

# **FANUC** Robot **series**

## **R-30*i*A/R-30*i*A Mate CONTROLLER Dual Check Safety Function OPERATOR'S MANUAL**

MAROCDCSO09071E REV. A

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## Conventions

This manual includes information essential to the safety of personnel, equipment, software, and data. This information is indicated by headings and boxes in the text.



### **WARNING**

Information appearing under **WARNING** concerns the protection of personnel. It is boxed and in bold type to set it apart from other text.



### **CAUTION**

Information appearing under **CAUTION** concerns the protection of equipment, software, and data. It is boxed to set it apart from other text.

**NOTE** Information appearing next to **NOTE** concerns related information or useful hints.

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

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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".



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# Safety

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FANUC Robotics is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace.

The appropriate level of safety for your application and installation can best be determined by safety system professionals. FANUC Robotics therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC Robotic systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

FANUC Robotics therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics training course and become familiar with the proper operation of the system. Persons responsible for programming the system-including the design, implementation, and debugging of application programs-must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

## CONSIDERING SAFETY FOR YOUR ROBOT INSTALLATION

Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:

- The safety of people and equipment
- Use of safety enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)
- Techniques for safe automatic operation of the robot(s)
- Regular scheduled inspection of the robot and workcell
- Proper maintenance of the robot

### Keeping People and Equipment Safe

The safety of people is always of primary importance in any situation. However, equipment must be kept safe, too. When prioritizing how to apply safety to your robotic system, consider the following:

- People
- External devices
- Robot(s)
- Tooling
- Workpiece

### Using Safety Enhancing Devices

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

### Setting Up a Safe Workcell

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and **not** replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC Robotics training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti-tie-down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.

- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum motion range of the robot, including any tooling attached to the wrist flange that extend this range.
- Position all controllers outside the robot work envelope.
- Never rely on software or firmware based controllers as the primary safety element unless they comply with applicable current robot safety standards.
- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell.
- Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end-use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.
- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro-magnetic interference (EMI), radio frequency interference (RFI), and electro-static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate *pinch points* . Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

### Staying Safe While Teaching or Manually Operating the Robot

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.
- Before teaching, visually inspect the robot and *work envelope* to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- FANUC Robotics recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in teach mode. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.



#### Warning

**Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.**

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:



#### Warning

**Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.**

- Using a low motion speed, single step the program for at least one full cycle.
- Using a low motion speed, test run the program continuously for at least one full cycle.
- Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

## Staying Safe During Automatic Operation

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.
- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.
- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

## Staying Safe During Inspection

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

### Staying Safe During Maintenance

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3-phase power source at the controller.
- Be aware that an applicator bell cup can continue to spin at a very high speed even if the robot is idle. Use protective gloves or disable bearing air and turbine air before servicing these items.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.



#### Warning

**Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock. HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the disconnect or circuit breaker to the OFF position removes power from the output side of the device only.**

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.

- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.
- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.

**Warning**

**Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.**

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

## **KEEPING MACHINE TOOLS AND EXTERNAL DEVICES SAFE**

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices.

### **Programming Safety Precautions**

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back-check limit switches in the workcell to make sure they do not fail.
- Implement “failure routines” in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use *handshaking* protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

### Mechanical Safety Precautions

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use software limits, limit switches, and mechanical hardstops to prevent undesired movement of the robot into the work area of machine tools and external devices.

## KEEPING THE ROBOT SAFE

Observe the following operating and programming guidelines to prevent damage to the robot.

### Operating Safety Precautions

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

### Programming Safety Precautions

The following safety measures are designed to prevent damage to the robot during programming:

- Establish *interference zones* to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

**Note** Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.



## **ADDITIONAL SAFETY CONSIDERATIONS FOR PAINT ROBOT INSTALLATIONS**

Process technicians are sometimes required to enter the paint booth, for example, during daily or routine calibration or while teaching new paths to a robot. Maintenance personnel also must work inside the paint booth periodically.

Whenever personnel are working inside the paint booth, ventilation equipment must be used. Instruction on the proper use of ventilating equipment usually is provided by the paint shop supervisor.

Although paint booth hazards have been minimized, potential dangers still exist. Therefore, today's highly automated paint booth requires that process and maintenance personnel have full awareness of the system and its capabilities. They must understand the interaction that occurs between the vehicle moving along the conveyor and the robot(s), hood/deck and door opening devices, and high-voltage electrostatic tools.

Paint robots are operated in three modes:

- Teach or manual mode
- Automatic mode, including automatic and exercise operation
- Diagnostic mode

During both teach and automatic modes, the robots in the paint booth will follow a predetermined pattern of movements. In teach mode, the process technician teaches (programs) paint paths using the teach pendant.

In automatic mode, robot operation is initiated at the System Operator Console (SOC) or Manual Control Panel (MCP), if available, and can be monitored from outside the paint booth. All personnel must remain outside of the booth or in a designated safe area within the booth whenever automatic mode is initiated at the SOC or MCP.

In automatic mode, the robots will execute the path movements they were taught during teach mode, but generally at production speeds.

When process and maintenance personnel run diagnostic routines that require them to remain in the paint booth, they must stay in a designated safe area.

### **Paint System Safety Features**

Process technicians and maintenance personnel must become totally familiar with the equipment and its capabilities. To minimize the risk of injury when working near robots and related equipment, personnel must comply strictly with the procedures in the manuals.

This section provides information about the safety features that are included in the paint system and also explains the way the robot interacts with other equipment in the system.

The paint system includes the following safety features:

- Most paint booths have red warning beacons that illuminate when the robots are armed and ready to paint. Your booth might have other kinds of indicators. Learn what these are.
- Some paint booths have a blue beacon that, when illuminated, indicates that the electrostatic devices are enabled. Your booth might have other kinds of indicators. Learn what these are.
- EMERGENCY STOP buttons are located on the robot controller and teach pendant. Become familiar with the locations of all E-STOP buttons.
- An intrinsically safe teach pendant is used when teaching in hazardous paint atmospheres.
- A DEADMAN switch is located on each teach pendant. When this switch is held in, and the teach pendant is on, power is applied to the robot servo system. If the engaged DEADMAN switch is released during robot operation, power is removed from the servo system, all axis brakes are applied, and the robot comes to an EMERGENCY STOP. Safety interlocks within the system might also E-STOP other robots.



### Warning

**An EMERGENCY STOP will occur if the DEADMAN switch is released on a bypassed robot.**

- Overtravel by robot axes is prevented by software limits. All of the major and minor axes are governed by software limits. Limit switches and hardstops also limit travel by the major axes.
- EMERGENCY STOP limit switches and photoelectric eyes might be part of your system. Limit switches, located on the entrance/exit doors of each booth, will EMERGENCY STOP all equipment in the booth if a door is opened while the system is operating in automatic or manual mode. For some systems, signals to these switches are inactive when the switch on the SCC is in teach mode. When present, photoelectric eyes are sometimes used to monitor unauthorized intrusion through the entrance/exit silhouette openings.
- System status is monitored by computer. Severe conditions result in automatic system shutdown.

## Staying Safe While Operating the Paint Robot

When you work in or near the paint booth, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.



### Warning

**Observe all safety rules and guidelines to avoid injury.**

**Warning**

**Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.**

**Warning**

**Enclosures shall not be opened unless the area is known to be nonhazardous or all power has been removed from devices within the enclosure. Power shall not be restored after the enclosure has been opened until all combustible dusts have been removed from the interior of the enclosure and the enclosure purged. Refer to the Purge chapter for the required purge time.**

- Know the work area of the entire paint station (workcell).
- Know the work envelope of the robot and hood/deck and door opening devices.
- Be aware of overlapping work envelopes of adjacent robots.
- Know where all red, mushroom-shaped EMERGENCY STOP buttons are located.
- Know the location and status of all switches, sensors, and/or control signals that might cause the robot, conveyor, and opening devices to move.
- Make sure that the work area near the robot is clean and free of water, oil, and debris. Report unsafe conditions to your supervisor.
- Become familiar with the complete task the robot will perform BEFORE starting automatic mode.
- Make sure all personnel are outside the paint booth before you turn on power to the robot servo system.
- Never enter the work envelope or paint booth before you turn off power to the robot servo system.
- Never enter the work envelope during automatic operation unless a safe area has been designated.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Remove all metallic objects, such as rings, watches, and belts, before entering a booth when the electrostatic devices are enabled.
- Stay out of areas where you might get trapped between a moving robot, conveyor, or opening device and another object.
- Be aware of signals and/or operations that could result in the triggering of guns or bells.
- Be aware of all safety precautions when dispensing of paint is required.
- Follow the procedures described in this manual.

### Special Precautions for Combustible Dusts (powder paint)

When the robot is used in a location where combustible dusts are found, such as the application of powder paint, the following special precautions are required to insure that there are no combustible dusts inside the robot.

- Purge maintenance air should be maintained at all times, even when the robot power is off. This will insure that dust can not enter the robot.
- A purge cycle will not remove accumulated dusts. Therefore, if the robot is exposed to dust when maintenance air is not present, it will be necessary to remove the covers and clean out any accumulated dust. Do not energize the robot until you have performed the following steps.
  1. Before covers are removed, the exterior of the robot should be cleaned to remove accumulated dust.
  2. When cleaning and removing accumulated dust, either on the outside or inside of the robot, be sure to use methods appropriate for the type of dust that exists. Usually lint free rags dampened with water are acceptable. Do not use a vacuum cleaner to remove dust as it can generate static electricity and cause an explosion unless special precautions are taken.
  3. Thoroughly clean the interior of the robot with a lint free rag to remove any accumulated dust.
  4. When the dust has been removed, the covers must be replaced immediately.
  5. Immediately after the covers are replaced, run a complete purge cycle. The robot can now be energized.

### Staying Safe While Operating Paint Application Equipment

When you work with paint application equipment, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.



#### **Warning**

**When working with electrostatic paint equipment, follow all national and local codes as well as all safety guidelines within your organization. Also reference the following standards: *NFPA 33 Standards for Spray Application Using Flammable or Combustible Materials* , and *NFPA 70 National Electrical Code* .**

- **Grounding** : All electrically conductive objects in the spray area must be grounded. This includes the spray booth, robots, conveyors, workstations, part carriers, hooks, paint pressure pots, as well as solvent containers. Grounding is defined as the object or objects shall be electrically connected to ground with a resistance of not more than 1 megohms.

- **High Voltage** : High voltage should only be on during actual spray operations. Voltage should be off when the painting process is completed. Never leave high voltage on during a cap cleaning process.
- Avoid any accumulation of combustible vapors or coating matter.
- Follow all manufacturer recommended cleaning procedures.
- Make sure all interlocks are operational.
- No smoking.
- Post all warning signs regarding the electrostatic equipment and operation of electrostatic equipment according to NFPA 33 Standard for Spray Application Using Flammable or Combustible Material.
- Disable all air and paint pressure to bell.
- Verify that the lines are not under pressure.

## Staying Safe During Maintenance

When you perform maintenance on the painter system, observe the following rules, and all other maintenance safety rules that apply to all robot installations. Only qualified, trained service or maintenance personnel should perform repair work on a robot.

- Paint robots operate in a potentially explosive environment. Use caution when working with electric tools.
- When a maintenance technician is repairing or adjusting a robot, the work area is under the control of that technician. All personnel not participating in the maintenance must stay out of the area.
- For some maintenance procedures, station a second person at the control panel within reach of the EMERGENCY STOP button. This person must understand the robot and associated potential hazards.
- Be sure all covers and inspection plates are in good repair and in place.
- Always return the robot to the “home” position before you disarm it.
- Never use machine power to aid in removing any component from the robot.
- During robot operations, be aware of the robot’s movements. Excess vibration, unusual sounds, and so forth, can alert you to potential problems.
- Whenever possible, turn off the main electrical disconnect before you clean the robot.
- When using vinyl resin observe the following:
  - Wear eye protection and protective gloves during application and removal
  - Adequate ventilation is required. Overexposure could cause drowsiness or skin and eye irritation.
  - If there is contact with the skin, wash with water.

- Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.
- When using paint remover observe the following:
  - Eye protection, protective rubber gloves, boots, and apron are required during booth cleaning.
  - Adequate ventilation is required. Overexposure could cause drowsiness.
  - If there is contact with the skin or eyes, rinse with water for at least 15 minutes. Then, seek medical attention as soon as possible.
  - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.

# **I. SAFETY PRECAUTIONS**





# 1

## SAFETY PRECAUTIONS

---

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.

## 1.1 OPERATOR SAFETY

---

Operator 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 operator safety.

