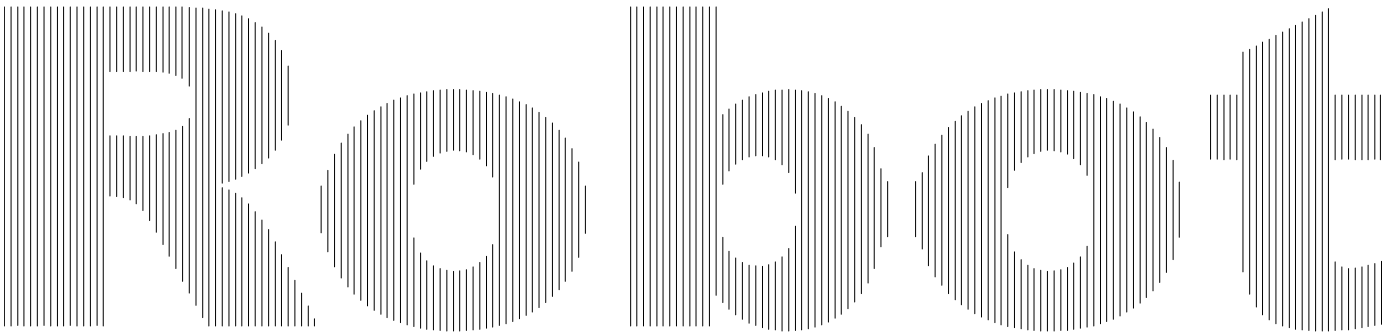
Simple and friendly

Kawasaki

Kawasaki Robot Controller
F Series Controller

CoreCubic-S Instruction Manual



Kawasaki Heavy Industries, Ltd.

90201-1489DED

Preface

This manual describes robot motion monitoring safety function CoreCubic-S, an option for the Kawasaki Robot Controller F series. Read and understand this manual thoroughly, and take appropriate safety measures in using this product.

Together with this manual, always refer to the separate manuals: “Safety Manual,” “Operation Manual,” “External I/O Manual,” and “Installation and Connection Manual.”

This manual is intended to be read by the following readers:

- One who is in charge of introducing the robot system
- One who designs the robot control system
- One who supervises the robot system
- One who conducts the maintenance of the robot system

and has proper knowledge on electric and control system and the laws and regulations concerning safety.

[NOTE]

This manual applies to and only to the below F series controllers:

【B-type】	【C-type】
F60	F52
F01/F02/F03/F04	
F11/F12/F14/F15	
F21/F22/F24/F25	
F31/F32/F34/F35	
F41/F42/F44/F45	

1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damage, and/or problems relating to industrial property rights as a result of using the system.
2. It is recommended that all personnel assigned for activation of operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different side or sold off to a different use, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.

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Symbols

The items that require special attention in this manual are designated with the following symbols.

Ensure proper and safe operation of the robot and prevent physical injury or property damage by complying with the safety matters given in the boxes with these symbols.

⚠ DANGER

Failure to comply with indicated matters can result in imminent injury or death.

⚠ WARNING

Failure to comply with indicated matters may possibly lead to injury or death.

⚠ CAUTION

Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.

[NOTE]

Denotes precautions regarding robot specification, handling, teaching, operation and maintenance.

⚠ WARNING

1. **The accuracy and effectiveness of the diagrams, procedures, and detail explanations given in this manual cannot be confirmed with absolute certainty. Should any unexplained questions or problems arise, please contact Kawasaki.**
2. **Safety related contents described in this manual apply to each individual work and not to all robot work. In order to perform every work in safety, read and fully understand the "Safety Manual", all pertinent laws, regulations and related materials as well as all the safety explanation described in each chapter, and prepare safety measures suitable for actual work.**

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1 Notes Concerning Safety

Law Compliance

When using this product, always follow the laws and standards of the country and area this product is used.

Risk Assessment

To ensure the safety of the robot and the robot system using this product, conduct proper risk assessment based on standard such as ISO 12100 “Safety of machinery — General principles for design — Risk assessment and risk reduction” etc. and take adequate protective measures to reduce the risk according to the standard.

Application of This Product

Do not use this product for the following purposes that may have a great risk of danger to the human life and properties. Kawasaki disclaims all the responsibilities, including responsibilities against default, defects, quality guarantee, illegal acts, and product liability, caused by using this product for such purposes.

1. Power, hydro or nuclear plants
2. Railways, airlines, vehicles and other transportation system
3. Medical institutes, and all equipment concerning medical and life-support
4. Entertainment facilities
5. Incineration and energy equipment
6. Facilities treating nuclear, chemical or other toxic substances
7. Mining and excavation
8. Other purposes that require high safety standards as 1 to 7 above.

Robot System Construction

Construction of safety related system for the robot using this product should be done by personnel who have completed the necessary education and training concerning the safety design and safety parameter settings. Especially, when designing the control system for safety related parts, consider the design thoroughly so that the failures in the control device and control circuit do not lead to any dangerous situations.

Notes Concerning the Use of CoreCubic-S

When using this product, observe thoroughly the notes and cautions mentioned in this manual. Not following the warnings given in this manual may lead to unexpected damages and failures of the robot and the robot system, fire, severe human damages, etc.

Relocation and Transfer

When relocating or transferring the ownership of this product, attach this manual to the robot without fail.

2 Notes and Cautions on Using CoreCubic-S

2.1 Notes and Cautions for System Designing

When designing the system, always follow the notes mentioned below. Not following the cautions mentioned here may result in unexpected errors and failures of the robot and the robot system. Also, it may lead accidents including severe human injuries by lowering the safety level for the whole system.

⚠ WARNING

1. **Select the proper safety devices to connect to safety input/output, such as emergency stop switch, light curtain etc. according to the required safety level.**
2. **Following the standards such as ISO 13849-1, design the system so that when a failure of the control system of the safety related part occurs, the system stops or so that the failure is detected through diagnostics. When using the safety output, configure the system to operate in the safe side (direction to stop) when it is OFF.**
3. **Always stop the robot before conducting parameter setting operations for CoreCubic-S.**
4. **Parameter setting operation for CoreCubic-S should always be done by personnel who have completed the required education course by Kawasaki and is certified as a robot system manager.**
5. **After completing system setting or transfer, always confirm the operation of all safety functions. Especially when setting enable/disable of the function according to the safety input, turn ON/OFF the safety input to confirm the safety function becomes enabled/disabled accordingly and that the safety function operates properly when enabled.**
6. **According to the standard such as ISO 13855, keep an appropriate safety distance between the installation position of the light curtain/laser scanner, etc. and the robot motion range.**
7. **According to the standard such as ISO 13857, keep an appropriate safety distance between the installation position of the safety fence and the robot motion range.**
8. **Each safety function stops the robot/device after robot/device exceeds the setting range. Since robot/device stops beyond the setting range, determine and set the range in consideration of this overrun.**

⚠ WARNING

9. When stopping the robot/device in each safety function, it may not stop normally due to brake failure, etc. Therefore, the risk assessment and system design must take in consideration of this. Do not go under the robot/device. Use the brake check function (For details, refer to the "Maintenance Software Option Manual.") to reduce the risk of brake failure.

10. Even if each safety function is set to stop at stop category 1/2, the robot/device stops at stop category 0 when the robot/device fails, the operation mode is switched, the enable switch is released in the Teach/Fast check mode, or the control power is OFF. Design the system so that the work pieces do not scatter even if it stops at stop category 0.

2.2 Cautions Concerning Wiring of this Product

Always follow the below mentioned cautions at the time of connection to safety input/output. Not following the warnings given in this manual may lead to unexpected damages and malfunctions of the robot and the robot system, fire, severe human damages, etc.

⚠ WARNING

1. **Turn OFF the robot controller power and external supply of DC power for I/O signals before connecting to input/output. If not, the robot or the devices connected to the safety input/output may move in an unexpected way.**
2. **Do not exceed the maximum load of the power terminals for I/O signals.**
3. **External supply of DC power for I/O signals should satisfy the following points:**
   - **Use power for PELV or SELV with double insulation or enforced insulation between the primary and secondary circuit.**
   - **(For North America) Use power that fulfills the output characteristics requirements defined in UL508 for Class 2 circuit or restricted voltage current circuit. For power I/O signal cable, use shielded cable and place it away from high voltage line or power line.**
   - **If the optional safety I/O board is used and the safety input/output function is used, the jumper connector setting on the safety I/O board must be changed when the power supply inside the robot controller is used as the power supply for the safety input/output signal. See Chapter 9 for details.**
4. **Use shielded cable as I/O signal power cable, and place it away from high voltage line or power line.**
5. **For connector of the I/O signal line, use ferrule terminal of the required size, or use required line, and connect them so that no short circuit between the terminals occur.**
6. **Secure the I/O signal cables inside the controller so no excess load is put on the connectors.**
7. **Do not connect the load over the rated current to output.**
8. **When wiring output, connect so that 24 V DC does not come in contact with the safety output. Always ground the GND line of the power source so that the unit does not turn ON when the output line touches the case.**
9. **When wiring input, be careful so that the input lines do not come in contact with each other.**
10. **Be careful so that foreign objects such as chips and wire off cuts do not enter the unit.**

⚠ WARNING

11. Inadequate wiring may impair the safety function. Make sure all wirings are correctly done, and always conduct operation checks before actual operations.
12. It is recommended to connect the rod terminal, but when connecting the stranded wire, please twist the conductor part moderately before connecting the beard part. Do not solder the conductors. This may cause poor connection or decreasing its retention force (pull-out force).
13. When using ferrules (solderless connectors), use a tool specified by the manufacturer and use ferrules which are suitable for the wire size described in Chapter 9.

2.3 Cautions Concerning Maintenance Operations

Always follow the below mentioned cautions at the time of maintenance of this product. Not following the warnings given in this manual may lead to unpredicted damages and malfunctions of the robot and the robot system, fire, severe human injuries, etc.

⚠ WARNING

1. All operation such as cleaning, wiring and replacement should be done after turning OFF the robot controller power and DC power for external supply for input/output signal.
2. Parts replacement should always be done by personnel who have completed the required education course by Kawasaki and is certified as a robot system administrator.
3. Safety parameters are stored on the CFast card on the main CPU board. When replacing any related parts and safety parameters, make sure that the setting data is correct in operation. Especially when enable/disable for the safety function according to the safety input, turn ON/OFF the safety input to confirm that the safety function switch to enable/disable accordingly.
4. Do not disassemble or remodel components such as circuit boards and harnesses. If repaired or remodeled by someone other than KHI personnel, it will be out of guarantee.
5. Before touching any parts inside the controller, be sure to touch a grounded metal object, etc. to discharge static electricity from your body.

2.4 Cautions Concerning the Disposal of this Product

When disposing this product, treat it as industrial waste. Always follow the rules concerning waste disposal, e.g. laws concerning the treatment of wastes and cleaning.

2.5 Cautions When Using Two Clean Robots

When using two clean robots (the clean robot is treated as a "device" in CoreCubic-S.) in a controller required two servo boards in clean robot specifications, be sure to observe the following precautions. Deviations from the cautions described in this manual may cause unexpected failures or malfunctions of the robot or robot system, or may reduce the safety level of the entire system, resulting in serious personal injury or other disasters.

⚠ WARNING

1. When designing a system that uses two clean robots, perform a risk assessment and design the system in accordance with one of the following conditions.
- **Ensure of setting that the motion range of two clean robots do not overlap.**
- **If the motion ranges of two clean robots overlap, limit or teach the motion ranges so that the clean robots do not collide with each other.**

2. In a system using that uses two clean robots, when a failure of one clean robot (such as a failure of an encoder) is detected, there is a function that enables the operation of another clean robot in which no failure is detected. When using this function, perform a risk assessment and design the system in accordance with one of the following conditions.
- **Ensure of setting that the motion range of two clean robots do not overlap.**
- **If the motion ranges of two clean robots overlap, restart the operation of the clean robot without the detected failure after confirming that the clean robot with the detected failure does not stop in the overlapping motion range.**

3 Rules and Regulations

This product is certified by the following standards.

⚠ CAUTION

This product is certified for the above standards by a third-party certification organization, but this does not guarantee the product to be free of all damage and malfunctions. Before using this product, perform proper risk assessment for the robot system including this product and take adequate measures to decrease the risks of any danger following the pertinent regulation.

Certifying Organization	Standards
TUV SUD	EN 61508-1:2010 EN 61508-2:2010 EN 61508-3:2010 EN IEC 62061:2021 EN ISO 13849-1:2015 EN ISO 10218-1:2011 EN 61800-5-1:2007/A1:2017 EN 61800-5-2:2017 EN 61326-3-1:2017
ODVA®	The EtherNet/IP™ Specification, The CIP™ Networks Library, , Volume 2, Edition 1.29. The CIP Safety™ Specification, The CIP™ Networks Library, , Volume 5, Edition 2.22.



4 Version Confirmation

CoreCubic-S consists of a main CPU board, a power sequence board, a servo board, and a safety I/O board (option). The part numbers of each board for CoreCubic-S are listed below.

No.	Board name	Part number
(1)	Main CPU board (2AA board)	50999-0690
(2)	Power sequence board (2AP board)	50999-3169
(3)	Servo board (2AB board)	50999-3153
(4)	Servo board (2FB board)	50999-3195
(5)	Safety I/O board (2DJ board) *Option	50999-3149

Safety software runs on the main CPU board (1) and the servo board ((3) or (4)). There are three safety software versions, each version corresponding to the main CPU board (safety software A), the first servo board (safety software B), and the second servo board (safety software C). (The second servo board may not be available depending on the configuration.)

Indicates the safety software version of CoreCubic-S.

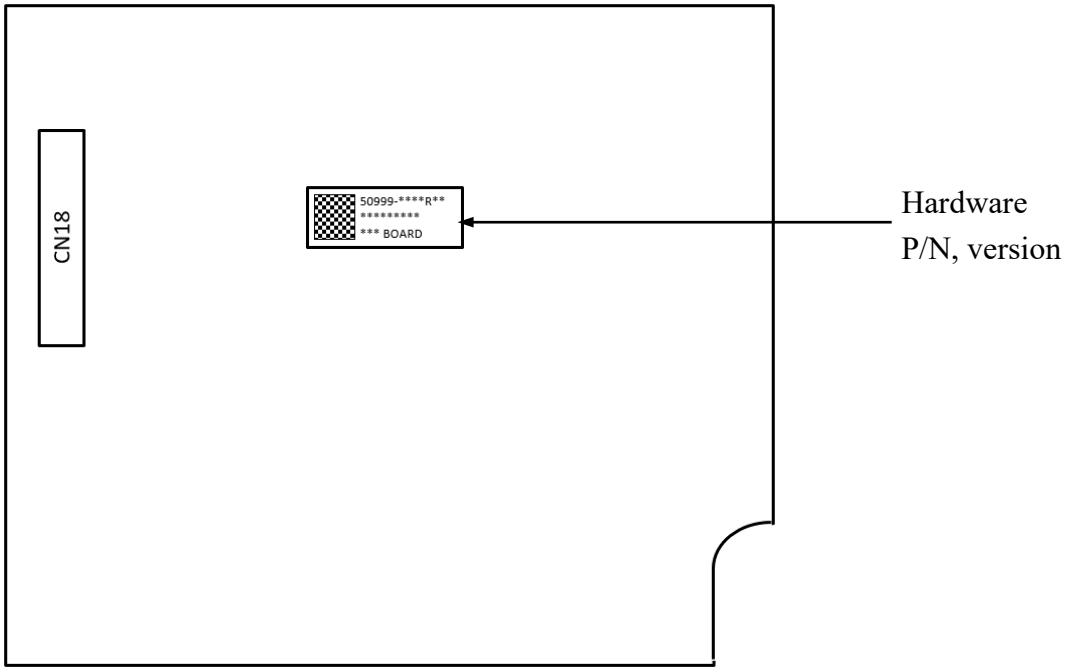
Safety software (A/B/C) versions
CCSA_00000100/CCSB_00000100/CCSC_00000100

Each hardware version that makes up CoreCubic-S and how to check and identify the software version are listed below.

4.1 Hardware Version Confirmation

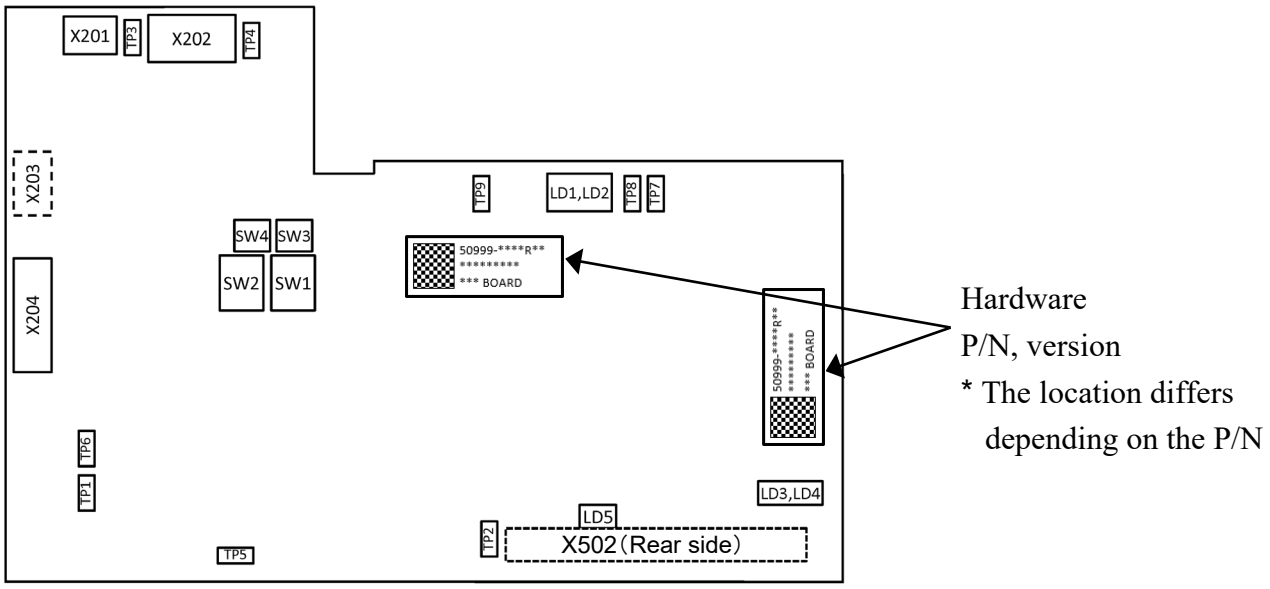
(1) Main CPU board (2AA board)

Safety software A operates on the CPU installed on this board.



Main CPU board (2AA board) front

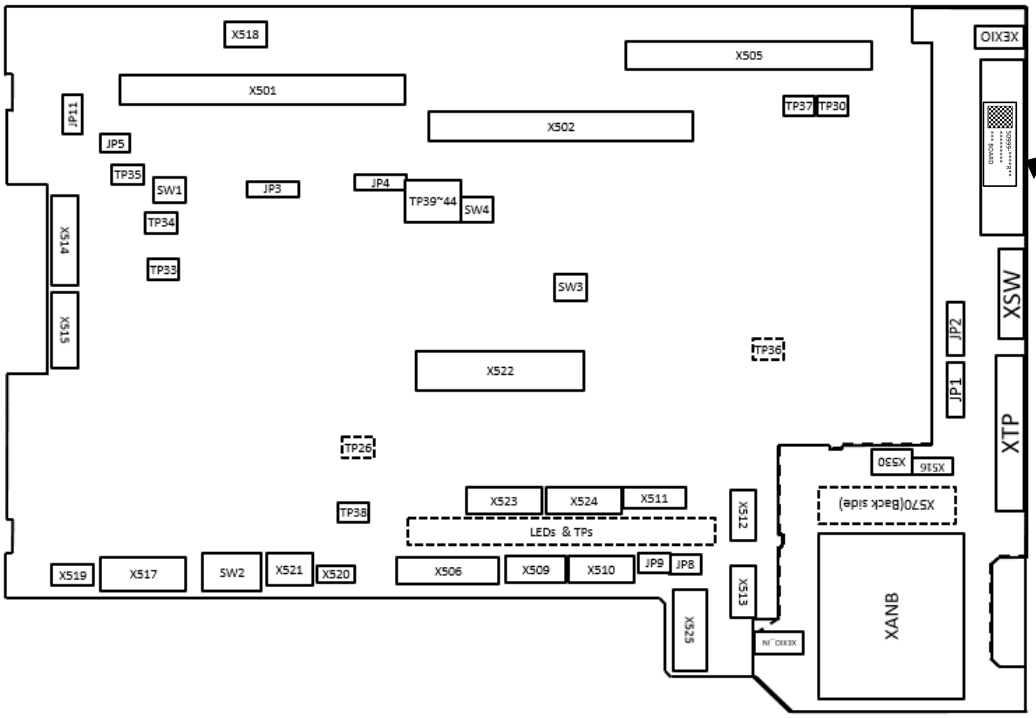
(2) Power sequence board (2AP board)



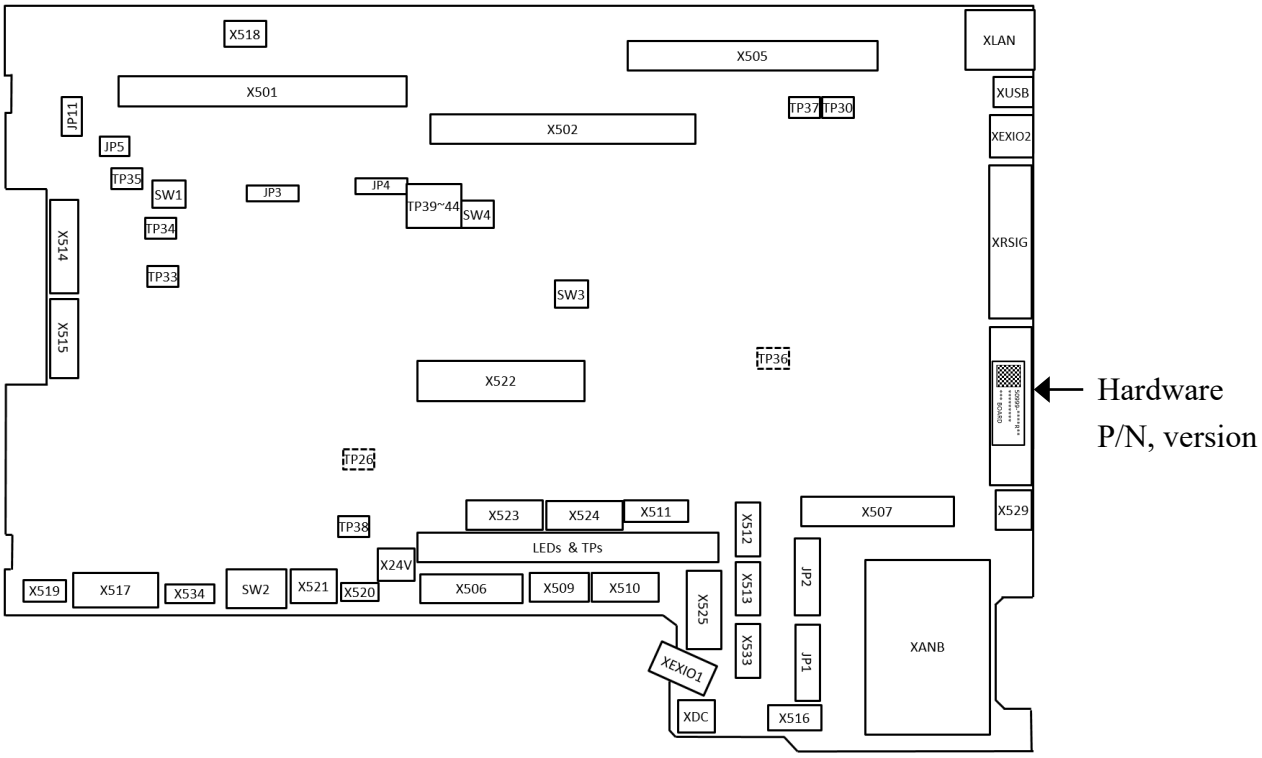
Power sequence board (2AP board) front

(3) Servo board (2AB board or 2FB board)

Safety software B (or C) operates on the CPU installed on this board. (In a system where two boards are used, safety software B operates on the CPU of the first board and safety software C operates on the CPU of the second board.)

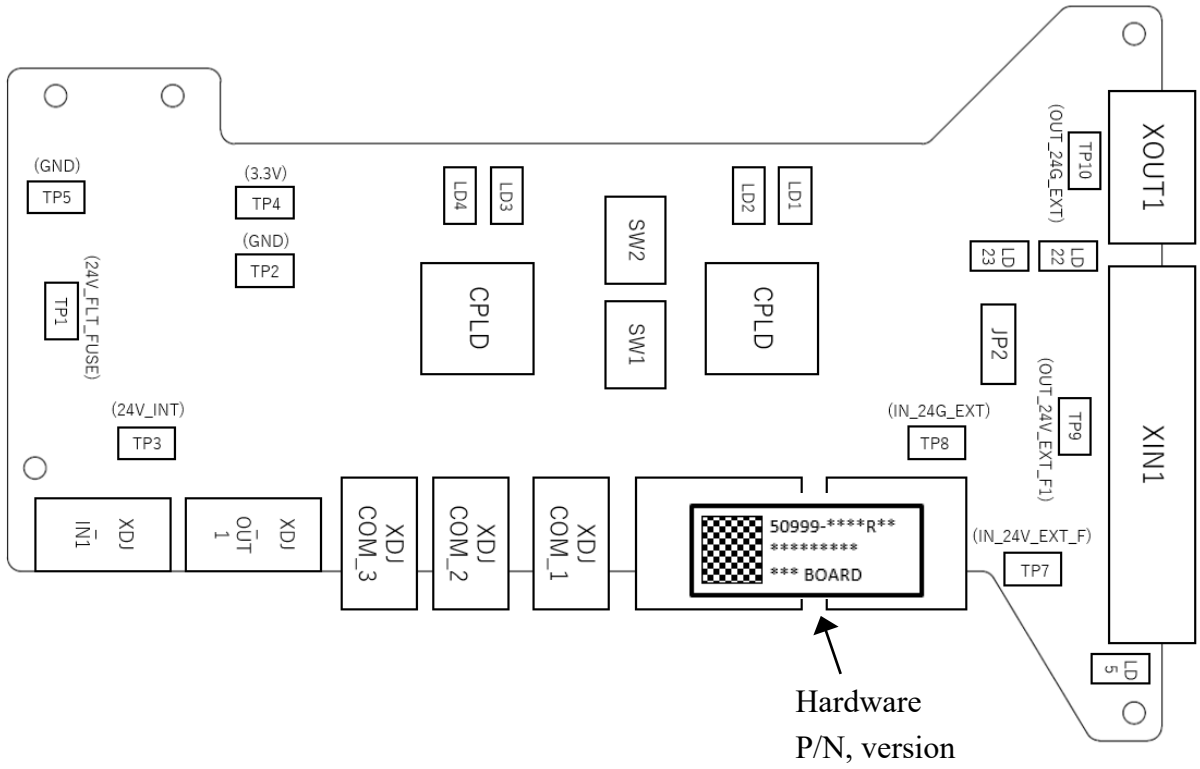


Servo board (2AB board) front *For F6x controller



Servo board (2FB board) front *For controllers other than F6x

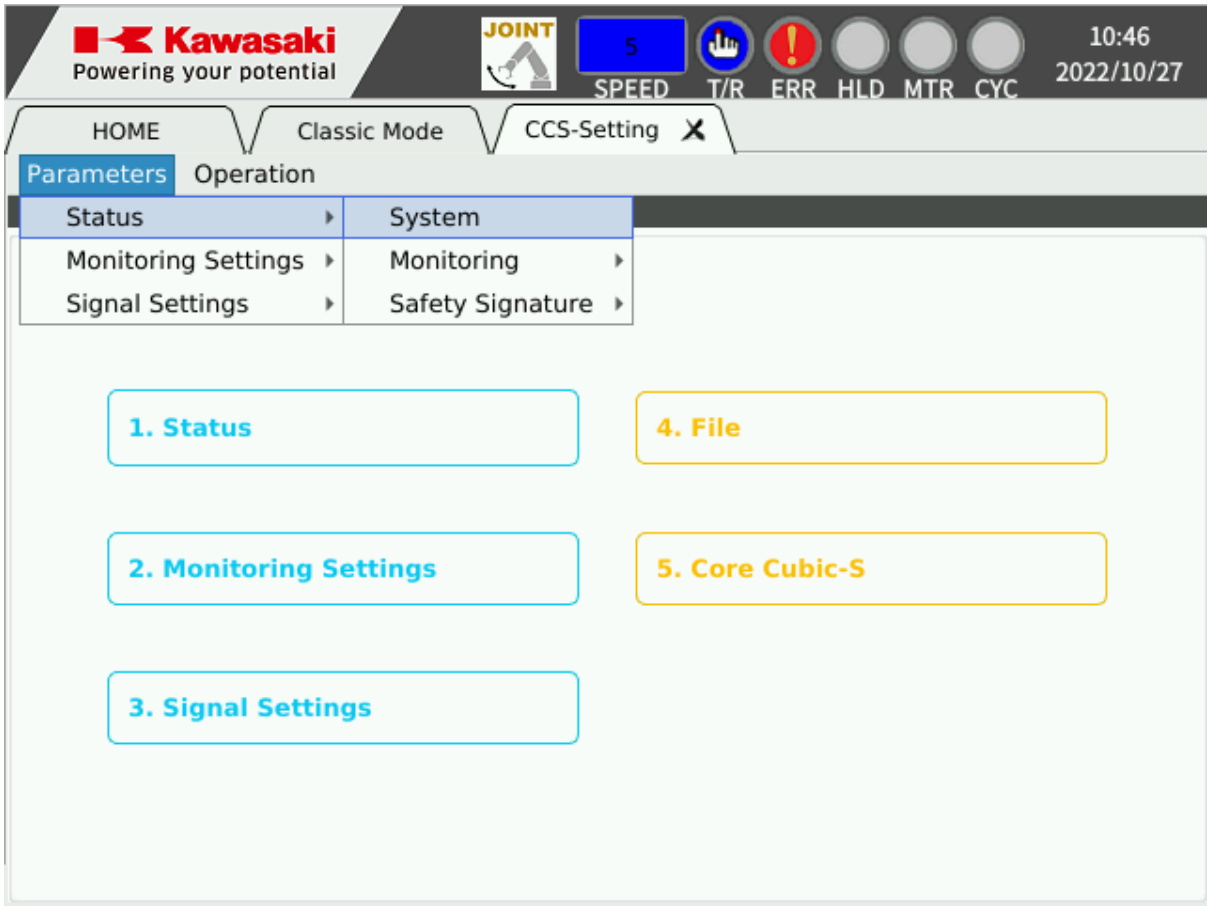
(4) Safety I/O board (2DJ board)



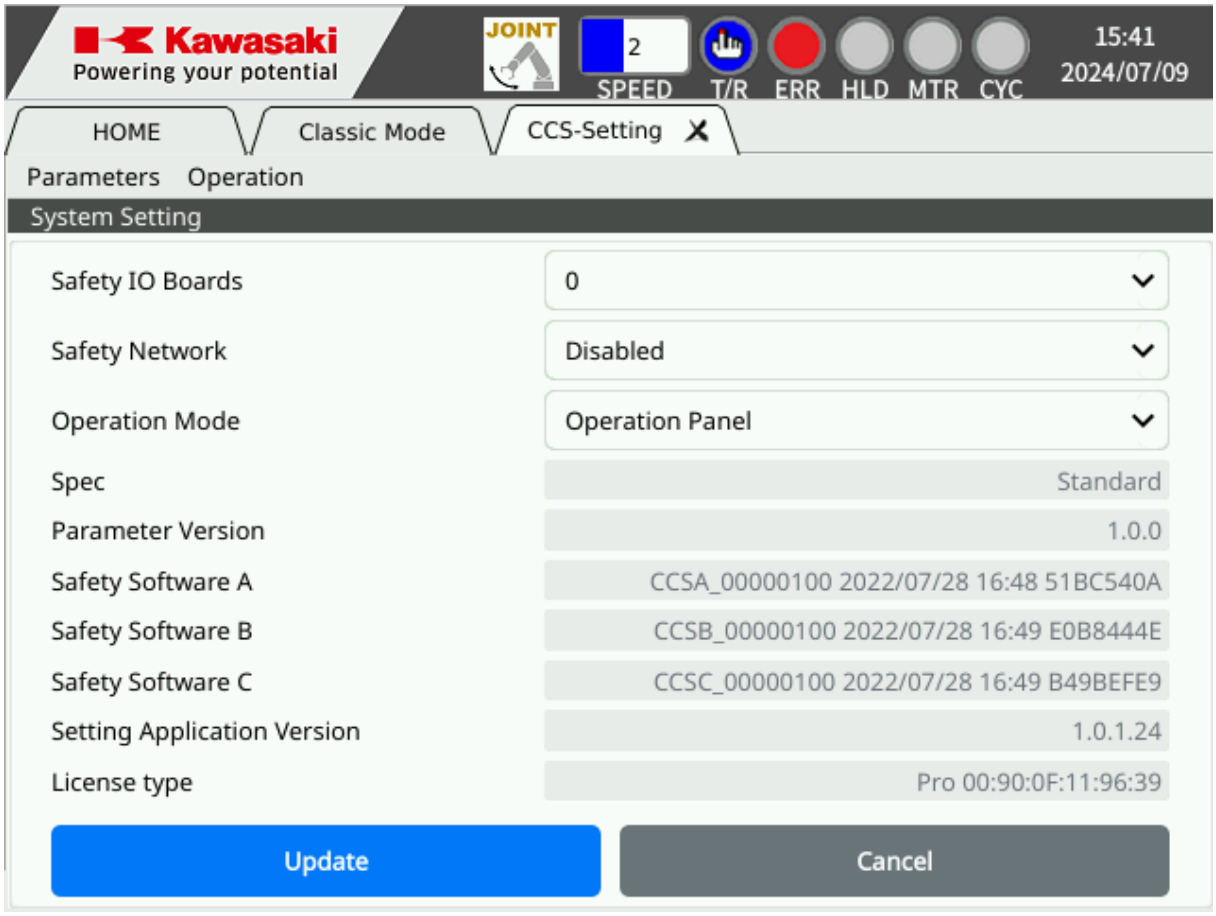
Safety I/O board (2DJ board) front

4.2 Software Version Confirmation

The software version of the safety software and the setting application can be checked from the system setup screen of the setting application.
Select [Status] from the menu, and then select [System].



The versions for the safety software and the setting application are displayed.



The safety software versions are displayed in the following formats.

- Safety software A (software on the main CPU board)
  Safety software A CCSA_nnnnnnnn yyyy/mm/dd hh:mm XXXXXXXX
- Safety software B (software on the first servo board)
  Safety software B CCSB_nnnnnnnn yyyy/mm/dd hh:mm XXXXXXXX
- Safety software C (software on the second servo board*)
  Safety software C CCSC_nnnnnnnn yyyy/mm/dd hh:mm XXXXXXXX

(* The second servo board is used only when two servo boards are connected to one main CPU board, such as clean robot specifications.)

1. CCSA_nnnnnnnn/CCSB_nnnnnnnn/CCSC_nnnnnnnn
   Represents the safety software version.
2. yyyy/mm/dd hh:mm
   Represents the date and time the safety software was created.
3. XXXXXXXX
   Represents the checksum value of the safety software.

5 Overview

Robot motion monitoring safety function, CoreCubic-S, is a safety function that monitors robot/device motion status and gets robot/device protective stop/emergency stop when robot/device moves out of the regulated motion. The protective stop function of robot/device can be enabled/disabled according to the safety input for each safety function. Also, robot/device motion status can be output using the safety output. The chart below describes the safety functions of CoreCubic-S.

Safety function of CoreCubic-S

Safety function	Contents of function
(1) Motion area monitoring function [Option]	Monitors if the monitored model set for the robot is inside the motion permission area or out of the motion prohibited area set in the XYZ plane. Protective stop functions when the monitored model is outside motion permission area or inside the motion prohibited area. The motion area monitoring is executed according to the safety input corresponding for each area. Also, predicts the stop position of the robot's monitored model, and when predicted stop position is outside motion permission area or inside the motion prohibited area, protective stop functions.
(2) Joint monitoring function [Option*]	Monitors the joint angle (rotational axis) or position (linear axis) of robot/device. Protective stop functions when the joint is out of the set motion permission joint range or inside the set motion prohibited joint range. There are Constant joint monitoring that protective stop functions all the time and Selective joint monitoring which can set enable/disable of protective stop according to the safety input are provided. There is no function to predict the stop position for joint monitoring function.
(3) Speed monitoring function [Option*]	Monitors the speed of monitoring points/axes of robot/device. Protective stop functions when the speed exceeds the set motion permission speed. This function includes teach mode speed monitoring and fast check mode speed monitoring which protective stop functions all the time, and the user speed monitoring which can set enable/disable of protective stop according to the safety input.

(4) Tool orientation monitoring function [Option]	Monitors the tool orientation of robot. Protective stop functions when getting outside motion permission tool orientation range. The tool orientation range can be set by using up to maximum five cones. The tool orientation monitoring is executed according to the safety input corresponding for each orientation. There is no function to predict the stop position for tool orientation monitoring function.
(5) Stop monitoring function [Option]	Monitors the stop status of robot/device. A protective stop is performed when the joint being monitored moves. Stop monitoring is performed according to the safety input signal corresponding to robot/device.
(6) Protective stop function [Option*]	With external safety protection devices such as safety fences connected, this function will stop the robot/device in cases such as when a person has entered the operating area of the robot/device, etc. The following settings are possible: 1. The motor power is shut OFF right after protective stop is input. (Stop category 0) 2. Performs deceleration when protective stop is input and the motor power is shut OFF after it comes to a stop. During deceleration, the deceleration of the robot/device is monitored and the motor power is shut OFF if it is not decelerating. (Stop category 1) 3. Performs deceleration when protective stop is input and performs stop monitoring after it comes to a stop. During deceleration, the deceleration of the robot/device is monitored and the motor power is shut OFF if it is not decelerating. Operation is resumed once the input is cleared. (Stop category 2)
(7) Emergency stop function [Option*]	Connects an external emergency switch, and functions emergency stop to robot/device when the emergency stop switch is pressed. The following settings are possible: 1. The motor power is shut OFF right after emergency stop is input. (Stop category 0) 2. Performs deceleration when emergency stop is input and the motor power is shut OFF after it comes to a stop. During deceleration, the deceleration of the robot/device is monitored and the motor power is shut OFF if it is not decelerating. (Stop category 1)

[Option*]: indicates that some functions are optional.

«Optional functions»
Optional functions are managed under license. The available optional functions differ depending on the license type. The available optional functions for each license type are listed below.

Function	Function setting	License type			
		None	Lite	Base	Pro
Common	Number of configurable tools	1	1	32	32
Area monitoring	Number of area monitoring sets	0	1	9	16
Joint monitoring	Number of selected joint monitoring sets	0	0	8	18
Speed monitoring	Number of user speed monitoring sets	0	0	4	18
Tool orientation monitoring	Number of tool orientation monitoring sets	0	0	5	8
Stop monitoring	Number of stop monitoring sets	0	0	4	18
Protective stop	Number of user protective stop sets	0	0	4	18
Emergency stop	Number of user emergency stop sets	0	0	4	18
Logic operation	Available operations	None	THROUGH NOT	THROUGH NOT AND OR XOR	THROUGH NOT AND OR XOR

The following function is managed under a dedicated license separate from the above license types.

- EtherNet/IP Safety

«Robot/device»
External axes for which cooperative settings have been made are included in the robot. Other external axes must be specified as devices in order to be monitored by each safety function. Use the CCS_SETDEVICE instruction (described in section 17.1.2) to specify them to the devices.

⚠ WARNING

1. **Each safety function stops after robot/device exceeds the setting range (area, angle/position, tool orientation). Since robot/device stops beyond the setting range, determine the range in consideration of this overrun distance.**
2. **When stopping the robot/device in each safety function, it may not stop normally due to brake failure, etc. Please take this into account when conducting risk assessments and designing systems. Do not get under the robot/device. Also, use the brake check function (Refer to "Maintenance Software Option Manual" for details) to reduce the risk of brake failure.**
3. **In each safety function, even if the stop category is set to 1/2, the robot/device may stop in stop category 0 with such as the failure of robot/device, switching the operation mode, releasing the enable switch during the teach/fast check mode, and controller power OFF. Therefore, design the system so that the workpieces will not scatter even if it stops in stop category 0.**
4. **The motion area monitoring function's stop position prediction function predicts the position at which the robot will stop and makes it stop within that setting area. However, this function does not guarantee that the robot will not go outside of the setting area. Since the stop position may exceed the setting area depending on the failure of the robot or operating conditions, determine the area with enough allowance.**
5. **The stop monitoring is not a function to guarantee that robot/device will not move at all. This is a function to stop robot/device when robot/device moves while the stop monitoring function is enabled.**
   Therefore, the risk assessment and system design must take in consideration that robot/device moves until CoreCubic-S makes it stop (For 20 ms).

6 Specifications

6.1 General Specifications

Item	Specification
Number of applicable axes	Maximum 17 axes
Safety function	Motion area monitoring function [Option], joint monitoring function [Option*], speed monitoring function [Option*], tool orientation monitoring function [Option], stop monitoring function [Option], protective stop function [Option*], emergency stop function [Option*] [Option*]: indicates that some functions are optional.
Safety performance*1	Protective stop function, emergency stop function: PL e(Category 4), SIL3 Other safety functions: PL d(Category 3), SIL2
Response time	1. Motor power shutoff (STO) ・ Stop category 0: From when the safety input is turned OFF (or the safety function is activated) to when the output is turned OFF Maximum 290 ms (Safety software: 20 ms + power sequence board: 270 ms) ・ Stop category 1: From the safety function is activated to the output is turned OFF. Maximum 290 ms (Safety software: 20 ms + power sequence board: 270 ms) Note This is different from the time it takes for the robot/devices to actually stop after the safety input is turned OFF. See Chapter 13 for how to calculate the response time. 2. User safety output 1 to 32 (Optional safety I/O board) From when the safety input is turned OFF (or the safety function is activated) to when the output is turned OFF Maximum 30 ms 3. User safety output 101 (power sequence board) From when the safety input is turned OFF (or the safety function is activated) to when the output is turned OFF Maximum 20 ms 4. Network safety output [Option] From when the safety input is turned OFF (or the safety function is activated) to when the output is turned OFF Maximum 40 ms Note The above times do not include the safety input filter times or the RPI of EtherNet/IP Safety.
Failure response time	Motor power shutoff (STO) From the time a failure is detected by the self-diagnostic function until the output is turned OFF Maximum 290 ms (Safety software: 20 ms + power sequence board: 270

	ms)
Input/output	1. Dual channel safety input (1) Fixed safety input: 11 channels (are input to power sequence board) (2) User safety input: Maximum 32 channels (up to 8 channels can be connected on one optional safety I/O board, and up to four safety I/O boards can be connected) 2. Dual channel safety output (1) Fixed safety output: 6 channels (are output from the power sequence board) (2) User safety output: Maximum 33 channels (up to 8 channels can be connected on one optional safety I/O board, and up to four safety I/O boards can be connected. 1 output on the power sequence board*2) 3. Tool ID1 input: 5 channels (are input to the first board of the optional safety I/O board) 4. Network safety input: 64 channels [Option] 5. Network safety output: 64 channels [Option]
Relevant I/F	Ethernet port (mounted on the main CPU board and servo board)...Connects to the safety controller (PLC) or to a PC for setting safety parameters (Safety parameters are set by PC or teach pendant)
Overvoltage category	II
Pollution degree	2
Ambient temperature	0 to 65℃
Ambient humidity	20 to 85%RH (without condensation)
Storage ambient temperature	-25 to 70℃
Storage ambient humidity	20 to 85%RH (without condensation)
Altitude	0 to 1000 m above sea level

*1 Indicates the safety performance of the robot controller including CoreCubic-S. When connecting an external safety device, the safety performance should be evaluated for the whole system including the safety device.

*2 The user safety output on the power sequence board is used only for special purposes, so detailed information is not disclosed.

6.2 Dual Channel Safety Input Specification

6.2.1 Fixed Safety Input Specification

Item	Specification
Input names	Fixed Safety Input 1. TP Emergency Stop Fixed Safety Input 2. TP Enable Fixed Safety Input 3. Operation Panel Teach/Repeat Mode Fixed Safety Input 4-1. Operation Panel Fast Check Mode[*1] Fixed Safety Input 4-2. Power Sequence Board Master/Secondary Enable[*1] Fixed Safety Input 5. Operation Panel Emergency Stop Fixed Safety Input 6. External Emergency Stop Fixed Safety Input 7. Safety Fence 1 Opened Fixed Safety Input 8. Safety Fence 2 Opened[*2] Fixed Safety Input 9. External Enable Fixed Safety Input 10. Reserve Fixed Safety Input 11. Motor Power Shutoff Input
Insulation method	Photocoupler insulation
Input voltage range	DC21.6 to 26.4 V (DC24 V±10%)
Maximum input current	6.8 mA
Input type	Fixed safety input 1 to 10: Sink input (PNP compatible) Fixed safety input 11 : Source input (NPN compatible)
Input diagnostics	Input discrepancy diagnostics Input test pulse diagnostics
Input filter	3.0 ms
Dual channel input logic setting	Fixed safety input 3, 4-2: Complementary Considered input ON when dual channel input A is ON, and B is OFF. Others are considered OFF. All other times input: Equivalent When both of dual channel input is ON, it is considered Input ON. Others are considered OFF.

Input that can be connected externally by the user =>Input from XES connector	Fixed Safety Input 6. External Emergency Stop Fixed Safety Input 7. Safety Fence 1 Opened Fixed Safety Input 8. Safety Fence 2 Opened Fixed Safety Input 9. External Enable
External connection cable specification	Cable length: 50 m or less Shielded type Electrostatic capacity: below 22 nF (wiring capacity included) Conductor resistance: below 5 Ω Inductance: below 40 uH Note For details, refer to the "External I/O Manual" for controller.

*1 Use fixed safety input 4-1 for general specifications (other than clean specifications) and fixed safety input 4-2 for clean robot specifications.

*2 Safety fence 2 input is used only for clean robot specifications.

6.2.2 User Safety Input Specification

Item	Specification
Channel	User safety input: Maximum 32 channels (up to 8 channels can be connected on one optional safety I/O board, and up to four safety I/O boards can be connected.*1)
Insulation method	Photocoupler insulation
Input voltage range	DC21.6 to 26.4 V (DC24 V±10%)
Maximum input current	6.8 mA
Input type	Sink input (PNP compatible)
Input Diagnostics	Input discrepancy diagnostics (Acceptable time of discrepancy can be set), Input test pulse diagnostics (can be disabled)
Input filter	Configurable between 1 to 127 ms, in units of 1 ms [The total delay time of the user safety input section is the sum of the fixed filter for test pulse removal (1 ms) + the set value by the safety parameter (1 ms to 127 ms)]
Dual channel input logic setting	Following settings possible: 1. Equivalent Considered input ON when both of dual channel input is ON. Others are considered OFF. 2. Complementary Considered input ON when dual channel A is ON, and B is OFF. Others are considered OFF.
External connection cable specification	Cable length: 50 m or less Shielded type Electrostatic capacity: below 22 nF (wiring capacity included) Conductor resistance: below 5 Ω Inductance: below 40 uH

*1 The number of safety I/O boards that can be mounted differs depending on the type of controller used.

6.3 Dual Channel Safety Output Specification

6.3.1 Fixed Safety Output

Item	Specification
Output names	Fixed Safety Output 1. Motor Power Shutoff (STO) => Connects to the servo amplifier circuit for each axis inside of the controller Fixed Safety Output 2. Motor Brake Power Shutoff (SBC) => Connects to the brake circuit for each axis inside of the controller Fixed Safety Output 3. Motor Power Normal => Used for special external axes, etc. Note Outputs to X202 connector Fixed Safety Output 4. TP/Operation Panel Emergency Stop Being Input => Used for special use (not disclosed) Note Outputs to X202 connector Fixed Safety Output 5. Motor Power Shutoff Output => Used when using the multi-axis controller Note Outputs to X510 connector Fixed Safety Output 6. External Enable Output => Used when using the multi-axis controller Note Outputs to X510 connector

Note Fixed safety output is dedicated for a use inside controller, detailed information to a user is not disclosed.

6.3.2 User Safety Output

Item	Specification
Channels	User safety output: Maximum 32 channels (up to 8 channels can be connected on one optional safety I/O board, and up to four safety I/O boards can be connected.[*1])
Insulation method	Photocoupler insulation
Power voltage	DC21.6 to 26.4 V (DC24 V±10%)
Maximum output current	0.2 A/1 channel (When using an external 24 V power supply)[*1]
ON voltage drop	1.0 V or lower
Leak current	13 uA or lower
Protection	Output short circuit protection
Output type	Source output (PNP compatible)

Output diagnostics test pulse OFF time	Maximum 500 μs
External connection cable specification	Cable length: 50 m or less Shielded type Static capacity: less than 22 nF (wiring capacity included) Conductor resistance: less than 5 Ω Inductance: less than 40 uH

1 The 24 V power supply (hereinafter referred to as "internal power supply") supplied from the servo board to the safety I/O board can also be used as the user safety input/output power supply on the safety I/O board, but in this case, the jumper harness setting (XDJCOM) of the safety I/O board must be switched. However, be sure to observe the following conditions when using the internal power supply.

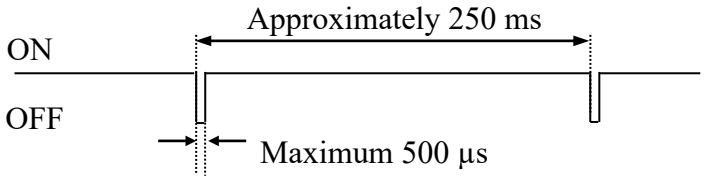
(1) The total current required for the safety input/output (total of 8 channels of dual channel input and 8 channels of dual channel output) of the safety I/O board should be within 0.8 A.

(2) When using two or more safety I/O boards, set the XDJCOM* settings to be supplied from an external power supply (refer to Chapter 9 for details), and supply an external 24 V power supply to the XIN and XOUT connectors externally. (Internal power is not available)

If the above conditions are not satisfied, the memory save may not be executed normally due to power shutoff the F controller.

⚠ CAUTION

For dual channel safety output, test pulse signal is output regularly for output signal diagnosis as shown in the figure below. Select the connected devices that do not cause malfunction by this test pulse or use the filtering function if the device has one.



6.4 Tool ID1 (Single channel) Specification

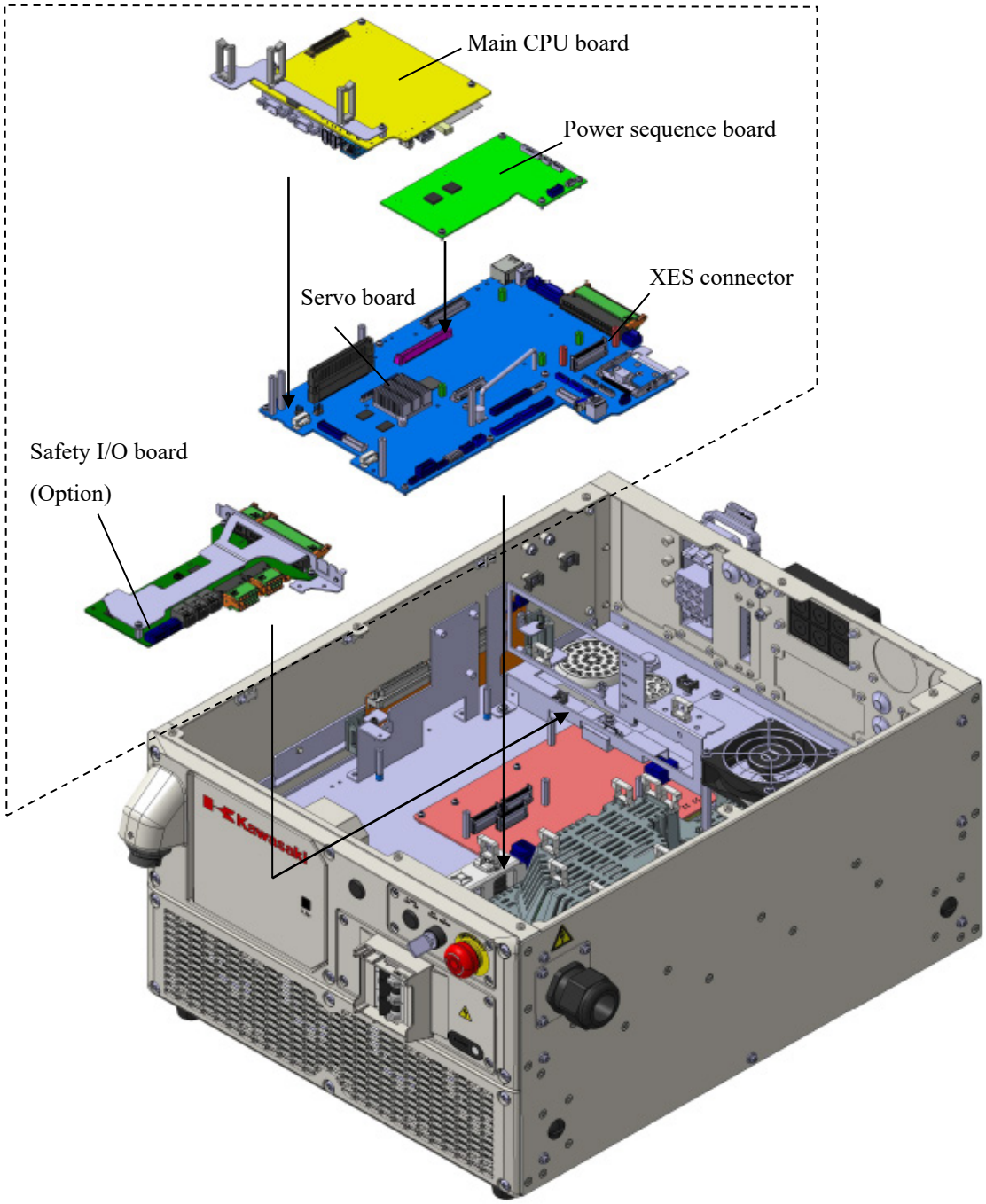
Item	Specification
Channel	5 channels
Insulation method	Photocoupler insulation
Input voltage range	DC21.6 to 26.4 V (DC24 V±10%)
Maximum input current	6.8 mA
Input type	Sink input (PNP compatible)
Input Diagnostics	Checks discrepancy with tool number on AS program
Use of tool ID1	Enables/disables use of tool ID1

6.5 Network Safety Input/Output Specification

Item	Specification
Supported network	EtherNet/IP Safety
Network safety output	64 channels
Network safety input	64 channels
Minimum RPI	20 ms

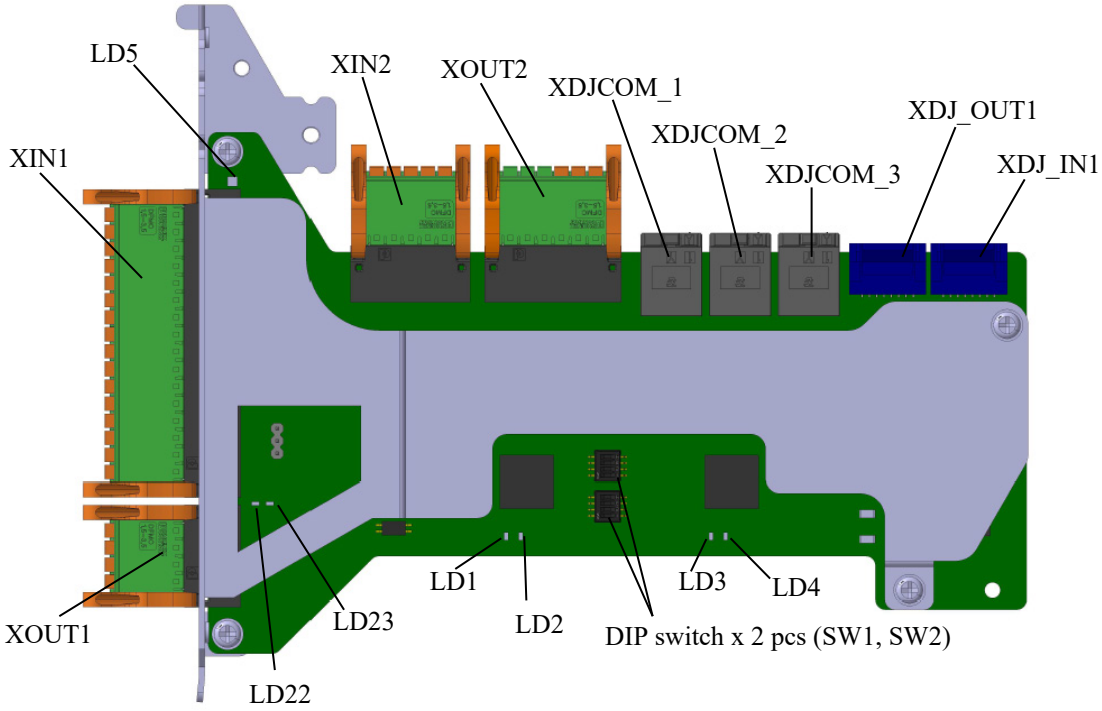
6.6 Hardware Configuration, Names and Functions of Each Part

The CoreCubic-S achieves safety functions by using multiple boards mounted as standard (some are options) on the controller. The following figure shows the boards related to CoreCubic-S using the F0xB controller as an example. Note Although the figure below shows an example of an F0xB controller, the mounting position and method (especially safety I/O board) differ depending on the type of controller.



Option: A top view of the safety I/O board is shown below.

Note For detailed information on other boards, refer to "Troubleshooting Manual" for each controller. Metal plate shape may vary depending on the controller used.



Connector

No.	Content
XIN1	・ External power supply for the safety input: Input of 24 V/GND (*1) ・ User safety (Dual channel) input ch1 to ch6 ・ Tool ID1 (Single channel) input ch1 to ch5 (*2)
XIN2	・ External power supply for the safety input: Input of 24 V/GND (*1) ・ User safety (Dual channel) input ch7 to ch8
XOUT1	・ External power supply for the safety input: Input of 24 V/GND (*3) ・ User safety (Dual channel) output ch1 to ch3
XOUT2	・ External power supply for the safety input: Input of 24 V/GND (*3) ・ User safety (Dual channel) output ch4 to ch8
XDJCOM_1	Connector to commonize the power supply for the external input/output (*4) Note Default is this setting
XDJCOM_2	Connector to commonize of the internal power supply on safety I/O board and the external input/output power supply (*5)
XDJCOM_3	Connector not to commonize for each power supply (*6)
XDJ_OUT1	Connector for communication connection between safety I/O boards
XDJ_IN1	Connector for communication connection between safety I/O board (The first board) and servo board

*1 The external power supply for the safety input connected to XIN1 and XIN2 is connected inside the safety I/O board. In addition, it is not possible to output and use the internal power supply from this connector to the outside.

*2 Only the first safety I/O board can be used for the tool ID1 input. (Inputs on the 2nd to 4th boards cannot be used.)

*3 The external power supply for the safety output connected to XOUT1 and XOUT2 on each is connected internally on board. In addition, it is not possible to output and use the internal power supply from this connector to the outside.

*4 Connects the input terminal of external power supply for the safety input on XIN1 and XIN2 to the output terminal of external power supply for the safety output on XOUT1 and XOUT2.

*5 When using the 24 V power supply (internal power supply) from the XDJ_IN1 connector which is connected to the safety I/O board from the servo board as the power supply for the safety input/output, it is also set to this connector.

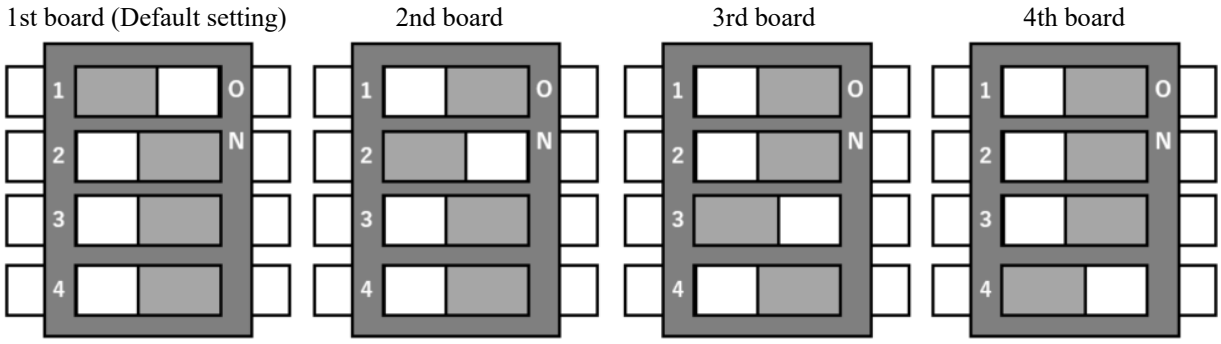
*6 Sets to this connector when the above internal power supply, safety output power supply, and safety input power supply are to be separated (not connected).

LED

Name	Content	Color	Status
LD1	For normal communication diagnostic display of safety I/O board CPLD#A/#B	Green	Normal: Flicker, Error: Light ON
LD2	For error occurrence display of safety I/O board CPLD#A/#B	Red	DIP switch setting error: Flicker, When error occurs: Light ON
LD3	For normal communication diagnostic display of safety I/O board CPLD#A/#B	Green	Normal: Flicker, Error: Light ON
LD4	For error occurrence display of safety I/O board CPLD#A/#B	Red	DIP switch setting error: Flicker, When error occurs: Light ON
LD5	For checking the fuse of the power supply for safety I/O board external input	Green	Normal: Light ON (24 V for input is enabled) When the fuse is blown: Light OFF (24 V for input is disabled)
LD22	For checking the fuse of the power supply 1 for safety I/O board external output	Green	Normal: Light ON (24 V for output is enabled) When the fuse is blown: Light OFF (24 V for output is disabled)
LD23	For checking the fuse of the power supply 2 for safety I/O board external output	Yellow	Normal: Light ON (24 V for output is enabled) When the fuse is blown: Light OFF (24 V for output is disabled)

DIP Switch

In safety I/O boards, two DIP switches (4 bits) are mounted per a board (SW1, SW2) so that the setting of the DIP switch must be switched according to the number of connected safety I/O boards. Use the same settings for SW1 and SW2 on the same board. If you set it differently, an error occurs and it does not work. For the DIP switch setting of the safety I/O board, perform as the following figures below.



WARNING

The safety function may not function properly if the DIP switch setting of the safety I/O board is incorrect. Check the DIP switch settings after replacing the circuit board.

6.7 Restrictions on Combining CoreCubic-S and Other Functions

When using CoreCubic-S, there are functions that can be used together with CoreCubic-S and others that cannot. Robot motion is not guaranteed for using with functions other than stated here. When using a function with CoreCubic-S for the first time, please contact Kawasaki beforehand.

1. Functions and options that cannot be used with CoreCubic-S

#	Function	Reason for restriction
1	Servo gain change function	Setting a small gain may cause displacement error in CoreCubic-S.
2	Soft absorber function	Setting a small gain may cause displacement error in CoreCubic-S.

2. Functions and options that can be used with CoreCubic-S, but with restrictions

#	Function	Reason for restriction
1	Spin function	Constant joint monitoring is disabled for the spin axis.
2	Mitsubishi motor (External axis)	This axis cannot connect with CoreCubic-S, so do not monitor this axis with CoreCubic-S.
3	Servo weld gun	Displacement error will occur in CoreCubic-S when servo weld gun is pressurized, so do not monitor this axis with CoreCubic-S.
4	Tool change function	Communication error occurs between encoder and CoreCubic-S after tool change (when disconnecting external motor axis and connecting to a different external axis motor), so do not monitor this axis with CoreCubic-S.

7 Safety Function

■ For "~" in signal name

A signal with "~" at the beginning of the signal name indicates that the signal is in the state of the name when the signal is OFF.

7.1 Motion Area Monitoring Function

[Motion area monitoring function is an option.]

Item	Specification
Contents of function	Protective stop is functioning for the all robots/devices when the monitored part of robot is outside motion permission area. Also, the safety status is output.
Applicable to	Robot
Monitored part	1. Robot (arm) Monitors the monitored model on the arm. The monitored model is set at the time of shipment. You can configure up to 20 spheres or capsules by changing to user settings. 2. Robot (tool) Monitors the monitored model on the tool. You can set up to 20 spheres, capsules, or cuboids per tool number. Specifies the tool number by tool ID1 or tool ID2. Note The number of cuboids that can be set is limited.
Function settings	16 sets can be set. Each set is set the motion permission or prohibition to the area. Each space is a convex triangle to octagon in the XY plane, with upper and lower limits in the Z direction. Note Each set can be enabled or disabled. Note For each set, you can enable/disable protective stop in teach mode, fast check mode, and repeat mode in each. Note Each set can be configured with stop category 0/1. Note Motion is prohibited in outside of the motion permission area, and motion is permitted in the outside of the motion prohibition area. Motion is prohibited in the area where motion permission area and motion prohibition area overlap.
Function conditions	The motion area monitoring is executed according to the safety input corresponding for settings of each set. Protective stop is disabled in both teach mode and override status. During Disabling Motion Area Monitoring Protective Stop corresponding to each set is disabled, the protective stop is disabled.
Safety input	Fixed Safety Input: Operation Panel Teach/Repeat Mode Fixed Safety Input: Operation Panel Fast Check Mode Fixed Safety Input: Tool ID1-1 to 1-5 Internal Safety Input: User Teach/Repeat Mode Internal Safety Input: User Fast Check Mode Internal Safety Input: Tool ID2-1 to 2-5 Internal Safety Input: Disabling Motion Area Monitoring Protective Stop 1 to 16
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: Inside Motion Permission Area 1 to 16
Stop position prediction	Predicts the stop position of stop monitoring part and stops the robot within the setting area. Note Enable/disable can be set for each set.

⚠ WARNING

The stop position prediction function does not guarantee that the robot will not go out of the setting area. Since the stop position may exceed the setting area depending on the failure or operating conditions of the robot, determine the area with enough allowance.

7.2 Joint Monitoring Function

[Selective joint monitoring function is an option.]

Item	Specification
Contents of function	Protective stop is functioning for the all robots/devices when the joint angle/position of robot/device when the joint is out of the set motion permission joint range. Also, the safety status is output.
Applicable to	Robot, devices
Monitored part	Monitors the angle of rotational axis and position of linear axis of robot/device.
Function settings	You can set one set of constant joint monitoring and 18 sets of selective joint monitoring.
	Constant joint monitoring: 1 set Motion prohibition joint range is set for each axis of the robot at the time of shipment. Note Protective stop is enabled in teach mode, fast check mode, and repeat mode. Note Stop category is 0.
	Selective joint monitoring: 18 sets Each set sets either robot/device 1 to 17 as the monitoring target. For each joint, it is set enable/disable, motion permission/prohibition, and joint range. Note Enable/disable can be set for each set. Note Enable/disable of protective stop can be set for each set in teach mode, fast check mode, and repeat mode. Note Each set can be configured with stop category 0/1.
	Note Motion is prohibited in outside of the motion permission range, and motion is permitted in the outside of the motion prohibition range. Motion is prohibited in the range where motion permission range and motion prohibition range overlap.
Function conditions	The joint monitoring is executed according to the safety input corresponding for settings of each set. Protective stop is disabled in both teach mode and override status. During Disabling Selective Joint Monitoring Protective Stop corresponding to each set of Selective joint monitoring, the protective stop is disabled.
Safety input	Fixed Safety Input: Operation Panel Teach/Repeat Mode Fixed Safety Input: Operation Panel Fast Check Mode Internal Safety Input: User Teach/Repeat Mode Internal Safety Input: User Fast Check Mode Internal Safety Input: Disabling Selective Joint Monitoring Protective Stop 1 to 18
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: Inside Motion Permission Constant Joint Range Internal Safety Output: Inside Motion Permission Selective Joint Range 1 to 18
Stop position prediction	None

7.3 Speed Monitoring Function

[User speed monitoring function is an option.]

Item	Specification
Contents of function	Protective stop is functioning for the all robots/devices when the monitored part speed of robot/device exceeds the motion permission speed. Also, the safety status is output.
Applicable to	Robot, devices
Monitored part	1. Robot (arm), devices Monitors the monitoring points on the arm/devices. The monitoring point is set at the time of shipment. You can configure up to 20 points of user setting. 2. Robot (tool) Monitors the monitoring point on the tool and TCP. You can set up to 20 points of user setting per tool number. Specifies the tool number by tool ID1 or tool ID2. 3. Joint Monitors each joint speed of devices and robot.
Function settings	You can set one set of teach mode speed monitoring, and one set of fast check mode speed monitoring, and 18 sets of user speed monitoring.
	Teach mode speed monitoring: 1 set Fast check mode speed monitoring: 1 set Monitors the XYZ synthesis speed of the robot. Depending on the AS software configuration, a monitoring point and the maximum speed of the motion permission are set for each set. Note Protective stop is enabled in teach mode for the teach mode speed monitoring. Note Protective stop is enabled in fast check mode for the fast check mode speed monitoring. Note Each set can be configured with stop category 0/1.
	User speed monitoring: 18 sets Each set sets either robot/device 1 to 17 as the monitoring target, and XYZ synthesis speed/ XY synthesis speed (robot only)/Z orientation speed (robot only)/joint speed. For each set, a monitoring point and the maximum speed of the motion permission are set. Note Each set can be enabled or disabled. Note For each set, you can enable/disable protective stop in teach mode, fast check mode, and repeat mode in each. Note Each set can be configured with stop category 0/1.
Function conditions	The speed monitoring is executed according to the safety input corresponding for settings of each set. Protective stop is disabled during Disabling User Speed Monitoring Protective Stop corresponding to each set of user speed monitoring.
Safety input	Fixed Safety Input: Operation Panel Teach/Repeat Mode Fixed Safety Input: Operation Panel Fast Check Mode Fixed Safety Input: Tool ID1-1 to 1-5 Internal Safety Input: User Teach/Repeat Mode Internal Safety Input: User Fast Check Mode Internal Safety Input: Tool ID2-1 to 2-5 Internal Safety Input: Disabling User Speed Monitoring Protective Stop 1 to 18
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: Within Motion Permission Teach Mode Speed Internal Safety Output: Within Motion Permission Fast Check Mode Speed Internal Safety Output: Within Motion Permission User Speed 1 to 18

7.4 Tool Orientation Monitoring Function

[Tool orientation monitoring function is an option.]

Item	Specification
Contents of function	Protective stop is functioning for the all robots/devices when the tool orientation of robot gets outside motion permission tool orientation range. Also, the safety status is output.
Applicable to	Robot
Monitored part	Monitors the tool orientation of robot. Specifies the tool number by tool ID1 or tool ID2.
Function settings	8 sets can be set. Each set is set with the range by using up to maximum five cones. Note Each set can be enabled or disabled. Note For each set, you can enable/disable protective stop in teach mode, fast check mode, and repeat mode in each. Note Each set can be configured with stop category 0/1. Note Motion is prohibited in outside of the motion permission range. Motion is prohibited in the range where motion permission range and motion prohibition range overlap.
Function conditions	The tool orientation monitoring is executed according to the safety input corresponding for settings of each set. Protective stop is disabled in both teach mode and override status. During Disabling Tool Orientation Monitoring Protective Stop corresponding to each set, the protective stop is disabled.
Safety input	Fixed Safety Input: Operation Panel Teach/Repeat Mode Fixed Safety Input: Operation Panel Fast Check Mode Fixed Safety Input: Tool ID1-1 to 1-5 Internal Safety Input: User Teach/Repeat Mode Internal Safety Input: User Fast Check Mode Internal Safety Input: Tool ID2-1 to 2-5 Internal Safety Input: Disabling Tool Orientation Monitoring Protective Stop 1 to 8
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: Inside Motion Permission Tool Orientation Range 1 to 8
Stop position prediction	None

7.5 Stop Monitoring Function

[Stop monitoring function is an option.]

Item	Specification
Contents of function	Stop monitoring is executed when entering the stop monitoring signals. Also, the safety status is output.
Applicable to	Robot, devices
Function settings	18 sets can be set. Each set sets a robot/device 1 to 17 to be monitored and enable/disable for each joint. Note Each set can be enabled or disabled. Note For each set, you can enable/disable protective stop in teach mode, fast check mode, and repeat mode in each.
Function conditions	The stop monitoring is executed according to the safety input corresponding for settings of each set.
Safety input	Fixed Safety Input: Operation Panel Teach/Repeat Mode Fixed Safety Input: Operation Panel Fast Check Mode Internal Safety Input: User Teach/Repeat Mode Internal Safety Input: User Fast Check Mode Internal Safety Input: ~Stop monitoring 1 to 18
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: ~Stop Monitoring Being Input 1 to 18 Internal Safety Output: In Stop Monitoring 1 to 18

7.6 Protective Stop Function

[SW safety fence protective stop/user protective stop function is an option.]

Item	Specification
Contents of function	Protective stop is functioning for applicable robots/devices to stop when protective stop signal is input. Also, the safety status is output.
Applicable to	Robot, devices
Function settings	Safety fence 1 protective stop 1 set, safety fence 2 protective stop 1 set, SW safety fence protective stop 1 set, user protective stop 18 sets can be set.
	Safety fence 1 protective stop: 1 set Safety fence 2 protective stop: 1 set (clean specifications only) SW safety fence protective stop: 1 set Safety fence 1 protective stop and SW safety fence protective stop are applicable to all robots/devices. However, the settings can be changed for clean specifications controllers. For details, refer to Chapter 9.1.3. Note SW safety fence protective stop can be enabled or disabled. Note Enabled in repeat mode. Note Each set can be configured with stop category 0/1.
	User protective stop: 18 sets Each set can be set either applicable to (1) all robots/devices, (2) robots/devices on the robot controller side, (3) robots/devices on the multi-axis controller side, or (4) any of robots/devices from 1 to 17 (stop category 2 only). Note Each set can be enabled or disabled. Note For each set, you can enable/disable protective stop in teach mode, fast check mode, and repeat mode in each. Note Each set can be configured with stop category 0/1/2.
Function conditions	The protective stop is executed according to the safety input corresponding for settings of each set.
Safety input	Fixed Safety Input: Operation Panel Teach/Repeat Mode Fixed Safety Input: Operation Panel Fast Check Mode Fixed Safety Input: ~Safety Fence 1 Opened Fixed Safety Input: ~Safety Fence 2 Opened Internal Safety Input: User Teach/Repeat Mode Internal Safety Input: User Fast Check Mode Internal Safety Input: ~SW Safety Fence Opened Internal Safety Input: ~User Protective Stop 1 to 18
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: ~SW Safety Fence Opened Being Input Internal Safety Output: ~User Protective Stop Being Input 1 to 18 Internal Safety Output: In User Protective Stop 1 to 18

7.7 Emergency Stop Function

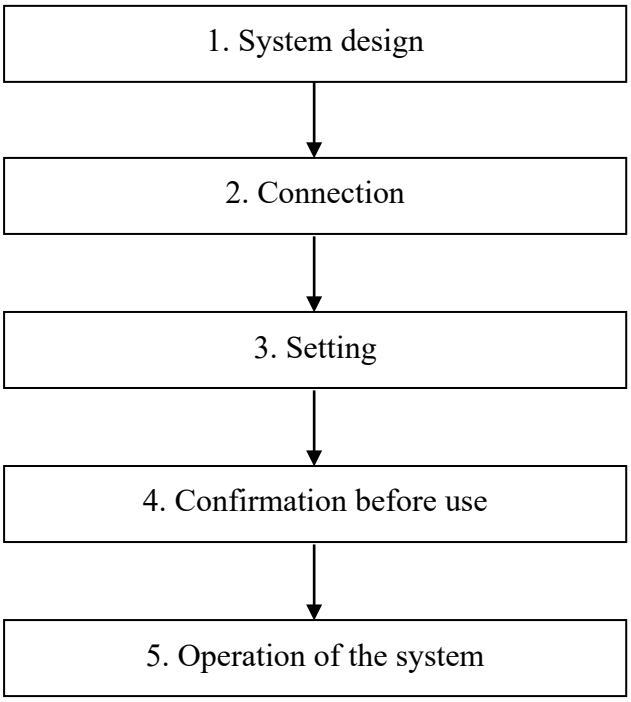
[SW external emergency stop/user emergency stop function is an option.]

Item	Specification
Contents of function	Emergency stop is functioning for applicable robots/devices to stop when emergency stop signal is input. Also, the safety status is output.
Applicable to	Robot, devices
Function settings	TP emergency stop 1 set, operation panel emergency stop 1 set, external emergency stop 1 set, SW external emergency stop 1 set, user emergency stop 18 sets can be set.
	TP emergency stop: 1 set This stop is applicable to all robots/devices. Note Stop category 0/1 can be configured.
	Operation panel emergency stop: 1 set This stop is applicable to all robots/devices. However, the settings can be changed for clean specifications controllers. For details, refer to Chapter 9.1.2. Note Stop category 0/1 can be configured.
	External emergency stop: 1 set SW external emergency stop: 1 set This stop is applicable to all robots/devices. However, the settings can be changed for clean specifications controllers. For details, refer to Chapter 9.1.2. Note SW external emergency stop can be enabled or disabled. Note Stop category 0/1 can be configured.
	User emergency stop: 18 sets Each set can be set either applicable to (1) all robots/devices, (2) robots/devices on the robot controller side, (3) robots/devices on the multi-axis controller side. Note Each set can be enabled or disabled. Note Each set can be configured with stop category 0/1.
Function conditions	The emergency stop is executed according to the safety input corresponding for settings of each set.
Safety input	Fixed Safety Input: ~TP Emergency Stop Fixed Safety Input: ~Operation Panel Emergency Stop Fixed Safety Input: ~External Emergency Stop Internal Safety Input: ~SW External Emergency Stop Internal Safety Input: ~User Emergency Stop 1 to 18
Safety output	Internal Safety Output: ~Motor Power Shutoff Command Performed 1 to 2 Internal Safety Output: ~SW External Emergency Stop Being Input Internal Safety Output: ~User Emergency Stop Being Input 1 to 18



8 Basic Operations of the Setting Application

Below shows a general flowchart for operating a safety system using CoreCubic-S.



