Simple and friendly

Kawasaki

Kawasaki Robot Controller
E Series

Cubic-S Instruction Manual

Robot

Kawasaki Heavy Industries, Ltd.

90210－1272DEC

PREFACE

This manual describes robot motion monitoring safety function Cubic-S, an option for the Kawasaki Robot Controller E 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 E series controllers:
E01, E02, E03, E04 (Univeral controller)
E10, E12, E13, E14, E20, E22, E23, E24 (Standard specification for Japan)
E30, E32, E33, E34 (Standard specification for North America)
E40, E42, E43, E44 (Standard specification for Europe)
(not including E70, E71, E73, E74, E75, E76, E91, E94, E97)
Cubic-S cannot be used with Y series robot YF003N.

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.

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 workpiece and not to all robot workpiece. In order to perform every workpiece 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 workpiece.**

CONTENTS

1.0 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 secure the safety of the robot and the robot system using this product, conduct proper risk assessment based on standard such as ISO12100 “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 failure in the control device and control circuit do not lead to any dangerous situations.

NOTES CONCERNING THE USE OF CUBIC-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.

2.0 NOTES AND CAUTIONS ON USING THE CUBIC-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 Cubic-S, such as emergency stop switch, light curtain etc. according to the required safety level.**
2. **Following the standards such as ISO13849-1, 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 self-diagnosis.**
   When using the safety output signal of Cubic-S, set the signals so that the system stops when the signal is OFF.
3. **Always stop the robot before conducting parameter setting operations for Cubic-S.**
4. **Parameter setting operation for Cubic-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 signal, turn ON/OFF the safety input signals to confirm the safety function becomes enabled/ disabled accordingly and that the safety function operates properly when enabled.**
6. **Take sufficient safety distance between the installation position of the light curtain/ laser scanner, etc. and the robot motion area according to the standard such as ISO13855.**
7. **Keep an adequate safety distance between the robot motion area and the safety fence, following safety standards such as ISO13852/ISO13853 etc.**
8. **In protective stop and emergency stop function, even if the stop category is set to 1 or 2, the robot may stop in stop category 0 due to malfunction, switching of teach/ repeat, controller power OFF, etc. Therefore, design the system assuming that the robot stops in stop category 0.**

2.1.1 NOTES AND CAUTIONS FOR MOTION AREA MONITORING FUNCTION

WARNING

1. **Stop distance prediction function is a function that predicts the distance it takes for the robot to stop exceeding the monitoring area and stops the robot beforehand within the monitoring area. However, this function does not guarantee that the monitored point stay within the monitored area. The robot may stop outside the allowable area, if the robot is malfunctioning or depending on the robot's motion conditions. Therefore, determine the monitoring area with enough allowance.**
2. **When not using the stop distance prediction function, keep the following precautions in mind and set the motion area with enough allowance.**
   ・The robot's stop distance may be longer due to malfunction or depending on the robot motion condition.
   ・The stop distance data Kawasaki provides for each robot are reference data, measured under a certain motion condition, and does not guarantee that the robot stops with in the distance shown by the provided data.
3. **Brakes can be checked via brake check function. When using Cubic-S, make sure to check if the brakes are functioning normally via brake check function to reduce the risks due to brake malfunction. For more information on brake check function, see the Brake Check Function manual, a separate volume.**

2.2 CAUTIONS CONCERNING WIRING OF THIS PRODUCT

Always follow the below mentioned cautions at the time of connection of this product. 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 Cubic-S. If not, the robot or the devices connected to Cubic-S 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.**
   - **When supplying the power for I/O signals from within the robot controller, use the attached XCS10 harness and connect the harness to the I/O signal connector to be used. See Chapter 9.3 for more details on XCS10 harness.**
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 Cubic-S connectors.**
7. **Do not connect the load over the rated current to the safety output.**
8. **When wiring the safety output, connect so that 24V DC does not come in contact with the safety output. Always earth the GND line of the power source so that the unit does not turn ON when the safety output line touches the case.**
9. **When wiring safety 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.**
11. **Inadequate wiring may impair the safety function. Make sure all wirings are correctly done, and always conduct operation checks before actual operations.**

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 to Cubic-S 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. **Cubic-S 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. **When replacing Cubic-S, load the necessary setting data and then confirm operation with that data. Especially when enabling/disabling the function according to the safety input signal, turn ON/OFF the safety input signals to confirm that the safety function becomes enabled/ disabled accordingly and that the safety function operates properly when enabled.**
4. **Do not dissemble or remodel Cubic-S. If repaired or remodeled by someone other than KHI personnel, it will be out of guarantee.**
5. **Before touching Cubic-S, always touch a grounded metal, etc. to release the static electricity charged in the human body, etc.**

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.

3.0 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	IEC61508-1,2,3,4 IEC62061 IEC61800-5-2 ISO13849-1 ISO10218-1 IEC60204-1 IEC61000-6-2 IEC61326-3-1 IEC61000-6-4 EN50178

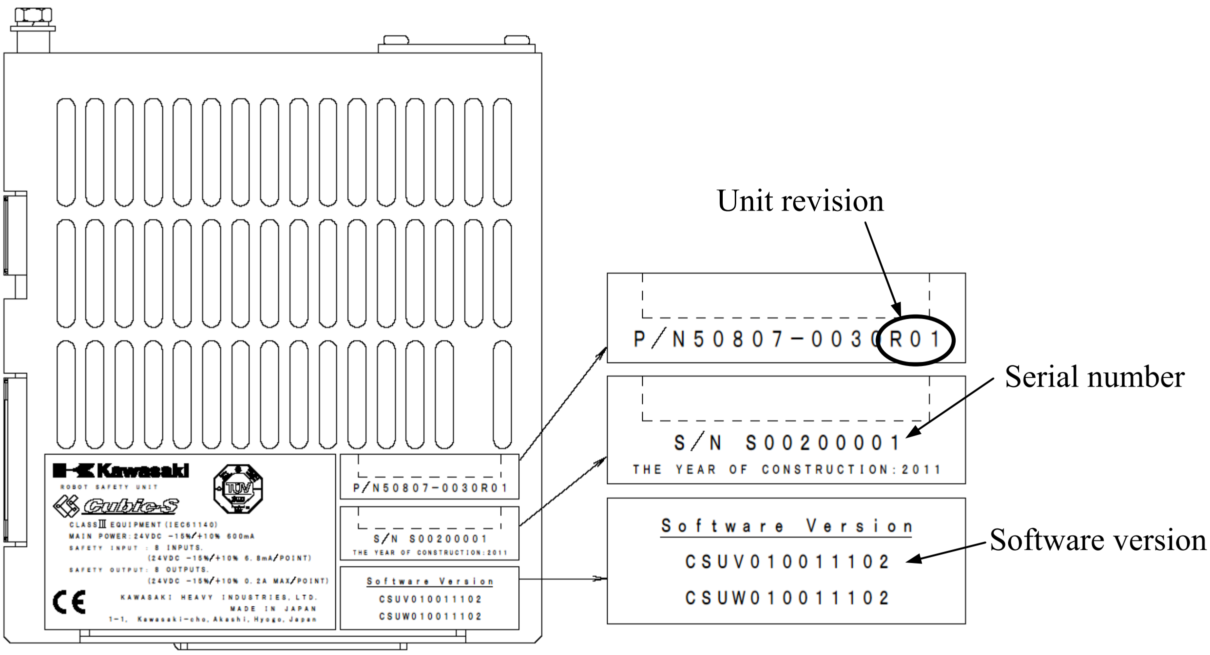
4.0 VERSION CONFIRMATION

The unit revision, software version, and the serial No. are indicated on the body of Cubic-S. The upper line is the unit revision, indicating the software and hardware version combined, and starts with R01. In the bottom lines are written the software version for the two CPU in Cubic-S.

The table below shows examples of Cubic-S software version.

Name	Software version indication
Version 1	CSUV010011102/CSUW010011102
Version 2	CSUV010222204/CSUW010222204
Version 3	CSUV010333305/CSUW010333305

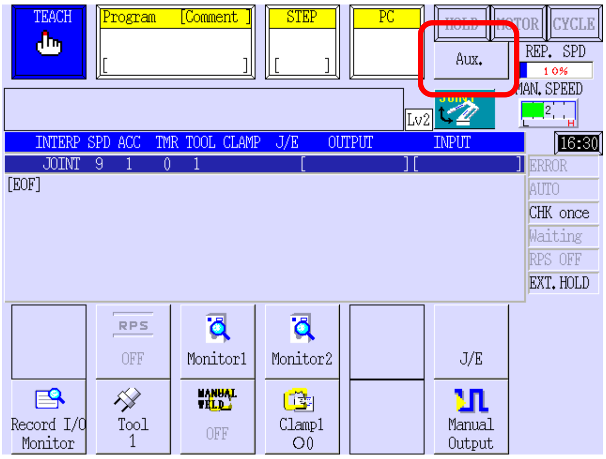
4.1 HOW TO CONFIRM THE VERSION ON THE UNIT BODY (PLAQUE DESCRIPTION)



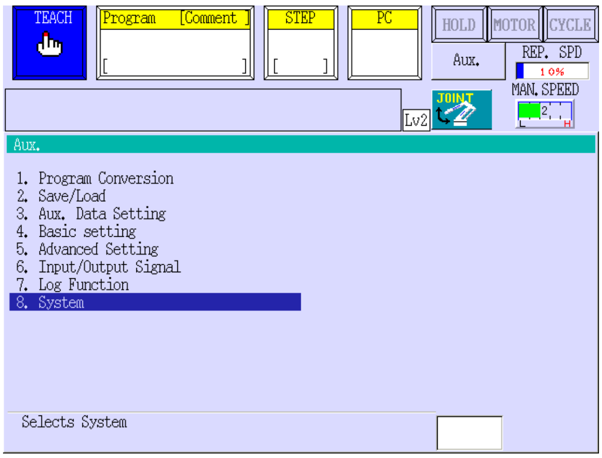
4.2 SOFTWARE VERSION CONFIRMATION

The software version of Cubic-S can be checked via auxiliary function [0804 Software version] using the teach pendant.

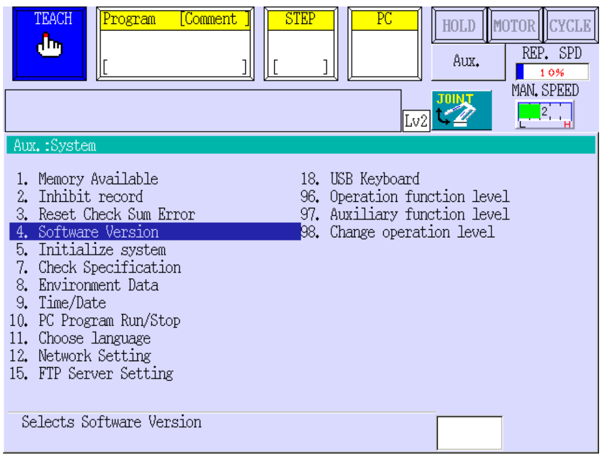
1. Press <Aux.> to display the auxiliary function screen.



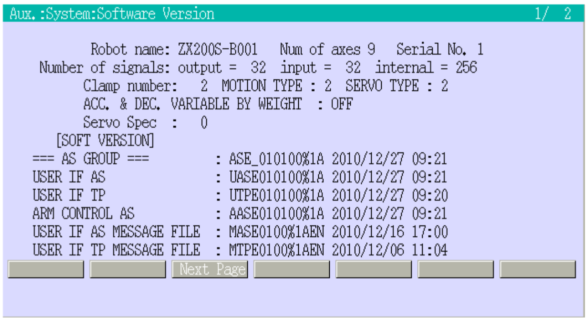
2. Select [8. System].

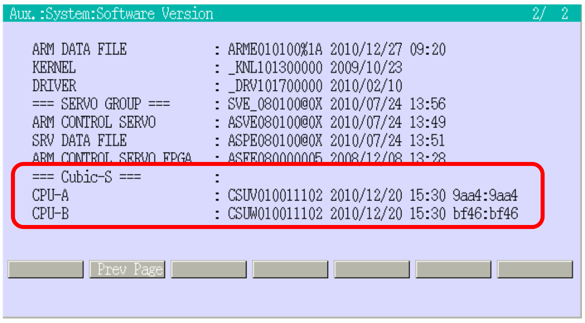


3. Select [4. Software Version].



The Cubic-S display area shows the software versions for CPU-A and CPU-B.





The versions are expressed in the following formats:

CPU-A CSUVllmmpppnn yyyy/mm/dd hh:mm

CPU-B CSUWllmmpppnn yyyy/mm/dd hh:mm

1. CSUVllmmpppnn / CSUWllmmpppnn

Shows the version of the software written on Cubic-S. This is the same as the content written on the sticker on the body of Cubic-S.

2. yyyy/mm/dd hh:mm

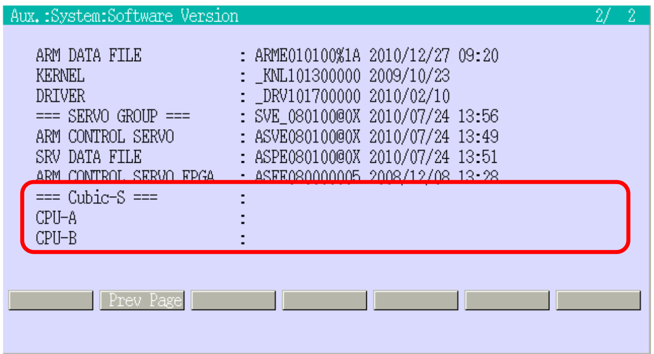
Shows the manufacture date of the software installed on Cubic-S.

3. xxxx/yyyy

Shows the sum check value Cubic-S(xxxx) and the sum check value re-calculated at time of startup (yyyy). The values match when startup is conducted normally.

*When Cubic-S does not start correctly

The version information will be blank when Cubic-S fails to start normally.



Connecting a terminal installed with KRterm or KCwin and executing monitor command ID on that terminal will display the same version information as above.

5.0 OVERVIEW

Robot motion monitoring safety function, Cubic-S, is a safety fucntion that monitors the robot motion status and shuts the power supply when the robot moves out of the regulated motion. The monitoring functions can be enabled/ disabled according to the user-defined safety input for each safety function. Also, the robot motion status can be output using the user-defined safety output.

The chart below describes the safety functions of Cubic-S.

Safety function	Contents of function
(1) Motion Area monitoring function	Monitors if the robot's monitored points (flange point, tool center point, set point on arm, set line segment on arm, tool) are out of the monitoring area or inside the prohibited area set in the XYZ plane, and shuts down the motor power. A constant monitoring area and a select monitoring area which can be enabled or disabled according to the safety input are provided. Also, there is a function where the stop position of the monitored points are estimated and the motor power is shut down when that estimated point is out of the restricted area or inside the entrance prohibited area.
(2) Joint monitoring function	The motor power is shut down when the joint angle (rotational axis) or the position (linear axis) exceeds the set range. Same as the area monitoring function, a constant monitored area and a select monitoring area which can be enabled or disabled according to the safety input are provided. There is no prediction function for joint monitoring function.
(3) Speed monitoring function	The motor power is shut down when the speed of the robot's flange point or TCP exceeds 250 mm/s or the setting speed. In repeat mode or fast check the robot is monitored based on 250 mm/s or the setting speed according to the safety input, but for teach mode, the speed is monitored based on 250 mm/s. However, when the speed is set lower than 250 mm/s and the speed monitoring function enabled, the setting speed takes precedence.
(4) Stop monitoring function	Monitors the stop status of the robot or the device axes (max. 3 axes) and if the monitored axis moves, the motor power is shut down. The monitoring is done according to the safety input signal set to the robot or the device axes.

(5) Tool orientation monitoring function	The motor power is shut down when the robot tool points out of the set tool orientation range. Five orientation ranges can be set, and the monitoring is done via safety input signals set for each of the orientation. There is no prediction function for tool orientation monitoring function.
(6) Protective stop function	This function uses the light curtain and safety door switch, and protectively stops the robot when a person enters the robot motion area. This function can be enabled or disabled according to the safety input signal setting. Also, the below settings are possible: Stop category 0: The motor power is shut OFF right after protective stop is input. Stop category 1: Robot reduces the speed when protective stop is input and the motor power is shut OFF after it comes to a stop. While the robot is slowing down, Cubic-S monitors if the speed is reducing properly, and if it is not slowing down, the motor power is shut OFF. Stop category 2: Robot reduces the speed when protective stop is input and performs stop monitoring after it comes to a stop. While the robot is slowing down, Cubic-S monitors if the speed is reducing properly, and if it is not slowing down, the motor power is shut OFF. When the input is released, robot motion resumes.
(7) Emergency Stop Function	This is a function where an external emergency switch connected and the robot is stopped in emergency when that emergency switch is pressed. Also, the below settings are possible: Stop category 0: The motor power is shut OFF right after emergency stop is input. Stop category 1: Robot reduces the speed when emergency stop is input and the motor power is shut OFF after it comes to a stop. While the robot is slowing down, Cubic-S monitors if the speed is reducing properly, and if it is not slowing down, the motor power is shut OFF.
(8) Safety state output function	Outputs the safety status of the safety functions 1 to 7, or the safety input status by allocating to each output channel.

WARNING

1. **The safety functions shuts down the power after the monitored point exceeds the monitoring range (area, angle/ position, tool orientation) and the robot stops out of the set range.　Therefore, determine the range in consideration of this overrun distance.**
2. **The stop distance prediction function is a function that predicts the distance it takes for the robot to stop exceeding the monitoring area and stops the robot beforehand within the monitoring area.　However, this function does not guarantee that the robot will not go out of the monitoring area and the robot's stop position may be outside the monitoring area due to malfunction of the robot or other robot motion conditions.　Therefore, determine the monitoring area with enough allowance.**
3. **The stop monitoring function is not a function to guarantee to always stop the robot.　This is a function to stop the robot when this function is enabled.　Therefore, the risk assessment and system design must take in consideration that the robot moves until Cubic-S stops the robot.**
4. **In protective stop and emergency stop function, even if the stop category is set to 1 or 2, the robot may stop in stop category 0 due to malfunction, switching of teach/ repeat, controller power OFF, etc.　Therefore, design the system assuming that the robot stops in stop category 0.**

6.0 SPECIFICATIONS

6.1 GENERAL SPECIFICATIONS

Item	Specification
Number of axes monitored	Max. 9 axes
Safety function	Area monitoring, joint monitoring, speed monitoring, stop monitoring, tool orientation monitoring, protective stop, emergency stop, safety status output
Safety performance*1	E1x, E2x, E3x, E4x controllers All safety function: PL d (Category 3), SIL2 E0x controller Protective stop, emergency stop only: PL e(Category 4), SIL3 Other safety functions: PL d(Category 3), SIL2
Response time	Emergency stop/ Protective stop (Stop category 0) : 20ms* Other safety function (Emergency stop/ including protective stop, stop category 1/2) : 60ms* Safety outputs directly allocated with safety input: 10ms* * input filtering time not included
Input/ output	Dual channel safety input 12 channels (4 set safety input, 8 user safety input) Dual channel safety output 12 channels (4 set safety input, 8 user safety input) Tool ID input 5 channels
Connection with PC	USB2.0
Overvoltage category	II
Pollution degree	2
Operation voltage	DC24V-15%+10%
Consumed Current	0.6A or less
Size	W40mm×H120mm×D140mm
Weight	0.5 kg or less
Device class	Class III
Protective structure	IP20
Ambient temperature	When installing vertically 0º to 65º When installing horizontally 0º to 60º
Ambient humidity	20 to 85%RH (without condensation)
Storage ambient temperature	-25 to 70 Cº
Storage ambient humidity	20 to 85 %RH (without condensation)
Altitude	0 - 1000 m above sea level

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

6.2 DUAL CHANNEL SAFETY INPUT SPECIFICATION

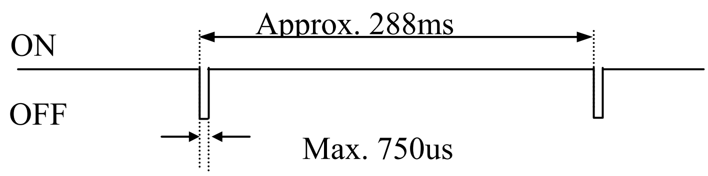
Item	Specification
Channels	12 channels(4: fixed safety input, 8: user safety input)
Insulation method	Opt coupler insulation
Input voltage range	DC20.4 to 26.4V (DC24V-15%+10%)
Maximum input current	6.8mA
Input type	Sink input (PNP compatible)
Input diagnosis	Input discrepancy diagnosis (Acceptable time of discrepancy can be set), Dual channel line short-circuit/ power short-circuit diagnosis (can be disabled)
Input filter	Configurable between 1 to 127ms, in units of 1ms
Dual channel input logic setting	Following settings possible: 1. Equivalent When both of dual channel input is ON, it is considered Input ON. Others are considered OFF. 2. Complementary Considered input ON when Channel A is ON, and B is OFF. Others are considered OFF.
External connection cable	Cable length: 50 m or less Shielded type Electrostatic capacity: below 22nF Conductor resistance: below 5Ω Inductance: below 40uH

6.3 DUAL CHANNEL SAFETY OUTPUT SPECIFICATION

Item	Specification
Channels	12 channels(4: fixed safety output, 8: user safety output)
Insulation method	Opt coupler insulation
Power voltage	DC20.4 to 26.4V (DC24V-15%+10%)
Maximum output current	0.2A/1 channel
ON Voltage Drop	1.2V or lower
Leak current	0.3mA or lower
Protection	Output short circuit protection
Output type	Source output (PNP compatible)
Output diagnosis test pulse OFF time	Max. 750us
External connection cable specification	Cable length: 50 m or less Shielded type Static capacity: less than 22nF Conductor resistance: less than 5Ω Inductance: less than 40uH

⚠ 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.

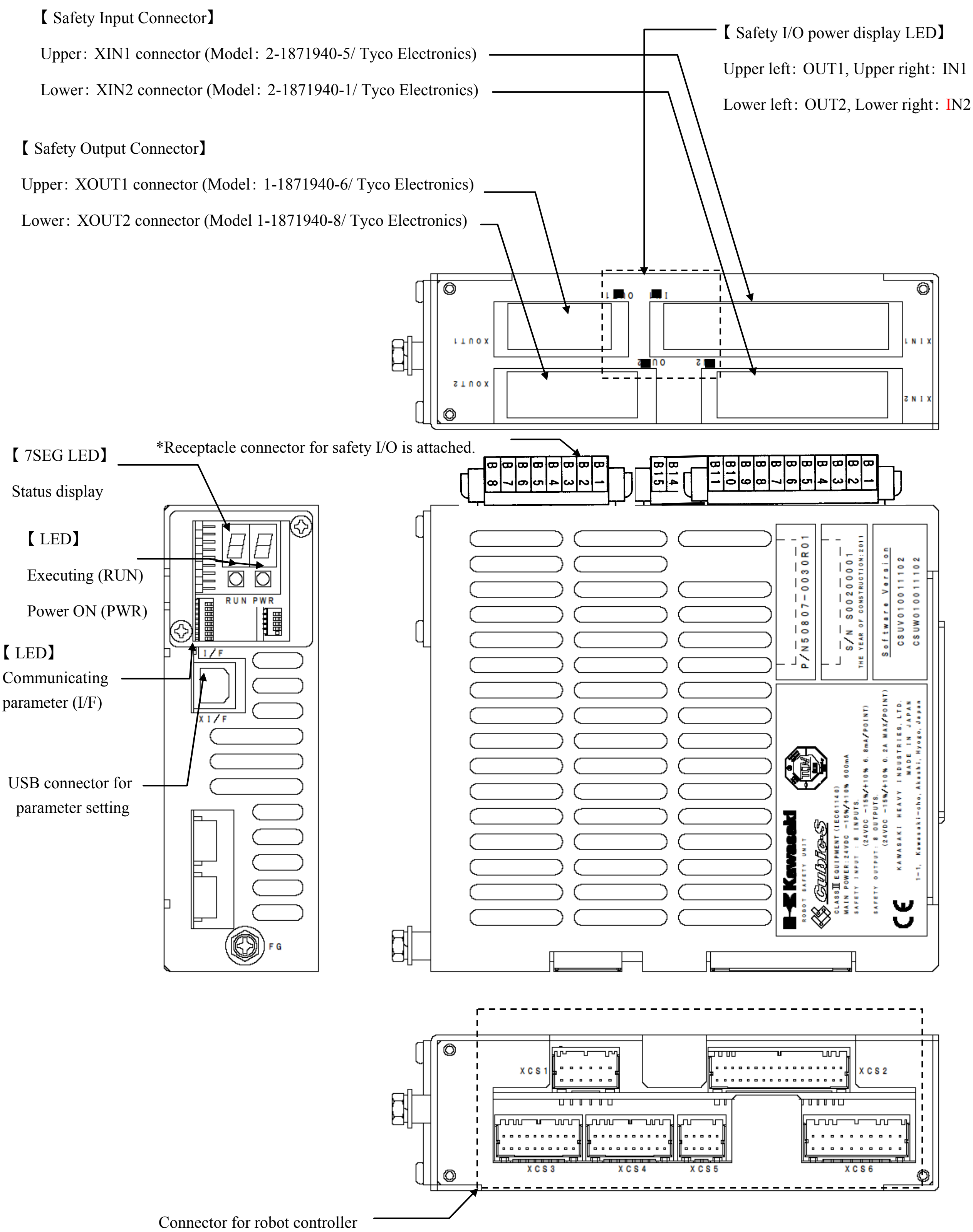


6.4 TOOL ID (SYSTEM 1 INPUT) SPECIFICATION

Item	Specification
Channel	5 channels
Insulation method	Opt coupler insulation
Input voltage range	DC20.4 to 26.4V (DC24V-15%+10%)
Maximum input current	6.8mA
Input type	Sink input (PNP compatible)
Input Diagnosis	Checks discrepancy with tool number on AS program
Use of tool ID	Enables/disables use of tool ID

6.5　NAMES AND FUNCTIONS OF EACH PART

Below figure shows the external view of Cubic-S and the name of each part.



Connector

No.	Content
XCS1	DC24V power input, servo board communication
XCS2	Fixed safety input, Motor power shut down, Other output (Teach/ repeat switching etc.)
XCS3	Encoder communication
XCS4	Encoder communication
XCS5	Fixed safety output *Normally not used.
XCS6	Option input/ output *Normally not used.
XIN1	Safety input (ch1 to 4), Tool ID input (See chapter 10 for details)
XIN2	Safety input (ch5 to 8) (See chapter 10 for details.)
XOUT1	Safety output (ch1 to 4) (See chapter 10 for details.)
XOUT2	Safety output (ch5 to 8) (See chapter 10 for details.)
XI/F	USB connector for parameter setting

LED

Name	Content	Color	Status
7SEG	Status indication	Red	Normal : Rotate Error: Error code displayed *See Chapter 14 for details
PWR	Power ON	Green	Power ON: Light ON
RUN	In execution	Green	Normal operation: Flicker
I/F	Parameter communication	Red	Parameter communication: Light ON
IN1	Safety input connector XIN1 (ch1 to 4) 24Vpower status	Green	Power ON: Light ON Power OFF: Light OFF
IN2	Safety input connector XIN2(ch5 to 8) 24Vpower status	Green	Power ON: Light ON Power OFF: Light OFF
OUT1	Safety input connector XOUT1(ch1 to 4) 24Vpower status	Green	Power ON: Light ON Power OFF: Light OFF
OUT2	Safety input connector XOUT2(ch5 to 8) 24Vpower status	Green	Power ON: Light ON Power OFF: Light OFF

[NOTE]

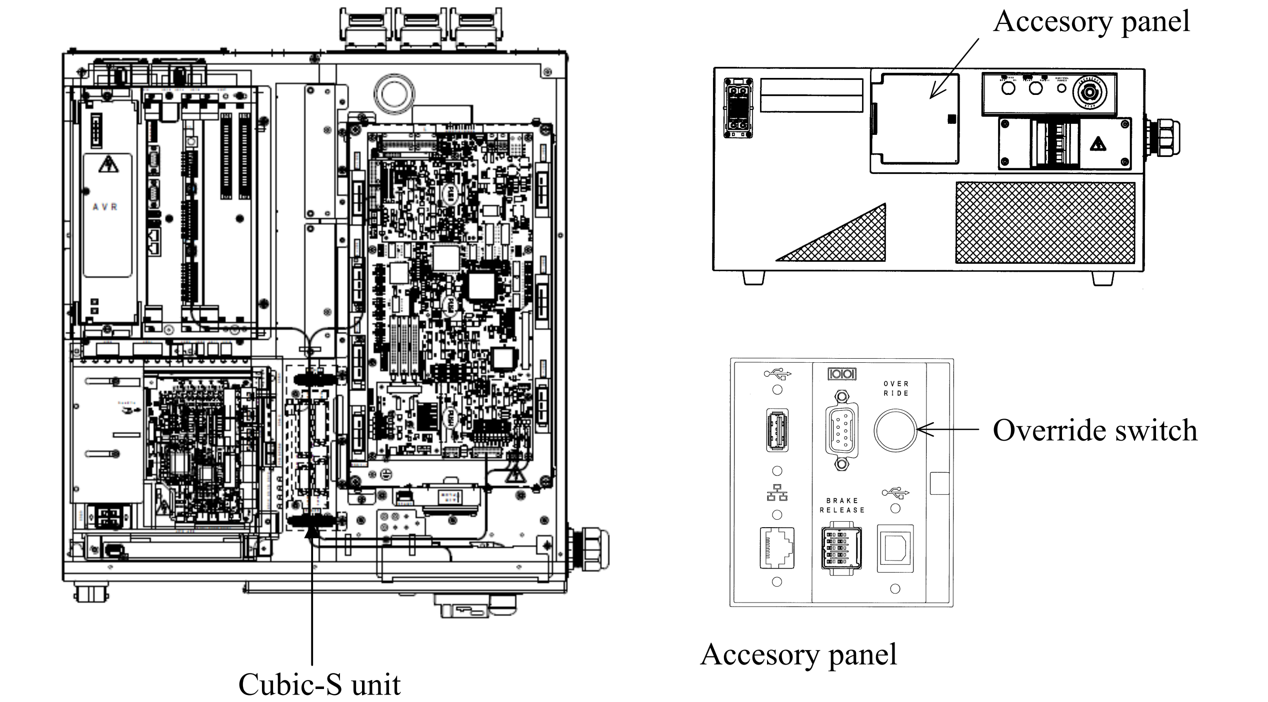
Dip SW inside 7SEG LED cover are all set to OFF at time of factory shipment. Do not change this setting.

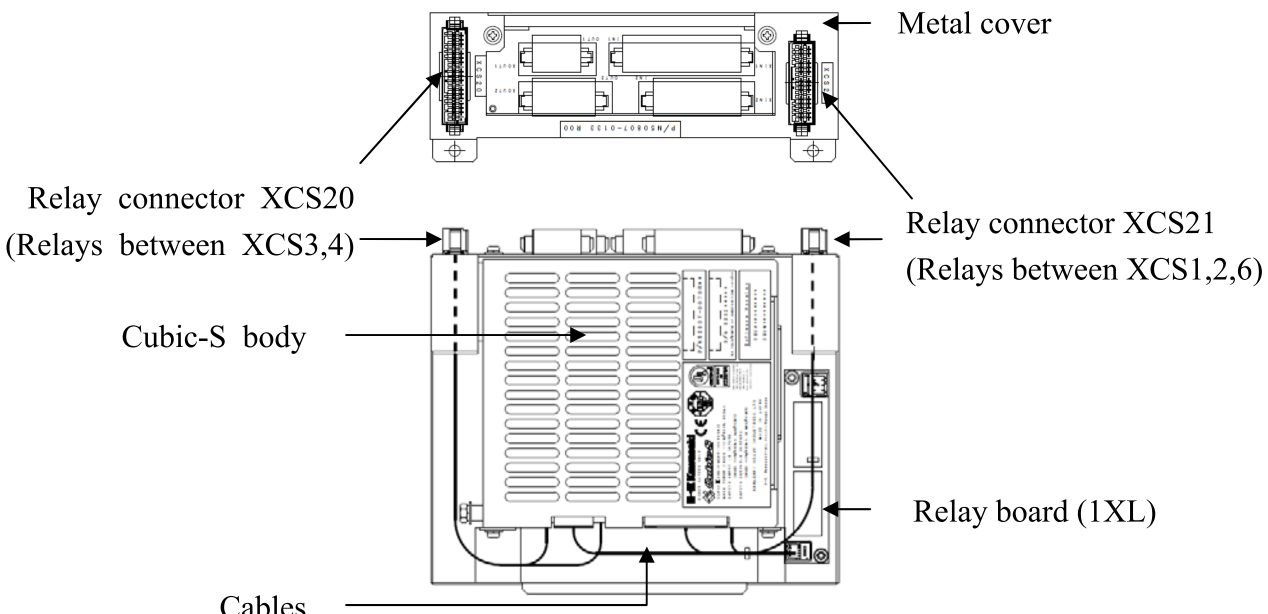
6.6 INSTALLATION POSITIONS

Below indicates the installation positions of override switch for each controller.

E0x controller

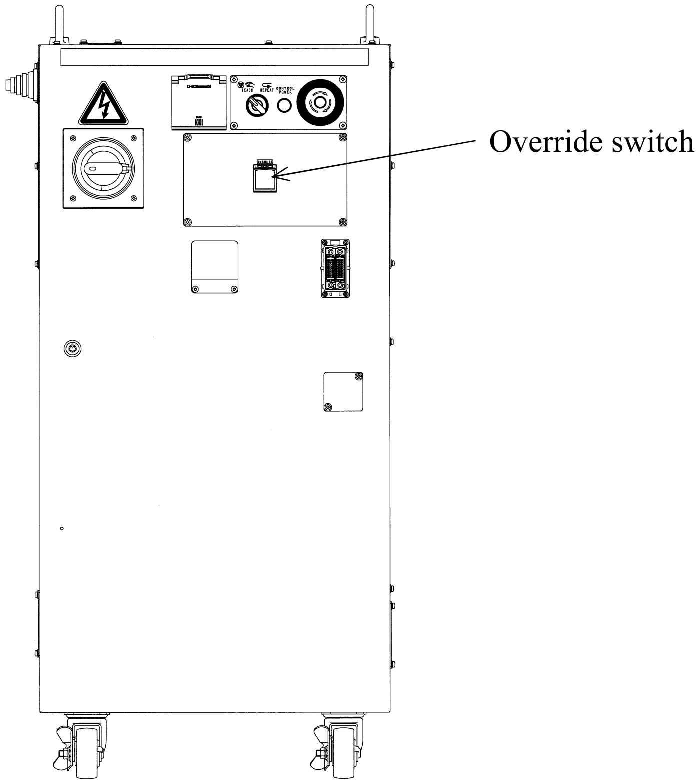
In E0x controller, the override switch is mounted as a part of the Cubic-S unit consisting of Cubic-S body, relay board (1XL board), harness and metal panel, at the position indicated in the figure below.

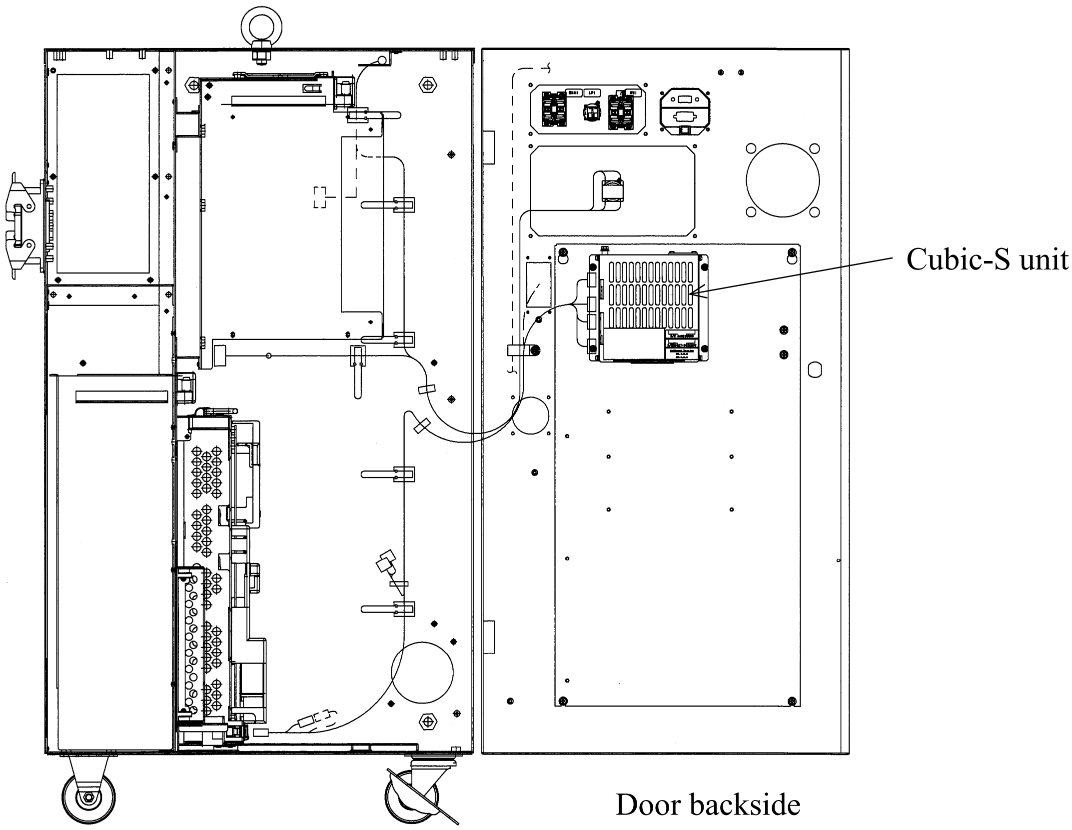




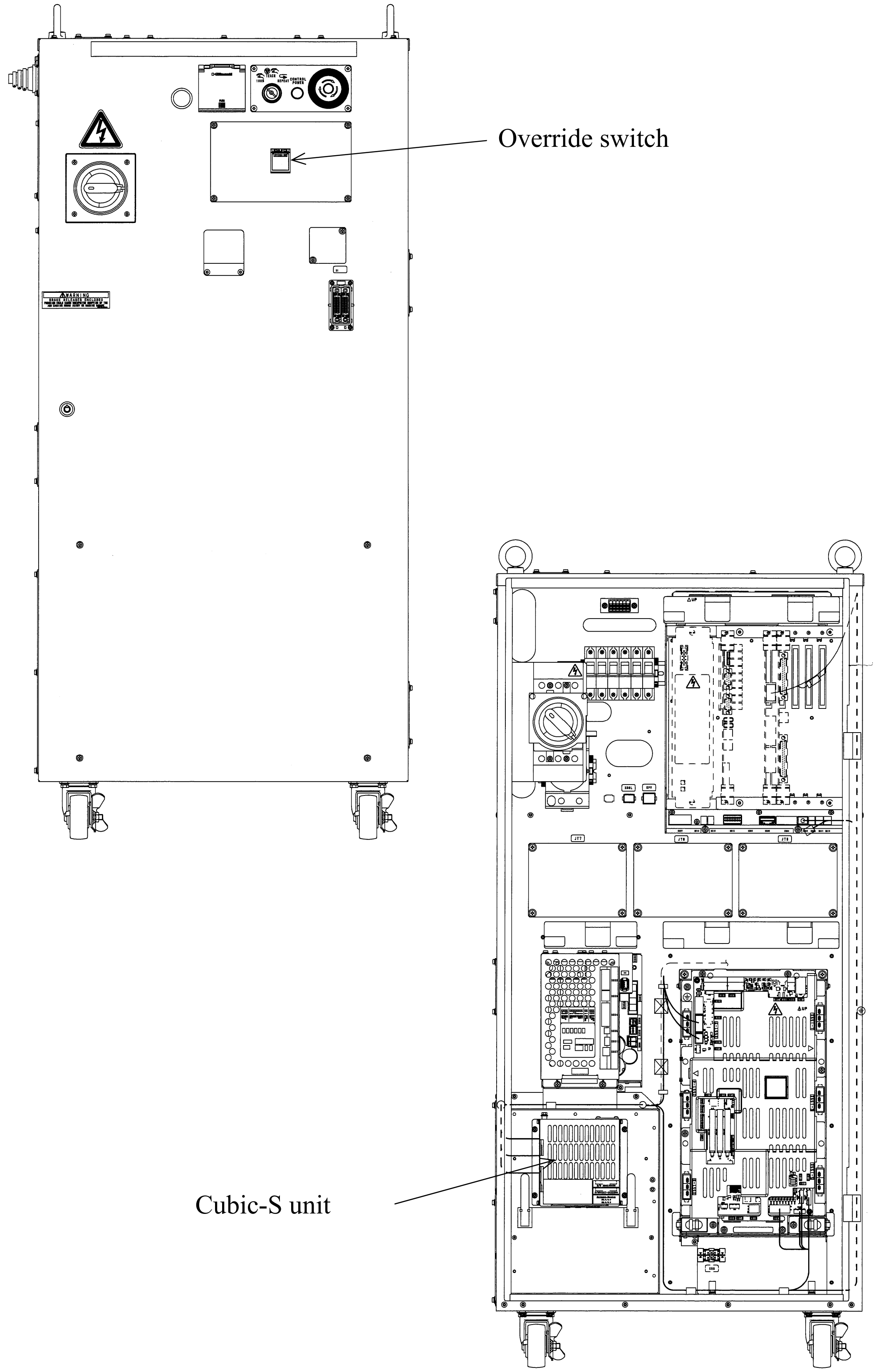
External view of Cubic-S Unit

E2x controller





E1x, E3x, E4x controllers



6.7 RESTRICTIONS ON COMBINING CUBIC-S AND OTHER FUNCTIONS

When using Cubic-S, there are functions that can be used together with Cubic-S and others that cannot.

Robot motion is not guaranteed for using with functions other than stated here. When using a function with Cubic-S for the first time, please contact Kawasaki beforehand.

1) Functions and options that cannot be used with Cubic-S

#	Fucntion	Reason for restriction
1	Spin function	Spin axis can rotate limitlessly, though unlimited rotation will cause error in Cubic-S motion limits.
2	Servo gain change function	Setting a small gain may cause displacement error in Cubic-S.
3	Soft absorber function	Setting a small gain may cause displacement error in Cubic-S.

2) Functions and options that can be used with Cubic-S, but with restrictions

#	Fucntion	Reason for restriction
1	Endless positioner function/ external spin function	Same as in spin function, unlimited rotation will cause error in Cubic-S motion limits. Therefore, do not monitor the spin axis with Cubic-S.
2	Mitsubishi motor (External axis)	This axis cannot connect with Cubic-S, so do not monitor this axis with Cubic-S.
3	Servo weld gun	Displacement error will occur in Cubic-S when servo weld gun is pressurized, so do not monitor this axis with Cubic-S.
4	Tool change function	Communication error occurs between encoder and Cubic-S after tool change (when disconnecting external motor axis and connecting to a different external axis motor), so do not monitor this axis with Cubic-S.

7.0 SAFETY FUNCTION

7.1 MOTION AREA MONITORING FUNCTION

Item	Specification
Monitored axes	Robot axes
Monitored area	1. Robot arm monitor (Manufacturer setting) ・Flange point 1 point ・Arm monitoring point 0 to 4 points ・Arm monitoring line segment 0 to 6 segments *The monitored points/ segments are set per arm and cannot be changed. 2. Tool monitor (user setting) : Monitored point is changed according to the tool number ・TCP 1 point ・Tool shape point 0 - 20 points ・Area including the tool shape point
Tool number	There are two types of tool numbers: current tool number which is transformed from the tool ID input using the tool number table, and the command tool number input from the robot controller. When these two tool numbers do not match, tool shape points of both tool numbers are monitored, and if the motion distance after the mismatch is greater than the set distance, an error occurs. *Tool ID can be used or not used depending on the user setting. When the tool ID is not used, tool number 1 is monitored regardless of the command tool number value.
Number of monitored area	Constant monitoring area: 1 area (including 8 constant prohibited areas) Select monitoring area: 4 areas *Each motion area can be set to whether the monitoring point and the monitoring line segment on arm are monitoring or not. *Select monitoring area can be set as monitoring area or prohibited area.
Monitored area setting	Constant monitoring area: octagonal prism (Within an octagon and the height as upper-lower limit) Constant prohibited area: quadrangular prism (Within a square and the height as upper-lower limit) Select monitoring area: hexagonal prism (Within a hexagon and the height as upper-lower limit) *When seen from above, the area should be in a convex shape.
Conditions to enable the monitoring function	Constant monitoring area: Always monitored. Select monitoring area: When safety input for validating monitoring is input for each area. *Setting of select monitoring area valid/ invalid can be changed during teach/ fast check mode. *Monitoring is not done when the override switch is pressed in teach mode. *When more than one area is validated, the overlapped areas are monitored.
Safety input allocated signal	・Selected area monitoring (1 to 4) (OFF: monitoring valid)
Safety output allocated signal	・Constant monitoring area (ON: Within the monitoring area and out of the prohibited area.) ・Select monitoring area (1 to 4) (When set as monitoring area, ON: within the monitoring area. When set to prohibited area, ON: out of the prohibited area.) This is output both with monitoring valid/ invalid.
Stop distance prediction	This function predicts from the speed of the monitored points, the stop position of each point and monitors if the predicted position is within the monitored area. *Stop distance prediction can be enabled/ disabled by setting.

⚠ WARNING

Stop distance prediction function does not guarantee that the monitored point stay within the monitored area. When setting the monitored area, take sufficient allowance between the limits of the monitored area and the safety fence or the safety distance.

7.2 JOINT MONITORING FUNCTION

Item	Specification
Monitored axes	Each axis
Monitor angle/ position*1	Constant monitoring angle/ position 1 set (1 set: Max. 9 axes) Select monitoring angle/ position 8 sets
Monitored area setting	Sets the monitored angle / pose area per axis. *Each motion area can be set to whether the monitoring point and the monitoring line segment on arm are monitored or not. *Select monitoring area can be set as monitoring area or prohibited area.
Conditions to enable the monitoring function	Constant monitoring angle/ position: Always monitored Select monitoring angle/ position : When safety input for monitoring enable corresponding to each monitoring angle/ position set is input * Valid/ invalid of select monitoring angle/ position can be changed during teach/ fast check mode. *Monitoring is not done when the override switch is pressed in teach mode. *When more than one area is validated, the overlapped areas are monitored.
Safety input allocation signal	・ Select monitoring angle/ position (1 to 8) (OFF: monitoring valid)
Safety output allocated signal	・ Within constant monitoring angle/ position (ON: within the area) ・ Within select monitoring angle/ position (1 to 8) (ON: within the area) * Output with both monitoring enable/ disable
Stop distance prediction function	No

*1 Angle is monitored for rotational axis, position is monitored for linear axis.

7.3 SPEED MONITORING FUNCTION

Item	Specification
Monitored axis	Robot axis, each axis
Monitored speed	・For robot axis: monitors the speed for the following monitoring points: 1. Robot arm monitoring (Manufacturer setting) ・Flange point 1 point 2. Tool monitor (user setting) : Monitored points are changed according to the tool number ・TCP 1 point ・Tool shape point 0 - 20 point *Monitored points are the same as in area monitoring. *Valid/ invalid of speed monitoring can be set for each point of TCP and tool shape point. Default setting is Invalid. *Same reaction as area monitoring when tool numbers do not match ・For individual joints: Linear speed for linear axis, the speed of vertex on the perimeter of rotation for rotational axis
Conditions to enable the monitoring function	1. In teach mode: monitors if speed is lower than 250 mm/s 2. When 250 mm/s speed monitor is input: monitors if speed is lower than 250 mm/s 3. When set speed monitor is input: monitors if speed is lower than set speed *Valid/ invalid of 250 mm/s speed monitoring and set speed monitoring can be changed during teach/ fast check mode.
Safety input allocated signal	・250 mm/s speed monitoring (OFF: monitoring enabled) ・Set speed monitoring (OFF : monitoring enabled)
Safety output allocated signal	・Below 250 mm/s (ON: below 250 mm/s) *Output with both monitoring enable/ disable ・Below set speed (ON: below set speed) *Output with both monitoring enable/ disable

If TCP and tool shape point speed are monitored, speed monitor error may occur when operating in check motion in teach mode.

7.4 STOP MONITORING FUNCTION

Item	Specification
Monitored axes	Robot axis, device axes (Max. 3 devices)
Conditions to enable the monitoring function	1. When robot stop monitoring is input: Monitors the robot axes*1 2. When equipment stop monitoring 1 is input: Monitors the joint set as equipment 1 3. When equipment stop monitoring 2 is input: Monitors the joint set as equipment 2 4. When equipment stop monitoring 3 is input: Monitors the joint set as equipment 3 *Valid/ invalid can be changed while in teach/ fast check mode.
Safety input allocated signal	・Robot stop monitor (OFF: monitoring enabled) ・Device stop monitor (1 - 3) (OFF: monitoring enabled)
Safety output allocated signal	・Robot stopped (ON: stopped due to monitoring result) ・Device stopped (1 - 3) (ON: stopped due to monitoring result)

*1 When robot moves in cooperation with external axis, such as when mounted on a traverse equipment, the robot axes include the external axis.

7.5 TOOL ORIENTATION MONITORING FUNCTION

Item	Specification
Monitored axes	Robot axis
Orientation of monitored tool	The orientation of TCP for tool orientation monitoring for each tool number. * Same reaction as area monitoring when tool numbers do not match
Monitoring area	Monitors the range of angle specified in form of a cone corresponding to the defined orientation. *Up to 5 tool orientation monitoring cone can be set.
Conditions to enable the monitoring function	When monitoring valid input corresponding to each tool orientation monitoring cone is input *Setting of select monitoring area valid/ invalid can be changed during teach/ fast check mode. *Monitoring is not done when the override switch is pressed in teach mode. *When more than one area is validated:. (1) When the tool orientation monitoring signals are allocated to the same user safety input port, monitors if the tool is pointing at one of the tool orientation cones. (2) When the tool orientation monitoring signals are allocated to different user safety input ports, monitors if the tool is pointing to the overlapped area of the validated tool orientation cones.
Safety input allocated signal	・Tool orientation monitoring (1 to 5) (OFF: Monitoring valid)
Safety output allocated signal	・Within monitored tool orientation area – all (OR signals 1 to 5) (ON: Within monitored area) ・Within monitored tool orientation area (1 to 5) (ON: Within monitored area) *Output for both monitoring valid/ invalid.
Stop distance prediction function	No

7.6 PROTECTIVE STOP FUNCTION

Item	Specification
Monitored axes	All axes
Number of input	4 channels
Stop Category	Can select Stop Category 0, 1, 2 for each protective stop input
Deceleration monitor (For Stop Category1/2)	Monitors if the joint speed is decreasing after protective stop is input. Deceleration is monitored and if the speed is not decreasing properly, the power is shut OFF.
Conditions to enable the function	When protective stop enable input and the corresponding protective stop are input * Valid/ invalid can be changed for each protective stop input while in teach/ fast check mode.
Safety input allocated signal	・Protective stop(1 to 4) (OFF: Protective stop) ・Protective stop valid (1 to 4) (OFF: Protective stop valid)
Safety output allocated signal	・Protective stop being input (OFF: Protective stop being input in one of the four channels with protective stop enabled) ・In protective stop (ON: stopped by protective stop) (Available in Cubic-S version 2 or later)

7.7 EMERGENCY STOP FUNCTION

Item	Specification
Monitored axes	All axes
Number of input	5 channels (1 Controller E-stop system + 4 ext. E-stop system)
Stop Category	Can select Stop Category0, 1
Deceleration monitor (For Stop Category1)	Monitors if the joint speed is decreasing after emergency stop is input. Deceleration is monitored and if the speed is not decreasing properly, the power is shut OFF.
Conditions to enable the function	Always valid
Safety input allocated signal	・External emergency stop (1 to 4) (OFF: Emergency stop)
Safety output allocated signal	Protective stop being input (OFF: Protective stop being input in one of the four channels with protective stop enabled)

7.8 SAFETY STATE OUTPUT FUNCTION

Item	Specification
Number of ports for user safety output	Max. 8 ports
Allocation	Can allocate Safety output allocated signal for each safety function for user safety input/ fixed safety input (teach/ fast check mode, teach speed monitoring, override, controller emergency stop) *Can allocate one output to more than one user safety output port.
Output diagnosis test pulse	Generates pulse that turns OFF output for 750 us for every 288 ms, when this signal is ON *turns OFF the safety output when error is detected by the test pulse.

8.0 BASIC OPERATIONS OF THE SETUP SOFTWARE

8.1 OPERATION ENVIRONMENT

The parameter configurator (CS-Configurator) requires the below operation environment for:

- Hardware: PC/AT compatible machine
- OS: Windows XP Service Pack3/7/8.0/8.1
- Operation confirmed machines:
  Lenovo ThinkPad R500 (Windows XP Service Pack3)
  Panasonic Let's note CF-SX3 (Windows 7)
  Sony VAIO Fit 13A (Windows 8.0)
  Sony VAIO Duo 13 (Windows 8.1)
  Note* Please note that CS-Configurator may not operate in unconfirmed machines.
- Memory: 512MB or more (1GB recommended)
- Hard disk: 200MB or more of free space required
- Software: Microsoft .NET Framework 3.5

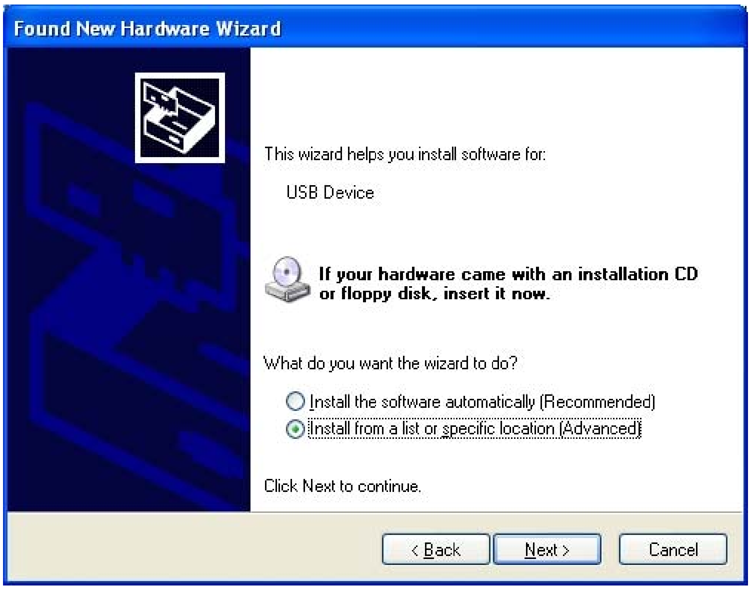
8.2 INSTALLATION PROCEDURE

8.2.1 INSTALLING THE USB COMMUNICATION DRIVER

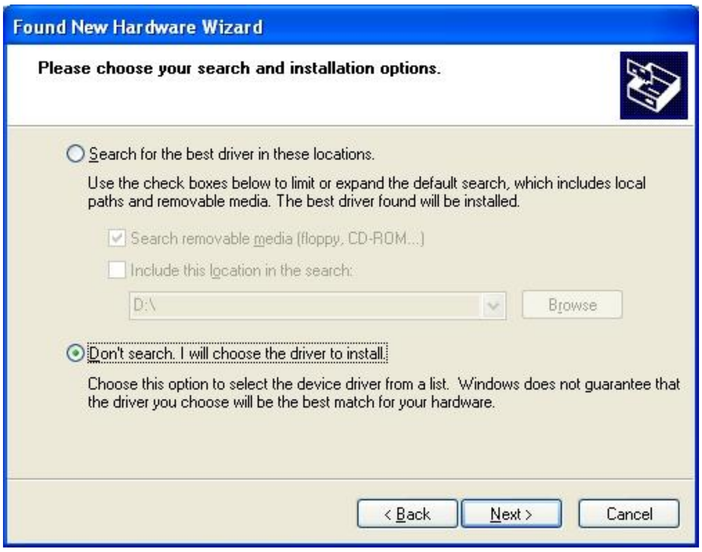
Communication method of the USB driver varies according to the OS. Refer to below for how to install in each OS.

1. For Windows XP

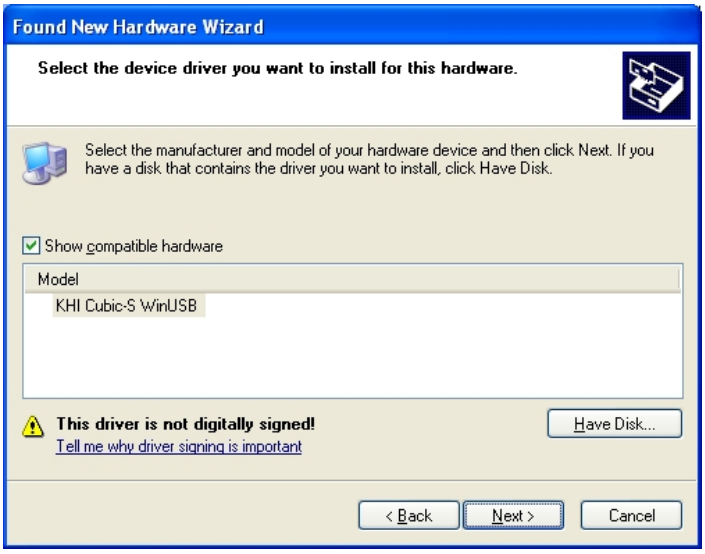
Connect the computer with Cubic-S using a USB cable. The OS in the computer automatically finds Cubic-S and starts the [Found New Hardware Wizard]. Select [Install from a list or specific location] and press <Next>.



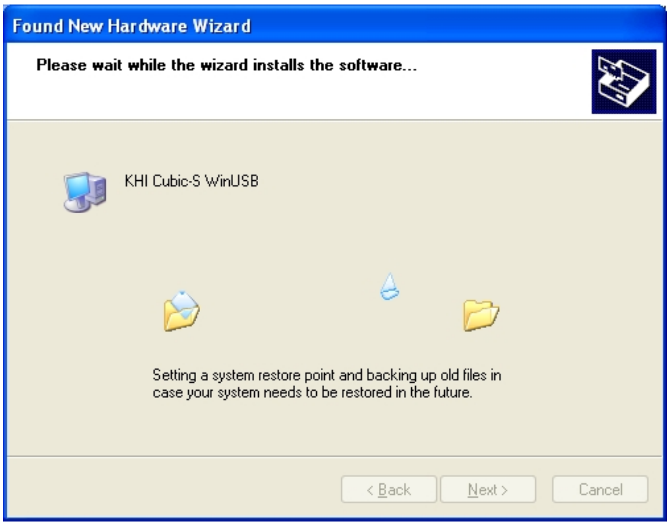
In the next window that appears, select [Don't search. I will choose the driver to install] and press <Next>.



In the next window, select the directory "KHI Cubic-S driver" in the CS-Configurator installation CD-ROM and click on <OK>.

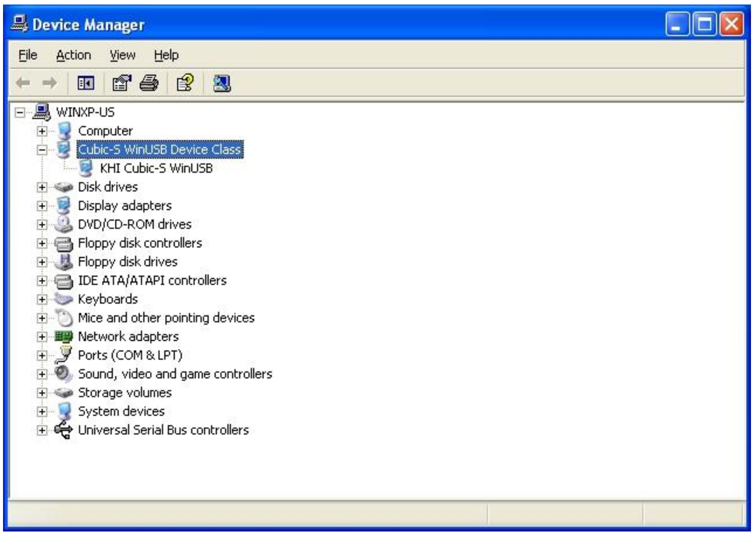


The OS finds “KHI Cubic-S WinUSB” and installs the necessary files.



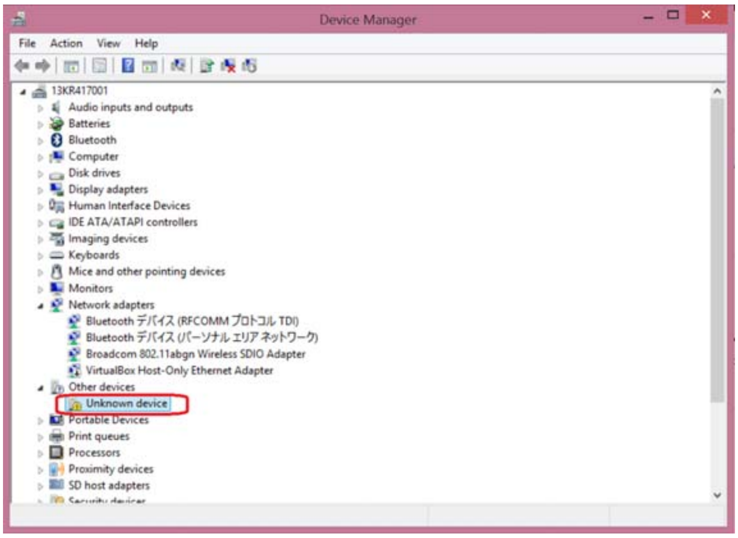
When the file is copied, confirm that the installation is completed in the “Completing the Found New Hardware Wizard” and click on <Finish> button.

Check via the Device Manager in your OS if WinUSB for Cubic-S is properly installed and operating.

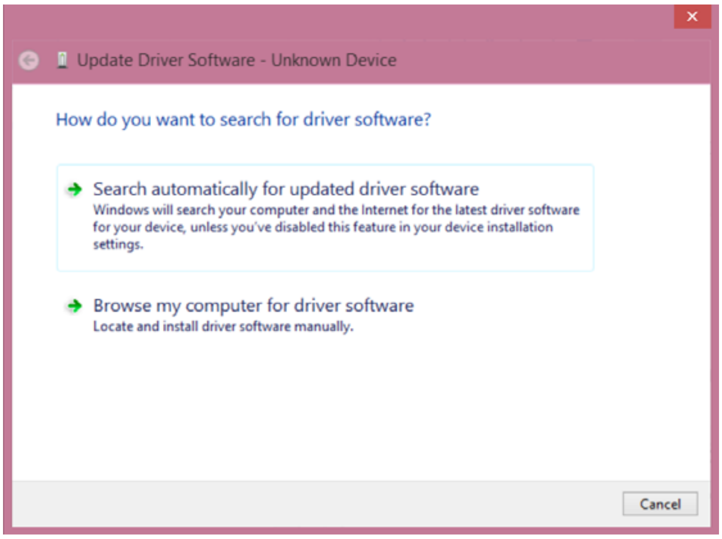


2. For Windows 7, Windows 8.0, Windows 8.1

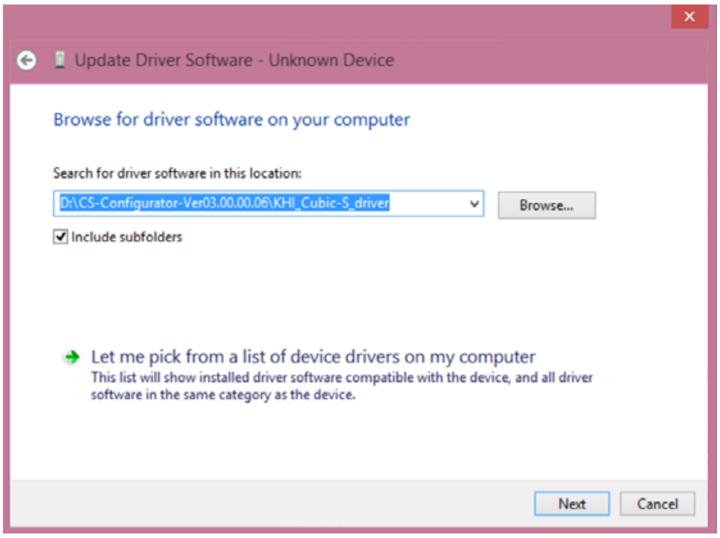
Connect the computer and Cubic-S using USB cable. OS automatically detects Cubic-S, and tries to starts automatic installation. If Cubic-S USB communication driver is not installed, installation starts as "Unknown device". Check the Device Manager to confirm that an Unknown device is installed.



Open the property of [Unknown Device] and click on [Update Driver] or right click on [Unknown Device] and select [Update Driver] to open the "Update Driver Software" screen.

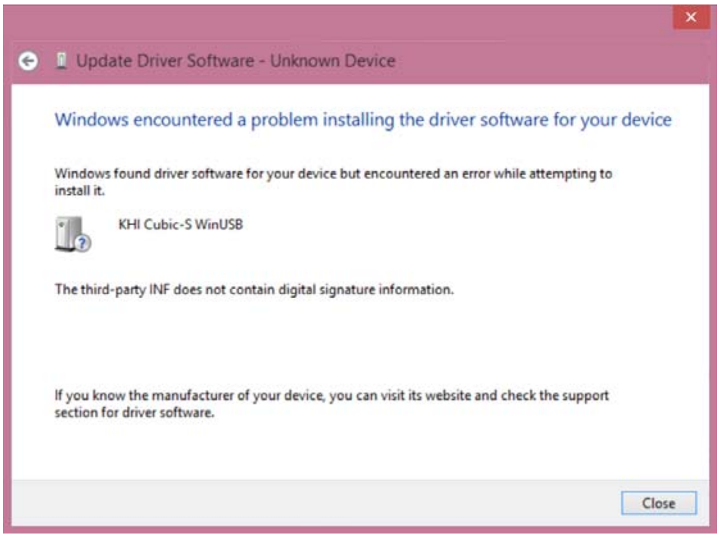


Select [Browse for driver software on your computer] in the inquiry window.



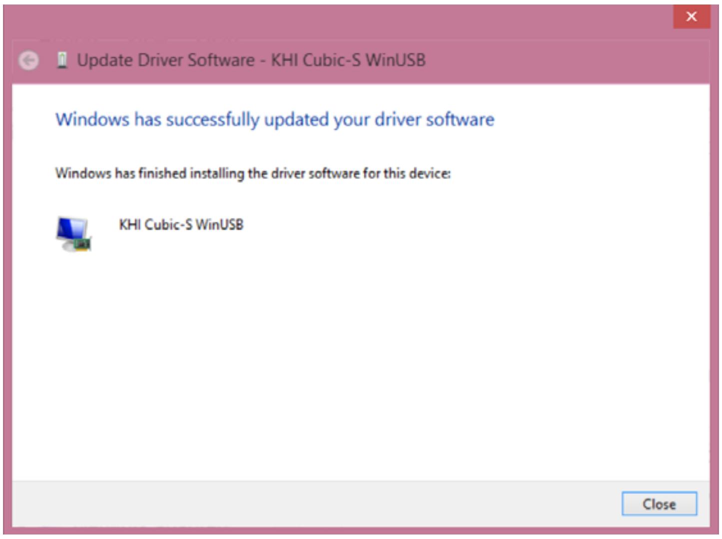
Press <Browse> and select the [KHI_Cubic-S_driver] directory in CD-ROM for CS-Configurator installation. Press <Next>. Update of device driver starts.

* In Windows 8.0 and Windows 8.1, the following error may happen when installing communication driver. In that case, disabling "driver signature enforcement" enables installation. Refer to Supplementary Notes 1 and 2 at the end of this section to disable the driver signature enforcement, restart the computer and then, follow the installation procedures in 2. over again from the beginning. For Windows 8.0 and Windows 8.1, refer to Supplementary Note 1 and 2 respectively. The following error will not occur in Windows 7.



During the installation, the message box saying "Windows can't verify the publisher of this driver software" appears. Select [Install this driver software anyway] and continue with the installation.

When the installation is complete, the following dialogue box appears. Press<Close> button to complete the installation process.

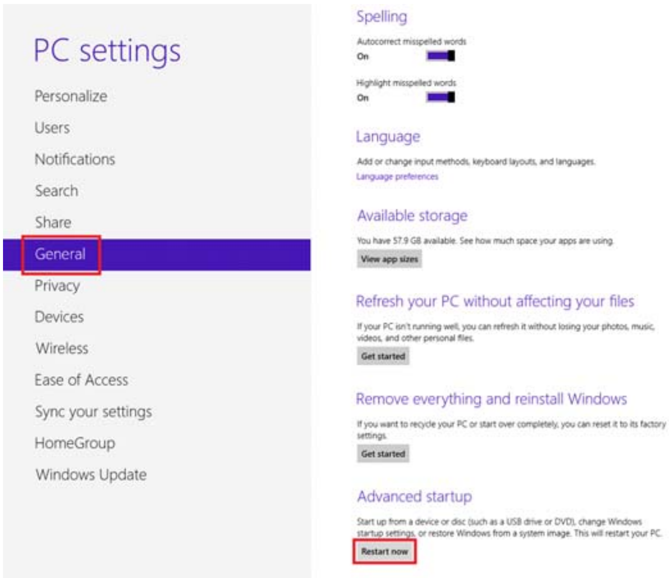


Supplementary note 1. How to disable driver signature enforcement in Windows 8.0

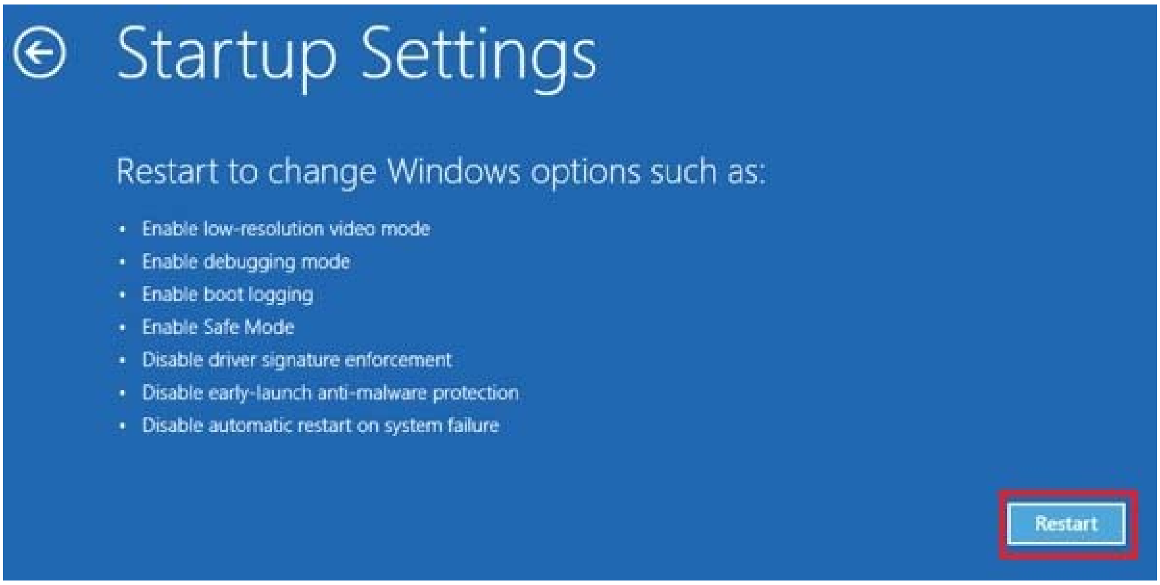
Here explains how to disable driver signature enforcement in Windows 8.0. Follow the below procedures.

Select [Charm]→[Setting]→[Change PC settings].

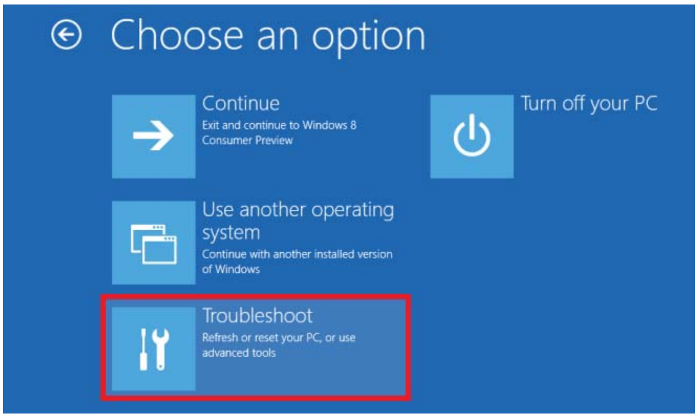
Select [General], then click on [Restart now] in [Advanced startup].



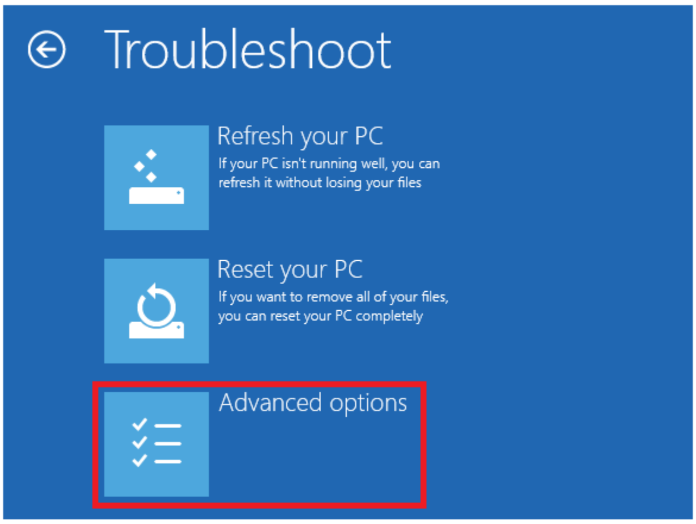
The Startup Settings Screen opens, so press <Restart>.



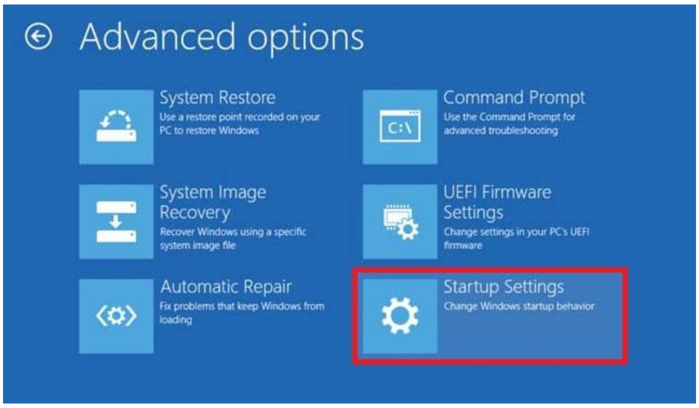
Select [Troubleshoot].



