information of the current monitoring object.
- Monitoring object type: Includes TCP, MTCP, sphere, and cuboid bounding box. TCP by default.
  - TCP: When the robot grips the tool, the current TCP is used for monitoring. When the robot grips the workobject, the flange center is used for monitoring.
  - MTCP: Supports up to four tools at the same time. You must select a reference point for the tool. The current TCP of the robot is not used for monitoring any more. You can view the parameters of the tool frame in the lower part of the software interface.



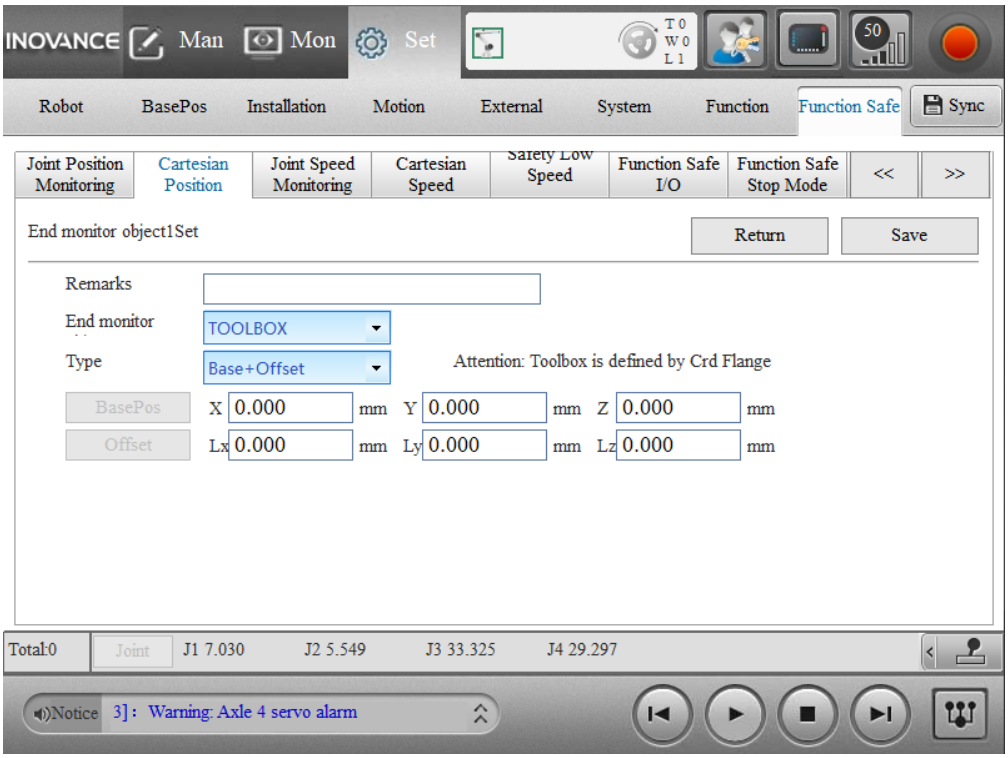
◦ BALL: The spherical center is offset from the Z direction of the flange frame, the spherical center range is [-10000, 10000] and the radius range is [0, 10000], in mm. The eccentric sphere is not supported.



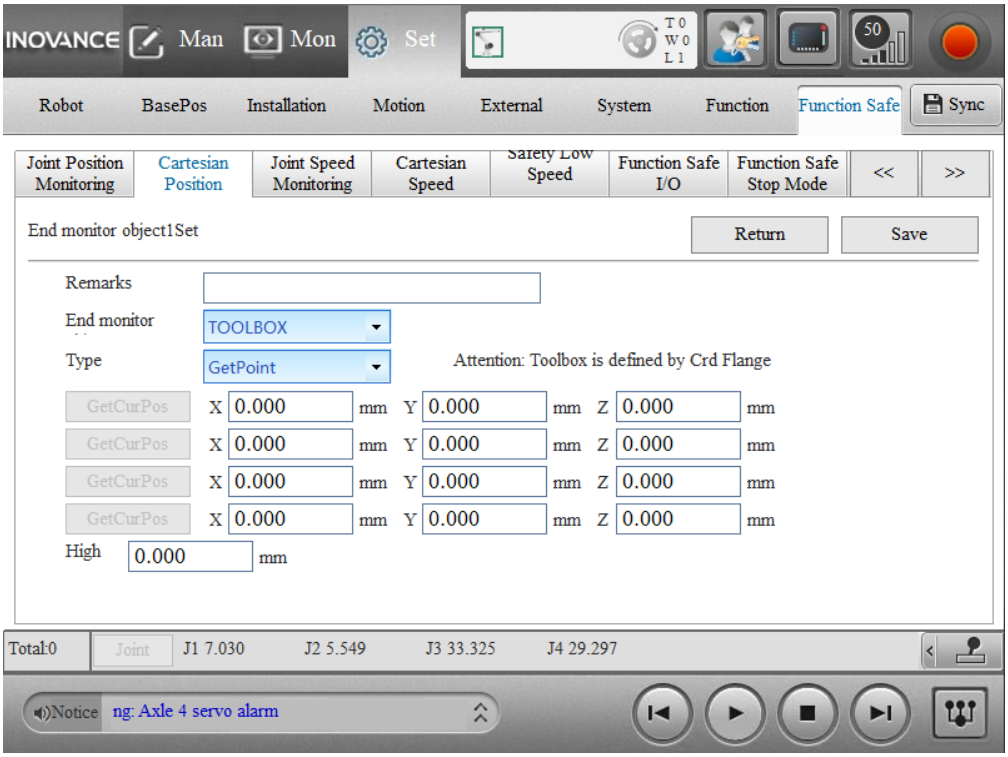
◦ TOOLBOX: There are three methods to acquire the points, namely, diagonal point, base point + offset, and get point.



When the point acquisition method is set to "Diagonal", you can enter the point manually or click the "GetCurPos" button to acquire the current point automatically. Note that the "GetCurPos" button is active only when the robot is in ECP mode. The points are taken in the flange frame. The range of the point value is [-10000, 10000], in mm.



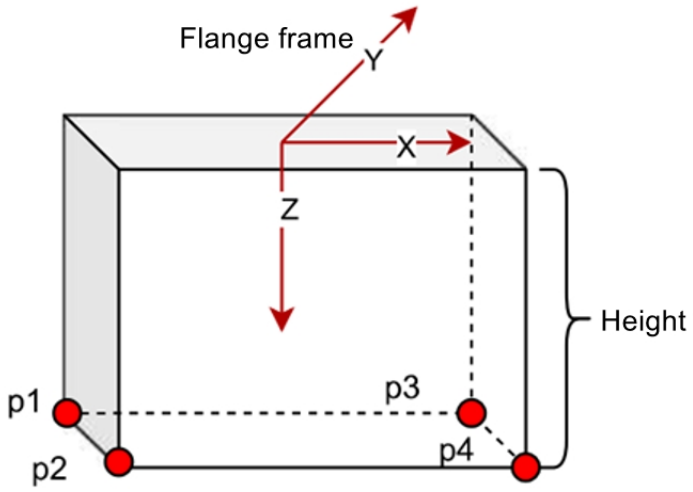
When the point acquisition method is set to "Base + offset", you can enter the datum point and the offset manually, or click the "BasePos" button to get the point automatically and then manually enter the offset. Note that the "BasePos" button is active only when the robot is in ECP mode. The point and offset are taken in the flange frame. The range of the point value is [-10000, 10000], and the range of the offset is [-10000, 0), (0, 10000], in mm.



When the point acquisition method is set to "GetPoint", you can enter the point manually, or click the "Get point" button to get the point automatically. Note that the "Get point" button is active only when the robot is in ECP mode. The points are taken in the flange frame.

Note that the points 1-4 are the four points on the bottom face of the cuboid. The height is the distance in the Z direction under the flange frame. The range of the point value is [-10000, 10000] and the range of height is [0, 10000], in mm.

