

FANUC Robot series

R-30iB/R-30iB Mate CONTROLLER

Dual Check Safety Functions

BASIC MANUAL

- **Original Instructions**

Before using the Robot, be sure to read the "FANUC Robot Safety Manual (B-80687EN)" and understand the content.

- No part of this manual may be reproduced in any form.
- All specifications and designs are subject to change without notice.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.

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Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual we have tried as much as possible to describe all the various matters.

However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.

Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

SAFETY PRECAUTIONS

Thank you for purchasing FANUC Robot.

This chapter describes the precautions which must be observed to ensure the safe use of the robot.

Before attempting to use the robot, be sure to read this chapter thoroughly.

Before using the functions related to robot operation, read the relevant operator's manual to become familiar with those functions.

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral devices installed in a work cell.

In addition, refer to the "FANUC Robot SAFETY HANDBOOK (B-80687EN)."

1 WORKING PERSON

The personnel can be classified as follows.

Operator:

- Turns robot controller power ON/OFF
- Starts robot program from operator's panel

Programmer or teaching operator:

- Operates the robot
- Teaches robot inside the safety fence

Maintenance engineer:

- Operates the robot
- Teaches robot inside the safety fence
- Maintenance (adjustment, replacement)

- An operator cannot work inside the safety fence.
- A programmer, teaching operator, and maintenance engineer can work inside the safety fence. The working activities inside the safety fence include lifting, setting, teaching, adjusting, maintenance, etc.
- To work inside the fence, the person must be trained on proper robot operation.

During the operation, programming, and maintenance of your robotic system, the programmer, teaching operator, and maintenance engineer should take additional care of their safety by using the following safety precautions.

- Use adequate clothing or uniforms during system operation
- Wear safety shoes
- Use helmet

2 DEFINITION OF WARNING, CAUTION AND NOTE

To ensure the safety of working persons and prevent damage to the machine, this manual indicates each precaution on safety with "Warning" or "Caution" according to its severity. Supplementary information is

indicated by "Note." Read the contents of each "Warning", "Caution" and "Note" before attempting to use the robots.

⚠ WARNING

Applied when there is a danger of death or injury to the working person and the equipment being damaged, if the approved procedure is not observed.

⚠ CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE

Notes are used to indicate supplementary information other than Warnings and Cautions.

- Read this manual carefully, and store it in a safe place.

3 WORKING PERSON SAFETY

Working person safety is the primary safety consideration. Because it is very dangerous to enter the operating space of the robot during automatic operation, adequate safety precautions must be observed. The following lists the general safety precautions. Careful consideration must be made to ensure working person safety.

- (1) Have the robot system working persons attend the training courses held by FANUC.

FANUC provides various training courses. Contact our sales office for details.

- (2) Even when the robot is stationary, it is possible that the robot is still in a ready to move state, and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure working person safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.
- (3) Install a safety fence with a gate so that no working person can enter the work area without passing through the gate. Install an interlocking device, a safety plug, and so forth in the safety gate so that the robot is stopped as the safety gate is opened.

The controller is designed to receive this interlocking signal of the door switch. When the gate is opened and this signal received, the controller stops the robot (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type). For connection, see Fig.3 (a) and Fig.3 (b).

- (4) Provide the peripheral devices with appropriate grounding (Class A, Class B, Class C, and Class D).
- (5) Try to install the peripheral devices outside the work area.
- (6) Draw an outline on the floor, clearly indicating the range of the robot motion, including the tools such as a hand.
- (7) Install a mat switch or photoelectric switch on the floor with an interlock to a visual or aural alarm that stops the robot when a working person enters the work area.
- (8) If necessary, install a safety lock so that no one except the working person in charge can turn on the power of the robot.

The circuit breaker installed in the controller is designed to disable anyone from turning it on when it is locked with a padlock.

- (9) When adjusting each peripheral device independently, be sure to turn off the power of the robot.
- (10) Operators should be ungloved while manipulating the operator's panel or teach pendant. Operation with gloved fingers could cause an operation error.

- (11) Programs, system variables, and other information can be saved on memory card or USB memories. Be sure to save the data periodically in case the data is lost in an accident.
- (12) The robot should be transported and installed by accurately following the procedures recommended by FANUC. Wrong transportation or installation may cause the robot to fall, resulting in severe injury to workers.
- (13) In the first operation of the robot after installation, the operation should be restricted to low speeds. Then, the speed should be gradually increased to check the operation of the robot.
- (14) Before the robot is started, it should be checked that no one is in the area of the safety fence. At the same time, a check must be made to ensure that there is no risk of hazardous situations. If detected, such a situation should be eliminated before the operation.
- (15) When the robot is used, the following precautions should be taken. Otherwise, the robot and peripheral equipment can be adversely affected, or workers can be severely injured.
 - Avoid using the robot in a flammable environment.
 - Avoid using the robot in an explosive environment.
 - Avoid using the robot in an environment full of radiation.
 - Avoid using the robot under water or at high humidity.
 - Avoid using the robot to carry a person or animal.
 - Avoid using the robot as a stepladder. (Never climb up on or hang from the robot.)
- (16) When connecting the peripheral devices related to stop(safety fence etc.) and each signal (external emergency , fence etc.) of robot. be sure to confirm the stop movement and do not take the wrong connection.
- (17) When preparing trestle, please consider security for installation and maintenance work in high place according to Fig.3 (c). Please consider footstep and safety bolt mounting position.

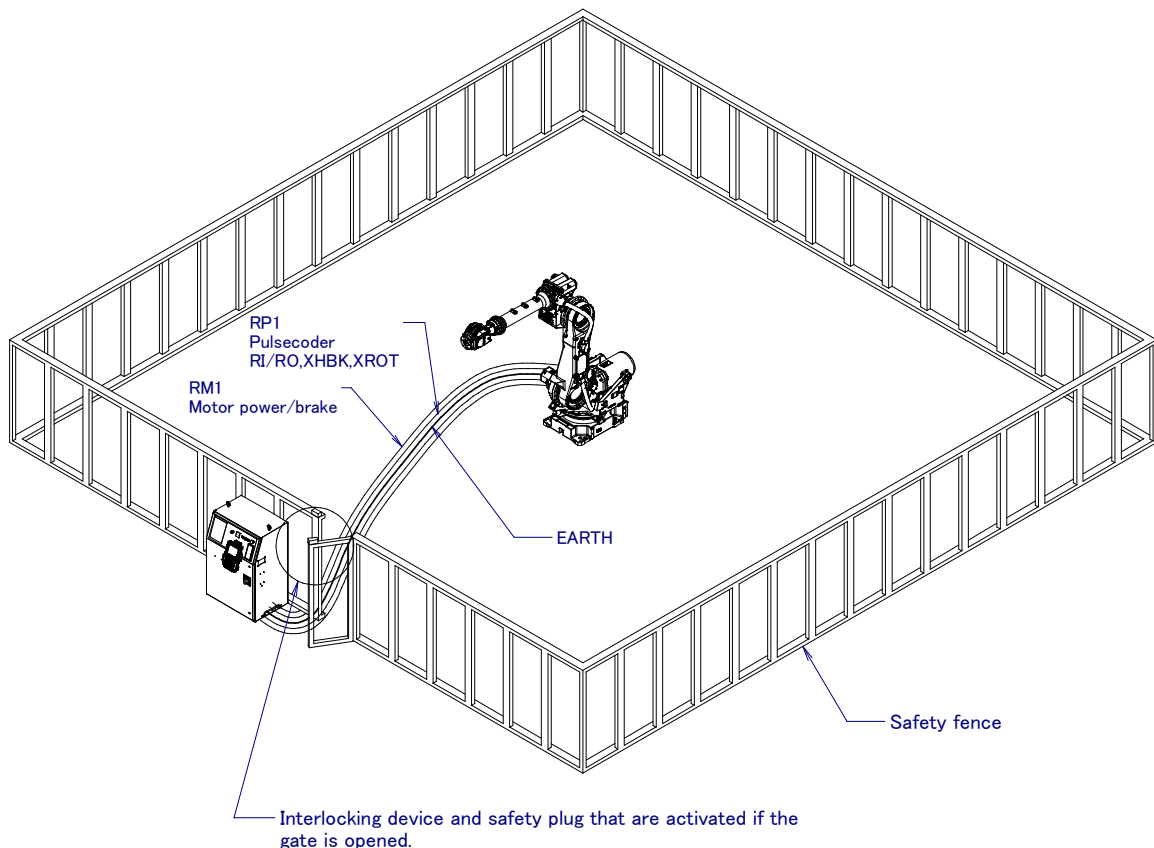
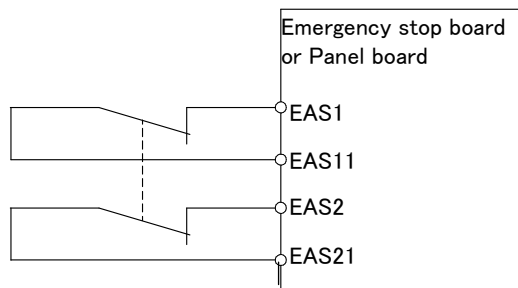
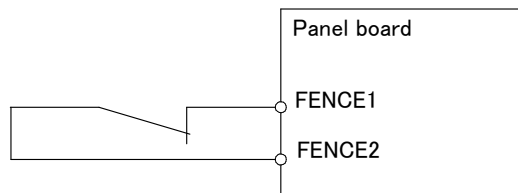


Fig. 3 (a) Safety fence and safety gate

Dual chain



Single chain



(Note)

In case of R-30iB, R-30iB Mate
Terminals EAS1,EAS11,EAS2,EAS21 are provided on the
emergency stop board.

Refer to the ELECTRICAL CONNECTIONS Chapter
of CONNECTION of
R-30iB controller maintenance manual (B-83195EN) or
R-30iB Mate controller maintenance manual (B-83525EN)
or R-30iB Mate controller (Open Air) maintenance manual
(B-83525EN) for details.

Fig. 3 (b) Limit switch circuit diagram of the safety fence

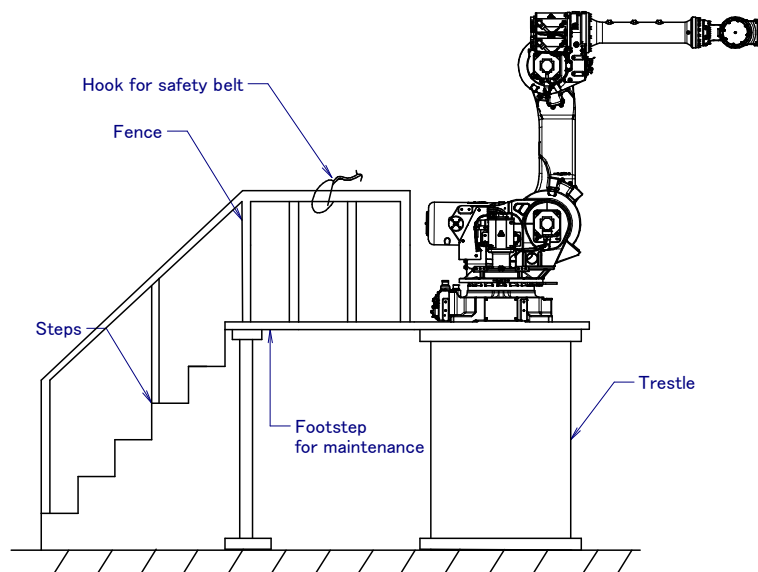


Fig.3 (c) Footstep for maintenance

3.1 OPERATOR SAFETY

The operator is a person who operates the robot system. In this sense, a worker who operates the teach pendant is also an operator. However, this section does not apply to teach pendant operators.

- (1) If you do not have to operate the robot, turn off the power of the robot controller or press the EMERGENCY STOP button, and then proceed with necessary work.
- (2) Operate the robot system at a location outside of the safety fence
- (3) Install a safety fence with a safety gate to prevent any worker other than the operator from entering the work area unexpectedly and to prevent the worker from entering a dangerous area.
- (4) Install an EMERGENCY STOP button within the operator's reach.

The robot controller is designed to be connected to an external EMERGENCY STOP button. With this connection, the controller stops the robot operation (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type), when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

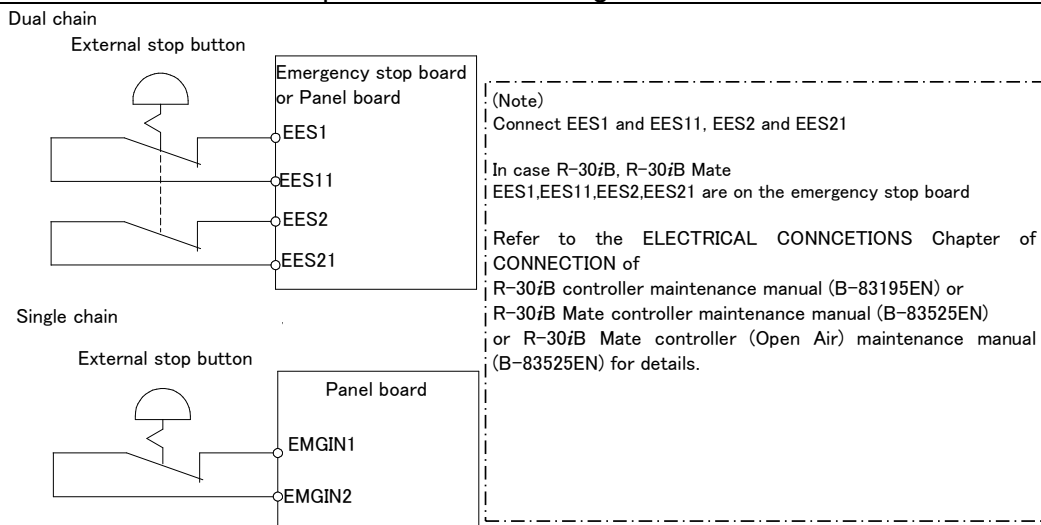


Fig.3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

While teaching the robot, the operator must enter the work area of the robot. The operator must ensure the safety of the teach pendant operator especially.

- (1) Unless it is specifically necessary to enter the robot work area, carry out all tasks outside the area.
- (2) Before teaching the robot, check that the robot and its peripheral devices are all in the normal operating condition.
- (3) If it is inevitable to enter the robot work area to teach the robot, check the locations, settings, and other conditions of the safety devices (such as the EMERGENCY STOP button, the DEADMAN switch on the teach pendant) before entering the area.
- (4) The programmer must be extremely careful not to let anyone else enter the robot work area.
- (5) Programming should be done outside the area of the safety fence as far as possible. If programming needs to be done in the area of the safety fence, the programmer should take the following precautions:
 - Before entering the area of the safety fence, ensure that there is no risk of dangerous situations in the area.
 - Be prepared to press the emergency stop button whenever necessary.
 - Robot motions should be made at low speeds.
 - Before starting programming, check the entire system status to ensure that no remote instruction to the peripheral equipment or motion would be dangerous to the working person.

Our operator panel is provided with an emergency stop button and a key switch (mode switch) for selecting the automatic operation mode (AUTO) and the teach modes (T1 and T2). Before entering the inside of the safety fence for the purpose of teaching, set the switch to a teach mode, remove the key from the mode switch to prevent other people from changing the operation mode carelessly, then open the safety gate. If the safety gate is opened with the automatic operation mode set, the robot stops (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type). After the switch is set to a teach mode, the safety gate is disabled. The programmer should understand that the safety gate is disabled and is responsible for keeping other people from entering the inside of the safety fence.

Our teach pendant is provided with a DEADMAN switch as well as an emergency stop button. These button and switch function as follows:

- (1) Emergency stop button: Causes the stop of the robot (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type) when pressed.
- (2) DEADMAN switch: Functions differently depending on the teach pendant enable/disable switch setting status.
 - (a) Disable: The DEADMAN switch is disabled.
 - (b) Enable: Servo power is turned off when the operator releases the DEADMAN switch or when the operator presses the switch strongly.

Note) The DEADMAN switch is provided to stop the robot when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30iB/R-30iB Mate employs a 3-position DEADMAN switch, which allows the robot to operate when the 3-position DEADMAN switch is pressed to its intermediate point. When the operator releases the DEADMAN switch or presses the switch strongly, the robot stops immediately.

The programmer's intention of starting teaching is determined by the controller through the dual operation of setting the teach pendant enable/disable switch to the enable position and pressing the DEADMAN switch. The programmer should make sure that the robot could operate in such conditions and be responsible in carrying out tasks safely.

Based on the risk assessment by FANUC, number of operation of DEADMAN SW should not exceed about 10000 times per year.

The teach pendant, operator panel, and peripheral device interface send each robot start signal. However the validity of each signal changes as follows depending on the mode switch and the DEADMAN switch of the operator panel, the teach pendant enable switch and the remote condition on the software.

Mode	Teach pendant enable switch	Software remote condition	Teach pendant	Operator panel	Peripheral device
AUTO mode	On	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed
	Off	Local	Not allowed	Allowed to start	Not allowed
		Remote	Not allowed	Not allowed	Allowed to start
T1, T2 mode	On	Local	Allowed to start	Not allowed	Not allowed
		Remote	Allowed to start	Not allowed	Not allowed
	Off	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed

T1,T2 mode: DEADMAN switch is effective.

- (6) To start the system using the operator's panel, make certain that nobody is the robot work area and that there are no abnormal conditions in the robot work area.
- (7) When a program is completed, be sure to carry out a test operation according to the procedure below.
 - (a) Run the program for at least one operation cycle in the single step mode at low speed.
 - (b) Run the program for at least one operation cycle in the continuous operation mode at low speed.
 - (c) Run the program for one operation cycle in the continuous operation mode at the intermediate speed and check that no abnormalities occur due to a delay in timing.
 - (d) Run the program for one operation cycle in the continuous operation mode at the normal operating speed and check that the system operates automatically without trouble.
 - (e) After checking the completeness of the program through the test operation above, execute it in the automatic operation mode.
- (8) While operating the system in the automatic operation mode, the teach pendant operator should leave the robot work area.

3.3 SAFETY OF THE MAINTENANCE ENGINEER

For the safety of maintenance engineer personnel, pay utmost attention to the following.

- (1) During operation, never enter the robot work area.
- (2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed.
- (3) If it becomes necessary to enter the robot operation range while the power is on, press the emergency stop button on the operator panel, or the teach pendant before entering the range. The maintenance personnel must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
- (4) When entering the area enclosed by the safety fence, the maintenance worker must check the entire system in order to make sure no dangerous situations exist. In case the worker needs to enter the safety area whilst a dangerous situation exists, extreme care must be taken, and entire system status must be carefully monitored.
- (5) Before the maintenance of the pneumatic system is started, the supply pressure should be shut off and the pressure in the piping should be reduced to zero.
- (6) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.
- (7) Do not operate the robot in the automatic mode while anybody is in the robot work area.
- (8) When you maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.
- (9) When a tool is mounted on the robot, or when any moving device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
- (10) If necessary, have a worker who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the worker should be ready to press the EMERGENCY STOP button at any time.
- (11) When replacing a part, please contact FANUC service center. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the worker.
- (12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.
- (13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
If there are two cabinets, turn off the both circuit breaker.
- (14) A part should be replaced with a part recommended by FANUC. If other parts are used, malfunction or damage would occur. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.
- (15) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the work area and that the robot and the peripheral devices are not abnormal.
- (16) When a motor or brake is removed, the robot arm should be supported with a crane or other equipment beforehand so that the arm would not fall during the removal.
- (17) Whenever grease is spilled on the floor, it should be removed as quickly as possible to prevent dangerous falls.
- (18) The following parts are heated. If a maintenance worker needs to touch such a part in the heated state, the worker should wear heat-resistant gloves or use other protective tools.
 - Servo motor
 - Inside the controller
 - Reducer
 - Gearbox

- Wrist unit
- (19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.
- (20) When a motor, reducer, or other heavy load is handled, a crane or other equipment should be used to protect maintenance workers from excessive load. Otherwise, the maintenance workers would be severely injured.
- (21) The robot should not be stepped on or climbed up during maintenance. If it is attempted, the robot would be adversely affected. In addition, a misstep can cause injury to the worker.
- (22) When performing maintenance work in high place, secure a footstep and wear safety belt.
- (23) After the maintenance is completed, spilled oil or water and metal chips should be removed from the floor around the robot and within the safety fence.
- (24) When a part is replaced, all bolts and other related components should put back into their original places. A careful check must be given to ensure that no components are missing or left not mounted.
- (25) In case robot motion is required during maintenance, the following precautions should be taken :
 - Foresee an escape route. And during the maintenance motion itself, monitor continuously the whole system so that your escape route will not become blocked by the robot, or by peripheral equipment.
 - Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.
- (26) The robot should be periodically inspected. (Refer to the robot mechanical manual and controller maintenance manual.) A failure to do the periodical inspection can adversely affect the performance or service life of the robot and may cause an accident
- (27) After a part is replaced, a test operation should be given for the robot according to a predetermined method. (See TESTING section of "R-30iB/R-30iB Mate Controller operator's manual (Basic Operation).") During the test operation, the maintenance staff should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

4.1 PRECAUTIONS IN PROGRAMMING

- (1) Use a limit switch or other sensor to detect a dangerous condition and, if necessary, design the program to stop the robot when the sensor signal is received.
- (2) Design the program to stop the robot when an abnormal condition occurs in any other robots or peripheral devices, even though the robot itself is normal.
- (3) For a system in which the robot and its peripheral devices are in synchronous motion, particular care must be taken in programming so that they do not interfere with each other.
- (4) Provide a suitable interface between the robot and its peripheral devices so that the robot can detect the states of all devices in the system and can be stopped according to the states.

4.2 PRECAUTIONS FOR MECHANISM

- (1) Keep the component cells of the robot system clean, and operate the robot in an environment free of grease, water, and dust.
- (2) Don't use unconfirmed liquid for cutting fluid and cleaning fluid.
- (3) Employ a limit switch or mechanical stopper to limit the robot motion so that the robot or cable does not strike against its peripheral devices or tools.
- (4) Observe the following precautions about the mechanical unit cables. Failure to follow precautions may cause mechanical troubles.

- Use mechanical unit cable that have required user interface.
 - Don't add user cable or hose to inside of mechanical unit.
 - Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
 - In the case of the model that a cable is exposed, Please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
 - When installing user peripheral equipment on the robot mechanical unit, please pay attention that equipment does not interfere with the robot itself.
- (5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please execute power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type.)
(Bad case example)
- Whenever poor product is generated, a line stops by emergency stop and power-off of the robot is executed.
 - When alteration was necessary, safety switch is operated by opening safety fence and power-off stop is executed for the robot during operation.
 - An operator pushes the emergency stop button frequently, and a line stops.
 - An area sensor or a mat switch connected to safety signal operate routinely and power-off stop is executed for the robot.
- (6) Power-off stop of Robot is executed when collision detection alarm (SRVO-050) etc. occurs. Please try to avoid unnecessary power-off stops. It may cause the trouble of the robot, too. So remove the causes of the alarm.

5 SAFETY OF THE ROBOT MECHANISM

5.1 PRECAUTIONS IN OPERATION

- (1) When operating the robot in the jog mode, set it at an appropriate speed so that the operator can manage the robot in any eventuality.
- (2) Before pressing the jog key, be sure you know in advance what motion the robot will perform in the jog mode.

5.2 PRECAUTIONS IN PROGRAMMING

- (1) When the work areas of robots overlap, make certain that the motions of the robots do not interfere with each other.
- (2) Be sure to specify the predetermined work origin in a motion program for the robot and program the motion so that it starts from the origin and terminates at the origin.
Make it possible for the operator to easily distinguish at a glance that the robot motion has terminated.

5.3 PRECAUTIONS FOR MECHANISMS

- (1) Keep the work areas of the robot clean, and operate the robot in an environment free of grease, water, and dust.

5.4 PROCEDURE TO MOVE ARM WITHOUT DRIVE POWER IN EMERGENCY OR ABNORMAL SITUATIONS

For emergency or abnormal situations (e.g. persons trapped in or pinched by the robot), brake release unit can be used to move the robot axes without drive power.