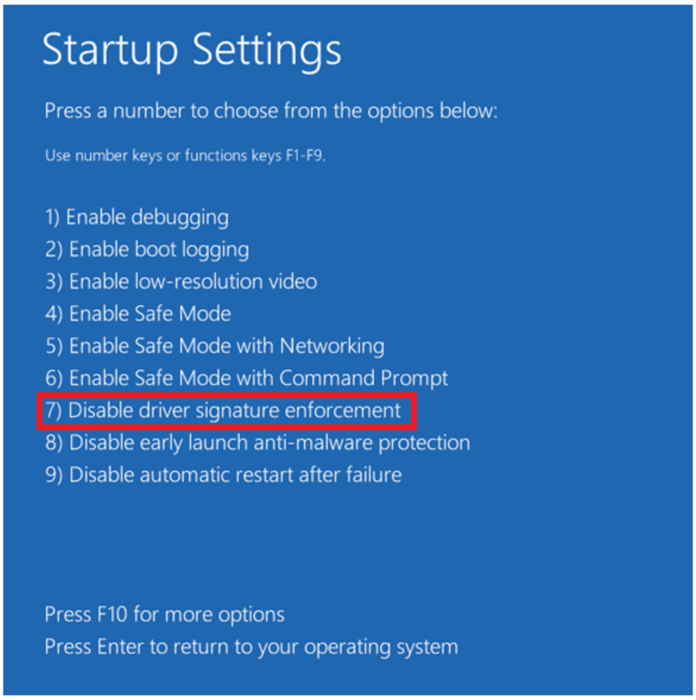
Select [Advanced options].



Select [Startup Settings]→<Restart>.



After restarting, select [7) Disable driver signature enforcement] in the following screen. (Press 7 on the keyboard).



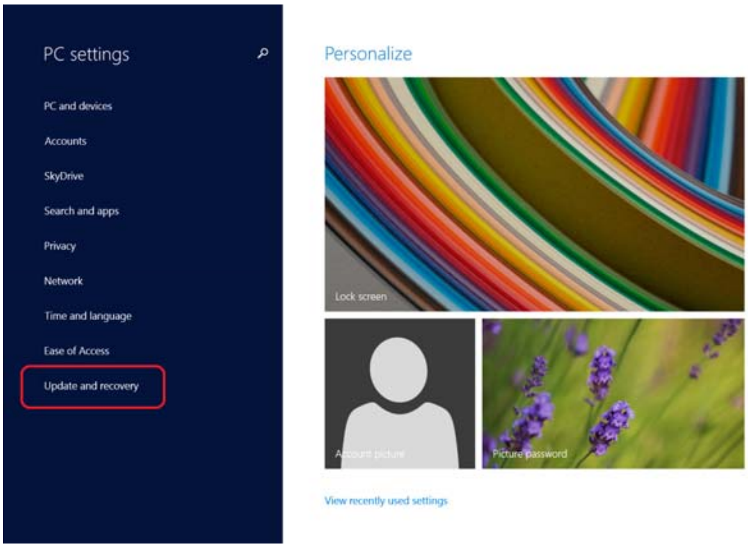
Setting is now complete. Restart Windows and follow the procedures in 2. above to install USB communication driver.

Supplementary Note 2. How to disable driver signature enforcement in Windows 8.1

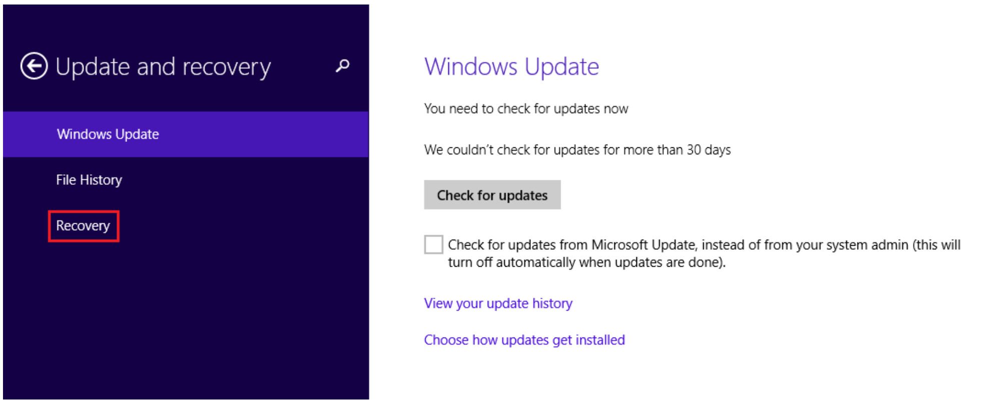
Here explains how to disable driver signature enforcement in Windows 8.1. Follow the below procedures.

Select [Charm]→[Setting]→[Change PC settings].

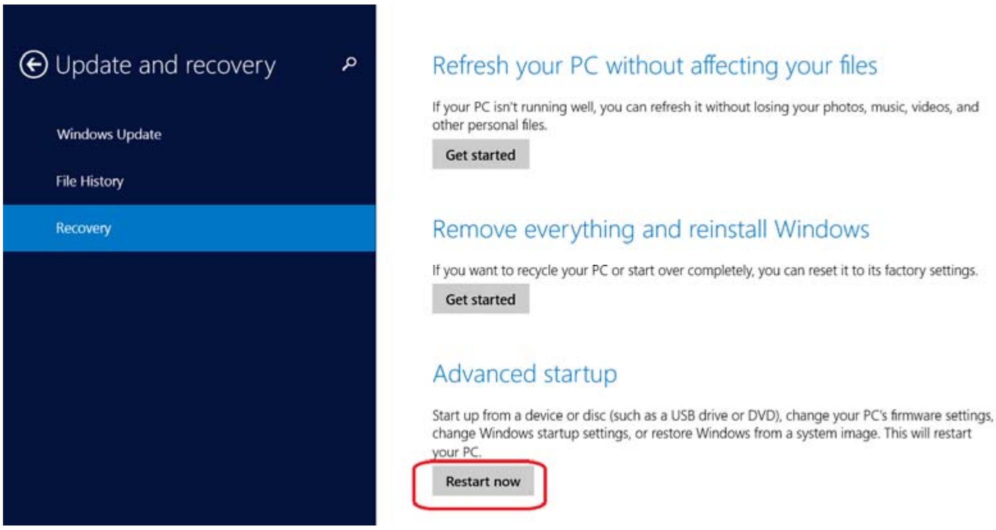
Select [Update and recovery].



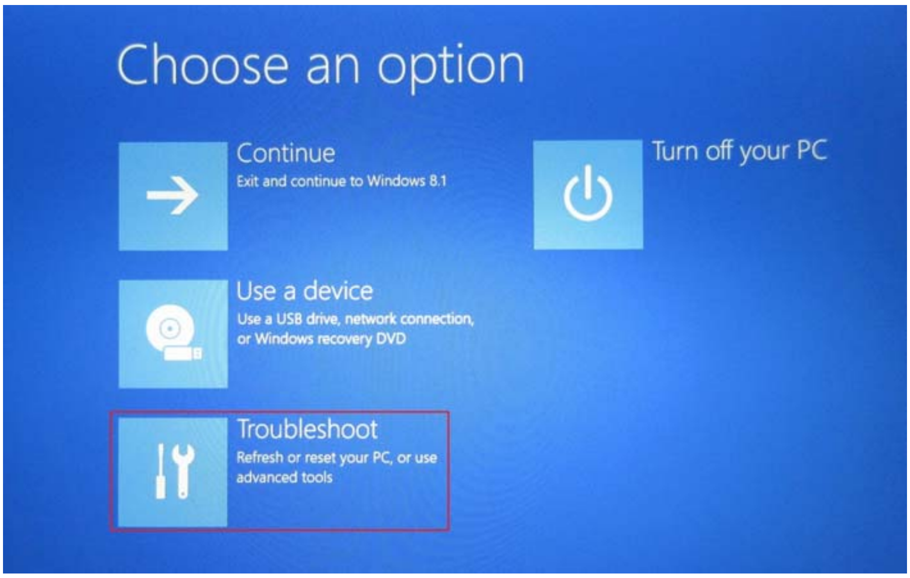
Select [Recovery].



Select <Restart now>.

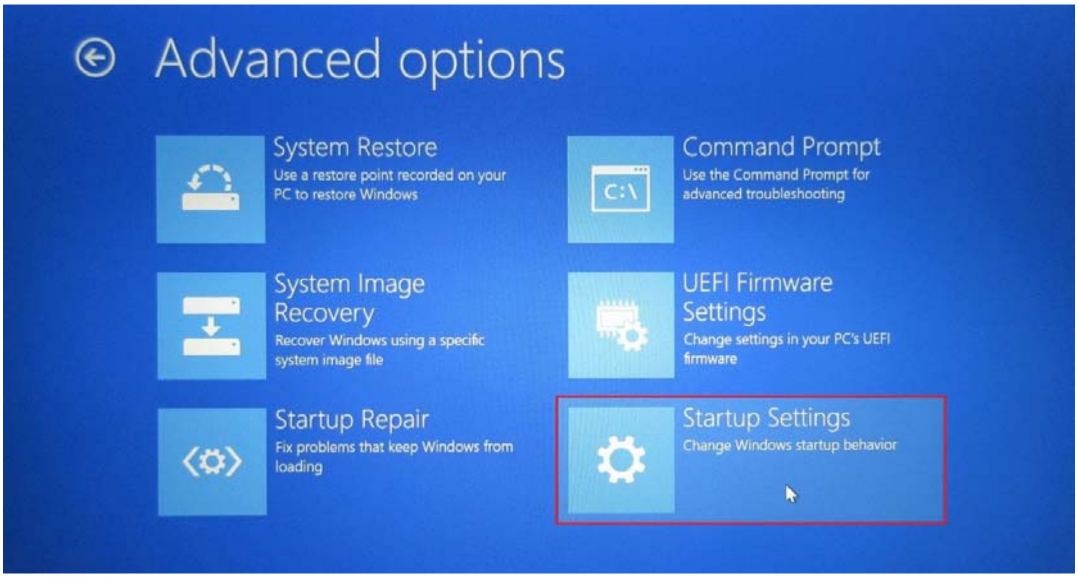


Select [Trouble shoot] in option selection screen.

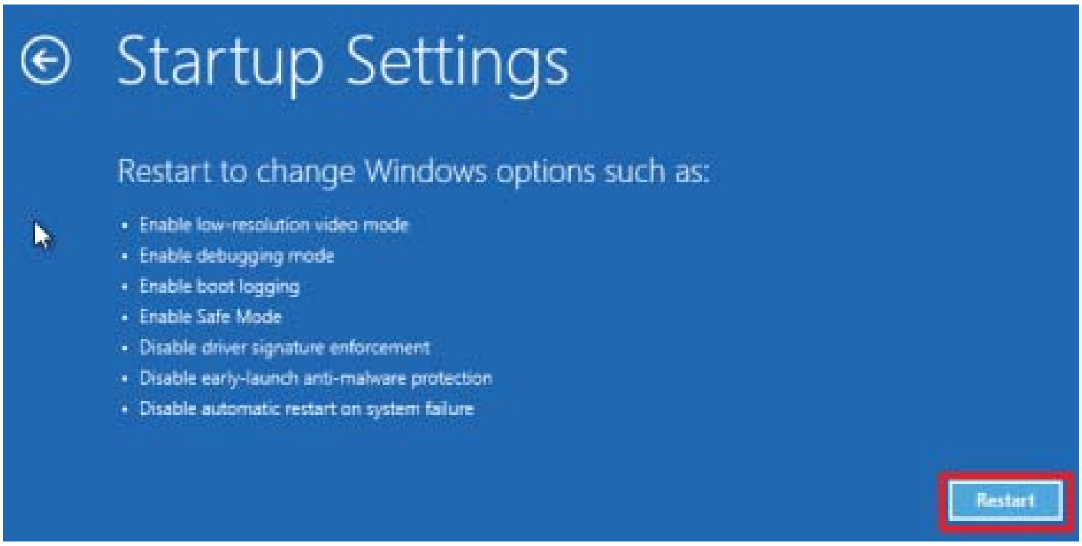


Select [Advanced options].

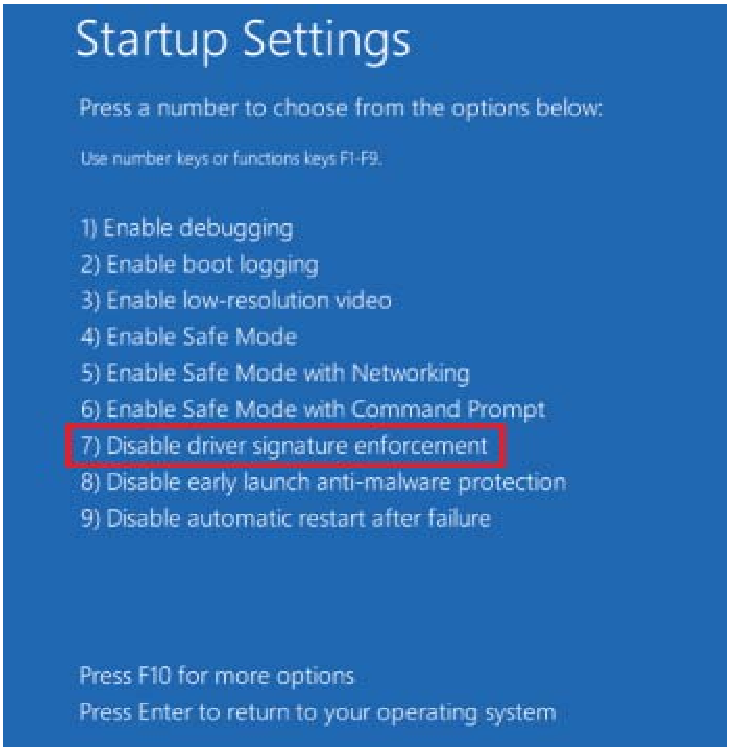
Select [Startup Settings].



Press <Restart>.



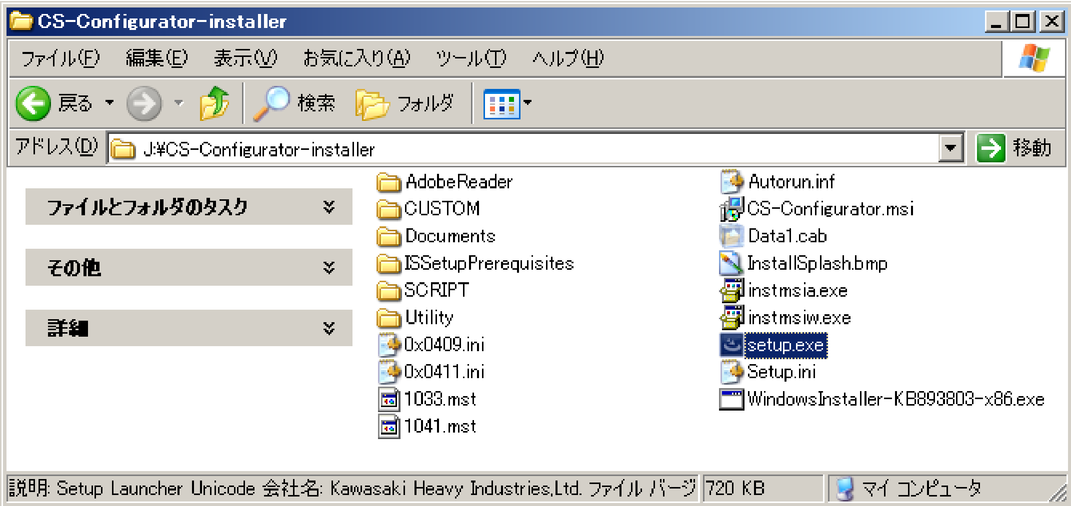
After restarting, select [7) Disable driver signature enforcement] in the following screen. (Press 7 on the keyboard).



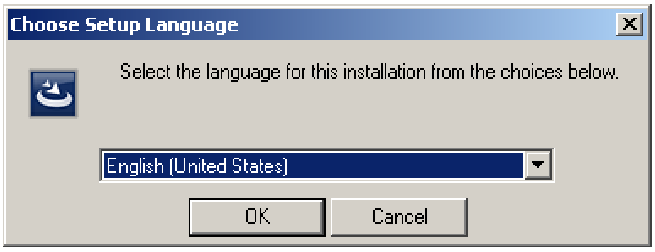
Setting is now complete. Restart Windows and follow the procedures in 2. above to install USB communication driver.

8.2.2 INSTALLING CS-CONFIGURATOR

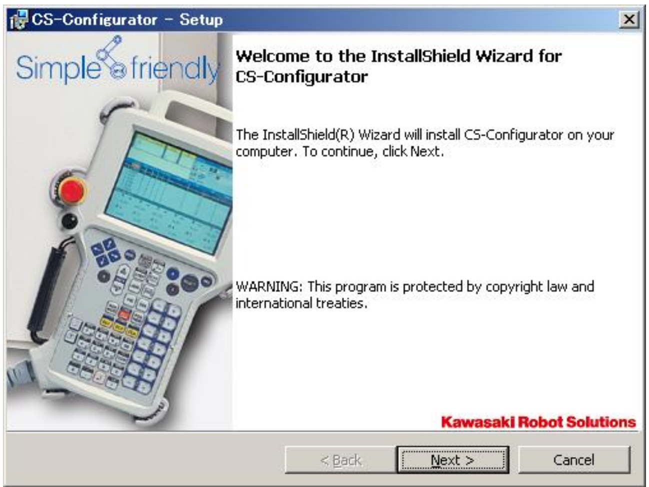
Execute [setup.exe] included in the "CS-Configurator-installer" directory in the CD-ROM for CS-Configurator set-up.



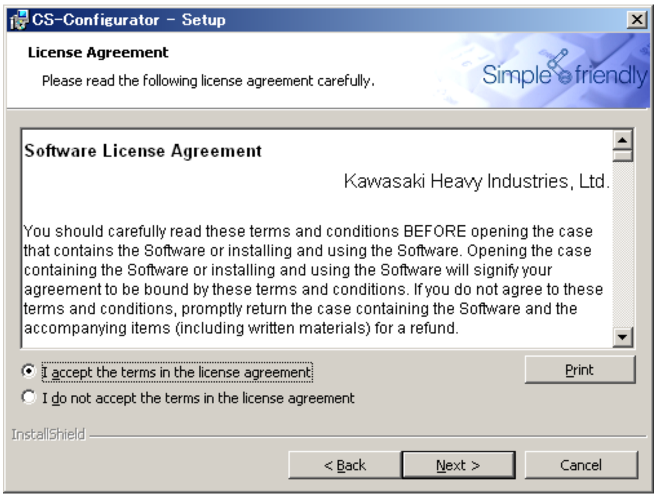
Select the language to use in this installment procedure.



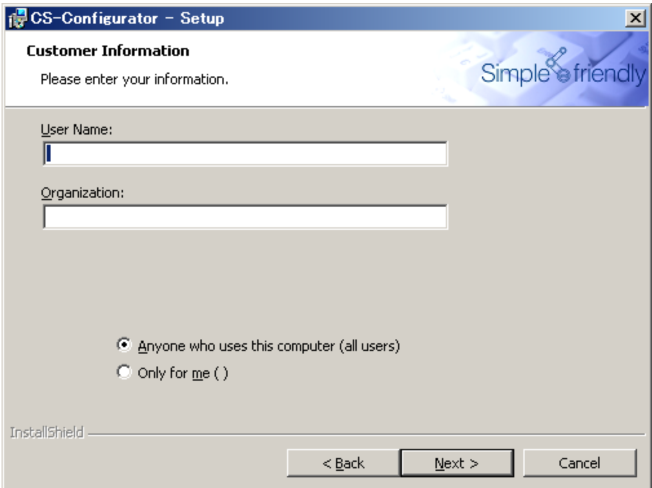
When the installer starts, click on <Next>.



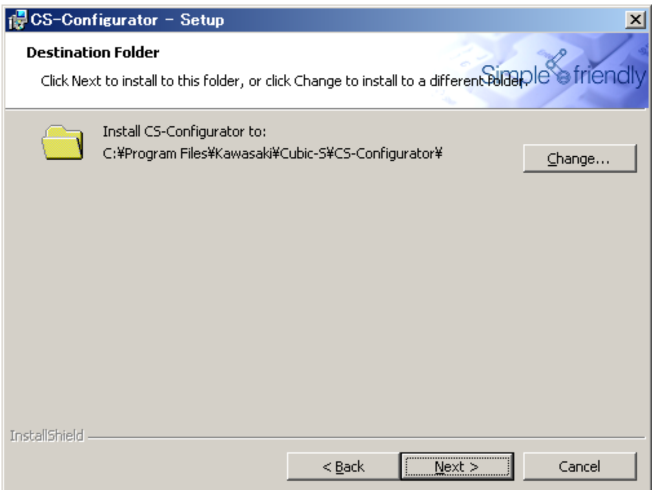
Click to check [I accept the license agreement] and click on the <Next> button.



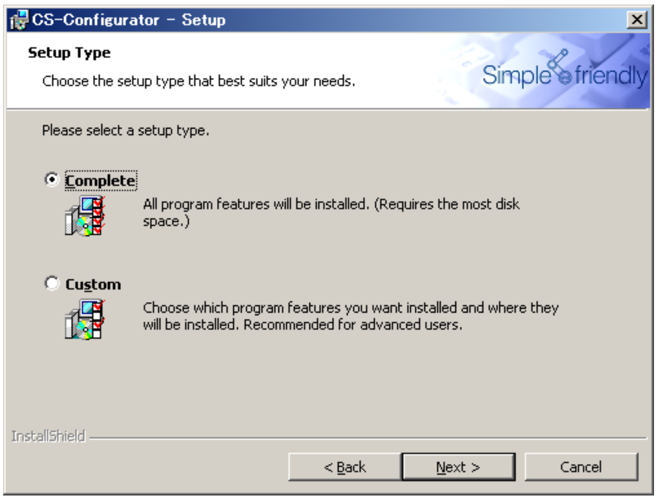
Enter the user information and click on <Next>.



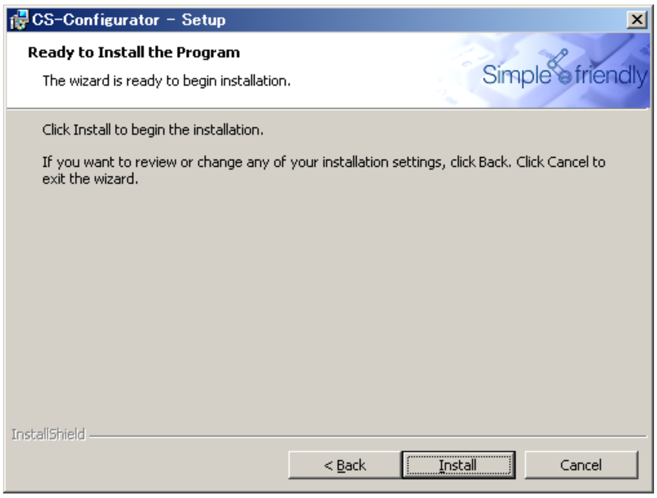
Choose the destination where CS-Configurator is to be installed. The default destination is under “C:¥Program Files¥Kawasaki¥Cubic-S¥CS-Configurator”. Click on <Next> button.

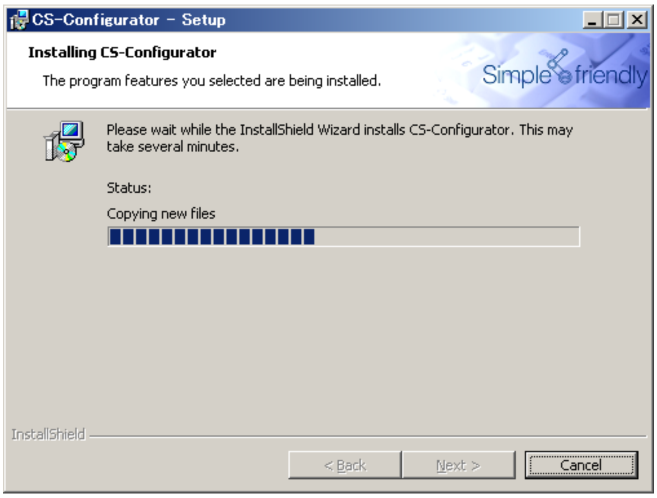


Select “Complete” and click on <Next> button.



Click on <Install>.





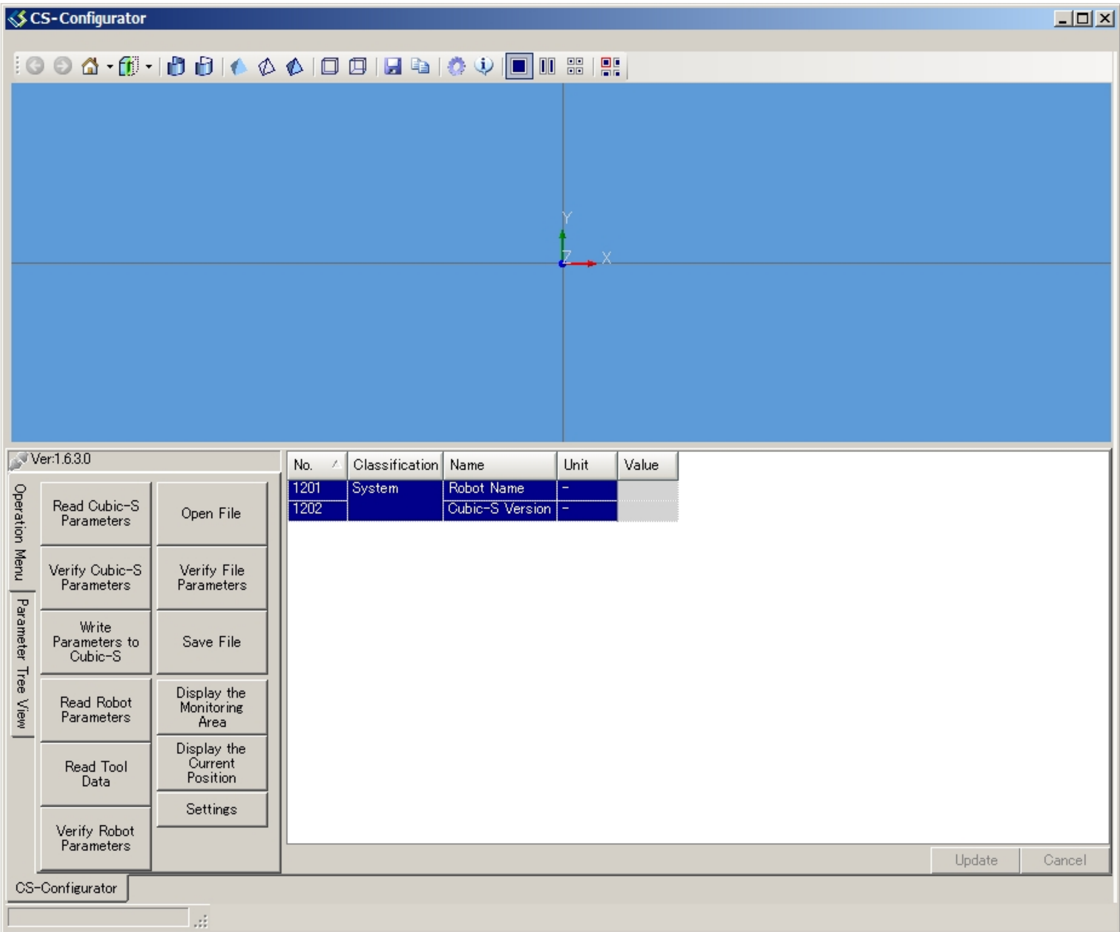
Installation is completed when the screen below is displayed.　Click on <Finish> to exit the installation.

8.3 STARTING AND ENDING CS-CONFIGURATOR

8.3.1 STARTING CS-CONFIGURATOR

To start the CS-Configurator, select [Start] - [CS-Configurator] - [Shortcut to KrHSMain.exe].

The screen below appears right after the software starts.



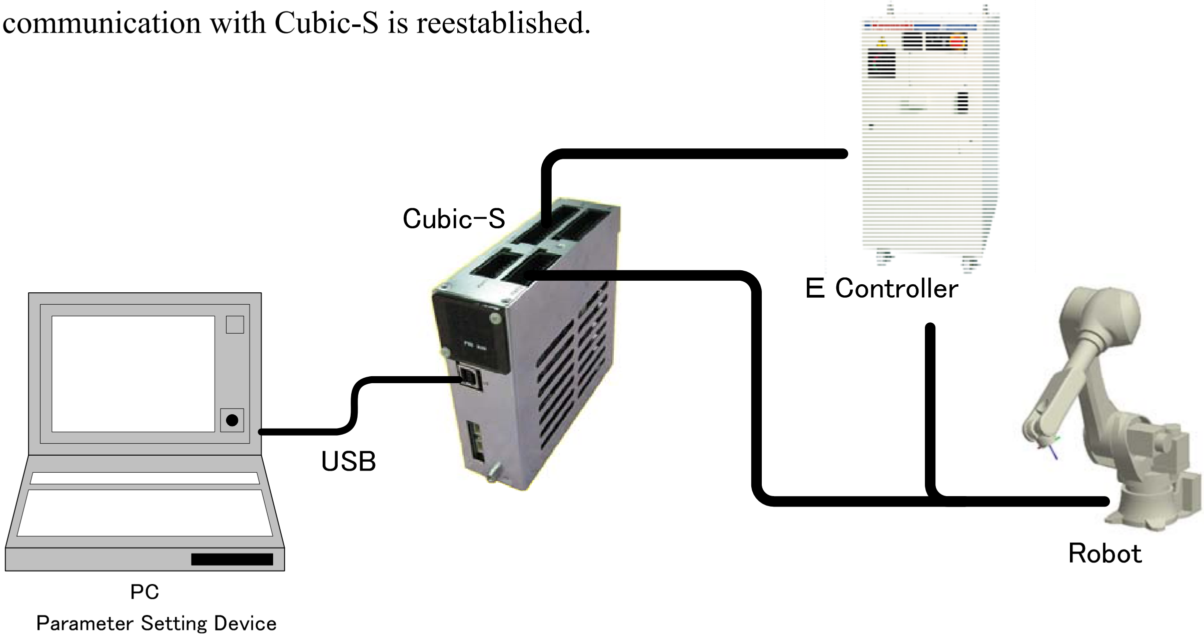
8.3.2 ENDING CS-CONFIGURATOR

To end the CS-configurator, click on <×> at the right end of the title bar.

8.4 CONNECTING WITH CUBIC-S

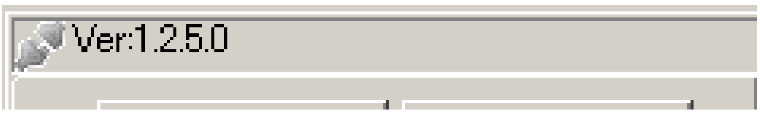
Connect Cubic-S with a personal computer installed with CS-Configurator via USB cable. After confirming that the personal computer and Cubic-S are connected correctly, click on [Operation Menu] tab and press <Read Robot Parameter> button. [OK] dialogue box appears when the connection is properly completed and the connection status changes to “connected”.

The “Connect/ disconnect icon” next to the version display changes to show the connected status. If the Cubic-S power is turned OFF or the USB cable is disconnected, the status of the icon changes to disconnected. The status display returns to connected when the communication with Cubic-S is reestablished.

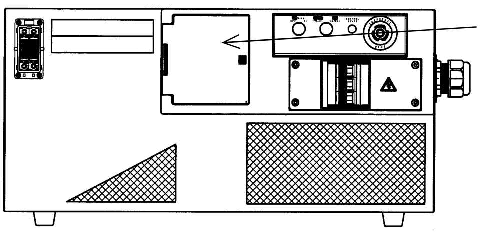


Connected

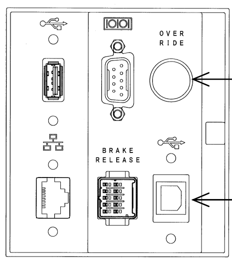
Disconnected



In E0x controller, USB port for Cubic-S is inside the accessory panel as shown in the figure below.



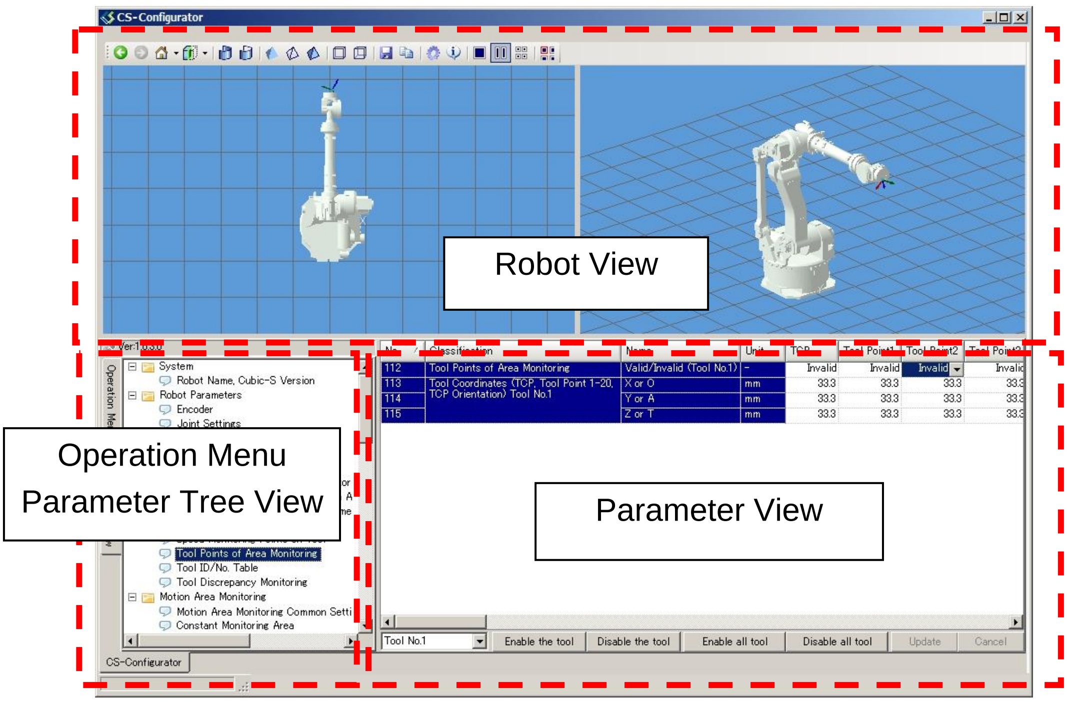
Inside accessary panel



8.5 DISPLAY CONFIGURATION

CS-Configurator consists of four parts. Overview of each part is as follows:

No	Display	Overview
1	Robot View	Graphically displays the robot, monitored areas (constant monitoring area, constant prohibited area, and selected area), tool shape points, arm monitor lines segments, arm monitor points, tool orientation cone. Display operations such as view change, split display are possible. Coordinate value changes of monitor area and tool shape points are not shown on the Robot view.
2	Operation Menu	This menu consists of buttons for reading/ writing parameters for Cubic-S, robot and other files. Click on the tabs to switch between operation menu and "Parameter tree view".
3	Parameter Tree View	The parameter configuration is displayed in tree structure. Selecting a node on the parameter tree view displays the setting screen for the selected parameter. Selecting monitoring node displays the ladder diagram on the parameter tree view. Click on the tabs to switch between "Operation menu" and the tree view.
4	Parameter Data View	Displays the parameter setting list selected in [Parameter Tree View]. When monitoring is selected in the tree view, ladder diagram is displayed.



8.6 ABOUT THE PARAMETERS

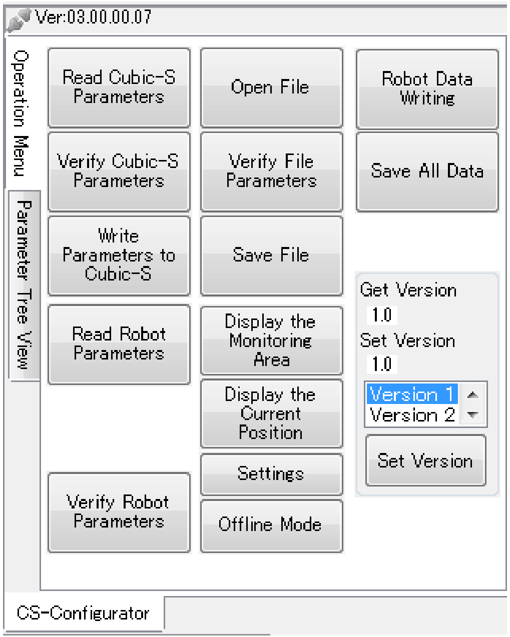
There are two types of parameters; robot parameter and user parameter, to set in the Cubic-S.

Robot parameters are parameters persistent to each robot such as robot axis configuration fan DH parameters. These parameters are set prior to use in the robot controller and cannot be changed by the user. The robot parameter is loaded via <Read Robot Parameters> button, explained later. The robot parameters are shown with their background grey in the "Parameter data view" list.

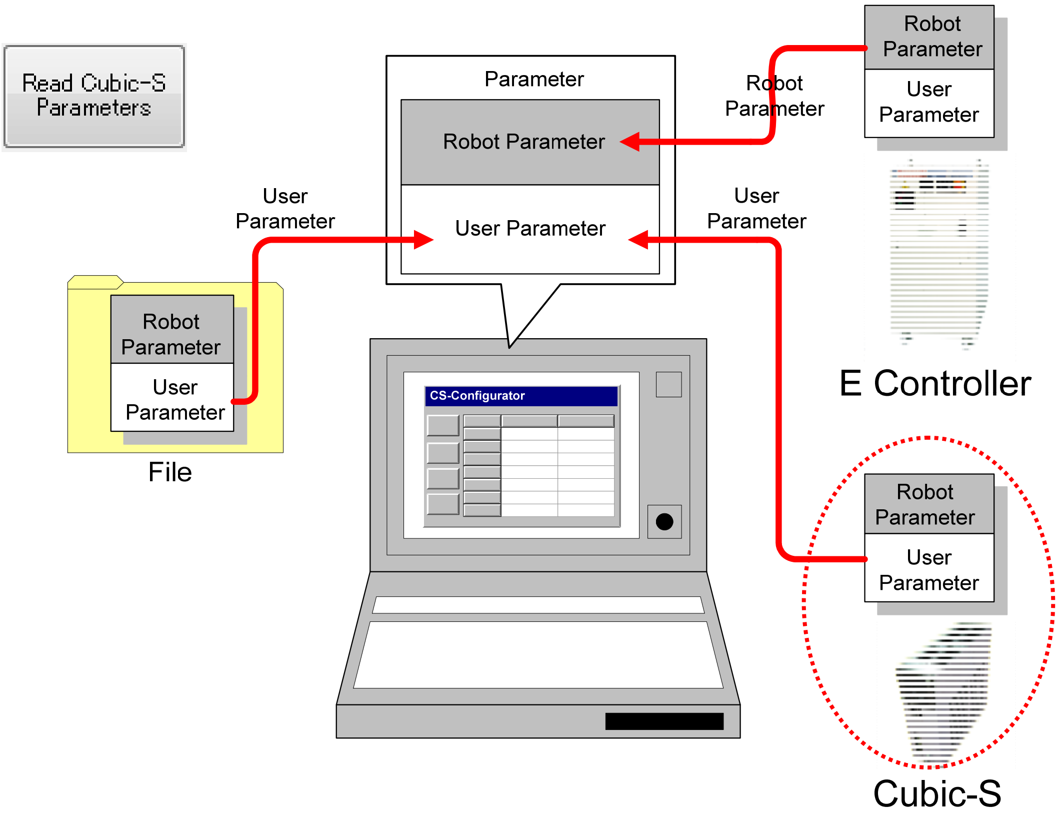
User parameters are parameters set by the user for each monitoring function, such as the motion area for motion area monitoring or joint range for joint monitoring. The user parameters are shown with white backgrounds in the "Parameter data view" list.

8.7 OPERATION MENU

The Operation menu is made up of the buttons shown in the screen below.

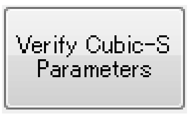


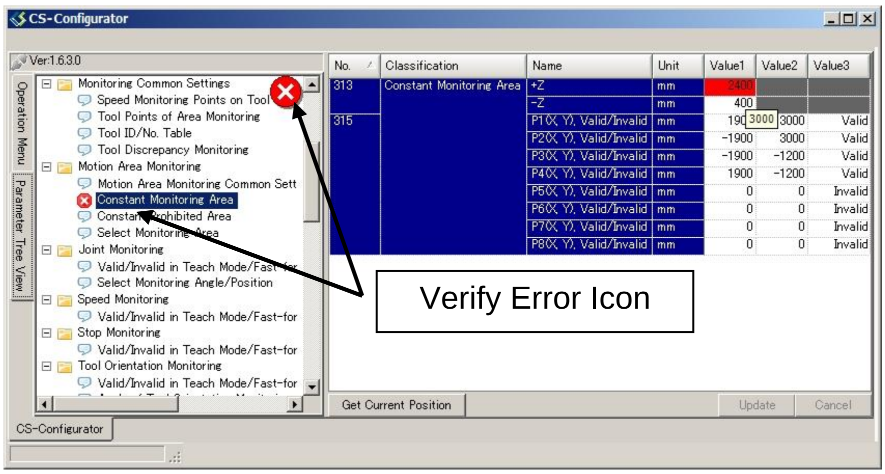
1. **<Read Cubic-S Parameters>**
   Reads from Cubic-S, only the user parameters. This button does not modify the robot parameters.



2. **<Verify Cubic-S Parameters>**

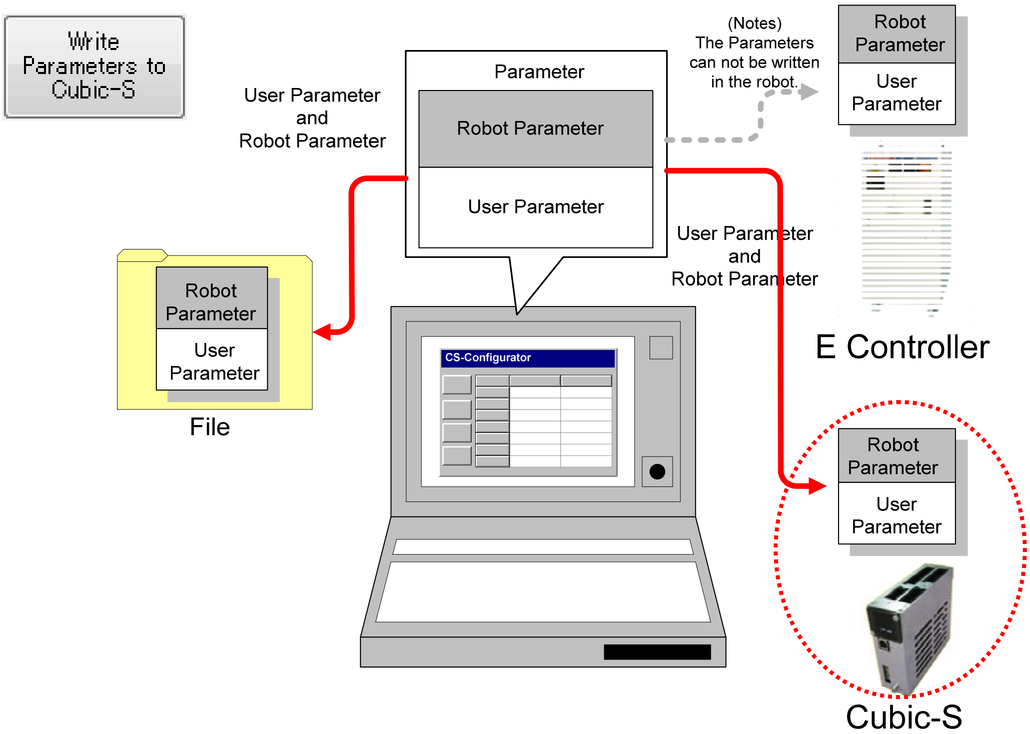
Compares the user parameters stored in CS-Configurator and the user parameters set in Cubic-S. When the parameters are not the same, the [Verify Error] icon is shown on the parameter tree view. These parameters are shown on the "Parameter data view" with the background in red and the pointer tip showing the parameter value stored in Cubic-S.



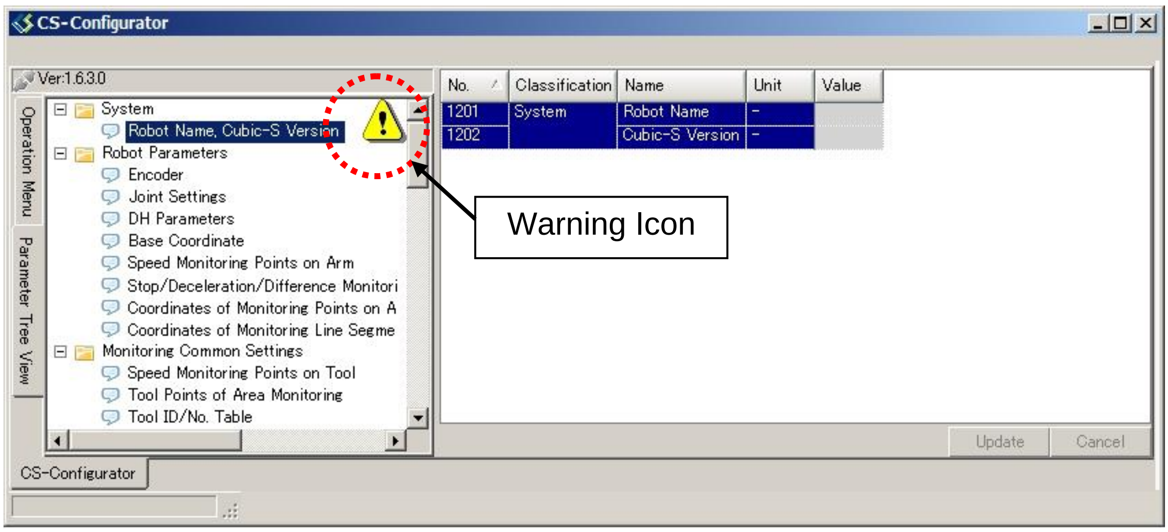


3. **<Write Parameters to Cubic-S>**

Writes to Cubic-S the parameter stored in CS-Configurator (both robot and user parameters). Before writing the parameters to Cubic-S, the robot parameters should be loaded to CS-Configurator by executing <Read Robot Parameter> and the user parameters by <Read Cubic-S Parameter> or <Open File>. Password is required to write the parameters onto Cubic-S.

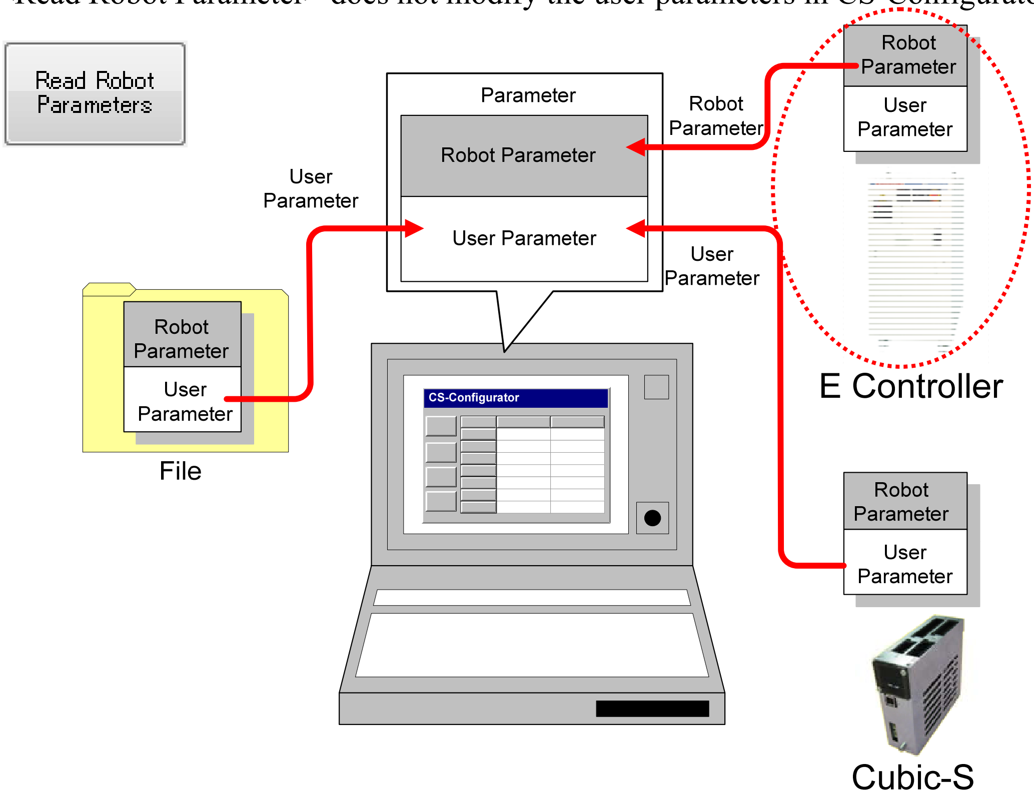


If the robot parameter remains unchanged or user parameter setting is still at default value (i.e. <Read Robot Parameter> nor <Read Cubic-S Parameter> is executed) after CS-Configurator being started (i.e. both the robot and the user parameters are in default setting) a warning icon is shown on the "Parameter Tree View".



4. <Read Robot Parameters>

Reads the robot parameters stored in the robot controller. Clicking on <Read Robot Parameter> button starts loading the parameters from the robot controller. Pressing <Read Robot Parameter> does not modify the user parameters in CS-Configurator.



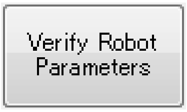
5. <Read Tool Data>

Reads from the robot controller only the tool shape data. Tool shape data are considered both as robot parameters and as user parameters, so they are stored also in the robot controller. Therefore, parameters can be set via the robot controller teach pendant. But also be careful that pressing <Read Cubic-S parameters> and <Read File Data> overwrites the tool shape data.

6. <Verify Robot Parameters>

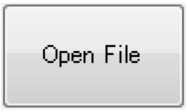
Compares robot parameters stored in CS-Configurator and those stored in the robot controller. When there are parameters that different, a warning icon is displayed. The comparison result is shown in the same way as after pressing <Verify Cubic-S Parameters>.

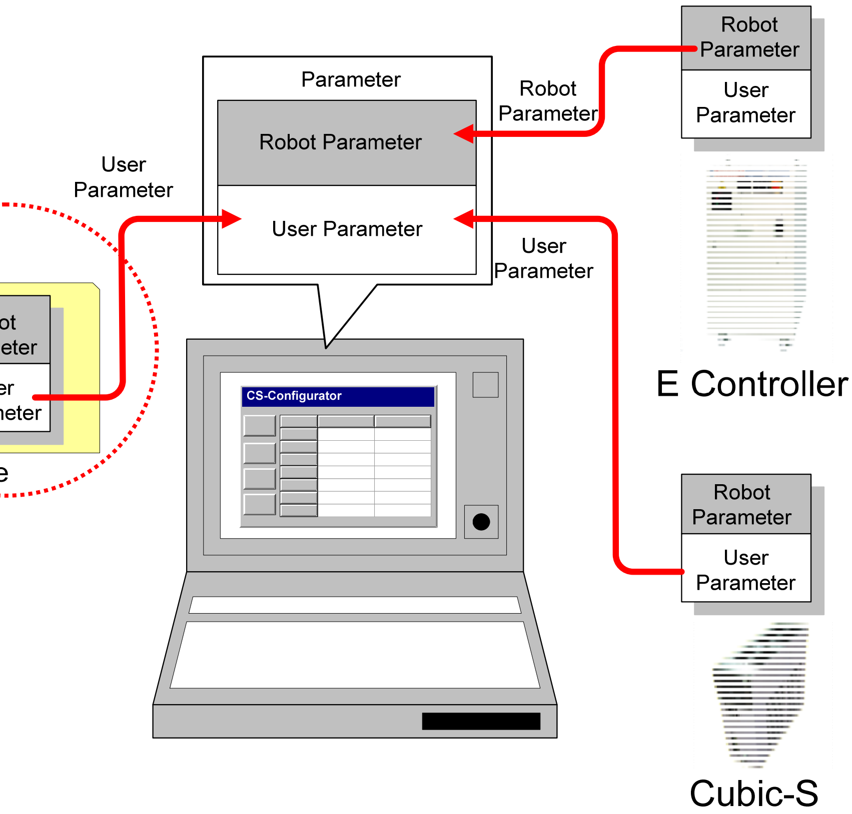
When <Write Cubic-S Parameter> button is pressed, Robot comparison is conducted internally. If error occurs as a result of the comparison, no data is written to Cubic-S. Check the set values in the robot controller side and modify them to match the data in Cubic-S.



7. <Open File>

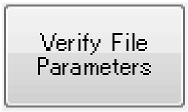
Reads the parameters written in the file (CSV file). User parameters are acquired via <Read File>. Pressing <Open File> button does not modify the robot parameters.





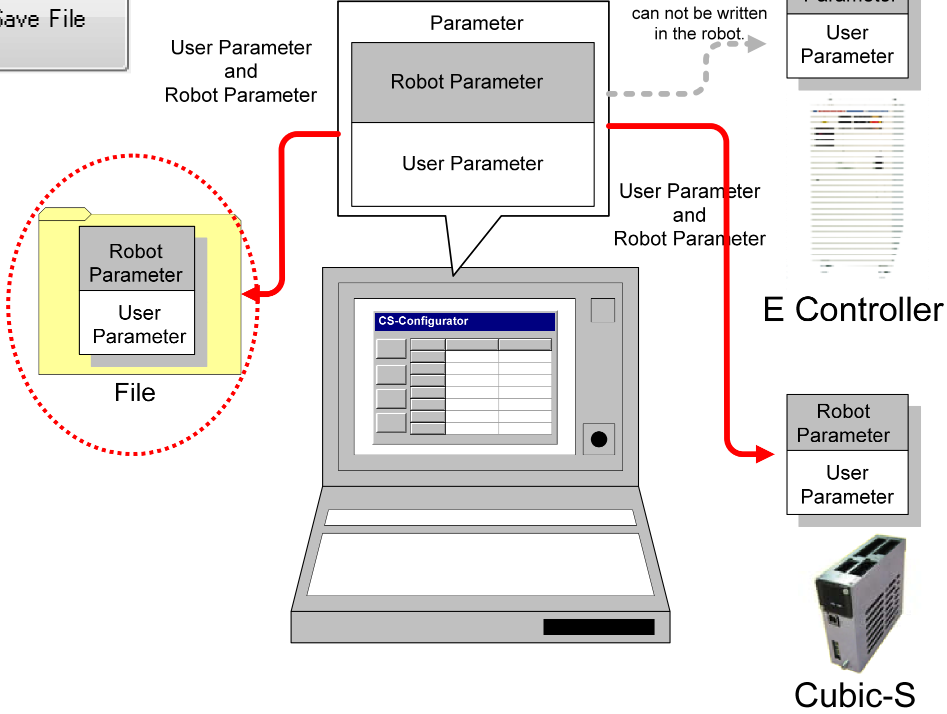
8. <Verify File Parameters>

Compares the user parameters stored in CS-Configurator and the user parameters written on the file. When there are parameters that do not match, the “Warning icon” is displayed. The comparison results are shown in the same way as <Verify Cubic-S>.



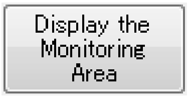
9. <Save File>

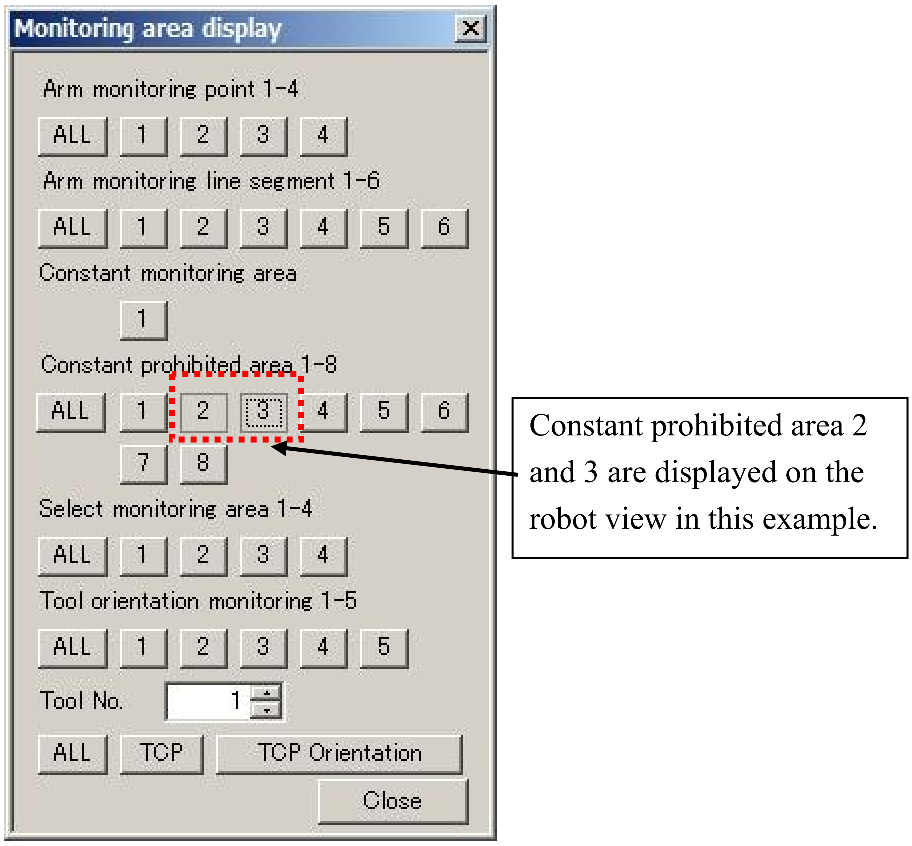
Writes to the files the parameters saved in CS-Configurator (both robot and user parameters). The parameters stored at the time <Save File> is pressed are written on to the file.



10. <Display the Monitoring Area>

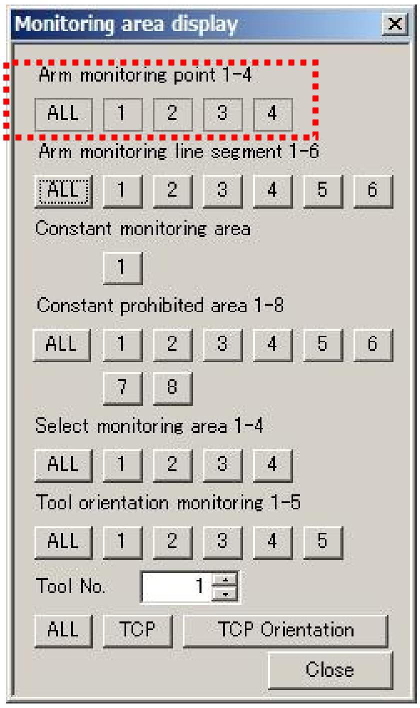
This button is used to switch the display ON/OFF on the robot view. The items on the display include: Arm monitoring point, arm monitoring line segment, constant monitoring area, constant prohibited area, select monitoring area, cone for tool orientation monitoring, tool shape points, TCP, TCP2. When the button looks as if popped up, the display is turned OFF, and when the button seems pressed down, the display is ON.

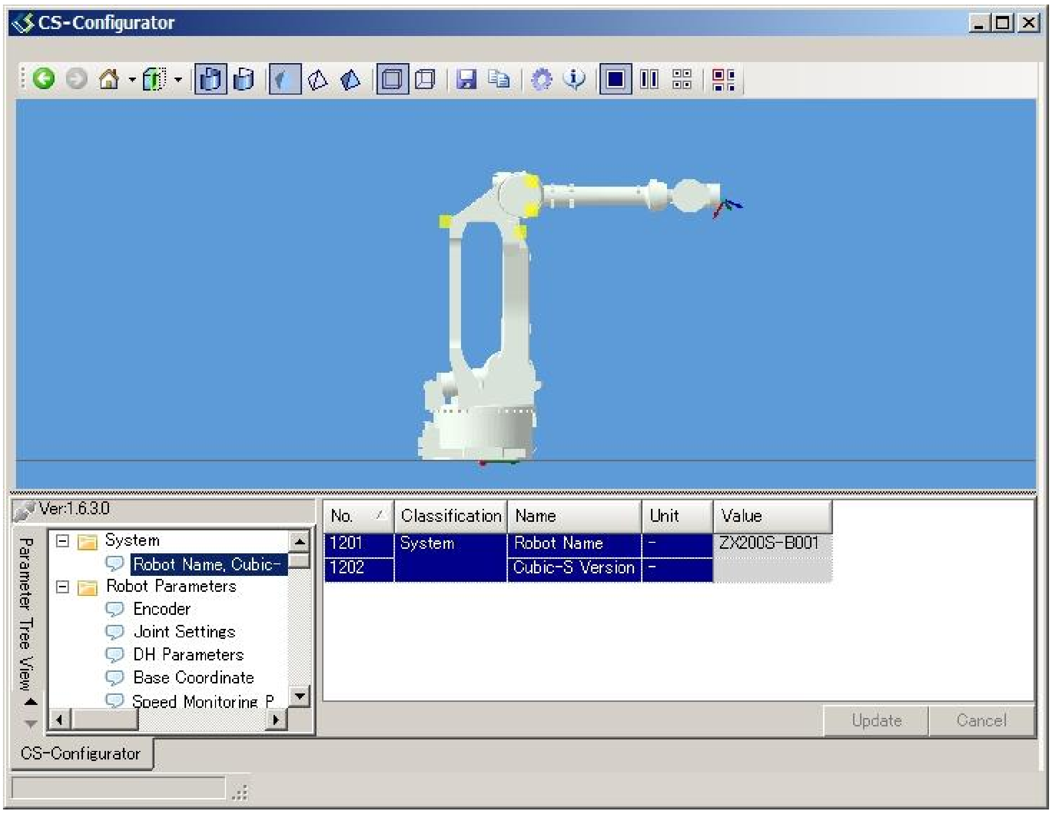




10-1. Arm monitoring point

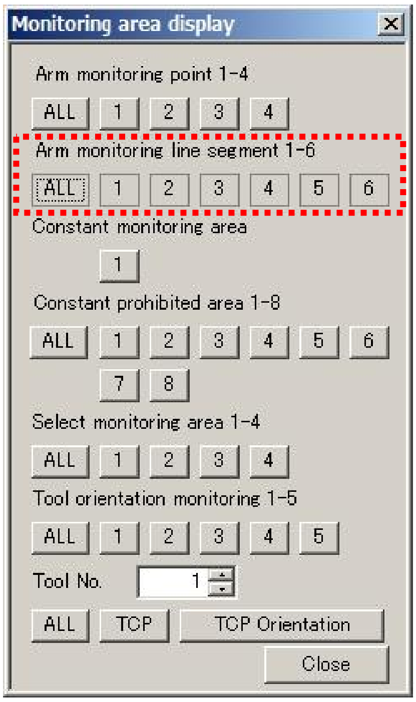
Pressing <ALL> button for "Arm monitoring point 1-4" displays all the arm monitoring points on the robot view. To select individual point to display press the <Number> buttons.

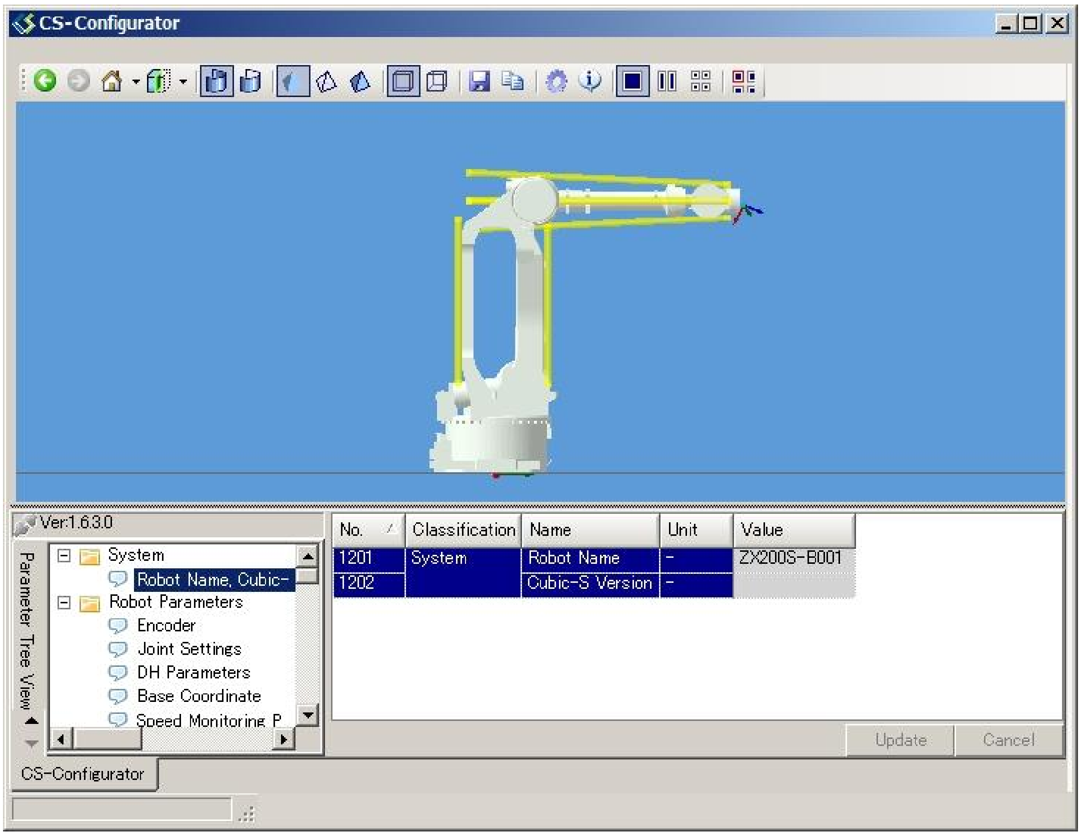




10-2. Arm monitoring line segment

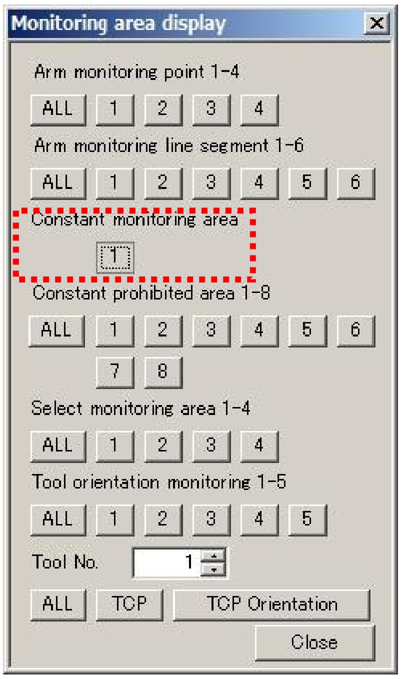
Pressing <ALL> button for "Arm monitoring line segment 1-6" displays all the arm monitoring line segments on the robot view. To select individual point to display press the <Number> buttons.

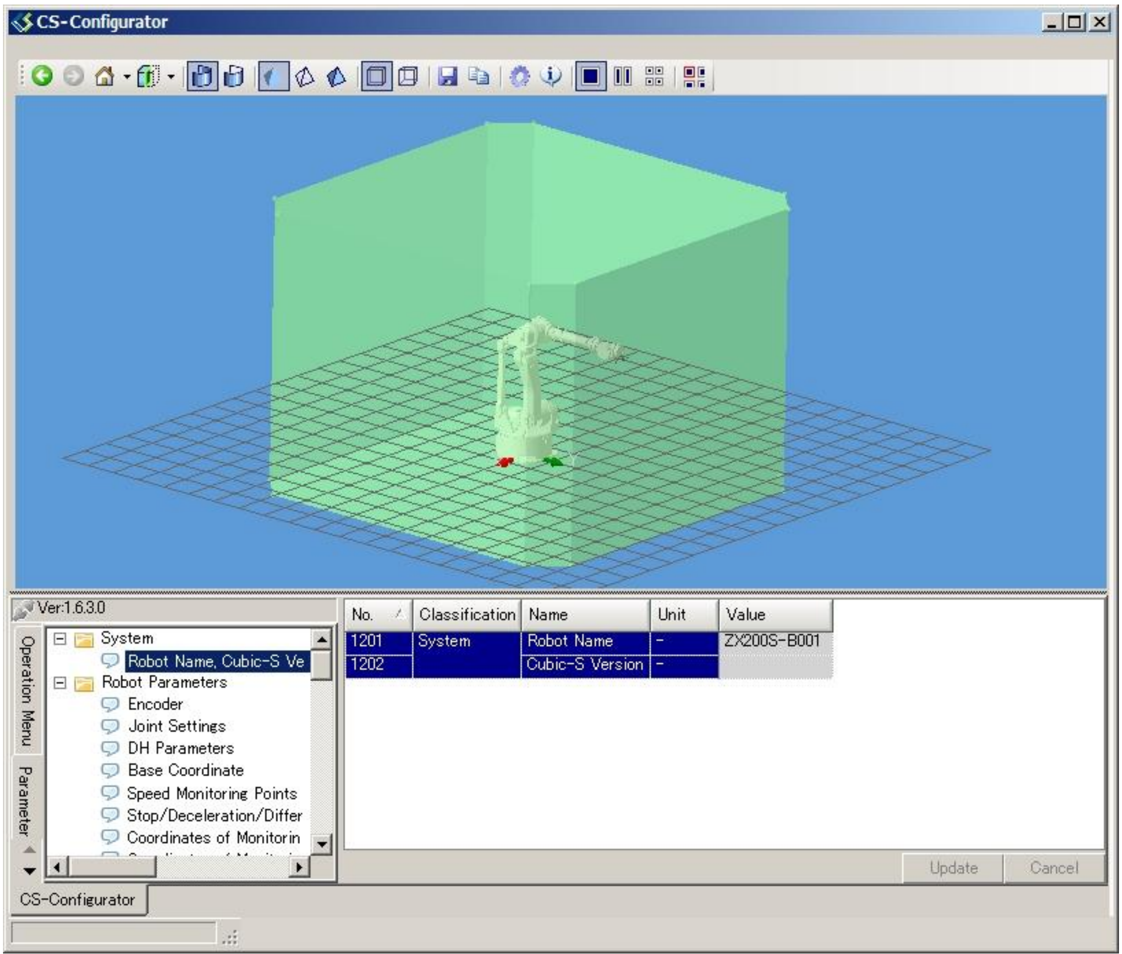




10-3. Constant monitoring area

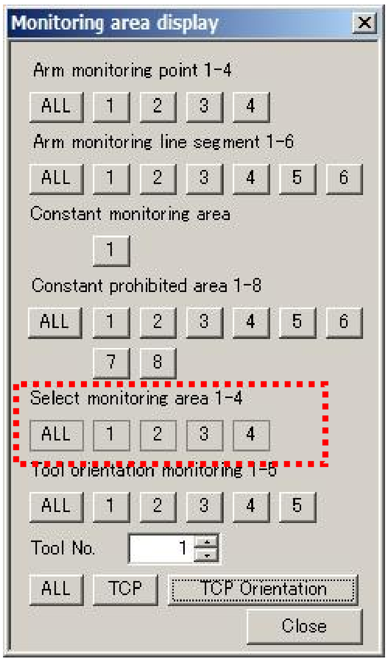
Pressing <1> button for “Constant monitoring area” displays the constant monitoring area on the robot view.

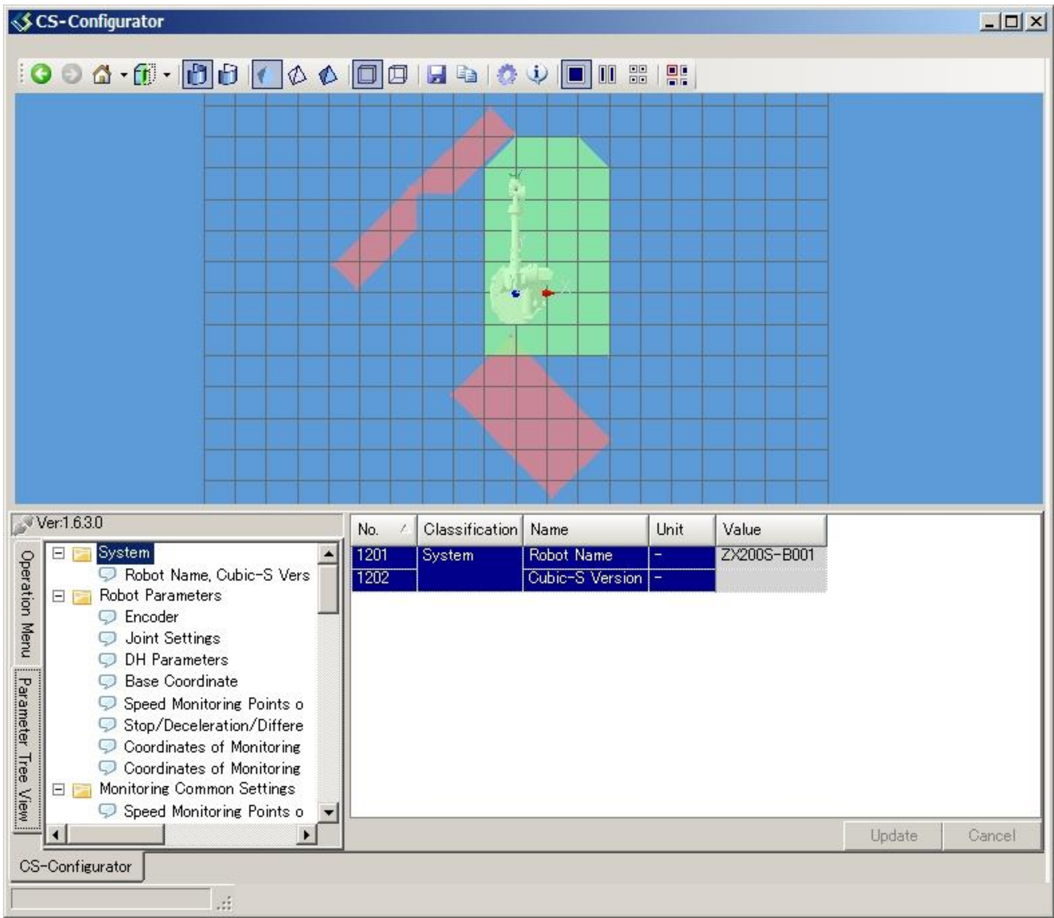




10-4. Select monitoring area

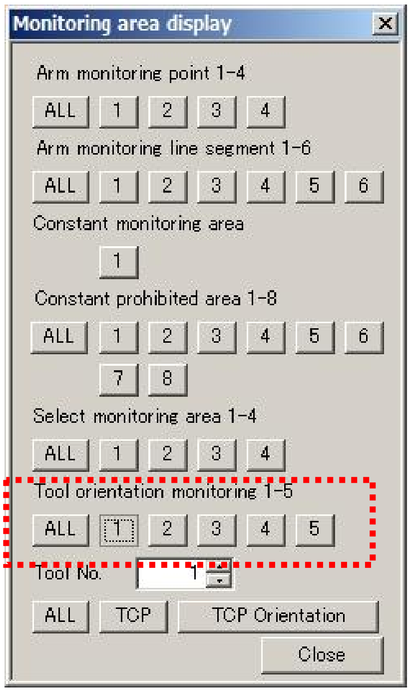
Pressing <ALL> button for “Select monitoring area 1-4” displays all the select monitoring areas on the robot view. To select individual area to display press the <Number> buttons.