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

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

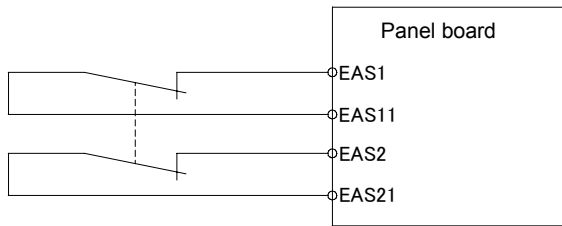
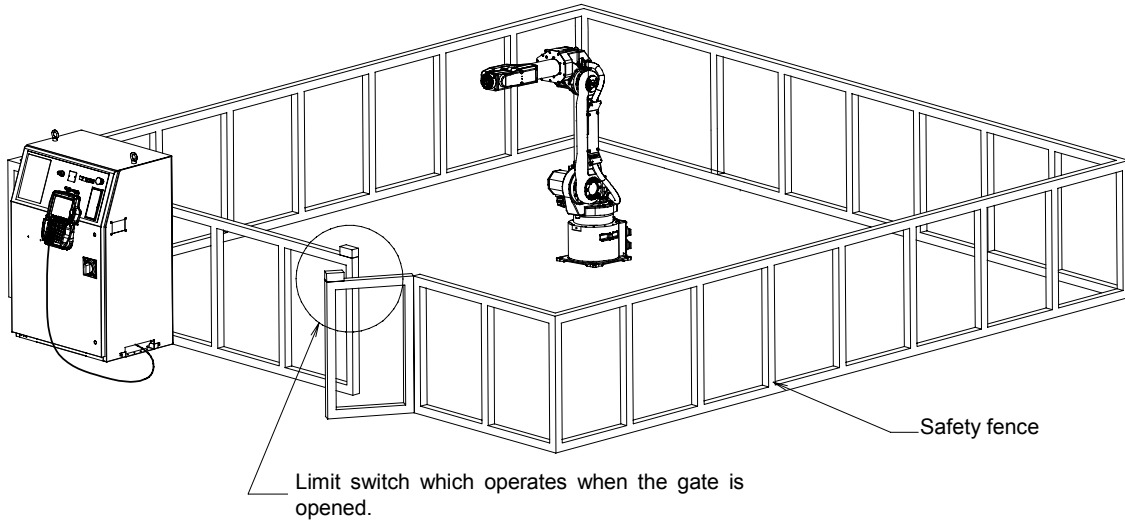
- (2) Even when the robot is stationary, it is possible that the robot is still ready to move state and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure operator safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.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

The controller is designed to receive this interlock signal. When the gate is opened and this signal received, the controller stops the robot in an emergency. For connection, see Fig.1.1.

- (4) Provide the peripheral devices with appropriate grounding (Class 1, Class 2, or Class 3).
- (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 an operator enters the work area.
- (8) If necessary, install a safety lock so that no one except the operator 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.



Note) In R-30iA controller,  
Terminals EAS1, 11 and EAS2, 21 are on the PC board on the operator's panel.  
Refer to the R-30iA CONTROLLER MAINTENANCE MANUAL

In R-30iA Mate controller,  
Terminals EAS1, 11 and EAS2, 21 are on the PC board in the E-stop unit.  
Refer to the R-30iA MATE CONTROLLER MAINTENANCE MANUAL

**Fig.1.1 Safety Fence and Safety**

## 1.1.1 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 it is not necessary for the robot to operate, 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 the work area.
- (3) Install a safety fence with a safety gate to prevent any worker other than the operator from entering the work area unexpectedly and also 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 when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

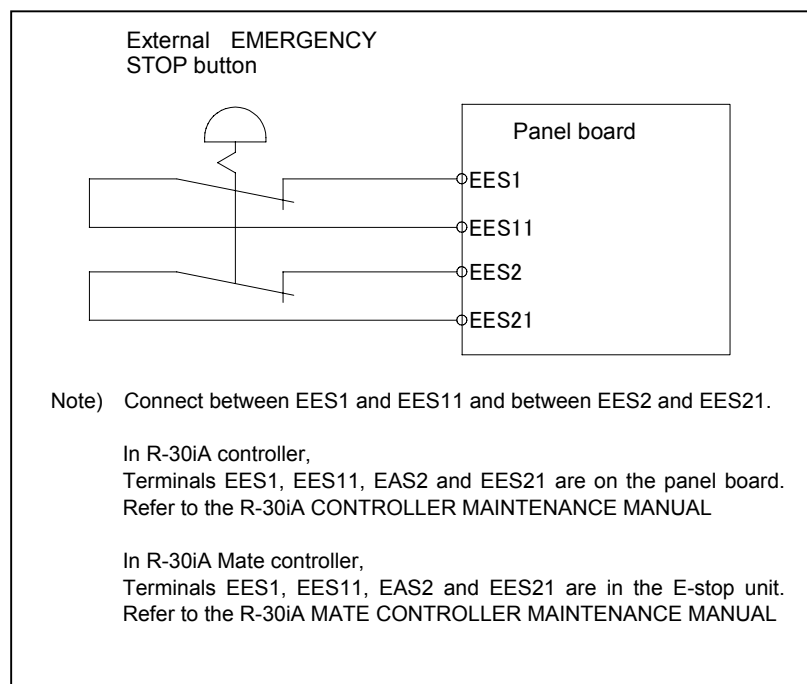


Fig.1.1.1 Connection Diagram for External Emergency Stop Switch

## 1.1.2 Safety of the Teach Pendant Operator

While teaching the robot, it is necessary for the operator to enter the work area of the robot. It is particularly necessary to ensure the safety of the teach pendant operator.

- (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) When entering the robot work area and teaching the robot, be sure to check the location and condition of the safety devices (such as the EMERGENCY STOP button and the deadman's switch on the teach pendant).

The teach pendant supplied by FANUC is provided with a teach pendant enable switch and a deadman's switch in addition to the EMERGENCY STOP button. The functions of each switch are as follows.

EMERGENCY STOP button : Pressing this button stops the robot in an emergency, irrespective to the condition of the teach pendant enable switch.

Deadman's switch : The function depends on the state of the teach pendant enable switch.

When the enable switch is on - Releasing the finger from the dead man's switch stops the robot in an emergency.

When the enable switch is off - The deadman's switch is ineffective

#### NOTE

The deadman's switch is provided so that the robot operation can be stopped simply by releasing finger from the teach pendant in case of emergency.

- (4) The teach pendant operator should pay careful attention so that no other workers enter the robot work area.

#### NOTE

In addition to the above, the teach pendant enable switch and the deadman's switch also have the following function. By pressing the deadman's switch while the enable switch is on, the emergency stop factor (normally the safety gate) connected to the controller is invalidated. In this case, it is possible for an operator to enter the fence during teach operation without pressing the EMERGENCY STOP button. In other words, the system understands that the combined operations of pressing the teach pendant enable switch and pressing the deadman's switch indicates the start of teaching.

The teach pendant operator should be well aware that the safety gate is not functional under this condition and bear full responsibility to ensure that no one enters the fence during teaching.

- (5) When entering the robot work area, the teach pendant operator should enable the teach pendant whenever he or she enters the robot work area. In particular, while the teach pendant enable switch is off, make certain that no start command is sent to the robot from any operator's panel other than the teach pendant.

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 ON/OFF switch on the Teach pendant and the three modes switch on the Operator's panel and Remote condition on the software.

Operator 's panel Three modes switch	Teach pendant ON/OFF switch	Software remote condition	Teach pendant	Operator's panel	Peripheral devices
T1/T2	On	Independent	Allowed to start	Not allowed	Not allowed
AUTO	Off	Remote OFF	Not allowed	Allowed to start	Not allowed
AUTO	Off	Remote ON	Not allowed	Not allowed	Allowed to start

- (6) To start the system using the operator's box, make certain that nobody is in 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 run 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 run 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.

### 1.1.3 Safety During Maintenance

---

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

- (1) Except when specifically necessary, turn off the power of the controller while carrying out maintenance. Lock the power switch, if necessary, so that no other person can turn it on.
- (2) When disconnecting the pneumatic system, be sure to reduce the supply pressure.
- (3) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.
- (4) If it is necessary to enter the robot work area for maintenance when the power is turned on, the worker should indicate that the machine is being serviced and make certain that no one starts the robot unexpectedly.
- (5) Do not operate the robot in the automatic mode while anybody is in the robot work area.
- (6) When it is necessary to maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.
- (7) 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.
- (8) If necessary, have a worker who is familiar with the robot system stand beside the operator's 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.
- (9) When replacing or reinstalling components, take care to prevent foreign matter from entering the system.
- (10) When handling each unit or printed circuit board in the controller during inspection, turn off the power of the controller and also turn off the circuit breaker to protect against electric shock.
- (11) When replacing parts, be sure to use those specified by FANUC. In particular, never use fuses or other parts of non-specified ratings. They may cause a fire or result in damage to the components in the controller.

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## **1.2 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES**

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### **1.2.1 Precautions in Programming**

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- (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.

### **1.2.2 Precautions for Mechanism**

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- (1) Keep the component cells of the robot system clean, and operate the robot in an environment free of grease, water, and dust.
- (2) Employ a limit switch or mechanical stopper to limit the robot motion so that the robot does not come into contact with its peripheral devices or tools.



## **1.3 SAFETY OF THE ROBOT MECHANISM**

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### **1.3.1 Precautions in Operation**

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- (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.

### **1.3.2 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.

### **1.3.3 Precautions for Mechanisms**

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

## **1.4 SAFETY OF THE END EFFECTOR**

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### **1.4.1 Precautions in Programming**

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- (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.
- (3) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

## **1.5 SAFETY IN MAINTENANCE**

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- (1) Never enter the robot work area while the robot is operating. Turn off the power before entering the robot work area for inspection and maintenance.
- (2) If it is necessary to enter the robot work area with the power turned on, first press the EMERGENCY STOP button on the operator's box.
- (3) When replacing or reinstalling components, take care to prevent foreign matter from entering the system. When replacing the parts in the pneumatic system, be sure to reduce the pressure in the piping to zero by turning the pressure control on the air regulator.
- (4) When handling each unit or printed circuit board in the controller during inspection, turn off the power of the controller and turn off the circuit breaker to protect against electric shock.
- (5) When replacing parts, be sure to use those specified by FANUC. In particular, never use fuses or other parts of non-specified ratings. They may cause a fire or result in damage to the components in the controller.
- (6) Before restarting the robot, be sure to check that no one is in the robot work area and that the robot and its peripheral devices are all in the normal operating state.

## 1.6 WARNING LABEL

### (1) Greasing and degreasing label

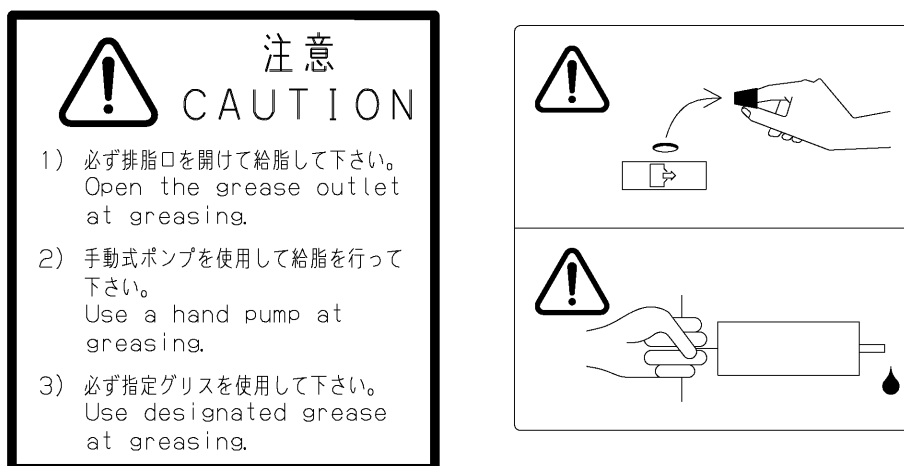


Fig. 1.6 (a) Greasing and Degreasing Label

### Description

When greasing and degreasing, observe the instructions indicated on this label.

- 1) When greasing, be sure to keep the grease outlet open.
- 2) Use a manual pump to grease.
- 3) Be sure to use a specified grease.

## (2) Step-on prohibitive label

**Fig. 1.6 (b) Step-on Prohibitive Label****Description**

Do not step on or climb the robot or controller as it may adversely affect the robot or controller and you may get hurt if you lose your footing as well.

## (3) High-temperature warning label

**Fig. 1.6 (c) High-temperature warning label****Description**

Be cautious about a section where this label is affixed, as the section generates heat. If you have to inevitably touch such a section when it is hot, use a protective provision such as heat-resistant gloves.

# 1

## OVERVIEW

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## 1.1 OVERVIEW

Dual Check Safety (DCS) checks 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 by two independent channels. Safety data and processes are cross-checked by the two CPUs. Self-diagnosis of safety hardware and software is executed periodically to prevent potential failure accumulation.

Dual Check Safety does not need additional external sensors to monitor speed and position. Only the built-in servo motor sensors are used for this function. (To use the OPSFTY safety inputs, external electrical circuits are required.)

Dual Check Safety consists of six safety functions as follows:

- Emergency Stop Control
- T1 Mode Speed Check
- Joint Position Check
- Joint Speed Check
- Cartesian Position Check
- Cartesian Speed Check

The motor power is shut down when the safety function detects errors such as inconsistency of position or speed data when cross-checked between the two CPUs.

These functions, except Emergency Stop Control, are collectively called Position/Speed Check. To use Position/Speed Check, the DCS Position/Speed Check software option is needed.

Emergency Stop Control is certified to meet the requirements of Control Reliability (ASNI/RIA R15.06) and category 4 in European Standard EN954-1 by a recognized notified body.

Position/ Speed Check is certified to meet the requirements of category 3 in European Standard EN954-1 by a notified body.

### **WARNING**

When Position/Speed Check is used, adequate risk assessment for the whole robot system is necessary to verify that a Category 3 safety function is adequate.

## 1.2 SAFETY FUNCTIONS

Dual Check Safety provides the following safety functions.