Please refer to controller maintenance manual and mechanical unit operator's manual for using method of brake release unit and method of supporting robot.

6 SAFETY OF THE END EFFECTOR

6.1 PRECAUTIONS IN PROGRAMMING

- (1) To control the pneumatic, hydraulic and electric actuators, carefully consider the necessary time delay after issuing each control command up to actual motion and ensure safe control.
- (2) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

7 STOP TYPE OF ROBOT

The following three robot stop types exist:

Power-Off Stop (Category 0 following IEC 60204-1)

Servo power is turned off and the robot stops immediately. Servo power is turned off when the robot is moving, and the motion path of the deceleration is uncontrolled.

The following processing is performed at Power-Off stop.

- An alarm is generated and servo power is turned off.
- The robot operation is stopped immediately. Execution of the program is paused.

Frequent Power-Off stop of the robot during operation can cause mechanical problems of the robot.

Avoid system designs that require routine or frequent Power-Off stop conditions.

Controlled stop (Category 1 following IEC 60204-1)

The robot is decelerated until it stops, and servo power is turned off.

The following processing is performed at Controlled stop.

- The alarm "SRVO-199 Controlled stop" occurs along with a decelerated stop. Execution of the program is paused.
- An alarm is generated and servo power is turned off.

Hold (Category 2 following IEC 60204-1)

The robot is decelerated until it stops, and servo power remains on.

The following processing is performed at Hold.

- The robot operation is decelerated until it stops. Execution of the program is paused.



WARNING

The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when Controlled stop is used.

When the emergency stop button is pressed or the FENCE is open, the stop type of robot is "Power-Off stop" or "Controlled stop." The configuration of stop type for each situation is called "stop pattern." The stop pattern is different according to the controller type or option configuration.

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Servo disconnect
A	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	P-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
B	AUTO	P-Stop	P-Stop	P-Stop	P-Stop	P-Stop
	T1	P-Stop	P-Stop	-	P-Stop	P-Stop
	T2	P-Stop	P-Stop	-	P-Stop	P-Stop
C	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	C-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop

P-Stop: Power-Off stop

C-Stop: Controlled stop

-: Disable

The following table indicates the Stop pattern according to the controller type or option configuration.

Option	R-30iB/ R-30iB Mate
Standard	A (*)
Controlled stop by E-Stop (A05B-2600-J570)	C (*)

(*) R-30iB/R-30iB Mate does not have servo disconnect. R-30iB Mate does not have SVOFF input.

The stop pattern of the controller is displayed in "Stop pattern" line in software version screen. Please refer to "Software version" in operator's manual of controller for the detail of software version screen.

"Controlled stop by E-Stop" option

When "Controlled stop by E-Stop" (A05B-2600-J570) option is specified, the stop type of the following alarms becomes Controlled stop but only in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop which is the normal operation of the system.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

Controlled stop is different from Power-Off stop as follows:

- In Controlled stop, the robot is stopped on the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Controlled stop, physical impact is less than Power-Off stop. This function is effective for systems where the physical impact to the mechanical unit or EOAT (End Of Arm Tool) should be minimized.
- The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop, depending on the robot model and axis. Please refer to the operator's manual of a particular robot model for the data of stopping distance and stopping time.

When this option is loaded, this function cannot be disabled.

The stop type of DCS Position and Speed Check functions is not affected by the loading of this option.

**WARNING**

The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when this option is loaded.

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1 OVERVIEW

This chapter gives an overview of the DCS function and position / speed check functions.

About the DCS function

The Dual Check Safety (DCS) function checks the speed and position data of motors with two independent CPUs in the robot controller. This function can detect position and speed errors immediately and shut down the motor power through two independent channels.

Processes and data related to safety are cross-checked by two CPUs. Self-diagnosis of safety hardware and software is executed periodically to prevent accumulation of potential failures.

The DCS Position/Speed Check function does not need additional external sensors to monitor speed and position. Only the built-in servo motor sensors are used for these functions. (To use safety inputs or safety outputs, electrical circuits to connect signals are required.)

The DCS function has been certified by a standards certification organization as meeting the requirements of international safety standards ISO 13849-1 and IEC 61508.

About the Position / Speed Check Function

The DCS Position / Speed Check function checks the position or speed of the robot and shuts down the motor power if they are outside of specified limits.

- The function can check the location and speed of each joint.
- The function can check if the robot tools and arm's geometric models have moved outside a specified zone.
- The function can check the speed at the end points of the tools.
- The function can check the difference between the current tool position and a standard position.
- The function can activate or disable check features by means of Safety I/O signals.

1.1 INTRODUCTION

This manual describes basic operational procedures of the DCS function.

Please refer to "Dual Check Safety Function Manual B-83184EN" for details on the DCS function.

The content of this manual is as below.

Content of this Document		
Chapter	Title	Overview
Chapter 1	Overview	Gives an overview of the DCS function and position / speed check function.
Chapter 2	Limiting a Robot Workspace	Describes the method for limiting the workspace of robots using the DCS function.
Chapter 3	Switching the Workspace	Describes the method for changing the workspace of robots by using safety I/O.
Chapter 4	Checking if auxiliary axes are stationary	Describes the methods for checking if auxiliary axes are stationary.

1.2 DCS MENU COMPONENTS

Describes the DCS menu components.

1.2.1 DCS Menu Display

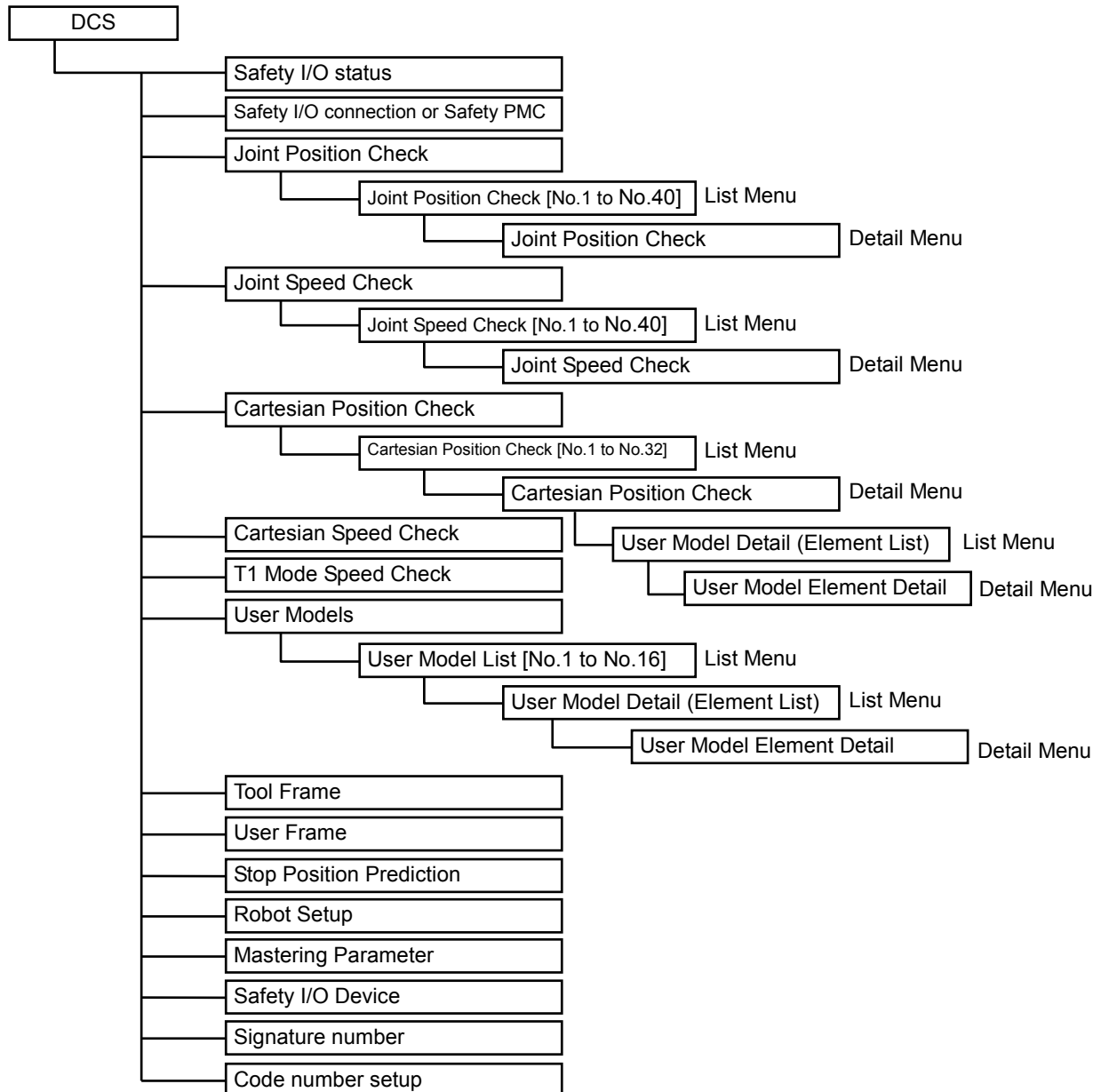
The DCS screen is displayed by the following operation.

[MENU] key → "0 — NEXT —" → "SYSTEM" → "DCS"

1.2.2 DCS Menu Components

The DCS menu is composed of the following components.

- * The components of the menu vary depending on the selected options.



1.3 COMPONENTS OF THE POSITION / SPEED CHECK FUNCTION

The Position / Speed Check function consists of the following components.

Safety Category, PL (Performance Level), and SIL (Safety Integrity Level) are specified in the following table.

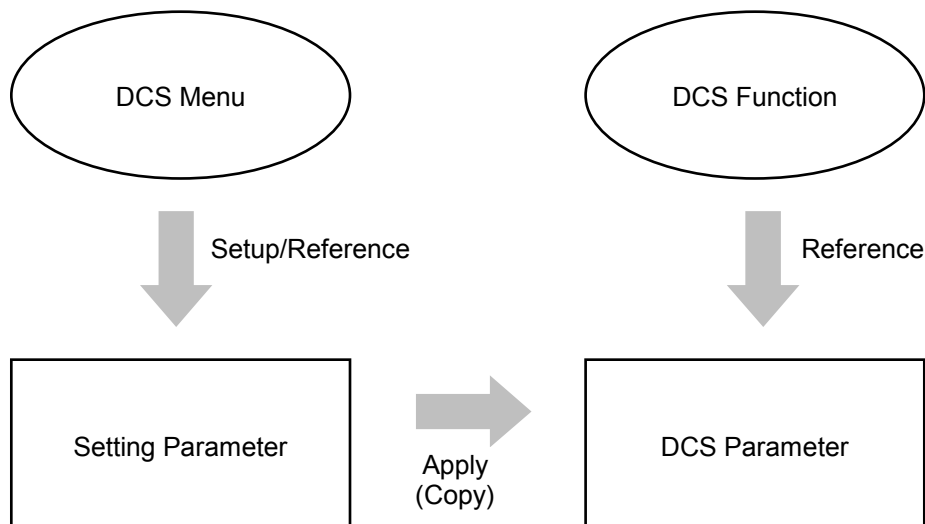
Components of the Position / Speed Check Function

Function name	Standard / Optional	ISO13849-1 / IEC 61508	Description
JOINT POSITION CHECK FUNCTION	Option A05B-2600-J567	Category 3 PL d SIL 2	Shuts down the motor power when Joint position is out of the specified safe zone.
JOINT SPEED CHECK FUNCTION	Option A05B-2600-J567 A05B-2600-J555	Category 3 PL d SIL 2	Shuts down the motor power when Joint speed exceeds the specified limit.
CARTESIAN POSITION CHECK FUNCTION - ZONE CHECK FUNCTION - ORIENTATION CHECK FUNCTION	Option A05B-2600-J567	Category 3 PL d SIL 2	Cartesian Position Check function is composed of Zone Check function and Orientation Check function. Zone Check Function: Shuts down the motor power when the shape model mounted on the tool or robot arm is out of the specified safe zone. Orientation Check Function: Shuts down the motor power when robot orientation (W, P, R) is outside the specified limit.
CARTESIAN SPEED CHECK FUNCTION	Option A05B-2600-J567	Category 3 PL d SIL 2	Shuts down the motor power when the TCP speed exceeds the specified limit.
T1 MODE SPEED CHECK FUNCTION	Option A05B-2600-J567	Category 3 PL d SIL 2	Shuts down the motor power when the TCP or Face Plate speed exceeds the specified limit (Max. 250mm/sec).
BASIC POSITION CHECK FUNCTION	Option A05B-2600-J556	Category 3 PL d SIL 2	The Basic Position Check function is a restricted version of the Cartesian Position check function. Please refer to "1.6 CAUTIONS AND LIMITATIONS" in "Dual Check Safety Function Manual B-83184EN" for details on restriction.

1.4 APPLY TO DCS PARAMETER

The parameters for DCS functions (DCS parameters) are stored in a different memory area from the parameters for other functions, and data integrity is checked.

Users cannot change DCS parameters directly. To change DCS parameters, users must change the normal parameters (setting parameters) first, and then copy the parameters from the setting parameters to the DCS parameters. This operation is called "Apply to DCS parameter."



When an item in a DCS menu is changed, the setting parameter is changed. When the value of setting parameters and the value of DCS parameters are different, the alarm "SYST-212 Need to apply to DCS param" occurs. This alarm cannot be reset until the "Apply to DCS parameter" procedure is carried out.

Normally, the DCS menu is protected, as an alarm occurs if a DCS menu item is changed unintentionally. When a numeric key or function key is pressed while in a DCS menu, the message "Do you want to change setting?" is displayed.

If F4 [YES] is pressed, the protection is released, and users can change items in the DCS menu.

When the Teach Pendant enable switch is turned off, the DCS menu is protected. The protection cannot be released when the Teach Pendant enable switch is off.

Robot setup data and mastering parameters are also referenced by DCS Position/Speed Check functions. These parameters are used for normal motion control as well as setting parameters for the DCS Position/Speed Check functions. These parameters are set by other areas of the controller software and are not changed in the DCS menu.

However, if these parameters are changed, they will need to be applied to DCS parameters by using the "Apply to DCS parameter" procedure. When the DCS Position/Speed Check option is loaded, and the mastering data or robot setup data is changed, for example when robot mastering is changed, the alarm "SYST-212 Need to apply to DCS param" occurs. This alarm cannot be reset until the "Apply to DCS parameter" procedure is carried out.

When a backup file (for example SYSVARS.SV or SYSMASST.SV) is loaded, and the setting parameters (including mastering parameters and robot setup data) are changed, the alarm "SYST-212 Need to apply to DCS param" occurs. This alarm cannot be reset until the "Apply to DCS parameter" procedure is carried out.

**Caution**

If an operator who does not know the code number changes Setting parameters, Mastering parameters or robot setup data by loading a backup file, the alarm "SYST-212 Need to apply to DCS param" occurs, and the system will not work. An operator who knows the code number must change setting parameters, mastering parameters or robot setup data.

**Caution**

The "SYST-212 Need to apply to DCS param" alarm is not a safety function. This alarm is intended to guide the operator to apply to DCS parameter when setting parameters are modified. There are situations that the alarm does not occur, but the modified parameters do not take effect until the apply process is complete and the power is cycled on the controller.

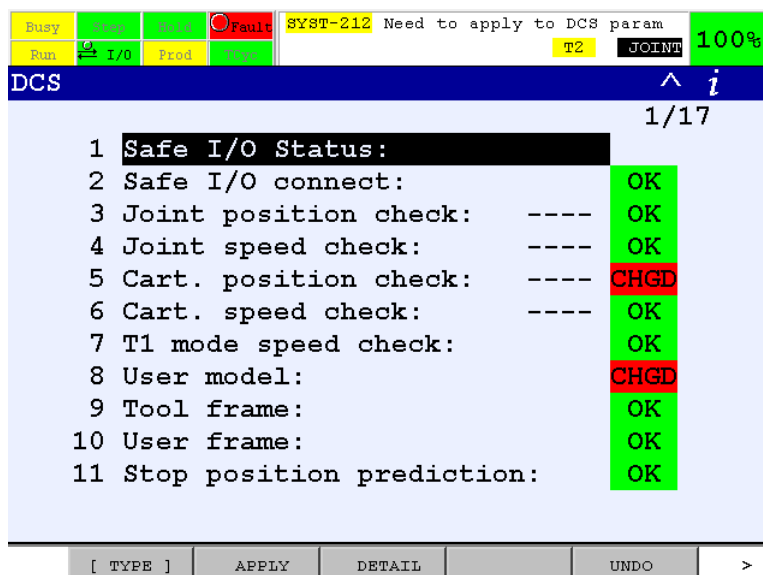
**Caution**

If you removed a battery cable from a motor on a robot, you need to change mastering parameter. Before the correct mastering data is set and applied to DCS parameter, DCS uses the previous mastering parameter. So, DCS Joint/Cartesian position check function may cause alarm. In this case, please disable the Joint/Cartesian position check to do mastering operation.

1.4.1 Operation to apply to DCS parameters

The operation to apply to DCS parameters is as follows.

1. [MENU] key → "0 — NEXT —" → "SYSTEM" → "DCS" shows the DCS top menu.
If the DCS top menu is not displayed, press [PREV] until it is displayed.



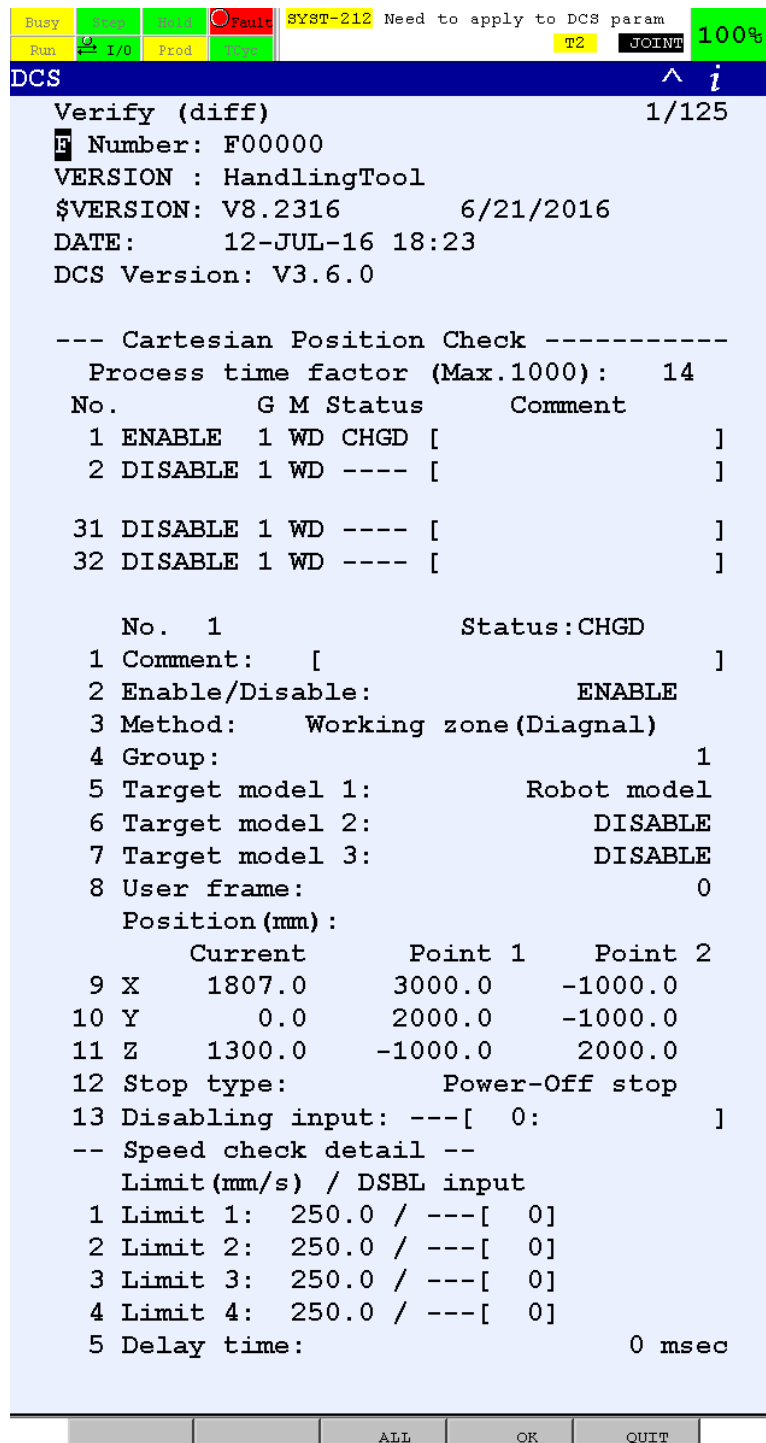
2. Press F2 [APPLY] in the DCS top menu.
If there is an invalid setting (for example, invalid user frame number is used in Cartesian Position check), the menu page of the invalid parameter is displayed, and a message is displayed on the prompt line. In this case, please check the settings in the displayed page.
3. The message "Code number (Master):" is displayed. Please enter the 4 digit code number. (Default code number is "1111.")
Apply to DCS parameter is not done until the correct code number is entered.
When "Master" is displayed in parentheses, the master code number must be entered.
If "Base" or "Position/Speed Check" or "I/O Connect" is displayed in parenthesis, the corresponding local code number or master code number must be entered (Please refer to "2.5 DCS CODE NUMBER" in "Dual Check Safety Function Manual B-83184EN" for the detail of local code number).

* At this time, the message "Enter previous code number:" may be displayed. Please refer to "2.5 DCS CODE NUMBER" in "Dual Check Safety Function Manual B-83184EN" for details.



Caution

Make sure you change the master code number from the default "1111" setting to prevent DCS parameters from being changed by an unauthorized user.



4. DCS Verify Menu is displayed. The content of the DCS menus is displayed in the DCS verify menu. Verify the setting values at this time.
Pressing F3 [ALL] or F3 [DIFF] toggles the display between the "DIFF" and "ALL" menu.
The "DIFF" menu only shows the items that were changed after the last verify was performed.
The "ALL" menu shows all DCS parameters that are being applied by this operation, including unchanged parameters.
5. When the DCS verify menu is displayed, copying from setting parameter to DCS parameter is complete. The displayed values are read from the copied DCS parameters. The displayed values can be checked to verify that the copy to DCS parameters was achieved correctly.
After verifying the displayed values, press F4 [OK] if the displayed values are correct.

If the displayed value are not correct, press F5 [QUIT], change the settings and do the apply operation again.

When F4 [OK] is pressed, it is recorded that the displayed DCS parameters are verified by the operator.

If F5 [QUIT] is pressed, the DCS parameters are updated but the values are not verified yet. In this situation, the alarm "SYST-219 Need to apply to DCS param" is displayed. To clear the alarm, perform the applying operation to DCS parameter procedure again.

6. After F4 [OK] is pressed, cycle power on robot controller.
Changed parameter values will be used after the cycle power.
Until a cycle power is performed, the alarm "SYST-290 Cycle power to use new DCS parameter" will occur.
7. Perform the actual DCS function to verify that the changed parameters are set correctly.

**Warning**

If a robot is used with an incorrect DCS parameter setting, the safety function will not work correctly and serious personal injury could result. When the DCS parameter is changed, the value must be verified, and the related DCS functions must be tested again.

1.5 SAFETY I/O

Safety I/O are safety signals that can be used in DCS. Safety I/O is expressed by a 3 character type and an index number, such as "SPI [1]."

For example, safety input signal SFDI1 is represented as Safety I/O SPI [1]. To switch the safety zone according to SFDI1, set SPI [1] to the disabling I/O.

The table below shows the Safety I/O used in this manual. Please refer to "SAFE I/O" in the "Dual Check Safety Function Manual B-83184EN" for details.