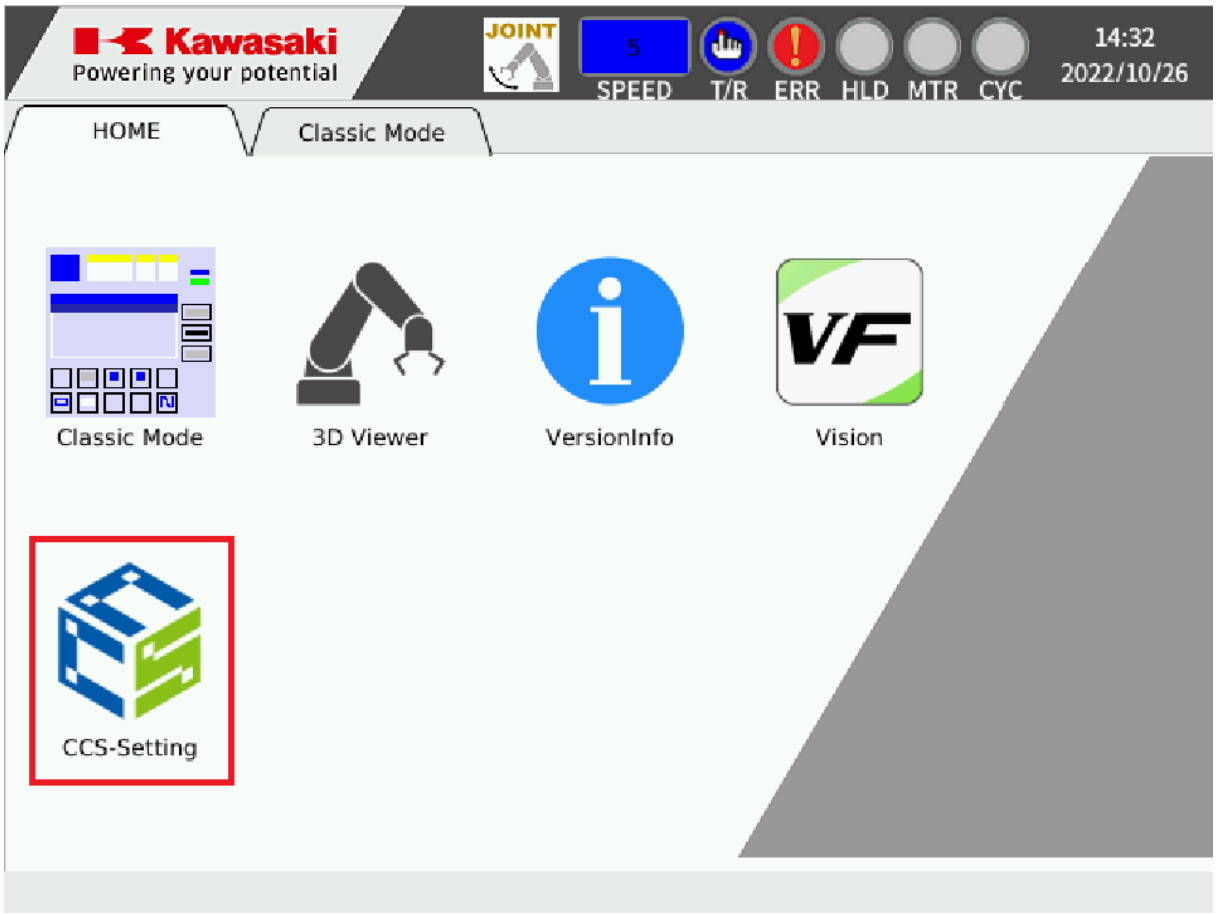
The below chart describes the necessary information and references for each procedure in the flow.

No.	Step	Necessary information	Reference
1	System design	Standards	Chapter 3
		Overview	Chapter 5
		Specifications	Chapter 6, Chapter 7
2	Connection	Connection method	Chapter 9, Chapter 10
3	Setting	Setting method	Section 11.1
4	Confirmation before use	Method of confirmation before use	Section 11.2

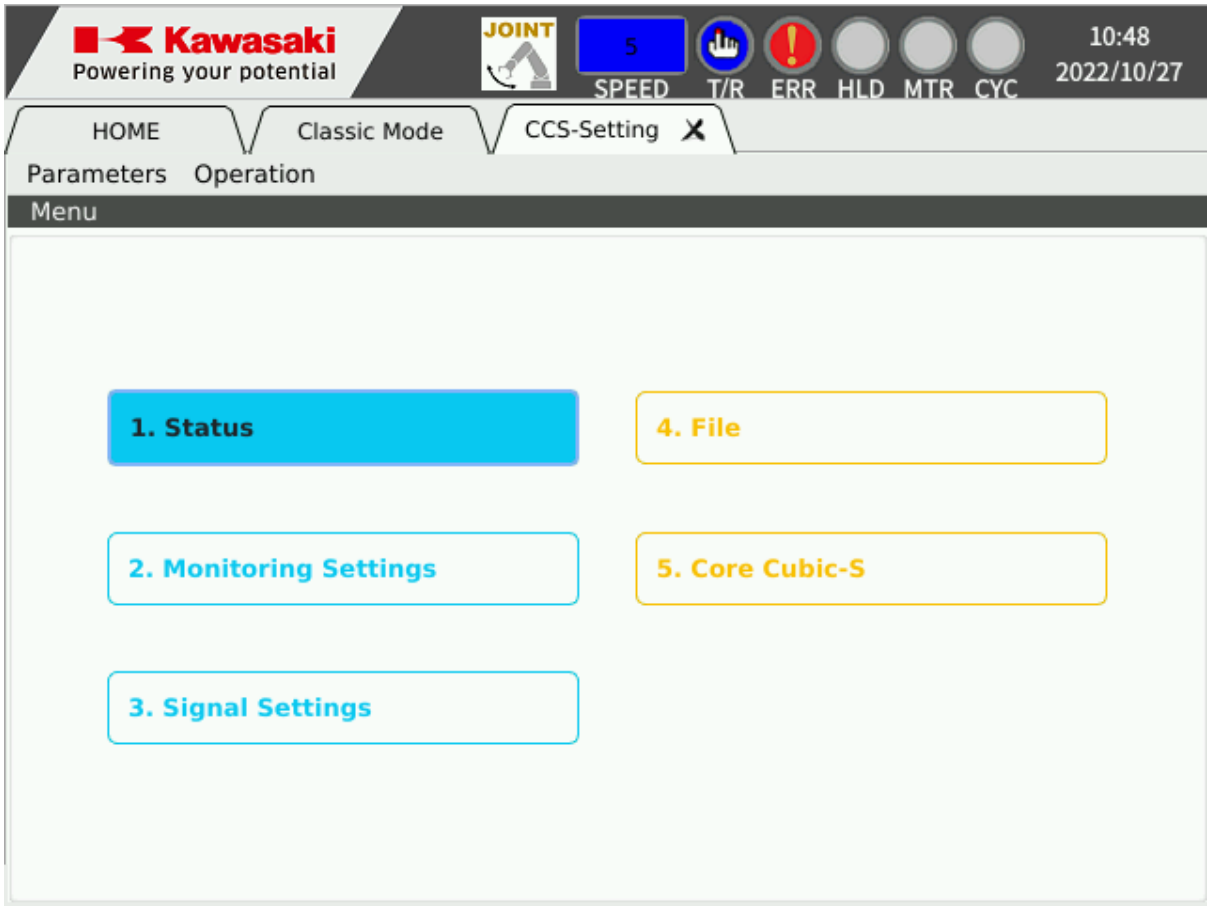
8.1 Starting and Ending the Setting Application

8.1.1 Starting the Setting Application

Select the icon of the setting application from the launcher screen of TP. Starting the 3D viewer application at the same time may cause the application to run very slowly and result in a timeout error. End the 3D viewer application when starting the settings application.



The screen below appears right after the application starts.



8.1.2 Ending the Setting Application

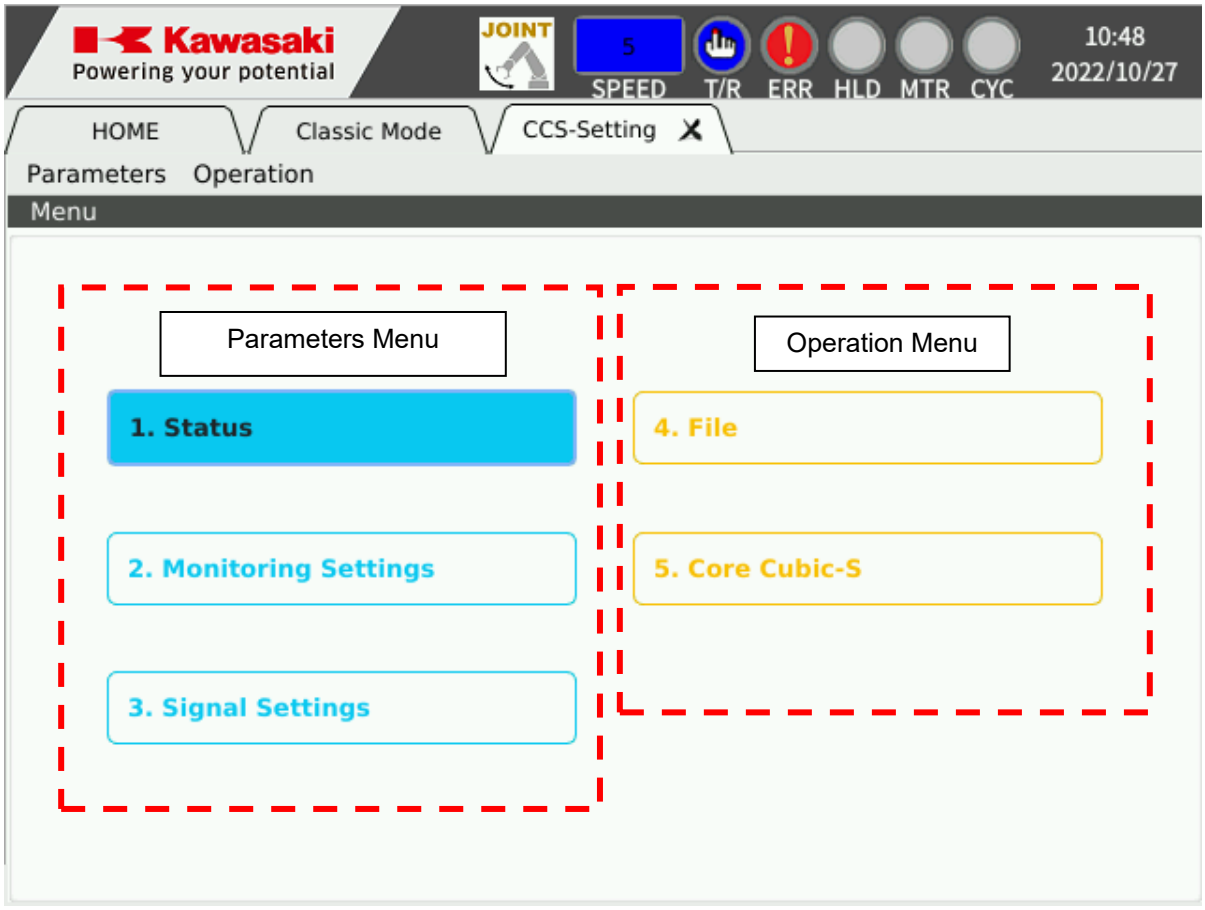
To exit, press the <×> button to the right side of the tab. At this time, data that has not been <Write Core Cubic-S> will be discarded. If you want to save the data, Execute <Write Core Cubic-S> or <Output ParameterFile>.

8.2 Display Configuration

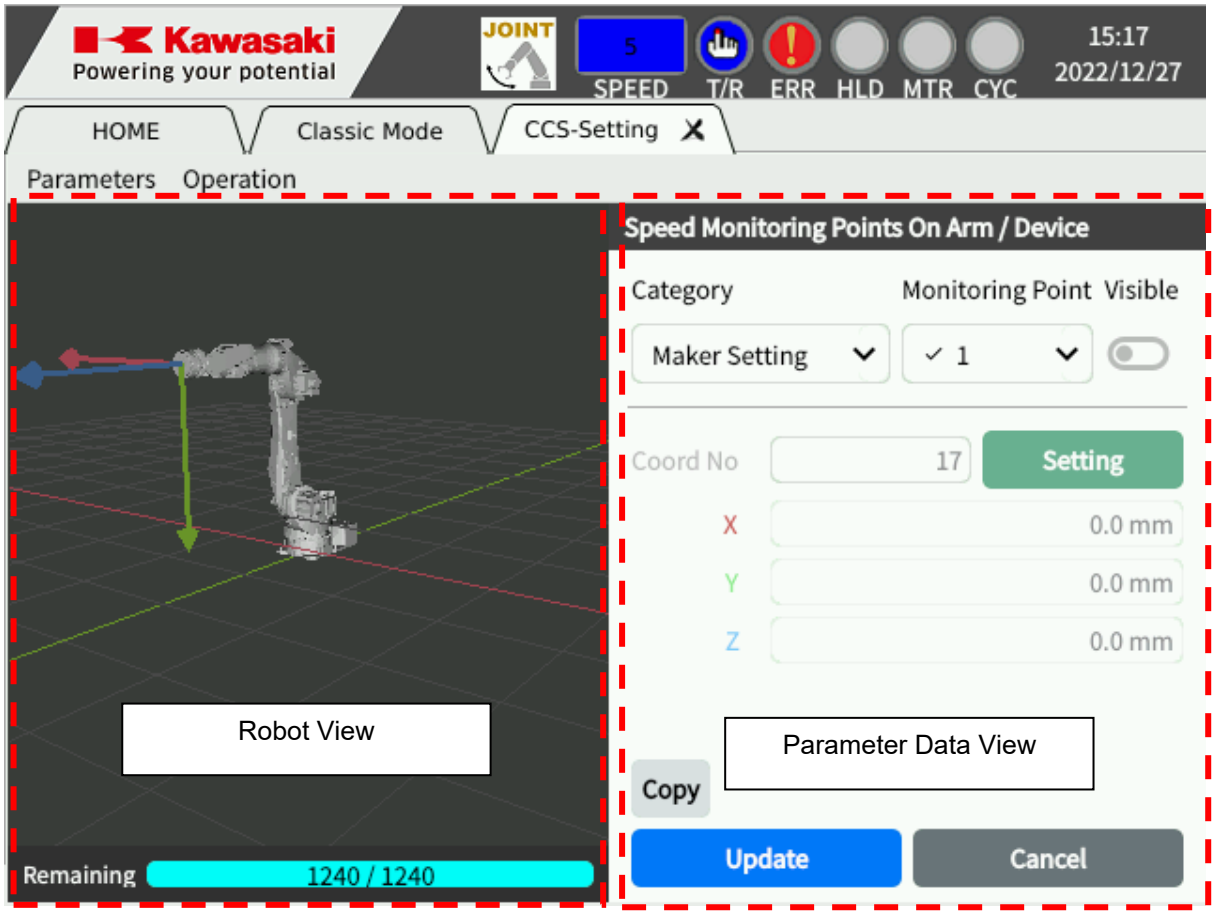
The setting application consists of four parts. Overview of each part is as follows:

No	Display	Overview
1	Robot View	Graphically displays the robot, monitored areas (motion monitoring area, motion prohibited area), area monitoring spheres/capsules on arm and tool, area monitoring cuboids on tool, speed monitoring (coordinates of speed monitoring on tool, monitoring points on arm/device), and the tool orientation monitoring cones. Display operations such as view change, zoom in and out are possible. The coordinate origin set in the world coordinates is indicated by an arrow showing the X (red), Y (green), and Z (blue) directions. Coordinate value changes of monitored areas or etc., is not available on the view.
2	Operation Menu	This menu consists of buttons and pull-down menu using for read and writing parameters, such as "Read Core Cubic-S," "Write Core Cubic-S," "Open File" or "Output ParameterFile."
3	Parameters Menu	By selecting the Status, Monitoring Settings, and Signal Settings items, each parameter configuration is displayed in Parameter Data View for the Status, Monitoring Settings and Signal Settings. Selecting the Monitoring Settings displays the list on the "Parameter Data Setting Screen."
4	Parameter Data View	Displays the parameter setting screen for the setting function selected in "Parameters Menu." When a monitoring item is selected, the list is displayed.

- **Operation Menu/Parameters Menu**



- **Robot View/Parameter Data View**

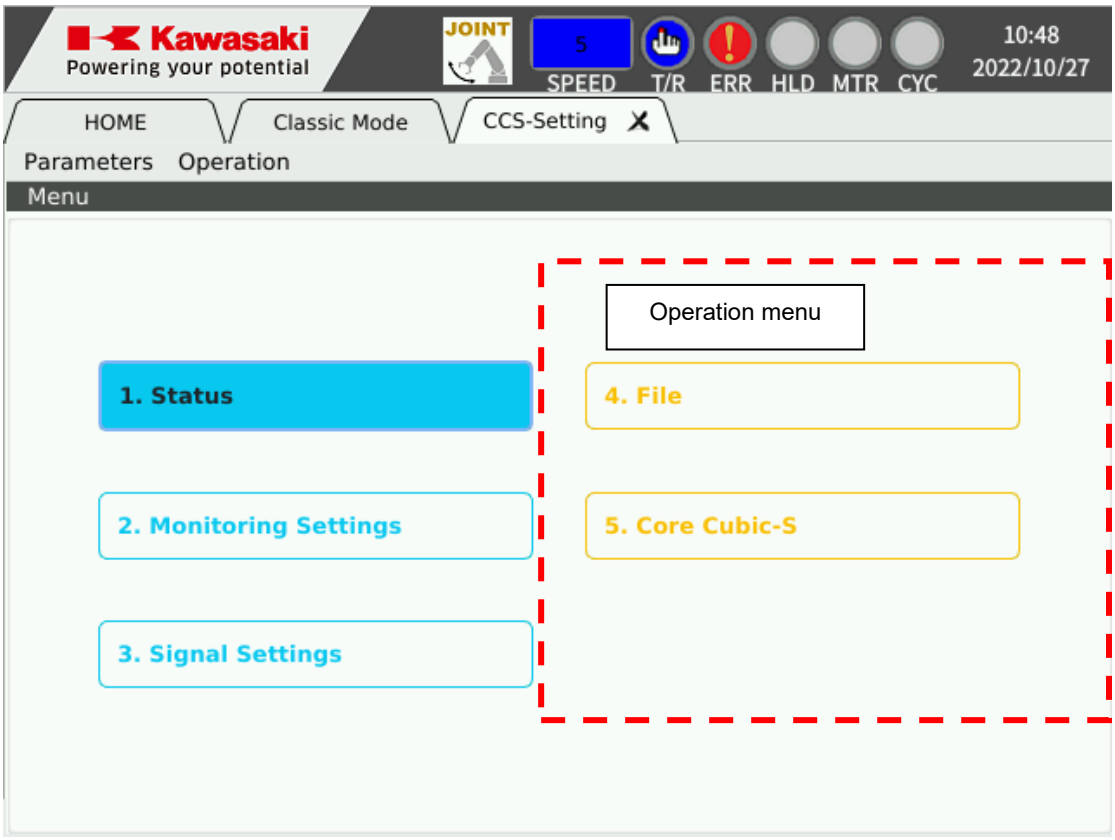


8.3 About the Parameters

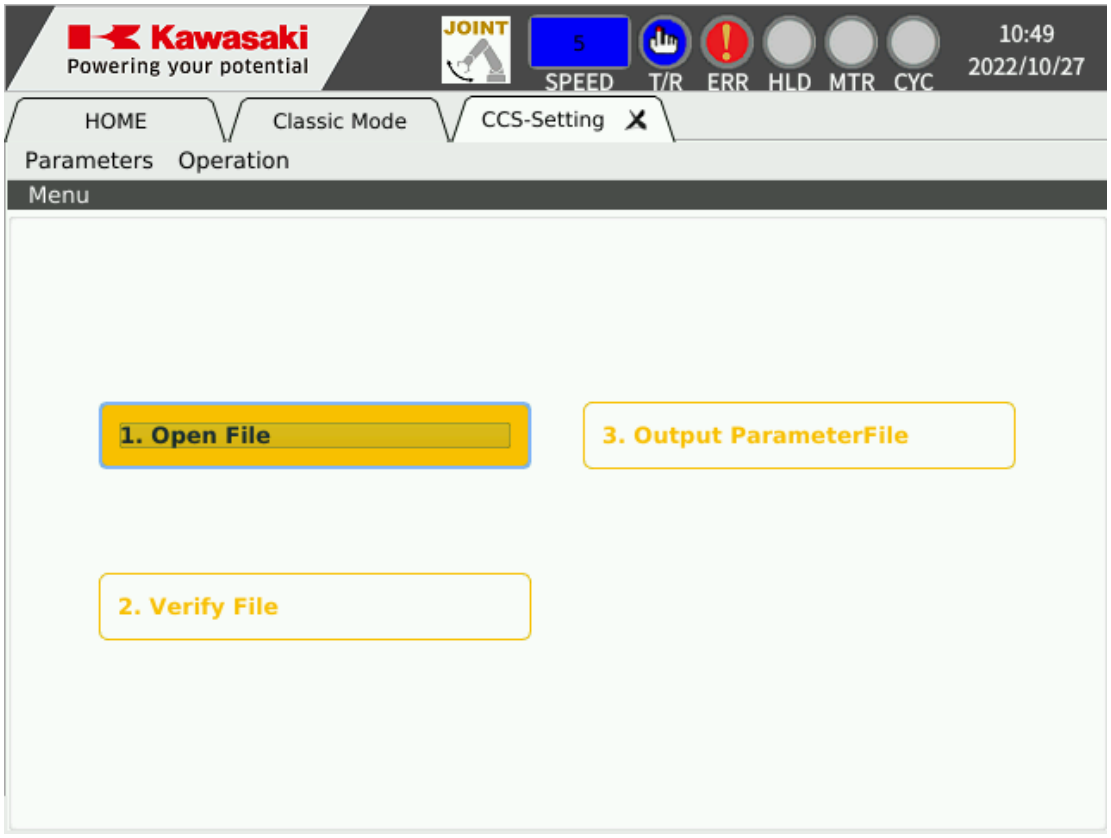
There are two types of parameters; robot parameter and user parameter, to set in the CoreCubic-S. Robot parameters are parameters persistent to each robot such as robot axis configuration and DH parameters. These parameters are set prior to use in the robot controller and cannot be changed by the user. Robot parameters are read from CoreCubic-S to the setting application when the setting application starts.

8.4 Operation Menu

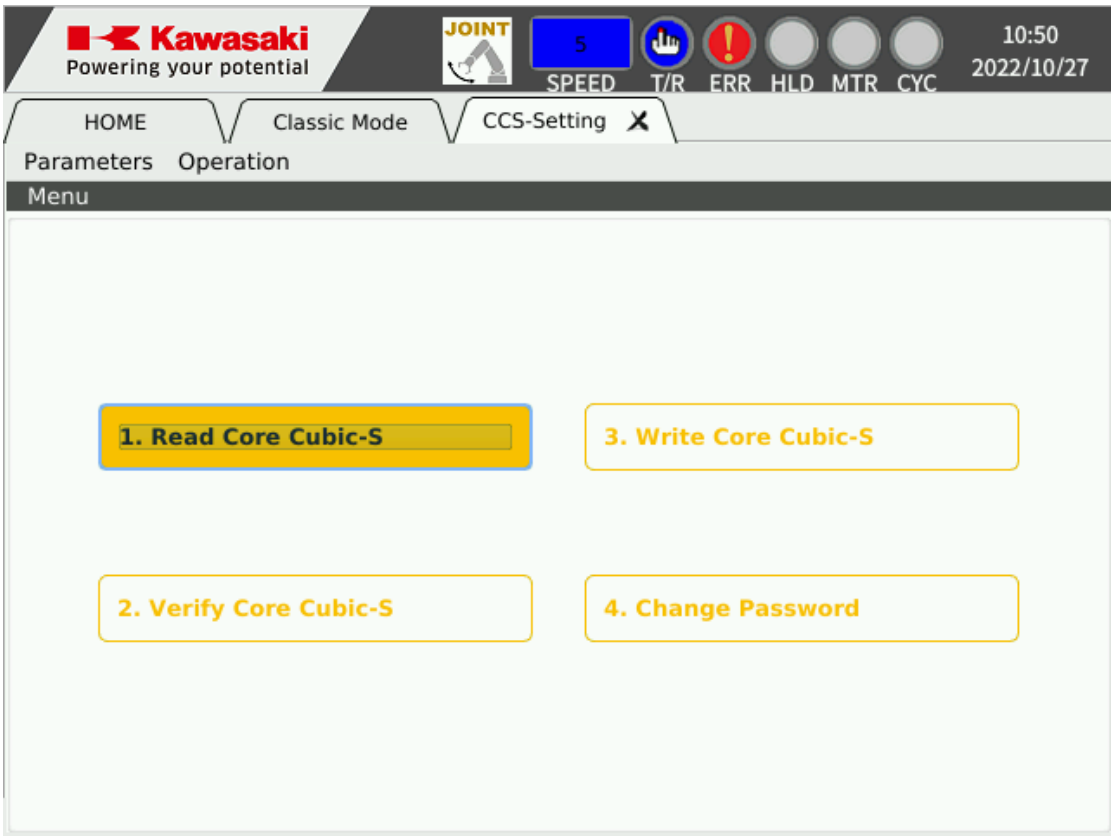
The Operation menu is made up with each buttons in the <File> and <Core Cubic-S>. <File> is made up with <Open File>, <Verify File>, and <Output ParameterFile>, then <Core Cubic-S> is made up with <Read Core Cubic-S>, <Verify Core Cubic-S>, <Write Core Cubic-S> and <Change Password>. This section describes the role of each button.



・ When selecting File



・ When selecting CoreCubic-S



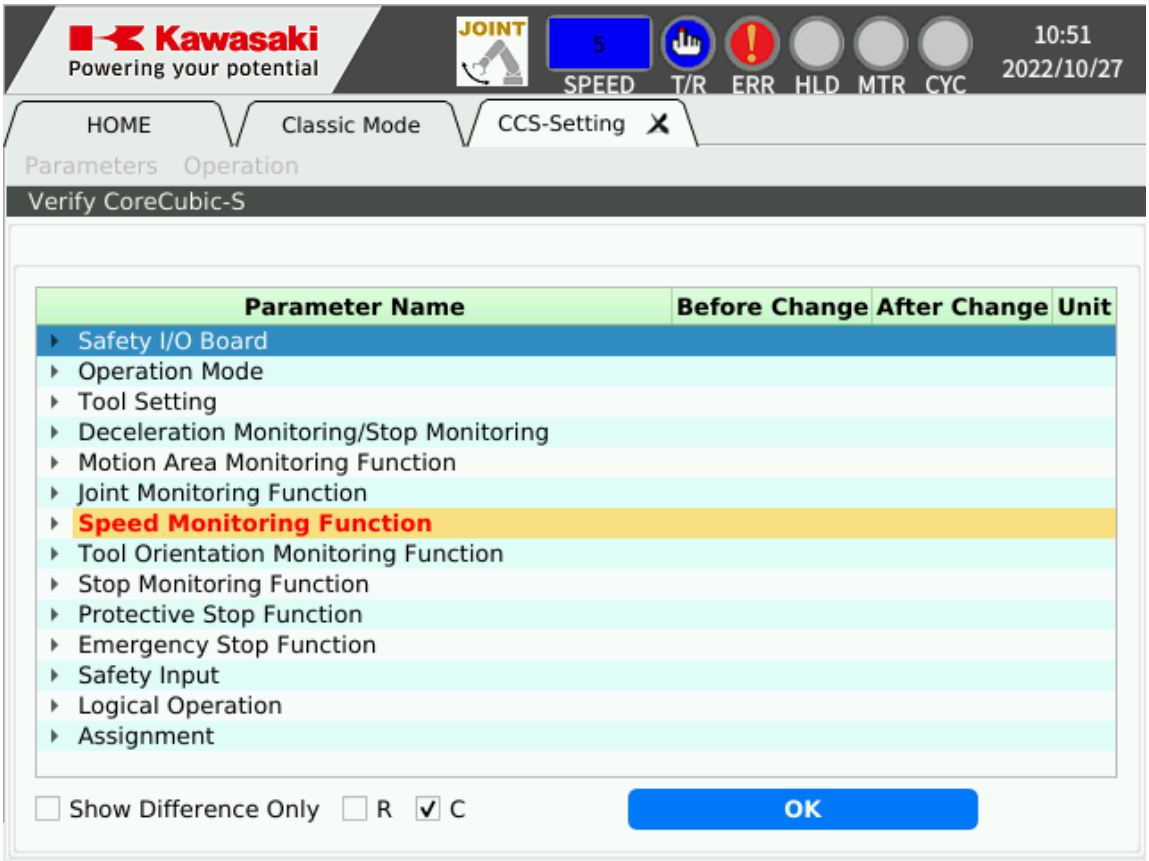
1. <Read Core Cubic-S>

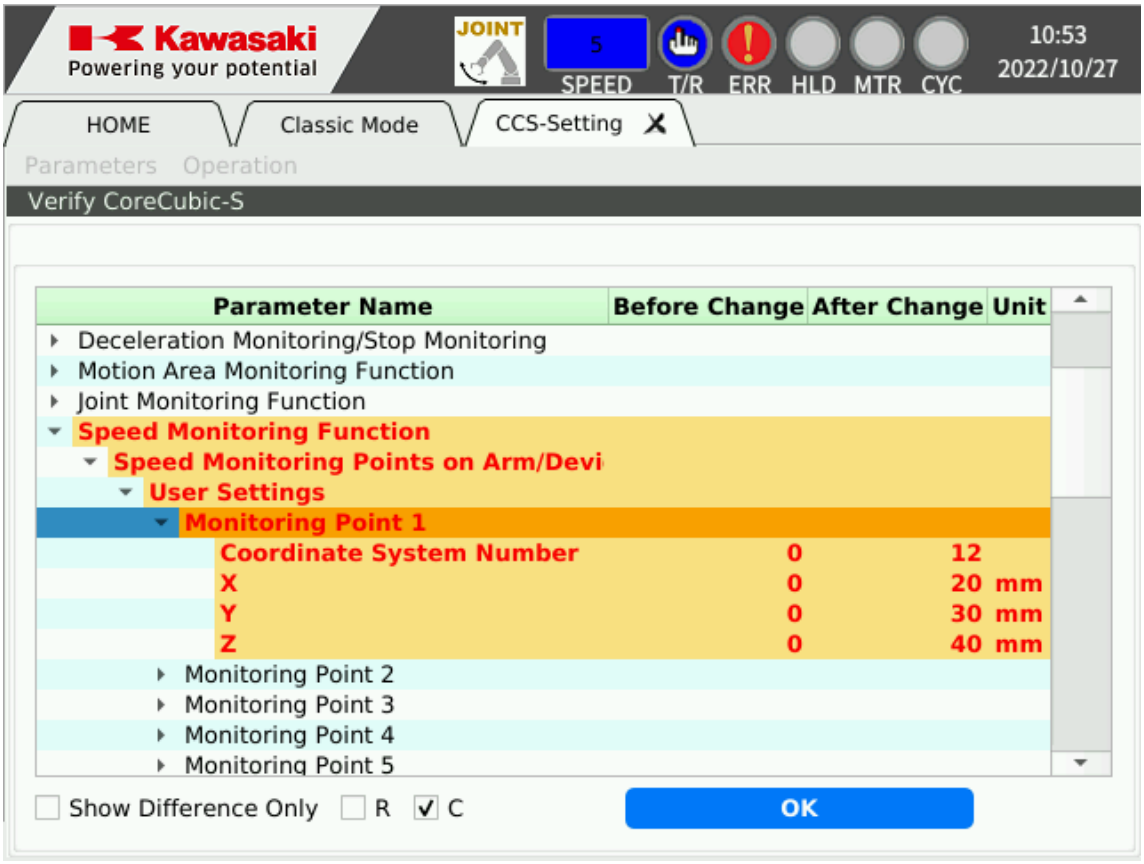
By selecting <Core Cubic-S> then <Read Core Cubic-S> from the setting application menu, reads only the user parameters from parameters stored in the CoreCubic-S to the setting application. Note that pressing <Read Core Cubic-S> button does not modify the robot parameters.

2. <Verify Core Cubic-S>

By selecting <Core Cubic-S> then <Verify Core Cubic-S> from the setting application menu, compares the user parameters stored in the setting application with the user parameters which already set in CoreCubic-S. It displays the verification results in a hierarchical tree view on the parameter data view. Different parameters display the background color in orange and the items and parameter values in red. You can change the items displayed by checking the check boxes at the bottom.

- Show Difference Only: Displays only changed rows.
- R: Displays robot parameters.
- C: Displays user parameters.





3. <Write Core Cubic-S>

By selecting <Core Cubic-S> then <Write Core Cubic-S> from the setting application menu, writes to CoreCubic-S the parameter set by the setting application (both robot and user parameters). Before setting the parameters to CoreCubic-S, you must enter a preset password.

Since Update button in each setting screen only updates the value held by the setting application, <Write Core Cubic-S> is required to write to CoreCubic-S.

4. <Open File>

By selecting <File>, <Open File> from the setting application menu, reads the parameters written in the file (csv file). User parameters are updated. Note that pressing <Open File> button does not modify the robot parameters.

5. <Verify File>

By selecting <File> then <Verify File> from the setting application menu, compares the user parameters stored in the setting application with the user parameters stored in the file. Verification results are displayed in a hierarchical structure in tree format similar to <Verify Core Cubic-S>.

6. <Output ParameterFile>

By selecting <File> then <Output ParameterFile> from the setting application menu, writes the parameters (both robot parameters and user parameters) stored in the setting application to a file. When outputting to a CFast card, the three most recent files will be output and the oldest files will be automatically deleted.

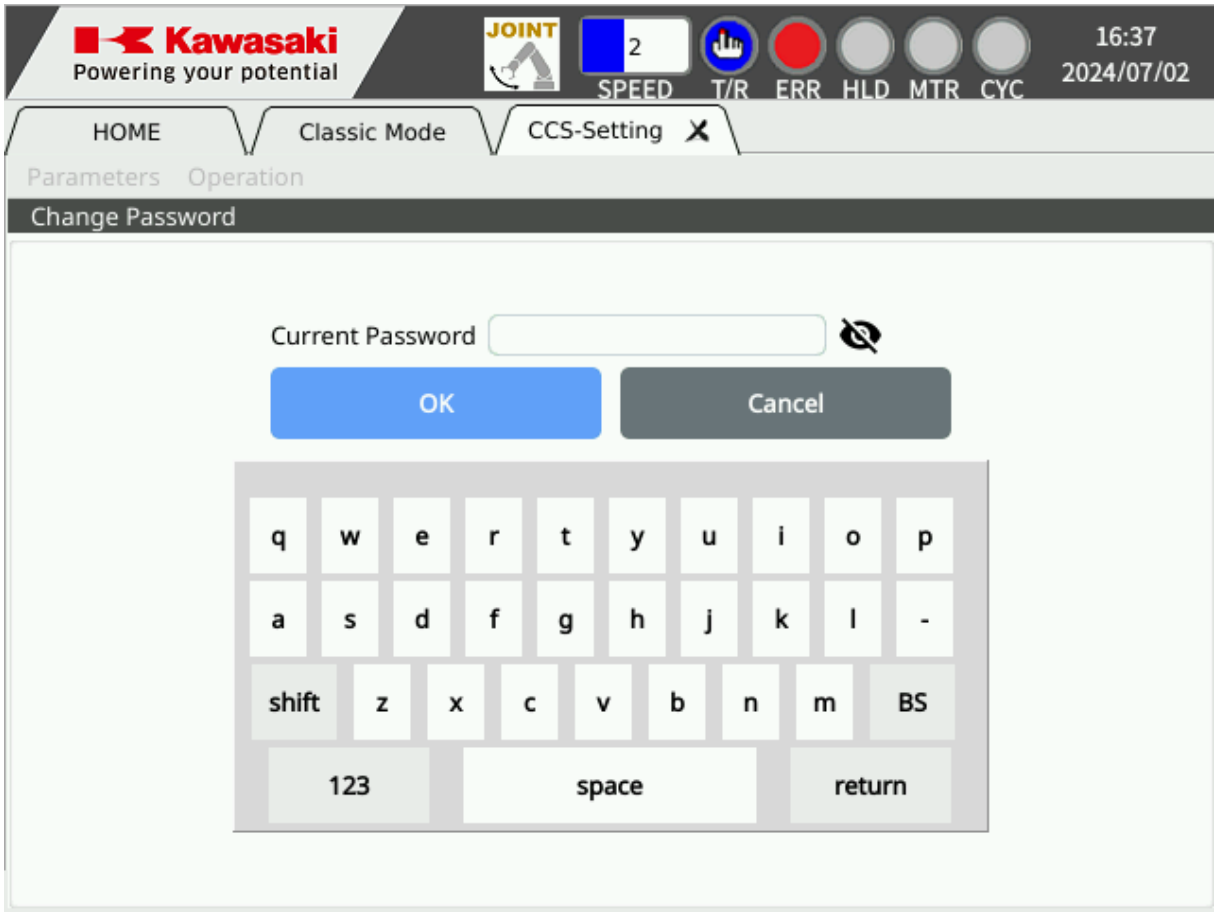
8.5 Password

Password is necessary for <Write CoreCubic-S>.
The password is managed in CoreCubic-S.

1. Default setting of password before shipping

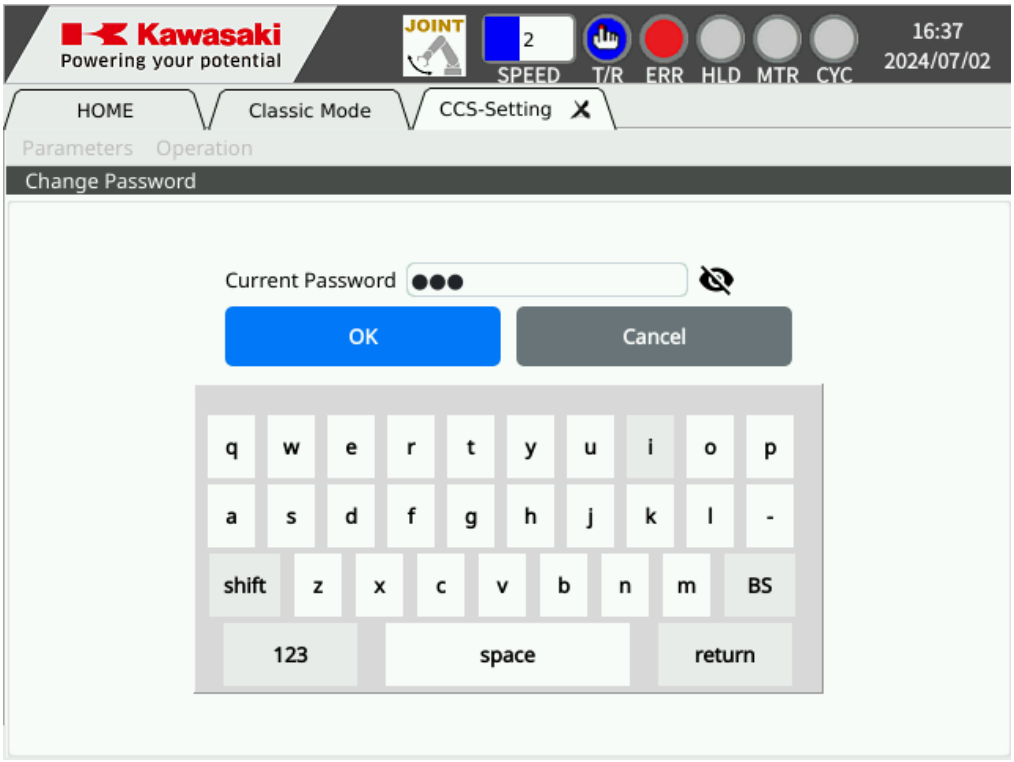
The default password for CoreCubic-S before shipping is "khi." After logging in with the default password, use "Change Password" to change it to a new password. Please contact Kawasaki if you have forgotten your set password.

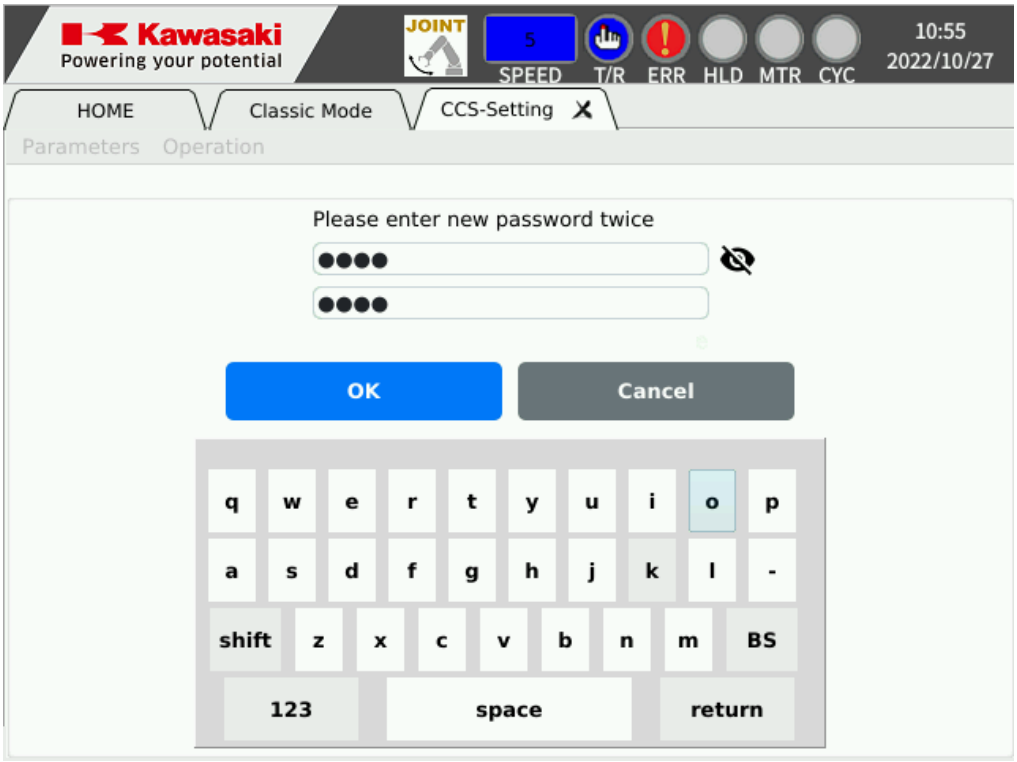
After executing <Write CoreCubic-S>, if the password is already set, the Input Password dialogue box is displayed. Enter the password.



2. How to Change a Password

You can change the password by selecting <CoreCubic-S> then <Change Password>.

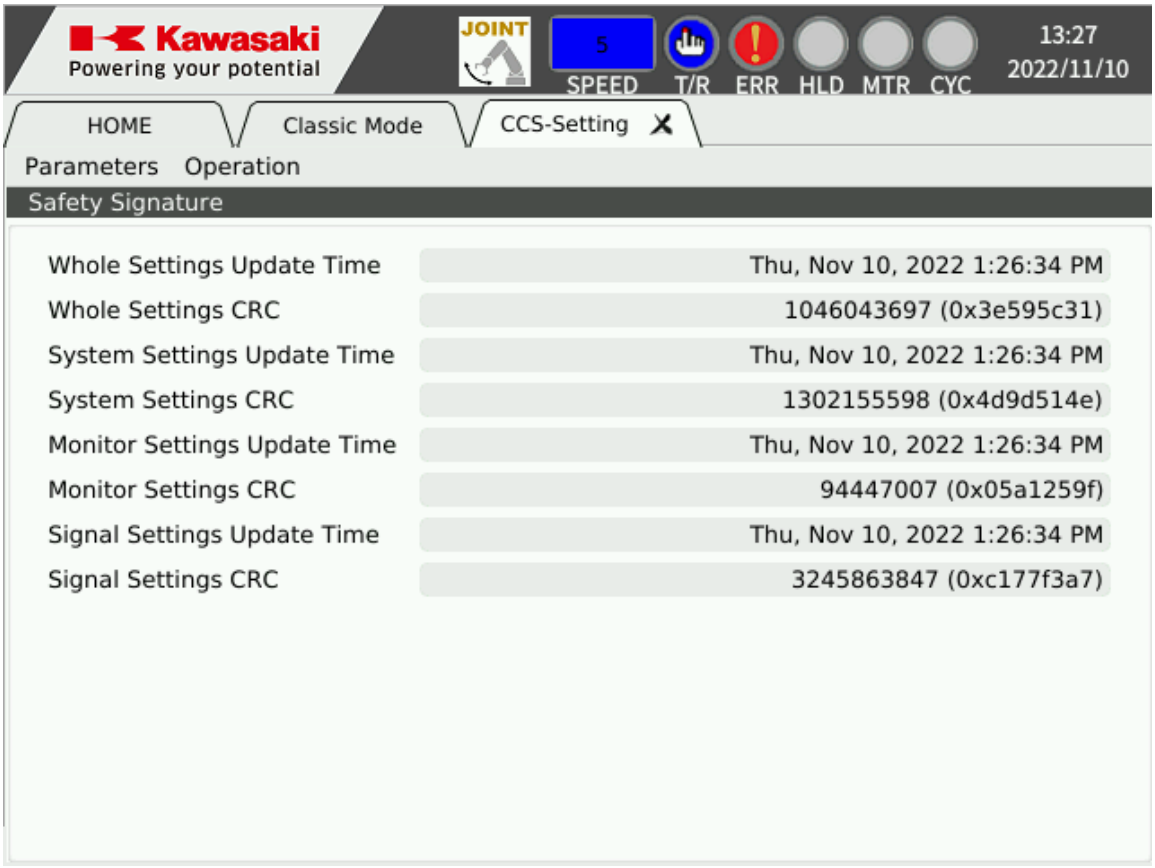




8.6 Safety Signature

1. CRC Display

By selecting <Status> -> <Safety Signature> -> <CRC Display> from the menu of the setting application, displays the CRC value of the set parameter and the date and time when the setting was updated. It cannot be set. The parameter CRC value does not change unless you change the parameter. Therefore, once the setting is completed and the CRC value is recorded, it is possible to check whether the parameter has been changed.



2. Safety Report

The last three times of the safety parameters when writing to CoreCubic-S are recorded and output as a safety report file in CSV format. When you select <Status> -> <Safety Signature> -> <Publish Safety Report> from the menu of the setting application, a safety report file that can be issued is displayed, and you can issue it by selecting the file name. The safety report file name is CCS_Safetyreport_Timestamp.txt. The only save destination is a USB memory stick inserted into the TP.

The contents of the safety report file consist of a "number," a "parameter name," and a "set value."

```
.CCSDATA
1-00-00,Specification,2,
101-00-01,Name,BXP210L-A001,
101-00-02,Name,,
101-00-03,Name,,
101-00-04,Name,,
101-00-05,Name,,
101-00-06,Name,,
101-00-07,Name,,
101-00-08,Name,,
101-00-09,Name,,
101-00-10,Name,,
101-00-11,Name,,
101-00-12,Name,,
101-00-13,Name,,
101-00-14,Name,,|
101-00-15,Name,,
101-00-16,Name,,
101-00-17,Name,,
101-00-18,Name,,
101-00-19,Name,,
102-00-01,Serial Number,0,0,0,0,0,0,0,0,0,0,
102-00-02,Serial Number,0,0,0,0,0,0,0,0,0,0,
103-00-01,Assignment,1,1,1,1,1,1,2,2,3,3,
103-00-02,Assignment,4,4,5,5,6,6,7,7,
104-00-01,DH Parameters - Coordinate System,1,1,1,0,0,0,0,0,0,0,
104-00-02,DH Parameters - Coordinate System,1,1,1,1,1,1,1,0,0,0,
104-00-03,DH Parameters - Coordinate System,0,0,0,0,0,0,0,0,0,0,
104-00-04,DH Parameters - Coordinate System,0,0,0,0,0,0,0,0,0,0,
104-00-05,DH Parameters - Coordinate System,0,0,0,0,0,0,0,0,0,0,
```

9 Connection Methods

The CoreCubic-S system has the following safety input/output functions (1) to (6). This chapter describes connection methods of each input/output.

Note For general cautions on connection, refer to 2.2.

(1) Fixed safety input: (Refer to 9.1)

Safety input that functions have been allocated beforehand and cannot be changed by users. This is input to power sequence board/safety I/O board.

- Input that is installed as standard (such as emergency stop on the controller operation panel and TP enable)
- Input that users can connect from XES connector on the servo board (safety fence, external emergency stop, etc.)
- Input that users can connect from XIN1 connector on the first safety I/O board (tool ID1)

(2) User safety input: (Refer to 9.2)

Safety input that users can allocate functions. This is input from XIN1/XIN2 connector on the safety I/O board (option: up to four safety I/O boards).

(3) Network safety input: (Refer to 9.3)

Safety input that users can allocate functions. This can be input from the external safety network device via the Ethernet port of the controller.

(4) Fixed safety output:

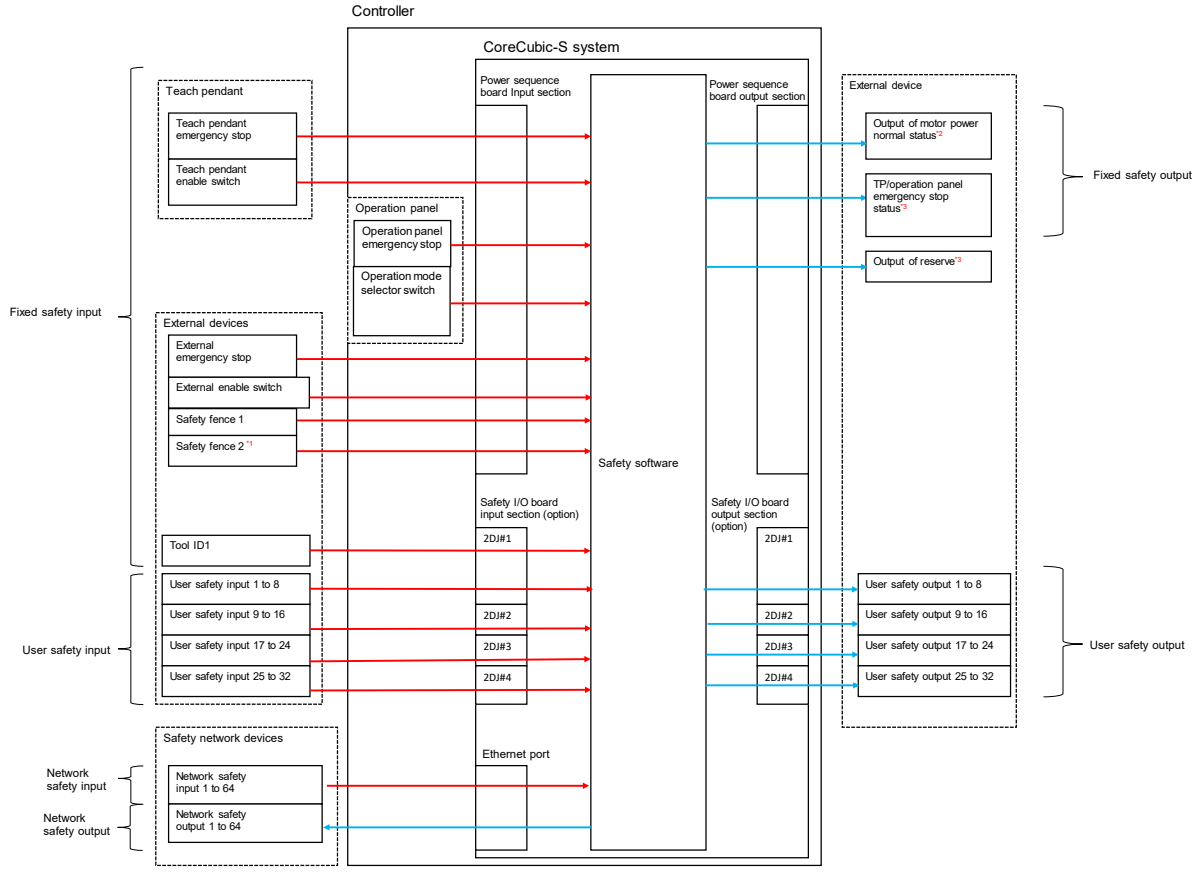
Safety output that functions have been allocated beforehand and cannot be changed by users. This is output from X202 connector on power sequence board, etc. There are such as an output of motor power normal and an output of TP/operation panel emergency stop being input. Although users cannot use this function arbitrarily, only for special purposes can be used.

(5) User safety output: (Refer to 9.2)

Safety output that users can allocate functions. This is output from XOUT1/XOUT2 connectors on safety I/O board (option: up to four safety I/O boards).

(6) Network safety output: (Refer to 9.3)

Safety output that users can allocate functions. This can be output to the external safety network device via the Ethernet port of the controller.



CoreCubic-S System Input/Output Configuration Diagram

*1 Used for clean robot use

*2 Output for Mitsubishi amplifier. For details, refer to “External Axis Addition Manual."

*3 Used for special use

9.1 Fixed Safety Inputs

The following fixed safety inputs are provided in CoreCubic-S system.

Name of fixed inputs	Use	Operation mode	Applicable to
TP Emergency Stop	Emergency stop switch on teach pendant	Enable in all operation modes	All robots/devices
TP Enable	Enable switch on teach pendant	Enable only in teach mode or fast check mode	All robots/devices
Operation Panel Teach/Repeat Mode*2	Operation mode selector switch on operation panel	-	All robots/devices
Operation Panel Fast Check Mode*2			
Operation Panel Emergency Stop	Emergency stop switch on operation panel	Enable in all operation modes	All robots/devices*4
External Emergency Stop*1	Emergency stop switch that can be connected externally	Enable in all operation modes	All robots/devices*4
Safety Fence 1 Opened*1	Safety fence that can be connected externally	Enable only in repeat mode	All robots/devices*6
Safety Fence 2 Opened*1,*5	Safety fence that can be connected externally	Enable only in repeat mode	None*6
External Enable*1,*3	Enable switch that can be connected externally	Enable only in teach mode or fast check mode	All robots/devices
Tool ID1*7	Tool ID input that can be connected externally	-	-

*1 For the connection methods of each input, refer to "External I/O Manual."

*2 The operation mode can also be changed by allocating the function of switching the operation mode to the user safety input/network safety input. For details, refer to 9.1.1.

*3 When using the external enable input, robot is not moved without turning ON of both enable switch on teach pendant and external enable switch.

*4 The applicable robot/device can be changed for clean specification controller only. For details, refer to 9.1.2.

*5 Safety fence 2 opened input can be used for clean specification controller only. For details, refer to 9.1.3.

*6 The applicable robot/device can be changed for clean specification controller only. For details, refer to 9.1.3.

*7 Safety I/O board (option) is required to use the tool ID1 input. For details, refer to 9.2.2.

9.1.1 Switching the operation mode

For switching the operation mode, the following method is available.

- Switching by the operation mode selector switch installed in the controller as standard
- Switching by allocating the operation mode change function to the user safety input/network safety input and using the safety input

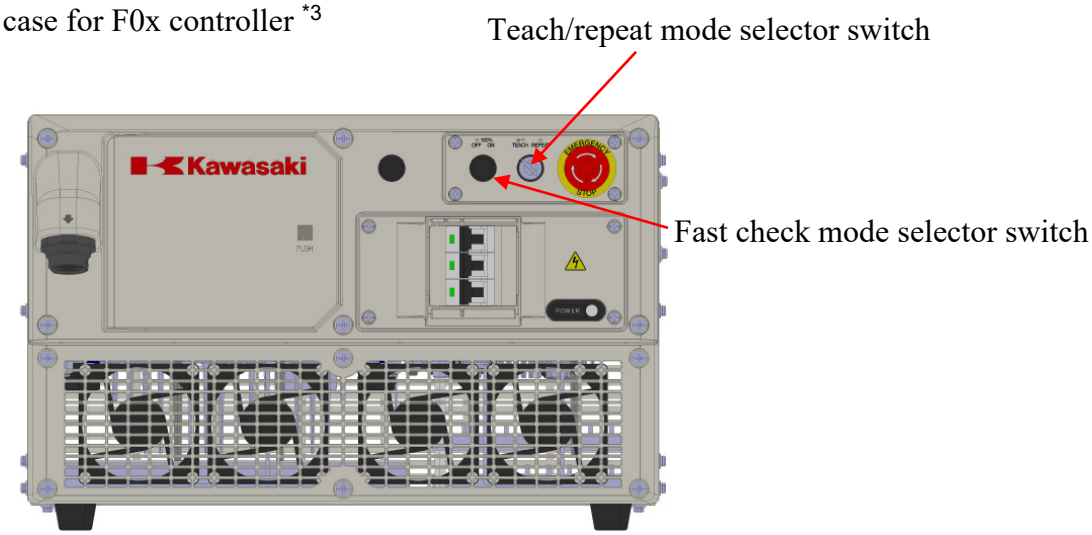
9.1.1.1 Switching by the Operation Mode Selector Switch Installed in the Controller as Standard

Change the operation mode using operation mode selector switch (teach/repeat mode selector switch, fast check mode selector switch *1,*2) on the operation panel installed in the controller as standard.

*1 In some controllers, only one selector switch is provided to change teach/fast check/repeat modes.

*2 Fast check mode selector switch is optional depending on your controller.

(Example) In case for F0x controller *3



Front of the controller

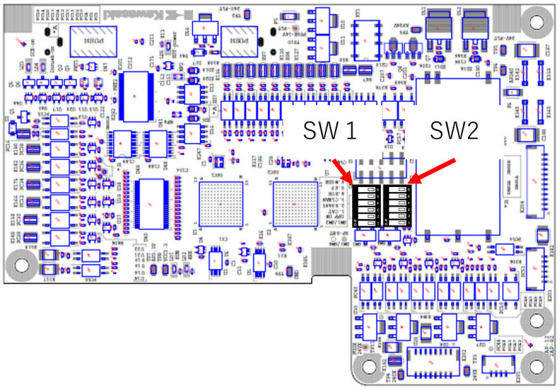
*3 For other controllers, refer to the "Troubleshooting Manual" for each controller. The mounting location of the switches depend on the controller used.

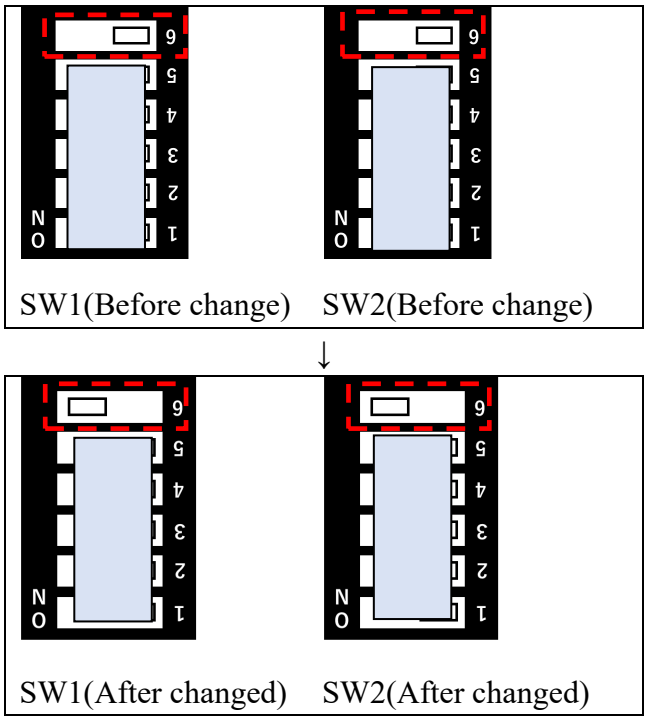
9.1.1.2 Switching by the User Safety Input/Network Safety Input

When externally switching the operation mode, perform steps (1) to (4) below.

(1) Changing the DIP switch settings on the power sequence board

Change the 6th bit of SW1 and SW2 on the power sequence board from OFF to ON as shown below. Also, keep the current settings of the 1st to 5th bit switch.





(2) Removing the operation mode selector switch

Remove the operation mode selector switch (teach/repeat mode selector switch, fast check mode selector switch) installed on the control panel of the controller to prevent it from being used by mistake.

(3) Changing the safety parameters (system setting)

In [System setting], change [Operation panel] to [User] on [Operation mode:Input setting].

(4) Changing the safety parameters (signal setting)

In [Signal setting], allocate the safety input used for switching the operation mode to [Internal safety input 1] and [Internal safety input 2].

When not using the fast check mode, it is not necessary to allocate the signal to [Internal safety input 2].

(5) External wiring

- When switching the operation mode using the user safety input:
  Connect the external operation mode selector switch to the user safety input of safety I/O board.
- When switching the operation mode using the network safety input:
  Connect the Ethernet port of the controller and the safety network device using the Ethernet cable.

Input the safety input so that the input status combinations in each operation mode become as shown in the table below.

Operation mode	Internal safety input 1	Internal safety input 2
Teach mode	ON	OFF
Fast check mode	ON	ON
Repeat mode	OFF	OFF or ON

Input status combinations of internal safety inputs 1 and 2 in each operation mode

For other precautions, refer to Section 9.3.

⚠ WARNING

Because the operation mode selector switches on the operation panel become disabled if the operation mode is changed by the user safety input/network safety input, remove the operation mode selector switches on the operation panel to prevent it from being used by mistake.

⚠ WARNING

Make sure that the operation mode has been changed as expected after setting and wiring of this chapter is complete.

Example 1:
The following show examples of safety parameter settings and external wiring when switching teach/fast check/repeat modes using user safety inputs 1 and 2 on safety I/O board.

System setting	
Operation mode: Input setting	User

Table 9.1.1.2-1 Operation mode: Input setting

User safety input	User safety input setting			
	Pulse diagnostics	Filtering time	Dual input logic	Allowed time of discrepancy
User safety input 1	Enable	1 ms	Complementary	1000 ms
User safety input 2	Enable	1 ms	Equivalent	1000 ms

Table 9.1.1.2-2 Example of input setting for user safety inputs 1 and 2

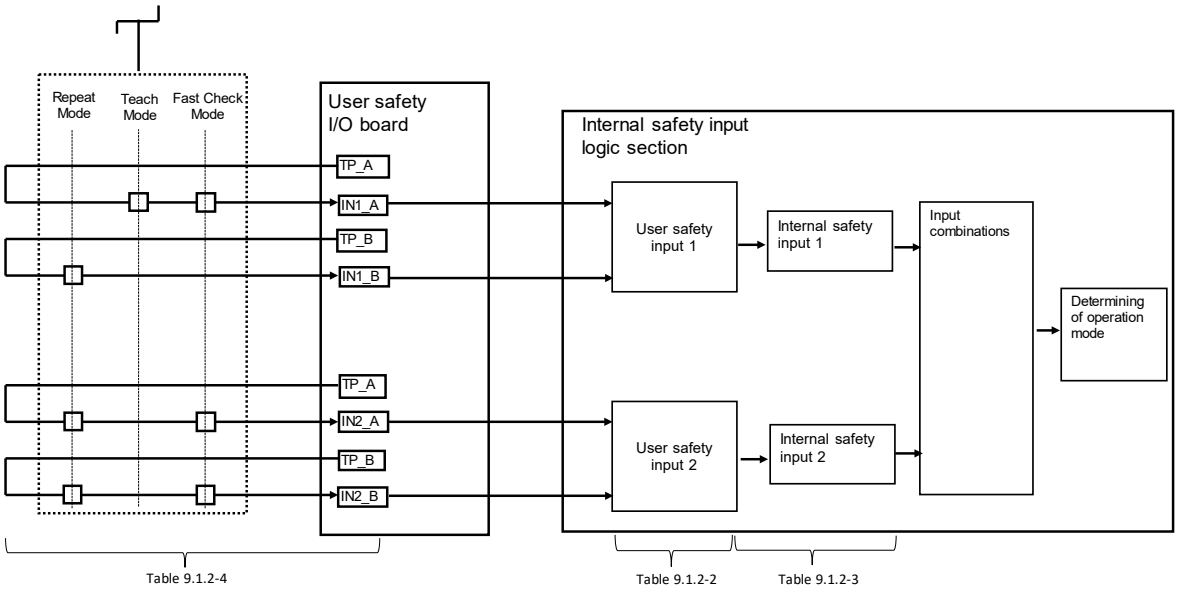
Logical operation expression			Allocation
Operation contents	Operation input 1	Operation input 2	
Through	User safety input 1	-	Internal safety input 1
Through	User safety input 2	-	Internal safety input 2

Table 9.1.1.2-3 Example of signal allocation for internal safety inputs 1 and 2

Connect the operation mode selector switches after the above safety parameter settings so that input combinations in each operation mode become as shown in the table below.

Operation mode	User safety input 1		User safety input 2	
	IN1-A	IN1-B	IN2-A	IN2-B
Teach mode	ON	OFF	OFF	OFF
Fast check mode	ON	OFF	ON	ON
Repeat mode	OFF	ON	OFF or ON	OFF or ON

Table 9.1.1.2-4 Input status combinations of user safety inputs 1 and 2 in each operation mode



Connection example between safety I/O board and operation mode selector switches (three-notch)

Example 2:
The following show examples of safety parameter settings and external wiring when switching teach/repeat modes (fast check mode is not used) using user safety input 1 on safety I/O board.

System setting	
Operation mode: Input setting	User

Table 9.1.1.5 Operation mode: Input setting

User safety input	User safety input setting			
	Pulse diagnostics	Filtering time	Dual input logic	Allowed time of discrepancy
User safety input 1	Enable	1 ms	Complementary	1000 ms

Table 9.1.1.2-6 Example of input setting for user safety input 1

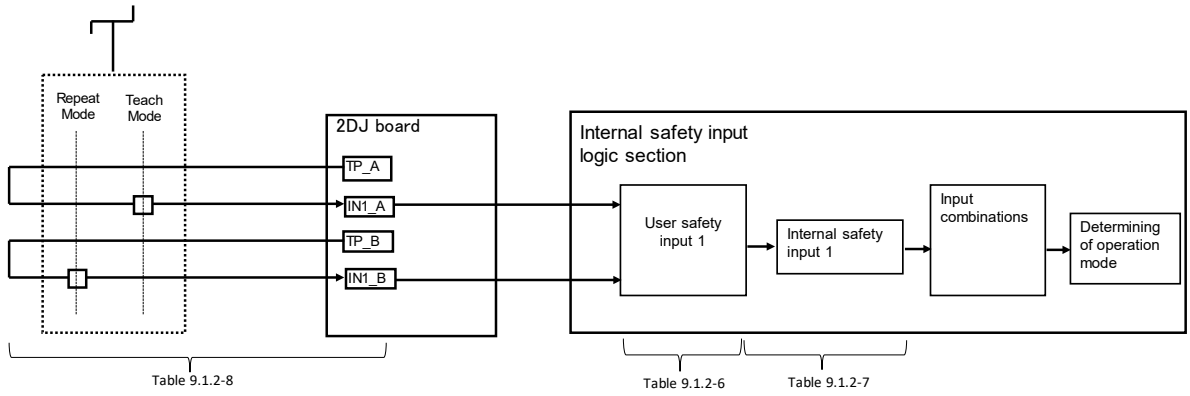
Logical operation expression			Allocation
Operation contents	Operation input 1	Operation input 2	
Through	User safety input 1	-	Internal safety input 1

Table 9.1.1.2-7 Example of signal allocation for internal safety input 1

Connect the operation mode selector switches after the above safety parameter settings so that input combinations in each operation mode become as shown in the table below.

Operation mode	User safety input 1	
	IN1-A	IN1-B
Teach mode	ON	OFF
Repeat mode	OFF	ON

Table 9.1.1.2-8 Input status combinations of user safety input 1 in each operation mode



Connection example between safety I/O board and operation mode selector switches (two-notch)

9.1.2 Operation Panel Emergency Stop/External Emergency Stop

Safety parameter settings on the clean specification controller can specify the robot/device for which operation panel emergency stop/external emergency stop is enabled, as shown in the table below.

Emergency stop signal	Operation panel emergency stop/External emergency stop/SW external emergency stop Applicable robot/device settings	
	All at once setting	Individual setting*1
External emergency stop, SW external emergency stop	Enabled for all robots/devices	Enabled only for the robot/device allocated to servo board 1
Operation panel emergency stop	Enabled for all robots/devices	Enabled only for the robot/device allocated to servo board 2

*1 "Individual setting" can be set for clean specification controller only.

⚠ WARNING

For clean specification controller, only when the emergency stop switch of both "the robot/device allocated to servo board 1" and "the robot/device allocated to servo board 2" for each are provided, and also determined the system setting is correct by taking the risk assessment, "Individual setting" can be used.

9.1.3 Safety Fence

Safety parameter settings on the clean specification controller can specify the robot/device for which safety fence 1/safety fence 2 is enabled, as shown in the table below.

Safety fence signal	Safety fence protective stop Applicable robot/device settings	
	All at once setting	Individual setting*
Safety fence 1 SW safety fence	Enabled for all robots/devices	Enabled only for the robot/device allocated to servo board 1
Safety fence 2	Enabled for all robots/devices	Enabled only for the robot/device allocated to servo board 2

Note "Individual setting" can be set for clean specification controller only.

⚠ WARNING

For clean specification controller, only when the safety fence of both "the robot/device allocated to servo board 1" and "the robot/device allocated to servo board 2" for each are provided, and also determined the system setting is correct by taking the risk assessment, "Individual setting" can be used.

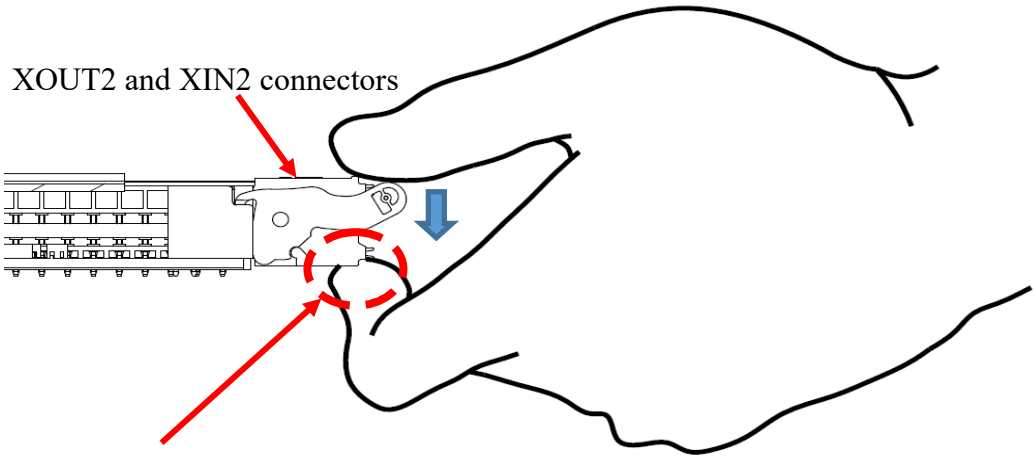
9.2 Connection for Safety I/O board

The user safety input/output is connected to XOUT1/2 and XIN1/2 connectors of safety I/O board. For the layout of safety I/O board, refer to chapter 6. For the pin specifications, arrangement, and connection procedure, see sections 9.2.2 and 9.2.3.

9.2.1 Cautions on Safety Input/Output Section Connection

(1) Cautions on connector insertion/removal

Note the following when inserting/removing XIIN and XOUT connectors.



Note When unlocking the connector, apply force while supporting the lower part of the connector. (Stress applied on the board when the connector is removed is reduced.)

(2) User safety input/output connector specification

The connector models for user safety input/output of the safety I/O board is as follows.

- XIN1 : DMC1.5/16-G1F-3.5-LR_P26THR (PHOENIX CONTACT)
- XIN2 : DMC1.5/5-G1F-3.5-LR_P26THR (PHOENIX CONTACT)
- XOUT1 : DMC1.5/4-G1F-3.5-LR_P26THR (PHOENIX CONTACT)
- XOUT2 : DMC1.5/6-G1F-3.5-LR_P26THR (PHOENIX CONTACT)

When using rod terminals (crimping terminals), the following specifications are recommended.

1. When using the rod terminal (It is recommended to connect the rod terminal.)
   - Recommended rod terminal: AI0.25-8 YE (PHOENIX CONTACT)
   - Applicable electrical wire: AWG24
   - Rated current: Within 3.5 A per a pin
   - Rod terminal tip diameter: 0.8 mm
   - Rod terminal tip length: 8 mm
   - Insulation sleeve diameter: 4.5 mm

   Note It is recommended to use a rod terminal that matches the electrical wire size above.



2. When not using the rod terminal
   - AWG24 to AWG22
   - Wire coating peeling margin: 10 mm (Recommended)

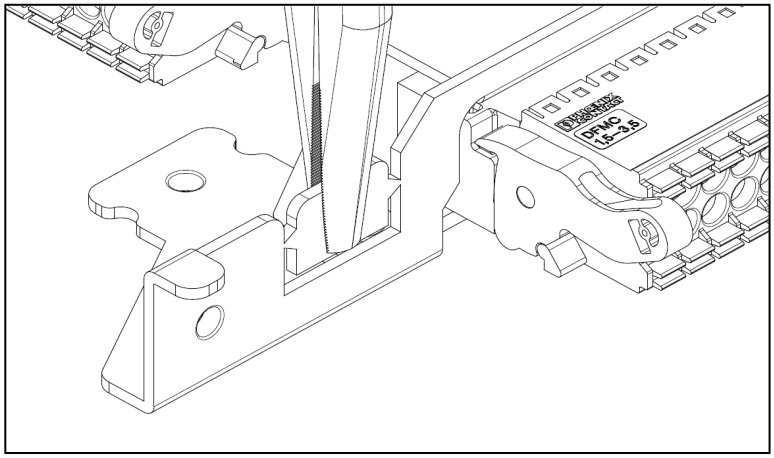
   (CAUTION) - Be careful not to let the sheath of wire get caught in the clamp part of the connector when wiring.
   - Make sure that the wires are not in contact with adjacent terminals.

(3) User safety input/output connection methods

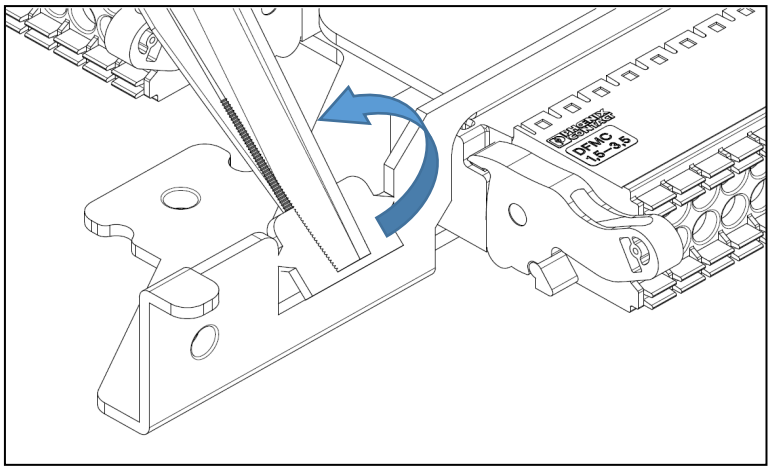
Follow the procedure below when wiring to XIN2/XOUT2 connectors on the side surface of safety I/O board.

(Note An example of F0x and F60 controllers is shown below. The metal plate shape of safety I/O board may differ depending on the controller. For other controllers, refer to the "External I/O Manual" for each controller. The wiring to the safety I/O board varies depending on the controller used.)

