INOVANCE

FORWARD, ALWAYS PROGRESSING

Industrial Robot System

Safety Functions Guide

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

Data code PS00016974 A01

Preface

Introduction

This guide describes the safety functions of the Inovance industrial robots. 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 Series Robot Controller User Guide	PS00010914	This guide describes general specifications, installation and wiring, common fault diagnosis and solutions, and maintenance of the product.
IRCB501 High-Protection Series Robot Controller User Guide	PS00015334	This guide describes general specifications, installation and wiring, common fault diagnosis and solutions, and maintenance of the product.
Robot Functional Safety Expansion Card User Guide	19012408	This guide provides product safety information, installation instructions on functional safety expansion cards, commissioning and maintenance of safety parameters.
Industrial Robot System Safety Functions Guide	PS00016974	This guide provides product safety information, installation instructions on functional safety expansion cards, commissioning and maintenance of safety parameters.

Revision History

Revision Date	Version	Description
August 2024	A01	Corrected some minor errors.
June 2024	A00	Initial release

Access to the Guide

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

- Do keyword searching under Service and Support at http://www.inovance.com.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install My Inovance app, where you can search for and download user guides.

Warranty Disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for faults or damage that occur during normal operation. Maintenance will be charged after the warranty expires.

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

- Damage caused by operations not following the instructions in the user guide
- The product is damaged due to fire, flood, and abnormal 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 (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.

Fundamental Safety Instructions

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, personal injury, 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 in an environment that complies with the design specifications. Malfunction or component damage caused by improper usage is not covered by warranty.
- 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 death or severe personal injuries.

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

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

Safety Precautions

- 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.
- Users must take mechanical precautions to protect personal safety and wear protective equipment, such as anti-smashing shoes, safety clothing, safety glasses, protective gloves, and protective sleeves.

Unpacking
 • Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking. • 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.
 • Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking. • Unpack the package by following the package sequence. Do not hit the package with force. • 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 transported by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure the components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injury or equipment damage.
- Never stand or stay 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 equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply 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 storing or transporting the equipment 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.
- Pack the equipment strictly before transportation. Use a sealed box 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 on the equipment.

- Read through the guide and safety instructions before installation.
- Do not install this 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 red.
- When the equipment 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 combustible objects. Failure to comply can result in fire accident.

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the 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.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, cut off all the power supplies of the equipment, and 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 will result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply will 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 end of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to the 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.
- Fix the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may overheat or damage the connecting part, resulting in 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 proper 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 of the product.
- 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
 DANGER • 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. • Do not open the cabinet door or protective cover of the product, touch any wiring terminal of the product, or remove any part of the product with power on. Failure to comply can result in an electric shock.
 WARNING • Perform a trial run after wiring and parameter setting to ensure the equipment operates 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 a fire. • Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injury.

Operation
 DANGER • The equipment must be operated only by professionals. Failure to comply can result in death or personal injury. • 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.
 WARNING • Do not touch the equipment enclosure, fan, or resistor with bare hands to sense the temperature. Failure to comply may result in personal injury. • Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply will 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.
- In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will result in an electric shock.

- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not repair 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.

- Require for repair services according to the product warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage circuit breaker (ELCB) trips, wait as specified on the product warning sign before power-on or further operations. Failure to comply may result in personal injuries, equipment damage or even death.
- When the equipment is faulty or damaged, require professionals to perform troubleshooting and repair by following repair instructions and keep a repair record.
- Replace quick-wear parts of the equipment according to the replacement instructions.
- Do not operate on damaged equipment. Failure to comply may result in death, personal injury, 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 property damage, personal injury, or even death. • Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

Safety Labels

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

Table of Contents

1 Safety Overview

1.1 List of Safety Functions

SF Ident	Safety Function	Classification	Description
SF01	System emergency stop	Emergency stop	Triggered by an emergency stop signal. Once triggered, the power to the motor is cut off and the brake is applied.
SF02	System protection stop	Protective stop	Triggered by a protective stop signal. Once triggered, the power to the motor is cut off and the brake is applied.
SF03	External emergency stop	Emergency stop	Safety DI, which can be configured for emergency stop function. Can be configured as Category 0 or Category 1 stop.
SF04	External protective stop	Protective stop	Safety DI, which can be configured for protective stop function. Can be configured as Category 0 or Category 1 stop.
SF05	Robot estop status output	Status output	Safety DO, which can be configured for emergency stop status. When the external emergency stop DI inputs high level, the DO outputs low level. When the emergency stop DI inputs low level or floating, the DO outputs high resistance.
SF06	Robot moving status output	Status output	Safety DO, which can be configured for the motion status. The DO outputs low level when the robot is in the moving state, and high resistance when the robot is in a non-moving state.
SF07	Robot stopping status output	Status output	Safety DO, which can be configured for the stop status. The DO outputs low level when the robot is in the stopped state, and high resistance when the robot is in a non-stopped state.

SF Ident	Safety Function	Classification	Description
SF08	Safe state status output	Status output	Safety DO, which can be configured for safety status. The safety status is abnormal as long as one of the safety functions is abnormal. The DO outputs low level when the safety status is abnormal, and high resistance when the safety status is normal.
SF09	Safety manual mode	Safety operation control	In manual mode, monitor whether the TCP speed is less than 250 mm/s. If it is greater than 250 mm/s, it triggers a Category 0 or Category 1 stop, and the safety status output. You can configure the Category 0 or Category 1 stop and the trigger method.
SF10	Joint position monitor	Safety operation control	Monitors whether the position of each joint is within the set safety range. Exceeding the safety range triggers a Category 0 or Category 1 stop, and the safety status output. You can configure the Category 0 or Category 1 stop and the trigger method.
SF11	Joint speed monitor	Safety operation control	Monitors whether the speed of each joint is within the set speed limit. Exceeding the speed limit triggers a Category 0 or Category 1 stop, and the safety status output. You can configure the Category 0 or Category 1 stop and the trigger method.
SF12	TCP position monitor	Safety operation control	Monitors whether the TCP position is within the set safety zone. Exceeding the safety zone triggers a Category 0 or Category 1 stop, and the safety status output. You can configure the Category 0 or Category 1 stop and the trigger method. You can configure different ways for the safety tools to take effect and set the safety envelope.

SF Ident	Safety Function	Classification	Description
SF13	TCP speed monitor	Safety operation control	Monitor whether the TCP speed is within the set speed limit. Exceeding the speed limit triggers a Category 0 or Category 1 stop, and the safety status output. You can configure the Category 0 or Category 1 stop and the trigger method.
SF14	3-Position enabling function	Safety operation control	The teach pendant is provided with a 3-position enable switch. When the switch is continuously held in the middle position (ON), the robot is allowed to move. When the switch is in the released or pressed position, the robot stops and the brake acts. Safety parameters are not available.

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

Terms/ Abbreviations	Description
Cat.	Safety category It includes B, 1, 2, 3, and 4.
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval
SFF	Safe failure fraction
PFHd	Probability of a dangerous failure per Hour
PL	Performance level
SC	Systematic capability
SIL	Safety integrity level
T_1	Test interval
DI	Digital input
DO	Digital output
MTTFd	Mean time to dangerous failure

1.3 Safety Standards and Specifications

Safety standards

EU Directive	Standard
Machinery Directive 2006/42/EC (Functional Safety)	ISO 10218-1:2011 ISO 13849-1: 2023 ISO 13849-2: 2012 EN ISO 10218-1:2011 EN ISO 13849-1: 2023 EN ISO 13849-2: 2012
EMC Directive	IEC 61800-5-2:2016 IEC 61800-3:2017 IEC 61000-6-4/A1:2010 EN 61000-6-4/A1:2011 EN 61800-5-2: 2017 EN 61800-3: 2018

Safety parameters

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

SF Ident	Safety function	Safety status	PFHd (6-axis robot)	PFHd (SCARA robot)
SF01	System emergency stop	Category 0 Stop	7.68x10^{-8}	4.94x10^{-8}
SF02	System protection stop	Category 0 Stop	7.68x10^{-8}	4.94x10^{-8}
The following functions require an expansion safety card.				
SF03	External emergency stop	Category 0/1 Stop for user configuration	4.94x10^{-8}	4.29x10^{-8}
SF04	External protective stop	Category 0/1 Stop for user configuration	4.94x10^{-8}	4.29x10^{-8}
SF05	Robot estop status output	DO Output Low	4.29x10^{-8}	
SF06	Robot moving status output	DO output low	1.03x10^{-7}	5.79x10^{-8}

SF Ident	Safety function	Safety status	PFHd (6-axis robot)	PFHd (SCARA robot)
SF07	Robot stopping status output	DO output low	$1.03x10^{-7}$	$5.79x10^{-8}$
SF08	Safe state status output	DO output low	$4.29x10^{-8}$	$4.29x10^{-8}$
SF09	Safety manual mode	Category 0/1 Stop for user configuration	$1.78x10^{-7}$	$1.03x10^{-7}$
SF10	Joint position monitor	Category 0/1 Stop for user configuration	$5.79x10^{-8}$	$4.29x10^{-8}$
SF11	Joint speed monitor	Category 0/1 Stop for user configuration	$5.79x10^{-8}$	$4.29x10^{-8}$
SF12	TCP position monitor	Category 0/1 Stop for user configuration	$1.78x10^{-7}$	$1.03x10^{-7}$
SF13	TCP speed monitor	Category 0/1 Stop for user configuration	$1.78x10^{-7}$	$1.03x10^{-7}$
SF14	3-Position enabling function	Brake action	$4.29x10^{-8}$	$4.29x10^{-8}$

1.4 Precautions for Use

Safety Precautions

The chapter contains the warning symbols used in this guide and the safety instructions which you must obey when you install or connect an 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.

Illustrations, pictures, or figures used in this manual are intended as examples only and may not cover all products to which this guide applies.

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.

Table 1–1 Description for warning symbols

Key	Indication	Meaning	Consequences of negligence
Example  DANGER	DANGER	Major 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.
 Hazardous voltage Electric shock	CAUTION	Minor risks	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.

- The user must take safety as the highest priority in electrical installation and system design.
- The design, installation, commissioning and maintenance of the system shall be carried out by trained and experienced personnel. They should read the operation instructions and relevant 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 Precautions

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. Generally, the E-stop is required to be independent from any complex or intelligent control. It may use purely electromechanical devices to either disconnect the power or initiate a controlled 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. The use of individual sub-systems such as drives with STO function, which are intended for safety-related applications, does not in itself ensure that the complete system is safe.
- 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. A company and individual who constructed the safety related system must take full responsibility for installation and commissioning of the system. 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 (communication security)**
  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.
- **TCP position monitoring**
  The TCP position monitoring is based on the base coordinate system. If the robot base moves, the TCP only represents a spatial position relative to the base. Set the safety parameters properly.
- **TCP speed monitoring**
  The TCP speed monitoring is based on the base coordinate system. If the robot base moves, the speed only represents a speed relative to the base. Set the safety parameters properly.
- **Safety manual mode monitoring**
  The safety manual mode monitoring is active only in manual low-speed mode. For automatic mode and manual high-speed mode, use TCP 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

2.1 Nameplate and Model

IRCB501 series

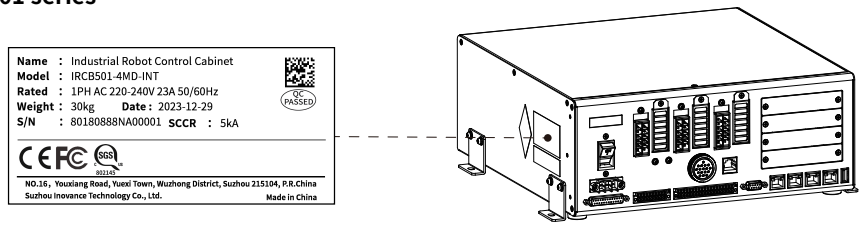


Figure 2-1 Nameplate

IR CB 501 - 4 M D - INT
① ② ③ ④ ⑤ ⑥ ⑦

① **Product Family** INOVANCE Robot	⑤ **Power Class** A: 400W+400W+400W+400W B: 750W+400W+400W+400W C: 750W+750W+400W+400W D: 1000W+1000W+750W+400W E: 2000W+2000W+750W+750W F: 750W+750W+750W+750W+400W+400W H: 400W+400W+400W+400W+400W+400W L: 750W+750W+400W+400W+400W+400W M: 1200W+750W+750W+400W
② **Product Type** Cabinet	⑥ **Input Voltage** D: Single-phase 220 VAC S: Three-phase 220 VAC T: Three-phase 380 VAC
③ **Product Series** 500: 1.0 series 501: 2.0 series	⑦ **Functional Safety** Blank: Not functional safety certificated INT: Functional safety certificated
④ **Number of Servo Axes** 4: 4 axes 6: 6 axes	

IRCB501 High-Protection Series

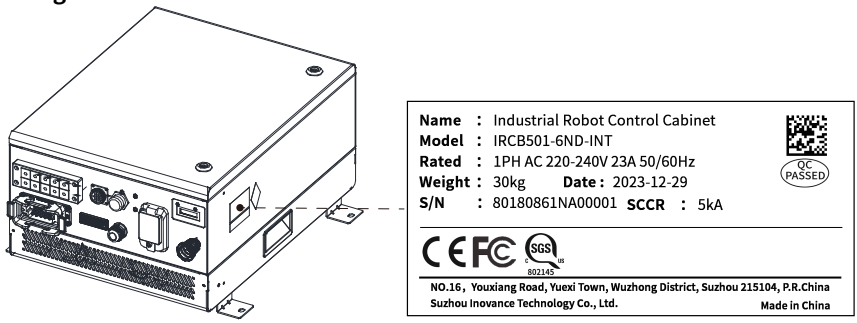


Figure 2-2 Nameplate

IR ① CB ② 501 ③ - 6 ④ N ⑤ D ⑥ - INT ⑦

① **Product Family** INOVANCE Robot	⑤ **Power Class** A: 400W+400W+400W+400W B: 750W+400W+400W+400W C: 750W+750W+400W+400W M: 1200W+750W+750W+400W N: 2000W+2000W+1200W+400W+400W+200W R: 750W+750W+500W+150W+150W+90W L: 750W+750W+400W+400W+400W+400W G: 5000W+5000W+2000W+2000W+2000W+2000W
② **Product Type** Cabinet	⑥ **Input Voltage** D: Single-phase 220 VAC S: Three-phase 220 VAC T: Three-phase 380 VAC
③ **Product Series** 500: 1.0 series 501: 2.0 series	⑦ **Function Safety** Blank: Not functional safety certificated INT: Functional safety certificated
④ **Number of Servo Axes** 4: 4 axes 6: 6 axes	

2.2 Components

IRCB501 Series

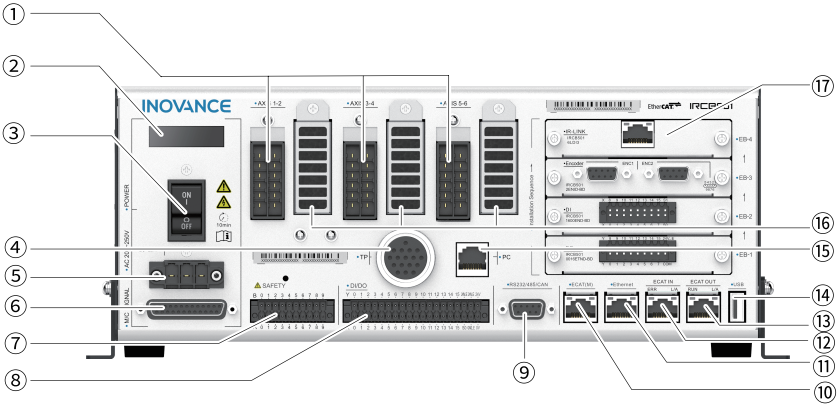


Figure 2-3 Parts Number

No.	Name	Description
①	Power connector	Connects to power cable of the robot
②	LED display	Displays controller status and alarms
③	Power switch	Power switch of the controller
④	Hand-held teach pendant connector	Connects to the hand-held teach pendant
⑤	220 VAC power input	Connects to external 220 VAC power supply
⑥	Encoder interface	Receives motor encoder feedback
⑦	Safety interface	Emergency stop, safety door, and start confirmation
⑧	User I/O	16x DIs and 16x DOs
⑨	DB9 interface	RS232, RS485 and CAN communication interface
⑩	EtherCAT interface	Connects to EtherCAT master (external axis)
⑪	Ethernet port	Ethernet communication interface
⑫	EtherCAT-IN interface	EtherCAT slave input interface
⑬	EtherCAT-OUT interface	EtherCAT slave output interface
⑭	USB Interface	USB2.0 interface for PC and peripherals
⑮	PC-based teach pendant interface	Connects to PC-based teach pendant
⑯	Heat dissipation hole	Used for heat dissipation
⑰	Expansion card slot	Connects to optional parts such as DI and DO expansion cards

IRCB501 High-Protection Series

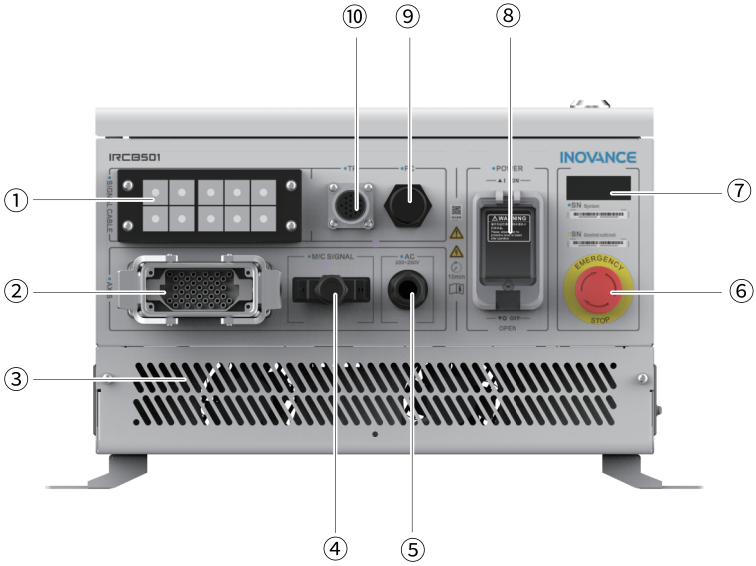


Figure 2-4 Parts Number

No.	Name	Description
①	Cable entry system	Introduces external cables into the controller, enhancing the controller's IP rating
②	Power connector	Connects to power supply cable and brake cable of the motor
③	Heat dissipation hole	Air inlet for heat dissipation
④	Encoder connector	Motor encoder feedback, etc
⑤	Power cable connector	Connects to external 220 VAC power input
⑥	Emergency stop button	Press for emergency stop
⑦	LED display	Displays controller status and alarms
⑧	Power switch	Power switch of the controller (Close the protective cover after operating the air circuit breaker.)
⑨	Virtual teach pendant connector	Network connector for the virtual teach pendant (This connector is used for temporary debugging. If long-term use is needed, please connect the wire to this connector through the ① cable entry system.)
⑩	Hand-held teach pendant connector	Connects to the hand-held teach pendant

2.3 Technical Data

Item	Specification	
Series	IRCB501 series controller	IRCB501 high-protection series controller
Model	IRCB501-6LD/4AD/4CD: Standard power model IRCB501-6LD/4AD/4CD-INT: Standard power model IRCB501-6FD/4ED: High power model IRCB501-6FD/4ED-INT: High power model	IRCB501-6ND/4MD/6RD: Standard power model IRCB501-6ND/4MD-INT: Standard power model IRCB501-6GT: High power model
Controlled axes	6 robot axes + 3 external axes	6 robot axes + 3 external axes
Mounting mode	Vertical mounting, horizontal mounting, 19'' rack mounting	Vertical mounting, horizontal mounting, 19'' rack mounting
Motion mode	Point-to-point, linear interpolation, circular interpolation, and free curve interpolation	Point-to-point, linear interpolation, circular interpolation, and free curve interpolation
Program storage space	Maximum number of lines per program: 2000 Maximum storage space for a single program file: 500 KB Maximum number of points: 9999 points Multi-tasking: Supports 1 main task, 2 PLC tasks, 1 xqt task	Maximum number of lines per program: 2000 Maximum storage space for a single program file: 500 KB Maximum number of points: 9999 points Multi-tasking: Supports 1 main task, 2 PLC tasks, 1 xqt task
Retentive memory	Amount of saved data (Bytes): Supports 256 B, R, D, PR, or STR variables	Amount of saved data (Bytes): Supports 256 B, R, D, PR, or STR variables
Power-on/ power-off interval	2s	2s
Standard I/O	General digital I/Os: Standard 16 inputs and 16 NPN-type outputs (expandable) Safety I/Os: 6	General digital I/Os: Standard 16 inputs and 16 NPN-type outputs (expandable) Safety I/Os: 6
Ethernet	2x, one for TP/virtual TP, speed: 100 Mbps	2x, one for TP/virtual TP, speed: 100 Mbps
EtherCAT	3x, one for master and two for slave, speed 100 Mbit/s, full-duplex mode, linear topology and external axes supported EtherCAT slave sync jitter < 1 μs	3x, one for master and two for slave, speed 100 Mbit/s, full-duplex mode, linear topology and external axes supported EtherCAT slave sync jitter < 1 μs
USB2.0	1x	1x
RS-232	1x (reserved)	1x (reserved)

Item	Specification	
RS-485	1x, standard Modbus-RTU protocol supported, baud rate 4800 bits/s to 115200 bit/s	1x, standard Modbus-RTU protocol supported, baud rate 4800 bits/s to 115200 bit/s
CAN bus	1x, used for CANopen master, max. rate 1M	1x, used for CANopen master, max. rate 1M
Expansion slots (4x)	16-channel digital input (DI) expansion card	16-channel digital input (DI) expansion card
	16-channel digital output (DO) expansion card	16-channel digital output (DO) expansion card
	2-channel incremental encoder expansion card	2-channel incremental encoder expansion card
	PROFINET slave expansion card	PROFINET slave expansion card
	IR-LINK adapter board expansion card	IR-LINK adapter board expansion card
	Functional safety expansion card (supported only by "-INT" controller)	Functional safety expansion card (supported only by "-INT" controller)
Control mode	InoRobotLab, teach pendant, remote I/O, and remote Ethernet (API)	InoRobotLab, teach pendant, remote I/O, and remote Ethernet (API)
Input voltage range	Rated single-phase 220 VAC to 240 VAC, 50/60 Hz (The input voltage should be within the range of -15% and +10% of the rated voltage.)	Standard models: Single-phase rated voltage 220 VAC (The rated voltage of the -INT model is 220 VAC to 240 VAC.) High-power models: Three-phase rated voltage 380 VAC to 415 VAC, 50/60 Hz (The input voltage should be within the range of -15% and +10% of the rated voltage.)
Input current range	Standard models: Max. 10 A High-power models: Max. 20 A	Standard models: Max. 23 A High-power models: Max. 20 A
Protection rating	IP20	IP54
Ambient temperature	Standard models: 0°C to 45°C High-power models: 0°C to 40°C	0°C to 45°C
Relative humidity	Humidity: 20% RH to 95% RH (30°C) (non-condensing)	20% RH to 95% RH (30°C) (non-condensing)
Altitude	1,000 m	1,000 m

Item	Specification	
Certification	Non-INT controller: CE certification, cSGSus certification, and FCC certification INT controller: CE certification, cSGSus certification, FCC certification, and functional safety certification (Only supported by "-INT" controller and requires a functional safety expansion card.) KC certification is in progress.	Non-INT controller: CE certification (IRCB501-6RD/6GT without any certification) INT controller: CE certification, cSGSus certification, FCC certification, and functional safety certification (Only supported by "-INT" controller and requires a functional safety expansion card.) KC certification is in progress.
Noise level	⩽ 65 dB	⩽ 70 dB
Dimensions (WxDxH)	Standard models: 330 mm x 338.5 mm x 130 mm High-power models: 330 mm x 400 mm x 130 mm	Standard models: 445 mm x 575 mm x 276 mm High-power models: 445 mm x 600 mm x 300 mm
Weight	Standard models: 8 kg High-power models: 10 kg	Standard models: 30 kg High-power models: 35 kg
Supported robot models (Standard)	IR-C8 series IR-S4 series IR-S7 series IR-S10 series IR-CS3 series IR-CS6 series IR-CS10 series IR-S20 series IR-GS20 series IR-S50 series IRS311 series IR-R4 series IR-R7 series IR-R11 series	IR-R10 series IR-R20 series IR-R25 series IR-R35 series

2.4 Scope of Certification

The scope of certification covers the IRCB501 series and IRCB501 high-protection series robot controllers, and SCARA series robots and IR-R series 6-axis robots.