Safety I/O types

Type	Range of index	Input/Output	Category / PL / SIL	Slot	Description
SPI	1-64	Input	Category 4 PL e SIL 3 (Note)	1	Safe Peripheral Input In the B cabinet controller of R-30iB, safety inputs SFDI1-8 on the Safety I/O board correspond to SPI [1-8]. Safety I/O board is a hardware option. When the hardware is not equipped, SPI [1-8] are always OFF. In the A cabinet controller of R-30iB, safety inputs SFDI1-2 on the emergency stop board correspond to SPI [1-2]. SPI [3-8] are always OFF. In R-30iB Mate, an additional safety I/O device is needed to use safety input. ON: Both dual circuits are CLOSED, OFF: Either circuit is OPEN When an additional safety I/O device is connected, the additional safety input signals are assigned to SPI. Please refer to "5.4 ADDITIONAL SAFETY SIGNALS" in "Dual Check Safety Function Manual B-83184EN" for details.
CPC	1-32	Input	Category 3 PL d SIL 2	6	Cartesian Position Check Status of Cartesian Position Check functions. When the status is SAFE, it is ON. Otherwise, it is OFF.
CSC	1-16	Input	Category 3 PL d SIL 2	7	Cartesian Speed Check Status of Cartesian Speed Check functions. When the status is SAFE, it is ON. Otherwise, it is OFF.
JPC	1-40	Input	Category 3 PL d SIL 2	8	Joint Position Check Status of Joint Position Check functions. When the status is SAFE, it is ON. Otherwise, it is OFF.
JSC	1-40	Input	Category 3 PL d SIL 2	9	Joint Speed Check Status of Joint Speed Check functions. When the status is SAFE, it is ON. Otherwise, it is OFF.
---	0				Not defined This means no Safety I/O is defined.

Note: When SFDI and SFDO of I/O Unit-MODEL A is used, an application involving the SFDI and SFDO may achieve cat 3, PL=d, SIL 2.

1.5.1 DCS Safety I/O status menu

The DCS Safety I/O status menu is displayed by pressing the [ENTER] key or the F3 [DETAILS] key while the cursor is on the "Safe I/O status" item in the DCS top menu.

In the DCS Safety I/O status menu, Safety I/O status and comment are displayed. The Safety I/O comment can be changed in this menu.

Busy	Stop	Hold	Ready			AUTO	TOOL	100%
Run	I/O	Prod	Prog					

DCS
^ i

```

Safe I/O status                                1/64
      Status                               Comment
SPI[  1] ON   [SFDI1]
SPI[  2] ON   [SFDI2]
SPI[  3] ON   [SFDI3]
SPI[  4] ON   [SFDI4]
SPI[  5] ON   [SFDI5]
SPI[  6] ON   [SFDI6]
SPI[  7] ON   [SFDI7]
SPI[  8] ON   [SFDI8]
SPI[  9] OFF  [
SPI[ 10] OFF  [
    
```

[TYPE]	[DATA]				
----------	----------	--	--	--	--

Items in DCS Safety I/O status menu

Item	Description
Safety I/O name	The Safety I/O names are displayed.
Status	The Safety I/O status (ON, OFF) is displayed.
Comment	The Safety I/O comment is displayed. Press [ENTER] key to change the comment.

Operation of DCS Safety I/O status menu

Operation	Description
F2 (Data)	A pull-up menu of the Safety I/O types is displayed for selection of Safety I/O type.
PREV DCS	The Top menu is displayed.

1.6 CAUTIONS AND LIMITATIONS

1.6.1 Hardware

**Warning**

At initial start-up, operation check and validation of the wiring for the safety signals should be carried out, and then the wiring should be protected using cable ducts, etc.

**Caution**

R-30iB and R-30iB Mate are evaluated as a system with the high demand mode of operation defined in IEC61508. To confirm that the safety function works correctly, please check alarm detection by inputting an emergency stop twice or more a year, or check the system's operation by cycling the power twice or more a year.

1.6.2 Software

- * Limitations for DCS Position/Speed Check functions are applied to DCS Joint Speed Check function and DCS Basic Position Check function. Please read "also cannot be used with DCS Joint Speed Check function and DCS Basic Position Check function" as "cannot be used with DCS Position/Speed Check function."

Robot model

DCS Position/Speed Check functions are supported on most, but not all, robot models. Contact your FANUC representative for a list of supported robot models.

If DCS Position/Speed Check is loaded into the system of an unsupported robot model, "SYST-218 DCS Unavailable robot model" or "SRVO-364 DCS PRMCRC alarm" occurs. This alarm cannot be cleared until the software option configuration is changed.

Servo gun axis, Independent axis

Servo gun axis and Independent axis cannot be used with DCS Position/Speed Check functions. These axes are regarded as EXCLUDED axes.

Positioner axis

To use DCS Position/Speed Check functions for a positioner axis that is not of a FANUC product, please use "Basic Positioner (A05B-2600-H896)" and set the positioner as "Known Kinematics." If another positioner type is used, the alarm "SYST-218 DCS Unavailable robot model" occurs.

If using DCS Position/Speed Check functions for a positioner axis of a FANUC product, some positioner models are supported, but not all. Contact your FANUC representative for a list of supported robot models.

When a positioner axis of FANUC make is used with coordinated motion function, "unknown point calibration for positioner" is not available if the system has DCS Position/Speed Check option. Please use "known four point calibration" or "known direct calibration."

Continuous turn function

Continuous turn axes are regarded as Speed Only axes, and the axis can be used only for Joint Speed Check function. The continuous turn axis cannot be used for Joint Position Check function.

When a motion group includes a continuous turn axis, except when it is an Auxiliary Extended Axis, the motion group cannot be used with the Cartesian Position Check and Cartesian Speed Check functions. The T1 Mode Speed Check function for the motion group checks regards the position of the continuous turn axis as always 0, and checks the DCS TCP speed and the wrist flange center speed.

- * When the last robot axis of M-2iA or M-3iA is continuous turn axis, the axis is regarded as EXCLUDE axis. The continuous turn axis cannot be used for Joint Speed Check function.
- * In 7DC1 series or 7DD0 series software, the continuous turn axis is regarded as EXCLUDE axis. The continuous turn axis cannot be used for Joint Speed Check function.

Extended Axis Control

Axes configured using the Extended Axis Control option are supported in the Position Check and Speed Check functions. In the case where the Extended Axis is being used as a robot transfer unit (RTU) and is configured as an Integrated Axis, the safe zone of the Cartesian Position Check will remain stationary as the robot moves along the transfer unit. If the Extended Axis is configured as an Auxiliary Axis, the safe zone will travel along the transfer unit with the robot.

RAIL Unit

If the robot transfer unit (RTU) is configured as an independent group it should be setup as a Rail Unit (H894). In this case the safe zone will travel along the transfer unit with the robot.

**Caution**

When the robot is mounted on a rail axis, the safe zone moves when the world frame of the robot moves along with the movement of the rail axis. To fix the safe zone, the rail axis should be defined as Integrated Rail axis of the same motion group as the robot.

1.7 STOPPING DISTANCE

Dual Check Safety (DCS) stops the robot by shutting down the motor power. When the motor power is shut down while the robot is moving, the robot's momentum causes it to move some distance before it completely stops. This distance depends on the type of robot, payload, and speed.

The default scan time of the Position/Speed Check functions is 8 msec. This scan time might change according to your system configuration. The actual scan time is displayed in the DCS robot SETUP menu (Refer to Section "2.3 ROBOT STOP POSITION PREDICTION").

DCS Position/Speed Check functions will detect an alarm within a maximum of one scan time.

The stop distance is calculated as follows

$(\text{Speed} \times \text{Scan time}) + \text{moving distance through momentum}$

**Warning**

The robot stopping distance must be considered when DCS Position/Speed Check is used. A risk assessment for the whole robot system is necessary.

**Warning**

If controlled stop is set as a stop type, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

**Warning**

If Safety I/O Connect feature is used, safety signal status could be delayed by a maximum of 2 ms. In this case, a risk assessment for the whole robot system is necessary, including the additional 2 ms delay.

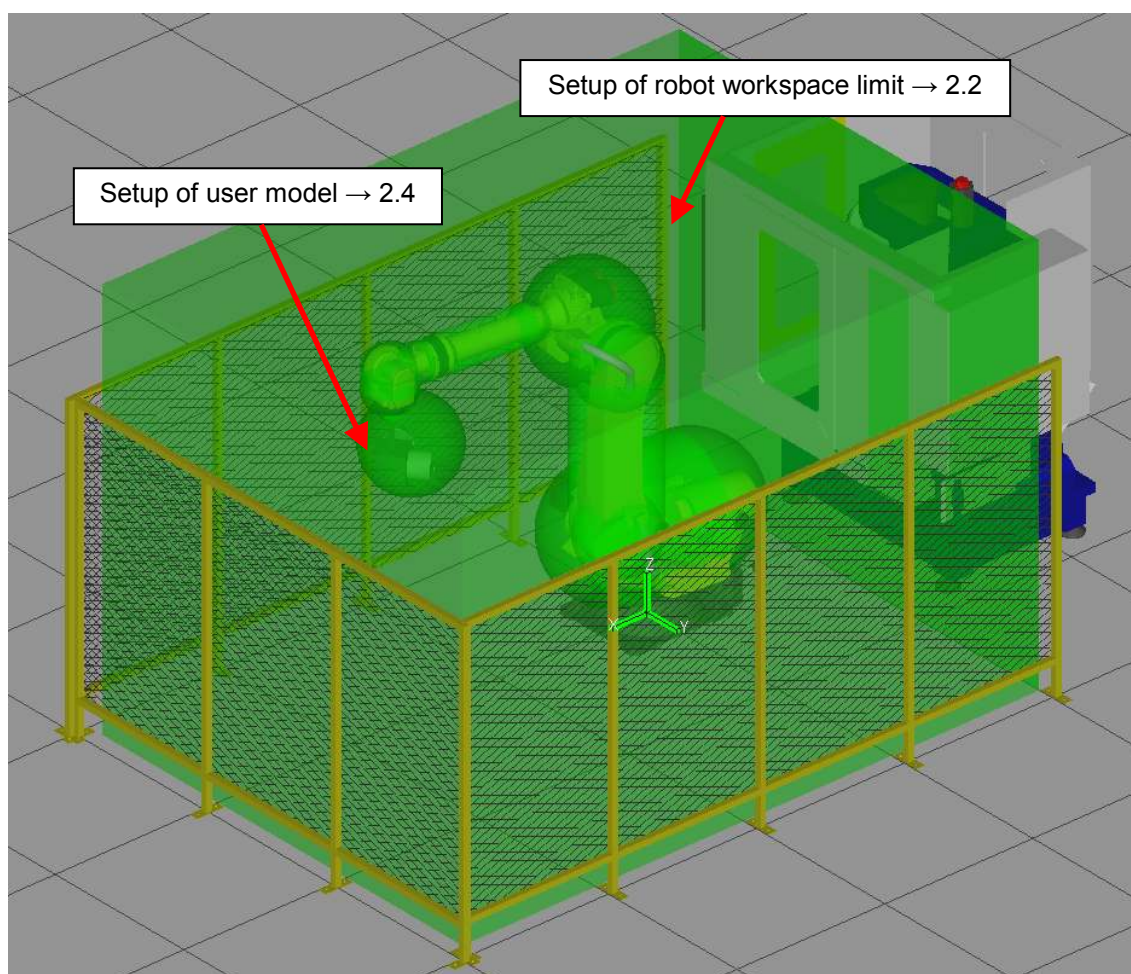
2 LIMITING A ROBOT WORKSPACE

2.1 OVERVIEW

This chapter describes the method for limiting the workspace of a robot with Dual Check Safety (DCS) functions.

The robot stops when it performs an operation which goes beyond the specified workspace.

The following picture shows the restricted workspace of the robot.



This chapter describes the setup procedure to limit the robot workspace.

Type	Item	Description
Settings	Setup of robot workspace limit	Set the limits of the robot workspace with Cartesian Position Check function
	Setup of Stop Position Prediction	Set a robot to stop within the programmed workspace.
	Setup of user model	Set user models in order to limit the workspace of equipment attached by users, such as hands.
Check	Check the DCS zone using 4D graphics	Check the robot shape and robot workspace specified in the DCS function using a three-dimensional display.
Troubleshooting	Recovery from alarm	Recovering from an alarm when a robot moves out of the workspace.

2.2 LIMITING A ROBOT WORKSPACE BY CARTESIAN POSITION CHECK

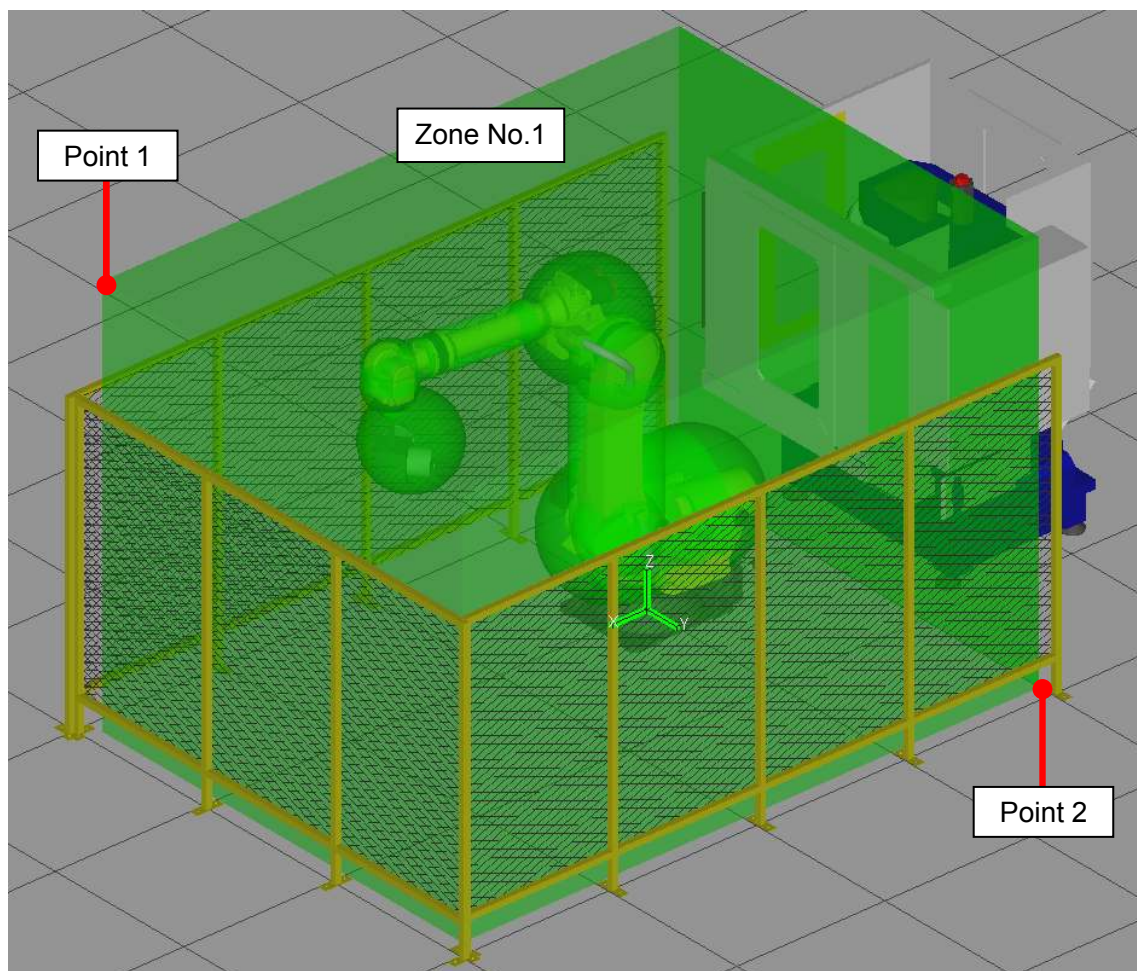
This section describes the procedure to set a robot workspace as shown in the following figure using the DCS Cartesian Position Check function.

Warning

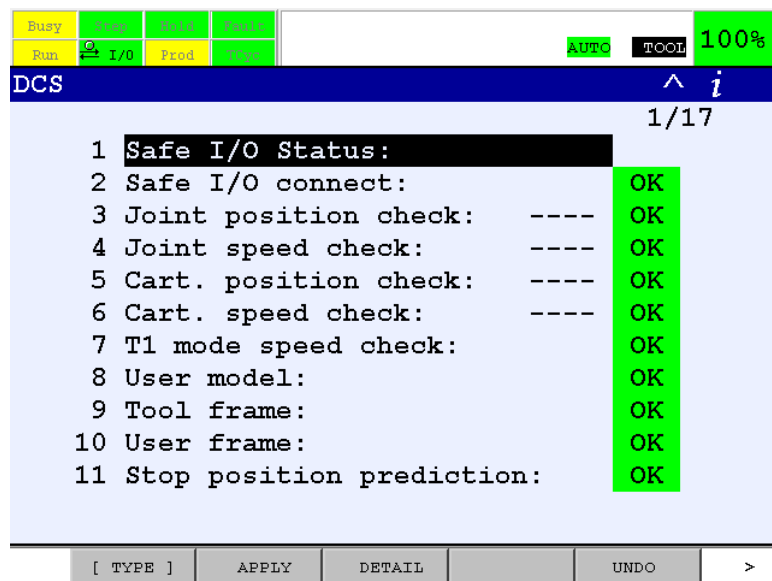
If a robot workspace is set up incorrectly, the safety function will not work, and serious personal injury could result. When a robot workspace is changed, the values must be verified and the function must be tested again.

Caution

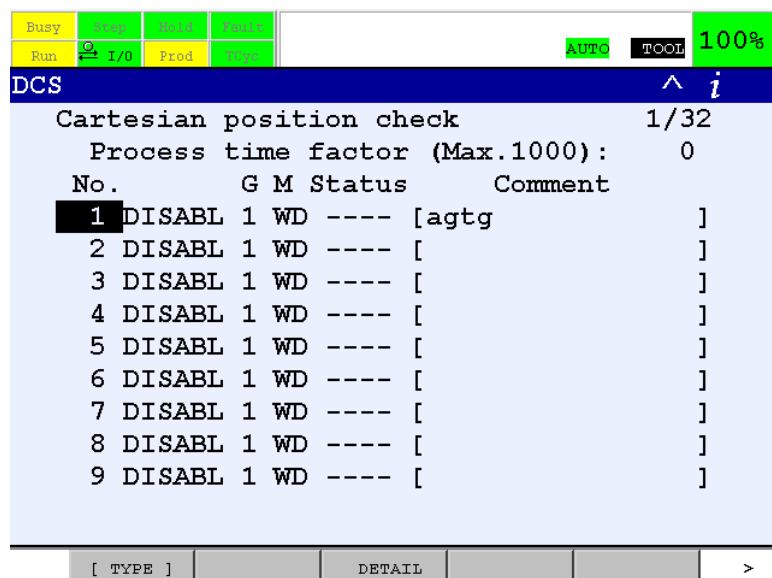
If the robot is mounted on a rail axis, the robot workspace moves when the world frame of the robot moves along with the movement of the rail axis. To fix the robot workspace, the rail axis should be defined as Integrated Rail axis of the same motion group as the robot.



1. Press [MENU] key on Teach Pendant to display MENU pop up screen.
2. Select "0 -- NEXT --" → "6 SYSTEM" → "DCS", and press [Enter] key to display DCS top menu.



3. Select [Cart. position check] and press [Enter] key to display Cartesian Position Check list menu.



4. Select any "No." and press [Enter] key to display Cartesian Position Check menu.

Busy	Stop	Hold	Ready		AUTO	TOOL	100%
Run	I/O	Prod	Clk				

DCS^ i

```

Cartesian position check                                1/14
    No.   1                               Status:----
1 Comment: [ ]
2 Enable/Disable:                               DISABLE
3 Method:   Working zone(Diagonal)
4 Group:                                         1
5 Target model 1:           Robot model
6 Target model 2:           DISABLE
7 Target model 3:           DISABLE
8 User frame:                                     0
    Position(mm) :
          Current             Point 1            Point 2
9 X      1592.0              0.0                0.0
10 Y       0.0               1.0                0.0
11 Z     1515.0              0.0                0.0
12 Stop type:                 Controlled stop
13 Speed check:                <DETAIL>
14 Disabling input: ---[ 0:         ]
  
```

[TYPE]	PREV	NEXT	RECORD	UNDO	>
----------	------	------	--------	------	---

5. Perform the following settings in Cartesian Position Check menu.

Number	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable Cartesian Position Check function of the displayed No.
3	Method	"Working zone (Diagonal)"	Define the robot workspace to be the inside of a box using the Cartesian Position Check function. The setting "Working zone(Diagonal)" defines the coordinates of the two ends of the diagonal of a box.
9	X Point 1 Point 2	Values for the coordinates of the two ends of the diagonal of a box	Defines the coordinates of the two ends of the diagonal of the box for which "Diagonal (IN)" is the robot workspace.
10	Y Point 1 Point 2		
11	Z Point 1 Point 2		
12	Stop type	"Power-Off stop"	Configure so that if a robot goes beyond the workspace, robot motor power immediately shuts down and the robot stops.

- Press [PREV] key two times to display DCS top menu.

Setup of a robot workspace is now complete. If a robot arm goes beyond a specified workspace, DCS Cartesian Position Check function limits the robot.

2.3 ROBOT STOP POSITION PREDICTION

If only the workspace is set using Cartesian Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace.

To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The setup procedure for the Stop Position Prediction function is as follows.



Warning

If Stop Position Prediction is set up incorrectly, the robot will leave the safety zone, and serious personal injury could result. When Stop Position Prediction is changed, the values must be verified and the function must be tested again.



Warning

If an axis does not have a mechanical brake, the axis can move freely when the motor power is shut down, and Stop Position Prediction does not work correctly for the axis. In this case, a risk assessment for the whole robot system is necessary, including the free movement of the axis that does not have a mechanical brake.

Note

If a robot does not need to stop inside a robot restriction zone, the settings in this section are not required.
Go to "2.4 SETUP OF USER MODEL."

1. Select "Stop position prediction" in DCS top menu and press [Enter] key to display Stop Position Prediction Menu.

Busy	Stop	Hold	Start						
Run	I/O	Prod	Stop					AUTO	JOINT 100%
DCS ^ i									
Stop position prediction								1/50	
Group: 1								Status	
Cartesian									
1 Mode:								DEFAULT OK	
Power-Off stop									
2 Stopping distance (mm):								358.8 OK	
3 Speed (mm/sec):								1000.0 OK	
Controlled stop									
4 Stopping distance (mm):								501.5 OK	
5 Speed (mm/sec):								1000.0 OK	
Joint J1									
6 Mode:								DISABLE OK	
[TYPE] GROUP [CHOICE] UNDO									

2. Perform the following settings in the Stop Position Prediction Menu.

Number	Item	Setting	Description
1	Mode	"DEFAULT"	Configure using the setting type for the Stop Position Prediction function, so that default values according to robot type are automatically set to "stop distance" and "speed."