The diagram is shown below:



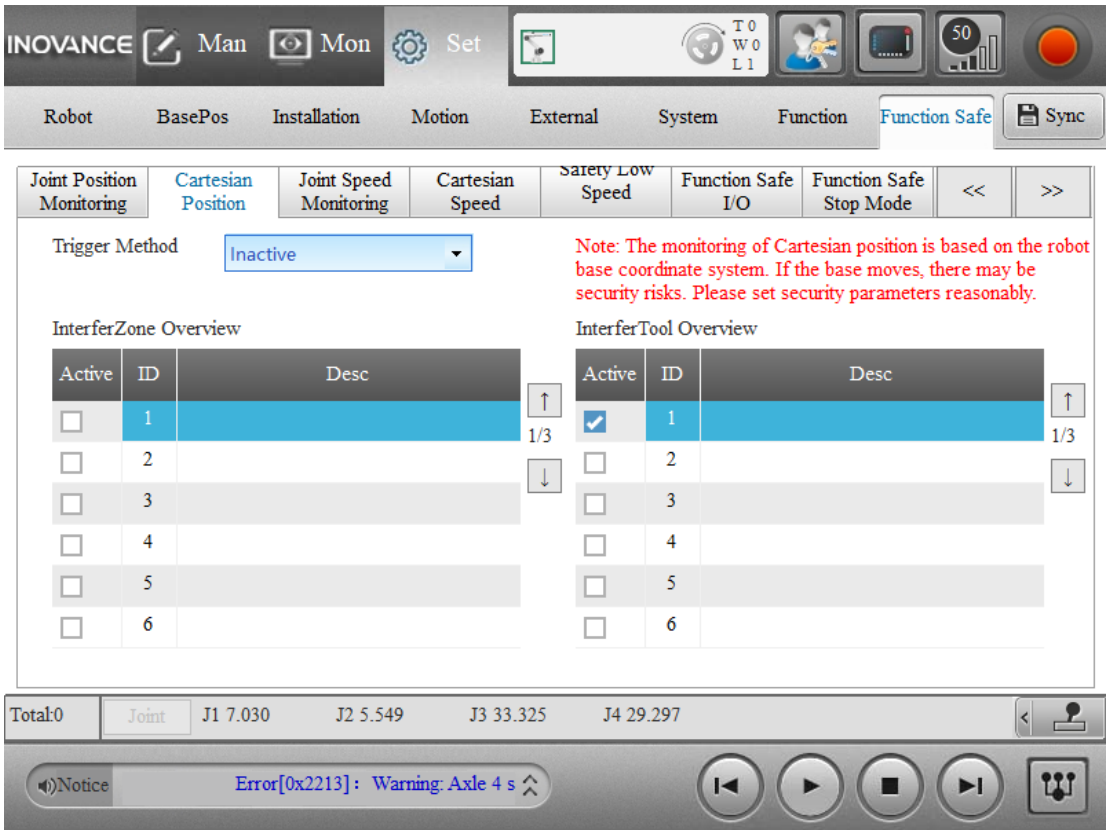
CAUTION

Notes of the cuboid bounding box:

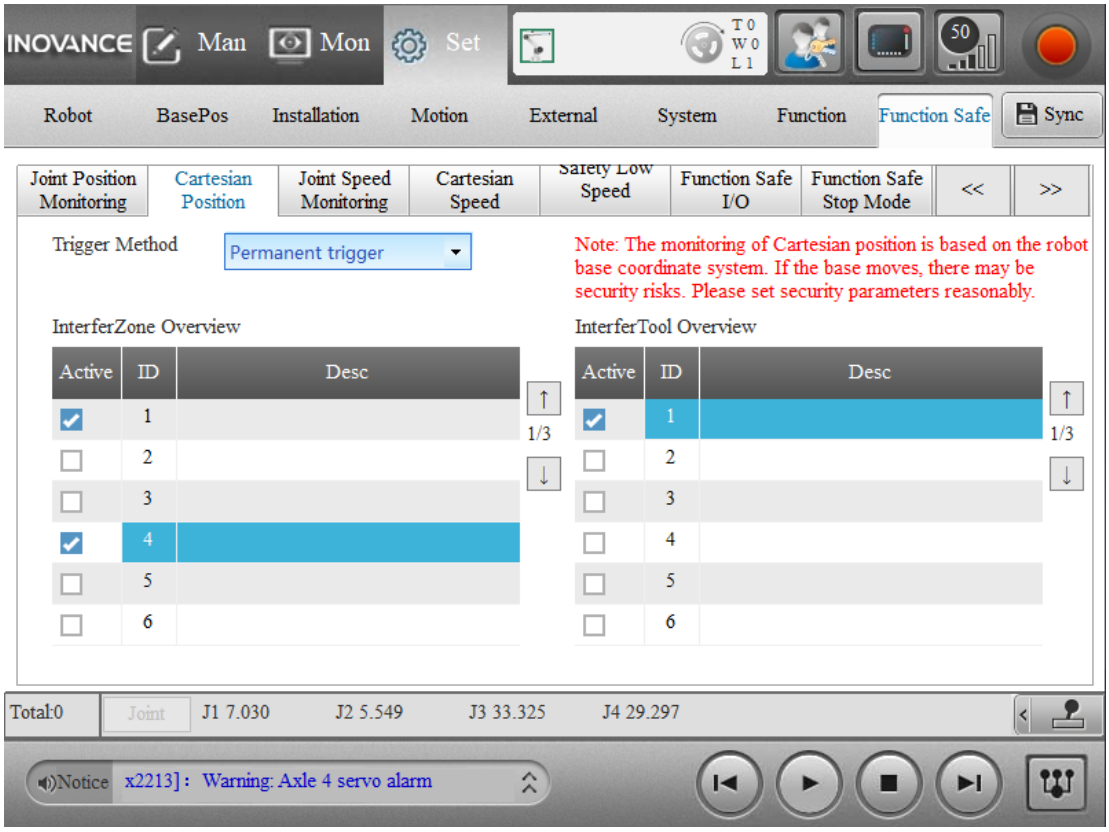
- The orientation of the cuboid bounding box is the same as that of the flange frame. That is, a tilted cuboid bounding box cannot be defined under the flange frame.
- Before getting a point, you must calibrate an external tool and then move the robot to the point on the external tool.
- Regarding the setting of the four points + height, for the 6-axis robots, you need to rotate the J5 axis so that the Z axis of the flange frame points downwards before setting the points and height; for the SCARA robots, just set the points and height normally.

6. Select an end monitoring object and double-click it to open the parameter setting interface.

7. After configuring the monitoring object, click the "Save" button.



8. Check the interference zone and monitoring object to be used.



After the parameters are configured and saved, the Cartesian position monitoring function takes effect immediately.

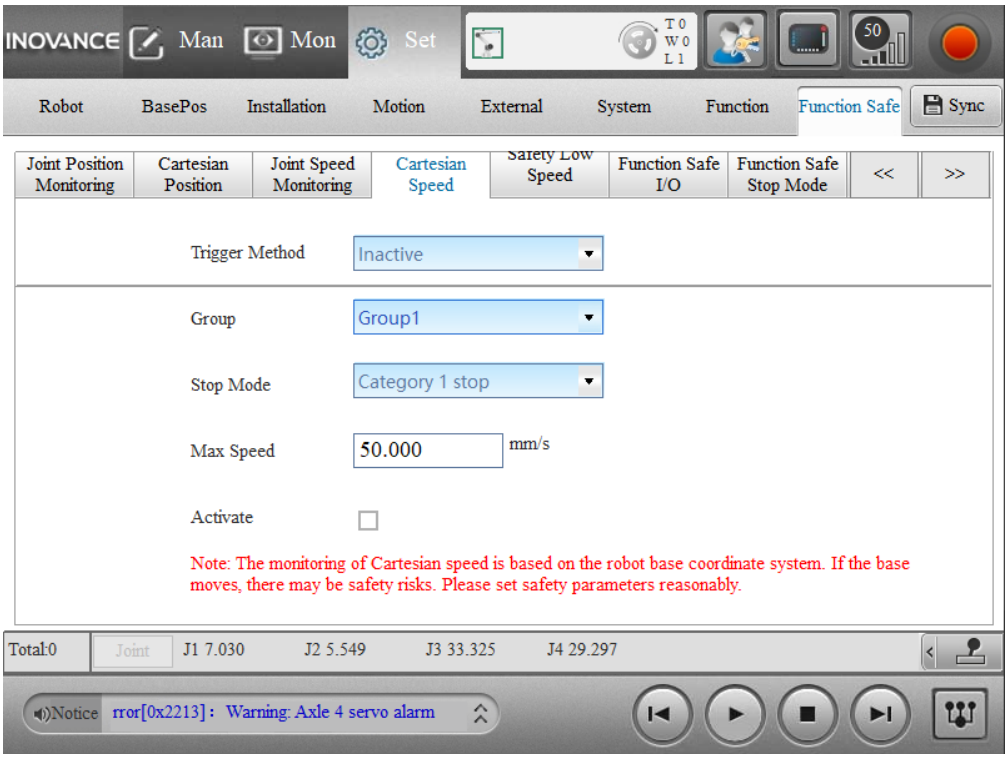
CAUTION

When using the position monitoring function, the following precautions/restrictions need to be taken:

- Once determined, the position of the interference zone under the world frame will not change even if the corresponding tool/workobject parameters are modified. If you need to modify the position of the interference zone, you need to modify the points of the interference zone and save the changes.
- After the monitoring object at the end of robot enters the interference zone, you need to disable the interference zone function to clear the alarm and continue motion.
- The larger the robot speed, the greater the distance the robot enters the interference zone. Therefore, you need to set the interference zone and safety distance as large as possible according to the actual working conditions.
- When the robot grips the workobject, if you set the monitoring object type to "TCP", the flange center is used for detection, which may result in collision between the workobject and external devices or obstacles. In this case, it is recommended to set the monitoring object type to sphere or cuboid bounding box.
- When the interference zone is activated, it is detected in any motion mode.
- When the cuboid bounding box is defined by the four points + height,for the 6-axis robots, you need to rotate the J5 axis so that the Z axis of the flange frame points downwards before setting the points and height. Otherwise, the cuboid cannot be formed properly.