IRCB501 series certification list

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IR-S4	4	40	IR-S4-40Zbcd(*)-INT	IRB-S4-40Zbcd(*)-INT	IRCB501-4AD(*)-INT
IR-S7	7	50/60/70	IR-S7-aZbcd(*)-INT	IRB-S7-aZbcd(*)-INT	IRCB501-4CD(*)-INT

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IR-GS10	10	50/60/70/80	IR-GS10-aZbcd(*)-INT	IRB-GS10-aZbcd(*)-INT	IRCB501-4CD(*)-INT
IR-S10	10	50/60/70/80	IR-S10-aZbcd(*)-INT	IRB-S10-aZbcd(*)-INT	IRCB501-4CD(*)-INT
IR-S7 (Customized models)	7	60	IR-S7-60Z20S3-C2	IRB-S7-60Z20S3-C2	IRCB501-4CD(*)-INT
IR-S20	20	60/70/80/100	IR-S20-aZbcd(*)-INT	IRB-S20-aZbcd(*)-INT	IRCB501-4ED(*)-INT
IR-GS20	20	60/70/80/100	IR-GS20-aZbcd(*)-INT	IRB-GS20-aZbcd(*)-INT	IRCB501-4ED(*)-INT
IR-CS3	3	40	IR-CS3-40Zbcd(*)-INT	IRB-CS3-40Zbcd(*)-INT	IRCB501-4AD(*)-INT
IR-CS6	6	50/60/70	IR-CS6-aZbcd(*)-INT	IRB-CS6-aZbcd(*)-INT	IRCB501-4CD(*)-INT
IR-CS10	10	50/60/70/80	IR-CS10-aZbcd(*)-INT	IRB-CS10-aZbcd(*)-INT	IRCB501-4CD(*)-INT
IR-C8	8	62	IR-C8-62Zbcd(*)-INT	IRB-C8-62Zbcd(*)-INT	IRCB501-4ED(*)-INT
IR-TS4	4	35	IR-TS4-35Zbcd(*)-INT	IRB-TS4-35Zbcd(*)-INT	IRCB501-4CD(*)-INT
IR-TS5	5	55	IR-TS5-55Zbcd(*)-INT	IRB-TS5-55Zbcd(*)-INT	IRCB501-4CD(*)-INT
IRS111-3	3	25/30	IRS111-3-aZbTSd(*)-INT	IRB111-3-aZbTSd(*)-INT	IRCB501-4AD(*)-INT
IRS111-10	10	50	IRS111-10-50ZbTSd(*)-INT	IRB111-10-50ZbTSd(*)-INT	IRCB501-4CD(*)-INT
IRS111-20	20	60/70/80/100	IRS111-20-aZbTSd(*)-INT	IRB111-20-aZbTSd(*)-INT	IRCB501-4CD(*)-INT
IRS11-8-50TS5	8	50	IRS11-8-50TSd(*)-INT	IRB11-8-50TSd(*)-INT	IRCB501-4AD(*)-INT
IR-S50	50	120	IR-S50-120Zbcd(*)-INT	IRB-S50-120Zbcd(*)-INT	IRCB501-4ED(*)-INT
IR-GS50	50	120	IR-GS50-120Zbcd(*)-INT	IRB-GS50-120Zbcd(*)-INT	IRCB501-4ED(*)-INT
IRS311-3	3	60	IRS311-3-60TSd(*)-INT	IRB311-3-60TSd(*)-INT	IRCB501-6LD(*)-INT
IRS311-7	7	70/90	IRS311-7-aTSd(*)-INT	IRB311-7-aTSd(*)-INT	IRCB501-6LD(*)-INT
IRS311-7 (Customized models)	7	90	IRS311-7-90TS5-GJ-B1	IRB311-7-90TS5-GJ-B1	IRCB501-6LD(*)-INT
IR-R4	4	56/54/60	IR-R4-acd(*)-INT	IRB-R4-acd(*)-INT	IRCB501-6LD(*)-INT

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IR-R4H	4	54	IR-R4H-54cd(*)-INT	IRB-R4H-54cd(*)-INT	IRCB501-6LD(*)-INT
IR-R7	7	70/90/140	IR-R7-acd(*)-INT	IRB-R7-acd(*)-INT	IRCB501-6LD(*)-INT
IR-R7H	7	70/90/140	IR-R7H-acd(*)-INT	IRB-R7H-acd(*)-INT	IRCB501-6LD(*)-INT
IR-R10	10	110/120	IR-R10-acd(*)-INT	IRB-R10-acd(*)-INT	IRCB501-6FD(*)-INT
IR-R10H	10	110/120	IR-R10H-acd(*)-INT	IRB-R10H-acd(*)-INT	IRCB501-6FD(*)-INT
IR-R11	11	90	IR-R11-90cd(*)-INT	IRB-R11-90cd(*)-INT	IRCB501-6FD(*)-INT
IR-CR7H	7	70/90/140	IR-CR7H-acd(*)-INT	IRB-CR7H-acd(*)-INT	IRCB501-6LD(*)-INT
IR-CR10H	10	110/120	IR-CR10H-acd(*)-INT	IRB-CR10H-acd(*)-INT	IRCB501-6FD(*)-INT

IRCB501 high-protection controller certification list

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IR-R10	10	140/200	IR-R10-acd(*)-INT	IRB-R10-acd(*)-INT	IRCB501-6ND(*)-INT
IR-R12	12	140	IR-R12-140cd(*)-INT	IRB-R12-140cd(*)-INT	IRCB501-6ND(*)-INT
IR-R13	13	140	IR-R13-140cd(*)-INT	IRB-R13-140cd(*)-INT	IRCB501-6ND(*)-INT
IR-R15	15	145	IR-R15-145cd(*)-INT	IRB-R15-145cd(*)-INT	IRCB501-6ND(*)-INT
IR-R16	16	200	IR-R16-200cd(*)-INT	IRB-R16-200cd(*)-INT	IRCB501-6ND(*)-INT
IR-R20	20	120/170/200	IR-R20-acd(*)-INT	IRB-R20-acd(*)-INT	IRCB501-6ND(*)-INT
IR-R25	25	170/200	IR-R25-acd(*)-INT	IRB-R25-acd(*)-INT	IRCB501-6ND(*)-INT
IRGF-R10	10	140/200	IRGF-R10-acd(*)-INT	IRGF-R10-acd(*)-INT	IRCB501-6ND(*)-INT
IRGF-R20	20	120/170/200	IRGF-R20-acd(*)-INT	IRGF-R20-acd(*)-INT	IRCB501-6ND(*)-INT
IR-R35-170S10	35	170	IR-R35-170cd(*)-INT	IRB-R35-170cd(*)-INT	IRCB501-6ND(*)-INT
IR-CR10	10	140/200	IR-CR10-acd(*)-INT	IRB-CR10-acd(*)-INT	IRCB501-6ND(*)-INT
IR-CR12	12	140	IR-CR12-140cd(*)-INT	IRB-CR12-140cd(*)-INT	IRCB501-6ND(*)-INT

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IR-CR13	13	140	IR-CR13-140cd(*)-INT	IRB-CR13-140cd(*)-INT	IRCB501-6ND(*)-INT
IR-CR15	15	145	IR-CR15-145cd(*)-INT	IRB-CR15-145cd(*)-INT	IRCB501-6ND(*)-INT
IR-CR16	16	200	IR-CR16-200cd(*)-INT	IRB-CR16-200cd(*)-INT	IRCB501-6ND(*)-INT
IR-CR20	20	120/170/200	IR-CR20-acd(*)-INT	IRB-CR20-acd(*)-INT	IRCB501-6ND(*)-INT
IR-CR25	25	170/200	IR-CR25-acd(*)-INT	IRB-CR25-acd(*)-INT	IRCB501-6ND(*)-INT
IRCB501 high protection controller matching small-payload manipulator	4	40	IR-S4-40Zbcd(*)-INT	IRB-S4-40Zbcd(*)-INT	IRCB501-4MD(*)-INT
	7	50/60/70	IR-S7-aZbcd(*)-INT	IRB-S7-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	10	50/60/70/80	IR-GS10-aZbcd(*)-INT	IRB-GS10-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	10	50/60/70/80	IR-S10-aZbcd(*)-INT	IRB-S10-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	20	60/70/80/100	IR-S20-aZbcd(*)-INT	IRB-S20-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	20	60/70/80/100	IR-GS20-aZbcd(*)-INT	IRB-GS20-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	25	60/70/80/100	IR-S25-aZbcd(*)-INT	IRB-S25-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	25	60/70/80/100	IR-GS25-aZbcd(*)-INT	IRB-GS25-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	30	60/70/80/100	IR-S30-aZbcd(*)-INT	IRB-S30-aZbcd(*)-INT	IRCB501-4MD(*)-INT

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IRCB501 high protection controller matching small-payload manipulator	30	60/70/80/100	IR-GS30-aZbcd(*)-INT	IRB-GS30-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	35	80/100	IR-S35-aZbcd(*)-INT	IRB-S35-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	35	80/100	IR-GS35-aZbcd(*)-INT	IRB-GS35-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	3	40	IR-CS3-40Zbcd(*)-INT	IRB-CS3-40Zbcd(*)-INT	IRCB501-4MD(*)-INT
	6	50/60/70	IR-CS6-aZbcd(*)-INT	IRB-CS6-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	10	50/60/70/80	IR-CS10-aZbcd(*)-INT	IRB-CS10-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	20	80/100	IR-CS20-aZbcd(*)-INT	IRB-CS20-aZbcd(*)-INT	IRCB501-4MD(*)-INT
	50	120	IR-CS50-120Zbcd(*)-INT	IRB-CS50-120Zbcd(*)-INT	IRCB501-4MD(*)-INT
	3	35	IR-CTS3-35Zbcd(*)-INT	IRB-CTS3-35Zbcd(*)-INT	IRCB501-4MD(*)-INT
	4	35	IR-CTS4-35Zbcd(*)-INT	IRB-CTS4-35Zbcd(*)-INT	IRCB501-4MD(*)-INT
	8	62	IR-C8-62Zbcd(*)-INT	IRB-C8-62Zbcd(*)-INT	IRCB501-4MD(*)-INT
	4	35	IR-TS4-35Zbcd(*)-INT	IRB-TS4-35Zbcd(*)-INT	IRCB501-4MD(*)-INT
	5	55	IR-TS5-55Zbcd(*)-INT	IRB-TS5-55Zbcd(*)-INT	IRCB501-4MD(*)-INT
	3	25/30	IRS111-3-aZbTSd(*)-INT	IRB111-3-aZbTSd(*)-INT	IRCB501-4MD(*)-INT
	10	50	IRS111-10-50ZbTSd(*)-INT	IRB111-10-50ZbTSd(*)-INT	IRCB501-4MD(*)-INT
	20	60/70/80/100	IRS111-20-aZbTSd(*)-INT	IRB111-20-aZbTSd(*)-INT	IRCB501-4MD(*)-INT
	8	50	IRS11-8-50TSd(*)-INT	IRB11-8-50TSd(*)-INT	IRCB501-4MD(*)-INT
	50	120	IR-S50-120Zbcd(*)-INT	IRB-S50-120Zbcd(*)-INT	IRCB501-4MD(*)-INT
	50	120	IR-GS50-120Zbcd(*)-INT	IRB-GS50-120Zbcd(*)-INT	IRCB501-4MD(*)-INT

Series	Payload (kg)	Arm length (cm)	Robot system model	Manipulator model	Controller model
IRCB501 high protection controller matching small-payload manipulator	3	60	IRS311-3-60TSd(*)-INT	IRB311-3-60TSd(*)-INT	IRCB501-6ND(*)-INT
	7	70/90	IRS311-7-aTSd(*)-INT	IRB311-7-aTSd(*)-INT	IRCB501-6ND(*)-INT
	4	56/54/60	IR-R4-acd(*)-INT	IRB-R4-acd(*)-INT	IRCB501-6ND(*)-INT
	4	54	IR-R4H-54cd(*)-INT	IRB-R4H-54cd(*)-INT	IRCB501-6ND(*)-INT
	7	70/90/140	IR-R7-acd(*)-INT	IRB-R7-acd(*)-INT	IRCB501-6ND(*)-INT
	7	70/90/140	IR-R7H-acd(*)-INT	IRB-R7H-acd(*)-INT	IRCB501-6ND(*)-INT
	10	110/120	IR-R10-acd(*)-INT	IRB-R10-acd(*)-INT	IRCB501-6ND(*)-INT
	10	110/120	IR-R10H-acd(*)-INT	IRB-R10H-acd(*)-INT	IRCB501-6ND(*)-INT
	11	90	IR-R11-90cd(*)-INT	IRB-R11-90cd(*)-INT	IRCB501-6ND(*)-INT
	4	56/54/60	IR-CR4-acd(*)-INT	IRB-CR4-acd(*)-INT	IRCB501-6ND(*)-INT
	4	54	IR-CR4H-54cd(*)-INT	IRB-CR4H-54cd(*)-INT	IRCB501-6ND(*)-INT
	7	70/90/140	IR-CR7-acd(*)-INT	IRB-CR7-acd(*)-INT	IRCB501-6ND(*)-INT
	7	70/90/140	IR-CR7H-acd(*)-INT	IRB-CR7H-acd(*)-INT	IRCB501-6ND(*)-INT
	10	110/120	IR-CR10-acd(*)-INT	IRB-CR10-acd(*)-INT	IRCB501-6ND(*)-INT
	10	110/120	IR-CR10H-acd(*)-INT	IRB-CR10H-acd(*)-INT	IRCB501-6ND(*)-INT
	11	90	IR-CR11-90cd(*)-INT	IRB-CR11-90cd(*)-INT	IRCB501-6ND(*)-INT

3 Installation and Wiring

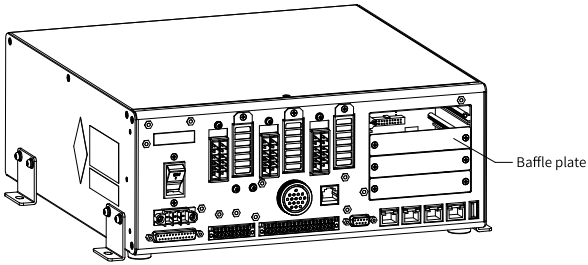
3.1 Installing Expansion Card

Caution

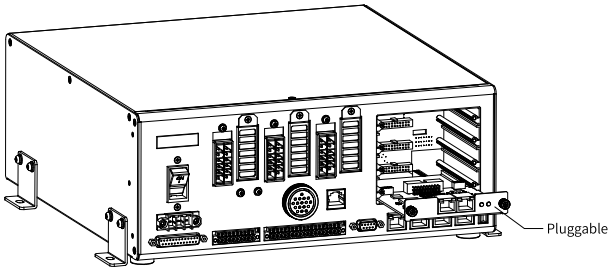
- Disconnect the external power supply of the system before removing/installing the expansion card. If the power supply is not disconnected, it may cause damage to the controller and failure of the expansion card.
- Unplugging the functional safety extension card when it is powered on results in loss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

Operation steps for IRCB501 series

1. Remove the screws fixing the dummy panel for expansion card using a Phillips screwdriver and then remove the cover.

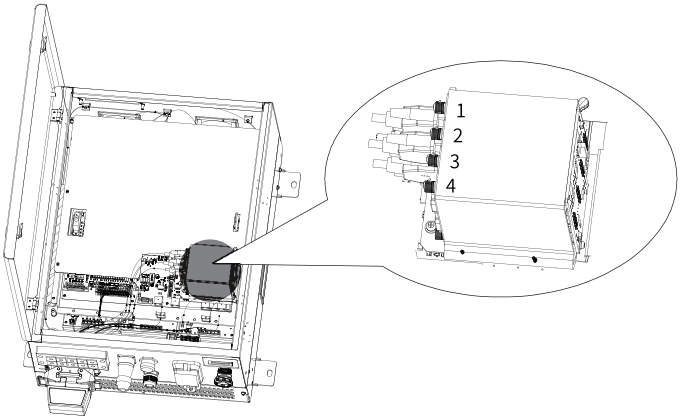


2. Align the expansion card with and insert it into the card slot and then tighten the expansion card with the Phillips screwdriver.



Operation steps for IRCB501 high protection series

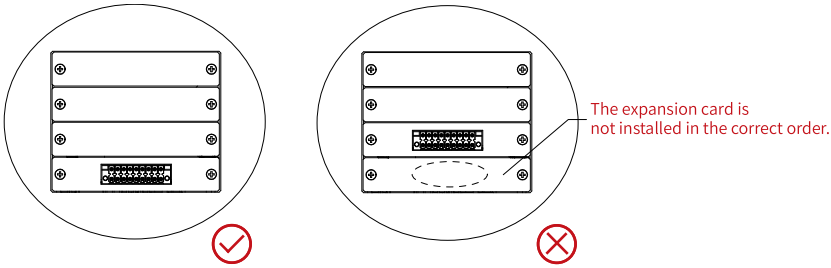
1. Open the top cover of the controller.



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.

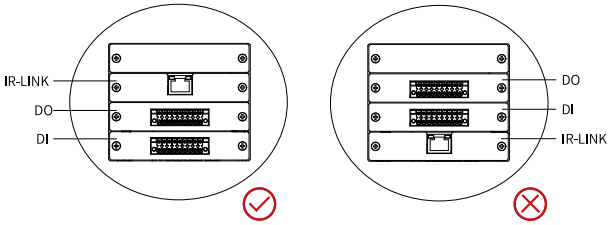


Note

- 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.

Note

The IR-LINK expansion card must be mounted after expansion cards. Otherwise, it cannot be used properly.



Note

- 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.

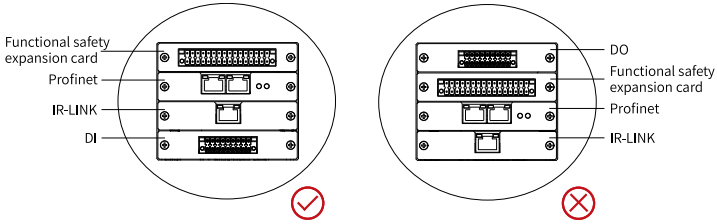


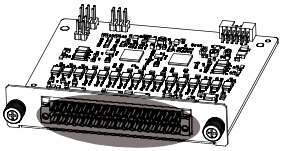
Table 3–1 Optional expansion cards

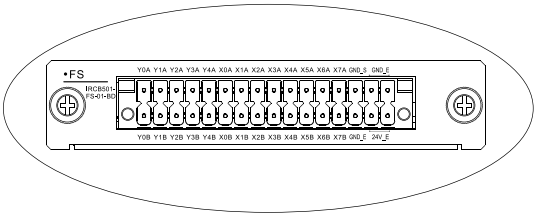
Ordering Code	Model	Name	Software Configuration
01650027	IRCB501-0016ETND-BD	IRCB501 series I/O expansion card with 16 NPN outputs	0016
01650026	IRCB501-1600END-BD	IRCB501 series I/O expansion card with 16 inputs	1600
01650025	IRCB501-2ENID-BD	IRCB501 series 2-channel incremental encoder expansion card	2ENC

Ordering Code	Model	Name	Software Configuration
01650028	IRCB501-2PN-BD	IRCB501 series PROFINET expansion card	PN
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	-

3.2 Connecting DI

3.2.1 DI Definition





Definition	I/O Number	Definition	I/O Number	Name
X0A	DI0A	X0B	DI0B	Safety 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 DIs			

3.2.2 DI Specifications

Item	Specification
Number of channels	16 channels (X0A to X7A and X0B to X7B)
Input type	Source type (PNP)
Max. input voltage	30 V
Input impedance	>4 kΩ
Input voltage when input is ON	18 VDC to 30 VDC

Item	Specification
Input voltage when input is OFF	0 VDC to 3 VDC
Hardware response time	ON/OFF: 250 μs/250 μs
Frequency range	1 kHz

3.2.3 Wiring Procedure

Wiring rules

GND_S is the common terminal for the 16 DIs. When GND_S is connected to 24 V and X* A and X* B are connected to 0 V, the input signal is inactive (optocoupler OFF); When GND_S is connected to 0 V and X* A and X* B are connected to 24 V, the input signal is active (optocoupler ON). The NPN type I/O device can be connected.

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

The load current flows to the output (Y) terminal, and such output is called an NPN type output, which is a low-level output.

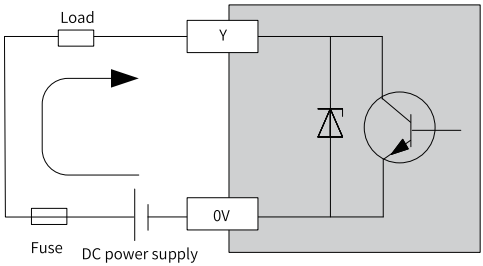


Figure 3-1 NPN output

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

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

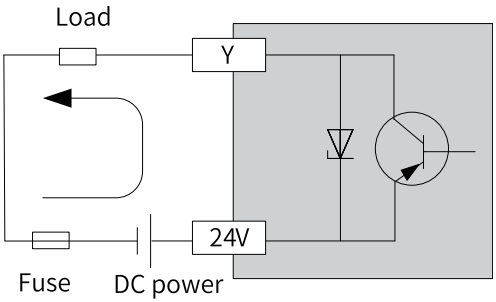


Figure 3-2 PNP output

Note

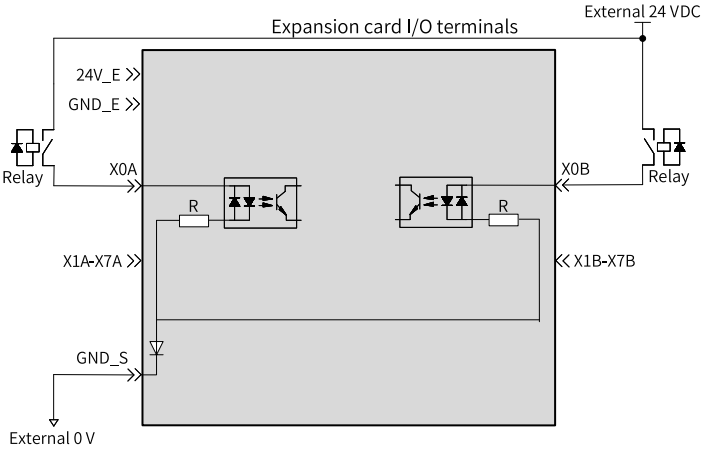
NPN output is low level, while PNP output is high level.

Wiring diagram

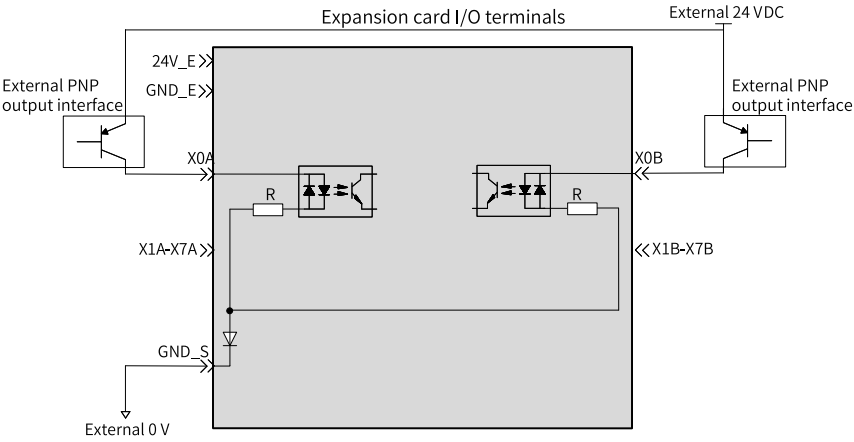
Here we take X0A and X0B as an example (X1A to X7A and X0B to X7B are the same as X0A). It is recommended to use an external power supply.

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.

- Case 1: The host controller provides relay output.



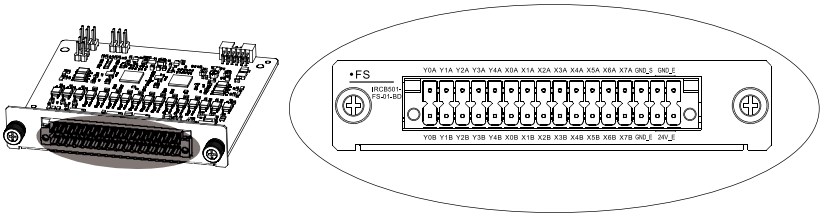
- Case 2: The host controller provides open-collector output.



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 can be connected or not. If the DO function is needed, it is necessary to perform wiring according to the DO wiring instructions.

3.3 Connecting DO

3.3.1 DO Definition



Definition	I/O Number	Definition	I/O Number	Name
Y0A	DO0A	Y0B	DO0B	Safety 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				

3.3.2 DO Specifications

Item	Specification
Number of channels	10 channels (Y0A to Y4A and Y0B to Y4B)
Output type	Sink type (NPN)
Operating voltage range	0 VDC to 29 VDC
24V_E and GND_E power supply	24 V±20%/0.2 A
Output load (resistive load)	0.4 A/point
Hardware response time	<250 μs (OFF -> ON), 250 μs (ON -> OFF)
Leakage current	Max. 350 μA@24 V
Short circuit protection	Overcurrent protection (0.8 A)
Output frequency	1 kHz

3.3.3 Wiring Procedure

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 0.2 A. If the single output current exceeds 0.8 A, an over-current alarm occurs.

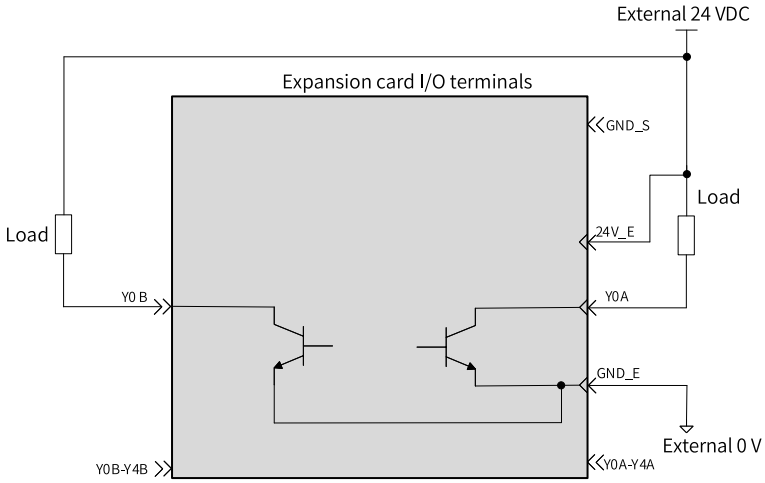
1. Do not short-circuit outputs directly to +24 V.
2. Do not connect outputs to 0V and GND_E to +24V of the power supply.
3. The connected load voltage of outputs should be less than 29 V.

Failure to comply with the above three requirements may damage the circuit.