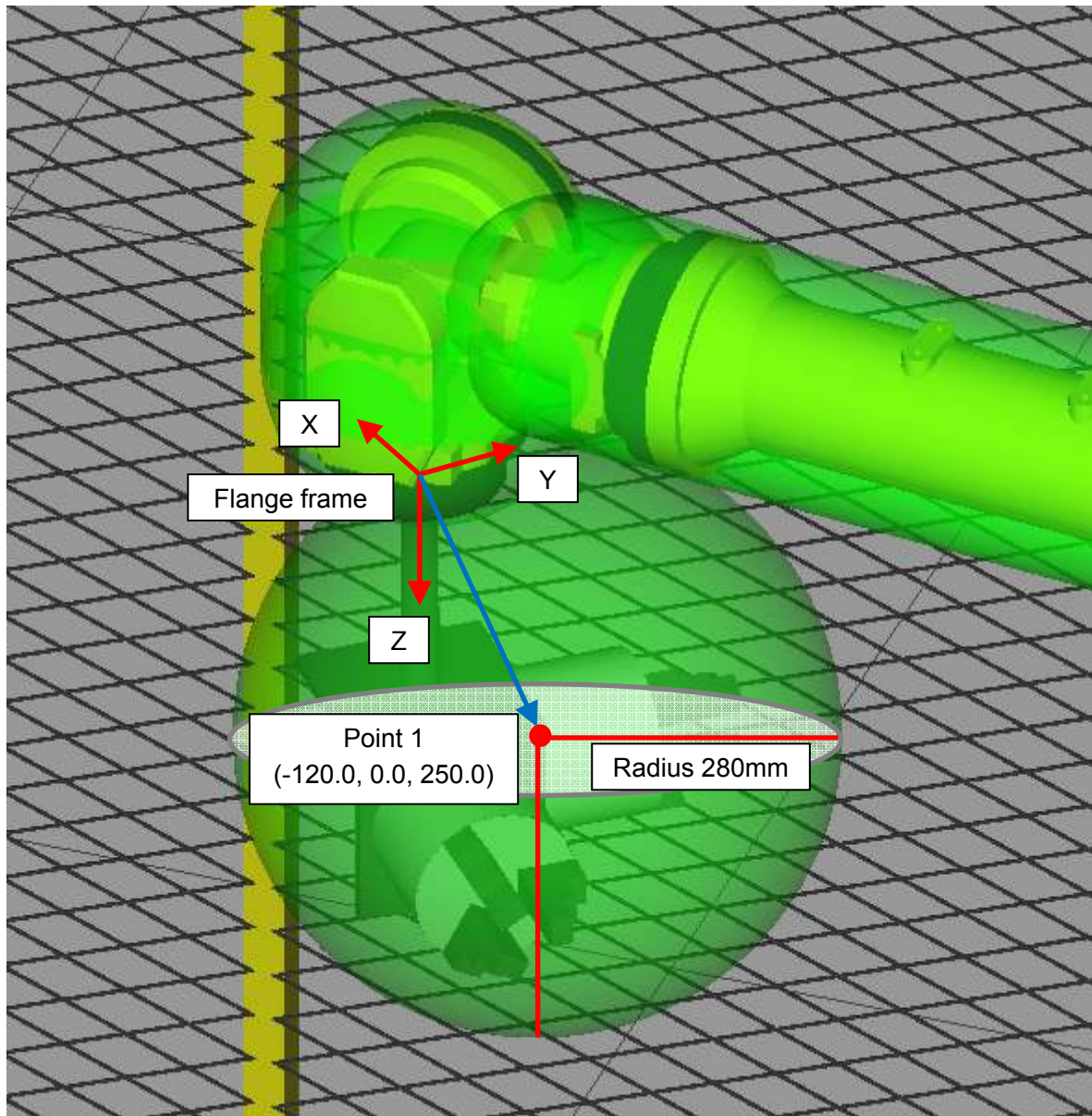
Setup of the Stop Position Prediction function is now complete. The robot will stop within the robot workspace when servo power is shut down.

2.4 SETUP OF USER MODEL

Since DCS function check is not set for hands, etc. attached to the robot, they are not subject to checking by the DCS function.

To limit the workspace of hands, etc. attached to the robot like the ones shown in the following picture, user models must be set.

The setup procedure for a user model is as follows.



- | | | | | | | | | |
|-----------------|------|--------|---------|--------|--|------|-------|------|
| Busy | Stop | Hold | Wait | | | AUTO | JOINT | 100% |
| Run | I/O | Prod | Stop | DCS | | | | |
| User model list | | | | 1/16 | | | | |
| No. | Elem | Status | Comment | | | | | |
| 1 | 0 | OK | [] | | | | | |
| 2 | 0 | OK | [] | | | | | |
| 3 | 0 | OK | [] | | | | | |
| 4 | 0 | OK | [] | | | | | |
| 5 | 0 | OK | [] | | | | | |
| 6 | 0 | OK | [] | | | | | |
| 7 | 0 | OK | [] | | | | | |
| 8 | 0 | OK | [] | | | | | |
| 9 | 0 | OK | [] | | | | | |
| 10 | 0 | OK | [] | | | | | |
| [TYPE] | | | | DETAIL | | | | > |

- | | | | | | | | | |
|------|------|------|-------|--|--|------|-------|------|
| Busy | Stop | Hold | Start | | | Auto | JOINT | 100% |
| Run | I/O | Prod | Stop | | | | | |

DCS
^ i

User model detail(10 elements) 1/11

No. 1 [*****]

Elements

No.	Link	Shape	Size	Status
1	DISABLE	99 Point	0.0	OK
2	DISABLE	99 Point	0.0	OK
3	DISABLE	99 Point	0.0	OK
4	DISABLE	99 Point	0.0	OK
5	DISABLE	99 Point	0.0	OK
6	DISABLE	99 Point	0.0	OK
7	DISABLE	99 Point	0.0	OK
8	DISABLE	99 Point	0.0	OK

[TYPE]
DETAIL
ROBOT
UNDO
>

3. Select any "No." and press [Enter] key to display User Model Element Detail Menu.

Busy Run I/O Prod Auto JOINT 100%
 DCS ^ i
 User element detail 1/9
 No. 1 [*****]
 Element: 1 Status: OK
 1 Enable/Disable: ENABLE
 2 Link No. (99:FacePlate): 99
 3 Link type: NORMAL
 4 Tool frame: 0
 5 Shape: Point
 6 Size (mm): 280.0
 Pos1
 7 X: -120.000 Y: 0.000 Z: 250.000
 Pos2
 8 X: 0.000 Y: 0.000 Z: 0.000
 [TYPE] UNDO >

4. Perform the following settings in the User Model Element Detail Menu.

Number	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable the user model elements of the displayed No.
2	Link Number	"99"	Configure to mount the user model element on a flange.
4	Tool frame	"0"	Configure so that the base frame of the element is the flange frame.
5	Shape	"Point"	Configure so that the shape of a user model element is a sphere.
6	Size (mm)	"280.0"	Configure so that the radius of a user model element is 280 mm.
7	Pos1 X Y Z	X: "-120.000" Y: "0.000" Z: "250.000"	Configure the center point of the sphere of a user model element to be the base frame of the flange frame. Point 2 is not used.

Next, to enable the specified user models, set the number of the user model to be the target model for Cartesian Position Check.

- Press the [Prev] key 3 times to display DCS top menu.

Busy	Stop	Hold	Ready		AUTO	TOOL	100%
Run	I/O	Prod	Stop				

DCS
^ i

1/17

- 1 Safe I/O Status:
- 2 Safe I/O connect: OK
- 3 Joint position check: ---- OK
- 4 Joint speed check: ---- OK
- 5 Cart. position check: ---- OK
- 6 Cart. speed check: ---- OK
- 7 T1 mode speed check: OK
- 8 User model: OK
- 9 Tool frame: OK
- 10 User frame: OK
- 11 Stop position prediction: OK

[TYPE]
APPLY
DETAIL
UNDO
>

- Select "Cart. position check" and press the [Enter] key to display Cartesian Position Check list menu.

Busy	Stop	Hold	Ready		AUTO	JOINT	100%
Run	I/O	Prod	Stop				

DCS
^ i

Cartesian position check

1/32

Process time factor (Max.1000): 0

No.	G	M	Status	Comment
1	DISABL	1	WD ----	[]
2	DISABL	1	WD ----	[]
3	DISABL	1	WD ----	[]
4	DISABL	1	WD ----	[]
5	DISABL	1	WD ----	[]
6	DISABL	1	WD ----	[]
7	DISABL	1	WD ----	[]
8	DISABL	1	WD ----	[]
9	DISABL	1	WD ----	[]

[TYPE]
DETAIL
>

7. Select the number selected in step 4 of "2.2 LIMITING A ROBOT WORKSPACE BY CARTESIAN POSITION CHECK" and press [Enter] key to display Cartesian Position Check Menu.

Busy	Stop	Hold	Auto					
Run	I/O	Prod	Stop		AUTO	JOINT	100%	

DCS ^ i

Cartesian position check 1/14

No. 1 Status: **SAFE**

1 Comment: [*****]

2 Enable/Disable: ENABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: User model 1

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

	Current	Point 1	Point 2
9 X	1807.0	3000.0	-1000.0
10 Y	0.0	2000.0	-1000.0
11 Z	1300.0	-1000.0	2000.0

12 Stop type: Power-Off stop

13 Speed check: <DETAIL>

14 Disabling input: ---[0:]

[TYPE]	PREV	NEXT	[CHOICE]	UNDO	>
----------	------	------	----------	------	---

8. Perform the following settings in Cartesian Position Check menu.

Number	Item	Setting	Description
6	Target model 2.	"No." selected in the User Model List Menu in step 4.	Set the specified user models to be the target for Cartesian Position Check.

Setup of a user model is now complete.

Perform the applying operation after user model setup is complete.

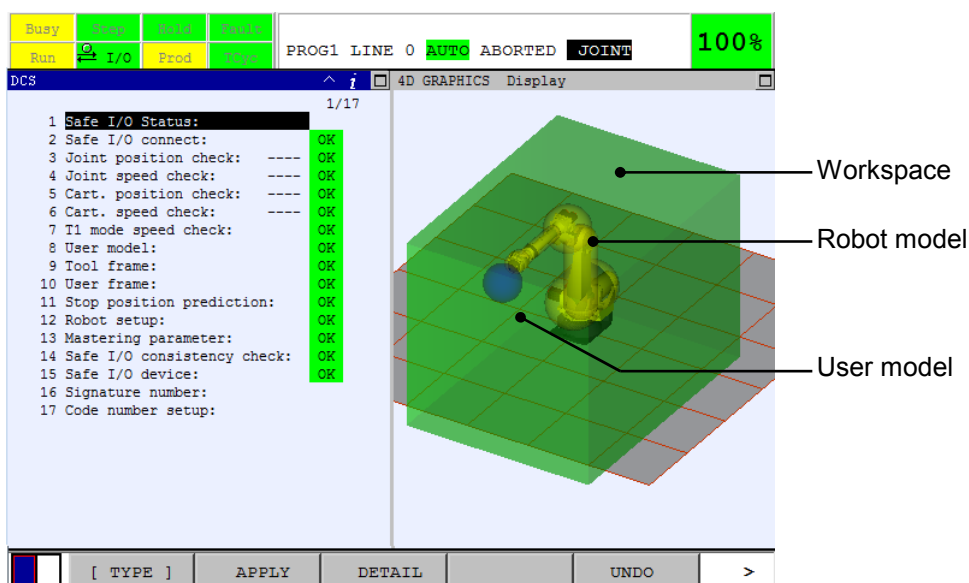
Please refer to "1.4.1 Operation to apply to DCS parameters" in chapter 1 for the applying operation.

2.5 4D GRAPHICS DCS DISPLAY

In the 4D Graphics DCS Display Menu, you can check robot shapes and robot workspaces specified in DCS functions using a three-dimensional display.

The procedure to display 4D graphic DCS is as follows.

1. Press [MENU] key on Teach Pendant to display MENU pop up screen.
2. Select "0 -- NEXT --" → "6 SYSTEM" → "DCS", and press [Enter] key to display DCS top menu.
3. Press [F8] key or press [FCTN] key while pressing [i] key to display related menu.
4. Select "4D DCS Display" to display 4D graphic DCS Display Menu.



5. Operate the display.
There are two ways to operate the display. One is key input and the other is touch panel operation.

Enlarge / Reduce

Press F3 [ZOOM] and perform the following operations.

Display	Key input	Touch panel operation
Enlarge the display	Press the [↑] (enlarge) key.	Touch the upper half of the screen.
Reduce the display	Press the [↓] (reduce) key.	Touch the lower half of the screen.

Pan operation

Press F4 [PAN] and perform the following operation.

Display	Key input	Touch panel operation
Pan the display	Press the [↑] / [↓] / [←] / [→] key.	Touch the screen and drag your finger up, down, left or right.

Rotation

Press F5 [ROTATE] and perform the following operation.

Display	Key input	Touch panel operation
Rotate the display	Press the [↑] / [↓] / [←] / [→] key.	Touch the screen and drag it up, down, left or right.

Note

Please refer to "4D Graphic Function" in "R-30iB/R-30iB Mate CONTROLLER Optional Function OPERATOR'S MANUAL" (B-83284EN-2) for detailed operation of the "4D Graphics DCS Display" Menu.

2.6 RECOVERY FROM ALARM

When a robot moves out of its robot workspace, "SRVO-402 DCS Cart. pos. limit (%d,%s:G%d,M%d) %02x" alarm occurs and the robot stops.

Cartesian Position Check number, Comment (If comment was input), Group number, and User Model number (0: robot model) are displayed in order from the left in the alarm.

If the Stop Position Prediction function is enabled, the stop position of the robot will be within the robot workspace, and the alarm can be cleared.

The alarm cannot be cleared when the robot is outside the robot workspace.

The procedure to recover from an alarm is as follows:

1. Set mode switch to [T1] to enable teach pendant.
2. Press [SHIFT] + [RESET] key to clear the alarm.

NOTE

Keep pressing [SHIFT] key until the robot has returned to the robot workspace. If the [SHIFT] key is released while the robot is still outside the robot workspace, the alarm occurs again and the robot stops.

3. Press and hold [SHIFT] key and jog the robot to move the robot to the robot workspace.

NOTE

As the robot workspace is set in Cartesian Position Check, the position and orientation of the flange just before the alarm occurs are recorded. The robot can be jogged toward the position and orientation just before where the alarm occurs. If the robot is jogged away from the position and orientation where the alarm occurs, the alarm occurs again and the robot stops.

In the following cases, robots cannot be recovered from alarm with procedure above, since the data for the frame position and orientation just before the alarm occurs are lost. Disable the Cartesian Position Check function settings, recover from the alarm, then enable the settings again.

- The motor or Pulse coder is replaced, and the robot position exits the robot workspace.
- The Zone or shape model is changed and applied to DCS parameters, power to the controller is cycled, and the current position exits the robot workspace.
- The controller power is turned off while the robot is moving, and the robot exits the robot workspace by momentum movement.
- The mastering parameters or robot setup data are changed and applied to DCS parameters, power to the controller is cycled, and the robot exits the robot workspace.

Operation of recovery from alarm is now complete.

3 SWITCHING THE WORKSPACE

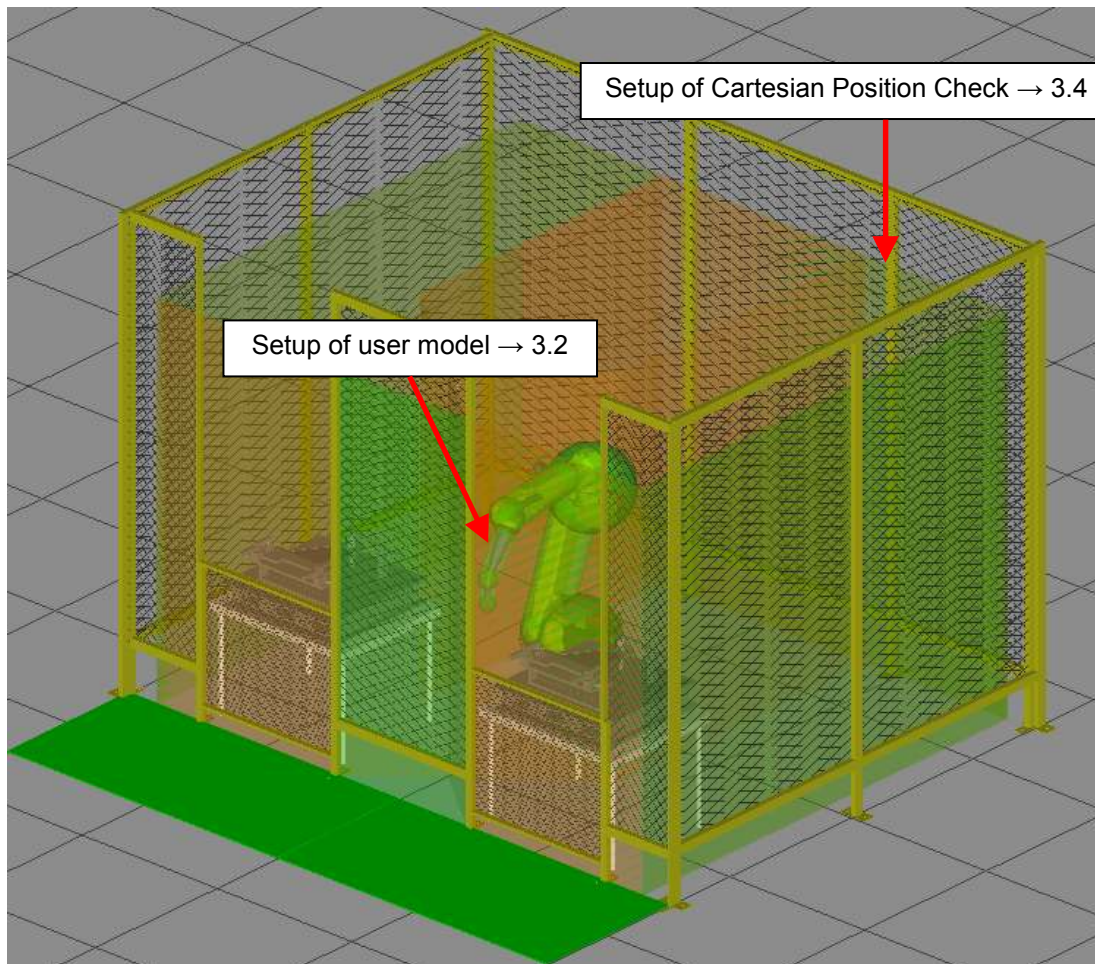
3.1 OVERVIEW

This chapter describes the method for enabling and disabling the robot workspace using safety I/O.

For an arc welding robot system as shown below, set the robot to weld a workpiece which is not being worked on by the operator when the operator is on a safe mat. When the robot approaches the workpiece which is being worked on by the operator, the robot stops, ensuring the safety of the operator.

Safety I/Os are safe signals that can be used in DCS. For example, to switch the zone of the Zone Check Function, the safety input is set to a disabling input for the Zone Check Function.

In this chapter, a safe zone that is not a box shape will be set (a maximum of 8 vertexes from P1 to P8, and upper / lower limits). The Zone Check Function checks if the shape model is within the safe zone.



This chapter describes the setup procedure to change a robot workspace.

Type	Item	Description
Settings	Setup of user model	Set user models to limit the motion range of equipment attached by users, such as hands.
	Setup of safety signal connections	Safety I/O checks if there is an operator is on a safe mat. Connect a safe mat to the safety signals.
	Setup of Cartesian Position Check	Set the Cartesian Position Check zone.

3.2 SETUP OF USER MODEL

The setup procedure for the user model for an arc welding torch is as follows. The user model of the torch is set using two "Line_seg" shape elements.



Warning

If a robot workspace is set up incorrectly, the safety function will not work, and serious personal injury could result. When a robot workspace is changed, the values must be verified and the function must be tested again.

1. Press [MENU] key on Teach Pendant to display MENU pop up screen.
2. Select "0 -- NEXT --" → "6 SYSTEM" → "DCS", and press the [Enter] key to display DCS top menu.

Busy	Stop	Hold	Ready	TEST LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Open					

DCS i

1/17

1	Safe I/O Status:	
2	Safe I/O connect:	OK
3	Joint position check:	---- OK
4	Joint speed check:	---- OK
5	Cart. position check:	---- OK
6	Cart. speed check:	---- OK
7	T1 mode speed check:	OK
8	User model:	OK
9	Tool frame:	OK
10	User frame:	OK
11	Stop position prediction:	OK

[TYPE]	APPLY	DETAIL	UNDO	>
----------	-------	--------	------	---

3. Select "User model" and press the [Enter] key to display User Model List Menu.

Busy	Stop	Hold	Ready	TEST LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Open					

DCS i

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User model list

No.	Elem	Status	Comment
1	0	OK	[]
2	0	OK	[]
3	0	OK	[]
4	0	OK	[]
5	0	OK	[]
6	0	OK	[]
7	0	OK	[]
8	0	OK	[]
9	0	OK	[]
10	0	OK	[]

[TYPE]		DETAIL		>
----------	--	--------	--	---

4. Select any "No." and press the [Enter] key to display User Model Detail (Element List) Menu.

Busy	Stop	Hold	Auto	PROG1 LINE 0	AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Stop					
DCS								
User model detail (10 elements)								1/11
No.	1	[*****]						
Elements								
No.	Link	Shape	Size	Status				
1	DISABLE	99	Point	0.0	OK			
2	DISABLE	99	Point	0.0	OK			
3	DISABLE	99	Point	0.0	OK			
4	DISABLE	99	Point	0.0	OK			
5	DISABLE	99	Point	0.0	OK			
6	DISABLE	99	Point	0.0	OK			
7	DISABLE	99	Point	0.0	OK			
8	DISABLE	99	Point	0.0	OK			

5. Select any "No." and press the [Enter] key to display User Model Element Detail Menu.

Busy	Stop	Feed	Auto	PROG1 LINE 0	AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Stop					
DCS								
User element detail								1/9
No.	1	[*****]						
Element:	1	Status:	OK					
1 Enable/Disable:				ENABLE				
2 Link No. (99:FacePlate):				99				
3 Link type:				NORMAL				
4 Tool frame:				0				
5 Shape:				Line_seg				
6 Size (mm):				60.0				
Pos1								
7 X:		0.000	Y:		0.000	Z:		0.000
Pos2								
8 X:		0.000	Y:		0.000	Z:		280.000

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable the user model elements of the displayed No.
5	Shape	"Line_seg"	Configure so that the shape of a user model element is line segment.
6	Size (mm)	"60.0"	Configure so that the radius of a user model element is 60 mm.
7	Pos1 X Y Z	X: "0.000" Y: "0.000" Z: "0.000"	Set the position of one end on the center line of a user model element.
8	Pos2 X Y Z	X: "0.000" Y: "0.000" Z: "280.000"	Specify the position of the other end on the center line of a user model element.

6. Press the [Prev] key to return to "User Model Detail (Element List) Menu", select another shape element ("No.2" in the example), and perform the following settings.

Busy	Stop	Hold	Reset	PROG1 LINE 0	AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Stop					

DCS ^ i

User element detail 1/9

No. 1 [*****]

Element: 2 Status: OK

1 Enable/Disable: ENABLE

2 Link No. (99:FacePlate): 99

3 Link type: NORMAL

4 Tool frame: 0

5 Shape: Line_seg

6 Size (mm): 50.0

Pos1

7 X: 0.000 Y: 0.000 Z: 280.000

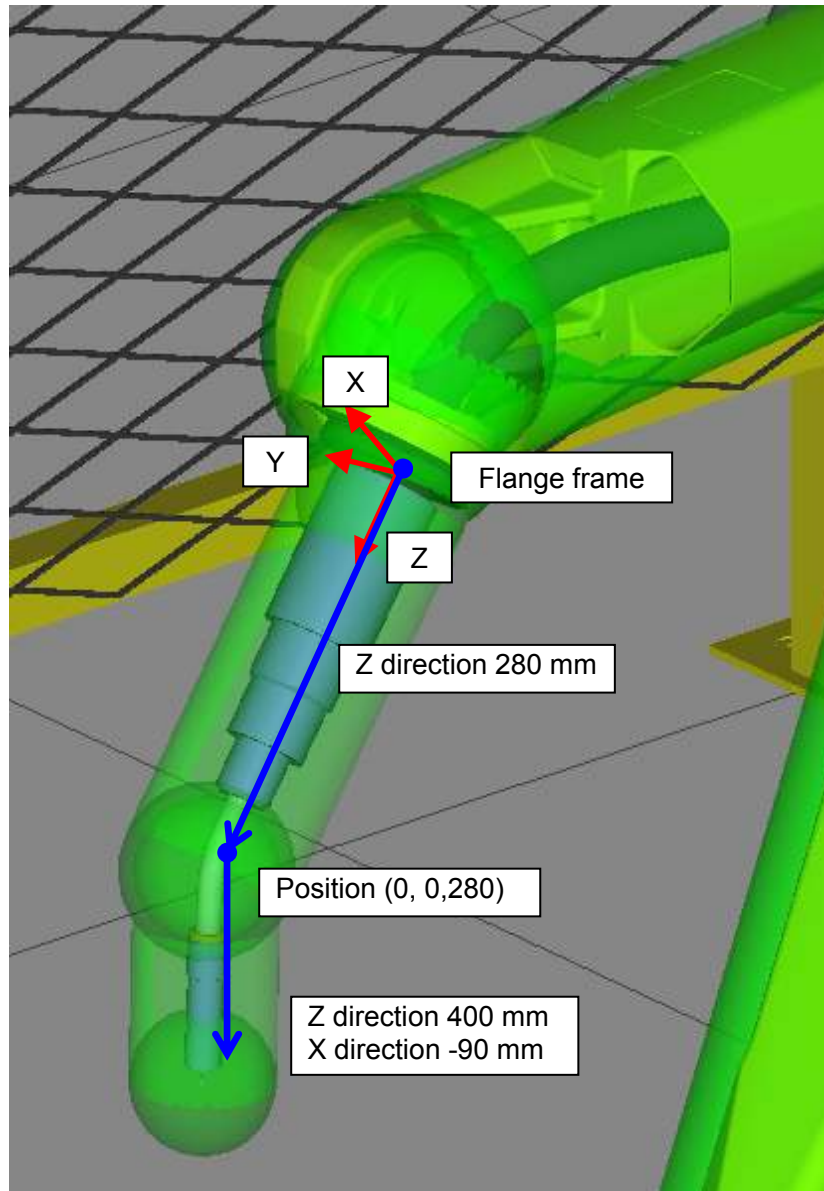
Pos2

8 X: -90.000 Y: 0.000 Z: 400.000

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable the user model elements of the displayed No.
5	Shape	"Line_seg"	Configure so that the shape of a user model element is line segment.
6	Size (mm)	"50.0"	Configure so that the radius of a user model element is 50 mm.
7	Pos1 X Y Z	X: "0.000" Y: "0.000" Z: "280.000"	Specify the position of one end on the center line of a user model element.
8	Pos2 X Y Z	X: "-90.000" Y: "0.000" Z: "400.000"	Specify the position of the other end on the center line of a user model element.