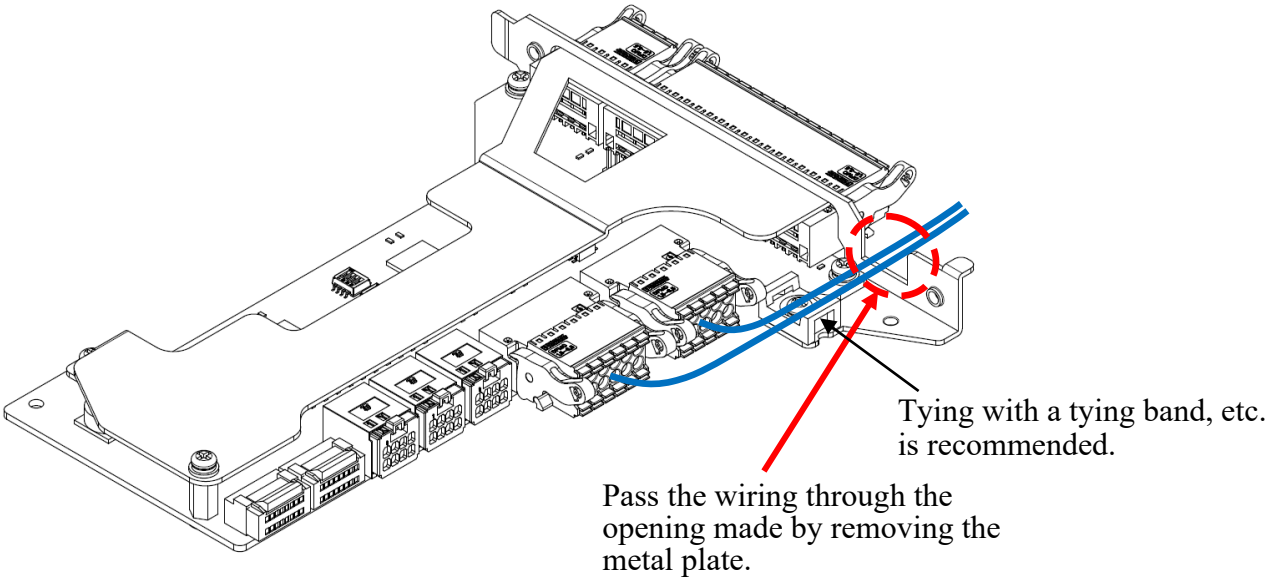
1. Removing the metal plate on wiring route



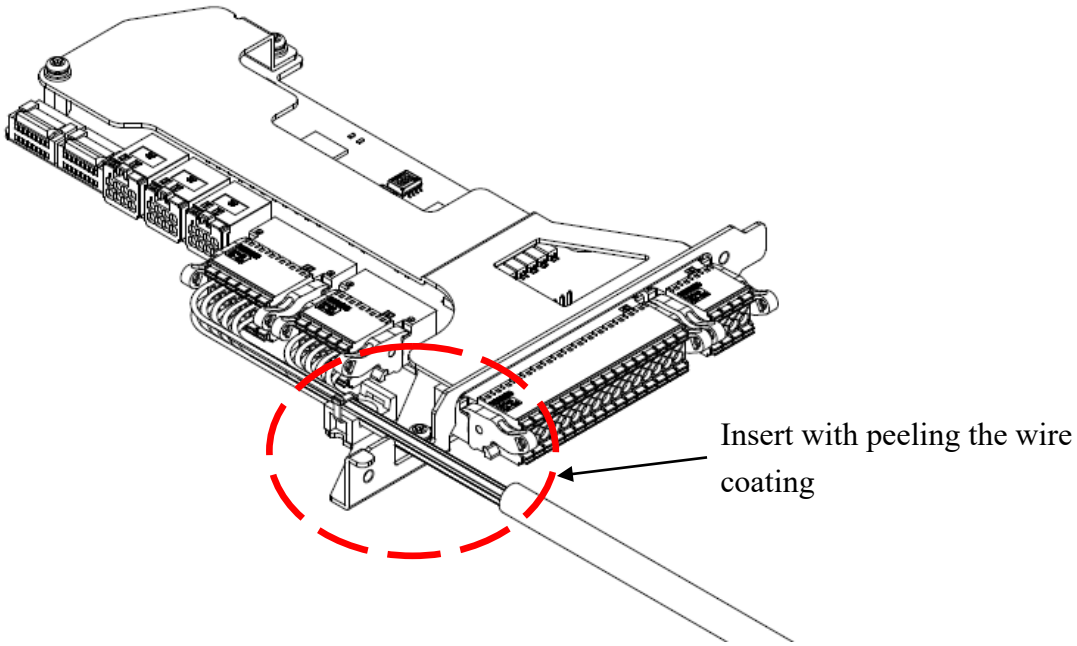
Twist and remove the metal plate with pliers, etc.



2. Wiring route from the connector

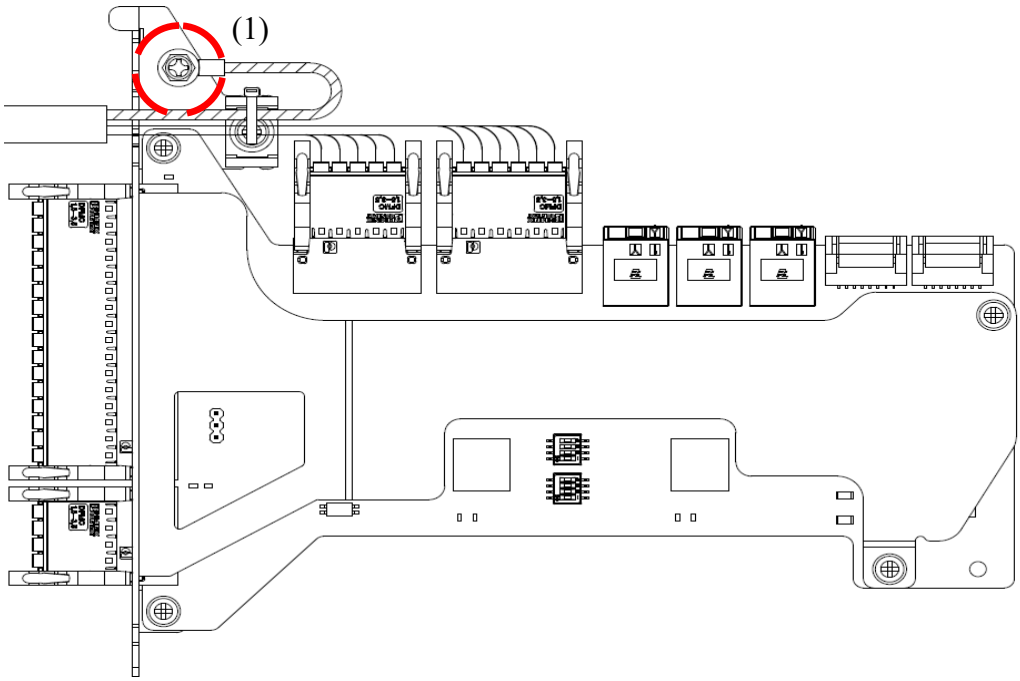


3. Cautions when connecting



4. Grounding the shielded cables

The shielded cable can be grounded to (1) as shown below. (Recommended screws: M3-6 P3)



(1) When grounding the shielded cable to the case side, refer to the "Installation and Connection Manual" of each controller.

(4) The supply source of 24 V power used in the user safety input/output

The supply source of 24 V power used in the user safety input/output circuit part (internal power of the controller or external power) can be changed by XDJCOM_* jumper connector on safety I/O board. The power supply settings are shown in the table below.
Refer to below and connect with external devices.

Connectors to connect jumper harness	Descriptions of XDJCOM_1/2/3
XDJCOM_1 (default)	The external power is used for the user safety input/output. Power is used commonly for input and output inside safety I/O board. The 24 V power needs to be supplied externally to either XIN* or XOUT*.
XDJCOM_2	The internal power of robot controller is used for the user safety input/output. The 24 V power does not need to be supplied externally because the internal power of safety I/O board is used.
XDJCOM_3	The external power is used for the user safety input/output. The safety input power supply and the safety output power supply are separated inside the safety I/O. The 24 V power needs to be supplied externally to input part (XIN1 or XIN2) and output part (XOUT1 or XOUT2) respectively.

9.2.2 Connection between the User Safety Output and Output Devices

⚠ WARNING

1. **Do not connect the load over the rated current (refer to Chapter 6) to each safety output. The output will be damaged and the safety function will fail.**
2. **In wiring for the safety output, connect so that 24 V DC does not come in contact with the safety output. The load may turn ON by mistake. Ground the GND line of the power source so that the unit does not turn ON when the safety output line touches the case of the unit.**
3. **Use shielded cable for the output signal, and place the cables away from high voltage lines and power cables.**
4. **Fix cables so that no excess load is added to the CoreCubic-S connector.**
5. **Keep the length of the cables within 50 m.**
6. **Do not apply source power to the output terminal. CoreCubic-S may be damaged.**
7. **Do not apply voltage higher than the maximum voltage to the power supply terminal. Applying voltage exceeding the maximum voltage may result in failure or damage, etc.**
8. **Do not apply reverse voltage to the power supply terminal and GND terminal.**
9. **Be careful not to exceed the current rating (within 3.5 A) per a pin of the connector.**
10. **The safety output is a dual channel output, so use Ch.A and Ch.B in pairs.**
11. **After wiring the user safety output, make sure that the safety function of the intended channel works correctly.**

When connecting an external safety relay (forced-guide relay) driven by the user safety output, perform weld check referring to Section 10.1.3.

Note Since the connection differs depending on XDJCOM_* jumper connector settings, refer to (1) and (2) below for wiring.

(1) When setting to XDJCOM_1 or XDJCOM_3 (when using an external power supply in the safety output circuit)

Note When setting to XDJCOM_1, the 24 V power of safety input part (XIN*) and safety output part (XOUT*) is used commonly inside safety I/O board. If the external 24 V power has been input to XOUT* connector, the external 24 V power input to XIN* is not necessary.

Note When setting to XDJCOM_3, the 24 V power of safety input part (XIN*) and safety output part (XOUT*) is used independently inside safety I/O board. (The required external 24 V power needs to be supplied to input (XIN*) and output (XOUT*) respectively.)

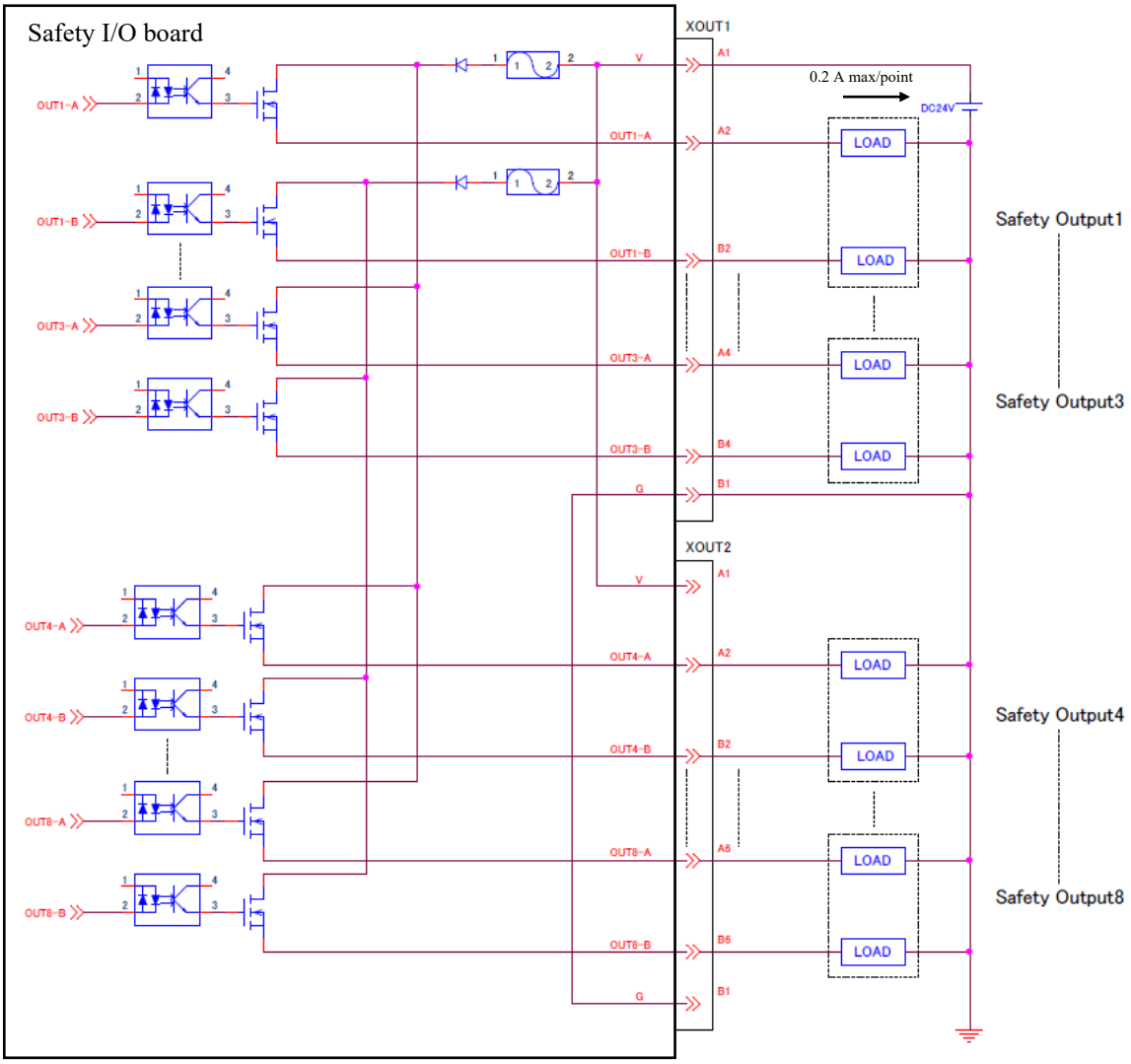


Figure 9.2.2.1 When the safety output circuit is operated by an external power source (default setting)

(2) When setting to XDJCOM_2 (when using an internal power supply in the safety output circuit)

Note Use up to one safety I/O board, and total load current used for safety input/output (total of 8 channels of dual channel input and 8 channels of dual channel output) should be within 0.8 A.

Note When using two or more safety I/O boards, set the XDJCOM* settings to be supplied from an external power supply (XDJCOM_1 or XDJCOM_3), and use an external 24 V power supply to the input (XIN*) and output (XOUT*) connectors.

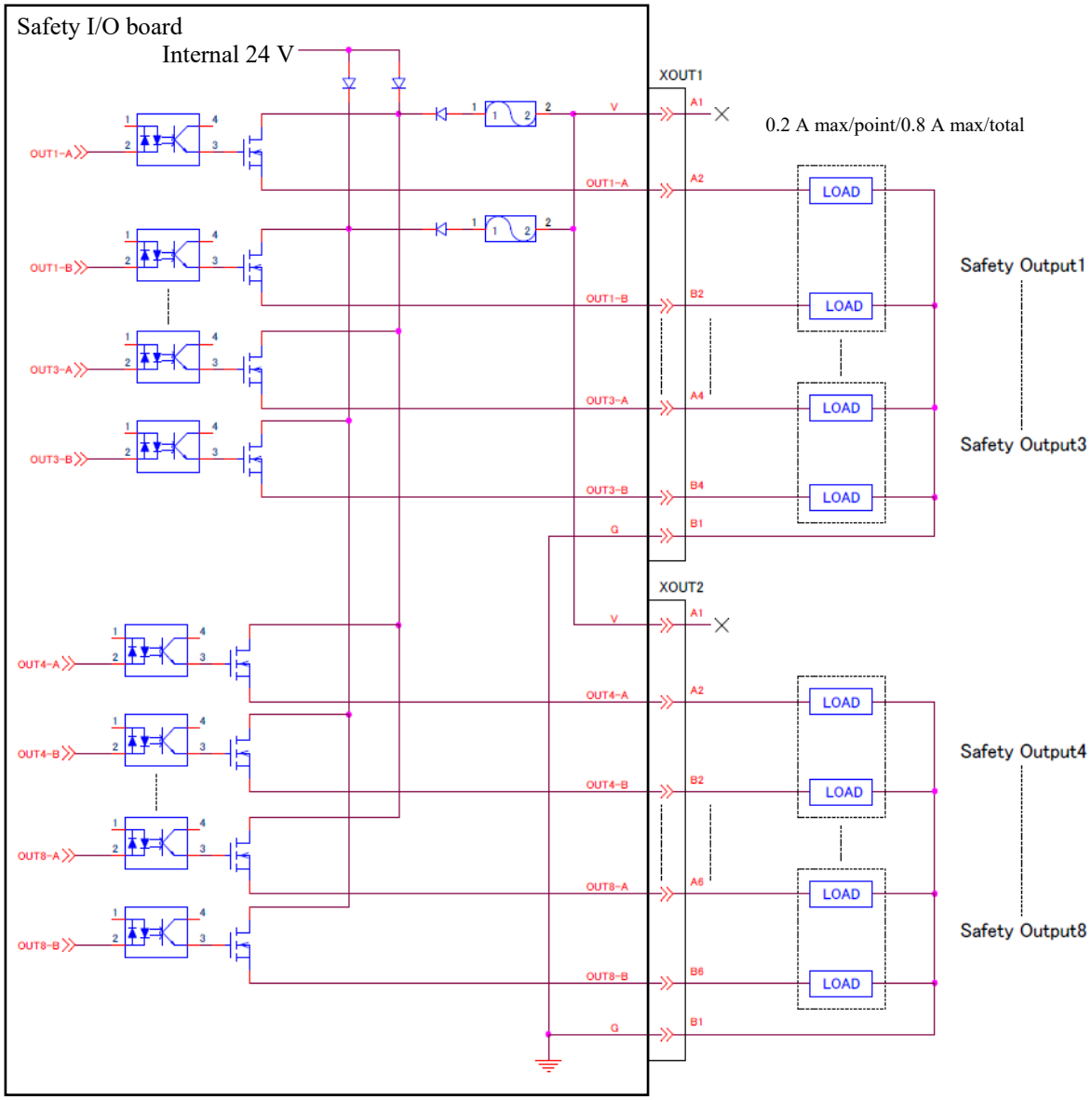


Figure 9.2.2.2 When the safety output circuit is operated by an internal power source

Note The internal 24 V power supply cannot be removed from the XOUT connector.

XOUT1 connector: 8 pins

On-board connector model/DMC1.5/4-G1F-3.5-LR_P26THR(PHOENIX CONTACT)

Pin No.	Name	Terminal explanation
A1	V	For safety output, external 24 V power supply input
B1	G	For safety output, external GND power supply input
A2	OUT1-A	User safety output Ch1-A
B2	OUT1-B	User safety output Ch1-B
A3	OUT2-A	User safety output Ch2-A
B3	OUT2-B	User safety output Ch2-B
A4	OUT3-A	User safety output Ch3-A
B4	OUT3-B	User safety output Ch3-B

Note The LD22 and LD23 light up when 24 V power is supplied internally or externally to the safety output circuit in the board.
Set to XDJCOM_1 or XDJCOM_3 when using an external 24 V power input.

XOUT2 connector: 12 pins

On-board connector model/DMC1.5/6-G1F-3.5-LR_P26THR(PHOENIX CONTACT)

Pin No.	Name	Terminal explanation
A1	V*1	For safety output, external 24 V power supply input
B1	G*1	For safety output, external GND power supply input
A2	OUT4-A	User safety output Ch4-A
B2	OUT4-B	User safety output Ch4-B
A3	OUT5-A	User safety output Ch5-A
B3	OUT5-B	User safety output Ch5-B
A4	OUT6-A	User safety output Ch6-A
B4	OUT6-B	User safety output Ch6-B
A5	OUT7-A	User safety output Ch7-A
B5	OUT7-B	User safety output Ch7-B
A6	OUT8-A	User safety output Ch8-A
B6	OUT8-B	User safety output Ch8-B

Note The LD22 and LD23 light up when 24 V power is supplied internally or externally to the safety output circuit in the board.
Set to XDJCOM_1 or XDJCOM_3 when using an external 24 V power input.

*1 This is connected to the V and G pins on the XOUT1 connector within the board.

9.2.3 Connection between the User Safety Input, Tool ID1 Input, and Input Devices

⚠ WARNING

1. **Use shielded cable for the input signal, and place the cables away from high voltage lines and power cables.**
2. **Fix the cables so that no excess load is added to the CoreCubic-S connector.**
3. **Keep the length of the cables within 50 m.**
4. **Do not supply the power to the test pulse output terminal. CoreCubic-S may be damaged.**
5. **Do not supply the power over the maximum voltage to the power supply terminal. Supplying the voltage exceeding the maximum voltage may result in failure or damage, etc.**
6. **Do not supply reverse voltage to the power supply terminal and GND terminal.**
7. **Be careful not to exceed the maximum current of the connector.**
8. **After wiring the user safety input, make sure that the safety function of the intended channel works correctly.**

Connect with input devices referring to the following.

(1) When setting to XDJCOM_1 or XDJCOM_3 (when the external power is used in the safety input circuit)

Note When setting to XDJCOM_1, the 24 V power of safety input part (XIN*) and safety output part (XOUT*) is used commonly inside safety I/O board. If the external 24 V power has been input to XOUT* connector, the external 24 V power input to XIN* is not necessary.
Note When setting to XDJCOM_3, the 24 V power of safety input part (XIN*) and safety output part (XOUT*) is used independently inside safety I/O board. (The required external 24 V power needs to be supplied to input (XIN*) and output (XOUT*) respectively.)
Note To use the tool ID input when using the external power, set JP1 to [2-1](G2≠G1).

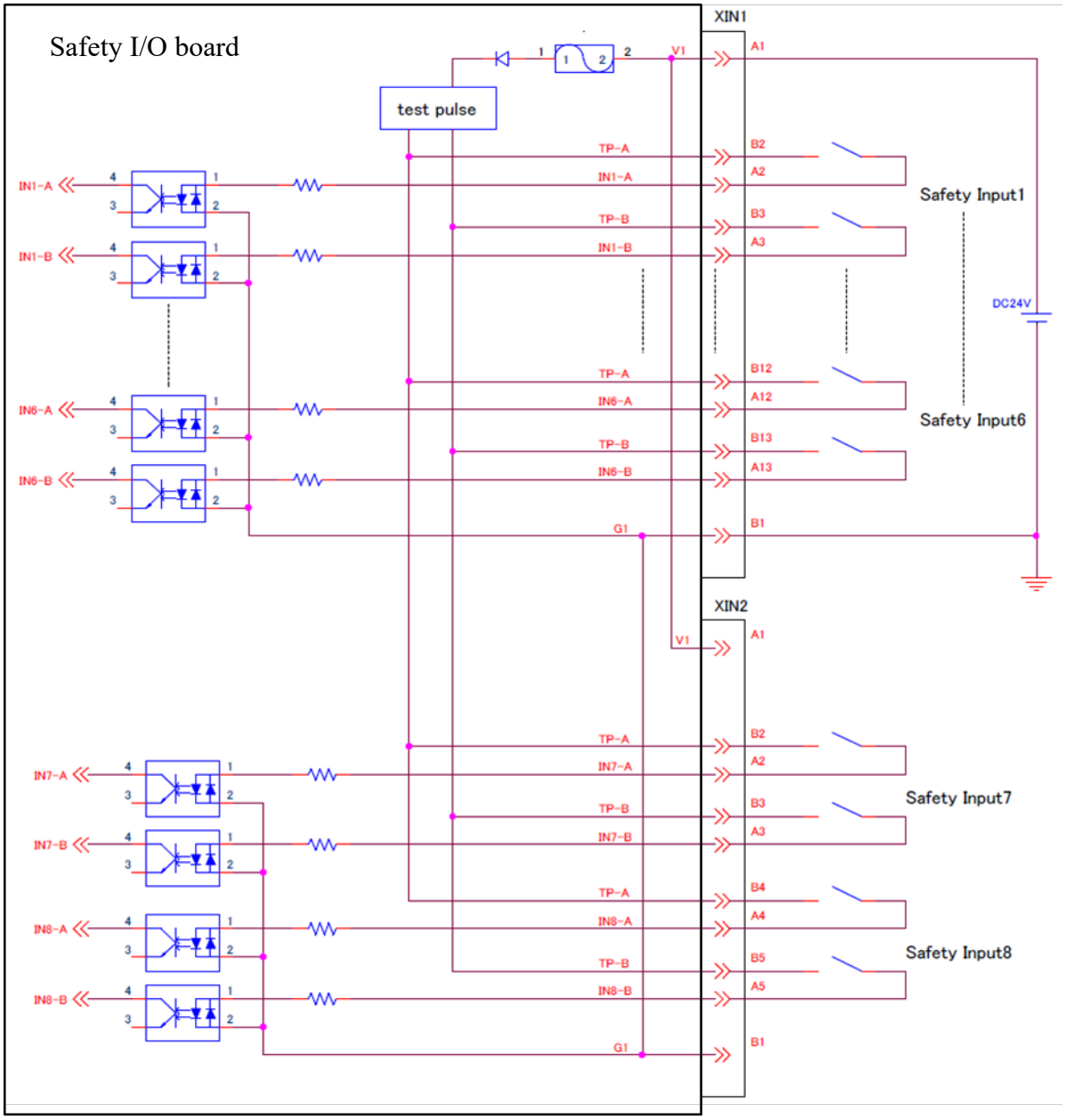


Figure 9.2.3.1 When the safety input circuit is operated by an external power source (default)

(2) When setting to XDJCOM_2 (when the internal power is used in the safety input circuit)

Note Use up to one safety I/O board, and total load current used for safety input/output (total of 8 channels of dual channel input and 8 channels of dual channel output) should be within 0.8 A.

Note When using two or more safety I/O boards, set the XDJCOM* settings to be supplied from an external power supply (XDJCOM_1 or XDJCOM_3), and use an external 24 V power supply to the XIN and XOUT connectors.

Note To use the tool ID input when using the internal power, set JP1 to [3-2](G2=G1).

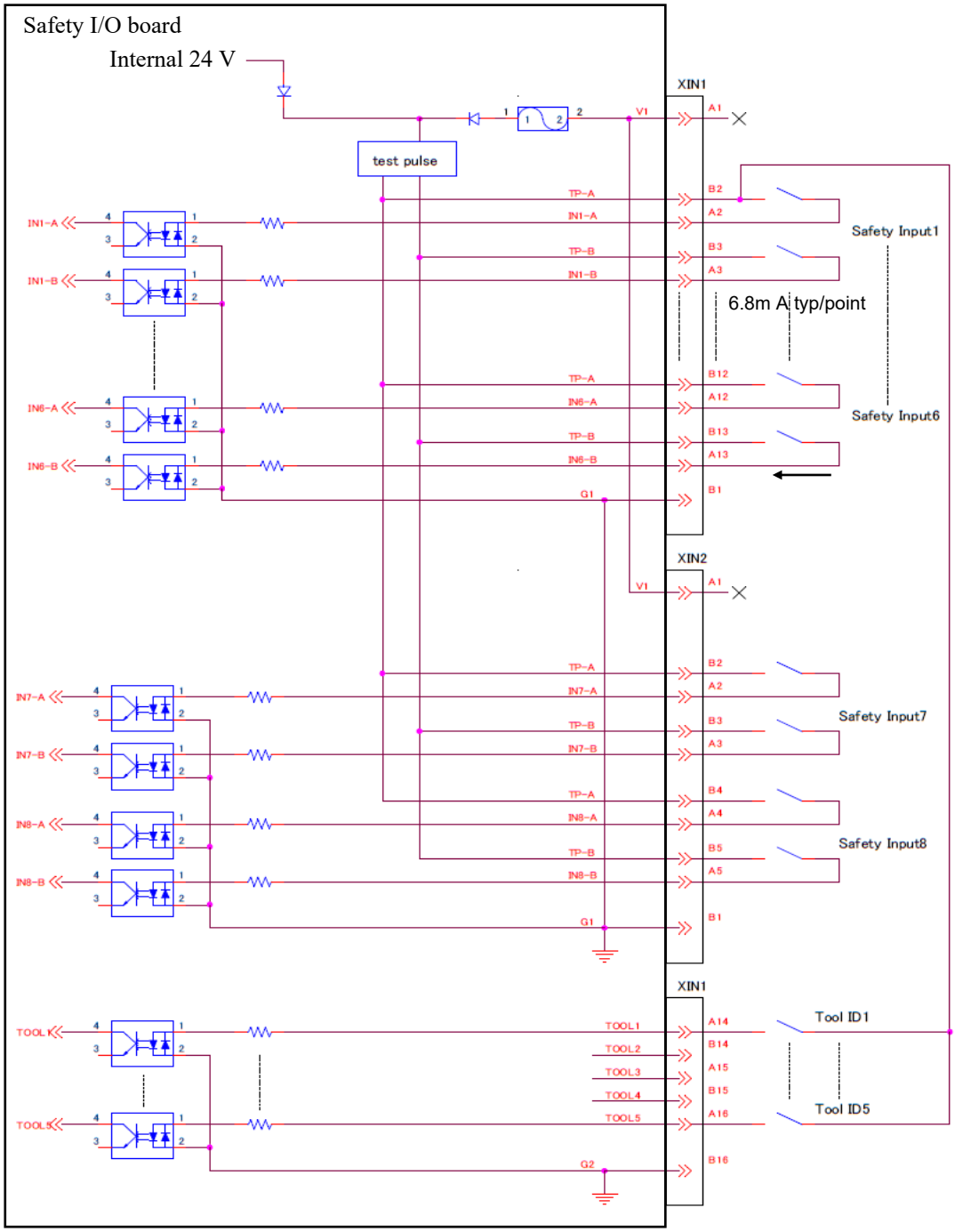


Figure 9.2.3.2 When the safety input circuit is operated by an internal power source

XIN1 connector: 32 pins

On-board connector model/DMC1.5/16-G1F-3.5-LR_P26THR (PHOENIX CONTACT)

Pin No.	Name	Terminal explanation	Pin No.	Name	Terminal explanation
A1	V1	For safety input, external 24 V power supply input	B1	G1	For safety input, external GND input
A2	IN1-A	User safety input Ch1-A	B2	TP-A	Test pulse A
A3	IN1-B	User safety input Ch1-B	B3	TP-B	Test pulse B
A4	IN2-A	User safety input Ch2-A	B4	TP-A	Test pulse A
A5	IN2-B	User safety input Ch2-B	B5	TP-B	Test pulse B
A6	IN3-A	User safety input Ch3-A	B6	TP-A	Test pulse A
A7	IN3-B	User safety input Ch3-B	B7	TP-B	Test pulse B
A8	IN4-A	User safety input Ch4-A	B8	TP-A	Test pulse A
A9	IN4-B	User safety input Ch4-B	B9	TP-B	Test pulse B
A10	IN5-A	User safety input Ch5-A	B10	TP-A	Test pulse A
A11	IN5-B	User safety input Ch5-B	B11	TP-B	Test pulse B
A12	IN6-A	User safety input Ch6-A	B12	TP-A	Test pulse A
A13	IN6-B	User safety input Ch6-B	B13	TP-B	Test pulse B
A14	TOOL1	Tool ID1 input 1	B14	TOOL2	Tool ID1 input 2
A15	TOOL3	Tool ID1 input 3	B15	TOOL4	Tool ID1 input 4
A16	TOOL5	Tool ID1 input 5	B16	G2	For tool ID1 input, external GND input

Note The LD5 LED lights up when 24 V power is supplied internally or externally.
Set to XDJCOM_1 or XDJCOM_3 when using an external 24 V power input.

XIN2 connector: 10 pins

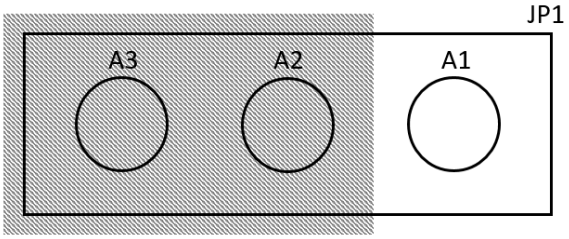
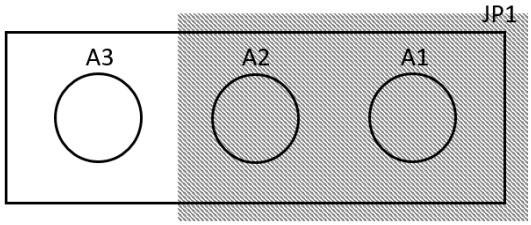
On-board connector model/DMC1.5/5-G1F-3.5-LR_P26THR (PHOENIX CONTACT)

Pin No.	Name	Terminal explanation	Pin No.	Name	Terminal explanation
A1	V1*1	For safety input, external 24 V power supply input	B1	G1*1	For safety input, external GND input
A2	IN7-A	User safety input Ch7-A	B2	TP-A	Test pulse A
A3	IN7-B	User safety input Ch7-B	B3	TP-B	Test pulse B
A4	IN8-A	User safety input Ch8-A	B4	TP-A	Test pulse A
A5	IN8-B	User safety input Ch8-B	B5	TP-B	Test pulse B

Note The LD5 LED lights up when 24 V power is supplied internally or externally.
Set to XDJCOM_1 or XDJCOM_3 when using an external 24 V power input.

*1 This is connected to the V1 and G1 pins on the XIN1 connector within the board.

Use the external 24 V power when using the tool ID (1-5) input of safety I/O board. Input the unused test pulse to the tool ID (1-5) when using only the internal 24 V power. The connections of the GND for tool ID and the connection of the GND for safety input can be changed. Change it, referring to the table below.

TOOL GND Set (JP1)	
3-2	2-1 (default)
Tool ID GND (G2) = Safety input GND (G1)	Tool ID GND (G2) ≠ Safety input GND (G1)
	

9.2.4 Types of Input Devices and Connection Methods

WARNING

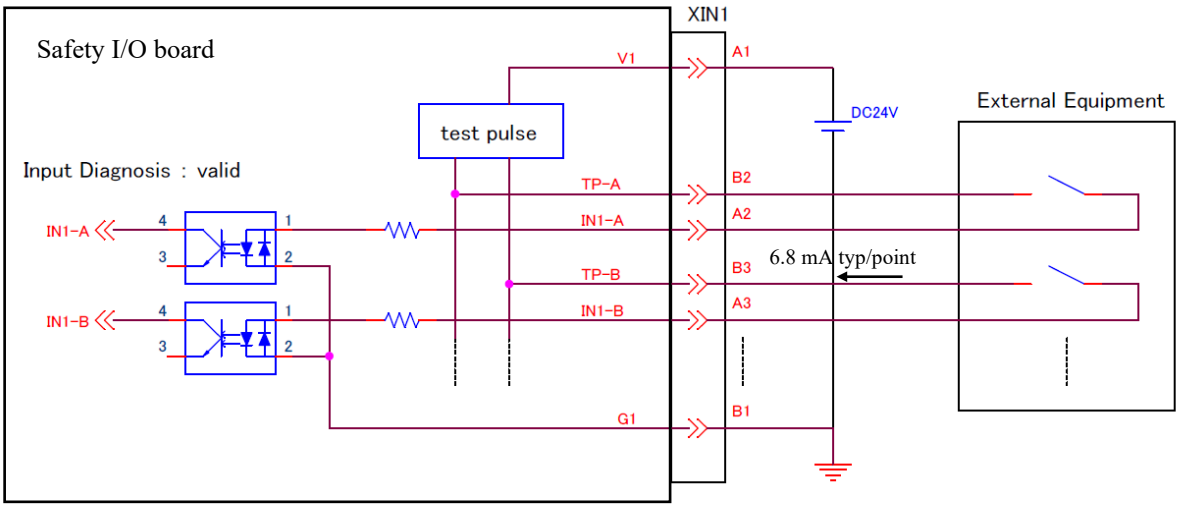
When connecting to contact type devices, set to "enable" the pulse diagnostics of the user safety input without fail. If diagnostics is set to "disable," trouble in input line may not be detected properly.

There are two cases for connection with input devices:

1. Connection with contact type devices: Ex) emergency stop push button switch and safety limit switch, etc.

CoreCubic-S uses test pulse output terminals combined with safety input terminal. Input the test pulse from CoreCubic-S via the contacts of external device. (See wiring example 1)
When using wiring example 1, enable the relevant pulse diagnostics of the user safety input in the CoreCubic-S parameter value setting.

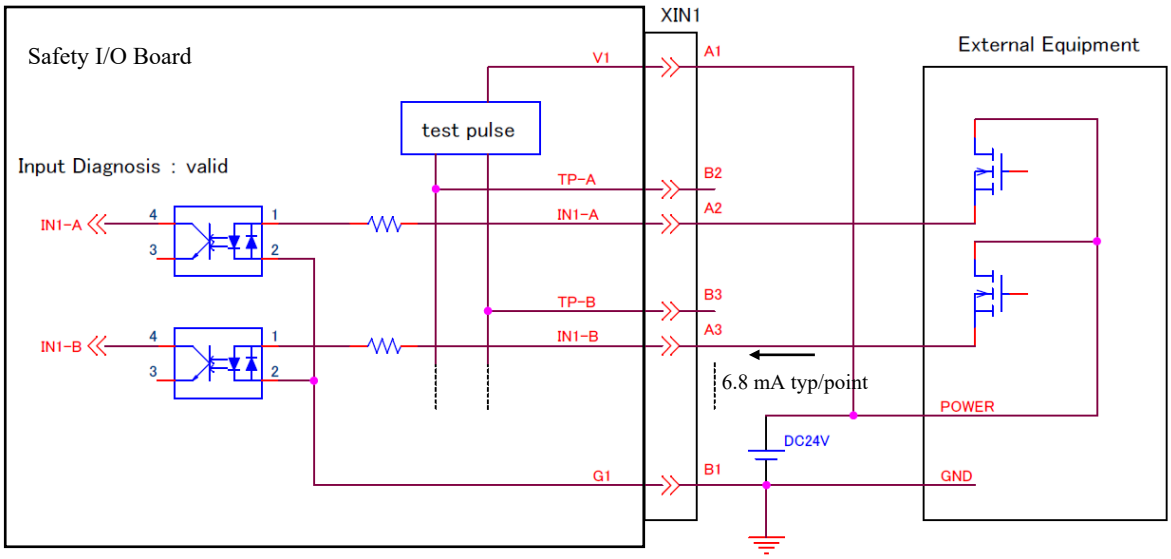
Wiring example 1: Input device such as emergency stop push button



2. PNP semiconductor output (current source output type) device: Ex) light curtain, etc.

Input PNP semiconductor output signal to the safety input terminal of CoreCubic-S.
(See wiring example 2)
When using wiring example 2, set to "disable" the relevant pulse diagnostics of the user safety input in the CoreCubic-S parameter value setting.

Wiring example 2: Input device e.g. light curtain, etc.



Set the filter time of the CoreCubic-S to “pulse width of external device + 4 ms (round away from first place of decimals)” when the diagnostics pulse is included in the output from the external device.

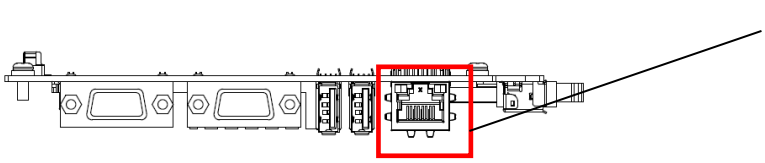
9.3 Connecting with the Safety Network Devices

[The network safety input/output function is an option.]

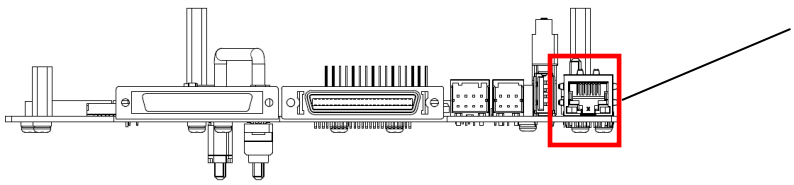
9.3.1 Connecting with EtherNet/IP Safety

Connect the Ethernet cable to the Ethernet port shown below using the shielded cable of category 5e or more. Supported connector is RJ45 connector.

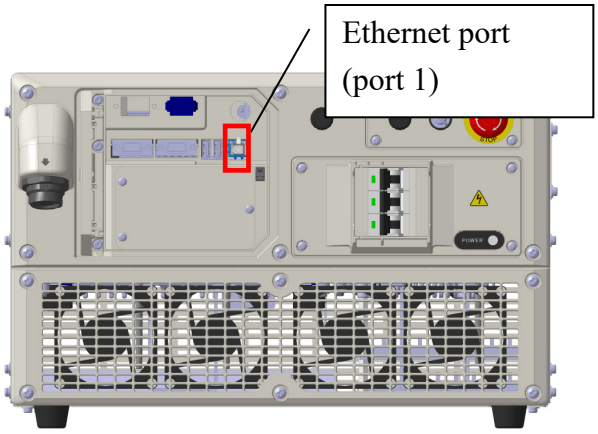
・ When connecting to the Ethernet port (port 1) on the main CPU board



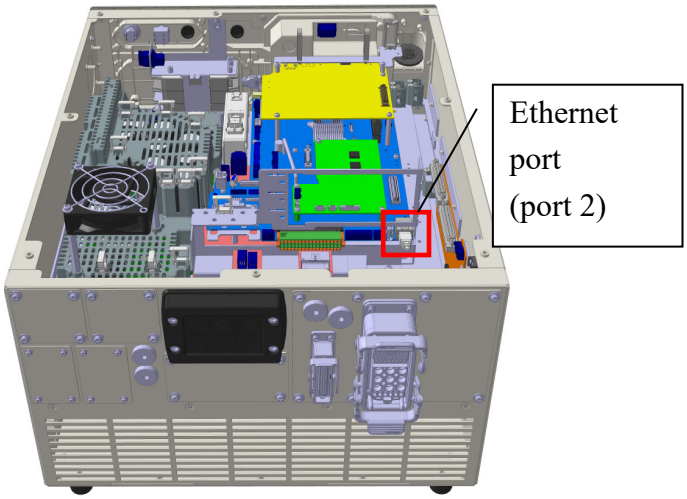
・ When connecting to the Ethernet port (port 2) on the servo board



Using the F0x controller as an example, the locations of port 1 and port 2 are shown below.



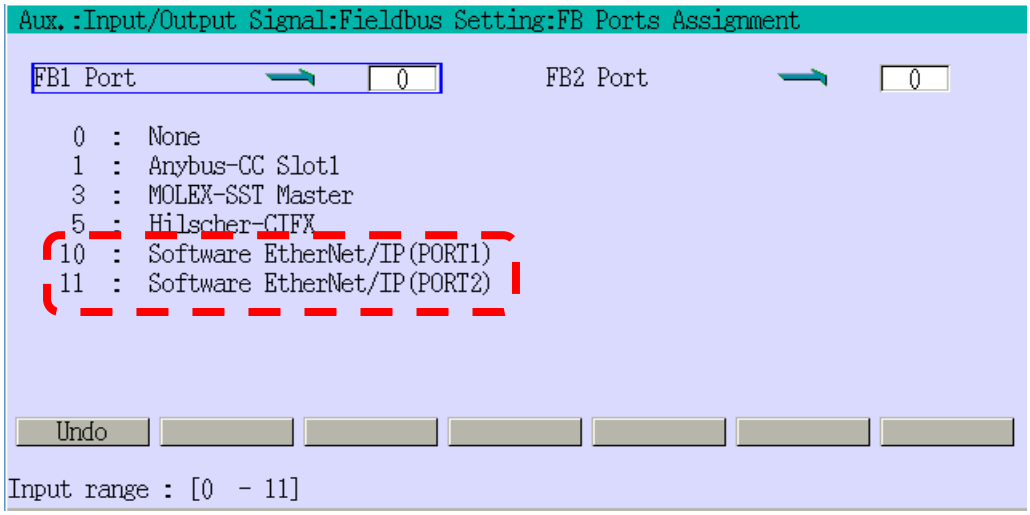
Front of controller



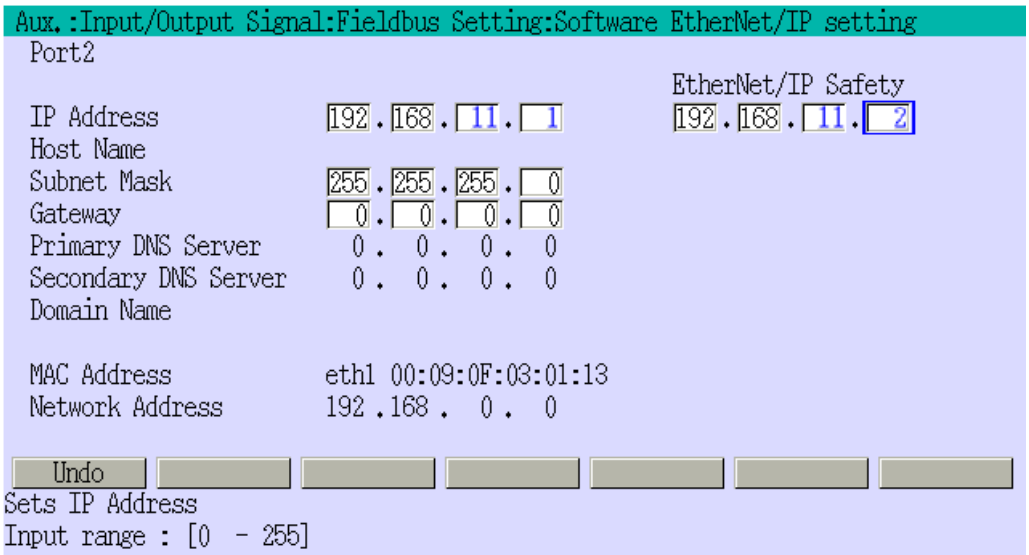
Rear of controller

Note For each controller for how to insert port 1 and port 2, refer to the "Installation and Connection Manual."

Assign the port to which the Ethernet cable is connected using [Aux. Function]→ [6. Input/Output Signal] → [9. Fieldbus Setting] → [1. FB Ports Assignment].



Configure the IP address of the Ethernet port via Auxiliary function 0812.
The item of “EtherNet/IP Safety” is displayed on the port specified by the CoreCubic-S EtherNet/IP Safety port setting.



Turn OFF the robot controller power once after the completion of IP address setting, and turn it ON again.



10 Safety Input/Output Function

10.1 Safety Input Function

As the safety dual input function of CoreCubic-S, it is possible to use up to 32 channels of user safety input (XIN1,2 connector part) using the optional safety I/O board. (*The number of user safety input channels varies depends on the number of safety I/O boards. A maximum of 8 channels can be used when one safety I/O board is connected, and a maximum of 32 channels can be used when four boards are connected. However, it may not be able to install up to four boards due to the type of controller or space limitations.) When using the user safety input, select the setting and wiring according to the number of safety I/O boards and the input device to be connected.
In addition, the fixed safety input (the safety dual input such as emergency stop on the controller operation panel, safety fence, external emergency stop) that is installed as standard in the controller is input to the power sequence board. Refer to the "External I/O Manual" for how to use.

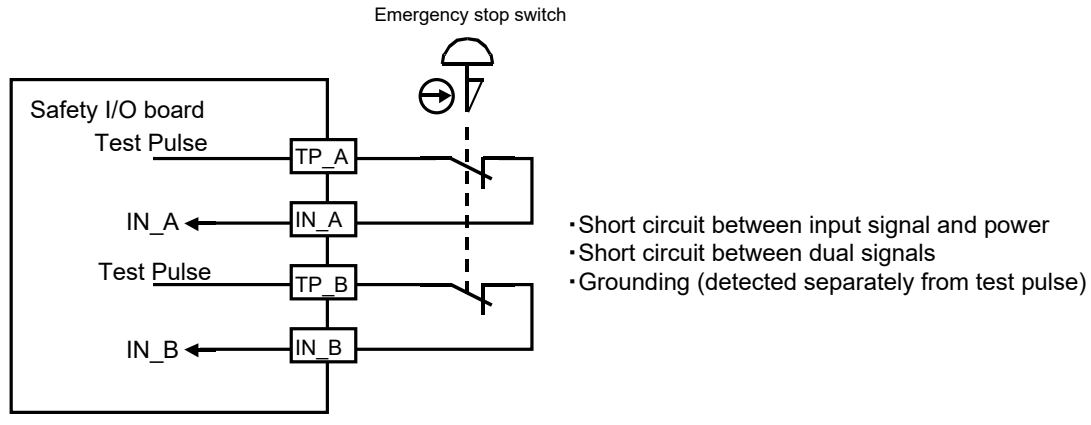
[NOTE]

CoreCubic-S safety system is designed as dual safety input. It cannot be used in single safety input.

The usage of user safety input differs depends on the kind of the connected input device as shown below.

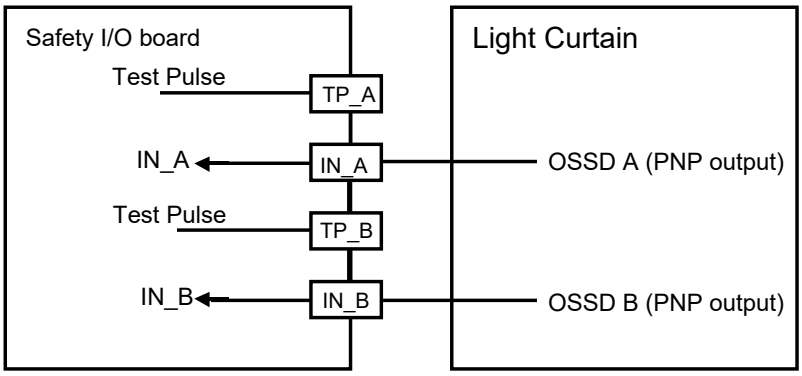
1. How to connect contact output type device to user safety input

Inputs the test pulse from the safety I/O board test output terminal to the safety I/O board user safety input terminal via the contact of the connected device. The errors shown in the figures below can be detected according to the test pulse. (Set the safety input diagnostics to “enable”)



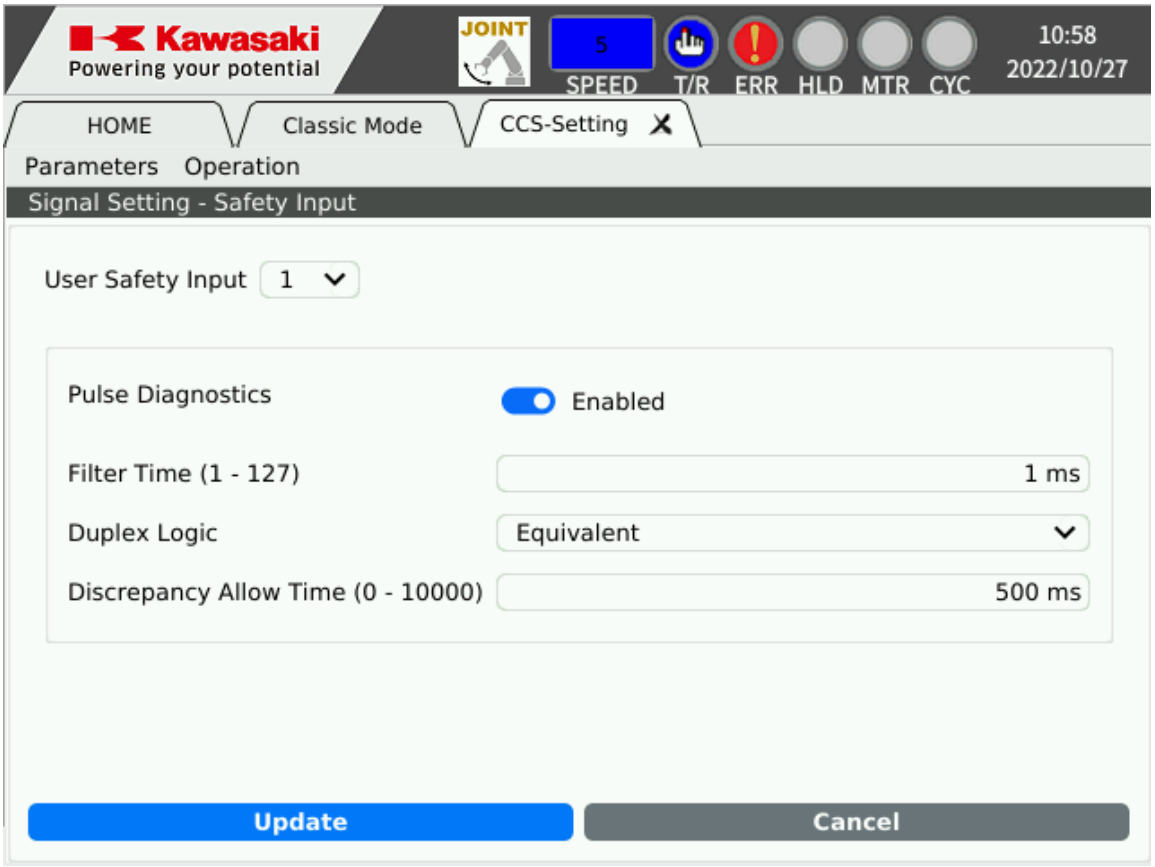
2. When connecting semiconductor output (OSSD) type devices to user safety input

Inputs to the safety input terminal DC24 V OSSD such as the light curtain. External devices detect the error of OSSD output line (short circuit with between output line and power, short circuit between dual signals, grounding) (Safety I/O board test pulse is not used. Set the safety input diagnostics to “disable.”)



10.1.1 Safety Input Setting

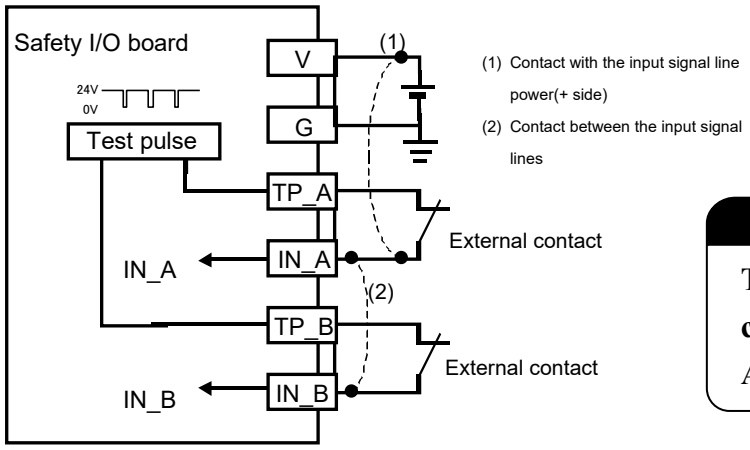
When using the user safety input, set each channel as below.
In some robot or controller type, the user safety input may be already used in the system, and the signal cannot be allocated by the user. In this case, the parameters cannot be changed.
Also, the fixed safety inputs are already set by default by the robot controller, and cannot be modified.



Pulse Diagnostics

Item	Setting	Content
Pulse Diagnostics	Enabled	Checks the safety input channel by test pulse output from the safety I/O board.
	Disabled	Does not check the safety input channel by test pulse output from the safety I/O board.

Test pulse detects the input wiring trouble shown in the figure below.



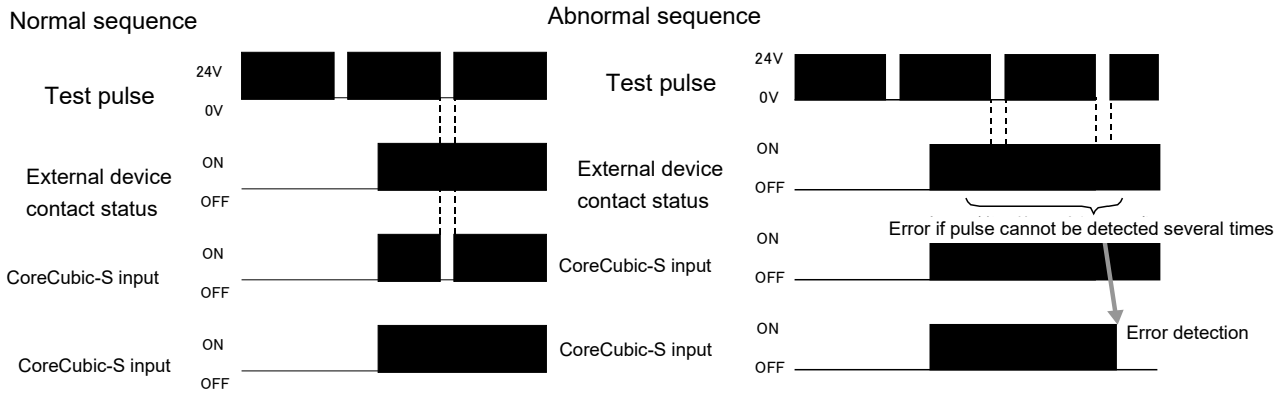
WARNING

This test does not detect short circuits between the channels (Ex. A side of ch1 and A side of ch2).

CAUTION

1. Ground the 0 V (GND) of the power that is used.
2. Short circuit between the input and GND line can be detected irrelevant of the safety input diagnostics setting (test pulse). Having the GND line short circuited for an extended time period results in malfunction in the test pulse output part, so remove the cause of the abnormality as soon as possible.

When an error is detected by the test pulse, the CoreCubic-S input value becomes OFF.



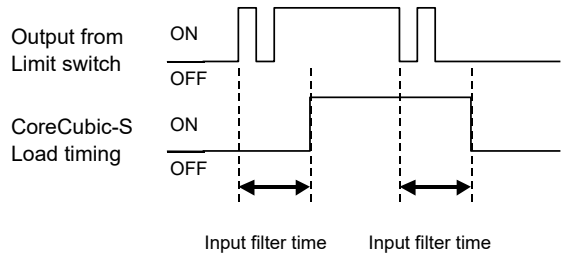
WARNING

When performing the wiring in 10.1-1, enable the test pulse diagnostics without fail. If disabled, short circuit in the input wiring may not be detected.

Filter Time

Item	Setting	Content
Filter Time	1 ms to 127 ms (Settable in increments of 1 ms)	See figure below for details.

Input filter may be used to reduce chattering and other the influences from external devices, as shown in the figure below.
The input signal is taken in as an internal signal after passing through the filter for test pulse removal (fixed input filter: 1 ms) and the set filter. Therefore, the input filter value has 1 ms + set value (1 ms to 127 ms). (As a result, the input delay of setting filter value + 1 ms occurs.)



⚠ CAUTION

Include the filter time in the response time. The response time affects the calculation of safety distance restricted by regulations such as ISO 13855, so be careful when setting.

Duplex Logic

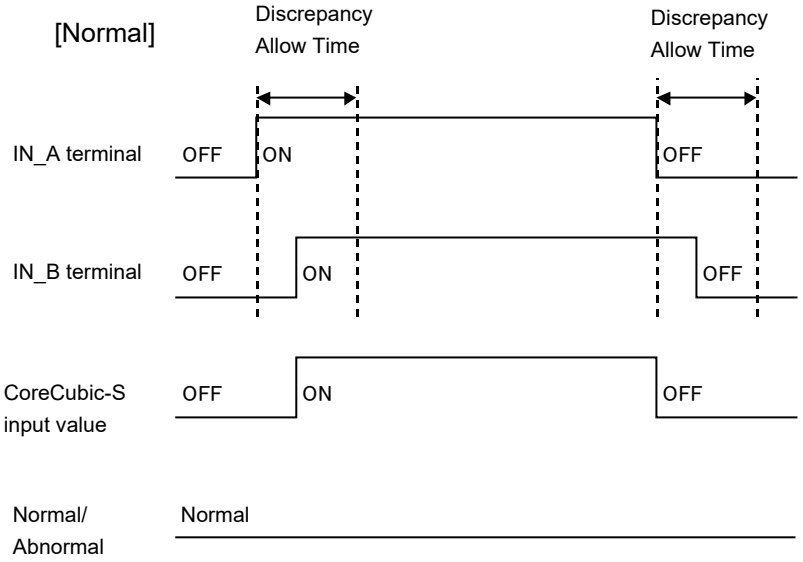
Item	Setting	Content
Duplex Logic	Equivalent	Dual input logic equivalent
	Complementary	Dual input logic complementary

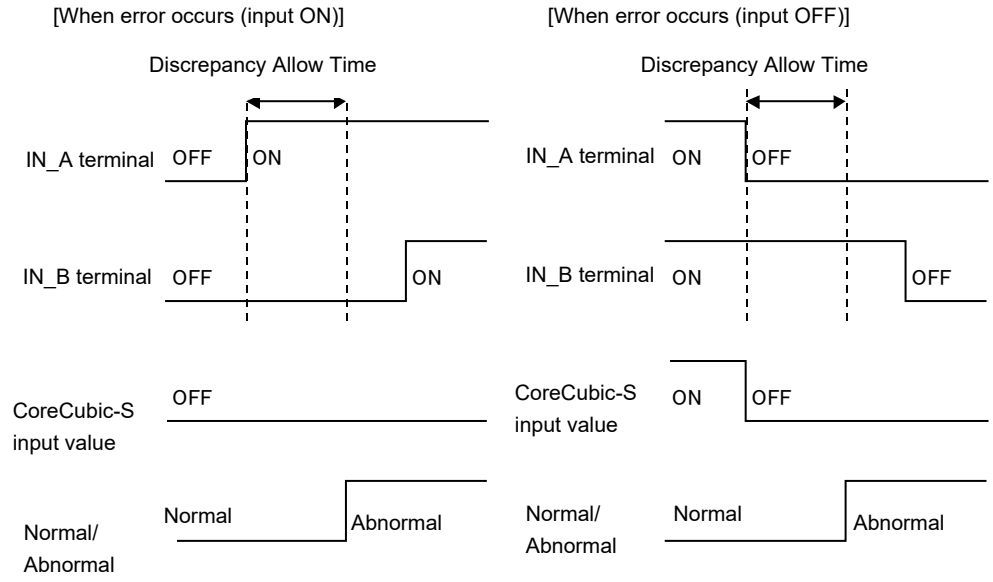
Discrepancy Allow Time

Item	Setting	Content
Discrepancy Allow Time	0 ms to 10000 ms (Settable in increments of 1 ms)	Allowed time of mismatch between the dual signals. When the signals do not match for the set time, error occurs.

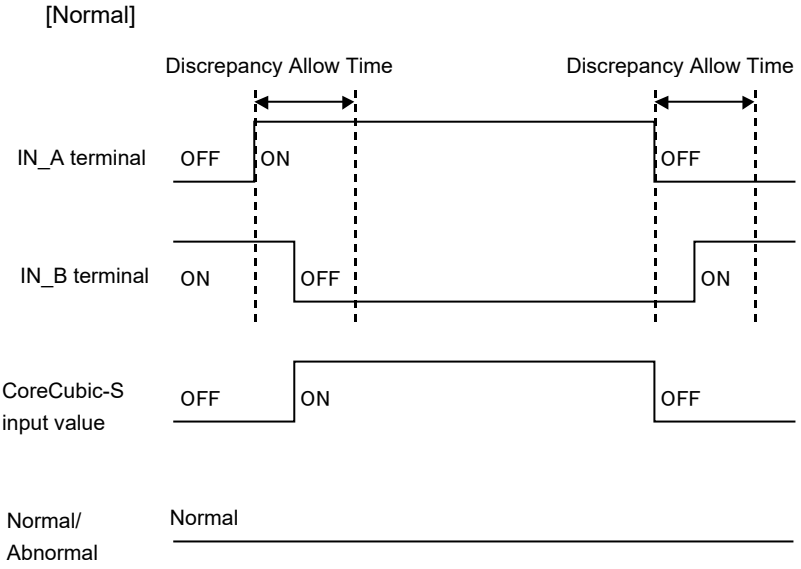
For details, see the following figure.

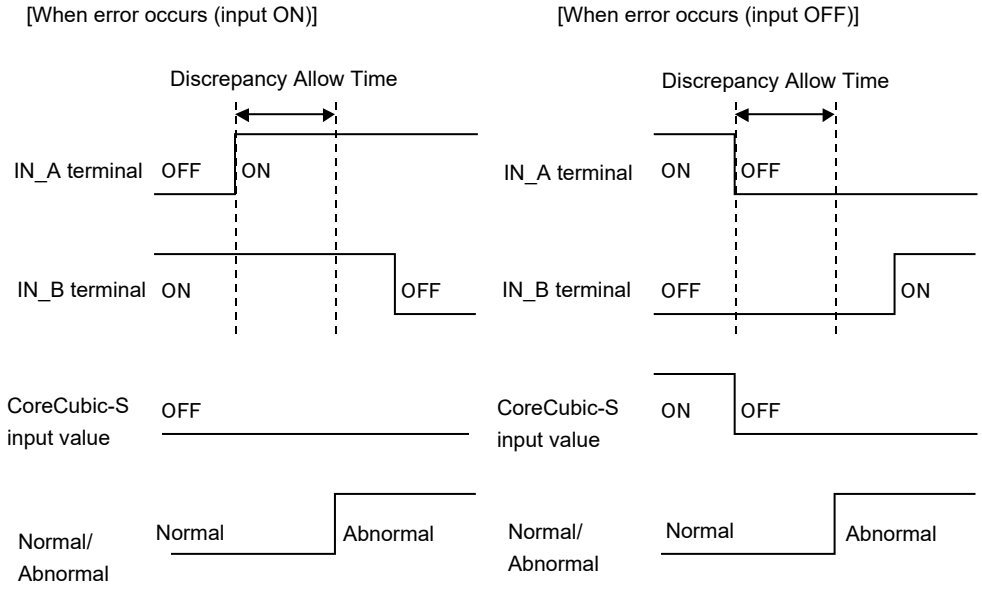
Equivalent Setting





Complementary Setting



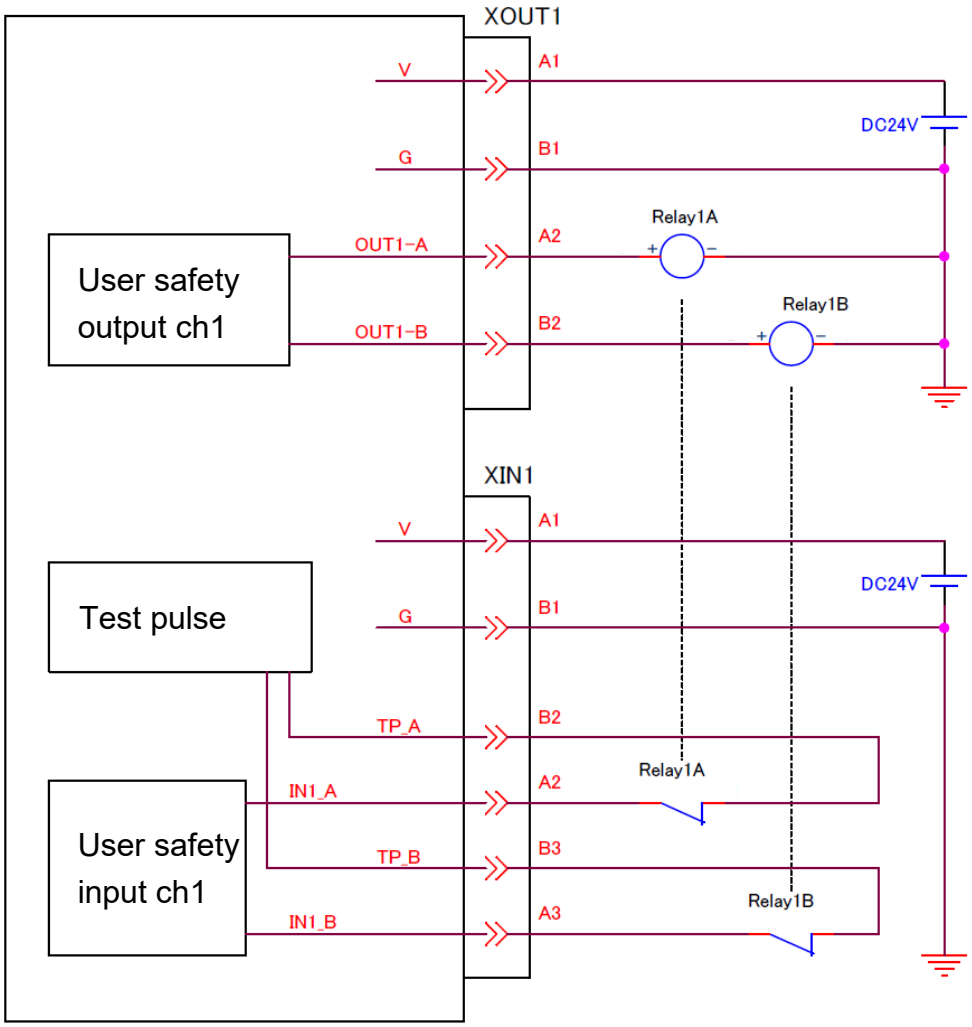


10.1.2 Error Reset

To recover from the trouble that occurred in the safety input terminals, remove the cause of the error and reset the error status. For error caused by input discrepancy, remove the cause of the error and input an inactive signal, such as by pressing the emergency stop button, or any operation that turns off the dual input signal, and reset the error status.

10.1.3 Weld Check Function for Safety Relay Connected to Safety Output

Allocating “weld check” in safety input allocation function allows the weld check to be conducted for external safety relay (forced guide relay) driven by the CoreCubic-S safety output. The below figure shows the wiring to drive the external safety relay by user safety output ch1 and to perform weld check of the safety relay via user safety input ch1. (For details on the contents of weld error, see the error code part in Chapter 14.) Wire according to the channel for welding check.



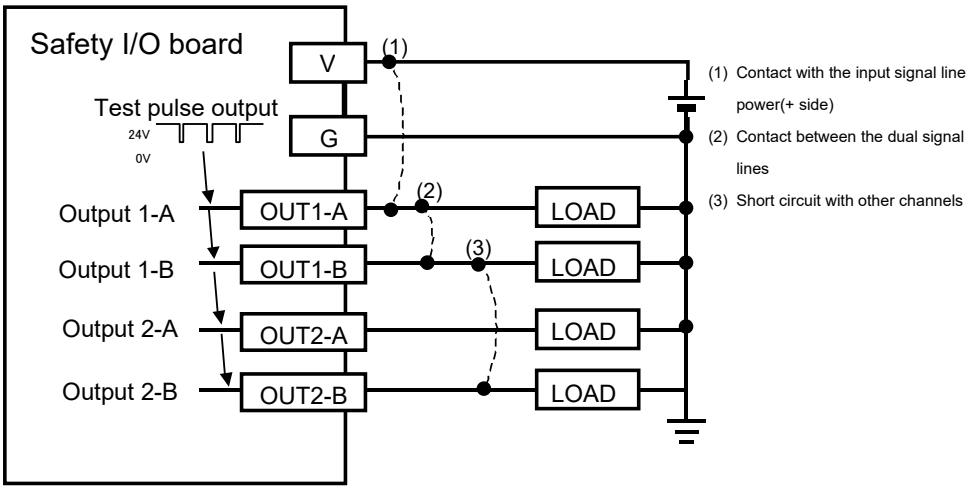
10.2 Safety Output Function

As the safety dual output function of CoreCubic-S, it is possible to use up to 32 channels of user safety output (XOUT1,2 connector part) using the optional safety I/O board. (*the number of user safety output channels varies depends on the number of safety I/O boards. A maximum of 8 channels can be used when one safety I/O board is connected, and a maximum of 32 channels can be used when four boards are connected. However, it may not be able to install up to four boards due to the type of controller or space limitations.) When using the user safety output, select the setting and wiring according to the number of safety I/O boards and the input device to be connected.

10.2.1 Safety Output Setting

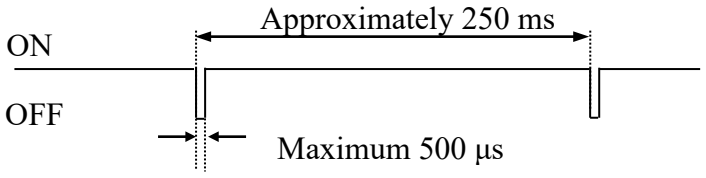
When the user safety output is used, function allocation settings are done for each channel. For details on the setting, see Chapter 8. In some robot or controller type, the user safety output may be already used in the system, and the signal cannot be allocated by the user. In this case, the parameters cannot be changed. (The fixed safety outputs are already set by default by the robot controller, and cannot be modified.)

Safety output from the safety I/O board periodically outputs test pulse of below specification. The test pulse detects the error (1) to (3) shown in the figure below.



CAUTION

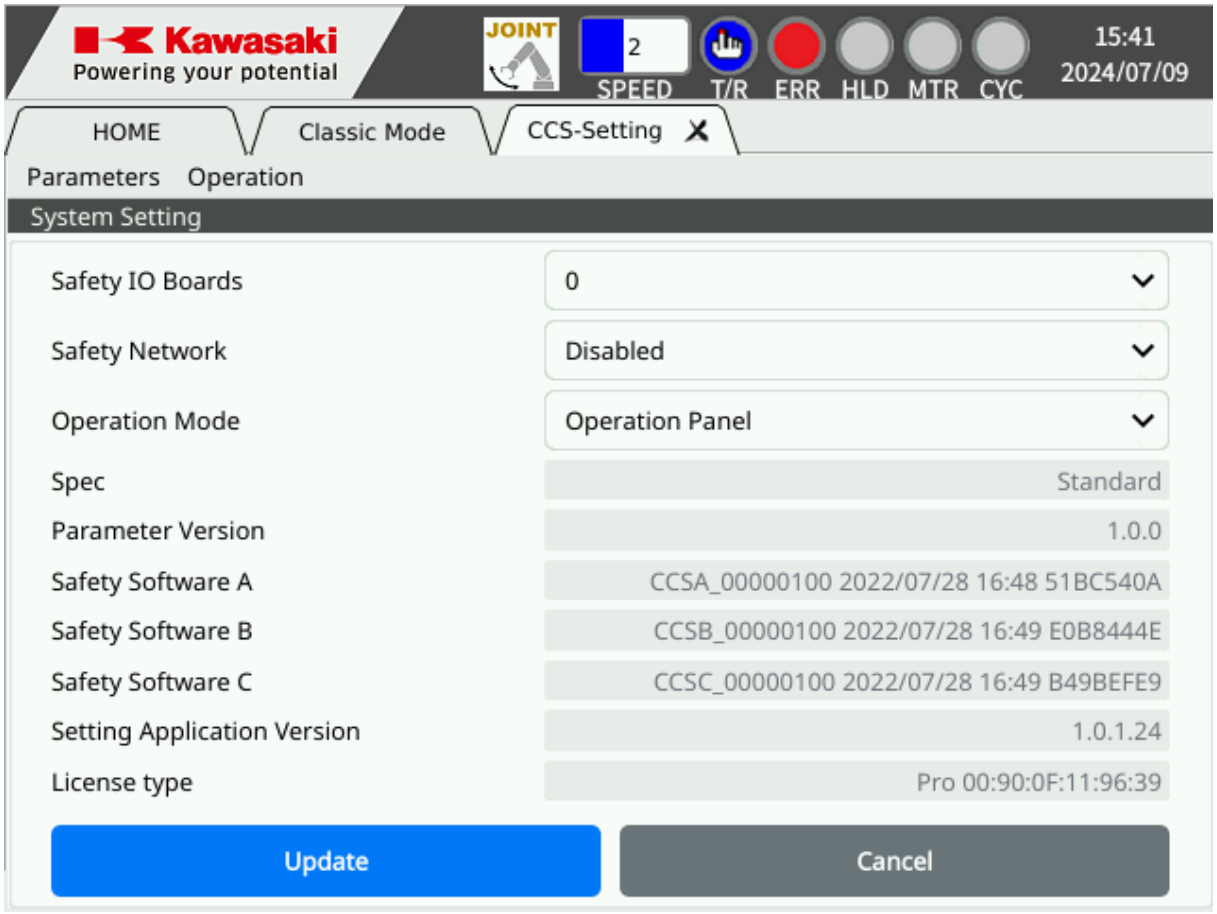
1. **Ground the 0 V (GND) of the power that is used.**
2. **Short circuit between the input and GND line can be detected irrelevant of the safety input diagnostics setting (test pulse). Having the GND line short circuited for an extended span of time results in malfunction in the test pulse output part, so remove the cause of the abnormality as soon as possible.**
3. **Select the connected devices so that they do not malfunction due to the test pulse from the safety output. Or if filter can be used in the connected devices, use adequate filtering.**



10.3 Network Safety Input/Output Function

[The network safety input/output function is an option.]

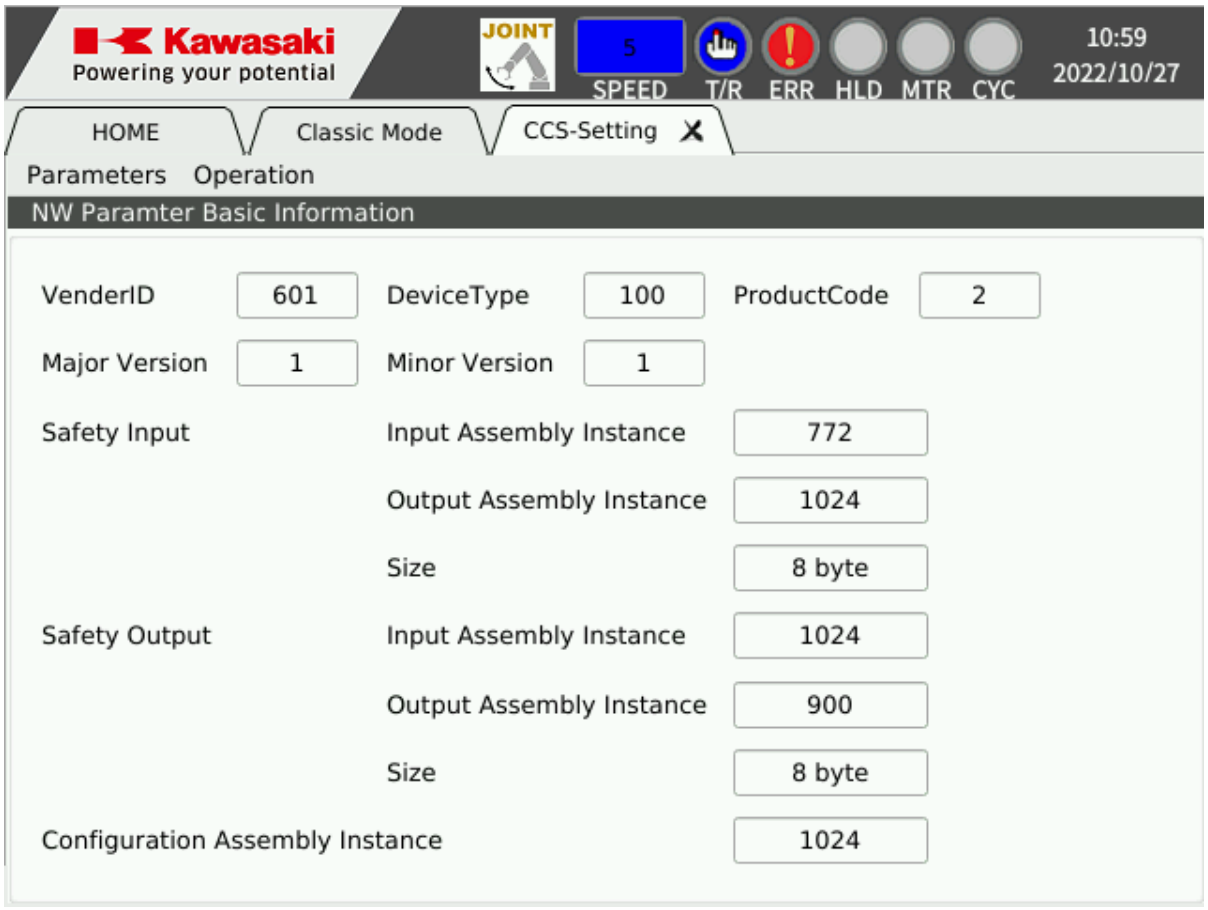
The network safety input/output function supports EtherNet/IP Safety and enables to use 64 network safety I/O points at maximum. When using network safety input/output, select settings and wiring according to the input device to be connected. Functions can be enabled/disabled in the setting application under <Status> -> <System>.