**Safety functions**

Safety function	Standard / Option	EN954-1 Category	Description
Emergency Stop Control	Standard	Category 4	This function shuts down motor power depending on the condition of: the operator panel emergency stop, teach pendant emergency stop, external emergency stop, safety fence, DEADMAN switch, SVOFF input, servo disconnect input, NTED input, and 3 mode switch. This function is integrated as a standard feature, and is not described in this document.
T1 Mode Speed Check	Option	Category 3	This function checks whether the speed of the tool center point (TCP) or the center of the wrist flange exceeds 250mm/sec in T1 mode. When either of these exceeds this speed, the function shuts down motor power. This function is always active when position/speed process is enabled.
Joint Position Check	Option	Category 3	This function checks whether the joint position is inside or outside of a specified zone. When the joint position is not in a safe zone, the function shuts down motor power. This function can be enabled / disabled for each axis using the safety input signals OPSFTY1-4 (*1).
Joint Speed Check	Option	Category 3	This function checks whether the joint speed exceeds a specified speed limit. When the joint speed exceeds the speed limit, the function shuts down motor power. This function can be enabled / disabled for each axis using the safety input signals OPSFTY1-4 (*1).
Cartesian Position Check	Option	Category 3	This function checks whether the TCP position is inside or outside a specified Cartesian safety zone. When the TCP position is not in a safe zone, the function shuts down motor power. This function can be enabled / disabled for each motion group using the safety input signals OPSFTY1-4 (*1).
Cartesian Speed Check	Option	Category 3	This function checks whether the TCP speed exceeds a specified speed limit. When the TCP speed exceeds the speed limit, the function shuts down motor power. This function can be enabled / disabled for each motion group using the safety input signals OPSFTY1-4 (*1).

\*1 R-30iA Mate controller does not have safety input signals OPSFTY.

## 1.3 T1 MODE SPEED CHECK FUNCTION

The standard Robot control software limits the TCP speed and the wrist flange center speed not to exceed 250 mm/sec.

In addition to this speed control by the standard robot control software, Dual Check Safety shuts down the motion power in case the TCP speed or the wrist flange center speed exceeds 250 mm/sec.

### T1 mode speed check alarm

When the TCP speed exceeds 250mm/sec in T1 mode, the following alarm occurs:

- SRVO-340 DCS T1 TCP speed

When the wrist flange center speed exceeds 250mm/sec in T1 mode, the following alarm occurs:

- SRVO-341 DCS T1 flange speed

### Setup T1 mode speed check

T1 Mode Speed Check is always enabled when Position/ Speed process is enabled. This function is always disabled when Position/ Speed process is disabled.

Position/ Speed process is disabled by default. (Refer to Section 3.5 DCS TOP MENU.)

### DCS TCP

In Dual Check Safety, the TCP speed is calculated by using the DCS TCP (Refer to Section 3.6 DCS TCP MENU), which is different from a standard TCP. To use T1 mode speed check, the DCS TCP must be set correctly.

The standard Robot control software limits the ordinary TCP speed and the wrist flange center speed not to exceed 250 mm/sec. However, it does not limit the DCS TCP speed. When the DCS TCP is different from the ordinary TCP, especially if the DCS TCP is longer than the ordinary TCP, the T1 mode speed check alarm can occur. In this case, decrease the override.

Refer to the application-specific *Setup and Operations Manual* for information on setting up a standard TCP or *tool frame*.

### Warning for TCP setup

#### **WARNING**

Set the most distant point of the end-effector from the wrist flange center as the DCS TCP. If not, a point on the end-effector more distant from the wrist flange center than the DCS TCP might exceed 250 mm/sec



**⚠ WARNING**

When multiple end-effectors are used, set the TCP of the largest end-effector as the DCS TCP. If the TCP of a smaller end effector is set as the DCS TCP, the TCP of a larger end-effector might exceed 250mm/sec.

**⚠ CAUTION**

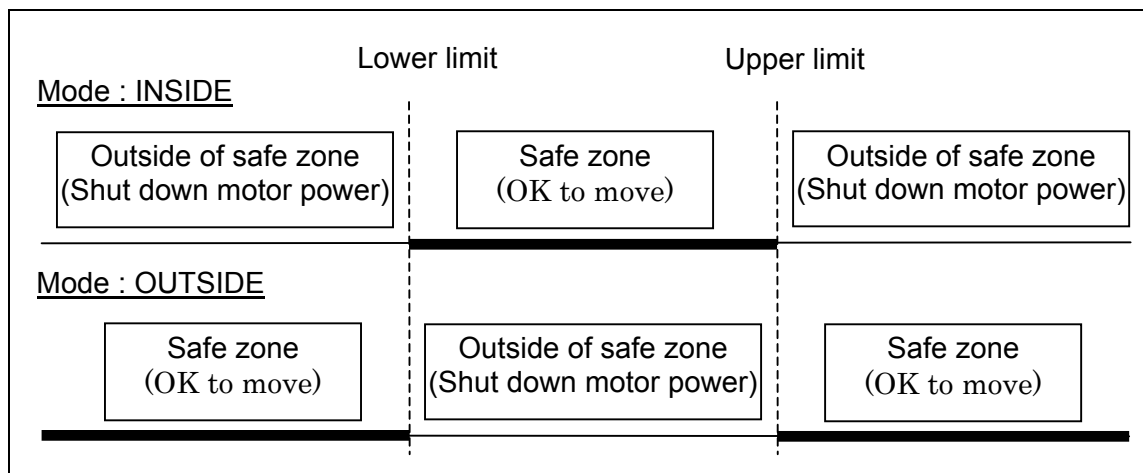
When the DCS TCP is different from the ordinary TCP, especially if the DCS TCP is longer than the ordinary TCP, the T1 mode speed check alarm can occur. In this case, decrease the override.

## 1.4 JOINT POSITION CHECK

Joint Position Check checks the Joint position of the robot and shuts down the motor power if the Joint position is outside of the safe zone.

### Setup safe zone

The safe zone is configured based on the position of the upper and lower limit. The mode setting can select whether the safe area is INSIDE or OUTSIDE of the specified zone.



- One safe zone can be defined for each axis.
- When one of the axes is out of the safe zone, "SRVO-345 DCS Joint position" alarm occurs, and motor power is shut down.
- It is possible to ENABLE / DISABLE Joint position check by using safety input signals OPSFTY1-4 for each axis. When the specified OPSFTY circuits are CLOSED, Joint position check is disabled. When they are OPEN, it is enabled.

#### **⚠ WARNING**

If Joint Position Check is set incorrectly, the safety function will not work, and serious personal injury could result. When Joint Position Check is changed, the values must be verified and the function must be tested again.

#### **⚠ CAUTION**

R-30iA Mate does not have OPSFTY inputs.

### Recover from alarm

When the robot is outside of the safe zone, the alarm cannot be cleared. To move the robot to the safe zone, press and hold the SHIFT and RESET keys, and jog the robot. If SHIFT key is released while the robot is still outside of the safe zone, or the robot moves in a direction away from the safe zone, an alarm occurs and motor power is shut down.

## DCS Joint Position Check menu

DCS			
Joint position check		GROUP:1 1/10	
Stop type:		Emergency stop	
Axis Mode	Upper	Lower	OPSFTY
1 DISABLE	0.000	0.000	deg 0
2 DISABLE	0.000	0.000	deg 0
3 DISABLE	0.000	0.000	deg 0
4 DISABLE	0.000	0.000	deg 0
5 DISABLE	0.000	0.000	deg 0
6 DISABLE	0.000	0.000	deg 0
7 DISABLE	0.000	0.000	mm 0
8 DISABLE	0.000	0.000	mm 0
9 DISABLE	0.000	0.000	mm 0

Press PREV key to exit  
[ TYPE ] GROUP [CHOICE]

## 1.5 JOINT SPEED CHECK

Joint Speed Check checks the Joint speed of the robot, and shuts down motor power if the Joint speed exceeds the specified limit.

### Setup speed limit

- One speed limit can be defined for each axis.
- When one of the axes exceeds the speed limit, the "SRVO-346 DCS Joint speed" alarm occurs, and motor power is shut down.
- This function can be used to check if the axis is stationary by setting the speed limit to 0. False alarms caused by vibration during servo ON can be avoided by tuning of the Permissible distance.
- It is possible to ENABLE / DISABLE Joint Speed Check by using safety input signals OPSFTY1-4. It is possible to specify the signal of OPSFTY1-4 for each axis. When the specified OPSFTY circuits are CLOSED, Joint Speed Check is disabled. When they are OPEN, it is enabled.

#### **WARNING**

If Joint Speed Check is set incorrectly, the safety function will not work, and serious personal injury could result. When Joint Speed Check is changed, the values must be verified and the function must be tested again.

#### **WARNING**

When Permissible distance is not set to 0, motor power does not shut down immediately when axis speed exceeds the speed limit. The stopping distance can be increased by acceleration in the Permissible distance. Adequate risk assessment for whole robot system is necessary to determine Permissible distance.

#### **CAUTION**

R-30iA Mate does not have OPSFTY inputs.

## DCS Joint Speed Check menu

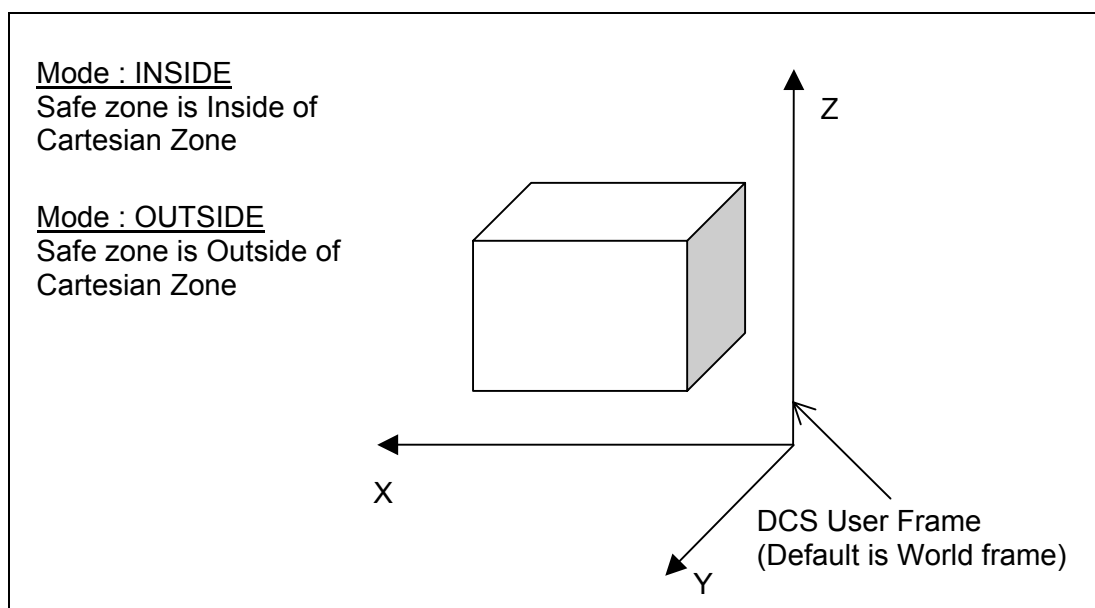
DCS			
Joint speed check		GROUP:1	1/12
Stop type:		Emergency stop	
Permissible distance			
for linear axis(mm):		0.000	
for rotary axis(deg):		0.000	
Axis Mode	Speed limit	OPSFTY	
1 DISABLE	0.000 deg/sec	0	
2 DISABLE	0.000 deg/sec	0	
3 DISABLE	0.000 deg/sec	0	
4 DISABLE	0.000 deg/sec	0	
5 DISABLE	0.000 deg/sec	0	
6 DISABLE	0.000 deg/sec	0	
7 DISABLE	0.000 mm/sec	0	
8 DISABLE	0.000 mm/sec	0	
9 DISABLE	0.000 mm/sec	0	
Press PREV key to exit			
[ TYPE ]	GROUP	[CHOICE]	

## 1.6 CARTESIAN POSITION CHECK

Cartesian Position Check checks the position of the robot TCP and shuts down the motor power if the TCP position is outside of the safe zone.

### Setup safe zone

The Safe zone is configured based on the upper and lower limits of X, Y and Z in the DCS User frame. The Mode setting can be used to specify whether the safe zone is inside or outside of the limits.



- One safe zone can be set for each motion group.
- The safe zone can be specified by the position based on the DCS User Frame. If the DCS User Frame is the default value (All 0), the DCS User Frame is the same as the World Frame. (Refer to Section 3.7 DCS USER FRAME MENU)
- Then Cartesian Position Check checks whether the DCS TCP is inside or outside of the safe zone. (Refer to Section 3.6 DCS TCP MENU)
- The current DCS TCP position based on the DCS User Frame is displayed on the Cartesian Position Check SETUP screen. Refer to this display to set up the safe zone.

#### **⚠ WARNING**

When DCS User Frame or DCS TCP is set incorrectly, the safety function might not work and serious personal injury could result. Set the DCS User Frame and DCS TCP properly to ensure that this function works correctly.

- If one motion group whose Cartesian Position Check is enabled is outside of safe zone, alarm “SRVO-342 DCS Cartesian position ” occurs, and the motor power is shut down.
- It is possible to ENABLE / DISABLE Cartesian Position Check using the safety input signals OPSFTY1-4 for each motion group. When the specified OPSFTY circuits are CLOSED, Cartesian Position Check is disabled. When they are OPEN, it is enabled.

**⚠ WARNING**  
 If Cartesian Position Check is set incorrectly the safety function will not work and serious personal injury could result. When Cartesian Position Check is changed, the values must be verified and the function must be tested again.

**⚠ CAUTION**  
 R-30iA Mate does not have OPSFTY inputs.

**Recover from alarm**

When the robot is outside of the safe zone, the alarm cannot be cleared. To move the robot to the safe zone, press and hold the SHIFT and RESET keys, and jog the robot. If the SHIFT key is released while still outside of the safe zone, or the robot moves in a direction away from the safe zone, alarm occurs and motor power is shut down.

**DCS Cartesian Position Check menu**

DCS			
Cartesian position check GROUP:1 1/6			
Mode:		DISABLE	
OPSFTY:		0	
Stop type:		Emergency stop	
	Current	Upper	Lower
X	1807.000	0.000	0.000 mm
Y	0.000	0.000	0.000 mm
Z	1300.000	0.000	0.000 mm
Press PREV key to exit			
[ TYPE ] GROUP		[ CHOICE ]	

## 1.7 CARTESIAN SPEED CHECK

The Cartesian Speed Check checks the TCP speed of the robot and shuts down the motor power if the TCP speed exceeds the speed limit.