7. Press the [Prev] key 3 times to display DCS top menu.

DCS check can now be added to a welding torch.



3.3 CHECKING IF THERE IS AN OPERATOR ON A SAFE MAT

As a precondition, two safe mats are connected to the emergency stop board as redundant contacts.

The left safe mat is connected to SFDI11 and SFDI21, and the state can be referenced by Safety I/O SPI [1]. The right safe mat is connected to SFDI12 and SFDI22, and the state can be referenced by Safety I/O SPI [2].

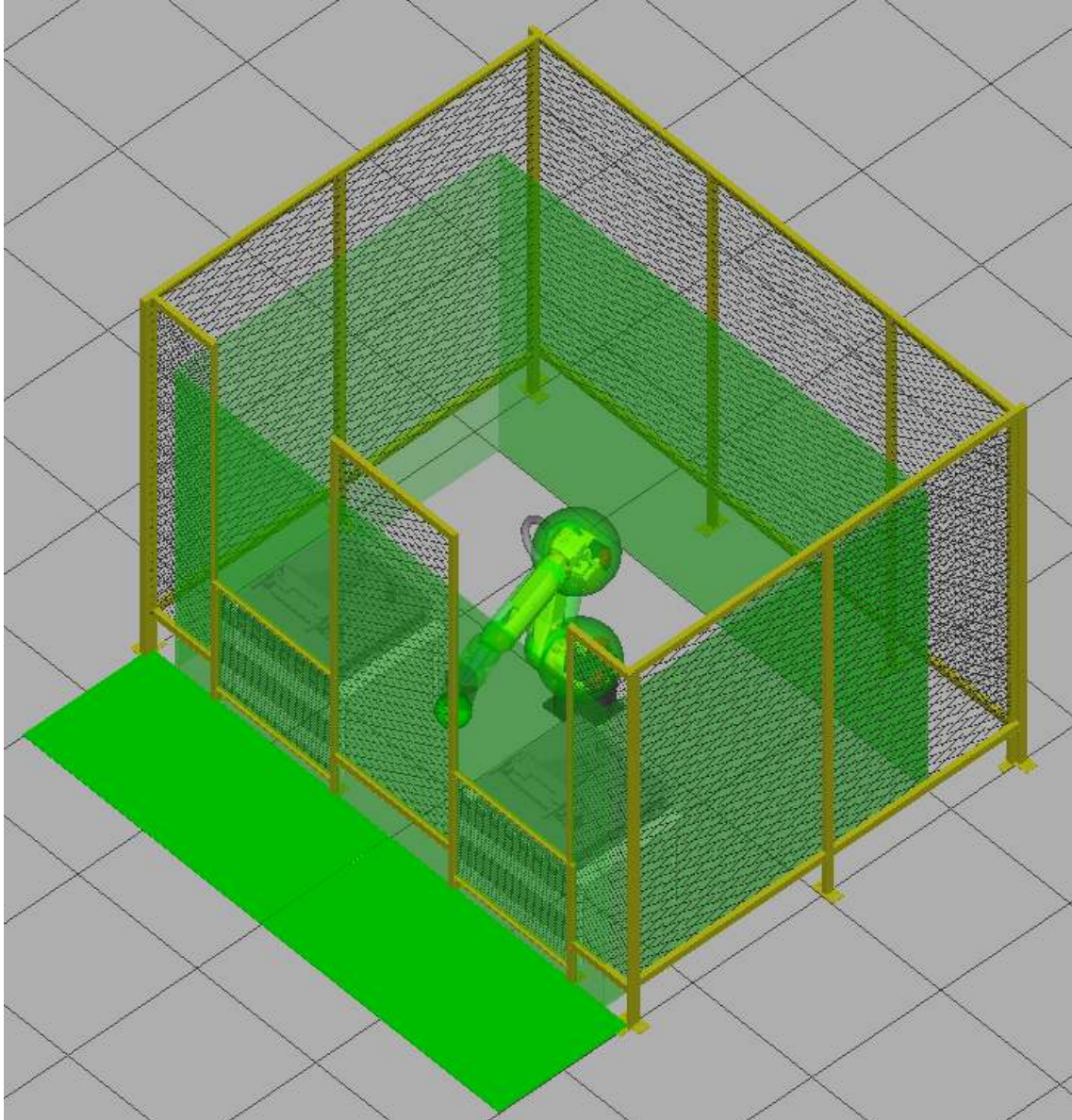
When there is no operator on a safe mat, both redundant signals (SFDI11 and SFDI21 in case of the left safe mat) are closed and Safety I/O (SFDI [1]) is ON. If either of the redundant signals is open, Safety I/O (SFDI [1]) is turned OFF.

NOTE

Refer to "Safety signal connection" in "R-30iB / R-30iBMate Controller Dual Check Safety Function Manual" (B-83184EN) for details on safety signal connection.

3.4 SETUP OF CARTESIAN POSITION CHECK

In Cartesian Position Check setup, three zones, from No. 1 to No. 3, are set up.

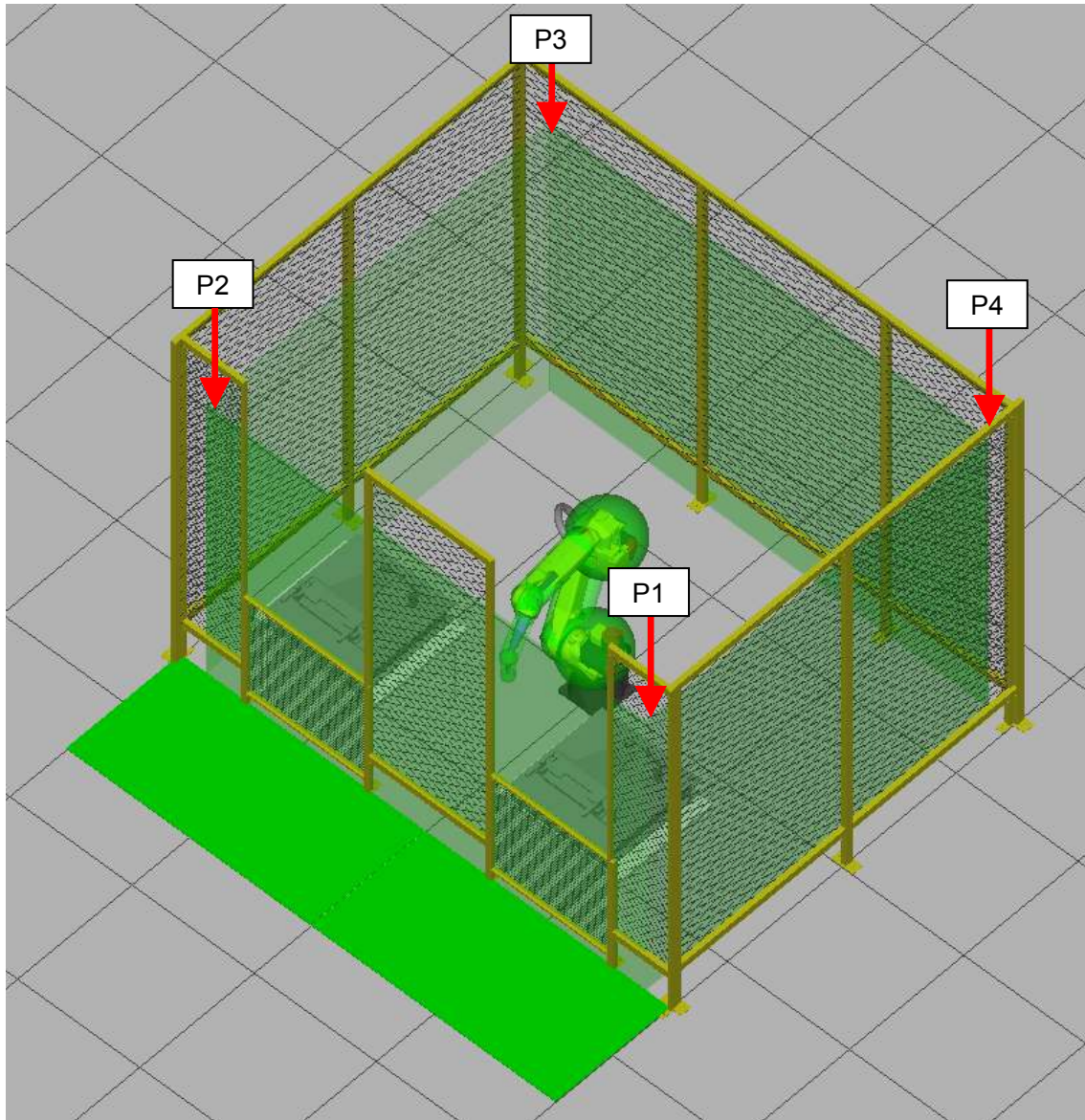


Type	Setting
No.1	A zone that surrounds the whole workspace of the robot. Always active. Disabling input is not set.
No.2	A zone that is enabled when an operator is on the left safe mat. If this zone is enabled, the robot cannot move to the left side. SPI [1], which shows the status of the left safe mat, is set to the disabling input.
No.3	A zone that is enabled when an operator is on the right safe mat. If this zone is enabled, the robot cannot move to the right side. SPI [2], which shows the status of the right safe mat, is set to the disabling input.

3.4.1 Setup of No.1 Zone

This section describes the setup method for No.1 zone.

No.1 zone is always active, so disabling input is not set. An alarm occurs if the robot exits the zone when there is no operator on a safe mat.



1. Select "Cart. position check" in DCS screen and press the [Enter] key to display Cartesian Position Check menu.

Busy	Stop	Hold	Pause			AUTO	G1 JOINT	100%
Run	Weld	Estab	Release					

DCS ^ i

Cartesian position check 1/32

Process time factor (Max.1000): 0

No.	G	M	Status	Comment
1	DISABL	1	WD ----	[]
2	DISABL	1	WD ----	[]
3	DISABL	1	WD ----	[]
4	DISABL	1	WD ----	[]
5	DISABL	1	WD ----	[]
6	DISABL	1	WD ----	[]
7	DISABL	1	WD ----	[]
8	DISABL	1	WD ----	[]
9	DISABL	1	WD ----	[]

[TYPE]
DETAIL
>

2. Select any "No." and press the [Enter] key to display Cartesian Position Check detail menu.

Busy	Stop	Hold	Pause	PROG1 LINE 0		T2	ABORTED	TOOL	100%
Run	Weld	Estab	Release						

DCS i

Cartesian position check 1/14

No. 1 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: DISABLE

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

Current
Point 1
Point 2

[TYPE]
PREV
NEXT
RECORD
UNDO
>

3. Perform the following settings in Cartesian Position Check detail menu.

Busy	Stop	Hold	Feed	PROG1 LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Etab	Power					

DCS i

Cartesian position check 1/21

No. 1 Status: **SAFE**

1 Comment: [*****]

2 Enable/Disable: **ENABLE**

3 Method: Working zone (Lines)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: User model 1

7 Target model 3: **DISABLE**

8 User frame: 0

9 Number of vertexes: 4

Position (mm):

	X	Y
Current	894.1	-930.0
10 P1	1500.0	-1800.0
11 P2	1500.0	1800.0
12 P3	-1500.0	1800.0
13 P4	-1500.0	-1800.0
14 P5	0.0	0.0
15 P6	0.0	0.0
16 P7	0.0	0.0
17 P8	0.0	0.0
Current	Z1	Z2
18	471.4	-500.0
19 Stop type:	Power-Off stop	
20 Speed check:	<DETAIL>	
21 Disabling input:	---[0:]	

[TYPE] PREV NEXT RECORD UNDO >

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable Cartesian Position Check for the displayed No.
3	Method	"Working zone (Lines)"	The safe zone is defined to be inside the vertexes of a polygon in the X-Y plane in "Lines."
6	Target model 2	The "No." of the user model set in "3.2 SETUP OF USER MODEL"	Specify the set user model to be the target for Cartesian Position Check.
9	Number of vertexes	"4"	Set the number of vertexes for the polygon in the X-Y plane. Here, we specify it to be "4", the number of vertexes P1 to P4.
10	P1	X: "1500.0" Y: "-1800.0"	Specify the X-Y coordinates of vertex P1.
11	P2	X: "1500.0" Y: "1800.0"	Specify the X-Y coordinates of vertex P2.
12	P3	X: "-1500.0" Y: "1800.0"	Specify the X-Y coordinates of vertex P3.
13	P4	X: "-1500.0" Y: "-1800.0"	Specify the X-Y coordinates of vertex P4.

No.	Item	Setting	Description
14	P5	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P5. As vertex P5 is not used for No.1, "0.0" is specified for both X and Y.
15	P6	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P6. As vertex P6 is not used for No.1, "0.0" is specified for both X and Y.
16	P7	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P7. As vertex P7 is not used for No.1, "0.0" is specified for both X and Y.
17	P8	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P8. As vertex P8 is not used for No.1, "0.0" is specified for both X and Y.
18	Z	Z1: "-500.0" Z2: "2000.0"	Specify the Z coordinates of upper and lower limit.
20	Stop type	"Power-Off stop"	Specify "Power-off stop", to immediately shut down the motor power.

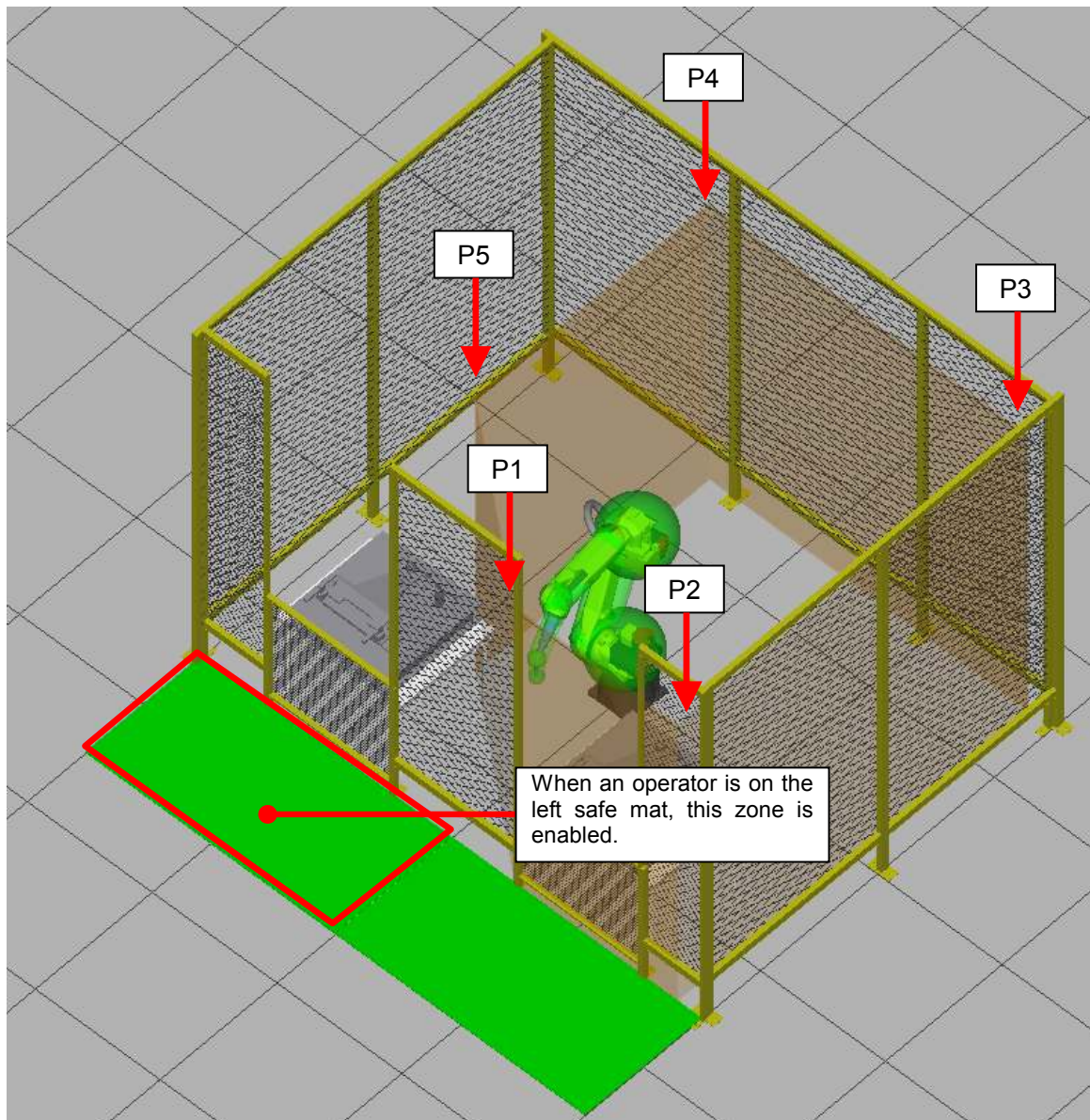
4. Press the [Prev] key 3 times to display DCS top menu.

Setup of No.1 zone is now complete.

3.4.2 Setup of No.2 Zone

This section describes the setup method for No.2 zone.

SPI [1], which shows the status of the left safe mat, is set to the disabling input. When there is no operator on the left safe mat, SPI [1] is ON and this zone is disabled. When there is no operator on the left safe mat, this zone is enabled. When the robot is about to exit this zone, it stops.



1. Select "Cart. position check" in DCS screen and press the [Enter] key to display Cartesian Position Check menu.

Busy	Stop	Hold	Reset	PROG1 LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Etab	Done					

DCS i

Cartesian position check 2/32

Process time factor (Max.1000): 31

No.	G	M	Status	Comment
1	ENABLE	1	WL	SAFE []
2	DISABL	1	WD	---- []
3	DISABL	1	WD	---- []
4	DISABL	1	WD	---- []
5	DISABL	1	WD	---- []
6	DISABL	1	WD	---- []
7	DISABL	1	WD	---- []
8	DISABL	1	WD	---- []
9	DISABL	1	WD	---- []

[TYPE]
DETAIL
>

2. Select any "No." and press the [Enter] key to display Cartesian Position Check detail menu.

Busy	Stop	Hold	Reset	PROG1 LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Etab	Done					

DCS i

Cartesian position check 1/14

No. 2 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: DISABLE

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

Current	Point 1	Point 2

[TYPE]
PREV
NEXT
RECORD
UNDO
>

3. Perform the following settings in Cartesian Position Check detail menu.

Busy	Stop	Hold	Pause	PROG1 LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Open					

DCS i

Cartesian position check 1/21

No. 2 Status: SAFE

1 Comment: [*****]

2 Enable/Disable: ENABLE

3 Method: Working zone (Lines)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: User model 1

7 Target model 3: DISABLE

8 User frame: 0

9 Number of vertexes: 5

Position (mm):		X	Y
Current		890.0	-924.4
10	P1	1500.0	-500.0
11	P2	1500.0	-1800.0
12	P3	-1500.0	-1800.0
13	P4	-1500.0	750.0
14	P5	500.0	750.0
15	P6	0.0	0.0
16	P7	0.0	0.0
17	P8	0.0	0.0
Current		Z1	Z2
18	444.8	-500.0	2000.0

19 Stop type: Power-Off stop

20 Speed check: <DETAIL>

21 Disabling input: SPI[1:SFDI1]

[TYPE] PREV NEXT RECORD UNDO >

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable Cartesian Position Check for the displayed No.
3	Method (Safe side)	"Lines (IN) "	The safe zone is defined to be inside the vertexes of a polygon in the X-Y plane in "Lines."
6	Target model 2	The "No." of the user model set in "3.2 SETUP OF USER MODEL"	Specify the set user model to be the target for Cartesian Position Check.
9	Number of vertexes	"5"	Set the number of vertexes for the polygon in the X-Y plane. Here, we specify it to be "5", the number of vertexes P1 to P5.
10	P1	X: "1500.0" Y: "500.0"	Specify the X-Y coordinates of vertex P1.
11	P2	X: "1500.0" Y: "1800.0"	Specify the X-Y coordinates of vertex P2.
12	P3	X: "-1500.0" Y: "1800.0"	Specify the X-Y coordinates of vertex P3.
13	P4	X: "-1500.0" Y: "-750.0"	Specify the X-Y coordinates of vertex P4.
14	P5	X: "500.0" Y: "-750.0"	Specify the X-Y coordinates of vertex P5.
15	P6	X: "0.0"	Specify the X-Y coordinates of vertex P6.

No.	Item	Setting	Description
		Y: "0.0"	As vertex P6 is not used for No.2, "0.0" is specified for both X and Y.
16	P7	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P7. As vertex P7 is not used for No.2, "0.0" is specified for both X and Y.
17	P8	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P8. As vertex P8 is not used for No.2, "0.0" is specified for both X and Y.
18	Z	Z1: "-500" Z2: "2000"	Specify the Z coordinates of upper and lower limit.
20	Stop type	"Power-Off stop"	Specify "Power-off stop", to immediately shut down the motor power.
21	disabling input	"SPI[1]"	Specify the Safety I/O that indicates the state of the left safe mat. If the specified Safety I/O is ON, this zone is disabled.