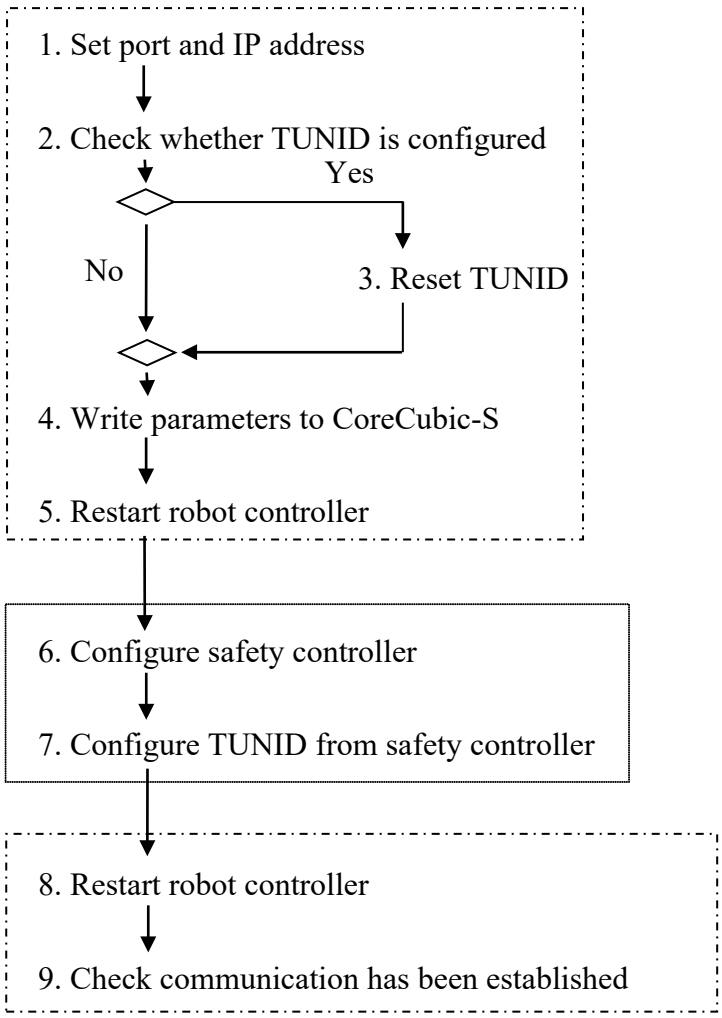
10.3.1 EtherNet/IP Safety Settings

This section explains how to configure EtherNet/IP Safety on the CoreCubic-S side. Configure the safety controller side according to the device used. Appendix A explains how to configure Rockwell Automation's GuardLogix.

From the setting application, select <Monitoring> -> <EtherNet/IP Safety> -> <NW Parameter Basic Information> to display the EtherNet/IP Safety Information Display screen.

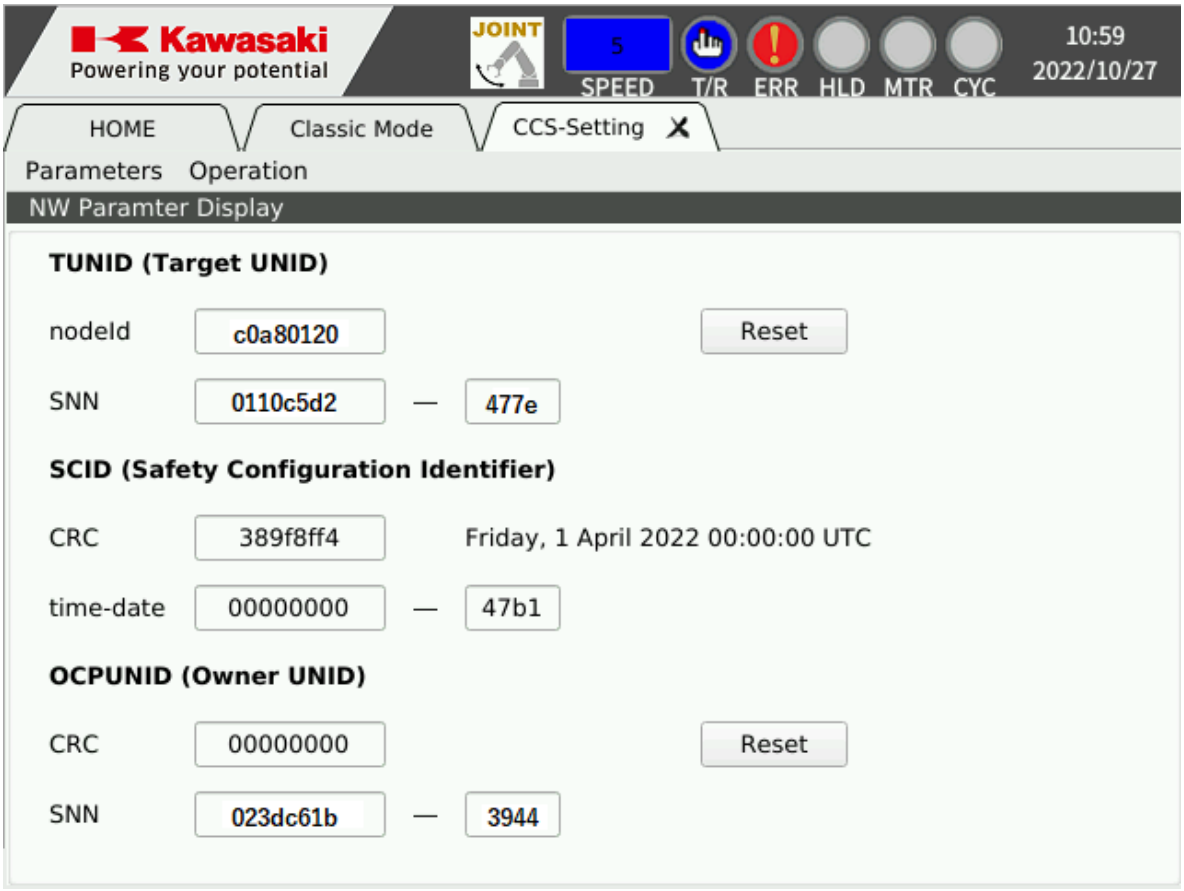


Follow the procedure shown below to establish communication.
[ ] is the procedure for the robot controller. [ ] is the procedure on the safety controller side.



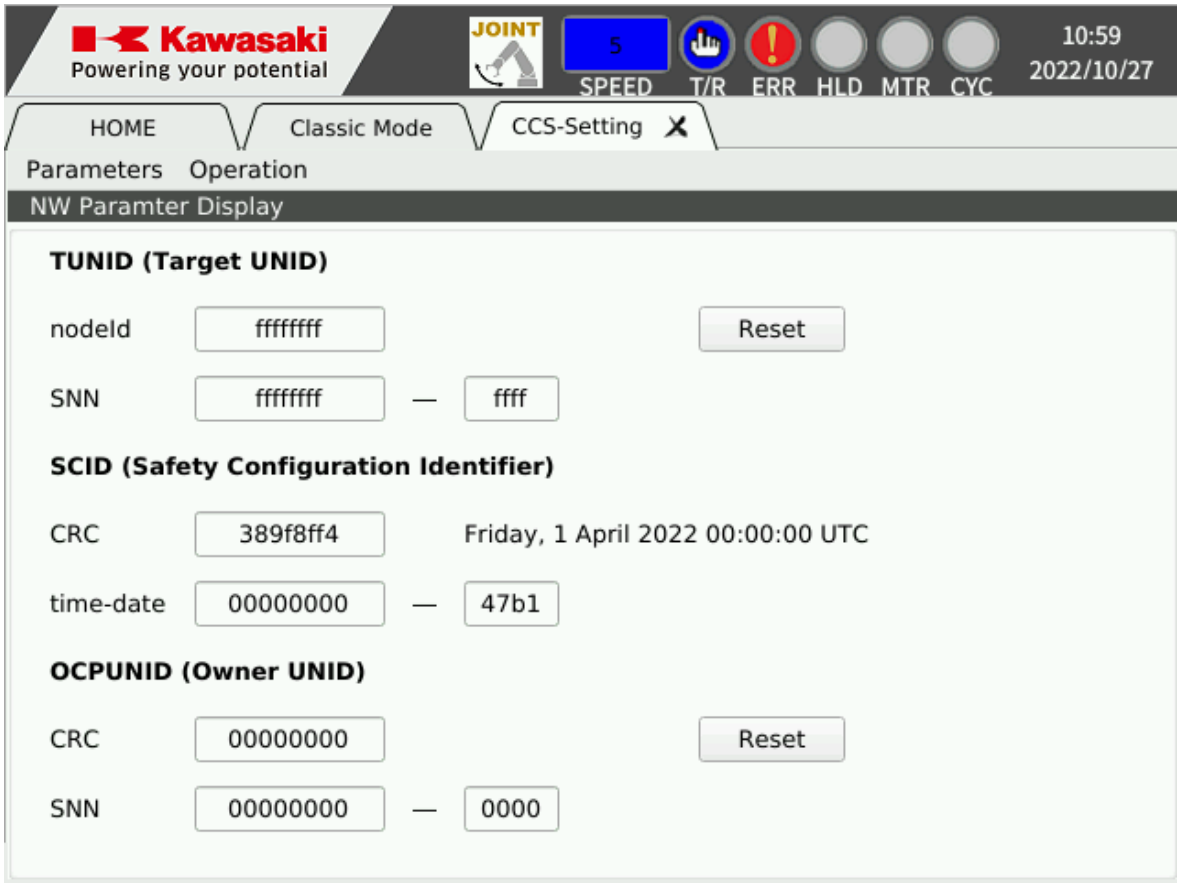
1. Set port and IP address
   Refer to Chapter 9 to configure the wired port settings and the EtherNet/IP Safety IP address.

2. Check whether TUNID is configured
   From the setting application, select <Monitoring> -> <EtherNet/IP Safety> -> <NW Parameter Display> and check whether the TUNID is set.
   If the TUNID nodeID and SNN display "FF," this means the TUNID has been reset, so you do not need to follow step 3.



   By default, the settings on the safety-software side will have already been reset. If the TUNID settings on the robot-controller side and safety controller side do not match, for instance when a safety controller has been replaced, the TUNID needs to be reset.

3. Reset TUNID
   Reset the TUNID using the setting application. From the setting application, select <Monitoring> -> <EtherNet/IP Safety> -> <NW Parameter Display> to display the EtherNet/IP Safety Setting Display Reset screen.
   Resetting the TUNID also resets the OCPUNID.
   "Reset Ownership" on the safety controller side cannot be used.



4. Write parameters to CoreCubic-S
   Write parameters to CoreCubic-S using the setting application.
   Refer to Chapter 8 for writing parameters to CoreCubic-S.

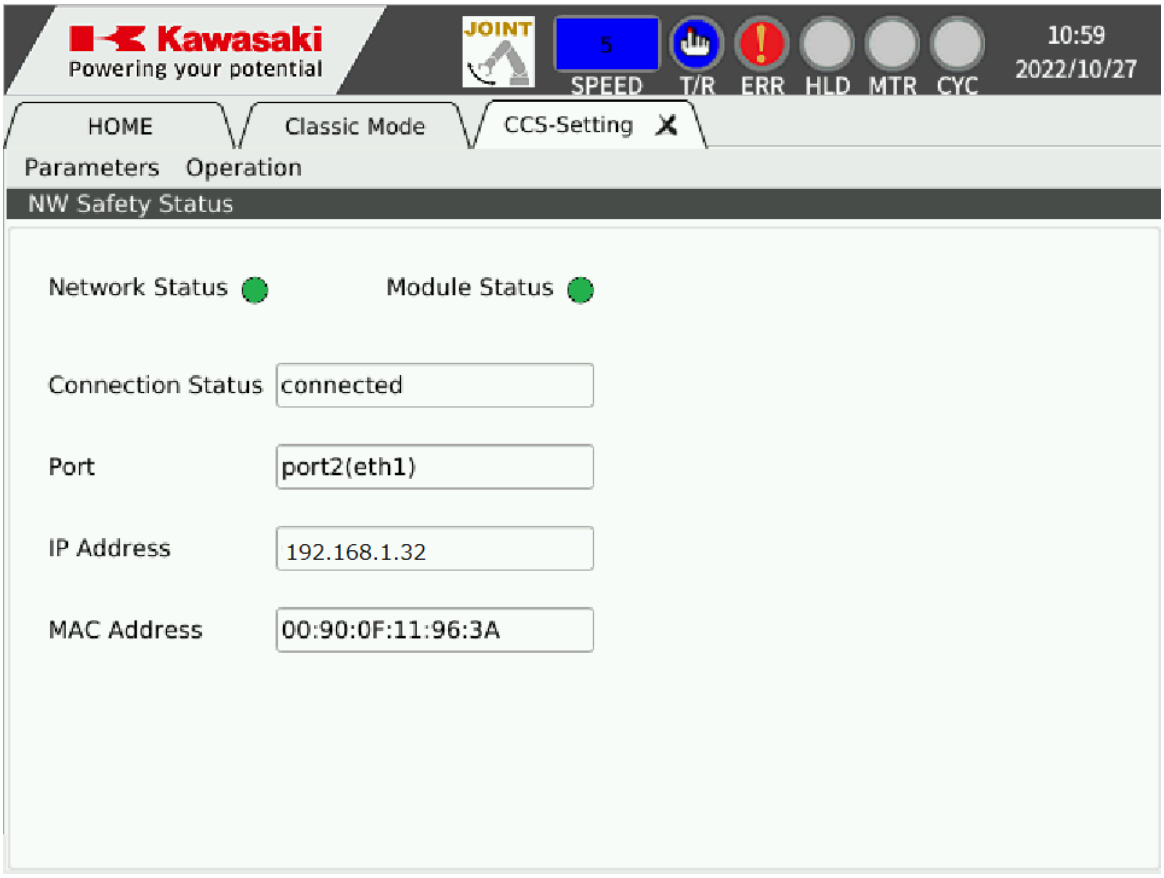
5. Restart robot controller
   Turn OFF the robot controller's controller power and then restart it so that the settings will be applied.

6. Configure safety controller
   Configure the safety controller. Appendix A explains how to configure Rockwell Automation's GuardLogix.

7. Configure TUNID from safety controller
   From the safety controller, set TUNID to CoreCubic-S. Safety Network Number is associated with TUNID in Rockwell Automation's GuardLogix. Appendix A.2 explains how to configure the Safety Network Number in Rockwell Automation's GuardLogix.

8. Restart robot controller
   Turn OFF the robot controller's controller power and then restart it so that the safety controller settings will be applied.

9. Check communication has been established
   From the setting application, select <Monitoring> -> <CIP Safety Information> -> <NW Safety Status> to display the EtherNet/IP Safety Monitor Display screen. Check whether communication has been established.



Network Status LED

Indicator	Status	Explanation	Countermeasure
Off	Not online.	No IP address.	Check the network is operating properly.
Blinking green	Online, but connection is not established.	An IP address has been acquired, but connection has not been established.	Check the network and configuration.
Steady green light	Online, connection has been established.	Operating normally.	None
Blinking red	One or several I/O connections have timed out.	A recoverable network error has been detected.	Check the network and configuration.
Steady red light	Fatal link error.	An error preventing communication on the network has been detected, such as duplicate IP addresses.	Turn the controller power back ON. Check IP address settings for the network.
Blinking red/green		PROPOSING TUNID is running.	None

Module Status LED

Indicator	Status	Explanation	Countermeasure
Steady green light	Operating normally	Operating normally.	None
Steady red light	Irrecoverable error	An irrecoverable error was detected.	Turn the controller power back ON. If the problem persists, replace CoreCubic-S.
Blinking red and green	Configuring	Currently configuring or diagnosing.	None
Blinking green	Idle	Idle state. Wait for a connection from the scanner.	Establish a connection.
Blinking red	Recoverable error	A recoverable error has been detected.	Turn the controller power back ON.

10.3.2 EtherNet/IP Safety Precautions

This section describes the precautions for using the safety device (CoreCubic-S EtherNet/IP Safety function).

- The replacement of safety devices requires that the replacement device be configured properly and operation of the replacement device shall be user verified.
- If you choose to configure safety connections with an SCID=0, you are responsible for ensuring that originators and targets have the correct configurations.
- The user should assign SNN numbers for each safety network or safety sub-net that are unique system-wide.
- When a safety device is configured directly from a workstation, please compare the transferred SCID and configuration data with the SCID and configuration data originally viewed in the workstation.
- The user testing is the means by which all downloads are validated.
- The signature should only be considered “verified” (and configuration locked) after user testing.
- Configuring an originator with connection data and/or target configuration data must be downloaded to the target so it can be tested and verified. Only then can SCIDs from the target be confirmed.
- Please clear any preexisting configuration from any safety device before installing it onto a safety network.
- Please commission all safety devices with IP address prior to installing it onto a safety network.
- Please carefully consider implications of mixing different SIL level devices on the network.
- Please test safety connection configurations after they are applied in an originator to confirm the target connection is operating as intended.
- The LEDs are NOT reliable indicators and cannot be guaranteed to provide accurate information. They should ONLY be used for general diagnostics during commissioning or troubleshooting. Do not attempt to use LEDs as operational indicators.
- The originators that have an “automatic” SNN setting feature should only use that feature when the safety system is not being relied upon.
- Please verify that all originator-configured safety devices have their ownership assignments as part of the final verification process.
- Please visually verify that all configuration data was downloaded correctly.



11 Settings and Checks Before Use

11.1 Settings

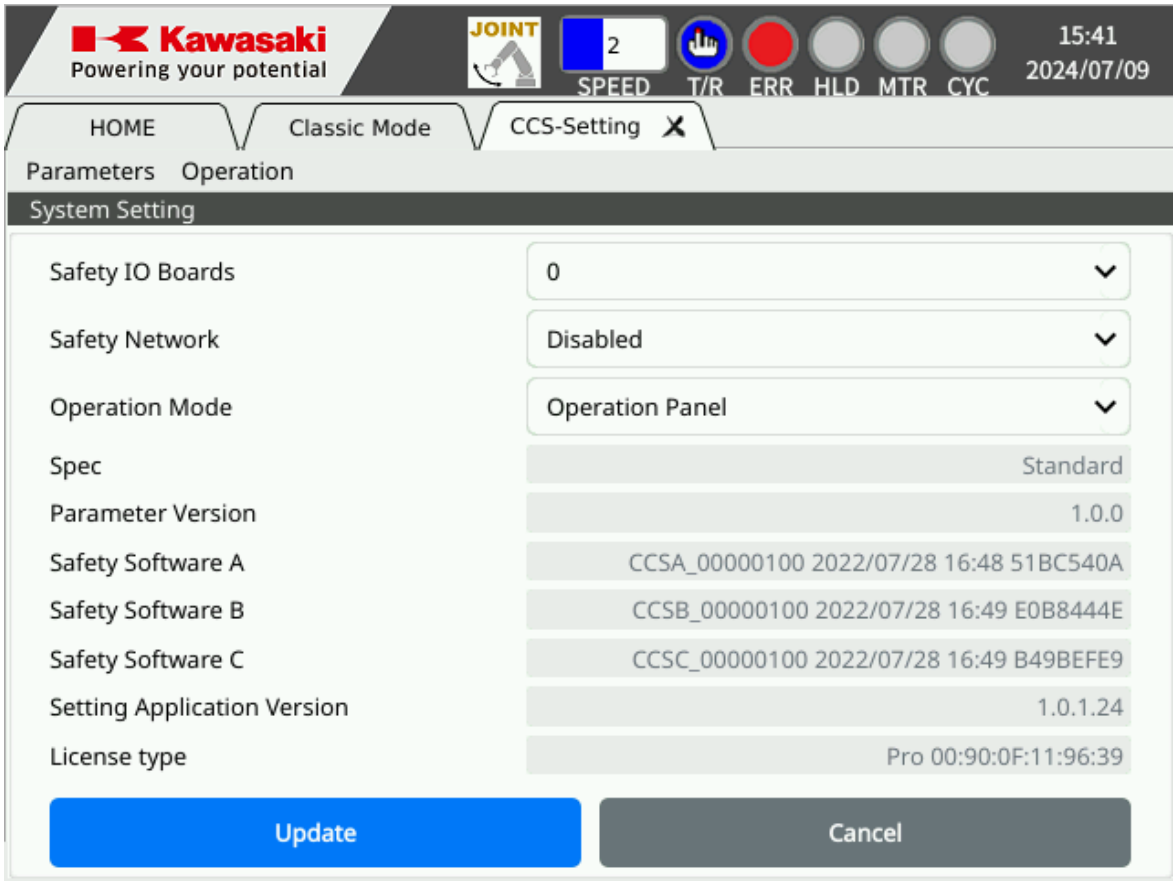
This section describes the parameters for each function and the methods and precautions, etc. when setting the parameters.

CAUTION

If there is an error with the parameters, the safety functions will not function correctly.
After setting the parameters, check that the settings are as intended.

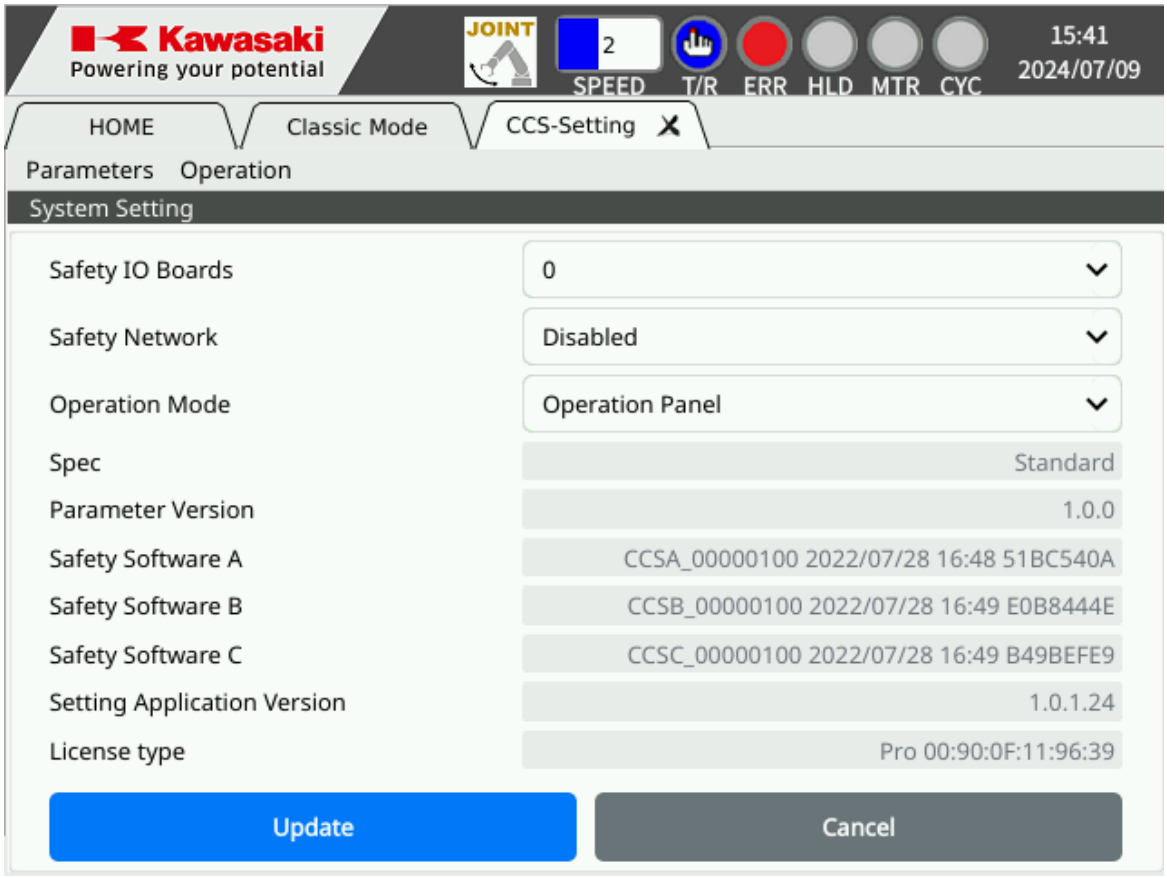
11.1.1 Updating Parameters

<Update> and <Cancel> buttons are located at the bottom of the settings screen. If you click <Update>, the parameters set on each screen are updated to the parameters stored by in the setting application. At this time, the parameters are not applied to CoreCubic-S. If you want to apply them to CoreCubic-S, [Write to CoreCubic-S] is required. If you click Cancel, the parameters set on each screen are canceled and the settings screen closes.
The parameter status can be identified by color. Parameters updated on the screen are shown in blue, parameters updated but not written to CoreCubic-S are shown in orange and parameters written to CoreCubic-S are shown in black.



11.1.2 System Setting

Executes the system setting. You can configure the settings by selecting [Status] -> [System] from the setting application menu.



Safety IO Boards

Configures the number of safety IO boards to be used.

Safety Network

The network safety input/output function can be enabled/disabled. For details on network safety input/output function, see section 10.3.

Operation Mode

Configures the input method for the operation mode. See Section 9.1.1 for details on how to input the operation mode.

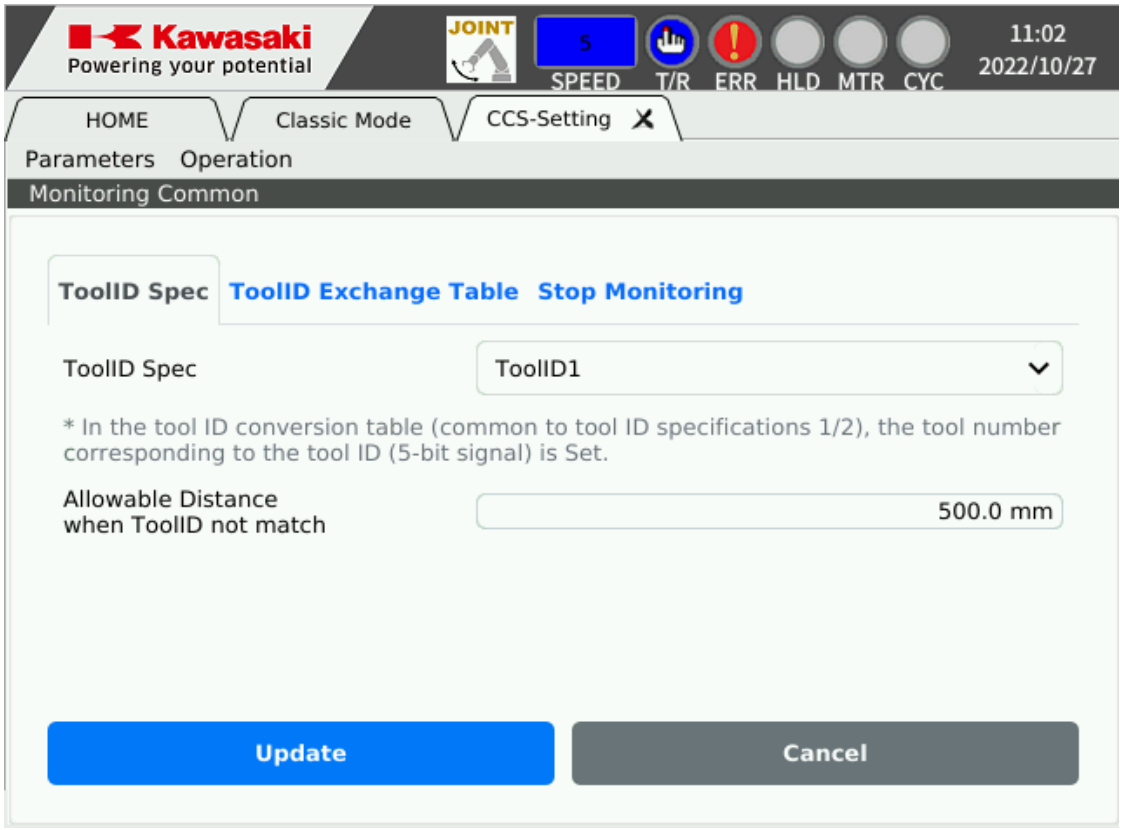
11.1.3 Monitoring Common Settings

[Tool ID/stop monitoring function is an option.]

Set common parameters for each function. Parameters can be set by selecting [Common] under [Monitoring settings] from the menu of setting application. A maximum of 32 tools can be defined for CoreCubic-S. For AS software, the 18 tools from tool numbers 1 to 18 are used. For the tool number, refer to "17.2 How to Specify Tool Setting via AS Software."

1. Tool Setting

Configure the setting relating to the tool ID converted to the tool number.



ToolID Spec

Select whether to use the combination of the current tool number and the command tool number converted from the tool ID 1 of the fixed safety input or the tool number converted from the tool ID 2 of the internal safety input as the tool number.

Allowable Distance when ToolID not match

When selecting tool ID 1 as the tool ID specification, set the allowable moving distance at which the tool number (current tool number) input to CoreCubic-S and the tool number (command tool number) of the tool selected in the robot controller (AS software) can be moved without being matched. When the current tool number and command tool number are not matched,

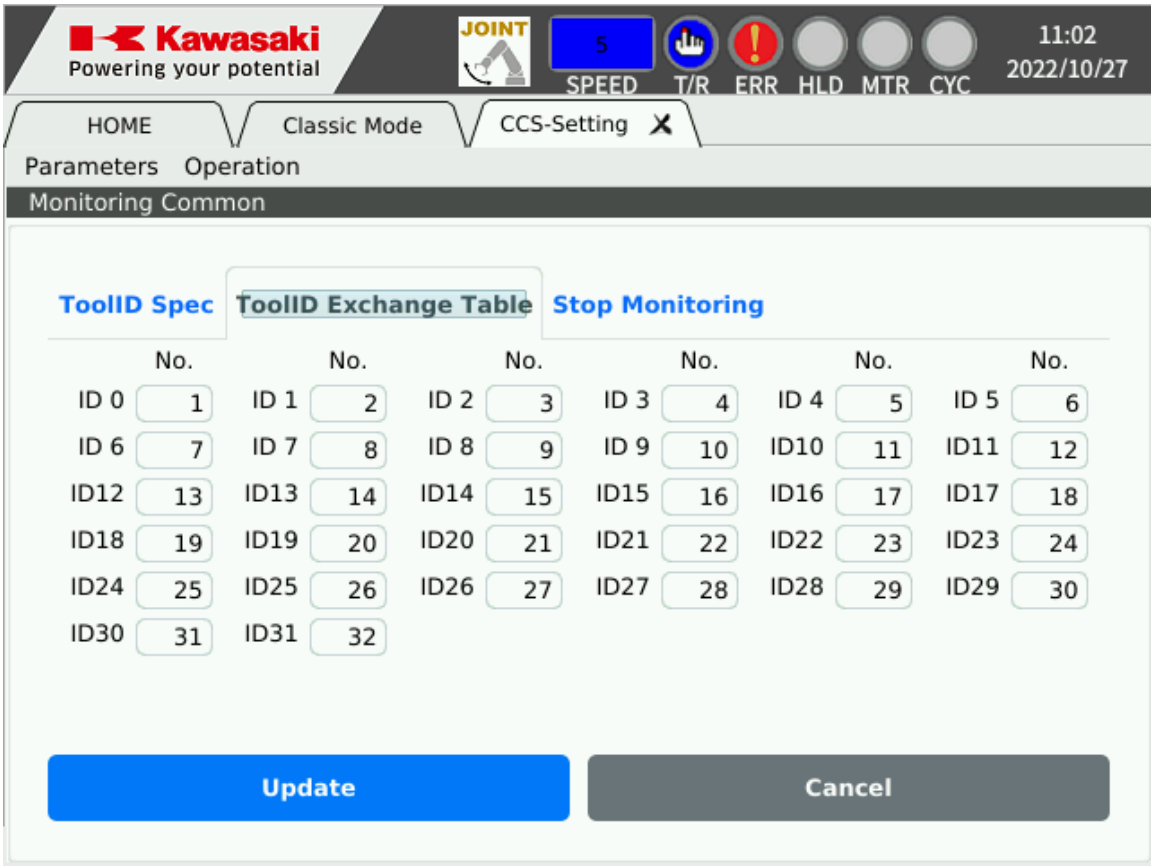
If the moving distance is less than the set distance:	Possible to move
If the moving distance is more that the set distance:	The power to the robot is immediately shut off

Also, when the tool numbers are mismatched, the tool monitored models for both the current tool number and command tool number are monitored. This setting is used when changing tools. During a tool change, the current tool number and command tool number switch and therefore moving distance is required. Set a distance that prevents the generation of unnecessary errors and maintains safety.

2. Tool ID Exchange Table

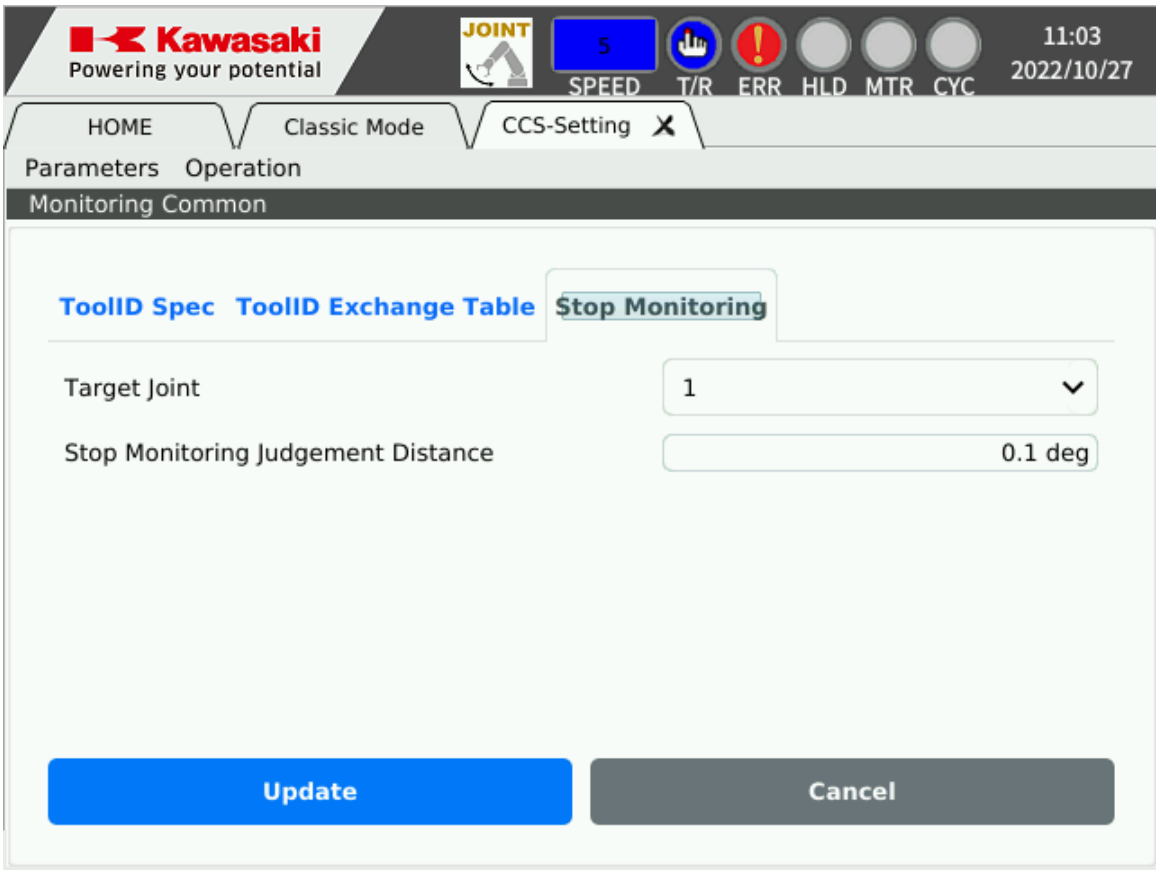
Set the value to convert to the tool number handled within CoreCubic-S from the Tool ID1 input or Tool ID2 input.

An explanation regarding the tool ID follows. As the Tool ID, 5 bits of information will be entered. Tool ID Input 1 represents the least significant bit and the 5 bits of which the most significant bit is Tool ID input 5 indicate the Tool IDs 0 to 31. These Tool IDs 0 to 31 can be converted to the set tool numbers 1 to 32 with "11.1.4 Motion Area Monitoring Function" and "11.1.6 Speed Monitoring Function."



3. Stop Monitoring

Set the joint range for determining stopping when stop monitoring. Set in unit of [deg] for a rotation axis, and in unit of [mm] for a linear motion axis.



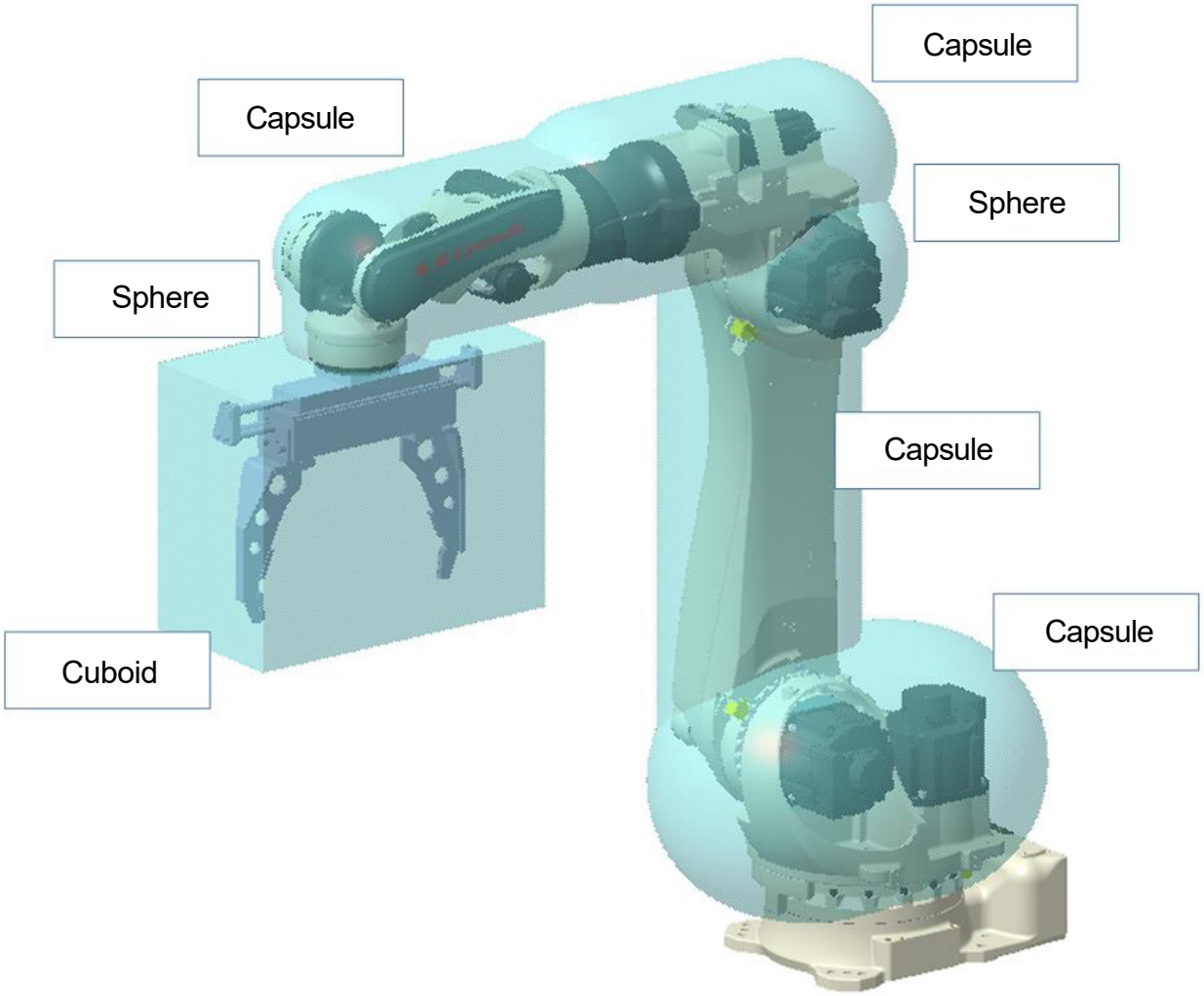
11.1.4 Motion Area Monitoring Function

[Motion area monitoring function is an option.]

This function performs protective stop of the robot/device when the monitored model position is outside the motion permitted area.
Describes the area setting and monitored model setting methods.

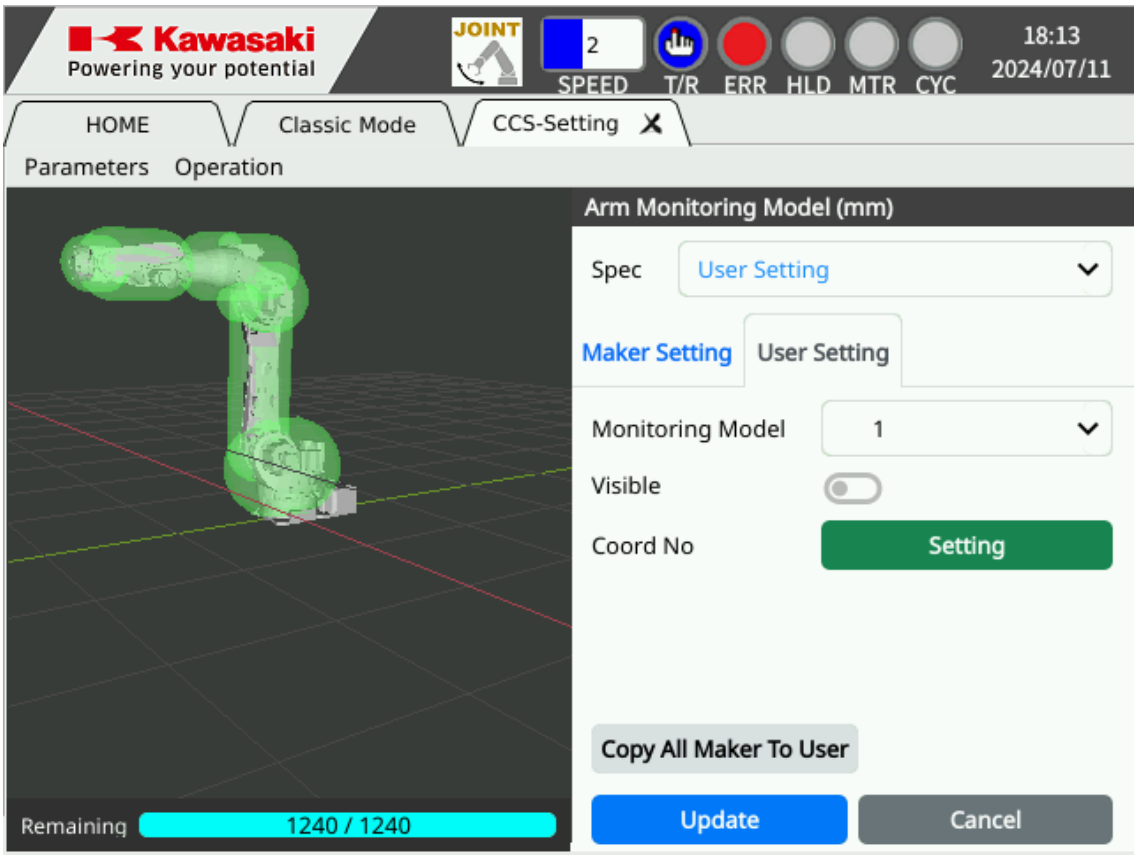
1. Monitored Model Settings

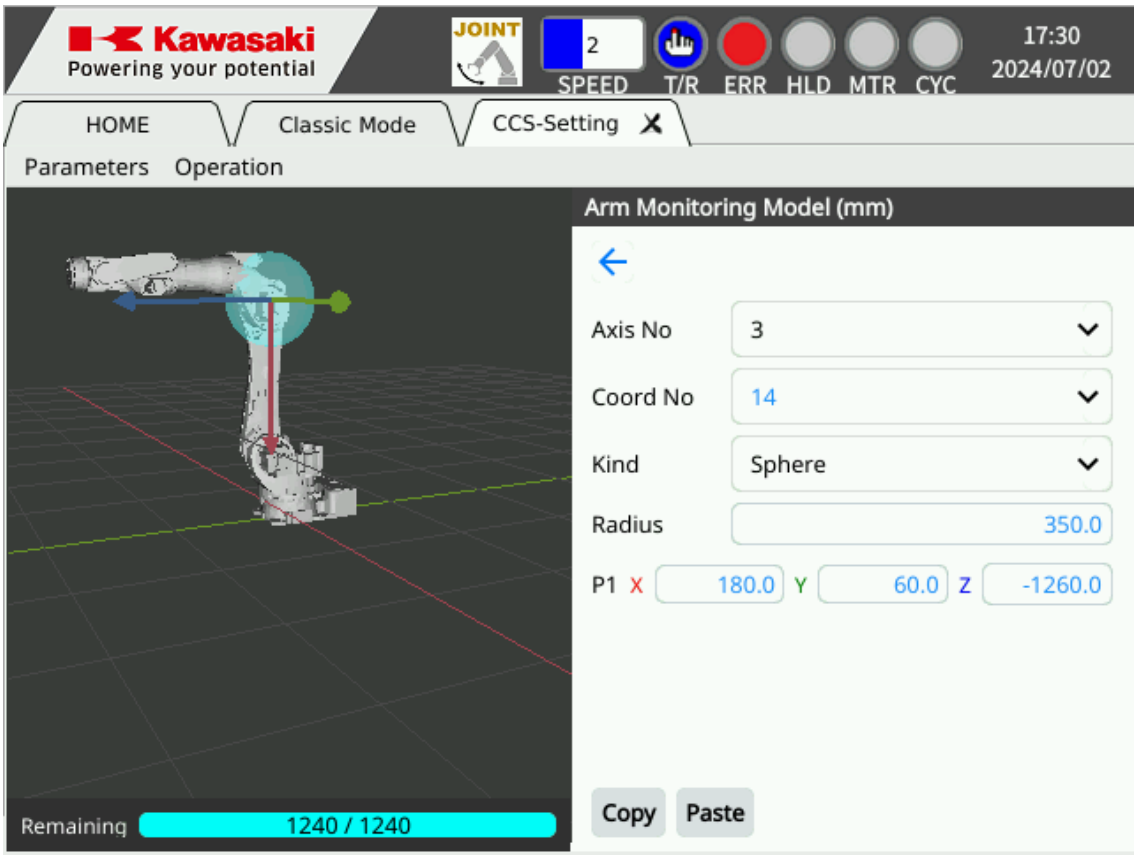
The monitored model is comprised of spheres and capsules (cylinders with a hemisphere on both ends) and cuboids, and can be set on each joint of the arm and on the tool.



1-1. Monitoring Area Arm Model Setting

Configure the settings for the monitored model set on the arm. Settings can be configured by selecting [Monitoring Area Arm] under [Area Monitoring Function] under [Monitoring settings] from the setting application menu.


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2
SPEED
T/R
ERR
HLD
MTR
CYC
18:13
2024/07/11
HOME
Classic Mode
CCS-Setting
Parameters
Operation
Arm Monitoring Model (mm)
Spec
User Setting
Maker Setting
User Setting
Monitoring Model
1
Visible
Coord No
Setting
Copy All Maker To User
Update
Cancel
Remaining
1240 / 1240


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JOINT
2
SPEED
T/R
ERR
HLD
MTR
CYC
17:30
2024/07/02
HOME
Classic Mode
CCS-Setting
Parameters
Operation
Arm Monitoring Model (mm)
Axis No
3
Coord No
14
Kind
Sphere
Radius
350.0
P1 X
180.0
Y
60.0
Z
-1260.0
Copy
Paste
Remaining
1240 / 1240

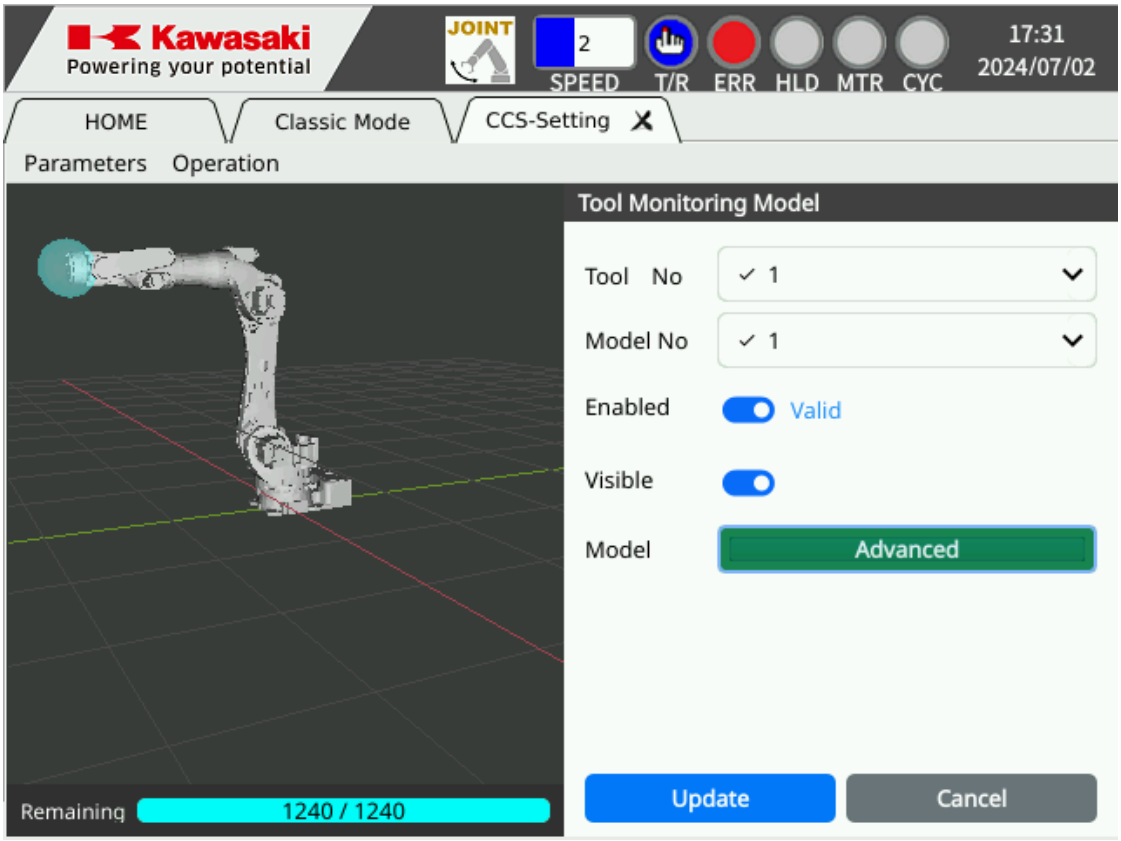
There are Maker settings and User settings for the monitored model. You can select which setting to use in the [Spec].
The default manufacturer (Maker) settings are set to a maximum of 20 spheres and capsules. The Maker settings cannot be changed, but the monitored model display and settings can be checked.
A maximum of 20 spheres and capsules can be set as User settings. In the case of spheres and coordinate numbers connected to joint numbers, set sphere center coordinates, and in the case of capsules, set the radius and coordinates for both ends of the line segment at the center of the capsule.
Monitoring models can be copied and pasted by selecting the <copy> button for the monitoring model you want to copy and selecting the <paste> button for the paste destination.

⚠ CAUTION

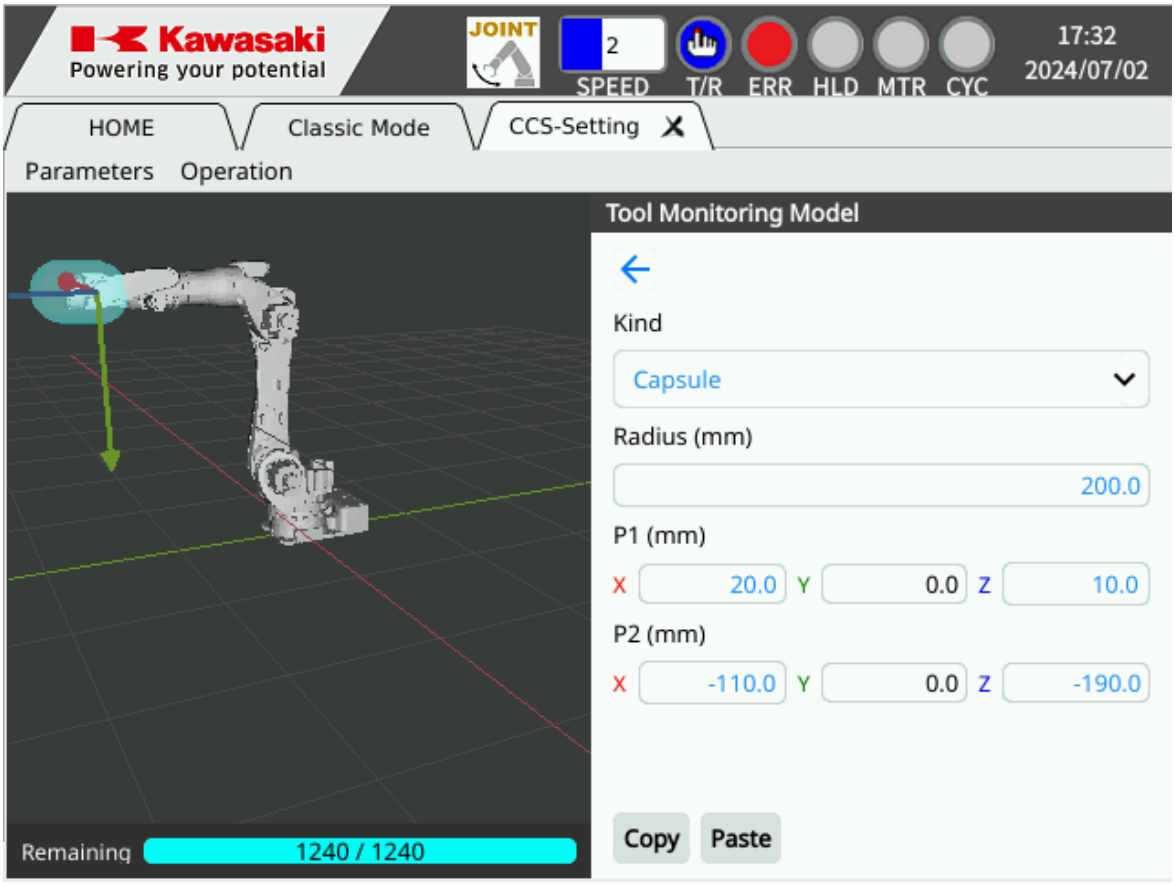
When there is a device attached to the arm, it is recommended to use the user settings of the arm area monitoring sphere/capsule settings as a monitoring target.

1-2. Settings for the Tool Area Monitoring Model

Configures the settings for the monitored model set on the tool. Settings can be configured by selecting [Tool Monitoring Area] under [Area Monitoring Function] under [Monitoring settings] from the setting application menu.
A maximum of 20 monitored models can be set for each of the 32 tools. Press the Set button of the model and input detailed settings on the settings screen for each model.



In the case of spheres, set sphere center coordinates, in the case of capsules, set the radius and coordinates for both ends of the line segment at the center of the capsule, and in the case of the cuboid, set the center coordinates and the width in each direction.



2. Area Setting

[Area definition method]

Each area is defined by

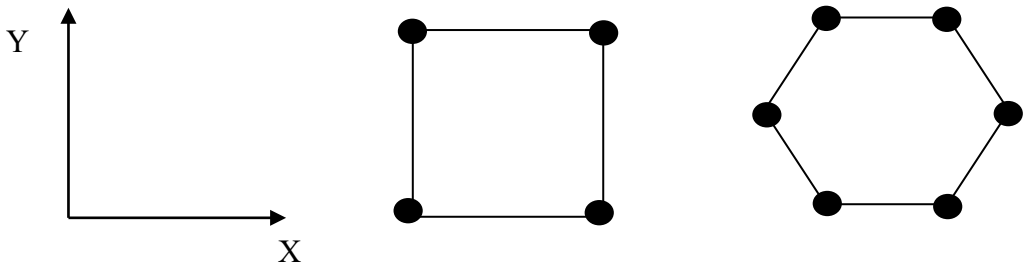
1. A polygon viewed from the top
2. Vertical Height Limit

1. A polygon viewed from the top

Define a polygon as shown in the example below, with points in XY coordinates

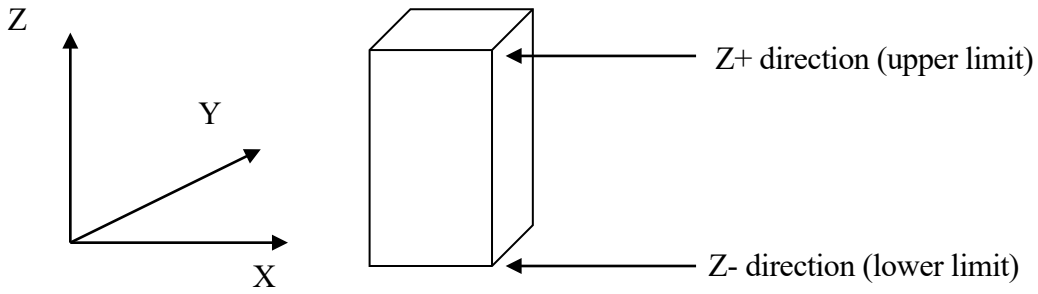
Example 1: Square (defined by 4 points)

Example 2: Hexagon (defined by 6 points)



2. Vertical Height Limit

Specifies the lower and upper limit of the polygonal pillar



[NOTE]

The XYZ coordinate system relative to the setting area is the same as the robot's coordinate system.

[Notes when defining the polygon]

When defining a polygon viewed from the top, be aware of the following 2 points.

1. Each point is set counterclockwise.
2. A polygon that is not a convex polygon cannot be set.

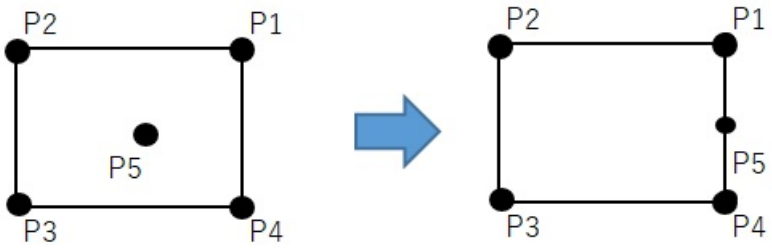
1. Each point is set counterclockwise.

When increasing the number of vertices of a polygon shape, setting the vertex position using the current location acquisition function, or manually moving vertices, the order of vertices may be clockwise. If that is the case, press the <Correct Vertices> button or perform an update to have the setting application automatically sort the vertices.

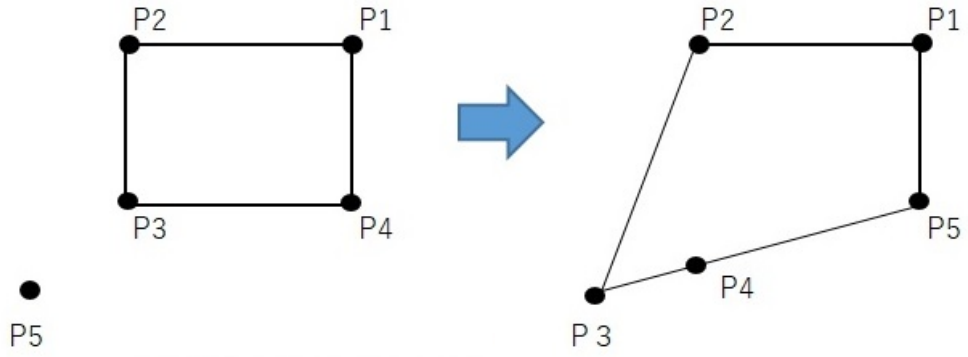
2. A polygon that is not a convex polygon cannot be set.

When increasing the number of vertices of a polygon shape, setting the vertex position using the current location acquisition function, or manually moving vertices, the vertices may form a shape that is not a convex polygon. If that is the case, press the <Correct Vertices> button or perform an update to have the setting application automatically adjust the vertex position to between two side vertices.

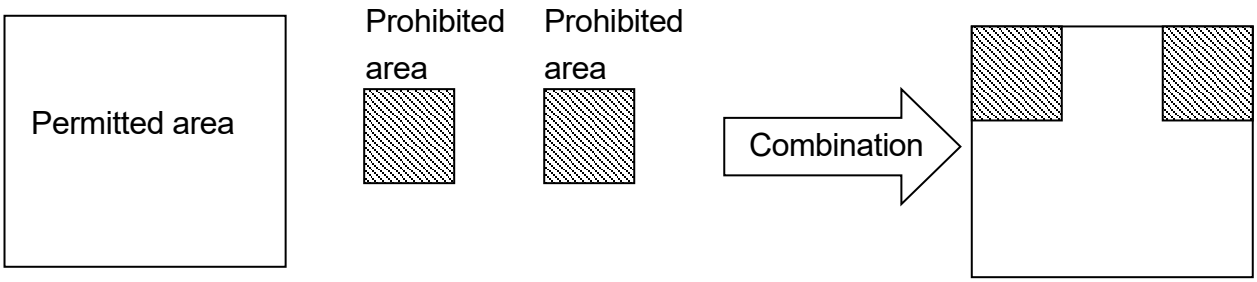
Example 1: When the vertex P5 is set inside the square, it is moved automatically to between P1 and P4.



Example 2: When the vertex P5 is set outside of the square, the vertex P4 is moved between P3 and P5 after automatic sorting counterclockwise.



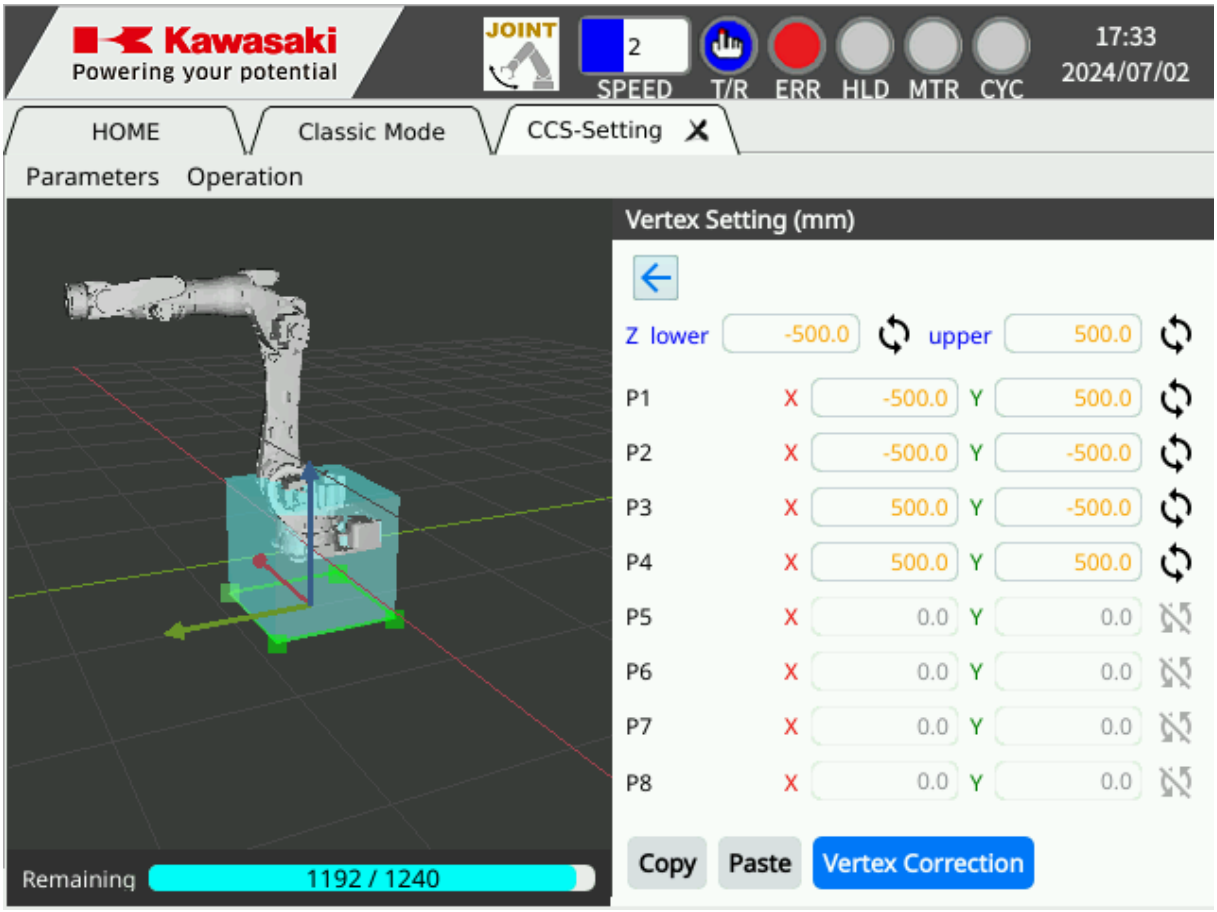
Also, a shape that is not a convex polygon is realized by combining multiple areas as follows.



Area Setting

The area can be set by selecting [Area Setting] under [Area Monitoring Function] under [Monitoring settings] from the setting application menu.

For the area of each of the 16 sets, select enable/disable, whether to display in view, whether it is a permitted area or prohibited area, the number of vertices, and configure the vertex settings and the stop settings.



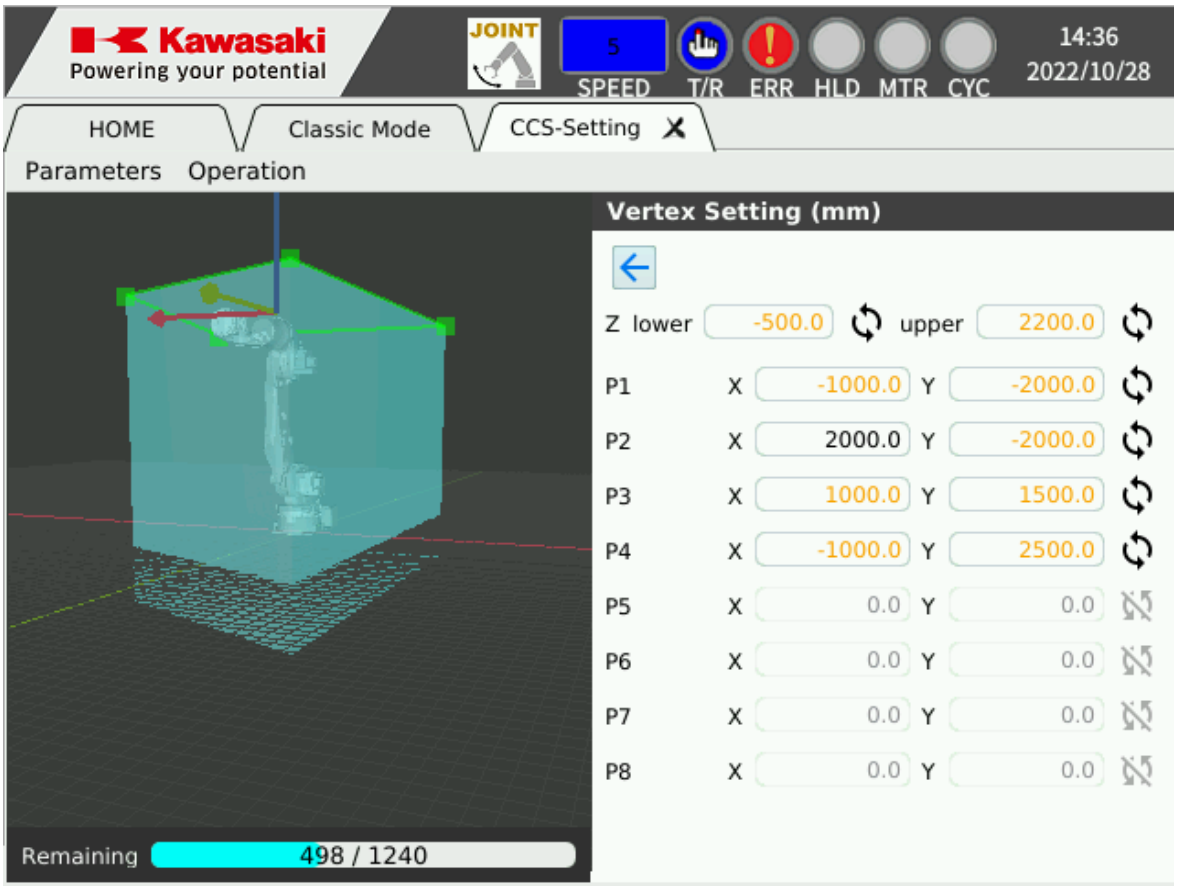
Transition to the Vertex Setting screen by pressing the <Setting> button of Vertex Setting. With the current location acquisition function, it is possible to fetch position data for robot flange points to support when inputting the spatial position coordinate values. When the



icon in the area vertex position for P1 to P8 is pressed, the X,Y values from the robot position data are reflected on the screen. When the Z maximum/minimum

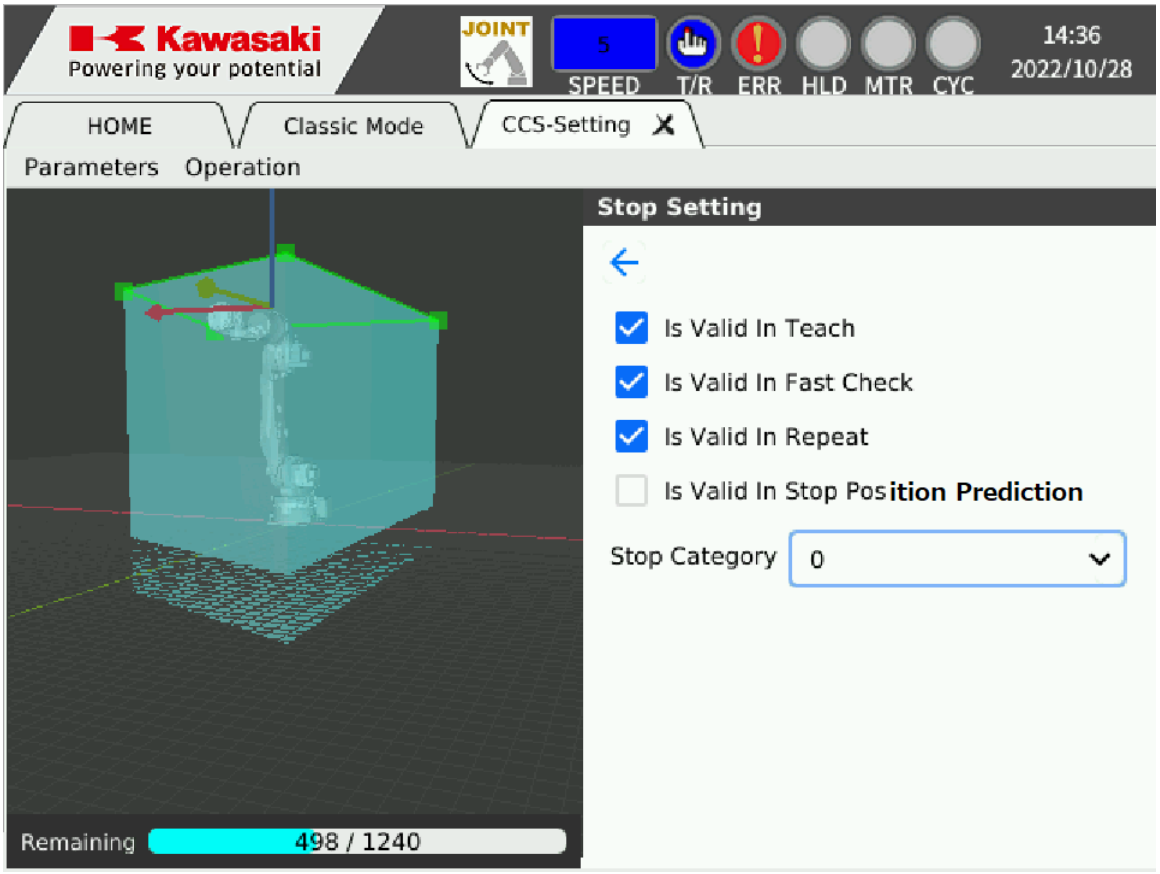


icon is pressed, the Z values from the robot position data are reflected on the screen. Monitoring models can be copied and pasted. Select the <Copy> button for the monitoring model you want to copy and select the <Paste> button for the paste destination.


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SPEED
T/R
ERR
HLD
MTR
CYC
14:36
2022/10/28
HOME
Classic Mode
CCS-Setting
Parameters
Operation
Vertex Setting (mm)
Z lower -500.0 upper 2200.0
P1 X -1000.0 Y -2000.0
P2 X 2000.0 Y -2000.0
P3 X 1000.0 Y 1500.0
P4 X -1000.0 Y 2500.0
P5 X 0.0 Y 0.0
P6 X 0.0 Y 0.0
P7 X 0.0 Y 0.0
P8 X 0.0 Y 0.0
Remaining 498 / 1240

Stop Setting

Transition to the stop settings screen by pressing the <Setting> button of Stop Setting. It is possible to set whether to stop when in teach mode, whether to stop when in fast check mode, whether to stop when in repeat mode, whether to enable the stop position prediction function, and also to set the stop category. Stop position prediction can only be enabled when the stop category is 0.



When setting whether to enable stop for each mode, if you want to the robot to move and work freely during teach mode, for example, uncheck the checkbox for [Valid In Teach Mode] to set to disable.

By switching between "Valid" and "Invalid" (unchecked) of the stop position prediction function, the motion changes as follows.

[When checked]

CoreCubic-S predicts the distance until the robot stops based on the current speed it is traveling. When it is determined that the robot will go beyond the motion permitted area if it continues to move at the current speed, power to the robot is immediately shut off.

The area monitoring function stop position prediction function does not guarantee that the robot will not go beyond the set area range. The stop position may be beyond the area range if the robot fails or because of the robot operating conditions, etc.

[When unchecked]

CoreCubic-S determines whether the current values for the robot are within the area or outside of the area and if they are outside of the area, power to the robot is immediately shut off.

During high-speed operation, because power to the robot is shut off at the point when the robot goes out of the area, the amount of excess until the robot actually stops is large.

3. Limits on the number of monitoring area and models that can be configured

There is a limit to the number of areas and monitored models that can be configured. The table below shows the consumption of each monitored model per space.

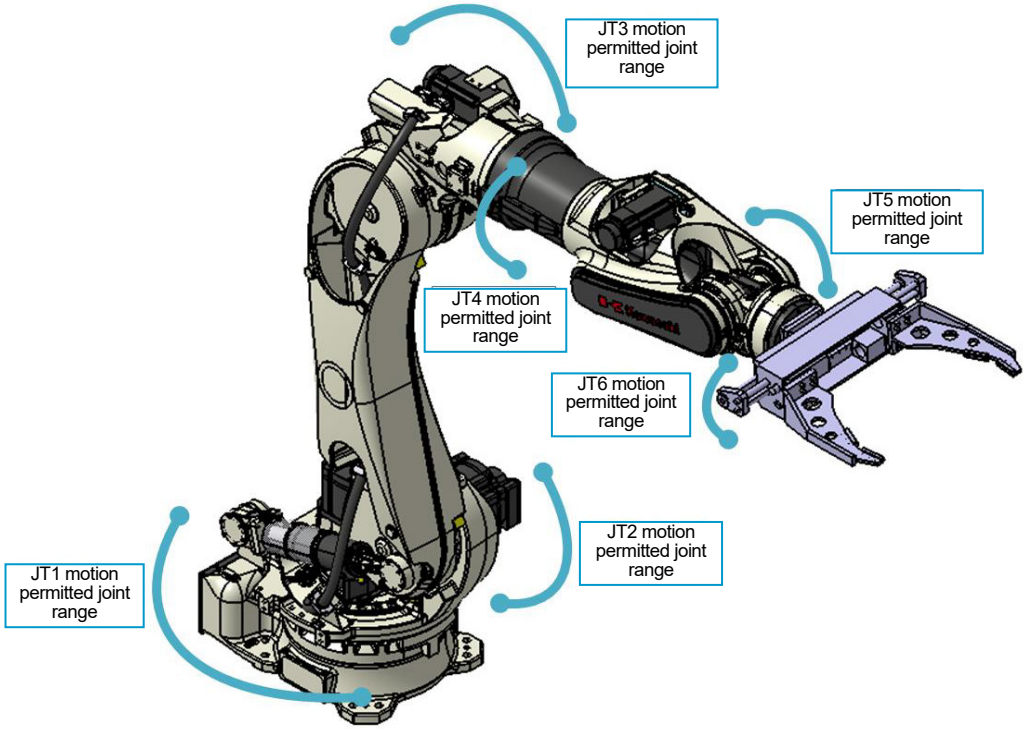
	Spheres	Capsules	Cuboids
Motion Permitted area	3	6	63
Motion Prohibited area	3	8	115

For example, if 1 motion permitted area and 2 motion prohibited area are set and being valid, adding or enabling 1 capsule on the arm or tool consumes
6 (capsules) × 1 (motion permitted area) + 8 (capsules) × 2 (motion prohibited area) = 22.
Adding or enabling the area consumes the sum of the monitoring model on the arm and the tool.
Check the available remaining amount displayed on each setting screen before setting. If the remaining amount is insufficient, an error occurs and the setting cannot be performed. Since cuboids consume more than spheres and capsules, the use of spheres and capsules is recommended.