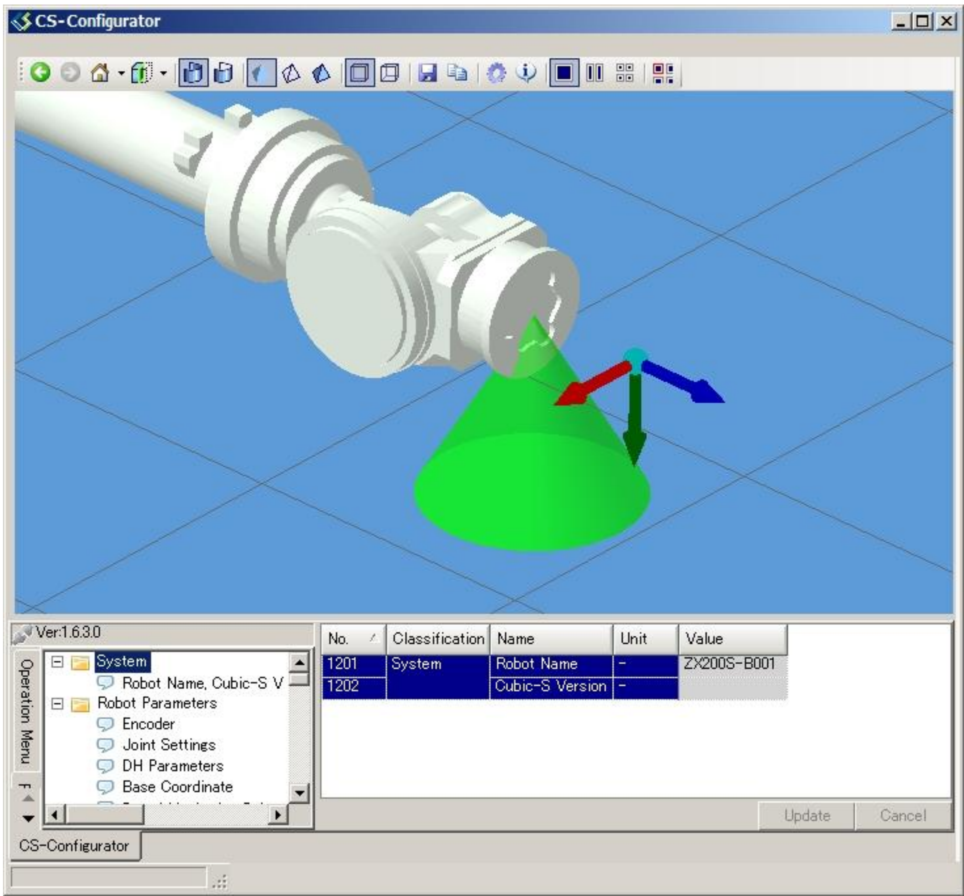




10-5 Tool orientation monitoring

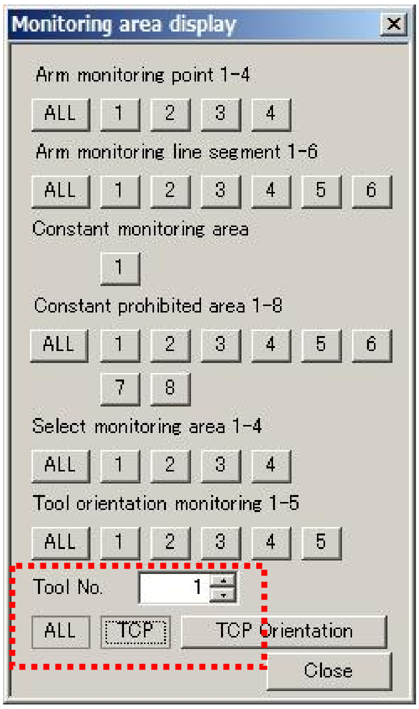
Pressing <ALL> button for “Tool orientation monitoring 1-5” displays all the cones showing the area of tool orientation monitoring on the robot view. To select individual cone to display press the <Number> buttons.

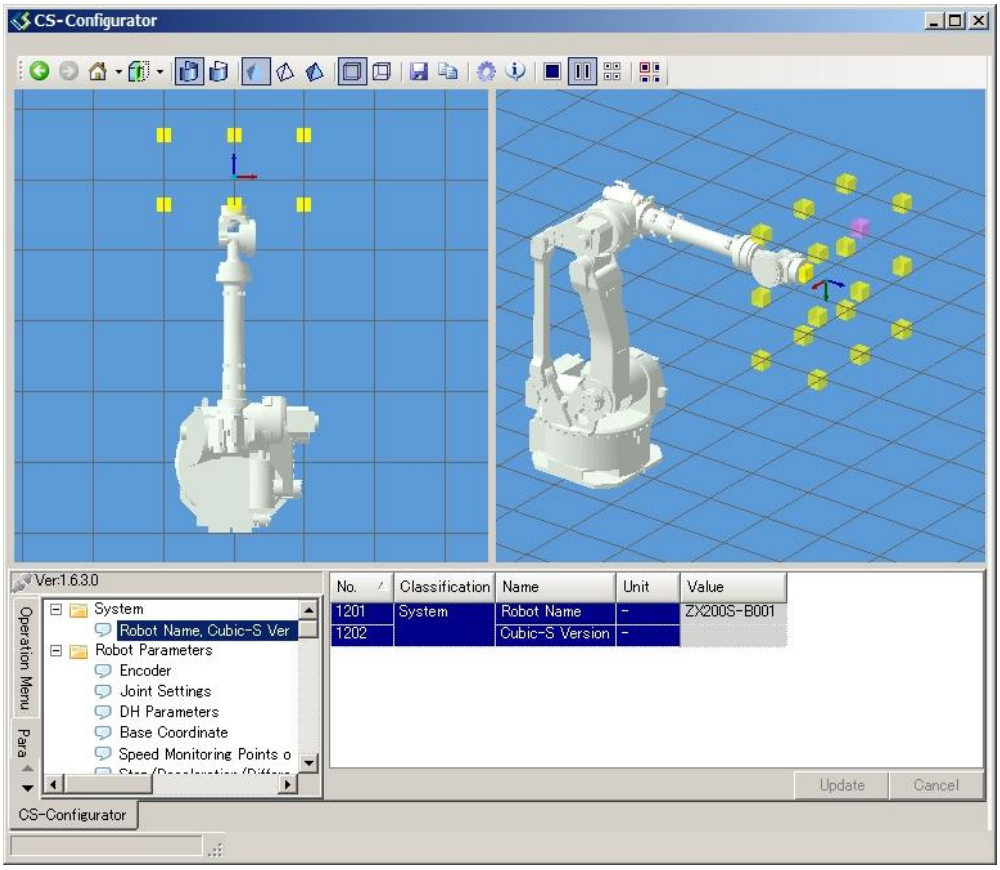




10-6 Tool shape point

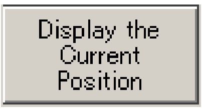
Selecting the tool number and pressing <ALL> button displays the tool shape points on the robot view. Pressing TCP shows only the tool center point.

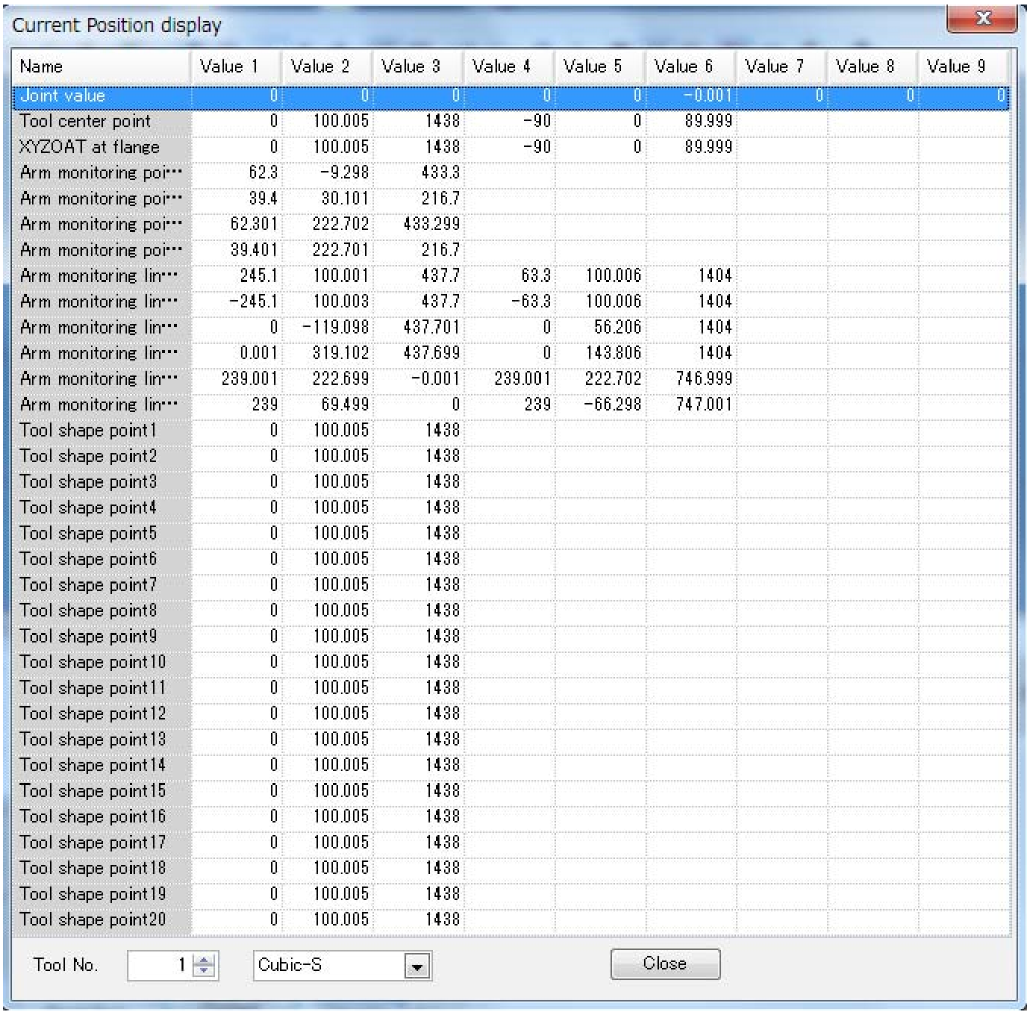




11. <Display the Current Position>

Displays the current values of the robot's joint value, pose information, monitoring lines, and monitoring points. Switching between Cubic-S/CS-Configurator at the bottom of the page switches the display between position data stored in Cubic-S and position data displayed in CS-Configurator (displayed on CS-Configurator model using axis values acquired from Cubic-S). Normally, the values should match with a minimum difference.

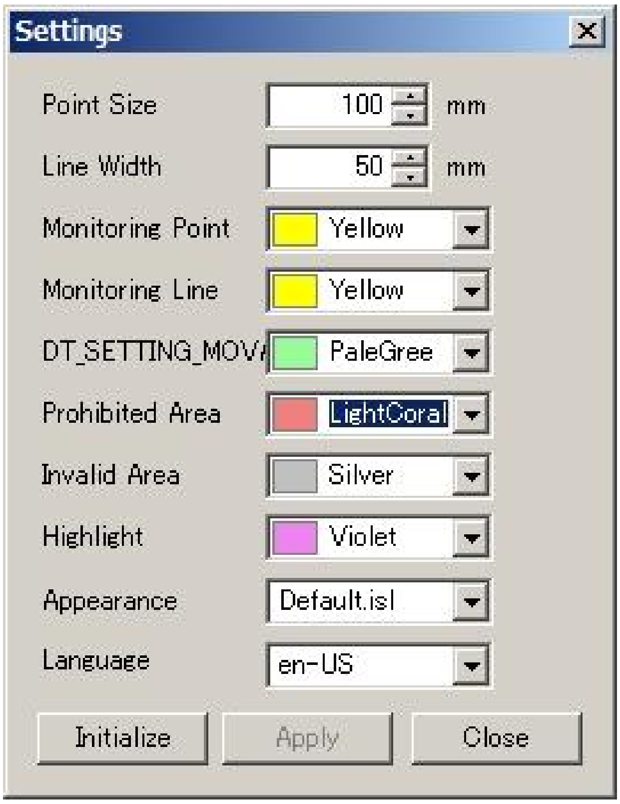




Name	Value 1	Value 2	Value 3	Value 4	Value 5	Value 6	Value 7	Value 8	Value 9
Joint value	0	0	0	0	0	-0.001	0	0	0
Tool center point	0	100.005	1438	-90	0	89.999			
XYZOAT at flange	0	100.005	1438	-90	0	89.999			
Arm monitoring poi…	62.3	-9.298	433.3						
Arm monitoring poi…	39.4	30.101	216.7						
Arm monitoring poi…	62.301	222.702	433.299						
Arm monitoring poi…	39.401	222.701	216.7						
Arm monitoring lin…	245.1	100.001	437.7	63.3	100.006	1404			
Arm monitoring lin…	-245.1	100.003	437.7	-63.3	100.006	1404			
Arm monitoring lin…	0	-119.098	437.701	0	56.206	1404			
Arm monitoring lin…	0.001	319.102	437.699	0	143.806	1404			
Arm monitoring lin…	239.001	222.699	-0.001	239.001	222.702	746.999			
Arm monitoring lin…	239	69.499	0	239	-66.298	747.001			
Tool shape point1	0	100.005	1438						
Tool shape point2	0	100.005	1438						
Tool shape point3	0	100.005	1438						
Tool shape point4	0	100.005	1438						
Tool shape point5	0	100.005	1438						
Tool shape point6	0	100.005	1438						
Tool shape point7	0	100.005	1438						
Tool shape point8	0	100.005	1438						
Tool shape point9	0	100.005	1438						
Tool shape point10	0	100.005	1438						
Tool shape point11	0	100.005	1438						
Tool shape point12	0	100.005	1438						
Tool shape point13	0	100.005	1438						
Tool shape point14	0	100.005	1438						
Tool shape point15	0	100.005	1438						
Tool shape point16	0	100.005	1438						
Tool shape point17	0	100.005	1438						
Tool shape point18	0	100.005	1438						
Tool shape point19	0	100.005	1438						
Tool shape point20	0	100.005	1438						

12. <Settings>

This is used to change the display color and size of the monitoring points and lines, or the monitoring areas. Setting of the overall appearance of CS-Configurator and the language setting is also done here.



13. <Offline Mode>

Pressing <Offline Mode> sets the robot monitoring area offline. To set the monitoring area etc. offline, change to offline mode, and then load the data acquired online by pressing <Open File>. Set the monitor area referring to the robot model that is displayed and press <Save File> to save the data. When connected to the robot, execute <Read from Cubic-S> and <Read Robot Parameters>, and then execute <Open File> to load the data set offline. The data set in Cubic-S is overwritten, so be careful. Finally, press <Write Parameters to Cubic-S>. This procedure will set the data offline to Cubic-S.

14. <Robot Data Writing>

Pressing <Robot Data Writing> executes <Read Cubic-S Parameters>→< Read Robot

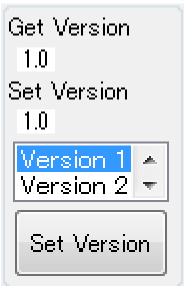
Parameters >→<Write Parameter to Cubic-S > simultaneously. Password is asked when this button is pressed.

15. <Save All Data>

Pressing < Save All Data > executes < Read Robot Parameters >→<Write Parameter to Cubic-S >→<Save File> simultaneously.

16. <Set Version>

Sets the CS-Configurator version. Pressing <Set Version> sets the selected version.

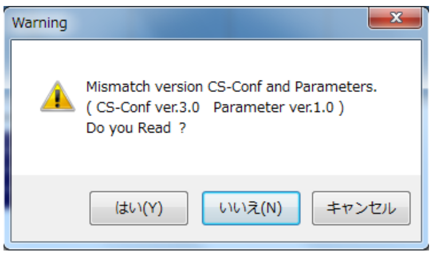


[Get Version] shows the version of the Cubic-S from which parameters were read.

[Set Version] shows the currently set version of the CS-Configurator. Version setting change can be confirmed by this display.

Set the version to match the Cubic-S version connected to the controller. See chapter 4 in this manual for how to confirm the Cubic-S version. The version of the Cubic-S actually mounted and the version setting in CS-Configurator have to match to correctly write the parameters to Cubic-S.

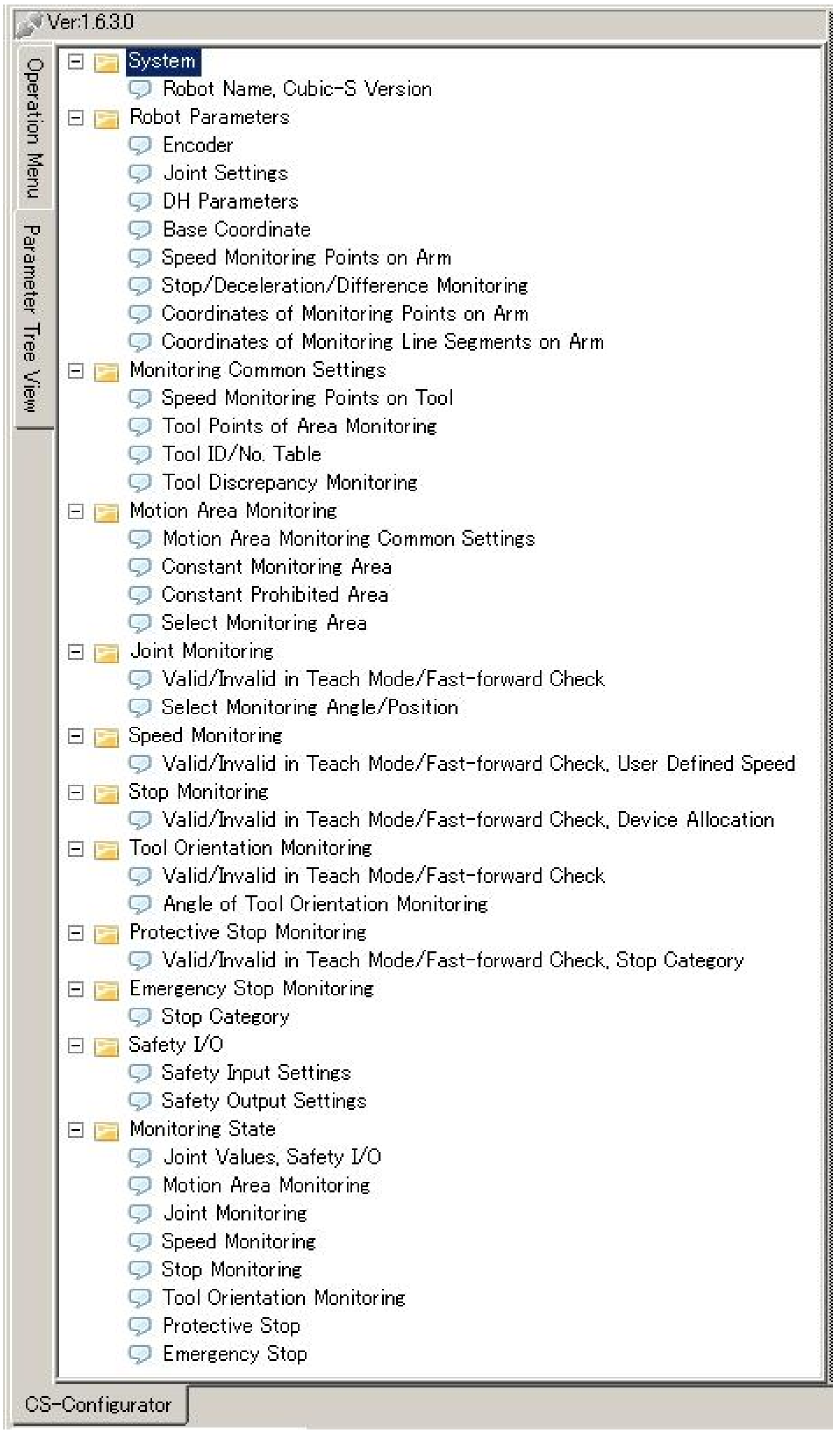
When Cubic-S parameters are read with the versions mismatching, the following popup window will appear. Match the version settings.



Note that when version setting is changed, parameters that have been read on the CS-Configurator are initialized. Once set, the version setting is retained even after restart.

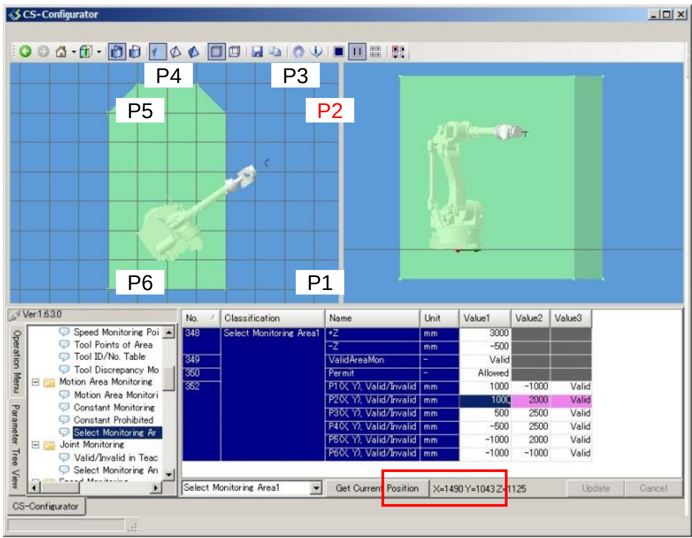
8.8 PARAMETER TREE VIEW

Clicking on the parameter item to modify on [Parameter Tree View] displays the parameter setting list on the [Parameter Tree View]. [System Node] and [Robot Parameter Node] cannot be modified. [Monitoring Node] is not a parameter. See Chapter 11 for detail on setting each parameter.

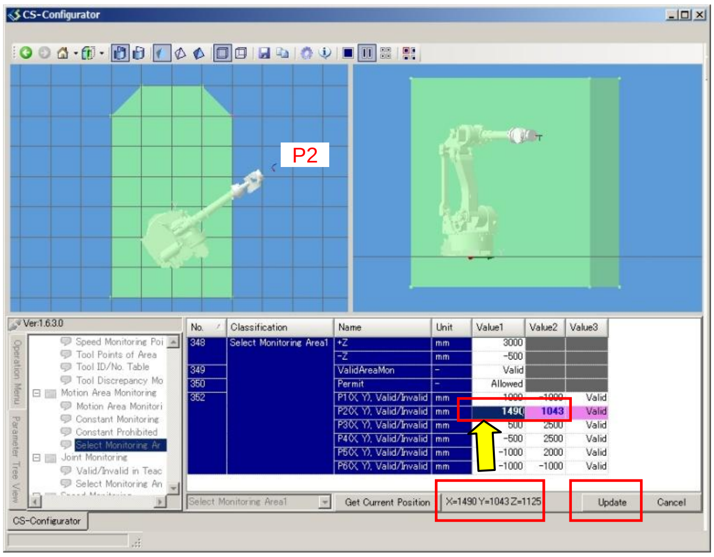


8.9 "GET CURRENT POSITION" FUNCTION

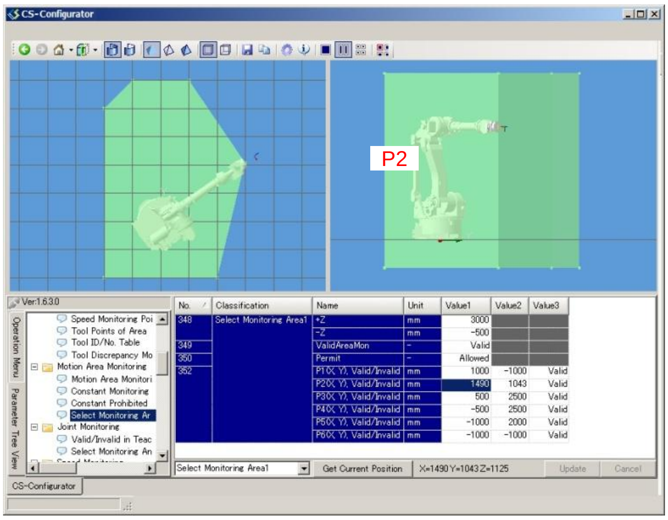
The <Get Current Position> button appears in the setting list for constant monitoring area, constant prohibited area, and selected area. The robot's TCP data can be acquired as auxiliary data when entering the monitoring area coordinate points.



The cursor is moved to P2(X, Y) to change its values.

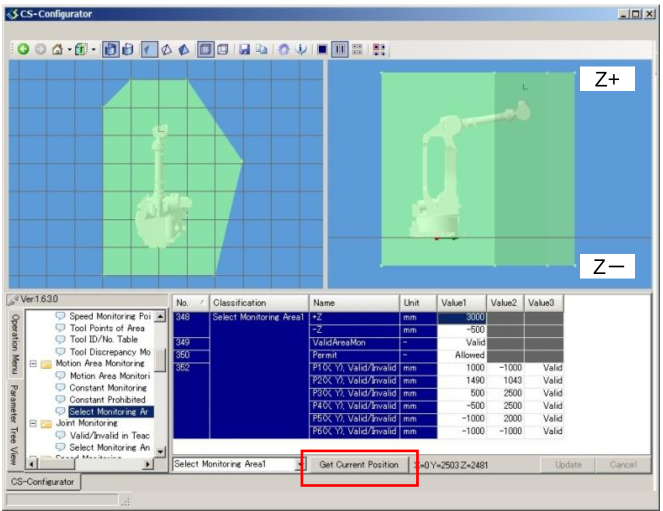


Confirm the actual robot and the current robot pose data displayed next to the <Get Current Position> button and press < Get Current Position>. The robot pose data is entered in P2(X, Y). Pressing <Update> button completes the data modification.

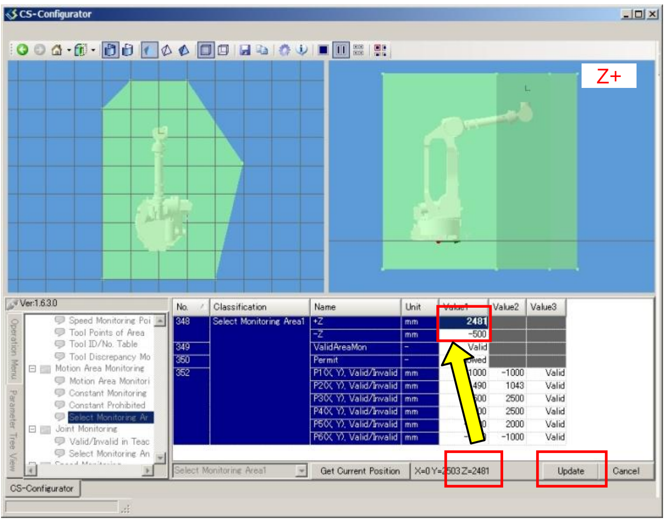


The change in area can be confirmed on the [Robot view] display.

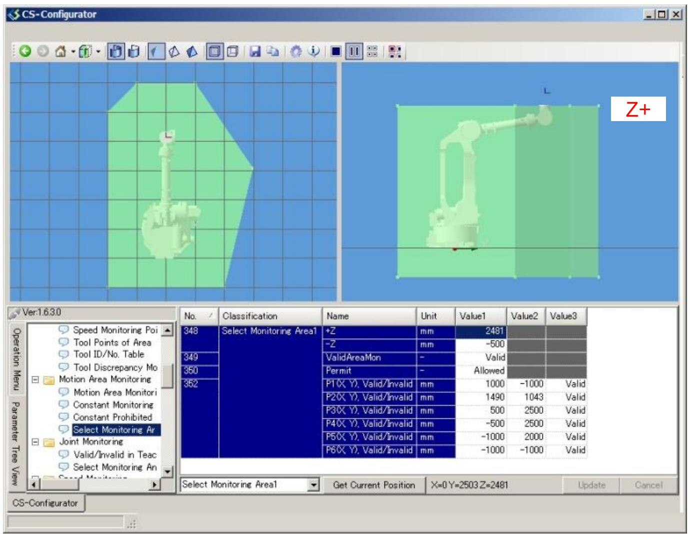
Pressing <Get Current Position> button at each line of the edge points of the motion area P1 to P8 enters only the X, Y values of the robot pose data.　To change only the Z value, move the cursor to [+Z] or [-Z] line.　Then, only the Z value of the robot pose data is entered into the list.



Move the cursor to [+Z] to change only the Z value.



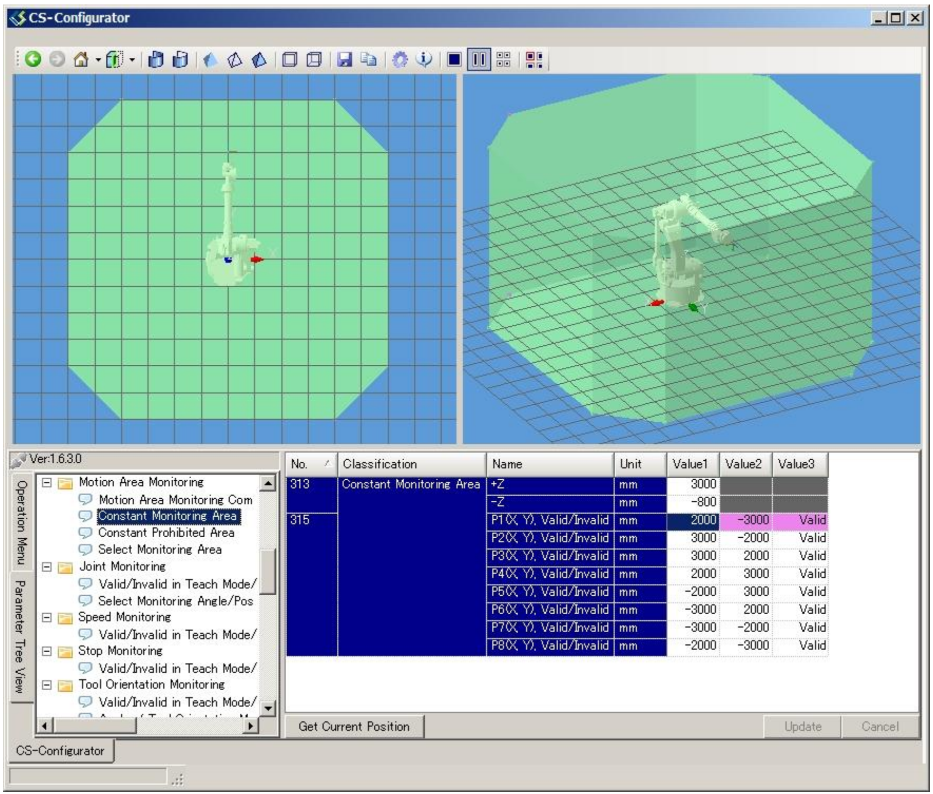
Confirm the actual robot and the current robot pose data displayed next to the <Get Current Position> button and press < Get Current Position>. The robot pose data is entered in Z+ value. Pressing <Update> button completes the data modification.

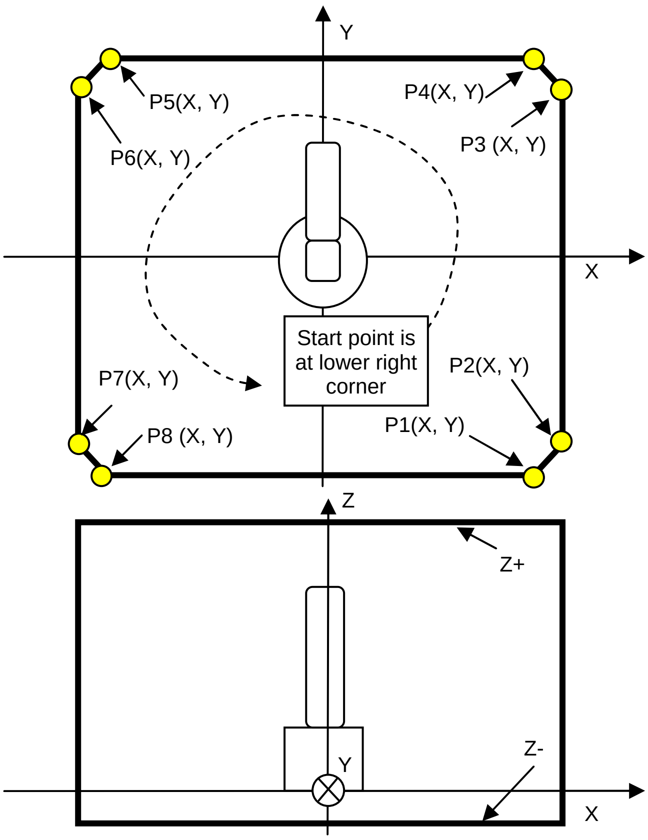


The change in area can be confirmed on the [Robot view] display.

8.10 CONSTANT MONITORING AREA SETTING

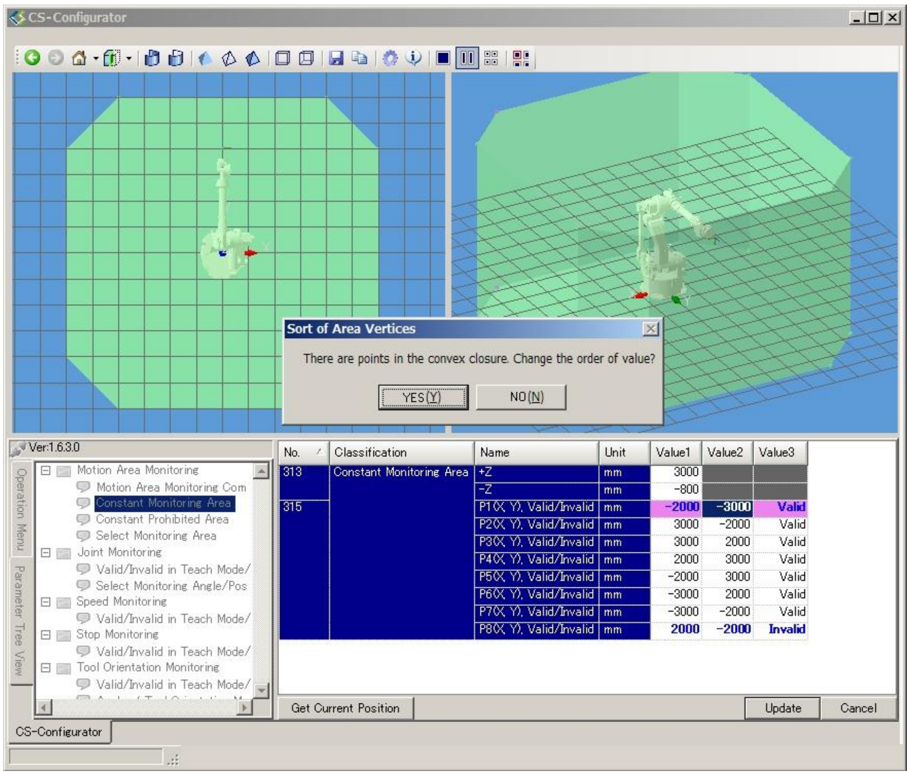
Up to 8 vertex points can be set to define the constant monitoring area. The points should be in order in counter clockwise way seen from the top of the area. If set in a different order, a message appears if the points can be reordered. Pressing <OK> reorders the points in counter clockwise order starting from the bottom right corner. To disable the points leaving the XY values as it is, change the value 3 setting from [Valid] to [Invalid]. To display the constant monitoring area on the [Robot view], use the [Display] dialogue boxes in the [Operation Menu].


CS-Configurator
Ver:1.6.3.0
Operation Menu
Parameter Tree View
Motion Area Monitoring
Motion Area Monitoring Com
Constant Monitoring Area
Constant Prohibited Area
Select Monitoring Area
Joint Monitoring
Valid/Invalid in Teach Mode/
Select Monitoring Angle/Pos
Speed Monitoring
Valid/Invalid in Teach Mode/
Stop Monitoring
Valid/Invalid in Teach Mode/
Tool Orientation Monitoring
Valid/Invalid in Teach Mode/
No.
Classification
Name
Unit
Value1
Value2
Value3
313
Constant Monitoring Area
+Z mm 3000
-Z mm -800
315
P1(X, Y), Valid/Invalid mm 2000 -3000 Valid
P2(X, Y), Valid/Invalid mm 3000 -2000 Valid
P3(X, Y), Valid/Invalid mm 3000 2000 Valid
P4(X, Y), Valid/Invalid mm 2000 3000 Valid
P5(X, Y), Valid/Invalid mm -2000 3000 Valid
P6(X, Y), Valid/Invalid mm -3000 2000 Valid
P7(X, Y), Valid/Invalid mm -3000 -2000 Valid
P8(X, Y), Valid/Invalid mm -2000 -3000 Valid
Get Current Position
Update
Cancel
CS-Configurator

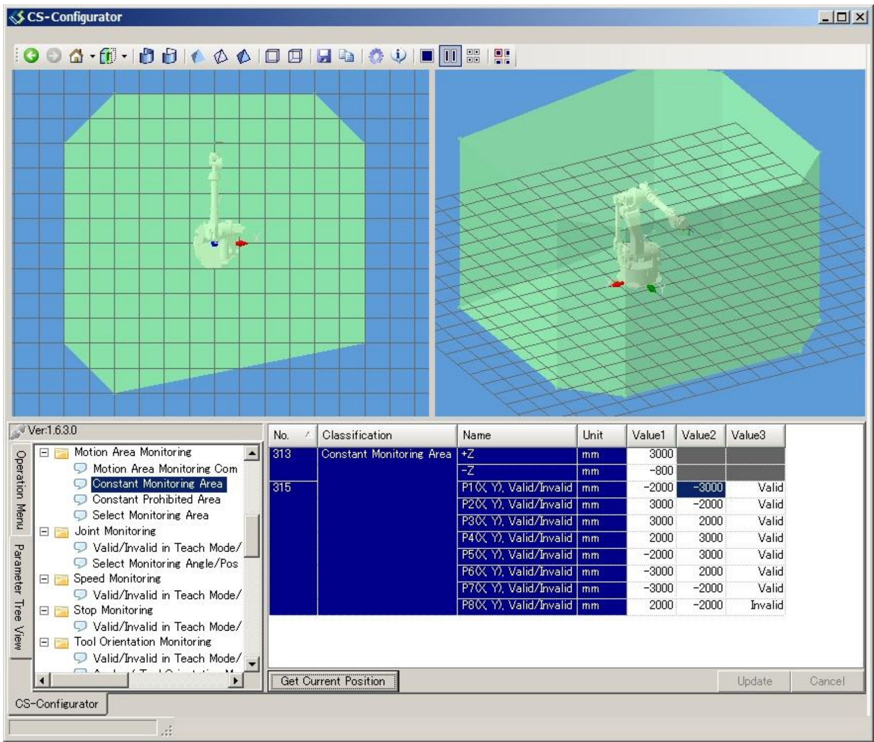

Y
P5(X, Y)
P4(X, Y)
P6(X, Y)
P3 (X, Y)
X
Start point is
at lower right
corner
P7(X, Y)
P2(X, Y)
P8 (X, Y)
P1(X, Y)
Z
Z+
Y
Z-
X

(Sorting to counter clockwise order)

In the example below, if point P1 X = 2000, Y= -3000 is changed to X = 2000, Y = -2000, then there will be a point included inside the area. A message appears to confirm sorting in CS-Configurator and the sorting operation is executed.

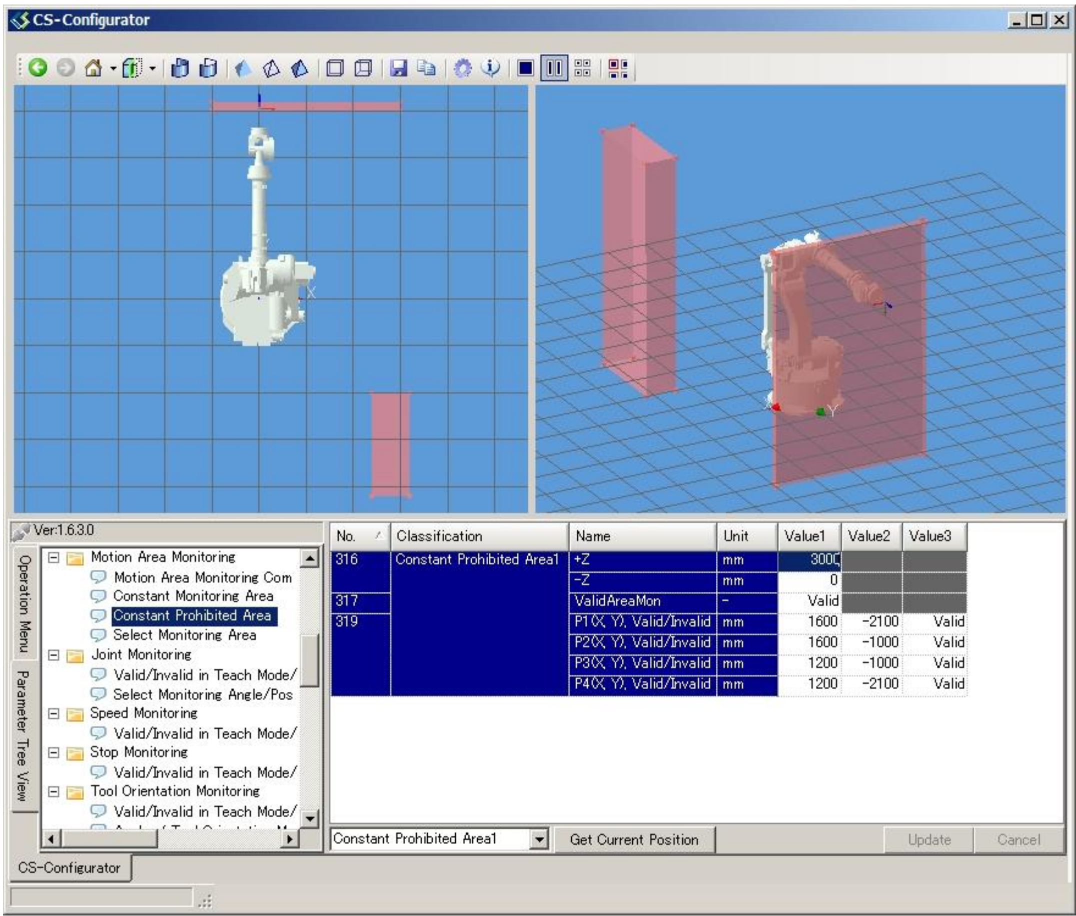


After the sort operation, point P1 X = 2000, Y = -2000 is invalidated and the remaining 5 points are shifted up, and reordered. In the Cubic-S, the reordered result is displayed.



8.11 CONSTANT PROHIBITED AREA SETTING

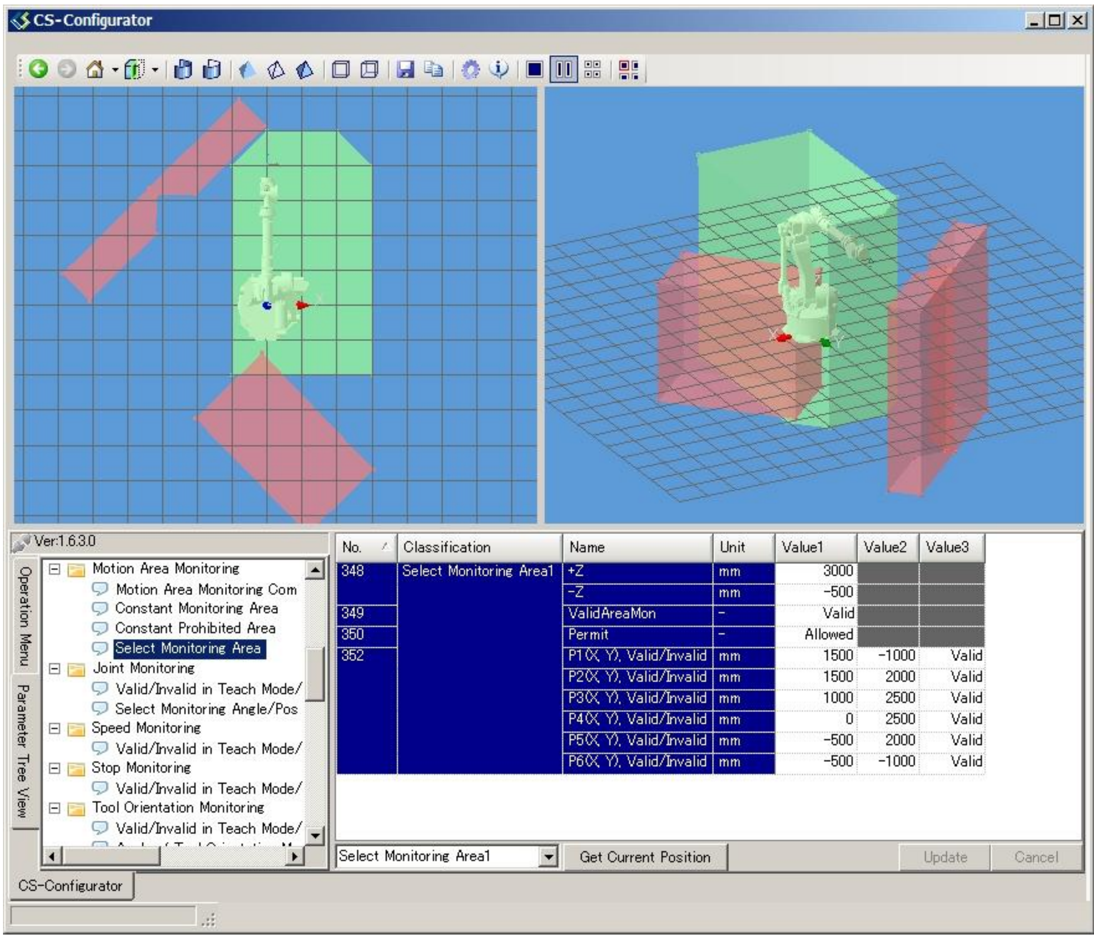
Up to 4 vertex points can be set to define the constant prohibited area. These points should be in counter clockwise order seen from above the area. If set in a different order, a message appears if the points can be reordered. Pressing <OK> reorders the points in counter clockwise order starting from the bottom right corner. To disable the points leaving the XY values as it is, change the value 3 setting from [Valid] to [Invalid]. To display the constant prohibited area on the [Robot view], use the [Display] dialogue boxes in the [Operation Menu].



8.12 SELECT MONITORING AREA

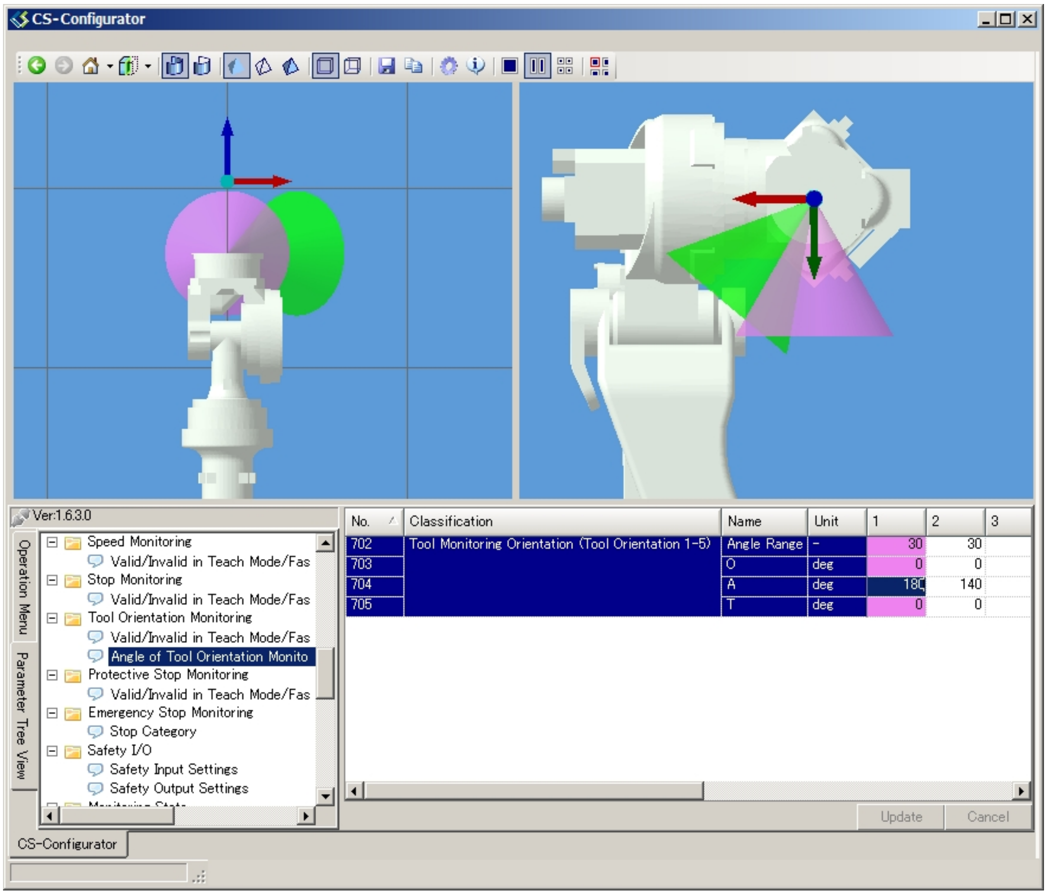
Up to 6 vertex points can be set to define the select monitoring area. The points should be in order in counter clockwise way seen from the top of the area. If set in a different order, a message appears if the points can be reordered. Pressing <OK> reorders the points in counter clockwise order starting from the bottom right corner. To disable the points leaving the XY values as it is, change the value 3 setting from [Valid] to [Invalid]. To display the select monitoring area on the [Robot view], use the [Display] dialogue boxes in the [Operation Menu].

The select monitoring area need to be specified if that area is permitted area or prohibited area. Permitted area is shown in green and prohibited area is shown red.



8.13 ANGLE OF TOOL ORIENTATION MONITORING

Five cones can be defined to indicate the angle of tool orientation monitoring.

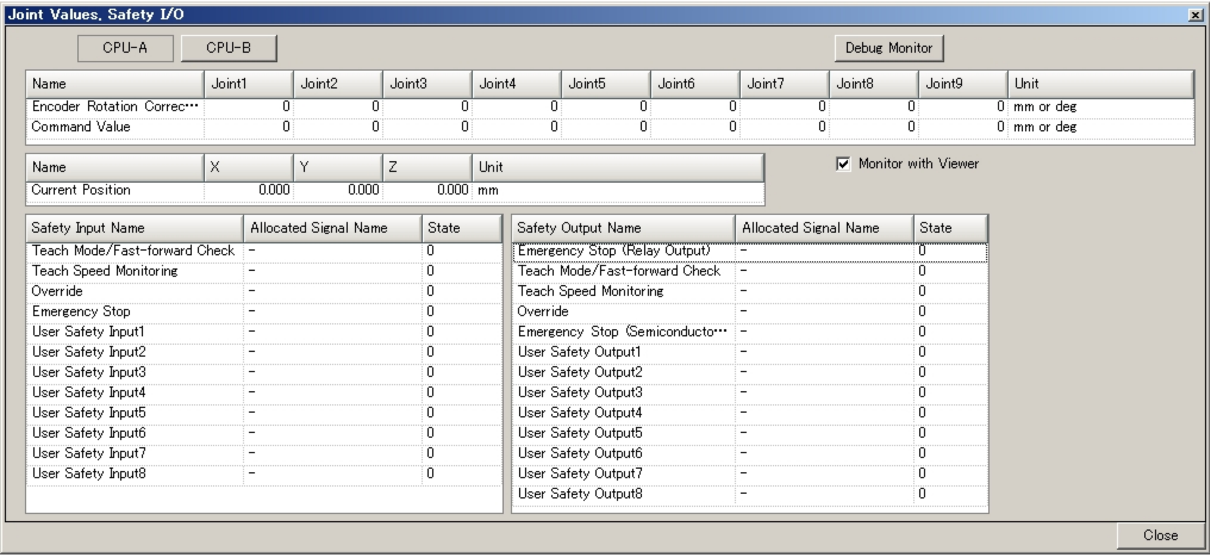


8.14 MONITORING

This function allows monitoring of Cubic-S status.

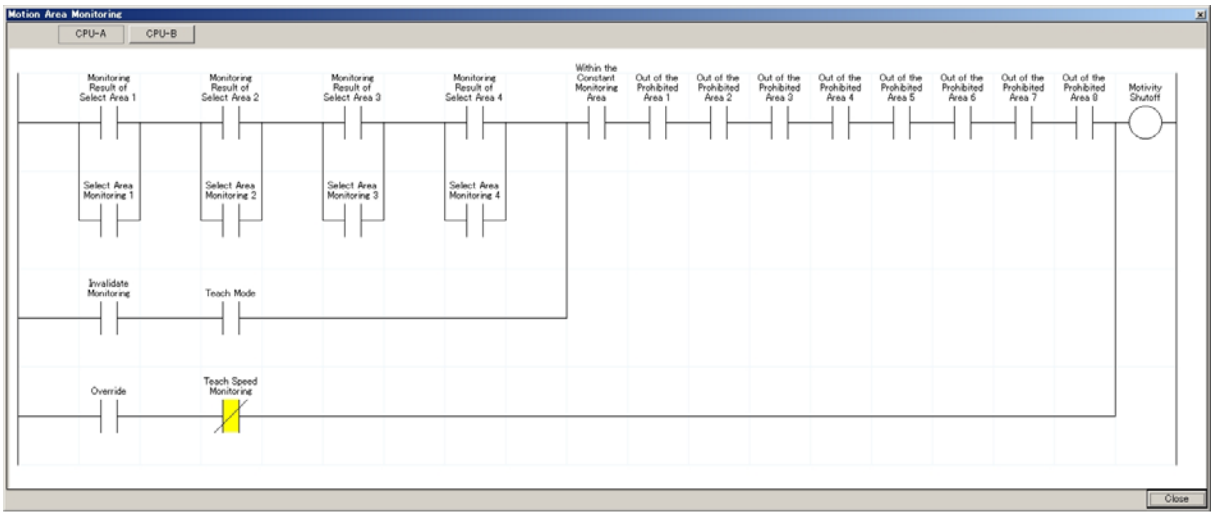
1. Joint Values, Safety I/O

Monitors the robot values Cubic-S acquires from the robot controller. The monitored values include: joint values, command values and safety I/O signal status.
CS-Configurator and Cubic-S communicates with each other periodically, and the values are updated constantly.



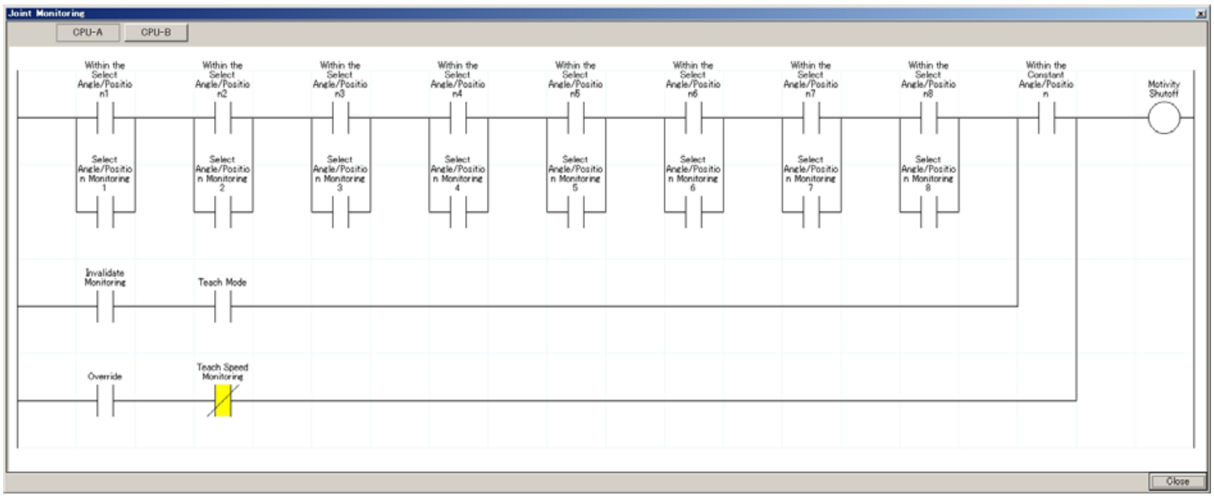
2. Motion Area Monitoring

Monitors the status of safety output and emergency stop signal related to motion area monitoring. When there is no error as result of area monitoring, the emergency stop signal is turned ON and the emergency stop is released.



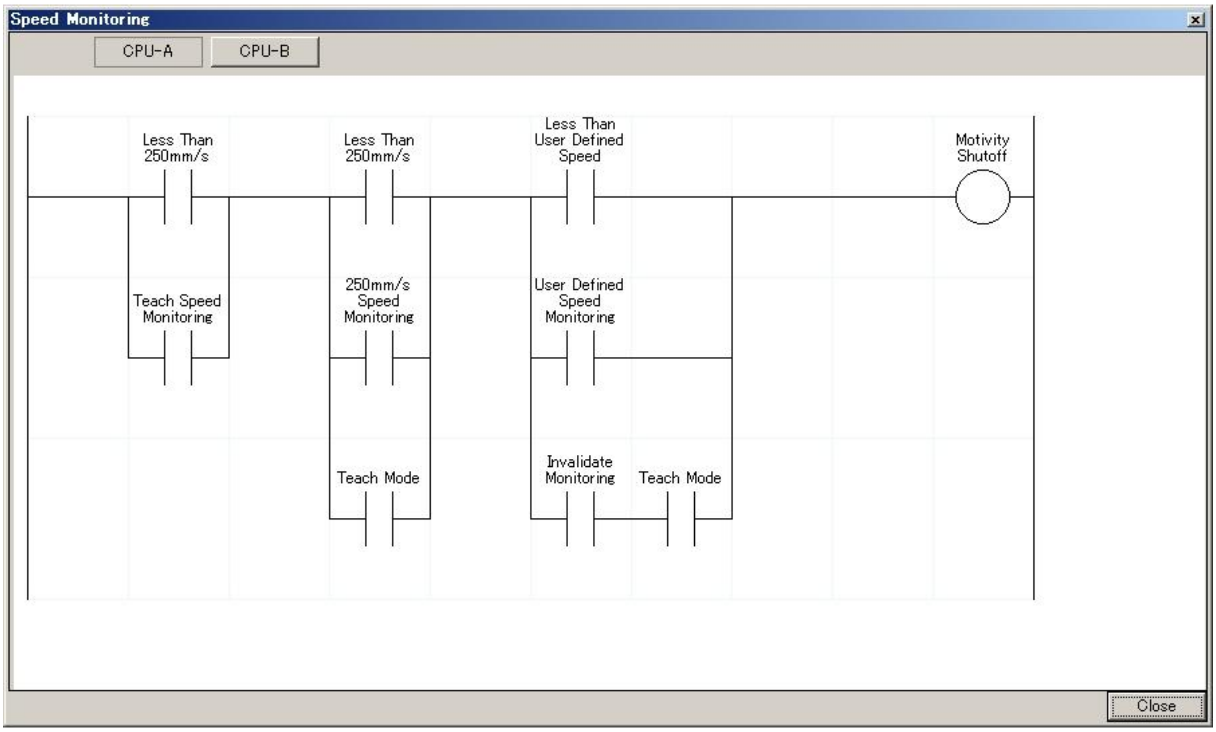
3. Joint Monitoring

Monitors the status of safety output and emergency stop signal related to joint monitoring. When there is no error as result of the monitoring, the emergency stop signal is turned ON and the emergency stop is released.



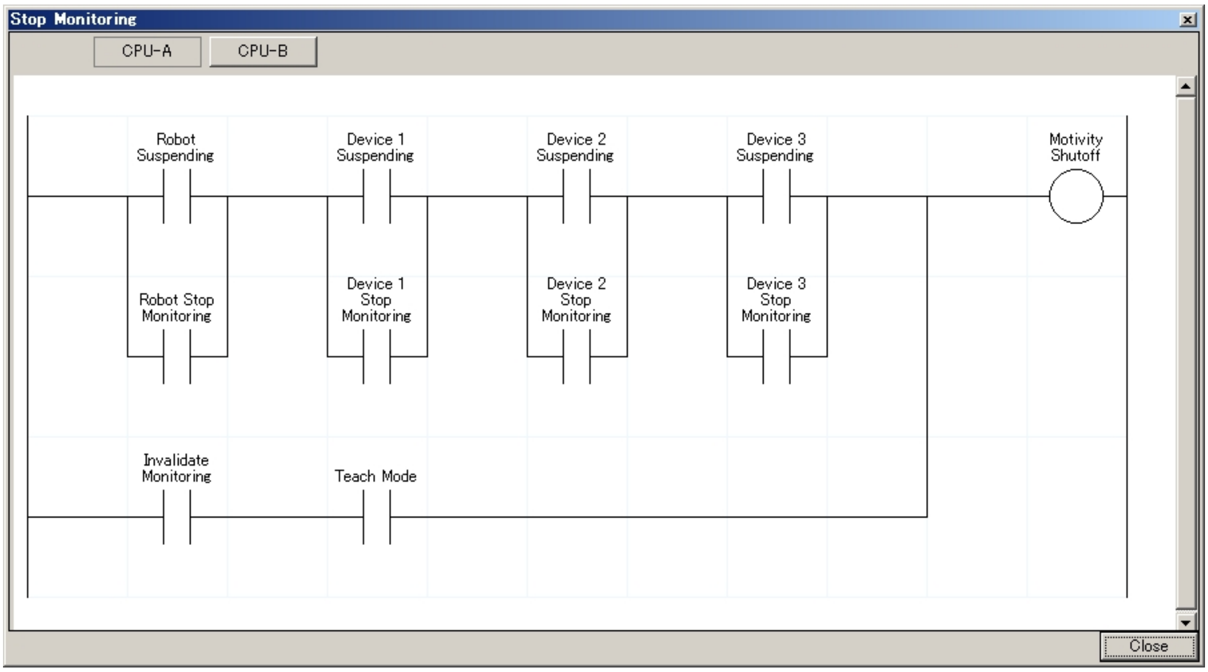
4. Speed Monitoring

Monitors the status of safety output and emergency stop signal related to speed monitoring. When there is no error as result of the monitoring, the emergency stop signal is turned ON and the emergency stop is released.



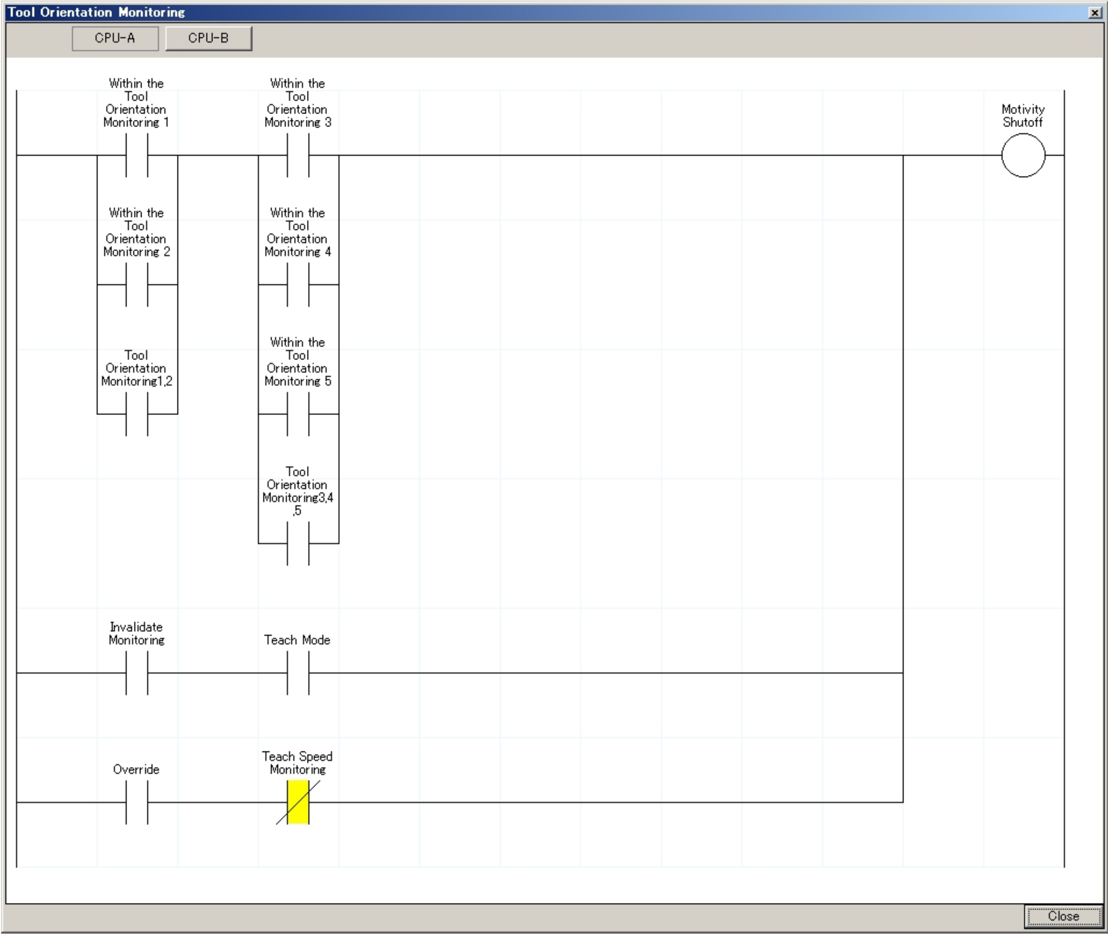
5. Stop Monitoring

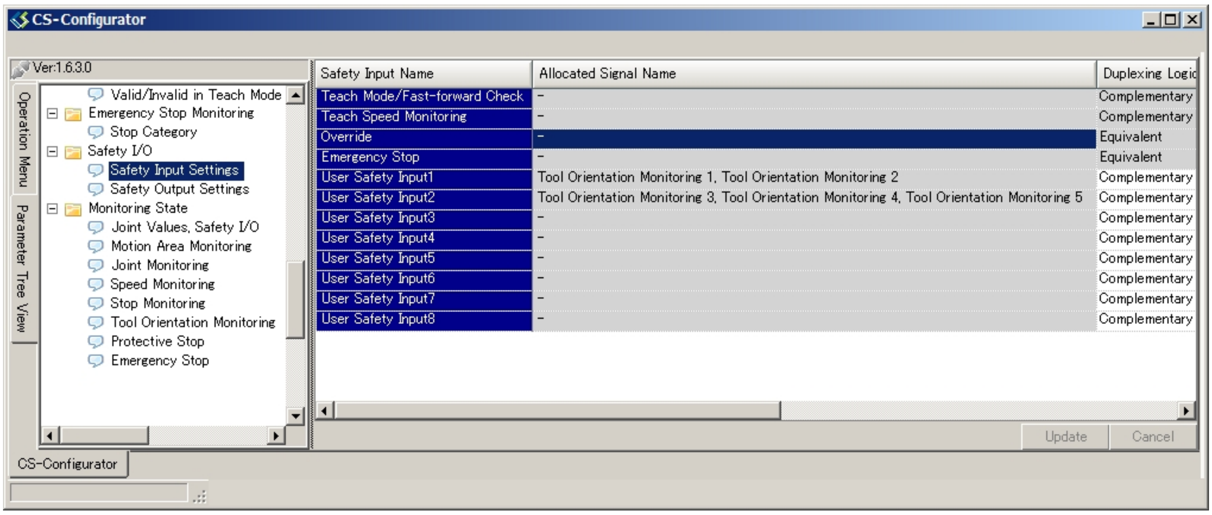
Monitors the status of safety output and emergency stop signal related to stop monitoring. When there is no error as result of the monitoring, the emergency stop signal is turned ON and the emergency stop is released.



6. Tool Orientation Monitoring

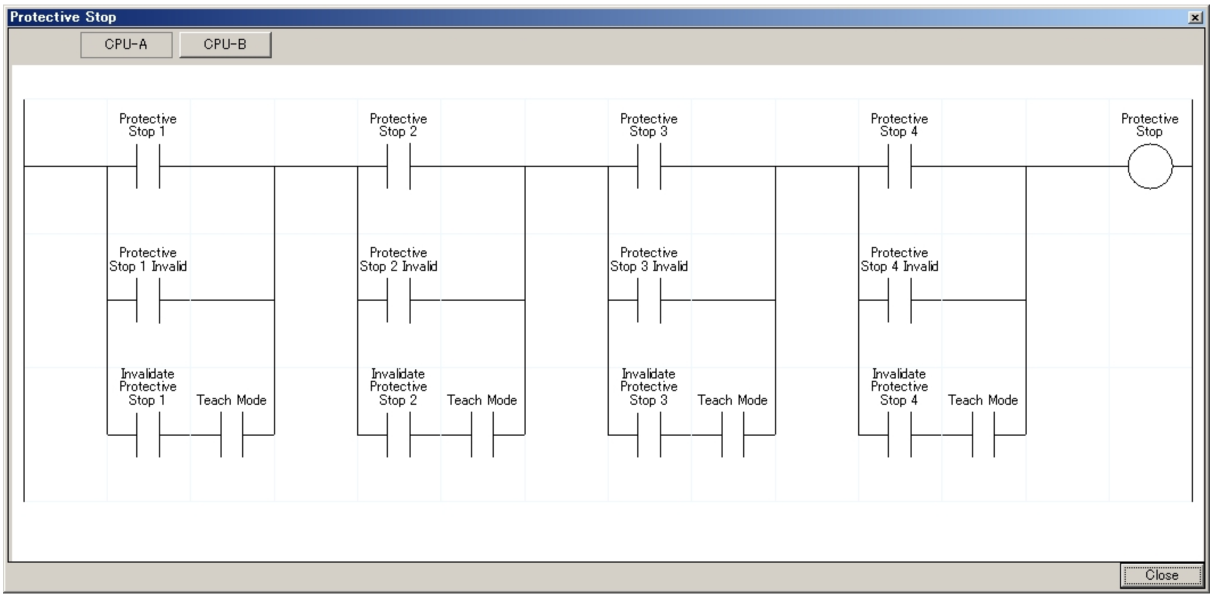
Monitors the status of safety output related to tool orientation monitoring. The logic circuit for tool orientation monitoring is related to the safety input setting. When tool orientation monitor 1 and 2 are both allocated to the same port number, and tool orientation monitor 3, 4, 5 are allocated together on a different port, the ladder diagram looks like below. As the result of the tool monitoring, if no trouble is found, the emergency stop signal turns ON and the emergency is released.





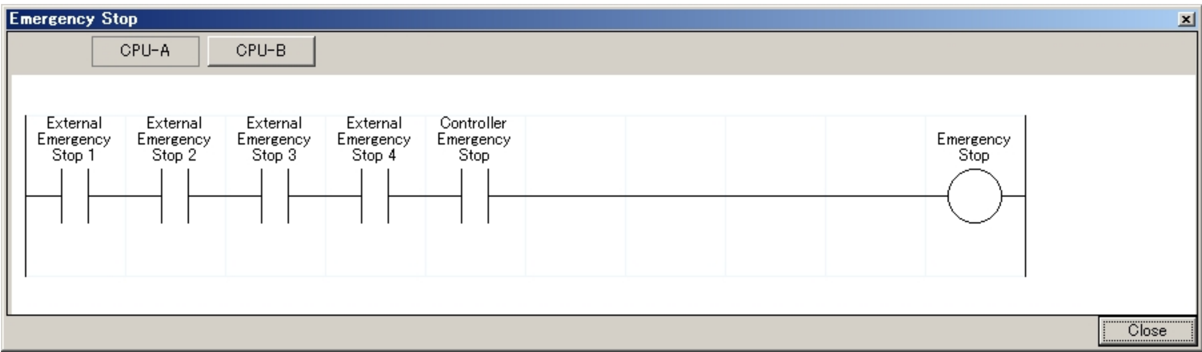
7. Protective Stop

Monitors the signal status related to protective stop monitoring. When the robot comes to an emergency stop status by protective stop function, this emergency stop signal turns OFF and emergency stop is input to the robot.



8. Emergency Stop

Monitors the signal status related to emergency stop monitoring. When the emergency stop function activates, this signal is turned OFF and the robot stops.



8.15 PASSWORD

Password is necessary for [Write Parameter to Cubic-S]. In Cubic-S version 1, the password is managed in CS-Configurator. In Cubic-S version 2 or later, the password operations are done in Cubic-S.

1. Default Setting of Version 1 Password

The password setting is done when [Write Parameter to Cubic-S] is used for the first time after installing CS-Configurator.