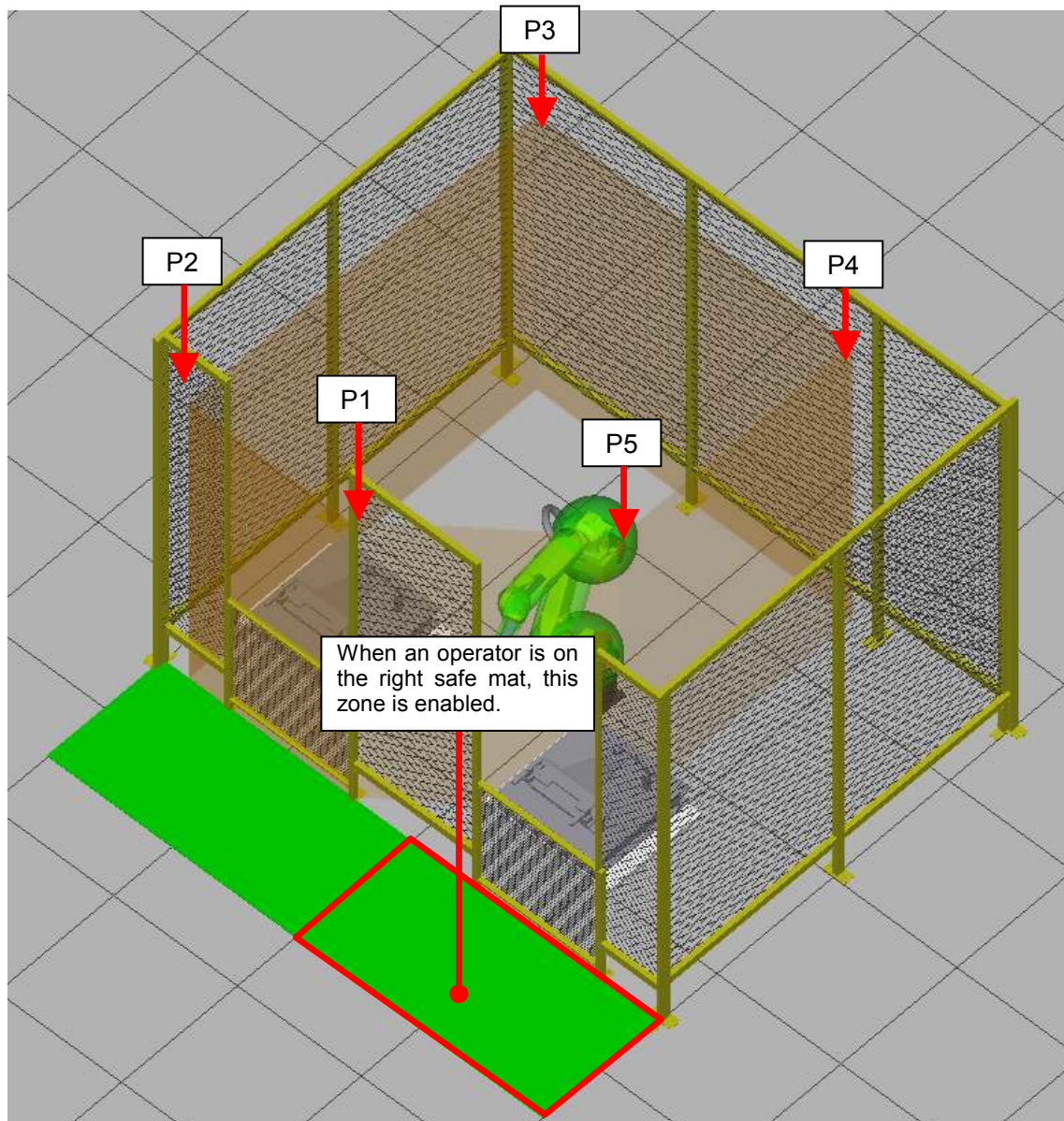
4. Press the [Prev] key 3 times to display DCS top menu.

Setup of No.2 zone is now complete.

3.4.3 Setup of No.3 Zone

This section describes the setup method for No.3 zone.

SPI [2], which shows the status of the right safe mat, is set to the disabling input. When an operator is not on the right safe mat, SPI [2] is turned ON and this zone is disabled. When an operator is on the right safe mat, this zone is enabled. When the robot is about to exit this zone, it stops.



1. Select "Cart. position check" in DCS screen and press the [Enter] key to display Cartesian Position Check menu.

Busy	Stop	Hold	Pause	PROG1 LINE 0	T2	ABORTED	TOOL	100%
Run	Weld	Estab	Start					

DCS i

Cartesian position check 3/32

Process time factor (Max.1000): 52

No.	G	M	Status	Comment
1	ENABLE	1	WL	SAFE []
2	ENABLE	1	WL	SAFE []
3	DISABL	1	WD	---- []
4	DISABL	1	WD	---- []
5	DISABL	1	WD	---- []
6	DISABL	1	WD	---- []
7	DISABL	1	WD	---- []
8	DISABL	1	WD	---- []
9	DISABL	1	WD	---- []

[TYPE] DETAIL >

2. Select any "No." and press the [Enter] key to display Cartesian Position Check detail menu.

Busy	Stop	Hold	Pause	TEST LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Start					

DCS i

Cartesian position check 1/14

No. 3 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: DISABLE

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

Current	Point 1	Point 2

[TYPE] PREV NEXT RECORD UNDO >

3. Perform the following settings in Cartesian Position Check detail menu.

Busy	Stop	Hold	Feed	TEST LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Brk					

DCS

^
i

Cartesian position check
1/21

No. 3
Status: SAFE

1 Comment: [*****]

2 Enable/Disable: ENABLE

3 Method: Working zone(Lines)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: User model 1

7 Target model 3: DISABLE

8 User frame: 0

9 Number of vertexes: 5

Position (mm) :

X
Y

Current
1157.9
547.3

10 P1
1500.0
500.0

11 P2
1500.0
1800.0

12 P3
-1500.0
1800.0

13 P4
-1500.0
-750.0

14 P5
500.0
-750.0

15 P6
0.0
0.0

16 P7
0.0
0.0

17 P8
0.0
0.0

Current
Z1
Z2

18 436.0
-500.0
2000.0

19 Stop type: Power-Off stop

20 Speed check: <DETAIL>

21 Disabling input: SPI[2:SFDI2]

[TYPE]

PREV

NEXT

RECORD

UNDO

>

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable Cartesian Position Check for the displayed No.
3	Method	"Working zone(Lines)"	The safe zone is defined to be inside the vertexes of a polygon in the X-Y plane in "Lines."
6	Target model 2	The "No." of the user model set in "3.2 SETUP OF USER MODEL"	Specify the set user model to be the target for Cartesian Position Check.
9	Number of vertexes	"5"	Set the number of vertexes for the polygon in the X-Y plane. Here, we specify it to be "5", the number of vertexes P1 to P5.
10	P1	X: "1500.0" Y: "-500.0"	Specify the X-Y coordinates of vertex P1.
11	P2	X: "1500.0" Y: "-1800.0"	Specify the X-Y coordinates of vertex P2.
12	P3	X: "-1500.0" Y: "-1800.0"	Specify the X-Y coordinates of vertex P3.
13	P4	X: "-1500.0" Y: "750.0"	Specify the X-Y coordinates of vertex P4.

No.	Item	Setting	Description
14	P5	X: "500.0" Y: "750.0"	Specify the X-Y coordinates of vertex P5.
15	P6	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P6. As vertex P6 is not used for No.3, "0.0" is specified for both X and Y.
16	P7	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P7. As vertex P7 is not used for No. 3, "0.0" is specified for both X and Y.
17	P8	X: "0.0" Y: "0.0"	Specify the X-Y coordinates of vertex P8. As vertex P8 is not used for No. 3, "0.0" is specified for both X and Y.
18	Z	Z1: "-500" Z2: "2000"	Specify the Z coordinates of upper and lower limit.
20	Stop type	"Power-Off stop"	Specify [Power-off stop], to immediately shut down the motor power.
21	disabling input	"SPI[2]"	Set the Safety I/O that indicates the state of the right safe mat. If the specified Safety I/O is ON, this zone is disabled.

4. Press the [Prev] key 3 times to display DCS top menu.

Setup of No.3 zone is now complete.

Perform an apply operation after setup for zones No.1 to No.3 is complete.

Please refer to "1.4.1 Operation to apply to DCS parameters" in chapter 1 for the applying operation.

4 CHECKING IF AUXILIARY AXES ARE STATIONARY

4.1 OVERVIEW

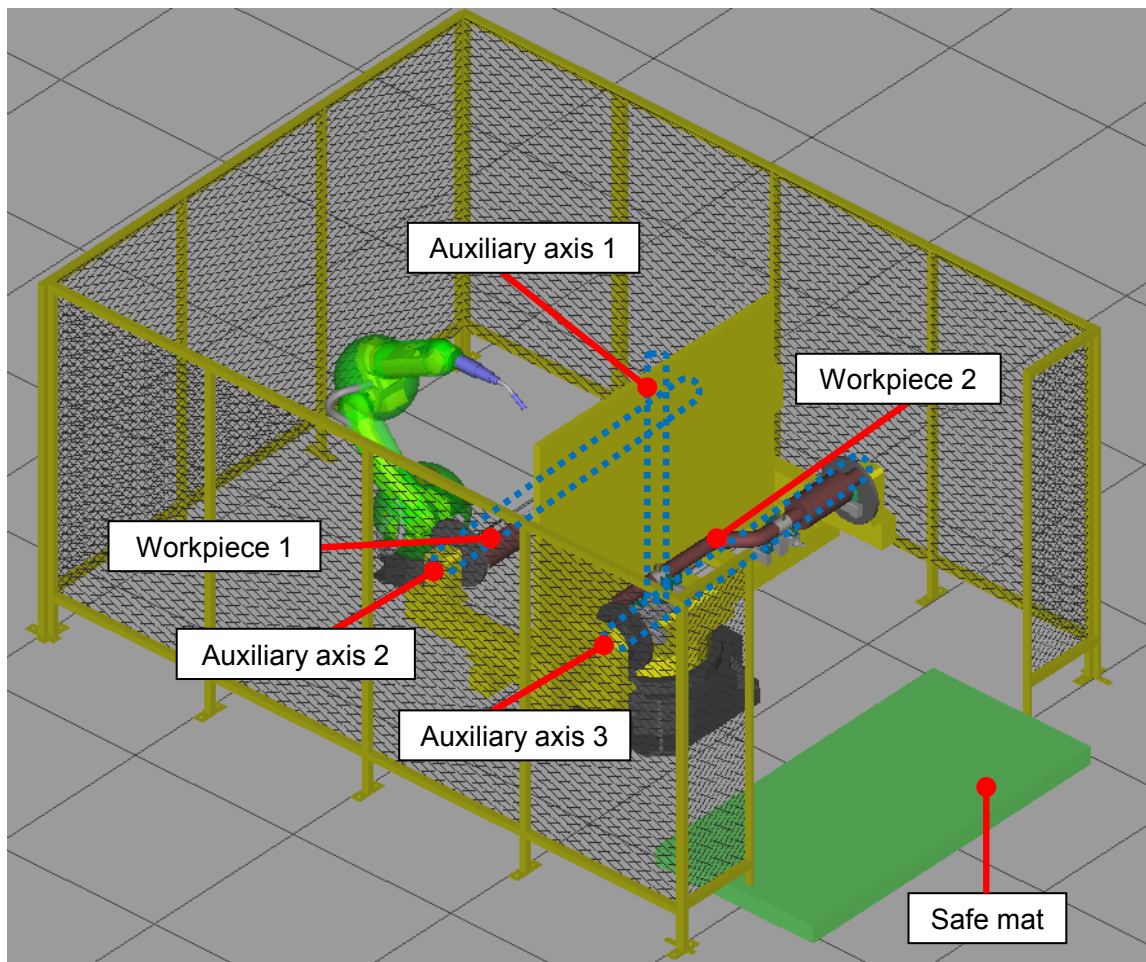
This chapter describes the system that checks if auxiliary axes are stationary.

In the case of the arc welding robot shown in the picture below, an operator steps onto the safe mat and replaces Workpiece 2. The robot welds Workpiece 1 while the operator is replacing the workpiece. The robot performs the welding in coordination with auxiliary axis 2.

When the operator finishes replacing the workpiece and leaves the safe mat, and the robot finishes welding Workpiece 1, auxiliary axis 1 rotates 180 degrees and Workpiece 1 and Workpiece 2 switch places.

After that, the robot welds Workpiece 2 in coordination with auxiliary axis 3, and the operator replaces Workpiece 1.

When an operator is on the safe mat, the system checks if auxiliary axis 1 and the auxiliary axis on the side of the safe mat (2 or 3) are stationary. If an auxiliary axis moves while the system is checking for stop, an alarm occurs and the robot and all auxiliary axes stop.



In this chapter, the following settings are performed.

Type	Item	Description
Settings	Setup of stop check for auxiliary axis 1	Set the input signal from a safe mat to be disabling input.
	Zone setup for auxiliary axis 1	Set the positions of auxiliary axis 1 where both auxiliary axes 2 and 3 are able to move (stop check is disabled).
	Setup of stop check for auxiliary axes 2 and 3	Set the signal that represents the status of Joint Position Check (JPC) to be disabling input.
	Setup of robot workspace	Set up the robot workspace.

4.2 SETTING UP STOP CHECK FOR AUXILIARY AXIS 1

Specify the following settings in the Joint Speed Check function of the DCS function, to monitor to ensure that auxiliary axis 1 does not rotate when an operator is on a safe mat (plate).



Warning

If a robot workspace is set up incorrectly, the safety function will not work, and serious personal injury could result. When a robot workspace is changed, the values must be verified and the function must be tested again.

1. Press [MENU] key on Teach Pendant to display MENU pop up screen.
2. Select "0 -- NEXT --" → "6 SYSTEM" → "DCS", and press the [Enter] key to display DCS top menu.

Busy	Stop	Hold	Reset	TEST LINE 0	AUTO	ABORTED	TOOL	100%	
Run	Weld	Estab	Clear	DCS					i
									1/17
1 Safe I/O Status:									
2 Safe I/O connect:									OK
3 Joint position check: ----									OK
4 Joint speed check: ----									OK
5 Cart. position check: ----									OK
6 Cart. speed check: ----									OK
7 T1 mode speed check:									OK
8 User model:									OK
9 Tool frame:									OK
10 User frame:									OK
11 Stop position prediction:									OK
[TYPE]									APPLY
DETAIL									UNDO
									>

3. Select "Joint speed check" and press the [Enter] key to display Joint Speed Check menu.

Busy	Stop	Hold	Reset	PROGMAIN LINE 0	T2	ABORTED	G2 JOINT	10%	
Run	Weld	Estab	Clear	DCS					^ i
Joint speed check									1/40
No.	G	A	Status	Comment					
1	DISABLE	1	1 ----	[]
2	DISABLE	1	1 ----	[]
3	DISABLE	1	1 ----	[]
4	DISABLE	1	1 ----	[]
5	DISABLE	1	1 ----	[]
6	DISABLE	1	1 ----	[]
7	DISABLE	1	1 ----	[]
8	DISABLE	1	1 ----	[]
9	DISABLE	1	1 ----	[]
10	DISABLE	1	1 ----	[]
[TYPE]									DETAIL

4.CHECKING IF AUXILIARY AXES ARE STATIONARY

4. Select any "No." and press the [Enter] key to display Joint Speed Check detail menu.

Busy	Stop	Hold	Pause	PROGMAIN LINE 0	T2	ABORTED	G2 JOINT	10%
Run	Weld	Etab	Stop					

DCS ^ i

Joint speed check 1/12

No. 1 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Direction: ALL

4 Group: 1

5 Axis: 1

Speed(deg/sec):

Current: 0.000

6 Limit: 0.000

7 Stop type: Power-Off stop

8 Speed control: DISABLE

[TYPE]	PREV	NEXT	UNDO
----------	------	------	------

5. Perform the following settings in Joint Speed Check menu.

Busy	Stop	Hold	Pause	PROGMAIN LINE 0	AUTO	ABORTED	G1 JOINT	100%
Run	Weld	Etab	Stop					

DCS ^ i

Joint speed check 1/12

No. 1 Status: **SAFE**

1 Comment: [*****]

2 Enable/Disable: ENABLE

3 Direction: ALL

4 Group: 2

5 Axis: 1

Speed(deg/sec):

Current: 0.000

6 Limit: 0.000

7 Stop type: Power-Off stop

8 Speed control: DISABLE

9 Override limit: 100%

10 Delay time: 0 msec

11 Disabling input: SPI[1:SFDI1]

12 Permissible distance (deg): 0.2

[TYPE]	PREV	NEXT	UNDO
----------	------	------	------

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
4	Group	"2"	Select auxiliary axis 1's group.
5	Axis	"1"	Select the axis for which auxiliary axis 1 is set.
6	Limit	"0"	This function can be used as a stop check function when the speed limit is set to "0."

No.	Item	Setting	Description
8	disabling input	"SPI[1]"	To enable / disable the Joint Position Check dynamically, a Safety I/O can be set as a disabling input. When the specified Safety I/O is ON, this function disabled. When the specified Safety I/O is OFF, this function is enabled. Here, the condition is connecting so that input signals from safe mats are sent to SPI[1]. When an operator is on a safe mat, SPI[1] is turned OFF and stop check is enabled.
9	Permissible distance	"5"	Set the permissible movement distance for when checking if the axis is stationary. Set 5 deg for the permissible distance here, to permit subtle movements when the servo is ON. An alarm does not occur if the movement is less than the permissible distance, even when the function is checking if the axis is stationary. Decide a suitable permissible distance value for your system through risk assessment.

6. Press the [Prev] key 2 times to display DCS top menu.

After these steps, the DCS Joint Speed Check function is enabled when an operator is on a safe mat, and emergency stop occurs when auxiliary axis 1 moves.

4.3 SETUP OF POSITION CHECK FOR AUXILIARY AXIS 1

Set the position of auxiliary axis 1 where both the auxiliary axes 2 and 3 are able to move (stop check is disabled) to Joint Position Check No. 1 and No. 2, respectively.



Warning

If a robot workspace is set up incorrectly, the safety function will not work, and serious personal injury could result. When a robot workspace is changed, the values must be verified and the function must be tested again.

1. Select "Joint position check" in DCS screen and press the [Enter] key to display Joint Position Check list menu.

Busy	Stop	Reset	Pause	PROG1 LINE 0			AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Test							
DCS										
Joint Position check										1/40
No.	G		A		Status		Comment			
1	DISABLE		1	1	----		[]			
2	DISABLE		1	1	----		[]			
3	DISABLE		1	1	----		[]			
4	DISABLE		1	1	----		[]			
5	DISABLE		1	1	----		[]			
6	DISABLE		1	1	----		[]			
7	DISABLE		1	1	----		[]			
8	DISABLE		1	1	----		[]			
9	DISABLE		1	1	----		[]			
10	DISABLE		1	1	----		[]			
[TYPE]			PREV		NEXT		UNDO		>	

2. Select "No. 1" and press the [Enter] key to display Joint Position Check detail menu.

Busy	Stop	Reset	Pause	PROG1 LINE 0	AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Stop					
DCS								
Joint position check								1/9
No. 1				Status:----				
1	Comment:			[REDACTED]				
2	Enable/Disable:			DISABLE				
3	Group:			1				
4	Axis:			1				
5	Safe side:			INSIDE				
Position (deg):								
Current:				-4.021				
6	Upper limit:			0.000				
7	Lower limit:			0.000				
8	Stop type:			Power-Off stop				
[TYPE]				PREV	NEXT	UNDO		Y

3. Perform the following settings in Joint Position Check detail menu.

Busy	Stop	Hold	Reset	PROGMAIN LINE 0	AUTO	ABORTED	G1 JOINT	100%
Run	Weld	Estab	Break					

DCS ^ i

Joint position check 1/9

No. 1 Status: **SAFE**

1 Comment: [*****]

2 Enable/Disable: **ENABLE**

3 Group: 2

4 Axis: 1

5 Safe side: **INSIDE**

Position (deg):

Current: 0.288

6 Upper limit: 5.000

7 Lower limit: -5.000

8 Stop type: Not stop

9 Disabling input: ---[0:]

[TYPE]	PREV	NEXT	UNDO	>
----------	------	------	------	---

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
3	Group	"2"	Select auxiliary axis 1's group.
4	Axis	"1"	Select the axis for which auxiliary axis 1 is set.
6	Upper limit	"5"	Set the upper limit of auxiliary axis 1. Motion of auxiliary axis 2 becomes available within this range of values.
7	Lower limit	"-5"	Set the lower limit of auxiliary axis 1. Motion of auxiliary axis 2 becomes available within this range of values.
8	Stop type	"Not stop"	By selecting "Not stop", an alarm does not occur even when auxiliary axis 1 exits this motion range. As Safety I/O JPC[1] is ON when the axis is in this zone, this signal is used to enable / disable stop check for auxiliary axis 2.

With this setting, the zone of auxiliary axis 1 where auxiliary axis 2 is able to move is set to Joint Position Check No. 1.

Next, set the zone of auxiliary axis 1 where auxiliary axis 3 is able to move to Joint Position Check No. 2.

4.CHECKING IF AUXILIARY AXES ARE STATIONARY

4. Press [Prev] key to display Joint Position Check list menu.

Busy	Stop	Hold	Pause	PROGMAIN LINE 0			AUTO	ABORTED	G1 JOINT	100%
Run	Weld	Estab	Open							
DCS										
Joint Position check										2/40
No.	G A Status			Comment						
1	ENABLE	2	1	SAFE	[
2	DISABLE	1	1	----	[
3	DISABLE	1	1	----	[
4	DISABLE	1	1	----	[
5	DISABLE	1	1	----	[
6	DISABLE	1	1	----	[
7	DISABLE	1	1	----	[
8	DISABLE	1	1	----	[
9	DISABLE	1	1	----	[
10	DISABLE	1	1	----	[
[TYPE]										
DETAIL										
>										

5. Select "No. 2" and press the [Enter] key to display Joint Position Check detail menu.

Busy	Stop	Hold	Pause	PROGMAIN LINE 0 AUTO ABORTED G1 JOINT			100%
Run	Weld	Estab	Open				
DCS							
Joint position check							1/9
No. 2			Status:----				
1	Comment:			[*****]			
2	Enable/Disable:			DISABLE			
3	Group:			1			
4	Axis:			1			
5	Safe side:			INSIDE			
Position (deg):							
Current:			-35.728				
6	Upper limit:			0.000			
7	Lower limit:			0.000			
8	Stop type:			Power-Off stop			
[TYPE]		PREV	NEXT			UNDO	>

6. Perform the following settings in Joint Position Check detail menu.

Joint position check 1/9

No. 2 Status: **UNSF**

1 Comment: [*****]

2 Enable/Disable: **ENABLE**

3 Group: 2

4 Axis: 1

5 Safe side: **INSIDE**

Position (deg):

Current: 0.288

6 Upper limit: 175.000

7 Lower limit: 185.000

8 Stop type: Not stop

9 Disabling input: ---[0:]

[TYPE] PREV NEXT UNDO >

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
3	Group	"2"	Select auxiliary axis 1's group.
4	Axis	"1"	Select the axis for which auxiliary axis 1 is set.
6	Upper limit	"175"	Set the upper limit of auxiliary axis 1. Motion of auxiliary axis 3 becomes available within this range of values.
7	Lower limit	"185"	Set the lower limit of auxiliary axis 1. Motion of auxiliary axis 3 becomes available within this range of values.
8	Stop type	"Not stop"	By selecting "Not stop", an alarm does not occur even when auxiliary axis 1 exits this motion range. As Safety I/O JPC[1] is ON when the axis is in this zone, this signal is used to enable / disable stop check for auxiliary axis 2.

7. Press the [Prev] key 2 times to display DCS top menu.

4.4 SETUP OF STOP CHECK FOR AUXILIARY AXES 2 AND 3

Set up stop check for auxiliary axes 2 and 3.

Set auxiliary axis 2 (Group 3, Axis 1) to Joint Speed Check No. 2. Set the speed limit to 0 and check if the axis is stationary. Set JPC[1], which indicates the state of Joint Position Check No. 1, as disabling input. Set the permissible distance to 0.2 deg.

Next, set auxiliary axis 3 (Group 4, Axis 1) to Joint Speed Check No. 3. Set the speed limit to 0 and check if the axis is stationary. Set JPC[2], which indicates the state of Joint Position Check No. 2, as disabling input. Set the permissible distance to 0.2 deg.

The workpiece can be rotated only when it is in front of the robot. Whether or not the workpiece is in front of the robot is determined by the position of auxiliary axis 1. The position check of auxiliary axis 1 is already set in No. 1 and 2 of Joint Position Check. Using the result, the stop check for auxiliary axis 2 and 3 is enabled / disabled.



Warning

If a robot workspace is set up incorrectly, the safety function will not work, and serious personal injury could result. When a robot workspace is changed, the values must be verified and the function must be tested again.