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 input circuits are required for connection of load. For example, Y0_A and Y0_B are in one group:



Wiring example

- Driving inductive load

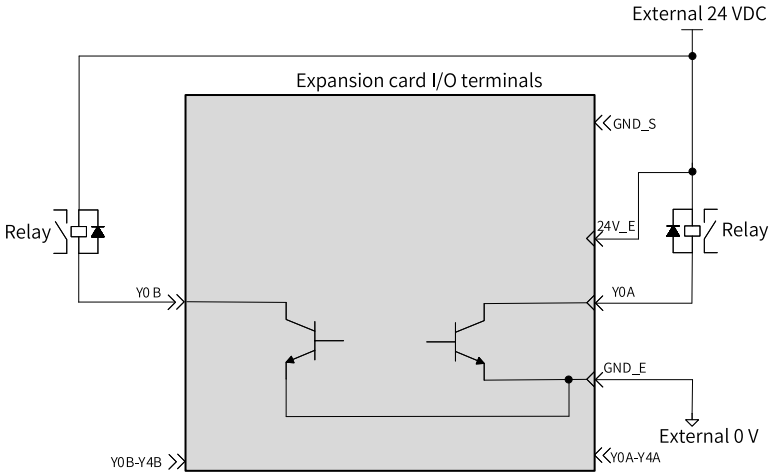
Note

When the inductive load is applied, large back EMF will be produced between contacts and arc discharge is also caused when the inductive load stops. This may result in contact failure or contact sag, shortening the contact lifetime. Therefore, you can use a parallel flywheel diode with the load to extend the lifetime of the product.

The flywheel diode must meet the following requirements:

- Reverse voltage: 5 to 10 times of load voltage;
- Forward current: Larger than load current.

Correct wiring:



Wrong wiring:

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

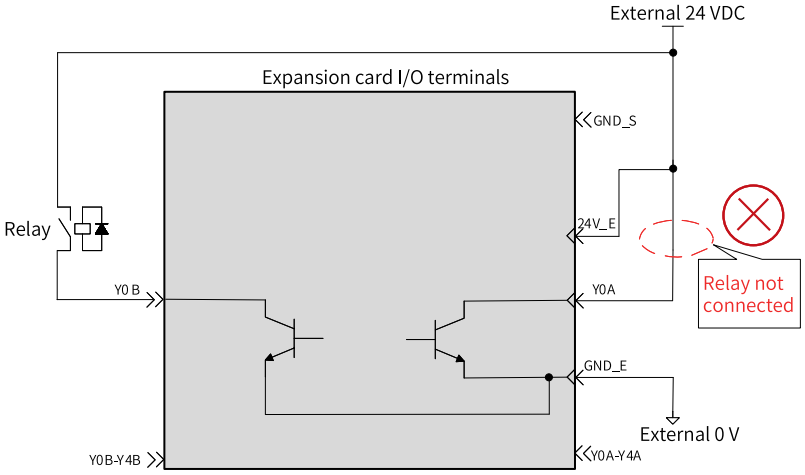


Figure 3-3

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

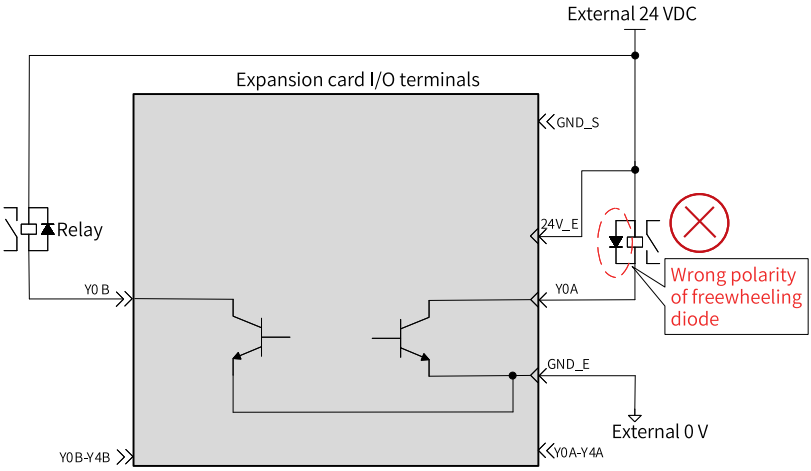
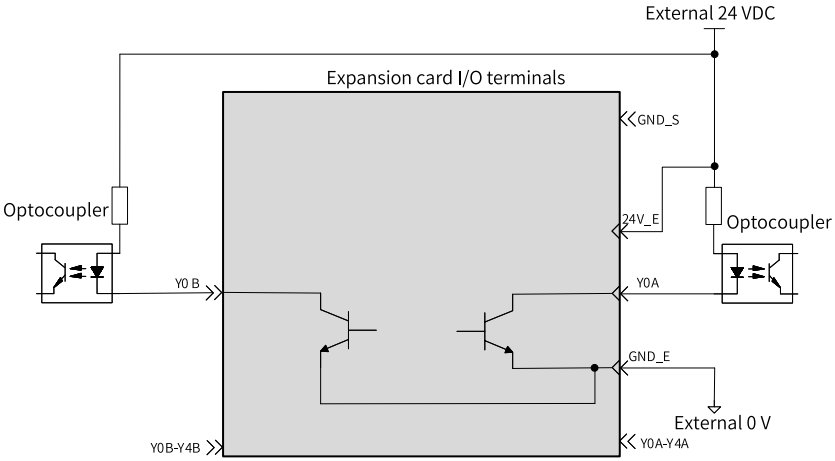


Figure 3-4

- Driving optocoupler load



4 Safety Functions

4.1 Overview

Safety function	Description
Safety I/O (communication security)	The safety I/Os are dual-circuit compliant. A safety DI can be configured to trigger an emergency stop, a safety door, a safety function, or select a safety tool mode and number. A safety DO can be configured to indicate a status, including emergency stop status, running status, stop status, and status of a safety function.
Safety manual mode monitoring	It is a safety monitoring function. When the robot's TCP speed exceeds 250 mm/s in the manual mode, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration.
Joint position monitoring	It is a safety monitoring function. When the position of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to eight groups of joint position monitoring parameters. Each group of parameters can be used to monitor up to six joints of the robot.
Joint speed monitoring	It is a safety monitoring function. When the speed of any robot joint exceeds the range set by the user, the it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to eight groups of joint speed monitoring parameters. Each group of parameters can be used to monitor up to six joints of the robot.
TCP position monitoring	It is a safety monitoring function. When the robot's TCP position exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to 16 groups of TCP position monitoring parameters. Each group of parameters can be used to monitor a designated end monitoring object of the robot.
TCP speed monitoring	It is a safety monitoring function. When the robot's TCP speed exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to eight groups of TCP speed monitoring parameters.
Safety tool mode setting	It allows you to set a target TCP to be monitored by the safety module.

4.2 Safety I/Os

Overview

The safety I/Os are dual-circuit compliant. A safety DI can be configured to trigger an emergency stop, a safety door, a safety function, or select a safety tool mode and number.

A safety DO can be configured to indicate a status, including emergency stop status, running status, stop status, and status of a safety function.

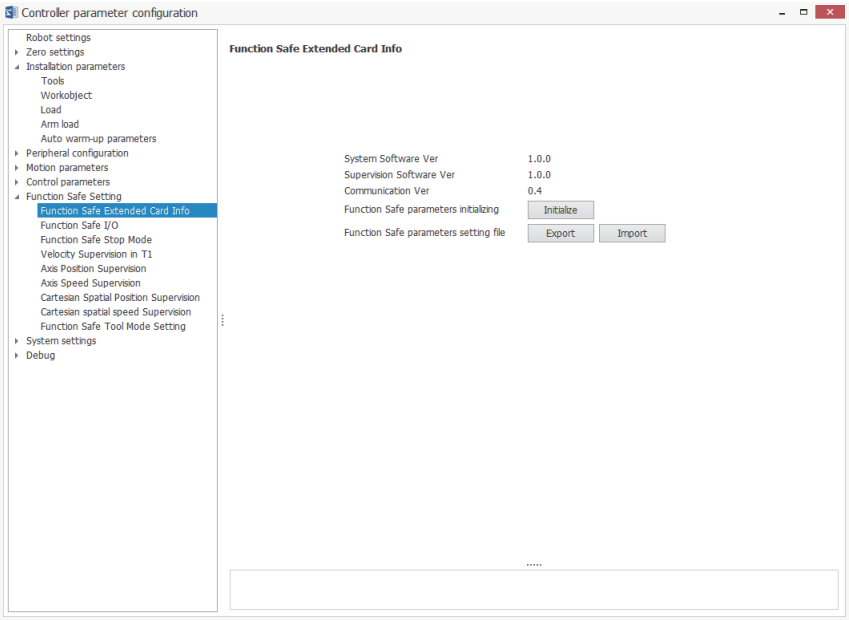
Related Parameters

The following table describes the parameters related to the safety I/O functions.

Name	Setpoint	Default	Description
Safety DI configuration	NULL	NULL	The safety I/Os are dual-circuit compliant. A safety DI can be configured to trigger an emergency stop, a safety door, a safety function, or select a safety tool mode and number.
	Emergency stop trigger		
	Safety door		
	Joint position monitoring trigger		
	Joint speed monitoring trigger		
	TCP position monitoring trigger		
	TCP speed monitoring trigger		
	Safety manual mode monitoring trigger		
	TCP/ECP mode		
	Tool number bit0		
	Tool number bit1		
	Tool number bit2		
	Tool number bit3		
DI trigger threshold configuration	0 ms to 1000 ms	4 ms	The dual-circuit DI requires the two inputs to be synchronous within the DI trigger threshold. Otherwise, an error occurs. Note: When the two inputs are dis-synchronized for more than 6 ms, a stop will be triggered.

Name	Setpoint	Default	Description
Safety DO configuration	NULL	NULL	A safety DO can be configured to indicate a status, including emergency stop status, running status, stop status, and status of a safety function.
	Emergency stop status		
	Running status		
	Stop status		
	Joint position monitoring status		
	Joint speed monitoring status		
	TCP position monitoring status		
	TCP speed monitoring status		
	Safety manual mode monitoring status		

Safety parameter initialization



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

Note

After initialization, restart the controller.

4.3 Joint Position Monitoring

Overview

It is a safety monitoring function. When the position of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to eight groups of joint position monitoring parameters. Each group of parameters can be used to monitor up to six joints of the robot.

Related Parameters

The following table describes the parameters related to the joint position monitoring function.

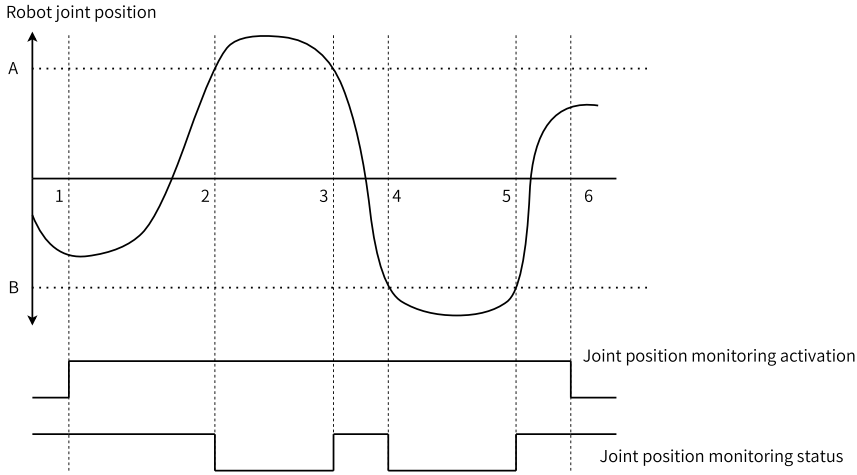
Name	Setpoint	Default	Description
Trigger method	Inactive	Inactive	When you choose "Inactive", the joint position monitoring function is disabled. The position of the robot joint is not monitored. When you choose "Always active", the joint position monitoring function is permanently enabled. The position of the robot joint is monitored in real time. When you choose "DI trigger", the joint position monitoring function is enabled or disabled depending on the status of the bound DI.
	Always active		
	DI trigger		
Safety range of joint position	The safety range of the joint position is subject to the robot model. It must not exceed the position limit of the robot joint.	0	You can set the safety range of the monitored robot joint position in the forward and reverse directions.
Stop mode	Category 0 stop	Category 0 stop	When the position of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
	Category 1 stop		

Name	Setpoint	Default	Description
Activate	False	False	Whether to activate the current group of joint position monitoring parameters. If not activated, the group of parameters will not be used for the joint position monitoring.
	True		

Function trigger method

- Option 1: You can set the trigger method to "Always active".
- Option 2: You can set the trigger method to "DI trigger". In this case, you need to set the status of the bound DI to "TRUE".

Sequence diagram



Name	Definition	Description
A	Upper limit of joint position monitoring	Defines the upper position limit of each joint
B	Lower limit of joint position monitoring	Defines the lower position limit of each joint
-	Joint position monitoring limits (A and B)	Subject to robot model and must be within the range of joint position limits.

Step	Behavior
1	Activate the joint position monitoring function. The safety module starts monitoring the joint position.
2	When the position of any joint exceeds the upper limit (A), the joint position monitoring status changes to abnormal.

4.4 Joint Speed Monitoring

Overview

It is a safety monitoring function. When the speed of any robot joint exceeds the range set by the user, the it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to eight groups of joint speed monitoring parameters. Each group of parameters can be used to monitor up to six joints of the robot.

Related parameters

The following table describes the parameters related to the joint speed monitoring function.

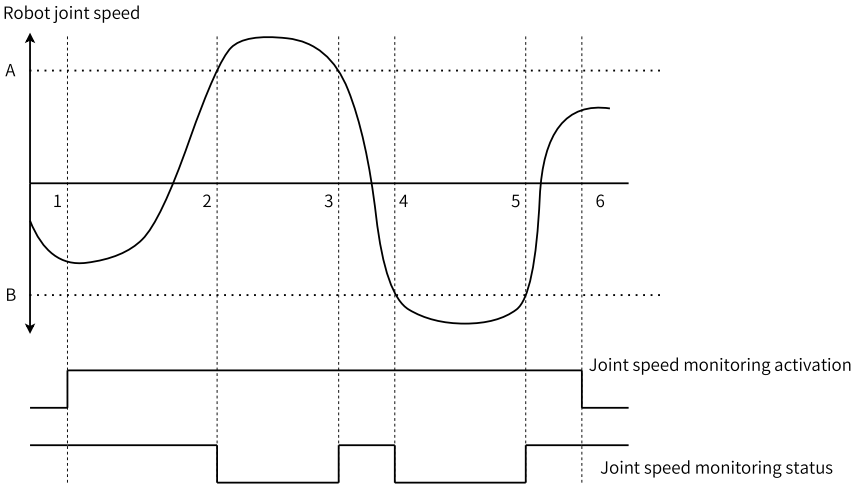
Name	Setpoint	Default	Description
Trigger method	Inactive	Inactive	When you choose "Inactive", the joint speed monitoring function is disabled. The speed of the robot joint is not monitored.
	Always active		When you choose "Always active", the joint speed monitoring function is permanently enabled. The speed of the robot joint is monitored in real time.
	DI trigger		When you choose "DI trigger", the joint speed monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of joint speed	The safety range of the joint speed is subject to the robot model. It must not exceed the speed limit of the robot joint.	0	You can set the safety range of the robot joint speed to be monitored.

Name	Setpoint	Default	Description
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the speed of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate the current group of joint speed monitoring parameters. If not activated, the group of parameters will not be used for the joint speed monitoring.

Function trigger method

- Option 1: You can set the trigger method to "Always active".
- Option 2: You can set the trigger method to "DI trigger". In this case, you need to set the status of the bound DI to "TRUE".

Sequence diagram



4.5 TCP Position Monitoring

Overview

It is a safety monitoring function. When the robot's TCP position exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to 16 groups of TCP position monitoring parameters. Each group of parameters can be used to monitor a designated end monitoring object of the robot.

Related parameters

The parameters involved in TCP position monitoring include trigger method, safety zone parameters, and end monitoring object parameters.

Trigger method:

Name	Setpoint	Default	Description
Trigger method	Inactive	Inactive	When you choose "Inactive", the TCP position monitoring function is disabled. The TCP position of the robot's end monitoring object is not monitored.
	Always active		When you choose "Always active", the TCP position monitoring function is permanently active. The TCP position of the robot's end monitoring object is monitored in real time.
	DI trigger		When you choose "DI trigger", the TCP position monitoring function is enabled or disabled depending on the status of the bound DI.

Interference zone parameters:

Name	Setpoint	Default	Description
Activate	False True	False	Whether to activate or deactivate a safety zone. If deactivated, the zone will not be used for TCP position monitoring.
Remarks	The length of remarks must not exceed 31 characters.	NULL	Descriptive information of the safety zone.
Inside/Outside	Inside Outside	Inside	Specifies the inside or outside of the safety zone as an interference zone.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the TCP 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], in mm	0	Increases or decreases the interference zone as a whole by the set safety distance.
Safety zone setting method	Diagonal point Base point + offset	Diagonal point	You can set the safety zone by diagonal points, or by base point + offset. The point is taken relative to the current workobject coordinate system.
Safety zone point parameter	The range of the point value is [-10000,10000], in mm. The range of offset value is [-10000,0)(0,10000], in mm.	0	You can enter the point manually or click the **Get point** button to acquire the current point automatically.

End monitoring object parameters:

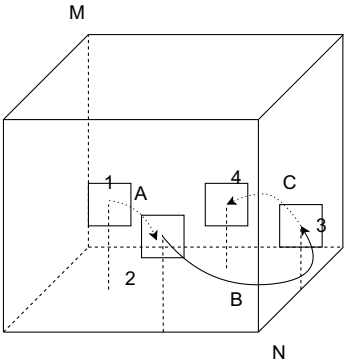
Name	Setpoint	Default	Description
Activate	False	False	Whether to activate or deactivate the current end monitoring object. If deactivated, the object will not be used for TCP position monitoring.
	True		
Remarks	The length of remarks must not exceed 31 characters.	NULL	Descriptive information of the end monitoring object.
Monitoring object type	TCP (tool selected in the safety tool mode setting)	TCP	Specifies the inside or outside of the safety zone as an interference zone.
	MTCP		
	Sphere		
	Cuboid bounding box		

Name	Setpoint	Default	Description
Monitoring object parameters	The range of the point value is [-10000,10000], in mm. The range of offset value is [-10000,0)(0,10000], in mm. The range of sphere center is [-10000,10000] and the range of radius is (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 coordinate system in the lower part of the software interface. • Sphere: The spherical center is offset from the Z direction of the flange coordinate system. The eccentric sphere is not supported. • Cuboid bounding box: You can define the box by diagonal points, by base point + offset, or by getting the robot points.

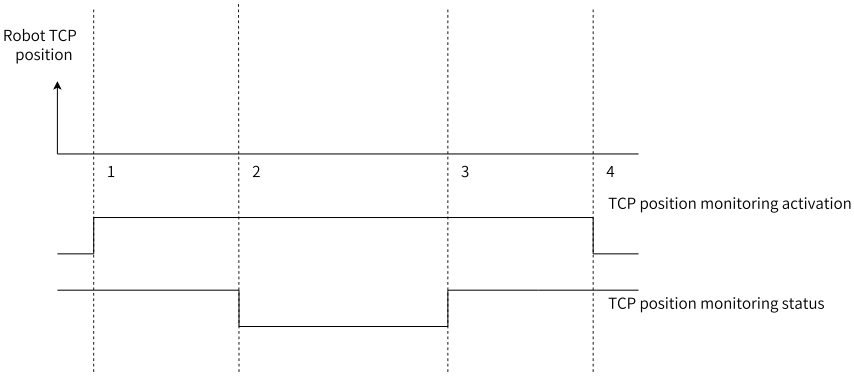
Function trigger method

- Option 1: You can set the trigger method to "Always active".
- Option 2: You can set the trigger method to "DI trigger". In this case, you need to set the status of the bound DI to "TRUE".

Sequence diagram



1 and 4 are located within the safety zone,
while 2 and 3 are located on the critical plane of safety zone;
trajectory segments A and C are located within
the safety zone, while B is located outside the safety zone.



Name	Definition	Description
M, N	The safety zone is a cube with M and N as the diagonal points.	User-defined limits of TCP position
-	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.

Step	Behavior
1	Activate the TCP position monitoring function. The safety module starts monitoring the TCP position.
2	When the TCP position exceeds the safety zone, the TCP position monitoring status changes to abnormal.

4.6 TCP Speed Monitoring

Overview

It is a safety monitoring function. When the robot's TCP position exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration. You can configure up to eight groups of TCP speed monitoring parameters.

Related parameters

The following table describes the parameters related to the TCP speed monitoring function.

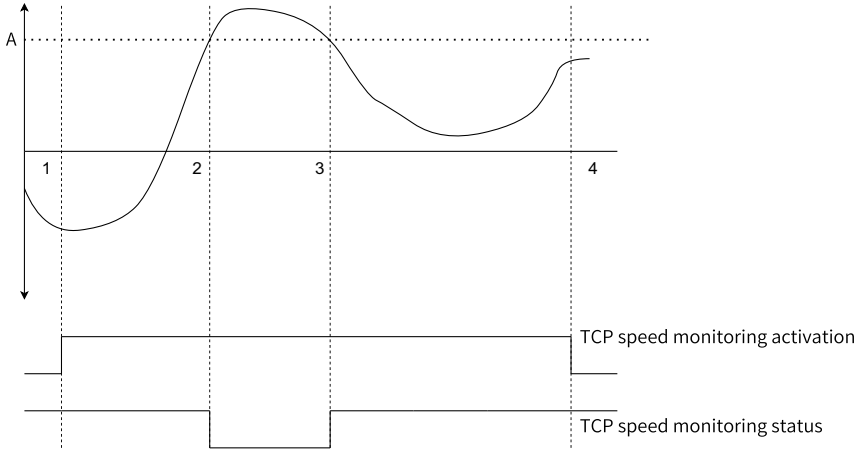
Name	Setpoint	Default	Description
Trigger method	Inactive	Inactive	When you choose "Inactive", the TCP speed monitoring function is disabled. The TCP speed of the robot is not monitored.
	Always active		When you choose "Always active", the TCP speed monitoring function is permanently enabled. The TCP speed of the robot is monitored in real time.
	DI trigger		When you choose "DI trigger", the TCP speed monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of TCP speed	0 to 10000 mm/s	0	You can set the safety range of the robot TCP speed to be monitored.
Stop mode	Category 0 stop	Category 0 stop	When the speed of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
	Category 1 stop		

Name	Setpoint	Default	Description
Activate	False True	False	Whether to activate or deactivate the group of TCP speed parameters. If deactivated, the group of parameters will not be used for TCP speed monitoring.

Function trigger method

- Option 1: You can set the trigger method to "Always active".
- Option 2: You can set the trigger method to "DI trigger". In this case, you need to set the status of the bound DI to "TRUE".

Sequence diagram



Name	Definition	Description
A	Upper limit of TCP speed monitoring	Defines the upper limit of the TCP speed
-	TCP speed monitoring limit (speed amplitude)	0 to 10000 mm/s

Step	Behavior
1	Activate the TCP speed monitoring function. The safety module starts monitoring the TCP speed.
2	When the TCP speed exceeds the upper limit, the TCP speed monitoring status changes to abnormal.

4.7 Safety Manual Mode Monitoring

Overview

It is a safety monitoring function. When the robot's TCP speed exceeds 250 mm/s in manual mode, it triggers a Category 0 or 1 emergency stop and sets an output signal, depending on the user configuration.

Related Parameters

The following table describes the parameters related to the safety manual mode monitoring function.

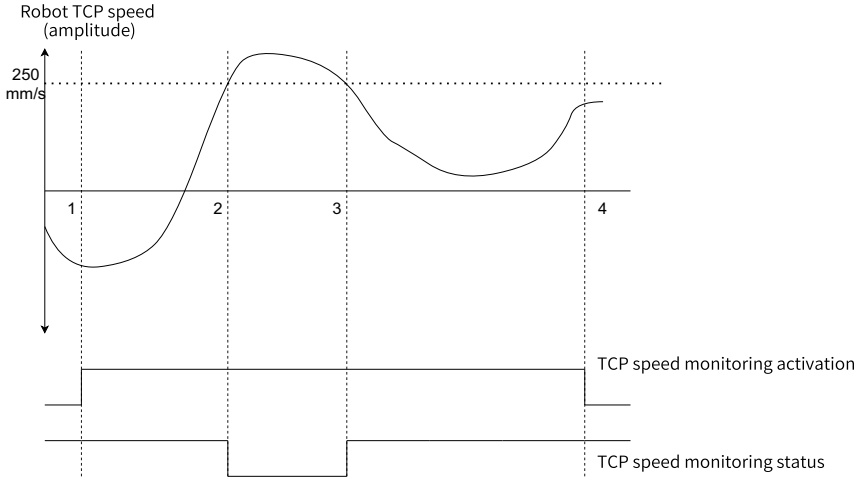
Name	Setpoint	Default	Description
Trigger method	Inactive	Inactive	When you choose "Inactive", the safety manual mode monitoring function is disabled. The TCP speed of the robot safety tool is not monitored.
	Always active		When you choose "Always active", the safety manual mode monitoring function is permanently enabled. The TCP speed of the robot is monitored in real time.
	DI trigger		When you choose "DI trigger", the safety manual mode monitoring function is enabled or disabled depending on the status of the bound DI.
Stop mode	Category 0 stop	Category 0 stop	When the TCP speed of the robot's safety tool exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
	Category 1 stop		

Function trigger method

- Option 1: You can set the trigger method to "Always active".

- Option 2: You can set the trigger method to "DI trigger". In this case, you need to set the status of the bound DI to "TRUE".

Sequence diagram



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

Step	Behavior
1	Activate the TCP speed monitoring function. The safety module starts monitoring the TCP speed.
2	When the TCP speed exceeds the upper limit, the TCP speed monitoring status changes to abnormal.

4.8 Safety Tool Mode Setting

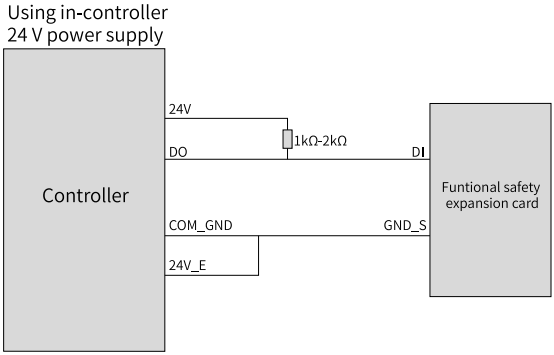
Overview

It allows you to set a target TCP to be monitored by the safety module.