2. Default Setting at Time of Factory Shipment of Version 2

The default password set at time of factory shipment is three letters “khi”.

After executing [Write Parameter to Cubic-S], if the password is already set, the [Enter your password] dialogue box is displayed. Enter the password.

- Entering “reset1234” as password allows you to change the password setting. The password default setting screen appears, so set the password.
- For version 1, the password information is stored in the following file. In case you have forgotten your password, delete the file to initialize the password setting.
  “C:¥Program Files¥Kawasaki_Robot¥CS-Configurator¥system¥plugins¥wtmnt.config”

9.0 CONNECTION METHODS

For general cautions on connection, refer to 2.2.

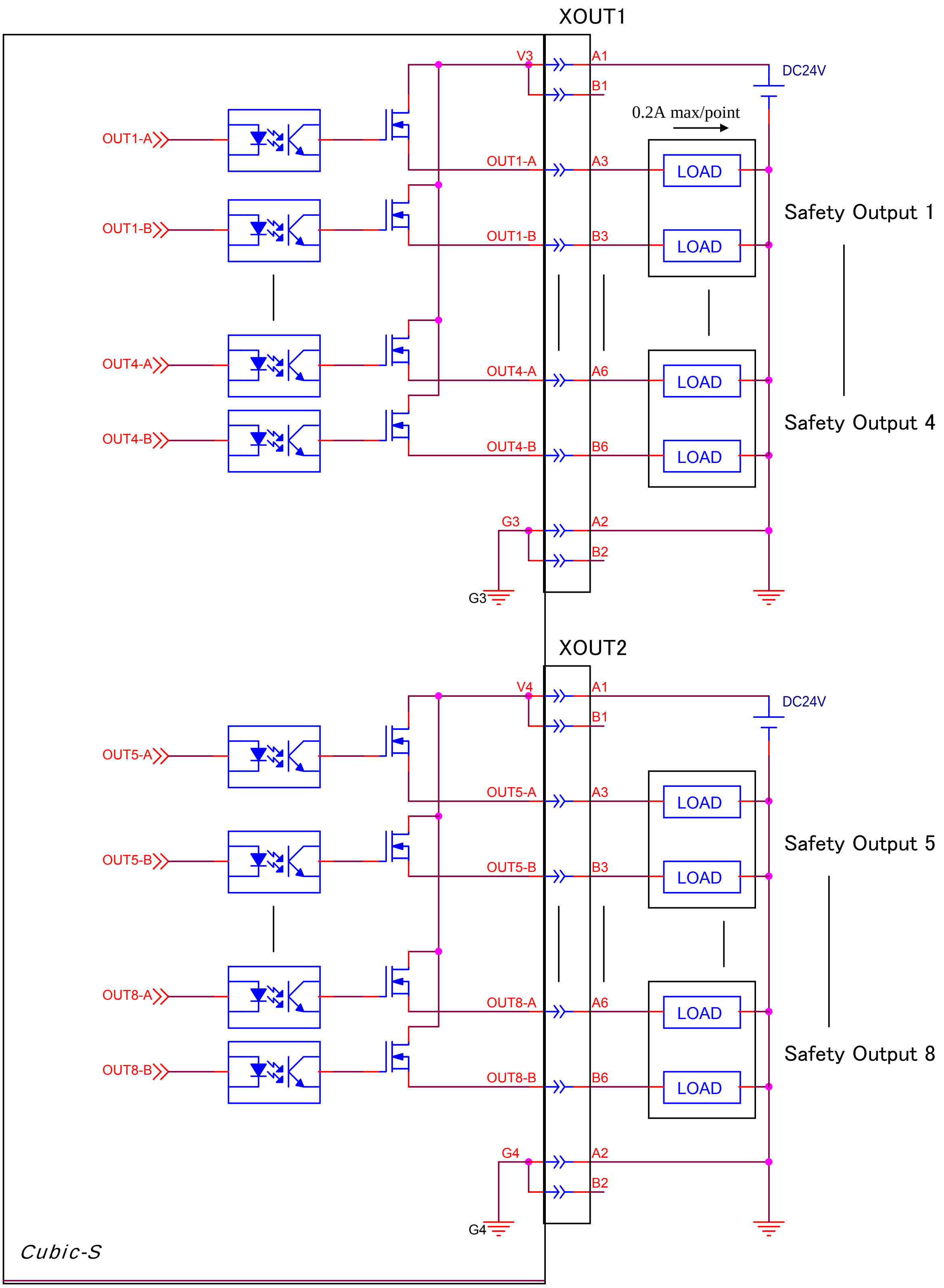
9.1 CONNECTING WITH OUTPUT DEVICES

9.1.1 CAUTIONS FOR WIRING THE SAFETY OUTPUT

⚠ WARNING

1. **Do not connect the load over the rated current to the safety output. The output will be damaged and the safety function will fail.**
2. **Connect so that 24V DC does not come in contact with the safety output. The load may turn ON by mistake. Earth 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 volt lines and power cables.**
4. **Fix the output signal cables so that no excess load is added to the Cubic-S connector.**
5. **Keep the length of the cables within 50 m.**
6. **Do not apply source power to the output terminal. Cubic-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 maximum current of the connector.**
10. **The safety output is a dual channel output, so use Ch.A and Ch.B in pairs.**

Connect with output devices referring to the below figure:



XOUT1 connector: 12 pins

On-board connector model/1-1871935-6 ,

Receptacle connector model /1-1871940-6 (Tyco Electronics)

Pin No.	Name	Terminal explanation
A1	V3*	24V (Power source) XOUT1 power supply terminal
B1	V3*	24V (Power source) XOUT1 power supply terminal
A2	G3*	GND XOUT1 GND terminal
B2	G3*	GND XOUT1 GND terminal
A3	OUT1-A	Safety output Ch1-A
B3	OUT1-B	Safety output Ch1-B
A4	OUT2-A	Safety output Ch2-A
B4	OUT2-B	Safety output Ch2-B
A5	OUT3-A	Safety output Ch3-A
B5	OUT3-B	Safety output Ch3-B
A6	OUT4-A	Safety output Ch4-A
B6	OUT4-B	Safety output Ch4-B

NOTE* OUT1 LED turns on when power is supplied between V3-G3.

XOUT2 connector: 16 pins

On-board connector model/1-1871935-8 ,

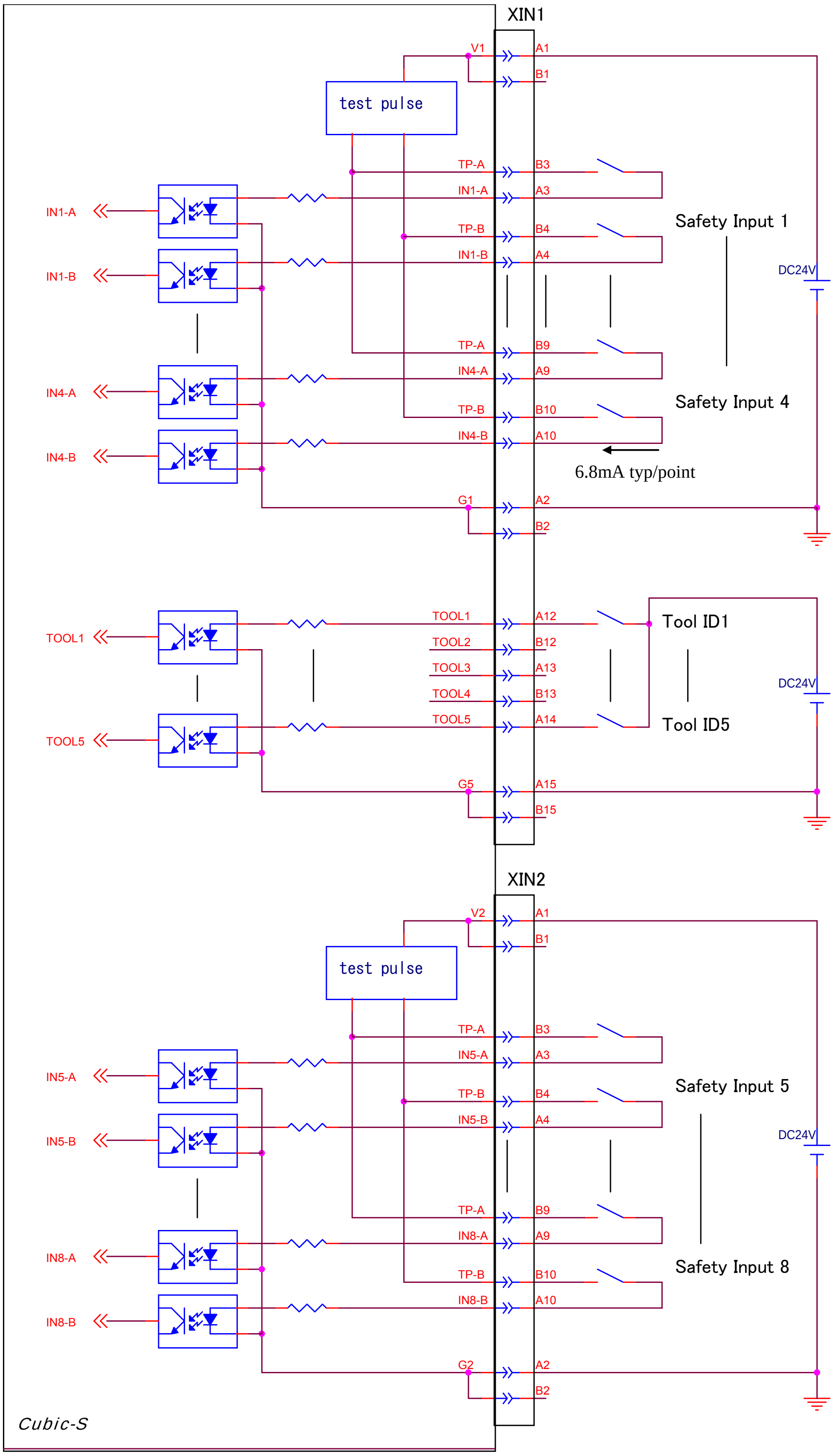
Receptacle connector model /1-1871940-8 (Tyco Electronics)

Pin No.	Name	Terminal explanation
A1	V4*	24V (Power source) XOUT2 power supply terminal
B1	V4*	24V (Power source) XOUT2 power supply terminal
A2	G4*	GND XOUT2 GND terminal
B2	G4*	GND XOUT2 GND terminal
A3	OUT5-A	Safety output Ch5-A
B3	OUT5-B	Safety output Ch5-B
A4	OUT6-A	Safety output Ch6-A
B4	OUT6-B	Safety output Ch6-B
A5	OUT7-A	Safety output Ch7-A
B5	OUT7-B	Safety output Ch7-B
A6	OUT8-A	Safety output Ch8-A
B6	OUT8-B	Safety output Ch8-B
A7	N.C	Not used
B7	N.C	Not used
A8	N.C	Not used
B8	N.C	Not used

NOTE* OUT2 LED turns on when power is supplied between V4-G4.

9.2 CONNECTING WITH INPUT DEVICES

Connect with input devices referring to the below figure:



XIN1 connector: 30 pins

On-board connector model/2-1871935-5, Receptacle connector model/2-1871940-5 (Tyco Electronics)

Pin No.	Name	Terminal explanation
A1	V1*	24V (Power source) XIN1 power supply terminal
B1	V1*	24V (Power source) XIN1 power supply terminal
A2	G1*	GND XIN1 GND terminal
B2	G1*	GND XIN1 GND terminal
A3	IN1-A	Safety input Ch1-A
B3	TP-A	Test pulse output A
A4	IN1-B	Safety input Ch1-B
B4	TP-B	Test pulse output B
A5	IN2-A	Safety input Ch2-A
B5	TP-A	Test pulse output A
A6	IN2-B	Safety input Ch2-B
B6	TP-B	Test pulse output B
A7	IN3-A	Safety input Ch3-A
B7	TP-A	Test pulse output A
A8	IN3-B	Safety input Ch3-B
B8	TP-B	Test pulse output B
A9	IN4-A	Safety input Ch4-A
B9	TP-A	Test pulse output A
A10	IN4-B	Safety input Ch4-B
B10	TP-B	Test pulse output B
A11	N.C	Not used
B11	N.C	Not used
A12	TOOL1	Tool ID input 1 (System 1 input)
B12	TOOL2	Tool ID input 2 (System 1 input)
A13	TOOL3	Tool ID input 3 (System 1 input)
B13	TOOL4	Tool ID input 4 (System 1 input)
A14	TOOL5	Tool ID input 5 (System 1 input)
B14	N.C	Not used
A15	G5	GND (GND for tool ID input)
B15	G5	GND (GND for tool ID input)

NOTE* IN1 LED turns ON when power is supplied between V1-G1.

XIN2 connector: 22 pins

On-board connector model/2-1871935-1, Receptacle connector model/2-1871940-1 (Tyco Electronics)

Pin No.	Name	Terminal explanation
A1	V2*	24V (Power source) XIN2 power supply terminal
B1	V2*	24V (Power source) XIN2 power supply terminal
A2	G2*	GND XIN2 GND terminal
B2	G2*	GND XIN2 GND terminal
A3	IN5-A	Safety input Ch5-A
B3	TP-A	Test pulse output A
A4	IN5-B	Safety input Ch5-B
B4	TP-B	Test pulse output B
A5	IN6-A	Safety input Ch6-A
B5	TP-A	Test pulse output A
A6	IN6-B	Safety input Ch6-B
B6	TP-B	Test pulse output B
A7	IN7-A	Safety input Ch7-A
B7	TP-A	Test pulse output A
A8	IN7-B	Safety input Ch7-B
B8	TP-B	Test pulse output B
A9	IN8-A	Safety input Ch8-A
B9	TP-A	Test pulse output A
A10	IN8-B	Safety input Ch8-B
B10	TP-B	Test pulse output B
A11	N.C	Not used
B11	N.C	Not used

NOTE* IN2 LED turns ON when power is supplied between V2-G2.

9.2.1 TYPES OF INPUT DEVICES AND CONNECTION METHODS

WARNING

When connecting to contact type devices, enable the Cubic-S input diagnosis without fail.　If diagnosis is not validated, trouble in input line may not be detected properly.

There are two cases for connection with input devices:

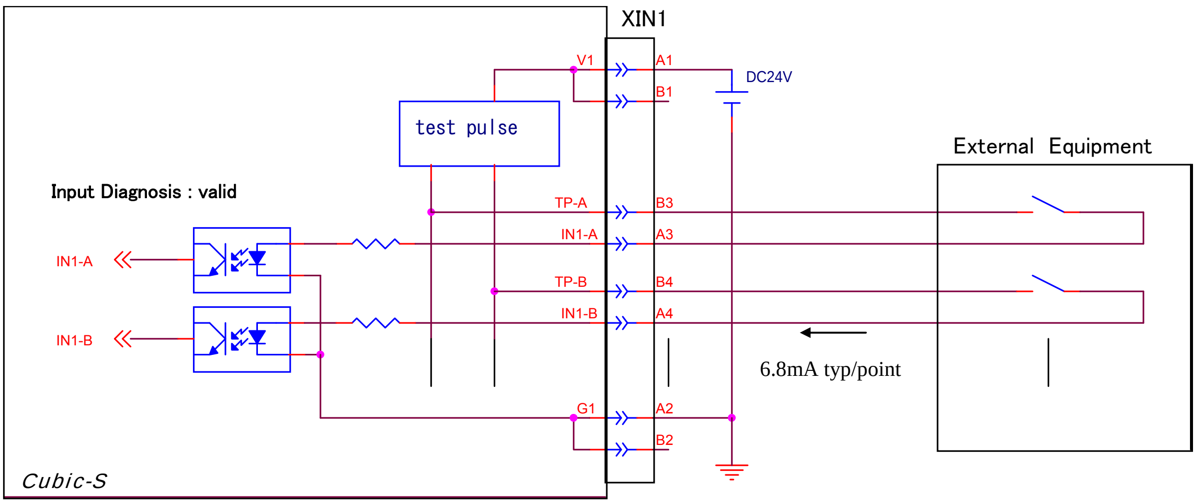
1) Connection with contact type devices:

Ex) emergency stop push button switch and safety limit switch, etc.

Cubic-S uses test pulse output terminals combined with safety input terminal. Input the test pulse from Cubic-S via the contacts of external device. (See wiring example 1)

When using wiring example 1, enable the relevant input diagnosis in the Cubic-S parameter value setting.

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



2) PNP semiconductor output (current source output type) device:

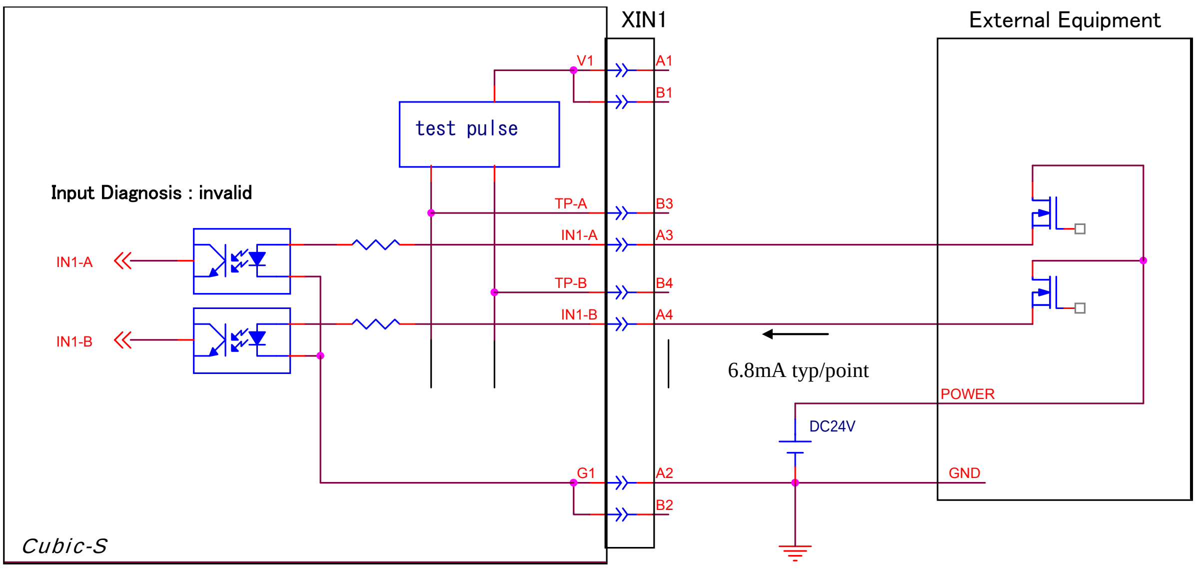
Ex) light curtain, etc.

Input PNP semiconductor output signal to the safety input terminal of Cubic-S.

(See wiring example 2)

When using wiring example 2, disable the relevant input diagnosis in the Cubic-S parameter value setting.

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



9.2.2 CAUTIONS ON SAFETY INPUT CONNECTION

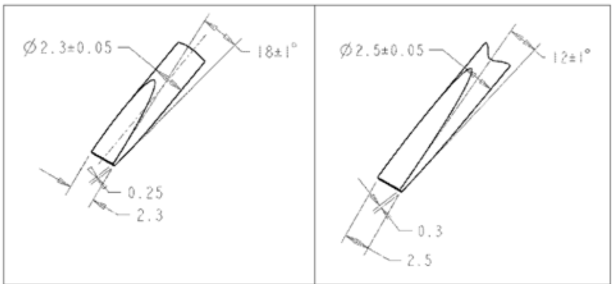
⚠ WARNING

1. **Use shielded cable for the output signal, and place the cables away from high volt lines and power cables.**
2. **Fix the output signal cables so that no excess load is added to the Cubic-S connector.**
3. **Keep the length of the cables within 50 m.**
4. **Do not supply the power to the test pulse output terminal. Cubic-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.**

USER SAFETY INPUT/ OUTPUT CONNECTOR SPECIFICATION

Tyco Electronics D1900 series spring clamp connector

Wiring tools: 1891348-1 Flat-headed screw driver can be used as in the figure below.

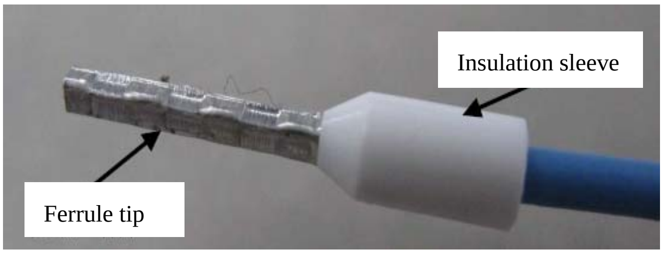


Screwdriver diameter φ 2.3mm | Screwdriver diameter φ 2.5mm

(1) When using ferrule terminal (Use of rod terminal recommended)

・Applicable lines : AWG24 to AWG22
・Tip diameter: 1.2 mm or less
・Tip length: 5 to 7mm
・Insulation sleeve diameter: 3.5 mm or less

*It is recommended that ferrule terminal matching the size of the above cables are used.



(2) When not using ferrule terminal

- Applicable lines : AWG24 to AWG20
- Cable stripping length: 7.0mm±0.3mm (recommended)

CAUTION

1. **Be careful so that the wire cover does not get caught in the clamps of the connector.**
2. **Be careful so that the terminals do not touch the lines around it.**

9.3 HOW TO WIRE EXTERNAL EMERGENCY STOP TO ROBOT CONTROLLER WITH CUBIC-S

Connect and set the robot controller with Cubic-S as shown below when using external emergency stop signal.

X7 connector (external emergency stop) on 1TR board is connected to Cubic-s inside the controller. Therefore, to input emergency stop signal from outside the controller, or to use the emergency stop output from the controller, wire Cubic-S as described below.

[**NOTE**]

1. In robot controller built-in with Cubic-S, the number of safety circuit system is fixed to 2 systems, and cannot be used with only 1 system.
2. In robot controller built-in with Cubic-S, set the JP1/ JP2 jumpers in 1TR board to JP2 side. If not, Cubic-S will detected an error.

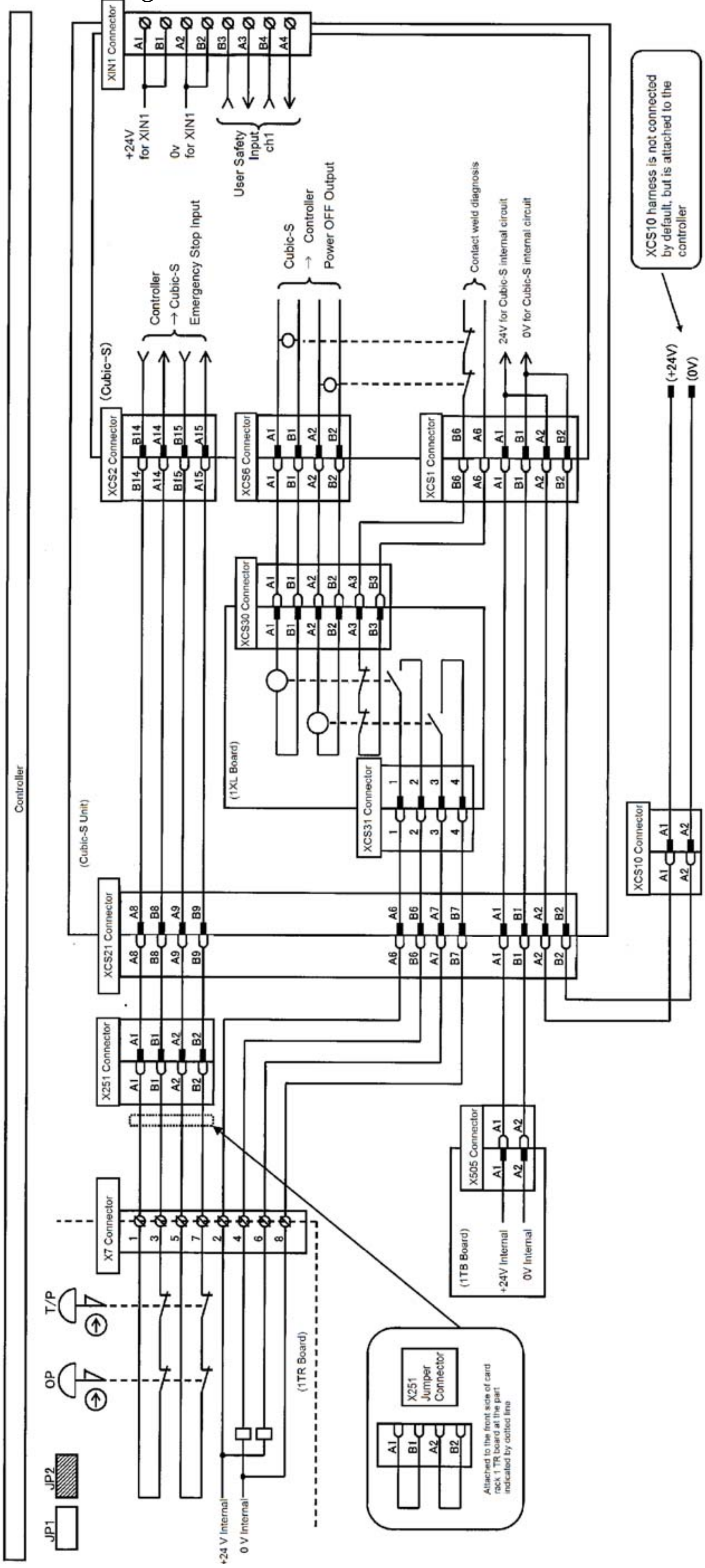
WARNING

After changing the wiring, confirm without fail that all emergency stop button functions properly.

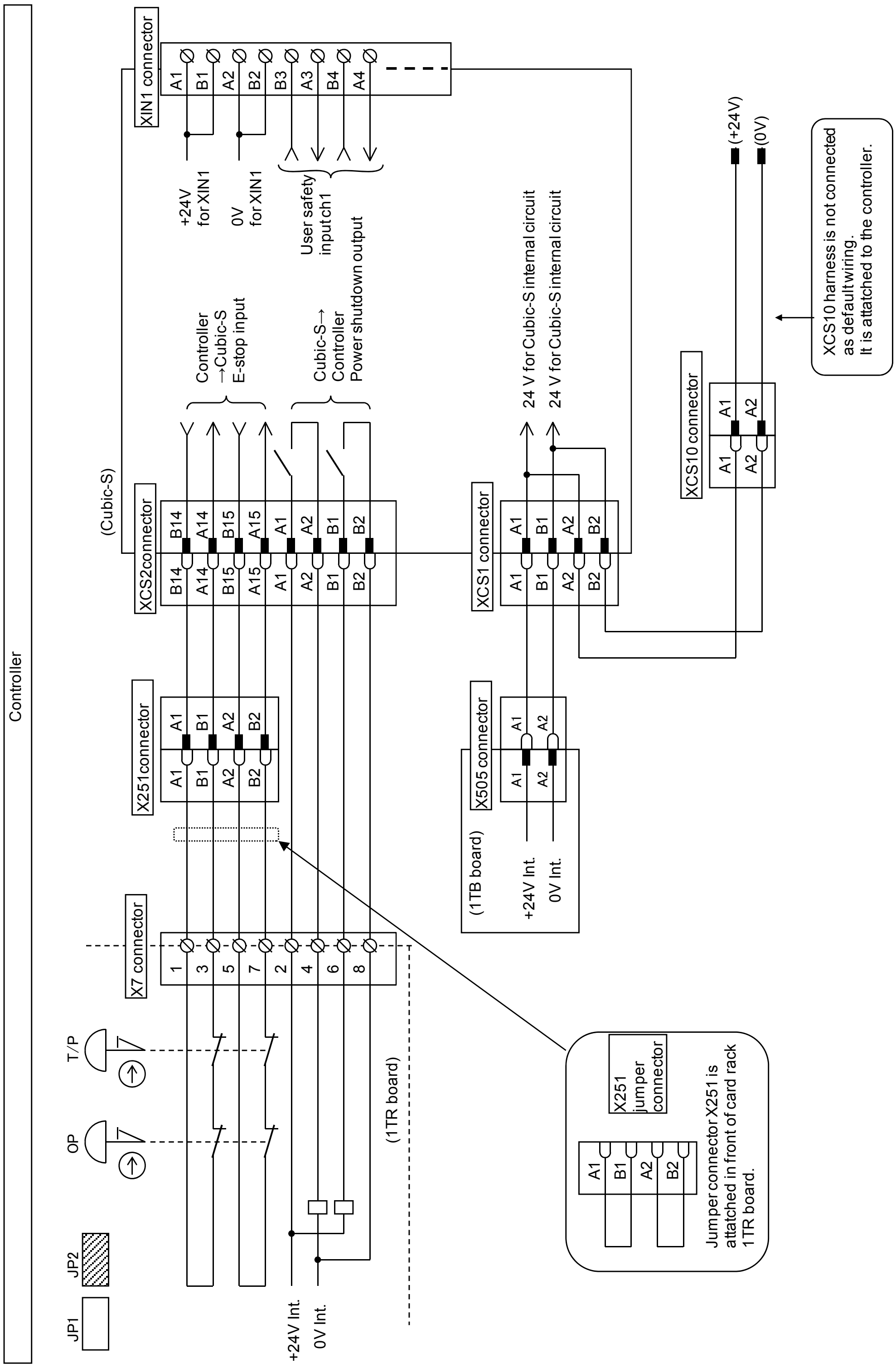
Default emergency stop wiring

The emergency stop wiring done at factory shipment for robot controller installed with Cubic-S is as follows.

Default wiring for E0x Controller



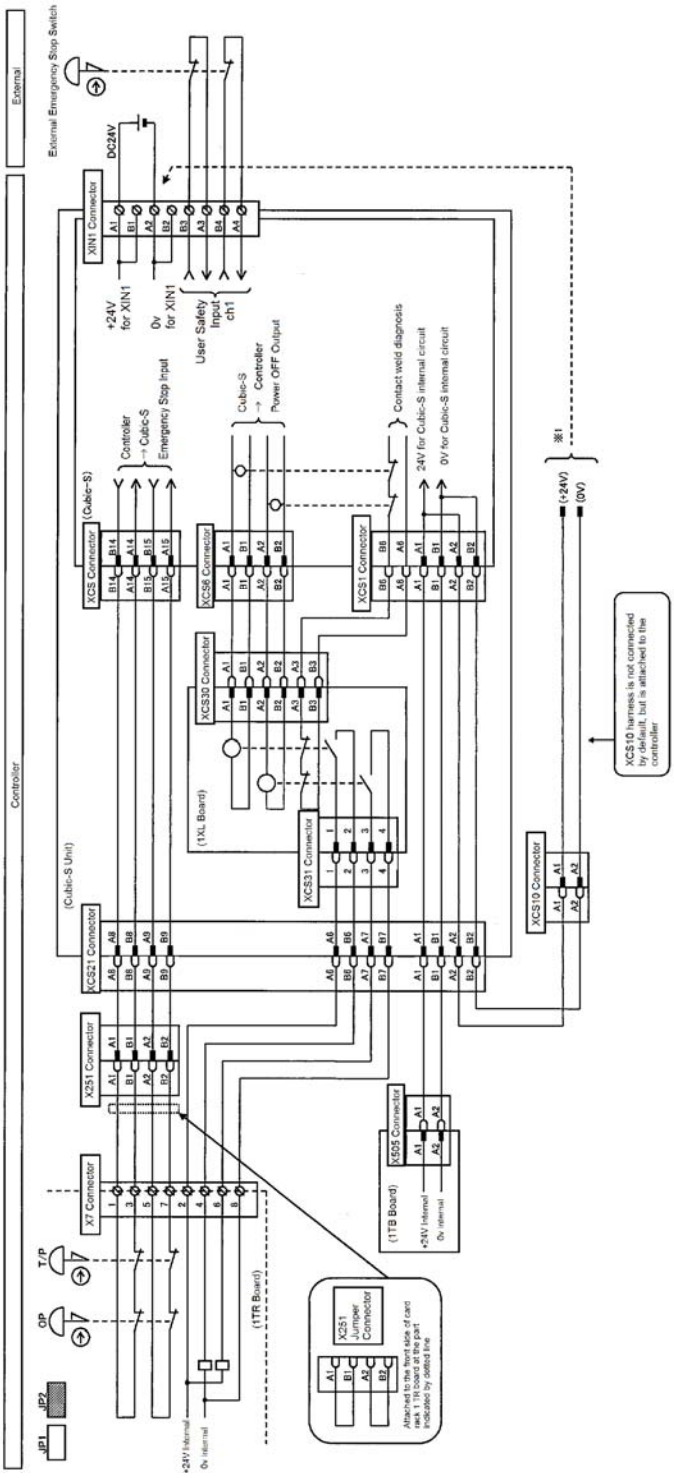
Default wiring for E1x, E2x, E3x, E4x Controllers



Pattern 1: Inputting to controller via external emergency stop switch contact

Connect external emergency stop switch contact and DC24V power source to user safety input of Cubic-S (X1N1, 2 connector parts, total of 8 dual inputs).　The below figure shows example of connection to user safety input Ch1 of X1N1 connector.　Allocating emergency stop function to input connected to Cubic-S inputs external emergency stop signal to the controller via Cubic-S.

E0x Controller wiring example in pattern 1

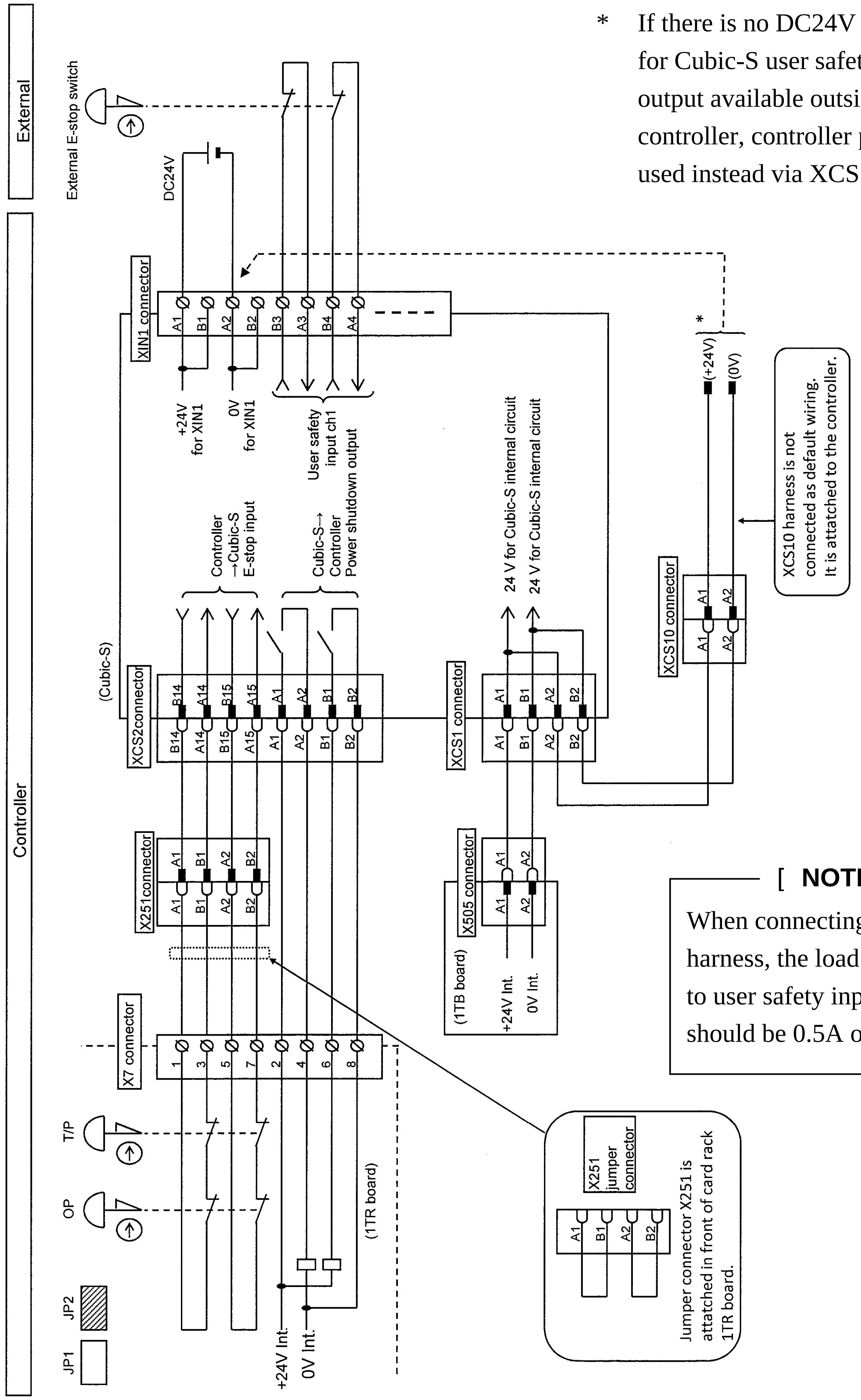


*　If there is no DC24V power source for Cubic-S user safety input/ output available outside the controller, controller power can be used instead via XCS10 harness.

[**NOTE**]

When connecting via XCS10 harness, the load connected to user safety input/ output should be 0.5A or less.

E1x, E2x, E3x, E4x controller wiring example in pattern 1



* If there is no DC24V power source for Cubic-S user safety input/ output available outside the controller, controller power can be used instead via XCS10 harness.

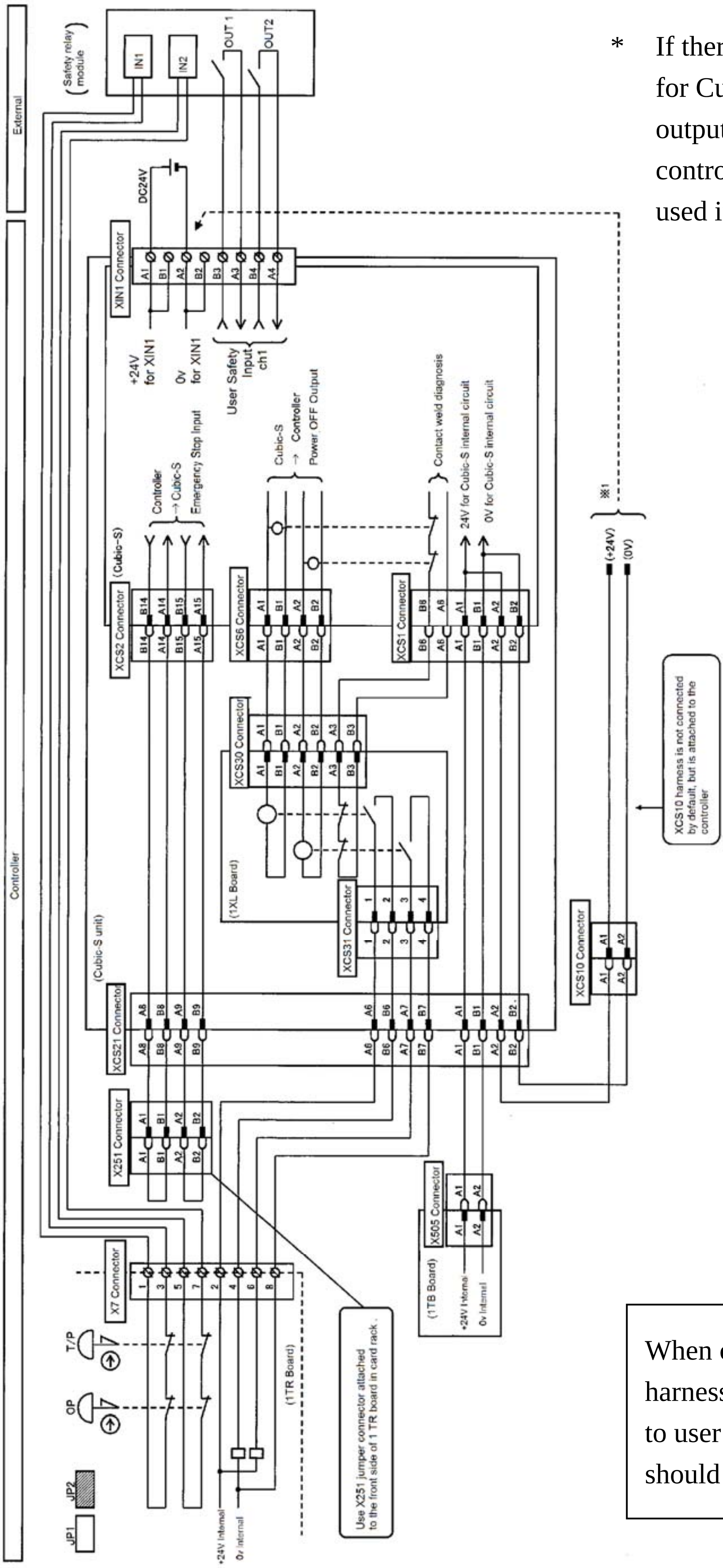
[NOTE]

When connecting via XCS10 harness, the load connected to user safety input/ output should be 0.5A or less.

Pattern 2: Creating a safety circuit outside the controller

Configure a safety circuit externally by taking out the emergency stop switch from the controller and setting it outside the controller with external emergency stop signal. First, remove the wiring between pins 1, 3, 5, 7 on connector X7 on 1TR board and X251 connector relayed to the front part of 1TR board. Then, connect X251 jumper connector which is bundled with X251 relay connector, as shown in figure below. Next, remove the emergency stop contact from X7 connector pins 1-3, 5-7 on 1TR board, and take it outside the controller. Connect the external emergency stop input signal to user safety input in Cubic-S (X1N1, 2 connector parts, total of 8 dual inputs). The below figure shows example of connection to user safety input Ch1 of X1N1 connector. Allocating emergency stop function to input connected to Cubic-S inputs external emergency stop signal to the controller via Cubic-S.

E0x Controller wiring example in pattern 2

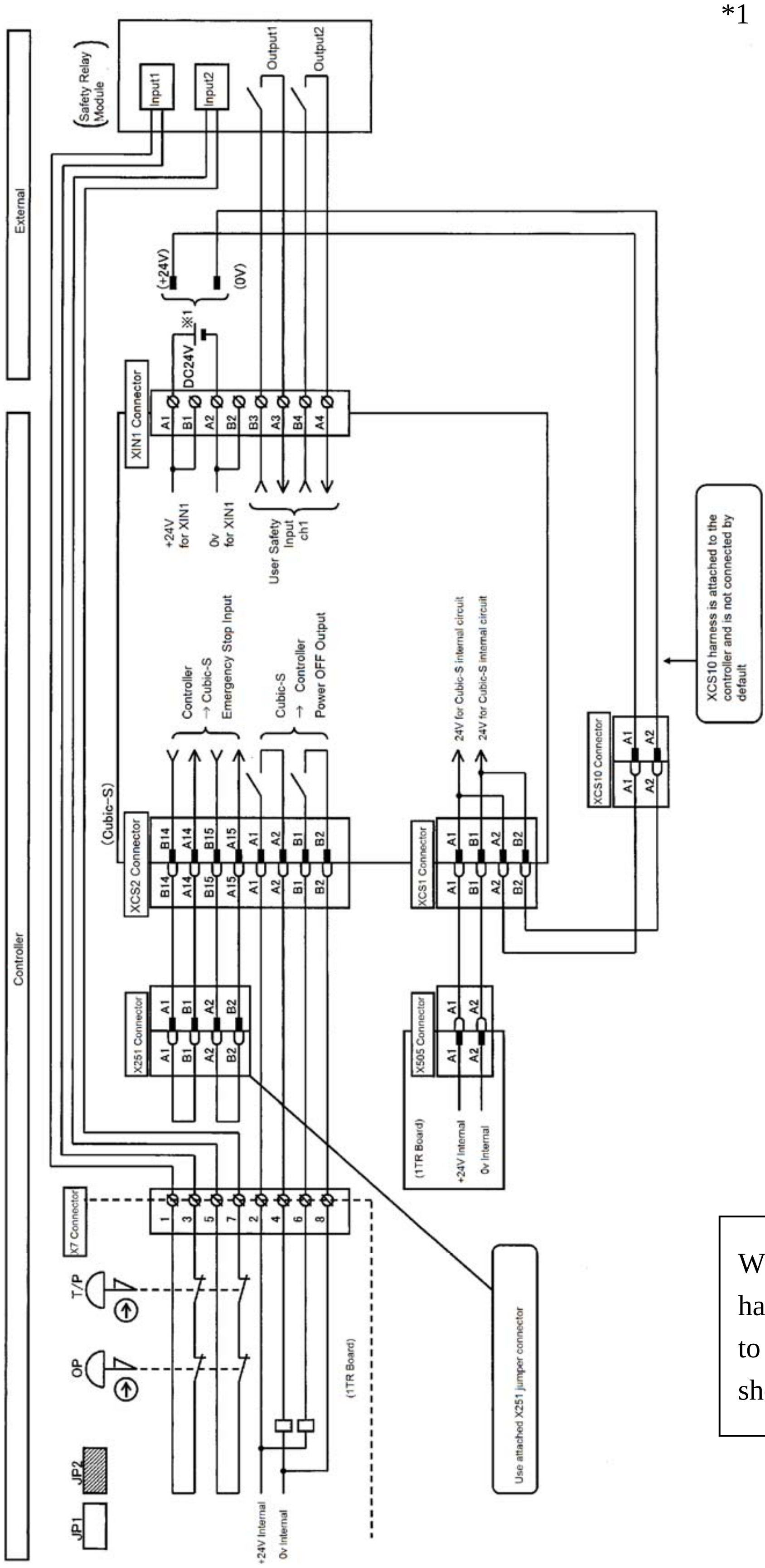


* If there is no DC24V power source for Cubic-S user safety input/ output available outside the controller, controller power can be used instead via XCS10 harness.

[**NOTE**]

When connecting via XCS10 harness, the load connected to user safety input/ output should be 0.5A or less.

E1x, E2x, E3x, E4x Controller wiring example in pattern 2



*1 If there is no DC24V power source for Cubic-S user safety input/ output available outside the controller, controller power can be used instead via XCS10 harness.

[NOTE]

When connecting via XCS10 harness, the load connected to user safety input/ output should be 0.5A or less.

10.0 SAFETY INPUT/ OUTPUT FUNCTION

10.1 SAFETY INPUT FUNCTION

The dual safety input in Cubic-S can be divided into two types: 8channels of user safety input (XIN1,2 connector part), which can the functions can be set by the user, and 4 channels of fixed safety input (XCS2 connector part, teach/ fast check mode fixed input, teach speed monitor fixed input, override switch fixed input, emergency stop fixed input), which are used internally in the robot controller and the settings cannot be changed by the user.

[**NOTE**]

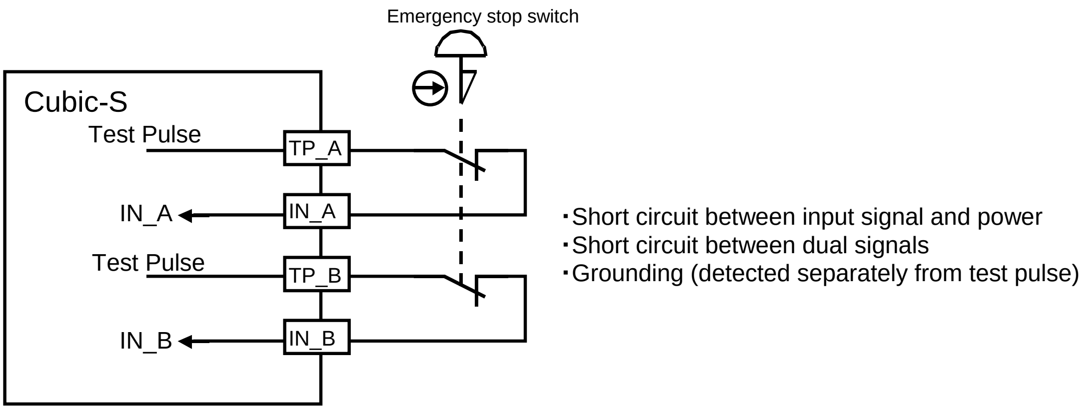
Cubic-S safety system is designed as dual safety input. It cannot be used in single safety input.

The user safety input are used differently according to the input device that is connected, as shown below.

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

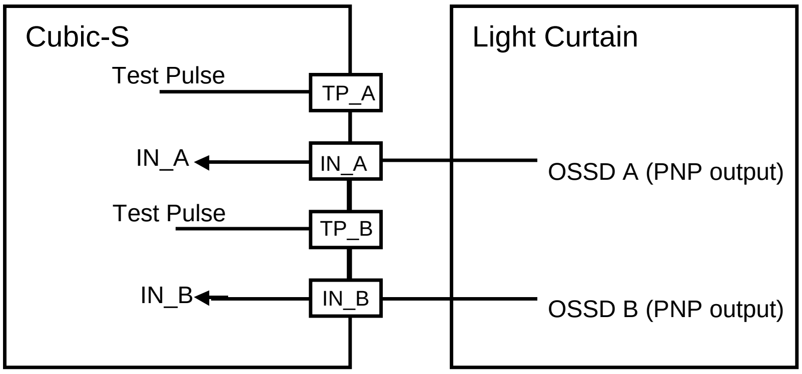
Inputs the test pulse from Cubic-S test output terminal to the Cubic-S user safety input terminal via the contact of the connected device. The errors shown in the figures below can be detected according to the test pulse.

(Set the safety input diagnosis to “Do”.)



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

Inputs to the safety input terminal DC24V 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) (Cubic-S test pulse is not used. Set the safety input diagnosis to “Do not”.)



10.1.1 SAFETY INPUT LOGIC SETTING

When using the user safety input, set each channel as below. For detail on how to set them, see Chapter 11.

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.

(Setting1) Function allocation setting

Item	Setting	Content
Allocated signal name	For more information on function allocation, see Chapter 11. *See 10.1.3 for detail on when the "safety input stuck" function is allocated.	

(Setting2) Setting of input logic

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

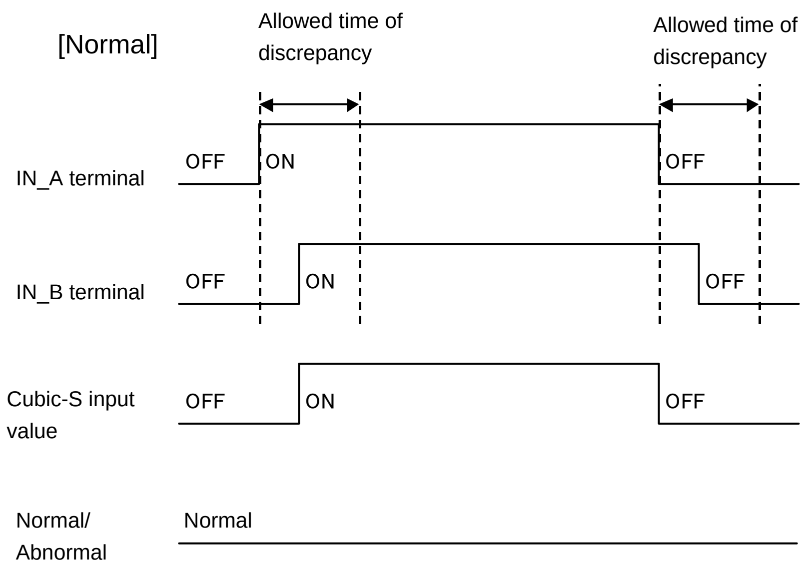
(Setting3) Time setting for allowed time of discrepancy

Item	Setting	Content
Allowed time of discrepancy	0 ms to 30000 ms (Settable in increments of 1ms)	Allowed time of mismatch between the dual signals. When the signals do not match for the set time, error occurs.

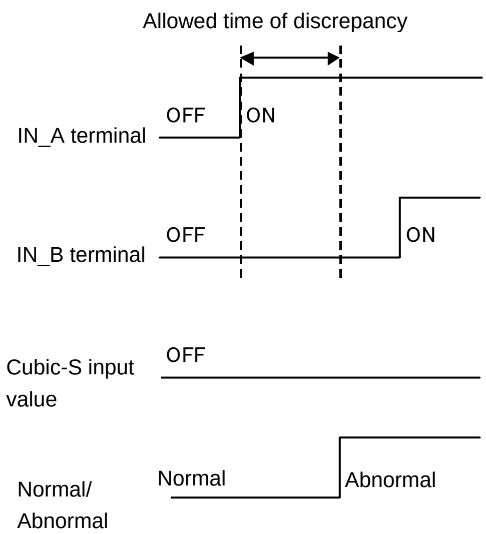
For details on Setting 2, 3, see the following figure.

Equivalent Setting

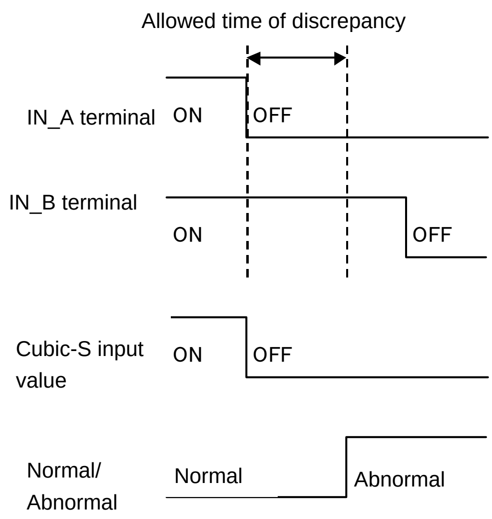
[Normal]



[When error occurs (input ON)]

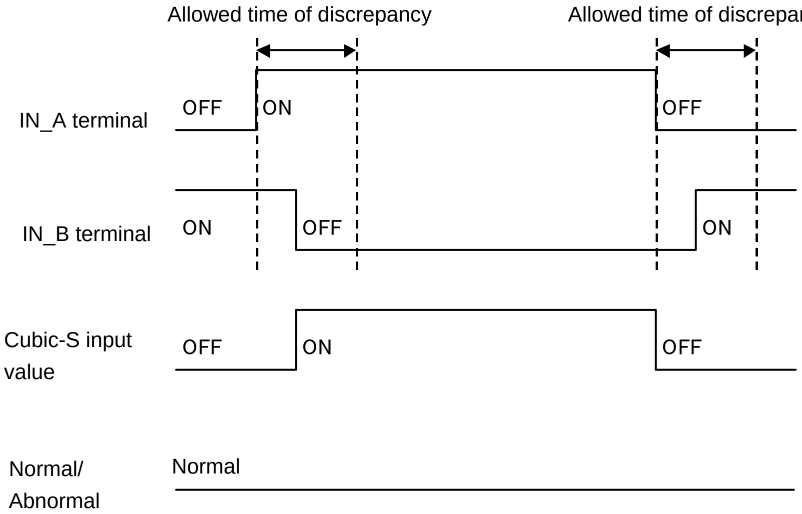


[When error occurs (input OFF)]

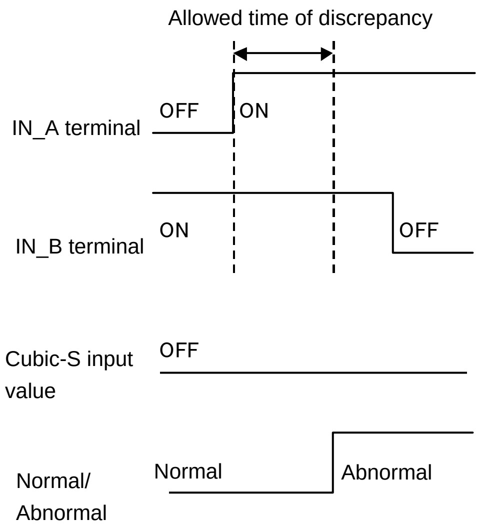


Complementary Setting

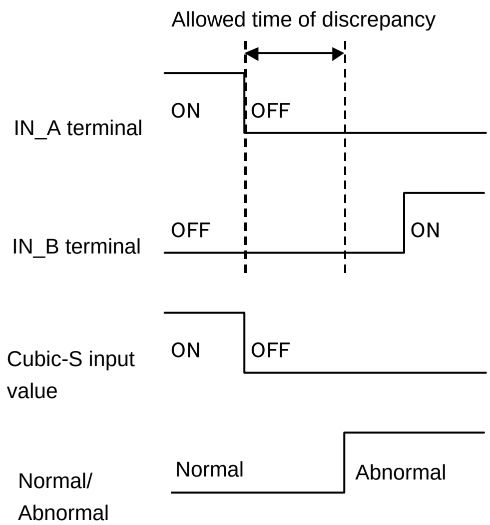
[Normal]



[When error occurs (input ON)]



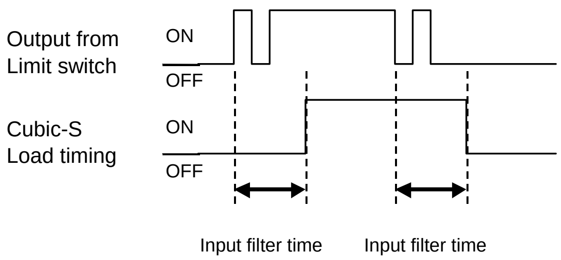
[When error occurs (input OFF)]



(Setting4) Input filtering time setting

Item	Setting	Content
Filter value	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.



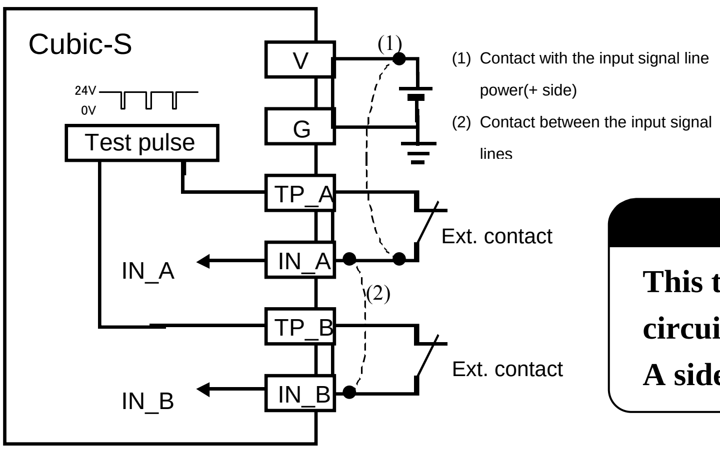
CAUTION

Include the filtering time in the response time. The response time affects the calculation of safety distance restricted by regulations such as ISO13855, so be careful when setting.

(Setting5) Input test pulse diagnosis valid/ invalid Setting

Item	Setting	Content
Safety input diagnosis	Valid	Checks the safety input ch by test pulse output from Cubic-S
	Invalid	Does not check the safety input ch by test pulse output from Cubic-S

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



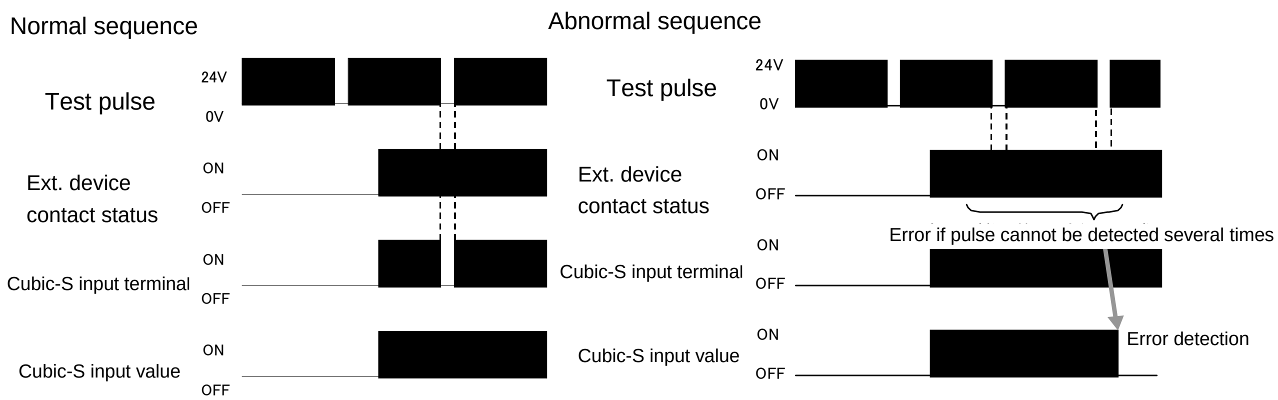
WARNING

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

⚠ CAUTION

1. Ground the 0V (GND) of the power that is used.
2. Short circuit between the input and GND line can be detected irrelevant of the safety input diagnosis 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 Cubic-S input value becomes OFF.



⚠ WARNING

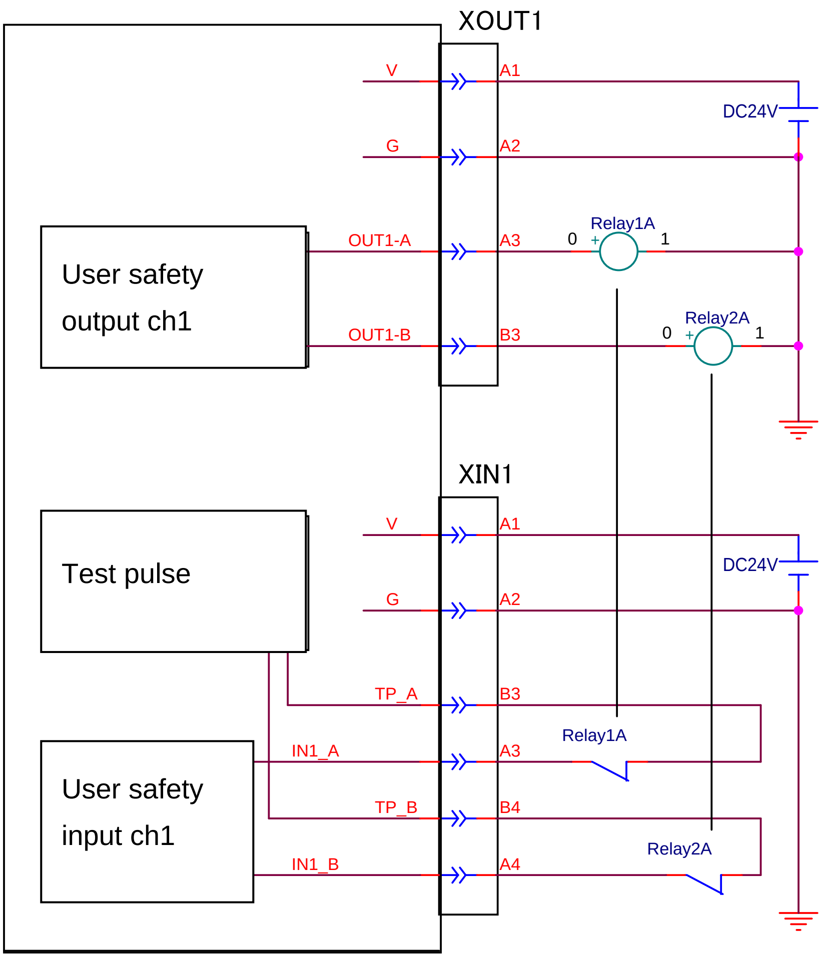
When performing the wiring in 10.1-1, enable the test pulse diagnosis without fail. If disabled, short circuit in the input wiring may not be detected.

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 of 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 driven by the Cubic-S safety output.　The below figure shows the wiring to drive the external safety relay by safety output ch 1 and to perform weld check of that relay via safety input ch1.　For details on the contents of weld error, see Chapter 14 Error code (E9428).　Perform the actual wiring according to the channel that is used.



10.2 SAFETY OUTPUT FUNCTION

The dual safety output in Cubic-S can be divided into two types: 8channels of user safety output (XOUT1,2 connector part), which can the functions can be set by the user, and 4 channels of fixed safety output (XCS5 connector part, teach/ fast check mode fixed output, teach speed monitor fixed output, override switch fixed output, emergency stop fixed output), which are used internally in the robot controller and the settings cannot be changed by the user.

[NOTE]

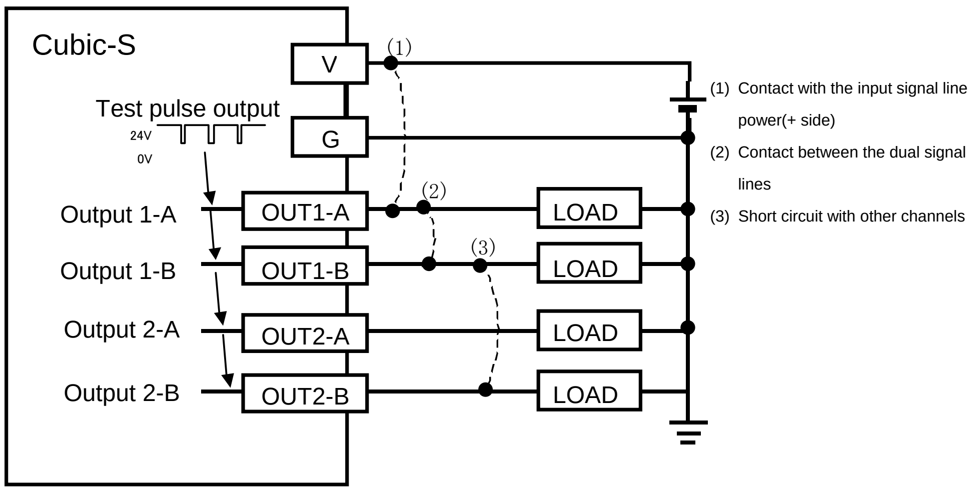
Cubic-S safety system is designed as dual safety input. It cannot be used in single safety input.

10.2.1 SAFETY OUTPUT SETTING

When use 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 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.

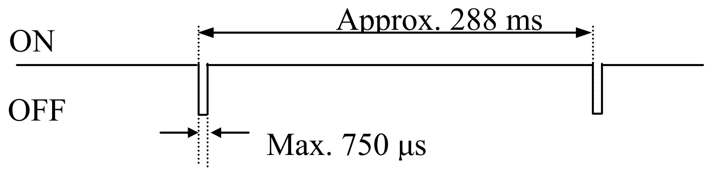
Also the fixed safety outputs are already set by default by the robot controller, and cannot be modified.

Cubic-S safety output 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 0V (GND) of the power that is used.**
2. **Short circuit between the input and GND line can be detected irrelevant of the safety input diagnosis 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.**



11.0 CUBIC-S SETTING AND CONFIRMATION BEFORE USE

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

1. System Design

↓

2. Connection and wiring

↓

3. Setting

↓

4. Confirmation before use

↓

5. Operation of the system

Refer to the below chart for the necessary information and reference chapters for each procedure in the flow.

No.	Step	Necessary information	Reference
1	System design	Standards	3.0
		Overview	5.0
		Specifications	6.0
2	Connection	Connection method	9.0
3	Setting	Setting method	11.1
4	Confirmation before use	Method of confirmation before operation	11.2

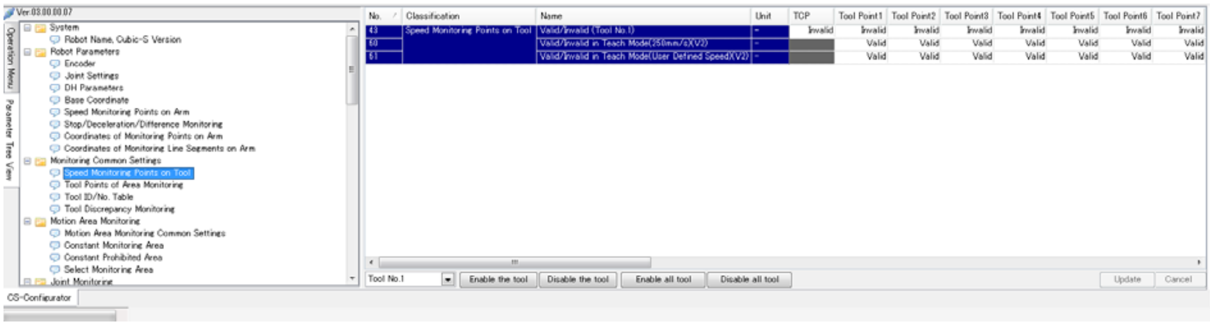
11.1 SETTING

This chapter describes the parameters, the setting methods and notes necessary for each function.

11.1.1 COMMON SETTINGS FOR MONITORING FUNCTIONS

This section describes the parameters necessary for the common setting for each function. Maximum of 32 tools can be defined in Cubic-S. However in AS software, 18 tools, tools number 1 to 18, are used.

1. Speed Monitoring Points on Tool



No.	Classification	Name	Unit	TCP	Tool Point1	Tool Point2	・・・・・・・	Tool Point20
43	Speed Monitoring	Valid/Invalid (Tool No.1)	-	Valid/ Invalid	Valid/ Invalid	Valid/ Invalid	・・・・・・・	Valid/ Invalid
60		Valid/Invalid at teach (250mm/s)	-	-	Valid/ Invalid	Valid/ Invalid	・・・・・・・	Valid/ Invalid
61		Valid/Invalid at teach (250mm/s)	-	-	Valid/ Invalid	Valid/ Invalid	・・・・・・・	Valid/ Invalid

Speed Monitoring Points on Tool Valid/Invalid
Valid/Invalid at teach (set speed)
Sets if the monitoring is enabled or disabled for speed monitoring function.
[Valid/ Invalid] is selected for each TCP (tool center point) and Tool Points 1 to 20. For Cubic-S version 2 and later, monitoring at teaching (at 250 mm/s and at set speed) can be set for each tool shape point when monitoring for tool shape points 1 to 20 are set to valid. (Parameters No. 60, 61)

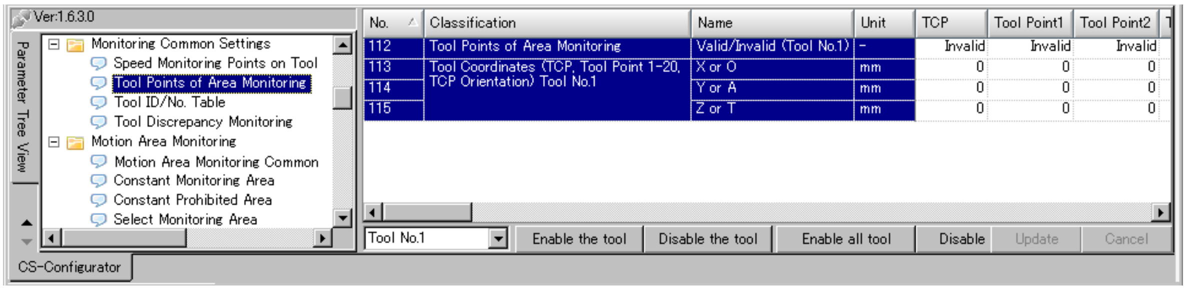
[Valid/ Invalid] can be set simultaneously for all selected tools using the [Enable all tools]/ [Disable all tools] buttons at the bottom of the screen. Select the desired tools or the tool shape points and press [Enable all tools]/ [Disable all tools]. The TCP of the selected tools or the selected tool shape points (1- 20) are enabled/ disabled all at once.

CAUTION

1. **Only the flange point is monitored for speed as default. Be careful that the tool shape points are not monitored without setting them.**
2. **When monitoring the speed at the tool shape points, error may be detected when operating in teach mode.**

2. Tool Points of Area Monitoring

Here, tools used in Cubic-S are set.



Up to 32 tools can be defined, and for each tool, up to 22 to points/ orientations, TCP (tool center point), Tool Points (tool shape points) 1 to 20, TCP2 (tool orientation), can be set. From the pull down menu shown in the bottom part of the above screen, select from tool numbers 1 to 32, and set the below parameters. The setting procedure for tool number 1 is explained below. Follow the same procedures to set tools 2 to 32.

No.	Classification	Name	Unit	TCP	Tool Point 1	Tool Point 2		Tool Point 20	TCP2
112	Tool Points of Area Monitoring	Valid/ Invalid (Tool No 1)	-	Valid/ Invalid	Valid/ Invalid	Valid/ Invalid		Valid/ Invalid	Valid/ Invalid
113	Tool Coordinates (TCP. Tool Point 1-20, TCP Orientation) Tool No.1	X or O	mm or deg	10000 to -10000	10000 to -10000	10000 to -10000		10000 to -10000	360 to -360
114		Y or A	mm or deg	10000 to -10000	10000 to -10000	10000 to -10000		10000 to -10000	360 to -360
115		Z or T	mm or deg	10000 to -10000	10000 to -10000	10000 to -10000		10000 to -10000	360 to -360

Tool Points of Area Monitoring Valid/Invalid

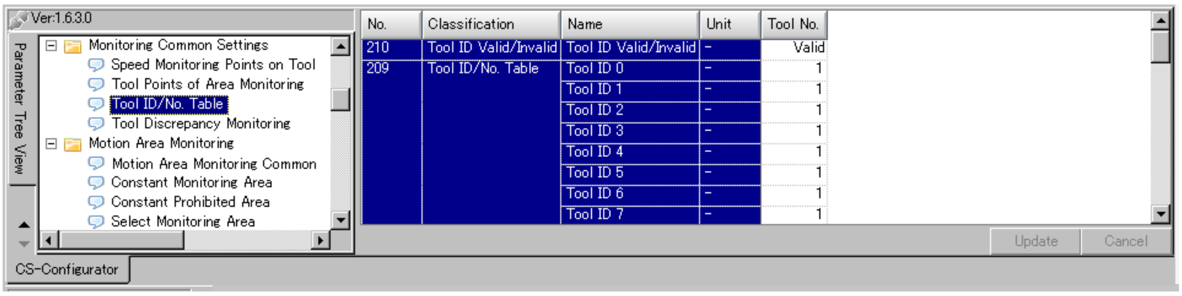
Sets if the area monitoring function is enabled (Valid) or disabled (Invalid) for TCP and Tool Point 1 to 20. TCP2 is used in tool orientation monitoring function, and the enable/ disable setting cannot be changed.

Tool Coordinates (TCP. Tool Point 1-20, TCP Orientation) Tool No, 1 X or O/ Y or A/ Z or T

For TCP (tool center point), and Tool Points (tool shape point) 1 to 20, the X/Y/Z values for the XYZ coordinates for each point are set. Unit is in [mm].
For TCP2 (tool orientation), set the O, A, T values for the three Euler's angles. Unit is in [deg].

However, if all XYZ values are 0, that tool is not enabled even if the tool is set to [Valid].