1. Select "Joint speed check" in DCS screen and press the [Enter] key to display Joint Speed Check list menu.

Busy	Stop	Hold	Pause	PROGMAIN LINE 0			AUTO	ABORTED	G1 JOINT	100%
Run	Weld	Estab	Brake							
DCS										
Joint speed check										2/40
No.	G		A	Status	Comment					
1	ENABLE	2	1	SAFE	[
2	DISABLE	1	1	----	[
3	DISABLE	1	1	----	[
4	DISABLE	1	1	----	[
5	DISABLE	1	1	----	[
6	DISABLE	1	1	----	[
7	DISABLE	1	1	----	[
8	DISABLE	1	1	----	[
9	DISABLE	1	1	----	[
10	DISABLE	1	1	----	[
[TYPE]										
DETAIL										

2. Select "No. 2" and press the [Enter] key to display Joint Speed Check detail menu.

Busy	Stop	Hold	Reset	PROGMAIN LINE 0	AUTO	ABORTED	G1 JOINT	100%
Run	Weld	Estab	Clear					

DCS ^ i

Joint speed check 1/12

No. 2 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Direction: ALL

4 Group: 1

5 Axis: 1

Speed(deg/sec):

Current: 0.000

6 Limit: 0.000

7 Stop type: Power-Off stop

8 Speed control: DISABLE

[TYPE] PREV NEXT UNDO

3. Perform the following settings in Joint Speed Check detail menu.

Busy	Stop	Hold	Reset		AUTO	G1 JOINT	100%
Run	Weld	Estab	Clear				

DCS ^ i

Joint speed check 1/12

No. 2 Status:DSBL

1 Comment: []

2 Enable/Disable: ENABLE

3 Direction: ALL

4 Group: 3

5 Axis: 1

Speed(deg/sec):

Current: 0.000

6 Limit: 0.000

7 Stop type: Power-Off stop

8 Speed control: DISABLE

9 Override limit: 100%

10 Delay time: 0 msec

11 Disabling input: JPC[1:]

12 Permissible distance (deg): 0.2

[TYPE] PREV NEXT UNDO

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
4	Group	"3"	Select auxiliary axis 2's group.
5	Axis	"1"	Select the axis for which auxiliary axis 2 is set.
6	Limit	"0"	This function can be used as a stop check function when the speed limit is set to 0.
7	Stop type	"Power-Off stop"	Select [Power-off stop], to immediately shut down the power.

4.CHECKING IF AUXILIARY AXES ARE STATIONARY

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5. Select "No. 3" and press the [Enter] key to display Joint Speed Check detail menu.

Busy	Stop	Hold	Pause			
Run	Weld	Estab	Release	T2	G1 JOINT	100%
DCS ^ i						
Joint speed check						1/12
No. 3						Status:----
1 Comment: [REDACTED]						
2 Enable/Disable:						DISABLE
3 Direction:						ALL
4 Group:						1
5 Axis:						1
Speed(deg/sec):						
Current:						0.000
6 Limit:						0.000
7 Stop type:						Power-Off stop
8 Speed control:						DISABLE
[TYPE] PREV NEXT UNDO						

6. Perform the following settings in Joint Speed Check detail menu.

Busy	Stop	Hold	Reset		AUTO	G1 JOINT	100%
Run	Weld	Estab	Stop				

DCS

^
i

Joint speed check
1/12

No. 3
Status: SAFE

1 Comment: []

2 Enable/Disable: ENABLE

3 Direction: ALL

4 Group: 4

5 Axis: 1

Speed(deg/sec):

Current: 0.000

6 Limit: 0.000

7 Stop type: Power-Off stop

8 Speed control: DISABLE

9 Override limit: 100%

10 Delay time: 0 msec

11 Disabling input: JPC[2:]

12 Permissible distance (deg): 0.2

[TYPE]
PREV
NEXT
UNDO

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
4	Group	"4"	Select auxiliary axis 3's group.
5	Axis	"1"	Select the axis for which auxiliary axis 3 is set.
6	Limit	"0"	This function can be used as a stop check function when the speed limit is set to 0.
7	Stop type	"Power-Off stop"	Select "Power-off stop", to immediately shut down the power.
8	disabling input	"JPC[2] "	The result of Joint Position Check No. 2 is reflected to this signal. JPC[1] is ON when auxiliary axis 1 is between 175 deg to 185 deg, and motion of auxiliary axis 3 becomes available when the stop check for auxiliary axis 3 is disabled.
9	Permissible distance	"0.2"	Set the permissible movement distance for when checking if the axis is stationary. Set 0.2 deg for the permissible distance here, to permit subtle movements when the servo is ON. An alarm does not occur if the movement is less than the permissible distance, even when the function is checking if the axis is stationary. Decide a suitable permissible distance value for your system through risk assessment.

7. Press the [Prev] key 2 times to display DCS top menu.

The above setting will prevent the workpiece on the side of a safe mat from rotating when an operator is on the safe mat.

4.CHECKING IF AUXILIARY AXES ARE STATIONARY

3. Perform the following settings in Joint Position Check detail menu.

Busy	Stop	Hold	Reset						
Run	Weld	Estab	Power			AUTO	G1 JOINT	100%	

DCS ^ i

Joint position check 1/9

No. 3 Status: **SAFE**

1 Comment: [REDACTED]

2 Enable/Disable: **ENABLE**

3 Group: 2

4 Axis: 1

5 Safe side: **INSIDE**

Position (deg):

Current: 0.000

6 Upper limit: 180.000

7 Lower limit: -180.000

8 Stop type: **Power-Off stop**

9 Disabling input: ---[0:]

[TYPE]	PREV	NEXT	UNDO	>
----------	------	------	------	---

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
3	Group	"2"	Select auxiliary axis 1's group.
4	Axis	"1"	Select the axis for which auxiliary axis 1 is set.
6	Upper limit	"180"	Set the upper limit of auxiliary axis 1.
7	Lower limit	"-180"	Set the lower limit of auxiliary axis 1.
8	Stop type	"Power-Off stop"	Select "Power-off stop", to immediately shut down the power.

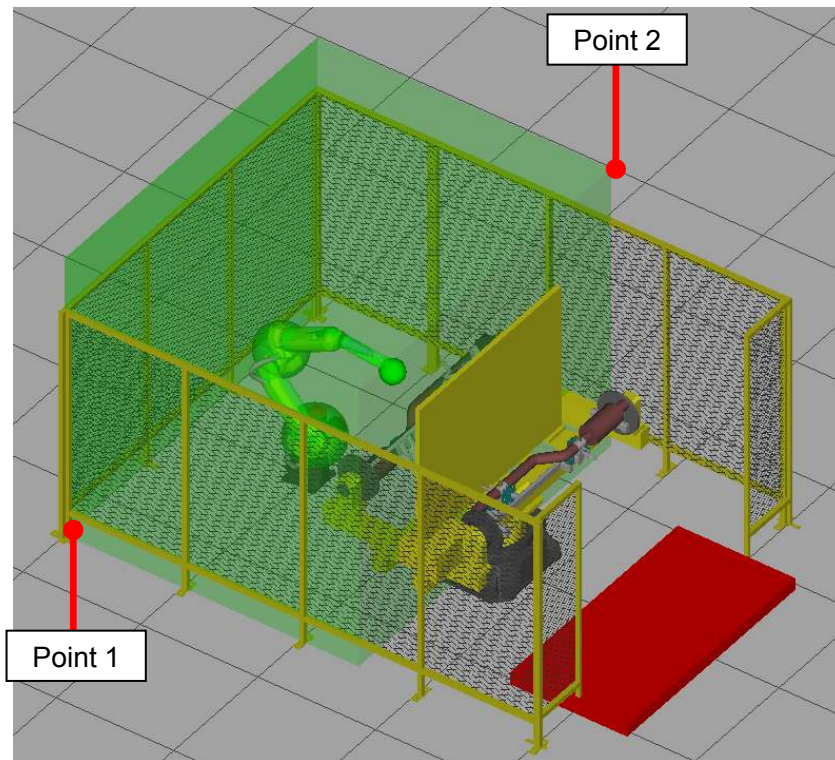
4. Press the [Prev] key 2 times to display DCS top menu.

The above settings will allow limiting the motion range of the turntable.

4.6 SETTING UP THE ROBOT WORKSPACE

Set up Cartesian Position Check and limit the robot workspace, so that the robot does not enter a safe mat side.

Set a welding torch model to user model No. 1. Refer to "3. SWITCHING THE WORKSPACE" for details on the setup method.



Set up Cartesian Position Check as follows.

1. Select "Cart. position check" in DCS screen and press the [Enter] key to display Cartesian Position Check list menu.

Busy	Stop	Hold	Run		T2	G1 JOINT	100%
Run	Weld	Etab	Done				

DCS^ i

```

Cartesian position check                                1/32
Process time factor (Max.1000):                        0
No.              G M Status      Comment
1 DISABL 1 WD ---- [                                     ]
2 DISABL 1 WD ---- [                                     ]
3 DISABL 1 WD ---- [                                     ]
4 DISABL 1 WD ---- [                                     ]
5 DISABL 1 WD ---- [                                     ]
6 DISABL 1 WD ---- [                                     ]
7 DISABL 1 WD ---- [                                     ]
8 DISABL 1 WD ---- [                                     ]
9 DISABL 1 WD ---- [                                     ]
  
```

[TYPE]	DETAIL			>
----------	--------	--	--	---

4.CHECKING IF AUXILIARY AXES ARE STATIONARY

2. Select any "No." and press the [Enter] key to display Cartesian Position Check detail menu.

Busy	Stop	Hold	Ready		T2	G1 JOINT	100%
Run	Weld	Estab	Done				

DCS

^ i

Cartesian position check 1/14

No. 1 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: DISABLE

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

	Current	Point 1	Point 2
9 X	905.0	-1000.0	3000.0
10 Y	0.0	-1500.0	1500.0
11 Z	750.0	-2000.0	2500.0

[TYPE]	PREV	NEXT	RECORD	UNDO	>
----------	------	------	--------	------	---

3. Perform the following settings in Cartesian Position Check detail menu.
Enter "1", the user model No. of welding torch, for "Target model 2."

Busy	Stop	Hold	Ready		AUTO	G1 JOINT	100%
Run	Weld	Estab	Done				

DCS

^ i

Cartesian position check 1/14

No. 1 Status: **SAFE**

1 Comment: [*****]

2 Enable/Disable: ENABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: User model 1

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

	Current	Point 1	Point 2
9 X	905.0	-1000.0	3000.0
10 Y	0.0	-1500.0	1500.0
11 Z	750.0	-2000.0	2500.0

12 Stop type: Power-Off stop

13 Speed check: <DETAIL>

14 Disabling input: ---[0:]

[TYPE]	PREV	NEXT	[CHOICE]	UNDO	>
----------	------	------	----------	------	---

No.	Item	Setting	Description
2	Enable/Disable	"ENABLE"	Enable the displayed No.
3	Method	"Working zone(Diagonal)"	Define the robot workspace to be the inside of a box using the Cartesian Position Check function. The setting "Working zone (Diagonal)" defines the coordinates of the two ends of the diagonal of a box.
9	X Point 1 Point 2	Values for the coordinates of the two ends of the diagonal of a box	Defines the coordinates of the two ends of the diagonal of the box for which "Working zone (Diagonal)" is the robot workspace.
10	Y Point 1 Point 2		
11	Z Point 1 Point 2		
12	Stop type	"Power-Off stop"	Configure so that if a robot goes beyond the workspace, robot motor power immediately shuts down and the robot stops.

Perform an applying operation once the settings up to here are complete.

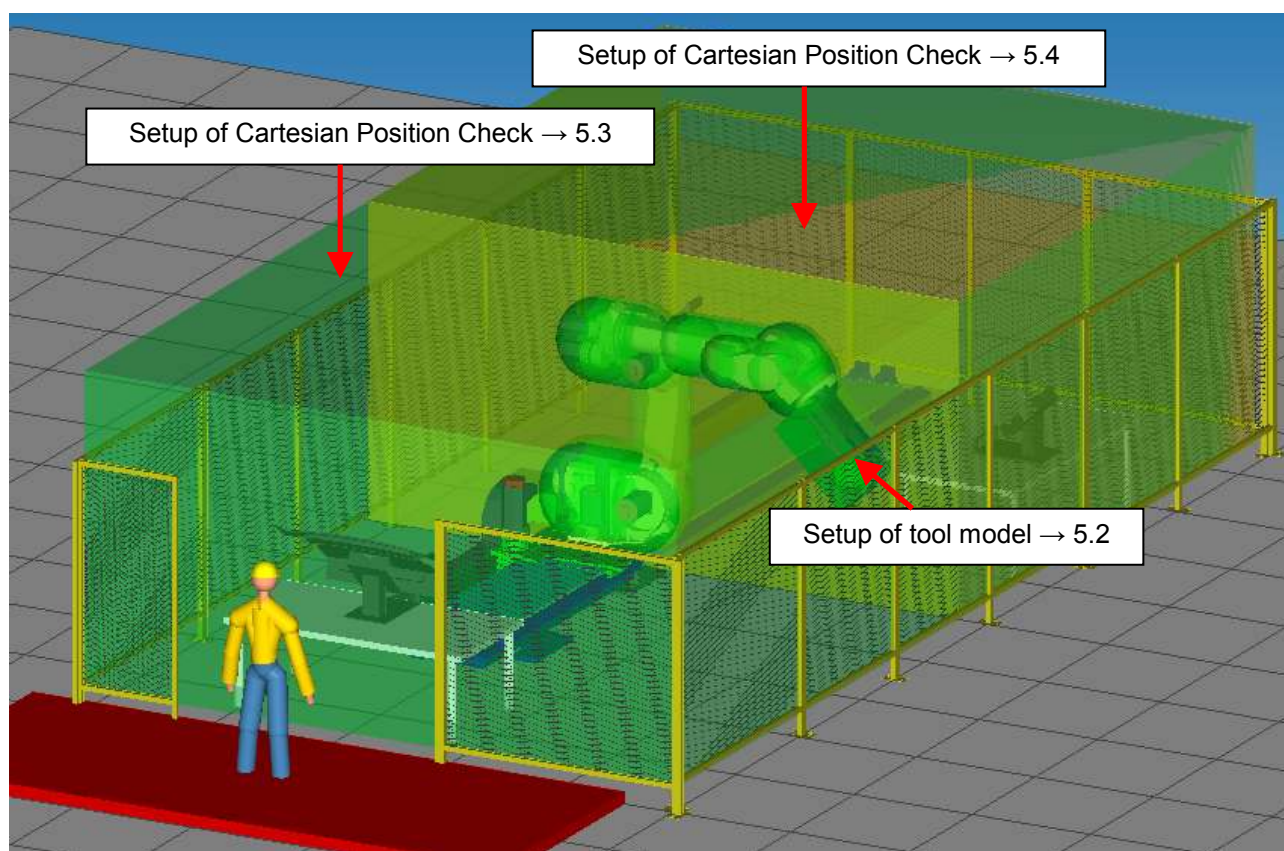
Please refer to "1.4.1 Operation to apply to DCS parameters" in chapter 1 for the applying operation.

5 SET A SLOWDOWN ZONE

5.1 OVERVIEW

This chapter describes the method to set a slowdown zone.

In a Handling robot system as shown below, a danger area is increased by gripping works. For that reason, the robot must set user models in each the case of tool. And only if an operator is in collaborate zone, the robot slowdown to ensure safety of an operator. If the robot enter in the zone where a speed check function enable at a high speed, the robot stops, and work efficiency becomes worse. When Speed Check function becomes to enable, delay that turn enable at time before slowing down.



This chapter describes the setup procedure to change a robot workspace.

Type	Item	Description
Settings	Setup of tool model	Set the user model in each the case of tool
	Setup of Cartesian Position Check	Set the Cartesian Position Check zone
	Setup of Cartesian Position Speed Check	Set the slowdown zone

5.2 SETUP OF TOOL MODEL

This section describes method that set the user models in each tool states. There are two states that work exists or not. The user model of the tool is set using "box" shape elements.



Warning

If a robot workspace is set up incorrectly, the safety function will not work, and serious personal injury could result. When a robot workspace is changed, the values must be verified and the function must be tested again.

1. Press [MENU] key on Teach Pendant to display MENU pop up screen.
2. Select "0 -- NEXT --" → "6 SYSTEM" → "DCS", and press the [Enter] key to display DCS top menu.

Busy	Stop	Hold	Ready	TEST LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Down					
DCS								i
								1/17
1 Safe I/O Status:								
2 Safe I/O connect:								OK
3 Joint position check: ----								OK
4 Joint speed check: ----								OK
5 Cart. position check: ----								OK
6 Cart. speed check: ----								OK
7 T1 mode speed check:								OK
8 User model:								OK
9 Tool frame:								OK
10 User frame:								OK
11 Stop position prediction:								OK
[TYPE]								APPLY
DETAIL								UNDO
								>

3. Select "User model" and press the [Enter] key to display User Model List Menu.

Busy	Stop	Hold	Ready	TEST LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Estab	Down					
DCS								i
User model list								1/16
No.	Elem	Status	Comment					
1	0	OK	[]					
2	0	OK	[]					
3	0	OK	[]					
4	0	OK	[]					
5	0	OK	[]					
6	0	OK	[]					
7	0	OK	[]					
8	0	OK	[]					
9	0	OK	[]					
10	0	OK	[]					
[TYPE]								>
DETAIL								

4. Select any "No." and press the [Enter] key to display User Model Detail (Element List) Menu.

Busy	Stop	Hold	Reset	PROG1 LINE 0	AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Stop					

DCS ^ i

User model detail (10 elements) 1/11

No. 1 [*****]

Elements

No.	Link	Shape	Size	Status
1 DISABLE	99	Point	0.0	OK
2 DISABLE	99	Point	0.0	OK
3 DISABLE	99	Point	0.0	OK
4 DISABLE	99	Point	0.0	OK
5 DISABLE	99	Point	0.0	OK
6 DISABLE	99	Point	0.0	OK
7 DISABLE	99	Point	0.0	OK
8 DISABLE	99	Point	0.0	OK

5. Select any "No." and press the [Enter] key to display User Model Element Detail Menu.

Busy	Step	Hold	Reset	PICK LINE 0	AUTO	ABORTED	JOINT	100%
Run	Gun	Weld	I/O					

DCS ^ i

User element detail 1/9

No. 1 [*****]

Element: 1 Status: OK

1 Enable/Disable: DISABLE

2 Link No. (99:FacePlate): 99

3 Link type: NORMAL

4 Tool frame: 0

5 Shape: Point

6 Size (mm): 0.0

Pos1

7 X: 0.000 Y: 0.000 Z: 0.000

[TYPE] UNDO >

6. Press the item of "5 Shape" and select "Box". Perform following settings in User Element Detail (Box) menu.

Busy	Step	Hold	Pause	PICK LINE 0	AUTO	ABORTED	JOINT	100%
Run	Gun	Weld	I/O					

DCS ^ i

User model detail(Box) 1/10

No. 1 [*****]

Element: 1 Status: OK

1 Enable/Disable: ENABLE

2 Link No. (99:FacePlate): 99

3 Link type: NORMAL

4 Tool frame: 0

5 Shape: Box

Box

6 Width (X) (mm): 450.0

7 Height (Y) (mm): 420.0

8 Thick (Z) (mm): 800.0

Offset

9 X: -100.0 Y: 90.0 Z: 0.0

[TYPE] UNDO >

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable the user model elements of the displayed No.
5	Shape	"Box"	Configure so that the shape of a user model element is line segment.
6	Width (X) (mm)	X: "450.0"	Set the Width of the box element.
7	Height (Y) (mm)	Y: "420.0"	Set the Height of the box element.
8	Thick (Z) (mm)	Z: "800.0"	Set the Thick of the box element.
9	Offset	X: "-100.0" Y: "90.0" Z: "0.0"	Set the position at the center of Width(X) and Height(Y) on the plane of Thick(Z)=0.

7. Press the [Prev] key 2 times to display User model list. Select other item and perform following setting in User Element Detail (Box) menu.

Busy Step Hold Pause
 Run Gun Weld I/O PICK LINE 0 AUTO ABORTED JOINT 100%

DCS ^ i

User model detail(Box) 1/10

No. 2 [*****]

Element: 1 Status: OK

1 Enable/Disable: ENABLE
 2 Link No. (99:FacePlate): 99
 3 Link type: NORMAL
 4 Tool frame: 0
 5 Shape: Box
 6 Width (X) (mm): 750.0
 7 Height (Y) (mm): 600.0
 8 Thick (Z) (mm): 1400.0
 Offset
 9 X: -50.0 Y: 100.0 Z: -200.0

[TYPE] UNDO >

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable the user model elements of the displayed No.
5	Shape	"Box"	Configure so that the shape of a user model element is line segment.
6	Width (X) (mm)	X: "750.0"	Set the Width of the box element.
7	Height (Y) (mm)	Y: "600.0"	Set the Height of the box element.
8	Thick (Z) (mm)	Z: "1400.0"	Set the Thick of the box element.
9	Offset	X: "-50.0" Y: "100.0" Z: "-200.0"	Set the position at the center of Width(X) and Height(Y) on the plane of Thick(Z)=0.