5.4.10 Configuring Cartesian Speed Monitoring Parameters

You can configure the Cartesian speed monitoring parameters as needed, as shown in the figure below:



Name	Value range	Default	Description
Trigger Method	Inactive	Inactive	When "Inactive" is selected, the Cartesian speed monitoring function is deactivated and does not provide safety monitoring for the Cartesian speed of the robot.
	Permanent trigger		When "Permanent trigger" is selected, the Cartesian speed monitoring is permanently active and provides the real-time safety monitoring for the Cartesian speed of the robot.
	I/O trigger		When "I/O trigger" is selected, the Cartesian speed monitoring function is activated or deactivated based on the status of the bound I/O.
Cartesian speed safety range	0-10000 mm/s	0	You can set the safety ranges for the monitored robot Cartesian speed.
Stop mode	Category 0 stop	Category 0 stop	If any robot Cartesian speed exceeds the user-configured range, the function triggers a Category 0 or 1 emergency stop.
	Category 1 stop		
Activation	Deactivate	Deactivate	Indicates the activation of the current Cartesian speed. If not activated, this set of parameters will not be used for Cartesian speed monitoring.
	Activate		

CAUTION

The Cartesian speed monitoring supports up to eight groups of parameters.

After the parameters are configured and saved, the Cartesian speed monitoring function takes effect immediately.

5.5 Verification and Validation

NOTE

- The system must not be considered safe until all safety functions are validated.
- Validation tests must be performed for each safety function.

Basic Requirements

- Technical staff must be trained to understand the requirements and principles of designing and operating safety-related systems.
- Operation and maintenance personnel must be trained on the requirements and principles of designing and operating safety-related systems.
- Operators must be trained to understand the requirements and principles of designing and operating safety-related systems.
- If safety-related circuits on the control board do not function properly, replace the control board or the entire equipment.

PL level verification

Verification of the functional safety system demonstrates and ensures that the implemented safety system meets the requirements specified for the system in the safety requirements specification phase.

The most convenient way to verify the required PL level reached with the implemented system is to use a specific safety calculator software.

Validation test

IEC 61508, EN IEC 62061, and EN ISO 13849 standards require that the equipment be validated for acceptance of safety functions. The test program and report must be documented and signed by this person. Signed reports must be maintained in the device log. Any new validation tests that are performed due to changes or maintenance shall be recorded.

Validation test shall be carried out:

- At initial start-up of the safety function
- After any changes related to the safety function (wiring, components, settings, etc.)
- After any maintenance work related to safety functions are done.

Checklist

Follow the checklist below to perform the validation test.

Procedure	Test
1	Ensure that the robot can run and stop freely during the test.
2	Set the safety low speed monitoring function to be permanent trigger and the stop category to Category 0 or 1 stop. Run the robot program in manual mode and check that the robot operates normally.
3	Set the safety low speed monitoring function to be permanent trigger and the stop category to Category 0 or 1. Run the robot program in automatic mode and check that the robot operates normally.
4	1. Set the joint position monitoring function to be permanent trigger. Set the upper limit of each joint in Group 1 to 10°, lower limit to -10°, and the stop category to Category 1. Operate the robot joints to exceed the limit, and check that Category 1 stop is triggered. A Category 1 stop alarm occurs and the alarm cannot be cleared. 2. To clear the alarm, set the monitoring function to be inactive. Then you can clear the alarm and the robot restores normal operation. 3. Set the joint position monitoring function to be permanent trigger. Set the upper limit of each joint in Group 1 to 10°, lower limit to -10°, and the stop category to Category 0. Operate the robot joints to exceed the limit, and check that Category 0 stop is triggered. A Category 0 stop alarm occurs and the alarm cannot be cleared. 4. To clear the alarm, set the monitoring function to be inactive. Then you can clear the alarm and the robot restores normal operation.
5	1. Set the joint speed monitoring function to be permanent trigger. Set the limit of each joint in Group 1 to 10°/s, and the stop category to Category 1. Operate the robot joints to exceed the limit, and check that Category 1 stop is triggered. A Category 1 stop alarm occurs. You can clear the alarm and the robot restores normal operation. 2. Set the monitoring function to be inactive. Operate the robot joints to exceed the limit that Category 1 stop is triggered. No alarm occurs and the robot operates normally. 3. Set the joint position monitoring function to be permanent trigger. Set the limit of each joint in Group 1 to 10°/s, and the stop category to Category 0. Operate the robot joints to exceed the limit, and check that Category 0 stop is triggered. A Category 0 stop alarm occurs. You can clear the alarm and the robot restores normal operation. 4. Set the monitoring function to be inactive. Operate the robot joints to exceed the limit that Category 0 stop is triggered. No alarm occurs and the robot operates normally.

Procedure	Test
6	1. Set the Cartesian position monitoring function to be permanent trigger. Configure an interference zone and set the stop category to Category 1. Operate the robot to exceed the interference zone, and check that Category 1 stop is triggered. A Category 1 stop alarm occurs and the alarm cannot be cleared. 2. To clear the alarm, set the monitoring function to be inactive. Then you can clear the alarm and the robot restores normal operation. 3. Set the Cartesian position monitoring function to be permanent trigger. Configure an interference zone and set the stop category to Category 0. Operate the robot to exceed the interference zone, and check that Category 0 stop is triggered. A Category 0 stop alarm occurs and the alarm cannot be cleared. 4. To clear the alarm, set the monitoring function to be inactive. Then you can clear the alarm and the robot restores normal operation.
7	1. Set the Cartesian speed monitoring function to be permanent trigger. Configure a speed limit and set the stop category to Category 1. Operate the TCP speed to exceed the limit, and check that Category 1 stop is triggered. A Category 1 stop alarm occurs. You can clear the alarm and the robot restores normal operation. 2. Set the monitoring function to be inactive. Operate the TCP speed to exceed the limit that Category 1 stop is triggered. No alarm occurs and the robot operates normally. 3. Set the Cartesian speed monitoring function to be permanent trigger. Configure a speed limit and set the stop category to Category 0. Operate the TCP speed to exceed the limit, and check that Category 0 stop is triggered. A Category 0 stop alarm occurs. You can clear the alarm and the robot restores normal operation. 4. Set the monitoring function to be inactive. Operate the TCP speed to exceed the limit that Category 0 stop is triggered. No alarm occurs and the robot operates normally.

Test Report

The report shall contain the following:

- The description of the safety application (including a figure)
- The description and revisions of safety components that are used in the safety application
- A list of all safety functions that are used in the safety application
- A list of all safety related parameters and their values (the drive has no safety-related parameters, but listing the non-safety related parameter and its setting is recommended)
- The test results for each safety function, checks, date of the tests and signature by the test personnel

6 Inspection and Maintenance

6.1 Maintenance Precautions

Before maintenance, be sure to read this guide and other related guides carefully to fully understand the safety maintenance procedures.

Maintenance work on the robot system must be performed by personnel who have been properly trained and qualified in safety.

Safety-trained and qualified personnel refer to those who have completed and passed safety training that complies with the applicable national laws and regulations, and is intended for workers engaged in industrial robot-related tasks. This training typically covers knowledge of industrial robots, operation and teaching methods, inspection and maintenance procedures, and relevant safety regulations.



- Maintenance work must be performed by personnel who have been properly trained and qualified in safety. Before maintenance, be sure to read and understand the "Safety Precautions" in the guide. Operating without understanding the safety precautions may result in severe personal injury.
- Do not remove or work on any parts not covered in this guide. Follow the maintenance procedure strictly as described in this guide. Improper operation may not only cause improper function of the robot system but also serious safety problems.
- It is strictly prohibited to enter the robot's motion area while the power is ON. Even if the robot appears stationary, it may suddenly move and cause severe injury.
- Check the motion of the robot after components replacement outside the safety fence. Failure to comply may cause severe injury due to unexpected movement of the robot.
- Before operating the robot system, make sure that both the emergency stop switch and safeguard switch function properly. If the safety switches fail, protective functions will not activate in emergencies, which may result in severe injury.
- Only local control modes that have passed safety assessment are allowed. All other control modes and remote control access channels are prohibited.



- Open the cover of the controller only when maintenance is needed. High-voltage live parts are present inside the controller, and there is a risk of electric shock even when the power is off.
- Before performing maintenance, turn off the power to the controller and related equipment, and unplug the power plug. Failure to comply may result in electric shock or equipment malfunction.
- Do not install or remove the motor connector while the power is on. Failure to comply may cause abnormal action of the robot and serious danger.
- Ensure the power is locked by unplugging the power plug. Always connect the AC power cable to the power plug. Do not connect it directly to the factory power supply.
- For tasks such as inspection and maintenance that must be performed with the power on, two persons are required to work together. One person must be positioned where the emergency stop button can be pressed at any time. The other person must work within the robot's motion range, remain highly alert, and complete the work quickly. The safe evacuation path must be confirmed in advance before starting the work.
- Maintenance personnel must keep the robot key properly. Unauthorized personnel are strictly prohibited from accessing the robot software system in manual mode, and from viewing or modifying programs and parameters.