### Setup speed limit

- One speed limit can be set for each motion group.
- Cartesian Speed Check checks the DCS TCP speed.  
(Refer to Section 3.6 DCS TCP MENU)

**⚠ WARNING**

When DCS TCP is set incorrectly, the safety function will not work and serious personal injury could result. Set the DCS User Frame and DCS TCP properly to ensure that this function works correctly.

- If one motion group whose Cartesian Speed Check is enabled exceeds the speed limit, alarm “SRVO-343 DCS Cartesian speed” occurs, and the motor power is shut down.
- This function can be used to check if the robot is stationary by setting the speed limit to 0. False alarms caused by vibration during servo ON can be avoided by tuning of the permissible distance.
- It is possible to ENABLE / DISABLE Cartesian Speed Check by using safety input signals OPSFTY1-4 for each motion group. When the specified OPSFTY circuits are CLOSED, Cartesian Speed Check is disabled. When they are OPEN, it is enabled.

**⚠ WARNING**

If Cartesian Speed Check is set incorrectly, the safety function will not work, and serious personal injury could result. When Cartesian Speed Check is changed, the values must be verified and the function must be tested again.

**⚠ WARNING**

When the Permissible distance is not set to 0, the motor power does not shut down immediately when the TCP speed exceeds speed limit. The stopping distance can be increased by acceleration in Permissible distance. Adequate risk assessment for the whole robot system is necessary to determine Permissible distance.

**⚠ CAUTION**

R-30iA Mate does not have OPSFTY inputs.



## DCS Cartesian Speed Check menu

```
DCS
-----
Cartesian speed check   GROUP:1 1/4
Mode:                   DISABLE
OPSFTY:                 0
Stop type:              Emergency stop
Speed limit:            0.000 mm/sec

Press PREV key to exit
[ TYPE ] GROUP        [ CHOICE ]
```

# 2

## CAUTIONS AND LIMITATIONS

---

## 2.1 HARDWARE

---

### R-30iA controller

- The Dual Check Safety Panel board is required to use Dual Check Safety in an R-30iA controller.  
If the DCS Position/Speed check option is loaded into an R-30iA controller whose Panel board is not Dual Check Safety type, the alarm "SYST-217 DCS pos./speed is not available" will occur.

### R-30iA Mate controller

- To use Dual Check Safety in an R-30iA Mate controller. Dual Check Safety type hardware is required.  
If the DCS Position/Speed check option is loaded in the R-30iA Mate controller that does not have Dual Check Safety type hardware, the alarm "SYST-217 DCS pos./speed is not available" will occur.
- The R-30iA Mate controller does not have OPSFTY inputs. The OPSFTY status is always OPEN in an R-30iA Mate controller.

 **CAUTION**

The R-30iA Mate does not have OPSFTY inputs. Check that the system does not need OPSFTY inputs before ordering the DCS Position/Speed Check option for the R-30iA Mate controller.

### Auxiliary axis board

- Auxiliary axis board axes are not used for Dual Check Safety Position/Speed Check. These axes are regarded as EXCLUDED axes. Axes that should be used by Position/Speed Check must be connected to the Servo Card.

## 2.2 SOFTWARE

---

### Robot model

Dual Check Safety is 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" occurs. This alarm cannot be cleared until the software option configuration is changed.

### Extended axis

When DCS Position/Speed Check is loaded, all extended axes must be Integrated Extended Axes. If there is an Auxiliary Extended Axis in the system, the alarm "SRVO-359 DCS SYSTEM alarm" occurs. This alarm cannot be cleared while there is an Auxiliary Extended Axis.

### Servo gun axis, Independent axis

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

### Positioner axis

To use DCS Position/Speed Check for a positioner axis, the positioner must be a Basic positioner with Known Kinematics. If another positioner type is used, the alarm "SYST-218 DCS Unavailable robot model" occurs.

### Continuous turn

The Continuous turn option cannot be loaded with DCS Position/Speed Check.

## 2.3 CAUTION WHEN USING POSITION / SPEED CHECK

To use DCS Position/Speed Check, the Position/speed process must be set to ENABLE. In this setting, some operations can cause an alarm, and the alarm cannot be cleared until the code number is entered. If an operator who does not know the code number does the operation, the alarm cannot be cleared and the system will not work. Be sure to take care when performing the following operations.

### Load backup files

When the DCS parameter (Refer to Section 3.1 DCS PARAMETER) is changed by loading a .SV file or an image file, "SYST-219 Need to verify DCS param" occurs. This alarm cannot be cleared until "verify DCS parameter" operation is performed in the DCS top menu. (Refer to Section 3.14 SAVE / LOAD DCS)

#### CAUTION

When Position/Speed Process is set to ENABLE, and an operator who does not know the code number loads files, the alarm "SYST-219 Need to verify DCS param" occurs, and the system will not work. An operator who knows the code number should load files.

### Change mastering parameters

When mastering parameters are changed and calibration or cycle power is performed, the alarm " SYST-212 Need to apply DCS param" occurs. This alarm cannot be cleared until the apply DCS parameter operation is performed in the DCS mastering parameter menu. (Refer to Section 3.3 APPLY TO DCS PARAMETER)

### Change robot setup

When robot setup data is changed and controller power has been cycled, the alarm " SYST-212 Need to apply DCS param" occurs. This alarm cannot be cleared until the Apply DCS parameter operation is performed in the DCS robot SETUP menu. (Refer to Section 3.3 APPLY TO DCS PARAMETER)

#### CAUTION

If Position/Speed Process is set to ENABLED, and an operator who does not know the code number changes Mastering parameters or robot setup data, the alarm "SYST-212 Need to apply DCS param" occurs, and the system will not work. An operator who knows the code number must change mastering parameters or robot setup data.

## 2.4 STOPPING DISTANCE

---

Dual Check Safety 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 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 3.12 DCS ROBOT SETUP MENU). Position / Speed Check will detect an alarm within a maximum of one scan time.

The stop distance is calculated as follows:

(Speed × Scan time) + moving distance through momentum

 **WARNING**

The robot stopping distance must be considered when 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 1 second. In this case, a risk assessment for the whole robot system is necessary, including the 1 second delay.

# 3

## SETUP POSITION/SPEED CHECK

---

## 3.1 DCS PARAMETERS

Dual Check Safety (DCS) Parameters are protected by a code number. Unless the correct code number is entered, the value of the DCS Parameters cannot be changed.


The DCS parameters are retained in two separate areas inside the robot controller. The consistency between the parameter values retained in each area is checked, and an alarm is generated if any inconsistency occurs.

NOTE: Cycle power when the DCS parameter values are changed. The changed parameter values are effective after power is cycled.

### WARNING

If the robot is used with incorrect DCS parameters the safety function will not work, and serious personal injury could result. When the DCS parameters are changed, the values must be verified and the function must be tested again.

### Code number input

Pressing  or a number or function key in the DCS menu will display the following message.

Enter code number: ----

Type the four digit code, and press ENTER.

The following message is displayed when the correct code number is input, and it becomes possible to change DCS parameters.

Protection is released.

After the correct code number is entered, it is possible to change DCS parameters in the screen. After moving to another screen, the code number must be input again to change DCS parameters.

The following message is displayed when an incorrect code number is input. In this case, the DCS parameter protection is not released.

Wrong code number !

### Change code number

The default code number is set to "1111". The code number can be changed in the DCS top menu. (Refer to Section 3.5 DCS TOP MENU)



 **CAUTION**

Make sure to change the code number from the default “1111” setting, to prevent DCS parameters from being changed by an unauthorized person.

## 3.2 POSITION / SPEED PROCESS

To use Position/speed check, Position/speed process must be set to ENABLE. By default, Position/speed process is set to DISABLE.

Position/speed process can be changed in the DCS top menu. (Refer to Section 3.5 DCS TOP MENU)

DCS	
	1 / 10
1 Position/speed process:	DISABLE (Speed check (<250mm/sec) in T1)
2 TCP:	
3 User frame:	
4 Joint position check:	DISABLE
5 Joint speed check:	DISABLE
6 Cartesian position check:	DISABLE
7 Cartesian speed check:	DISABLE
8 Robot setup:	OK
9 Mastering parameter:	OK
10 Change code number:	
[ TYPE ] VERIFY DETAIL [CHOICE]	

- When the Position/speed process is changed from DISABLE to ENABLE, the robot setup data and Mastering parameters need to be applied to the DCS parameters. (Refer to Section 3.3 APPLY TO DCS PARAMETER)
- When the Position/speed process is set to ENABLE, the alarm "SYST-212 Need to apply to DCS param" occurs when changing Mastering parameters or robot setup data. To clear this alarm, Apply to DCS parameter is needed in the DCS menu. (Refer to Section 3.3 APPLY TO DCS PARAMETER)
- When Position/speed process is set to DISABLE, none of the Position/speed check functions can be enabled.
- To change Position/speed process from ENABLE to DISABLE, all the Position/speed check functions must be disabled.

### CAUTION

T1 Mode Speed Check does not work when Position/speed process is set to DISABLE.

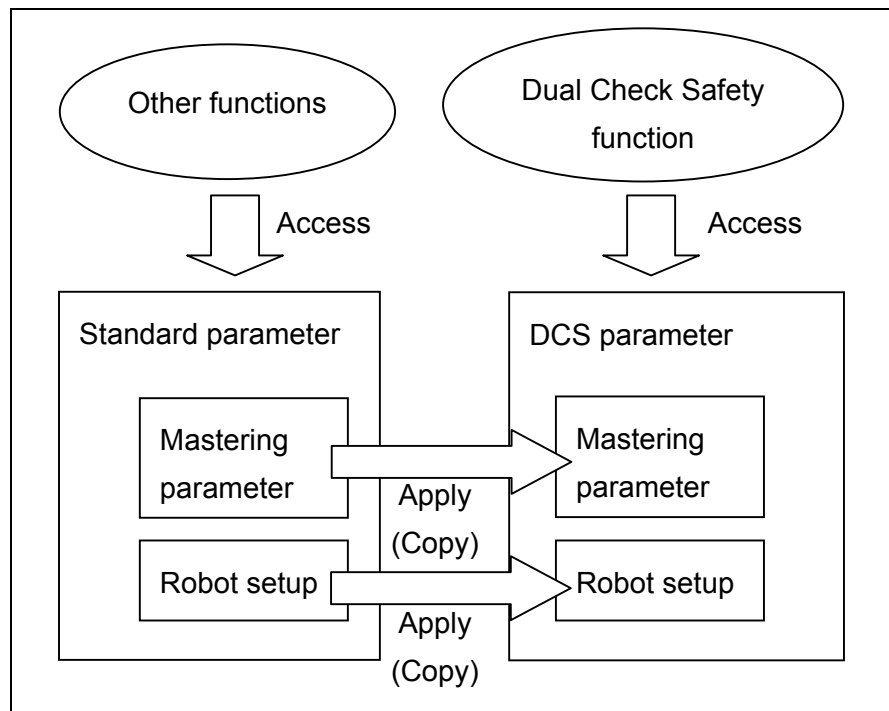
### CAUTION

If an operator who does not know the code number changes the Mastering parameters or robot setup data when Position/Speed process is set to ENABLE, the alarm "SYST-212 Need to apply DCS param" occurs and the system will not work. An operator who knows the code number must change mastering parameters or robot setup data.

### 3.3 APPLY TO DCS PARAMETER

The robot Setup data and Mastering data are necessary to calculate the position and speed of the robot. But standard robot settings are not DCS parameters, and Dual Check Safety cannot access this data. This data must be copied to the DCS parameters, and Dual Check Safety then accesses the copied DCS parameters.

Apply to DCS parameter allows you to copy standard robot setup data or Mastering data to DCS parameters.



- The code number must be entered to change DCS parameters.
- In the menu to Apply to DCS parameter, the value to apply is displayed. Make sure to verify the displayed value.
- When Apply to DCS parameter is performed, make sure to test the Dual Check Safety functions.

#### Apply Mastering parameter

- Mastering parameters can be changed in the Master/Cal menu.
- When Position/speed process is set to ENABLE, the alarm "SYST-212 Need to apply to DCS param" occurs. The DCS mastering parameter menu is displayed automatically by calibration or cycling power after changing the mastering parameters.
- This alarm cannot be cleared until the mastering parameters are applied to the DCS parameters. (Refer to Section 3.3 APPLY TO DCS PARAMETER.)

#### **Apply robot setup data**

- Robot setup data can be changed in the Controlled Start Maintenance menu
- When Position/speed process is set to ENABLE, the alarm "SYST-212 Need to apply to DCS param" occurs and the DCS robot SETUP menu is displayed automatically each time power is cycled.
- This alarm cannot be cleared until robot setup data is applied to the DCS parameter. (Refer to Section 3.3 APPLY TO DCS PARAMETER.)

## 3.4 DCS MENU

Dual Check Safety setup can be performed in the DCS menu. A code number is needed to change DCS parameters.

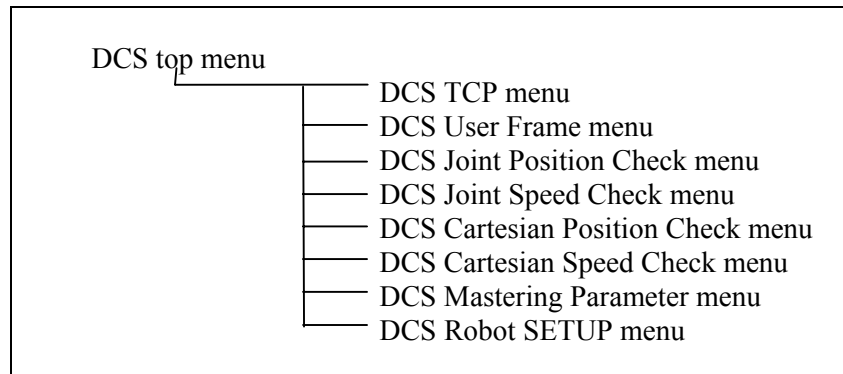
### Display DCS menu

The DCS menu is displayed by the following operation.