8. Press the [Prev] key 3 times to DCS top menu. Select Tool frame.

Busy Step Hold Pause
 Run Gun Weld I/O PICK LINE 0 AUTO ABORTED JOINT 100%

DCS ^ i

Tool frame 1/17

Group: 1 Status

Tool select: 0 OK

(0:FacePlate,-1:Tool change)

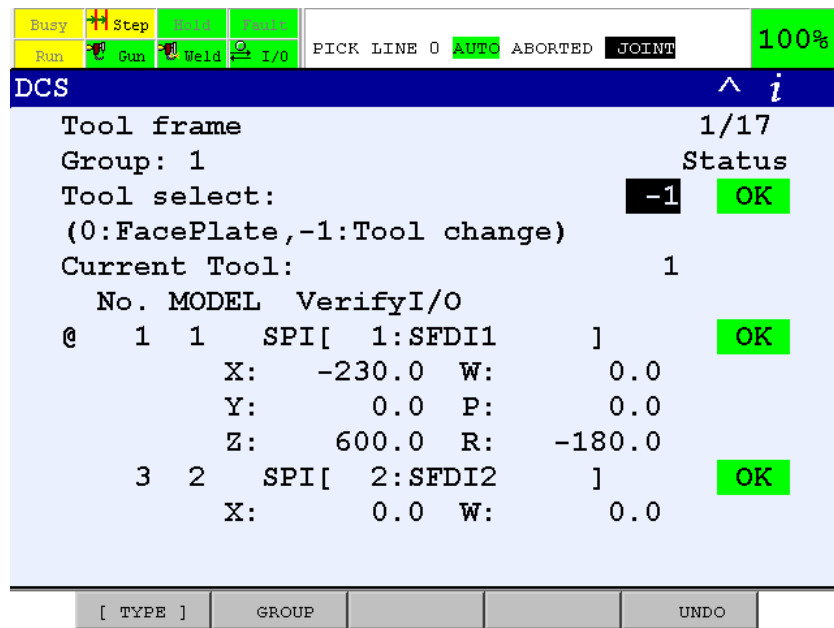
Current Tool: 0

No. MODEL VerifyI/O

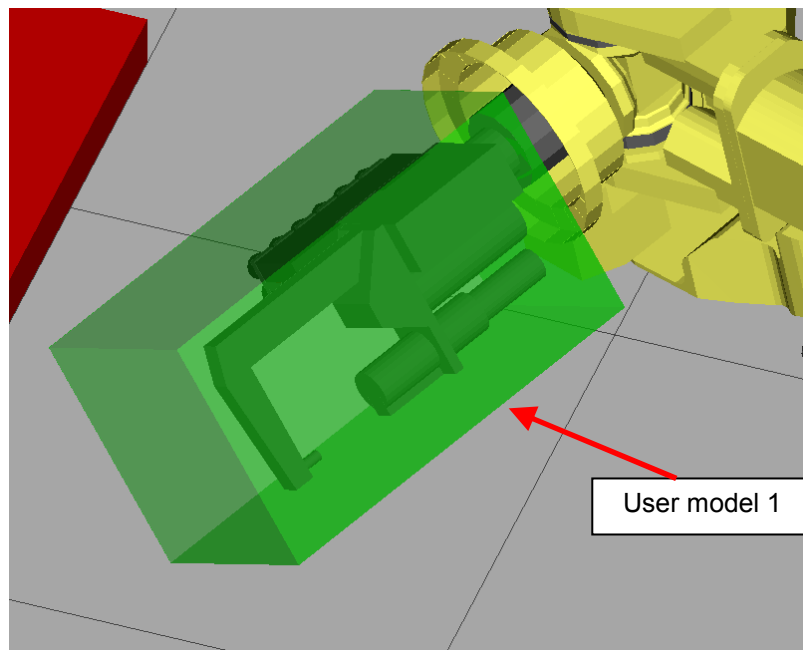
0 0 ---[0:] OK
 X: 0.0 W: 0.0
 Y: 0.0 P: 0.0
 Z: 0.0 R: 0.0
 0 0 ---[0:] OK
 X: 0.0 W: 0.0

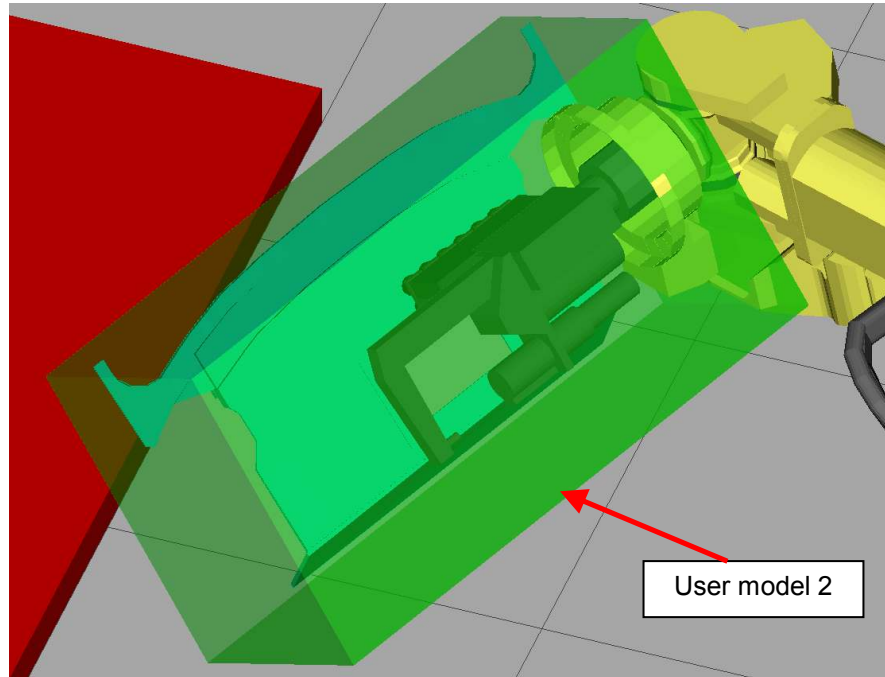
[TYPE] GROUP UNDO

8. Perform following settings in Tool frame menu



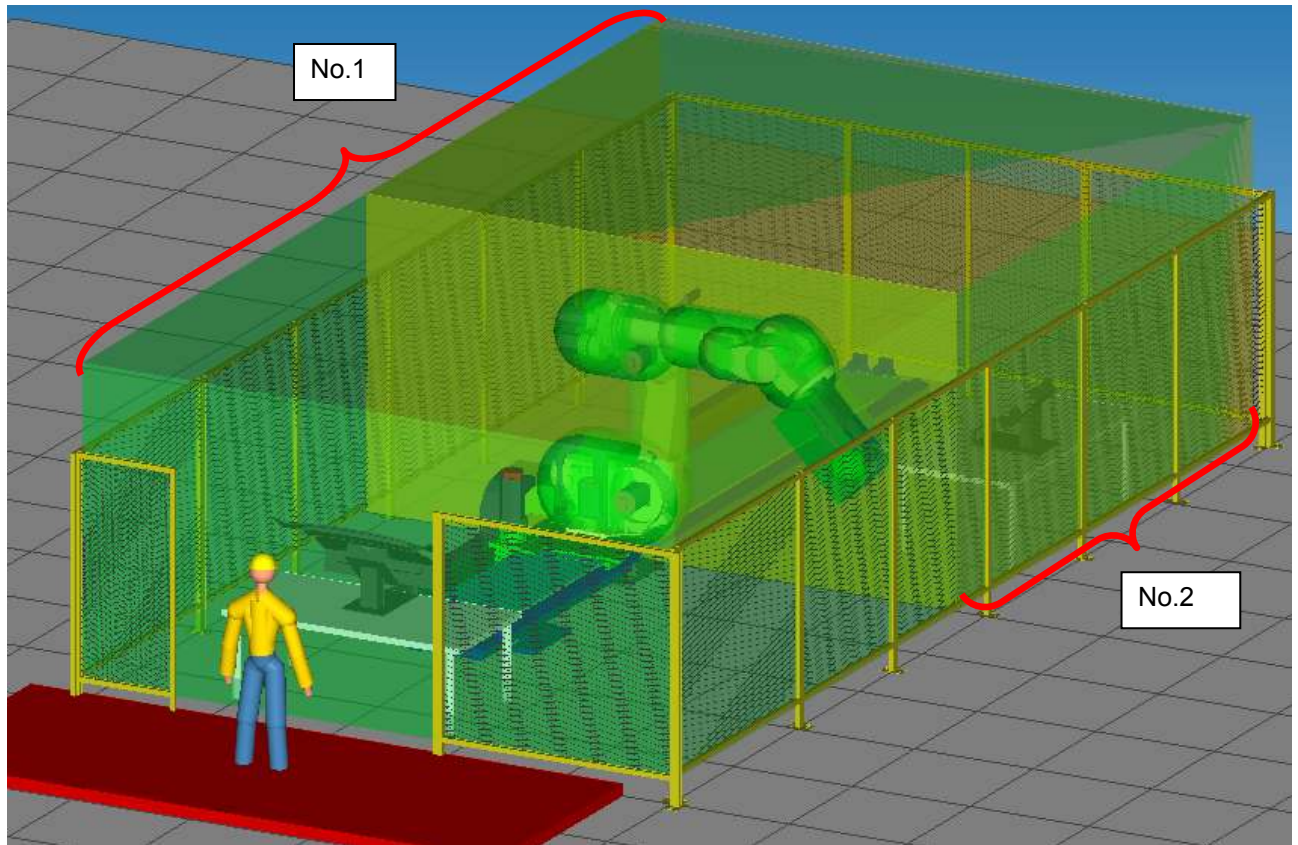
DCS check can now be added to a tool and a work.





5.3 SETUP OF CARTESIAN POSITION CHECK

In Cartesian Position Check setup, set up 2 zones of No. 1, No. 2, .

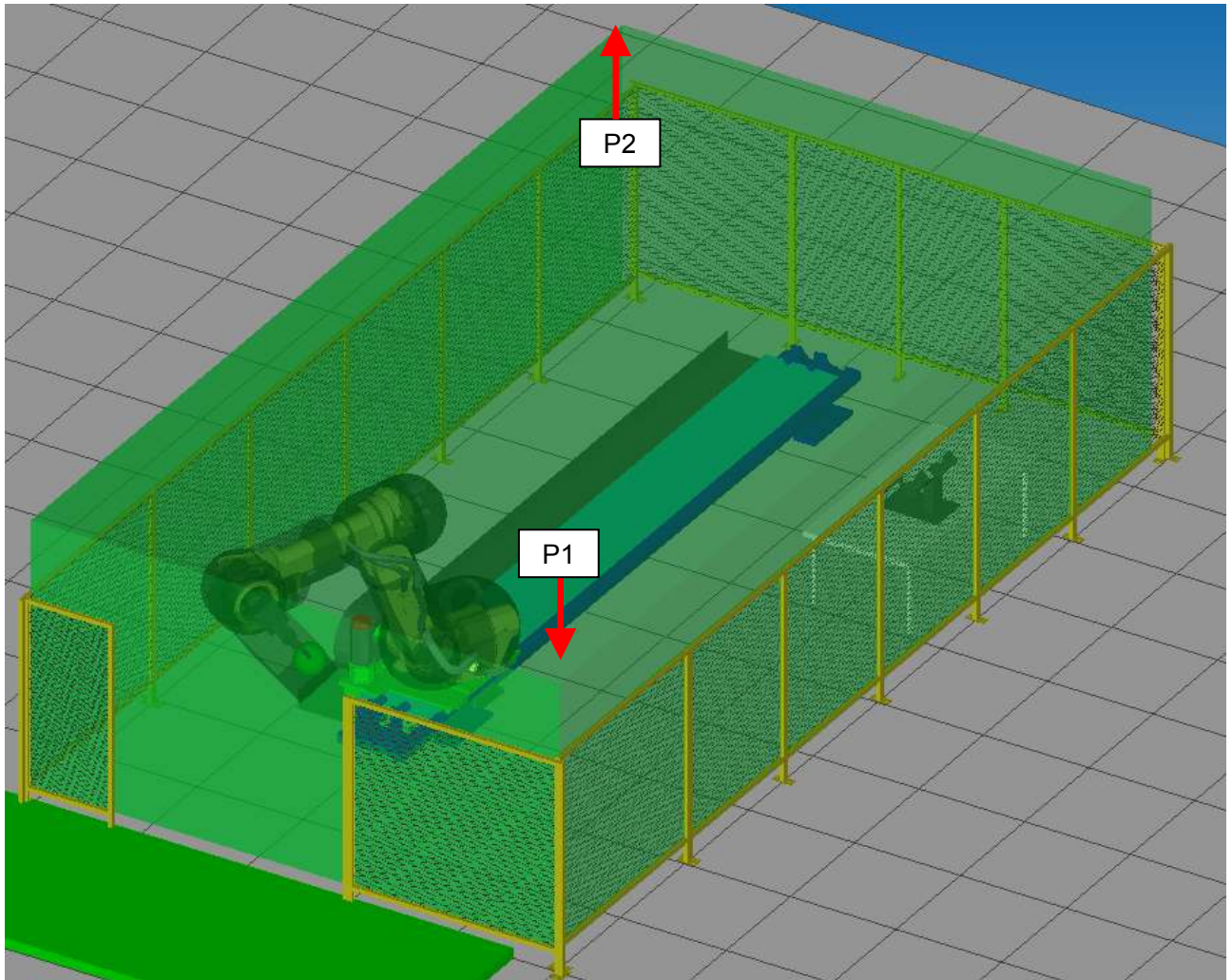


Type	Setting
No.1	A zone that surrounds the whole workspace of the robot. Always active. Disabling input is not set.
No.2	A zone that is enabled when an operator is on the safe mat. In this zone is enabled, if the robot goes out of the zone, Speed Check Function become to enable. SPI [3], which shows the status of the safe mat, is set to the disabling input.

5.3.1 Setup of No.1 Zone

This section describes the setup method for No.1 zone.

No.1 zone is always active, so disabling input is not set. An alarm occurs if the robot exits the zone when there is no operator on a safe mat.



1. Select "Cart. position check" in DCS screen and press the [Enter] key to display Cartesian Position Check menu.

Busy	Stop	Hold	Pause	PROG1 LINE 0	AUTO	ABORTED	JOINT	100%
Run	I/O	Prod	Stop					
DCS								
Cartesian position check								1/32
Process time factor (Max.1000):								0
No.	G	M	Status	Comment				
1	DISABL	1	DI	----	[
2	DISABL	1	DI	----	[
3	DISABL	1	DI	----	[
4	DISABL	1	DI	----	[
5	DISABL	1	DI	----	[
6	DISABL	1	DI	----	[
7	DISABL	1	DI	----	[
8	DISABL	1	DI	----	[
9	DISABL	1	DI	----	[

2. Select any "No." and press the [Enter] key to display Cartesian Position Check detail menu.

Busy	Stop	Hold	Pause	PROG1 LINE 0 T2 ABORTED TOOL			100%	
Run	Weld	Estab	Stop					
DCS								i
Cartesian position check								1/14
No. 1		Status:----						
1	Comment: [*****]							
2	Enable/Disable:						DISABLE	
3	Method: Working zone (Diagonal)							
4	Group:						1	
5	Target model 1:						Robot model	
6	Target model 2:						DISABLE	
7	Target model 3:						DISABLE	
8	User frame:						0	
Position (mm):								
Current		Point 1		Point 2				
[TYPE]		PREV	NEXT	RECORD	UNDO	>		

3. Perform the following settings in Cartesian Position Check detail menu.

Busy	Step	Hold	Safe	PICK LINE 0	AUTO	ABORTED	JOINT	100%
Run	Gun	Weld	I/O					

DCS ^ i

Cartesian position check 1/14

No. 1 Status: **SAFE**

1 Comment: [*****]

2 Enable/Disable: **ENABLE**

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: Tool change

7 Target model 3: DISABLE

8 User frame: 0

Position (mm) :

	Current	Point 1	Point 2
9 X	-24.6	3000.0	-2000.0
10 Y	-2111.3	-3200.0	6000.0
11 Z	751.2	-500.0	2000.0

12 Stop type: Power-Off stop

13 Speed check: <DETAIL>

14 Disabling input: ---[0:]

[TYPE]	PREV	NEXT	[CHOICE]	UNDO	>
----------	------	------	------------	------	---

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable Cartesian Position Check for the displayed No.
3	Method	"Working zone (Diagonal)"	The Safe zone is defined as the upper and lower limits of X, Y and Z
6	Target model 2	"Tool change"	Specify the set tool model to be the target for Cartesian Position Check.
9	X	Point1: "3000.0" Point2: "-2000.0"	Specify the X-Y coordinates of vertex P1.
10	Y	Point1: "-3200.0" Point2: "6000.0"	Specify the X-Y coordinates of vertex P2.
11	Z	Point1: "-500.0" Point2: "2000.0"	Specify the upper and lower .
20	Stop type	"Power-Off stop"	Specify "Power-off stop", to immediately shut down the motor power.

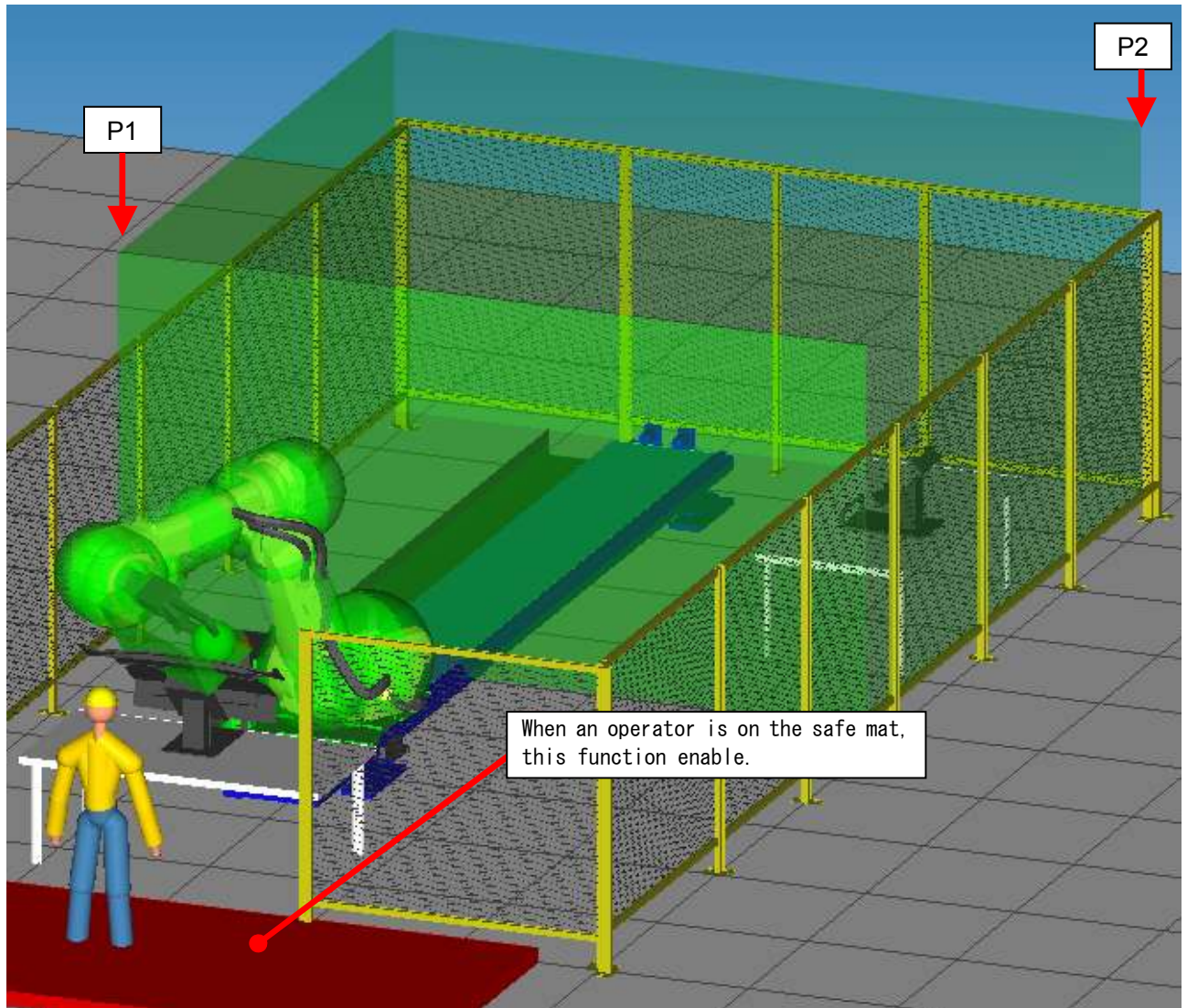
4. Press the [Prev] key 3 times to display DCS top menu.

Setup of No.1 zone is now complete.

5.3.2 Setup of No.2 Zone

This section describes the setup method for No.2 zone.

SPI [1], which shows the status of the safe mat, is set to the disabling input. When there is no operator on the safe mat, SPI [1] is ON and this zone is disabled. When there is no operator on the left safe mat, this zone is enabled. When the robot is about to exit this zone, it stops.



1. Select "Cart. position check" in DCS screen and press the [Enter] key to display Cartesian Position Check menu.

Busy	Stop	Hold	Reset	PROG1 LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Etab	Down					

DCS i

Cartesian position check 2/32

Process time factor (Max.1000): 31

No.	G	M	Status	Comment
1	ENABLE	1	WL	SAFE []
2	DISABL	1	WD	---- []
3	DISABL	1	WD	---- []
4	DISABL	1	WD	---- []
5	DISABL	1	WD	---- []
6	DISABL	1	WD	---- []
7	DISABL	1	WD	---- []
8	DISABL	1	WD	---- []
9	DISABL	1	WD	---- []

[TYPE] DETAIL >

2. Select any "No." and press the [Enter] key to display Cartesian Position Check detail menu.

Busy	Stop	Hold	Reset	PROG1 LINE 0	AUTO	ABORTED	TOOL	100%
Run	Weld	Etab	Down					

DCS i

Cartesian position check 1/14

No. 2 Status:----

1 Comment: [*****]

2 Enable/Disable: DISABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: DISABLE

7 Target model 3: DISABLE

8 User frame: 0

Position (mm):

Current	Point 1	Point 2

[TYPE] PREV NEXT RECORD UNDO >

3. Perform the following settings in Cartesian Position Check detail menu.

Busy	Step	Hold	Pause	PICK LINE 0	AUTO	ABORTED	JOINT	100%
Run	Gun	Weld	I/O					

DCS ^ i

Cartesian position check 1/14

No. 2 Status: DSBL

1 Comment: [*****]

2 Enable/Disable: ENABLE

3 Method: Working zone (Diagonal)

4 Group: 1

5 Target model 1: Robot model

6 Target model 2: Tool change

7 Target model 3: DISABLE

8 User frame: 0

Position (mm) :

	Current	Point 1	Point 2
9 X	-24.6	-2000.0	3000.0
10 Y	-2111.3	1300.0	6000.0
11 Z	751.2	-500.0	2000.0

12 Stop type: Speed check (P)

13 Speed check: <DETAIL>

14 Disabling input: SPI[3:SFDI3]

[TYPE]	PREV	NEXT	[CHOICE]	UNDO	>
----------	------	------	----------	------	---

No.	Item	Setting	Description
1	Enable/Disable	"ENABLE"	Enable Cartesian Position Check for the displayed No.
3	Method	"Working zone (Diagonal)"	The Safe zone is defined as the upper and lower limits of X, Y and Z
6	Target model 2	"Tool change"	Specify the set tool model to be the target for Cartesian Position Check.
9	X	Point1: "3000.0" Point2: "-2000.0"	Specify both ends of the x coordinates
10	Y	Point1: "-3200.0" Point2: "6000.0"	Specify both ends of the Y coordinates.
11	Z	Point1: "-500.0" Point2: "2000.0"	Specify both ends of the Z coordinates
12	Stop type	"Speed check (P)"	Out of zone, If current speed exceeds the speed limit, robot motor power immediately shuts down and the robot stops.
13	Disabling input	"SPI[3]"	There is no operator on safe mat, this function disable.

4. Select any "No." and press the [Enter] key to display Speed Check detail menu.

Busy	Step	Hold	Reset	PICK LINE 0	AUTO	ABORTED	JOINT	100%
Run	Gun	Weld	I/O					

DCS ^ i

Speed check detail 1/6

No. 2 Status: **CHGD**

1 Speed control: **DISABLE**

Limit (mm/s) / DSBL input / OVR Lim

2 Limit 1: 250.0 / ---[0] / 100 %

3 Limit 2: 250.0 / ---[0] / 100 %

4 Limit 3: 250.0 / ---[0] / 100 %

5 Limit 4: 250.0 / ---[0] / 100 %

6 Delay time: 0 msec

[TYPE] [CHOICE] UNDO

5. Perform the following setting In Speed check detail menu

Busy	Step	Hold	Reset	PICK LINE 0	AUTO	ABORTED	JOINT	100%
Run	Gun	Weld	I/O					

DCS ^ i

Speed check detail 1/6

No. 2 Status: **DSBL**

1 Speed control: **OVERVERRIDE**

Limit (mm/s) / DSBL input / OVR Lim

2 Limit 1: 50.0 / SPI[4] / 5 %

3 Limit 2: 100.0 / SPI[5] / 10 %

4 Limit 3: 150.0 / SPI[6] / 15 %

5 Limit 4: 250.0 / ---[0] / 25 %

6 Delay time: 1000 msec

[TYPE] [CHOICE] UNDO

No.	Item	Setting	Description
1	Speed control	"OVERVERRIDE"	When there is an operator is on the safe mat and when the robot and models left the zone of No.2, the robot slowdown to ensure safety of an operator.
2	Limit 1	Limit (mm/s) : "50 " DSBL : SPI[4] OVERVERRIDE : "5%"	When SPI[4] is OFF, OVERVERRIDE is lower than 5% and if current speed exceeds 50mm/s, robot motor power immediately shuts down and the robot stops.
3	Limit2	Limit (mm/s) : "100 " DSBL : SPI[5] OVERVERRIDE : "10%"	When SPI[5] is OFF, OVERVERRIDE is lower than 10% and if current speed exceeds 100mm/s, robot motor power immediately shuts down and the robot stops.
4	Limit3	Limit (mm/s) : "150 " DSBL : SPI[4] OVERVERRIDE : "15%"	When SPI[6] is OFF, OVERVERRIDE is lower than 15% and if current speed exceeds 150mm/s, robot motor power immediately shuts down and the robot stops.

No.	Item	Setting	Description
5	Limit 4	Limit (mm/s) : "250 " DSBL : ---[0] OVERRIDE : "25%"	OVERRIDE is lower than 25% and if current speed exceeds 250mm/s, robot motor power immediately shuts down and the robot stops.
6	Delay time	1000msec	The robot does not stop for 1000 msec after speed check become "ENABLE"

Setup of No.2 zone is now complete.

6. Press the [Prev] key 3 times to display DCS top menu.

Setup of No.3 zone is now complete.

Perform an apply operation after setup for zones No.1 to No.3 is complete.

Please refer to "1.4.1 Operation to apply to DCS parameters" in chapter 1 for the applying operation.

REVISION RECORD

Edition	Date	Contents
01	Jun, 2016	