11.1.5 Joint Monitoring Function

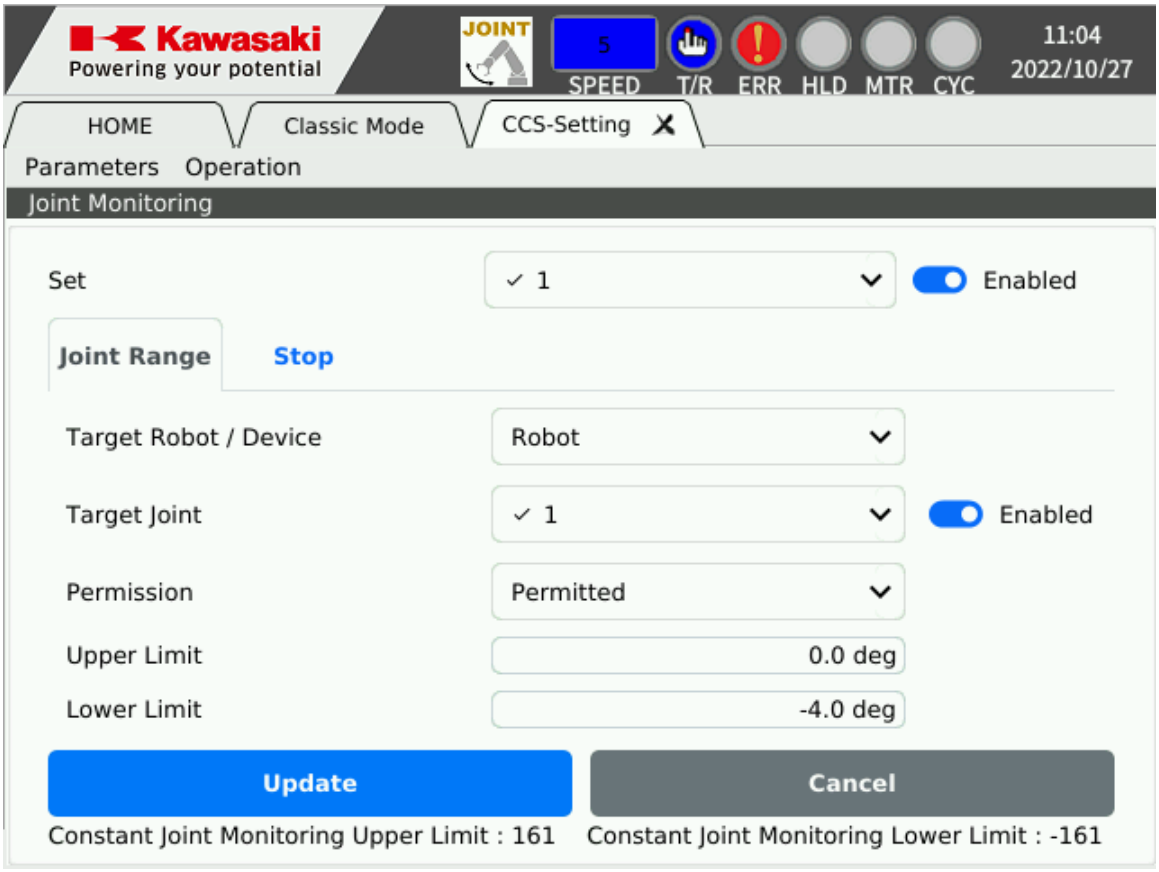
[Selective joint monitoring is an option.]

This function performs protective stop of the robot/device when the angle or position of each joint of the robot/device is outside of the motion permitted joint range. Settings can be configured for 18 sets by selecting [Axis Monitoring Function] under [Monitoring settings] from the menu in the setting application. The range that is continuously monitored is set by the default manufacturer settings and this range cannot be changed.



1. Joint Range Settings

Configure the joint range settings for each joint of the robot/device for each set.



Set

Specify the set being configured. By switching "Enabled" ON or OFF, you can select whether or not to enable monitoring of that set. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Target Robot/Device

Specify the target for monitoring. Only one target robot/device per set can be enabled. If this is changed, the target robot/device prior to the change will be removed from the monitoring targets.

Target Joint

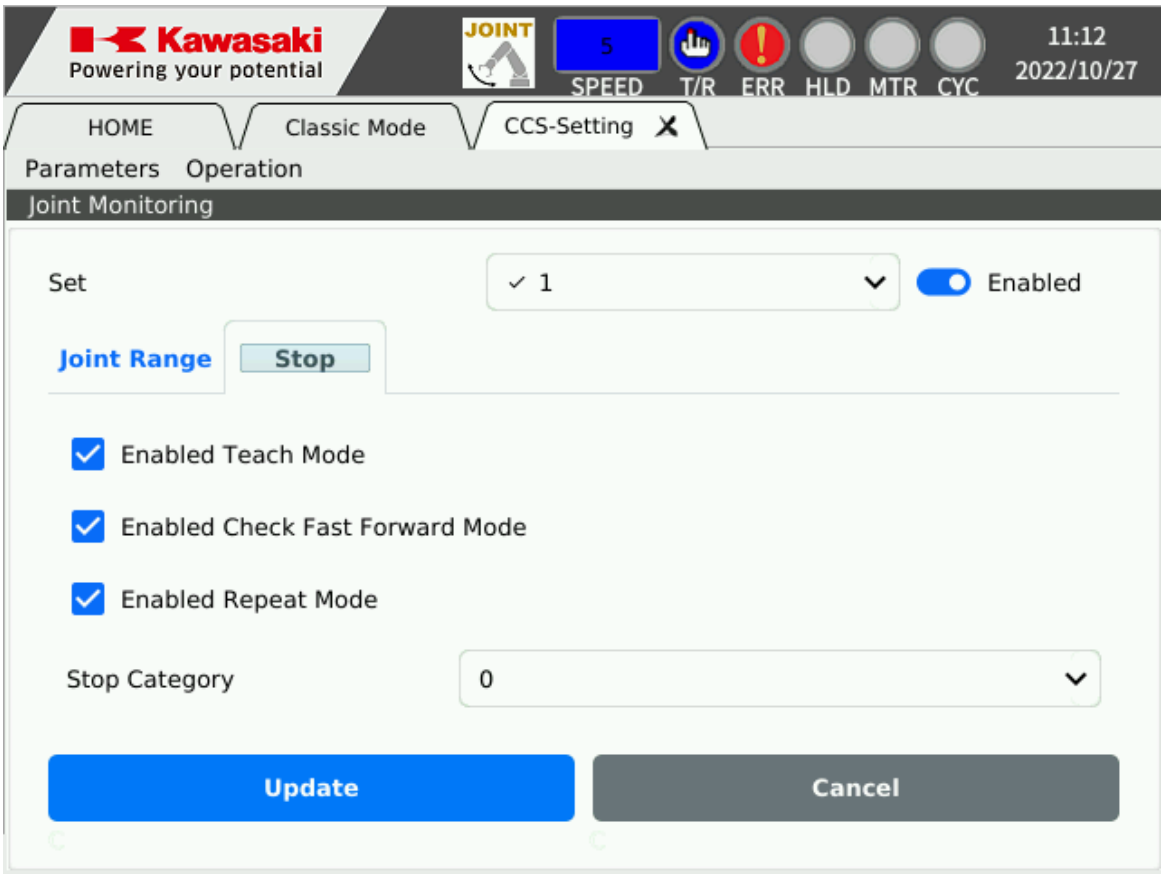
Enabled/disabled monitoring for the joints included in the target set by the Target Robot/Device. By setting "Enabled" to ON or OFF, you can select whether to enable monitoring for each joint. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Permission, Upper Limit and Lower Limit

Configure joint range settings and whether the range is motion permitted or prohibited.

2. Stop Setting

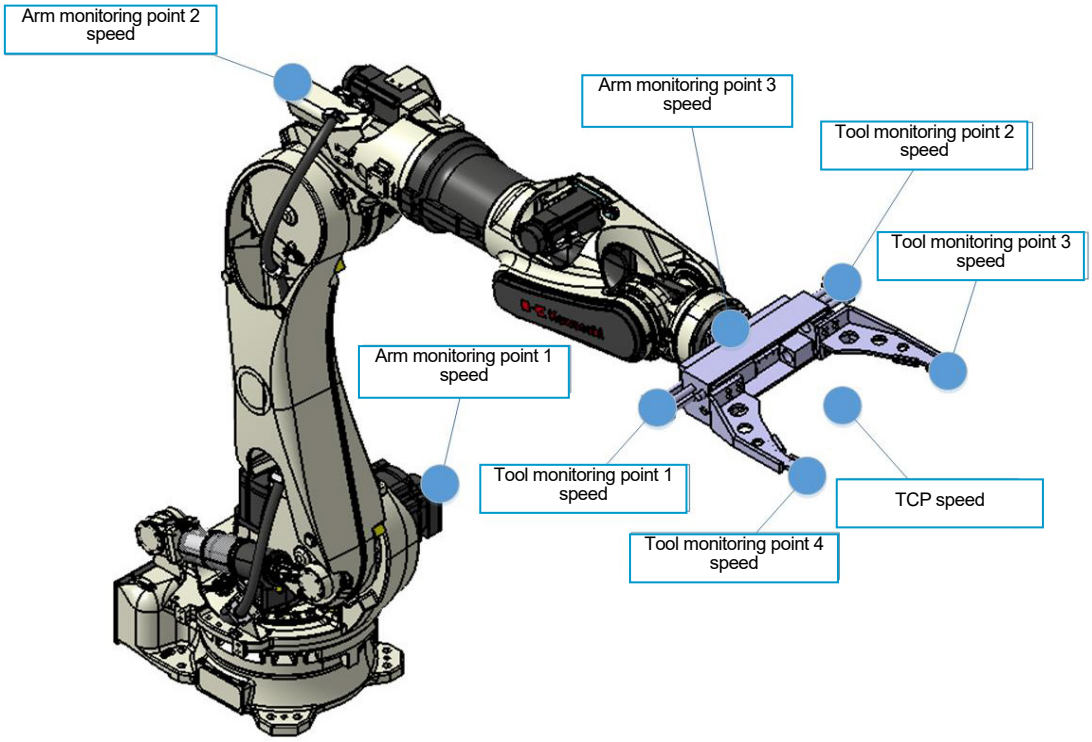
Set the stop category and whether to perform protective stop for teach mode, fast check mode and repeat mode for each set. For example, if you want the robot to move and work freely during teach mode, set to disable.



11.1.6 Speed Monitoring Function

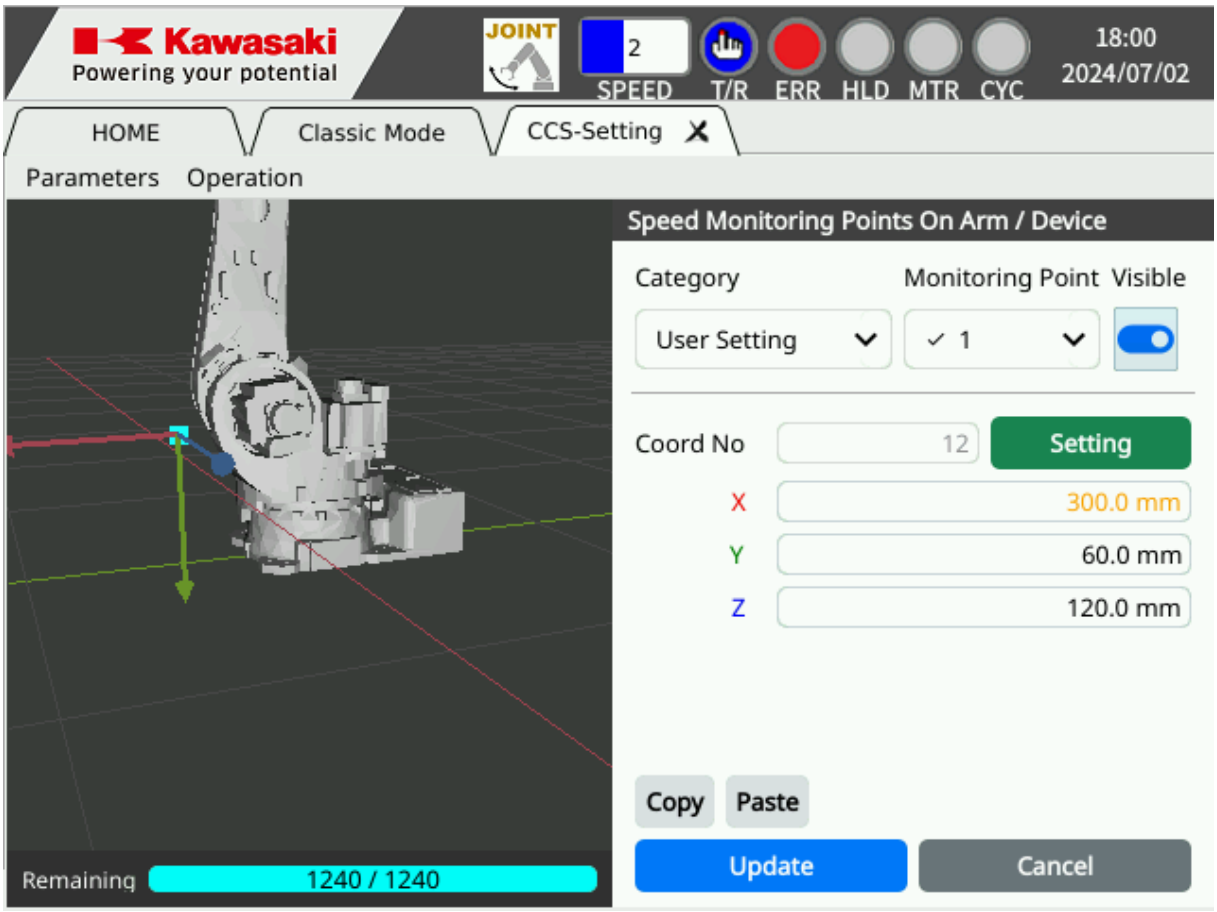
[User speed monitoring function is an option.]

This function performs protective stop of the robot/device when the speed of each monitoring point or joint of the robot/device exceeds the motion monitoring speed.



1. Arm/Device Speed Monitoring Points Settings

Configure the settings for the monitoring points set for the robot. Settings can be configured by selecting [Speed Monitoring Points On Arm/Device] under [Speed Monitoring Function] under [Monitoring settings] from the menu in the setting application.

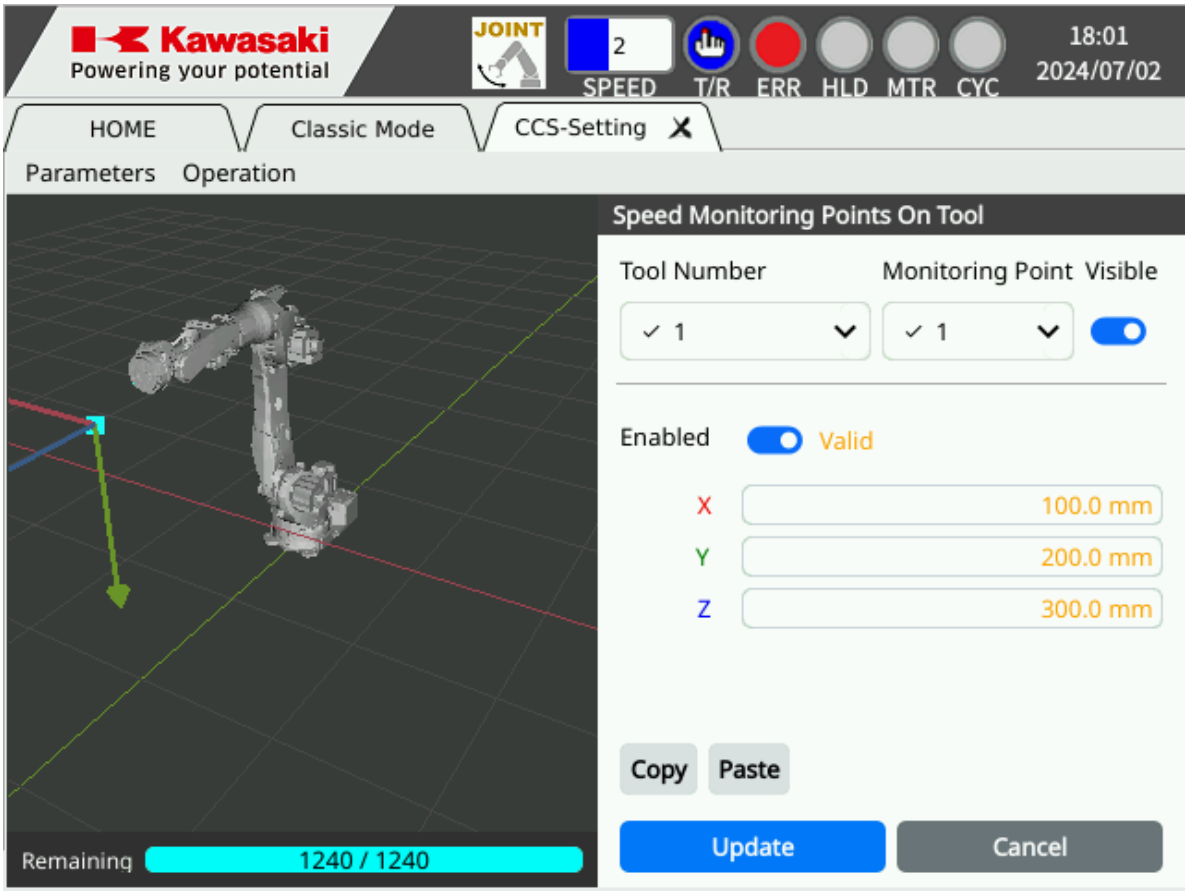


There are manufacturer settings and user settings for the monitoring points.
The default manufacturer settings are set to a maximum of 20 points. The manufacturer settings cannot be changed, but the monitoring points display and settings can be checked.
In addition to the manufacturer settings, a maximum of 20 points can be set as user settings. Set the coordinate numbers connected to joint numbers and the XYZ coordinates. Monitoring points can be disabled by setting disable for the coordinate numbers.
Monitoring points can be copied and pasted by selecting the <copy> button for the monitoring point you want to copy and selecting the <paste> button for the paste destination.

2. Tool Speed Monitoring Point Settings

Configure the settings for the monitoring points set for the tool. Settings can be configured by selecting [Speed Monitoring Points On Tool] under [Speed Monitoring Function] under [Monitoring settings] from the menu in the setting application.

A maximum of 20 monitoring points can be set as XYZ coordinates for each of the 32 tools. Monitoring points can be copied and pasted by selecting the <copy> button for the monitoring point you want to copy and selecting the <paste> button for the paste destination.

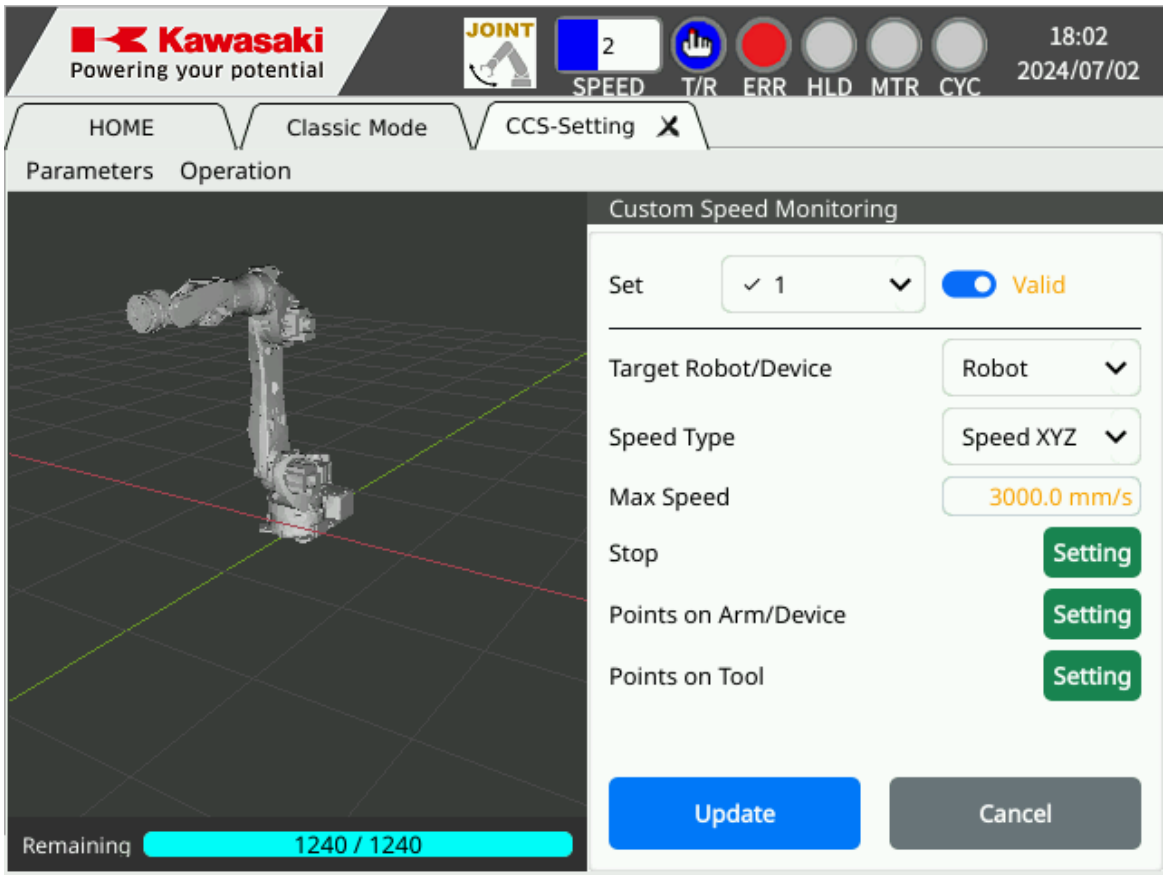


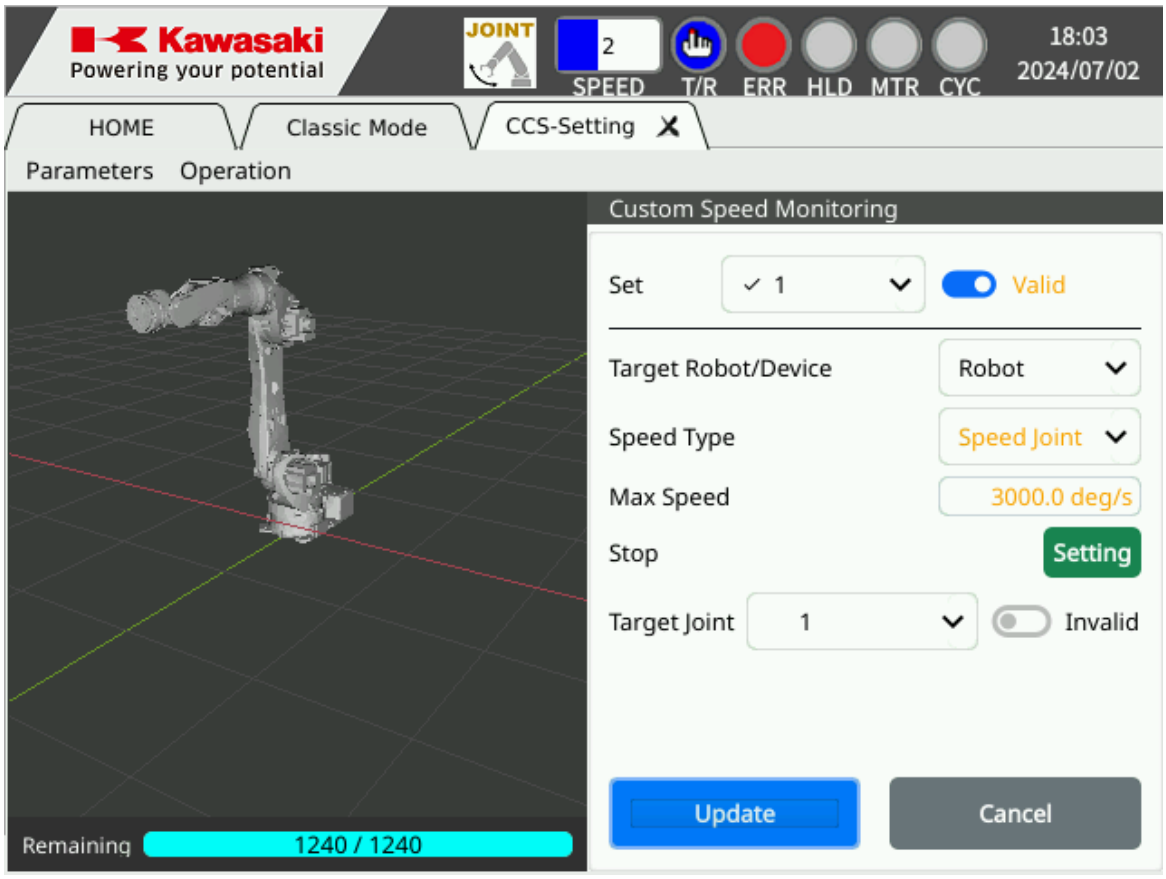
3. User Speed Monitoring

The monitoring speed and stop settings for each monitoring point and joint can be set in 18 sets. Settings can be configured by selecting [User Speed Monitoring] under [Speed Monitoring Function] under [Monitoring settings] from the menu in the setting application.

3-1. Speed Settings

Set the motion monitoring speed for the monitoring points and joints for each set.


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MTR
CYC
18:02
2024/07/02
HOME
Classic Mode
CCS-Setting
Parameters
Operation
Custom Speed Monitoring
Set
1
Valid
Target Robot/Device
Robot
Speed Type
Speed XYZ
Max Speed
3000.0 mm/s
Stop
Setting
Points on Arm/Device
Setting
Points on Tool
Setting
Update
Cancel
Remaining
1240 / 1240


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HLD
MTR
CYC
18:03
2024/07/02
HOME
Classic Mode
CCS-Setting
Parameters
Operation
Custom Speed Monitoring
Set
1
Valid
Target Robot/Device
Robot
Speed Type
Speed Joint
Max Speed
3000.0 deg/s
Stop
Setting
Target Joint
1
Invalid
Update
Cancel
Remaining
1240 / 1240

Set

Specify the set being configured. By switching "Enabled" ON or OFF, you can select whether or not to enable monitoring of that set. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Target Robot/Device

Set the target robot or device for monitoring. Only one target robot/device per set can be enabled. If this is changed, the target robot/device prior to the change will be removed from the monitoring targets.

Speed Type

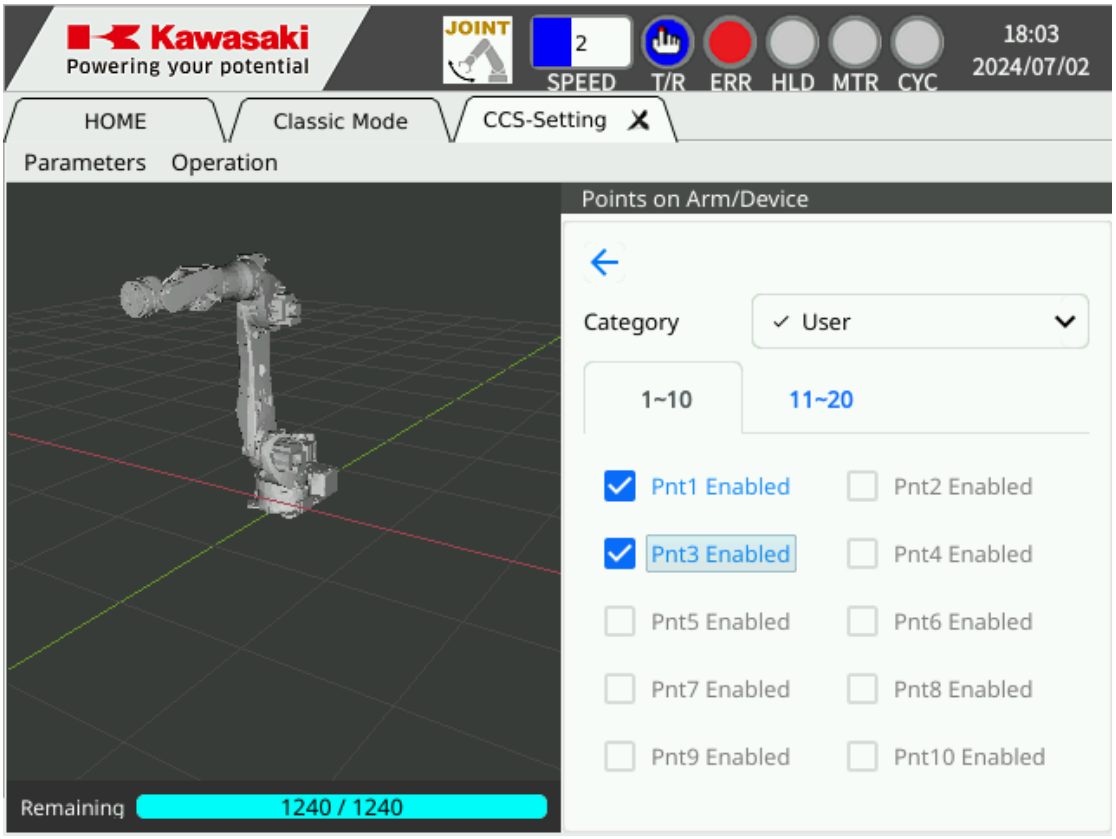
Select from XYZ combined speed, XY combined speed, Z orientation speed and joint speed for the type of speed to be monitored. The items that can be set differ depending on the type.

Upper Speed Limit

Set the upper limit for motion monitoring speed.

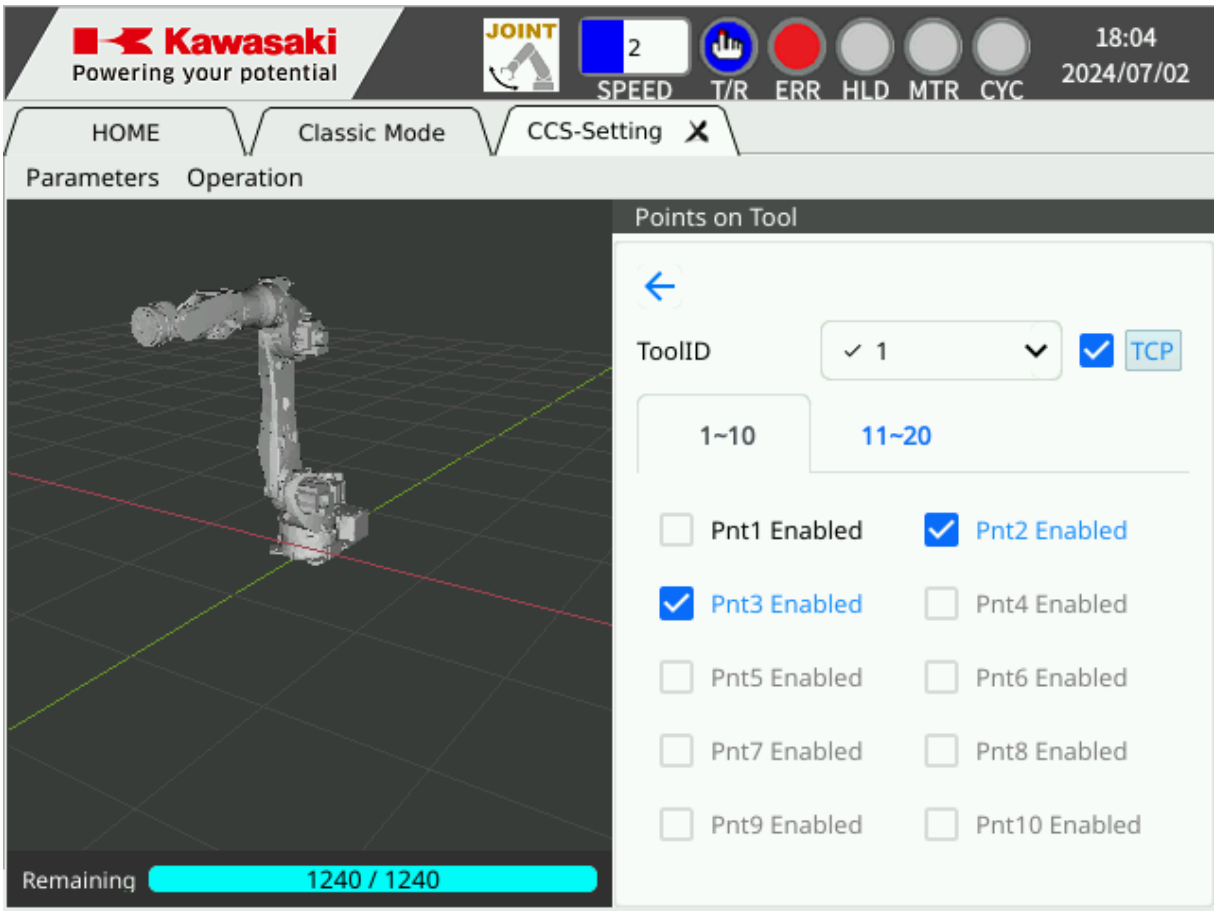
Points on Arm/Device

This can be set only when XYZ combined speed, XY combined speed or Z orientation speed are selected for the type of speed settings. Set whether to enable or disable monitoring at each Speed Monitoring Points on Arm/Device.



Tool Speed Monitoring Point Enable/Disable

This can be set when XYZ combined speed, XY combined speed or Z orientation speed are set for the type of speed settings. Set whether to enable or disable monitoring at each Speed Monitoring Points on Tool. TCP is monitored constantly.



WARNING

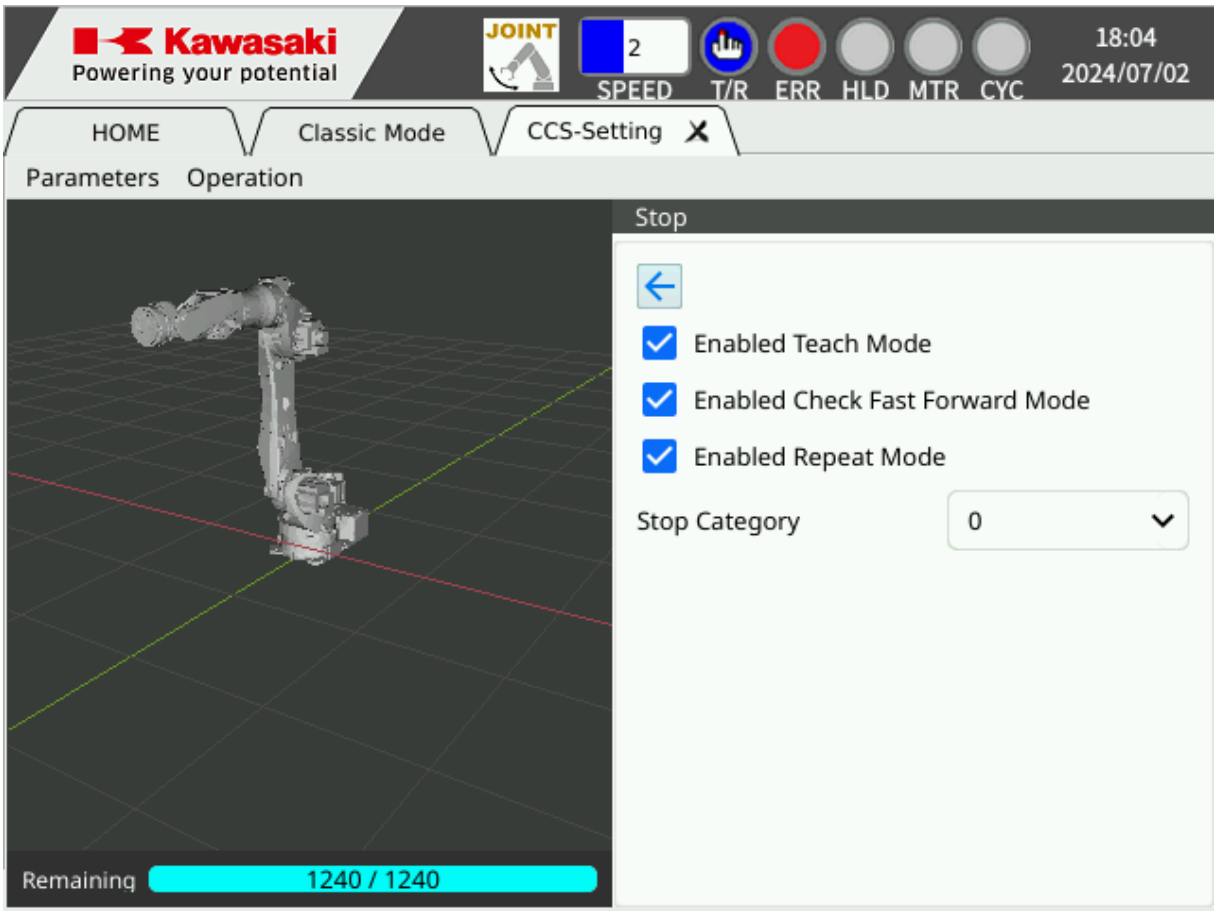
When the tool shape is large, speed monitoring is recommended not just for the TCP, but also for the tool end, etc. If monitoring is not set, the speed will increase for the tool end and this may be dangerous.

Target Joint

This can be set when joint speed is selected from the speed setting types. Set the joint number for monitoring. When this function is enabled, a ✓ mark will be displayed to the left of the number.

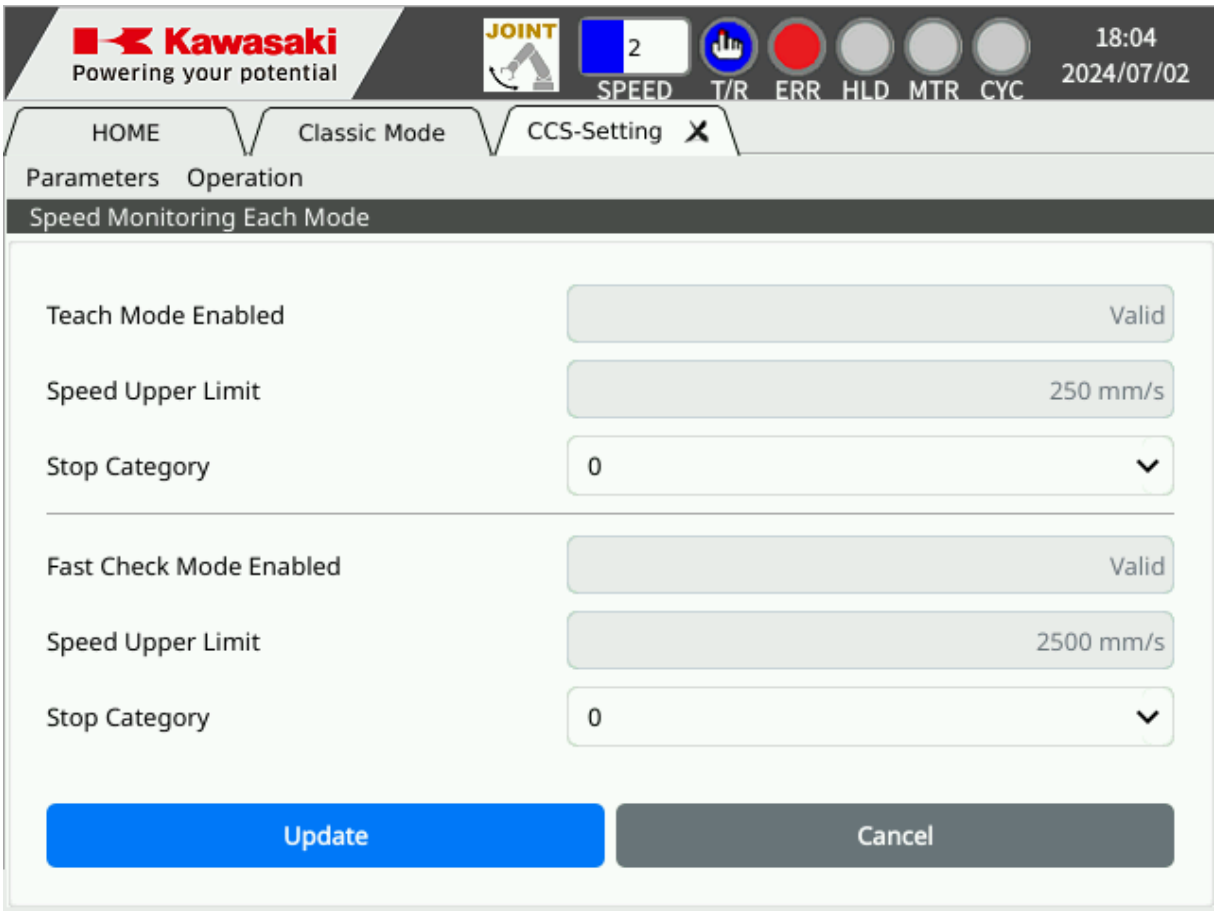
3-2. Stop Setting

Set the stop category and whether to perform protective stop for teach mode, fast check mode and repeat mode for each set. For example, when the user set speed is less than 250 mm/s and you want the robot to move freely in teach mode, set to disable protective stop.



4. Speed Monitoring Settings for Each Mode

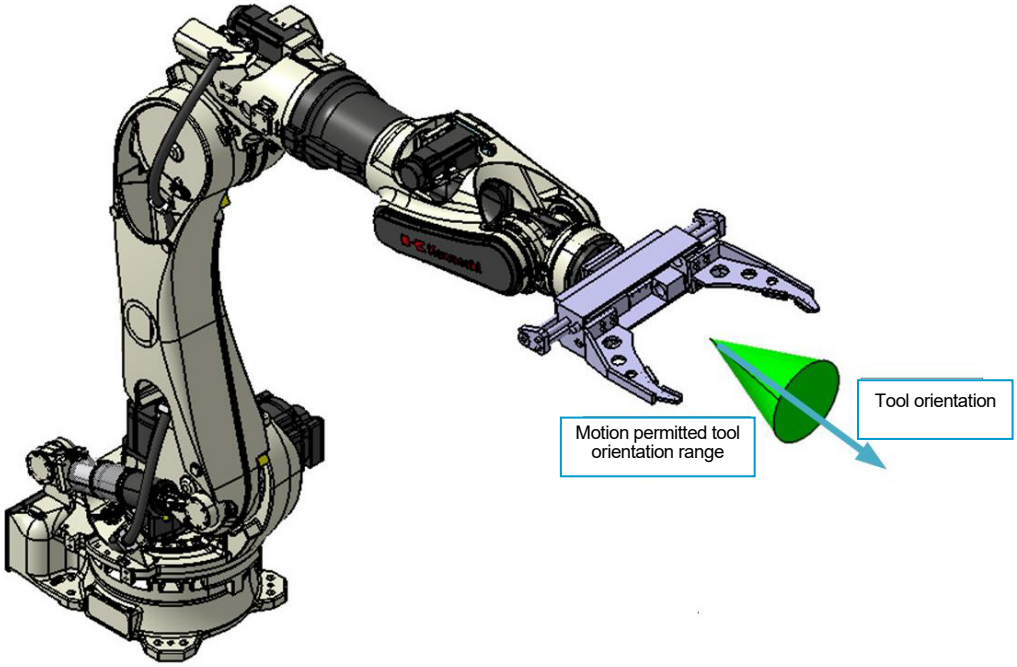
Set the stop category for the teach mode and fast check mode. Settings can be configured by selecting [Speed Monitoring Each Mode] under [Speed Monitoring Function] under [Monitoring settings] from the menu in the setting application.



11.1.7 Tool Orientation Monitoring Function

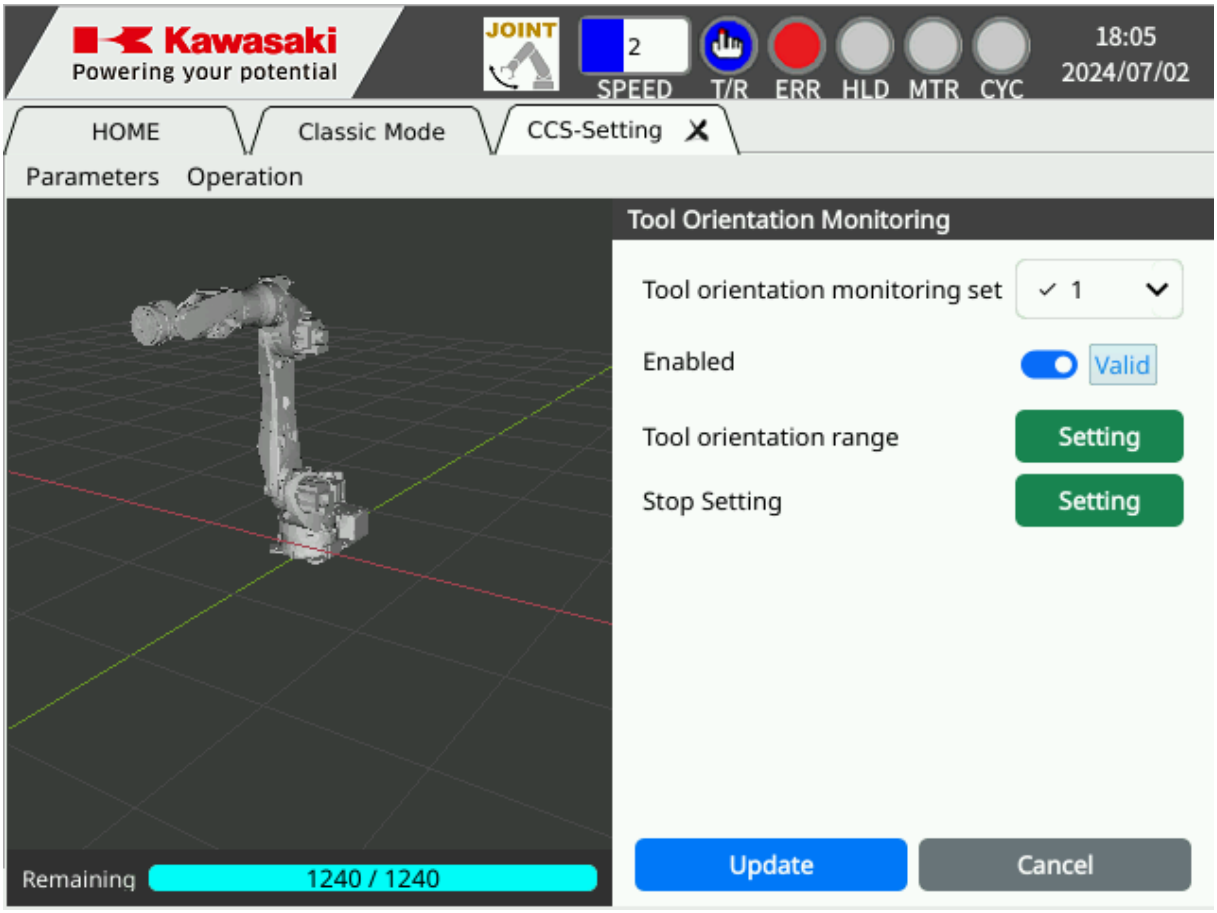
[Tool orientation monitoring function is an option.]

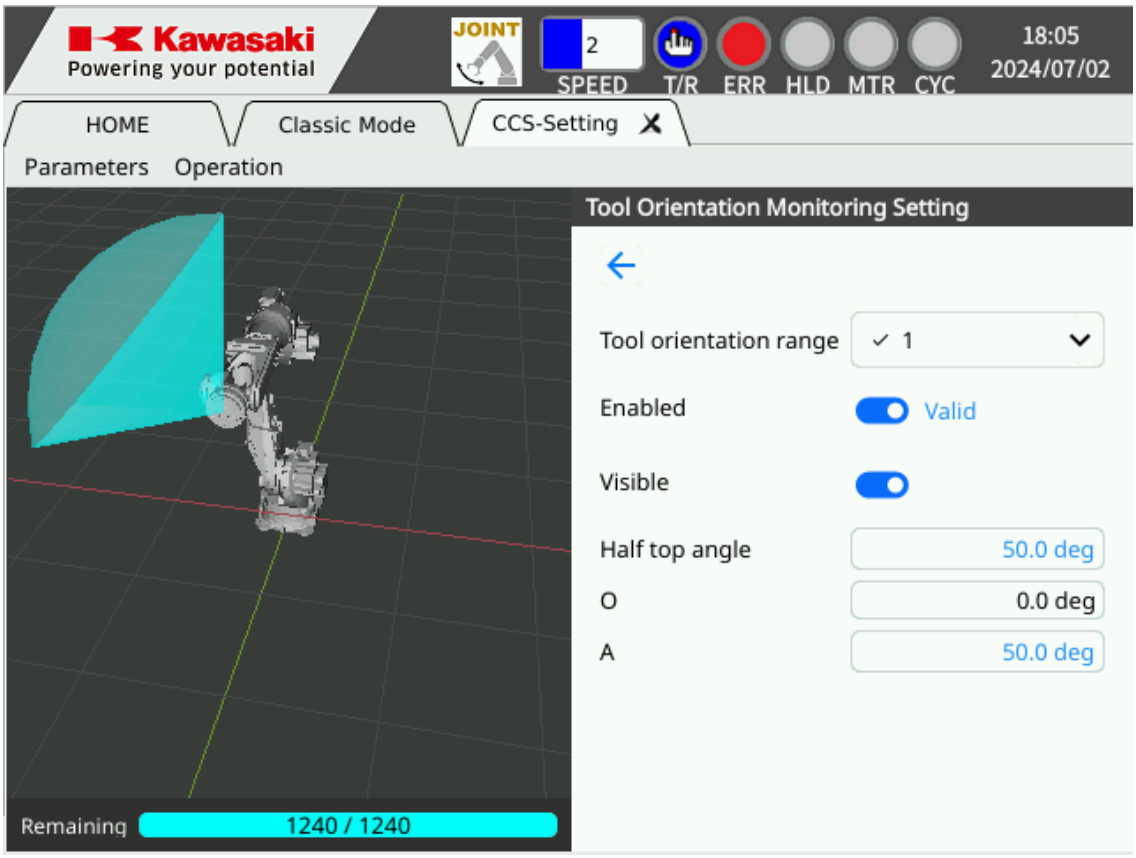
This function performs protective stop of the robot/device when the robot tool orientation is outside of the motion permitted tool orientation range. Settings can be configured for 8 sets by selecting [Tool Orientation Monitoring] under [Monitoring Settings] from the menu in the setting application.



1. Tool Orientation Range Setting

Set the tool orientation range for each set.





Tool orientation monitoring set

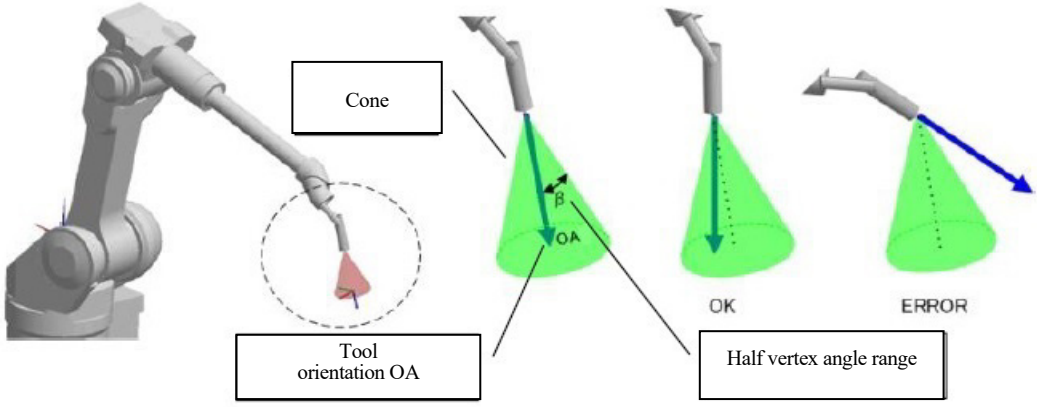
Specify the set being configured. By switching "Enabled" ON or OFF, you can select whether or not to enable monitoring of that set. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Tool orientation range

A motion permitted tool orientation range that combines a maximum of 5 cones can be set for a single set. By switching <Enabled> ON or OFF, you can select whether or not to enable monitoring of each cone. If tool orientation ranges 1 to 5 are all disabled, the tool orientation monitoring set is also disabled.

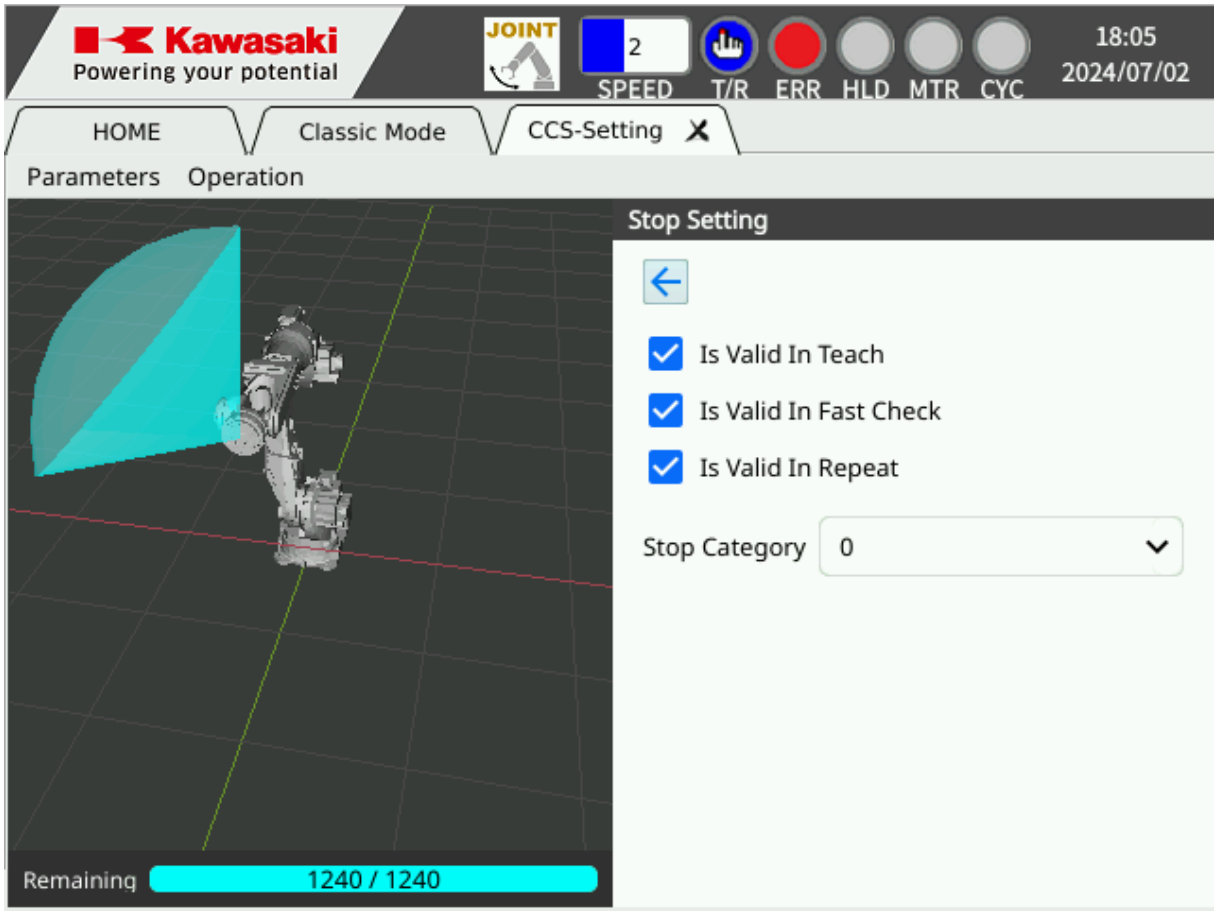
Half Apex Angle, O, A

Set the cone shape. As the OA values, move the robot's tool in the orientation you want to set, and input the OA value displayed by the monitor command WHERE7 (when there is a cooperative external joint, this command displays the current position from the location and position including data for this joint). A maximum of 5 cones can be set for a single set.



2. Stop Setting

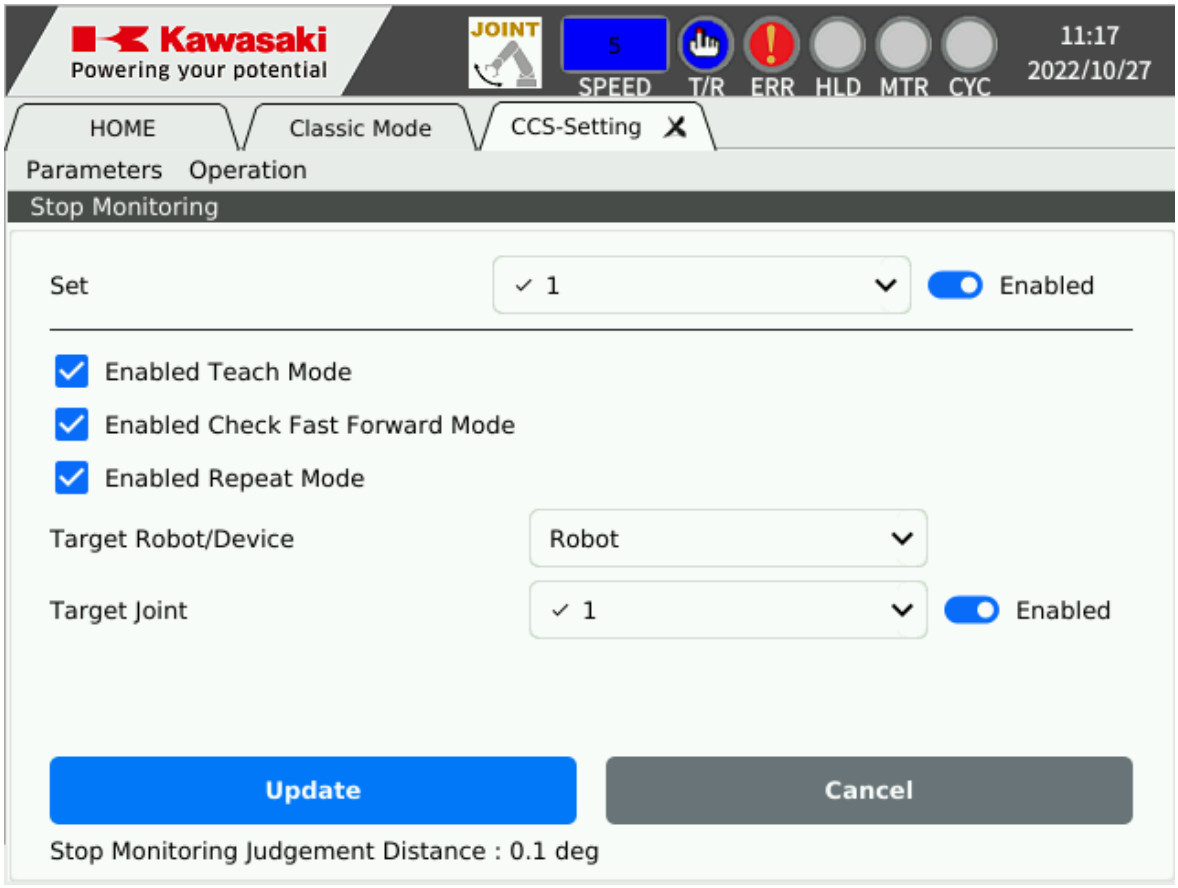
Set the stop category and whether to perform protective stop for teach mode, fast check mode and repeat mode for each set. For example, if you want the robot to move and work freely during teach mode, set to disable.



11.1.8 Stop Monitoring Function

[Stop monitoring function is an option.]

This function performs stop monitoring of the robot/device when the stop monitoring signal is input. Settings can be configured for 18 sets by selecting [Stop Monitoring] under [Monitoring Settings] from the menu in the setting application.



Set

Specify the set being configured. By switching "Enabled" ON or OFF, you can select whether or not to enable monitoring of that set. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Valid in Each Mode

Set whether to perform monitoring when in teach mode, fast check mode and repeat mode for each set. For example, when letting the robot move freely during teach mode, set to disable.

Target Robot/Device

Set the targets for monitoring. Only one target robot/device per set can be enabled. If this is changed, the target robot/device prior to the change will be removed from the monitoring targets.

Target Joint

"Enabled" or not monitoring for the joints included in the target set by the Target Robot/Device. By setting "Enabled" to ON or OFF, you can select whether to enable monitoring for each joint. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Stop Monitoring Judgment Distance

The stop monitoring function determines that an operation has occurred when the value set in the stop monitoring tag of the monitoring common settings is exceeded.

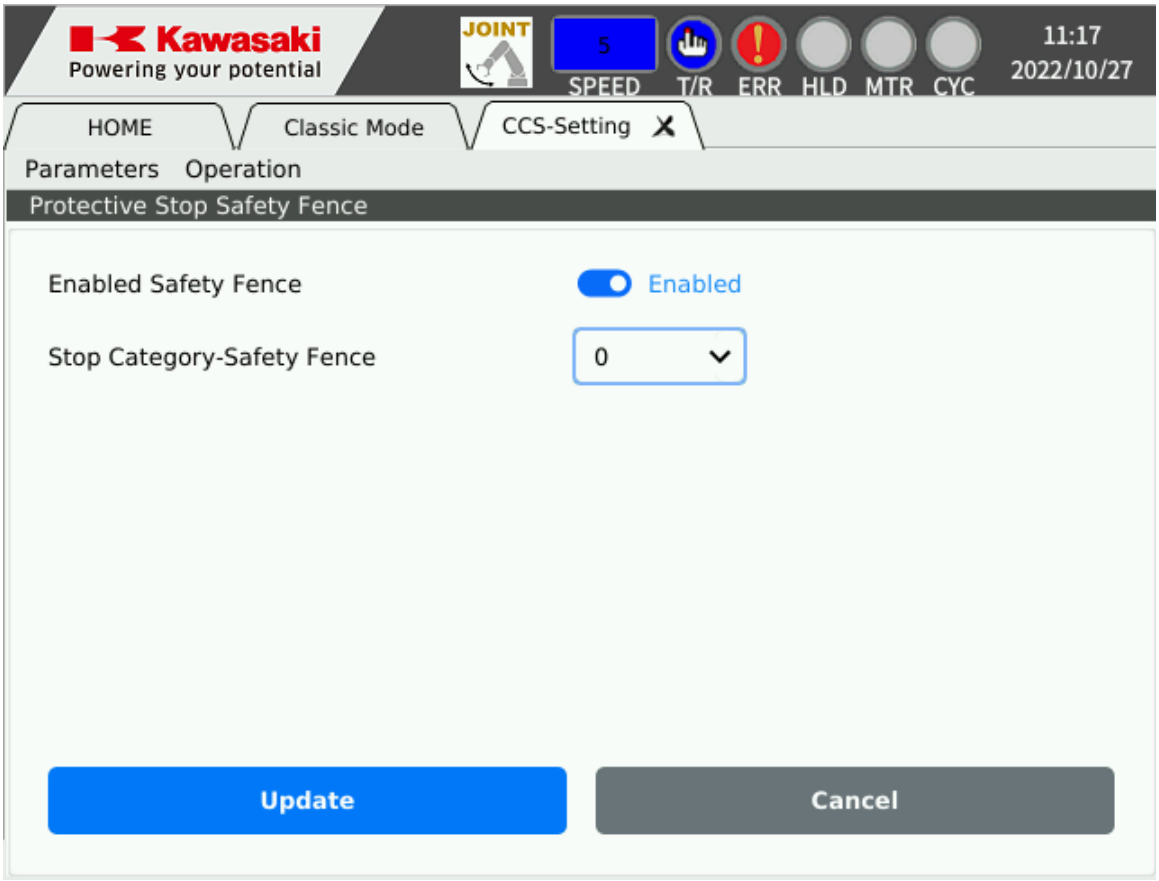
11.1.9 Protective Stop Function

[SW safety fence protective stop/user protective stop function is an option.]

This function performs protective stop of the robot/device when the protective stop signal is input from the fixed safety input, user safety input, network safety input, etc. Refer to Chapter 11.1.12 for detailed instructions on assigning functions to the various safety inputs and outputs.

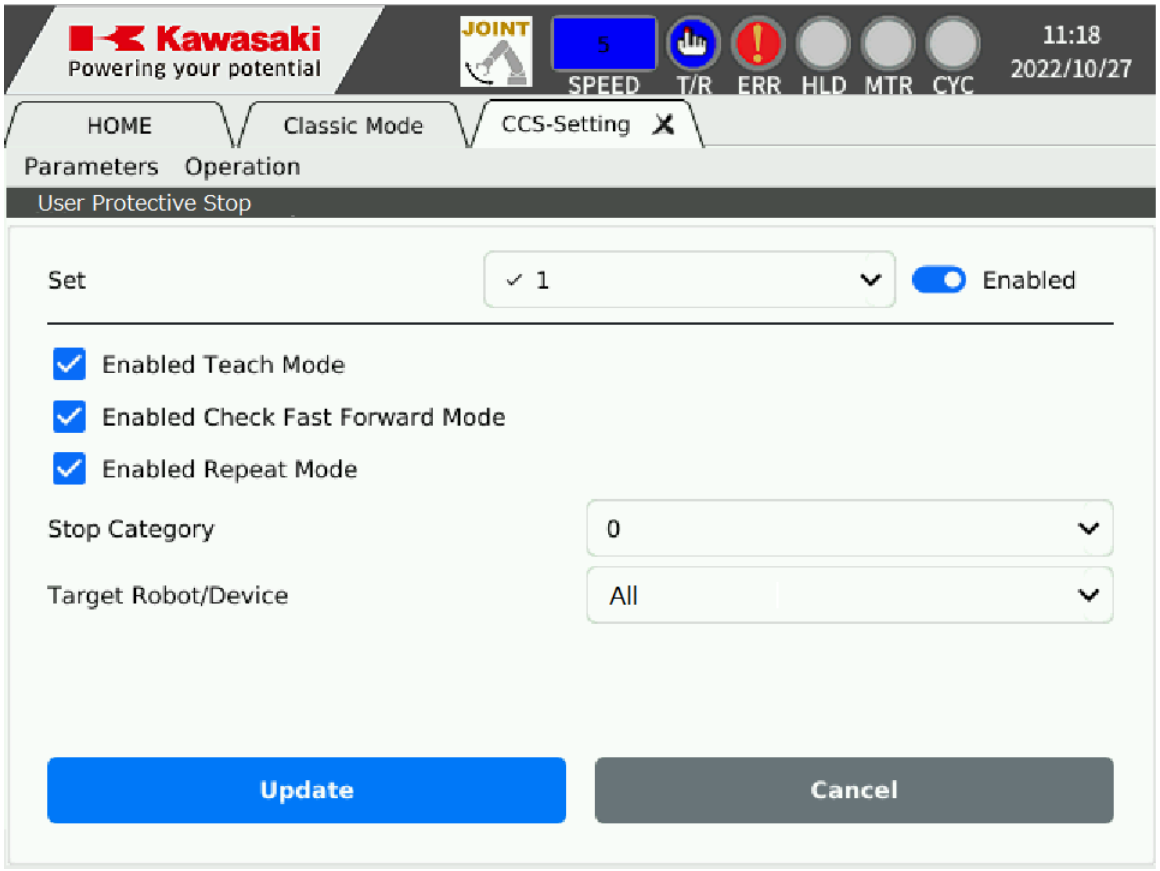
1. Protective Stop Safety Fence Setting

This setting performs protective stop when the safety fence opened, and enables only in repeat mode. Settings can be configured by selecting [Protective Stop Safety Fence] under [Protective Stop] under [Monitoring Setting] from the menu in the setting application. Enabled/disabled and Stop Category 0 or 1 of [Enabled Safety Fence] having the same function as "Safety Fence 1 Opened" of fixed safety input can be set.



2. User Protective Stop Settings

This setting performs protective stop when the user protective stop signal is input. Settings can be configured for 18 sets by selecting [User Protective Stop] under [Protective Stop] under [Monitoring Settings] from the menu in the setting application.



User Protective Stop Set

Specify the set being configured. By switching "Enable function" ON or OFF, you can select whether or not to enable protective stop for that set. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Valid/Invalid in Each Mode

Set whether to perform protective stop when in teach mode, fast check mode and repeat mode for each set. For example, if you want the robot to move and work freely during teach mode, set to disable.

Stop Category

Set the stop category for each set. 0, 1, 2 can be selected.

Target Robot/Device

Set the target to stop for each set. "All" can be selected.

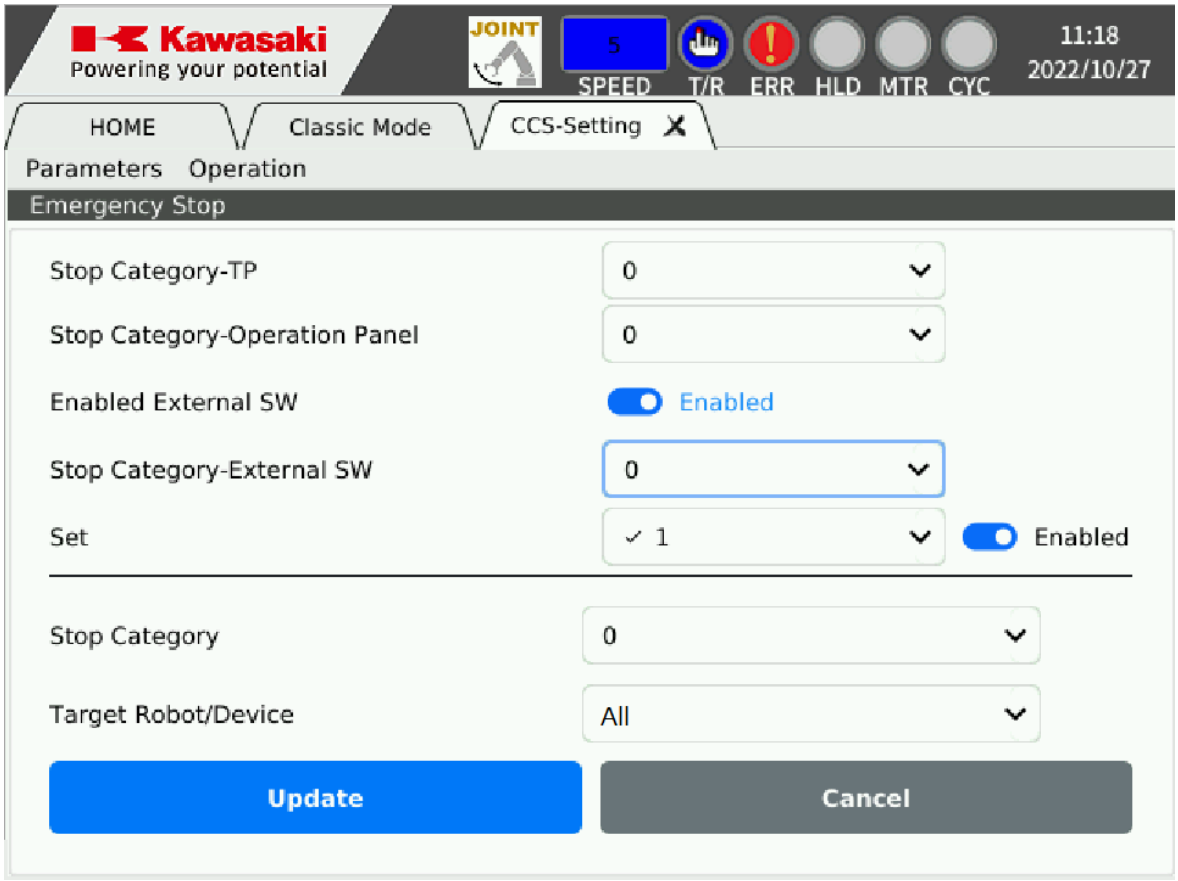
⚠ WARNING

When stop category 2 is selected with the protective stop function, the robot may start moving automatically after protective stop is canceled.

11.1.10 Emergency Stop Function

[SW external emergency stop/user emergency stop function is an option.]

The function performs emergency stop of the robot/device when an emergency stop signal is input from the fixed safety input, user safety input, network safety input, etc. Settings can be configured by selecting [Emergency Stop] under [Monitoring Setting] from the setting application menu. Refer to Chapter 11.1.12 for detailed instructions on assigning functions to the various safety inputs and outputs.



Stop Category-TP

Set the stop category when there is an emergency stop at the teach pendant.

Stop Category-Operation Panel

Set the stop category when there is an emergency stop at the operation panel.

Enabled External SW

Enabled/disabled of SW external emergency stop which has the same function as external emergency stop of fixed safety input is set.

Stop Category-External SW

Set the stop category when tan emergency stop is triggered by an external signal. 0 and 1 are selectable.

Set

Set the stop category and stop target for each signal for the 18 sets that can be input as an emergency stop signal by the user. When this function is enabled, a ✓ mark will be displayed to the left of the number.

Stop Category

Set the Stop Category for each set. 0,1 can be selected.

Target Robot/Device

Set the target to be stopped for each set. "All" can be selected.

11.1.11 Safety Input/Output Signals

The following safety inputs and outputs can be used with the CoreCubic-S.
Signals with ~ at the beginning of the signal name indicate that the signal is OFF and states as the signal name describes.

(1) Fixed safety inputs

These are the signals that are input to the Power Sequence Board. (Refer to Section 9.1 for details. The connector is mounted on a servo board or power sequence board.)

Signal name	Number	Explanation
~TP Emergency Stop	1001	Teach pendant emergency stop switch status. ON: Do not stop, OFF: Stop
TP Enable	1002	Teach pendant enable switch status. ON: Enable, OFF: Disable
Operation Panel Teach/Repeat Mode	1003	Operation panel operation mode selector switch status.*1 ON: Teach/Fast Check Mode, OFF: Repeat Mode
Operation Panel Fast Check Mode	1004	Operation panel operation mode selector switch (Fast check mode) status.*1 ON: Fast Check Mode, OFF: Teach Mode
2AP Board Master/Secondary Enable*2	1005	Operation panel power sequence board master/secondary selector switch status. ON: Master enable, OFF: Secondary enable
~Operation Panel Emergency Stop	1006	Operation panel emergency stop switch status. ON: Do not stop, OFF: Stop
~External Emergency Stop	1007	Externally connected emergency stop switch status. ON: Do not stop, OFF: Stop
~Safety Fence 1 Opened	1008	Status of the externally connected safety fence. ON: Closed, OFF: Opened
~Safety Fence 2 Opened*3	1009	Status of the externally connected safety fence. ON: Closed, OFF: Opened
External Enable	1010	Status of the externally connected enable switch. ON: Enable, OFF: Disable

*1 When 1003 is ON and 1004 is OFF, teach mode is set. When both are ON, fast check mode is set.

*2 Power Sequence Board Master/Secondary Enable input is available only for clean specification controllers.

*3 Safety Fence 2 Open input is available only for clean specification controllers.

(2) Fixed safety outputs

These are the signals output from the Power Sequence Board. (Refer to Section 9.1 for details. The connector is mounted on a servo board or power sequence board.)

Signal name	Number	Explanation
~Motor Power Shutoff	3001	Status of power shut off signal (STO) from the power sequence board to the servo amplifier. ON: Do not shut off, OFF: Shut off
~Motor Brake Power Shutoff	3002	Status of motor brake power shut off signal (SBC) from the power sequence board to the servo amplifier. ON: Do not shut off, OFF: Shut off
Motor Power Normal	3003	Status of that motor power signal output from the power sequence board to the X 202 connector is shut off. ON: Do not shut off (Power ON), OFF: Shut off (Power OFF) (Output for Mitsubishi amplifier)

(3) Internal safety inputs

These are the internal signals input to each safety function (option) in the CoreCubic-S. The logic operation signal is assigned and used. (Refer to Section 11.1.12 for details)

Signal name	Number	Explanation
User Teach/Repeat Mode[*1]	-	Teach/Repeat Mode Switching Signal ON: Teach/Fast Check Mode, OFF: Repeat Mode
User Fast Check Mode[*1]	-	Fast Check Mode Switching Signal ON: Fast Check Mode, OFF: Teach Mode
Tool ID 2-1 to Tool ID 2-5	-	Indicates the tool ID when tool ID 2 is selected in the tool ID specification. It is treated as a 5-digit binary number and is converted to a tool number by a conversion table.
Disabling Motion Area Monitoring Protective Stop 1 to Disabling Motion Area Monitoring Protective Stop 16	-	Signal that disables protective stop by motion area monitoring set 1 to 16 of Motion Area Monitoring function. ON: Disable, OFF: Enable
Disabling Selective Joint Monitoring Protective Stop 1 to Disabling Selective Joint Monitoring Protective Stop 18	-	Signal that disables protective stop by selected joint monitoring set 1 to 18 of Joint Monitoring function. ON: Disable, OFF: Enable
Disabling User Speed Monitoring Protective Stop 1 to Disabling User Speed Monitoring Protective Stop 18	-	Signal that disables protective stop by user speed monitoring set 1 to 18 of Speed Monitoring function. ON: Disable, OFF: Enable

Disabling Tool Orientation Monitoring Protective Stop 1 to Disabling Tool Orientation Monitoring Protective Stop 8	-	Signal that disables protective stop by tool orientation monitoring set 1 to 8 of Tool Orientation Monitoring function. ON: Disable, OFF: Enable
~Stop Monitoring 1 to ~Stop Monitoring 18	-	Signal that can be input as stop monitoring set 1 to 18 of Stop Monitoring function. ON: Do not monitor, OFF: Monitor
~SW Safety Fence Opened	-	A signal that can be input as a safety fence signal for the protective stop function. This function is same as the ~Safety Fence 1 Opened of the Fixed safety input, and input from user safety input or a network safety input. Software signal that can be input as a safety fence signal. ON: Closed, OFF: Opened
~User Protective Stop 1 to ~User Protective Stop 18	-	Signal that can be input as User Protective Stop set 1 to 18 of Protective Stop function. ON: Do not stop, OFF: Stop
~SW External Emergency Stop	-	Software signal that can be input as an emergency stop signal of Emergency Stop function. This function is same as the ~External Emergency Stop of the Fixed safety input, and input from user safety input or network safety input. ON: Do not stop, OFF: Stop
~User Emergency Stop 1 to ~User Emergency Stop 18	-	Signal that can be input as user emergency stop set 1 to 18 of Emergency Stop function. ON: Do not stop, OFF: Stop
SW External Enable	-	Software signal that can be input as an enable switch. This function is same as the External Enable of the Fixed safety input, and input from user safety input or network safety input. ON: Enable, OFF: Disable
Resetting Safety Signature Alarm	-	Signal that resets the safety signature alarm. (Updates the stored overall CRC value to the overall CRC value of the parameter being set.) ON: Reset, OFF: Do not reset
Welding Check for User Safety Output 1 to Welding Check for User Safety Output 32	-	Signal to perform fusing check of force guided relays connected to each user safety output

*1 For more details on switching modes using user safety input, see Section 9.1.1.