**MENU** → 0 -- NEXT -- → 6 SYSTEM → **F1**, [TYPE] → DCS

### Structure of DCS menu

The following is the structure of the DCS menu.



## 3.5 DCS TOP MENU

This is the first DCS menu. Each DETAIL menu can be displayed from this menu. The DCS top menu can be displayed by pressing **PREV** from each DETAIL menu. Position /Speed process and the code number can be changed in this menu.

### Items in DCS top menu

DCS	
	1/ 10
1 Position/speed process:	DISABLE (Speed check (<250mm/sec) in T1)
2 TCP:	
3 User frame:	
4 Joint position check:	DISABLE
5 Joint speed check:	DISABLE
6 Cartesian position check:	DISABLE
7 Cartesian speed check:	DISABLE
8 Robot setup:	OK
9 Mastering parameter:	OK
10 Change code number:	
[ TYPE ] VERIFY DETAIL [CHOICE]	

Items in DCS top menu	
Item	Description
Position/Speed process	Enable/Disable Position/Speed process. (Refer to Section 3.2 POSITION / SPEED PROCESS)
TCP	Press <b>ENTER</b> or <b>F3</b> , DETAIL, on this item to display the DCS TCP menu.
User Frame	Press <b>ENTER</b> or <b>F3</b> , DETAIL, on this item to display the DCS User Frame menu.
Joint Position Check	ENABLE is displayed when Joint position check is set to ENABLE on any axis. DISABLE is displayed when no axis has Joint Position Check set to ENABLE. Press <b>ENTER</b> or <b>F3</b> , on this menu to display the DCS Joint Position Check menu.
Joint Speed Check	ENABLE is displayed when Joint Speed Check is set to ENABLE on any axis. DISABLE is displayed when no axis has Joint Speed Check set to ENABLE. Press <b>ENTER</b> or <b>F3</b> , DETAIL on this item to display the DCS Joint Speed Check menu.
Cartesian Position Check	ENABLE is displayed when there is any group with Cartesian Position Check set to ENABLE. DISABLE is displayed when there is no group with Cartesian Position Check set to ENABLE. Press <b>ENTER</b> key or <b>F3</b> , DETAIL on this item to display the DCS Cartesian Position Check menu.
Cartesian Speed Check	ENABLE is displayed when there is any group with Cartesian Speed Check set to ENABLE. DISABLE is displayed when there is no group with Cartesian Speed Check set to ENABLE. Press <b>ENTER</b> or <b>F3</b> ,DETAIL on this item to display the DCS Cartesian Speed Check menu.
Robot Setup	Status of Robot setup is displayed. OK : All Robot setup data are copied to DCS parameters. CHGD : Some Robot setup data are not copied to DCS parameters. (Need to apply to DCS parameter.) Press <b>ENTER</b> or <b>F3</b> ,DETAIL on this item to display the DCS robot SETUP menu.
Mastering Parameter	Status of mastering parameter is displayed. OK : All mastering parameters are copied to DCS parameters. CHGD : Some mastering parameters are not copied to DCS parameters. (Need to apply to DCS parameter.) Press <b>ENTER</b> or <b>F3</b> ,DETAIL on this item to display the DCS mastering parameter menu.
Change Code Number	Press <b>ENTER</b> on this item to change the code number.
VERIFY	When DCS parameters are changed by file loading, the alarm "SYST-219 Need to verify DCS param" occurs. To clear this alarm, press <b>F2</b> , VERIFY, on this item and enter the code number. Refer to Section 3.14 SAVE / LOAD DCS PARAMETERS for details.

 **CAUTION**

T1 mode speed check does not work when Position/speed process is set to DISABLE.

**! CAUTION**

Make sure to change the code number to prevent DCS parameter change by unauthorized person.

**Procedure Change code number****Step**

1. **MENU** → 0 -- NEXT -- → 6 SYSTEM → **F1**, [TYPE] → DCS, DCS menu is displayed. If the other DCS menu displayed, press **PREV**.

```

DCS
                                     1/ 10
1 Position/speed process:  DISABLE
  (Speed check (<250mm/sec) in T1)
2 TCP:
3 User frame:
4 Joint position check:    DISABLE
5 Joint speed check:     DISABLE
6 Cartesian position check: DISABLE
7 Cartesian speed check:  DISABLE
8 Robot setup:           OK
9 Mastering parameter:   OK
10 Change code number:
[ TYPE ] VERIFY  DETAIL [CHOICE]

```

2. Press **ENTER** on the Change code number. The following message is displayed.

```
Enter code number: ----
```

3. Enter current code number. The following message is displayed.

```
Enter new code number: ----
```

4. Enter new code number. The following message is displayed.

```
Verify new code number: ----
```

5. Enter new code number, again.



---

**Procedure Verify DCS parameter**


---

**Step**

1. **MENU** → 0 -- NEXT -- → 6 SYSTEM → **F1**, [TYPE] → DCS, DCS menu is displayed. If the other DCS menu displayed, press **PREV**.

```

DCS
                                     1/ 10
1 Position/speed process:  DISABLE
  (Speed check (<250mm/sec) in T1)
2 TCP:
3 User frame:
4 Joint position check:    DISABLE
5 Joint speed check:     DISABLE
6 Cartesian position check: DISABLE
7 Cartesian speed check:  DISABLE
8 Robot setup:           OK
9 Mastering parameter:   OK
10 Change code number:
[ TYPE ] VERIFY  DETAIL [CHOICE]

```

2. Press **F2**, VERIFY.
3. If the code number was changed because SYSPASS.SV was loaded, the following message is displayed. (This message is not displayed if the code number is not changed.)

```
Enter previous code number: ----
```

4. Enter the code number that was used before SYSPASS.SV was loaded. If the code number is correct, the following message is displayed.

```
Enter code number: ----
```

5. Enter the code number. If the code number is correct, the following message is displayed.

```
All DCS parameters are correct ?
                                YES   NO
```

6. If you have verified all DCS parameters, press **F4**, YES. The following message is displayed.

```
Please test DCS functions.
```

7. Test DCS functions.

 **WARNING**

If DCS parameters are incorrect, the safety function will not work correctly and serious personal injury could result. When the VERIFY operation is performed, all DCS parameters must be verified, and the Position/Speed Check functions must be tested again.

## 3.6 DCS TCP MENU

Dual Check Safety uses the DCS TCP that is in the DCS parameters, and is separate from a standard tool frame.

DCS TCP is used by the following DCS functions.

- T1 Mode Speed Check.
- Cartesian Position Check.
- Cartesian Speed Check.

The DCS TCP can have different values from a standard tool frame. Dual Check Safety always uses a DCS TCP to calculate Cartesian position and speed.

Refer to the application-specific *Setup and Operations Manual* for information on setting up a standard TCP or *tool frame*.

### DCS TCP Setup

- One DCS TCP can be set for each motion group.
- The DCS TCP is set by X, Y, Z values. The meaning of these values is the same as for standard tool frames.
- In the DCS TCP menu, a standard tool frame can be copied to the DCS TCP.
- To change the DCS TCP, you must enter the code number.
- When the DCS TCP is changed, cycle power.

#### **WARNING**

If the robot is used with an incorrect DCS TCP, the safety function does not work correctly and serious personal injury could result. When the DCS TCP is changed, the value must be verified, and Cartesian Speed Check must be tested again.

#### **CAUTION**

There is only one DCS TCP for each motion group. The DCS TCP cannot be switched dynamically like a standard tool frame.

### Items in the DCS TCP menu

DCS	
TCP	GROUP:1 1/3
1 X:	0.000 mm
2 Y:	0.000 mm
3 Z:	0.000 mm
Press PREV key to exit	
[ TYPE ]	GROUP COPY

Items in DCS TCP menu

Item	Description
Group	This item indicates the group number. The group number can be changed by pressing <b>F2</b> , GROUP.
X	This item indicates the X value of the DCS TCP. Unit: mm
Y	This item indicates the Y value of the DCS TCP. Unit: mm
Z	This item indicates the Z value of the DCS TCP. Unit: mm
COPY	Press <b>F3</b> , COPY, and the message "Copy source UTOOL number : " is displayed. Type the copy source tool frame number, and press ENTER, and the value of the tool frame is copied to the DCS TCP.

## 3.7 DCS USER FRAME MENU

Dual Check Safety uses the DCS user frame that is in the DCS parameters, and is separate from a standard user frame.

The DCS user frame is used by the following DCS function:

- Cartesian Position Check

DCS user frames can have different values from a standard user frame. Dual Check Safety always uses DCS user frame to calculate the Cartesian position.

The DCS user frame values are all set to 0 by default. This means the same as world frame.

Refer to the application-specific *Setup and Operations Manual* for information on setting up a standard *user frame*.

### DCS user frame Setup

- One DCS user frame can be set for each motion group.
- The DCS user frame is set using X, Y, Z, W, P, and R values. The meaning of these values is the same as for a standard user frame.
- In the DCS user frame menu, a standard user frame can be copied to the DCS user frame.
- To change the DCS user frame, you must enter the code number.
- When the DCS user frame is changed, cycle power.

#### **WARNING**

If a robot is used with an incorrect DCS user frame, the safety function does not work correctly and serious personal injury could result. When the DCS user frame is changed, the value must be verified, and the Cartesian Position Check must be tested again.

#### **CAUTION**

There is only one DCS user frame for each motion group. The DCS user frame cannot be switched dynamically like a standard user frame.

## Items in DCS user frame menu

DCS		
User frame	GROUP:1	1/6
1 X:		0.000 mm
2 Y:		0.000 mm
3 Z:		0.000 mm
4 W:		0.000 deg
5 P:		0.000 deg
6 R:		0.000 deg
Press PREV key to exit		
[ TYPE ] GROUP COPY		

## Items in DCS user frame menu

Item	Description
Group	This item indicates the group number. Group number can be changed by pressing <b>F2</b> (GROUP) key.
X	This item indicates the X value of DCS user frame. Unit: mm
Y	This item indicates the Y value of DCS user frame. Unit: mm
Z	This item indicates the Z value of DCS user frame. Unit: mm
W	This item indicates the W value of DCS user frame. Unit: deg
P	This item indicates the P value of DCS user frame. Unit: deg
R	This item indicates the R value of DCS user frame. Unit: deg
COPY	Press <b>F3</b> , COPY, and the message "Copy source UFRAME number : " is displayed. Enter the copy source user frame number, and the value of the user frame is copied to the DCS user frame.

## 3.8 DCS JOINT POSITION CHECK MENU

Joint position check setup can be performed in this menu.

### Items in DCS Joint Position Check menu

DCS			
Joint position check	GROUP:1	1/10	
Stop type:	Emergency stop		
Axis Mode	Upper	Lower	OPSFTY
1 DISABLE	0.000	0.000	deg 0
2 DISABLE	0.000	0.000	deg 0
3 DISABLE	0.000	0.000	deg 0
4 DISABLE	0.000	0.000	deg 0
5 DISABLE	0.000	0.000	deg 0
6 DISABLE	0.000	0.000	deg 0
7 DISABLE	0.000	0.000	mm 0
8 DISABLE	0.000	0.000	mm 0
9 DISABLE	0.000	0.000	mm 0
Press PREV key to exit			
[ TYPE ]	GROUP	[ CHOICE ]	

### Items in DCS Joint Position Check menu

Item	Description
Group	This item indicates the group number. The group number can be changed by pressing <b>F2</b> , GROUP.
Stop type	This item indicates the stop type when Joint position is not in a safe zone. Emergency stop : Motor power is shut down immediately. Controlled stop : Deceleration stop, then motor power is shut down. (Motor power shutdown is delayed for maximum 1 second.)
Axis	This item indicates the axis number.
Mode	This item indicates the mode of Joint Position Check. DISABLE : Joint Position Check is disabled for this axis. INSIDE : Inside is safe zone OUTSIDE : Outside is safe zone.
Upper limit	This item indicates the upper limit of the zone. Unit : deg for rotary axis, mm for linear axis.
Lower limit	This item indicates the lower limit of the zone. Unit : deg for rotary axis, mm for linear axis.
OPSFTY	This is the OPSFTY signal number which is used to ENABLE / DISABLE the Joint Position Check. 0 : Joint Position Check is always set to ENABLE 1~4 : When OPSFTY input circuits are CLOSED, the Joint Position Check for the axis is DISABLED. When the circuits are OPEN, the is ENABLED. * If Mode is set to DISABLE, the Cartesian Position Check is always DISABLED regardless of the setting of this item.

 **WARNING**

If "Controlled stop" is set as stop type, motor power shutdown is delayed for a maximum of 1 second. In this case, the risk assessment for a whole robot system must include the 1 second delay.



## 3.9 DCS JOINT SPEED CHECK MENU

Joint Speed Check setup can be performed in this menu.