Related parameters

Name	Setpoint	Default	Description
Safety tool mode	Follow system tool	Fixed safety tool	When you choose "Follow system tool", you need to configure five standard DOs. Besides, you need to configure the corresponding safety DIs and perform physical connection. These DIs are used to select the tool mode (TCP, ECP) mode and the tool number.
	Fixed safety tool		When you choose "Fixed safety tool", you need to set the tool number or workobject number for monitoring.
	Manual setting		When you choose "Manual setting", you need to configure the safety DIs and complete physical connection.

Wiring diagram of safety tool



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, refer to the InoRobotLab User Guide and the Teach Pendant User manual. For hardware installation, refer to the Controller User Guide and *"3.1 Installing Expansion Card" on page 32* of this guide.

5.2 Configuration on InoRobotLab

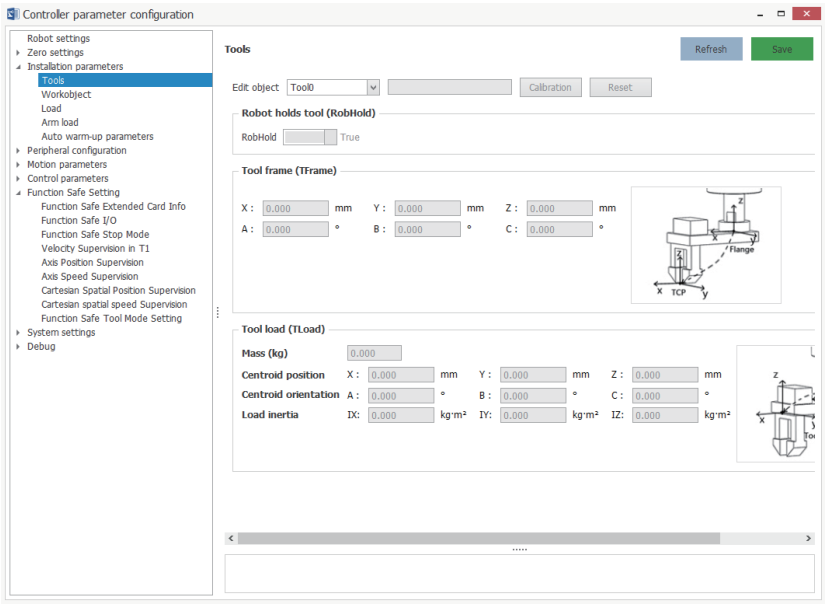
The following table describes the safety functions configuration steps.

No.	Operation
1	Configure the basic parameters
2	Configure the system access
3	Configure the safety tool
4	Configure the safety I/Os
5	Configure the safety stop parameters
6	Configure the safety manual mode monitoring parameters
7	Configure the joint position monitoring parameters
8	Configure the joint speed monitoring parameters
9	Configure the TCP position monitoring parameters
10	Configure the TCP speed monitoring parameters

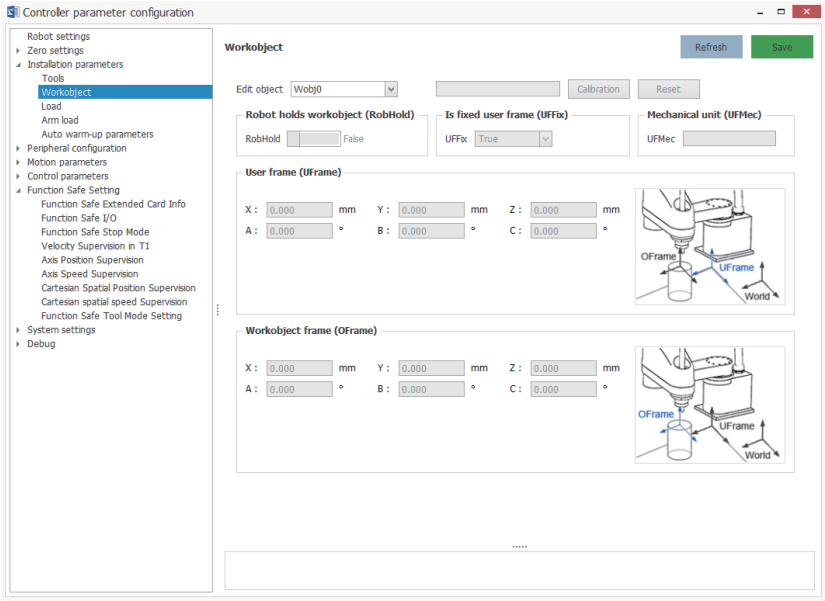
5.2.1 Configuring the Basic Parameters

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 the System Access

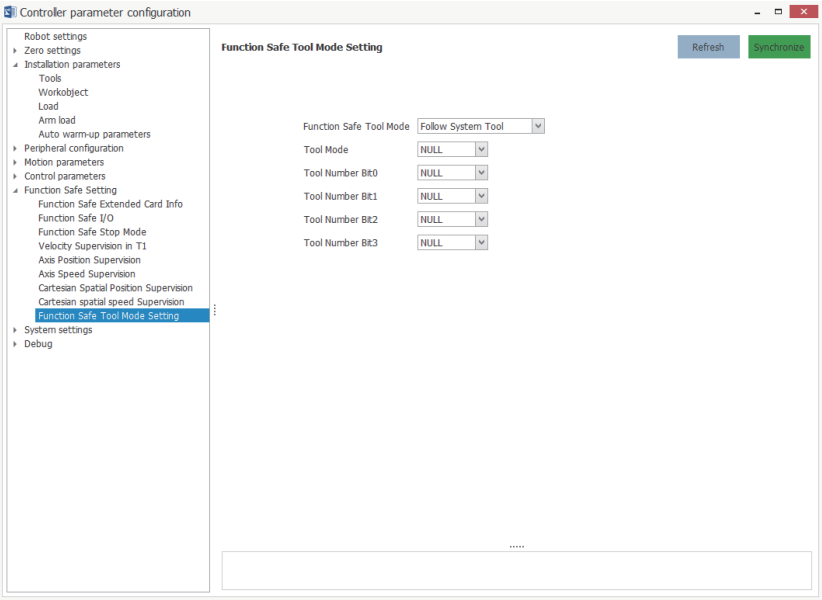
Only authorized operators (editor, administrator and manufacturer) are allowed to modify the safety function parameters. Safety function password is required.

5.2.3 Configuring the Safety Tool

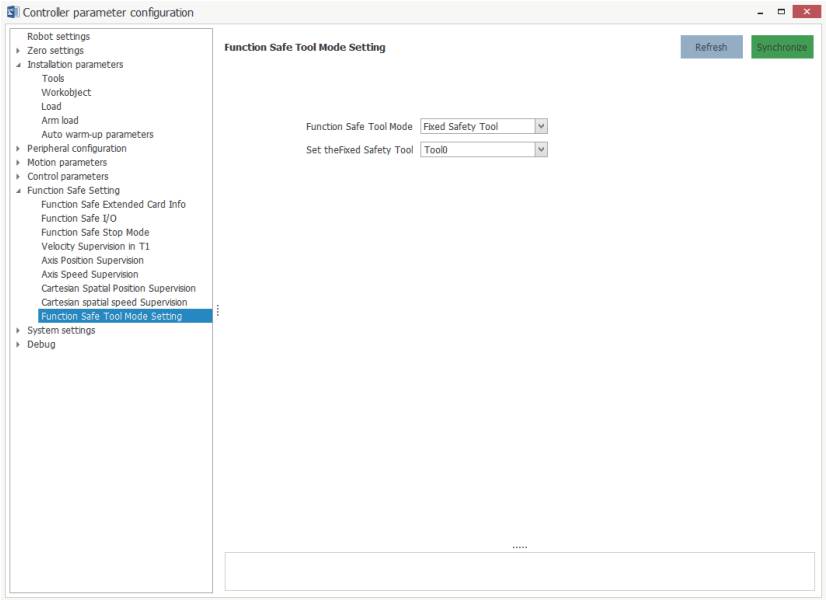
You can set the safety tool to follow the system, use a fixed safety tool, or manually switch the safety tool.

The setting of the safety tool is described below.

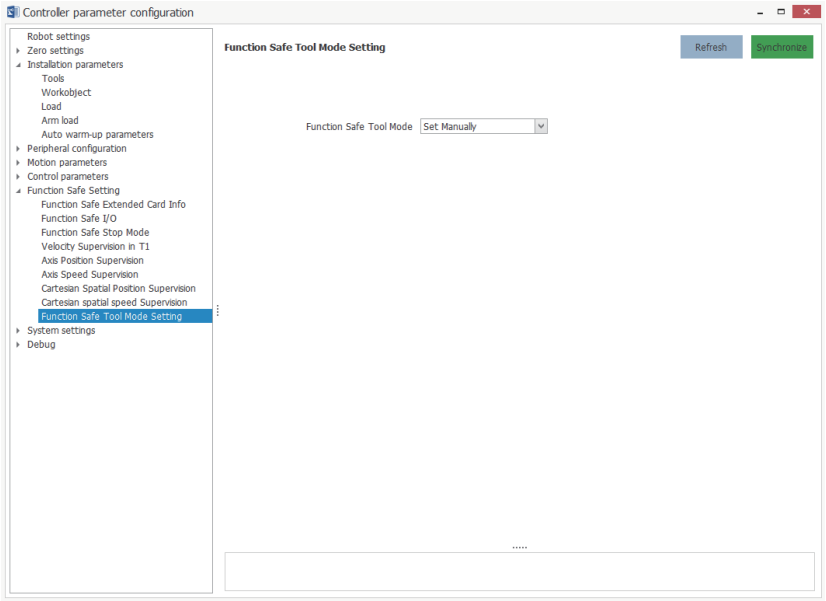
1. If you set the safety tool to follow the system, five standard DOs need to be used. Therefore, these five DOs cannot be used for other functions. It is required to connect the five DOs to DI3-DI7 of the safety expansion card. The controller triggers the corresponding standard DO to provide an output when switching the tool.



2. If you set the safety tool to fixed safety tool, you need to specify a tool (TCP mode) or a workobject (ECP mode) as the safety tool\workobject. In this case, you cannot switch the safety tool via safety I/O or standard I/O. The selected workobject must be held by the robot.



3. If you choose to manually switch the tool, you need to connect the external I/Os to the DI3-DI7 of the safety expansion card. The tool can be switched by the operator manually or by the external device.



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

- 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 TCP position/speed monitored by the safety function and the actual TCP position/speed.
- When you set the safety tool to follow the system or choose to manually switch the safety tool, configure DI4 to DI8 as needed and perform physical connection.
- The safety tool settings are restored to the default values after the controller is restarted. You need to configure the safety tool again each time you restart the controller.

Example:

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

Safety tool mode	Safety I/O	Connection/Status	Description
Follow the system	DI3	Connect standard DO23 of the robot to the safety DI3	Configure the TCP or ECP mode
	DI4	Connect standard DO34 of the robot to the safety DI4	To switch between up to 16 tools/ workobjects, you need to configure safety DI4 to tool number bit0.
	DI5	Connect standard DO56 of the robot to the safety DI5	Configure safety DI5 to tool number bit1
	DI6	Connect standard DO67 of the robot to the safety DI6	Configure safety DI6 to tool number bit2
	DI7	Connect standard DO78 of the robot to the safety DI7	Configure safety DI7 to tool number bit3
Manual setting	DI3	The user controls the status of safety DI3.	If you need to switch between TCP and ECP modes, you need to configure DI3 to the TCP/ECP mode.
	DI4	The user controls the status of safety DI4.	To switch between up to 16 tools/ workobjects, you need to configure safety DI4 to tool number bit0.
	DI5	The user controls the status of safety DI5.	Configure safety DI5 to tool number bit1
	DI6	The user controls the status of safety DI6.	Configure safety DI6 to tool number bit2
	DI7	The user controls the status of safety DI7.	Configure safety DI7 to tool number bit3

The status of DI4-DI7 needs to be set according to the tool/workobject number you want to switched to.

- For example, if you want to switch the safety tool to Tool7, you need to increase the level of DI4, DI5, and DI6.
- If you want to switch the safety tool to Tool11, you need to increase the level of DI4, DI5, and DI7, and decrease the level of DI6.

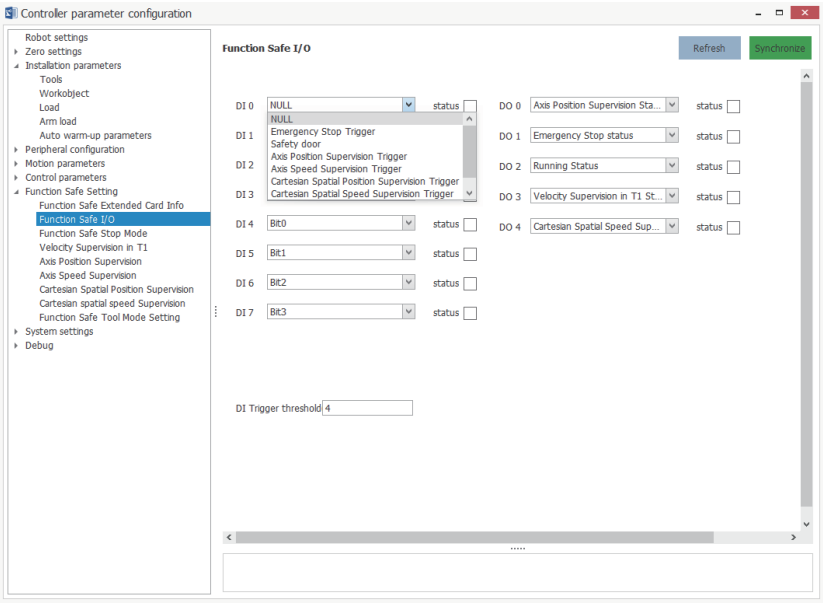
Caution

Safety DI4-DI7 are not required in all cases.

- If the range of tool or workpiece number you need to switch is smaller than 8, you only need to configure DI4-DI6.
- If the range of tool or workpiece number you need to switch is smaller than 4, you only need to configure DI4-DI5.
- If the range of tool or workpiece number you need to switch is smaller than 2, you only need to configure DI4.

5.2.4 Configuring the Safety I/Os

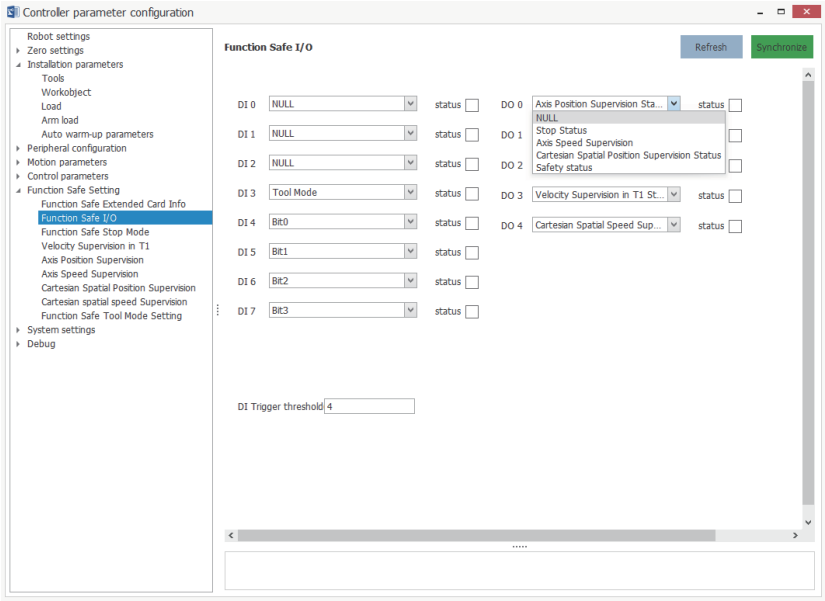
1. A safety DI can be configured to trigger an emergency stop, a safety door, a safety function, or select a safety tool mode and number. You can view the status of the DI in the status bar after the configuration is completed.



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. A safety DO can be configured to indicate a status, including emergency stop status, running status, stop status, and status of a safety function. You can view the status of the DO in the status bar after the configuration is completed.



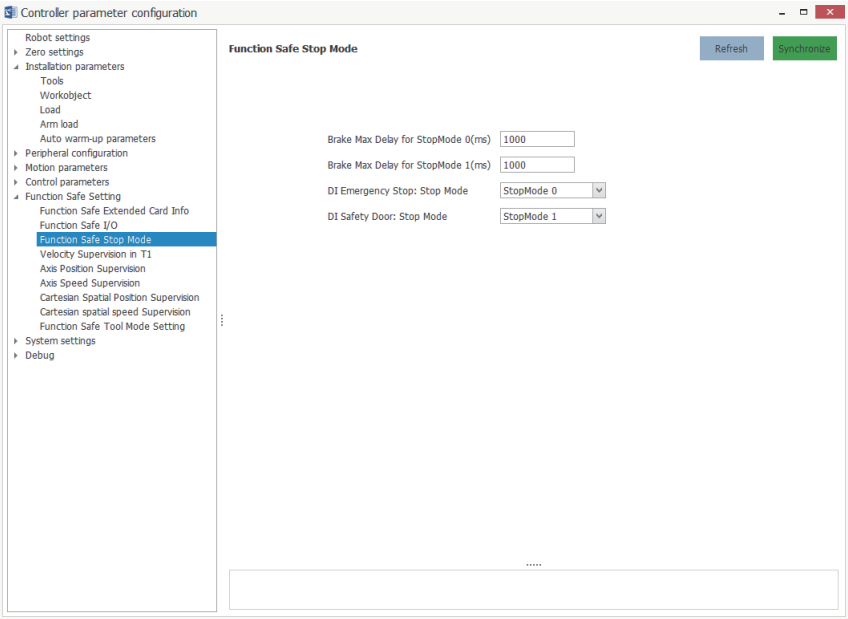
5.2.5 Configuring the Safety Stop Parameters

The safety stop parameters include:

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

You can configure the safety stop parameters as needed.

- The DI-triggered emergency stop is divided into Category 0 emergency stop and Category 1 emergency stop.
- The safety door-triggered stop is divided into Category 0 emergency stop and Category 1 emergency stop.



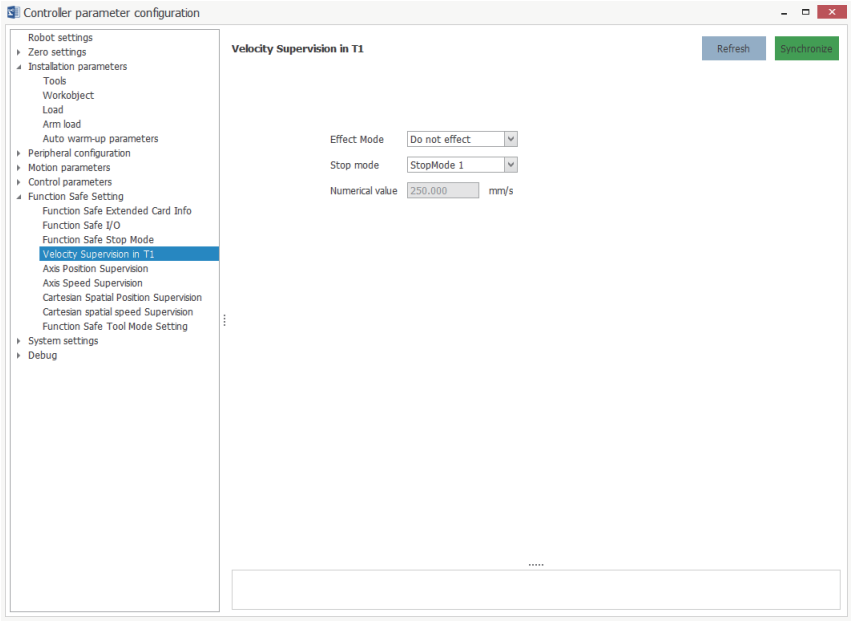
The safety stop parameters take effect immediately after being configured and saved.

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.

5.2.6 Configuring the Safety Manual Mode Monitoring Parameters

You can configure the parameters of the safety manual mode monitoring function as needed, as shown below.

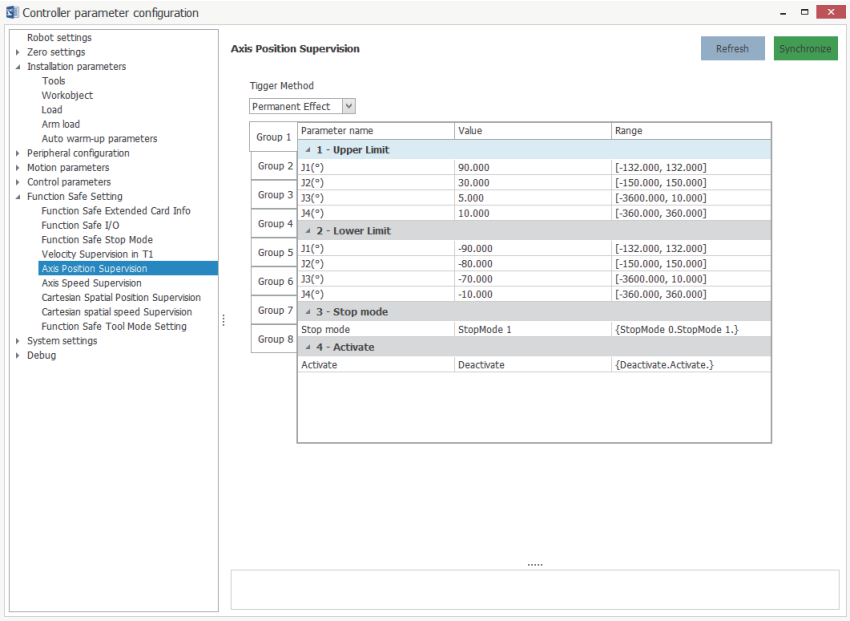

Controller parameter configuration
Robot settings
Zero settings
Installation parameters
Tools
Workobject
Load
Arm load
Auto warm-up parameters
Peripheral configuration
Motion parameters
Control parameters
Function Safe Setting
Function Safe Extended Card Info
Function Safe I/O
Function Safe Stop Mode
Velocity Supervision in T1
Axis Position Supervision
Axis Speed Supervision
Cartesian Spatial Position Supervision
Cartesian spatial speed Supervision
Function Safe Tool Mode Setting
System settings
Debug
Velocity Supervision in T1
Refresh
Synchronize
Effect Mode
Do not effect
Stop mode
StopMode 1
Numerical value
250.000
mm/s

Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the safety manual mode monitoring function is disabled. The TCP speed of the robot safety tool is not monitored. • When you choose "Always active", the safety manual mode monitoring function is permanently enabled. The TCP speed of the robot safety tool is monitored in real time. • When you choose "DI trigger", the safety manual mode monitoring function is enabled or disabled depending on the status of the bound DI.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the TCP speed of the robot safety tool exceeds the range set by the user, it triggers a Category 0 emergency stop or Category 1 emergency stop.
Value	Unchangeable	250 mm/s	In the manual mode, the TCP speed of the safety tool is monitored. Once the speed exceeds 250 mm/s, the corresponding action is triggered.

After the parameters are configured and saved, the safety manual mode monitoring function takes effect immediately.

5.2.7 Configuring the Joint Position Monitoring Parameters

You can configure the parameters of the joint position monitoring function as needed, as shown below.



Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the joint position monitoring function is disabled. The position of the robot joint is not monitored. • When you choose "Always active", the joint position monitoring function is permanently enabled. The position of the robot joint is monitored in real time. • When you choose "DI trigger", the joint position monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of joint position	The safety range of the joint position is subject to the robot model. It must not exceed the position limit of the robot joint.	0	You can set the safety range of the monitored robot joint position in the forward and reverse directions.

Name	Setpoint	Default	Description
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the position of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate the current group of joint position monitoring parameters. If not activated, the group of parameters will not be used for the joint position monitoring.

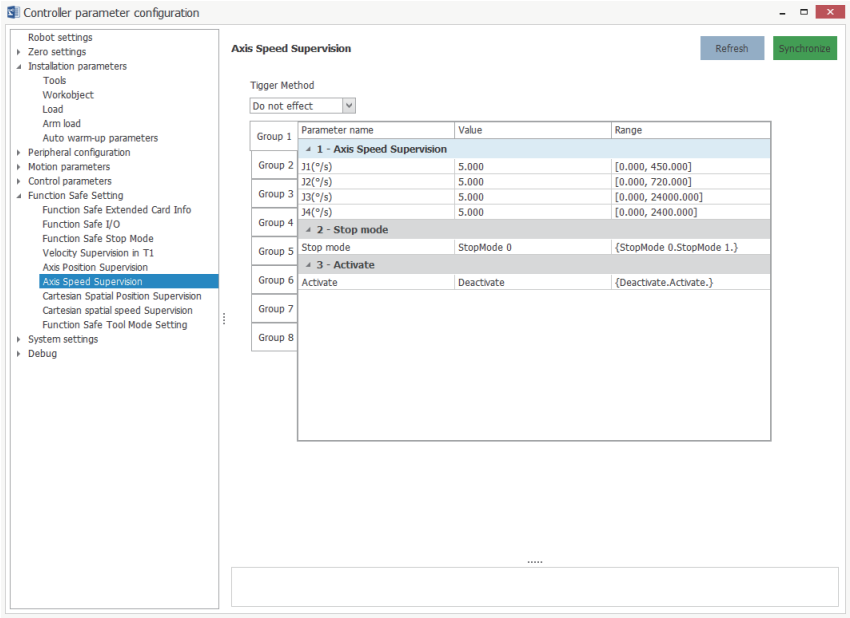
Note

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.

5.2.8 Configuring the Joint Speed Monitoring Parameters

You can configure the parameters of the joint speed monitoring function as needed, as shown below.