If the robot has been stored for more than six months without use, a gradual power-up is required before re-energizing to reactivate the electrolytic capacitors. Otherwise, there is a risk of equipment damage.

6.2 Routine Inspection

The ambient temperature, humidity, dust, and vibration will age the equipment and thereby reduces its service life. Therefore, it is necessary to carry out routine and regular maintenance. More frequent inspections are required if the drive is used in environments subject to the following conditions:

■ High ambient temperature

■ Frequent start/stop

■ AC power supply or load fluctuation

■ Strong vibration or impact

■ Dust and hydrochloric acid

Check the following items daily to ensure a proper operation of the device. It is recommended to make a copy of this checklist and sign the "Checked" column after each inspection.

Inspection item	Content	Solution	Checked
Installation environment	Check that the controller and cables are normal.	Check the mounting bracket for vibration. Check whether terminals become loose or get corroded.	□
Input voltage	Input power supply voltage	Check that the input voltage is within the permissible range. Check whether a heavy load is being started around the equipment.	□
No.	Controller connection terminals	Check that the screws on both sides of the input, output, and SAFETY terminals are tight.	□

6.3 Regular Inspection

Regularly inspect the areas that are difficult to check during operation. Always keep the controller clean. Effectively remove dust, especially metal dust, from the product surface to prevent it from entering the product.

Inspection item	Content	Solution	1-Month inspection
Cable	Check power cables and connections for discoloration. Check whether the insulation layer is aged or cracked.	Replace the cracked cable. Replace the damaged terminals.	□
Air duct	Check whether the air duct and heatsink are blocked. Check whether the fan is damaged.	Clean the air duct. Replace the damaged fan.	□

6.4 File Backup and Recovery

The robot system provides file backup and loading functions. The file includes configuration files and program files, both of which are backed up and loaded through a USB drive (recommended to use branded USB drives).

Configuration file backup and loading

- Configuration file backup

Function:

It allows you to save all robot-related parameters into a file and store the file in local disk.

Procedure:

1. Click the "Configuration file backup" button, select the save path and enter the file name.
2. After the backup is complete, you can find the backup file in the specified path.

> NOTE
>
> The backup file is named "robotcfg.cfg.bk" by default and covers the following:
>
> 1. PLC program [plcfiles]
> 2. Network configuration, operation logs [systemConf]
> 3. Robot model and controller model information [initConf]
> 4. Robot settings, peripheral configuration, motion parameters, zero point settings, etc. in controller parameter configuration [RobotParams, RobotParamsDefault]
> 5. Process data files (vision calibration and conveyor tracking process)
> 6. Mechanical unit configuration parameters
> 7. Tool, work object, and load parameters
> 8. BRD variables

- Configuration file loading

You can load the configuration from the USB drive into the memory card of the robot controller. Do as follows:

1. Insert the USB drive into the controller and check the USB connection status in the monitoring interface. Keep the USB drive in good communication during operation.
2. Click the load button and confirm. The system loads the file automatically and exits when the loading is complete. After this, restart the controller.

> CAUTION
>
> Do not load configuration files of different robot models to avoid calibration parameter errors, which may affect robot positioning accuracy.

Program backup and loading

The program backup function allows you to back up the control program in the memory card of the controller into a USB drive, while the program loading functions allows you to load the control program from

the USB drive into the controller. The backup and loading directories for version 14 and earlier are different from those for version 15 and later, as shown in the table below:

Type	Version 14 and Earlier	Version 15 and Later
Program backup	1. TeachProgram 2. PalletInfo	1. TeachProgram 2. PalletInfo 3. TecParameter
Program loading	1. TeachProgram 2. PalletInfo	1. TeachProgram 2. PalletInfo 3. TecParameter

The functions of each folder are as follows:

TeachProgram: Program file folder containing all .pro program files

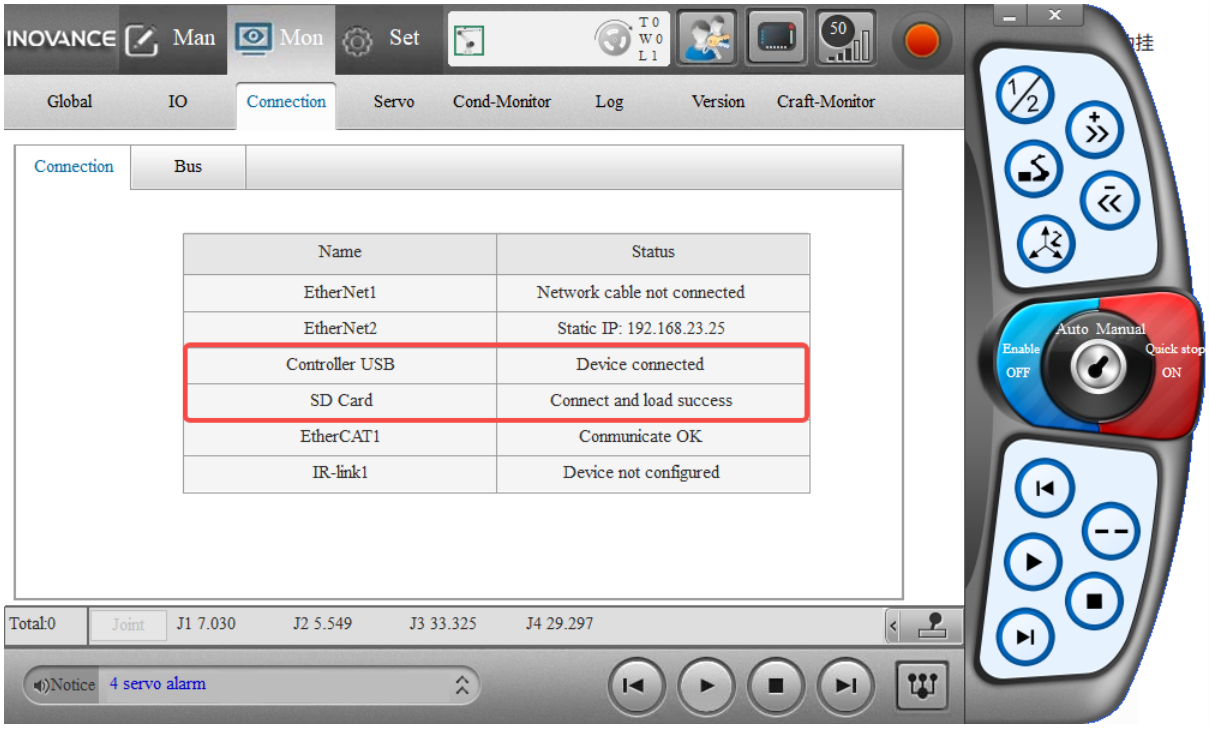
PalletInfo: Pallet file folder containing information about the stacking and pallet. It needs to be used when pallet variables are used.

TecParameter: Process folder containing information about the screw driving and dispensing processes. It needs to be used when the screw driving, dispensing processes are used.

- Program backup

The program backup procedure is as follows:

1. Insert the USB drive into the controller and check connection status between the USB drive and the memory card. If the monitored communication status in the software displays "The USB controller has been inserted into the device and successfully mounted" and "The memory card has been inserted and successfully mounted", it indicates that the communication is normal. Otherwise, check the connection. Keep the memory card and the USB drive in good communication during operation.