### Items in DCS Joint Speed Check menu


DCS		
Joint speed check	GROUP:1	1/12
Stop type:	Emergency stop	
Permissible distance		
for linear axis(mm) :	0.000	
for rotary axis(deg) :	0.000	
Axis Mode	Speed limit	OPSFTY
1 DISABLE	0.000 deg/sec	0
2 DISABLE	0.000 deg/sec	0
3 DISABLE	0.000 deg/sec	0
4 DISABLE	0.000 deg/sec	0
5 DISABLE	0.000 deg/sec	0
6 DISABLE	0.000 deg/sec	0
7 DISABLE	0.000 mm/sec	0
8 DISABLE	0.000 mm/sec	0
9 DISABLE	0.000 mm/sec	0
Press PREV key to exit		
[ TYPE ]	GROUP	[CHOICE]

### Items in DCS Joint Speed Check menu

Item	Description
Group	This item indicates the group number. Press <b>[F2]</b> , GROUP to change the group number.
Stop type	This item indicates the stop type when Joint speed exceeds the speed limit. Emergency stop : Motor power is shut down immediately. Controlled stop : Deceleration stop, then motor power is shut down. (Motor power shutdown is delayed for maximum 1 second.)
Permissible distance	This item indicates the motor power is not shut down even though the Joint speed exceeds the speed limit, and the distance moved is less than the Permissible distance. This item is used to avoid false alarms caused by vibration during servo ON. Normally it should be set to 0. For a linear axis(mm) : Permissible distance for linear axis. This setting is used for all linear axes of all groups in Joint Speed Check. For a rotary axis(deg) : Permissible distance for rotary axis. This setting is used for all rotary axes of all groups in Joint Speed Check.
Axis	This item indicates the axis number.
Mode	This item indicates the mode of Joint speed check. DISABLE : Joint Speed Check is disabled for this axis. ENABLE : Joint Speed Check is enabled for this axis.
Speed limit	This item indicates the speed limit Unit : mm/sec

Item	Description
OPSFTY	<p>The OPSFTY signal number which is used to ENABLE / DISABLE the Joint Speed Check.</p> <p>0 : Joint Speed Check is always set to ENABLE.</p> <p>1~4 : When OPSFTY input circuits are CLOSED, Joint Speed Check for the group is DISABLED. When the circuits are OPEN, the function is ENABLED.</p> <p>* If Mode is DISABLE, the Joint Speed Check is always DISABLED regardless of the setting of this item.</p>

 **WARNING**  
 If Controlled stop is set as stop type, motor power shutdown is delayed for a maximum of 1 second. In this case, the risk assessment for the whole robot system must include the 1 second delay.

 **WARNING**  
 If Permissible distance is not 0, motor power is not shut down immediately when Joint speed exceeds the speed limit. The stopping distance can be increased by acceleration during the Permissible distance. In this case, adequate risk assessment for the whole robot system is necessary to determine the Permissible distance.

## 3.10 DCS CARTESIAN POSITION CHECK MENU

Cartesian Position Check setup can be performed in this menu.

### Items in DCS Cartesian Position Check menu

DCS			
Cartesian position check GROUP:1 1/6			
Mode:	DISABLE		
OPSFTY:	0		
Stop type:	Emergency stop		
Current	Upper	Lower	
X	1807.000	0.000	0.000 mm
Y	0.000	0.000	0.000 mm
Z	1300.000	0.000	0.000 mm
Press PREV key to exit			
[ TYPE ] GROUP [ CHOICE ]			

Items in DCS Cartesian Position Check menu

Item	Description
Group	This item indicates the group number. Press <b>F2</b> , GROUP to change the Group number.
Mode	This item indicates the Cartesian Position Check mode. DISABLE : Cartesian Position Check is disabled for this group. INSIDE : Inside is safe zone OUTSIDE : Outside is safe zone.
OPSFTY	The OPSFTY signal number which switches ENABLE / DISABLE of Cartesian Position Check. 0 : Cartesian Position Check is always set to ENABLE. 1~4 : When OPSFTY input signal is CLOSE, Cartesian Position Check for the group is set to DISABLE. When the signal is OPEN, the function is set to ENABLE. * If Mode is set to DISABLE, Cartesian Position Check is always set to DISABLE regardless of the setting of this item.
Stop type	This item indicates the stop type when TCP is on the outside of a safe zone. Emergency stop : Motor power is shut down immediately. Controlled stop : Deceleration stop, then motor power is shut down. (Motor power shutdown is delayed for maximum 1 second.)
Current position	This item indicates the current DCS TCP position calculated in the DCS user frame. Unit : mm/sec
Upper limit	This item indicates the upper limit of the zone. Unit : mm/sec
Lower limit	This item indicates the lower limit of the zone. Unit : mm/sec

 **WARNING**

If Controlled stop is set as the stop type, motor power shutdown is delayed for a maximum of 1 second. In this case, the risk assessment for the whole robot system must include the 1 second delay.

## 3.11 DCS CARTESIAN SPEED CHECK MENU

Cartesian Speed Check setup can be performed in this menu.

### Items in DCS Cartesian Speed Check menu

DCS	
Cartesian speed check	GROUP:1 1/4
Mode:	DISABLE
OPSFTY:	0
Stop type:	Emergency stop
Speed limit(mm/sec):	0.000
Permissible distance(mm):	0.000
Press PREV key to exit	
[ TYPE ]	GROUP [ CHOICE ]

### Items in DCS Cartesian Speed Check menu

Item	Description
Group	This item indicates the group number. Press <b>F2</b> , GROUP, to change the Group number.
Mode	This item indicates the Cartesian Speed Check mode. DISABLE : Cartesian Speed Check is disabled for this group. ENABLE : Cartesian Speed Check is enabled for this group.
OPSFTY	This item indicates the OPSFTY signal number that sets Cartesian Speed Check. 0 : Cartesian Speed Check is always set to ENABLE 1~4 : When OPSFTY input circuits are CLOSED, Cartesian Speed Check for the group is DISABLED. When the circuits are OPEN, the Cartesian Speed Check is ENABLED. * If Mode is set to DISABLE, Cartesian Speed Check is always set to DISABLED regardless of the setting of this item.
Stop type	This item indicates the stop type when TCP speed exceeds the speed limit. Emergency stop : Motor power is shut down immediately. Controlled stop : Deceleration stop, then motor power is shut down. (Motor power shutdown is delayed for maximum 1 sec.)
Speed limit	This item indicates the speed limit. Unit : mm/sec
Permissible distance	This item indicates that if the distance moved is less than the Permissible distance, motor power is not shut down even though the TCP speed exceeds the speed limit. This item is used to avoid false alarms caused by vibration during servo ON. Normally it should be set to 0. This setting is used for all groups in Cartesian Speed Check. Unit : mm

### WARNING

If Controlled stop is set as a stop type, motor power shutdown is delayed for a maximum of 1 second. In this case, the risk assessment for the whole robot system must include the 1 sec delay.

 **WARNING**

If Permissible distance is not 0, motor power is not shut down immediately when TCP speed exceeds the speed limit. And stopping distance can be increased by acceleration during Permissible distance. In this case, adequate risk assessment for the whole robot system is necessary to determine the Permissible distance.

## 3.12 DCS ROBOT SETUP MENU

In this menu, robot settings can be applied to DCS parameters. "Apply to DCS parameter" means to copy standard robot settings to DCS parameters. (Refer to Section 3.3 APPLY TO DCS PARAMETER)

**⚠ WARNING**  
 If incorrect robot settings are applied to DCS parameters, the safety function will not work and serious personal injury could result. When the robot settings are applied, the values must be verified, and the status column of all lines must be OK. Position/Speed Check must also be tested again.

### Items in DCS robot setup menu

DCS	
Robot setup	1/11
	Status
1 Number of groups: 1	OK
2 Scan time: 8 msec	OK
3 ----- Group 1 -----	
4 Robot: R-2000iB/165F	CHGD
5 Number of axes: 6	OK
6 J1: Servo card - Axis 1	OK
7 J2: Servo card - Axis 2	OK
8 J3: Servo card - Axis 3	OK
9 J4: Servo card - Axis 4	OK
10 J5: Servo card - Axis 5	OK
11 J6: Servo card - Axis 6	OK
Press PREV key to exit	
[ TYPE ]	APPLY

### Items in DCS robot setup menu

Item	Description
Number of groups	This item indicates the number of DCS motion groups.
Scan time	This item indicates the scan time of position / speed checking process.
Robot	This item indicates the robot model name of the group assigned to this DCS motion group.
Number of axes	This item indicates the number of axes in this motion group.
J1 - J9	This item indicates the hardware configuration of each axis. Servo card : This axis is connected to servo card. Excluded! : This axis is excluded by Dual Check Safety. Joint Position Check and Joint Speed Check cannot be enabled for this axis. If T1 mode speed check, Cartesian Position Check, or Cartesian Speed Check is enabled for the motion group of this axis, this axis is regarded as always at 0 deg (or 0 mm).

Item	Description
Direction	<p>This item indicates the direction of Extended axis or Positioner.</p> <p>[Extended axis]            Auxiliary axes : No direction            In this case, the alarm "SRVO-359 DCS SYSTEM alarm" occurs.            X : X direction, Y : Y direction, Z : Z direction</p> <p>[Positioner axis]            +X : +X direction, -X : -X direction            +Y : +Y direction, -Y : -Y direction            +X : +Z direction, -Z : -Z direction</p>
Arm length	This item indicates the arm length of the extended axis
Offset	This item indicates the offset of the extended axis
Offset X Offset Y Offset Z	This item indicates the offset of the positioner axis
Axis type	<p>This item indicates the axis type of extended axis, positioner axis or independent axis.</p> <p>Linear axis or Rotary axis.</p>
Motor direction	This item indicates the motor direction of extended axis, positioner axis or independent axis
Gear ratio	This item indicates the gear ratio of extended axis, positioner axis or independent axis
Pos. tolerance	<p>This item indicates the position tolerance of the extended axis, positioner axis or independent axis.</p> <p>If the difference between the command position and feedback position exceeds this value, the alarm "SRVO-365 DCS FB_CMP alarm" occurs.</p>
Status	<p>This item indicates the status of apply for each item is displayed.</p> <p>OK : Robot setting is copied to DCS parameter            CHGD : Robot setting is changed but not applied to DCS parameter. The alarm "SYST-212 Need to apply to DCS param" occurs.            PEND : Robot setting is changed and applied to DCS parameter, but controller power is not cycled yet, and the new setting is not used.            Power must be cycled.</p>
APPLY	<p>Press <b>F3</b>, APPLY, and input the correct code number. The message "Apply The CHGD items to DCS param?" is displayed. Robot settings are copied to DCS parameters by pressing <b>F4</b>, OK.</p>



---

**Procedure Apply robot setup data**


---

**Step**

1. Press **F3** (DETAIL) on "Robot setup" line in DCS top menu. The DCS robot setup menu is displayed.

```

DCS
Robot setup                               1/11
                                           Status
  1 Number of groups: 1                   OK
  2 Scan time: 8 msec                     OK
  3 ----- Group 1 -----
  4 Robot: R-2000iB/165F                   CHGD
  5 Number of axes: 6                     OK
  6 J1: Servo card - Axis 1               OK
  7 J2: Servo card - Axis 2               OK
  8 J3: Servo card - Axis 3               OK
  9 J4: Servo card - Axis 4               OK
 10 J5: Servo card - Axis 5               OK
 11 J6: Servo card - Axis 6               OK
Press PREV key to exit
[ TYPE ]                                APPLY

```

**⚠ WARNING**

If incorrect robot setup data is applied to DCS parameters, the safety function will not work and serious personal injury could result. All displayed robot setup data must be verified before applying the robot setup data.

2. Press **F3** (APPLY). The following message is displayed.

```
Enter code number: ----
```

3. Enter code number
4. If the code number is correct, the following message is displayed.

```
Apply the CHGD items to DCS param?
                                OK  CANCEL
```

5. Press **F4** (OK), then the robot setup data are applied to DCS parameters, and the following message is displayed.

```
Please verify items, and cycle power
```

6. Please verify that all "CHGD" items are changed to "PEND".
7. All "PEND" items are changed to "OK" by cycling power.

 **WARNING**

If incorrect robot settings are applied to DCS parameters, the safety function will not work and serious personal injury could result. When the robot settings are applied, the values must be verified, and the status column of all lines must be OK. Position/Speed Check must also be tested.

### 3.13 DCS MASTERING PARAMETER MENU

In this menu, mastering parameters can be applied to DCS parameters. Apply to DCS parameter means to copy standard mastering parameters to DCS parameters. (Refer to Section 3.3 APPLY TO DCS PARAMETER)

**⚠ WARNING**  
 If incorrect mastering parameters are applied to DCS parameters, the safety function will not work and serious personal injury could result. When the mastering parameters are applied, the values must be verified, and the status column of all lines must be OK. Position/Speed Check must also be tested.

#### Items in DCS Mastering parameter menu

DCS				
Mastering parameter				1/7
Axis	Position	Master count	Status	
1	----- Group 1 -----			
2 J1	0.000 deg	0	OK	
3 J2	0.000 deg	0	OK	
4 J3	0.000 deg	0	OK	
5 J4	0.000 deg	0	OK	
6 J5	0.000 deg	0	OK	
7 J6	0.000 deg	0	OK	
Press PREV key to exit				
[ TYPE ]		APPLY		

#### Items in DCS Mastering parameters menu

Item	Description
Axis	This item indicates the axis number.
Position	This item indicates the current position calculated by applied mastering parameters. Verify that the displayed position shows the correct robot position when mastering parameters are applied to DCS parameters.
Master count	This item indicates the value of mastering parameters that are copied to DCS parameters. Before applying mastering parameters, the previous mastering parameters are displayed. After applying mastering parameters, new mastering parameters are displayed

Item	Description
Status	<p>This item indicates the status of each axes' mastering parameters is displayed.</p> <p>OK : Mastering parameters are copied to DCS parameters</p> <p>CHGD : Mastering parameters are changed but not applied to DCS parameters. The alarm "SYST-212 Need to apply to DCS param" occurs.</p> <p>Not displayed: This axis is excluded by Dual Check Safety. So mastering parameters of this axis are not copied to DCS parameters.</p>
APPLY	<p>Press <b>F3</b>, APPLY, and input the correct code number. The message "Apply The CHGD items to DCS param?" is displayed. Standard Mastering parameters are copied to DCS parameters by pressing <b>F4</b> (OK)</p>

**Procedure Apply mastering parameters**

**Step**

1. Press **F3**,DETAIL, on the Mastering parameter line in the DCS top menu. The DCS mastering parameter menu is displayed.