Controller parameter configuration
Robot settings
Zero settings
Installation parameters
Tools
Workobject
Load
Arm load
Auto warm-up parameters
Peripheral configuration
Motion parameters
Control parameters
Function Safe Setting
Function Safe Extended Card Info
Function Safe I/O
Function Safe Stop Mode
Velocity Supervision in T1
Axis Position Supervision
Axis Speed Supervision
Cartesian Spatial Position Supervision
Cartesian spatial speed Supervision
Function Safe Tool Mode Setting
System settings
Debug
Axis Speed Supervision
Refresh
Synchronize
Tigger Method
Do not effect
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
Group 7
Group 8
Parameter name
Value
Range
1 - Axis Speed Supervision
J1(°/s)
5.000
[0.000, 450.000]
J2(°/s)
5.000
[0.000, 720.000]
J3(°/s)
5.000
[0.000, 24000.000]
J4(°/s)
5.000
[0.000, 2400.000]
2 - Stop mode
Stop mode
StopMode 0
{StopMode 0.StopMode 1.}
3 - Activate
Activate
Deactivate
{Deactivate.Activate.}

Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the joint speed monitoring function is disabled. The speed of the robot joint is not monitored. • When you choose "Always active", the joint speed monitoring function is permanently enabled. The speed of the robot joint is monitored in real time. • When you choose "DI trigger", the joint speed monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of joint speed	The safety range of the joint speed is subject to the robot model. It must not exceed the speed limit of the robot joint.	0	You can set the safety range of the robot joint speed to be monitored.

Name	Setpoint	Default	Description
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the speed of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate the current group of joint speed monitoring parameters. If not activated, the group of parameters will not be used for the joint speed monitoring.

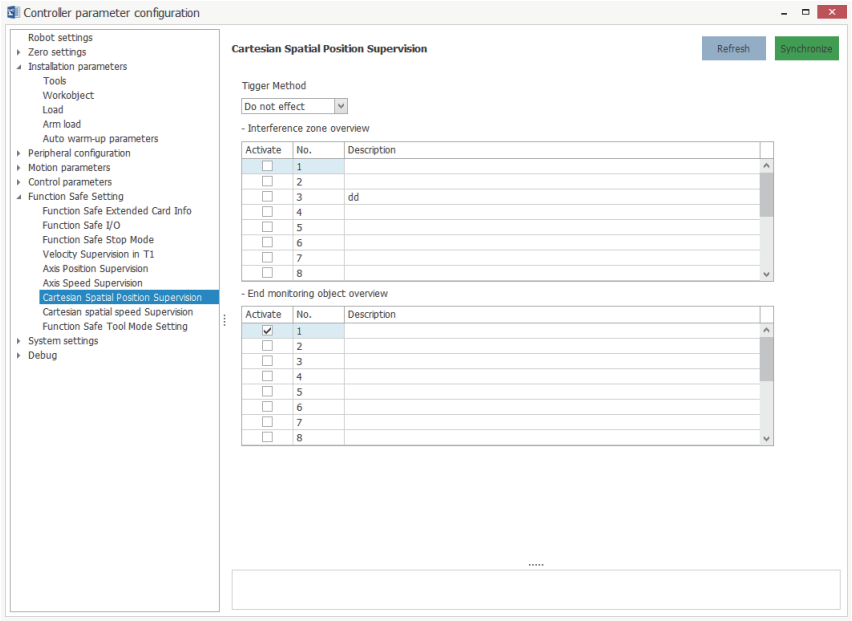
Note

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.

5.2.9 Configuring the TCP Position Monitoring Parameters

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



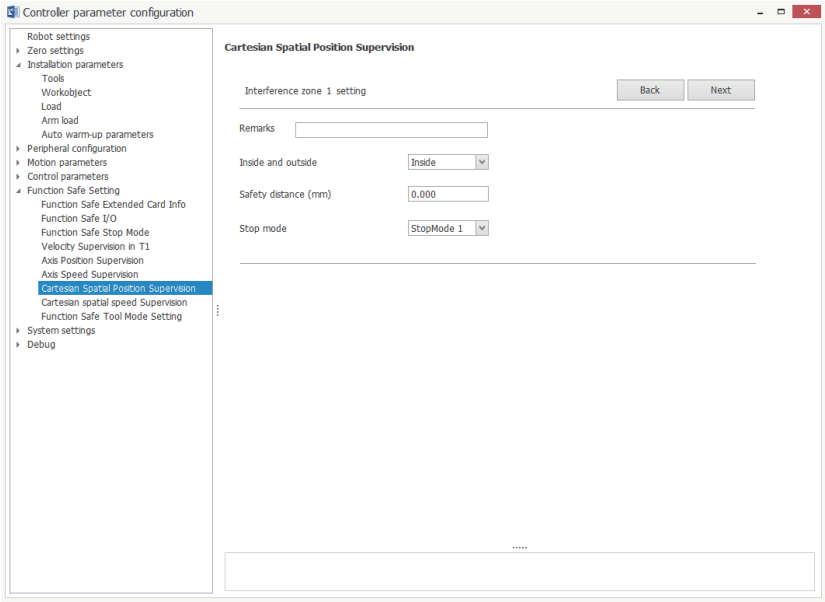
You can activate or deactivate the 16 interference zones and 16 monitoring objects, and view the description of the interference zones and monitoring objects.

Caution

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

---

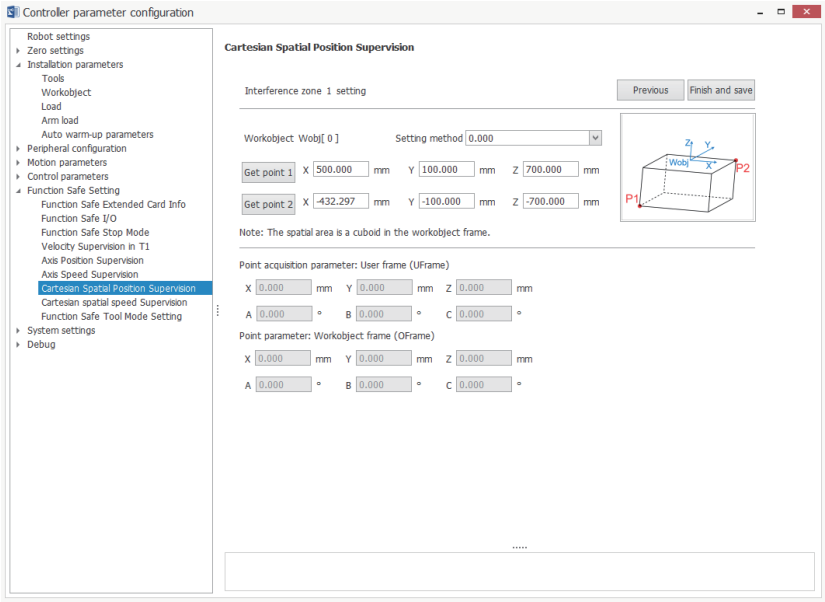
1. Select an interference zone and double-click it to open the parameter setting interface.



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 TCP 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" options. The range of safety distance is [0,10000], in mm.

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



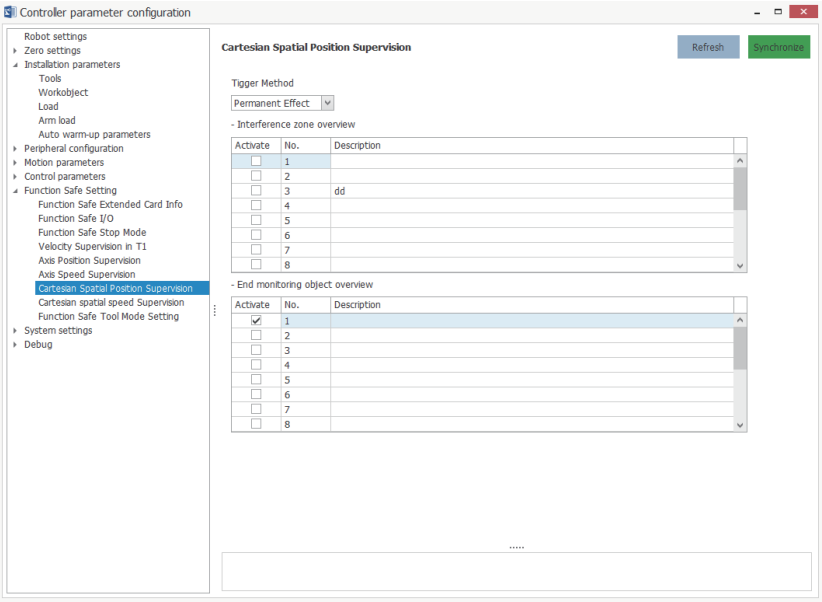
Parameter description:

- Setting method: Sets the interference zone by diagonal points, or by base point + offset. The points are taken in the current workobject coordinate system.
- 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 coordinate parameters in the lower part of the software interface.

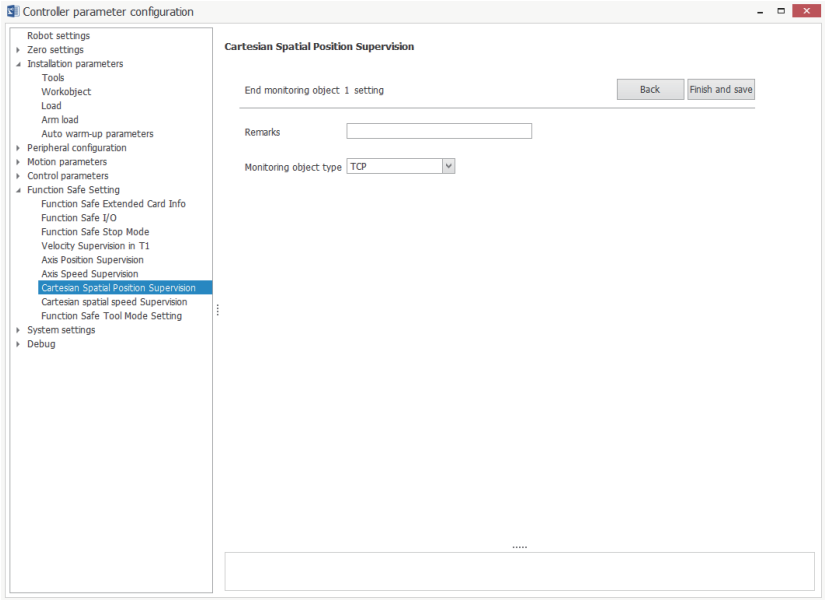
Caution

- The value of the safety distance cannot be less than 0.
- The position of the interference zone is relative to the active workobject coordinate system.
- You cannot get the points of the interference zone in a workobject coordinate system where the workobject is not held by the robot.
- You cannot get the points of the interference zone in a workobject coordinate system where the user coordinate system 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.

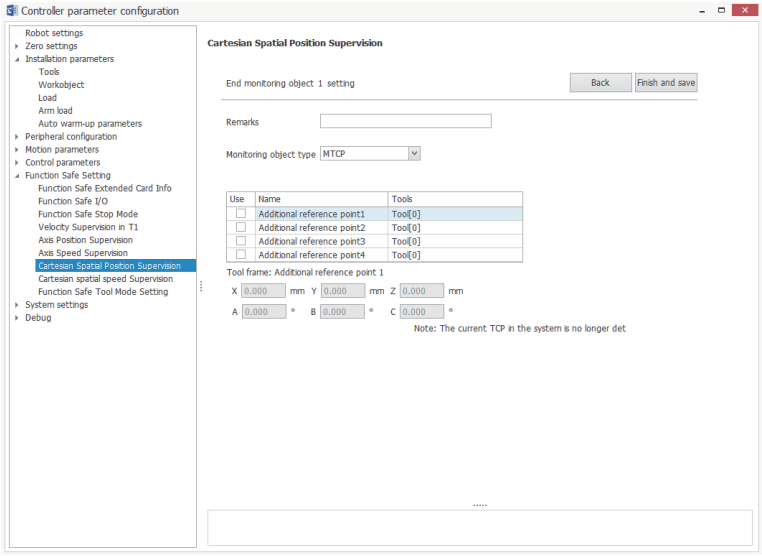


4. Select an end monitoring object and double-click it to open the parameter setting interface.

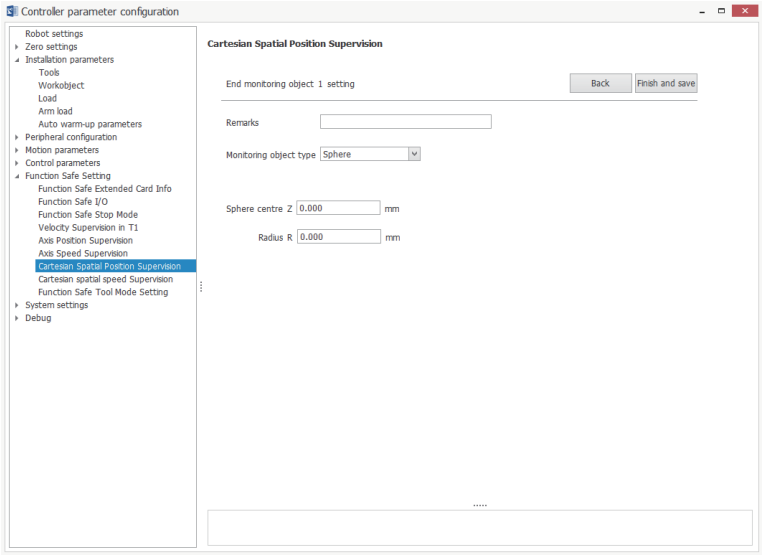


Parameter description:

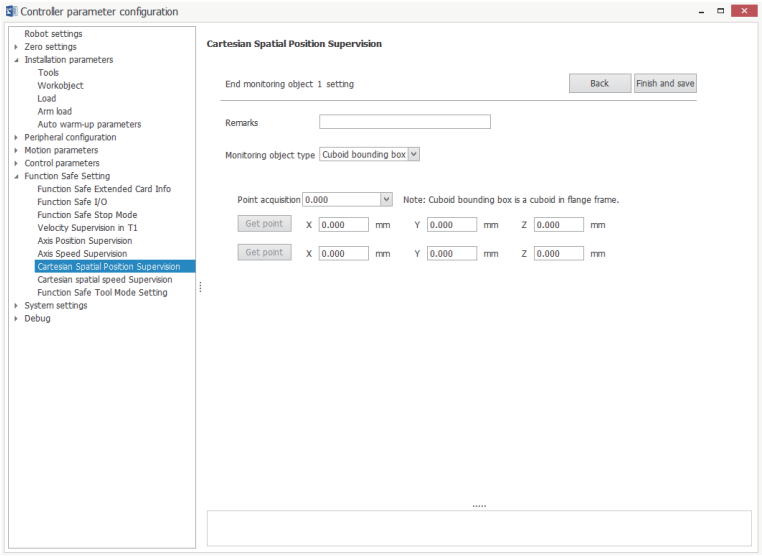
- Remarks: Descriptive information of the current monitoring object.
- Monitoring object type: Includes TCP, MTCP, sphere, and cuboid bounding box. TCP by default.
  - TCP: When the robot grips the tool, the current TCP is used for monitoring. When the robot grips the workobject, the flange center is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



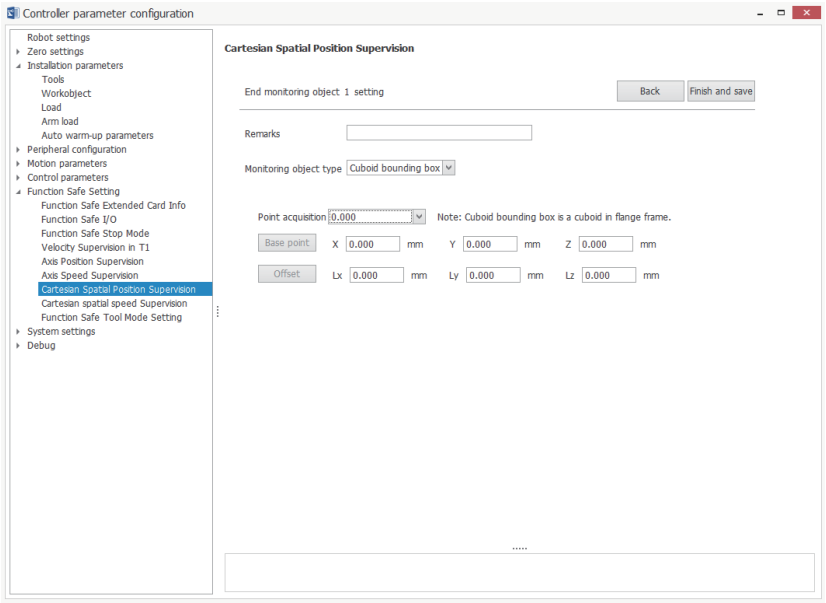
- Sphere: The spherical center is offset from the Z direction of the flange coordinate system, the spherical center range is [-10000,10000] and the radius range is [0,10000], in mm. The eccentric sphere is not supported.



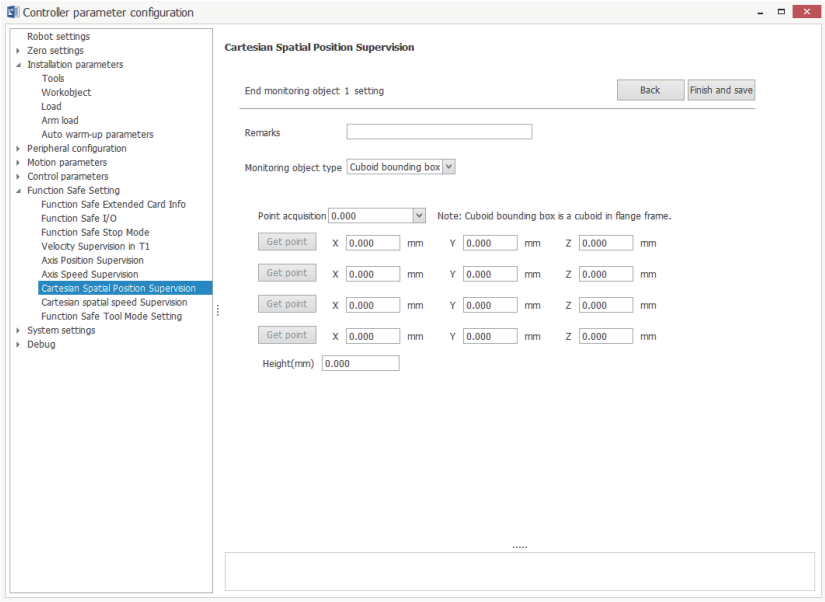
- Cuboid bounding box: You can define the box by diagonal points, by base point + offset, or by getting the robot points.



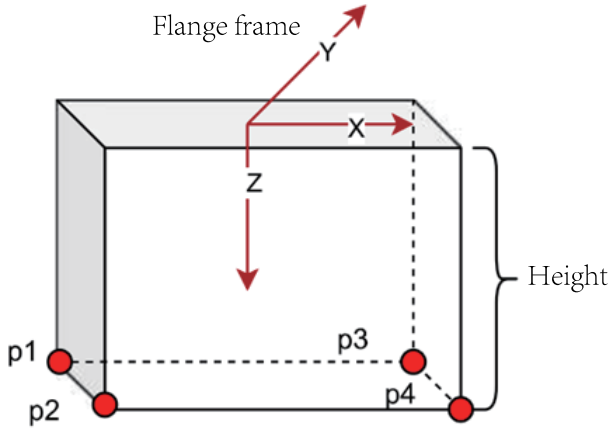
When the point acquisition method is set to "diagonal point", you can enter the point manually or click the **Get point** button to acquire the current point automatically. Note that the **Get point** button is active only when the robot is in ECP mode. The points are taken in the flange coordinate system.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



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



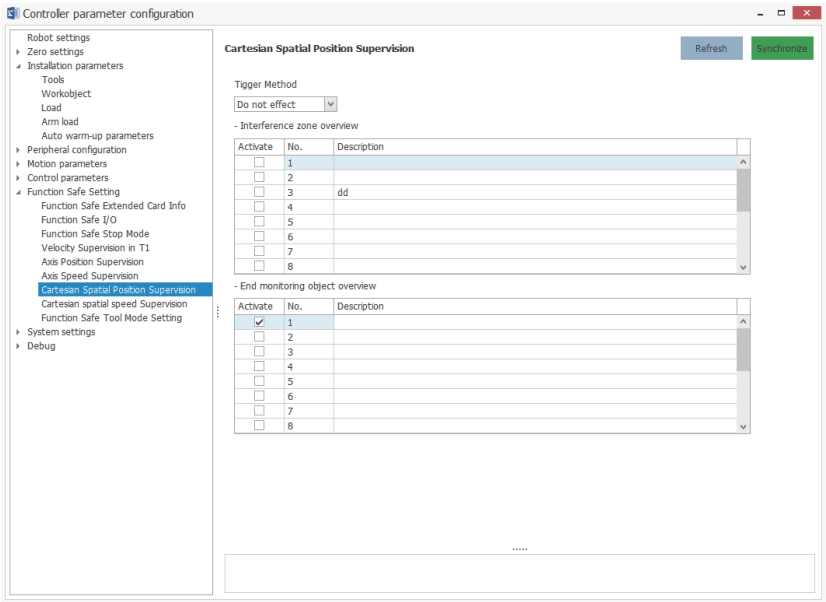
When the point acquisition method is set to "get point", you can enter the point manually, or click the **Get point** button to get the point automatically. Note that the **Get point** button is active only when the robot is in ECP mode. The points are taken in the flange coordinate system. Note that the four points are the four points on the bottom face of the cuboid. The height is the distance in the Z direction under the flange coordinate system. The range of the point value is [-10000,10000] and the range of height is [-0.10000], in mm.



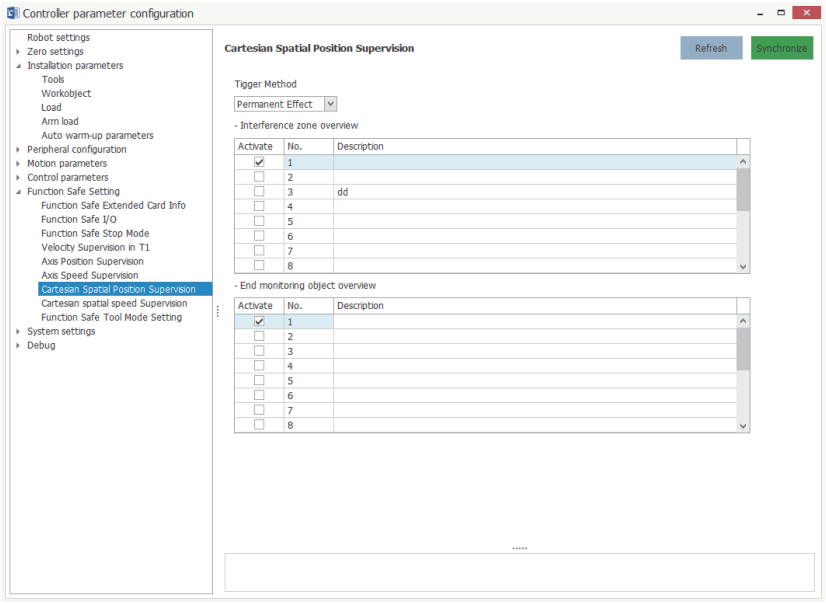
Notes of the cuboid bounding box:

- The orientation of the cuboid bounding box is the same as that of the flange coordinate system. That is, a tilted cuboid bounding box cannot be defined under the flange coordinate system.
- 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 coordinate system 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 TCP position monitoring function takes effect immediately.

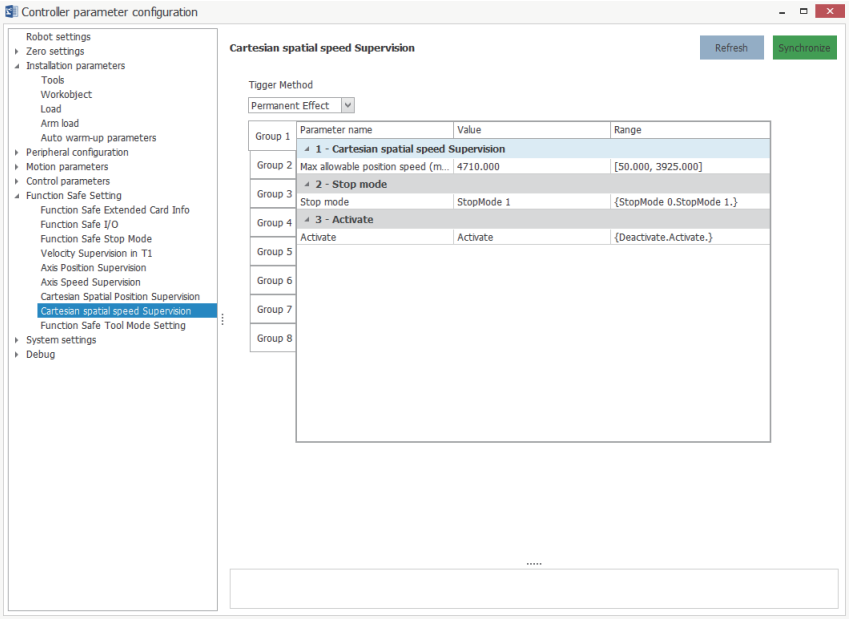
Note:

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

- Once determined, the position of the interference zone under the world coordinate system 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 coordinate system points downwards before setting the points and height. Otherwise, the cuboid cannot be formed properly.

5.2.10Configuring the TCP Speed Monitoring Parameters

You can configure the parameters of the TCP speed monitoring function as needed, as shown below.


Controller parameter configuration
Robot settings
Zero settings
Installation parameters
Tools
Workobject
Load
Arm load
Auto warm-up parameters
Peripheral configuration
Motion parameters
Control parameters
Function Safe Setting
Function Safe Extended Card Info
Function Safe I/O
Function Safe Stop Mode
Velocity Supervision in T1
Axis Position Supervision
Axis Speed Supervision
Cartesian Spatial Position Supervision
Cartesian spatial speed Supervision
Function Safe Tool Mode Setting
System settings
Debug
Cartesian spatial speed Supervision
Refresh
Synchronize
Tigger Method
Permanent Effect
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
Group 7
Group 8
Parameter name
Value
Range
1 - Cartesian spatial speed Supervision
Max allowable position speed (m...
4710.000
[50.000, 3925.000]
2 - Stop mode
Stop mode
StopMode 1
{StopMode 0.StopMode 1.}
3 - Activate
Activate
Activate
{Deactivate.Activate.}

Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the TCP speed monitoring function is disabled. The TCP speed of the robot is not monitored. • When you choose "Always active", the TCP speed monitoring function is permanently enabled. The TCP speed of the robot is monitored in real time. • When you choose "DI trigger", the TCP speed monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of TCP speed	0 to 10000 mm/s	0	You can set the safety range of the robot TCP speed to be monitored.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the position of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate or deactivate the group of TCP speed parameters. If deactivated, the group of parameters will not be used for TCP speed monitoring.