3. Tool ID/No. Table



No.	Classification	Name	Unit	Tool No.
210	Tool ID Valid/Invalid	Tool ID Valid/Invalid	-	Valid/Invalid
209	Tool ID/No. Table	Tool ID 0	-	1 to 32
		Tool ID 1	-	1 to 32
		Tool ID 31	-	1 to 32

Tool ID Valid/Invalid

Sets if the tool ID input signal input to XIN1connector can (Valid) or cannot (Invalid) be transformed to the tool number (current tool number) in Cubic-S. When this function is used, the values set in [Tool ID/No. Table] is used to transform the tool ID to the current tool number. When not used, the current tool number is fixed to 1 regardless of the tool ID.

Tool ID/No. Table

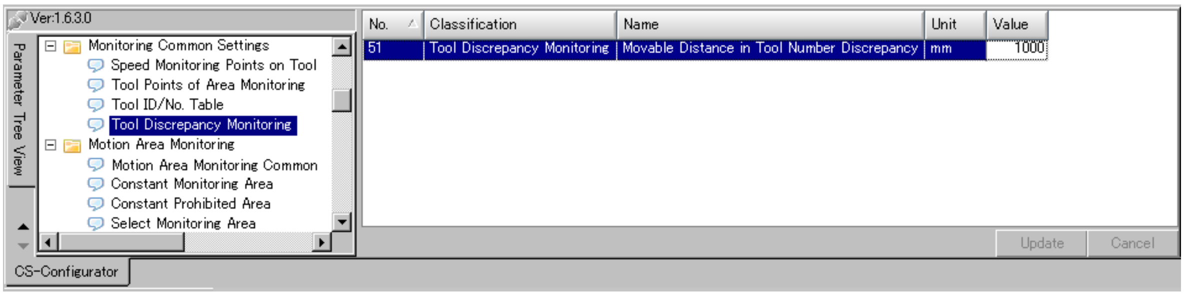
Sets the values to use when changing the tool ID input to XIN1 connector to the tool number (current tool number) used in Cubic-S.

Tool ID works as following:

The following 5 bit data is input to XIN1 connector as the tool ID: A12 (tool ID input 1), B12 (tool ID input 2), A13 (tool ID input 3), B13 (tool ID input 4), A14 (tool ID input 5) (See chapter 9 for details). The 5 bits with tool ID input 1 as the lowest bit and tool ID input 5 as the highest bit shows the tool ID 0 to 31.

This tool ID 0 to 31 is then changed to the current tool numbers 1 to 32 set as explained in "11.1.1 2. Tool Points of Area Monitoring".

4. Tool Discrepancy Monitoring



No.	Classification	Name	Unit	Value
51	Tool Discrepancy Monitoring	Movable Distance in Tool Number Discrepancy	mm	0 to 10000

<u>Movable Distance in Tool Number Discrepancy</u>

Sets the distance the robot is allowed to move with the tool number input to Cubic-S (current tool number) and the command tool number selected by the robot controller (AS software) mismatched. When the current tool number and the command tool number do not match;

Motion distance is less than the set distance: robot can move

Motion distance is more than the set distance: shuts OFF motor power to the robot right away

When the tool numbers do not match, the tool shape point for both current and command tools are monitored.

This setting is used when tool change is required. When the tool changes, the current tool number and the command tool number switches, so the allowable motion distance will be necessary. Set a distance where unnecessary error will not occur and safety is confirmed.

11.1.2 HOW TO SET TOOL NUMBER AND TOOL SHAPE VIA ROBOT CONTROLLER (AS SOFTWARE)

For how to set the tool number and tool shape via robot controller (AS software), please refer to 17.2 “How to Specify Tool Shape Point and number via AS Software”.

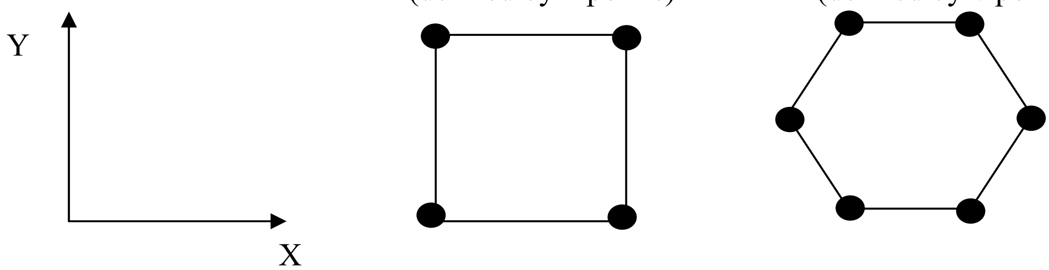
11.1.3 MOTION AREA MONITORING FUNCTION

This section explains about the parameters for motion area monitoring function.

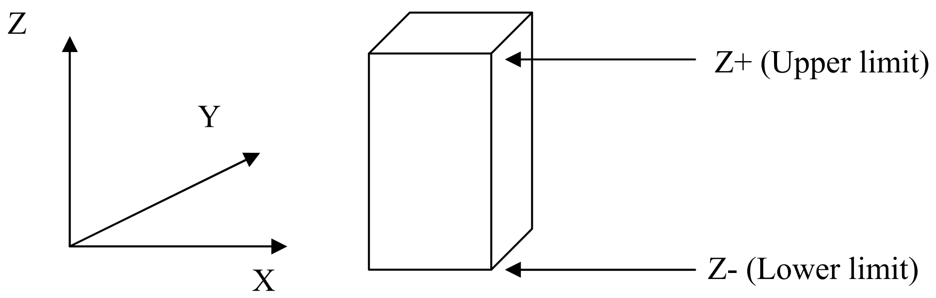
【How to define the monitoring areas】
Each monitoring area is defined by:
Polygon defining the top (base) surface of the area
Upper/ lower limits defining the height of the area.

(1) Polygon defining the top (base) surface of the area
Define in XY coordinates values, a polygon as shown below.

Ex. 1: tetragon (defined by 4 points) Ex. 2: hexagon (defined by 6 points)



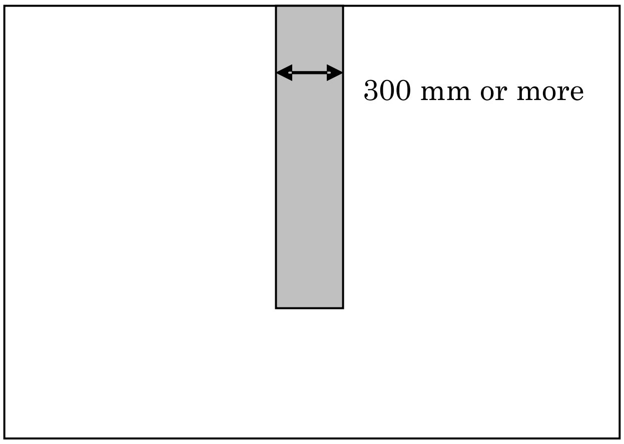
(2) Upper/ lower limits defining the height of the area.
Specify the upper and lower limits of the polygon.



«Notes for when defining the area»

WARNING

1. **The robot may exceed the monitored area and fall due to brake malfunction etc. Therefore, do not leave space beneath the monitored area where a person can enter.**
2. **The arm is monitored by monitoring if the points and line segments predefined on the arm do not exceed the monitored area. Arm without defined points and line segments and tools installed on the arm are not monitored and may exceed the monitored area, so be careful when setting the motion area.**
3. **When setting a monitored area in concave shape using prohibited area, set the width of the prohibited area greater than 300 mm.**



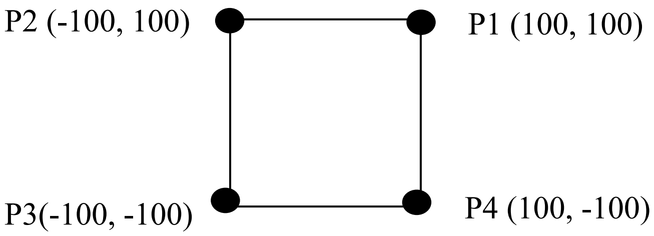
When defining the base polygon, take in consideration the following two points:

1. The points should be in counterclockwise order when seen from above the polygon
2. Area in convex shape cannot be set.

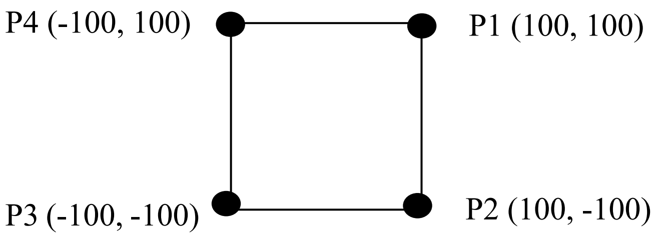
1. The points are set in counterclockwise order.

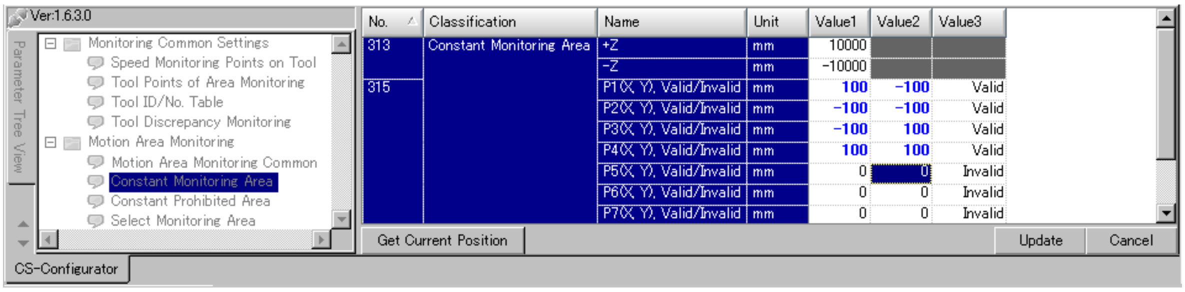
To define a square as shown below, set the X,Y coordinate values of points P1 (first point) to P4 (fourth point) so that the four points are in counterclockwise order. If entered in clockwise order, a message asking if the order can be changed appears.

Example of when the points are in counterclockwise order:
The below setting is correctly in counterclockwise order.

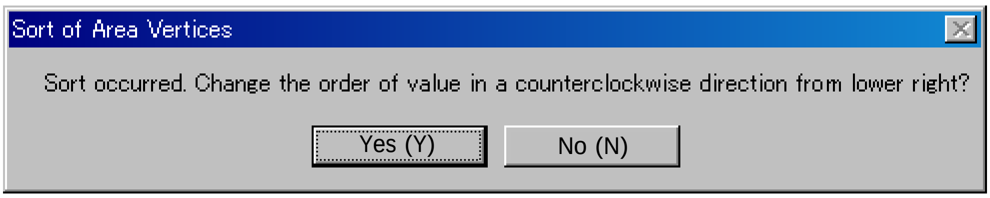


Example of when the points are in clockwise order:
When set in clockwise order, a message is displayed asking if the points can be reordered automatically.





Pressing <Update> after setting the points in clockwise order displays the dialogue box "Sort occurred. Change the order of value in a counterclockwise direction from lower right?"

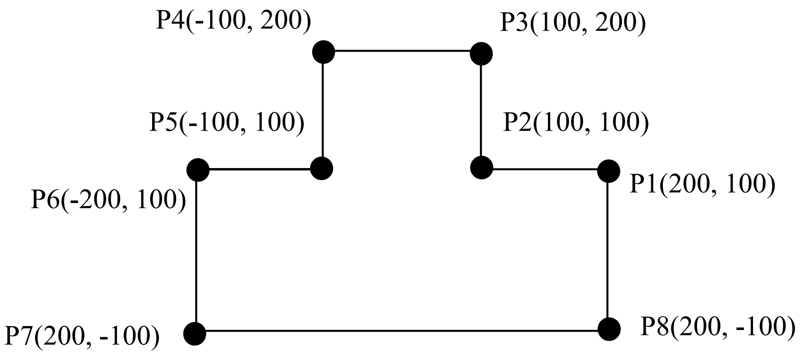


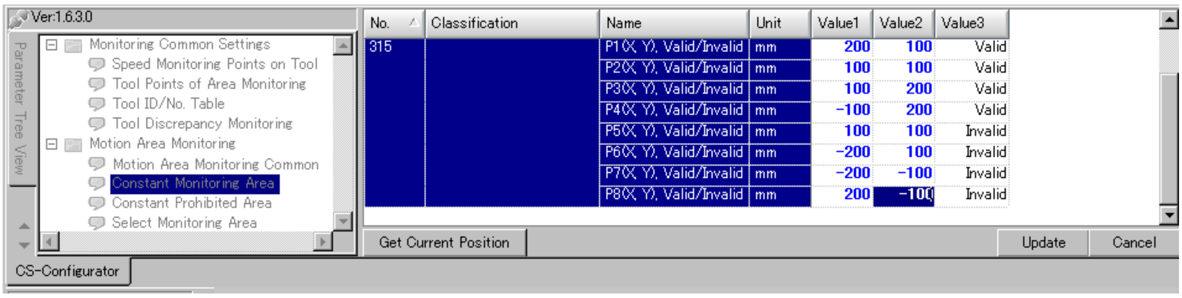
Selecting <Yes> automatically sorts the points in counterclockwise order.
To reorder the points manually, select <No> and return to the setting screen.

2. The area cannot be in convex shape.

Convex or concave shape cannot be set on its own. It can be set by combining monitoring area and prohibited area.

In the below example, monitoring area in a convex shape is set.

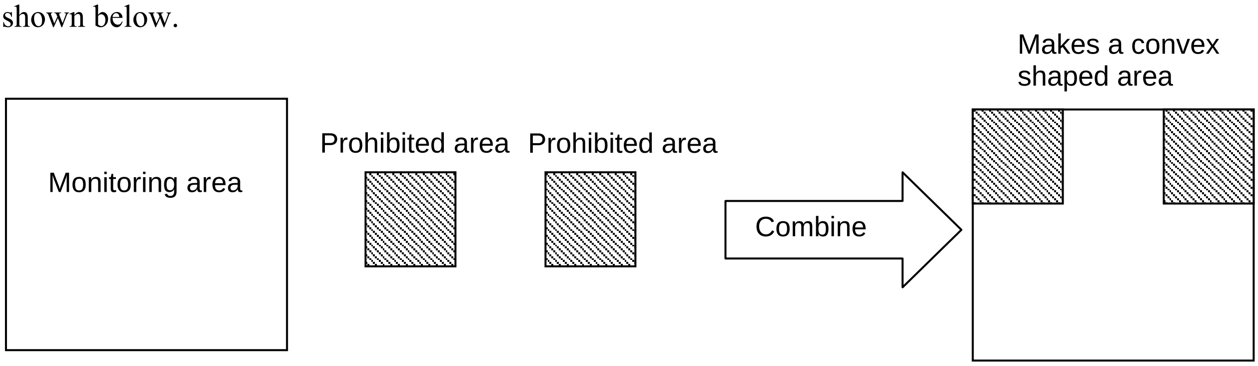




Pressing <Update> after setting the points in convex shape displays the dialogue box “Sort occurred. Change the order of value in a counterclockwise direction from lower right?”

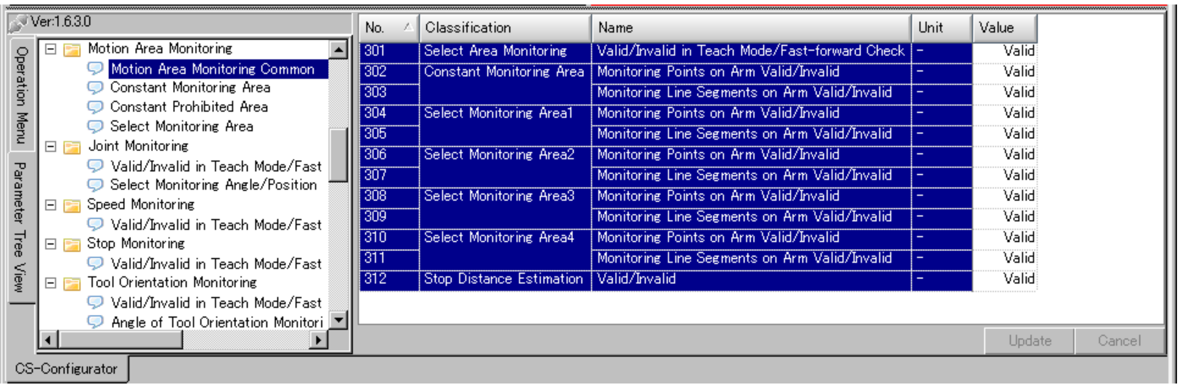
Selecting <Yes> automatically sorts the points so it is not in a convex shape.
To reorder the points manually, select <No> and return to the setting screen.

Monitoring areas in convex or concave shape can be set by combining various polygons as shown below.



1. Motion Area Monitoring Common

Common settings for motion area monitoring are done here.



No.	Classification	Name	Unit	Value
301	Select Area Monitoring	Valid/Invalid in Teach Mode/Fast-forward Check	-	Valid/Invalid
302	Constant Monitoring Area	Monitoring Points on Arm Valid/Invalid	-	Valid/Invalid
303		Monitoring Line Segments on Arm Valid/Invalid	-	Valid/Invalid
304	Select Monitoring Area1	Monitoring Points on Arm Valid/Invalid	-	Valid/Invalid
305		Monitoring Line Segments on Arm Valid/Invalid	-	Valid/Invalid
306	Select Monitoring Area2	Monitoring Points on Arm Valid/Invalid	-	Valid/Invalid
307		Monitoring Line Segments on Arm Valid/Invalid	-	Valid/Invalid
308	Select Monitoring Area3	Monitoring Points on Arm Valid/Invalid	-	Valid/Invalid
309		Validity of Monitoring Line Segments on Arm Valid/Invalid	-	Valid/Invalid
310	Select Monitoring Area 4	Monitoring Points on Arm Valid/Invalid	-	Valid/Invalid
311		Monitoring Line Segments on Arm Valid/Invalid	-	Valid/Invalid
312	Stop Distance Estimation	Valid/Invalid	-	Valid/Invalid

Select Area Monitoring / Valid/Invalid in Teach Mode/Fast-forward Check

Sets if select monitoring areas 1 to 4 are enabled (Valid) or disabled (Invalid) in Teach mode/ fast check mode.
When enabled, starts monitoring select monitoring area 1 to 4 when select monitoring area signals 1 to 4 are input, regardless of teach mode/ fast check/ repeat mode.
When disabled, does not monitor the select monitoring area 1 to 4 even when select monitoring area signals 1 to 4 are input, in teach mode/ fast check.
For example, when the robot needs to be moved freely while teaching, this function is disabled.

Constant Monitoring Area/ Monitoring Points on Arm Valid/Invalid
Constant Monitoring Area/ Monitoring Line Segments on Arm Valid/Invalid

Sets if the monitoring points and line segments on arm are used for monitoring constant monitoring area and constant prohibit area 1 to 8.
When enabled:
The robot power is shut OFF right away when the monitoring points and line segments on arm are within the constant monitoring area and outside of the constant prohibit area 1 to 8 (when applies).

When disabled:
The robot power is not shut OFF even when the monitoring points and line segments on arm are within the constant monitoring area and outside of the constant prohibit area 1 to 8 (when applies).

Select Monitoring Area 1 to 4/ Monitoring Points on Arm Valid/Invalid
Select Monitoring Area1 to 4/ Monitoring Line Segments on Arm Valid/Invalid

Sets whether the monitoring points on arm/ monitoring lines on arm is enabled or disabled when the selected monitoring area 1 to 4 is monitored.
When enabled:
The motor power to the robot is shut down right away when the monitoring points on arm / monitoring lines on arm is out of (when allowable area is set) or inside (when prohibited area is set) the selected monitoring area.

When disabled:
The motor power to the robot does not shut down even when the monitoring points on arm / monitoring lines on arm is out of (when allowable area is set) or inside (when prohibited area is set) the selected monitoring area.

<u>Stop Distance Estimation / Valid/Invalid</u>

When monitoring using constant monitoring areas and constant prohibited areas 1 to 8 or using select monitoring area, selects whether the stop distance estimation function is enabled (Valid) or disabled (Invalid).

When enabled:

Cubic-S estimates the distance the robot takes before it stops based on the current robot speed. When Cubic-S determines that the robot will be out of the movable area if it keeps on moving at that speed, the motor power to the robot is shut OFF right away.

Stop distance estimation function of the motion area monitoring function does not guarantee that the robot will not surpass the set motion range. The stop position may be out of the motion range if the robot fails or under certain motion conditions.

When disabled:

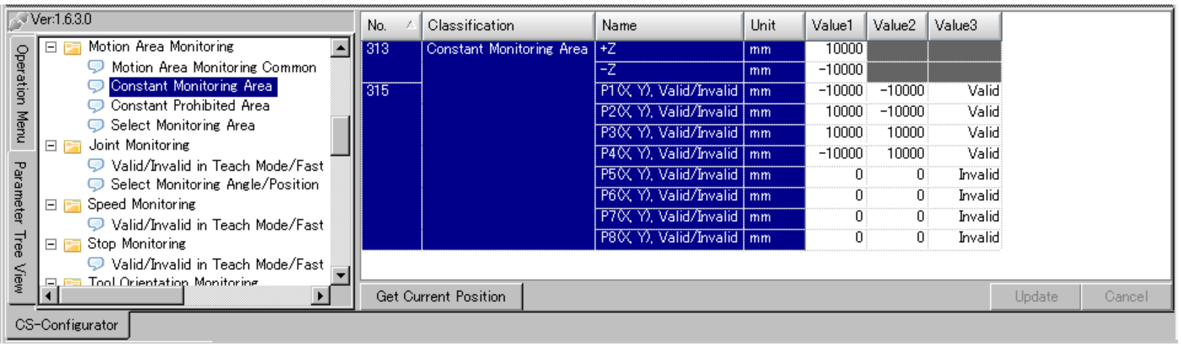
Cubic-S determines if the robot is in or out of the motion area using the current value, and when the robot is out of the motion area, the motor power to the robot is shut OFF right away.

When operating the robot in high speed, the motor power to the robot is shut OFF when the robot gets out of the motion area, so the distance the robot takes before the robot actually stops will be big.

2. Constant Monitoring Area

Constant monitoring area is set in this screen.

The constant monitoring area is expressed as a polygon defined by maximum of eight points seen from above the polygon and upper and lower limit in the direction of the height of the polygon.



No.	Classification	Name	Unit	Value1	Value2	Value3
313	Constant Monitoring Area	+Z	mm	-100000 to 100000	-	-
		-Z	mm	-100000 to 100000	-	-
315		P1(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P2(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P3(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P4(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P5(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P6(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P7(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid
		P8(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/Invalid

Constant Monitoring Area/ +Z/-Z

Sets the upper and lower limits in the vertical direction of the constant monitoring area.
+Z: Upper limit –Z: Lower limit

Constant Monitoring Area/ P1-P8(X, Y), Valid/Invalid

Value1/Value2

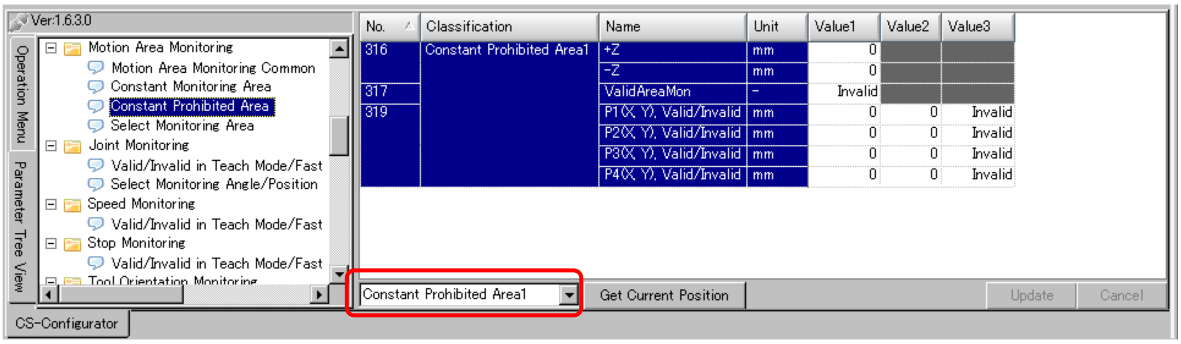
Defines the polygon for constant monitoring area with maximum of 8 points in XY coordinate values.

Value3

Sets if the point is used (Valid) or not used (Invalid) as a point on the polygon defining the constant monitoring area.

3. Constant Prohibited Area

Sets the constant prohibited area. The constant prohibited area is defined by maximum of four point of the polygon, seen from above the polygon and by upper and lower limit in the direction of the height of the polygon.



Maximum of eight prohibited areas can be defined. Select from constant prohibited area 1 to 8 from the pull down menu in the lower part of the setting screen, as shown in the figure above, and then set the values for the below parameters.

No.	Classification	Name	Unit	Value1	Value2	Value3
316	Constant Prohibited Area1	+Z	mm	-100000 to 100000	-	-
		-Z	mm	-100000 to 100000	-	-
317		ValidArea Mon	-	Valid/ Invalid	-	-
319		P1(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P2(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P3(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P4(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid

<u>Constant Prohibited Area1/ +Z/-Z</u>

Sets the upper and lower limit in the vertical direction of the constant prohibited area.
+Z: Upper limit –Z : Lower limit
Selecting Value1 or Value2 and then pressing <Get Current Position> at the bottom of the screen downloads the current pose data into the list.
(<Get Current Position> button can be used in the same way for all other monitoring area.)

<u>Constant Prohibited Area1/ ValidAreaMon</u>

Sets if the constant prohibited area is used (Valid) or not used (Invalid).

<u>Constant Prohibited Area1/ P1-P4(X,Y), Valid/Invalid</u>

Value1/Value2

Defines the polygon for constant prohibited area with maximum of four points in XY coordinate values.

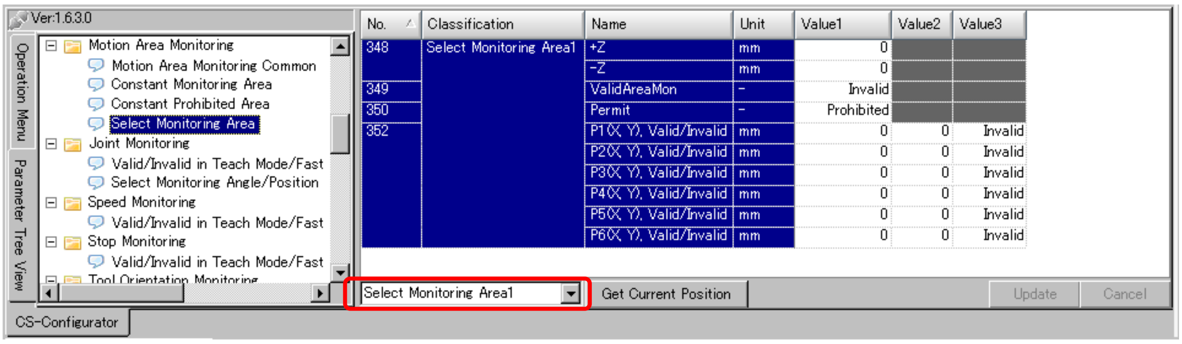
Selecting Value1 or Value2 and then pressing <Get Current Position> at the bottom of the screen downloads the current pose data into the list.

Value3

Sets if the point is used (Valid) or not used (Invalid) as a point on the polygon defining the constant prohibited area.

4. Select Monitoring Area

Sets the select monitoring area.



The select monitoring area is defined by a polygon with maximum of six points when seen from above the polygon, and by the upper and lower limit in the direction of the height of the polygon.

Maximum of four select monitoring areas can be used. Select from constant prohibited area 1 to 8 from the pull down menu in the lower part of the setting screen, as shown in the figure above, and then set the values for the below parameters.

No.	Classification	Name	Unit	Value1	Value2	Value3
348	Select Monitoring Area1	+Z	mm	-100000 to 100000	-	-
		-Z	mm	-100000 to 100000	-	-
349		ValidArea Mon	-	Valid/ Invalid	-	-
350		Permit	-	Permitted/Prohibited	-	-

352		P1(X,Y), Valid/ Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P2(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P3(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P4(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P5(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid
		P6(X,Y), Valid/Invalid	mm	-100000 to 100000	-100000 to 100000	Valid/ Invalid

Select Monitoring Area1/ +Z/-Z

Sets the upper and lower limit in the direction of the height of the select monitoring area.
+Z: Upper limit –Z: Lower limit

Select Monitoring Area1/ ValidAreaMon

Sets if the select monitoring area is used (Valid) or not used (Invalid).

Select Monitoring Area1/ Permitted/Prohibited

Sets the area to monitoring (permitted) area or prohibited area.

Select Monitoring Area1/ P1-P6 (X,Y), Valid/Invalid

Value1/Value2

Defines the polygon for select monitoring area with maximum of six points in XY coordinate values.

Value3

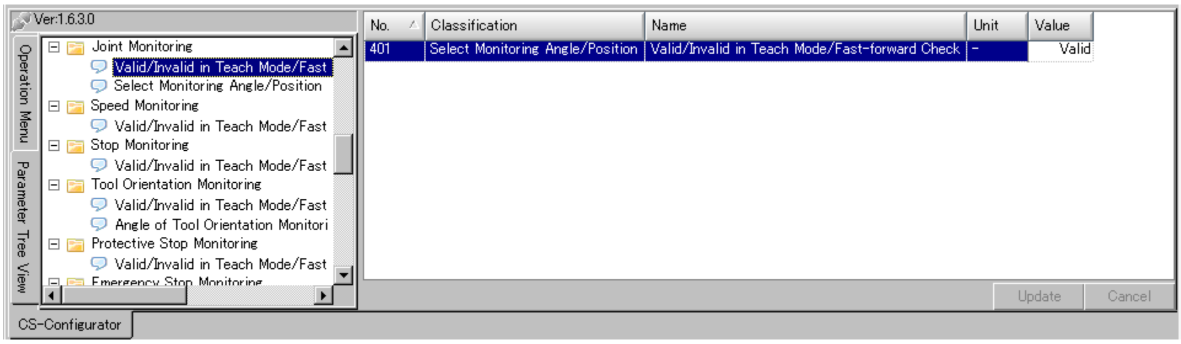
Sets if the point is used (Valid) or not used (Invalid) as a point on the polygon defining the select monitoring area.

11.1.4 JOINT MONITORING FUNCTION

For joint monitoring function, set the values for the following parameters.

1. Valid/Invalid in Teach Mode/Fast-forward Check

This screen sets whether the select joint monitoring function is used or not used in teach mode.



No.	Classification	Name	Unit	Value
401	Select Monitoring Angle/Position	Valid/Invalid in Teach Mode/Fast-forward Check	-	Valid/ Invalid

<u>Select Monitoring Angle/ Position</u>

<u>Valid/Invalid in Teach Mode/Fast-forward Check</u>

Sets if the select monitoring angle/ position 1 to 8 is used (Valid) or not used (Invalid) in teach/ fast check mode.

When used:

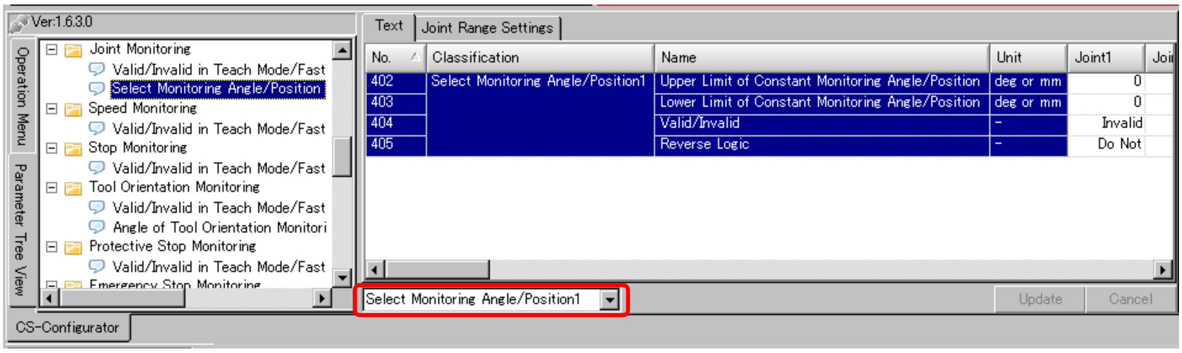
Monitors select monitoring angle/ position 1 to 8 when select monitoring angle/ position monitoring signal 1 to 8 is input in teach/ fast check/ repeat mode.

When not used:

Does not monitors select monitoring angle/ position 1 to 8 even when select monitoring angle/ position monitoring signal 1 to 8 is input in teach and fast check mode. This is selected, for example, when the robot needs to be moved freely during teaching.

2. Select monitoring angle/Position

Sets the values necessary for select monitoring angle/ position.



Maximum of eight select monitoring angle/ position can be used.

Select one out of Select Monitoring Angle/Position 1 to 4 from the pull down menu at the bottom of the screen and set the values for the following parameters. Below explains the setting procedures for Select Monitoring Angle/Position 1. Repeat the same procedures for Select Monitoring Angle/Position 2 to 8.

No.	Classification	Name	Unit	Joint1	Joint2		Joint9
402	Select Monitoring Angle/ Position1	Upper Limit of Constant Monitoring Angle/ Position	deg or mm	-100000 to 100000	-100000 to 100000		-100000 to 100000
403		Lower Limit of Constant Monitoring Angle/ Position	deg or mm	-100000 to 100000	-100000 to 100000		-100000 to 100000
404		Valid/ Invalid	-	Valid/ Invalid	Valid/ Invalid		Valid/ Invalid
405		Reverse Logic	-	Do/ Do Not	Do/ Do Not		Do/ Do Not

Select Monitoring Angle/ Position1

Sets the upper limit value of angle/ position for JT1 to JT9.

Select Monitoring Angle/ Position1Lower

Sets the lower limit value of angle/ position for JT1 to JT9.

Valid/Invalid

Selects whether the angle/ position is monitored (Valid) or not (Invalid) for that axis. Select validity/ invalidity for each of JT1 to JT9.

Reverse Logic

Select [Do] when the logic is reversed, [Do Not] when it is not reversed.

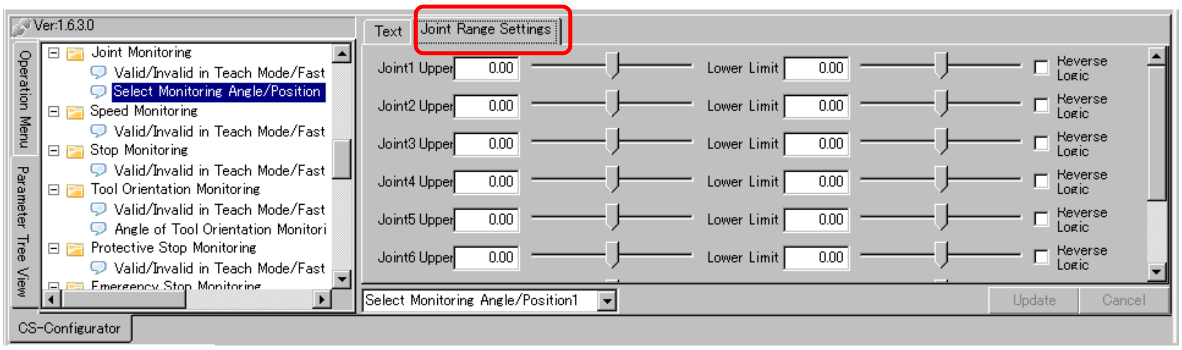
When logic is not reversed:

When the monitored axis (Valid selected) moves within the area between the Upper Limit of Constant Monitoring Angle/Position and Lower Limit of Constant Monitoring Angle/Position, Cubic-S does not do anything, but when the axis gets out of this area, the motor power to the robot is shut OFF immediately.

When logic is reversed:

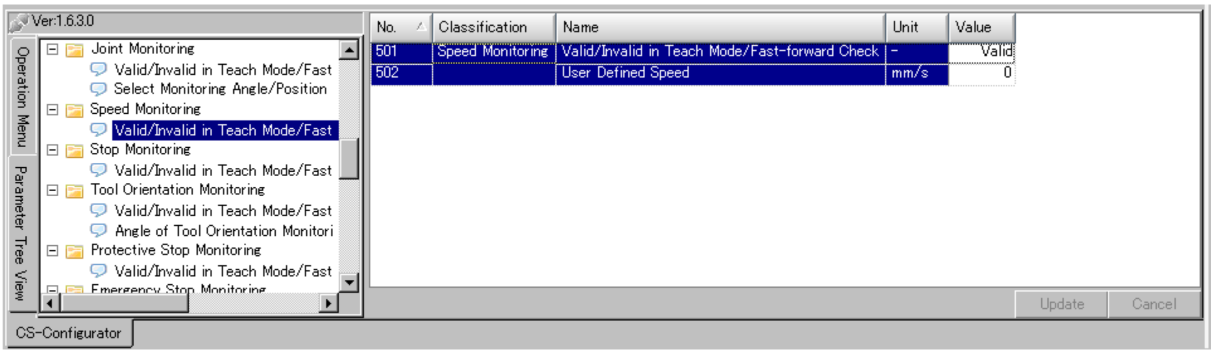
When the monitored axis (Valid selected) moves out of the area between the Upper Limit of Constant Monitoring Angle/Position and Lower Limit of Constant Monitoring Angle/Position, Cubic-S does not do anything, but when the axis gets inside this area, the motor power to the robot is shut OFF immediately.

Selecting [Joint Range Settings] tab allows setting of upper and lower limit using the cursor. The cursor for the upper limit cannot be moved to a value lower than the lower limit setting or the lower limit cannot be set to a value greater than the upper limit value.



11.1.5 SPEED MONITORING FUNCTION

For speed monitoring function, set the values for the following parameters.



No.	Name	Unit	Value
501	Valid/Invalid in Teach Mode/Fast-forward Check	-	Valid/ Invalid
502	User Defined Speed	mm/s	0 to 10000

<u>Valid/Invalid in Teach Mode/Fast-forward Check</u>

Sets if the speed monitoring function is used (Valid) or not used (Invalid) in teach/ fast check mode.

When used:

Monitors for the user defined speed when set speed monitoring signal is input in teach/ fast check/ repeat mode.

When not used:

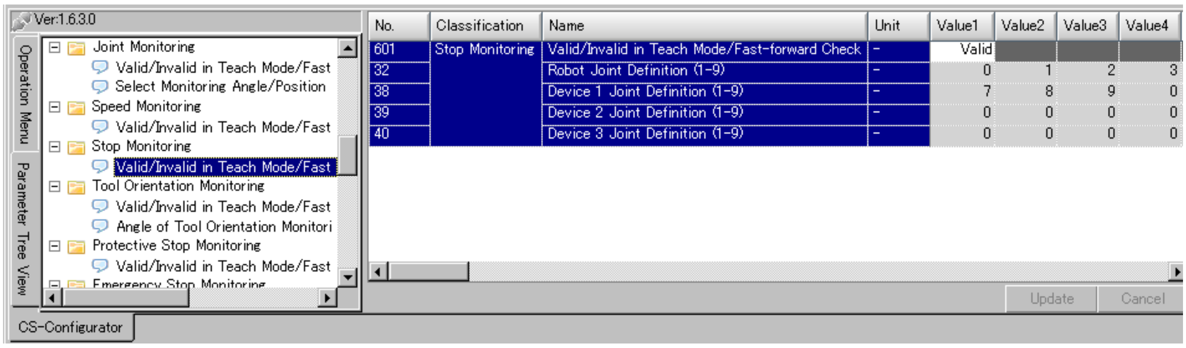
Does not monitor for the user defined speed even when set speed monitoring signal is input in teach and fast check mode. This is selected, for example, when the robot needs to be moved freely during teaching when the user defined speed is set lower than 250 mm/s. The default setting is [Valid].

<u>User Defined Speed</u>

Sets the allowable speed for when monitoring the set speed. If the robot is moving slower than the user defined speed when set speed monitoring is input, Cubic-S does not do anything, but when the robot’s speed exceed the user defined speed, the motor power to the robot is shut OFF immediately.

11.1.6 STOP MONITORING FUNCTION

For stop monitoring function, set the values for the following parameters.



<u>**Valid/Invalid inTeach Mode/Fast-forward Check**</u>

Sets if the Stop monitoring function is used (Valid) or not used (Invalid) in teach/ fast check mode.

When used, the robot stop or device stop 1 to 3 is monitored when the Robot Stop Monitoring or Device Stop Monitoring 1 to 3 is input, in repeat mode or teach/ fast check mode.

When not used, in teach/ fast check mode, robot stop or device stop 1 to 3 is not monitored even when robot stop or device stop 1 to 3 is input.　This is selected, for example, when the robot needs to be moved freely during teaching regardless of robot stop monitoring or device stop monitoring 1 to 3.

[NOTE]

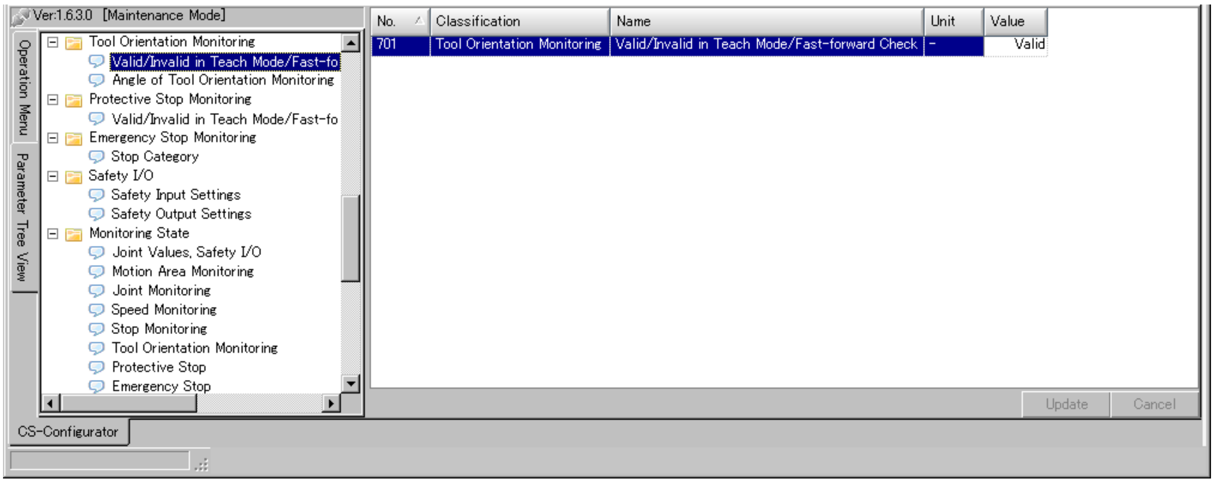
In Stop Monitoring function, it is considered that the robot moved when the axis moves more than 0.1deg for rotational axis (axis value shown in deg) or more than 0.5 mm for linear axis (axis value shown in mm).

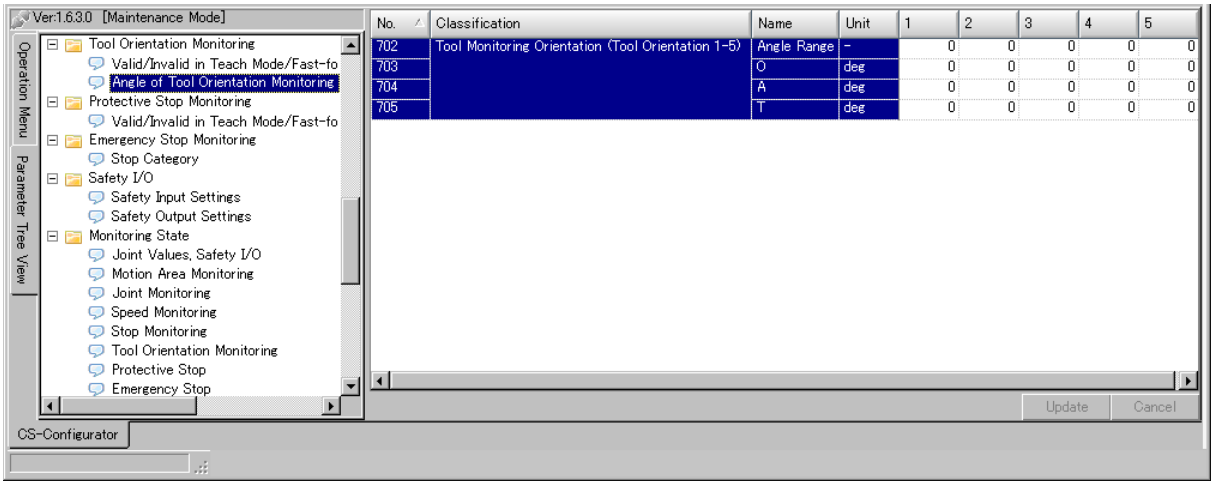
<u>**Device 1 – 3 Joint Definition**</u>

Displays the joint number allocated to devices 1 to 9. This cannot be set here.　Set by CBS_SETDEVICE command.

11.1.7 TOOL ORIENTATION MONITORING FUNCTION

For tool orientation monitoring function, set the values for the following parameters.





No.	Name	Unit	Value
701	Valid/Invalid in Teach Mode/Fast-forward Check	-	Valid/ Invalid
702	Angle Range	-	0 to 180
703	O	deg	-180 to 180
704	A	deg	-180 to 180
705	T	deg	-180 to 180

Valid/Invalid in Teach Mode/Fast-forward Check
Sets if the tool orientation monitoring function is used (Valid) or not used (Invalid) in teach/

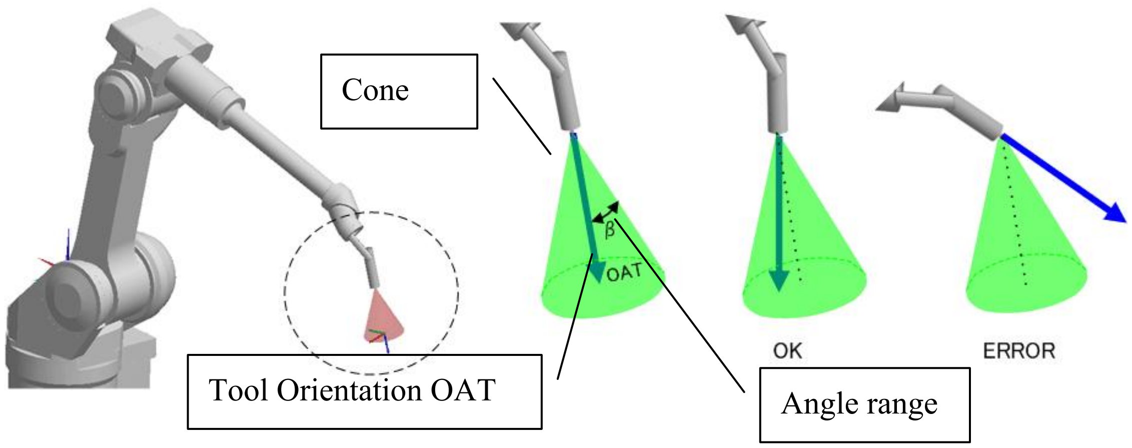
fast check mode.
When used, the tool orientation is monitored when the Tool Orientation Monitoring is input, in repeat mode or teach/ fast check mode.
When not used, in teach/ fast check mode, tool orientation is not monitored even when Tool Orientation Monitoring is input.
Set this parameter value to Invalid for example when the robot posture needs to be moved freely during teaching.

Angle Range

Sets in degrees the allowable range of tool orientation when monitoring the tool orientation. When tool orientation monitoring signal is input, if the robot's tool orientation stays within the set angle range, Cubic-S does not do anything, but when it gets out of the set range, the motor power to the robot is shut OFF immediately.

OAT

Sets the base tool orientation for tool orientation monitoring. To find the OAT values for the base orientation, move the tool to the desired orientation and execute monitor command WHERE 7 (shows the current pose information including the external axis). Input the OAT values displayed by that command.



[NOTE]

Up to 5 signals can be used for tool orientation monitoring. For each, the cone for angle range and tool orientation OAT can be set.

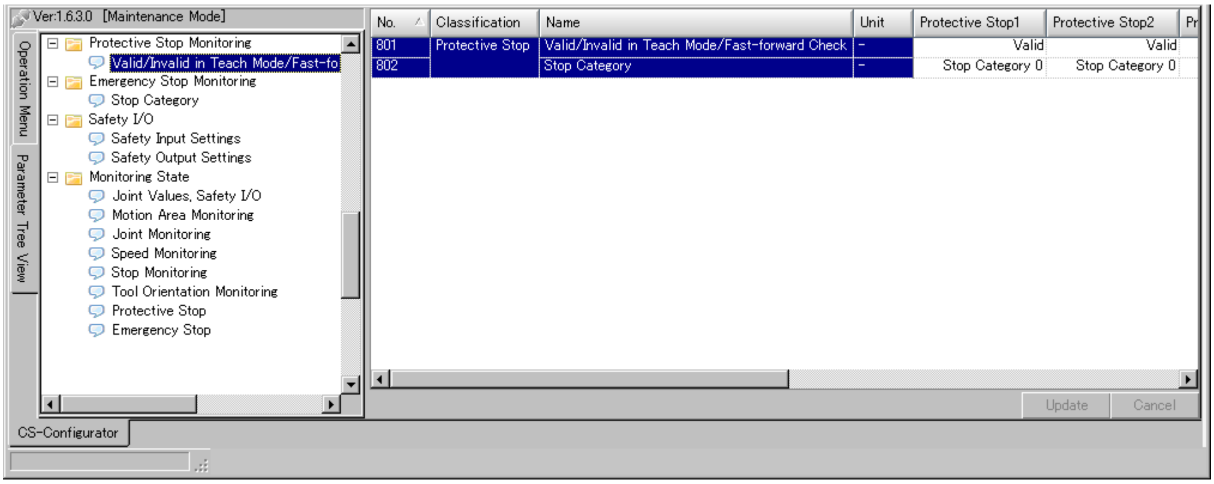
[NOTE]

When more than one tool orientation monitoring is enabled,

1. if the tool orientation monitoring signal is assigned to the same user defined safety input, monitors if the tool orientation is within one of the set angle ranges (OR)
2. if the tool orientation monitoring signal is assigned to separate user defined safety inputs, monitors if the tool orientation is within the overlapped area of the cone (AND).

11.1.8 PROTECTIVE STOP FUNCTION

For protective stop* function, set the values for the following parameters.



No.	Name	Unit	Value
801	Valid/Invalid in Teach Mode/Fast-forward Check	-	Valid/ Invalid
802	Stop Category	-	Stop Category 0/1/2

Valid/Invalid in Teach Mode/Fast-forward Check

Sets if the protective stop function is used (Valid) or not used (Invalid) in teach/ fast check mode.
When used, the robot stops in the method of the selected stop category when the Protective Stop is input, even when in teach/ fast check mode.
For example, set this parameter value to Invalid and assign the open/close status of the safety fence as the Protective Stop input, then you can set as “the motor power to robot is shut OFF when the safety fence open in repeat mode but not in teach/ fast check mode”.

Stop Category

Sets whether the motor power to the robot is shut OFF immediately or shut OFF after deceleration when emergency stop is input.

Stop Category 0

The motor power to the robot is shut OFF right after the Protective Stop is input.

Stop Category 1

When the protective stop is input, the motor power to the robot is shut OFF after the robot decelerates and stops. While the robot decelerating, the speed is monitored for a certain time and if the speed is not decreasing properly, the motor power to the robot is shut OFF.

This is set when large sized robot or robot holding a heavy workpiece is used and when it is better to stop the robot gradually.

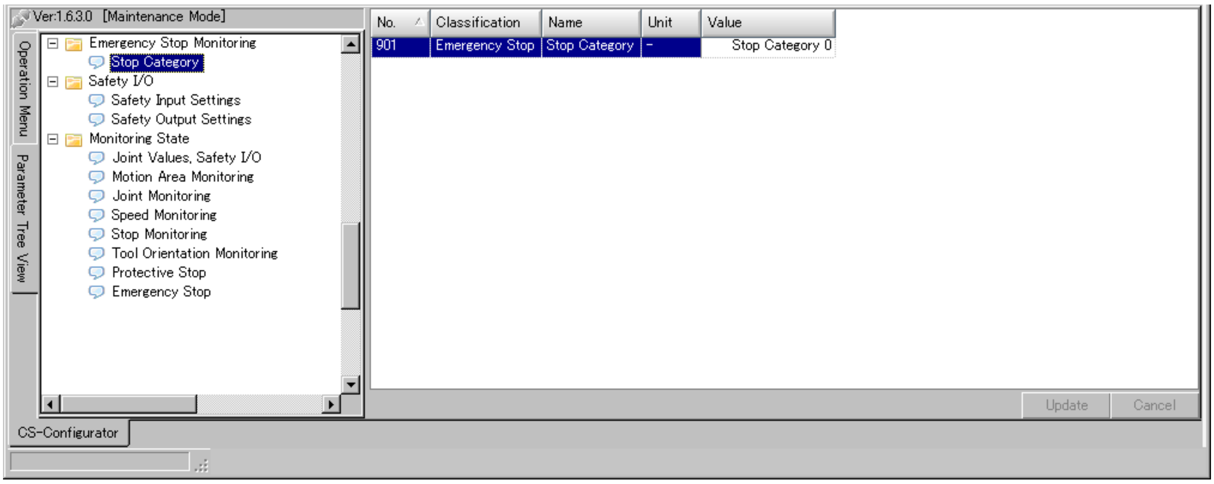
Stop Category2

When the protective stop is input, the robot reduces the speed and stops, and then starts stop monitoring. When the robot is decelerating, the deceleration is monitored for a certain time and if the robot does not reduce the speed normally, the motor power to the robot is shut OFF immediately. The robot resumes operation when protective stop is released.

NOTE* Up to 4 systems can be used for Protective Stop, and each can be set toValid/Invalid in Teach Mode/Fast-forward Check and Stop Category.

11.1.9 EMERGENCY STOP FUNCTION

For emergency stop function, set the values for the following parameter.



No.	Name	Unit	Value
901	Stop Category	-	Stop Category 0/1

Stop Category

Sets whether the motor power to the robot is shut OFF immediately or shut OFF after deceleration when emergency stop is input.

Stop Category 0

The motor power to the robot is shut OFF right after the emergency stop is input.

Stop Category 1

When the emergency stop is input, the motor power to the robot is shut OFF after the robot decelerates and stops. While the robot decelerating, the speed is monitored for a certain time and if the speed is not decreasing properly, the motor power to the robot is shut OFF.

This is set when large sized robot or robot holding a heavy workpiece is used and when it is better to stop the robot gradually.

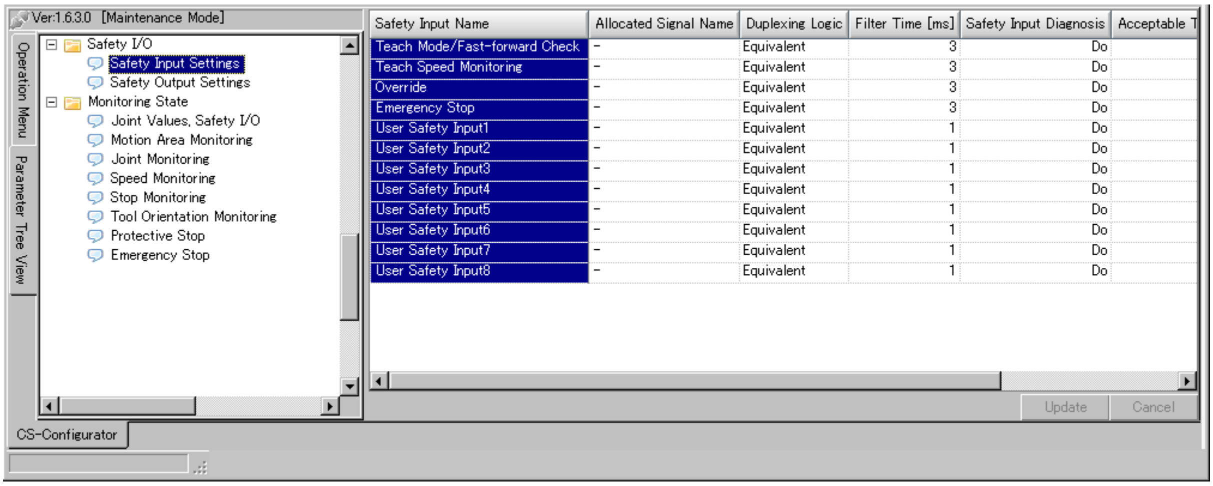
[NOTE]

The above setting for emergency stop function will be reflected to all emergency stop inputs to Cubic-S including emergency stop via teach pendant and controller.

11.1.10 SAFETY I/O

11.1.10.1 SAFETY INPUT SETTINGS

For safety input, set the values for the following parameters.



The following parameter values can be set for each port (Teach Mode/Fast-forward Check, Teach Speed Monitoring, Override, Emergency Stop, User Safety Input 1 to 8).

Name	Value	Unit
Allocated Signal Name	Select signal name from the list	-
Duplexing Logic	Complementary/Equivalent	-
Filter Time [ms]	1 to 127	ms
Safety Input Diagnosis	Do/ Do not	-
Acceptable Time of Discrepancy [ms]	0 to 30000	ms

Port

[Teach Mode/Fast-forward Check]

Inputs the signal that shows the status of teach/ fast check mode.
Signal cannot be assigned by the user to this port.

[Teach Speed Monitoring]

This signal is input when in teach mode, not including fast check mode, i.e. the robot moves in speed lower than 250 mm/s.
Signal cannot be assigned by the user to this port.

[Override]

Switch information to temporarily disable the monitoring function is input. This is used for

when returning the robot inside the monitoring area in area monitoring function.
Signal cannot be assigned by the user to this port.

[Emergency Stop]

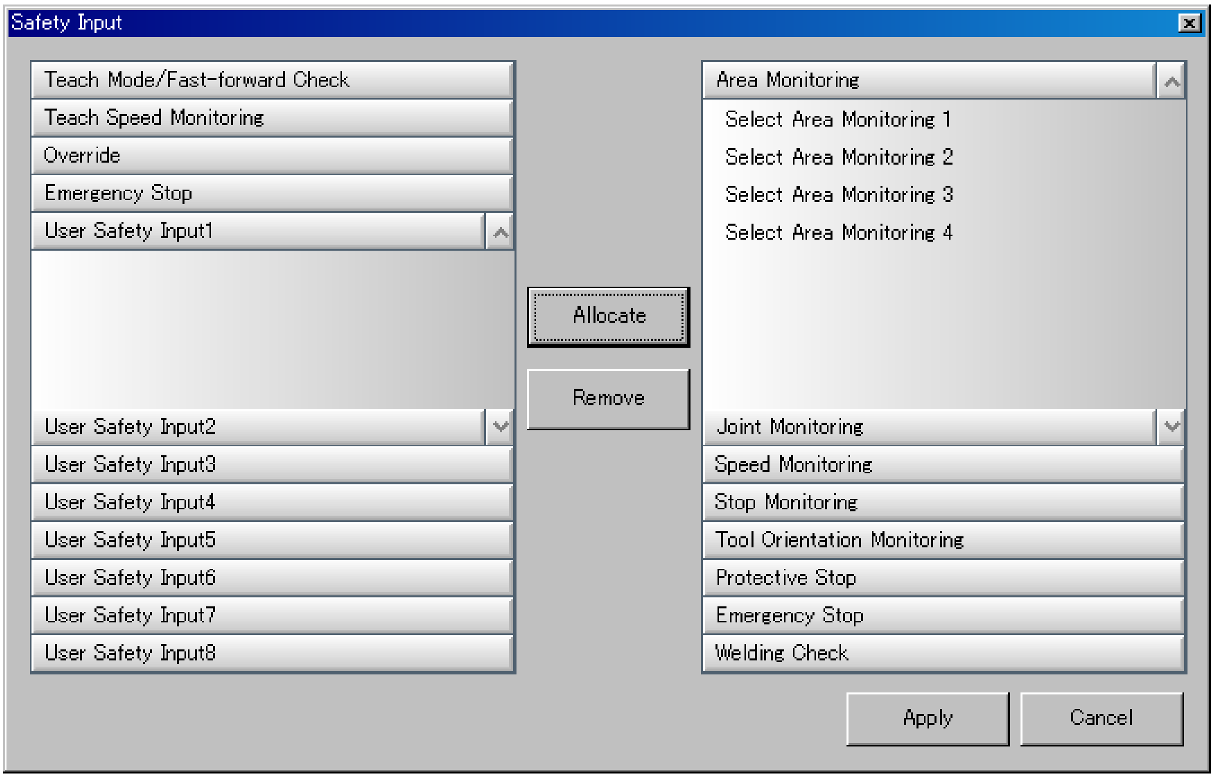
Inputs the status of the emergency stop switch on teach pendant and the controller.
Signal cannot be assigned by the user to this port.

[User Safety Input 1 - 8]

Safety input signals can be assigned to these ports.
To input the selected signal, the signal needs to be wired. See 9.0 for details on wiring.

[NOTE]

Depending on the robot or controller used, the user safety output is used by the system, and cannot be assigned by the user. In this case, the parameter value setting will not be allowed.



<u>Allocated Signal Name</u>

Allocates the signal shown in the list to each port. More than one signal can be allocated to a port.
Select the port number from the list on the left and select the signal to allocate to the selected port from the list on the right. Press the [Apply] button and the allocated signal is displayed on the left column. To cancel the signal, select the signal to cancel from the list on the left ad

press [Cancel].

No.	Signal name		Explanation
1	Area Monitoring*	Select Area Monitoring 1	Monitors if the robot is in/ out of the select monitoring area 1 to 4. OFF : Monitor ON : Do not monitor
2		Select Area Monitoring 2	
3		Select Area Monitoring 3	
4		Select Area Monitoring 4	
5	Joint Monitoring**	Select angle/ position monitoring 1	Monitors if the robot is in/ out of the select angle/ position monitoring 1 to 8 OFF : Monitor ON : Do not monitor
6		Select angle/ position monitoring 2	
7		Select angle/ position monitoring 3	
8		Select angle/ position monitoring 4	
9		Select angle/ position monitoring 5	
10		Select angle/ position monitoring 6	
11		Select angle/ position monitoring 7	
12		Select angle/ position monitoring 8	
13	Speed Monitoring	250mm/s spec monitoring	Monitors if the robot is moving under 250mm/s. OFF : Monitor , ON : Do not monitor
14		User speed monitoring	Monitors if the robot is moving under set speed. OFF : Monitor , ON : Do not monitor
15	Stop Monitoring	Robot Stop monitoring	Monitors if the robot is stopped. OFF : Monitor , ON : Do not monitor
16		Device Stop monitoring 1	Monitors if device 1 to 3 is stopped. OFF : Monitor , ON : Do not monitor
17		Device Stop monitoring 2	
18		Device Stop monitoring 3	
19	Tool Orientation Monitoring***	Tool orientation Monitoring 1	Monitors if the robot is within the come defined as tool orientation monitoring 1 to 5. OFF : Monitor , ON : Do not monitor
20		Tool orientation Monitoring 2	
21		Tool orientation Monitoring 3	
22		Tool orientation Monitoring 4	
23		Tool orientation Monitoring 5	

24	Protective Stop	Protective Stop 1	Input to Protective Stop 1 to 4 OFF : Protective Stop, ON : Protective Stop canceled
25		Protective Stop 2	
26		Protective Stop 3	
27		Protective Stop 4	
28		Protective Stop Valid 1	Inputs if Protective Stop 1 to 4 is enabled or disabled When disabled, input of Protective Stop 1 to 4 will not function as Protective Stop in the Protective Stop side. OFF : Protective Stop enabled , ON : Protective Stop disabled When no signal is assigned, functions as Protective Stop enabled.
29		Protective Stop Valid 2	
30		Protective Stop Valid 3	
31		Protective Stop Valid 4	
32	Emergency Stop	Ext. Emergency Stop 1	Input to Ext. Emergency Stop 1 to 4 OFF : Emergency Stop, ON : Emergency Stop Canceled
33		Ext. Emergency Stop 2	
34		Ext. Emergency Stop 3	
35		Ext. Emergency Stop 4	
36	Weld check	Teach mode output weld check	Input for checking weld of forced guide relay connected with user defined safety output (connection with B contact). See also 10.1.3.
37		Teach speed monitoring weld check	
38		Override output weld check	
39		E-stop output weld check	
40		User defined safety output 1 Weld Check	
41		User defined safety output 2 Weld Check	
42		User defined safety output 3 Weld Check	
43		User defined safety output 4 Weld Check	
44		User defined safety output 5 Weld Check	
45		User defined safety output 6 Weld Check	
46		User defined safety output 7 Weld Check	
47		User defined safety output 8 Weld Check	

NOTE* When more than one area monitoring is enabled (same signal being allocated or different signals being allocated), only the AND area of the enabled monitoring areas become the area the robot can move.

NOTE** When more than one angle/ position monitoring is enabled (same signal being allocated or different signals being allocated)、only the AND range of the enabled monitoring angle/ position become the angle/ position the robot can move.

NOTE*** When more than one tool orientation monitoring is enabled, the OR area of the monitored cones become the motion area when the same signal is allocated. When different signals or allocated, the AND area of the cone becomes the motion area.

Duplexing Logic

Sets the ON/ OFF status of the dual channel input signal.

[Complementary]

CH A: ON CH B: OFF → ON
CH A: OFF CH B: ON → OFF
CH A: ON CH B: ON → OFF (abnormal)
CH A: OFF CH B: OFF → OFF (abnormal)

[Equivalent]

CH A: ON CH B: ON → ON
CH A: OFF CH B: OFF → OFF
CH A: ON CH B: OFF → OFF (abnormal)
CH A: OFF CH B: ON → OFF (abnormal)

Filter Time [ms]

Sets the filter value for the input signal in units of ms.

Safety Input Diagnosis

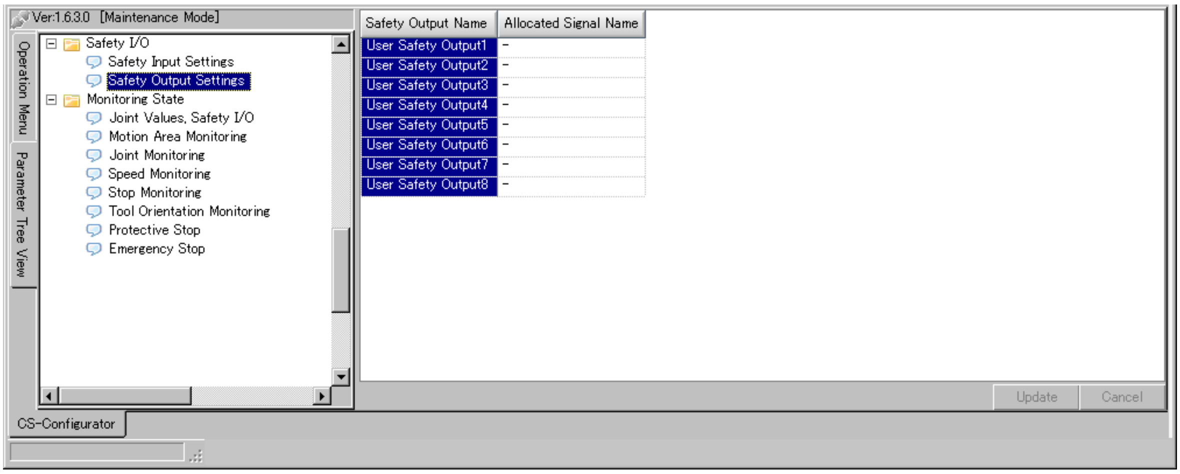
Sets whether to check or not if the safety input part fails by inputting a test pulse signal that turns OFF periodically to user defined safety input signals. Set this to disable (Do not) when connecting to safety PLC that conducts self diagnosis of the output signal.

Acceptable Time of Discrepancy

Sets the time to wait until error is given after the signal status of the dual channel signal input is mismatched. Unit is ms.

11.1.10.2 SAFETY OUTPUT SETTINGS

For safety output, set the values for the following parameters.



The following parameter value setting is made for each port (User Safety Output 1 to 8).

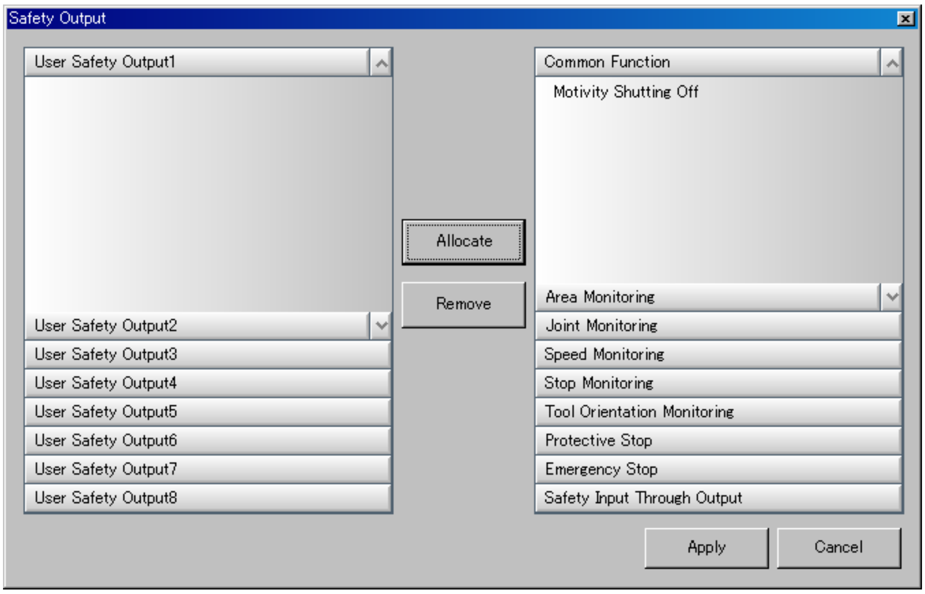
Name	Value	Unit
Allocated Signal Name	Select signal name from the list	-

[NOTE]

Depending on the robot or controller used, the user safety output is used by the system, and cannot be assigned by the user. In this case, the parameter value setting will not be allowed.

<u>Allocated Signal Name</u>

Assigns the signal shown in the list to each port.



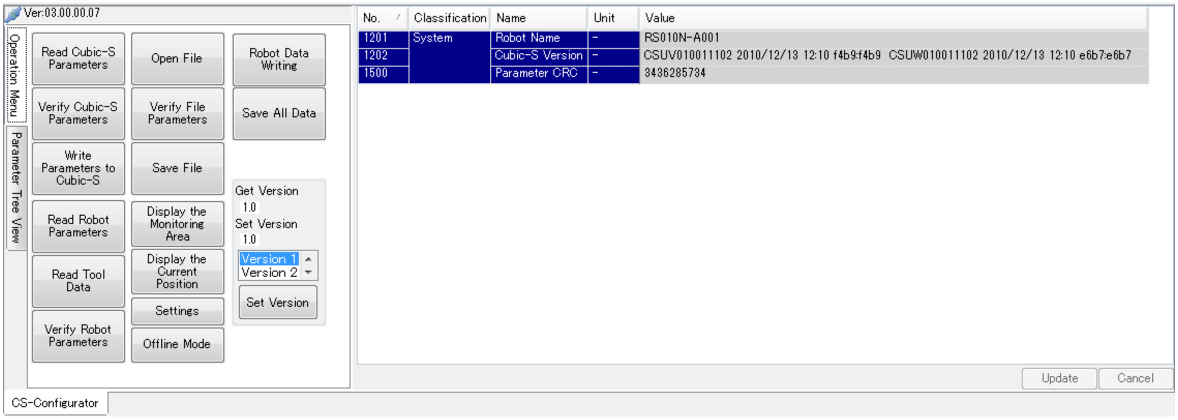
From the left column, select the port number of the port to allocate the signal in the right column and click on <Apply>. The signal name is shown for the allocated port in the left column. To cancel the allocation, select the signal to cancel from the left column and then press <Cancel>.

No.	Signal name		Description
1	Common Function	Motivity Shutting Off	Outputs if the power OFF signal is output to the controller. OFF: Signal emitting ON: Not output
2	Area Monitoring	Constant Monitoring Area	Outputs if the monitoring point/ line is inside the Constant Monitoring Area or not OFF: Out of area ON: Inside the area
3		Select Monitoring Area1	Outputs if the monitored point/ line is within the range of Select Monitoring Area 1 to 4, regardless of the relevant signal input. OFF: Out of area ON: Inside the area
4		Select Monitoring Area2	
5		Select Monitoring Area3	
6		Select Monitoring Area4	
7	Joint Monitoring	In range of constant monitoring area/ position	Outputs if the monitoring axis is within the range of constant monitoring angle/ position. OFF: Out of range ON: Inside the range
8		In range of constant monitoring area/ position 1	Outputs if the monitored axis is within the range of select angle/ position 1 to 8 regardless of the relevant signal input. OFF: out of range ON: inside the range
9		In range of constant monitoring area/ position 2	
10		In range of constant monitoring area/ position 3	
11		In range of constant monitoring area/ position 4	
12		In range of constant monitoring area/ position 5	
13		In range of constant monitoring area/ position 6	
14		In range of constant monitoring area/ position 7	
15		In range of constant monitoring area/ position 8	

16	Speed Monitoring	Less than 250mm/sec	Outputs if the monitored speed is below 250 mm/ s regardless of the relevant signal input.. OFF : monitored speed > 250 mm/s ON : monitored speed ≤ 250 mm/s
17		Less than user speed	Outputs if the monitored speed is below the user defined speed regardless of the relevant signal input. OFF : monitored speed > user speed ON : monitored speed ≤ user speed
18	Stop Monitoring	Robot Stop	Outputs if the robot is stopped when Robot Stop Monitoring is input. OFF : Not stopped ON : Stopped *OFF when Robot Stop Monitoring is not input
19		Device Stop 1	Outputs if the device 1 to 3 is stopped when Device Stop Monitoring 1 to 3 is input. OFF : Not stopped ON : Stopped *OFF when Device Stop Monitoring 1 to 3 is not input
20		Device Stop 2	
21		Device Stop 3	
22	Tool Orientation Monitoring	Total area for tool orientation monitoring	Outputs if the tool orientation is within one of the range of tool orientation monitoring 1 to 5 regardless of tool orientation monitoring 1 to 5 being input or not. OFF : Not in any of the range ON: Inside one of the ranges
23		In range of tool orientation monitoring 1	Outputs if the tool orientation is within the range of tool orientation monitoring 1 to 5 regardless of the relevant signal input. OFF : Not in any of the range ON: Inside one of the ranges
24		In range of tool orientation monitoring 2	
25		In range of tool orientation monitoring 3	
26		In range of tool orientation monitoring 4	
27		In range of tool orientation monitoring 5	
28	Protective Stop	Protective Stop Input	Outputs if any one of Protective Stop 1 to 4 is input. OFF : At least one is input ON : None is input

29	Protective Stop	In Protective Stop	Outputs if the robot is stopped by protective stop function or not. (Can be used in Cubic-S version 2 and later.) OFF : Not in protective stop ON : In protective stop
30	Emergency Stop	Emergency Stop Input	Outputs if any of the emergency stop; via teach pendant, via controller, or external emergency stop 1 to 4 is input. OFF : At least one is input ON : None is input
31	Safety Input Through Output	Teach Mode Input	Outputs the status of teach/ fast check mode OFF : Repeat mode ON : teach/ fast check mode
32		Teach speed monitoring input	Outputs the status of teach mode (not including fast check) OFF : Teach mode ON : Repeat mode / Fast check mode
33		Override input	Outputs the status of override switch OFF : Override switch OFF ON : Override switch ON
34		Controller emergency stop input	Outputs whether if emergency stop via teach pendant or controller is input or not OFF : Either of the buttons pressed ON : Both buttons are released
35		User-defined safety input 1	Outputs the signal status input to user safety input port 1 to 8 OFF: Input signal is OFF ON: Input signal is ON
36		User-defined safety input 2	
37		User-defined safety input 3	
38		User-defined safety input 4	
39		User-defined safety input 5	
40		User-defined safety input 6	
41		User-defined safety input 7	
42		User-defined safety input 8	

11.1.11 PARAMETER CRC



No.	Name	Value	Unit
1500	Parameter CRC	Parameter CRC value	-

Displays the set parameter CRC value (cannot set from this screen). The parameter CRC value does not change unless parameter is modified. Therefore, record the CRC value after the setting is complete so that it possible to check if the parameter has changed or not by comparing the CRC value with the recorded value.