DCS				
Mastering parameter				1/7
	Axis	Position	Master count	Status
1	----- Group 1 -----			
2	J1	12.938 deg	746538	CHGD
3	J2	24.887 deg	-10194	CHGD
4	J3	11.485 deg	2827	CHGD
5	J4	-10.394 deg	-473629	CHGD
6	J5	103.872 deg	-6352	CHGD
7	J6	-87.130 deg	18273	CHGD
Press PREV key to exit				
[ TYPE ]                      APPLY				

2. Press **F3**,APPLY. The following message is displayed.

Enter code number: ----

3. Enter code number.
4. If the code number is correct, the following message is displayed.

Apply the CHGD items to DCS param?  
OK      CANCEL

5. Press **F4**,OK, then the mastering parameters are applied to DCS parameters, and the following message is displayed.

Please verify the applied items

6. Verify that the new mastering parameters are displayed and that the Status column of all lines shows OK. When the mastering parameters are applied, the displayed current position is changed to the value that is calculated by the new mastering parameters. Verify that the displayed current position shows the current robot position correctly. If it is not correct, perform mastering again.

 **WARNING**

If the incorrect mastering parameters are applied to the DCS parameters, the safety function will not work and serious personal injury could result. When the mastering parameters are applied, the values must be verified, and the status column of all lines must be OK. Position/Speed Check must also be tested again.

## 3.14 SAVE / LOAD DCS PARAMETERS

### Save DCS parameters

DCS parameters are saved in the following files.

File that DCS parameters are saved

File	Saved DCS parameters
SYSPASS.SV	Code number
SYSMAST.SV	Mastering data
SYSVARS.SV	All DCS parameters except the above

### Load DCS parameters

To load the files in which DCS parameters are saved, code number input is not needed. However, the "SYST-219 Need to verify DCS param" alarm occurs if any DCS parameter is changed if one of these files is loaded. To clear this alarm, the Verify DCS parameter operation is needed. (Refer to Section 3.5 DCS TOP MENU), and this operation requires the code number input.

When Position/Speed process is set to DISABLE, this alarm does not occur.

#### CAUTION

When Position/Speed process is set to ENABLE, if an operator who does not know the code number loads files, the alarm "SYST-219 Need to verify DCS param" will occur, and the system will not work. An operator who knows the code number should load files.

\* The alarm "SYST-219 Need to verify DCS param" occurs, when image backup is loaded. The "VERIFY DCS parameter" operation is needed to clear the alarm.

## 3.15 STATUS MONITOR (NON-SAFETY FUNCTION)

The following status signals can be monitored as digital inputs (DI) by assigning rack 36, slot 0, start point 1-5.

Assignment	Status
Rack 36, Slot 0, Start point 0	"Position/speed process" setting (ON:ENABLE, OFF:DISABLE)
Rack 36, Slot 0, Start point 1	OPSFTY11,OPSFTY12 (ON: Either circuit is OPEN, OFF: Both are CLOSED)
Rack 36, Slot 0, Start point 2	OPSFTY21,OPSFTY22 (ON: Either circuit is OPEN, OFF: Both are CLOSED)
Rack 36, Slot 0, Start point 3	OPSFTY31,OPSFTY32 (ON:Either circuit is OPEN, OFF: Both are CLOSED)
Rack 36, Slot 0, Start point 4	OPSFTY41,OPSFTY42 (ON:Either circuit is OPEN, OFF: Both are CLOSED)



### WARNING

Status monitoring is not a safety function. The status monitoring DIs must not be used for safety purposes or serious personal injury could result.

## 3.16 MOTION GROUP MAPPING

Position/Speed Check can use a maximum of 7 motion groups. Motion group mapping changes the assignment between a DCS motion group and an actual motion group.

- For example, if all 7 DCS motion groups are assigned to actual group 1, 7 Cartesian position checks and 7 Cartesian speed checks can be used with actual motion group 1, and 7 Joint position checks and 7 Joint speed checks can be used for each axis of actual motion group 1.
- DCS TCP and DCS user frame can be defined for each DCS motion group.
- T1 mode speed check is executed for each DCS motion group.
- The motion group number specified in a DCS alarm is the actual motion group number (not the DCS group number).
- Motion group mapping is set up by the system variable \$DCS\_GRP\_MAP. (Refer to the table below. The setting of the above example is that \$DCS\_GRP\_MAP[1-7] are all 1.)  
After changing \$DCS\_GRP\_MAP, cycle power, The robot parameters that reflect the motion group mapping are displayed in the DCS robot setup menu. Verify the displayed parameters and press "APPLY".
- \$DCS\_GRP\_MAP contains the actual motion group number. If an element is set to 0 or a non-existent motion group, the DCS motion groups of the element and all the following elements are disabled. For example, if \$DCS\_GRP\_MAP[4] is set to 0, DCS motion groups 4 through 7 will be disabled.

**Setup motion group mapping**

System variable	Default	Description
\$DCS_GRP_MAP[1]	1	Actual motion group number that is assigned to DCS motion group 1.
\$DCS_GRP_MAP[2]	2	Actual motion group number that is assigned to DCS motion group 2.
\$DCS_GRP_MAP[3]	3	Actual motion group number that is assigned to DCS motion group 3.
\$DCS_GRP_MAP[4]	4	Actual motion group number that is assigned to DCS motion group 4.
\$DCS_GRP_MAP[5]	5	Actual motion group number that is assigned to DCS motion group 5.
\$DCS_GRP_MAP[6]	6	Actual motion group number that is assigned to DCS motion group 6.
\$DCS_GRP_MAP[7]	7	Actual motion group number that is assigned to DCS motion group 7.

### CAUTION

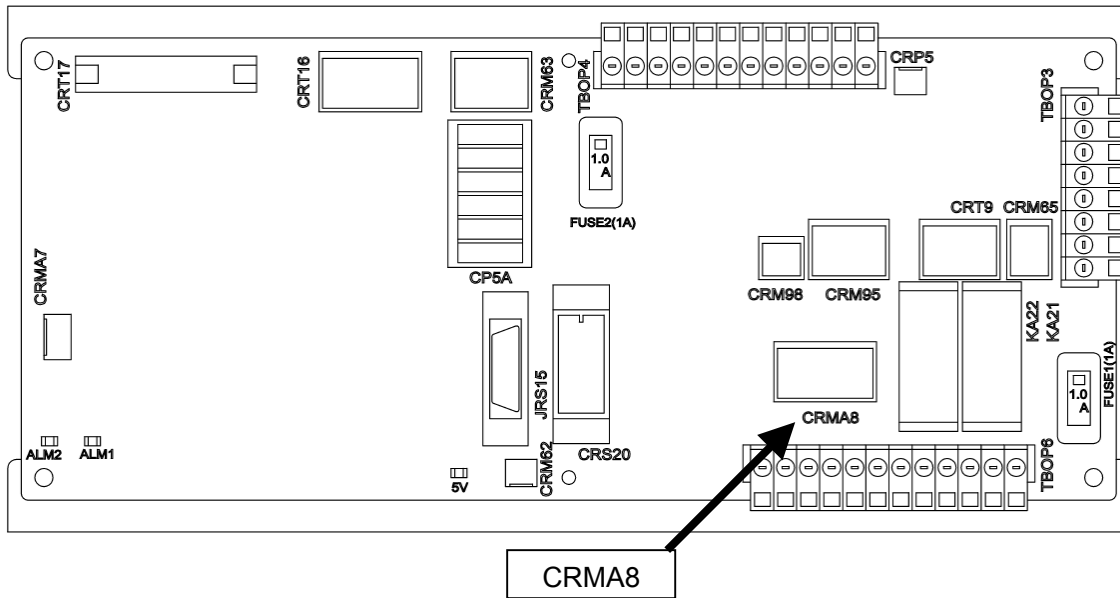
When motion group mapping is used, it may be difficult to understand the DCS setting. Therefore, test DCS functions carefully.



# 4

## OPTION SAFETY SIGNALS

In the R-30iA controller, option safety signals (OPSFTY) are in the CRMA8 connector on the Panel board.  
(R-30iA Mate does not have option safety signals.)



CRMA8 Connector

A1	OPSFTY11	B1	OPSFTY12
A2	OPSFTY21	B2	OPSFTY22
A3	OPSFTY31	B3	OPSFTY32
A4	OPSFTY41	B4	OPSFTY42
A5	ESPDO11	B5	ESPDO12
A6	ESPDO21	B6	ESPDO22
A7	+24E	B7	0V
A8	+24E	B8	0V

Note) ESPDO are not currently used.

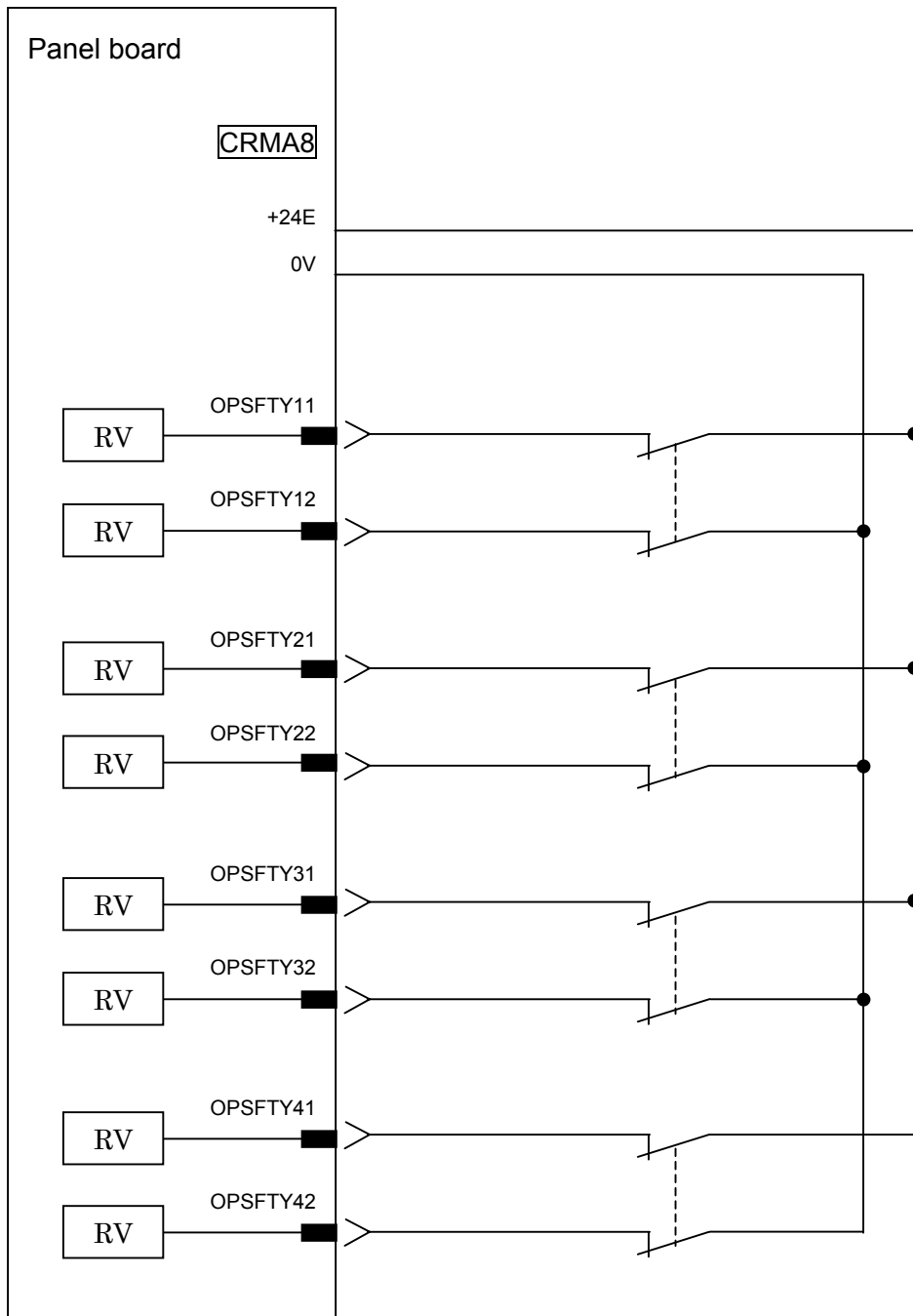
Specification of the connectors for cable side.