Note

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

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

5.3 Configuration on Teach Pendant

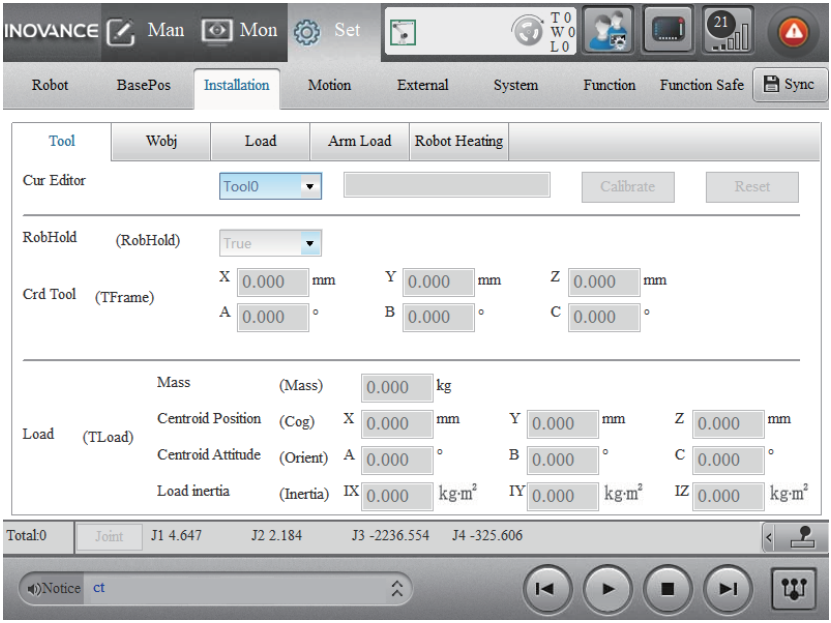
The following table describes the safety functions configuration steps.

No.	Operation
1	Configure basic parameters
2	Configure system access
3	Configure safety tool
4	Configure safety I/Os
5	Configure safety stop parameters
6	Configure safety manual mode monitoring parameters
7	Configure joint position monitoring parameters
8	Configure joint speed monitoring parameters
9	Configure TCP position monitoring parameters
10	Configure TCP speed monitoring parameters

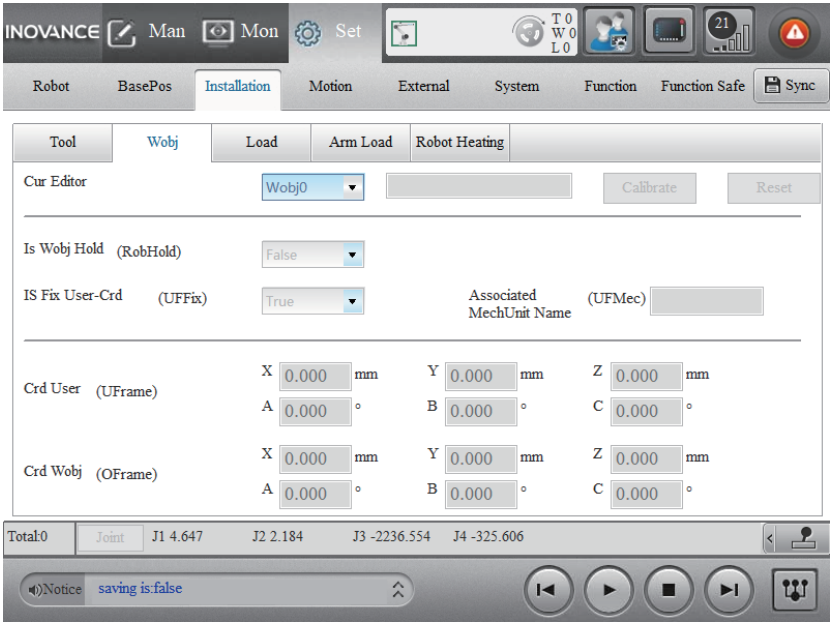
5.3.1 Configuring the Basic Parameters

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 the System Access

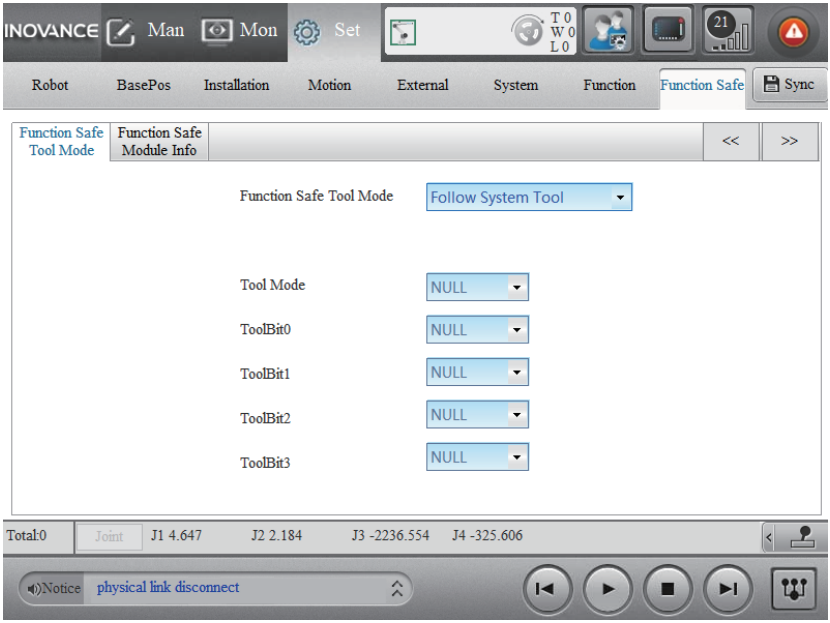
Only authorized operators (editor, administrator and manufacturer) are allowed to modify the safety function parameters. Safety function password is required.

5.3.3 Configuring the Safety Tool

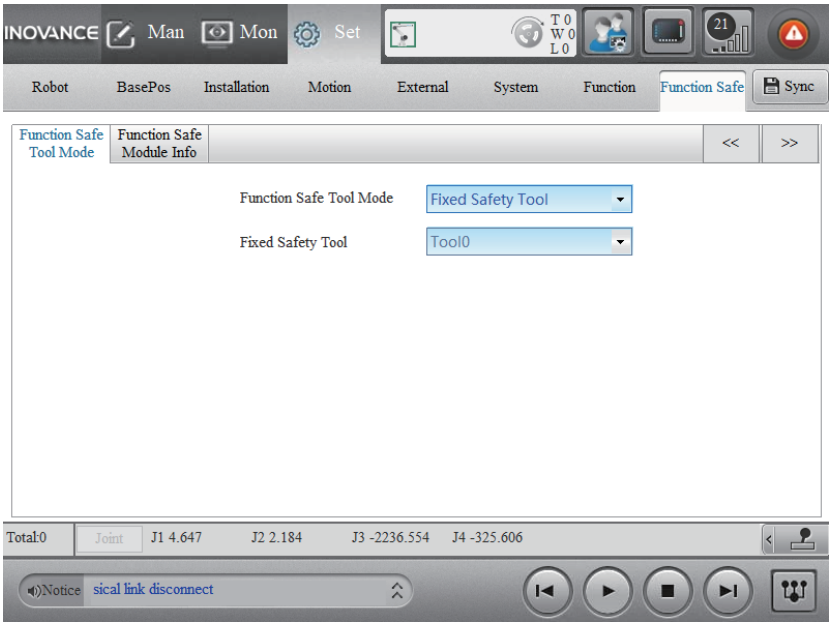
You can set the safety tool to follow the system, use a fixed safety tool, or manually switch the safety tool.

The setting of the safety tool is described below.

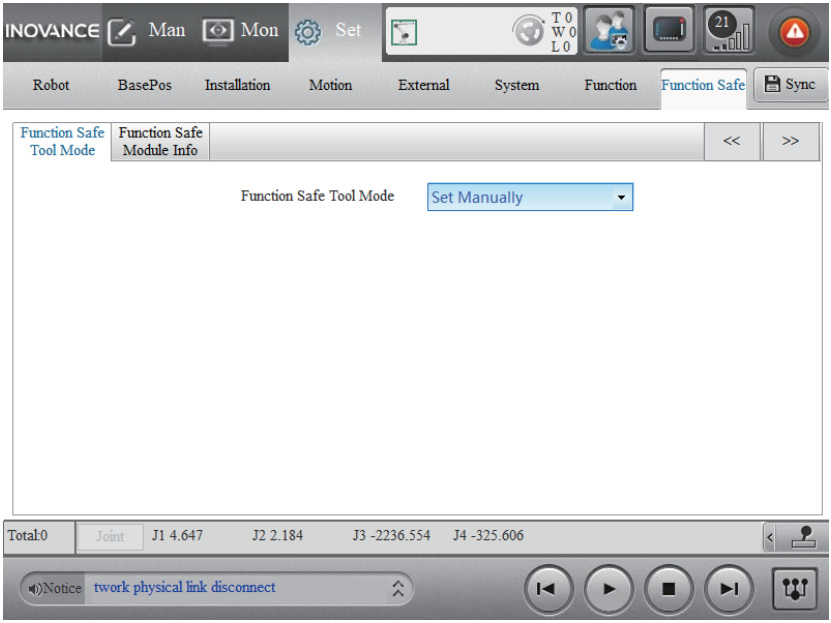
1. If you set the safety tool to follow the system, five standard DOs need to be used. Therefore, these five DOs cannot be used for other functions. It is required to connect the five DOs to DI3-DI7 of the safety expansion card. The controller triggers the corresponding standard DO to provide an output when switching the tool.



2. If you set the safety tool to fixed safety tool, you need to specify a tool (TCP mode) or a workobject (ECP mode) as the safety tool\workobject. In this case, you cannot switch the safety tool via safety I/O or standard I/O. The selected workobject must be held by the robot.



3. If you choose to manually switch the tool, you need to connect the external I/Os to the DI3-DI7 of the safety expansion card. The tool can be switched by the operator manually or by the external device.



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

- 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 TCP position/speed monitored by the safety function and the actual TCP position/speed.
- When you set the safety tool to follow the system or choose to manually switch the safety tool, configure DI3 to DI7 as needed and perform physical connection.
- The safety tool settings are restored to the default values after the controller is restarted. You need to configure the safety tool again each time you restart the controller.

Example:

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

Safety tool mode	Safety I/O	Connection/Status	Description
Follow the system	DI3	Connect standard DO23 of the robot to the safety DI3	Configure the TCP or ECP mode
	DI4	Connect standard DO34 of the robot to the safety DI4	To switch between up to 16 tools/ workobjects, you need to configure safety DI5 to tool number bit0.
	DI5	Connect standard DO56 of the robot to the safety DI5	Configure safety DI6 to tool number bit1
	DI6	Connect standard DO67 of the robot to the safety DI6	Configure safety DI7 to tool number bit2
	DI7	Connect standard DO78 of the robot to the safety DI7	Configure safety DI8 to tool number bit3
Manual setting	DI3	The user controls the status of safety DI3.	If you need to switch between TCP and ECP modes, you need to configure DI4 to the TCP/ECP mode.
	DI4	The user controls the status of safety DI4.	To switch between up to 16 tools/ workobjects, you need to configure safety DI5 to tool number bit0.
	DI5	The user controls the status of safety DI5.	Configure safety DI6 to tool number bit1
	DI6	The user controls the status of safety DI6.	Configure safety DI7 to tool number bit2
	DI7	The user controls the status of safety DI7.	Configure safety DI8 to tool number bit3

The status of DI4-DI7 needs to be set according to the tool/workobject number you want to switched to.

- For example, if you want to switch the safety tool to Tool7, you need to increase the level of DI4, DI5, and DI6.
- If you want to switch the safety tool to Tool11, you need to increase the level of DI4, DI5, and DI7, and decrease the level of DI6.

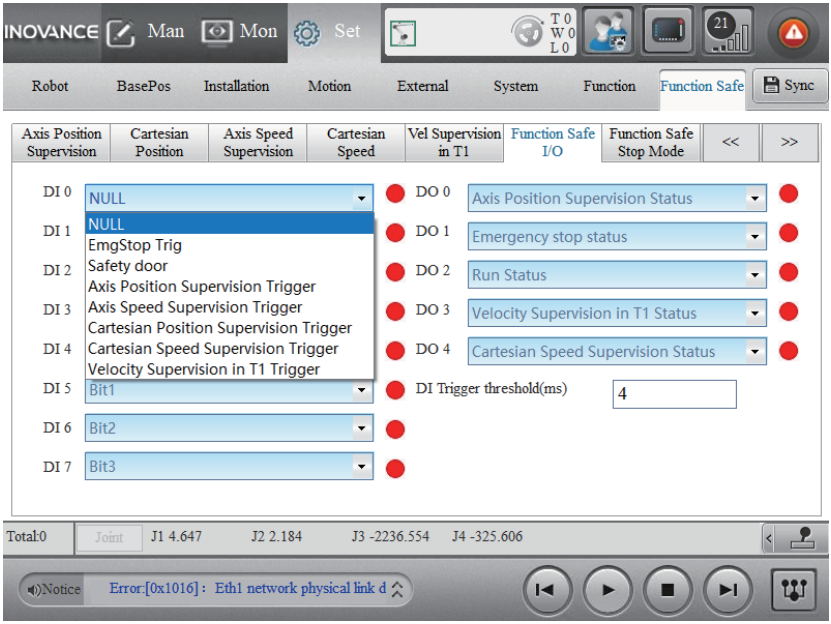
Caution

Safety DI4-DI7 are not required in all cases.

- If the range of tool or workpiece number you need to switch is smaller than 8, you only need to configure DI4-DI6.
- If the range of tool or workpiece number you need to switch is smaller than 4, you only need to configure DI4-DI5.
- If the range of tool or workpiece number you need to switch is smaller than 2, you only need to configure DI4.

5.3.4 Configuring the Safety I/Os

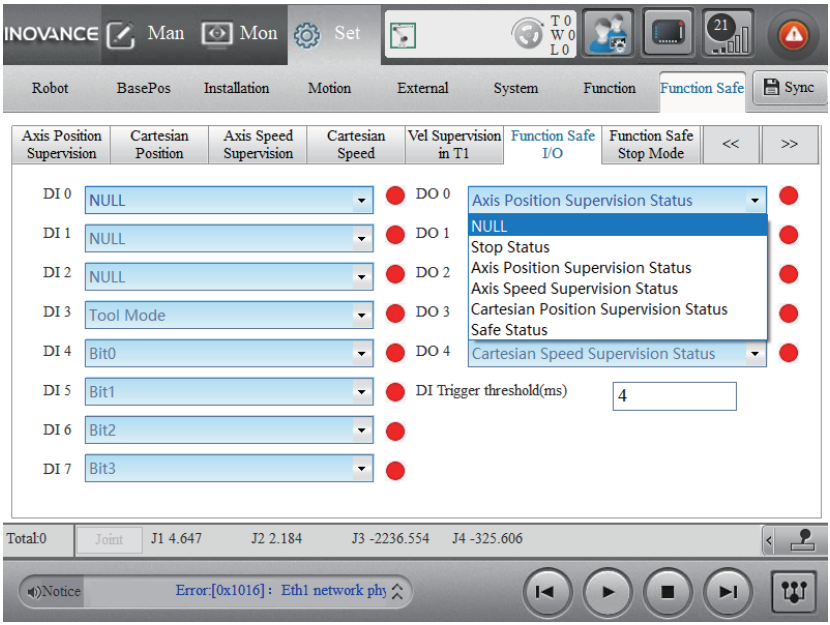
1. A safety DI can be configured to trigger an emergency stop, a safety door, a safety function, or select a safety tool mode and number. You can view the status of the DI in the status bar after the configuration is completed.



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. A safety DO can be configured to indicate a status, including emergency stop status, running status, stop status, and status of a safety function. You can view the status of the DO in the status bar after the configuration is completed.



The safety I/Os take effect immediately after being configured and saved.

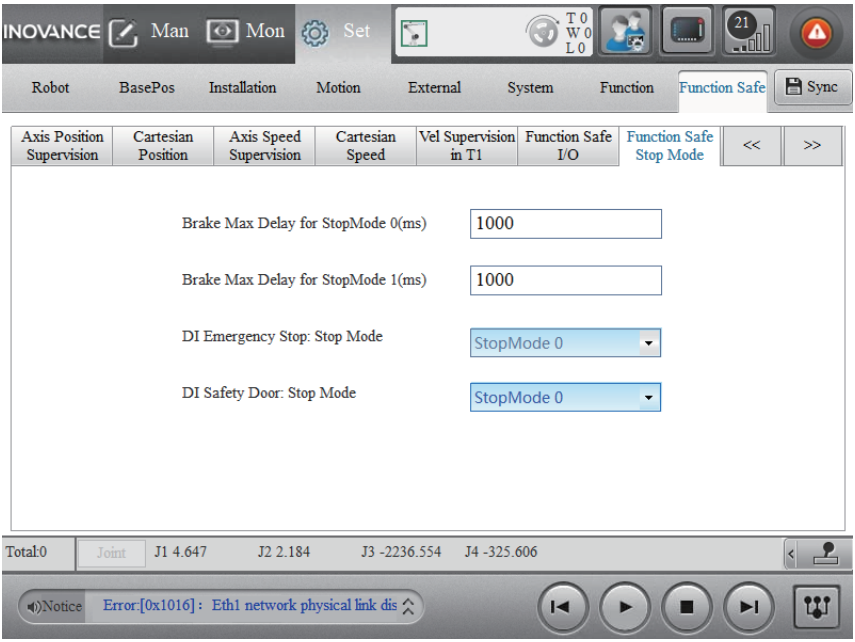
5.3.5 Configuring the Safety Stop Parameters

The safety stop parameters include:

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

You can configure the safety stop parameters as needed.

- The DI-triggered emergency stop is divided into Category 0 emergency stop and Category 1 emergency stop.
- The safety door-triggered stop is divided into Category 0 emergency stop and Category 1 emergency stop.



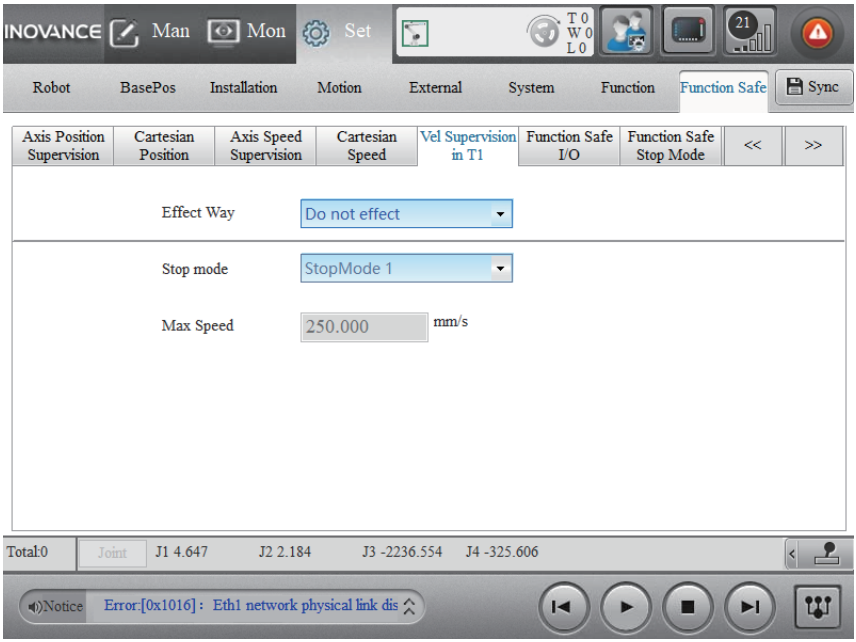
The safety stop parameters take effect immediately after being configured and saved.

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 the Safety Manual Mode Monitoring Parameters

You can configure the parameters of the safety manual mode monitoring function as needed.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L 0
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Robot
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Installation
Motion
External
System
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Function Safe
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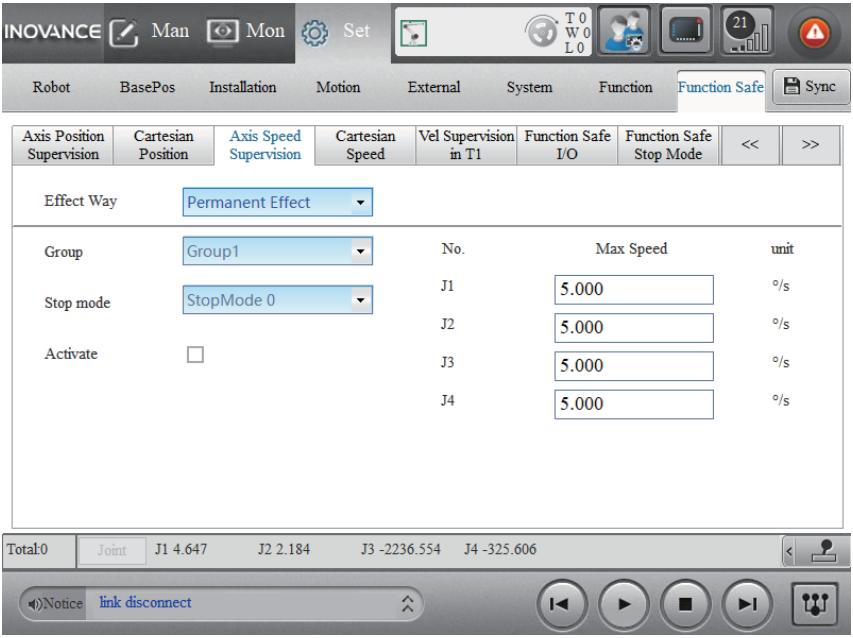
Axis Position Supervision
Cartesian Position
Axis Speed Supervision
Cartesian Speed
Vel Supervision in T1
Function Safe I/O
Function Safe Stop Mode
<<
>>
Effect Way
Do not effect
Stop mode
StopMode 1
Max Speed
250.000
mm/s
Total:0
Joint
J1 4.647
J2 2.184
J3 -2236.554
J4 -325.606
Notice
Error:[0x1016]: Eth1 network physical link dis

Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the safety manual mode monitoring function is disabled. The TCP speed of the robot safety tool is not monitored. • When you choose "Always active", the safety manual mode monitoring function is permanently enabled. The TCP speed of the robot safety tool is monitored in real time. • When you choose "DI trigger", the safety manual mode monitoring function is enabled or disabled depending on the status of the bound DI.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the TCP speed of the robot safety tool exceeds the range set by the user, it triggers a Category 0 emergency stop or Category 1 emergency stop.
Value	Unchangeable	250 mm/s	In the manual mode, the TCP speed of the safety tool is monitored. Once the speed exceeds 250 mm/s, the corresponding action is triggered.

After the parameters are configured and saved, the safety manual mode monitoring function takes effect immediately.

5.3.7 Configuring the Joint Position Monitoring Parameters

You can configure the parameters of the joint position monitoring function as needed.



Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the joint position monitoring function is disabled. The position of the robot joint is not monitored. • When you choose "Always active", the joint position monitoring function is permanently enabled. The position of the robot joint is monitored in real time. • When you choose "DI trigger", the joint position monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of joint position	The safety range of the joint position is subject to the robot model. It must not exceed the position limit of the robot joint.	0	You can set the safety range of the monitored robot joint position in the forward and reverse directions.

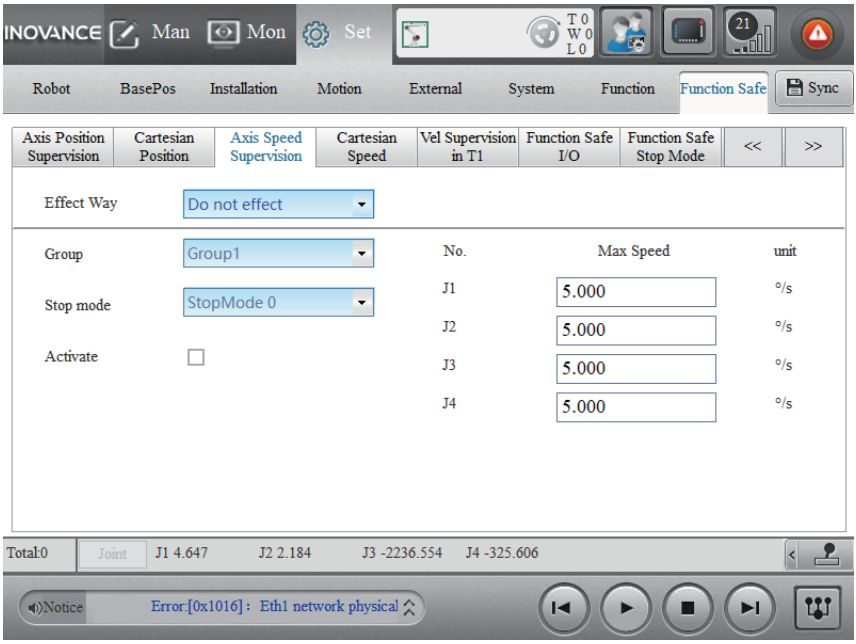
Name	Setpoint	Default	Description
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the position of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate the current group of joint position monitoring parameters. If not activated, the group of parameters will not be used for the 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 the Joint Speed Monitoring Parameters

You can configure the parameters of the joint speed monitoring function as needed.