11.2 CONFIRMATION BEFORE USE

This section explains the confirmation method and cautions before using each function.

11.2.1 AREA MONITORING FUNCTION

No.	Confirmation Method	Check Points	Results
1	Select [Valid] for Valid/Invalid in Teach Mode/Fast-forward Check, and touch at least one side of the monitoring area with all the monitoring points on the tool that is set to enable, and check if the motor power to the robot is shut OFF Right away.	At least one side of: Constant monitoring area Constant prohibited area 1 to 8 Selected monitoring area 1 to 4	
2	When changing tools according to tool ID, confirm tool 1 works for all the tools used.	Tool 1 to 32 (for all tools used)	
3	When changing tools according to tool ID, input a tool ID different from the command tool number and check that the motor power to the robot is shut OFF immediately after the robot moves more than the allowable motion range at time of tool mismatch.	Acceptable distance at tool mismatch	
4	When Valid/Invalid in Monitoring Line Segments on Arm is set to Valid, set Teach Mode/Fast-forward Check to Valid and input each monitoring validity signal. When only the monitoring line segment touches the set area in teach mode, confirm that the motor power to robot is shut OFF immediately. Check for at least one side of the monitoring area.	Constant Monitoring Area	
		Select Monitoring Area 1 to 4	
5	When Valid/Invalid in Monitoring Line Segments on Arm is set to Invalid, set Teach Mode/Fast-forward Check to Valid and input each monitoring validity signal. When the only the monitoring line segment touches the set area in teach mode, confirm that the motor power to robot is NOT shut OFF immediately. Check for at least one side of the monitoring area.	Constant Monitoring Area	
		Select Monitoring Area 1 to 4	
6	When Valid/Invalid in Teach Mode/Fast-forward Check is set to Valid, input each monitoring validity signal and	Constant Monitoring Area	
		Constant Prohibited Area1 to 8	

No.	Confirmation Method	Check Points	Results
	when the TCP or tool shape point touches the monitoring area in teach mode, confirm that the motor power to robot is shut OFF immediately. Check for all sides of the monitoring area.	Select Monitoring Area1 to 4	
7	When Valid/Invalid in Teach Mode/Fast-forward Check is set to Invalid, input each monitoring validity signal and when the TCP or tool shape point touches the monitoring area in teach mode, confirm that the motor power to robot is not shut OFF immediately. Check for all sides of the monitoring area.	Select Monitoring Area1 to 4	
8	Input each monitoring validity signal and when the TCP or tool shape point touches the monitoring area in repeat mode, confirm that the motor power to robot is shut OFF immediately. Check for all sides of the monitoring area.	Constant Monitoring Area	
		Constant Prohibited Area1 to 8	
		Select Monitoring Area1 to 4	
9	When more than one signal is assigned, if the robot is in the AND range of the acceptable area, check that the motor power to robot is not shut OFF. Confirm that the motor power is shut OFF when out of range.	Combination of multiple signals	
10	For all program used, input the select monitoring signal to set the area as used in the program test starting from a low speed (10 % of monitor speed), and then gradually raising until the actual speed used is reached. Check that the robot is not stopped by area monitoring function. Repeat this procedure 10 cycles at the actual speed. Recheck the teaching if the robot stops.	All programs used	
11	For all monitoring area, decrease the area by 10 mm for monitoring area, and increase the area by 10 mm for prohibited area. In all programs used, input the select monitoring signal to set the area as used in the program and test starting from a low speed (10 % of monitor speed), gradually raising until the actual speed used is reached. Check that the robot is not stopped by area monitoring function. Repeat this procedure 10 cycles at the actual speed. Recheck the teaching if the robot stops.	All programs used	

11.2.2 JOINT MONITORING FUNCTION

No.	Confirmation Method	Check Points	Results
1	When Valid/Invalid in Teach Mode/Fast-forward Check is set to Valid, input each monitoring signal, move the robot from inside the monitoring angle/ position to out of the range and confirm that the motor power to the robot is shut OFF right away. Check the same thing with the upper and lower limits.	Select monitoring angle/ position 1 to 8	
2	When Valid/Invalid in Teach Mode/Fast-forward Check is set to Invalid, input each monitoring signal, move the robot from inside the monitoring angle/ position to out of the range and confirm that the motor power to the robot is not shut OFF. Check the same thing with the upper and lower limits.	Select monitoring angle/ position 1 to 8	
3	Input each monitoring signal, move the robot in repeat mode, from inside the monitoring angle/ position to out of the range and confirm that the motor power to the robot is not shut OFF. Check the same thing with the upper and lower limits.	Select monitoring angle/ position 1 to 8	
4	When more than one signal is assigned, check that the motor power is not shut OFF when within the AND range of the acceptable angle/ position. If not within the AND area, than confirm that the motor power is shut OFF.	Combination of multiple signals	

11.2.3 SPEED MONITORING FUNCTION

No.	Confirmation Method	Check Points	Results
1	【When the speed set for speed monitoring is below 250 mm/s】 When Valid/Invalid in Teach Mode/Fast-forward Check is set to [Valid], input each monitoring enable signal and in teach mode, move the robot in a speed faster than the set monitoring speed. Check if the motor power to the robot is shut OFF immediately under these conditions.	Speed monitoring function	
2	【When the speed set for speed monitoring is below 250 mm/s】 When Valid/Invalid in Teach Mode/Fast-forward Check is set to [Invalid], input each monitoring enable signal and in teach mode, move the robot in a speed faster than the set monitoring speed. Check if the motor power to the robot is shut OFF immediately under these conditions.	User speed monitoring	
3	Input each monitoring enable signal and in repeat mode, move the robot in a speed faster than the set monitoring speed. Check if the motor power to the robot is shut OFF immediately under these conditions.	250 mm/s speed monitoring	
		User speed monitoring	
4	When more than one signal is assigned, check that the motor power is not shut OFF when the robot speed is within the AND range of the relevant speeds. If not within the AND area, than confirm that the motor power is shut OFF.	Combination of multiple signals	

11.2.4 MONITORING FUNCTION

No.	Confirmation Method	Check Points	Results
1	When Valid/Invalid in Teach Mode/Fast-forward Check is set to [Invalid], input each monitoring enable signal and in teach mode, move the robot more than 0.1 deg for rotational axis (axis value shown in deg) or more than 0.5 mm for linear axis (axis value shown in mm) and check that the motor power to the robot is shut OFF immediately.	Robot stopped	
		Device stopped 1 to 3	
2	When Valid/Invalid in Teach Mode/Fast-forward Check is set to [Invalid], input each monitoring enable signal and in teach mode, move the robot more than 0.1 deg for rotational axis or more than 0.5 mm for linear axis and check that the motor power to the robot is shut OFF immediately.	Robot stopped	
		Device stopped 1 to 3	
3	Input each monitoring enable signal and in repeat mode, move the robot more than 0.1 deg for rotational axis or more than 0.5 mm for linear axis and check that the motor power to the robot is shut OFF immediately.	Robot stopped	
		Device stopped 1 to 3	

11.2.5 TOOL ORIENTATION MONITORING FUNCTION

No.	Confirmation Method	Check Points	Results
1	When Valid/Invalid inTeach Mode/Fast-forward Check is set to [Invalid], input each monitoring enable signal and in teach mode, move the robot out of the cone angle area from each base orientation and check that the motor power to the robot is shut OFF immediately.	Tool Orientation Monitoring 1	
		Tool Orientation Monitoring 2	
		Tool Orientation Monitoring 3	
		Tool Orientation Monitoring 4	
		Tool Orientation Monitoring 5	
2	When Valid/Invalid inTeach Mode/Fast-forward Check is set to [Invalid], input each monitoring enable signal and in teach mode, move the robot out of the cone angle area from each base orientation and check that the motor power to the robot is shut OFF immediately.	Tool Orientation Monitoring 1	
		Tool Orientation Monitoring 2	
		Tool Orientation Monitoring 3	
		Tool Orientation Monitoring 4	
		Tool Orientation Monitoring 5	
3	Input each monitoring enable signal and in repeat mode, move the robot out of the cone angle area from each base orientation and check that the motor power to the robot is shut OFF immediately.	Tool Orientation Monitoring 1	
		Tool Orientation Monitoring 2	
		Tool Orientation Monitoring 3	
		Tool Orientation Monitoring 4	
		Tool Orientation Monitoring 5	
4	When more than one signal is assigned, check that the motor power is not shut OFF when the tool orientation is within the AND range of acceptable cone. If not within the AND area, than confirm that the motor power is shut OFF.	Combination of multiple signals (assigned to same port)	
5	When more than one signal is assigned, check that the motor power is not shut OFF when the tool orientation is within the AND range of acceptable cone. If not within the AND area, than confirm that the motor power is shut OFF.	Combination of multiple signals (assigned to same port)	

11.2.6 PROTECTIVE STOP FUNCTION

No.	Confirmation Method	Check Points	Results
1	Confirm that the motor power is shut down in teach mode when the enabled Protective Stops are input.	Protective Stop 1	
		Protective Stop 2	
		Protective Stop 3	
		Protective Stop 4	
2	Confirm that the motor power is shut down in teach mode when the disabled Protective Stops are input.	Protective Stop 1	
		Protective Stop 2	
		Protective Stop 3	
		Protective Stop 4	
3	Confirm that the motor power is shut down in repeat mode when the Protective Stops are input.	Protective Stop 1	
		Protective Stop 2	
		Protective Stop 3	
		Protective Stop 4	
4	Confirm that the motor power is shut down when the Protective Stops set to Stop Category 0 are input.	Protective Stop 1	
		Protective Stop 2	
		Protective Stop 3	
		Protective Stop 4	
5	Confirm that the robot decelerates and then the motor power is shut down when the Protective Stops set to Stop Category 1 are input.	Protective Stop 1	
		Protective Stop 2	
		Protective Stop 3	
		Protective Stop 4	
6	Confirm that the robot decelerates and then stops when the Protective Stops set to Stop Category 2 are input. Later, confirm that the operation restarts when each signal input is released.	Protective Stop 1	
		Protective Stop 2	
		Protective Stop 3	
		Protective Stop 4	

11.2.7 EMERGENCY STOP FUNCTION

No.	Confirmation Method	Check Points	Results
1	In teach mode, check that the motor power to the robot is shut off in the stop category set for emergency stop. (Stop Category 0: motor power OFF immediately, Stop Category 1: motor power off after deceleration)	Emergency Stop via TP	
		Emergency Stop via Controller	
		External Emergency Stop 1	
		External Emergency Stop 2	
		External Emergency Stop 3	
		External Emergency Stop	
2	In repeat mode, check that the motor power to the robot is shut off in the stop category set for emergency stop. (Stop Category 0: motor power OFF immediately, Stop Category 1: motor power off after deceleration)	Emergency Stop via TP	
		Emergency Stop via Controller	
		External Emergency Stop 1	
		External Emergency Stop 2	
		External Emergency Stop 3	
		External Emergency Stop 4	

11.2.8 SAFETY I/O

For both user safety input and output, use the list on 11.1.10.1 Safety Input Settings and 11.1.10.2 Safety Output Settings and confirm that all signals used are operating without problem.

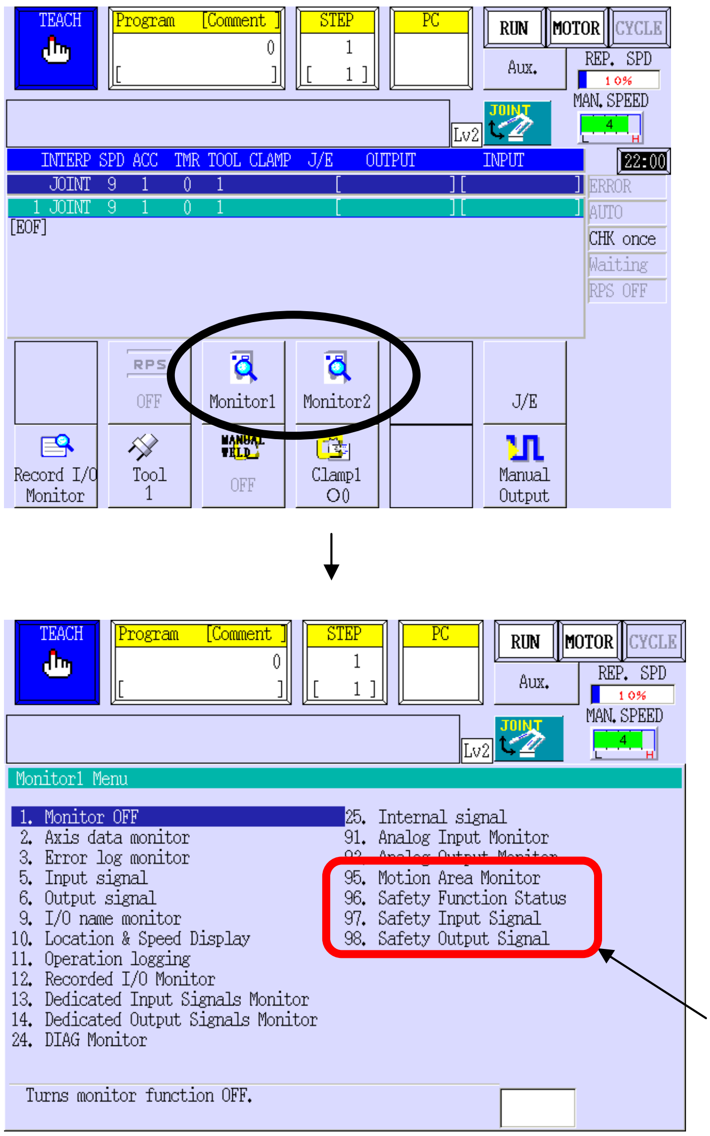
12.0 MONITOR FUNCTION

12.1 TP MONITOR FUNCTION

There are four monitor functions exclusive for Cubic-S that can be used via TP.

1. Motion area monitor
2. Safety function status monitor
3. Safety input signal monitor
4. Safety output signal monitor

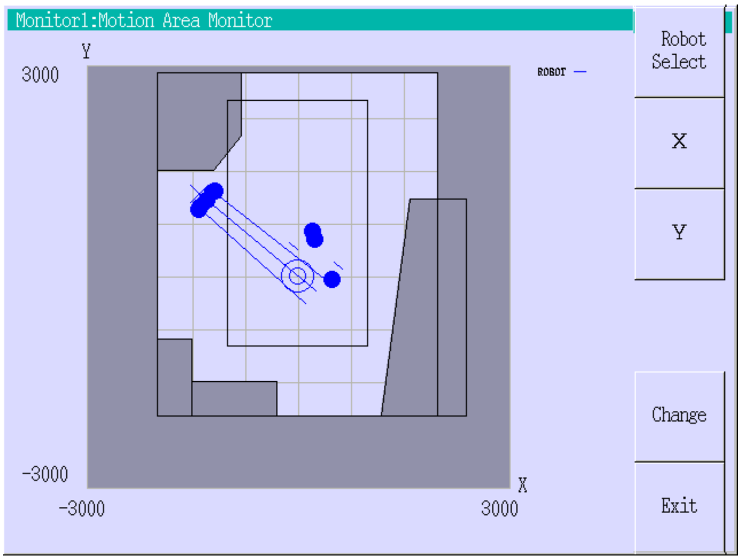
In the monitor menu displayed via the Teach screen, the Cubic-S monitor function menus are displayed in numbers 95 to 98.



Monitor functions for Cubic-S

12.1.1 MOTION AREA MONITOR

Selecting [95 Motion Area Monitor] displays the screen below.



In the first screen the robot and the motion area is shown in XY plane. The robot cannot enter the area indicated in grey.

In this screen, the display can be controlled using the keys shown in the table below.

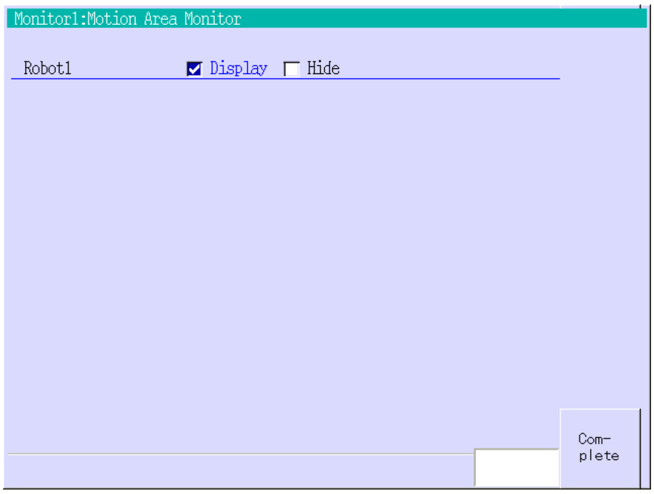
Input keys	Operation
A key ＋ ↑ key	Magnifies the graphic display
A key ＋ ↓ key	Minimizes the graphic displays
↑ key	Moves upwards the center of the graphic display.
↓ key	Moves downwards the center of the graphic display.
← key	Moves the center of the graphic display to the left.
→ key	Moves the center of the graphic display to the right.
R key	Exits the graphic display screen and returns to the Teach screen.

On the right end of the screen, five buttons are displayed:

1. Robot Select
2. X
3. Y
4. Change
5. Exit

Below explains about each of the buttons 1 through 5.

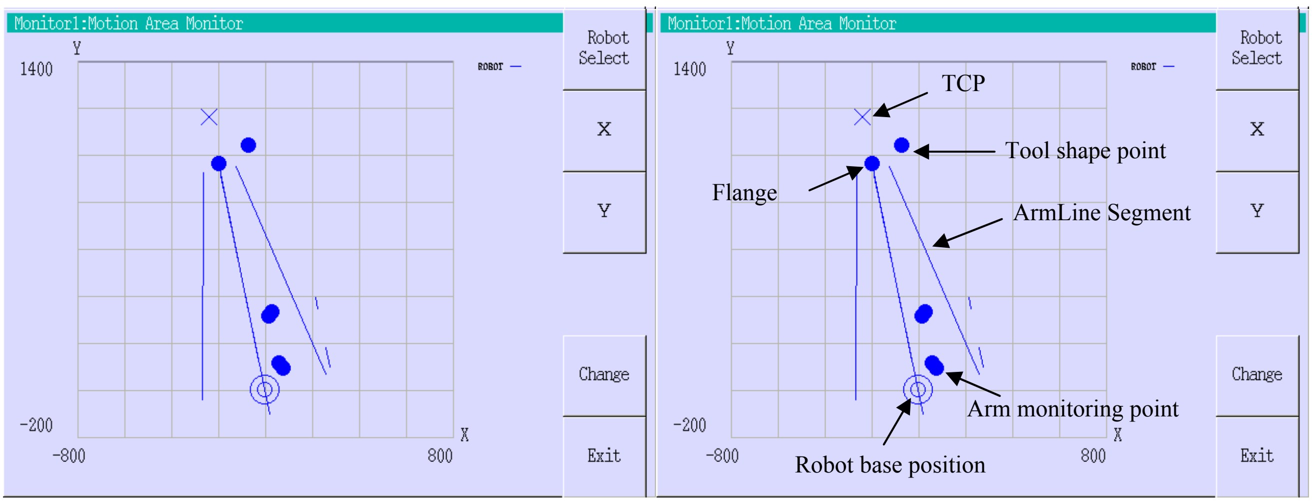
< Robot Select > button



Select display or no display and press <Complete>. The setting is changed.

Selecting [Display] displays robot information such as the robot base, tool, tool shape etc., as shown in the figure below left.
(*In this example there is only one tool shape point.)

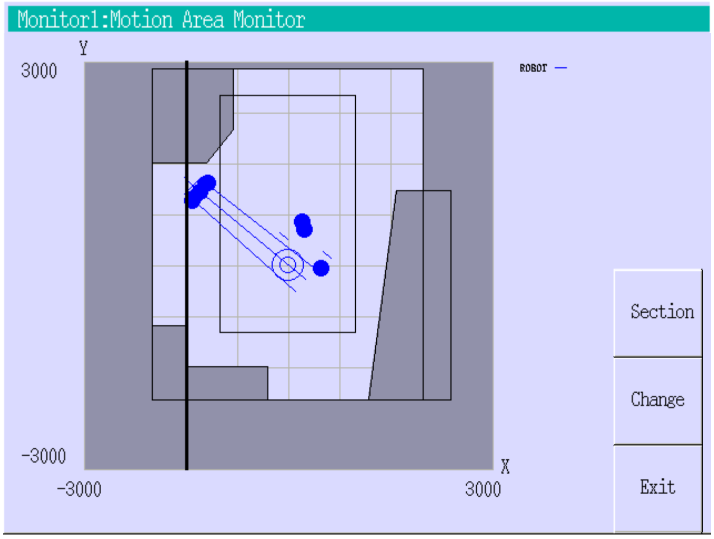
The figure on the right is shown with explanations of the display.



The robot information is indicated by symbols shown I nthe table below.

Symbol	Definition
×	TCP
●	Flange/Tool shape point/ Arm monitoring point
-	Arm monitoring line segment
◎	Robot base axis

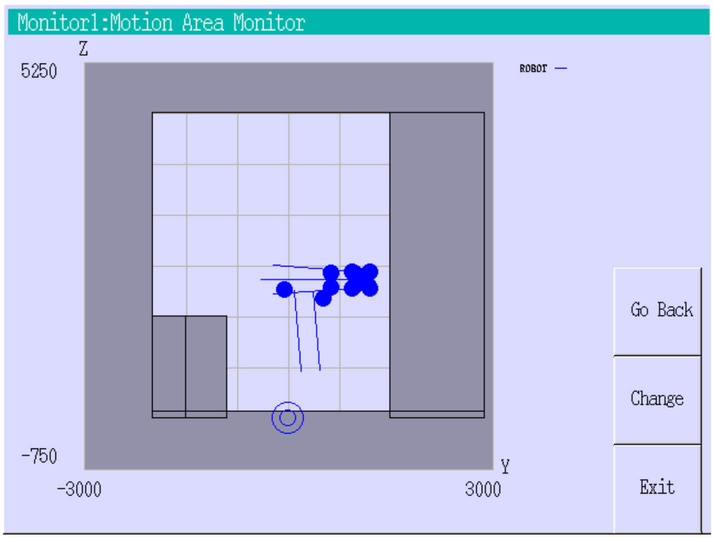
<X> button



Pressing the <X> button displays a bold line perpendicular to the X coordinate (vertical line).

This line can be moved left and right via → or ← key.

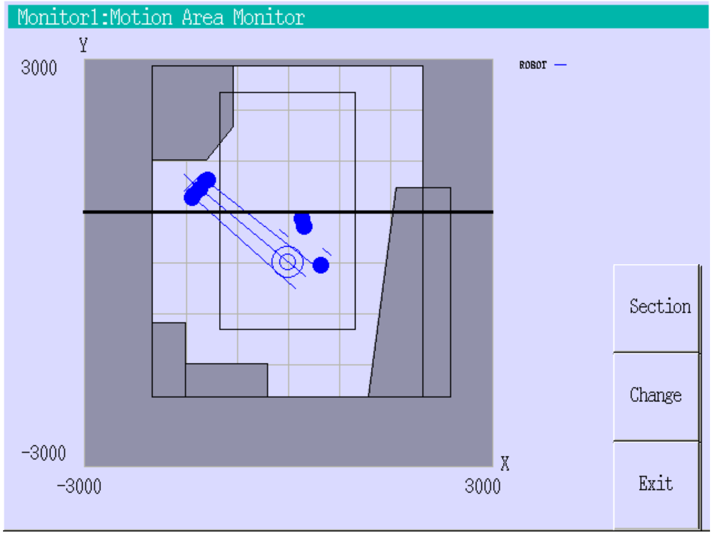
Move the line to the desired place and press <Section> button.



Pressing <Section> button displays the YZ plane.

Press <Go Back> key to return to the XY plane display.

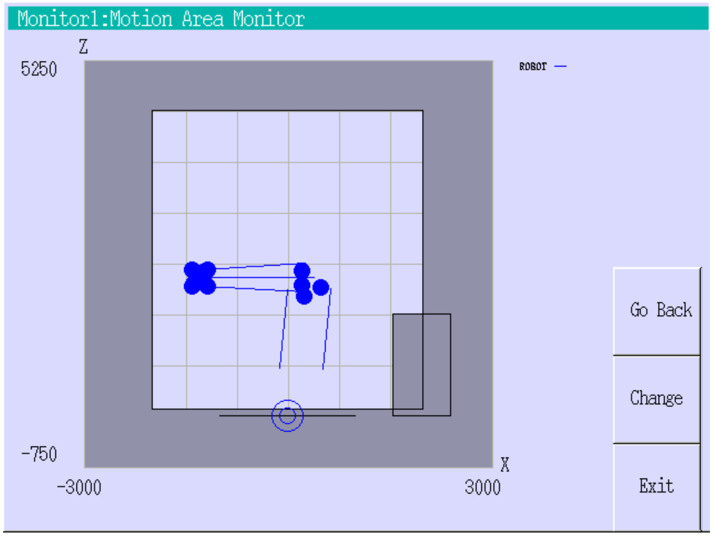
<Y> button



Pressing the <Y> button displays a bold line perpendicular to the Y coordinate (horizontal line).

This line can be moved up and down via ↑ or ↓ key.

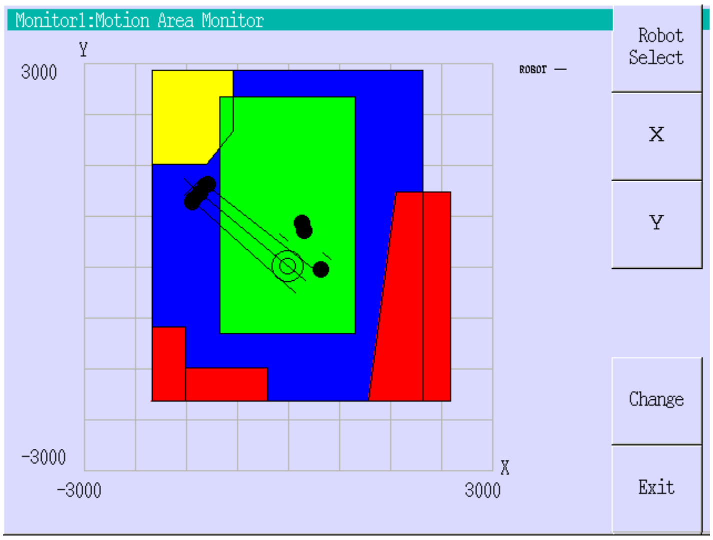
Move the line to the desired place and press <Section> button.



Pressing <Section> button displays the XZ plane.

Press <Go Back> key to return to the XY plane display.

<Change Display> button



Pressing <Change > button displays the motion areas in the color shown in the table below.

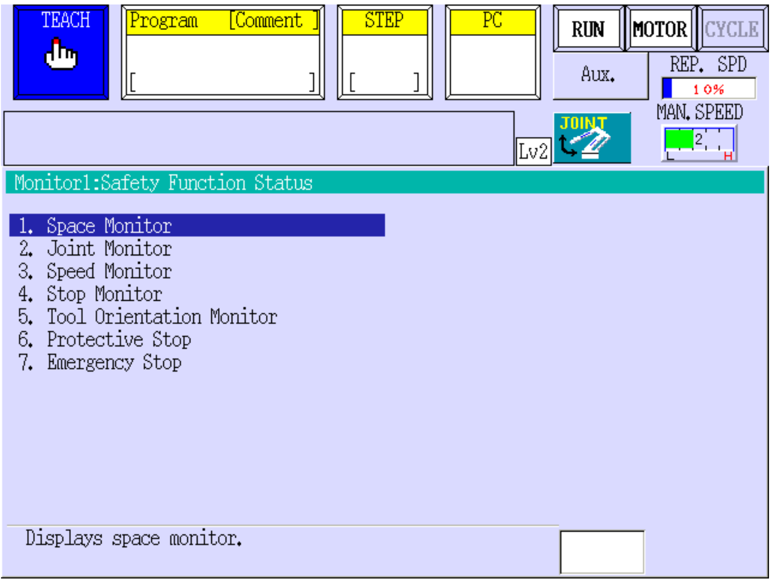
Displayed Item	Color
Constant prohibited area	Red
Selected prohibited area	Yellow
Selected allowed area	Green
Constant allowed area	Blue

<Exit> button

Pressing the <Exit> button ends the monitor screen and returns to the Teach screen.

12.1.2 SAFETY FUNCTION STATUS

Selecting [96 Safety Function Status] displays the screen as shown below.

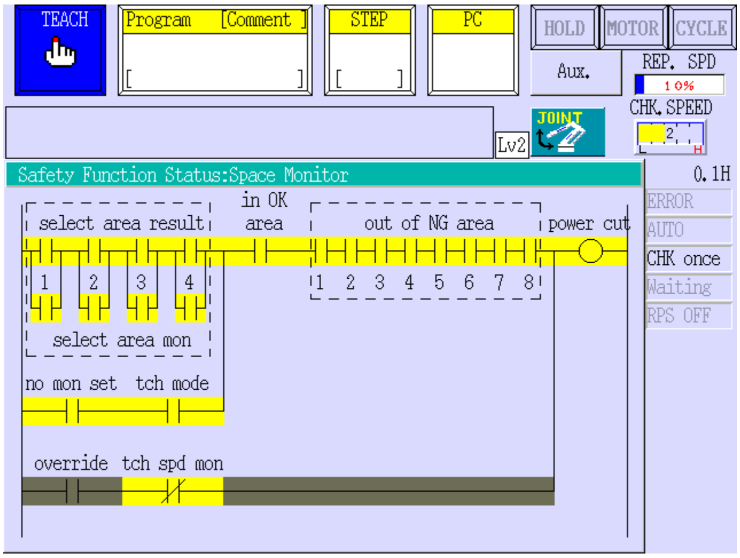


Seven menus below are available.

1. Space monitor
2. Joint monitor
3. Speed monitor
4. Stop monitor
5. Tool Orientation monitor
6. Protective stop
7. Emergency stop

The following section explains each of the menu.

1. Space monitor



Selecting [Space monitor] displays the ladder diagram showing the status of the area monitor function.

The parts where the conditions are satisfied are shown in yellow.

・Select area result

Displays the monitoring results of select area 1 – 4. It is indicated in yellow when the monitoring result is normal.

・Select area

Displays whether the select area 1 – 4 is enabled or disabled. It is indicated in yellow when disabled.

・in OK area

Displays whether the robot is within the constant monitoring area or not. It is indicated in yellow when the robot is within the area.

・out of NG area

Displays whether the robot is out of the constant prohibited area 1-8 or not. It is indicated in yellow when the robot is not in the area.

・no mon set

Displays the setting of parameter [Valid/ Invalid in Teach Mode]. It is indicated in yellow when [Valid/ Invalid in Teach Mode] is set to invalid.

・tch (Teach) mode (Tch/C fast(forward))

Displays if the mode is in Teach mode or not. It is indicated in yellow when in Teach mode. When the option fast check mode is ON, the display changes to [tch/C fast]. This shows that the mode is in Teach mode or fast check mode. It is indicated in yellow when in either of the modes.

・override

Displays whether the override switch is ON or not. It is indicated in yellow when the switch is ON.

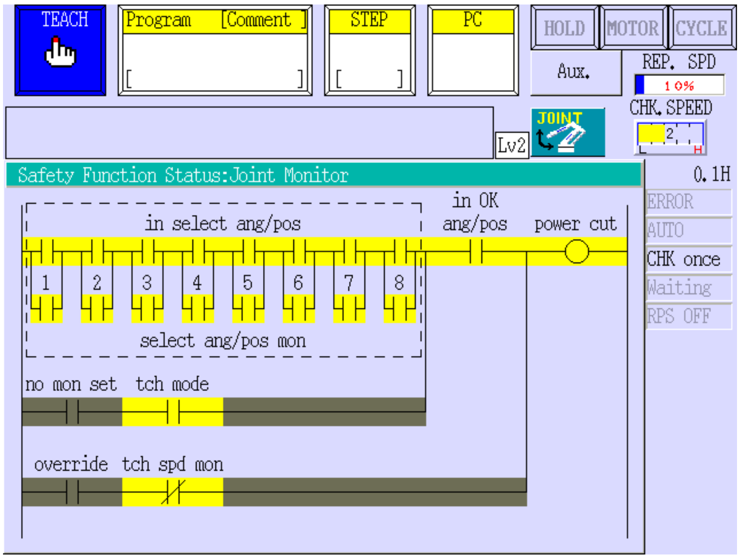
・tch spd mon

Displays whether theTeach speed monitoring input is ON or not. It is indicated in yellow when the switch is OFF.

・power cut

Displays the output status of emergency stop to the robot from Cubic-S area monitoring. It is indicated in yellow when the output is OFF.

2. Joint monitor



Selecting [Joint Monitor] displays the ladder diagram showing the status of the axis monitoring function.

The parts where the conditions are satisfied are shown in yellow.

・in select ang/pos

Displays the monitoring result of select angle/ area 1 – 8. It is indicated in yellow when the monitroing result is normal.

・select ang/pos mon

Displays whether select angle/ area 1 – 8 is valid or invalid. It is indicated in yellow when invalid.

・in OK ang/pos

Displays whetherthe robot is within the constant monitoring angle/ position or not. It is indicated in yellow when the robot is within the area.

・no mon set

Displays the setting of parameter [Valid/ Invalid in Teach Mode]. It is indicated in yellow when [Valid/ Invalid in Teach Mode] is set to invalid.

・tch (teach) mode (Tch/C fast(forward))

Displays if the mode is in Teach mode or not. It is indicated in yellow when in Teach mode. When the option fast check mode is ON, the display changes to [tch/C fast]. This shows that the mode is in Teach mode or fast check mode. It is indicated in yellow when ineither of the modes.

・override

Displays whether the override switch is ON or not. It is indicated in yellow when the switch is ON.

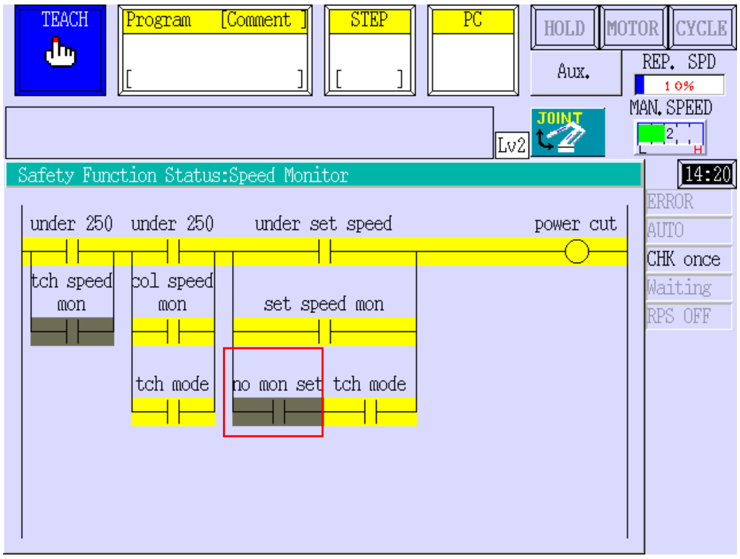
・tch spd mon

Displays whether theteach speed monitor input is ON or not. It is indicated in yellow when the switch is OFF.

・power cut

Displays the output status of emergency stop to the robot from Cubic-S area monitoring. It is indicated in yellow when the output is OFF.

3. Speed Monitor



Selecting [Speed monitor] displays the ladder diagram showing the status of the speed monitor function.

The parts where the conditions are satisfied are shown in yellow.

・under 250

Displasys the monitoring result of speed 250mm/s. It is indicated in yellow when the speed at the arm monitoring point is below 250mm/s.

・tch speed mon

Displays whether theTeach speed monitoring input is ON or not. It is indicated in yellow when the switch is OFF.

・col speed mon

Displays whether the monitoring of cooperation speed (250mm/s) is valid or invalid. It is indicated in yellow when the monitor is set to invalid.

・under set speed

Displays the monitoring result of the set speed. It is indicated in yellow when the speed at the arm monitoring point is below the set speed.

・col speed mon

Displays whether the monitoring of set speed is valid or invalid. It is indicated in yellow when invalid.

・tch (teach) mode (Tch/C fast(forward))

Displays if the mode is in Teach mode or not. It is indicated in yellow when in Teach mode. When the option fast check mode is ON, the display changes to [tch/C fast]. This shows that the mode is in Teach mode or fast check mode. It is indicated in yellow when ineither of the modes.

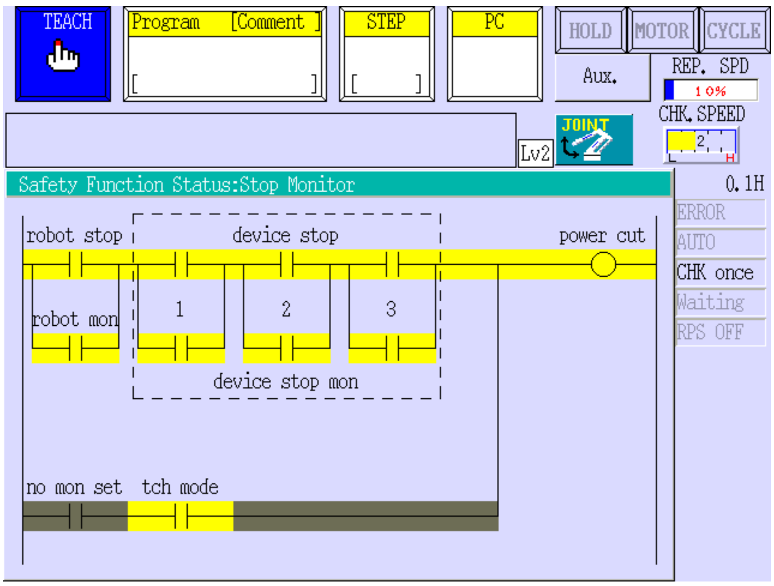
・no mon set

Displays the setting of parameter [Valid/ Invalid in Teach Mode]. It is indicated in yellow when [Valid/ Invalid in Teach Mode] is set to invalid.

・power cut

Displays the output status of emergency stop to the robot from Cubic-S area monitoring. It is indicated in yellow when the output is OFF.

4. Stop Monitor



Selecting [Stop Monitor] displays the ladder diagram showing the status of the stop monitor function.

The parts where the conditions are satisfied are shown in yellow.

・robot stop

Displays the result of stop monitoring of the robot axis. It is indicated in yellow when the monitoring result is normal.

・robot mon

Displays whether the stop monitoring of robot axes is valid or invalid. It is indicated in yellow when the monitor is set to invalid.

・device stop

Displays the monitoring result of devices 1 through 3. It is indicated in yellow when no abonormality is monitored.

・device stop mon

Displays whether the stop monitoring of device 1 through 3. It is indicated in yellow when the monitor is set to invalid.

・no mon set

Displays the setting of parameter [Valid/ Invalid in Teach Mode]. It is indicated in yellow when [Valid/ Invalid in Teach Mode] is set to invalid.

・tch (teach) mode (Tch/C fast(forward))

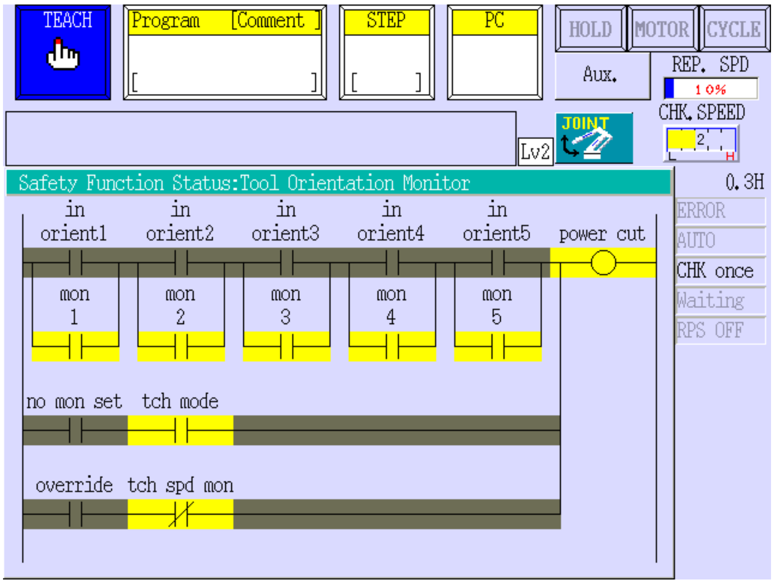
Displays if the mode is in Teach mode or not. It is indicated in yellow when in Teach mode. When the option fast check mode is ON, the display changes to [tch/C fast]. This shows that the mode is in Teach mode or fast check mode. It is indicated in yellow when ineither of the modes.

・power cut

Displays the output status of emergency stop to the robot from Cubic-S area monitoring. It is indicated in yellow when the output is OFF.

5. Tool Orientation Monitor

Selecting [Tool Orientation Monitor] displays the ladder diagram showing the status of the tool direction monitoring function.

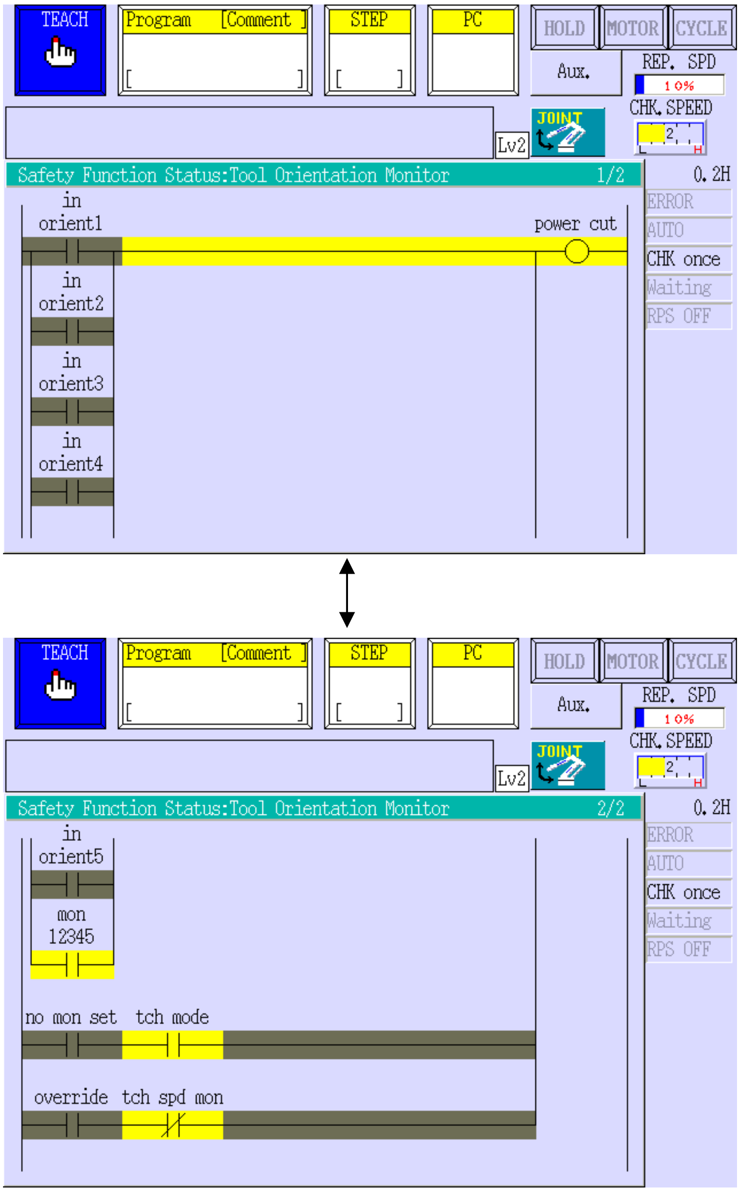


The parts where the conditions are satisfied are shown in yellow.

For tool orientation monitoring, the ladder diagram configuration changes according to how the the input is allocated.

In the figure above, tool orientation monitoring input 1 to 5 are all allodcated to separate user inputs. When the inputs are allocated to separate user inputs, the ladder diagram is displayed in series.

In the figure below, tool orientation monitoring input 1 to 5 are all to te same user input. When more than one inputs are allocated to one user input, the ladder diagagram is shown as below.



There may be a second page depending on how the inputs are allocated.

Use <↑> and <↓> keys to switch between the pages.

・in orient1-5

Displays whether tool orientation range 1 through 5 is within the area or not. It is indicated in yellow when the tool is within the area.

・mon 1-5

Displays whether the monitoirng of tool orientations 1 to 5 are enabled or not. It is indicates in yellow when the monitor is disabled. When more than one input are allocated to the same user input, the numbers appear side by side like “mon 12345” or “mon 234”.

・no mon set

Displays the setting of parameter [Valid/ Invalid in Teach Mode]. It is indicated in yellow when [Valid/ Invalid in Teach Mode] is set to invalid.

・tch (teach) mode (Tch/C fast(forward))

Displays if the mode is in Teach mode or not. It is indicated in yellow when in Teach mode. When the option fast check mode is ON, the display changes to [tch/C fast]. This shows that the mode is in Teach mode or fast check mode. It is indicated in yellow when in either of the modes.

・Override

Displays whether the override switch is ON or not. It is indicated in yellow when the switch is ON.

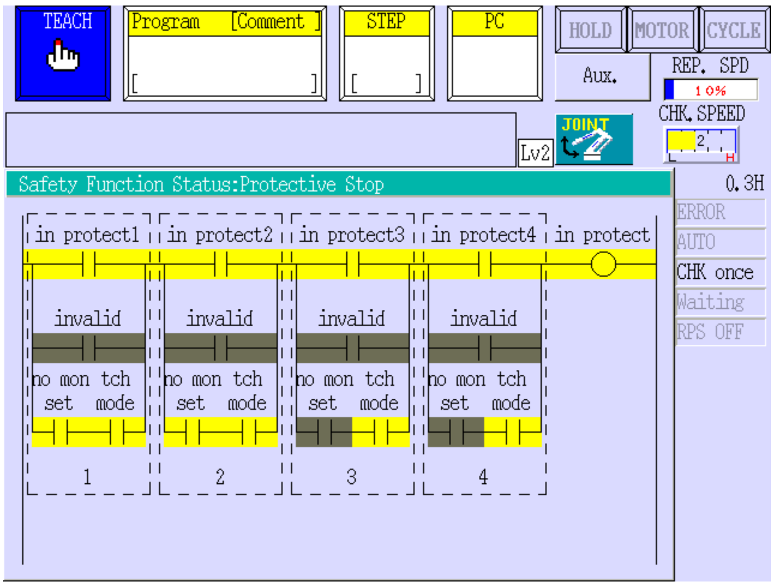
・tch spd mon (teach speed monitor)

Displays whether theTeach speed monitoring input is ON or not. It is indicated in yellow when the switch is OFF.

・Power cut

Displays the output status of emergency stop to the robot from Cubic-S area monitoring. It is indicated in yellow when the output is OFF.

6. Protective Stop



Selecting [Protective Stop] displays the ladder diagram showing the status of the protective stop function.

The parts where the conditions are satisfied are shown in yellow.

・in protect1-4

Displays whether protective stop inputs 1 through 4 are ON or not. It is indicated in yellow when the switch is ON.

・invalid

Displays whether protective stop invalid inputs 1 through 4 are ON or not. It is indicated in yellow when the switch is ON.

・no mon set

Displays the setting of parameter [Valid/ Invalid in Teach Mode] for protective stop input 1-4. It is indicated in yellow when [Valid/ Invalid in Teach Mode] is set to invalid.

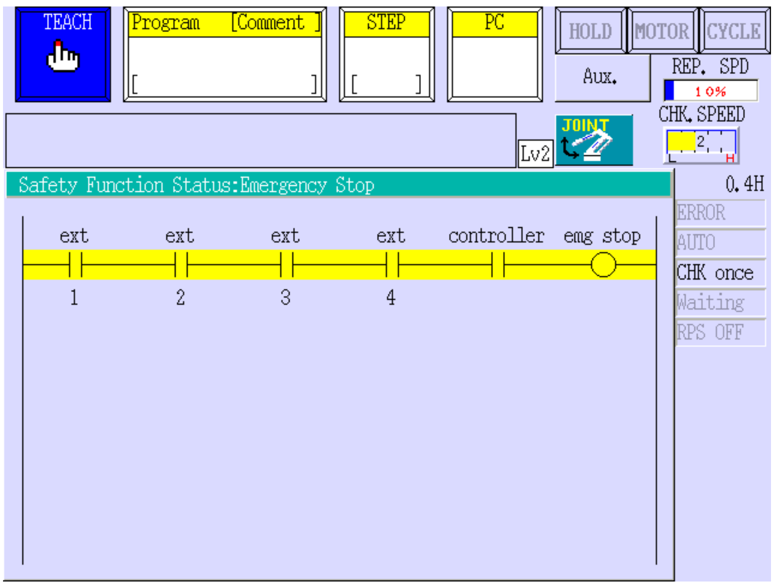
・Teach mode (Tch/C fast(forward))

Displays if the mode is in Teach mode or not. It is indicated in yellow when in Teach mode. When the option fast check mode is ON, the display changes to [tch/C fast]. This shows that the mode is in Teach mode or fast check mode. It is indicated in yellow when in either of the modes.

・in protect

Displays the output status of protective stop to the robot controller from Cubic-S protective stop function. It is indicated in yellow when the output is OFF.

7. Emergency Stop



Selecting [Emergency Stop] displays the ladder diagram showing the status of the emergency stop function.

The parts where the conditions are satisfied are shown in yellow.

・Ext(ernal)

Displays whether the external emergency stop input 1-4 is ON or not. It is indicated in yellow when the switch is ON.

・controller

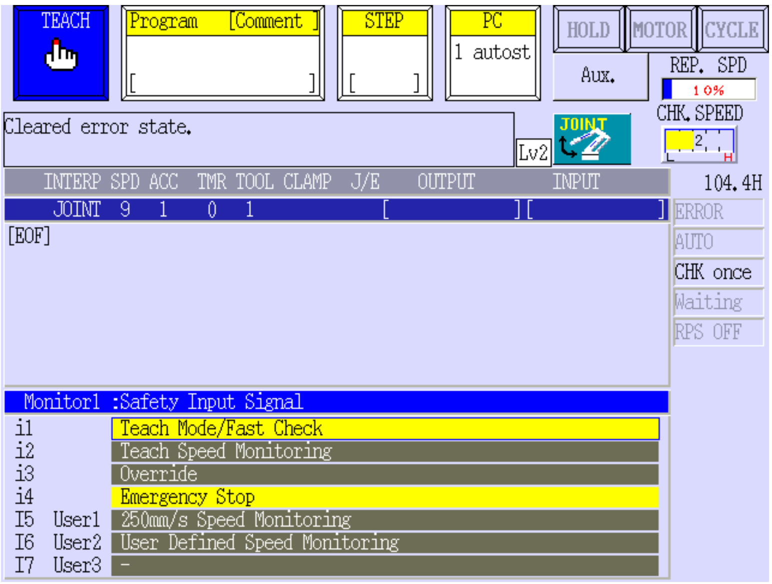
Displays whether the emergency stop on the controller operation panel or on the teach pendant is ON. It is indicated in yellow when the switch is OFF.

・emg stop (Emergency Stop)

Displays the output status of emergency stop to the robot controller from one of the emergency stops mentioned above. It is indicated in yellow when the output is OFF.

12.1.3 SAFETY INPUT SIGNAL MONITOR

Selecting [97 Safety Input Signal] displays the below screen.



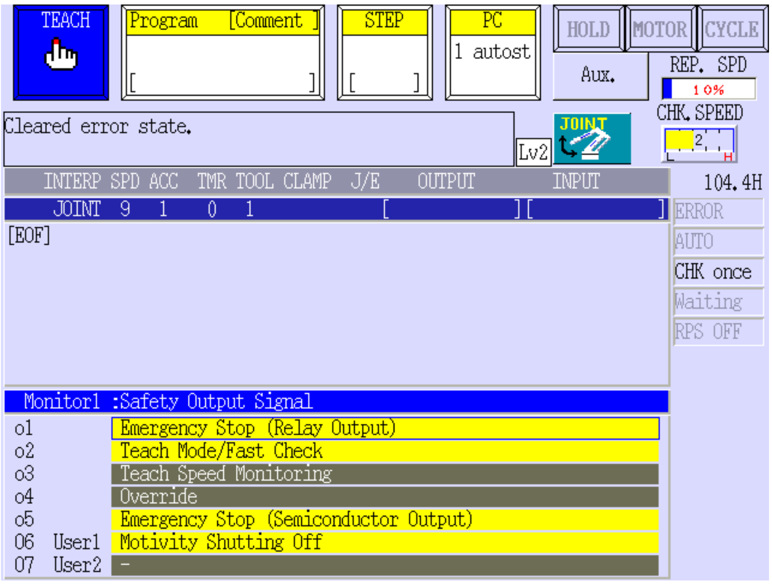
The signals that are ON are shown in yellow.

The lower case “i” indicates designated signals and upper case “I” indicates user defined signals.

The signal names are shown for the ports that have signals allocated. Ports with no signal allocated are indicated by “-”.

12.1.4 SAFETY OUTPUT SIGNAL MONITOR

Selecting [98 Safety Output Signal] displays the below screen.



The signals that are ON are shown in yellow.

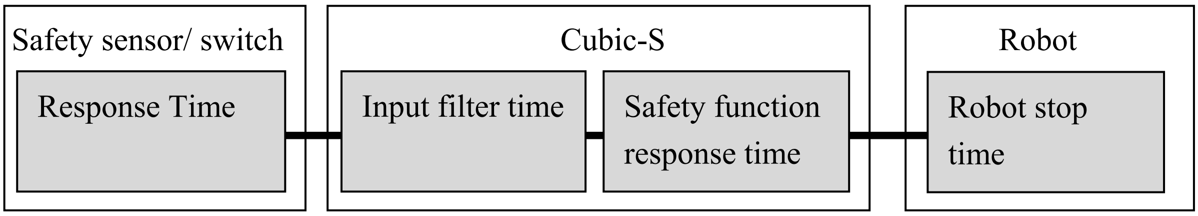
The lower case "o" indicates designated signals and upper case "O" indicates user defined signals.

The signal names are shown for the ports that have signals allocated. Ports with no signal allocated are indicated by "-".

13.0 RESPONSE TIME OF CUBIC-S

Response time refers to the maximum time it takes between the time the input from the sensor/ switch is turned OFF and the time the output is turned OFF or the machine stops. From this response time, derive the safety distance stated in the safety standards such as ISO13855 (for example: the distance between the robot motion area and the light curtain).

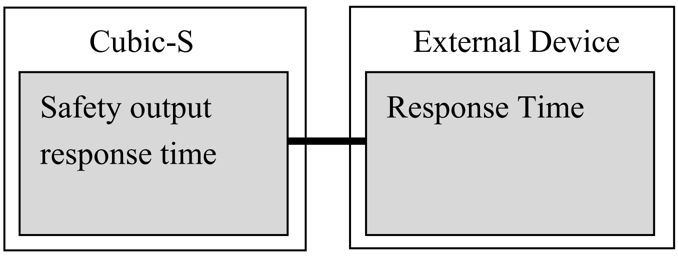
1. When stopping the robot via safety sensor/ switch.



Response time for the whole system = Response time of safety sensor/ switch +
time set for Cubic-S input filter + Response time of Cubic-S safety function +
Robot stop time
The response time of Cubic-S safety function is:
Emergency stop/ Protective Stop, Stop category 0: 20 ms
Other safety functions (including Emergency stop/ Protective Stop, Stop category 1) : 60 ms

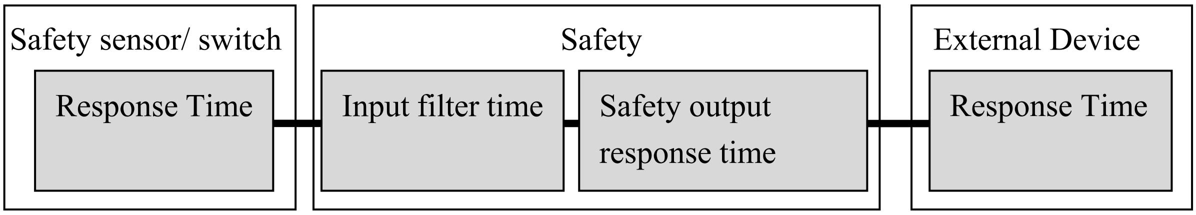
The robot stop time differs among the robot models. Please refer to the data provided by Kawasaki.

2. When stopping external devices using the safety function of Cubic-S



Response time for the whole system = Response time of Cubic-S safety output (60ms) +
Response time of external devices

3. When stopping the external devices by connecting safety sensor/ switch to Cubic-S, and assigning directly to safety output



Response time for the whole system = Response time of safety sensor/ switch +
time set for Cubic-S input filter＋Response time of Cubic-S directly assigned safety output (10 ms)＋external device response time

14.0 TROUBLESHOOTING

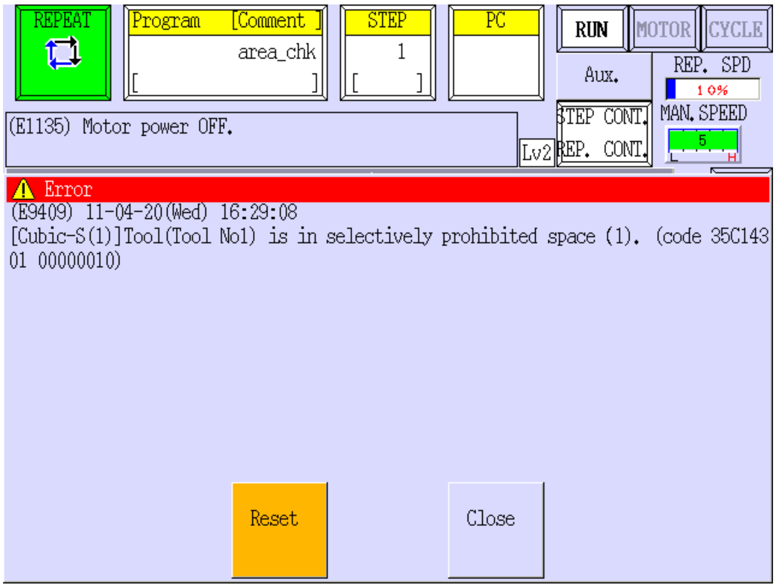
14.1 ERROR DISPLAY

Error message is displayed on the display screen of the teach pendant and the PC installed with terminal software (KRterm/KCwin32).

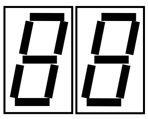
On the teach pendant, the error message is displayed on the error popup screen.　The figure below shows an example of the error popup screen displayed on the teach pendant LCD panel.

System message area

Error pop up screen



The error code is also displayed on the 7SEG LED on the Cubic-S body.



The number indicates the error content.

The error detected by Cubic-S is displayed with the error message beginning with [Cubic-S(X)] and emergency stop signal is output from Cubic-S to the robot controller 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 -> ON the CONTROLLER POWER.

14.2 CAUSES AND COUNTERMEASURES FOR ERROR OCCURENCE

This section explains the mechanical and electrical causes which are the common causes of error that occurs in Cubic-S. The robot may move abnormally due to mechanical, electrical or other factors. As a result of the abnormal motion, the robot , for example, may exceed the monitoring area, which will also cause error in Cubic-S.

Main Cause

1. Mechanical Factor
   (1) Motor brake is abraded.
   (2) Reduction 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 reduction gear.
   (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 block.
   (3) Malfunction of the servo board.
   (4) Malfunction of the Munity.
   (5) Disconnection of harness between servo board (X507) and Cubic-S (XCS1)
   (6) Disconnection of PN power line between MC unit and servo amplifier unit.
   (7) Abnormality in primary power voltage.
   (8) Malfunction of the motor. (Including brakes)
   (9) Incorrect wiring of motor power line, encoder line or brake line.
   (10) Disconnected encoder harness or short circuit, or malfunction of the encoder.
   (11) 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 reduction gear motor. Check also for deformation of the arm.
2. If any parts of the reduction gear has been damaged, replace the part.
3. Revise the load and motion patter of the robot.
4. If the error is caused by electrical factors, check the harness, servo amplifier unit, MC

unit(power source unit), motor, etc, and replace it/ them if necessary.

5. When a sudden change in joint values occur, modify the taught data.

CAUTION

When the zeroing data is modified in the robot, the modification should be reflected in the Cubic-S.　Write the robot parameter to Cubic-S using CS-conf.

Error code: E9400
Error message: [Cubic-S(X)] Cubic-S is not installed.
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: Irrelevant

Content

This error indicates that the communication with Cubic-S was not started after controller power ON. It is detected by AS software.

Main Cause

1. Cubic-S is not correctly installed.
2. Defective Cubic-S.

Countermeasure

1. Reinstall the Cubic-S correctly.
2. If Cubic-S is defective, replace Cubic-S.

Error code: E9401
Error message: [Cubic-S(X)] Initialization error (Code:%X)
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: -

Content

This error indicates that error occurred in the Cubic-S startup sequence after the controller power is turned ON.

Main Cause

1. No parameter was written in Cubic-S.
   (Cubic-S is normally shipped with the initial values set to the parameters. When the Cubic-S software is replaced, the parameters are all reset to 0.)
2. Cubic-S is not correctly installed. (Was able to communicate normally at the beginning of the startup operation, but lost communication during the operation.)
3. Defective Cubic-S.

Countermeasure

1. When Cubic-S software is replaced, write the Cubic-S parameter via CS-conf following the procedure below:
   «In the Cubic-S to be replaced»
   (1) Perform [Read Cubic-S Parameters]
   (2) Perform [Read Robot Parameters]
   (3) Perform [Save File]
   «In the Cubic-S that was replaced»
   (4) Perform [Open File] and read the files saved in procedure (3)
   (5) Perform [Read Robot Parameters]
   (6) Perform [Write Parameters to Cubic-S], and turn OFF/ON the controller power
2. Turn OFF/ ON the controller power to see if the error can be reset.
3. Replace Cubic-S.

Error code: E9402
Error message: [Cubic-S(X)] Mismatch in X between robot controller and Cubic-S. (XX)
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: Irrelevant

Content
This error indicates that in the parameter verification conducted in the startup sequence after controller power ON, a mismatch was detected between the parameters in AS software and Cubic-S. It is detected by AS software or Cubic-S.

・"X" in the message [Mismatch in X] show the parameter where mismatch was found.
・"XX" at the end of the error message says "AS" or "Cubic-S" according to where the error was detected.

・Example of error message display
If mismatch in Jt1 zeroing value is found by Cubic-S:
[Cubic-S(X)] Mismatch in JT1 zeroing values between robot controller and Cubic-S. (Cubic-S)
If mismatch in Jt1 motion upper limit value is found by Cubic-S:
[Cubic-S(X)] Mismatch in motion upper limit value between robot controller and Cubic-S. (Cubic-S)

Main Cause
1. Changed the parameters (zeroing, motion limits, base coordinates, tool data, etc.) only in AS software and did not write them to Cubic-S.
2. Changed the parameters (area monitoring tool shape points (parameters No. 113 -), etc.) only in Cubic-S via CS-conf and not in AS software.
3. Replaced Cubic-S but did not load the parameters.

Countermeasure
1. When the robot parameters (zeroing, motion limits, base coordinates, tool data, etc.) were changed only in AS software, reflect the changes to Cubic-S via CS-conf following the below procedures.
   (1) Perform [Read Cubic-S Parameters]
   (2) Perform [Read Robot Parameters]
   (3) Perform [Write Parameters to Cubic-S], and turn OFF/ON the controller power
2. When modifying in AS software the robot/ user parameter that is target of verification check, such as tool registration, reflect the changes to Cubic-S via CS conf following the

below procedure.

(1) Perform [Read Cubic-S Parameters]
(2) Perform [Read Robot Parameters]
(3) Perform [Read Tool Data]
(4) Perform [Write Parameters to Cubic-S], and turn OFF/ON the controller power

3. When modifying in CS-conf the robot/ user parameter, such as tool registration, that is target of verification check, make the same modifications in AS software so the parameter values match. The tool registration is done via SET_TOOLSHAPE instruction or Aux.304 Tool Registration. For details, see 11.1.2 How to Set Tool Number and Tool Shape via Robot Controller (AS Software).
4. When Cubic-S software is replaced, write the Cubic-S parameter via CS-conf following the procedure below:

«In the Cubic-S to be replaced»

(1) Perform [Read Cubic-S Parameters]
(2) Perform [Read Robot Parameters]
(3) Perform [Save File]

«In the Cubic-S that was replaced»

(4) Perform [Open File] and read the files saved in procedure (3)
(5) Perform [Read Robot Parameters]
(6) Perform [Write Parameters to Cubic-S], and turn OFF/ON the controller power

Note (About the messages of parameter discrepancy displayed at controller power ON)
If mismatch in parameter is detected in the parameter verification check, the following messages are displayed on TP or other terminal screens when the controller power is turned ON. Follow the procedures explained here to operated the robot in that case.

1. When mismatch is detected in robot parameter (zeroing, motion upper and lower limits, base coordinates, etc.)the message below appears:

«TP Display»

```
[Cubic-S(1)]Mismatch in Upper motion limit of Jt 1 between robot controller and
Cubic-S.(AS)
Download robot data from PC for setting parameter.
(2:All Skip 1:Next)
```

«Terminal Display»

[Cubic-S(1)] Mismatch in upper motion limit of Jt 1 between robot controller and Cubic-S. (Cubic-S)

Download robot data from PC for setting parameter.
(2:All Skip 1:Next)

If [2: All Skip] is selected here, the [(2:All Skip 1:Next)] message will not appear when parameter mismatch is detected. If [1:Next] is selected, the same confirmation message will appear the next time parameter mismatch is detected. (See figure below.)

```
[Cubic-S(1)]Mismatch in Upper motion limit of Jt 1 between robot controller and
Cubic-S.(AS)
Download robot data from PC for setting parameter.
(2:All Skip 1:Next)1
[Cubic-S(1)]Mismatch in Zeroing value of Jt 1 between robot controller and Cubic
-S.(AS)
Download robot data from PC for setting parameter.
(2:All Skip 1:Next)
```

Startup procedure continues after all robot parameters are verified. Release the error as described in countermeasure 1.

2. When mismatch was detected in the robot/ user parameter that are target of verification check(such as tool registration), the message below is displayed. (Case 1)

*The message displayed differs depending on the software version. If not displayed as shown below, see 3. (Case 2) below.

«TP Display»

```
[Cubic-S(1)]Mismatch in Tool1 TCP(XYZ) between robot controller and Cubic-S.(AS)

Do you start by the Cubic-S side parameter? (2:all Yes, 1:Yes, 0:No)
Number ?
```

«Terminal Display»
[Cubic-S(1)] Mismatch in Tool1 TCP (XYZ) between robot controller and Cubic-S.
(Cubic-S)
Do you start by the Cubic-S side parameter ? (2:All Skip 1:Yes, 0:No)
Number?

If [2: All Skip] is selected here, the [(2:All Skip 1:Next)] message will not appear when parameter mismatch is detected, and will automatically reflect the values set in Cubic-S to AS software. If [1:Yes] is selected, the values set in Cubic-S is automatically reflected in AS software. If [0:No] is selected, the parameter values are kept unchanged. The same confirmation message will appear the next time parameter mismatch is detected. (See figure below.)

Startup procedure continues after all robot parameters are verified. Release the error as described in countermeasure 2 or 3.

```
[Cubic-S(1)]Mismatch in Tool1 TCP(XYZ) between robot controller and Cubic-S.(AS)

Do you start by the Cubic-S side parameter? (2:all Yes, 1:Yes, 0:No)
Number ?0
[Cubic-S(1)]Mismatch in Tool1 TCP(OAT) between robot controller and Cubic-S.(AS)

Do you start by the Cubic-S side parameter? (2:all Yes, 1:Yes, 0:No)
Number ?
```

CAUTION

Selecting [2:all Yes] or [1:Yes] here automatically changes the AS software tool setting. Be aware that executing a program with the incorrect tool setting may result in interference with the surrounding.

3. When mismatch was detected in the robot/ user parameter that are target of verification check (such as tool registration), the message below is displayed. (Case 2)

*The message displayed differs depending on the software version. If not displayed as shown below, see 2. (Case 1) above.

«TP Display»

```
[Cubic-S(1)]Mismatch in Tool1 TCP(XYZ) between robot controller and Cubic-S.(AS)

Set Cubic-S parameter and AS parameter to agree.(2:All Skip 1:Next)
```

«Terminal Display»

[Cubic-S(1)] Mismatch in Tool1 TCP (XYZ) between robot controller and Cubic-S. (Cubic-S)

Set Cubic-S parameter and AS parameter to agree. (2:All Skip 1:Next)

Selecting [2: All skip] cancels the display of selection [(2:All Skip 1:Next)] even when parameter mismatch is detected. Selecting [1:Next] allows display of the selection message every time mismatch is detected.

Startup procedure continues after all robot parameters are verified. Release the error as described in countermeasure 2 or 3.

Error code: E9403
Error message: [Cubic-S(X)] System error. (Code: xxxxxxxx)
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: -

Content

Error with an error code not defined in Cubic-S specification occurred. It is detected by Cubic-S. Error reset may be possible. The display on 7SEG LED differs according to the error code.

Main Cause

1. Defective Cubic-S.

Countermeasure

1. Turn OFF/ ON the motor power to see if the error can be reset.
2. If this error occurs when a certain program step is executed or when a certain operation is done, report Kawasaki the detailed information of the situation, including all the contents of the error message, robot type, controller type and model, AS software, servo software, Cubic-S version, program contents, operation done when error occurred, all AS software save data, all Cubic-S parameters.

Error code: E9404
Error message: [Cubic-S] Parameter may be changed. Turn OFF & ON the control power for verification.
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: Irrelevant

Content

This error indicates that the parameter values for parameters that are target of verification check might have been changed. It is detected by AS software. Turn OFF/ ON the controller power to verify the parameters. Parameter verification is conducted automatically in the startup Cubic-S sequence when controller power is turned ON.

Main Cause

1. The parameters that are target of verification check has been changed due to monitor command/ program instruction, TP auxiliary functions, loading of save data, etc. This error occur seven when the same values as before are set.

Countermeasure

1. Turn OFF/ ON the controller power.

Error code: E9405
Error message: [Cubic-S] Cannot use with Cubic-S.
Error processing ：Motor power OFF Error reset: Acceptable
7SEG LED display: Irrelevant

Content

This error appears when a program instruction that cannot be used with Cubic-S option ON is executed.
Examples of the instructions that cannot be used are:
・ULIMIT / LLIMIT
・BASE
These instructions change the parameters that are targets of parameter control. The parameters must match in AS software and Cubic-S so these program instructions may not be executed.

Main Cause

1. Executed a program instruction that can be used only with Cubic-S option OFF.

Countermeasure

1. Reset the error.
2. Change the program so the instruction that cause the error is not executed.

Error code: E9406
Error message: [Cubic-S(X)] XXXX (XX Tool number X) is out of always allowed space. (code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 50

Content
This error indicates that the robot moved out of the constant monitoring area or predicted by the protective stop function that the robot will be outside the constant monitoring area. It is detected by Cubic-S.

The error message indicates where the robot that went out of the monitoring area, and the tool number of the tool where the error was detected.

1. Message indicating where the robot exited the monitoring area
The points or line segments below are used for area monitoring in Cubic-S.
“XXXX” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool
(2) Flange point
(3) Arm monitoring point 1 – 4
(4) Arm line segment 1 - 6

(1) tool is constituted of TCP, tool shape point, and line segments connecting the points.