(4) Internal safety output signals

These are the internal signals output from each safety function (option) in the CoreCubic-S. (Refer to Section 11.1.12 for details)

Signal name	Number	Explanation
~Motor Power Shutoff Command Performed 1 to ~Motor Power Shutoff Command Performed 2	2001 to 2002	Indicates whether motor power shut-off commands 1 to 2 are being executed. ON: Not performed, OFF: Performed
Inside Motion Permission Area 1 to Inside Motion Permission Area 16	2003 to 2018	Indicates whether the robot is within the motion permission area of motion area monitoring set 1 to 16 of Motion Area Monitoring function. ON: Inside, OFF: Outside
Inside Motion Permission Constant Joint Range	2019	Indicates whether the robot is within the motion monitoring joint range for Constant joint monitoring of Joint Monitoring function. ON: Inside, OFF: Outside
Inside Motion Permission Selective Joint Range 1 to Inside Motion Permission Selective Joint Range 18	2020 to 2037	Indicates whether the robot is within the motion monitoring joint range for Selective joint monitoring set 1 to 18 of Joint Monitoring function. ON: Inside, OFF: Outside
Within Motion Permission Teach Mode Speed	2038	Indicates whether the robot is below the motion monitoring speed for teach mode speed monitoring of Speed Monitoring function. ON: Within, OFF: Above
Within Motion Permission Fast Check Mode Speed	2039	Indicates whether the robot is below the motion monitoring speed for fast check mode speed monitoring of Speed Monitoring function. ON: Within, OFF: Above
Within Motion Permission User Speed 1 to Within Motion Permission User Speed 18	2040 to 2057	Indicates whether the robot/device is below the motion monitoring speed for user speed monitoring set 1 to 18 of Speed Monitoring function. ON: Within, OFF: Above
Inside Motion Permission Tool Orientation Range 1 to Inside Motion Permission Tool Orientation Range 8	2058 to 2065	Indicates whether the robot is within the motion monitoring tool orientation range for tool orientation monitoring set 1 to 8 of Tool Orientation Monitoring function. ON: Inside, OFF: Outside
~Stop Monitoring Being Input 1 to ~Stop Monitoring Being Input 18	2066 to 2083	Indicates whether User Stop Monitoring set 1 to 18 of Stop Monitoring function is enabled and whether ~Stop Monitoring set 1 to 18 are being input. ON: Not being input, OFF: Being input

In Stop Monitoring 1 to In Stop Monitoring 18	2084 to 2101	Indicates whether the robot/device is stopped due to User Stop Monitoring set 1 to 18 of Stop Monitoring function. ON: Stopped, OFF: Not stopped
~SW Safety Fence Opened Being Input	2102	Indicates whether SW Safety Fence Protective Stop of Protective Stop function is enabled and whether ~SW Safety Fence Opened is input. ON: Not being input, OFF: Being input
~User Protective Stop Being Input 1 to ~User Protective Stop Being Input 18	2103 to 2120	Indicates whether User Protective Stop set 1 to 18 of Protective Stop function is enabled and whether ~User Protective Stop set 1 to 18 are being input. ON: Not being input, OFF: Being input
In User Protective Stop 1 to In User Protective Stop 18	2121 to 2138	Indicates whether the robot/device is stopped due to User Protective Stop set 1 to 18 of Protective Stop function. ON: Stopped, OFF: Not stopped
~SW External Emergency Stop Being Input	2139	Indicates whether SW External Emergency Stop of Emergency Stop function is enabled and whether ~SW External Emergency Stop is input. ON: Not being input, OFF: Being input
~User Emergency Stop Being Input 1 to ~User Emergency Stop Being Input 18	2140 to 2157	Indicates whether User Emergency Stop set 1 to 18 of Emergency Stop function is enabled and whether ~User Emergency Stop set 1 to 18 are being input. ON: Not being input, OFF: Being input
In Teach Mode	2158	Indicates if the teach mode is running. ON: In teach mode, OFF: Not in teach mode
In Fast Check Mode	2159	Indicates if fast check mode is running. ON: In fast check mode, OFF: Not in fast check mode
In Repeat mode	2160	Indicates if repeat mode is running. ON: In repeat mode, OFF: Not in repeat mode
~ Safety Signature Alarm	2161	Indicates whether the Safety Signature Alarm is being generated. (Indicates that the overall CRC value of the parameter being set and the stored overall CRC value are not matched.) ON: Alarm not occurring, OFF: Alarm occurring
Always ON	2162	Always ON

(5) User safety input

This signal is externally input to the safety I/O board (option). (See Section 9.2 for details. They are input from the XIN connector)

Signal name	Number	Explanation
User Safety Input 1 to User Safety Input 32	1101 to 1132	Input from the safety I/O board (option), XIN connector. 1st safety I/O board... User Safety Input 1 to 8 2nd safety I/O board... User Safety Input 9 to 16 3rd safety I/O board... User Safety Input 17 to 24 4th safety I/O board... User Safety Input 25 to 32

(6) User safety output

This signal is output from the safety I/O board (option) or power sequence board. (See Chapter 9.2 for details.) The logic operation result signal is assigned and used. (see Section 11.1.12 for details)

Signal name	Number	Explanation
User Safety Output 1 to User Safety Output 32	-	Output from the safety I/O board (option), XOUT connector. 1st safety I/O board... User Safety Output 1 to 8 2nd safety I/O board... User Safety Output 9 to 16 3rd safety I/O board... User Safety Output 17 to 24 4th safety I/O board... User Safety Output 25 to 32
User Safety Output 101	-	Output from the X510 connector of the servo board via the power sequence board.

(7) Network safety input (option)

This signal is input to the CoreCubic-S via an external safety controller. (See Section 10.3 for details.)

Signal name	Number	Explanation
Network Safety Input 1 to Network Safety Input 64	1501 to 1564	Input from external safety controller.

(8) Network safety output (option)

This signal is output from CoreCubic-S via an external safety controller. (See Section 10.3 for details.) The logic operation result signal is assigned and used. (see Section 11.1.12 for details)

Signal name	Number	Explanation
Network Safety Output 1 to Network Safety Output 64	-	Output to external safety controller.

(9) Logic operation results (option)

Stores the result of logic operation (THRU, AND, XOR, NOT). It can be assigned to internal safety input, user safety output, and network safety output. (see Section 11.1.12 for details)

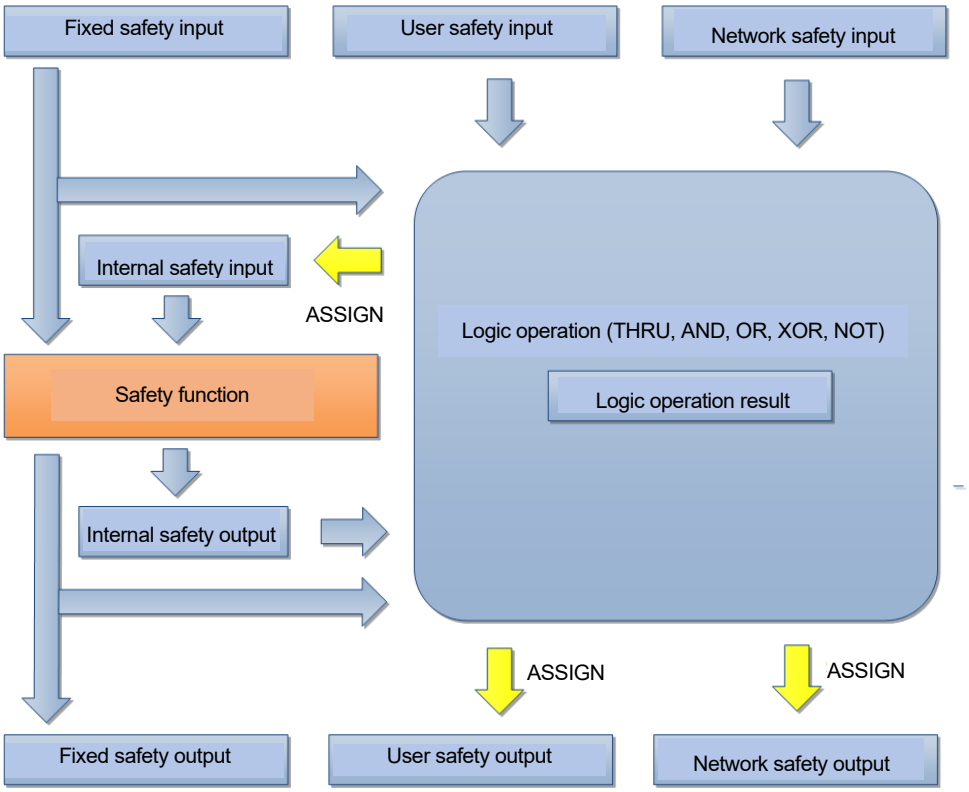
Signal name	Number	Explanation
Logic operation results 1 to Logic operation results 400	1 to 400	Shows the results of logic operations (THRU, AND, XOR, NOT) executed for the following signals. · Fixed safety input · User safety input · Network safety input · Fixed safety output · Internal safety output · Logic operation results

11.1.12 Logic Operations and Signal Assignment

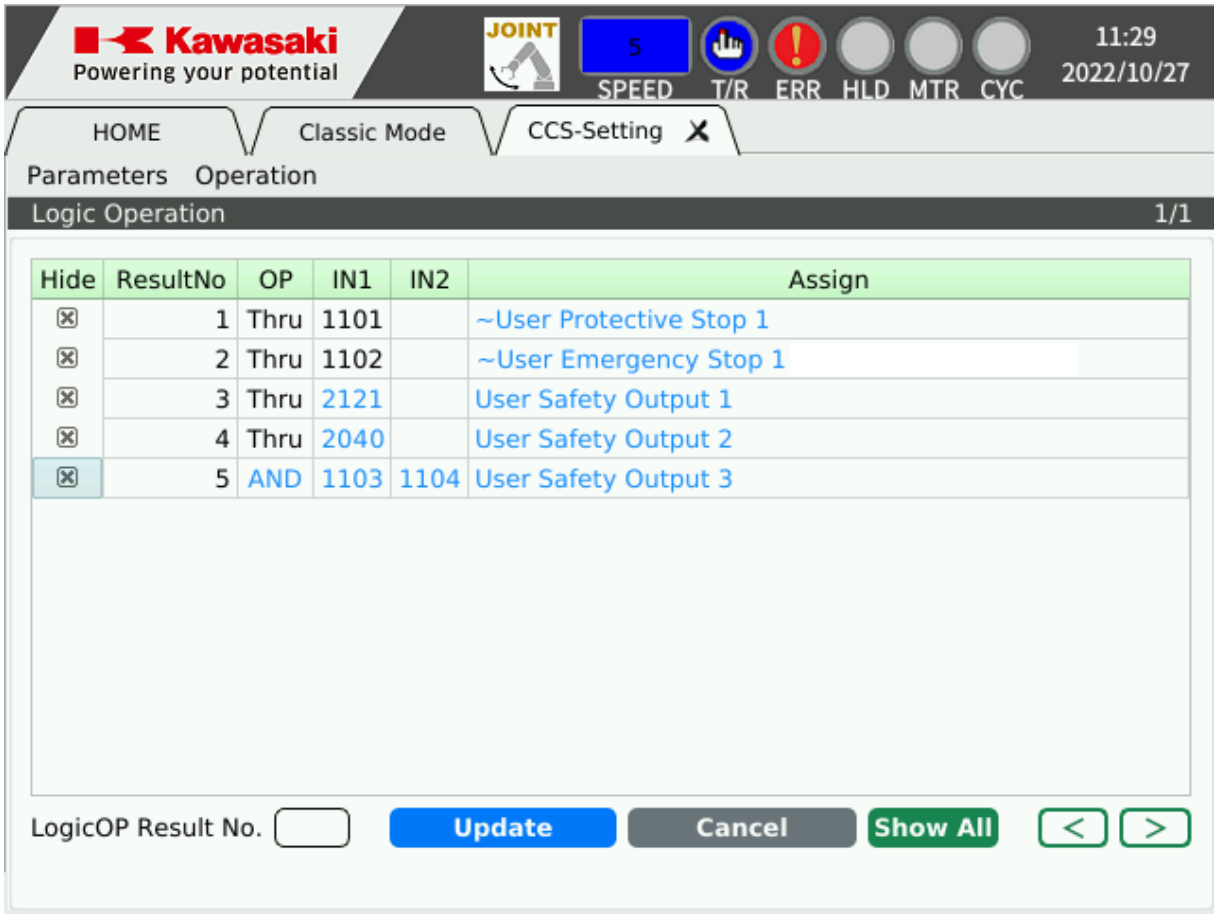
[Logic operations is an option.]

By selecting [Logic Operation] under [Signal Settings] from the settings application menu, the results of logic operations (THRU, AND, XOR, NOT) executed for the following signals can be assigned to internal safety inputs, user safety outputs and network safety outputs.

· Fixed safety input
· User safety input
· Network safety input
· Fixed safety output
· Internal safety output
· Logic operation results

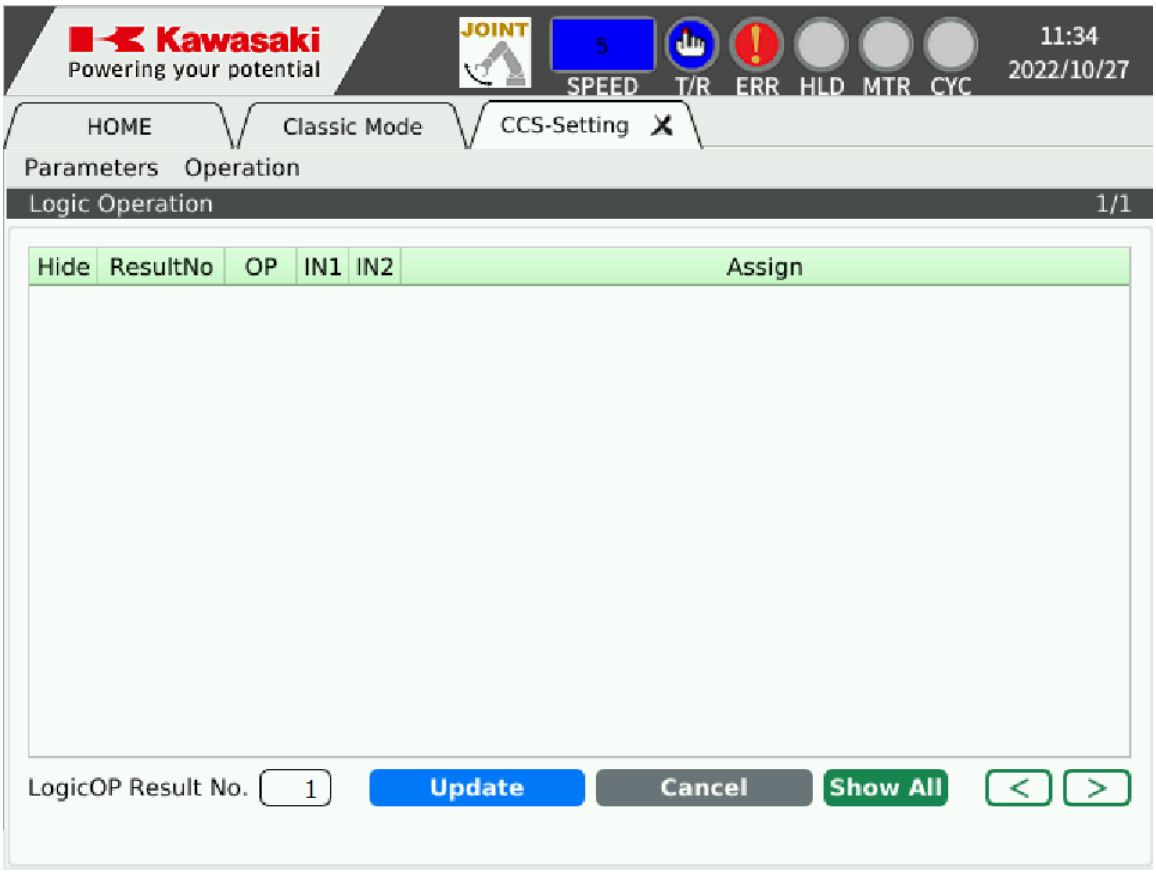


The figure below is a sample of setting that
Stores the User safety input 1 as it is in (THRU) LogicOP Result No. 1, and assigns ~User Protective Stop 1,
Stores the User safety input 2 as it is in (THRU) LogicOP Result No. 2, and assigns ~User Emergency Stop 1,
Stores the ~User Protective Stop Being Input 1 as it is in (THRU) LogicOP Result No. 3, and assigns User Safety Output 1
Stores the ~User Emergency Stop Being Input 1 as it is in (THRU) LogicOP Result No. 4, and assigns User Safety Output 2
Stores (AND) of the User safety input 3 and the User safety input 4 in LogicOP Result No. 5, and assigns User Safety Output 3.


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MTR
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11:29
2022/10/27
HOME
Classic Mode
CCS-Setting
Parameters
Operation
Logic Operation
1/1
Hide
ResultNo
OP
IN1
IN2
Assign
1 Thru 1101 ~User Protective Stop 1
2 Thru 1102 ~User Emergency Stop 1
3 Thru 2121 User Safety Output 1
4 Thru 2040 User Safety Output 2
5 AND 1103 1104 User Safety Output 3
LogicOP Result No.
Update
Cancel
Show All
<
>

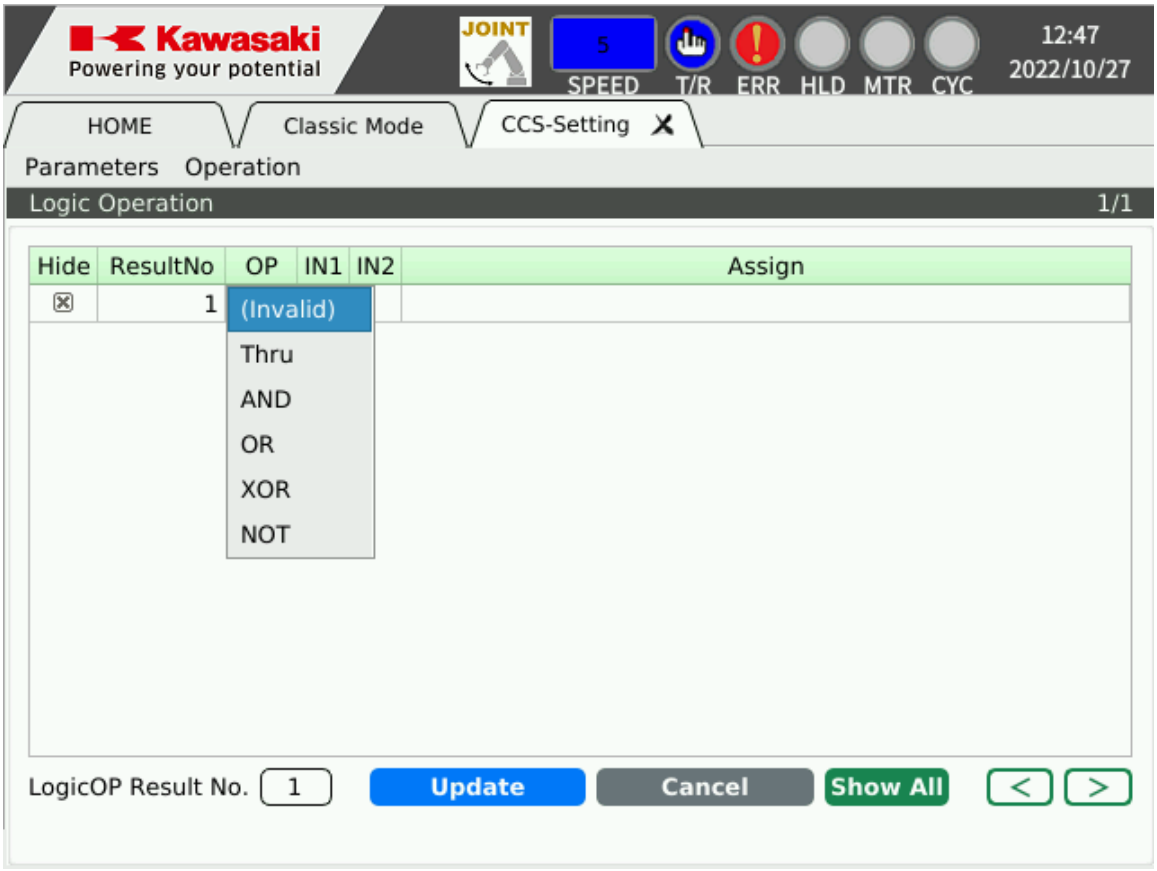
1. Logic Operation Setting Procedure

First, a number (1 to 400) you want to set in the input box for the LogicOP Result No., this can be assigned.

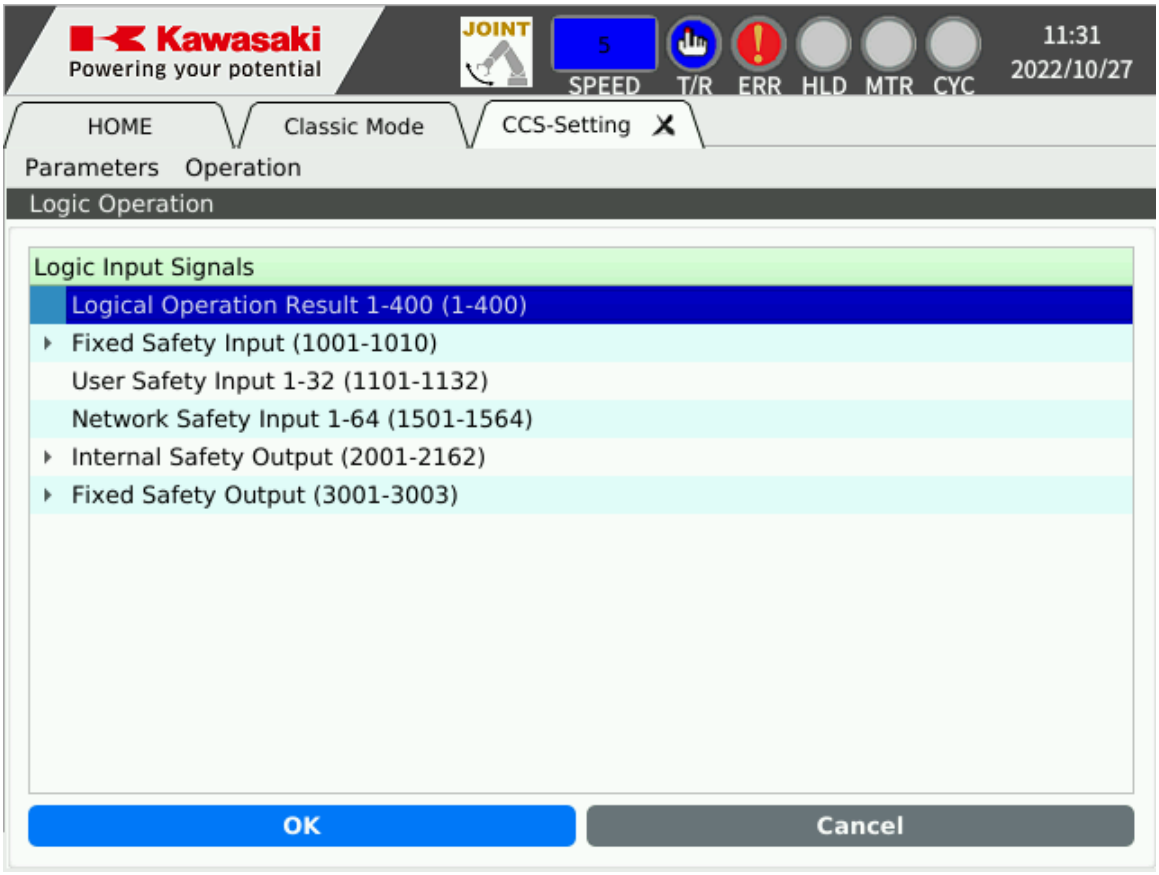


Next, configure the settings for operation content, operation input 1, operation input 2 and assignment.

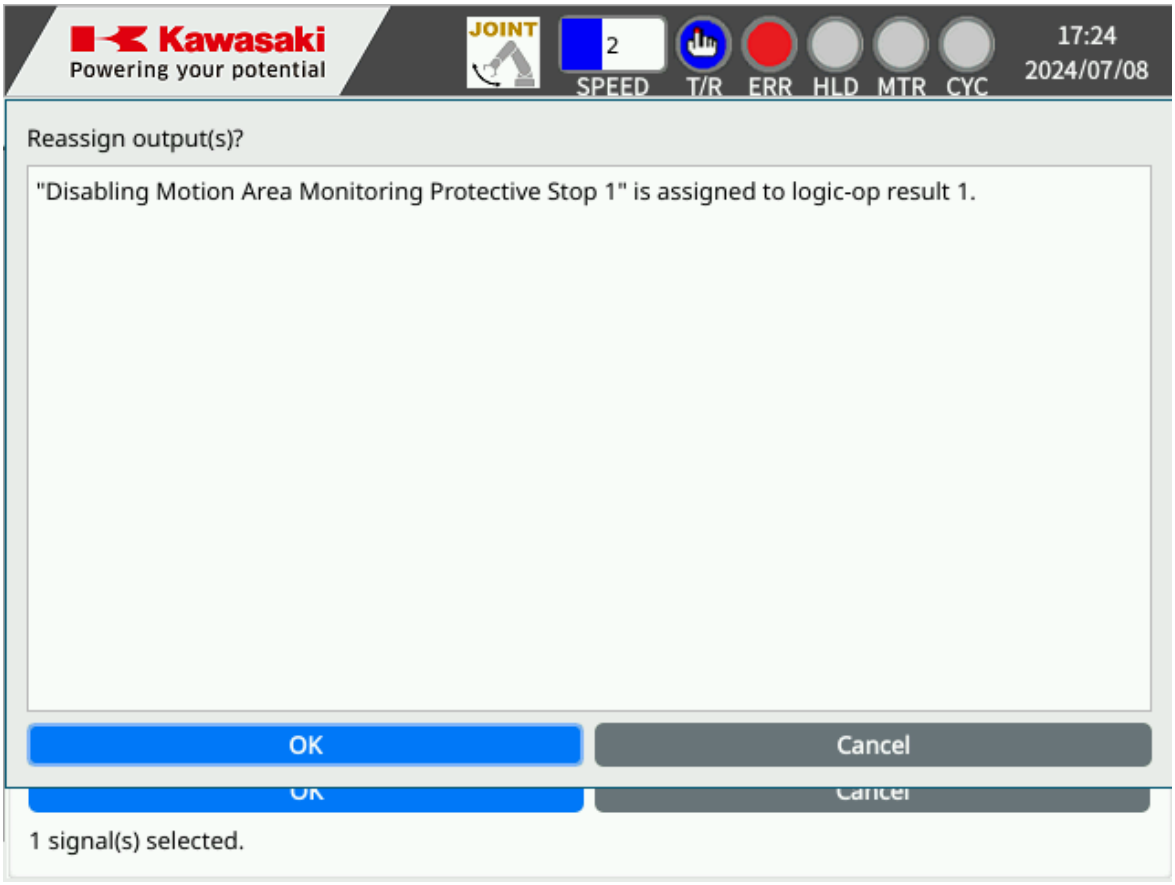
Select the operation content from the list.



Select the operation inputs 1 and 2 from the tree. It is possible to input operation inputs 1 and 2 for disabling operations and operation input 2 for unary operations (THRU, NOT), but these will not be used for operations.



Select the assignment from the tree. Multiple signals can be assigned to a single LogicOP Result No. Check the checkbox to enable the assigned signals.
The same signal cannot be assigned to multiple LogicOP Result No. If the same signal is assigned, a warning message is output and when you select "OK," the duplicated result is automatically deleted and the signal is assigned to the current operation result. If you select "Cancel," the signal is not assigned to the current operation result.



2. Display or Hide Logic Operations

By selecting the × mark in the Hide field, the logic operation can be temporarily hidden. By selecting the <Show all> button, or inputting it in the logic operation result number field, or by reopening the logic operations settings screen, the logic operation is no longer hidden. Also, if there are too many operations to display on one page, press "<" or ">" to move between pages.

3. Logic Operation Errors

A warning or error will be generated when the following types of operations are updated. In the case of an error, it is not possible to update without canceling.

· A warning is generated if there is an operation result not used.
· An error is generated if an operation input using an operation is blank.
· An error is generated if there is an undefined signal number.
· If the logic operation result set to operation inputs 1 and 2 is greater than or equal to the result number, an error occurs.

11.2 Checks Before Use

Do as shown below to check each function prior to using it.

11.2.1 Motion Area Monitoring Function

No.	How to Check	Items to Check	Check Results
1	When MoveAreaTeachValid is set to enabled and all tool monitoring points that are set to enabled are in contact with at least one surface in any area in teach mode, check that the robot/device power shuts off and stops in accordance with the stop category setting.	Tool monitoring sphere/ capsule/cuboids	
2	When switching between tools by entering a tool ID, check if No.1 is satisfied for all tools used.	Tools 1 to 32 (all tools used)	
3	When switching tools by entering tool ID 1, input a tool ID different from the command tool number, and check that the robot/device power immediately shuts off and stops if the tool moves more than the allowed travel distance when there is a tool discrepancy.	Allowed travel distance when there is a tool discrepancy	
4	When there is a valid setting for the arm area monitoring sphere/capsule, set MoveAreaTeachValid to enabled and input each monitoring enable signal, and with only the arm area monitoring sphere/capsule in contact with a surface in the set area, check at least one surface in each set area to confirm that the robot/device power shuts off and stops in accordance with the stop category setting.	Arm area monitoring sphere/capsule (Enabled)	
5	When there is an invalid setting for the arm area monitoring sphere/capsule, set MoveAreaTeachValid to enabled and input each monitoring enable signal, and with only the arm area monitoring sphere/capsule in contact with a surface in the set area in teach mode, check at least one surface in each set area to confirm that the robot/device power does not shut off in accordance with the stop category setting.	Arm area monitoring sphere/capsule (Disabled)	

6	When MoveAreaTeachValid is set to enabled, input each monitoring enable signal, and with the TCP or tool arm area monitoring sphere/capsule/cuboids in contact with a surface in the set area in teach mode, check all surfaces in the set area to confirm that the robot/device power shuts off and stops in accordance with the stop category setting.	MoveAreaTeachValid (Enabled) Area sets 1 to 16	
7	When MoveAreaTeachValid is set to disabled, input each monitoring enable signal, and with the TCP or tool arm area monitoring sphere/capsule/cuboids in contact with a surface in the set area in teach mode, check all surfaces in the set area to confirm that the robot/device power does not shut off in accordance with the stop category setting.	MoveAreaTeachValid (Disabled) Area sets 1 to 16	
8	When MoveAreaRepeatValid is set to enabled, input each monitoring enable signal, and with the TCP or tool arm area monitoring sphere/capsule/cuboids in contact with a surface in the set area in repeat mode, check all surfaces in the set area to confirm that the robot/device power shuts off and stops in accordance with the stop category setting.	MoveAreaRepeatValid (Enabled) Area sets 1 to 16	
9	When MoveAreaRepeatValid is set to disabled, input each monitoring enable signal, and with the TCP or tool arm area monitoring sphere/capsule/cuboids in contact with a surface in the set area in repeat mode, check all surfaces in the set area to confirm that the robot/device power does not shut off in accordance with the stop category setting.	MoveAreaRepeatValid (Disabled) Area sets 1 to 16	
10	When MoveAreaCheakFastValid is set to enabled, with the TCP or tool arm area monitoring sphere/capsule/cuboids in contact with a surface in the set area in fast check mode, check all surfaces in the set area to confirm that the robot/device power shuts off and stops in accordance with the stop category setting.	MoveAreaCheakFastValid (Enabled) Area sets 1 to 16	
11	When MoveAreaCheakFastValid is set to disabled, with the TCP or tool arm area monitoring sphere/capsule/cuboids in contact with a surface in the set area in fast check mode, check all surfaces in the set area to confirm that the robot/device power does not shut off in accordance with the stop category setting.	MoveAreaCheakFastValid (Disabled) Area sets 1 to 16	

12	Check that internal safety input signals are set to enabled or disabled as intended for all safety inputs related to the internal safety input signals assigned by the logic operation function.	Relevant safety inputs	
13	When multiple monitoring enable signals are assigned, check that the robot/device power does not shut off and stops when it is within the AND range of the permitted area. Also, check that the power shuts off when it is outside the AND range.	Multiple signal combinations	
14	For all programs to be used, use the area in which the program will be run to move robot starting from a low speed (monitor speed at around 10%) and then gradually increase the speed until it reaches operating speed. Check that it is not stopped by the area monitoring function. Also, repeat this at operating speed for around 10 cycles. If it stops, review the teaching.	All programs to be used	
15	For all areas, reduce the monitoring area by 10 mm and increase the prohibited area by 10 mm. For all programs to be used, use the area in which the program will be run to move robot starting from a low speed (monitor speed at around 10%) and then gradually increase the speed until it reaches operating speed. Check that it is not stopped by the area monitoring function. Also, repeat this at operating speed for around 10 cycles. If it stops, review the teaching.	All programs to be used	

11.2.2 Joint Monitoring Function

No.	How to Check	Items to Check	Check Results
1	When SelectAxisTeachValid is set to enabled, input each monitoring enable signal, move the robot/device from within each monitoring angle/position range to outside of the range in teach mode and check that the robot/device power shuts off and stops in accordance with the stop category setting. Check both the upper and lower limits.	SelectAxisTeachValid (Enabled) Continuous joint monitoring Selected joint monitoring sets 1 to 18	
2	When SelectAxisTeachValid is set to disabled, input each monitoring enable signal, move the robot/device from within each monitoring angle/position range to outside of the range in teach mode and check that the robot/device power does not shut off. Check both the upper and lower limits.	SelectAxisTeachValid (Disabled) Continuous joint monitoring Selected joint monitoring sets 1 to 18	
3	When SelectAxisCheckFastValid is set to enabled, input each monitoring enable signal, move the robot/device from within each monitoring angle/position range to outside of the range in fast check mode and check that the robot/device power shuts off and stops in accordance with the stop category setting. Check both the upper and lower limits.	SelectAxisCheckFastValid (Enabled) Continuous joint monitoring Selected joint monitoring sets 1 to 18	
4	When SelectAxisCheckFastValid is set to disabled, input each monitoring enable signal, move the robot/device from within each monitoring angle/position range to outside of the range in fast check mode and check that the robot/device power does not shut off. Check both the upper and lower limits.	SelectAxisCheckFastValid (Disabled) Continuous joint monitoring Selected joint monitoring sets 1 to 18	
5	When SelectAxisRepeatValid is set to enabled, input each monitoring enable signal, move the robot/device from within each monitoring angle/position range to outside of the range in repeat mode and check that the robot/device power shuts off and stops in accordance with the stop category setting. Check both the upper and lower limits.	SelectAxisRepeatValid (Enabled) Continuous joint monitoring Selected joint monitoring sets 1 to 18	
6	When SelectAxisRepeatValid is set to disabled, input each monitoring enable signal, move the robot/device from within each monitoring angle/position range to outside of the range in repeat mode and check that the robot/device power does not shut off. Check both the upper and lower limits.	SelectAxisRepeatValid (Disabled) Continuous joint monitoring Selected joint monitoring sets 1 to 18	

7	When multiple monitoring enable signals are assigned, check that the robot/device power does not shut off when it is within the AND range of the permitted angle/position. Also, check that the power shuts off and stops when it is outside the AND range.	Multiple signal combinations	
8	Check that internal safety input signals are set to enabled or disabled as intended for all safety inputs related to the internal safety input signals assigned by the logic operation function.	Relevant safety inputs	

11.2.3 Speed Monitoring Function

No.	How to Check	Items to Check	Check results
1	(If the speed of the configured speed monitoring is 250 mm/s or lower) When TeachSpeedValid is set to enabled, input each monitoring enable signal, operate the robot/device in teach mode at a speed that exceeds the configured speed and check that the robot/device power shuts off and stops in accordance with the stop category setting.	TeachSpeedValid (Enabled)	
2	(If the speed of the configured speed monitoring is 250 mm/s or lower) When TeachSpeedValid is set to disabled, input each monitoring enable signal, operate the robot/device in teach mode at a speed that exceeds the configured speed and check that the robot/device power does not shut off.	TeachSpeedValid (Disabled)	
3	When CheckSpeedValid is set to enabled, input each monitoring enable signal, operate the robot/device in fast check mode at a speed that exceeds the target speed and check that the robot/device power shuts off and stops immediately.	CheckSpeedValid (Enabled)	
4	When CheckSpeedValid is set to disabled, input each monitoring enable signal, operate the robot/device in fast check mode at a speed that exceeds the target speed and check that the robot/device power does not shut off.	CheckSpeedValid (Disabled)	
5	When UsrSpeedRepeatValid is set to enabled, input each monitoring enable signal, operate the robot/device in repeat mode at a speed that exceeds the target speed and check that the robot/device power shuts off and stops immediately.	UsrSpeedRepeatValid (Disabled)	

6	When UsrSpeedRepeatValid is set to disabled, input each monitoring enable signal, operate the robot/device in repeat mode at a speed that exceeds the target speed and check that the robot/device power does not shut off.	UsrSpeedRepeatValid (Enabled)	
7	When multiple monitoring enable signals are assigned, check that the robot/device power does not shut off when it is within the AND range of the permitted target speed. Also, check that the power shuts off and stops when it is outside the AND range.	Multiple signal combinations	
8	Check that internal safety input signals are set to enabled or disabled as intended for all safety inputs related to the internal safety input signals assigned by the logic operation function.	Relevant safety inputs	

11.2.4 Tool Orientation Monitoring Function

No.	How to Check	Items to Check	Check Results
1	When ToolOrientTeachValid is set to enabled, input each monitoring enable signal, move the robot/device from each reference direction to outside of the cone angle range in teach mode and check that the robot/device power shuts off and stops in accordance with the stop category setting.	ToolOrientTeachValid sets 1 to 8	
2	When ToolOrientTeachValid is set to disabled, input each monitoring enable signal, move the robot/device from each reference direction to outside of the cone angle range in teach mode and check that the robot/device power does not shut off.	ToolOrientTeachValid sets 1 to 8	
3	When ToolOrientCheckFastValid is set to enabled, input each monitoring enable signal, move the robot/device from each reference direction to outside of the cone angle range in fast check mode and check that the robot/device power shuts off and stops in accordance with the stop category setting.	ToolOrientCheckFastValid sets 1 to 8	
4	When ToolOrientCheckFastValid is set to disabled, input each monitoring enable signal, move the robot/device from each reference direction to outside of the cone angle range in fast check mode and check that the robot/device power does not shut off.	ToolOrientCheckFastValid sets 1 to 8	

5	When ToolOrientRepeatValid is set to enabled, input each monitoring enable signal, move the robot/device from each reference direction to outside of the cone angle range in repeat mode and check that the robot/device power shuts off and stops in accordance with the stop category setting.	ToolOrientRepeatValid sets 1 to 8	
6	When ToolOrientRepeatValid is set to disabled, input each monitoring enable signal, move the robot/device from each reference direction to outside of the cone angle range in repeat mode and check that the robot/device power does not shut off.	ToolOrientRepeatValid sets 1 to 8	
7	When up to 5 cones are assigned in the same set, check that the robot/device power does not shut off when it is within the OR range of the permitted cones. Also, check that the power shuts off and stops when it is outside the OR range.	Multiple signal combinations (assigned to the same signal)	
8	When multiple monitoring enable signals are assigned by individual signals, check that the robot/device power does not shut off when it is within the AND range of the permitted cones. Also, check that the power shuts off when it is outside the AND range.	Multiple signal combinations (assigned to individual signals)	
9	Check that internal safety input signals are set to enabled or disabled as intended for all safety inputs related to the internal safety input signals assigned by the logic operation function.	Relevant safety inputs	

11.2.5 Stop Monitoring Function

No.	How to Check	Items to Check	Check Results
1	When StopMonTeachValid is set to enabled, input each monitoring enable signal, operate to move over the StopJudgeDist in teach mode and check that the robot/device power shuts off and stops immediately.	StopMonTeachValid (Enabled) Sets 1 to 18	
2	When StopMonTeachValid is set to disabled, input each monitoring enable signal, operate to move over the StopJudgeDist in teach mode and check that the robot/device power does not immediately shut off.	StopMonTeachValid (Disabled) Sets 1 to 18	

3	When StopMonCheckFastValid is set to enabled, input each monitoring enable signal, operate to move over the StopJudgeDist in fast check mode and check that the robot/device power shuts off and stops immediately.	StopMonCheckFastValid (Enabled) Sets 1 to 18	
4	When StopMonCheckFastValid is set to disabled, input each monitoring enable signal, operate to move over the StopJudgeDist in fast check mode and check that the robot/device power does not immediately shut off.	StopMonCheckFastValid (Disabled) Sets 1 to 18	
5	When StopMonRepeatValid is set to enabled, input each monitoring enable signal, operate to move over the StopJudgeDist in repeat mode and check that the robot/device power shuts off and stops immediately.	StopMonRepeatValid (Enabled) Sets 1 to 18	
6	When StopMonRepeatValid is set to disabled, input each monitoring enable signal, operate to move over the StopJudgeDist in repeat mode and check that the robot/device power does not immediately shut off.	StopMonRepeatValid (Disabled) Sets 1 to 18	
7	Check that internal safety input signals are set to enabled or disabled as intended for all safety inputs related to the internal safety input signals assigned by the logic operation function.	Relevant safety inputs	

11.2.6 Protective Stop Function

No.	How to Check	Items to Check	Check Results
1	When ProtStopUsrTeachValid is set to enabled, check that each protective stop shuts off the power and robot stops when its respective signal is input while in teach mode.	ProtStopUsrTeachValid (Enabled) User protective stop 1 to 18	
2	When ProtStopUsrTeachValid is set to disabled, check that each protective stop does not shut off the power when its respective signal is input while in teach mode.	ProtStopUsrTeachValid (Disabled) User protective stop 1 to 18	
3	When ProtStopUsrCheckFastValid is set to enabled, check that each protective stop shuts off the power and robot stops when its respective signal is input while in fast check mode.	ProtStopUsrCheckFastValid (Enabled) User protective stop 1 to 18	
4	When ProtStopUsrCheckFastValid is set to disabled, check that each protective stop does not shut off the power when its respective signal is input while in fast check mode.	ProtStopUsrCheckFastValid (Disabled) User protective stop 1 to 18	
5	When ProtStopUsrRepeatValid is set to enabled, check that each protective stop shuts off the power and robot stops when its respective signal is input while in repeat mode.	Safety fence 1 protective stop	
		Safety fence 2 protective stop	
		SW safety fence protective stop	
		User protective stop 1 to 18	
6	When ProtStopUsrRepeatValid is set to disabled, check that each protective stop does not shut off the power when its respective signal is input while in repeat mode.	Safety fence 1 protective stop	
		Safety fence 2 protective stop	
		SW safety fence protective stop	
		User protective stop 1 to 18	
7	When each protective stop is set to stop category 0, check that the power immediately shuts off and robot stops when each signal is input.	Safety fence 1 protective stop	
		Safety fence 2 protective stop	
		SW safety fence protective stop	
		User protective stop 1 to 18	
8	When each protective stop is set to stop category 1, check that the power shuts off and robot stops after deceleration stops when each signal is input.	Safety fence 1 protective stop	
		Safety fence 2 protective stop	
		SW safety fence protective stop	
		User protective stop 1 to 18	
9	When each protective stop is set to stop category 2, check that operation stops after deceleration stops when each signal is input. Next, check that operation resumes once each signal input is cleared.	Safety fence 1 protective stop	
		Safety fence 2 protective stop	
		SW safety fence protective stop	
		User protective stop 1 to 18	

10	Check that internal safety input signals are set to enabled or disabled as intended for all safety inputs (fixed, user or network safety inputs) related to the internal safety input signals assigned by the logic operation function.	Relevant safety inputs	

11.2.7 Emergency Stop Function

No.	How to Check	Items to Check	Check Results
1	In teach mode, input each emergency stop signal and check that power is shut off and robot stops as set by the stop category. (Stop category 0: Immediate shut-off, Stop category 1: Shut-off after deceleration stops)	TP emergency stop	
		Operation panel emergency stop	
		External emergency stop	
		SW external emergency stop	
		User emergency stop 1 to 18	
2	In repeat mode, input each emergency stop signal and check that power is shut off and robot stops as set by the stop category. (Stop category 0: Immediate shut-off, Stop category 1: Shut-off after deceleration stops)	TP emergency stop	
		Operation panel emergency stop	
		External emergency stop	
		SW external emergency stop	
		User emergency stop 1 to 18	

11.2.8 Safety Inputs and Outputs

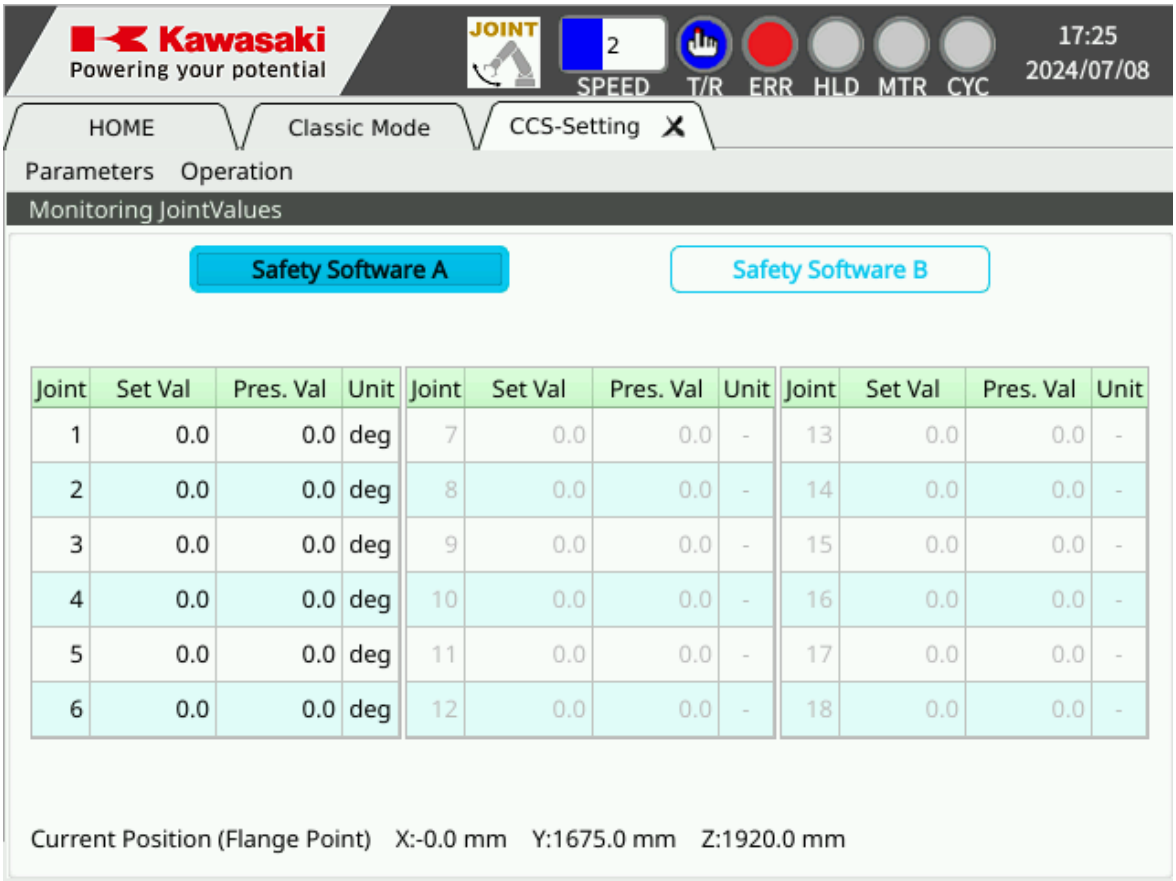
Use the list of 11.1.11 Safety Input/Output Signals to check that the signals being used for user safety inputs, user safety outputs, network safety inputs and network safety outputs are operating correctly.

12 Monitoring

The internal status of CoreCubic-S can be monitored by selecting [Status] -> [Monitoring] from the setting application menu.
The setting application and robot controller communicate at fixed intervals for monitoring, and the values are continuously updated.

1. Joint Values

Select [Status] -> [Monitoring] -> [jointValues] in the setting application menu to monitor the command value, present value of the joint, and the present position of the robot's flange point in each safety software.

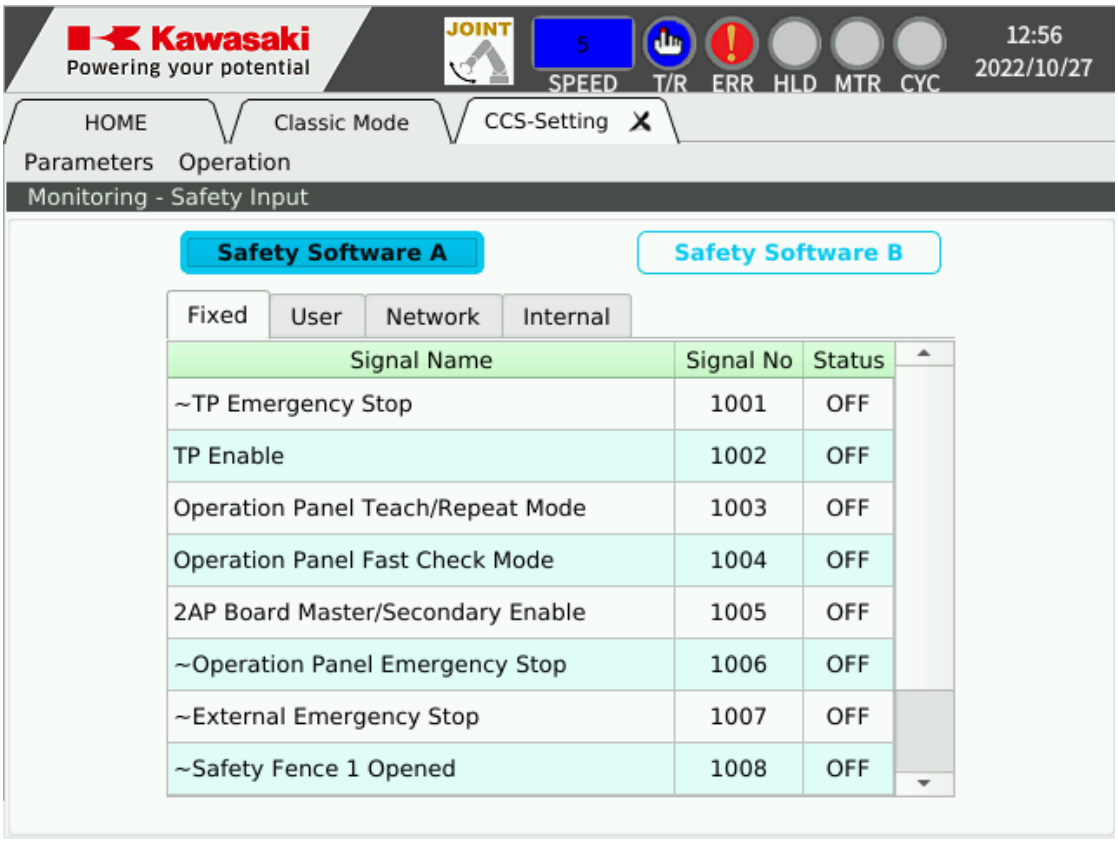


2. Safety Input/Output Signals

Select [Status] -> [Monitoring] -> [Safety Input]/[Safety Output] in the setting application menu to monitor the status of safety input/output signals in each safety software. For an explanation of each signal, refer to 11.1.11 Safety Input/Output Signals.

2.1 Safety Input Signals

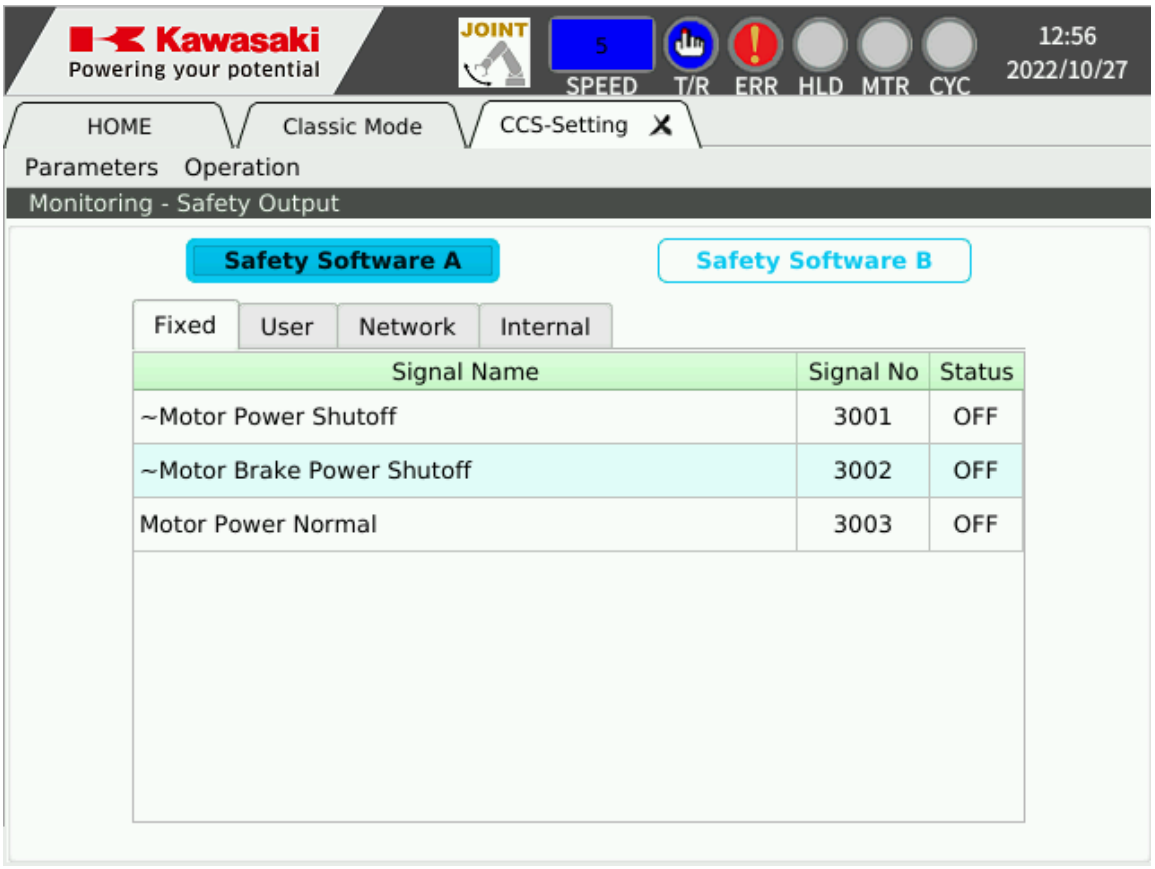
Select [Safety Input] to monitor the status of fixed safety input signals, user safety input signals [Option], network safety input signals [Option], and internal safety input signals [Option*] in each safety software.
[Option*]: indicates that some functions are optional.


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HOME
Classic Mode
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Parameters
Operation
Monitoring - Safety Input
Safety Software A
Safety Software B
Fixed
User
Network
Internal
Signal Name
Signal No
Status
~TP Emergency Stop 1001 OFF
TP Enable 1002 OFF
Operation Panel Teach/Repeat Mode 1003 OFF
Operation Panel Fast Check Mode 1004 OFF
2AP Board Master/Secondary Enable 1005 OFF
~Operation Panel Emergency Stop 1006 OFF
~External Emergency Stop 1007 OFF
~Safety Fence 1 Opened 1008 OFF

2.2 Safety Output Signals

Select [Safety Output] to monitor the status of fixed safety output signals, user safety output signals [Option], network safety output signals [Option], and internal safety output signals [Option*] in each safety software.

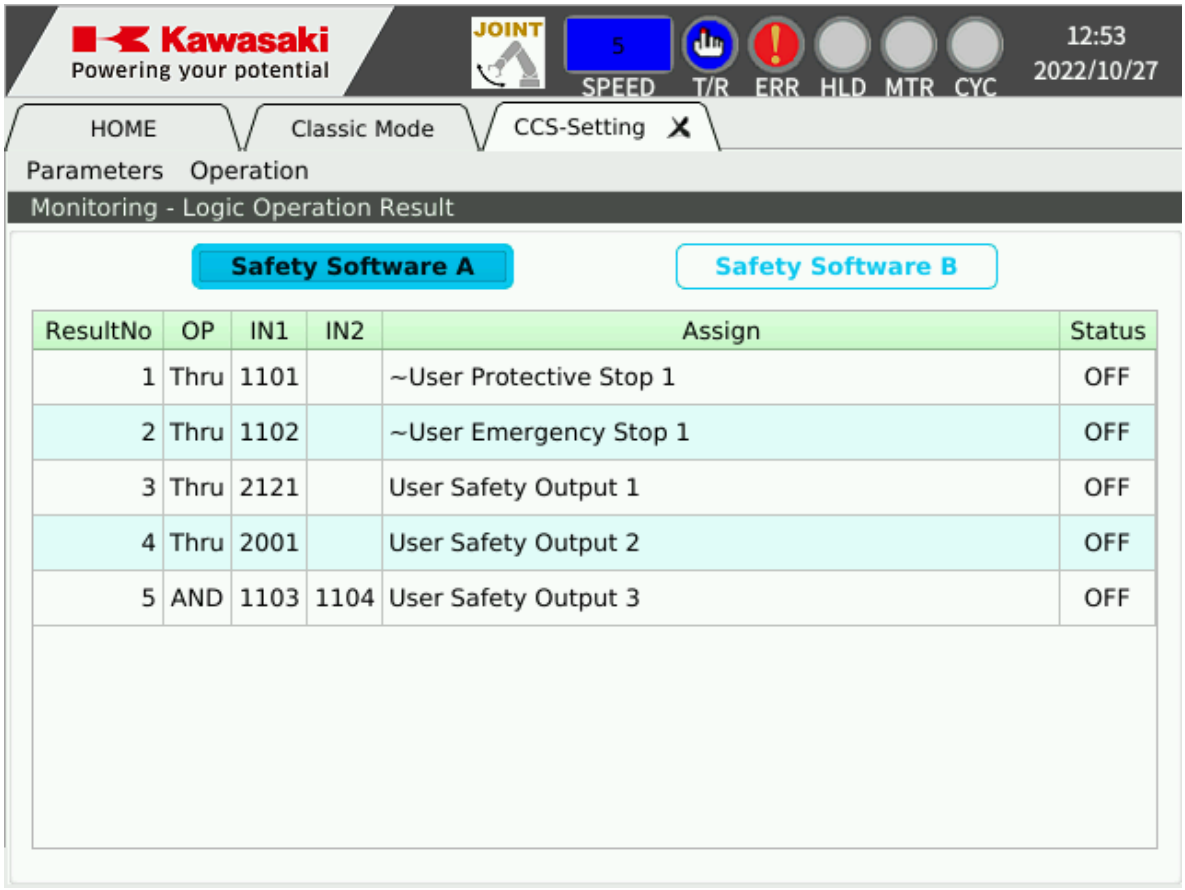
[Option*]: indicates that some functions are optional.



3. Logic Operation Results

[Logic operation is an option.]

Select [Status] -> [Monitoring] -> [Logic Operation Result] in the setting application menu to monitor the status of logic operation results in each safety software. Move the cursor over the signal number of operation inputs 1 and 2 to display the signal name in a tooltip.

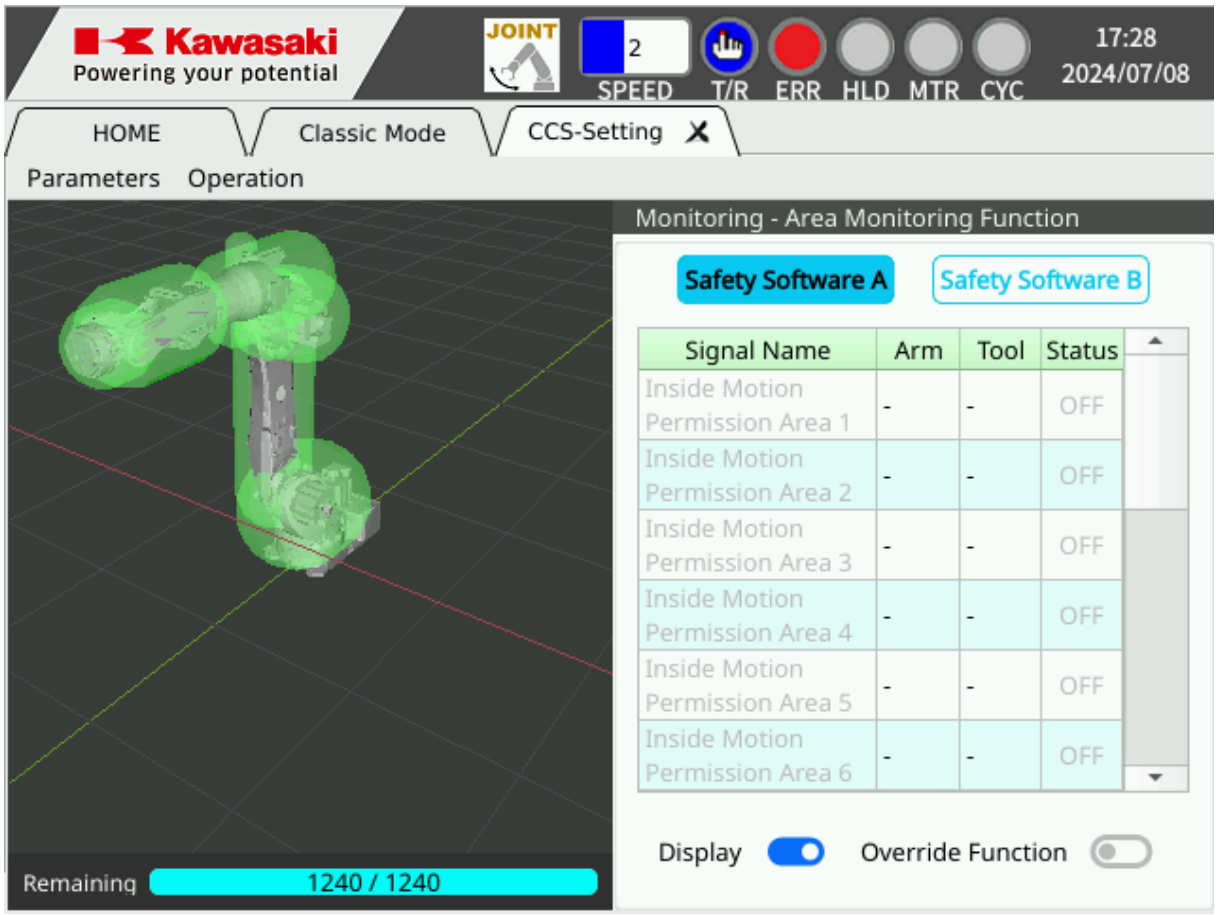


ResultNo	OP	IN1	IN2	Assign	Status
1	Thru	1101		~User Protective Stop 1	OFF
2	Thru	1102		~User Emergency Stop 1	OFF
3	Thru	2121		User Safety Output 1	OFF
4	Thru	2001		User Safety Output 2	OFF
5	AND	1103	1104	User Safety Output 3	OFF

4. Motion Area Monitoring Function

[Motion area monitoring function is an option.]

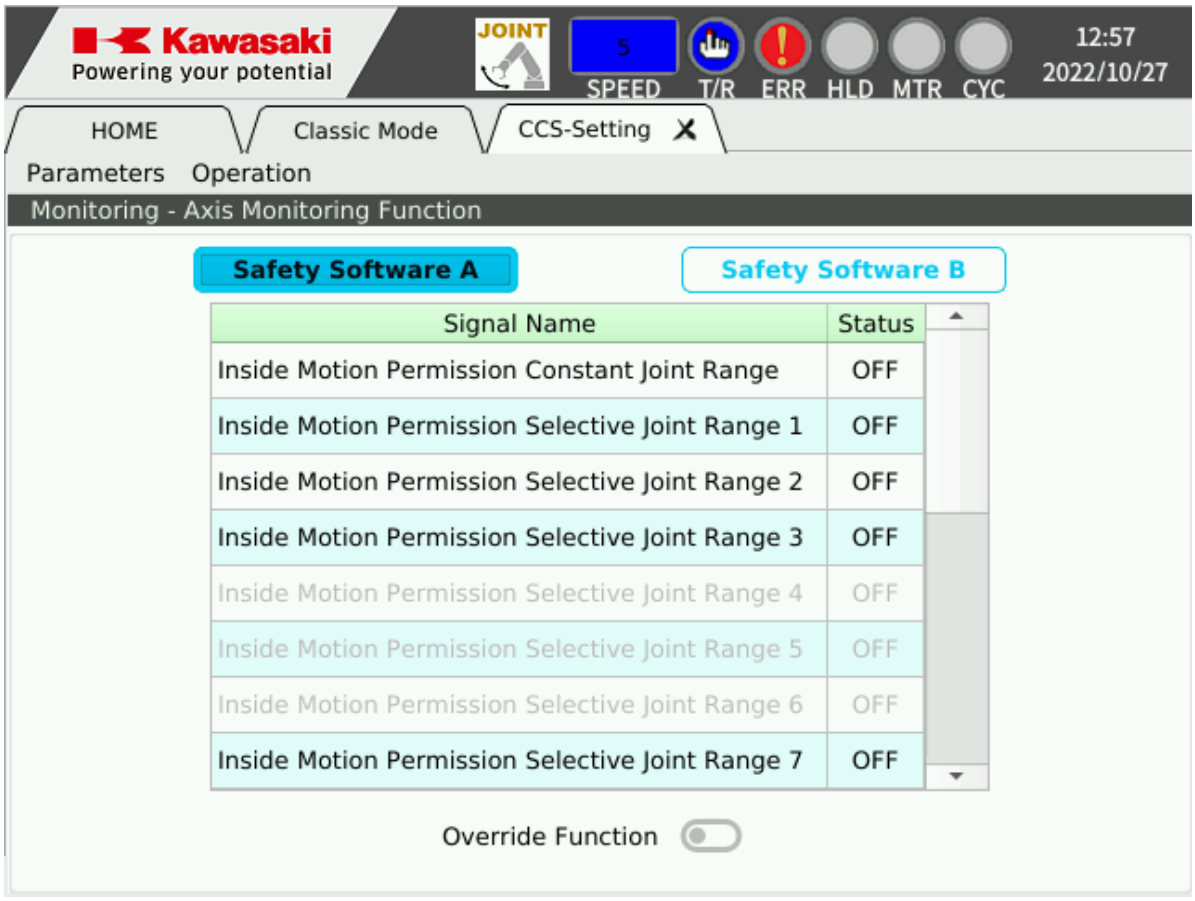
Select [Status] -> [Monitoring] -> [Area Monitoring Function] in the setting application menu to monitor the status of internal safety output signals related to the motion area monitoring function in each safety software. Signals for which the function is disabled are grayed out. The number and status of each arm or tool model that is outside the motion monitoring area are displayed. The model outside the motion monitoring area/inside the motion prohibited area is 3D-displayed in yellow. The override function is available from this screen. For more information about the override function, refer to "14 Troubleshooting."



5. Joint Monitoring Function

[Selective joint monitoring is an option.]

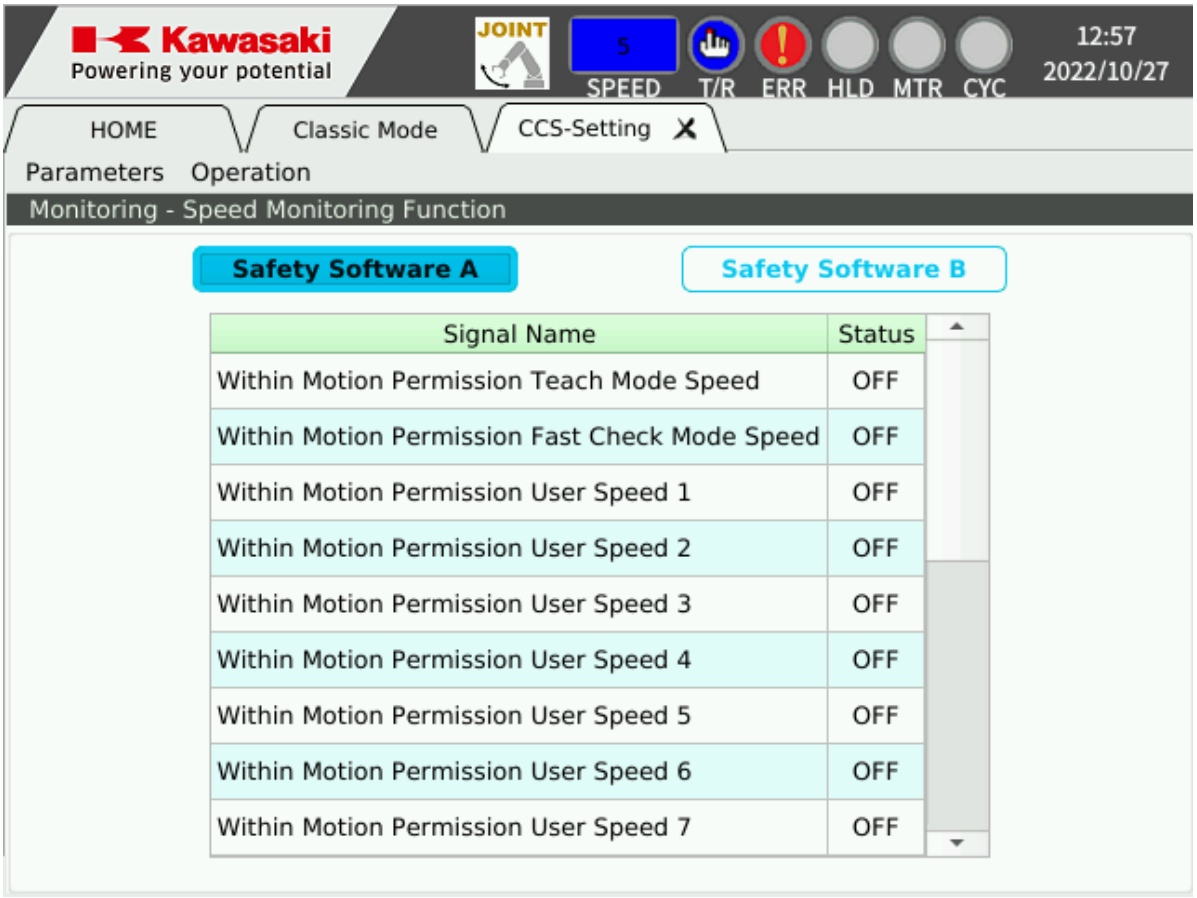
Select [Status] -> [Monitoring] -> [Axis Monitoring Function] in the setting application menu to monitor the status of internal safety output signals related to the joint monitoring function in each safety software. Signals for which the function is disabled are grayed out.
The override function is available from this screen. For more information about the override function, refer to "14 Troubleshooting."



6. Speed Monitoring Function

[User speed monitoring function is an option.]

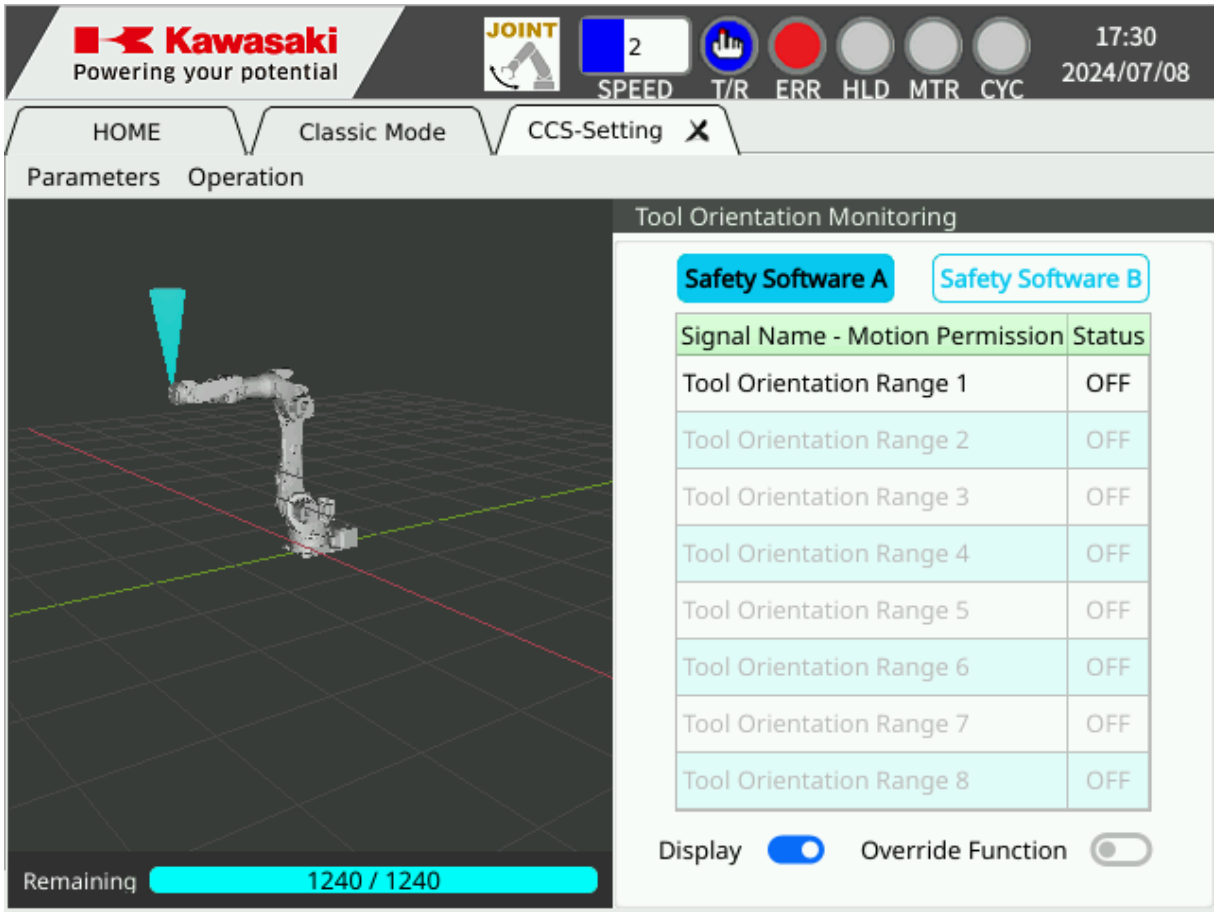
Monitoring can be performed by selecting [Status] -> [Monitoring] -> [Speed Monitoring Function] in the setting application menu. This allows you to monitor the status of internal safety output signals related to the speed monitoring function in each safety software. Signals for which the function is disabled are grayed out.



7. Tool Orientation Monitoring Function

[Tool orientation monitoring function is an option.]

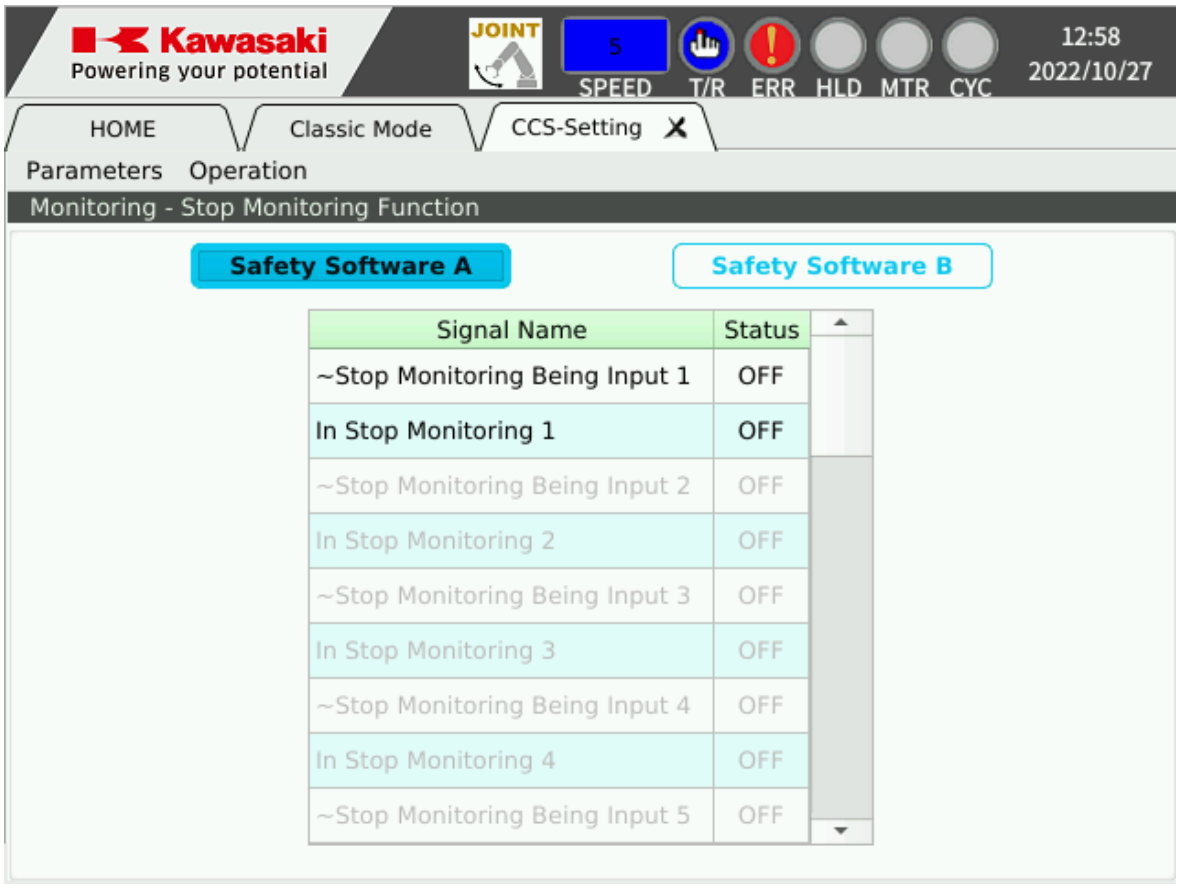
Select [Status] -> [Monitoring] -> [Tool Orientation Monitoring] in the setting application menu to monitor the status of internal safety output signals related to the tool orientation monitoring function in each safety software. Signals for which the function is disabled are grayed out. The tool orientation monitoring model is also displayed in 3D.
The override function is available from this screen. For more information about the override function, refer to "14 Troubleshooting."