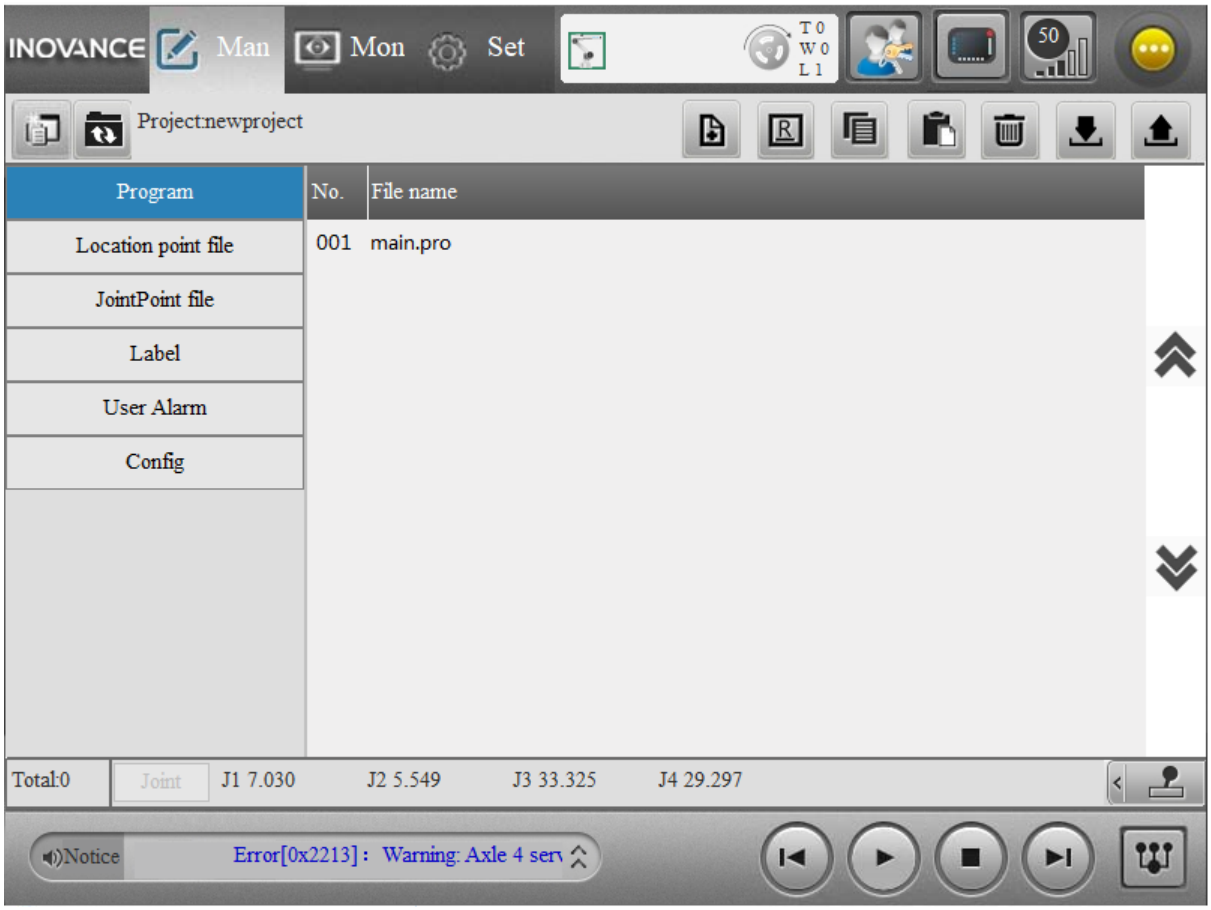
2. Click the backup button and confirm. The system backs up the program automatically and exits when the loading is complete.

3. After the backup is complete, several new folders will appear in the root directory of the USB drive.

- Program loading

The program loading procedure is as follows:

1. Insert the USB drive into the controller and check connection status between the USB drive and the memory card. If the monitored communication status in the software displays "The USB controller has been inserted into the device and successfully mounted" and "The memory card has been inserted and successfully mounted", it indicates that the communication is normal. Otherwise, check the connection. Keep the memory card and the USB drive in good communication during operation.
2. Click the load button and confirm. The system loads the program automatically.
3. Go to the programming interface and click the refresh button in the upper-left corner. The loaded program appears in the program list.



7 Safety Function Troubleshooting

CAUTION

Faults and warnings of safety functions are classified according to severity. They can be classified into three categories:

- Category 1 (or No.1) Non-resettable fault
- Category 2 (or No.2) Resettable fault
- Category 3 (or No.3) Resettable warning