2. Message indicating the tool number where the tool was detected
Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The message differs according to the tool information of the tool where the error was detected.
“XX Tool number X” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

3. Example of error message display
(1) When the tool pose (command tool number 1 and current tool number 1) is out of the

constant monitoring area
[Cubic-S(1)] Tool (Tool number 1) is out of always allowed area. (Code xxxxxxxx)

(2) When the tool pose (Current tool number 1) is out or the constant monitoring area
[Cubic-S(1)] Tool (Current tool number 1) is out of always allowed area. (Code xxxxxxxx)

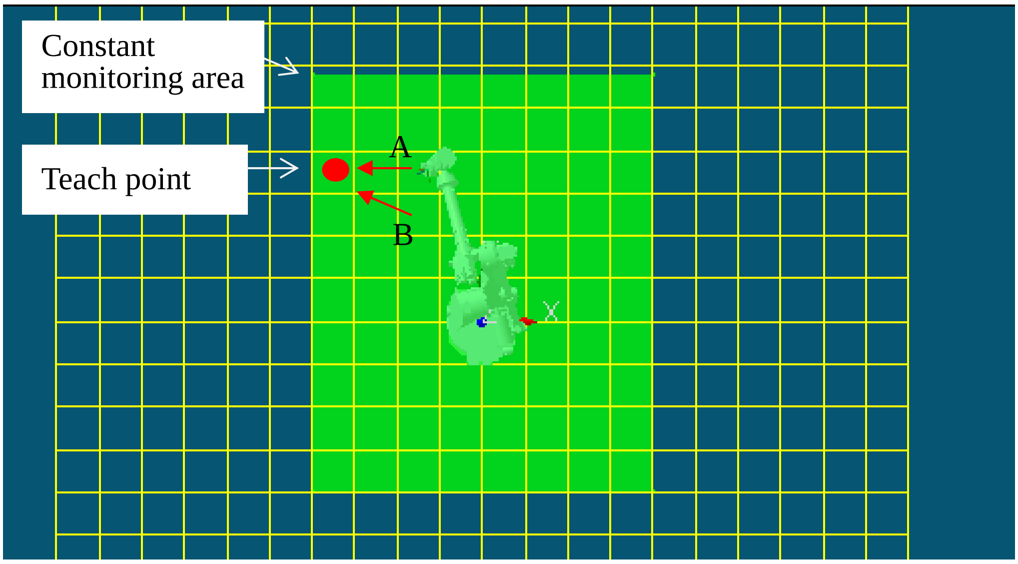
(3) When the line segment on arm 2 (command tool number 1 and current tool number 1) is
[Cubic-S(1)] Arm line segment 2 (Tool number 1) is out of always allowed area. (Code xxxxxxxx)

Main Cause

1. The robot has exceeded the constant monitoring area when the robot was moved manually or by program execution. Or if the robot stopped by protective stop function, the robot has approached the constant monitoring area.)
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error. If the robot stopped by protective stop function, the error can be reset.
2. If the error keeps occurring after being reset, the robot is outside the constant monitoring area, so use the override switch following the below procedure and move the robot back inside the monitoring area.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot inside the monitoring area.
   (3) Release the override and confirm that the error does not occur anymore.
3. Check if the constant monitoring area setting is correct. If it is correct, modify the program.
4. When the robot stops due to the protective stop function, modify the taught data referring to below:
   (1) Reduce the speed of the step where the error occurs. (Shorten the distance to anticipate the error to lessen the possibility of detecting the error.)
   (2) Separate the endpoint of the constant monitoring area and taught point.
   (3) Change the direction of the motion to approach the constant monitoring area from perpendicular direction to a slanted direction. (In the figure below, change to B instead of A)
5. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.


Constant monitoring area
Teach point
A
B
X

Error code: E9407
Error message: [Cubic-S(X)]XXXX(XX tool number X) is in always prohibited space (X) (Code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 51

Content

This error indicates that the robot moved out of the constant prohibited area or predicted by the protective stop function that the robot will enter the constant prohibited area. It is detected by Cubic-S.

The error message indicates where the robot that entered the prohibited area is, and the tool number of the tool where the error was detected.

1. Message indicating where the robot entered the prohibited area

The points or line segments below are used for area monitoring in Cubic-S.
“XXXX” in the message “XXXX (XX Tool number X)” shows one of the following:

(1) Tool
(2) Flange point
(3) Arm monitoring point 1 – 4
(4) Arm line segment 1 - 6

(1) tool is constituted of TCP, tool shape point, and line segments connecting the points.

2. Message indicating the tool number where the tool was detected

Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The message differs according to the tool information of the tool where the error was detected.
“XX Tool number X” in the message “XXXX (XX Tool number X)” shows one of the following:

(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

3. Constant prohibited area number in the error message

For “Always prohibited space (X)”, X indicates the number of the prohibited area that the robot exceeded from.

4. Example of error message display

(1) When the tool pose (command tool number 1 and current tool number 1) entered the constant prohibited area
[Cubic-S(1)]XXXX(Tool number 1) is in always prohibited space (X) (Code xxxxxxxx)

(2) When the tool pose (current tool number 1) entered the constant prohibited area (2)
[Cubic-S(1)]XXXX(Current tool number 1) is in always prohibited space (2) (Code xxxxxxxx)

(3) When the arm line segment (command tool number 1 and current tool number 1) entered the constant prohibited area (3)
[Cubic-S(1)] Arm line segment 2(Current tool number 1) is in always prohibited space (2) (Code xxxxxxxx)

Main Cause

1. The robot has entered the constant prohibited area when the robot was moved manually or by program execution. Or if the robot stopped by protective stop function, the robot has approached the constant prohibited area.)
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error. If the robot stopped by protective stop function, the error can be reset.
2. If the error keeps occurring after being reset, the robot is inside the constant prohibited area, so use the override switch following the below procedure and move the robot back outside the prohibited area.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot outside the prohibited area.
   (3) Release the override and confirm that the error does not occur anymore.
3. Check if the constant prohibited area setting is correct. If it is correct, modify the program.
4. When the robot stops due to the protective stop function, modify the taught data referring to below:
   (1) Reduce the speed of the step where the error occurs. (Shorten the distance to

anticipate the error to lessen the possibility of detecting the error.)

(2) Separate the endpoint of the constant monitoring area and taught point.

(3) Change the direction of the motion to approach the constant monitoring area from perpendicular direction to a slanted direction. (Refer to E9406)

5. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9408
Error message: [Cubic-S(X)]XXXX(XX Tool number X) is out of selectively allowed space (X) . (Code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 52

Content
This error indicates that the robot moved out of the select monitoring area or predicted by the protective stop function that the robot will be outside the select monitoring area. It is detected by Cubic-S.

The error message indicates where the robot that went out of the select monitoring area, and the tool number of the tool where the error was detected.

1. Message indicating where the robot exited the select monitoring area
The points or line segments below are used for area monitoring in Cubic-S.
“XXXX” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool
(2) Flange point
(3) Arm monitoring point 1 – 4
(4) Arm line segment 1 - 6

(1) tool is constituted of TCP, tool shape point, and line segments connecting the points.

2. Message indicating the tool number where the tool was detected
Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The message differs according to the tool information of the tool where the error was detected.
“XX Tool number X” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

3. Select monitoring area number in the error message
For “selectively allowed space (X)” , the number of the monitoring area that the robot

exceeded from.

4. Example of error message display

(1) When the tool pose (command tool number 1 and current tool number 1) is out of the select monitoring area (1)
[Cubic-S(1)] Tool (Tool number 1) is out of selectively allowed area(1). (Code xxxxxxxx)

(2) When the tool pose (Current tool number 1) is out of the constant monitoring area
[Cubic-S(1)] Tool (Current tool number 1) is out of selectively allowed area (2). (Code xxxxxxxx)

(3) When the line segment on arm 2 (command tool number 1 and current tool number 1) is out of the constant monitoring area
[Cubic-S(1)] Arm line segment 2 (Tool number 1) is out of selectively allowed area (3). (Code xxxxxxxx)

Main Cause

1. The robot has exceeded the select monitoring area when the robot was moved manually or by program execution. Or if the robot stopped by protective stop function, the robot has approached the constant monitoring area.)
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error. If the robot stopped by protective stop function, the error can be reset.
2. If the error keeps occurring after being reset, the robot is outside the select monitoring area, so use the override switch following the below procedure and move the robot back inside the monitoring area.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot inside the monitoring area.
   (3) Release the override and confirm that the error does not occur anymore.
3. Check if the select monitoring area setting, wiring and method of use (including external devices) are correct. If they are correct, modify the program.
4. When the robot stops due to the protective stop function, modify the taught data referring to below:
   (1) Reduce the speed of the step where the error occurs. (Shorten the distance to anticipate the error to lessen the possibility of detecting the error.)

(2) Separate the endpoint of the constant monitoring area and taught point.

(3) Change the direction of the motion to approach the constant monitoring area from perpendicular direction to a slanted direction. (Refer to E9406)

5. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9409
Error message: [Cubic-S(X)]XXXX(XX Tool number X) is in selectively prohibited space (X).(Code xxxxxxxx)
Error processing: : Motor power OFF Error reset: Acceptable
7SEG LED display: 53

Content
This error indicates that the robot moved inside the select prohibited area or predicted by the protective stop function that the robot will be inside the select monitoring area. It is detected by Cubic-S.

The error message indicates where the robot that went out of the select prohibited area, and the tool number of the tool where the error was detected.

1. Message indicating where the robot entered the select prohibited area
The points or line segments below are used for area monitoring in Cubic-S.
“XXXX” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool
(2) Flange point
(3) Arm monitoring point 1 – 4
(4) Arm line segment 1 - 6

(1) tool is constituted of TCP, tool shape point, and line segments connecting the points.

2. Message indicating the tool number where the tool was detected
Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The message differs according to the tool information of the tool where the error was detected.
“XX Tool number X” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

3. Select prohibited area number in the error message
For “selectively prohibited space (X)” , the number of the monitoring area that the robot

exceeded from.

4. Example of error message display

(1) When the tool pose (command tool number 1 and current tool number 1) entered the select prohibited area (1)
[Cubic-S(1)] Tool (Tool number 1) is in the selectively allowed area(1). (Code xxxxxxxx)

(2) When the tool pose (Current tool number 1) entered the select prohibited area
[Cubic-S(1)] Tool (Current tool number 1) is in selectively prohibited area (2). (Code xxxxxxxx)

(3) When the line segment on arm 2 (command tool number 1 and current tool number 1) entered the select prohibited area (3)
[Cubic-S(1)] Arm line segment 2 (Tool number 1) is out of selectively allowed area (3). (Code xxxxxxxx)

Main Cause

1. The robot has entered the select prohibited area when the robot was moved manually or by program execution. Or if the robot stopped by protective stop function, the robot has approached the select prohibited area.)
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error. If the robot stopped by protective stop function, the error can be reset.
2. If the error keeps occurring after being reset, the robot is inside the select prohibited area, so use the override switch following the below procedure and move the robot back outside the prohibited area.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot outside the prohibited area.
   (3) Release the override and confirm that the error does not occur anymore.
3. Check if the select prohibited area setting, wiring and method of use is correct. If they are correct, modify the program.
4. When the robot stops due to the protective stop function, modify the taught data referring to below:
   (1) Reduce the speed of the step where the error occurs. (Shorten the distance to anticipate the error to lessen the possibility of detecting the error.)
   (2) Separate the endpoint of the constant monitoring area and taught point.

(3) Change the direction of the motion to approach the constant monitoring area from perpendicular direction to a slanted direction. (Refer to E9406)

5. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9410
Error message: [Cubic-S(X)]JTXX is out of always monitored range of axis (X)
(Code　xxxxxxxx)
Error processing: Motor power OFF　　Error reset: Acceptable
7SEG LED display: 54

Content

This error indicates that the joint with the displayed joint number is outside the constant joint monitoring area.　It is detected by Cubic-S.

Main Cause

1. The zeroing values have become inadequate due to motor replacement, etc. and the axis values exceeded the constant monitoring angle (upper/ lower limits).
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. If the zeroing data are correct, use the override switch to move the robot back in the constant monitor angle.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot inside the monitoring area.
   (3) Release the override and confirm that the error does not occur anymore.
2. If the zeroing value is improper, redo zeroing.
3. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9411

Error message: [Cubic-S(X)]JTXX is out of selectively monitored range of axis (X) (Code xxxxxxxx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 55

Content

This error indicates that the displayed axis is out of the select joint monitoring area. It is detected by Cubic-S.

Main Cause

1. The robot has exceeded the select joint monitoring range when the robot was moved manually or by program execution.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Follow the below procedure to use the override switch and to move the arm within the select joint monitoring area.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot inside the monitoring area.
   (3) Release the override and confirm that the error does not occur anymore.
2. Check if the select joint monitoring setting, wiring and method of use are correct. If they are correct, modify the program.
3. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9412

Error message: [Cubic-S(X)]XXXX(XX Tool number X) speed exceeded 250mm/s.
(Code xxxxxxxx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 56

Content

This error indicates that the robot speed exceeded 250 mm/s. It is detected by Cubic-S.

The error message indicates where the robot exceeded 250 mm/s, and the tool number of the tool where the error was detected.

1) Message indicating where the robot exceeded 250 mm/s

The points or line segments below are used for area monitoring in Cubic-S.
"XXXX" in the message "XXXX (XX Tool number X)" shows one of the following:

(1) TCP
(2) Flange point
(3) Tool shape point 1 – 20
(4) Arm monitoring point 1 - 6

2) Message indicating the tool number where the tool was detected

Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The message differs according to the tool information of the tool where the error was detected.
"XX Tool number X" in the message "XXXX (XX Tool number X)" shows one of the following:

(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

3) Example of error message display

(1) When the flange point (command tool number 1 and current tool number 1) exceeded 250 mm/s.

[Cubic-S(X)] Flange point (Tool number 1) speed exceeded 250mm/s. (Code xxxxxxxx)

(2) When the tool shape point (current tool number 1) exceeded 250 mm/s.

[Cubic-S(X)] Tool shape point1 (Current tool number 1) speed exceeded 250mm/s.
(Code xxxxxxxx)

(3) When the line segment on arm 2 (command tool number 1 and current tool number 1) exceeded 250 mm/s.

[Cubic-S(1)] Arm line segment 2 (Tool number 1) speed exceeded 250mm/s. (Code xxxxxxxx)

Main cause

1. The robot speed has exceeded the 250 mm/s when the robot was moved manually or by program execution.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error.
2. Check if the 250 mm/s speed monitoring setting, wiring and method of use (including external devices) are correct. If they are correct, modify the program.
3. Reduce the manual speed when in manual operating.
4. Reduce the program speed when executing program.
5. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9413
Error message: [Cubic-S(X)]XXXX(XX Tool number X) exceeded the setting speed.
(Code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 56

Content
This error indicates that the robot speed exceeded set speed. It is detected by Cubic-S.

The error message indicates where the robot exceeded set speed, and the tool number of the tool where the error was detected.

1) Message indicating where the robot exceeded set speed
The points or line segments below are used for area monitoring in Cubic-S.
“XXXX” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) TCP
(2) Flange point
(3) Tool shape point 1 – 20
(4) Arm monitoring point 1 - 6

2) Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The message differs according to the tool information of the tool where the error was detected.
“XX Tool number X” in the message “XXXX (XX Tool number X)” shows one of the following:
(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

3) Example of error message display
(1) When the flange point (command tool number 1 and current tool number 1) exceeded set speed.
[Cubic-S(X)] Flange point (Tool number 1) speed exceeded set speed. (Code xxxxxxxx)

(2) When the tool shape point (current tool number 1) exceeded set speed.

[Cubic-S(X)]Tool shape point1 (Current tool number 1) speed exceeded set speed. (Code xxxxxxxx)

(3) When the line segment on arm 2 (command tool number 1 and current tool number 1) exceeded set speed.

[Cubic-S(1)] Arm line segment 2 (Tool number 1) speed exceeded set speed. (Code xxxxxxxx)

Main Cause

1. The robot speed has exceeded the set speed when the robot was moved manually or by program execution.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error.
2. Check if the set speed monitoring setting, wiring and method of use (including external devices) are correct.
3. Reduce the manual speed when in manual operating.
4. Reduce the program speed when executing program.
5. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9414

Error message: [Cubic-S(X)] JTXX has moved during monitor for stoppage.
(Code xxxxxxxx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 57

Content

This error indicates that the axis with the displayed joint number has moved while stop monitoring was being done. It is detected by Cubic-S.

Main Cause

1. The robot moved by manual operation or program execution while stop monitoring is being conducted.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error.
2. Check if the setting, wiring (including external devices), method of use of the stop monitor.
3. Modify the program so that the robot does not move during stop monitoring.
4. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9415
Error message: [Cubic-S(X)] XX Tool number X orientation is out of tool orientation range(XX). (Code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 58

Content
This error indicates that the robot's tool orientation exceeded the set tool orientation range.
It is detected by Cubic-S.

The error message indicates the tool number of the tool and the tool orientation range number where the error was detected.

1) Message indicating the tool number where the tool was detected
Cubic-S calculates the robot pose using the current tool number (tool number by tool ID input) and command tool number (tool number selected by AS software). The messages differ according to the tool information of the tool where the error was detected.
"XX Tool number X" in the message "XXXX (XX Tool number X)" shows one of the following:
(1) Tool number 1 to 32
(2) Command tool number 1 to 32
(3) Current tool number 1 to 32

(1) appears when error is detected in both command and current tool. (2) and (3) appears when the error is detected either in the command or the current tool.

2) Tool orientation range number in the error message
For "Tool orientation range (XX)" , XX indicates the number of the tool orientation range that the robot exceeded from. When error occurs in more than one tool orientation, all the numbers are shown here.

3) Example of error message display
(1) When the tool pose (command tool number 1 and current tool number 1) exceeded the tool orientation range number 1
[Cubic-S(1)] Tool number 1 orientation is out of tool orientation range (1) (Code xxxxxxxx)

(2) When the tool pose (current tool number 1) exceeded the tool orientation range numbers 1 and 2

[Cubic-S(1)] Current tool number 1 orientation is out of tool orientation range (1 2) (Code xxxxxxxx)

Main Cause

1. The robot has exceeded the tool orientation range when the robot was moved manually or by program execution.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Use the override switch following the below procedure and move the robot back outside the prohibited area.
   (1) Switch to teach mode and press ERROR RESET while pressing the override switch to rest the error.
   (2) Continue pressing the override switch and manually move the robot outside the prohibited area.
   (3) Release the override and confirm that the error does not occur anymore.
2. Check if the select monitoring area setting, wiring and method of use (including external devices) are correct.
3. Modify the program so that the tool does not exceed the set orientation range.
4. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9416
Error message: [Cubic-S(X)] Deceleration monitor error (JTXX) at protection stop.
(code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 59

Content

This error indicates that Cubic-S detected error in the displayed axis when monitoring deceleration by input of protective stop signal. Cubic-S monitors each axis when robot comes to a decelerated stop.

Main Cause

1. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9417
Error message: [Cubic-S(X)] Deceleration monitor error (JTXX)at emergency stop. (code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 60

Content

This error indicates that Cubic-S detected error in the displayed axis when monitoring deceleration by input of emergency stop signal. Cubic-S monitors each axis when robot comes to a decelerated stop.

Main Cause

1. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9418

Error message: [Cubic-S(X)] Deviation error in JtXX. (code xxxxxxxx)
Check zeroing, home pose etc in teach mode.

Error processing: Motor power OFF Error reset: Acceptable(Teach mode)

7SEG LED display: 10

Content

This error indicates that the difference between the current encoder value and the robot controller command value has exceeded the set threshold value. It is detected by Cubic-S. The limit value differs according to the robot type and axis.

Main Cause

1. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

WARNING

When this error occurs, there is a great possibility that the encoder internal value is not saved. Therefore, always match the scribes mark (mechanical origin) of all axes in teach mode and confirm that all angle values are at 0°. If the angle values are not at 0°, perform zeroing without fail.

CAUTION

Automatic operation can be resumed after resetting this error. However, the current value is wrong so there is a strong possibility that the robot pose deviates if the robot is moved without confirming the zeroing values.

Error code: E9419
Error message: [Cubic-S(X)] Encoder value error in JtXX (Code xxxxxxxx).
Check zeroing data, home pose etc in teach mode.
Error processing: Motor power OFF Error reset: Acceptable(Teach mode)
7SEG LED display: 0A

Content

This error indicates that the difference between the encoder value stored right before the controller power is turned OFF and the encoder value right after the next time the power is turned ON has exceeded the set threshold value. It is detected by Cubic-S. The limit value differs according to the robot type and axis.

[**NOTE**]

This error may occur in below cases, but they are not abnormalities:

- Controller power ON/ OFF right after the zeroing is turned ON.
- Controller power ON/ OFF right after replacing Cubic-S.
- Controller power ON/ OFF with the separate harness between the controller and arm disconnected and then turning ON the controller with the separate harness reconnected.

Main Cause

1. When the controller power is turned OFF while the robot is in motion, the arm cannot stop suddenly, so there will be a deviation between the last encoder value recorded before Cubic-S turned OFF the controller power and the actual pose of the arm.
2. The robot pose deviated from the encoder internal data due to decrease in the encoder backup battery, disconnection of encoder harness, malfunction of encoder, etc.
3. Replaced the motor or encoder.
4. The arm (motor) was forcibly moved while the controller power is OFF.
5. Modified the zeroing data. (This error occurs in all axes at this time.)
6. Replaced the Cubic-S. (This error occurs in all axes at this time.)

Countermeasure

1. After the error occurs, reset the error in teach mode and check the zeroing pose and home pose to see if there are no deviations.
2. If the motor or encoder is replaced, perform zeroing right away.
3. Check the encoder backup battery and if the voltage has declined below +3.3 V, immediately replace the battery. At the same time, replace the encoder and axes batteries, too.
4. Check to see there are no disconnections and short circuits in the encoder harness.

5. Replace the encoder or the encoder battery backup board.
6. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

⚠ WARNING

When this error occurs, there is a great possibility that the encoder internal value is not saved.　Therefore, always match the scribes mark (mechanical origin) of all axes in teach mode and confirm that all angle values are at 0°.　If the angle values are not at 0°, perform zeroing without fail.

⚠ CAUTION

Automatic operation can be resumed after resetting this error.　However, the current value is wrong so there is a strong possibility that the robot pose deviates if the robot is moved without confirming the zeroing values..

Error code: E9420
Error message: [Cubic-S(X)] Command error in JTXX (code xxxxxxxx) at power ON.
Check zeroing, home pose in teach mode.
Error processing: Motor power OFF Error reset: Acceptable(Teach mode)
7SEG LED display: 10

Content
This error indicates that the difference between the robot controller command value stored right before the controller power is turned OFF and the command value right after the next time the power is turned ON has exceeded the set threshold value. It is detected by Cubic-S. The limit value differs according to the robot type and axis.

[**NOTE**]

This error may occur in below cases, but they are not abnormalities:
・Controller power ON/ OFF right after the zeroing is turned ON.
・Controller power ON/ OFF right after replacing Cubic-S.
・Controller power ON/ OFF with the separate harness between the controller and arm disconnected and then turning ON the controller with the separate harness reconnected.

Main Cause
1. When the controller power is turned OFF while the robot is in motion, the arm cannot stop suddenly, so there will be a deviation between the last encoder value recorded before Cubic-S turned OFF the controller power and the actual pose of the arm.
2. The robot pose deviated from the encoder internal data due to decrease in the encoder backup battery, disconnection of encoder harness, malfunction of encoder, etc.
3. Replaced the motor or encoder.
4. The arm (motor) was forcibly moved while the controller power is OFF.
5. Modified the zeroing data. (This error occurs in all axes at this time.)
6. Replaced the Cubic-S. (This error occurs in all axes at this time.)

Countermeasure
1. After the error occurs, reset the error in teach mode and check the zeroing pose and home pose to see if there are no deviations.
2. If the motor or encoder is replaced, perform zeroing right away.
3. Check the encoder backup battery and if the voltage has declined below +3.3 V, immediately replace the battery. At the same time, replace the encoder and axes batteries, too.
4. Check to see there are no disconnections and short circuits in the encoder harness.
5. Replace the encoder or the encoder battery backup board.

6. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

WARNING

When this error occurs, there is a great possibility that the encoder internal value is not saved.　Therefore, always match the scribes mark (mechanical origin) of all axes in teach mode and confirm that all angle values are at 0°.　If the angle values are not at 0°, perform zeroing without fail.

CAUTION

Automatic operation can be resumed after resetting this error.　However, the current value is wrong so there is a strong possibility that the robot pose deviates if the robot is moved without confirming the zeroing values.

Error code: E9421

Error message: [Cubic-S(X)] Sudden change of enc. value in JtXX (Code xxxxxxxx).
Check zeroing, home pose in teach mode.

Error processing: Motor power OFF Error reset: Acceptable(Teach mode)

7SEG LED display: 10

Content

This error indicates that the deviation value of the encoder current value per time unit exceeded the set value. It is detected by Cubic-S. The limit value differs according to the robot type and axis.

Main Cause

1. Malfunction of the encoder.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. After the error occurs, reset the error in teach mode and check the zeroing pose and home pose to see if there are no deviations.
2. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

WARNING

When this error occurs, there is a great possibility that the encoder internal value is not saved. Therefore, always match the scribes mark (mechanical origin) of all axes in teach mode and confirm that all angle values are at 0°. If the angle values are not at 0°, perform zeroing without fail.

CAUTION

Automatic operation can be resumed after resetting this error. However, the current value is wrong so there is a strong possibility that the robot pose deviates if the robot is moved without confirming the zeroing values.

Error code: E9422

Error message: [Cubic-S(X)] Software processing error in safety unit. (code xx xx)

Error processing: Motor power OFF

Content

This error indicates that abnormality occurred in Cubic-S software processing.

*Reference: The 7SEG LED for this error differs according to the content of the error as shown below:

7SEG LED	Content	Error reset
11	Matching monitor error	Not possible
38	Process time error	Not possible
40	Calculation value error	Not possible

Main Cause

1. Defective Cubic-S.

Countermeasure

1. Turn OFF/ ON the controller power to see if the error can be reset. 。
2. If this error occurs when a certain program step is executed or when a certain operation is done, report Kawasaki the detailed information of the situation, including all the contents of the error message, robot type, controller type and model, AS software, servo software, Cubic-S version, program contents, operation done when error occurred, all AS software save data, all Cubic-S parameters.

Error code: E9424
Error message: [Cubic-S(X)]]Tool numbers do not coincide.(Command X Current X).(code xxxxxxxx)
Error processing: Motor power OFF　　　　Error reset: Acceptable
7SEG LED display: 16

Content

This error indicates that there is a mismatch of the command tool number (the tool number of the tool currently selected by AS software) and the current tool number (tool number specified by tool ID input).　It is detected by Cubic-S.　Cubic-S detects the error when there is a mismatch in the command tool and current tool and the robot moves more than the distance set in Cubic-S parameter No. 51 “Movable Distance in Tool Number Discrepancy” . This error is not detected if Cubic-S parameter No.210 “Tool ID Valid/ Invalid” is set to Invalid.

Main Cause

1. The same tool number as the tool number selected for manual operation or program execution is not input in tool ID.

Countermeasure

1. Reset the error after matching the command tool number and the current tool number.. The error cannot be rest unless the tool numbers match.　(Possible is controller power is turned OFF/ ON).
2. Check if the settings for parameter No.51 “Toll Discrepancy Monitoring”, No.209 “Tool ID/ No. Table and No.21“Tool ID Valid/ Invalid”.
3. Fix the wiring connected to XIN connector tool ID input 1 to 5 or in external devices if there are any problem.
4. Check if the tools selected in manual operation or at program execution are correct.

Error code: E9425
Error message: [Cubic-S(X)] Relay for internal emergency stop is welded. (Code xxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 17

Content

This error indicates that the relay for power shut down inside Cubic-S has stuck.

Main Cause

1. Defect in Cubic-S.

Countermeasure

1. Replace Cubic-S if error cannot be released.

Error code: E9426
Error message: [Cubic-S(X)] Relay for external emergency stop is welded.(code xxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 17

Content

This error indicates that the external safety relay (option for E1x, E2x, E3x, E4x controllers. Safety relay in 1 XL board inside Cubic-S unit for E0x controller) for Cubic-S power shut down has welded.

Main Cause

1. Defect in external safety relay (option) connected between XCS1connector pins A6-B6or the wiring to it.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the external safety relay (or 1XL board in E0x controller) connected between XCS1connector pins A6-B6 or the wiring to it. Replace if any abnormality is found.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

Error code: E9427
Error message: [Cubic-S(X)] Failure in circuit for relay weld detection or in wiring.
(code xxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 17

Content
This error indicates that there was trouble (abnormality in weld check line diagnosis pulse) in the weld check circuit for external safety relay (option) for Cubic-Slower shut down or in its wiring.

Main Cause
1. Defect in external safety relay (option) connected between XCS1connector pins A6-B6 or the wiring to it (E1x, E2x, E3x, E4x controllers). Defect in 1XL board inside Cubic-S unit or XCS1-XCS30 harness (E0x controller).
2. Defect in Cubic-S.

Countermeasure
1. Check if there are no abnormalities in the external safety relay (option) connected between XCS1connector pins A6-B6 or the wiring to it (E1x, E2x, E3x, E4x controllers). Check if there are no abnormalities in 1XL board inside Cubic-S unit or XCS1-XCS30 harness (E0x controller).
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

Error code: E9428
Error message: [Cubic-S(X)] External safety relay (user output XX) is welded.
(code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 18

Content

The "weld check function for safety relay connected to safety output" mentioned in 10.1.3, has detected that there is an error of wiring or weld external safety relay connected to the relevant safety output and safety input has stuck (Contact B close status cannot be detected as safety input in the external relay although relevant safety output is OFF).
*This error is detected only if weld check function is used in user safety output in XOUT1,2 connector and when trouble occurs in that part.

Main Cause

1. Malfunction in the external safety relay connected to the relevant safety input/ output or defective wiring to the relay.
2. The 24V power is not supplied to the connector of the relevant safety input.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the external safety relay connected to the relevant safety input/ output or defective wiring to the relay using "weld check function for safety relay connected to safety output".
2. Check if 24V power is properly supplied to the allocated safety input connector.。
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9452

Error message: [Cubic-S(X)] External safety relay (output of Teach/Fast Check mode) is welded. (code xxxxxxxxxxxxxxxxxx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 18

Content

The "weld check function for safety relay connected to safety output" mentioned in 10.1.3, has detected that there is an error of wiring or weld external safety relay connected to the relevant safety output and safety input has stuck (Contact B close status cannot be detected as safety input in the external relay although relevant safety output is OFF).
*This error is detected only if weld check function is used in teach/ fast check mode fixed safety output in XCS5 connector and when trouble occurs in that part.

Main Cause

1. Malfunction in the external safety relay connected to the relevant safety input/ output (for teach/ fast check mode fixed safety output, XCS5 connector pins A1 or B1) or defective wiring to the relay.
2. The 24V power is not supplied to the connector of the relevant safety input.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the external safety relay connected to the relevant safety input/ output (for teach/ fast check mode fixed safety output, XCS5 connector pins A1 or B1) or defective wiring to the relay using "weld check function for safety relay connected to safety output".
2. Check if 24V power is properly supplied to the safety input connector.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9453
Error message: [Cubic-S(X)] External safety relay (output of teach speed monitor) is welded. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 18

Content

The "weld check function for safety relay connected to safety output" mentioned in 10.1.3, has detected that there is an error of wiring or weld external safety relay connected to the relevant safety output and safety input has stuck (Contact B close status cannot be detected as safety input in the external relay although relevant safety output is OFF).
*This error is detected only if weld check function is used in teach speed monitoring fixed safety output in XCS5 connector and when trouble occurs in that part.

Main Cause

1. Malfunction in the external safety relay connected to the relevant safety input/ output (for teach speed monitoring fixed safety output, XCS5 connector pins A1 or B1) or defective wiring to the relay.
2. The 24V power is not supplied to the connector of the relevant safety input.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the external safety relay connected to the relevant safety input/ output (for teach speed monitoring fixed safety output, XCS5 connector pins A1 or B1) or defective wiring to the relay using "weld check function for safety relay connected to safety output".
2. Check if 24V power is properly supplied to the safety input connector.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9454
Error message: [Cubic-S(X)] External safety relay (output of override) is welded.
(code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 18

Content

The “weld check function for safety relay connected to safety output” mentioned in 10.1.3, has detected that there is an error of wiring or weld external safety relay connected to the relevant safety output and safety input has stuck (Contact B close status cannot be detected as safety input in the external relay although relevant safety output is OFF).
*This error is detected only if weld check function is used in override monitoring fixed safety output in XCS5 connector and when trouble occurs in that part.

Main Cause

1. Malfunction in the external safety relay connected to the relevant safety input/ output (for override monitoring fixed safety output, XCS5 connector pins A1 or B1) or defective wiring to the relay.
2. The 24V power is not supplied to the connector of the relevant safety input.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the external safety relay connected to the relevant safety input/ output (for override fixed safety output, XCS5 connector pins A1 or B1) or defective wiring to the relay using “weld check function for safety relay connected to safety output”.
2. Check if 24V power is properly supplied to the safety input connector.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9455

Error message: [Cubic-S(X)] External safety relay (output of emergency stop) is welded. (code xx xx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 18

Content

The “weld check function for safety relay connected to safety output” mentioned in 10.1.3, has detected that there is an error of wiring or weld external safety relay connected to the relevant safety output and safety input has stuck (Contact B close status cannot be detected as safety input in the external relay although relevant safety output is OFF).

*This error is detected only if weld check function is used in emergency stop monitoring fixed safety output in XCS5 connector and when trouble occurs in that part.

Main Cause

1. Malfunction in the external safety relay connected to the relevant safety input/ output (for emergency stop monitoring fixed safety output, XCS5 connector pins A4 or B4) or defective wiring to the relay.
2. The 24V power is not supplied to the connector of the relevant safety input.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the external safety relay connected to the relevant safety input/ output (for emergency stop fixed safety output, XCS5 connector pins A4 or B4) or defective wiring to the relay using “weld check function for safety relay connected to safety output”.
2. Check if 24V power is properly supplied to the safety input connector.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9430

Error message: [Cubic-S(X)] Failure in circuit for driving e-stop relay or in wiring. (code xx xx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 19

Content

This error indicates that there was malfunction in the circuit that drives the relay for power shut down in Cubic-S or other troubles occurred in external safety relay (option for E1x, E2x, E3x, E4x controllers. Safety relay in 1 XL board inside Cubic-S unit for E0x controller), wiring, or relay itself.

Main Cause

1. Defect in Cubic-S.
2. (When external safety relay (Option) is connected to XCS6 pins A1-B1 or pins A2-B2) Defect in external relay connected to XCS6 A1-B1and A2-B2 or wiring (E1x, E2x, E3x, E4x controllers). Or, defect in 1 XL board inside Cubic-S unit or XCS1-XCS30 harness (E0x controller).

Countermeasure

1. If error cannot be reset, replace Cubic-S.
2. (When external safety relay (Option) is connected to XCS6 pins A1-B1 or pins A2-B2) Confirm that there are defects in external relay connected to XCS6 A1-B1and A2-B2 or wiring (E1x, E2x, E3x, E4x controllers). Or, check if there are no defect in safety relay in 1 XL board inside Cubic-S unit (E0x controller).

Error code: E9431
Error message: [Cubic-S(X)] Failure in circuit for safety output (user XX) or in wiring. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 21

Content

This error indicates that there was short circuit or grounding in the wiring connected to user safety output, malfunction in external devices, or defect in Cubic-S safety output circuit.
(*The error message above appears when error occurs in user safety output in XOUT1,2 connector.)

Main Cause

1. Short circuit or grounding in the wiring connected to XOUT connector pin for user safety output, or malfunction in the external devices. *Refer to 10.2.1.
2. 24V power is not supplied to XOUT connector.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to the user safety output on XCS5 connector indicated in the error message or in the external devices. (See Chapter 9 for details on the wiring method).
2. Check if 24 V power is supplied to the XOUT connector. (See Chapter 9 for details on the power connection)
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

[**NOTE**]

Having GND short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9456
Error message: [Cubic-S(X)] Failure in circuit for fixed safety output (Teach/Fast Check mode) or in wiring. (code xxxxxxxxxxxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 21

Content

This error indicates that there was short circuit or grounding in the wiring connected to fixed safety output, malfunction in external devices, or defect in Cubic-S safety output circuit.
(*The error message above appears when error occurs in teach/ fast check mode fixed safety output in XCS5 connector A1 or B1 pin.)

Main Cause

1. Short circuit or grounding in the wiring connected to XCS5connector pin A1 or B1 for emergency stop fixed safety output, or malfunction in the external devices. *Refer to 10.2.1.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to the teach/ fast check fixed safety output on XCS5 connector pin A1 or B1 indicated in the error message or in the external devices.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[**NOTE**]

Having GND short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9457

Error message: [Cubic-S(X)] Failure in circuit for fixed safety output (teach speed monitor) or in wiring. (code xx xx)

Error processing: Motor power OFF   Error reset: Acceptable

7SEG LED display: 21

Content

This error indicates that there was short circuit or grounding in the wiring connected to fixed safety output, malfunction in external devices, or defect in Cubic-S safety output circuit.
(*The error message above appears when error occurs in teach speed monitoring fixed safety output in XCS5 connector A2 or B2 pin.)

Main Cause

1. Short circuit or grounding in the wiring connected to XCS5connector pin A2 or B2 for teach speed monitoring fixed safety output, or malfunction in the external devices.
   *Refer to 10.2.1.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to the teach speed monitoring fixed safety output on XCS5 connector pin A2 or B2 indicated in the error message or in the external devices.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[**NOTE**]

Having GND short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9458
Error message: [Cubic-S(X)] Failure in circuit for fixed safety output (override) or in wiring. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 21

Content

This error indicates that there was short circuit or grounding in the wiring connected to fixed safety output, malfunction in external devices, or defect in Cubic-S safety output circuit. (*The error message above appears when error occurs in override fixed safety output in XCS5 connector A3 or B3 pin.)

Main Cause

1. Short circuit or grounding in the wiring connected to XCS5connector pin A3 or B3 for override fixed safety output, or malfunction in the external devices. *Refer to 10.2.1.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to the override fixed safety output on XCS5 connector pin A3 or B3 indicated in the error message or in the external devices.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[**NOTE**]

Having GND short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9459

Error message: [Cubic-S(X)] Failure in circuit for fixed safety output (emergency stop) or in wiring. (code xx xx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 21

Content

This error indicates that there was short circuit or grounding in the wiring connected to fixed safety output, malfunction in external devices, or defect in Cubic-S safety output circuit.
(*The error message above appears when error occurs in emergency stop fixed safety output in XCS5 connector A4 or B4 pin.)

Main Cause

1. Short circuit or grounding in the wiring connected to XCS5connector pin A4 or B4 for emergency stop fixed safety output, or malfunction in the external devices. *Refer to 10.2.1.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to the emergency stop fixed safety output on XCS5 connector pin A4 or B4 indicated in the error message or in the external devices.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[**NOTE**]

Having GND short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9433
Error message: [Cubic-S(X)] Failure in circuit for safety input (user %-M) or in wiring. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content

This error indicates that there was short circuit or grounding in the wiring connected to user safety input, malfunction in external devices, or defect in Cubic-S safety input circuit. (*The error message above appears when error occurs in user safety input in XIN1,2 connector.)

*This error is detected only when the "safety input diagnosis" (see 11.1.10.1) is enabled for the relevant safety input.

Main Cause

1. Short circuit with the power line or the dual input line occurred in the wiring connected to the XIN connector user safety input indicated in the error message or in external devices. NOTE*XIN1 connector (ch1 to 4) and XIN2 connector (ch5 to 8) for user safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit with the power line occurs in ch1, this error may occur in ch2 to 4 inputs if input is ON in any of the channels.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to the user safety input on XIN connector indicated in the error message or in the external devices. Also, check wirings for other channels sharing the test pulse.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

Error code: E9444
Error message: [Cubic-S(X)] Status of safety input (user XX) does not coincide. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content

This error indicates that there was mismatch in the dual input in user safety input. (*The error message above appears when error occurs in user safety input in XIN1,2 connectors.)

Main Cause

1. The detected error can be divided in two as below following the “input logic setting” mentioned in 10.1.1.

   【Equivalent setting】

   One line of dual input connected to user safety input was ON and the other was OFF for more than the time set in “Allowed time of Discrepancy” (See 10.1.1). Main causes are (1) mismatch occurred exceeding the “allowed time of discrepancy setting” in the dual contact of external devices, (2) defective contact in external devices, (3) short circuit with power line or GND of one of the lines in dual input.

   【Complementary setting】

   The dual input connected to user safety input was ON,ON or OFF, OFF for more than the time set in “Allowed time of Discrepancy” (See 10.1.1). Main causes are (1) mismatch occurred exceeding the “allowed time of discrepancy setting” in the dual contact of external devices, (2) defective contact in external devices, (3) short circuit with power line or GND of one of the lines in dual input.

   NOTE*XIN1 connector (ch1 to 4) and XIN2 connector (ch5 to 8) for user safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit with the power line occurs in ch1, this error may occur in ch2 to 4 inputs if input is ON in any of the channels.
2. Defect in Cubic-S.

Countermeasure

1. Check if troubles mentioned in (1), (2), (3) above are not occurring in devices and wirings connected to user safety input mentioned in XIN connector error message.(For (1), the “allowed time of discrepancy” may be changed depending on the motion of the external device used.)

   Also, check wirings for other channels sharing the test pulse.

2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[NOTE]

1. To recover from this error, remove the cause or the error and input the inactive signal (turns OFF the relevant safety input) before conducting error reset procedure.
2. Having GND in (3) above short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9460

Error message: [Cubic-S(X)] Failure in circuit for fixed safety input (Teach/Fast Check mode) or in wiring. (code xx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 22

Content

This error indicates that there is an abnormality in: the wiring connected to the fixed safety input, such as short circuit or grounding; teach/ repeat switch; Cubic-S safety input circuit. (*The error message above appears when error occurs in teach/ fast check mode fixed safety input in XCS2 connector.)

Main Cause

1. Error, such as short circuit with power source or short circuit between the dual input lines, occurred in the wiring connected to fixed safety input for teach/ fast check mode (XCS2 connector B6-A6, B7-A8, A7, B8 pins) or teach/ repeat switch.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the teach/ fast check mode fixed safety input power line, this error may occur in override and emergency stop fixed safety inputs if input is ON in any of the channels.
2. Incorrect jumper setting on 1TR board.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for teach/ fast check mode (XCS2 connector B6-A6, B7-A8, A7, B8 pins) or teach/ repeat switch.
   Also, check wirings for other channels sharing the test pulse.
   In case of E0x controller, replace 1XS board.
2. Check the setting of jumpers JP1, JP2 on 1TR board and if set to JP1, change the setting to JP2.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9461
Error message: Failure in circuit for fixed safety input (teach speed monitor) or in wiring. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content

This error indicates that there is an abnormality in: the wiring connected to the fixed safety input, such as short circuit or grounding; teach/ repeat switch; Cubic-S safety input circuit. (*This error message shows the message that appears when error occurs in teach speed monitoring fixed safety input in XCS2 connector, when teach/repeat switch supporting fast check mode is used. This error does not occur when the teach/ repeat switch does not support fast check mode.)

Main Cause

1. Error, such as short circuit with power source or short circuit between the dual input lines, occurred in the wiring connected to fixed safety input for teach speed monitoring (XCS2 connector B9-A9, B10-A11 pins) or teach/ repeat switch.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the teach/ fast check mode fixed safety input power line, this error may occur in override and emergency stop fixed safety inputs if input is ON in any of the channels.
2. Incorrect jumper setting on 1TR board.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for teach speed monitoring (XCS2 connector B9-A9, B10-A11 pins) or teach/ repeat switch.
   Also, check wirings for other channels sharing the test pulse. In case of E0x controller, replace 1XS board.
2. Check the setting of jumpers JP1, JP2 on 1TR board and if set to JP1, change the setting to JP2.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9462
Error message: [Cubic-S(X)] Failure in circuit for fixed safety input (override) or in wiring. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content

This error indicates that there is an abnormality in: the wiring connected to the fixed safety input, such as short circuit or grounding; teach/ repeat switch; Cubic-S safety input circuit.
(*This error message shows the message that appears when error occurs in override fixed safety input in XCS2 connector, when teach/repeat switch supporting fast check mode is used. This error does not occur when the teach/ repeat switch does not support fast check mode.)固

Main Cause

1. Error, such as short circuit with power source or short circuit between the dual input lines, occurred in the wiring connected to fixed safety input for override (XCS2 connector B12-A12, B13-A13 pins) or teach/ repeat switch.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the teach/ fast check mode fixed safety input power line, this error may occur in override and emergency stop fixed safety inputs if input is ON in any of the channels.
2. Incorrect jumper setting on 1TR board.
3. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for override (XCS2 connector B12-A12, B13-A13 pins) or teach/ repeat switch.
   Also, check wirings for other channels sharing the test pulse.
2. Check the setting of jumpers JP1, JP2 on 1TR board and if set to JP1, change the setting to JP2.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9463
Error message: [Cubic-S(X)] Failure in circuit for fixed safety input (emergency stop) or in wiring. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content
This error indicates that there is an abnormality in: the wiring connected to the fixed safety input, such as short circuit or grounding; teach/ repeat switch; Cubic-S safety input circuit. (*This error message shows the message that appears when error occurs in emergency fixed safety input in XCS2 connector, when teach/repeat switch supporting fast check mode is used. This error does not occur when the teach/ repeat switch does not support fast check mode.)

Main Cause
1. Error, such as short circuit with power source or short circuit between the dual input lines, occurred in the wiring connected to fixed safety input for emergency stop (XCS2 connector B14-A14, B15-A15 pins) or teach/ repeat switch.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the emergency stop fixed safety input power line, this error may occur in teach/ fast check fixed input, teach speed monitoring function and override fixed safety inputs if input is ON in any of the channels.
2. Incorrect jumper setting on 1TR board.
3. Defect in Cubic-S.

Countermeasure
1. Check if there are no abnormalities in the wiring connected to fixed safety input for teach/ fast check mode (XCS2 connector B14-A14, B15-A15 pins) or teach/ repeat switch.
   Also, check wirings for other channels sharing the test pulse.
2. Check the setting of jumpers JP1, JP2 on 1TR board and if set to JP1, change the setting to JP2.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

[NOTE]

1. To recover from this error, remove the cause or the error and input the inactive signal (turns OFF the relevant safety input) before conducting error reset procedure.
2. Having GND in (3) above short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9464
Error message: [Cubic-S(X)] Coincidence error of fixed safety input (Teach/Fast Check mode) state. (code xx xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content

This error indicates that there was mismatch in the dual input in fixed safety output. (*The error message above appears when error occurs in teach/ fast check mode fixed safety input in XCS2 connector.)

Main Cause

1. The dual input connected to teach/ fast check mode fixed safety output(XCS2 connector B6-A6, B7-A8, A7, B8 pins) was ON,ON or OFF, OFF [*1]for more than the time set in "Allowed time of Discrepancy" [*2]. Main causes are (1) mismatch occurred exceeding the "allowed time of discrepancy setting" in the dual contact of teach/ repeat switch, (2) defective contact in teach/ repeat switch, (3) short circuit with power line or GND of one of the lines in dual input.
   *1 Input logic setting for teach/ fast check mode fixed safety input is set to Complementary.
   *2 The allowed time of discrepancy is fixed for fixed safety input, and cannot be changed.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the emergency stop fixed safety input power line, this error may occur in teach/ fast check fixed input, teach speed monitoring function and override fixed safety inputs if input is ON in any of the channels.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for teach/ fast check mode (XCS2 connector B6-A6, B7-A8, A7, B8 pins) or teach/ repeat switch. Also, check wirings for other channels sharing the test pulse.
   In case of E0x controller, replace 1XS board.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

Error code: E9465

Error message: [Cubic-S(X)] Coincidence error of fixed safety input(teach speed monitor) state.(code xx xx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 22

Content

This error indicates that there was mismatch in the dual input in fixed safety input. (*This error message shows the message that appears when error occurs in teach speed monitoring fixed safety input in XCS2 connector.)

Main Cause

1. The detected error can be divided in two as below following the “input logic setting” mentioned in 10.1.1.

   【Equivalent setting】

   One line of dual input connected to teach speed monitoring fixed safety input (XCS2 connector B9-A9, B10-A11 pins) was ON and the other was OFF for more than the time set in “Allowed time of Discrepancy” (See 10.1.1). Main causes are (1) mismatch occurred exceeding the “allowed time of discrepancy setting” in the dual contact of teach/ repeat switch, (2) defective contact in teach/ repeat switch, (3) short circuit with power line or GND of one of the lines in dual input.

   【Complementary setting (when teach/ repeat switch used does not support fast check mode) 】

   The dual input connected to teach speed monitoring fixed safety input (XCS2 connector B9-A9, B10-A11 pins) was ON,ON or OFF, OFF for more than the time set in “Allowed time of Discrepancy” (See 10.1.1). Main causes are (1) mismatch occurred exceeding the “allowed time of discrepancy setting” in the dual contact of teach/ repeat switch, (2) defective contact in teach/ repeat switch, (3) short circuit with power line or GND of one of the lines in dual input.

   *1 The allowed time of discrepancy is fixed for fixed safety input, and cannot be changed.

   *2 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the emergency stop fixed safety input power line, this error may occur in teach/ fast check fixed input, teach speed monitoring function and override fixed safety inputs if input is ON in any of the channels.

2. Defect in Cubic-S.
3. Defect in teach/ repeat/ (fast-forward check) switch.

4. (Only for E0x controller): Defect in operation panel board (1XS board) or X413 connector not connected to 1XS board.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for teach speed monitor (XCS2 connector B9-A9, B10-A11 pins) or teach/ repeat/ (fast-forward check) switch. Also, check wirings for other channels sharing the test pulse. For E0x controller, check if X413 connector on 1XS board is connected. If it is, replace 1XS board.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[**NOTE**]

1. To recover from this error, remove the cause or the error and input the inactive signal (turns OFF the relevant safety input) before conducting error reset procedure.
2. Having GND in (3) above short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9466

Error message: [Cubic-S(X)] Coincidence error of fixed safety input (override) state. (code xxxxxxxxxxxxxxxxxx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 22

Content

This error indicates that there was mismatch in the dual input in fixed safety output. (*Error message above appears when error occurs in override fixed safety input in XCS2 connector.)

Main Cause

1. The dual input connected to override fixed safety output (XCS2 connector B12-A12, B13-A13 pins) was ON,ON or OFF, OFF *1 for more than the time set in “Allowed time of Discrepancy” *2. Main causes are (1) mismatch occurred exceeding the “allowed time of discrepancy setting” in the dual contact of override switch, (2) defective contact in override switch, (3) short circuit with power line or GND of one of the lines in dual input.
   *1 Input logic setting for override fixed safety input is set to Complementary.
   *2 The allowed time of discrepancy is fixed for fixed safety input, and cannot be changed.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the emergency stop fixed safety input power line, this error may occur in teach/ fast check fixed input, teach speed monitoring function and override fixed safety inputs if input is ON in any of the channels.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for override (XCS2 connector B12-A12, B13-A13 pins) or teach/ repeat switch.
   Also, check wirings for other channels sharing the test pulse.
2. Replace Cubic-S if there is no problem in 1 above, or error cannot be reset after removing all defects.

[**NOTE**]

1. To recover from this error, remove the cause or the error and input the inactive signal (turns OFF the relevant safety input) before conducting error reset procedure.
2. Having GND in (3) above short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9467
Error message: [Cubic-S(X)] Coincidence error of fixed safety input (emergency stop) state.(code xxxxxxxxxxxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 22

Content

This error indicates that there was mismatch in the dual input in fixed safety output. (*The error message above appears when error occurs in emergency fixed safety input in XCS2 connector.)

Main Cause

1. The dual input connected to emergency fixed safety output(XCS2 connector B14-A14 B15-A15 pins) was ON,ON or OFF, OFF *1 for more than the time set in “Allowed time of Discrepancy” *2. Main causes are (1) mismatch occurred exceeding the “allowed time of discrepancy setting” in the dual contact of emergency switch, (2) defective contact in emergency switch, (3) short circuit with power line or GND of one of the lines in dual input.
   *1 Input logic setting for emergency fixed safety input is set to Complementary.
   *2 The allowed time of discrepancy is fixed for fixed safety input, and cannot be changed.
   NOTE* 4 channels of fixed safety input share the same test pulse, so if there is a malfunction in the test pulse output line, this error may occur in other channels with the input ON. For example, if short circuit occurs in the emergency stop fixed safety input power line, this error may occur in teach/ fast check fixed input, teach speed monitoring function and override fixed safety inputs if input is ON in any of the channels.
2. Defect in Cubic-S.

Countermeasure

1. Check if there are no abnormalities in the wiring connected to fixed safety input for emergency stop (XCS2 connector B14-A14, B15-A15 pins) or teach/ repeat switch. Also, check wirings for other channels sharing the test pulse.
2. Replace Cubic-S if there is no problem in 1 and 2 above, or error cannot be reset after removing all defects.

[**NOTE**]

1. To recover from this error, remove the cause or the error and input the inactive signal (turns OFF the relevant safety input) before conducting error reset procedure.
2. Having GND in (3) above short circuited (grounded) for an extended time period may result in malfunction of the safety output part, so fix the short circuit as soon as possible.

Error code: E9435
Error message: [Cubic-S(X)] Power has dropped. (codexxxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 24

Content
This error indicates that decrease in the power source (24V) to Cubic-S has decreased.

Main Cause
1. Decrease in 24V power source or defect in wiring connected to A1-B1 (A2-B2) A4 pins on XCS1 connector.
2. (When using XCS6 connector) Defect in wiring of A1-B1 (A2-B2) A4 pins on XCS1 connector (E1x, E2x, E3x, E4x controller). Or, Defect in 1XL board in Cubic-S unit or XCS1-XCS30 harness (ground lines, etc.) (E0x controller)
3. Defect in Cubic-S.

Countermeasure
1. Check if there are not problems in the wiring of A1-B1 (A2-B2) A4 pins on XCS1 connector.
2. (When using XCS6 connector) check if there are not problem in the wiring connected to A1 and A2 pins on XCS1 connector (E1x, E2x, E3x, E4x controller). For E0x controller, Check if there are not problems in 1XL board in Cubic-S unit or XCS1-XCS30 harness.
3. Replace Cubic-S if there are no problems in 1 and 2 above, or error cannot be reset after removing all defects.

Error code: E9436

Error message: [Cubic-S(X)] Error in communication with servo board X. (code xxxxxxxxxxxxxxxx)(type: X)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 26

Content

This error indicates that Cubic-S detected abnormality in communication with servo board.

Main Cause

1. Defect in the wiring connected to A3 and A4 pins on XCS1 connector.
2. Defect in the servo board.
3. Defect in Cubic-S.

Countermeasure

1. Check if the wiring connected to A3 and A4 pins on XCS1 connector is correct.
2. Replace the servo board.
3. Replace Cubic-S.

Error code: E4082

Error message: [Servo board x] Error in communication with Cubic-S. (code: xxxx)

Error processing: Motor power OFF Error reset: Acceptable

Content

This error indicates that the servo board detected abnormality in communication with Cubic-S.

Main Cause

1. Defect in the communication line connected to XCS1 connector pins B3, B4.
2. Defect in the power line connected to XCS1 connector pins A1, B1, A2, B2.
3. (When using XCS6 connector) Defect in the wiring (ground faults, etc.) connected to XCS6 connector pins A1,A2. (E1x, E2x, E3x, E4x controller). Or, Defect in 1XL board in Cubic-S unit or XCS1-XCS30 harness (ground lines, etc.) (E0x controller)
4. Defect in Cubic-S.
5. Defect in the servo board (1TB board).

Countermeasure

1. Check if there are not problems in the communication line connected to XCS1connector pins B3, B4.
2. Check if there are not problems in the power line connected to XCS1 connector pins A1, B1, A2, B2.
3. (When using XCS6 connector) Check if there are not problems in the wiring (ground faults, etc.) connected to XCS6 connector pins A1,A2 (E1x, E2x, E3x, E4x controller). For E0x controller, Check if there are not problems in 1XL board in Cubic-S unit or XCS1-XCS30 harness.
4. Replace Cubic-S.
5. Replace the servo board.

Error code: E9437
Error message: [Cubic-S(X)] Encoder communication error in JtXX. (code xxxxxxxxxxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 26

Content

This error indicates that Cubic-S detected abnormality in encoder communication.

Main Cause

1. The harnesses between the servo board⇔Cubic-S (XCS3,4 connectors)) ⇔separate harness ⇔ machine harness⇔encoder are disconnected or short circuited.
2. Defect in the encoder.
3. Defect in Cubic-S.
4. Defect in the servo board.

Countermeasure

1. Check if there is no problem in the harnesses between the servo board⇔Cubic-S (XCS3,4 connectors) ⇔separate harness ⇔ machine harness⇔encoder.
2. Replace the encoder.
3. Replace Cubic-S.
4. Replace the servo board.

Error code: E9439

Error message: [Cubic-S(X)] Encoder failure in JtXX. (code xx xx)

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: 32

Content

This error indicates that error was detected in the encoder.

*This error is disabled as default setting and it normally does not occur. (This setting cannot be changed by the user).

Main Cause

1. Defect in the encoder.
2. Decrease in battery or encoder power.

Countermeasure

1. Replace the encoder.
2. Replace the battery.
3. Confirm that there are no defects in the encoder line.

Error code: E9440
Error message: [Cubic-S(X)] Override switch is kept ON. (code xx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 34

Content

This error indicates that the input signal from the override switch is ON for more than 5 minutes.

Main Cause

1. The override switch was pressed continuously for more than 5 minutes.
2. Malfunction of the override switch.
3. Defect in Cubic-S.

Countermeasure

1. Release the override switch.
2. Replace the override switch.
3. Replace Cubic-S.

Error code: E9423

Error message: [Cubic-S(X)] Safety unit error. (code xx xx)

Error processing: Motor power OFF

Content

This error indicates the error was detected as result of the self diagnosis inside Cubic-S.

Main Cause

1. Error in Cubic-S.

Countermeasure

1. Try resetting the error by turning OFF/ ON the power.
2. When error cannot be reset in method 1 above, replace Cubic-S.

Error code: E9442
Error message: [Cubic-S(X)] Parameter values are rewritten in PC. (code xxxxxxxx)
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: 42

Content

This error indicates that parameter was written from personal computer for parameter setting to Cubic-S. It is detected by Cubic-S. After parameters have been modified, controller power should be turned OFF/ ON to verify the parameters between the AS software and Cubic-S.

Main Cause

1. Parameter values were written via the personal computer set for parameter setting.

Countermeasure

1. Turn OFF/ ON the controller power.

Error code: E9443

Error message: [Cubic-S] Tool data is different from that of tool shape number.

Error processing: Display only Error reset: Not acceptable

7SEG LED display: Not related

Content

This error indicates that the tool transformation value set by TOOL command/ instruction and that set by SET_TOOL command/ instruction are different. If system switch CBS_TOOLCHG is ON, this error is detected by AS software.

The tool transformation value set by SET_TOOLSHAPE command/ instruction is used in space monitoring function in Cubic-S. Tool transformation value different from that used in space monitoring in Cubic-S cannot be specified by AS software.

Main Cause

1. The tool transformation value set in TOOL command/ instruction and the tool transformation value for tool shape number set in SET_TOOLSHAPE command/ instruction do not match.

Countermeasure

1. Confirm the tool transformation value ad tool shape number.
2. Using SET_TOOLSHAPE command/ instruction, register the tool transformation value that is to be use in TOOL command/ instruction.

Error code: E9448

Error message: [Cubic-S(X)] No response from Cubic-S.

Error processing: Motor power OFF Error reset: Acceptable

7SEG LED display: Irrelevant

Content

This error indicates that error occurred in communication with Cubic-S. It is detected in AS software.

Main Cause

1. Cubic-S is not correctly installed. (Was able to communicate normally at the beginning of the startup operation, but lost communication during the operation.)
2. Defect in Cubic-S.

Countermeasure

1. Reset the error.
2. If error cannot be reset, try resetting the error by turning OFF/ ON the controller power.
3. Replace Cubic-S.

Error code: E9449
Error message: [Cubic-S(X)] JTXX speed exceeded 250mm/s. (code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 56

Content

This error indicates that the speed of the axis with the displayed joint number exceeded 250 mm/s. It is detected by Cubic-S. The speed of the rotation axis is calculated from the equivalent radius setting.

Main Cause

1. The joint speed exceeded 250 mm/s during manual operation or program execution.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error.
2. Check if the setting, wiring (including external devices) and the method of use of the 250 mm/s speed monitor are correct.
3. Check if the joint speed monitor setting (robot parameter) is correct.
4. Reduce the manual speed when in manual operating.
5. Reduce the program speed when executing program.
6. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9450
Error message: [Cubic-S(X)] JTXX exceeded the setting speed. (code xxxxxxxx)
Error processing: Motor power OFF Error reset: Acceptable
7SEG LED display: 56

Content

This error indicates that the speed of the axis with the displayed joint number exceeded the user set speed. It is detected by Cubic-S. The speed of the rotation axis is calculated from the equivalent radius setting.

Main Cause

1. The joint speed exceeded 250 mm/s during manual operation or program execution.
2. Malfunction due to mechanical, electrical, or other causes.

Countermeasure

1. Reset the error.
2. Check if the setting, wiring (including external devices) and the method of use of the set speed monitor are correct.
3. Check if the joint speed monitor setting (robot parameter) is correct.
4. Reduce the manual speed when in manual operating.
5. Reduce the program speed when executing program.
6. For malfunction due to mechanical, electrical, or other causes, remove the cause of the malfunction.

Error code: E9451
Error message: [Cubic-S(X)] Parameter No.X is out of range. (code xxxxxxxx)
Error processing: Motor power OFF Error reset: Not acceptable
7SEG LED display: 39

Content

This error indicates that the parameter value of the displayed parameter number exceeded the upper and lower limits. It is detected by Cubic-S. The upper and lower limit values differ according to the parameter.

Main Cause

1. Parameter value outside the upper and lower limit was written to Cubic-S.

Countermeasure

1. Reset the upper and lower limits of the parameter values via CS-conf an load it to Cubic-S.
2. If the parameter values cannot be modified via CS-Conf, report Kawasaki the detailed information of the situation, including all the contents of the error message, robot type, controller type and model, AS software, servo software, Cubic-S version, program contents, operation done when error occurred, all AS software save data, all Cubic-S parameters.

15.0 SAFETY DISTANCE

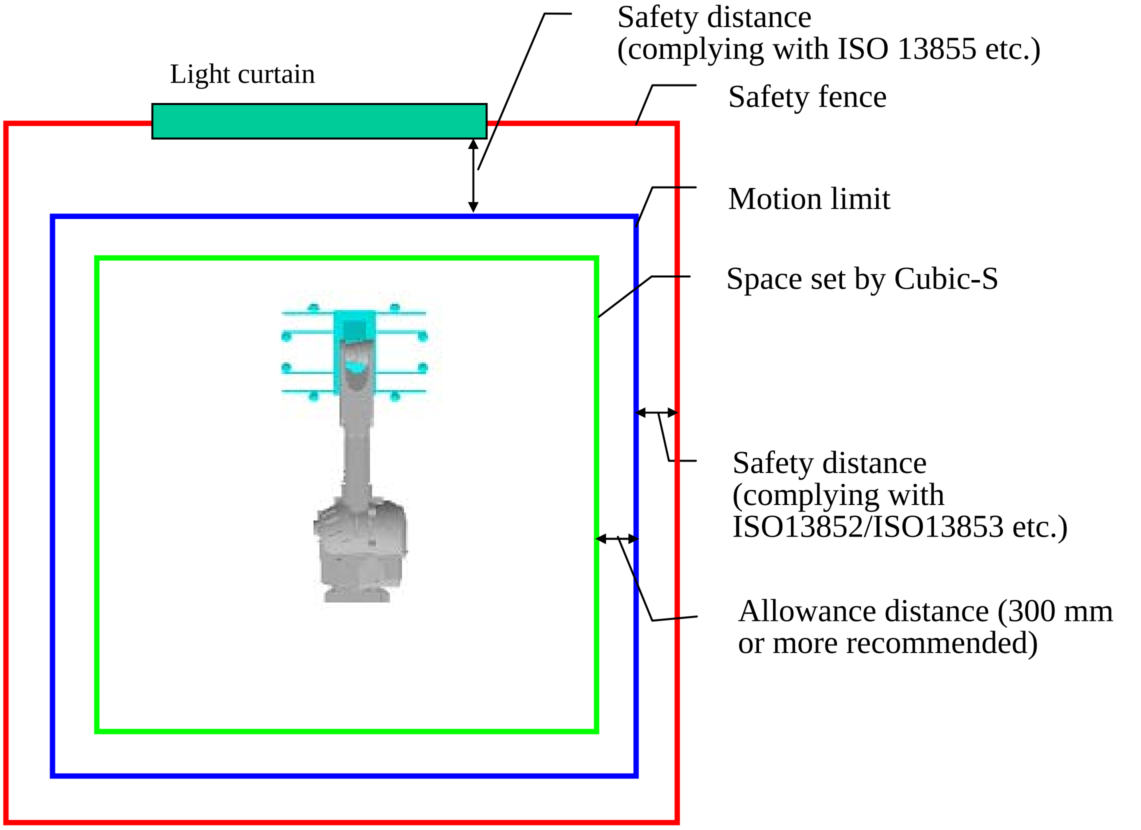
When executing space setting with Cubic-S, the safety distance should be set between the robot and the installation position of light curtain/ laser scanner, and/ or safety fence, etc. The distance between robot and light curtain/ laser scanner should comply with standards such as ISO13855 etc. The distance between robot and safety fence should comply with standards such as ISO13852/ISO13853 etc.

As shown in the figure below, when using stop distance prediction function, set the robot's motion limit area leaving some allowance (300 mm or more recommended) from the area set by Cubic-S. When not using the stop distance prediction function, set the motion limit area including the adequate distance according to the maximum speed and load conditions plus some allowance (300 mm or more recommended). Kawasaki will provide the necessary data for the adequate distance according to the speed and load.

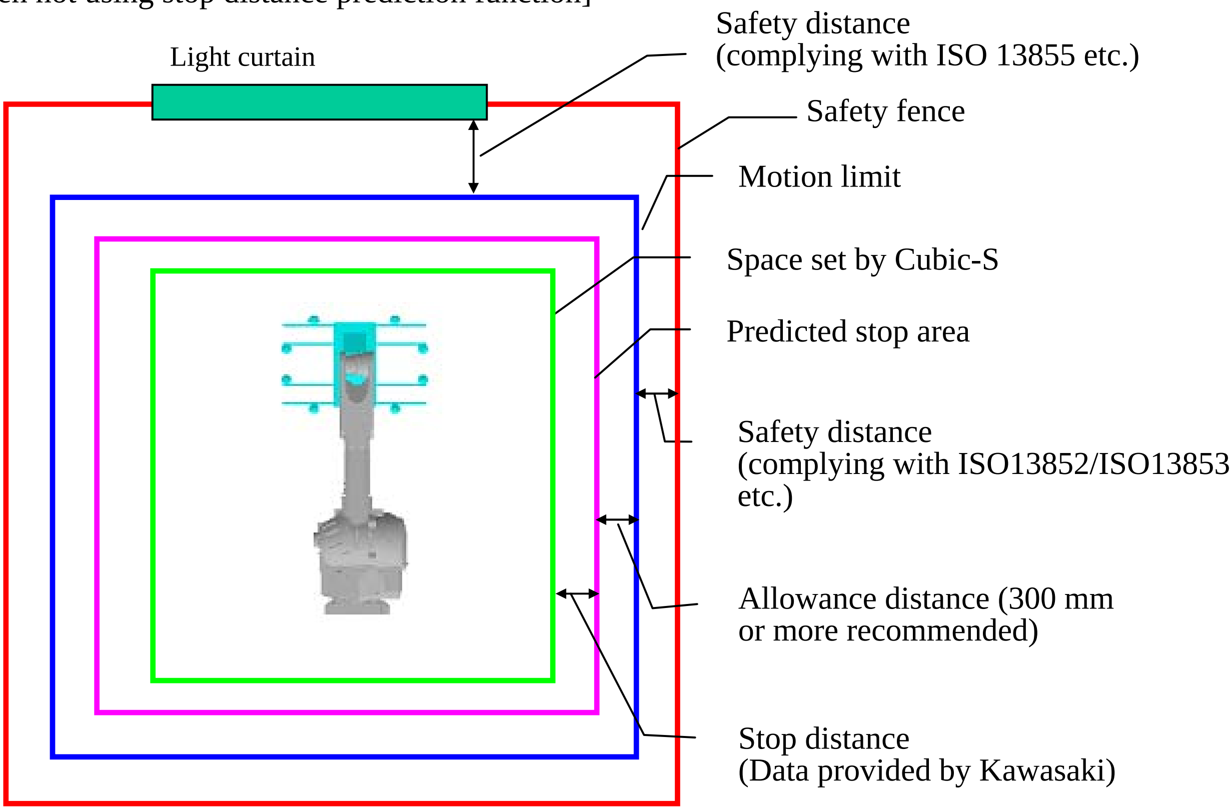
⚠ WARNING

1. **Stop distance prediction function stops the robot within the set area by predicting the distance the robot takes before it stops. However, this function does not guarantee that the monitored point stay within the monitored area. The robot may stop outside the allowable area, if the robot is malfunctioning or depending on the robot's motion conditions. Always conduct risk assessment and if any personnel is to work or pass in an area touching the safety fence, leave sufficient allowance around the motion area.**
2. **If not using the stop distance prediction function, take note of the below cautions. Also, always conduct risk assessment and if any personnel is to work or pass in an area touching the safety fence, leave sufficient allowance around the motion area.**
   ・Stop distance may be longer if the robot is malfunctioning or depending on the robot's motion conditions.
   ・The stop distance data Kawasaki provides for each robot are reference data, measured under a certain motion condition, and does not guarantee that the robot stops with in the distance shown by the provided data.
3. **Brakes can be checked via brake check function. When using Cubic-S, make sure to check if the brakes are functioning normally via brake check function to reduce the risks due to brake malfunction. For more information on brake check function, see the Brake Check Function manual, a separate volume.**

[When using stop distance prediction function]



[When not using stop distance prediction function]



16.0 MAINTENANCE AND INSPECTION

16.1 ABOUT MAINTENANCE

To maintain the Cubic-S functions, conduct the following inspections daily or periodically.

- Confirm that the robot is used within Cubic- S specification.
- Confirm that the installation status and the wiring of Cubic-S are adequate.
- Every day before starting operation, check to see that the safety functions of Cubic-S are working normally.

16.2 ABOUT REPLACEMENT

If any deficit is found in the inspection, or if 20 years have passed after Cubic-S's manufacture date, replace Cubic-S with a new one.

1. Always turn OFF the controller power and the external power supply for input/ output signals before cleaning, wiring or replacing Cubic-S.
2. Only those who have completed Kawasaki's education course and are in charge of the robot system can replace Cubic-S.
3. Do not disassemble or modify Cubic-S. Any repair or refurbish done by those other than Kawasaki is outside of warranty.
4. Before touching Cubic-S, discharge the electro-static in human body by touching a grounded metal, etc.

WARNING

When replacing Cubic-S, load the necessary setting data and then confirm operation with that data. Especially when enabling/disabling the function according to the safety input signal, turn ON/OFF the safety input signals to confirm that the safety function becomes enabled/ disabled accordingly and that the safety function operates properly when enabled.

16.3 HOW TO REPLACE CUBIC-S

Replacement procedure of Cubic-S for E1x, E2x, E3x, E4x controllers.

1. Backup Cubic-S parameters.
   Before replacing Cubic-S, create a backup file of the Cubic-S parameters.
   With the robot controller turned ON, download the parameters from Cubic-S using CS-Configurator.
   «Execute the following before replacing Cubic-S»
   (1) Perform [Read Cubic-S Parameters]
   (2) Perform [Read Robot Parameters]
   (3) Perform [Save File]

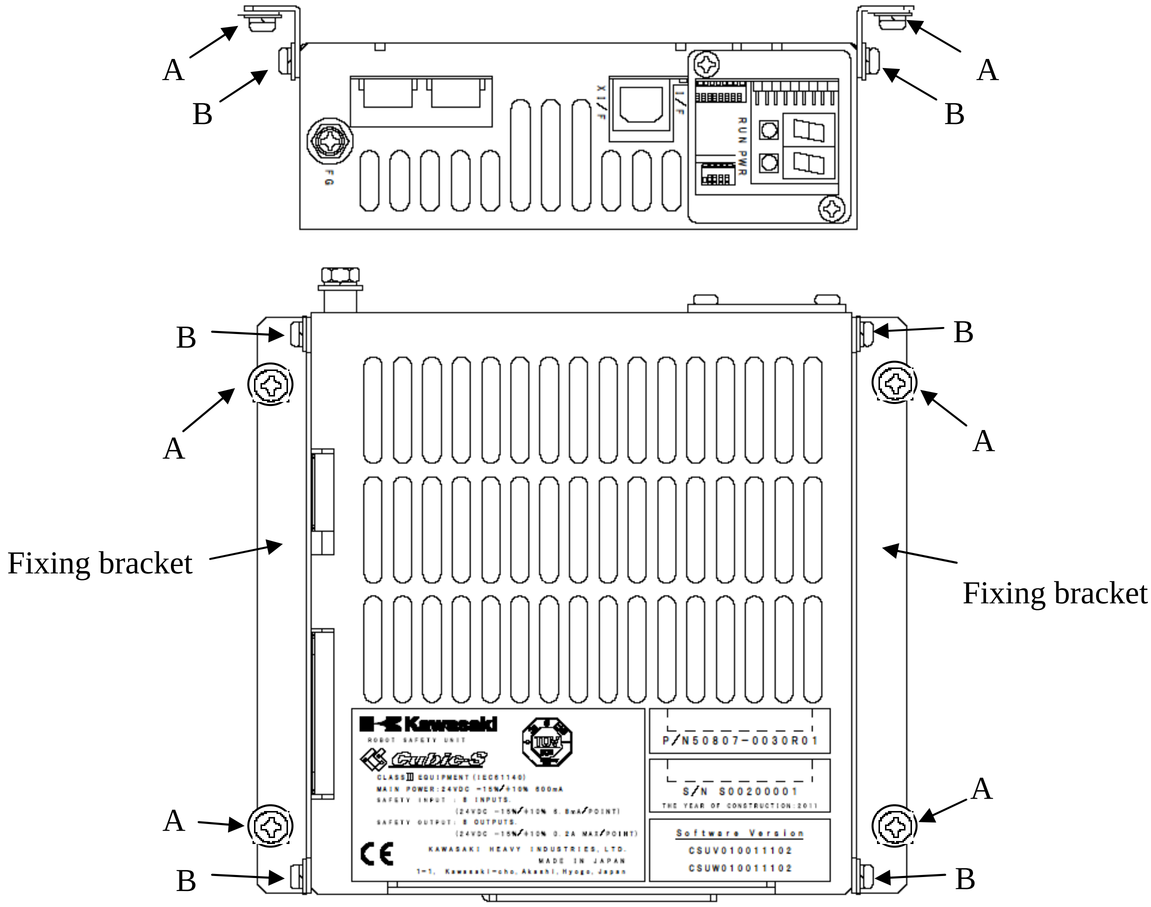
2. Create robot controller backup file
   Save all data in robot controller via Aux. 0201 Save. (This saved data will not be necessary unless trouble occurs in procedure 8).