8. Stop Monitoring Function

[Stop monitoring function is an option.]

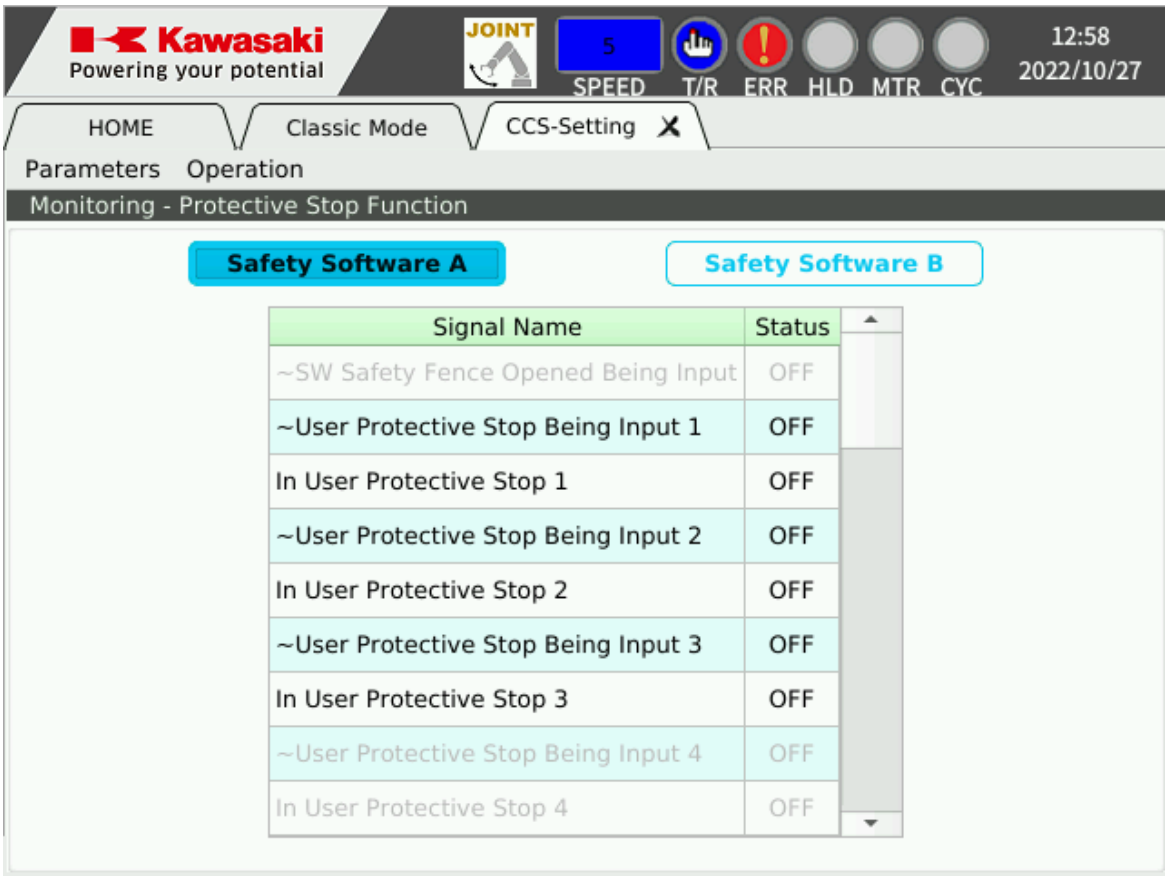
Select [Status] -> [Monitoring] -> [Stop Monitoring Function] in the setting application menu to monitor the status of internal safety output signals related to the stop monitoring function in each safety software. Signals for which the function is disabled are grayed out.



9. Protective Stop Function

[SW safety fence protective stop/user protective stop function is an option.]

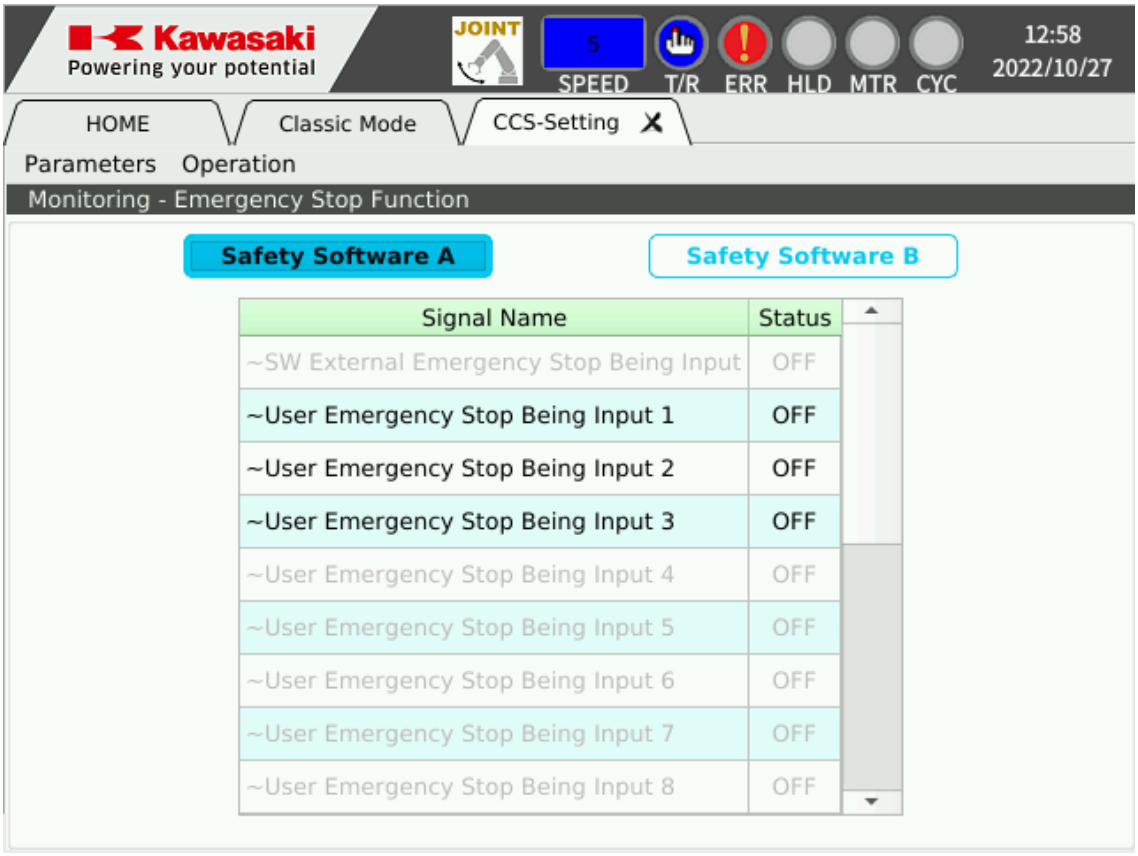
Select [Status] -> [Monitoring] -> [Protective Stop Function] in the setting application menu to monitor the status of internal safety output signals related to the protective monitoring function in each safety software. Signals for which the function is disabled are grayed out.



10. Emergency Stop Function

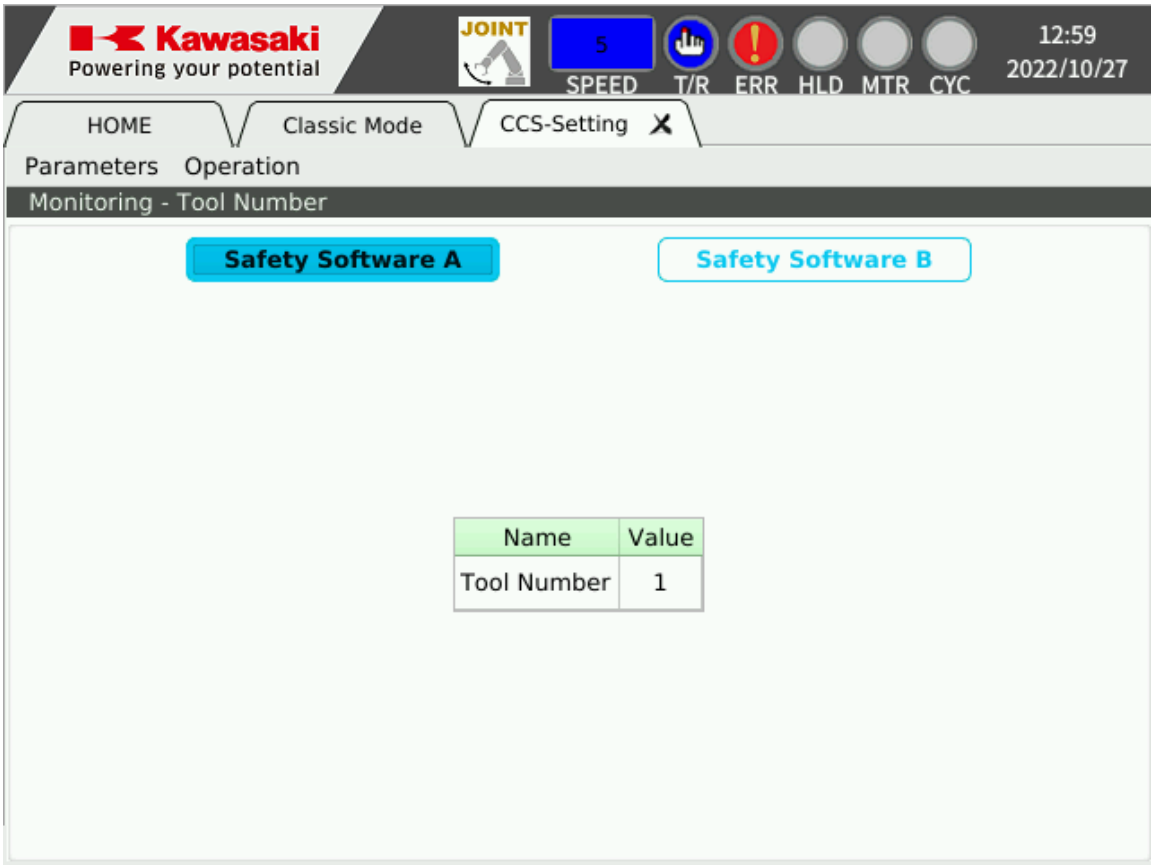
[SW external emergency stop/user emergency stop function is an option.]

Select [Status] -> [Monitoring] -> [Emergency Stop Function] in the setting application menu to monitor the status of internal safety output signals related to the emergency stop function in each safety software. Signals for which the function is disabled are grayed out.



11. Tool Number

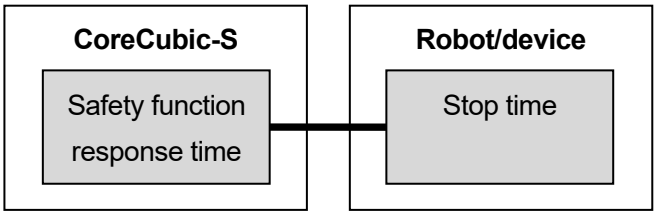
Select [Status] -> [Monitoring] -> [Tool Number] in the setting application menu to monitor tool number values in each safety software.



13 Response Time

The response time is the amount of time it takes for the robot/device or external device to stop following an OFF input from an externally installed safety sensor/switch, etc., or following activation of the CoreCubic-S safety function. Use this response time to calculate the safety distance as stipulated by standards such as ISO 13855, ISO 13857, etc. For details about safety distance, refer to Chapter 15.

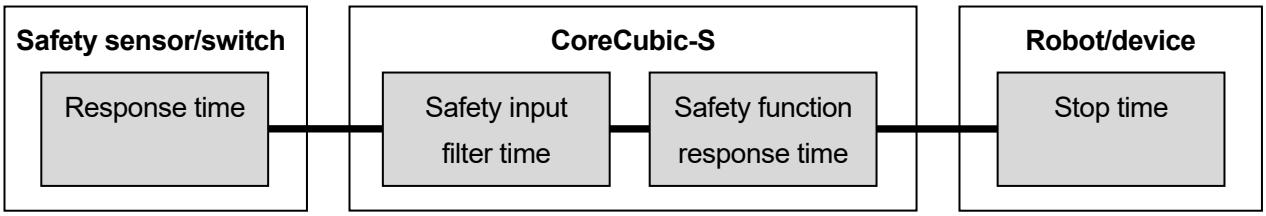
Stopping a Robot/Device via the CoreCubic-S Safety Function



Overall system response time =
(CoreCubic-S safety function response time: 20 ms) + (Robot/device stop time*1)

*1: For details about robot stop time, refer to Chapter 15.

Stopping a Robot/Device via a Safety Sensor/Switch Connected to a Fixed Safety Input/User Safety Input



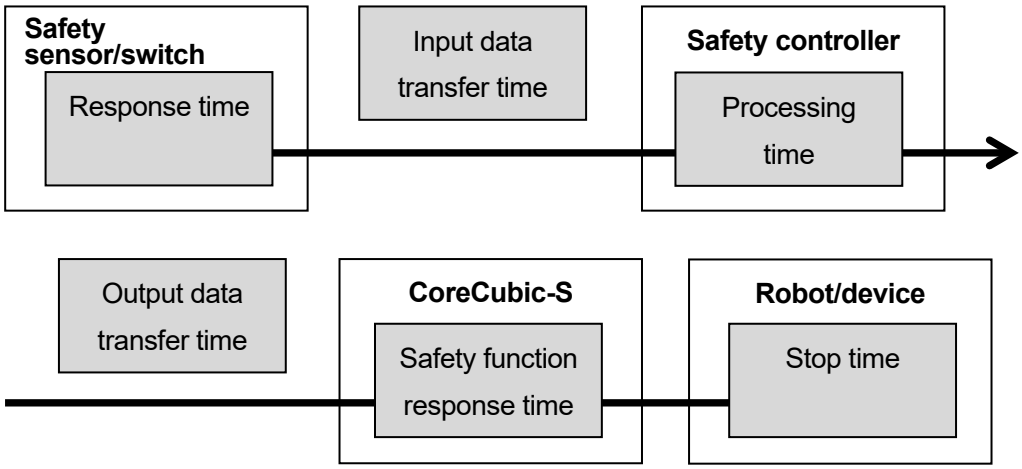
Overall system response time =
(Safety sensor/switch response time) + (Safety input filter time*1)
+ (CoreCubic-S safety function response time: 20 ms) + (Robot/device stop time*2)

*1: Filter time varies depending on the safety input used.
Fixed safety input (refer to section 6.2.1): 3 ms
User safety input (refer to section 10.1.1): the setting filter time (refer to section 10.1.1) + 1 ms
*2: For details about robot stop time, refer to Chapter 15.

[NOTE]

For the safety sensor/switch response time, use the value specified in the respective documentation for each device used.

Stopping a Robot/Device via a Safety Sensor/Switch Connected to an External Safety Controller



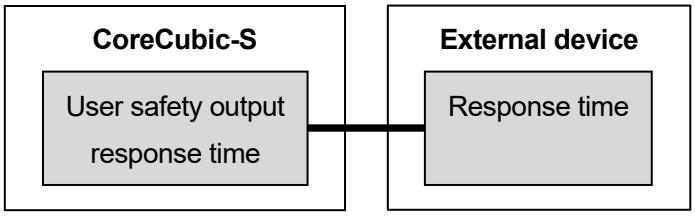
Overall system response time =
(Safety sensor/switch response time) + (Input data transfer time)
+ (Safety controller processing time) + (Output data transfer time)
+ (CoreCubic-S safety function reaction time: 20 ms) + (Robot/device stop time*1)

*1: For details about robot stop time, refer to Chapter 15.

[NOTE]

For the safety sensor/switch response time, input data transfer time, safety controller processing time, and output data transfer time, use the values specified in the respective documentation for each device used.

Stopping an External Device Connected to a User Safety Output via the CoreCubic-S Safety Function



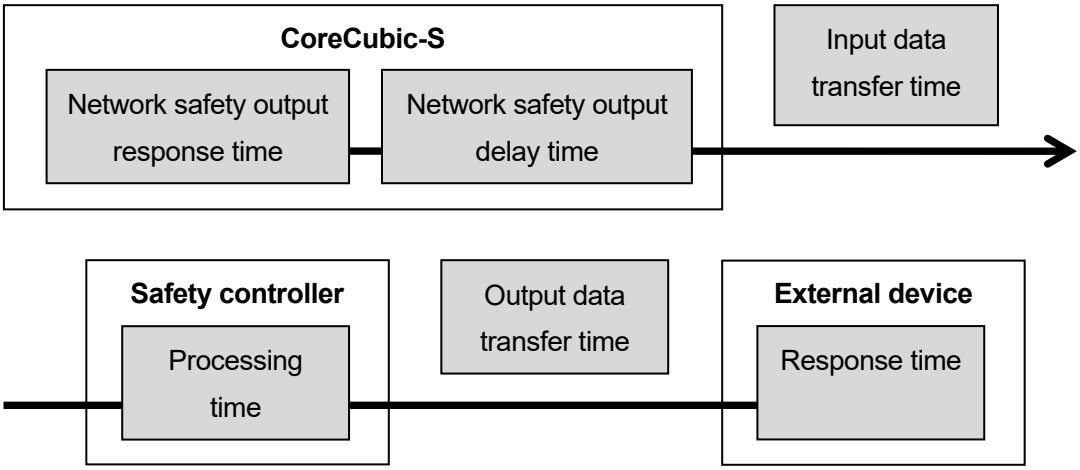
Overall system response time =
(User safety output response time*1) + (External device response time)

*1: Response time varies depending on the user safety output used.
User safety outputs 1 to 32 (output from the safety I/O board XOUT connector): 30 ms
User safety output 101 (output from the servo board X510 connector via the power sequence board): 20 ms

[NOTE]

For the external device response time, use the value specified in the respective documentation for each device used.

Stopping an External Device Connected to an External Safety Controller via the CoreCubic-S Safety Function



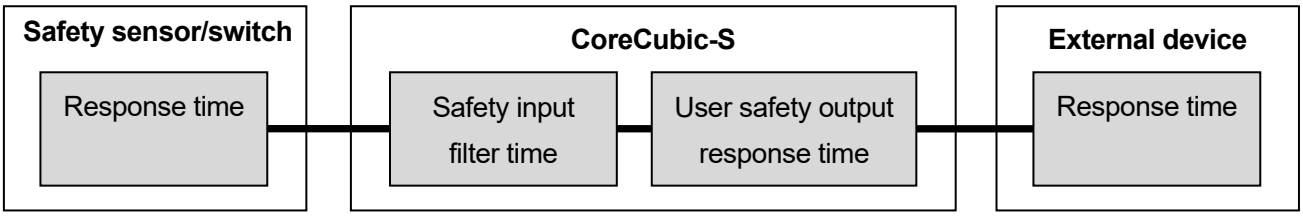
Overall system response time =
(Network safety output response time: 40 ms) + (Network safety output delay time*1)
+ (Input data transfer time) + (Safety controller processing time)
+ (Output data transfer time) + (External device response time)

*1: For EtherNet/IP Safety, the maximum delay is the RPI (Requested Packet Interval) set for the safety controller.

[NOTE]

For the input data transfer time, safety controller processing time, output data transfer time, and external device response time, use the values specified in the respective documentation for each device used.

Stopping an External Device Connected to a User Safety Output via a Safety Sensor/Switch Connected to a Fixed Safety Input/User Safety Input



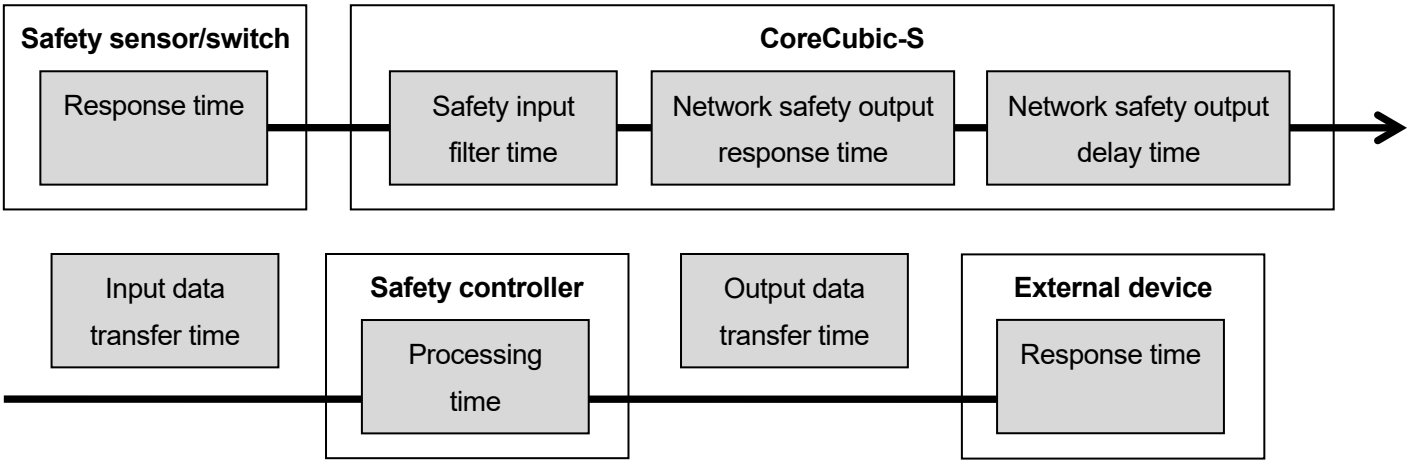
Overall system response time =
(Safety sensor/switch response time) + (Safety input filter time*1)
+ (User safety output response time*2) + (External device response time)

*1: Filter time varies depending on the safety input used.
Fixed safety input (refer to section 6.2.1): 3 ms
User safety input (refer to section 6.2.2): the setting filter time (refer to section 10.1.1) + 1 ms
*2: Response time varies depending on the user safety output used.
User safety outputs 1 to 32 (output from the safety I/O board XOUT connector): 30 ms
User safety output 101 (output from the servo board X510 connector via the power sequence board): 20 ms

[NOTE]

For the safety sensor/switch response time and external device response time, use the values specified in the respective documentation for each device used.

Stopping an External Device Connected to an External Safety Controller via a Safety Sensor/Switch Connected to a Fixed Safety Input/User Safety Input



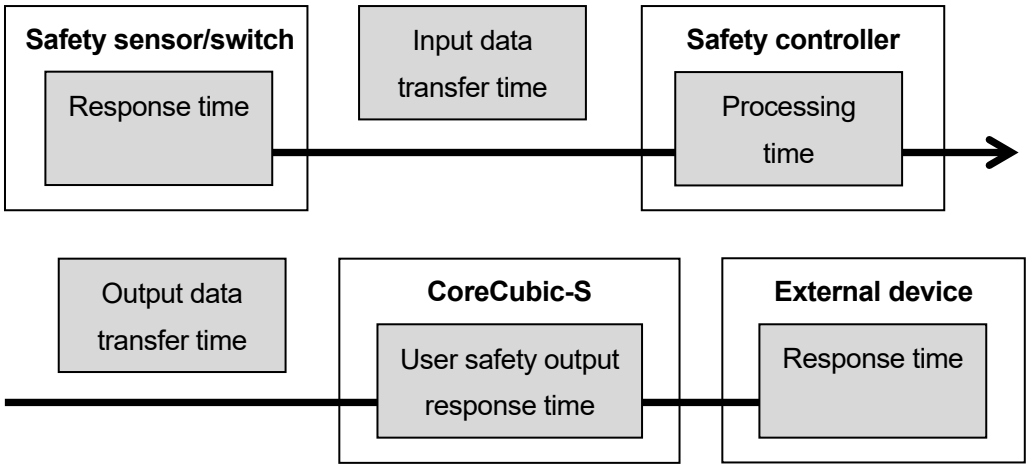
Overall system response time =
(Safety sensor/switch response time) + (Safety input filter time*1)
+ (Network safety output response time: 40 ms) + (Network safety output delay time*2)
+ (Input data transfer time) + (Safety controller processing time)
+ (Output data transfer time) + (External device response time)

*1: Filter time varies depending on the safety input used.
Fixed safety input (refer to section 6.2.1): 3 ms
User safety input (refer to section 6.2.2): the setting filter time (refer to section 10.1.1) + 1 ms
*2: For EtherNet/IP Safety, the maximum delay is the RPI (Requested Packet Interval) set for the safety controller.

[NOTE]

For the safety sensor/switch response time, input data transfer time, safety controller processing time, output data transfer time, and external device response time, use the values specified in the respective documentation for each device used.

Stopping an External Device Connected to a User Safety Output via a Safety Sensor/Switch Connected to an External Safety Controller



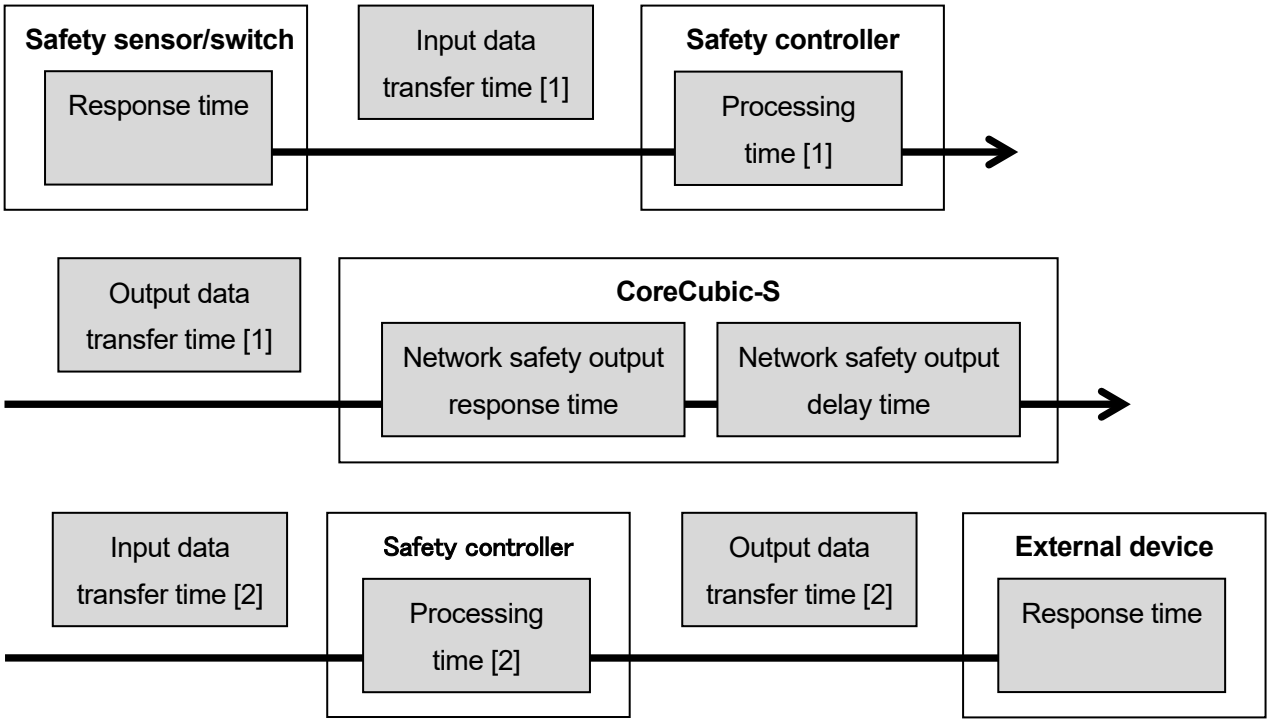
Overall system response time =
(Safety sensor/switch response time) + (Input data transfer time)
+ (Safety controller processing time) + (Output data transfer time)
+ (User safety output response time*1) + (External device response time)

*1: Response time varies depending on the user safety output used.
User safety outputs 1 to 32 (output from the safety I/O board XOUT connector): 30 ms
User safety output 101 (output from the servo board X510 connector via the power sequence board): 20 ms

[NOTE]

For the safety sensor/switch response time, input data transfer time, safety controller processing time, output data transfer time, and external device response time, use the values specified in the respective documentation for each device used.

Stopping an External Device Connected to an External Safety Controller via a Safety Sensor/Switch Connected to an External Safety Controller



Overall system response time =
(Safety sensor/switch response time) + (Input data transfer time [1])
+ (Safety controller processing time [1]) + (Output data transfer time [1])
+ (Network safety output response time: 40 ms) + (Network safety output delay time*1)
+ (Input data transfer time [2]) + (Safety controller processing time [2])
+ (Output data transfer time [2]) + (External device response time)

*1: For EtherNet/IP Safety, the maximum delay is the RPI (Requested Packet Interval) set for the safety controller.

[NOTE]

The safety controllers must be identical.

[NOTE]

For the safety sensor/switch response time, input data transfer time, safety controller processing time, output data transfer time, and external device response time, use the values specified in the respective documentation for each device used.



14 Troubleshooting

14.1 Error Display

Error message is displayed on the LCD panel of the teach pendant and the display of PC installed with terminal software (KRterm).

On the teach pendant, the error message is displayed on the error popup screen. The figure below shows an example of the error popup screen displayed on the teach pendant LCD panel.

Error popup screen →



The error detected by CoreCubic-S is displayed with the error message beginning with [detected location] and the robot motor power is shut off.
See the table below for how to reset the error.

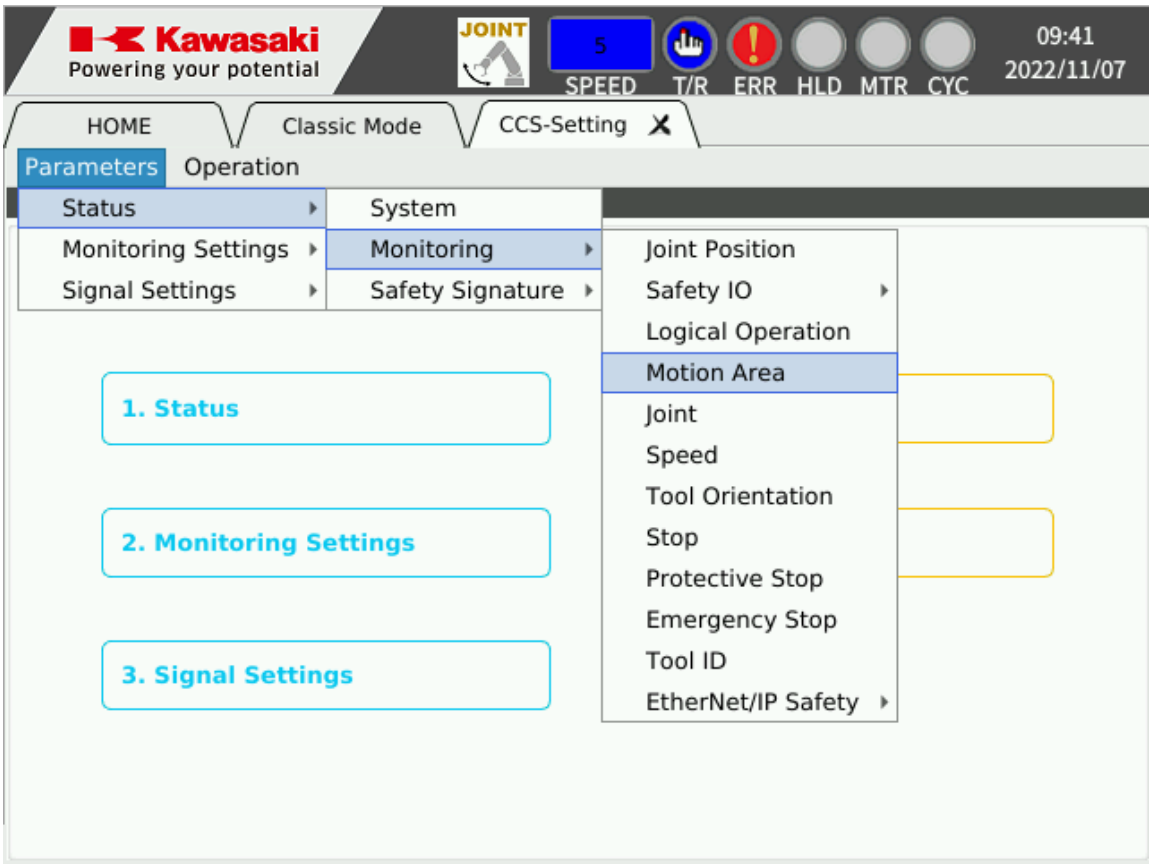
Classification	
Error resettable	Remove the cause of the error and press <Reset> on the teach pendant or the operation panel, or the Motor ON or A + Cycle Start, if necessary. The operation continues after the error is reset.
Error not resettable	Remove the cause of the error and turn OFF and ON the Controller Power.

14.2 Override Function

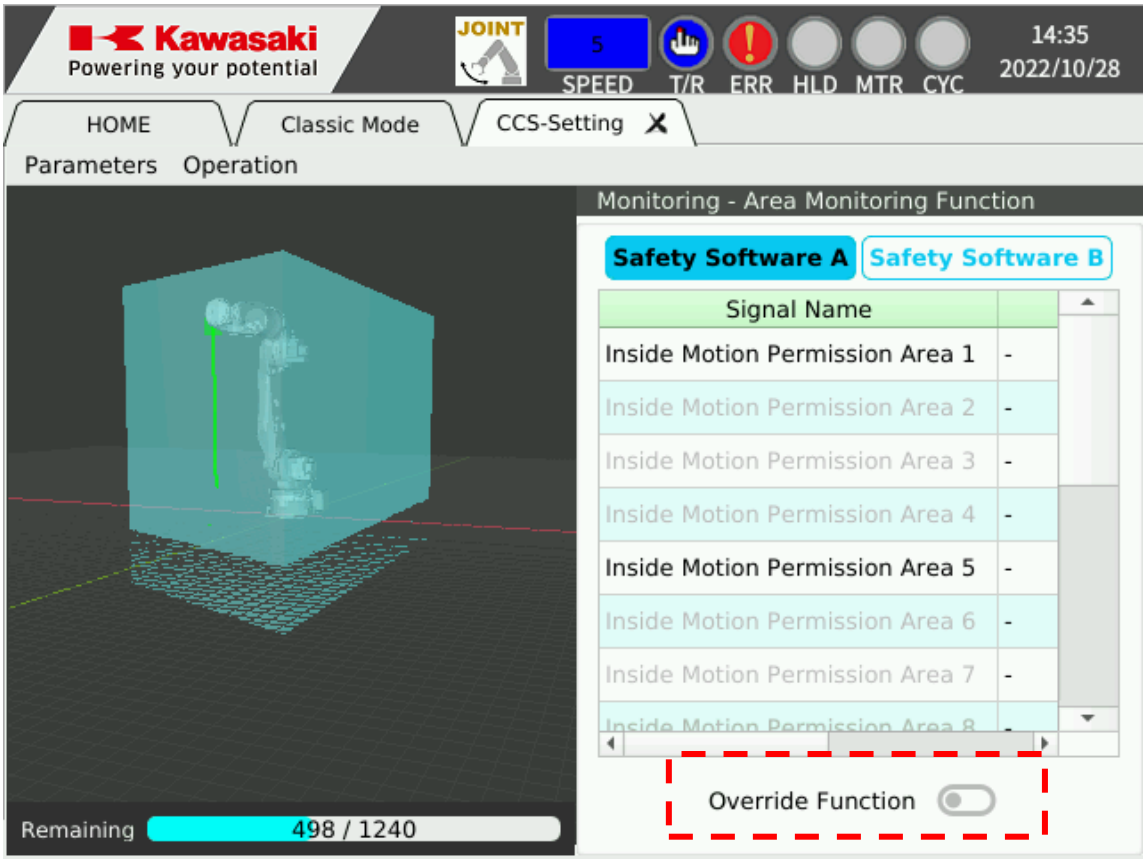
If the monitoring target is detected in the motion area monitoring function [Option], joint monitoring function [Option*], or tool orientation monitoring function [Option] as an error of outside the permitted range, you can use the override function to return to the permission range.
[Option*]: indicates that some functions are optional.

Use the override function in the following steps.

1. Switch to teach mode.
2. Display the monitoring screen of each monitoring function from the menu.
   The following is an example of the motion area monitoring function.



3. Press the "Override Function" button to turn ON the override function.



If it is not detected that the TP enable (trigger) switch is ON, for 10 seconds while the override function is ON, the override function is turned OFF. While the override function is ON, getting the TP enable (trigger) switch ON then OFF causes what the override function will be turned OFF. Moreover, the override function is turned OFF when you switch to another screen while the override function is ON.

4. Reset the error, and turn ON the motor.

5. Move the robot into the permitted range by manual operation in teach mode.

14.3 Mechanical, Electrical, and Other Factors and Countermeasures for Error Occurrence

This section explains the mechanical and electrical causes which are the common causes of error that occurs in CoreCubic-S. For the robot arm and the controller, the robot may move abnormally due to mechanical, electrical or other factors. As a result of the abnormal motion, for example, exceeding the permitted area will be detected by CoreCubic-S and result an error.

Main Cause

1. Mechanical Factor
   (1) Motor brake is abraded.
   (2) Reducer or gear, bearing is damaged.
   (3) The robot arm interfered with the jig, etc.
   (4) Cable, etc. was caught in the robot arm.
   (5) The backlash was small in the gear reducer part.
   (6) The load exceeded the maximum load of the robot.
   (7) Motion pattern included motion that exceeded the motor rate (counter teach etc.).
   (8) Motor brake was not released.
2. Electrical Factor
   (1) Disconnection or short circuit of motor power line phase U, V, W.
   (2) Malfunction of the power unit/amplifier board.
   (3) Malfunction of the servo board/main CPU board/power sequence board.
   (4) Abnormality in primary power voltage.
   (5) Malfunction of the motor. (Including brakes)
   (6) Incorrect wiring of motor power line, encoder line or brake line.
   (7) The robot moved abnormally due to disconnection of encoder harness or short circuit, or malfunction of the encoder.
   (8) Brake release switch pressed.
3. Made a sudden change in robot pose.

Countermeasure

1. If the robot arm has interfered, back the arm in teach mode and check if there are no problem in the operating part such as a reducer. Check also for any displacement by the deformation of the arm.
2. If any parts of the reducer have been damaged, replace the part if necessary.
3. Recheck the load and motion pattern of the robot.
4. If the error is caused by electrical factors, check the harness, servo board, power unit amplifier board, motor, etc., and replace it/them if necessary.
5. When a sudden change in joint values occurs, modify the taught data.

⚠ CAUTION

When the zeroing data is modified, the modification should be reflected in the safety software. Write the robot parameter to the safety software using setting application.

■Error code: D4300

Error message	[Safety I/O board(XX)] Voltage drop error of the CPLD power supply. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	This occurs when the safety I/O board has started normally, but the 3.3 V power supply on the board drops during operation.
Main Cause	• Disconnection or ground fault of the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board • Failure of the safety I/O board • Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities in the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board. 2. Replace the safety I/O board. 3. Replace the servo board.

■Error code: D4301

Error message	[Safety I/O board(XX)] Error of the clock. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	The clock frequency on the safety I/O board has deviated from the rated value.
Main Cause	• Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Replace the safety I/O board.

■Error code: D4302

Error message	[Safety I/O board(XX)] Error of the reset IC. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	This occurs when the reset IC of the safety I/O board indicates an error on start.
Main Cause	• Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Replace the safety I/O board.

■Error code: D4303

Error message	[Safety I/O board(XX)] The error reset input continues to be ON. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	The error reset input included in communication from the main CPU board or servo board to the safety I/O board has continued for more than a certain length of time.
Main Cause	· Failure of the main CPU board · Failure of the servo board · Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Replace the main CPU board. 2. Replace the servo board. 3. Replace the safety I/O board.

■Error code: D4304

Error message	[Safety I/O board(XX)] Error of the DIP switch. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	A mistake has been detected in the board address setting DIP switches (SW1, 2) on the safety I/O board.
Main Cause	• Incorrect setting of the safety I/O board DIP switches • Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the safety I/O board DIP switch (SW1, 2) settings and set them correctly.*1 2. Replace the safety I/O board.

*1 Refer to Chapter 6.6 for details on how to set DIP switches for the safety I/O board

⚠ WARNING

If the safety I/O board DIP switch settings are incorrect, safety functions may not function properly. Ensure safety functions are checked after changing DIP switch settings.

■Error code: D4305

Error message	[Safety software] Error of the communication with Power sequence board(1). (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	This error occurs when main CPU board or servo board is not receiving a signal from the power sequence board.
Main Cause	・ Failure of the power sequence board ・ Failure of the servo board ・ Failure of the main CPU board Such things as these may be attributable to the main cause.
Countermeasure	1. Replace the power sequence board. 2. Replace the servo board. 3. Replace the main CPU board.

■Error code: D4306

Error message	[Safety software] Error of the power supply of Safety software X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	This error occurs when there is an abnormality in the 24 V, 12 V, 5 V, 3.3 V, 1.8 V, or 1.0 V power supply generated on the servo board.
Main Cause	Check the causes of the following error codes in the Troubleshooting Manual of each controller. Error code: D1543, D1544, D1545, D1548, D1585, E1300
Countermeasure	Check the countermeasures of the following error codes in the Troubleshooting Manual of each controller. Error code: D1543, D1544, D1545, D1548, D1585, E1300

■Error code: D4307

Error message	[Safety software] Error of the synchronization between Safety software X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5,6 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	A synchronization error has occurred in communication between each safety software on the main CPU board and servo board. This is detected by the safety software.
Main Cause	・ An error occurred in the communication between boards due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: D4308

Error message	[Safety software] Error of the processing of Safety software X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	An error has occurred in the processing order in each safety software on the main CPU board and servo board. This is detected by the safety software.
Main Cause	・ An error occurred in the communication between boards due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: D4309

Error message	[Safety software] Error of the memory of Safety software X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	This error occurs when a fault occurs in the memory on the main CPU board or on the servo board.
Main Cause	・ An error occurred on the board due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: D4310

Error message	[Safety software] Error of the safety parameters (in ROM) of Safety software X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	An error has occurred in the safety parameters (data in CFast) used by each safety software on the main CPU board and servo board. This is detected by the safety software.
Main Cause	・ Failure of the CFast ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the CFast. 3. Replace the main CPU board. 4. Replace the servo board.

■Error code: D4311

Error message	[Safety software] Error of the safety parameters (in RAM) of Safety software X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	An error has occurred in the safety parameters (data in DRAM) used by each safety software on the main CPU board and servo board. This is detected by the safety software.
Main Cause	・ An error occurred on the board due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: D4312

Error message	[Safety software] Error of Safety software X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	An error has occurred in each safety software stored on CFast. This is detected by the safety software.
Main Cause	・ Failure of the CFast ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the CFast. 3. Replace the main CPU board. 4. Replace the servo board.

■Error code: D4313

Error message	[Safety software] Error of the clock of the encoder FPGA that communicates with Safety software X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	This error occurs when there is an abnormality in the FPGA clock for encoder communication on the servo board.
Main Cause	Failure of the servo board
Countermeasure	Replace the servo board.

■Error code: D4314

Error message	[Safety software] Error of the communication with Safety I/O board (X). (0x XXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Not possible
Contents	The main CPU board or servo board has detected an error in the communication data from the safety I/O board.
Main Cause	• Error of the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board • Incorrect setting of the safety I/O board DIP switches • Incorrect setting of parameters (number of I/O boards setting) • Failure of the safety I/O board • Failure of the servo board • Failure of the main CPU board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities in the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board. 2. Check the safety I/O board DIP switch (SW1, 2) settings and set them correctly.*1 3. Check the parameter settings and set them correctly. 4. Replace the safety I/O board. 5. Replace the servo board. 6. Replace the main CPU board.

*1 Refer to Chapter 6.6 for details on how to set DIP switches for the safety I/O board

⚠ WARNING

If parameter settings or safety I/O board DIP switch settings are incorrect, safety functions may not function properly. Ensure safety functions are checked after setting parameters and changing DIP switch settings.

■Error code: D4316

Error message	[Safety software] Error of the setting of Power sequence board(1)'s DIP switch XX. (0x XXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Not possible
Contents	Incorrect DIP switch settings were detected on the power sequence board.
Main Cause	• Incorrect setting of the power sequence board DIP switches • Failure of the power sequence board • Failure of the servo board • Failure of the main CPU board Such things as these may be attributable to the main cause.
Countermeasure	1. Check whether the setting values of the DIP switches on the power sequence board are correct. 2. Replace the power sequence board. 3. Replace the servo board. 4. Replace the main CPU board.

Note Refer to Chapter 9.1.1 of this manual for how to set DIP switch 6 on the power sequence board.

Note For DIP switch settings on other power sequence boards, refer to the Power Sequence Board chapter in each controller's Troubleshooting Manual.

⚠ WARNING

If the parameter settings or power sequence board DIP switch settings are incorrect, safety functions may not function properly. Ensure safety functions are checked after setting parameters and changing DIP switch settings.

■Error code: D4317

Error message	[Safety software] Initialization error of Safety I/O board (X). (0x XXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Not possible
Contents	An error in initialization of the safety I/O board was detected on power supply startup.
Main Cause	• Error of the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board • Incorrect setting of the safety I/O board DIP switches • Incorrect setting of parameters (number of I/O boards setting) • Failure of the safety I/O board • Failure of the servo board • Failure of the main CPU board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities in the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board. 2. Check the safety I/O board DIP switch (SW1, 2) settings and set them correctly.*1 3. Check the parameter settings and set them correctly. 4. Replace the safety I/O board. 5. Replace the servo board. 6. Replace the main CPU board.

*1 Refer to Chapter 6.6 for details on how to set DIP switches for the safety I/O board

⚠ WARNING

If parameter settings or safety I/O board DIP switch settings are incorrect, safety functions may not function properly. Ensure safety functions are checked after setting parameters and changing DIP switch settings.

■Error code: D4318

Error message	Error of the setting of Power sequence board(X)'s DIP switch XX.
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Not possible
Contents	Incorrect DIP switch settings were detected on the power sequence board.
Main Cause	• Incorrect setting of the power sequence board DIP switches • Failure of the power sequence board • Failure of the servo board • Failure of the main CPU board Such things as these may be attributable to the main cause.
Countermeasure	1. Check whether the setting values of the DIP switches on the power sequence board are correct. 2. Replace the power sequence board. 3. Replace the servo board. 4. Replace the main CPU board.

Note For DIP switch settings on power sequence boards, refer to the Power Sequence Board Chapter in each controller's Troubleshooting Manual.

⚠ WARNING

If the parameter settings or power sequence board DIP switch settings are incorrect, safety functions may not function properly. Ensure safety functions are checked after setting parameters and changing DIP switch settings.

■Error code: D4320

Error message	Initialization error of Safety software.
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Not possible
Contents	An error has occurred in the activation process of the safety software.
Main Cause	• Failure of the main CPU board • Failure of the servo board • Failure of the CFast Such things as these may be attributable to the main cause.
Countermeasure	1. Replace the main CPU board. 2. Replace the servo board. 3. Replace the CFast.

■Error code: E4300

Error message	[Power sequence board(1)] Error of the communication with Safety software X. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5,6 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Possible
Contents	The power sequence board detected an error in the communication data from the main CPU board or servo board.
Main Cause	・ AS software, servo software and safety software versions are inconsistent. ・ Failure of the power sequence board ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check each software version. 2. Replace the power sequence board. 3. Replace the main CPU board. 4. Replace the servo board.

■Error code: E4301

Error message	[Power sequence board(1)] Error of the setting by Safety software A/B. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5,6 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Possible
Contents	An error has been detected in the safety parameters set on the power sequence board.
Main Cause	・ Failure of the power sequence board ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Replace the power sequence board. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: E4302

Error message	[Safety I/O board(XX)] Pulse diagnostics error of user safety outputXX. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5,6 OFF User Safety Output: Only channel with errors OFF Network Safety Output: Not change
Error reset	Possible
Contents	A pulse diagnostics error is detected in the user-safety output of the safety I/O board.
Main Cause	• An abnormality in the wiring connected to the XOUT1 or XOUT2 connector on the safety I/O board, or there is a capacitive load (capacitor, etc.) connected to the output circuit. • Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities with the wiring connected to the XOUT1 or XOUT2 connector on the safety I/O board.*1 2. Replace the safety I/O board.

*1 Refer to Chapter 9.2 for details on safety I/O board wiring methods.

■Error code: E4303

Error message	[Safety I/O board(XX)] Discrepancy of the dual output of user safety outputXX. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5,6 OFF User Safety Output: Only channel with errors OFF Network Safety Output: Not change
Error reset	Possible
Contents	A mismatch between the output state and feedback state was detected in the user safety output of the safety I/O board.
Main Cause	• An abnormality in the wiring connected to the XOUT1 or XOUT2 connector on the safety I/O board • Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities with the wiring connected to the XOUT1 or XOUT2 connector on the safety I/O board.*1 2. Replace the safety I/O board.

*1 Refer to Chapter 9.2 for details on safety I/O board wiring methods.

■Error code: E4304

Error message	[Safety I/O board(XX)] Pulse diagnostics error of user safety inputXX. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * As a result of the safety input of the error Ch. being turned OFF, the related safety output is turned OFF.
Error reset	Possible
Contents	There was a short-circuit or ground fault in the wiring, or error in an external device connected, or an abnormality in the safety input of the safety I/O board. This error is only detected when "Input Test Pulse Diagnostics" (Refer to Section 10.1.1) is enabled for the corresponding safety input channel.
Main Cause	• A short circuit between the power supply and wiring connected to the user safety input of the XIN1 or XIN2 connector on the safety I/O board, or a short circuit between duplexed inputs. * Each safety I/O board shares test pulses for user safety input. If a wiring fault occurs in a test pulse output line, this fault may also occur on other channels where the input is ON. (For example, if a short circuit between power occurs on ch1, this error may also occur on channels where inputs from ch2 to 8 are ON.) • Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities with the wiring connected to the user safety input of the XIN1 or XIN2 connector on the safety I/O board and with external devices. Also, check that there are no abnormalities in the wiring of the other channels that share the test pulse. 2. Replace the safety I/O board.

* Refer to Chapter 9.2 for details on safety I/O board wiring methods.

[NOTE]

When performing recovery error processing, remove the cause of the error and input the inactive signal (relevant safety input is OFF) before resetting the error.

■Error code: E4306

Error message	[Safety I/O board(XX)] Error of the communication with XX. (0xXXXX)(0xXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Possible
Contents	The safety I/O board detected an error in the communication data from the main CPU board or servo board.
Main Cause	• Error of the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board • Failure of the safety I/O board • Failure of the servo board • Failure of the main CPU board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that there are no abnormalities in the harness connected to the XDJ_IN or XDJ_OUT connector on the safety I/O board. 2. Replace the safety I/O board. 3. Replace the servo board. 4. Replace the main CPU board.

■Error code: E4307

Error message	[Servo board(XX)] Error of the communication with Safety I/O board(XX). (0xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: Not change
Error reset	Possible
Contents	A communication error was detected between the safety I/O board and the servo board by the servo software on the servo board. The code indicates whether the CPLD that detected the error on the safety I/O board is #A or #B. Code notation: CPLD #A: (0x01), #B: (0x10), or #A/#B: (0x11).
Main Cause	・ The settings for the number of safety I/O boards and the number of safety I/O boards connected are different. ・ Mistake in setting of display switch on the safety I/O board. ・ Abnormality in the connection harness between the servo board and safety I/O board (or between safety I/O boards). ・ Failure of the safety I/O board. ・ Failure of the servo board. Such things as these may be attributable to the main cause.
Countermeasure	1. Check that the CoreCubic-S settings and the total number of connected safety I/O boards match. 2. Check the safety I/O board DIP switch settings. (If the same settings are used even though multiple safety I/O boards are in use, communication will not be possible.) 3. Check the connections between safety I/O board controllers and the harness connections between safety I/O boards. 4. Replace the safety I/O board. 5. Replace the servo board.

■Error code: E4308

Error message	[Servo board(XX)] Error of the communication packet size from Safety I/O board(XX). (0xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: Not change
Error reset	Possible
Contents	An error is detected when there is an abnormality in serial communication with the safety I/O board (SV detection error). The code indicates whether CPLD #A or #B detected the error. Code notation: CPLD #A: (0x01), #B: (0x10), or #A/#B: (0x11)
Main Cause	The size of the data received from the safety I/O board does not match the expected size due to malfunction of the safety I/O board or abnormal wiring of the safety I/O board.
Countermeasure	1. Check that the CoreCubic-S settings and the total number of connected safety I/O boards match. 2. Check the connections between safety I/O board controllers and the connections between the safety I/O boards. 3. Check the safety I/O board DIP switch settings. If different boards have the same settings, communication will not be possible. 4. Replace the safety I/O board where the error is occurring.

■Error code: E4309

Error message	[Safety software] Deceleration monitoring error of JT XX. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	A deceleration monitoring error was detected for the joint during deceleration stop monitoring. During a deceleration stop, the safety software monitors the speed of each joint.
Main Cause	1. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4310

Error message	[Safety software] Stop monitoring error of JT XX. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	The joint was operated during stop monitoring.
Main Cause	1. Joint was moved during stop monitoring, either by manual operation or by program execution 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the stop monitoring settings, wiring (including external equipment) and usage are correct. 3. Change the program so that it does not operate the joint during stop monitoring. 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4311

Error message	[Safety software] On-arm area monitoring model XX became outside motion permission area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot left the motion permission area. The area monitoring model number of the arm that left the motion permission area and the motion permission area settings are displayed in the error message.
Main Cause	1. The robot has exceeded the motion permission area due to movement by manual operation or program execution. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. The robot is outside the motion permission area, so use the following procedure to move it inside of the motion permission area by using the override function. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot into the motion permission area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check whether the motion permission area is set correctly. If correct, modify the teaching setting and change the program. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4312

Error message	[Safety software] On-tool area monitoring model XX (XX tool number X) became outside motion permission area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot left the motion permission area. The area monitored model number of the tool that left the motion permission area and the motion permission area settings are displayed in the error message. (XX Tool number X) displays one of the following (1) to (3): (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) is displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is tool ID2, (1) is displayed.
Main Cause	1. The robot has exceeded the motion permission area due to movement by manual operation or program execution. 2. Malfunction due to a mechanical, electrical or other factor.

Countermeasure	1. The robot is outside the motion permission area, so use the following procedure to move it inside of the motion permission area by using the override function. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot into the motion permission area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check whether the motion permission area is set correctly. If correct, modify the teaching setting and change the program. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4313

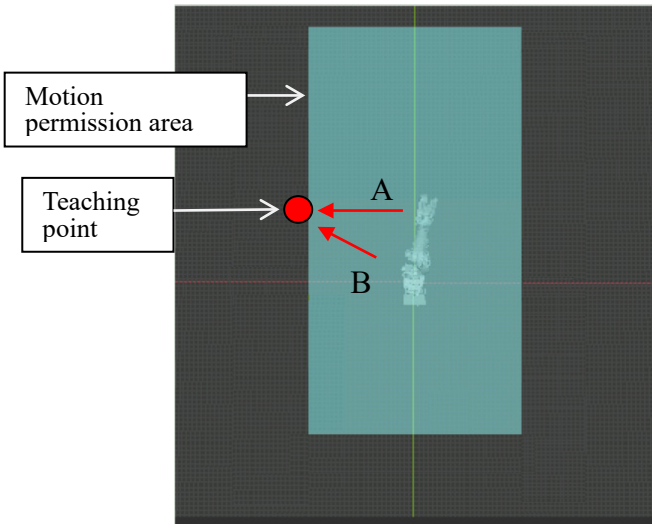
Error message	[Safety software] On-arm area monitoring model XX became inside motion prohibition area X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot entered the motion prohibited area. The area monitored model number of the arm that entered the prohibited area and the prohibited area settings are displayed in the error message.
Main Cause	1. The robot has entered the motion prohibited area due to movement by manual operation or program execution. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. The robot is inside the motion prohibited area, so use the following procedure to move it outside of the motion prohibited area by using the override function. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot out of the motion prohibited area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check whether the motion prohibited area is set correctly. If correct, modify the teaching setting and change the program. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4314

Error message	[Safety software] On-tool area monitoring model XX (XX tool number X) became inside motion prohibition area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot entered the motion prohibited area. The area monitored model number of the tool that entered the prohibited area and the prohibited area settings are displayed in the error message. (XX Tool number X) displays one of the following (1) to (3): (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) is displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is tool ID2, (1) is displayed.
Main Cause	1. The robot has entered the motion prohibited area at a position due to movement by manual operation or program execution. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. The robot is inside the motion prohibited area, so use the following procedure to move it outside of the motion prohibited area by using the override function. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot out of the motion prohibited area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check whether the motion prohibited area is set correctly. If correct, modify the teaching setting and change the program. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4315

Error message	[Safety software] The predicted stop position of on-arm area monitoring model XX became outside motion permission area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot was predicted to leave the motion permission area by the stop position prediction function. The area monitored model number of the arm that left the motion permission area and the set of motion permission areas are displayed in the error message.
Main Cause	1. The robot was close to the edge of the motion permission area. 2. Malfunction due to a mechanical, electrical or other factor.
Counter-measure	1. Execute an error reset. The stop position prediction function resets the error when stopped in the motion permission area. 2. Check whether the motion permission area settings, wiring (including external equipment) and usage are correct. If correct, modify the teaching setting and change the program. 3. When stopped by the stop position prediction function, refer to the following when modifying the teaching setting. (1) Reduce the speed of the step in which the error occurs. (2) Increase the distance between the edges of the motion permission area and the teaching point. (3) Tilt the direction of motion that approaches the edge of the motion permission area away from the vertical direction with respect to the space. (The example in the figure below shows the operation of B, not A.) 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.


Motion
permission area
Teaching
point
A
B

■Error code: E4316

Error message	[Safety software] The predicted stop position of on-tool area monitoring model XX (XX tool number X) became outside motion permission area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot was predicted to leave the motion permission area by the stop position prediction function. The area monitored model number of the tool that left the motion permission area and the set of motion permission areas are displayed in the error message. (XX Tool number X) displays one of the following (1) to (3): (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) is displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is tool ID2, (1) is displayed.
Main Cause	1. The robot was close to the edge of the motion permission area. 2. Malfunction due to a mechanical, electrical or other factor.

Countermeasure	1. Execute an error reset. The stop position prediction function resets the error when stopped in the motion permission area. 2. Check whether the motion permission area settings, wiring (including external equipment) and usage are correct. If correct, modify the teaching setting and change the program. 3. When stopped by the stop position prediction function, refer to the following when modifying the teaching setting. (1) Reduce the speed of the step in which the error occurs. (2) Increase the distance between the edges of the motion permission area and the teaching point. (3) Tilt the direction of motion that approaches the edge of the motion permission area away from the vertical direction with respect to the space. (Refer to E4315) 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4317

Error message	[Safety software] The predicted stop position of on-arm area monitoring model XX became inside motion prohibition area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot was predicted to enter the prohibited area by the stop position prediction function. The area monitored model number of the arm that entered the prohibited area and the prohibited area settings are displayed in the error message.
Main Cause	1. The robot was close to the motion prohibited area. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. The stop position prediction function resets the error when stopped outside of the motion prohibited area. 2. Check whether the motion prohibited area is set correctly. If correct, modify the teaching setting and change the program. 3. When stopped by the stop position prediction function, refer to the following when modifying the teaching setting. (1) Reduce the speed of the step in which the error occurs. (2) Increase the distance between the edge of the motion prohibited area and the teaching point. (3) Tilt the direction of motion that approaches the edge of the motion prohibited area away from the vertical direction with respect to the space. (Refer to E4315) 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4318

Error message	[Safety software] The predicted stop position of on-tool area monitoring model XX (XX tool number X) became inside motion prohibition area X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Motion Area Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The safety software detected that the robot was predicted to enter the prohibited area by the stop position prediction function. The area monitored model number of the tool that entered the prohibited area and the prohibited area settings are displayed in the error message. (XX Tool number X) displays one of the following (1) to (3): (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) is displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is tool ID2, (1) is displayed.
Main Cause	1. The robot was close to the motion prohibited area. 2. Malfunction due to a mechanical, electrical or other factor.

Countermeasure	1. Execute an error reset. The stop position prediction function resets the error when stopped outside of the motion prohibited area. 2. Check whether the motion prohibited area is set correctly. If correct, modify the teaching setting and change the program. 3. When stopped by the stop position prediction function, refer to the following when modifying the teaching setting. (1) Reduce the speed of the step in which the error occurs. (2) Increase the distance between the edge of the motion prohibited area and the teaching point. (3) Tilt the direction of motion that approaches the edge of the motion prohibited area away from the vertical direction with respect to the space. (Refer to E4315) 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4319

Error message	[Safety software] JT XX became outside motion permission joint range of constant joint monitoring. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Joint Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The axis with the displayed axis number is outside the motion permission joint range of the constant joint monitoring. This is detected by the safety software.
Main Cause	1. The zeroing value was changed to an improper value due to motor replacement, etc., and the axis value exceeded the constant joint monitoring range (motion limits) 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. If the zeroing value is correct, use the override switch to move it within the constant joint monitoring range with the following procedure. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) Continue to hold the override switch and manually move the robot to the constant joint monitoring range in teach mode. (3) Disable the override switch and make sure no errors occur. 2. If the zeroing value is inappropriate, conduct zeroing. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4320

Error message	[Safety software] JT XX became outside motion permission joint range of selective joint monitoring X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Joint Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The axis with the displayed axis number is outside the motion permission joint range of the selected joint monitoring. This is detected by the safety software.
Main Cause	1. The selected joint monitoring range has been exceeded at a position due to movement by manual operation or program execution 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Use the override switch to move it into the selected joint monitoring range with the following procedure. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot into the selected joint monitoring area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check that the selected joint monitoring settings, wiring (including external equipment) and usage are correct. If correct, modify the teaching setting and change the program. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4321

Error message	[Safety software] JT XX became inside motion prohibition joint range of selective joint monitoring X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Joint Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The axis with the displayed axis number has entered the motion prohibited joint range of the selected joint monitoring. This is detected by the safety software.
Main Cause	1. The selected joint monitoring range has entered the motion prohibited range at a position due to movement by manual operation or program execution 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Use the override switch to move it out of the selected joint monitoring movement prohibited area with the following procedure. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot out of the selected joint monitoring motion prohibited area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check that the selected joint monitoring settings, wiring (including external equipment) and usage are correct. If correct, modify the teaching setting and change the program. 3. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4322

Error message	[Safety software] On-arm/device speed monitoring point XX exceeded the setting speed of teach mode speed monitoring. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	Speed monitoring point X on the arm or device has exceeded the set speed for teach mode speed monitoring. This is detected by the safety software. The arm or device speed monitoring point number that exceeded the set speed is displayed in the error message.
Main Cause	1. The speed has exceeded the set speed, either through manual operation or by program execution. 2. Incorrect load settings. 3. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the teach mode speed monitoring settings and usage are correct. 3. If load settings are incorrect, set the load correctly. 4. Reduce the teach speed for manual operation. 5. Reduce the speed in the program for program execution. 6. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4323

Error message	[Safety software] XXXX (XX tool number X) exceeded the setting speed of teach mode speed monitoring. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	Speed monitoring point on the TCP or tool has exceeded the set speed for teach mode speed monitoring. This is detected by the safety software. The TCP or tool speed monitoring point number that exceeded the set speed and the tool number when an abnormality is detected is displayed in the error message.

Contents	1. Message of the location where the robot exceeded the set speed The following points or positions are used by the safety software for speed monitoring. "XXXX" in the message "XXXX (XX Tool number X)" displays one of the following (1) to (3): (1) TCP (2) Speed monitoring points 1 to 20 on the tool (3) TCP and speed monitoring points 1 to 20 on the tool 2. Message of the tool number when an abnormality is detected The safety software calculates the position using the tool of the present tool number (tool number by tool ID input) and command tool number (tool number selected by the AS software). The message differs depending on the information of the tool that detected the abnormality. "(XX Tool number X)" in the message "XXXX (XX Tool number X)" displays one of the following: (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 Here, (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) are displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is ID2, "tool number" is displayed. 3. Error message example (1) When the TCP (command tool number 1) exceeds the set speed. [The TCP (command tool number 1) exceeded the set speed for teach mode speed monitoring.] (2) When the speed monitoring point 1 on the tool (present tool number 1) exceeds the set speed. [The speed monitoring point 1 on the tool (present tool number 1) exceeded the set speed for teach mode speed monitoring.] (3) When speed monitoring points 1, 3 and 5 on the TCP and tool (command present tool number 1) exceeds the set speed. [The speed monitoring points 1, 3 and 5 on the TCP and tool (present tool number 1) exceeded the speed set in teach mode speed monitoring.]

Main Cause	1. The speed has exceeded the set speed, either through manual operation or by program execution. 2. Incorrect load settings. 3. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the teach mode speed monitoring settings and usage are correct. 3. If load settings are incorrect, set the load correctly. 4. Reduce the teach speed for manual operation. 5. Reduce the speed in the program for program execution. 6. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4324

Error message	[Safety software] On-arm/device speed monitoring point XX exceeded the setting speed of fast check mode speed monitoring.(0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	Speed monitoring point X on the arm or device has exceeded the set speed for fast check mode speed monitoring. This is detected by the safety software. The arm or device speed monitoring point number that exceeded the set speed is displayed in the error message.
Main Cause	1. The speed exceeded the set speed due to operation in fast check mode. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the fast check mode speed monitoring settings and usage are correct. 3. Reduce the set speed for fast check mode. 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4325

Error message	[Safety software] XXXX (XX tool number X) exceeded the setting speed of fast check mode speed monitoring. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	Speed monitoring point on the TCP or tool has exceeded the set speed for fast check mode speed monitoring. This is detected by the safety software. The TCP or tool speed monitoring point number that exceeded the set speed and the tool number when an abnormality is detected is displayed in the error message.

Contents	1. Message of the location where the robot exceeded the set speed The following points or positions are used by the safety software for speed monitoring. "XXXX" in the message "XXXX (XX Tool number X)" displays one of the following (1) to (3): (1) TCP (2) Speed monitoring points 1 to 20 on the tool (3) TCP and speed monitoring points 1 to 20 on the tool 2. Message of the tool number when an abnormality is detected The safety software calculates the position using the tool of the present tool number (tool number by tool ID input) and command tool number (tool number selected by the AS software). The message differs depending on the information of the tool that detected the abnormality. "(XX Tool number X)" in the message "XXXX (XX Tool number X)" displays one of the following: (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 Here, (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) are displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is ID2, "tool number" is displayed. 3. Error message example (1) When the TCP (command tool number 1) exceeds the set speed. [The TCP (command tool number 1) exceeded the set speed for fast check mode speed monitoring.] (2) When the speed monitoring point 1 on the tool (present tool number 1) exceeds the set speed. [The speed monitoring point 1 on the tool (present tool number 1) exceeded the set speed for fast check mode speed monitoring.] (3) When speed monitoring points 1, 3 and 5 on the TCP and tool (command present tool number 1) exceeds the set speed. [The speed monitoring points 1, 3 and 5 on the TCP and tool (present tool number 1) exceeded the set speed in fast check mode speed monitoring.]

Main Cause	1. The speed exceeded the set speed due to operation in fast check mode. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the fast check mode speed monitoring settings and usage are correct. 3. Reduce the set speed for fast check mode. 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4326

Error message	[Safety software] On-arm/device speed monitoring point XX exceeded the setting speed of user speed monitoring X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	Speed monitoring point on the arm or device has exceeded the set speed for user speed monitoring. This is detected by the safety software. The arm or device speed monitoring point number that exceeded the set speed and the user speed monitoring setting is displayed in the error message.
Main Cause	1. The speed has exceeded the set speed, either through manual operation or by program execution. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the user speed monitoring settings and usage are correct. 3. Reduce the teach speed for manual operation. 4. Reduce the speed in the program for program execution. 5. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4327

Error message	[Safety software] XXXX (XX tool number X) exceeded the setting speed of user speed monitoring X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	Speed monitoring point on the TCP or tool has exceeded the set speed for user speed monitoring. This is detected by the safety software. The TCP or tool speed monitoring point number that exceeded the set speed, the tool number when an abnormality is detected, and the user speed monitoring setting number is displayed in the error message.

Contents	
	1. Message of the location where the robot exceeded the set speed The following points or positions are used by the safety software for speed monitoring. "XXXX" in the message "XXXX (XX Tool number X)" displays one of the following (1) to (3): (1) TCP (2) Speed monitoring points 1 to 20 on the tool (3) TCP and speed monitoring points 1 to 20 on the tool 2. Message of the tool number when an abnormality is detected The safety software calculates the position using the tool of the present tool number (tool number by tool ID input) and command tool number (tool number selected by the AS software). The message differs depending on the information of the tool that detected the abnormality. "(XX Tool number X)" in the message "XXXX (XX Tool number X)" displays one of the following: (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 Here, (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) are displayed when an error is detected by either the command tool or the present tool. Note When the tool ID specification is ID2, "tool number" is displayed. 3. Error message example (1) When the TCP (command tool number 1) exceeded the set speed for user monitoring 1. [The TCP (command tool number 1) exceeded the set speed for user speed monitoring 1.] (2) When the speed monitoring point 1 on the tool (present tool number 1) exceeds the set speed for user speed monitoring 2. [The speed monitoring point 1 on the tool (present tool number 1) exceeded the set speed in user speed monitoring 2.] (3) When speed monitoring points 1, 3 and 5 on the TCP and tool (command tool number 1 and present tool number 1) exceeds the set speed for user monitoring 3. [The speed monitoring points 1, 3 and 5 on the TCP and tool (tool number 1) exceeded the set speed in user speed monitoring 3.]

Main Cause	1. The speed has exceeded the set speed, either through manual operation or by program execution. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the user speed monitoring settings and usage are correct. 3. Reduce the teach speed for manual operation. 4. Reduce the speed in the program for program execution. 5. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4328

Error message	[Safety software] JT XX exceeded the setting speed of user speed monitoring X. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Speed Monitoring function is assigned is turned OFF.
Error reset	Possible
Contents	The speed of the axis with the displayed axis number has exceeded the set speed in user speed monitoring. This is detected by the safety software. The axis number that exceeded the set speed and the user speed monitoring setting is displayed in the error message.
Main Cause	1. The speed has exceeded the set speed, either through manual operation or by program execution. 2. Malfunction due to a mechanical, electrical or other factor.
Countermeasure	1. Execute an error reset. 2. Check that the user speed monitoring settings and usage are correct. 3. Reduce the teach speed for manual operation. 4. Reduce the speed in the program for program execution. 5. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4329

Error message	[Safety software] The tool (XX tool number X) became outside tool orientation monitoring X's range XX. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * The safety output Ch. to which the signal related to Tool Orientation Monitoring function is assigned is turned OFF.
Error reset	Possible

Contents	1. Message of the tool number when an abnormality is detected The safety software calculates the tool orientation using the tool of the present tool number (tool number by tool ID input) and command tool number (tool number selected by the AS software). The message differs depending on the information of the tool that detected the abnormality, and one of the following, (1) to (3), is displayed in "(XX tool number X)" in the message. (1) Tool number 1 to 32 (2) Command tool number 1 to 32 (3) Present tool number 1 to 32 Here, (1) is displayed when an error is detected by both the command tool and the present tool. (2) or (3) are displayed when an error is detected by either the command tool or the present tool. 2. Tool orientation monitoring number message The tool orientation monitoring setting number is displayed in the "Tool orientation monitoring X" in the message. 3. Tool orientation range number message The tool orientation range number is displayed in the "Range X" in the message. Multiple numbers are displayed when errors are detected in several tool orientations at the same time. 4. Error message example (1) When the tool (command tool number 1 and present tool number 1) leaves range 1 of the tool orientation monitoring setting 1. [The tool (tool number 1) has left range 1 of tool orientation monitoring 1.] (2) When the tool (present tool number 1) leaves range 1 or 2 of the tool orientation monitoring setting 2. [The tool (present tool number 1) has left range 1 or 2 of tool orientation monitoring 2.]
Main Cause	1. The tool orientation range has been exceeded, either manually or by program execution. 2. Malfunction due to a mechanical, electrical or other factor.

Countermeasure	1. Use the override switch to move it into the tool orientation range with the following procedure. (1) Switch to teach mode, then perform an Error Reset while the override switch is enabled to reset the error. (2) With the override switch still enabled, manually move the robot into the tool orientation monitoring area in teach mode. (3) Disable the override switch and make sure no errors occur. 2. Check that the tool orientation monitoring settings, wiring (including external equipment) and usage are correct. 3. Change the program so that it does not exceed the tool orientation range. 4. If there is a mechanical, electrical or other factor causing the error, eliminate the cause.

■Error code: E4330

Error message	[Safety software] Error of the communication between Safety software X. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Possible
Contents	A CRC error has occurred in communication between each safety software on the main CPU board and servo board. This is detected by the safety software.
Main Cause	・ An error occurred in the communication between boards due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: E4331

Error message	[Safety software] Discrepancy of the processing of Safety software A/B. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Possible
Contents	An error has occurred due to diagnostics of processing results by each safety software on the main CPU board and servo board. This is detected by the safety software.
Main Cause	・ Malfunction due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: E4332

Error message	[Safety software] Error of command value communication. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for encoder value is turned OFF.
Error reset	Possible
Contents	An error has occurred in command value communication between the AS software and safety software on the main CPU board. This is detected by the safety software.
Main Cause	・ Malfunction due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Perform an error reset and resume the process. 2. Replace the main CPU board. 3. Replace the servo board.

■Error code: E4333

Error message	[Safety software] Error of encoder communication of JTXX. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for encoder value is turned OFF.
Error reset	Possible
Contents	Safety software #A or #B compares the CRC value included in data received from the encoder and the CRC value calculated from the received data, and if there is a difference, this indicates that an encoder communication abnormality has been detected.

Main Cause	・ An error occurred in the encoder communication data due to electrical factors (noise, etc.) ・ Abnormal CRC value was received from the encoder due to an encoder or harness failure. ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check for abnormalities in the harnesses between the servo board ⇔ separate harness ⇔ machine harness ⇔ encoder. 2. Replace the encoder. 3. Replace the servo board.

■Error code: E4334

Error message	[Safety software] Error of the difference between the position present value and the position command value of JT XX. (0xXXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for encoder value is turned OFF.
Error reset	Possible
Contents	The difference between the position present value from the encoder and the position command value of the AS software exceeded the threshold. This is detected by the safety software.
Main Cause	・ Malfunction due to an electrical (noise, etc.) or other factor. ・ Failure of the encoder. ・ Abnormality of the encoder communication routing (separation/machine, controller internal harness, etc.) ・ Failure of the servo board. ・ Failure of the main CPU board Such things as these may be attributable to the main cause.

Countermeasure	1. Perform an error reset and resume the process. 2. Replace the encoder. 3. Check the separation/machine and controller internal harness and replace if there are any abnormalities. 4. Replace the servo board. 5. Replace the main CPU board.

⚠ WARNING

There is a high possibility that the internal data of the encoder is not maintained when this error occurs. Therefore, be sure to confirm that the angle value for each axis becomes 0 degree after setting all axes to their scribe marks (mechanical origin) in teach mode. If the angle values do not go to 0, execute zeroing without fail.

⚠ CAUTION

After the error reset, automatic operation is possible, but due to the disrupted present values, there is a high possibility of causing misalignment of the robot if operated without performing zeroing as explained above.

■Error code: E4335

Error message	[Safety software] Error of the encoder value of JT XX. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for encoder value is turned OFF.
Error reset	Possible
Contents	This indicates that the change in present encoder value per unit time has exceeded the rated value.
Main Cause	1. Failure of the encoder. 2. Malfunction due to another mechanical, electrical or other factor.
Countermeasure	1. After the error occurs, reset the error in teach mode and then check the zeroing position and origin and check for any misalignment. 2. If there is another mechanical, electrical or other factor causing the error, eliminate the cause.

⚠ WARNING

There is a high possibility that the internal data of the encoder is not maintained when this error occurs. Therefore, be sure to confirm that the angle value for each axis becomes 0 degree after setting all axes to their scribe marks (mechanical origin) in teach mode. If the angle values do not go to 0, execute zeroing without fail.

⚠ CAUTION

After the error reset, automatic operation is possible, but due to the disrupted present values, there is a high possibility of causing misalignment of the robot if operated without performing zeroing as explained above.

■Error code: E4336

Error message	[Safety software] Error of the position present value of JT XX. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for encoder value is turned OFF.
Error reset	Possible
Contents	The difference between the position present values stored immediately before turning OFF the controller power and position present values at the next controller power ON exceeds the threshold. This is detected by the safety software.
Main Cause	・ Because the controller power was turned OFF during robot operation, the present value of the stored position and the actual stopped position are misaligned. ・ The arm (motor) was moved forcibly when the controller power was OFF. ・ The internal data of the encoder is not maintained due to a deterioration of the encoder backup battery voltage, disconnection of the encoder harness (machine harness), failure of the encoders, etc. ・ Failure of the motor or encoder ・ Zeroing was changed ・ Failure of the main CPU board (including CFast) ・ Failure of the servo board Such things as these may be attributable to the main cause.

Countermeasure	1. After the error occurs, reset the error in teach mode and then check the zeroing position and origin and check for any misalignment. 2. Perform zeroing of the encoder promptly after replacing the motor or the encoder at the same time. 3. Check the battery for encoder backup, and if the voltage is at or below approx. +3.3 V, immediately replace the battery. 4. Check the encoder harness (machine harness) for abnormalities, and if replace if any are found. 5. Replace the encoder and/or the encoder battery backup board. 6. Replace the main CPU board. 7. Replace the servo board. 8. If there is another mechanical, electrical or other factor causing the error, eliminate the cause.