For troubleshooting of faults related to safety functions, see the table below.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9016	J1 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 1 speed limit	Clear the alarm.
0x9017	J2 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 1 speed limit	Clear the alarm.
0x9018	J3 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 1 speed limit	Clear the alarm.
0x9019	J4 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 1 speed limit	Clear the alarm.
0x901A	J5 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 1 speed limit	Clear the alarm.
0x901B	J6 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 1 speed limit	Clear the alarm.
0x901C	J1 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 2 speed limit	Clear the alarm.
0x901D	J2 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 2 speed limit	Clear the alarm.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x901E	J3 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 2 speed limit	Clear the alarm.
0x901F	J4 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 2 speed limit	Clear the alarm.
0x9020	J5 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 2 speed limit	Clear the alarm.
0x9021	J6 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 2 speed limit	Clear the alarm.
0x9022	J1 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 3 speed limit	Clear the alarm.
0x9023	J2 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 3 speed limit	Clear the alarm.
0x9024	J3 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 3 speed limit	Clear the alarm.
0x9025	J4 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 3 speed limit	Clear the alarm.
0x9026	J5 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 3 speed limit	Clear the alarm.
0x9027	J6 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 3 speed limit	Clear the alarm.
0x9028	J1 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 4 speed limit	Clear the alarm.
0x9029	J2 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 4 speed limit	Clear the alarm.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x902A	J3 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 4 speed limit	Clear the alarm.
0x902B	J4 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 4 speed limit	Clear the alarm.
0x902C	J5 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 4 speed limit	Clear the alarm.
0x902D	J6 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 4 speed limit	Clear the alarm.
0x902E	J1 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 5 speed limit	Clear the alarm.
0x902F	J2 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 5 speed limit	Clear the alarm.
0x9030	J3 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 5 speed limit	Clear the alarm.
0x9031	J4 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 5 speed limit	Clear the alarm.
0x9032	J5 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 5 speed limit	Clear the alarm.
0x9033	J6 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 5 speed limit	Clear the alarm.
0x9034	J1 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 6 speed limit	Clear the alarm.
0x9035	J2 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 6 speed limit	Clear the alarm.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9036	J3 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 6 speed limit	Clear the alarm.
0x9037	J4 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 6 speed limit	Clear the alarm.
0x9038	J5 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 6 speed limit	Clear the alarm.
0x9039	J6 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 6 speed limit	Clear the alarm.
0x903A	J1 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 7 speed limit	Clear the alarm.
0x903B	J2 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 7 speed limit	Clear the alarm.
0x903C	J3 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 7 speed limit	Clear the alarm.
0x903D	J4 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 7 speed limit	Clear the alarm.
0x903E	J5 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 7 speed limit	Clear the alarm.
0x903F	J6 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 7 speed limit	Clear the alarm.
0x9040	J1 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 8 speed limit	Clear the alarm.
0x9041	J2 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 8 speed limit	Clear the alarm.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9042	J3 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 8 speed limit	Clear the alarm.
0x9043	J4 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 8 speed limit	Clear the alarm.
0x9044	J5 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 8 speed limit	Clear the alarm.
0x9045	J6 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 8 speed limit	Clear the alarm.
0x9046	J1 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 1 position limit	Disable the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.
0x9047	J2 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 1 position limit	Disable the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.
0x9048	J3 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 1 position limit	Disable the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9049	J4 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 1 position limit	Disable the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.
0x904A	J5 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 1 position limit	Disable the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.
0x904B	J6 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 1 position limit	Disable the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.
0x904C	J1 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 2 position limit	Disable the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x904D	J2 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 2 position limit	Disable the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.
0x904E	J3 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 2 position limit	Disable the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.
0x904F	J4 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 2 position limit	Disable the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.
0x9050	J5 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 2 position limit	Disable the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9051	J6 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 2 position limit	Disable the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.
0x9052	J1 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 3 position limit	Disable the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.
0x9053	J2 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 3 position limit	Disable the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.
0x9054	J3 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 3 position limit	Disable the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9055	J4 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 3 position limit	Disable the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.
0x9056	J5 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 3 position limit	Disable the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.
0x9057	J6 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 3 position limit	Disable the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.
0x9058	J1 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 4 position limit	Disable the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9059	J2 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 4 position limit	Disable the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.
0x905A	J3 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 4 position limit	Disable the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.
0x905B	J4 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 4 position limit	Disable the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.
0x905C	J5 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 4 position limit	Disable the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x905D	J6 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 4 position limit	Disable the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.
0x905E	J1 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 5 position limit	Disable the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.
0x905F	J2 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 5 position limit	Disable the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.
0x9060	J3 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 5 position limit	Disable the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9061	J4 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 5 position limit	Disable the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.
0x9062	J5 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 5 position limit	Disable the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.
0x9063	J6 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 5 position limit	Disable the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.
0x9064	J1 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 6 position limit	Disable the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9065	J2 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 6 position limit	Disable the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.
0x9066	J3 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 6 position limit	Disable the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.
0x9067	J4 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 6 position limit	Disable the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.
0x9068	J5 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 6 position limit	Disable the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9069	J6 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 6 position limit	Disable the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.
0x906A	J1 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 7 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x906B	J2 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 7 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x906C	J3 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 7 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x906D	J4 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 7 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x906E	J5 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 7 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x906F	J6 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 7 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x9070	J1 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 8 position limit	Disable the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9071	J2 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 8 position limit	Disable the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.
0x9072	J3 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 8 position limit	Disable the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x9073	J4 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 8 position limit	Disable the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.
0x9074	J5 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 8 position limit	Disable the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9075	J6 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 8 position limit	Disable the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.
0x9077	Overspeed in manual mode	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot in manual mode exceeds 250 mm/s.	Clear the alarm.
0x9078	Cartesian speed exceeds Group 1 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 1 limit.	Clear the alarm.
0x9079	Cartesian speed exceeds Group 2 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 2 limit.	Clear the alarm.
0x907A	Cartesian speed exceeds Group 3 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 3 limit.	Clear the alarm.
0x907B	Cartesian speed exceeds Group 4 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 4 limit.	Clear the alarm.
0x907C	Cartesian speed exceeds Group 5 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 5 limit.	Clear the alarm.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x907D	Cartesian speed exceeds Group 6 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 6 limit.	Clear the alarm.
0x907E	Cartesian speed exceeds Group 7 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 7 limit.	Clear the alarm.
0x907F	Cartesian speed exceeds Group 8 limit	No.2 Resettable fault	Reset manually	The Cartesian speed of the robot exceeds the Group 8 limit.	Clear the alarm.
0x9080	Robot enters interference zone 1	No.2 Resettable fault	Reset manually	The robot enters the interference zone 1.	Disable the Cartesian position monitoring function or deactivate the interference zone 1.
0x9081	Robot enters interference zone 2	No.2 Resettable fault	Reset manually	The robot enters the interference zone 2.	Disable the Cartesian position monitoring function or deactivate the interference zone 2.
0x9082	Robot entered interference zone 3	No.2 Resettable fault	Reset manually	The robot enters the interference zone 3.	Disable the Cartesian position monitoring function or deactivate the interference zone 3.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9083	Robot entered interference zone 4	No.2 Resettable fault	Reset manually	The robot enters the interference zone 4.	Disable the Cartesian position monitoring function or deactivate the interference zone 4.
0x9084	Robot entered interference zone 5	No.2 Resettable fault	Reset manually	The robot enters the interference zone 5.	Disable the Cartesian position monitoring function or deactivate the interference zone 5.
0x9085	Robot entered interference zone 6	No.2 Resettable fault	Reset manually	The robot enters the interference zone 6.	Disable the Cartesian position monitoring function or deactivate the interference zone 6.
0x9086	Robot entered interference zone 7	No.2 Resettable fault	Reset manually	The robot enters the interference zone 7.	Disable the Cartesian position monitoring function or deactivate the interference zone 7.
0x9087	Robot entered interference zone 8	No.2 Resettable fault	Reset manually	The robot enters the interference zone 8.	Disable the Cartesian position monitoring function or deactivate the interference zone 8.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9088	Robot entered interference zone 9	No.2 Resettable fault	Reset manually	The robot enters the interference zone 9.	Disable the Cartesian position monitoring function or deactivate the interference zone 9.
0x9089	Robot entered interference zone 10	No.2 Resettable fault	Reset manually	The robot enters the interference zone 10.	Disable the Cartesian position monitoring function or deactivate the interference zone 10.
0x908A	Robot entered interference zone 11	No.2 Resettable fault	Reset manually	The robot enters the interference zone 11.	Disable the Cartesian position monitoring function or deactivate the interference zone 11.
0x908B	Robot entered interference zone 12	No.2 Resettable fault	Reset manually	The robot enters the interference zone 12.	Disable the Cartesian position monitoring function or deactivate the interference zone 12.
0x908C	Robot entered interference zone 13	No.2 Resettable fault	Reset manually	The robot enters the interference zone 13.	Disable the Cartesian position monitoring function or deactivate the interference zone 13.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x908D	Robot entered interference zone 14	No.2 Resettable fault	Reset manually	The robot enters the interference zone 14.	Disable the Cartesian position monitoring function or deactivate the interference zone 14.
0x908E	Robot entered interference zone 15	No.2 Resettable fault	Reset manually	The robot enters the interference zone 15.	Disable the Cartesian position monitoring function or deactivate the interference zone 15.
0x908F	Robot entered interference zone 16	No.2 Resettable fault	Reset manually	The robot enters the interference zone 16.	Disable the Cartesian position monitoring function or deactivate the interference zone 16.
0x909C	Category 1 emergency stop time too long	No.2 Resettable fault	Reset manually	The Category 1 emergency stop exceeds the limit.	• Set the delay for Category 1 emergency stop to a larger value • Contact the manufacturer.
0x909D	STO stop time too long	No.2 Resettable fault	Reset manually	The STO stop time exceeds the limit.	• Set the delay for Category 0 emergency stop to a larger value • Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x909E	J1 CRC failed for master chip data frame	No.1 Non-resettable fault	Reset impossible	J1 CRC failed for master chip data frame	Contact the manufacturer.
0x909F	J2 CRC failed for master chip data frame	No.1 Non-resettable fault	Reset impossible	J2 CRC failed for master chip data frame	Contact the manufacturer.
0x90A0	J3 CRC failed for master chip data frame	No.1 Non-resettable fault	Reset impossible	J3 CRC failed for master chip data frame	Contact the manufacturer.
0x90A1	J4 CRC failed for master chip data frame	No.1 Non-resettable fault	Reset impossible	J4 CRC failed for master chip data frame	Contact the manufacturer.
0x90A2	J5 CRC failed for master chip data frame	No.1 Non-resettable fault	Reset impossible	J5 CRC failed for master chip data frame	Contact the manufacturer.
0x90A3	J6 CRC failed for master chip data frame	No.1 Non-resettable fault	Reset impossible	J6 CRC failed for master chip data frame	Contact the manufacturer.
0x90AA	J1 CRC failed for slave chip data frame	No.1 Non-resettable fault	Reset impossible	J1 CRC failed for slave chip data frame	Contact the manufacturer.
0x90AB	J2 CRC failed for slave chip data frame	No.1 Non-resettable fault	Reset impossible	J2 CRC failed for slave chip data frame	Contact the manufacturer.
0x90AC	J3 CRC failed for slave chip data frame	No.1 Non-resettable fault	Reset impossible	J3 CRC failed for slave chip data frame	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x90AD	J4 CRC failed for slave chip data frame	No.1 Non-resettable fault	Reset impossible	J4 CRC failed for slave chip data frame	Contact the manufacturer.
0x90AE	J5 CRC failed for slave chip data frame	No.1 Non-resettable fault	Reset impossible	J5 CRC failed for slave chip data frame	Contact the manufacturer.
0x90AF	J6 CRC failed for slave chip data frame	No.1 Non-resettable fault	Reset impossible	J6 CRC failed for slave chip data frame	Contact the manufacturer.
0x90B6	J1 SN code fluctuates in master chip data frame	No.1 Non-resettable fault	Reset impossible	J1 SN code fluctuates in master chip data frame	Contact the manufacturer.
0x90B7	J2 SN code fluctuates in master chip data frame	No.1 Non-resettable fault	Reset impossible	J2 SN code fluctuates in master chip data frame	Contact the manufacturer.
0x90B8	J3 SN code fluctuates in master chip data frame	No.1 Non-resettable fault	Reset impossible	J3 SN code fluctuates in master chip data frame	Contact the manufacturer.
0x90B9	J4 SN code fluctuates in master chip data frame	No.1 Non-resettable fault	Reset impossible	J4 SN code fluctuates in master chip data frame	Contact the manufacturer.
0x90BA	J5 SN code fluctuates in master chip data frame	No.1 Non-resettable fault	Reset impossible	J5 SN code fluctuates in master chip data frame	Contact the manufacturer.
0x90BB	J6 SN code fluctuates in master chip data frame	No.1 Non-resettable fault	Reset impossible	J6 SN code fluctuates in master chip data frame	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x90C2	J1 SN code fluctuates in slave chip data frame	No.1 Non-resettable fault	Reset impossible	J1 SN code fluctuates in slave chip data frame	Contact the manufacturer.
0x90C3	J2 SN code fluctuates in slave chip data frame	No.1 Non-resettable fault	Reset impossible	J2 SN code fluctuates in slave chip data frame	Contact the manufacturer.
0x90C4	J3 SN code fluctuates in slave chip data frame	No.1 Non-resettable fault	Reset impossible	J3 SN code fluctuates in slave chip data frame	Contact the manufacturer.
0x90C5	J4 SN code fluctuates in slave chip data frame	No.1 Non-resettable fault	Reset impossible	J4 SN code fluctuates in slave chip data frame	Contact the manufacturer.
0x90C6	J5 SN code fluctuates in slave chip data frame	No.1 Non-resettable fault	Reset impossible	J5 SN code fluctuates in slave chip data frame	Contact the manufacturer.
0x90C7	J6 SN code fluctuates in slave chip data frame	No.1 Non-resettable fault	Reset impossible	J6 SN code fluctuates in slave chip data frame	Contact the manufacturer.
0x90CE	J1 multi-turn value in master chip overflows	No.1 Non-resettable fault	Reset impossible	J1 multi-turn value in master chip overflows	Contact the manufacturer.
0x90CF	J2 multi-turn value in master chip overflows	No.1 Non-resettable fault	Reset impossible	J2 multi-turn value in master chip overflows	Contact the manufacturer.
0x90D0	J3 multi-turn value in master chip overflows	No.1 Non-resettable fault	Reset impossible	J3 multi-turn value in master chip overflows	Contact the manufacturer.
0x90D1	J4 multi-turn value in master chip overflows	No.1 Non-resettable fault	Reset impossible	J4 multi-turn value in master chip overflows	Contact the manufacturer.
0x90D2	J5 multi-turn value in master chip overflows	No.1 Non-resettable fault	Reset impossible	J5 multi-turn value in master chip overflows	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x90D3	J6 multi-turn value in master chip overflows	No.1 Non-resettable fault	Reset impossible	J6 multi-turn value in master chip overflows	Contact the manufacturer.
0x90DA	J1 multi-turn value in slave chip overflows	No.1 Non-resettable fault	Reset impossible	J1 multi-turn value in slave chip overflows	Contact the manufacturer.
0x90DB	J2 multi-turn value in slave chip overflows	No.1 Non-resettable fault	Reset impossible	J2 multi-turn value in slave chip overflows	Contact the manufacturer.
0x90DC	J3 multi-turn value in slave chip overflows	No.1 Non-resettable fault	Reset impossible	J3 multi-turn value in slave chip overflows	Contact the manufacturer.
0x90DD	J4 multi-turn value in slave chip overflows	No.1 Non-resettable fault	Reset impossible	J4 multi-turn value in slave chip overflows	Contact the manufacturer.
0x90DE	J5 multi-turn value in slave chip overflows	No.1 Non-resettable fault	Reset impossible	J5 multi-turn value in slave chip overflows	Contact the manufacturer.
0x90DF	J6 multi-turn value in slave chip overflows	No.1 Non-resettable fault	Reset impossible	J6 multi-turn value in slave chip overflows	Contact the manufacturer.
0x90E6	Joint position state abnormal	No.1 Non-resettable fault	Reset impossible	The joint position state is checked inconsistent between master and slave chips.	Contact the manufacturer.
0x90E7	Joint speed state abnormal	No.1 Non-resettable fault	Reset impossible	The joint speed state is checked inconsistent between master and slave chips.	Contact the manufacturer.
0x90E8	Cartesian speed status abnormal	No.1 Non-resettable fault	Reset impossible	The Cartesian speed status is checked inconsistent between master and slave chips.	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x90E9	Low-speed safety function state abnormal	No.1 Non-resettable fault	Reset impossible	The low-speed state is checked inconsistent between master and slave chips.	Contact the manufacturer.
0x90EA	Cartesian position monitoring function status abnormal	No.1 Non-resettable fault	Reset impossible	The Cartesian position status is checked inconsistent between master and slave chips.	Contact the manufacturer.
0x90EB	Category 1 emergency stop state abnormal	No.1 Non-resettable fault	Reset impossible	The emergency stop state is checked inconsistent between master and slave chips.	Contact the manufacturer.
0x90EC	Running state abnormal	No.1 Non-resettable fault	Reset impossible	The running state is checked inconsistent between master and slave chips.	Contact the manufacturer.
0x90ED	System initialization failed	No.1 Non-resettable fault	Reset impossible	System initialization failed	Contact the manufacturer.
0x90EE	Abnormal J1 in master chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J1 in master chip data frame	Contact the manufacturer.
0x90EF	Abnormal J2 in master chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J2 in master chip data frame	Contact the manufacturer.
0x90F0	Abnormal J3 in master chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J3 in master chip data frame	Contact the manufacturer.
0x90F1	Abnormal J4 in master chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J4 in master chip data frame	Contact the manufacturer.
0x90F2	Abnormal J5 in master chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J5 in master chip data frame	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x90F3	Abnormal J6 in master chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J6 in master chip data frame	Contact the manufacturer.
0x90F4	Abnormal J1 in slave chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J1 in slave chip data frame	Contact the manufacturer.
0x90F5	Abnormal J2 in slave chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J2 in slave chip data frame	Contact the manufacturer.
0x90F6	Abnormal J3 in slave chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J3 in slave chip data frame	Contact the manufacturer.
0x90F7	Abnormal J4 in slave chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J4 in slave chip data frame	Contact the manufacturer.
0x90F8	Abnormal J5 in slave chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J5 in slave chip data frame	Contact the manufacturer.
0x90F9	Abnormal J6 in slave chip data frame	No.1 Non-resettable fault	Reset impossible	Abnormal J6 in slave chip data frame	Contact the manufacturer.
0x9106	Master chip triggers Category 0 stop	No.2 Resettable fault	Reset manually	Master chip triggers Category 0 stop	Clear the alarm.
0x9107	Slave chip triggers Category 0 stop	No.2 Resettable fault	Reset manually	Slave chip triggers Category 0 stop	Clear the alarm.
0x20FD	MCU configuration information check error	No.1 Non-resettable fault	Reset impossible	MCU configuration information check error	Contact the manufacturer.
0x9301	MCUA failed to read EEPROM	No.1 Non-resettable fault	Reset impossible	Communication error between chip and EEPROM	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9302	MCUB failed to read EEPROM	No.1 Non-resettable fault	Reset impossible	Communication error between chip and EEPROM	Contact the manufacturer.
0x9303	MCUA failed to write EEPROM	No.1 Non-resettable fault	Reset impossible	Communication error between chip and EEPROM	Contact the manufacturer.
0x9304	MCUB failed to write EEPROM	No.1 Non-resettable fault	Reset impossible	Communication error between chip and EEPROM	Contact the manufacturer.
0x9305	MCUA has a DMA transmission error	No.1 Non-resettable fault	Reset impossible	Communication error between chip and EEPROM	Contact the manufacturer.
0x9306	MCUB has a DMA transmission error	No.1 Non-resettable fault	Reset impossible	Communication error between chip and EEPROM	Contact the manufacturer.
0x9307	MCUB discharge voltage collection failed	No.1 Non-resettable fault	Reset impossible	Discharge voltage abnormal	Contact the manufacturer.
0x9308	MCUA 3.3 V abnormal	No.2 Resettable fault	Reset manually	The power supply voltage of the safety controller is abnormal.	Check the power supply voltage.
0x9309	MCUB 3.3 V abnormal	No.2 Resettable fault	Reset manually	The power supply voltage of the safety controller is abnormal.	Check the power supply voltage.
0x930A	MCUA board voltage abnormal	No.2 Resettable fault	Reset manually	The board voltage of safety controller is abnormal.	Check the power supply voltage.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x930B	MCUAB board voltage abnormal	No.2 Resettable fault	Reset manually	The board voltage of safety controller is abnormal.	Check the power supply voltage.
0x930C	CRC check failed during MCUA initialization	No.1 Non-resettable fault	Reset impossible	EEPROM parameter in MCUA is abnormal.	Contact the manufacturer.
0x930D	CRC check failed during MCUB initialization	No.1 Non-resettable fault	Reset impossible	EEPROM parameter in MCUB is abnormal.	Contact the manufacturer.
0x930E	CRC check failed during MCUA mutual check	No.1 Non-resettable fault	Reset impossible	EEPROM parameter in MCUA is abnormal.	Contact the manufacturer.
0x930F	CRC check failed during MCUB mutual check	No.1 Non-resettable fault	Reset impossible	EEPROM parameter in MCUB is abnormal.	Contact the manufacturer.
0x9310	MCUA chip self-test failed	No.1 Non-resettable fault	Reset impossible	The chip is damaged.	Contact the manufacturer.
0x9311	MCUB chip self-test failed	No.1 Non-resettable fault	Reset impossible	The chip is damaged.	Contact the manufacturer.
0x9312	MCUA failed to parse mailbox data of the host controller	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x9313	MCUA failed to process mailbox data of the host controller	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x9314	MCUA failed to parse MCUB mailbox data	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x9315	MCUA failed to process MCUB mailbox data	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9316	MCUB failed to parse MCUA mailbox data	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x9317	MCUB failed to process MCUA mailbox data	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x9318	MCUA detects disconnection from MCUB	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x9319	MCUA detects disconnection from FPGA	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x931A	MCUA failed to compare DIs	No.2 Resettable fault	Reset manually	DI abnormal	Check the DI
0x931B	MCUB failed to compare DIs	No.2 Resettable fault	Reset manually	DI abnormal	Check the DI
0x931C	MCUA timed out while waiting for a message from MCUB	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x931D	MCUA interrupt execution timeout	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x931E	MCUB interrupt execution timeout	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer.
0x931F	MCUA timing abnormal	No.1 Non-resettable fault	Reset impossible	Hardware fault	Contact the manufacturer.
0x9320	MCUB timing abnormal	No.1 Non-resettable fault	Reset impossible	Hardware fault	Contact the manufacturer.
0x9321	MCUA failed to compare DOs	No.2 Resettable fault	Reset manually	The DO is abnormal.	Check the external 24 V power supply of the safety module.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9322	MCUB failed to compare DOs	No.2 Resettable fault	Reset manually	The DO is abnormal.	Check the external 24 V power supply of the safety module.
0x9323	MCUA parameter initialization failed	No.1 Non-resettable fault	Reset impossible	Parameter saving error	Contact the manufacturer.
0x9324	MCUB parameter initialization failed	No.1 Non-resettable fault	Reset impossible	Parameter saving error	Contact the manufacturer.
0x9325	MCUA failed to save parameters	No.1 Non-resettable fault	Reset impossible	Parameter saving error	Contact the manufacturer.
0x9326	MCUB failed to save parameters	No.1 Non-resettable fault	Reset impossible	Parameter saving error	Contact the manufacturer.
0x9327	MCUA output pin read-back failed	No.2 Resettable fault	Reset manually	Pin read-back error	Check the external 24 V power supply of the DI terminal.
0x9328	MCUB output pin read-back failed	No.2 Resettable fault	Reset manually	Pin read-back error	Check the external 24 V power supply of the DI terminal.
0x9329	DI comparison failed for three-position enable	No.1 Non-resettable fault	Reset impossible	The teach pendant enable signal is abnormal.	Contact the manufacturer.
0x932A	Clock self-test failed	No.1 Non-resettable fault	Reset impossible	Chip exception	Contact the manufacturer.
0x932B	CPU self-test failed	No.1 Non-resettable fault	Reset impossible	Chip exception	Contact the manufacturer.
0x932C	RAM self-test failed	No.1 Non-resettable fault	Reset impossible	Chip exception	Contact the manufacturer.
0x932D	Flash self-test failed	No.1 Non-resettable fault	Reset impossible	Chip exception	Contact the manufacturer.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x932E	MCUA triggers external protective stop	No.2 Resettable fault	Reset manually	External protective stop properties have been configured, but there is no DI input	Change the DI properties or check the DI input
0x932F	MCUA triggers an emergency stop	No.2 Resettable fault	Reset manually	The emergency stop properties have been configured, but there is no DI input	Change the DI properties or check the DI input
0x9330	MCUB triggers external protective stop	No.2 Resettable fault	Reset manually	External protective stop properties have been configured, but there is no DI input	Change the DI properties or check the DI input
0x9331	MCUB triggers an emergency stop	No.2 Resettable fault	Reset manually	The emergency stop properties have been configured, but there is no DI input	Change the DI properties or check the DI input
0x9332	MCUA parameter read-back failed	No.1 Non-resettable fault	Reset impossible	Safety parameter saving error	Contact the manufacturer.
0x9333	MCUB parameter read-back failed	No.1 Non-resettable fault	Reset impossible	Safety parameter saving error	Contact the manufacturer.
0x9334	System restart required after reset of safety controller parameters	No.3 Resettable warning	Reset manually	The safety controller parameters have been initialized and take effect after reboot.	Manually restart the controller