INOVANCE
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Robot
BasePos
Installation
Motion
External
System
Function
Function Safe
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Axis Position Supervision
Cartesian Position
Axis Speed Supervision
Cartesian Speed
Vel Supervision in T1
Function Safe I/O
Function Safe Stop Mode
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Group
Group1
Stop mode
StopMode 0
Activate
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Max Speed
unit
J1
5.000
°/s
J2
5.000
°/s
J3
5.000
°/s
J4
5.000
°/s
Total:0
Joint
J1 4.647
J2 2.184
J3 -2236.554
J4 -325.606
Notice
Error:[0x1016]: Eth1 network physical

Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the joint speed monitoring function is disabled. The speed of the robot joint is not monitored. • When you choose "Always active", the joint speed monitoring function is permanently enabled. The speed of the robot joint is monitored in real time. • When you choose "DI trigger", the joint speed monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of joint speed	The safety range of the joint speed is subject to the robot model. It must not exceed the speed limit of the robot joint.	0	You can set the safety range of the robot joint speed to be monitored.

Name	Setpoint	Default	Description
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the speed of any robot joint exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate the current group of joint speed monitoring parameters. If not activated, the group of parameters will not be used for the joint speed monitoring.

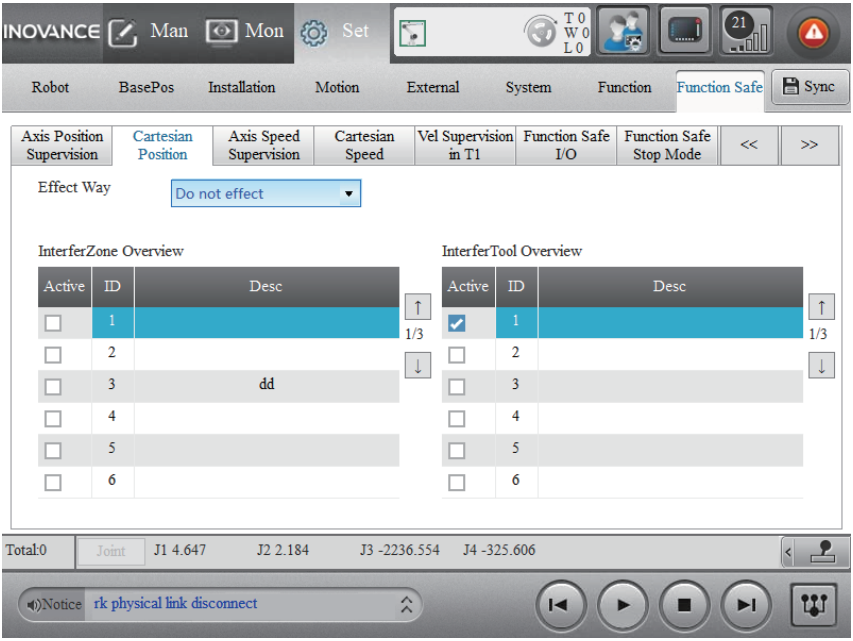
Note

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 the TCP Position Monitoring Parameters

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

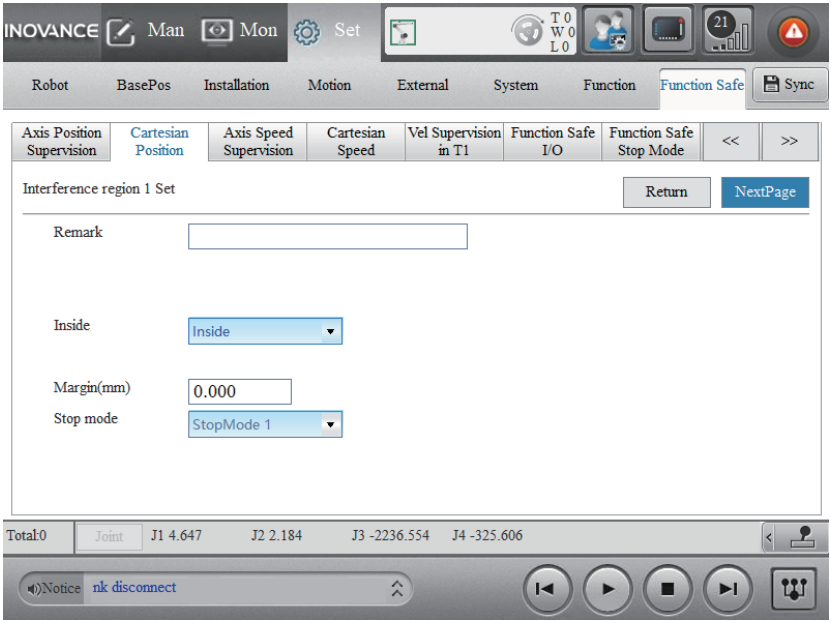


You can activate or deactivate the 16 interference zones and 16 monitoring objects, and view the description of the interference zones and monitoring objects.

Caution

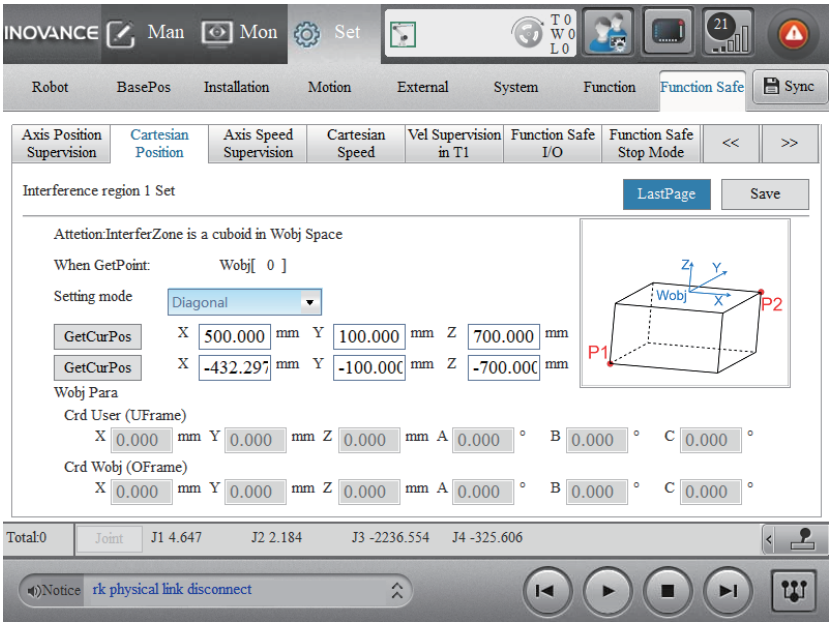
Multiple interference zones can be activated simultaneously, but only one end monitoring object can be activated.

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/Outside	Specifies the inside or outside of the interference zone as the interference zone.
Stop mode	Category 0 stop, Category 1 stop. When the TCP 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/ 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 **Next** in the upper-right corner..



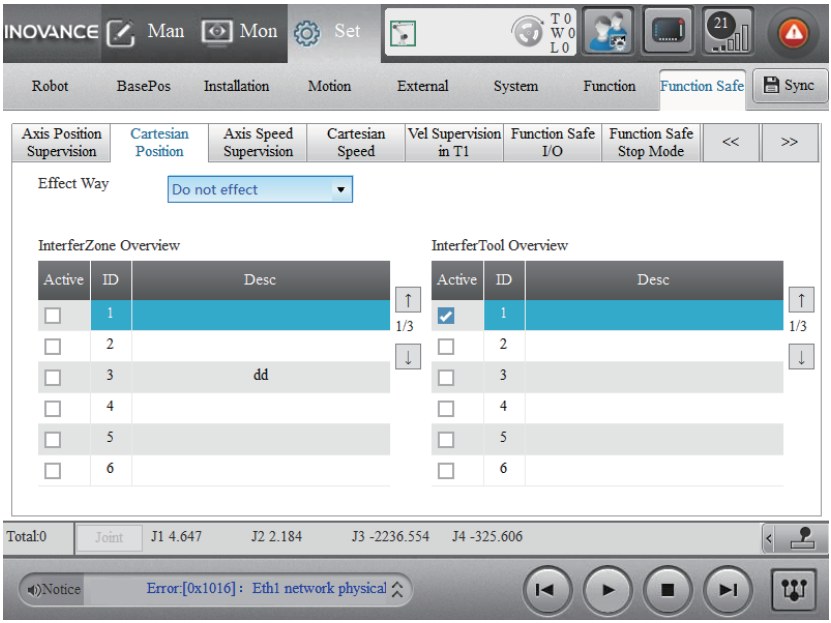
Parameter description:

- Setting method: Sets the interference zone by diagonal points, or by base point + offset. The points are taken in the current workobject coordinate system.
- 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 coordinate parameters in the lower part of the interface.

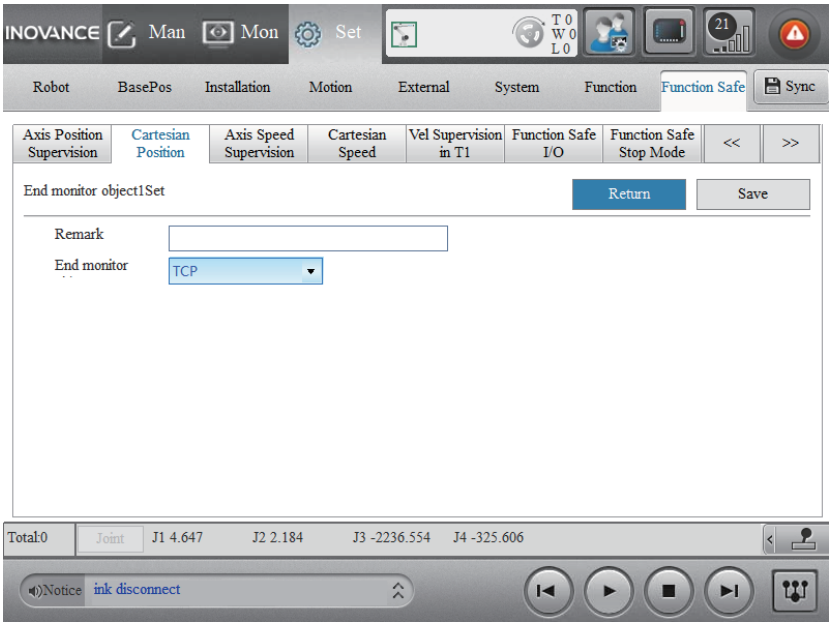
Caution

- The value of the safety distance cannot be less than 0.
- The position of the interference zone is relative to the active workobject coordinate system.
- You cannot get the points of the interference zone in a workobject coordinate system where the workobject is not held by the robot.
- You cannot get the points of the interference zone in a workobject coordinate system where the user coordinate system 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 **Finish and save** button to save the interference zone parameters and return to the interference zone overview interface.

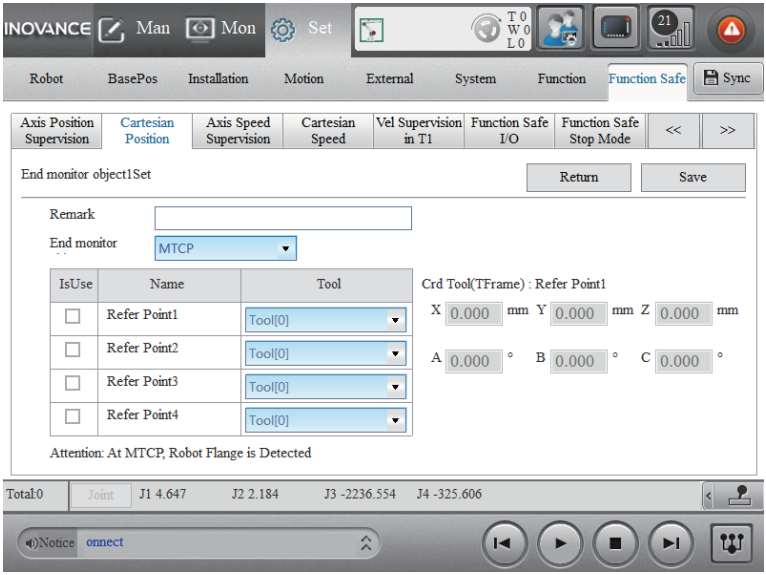


5. Select an end monitoring object and double-click it to open the parameter setting interface.

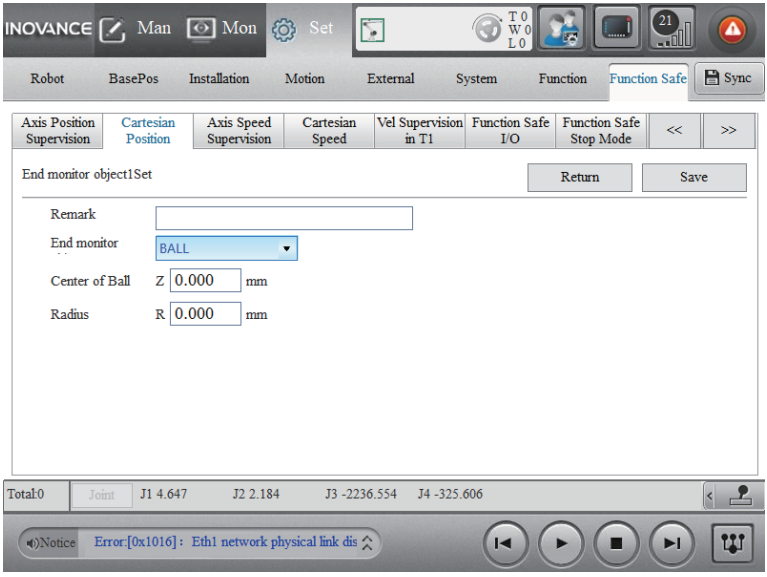


Parameter description:

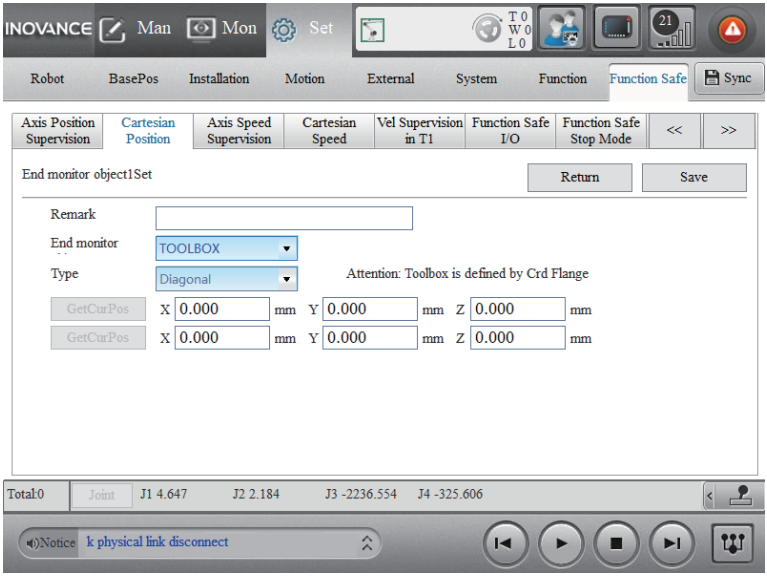
- Remarks: Descriptive information of the current monitoring object.
- Monitoring object type: Includes TCP, MTCP, sphere, and cuboid bounding box. TCP by default.
  - TCP: When the robot grips the tool, the current TCP is used for monitoring. When the robot grips the workobject, the flange center is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



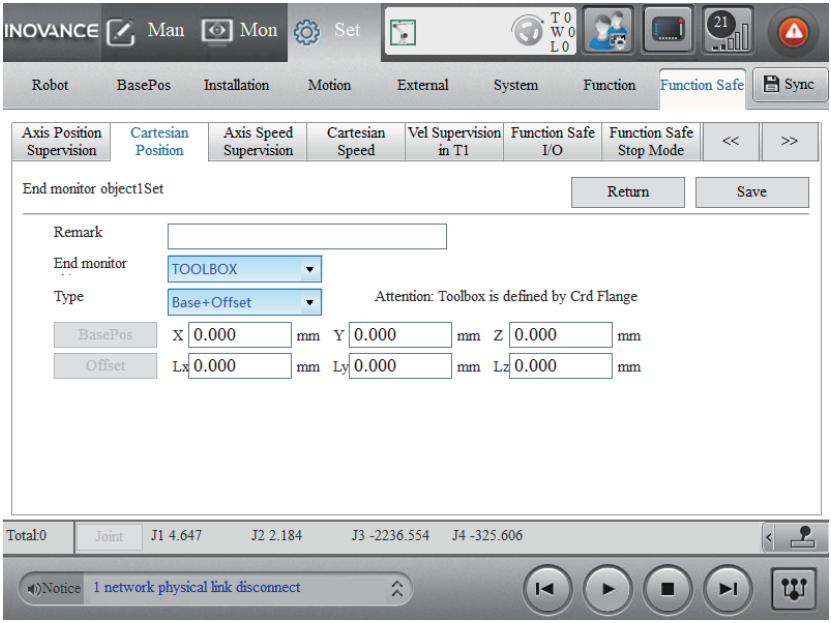
- Sphere: The spherical center is offset from the Z direction of the flange coordinate system, the spherical center range is [-10000,10000] and the radius range is [0,10000], in mm. The eccentric sphere is not supported.



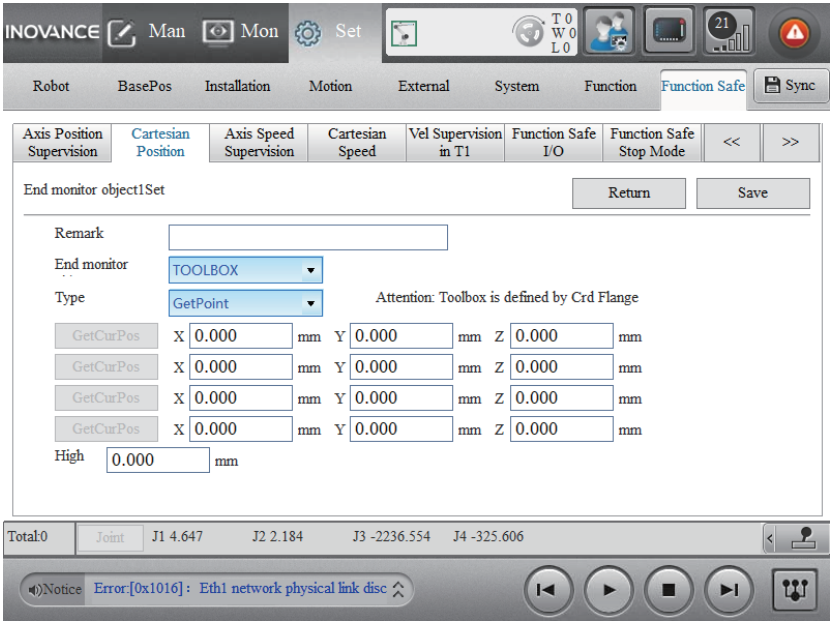
- Cuboid bounding box: You can define the box by diagonal points, by base point + offset, or by getting the robot points.



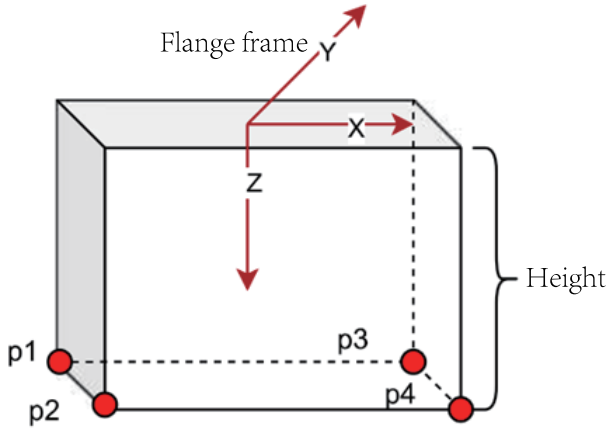
When the point acquisition method is set to "diagonal point", you can enter the point manually or click the **Get point** button to acquire the current point automatically. Note that the **Get point** button is active only when the robot is in ECP mode. The points are taken in the flange coordinate system.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



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



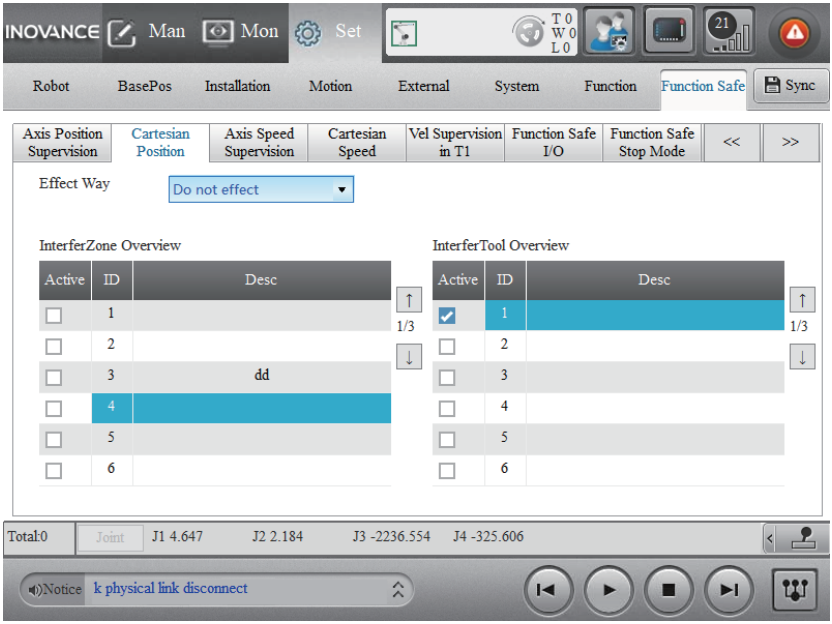
When the point acquisition method is set to "get point", you can enter the point manually, or click the **Get point** button to get the point automatically. Note that the **Get point** button is active only when the robot is in ECP mode. The points are taken in the flange coordinate system. Note that the four points are the four points on the bottom face of the cuboid. The height is the distance in the Z direction under the flange coordinate system. The range of the point value is [-10000,10000] and the range of height is (-0.10000], in mm. The diagram is shown below:



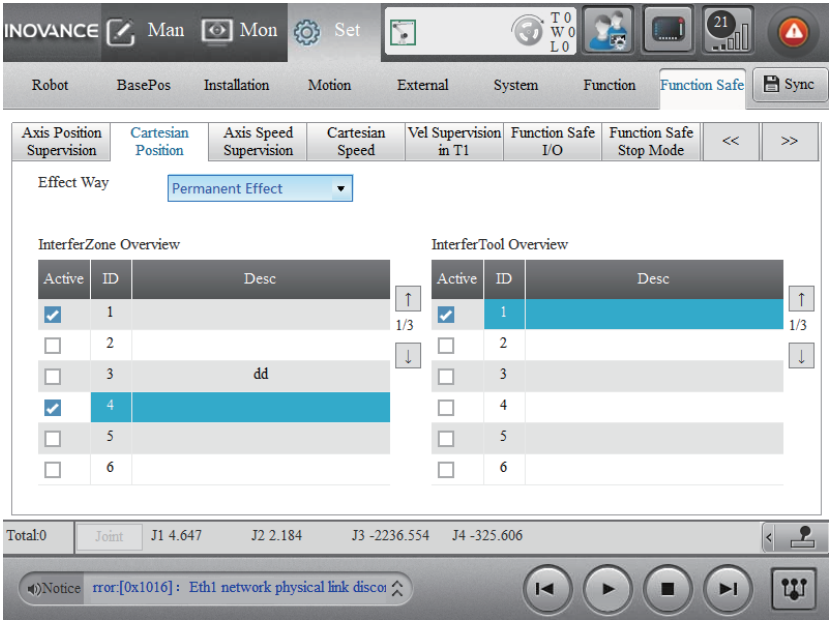
Notes of the cuboid bounding box:

- The orientation of the cuboid bounding box is the same as that of the flange coordinate system. That is, a tilted cuboid bounding box cannot be defined under the flange coordinate system.
- 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 coordinate system 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 **Finish and save** button.



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



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

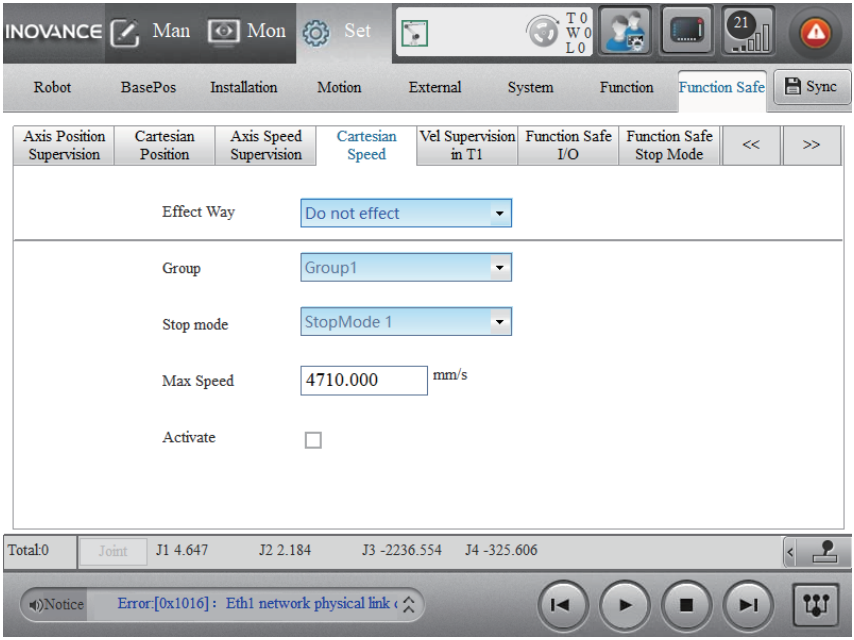
Caution

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

- Once determined, the position of the interference zone under the world coordinate system 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 coordinate system points downwards before setting the points and height. Otherwise, the cuboid cannot be formed properly.

5.3.10Configuring the TCP Speed Monitoring Parameters

You can configure the parameters of the TCP speed monitoring function as needed, as shown below.