⚠ WARNING

There is a high possibility that the internal data of the encoder is not maintained when this error occurs. Therefore, be sure to confirm that the angle value for each axis becomes 0 degree after setting all axes to their scribe marks (mechanical origin) in teach mode.
If the angle values do not go to 0, execute zeroing without fail.

⚠ CAUTION

After the error reset, automatic operation is possible, but due to the disrupted present values, there is a high possibility of causing misalignment of the robot if operated without performing zeroing as explained above.

■Error code: E4337

Error message	[Safety software] Error of the position command value of JT XX. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for encoder value is turned OFF.
Error reset	Possible
Contents	The difference between the position command values stored immediately before turning OFF the controller power and position command values at the next controller power ON exceeds the threshold. This is detected by the safety software.
Main Cause	・ Because the controller power was turned OFF during robot operation, the present value of the stored position and the actual stopped position are misaligned. ・ The arm (motor) was moved forcibly when the controller power was OFF. ・ The internal data of the encoder is not maintained due to a deterioration of the encoder backup battery voltage, disconnection of the encoder harness (machine harness), failure of the encoders, etc. ・ Failure of the motor or encoder ・ Zeroing was changed ・ Failure of the main CPU board (including CFast) ・ Failure of the servo board Such things as these may be attributable to the main cause.

Countermeasure	1. After the error occurs, reset the error in teach mode and then check the zeroing position and origin and check for any misalignment. 2. Perform zeroing of the encoder promptly after replacing the motor or the encoder at the same time. 3. Check the battery for encoder backup, and if the voltage is at or below approx. +3.3 V, immediately replace the battery. 4. Check the encoder harness (machine harness) for abnormalities, and if replace if any are found. 5. Replace the encoder and/or the encoder battery backup board. 6. Replace the main CPU board. 7. Replace the servo board. 8. If there is another mechanical, electrical or other factor causing the error, eliminate the cause.

⚠ WARNING

There is a high possibility that the internal data of the encoder is not maintained when this error occurs. Therefore, be sure to confirm that the angle value for each axis becomes 0 degree after setting all axes to their scribe marks (mechanical origin) in teach mode.
If the angle values do not go to 0, execute zeroing without fail.

⚠ CAUTION

After the error reset, automatic operation is possible, but due to the disrupted present values, there is a high possibility of causing misalignment of the robot if operated without performing zeroing as explained above.

■Error code: E4338

Error message	[Safety software] Discrepancy of the present tool number (No. X) and the command tool number (No.X) (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * Safety Output Ch. assigned to the function for Tool-ID is turned OFF.
Error reset	Possible
Contents	The tool has moved a distance greater than the safety parameter "Permissible movement distance with tool number mismatch" while the present tool number (tool number input from the safety I/O board) and the command tool number (tool number selected in the AS software) do not match. This is detected by the safety software.
Main Cause	・ The tool number selected in the AS software during manual operation or program execution is not entered in the safety I/O board tool number. ・ Failure of wiring ・ Failure of the safety I/O board Such things as these may be attributable to the main cause.
Countermeasure	1. After matching the present tool number with the command tool number, execute an error reset. If the present tool number and command tool number are mismatched, error reset cannot be executed. 2. Make sure that the correct tool is selected for manual operation or program execution. 3. Check if the settings for "Permissible movement distance with tool number mismatch," "Tool ID Conversion Table," and "Tool ID Specifications" are correct. 4. Correct any errors with wiring or external equipment connected to tool ID inputs 1 to 5 on the safety I/O board XIN1 connector. 5. Replace the safety I/O board.

■Error code: E4339

Error message	[Safety software] Error of the processing of EtherNet/IP Safety. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: Not change Network Safety Output: All OFF
Error reset	Possible
Contents	An error has occurred in the EtherNet/IP Safety process. Error Reset may not be possible.
Main Cause	・ Abnormality due to electrical factors (noise, etc.) ・ Failure of the main CPU board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check if it can be reset. 2. Turn the power supply OFF and then ON and check if it can be reset. 3. Replace the main CPU board. 4. Replace the servo board.

■Error code: E4340

Error message	[Safety software] Discrepancy of the dual input of user safety input XX. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: * Network Safety Output: * * As a result of the safety input of the error Ch. being turned OFF, the related safety output is turned OFF.
Error reset	Possible
Contents	A duplex input mismatch error was found in the user safety input of the safety I/O board.
Main Cause	The causes of the detected abnormalities are classified as follows according to "Safety Input Settings" in Section 10.1.1. [When setting is Equivalent] This indicates that the state where one side of the duplex input connected to the user safety input is ON and one side is OFF has exceeded the time specified by the "Discrepancy Allow Time" (see Section 10.1.1). The main cause may be attributable to the following. (1) Mismatched operation exceeds the "Discrepancy Allow Time" in the operation of the duplex contacts of the external device. (2) Contact failure of external device. (3) One side of the duplex input has a power or GND short circuit. (4) Failure of the safety I/O board [When setting is Complementary] This indicates that the state where the duplex input connected to the user safety input is ON, ON or OFF, OFF has exceeded the time specified by the "Discrepancy Allow Time." The main cause may be attributable to the following. (1) Mismatched operation exceeds the "Discrepancy Allow Time" in the operation of the duplex contacts of the external device. (2) Contact failure of external device. (3) One side of the duplex input has a power or GND short circuit, or a short circuit between duplex inputs. (4) Failure of the safety I/O board

Countermeasure	1. Check if events similar to (1), (2), or (3) have occurred in the device or wiring connected to the user safety input of the XIN1 or XIN2 connector. (For events similar to (1), the "Discrepancy Allow Time" can also be reconfigured to match the behavior of the external device as a countermeasure.) Also, check that there are no abnormalities in the wiring of the other channels that share the test pulse. 2. If the error cannot be cleared by resetting the error when there was no abnormality in Step 1 or when the abnormality was cleared, replace the safety I/O board.

■Error code: E4341

Error message	[Safety software] User safety output XX is welded. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5,6 OFF User Safety Output: Only channel with errors OFF Network Safety Output: Not change
Error reset	Possible
Contents	This error occurs when the "Weld Check Function for Safety Relay Connected to Safety Output" described in section 10.1.3 is set as the user safety input for the safety I/O board. This indicates that there is an abnormality in the welding or wiring of the external safety relay set as the target of the weld check function (the B contact closed state of the external relay cannot be detected by the safety input even though the corresponding safety output is OFF).
Main Cause	• Failure of the external safety relay set as the target of the weld check function or an abnormality in the connected wiring. • 24 V power is not supplied to the XIN1 or XIN2 connector on the safety I/O board. • Failure of the safety I/O board. Such things as these may be attributable to the main cause.
Countermeasure	1. Check that the settings and wiring for the channels to which the weld check function is assigned are correct. 2. Replace the safety relay. 3. Check whether 24 V power is being supplied to the XIN1 or XIN2 connector on the safety I/O board.*1 4. Replace the safety I/O board.

*1 Refer to Chapter 9.2 for the 24 V power supply connection method.

⚠ WARNING

If parameter settings are incorrect, safety functions may not function properly. Ensure safety functions are checked after changing parameter settings.

■Error code: E4342

Error message	[Safety software] The error reset input continues to be ON. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: All OFF Network Safety Output: All OFF
Error reset	Possible
Contents	The input signal from error reset is continuing to stay ON.
Main Cause	1. The error reset input stayed in an ON state for more than 1 second. 2. Failure of the main CPU board 3. Failure of the servo board
Countermeasure	1. Turn controller power OFF and then ON and check if it can be reset. 2. Check the signal state when using a dedicated signal for external error reset. 3. Replace the main CPU board. 4. Replace the servo board.

■Error code: E4343

Error message	[Safety software] The override input continues to be ON. (0xXXXXXXXXXXXXXXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	The input signal from the override switch is ON for more than 3 minutes.
Main Cause	・ The override state continued for more than 3 minutes. ・ Failure of the teach pendant ・ Failure of the main CPU board (including CFast) ・ Failure of the servo board
Countermeasure	1. Disable the override switch. 2. Turn controller power OFF and then ON and check if it can be reset. 3. Replace the teach pendant. 4. Replace the main CPU board. 5. Replace the servo board.

■Error code: E4345

Error message	(Servo board(X))[Power sequence board(X)] Pulse diagnostics error of user safety output 101. (xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: 101 OFF Network Safety Output: Not change
Error reset	Possible
Contents	A pulse diagnostics error was detected in the user safety output 101 output on the power sequence board.
Main Cause	• An abnormality in the harness connected to the X510 connector (on the servo board), or there is a capacitive load (capacitor, etc.) connected to the output circuit. • Failure of the power sequence board • Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check that the harness connected to the X510 connector (on the servo board) is not connected to an abnormal (shorted, disconnected) or capacitive load. 2. Replace the power sequence board. 3. Replace the servo board.

■Error code: E4346

Error message	(Servo board(X))[Power sequence board(X)] Discrepancy of the dual output of user safety output 101. (xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: 101 OFF Network Safety Output: Not change
Error reset	Possible
Contents	A mismatch between the output state and feedback state was detected in the user safety output 101 output of the power sequence board.
Main Cause	• Failure of the power sequence board • Failure of the servo board • An abnormality in the harness connected to the X510 connector (on the servo board). Such things as these may be attributable to the main cause.
Countermeasure	1. Check that the harness connected to the X510 connector (on the servo board) is not connected to an abnormal (shorted, disconnected). 2. Replace the power sequence board. 3. Replace the servo board.

■Error code: E4347

Error message	(Servo board(X))[Power sequence board(X)] Pulse diagnostics error of fixed safety output 6 (External Enable Output). (xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,6 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	A pulse diagnostics error was detected in the external enable output on the power sequence board.
Main Cause	• An abnormality in the wiring connected to the X510 connector (on the servo board), or there is a capacitive load (capacitor, etc.) connected to the output circuit. • Failure of the power sequence board • Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the wiring connected to the X510 connector (on the servo board). 2. Replace the power sequence board. 3. Replace the servo board.

■Error code: E4348

Error message	(Servo board(X))[Power sequence board(X)] Discrepancy of the dual output of fixed safety output 6 (External Enable Output). (xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,6 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	A mismatch between the output state and feedback state was detected in the external enable output of the power sequence board.
Main Cause	• Abnormality of wiring connected to the X510 connector (on the servo board) • Failure of the power sequence board • Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the wiring connected to the X510 connector (on the servo board). 2. Replace the power sequence board. 3. Replace the servo board.

■Error code: E4349

Error message	(Servo board(X))[Power sequence board(X)] Pulse diagnostics error of fixed safety output 5 (Motor Power Shutoff Output). (xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	A pulse diagnostics error was detected in the motor power shut-off output on the power sequence board.
Main Cause	• An abnormality in the wiring connected to the X510 connector (on the servo board), or there is a capacitive load (capacitor, etc.) connected to the output circuit. • Failure of the power sequence board • Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the wiring connected to the X510 connector (on the servo board). 2. Replace the power sequence board. 3. Replace the servo board.

■Error code: E4350

Error message	(Servo board(X))[Power sequence board(X)] Discrepancy of the dual output of fixed safety output 5 (Motor Power Shutoff Output). (xXX)
Error processing	Motor power OFF Fixed Safety Output: 1,2,3,5 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	A mismatch between the output state and feedback state was detected in the motor power shut-off output of the power sequence board.
Main Cause	• Abnormality of wiring connected to the X510 connector (on the servo board) • Failure of the power sequence board • Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the wiring connected to the X510 connector (on the servo board). 2. Replace the power sequence board. 3. Replace the servo board.

■Error code: E4351

Error message	Safety parameters were rewritten. Turn OFF & ON the controller power.
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Not possible
Contents	Although the CoreCubic-S safety parameters have been changed, the change has not reflected in the safety software because the controller power has not been turned OFF/ON. This is detected by the AS software.
Main Cause	The controller power has not been turned OFF/ON after the CoreCubic-S safety parameters have been changed.
Countermeasure	Turn OFF/ON the controller power.

■Error code: E4352

Error message	Discrepancy of the specified tool transformation value and the tool transformation value registered for Safety software.
Error processing	Motor power: Not change Fixed Safety Output: Not change User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	The robot parameters related to the CoreCubic-S safety parameters have changed so that the CoreCubic-S safety parameters need to be updated. This is detected by the AS software.
Main Cause	Parameters related to robot parameters within safety parameters have been changed.
Countermeasure	Update the safety parameters of CoreCubic-S by following the steps below. 1. Launch the setting application and read out the robot parameters. 2. Execute -> <CoreCubic-S>-><CoreCubic-S write> from the operation menu of the setting application. 3. Turn the controller power OFF/ON.

■Error code: E4353

Error message	Discrepancy of the robot parameters in safety parameters and the related parameters.
Error processing	Motor power OFF Fixed Safety Output: 1,2,3 OFF User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	The robot parameters related to the CoreCubic-S safety parameters have changed so that the CoreCubic-S safety parameters need to be updated. This is detected by the AS software.
Main Cause	Parameters related to robot parameters within safety parameters have been changed.
Countermeasure	Update the safety parameters of CoreCubic-S by following the steps below. 1. Launch the setting application and read out the robot parameters. * If the setting application is running, please relaunch it. 2. Execute -> <CoreCubic-S>-><CoreCubic-S write> from the operation menu of the setting application. 3. Turn the controller power OFF/ON.

■Error code: E4354

Error message	Incorrect license of CoreCubic-S option [XX]. Load the correct license file.
Error processing	Motor power: Not change Fixed Safety Output: Not change User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	This error occurs when the CoreCubic-S license code is invalid.
Main Cause	[If this error is displayed when you load a file] The CoreCubic-S license code of the loaded file is invalid. [In cases other than the above] The CFast being used may be for a different controller.
Countermeasure	Load the correct CoreCubic-S license file.

■ Error code: E4355

Error message	[Power sequence board(XX)] Pulse diagnostics error of fixed safety input 9 (External Enable).
Error processing	Motor power OFF Fixed Safety Output: Not change User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	This indicates that a diagnostic pulse error was detected in the external enable input section on the power sequence board.
Main Cause	・ Fault in wiring connected to the XES connector ・ Failure of the power sequence board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the wiring connected to the XES connector. 2. Replace the power sequence board. 3. Replace the servo board.

■ Error code: E4356

Error message	[Power sequence board(XX)] Discrepancy of the dual input of fixed safety input 9 (External Enable).
Error processing	Motor power OFF Fixed Safety Output: Not change User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	This indicates that a mismatch in the input status and feedback status was detected in the external enable input section on the power sequence board.
Main Cause	・ Fault in wiring connected to the XES connector ・ Failure of the power sequence board ・ Failure of the servo board Such things as these may be attributable to the main cause.
Countermeasure	1. Check the wiring connected to the XES connector. 2. Replace the power sequence board. 3. Replace the servo board.

■ Error code: E4357

Error message	The motor power cannot be turned ON because the startup processing of Safety software is in progress.
Error processing	Motor power OFF Fixed Safety Output: Not change User Safety Output: Not change Network Safety Output: Not change
Error reset	Possible
Contents	Occurs when attempting to turn the motor power ON before the safety software startup processing has finished.
Main Cause	Safety software startup processing has not finished.
Countermeasure	Wait until the safety software startup processing has finished before turning the motor power back ON.



15 Safety Distance

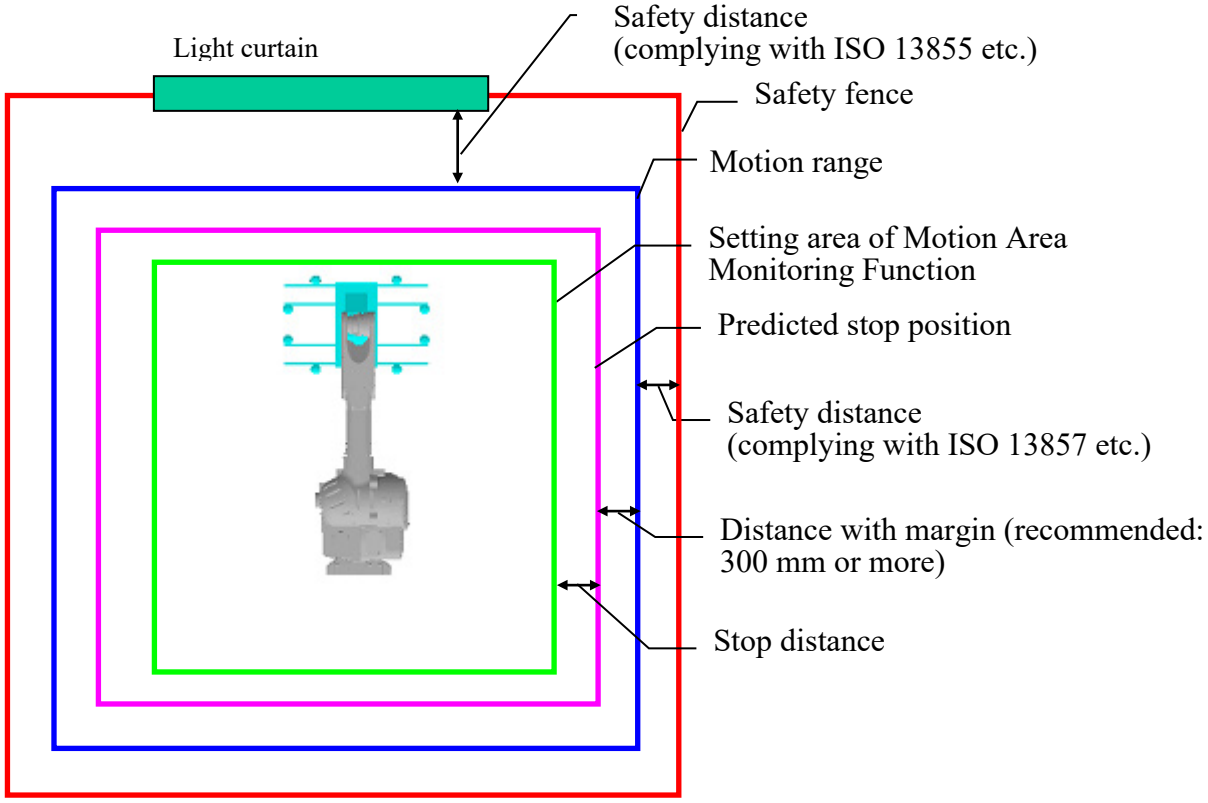
When executing area setting with the motion area monitoring function, the safety distance should be set between the robot motion range and the installation position of light curtain/laser scanner, and/or safety fence, etc. The safety distance from light curtain/laser scanner should comply with standards such as ISO 13855 etc. The safety distance from the safety fence should comply with standards such as ISO 13857 etc.

When not using the stop position prediction function, the robot motion range must be the range obtained by adding the stop distance with margin (recommended: 300 mm or more) according to the operating conditions such as the speed and load of the robot from the setting area set by the motion area monitoring function. (To determine the stop distance according to the operating conditions such as the speed and load of the robot, conduct a risk assessment referring to the stop distance/stop time described in "Installation and Connection Manual" for each robot or "Stopping time and distance" (90202-1279).) When using the stop position prediction function, make the range obtained by adding a margin (recommended: 300 mm or more) to the setting area set by the motion area monitoring function.

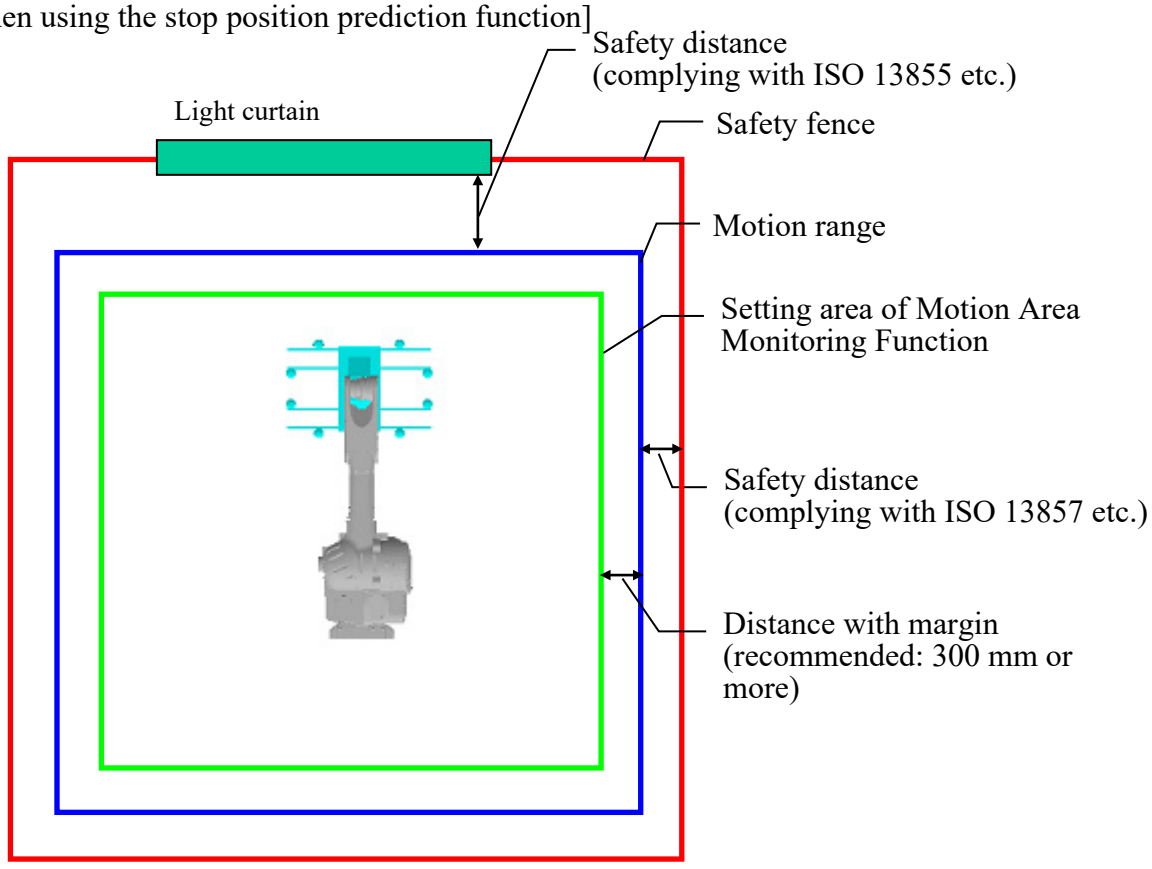
⚠ WARNING

1. **When not using the stop position prediction function of the motion area monitoring function, the motion area monitoring function stops the robot after the robot exceeds the setting area. Therefore, the robot goes out the setting area and stops, so determine the area with considering the distance beyond the setting area.**
2. **The stop position prediction function of the motion area monitoring function is a function that predicts the robot stop position and stops the robot within the setting area. However, this function does not guarantee that the robot will not go out of the setting area. Since the stop position may exceed the setting area depending on the robot failure or operating conditions, determine the area with enough allowance.**

[When not using the stop position prediction function]



[When using the stop position prediction function]



16 Maintenance and Inspection

16.1 About Maintenance

To maintain the safety functions of the controller including CoreCubic-S, conduct the following inspections daily or periodically.

- Confirm that the robot is used within the controller specification.
- Confirm that the installation status for each board inside the controller and the wiring of the safety I/O board and the XES connector on the servo board are adequate.
- Every day before starting operation, check to see that each safety function of the controller is working normally.
- Specific inspection details for safety functions are described in "11.2 Checks Before Use" in this manual.

16.2 About Replacement

If any deficit is found in the inspection, replace the board according to the "Troubleshooting Manual" for each controller. In addition, replace the controller itself including CoreCubic-S if 20 years have passed after the controller’s manufacture date.

1. Always turn OFF the controller power and the external power supply for input/output signals before cleaning, wiring or replacing boards and connectors inside the controller.
2. Only those who have completed Kawasaki’s education course and are in charge of the robot system can replace boards inside the controller.
3. Before touching boards inside the controller, discharge the electro-static in human body by touching a grounded metal, etc.
4. Inspect the safety functions based on the descriptions in "11.2 Checks Before Use" in this manual when replacing boards inside the controller and cleaning, wiring, or replacing connectors.
5. When replacing the storage medium (CFast), back up and load the safety parameters as described in the next section. When replacing only the board without replacing the storage medium (CFast), it is not necessary to back up and load the safety parameters.

⚠ WARNING

1. **When replacing the board inside the controller, confirm that there are no errors in DIP switch settings, wiring conditions, etc. Be sure to inspect the safety functions based on the descriptions in "11.2 Checks Before Use" after replacement. Especially when enabling/disabling the safety functions according to the safety input signals, turn ON/OFF all safety input signals to confirm that the safety functions become enabled/disabled accordingly. Incorrect DIP switch settings of the board may cause the safety functions not to operate properly, resulting in a hazardous condition.**
2. **Safety parameters are stored in the controller's storage medium (CFast). When replacing the storage medium, load the safety parameters, confirm that there are no errors in the parameters, and inspect the safety functions according to the descriptions in "11.2 Checks Before Use". Especially when enabling/disabling the safety functions according to the safety input signals, turn ON/OFF all safety input signals to confirm that the safety functions become enabled/disabled accordingly. Incorrect safety parameters may cause the safety functions not to operate properly, resulting in a hazardous condition.**

16.3 How to Back Up and Load the Safety Parameters

«Backup and loading procedures for safety parameters»

(1) Back up safety parameters.
Before replacing the storage medium (CFast) on the main CPU board or the main CPU board including CFast, create a backup file of the safety parameters.
With the robot controller turned ON, download the parameters from the storage medium (CFast) using the setting application via the teach pendant.

«Execute on the storage media (CFast) before replacement»
Execute the following, referring to section 8.4.
1) Perform [Read CoreCubic-S].
2) Perform [Save File].

(2) Create robot controller backup file.
Save all data in robot controller via "Auxiliary function 0201 Save."

(3) Replace the storage medium (CFast) or the main CPU board including CFast.

(4) Load robot controller backup file.
Refer to 17.3 to 17.5 in the F series controller "Operation Manual" (90203-1114), initialize the system, and load the data saved in (2). After that, turn OFF/ON the controller power of the robot controller.

Note If you get the "(E4354) Incorrect license of CoreCubic-S option [XX]. Load the correct license file." error message after replacing the main CPU board, please load the license file corresponding to the replaced main CPU board.

(5) Load CoreCubic-S backup file.
When the controller power of the robot controller is turned ON, the following error occurs because the safety parameters of CoreCubic-S are not configured at this point.
"(D4310) [Safety software] Error of the safety parameters (in ROM) of XX (0xXX)."
Using the setting application, write the safety parameters read from the backup file in (1) to CoreCubic-S according to the following procedure.

«Execute on the storage media (CFast) after replacement»
Execute the following, referring to section 8.4.
1) Execute <Open File> to read the safety parameters of the backup file in (1) onto the setting application.

Note Robot parameters are automatically read out when the setting application is started.

2) Execute <Write CoreCubic-S>.
After the writing is completed, turn the robot controller power OFF/ON.

(6) Confirmation after replacement

1) Check the version

From the auxiliary menu, select [8. System] [4. Software Version] and confirm that the correct software version is selected.

2) Confirmation of safety parameters

After loading the safety parameters, confirm that they are correct and inspect the safety functions based on the descriptions in "11.2 Checks Before Use."

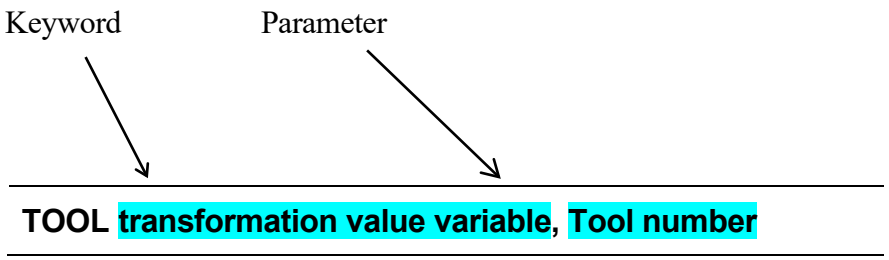
Especially when enabling/disabling the safety functions according to the safety input signals, turn ON/OFF all safety input signals to confirm that the safety functions become enabled/disabled accordingly. Incorrect CoreCubic-S setting data may cause the safety functions not to operate properly, resulting in a hazardous condition.

17 AS Software Setting

This chapter explains the AS languages specific to CoreCubic-S and major AS languages and setting used with CoreCubic-S. (For details on AS languages, refer to "AS Language Reference Manual," separate volume.)

Example

AS command/instruction are described as shown below.



Parameters marked with [ ] can be omitted.

Always enter a space between the keyword and the parameter.

↵ represents the Enter (Return) key in the examples.

17.1 AS Languages Specific to CoreCubic-S

17.1.1 System Switch

This section describes the below AS system switches specific to CoreCubic-S.

CCS_AUXTOOL1

Function

Switches whether tool number 1 of the block teaching is set as tool number 1 of CoreCubic-S (ON) or tool number 1 specified in TOOL of AS language is set as tool number 1 of CoreCubic-S (OFF).

Explanation

If this switch is ON, tool numbers 1 to 9 set in block teaching are used as tool numbers 1 to 9 in CoreCubic-S. Tool numbers 1 to 9 specified by AS language TOOL command/instruction are used as tool numbers 10 to 18 in CoreCubic-S.

If this switch is OFF, tool numbers 1 to 9 specified by AS language TOOL command/instruction are used as tool numbers 1 to 9 in CoreCubic-S. Tool numbers 1 to 9 set in block teaching are used as tool numbers 10 to 18 in CoreCubic-S.

Turning ON/OFF this switch causes the error “(E4353) Discrepancy of the robot parameters in safety parameters and the related parameters.
.” to occur. The modification of switch setting will be reflected in CoreCubic-S by turning OFF/ON the controller switch after writing the setting to CoreCubic-S via the setting application.

Default setting for this switch is OFF.

Example

CCS_AUXTOOL1 ON Sets tool number 1 in block teaching as tool number 1 in CoreCubic-S.

For more details on how to use this switch, refer to section 17.2.

17.1.2 Monitor Command/Program Instruction

This section describes the monitor command/program instruction specific to CoreCubic-S.

Monitor Command/Program Instruction	
CCS_SETTOOL	**Tool transformation value, Tool number**

Function

Sets the TCP/tool orientation held by CoreCubic-S for each tool number.
After setting, the error "(E4353) Discrepancy of the robot parameters in safety parameters and the related parameters." occurs. After that, the settings can be written to CoreCubic-S via the setting application. After writing to CoreCubic-S, the configured tool information can be used when the controller power is turned OFF/ON.

Parameter

Tool transformation value
Specify the position and posture (tool transformation value) of the tool coordinates as viewed from the robot's tool mounting flange coordinates (null tool coordinates) in transformation value variable or compound transformation value variable.

Tool number
Specify the tool number to use as an integer from 1 to 9. When starting the setting application after execution, the tool transformation value is set to the specified tool number when the system switch CCS_AUXTOOL1 is OFF. When the system switch CCS_AUXTOOL1 is ON, the value will be set for the tool number that is the specified value plus 9.

Monitor Command

CCS_SETDEVICE Device number = Axis number

Function

Specifies and confirms the device axis to be monitored by CoreCubic-S.

Parameter

Device number

Specifies the device number (1 to 18) to be set.

Axis number

Specifies the external axis number to assign to the specified device. However, axes to which no channel is assigned and Mitsubishi Motors (external axes) cannot be set. Also, do not set the axes listed in Section 6.7, such as the servo welding gun axis and tool change axis, to the device.

Explanation

This command allows you to assign any axis to the device. By assigning the device number, it can be set to be monitored by CoreCubic-S. After execution, the error "(E4353) Discrepancy of the robot parameters in safety parameters and the related parameters." occurs. After the settings are written to CoreCubic-S via the setting application, turn the controller switch OFF/ON.

Example

The following is an example of assigning 7-axis to device 1.

```
>ccs_setdevice 1 = 7
  Joint 7 : device 0 -> 1
```

"device 0" means not assigned to a device.

17.2 How to Specify Tool Setting via AS Software

This section explains the relation between the tool to monitor with CoreCubic-S and AS software setting.

CoreCubic-S holds 32 pieces of tool information separate from AS software.

In "1-2. Settings for the Tool Area Monitoring Model" of "11.1.4 Motion Area Monitoring Function," the tool shape model is set for tool numbers 1 to 32.
In "2. Tool Speed Monitoring Point Settings" of "11.1.6 Speed Monitoring Function," the speed monitoring points are set for tool number 1 to 32.

To set the TCP/tool orientation to the tool information held by CoreCubic-S, it is necessary to set it by CCS_SETTOOL command/instruction or the auxiliary 0304 Tool Coordinates and write the setting to CoreCubic-S in the setting application.

In addition, the command tool number need to be notified to CoreCubic-S from AS software when using "Tool ID Specifications 1" (a combination of the current tool number converted from the fixed safety input tool ID 1 and the command tool number) in "1. Tool Setting" in "11.1.3 Monitoring Common Settings".

The setting and determination methods differ when using AS language and block teaching.
Below describes about each method.

17.2.1 How to Specify Tool Setting and Tool Number in AS Language

1. System switch
   Use with CCS_AUXTOOL1 OFF.

2. Tool setting
   TCP and tool orientation can be set by CCS_SETTOOL command/instruction.
   After starting the setting application and writing to CoreCubic-S, the configured tool information is available when the controller power is turned OFF/ON.

3. Specifying tool number
   Specify the tool number (command tool number) of the tool to monitor during robot operation using TOOL command/instruction.

This section describes the behavior of each instruction when using with CoreCubic-S.

Monitor Command

TOOL Transformation value variable, Tool number

Function

Specifies the tool to be used by the pose variable and tool number.

Parameter

Transformation value variable

Sets the tool transformation value to use using pose variable and tool number (Transformation value variable or compound transformation value variable). When omitted, the current tool transformation value is displayed.

If the specified transformation value variable is different from the tool transformation value specified by CCS_SETTOOL command/instruction, the error "(E4352) Discrepancy of the specified tool transformation value and the tool transformation value registered for Safety software." occurs.

Tool number

Specify the tool number to monitor by CoreCubic-S. When transformation value variable is specified, this cannot be omitted.

When parameters are omitted, the value currently set is displayed.

Program Instruction

TOOL Transformation value variable, Tool number

Function

Specifies the tool to be used by the pose variable and tool number.

Parameter

Transformation value variable

Sets the tool transformation value to use using pose variable and tool number (Transformation value variable or compound transformation value variable). When omitted, the current tool transformation value is displayed.

If the specified transformation value variable is different from the tool transformation value specified by CCS_SETTOOL command/instruction, the error "(E4352) Discrepancy of the specified tool transformation value and the tool transformation value registered for Safety software." occurs.

Tool number

Specify the tool number to monitor by CoreCubic-S.

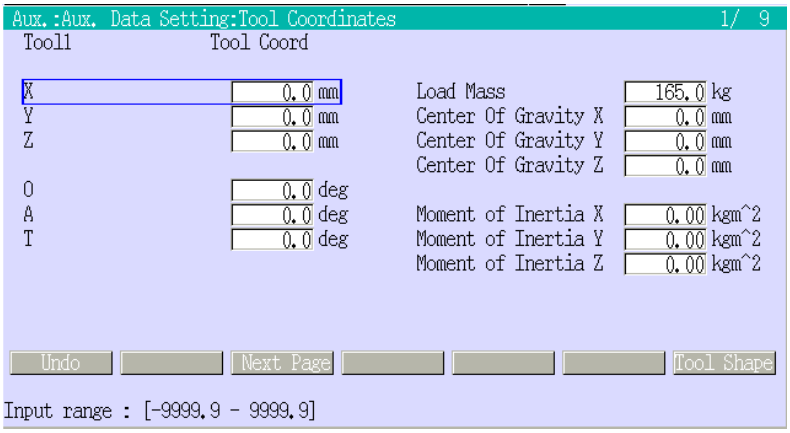
17.2.2 How to Specify Tool Setting and Tool Number Using Block Teaching

1. System switch

Use with CCS_AUXTOOL1 ON.

2. Tool setting

TCP and tool orientation can be set via auxiliary function 0304 Tool Coordinates.



Set the tool transformation value (XYZOAT). After starting the setting application and writing to CoreCubic-S, the configured tool information is available when the controller power is turned OFF/ON.

Auxiliary function 0304 allows setting for tools 1 to 9.

3. Specifying tool number

Specify the tool number (command tool number) of the tool to monitor during robot operation using block teaching.

Appendix A Safety Controller Configuration Example

This section provides a configuration example for Rockwell Automation's GuardLogix controller system.
Refer to the following manuals for details regarding GuardLogix controller systems:

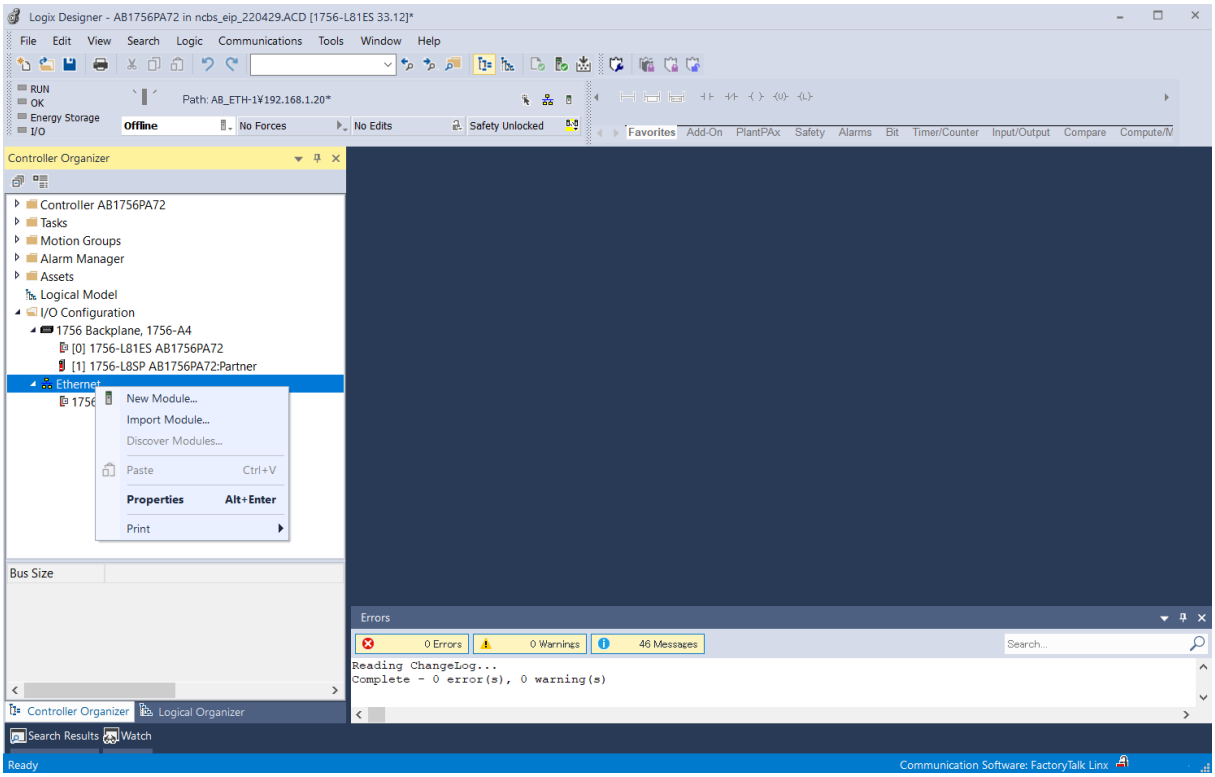
- GuardLogix Controller User Manual 1756-UM020
- GuardLogix Controller System Safety Reference Manual 1756-RM093

Appendix A.1 Adding the Module to I/O Configuration Tree

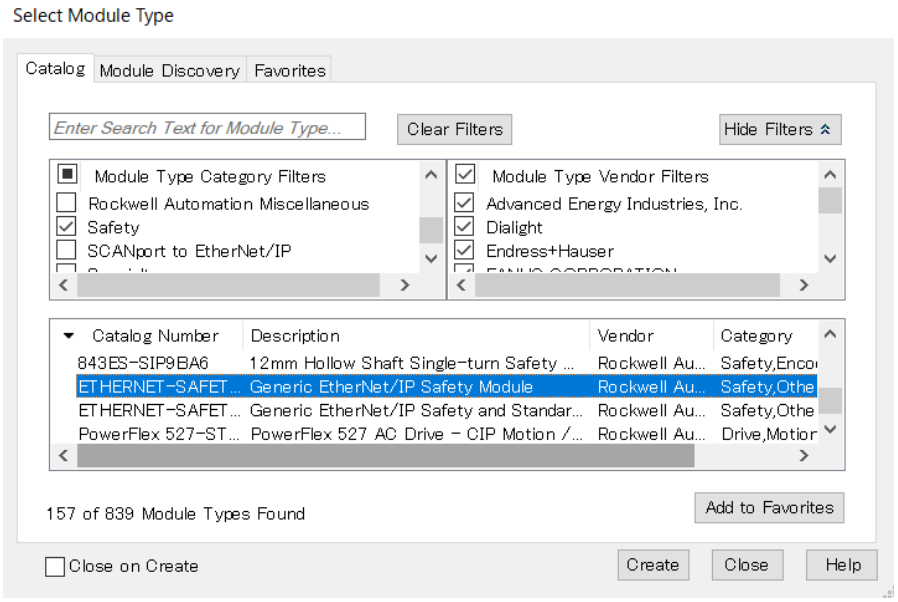
This section explains how to configure the module on Studio 5000 software.

Follow the procedure below to add the module to the I/O Configuration tree.

1. From the I/O Configuration tree, right-click on the Ethernet Bridge module, then select [New Module], as shown in the image.



2. Click [Generic EtherNet/IP Safety Module] in the [Select Module Type] dialog box and then click <Create> at the very bottom of the dialog box.

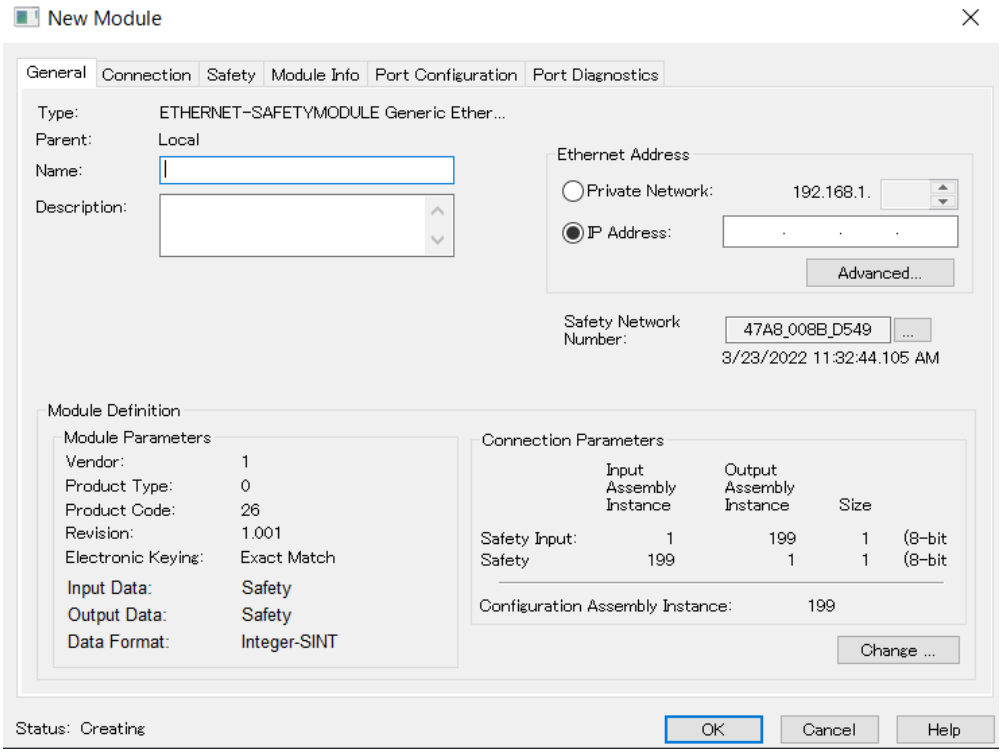


When you click <Create>, the Module Properties dialog box will display.

Appendix A.2 Using the Module Properties and General Dialog Boxes

Follow the procedures below to configure the module via Module Properties and General dialog boxes.

1. From the I/O Configuration tree, double-click [Generic EtherNet/IP Safety Module] to display the Module Properties dialog box.



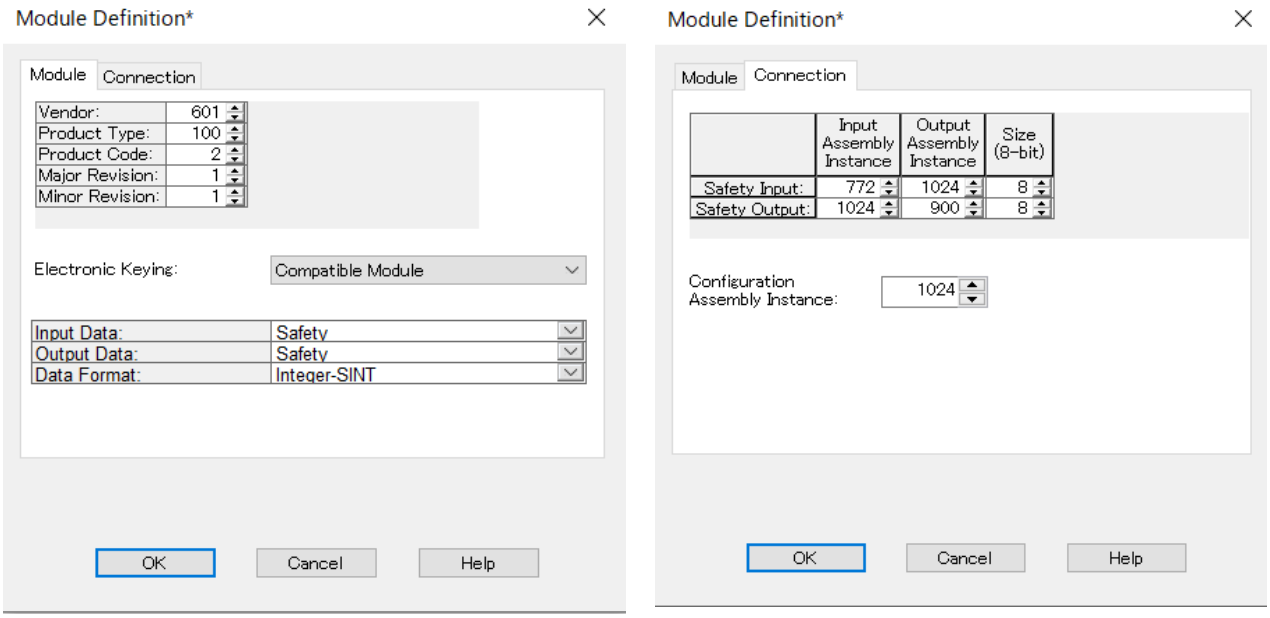
[Name]
Enter a specific name.

[IP Address]
Enter the IP address of the Ethernet port that you are using.

[Description]
Enter description if necessary.

[Safety Network Number]
For a detailed explanation about Safety Network Numbers (SNN), refer to the "GuardLogix Controller Safety Reference Manual." In most cases, use the defaults provided by Studio 5000 software.

2. Once entered, click <Change> to display the Module Definition dialog box.

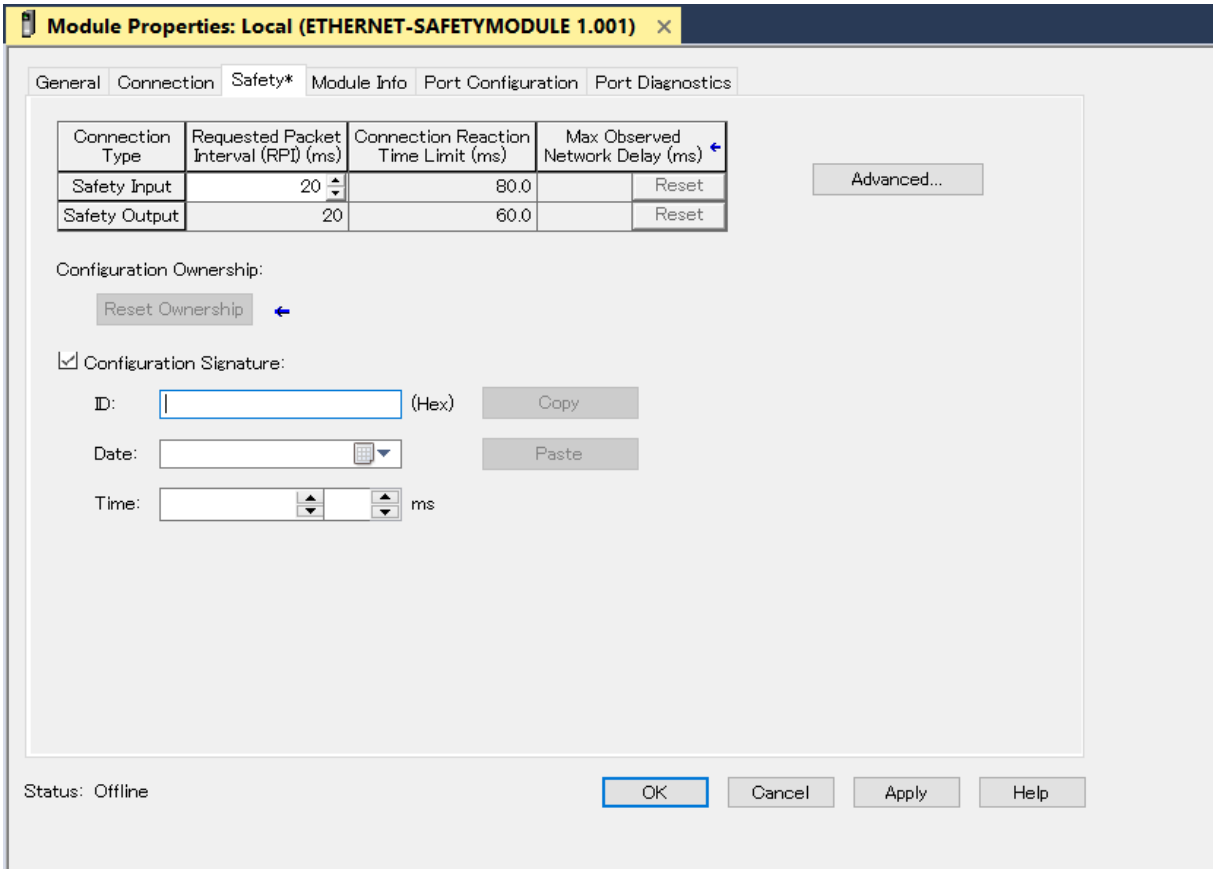


Check that the settings in the Module Definition dialog box are as shown in “10.3.1 EtherNet/IP Safety Settings.”

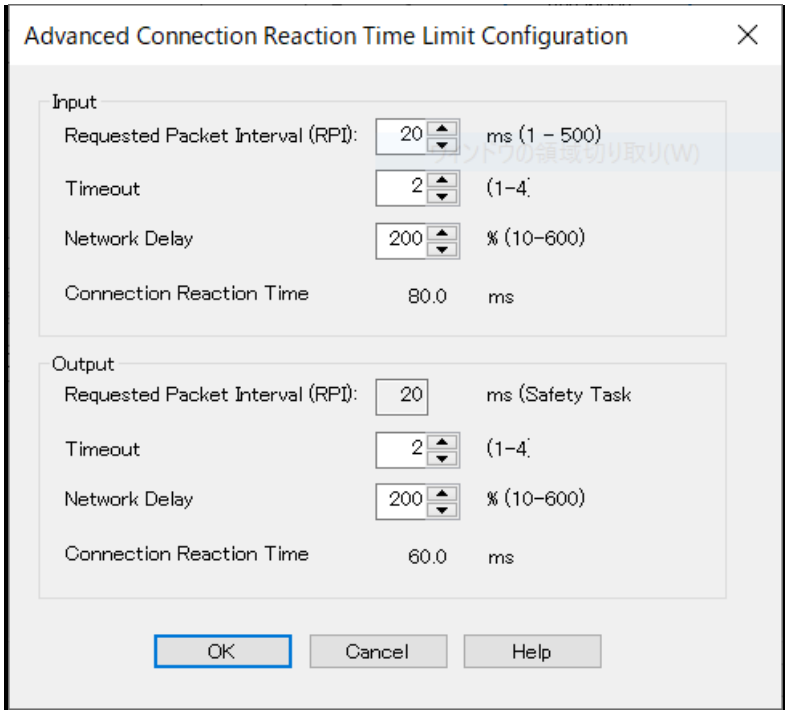
Appendix A.3 Safety Dialog Box Operations

This section explains what to input after clicking the Safety tab.

1. In the Module Properties dialog, click the [Safety] tab to display the Safety dialog box.



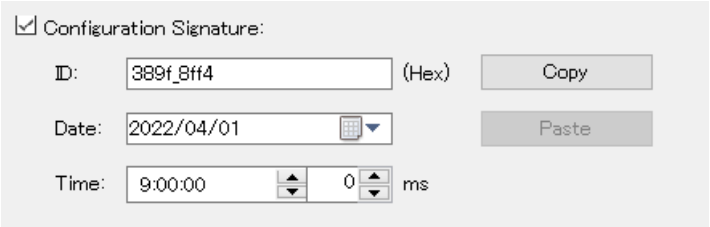
2. Configure Requested Packet Interval (RPI) and Connection Reaction Time Limit (CRTL) by following the procedure detailed below:
3. In the Safety dialog box, click <Advanced> to display the Advanced Connection Reaction Time Limit Configuration dialog box.



Check that the Input RPI is set according to your requirements. The minimum acceptable Input RPI is 20 ms. Setting it to below 20 ms will cause a timeout and the connection will be interrupted. Also, the connection time may be longer if the RPI setting time is larger depending on the PLC to be connected.

4. For Configuration Signature, set the following as required:
   ID: 389F_8FF4
   Date/Time: 2022/04/01 0:00:00 0 ms (GMT)

   The Date/Time must be entered for each region relative to the standard time above.
   The following is the input screen for Japan (+9:00.000).



5. When all settings are complete, click the <OK> button to finalize the new Module.

Appendix A.4 Saving and Downloading Module Configurations

It is recommended that you save the module after configuring it.

If both the MS and NS LED indicators are not lit green after downloading the program, you may have lost ownership. Ownership is based on the following:

- IP address
- Safety network number
- GuardLogix slot number
- GuardLogix safety network number
- Path from GuardLogix controller
- Configuration signature

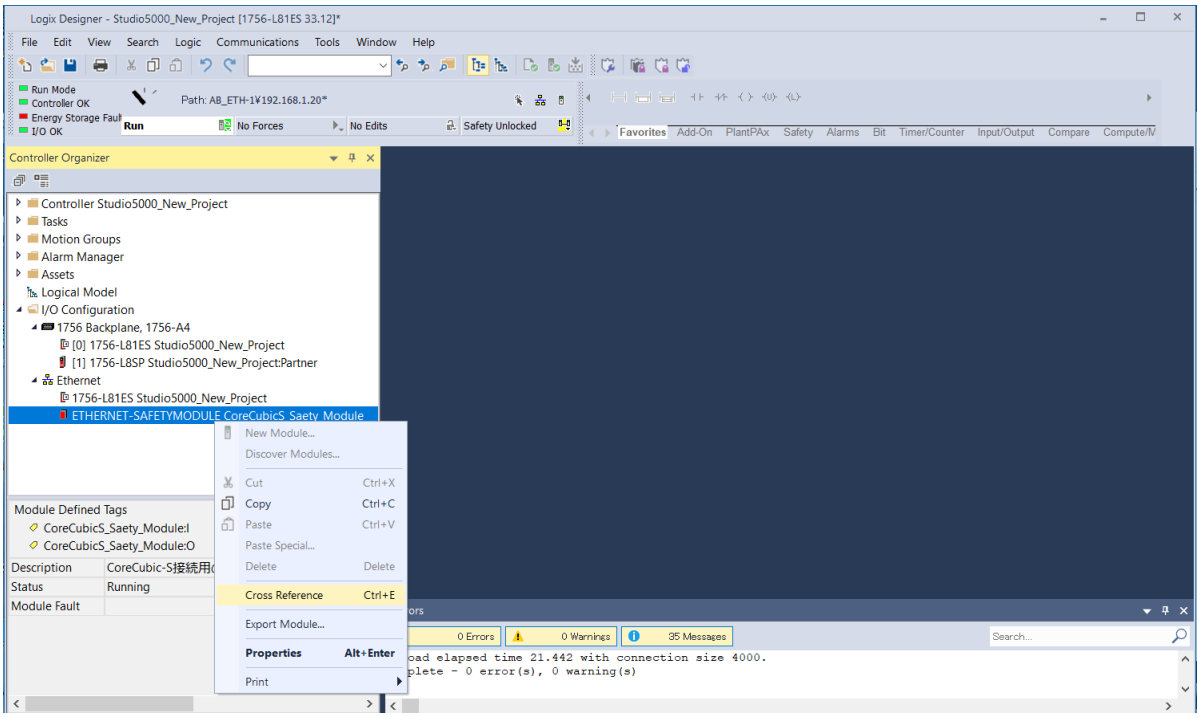
Changing any of these will cause the connection with the GuardLogix controller to be lost, and a yellow warning will appear in the Studio 5000 tree. Follow the below steps to re-establish connection.

1. Refer to “10.3.1 EtherNet/IP Safety Settings” and reset the TUNID.
2. Restart the robot controller.
3. Reconfigure the TUNID from Studio 5000.
4. Restart the robot controller.

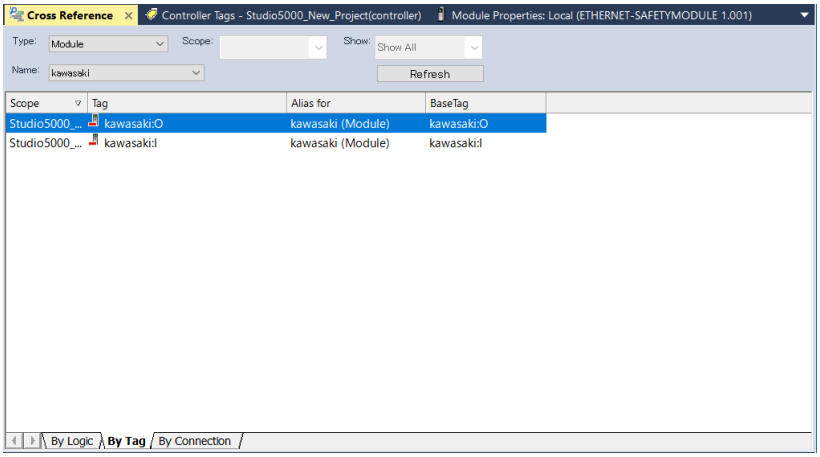
Appendix A.5 Monitoring Safety Input Data/Output Data

Input data/output data on the safety controller side can be monitored by referring to [Cross Reference] on the generated module.

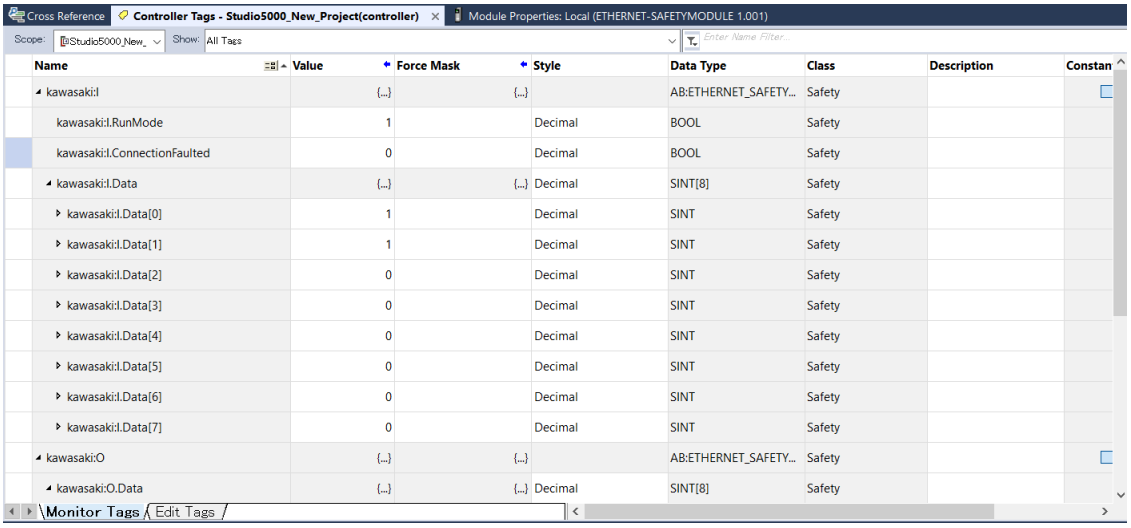
1. From the I/O Configuration tree, right-click on the [Ethernet Bridge] module, then select [Cross Reference] as shown in the image.



2. In Cross Reference, double-click <Name>:O or <Name>:I to open the Controller Tags.



3. In Controller Tags, open Monitor Tags shown as below.



Input Data

- I.RunMode: Module mode
- I.ConnectionFaulted: Communication status
- I.Data: Safety inputs from the module

kawasaki:I	{...}	{...}		AB:ETHERNET_SAFETY...	Safety
kawasaki:I.RunMode	0		Decimal	BOOL	Safety
kawasaki:I.ConnectionFaulted	0		Decimal	BOOL	Safety
kawasaki:I.Data	{...}	{...}	Decimal	SINT[8]	Safety
kawasaki:I.Data[0]	0		Decimal	SINT	Safety
kawasaki:I.Data[1]	0		Decimal	SINT	Safety
kawasaki:I.Data[2]	0		Decimal	SINT	Safety
kawasaki:I.Data[3]	0		Decimal	SINT	Safety
kawasaki:I.Data[4]	0		Decimal	SINT	Safety
kawasaki:I.Data[5]	0		Decimal	SINT	Safety
kawasaki:I.Data[6]	0		Decimal	SINT	Safety
kawasaki:I.Data[7]	0		Decimal	SINT	Safety

Output Data

• O.Data: Safety outputs to the module

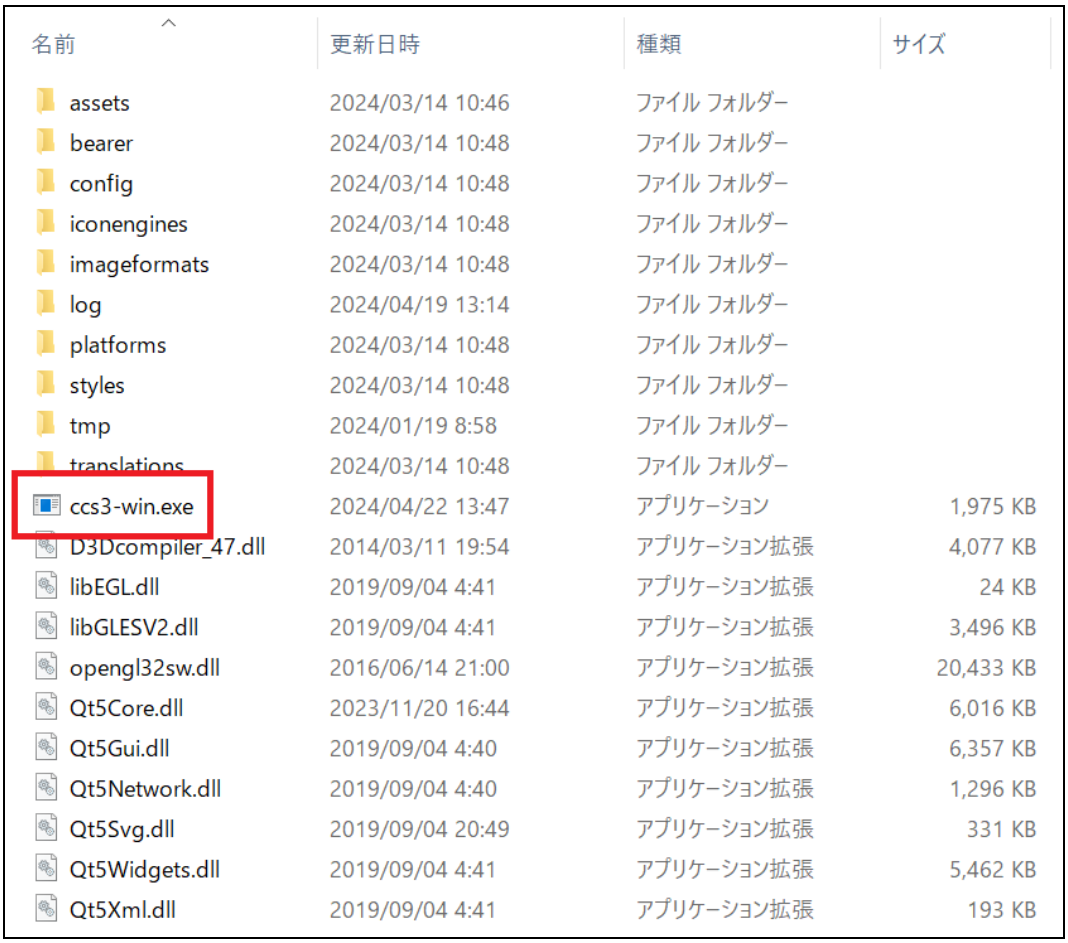
kawasaki:O	{...}	{...}		AB:ETHERNET_SAFETY...	Safety
kawasaki:O.Data	{...}	{...}	Decimal	SINT[8]	Safety
kawasaki:O.Data[0]	0		Decimal	SINT	Safety
kawasaki:O.Data[1]	0		Decimal	SINT	Safety
kawasaki:O.Data[2]	0		Decimal	SINT	Safety
kawasaki:O.Data[3]	0		Decimal	SINT	Safety
kawasaki:O.Data[4]	0		Decimal	SINT	Safety
kawasaki:O.Data[5]	0		Decimal	SINT	Safety
kawasaki:O.Data[6]	0		Decimal	SINT	Safety
kawasaki:O.Data[7]	0		Decimal	SINT	Safety

Appendix B PC Setting Application Setup

CoreCubic-S can be set up on either PC or TP. Although its functionality is the same with both methods, this chapter explains how to set it up on a PC, as it differs from the TP version.

Appendix B.1 Startup

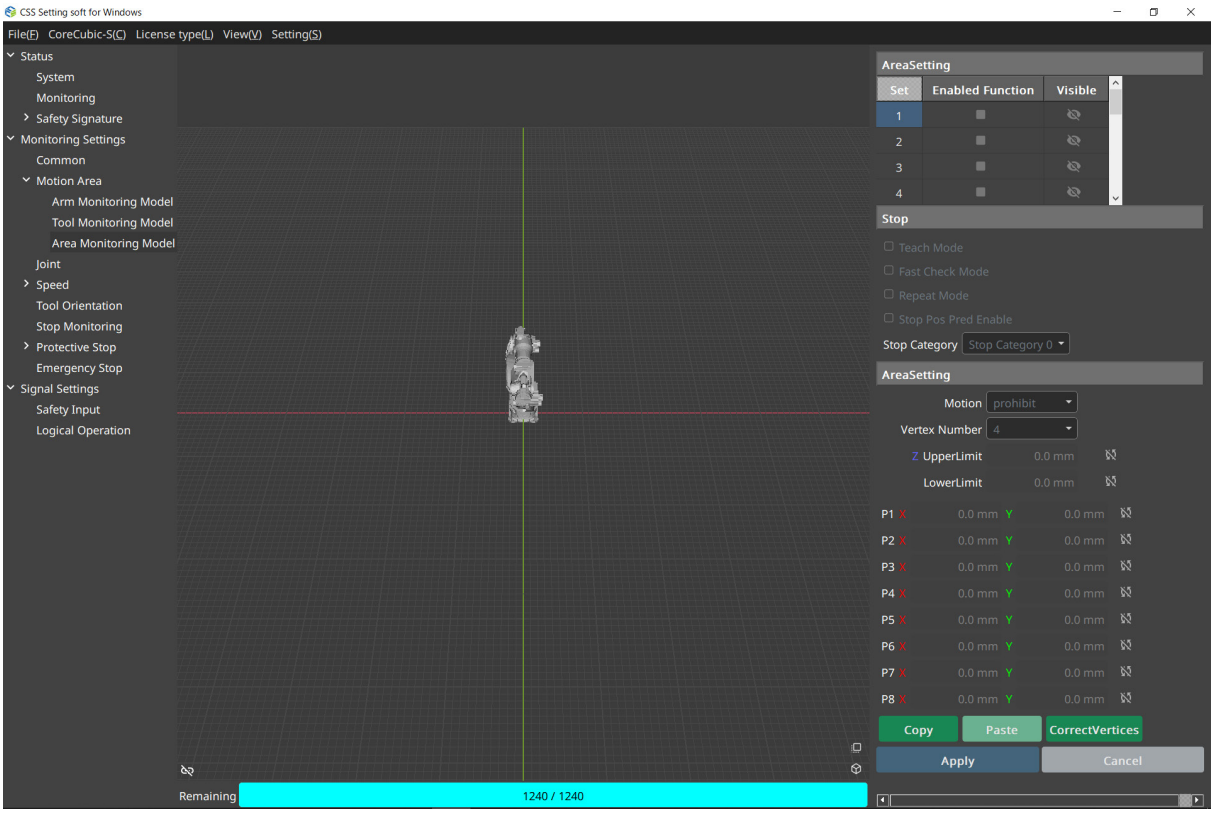
Double-click ccs3-win.exe to launch the setting application.





Appendix B.2 Screen Configuration

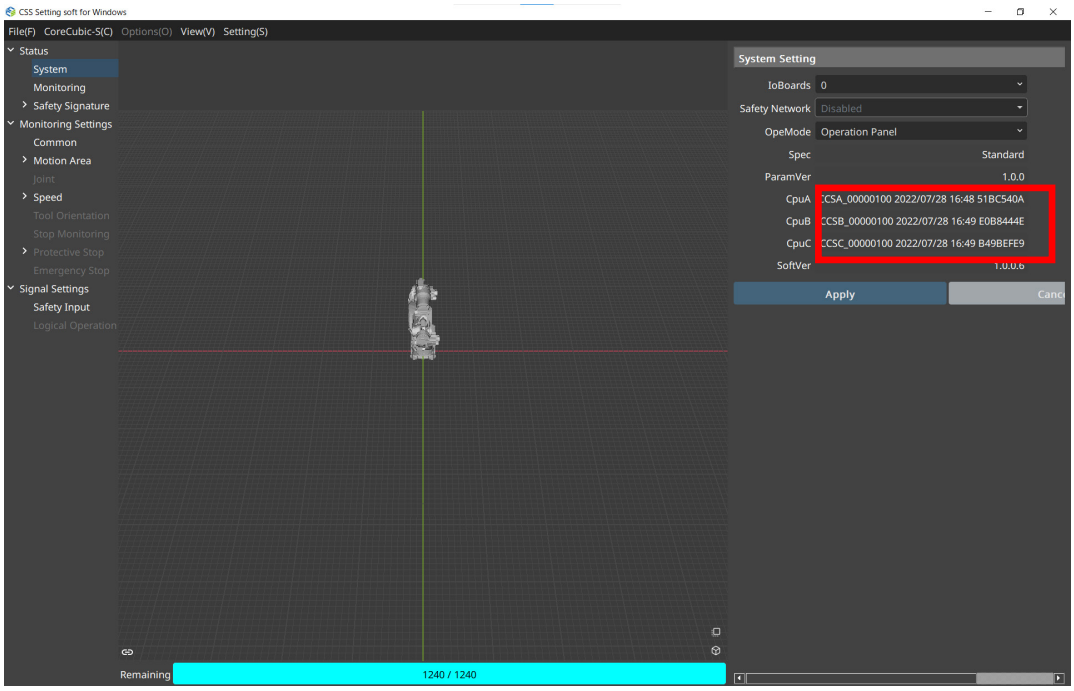
Like the TP version, it consists of four parts: Robot View, Operation Menu, Parameters Menu, and Parameter Data View.



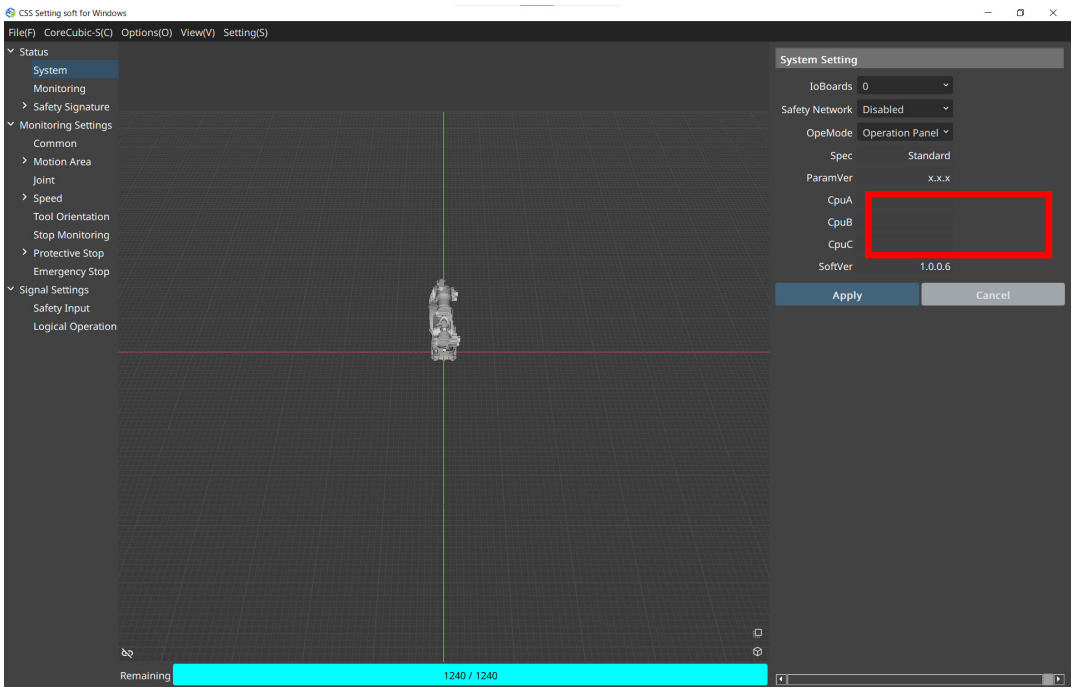
Appendix B.3 Controller Connection

Start the controller with the PC and the controller connected via a LAN cable, and then launch the setting application. Once connected, the names of the software will be displayed in [Safety Software A to C], as shown in the red box in the image below.

Connected status: Safety software names are shown

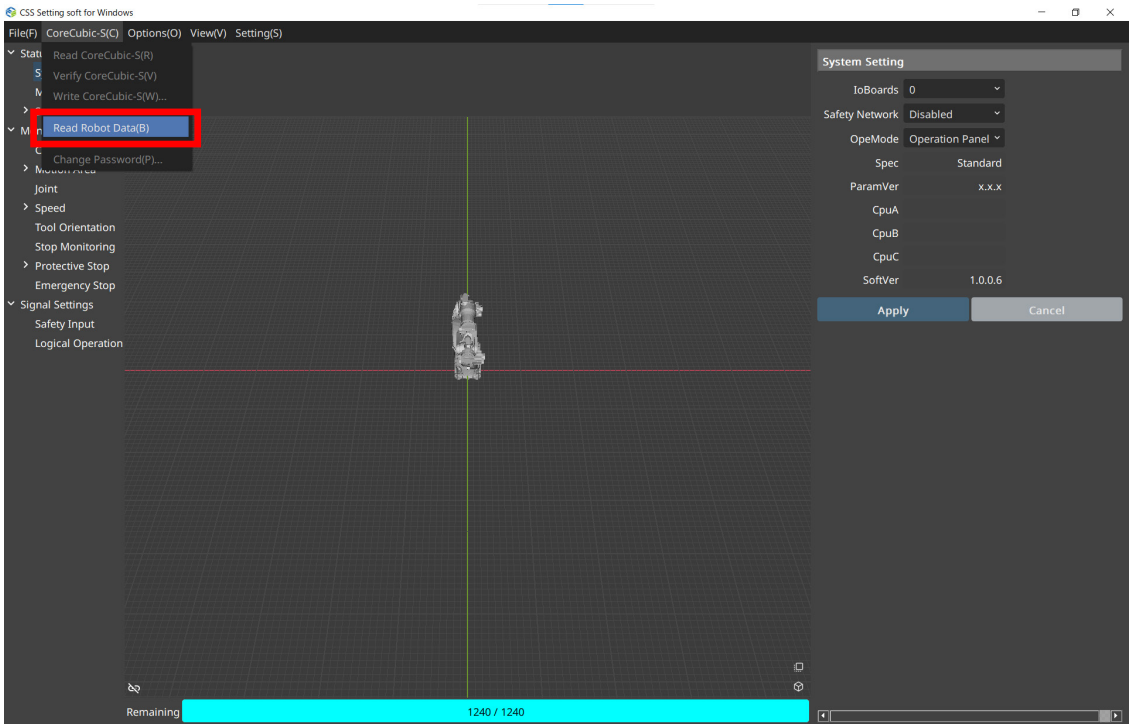


Disconnected status: No safety software names



Appendix B.4 Reading Robot Parameters

Robot parameters can also be read from a file even when the controller is disconnected.
Select [CoreCubic-S]-> [Read Robot Data] from the menu and select the file to be read. Note that user parameters will not be updated at this time.



Appendix B.5 Switching Display Languages

CoreCubic-S is available in Japanese, English, Chinese, and Korean.
Select [Setting]-> [Language] from the menu to switch the display language.
Note that the settings of the PC version will not synchronize with the language set on the controller side.

Appendix B.6 Switching Options

You can switch between configurable elements depending on your CoreCubic-S options.
Select [Options] from the menu to switch between None, Lite, Base, and Pro.
Note that the CoreCubic-S option itself cannot be switched.

Kawasaki Robot Controller F Series Controller

CoreCubic-S Instruction Manual

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