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9345	Main chip of the safety module failed to read the parameter version number	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9346	Slave chip of the safety module failed to read the parameter version number	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9347	Main chip of the safety module failed to read the parameter length	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9348	Slave chip of the safety module failed to read the parameter length	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9349	CRC write error on the main chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x934A	CRC write error on the slave chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x934B	Length check error on the main chip of the safety module during program update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x934C	Length check error on the main chip of the safety module during program update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x934D	Parameter version number write error on the main chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x934E	Parameter version number write error on the slave chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x934F	Length info write error on the main chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9350	Length info write error on the slave chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9351	Parameter error on the main chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9352	Parameter error on the slave chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9353	Parameter write error on the main chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9354	Parameter write error on the slave chip of the safety module during software update	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9355	Incompatible version parameters detected in the main chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9356	Incompatible version parameters detected in the slave chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9361	CRC error detected while writing safety parameters to the main chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x9362	CRC error detected while writing safety parameters to the slave chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9363	Error writing safety parameters during the initialization phase of the main chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9364	Error writing safety parameters during the initialization phase of the slave chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9365	Error writing flag bit during the initialization phase of the main chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9366	Error writing flag bit during the initialization phase of the slave chip of the safety module	No.2 Resettable fault	Reset manually	Software update caused a safety parameter compatibility issue	Initialized the safety parameters.
0x9369	Abnormal relay state detected by the main chip of the safety module	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x936A	Abnormal relay state detected by the slave chip of the safety module	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.
0x936B	Emergency stop triggered by the main chip of the safety module on the DI-configurable teach pendant/ controller	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.
0x936C	Emergency stop triggered by the slave chip of the safety module on the DI-configurable teach pendant/ controller	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.
0x936D	Abnormal relay state detected by the main chip of the safety module during DI mutual-check monitoring process	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.
0x936E	Abnormal relay state detected by the slave chip of the safety module during DI mutual-check monitoring process	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.