INOVANCE
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Set
T 0
W 0
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21
Robot
BasePos
Installation
Motion
External
System
Function
Function Safe
Sync
Axis Position Supervision
Cartesian Position
Axis Speed Supervision
Cartesian Speed
Vel Supervision in T1
Function Safe I/O
Function Safe Stop Mode
<<
>>
Effect Way
Do not effect
Group
Group1
Stop mode
StopMode 1
Max Speed
4710.000
mm/s
Activate
Total:0
Joint
J1 4.647
J2 2.184
J3 -2236.554
J4 -325.606
Notice
Error:[0x1016]: Eth1 network physical link

Name	Setpoint	Default	Description
Trigger method	Inactive Always active DI trigger	Inactive	• When you choose "Inactive", the TCP speed monitoring function is disabled. The TCP speed of the robot is not monitored. • When you choose "Always active", the TCP speed monitoring function is permanently enabled. The TCP speed of the robot is monitored in real time. • When you choose "DI trigger", the TCP speed monitoring function is enabled or disabled depending on the status of the bound DI.
Safety range of TCP speed	0 to 10000 mm/s	0	You can set the safety range of the robot TCP speed to be monitored.
Stop mode	Category 0 stop Category 1 stop	Category 0 stop	When the TCP speed of the robot exceeds the range set by the user, it triggers a Category 0 or 1 emergency stop.
Activate	False True	False	Whether to activate or deactivate the group of TCP speed parameters. If deactivated, the group of parameters will not be used for TCP speed monitoring.

Note: The TCP speed monitoring supports up to eight groups of parameters.

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

5.4 Verification and Validation

说明

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

Basic requirements

- Technicians must be trained to understand the requirements and principles of safety-related system design and commissioning.
- Execution and maintenance personnel must be trained on the requirements and principles for the design and operation of safety-related systems.
- Operation personnel must be trained to understand the requirements and principles for the design and operation of 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 the safety function.

Checklist

Follow the checklist below to perform the validation test.

Step	Test	Result
1	Ensure that the robot can run and stop freely during the test.	
2	Set the low-speed monitoring function to be permanent active 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 low-speed monitoring function to be permanent active and the stop category to Category 0 or 1. Run the robot program in automatic mode and check that the robot operates normally.	
5	1. Set the joint position monitoring function to be permanent active. 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 active. 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.	
6	1. Set the joint speed monitoring function to be permanent active. 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 active. 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.	

Step	Test	Result
7	1. Set the TCP position monitoring function to be permanent active. 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 TCP position monitoring function to be permanent active. 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.	
8	1. Set the TCP speed monitoring function to be permanent active. 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 TCP speed monitoring function to be permanent active. 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:

- description of the safety application (including a figure)
- a 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 Routine Maintenance

6.1 Maintenance Precautions

Before maintenance, read this guide, and other related guides carefully to fully understand the methods of safe maintenance.

Only authorized personnel who have taken safety training should be allowed to maintain the robot system.

Safety training is the program for industrial robot operators that follows the laws and regulations of each nation. The personnel who have taken safety training acquire knowledge of industrial robots (operations, teaching, etc.), knowledge of inspections, and knowledge of related rules/regulations.

DANGER

- Only authorized personnel who have taken safety training should be allowed to maintain the robot system. Before performing any routine maintenance, read the maintenance precautions carefully. Operating the robot system without understanding the safety precautions may result in serious injury or major damage.
- Do not remove any parts that are not covered in this guide. Follow the maintenance procedure strictly as described in this guide. Improper removal of parts or improper maintenance may not only cause improper function of the robot system but also serious safety problems. Do not enter the operating area while the power is ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the robot may move even it seems to be stopped.
- Keep away from the robot while the power is ON if you have not taken the training courses. Do not enter the operating area. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the robot may move even it seems to be stopped.
- When you check the operation of the robot after replacing parts, be sure to check it while you are outside of the safeguarded area. Otherwise, it may cause serious safety problems as the robot may move unexpectedly.
- Before operating the robot system, make sure that both the emergency stop switch and safeguard switch function properly. Operating the robot system when the switches do not function properly is extremely hazardous and may result in serious bodily injury and/or serious damage to the robot system as the switches cannot fulfill their intended functions in an emergency.

CAUTION

- Open the cover of the controller only when maintenance is needed. High voltage inside the controller poses a risk of electric shock even when the power is turned off.
- Before performing any replacement procedure, turn off the controller and related equipment, and then disconnect the power plug from the power source. Operating with the power ON may cause electric shock or malfunction.
- Do not connect or disconnect the motor connectors while the power is turned on. Failure to comply may result in abnormal action of the robot, which is dangerous. Also, operating with the power ON may cause electric shock or malfunction.
- Ensure the power is locked by unplugging the power plug. Be sure to connect the AC power cable to a power receptacle. Do not connect it directly to a factory power source.
- The maintenance must be carried out with the power ON. To perform the maintenance, have two people to work together. One people shall maintain a posture where the emergency stop button can be pressed immediately, while the other people shall be within the operating area of the robot to perform the work quickly while staying alert. Before performing any work, confirm the evacuation path.

WARNING

- Do not remove or work on any parts not covered in this guide.
- Maintenance personnel must keep the robot key properly. Unauthorized personnel are not allowed to access the robot software system in manual mode to browse or modify programs and parameters.

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.

Item	Description	Solution	Checked
Installation environment	Check that the controller and cables are normal.	Check for the mounting bracket 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.	☐
Terminal	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.

Item	Description	Solution	Monthly Inspection
Cable	Check whether power cables and the connectors are discolored. Check whether the insulation 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 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 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 [systemiConf].
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:

Table 6–1 Difference in backup and loading directories

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 respective folders are explained below:

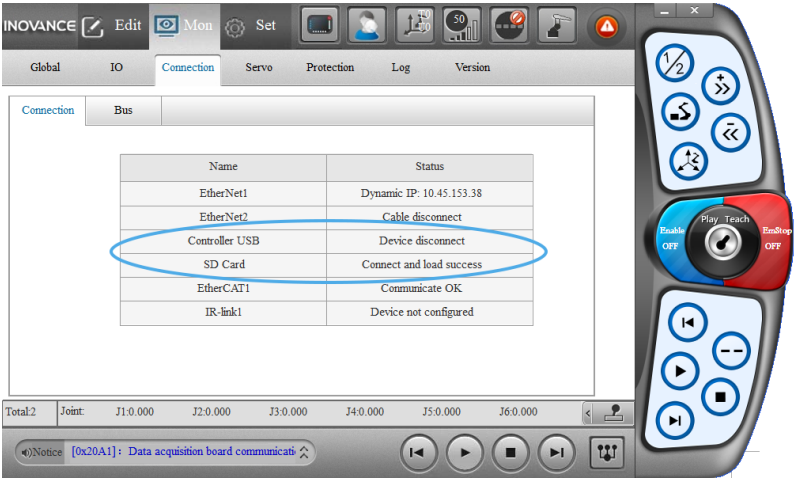
TeachProgram: Program file folder containing all .pro program files

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:

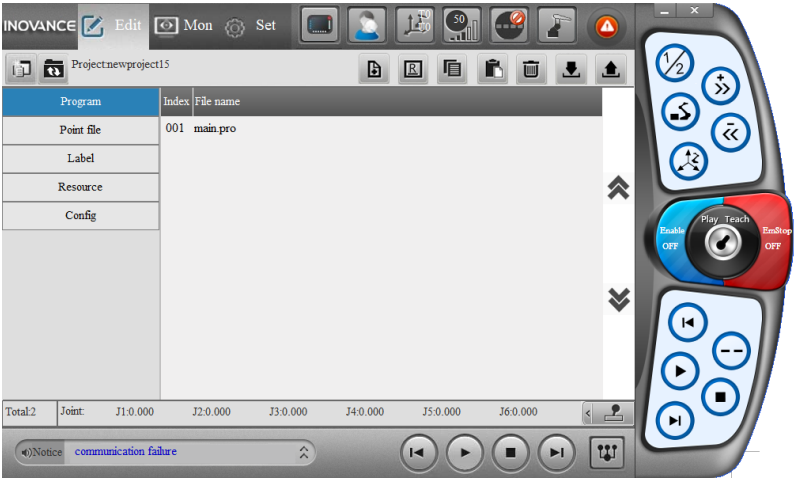
  1. Insert the USB drive into the controller and check connection status between the USB drive and the memory card. If the monitored communication status in the software displays "The USB controller has been inserted into the device and successfully mounted" and "The memory card has been inserted and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


INOVANCE
Edit
Mon
Set
Project:newproject15
Program
Point file
Label
Resource
Config
Index
File name
001 main.pro
Total:2
Joint:
J1:0.000
J2:0.000
J3:0.000
J4:0.000
J5:0.000
J6:0.000
Notice
communication failure
Play
Teach
Enable
OFF
EmStop
OFF

7 Safety Functions Troubleshooting

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	Cause	Solution
0x9016	J1 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 1 speed limit	Clear alarm
0x9017	J2 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 1 speed limit	Clear alarm
0x9018	J3 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 1 speed limit	Clear alarm
0x9019	J4 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 1 speed limit	Clear alarm
0x901A	J5 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 1 speed limit	Clear alarm
0x901B	J6 exceeds Group 1 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 1 speed limit	Clear alarm
0x901C	J1 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 2 speed limit	Clear alarm
0x901D	J2 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 2 speed limit	Clear alarm
0x901E	J3 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 2 speed limit	Clear alarm
0x901F	J4 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 2 speed limit	Clear alarm
0x9020	J5 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 2 speed limit	Clear alarm
0x9021	J6 exceeds Group 2 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 2 speed limit	Clear alarm
0x9022	J1 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 3 speed limit	Clear alarm
0x9023	J2 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 3 speed limit	Clear alarm
0x9024	J3 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 3 speed limit	Clear alarm

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
0x9025	J4 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 3 speed limit	Clear alarm
0x9026	J5 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 3 speed limit	Clear alarm
0x9027	J6 exceeds Group 3 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 3 speed limit	Clear alarm
0x9028	J1 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 4 speed limit	Clear alarm
0x9029	J2 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 4 speed limit	Clear alarm
0x902A	J3 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 4 speed limit	Clear alarm
0x902B	J4 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 4 speed limit	Clear alarm
0x902C	J5 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 4 speed limit	Clear alarm
0x902D	J6 exceeds Group 4 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 4 speed limit	Clear alarm
0x902E	J1 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 5 speed limit	Clear alarm
0x902F	J2 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 5 speed limit	Clear alarm
0x9030	J3 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 5 speed limit	Clear alarm
0x9031	J4 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 5 speed limit	Clear alarm
0x9032	J5 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 5 speed limit	Clear alarm
0x9033	J6 exceeds Group 5 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 5 speed limit	Clear alarm
0x9034	J1 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 6 speed limit	Clear alarm
0x9035	J2 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 6 speed limit	Clear alarm
0x9036	J3 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 6 speed limit	Clear alarm
0x9037	J4 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 6 speed limit	Clear alarm
0x9038	J5 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 6 speed limit	Clear alarm
0x9039	J6 exceeds Group 6 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 6 speed limit	Clear alarm
0x903A	J1 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 7 speed limit	Clear alarm

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
0x903B	J2 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 7 speed limit	Clear alarm
0x903C	J3 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 7 speed limit	Clear alarm
0x903D	J4 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 7 speed limit	Clear alarm
0x903E	J5 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 7 speed limit	Clear alarm
0x903F	J6 exceeds Group 7 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 7 speed limit	Clear alarm
0x9040	J1 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 8 speed limit	Clear alarm
0x9041	J2 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 8 speed limit	Clear alarm
0x9042	J3 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 8 speed limit	Clear alarm
0x9043	J4 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 8 speed limit	Clear alarm
0x9044	J5 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J5 exceeds Group 8 speed limit	Clear alarm
0x9045	J6 exceeds Group 8 speed limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 8 speed limit	Clear alarm
0x9046	J1 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J1 exceeds Group 1 position limit	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 1, and move the robot to a safe position.
0x9049	J4 exceeds Group 1 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 1 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.
0x904D	J2 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 2 position limit	Close 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	Cause	Solution
0x904E	J3 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 2 position limit	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 2, and move the robot to a safe position.
0x9051	J6 exceeds Group 2 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 2 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 3, and move the robot to a safe position.
0x9055	J4 exceeds Group 3 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 3 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 4, and move the robot to a safe position.
0x9059	J2 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 4 position limit	Close 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	Close 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	Close 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	Close 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	Cause	Solution
0x905D	J6 exceeds Group 4 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 4 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 5, and move the robot to a safe position.
0x9061	J4 exceeds Group 5 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 5 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.
0x9065	J2 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 6 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 6, and move the robot to a safe position.
0x9069	J6 exceeds Group 6 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 6 position limit	Close 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	Close 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	Close 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	Cause	Solution
0x906C	J3 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J3 exceeds Group 7 position limit	Close the joint position monitoring function or deactivate Group 7, and move the robot to a safe position.
0x906D	J4 exceeds Group 7 position limit	No.2 Resettable fault	Reset manually	J4 exceeds Group 7 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.
0x9071	J2 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J2 exceeds Group 8 position limit	Close 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	Close 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	Close 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	Close the joint position monitoring function or deactivate Group 8, and move the robot to a safe position.
0x9075	J6 exceeds Group 8 position limit	No.2 Resettable fault	Reset manually	J6 exceeds Group 8 position limit	Close 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 TCP speed of the robot in manual mode exceeds 250 mm/s.	Clear alarm
0x9078	TCP speed exceeds Group 1 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 1 limit.	Clear alarm
0x9079	TCP speed exceeds Group 2 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 2 limit.	Clear alarm
0x907A	TCP speed exceeds Group 3 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 3 limit.	Clear alarm
0x907B	TCP speed exceeds Group 4 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 4 limit.	Clear alarm

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
0x907C	TCP speed exceeds Group 5 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 5 limit.	Clear alarm
0x907D	TCP speed exceeds Group 6 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 6 limit.	Clear alarm
0x907E	TCP speed exceeds Group 7 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 7 limit.	Clear alarm
0x907F	TCP speed exceeds Group 8 limit	No.2 Resettable fault	Reset manually	The TCP speed of the robot exceeds the Group 8 limit.	Clear alarm
0x9080	Robot enters interference zone 1	No.2 Resettable fault	Reset manually	The robot enters the interference zone 1.	Close the TCP 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.	Close the TCP position monitoring function or deactivate the interference zone 2.
0x9082	Robot enters interference zone 3	No.2 Resettable fault	Reset manually	The robot enters the interference zone 3.	Close the TCP position monitoring function or deactivate the interference zone 3.
0x9083	Robot enters interference zone 4	No.2 Resettable fault	Reset manually	The robot enters the interference zone 4.	Close the TCP position monitoring function or deactivate the interference zone 4.
0x9084	Robot enters interference zone 5	No.2 Resettable fault	Reset manually	The robot enters the interference zone 5.	Close the TCP position monitoring function or deactivate the interference zone 5.
0x9085	Robot enters interference zone 6	No.2 Resettable fault	Reset manually	The robot enters the interference zone 6.	Close the TCP position monitoring function or deactivate the interference zone 6.
0x9086	Robot enters interference zone 7	No.2 Resettable fault	Reset manually	The robot enters the interference zone 7.	Close the TCP position monitoring function or deactivate the interference zone 7.
0x9087	Robot enters interference zone 8	No.2 Resettable fault	Reset manually	The robot enters the interference zone 8.	Close the TCP position monitoring function or deactivate the interference zone 8.
0x9088	Robot enters interference zone 9	No.2 Resettable fault	Reset manually	The robot enters the interference zone 9.	Close the TCP position monitoring function or deactivate the interference zone 9.
0x9089	Robot enters interference zone 10	No.2 Resettable fault	Reset manually	The robot enters the interference zone 10.	Close the TCP position monitoring function or deactivate the interference zone 10.
0x908A	Robot enters interference zone 11	No.2 Resettable fault	Reset manually	The robot enters the interference zone 11.	Close the TCP position monitoring function or deactivate the interference zone 11.
0x908B	Robot enters interference zone 12	No.2 Resettable fault	Reset manually	The robot enters the interference zone 12.	Close the TCP position monitoring function or deactivate the interference zone 12.

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
0x908C	Robot enters interference zone 13	No.2 Resettable fault	Reset manually	The robot enters the interference zone 13.	Close the TCP position monitoring function or deactivate the interference zone 13.
0x908D	Robot enters interference zone 14	No.2 Resettable fault	Reset manually	The robot enters the interference zone 14.	Close the TCP position monitoring function or deactivate the interference zone 14.
0x908E	Robot enters interference zone 15	No.2 Resettable fault	Reset manually	The robot enters the interference zone 15.	Close the TCP position monitoring function or deactivate the interference zone 15.
0x908F	Robot enters interference zone 16	No.2 Resettable fault	Reset manually	The robot enters the interference zone 16.	Close the TCP 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.	1. Set the delay for Category 1 emergency stop to a larger value 2. Contact the manufacturer to solve the problem
0x909D	STO stop time too long	No.2 Resettable fault	Reset manually	The STO stop time exceeds the limit.	1. Set the delay for Category 0 emergency stop to a larger value 2. Contact the manufacturer to solve the problem
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	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	J1 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	J1 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	J1 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	J1 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	J1 SN code fluctuates in master chip data frame	Contact the manufacturer
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	J1 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	J1 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	J1 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	J1 SN code fluctuates in slave chip data frame	Contact the manufacturer

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
0x90C7	J6 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
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
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

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
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	TCP speed state abnormal	No.1 Non-resettable fault	Reset impossible	The TCP speed state is checked inconsistent between master and slave chips.	Contact the manufacturer
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	TCP position monitoring function state abnormal	No.1 Non-resettable fault	Reset impossible	The TCP position state 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	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 alarm
0x9107	Slave chip triggers Category 0 stop	No.2 Resettable fault	Reset manually	Slave chip triggers Category 0 stop	Clear 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
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

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
0x9307	MCUB discharge voltage collection failed	No.1 Non-resettable fault	Reset impossible	The discharge voltage is 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.
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
0x9316	MCUB failed to parse MCUA mailbox data	No.1 Non-resettable fault	Reset impossible	Communication error	Contact the manufacturer

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
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 waiting for MCUB message	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 power supply
0x9322	MCUB failed to compare DOs	No.2 Resettable fault	Reset manually	The DO is abnormal.	Check the power supply
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.1 Non-resettable fault	Reset impossible	Pin read-back error	Contact the manufacturer
0x9328	MCUB output pin read-back failed	No.1 Non-resettable fault	Reset impossible	Pin read-back error	Contact the manufacturer
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

Fault code	Fault name	Fault level	Reset mode	Cause	Solution
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
0x932E	MCUA triggers safety door	No.2 Resettable fault	Reset manually	The safety door properties have been configured and a DI input is received.	Change the DI properties or stop DI input
0x932F	MCUA triggers an emergency stop	No.2 Resettable fault	Reset manually	The emergency stop properties have been configured and a DI input is received.	Change the DI properties or stop DI input
0x9330	MCUB triggers safety door	No.2 Resettable fault	Reset manually	The safety door properties have been configured and a DI input is received.	Change the DI properties or stop DI input
0x9331	MCUB triggers an emergency stop	No.2 Resettable fault	Reset manually	The emergency stop properties have been configured and a DI input is received.	Change the DI properties or stop 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

8 Certification and Standard Compliance

Model	Certification Compliance
IRCB501-4MD IRCB501-6ND	CE Certification
IRCB501-4AD IRCB501-4CD IRCB501-4ED IRCB501-6LD IRCB501-6FD	CE Certification CSGSus Certification FCC Certification
IRCB501-4AD-INT IRCB501-4CD-INT IRCB501-4ED-INT IRCB501-4MD-INT IRCB501-6LD-INT IRCB501-6FD-INT IRCB501-6ND-INT	CE Certification CSGSus Certification Functional safety certification (functional safety extension card required) FCC Certification KC Certification (in progress)

CE Certification

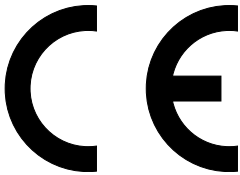


Figure 8-1 CE Marking

- The CE mark indicates compliance with the Low Voltage Directive (LVD), Electromagnetic Compatibility (EMC), and Restriction of Hazardous Substances (RoHS) directives for commercial trades (production, import, and sales) in Europe.
- The CE mark is mandatory for engaging in commercial business (production, importation, and distribution) in Europe.
- The product complies with the LVD, EMC, and RoHS directives and is labeled with the CE mark.
- The machinery and devices equipped with this product must also meet CE requirements when sold in Europe.
- The integrator who integrates this drive into other products and attaches CE mark to the final assembly has the responsibility of ensuring compliance with CE certification.

CSGSus Certification

CERTIFICATE OF COMPLIANCE

Certificate Number: SGSNA/24/GZ/00032X

Contract Number: 802145
Certificate Project Number: GZ-CERT231203997

Certified Product: Industrial Robot
Trademarks: INOVANCE
Model(s): See page 2-4
Technical Data: Cabinet models IRCB501-4AD(*), IRCB501-4AD(*)-INT, IRCB501-4CD(*),IRCB501-4CD(*)-INT, IRCB501-6FD (*), IRCB501-6FD(*)-INT and IRCB501-6LD(*), IRCB501-6LD(*)-INT: 1PH, 220-240VAC, 10A, 50/60Hz, SCCR: 5 kA
Cabinet model IRCB501-4ED(*),IRCB501-4ED-INT: 1PH, 220-240VAC, 20A, 50/60Hz, SCCR: 5 kA

Certificate Holder: Suzhou Inovance Technology Co., Ltd.
No.16, Youxiang Road, Yuexi Town, Wuzhong District, Suzhou, 215104, China

This certificate supercedes previous certificates issued with the same certificate number. Certification is valid when products are indicated on the SGS directory of certified products at www.sgs.com or using the QR code below. The product is certified according to ISO/IEC Guide 17067, Conformity assessment - Fundamentals of product certification, System 3, and in accordance with:

UL 1740, 4th Ed., Jan. 26, 2018
NFPA 79 2021 Edition, Dated Oct. 25, 2020
CAN/CSA Z434-14 (R2019), Reaffirmed 2019

Certification Condition
The final compliance to this robot needed re-evaluation at final install site considering guard fence which will be supplied by integrator to prevent accessing to hazard moving part.

Authorized by: Effective date: 28 April 2024

Jason Wei
Certifier

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SGS operates certification programs under the authority of several accreditation or recognition bodies including A2LA, ANAB, OSHA NRTL, and Standards Council of Canada. This certificate is issued by the company under its General Conditions for Certification Services accessible at https://www.sgs.com/en/terms-and-conditions. Attention is drawn to the limitations of liability defined therein and in the Test Report here above mentioned which findings are reflected in this Certificate. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Certification Body

Connectivity & Products, a division of SGS North America Inc.
620 Old Peachtree Road, Ste. 100, Suwanee, GA 30024, USA
t +1 770 570 1800 f +1 770 277 1240 www.sgs.com

Figure 8-2 Cover of CSGSus certificate

cSGSus certification is a service provided by SGS to certify the compliance of products with standards, regulations, customer requirements, and other conditions.

Function Safety Certification

CERTIFICATE

SGS

Functional Safety

Certificate No. FS/SHFS2404000165MD

Certificate Holder:	Suzhou Inovance Technology Co., Ltd. No.52, Tian E Dang Road, Yuexi, Wuzhong District, 215104 Suzhou City, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA.
Manufacturer:	Suzhou Inovance Technology Co., Ltd. No.52, Tian E Dang Road, Yuexi, Wuzhong District, 215104 Suzhou City, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA.
Trademarks:	INOVANCE
Certified Product:	Industrial Robot
Model (s) No. / Series:	Refer to APPENDIX II
Assessment Performed:	ISO 13849-1:2023, EN ISO 13849-1:2015
Conclusion:	The safety architecture and performance level meet PL d with Cat. 3 according to ISO 13849-1:2023 & EN ISO 13849-1:2015, detail information of safety function items is shown in APPENDIX I.

As shown in the technical report number(s): SHFS240400016571

This certificate confirms the achievement of the requirements of functional safety based on proof of the safety-related parameters (failure rate, $MTTF_D$ / PFH, safety architecture etc), proofs that processes, and methods are established at the manufacturer guaranteeing that unexceptionable processes in terms of risk analysis, design, production, validation, modification and quality management comply with the standard.

This certificate is issued by the company under its General Conditions for Certification Services accessible at https://www.sgs.com/en/terms-and-conditions. Attention is drawn to the limitations of liability defined therein and in the Test Report here above mentioned which findings are reflected in this Certificate. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Authorized by: Effective date: 17/04/2024

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Figure 8-3 Cover of functional safety certificate

- Machinery Directive 2006/42/EC
- ISO 13849-1:2023 Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design
- ISO 10218-1:2011 — Robots And Robotic Devices — Safety Requirements For Industrial Robots — Part 1: Robots

FCC Certification

Figure 8-4 FCC mark

- FCC is a mandatory certification in the United States, mainly for electromagnetic compatibility testing of wireless devices.
- The FCC is charged with regulating interstate and international communications by radio, television, wire, satellite and cable.
- The FCC's jurisdiction covers the 50 states, the District of Columbia, and U.S. Possessions.
- FCC certification is required for many radio applications, communication products and digital products to enter the American market.

KC Certification

Note

IRCB501 and IRCB501 high protection controllers are being KC certificated.

Figure 8-5 KC mark

The KC mark indicates compliance with the Korea Certification (KC) and electromagnetic compatibility (EMC) standards for commercial trades (production, import, and sales) in Korea.

- The KC mark is mandatory for engaging in commercial business (production, importation, and distribution) in Korea.
- The machinery and devices equipped with this product must also meet KC requirements when sold in Korea.

- The integrator who integrates this product into other products and attaches KC mark to the final assembly has the responsibility of ensuring compliance with KC certification.
- To ensure machines or devices that the product is installed in as a whole comply with the KC certification, the following information must be included:

Appllicant Suzhou Inovance Technology Co., Ltd.
AC Servo Drive
Model SV670 series
Made In China
Manufacturer
Suzhou Inovance Technology Co.,Ltd.

A급기기 (업무용 방송통신기자재)
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