3. Turn OFF the robot controller
   Turn OFF the robot controller before replacing the Cubic-S.

4. Remove the connected harnesses.

5. Remove Cubic-S from the controller.
   Cubic-Sis fixed inside the controller with screws as shown in the figure below. First remove four screws at A.
   *A: Screws (M3-6 P=3) that fixes Cubic-S and fixing brackets to the controller.

6. Next, remove the four B screws. Then remove the two fixing bracket from Cubic-S.
   *B: Screws (M3-6 P=3) that attaches the fixing brackets to Cubic-S.



7. Follow procedures 4 through 6 in reverse order to install the new Cubic-S to the controller.

> **CAUTION**
>
> **Use only M3 L=6 P=3 for screws B.　A longer screw may interfere with other parts inside Cubic-S and cause malfunction.**

8. Parameter mismatch warning will appear when robot controller is turned ON.
   The below message appears when the robot controller is turned ON, because the setting of the controller and the new Cubic-S do not match at this time.

```
[Cubic-S(1)]Mismatch in Upper motion limit of Jt 1 between robot controller and
Cubic-S.(AS)
Download robot data from PC for setting parameter.
(2:All Skip 1:Next)
```

   Here, select (2: All Skip) .　(This way, the message asking (2: All skip, 1: Next) wil not appear hereafter even when mismatch is detected.)

Also, if the tool setting does not match, another message, different from the one above, will be displayed as shown below. Either one of the two mismatch messages will appear depending on the software version.

1) Tool setting mismatch (Case 1)
If the message below does not appear, see “2) Tool setting mismatch (Case 2)”.

```
[Cubic-S(1)]Mismatch in Tool1 TCP(XYZ) between robot controller and Cubic-S.(AS)

Do you start by the Cubic-S side parameter? (2:all Yes, 1:Yes, 0:No)
Number ?
```

Here, select [0: No].

If [2: All Yes] or [1: Yes] is selected, the tool setting in AS software will be modified automatically. To return to the original setting, load the data saved in procedure 2, reboot the robot controller (turn OFF/ON) and conduct procedure 8 again. Then select [0: No].

CAUTION

Selecting [2: All Skip] or [1: Next] automatically modifies the tool setting in AS software. Executing programs with a wrong tool setting may cause the robot to interfere with the surroundings. Always check if the tool setting is correct before operating the robot.

1) Tool setting mismatch (Case 2)
If the message below does not appear, see “1) Tool setting mismatch (Case 1)”.

```
[Cubic-S(1)]Mismatch in Tool1 TCP(XYZ) between robot controller and Cubic-S.(AS)

Set Cubic-S parameter and AS parameter to agree.(2:All Skip 1:Next)
```

Here, select (2: All Skip) . (This way, the message asking (2: All skip, 1: Next) will not appear hereafter even when mismatch is detected.)
Startup procedure continues after all robot parameters are verified, but error (E9402)
[Cubic-S(X)] Mismatch in X between robot controller and Cubic-S. (XX)
will appear. This error will always occur in this procedure.

9. Load Cubic-S backup file.

After ignoring the mismatch error following procedure 8 above, reload the backup data to Cubic-S via CS-Configurator.

«Execute the following after replacing Cubic-S»

(1) Perform [Open File] and read the files saved in procedure 1.-(3) above

(2) Perform [Read Robot Parameters]

(3) Perform [Write Parameters to Cubic-S]

After loading is completed, turn OFF/ON the controller power.

10. Error reset after rebooting the robot controller

When the controller power is turned OFF/ ON, the controller will start without displaying the mismatch message, and error E9419 or E9420 occurs. (If mismatch error still occurs here as described in procedure 8, retry procedures 8 and 9).

(E9419) [Cubic-S(X)] Encoder value error in JTXX (Code xxxxxxxx)

Check zeroing data, home pose etc in teach mode.

This error always occurs when Cubic-S is replaced. Change to teach mode, reset the error and confirm that all data such as zeroing position or home position are correct.

11. Confirmation after replacement

Check to see if all functions used such as motion area monitor and axis monitor are operating normally. Especially, when changing the valid/ invalid setting of the safety functions according to the safety input, turn ON/OFF the safety input and confirm that the safety function setting is done accordingly. Incorrect data setting in Cubic-S will lead to malfunction of the safety function and result in accidents.

Replacement procedure of Cubic-S for E0x controller

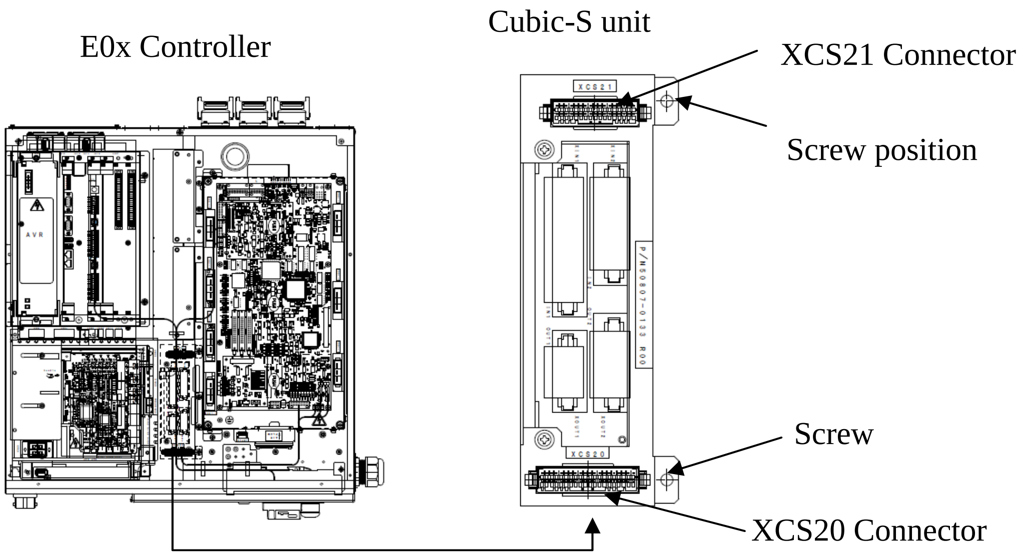
Note* Steps 1. to 3. are the same as for E1x, E2x, E3x, E4x controllers.

4. Remove the harness (XCS21, XCS20) connected to Cubic-S unit.

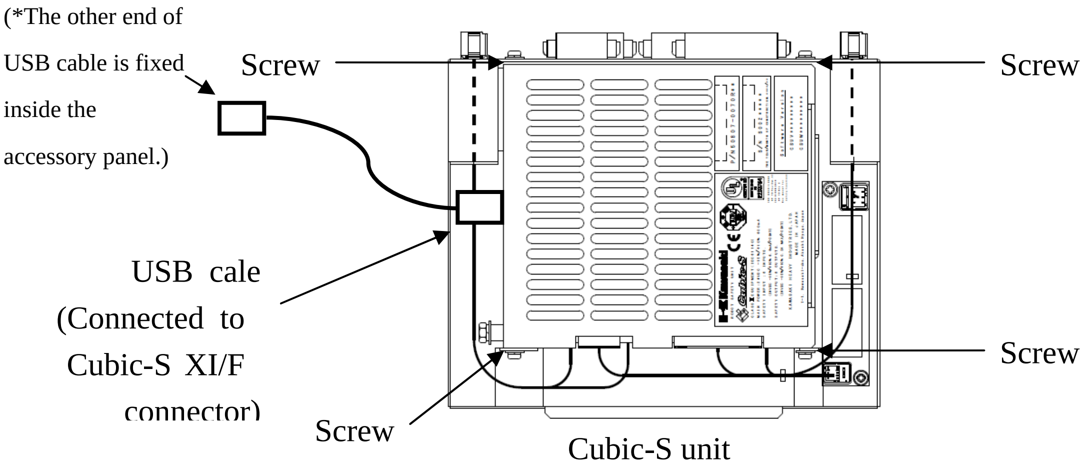
5. Remove the Cubic-S unit from the controller.

The Cubic-S unit is fixed to the inside of the controller with two screws at the place indicated in the figure below. Remove the screws and raise the Cubic-S unit a little. Remove the USB cable connected XI/F connector in Cubic-S unit. (Use the figure below as reference).

Note* The screws removed (M4 L=8 P=3) area used to fix the replaced Cubic-S to the controller as explained later.



6. Remove the metal cover for Cubic-S unit fixing the Cubic-S.
   Cubic-S is fixed to the metal cover with four screws in positions indicated in figure belpw.
   Remove the Cubic-S unit from Cubic-S.
   Note* The removed screws (M3 L=6 P=) are used to fix the Cubic-S to the controller as explained later.



7. Remove the relay harness connected to Cubic-S, located inside the Cubic-S unit.

8. Remove Cubic-S and mount the Cubic-S to the controller following the steps 4 to 7 in reverse order.

CAUTION

When mounting Cubic-S to the metal cover of Cubic-S unit, always use screwswith same specification as those used before replacement (M3 L=6 P=3). If the screws are longer than the specification, the screw might interfere with parts inside of Cubic-S and might result in malfunction.

9. For procedures after this, follow the steps 8 to 11 for E1x, E2x, E3x, E4x controllers.

17.0 AS SOFTWARE SETTING

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

EXAMPLE

AS command/ instruction are described as shown below.

Keyword Parameter

CBSMON_EXTDISABLE axis number

Parameters marked with can be omitted.

Always enter a space between the keyword and the parameter.

↵ represents the Enter key in the examples.

17.1 AS LANGUAGES SPECIFIC TO CUBIC-S OPTION

17.1.1 SYSTEM SWITCH

This section describes the below AS system switches.

CBS_TOOLCHG	Validates switching of tool number set from AS software to Cubic-S.
CBS_AUXTOOL1	Sets tool number 1 of block teaching as tool number1 for Cubic-S.
CBS_BASE	Reflects the base coordinates setting to Cubic-S coordinates.

CBS_TOOLCHG

Function

Specifies whether to switch the tool number sent from AS software to Cubic-S.

Explanation

This switch is used to enable (ON) or disable (OFF) switching of tool number sent from AS software to Cubic-S.

If this switch is ON, when the tool number used changes, the tool number sent from AS software to Cubic-S changes too. Also, TOOL command/ instruction will demand specification of tool number.

If this switch if OFF, the tool number sent from AS software to Cubic-S will be 1.

Turning ON/OFF this switch causes the error “(E9404) Parameter may be changed. Turn OFF & ON the control power for verification.” to occur. The modification of switch setting will be reflected in Cubic-S by turning OFF/ON the controller switch after writing the setting to Cubic-S via CS-Configurator.

Default setting for this switch is OFF.

Example

CBS_TOOLCHG ON Enables switching of tool number sent from AS software to Cubic-S.

For more details on how to use this switch, refer to Section 17.2 or Chapter 18.

CBS_AUXTOOL1

Function

Specifies whether to set Tool number 1 of block teaching as Tool number 1 for Cubic-S.

Explanation

This switch is used to switch between using tool number 1 in block teaching as tool number 1 in Cubic-S (ON) and using tool number 1 specified by TOOL command/ instruction of AS language (OFF).

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

If this switch is OFF, tool numbers 1 to 9 specified by AS language TOOL command/ instruction are used as tool numbers1 to 9 in Cubic-S. Tool numbers 1 to 9 set in block teaching are used as tool numbers 10 to 18 in Cubic-S.

Turning ON/OFF this switch causes the error "(E9404) Parameter may be changed. Turn OFF & ON the control power for verification." to occur. The modification of switch setting will be reflected in Cubic-S by turning OFF/ON the controller switch after writing the setting to Cubic-S via CS-Configurator.

Default setting for this switch is OFF.

Example

CBS_AUXTOOL1 ON   Sets tool number 1 in block teaching as tool number 1 in Cubic-S.

For more details on how to use this switch, refer to Section 17.2 or Chapter 18.

CBS_BASE

Function

Specifies whether to reflect the robot base coordinates to Cubic-S coordinates.

Explanation

This switch is used to determine whether to reflect the robot base coordinate to Cubic-S coordinates (ON) or not (OFF).

If this switch is ON, the base coordinates is reflected to the coordinates of the robot monitored by Cubic-S. Therefore, when the robot base coordinates is set, turning this switch ON/ OFF changes the pose monitored by Cubic-S.

Turning ON/OFF this switch causes the error "(E9404) Parameter may be changed. Turn OFF & ON the control power for verification." to occur. Cubic-S coordinates changes by turning OFF/ON the controller switch after writing the setting to Cubic-S via CS-Configurator.

Default setting for this switch is OFF.

Example

CBS_BASE ON   Reflects the base coordinates setting to Cubic-S coordinates.

17.1.2 MONITOR COMMAND/ PROGRAM INSTRUCTION

This section explains about the below monitor command/ program instruction.

CBSMON_EXTDISABLE	Specifies the external axis where Cubic-S monitoring is nullified.
CBSMON_EXTENABLE	Specifies the external axis where Cubic-S monitoring is validate.
CBSMON_SETDEVICE	Specifies the device to use in Cubic-S stop monitoring.

Monitor Command/Program Instruction

CBSMON_EXTDISABLE axis number

Function

Specifies the external axis number to nullify the Cubic-S monitoring.

Parameter

Axis number
(Can be omitted when used as monitor command. Cannot be omitted when used as program instruction)
Specify the external axis number to nullify the Cubic-S monitoring. Robot axis cannot be set. Monitoring is valid in all axes as default setting.

Explanation

Executing this command/ instruction removes the specified external axis from the target of Cubic-S monitoring. After executing, the error "(E9404) Parameter may be changed. Turn OFF & ON the control power for verification." occurs, so turn OFF/ON the controller power after writing the setting to Cubic-S via CS-Configurator. After that, the specified external axis is not monitored.

Axis number can be omitted only in monitor command. The current monitoring status is displayed after executing. ENABLE is displayed when monitoring is valid. DISABLE is displayed when monitoring is invalid. DISCONNECT is displayed when external axis is disconnected.

Example

In the example, monitoring of JT7 is nullified when setting JT9. All axes JT7 – JT9 are valid before changing the setting.

```
>cbsmon_extdisable 7
     JT7            JT8            JT9
  DISABLE        ENABLE        ENABLE
```

Monitor Command/Program Instruction

CBSMON_EXTENABLE axis number

Function

Specifies the external axis number to validate the Cubic-S monitoring.

Parameter

Axis number

(Can be omitted when used as monitor command. Cannot be omitted when used as program instruction)

Specify the external axis number to validate the Cubic-S monitoring. Cannot specify robot axis. Monitoring is valid in all axes as default setting.

Explanation

Executing this command/ instruction includes the specified external axis as the target of Cubic-S monitoring. After executing, the error "(E9404) Parameter may be changed. Turn OFF & ON the control power for verification." occurs, so turn OFF/ON the controller power after writing the setting to Cubic-S via CS-Configurator. The specified external axis is monitored by Cubic-S after restarting the controller.

Axis number can be omitted only in monitor command. The current monitoring status is displayed after executing. ENABLE is displayed when monitoring is valid. DISABLE is displayed when monitoring is invalid. DISCONNECT is displayed when external axis is disconnected.

Example

In the example, monitoring of JT7 is validated when setting JT9. All axes JT7 – JT9 are invalid before changing the setting.

```
>cbsmon_extenable  7
     JT7            JT8            JT9
   ENABLE        DISABLE        DISABLE
```

Monitor Command

CBS_SETDEVICE device number = axis number

Function

Specifies and confirms the device axis to use in Cubic-S stop monitoring.

Parameter

Device number
Specifies the device number to set.

Axis number
Specify the axis number to allocate to the specified device. However, axis with not channel allocated or Mitsubishi motor (external axis) cannot be specified. Axes that are not target of Cubic-S monitor such as servo gun axis can be specified, but stop monitoring will not carried out.

Explanation

Executing this command allocates a desired axis to stop monitoring device. After executing, the error “(E9404) Parameter may be changed. Turn OFF & ON the control power for verification.” occurs, so turn OFF/ON the controller power after writing the setting to Cubic-S via CS-Configurator.

When the parameters are omitted, the current setting is displayed.

Example

The example below allocates JT7, 8 to Device 1.

```
>cbs_setdevice 1 = 7, 8
Device 1   7,8
Device 2   0
Device 3   0
```

0 in Device 2, 3 mean that they have no axis allocated.

17.2 HOW TO SPECIFY TOOL SHAPE POINT AND NUMBER VIA AS SOFTWARE

This section explains the relation between the tool setting explained in 11.1.1 Common Settings for Monitoring Functions and AS software setting.

1. Tool shape point setting

   Among the items for [2. Tool Points of Area Monitoring] described in 11.1.1 Common Settings for Monitoring Function, the following items are set via AS software.
   ・Valid/ invalid of TCP/ tool shape point 1 - 8 (Parameter No.112)
   ・TCP/ tool shape point 1 - 8/ Coordinates for tool orientation monitoring (Parameters No.113 to 115, etc.)
   Tool shape point 9 and higher cannot be set.

2. Specification of tool number to monitor

   In [1. Speed Monitoring Points on Tool] explained in 11.1.1 Common Settings for Monitoring Functions, each items are set for tool numbers 1 to 32. After setting the items to those tools, AS software is used to specify which tool number to monitor. (However, AS software uses only tool numbers 1 to 18, and ignores 19 and greater).

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

17.2.1 HOW TO SPECIFY TOOL SHAPE POINT AND TOOL NUMBER IN AS LANGUAGE

1. Setting tool shape point

   Use SET_TOOLSHAPE instruction to set tool shape point (TCP/ tool shape point 1 to 8/ tool orientation monitoring TCP coordinates). Also, valid/ invalid setting of TCP/ tool shape point is done by ENA_TOOLSHAPE instruction. Below describes how each instructions function when used in Cubic-S. (For SET_TOOLSHAPE and ENA_TOOLSHAPE also refer to “AS Language Reference Manual”, a separate volume.)

Monitor Command/Program Instruction

SET_TOOLSHAPE tool transformation value, tool no. = transformation value variable1, …,transformation value variable 8

Function

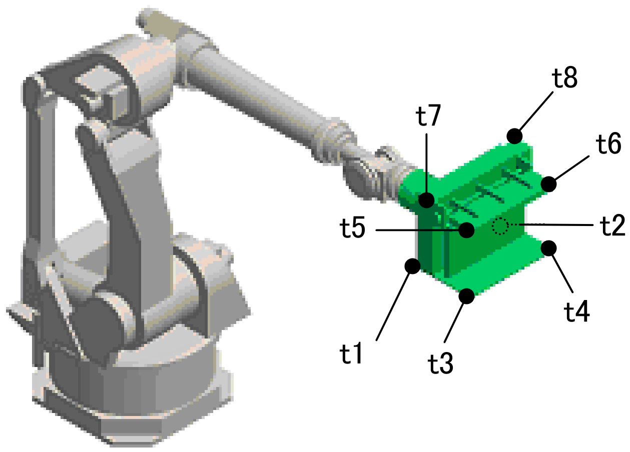
Registers the TCP/tool shape point 1 to 8/ coordinate for tool orientation monitoring for each tool number. When this is set, error “(E9404) Parameter may be changed. Turn OFF & ON the control power for verification.” occurs. After this error occurs, the settings can be written to Cubic-S via CS-Configurator. Then, turn OFF/ON the control power to use the tool information in Cubic-S.

Parameter

Tool transformation value (Must specify when Cubic-S option is ON)
Specifies tool transformation value. After execution, pressing <Read Tool Data> in CS-Configurator sets the XYZ values of the specified tool transformation value to the XYZ of the TCP in [2. Tool Points of Area Monitoring] described in 11.1.1 Common Settings for Monitoring Functions. At the same time, the OAT values of the specified tool transformation value are set to OAT of the tool orientation monitoring TCP.

Tool number
Specifies the tool numbers to use by integers from 1 to 9. After execution, pressing <Read Tool Data> in CS-Configurator sets tool transformation value and transformation value variable 1 - 8 to the specified tool number (when system switch CBS_AUXTOOL1 is OFF). When system switch CBS_AUXTOOL1 is ON, the settings are done to tools with specified tool number plus 9, (tool numbers 10 - 18).

Transformation value variable 1 - Transformation value variable 8 (Can omit all when Cubic-S option is ON)
Specifies the points on the tool shape using transformation value variables. Maximum of 8 points can be specified. After execution, pressing <Read Tool Data> in CS-Configurator sets the XYZ values of the specified tool transformation value to the XYZ of the TCP in [2. Tool Points of Area Monitoring] described in 11.1.1 Common Settings for Monitoring Functions.



Example

Refer to Chapter 18 for example of usage.

Monitor Command/Program Instruction

ENA_TOOLSHAPE tool shape no.= TRUE/ FALSE

Function

Switches between valid/ invalid of space monitoring by TCP/ tool shape points 1 – 8 in Cubic-S. When this is set, error "(E9404) Parameter may be changed. Turn OFF & ON the control power for verification." occurs. After this error occurs, the settings can be written to Cubic-S via CS-Configurator. Then, turn OFF/ON the control power to use the tool information in Cubic-S.

Parameter

Tool shape number
Specifies in whole number from 1 to 9, the number of the tool shape to set enable/ disable.

TRUE/FALSE
Specify TRUE to enable space monitoring. Specify FALSE to disable the space monitoring. After execution, pressing <Read Tool Data> in CS-Configurator sets whether to enable or disable the transformation value variable 1 – 8 to the specified tool number (when system switch CBS_AUXTOOL1 is OFF). When system switch CBS_AUXTOOL1 is ON, the settings are done to tools with specified tool number plus 9, (tool numbers 10 – 18).

Example

Refer to Chapter 18 for example of usage.

2. Specifying tool number

The tool number of the tool to monitor during robot operation is specified via TOOL command/ instruction. The tool number sent from AS software to Cubic-S differs according to the conditions of system switches CBS_TOOLCHG and CBS_AUXTOOL1. See the table below.

		CBS_AUXTOOL1	
		OFF	ON
CBS_TOOLCHG	OFF	1 (*1)	− (*2)
	ON	1 - 9 (*3)	10 - 18 (*4)

NOTE*1 Regardless of the specification in TOOL command/ instruction, Tool number 1 is sent to Cubic-S as the tool to monitor. In this case, tool settings for tool number 1 in AS language SET_TOOLSHAPE command/ instruction are used for the tool to monitor. When more than one tool is actually used, but set only one tool for Cubic-S monitoring, set the tool shape for the largest tool in SET_TOOLSHAPE instruction.

NOTE*2 Same as for NOTE*1, 1 is sent to Cubic-S. In this case, tool settings for tool number 1 taught via auxiliary function is used as target tool for monitoring.

NOTE*3 Numbers 1 to 9 set in TOOL command/ instruction are sent to Cubic-S. In this case, tool settings for tool numbers 1-9 in AS language SET_TOOLSHAPE command/ instruction are used for the tool to monitor. Modification of tool setting via SET_TOOLSHAPE command requires turning OFF/ON the controller power, so maximum of 9 tools can be set without turning OFF/ON the controller power.

NOTE*4 Numbers 1- 9 specified in TOOL command/ instruction plus 9, or 10 – 18, are sent to Cubic-S. In this case, tool settings for tool numbers 1-9 in AS language SET_TOOLSHAPE command/ instruction are used for the tool to monitor. Modification of tool setting via SET_TOOLSHAPE command requires turning OFF/ON the controller power, so maximum of 9 tools can be set without turning OFF/ON the controller power.

Monitor Command

TOOL transformation value variable, tool number

Function

Defines the position and orientation (Tool transformation value) of the tool coordinates as seen from the coordinates on the robot tool flange surface (null tool coordinates).

Parameter

Transformation value variable

Sets the new tool transformation value using pose variables (Transformation value variable or compound transformation value variable). When omitted, the current tool transformation value is displayed for modification.

When CBS_TOOLCHG is ON, if the specified transformation value variable differs from the tool transformation value specified by SET_TOOLSHAPE, error "(E9443) [Cubic-S] Tool data is different from that of tool shape number." occurs.

Tool number

Specify the tool number to monitor by the Cubic-S. When system switch CBS_TOOLCHG is ON this cannot be omitted.

Example

Refer to Chapter 18 for example of usage.

Program Instruction

TOOL transformation value variable, tool number

Function

Defines the position and orientation (Tool transformation value) of the tool coordinates as seen from the coordinates on the robot tool flange surface (null tool coordinates).

Parameter

Transformation value variable

Sets the new tool transformation value using pose variables (Transformation value variable or compound transformation value variable). Specifying NULL sets the tool coordinates to the null tool coordinates.

When CBS_TOOLCHG is ON, if the specified transformation value variable differs from the tool transformation value specified by SET_TOOLSHAPE, error "(E9443) [Cubic-S] Tool data is different from that of tool shape number." occurs.

Tool number

Specify the tool number to monitor by the Cubic-S. When system switch CBS_TOOLCHG is ON this cannot be omitted.

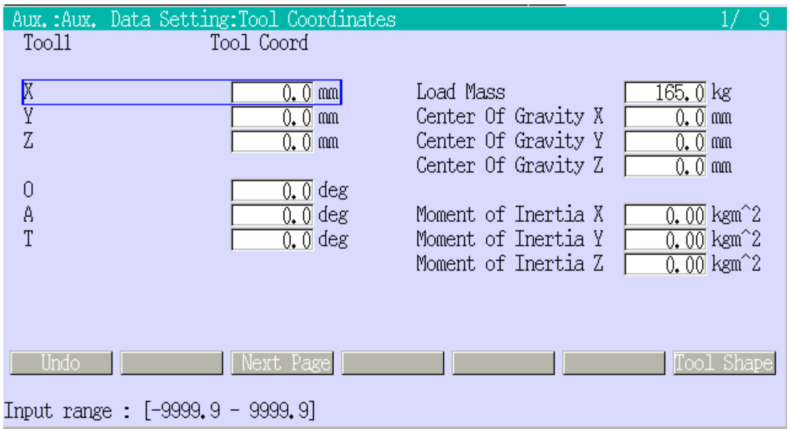
Example

Refer to Chapter 18 for example of usage.

17.2.2 HOW TO SPECIFY TOOL SHAPE POINT AND TOOL NUMBER USING AUXILIARY FUNCTION

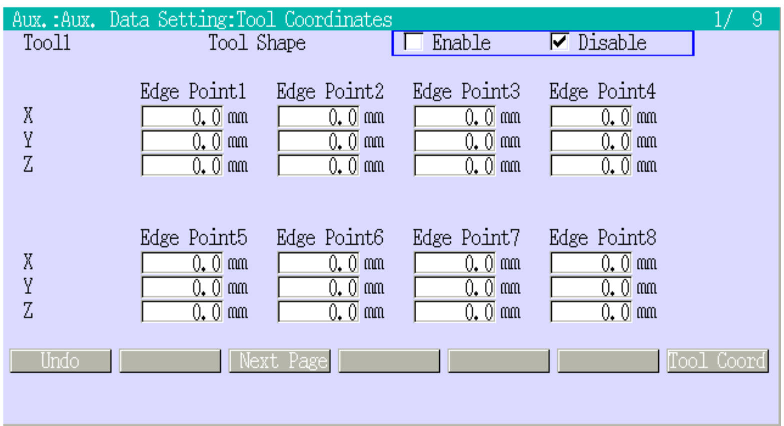
1. Setting tool shape point

Tool shape point setting (TCP/Tool shape points 1-8, coordinates for tool orientation monitoring and setting of valid/ invalid of tool shape points can be done via auxiliary function 0304 Tool Registration.



Set the tool transformation value (XYZOAT). After setting, pressing <Read Tool Data> in CS-Configurator sets the XYZ values of the specified tool transformation value to the XYZ of the TCP in [2. Tool Points of Area Monitoring] described in 11.1.1 Common Settings for Monitoring Functions and the OAT values of the specified tool transformation value are set to OAT of the tool orientation monitoring.

Next, press <Tool shape> to move to tool shape setting screen.



Set XYZ values for end points 1 - 8. After setting, pressing <Read Tool Data> in CS-Configurator sets the specified XYZ values for end points 1 - 8 to XYZ in [2. Tool Points of Area Monitoring] described in 11.1.1 Common Settings for Monitoring Functions. At the same time, the valid/ invalid setting for TCP/ tool shape point 1 - 8 in [2. Tool Points of Area Monitoring] change according to the valid/ invalid setting of the tool shapes.

Aux. 0304 allows setting for tools 1 -9. To which number the settings are read to when <Read Tool Data> in CS-Configurator is pressed depends on the setting of CBS_AUXTOOL1 system switch. When CBS_AUXTOOL1 is ON, sets tool numbers 1 -9 in CS-Configurator and when it is OFF, CS-Configurator sets tool numbers 10 - 18.

2. Specifying tool number

Specify the tool number of the tool to monitor during robot operation using auxiliary function. The tool number sent from AS software to Cubic-S differs according to the conditions of system switches CBS_TOOLCHG and CBS_AUXTOOL1. See the table below.

		CBS_AUXTOOL1	
		OFF	ON
CBS_TOOLCHG	OFF	- (*1)	1 (*2)
	ON	10 - 18 (*3)	1 - 9 (*4)

NOTE*1 Regardless of the specification by auxiliary function, tool number 1 is sent to Cubic-S as the tool to monitor. In this case, tool settings for tool number 1 in AS language SET_TOOLSHAPE command/ instruction are used for the tool to monitor.

NOTE*2 Regardless of the specification by auxiliary function, tool number 1 is sent to Cubic-S as the tool to monitor. In this case, tool settings for tool number 1 set by auxiliary function are used for the tool to monitor. When more than one tool is actually used, but set only one tool for Cubic-S monitoring, set the tool shape for the largest tool in Aux. 0304 Tool Registration.

NOTE*3 Numbers 1- 9 specified by auxiliary function plus 9, or 10 - 18, are sent to Cubic-S. In this case, tool settings for tool numbers 1-9 by auxiliary function are used for the tool to monitor.

NOTE*4 Numbers 1 to 9 set by auxiliary function are sent to Cubic-S. In this case, tool settings for tool numbers 1-9 by auxiliary function are used for the tool to monitor.

17.3 SETTING BY AS SOFTWARE CONCERNING EXTERNAL AXES

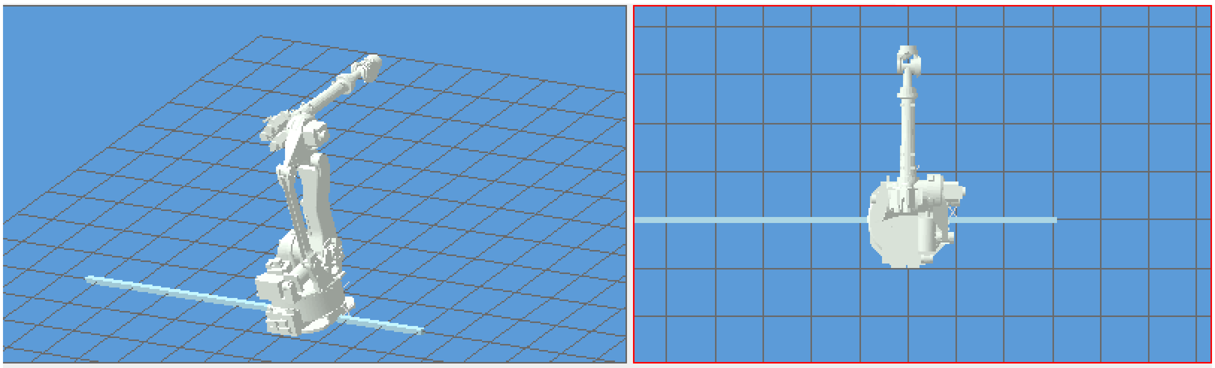
17.3.1 SWITCHING BETWEEN VALID/ INVALID OF EXTERNAL AXIS MONITORING

To invalidate Cubic-S monitoring such as axis monitoring for external axes, execute CBSMON_EXTDISALBLE command/ instruction. To validate Cubic-S monitoring, execute CBSMON_EXTENABLE command/ instruction.
For limitations in combination between Cubic-S and other functions, see section 6.6.

17.3.2 SETTING TO CONDUCT SPACE MONITORING IN COORDINATES INCLUDING TRAVERSE AXIS

To conduct space monitoring by Cubic-S using coordinates including traverse axis, [Linear cooperation] in Aux. 2002 External Axis Setting should be set to “enable” (other than “0”). For Linear axis cooperation setting, see “External Axis Addition Manual”. Only one axis can cooperate with traverse axis.

After enabling linear axis cooperation and writing the parameters to Cubic-S, the robot will be displayed on CS-Configurator screen as shown in the figure below with the line beneath the robot base indicating the traverse axis.



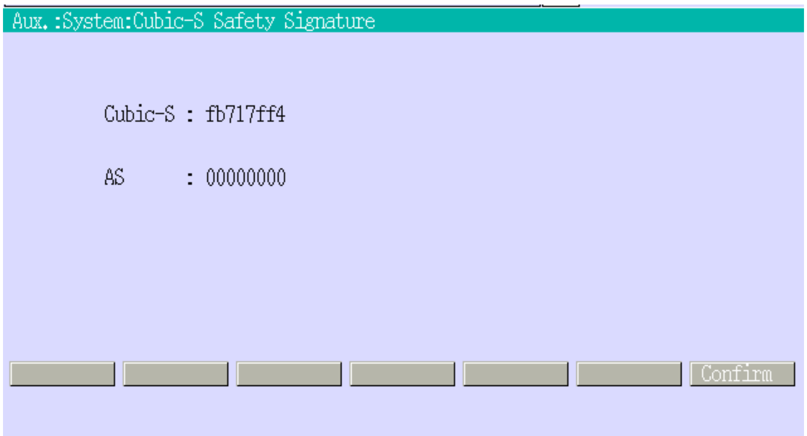
17.4 CUBIC-S SAFETY SIGNATURE

This section explains about the function that monitors the change CRC value set in Cubic-S (see 11.1.1 Parameter CRC). This function consists of the following parts.

- Aux. 0820 Cubic-S Safety Signature
- Dedicated output signal “Cubic-S Safety Signature”
- Dedicated input signal “Cubic-S Safety Signature Reset”

17.4.1 AUX 0820 CUBIC-S SAFETY SIGNATURE

Displays the CRC value of the parameter set in Cubic-S and the recent CRC value stored in AS. Pressing <Confirm> key rewrites the CRC value in AS with the current value set in Cubic-S. However, <Confirm> key will not be displayed when dedicated input signal “Cubic-S Safety Signature Reset” is enabled.



17.4.2 DEDICATED OUTPUT SIGNAL “CUBIC-S SAFETY SIGNATURE”

This signal outputs the result of comparing the CRC value of Cubic-S parameter and the CRC value stored in AS. The signal turns ON when the two values do not match.

17.4.3 DEDICATED INPUT SIGNAL “CUBIC-S SAFETY SIGNATURE RESET”

When this signal is turned ON, the CRC value stored in AS is rewritten with the CRC value currently set in Cubic-S.

18.0 CUBIC-S PARAMETER SETTING EXAMPLES

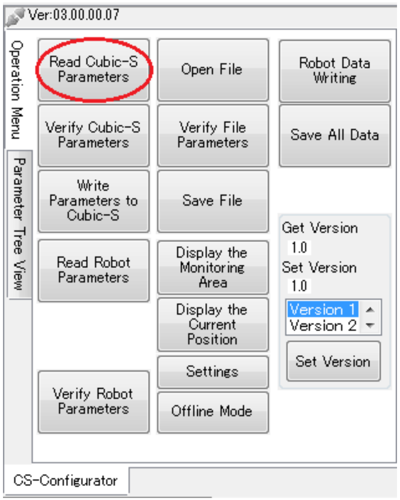
This chapter explains how to set the parameters for Cubic-S.

The settings shown here are only examples, and do not guarantee the safety in actual application.

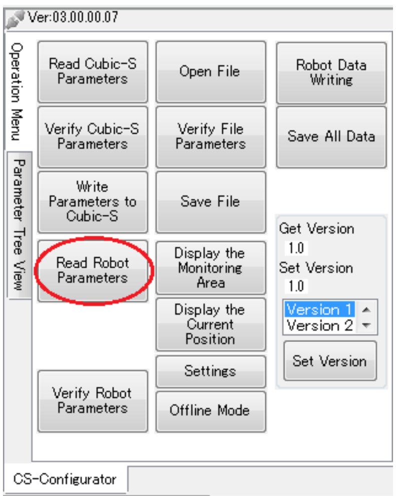
18.1 HOW TO USE CS-CONFIGURATOR

This section explains how to use CS-Configurator. The procedures below sets the parameters in CS-Configurator and writes them into Cubic-S.

1. Read Cubic-S
   Select <Operation Menu> tab and execute < Read Cubic-S Parameters >.

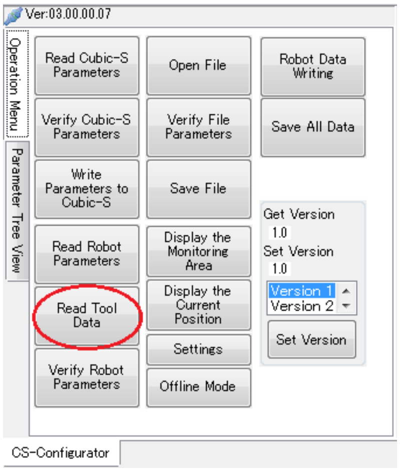


2. Read Robot Parameters
   Execute <Read Robot Parameters>.



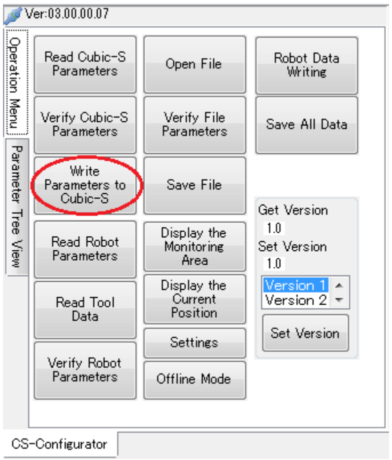
3. Read Tool Data

Execute <Read Tool Data>. < Read Tool Data > button is displayed after executing <Read Robot Parameters>. This is not necessary when not changing tool data.

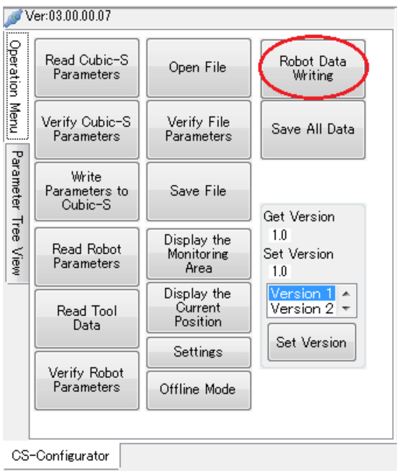


4. Write Parameter to Cubic-S

Execute < Write Parameter to Cubic-S >.

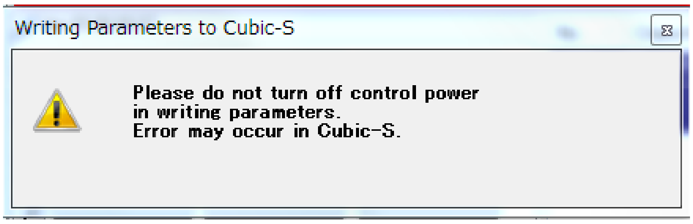


Executing <Robot Data Writing> shown below executes 1. < Read Cubic-S Parameters >, 2. <Read Robot Parameters>, 4. < Write Parameter to Cubic-S > all at once.

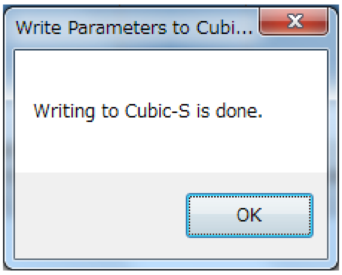


5. To complete writing in Cubic-S

After the parameters are written to Cubic-S, the popup window [Writing Parameters to Cubic-S] is displayed on CS-Configurator. While this popup is displayed, do not turn OFF/ON the controller power for the robot until [Writing to Cubic-S is done] popup window appears. If the controller power is turned OFF/ ON before the writing complete popup is displayed, the data setting may be abnormal and error may occur.



When [Writing to Cubic-S is done] popup shown below appears on CS-Configurator, turn OFF/ ON the robot controller power.



When the parameters are written into Cubic-S, the below error will appear on the TP screen.
(E9442)[Cubic-S(1)] Parameter values are rewritten in PC for setting parameters.
This error is cleared by turning OFF / ON the controller power.

Confirm that the below error does not occur when turning ON the controller power.
(E9402)[Cubic-S(1)] Mismatch in X between robot controller and Cubic-S.
Start from procedure 1 when this error occurs.

18.2 EXAMPLE OF TOOL DATA SETTING

This section explains how to set the tool data to Cubic-S using an example. There are two ways to set the tool data to Cubic-S: by AS language and by auxiliary function screen.
The following four examples of tool setting in Cubic-S are explained here.

1. Setting by AS language without tool change
2. Setting by AS language with tool change
3. Setting by auxiliary function without tool change
4. Setting by auxiliary function with tool change

18.2.1 SETTING BY AS LANGUAGE WITHOUT TOOL CHANGE

This section explains how to set a tool as shown below in Figure 18.1 and when the tool is not changed. Refer to tables 18.1and 18.2 for the TCP coordinate values and the tool size of the tool to set.

Table 18.1 Tool TCP coordinates to set

	X[mm]	Y[mm]	Z[mm]	O[deg]	A[deg]	T[deg]
tl1	0.0	120.0	85.0	120	90	90

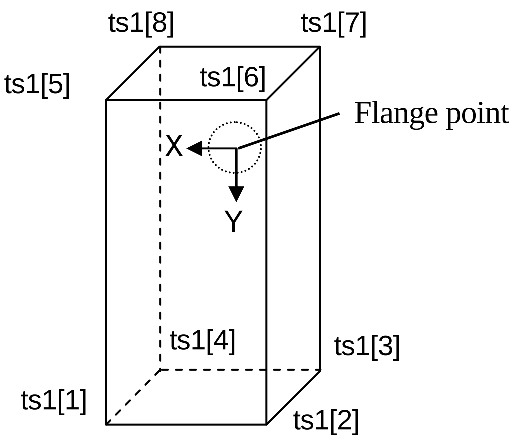


Figure 18.1 Tool to set

Table 18.2 Tool size of tools to set

	X[mm]	Y[mm]	Z[mm]
ts1[1]	80.0	200.0	115.0
ts1[2]	-80.0	200.0	115.0
ts1[3]	-80.0	200.0	-30.0
ts1[4]	80.0	200.0	-30.0
ts1[5]	80.0	-60.0	115.0
ts1[6]	-80.0	-60.0	115.0
ts1[7]	-80.0	-60.0	-30.0
ts1[8]	80.0	-60.0	-30.0

In actual setting operation, keep enough allowances in all XYZ directions of the tool shape points for safety purpose.

1. System Switch Setting
   In this example, the tool setting is done by AS language, and the tool is not changed. Turn both CBS_TOOLCHG and CBS_AUXTOOL1 switches OFF.

2. Tool Data Setting
   To set the tool using AS language, use SET_TOOLSHAPE and ENA_TOOLSHAPE command/ instructions as explained in 17.2.1. Tool number is 1 in this example.

   First, set the TCP coordinates tl1 and tool shape point ts1[1] - ts1[8] using POINT instruction. Using POINT instruction set the values in Tables 18.1 and 18.2. In this example, set 0 to all OAT values in ts1[1] to ts1[8].

   After setting tl1 and ts1[1] - ts1[8], set the tool shape using SET_TOOLSHAPE command. Input as below.

```
>set_toolshape tl1,1 = ts1[1], ts1[2], ts1[3], ts1[4], ts1[5], ts1[6], ts1[7], ts1[8]↵
```

   At this time, the following error message will appear.
   (E9404)[Cubic-S] Parameter may be changed. Turn OFF & ON the control power for verification.

   This error indicates that changes that might affect Cubic-S have been made. When this error occurs, the controller power should be turned OFF/ ON to check that the settings match those in Cubic-S. (This error cannot be reset by “Error Reset”).

   However, here, do not turn OFF/ ON the controller power, but follow the procedures below, write the data to Cubic-S as explained in 18.1 and then turn OFF/ ON the controller power. This way the operation will be done more efficiently.

   In this status, execute the following command:

```
> ena_toolshape 1 = true↵
```

   This will enable the monitoring of tool shape points 1 – 8 specified in SET_TOOLSHAPE command.

   After executing the command, in CS-Configurator conduct <Read Cubic-S>, <Read Robot Parameters>, <Read Tool Data> and then <Write to Cubic-S> accordingly and write the tool data to Cubic-S.
   In this example, the tool is not changed, so there is no need to change Tool ID Conversion Table in No.209 and No.210 from the default setting.

   The settings done in this example is summarized in the table below:

Table 18.3 Relevant System Switch

Switch name	ON/OFF
CBS_TOOLCHG	OFF
CBS_AUXTOOL1	OFF

Table 18.4 Tool Data Setting Value and Setting Methods

No.	Menu Name	Category	Setting	Method of Setting
112	Tool Points of Area Monitoring	Tool Points of Area Monitoring	Valid	ENA_TOOLSHAPE instruction/ command
113	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
114	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
115	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
210	Monitoring Common Settings	Tool ID valid/ invalid	Valid	Set by CS-Configurator
209	Monitoring Common Settings	Tool ID/No. Table	All 1	Set by CS-Configurator

18.2.2 SETTING BY AS LANGUAGE WITH TOOL CHANGE

This section explains how to set the tools by AS language and switches tools between the tools set in 18.2.1 and tool defined by the values in the table below. In this example the tool set in advance is numbered 1, and the tool newly set is numbered 2. Therefore, CBS_TOOLCHG switched is turned ON and CBS_AUXTOOL1switch is turned OFF.

Table 18.5 Tool TCP coordinates to set

	X[mm]	Y[mm]	Z[mm]	O[deg]	A[deg]	T[deg]
tl2	0.0	300.0	50.0	70	50	50

Table 18.6 Tool size of tools to set

	X[mm]	Y[mm]	Z[mm]
ts2[1]	50.0	400.0	100.0
ts2[2]	-50.0	400.0	100.0
ts2[3]	-50.0	400.0	-50.0
ts2[4]	50.0	400.0	-50.0
ts2[5]	50.0	-30.0	100.0
ts2[6]	-50.0	-30.0	100.0
ts2[7]	-50.0	-30.0	-50.0
ts2[8]	50.0	-30.0	-50.0

1. System Switch Setting

In this example, the tool setting is done by AS language, and the tool is changed. Turn CBS_TOOLCHG switch ON and CBS_AUXTOOL1 switch OFF.

2. Tool Data Setting

Set the TCP coordinates tl2 and tool shape points ts2[1] - ts2[8] by POINT instruction. After setting tl2 and ts2[1] - ts2[8], set the tool shape points using SET_TOOLSHAPE command. Enter as shown below.

>set_toolshape tl2,2 = ts2[1], ts2[2], ts2[3], ts2[4], ts2[5], ts2[6], ts2[7], ts2[8]↵

At this time, the following error message will appear.
(E9404)[Cubic-S] Parameter may be changed. Turn OFF & ON the control power for verification.
Do not turn OFF/ ON the controller power. Continue with the procedure and turn OFF/ ON the controller power after setting with the CS-Configurator is done.

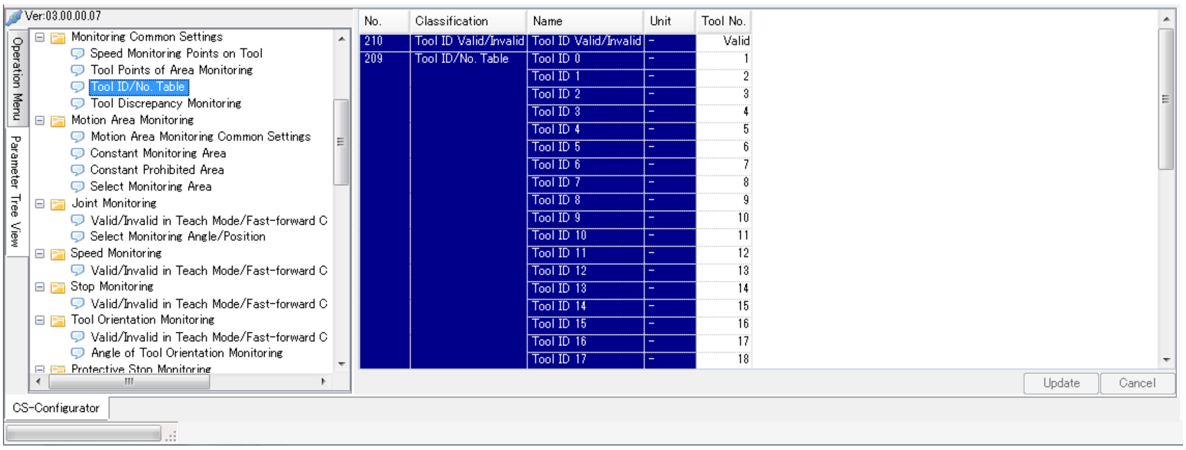
In this status, execute the following command:
>ena_toolshape 2 = true↵
This will enable the monitoring of tool shape points 1- 8 of tool 2.

After conducting the above setting, execute <Read Tool Data> in CS-Configurator. The set tool data is registered in No.112 – 118.

3. Tool ID Table Setting

In this example, set the Tool ID Conversion Table No. 209 as below before writing to Cubic-S.
The default values in the Tool ID table are all 1, so unless the table setting is done, Cubic-S will not detect the change in current tool number.

Table 18.7 Tool ID/ No. Conversion Table



Conduct <Write Parameters to Cubic-S> after the tool ID conversion table setting is completed.

4. Program Execution

This sample program changes tool while the robot is in operation.

```
.PROGRAM toolchg()
1   JMOVE p[0]
2   TOOL tl1,1
3   LMOVE p[1]
4   LMOVE p[2]
5   TOOL tl2,2
6   LMOVE p[3]
7   LMOVE p[4]
8   TOOL tl1,1
9   LMOVE p[5]
.END
```

Cubic-S monitors Tool 1 from after executing step 2 “TOOL tl1,1” to step 4 “LMOVE p[2]”. Then, Cubic-S monitors Tool 2 from after executing step 5 “TOOL tl2,2” to step7 “LMOVE p[4]”.　From after executing step 8 “TOOL tl1,1”, Cubic-S monitors tool 1 again.

Execute TOOL instruction and when the tool changes, change the current tool number that is input to Cubic-S.　For the current tool number, refer to Chapter 9 and enter the tool ID to XIN1 connector A12 – 14, B13, B14.　When the robot moves more than the distance set in No.51 “Movable Distance in Tool Number Discrepancy” with Command Tool No. and Current Tool No. not matching, the following error occurs:
(E9424)[Cubic-S (1)] Tool numbers do not coincide. (Command X, Current X)
When this error occurs, confirm that the Tool ID input to Cubic-S and the Tool ID table

settings are correct and match the Current Tool No. with the Command Tool No., then reset the error.

The settings done in this example is summarized in the table below:

Table 18.8 Relevant System Switch

Switch name	ON/OFF
CBS_TOOLCHG	ON
CBS_AUXTOOL1	OFF

Table 18.9 Tool Data Setting Value and Setting Methods

No.	Menu Name	Category	Setting	Method of Setting
112	Tool Points of Area Monitoring	Tool Points of Area Monitoring	Valid	ENA_TOOLSHAPE instruction/ command
113	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
114	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
115	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
116	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 2	Refer to Table 18.5, 18.6	SET_TOOLSHAPE instruction/ command
117	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 2	Refer to Table 18.5, 18.6	SET_TOOLSHAPE instruction/ command
118	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 2	Refer to Table 18.5, 18.6	SET_TOOLSHAPE instruction/ command
51	Monitoring Common Settings	Tool Discrepancy Monitoring	Desired Distance (mm)	Set by CS-Configurator
210	Monitoring Common Settings	Tool ID valid/ invalid	Valid	Set by CS-Configurator
209	Monitoring Common Settings	Tool ID/No. Table	Refer to Table 18.7	Set by CS-Configurator

18.2.3 SETTING BY AUXILIARY FUNCTION WITHOUT TOOL CHANGE

This section explains how to set tools using auxiliary functions and when the tool is not changed. Refer to tables 18.1and 18.2 in 18.2.1 for the TCP coordinate values and the tool size of the tool to set.

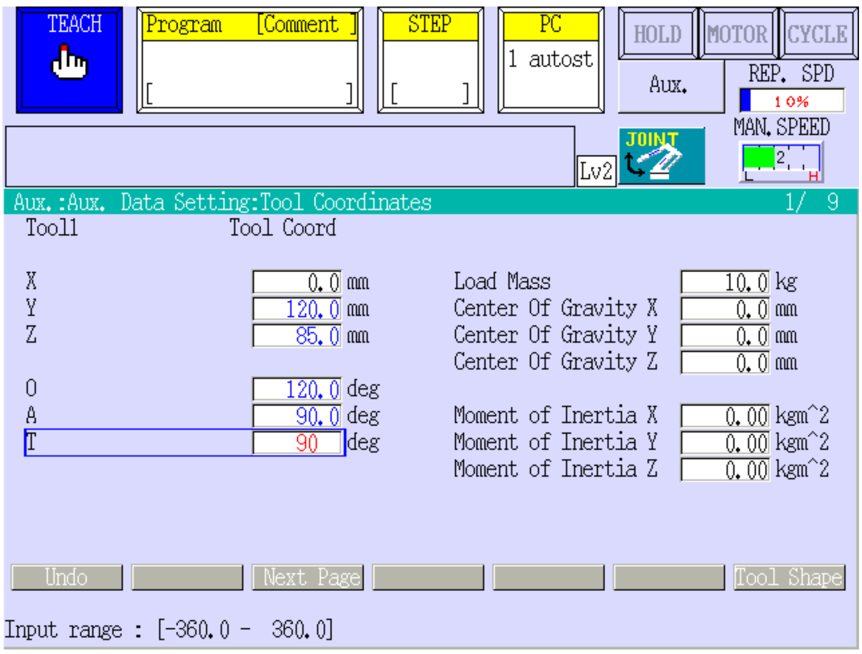
1. System Switch Setting

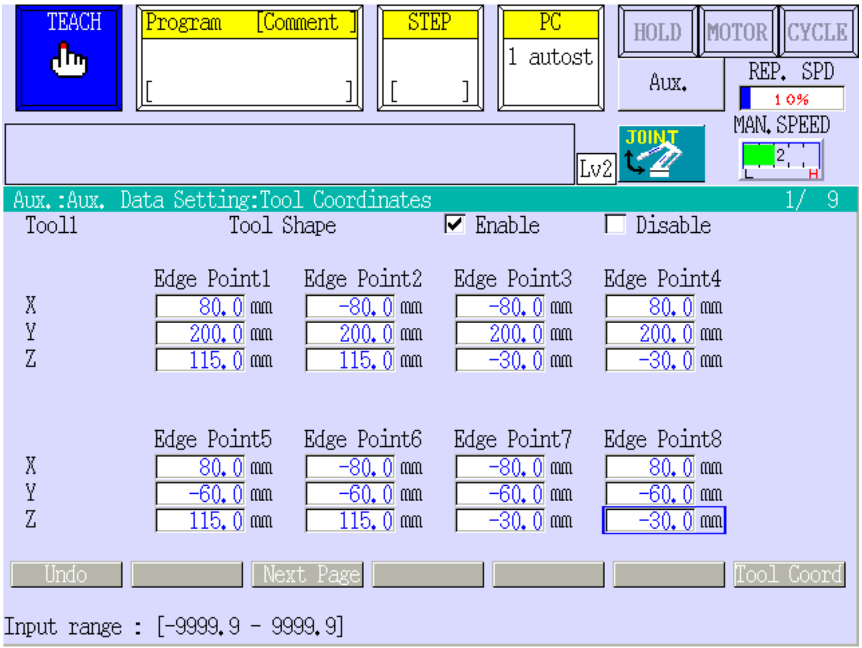
   In this example, tool setting is done via Aux. 0304and tool change is not conducted. Therefore, CBS_TOOLCHG switch is set to OFF and CBS_AUXTOOL1 switch is set to ON.

2. Tool Data Setting

   For tool data setting, refer to 17.2.2. Only tool number 1 is set in this example.

   In Aux. 0304, setting for tool 1 is done as shown in below. To set the tool shape points, press <Tool Shape> button.





After setting is done, execute <Read Tool Data> in CS-Configurator and confirm that the tool data set in Aux. 0304 is set to Tool No. 1. If the set tool data is registered in Tool 10 in No. 140 – 142, CBS_AUXTOOL1 switch is OFF. Turn the switch ON and read the tool data again. If CBS_AUXTOOL1 switch is ON, the tool data are registered to Tool No. 1 in No.112 – 115.

After confirming that the set tool data are registered in Tool No. 1 in No.112 – 115, execute <Write Parameters to Cubic-S> and turn OFF/ ON the controller power. If no error occurs when turning back ON the controller power, the setting is complete.

The settings done in this example is summarized in the table below:

Table 18.10 Relevant System Switch

Switch Name	ON/OFF
CBS_TOOLCHG	OFF
CBS_AUXTOOL1	ON

Table 18.11 Tool Data Setting Value and Setting Methods

No.	Menu Name	Category	Setting	Method of Setting
112	Tool Points of Area Monitoring	Tool Points of Area Monitoring	Valid	ENA_TOOLSHAPE instruction/ command
113	Tool Points of Area Monitoring	Tool shape coordinate	Refer to Table 18.1,	SET_TOOLSHAPE instruction/ command

		Tool No. 1	18.2	
114	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
115	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
210	Monitoring Common Settings	Tool ID valid/ invalid	Valid	Set by CS-Configurator
209	Monitoring Common Settings	Tool ID/No. Table	All 1	Set by CS-Configurator

18.2.4 SETTING BY AUXILIARY FUNCTION WITH TOOL CHANGE

This section explains how to set tools using auxiliary functions and change tool to monitor during operation. Refer to tables 18.2.2 for the TCP coordinate values and the tool size of the tool to set.

1. System switch setting

   In this example, the tool setting is done by Aux. 0304 and the tool is not changed. Turn both CBS_TOOLCHG and CBS_AUXTOOL1 switches ON.

2. Tool Data Setting

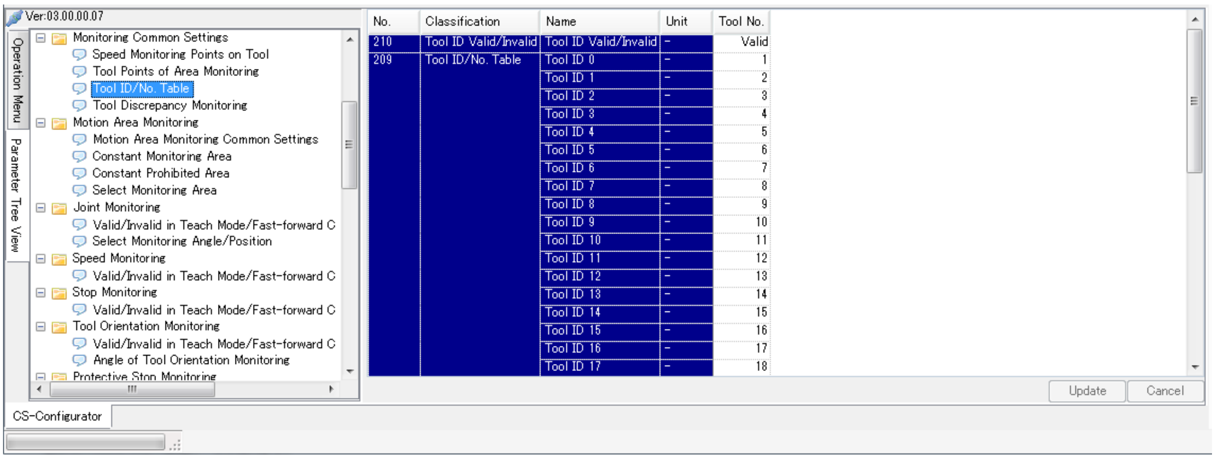
   Set the tool data for Tool 1 and Tool 2 via Aux. 0304 and execute <Read Tool Data> in CS-Configurator.

   At this time, confirm that the tool data is set to Tool No. 1 and 2. If confirmed, write the settings to Cubic-S and turn OFF/ ON the controller power. If the set tool data is registered in Tool 10 and 11 in No. 140 – 145, turn CBS_AUXTOOL1 switch ON and execute <Read Tool Data> again.

3. Too l ID Table Setting

   In this example, set the Tool ID conversion table in No. 209 as shown below before writing to Cubic-S.

   The default values in the Tool ID table are all 1, so unless the table setting is done, Cubic-S will not detect the change in current tool number.



   After the setting of tool ID conversion table is done, execute <Write Parameters to Cubic-S>.

4. Program Execution

   To create a program using in block teaching, set the tool numbers to use in each step for

each Tool No. to use.
Also, when the tool changes during the execution of the program, change the Tool No. toinput to Cubic-S accordingly. For the current tool number, refer to Chapter 9 and enter the tool ID to XIN1 connector A12 – 14, B13, B14. In block teaching too, when the robot moves more than the distance set in No.51 “Movable Distance in Tool Number Discrepancy” with Command Tool No. and Current Tool No. not matching, the following error occurs:
(E9424)[Cubic-S (1)] Tool numbers do not coincide. (Command X, Current X)

When this error occurs, confirm that the Tool ID input to Cubic-S and the Tool ID table settings are correct and match the Current Tool No. with the Command Tool No., then reset the error.

The settings done in this example is summarized in the table below:

Table 18.12 Relevant System Switch

Switch name	ON/OFF
CBS_TOOLCHG	ON
CBS_AUXTOOL1	ON

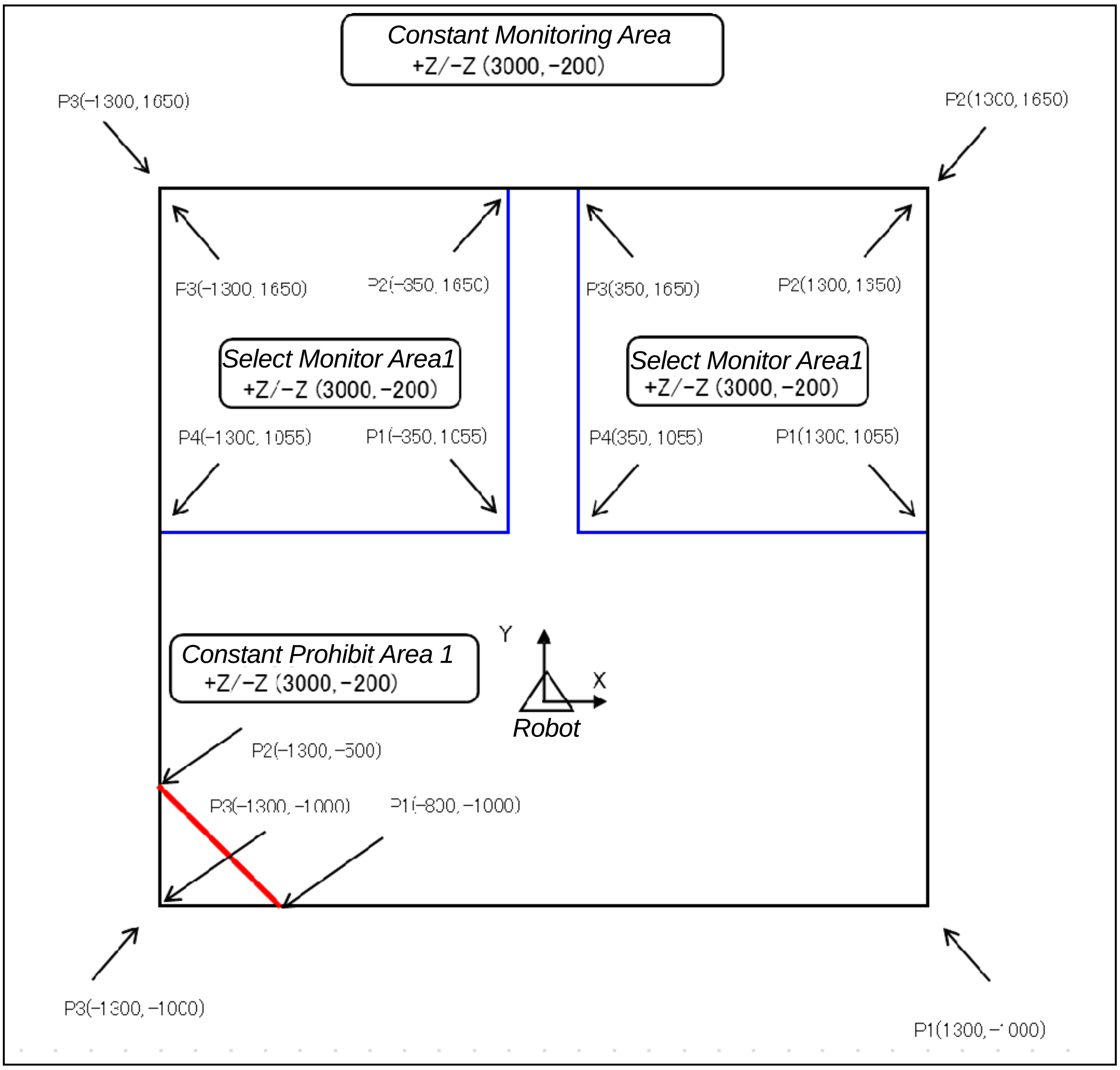
Table 18.13 Tool Data Setting Value and Setting Methods

No.	Menu Name	Category	Setting	Method of Setting
112	Tool Points of Area Monitoring	Tool Points of Area Monitoring	Valid	ENA_TOOLSHAPE instruction/ command
113	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
114	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
115	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 1	Refer to Table 18.1, 18.2	SET_TOOLSHAPE instruction/ command
116	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 2	Refer to Table	SET_TOOLSHAPE instruction/ command

			18.5, 18.6	
117	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 2	Refer to Table 18.5, 18.6	SET_TOOLSHAPE instruction/ command
118	Tool Points of Area Monitoring	Tool shape coordinate Tool No. 2	Refer to Table 18.5, 18.6	SET_TOOLSHAPE instruction/ command
51	Monitoring Common Settings	Tool Discrepancy Monitoring	Desired distance (mm)	Set by CS-Configurator
210	Monitoring Common Settings	Tool ID valid/ invalid	Valid	Set by CS-Configurator
209	Monitoring Common Settings	Tool ID/No. Table	See 3.	Set by CS-Configurator

18.3 EXAMPLE OF CUBIC-S MONITORING AREA SETTING

This section shows an example of Cubic-S monitoring area setting. In monitoring area setting, constant monitoring area, constant prohibited area, and select Monitoring area can be set. This example sets the monitoring area as shown in the figure below.



Also, in this example, the below contents are set to User Safety Input/ Output.

Safety Input

User Safety Input1	External Emergency Stop 1
User Safety Input2	Select Monitoring Area 1
User Safety Input3	Select Monitoring Area 2

Safety Output

User Safety Output 1	Select Monitoring Area 1
User Safety Output 2	Select Monitoring Area 2

In this example, select monitoring area is set as select prohibited area. select monitoring area 1 for User Safety Input turns OFF, the robot will be prohibited to enter that area. When setting the poses in the area, use the actual measurement values instead of data acquired by CAD drawings.

1. Monitoring Area Setting
   Monitoring area setting is done using CS-Configurator. The items set in this exampleare shown in the table below. Enter the values in the figure above for the coordinate values of the vertices of the monitoring area. See 11.1.3 Motion Area Monitoring Function for details of each setting items. When the setting is complete, execute <Write Parameters to Cubic-S> and turn OFF/ ON the controller power.

Set Items

No.	Menu Name	Category	Setting	Method of Setting
301	Monitoring Common Setting	Select Monitoring Area	Valid/Invalid in Teach Mode/Fast-forward Check	Valid
302	Monitoring Common Settings	Constant Monitoring Area	Monitoring Points on Arm Valid/Invalid	Valid
303	Monitoring Common Settings	Constant Monitoring Area 1	Monitoring Line Segments on Arm Valid/Invalid	Valid
304	Monitoring Common Settings	Select Monitoring Area	Monitoring Points on Arm Valid/Invalid	Valid
305	Monitoring Common Settings	Constant Monitoring Area 1	Monitoring Line Segments on Arm Valid/Invalid	Valid
306	Monitoring Common Settings	Constant Monitoring Area 2	Monitoring Points on Arm Valid/Invalid	Valid
307	Monitoring Common Settings	Constant Monitoring Area 2	Monitoring Line Segments on Arm Valid/Invalid	Valid
308	Monitoring Common Settings	Constant Monitoring Area 3	Monitoring Points on Arm Valid/Invalid	Valid
309	Monitoring Common Settings	Constant Monitoring Area 3	Monitoring Line Segments on Arm Valid/Invalid	Valid
310	Monitoring Common Setting	Constant Monitoring Area 4	Monitoring Points on Arm Valid/Invalid	Valid
311	Monitoring Common Setting	Constant Monitoring Area 4	Monitoring Line Segments on Arm Valid/Invalid	Valid
312	Monitoring Common Setting	Stop Distance Estimation	Valid/Invalid	Invalid
313	Monitoring Common Setting	Constant Monitoring Area	Z+/Z-	Z+ : 3000 Z- : -200
315	Monitoring Common Setting	Constant Monitoring Area	P1(X,Y) - P8(X,Y), Valid/Invalid	Set according to the figure in this section, valid for set points.
316	Monitoring	Constant	Z+/Z-	Z+ : 3000

	Common Setting	Monitoring Area 1		Z- : -200
317	Monitoring Common Setting	Constant Monitoring Area 1	Valid/Invalid	Valid
319	Monitoring Common Setting	Constant Monitoring Area 1	P1(X,Y) - P4(X,Y), Valid/Invalid	Set according to the figure in this section, valid for set points.
348	Monitoring Common Setting	Select Monitoring Area1	Z+/Z-	Set according to the figure in this section,
349	Monitoring Common Setting	Select Monitoring Area1	Valid/Invalid	Valid
350	Monitoring Common Setting	Select Monitoring Area1	Permitted/Prohibited	Prohibited
352	Monitoring Common Setting	Select Monitoring Area1	P1(X,Y) - P6(X,Y), Valid/Invalid	Set according to the figure in this section, valid for set points.
353	Monitoring Common Setting	Select Monitoring Area 2	Z+/Z-	Set according to the figure in this section,
354	Monitoring Common Setting	Select Monitoring Area 2	Valid/Invalid	Valid
355	Monitoring Common Setting	Select Monitoring Area 2	Permitted/Prohibited	Prohibited
357	Monitoring Common Setting	Select Monitoring Area 2	P1(X,Y) - P6(X,Y), Valid/Invalid	Set according to the figure in this section, valid for set points.
-	Safety Input/ Output	Safety Input Setting	Safety Input Name	User Safety Input 1
			Allocated Signal Name	External Emergency Stop 1
			Duplexing Logic	Equivalent
			Filter time [ms]	3
			Safety Input Diagnosis	Do
			Acceptable Time of Discrepancy [ms]	500
-	Safety Input/ Output	Safety Input Setting	Safety Input Name	User Safety Input 2
			Allocated Signal Name	Select Monitoring Area 1
			Duplexing Logic	Equivalent
			Filter time [ms]	3

			Safety Input Diagnosis	Do
			Acceptable Time of Discrepancy [ms]	500
-	Safety Input/ Output	Safety Input Setting	Safety Input Name	User Safety Input 3
			Allocated Signal Name	Select Monitoring Area 2
			Duplexing Logic	Equivalent
			Filter time [ms]	3
			Safety Input Diagnosis	Do
			Acceptable Time of Discrepancy [ms]	500
-	Safety Input/ Output	Safety Output Setting	Safety Output Name	User Safety Output 1
			Allocated Signal Name	Select Monitoring Area 1
-	Safety Input/ Output	Safety Output Setting	Safety Output Name	User Safety Output 2
			Allocated Signal Name	Select Monitoring Area 2

Note*1 The Response time differs according to the filter time, so set an appropriate filter time. For response time, refer to 13.0 Response Time in this manual.

Note*2 The “Do/ Do not” setting for input test pulse diagnosis depends on the connected devices. For details, see”1. How to connect contact output type device to user safety input” and “2. When connecting semi conductor output (OSSD) type devices to user safety input” in 10.1 Safety Input Function.

Enter the values below for points P1 - P4 of the constant monitoring area.

Category	Name	Value 1	Value 2	Value 3
Constant Monitoring Area	P1(X,Y)Valid/ Invalid	1300	-1000	Valid
	P2(X,Y)Valid/ Invalid	1300	1650	Valid
	P3(X,Y)Valid/ Invalid	-1300	1650	Valid
	P4(X,Y)Valid/ Invalid	-1300	-1000	Valid

Select Monitoring Area 1	P1（X,Y）Valid/ Invalid	1300	1055	Valid
	P2(X,Y)Valid/ Invalid	1300	1650	Valid
	P3(X,Y)Valid/ Invalid	350	1650	Valid
	P4(X,Y)Valid/ Invalid	350	1055	Valid
Select Monitoring Area 2	P1(X,Y)Valid/ Invalid	-350	1055	Valid
	P2(X,Y)Valid/ Invalid	-350	1650	Valid
	P3(X,Y)Valid/ Invalid	-1300	1650	Valid
	P4(X,Y)Valid/ Invalid	-1300	1055	Valid
Constant Prohibited Area1	P1(X,Y)Valid/ Invalid	-800	-1000	Valid
	P2(X,Y)Valid/ Invalid	-1300	-500	Valid
	P3(X,Y)Valid/ Invalid	-1300	-1000	Valid

*For items not on this table, set 0 for values 1 and 2, set invalid for value 3.

2. Write the parameters to Cubic-S

To write the parameters to Cubic-S execute <Read Cubic-S Parameters>, <Read Robot Parameters>, <Write Parameters to Cubic-S> in this order or execute <Robot Data Writing>.

When the monitoring area setting is complete, check the area monitoring function following the checklist on “11.2.1Area Monitoring Function”.

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