Fault code	Fault name	Fault level	Reset mode	Fault cause	Solution
0x936F	Abnormal relay state detected by the slave chip, leading to an emergency stop output from the main chip of the safety module	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.
0x9370	Abnormal relay state detected by the main chip, leading to an emergency stop output from the slave chip of the safety module	No.2 Resettable fault	Reset manually	The input of safety DI port is abnormal.	Check the circuit.
0x9390	Configured DI additional emergency stop triggered by the main chip of the safety module	No.2 Resettable fault	Reset manually	The additional emergency stop configured on the safety module has been triggered.	Restore the additional emergency stop DI on the safety module.
0x9391	Configured DI additional emergency stop triggered by slave chip of the safety module	No.2 Resettable fault	Reset manually	The additional emergency stop configured on the safety module has been triggered.	Restore the additional emergency stop DI on the safety module.



Reset manually: Initializing safety controller parameters requires a power cycle to take effect. Manually restart the control cabinet afterwards.

8 Certification and Standard Compliance

Certification mark	Certification	Description	Instruction
CE	CE	The product complies with the LVD, MD, EMC, and RoHS directives and is labeled with the CE mark.	• EN 60204-1:2018 • EN ISO 10218-1:2011 • EN ISO 12100:2010 • EN 61000-6-2:2019 • EN 61000-6-4:2019 • ISO 13849-1:2023 • EN ISO 13849-1:2015
SGS TÜV SAAR FUNKTIONALE SICHERHEIT GEPRÜFT FUNCTIONAL SAFETY APPROVED	SGS-TUV Saar	This product is certified by SGS-TUV Saar for functional safety.	
SGS C US	cSGSus	This product is certified by SGS North America of Nationally Recognized Test Laboratory (NRTL).	• UL 1740,4th Ed., Jan. 26, 2018 • NFPA 79 2021 Edition, Dated Oct. 25, 2020 • CAN/CSA Z434-14 (R2019), Reaffirmed 2019
FC	FCC	This product has passed the Federal Communications Commission (FCC) EMC testing and carries the FCC mark.	-

KC certification mark

The robot controller with the KC mark on the nameplate complies with the electromagnetic compatibility standards of South Korea.

이 기기는 업무용(A 급) 전자파적합기기로서 판매자 또는사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

For sellers or other users, please bear in mind that this device is an A-grade electromagnetic wave device.

This device is intended to be used in areas other than at home.

Model	Certification Compliance
IRCB501-4MD	CE Certification
IRCB501-6ND	

Model	Certification Compliance
IRCB501-4AD	CE certification, cSGSus certification and FCC certification
IRCB501-4CD	
IRCB501-4ED	
IRCB501-6LD	
IRCB501-6FD	
IRCB501-4AD-INT	CE Certification cSGSus Certification Functional safety certification (functional safety expansion card required) FCC certification KC certification
IRCB501-4CD-INT	
IRCB501-4ED-INT	
IRCB501-4MD-INT	
IRCB501-6LD-INT	
IRCB501-6FD-INT	
IRCB501-6ND-INT	

Service and Support

Should you encounter a safety accident during the use or operation of the product, or face challenges in operating and maintaining the equipment, which remain unresolved after the relevant documentation is consulted, we provide multiple channels to ensure prompt resolution:

- Channel #1: Contact service@inovance.com.
- Channel #2: Visit https://www.inovance.com/global to access document downloads, after-sales support, spare parts ordering, repair applications, and authenticity verification services.
- Channel #3: Download My Inovance app (https://zshc-eu.inovance.com/download-pc/) where you can access products info and documentation, and query product parameters.

We are committed to providing you with quick and professional technical support, and we look forward to your satisfaction and trust.

19013000A00

Copyright © Shenzhen Inovance Technology Co., Ltd.

Shenzhen Inovance Technology Co., Ltd.

www.inovance.com

Add.: Inovance Headquarters Tower, High-tech Industrial Park,
Guanlan Street, Longhua New District,
Shenzhen 518000, P.R. China

Tel: (0755) 2979 9595 Fax: (0755) 2961 9897

Suzhou Inovance Technology Co., Ltd.

www.inovance.com

Add.: No. 52, Tian E Dang Road, Wuzhong District, 215104,
Suzhou City, Jiangsu Province, P.R. China

Tel: (0512) 6637 6666 Fax: (0512) 6285 6720