Manufacturer : Tyco Electronics AMP  
Housing : 2-1318118-8  
Contact : 1318107-1

OPSFTY11 and OPSFTY12  
OPSFTY21 and OPSFTY22  
OPSFTY31 and OPSFTY32  
OPSFTY41 and OPSFTY42

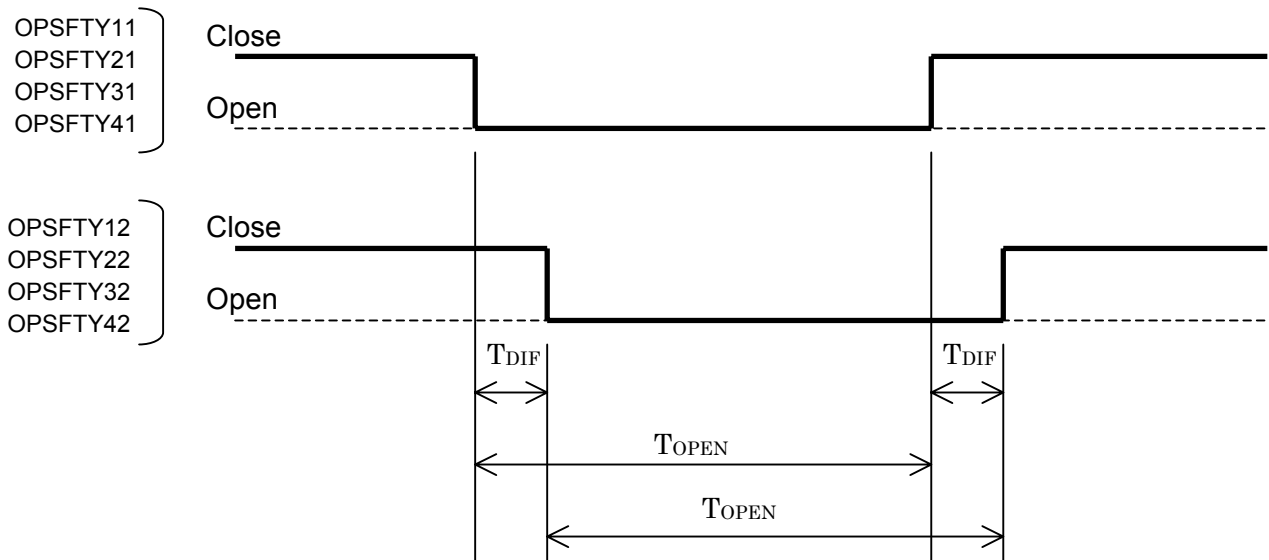
Connect duplicitously as in the above combination.

**Connection diagram**



### Timing specification

Duplicate inputs are used for the OPSFTY signal so that a response is made even when a single failure occurs. The status of these duplicate input signals must be changed simultaneously according to the timing specifications provided in this section. The robot control unit always checks that the status of the duplicate inputs is the same, and if the control unit finds a discrepancy, it issues an alarm. If the timing specifications are not satisfied, an alarm might be issued because of a signal discrepancy.



$$T_{DIF} \text{ (input time difference)} < 200\text{msec}$$

$$T_{OPEN} \text{ (input hold period)} > 2\text{sec}$$

# 5

## ALARM CODES

<b>SYST-212</b>	<b>PAUSE.G</b>	<b>Need to apply to DCS param</b>
	[Cause]	When "Position/Speed process" is ENABLE, mastering parameter or robot setting is changed.
	[Remedy]	Do "APPLY" operation in DCS menu.
<b>SYST-217</b>	<b>PAUSE.G</b>	<b>DCS pos./speed is not available</b>
	[Cause]	"Position/Speed process" is set to ENABLE, but DCS Position/Speed Check Function is not available in this system. - Dual Check Safety is not available in this hardware type. - "DCS Position/Speed Check Function" option is not loaded. - \$DCS_CFG.\$SYS_PARAM is 1.
	[Remedy]	Set "Position/Speed process" to DISABLE.
<b>SYST-218</b>	<b>PAUSE.G</b>	<b>DCS Unavailable robot model G: i Hex</b>
	[Cause]	"DCS Position/Speed Check Function" option is loaded, but this robot model is not supported. "i" is hexadecimal value and each bit is corresponded to motion group.
	[Remedy]	Delete "DCS Position/Speed check function" option. This alarm can be cleared by setting \$DCS_CFG.\$SYS_PARAM to 1, but in this case, Position/Speed check function can not be used.
<b>SYST-219</b>	<b>PAUSE.G</b>	<b>Need to verify DCS param ( i )</b>
	[Cause]	When "Position/Speed process" is enabled. backup files are loaded and DCS parameter is changed. The meaning of "i" is the following. 1 : Image backup is loaded. 2 : SYSVARS.SV is loaded and DCS parameter is changed. 4 : SYSVARS.SV is loaded and DCS parameter for robot setting is changed. 8 : SYSMAST.SV is loaded and DCS parameter in mastering parameter for DCS is changed. 16 : SYSPASS.SV is loaded and code number for DCS parameter is changed.
	[Remedy]	Check the setting in DCS menu, and do the VERIFY operation in DCS top menu.
<b>SRVO-335</b>	<b>SERVO</b>	<b>DCS OFFCHK alarm i, j</b>
	[Cause]	A failure was detected in the safety signal input circuit.
	[Remedy]	Replace the panel board.

<b>SRVO-336</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS RAMCHK alarm i, j</b> DRAM failure is detected. Replace CPU card. Replace main board.
<b>SRVO-337</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS PRMCHK alarm i, j</b> DCS parameter error is detected. 1. If power down occurred while DCS parameters were being changed, set the DCS parameters again. 2. Load backup files. 3. Replace main board, CPU card, FROM/SRAM module.
<b>SRVO-338</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS FLOW alarm i, j</b> DCS process error is detected. Replace main board. Replace CPU card. Replace FROM/SRAM module.
<b>SRVO-339</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS MISC alarm i, j</b> DCS process error is detected. Replace main board. Replace CPU card. Replace FROM/SRAM module.
<b>SRVO-340</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS T1 TCP speed(G i) j, k</b> TCP speed exceeds 250mm/sec in T1 mode. Decrease override.
<b>SRVO-341</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS T1 flange speed(G i) j, k</b> Wrist flange centre speed exceeds 250mm/sec in T1 mode. Decrease override.
<b>SRVO-342</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS Cartesian position(G i) j, k</b> TCP position is on outside of the safe zone. Press RESET key with SHIFT key, and jog to the safe zone with holding SHIFT key.
<b>SRVO-343</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS Cartesian speed(G i) j, k</b> TCP speed exceeds the speed limit. Decrease TCP speed.
<b>SRVO-344</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS GRP alarm(G i) j, k</b> DCS process error is detected. Replace main board. Replace CPU card. Replace FROM/SRAM module.

<b>SRVO-345</b>	<b>SERVO</b>	<b>DCS Joint position(G i,A j) k, l</b>
	[Cause]	Joint position is on outside of the safe zone.
	[Remedy]	Press RESET key with SHIFT key, and jog to the safe zone with holding SHIFT key.
<b>SRVO-346</b>	<b>SERVO</b>	<b>DCS Joint speed(G i,A j) k, l</b>
	[Cause]	Joint speed exceeds the speed limit.
	[Remedy]	Decrease Joint speed.
<b>SRVO-347</b>	<b>SERVO</b>	<b>DCS AXS alarm(G i,A j) k, l</b>
	[Cause]	DCS process error is detected.
	[Remedy]	Replace main board. Replace CPU card. Replace FROM/SRAM module.
<b>SRVO-348</b>	<b>SERVO</b>	<b>DCS MCC OFF alarm i, j</b>
	[Cause]	A command was issued to turn off the magnetic contactor, but the magnetic contactor was not turned off.
	[Remedy]	Replace the E-stop unit. Replace the panel board. If a signal is connected to the emergency stop unit CRM72, check whether there is a problem in the connection destination.
<b>SRVO-349</b>	<b>SERVO</b>	<b>DCS MCC ON alarm i, j</b>
	[Cause]	A command was issued to turn on the magnetic contactor, but the magnetic contactor was not turned on.
	[Remedy]	Replace the E-stop unit. Replace the panel board. Replace servo amplifier.
<b>SRVO-350</b>	<b>SERVO</b>	<b>DCS CPU alarm i, j</b>
	[Cause]	CPU failure is detected.
	[Remedy]	Replace main board. Replace CPU card. Replace FROM/SRAM module.
<b>SRVO-351</b>	<b>SERVO</b>	<b>DCS CRC alarm i, j</b>
	[Cause]	DCS code data error occurs.
	[Remedy]	Replace main board. Replace CPU card. Replace FROM/SRAM module.
<b>SRVO-352</b>	<b>SERVO</b>	<b>DCS COUNT1 alarm i, j</b>
	[Cause]	DCS process is stopped.
	[Remedy]	Replace CPU card. Replace main board. Replace panel board. Replace FROM/SRAM module.

<b>SRVO-353</b>	<b>SERVO</b>	<b>DCS COUNT2 alarm i, j</b> [Cause] DCS process is stopped. [Remedy] Replace CPU card. Replace main board. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-354</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS DICLK alarm i, j</b> DCS process is stopped. Replace CPU card. Replace main board. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-355</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS ITP_TIME alarm i, j</b> DCS scan time error occurs. Replace CPU card. Replace main board. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-356</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS ITP_SCAN alarm i, j</b> DCS scan time error occurs. Replace CPU card. Replace main board. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-357</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS ENABLED alarm i, j</b> 1. Joint position check, Joint speed check, Cartesian position check or Cartesian speed check is enabled when "Position/Speed process" is DISABLE. 2. Cartesian position check or Cartesian speed check is enabled for the motion group that does not exist. 3. Joint position check or Joint speed check is enabled for the axis that does not exist. 4. Joint position check or Joint speed check is enabled for the axis that is excluded. Disable Joint position check, Joint speed check, Cartesian position check or Cartesian speed check.
<b>SRVO-358</b>	<b>SERVO</b> [Cause] [Remedy]	<b>DCS INVPRM alarm i, j</b> Invalid data is set in DCS parameter. Load backup files that was saved in normal condition.

<b>SRVO-359</b>	<b>SERVO</b>	<b>DCS SYSTEM alarm i, j</b>
	[Cause]	1. Auxiliary extended axis is used. 2. DCS process error occurs.
	[Remedy]	1. Delete Auxiliary extended axis, or change to Integrated extended axis. This alarm can be cleared by setting \$DCS_CFG.\$SYS_PARAM to 1, but in this case, Position/Speed check function can not be used. 2. Replace main board, CPU card or FROM/SRAM module.
<b>SRVO-360</b>	<b>SERVO</b>	<b>DCS CC_TCP alarm(G i) j, k</b>
	[Cause]	Results of TCP position calculations by 2 CPUs are different.
	[Remedy]	Replace main board. Replace CPU card. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-361</b>	<b>SERVO</b>	<b>DCS CC_FP alarm(G i) j, k</b>
	[Cause]	Results of wrist flange center position calculations by 2 CPUs are different.
	[Remedy]	Replace main board. Replace CPU card. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-362</b>	<b>SERVO</b>	<b>DCS CC_TCPS alarm(G i) j, k</b>
	[Cause]	Results of TCP speed calculations by 2 CPUs are different.
	[Remedy]	Replace main board. Replace CPU card. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-363</b>	<b>SERVO</b>	<b>DCS CC_FPS alarm(G i) j, k</b>
	[Cause]	Results of wrist flange center speed calculations by 2 CPUs are different.
	[Remedy]	Replace main board. Replace CPU card. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-364</b>	<b>SERVO</b>	<b>DCS PRMCRC alarm(G i) j, k</b>
	[Cause]	This robot model is not supported.
	[Remedy]	Delete "DCS Position/Speed check function" option. This alarm can be cleared by setting \$DCS_CFG.\$SYS_PARAM to 1, but in this case, Position/Speed check function can not be used.



<b>SRVO-365</b>	<b>SERVO</b>	<b>DCS FB_CMP alarm(G i,A j) k, l</b>
	[Cause]	Difference between position command and position feedback exceeds position tolerance.
	[Remedy]	If "SRVO-023 Stop error excess" or "SRVO-024 Move error excess" also occurs, follow the remedy of these alarms. Check the setting data displayed in DCS robot setup menu.
<b>SRVO-366</b>	<b>SERVO</b>	<b>DCS FB_INFO alarm(G i,A j) k, l</b>
	[Cause]	Invalid data is set in DCS parameter for axis number.
	[Remedy]	Check the setting data displayed in DCS robot setup menu.
<b>SRVO-367</b>	<b>SERVO</b>	<b>DCS CC_JPOS alarm(G i,A j) k, l</b>
	[Cause]	Results of Joint position calculations by 2 CPUs are different.
	[Remedy]	Replace main board. Replace CPU card. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-368</b>	<b>SERVO</b>	<b>DCS CC_JSPD alarm(G i,A j) k, l</b>
	[Cause]	Results of Joint speed calculations by 2 CPU are different.
	[Remedy]	Replace main board. Replace CPU card. Replace panel board. Replace FROM/SRAM module.
<b>SRVO-378</b>	<b>SERVO</b>	<b>OPSFTY11 status abnormal</b>
<b>SRVO-379</b>	<b>SERVO</b>	<b>OPSFTY12 status abnormal</b>
<b>SRVO-380</b>	<b>SERVO</b>	<b>OPSFTY21 status abnormal</b>
<b>SRVO-381</b>	<b>SERVO</b>	<b>OPSFTY22 status abnormal</b>
<b>SRVO-382</b>	<b>SERVO</b>	<b>OPSFTY31 status abnormal</b>
<b>SRVO-383</b>	<b>SERVO</b>	<b>OPSFTY32 status abnormal</b>
<b>SRVO-384</b>	<b>SERVO</b>	<b>OPSFTY41 status abnormal</b>
<b>SRVO-385</b>	<b>SERVO</b>	<b>OPSFTY42 status abnormal</b>
	[Cause]	A Chain alarm was detected with the OPSFTY signal.
	[Remedy]	Check whether the circuitry connected to the dual input signal (OPSFTY) is faulty. Check whether the timing of the dual input signal (OPSFTY) satisfies the timing specification. Replace the panel board.
	(Note)	To recover from this alarm, chain alarm reset operation is required.
	(Note)	If this alarm is issued, do not reset the chain error alarm until the failure is checked and corrected. If robot use is continued with one of the double circuits being faulty, safety may not be guaranteed when the other circuit fails.



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